

***TomoCon***



*User's manual*

***TatraMed***

# **TomoCon Workstation**

## **TomoCon Viewer**

## **TomoCon Lite**

### **User's Manual**

Version 23

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All patient names used in this manual are fictitious.

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### **TomoCon PACS**

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# 1 General note

## 1.1 *Intended use*

TomoCon PACS is a PACS system designed to be used for patient image data storage, handling, transfer, visualization and diagnostics. The system enables DICOM data import and export and the visualization of stored images for diagnostic purposes.

## 1.2 *TomoCon PACS client applications*

TomoCon Workstation, TomoCon Viewer and TomoCon Lite (hereinafter referred to as TomoCon) are client applications of TomoCon PACS system. All three client applications provide the same basic functionality. The applications also provide advanced functionality that varies depending on the purchased license. Where appropriate, the user is advised of divergence from the basic functionality.

## 1.3 *Medical device class and CE mark*

TomoCon PACS has been classified as a Class IIb medical device, according to Directive MDD 93/42/EEC as amended by Directive 2007/47/EC and has been certified as such. Written declaration of conformity is available on request (see 30 Contact).



## 1.4 *Markings used in this manual*



Mandatory sign indicates the actions or supplementary information that need to be followed or observed in order to minimize risk related to a hazardous situation.



Warning sign indicates possible hazards. Exercise special caution to avoid the dangerous situation and the negative consequences.



Information sign indicates a piece of information of a special interest or for a special consideration.

## 1.5 **Safety precautions**



To use TomoCon for the purpose of diagnostics, appropriate medical education and experience is necessary. TomoCon itself does not replace the expert knowledge of trained medical personnel.



Thorough comprehension of the entire user manual is required prior to the clinical use of TomoCon.



If the system is used by an unexperienced user for the purpose of diagnostics, a serious patient injury or death related to misdiagnosis may occur.



The knowledge of the language of this User's manual and of TomoCon user interface on an adequate level is required.



If the system is used without the proper understanding of the system user interface or the User's manual for the purpose of diagnostics, a serious patient injury or death related to misdiagnosis may occur.



If the system is used in worse than the minimal specified hardware configuration (see 2.1.1 System installation requirements) for the purpose of patient diagnostics, a serious patient injury or death related to misdiagnosis may occur.



Solid understanding of the installation instructions in this documentation (see 2.1.2 Installing TomoCon) is mandatory before installing TomoCon for clinical usage.



If the system is installed by an unskilled system operator and subsequently used for the purpose of the patient diagnostics, a serious patient injury or death related to misdiagnosis may occur.



Diagnosing users should be aware that certain views may display interpolated data. Interpolated data, although based on the original data set, may give the appearance of healthy tissue in situations in which pathology, which is smaller than the scanning resolution, may be present. Occasionally, interpolated data may also include image artifacts, which should not be interpreted as actual pathology.



If the attention is not paid to physical units of measurements performed in TomoCon for the purpose of diagnostics, a serious patient harm or death related to misdiagnosis may occur (see 9 Annotations and measurements).



TomoCon saves images along with personal patient information (when opening in the local database and when exporting from TomoCon). It is important to protect this data from access by unauthorized persons.



If the data is not protected from an un-authorized access, intentional or unintentional modification of the data subsequently used for diagnosis may result in patient harm or death related to misdiagnosis.

### 1.5.1 Network security requirements

It is strictly recommended to use TomoCon only within a secured network environment. It is assumed that a secured network environment includes the following at the very minimum:

- Firewall or router safeguards to ensure that only approved external hosts have network access to TomoCon.
- Firewall or router safeguards to ensure that TomoCon has network access only to approved external hosts.
- Any network communication with external hosts outside the local secured network uses appropriately secure network channels (e.g. Virtual Private Network (VPN)).

## 2 Getting started

### 2.1 *Installing and uninstalling TomoCon*

#### 2.1.1 **System installation requirements**



TomoCon requires the following hardware and software as minimal configuration.

##### 2.1.1.1 **Hardware requirements**

- **CPU**                      Pentium 4, 2.5 GHz
- **Memory**                 2 GB
- **CD-ROM**
- **Hard Disk**              1GB free disk space for software installation (at least 50 GB for patient image data)
- **Display**                 minimum resolution 1280 x 1024 with (32 bit/ true color)

Certified diagnostic monitors have to be used when using TomoCon for diagnostic purposes.

Volume rendering requires Open GL 4.5 compliant graphics card. To choose an appropriate graphics card, contact our customer service (see 30 Contact).

The mammography mode in TomoCon assumes the resolution of the monitors connected to the workstation is at least 3Mpx (recommended: two portrait-oriented mammography monitors both with the same resolution min. 3Mpx).

##### 2.1.1.2 **Additional hardware recommendation**

- **USB port**                      for attaching the protection USB key
- **Network port**                 for data acquisition, connection to PACS systems
- **Backup system**                based on magnetic tape, CD-R or HD media

##### 2.1.1.3 **Software requirements**

Operating System Microsoft Windows XP SP3, Windows Vista SP2, Windows 7 SP1, Windows 8, Windows 10.



### 2.1.2 Installing TomoCon

To install TomoCon:

1. Insert the installation CD into the drive. A window should soon be displayed automatically allowing you to select TomoCon for installation. If the window is displayed, proceed to step 3. If it is not displayed, go to step 2.
2. Run `SETUP.EXE` from the installation CD by double-clicking the 'My Computer' icon on the desktop, then double-clicking the icon of the CD-ROM drive ('D' for example), and finally double-clicking the 'Setup' or 'Setup.exe' executable file.
3. Follow the instructions provided by the TomoCon setup program.

### 2.1.3 Uninstalling TomoCon

To uninstall TomoCon in the Microsoft Windows XP operating system:

1. Click the Microsoft Windows **Start** button.
2. Go to **Settings, Control Panel**, and launch **Add/Remove Programs**. From the list of currently installed programs select **TomoCon**, and click the **Change/Remove**.

To uninstall TomoCon in the Microsoft Windows Vista or 7 operating systems:

1. Click Microsoft Windows **Start** button.
2. Go to **Control Panel**, and launch **Uninstall a program**. From the list of currently installed programs select **TomoCon**, and click the **Uninstall**.

To uninstall TomoCon in the Microsoft Windows 8 or 10 operating system:

1. Go to **Start** screen by pressing Windows key, and right click on **TomoCon** icon.
2. Click on the **Uninstall** item in the **Options** part.
3. Follow the uninstalling steps, and remove the application.

### 2.1.4 TomoCon Workstation License administration

License administration is an application for managing the licenses for TomoCon Workstation (see Figure 1). It can be launched from TomoCon Start Menu or from the **Licenses** dialog in TomoCon Workstation (2.1.5 TomoCon Workstation licenses).

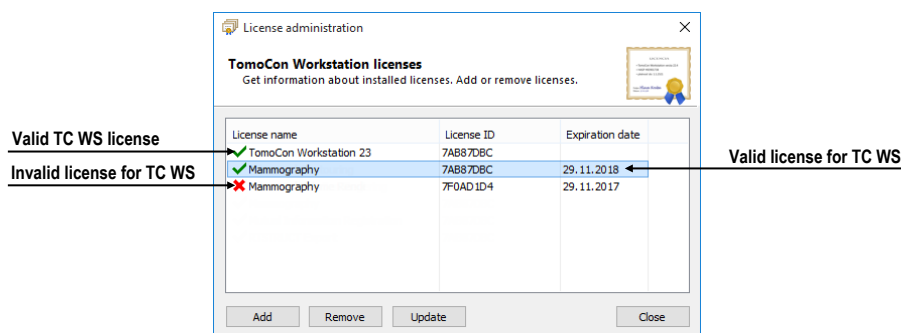
TomoCon Workstation provides the following licenses which can be installed or removed using the License administration application:

- TomoCon Workstation version
- MIR – Mutual Information Registration license (see 18.1.6 MIR)
- RTSTRUCT Export - License for saving RT structures in the DICOM format



After installing a license for RT structures all studies containing RT structures must be resaved (opened in TomoCon and saved again).

- Advanced Contouring license - for contouring using advanced Bolus and Margin tools (see 10.8.7 ROI margin drawing tool and 10.8.8 Bolus ROI defining drawing tool). This license includes the license for saving RT structures in the DICOM format.
- Mammography – license for the special diagnostic mode and workflows for the examination of mammographic studies (see 28 Mammography mode)



**Figure 1 – License administration**

To install licenses in TomoCon Workstation:

1. Launch **License Administration** application from TomoCon Start Menu (Microsoft Windows 7 or lower) or from **Start** screen (Microsoft Windows 8, 10) or from the **Licenses** dialog in TomoCon Workstation.
2. To install licenses from a file, click the **Add** button and select the license file in the **Open file** dialog. Each license file is generated for a USB hardware key that has to be plugged in. New licenses are installed only if the license file is valid for the connected USB hardware key.
3. A license file can include one or more license types. All the licenses are installed automatically. The licenses installed previously that are not included in the license file are for this hardware key removed.
4. To update TomoCon licenses for all currently connected hardware keys, click **Update** button in the License administration tool. The licenses are downloaded via the Internet (providing the connection is available) and automatically installed.

5. To remove an installed license from TomoCon Workstation, select the required license from the list and push the **Remove** button in the License administration tool.

TomoCon Workstation needs to be restarted to apply the license changes.

### 2.1.5 TomoCon Workstation licenses

To view all licenses installed in TomoCon Workstation:

1. Select the **Licenses...** item in the **Help** menu.
2. The **Licenses** dialog (see Figure 2) listing the all installed licenses including currently invalid will be displayed. To install new or remove existing licenses, click the **License administration...** button and follow the steps outlined in the previous section.

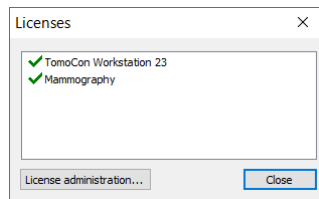


Figure 2 – Licenses dialog

### 2.1.6 Installation verification

To verify the installation process of TomoCon Viewer or TomoCon Workstation:

1. Install the application.
2. Check whether the icon of the application has been placed on the Microsoft Windows desktop.
3. Check whether the application shortcut is included in the Microsoft Windows installed applications.
4. Launch the application, and carry out the following steps in TomoCon:
  - If the application is being installed for the first time (it is not an upgrade), the **Select TomoCon Language** dialog will be displayed. Select the language, and click **OK** button.
  - If the DICOM receiver is not properly configured, the warning message “Could not start DICOM receiver” will be displayed. The reason could be that the TomoCon DICOM receive port is being used by another application. Click **OK** button.
  - Check that the main application window is displayed.

- Select the **About...** item in the **Help** submenu. The **About box** will be displayed.
- Check whether the version number in the **About box** is 23.

## 2.2 Starting TomoCon

To start TomoCon, locate application icon and click on it.

- Microsoft Windows 10:  
Open Start menu or Start screen in Tablet mode, type '*tomocon*' and find the application tile in search results.
- Microsoft Windows 8:  
Open Start screen, type '*tomocon*' and find the application tile on the left side.
- Microsoft Windows 7 and Vista:  
Open Start menu, type '*tomocon*' and find application item in 'Programs' group in search results.
- Microsoft Windows XP:  
Open Start menu, select '*All Programs*', '*TomoCon Workstation*' folder and finally '*TomoCon Workstation*' application item.

The optional start-up parameters are as follows:

- */t* - to start TomoCon in the touch screen mode (see 22 Touch screen mode).
- */m* or *-m* to start the TomoCon mammography mode (see 28 Mammography mode).

To start the TomoCon Workstation, a valid USB hardware key has to be plugged in. TomoCon Workstation cannot be started without the valid HASP key. If there is any problem with the key, TomoCon displays one of the following error messages:

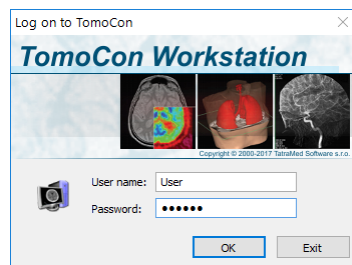
- **TomoCon Workstation license is not valid** – The hardware key is not compatible with the version of TomoCon installed. It is necessary to update the license using License administration application (see 2.1.4 TomoCon Workstation License administration).
- **HASP not found** – Make sure that the USB hardware key is plugged in properly. If the problem persists, contact TatraMed customer support (see 30 Contact); the problem can be one of the following:
  - HASP is damaged,

- The battery in the time hardware key is low, and the key must be changed.

## 2.3 Logging into TomoCon

TomoCon provides the following access authorization possibilities:

- Non-authorized access; TomoCon can be launched by any Windows user logged on computer.
- Authorized access with user name and password; the user needs to enter the user name and password into the **Log On to TomoCon** dialog (see Figure 3) and then click **OK** button to start the application. It is not possible to work with the application without entering the correct name and password.



**Figure 3 – Log On to TomoCon dialog**

## 3 Using TomoCon



The software runs on Microsoft Windows XP, Windows Vista, Windows 7, 8, 10. Good knowledge of the operating system used is recommended.

TomoCon (see Figure 4) consists of the following parts:

- Working area (see 3.1 Working area)
- Tools panel (see 3.2 Tools panel)
- Thumbnail palette (see 3.3 Thumbnails palette)
- TomoCon menu (see 3.4 Main menu)
- Toolbars (see 3.5 Main toolbar)
- Status bar (see 3.6 Status bar)

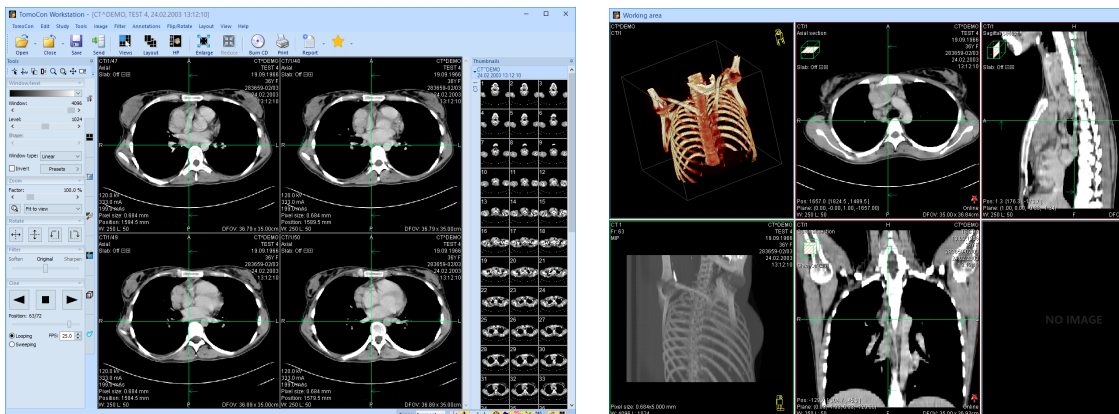


Figure 4 – TomoCon application

### 3.1 Working area

Working area is an area for visualization and diagnostics of patient data (it displays the examination images and other view types like MPR, 3D, etc.). Main working area is bound to main application window. Additional independent variable sized working areas can be created and moved to another monitor.

A new working area can be created by clicking the **Create new working area** item in the **View** submenu. New working area will automatically be created and positioned on the first free monitor.

### 3.1.1 Working area layout

A newly created working area consists of one segment which covers the whole working area, and it can be divided into more views. Segment is a defined part of working area with resizable bounds, and it can consist of either multiple smaller segments (see Figure 5). A working area can be arranged into desired layout by dividing segments and defining view layout for each of them (a newly created segment contains one view by default). The existing layout can be changed anytime by resizing, adding or deleting segments defined previously. This way all kinds of layouts can be created for viewing and diagnosing.

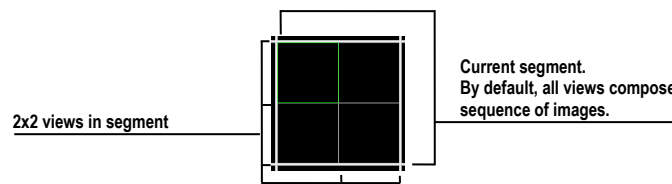



Figure 5 – Views in a segment

TomoCon allows defining the desired layout in a simple and quick way by using the tools docked in the **Define layout** tab in the tools panel. **Define layout** tool dialog (see Figure 6) is initially docked in the tools panel as the tab with the  icon. All these functions are also available via the **Layout** system menu.

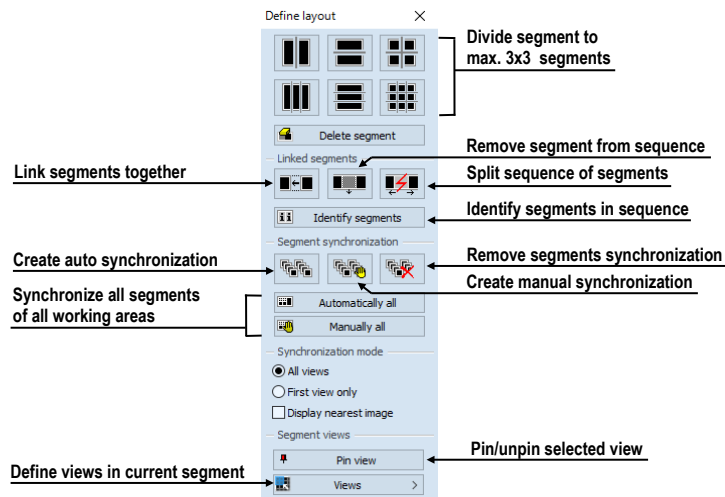


Figure 6 – Define layout tool dialog


To split an existing segment into smaller segments (see Figure 7a):

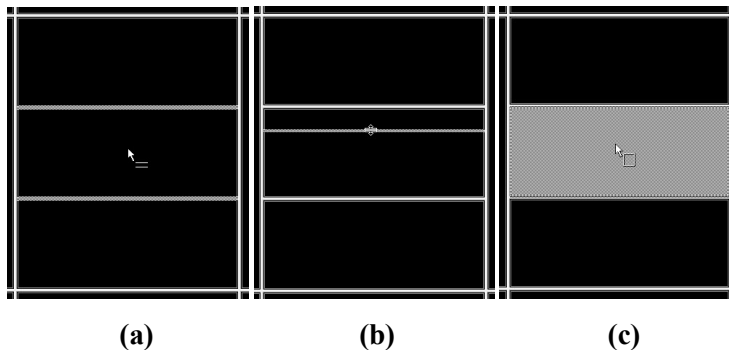
1. Select the requested layout type from the top of the **Define layout** dialog.
2. Click on the selected segment to divide.

Segments are divided by thick moveable separation lines. Size of each segment can be modified by dragging and moving them with the mouse cursor (see Figure 7b):

1. Move the mouse cursor to the segment boundary (separation) line to be moved.
2. Push down the left mouse button, move the line to the requested position, and release the mouse button.


To remove existing segment/segments (see Figure 7c):

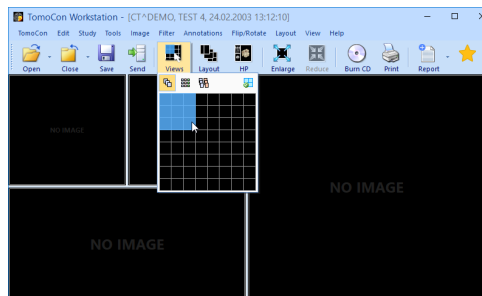
1. Click  **Delete segments** button in the top part of the **Define layout** tool dialog.
2. Move the mouse cursor to the segment/segments to be deleted (the segment/segments will be marked with white color), and click the left mouse button.



**Figure 7 – Definition of segments in working area - divide segment (a), move boundary of segment (b), delete segment (c)**

Once the layout of segments is defined, the layout of the views in each segment can be changed follow these steps (see Figure 8):

1. Select the segment by clicking into it.
2. Click  **Views** button in the **Segment views** section of the **Define layout** tool or in the main toolbar.
3. Select requested layout of views in grid.
4. Select the new desired display mode for the current segment (stack, matrix, all mode, 6.2 Segment display mode) in the toolbar above the grid selector.



**Figure 8 – Definition of views in a segment**



### 3.1.2 Organizing layouts

The layout of the working areas, segments and views can be stored for future use. Application allows managing the layouts in the following lists:

- **Recent layouts** - list of four recently used layouts.
- **Favorite layouts** - list of favorite layouts; any of the saved layouts can be added into or removed from this list with **Layouts manager**.
- **Other layouts** - list of other layouts, which are not in the favorite list. From this list any layout can be moved to **Favorite layouts** list.

#### 3.1.2.1 Save layout

To save the current layout:

1. Click the **Add layout...** item in **Layout** menu.
2. Enter the new layout name in the **Add layout** dialog (see Figure 9), and click **Add** button. New layout will be automatically added to **Other layouts** list using the name entered.

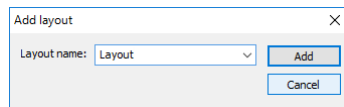




Figure 9 – Add layout dialog

#### 3.1.2.2 Load layout

To load a saved layout:

1. Click  **Layout** item in the main toolbar (see Figure 10a) or the **Favorite**, **Recent** or **Others** buttons (see Figure 10b) in the **Layouts** tool of the tools panel (the tab with the  icon).
2. Select the desired layout in the displayed window.

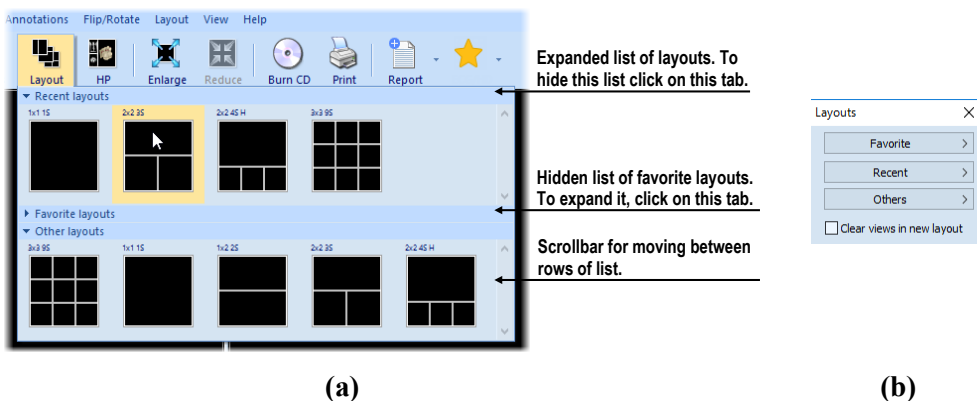


Figure 10 – Layouts list (a), Layouts tool (b)

### 3.1.2.3 Layouts manager

Layouts manager allows changing elementary properties of saving layouts using **Layouts manager** dialog (see Figure 11).

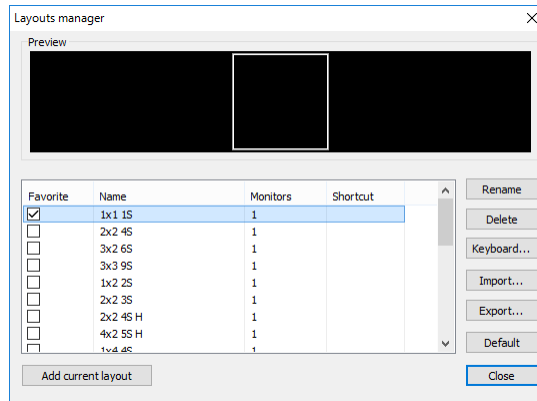


Figure 11 – Layouts manager dialog

Layouts manager can be launched by selecting **Layouts manager...** item in **Layout** menu. Individual layouts can be deleted (**Delete** button), renamed (**Rename** button) or moved from/to the list of favorite layouts (**Favorite** check box).

### 3.1.3 Current view

Current view is the most recently selected view from all working areas. A view is selected by clicking any mouse button while the mouse cursor is over the view. Subsequent actions apply to the current view. To change the current view, is sufficient to move the mouse to another view and again to press any button mouse. Current view (see Figure 12) is outlined with a colored frame according to the TomoCon settings (see 4.4 Color and style options).



Figure 12 – Working area

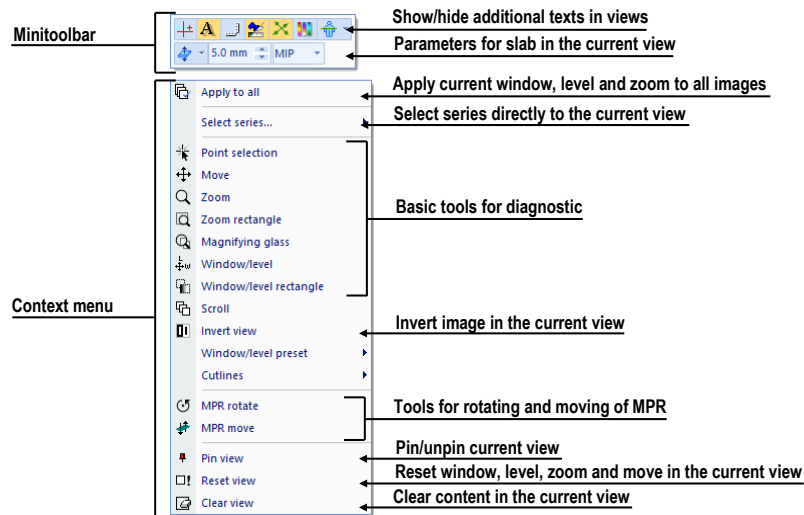
### 3.1.4 View context menu

View context menu is a popup menu that can be invoked by right-clicking in the current view. It offers the most frequently used set of commands and tools to be performed directly in the current view. An extra floating mini-toolbar is shown together with the context menu at the top. Use mini-toolbar to show or hide

information objects in the current view (ruler, texts, current point) and to control the slab projection properties in the current view.

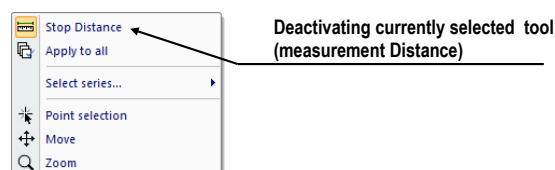
To apply a command or tool from the context menu:

1. Right-click within the area of the current view.
2. Select the command or tool from the context menu (see Figure 13). The context menu will hide automatically, and selected command will be performed, or selected tool will be activated in the current view.



**Figure 13 – View context menu with mini-toolbar**

When a tool is active in a view, the context menu shows an additional the **Stop...** item (at the top of context menu) to stop the tool easily (see Figure 14). Alternatively, a keyboard shortcut can be used to deactivate selected tool (for defining keyboard shortcuts see 4.5 Keyboard shortcuts). The **Stop...** item does not appear only when there is no active tool.



**Figure 14 – Deactivating currently selected tool**

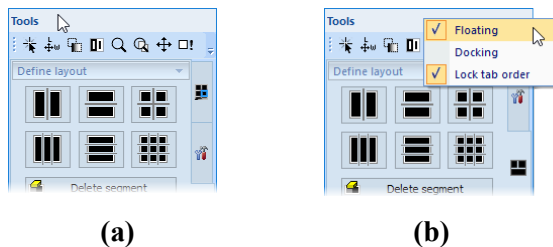
## 3.2 Tools panel

Tools panel contains basic tools for effective viewing images and performing diagnosis. It is highly configurable, and its tools dialogs can easily be moved around, hidden and shown or selected.

It can be useful for maximizing the actual working area. Tools panel can be placed at any position on the screen in floating state or docked to the left or right side of the main workspace. The panel is docked to the left side by default.



To undock a panel and:

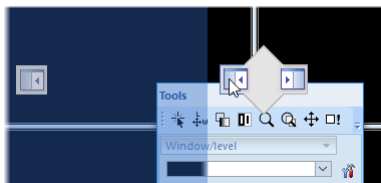
- make it floating by using the drag and drop method - drag the panel's title bar (see Figure 15a), and move the panel to a new position on the screen, then release the mouse button.
- restore its last floating position - right-click the tools panel title bar, then select **Floating** in the context menu (see Figure 15b).



**Figure 15 – Undock the Tools panel by drag & drop (a), by context menu (b)**


To re-dock tools panel:

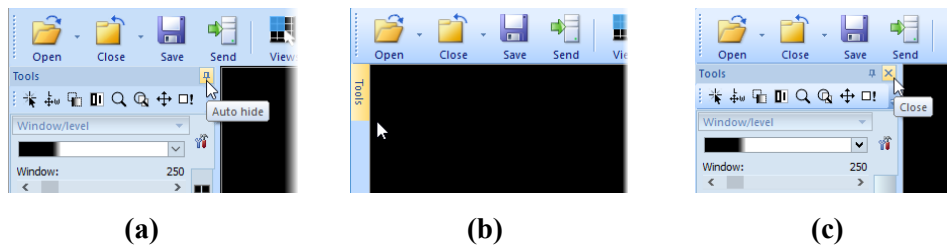
- to last docked position - right-click tools panel title bar, then select the **Docking** in the context menu (see Figure 15b).
- at a new dock position - drag the panel's title bar and move the panel. While moving the tools panel, docking navigators   are displayed in the application window showing available docking positions for the panel. Moving the mouse cursor over any of the docking navigators highlights the new docking position (see Figure 16). To dock the panel, just release the mouse button while the cursor is placed over the navigator.




**Figure 16 – Docking the Tools panel to the left edge**

To maximize the workspace area, the whole tools panel can be hidden permanently, or the auto-hide mode can be selected in which the tools panel is represented by only a thin bar on the main window edge.

To activate the auto hide mode, click  icon in the right corner of tools panel title bar (see Figure 17a). When the mouse cursor is moved over the bar (see Figure 17b), tools panel is automatically displayed and any of the docked tools can be used. To automatically hide tools panel again, move the mouse cursor outside the panel.



**Figure 17 – Turn on auto hide mode of the Tools panel (a), display hidden panel (b), close the Tools panel (c)**

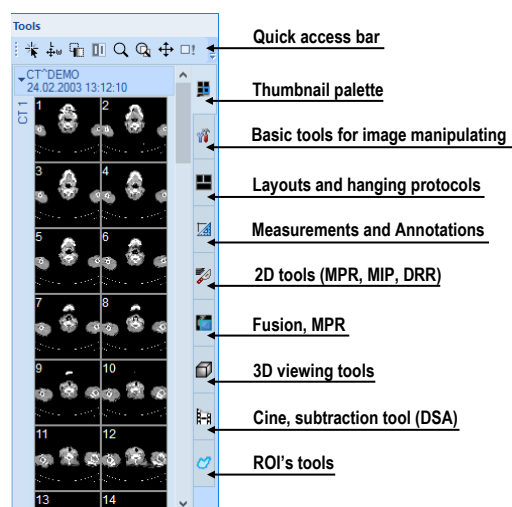
To permanently hide tools panel, click  icon in the right corner of tools panel title bar (see Figure 17c). The panel can be displayed again by clicking **Tools panel** in the **View** submenu.

### 3.2.1 Navigating through the Tools Panel

Tools panel (see Figure 18) is easy structured dialog and consists of three parts. First part is quick access toolbar and second part is title bar. Third the main part shows selected group of tools for viewing the images and performing diagnosis. The tools are organized into labeled sections for easy tool selection. One section represents the thumbnail palette. Each section is organized as a separate tab page with the tools docked in a specified arrangement.

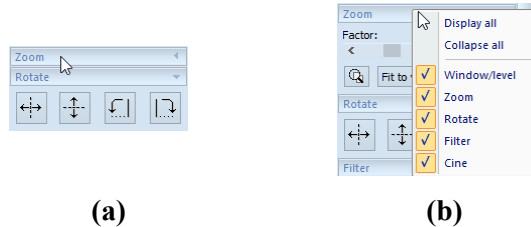
The order of docked tools can be rearranged in each page, and each tool can be individually hidden or undocked from tools panel. Tools panel can be customized to display the tools used most.

Tools for 2D, fusion, 3D, ROIs and Cine/DSA are initially hidden. The tools for 2D, fusion, 3D and ROIs are shown automatically when images with image transformation are available. The tools for Cine/DSA are shown automatically when multi-frame images are available.



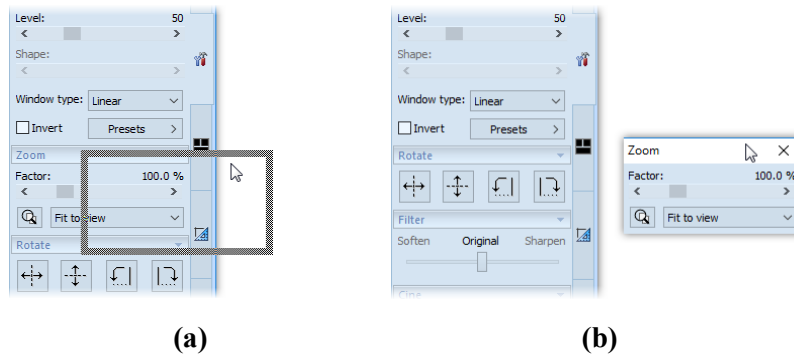
**Figure 18 – Tools panel**

To collapse or display the selected docked tool in the tools panel, click on its title bar (see Figure 19a) or use the tools panel's context menu (see Figure 19b). To display the context menu, right-click any tab page in the tools panel.



**Figure 19 – Collapsed Zoom tool (a), context menu of the tools panel (b)**

To undock selected tool from tools panel, use the drag and drop method. Press the left mouse button on the tool title bar, tool will be displayed as an empty frame (see Figure 20a), and drag it to a new position on the screen. Then release the mouse button on a preferred position (see Figure 20b).




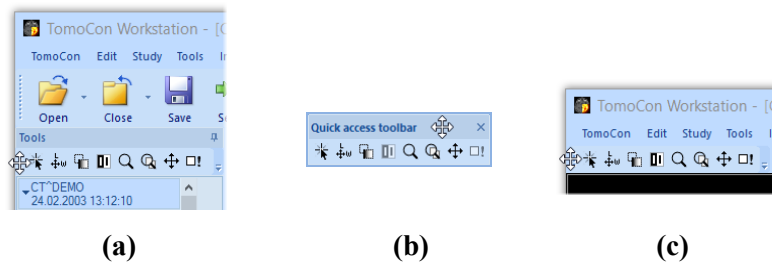
**Figure 20 – Undocking the Zoom tool (a), undocked Zoom tool (b)**

To dock a tool to the tools panel, press the left mouse button on the tool dialog's title bar, drag it to tools panel on a preferred position and release the mouse button. The tool will be automatically docked to the appropriate tool tab.


### 3.2.2 Quick access toolbar

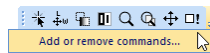
**Quick access** toolbar is a customizable toolbar initially docked to the top of the tools panel. It contains a set of commands selected by user. **Quick access** toolbar can be moved from its initial location in tools panel to any floating position or docked to any side of application window. **Quick access** toolbar can be also moved to another location by drag and drop method.

To undock **Quick access** toolbar from tools panel, press down the  icon in **Quick access** toolbar (see Figure 21a) and drag it to a new position on the screen (see Figure 21b, c). Then release the mouse button on requested position.



**Figure 21 – Quick access toolbar - undocking (a), moving to floating position (b), docking (c)**

Commands can be added or removed to/from **Quick access toolbar** using **Options** dialog which can be launched by clicking  icon in the toolbar and selecting the **Add or remove commands...** item in the context menu (see Figure 22).

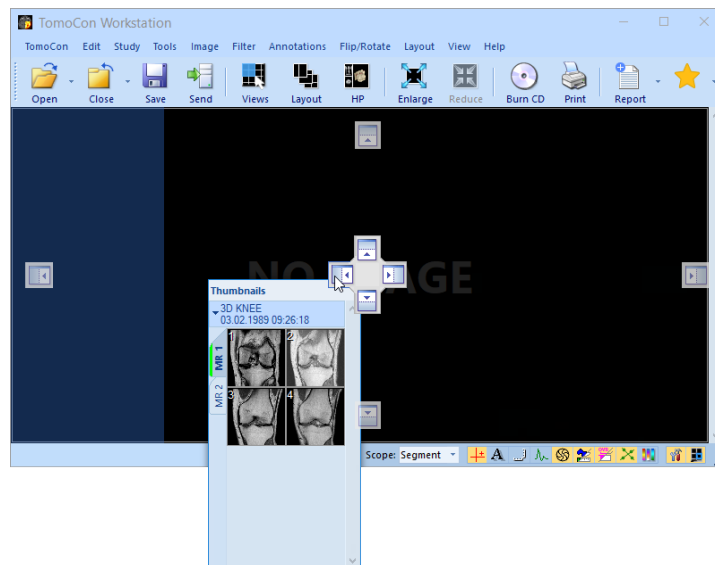


**Figure 22 – Displaying Options dialog to add/remove commands**

To add or remove a command to/from the **Quick access toolbar** using **Options** dialog, see 4.6 Quick access toolbar.


### 3.3 *Thumbnails palette*

Thumbnails palette is a powerful navigation tool for selecting images to be displayed in the working area. Thumbnail previews of all the images from all the open studies are shown in the palette. The thumbnails palette can be resized, docked inside the application border or be placed anywhere on the screen as floating using the drag and drop method. The thumbnails palette is docked in the tools panel by default.





**Figure 23 – Docking thumbnails palette to the left edge of TomoCon**

To dock a thumbnails palette to left edge of the application window:

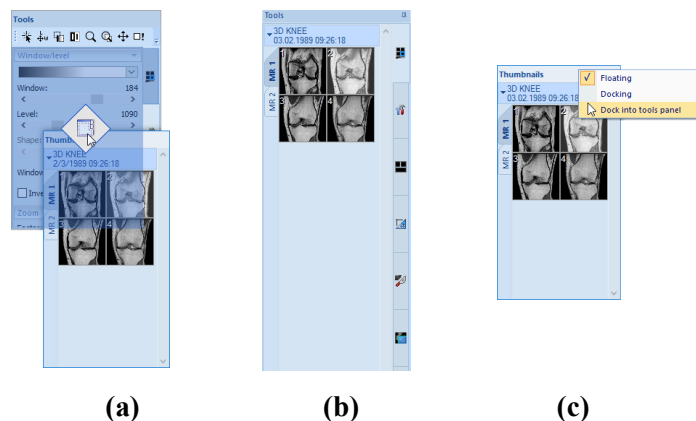
1. Drag the title bar of the thumbnails panel moving the panel over the displayed docking navigators. Each navigator represents a possible docking position.
2. Move the panel over the left docking navigator . A new docking position for the thumbnails palette will be displayed in translucent blue (see Figure 23).
3. Release the mouse button.

To dock a thumbnails palette to the tools panel using the drag and drop method:

1. Press and hold down the left mouse button on the title bar of the thumbnails panel, and drag the panel over the tools panel.
2. A special docking navigator  will be displayed over the tools panel (see Figure 24a).
3. Move the thumbnails palette over the navigator . A new docking position for the thumbnails palette will be displayed in translucent blue (see Figure 24a).
4. Release the mouse button to dock the thumbnail palette (see Figure 24b).


Alternatively, the thumbnail context menu can be used as follows:

1. Right-click the title bar of the thumbnails panel.
2. Select the **Dock into tools panel** item in the context menu (see Figure 24c).



**Figure 24 – Docking thumbnails palette to the tools panel (a), docked thumbnails palette (b), context menu of thumbnails bar (c)**

To undock the thumbnails palette from the tools panel using the drag and drop method:

1. Press and hold down the left mouse button on the thumbnails panel tab with the icon  (see Figure 24b), and drag the panel outside the tools panel.
2. The thumbnails palette will be immediately undocked from the tools panel and can be placed in any desired position.



- To complete the undocking process, release the mouse button.

Alternatively, the context menu of the tools panel can be used:

- Right-click the active thumbnail tab in the tools panel.
- Select the **Undock thumbnail** item in the context menu (see Figure 25).
- The thumbnail bar will be undocked from the tools panel and immediately moved to the last undocked position.

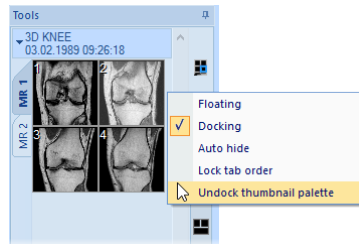


Figure 25 – Undocking thumbnail bar from the tools panel via context menu

### 3.3.1 Working with thumbnails palette

Each study is represented by a tab with the patient name and examination date (the date of study creation) as long as the date is available (see Figure 26a). Below, reduced images (see Figure 26b) of the series are displayed according to the selected series representation type for the study in the thumbnails palette. Selection of the representation type is possible by using the thumbnails palette context menu which opens by right-clicking the selected study in the thumbnails palette and selecting the **Show series** item.

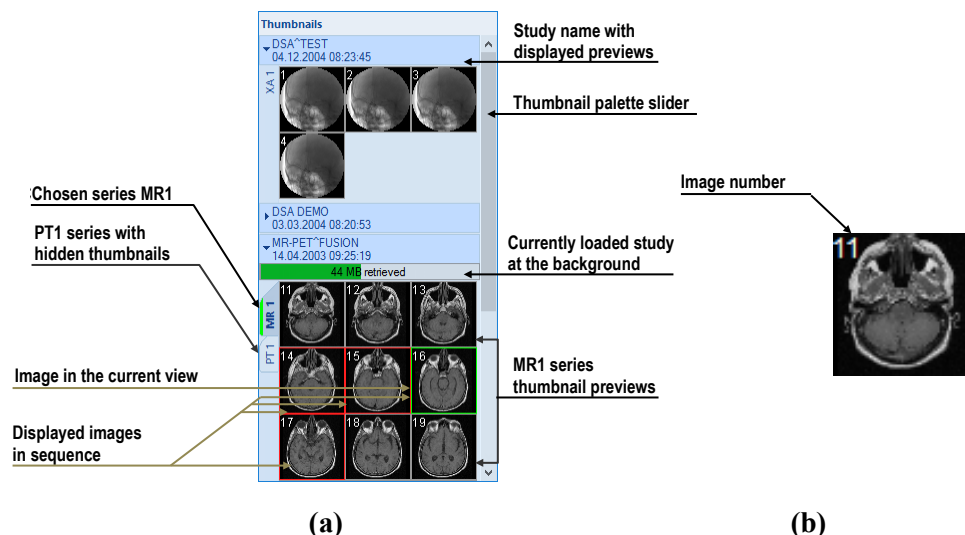
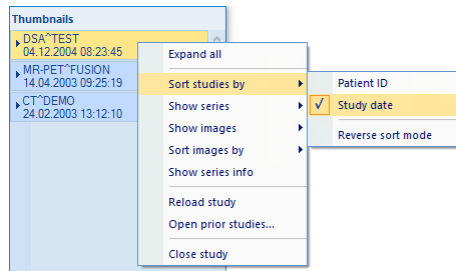


Figure 26 – Thumbnails palette in Tabbed mode (a), image thumbnail (b)

The way, multiple studies are grouped and ordered, can be set using the context menu (see Figure 27). When **Patient ID** is selected, studies are grouped and ordered by

Patient ID. When **Study date** is selected, studies are also sorted by date and time. Patient ID grouping takes precedence – when both **Patient ID** and **Study date** are selected, the studies will be grouped by Patient ID first and then sorted by Study date for each patient independently. If no sorting is selected, the studies are shown in the order of opening. Selecting **Reverse sort mode** sorts the studies in descending order.



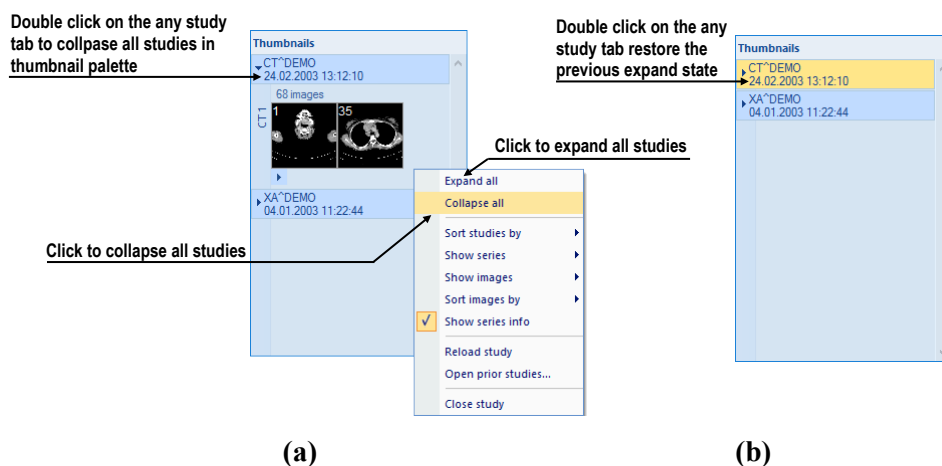
**Figure 27 – Thumbnails palette context menu, ‘Sort studies by’ submenu**

The image thumbnails of each study can be shown or hidden by clicking the study tab. The arrow in front of the patient name indicates the state – it points downwards, when the thumbnails are displayed; when the thumbnails are hidden, it points to the name of study (see Figure 26a).



If a single patient study is open in TomoCon, the thumbnails are always displayed and cannot be collapsed.

It is also possible to hide all studies at once by selecting **Collapse all** item in the context menu or to show them all by selecting **Expand all** item (see Figure 28). By double-clicking any of the study tabs all studies will collapse. To restore the previous state, double-click the study tab again.



**Figure 28 – Thumbnails palette context menu (a), Thumbnail palette with collapsed studies (b)**

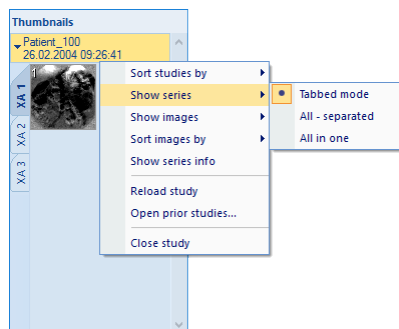
Keyboard shortcuts can be defined for collapse, expand and collapse/expand all actions using **Options** dialog (see 4.5 Keyboard shortcuts).

When opening a new patient study, the first series of the newly open study is automatically expanded in the thumbnail palette. When several studies with displayed thumbnails are opened, may not all fit on the screen. To show the series (thumbnails) that do not fit on the screen, use the scrollbar on the right side of the thumbnails palette.

### 3.3.2 Display options

The thumbnails palette supports three different series representation types for the study (see Figure 29):

- **Tabbed mode** - the selection of the series for which thumbnails are to be displayed is made by pushing the button with the series name in the list of series. Only a single series from the study can be displayed at a given time.
- **All - separated** - the thumbnails of all series of the study are displayed at a given time, sorted according to series.
- **All in one** - the thumbnails of all series of the study are displayed together without division into series.

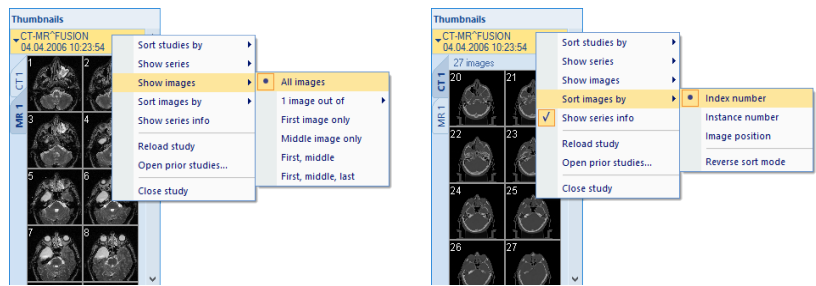


**Figure 29 – Selection of the series representation type in the thumbnail palette**

To select the image representation type in the series, right-click the study tab in the thumbnails palette and select the **Show images** item in the context menu (see Figure 30a).

Thumbnails can be sorted in the Thumbnails palette by selecting the **Sort images by** item in the context menu (see Figure 30b):

- **Index number** – as open
- **Instance number** – by the instance number value in DICOM data
- **Image position** – by the image position
- **Reverse sort mode** – select to show the images in reversed order.

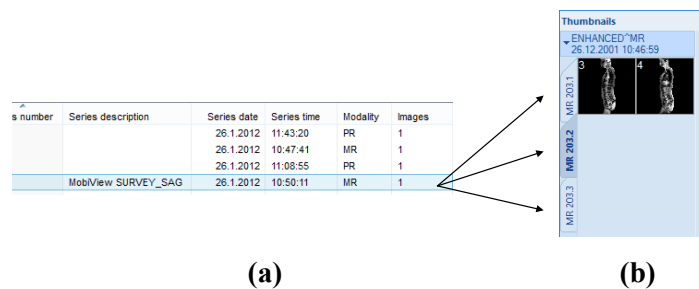


**Figure 30 – Context menu - selection image representation type (a), sorting images (b)**

An additional information about the series – the number of images and the series description – can be displayed on the series' tab. To show this information, select **Show series info** item in the context menu (see Figure 30a).

### 3.3.3 Multidimensional series in thumbnail palette

A multidimensional series is an enhanced series containing multiple items with separate coded routes and timing stored in one object. Each image in such a series is identified by multiple parameters as in standard series (dimension, stack position number, temporary position, etc.). When a multidimensional series is opened, it is automatically divided into separated virtual series according to the enhanced attributes in the DICOM properties in the images. Each virtual series is displayed in the thumbnail palette as a separate tab with the name consisting of the main series number and the virtual series number (see Figure 31).



**Figure 31 – Multidimensional series (a), virtual series in the thumbnail palette (b)**

### 3.3.4 Filtering images with measurements

Thumbnails palette offers a special image filter for quick identification of measurements in the images. It allows showing just the images and MPRs containing one or more measurement(s). If a study contains a measurement (in an MPR or an image), the study header in the thumbnail palette contains the orange filter check box in the right-hand corner.

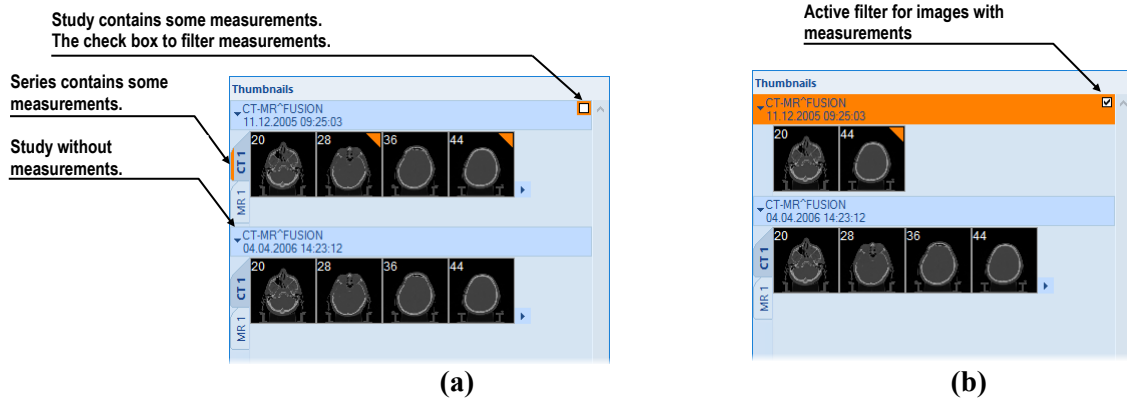


Figure 32 –The thumbnails palette - filter is disabled (a), filter is activated (b)

To filter images with measurements:

1. Click the check box in the right-hand corner of the study header (Figure 32a).
2. Only the images with measurements are displayed (Figure 32b).

### 3.4 Main menu

The majority of TomoCon functionality and features are accessible in the main menu. The main menu provides direct access to all functions for viewing and examining images. As with a typical Microsoft Windows application the items in the main menu are logically grouped into sub-menus. The main menu consists of the following sub-menus:

- **TomoCon** – defining the application settings, printing setup, image data printing (printing on a Microsoft Windows printer or DICOM printer), logging into and out of the application and closing TomoCon (see Figure 33).

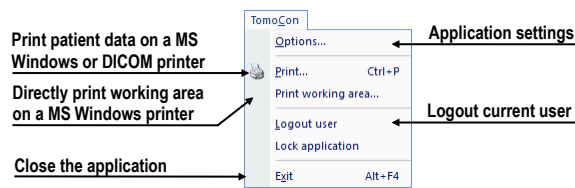


Figure 33 – TomoCon menu

- **Edit** – clipboard operations with images in the current view and the selected ROI contour (see Figure 34).

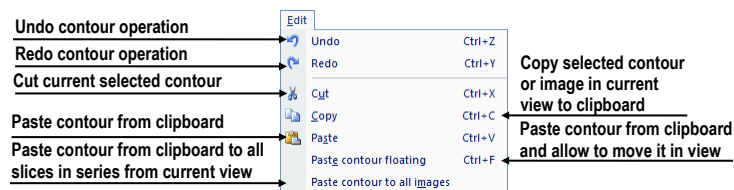


Figure 34 – Edit menu

- **Study** – patient study operations (opening, closing, saving studies, anonymizing, burning and signing studies and exporting images, see Figure 35).

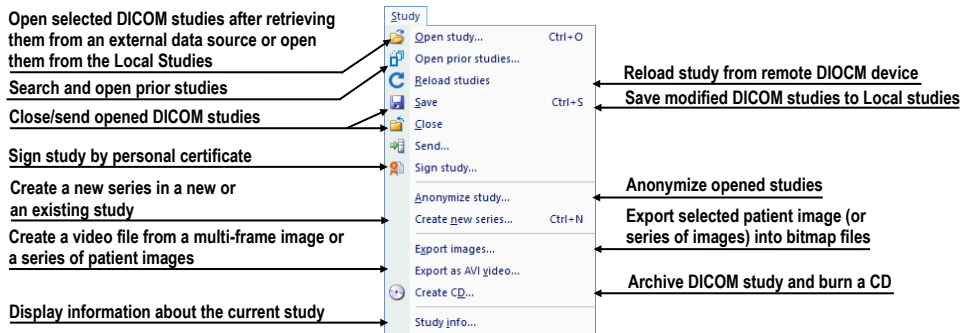


Figure 35 – Study menu

- **Tools** – tools for image data handling such as windowing/zooming, 3D viewing, reconstructed viewing (MPR, MIP, DRR), subtraction (DSA), creating regions of interests and registrations, launching the touch screen and mammography modes (see Figure 36).

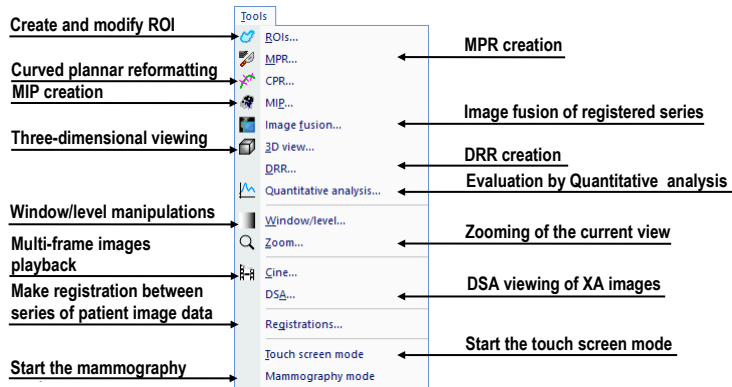


Figure 36 – Tools menu

- **Filter** – filters for image softening or sharpening in the current view (see Figure 37).

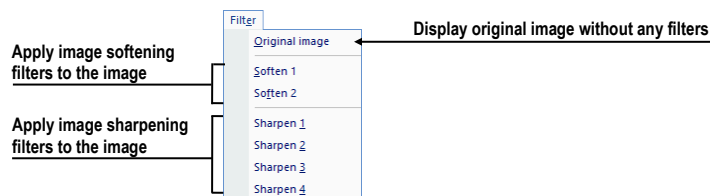


Figure 37 – Filter menu

- **Image** – viewing and handling of the images. Contains a comprehensive group of functions for windowing and zooming images in a view, creating shutters and reading raw DICOM data of images (see Figure 38).

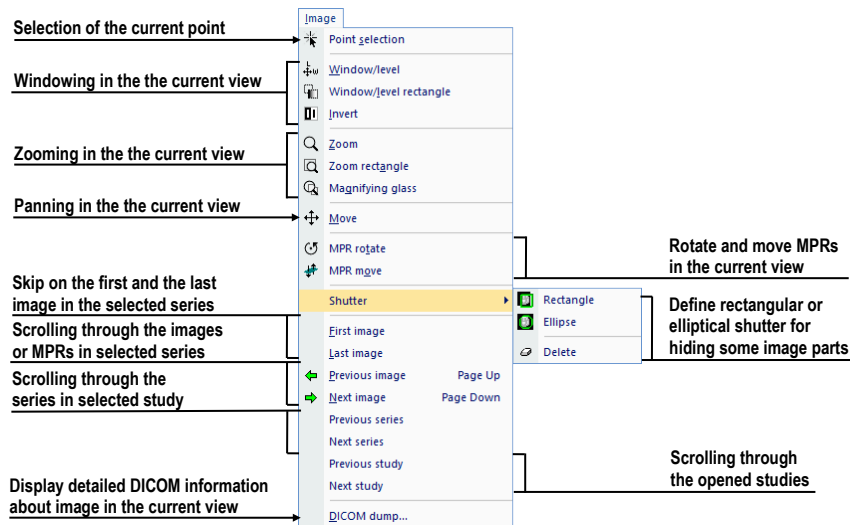


Figure 38 – Image menu

- **Annotations** – functions for annotation management. Creating various types of annotation and measurements in the current view and removing and editing selected annotations (see Figure 39).

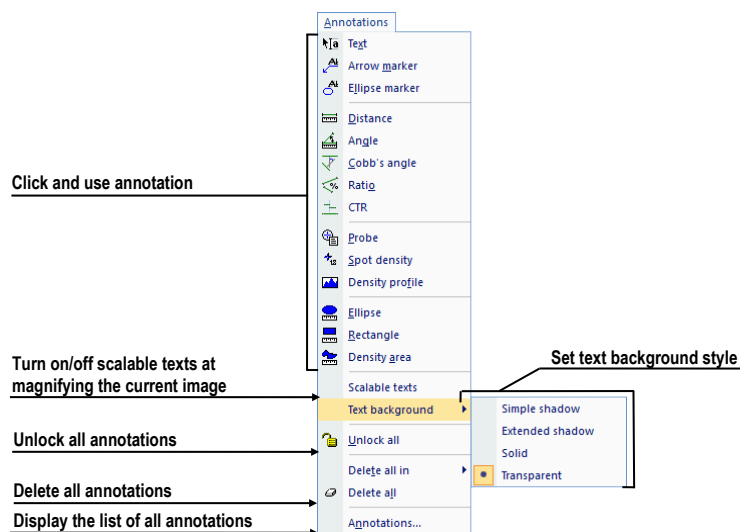


Figure 39 – Annotations menu

- **Flip/Rotate** – flipping and rotating the image in the current view (see Figure 40).

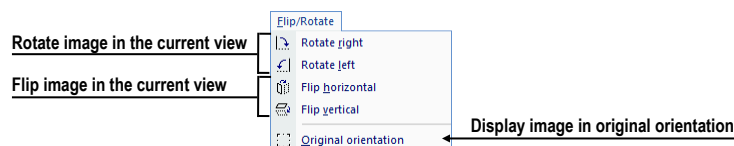


Figure 40 – Flip/Rotate menu

- **Layout** – the functions for managing layouts and hanging protocols, such as creating a layout or hanging protocol, defining sequences or synchronizations, etc. (see Figure 41).

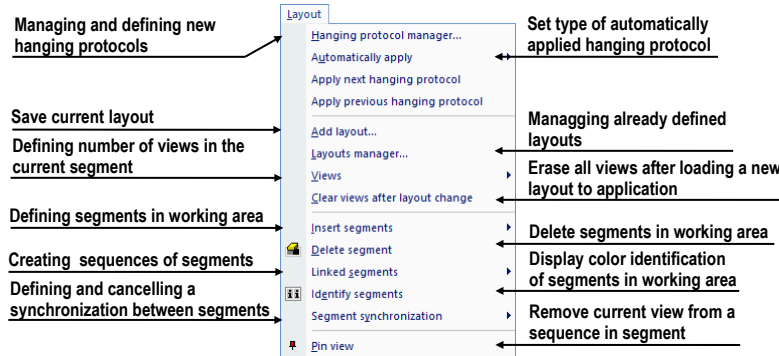


Figure 41 – Layout menu

- **View** – displaying/hiding toolbars, image descriptions, cutlines, reference lines, scrollbars in working areas, changing the current scope, view size, deleting views, creating new working areas or thumbnails palettes and changing the alignment of the images in the views (see Figure 42).

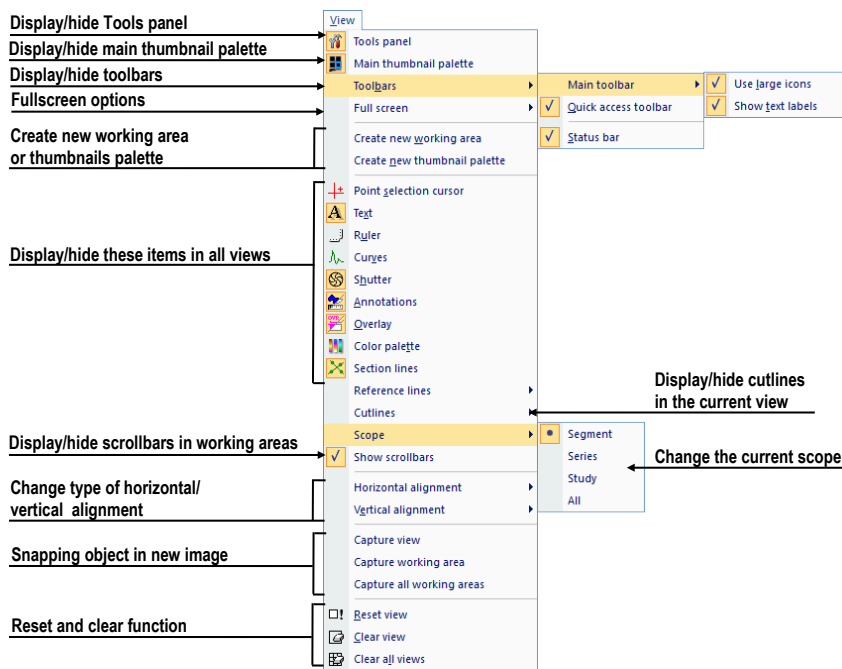
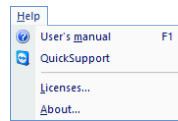


Figure 42 – View menu

- **Help** – displaying the application version, installing licenses and browsing the electronic version of the user's manual (see Figure 43).

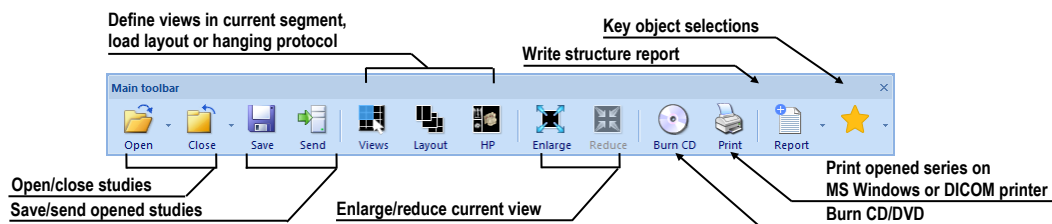




**Figure 43 – Help menu**

### 3.5 Main toolbar

Main toolbar (see Figure 44) is customizable toolbar which contains user selected buttons for frequently carried out tasks. Tools in toolbar are displayed based on the toolbar settings in the **Options** dialog (see 3.5.2 Customizing the main toolbar). The individual tools are visible based on the modalities available in all the open studies.



**Figure 44 – Main toolbar**

To customize the look of the main toolbar (the size of the icons and the display of the description text), use the **View/Toolbars/Main toolbar** submenu of the application menu (see Figure 45).



**Figure 45 – Submenu for customizing the visibility of the main toolbar**

#### 3.5.1 Moving the main toolbar

The main toolbar is docked at the top edge of the application window by default. The toolbar can be freely moved and can either be left freely floating or can be docked to any of the application edges.

To move the toolbar, drag it by the docking line (see Figure 46a) or by the toolbar title in floating state (see Figure 46b).



(a)

(b)

**Figure 46 – Moving of - docked toolbar (a), floating toolbar (b)**

To dock toolbar at any application edge, drag the toolbar over desired position until it is shown as docked, then release mouse button.

### 3.5.2 Customizing the main toolbar

The buttons displayed in the toolbar can be fully customized. Different sets of buttons can be made available according to the modality of open studies.

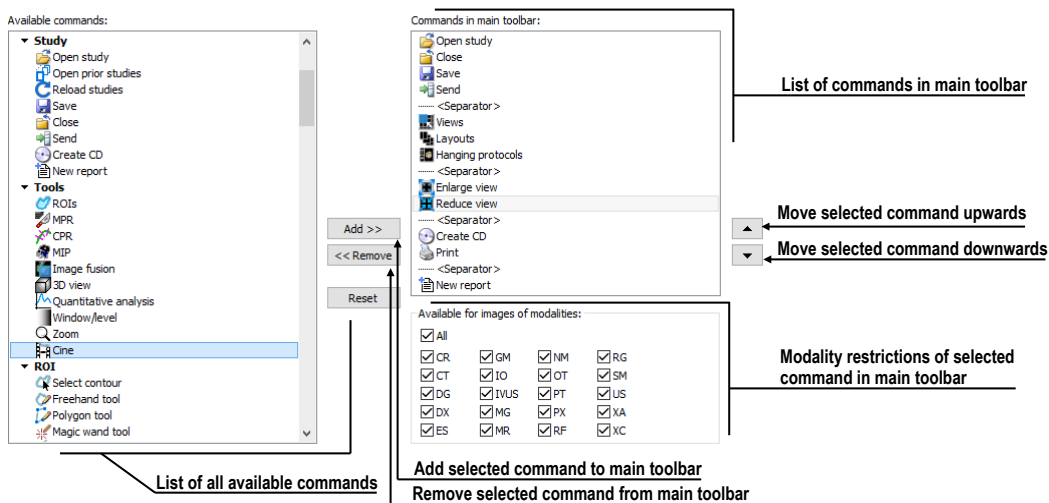
To customize, which commands will be displayed in the toolbar, use **Main toolbar** tab (see Figure 47) in **Options** dialog (select **Options...** in **TomoCon** main menu).

The list of all the available commands is displayed on the left; the list of the command currently selected to the main toolbar is on the right.

The commands can be easily moved between the two lists by mouse. Simply drag a command from a list to other one. The commands newly added to the main toolbar are set to be available for all modalities. To remove a command, it is sufficient to drag the command anywhere outside of the **Commands in main toolbar** list.

The order of commands in the main toolbar is determined by their order in the **Commands in main toolbar** list and can also be changed by dragging them to the requested position in the list.

Alternatively, to add a command to the toolbar, select one of the items in the **Available commands** list and click **Add>>**. The command will be added to the **Commands in main toolbar** list. To remove a command from the main toolbar, select one of the items in the **Commands in main toolbar** list and click **<<Remove**.



**Figure 47 – Main toolbar tab in TomoCon options**

To change the order of the commands in the main toolbar, use ▲ and ▼ buttons. Select the command to be moved in the **Commands in the main toolbar** list and move it upwards using ▲ or downwards using ▼.

To restrict the availability of selected command to certain modalities, use the modality checkboxes below in the **Available for images of modalities** box.

**Open, Save and Close study** commands cannot be removed from the toolbar and are always accessible.



### 3.6 Status bar


The Status bar is a horizontal bar at the bottom of the application window (see Figure 48). It displays the visibility toolbar, the scope panel and the progress of selected current task. It is visible by default and can be hidden if necessary.

To hide/show the Status bar, uncheck/check the **Status bar** item in **View/Toolbars** submenu of main menu.

The main parts of the Status bar are located on its right-hand side:

- **Scope panel** (see 3.6.1 Scope panel) for defining the scope of changes performed in the current view.
- **Visibility toolbar** which allows show/hide selected objects (texts, curves, overlays, measurements) in all views.

If the TomoCon application is receiving or sending studies via queue management, the number of studies remaining to be transferred is displayed on the left-hand side of the Status bar by means of the  or  icon.

If the TomoCon application is printing selected studies on a DICOM printer, the status of the printing tasks is displayed on the left-hand side of the Status bar by means of the  icon.

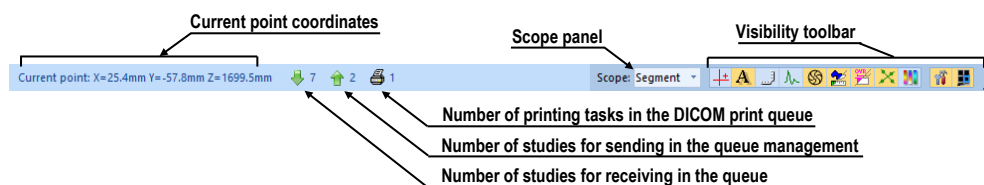


Figure 48 – Status bar

#### 3.6.1 Scope panel

At times, it is necessary to make a change to only one image in the current view of the working area, while at others the change shall apply to all the images in a series/a study or all views at one time. To control the behavior, use the **Scope panel** (see Figure 49) which is always available on the right-hand side of the **Status bar**.

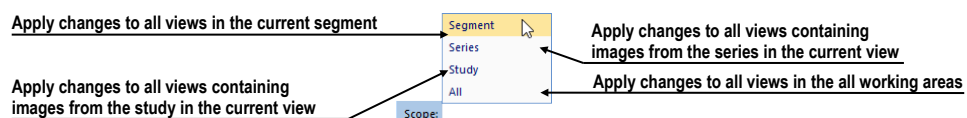


Figure 49 – Scope panel

### 3.7 Coordinate space

To be able to display the image position in the patient coordinate space, a transformation between the images and the actual patient has to be defined.

Once the transformation has been defined, it is possible to calculate the corresponding  $[x, y, z]$  position in the patient's body.

The orientations used in TomoCon are **Anterior**, **Posterior**, **Left**, **Right**, **Head** and **Feet**.

TomoCon coordinate system is as follows:

- $+x$  axis points to the **R** (the right side of the patient, direction left-to-right)
- $+y$  axis points to the **A** (the front side of the patient, direction back-to-front)
- $+z$  axis points to the **H** (the top of the patient, direction feet-to-head)

The coordinates are displayed in millimeters; the angles are displayed in degrees.

#### 3.7.1 Current point

After clicking in an image with the point selection mode activated, the global current point is automatically calculated and is displayed as a colored cross in the current view. When the image in the current view has image, transformation defined, the current point is calculated as the 3D point in the current series and is displayed with the colored cross in all the views related to the current view (see Figure 50).

The current point indication is displayed as a large cross (through the whole view) using red color by default. The style and color of current point representation in views can be changed in **Options** dialog (see 4.4 Color and style options).

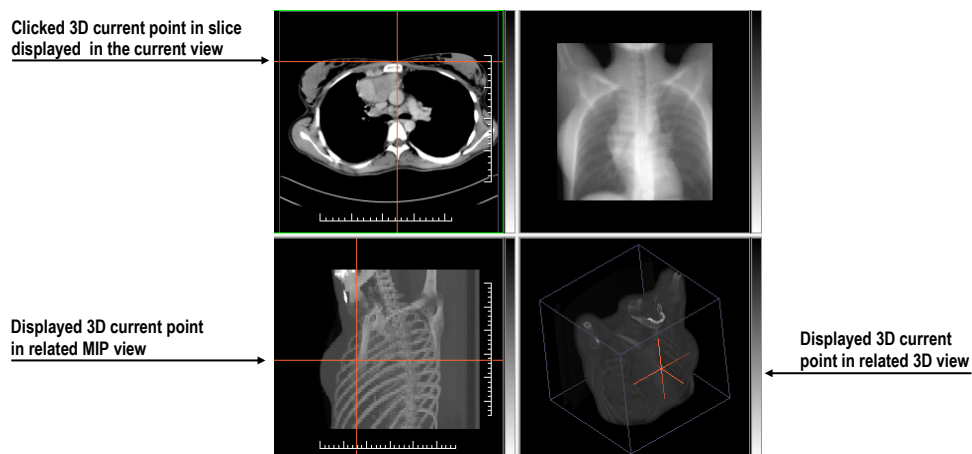


Figure 50 – Displayed 3D current point

### 3.7.2 Limits of accuracy in measurements

The image pixel size affects the precision of all measurements.

In 2D measurements, the precision is a function of the pixel size:

$$D = D_m \pm \sqrt{2} \cdot P_s$$

where  $D$  is distance,  $D_m$  is the measured distance and  $P_s$  is the pixel size.

$$S = S_m \pm 4 \cdot \sqrt{S_m} \cdot P_s$$

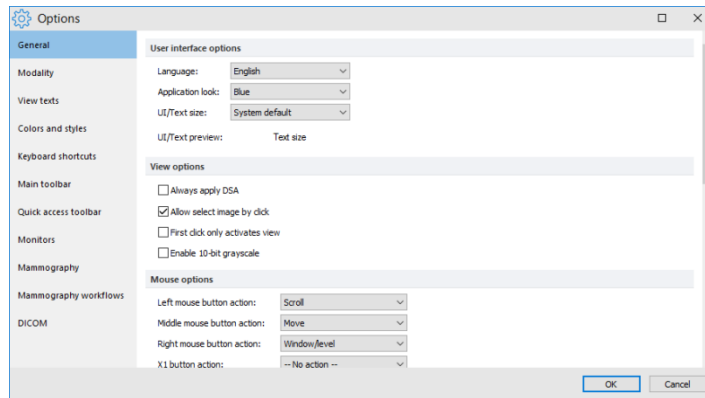
where  $S$  is area,  $S_m$  is the measured area and  $P_s$  is the pixel size.

## 4 Setting up the application

TomoCon provides the possibility to customize the default behavior using the **Options** dialog. Options that can be changed are grouped into several categories (general settings, shortcuts, modality settings, display features, etc.).

To display **Options** dialog, select the **Options...** item in the **TomoCon** submenu of the application menu (see 3.4 Main menu).

The **Options** dialog (see Figure 51) consists of two main parts. The left side displays the category names, while the right side displays the options available in the selected category. The options of the selected category having a similar task or functionality are categorized under a heading on the right side.



**Figure 51 – TomoCon options dialog**

The **Options** dialog allows setting up options in the following categories:

- **General** – for setting up the general application options (see 4.1 General options)
- **Modality** – for defining modality-dependent settings (see 4.2 Modality options)
- **View Texts** – for displaying/hiding text types in views (see 4.3 View texts)
- **Colors and styles** – for setting the color of the objects displayed in the views (see 4.4 Color and style options)
- **Keyboard shortcuts** – for the creation of shortcuts (see 4.5 Keyboard shortcuts)
- **Main toolbar** – for configuring buttons in the Main toolbar (see 3.5.2 Customizing the main toolbar)
- **Quick access toolbar** – for configuring buttons in the Quick access bar (see 4.6 Quick access toolbar)

- **Monitors** – for calibrating monitors (see 4.7 Monitors)
- **Mammography** – for configuring the settings of the mammography mode (see 4.8 Mammography)
- **Mammography workflows** – for defining mammography workflows (see 4.9 Mammography workflows)
- **DICOM** – for defining the DICOM settings of TomoCon (see 4.10 DICOM options)

## 4.1 General options

### 4.1.1 Application language

TomoCon allows selecting the application language in the **User interface options** section on the **General** tab of the **Options** dialog (see Figure 52). The language automatically changes when the application is restarted.

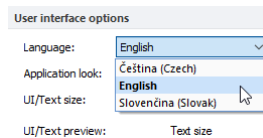


Figure 52 – User interface options section of the General tab

### 4.1.2 Application look

The appearance of TomoCon can be customized according to personal preferences or to correspond to other Microsoft Windows applications.

The application look can be changed by using **Application look** item in the **User interface options** section on the **General** tab of the **Options** dialog (see Figure 53).

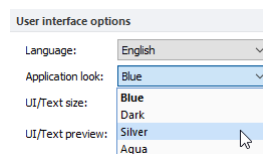
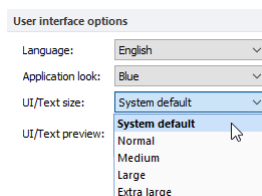


Figure 53 – User interface options section of the General tab

### 4.1.3 Scaling application fonts and dialogs

TomoCon is designed to work with monitors of all resolutions currently in use. The application can work with resolution starting from 1280x1024 up to multi-monitor systems with high resolution. Especially when using monitors with high resolution, the size of the text may need to be adjusted in order to make it legible; on the other

hand, it is also easy to gain more space for viewing on a small monitor this way. To change the size of the text used in all windows (dialog boxes, menus, etc.), change the scale degree of TomoCon GUI in the **User interface options** section on the **General** tab of the **Options** dialog (see Figure 54).



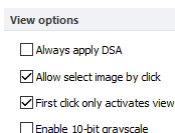
**Figure 54 – User interface options section of General tab**

In order to change the scale of text used in TomoCon, select the desired size from the combo box (see Figure 54) where all the available text sizes are listed ordered by size (**System default**, **Normal**, **Medium**, **Large**, **Extra large**). A preview of the selected size is automatically displayed underneath the combo box (**Text preview**). In order to apply the new settings, restart TomoCon.

#### 4.1.4 View options

These view settings can be adjusted in the **View options** section on the **General** tab of the **Options** dialog (see Figure 55):

- Turn on/off DSA mode automatic activation (**Always apply DSA**) – as long as the image in the current view contains DICOM structure for DSA.
- Turn on/off the option of image selection in the current view by clicking the image in the thumbnails palette (**Allow select image by click**).
- **First click only activates a view** – if checked, clicking in an inactive view makes the view active. If this check box is not selected, the view becomes active and the selected action is carried out immediately as well.
- Turn on/off 10-bit grayscale (**Enable 10-bit grayscale**) – this allows seeing more detail in views when doing diagnostic work with very dark and very light images.

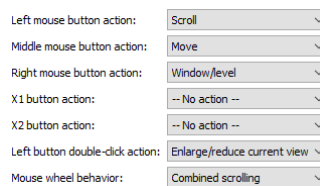


**Figure 55 – View options section of the General tab**



### 4.1.5 Mouse options

All TomoCon functions are designed to make maximum possible use of standard mouse buttons. The application allows customizations of the mouse by mapping predefined actions for mouse buttons as well as for scrolling wheel. The configured actions will be active anytime corresponding mouse button is pressed. The mapping can be done in the **Mouse options** section on the **General** tab of the **Options** dialog (see Figure 56).



**Figure 56 - Mouse options in General tab**

In addition, to the selected action standard behavior is retained for:

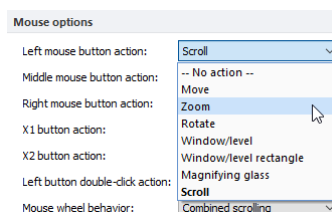
#### Left mouse button:

- Select items (a study, image in the thumbnails palette, current view, etc.).
- Click (a button, menu item, etc.).
- Carry out a primary action (window/level, zoom, etc.). A primary action is an action selected in the current view and is always activated by pressing the left mouse button. When you release the left mouse button, the primary action is deactivated.

#### Right mouse button:

- Display the context menu of the current view in the working area.
- Display the context menu of any window (tools panel, thumbnails palette, etc.).
- Select a group of images in Thumbnails palette.

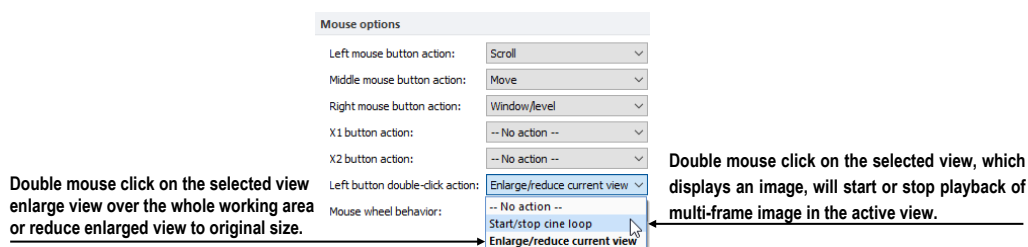
To map a predefined action for the left mouse button, click the **Left mouse button action** combo box (see Figure 57). The list of all possible actions is displayed. Select the required action. To cancel mapping, click on the **-- No action --** item in the combo box.



**Figure 57 – Selection of left mouse button action**

The action can also be defined for the middle button, the right button or two extra mouse buttons when using 5-button mouse.

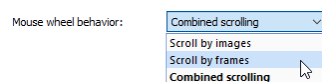
To define the behavior of left mouse button, double-click in current view and select the item from the list of predefined functions in the **Left button double-click action** combo box (see Figure 58). To cancel a mapping for a mouse button select -- **No action** -- in the combo box.



**Figure 58 – Mapping action for left mouse double-click**

To define the behavior of mouse wheel, click the **Mouse wheel behavior** combo box (see Figure 59). The list of all possible scrolling types is displayed with these options:

- **Scroll by images** – scrolling through the images within the series in the current view.
- **Scroll by frames** – scrolling through the images of multi-frame image in the current view (the function is not available for single images).
- **Combined scrolling** – scrolling through single and multi-frame images in the current view within the series.



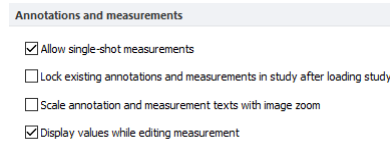
**Figure 59 – Mouse wheel behavior combo box**

#### 4.1.6 Annotations and measurements options

These view settings can be adjusted in the **Annotations and measurements** section on the **General** tab of the **Options** dialog (see Figure 60):

- **Allow single-shot measurements** - when the process of measurement definition in the current view is complete, the current view mode with the selected measurement type is automatically turned off.
- **Lock existing annotations and measurements in study after loading study** - if checked, all annotations and measurements in a study will be automatically locked after the study is loaded. Otherwise only annotations and measurements with 'locked' flag set explicitly will be locked.

- **Scale annotation and measurement texts with image zoom** - if checked, annotation and measurement texts are scaled according to image zoom while the image is zoomed in/out. Otherwise the size of the texts remains the same.

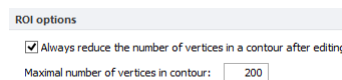


**Figure 60 – Annotations and measurements options section of the General tab**

#### 4.1.7 ROI options

The **ROI options** section (see Figure 61) on the **General** tab of the **Options** dialog allows setting up selected parameters to be used for ROI contours. The settings only apply to contours drawn or modified.

To simplify the contour of a ROI to a certain maximum number of points after editing, select the **Always reduce the number of vertices in a contour after editing** option and enter the number of vertices desired in "**Maximal number of vertices in contour**".



**Figure 61 – ROI options part in General tab**

#### 4.1.8 Confirmations

The **Confirmations** section (see Figure 62) on the **General** tab of the **Options** dialog allows suppressing the display of many confirmation dialogs which are displayed before TomoCon executes some actions.

- **Ask "Close currently opened studies?" before opening new study**
  - Checked* Confirmation dialog is displayed when a new study is going to be opened.
  - Unchecked* The currently opened studies are not closed when new study is opened.
- **Ask "Delete annotation" before deleting highlighted annotation by Delete key**
  - Checked* The confirmation prevents deleting annotation by randomly pressing **Delete** key.
  - Unchecked* The annotation is immediately deleted after pressing **Delete** key.

- **Ask "Do you want to save the changes?" before closing study with modified medical findings**

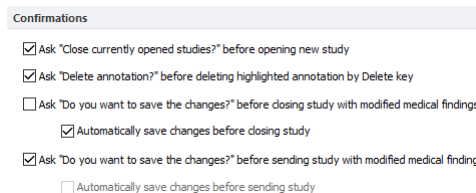
*Checked* The confirmation dialog is displayed when any changes in medical findings were done and the study is going to be closed.

*Unchecked* The behavior depends on the checkbox “**Automatically save changes before closing study**”. When it is checked, the changes are automatically saved when the study is being closed. When it's not checked, the user is responsible to save changes manually before closing the study.

- **Ask "Do you want to save the changes?" before sending study with modified medical findings**

*Checked* The confirmation dialog is displayed when any changes in medical findings were done and the study is going to be sent to other DICOM device.

*Unchecked* The behavior depends on the checkbox “**Automatically save changes before sending study**”. When it's checked, the changes are automatically saved before sending. When it's not checked, the user is responsible to save changes manually before sending the study.



**Figure 62 – Confirmations part in General tab**

#### 4.1.9 Digital signatures

The **Digital signatures** section (see Figure 63) on the **General** tab of the **Options** dialog allows to define **TSA url**, which will be used as timestamping service in the study signing process.



**Figure 63 – Digital signatures part in General tab**

## 4.2 Modality options

The **Modality** tab (see Figure 64) of the **Options** dialog is used to set up the properties for each individual modality type.

Key	Preset	Type	Window/Low	Level/Up	Shape
F4	Abdomen	WL	350	40	0
F5	Bone	WL	1000	200	0
	Brain	WL	80	40	0
F7	Foramen magnum	WL	1200	250	0
	Larynx	WL	180	80	0
F2	Lung	WL	1250	-500	0
F3	Mediastinum	WL	400	50	0
F6	Os petrosus	WL	1800	250	0

Figure 64 – Modality tab of the Options dialog

These properties can be set up for each modality:

- **Cine and image displaying options:**
  - Defining the default Cine frame rate (**Default frame rate, Use image frame rate**).
  - Specifying the bitmap interpolation mode (**Image interpolation mode**) for image data visualization (**None, Bilinear, Bicubic**).
  - Switching the supersampling function in views on/off (**Enable super-sampling**).
- **Window/level options:**
  - Selecting **Color map** palette and the palette gradation type (**Window type** and **Default shape**).
  - Adjusting the grayscale notation type (**Adjustment type**).
  - Checking the **Automatic background air suppression** check box in order to show the area containing air always as black (despite the window and level changes).
  - Checking the **Smart invert** check box in order to show the area containing air always as black when the colors in the view are inverted.

- **Window/level presets** containing user-defined window/level (or low/up) and shape combinations for each modality. These presets are used in image grayscale settings and can be assigned to F2 to F9 keyboard function keys as accelerators.

To add a new preset, click **Add**. This opens the **Window/Level preset** dialog (see Figure 65) where window, level and shape combinations are set, alternatively keyboard function key can be assigned. A combination selected from the **Window/level presets** list can be deleted by pushing down the **Delete** button or edited by clicking **Edit**. This opens the **Window/Level preset** dialog in which the preset can be changed.

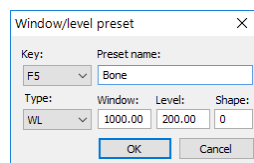


Figure 65 – The Window/level preset dialog

### 4.3 View texts

To define additional information to be displayed along with the predefined texts in the views (see Figure 66), use the **View texts** tab (see Figure 67) of the **Options** dialog. TomoCon provides a pre-configured set of information texts to be displayed on views which is fully user-adjustable per each view type.

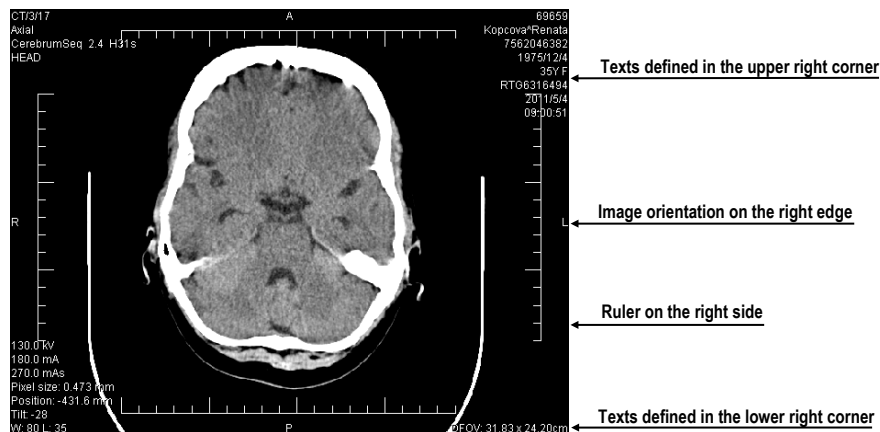
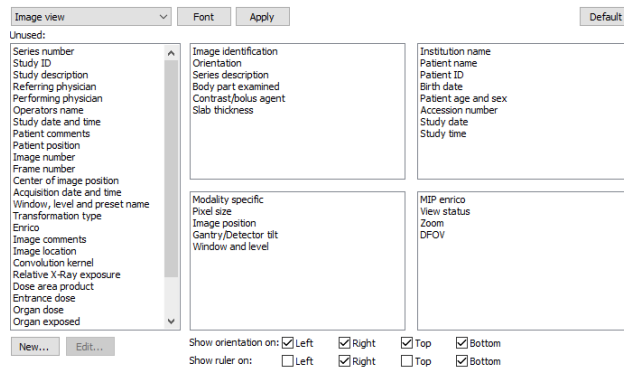


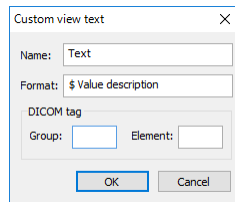
Figure 66 - Displayed view texts in view

To modify the information displayed in views, select a view type to be adjusted. Four identical rectangular areas represent the four view corners where the descriptive texts can be displayed. The area to the left from positioned texts shows the information that is currently unused. The texts can be moved around the areas by dragging and dropping.



**Figure 67 – TomoCon setup dialog, the View texts tab**

To define custom texts to be displayed in a view, push the **New...** button in the dialog, then select a particular DICOM element in **Custom view text** dialog (see Figure 68). Click **OK** to confirm the new information text, and add it to the predefined texts on the **View texts** tab.



**Figure 68 – Custom view text dialog**

Additional types of displayed information – orientation and ruler – can also be defined. Use the check boxes at the bottom to show the ruler and the orientation information at the left, right, top and/or bottom of the view (see Figure 69). The ruler and the position are designed to enhance the identification of the displayed image.



**Figure 69 – Definition of displaying of the orientation and the ruler**

To apply the changes, click **Apply**. To restore the default view texts, click **Default**.

## 4.4 Color and style options

The default colors and styles of certain displayed objects can be changed on the **Colors and styles** tab of the **Options** dialog (see Figure 70).

To change the color of a selected object, click the **Color** button or click the color box in the **Settings** section which indicates current object color. In the subsequent dialog, basic and a user-created color palette can be used to select the desired color from. It is possible to set the line as **Solid**, **Dashed**, **Dotted** or **Dash-dot** at line objects and the text shape as **Simple shadow** or **Extended shadow** at text objects. To restore the default color and style of the selected object, click the **Default** button.

A preview of the object using the newly assigned color or shape is displayed in the **Preview** frame.

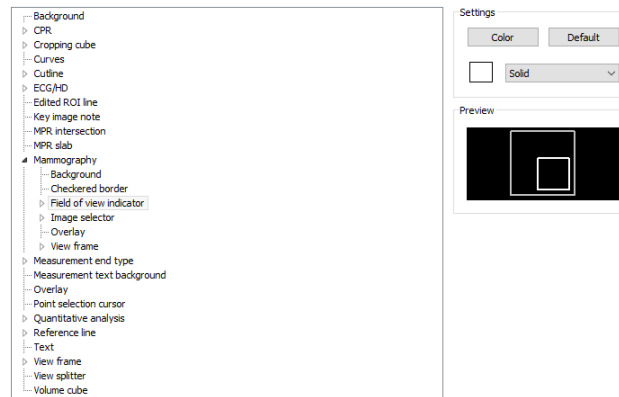


Figure 70 – The Colors and styles tab of the Options dialog

## 4.5 Keyboard shortcuts

Keyboard shortcuts are simple key combinations invoking specific functionality. Using the keyboard can often be much faster than using the mouse. TomoCon provides predefined shortcuts and accelerator keys for many tasks and allows definition of custom shortcuts for all important tasks. Combined, the shortcuts can make work with TomoCon easier, more efficient and user-friendly. Scope of each shortcut can also be defined (the type of view or mode). Identical shortcut can be used for different actions in different view types.

### 4.5.1 Scope

Certain keyboard shortcut can be set in such a way that they are applicable only for a certain type of view or mode while being inactive in another view or mode. For example, **Ctrl+O** shortcut can be used to launch the **Search studies** dialog in the main frame while opening the hanging protocol **Overview** in the mammography frame.

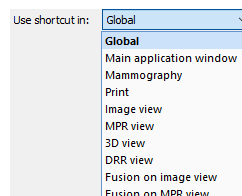


Figure 71 – Shortcut scopes

The shortcut scope (see Figure 71) can be set according to the view type (image, MPR, 3D, DRR, fusion) and/or according to the current window (main application



window, mammography, touch screen mode, print). The **Global** scope for a shortcut means that the shortcut will be accessible in all view types and modes.

## 4.5.2 Managing keyboard shortcuts

TomoCon allows the definition of custom shortcuts using keyboard shortcuts management on the **Keyboard shortcuts** tab of the **Options** dialog (see Figure 72).

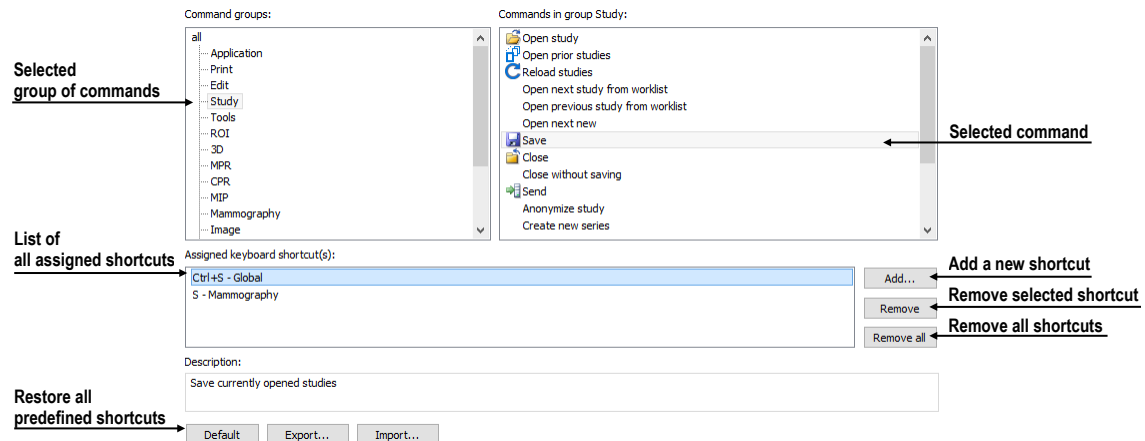


Figure 72 – The Keyboard shortcuts tab of the Options dialog

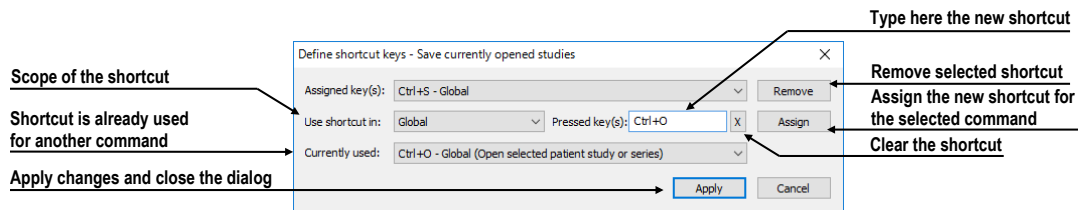
To manage shortcuts in the **Keyboard shortcuts** tab:

1. Browse through the **Command groups** in the list on the left-hand side of the dialog.
2. Select the desired command in the **Commands in group** list on the right.
3. The **Description** box displays a short description of the selected command, and the **Assigned keyboard shortcut(s)** list contains all (if any) shortcuts defined for the selected command.
4. Use the **Add**, **Remove** and **Remove all** buttons to manage the keyboard shortcuts for the selected command.

To create a new shortcut on the **Keyboard shortcuts** tab:

1. Select the desired command group in the list on the left-hand side of the dialog. The list of available commands is displayed on the right.
2. Select the desired command, and click **Add**.
3. The **Define shortcut keys** dialog is then displayed (see Figure 73). Press the key or key combination for the new shortcut. The key or key combination pressed is shown in the **Pressed key(s)** box. To re-select the combination, press the **Backspace** key. The key combination will be cleared, and a new one can be entered.

4. Select the desired scope for the shortcut in the **Use shortcut in** combo box.
5. If the shortcut has already been defined for another command, it is shown in the **Currently used** field.
6. Click **Assign** to confirm the new shortcut. The shortcut is then automatically added to the **Assigned key(s)** combo box. Using this method, any number of shortcuts can be entered for the selected command for use in multiple scopes.
7. Click **Apply** to confirm the changes, or click **Cancel** to discard them.



**Figure 73 - Define shortcut keys dialog**

To remove a previously defined keyboard shortcut:

1. Select the command as described above.
2. Select the shortcut in the **Assigned keyboard shortcut(s)** list box, and click **Remove**. The selected shortcut will be deleted.

To restore predefined keyboard shortcuts and delete all custom-defined shortcuts, click **Default**.

To create a file containing current keyboard shortcuts list, click **Export...** To import keyboard shortcuts from the shortcuts file, click **Import...** Only files with “.key” extension can be imported.

### 4.5.3 Predefined keyboard shortcuts

TomoCon provides predefined shortcuts and accelerator keys for many tasks. These can be changed anytime as described in the previous section.

This is a comprehensive list of the predefined shortcuts:

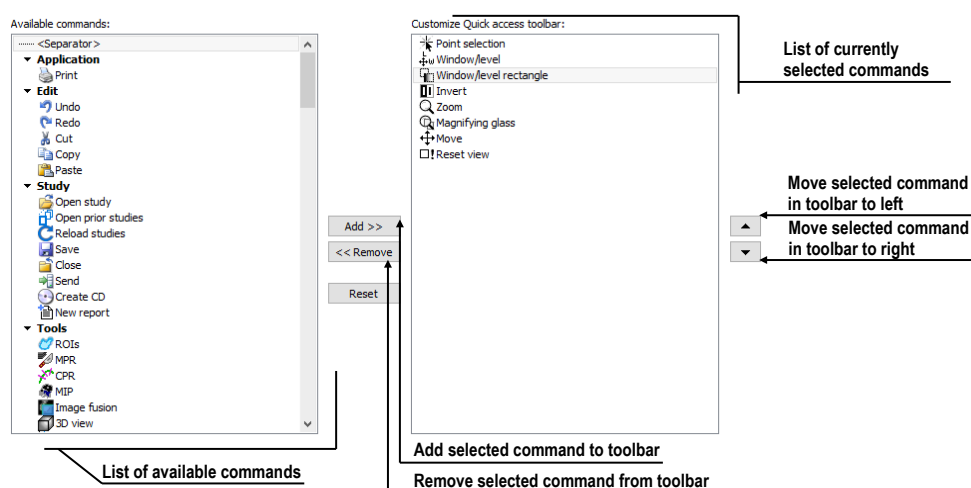
Shortcut description	Shortcut	Scope
Open user's manual	F1	Global
Quit the application	Alt+F4	Global
Display print interface	Ctrl+P	Global
Open selected patient study or series	Ctrl+O	Global
Save currently opened studies	Ctrl+S	Global
Insert new series into selected study	Ctrl+N	Global
Next image	Page Down, Num 3	Global
Previous image	Page Up, Num 9	Global
Select all images from series	Ctrl+A	Print

Deselect all images from series	Ctrl+D	Print
Invert selection	Ctrl+I	Print
Hide title bar	F11	Global
Hide title bar and menu	Ctrl+F11	Global
Hide title bar, menu and toolbars	F12	Global
Copy selected image or contour to clipboard	Ctrl+C	Global
Undo action	Ctrl+Z	Global
Redo action	Ctrl+Y	Global
Cut ROI contour	Ctrl+X	Global
Paste ROI contour	Ctrl+V	Global
Paste and edit ROI contour	Ctrl+F	Global

## 4.6 Quick access toolbar

The **Quick access toolbar** is a customizable toolbar for accessing commands which allows to add or remove its command buttons.

To configure the **Quick access toolbar**, select the **Quick access toolbar** tab of **Options** dialog (see Figure 74).



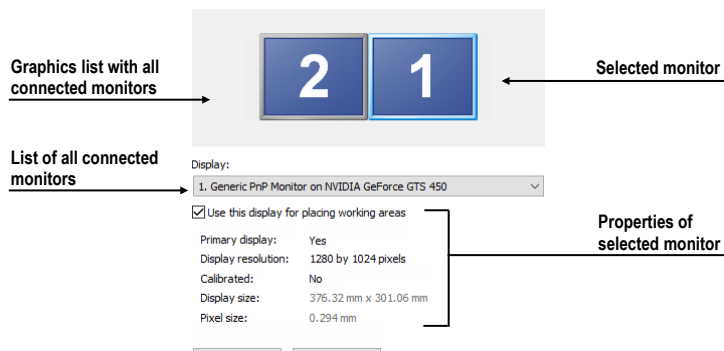
**Figure 74 – The Quick access toolbar tab of the Options dialog**

The list of all the available commands is displayed on the left (**Available commands**), the list of the command currently selected to the toolbar is on the right (**Customize Quick access toolbar**). The commands can be easily moved between the two lists by mouse. Simply drag a command from the **Available commands** list to **Customize Quick access toolbar** list or the other way around. The order of commands in the toolbar can also be changed by dragging them to the requested position. To remove a command, it is sufficient to drag the command anywhere outside of the **Customize Quick access toolbar** list.

Alternatively, to add a command to the toolbar, select one of the items in the **Available commands** list and click **Add>>**. The command will be added to the **Customize Quick access toolbar** list. To remove a command from the toolbar, select the corresponding item in the **Customize Quick access toolbar** list and click **<<Remove**. To change the order of the commands in the toolbar, use ▲ and ▼ buttons.

## 4.7 Monitors

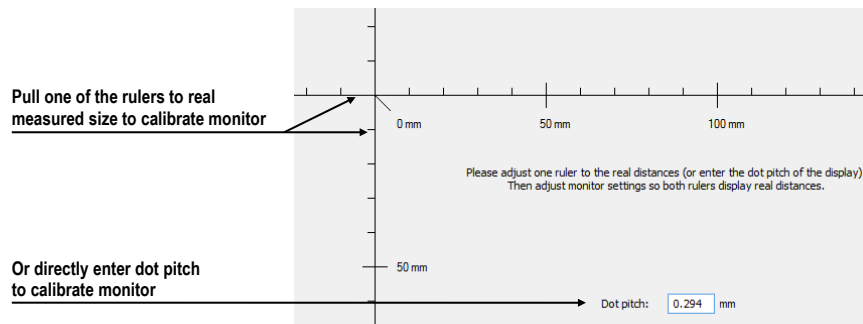
The **Monitors** tab (see Figure 75) allows calibrating any monitor connected to the computer by defining the physical dimensions of its display area. Calibration is the first and necessary step for displaying images in all zoom modes (see 7.2 Zooming an image). It allows viewing images in their actual physical dimensions on the calibrated monitor. Restriction of new working areas placement is also configured here. To prevent display of new working areas on a monitor, uncheck its **Use this display for placing working areas** option. This option applies to working areas created both manually and automatically.



**Figure 75 – Monitors tab**

To calibrate all connected monitors using the **Monitors** tab:

1. Select the required monitor in the preview frame, and click **Calibrate**.
2. The **Full screen calibration** dialog is displayed on the selected monitor (see Figure 76).
3. Calibrate the ruler displayed in the dialog with an actual measuring device (ruler). Place the cursor over the ruler on the monitor, and press and hold down the left mouse button to adjust the scale until it equals the exact distance measured by the actual ruler. To minimize the measurement error, choose the longest possible distance for the calibration (use long rulers).

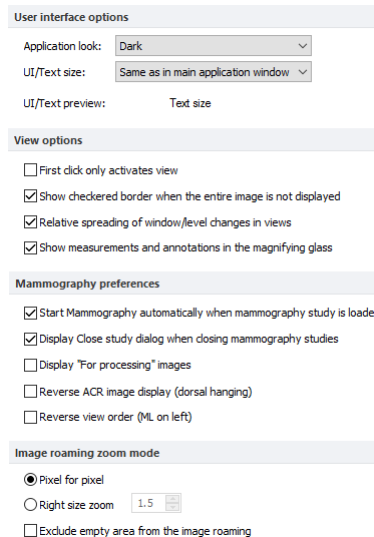


**Figure 76 – Monitor calibration**

4. Click **Next** and verify the calculated calibration size with the actual physical distance measurement tool (ruler), and click the **Finish**.

## 4.8 Mammography

The **Mammography** tab of the **Options** dialog (see Figure 77) allows setting up basic properties of the user interface, views and image roaming in the mammography mode:



**Figure 77 – The Mammography tab of the Options dialog**

- **User interface options:**
  - The **Application look** combo box allows changing the mammography interface, so that it corresponds to other Microsoft Windows applications.
  - The **UI/Text size** combo box allows changing the font scale used for all windows (dialogs, menus, etc.) in the mammography mode.
- **View options:**
  - The **First click only activates view** check box. If it is checked, clicking in an inactive view makes the view active. If this check box is

not selected, the view becomes active and the selected action is carried out immediately as well.

- The **Show checkered border when the entire image is not displayed** check box. If it is checked and the image in the mammography view is scaled in such a way that parts of the image is out of the view, the image is partially bordered with a checkered line to indicate which part of the image is displayed outside of the view (see Figure 78).
- The **Relative spreading of window/level changes in views** check box. If it is checked along with the **Scope all** check box, the percentage of the change of the window/level value in the current view is proportionally applied to the other views.
- The **Show measurements and annotations in the magnifying glass** check box. If it is checked, the magnifying glass in mammography is displayed with additional view objects, such as measurements and mammography graphic annotations.

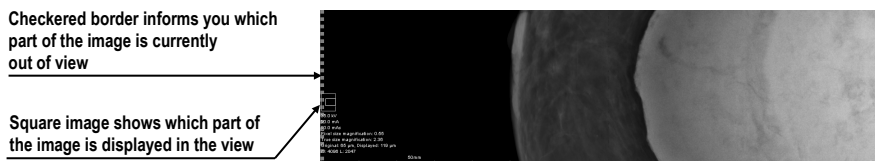


Figure 78 – Active checkered border

- **Mammography preferences:**
  - The **Start Mammography automatically when mammography study is loaded** check box. If it is checked, the mammography study is opened in the mammography mode.
  - The **Display Close study dialog when mammography study is being closed** check box. If it is checked, the **Close study** dialog is displayed to confirm study closing and saving.
  - The **Display “For processing” images** check box. If it is checked, the “raw” data (data not adjusted for screening or diagnosis) is displayed in the mammography mode.
  - The **Reverse ACR image display (dorsal hanging)** check box. If it is checked, the images are displayed in dorsal orientation.
  - The **Reverse view order (ML on left)** check box. If it is checked, the ML images are placed in front of CC images in the image navigator.
- **Image roaming zoom mode:**

- The **Pixel for pixel** radio button. If it is selected, each image is displayed so that one pixel in the display corresponds to one image pixel.
- The **Right size zoom** radio button. If it is selected, the images are displayed so that the largest image of the study fits into the view size and the rest of the images are displayed in the same physical size. The magnifying factor can be modified by changing the parameter in the edit box located to the right of the radio button.
- The **Exclude empty area from the image roaming** check box. If it is checked and the image contains areas with air only, then these areas are skipped when image roaming is being used.

## 4.9 **Mammography workflows**

The **Mammography workflows** tab of the **Options** dialog enables the configuration of workflows of hanging protocols that are applicable in the mammography mode. For a detailed description of the configuration process see 28.8 Workflows.


## 4.10 **DICOM options**

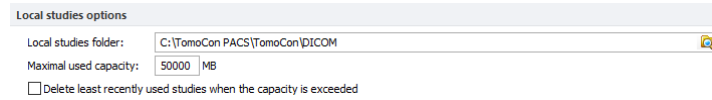
The following settings of the DICOM receiver and DICOM local studies are available through the **DICOM** tab of the **Options** dialog:

- The local studies folder properties (see 4.10.1 Local studies options).
- The tools for compacting and rebuilding the database of local studies (see 4.10.2 Database maintenance).
- The settings of the patient worklist that contains the studies important for the user (see 4.10.3 Studies worklist).
- The settings for receiving DICOM data in TomoCon (see 4.10.4 DICOM receiver settings).
- The external devices settings for DICOM data exchange (see 4.10.5 Remote DICOM devices).

### 4.10.1 **Local studies options**

It is possible to define the **Local studies folder** in the **Local studies options** section of the **DICOM** tab (see Figure 79) where all opened studies will be stored.

To define a local studies folder, click the  icon. The **Browse for folder** dialog then opens in which you can select a new local studies folder. This option is inaccessible when a study is opened.

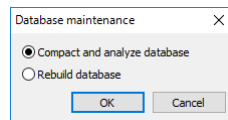


**Figure 79 – Local studies options section of the DICOM tab**

If the **Delete least recently used studies when the capacity is exceeded** option is checked, the local saved data size in the local studies folder cannot exceed the entered **Maximal used capacity**. If additional space is needed, the least recently used studies in the local studies folder are automatically deleted.

#### 4.10.2 Database maintenance

The local studies database is uniquely designed for maximum performance and stability when working with all the stored studies on your local hard disk. It is however possible that over time the integrity of the database is broken. For example, the local studies folder can increase in size beyond the hardware limits causing certain files to become corrupted or deleted, or causing TomoCon to shut down improperly (e.g. during power failure). In such cases the studies become no longer readable. To overcome this problem, TomoCon provides compacting and repairing functionality for the local studies database. To access database maintenance, click **Database maintenance** button in the **Local studies options** section. The **Database maintenance** dialog (see Figure 80) opens.



**Figure 80 – Database maintenance dialog**

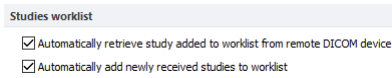
To avoid excess amounts of wasted disk space in local studies, select the **Compact and analyze database** option and click **OK**. To repair a damaged database, select the **Rebuild database** option and click **OK**.

#### 4.10.3 Studies worklist

Worklist is a list of pre-prepared studies from local studies or any remote DICOM device for immediate and quick access. This list is accessible in the **Worklist** tab of the **Search studies** dialog. Worklist can be managed manually (see Figure 81). Alternatively, check **Automatically add newly received studies to worklist** check



box on the **DICOM** tab of the **Options** dialog (see 5.10 Patients worklist) to automatically add all the retrieved studies to the worklist.

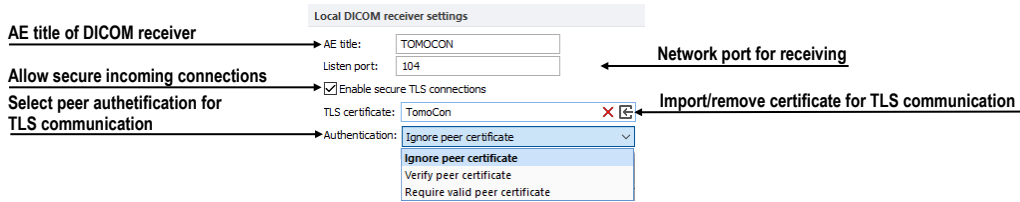


**Figure 81 – Studies worklist section of the DICOM options tab**

To improve the performance of working with the studies in the worklist, TomoCon allows activating the automatic download of each study added to the worklist, which has not yet been added to the local studies. To activate this function, check the **Automatically retrieve study added to worklist from remote DICOM device** check box.

#### 4.10.4 DICOM receiver settings

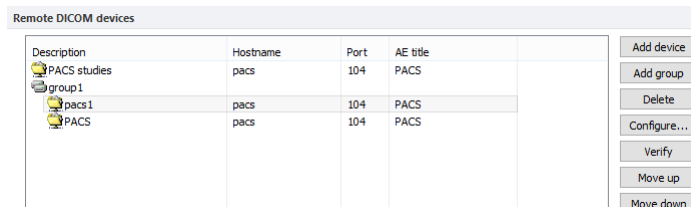
TomoCon contains a local DICOM receiver that automatically stores received patient data to Local studies. It is possible to set (see Figure 82) TomoCon application entity title (**AE Title**) to be used for DICOM connection with other devices, a port for receiving DICOM data (**Listen port**) and TLS options for secure connection.



**Figure 82 - Local DICOM receiver settings section of the DICOM tab**

#### 4.10.5 Remote DICOM devices

Each remote DICOM device configured in TomoCon (PACS, DICOM modality, etc.) is represented by a separate tab in the **Search studies** dialog. On each tab DICOM studies can be searched for and downloaded from the corresponding DICOM device. In addition, multiple DICOM devices can be grouped into a single DICOM group which is then represented by a single tab in the **Search studies** dialog.



**Figure 83 – Remote DICOM devices section of the DICOM options tab**

To manage DICOM devices and their groups, use the **Remote DICOM devices** section on the **DICOM** tab of the **Options** dialog (see Figure 83):

- To add a new DICOM group, click the **Add group** button and enter the group name into the edit box.
- To add a new DICOM device as a separate item, click **Add device** button. The **Device configuration** dialog (see Figure 84 - Figure 86) will be displayed to enter the required informations about a device.
- To add a new DICOM device into a previously defined group, select the group in the list and click **Add device**. The **Device configuration** dialog (see Figure 84 - Figure 86) is displayed to enter the required information about a device.
- To modify a group or a DICOM device, click **Configure...** The **Device configuration** dialog is displayed where the information concerning a group or a device can be modified (see Figure 84 - Figure 86).
- To verify the connection to a configured DICOM peer, click **Verify**.

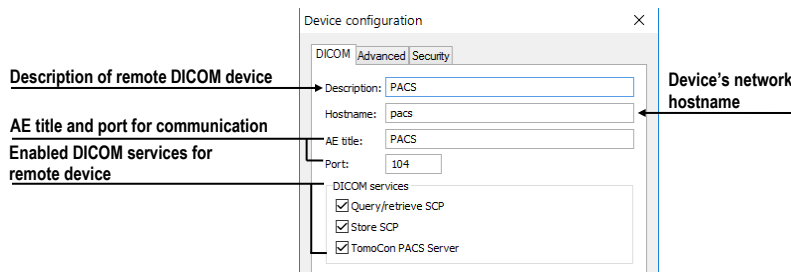


Figure 84 – Device configuration dialog – DICOM tab

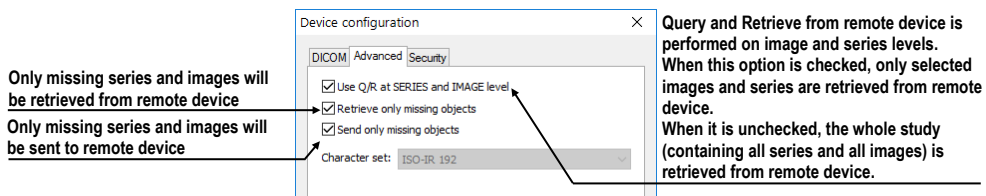


Figure 85 – Device configuration dialog – Advanced tab

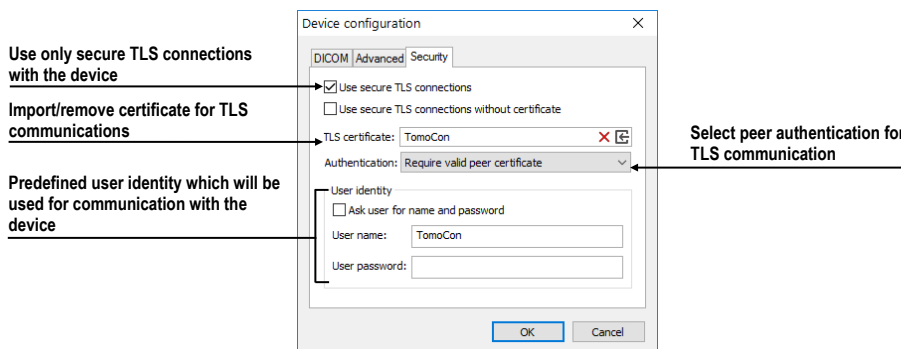



Figure 86 – Device configuration dialog – Security tab

## 5 Managing studies

For the management of DICOM studies, TomoCon provides the **Search studies** dialog (see Figure 87) containing comprehensive management tools for all studies stored in TomoCon, on remote DICOM devices and on CD/DVD data discs. TomoCon also makes it possible to send images and their reports and measurements to other DICOM devices, to burn studies on CD/DVD data discs and to manage the worklists of studies.

To display the **Search studies** dialog, click **Open**  in the main toolbar or select the **Open study...** item in the **Study** main submenu (see 3.4 Main menu).

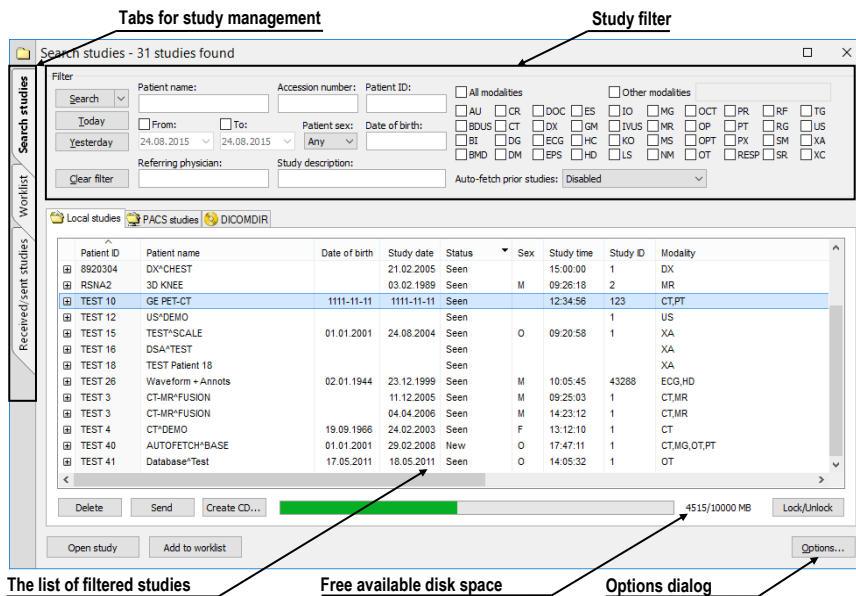


Figure 87 – Main parts of Search studies dialog

The **Search studies** dialog contains the following parts:

- The filtering section for defining the filtering conditions for searching studies (see 5.2 Search and filter studies).
- A tab enabling quick access to important studies – the patient worklist (see 5.10 Patients worklist).
- A tab for monitoring sent and received studies (see 5.9 Monitoring and controlling send/receive jobs).
- Tabs for configurable DICOM devices including a tab for local studies and DICOMDIR. Each device is represented by a separate tab on which the searched studies are displayed (see 5.1 Studies list).

## 5.1 Studies list

The study list displays basic information about looked-up studies. Studies in the list are sorted according to chosen study parameter. To sort, click the header of the column to sort by. The order in which columns are shown can also be rearranged by dragging and dropping (see Figure 88).

Patient ID	Patient name	Study date	Date of birth	Study date	Status	Sex	Study time	Study ID	Modality
8920304	DX*CHEST			21.02.2005	Seen		15:00:00	1	DX
RSNA2	3D KNEE			03.02.1989	Seen	M	09:26:18	2	MR
TEST 10	GE PET-CT	1111-11-11	1111-11-11	Seen			12:34:56	123	CT,PT
TEST 12	US*DEMO			Seen				1	US
TEST 15	TEST*SCALE	01.01.2001	24.08.2004	Seen	O		09:20:58	1	XA
TEST 16	DSA*TEST			Seen					XA
TEST 18	TEST Patient 18			Seen					XA
TEST 26	Waveform + Annots	02.01.1944	23.12.1999	Seen	M		10:05:45	43288	ECG,HD
TEST 3	CT-MR*FUSION	11.12.2005	Seen	M			09:25:03	1	CT,MR
TEST 3	CT-MR*FUSION	04.04.2006	Seen	M			14:23:12	1	CT,MR
TEST 4	CT*DEMO	19.09.1966	24.02.2003	Seen	F		13:12:10	1	CT

Figure 88 – Rearranging columns by dragging and dropping

Each study is initially displayed as a single row. Each study can be expanded to show a list of series by clicking on the symbol. The list of series shows the basic series properties (series date, time, description, images count, etc.) (see Figure 89). The series list can be hidden by clicking on the symbol.

Series number	Series description	Series date	Series time	Modality	Images
1		15.10.2010	09:17:52	OT	4
2	PR for OT series (WL and VOILUT)			PR	4
3	PR for OT series (shutter)			PR	4
4	PR for OT series (rotation)			PR	4

Figure 89 – Expanding study details in the Search studies dialog

If prior studies exist, they are displayed in a tree view for the selected study along with the series of the base study (see Figure 90). Each prior study can also be expanded to show the series list by clicking the symbol.

Patient name	Date of birth	Study date	Status	Sex	Study time	Study ID	Modality
AUTOFETCH*LAST 6 MONTHS*12	01.01.2001	10.09.2007	New	O	12:47:11	1	CT,MG,OT,PT
AUTOFETCH*LAST 6 MONTHS*12	01.01.2001	10.09.2007	New	O	12:47:11	1	CT,MG,OT,PT
Series number	Series description	Series date	Series time	Modality	Images		
1	LAST 6 MONTHS	21.02.2012	09:35:21	CT	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	MG	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	OT	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	PT	1		
AUTOFETCH*LAST YEAR	01.01.2001	01.03.2007	New	O	17:47:11	1	MG,OT
AUTOFETCH*LAST 2 YEARS	01.01.2001	01.03.2006	New	O	17:47:11	1	CT,MG,OT,PT
AUTOFETCH*LAST 6 MONTHS	01.01.2001	10.09.2007	New	O	17:47:11	1	CT,MG,OT,PT

Figure 90 – Study with 2 priors

The list of searched studies allows defining the information to be displayed. Right-clicking the study, list header shows the context menu listing column names. (see Figure 91). Check the columns to make them visible, or uncheck them to hide.

Patient ID	Patient name	Sex	Date of birth	Status	Study ID	Modality
TEST 26	Waveform + Annots	M	02.01.1944	Seen	43288	ECG,HD
TEST 12	US*DEMO			Seen	1	US
	TRAGICOMIX			New	4268331	CT
7DKT2Tp	TOUATIX		28.08.1953	New	4415342	CT
TEST 15	TEST*SCALE	O	01.01.2001	Seen	1	XA
TEST 18	TEST Patient 18			Seen		XA
TEST 45	TEST Enhanced*NonEnhanced	M	21.05.1984	Seen		CT
TEST 42	PR_GraphicAnnotation	F	04.12.1962	Seen	PMG	CT,MG,PR
TEST 31	PR Test	F		Seen	31	OT,PR
1111	Patient_100	M		Seen	1	XA
TEST 6	MR-PET*FUSION	M	11.12.1952	Seen	1	MR,PT
TEST 10	GE PET-CT		1111-11-11	Seen	123	CT,PT
TEST 46	ENHANCED*MR	F	01.01.1988	Seen		MR,PR
8920304	DX*CHEST			Seen	1	DX
TEST 16	DSA*TEST			Seen		XA
293828	DSA*DEMO	M	03.10.1972	Seen	09:10:10	XA
TEST 40	DIFFERENT	O	01.01.2001	New	17:47:11	MR,OT,XA
TEST 41	Database*Test	O	17.05.2011	Seen	14:05:32	OT

Figure 91 – Right-clicking the study header to select displayed and hidden columns

## 5.2 Search and filter studies

TomoCon allows searching patient studies archived in any DICOM-compatible data storage. Each configured storage is displayed in the **Search studies** dialog as a separate tab with its own list of searched studies (see Figure 92).

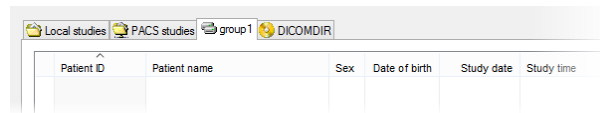


Figure 92 – DICOM storage tabs

To display the studies from configured storage in the **Search studies** dialog, click the tab with the storage name, define the filtering conditions and push the **Search** button.

These storage types are available:

- Local studies (see 5.2.3 Local studies)
- DICOM media (CD, HD, etc.) (see 5.2.6 DICOMDIR)
- External device with DICOM protocol (see 5.2.5 External DICOM storage)

When searching for a study, specify a filter to show only the studies meeting the filtering conditions (Note: the filter is not available in DICOMDIR storage).

To specify the filter, define the required information in the upper part of the **Search studies** dialog (see Figure 93), then click **Search** to start the search process.

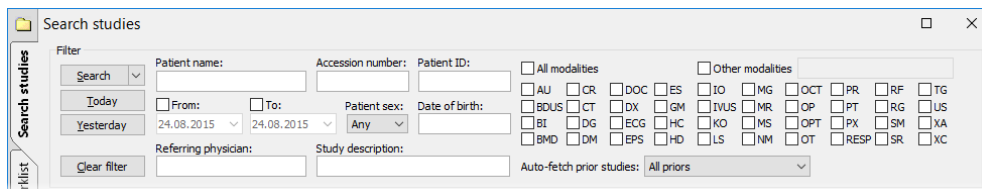
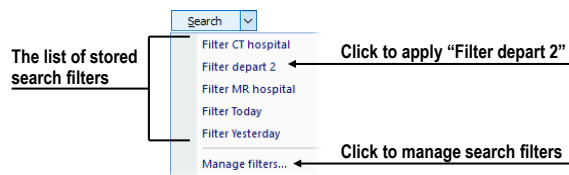


Figure 93 – Search section of the Search studies dialog

## 5.2.1 Managing search filters

Search filters allow defining custom group of predefined search criteria and providing more efficient study search. Each search filter can be stored for subsequent usage and can be directly applied to study search in the **Search studies** dialog through the **Search** menu (see Figure 94).

To display the **Search** menu, click ▼ icon on the **Search** button. The list of all stored search filters is then displayed where the required filter can be selected.



**Figure 94 – Search menu with stored search filters**

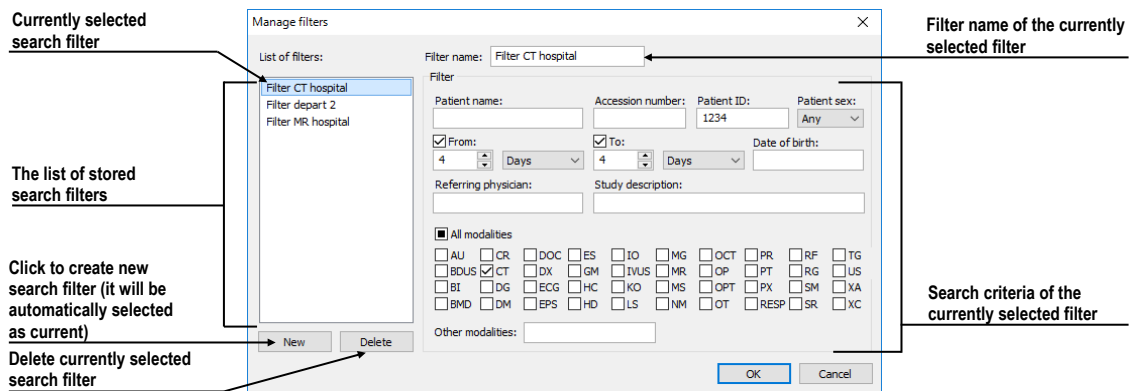
To manage the search filters, click ▼ icon on the **Search** button in the **Search studies** dialog, and then click the **Manage filters** item in the displayed menu (see Figure 94). The **Manage filters** dialog (see Figure 95) is displayed where a new search filter can be defined and existing ones can be changed or removed.

To create a new search filter in the **Manage filters** dialog, click **New** button, define the name of the filter in the **Filter name** edit box and define the searching criteria in the **Filter** section. To store a filter, click **OK**.

To change the search criteria of a previously defined filter, select the required filter in the **List of filters** and change its criteria in the **Filter** section.

To delete a previously defined search filter in the **Manage filter** dialog, select the filter in the **List of filters** and confirm by clicking **Delete**.

When the changes in the **Manage filters dialog** are complete, click **OK** to confirm. To discard the changes, click **Cancel**.



**Figure 95 – Manage filters dialog**

## 5.2.2 Search by selected study

It is possible to search studies according to the main parameters of the selected study (see Figure 96) in the **Search studies** dialog. The search parameters are defined in the **Search by** items in the context menu of the selected study. To display the context menu, right-click the selected study. Select a parameter, and the search process in the currently selected storage starts automatically.

Patient ID	Patient name	Sex	Date of birth	Status	Study date	Study time	Study ID	Modality
TEST 26	Waveform + Annots	M	02.01.1944	Seen	23.12.1999	10:05:45	43288	ECG,HD
TEST 12	US*DEMO			Seen			1	US
TEST 15	TEST*SCALE	O	01.01.2001	Seen				XA
TEST 18	TEST Patient 18			Seen				XA
TEST 45	TEST Enhanced*NonEnhanced	M	21.05.1984	Seen				CT
TEST 42	PR_GraphicAnnotation	F	04.12.1962	Seen				CT,IMG,PR
TEST 31	PR Test	F		Seen				OT,PR
1111	Patient_100	M		Seen				XA
TEST 6	MR-PET*FUSION	M	11.12.1952	Seen				MR,PT
TEST 10	GE PET-CT		1111-11-11	Seen				
TEST 46	ENHANCED*MR	F	01.01.1988	Seen				
8920304	DX*CHEST			Seen	04.06.59		1	
TEST 16	DSA*TEST			Seen	05.00.00			
293828	DSA*DEMO	M	03.10.1972	Seen	14.03.2010	09:10:10		
TEST 40	DIFFERENT	O	01.01.2001	New	01.03.2007	17:47:11	1	

Figure 96 – Searching in a specific storage

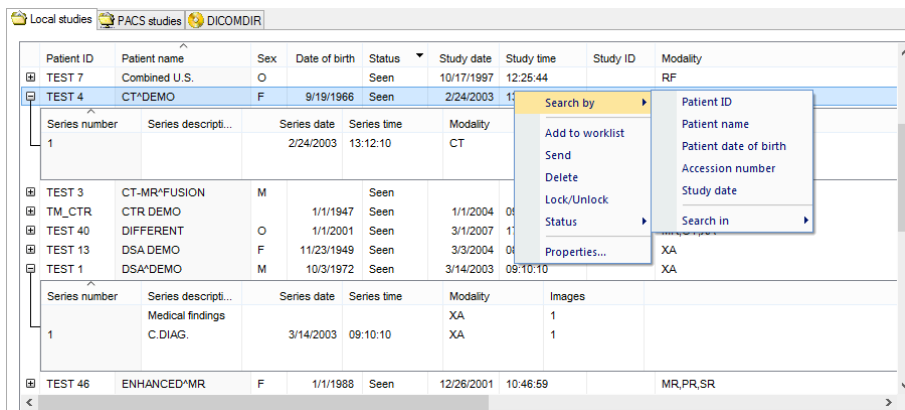
Searching according to the properties of the currently selected study can also be carried out in other storages. To choose DICOM storage for searching, select **Search in** item in the context menu of the selected study.

## 5.2.3 Local studies

TomoCon saves all open/retrieved DICOM data in a local DICOM storage on the local workstation. This storage is called **Local studies** and is represented in the **Search studies** dialog by the **Local studies** tab (see Figure 97). Studies from Local studies can be also exported or sent to external storages or media including newly created measurements and reports.

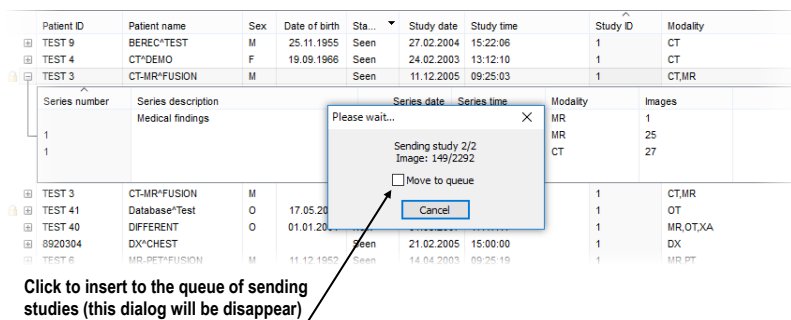
The **Locals studies** tab supports the following operations with each selected study in the list:

- Opening a study by clicking **Open study**.
- Locking a study against automatic deletion by clicking **Lock/Unlock**.
- Sending a study to an external PACS server or other external DICOM storage by clicking **Send**.
- Deleting a selected study by clicking **Delete**.
- Burning a study on CD. Clicking the **Create CD** button opens the **Create CD** dialog (see 27 Archiving images (CD) in which you can add a selected study to the list of studies ready for burning.
- Defining a study status (see 5.2.4 Study status).



**Figure 97 – Search studies dialog, the Local studies tab**


While receiving/sending a study to/from Local studies, the retrieving process can be moved to the receive/send queue by checking the **Move to queue** check box (see Figure 98). The process will run in the background in the queue not blocking any further work with TomoCon.



**Figure 98 – Search studies dialog, sending a study to a remote device**

### 5.2.4 Study status

Each study stored in Local studies shows the current viewing and diagnosing status. It is thus possible to identify a new study which has not been open yet and to identify **Seen**, **Read**, **Approved**, **Reported**, **Transcribed** and **Signed** studies. The current study status is displayed in the **Status** column in the list of local studies (see 5.2.3 Local studies). The status can be used for filtering and ordering the studies.

To filter studies, click the  icon in the **Status** column header and then select the required filter status in the displayed menu (see Figure 99).

The automatically associated status of each new saved study on the local studies storage is called **New**. When a study in the **New** status is viewed, its status automatically changes to **Read** or **Seen** (according to the study closing process). When a study is signed in TomoCon, its status automatically changes to **Signed**.



Study status can be manually changed according to the currently performed diagnosing steps.

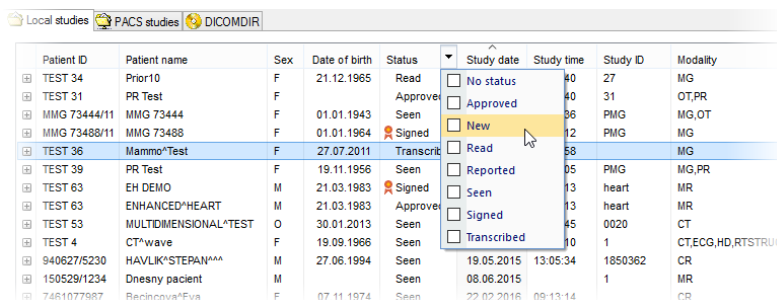


Figure 99 – Filtering by study status in the local studies

To manually change a study status, select the **Status** item in the context menu of the selected study and choose the required status from the displayed menu.

### 5.2.5 External DICOM storage

To be able to work with a study, it needs to be stored in Local studies. However, patient studies are usually generated by modality devices and are stored in the DICOM format on remote storages. Therefore, prior to working with any patient study stored remotely, it is necessary to retrieve it to your Local studies first.

TomoCon Workstation allows connecting to any standard external DICOM storage, searching for required patient studies and retrieving them to Local studies. By default, TomoCon Workstation is pre-configured so that it is possible to communicate with TomoCon PACS server immediately without any additional adjustment. This storage is represented in the **Search studies** dialog by the **PACS studies** tab.

TomoCon allows configuring a number of external DICOM storages to retrieve studies into Local studies from. The **Search studies** dialog shows a separate tab for each properly configured DICOM storage (see Figure 100).

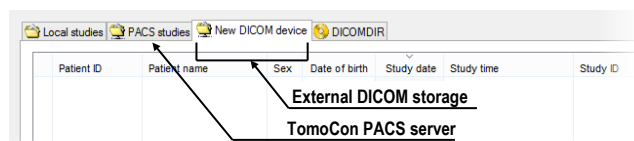
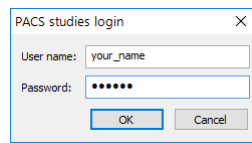


Figure 100 – New configured external DICOM storage

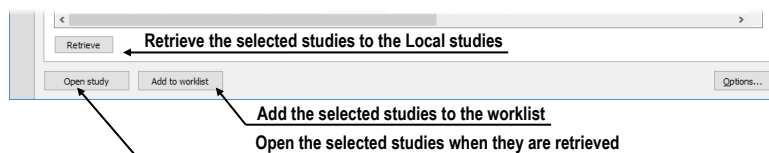
To retrieve, open or add a study to the worklist, activate the corresponding tab in the **Search studies** tab and carry out the following steps:

1. Click the **Search** button. You may be asked to provide your authorization (the valid user name and password) in the **PACS studies login** dialog (see Figure 101).



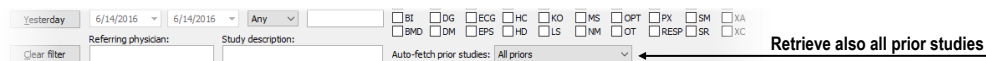
**Figure 101 – PACS studies login dialog**

2. The studies stored on the server that meet the filtering conditions will be included in the list.
3. Select the study from the list and (see Figure 102):
  - Click the **Retrieve** button to only store the study to the local studies.
  - Click the **Open study** button to store the study to the local studies and subsequent to open it.
  - Click the **Add to worklist** button to add the study to the patient worklist.



**Figure 102 – The buttons for the operations with the selected studies**

The selected study is always retrieved or opened along with its prior studies according to the option selected in the **Auto-fetch prior studies** combo box (see 5.3 Auto fetch prior studies).



**Figure 103 – Retrieving also all prior studies is active**

## 5.2.6 DICOMDIR



This functionality is not available in TomoCon Lite.

Any data stored in the DICOM format, whether on CD, HD or a shared network server directory can be accessed using the **DICOMDIR** tab of the **Search studies** dialog (see Figure 104).

To find DICOM studies using the DICOMDIR tab, proceed as follows:

1. Click the **Search** button.
2. In the **Browse for Folder** dialog that is displayed you can define the path to the searched folder (in which the DICOM data is stored). Alternatively, you

can select the folder from the drop-down menu which is displayed by clicking the arrow button next to the **Search** button.

3. TomoCon attempts to find the DICOMDIR file that contains the information concerning the DICOM files stored in the folder. If the file is not found, TomoCon attempts to scan the folder specified for DICOM images.
4. All DICOM files found in the specified folder (or defined in the DICOMDIR file) are displayed in the studies list.

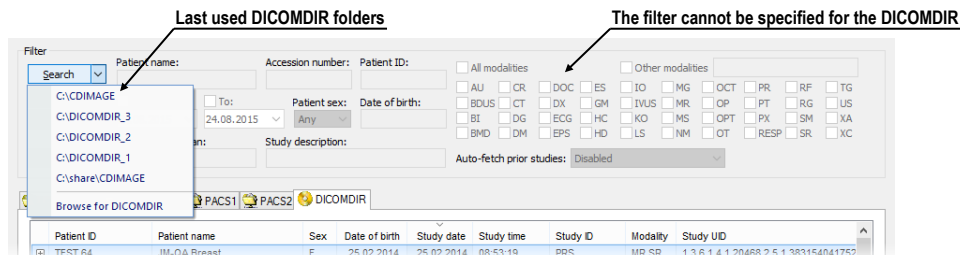


Figure 104 – DICOMDIR in the Search studies dialog

### 5.3 Auto fetch prior studies

This functionality makes it possible to work with the study and its priors as an entire package. Auto-fetching of prior studies for a selected study is configurable in the **Search studies** dialog and can be used when the study is opened or added to the worklist (see Figure 105) or the study is retrieved from the remote DICOM device.

Patient name	Date of birth	Study date	Status	Sex	Study time	Study ID	Modality
AUTOFETCH*LAST 6 MONTHS*12	01.01.2001	10.09.2007	New	O	12:47:11	1	CT,MG,OT,PT
AUTOFETCH*LAST 6 MONTHS*12	01.01.2001	10.09.2007	New	O	12:47:11	1	CT,MG,OT,PT
Series number	Series description	Series date	Series time	Modality	Images		
1	LAST 6 MONTHS	21.02.2012	09:35:21	CT	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	MG	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	OT	1		
1	LAST 6 MONTHS	21.02.2012	09:35:21	PT	1		
AUTOFETCH*LAST YEAR	01.01.2001	01.03.2007	New	O	17:47:11	1	MG,OT
AUTOFETCH*LAST 2 YEARS	01.01.2001	01.03.2006	New	O	17:47:11	1	CT,MG,OT,PT
AUTOFETCH*LAST 6 MONTHS	01.01.2001	10.09.2007	New	O	17:47:11	1	CT,MG,OT,PT

Figure 105 – Study in the worklist with 2 priors

To define auto-fetch of prior studies, click the **Auto-fetch prior studies** combo box in the filtering section of the **Search studies** dialog. The list of the timing and numerical criteria is displayed (see Figure 106) in which you can select the studies that are to be considered as priors.

Sometimes, particularly when the patient went through several examinations during one day, it is useful to treat a number of studies from that day as one when searching for a certain number of prior studies. Check the **Interpret studies from same day as one** menu item to treat studies within one day as a single study.

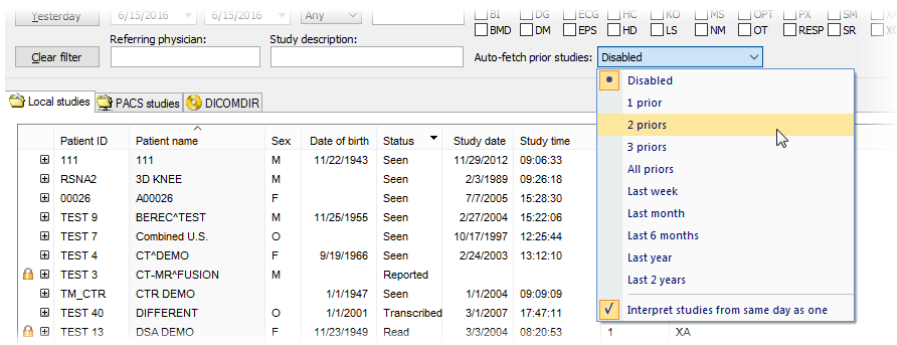


Figure 106 – Selecting Auto-fetch prior criteria

### 5.4 Opening a study

To open a study using the **Search studies** dialog, select the required tab (storage), click the row of the study and click the **Open study** button or double-click the row. The study immediately opens with all of its series.

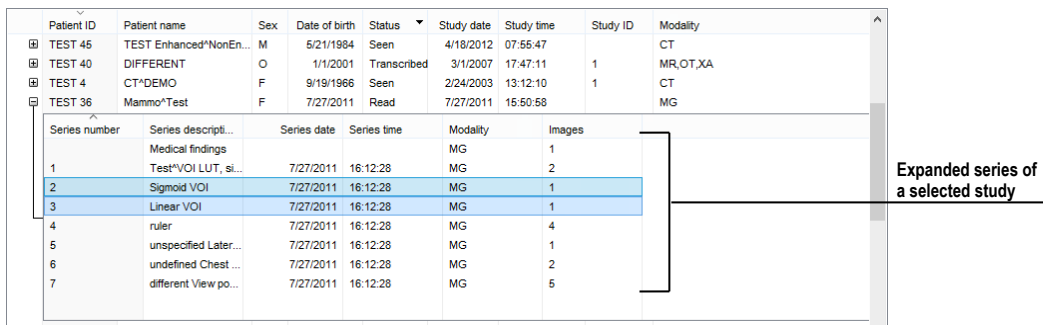


Figure 107 – Expanded series of a selected study, selection of multiple series

To open only a certain series of a selected study, expand the study by clicking the **+** symbol, select the series you want to open (see Figure 107) and click the **Open study** button.

The list of studies in the **Search studies** dialog allows the selection of multiple studies and series that you can open all at one time. By pressing the **Ctrl** button, you can select and deselect multiple studies or series. By pressing the **Shift** button, you can select a group of studies.

If the study is stored on a storage different from the local studies, it has to be initially downloaded into the local studies. The retrieval progress is displayed by progress bar (see Figure 109).

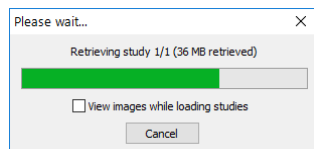


Figure 108 – Retrieving process progress bar

To perform the retrieval in the background, select the option **View images while loading studies** in this dialog. This process will be moved to the receive/send queue and its progress will be displayed in the thumbnail palette in study tab (see Figure 109). Upon its retrieval, every image is immediately loaded into TomoCon and displayed in the thumbnail palette; it can then be displayed in any view while the remaining images are still being retrieved.



After closing currently loaded studies which are retrieved in the background, their images will be incomplete in the Local studies on local computer disc.

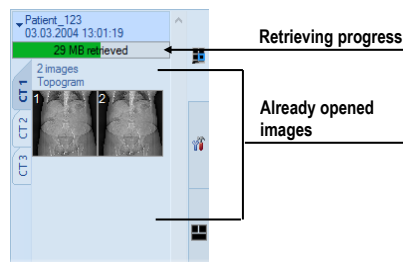


Figure 109 – A study open in thumbnail palette while still being retrieved

## 5.5 Reload study

After a patient's study from a remote DICOM device is opened (from PACS or from other DICOM modalities), there is a possibility to reload study from the source device again. This way the study images added onto the source device in the meantime are retrieved and opened.

To reload all open studies, select the Reload studies item in the Study main submenu (see 3.4 Main menu). To reload a single study, select Reload study in the study's context menu in the thumbnails palette (see Figure 110).

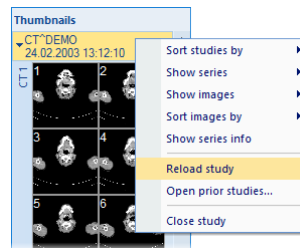


Figure 110 – Reload study by thumbnail palette context menu

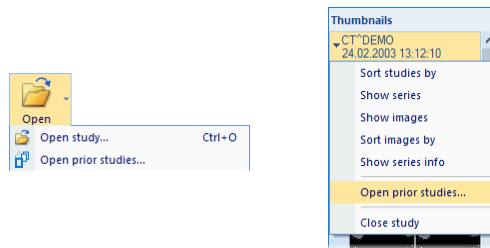
## 5.6 Opening prior studies

Once a study of patient is opened, there is a possibility to access any previous study of this patient using the **Open prior studies** dialog. It allows to find prior studies on any

configured remote DICOM storage or in Local studies according to the defined search criteria (same name, patient ID, etc.).

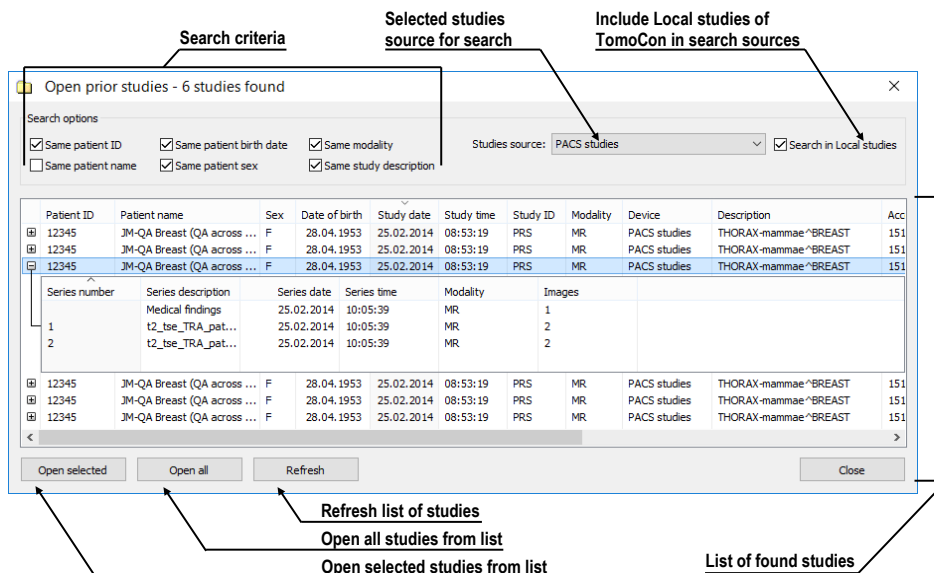
To open prior studies using the **Open prior studies** dialog:

- Display any image of the base study in the current view, and select the **Open prior studies...** item in **Study** main submenu or in **Open** context menu in the main toolbar (see Figure 111 a).
- Click on the thumbnail in the thumbnails palette belonging to the base series, and select **Open prior studies...** item in the context menu (see Figure 111 b).



(a) (b)  
**Figure 111 – Display Open prior studies dialog**

The **Open prior studies** dialog (Figure 112) contains two main parts. The first part is the filter for searching prior studies which allows to define the parameters of searched studies that need to match the base study and to select studies source for search. **Studies source** combo box allows selecting one remote DICOM source for search. **Search in Local studies** check box allows to select Local studies database in addition.



**Figure 112 – Open prior studies dialog**

The second part of the dialog contains action buttons and list of found studies. One or more studies (**Shift** and **Ctrl** key multi-selection) can be selected to be loaded. The action buttons allow opening selected studies (**Open selected**), opening all displayed studies in list (**Open all**) and searching prior studies according to the parameters defined using the selected DICOM sources (**Refresh**).

## 5.7 Closing and saving a study

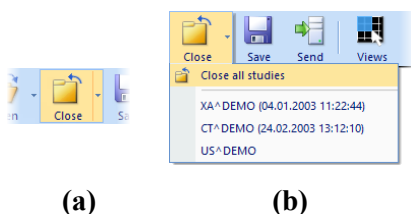


The saving functionality is not available in TomoCon Lite.

Usually, the final step in the viewing and diagnosing process with opened study images is to save your changes and to close the viewed patient study. While TomoCon is running, you can save and close all opened studies in one step or you can save and close only one particular study. When TomoCon is being closed, the closing of all studies and saving changes can be initiated automatically. The TomoCon behavior, when closing studies with changes, depends on its settings (see 4.1.8 Confirmations).

To close all opened studies, use one of the following methods:

- Click **Close** button in the main toolbar (see Figure 113a).
- Expand **Close** button in the main toolbar, and select the **Close all studies** item in the drop-down menu (see Figure 113b).
- Select **Study/Close** item in the main submenu.



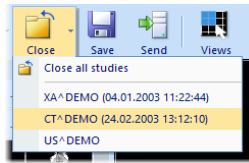
**Figure 113 – Closing all studies**

To close only one study use one of the following methods:

- Expand the **Close** button in the main toolbar, and select the item containing the name of the study in the drop-down menu (see Figure 114).
- Right-click any image in the thumbnails palette of the study to be closed, and then select the **Close study** item in the thumbnail palette context menu.

Before a study is closed, the changes you have made to the study images during the viewing and diagnosing process can be saved. TomoCon allows you to save the changes to the various objects, e.g. measurements, ROIs, correlations, reports, key notes and waveforms. These objects are saved in a DICOM-compatible format. As a

result, all changes you save can be uploaded to a PACS server and consequently retrieved and opened in another TomoCon workstation.



**Figure 114 – Closing a selected study**

You can of course save your changes as you work without closing the studies. This is advisable in order to safeguard against the loss of your work that could occur due to variety of reasons (power loss, etc.). To save all changes in all opened studies immediately without closing them, use one of the following options:

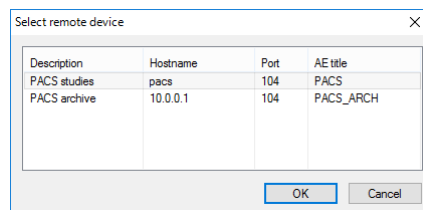
- Click the **Save** button in the main toolbar (see Figure 115).
- Select the **Study/Save** item in the main submenu.



**Figure 115 – Saving changes without closing a study**

## 5.8 ***Sending a study to an external device***

Patient data can be sent over the network to any PACS server or another DICOM data storage device. On the **Local studies** tab of the **Search studies** dialog select the study, and click the **Send** button. If multiple remote devices are available and defined, the **Select remote device** dialog (see Figure 116) is displayed in which you specify the target device. Select the desired remote device, and click the **OK** button. The study will be sent. To define the DICOM data source, go to the **Options** dialog (see 4.10.5 Remote DICOM devices).



**Figure 116 – Select remote device dialog**

## 5.9 ***Monitoring and controlling send/receive jobs***

It is extremely appropriate and practical to have the possibility to work with numbers of simultaneous jobs when dealing with network traffic. Sending/receiving numerous studies to/from various PACS systems would be a very inconvenient process if such a network-related process could start only after the previous one had been completed.



For this reason, the TomoCon application provides a mechanism to control and manage numerous sending and receiving jobs on the very intuitive **Received/sent studies** tab of the **Search studies** dialog (see Figure 117).

The **Received/sent studies** tab contains the list of all processing jobs during the current TomoCon session. The list is divided into two tab pages. The first - the **Received studies** tab displays all receiving/received jobs and the second - the **Sent studies** tab displays all sending/sent jobs. Each list on the tabs displays the main pieces of information concerning received/sent studies (see Figure 117) such as the current job status, the destination or source, the progress, the time at which the job started, the last access time and basic information about the study (the patient ID and name, study date, accession number and UID).

Status	Source	Progress	Patient ID	Patient name	Study date	Accession No.	Started	Last access time	Study UID
Pending	pacs	0	54631	MANIX	01.02.2005				1.2.840.113704.1.111.5600.1107858
Suspended	pacs	1667/2391		OBELIX	21.04.2004		14:35:27	14:36:30	1.3.12.2.1107.5.1.4.51964.4.0.3778
Retrieving	pacs	6/2391		OBELIX	21.04.2004		14:40:25	14:40:25	1.3.12.2.1107.5.1.4.51964.4.0.3778
Retrieved	pacs	723/723	Vafk,T6	PHENIX	27.09.2005		14:40:01	14:40:25	2.16.840.1.113669.632.20.1211.100

Figure 117 – Received studies tab

### 5.9.1 Managing receiving/sending jobs

The **Received studies** and **Sent studies** tabs provide the controls for active and passive jobs management. These controls allow to control the receiving/sending process of the studies or to obtain more precise information concerning the studies.

The controls of the **Received studies** tab and **Sent studies** tab allow the following operations (see Figure 118):

- Suspending an active job (the **Suspend** button).
- Restarting a job from the suspended status (the **Restart** button).
- Continuing with a job from the suspended status (the **Continue** button).
- Deleting a job if it is not in the receiving/sending status (the **Delete** button).
- Displaying detailed information concerning a job (the **Details** button).
- Opening a study if its job is already in the received status (by clicking the **Open study** button).

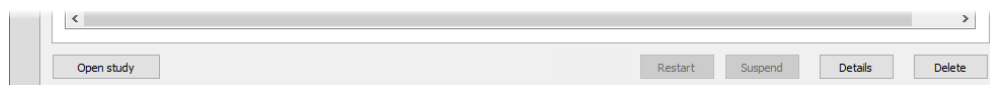


Figure 118 – Manage buttons on the Received studies tab

Clicking the **Details** button (or double-clicking an item in list) opens the **Task details** dialog (see Figure 119) which displays detailed information concerning the selected job (the status information, patient/study information and task information). It also contains a list of the proceeding images.

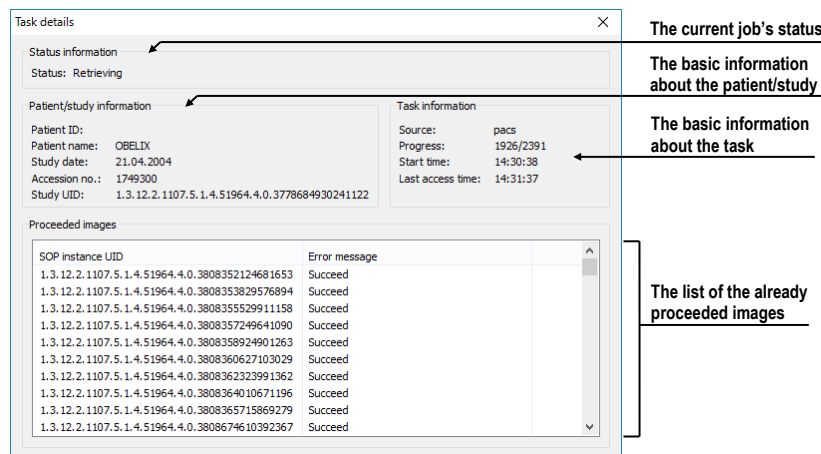


Figure 119 – The Task details dialog

## 5.9.2 Jobs notification

The TomoCon application also provides with notification concerning running jobs without having to open the **Search studies** dialog. If an unfinished job (receiving or sending) exists, the TomoCon status bar displays the corresponding icon as well as the total number of jobs currently running. If you move the cursor to these locations, a tool tip containing information about the jobs is displayed (see Figure 120).

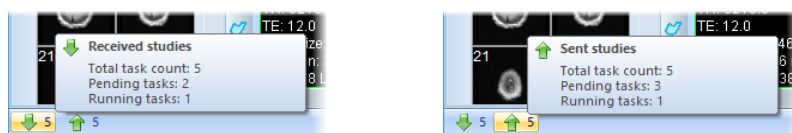


Figure 120 – Information about currently running jobs

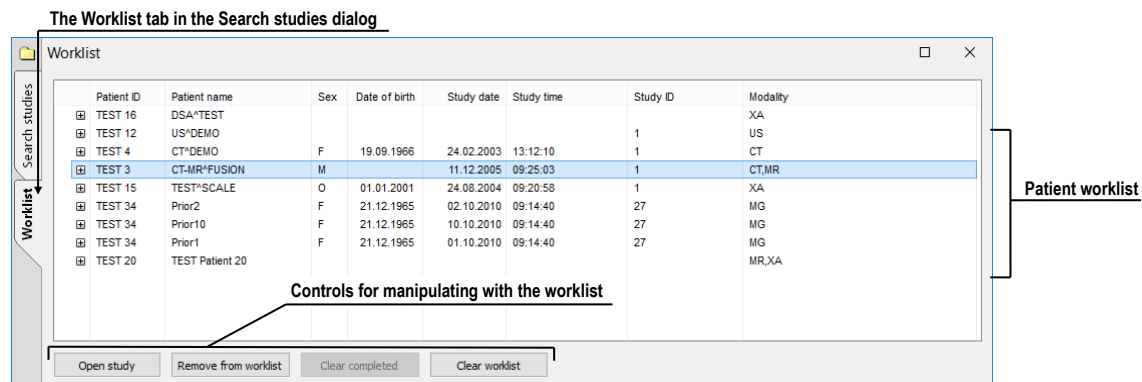
If you attempt to exit the TomoCon application when there are any unfinished sending/receiving jobs still running, a message dialog is displayed. You can then decide whether to cancel the job(s) and exit TomoCon or to wait until the process is complete.

## 5.10 Patients worklist

When opening a patient study, you can do so directly by selecting the particular study from the configured DICOM peer or local studies or by browsing the pre-prepared patient worklist. The patient worklist is the list from you can sequentially open prepared patient studies for viewing. Studies can be added to the patient worklist

manually by selecting from an arbitrary source (local studies, DICOM peer) or automatically when a new study is received.

To display the patient worklist, go to the **Worklist** tab of the **Search studies** dialog (see Figure 121). The patient worklist tab contains the list of the studies and the tools for managing the content of the worklist (see Figure 121).



**Figure 121 – The Worklist tab of the Search studies dialog**

This studies list is the same as the studies list on the **Search studies** tab. The main rows in the list represent the studies which can be expanded or collapsed.

When a study is expanded, the list of its content is displayed in a tree-like structure. It contains either the series list of the study itself or, if prior studies exist, it contains a list of the priors along with their content. The priors are ordered according to study date and time.

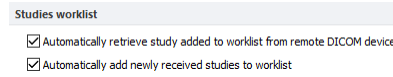
### 5.10.1 Adding a study to a worklist

It is possible to add a study to the worklist from the Local studies or any configured DICOM storage manually or to insert a received study automatically.

In order to add a selected patient to the patient worklist, proceed as follows:

1. Click the **Open** button in the main toolbar to display the **Search studies** dialog.
2. Set the filtering parameters, click the **Search** button and carry out the search on your local studies location or any remote PACS storage.
3. To retrieve the prior studies, select searching criterion for the prior studies in the **Auto-fetch prior study** list.
4. Select the studies you want to add to the worklist, and click the **Add to worklist** button, or select the **Add to worklist** item in the context menu.

To activate automatic addition of all received studies (via the DICOM receiver), enable the **Automatically add newly received studies to worklist** option on the **DICOM** tab of the **Options** dialog (see Figure 122).



**Figure 122 – Settings for the worklist**

To accelerate work with studies in the patient worklist, TomoCon enables automatic retrieval of a study (from the remote DICOM device) that is currently being added to the worklist (see Figure 123). To activate this option, check the **Automatically retrieve study added to worklist from remote DICOM device** option on the **DICOM** tab of the **Options** (see Figure 122).

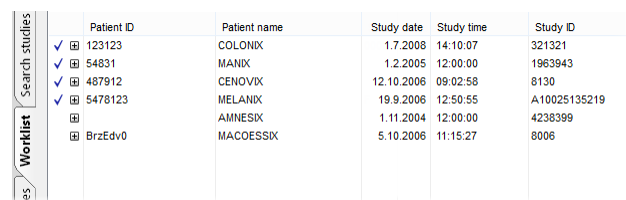


**Figure 123 – Automatic retrieval of a study being added to the worklist**

### 5.10.2 Reviewing a worklist

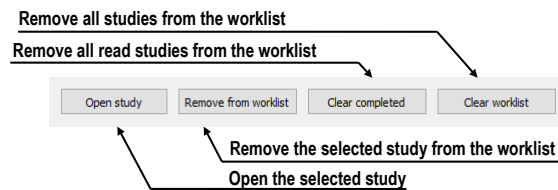
Your currently defined patient worklist is available at any time on the **Worklist** tab of the **Search studies** dialog. On the tab you can select from the following operations (see Figure 125) pertaining to the patient worklist studies:

- Opening a selected study along with all of its prior studies from the worklist (by clicking the **Open study** button). After a study from the worklist is opened, its status changes to read. All studies in the worklist that are in the read state are marked with the ✓ icon on the left-hand side of the row (see Figure 124).



**Figure 124 – The studies in the worklist**

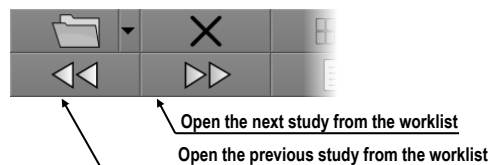
- Changing the order of the studies in the worklist - proceed as follows:
  1. Select one or more studies in the worklist that you want to reorder.
  2. Display the context menu by right-clicking the selection.
  3. Select the **Move up** or **Move down** menu item.



**Figure 125 – Manage part of the Patient worklist tab**

- Removing a selected study from the worklist (by clicking the **Remove** button).
- Removing all studies from the worklist that have already been read (by clicking the **Clear completed** button).
- Removing all studies from the worklist (by clicking the **Clear worklist** button).

The mammography mode allows to access all worklist studies automatically by clicking the buttons in the mammography toolbar (see Figure 126). By clicking the **Open previous study from worklist** button or the **Open next study from worklist** button in the mammography toolbar, you are able to review all studies prepared in the patient worklist without opening the **Search studies** dialog.



**Figure 126 – Worklist buttons in the mammography toolbar**

## 6 Viewing images

TomoCon application allows to review images of all loaded studies in any view of the working area (see 6.1 Display image in view). You can also use the sequence creation capability (see 6.3 Image sequence) or series synchronization possibilities (see 6.4 Series synchronization).

### 6.1 Display image in view

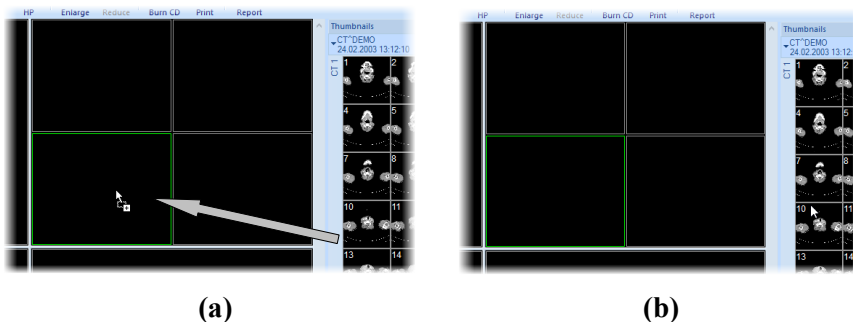
There are various ways in which to display an image in a view. You can use the selection of images in the thumbnails palette or move them by dragging and dropping.

To display an image in a selected view using the thumbnails palette:

1. Move the cursor over the desired view, and click (the view will change to the current view).
2. Move the cursor over the desired image in the thumbnails palette, and click the left mouse button (see Figure 127b).

Or by dragging and dropping:

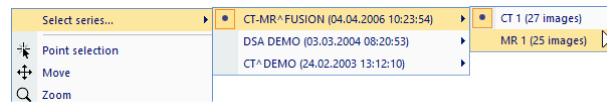
1. Move the cursor over the desired image in the thumbnails palette, and press and hold down the left mouse button.
2. Move the cursor over the desired view, and release the mouse button. The view will change to the current view (see Figure 127a).



**Figure 127 – Displaying image in view using drag&drop (a), by clicking (b)**

There is also a simplified manner of selecting a series for the current view. It is possible to quickly select the series you want to view by the context menu.

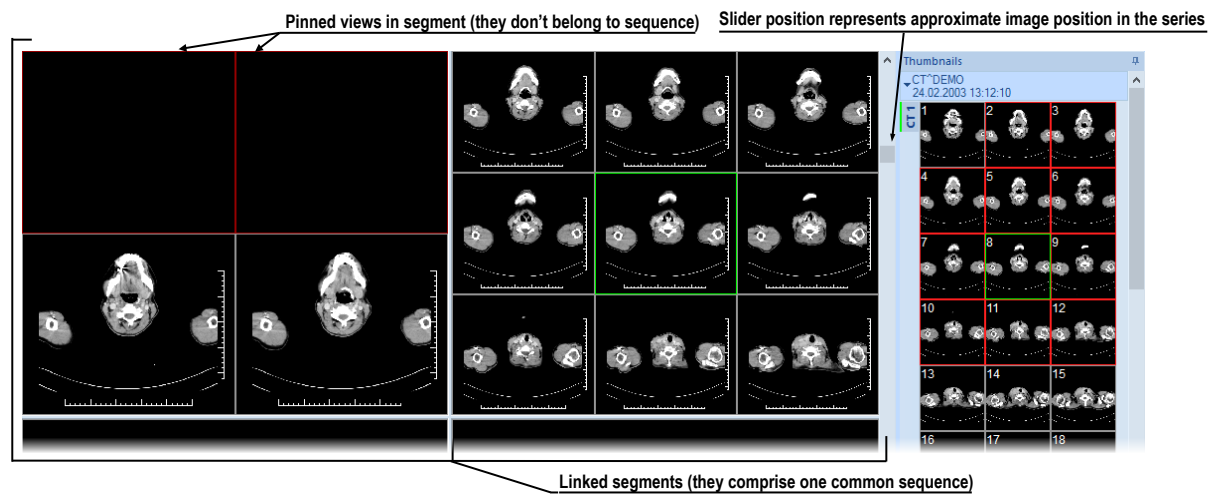
1. Move the cursor over the desired view, and click. This view will change to the current view.
2. Right-click to display its context menu (see Figure 128).
3. Select the desired series in the upper **Select series...** submenu. The first image of the selected series is then immediately displayed in this view.



**Figure 128 – Series selection using the view context menu**

When you select an image in the current non-pinned view, the application automatically creates a sequence containing all non-pinned views from the current segment and from all other segments linked to it (see Figure 129).

The identification of the image order in the series that is displayed in the current view is indicated in the scrollbar to the right of the working area. Its location represents the approximate image position in the series.



**Figure 129 – Working area with non-multiframe image in current view**

### 6.1.1 Multiframe image

When a multi-frame image is displayed in the current view, the position scrollbar is divided into two parts separated by a square box (see Figure 130).



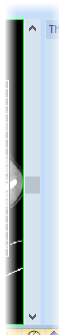
**Figure 130 – Working area with multiframe image in current view**

The upper part of the scrollbar represents the image position in the current series, and the lower part of the scrollbar represents the frame position in the current image. The current frame number of the multi-frame image is displayed in the box between the scrollbars. It is also possible to move through the frames using the mouse wheel.

### 6.1.2 Multidimensional series

When a multidimensional series is opened, it is automatically divided into virtual series and their images are displayed in the thumbnails palette. Each image in this series is identified by its dimension number, stack position (index number) and its temporary position.

When an image from a series with just one dimension is displayed in the current view, it is displayed as a standard image with the standard scrolling functionality. As a result of this, you can scroll through all of the images in the series in the current view using the vertical scrollbar (see Figure 131).



**Figure 131 – Standard scrollbar of the current view**

On the other hand, when an image from a series with more than one dimension is displayed in the current view, the special horizontal dimension scrollbar is displayed in the lower part of the working area (see Figure 132). Its position specifies the dimension of the displayed image in the current view. The vertical scrollbar is, of course, also displayed with its standard scrolling functionality within the selected dimension.



**Figure 132 – Dimension scrollbar of the current view**

When an image from a multidimensional series is displayed in the current view, you can scroll through the images using one of the following methods:

- Move to the next/previous image that has the same dimension as the dimension of the image displayed in the current view by scrolling with the



mouse wheel or using the vertical scrollbar. The dimension will be achieved, and the image will skip to the nearest image in the series.

- Move to the image with the next/previous dimension that has the same position in the series as the image in the current view, by scrolling with the mouse wheel while pressing down the ALT key or using the horizontal scrollbar (see Figure 133).

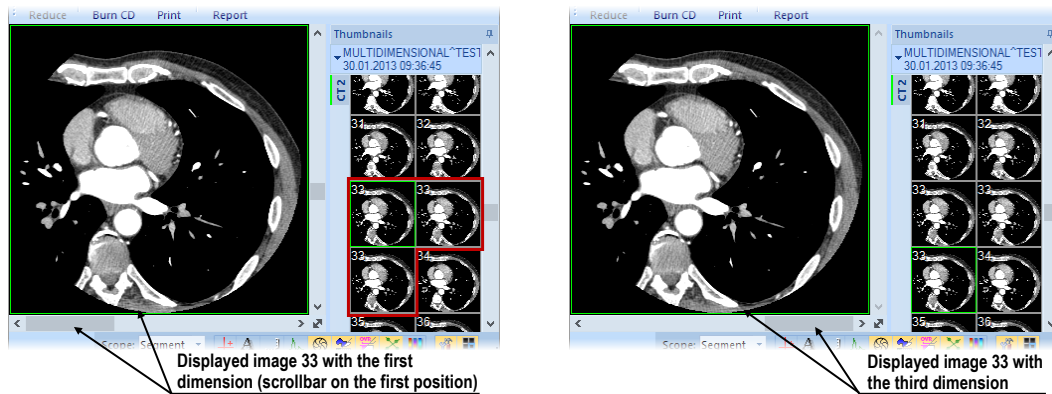



Figure 133 – Displayed image with the first and the third dimension in the current view

### 6.1.3 Scroll mode

Just as you can scroll through the images in the current view using the mouse wheel or the working area scrollbars, you can use the scroll view mode. This mode allows to scroll in the current view by moving the mouse. Horizontal movement allows to change the dimension (if applicable) in the current view, while vertical movement is used to change the image position in the series.

To activate the scroll mode, select the **Scroll** item in the context menu of the current view (see Figure 134). When the scroll mode is active, the mouse cursor is displayed as .

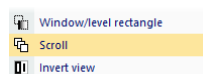




Figure 134 – Scroll item in the context menu

To scroll up/down among the images with the same dimension in the series volume, press down the left mouse button and move the mouse up/down vertically. When the mouse is moved, the cursor is displayed as .

To scroll between dimensions, press down the left mouse button and move left/right horizontally. When the mouse is moved, the cursor is displayed as .

## 6.2 Segment display mode

A segment may contain multiple views. When an image is selected in the view and there are more views in the segment, the other views will automatically display images from the selected series (when available) according to the selected display mode (see Figure 135).

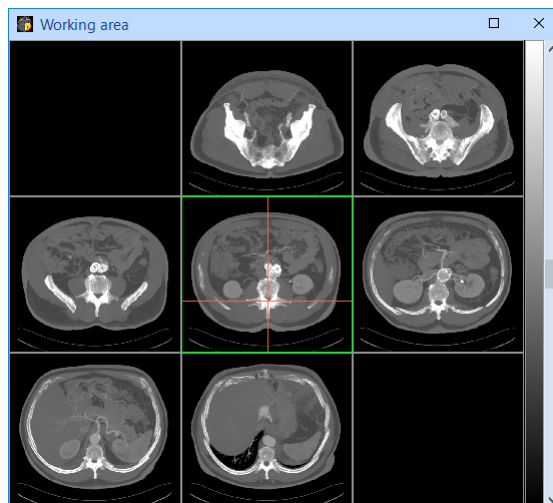





Figure 135 – Automatic fill-in of a 9-view segment

The image parameters (position, time and others) together with the display mode selected decide the way, the segment orders the images into the views and for scrolling. Using different modes can be very useful on multi-dimensional series.

There are three display modes available to be used for any segment. However, the usage of the different modes is especially useful in multi-view segments. For a better overview, the images being shown in the segment are marked in the thumbnail palette with a red border.



Figure 136 – Selecting the display mode

To select the view mode, click  **Views** in the **Segment views** section of the **Define layout** tool or click  **Views** in the main toolbar (see Figure 136). To set current segment display mode as default, click .

### 6.2.1 Matrix mode

The **Matrix** mode is suitable for multidimensional series viewing. The images within segment are ordered horizontally and vertically according to the dimensions available in the multi-dimensional series. The ordering in the vertical direction – within a column – corresponds to the order of scrolling using the vertical scrollbar of the segment. The horizontal ordering – within a row – corresponds to the scrolling using the horizontal scrollbar of the segment.

For example, when viewing a multi-dimensional series in two dimensions (the spatial position and the imaging time), the images on the same position taken at different times can be shown and evaluated in a single segment (see Figure 137).

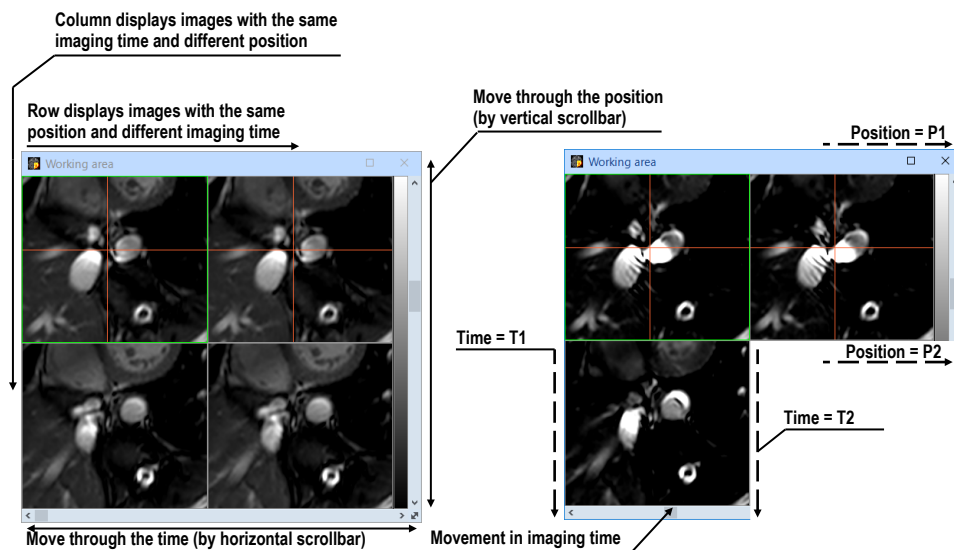


Figure 137 – Multi-dimensional series in a segment in the Matrix mode

### 6.2.2 Stack mode

The **Stack** mode is, similarly to the matrix mode, suitable for viewing multi-dimensional series. The images are ordered according to the first dimension available (the one that corresponds to the vertical scrollbar). Only the images with the same value of the second dimension are shown. The value of the second dimension for which the images are to be shown is selectable using the horizontal scrollbar.

For example, when viewing a multi-dimensional series with two dimensions (the spatial position and the imaging time), the images within the segment can be shown ordered according to the position while using the horizontal scrollbar to control the imaging time being shown (see Figure 138).

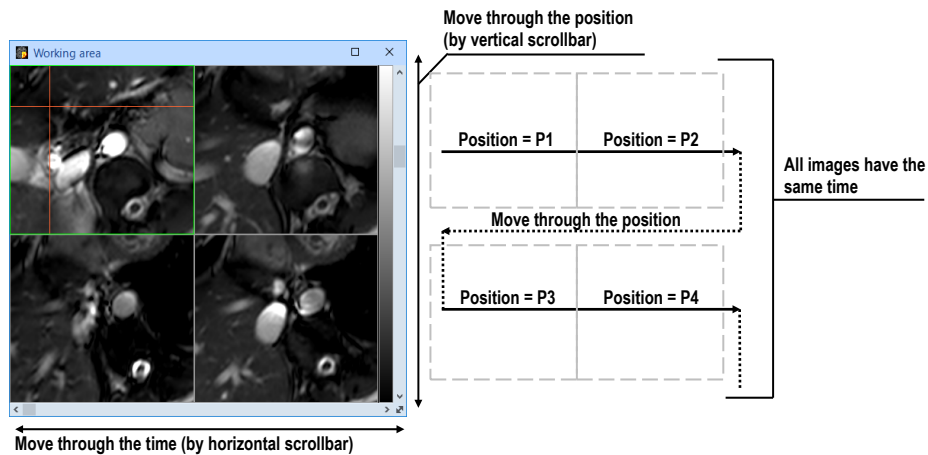


Figure 138 – Multi-dimensional series in a segment in the Stack mode

### 6.2.3 All mode

In the **All** mode the images are ordered in a traditional way (see Figure 139). The ordering is the same as in the thumbnail palette.

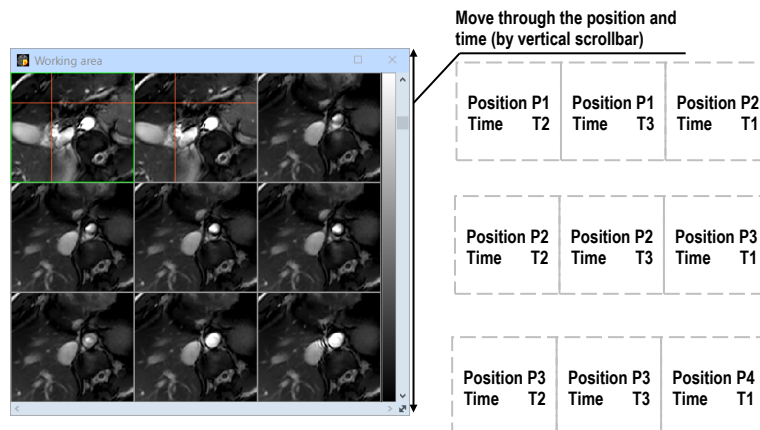
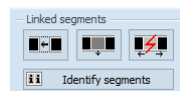


Figure 139 – Multi-dimensional series in a segment in the All mode


The ordering is independent on any multi-dimensional properties of the series. The horizontal scrollbar is disabled in this mode. The vertical scrollbar controls the image index in the current view.

## 6.3 Image sequence



When a new image is selected in the current view, the application automatically creates a sequence of images in the current segment. This sequence contains all views from this segment (linked by rows) with the exception of so-called pinned views. A pinned view can be used to display an arbitrary image without changing the sequence or potentially to display an MPR, 3D, etc. This view is outlined with a colored frame (the default color is red although this can be changed; see 4.4 Color and style options).

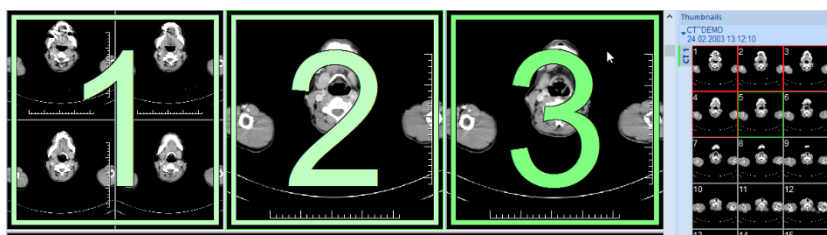


**Figure 140 – Linked segments section of the Define layout tool**

To manually pin/unpin the current view, click the  item in the context menu which is displayed by right-clicking. The status of this icon displays the pin status of the current view.



If you want to create a sequence containing more than one segment, TomoCon allows to link selected segments (see Figure 141) by means of the **Linked segments** section of the **Define layout** tool. Proceed as follows:

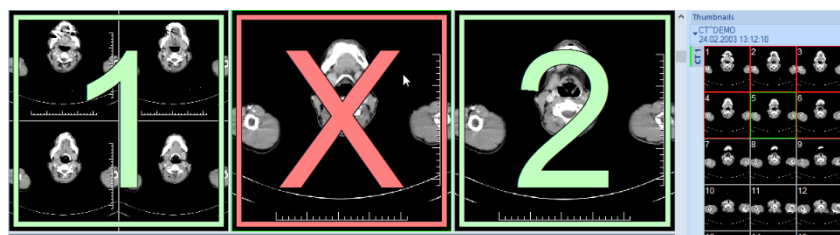
1. Click the first segment in the sequence and subsequently press the  button on the tools panel tab with the  icon.
2. Move the cursor over the working area. The first segment in the sequence will be marked with the number 1.
3. Move the cursor over the segment which you want to add to this sequence (this segment will be marked with next number in the sequence), and click. If you want to add additional segments to the sequence, hold down the **Ctrl** key while clicking. To end the process of linking segments, press the **Esc** key.



**Figure 141 – Linking of segments to a sequence**



To remove a linked segment from a sequence (see Figure 142), proceed as follows:

1. Press the  button on the tools panel tab with the  icon.
2. Move the cursor over the segment you want to remove (the segment will be marked with a cross), and click.
3. If you want to remove multiple segments from a sequence, hold down the **Ctrl** key while clicking.



**Figure 142 – Removing a segment from sequence**

To split an existing sequence (see Figure 143), proceed as follows:

1. Press the  button on the tools panel tab with the  icon.
2. Move the cursor over the first segment of the subsequent sequence (the segment will be marked with the number 1 and all subsequent linked segments will be numbered as in the new sequence), and click.

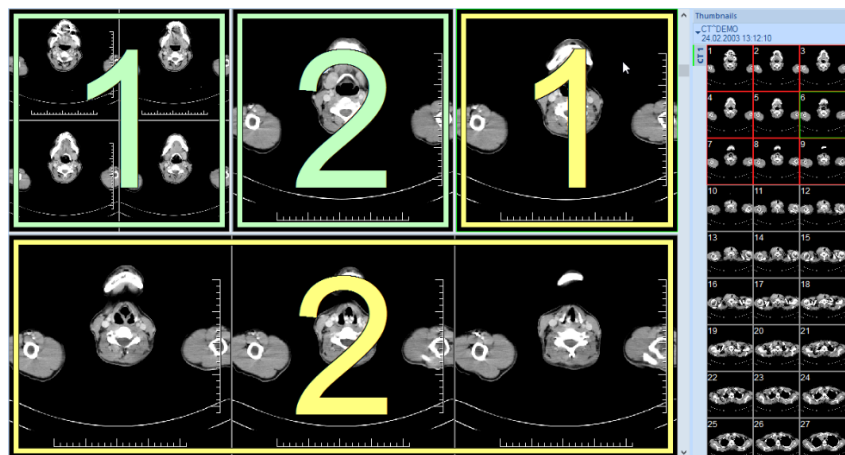


Figure 143 – Dividing an existing sequence

## 6.4 Series synchronization

Segments can be synchronized with each other when displaying images. This way, the images at the corresponding position coming from different series can be examined quickly without the need to manually scroll to corresponding images.

Synchronization can be either automatically guided by the spatial relationship of the series in the segments or guided manually by the initial position of the images in the segments at the instant when the synchronization is turned on.

- **Automatic synchronization** uses the registration among the series to find the corresponding images to be displayed in other segments. For the automatic synchronization to work between two series a registration must exist between them.

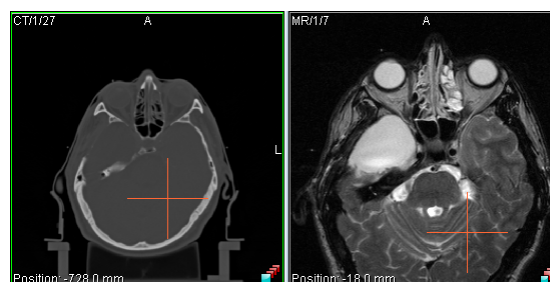
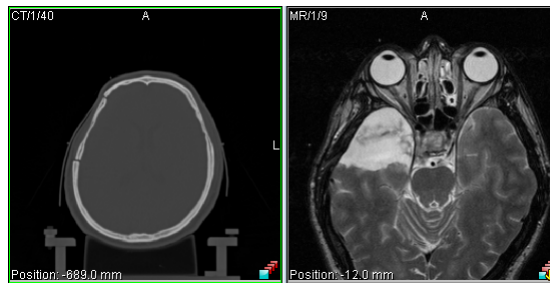


Figure 144 – Two segments synchronized automatically

For example, see Figure 144 where two segments are synchronized automatically. An existing registration is used to find matching images, as can be seen here by the current point indication, because the positions of the point in two series are geometrically identical.

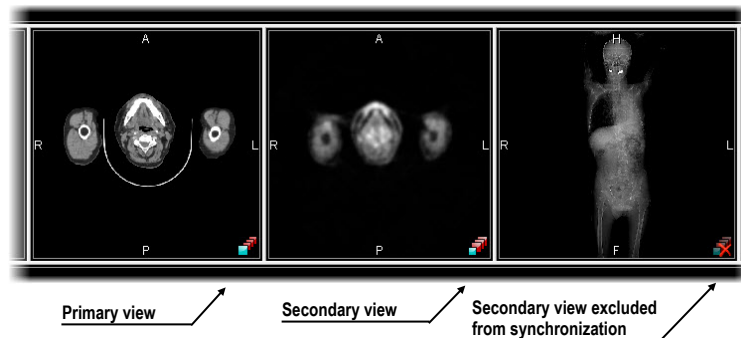
- **Manual synchronization** requires that there are images displayed in the segments when the synchronization is turned on. The images visible are then treated as the images at the initial positions. Further scrolling offsets the position of synchronized segment's images appropriately.

For example, see Figure 145 where two segments are synchronized manually. The relative offset of the images when synchronization is started is used to find the appropriate image.




**Figure 145 – Two segments synchronized manually**

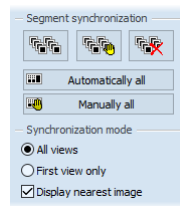
Synchronization occurs at the moment when an image is actively selected into a view. That view is called 'primary view', and the segment in which it is located is called 'primary segment', as they guide the selection of images to be displayed in all the other synchronized segments (secondary segments).



**Figure 146 – View synchronization status**


The status of synchronization of individual views is indicated by an icon in their lower right corners (see Figure 146). To customize the icon location, see 4.3 View texts, the **View status** text type.

The synchronization is controlled via the **Segment synchronization** section of the **Define layout** dialog in the tools panel tab with the  icon (see Figure 147).




**Figure 147 – Define layout tool Segment synchronization part**

To automatically synchronize all segments in the workspace:

1. Create or select a layout containing multiple segments to be synchronized.
2. Select  **Automatically all**.

All the segments found in the workspace are added to synchronization (marked with the icon of the automatic synchronization). The currently selected view becomes the primary view in the primary segment. All the other segments are set to be secondary segments and display the appropriate images.

To manually synchronize all segments in the workspace:

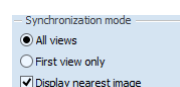
1. Create or select a layout containing multiple segments to be synchronized.
2. Select an image into one of the segments to become the primary segment.
3. Select images of another series at the initial spatial positions into a different segments.
4. Select  **Manually all**.

All the segments found in the workspace are marked for synchronization. Secondary segments' content is used to determine the requested relationship among the segments and is used in subsequent synchronization.

#### 6.4.1 Selecting synchronization mode

Two synchronization modes are available via the **Synchronization mode** part in the **Define layout** dialog (see Figure 148):

- Synchronize **All views**. The views are synchronized individually one by one. The number of views of every segment is the same.
- Synchronize the **First view only**. The first views of the secondary segments are synchronized to the currently selected view in the primary segment. The remaining views of the secondary segments are populated in the same way as they usually are regardless of the synchronization.



**Figure 148 – Define layout tool, Synchronization mode part**



When synchronizing all views, the synchronized segments are always aligned to the same layout – the total number of the views will be the same as well as their placement. When a view becomes pinned in the primary segment, its counterparts in the secondary segments are not being synchronized and will remain empty.

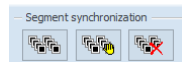
### 6.4.2 Controlling the selection of matching image

The appropriate image to be shown in the secondary segments is determined by the spatial position of the images in the primary segment. The appropriate image can either be positioned exactly at the same offset as the one in the primary view or can be simply the closest one to that position.

To show the image at the nearest position in the secondary views, check **Display nearest image** (see Figure 148). Uncheck **Display nearest image** to show only the images at the exactly same positions as in the primary views. The views in the secondary segment may display no image if there is no matching image in the series of the secondary segment.



### 6.4.3 Synchronizing individual segments

At times it may show necessary to control the synchronization of segments individually. The system allows individual selection of segments to be synchronized via the **Segment synchronization** part in the **Define layout** dialog (see Figure 149).




**Figure 149 – Define layout tool, Segment synchronization part**

To define automatic/manual synchronization of selected segments:

1. Click on one of the segments to be synchronized (this will initially become the primary segment).
2. Click  for automatic or  for manual synchronization, and move the cursor over the working area.
3. Click on the other one of the segments to be synchronized (the primary segment will be marked as **Pri.**). If multiple segments need to be selected, hold **Ctrl** while clicking on them.

To unselect individual segments from the synchronization:

1. Click , and move the cursor over the working area.
2. To cancel the synchronization altogether, click on the primary segment (it will be marked with the red frame as **Pri.**).

- To remove a secondary segment from the synchronization, click on it (it will be marked with the red frame and title **Sec.**).

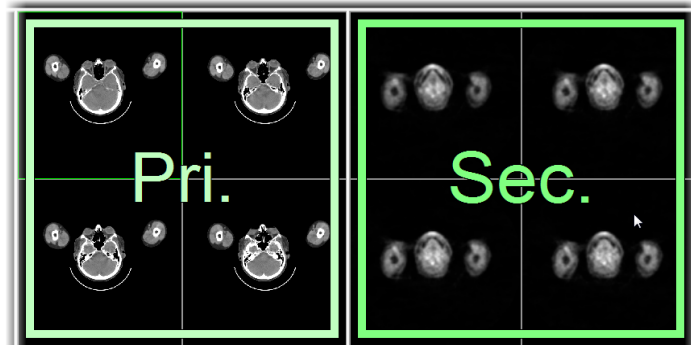



Figure 150 – Definition of synchronization for selected segments

## 6.5 Playing multi-frame images

Certain scanning devices (*XA*, *USG*, *MR*, etc.) are capable of capturing the entire sequence of image frames in a certain time period and storing it as one multi-frame image (like a movie). It is possible to use cine loops to automatically display a sequence of such multi-frame images. Additionally, it is possible to use cine loops to automatically display a sequence of non-multi-frame images from any series in the movie mode.

To quickly create and manipulate cine loops in any view of the working area, use the **Cine** tool in the tools panel. The **Cine** tool (see Figure 151) is docked in the tools panel and is accessible by clicking the tab with the  icon.

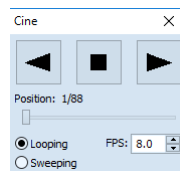
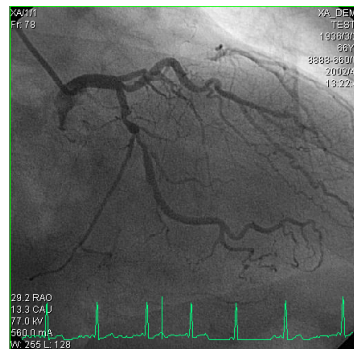


Figure 151 – Cine tool

Using this dialog, it is possible to control playback of images or a multi-frame image in any current view of the workspace. You can select the current view, and by the **Cine** tool you can select the playback mode. Then you can select another view, and in this tool you can select the playback mode for this new current view. During selection of another current view, the playback in the view will be kept.

If a multi-frame image contains curves (such as ECG), these can be projected into the image by selecting the **Curves** option in the **View** menu (see Figure 152). When playing, the current position in the sequence of frames is marked with a small vertical line inside the curve.



**Figure 152 – Cine view playing multi-frame image with the ECG curve**

If the **Double click starts/stops playback** option is allowed in the TomoCon settings (see 4.1.5 Mouse options), it is possible to start or stop the playback of a multi-frame image in the current view simply by double-clicking.

## 7 Manipulating images

### 7.1 Window and level manipulations

Window and level manipulations are among the most common tasks in digital medical imaging. These functions allow to view patient image data with appropriate contrast and image detailing in a particular grayscale range.


To change the window and level values, use any of the following methods:

- Adjusting the window/level using the mouse.
- Selecting a predefined window/level preset.
- Using the **Window/level** tool in the tools panel.

All changes of the window/level setting remain valid in any view until a new image is projected in the view, e.g. a new image is displayed in the view using the thumbnails palette. In this case, all window/level settings in the view are set up according to the values in the newly selected image. Current changes to the window/level settings in the current view are applied automatically and immediately to all images according to the limit selected in the **Scope** tool (segment, series, study, all).

The window/level changes applied to the current view can also be applied to the image (which is also displayed in the thumbnail preview). Select the **Apply** item in the context menu of the current view to apply these changes to the image. Click the **Apply to all** button to apply these changes to all images and views of the current series.

#### 7.1.1 Window/level tool

The **Window/level** tool (see Figure 153) is docked in the tools panel tab with the  icon by default.

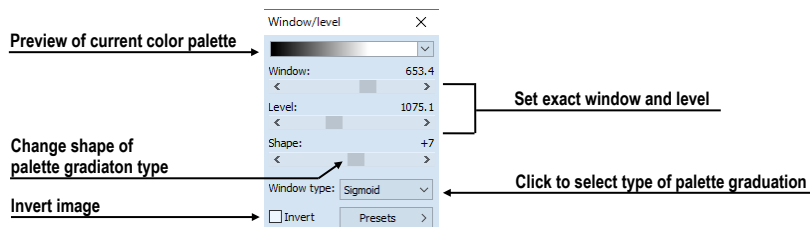


Figure 153 – Window/level tool

Using this tool, you can view and change the window/level setting of the currently selected view. To adjust the window, level and shape of the current view, use the

**Window**, **Level** and **Shape** sliders in the Window/level tool. Changes made by the **Window**, **Level** and **Shape** sliders define the contrast level of the displayed image data.

With this tool, you also can change the palette graduation type by selecting a new one from the **Window type** combo box, apply certain presets using the **Presets** button and invert the current color palette by checking the **Invert** check box.

### 7.1.2 Color palette

When an image view is shown, the color palette selected by default is defined using the application setup (see 4.2 Modality options). The color palette can be subsequently changed for the whole segment where the view is placed.

To change the color palette, select from the palettes available in the **Color palette** combo box (see Figure 154). The palette change will affect all the views in the current segment with the exception of the pinned views where the palette settings are individual.

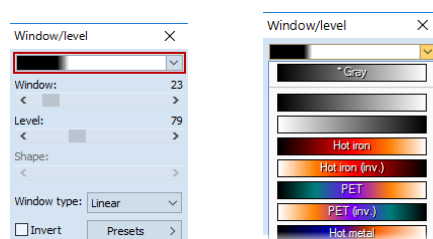


Figure 154 – Selecting color palette

The color palette in the segment can also be changed using the color palette which is displayed next to the segment:

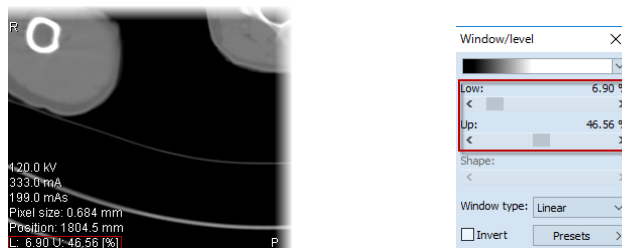
1. Make sure the color palette is displayed. To show the color palette indication, select **View/Color palette** from the main application menu.
2. Right-click the color palette indication. The list of the color palettes available is shown.
3. Select the desired color palette.

### 7.1.3 Window/level adjustment mode

The TomoCon application offers four ways in which to represent and change the values for a window/level setting. The visible range of the image data (the window) can be specified through the following methods:

- Window/level – the window value defines the width, and the level value defines the center in the image data displayed in the view.

- **Low/Up** – the Low value defines the lower (start) limit and the Up value defines the upper (end) limit in the image data values displayed in the view.
- **Low/Up [%]** – the Low value defines the lower (start) limit and the Up value defines the upper (end) limit in percentage of the image data values displayed in the view (see Figure 155).
- **Contrast/Brightness** – this method is accessible only for VOI LUT presets and cannot be used for other types of presets. Instead of changing the width and position of the image data, the contrast and brightness changes the width and position of the VOI lookup table (see 7.1.5 VOI LUT) defined by the preset.



**Figure 155 – Window/level tool and a view with the LU[%] adjustment type**

To change the current adjustment method, select the required method in the **Adjustment type** combo box on the **Modality** tab of the **Options** dialog (see 4.2 Modality options). For the specified modality the window/level information string in the views (the view texts) as well as in the **Window/level** tool is formatted according to this option (see Figure 155).

### 7.1.4 Palette graduation type

The color palette used for displaying image data is represented by the color gradient. This gradient can be modified by adjusting its curve type. Changing the graduation type slightly modifies the color gradient and therefore provides the possibility to refine the details displayed in the view.

The TomoCon application offers base linear, sigmoid and exponential types of color graduation. Sigmoid and exponential graduation can be refined by specifying the shape factor in the **Window/level** tool in the tools panel.

To change the current window/level graduation type, select a new type in the **Window type** combo box (see Figure 156) and from the displayed list select one of the following graduation types:

- **Linear** – the gradient changes linearly.
- **Sigmoid** – the gradient changes according to the sigmoid function.
- **Exponential** – the gradient changes according to the exponent function.

- **Histogram EQ** – this is a special window/level setting mode called histogram equalization. Using this method, you can optimally set the contrast of the image, so that the image intensities are evenly distributed. This mode is useful for overexposed and underexposed images.

Selecting the **Sigmoid** or the **Exponential** mode in the combo box makes the **Shape** slider accessible (it is otherwise disabled) which can be used to change the shape factor in the current view.

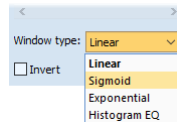


Figure 156 – Changing the palette graduation type

### 7.1.5 VOI LUT

Certain images may contain DICOM information about how to present image data to a user. This information is represented by a lookup table called the Values Of Interest Lookup Table (VOI LUT preset). The table can be used to transform the input image data intensities instead of the mathematical (linear, sigmoid or exponential) function.

When an image contains a VOI LUT preset, it is used for display within the view by default. In this case, the special **VOI LUT Data** graduation type is added to the **Window type** combo box in the **Window/level** tool (see Figure 157).

A VOI LUT preset does not use window, level and shape values. The **Contrast** (instead of the **Window**) slider and the **Brightness** (instead of the **Level**) slider are used to adjust the contrast and the brightness of the visible range (-100%, 100%) of the image data. Both values are set to 0% by default which means that the visible range is the entire data range.

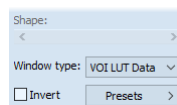


Figure 157 – Active VOI LUT Data window type

### 7.1.6 Presets

For quick and convenient adjustment of the window/level values the TomoCon application provides with the preset functionality. A preset is a set of the exact values for the window, level and shape. The preset values can also be defined inside any image as part of DICOM information. When you apply a preset, all values are applied to the view at one time.

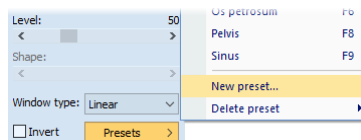
TomoCon provides a number of predefined presets for each modality and also offers the possibility to create and use own presets. Names and key shortcuts (F2-F9) can be assigned to the user-defined presets.

For each image displayed in the view, TomoCon provides an immediately accessible list of all applicable presets in the **Window/level preset** submenu in the context menu of the current view or in the drop-down list displayed by clicking the **Presets** button in the **Window/level** tool. The DICOM presets and modality presets are separated by the menu separator.

To apply a window/level preset, select the corresponding item from the list of presets in the context menu of the view or in the list in the Window/level tool. If any of the keyboard shortcut keys (F2 to F9) is assigned to a preset, simply press the keyboard shortcut and the preset will be applied.

To create a new window/level preset for a specified modality, proceed as follows:

1. Select the image of the modality for which you want to create a new preset in the current view.
2. Click the **Presets** button in the **Window/level** tool, and select the **New preset...** item (see Figure 158) in the displayed drop-down list.
3. The **Window/level preset** dialog is then displayed. The initial values for the window, level shape and palette graduation type (even if not displayed) are the same as the current window/level settings in the current view (see Figure 159).



**Figure 158 – Creating a new window/level preset**

4. Enter new preset's name into the **Preset** edit box.
5. Select the desired window/level type from **Type** combo box. Depending on the selected window/level type, values for the preset will be considered to be window/level, low/up, or low/up percentage.
6. Enter the new window (low), level (up) and shape values into the **Window (Low)**, **Level (Up)** and **Shape** edit boxes.
7. Select a keyboard shortcut (F2 to F9) from the **Key** combo box to be assigned to the new preset.
8. To save the preset, click the **OK** button.



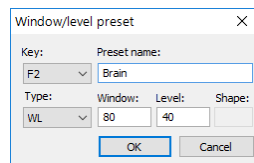


Figure 159 – Window/level preset dialog – defining a new preset

To remove a defined preset, proceed as follows:

1. Click the **Presets** button in the **Window/level** tools dialog.
2. The drop-down list is then displayed. All the defined presets are displayed in the **Delete preset** submenu.
3. Select the preset you want to remove in the displayed submenu list (see Figure 160).

Alternatively, to create a new or to edit and to remove an existing preset for each modality is possible on the **Modality** tab of the **Options** dialog (see 4.2 Modality options).

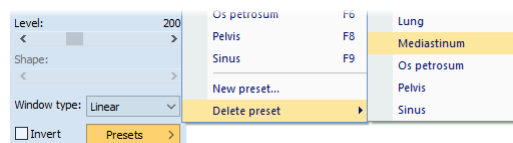


Figure 160 – Deleting a window/level preset

### 7.1.7 Inverting a color palette

The current view color palette can be inverted, so that the colors in the color gradient are ordered in reverse order. To invert the current color palette, check the **Invert** check box in the **Window/level** tool. If you want to use the original color palette within the current view, simply uncheck the **Invert** check box.

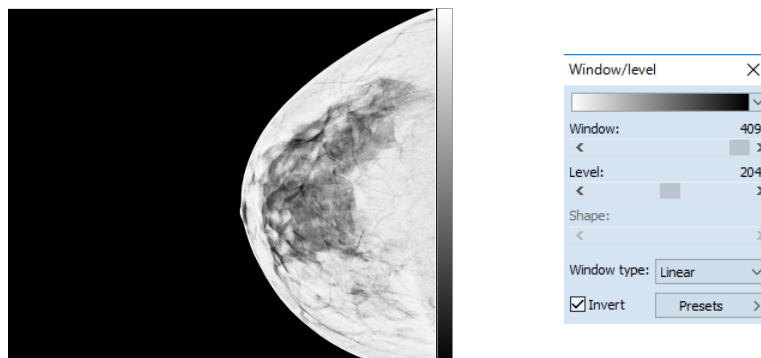






Figure 161 - Inverted view (Smart invert is activated)

If the current image contains DICOM information concerning background air and the **Smart invert** check box on the **Modality** tab of the **Options** dialog (see 4.2 Modality

options) for the image modality is checked, inverting the view inverts the entire image except for the air areas (see Figure 161).

### 7.1.8 Adjusting window/level using the mouse

In order to modify the window and the level simultaneously without using the **Window/level** tool, click the **Window/level**  icon in the **Image** menu or select the **Window/level** item in the context menu of the view (the cursor changes to the  form). Next, click in the view and move the cursor (holding down the left mouse button) horizontally (window) and vertically (level). The level and window values change immediately in the current view.

Alternatively, the level and window values can also be changed using the **Window/level rectangle**. This is accessible in the **Image** menu and in the context menu of the view through the **Window/level rectangle**  item. The cursor changes to the  form. Click in the image, and move the cursor within the view (holding down the mouse button). A rectangle will be drawn around the area. You can cancel the dragged rectangle by pressing the **Esc** button on the keyboard. After the mouse button is released, the window and the level are set for optimal contrast in the area within the rectangle.

## 7.2 Zooming an image

Zooming an image allows to change the zoom factor in the current view to examine fine details of the displayed image, e.g. when diagnosing small structures, contouring small objects or clicking reference points. To change this factor, when zooming in/out within images, select one of the following ways:

- Moving the cursor within the current view using the zoom or zoom rectangle function.
- Scrolling the mouse wheel while holding down the **Ctrl** key.
- Using the **Zoom** tool that is accessible in the tools panel (see 7.2.1 Zoom tool).

The interpretation of the current zoom factor depends on the currently selected zoom mode which defines the scaling between the image and the view size. Unlike the zoom factor, the zoom mode is not set separately for each view, but is set globally for the entire TomoCon application (except for the mammography mode).

TomoCon offers the following zoom modes (it is assumed that the zoom factor has not been changed, i.e. it is set to 100%):

- **Fit to view**. The image is displayed so it is entirely visible within the view.

- **True size.** The image is displayed so that 1 mm of the actual image is equal to 1 mm on the display.
- **Right size.** The images are displayed so that the largest image is fit to the view and the rest of the images are displayed in the same physical size.
- **Pixel for pixel.** Each image is displayed so that one pixel on the display corresponds to one image pixel. If the **Pixel for pixel** zoom mode is set as the current zoom mode and you change the zoom factor of the current view (using the zoom functions or the mouse wheel), the current zoom mode immediately changes to **Fit to view**.

When using the **True size** or **Right size** zoom mode, it is required that all monitors are calibrated, because these modes cannot display an image without the information concerning the physical dimensions of the display. The monitor is calibrated using the **Options** dialog (see 4.7 Monitors).

Information concerning the currently used zoom mode and the current zoom factor is also displayed in the view as part of the zoom view text (see Figure 162).




**Figure 162 – Zoom modes in the view texts**

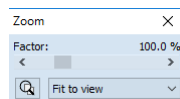
After the image is zoomed, some parts of the image may be moved outside the current view. You therefore may need to move the entire image within the view. To change the current image position within the current view, use the mouse with the active move function (see 7.2.3 Moving with the mouse).

The zoom and move changes in the current view are applied automatically and immediately to all images according to the limit selected in the **Scope** tool which is part of the status bar. The changes can be restricted to a single segment, series or study or applied to all views in all working areas. These changes can also be applied directly to the image (which will also be displayed in the thumbnail preview) by selecting the **Apply** item in the context menu of the current view or by selecting the **Apply to all** item in order to apply to all images and views of the current series.

TomoCon also provides the magnifying glass functionality which allows to magnify an area of interest within a small separate magnification window without changing the zoom factor of the current view (see 7.2.4 Magnifying glass).

### 7.2.1 Zoom tool

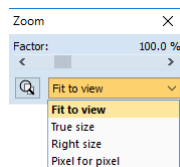
The **Zoom** tool (see Figure 163) is initially docked in the tools panel, and can be accessed by clicking the  icon.



**Figure 163 – Zoom tool**

The **Zoom factor** can be changed by moving the slider in the dialog; it can be set to any percentage from 50% to 1600%. The new zoom value is then immediately changed in the current view and the current values are displayed automatically at the right above the slider. The center of zooming is defined by the alignment of the current view. When changing the zoom factor, the image in the view is zoomed from this center equally in all directions. This can also be done by scrolling the mouse wheel while holding down the **Ctrl** key.





To change the current zoom mode, select a new mode from the **Zoom mode** combo box (see Figure 164). When the current zoom mode is **Pixel for pixel**, the **Zoom factor** slider is disabled.




**Figure 164 – Zoom mode combo box**


## 7.2.2 Zooming with the mouse

To modify the zoom factor using the mouse (without using the **Zoom** tool), select the zoom or zoom rectangle function. These functions are accessible in the view's context menu or in the **Image** submenu of the main menu:

- To activate the Zoom function, select the **Zoom**  item (the cursor changes to the  form). Next, click in the view, and move the cursor (holding down the left mouse button) in the image vertically. The image is then immediately zoomed, and the clicked point remains in the same position. This is useful when zooming a particular detail.
- To activate the zoom rectangle, select the **Zoom rectangle**  item (the cursor changes to the  form). Next, click in the view, and move the cursor (holding down the left mouse button) to draw the rectangle. The dragged rectangle can be canceled by pressing the **Esc** key. After the mouse button is released, the area within the rectangle is zoomed to fit the view.

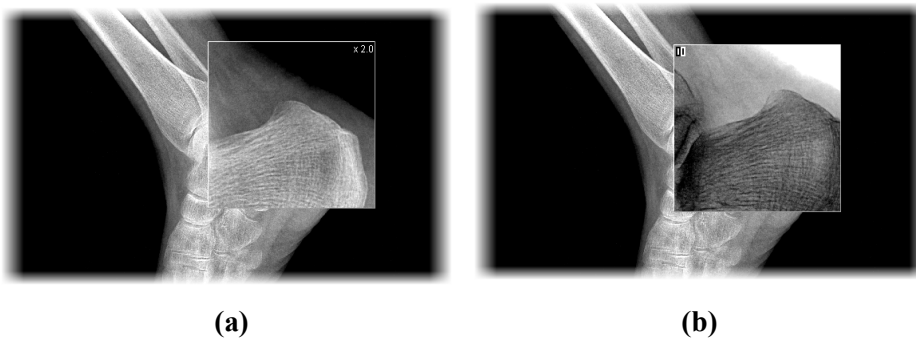
### 7.2.3 Moving with the mouse

To modify the position of an image within a view, use the **↕ Move** item from the **Image** submenu of the main menu or from the view's context menu. The cursor changes to the  form.

For required moving, click in the current view (the cursor changes to the  form), and move the mouse (holding down the left mouse button). The image then moves immediately as you move the mouse. To finish moving of the image, release the mouse button.



### 7.2.4 Magnifying glass

The magnifying glass function allows to magnify an area of interest within a small separate magnification window that moves along with the cursor.



**Figure 165 – Active Magnifying glass window - normal (a), invert (b)**

To activate the magnifying glass, proceed as follows:

1. Click the **Magnify** button in the **Zoom** tool, or select the **Magnifying glass**  item in context menu of the current view (the cursor changes to the  form).
2. Press and hold the left mouse button over the area of the image you want to magnify. The magnifying window appears at the position of the cursor, and displays the magnified part of the view (see Figure 165a). Moving the cursor across the selected view changes the magnifying glass position, and the part of the image it displays.
3. To change the zoom factor of the magnifying glass, press the **Ctrl** key and scroll the mouse wheel. It is possible to set a zoom factor of up to 8. The current zoom factor of the magnifying glass is displayed in the upper right-hand corner of the magnification window.
4. To invert the zoomed image in the magnification window, press the **Tab** key (see Figure 165b). To turn off the invert mode, press the **Tab** key again.
5. To close the magnifying glass window, release the mouse button.

### 7.3 Image filters

The TomoCon application includes numerous image processing filters for noise removal and small structure enhancement. These filters can be applied to any image in the working area using the **Filter** tool (see Figure 166) in the tools panel.

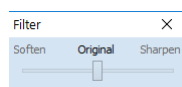


Figure 166 – Filter tool

To apply a filter to an image, select the view containing the image to be filtered. Next, select the degree of softening or sharpening using the slider (the left side is used for softening, the right side is used for sharpening and the middle position is used to switch off the filtering), see Figure 167.

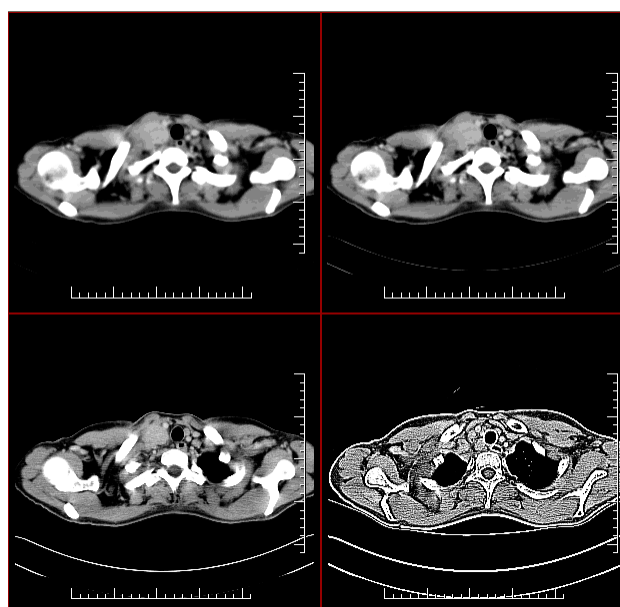


Figure 167 – The effects of the various filters

### 7.4 DSA - Digital Subtraction Angiography

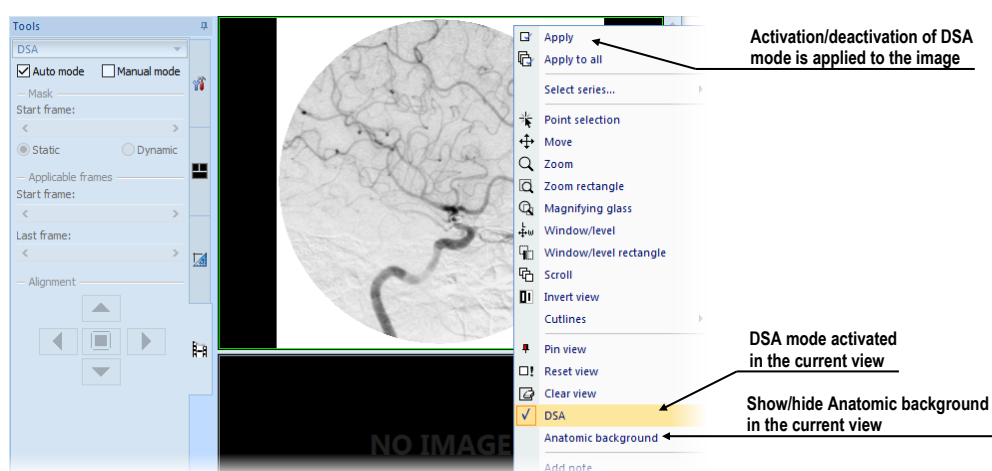
The DSA mode supports the display of multi-frame images with an image sequence taken with contrast media and without. The final DSA image is then displayed as the difference between the base image (with contrast media) and the mask image (without contrast media). To separate the base and mask images, the following modes can be used:

- **Automatic** - when the images contain DICOM information from the patient examination, and the separation occurs automatically after opening the patient data (see 7.4.1 Automatic DSA mode).

- **Manual** - when image separation has to be carried out manually (see 7.4.2 Manual DSA mode).

### 7.4.1 Automatic DSA mode


First, open the desired patient study with the multi-frame image containing the DICOM information concerning the DSA examination. After the image is displayed, the DSA mode depending on the **Always apply DSA** setting on the **General** tab of the **Options** dialog (see 4.1 General options) is turned on automatically in all views for all image types.



**Figure 168 – Automatic DSA mode**

The DSA mode in the current view can be turned off by selecting the **DSA** item in the view's context menu. The changes made in the current view can be applied to the image's thumbnail preview by selecting the **Apply** item in the context menu of the current view. The changes are applied to all images in the current series by selecting the **Apply to all** item in the context menu of the current view.

### 7.4.2 Manual DSA mode

To activate the manual DSA display mode, use the **DSA** tool which is initially docked in the tools panel. It is accessible at any time by clicking the tab with the  icon or by selecting the **DSA...** item in the **Tools** submenu. Proceed as follows:

1. Open the desired patient study containing the multi-frame image without DICOM information concerning the DSA examination, and select the multi-frame image in the current view.
2. Select the **Manual mode** in the **DSA** tool (see Figure 169).

The manual DSA mode then becomes active in the current view according to the following parameters of the **DSA** tool:

- **Mask** - the starting image number (**Start frame**) in the mask (image sequence without contrast media):
  - Static** - the mask frame is static for all selected frames
  - Dynamic** - the mask frame changes dynamically according to the currently selected frame
- **Applicable frame** - the image sequence with contrast media from which the mask image(s) is subtracted. **Start** is the first sequence image number and **Count** is the number of sequence images.
- **Alignment** - movement of the mask image relative to the base image.

The changes to these parameters are then applied immediately to the image in the current view. To return to the original setting, select the **Auto mode** item, and the settings will revert back to the original DICOM setting.

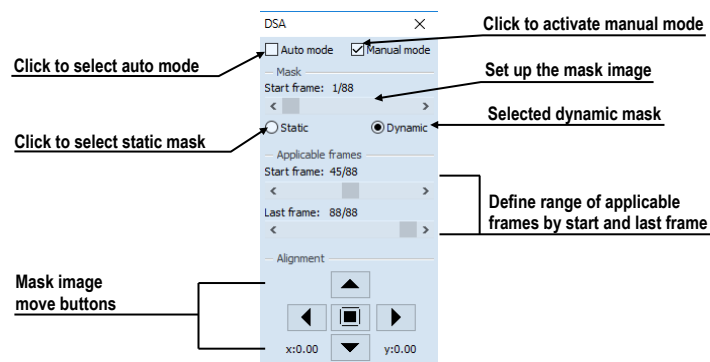


Figure 169 – DSA tool

## 7.5 Cutlines

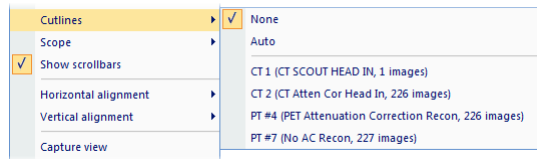
Cutlines are intersections of image planes in one series and a plane of a selected image from another series in which they are displayed. The **Cutlines** function can be used between two series only if registration between the series has been created (see 18 Registrations).

Open the desired patient study with multiple series and registrations between them. Select the image in the thumbnails palette in which the cutlines are to be displayed. Select the **Cutlines** item in the view's context menu or the **View/Cutlines** submenu to activate the **Cutlines** function (see Figure 170).

Select the patient series in the **Cutlines** menu. The cutlines of the selected series are then immediately displayed in the current view; these are called standard cutlines (if the planes are not parallel). Standard cutlines are displayed as lines with series and



image descriptions (see Figure 170). You can set up the cutline color and line shape in the application settings (see 4.4 Color and style options).



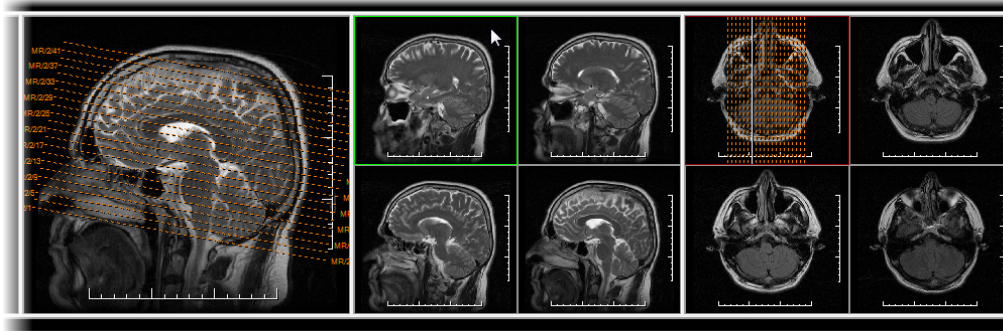
**Figure 170 – View/Cutlines menu**

Load the desired image from the selected series into another view; its position will be displayed in the view with the displayed cutlines (the current cutline). The current cutline is displayed as a line; you can set up the color and line shape in the application settings (see 4.4 Color and style options). The cutline automatically changes when another image of the selected series is chosen. This is also displayed when scrolling the images of the series with the displayed cutlines (as long as the planes are not parallel).

It is possible to project cutlines of multiple series into one image. Select the series you want to display in the image in the **Cutlines** menu.

It is also possible to display cutlines in multiple sequences/views at one time (see Figure 171). In each sequence/view right-click and select the **Cutlines** and the registered series.

If the cutlines cannot be displayed, there are no registrations defined between the series or the section planes are parallel (they do not intersect).



**Figure 171 – Displayed cutlines in the working area**

### 7.5.1 Hiding cutlines

The **None** item in the **Cutlines** menu (see Figure 170) is a predefined option which means that no cutlines will be displayed. Once the cutlines have been activated, select the **None** item to turn off the display of the cutlines (right-click and select **Cutlines/None**).

It is also possible to hide **Cutlines** by clicking the selected series in the **Cutlines** menu.

### 7.5.2 Auto mode

First, right-click in the current view, select the **Cutlines/Auto** item in the context menu (see Figure 170), and open an image from any patient series in a new window. The cutlines of the new series are then automatically displayed in the view with the **Auto** mode. The selected image is displayed as the current cutline. The current cutlines automatically change when the image in the current view is changed.



### 7.5.3 Printing cutlines

Defined cutlines can be printed out with the image on a standard Microsoft Windows printer or a DICOM printer (see 19 Print images).

## 7.6 Reference lines

Reference lines show the intersection of current view plane on all the other displayed views where the intersection can be calculated. In addition, the range of the images in the segment can be shown (see Figure 172).

To control the visibility of reference lines:

1. Select **View/Reference lines** item in the main menu.
2. Select  **Current** to show or hide the intersection with the current view plane.
3. Select  **First and Last** to show or hide the range of the images.

The visibility of reference lines can also be set from the mini-toolbar (see 3.1.4 View context menu) or the **Quick access toolbar** (see 3.2.2 Quick access toolbar) once configured.

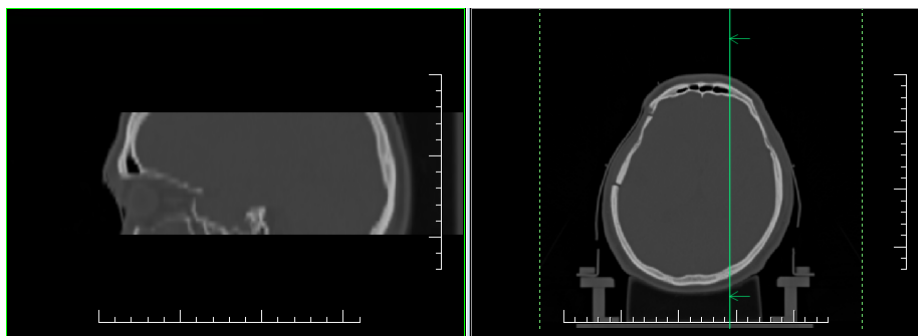


Figure 172 – Reference lines of the current view (sagittal MPR left)

Note that the reference lines are not displayed between different series, unless a registration exists. If a view plane is parallel to the current view plane, the reference lines are not shown on that view – there is no intersection between the two planes. The color and the style of reference lines can be customized in the application settings (see 4.4 Color and style options).

## 7.7 Key object selection

Key object selection (KOS) allows marking important images of clinical interest in an opened study. Each KOS consists of author's name, a user-supplied description and a reference to the selected images or other objects from the study. The KOS can quickly direct referring physicians to the relevant pathology when viewing study. Each KOS belongs to a study and is automatically opened when opening the study. Only key object selections which are not saved yet can be modified; once a KOS is saved, it becomes read-only.

### 7.7.1 Creating new key object selection

TomoCon allows creating new KOS at any time while viewing study images in view. To create new KOS click **★ Key object selection** in the main toolbar. Fill **Description** and **Author** (see Figure 173) and click **OK**.

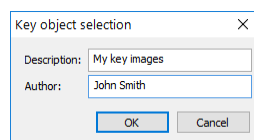


Figure 173 – Key object selection dialog

Newly created KOS will be automatically added to all opened key objects and selected as current. To display all currently editable key object selections, and see with one is current, click the arrow next to **★ Key object selection** in the main toolbar (see Figure 175).

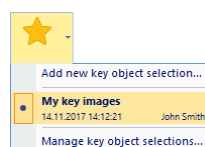


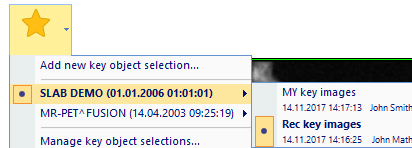
Figure 174 – List of all key objects

### 7.7.2 Managing key object selections

To display list of newly created key objects in opened studies, click the arrow next to **★ Key object selection** in the main toolbar (see Figure 175). For each KOS, object

description, author and creation date and time are shown. The list contains only those key objects that are not currently saved and the content and properties of which can be changed. Once the study is saved, all created key objects become read only and only new versions of objects can be modified.

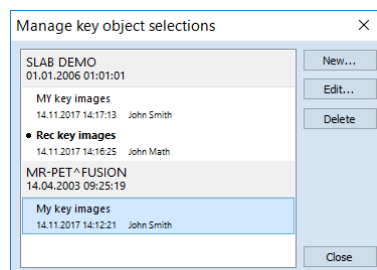
Currently selected KOS is highlighted in the list. Only images in the currently selected KOS can be modified. To change the currently selected KOS, click on the appropriate item in this list.



**Figure 175 – List of all key object selections. Multiple studies are open**

To see the list of all created and open key objects in all open studies, click **Manage key object selections** in KOS menu. The following actions can be performed with key objects (see Figure 176):

- Create **New...** KOS in selected study
- **Edit...** selected KOS, which allows to change the author and description. When a KOS is read only (already saved), then a revised version of the KOS will be created.
- **Delete** selected KOS, which will remove key object from local studies storage.



**Figure 176 – Manage key object selections dialog**

### 7.7.3 Adding/removing images to/from key object selection

To add an image into KOS:

1. Display the image in the current view and create a new KOS (see 7.7.1 Creating new key object selection) or select the desired KOS from the same study using the menu in the main toolbar, or using **Manage key object selections** dialog (see 7.7.2 Managing key object selections...).
2. Click the KOS identification icon (star icon) in the view (see Figure 177).

The color of KOS identification icon in view shows the relationship between currently selected KOS in TomoCon and the image:




-  Yellow star indicates that the image belongs to the currently selected KOS. To remove the image from KOS, click the icon.
-  Transparent star indicates that the image does not belong to any KOS. To insert the image to the currently selected KOS, click on this icon.
-  Blue star indicates that the image belongs to a non-current KOS. To insert the image to the currently selected KOS, click the icon.



Figure 177 – KOS identification icon in a view

#### 7.7.4 Key object selection in thumbnails

If a study contains any KOS, a KOS tab is displayed in thumbnails. Each existing KOS is displayed as a separate page with header showing image count and description and the thumbnails of images in KOS (see Figure 178).

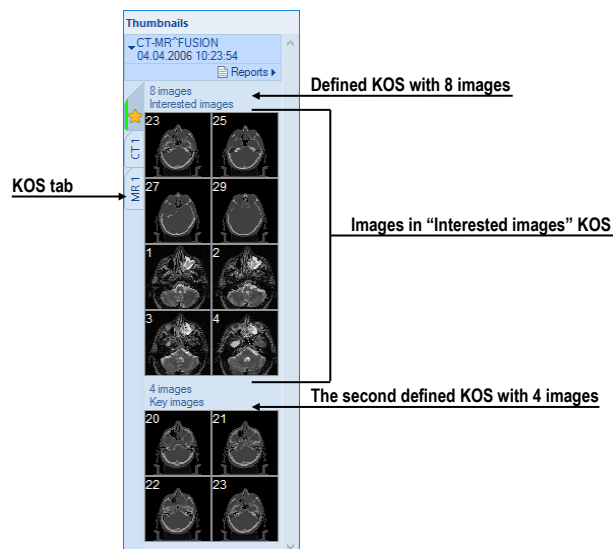



Figure 178 – KOS in thumbnails

To display images from a KOS, click the KOS tab in the related study and click on any image in the desired KOS. Selected image will be displayed in the current view in a special KOS display mode. In this mode, mouse wheel scrolls over all the images in

the KOS. To deactivate KOS display mode, click the  icon in view (see Figure 179).

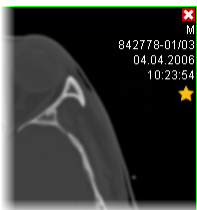


Figure 179 – KOS display mode in a view

### 7.7.5 Loading and saving a key object selection

Key object selections can be saved as DICOM objects in the Local studies storage; moreover, these DICOM objects can be sent over to a PACS. All key object selections can be saved by selecting **Save** in the **Study** menu, or when attempting to close TomoCon (depending on its setting, see 4.1.8 Confirmations).

**Search studies** dialog shows stored key object selections as objects of KO modality (see Figure 180). When a study with key objects is opened, all key objects that belong to the study also open automatically and are displayed in the thumbnails palette.

Patient ID	Patient name	Sex	Date of birth	Status	Study date	Study time	Study ID	Modality	Description
TEST 20	CT*MR study			Seen				CT,KO,MR	
Series number	Series description	Series date	Series time	Modality	Images				
1				KO	1				
1				KO	1				
1				KO	1				
2				CT	8				
3				MR	4				

3 key object selections

Figure 180 – Search studies dialog

## 7.8 Exporting images

The TomoCon application enables the export of patient image data in the following formats:

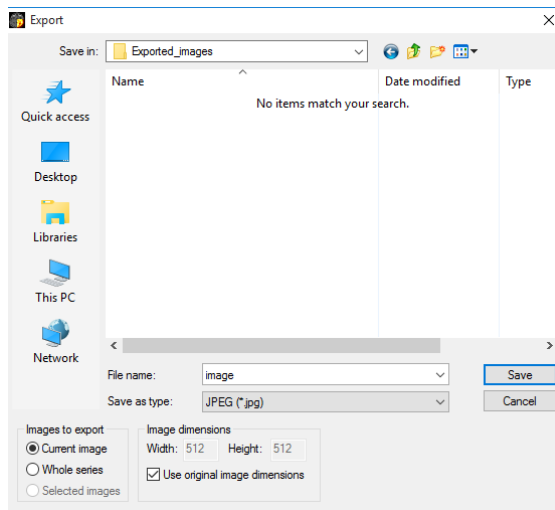
- JPEG, DICOM, TIFF, BMP (see 7.8.1 Export of images)
- AVI (see 7.8.2 Exporting images to an AVI format video file)

### 7.8.1 Export of images

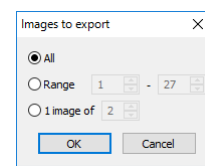
It is possible to export a selected patient image or an entire series of patient images into a bitmap file or a DICOM file. The **Export** dialog is opened by selecting the **Export images...** item in the **Study** submenu (see Figure 181a).

The available bitmap file formats are JPEG, BMP, TIFF and DICOM. Select the image dimensions for the bitmap file, or leave the dialog's presetting (**Use original image dimensions**).

If you selected the entire series option in the dialog, the **Images to export** dialog will be displayed in which you can define the range of images to be exported (see Figure 181b).



(a)



(b)

Figure 181 – Export images dialog (a), Images to export dialog (b)

## 7.8.2 Exporting images to an AVI format video file

It is possible to create a video file in desired video format from a series of patient image data. The **Create AVI** dialog (see Figure 182) opens by selecting the **Export as AVI video...** item in the **Study** submenu.

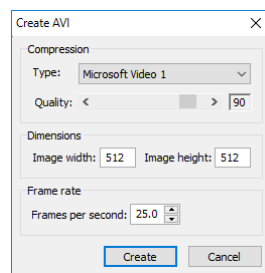


Figure 182 – Create AVI dialog

The **Create AVI** dialog allows to change the default parameters of exported video file (the compression, the image dimensions, the playback speed). To play a video file on another computer, it is necessary to have a format used (or compatible) on the computer.

After clicking the **Create** button, the **Frames to export** dialog is displayed (see Figure 182) to define the range of images to be exported.

## 7.9 ***Adding and removing images of series***

At times, it is necessary to remove unneeded images from a series or to add certain images to a series, potentially, a screenshot or a copy of the working area as a separate image. You can use the functionality of the thumbnail palette or the capture functions in the main submenu to carry out these tasks.

To insert a screenshot of the working area by means of the thumbnail palette, proceed as follows:

1. Select the desired working area (by clicking any view in the working area).
2. Move the cursor over the images belonging to the target series to which you want to add the screenshot.
3. Right-click to open the context menu, and select the **Insert image/Insert working area screenshot** item (see Figure 183). The screenshot of the working area is then automatically inserted at the end of the target series.

Alternatively, use the item of the main submenu as follows:

1. Select the desired working area (by clicking any view in the working area).
2. Select the **View/Capture working area** item in the main submenu.
3. The screenshot of the working area is then inserted at the end of the OT series in the current study. If the OT series does not exist, it will be created.

To insert a screenshot of the current view by means of the thumbnail palette, proceed as follows:

1. Prepare the image for the screenshot in the current view.
2. Move the cursor over the thumbnail previews of the images from the series into which the new image is to be inserted.
3. Right-click to display the context menu, and select the **Insert image/Insert view screenshot** item (see Figure 183). The screenshot of the current view is then automatically inserted at the end of the series.

Alternatively, use the item of the **View** main submenu as follows:

1. Prepare the image for the screenshot in the current view.
2. Select the **View/Capture view** item in the main submenu.



3. The screenshot of the current view is then automatically inserted at the end of the OT series in the current study. If the OT series does not exist, it will be created.

To insert a screenshot of all working areas using the **View** main submenu, proceed as follows:

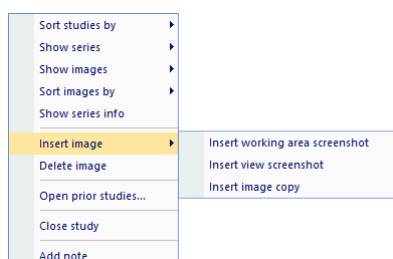
1. Select the **View/Capture all working areas** item.
2. The screenshot of all working areas is then automatically inserted at the end of the OT series in the current study. If the OT series does not exist, it will be created. A separate image will be created from each working area.

To insert a copy of a selected image in the current view (it will be copied as a DICOM image) proceed as follows:

1. Select the image for insertion into the current view.
2. Move the cursor over the thumbnail previews of the images from the series into which the new image is to be inserted.
3. Right-click to display the context menu, and select the **Insert image/Insert image copy** item (see Figure 183). The image from the current view is then automatically inserted at the end of the series.

To delete a selected image from a series, proceed as follows:

1. Move the cursor over the thumbnail preview of the image to be deleted. If you want to delete a group of images from the same series, right-click the first image holding down the mouse button, move to the last image and release the mouse button. The images for deletion will be highlighted in blue.
2. Right-click to display the context menu (see Figure 183), and select the **Delete image** item. The image/group of images is then automatically deleted from the series.

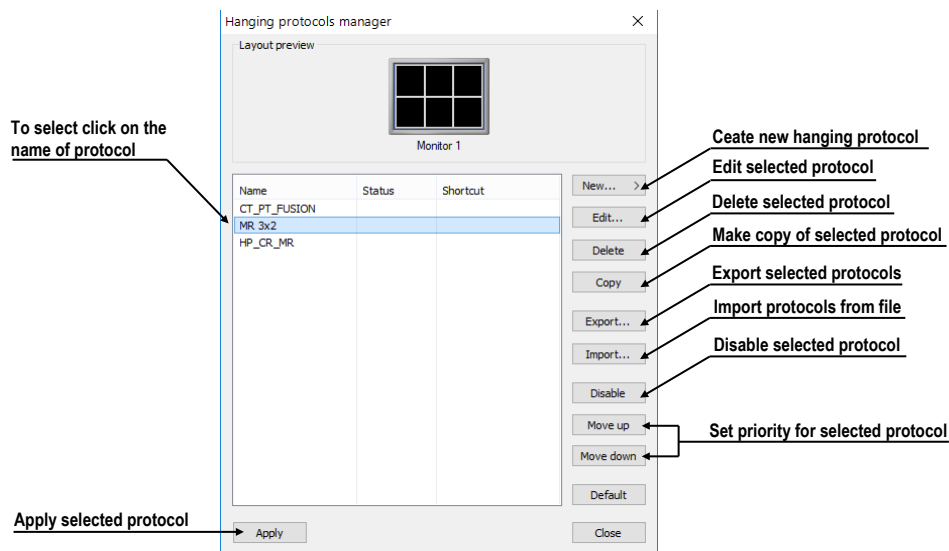


**Figure 183 – Context menu of the thumbnails palette**

## 8 Hanging protocols

If you frequently work with the same type of data series of individual patients, the TomoCon application provides with the possibility to display images from these series according your own guidelines. Such a group of guidelines defines a hanging protocol which can be saved for future use. You can later view or edit all stored hanging protocols or define new ones using the Hanging protocols manager (the **Hanging protocols manager** dialog, see Figure 184). To display the **Hanging protocols manager** dialog, select the **Hanging protocols manager...** item in the **Layout** main submenu.

You can apply defined and stored hanging protocols to the loaded studies manually, or you can activate the option for them to be applied automatically according to the first loaded study.



**Figure 184 – Hanging protocols manager dialog**

The **Hanging protocol manager** dialog provides a list of all defined hanging protocols and protocol handling tools. For the selected protocol the layout preview is displayed with advanced drag-and-drop functionality which can be used for moving working areas to a selected monitor. By this way, the working areas can be move between the monitors and place multiple working areas from one monitor onto another (see Figure 185). The number of working areas depends on the number of monitors connected to the workstation.

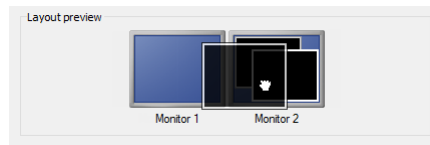


Figure 185 – Drag-and-drop functionality in the layout preview


## 8.1 Applying a hanging protocol

The TomoCon application provides with the possibility to apply a selected hanging protocol to the current working area manually or automatically.

To apply a hanging protocol automatically, check at least one of the following items in the **Layout** menu:

- **Automatically apply/Auto-apply hanging protocol.** The protocol is selected according to priority. TomoCon browses through all protocols one by one starting with the one with the highest priority, and applies the first protocol whose criteria conforms to the opened study.
- **Automatically apply/Apply last used hanging protocol.** When open the first study, the most recently used protocol is applied to the given study automatically.

To apply a hanging protocol manually, proceed as follows (see Figure 186):

1. Click the  **HP** icon in the main toolbar.
2. In the displayed window, click the required hanging protocol to be subsequently applied.

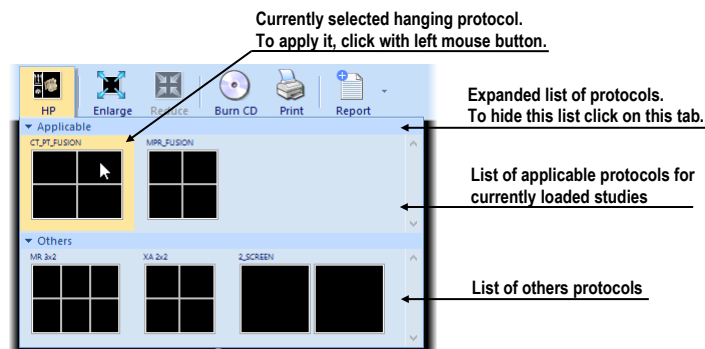


Figure 186 – List of hanging protocols

The name of the hanging protocol applied is displayed in TomoCon title bar. The name is removed after actions causing a change of the layout or after a change of the actual series in any segment.

## 8.2 *Importing and exporting hanging protocols*

To transfer previously defined hanging protocols from one computer to another, use import and export functions in the **Hanging protocol manager** dialog (to display the **Hanging protocol manager** dialog, select the **Hanging protocol manager...** item in the **Layout** menu).

To export hanging protocols:

1. Select the protocol(s) for export in the displayed list (to make multiple selections, hold down the **Ctrl** key).
2. Click the **Export...** button, and in the displayed dialog, enter the name of the file designated for export.

To import a hanging protocol:

1. Click the **Import...** button, and select the required file.
2. The imported hanging protocol will be added to the list of all protocols. If the imported protocol already exists, you can overwrite it or you can leave the original protocol.

## 8.3 *Manually creating and modifying a hanging protocol*

The **Hanging protocol manager** dialog allows to define a new protocol or edit an existing one. To display the **Hanging protocol manager** dialog, select the **Hanging protocol manager...** item in the **Layout** main submenu.

The main part of each protocol is the defined layout of the working area (for an explanation of how to define a layout, see 3.1.1 Working area layout). Once you apply the selected protocol to the opened study, the existing application layout is replaced by this layout and consequently all properties of the protocol are then applied to the individual parts of the working area.

To define a new hanging protocol, proceed as follows:

1. Click the **New...** button, and in the displayed list select the working area layout whereby a new protocol will be created.
2. In the displayed **Hanging protocol properties** dialog, define the properties of the new protocol, and click the **OK** button.

To modify the properties of a hanging protocol, proceed as follows:

1. In the list of all protocols, select the hanging protocol to be changed, and click the **Edit...** button.
2. In the displayed **Hanging protocol properties** dialog, make the required changes to the properties, and click the **OK** button to confirm the changes.

The **Hanging protocol properties** dialog (see Figure 187) allows to attach various criteria and properties to a selected hanging protocol. These criteria and properties relate to a particular view of the layout of the protocol and can differ for each view. As a result, you first have to select the view in the **Layout preview** window before defining the criteria and properties.

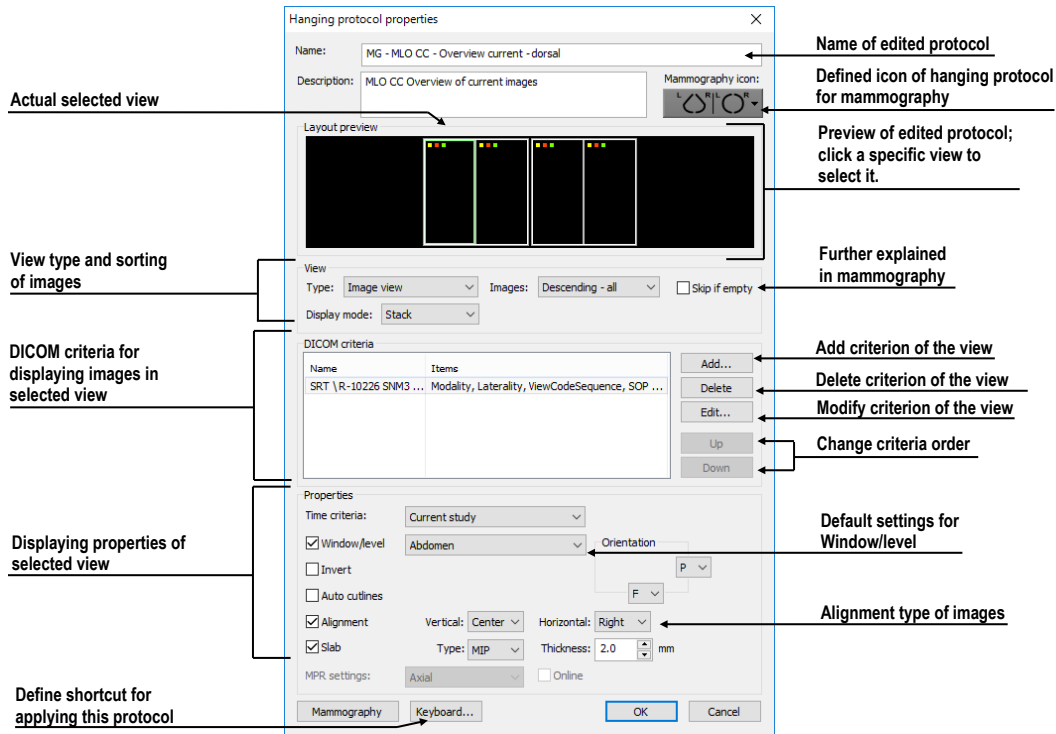


Figure 187 – Hanging protocol properties dialog

### 8.3.1 DICOM criteria

The DICOM criteria determine which images can be displayed in a particular view. They can be formulated using sets of selected DICOM tags with their allowed values (see Figure 188).

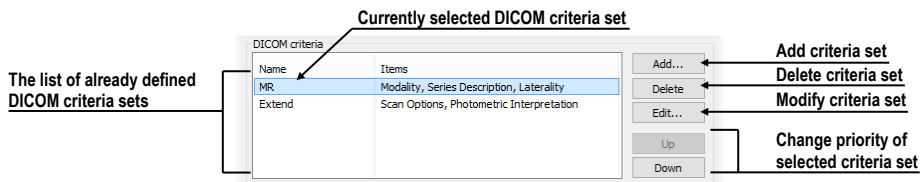
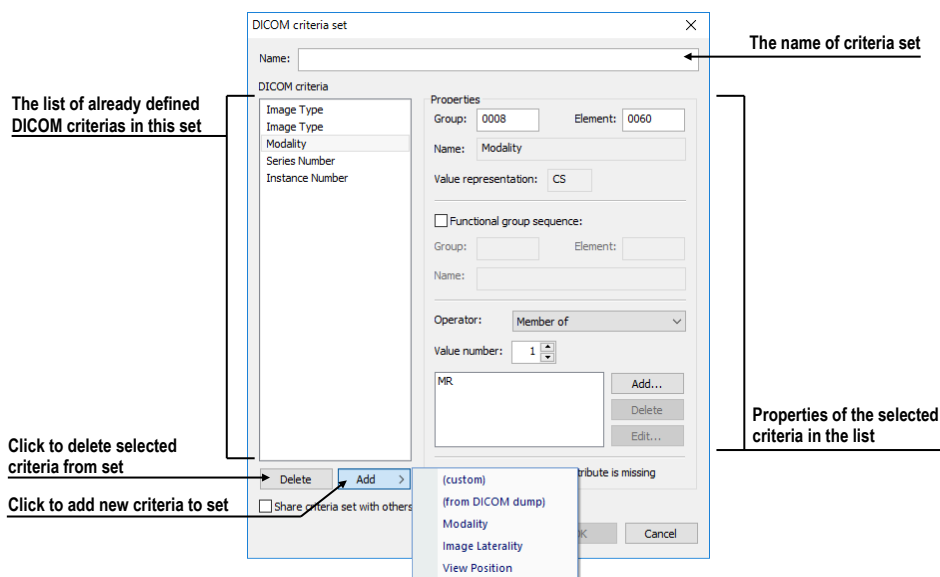


Figure 188 – Hanging protocol properties dialog

To add new sets of DICOM criteria in the **Hanging protocol properties** dialog, click the **Add...** button in the **DICOM criteria** section (see Figure 188). The **DICOM criteria set** dialog (see Figure 189) is then displayed in which you can edit or define new allowed values of the selected DICOM tags.

To add new DICOM criteria, click the **Add** button and make a selection in the displayed menu:

- **(custom)** – a new criterion defined by the DICOM group and element.
- **(from DICOM dump)** – a new criterion by selecting it directly in the DICOM dump of the image displayed in the current view. This option is allowed only when the layout of hanging protocol is the same as current layout and current view contains some displayed image.
- **Modality, Image Laterality, View Position** - a new criterion defined by selecting one of the predefined criteria.



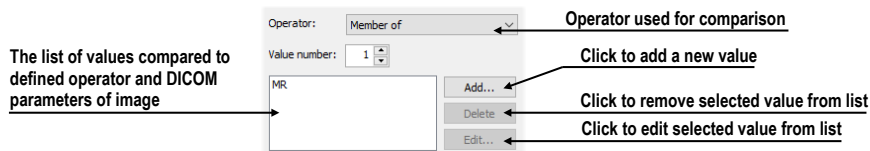
**Figure 189 – DICOM criteria set dialog**

After adding a new criterion, you can edit its properties in the **Properties** section of the **DICOM criteria set** dialog in the following manner:

1. Select the DICOM criteria in the list.
2. Define its DICOM group and element in the **Group** and **Element** boxes. The name of the DICOM tag is then automatically displayed in the **Name** box.
3. Check the **Functional group sequence** check box, and define its DICOM group and element if the edited DICOM tag refers to another functional DICOM tag.
4. Define the allowed values for the specified DICOM tag (see Figure 190):  
Select the operation to be used to compare the defined value with the value in the image.

To add a new value, click the **Add** button. The **Edit value** dialog is then displayed in which you can enter the desired value. Confirm by clicking the **OK** button, or discard the change by clicking the **Cancel** button.

To delete a defined value, select the required value in the list and click the **Delete** button.

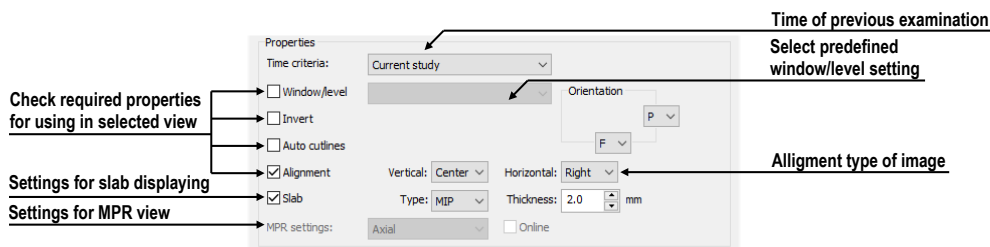


**Figure 190 – DICOM criteria set dialog**

To remove a DICOM criterion from a set, select the given DICOM criterion in the list and click the **Delete** button.

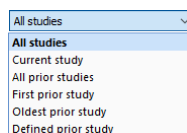
### 8.3.2 View properties

In the **View properties** part (see Figure 191), it is possible to specify various properties for the selected hanging protocol DICOM criteria set.



**Figure 191 – Hanging protocol properties dialog**

To define time sequencing criteria, click the **Time criteria** button and select the required item in the displayed list (see Figure 192). If a time constraint is defined for a view, all the images that are to be displayed in the view must comply with the time constraint.



**Figure 192 – Time criteria list for hanging protocol**

To apply the properties, check the checkbox next to each of the properties to be applied and, if necessary, set the corresponding parameters. These properties can be set:

- **Window/level** (select the specific type of window/level preset from the list)
- **Invert**

- **Auto cutlines**
- **Alignment** (select the type of alignment for the horizontal and vertical direction)
- **Slab** (turn on slab projection, and select its type and thickness)

### 8.3.3 Identification of criteria and properties

When you assign hang criteria and properties to particular views, small colored squares appear in the upper left-hand corner of each corresponding view (see Figure 193) that identify the criteria and properties. The meaning of the colors is as follows:

- yellow – DICOM criteria is defined for the view
- red – time criteria is defined for the view
- green – properties are defined for the view

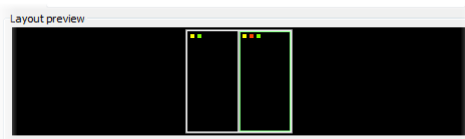


Figure 193 – Color identification of criteria and properties of view

## 8.4 Automatically creating a hanging protocol

The TomoCon application allows to create a hanging protocol automatically from the current layout and the displayed images in the views. The newly created hanging protocol will have the same layout as the currently displayed layout, and each view will have the basic criteria assigned, selected from the currently displayed image.

To automatically create a hanging protocol, proceed as follows:

1. Select the **Hanging protocol manager...** item in the **Layout** submenu.
2. Click the **New...** button in the displayed **Hanging protocol manager** dialog, and select the **(current layout and views)** item in the displayed menu (see Figure 194).

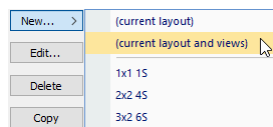


Figure 194 – List of layouts for new hanging protocol


3. The new hanging protocol will automatically be created, and its properties will be displayed in the **Hanging protocol properties** dialog in which it can be further modified.



## 9 Annotations and measurements

Annotations and measurements in the TomoCon application are used for measuring distances, angles, areas and density profiles and for describing specific parts of patient data. TomoCon offers the following annotation and measurement tools:

- **Text** - description of a specific location in an image (see 9.3 Text annotations)
- **Arrow marker** - description along with an arrow pointing to the point described (see 9.4 Arrow and ellipse marker)
- **Ellipse marker** - for a description of elliptical area (see 9.4 Arrow and ellipse marker)
- **Distance** - the distance between two points (see 9.5 Distance)
- **Distances and angle** (see 9.6 Distances and angle)
- **Cobb angle** - an angle between two independent lines (see 9.13 Cobb angle)
- **Ratio** - relative lengths of two independent lines in relation to each other (see 9.14 Ratio)
- **CTR** - Cardio-thoracic Ratio (see 9.15 CTR)
- **Probe** - displaying statistics of point level values in the specified circular area (see 9.7 Probe)
- **Density spot** - desired point level values (see 9.8 Density spot)
- **Density profile** - characteristics of all image points between two points (see 9.9 Density profile)
- **Ellipse** - characteristics of all image points included in the elliptical area (see 9.10 Ellipse)
- **Rectangle** - characteristics of all image points included in the rectangular area (see 9.11 Rectangle)
- **Area** - characteristics of all image points covered by a free area (see 9.12 Free area)

All annotations and measurements are included in the **Annotations** menu (see 3.4 Main menu). It is also possible to activate them by the tab with the  icon in the tools panel.



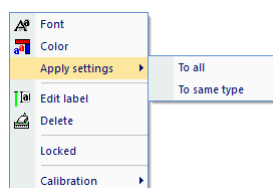
Observe the physical measurement units presented with the values of the measurements.

After using an annotation and measurement tool, it is possible to set up its properties using the annotations and measurements context menu (see Figure 195). The context menu is displayed by moving the cursor over the measurement (it will be highlighted) and pressing the context button.

The following operations are available:

- **Font** settings (see 9.1 Text settings...) and **Color** settings.
- Keep the color and font settings (**Apply settings**) for all newly created annotations and measurements (**For all tools**) or for newly created annotations and measurements of the same type (**For same type of tools**).
- Add or modify the label of the measurement (**Edit label**).
- Delete selected annotation or measurement (**Delete**).
- Lock/unlock selected annotation or measurement for moving, deleting and other operations mentioned above (**Locked**).

To lock all measurements and annotations in any newly loaded study, check **Lock existing annotations and measurements in study after loading study** option in **Options** dialog in **General** tab in section **Annotations and measurements**.



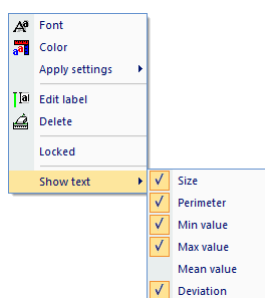
**Figure 195 – Annotations and measurements context menu**

When using a tool defining an area (Ellipse, Rectangle, Free area), the **Show text** item is added to the context menu (see Figure 196). This option allows to display or hide the size of the outlined area (**Size**), the minimal value (**Min value**), the maximal value (**Max value**), the mean value (**Mean value**) and the standard deviation (**Deviation**).

When using the Density profile tool, the **Show/Hide chart** item is added (see 9.9 Density profile).

If the image selected in the current view contains DICOM information concerning the measuring units, the **Value units** item is added to the context menu of the selected

measurement through which it is possible to change the value of the currently used measuring unit.



**Figure 196 – Context menu for ellipse, rectangle and free area**

To move the annotation and measuring tool to a different position within a view, move the cursor over the annotation/measuring tool until it is highlighted (the cursor changes from an arrow to a cross). Press and hold down the left mouse button, and then release it at the desired location (the annotation text moves along with the tool). Additionally, if the selected measurement type is Density spot, Density profile, Rectangle, Ellipse or Density area and the image within the current view is changed by scrolling the mouse wheel with the left mouse button pressed, the selected measurement tool moves to the new image.

When moving the angle and distance measuring tool, it is also possible to move only one point at the end of the measuring line. When the cursor is placed over the selected end point, it changes into a red circle (see Figure 202). Press and hold down the left mouse button and move the point to the alternate location within the current view. After moving the annotation and the measurement tool or its point, the displayed values are immediately recalculated.

The labels are the part of measurements. By moving the cursor over the measurement, the label is outlined by the rectangle of the same color as the actual measurement. Concurrently the cursor changes from an arrow to a cross. Then the position of the label relative to the measurement can be changed. At the following moving of the entire measurement with the label, the label position remains constant relative to the measurement.

For patient images with transformation, TomoCon calculates the actual point distances or area automatically. Images without transformation rarely contain sufficient information in the patient study data that is required for such calculations, and therefore the calculations are given in the pixels. In this case, you can convert the pixel units to length units (mm) or area units (cm<sup>2</sup>) manually using the calibration tool (see 9.16 Calibration).

For some of the annotations, the end display type can be changed in **Options** dialog (see 4.4 Color and style options).

## 9.1 Text settings

**Font size**, **Background** and **Scalable text** options can be set for measurement's texts in the **Font** dialog (see Figure 197) that is displayed by clicking the **Font** item in the context menu of any measurement .

- **Font size** affects only the selected measurement.
- If **Scalable text** is checked, the size of the text increases proportionally while you zoom in an image in a view. This option is global, i.e. it affects all measurements.
- Sometimes texts overlap each other or measurement graphics, and they are not readable. Therefore, you can specify text's background (**Background**):
  - **Simple** - text has simple shadow, text background isn't displayed
  - **Extended** - text has shadow all around, text background isn't displayed
  - **Solid** - text background is black rectangle
  - **Transparent** - text background is transparent black rectangle

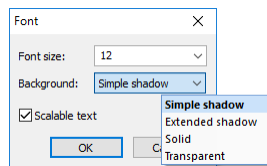


Figure 197 – Font dialog

## 9.2 Label editing

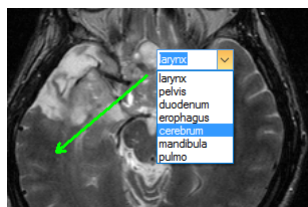
Each measurement can be labeled with additional informational text. This is useful when you want a measurement to be labeled with a description or note. When you define a label for a measurement, it then becomes a part of it and will take over the measurement font size and color. Afterwards, when you move the measurement within the view, the label follows along with it and its position is automatically updated. You can also simply change the relative position of the label (with regard to the measurement) by dragging it.

To define a new label or to change the existing label of a selected measurement, proceed as follows:

1. Display the context menu of the measurement (by right-clicking the measurement), and select the **Edit label** item.
2. An edit box is then displayed near the measurement (see Figure 198). To speed up the entry of the most frequently used labels, a combo box is available containing up to 20 of the most recently used labels (sorted chronologically)

for each measurement type. You can select any of these recently used labels or edit one to create a new label.



3. To confirm the entered text, press the **Enter** key or click in the view.
4. To discard the changes when editing a label, press the **Esc** key.

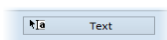


**Figure 198 – Assigning a label to the measurement**

It is not possible to add an additional text label for the text and marker annotation or the probe measurement.

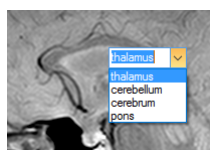
### 9.3 Text annotations

Short text descriptions can be written directly inside an image for an important structure or object using the Text annotation tool. To define a Text annotation, select the  **Text** item in the **Annotations** menu or click the **Text** button in the **Annotations** tool in the tools panel - the tab with the  icon (see Figure 199).






**Figure 199 – Text annotation button**

Next, click the point in the image to be annotated. An edit box then opens in which you can type in the description (see Figure 200). Press the **Enter** key to confirm the change and to complete the editing process.



**Figure 200 – Text annotations**

### 9.4 Arrow and ellipse marker

A short text description for an important structure or object can be written directly inside an image using the **Arrow** or **Ellipse marker** annotation mode. The mode is activated by selecting the  **Arrow**/ **Ellipse marker** item in the **Annotations** menu or by clicking the **Arrow** or **Ellipse marker** button in the **Annotations** tool (the tab with the  icon) in the tools panel (see Figure 201).

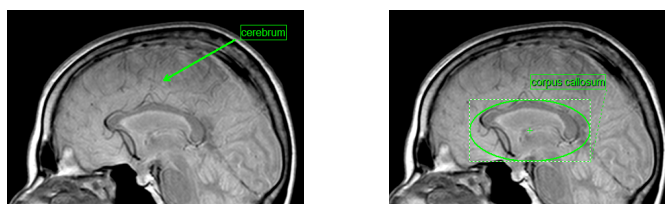


**Figure 201 – Arrow and Marker annotation button**

To define Arrow marker click the point in the image to be annotated. Drag the thin line to the location where the annotation text is to be placed and click.


To define Ellipse marker click the first point and move the cursor to the desired position and click again to define the second point of the ellipse.

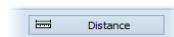
An edit box then opens after defining arrow or ellipse in which you can type in the description (see Figure 202). Press the **Enter** key to confirm the change and to complete the editing process.



**Figure 202 – Arrow marker and ellipse marker annotation**

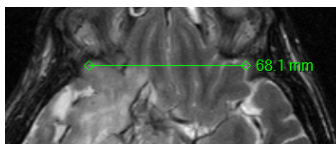
## 9.5 *Distance*

The Distance measurement can be used after selecting the  **Distance** item in the **Annotations** menu or clicking the **Distance** button in the **Measurements** tool in the tools panel (see Figure 203).




**Figure 203 – Distance measurement button**

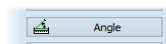
Click the first point and the second point while dragging the measurement line. The distance between these two points is displayed next to the second point (see Figure 204).



**Figure 204 – Distance between 2 points**

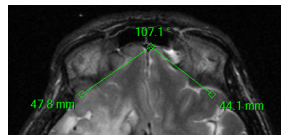
## 9.6 *Distances and angle*

The Distances and angle measurement can be used after selecting the  **Distances and angle** item in the **Annotations** menu or clicking the **Angle** button in the **Measurements** tool in the tools panel (see Figure 205).




**Figure 205 – Angle measurement button**

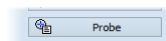
The use of this measurement is similar to the use of the Distance measurement, except that an additional third point has to be defined. Both the distances and the angle between the distance lines are displayed (see Figure 206).



**Figure 206 – Distances and angle between 3 points**

## 9.7 Probe

The Probe tool is a special circular measurement tool for tracking minimal, maximal and mean values of image points within the specified circular area. This measurement can be used after selecting the  **Probe** item in the **Annotations** menu or clicking the **Probe** button in the **Measurements** tool in the tools panel (see Figure 207).

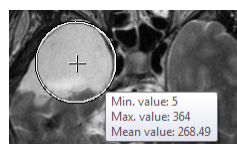


**Figure 207 – Probe measurement button**

To display the current minimal, maximal and mean value of the pixels that lie within the probe's circle, click the desired point in the selected view (see Figure 208).

To finish measuring, release the left mouse button. The Probe measurement tool remains active after realizing the left mouse button.


To change the size of the circle of the measurement, press the **Shift** key while holding down the left mouse button at any location within the selected view and move the cursor. The size of the Probe measurement changes according to the movement of the cursor. When the desired size is reached, release the left mouse button and the **Shift** key, and the new specified size will be stored.



**Figure 208 – Probe measurement**

It is possible to track values also for fusion. To display values calculated on fusion press **Ctrl** key. Displayed tooltip will show minimal, maximal and mean values for fusion series. It works only for ordinary fusion, subtraction mode is not supported.

## 9.8 Density spot

The Density spot measurement tool can be used after selecting the  **Spot density** item in the **Annotations** menu or clicking the **Spot density** button in the **Measurements** tool in the tools panel (see Figure 209).

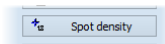


Figure 209 – Spot density measurement button

Click the desired point. The value of the image point is then displayed next to the defined point (see Figure 210).

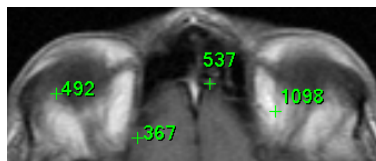



Figure 210 – Density spot at various points

## 9.9 Density profile

The line Density profile can be measured after selecting the  **Density profile** item in the **Annotations** menu or clicking the **Density profile** button in the **Measurements** tool in the tools panel (see Figure 211).

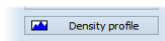


Figure 211 – Density profile measurement button

Click the first point, and holding down the left mouse button drag the measurement line to the desired location, and release the mouse button. The characteristics of all image points covered by the line are summarized and displayed as a tool tip (see Figure 212).

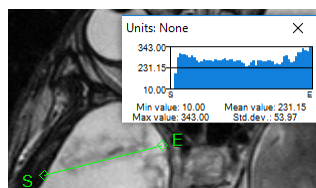




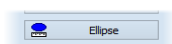
Figure 212 – Density profile of a line between 2 points

In the images of opened studies, you can create multiple measurement lines. The corresponding Density profile of a line can be temporarily hidden by clicking the  button in the upper right-hand corner of the chart. After clicking the measurement line with the context mouse button, the Density profile reappears by selecting the **Show/Hide chart** option.



## 9.10 Ellipse

Ellipse drawing is activated by selecting the  **Ellipse** item in the **Annotations** menu or by clicking the **Ellipse** button in the **Measurements** tool in the tools panel (see Figure 213).



**Figure 213 – Ellipse measurement button**


Click the first point, and holding down the left mouse button, move the cursor to the desired position, and click again to define the second point of the ellipse. The characteristics of all image points covered by the elliptical area are summarized and displayed above the ellipse (see Figure 214).

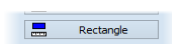


**Figure 214 – Elliptical area profile**

You can move the ellipse to any location inside an image simply by dragging it, or you can resize it by dragging its corners. The displayed values are then recalculated.

## 9.11 Rectangle

Rectangle drawing is activated by selecting the  **Rectangle** item in the **Annotations** menu or by clicking the **Rectangle** button in the **Measurements** tool in the tools panel (see Figure 215).



**Figure 215 – Rectangle measurement button**


Click the first point, and holding down the left mouse button, drag the cursor to the desired position, and click again to define the second point of the rectangle. The characteristics of all image points covered by the rectangular area are summarized and displayed above the rectangle (see Figure 216).



**Figure 216 – Rectangular area profile**

You can move the rectangle to any location inside the image simply by dragging it, or you can resize it by dragging its corners. The displayed values are then recalculated.

## 9.12 Free area

Free area drawing is activated by selecting the  **Density area** item in the **Annotation** menu or by clicking the **Density area** button in the **Measurements** tool in the tools panel (see Figure 217).

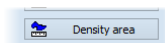



Figure 217 – Density area measurement button

An area can be outlined by dragging the  cursor with the left mouse button pressed. The characteristics of all image points covered by the free area are summarized and displayed next to the free area (see Figure 218).

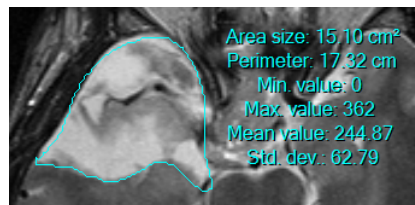






Figure 218 – Free Area

To add an additional area to the existing area, click the  **Area** icon and outline the area holding down the **Ctrl** key with the left mouse button pressed (the mouse cursor will have the  form). To remove a part of the area, click the icon again and outline the area holding down the **Shift** key with the left mouse button pressed (the cursor will have the  form).

You can move an area to any location inside the image by means of the mouse. The displayed values are then recalculated.

## 9.13 Cobb angle

The Cobb angle measurement can be used after selecting the  **Cobb's angle** item in the **Annotations** menu or clicking the **Cobb's angle** button in the **Measurements** tool in the tools panel (see Figure 219). This measures the angle between two independent lines.

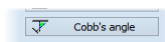


Figure 219 – Cobb's angle measurement button

Click the first point and the second point of the first line and then the first point and the second point of the second line. The smaller angle between these defined lines will be displayed at the end of one of them (see Figure 220).

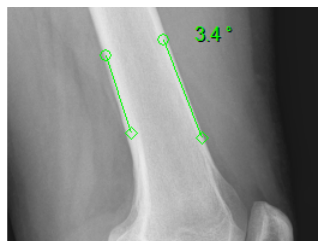



Figure 220 – Cobb's angle

### 9.14 Ratio

The **Ratio** measurement can be used by selecting the  **Ratio** item in the **Annotations** menu or clicking the **Ratio** button in the **Measurements** tool in the tools panel (see Figure 221). The **Ratio** measurement can be used to assess the relative lengths of anatomical features. For example, the width of spinal cord in relation to the width of the spine can be measured.

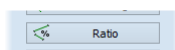


Figure 221 – Ratio measurement button

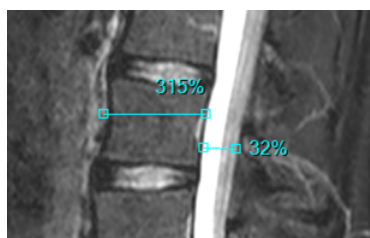



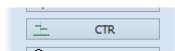
Figure 222 – Ratio

In a view, click the end points of 2 lines to measure (this means, 4 points have to be digitized in total). The measurement shows the relative lengths of both lines in relation to each other respectively (see Figure 222).

### 9.15 CTR

The CTR (Cardio-thoracic Ratio) measurement can be used by selecting the  **CTR** item in the **Annotations** menu or by clicking **CTR** button in the **Measurements** tool in the tools panel (see Figure 223). This measurement can only be used on CR and DX modalities. The CTR measurement is the transverse diameter of the heart compared with that of the thoracic cage used to help determine enlargement of the

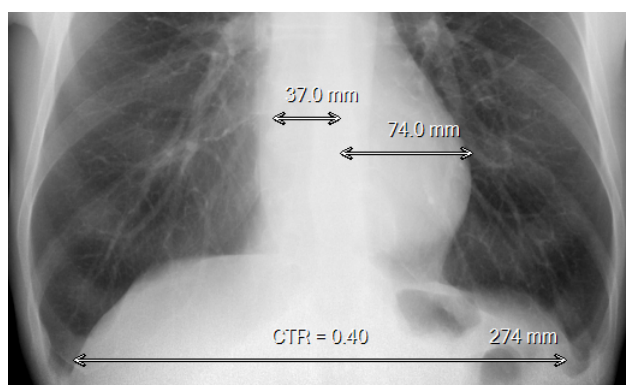
heart. The diameters are taken from chest PA x-rays images manually by moving the individual lines of the CTR measurement.



**Figure 223 – CTR measurement button**

The tool displays lines representing the left heart midline, the right heart midline and the diameter of the thorax (see Figure 224). Adjust the lines manually in the image to get accurate sizes of heart and thorax (by moving and resizing). The length of each line can be changed by dragging the line endpoints.

To change the guideline color or style, use the measurement context menu.



**Figure 224 – CTR measurement**

## 9.16 Calibration

For images without transformation in which the pixel size is unknown, calibration can be used to calculate the approximate distance between two points.



Calibration cannot be used for images containing transformation.

To activate calibration, select the **Calibration** item (see Figure 225) in the Distance measurement context menu.

The following two options are available:

- **Calibrate measurement** - to open the **Calibration** dialog in order to define the calibration (see Figure 225).
- **Apply to whole series** - to apply a defined calibration to a series.

The **Calibration** dialog allows to define calibration by entering a selected line length in millimeters into the **Enter distance** box. After clicking the **OK** button, all measured distances and areas in the image are calculated according to the defined calibration.





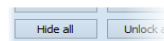
**Figure 225 – Calibration context menu and the Calibration dialog**

The calibration of previously calibrated images without transformation can be changed again using the **Calibration** dialog. A dialog will be displayed stating that the image has already been calibrated.

If you want to change the calibration in a series with previously calibrated images (by the **Apply to whole series** option), a warning dialog will be displayed stating that the images in the series have already been calibrated.

### 9.17 Hide/show annotations


To hide or display existing annotations in all views of all working areas, select the  **Annotations** item in the **View** menu or click the **Hide all** button in the **Manage annotations** tool in the tools panel tab with the  icon (see Figure 226).



**Figure 226 – Hide all buttons**

### 9.18 Discard annotations


An individual annotation can be deleted by clicking it with the context mouse button and selecting the **Delete** item in the displayed **Annotations** context menu or by selection dialog through the list of measurements (see 9.19 List of annotations).

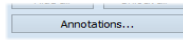
To discard all annotations defined in all opened patient studies, select the  **Delete all** item in the **Annotations** menu.

It is also possible to discard annotations in the current image, series or study using the corresponding items in the **Annotations /Delete all in** menu.

### 9.19 List of annotations

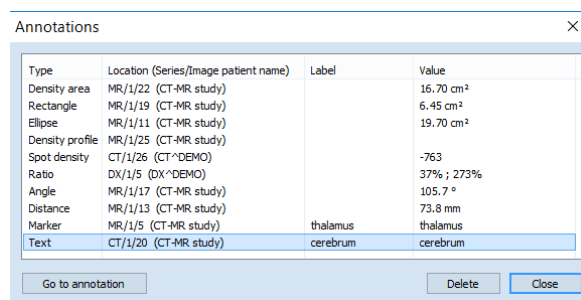
To open the dialog containing the list of all annotations defined in the opened studies, select the **Annotations...** item in the **Annotations** menu or click the **Annotations...**

button (see Figure 227) in the **Manage annotations** tool in the **Annotations** tab (the tab with the  icon) of the tools panel (see Figure 228).



**Figure 227 – Annotations... button**

The list contains the type (the **Type** column), the location in the “series/image” format (the **Location** column), the description (the **Label** column) and the value (the **Value** column) of the annotations. The **Value** column contains the measured values obtained using the measurement tool (distance, angle, density, etc.). For the ellipse, rectangle and density area measurements, the value column contains only the size of the measured area. No value is displayed for the density profile measurement.

A screenshot of the "Annotations" dialog window. It features a table with four columns: Type, Location (Series/Image patient name), Label, and Value. The table contains several rows of data, with the last row highlighted. Below the table are three buttons: "Go to annotation", "Delete", and "Close".

Type	Location (Series/Image patient name)	Label	Value
Density area	MR/1/22 (CT-MR study)		16.70 cm <sup>2</sup>
Rectangle	MR/1/19 (CT-MR study)		6.45 cm <sup>2</sup>
Ellipse	MR/1/11 (CT-MR study)		19.70 cm <sup>2</sup>
Density profile	MR/1/25 (CT-MR study)		
Spot density	CT/1/26 (CT^DEMO)		-763
Raio	DX/1/5 (DX^DEMO)		37% ; 273%
Angle	MR/1/17 (CT-MR study)		105.7 °
Distance	MR/1/13 (CT-MR study)		73.8 mm
Marker	MR/1/5 (CT-MR study)	thalamus	thalamus
Text	CT/1/20 (CT-MR study)	cerebrum	cerebrum


**Figure 228 – Annotations dialog**

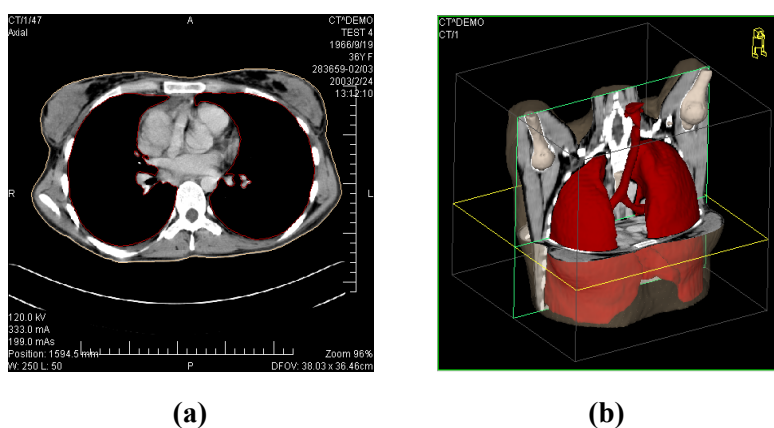
By selecting an annotation and clicking the **Go to annotation** button, the image with the selected annotation is displayed in the current view (the image or MPR). By clicking the **Delete** button, the selected annotation is deleted from both the list and the image or MPR.

## 10 Contouring the patient – create ROIs

Patient contouring is carried out using two-dimensional (2D) display that provides sharper imaging and better recognition of patient anatomical structures through colored highlighting in images (see Figure 229). When creating contours on multiple images, a ROI (Region of Interest) is automatically created along with the automatically calculated volume (in cm<sup>3</sup>) which can be displayed in the space in three-dimensional (3D) patient presentation (see Figure 229).

**i** The calculated ROI volume in TomoCon depends on the resolution setting for the specific ROI (see 10.7 Editing ROI properties).

The TomoCon application allows to create Regions of Interest (ROIs) of various types using the manual and automatic tools accessible on the **ROI** tab of the tools panel (the tab with the  icon); see Figure 230. This includes 2D and 3D viewing functionality of image series and drawn ROIs as well as advanced 2D and 3D drawing tools. Each ROI can be created in the original image direction or any reconstructed direction. The output from a ROI definition can be a DICOM RT Structure set (with an installed RTSTRUCT Export license) which can be sent to another DICOM-compatible system (e.g. the Treatment Planning System).



**Figure 229 – Displaying ROI - contour in 2D (a), ROI in 3D (b)**

The ROI tab of the tools panel (see Figure 230) consists of the following three main parts (tools) that simplify work with ROIs and ROI contours:

- **ROIs** tool allows to set the currently selected ROI, to delete a ROI or to create a new one as well as to manage previously defined ROIs in the **ROI administration** dialog.
- **ROI properties** tool for defining the properties of 2D and 3D visibility of the currently selected ROI.

- **ROI drawing** tool contains the group of manual and automatic tools for defining the contours of the currently selected ROI.

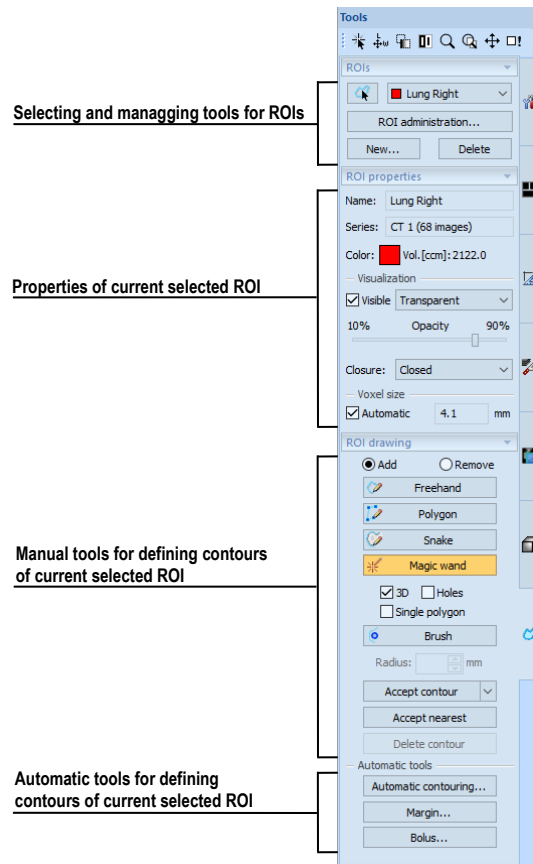



Figure 230 – ROI tab of the Tools panel

## 10.1 Creating new ROIs

TomoCon allows to create a new ROI on an image of the selected series by clicking the **New...** button in the **ROIs** tool (on the tab with the  icon) in the tools panel (see Figure 231). The newly created ROI will automatically be added to the ROI list and set as the currently selected ROI. You can then immediately define the ROI contours using the **ROI drawing** tool in the tools panel.

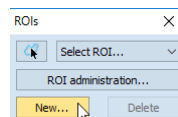


Figure 231 – Creating a new ROI in ROIs tool

To create a new ROI, proceed as follows:

1. Click the **New...** button in the **ROIs** tool in the tools panel.



2. The **New ROI** dialog for defining the main properties of the new ROI is then displayed (see Figure 232).
3. Select the series for the new ROI in the **Series** combo box. The default selected series is the series from the current view.
4. Select the ROI catalog type from the **Type** drop-down list, and enter the name of the new ROI into the **Name** box. If no name is entered, the new ROI will be named “New ROI ...” by default.
5. Select the color for the new ROI by clicking the color button next to the **Name** box. The default ROI color is randomly set.
6. Click the **OK** button. The new ROI will then be created automatically and set as the currently selected ROI.

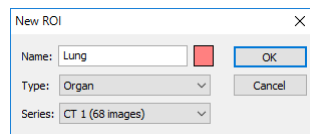


Figure 232 – New ROI dialog

## 10.2 Selecting ROI and contour

The currently selected ROI is currently selected ROI in the **Select ROI...** combo box in the **ROIs** tool in the tools panel (see Figure 233). Its properties are displayed in the **ROI properties** tool in the tools panel. All ROI drawing tools can only be used for this ROI.

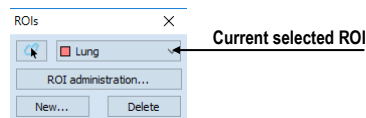


Figure 233 – ROIs dialog

To set the currently selected ROI, proceed in one of the following manners:

- Click the **Select ROI...** button in the **ROIs** dialog, and select the ROI from the displayed drop-down list (see Figure 234).

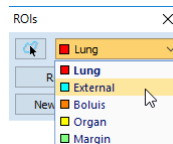




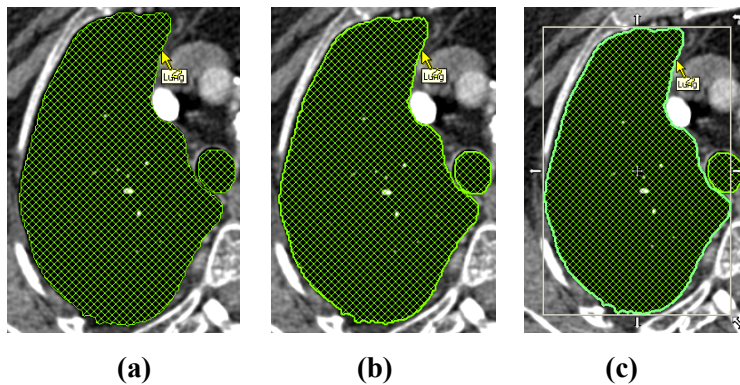
Figure 234 – Selecting the current ROI

or

- Use the **Select contour** tool to select the ROI contour. Once a contour is selected, the corresponding ROI is set as the currently selected ROI in the **Select ROI...** combo box.




To select a contour with the **Select contour** tool in the view, proceed as follows:

1. Click the  button in the **ROIs** tool in the tools panel, and move the cursor  towards the contour until the contour area is highlighted with the mesh pattern (see Figure 235a). The contour must be drawn with a continuous line; an interpolated contour drawn with a dashed line is unacceptable.
2. Click the highlighted contour (see Figure 235b) to select the ROI (if the ROI is not yet selected).
3. Click again to select the contour (see Figure 235c).



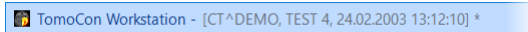
**Figure 235 – Selecting a contour**

When a contour is selected (see Figure 235c), it can be moved, rotated, resized or deleted as follows:

- To delete a selected contour in its entirety, press the **Delete** key.
- To move a selected contour, move the cursor towards the middle of the contour until the mouse pointer changes into an arrow cross . You can then drag the contour to the desired position.
- To rotate a selected contour, move the cursor to the rotate arrow . The mouse pointer changes into the same form as the rotate arrow. Press the left mouse button, and rotate the contour while holding down the mouse button until the desired position is reached. At the end release the left mouse button.
- To resize a selected contour, move the cursor to the resize arrow . The mouse pointer changes into the same form as the resize arrow. Drag the corner/side of the contour selection frame outward (to enlarge it) or inward (to make it smaller). At the end release the left mouse button.

### 10.3 Saving ROIs

When any changes to ROIs have been made in the opened studies, an asterisk (\*) is displayed after the study time in the TomoCon title bar at the top of the window (see Figure 236).



**Figure 236 – TomoCon title bar with asterisk**

If you want to save changes when a study is still open, press the **Ctrl+S** key combination on the keyboard or select the **Save** item in the **Study** submenu of the main menu. The changes to the ROIs will automatically be saved in the Local studies storage. To send these changes from TomoCon to a PACS, select the **Send...** item in the **Study** submenu. The TomoCon behavior when closing studies with changes depends on its settings (see 4.1.8 Confirmations).

### 10.4 Deleting a ROI

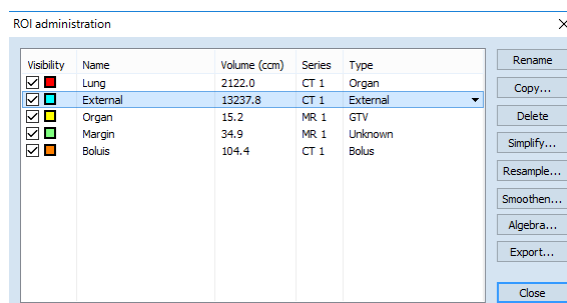
To delete a ROI in the ROIs tool in the tools panel, proceed as follows:

1. Select the current ROI in the drop-down list which is displayed after clicking the **Select ROI...** button in the **ROIs** dialog.
2. Click the **Delete** button in the same tool. After confirming the deletion operation, the currently selected ROI will be removed.

For an explanation of how to delete a ROI in the **ROI administration** dialog, see 10.5 ROI administration.

### 10.5 ROI administration

All ROI administration functions, such as rename, algebra, copy of ROI, etc., can be applied using the **ROI administration** dialog (see Figure 237).



**Figure 237 – ROI administration dialog**

The **ROI administration** dialog contains a list of all defined ROIs in the opened studies. For every ROI it displays the visibility indicator, color, name, image series

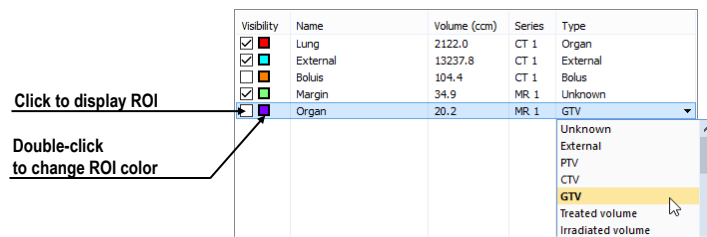
name and type. The following operations can be carried out with the ROIs displayed in the list:

- renaming, deleting and changing the visibility, color and DICOM ROI type
- copying a ROI to the same series or to another series (see 10.5.1 Copying a ROI)
- simplifying ROI contours (see 10.5.2 Simplifying a ROI)
- resampling ROI contours (see 10.5.3 Resampling a ROI)
- smoothing ROI contours (see 10.5.4 Smoothing a ROI)
- carrying out an algebraic operation between ROIs (see 10.5.5 ROI algebra)
- exporting a ROI to external files (see 10.5.6 Exporting a ROI to a DXF or VTK file)

To change the visibility of a ROI, check the check box to the left of the colored box in the relevant row (see Figure 238). The display or hiding of the ROI is then immediately applied to all views.

To change the color of a ROI, double-click the colored box in the relevant row (see Figure 238) and then select the color in the displayed **Color** dialog. The new color of the ROI is then immediately applied to all views.

To change the DICOM type of a ROI, display the drop-down list of the **Type** column (by clicking the ▼ button) in the relevant row and then select the desired DICOM type item in the list (see Figure 238).



**Figure 238 – Changing the ROI DICOM type**

To rename a ROI, select the ROI in the ROI list and click the **Rename** button. Type the new name into the displayed name box (see Figure 239), and press the **Enter** key.

Visibility	Name	Volume (ccm)	Series	Type
<input checked="" type="checkbox"/>	Lung	2122.0	CT 1	Organ
<input checked="" type="checkbox"/>	External	13237.8	CT 1	External
<input type="checkbox"/>	Bolus	104.4	CT 1	Bolus
<input checked="" type="checkbox"/>	Margin	34.9	MR 1	Unknown
<input type="checkbox"/>	Organ	20.2	MR 1	GTV

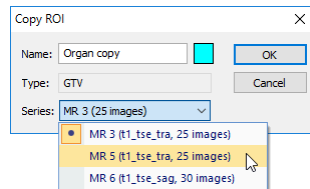
**Figure 239 – Renaming a selected ROI in the ROI administration dialog**

To delete a ROI, select the ROI in the ROI list and click the **Delete** button. A dialog is then displayed in which you are asked to confirm the operation.

### 10.5.1 Copying a ROI

To copy a ROI to the same series or to another series using the **ROI administration** dialog, proceed as follows:

1. Select the ROI in the ROI list.
2. Click the **Copy...** button. The **Copy ROI** dialog is then displayed. Type the name of the new ROI into the **Name** box, and select the color of the new ROI.
3. Select the target series from the **Series** drop-down menu (see Figure 240). It is only possible to select a target series that is registered with the source ROI series.
4. Once the copying process is complete, click the **OK** button.



**Figure 240 – Copy ROI dialog - selecting the target series**

The new ROI created as a copy from the source ROI is then added as a visible ROI at the end of ROIs list in the **ROI administration** dialog (see Figure 241).

Visibility	Name	Volume (ccm)	Series	Type
<input checked="" type="checkbox"/>	Lung	2122.0	CT 1	Organ
<input checked="" type="checkbox"/>	External	13237.8	CT 1	External
<input type="checkbox"/>	Bolus	104.4	CT 1	Bolus
<input checked="" type="checkbox"/>	Margin	34.9	MR 1	Unknown
<input checked="" type="checkbox"/>	Organ	1963.8	MR 3	GTV
<input checked="" type="checkbox"/>	Organ copy	1953.8	MR 5	GTV

← Copy of Organ ROI

**Figure 241 – New copy of the Organ ROI**

### 10.5.2 Simplifying a ROI

To simplify the contours of a selected ROI using the **ROI administration** dialog, proceed as follows:

1. Select the ROI in the ROI list.
2. Click the **Simplify...** button. The **Simplify ROI** dialog is then displayed (see Figure 242).
3. Select the simplification method type in the **Simplify ROI** dialog:
  - **Remove holes** - all holes will be removed from each ROI contour.
  - **Single polygon** - only one polygon will remain in each image with all holes being removed.
  - **Reduce number of vertices** - all polygons of each contour will be reduced according to the entered number of vertices.

- Once the simplification process is complete, click the **OK** button.

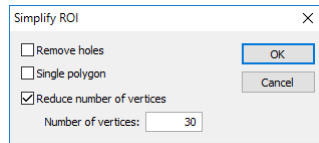


Figure 242 – Simplify ROI dialog

### 10.5.3 Resampling a ROI

TomoCon allows to resample contours in original slices onto reconstructed slices. As a result, a ROI in any direction can be drawn and modified.

To resample the contours of a ROI using the **ROI administration** dialog, proceed as follows:

- Display the image in the current view in the direction in which the ROI is to be resampled.
- Select the ROI to be resampled in the ROI list, and click the **Resample...** button. The **Resample ROI** dialog is then displayed (see Figure 243).
- Enter the number of contours you wish to be drawn in the new direction (that is, the number of planes to be used to cut the original ROI).
- In the **Into series** drop-down menu, select the target series in which the resampled ROI is to be created. The source ROI series is the default series.
- Check the **As new ROI** check box to create the new ROI from the resampled data, and leave the source contours as they are.
- Check the **Original images** check box to resample only to original slices. The option to select the number of slices remains inaccessible, because this is determined by the number of original slices intersected by the ROI.
- Click the **OK** button to apply resampling.

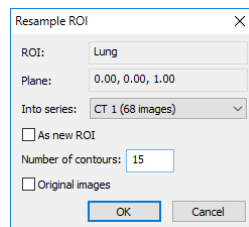


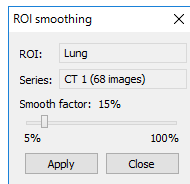
Figure 243 – Resample ROI dialog

### 10.5.4 Smoothing a ROI

Smoothing makes jagged contours rounder. The more smoothed, the more of an ellipse-like shape each ROI contour has.

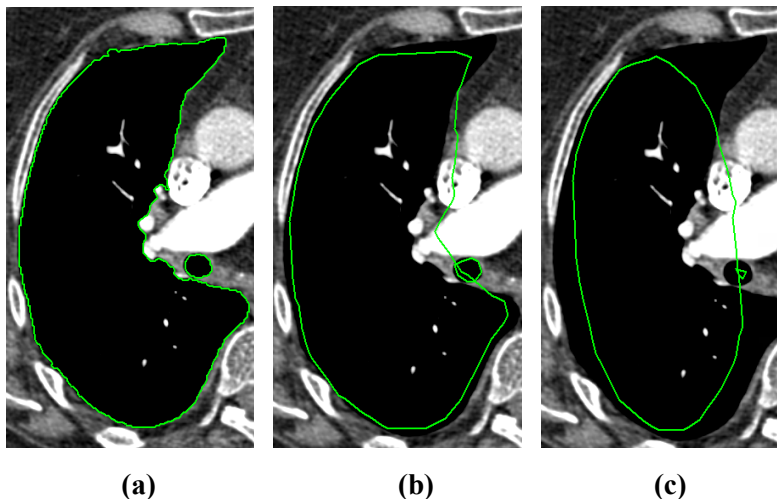
To smoothen ROI contours using the **ROI administration** dialog, proceed as follows:

1. Select the ROI for smoothing in the ROI list and click the **Smoothen...** button.
2. The **ROI smoothing** dialog is then displayed (see Figure 244).



**Figure 244 – ROI smoothing dialog**

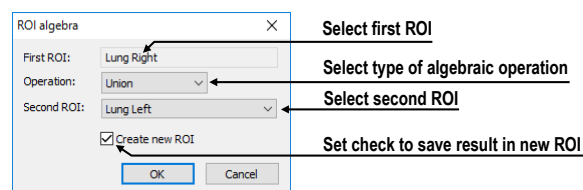
3. Use the slide bar to set the **Smooth factor** (5-100%).
4. Click the **Apply** button as many times as necessary to achieve the desired setting. Whenever you press this button, selected ROI contours will be rounder. The result is immediately displayed in the current view (see Figure 245).
5. When finished, click the **Close** button.



**Figure 245 – Source ROI (a), once smoothed ROI (b), 5 times smoothed ROI (c)**

### 10.5.5 ROI algebra

If any two ROIs are defined in the same series, TomoCon allows to carry out basic algebraic operations such as union, intersection and subtraction between them using the **ROI algebra** dialog (see Figure 246).

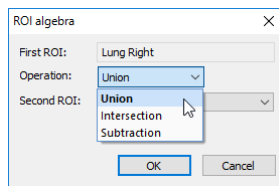


**Figure 246 – ROI algebra dialog**

The result of a specified algebraic operation can be saved to a new ROI or to the ROI that was selected as the first ROI for the operation.

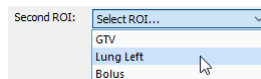
To carry out algebraic operations between two ROIs using the **ROI administration** dialog, proceed as follows:

1. Select the first ROI for the algebraic operation in the list of ROIs, and click the **Algebra...** button.
2. The **ROI algebra** dialog is then displayed where select the algebraic operation in the **Operation** combo box (see Figure 247).



**Figure 247 – ROI algebra dialog, defining the algebraic operation**

3. Select the second ROI in the drop-down list that is displayed by clicking the **Second ROI** button (see Figure 248).



**Figure 248 – Selecting the second ROI for algebra**

4. To save the algebra result as a new ROI, check the **Create new ROI** check box.
5. To carry out the specified algebraic operation with the defined parameters, click the **OK** button.

### 10.5.6 Exporting a ROI to a DXF or VTK file

All defined ROIs can be exported to external files in the AutoCAD DXF or VTK format.

To export a ROI using the **ROI administration** dialog, proceed as follows:

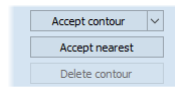
1. Select the ROI for export in the ROI list, and click the **Export...** button. Subsequently the **Export** dialog is displayed.
2. Select the desired file format, the file name and the target folder in the **Export** dialog. To save the file, click the **Save** button.

## 10.6 Accepting and deleting a contour

The accepting contour operation allows to accept an interpolated contour or the nearest contour in the displayed image using the **ROI drawing** tool (see Figure 249).



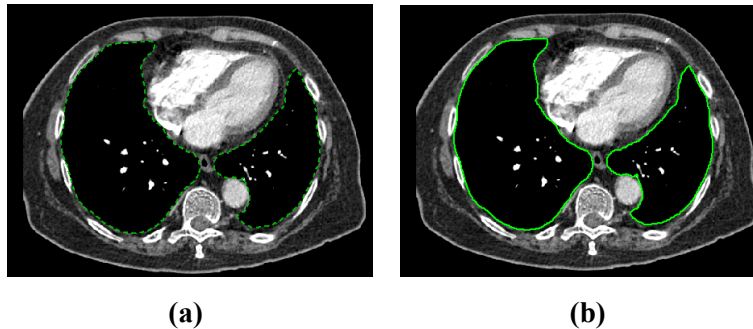
The accepted contour is then inserted into the currently selected ROI as a new 2D contour.



**Figure 249 – Accepting section of the ROI drawing tool**

To accept an interpolated contour:

1. Display the image with the interpolated contour (see Figure 250a) in the current view. The interpolated contour is outlined with a dashed line.
2. Click the **Accept contour** button in the **ROI drawing tool**.
3. The interpolated contour is then inserted into the currently selected ROI (see Figure 250b). The dashed line changes into a continuous line, and the interpolated contour is changed from a proposed contour to an actual contour.

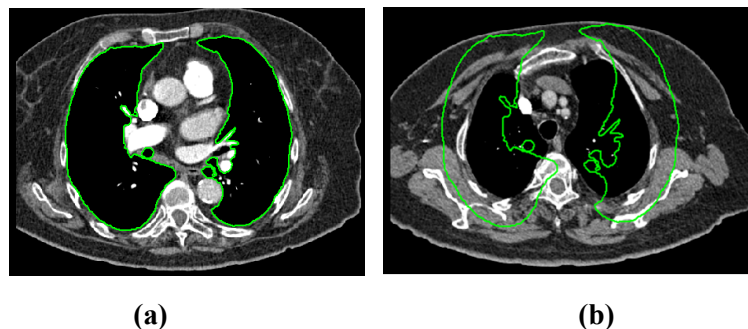


**Figure 250 – Interpolated contour (a), Accepted interpolated contour (b)**

To accept all the interpolated contours at once, click the down arrow on the **Accept contour** button. In the menu that is displayed, select **Accept all contours**.

To accept the nearest contour:

1. Check that there is no contour drawn for the ROI in the current view.
2. Click the **Accept nearest** button in the **ROI drawing tool**.
3. The nearest drawn contour is then automatically copied to the current image (see Figure 251).



**Figure 251 – Contour on the last image (a), Accepted nearest contour from the last image into the 1st image (b)**

To delete a contour of the currently selected ROI in the displayed image in the current view, click the **Delete contour** button in the **ROI drawing** tool in the tools panel.

## 10.7 Editing ROI properties

All 2D and 3D visibility properties of the currently selected ROI can be changed using the **ROI properties** tool in the tools panel (see Figure 252).

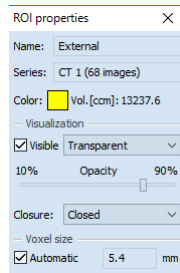


Figure 252 – ROI properties dialog

The currently selected ROI is labeled with the following in the **ROI properties** dialog:

- **Name/Series** – the name of the currently selected ROI and the image series in which the ROI is drawn.
- **Vol. [ccm]** – the volume size of the currently selected ROI in cubic centimeters. Volume calculation is not possible until the ROI is defined in at least one image.

The **ROI properties** dialog allows to change the following properties of the currently selected ROI:

- **Color** – click the **Color** button to change the color of the currently selected ROI.
- **Visibility** – check/uncheck the **Visible** check box to display/hide the currently selected ROI in the views.
- **Visualization type** – this specifies the rendering types (surface presentation) for the currently selected ROI in the 3D view as follows:
  - **Solid** – the ROI is displayed as an opaque object. A new current point can be defined by clicking the ROI object surface in the 3D view.
  - **Transparent** – the ROI is displayed as a transparent object with the transparency ratio that is defined by the **Opacity** slider (from 10% to 90% opacity). It is not possible to click to define a current point on the transparent surface of a drawn ROI in the 3D view.

- **Stripes** – the ROI is displayed as a set of contours laying in parallel planes (the wire-frame model).
- **Transparent with stripes** – the ROI is composed of the transparent and wire-frame model object.
- **Closure** – by default, the ROI is displayed in the 3D view with closed-end (**Closed**) surfaces. It is however also possible to display it as **Bottom open**, **Top open** or **Open** (both ends open). If the ROI is not displayed with closed-end surfaces, you can view the inside of the ROI through the open ends.
- **Voxel size** – the voxel size determines the granularity of the 3D reconstruction of a ROI. 3D reconstruction entails the processing of ROI contours and the creation of 3D representation from 2D contours.
  - To set the voxel size manually, enter the required size into the **Voxel size** box. To obtain the highest precision, the voxel size should be set to the minimal acceptable value (0.1 cm).
  - To calculate the voxel size automatically, check the **Automatic** check box. The voxel size is then automatically set to the value based on the voxel/cm<sup>3</sup> ratio.

## 10.8 *Editing contours using drawing tools*

Each ROI consists of separate contours that can be edited or created with the manual and automatic drawing tools. All the tools are accessible in the **ROI drawing** tool in the tools panel (see Figure 253).

There are five manual and three automatic drawing tools for contour editing in the displayed image in the current view as listed below.

- Manual drawing tools:
  - **Freehand** – to contour an area freehand (see 10.8.1 Freehand drawing tool).
  - **Polygon** – to contour an area using a polygon (see 10.8.2 Polygon drawing tool).
  - **Snake** – to contour an area using a semi-automatic tool called Snake (see 10.8.3 Snake drawing tool).
  - **Magic wand** – to contour an area by joining adjacent image pixels with similar gray level values (see 10.8.4 Magic wand drawing tool).
  - **Brush** – to contour an area using a circle cursor (see 10.8.5 Brush drawing tool).

- Automatic drawing tools:
  - **Automatic contouring** – to generate ROI contours in several adjacent images at the same time automatically (see 10.8.6 Automatic contouring drawing tool).
  - **Margin** – to generate a margin with defined properties of a previously created ROI automatically (see 10.8.7 ROI margin drawing tool).
  - **Bolus** – to generate the bolus type of a ROI placed on the surface of a previously created ROI automatically (see 10.8.8 Bolus ROI defining drawing tool).

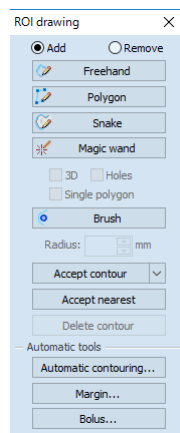


Figure 253 – ROI drawing tool

### 10.8.1 Freehand drawing tool

The Freehand drawing tool is a manual tool for defining the contour of the currently selected ROI by drawing the contour outline by dragging the cursor.

To use the Freehand drawing tool, proceed as follows:

1. Select the ROI (as the currently selected ROI) for which you want to edit a contour.
2. Select the adding contour mode (see Figure 254). To add a drawn contour to the ROI, check the **Add** radio button. To remove a drawn contour from the ROI, check the **Remove** radio button.

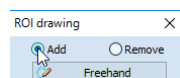



Figure 254 – Set Add/Remove mode for contour editing

3. Click the **Freehand**  button in the **ROI drawing** tool.
4. Press and hold down the left mouse button to draw the contour (see Figure 255).

5. Release the mouse button to close the contour.

When the freehand contour drawing process is complete, the contour closes with a straight line between the starting point and the ending point.

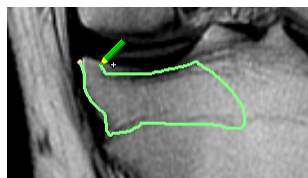




Figure 255 – Drawing a contour with the Freehand tool

### 10.8.2 Polygon drawing tool

The Polygon drawing tool is a manual tool for defining the points of a freely shaped polygon contour of the currently selected ROI.

To use the Polygon drawing tool, proceed as follows:

1. Select the ROI for which you want to edit a contour.
2. Select the adding contour mode (see Figure 254). To add a drawn contour to the ROI, check the **Add** radio button. To remove a drawn contour from the ROI, check the **Remove** radio button.
3. Click the **Polygon**  button in the **ROI drawing** tool.
4. Click in the view to define the starting point (the first vertex) of the polygon.
5. Move the cursor, and click to define the other polygon vertex or vertices (see Figure 256a).
6. To close the polygon, move the cursor towards the starting point until the mouse pointer changes to the closing symbol () and click (see Figure 256b).

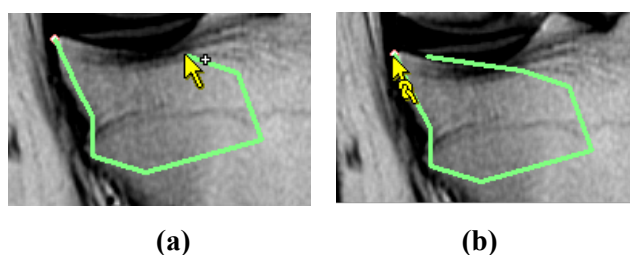




Figure 256 – Drawing a polygon contour (a), closing the polygon contour (b)

### 10.8.3 Snake drawing tool

The Snake drawing tool is a semi-automatic, edge detection tool for defining the contour parts of the currently selected ROI. The edges are detected in the image/MPR according to the current window and level values in the view (see 7.1 Window and level manipulations).

To use the Snake drawing tool, proceed as follows:

1. Select the ROI for which you want to edit a contour.
2. Select the adding contour mode (see Figure 254). To add a drawn contour to the ROI, check the **Add** radio button. To remove a drawn contour from the ROI, check the **Remove** radio button.
3. Click the **Snake**  button in the **ROI drawing** tool.
4. Click in the view to define the starting point (the first vertex) of the contour.
5. Move the cursor (it can be seen that a part of the current curve is attracted to the edges in the image), and click when the curve shape is suitable. Next, define the other parts of the contour (see Figure 257a).
6. If a defined part of the contour is not desired, the last part of the contour can be deleted by pressing the **Backspace** key.
7. To close the contour, move the cursor towards the starting point until the mouse pointer changes to the closing symbol () and click (see Figure 257b).

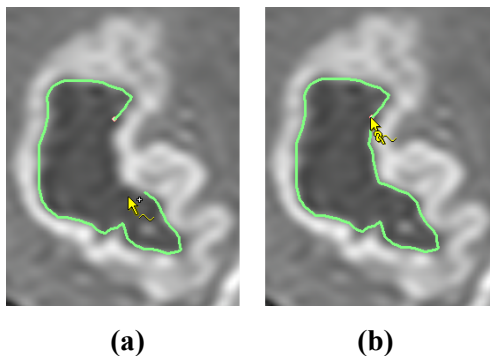



Figure 257 – Drawing a snake contour (a), closing the snake contour (b)

#### 10.8.4 Magic wand drawing tool

The Magic wand drawing tool is used to draw a contour of the currently selected ROI around a consistently colored area (bone, tissue). Move the mouse to contour an area by joining adjacent image pixels with similar gray level values and to change similarity factor.

To use the Magic wand drawing tool, proceed as follows:

1. Select the ROI for which you want to edit a contour.
  2. Select the adding contour mode (see Figure 254). To add a drawn contour to the ROI, check the **Add** radio button. To remove a drawn contour from the ROI, check the **Remove** radio button.
  3. Click the **Magic wand**  button in the **ROI drawing** tool.
  4. Select the 2D or 3D mode:
-

- To create a contour in the current view only, uncheck the **3D** check box.
  - To create contours within the entire volume for which the original image (non-reconstructed) is displayed in the current view, check the **3D** check box.
5. If only one polygon from the contoured region is to be selected as the final contoured area, check the **Single polygon** check box.
  6. To accept holes in the contours, check the **Holes** check box. This excludes any off-color areas enclosed within the area of the defined color range and creates holes in the contour instead.
  7. Press and hold down the left mouse button to define the starting point, and from there drag the cursor to demarcate the area what you want to define. The further you drag the cursor away from the starting point, the wider the color range will be (see Figure 258).
  8. Release the mouse button.
  9. To check that the contours have been properly created, scroll through the slices and/or rotating ROIs in the 3D view.

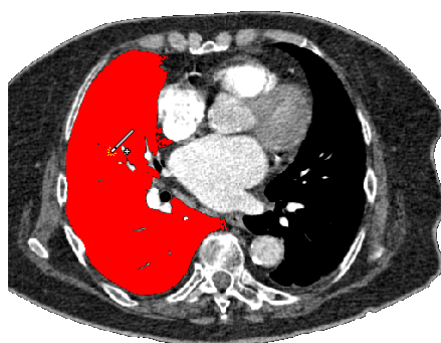



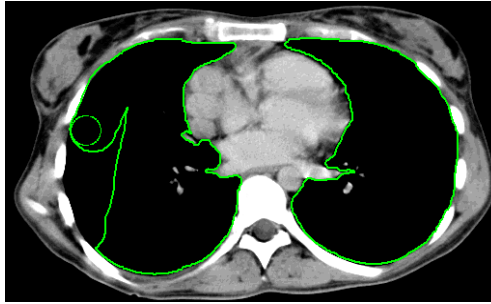
Figure 258 – Defining an area using the Magic wand drawing tool

### 10.8.5 Brush drawing tool

Using the Brush drawing tool, you can move the circular cursor with the defined size to add or remove parts of contours of the currently selected ROI.

To use the Brush drawing tool, proceed as follows:

1. Select the ROI for which you want to edit a contour.
2. Click the **Brush**  button in the **ROI drawing** tool.
3. If necessary, adjust the size of the brush tool by defining the **Radius** value in the box below the **Brush** button.



**Figure 259 – Adding an area to a contour using the Brush drawing tool**

4. To add/remove a contour, press and hold down the left mouse button and move the brush cursor to create the desired shape (see Figure 259).
5. To complete the contour creation process, release the mouse button.

Note that the adding or removing mode is selected automatically based on the position of the mouse cursor at the moment when the mouse button is pressed. Starting from the outside of existing contour, removes from it; starting from the inside of existing contour, adds to it. The default behavior can still be overridden by using **Ctrl** or **Shift** keys.

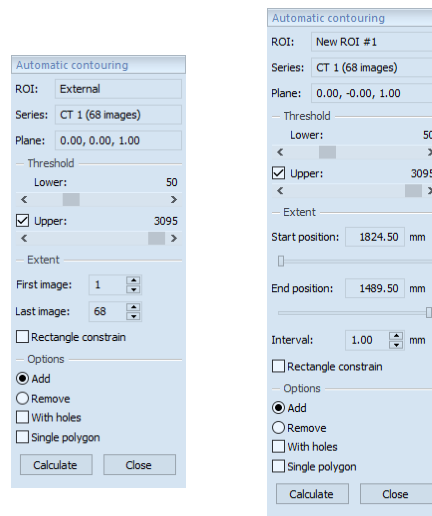
### 10.8.6 Automatic contouring drawing tool

This ROI definition tool automatically generates contours in adjacent original or reconstructed images at the same time. It is especially suitable for defining an outline of a patient (such as the skin surface). The contouring parameters (the image area and number of planes for contouring) can be specified by means of the Automatic contouring drawing tool prior to contour creation.

To use the Automatic contouring drawing tool, proceed as follows:

1. Select the ROI for which you want to edit a contour.
2. Click the **Automatic contouring...** button in the **ROI drawing** tool.
3. The **Automatic contouring** tool is then automatically displayed as a new tab in the tools panel where you can define the parameters for automatic contouring (see Figure 260).

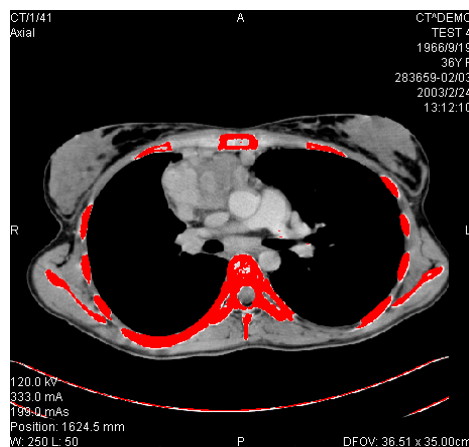




(a) (b)

**Figure 260 – Automatic contouring tool for original images (a), for reconstructed images (b)**

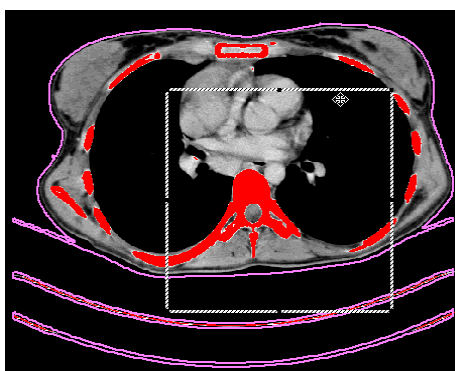
4. Select the **Lower** and **Upper** grayscale values for the search process. All grayscale values within the selected threshold value range will be considered as matching. This can be seen in the current view – the matching regions are displayed in red while the remainder appears in black (see Figure 261).



**Figure 261 – Segmented image with threshold selection, contouring bones**

5. Select the range of images/planes (in the **Extent** section of the tool) to be used for automatic contour search, choosing the appropriate **First image** and **Last image** values or the **Start position** and **End position** for the reconstructed images.
6. Define which part of the image is to be used (a limited rectangle or the whole image).
  - Whole image – it creates an outline based on the entire image (the default setting, **Rectangle constraint** check box is unchecked).

- Rectangle – only a limited area of the image will be used. To select the area, proceed as follows:
  - Check the **Rectangle constraint** check box.
  - Move the rectangle or drag the sides to change its size until the desired area is demarcated (see Figure 262).
  - To check that the desired area is properly demarcated in all slices, scroll through them in the current view.



**Figure 262 – Moving the rectangle constraint**

7. Select the contour adding mode in the **Options** part. To add all created contours to the currently selected ROI, check the **Add** radio button; to remove them, check the **Remove** radio button.
8. Select the advanced option for automatic contouring as follows:
  - **With holes** – holes in each image according to the setting of the minimal and maximal threshold value are searched.
  - **Single polygon** – only one polygon in each image without holes according to the setting of the minimal and maximal threshold value is created.
9. Click the **Calculate** button.

### 10.8.7 ROI margin drawing tool



This functionality is only available if the Advanced Contouring license is installed in the TomoCon Workstation.

The ROI margin tool is used to automatically create a margin around the source ROI with the defined dimensions and constraints of selected risk ROIs.

To generate a ROI margin using the ROI margin tool, proceed as follows:

1. Select the ROI for which you want to create a margin.

2. Click the **Margin...** button in the **ROI drawing** tool.
3. The **ROI margin** tool is then automatically displayed as a new tab in the tools panel where you can define parameters for the ROI margin (see Figure 263).
4. Set the margin size as desired along the x-axis, z-axis and y-axis. The sizes can be set individually for the minus and plus directions on each axis or jointly for all directions at the same time using the **Grow** scrollbar (from -1cm to 10cm).

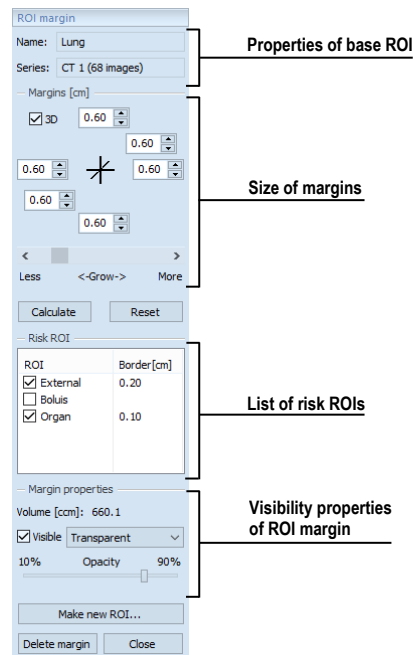


Figure 263 – ROI margin tool

5. If desired, select one **Risk ROI** or several risk ROIs (typically an organ at risk) and set the **Border** of safety margin for each risk ROI. The risk ROIs and their safety margins will not be included in the resulting ROI.
6. Click the **Calculate** button. The created margin will be displayed as a dashed line (see Figure 264).

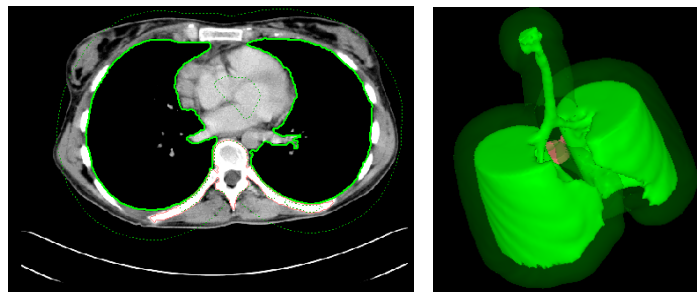
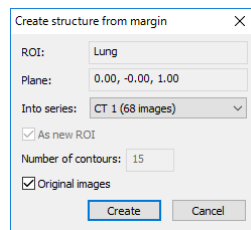


Figure 264 – Created ROI margin in 2D and 3D

7. Check the result in the images and the 3D view, and adjust the margin properties if necessary. Then recreate the margin.
8. To create a new ROI from the generated margin, click the **Make new ROI...** button. The **Create structure from margin** dialog (see Figure 265) is then displayed in which you proceed as follows:
  - Select the image series if one other than the default series is to be used (this is only possible if registration has been carried out).
  - If you do not wish to resample to original images, uncheck the **Original images** check box and enter a value into the **Number of contours** box.
  - To create the ROI, click the **Create** button.



**Figure 265 – Create structure from margin dialog**

You can then assign a new color to the margin ROI, resize it and carry out all operations with it that you can carry out with a manually drawn ROI. The margin ROI is no longer connected to the source ROI it was based on.

### 10.8.8 Bolus ROI defining drawing tool



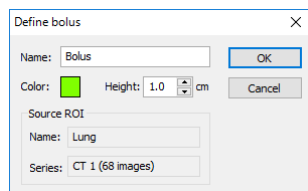
This functionality is only available if the Advanced Contouring license is installed in the TomoCon Workstation.

The Bolus ROI defining tool allows to define a rectangular ROI of a certain thickness. The bolus ROI must be located on the surface of a previously defined ROI. The basic parameters for ROI bolus calculation are the four markers in the current view. The first two (the left and right) must be located on an image in which the source ROI is drawn. The other two markers (the top and bottom) can be located in any image (original or reconstructed).

To generate a bolus ROI using the bolus drawing tool, proceed as follows:

1. Select the ROI for which you want to create a bolus, and click the **Bolus...** button in the **ROI drawing** tool. The **Define bolus** dialog (see Figure 266) is

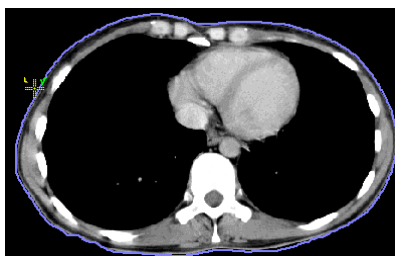
then displayed in which is possible to enter the name of the bolus ROI and its color and to define the height of bolus in cm in the **Height** box.



**Figure 266 – Define bolus dialog**

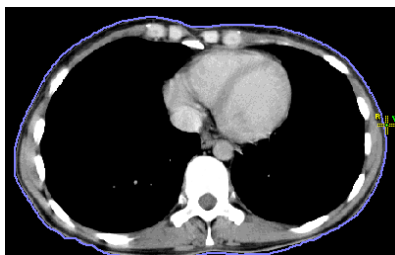
When finished making the settings, click the **OK** button to continue.

2. Define the left, right, top and bottom points of the bolus by clicking in the current view:
  - Define the leftmost point of the bolus by clicking the contour. The cursor marked as **L** will also be displayed with a green tick when it reaches the contour line of the currently selected ROI (see Figure 267).



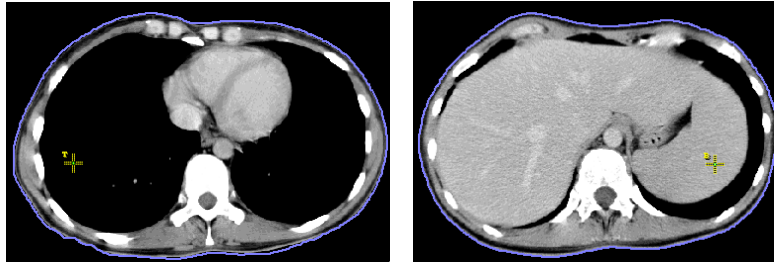
**Figure 267 – Defining the left point of the bolus**

- The cursor is now marked as **R**. Click the rightmost point of the bolus, as described above for the leftmost point (see Figure 268).



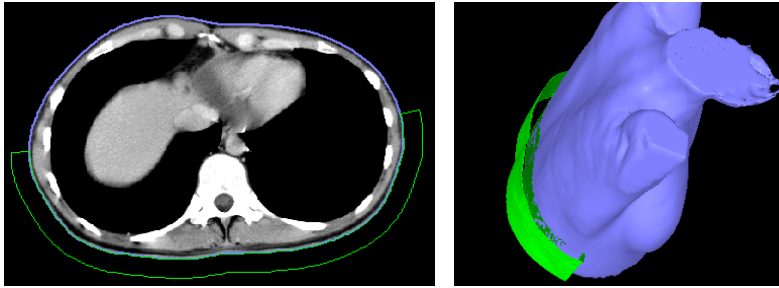
**Figure 268 – Defining the right point of the bolus**

- The top point and the bottom point (the cursor is marked as **T** and **B** respectively) can be selected in any image in the current view. It is not necessary that these points are located on the contour line but simply in a view displaying the same image series (see Figure 269).



**Figure 269 – Defining the top point and bottom point of the bolus**

- After the fourth point is defined in the current view, the bolus calculation process starts automatically. The bolus is generated and displayed as contours in the image series and as volume in the 3D view (see Figure 270).



**Figure 270 – Generated bolus ROI around the skin surface**

## 11 Slab projections

Slab is a planar projection of image data within a defined extent of the image data volume (see Figure 271). Slabs can be created on slices and on MPRs, and the projection method can be chosen to be one of MIP, MinIP, AvgIP algorithms.

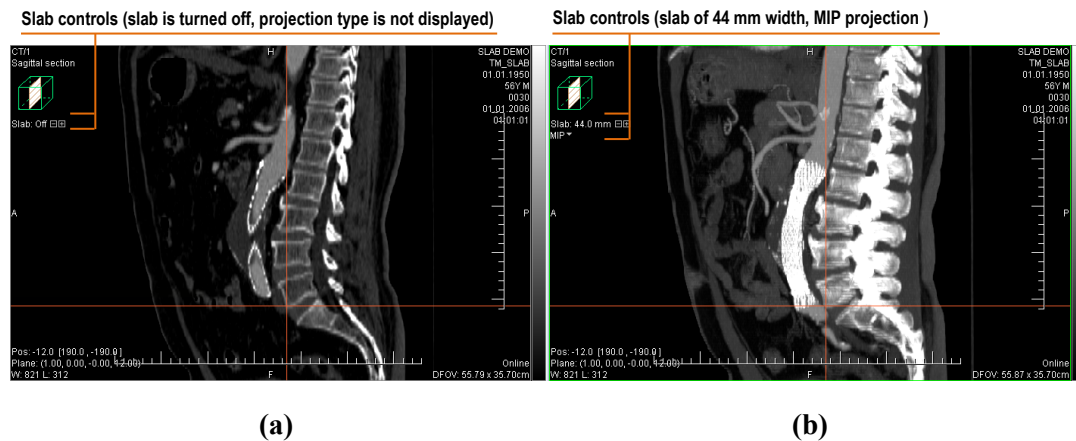




Figure 271 – Sagittal MPR - slab is turned off (a), slab is turned on with projection (b)

### 11.1 Creating slab projections

To create a slab projection:

1. Display arbitrary slice or a MPR in the current view. If image, must be with the transformation, e.i. it is possible to create MPR reconstruction from it.
2. Use  and  controls in the view to set the required slab width. Each mouse click on these controls adds or removes a slice or MPR section to/from the slab.
3. Select the method for the slab pixel values calculation (see Figure 272).

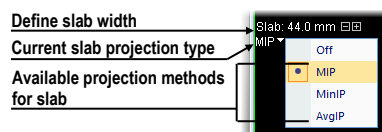


Figure 272 – Controls for defining slab in the current view

The view context menu can also be used to control slab projection:

1. Right-click in the current view.
2. In the mini-toolbar displayed with view context menu (see Figure 273), the slab mode can be toggled on or off, the exact slab width can be set, and the projection algorithm can be selected.

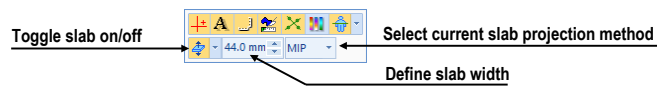


Figure 273 – Slab controls in view mini-toolbar

## 11.2 Slab projections on slices

A slab projection created on a slice view is a projection of contiguous interval of parallel slices. The total thickness of the slab is the product of the effective slice thickness and the number of slices within the slabs (see Figure 274).

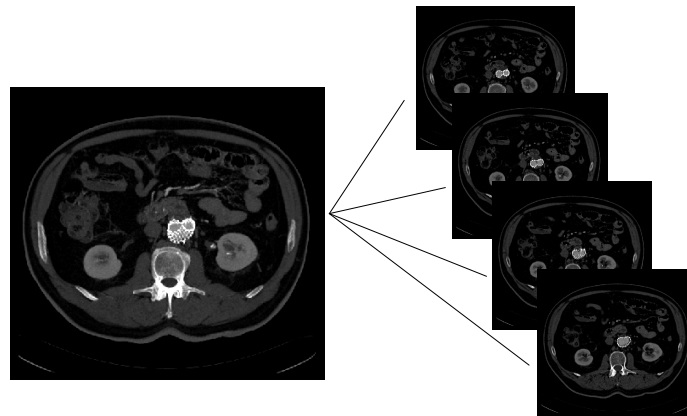


Figure 274 – Slab with 12 mm width composed by 4 slices (each with 3mm thickness)

## 11.3 Slab projections on MPRs

A slab projection on MPR is a projection of MPRs reconstructed in 1mm steps. In addition to the slab thickness control in the view, the width of the slab can be changed using another MPR view. When the mouse cursor is moved close to the MPR line indicator, the slab is highlighted. To change the width, drag the border of the highlighted slab area (see Figure 275).

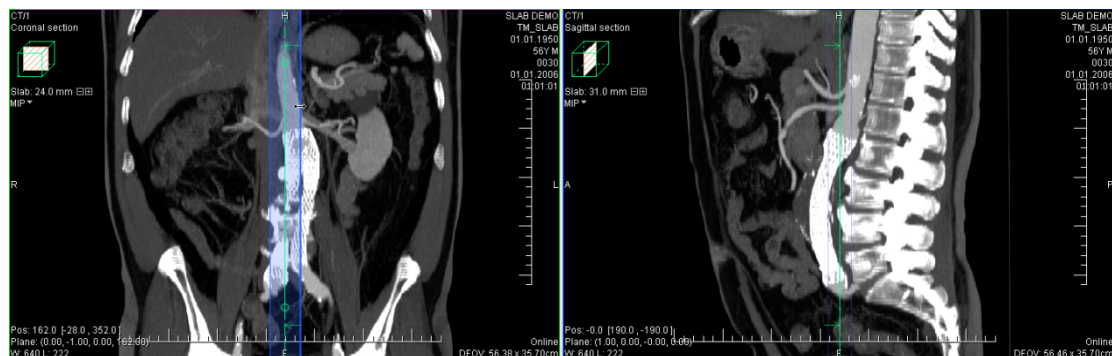
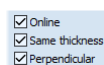


Figure 275 – Changing sagittal MPR slab width from axial MPR

In orthogonal MPR working area (see 12.3 Orthogonal MPR working area), the widths of slabs in the individual MPR segments can be synchronized - all the



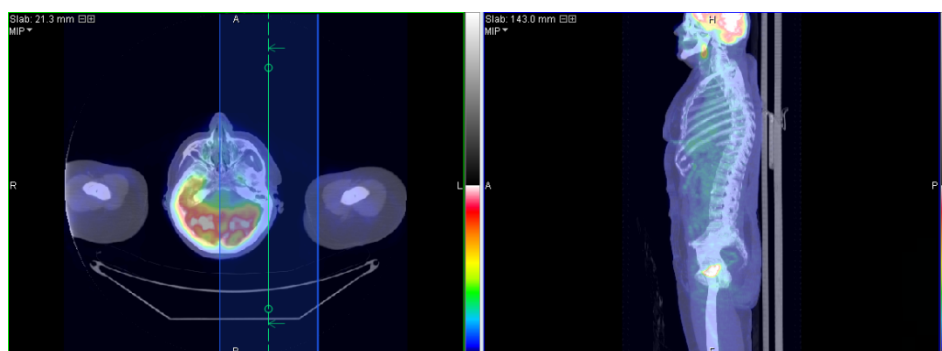
synchronized segments will maintain identical slab width settings. To synchronize the slab widths, check the **Same thickness** checkbox in **MPR** tool (see Figure 276).



**Figure 276 – Turned on the synchronization of the slabs width in orthogonal MPR working area**

## 11.4 Slab projections on fusion images

A slab can be created on fusion images (see Figure 277). A slab created on fusion MPR is calculated using the image information from both series. A slab created on a fusion image is only calculated using the image information from the base series, as there may be a difference between the slice spacing and orientation between the series.



**Figure 277 – Slab on fusion images and MPR**

## 11.5 Measurements and ROIs on slab projections

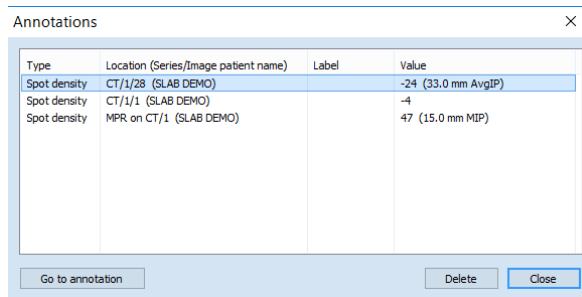
Measurements, ROIs and quantitative analyses can be created and used on slab projections. In all the situations, the position of the image is considered to be in the middle of the slab volume, thus all the measurements and ROIs are created on that slice/MPR (reference slice/reference MPR).



The calculated measurement values in various views and in the annotation list may differ, as the image data used for the respective values' calculation is different (for example, when in the individual views, different slice thickness is set).

The measurement values shown on the slab are the values calculated using the image information of the slab, not only of the reference image. The measurement values shown in the annotation list are calculated on the image where the annotation was recently edited. In case of a slab projection, the annotation list shows the information

about the slab (the slab thickness and the projection type) next to the measurement value (see Figure 278).



Type	Location (Series/Image patient name)	Label	Value
Spot density	CT/1/28 (SLAB DEMO)		-24 (33.0 mm AvgIP)
Spot density	CT/1/1 (SLAB DEMO)		-4
Spot density	MPR on CT/1 (SLAB DEMO)		47 (15.0 mm MIP)

Buttons: Go to annotation, Delete, Close


**Figure 278 – Annotations list with defined spot density on slabs and on image**

## 12 MPR – Multi-planar reformatting

Multi-planar reformatting (MPR) allows displaying of sections of a patient's body according to a defined plane. It offers a particular way of examining medical imaging data that differs from that of the original imaging. MPR allows to view three-dimensional volume in a plane direction other than the plane direction of the original imaging. MPR display mode can be started quickly and easily for any suitable study. MPRs can be displayed in the current view or in a special orthogonal working area using **MPR** tool docked in the tools panel.



Users responsible for diagnosis should be aware that MPR views display calculated data. Calculated data, although based on the original data set, may incorrectly (due to differences in dimensions) give the appearance of healthy tissues in situations where pathology may be present. Occasionally, calculated data may also include image artifacts that should not be interpreted as actual pathology.

The **MPR** tool (see Figure 279) is initially docked in the tools panel. You can access it at any time by clicking the tab with the  icon. To start using this tool, select the image of the series you would like to view with MPR in the desired view of the work area and:

- To show a single MPR in the current view, select one of **Axial**, **Sagittal** or **Coronal** radio buttons. A MPR of selected type and series is created and shown.
- To show three main perpendicular planes in a new overlapping working area, click **Orthogonal**. Alternatively, click the arrow next to **Orthogonal** button to select from the layouts available.

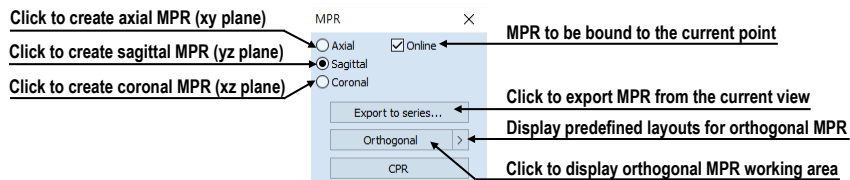


Figure 279 – MPR tool

### 12.1 MPR view indicators

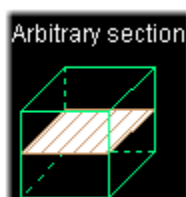
In addition to standard view texts, MPR views show this additional information:

- Plane indicator, in relation to the patient data volume.

MPR views show a small indicator of a plane within a box (see Figure 280). The indicator displays a general position and orientation of the MPR plane in the patient image data volume.

- Text indicator of the MPR plane.

If the MPR plane coincides with main planes, the orientation is also shown – **Axial section**, **Sagittal section** or **Coronal section** is displayed in this case. If the plane does not coincide with the main planes, **Arbitrary section** is indicated (see Figure 280).



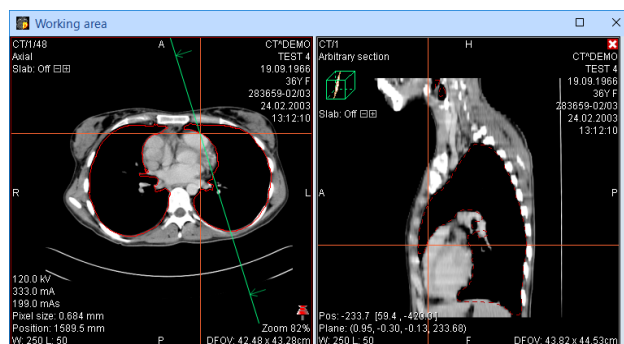
**Figure 280 – Indicator of MPR plane position and orientation**

In addition to the indication in the MPR view, the plane is indicated in other views too by:

- Intersection line showing intersections of the view plane with all the other MPR planes of the same series. The intersection lines can be used to rotate or move the appropriate MPRs (see 12.4 Interactive moving and rotating).
- Reference line showing the intersection of the current view's MPR with all the remaining views showing the same, or registered series. In addition, the borderlines – total extent of the volume – are displayed (see 7.6 Reference lines).

## 12.2 Online MPR

The **Online** check box in the **MPR** tool defines the online MPR to be bound to the current point (see Figure 281).



**Figure 281 – Arbitrary MPR view and intersected axial MPR plane**

All online planes are automatically shifted to intersect the current point. If the current point is changed by clicking in one of the views, all online planes will shift immediately.

### 12.3 Orthogonal MPR working area

Three perpendicular MPRs can be displayed easily in a special overlapping orthogonal working area. The special working area consists of three MPR segments which are initially orthogonal and possibly one general-purpose segment. The segments are shown according to the selected layout.

The orthogonal working area is placed over the existing working area, and is independent from the other working areas displayed at the time. It allows initially to display three orthogonal MPRs without any changes to overlapped working area, while orthogonality of planes is also possible to switch off and get arbitrarily rotated plane. In this way, the MPRs of requested series can be shown at any time without disrupting the current layout; once the work with MPRs is finished, it can be closed or moved away and the previous work in the overlapped working area can be resumed.

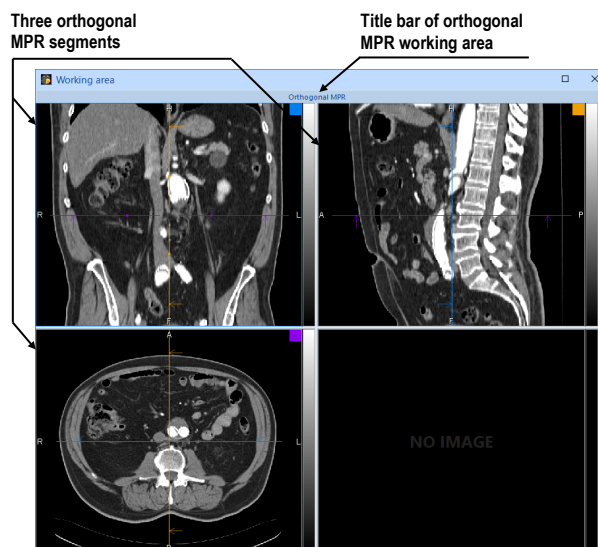


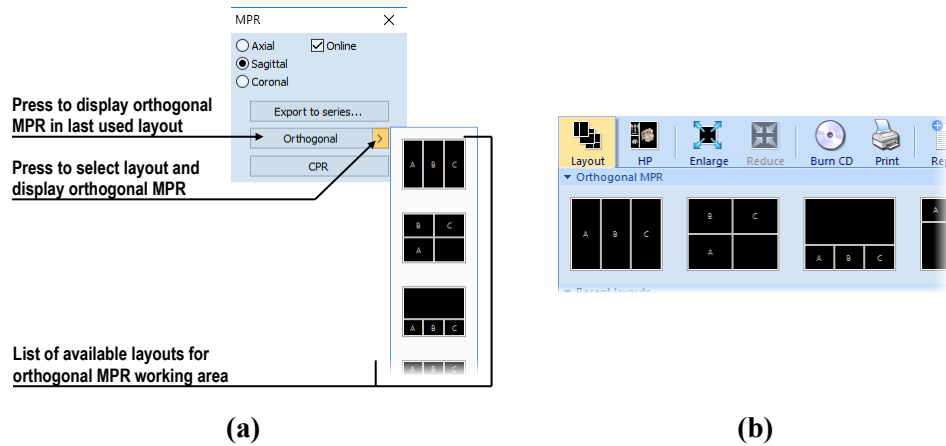


Figure 282 – Initial layout of orthogonal MPR working area

To display orthogonal MPR working area using the last used layout, select an image belonging to the appropriate series into the current view and press **Orthogonal** button (see Figure 283a) in **MPR tool**. To display working area using a different layout, click the arrow button and select the appropriate layout or select it using the  **Layout** item in the main toolbar (see Figure 283b).

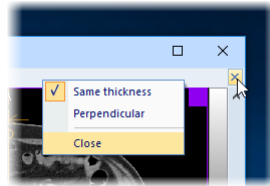
To close orthogonal MPR working area, click the close button  in the title bar of the working area or in the context menu in the title bar (see Figure 284). The working

area will be immediately closed, and the content of the original overlapped working area will be displayed.



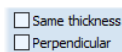
**Figure 283 – MPR tool (a), Layout list in the main toolbar of TomoCon (b)**

To move orthogonal MPR working area, drag it by the title bar over another area which should be overlapped; then release the mouse button.



**Figure 284 – Closing the orthogonal MPR working area**

Initially, all MPR views in working area are orthogonal to each other. If desired, however, the orthogonality may be turned off to change the plane of each MPR view independently of the other planes. To cancel orthogonality, check out **Perpendicular** option in the **MPR** dialog (see Figure 285). Similarly, it is possible to cancel the synchronization of slabs of MPR views. This means that the thickness and type of slab of a MPR view can be set to independently from the other MPR views of working area.



**Figure 285 – Turned off the slab synchronization and the orthogonality**

Each MPR segment has its own color identification (a small square in the upper right corner and the frame color); the intersection lines are drawn using the same colors for better orientation (see Figure 286). The predefined colors can be changed in the **Colors and styles** tab of the **Options** dialog (see 4.4 Color and style options).

All three MPR segments in orthogonal MPR working area are linked in the sense that if the series is changed or any image operation (window, level, invert, etc.) is performed in one segment, this operation is propagated to the other two segments.

To reset the content of the MPR segments to the original state, select **Reset View** in the context menu of any of the MPR segments. This resets the orientation of the MPRs and other alterations of the segments (like zoom) to the original state.

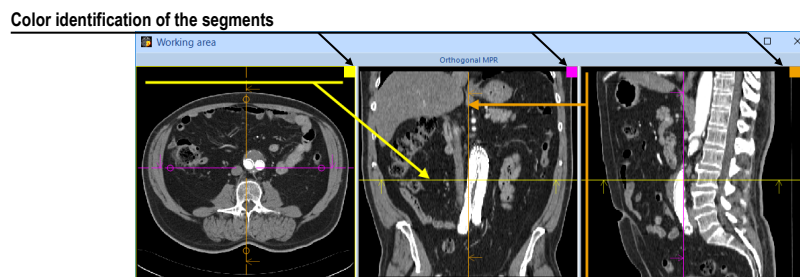


Figure 286 – Color identification of MPR segments

## 12.4 Interactive moving and rotating

To interactively rotate or move an MPR from another view, it is possible to use the intersection lines of planes (see Figure 287). These are displayed automatically for each MPR visible in the working area. Each view displays the intersection lines of all the other MPR views displayed in the working area - intersecting the image or MPR displayed in that view.

Moreover, each section line displays direction arrows which indicate the direction of reconstruction. In orthogonal MPR working area, the section lines colors match the color identification of the individual MPRs.

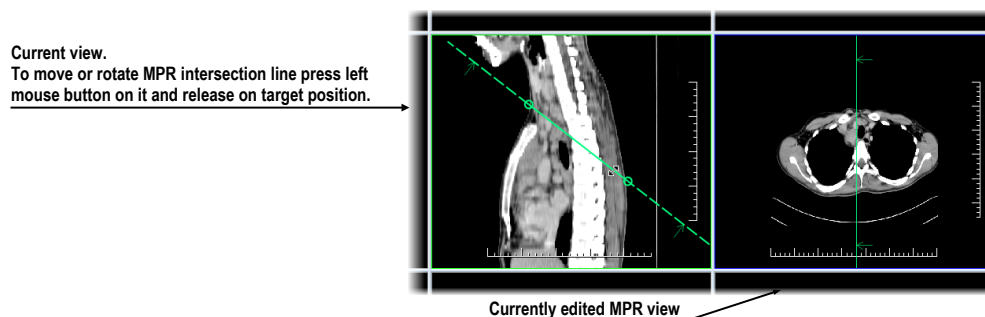
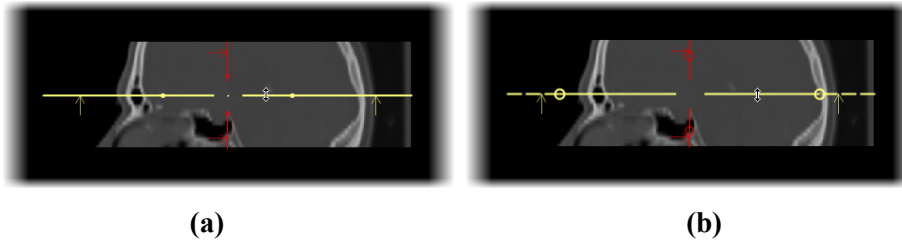


Figure 287 – Interactive moving of MPR

There are two types of MPR intersection lines. In the orthogonal MPR working area, there are initially available intersection lines rotating around the common intersection point of planes of MPR views (the perpendicularity of planes is always maintained). In other views or with **Perpendicular** option turned off, it is possible to use intersection lines rotating around the second point of the line.

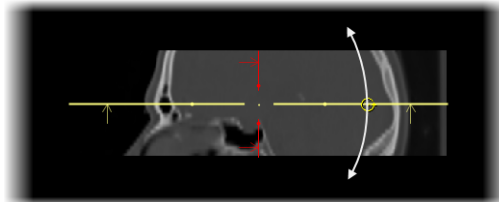
To shift the plane of the MPR represented by a section line, move the cursor over the intersection line in between the small circle indicators on the section line (see Figure

288). The MPR view coupled to the line is highlighted in blue. Then drag the line to requested position releasing the mouse button when done.



**Figure 288 – Interactive moving of MPR - section lines – orthogonal (a), other (b)**

To rotate the plane of the MPR with **Perpendicular** option on, move the cursor over or further away from any of the circles on the intersection line (the MPR coupled to the line is highlighted in blue), press and hold down the left mouse button and drag the circle to requested position. During the movement, the section line is rotated around the intersection with the perpendicular section line (see Figure 289).



**Figure 289 – Interactive rotating of section lines with Perpendicular option on**

Section lines of MPRs outside of the orthogonal working area and section lines when the **Perpendicular** option is turned off are handled in a very similar way. To rotate the plane of the MPR represented by a section line, move the cursor over any of the circles on the intersection line (the frame of MPR coupled to the line is highlighted in blue), press and hold down the left mouse button and drag the circle to requested position. During the movement the section line is rotated around the other circle of this line (see Figure 290a). To move rotating point of line represented by circle, drag and drop it to another position on line (see Figure 290b).



**Figure 290 – Interactive rotating with Perpendicular option turned off – rotation (a), changing the rotation center (b)**



## 12.5 Exporting MPR to series

TomoCon allows the saving of an MPR view as an additional series in a selected study. By setting the parameters for the exported MPR, it is possible to select the exact properties of the new series (the resolution, positioning of the first MPR, positioning of the last MPR, slab type and thickness). Once saved, the created MPR series can be sent to the PACS as a new series or reopened for viewing.

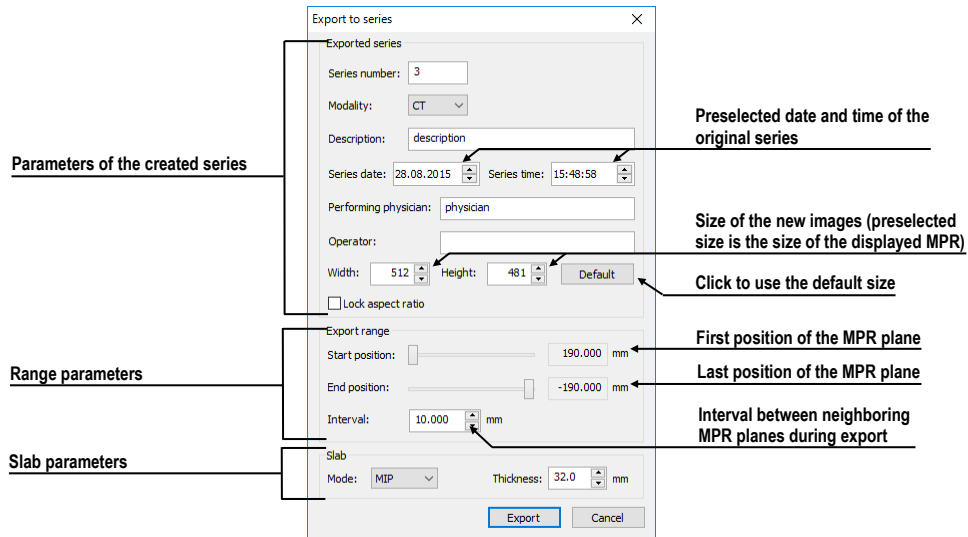


Figure 291 – Export to series dialog

To export an MPR view to a study, proceed as follows:

1. Display the required MPR in the current view.
2. Press the **Export to series...** button in the **MPR** tool.
3. The **Export to series** dialog will be displayed in which you can set the parameters for MPR export (see Figure 291).
4. After setting up the parameters, press the **OK** button.

## 13 CPR - Curved Planar Reformatting

Curved planar reformation is a tool which allows visualization of tubular anatomical structures such as blood vessels or spinal cord. It generates longitudinal cross-section in order to show lumen, wall and surrounding tissue in a curved plane.

CPR tool is controlled using a special working area (see 13.1 CPR working area). Its user interface has been optimized for CPR path definition and display of requested visualizations in a Curved MPR plane. The CPR plane can be defined in any direction and angle on the original patient series, and it can be rendered as a straightened or stretched reconstruction.



Users responsible for diagnosis should be aware that CPR view displays calculated data. Calculated data, although based on the original data set, may incorrectly (due to differences in dimensions) give the appearance of healthy tissues in situations where pathology may be present. Occasionally, calculated data may also include image artifacts that should not be interpreted as actual pathology.

### 13.1 CPR working area

CPR working area is designed to provide all necessary actions and tools needed for CPR. All views in this working area are associated with the CPR path you are currently working with, therefore all actions performed within the view are instantly reflected in the whole CPR working area. CPR working area (Figure 292) consists of four views (three MPR views and the CPR view).

The CPR view content with defined rotations or perpendicular transversal MPR planes can be exported as new DICOM images.

The CPR working area consists of three main parts (see Figure 292):

- The CPR tool docked in the tools panel (see 13.1.1 CPR tool).
- Three MPR views which show three MPR planes perpendicular to each other. They can be finely moved and rotated, and they are primarily used for CPR path definition.
- The CPR view with transversal views. It displays the CPR path as a straightened or stretched curved image. Additionally, it can display three transversal views along CPR path.

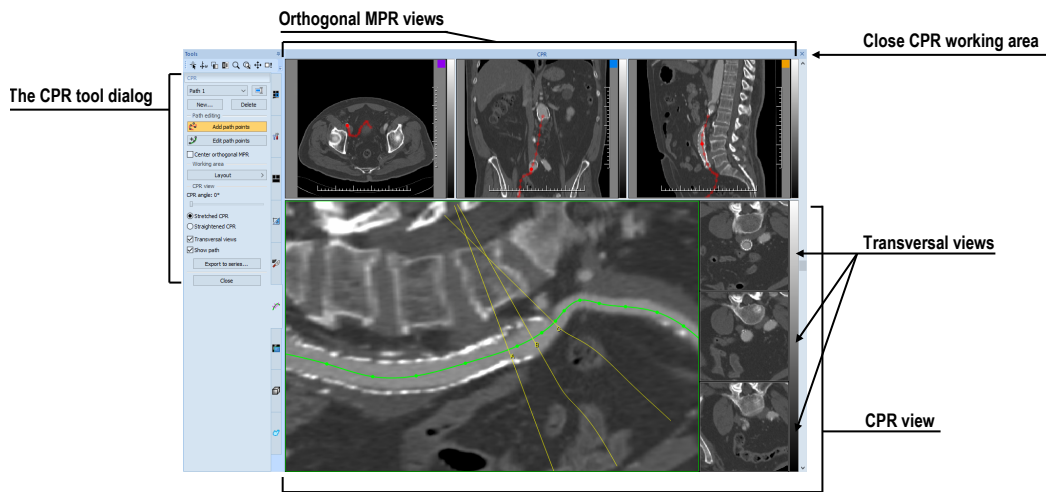



Figure 292 – CPR working area

### 13.1.1 CPR tool

The **CPR** tool (see Figure 293) contains several buttons allowing to access all functions for working with the CPR. This tool is visible only with the CPR working area and is docked in the tools panel (with the  icon).

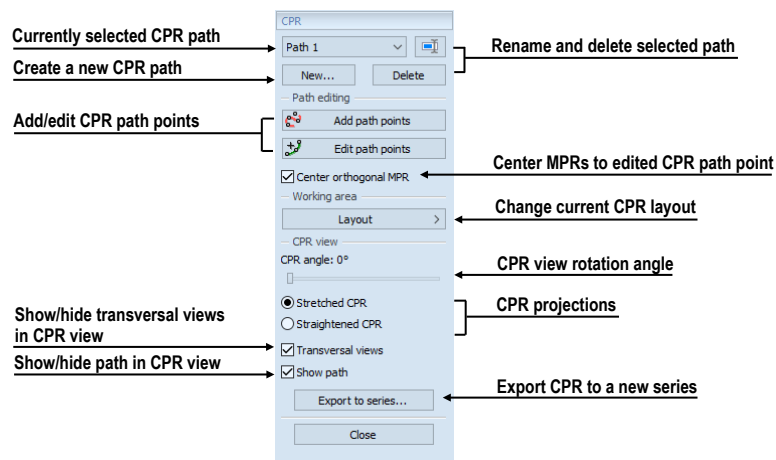


Figure 293 – CPR tool in the tools panel

The **CPR** tool tab is hidden by default. When the first CPR working area is created, **CPR** tool tab is displayed automatically (just beneath the **MPR** tool), and it is closed when the last CPR working area is closed.

### 13.1.2 CPR working area layout

You can change the current CPR working area views layout by selecting one of the predefined CPR layouts from **Layout** button items (Figure 294) or by selecting any layout from main toolbar's **Layout** button drop down menu.

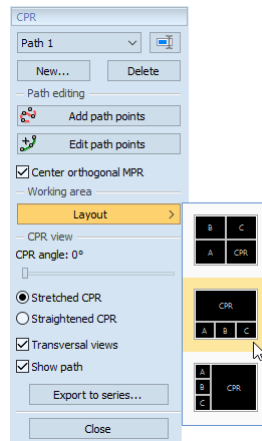



Figure 294 – Changing CPR layout

## 13.2 Creating/closing a CPR working area

To create a CPR working area:

1. Select a view with the series for which you would like to create CPR path.
2. Activate **MPR** tool, and click **CPR** button (see Figure 295), or click the  **CPR** item of the **Tools** main submenu.
3. CPR working area will be displayed with the last defined CPR path for a given series, and the **CPR** tool will be activated in the tools panel. If no CPR path is defined on selected series, a new empty CPR path with name “Path 1” is created and selected as active.

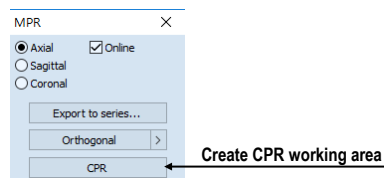

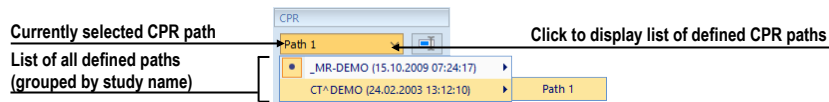


Figure 295 – Create a CPR working area

To close currently selected CPR working area, click the **Close**  button in the CPR working area title bar (see Figure 292). CPR working area will be closed automatically if the series currently used for the CPR path is closed or if a layout other than CPR is selected.

## 13.3 Current CPR path

All CPR actions are performed on the currently selected CPR path. The **CPR paths** combo box in the **CPR** tool in the tools panel provides the list of all created CPR paths. To select a CPR path, choose it using **CPR paths** combo box (see Figure 296).



**Figure 296 – Selecting CPR path**

To create a new CPR path:

1. Select a view with the series for which you would like to create a new CPR path.
2. Click **New...** button in the **CPR** tool (see Figure 297).
3. New CPR path is created for selected series, and it is automatically selected as current.



**Figure 297 – CPR tool, the CPR part**

To rename the currently selected CPR path:

1. Click **Rename** button in the **CPR** tool tab (see Figure 297).
2. Type a new name for the CPR path, and press **Enter**.

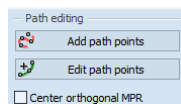
To delete the currently selected CPR path:

1. Click **Delete** button in the **CPR** tool tab (see Figure 297).
2. The CPR path will be deleted, and first available path is selected as current one.

## 13.4 CPR path

The CPR path is represented by a Bezier curve interpolating defined 3D points (key points). The number of key points is unlimited. Any changes performed to the CPR path are immediately reflected by CPR view. TomoCon provides two different modes for defining the CPR path key points (see Figure 298):

- Creation mode (see 13.4.1 Creation mode)
- Editing mode (see 13.4.2 Editing mode)

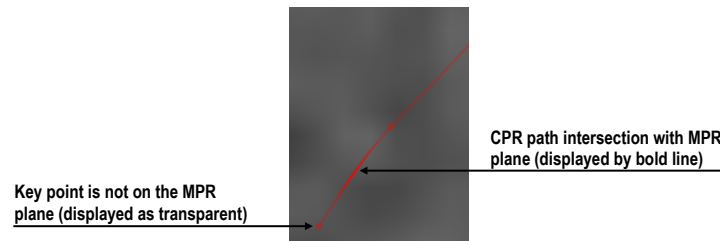


**Figure 298 – Path defining tools**

Defined CPR path is always displayed on the MPR views, even if the MPR plane does not intersect the path (see Figure 299). MPR view always shows projection of the path. If the CPR path is crossing the MPR plane, the path is displayed by bold red

color. Otherwise, if it is positioned behind or in front of the MPR plane, it is displayed by a transparent color.

To move center of the orthogonal MPR views to CPR path point, click on a requested point on the displayed CPR path. The position of point itself is not modified.




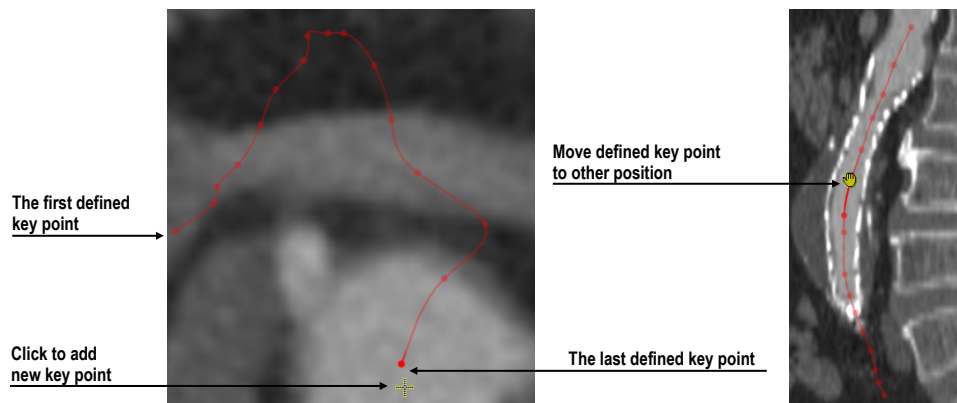
**Figure 299 – CPR path intersection with MPR plane**

When adding a new or editing existing key point, it may be useful to move all orthogonal MPR planes to that key point to make following adjustments easier. To do so, check **Center orthogonal MPR** check box (see Figure 298).

### 13.4.1 Creation mode

To add a new point to the currently selected path (see Figure 300):

1. Click  **Add path points** button (see Figure 298). The path is displayed in red.




**Figure 300 – Defining key points of CPR path**

2. Click within any MPR view in the CPR working area to specify the position of new path's key point.
3. New key point is added at the end of the selected path. The orthogonal MPR views will be automatically centered on this last point when **Center orthogonal MPR** option is checked in the **CPR** tool.

To remove last defined key point from CPR path, press **Backspace**.

To move already defined key point, drag and drop this point by mouse onto the requested position.


To start over, press **Delete**. The selected CPR path will be deleted.

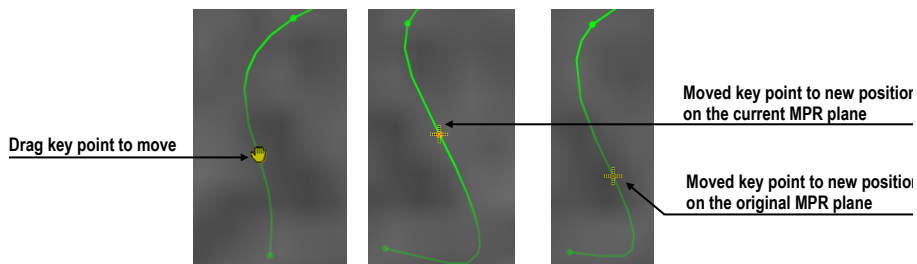
4. To finish path creation, click  **Add path points** button again.

### 13.4.2 Editing mode

This mode allows to add a new point into the CPR path or move an existing key point. In this mode, new points cannot be added at the end of the path.


To adjust position of any already defined key point (see Figure 301):

1. Click  **Edit path points** button (see Figure 298). Path is displayed in green.
2. Move mouse over the key point.
3. Drag and drop the key point by left mouse button to the new position. To move point in the current plane, use **Shift** during moving operation.



**Figure 301 – Moving of defined key point to the new position**

To add new key point between already defined CPR path key points (see Figure 302):

1. Click  **Edit path points** button (Figure 298). Path is displayed in green.
2. Move mouse near defined path. Note a new moving green point. It is a preview of a new key point within the defined path segment.
3. Click the left mouse button. A new key point is added between two already defined key points. Path is refined with respect to the position of the new key point.



**Figure 302 – Inserting new key point in the CPR path**

### 13.4.3 Deleting key point/points

To delete a key point of the CPR path:

1. Make sure that you are in the path adding or editing mode (**Add path points** or **Edit path points** button is pressed).
2. Move mouse over the key point. Grab the key point by pressing left mouse button.
3. Press **Delete** key. The key point being held is removed from the path.

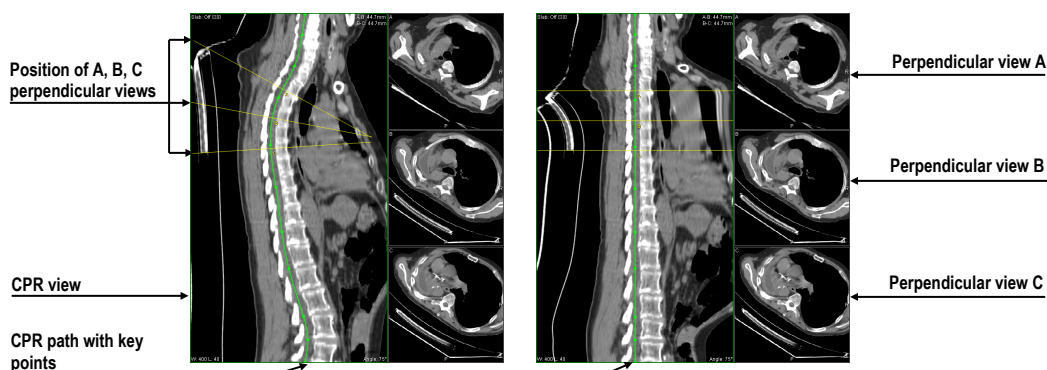
To delete all key points of the CPR path:

1. Make sure that you are in the path adding or editing mode (**Add path points** or **Edit path points** button is pressed).
2. Press **Delete** key. Confirmation dialog is displayed. Click **Yes** if you are sure that all already defined key points should be discarded.
3. CPR path contains no key points now. You can now define a new shape from the start.

### 13.5 Curved MPR view

The CPR view displays the view corresponding to the defined CPR path. The content of CPR view is calculated in real time and automatically adjusted to the length of the path. Whenever path key points are changed, curved planar reformation (CPR) is recalculated as well. Result is consequently displayed in CPR view.

Figure 303 shows an example of CPR view in both stretched and straightened projections with transversal views.



**Figure 303 – CPR view with transversal views in stretched and straightened projection**

Several actions can be performed in CPR view:

- To change the rotation of the plane, use mouse scroll wheel or **CPR angle** slider in the **CPR view** part in the **CPR tool**.



- To change the position of the transversal views along the curved plane, drag and drop yellow intersection line belonging to the central (B) transversal view.
- To change the interval of the transversal views along the curved plane, drag and drop yellow intersection lines belonging to the side (A or C) transversal views.
- To change zoom, window and level or move image in the view, use commands in the CPR view context menu.
- To define measurements, use commands in the **Annotations** main submenu.
- To show/hide CPR path, check/uncheck the **Show path** check box in the **CPR view** part in the **CPR** tool (see Figure 304).
- To change the current CPR projection, click **Stretched CPR** or **Straightened CPR** radio button in the **CPR view** part in the **CPR** tool (see Figure 304).

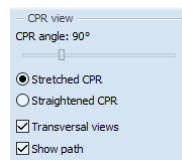


Figure 304 – CPR view settings

### 13.5.1 Measurements in CPR

Measurements defining in the CPR view have some restrictions. The Angle and Cobb's angle measurements cannot be created in this type of view. Only distances along the CPR path or in perpendicular direction can be measured in the Straightened type of rendering. Stretched rendering allows to measure distances in any directions in the plane.

### 13.5.2 Transversal views

Transversal views for CPR view provide quick overview of planar data perpendicular to the path. They are displayed to the right side from the CPR view as separate A, B and C MPR views. Position of planes in all three transversal views can be set simultaneously by mouse scrolling within any of the transversal views. Planes of other two transversal views are moved with the same step.

Transversal views can be hidden anytime by unchecking **Transversal views** check box in the in the **CPR view** part in the **CPR** tool (Figure 304).

### 13.5.3 Exporting CPR

Images rendered in the CPR view can be exported in DICOM format as a new DICOM series. TomoCon allows to export rotated CPR view (CPR view with defined angle range) or transversal view planes with defined offset and size.

To create a new DICOM series with exported images:

1. Click **Export to series...** button in the **CPR view** part in the **CPR tool**.
2. The **Export to series** dialog will be displayed (Figure 305). Here you can specify:
  - DICOM properties of new series and image dimensions.
  - Rotation angle range of CPR view (start angle, end angle, rotation step) for exporting rotated CPR view.
  - Transversal planes parameters (distance between planes and viewport size) for exporting transversal view.
3. Click the **Export** button.

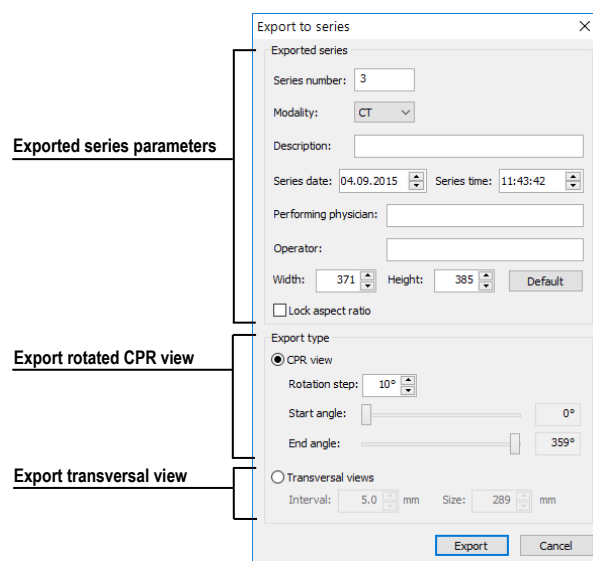



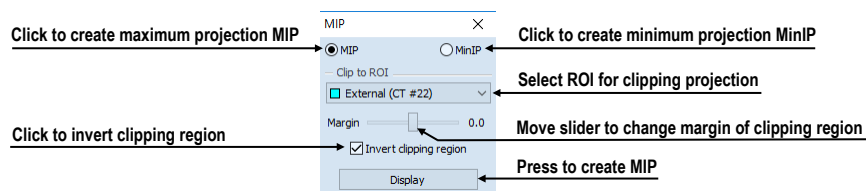
Figure 305 – Export to series dialog

## 14 MIP - Maximum intensity projection

MIP is a spatial method for displaying patient data. This method displays the projection of the maximum values from particular images to the 3D space. It searches for the maximum pixel values, and displays them in a plane. The result of this projection is a multi-frame image with the frames creating the impression of an MIP object rotating. Although it usually displays MIP calculated from maximum values, the TomoCon application also allows to create MIP calculated from minimum values; this is known as MinIP.

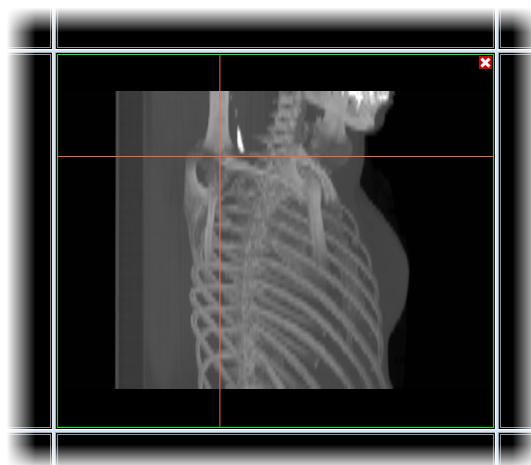
MIP display can be created quickly and easily for any suitable study selected in the current view using the **MIP** tool in the tools panel.

The **MIP** tool (see Figure 306) is initially docked in the tools panel on the tab with the  icon.



**Figure 306 – MIP/MinIP dialog**


To start using this tool, select the image of the series you would like to use for MIP visualization in any view in the work area. For standard projection (MIP), select the **MIP** option; for minimal projection (MinIP), select the **MinIP** option. To start the calculation process, press the **Display** button. The calculated projection is then immediately displayed in the current view (see Figure 307).

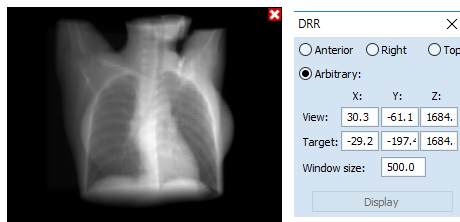


**Figure 307 – MIP in the current view**

## 15 DRR Reprojection

Digitally reconstructed radiograph (DRR) has become a valuable tool in clinical applications. It is a reconstruction of a conventional 2D X-ray image created from computed tomography data. TomoCon allows to create a DRR by summing CT intensities along a ray from each pixel (**View**) to the simulated X-ray source (**Target**).

To create **DRR** reprojection from patient image data, use the **DRR** tool (see Figure 308) which is initially docked in the tools panel on the tab with the  icon.



**Figure 308 – DRR Reprojection image and tool**

You can set the following parameters for DRR reprojection in the **DRR** tool:


- **Viewport settings** - setting up the DRR position to the patient's position (**Anterior** – on the front of the patient, **Right** – on the right side of the patient, **Top** - on top of the patient and **Arbitrary** - the position determined by the **View** and **Target** parameters)
- **Window size**

To start the process of DRR reprojection creation, press the **Display** button.

## 16 Multi-modality fusion

Multi-modality fusion makes it possible to display data from two registered series (see 18 Registrations) in combination or overlapping in one image view.

The ability to correlate 3D images from various common modalities (CT, MRI, PET) has become a valuable tool in radiology. TomoCon supports multi-modality fusion, and provides users with the ability to identify structures in one imaging modality, and then spatially locate the structures in the different modality (this includes CT-PET, CT scans with contrast media and without it, MRI series taken with different parameters and scans prior to treatment and following treatment, among others).

To create a fusion from a two-modality image series, use the **Fusion** tool (see Figure 309). It provides the controls for fusion settings such as the base series, fusion series, color palettes, translucency, the fusion method, etc. The **Fusion** tool is initially docked in the tools panel on the tab with the  icon.

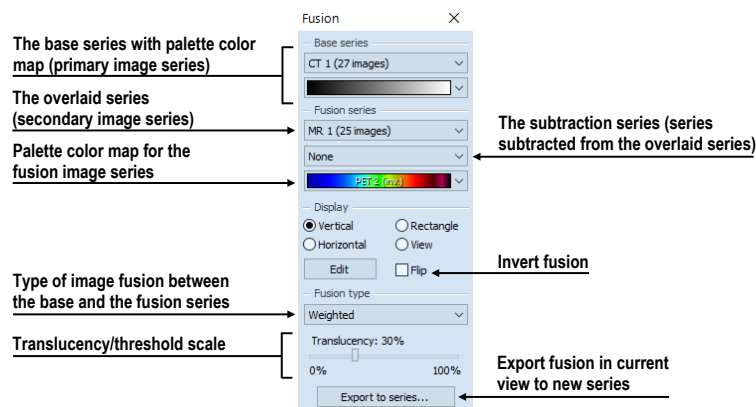


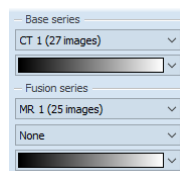
Figure 309 – Fusion tool

### 16.1 Creating multi-modality image fusion

To create fusion from a two-modality image series, use the **Fusion** tool (see Figure 309) as follows:

1. Click the **Base series** combo box to select the primary series (see Figure 310).
2. Click the following combo box to select the primary color map.
3. Click the **Fusion series** combo box to select the secondary series.
4. Click the second following combo box to select the secondary color map.

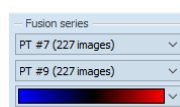
- The selected multi-modality fusion will be displayed in the current view. All other parameters will automatically be set up according to the most recently used fusion.



**Figure 310 – Series and color map selection**

To add a subtraction series to a multi-modality fusion, proceed as follows:

- Click the subtraction series combo box to select the subtraction series.
- The color palette will automatically change to the subtraction palette.
- If you want to change the used subtraction palette, click the subtraction palette combo box to select it.
- To remove a used subtraction series from a fusion, select the **None** item in the subtraction series combo box.



**Figure 311 – Subtraction series and color map selection**

To change the manner in which the fusion is displayed in the current view, click the desired type in the display section of the fusion tool (see Figure 312). TomoCon provides the following display options:

- Vertical** - the view is divided with a vertical line; the image from the fusion series is displayed on the right (see Figure 313, right).
- Horizontal** - the view is divided with a horizontal line; the image from the fusion series is displayed at the bottom.
- Rectangle** - the image from the overlaying series is displayed inside the rectangle (see Figure 313, left).
- View** - the image from the overlaying series is superimposed over the entire view.
- Edit** - after choosing this option (or double-clicking the separation line or inside the rectangle) and holding down the left mouse button, drag the rectangle, its frame or border to modify the border position, the rectangle frame position and its size.
- Flip** – switch the primary and the secondary series in the view.

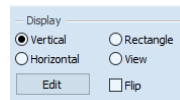


Figure 312 – Display section of the Fusion tool

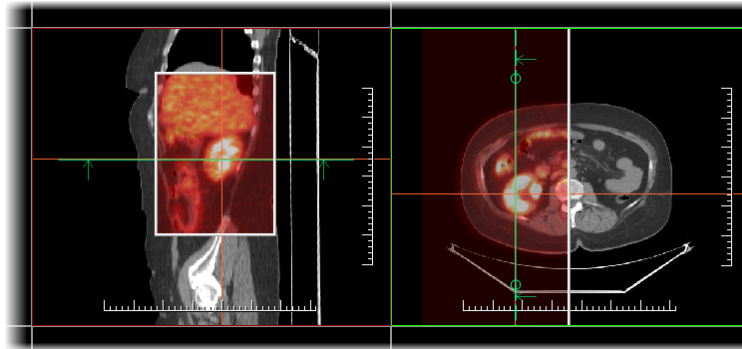


Figure 313 – Fusion images between CT and PET series

## 16.2 Fusion method

TomoCon provides five methods which are listed below for interfusing a primary and secondary series in a multi-modality fusion. For each fusion method, the scaling between the primary and secondary series can be changed using the fusion level (**Threshold/Translucency**).

- **Mask** – the image data of the secondary series with pixel values above the defined *Threshold* is displayed as  $(primary + secondary\ color) / 2$ .
- **Weighted** – the primary and secondary images are fused from the full primary image (*Translucency* = 0%) to the full secondary image (*Translucency* = 100%).
- **Merge** – it is calculated as  $(primary + secondary\ color) / 2$ .
- **Threshold** – the image data of the secondary series with pixel values above the defined *Threshold* is displayed in the defined color.
- **Contours** – it provides an anatomic image with contours of data from the secondary series corresponding to the threshold value.

To change the fusion method type, click the **Fusion type** combo box (see Figure 314) and select the method from the displayed list.

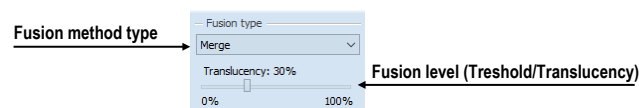


Figure 314 – Fusion type selection

### 16.3 Exporting fusion to a series

TomoCon enables the saving of a fusion view as an additional series in a selected study. It is possible to select the particular properties of the new series by selecting the parameters for the exported fusion in the **Export to series** dialog (see Figure 315). Once saved, the created fusion series can be sent to the PACS as a new series or reopened for viewing.

To export a fusion view to a new series, proceed as follows:

1. Display the desired fusion in the current view.
2. Press the **Export to series...** button in the **Fusion** tool.
3. Set the parameters for fusion export in the displayed **Export to series** dialog.
4. After setting up the parameters, press the **Export** button.

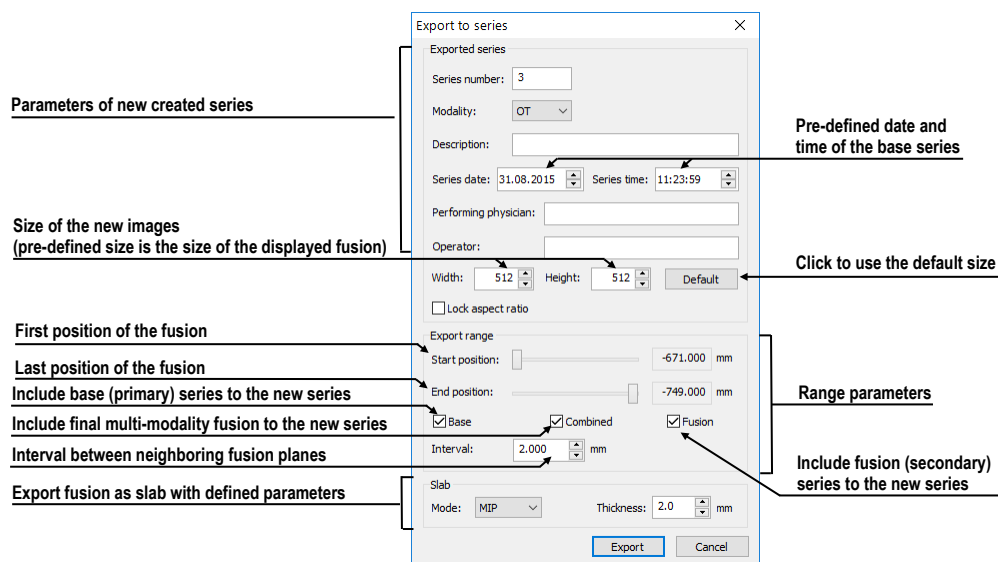




Figure 315 – Export to series dialog (parameters of the created series)



## 17 Three-dimensional visualization

The analysis of the image data is easier if the objects are displayed in the 3D view. Patient data is acquired as a set of two-dimensional (2D) images although the data can be interpreted as three-dimensional (3D) volume. TomoCon offers the possibility to view and navigate through 3D patient data as follows:

- Displaying interactive MPRs in 3D.
- Displaying ROIs defined by segmentation in 3D (see 10 Contouring the patient – create ROIs).
- Using the automatic volume rendering tool for 3D visualization of volume data (see 17.4 Volume rendering).

To define the parameters of the 3D view, use the **3D** tool (see Figure 316) in the **Tools** panel. It is initially docked in tools panel. You can access it at any time by clicking the tab with the  icon or by clicking the  **3D View** item in the **Tools** menu.

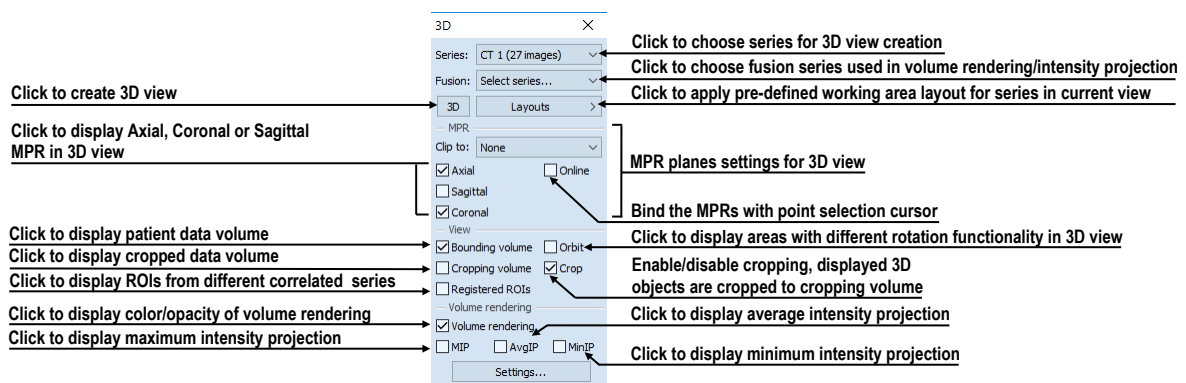


Figure 316 – 3D tool

To start using the tool, select the series you would like to view in 3D in the **Series** combo box or select any image of the series in the desired view. Next, in order to create the 3D view, click the required 3D visualization method in the tool:

- To display ROIs in 3D view (see Figure 317), click the **3D** button.
- To create 3D visualization of volume data using Volume rendering, select the **Volume rendering** check box.
- For the angiographic display of volume data in 3D, check the **MIP** (maximum projection) check box, the **AvgIP** (average projection) check box or the **MinIP** (minimum projection) check box.

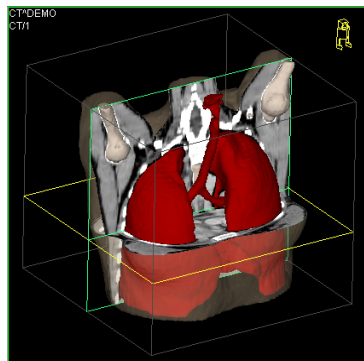







Figure 317 – 3D view

## 17.1 *Rotation, spatial orientation*

To activate the rotation action, click the  **Rotate** item in the context menu of the 3D view. The cursor will take the form of . The 3D view can be rotated by pressing and holding down the left mouse button.

The **Orbit** item in the context menu of the 3D view provides visual assistance for image rotation. After selecting the item, the 3D view is overlaid by a set of blue translucent spheres (see Figure 318). This marks the image areas with different rotation functionality; when placed over these areas, the cursor takes various forms (, , ) which describe the rotation axis to be used for rotation.

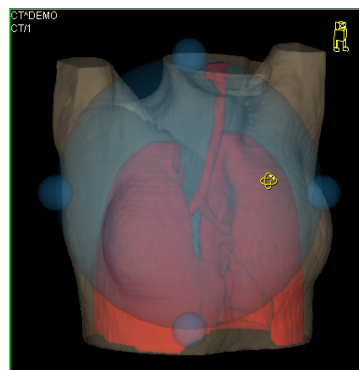


Figure 318 – 3D view with the Orbit function

To return to the initial viewing angle and zoom, select the **Reset view** item in the context menu of the 3D view.

For better spatial orientation, a small robot-like icon (called Enrico) is displayed in a selected corner of the 3D view. In properly oriented studies, its orientation corresponds to the patient's orientation. To set displaying the icon, see 4.3 View texts.

To rotate objects in the 3D view, use the **Rotate** tool in the tools panel. Two rotation modes are available: rotation in screen coordinates and rotation in patient coordinates (see Figure 319). The screen coordinate rotation mode uses buttons is similar to the

rotation in the 3D view. The patient rotation mode uses buttons to rotate volume around the patient coordinate system axes. The patient coordinate system axes are differentiated by color: x-red, y-green, z-blue. Rotation control with Enrico works in the same manner as rotation in the 3D view.

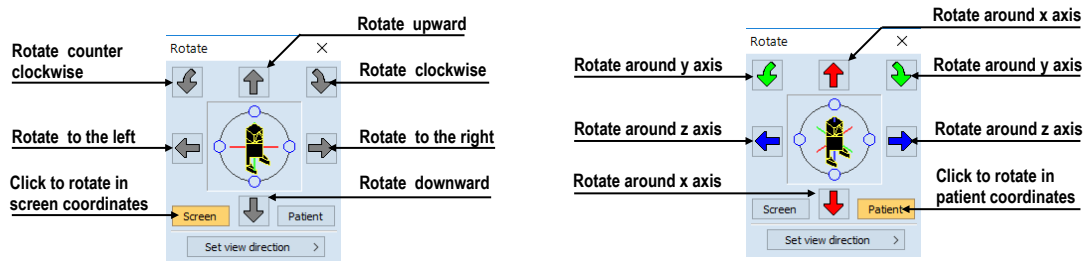


Figure 319 – Rotate tool (Screen mode, Patient mode)

## 17.2 Cropping volume of interest

Initially, the 3D view displays the entire bounding volume of the selected series. The boundary allows to display only partial series volume. Simply set cropping boundaries to define precisely the boundaries of desired spatial display.

In order to begin cropping, select the **Volume cropping** tool in the context menu of the 3D view (see Figure 320).

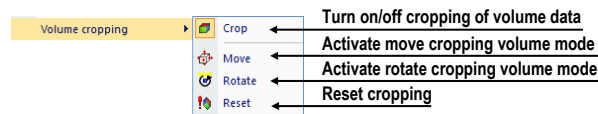


Figure 320 – Cropping menu

Next, drag selected object (the cropping arrow or cropping cube edge) in the view and move it to desired position. Then release the left mouse button (see Figure 321).

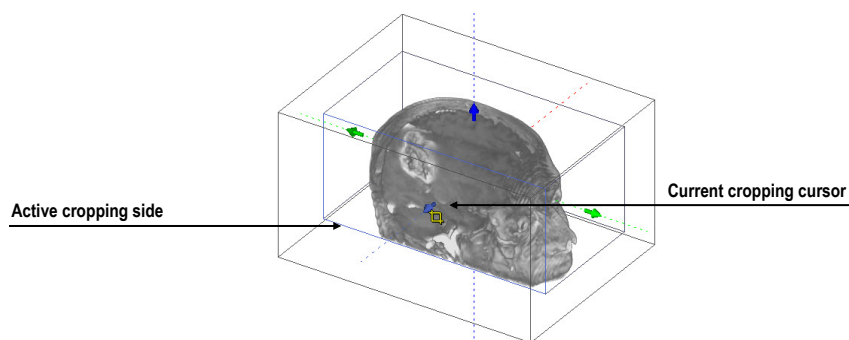



Figure 321 – Active cropping mode

Volume cropping can be used in the linked 2D views (the 2D views of the same series). In a 2D view, drag the edge of the cropping volume polygon (an intersection of cropping volume and current image plane) to the desired place and release the mouse button.

### 17.3 Moving a MPR plane

It is possible to move a MPR plane interactively in a view. When the cursor is placed at a MPR edge of the MPR plane, the cursor takes the form of  and the border of the MPR plane is highlighted in yellow (see Figure 322). You can then press and hold down the left mouse button to move the MPR plane. After releasing the left mouse button, the MPR plane will stay in the desired position.

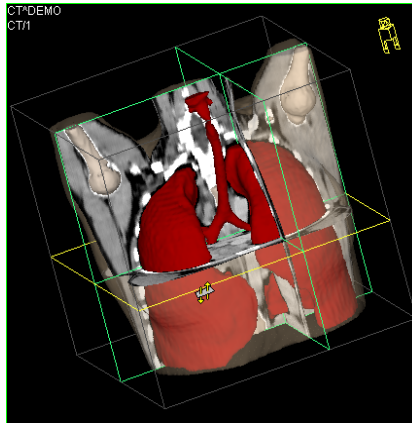


Figure 322 – 3D view with highlighted MPR plane

Movement of MPRs can be used in the linked 2D views (the 2D views of the same series). In a 2D view, drag the intersection line of given MPR (an intersection of the MPR and current image plane) to the desired place and release the mouse button.

### 17.4 Volume rendering

To display volume rendering visualization, use one of the following methods:

- Select the series for volume rendering in the **Select series...** combo box of the **3D** tool (see Figure 323a), and check the **Volume rendering** check box.
- Select the image from the series that is to be viewed using volume rendering in the required view, and check the **Volume rendering** check box in the **3D** tool.
- Select the image from the series that is to be viewed using volume rendering in the required view, select the pre-defined layout in the **3D** tool (see Figure 323b), and then check the **Volume rendering** check box.

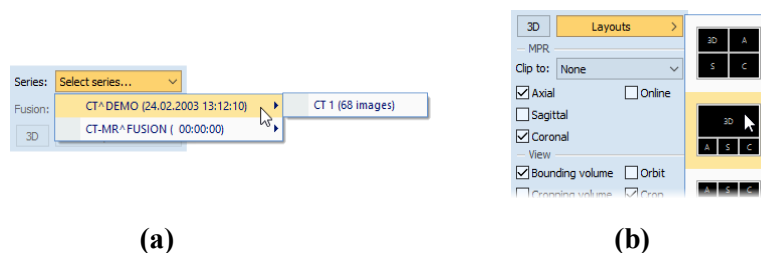
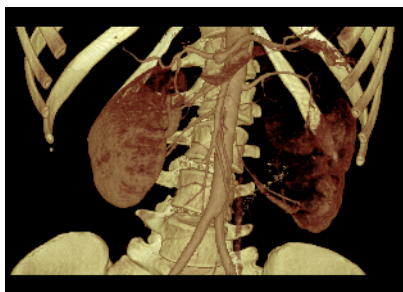


Figure 323 – Selecting series for volume rendering (a) using pre-defined layout (b)

The volume rendering visualization (see Figure 324) with the default or most recent color preset for the given modality is automatically calculated and displayed in the current view. Applying intensity projections (MIP, MinIP, AvgIP) is similar to that of volume rendering described above.



**Figure 324 – Volume rendering 3D view**

To change the parameters of volume rendering visualization, it is possible to use the following dialogs of the tools panel:

- The **Rotate** tool enables spatial manipulation of the current 3D view (see 17.1 Rotation, spatial orientation).
- The **Color and opacity** tool is used for defining and using pre-defined color presets (see 17.4.3 Creating and using color presets).
- The **Volume rendering settings** dialog allows to change the basic parameters of volume rendering visualization in the current view (see 17.4.2 Volume rendering settings).

### 17.4.1 Point selection and intensity projections

The current point in 3D volume rendering visualization can be selected in a similar way as in the classical 2D view (see 3.7.1 Current point). The point selection in volume rendering is set to the 3D point in the cropped data volume where the summed opacity is opaque. This is dependent on the opacity defined for the data values. For example, for the CT modality, this may be inside the bone, because the transfer function used in common presets does not define the whole interval for solid bones (see Figure 325). When solid isosurface is used, the point selection is applied on the isosurface. If it is not possible to apply point selection within the cropped volume, the point selection is set to the back face of the cropped volume.

The point selection in MIP and MinIP is set to the point in 3D data volume where the value along the ray is maximum in MIP or minimum in MinIP. The point selection for AvgIP in the 3D view is not defined, and is therefore set to the back face of the cropped volume. The point selection cursor for MIP, MinIP and AvgIP is displayed as

a 2D cross (as it is in image views). The point selection cursor for volume rendering is displayed as a 3D cross.

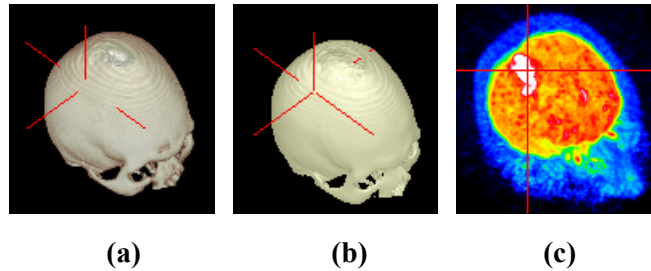


Figure 325 – Point selection, inside (a), on surface (b), in MIP (c)

### 17.4.2 Volume rendering settings

This dialog allows to define adjustments of volume rendering quality and lighting in the current view. The following parameters can be set:

- Basic volume rendering quality on the first tab (see Figure 326)

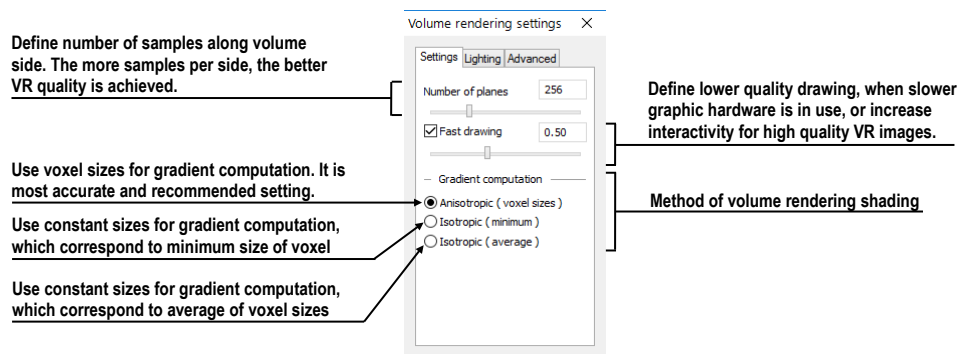


Figure 326 - Volume rendering settings, the first tab

- Lighting settings used in volume rendering on the second tab (see Figure 327)

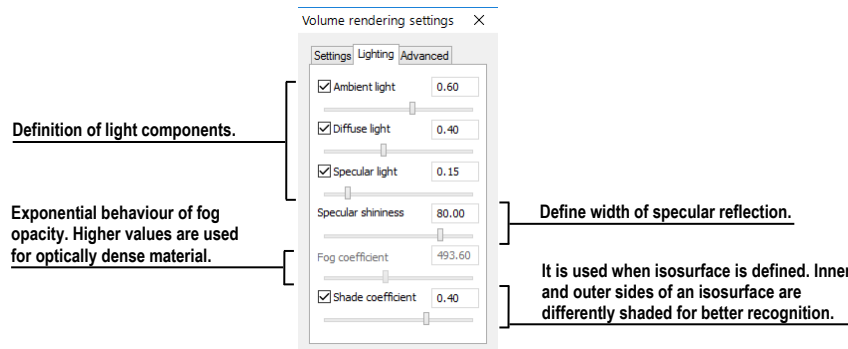


Figure 327 – Volume rendering settings, the second tab

- Settings for color corrections and advanced ray casting settings on the third tab (see Figure 328)

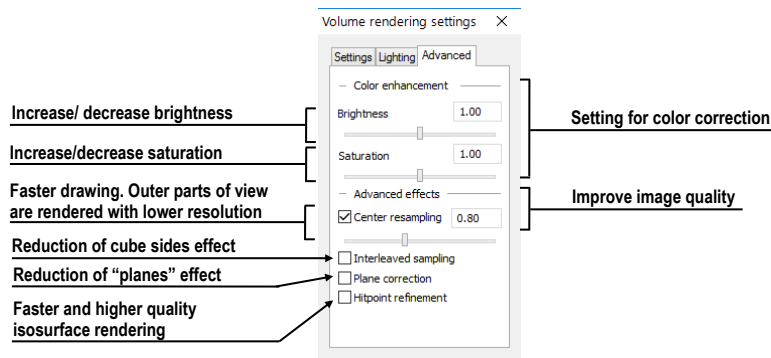


Figure 328 – Volume rendering settings, the third tab

### 17.4.3 Creating and using color presets

The TomoCon application allows to change the color, opacity and lighting of the volume rendering in the current 3D view using the saved color presets. TomoCon supplies a gallery of predefined color presets that makes it possible to define customized color presets for special volume rendering visualization in a 3D view.

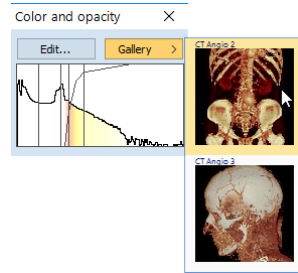


Figure 329 – Gallery of presets

To apply a color preset, click the **Gallery** button in the tools panel of the **Color and opacity** tool (see Figure 329). Next, select the desired preset in the displayed gallery list. The gallery contains the default presets included in the TomoCon installation (the default presets cannot be modified) as well as all of user customized presets.

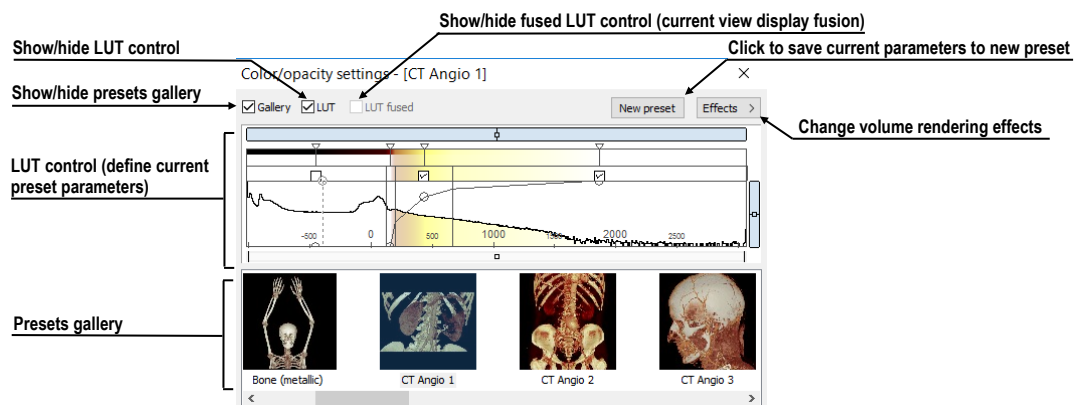
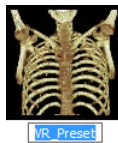


Figure 330 – Color/opacity settings dialog

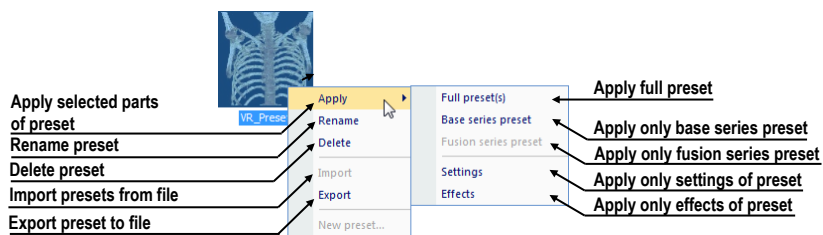
To create a new color preset, click the **Edit...** button in the tools panel of the **Color and opacity** tool. The **Color/opacity settings** dialog (see Figure 330) is then displayed. Define the color, the opacity and the interval parameters for the new preset in the **LUT** control of the **Color/opacity settings** dialog (see Figure 330). To modify the effects, use the **Effects** menu.

To save the color parameters for the new preset, click the **New preset** button. The new preset is then added to the end of the gallery of presets (in the lower part of the dialog), and it is possible to enter a name for it (see Figure 331).



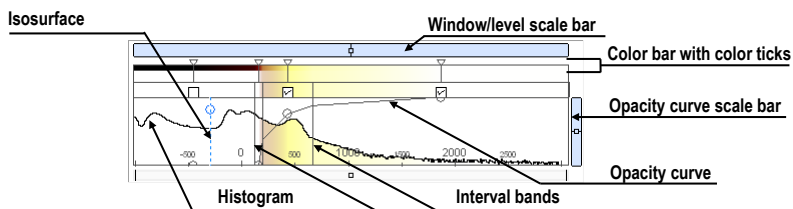
**Figure 331 – New saved preset**

To rename or delete a (non-predefined) preset, select the preset in the gallery of presets, right-click to display the preset context menu, and then select the **Rename** or **Delete** item (see Figure 332).



**Figure 332 – Context menu of the gallery of presets**

To set the color parameters for the preset, use the **LUT** control of the **Color/opacity settings** dialog (see Figure 333). This control defines the lookup table (LUT) and/or isosurfaces used in volume rendering. The **LUT** control can be used in the simple mode or in the advanced mode. In the simple mode, the color positions and the opacity curve are fixed to the interval bands. The advanced mode provides more flexibility in defining the custom color table, enabling the modification of the opacity curve and the color table independently from the interval bands.



**Figure 333 – LUT control part**

The **Window/level scale bar** is used to change the window and level values of the color table. Place the mouse over the bar. To change the level value, move the mouse



with the pressed left button. To change the window value, move the mouse with the pressed left button while additionally holding down the **Ctrl** key. To reset window/level value, double-click on the scroll bar.

To display the **Window/level scale bar** menu, right-click the **Window/level scale bar**. In the displayed menu, you can select the objects to be moved along with the **Window/level scale bar** – the **Color, Opacity, Check, Isosurface** items.

The **Color bar** shows the current color palette. To change the color, double-click the color position marker when the cursor changes to  $\diamond$  (in the simple mode) or  $\leftarrow \diamond$  (in the advanced mode). In the advanced mode, to insert a new color position marker, double-click on the **Color bar**. To delete an existing marker or change its color, display the context menu by right-clicking an existing marker. To insert a new color position marker or change interpolation mode between color position markers, right-click on the **Color bar**.

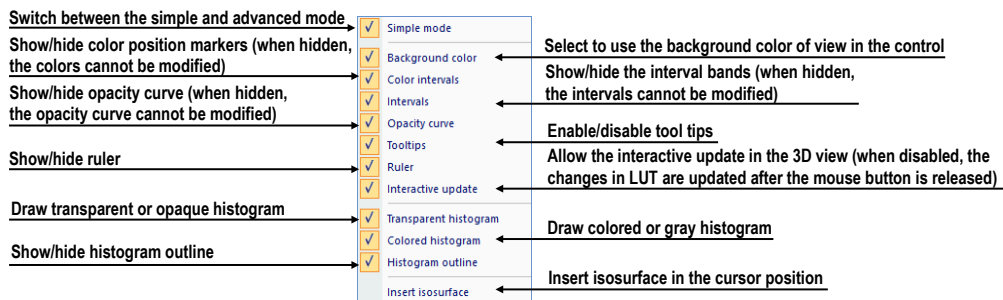





Figure 334 – LUT context menu

The **LUT** context menu (see Figure 334) contains the basic properties of the **LUT** control. To display the **LUT** context menu, right-click the **LUT** control.

**The interval bands** define the custom boundary intervals. It is possible to change the interval band when the cursor changes to  $\leftarrow \vdash$  or delete it via its context menu (**Delete** item). Only in the advanced mode, to add an interval band, double-click inside the interval or select the **Insert** item in the context menu of the interval band color scale. To display the context menu of the interval band color scale, right-click the color scale.

**The opacity curve** defines the opacity used in volume rendering. In the simple mode, the opacity curve is fixed to the center of the interval and automatically moves along with the interval band. To modify the opacity, move the cursor over the opacity curve point until it changes to  $\updownarrow$  (in the simple mode) or  $\leftarrow \updownarrow$  (in the advanced mode) and press and hold down the left mouse button while moving it. To change the curve slope (tangent), press **Alt** key and move the cursor over the curve until it changes to  $\curvearrowright$ . The opacity curve can be moved/scaled using the opacity curve scale bar. To move

the opacity curve in the advanced mode, press the **Alt + Shift** key combination and move the cursor over the curve until it changes to .

The **Isosurface** is displayed in the histogram area. To insert an isosurface, right-click the desired position and select the **Insert isosurface** item in the displayed context menu. The isosurface transparency is defined by the circle position. To move an isosurface, move the cursor over the isosurface line until it changes to  and press and hold down the left mouse button while moving it horizontally. To change the isosurface transparency, move the cursor over the isosurface line until it changes to  and press and hold down the left mouse button while moving it vertically. The radius of the circle can be changed using the + and - keys.

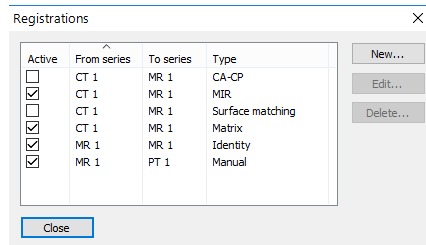
## 18 Registrations

In order to map one series to another and to define a relation between them, they have to be registered (matched to one another). It is then possible to transfer coordinates between the series bi-directionally, to coordinate the same position in both series and to display the data overlaid from both series in the image fusion mode (see 16 Multi-modality fusion).

TomoCon allows to define a new registration between selected series by the group of registration tools described in chapter 18.1 Defining registration. To define a new, edit or remove exist registration, use the **Registrations** dialog (see Figure 335). Each created registration can be saved with images in DICOM format and be sent to PACS.

Except your own registrations, TomoCon supports also frame of reference registrations which are stored with original patient data. The frame of reference registrations are not displayed in the **Registration** dialog, because they cannot be changed or removed. When opening a patient study (with the frame of reference), registration between the two series is created automatically.

To open the **Registrations** dialog (see Figure 335), click the **Registrations...** item in the **Tools** menu.



**Figure 335 – Registrations dialog**

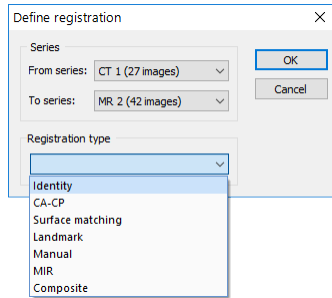
The following operations are available in the **Registrations** dialog:

- **New...** - defining a new registration between two series (see 18.1 Defining registration).
- **Edit...** - editing a selected registration.
- **Delete...** - deleting a selected registration from the list of registrations.

It is possible to define multiple registrations between two series. In this case, only one of them can be active (checked). Other registrations between the series are inactive (unchecked). Using the check box, it is possible to temporarily undefine a registration or to select a different one as active.

## 18.1 Defining registration

In order to define a relation between two series, press the **New...** button in the **Registrations** dialog (see Figure 335). The **Define registration** dialog opens (see Figure 336).



**Figure 336 – Define registration dialog, the Registration type menu**

The **Define registration** dialog (see Figure 336) specifies the following:

- **Series** between which defines the registration (**From series**, **To series**)
- **Registration types:**
  - **Identity** (see 18.1.1 Identity)
  - **CA-CP** (see 18.1.2 Patient-related (CA-CP))
  - **Surface matching** (see 18.1.3 Surface matching)
  - **Landmark** (see 18.1.4 Landmark)
  - **Manual** (see 18.1.5 Manual)
  - **MIR** (see 18.1.6 MIR)
  - **Composite** (see 18.1.7 Composite)

### 18.1.1 Identity

For Identity registration, it is assumed that the coordinate systems of the two image series are identical. This option is used if patient coordinate systems have been established in both image series (a frame of reference has been defined) or if the coordinate systems have remained identical through other means.

### 18.1.2 Patient-related (CA-CP)

CA-CP registration (see Figure 337) uses the coordinates of a patient's **CA**, **CP** and **Median** points to establish series registration. The distance between the **CA** and **CP** points must fall within the range of 21.0 and 28.5 mm.

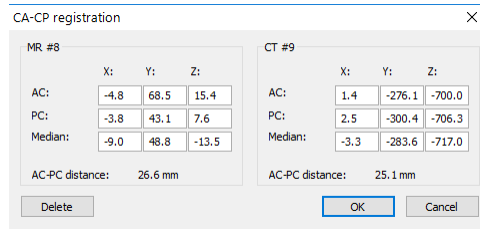


Figure 337 – CA-CP registration dialog

### 18.1.3 Surface matching

Surface matching registration (see Figure 338) uses ROIs to establish series registration. This is suitable for cases in which the same ROI structure was defined in both image series. These two ROIs are then matched.

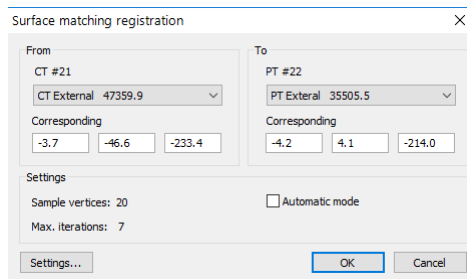


Figure 338 – Surface matching registration dialog

### 18.1.4 Landmark

Landmark registration (see Figure 339) uses the coordinates of multiple landmarks to establish series registration.

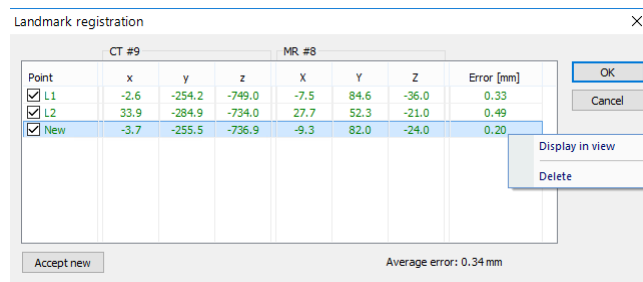


Figure 339 – Landmark registration dialog

An erroneous landmark pair with an error exceeding the acceptable value can be disabled without deleting the pair from the list by removing the  in the check box.

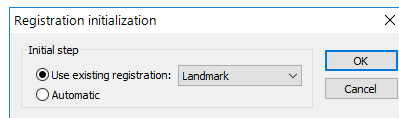
Landmarks can be renamed according to the names of the marked orientation points. To do so, click the landmark name (the default names are L1, L2, etc.) and overwrite it to match the marked structure or pin (e.g. Marker2). Each enabled landmark is displayed in the image <sup>+</sup>Marker2 with its respective name.

## 18.1.5 Manual

Manual registration concerns the mutual manual movement and rotation of the volumes of two registered series.

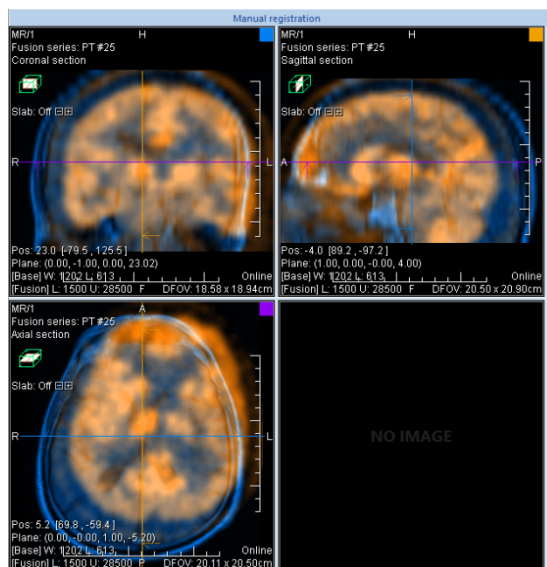
After selecting manual registration in the **Define registration** dialog, the **Registration initialization** dialog is displayed (see Figure 340) in which the initial settings of manual registration are defined. In this dialog, you can define the initial relation between the series:

- **Use existing registration** (selecting an existing registration from the list)
- **Automatic** (the centers of the 3D coordinate systems of the two series are assumed identical)



**Figure 340 – Registration initialization dialog**

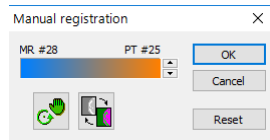
After confirming the initial step with **OK** button, the **Manual registration** dialog (see Figure 342) is displayed, and the current working area is overlapped with orthogonal MPR working area (see Figure 341). This special working area is placed over the existing working area, and it is independent from other working areas displayed at the time.





**Figure 341 – Manual registration working area layout**


Manual registration working area initially contains three orthogonal MPRs which show fusion MPRs of the series being registered. The current layout for this working area can be changed by selecting the appropriate item from the **Layout's** list after clicking the **Layout** menu in the main toolbar. The individual MPRs of the series

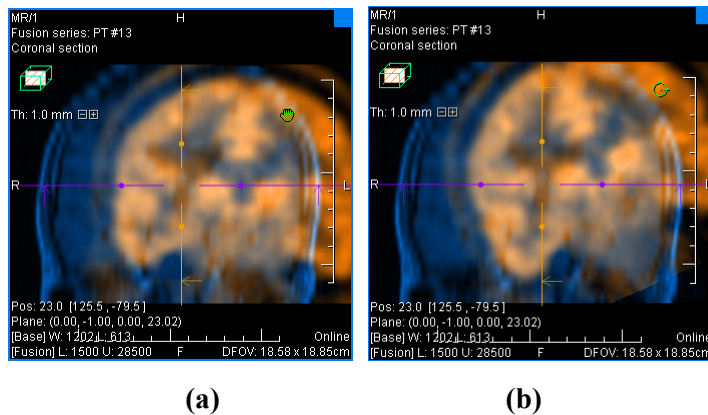
being registered are of different colors and are transparent. The color of the MPR of each series is displayed in the **Manual registration** dialog, and can be changed at any time (see Figure 342).





**Figure 342 – Manual registration dialog**

To adjust the registration, activate the first view. When the mouse cursor is placed close to the view center, the MPR can be moved (the cursor is displayed as ) . Press and hold down the left mouse button, move the MPR to the required position in the view, and release the mouse button (see Figure 343a). When the cursor is closer to the edge of the view, the MPR can be rotated around the center of the view (the cursor is displayed as ) . Press and hold down the left mouse button, rotate the MPR to the required orientation in the view, and release the mouse button (see Figure 343b). MPRs of one only series can be moved/rotated. The MPRs of the other series (called Base MPR) remain unchanged in the view. After releasing the mouse button, the registration is automatically recalculated and the other views are redrawn automatically.

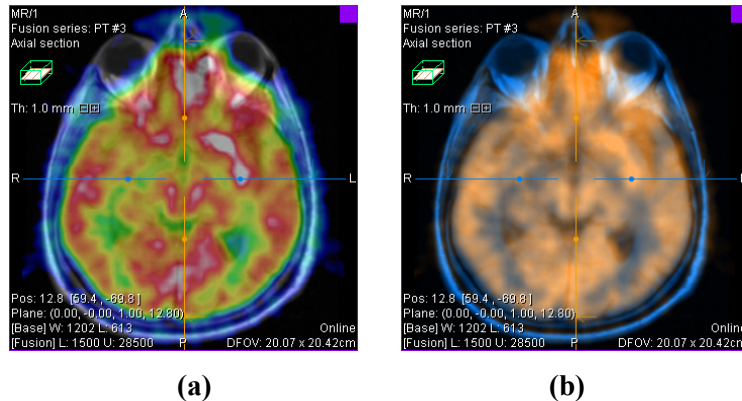
When editing manual registration, it is possible at any time to enter the move and rotate mode by pressing the  button (e.g. if another selected operation type is used in the view).



**Figure 343 – Panning (a) and rotating (b) an MPR during manual registration**

If necessary, it is possible to modify the plane of the Base MPR in any view. To do so, press  in the **Manual Registration** dialog. The manual registration mode will be (temporarily) turned off in all fusion views (see Figure 344a), and fusion MPR can be moved and/or rotated to desired position (standard display of MPR, see 12 MPR – Multi-planar reformatting). After pressing  again, manual registration mode is turned on and it is possible to continue editing the registration (see Figure 344b).

When editing manual registration, it is possible at any time to revert to the initial registration settings by pressing the **Reset** button in the **Manual Registration** dialog. After manual registration is successfully defined, press the **OK** button to add the registration to the list of existing registrations. Alternatively, after pressing the **Cancel** button, the registration will be discarded and will not be used.



**Figure 344 – Moving the Base MPR's plane (a), manual registration with shifted plane of the Base MPR (b)**

### 18.1.6 MIR

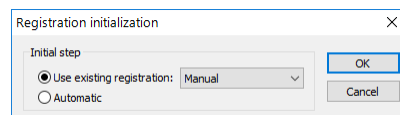


This functionality is only available with the MIR license in the TomoCon Workstation.

MIR (**M**utual **I**nformation **R**egistration) is a probability method for the calculation of the registration between two series for which final registration is calculated automatically.

After selecting MIR registration in the **Define registration** dialog, the **Registration initialization** dialog is displayed (see Figure 345). This dialog is displayed only when the registration between series is already defined. The initial transformation can be defined as:

- **Use existing registration** (selecting an existing registration from the list)
- **Automatic** (the centers of the 3D coordinate systems of the two series are assumed identical)

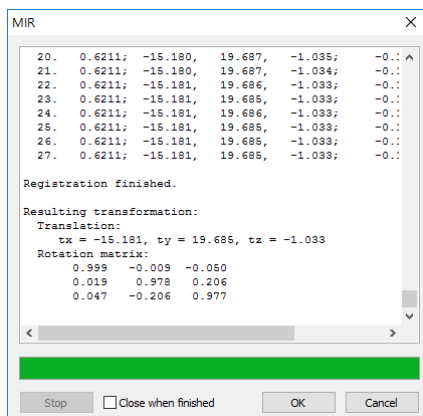


**Figure 345 – MIR registration initialization dialog**

After confirming the initial step with the **OK** button, the **MIR** dialog is displayed (see Figure 346) and current working area is overlapped by orthogonal MPR working area



showing three perpendicular fusion views. The registration process is displayed in this working area. The calculation of the registration starts automatically, and the progress is displayed in the log window.



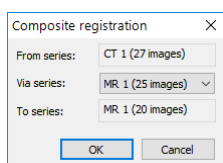
**Figure 346 – MIR dialog**

To stop the registration process because of to achieve desired result, click the **Stop** button. If you check the **Close when finished** check box, the registration dialog will close automatically as soon as the calculation is completed. When the registration is finished, the orthogonal working area for registration is closed automatically and the working area used previously is displayed.

### 18.1.7 Composite

Composite registration is based on composition of two registrations already existing. If there is a chain of two registrations, one from series A to series B and another one from series B to series C, composite registration can be created to register series A and C.

To create composite registration, make sure that there are at least two active registrations defined that can be joined together. In the **Registration type** combo box, select **Composite** item, and press **OK**. **Composite registration** dialog will be displayed. You can there select via which series composite registration should be created (see Figure 347).



**Figure 347 – Composite registration dialog for selection of Via series**

Changes made in original registrations after defining a composite registration are not applied to this registration. If these registrations are changed or even deleted, composite registration stays intact.

## 19 Print images

To print image data, TomoCon offers the special print interface for selection and adjustment of images before printing. In this interface, it is possible to print any selected images on monochrome, on a color Microsoft Windows printer or on any DICOM printer. The printing interface can be configured for simultaneous work with multiple printers while during the printing, it is possible to monitor and control the printing process. Printing is carried out in the background, and thus you can continue viewing while your print jobs are running.

To display the print interface, select the **Print...** item in the main menu. The main part of the printing interface is the working area which is similar to the main working area, and represents a virtual print film (i.e. print page). Images of different series and studies can be put in the print working area, which can be divided according to desired layout, and further process these images (such as zoom, filter, window/level, etc.). The prepared working area with pictures can then be printed on the selected printer as a film.

### 19.1 TomoCon print window

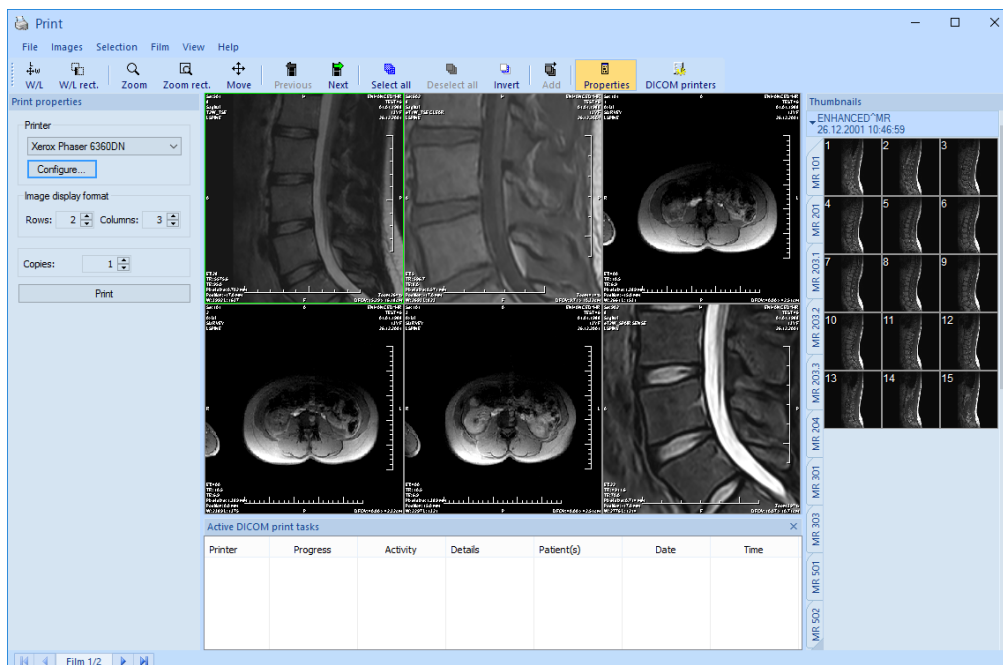


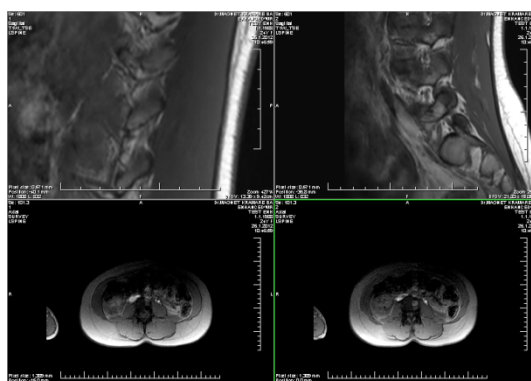
Figure 348 – TomoCon print interface

The TomoCon print interface window (see Figure 348) consists of the following main parts:

- Print working area (see 19.1.1 Print working area)
- Thumbnail palette (see 19.1.5 Thumbnail palette)
- Print queue (see 19.4.1 Monitoring and controlling the print process)
- Menu (see 19.1.2 Main menu)
- Standard toolbar (see 19.1.3 Toolbar)
- Status bar (see 19.1.4 Status bar)

### 19.1.1 Print working area

The print working area is a large black area (see Figure 349) representing one print film and is similar to the main working area. It is divided into smaller windows (views with displayed images) depending on the row and column settings in the **Image display format** item of the **Print properties** dialog (see 19.5 Print properties).



**Figure 349 – Working area with 2 rows and 2 columns**

When you have large number of images to print, you can compose and print a number of films at the same time. When you insert more images than can be placed on the current film, a new film will be automatically created into which the remaining images will be inserted.

The print working area displays only one print film at one time. If you have more than one print film, you can move between the films using the scroll bar in the status bar of the print window (see 19.2 Navigating between films) or by clicking the **Previous/Next** button in the toolbar (see Figure 351).

When composing a print film, the images can be viewed and modified using the usual tools (window/level, pan, zoom, etc.). Right-click the image, you want to modify and select the desired option from the displayed context menu (see Figure 350). Additionally, you can show/hide the additionally displayed objects (ruler, overlays,

texts, etc.) in all views using the **View** item of the main menu (see 19.1.2 Main menu).

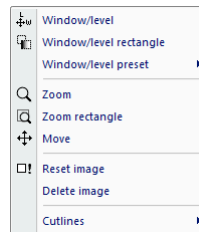


Figure 350 – Context menu in the current view

## 19.1.2 Main menu

The main menu provides with direct access to all functions for printing images. The items in the main menu are logically grouped into submenus like the TomoCon main menu. The main menu consists of the following submenus:

- **File** - DICOM printer installation (the **DICOM Printers...** item, see 19.5.1 Installing a printer) and completing work in the print window (the **Exit** item).
- **Images** - image modification (window/level, zoom, move, etc.) in the current view (see 19.3 Manipulating image for print).
- **Selection** - selecting images from the thumbnail palette to be displayed in the print working area (see 19.1.6 Select images for print).
- **Film** - navigating between films, deleting image/film(s) (see 19.2 Navigating between films).
- **View** - hiding/displaying objects (toolbar, status bar, etc.) in views.
- **Help** - browsing the electronic version of the user's manual.

## 19.1.3 Toolbar

The print window allows to use the toolbar buttons for frequently performed tasks in the printing preparation process. This toolbar (see Figure 351) is located above the print menu by default, and its visibility can be changed by checking/unchecking the **Toolbar** item in the **View** menu.

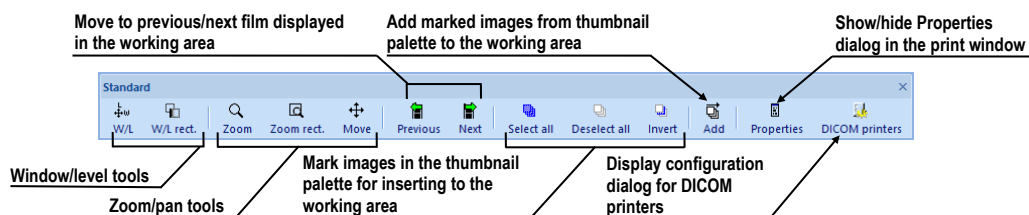


Figure 351 – Print Standard toolbar

The toolbar contains two groups of buttons. The first contains the buttons for activating the standard tools for image viewing, while the second contains the special buttons for inserting images into the working area and the buttons for moving between the print films.

### 19.1.4 Status bar

The Status bar (see Figure 352) is a horizontal bar in the lower part of the window. It displays the panel which is used for navigation between the films displayed in the working area and for displaying the current printing tasks. It is visible by default although it is possible to hide/show it by the unchecking/checking the **Status bar** option in the **View** menu.

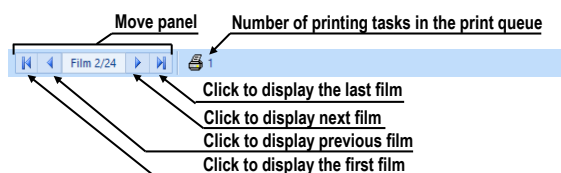


Figure 352 – Print Status bar

### 19.1.5 Thumbnail palette

The thumbnail palette, which is located on the right-hand side of the print window, enables to select and add images to the print films (see Figure 353). All series of opened studies are also displayed in this palette, and the work with it is identical to the work with the main thumbnail palette (see 3.3 Thumbnails palette).

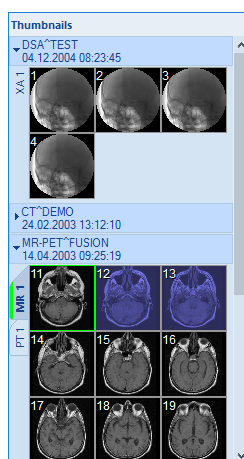



Figure 353 – Thumbnail palette in the print window

### 19.1.6 Select images for print

To select and add a group of images from the thumbnail palette to the films, proceed as follows:

1. Display the appropriate series tab in the thumbnail palette.
2. Click the required images. The images will be highlighted in blue (see Figure 354a).
3. Click the **Add** button (the  icon) in the toolbar. The selected images will automatically be added following the last image in the working area.

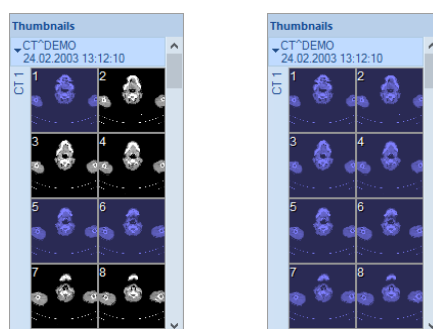





Figure 354 – Selected images in the thumbnail palette



To select and add all images of a displayed series from the thumbnail palette to a film, proceed as follows:

1. Click the **Select all** button (the  icon) in the toolbar. All of the images displayed in the thumbnail palette will be highlighted in blue (see Figure 354b).
2. Click the **Add** button (the  icon) in the toolbar. The selected images will automatically be added following the last image in the working area.

To clear all of the selected images in the thumbnail palette, click the **Deselect all** button (the  icon) in the toolbar.

## 19.2 Navigating between films

When launching the print interface, one empty film without images becomes available, displayed in the working area. After adding the images, they are placed, one after another, into the required number of films. The print working area represents one film. The number of images on the film is specified by the number of rows and columns in the **Image display format** item of the **Print properties** dialog.

If you are working with more than one film, you can move between them using the move panel in the status bar (see Figure 355a) or you can use the **Previous** ()/**Next** () buttons in the toolbar (see Figure 355b).



(a) (b)

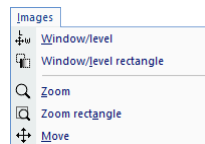
**Figure 355 – Move panel (a), Previous/Next buttons (b)**

To delete an image in the current view in the working area, select the **Delete image** item in the **Film** main menu. The images following the deleted image will be shifted by one position backward.

To delete an entire film that is displayed in the working area, select any view in the working area and select the **Delete film** item in the **Film** main menu. Similarly, to delete all films, select the **Delete all films** item.

### 19.3 *Manipulating image for print*

While composing a film, it is possible to view and modify the images in the same manner as in the main working area (zoom, zoom rectangle, pan, window/level and window/level rectangle). To modify the image data in the current view, use the tools available in the **Images** menu (see Figure 356). All tools can be used in an identical manner as described in 7 Manipulating images.



**Figure 356 – Images menu**

### 19.4 *Start printing*

Once you have finished composing films, use the options in the **Printer properties** dialog to select the printer, to set the print parameters (orientation, film or paper size, etc.) and submit the print job to the selected printer by clicking the **Print** button.

After printing starts on any DICOM printer, the current status of the printing process is displayed in the **Preparing data** dialog. Once the process is complete, a new print task is then added to the DICOM print queue (see 19.4.1 Monitoring and controlling the print process) located above the working area. During the DICOM print process, you can at any time check in detail which studies are being printing, alternatively monitor the occurrence of print errors.

#### 19.4.1 *Monitoring and controlling the print process*

Using the list of **Active DICOM print tasks** (see Figure 357), the current status of all performing print jobs on the DICOM printers can be monitored (pending status,

printing in progress, error have occurred). The list can be displayed/hidden by selecting the **Print queue** item in the **View** menu. In other columns of the queue are displayed additional information about the print job – Printer name, Progress, Details of the job, etc. Right-click the print job to display the context menu that lets the selected print job depending on its current status: **Pause**, **Restart**, **Delete** or **Cancel**.

Printer	Progress	Activity	Details	Patient(s)	Date	Time
DCMprint	[1 image - 1 film]	Error	Connection to printer failed	CT^DEMO	31.08.2015	13:18:00
DCMprint	[69 images - 69 films]	Paused		CT^DEMO	31.08.2015	13:20:07
DCMprint	17% [635 images - 635 films]	Printing	Printer: Conquest dicom printe...	GE PET-CT, CT^...	31.08.2015	13:22:31

Figure 357 – List of active DICOM print tasks

## 19.5 Print properties

The **Print properties** dialog, which is docked in the left-hand side of the print window, allows to configure the print options of the currently selected printer in the list of available printers. This list contains all available Microsoft Windows printers installed on the computer and all of configured DICOM printers.

For the currently selected printer, it can be configured the following (see Figure 358):

- The settings for the print process through the **Printer** option dialog. To display the **Printer** option dialog, click the **Configure...** button in the **Print properties** dialog. For a Microsoft Windows printer can be configured the settings as described in chapter 19.5.3 Configuring a Microsoft Windows printer; for a DICOM printer can be configured the settings as described in chapter 19.5.2 Configuring a DICOM printer.
- The number of rows and columns that define the number of images displayed on each film (**Image display format**).
- The number of copies of the printed films (**Copies**).
- The film settings (size, orientation, etc.) used only for DICOM printers.

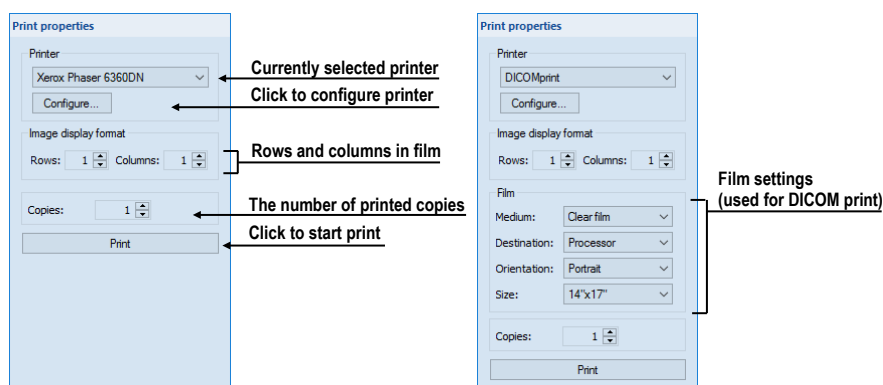


Figure 358 – Print properties dialog

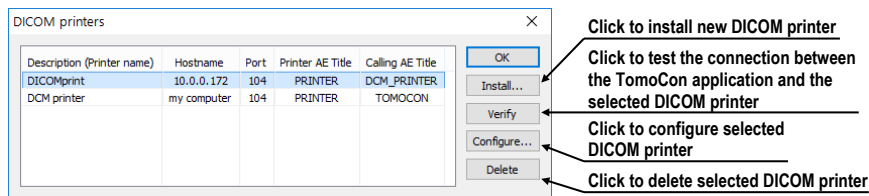


### 19.5.1 Installing a printer

To print images, use standard Microsoft Windows printer or special DICOM printer. While the Microsoft Windows printer comes installed as part of the Microsoft Windows operating system, it is necessary to install DICOM printers manually.

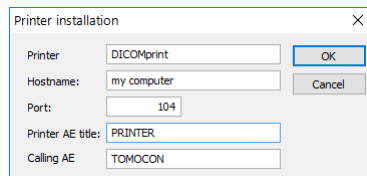
To install and configure a DICOM printer in the print interface, select the **DICOM Printers...** item in the **File** menu and define the printer parameters in the displayed **DICOM printers** dialog (see 19.5.2 Configuring a DICOM printer).

In the **DICOM printers** dialog, it is possible to install new printers, to configure previously installed printers and to verify DICOM connection to a printer (see Figure 359).



**Figure 359 – Printers dialog**

To install a new DICOM printer, click the **Install...** button to open the **Printer installation** dialog (see Figure 360) in which you can set the properties of the new printer (**Printer name**, **Hostname**, **Port**, **Printer AE title**, **Calling AE title**).



**Figure 360 – Printer installation dialog**

To configure the printing settings of the selected DICOM printer in the **DICOM Printers** dialog, click the **Configure...** button and adjust the printer settings in the displayed configuration dialog (see 19.5.2 Configuring a DICOM printer).

### 19.5.2 Configuring a DICOM printer

To configure the settings of a DICOM printer, select the corresponding printer in the printer combo box and click the **Configure...** button in the **Printer properties** dialog. The configuration dialog then opens (see Figure 361) in which you can define the following DICOM printer settings:

- **Trim** and printing **Priority**, **Resolution** defined in DPI units
- **Monochrome** (8/12 bit) or **Color print**

- **Density** of printing with defined color for **Border**, **Empty image** and **Min/Max** gray values on film
- **Image display format (Rows, Columns)** – the number of rows and columns in the working area that correspond to the image layout in the film
- **Film (Medium, Destination, Orientation, Size)** – the film properties

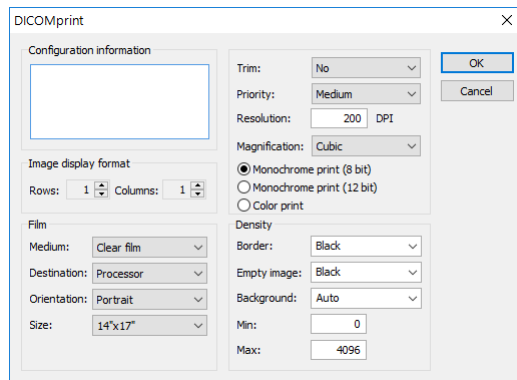


Figure 361 – Configuration dialog

### 19.5.3 Configuring a Microsoft Windows printer

To configure the settings of a Microsoft Windows printer, select the corresponding printer in the printer combo box and click the **Configure...** button in the **Printer properties** dialog. The **Print** configuration dialog then opens (see Figure 362).

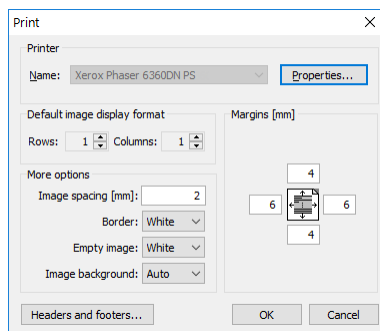


Figure 362 – Print dialog

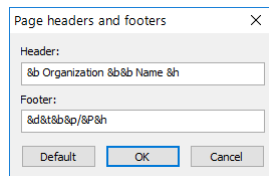
The **Print** configuration dialog allows to define the following settings of the Microsoft Windows printer:

- **Properties** of the printer - paper size and orientation, layout, color management and others.
- **Default image display format** – the default number of **Rows** and **Columns** in the working area that correspond to the image layout in the film.
- **Image spacing** between images on film in millimeters.
- Color of **Border**, **Empty image** and **Image background** on film.

- **Margins** (top, left, right, bottom) defined in millimeters.
- The header and footer to be inserted into each printed page. To define the header and footer, click the **Headers and footers...** button. In the **Page headers and footers** dialog which is then displayed can be defined the following types of texts for the page header and footer:

<b>For print</b>	<b>Type</b>
Horizontal line after header or before footer	<b>&amp;h</b>
Version of TomoCon	<b>&amp;v</b>
Date in short type	<b>&amp;d</b>
Date in extended type	<b>&amp;D</b>
Time	<b>&amp;t</b>
Time in 24 format	<b>&amp;T</b>
Current page number	<b>&amp;p</b>
Total pages count	<b>&amp;P</b>
Right alignment of text	<b>&amp;b [aligned text]</b>
Center of text	<b>&amp;b [centered text] &amp;b</b>
Prints a single ampersand	<b>&amp;&amp;</b>

An example is depicted in Figure 363 where the header contains the name of the organization in the middle and the name of the doctor on the right. Once you have completed the definition, click the **OK** button to confirm.



**Figure 363 – Page headers and footers dialog**

## 20 Quantitative analysis

The tool calculates the mean image value within a contoured region of interest (ROI) as a function of selected parameter (echo time, trigger time, image number). The result can be shown as a chart or a table.

The image set used in the evaluation is selected automatically based on the image where the ROI is defined. The images of the same spatial position are identified within the series of the image or within multiple series (when applicable). The set of images created in this way then determines the available parameters (the chart X values).

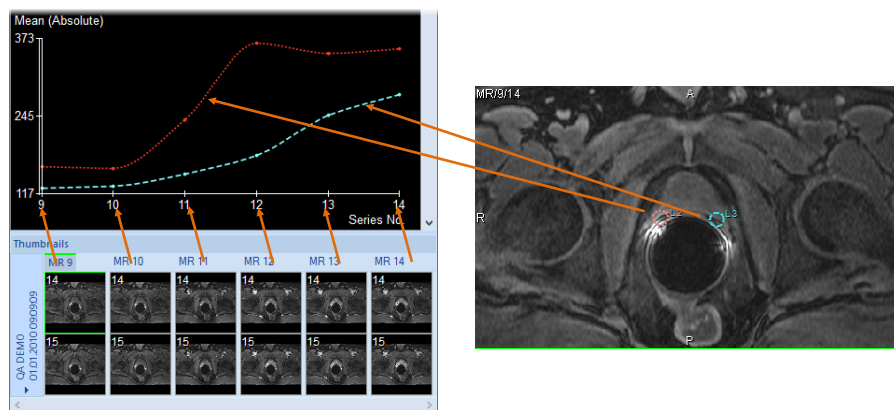
### 20.1 *Suitable image sets*

To be able to perform analysis, a suitable image set needs to be available. TomoCon automatically detects the suitable images (within one or across more series) based on their attributes. A set of rules, which depend of the type of series included in the analysis, controls the way the images are combined into a proper image set which is suitable for quantitative analysis.

The analysis can be performed across multiple image series (or series rows in the case of multi-dimensional series) or within a single series (series row). The selection can be made while creating a new quantitative analysis.

The type of the image series (single- or multi-dimensional) and the direction of the quantitative analysis also determine the main parameter used for navigation within the analysis later.

- **Single-dimensional image series** - the images of the same spatial positions across all the available series within the study are searched for (see Figure 364). This, for example, allows to evaluate the time course of the saturation of the contrast agent on a study composed of multiple image series, each of them scanned at a different time (though with the images on the same positions, see Figure 364). The navigation among the images in the analysis is performed using the series number when the quantitative analysis is created across series; when the quantitative analysis is created within a single image series, the slice number is used for navigation.

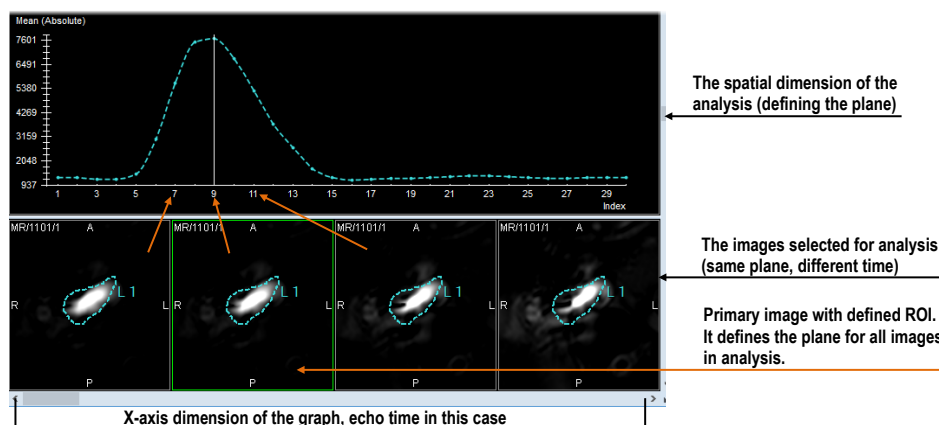


**Figure 364 – Analysis calculated on the MR9 – MR14 series, ROIs defined on the primary image**

- Multi-dimensional image series** – the images within the multi-dimensional series are looked for using the similar criteria as in the case of a single-dimensional image series; however, the images are only taken from a single multi-dimensional image series without scanning the remaining image series for additional images. The multi-dimensional image series is scanned through all the dimensions available to find the appropriate images.

If multiple dimensions can be used for the measurement within a single multi-dimensional series, it is possible to choose the desired one before a new analysis ROI is created. This way, multiple analyses in the study can be created, each for a different dimension parameter (see Figure 365).

When a quantitative analysis is created across series rows, the dimension in which the analysis is created is identical to the one on which the horizontal scrollbar is currently acting. When creating an analysis within a series row, the measurement direction will be according to the vertical scrollbar. In both cases, the dimension index is available for navigation within the quantitative analysis created.



**Figure 365 – Analysis calculated on the images of a single multidimensional series**

If, in the case of single-dimensional series, the image series selected by default to belong to the analysis should not belong to the measurement, it is possible to unselect individual image series from the analysis (see 20.5.5 Selecting the image series).

When a quantitative analysis is created within a single series or series row, no restrictions on the spatial position of images is imposed (the images may or may not be positioned on the same spatial position).

In addition to the main navigation parameter as described above, the following parameters can be used for evaluation if they are available in the images (e.g. Trigger time, Echo time, Normal time, Relative time or Slice position). Normal time represents the real time of the image series, while relative time starts from the first visible image series in the analysis and reflects time differences among the visible image series.

## 20.2 Quantitative analysis tool tab

The Quantitative analysis tool tab (see Figure 366) provides the access to quantitative analysis functionality.

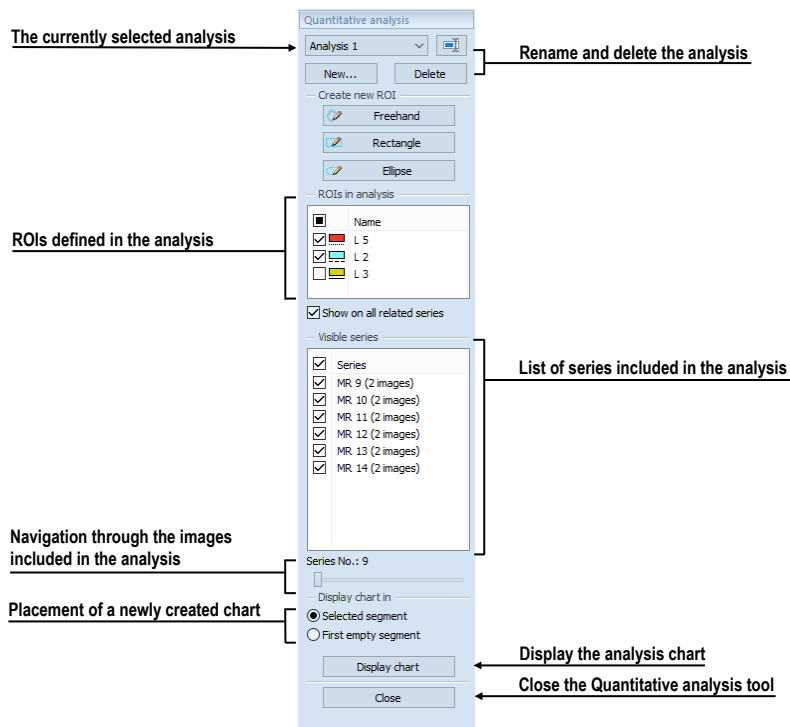



Figure 366 – Quantitative analysis tool tab

The tool tab is hidden by default. To show the tool tab, select **Tools/Quantitative analysis...** in the main menu. The tab can be displayed only if it is possible to create a quantitative analysis in the open study.

If a quantitative analysis measurement exists in an open study, the tool tab is also accessible via tools panel by clicking  tab.

### 20.2.1 Selecting a quantitative analysis

If multiple analyses exist within the loaded studies, the tool tab allows the selection of the current one.

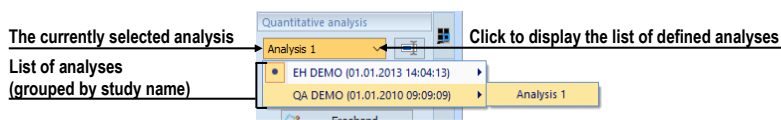



Figure 367 – Selecting analysis in the Analysis combo box

To select the analysis, select the desired analysis (see Figure 367) in the **Quantitative analysis** tool tab, in **Analysis** selection combo box. The name of the current analysis will be displayed in the **Analysis** selection combo box. If a chart/table view is displayed in the current view at the moment, it switches to show the newly selected analysis.

### 20.2.2 Renaming a quantitative analysis

To rename a quantitative analysis:

1. In the **QA** tool tab, next to the analysis selection combo box, click  **Re-name**.
2. Rename the analysis right in the selection combo box where the cursor is shown.

### 20.2.3 Deleting a quantitative analysis

To delete all the ROIs belonging to a single quantitative analysis:

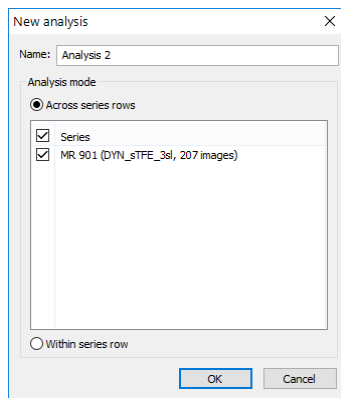
1. In the **QA** tool tab, under the analysis selection combo box, click **Delete**.
2. A confirmation dialog is show; click **Yes** to delete the selected analysis; **No** to cancel.

## 20.3 Creating an analysis


To create a new analysis:

1. Select an image where the ROI for analysis needs to be positioned into the current view.

2. Open **Quantitative analysis** tool using the menu (**Tools/Quantitative analysis...**) or using the tool tab.
3. Click **New...** to open **New analysis** dialog (see Figure 368).
4. Select a name for the analysis.
5. Select **Across** or **Within series** (resp. series row) mode for the new analysis.
6. In **Across** mode, select or unselect the image series to be part of the quantitative analysis (check/uncheck the series name).
7. Click **Ok** to create the analysis.



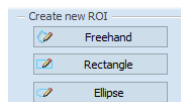
**Figure 368 – Creating a new quantitative analysis**

If a series contains multiple dimensions to be used for an analysis (for example, trigger time and echo time), the desired one must be selected in the current view when creating a new ROI. One analysis can be created in the study per each dimension available in the image series. The dimension of the current view can be changed using the  button in the lower right corner of the working area (see Figure 365).

### 20.3.1 Creating and delineating ROIs

To create a new ROI of the analysis in the current view:

- Select an appropriate tool for the ROI definition in the **Create new ROI** section of the **QA** tool (see Figure 369).



**Figure 369 – Quantitative analysis drawing tools in the QA tool tab**

Use the tool selected:

- **Freehand** – Press and hold the left mouse button while following the path to delineate with the mouse cursor. The ROI shape is drawn continuously as the mouse is being moved. Release the mouse button when done.



- **Rectangle** – Press the left mouse button at the corner position and hold it while dragging the mouse cursor to the opposite rectangle corner. The rectangle is drawn continuously as the mouse is being moved. Then release the button.
- **Ellipse** – Press the left mouse button at the corner position of the ellipse inscribing rectangle. While holding the button, drag the mouse cursor to the opposite corner of the inscribing rectangle. The ellipse is being drawn continuously while the mouse is being moved. Then release the button.

The ROI can also be defined on a series not belonging to the analysis. To do that, check the **Show on all related series** option (see Figure 370).

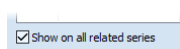


Figure 370 – Show on all related series option

## 20.4 Evaluating analysis results (using charts and tables)

Once the ROIs are defined, the analysis results can be shown in the graph or in the table.

To show the analysis results (see Figure 371):

1. Select where the chart should appear (either in the current segment or in the first available segment).
2. Click **Display chart** button.

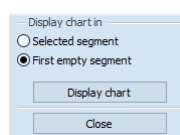


Figure 371 – Displaying analysis chart

## 20.5 Changing the display of results

### 20.5.1 Enabling and disabling the ROI display

To enable or disable the evaluation of a specific ROI, click the checkbox to the left of the ROI color and name in the **Quantitative analysis** tool tab, in **ROIs in analysis** list (see Figure 372). When a ROI is unchecked, it is not shown in the images nor in the chart/table views.

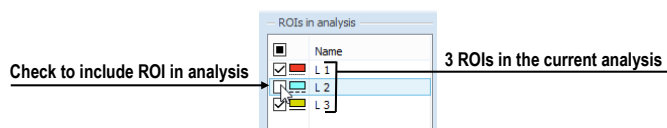


Figure 372 – ROIs in analysis section in the QA tool tab

## 20.5.2 Setting ROI style

The color and the line style (dotted, dashed, ...) can be set up for each individual ROI. These are used to display the ROI in the images and in the graph, and can be changed for each ROI in the toolbar.

To change the way ROI is shown:

1. In the **Quantitative analyses** tool tab, in **ROIs in analysis** list, right-click the desired ROI.
2. In the context menu, select **ROI style**.
3. Select the desired color and line style in the dialog (see Figure 373).

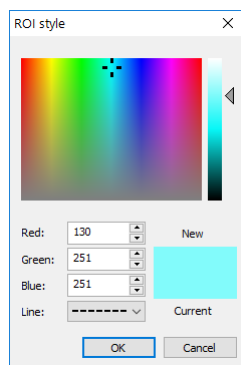


Figure 373 – ROIs style dialog

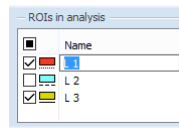
The ROI style dialog can also be displayed by double-clicking the color indication of the specific ROI in the **ROIs in analysis** list.

## 20.5.3 Renaming a ROI

A newly created ROI is named automatically, starting with the letter “L”, followed by the index of the ROI. The default name can be changed at will.

To rename an existing ROI:

1. In the **Quantitative analyses** tool tab, in **ROIs in analysis** list, right-click the desired ROI.
2. In the context menu, select **Rename**.
3. Change the name directly in the list (see Figure 374).



**Figure 374 – Renaming the ROI with predefined name L3**

The name can also be changed by selecting the ROI in the list and clicking the name once.

## 20.5.4 Deleting a ROI

To remove an existing ROI:

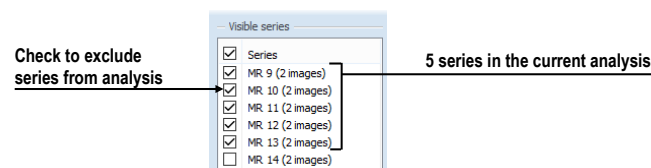
1. In the **Quantitative analyses** tool tab, in **ROIs in analysis** list, right-click the desired ROI.
2. In the context menu, select **Delete**.
3. The ROI will be removed from the analysis. If it is in the analysis only one, the whole analysis will be removed.

## 20.5.5 Selecting the image series

When the first ROI is created, the suitable image series to be used in the analysis measurement are automatically detected. If, for any reason, some image series need to be discounted from the measurement, they can be hidden from the analysis:

1. In the **Quantitative analyses** tool tab, in **Visible series** list (see Figure 375), find the series which needs to be included or excluded.
2. Click the checkbox next to the image series.

The checkbox state indicates whether the image series is used for the analysis or not.



**Figure 375 – Series in analysis section in the tool tab**

## 20.6 Evaluating analysis results

The quantitative analysis results can be shown as a chart or as a table in any of the views in the working area.

To show the evaluation results in chart (see Figure 376):

1. Select where the chart should appear (either in the current segment or in the first available segment).
2. Click **Display chart** button.
3. A new analysis chart is shown according to the selected placement (see 20.6.1 Working with the chart).

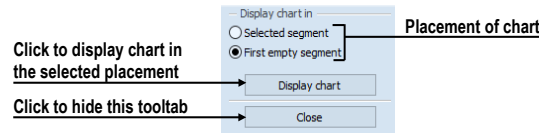


Figure 376 – Display chart in section in the tool tab

### 20.6.1 Working with the chart

The chart displays the mean values measured within the contoured ROIs on the images selected into analysis. The chart axes are scaled automatically to show all the measured data (see Figure 377); however, the scaling can be changed.

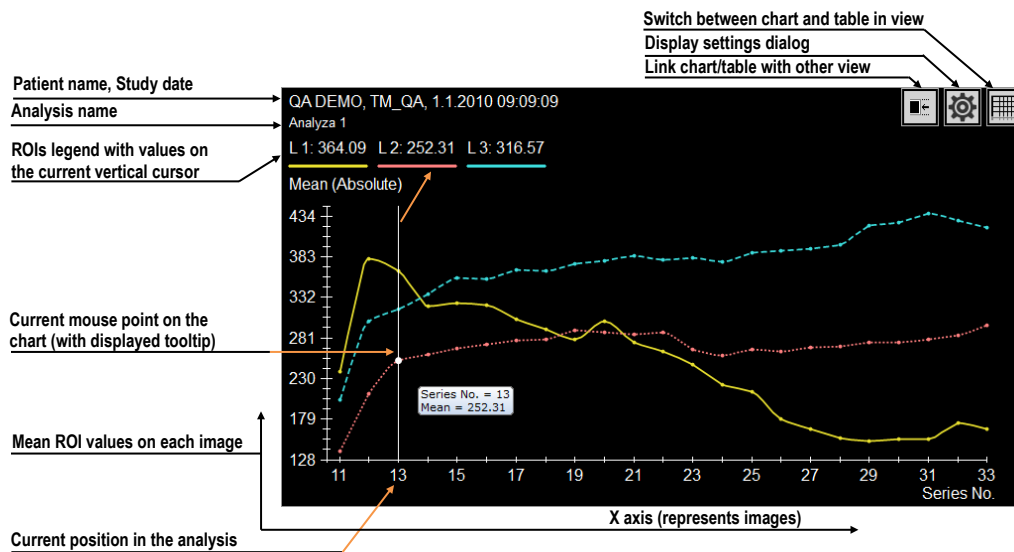




Figure 377 – Displayed analysis chart

The chart is the default evaluation view of the quantitative analysis. Clicking  or  button in the upper right corner switches between the chart and the table display.

The upper part of the chart (see Figure 378) shows the study identification, the identification of the analysis shown in the chart and the legend showing all the ROIs within the analysis with the value at the selected position of vertical chart cursor.

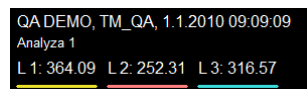
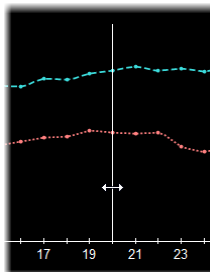


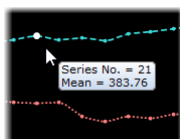
Figure 378 – Upper part of the chart

The vertical line (of the same color as the chart axis) in chart indicates the current position in the analysis – the image belonging to the analysis displayed in the linked segment. It can be changed by double clicking on the desired position in the chart (see Figure 379) or by moving by drag and drop method.



**Figure 379 – Current cursor of analysis in chart**



A tooltip can be used to inspect a specific value of any of the ROIs shown in the chart. To use the tooltip, move the mouse cursor over the value to be inspected. The point is highlighted, and a tooltip showing the value details is shown (see Figure 380).



**Figure 380 – Current chart point with tooltip**

ROI values are connected using either a straight line or a smooth curve. To turn on/off smoothing the graph, check/uncheck **Smooth curve** item in the context menu.

## 20.6.2 Working with the table

The chart is the default evaluation view of the quantitative analysis. Clicking  or  button in the upper right corner switches between the chart and the table display.

In the table mode, all the measured values are listed for all the ROIs and images within the analysis. Use the scroll bars to show the values that are not visible due to the limited view size; the horizontal scroll bar allows navigating through ROIs; the vertical scrollbar allows navigating through the images.

Current position in the analysis (the image in the linked segment) is indicated by highlighting the appropriate table row. To change the current position in the analysis in the table, click on a desired row in the table (see Figure 381). The highlighted row will be changed to the newly selected one.

Series No.	Min	Max	Mean
11	11.00	366.00	133.20
12	11.00	523.00	210.16
13	12.00	561.00	252.31
14	11.00	591.00	259.56
15	10.00	580.00	267.30
16	14.00	534.00	272.71
17	13.00	511.00	278.60
18	15.00	612.00	279.84
19	16.00	613.00	289.87
20	12.00	635.00	287.16
21	17.00	605.00	285.59
22	7.00	631.00	287.45
23	11.00	578.00	286.35
24	10.00	707.00	259.41
25	12.00	742.00	266.73
26	11.00	708.00	263.81
27	14.00	696.00	268.97
28	9.00	716.00	270.69
29	11.00	709.00	275.89
30	11.00	690.00	275.40

Figure 381 – Analysis table with highlighted current position of analysis

### 20.6.3 Current position in the analysis

The current position in the analysis corresponds to the image in the current view in the linked segment. Furthermore, current position is indicated by (see Figure 382):

- the vertical cursor in the chart
- the row highlight in the table
- the position slider control in the **Quantitative analysis** tool tab

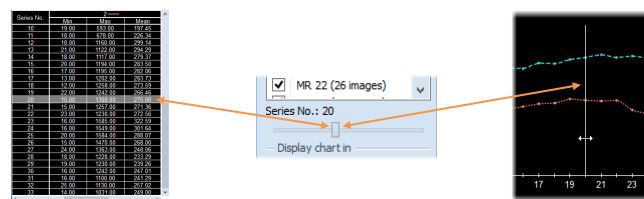


Figure 382 – Current position in the analysis in table and chart

Current position in the analysis can be changed in all of these places:

- By double-clicking the appropriate position in the chart (see 20.6.1 Working with the chart) or by dragging-and-dropping the vertical cursor.
- By double-clicking the appropriate row if the table (see 20.6.2 Working with the table).
- By scrolling to the desired image in the linked segment (see 20.6.6 Using multiple views and synchronizing the selection).
- By using the slider in the **Quantitative analysis** tool tab (see 20.6.6 Using multiple views and synchronizing the selection).

### 20.6.4 Selecting evaluation mode

The measurement results (the mean values of image data within the ROIs defined) can be presented in different scales:

- **Absolute** - the mean value is presented as calculated. For example, if the measurement is performed on CT image series, the mean value of the CT data is shown in the chart, table and tooltips.
- **Differential** - the mean value is presented as a difference to the value calculated at the position of the reference value (image).
- **Normalized** - the values are presented as a difference to the values calculated at the position of the reference value, scaled (normalized) to 100%:

$$Val_{presented} = \frac{Val_{measured} - Val_{reference}}{Val_{reference}} .100\%$$

To select the evaluation mode:

1. Right-click in the chart or in the table.
2. In the context menu, in **Evaluation mode** submenu, select the mode.

To select the reference value (image) for differential and normalized modes:

1. In chart or in table, right-click the value to be used as the reference value
2. In the context menu, select **Set as reference value**.


To hide or show the reference value (image):

1. Right-click in the chart or in the table.
2. In the context menu, in **Evaluation mode** submenu, select or unselect **Show reference value**.

Alternatively, use the evaluation settings (see 20.6.5 Other evaluation settings) to set the evaluation mode and the visibility of the reference value.

The current evaluation mode is always displayed in the description of the vertical axis in the chart and in the table header. In **Differential** and **Normalized** modes, the reference value is shown as well, and for better orientation in the chart a horizontal line at the position of the zero value is drawn.

## 20.6.5 Other evaluation settings

To set up the display of the analysis in the chart and in the table, click  button in the upper-right corner of the chart or table area. The settings dialog is shown (see Figure 383). These parameters are customizable in the dialog:

- The evaluation mode (see 20.6.4 Selecting evaluation mode).
- The visibility of the reference value (see 20.6.4 Selecting evaluation mode).
- The X-axis scaling:

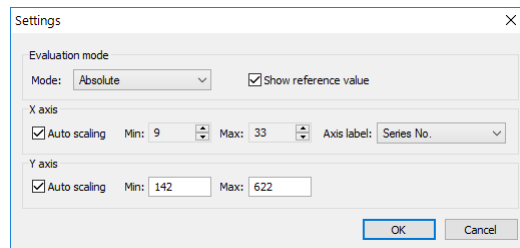
Select the '**Auto scaling**' option, or manually specify the minimum and maximum values for the X-axis. This range corresponds to the range of the

images included in the analysis results. The range is reflected both in the chart and in the table.

- The Y-axis scaling:

Select '**Auto scaling**', or manually specify the minimum and maximum values for the Y-axis representing the values measured in the analysis ROIs. The selected range is reflected in the chart only.

- The **Axis label** specify the label on the X-axis. The selected label also controls the ordering of the individual values.



**Figure 383 – Settings dialog**

## 20.6.6 Using multiple views and synchronizing the selection



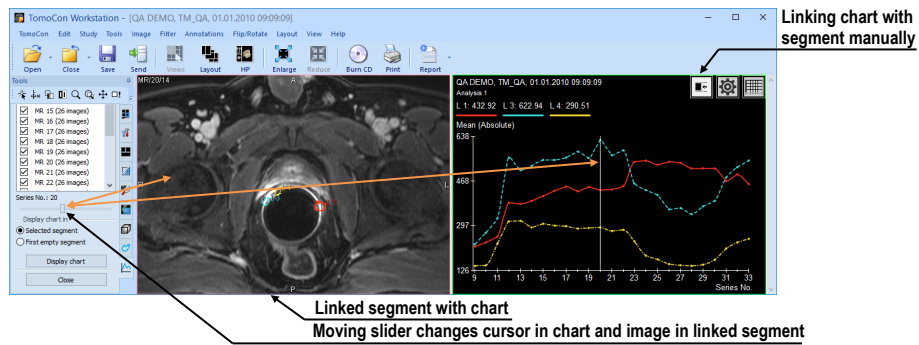
If the current view is the chart/table view, tool tab reflects the analysis shown in the chart or table. However, if the current view is the image view, the tool tab does not necessarily reflect the analysis which is shown in the image view.

When evaluating the analysis, it may be useful to view the numerical data or the chart at the same time as the image data where the measurement is performed. To aid in the evaluation, the current position in the analysis is synchronized among the chart/table view, the image segment and the analysis tool tab.

When the chart view is created in the first empty segment, the current segment and the newly created chart are linked automatically – meaning that the current position within the quantitative analysis is synchronized. If one of the linked segment is current, the other one is always marked by a pink colored frame. The color and the frame width can be customized (see 4.4 Color and style options).


The chart and the segment linked together show the identical position within the quantitative analysis; that is, changing the position in any of the segments changes the position/indication in the other one, as well as the indication in the tool tab.

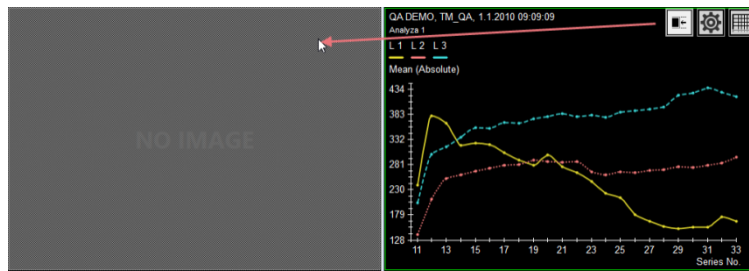




**Figure 384 – Linked view with analysis chart**

To link the yet unlinked chart to a segment, or to change an existing link:

1. In the chart/table to be linked, press and hold the mouse button on the  button.
2. Drag the mouse cursor over a segment to be linked. The segment will be highlighted (see Figure 385).
3. Release the mouse button.



**Figure 385 – Linking left segment with analysis chart**

Please note that the link is automatically removed in some situations:

- If an image not belonging to the image analysis is selected into the linked image segment.
- The chart/table is replaced by a different view or cleared.
- A new link is created to a different segment (a chart/table can only be linked to a single segment).

## 21 ECG/HD

TomoCon offers the possibility to review and enter measurements and diagnoses for ECG waveforms stored in patient DICOM data. As the result, it is very easy to analyze diagnostic patient images along with ECG diagnostic waveforms. The clinician has full access to comprehensive ECG/HD information using the Waveforms embedded working area that is automatically displayed when opening patient data with stored ECG/HD information or manually by selecting the ECG or HD image in thumbnails palette.

The waveform working area is placed over an existing working area, and is independent from the other working areas displayed at the time. It consists of three main parts (see Figure 386):

- ECG/HD grid paper with signals displayed.
- Information panel (on the right side) displaying values stored with the signals (like heart rate).
- Report panel (on the upper side) displaying text information stored with the signals (like medical findings).

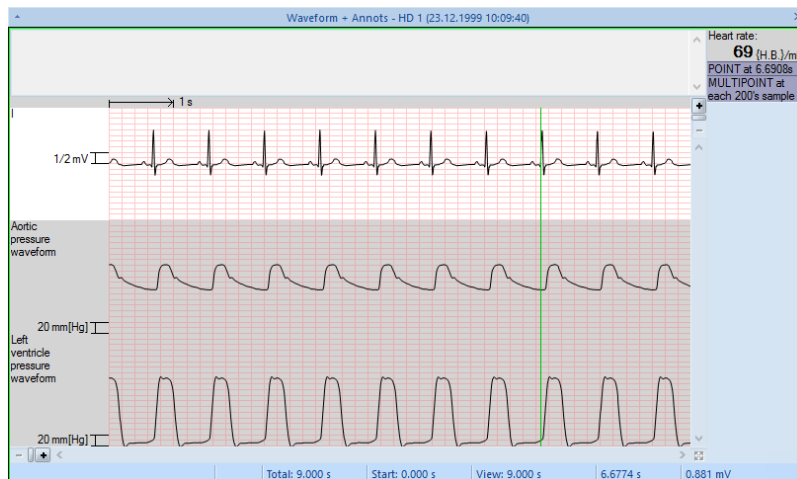
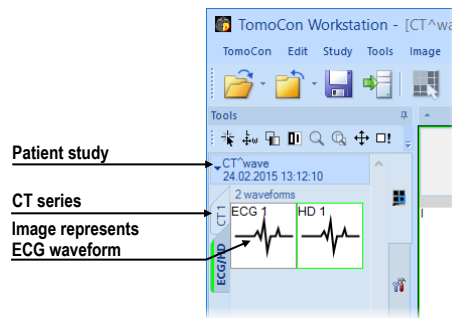


Figure 386 – ECG/HD embedded working area

### 21.1 Navigating through opened ECG/HD waveforms

All open ECG/HD waveforms are displayed as special image belonging to patient study in thumbnail palette (see Figure 387). To display a waveform preview in the waveform embedded working area, click on this symbolic image in the thumbnail palette.



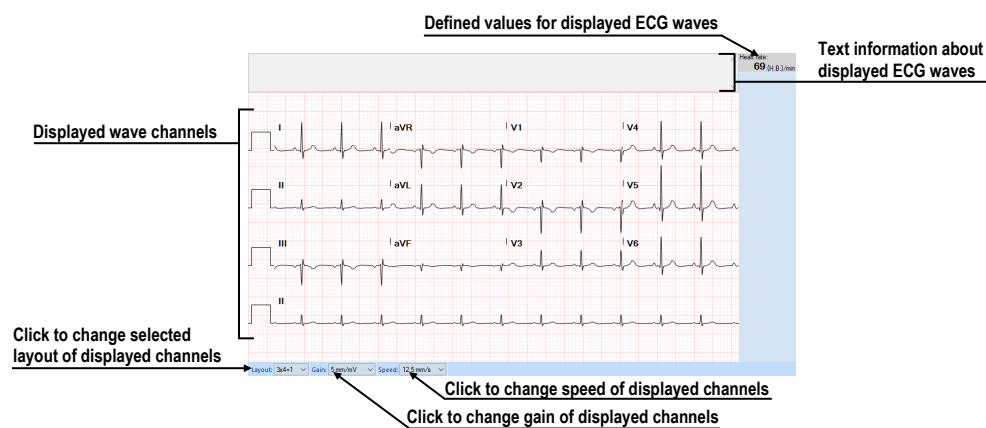
**Figure 387 – ECG/HD in thumbnail palette**

Selected waveform will consequently be displayed in the ECG or HD working area, according to the waveform type. Both ECG (see 21.2 ECG diagnostics) and HD (see 21.3 HD diagnostics) working area display waveforms on the red graph paper, but offer different diagnostic functionality.

## 21.2 ECG diagnostics

ECG working area displays the waveforms according to the selected layout type, selected gain and time interval. Following actions can be performed:

- Change the ECG speed, from 12.5 to 50 millimeters per second, in the lower working area panel.
- Change the gain value, from 5 to 40 millimeters per millivolt in the lower working area panel.
- Change the layout to display a desired number of waveforms.
- Scroll to display hidden waves by dragging the right scrollbar. This scrollbar is shown if not all the waveforms can be displayed in the grid.



**Figure 388 – Preview window for diagnosis of ECG**

### 21.3 HD diagnostics

The HD working area initially displays all the waveforms in grid. Following actions can be performed:

- Customize the range of displayed waveforms using the controls in the vertical and horizontal scrollbars (see 21.3.2 Customizing displayed waves and time interval).
- Display current time on a selected waveform position using the vertical time cursor (see 21.3.3 Time cursor in HD).

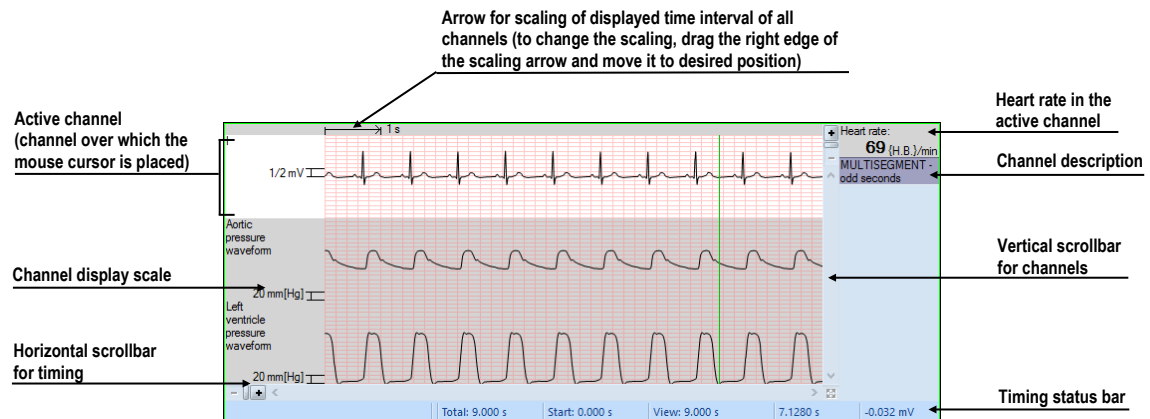


Figure 389 – Preview window for diagnosis of HD

#### 21.3.1 Status bar

The **Timing status bar** (see Figure 390) is the bar at the bottom of the **HD** embedded working area. It displays the main time and value parameters from the displayed HD channels.

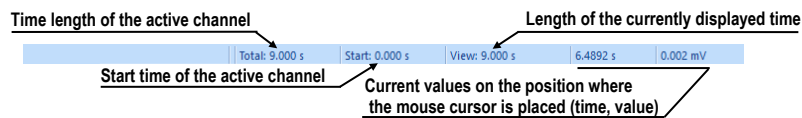
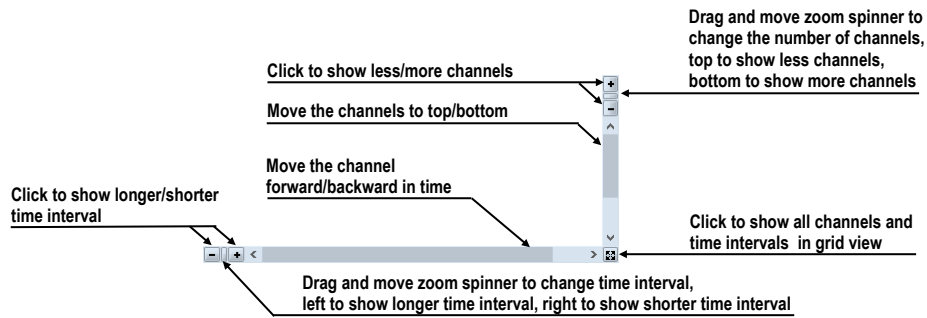


Figure 390 – Timing status bar

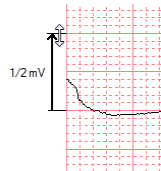
#### 21.3.2 Customizing displayed waves and time interval

To customize the displayed time range of all waveforms, use the horizontal timing scrollbar under the grid view (see Figure 391).



**Figure 391 – Waveform workspace scrollbars**

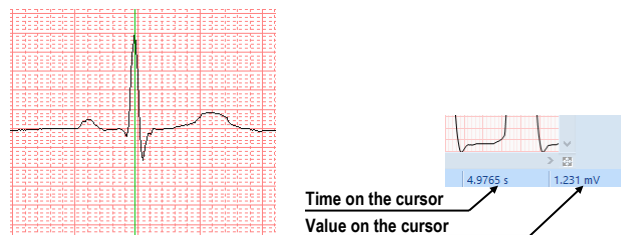
To customize the value scaling only for the active wave, use the vertical arrow in front of the active wave. Drag the top edge of the scaling arrow, and move it to the desired position. The active waveform is automatically vertically adjusted to the selected scale position (see Figure 392).



**Figure 392 – Active waveform value scaling**

### 21.3.3 Time cursor in HD

When previewing HD waveforms, it is often necessary to identify the time and value for the active waveform in a specific point. For this purpose, TomoCon offers the use of a time cursor tool (see Figure 393). This is a special cursor that is activated when the cursor hovers over the grid view. When moving the mouse, the status bar automatically displays the time and value from the current cursor position. Using the time cursor, it is also possible to find the minimum and maximum values in the active waveform.

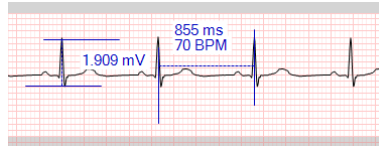


**Figure 393 – Time cursor with displayed waveform values**

## 21.4 Marker measurement in ECG/HD

When diagnosing using an ECG/HD examination, it is often necessary to measure the length or the value. For this purpose, manual measurement tool of the **Marker** type

(see Figure 394) is available. Using this tool, it is possible to graphically mark the measured time interval right in the examination. The marker can then be removed anytime.



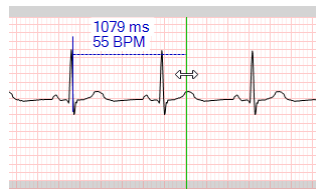
**Figure 394 – Markers in waveform**

To create a new measurement:

1. Move the cursor to a desired start location in a waveform.
2. Press and hold down the left mouse button at the start location, and move the cursor horizontally to measure the length, or vertically to measure the value.
3. Release the left mouse button.

To move or resize a previously defined measurement:

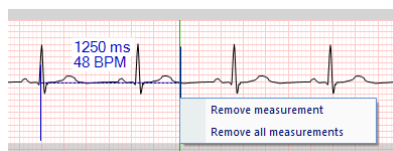
1. Move the cursor over the start/end line for resizing or over the main line for repositioning. The measurement will be highlighted.
2. Press and hold down the left mouse button and move the cursor to a new location (see Figure 395). The measurement limit(s) will move along with the cursor.
3. Release the left mouse button.



**Figure 395 – Editing a defined Marker**

To remove a previously defined measurement:

1. Move the cursor over a measurement. The measurement will be highlighted.
2. Press the right mouse button and select **Remove measurement** from the displayed context menu.




**Figure 396 – Marker context menu**

## 22 Touch screen mode

The TomoCon application offers the special touch screen mode for touch screens used in operating rooms. The touch screen mode is activated when starting TomoCon (see 2.2 Starting TomoCon) or during work with the application by selecting the **Touch screen mode** item in the **Tools** menu. The mode offers selected application functions that are operated using enlarged control buttons.

The touch screen mode window consists of the working area (on the left) and the panel with control buttons (on the right) (see Figure 397).

When the mode is started, the working area has only one view – the current view. Click the  button to change the layout of the working area (see 22.3 ). If there are multiple views in the working area, select an arbitrary view that is to be the current view. If patient studies were opened before switching to the touch screen mode and the current view was empty, the working area is filled with the image sequence. The first image is then the first image from the last series of the most recently opened study. If an image was selected in the current view, the working area is then filled with the image sequence from the current image series beginning with this image. If no patient study was open, the working area is empty.

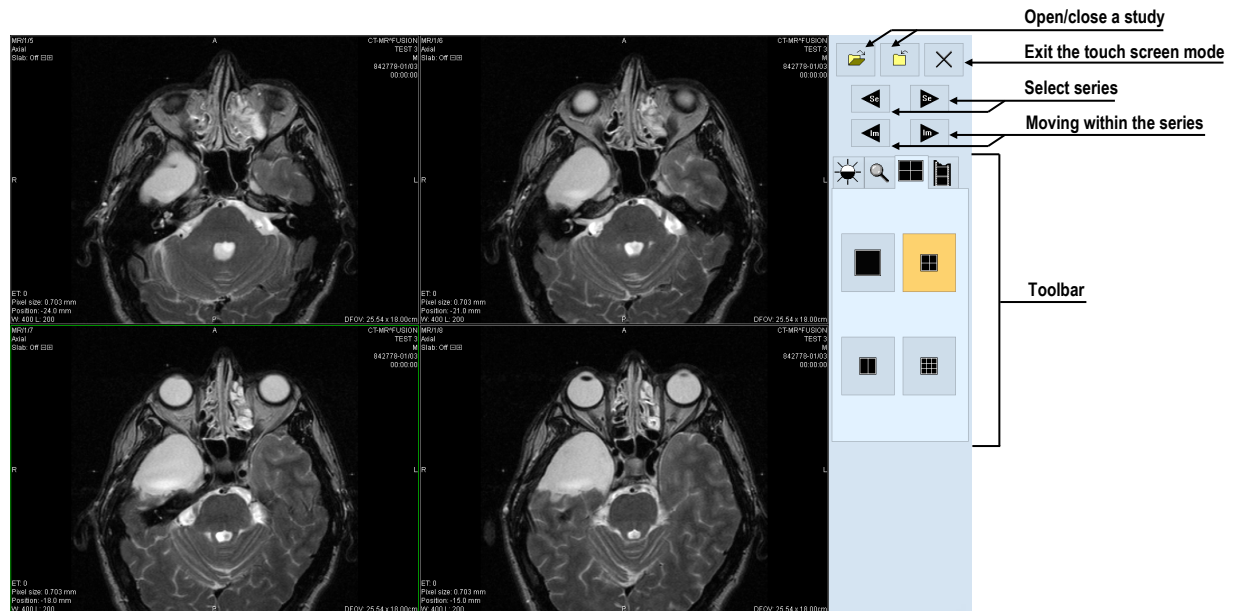




Figure 397 – Touch screen mode – layout







## 22.1 Opening a patient study

A patient study is opened in the touch screen mode by clicking the  button. The **Search studies** dialog is then displayed (see 5 Managing studies) where is possible to select and then to open a study.

## 22.2 Closing a patient study

All opened studies can be closed by clicking the  button. If the touch screen mode was activated when working with the application and changes were made (e.g. to ROIs, registrations, annotations), the TomoCon behavior, when closing studies with changes, depends on its settings (see 4.1.8 Confirmations).

## 22.3 Toolbar

After selecting the  tab, the group of acceleration buttons is displayed in the lower part of the panel (see Figure 398a) representing accelerating level increase  and accelerating level decrease . Clicking the buttons changes the level of the window , level  and shape  in the all images of the working area. The level changing process is indicated by the slider and the numerical values under the sliders. Inverting the colors in the image, resetting the default values of the window, level and shape in the working area alternatively applying new values of the window, level and shape to the series are possible using the buttons located in the lower part of the toolbar.

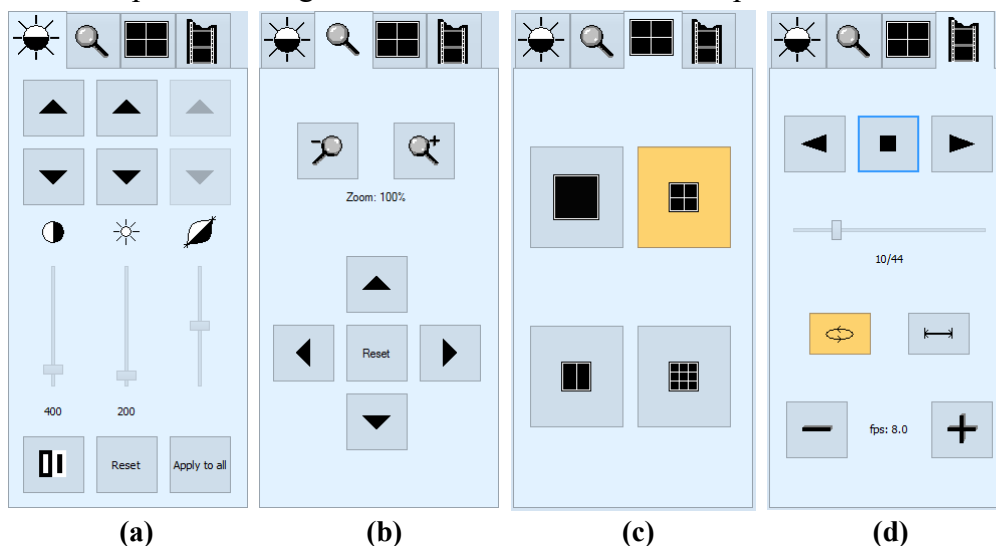





Figure 398 – Touch screen mode – tabs of the toolbar

After selecting the  tab, the buttons for zooming and moving the image in the working area are displayed in the lower part of the panel (see Figure 398b).



After selecting the  tab, the buttons representing the working area layout are displayed in the lower part of the panel (see Figure 398c).

After selecting the  tab, the buttons to control playing multi-frame images are displayed in the lower part of the panel (see Figure 398d).

## 23 Digital signature



This functionality is available on Microsoft Windows 7 operating system or later version.

Digital signatures related functionality in TomoCon allows digital signing of patient studies and verification of signatures when viewing studies.

The study signature is created based on a unique user certificate and it ensures:

- authenticity of the user (signer) – the system can verify the signer identity
- data integrity – the system can verify that the study has not been subsequently modified after signing

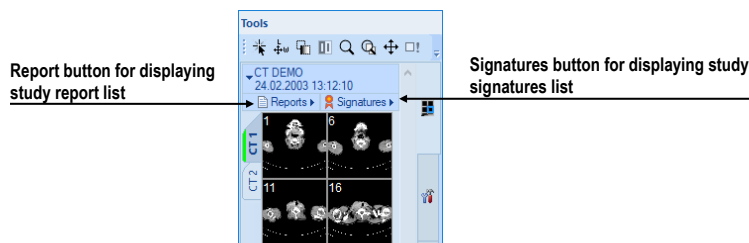
When signing, either the entire study can be signed (meaning all the currently open study objects will be signed), or the structured report can be signed on its own.

The digital signature of patient studies can be stored in DICOM format and sent over to another user, or uploaded onto a remote device (e.g. a PACS server).

When viewing a signed study, TomoCon automatically checks the validity of the user certificate. It also checks the validity of the individual objects' signatures, marks the objects altered after signing and also marks the objects that have not been signed at all.

### 23.1 Digitally signed study

Each DICOM study can contain multiple digital signatures, which has been created by different users. When a study with any digital signature is open in TomoCon, **Signatures** button will be displayed in the thumbnail palette in study tab (see Figure 399). When a study has no digital signatures, **Signatures** button is not shown.



**Figure 399 – Study in thumbnail palette with reports and signatures**

To display all digital signatures in study, click **Signatures** button in the thumbnail palette. The list of all study signatures will be displayed. Each signature is represented by the signer name, date and time of the signature verification state (see Figure 400).

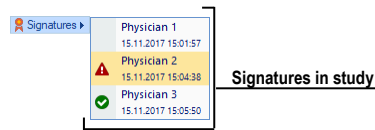


Figure 400 – The list of study signatures

To display a signature details and the list of objects signed click on the signature in displayed list. The **Signature information** dialog will be displayed with signature details (see 23.2 Signature details). The study objects (images, reports, other objects) are split by their signed status into three tabs in the thumbnail palette (see Figure 401):

- Valid – Objects with successful validation (objects are signed correctly by valid signature)
- Invalid – Objects with incorrect validation
- Not signed – Objects not signed by the currently selected signature

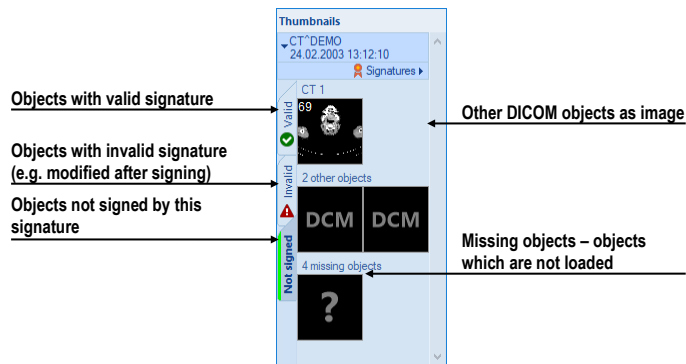


Figure 401 – Signature objects in thumbnail palette

## 23.2 Signature details

Signature details dialog (see Figure 402) displays information about signature, the certificate used, time stamp and signed objects statistics.

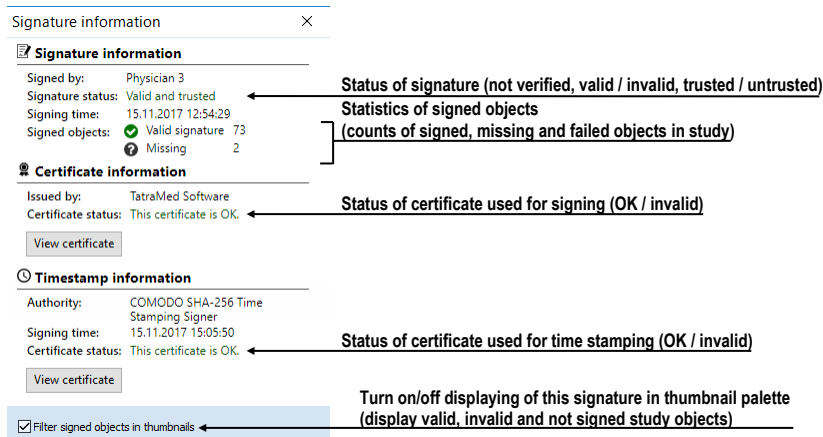


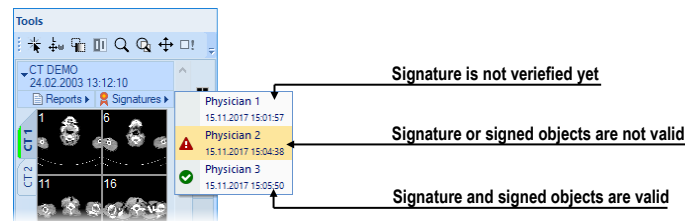


Figure 402 – Signature details dialog

When the **Signature details** dialog is displayed for the first time, the certificate is verified and the signed objects are validated. The result is indicated by an icon in thumbnail signature list:


- None – Status is not verified yet, shown immediately after opening a study.
-  – The signature certificate is not valid and/or signed objects are not correctly signed.
-  – The digital signature is valid and successfully verified. All opened signed objects are correctly signed.



**Figure 403 – The list of study signatures**

### 23.3 Signing study

A digital signature can be created for the entire open study (with all open images and other objects). User signing certificate is needed for signing the study; personal information from the certificate (signer name and organization) will be added to the study signature.

To sign the open study, click  **Sign study...** in **Study** main menu. **Sign study** dialog will be displayed for selecting signature certificate and starting the signing process.



**Figure 404 – Sign study dialog**

Each created digital signature is stored to the local study as a new signing key object (signed manifest with KO modality).

1		31.12.1899	MR	25
1		31.12.1899	CT	11
1	Signed Manifest	16.11.2017 12:44:24	KO	1

**Figure 405 – Digital signature stored in a local study**

### **23.4 *Digital signature in report***

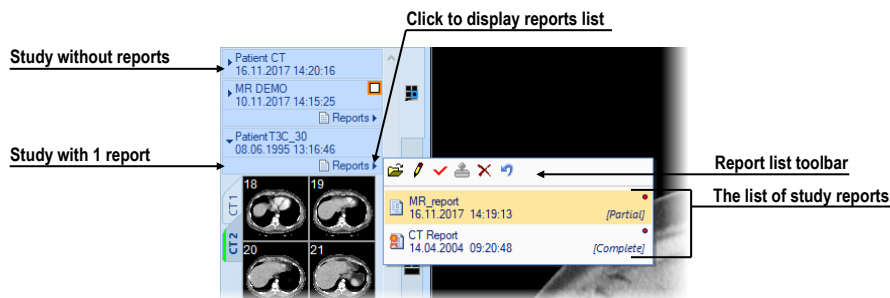
Digital signatures can also be created for DICOM structured reports. The signature can be used for completion and verification processes independently. When a document is verified, the name of the verifying observer is added to the document. The digital signature makes completion and verification secure by providing a lifetime integrity check for the document.

To see detailed information about using digital signature on structured report see 24 Structured reports.

## 24 Structured reports

A structured report is widely used as a standard mechanism for presenting the gathering, transmitting and exchanging of information in diagnostic medical imaging. It provides the framework for collecting the clinical questions and responses for a patient (medical reports, findings, annotations, etc.). All the information of a structured report is stored in a single object with SR modality, and the TomoCon application provides the functionality for creating new reports and viewing previously written reports. Each structured report can be stored in the PACS system, and TomoCon allows to download/send it directly from/to the PACS system.

The reports belonging to a study are accessible using the study tab in thumbnails palette (see Figure 406). The study header indicates the number of reports in the study. To show the study report list, click the arrow next to **Reports** title.





**Figure 406 – Reports in thumbnails palette**

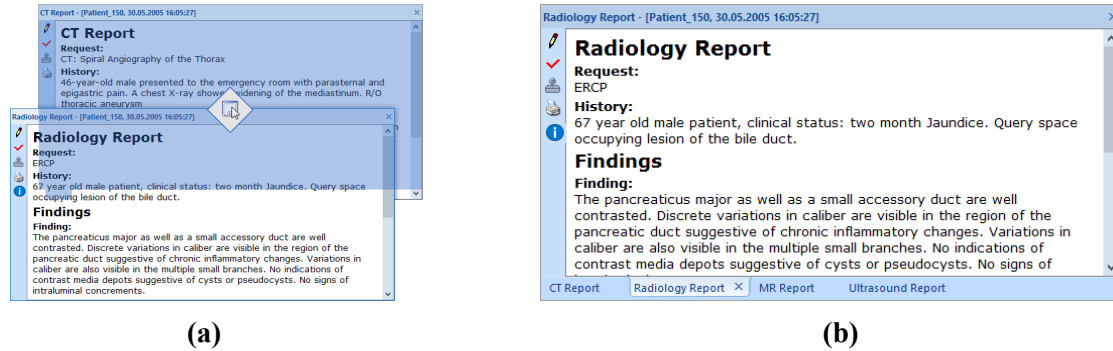
The list displays basic report information (title, date, time, state, type, signature) for each report. Additional actions on reports (display content, edit, change state, etc.) can be invoked from the toolbar available in the list.

TomoCon supports several types of structured report which can be opened and viewed using the **Reports** dialog. The main type is a text report which is composed of structured text blocks (see 24.1 Viewing a text report) and which allows to write text information concerning a patient study.



### 24.1 Viewing a text report

To view a structured report from the report list, double click the report in the report list or select it and click  **View report** icon in the toolbar. The preview of the report heading and body content is then displayed (see Figure 407b). Multiple reports can be shown at the same time, and their windows can either be floating or tabbed together; when tabbed together, they can be docked to the top or bottom sides of the application.

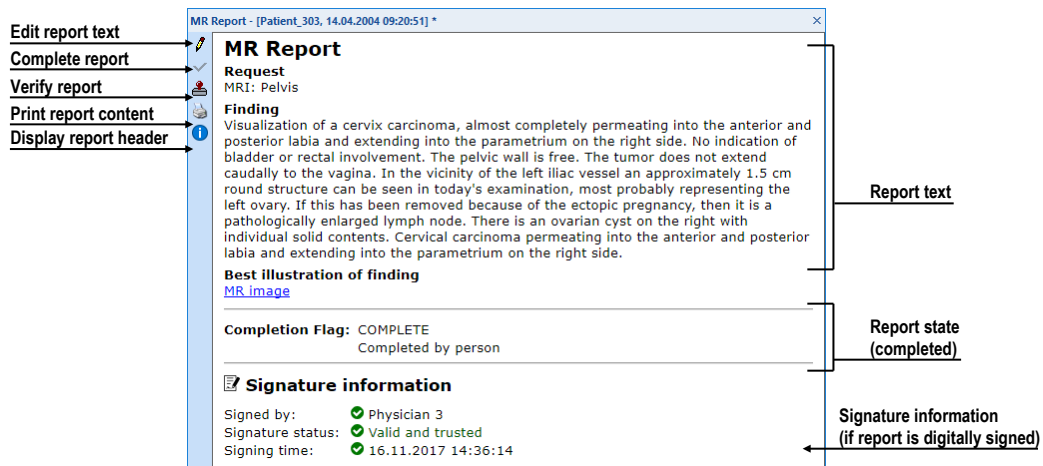
To add a report window as another tab to an existing report window, drag the report window to be tabbed by the title bar and drop it on the icon  indicating the tabbing (see Figure 407 a).



**Figure 407 - Tabbing a report window (a), Four reports as tabbed window**

To dock a report window to the top or to the bottom edge of the application, drag it by the title bar and drop it on the appropriate icon indication (icons  ,  ). Note that only single report window can be docked at the time, although multiple reports can be docked when tabbed together.

Each report window contains report text, title with main information about report, (report title, patient name and date of birth, Content Date/Time) and toolbar with allowed functionality (see Figure 408).



**Figure 408 – Report window**


If the report body contains a link to a patient image, clicking the link displays the image in the current view. If the study with this image is not open, a dialog is displayed informing that the referenced image cannot be found.


If the report is digitally signed (completed or verified), **Signature information** section is displayed below report body. It displays the name of signature creator and

signing time and status. If the report is verified by digital signature, the **Signature purpose** shows **Verification signature**.

It is also possible to copy the report text to the clipboard or to a text file (e.g. MS Word). Using the mouse or the **Ctrl+A** keyboard shortcut, select the text and press the **Ctrl+C** keys to copy the text and the **Ctrl+V** keys to insert the text into the document.

To print a report, open it and press the **Ctrl+P** keys. The standard Microsoft Windows dialog for printing then opens. Using the **Print** dialog, the report can be printed on a standard Microsoft Windows printer.

An open report can be edited directly within the window where it is displayed. To edit the report, click  in the toolbar. For more information about editing reports, see 24.5 Editing a report.

A report can be closed by clicking the  button in the upper right-hand corner of the report window.

## 24.2 Viewing a Mammo CAD report

A Mammo CAD report is the special structured report containing findings identified by a computer-aided detection system on mammography images. Each identified finding can be described in text form and represented graphically (CAD markers) on the corresponding mammography image (see Figure 409).

After opening a Mammo CAD report, the report is then added to the list of all study reports and all of its CAD markers are automatically displayed on the corresponding mammography images as special annotations with tooltips.

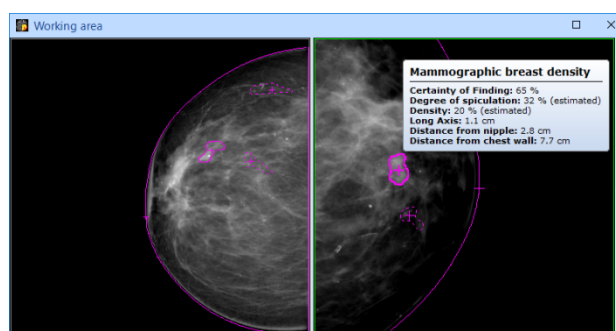


Figure 409 – Displayed CAD markers


To view a Mammo CAD report displayed in the report list, double click the report or select it and click  **View report** icon in the toolbar. The preview of the report heading and body content is then displayed (see Figure 410). The report content is composed of findings grouped by images with each image being represented by its preview. If you go to the image preview and click in the report, you can display this



image directly in the current view. If you move to a certain finding in the report and the referenced image is displayed in any view, this finding is then highlighted.

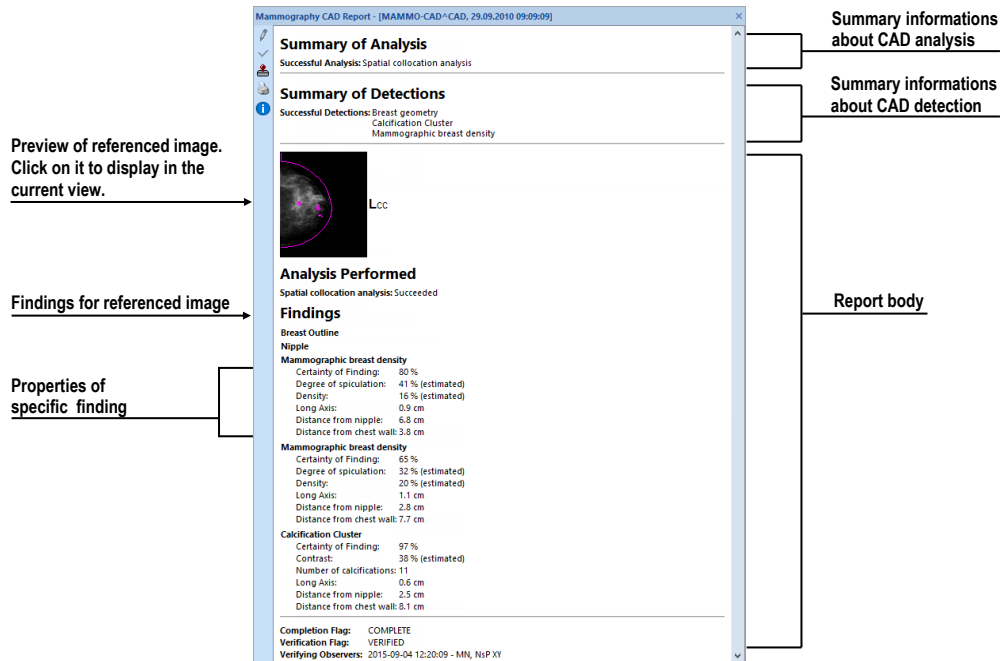


Figure 410 – Mammo CAD report preview

### 24.3 Report status

Each structured report has its own status which determines its processing status in time. The current report status is displayed in the report basic properties in the report list (see Figure 411). Reports can take the following three statuses:

- **Partial** – the report is open for editing. This status allows to edit the content of the report.
- **Complete** – the report is closed for editing. A report in this status cannot be edited; only a revised version of the report with the same content can be edited.
- **Verified** – the report has been verified by the verifying person (+ organization).

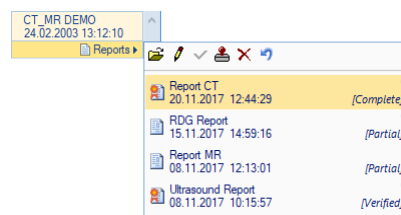




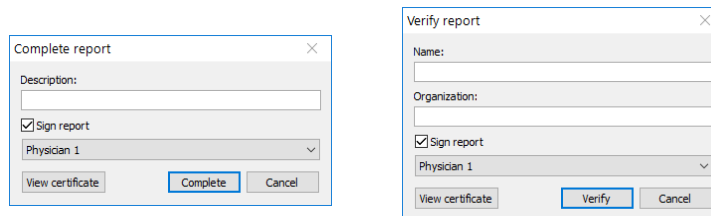
Figure 411 – Status of reports

To finish editing a report, select the report and click the  **Complete report** icon in toolbar of the reports list (see Figure 411). The **Complete report** dialog (see Figure 413) is then displayed in which you can add a note to the report concerning the completion process and select user certificate for digital signing.



**Figure 412 – Report verifying button**

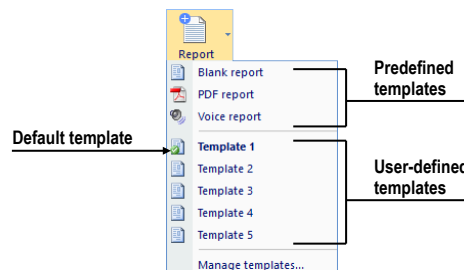
In order to verify a report, select the report and click the  **Verify report** icon in toolbar of the reports list (see Figure 412). The **Verify report** dialog is then displayed (see Figure 413) in which you can fill in the name and organization of the verifying person. Reports can be verified by more than one person and select user certificate for digital signing. The data concerning the verifying person(s) is displayed when the corresponding report is opened for viewing.



**Figure 413 – Complete report and Verify report dialog**




## 24.4 Creating a new report

TomoCon offers the possibility of creating three types of reports – structured text report, PDF report and voice report. To create a new report from the default template, click **Report** button in the main toolbar. To create a new report from another specific template, click the drop-down arrow of **Report** button and choose the template from the menu (see Figure 414). To manage templates, click the drop-down arrow of **Report** button and choose **Manage templates...** item.



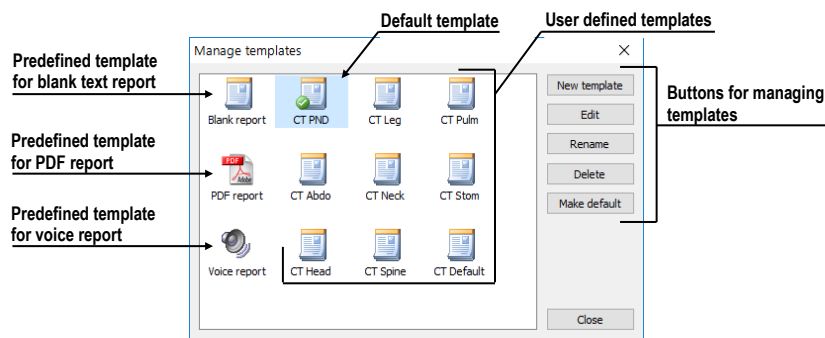
**Figure 414 – Report button with menu**

The template defines the type of the new report; you can select one of the following:

-  **Voice report** - verbally record a report in the recording dialog that is displayed subsequently.
-  **PDF report** - create a report from an existing PDF document stored on the disk.
-  **Text type templates** - write a text report in **Report** dialog displayed subsequently (see Figure 417). Select either **Blank report** template or another of the available text templates (e.g. Template 1, see Figure 414). User-defined text template defines the structure of the new text report.

### 24.4.1 Report template

TomoCon offers the possibility of using a template to create a new text report. Templates define the structure of a new text report, including texts that are initially used in the report. All defined report templates are listed in **Manage templates** dialog (see Figure 415).

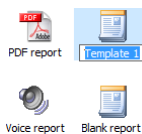


**Figure 415 – Manage templates dialog**

To create a new template, click **New template** button (see Figure 415) and enter the name of the report. **Report** dialog (24.4.3 Report editor) is then displayed for editing the new template. When done, the newly created template is automatically added into the list of templates.


To make changes to a template, select the template in the list and click **Edit** button. **Report** dialog is then displayed for editing the selected template.

To rename a template, select the template in the list, click **Rename** button and enter new name for the template (see Figure 416).



**Figure 416 – Entering a new name for a template**

### 24.4.2 Default template

One of templates can be defined as the default template to make the creation of new reports easier. When creating a new report (by clicking the **Report** button in the main toolbar), the default template is used. The default template is indicated by  symbol within the template icon.

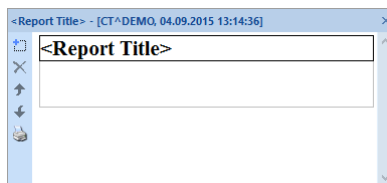
To set a template as the default template, select the template and click **Make default** button.

### 24.4.3 Report editor

TomoCon offers the possibility to create your own text structure report using the report editor. This concerns a special dialog window (see Figure 417) in which you can write a structured text. The heading of the newly created report is filled in automatically from the patient study properties.


To create a new text structure report using the report editor, click the drop-down arrow of **Report** button and choose the template from the menu.

If only one study is opened in TomoCon, the report editor opens with the patient's name in the heading. If multiple studies are opened in TomoCon, the **Select study...** dialog opens in which you can select the patient study for which the report is to be created.





**Figure 417 – Report dialog**

The report editor allows to insert texts into the text report through the text sections. A section is a separated part of texts, usually a group of sentences with the same meaning. Sections can be hierarchically arranged into a tree structure, thus allowing to write any structured information into the report.

To insert a new section into the report editor, click the  **Add new section** icon in the left toolbar of the dialog or select the **Add new section** item in the context menu of the **Report** dialog (the context menu opens by right-clicking in the dialog). A menu is then displayed with the section types that can be added to the text of the edit dialog (see Figure 418):

- **Text** - subtitle, report text
- **Container** - containing text or another container (maximum of 64 characters)

- **Concept modifier** - specification of the report heading
- **Observation context** - report information (writer, examining surgeon, etc.)
- **Property** - the physical properties of the medical findings

It is possible to move sections up and down in the report editor dialog using the **Move section up/down** arrows (icons  and .

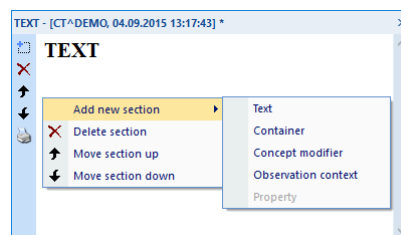



Figure 418 – Report dialog – context menu

## 24.5 Editing a report

To edit an existing report, select it from the report list by clicking on the report; then click  **Edit report** icon in the toolbar. The **Report** editor (see Figure 417) is then displayed in which you can change the content of the report.

Partially created reports can be edited at any time. When editing a completed and verified report, a new document is created with the same contents for editing. The original document will not change, and the link to the original document (Predecessor Docs) will be added to the heading of the revised version. If the original report was not loaded into the application, it is not possible to open it.

Once the report is edited, it is marked by an icon (a small red dot, see Figure 419a) in the study's report list, as well as in the report tab, when tabbed. The modification is also indicated by an asterisk after the report information in the title bar.

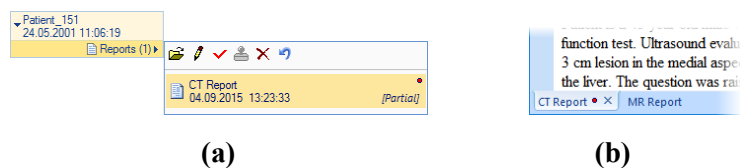

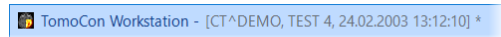


Figure 419 - Modified report indication - in the reports list (a), in the report window (b)

To revert report changes, select it from the report list by clicking on the report and click  **Revert report** icon in the toolbar. Report will be reloaded to the last saved state of the study, and all unsaved changes will be lost. Reverting newly created report will remove it from the study.

## 24.6 Saving a report

If any changes have been made to structured reports (a newly created report, a changed report status, etc.) in the opened studies, an asterisk (\*) is displayed after the study time in the title bar at the top of the main window (see Figure 420).



**Figure 420 – TomoCon title bar with asterisk**

If you want to save changes when a study is still open, press the **Ctrl+S** key combination on the keyboard or select the **Save** item in the main toolbar. The changes to the structured reports will automatically be saved in the Local studies storage. Saving reports while closing the study depends on TomoCon options, see 4.1.8 Confirmations. To send these changes from TomoCon to a PACS, select the **Send** item in the main toolbar.

## 25 Study anonymization

The TomoCon application allows to save the series of all opened studies as a new anonymized study to the Local studies. This is carried out in the **Anonymize study** dialog (see Figure 421) which is opened by selecting the **Anonymize study...** item in the **Study** menu.

Field	Value	Checked
Patient ID	123456	<input checked="" type="checkbox"/>
Patient's name	ANONYM	<input checked="" type="checkbox"/>
Patient's sex	F	<input checked="" type="checkbox"/>
Patient's birth date	19660919	<input type="checkbox"/>
Patient's age		<input type="checkbox"/>
Patient comments		<input type="checkbox"/>
Patient's address		<input checked="" type="checkbox"/>
Study date	20030224	<input checked="" type="checkbox"/>
Study time	131210	<input checked="" type="checkbox"/>
Study ID	1	<input checked="" type="checkbox"/>
Study description		<input checked="" type="checkbox"/>
Accession number	283659-02/03	<input checked="" type="checkbox"/>
Acquisition date	20030224	<input checked="" type="checkbox"/>
Acquisition time	131210	<input checked="" type="checkbox"/>
Series date	20030224	<input checked="" type="checkbox"/>
Series time	131210	<input checked="" type="checkbox"/>
Operators name		<input type="checkbox"/>
Institution name		<input type="checkbox"/>
Institution address		<input type="checkbox"/>
Performing physician's name		<input type="checkbox"/>
Referring physician's name		<input type="checkbox"/>
Admitting diagnoses description		<input checked="" type="checkbox"/>

**Figure 421 – Anonymize study dialog**

The items in the dialog are filled with DICOM data obtained from the first opened study. Check the check box next to the item you want to change. This provides access to the text box of the item. Click the **OK** button to save the new anonymized study. You can monitor the saving process in the **Saving anonymized study...** dialog.

## 26 Creating a new patient study/series

A new study or new series can be added by means of the **Select study** dialog which is displayed by selecting the **Create new series...** item in the **Study** submenu of the **TomoCon** menu (see 3.4 Main menu).

To create a new series in an existing study, proceed as follows:

1. Select the existing study for the insertion of the new series from the studies list in the **Select study** dialog (see Figure 422).
2. Click the **OK** button in the **Select study** dialog. The **New series** dialog then opens.
3. Fill the information concerning the new series into the **New series** dialog, and click the **OK** button.
4. The new series is then automatically added to the selected study.

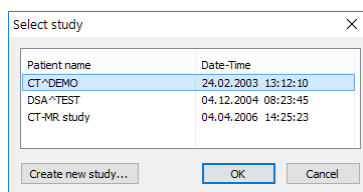


Figure 422 – Select study dialog

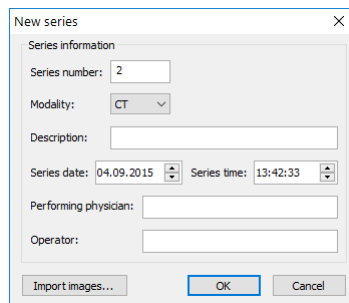


Figure 423 – New series dialog

To create a new series in a new study, proceed as follows:

1. Click the **Create new study...** button in the **Select study** dialog. The **New study** dialog then opens.
2. Fill the information concerning the new study into the **New study** dialog (see Figure 424), and click the **OK** button. The **New series** dialog then opens.
3. Fill the information concerning the new series into the **New series** dialog (see Figure 423).



4. To import the images that will be automatically inserted into the newly created series, click the **Import images...** button. Next, select the graphical files in your computer (bitmap, JPEG or TIFF files) in the displayed **Open** dialog, and click the **Open** button.
5. Click the **OK** button in the **New series** dialog.
6. The new study along with the new series will be automatically added to the local storage.

New study

Patient information

Patient ID:

Name:

Birth date:  04.09.2015  Patient's sex: Unknown

Size:  cm Weight:  kg

Admitting diagnoses:

Study information

Study ID:

Accession number:

Study description:

Study date: 04.09.2015  Study time: 13:43:22

Referring physician:

OK Cancel

**Figure 424 – New study dialog**

## 27 Archiving images (CD, local directory, USB)

Patient studies can be archived on the CD medium, local directory or USB drive by means of the **Create CD** dialog. In order to burn such data on a CD, it is necessary that one of the following requirements is met:

- Launched “Windows IMAPI” or “Windows IMAPI2” service.
- Installed Nero Burning ROM 6.3 or higher.

To open **Create CD** dialog (see Figure 425) select **Create CD...** in **Study** menu. To add currently opened studies to the prepared data set, click **Add**. To remove a study, a series or an image from the set, click **Remove** or press **Delete** on the keyboard. To remove all studies from the prepared data set click **Remove all**.

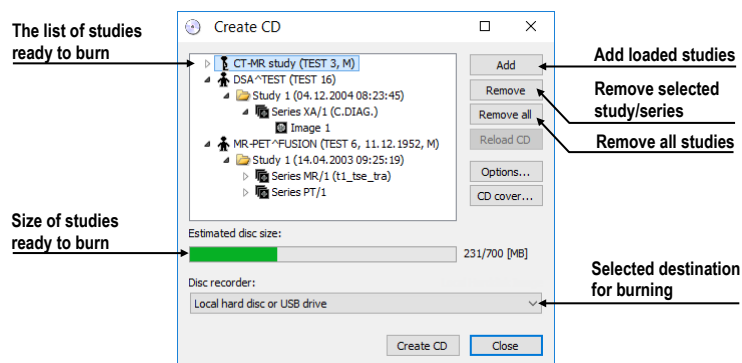
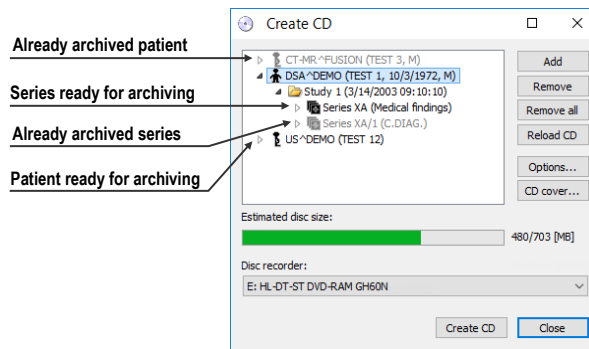


Figure 425 – Create CD dialog (studies prepared for archiving)

To store the prepared data set onto selected destination (CD or a selected directory on disc) click **Create CD**. The destination is defined using **Disc recorder** selection. When a local hard disc or a USB drive is selected, the **Select folder** dialog will be displayed before each burning process.

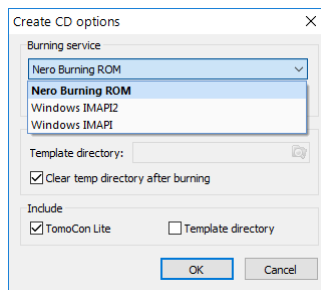
To close **Create CD** dialog click **Close**; the created data set will be retained for next archiving. When the dialog is reopened (e.g. when loading new patient data to the application), the set will be available and new studies can be added by clicking the **Add** button.

It is possible to add patient studies to a CD with previously archived patient data. After inserting a CD, the **Create CD** dialog displays the newly added studies/series along with the previously archived studies (see Figure 426); they will be gray and it is not possible to remove them from the list.



**Figure 426 – Create CD dialog (adding a study/series to a CD)**

To configure the archiving options, click the **Options...** button. The **Create CD options** dialog then opens (see Figure 427).




**Figure 427 – Create CD options dialog**

These settings can be configured in **Create CD options** dialog:

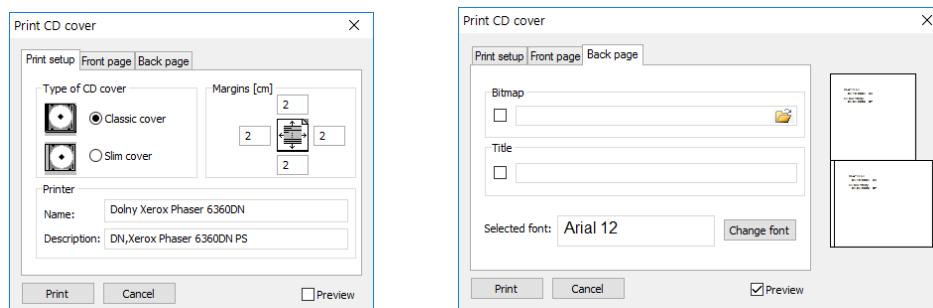
- **Burning service** - selection of the burning service type to be used for archiving on CD or DVD.
- **Maximal CD capacity** - user-specified CD capacity.
- **Template directory** - the directory that will be copied to the CD during the burning process.
- **Clear temp directory after burning** - if this option is checked, the temp dictionary serving for the temporary storage of studies prepared for archiving will be deleted after burning.
- Object types which will be archived together with studies (**Include**):
  - **TomoCon Lite** - the TomoCon Lite viewer will be added to the archive. The viewer has all TomoCon functionality except for data import. Only the DICOM image archive on the given CD can be viewed with the viewer.
  - **Template directory** - the **Template directory** will be copied to the CD.

To create and print a cover for the created CD, use the **CD cover** dialog (see Figure 428) which is opened by clicking the **CD cover...** button. The list of patients from the **Create CD** dialog is then automatically placed on the front page and the back page of the cover.

The following settings are available in the **Print CD cover** dialog:

- General settings (**Print setup** tab) - cover size settings according to selected type (**Type of CD cover**) and definition of the margins excluded from the print area (**Margins**).
- Front/back cover page settings:
  - Selecting a picture to accompany the text on the front/back page (**Bitmap**). Click the button with the  icon to select the picture, and click the check box to print the picture on the front/back page.
  - Setting up the **Title**. Use the **Change font** button to change the font size and type for the title. Click the check box to print the title on the front/back page.

In order to print the CD cover, click the **Print** button which opens the standard Microsoft Windows print dialog (the **Print** dialog). Select the printer, specify the print parameters, and click the **OK** button to initiate printing.



**Figure 428 – Print CD cover dialog, Print setup tab and Front page tab**

## 28 Mammography mode



This functionality is only available with the Mammography license in the TomoCon Workstation.

The TomoCon application provides a powerful diagnostic mode for digital mammography. Its user interface and workflow have been optimized to support experienced mammography reviewers in high-volume reading. The mammography mode offers flexible and interactive diagnostic tools that radiologists require for clarity and efficiency in their work. In particular, it provides advanced workflow and image manipulation tools with customizable and flexible hanging protocols for diagnostic images from any vendor. It is of course also possible to access the other standard diagnostic tools, such as the magnifying glass, annotations and the window/level in this mode. In combination with the predefined views for the single, double and quadruple tiling of the display, you get immediately access to all spatial information in digital mammograms.

### 28.1 Starting the mammography mode

You can activate the mammography mode in the following ways:

- Manually
  - by selecting the **Tools/Mammography mode** item in the main sub-menu.
  - by defining and using the custom shortcut (see 4.5 Keyboard shortcuts).
- Automatically by:
  - using the command line.

Lunch TomoCon by using the **/m** or **-m** command line parameter. Using this feature is recommended when you want to create a desktop shortcut for quick access to the mammography mode.
  - opening a mammography study.

Check the **Start Mammography automatically when mammography study is loaded** check box on the **Mammography** tab of the **Options** dialog (see 4.8 Mammography).

It is assumed when activating the mammography mode that the resolution of the monitors connected to the workstation is at least 3Mpx. If you have only one monitor,

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you should use the landscape monitor orientation. That stated, it is strongly recommended to use two portrait-oriented mammography monitors, both with the same resolution (3Mpx or higher). In order to use all zooming modes, you have to calibrate your monitors before beginning the diagnosing process. For an explanation about how to calibrate your monitors, see 4.7 Monitors.

## 28.2 Mammography workspace

The standard diagnostic workstation for digital mammography consists of two high-resolution monitors designated for mammography and optionally a third standard monitor for multi-modality images (MRI, US) and patient data management.

The mammography mode offers a specially designed workspace allowing to take advantage of the maximal level of available high-resolution display monitors in the dual-portrait mode (see Figure 429).

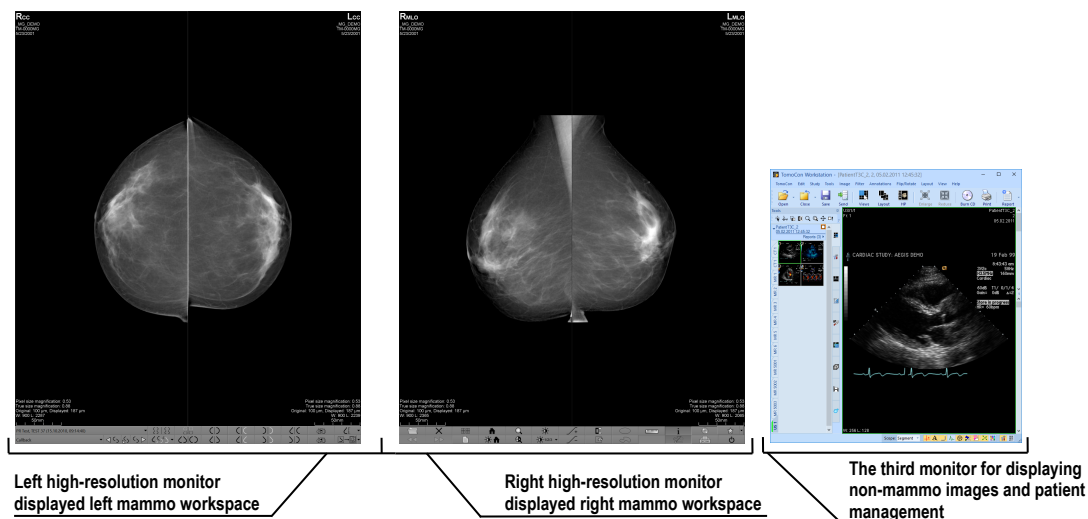


Figure 429 – Mammography workspace

The mammography workspace consists of two full-screen working areas along with the mammography toolbars that cover the entire display area of each high-resolution monitor. The toolbars are designed mainly for accelerated work with mammography image diagnosis, hangings, workflows and mammo-patient management.

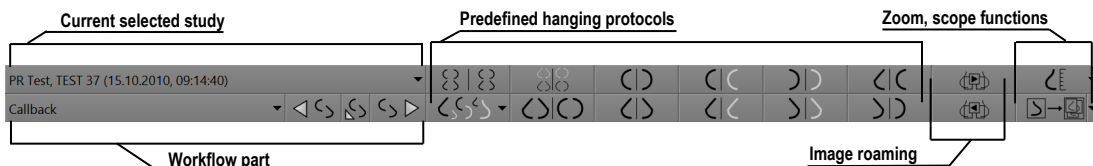
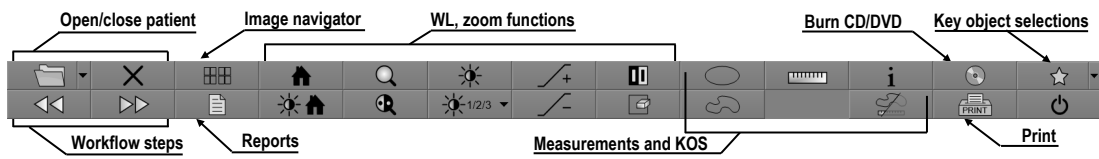


Figure 430 – Mammo toolbar on the left monitor



**Figure 431 – Mammo toolbar on the right monitor**

The two rows of toolbar buttons contain the most frequently used mammography tools. The toolbar on the left monitor offers the workflow and hanging functions (see Figure 430), while the toolbar on the right monitor contains the mammo-patient management and diagnosis tools (see Figure 431).

All mammography functionalities are accessible in the main mammography application menu. The menu is located at the top of each monitor, and is hidden by default. To display the main menu, move the cursor to the top of the monitor (see Figure 432). When you move the cursor out of the main menu area, the main menu is hidden again. For a full description of all the items in the main menu, see 3.4 Main menu.



**Figure 432 – Main mammography menu**

### 28.2.1 Working area

The working area is the visualization area of the workspace for displaying and diagnosing mammography images. The size of the mammography working area cannot be customized; it is adjusted according to the resolution of monitor.

In the mammography mode, TomoCon offers three predefined working areas with different mammography layouts that can be applied to the workspace on each monitor separately. By default, the working area consists of two non-resizable segments (layout 2x1), each with one view (see Figure 433) in which you can view and diagnose the mammography images.

To change the current working area layout, you can proceed in one of the following manners:

- Manually - using the mammo image navigator (see 28.9 Image navigator) through which you can change the division of each working area.
- Automatically - using the hanging protocol (see 28.7 Hanging protocols) through which the current layout of each working area is defined according to the hanging protocol layout.
- Automatically - using the hanging protocol defined in the current step of the selected workflow (see 28.8 Workflows).

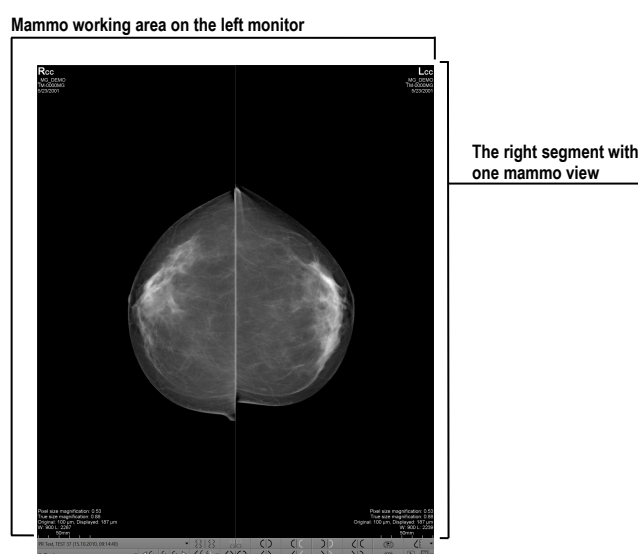



Figure 433 – Initial layout of the left workspace

### 28.3 Opening a patient study

The TomoCon application provides everything required for patient study management using the **Search studies** dialog (see 5 Managing studies). The dialog offers all of the functions needed to manage patient studies (e.g. search, open, send, receive and open patient images), to manage the worklist and to burn patient data to a CD/DVD.

To open a mammography study in the mammography mode, click the **Open study**  button in the mammography toolbar on the right monitor. The **Search studies** dialog then opens from where you can carry out the following:

- Finding and opening a required study stored in the local studies (see Figure 434) by taking the following steps:
  1. Activate the **Local studies** tab of the **Search studies** vertical tab.
  2. Define the search criteria in the **Filter** section.
  3. Click the **Search** button. The list of matched studies is then displayed in the studies list.
  4. Select the patient data, and click the **Open study** button.
- Finding and opening a required study stored in a remote DICOM device by taking the following steps:
  1. Activate the remote DICOM device tab (for example, the **PACS studies** tab).
  2. Define the search criteria in the **Filter** section.



3. Click the **Search** button. The list of matched studies is then displayed in the studies list.
  4. Select the patient data, and click the **Open study** button.
- Managing a worklist and opening patient data from a defined worklist by taking the following steps:
    1. Activate the **Worklist** vertical tab.
    2. Select the patient data from the worklist, and click the **Open study** button.

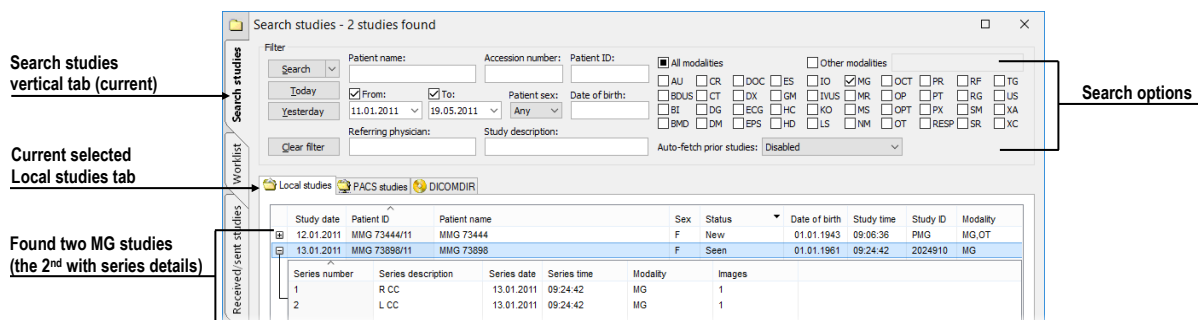


Figure 434 – Opened patient study from the Local studies

A complete description of the Search studies dialog, see chapter 5 Managing studies. To access additional tools, e.g. opening prior studies (see opening studies from the worklist or opening the next new study, click the arrow icon in **Open study** button. Then the required operation with studies can be selected from the displayed menu (see Figure 435).

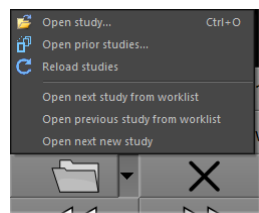
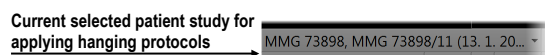


Figure 435 – Open study menu

### 28.3.1 Currently selected patient study

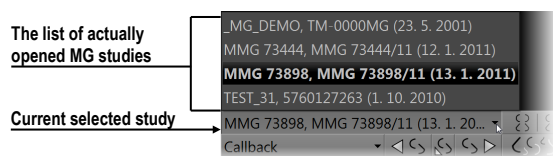
The currently selected patient study is the mammography study for which hanging protocols and workflows are applied. When a certain hanging protocol or workflow is selected, the images of this study are displayed in the mammography workspaces according to the rules defined in the hanging protocol or workflow.

The currently selected study is indicated by the study selector in the toolbar on the left monitor (see Figure 436).



**Figure 436 – Selector of current study**


To change the currently selected patient study, click the study selector in the left mammography workspace. Doing so opens the list of all opened mammography studies (see Figure 437) in which you can select a new current study.

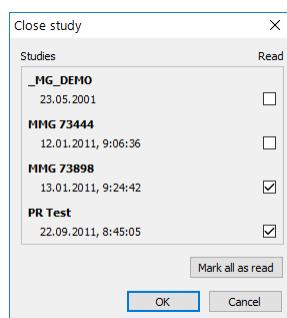


**Figure 437 – Changing of the currently selected study**

## 28.4 Closing and saving a patient study

As in the general TomoCon mode, working with opened studies in the mammography mode can be finished at any time by saving and closing them. In order to save and close opened studies, use one of the following methods:

- Select the **Close** menu item in the **Study** submenu of the main menu.
- Click the **Close currently open studies**  button in the mammography toolbar on the right monitor.
- If the currently selected workflow contains the close study function. For further information about using workflow, see 28.8 Workflows.



**Figure 438 – Close study dialog**

For mammography images, TomoCon provides with the special confirmation **Close study** dialog (see Figure 438) which is displayed automatically after the close study operation is selected. The dialog allows to confirm the saving and closing of all opened studies along with the changing of their read status.

The **Close study** dialog contains the following:

- **Study list** which contains all the studies that are to be closed. The corresponding **Read** check box appears for each study. If all images of a study have been previewed, the **Read** check box is checked.
- **Mark all as read** button serves as a shortcut for marking all studies as read.
- **Save study** check box. If studies are closed without this option activated, any potential changes will not be saved. This check box is not displayed if no study was changed during the previewing session.
- **OK** button for closing all studies according to the selected saving options.
- **Cancel** button for canceling the closing of the studies.

To cancel the **Close study** dialog display, uncheck the **Display Close study dialog when closing mammography studies** checkbox on the **Mammography** tab of the **Options** dialog (see Figure 439).

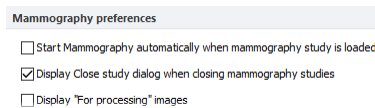



Figure 439 – The Close study dialog display setting

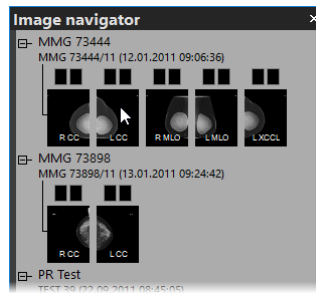
## 28.5 Displaying images

The mammography mode allows to display the images of all opened mammography studies in one of the following ways:

- The direct display of one or more image(s) using the mammography image navigator (see Figure 440) in any view of the mammography workspace. The image navigator is an additional image tool that displays the preview of all opened mammography images in the hierarchical tree, and allows to display an image of any opened mammography study in the workspace view in a very simple manner.

To display an image in the current view of the mammography workspace using the mammo image navigator, proceed as follows:

1. Click the image navigator  button in the toolbar on the right monitor. The image navigator is then displayed.
2. Expand the selected mammography study, and click the required image preview in the image navigator (see Figure 440).



**Figure 440 – Display image using the image navigator**

For a full description of mammo image navigator functionality, see 28.9 Image navigator.

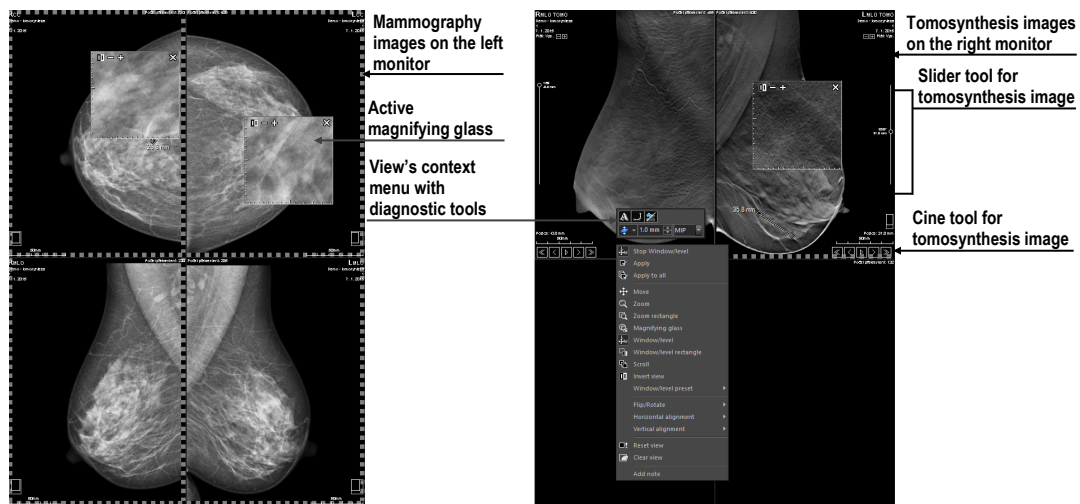
- Automatic image display adhering to defined hanging protocol rules. This option ensures that the images of the currently selected study are placed in the correct order and orientation. A hanging strategy for the display of the mammography study images is defined for each hanging protocol.

To apply a hanging protocol to the images of the current mammography study, click the button of the desired hanging protocol in the toolbar on the left monitor (see Figure 441).



**Figure 441 – Apply hanging protocol section of the toolbar**

TomoCon enables to set numerous properties and parameters for image display during the viewing and diagnosing process (see Figure 442).



**Figure 442 – Mammography working areas with displayed images**

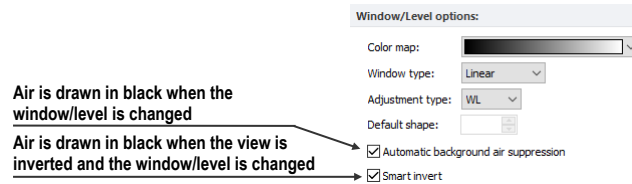
When display a mammography image, the initial settings of the following modifiable display parameters and properties are used:

- Zoom settings – defined by the image zoom factor stored with the image in the thumbnail palette
- Window/level settings – defined by the image Window/level settings stored with the image in the thumbnail palette
- Rotation and alignment settings according to the laterality and image orientation.
- Air suppression type (see 28.6 Air gap suppression in a view).

## 28.6 Air gap suppression in a view

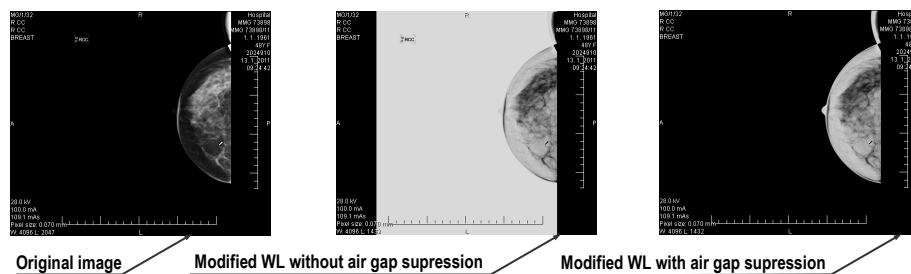
When change the window/level during examining an image, sometimes it is useful to exclude all parts of the image which are not covered by tissue, i.e. the air gap contained in the image.

TomoCon provides with support for automatic air gap suppression for images of all modalities using the settings on the **Modality** tab of the **Options** dialog (see Figure 443).



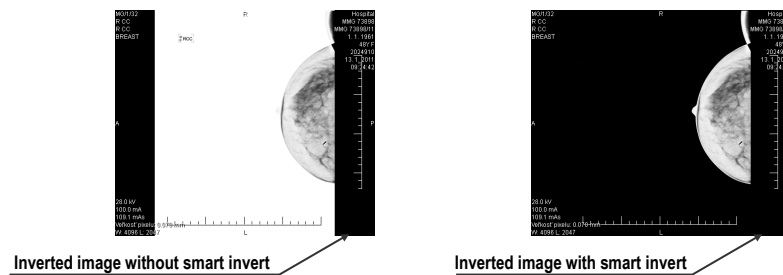
**Figure 443 – Air gap suppression settings for the selected MG modality**

If the **Automatic background air suppression** check box is checked, the air gaps in the image are always displayed in black, even when the window/level changes (see Figure 444).



**Figure 444 – Applying air gap suppression to an image**

If the **Smart invert** check box is checked and the image is displayed in the inverted mode (the **Invert** option is checked in the context menu of the view), the gaps with air remain displayed in black (i.e. they are not inverted, see Figure 445).



**Figure 445 – Applying smart invert to an image**

By default, air gap suppression with the smart invert option is set for mammography, although it is possible to change this option for a selected modality at any time on the **Modality** tab of the **Options** dialog (see 4.2 Modality options).

## 28.7 Hanging protocols

When a mammography study is opened, it can be examined applying defined mammography hanging protocols. This manner of examination ensures that all study images with a specified set of images will be displayed in the correct order in the views in the mammography mode and that each image will be placed in the correct orientation according to the preference of the respective radiologist.

A mammography hanging protocol is a hanging strategy defining how a mammography image is rotated and placed in a view. The strategy is based on the view position, the laterality, the patient orientation and other characteristics of the view. You can specify preferred image orientation for the right and left views and for the new images or the images of the prior studies to be displayed in the mammography mode.

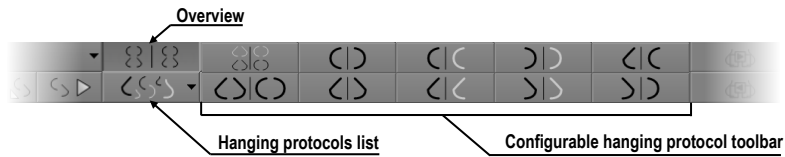
TomoCon provides with a group of predefined hanging protocols that can be used at any time during the diagnosing process (see 28.7.2 Predefined hanging protocols). You can edit the rules of each hanging protocol or define own protocols for displaying images with own preferences (see 28.7.3 Customizing hanging protocols).

To quick apply a hanging protocol, use the hanging protocol buttons in the mammography toolbar located on the left monitor (see 28.7.1 Applying a hanging protocol).

### 28.7.1 Applying a hanging protocol

For simple hanging protocol application is available the configurable hanging protocol toolbar that allows to quickly apply up to ten selected protocols. The selected protocols are mapped on the toolbar buttons, each with a preview of the

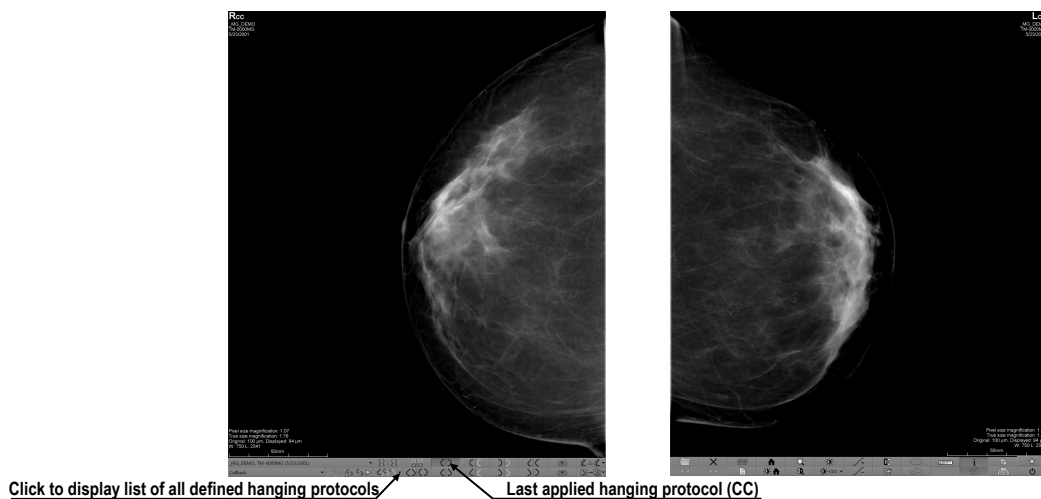
corresponding protocol. The hanging protocol toolbar is located in the mammography toolbar on the left monitor (see Figure 446).




**Figure 446 – Toolbar on the left monitor (hanging protocols section)**

To apply a hanging protocol to the images of the current mammography study, click the button of the desired hanging protocol in the hanging protocol toolbar. The button remains pressed and the protocol mapped on the button applies to the current mammography study and workspace; each image that adheres to the protocol view rules (laterality, orientation) is rotated according to the protocol and is displayed in the relevant view (see Figure 447). The views without matching images remain empty.

The configuration of the hanging protocol toolbar depends on the currently selected workflow. The workflows allow to carry out all desired diagnostic steps using the predefined workflows and the corresponding hanging protocols. For each workflow, own configuration of the hanging protocols toolbar can be defined in a very simple manner on the **Mammography workflow** tab of the **Options** dialog (see 28.8 Workflows). The TomoCon application supplies seven predefined workflows, each with some predefined hanging protocols. For a complete description of the workflow functionality, see 28.8 Workflows.



**Figure 447 – Applied CC hanging protocol**

If a hanging protocol is not selectable in the hanging protocols toolbar, the list of all defined hanging protocols is available. To display the hanging protocol list, click the  button in the mammography toolbar on the left monitor. The drop-down menu is then displayed (see Figure 448) containing all defined hanging protocols, each of

which is represented by the name and the preview. To apply a hanging protocol from the displayed list, select the corresponding item in the list.

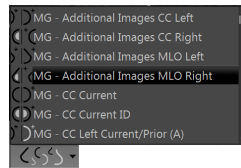


Figure 448 – Hanging protocols list







## 28.7.2 Predefined hanging protocols

The TomoCon application provides with a group of predefined hanging protocols for mammography images, allowing to display images in the correct order and orientation. To manage all predefined hanging protocols, use the **Hanging protocol manager** dialog which is displayed by selecting the **Hanging protocol manager...** item in the **Layout** main menu (see 3.4 Main menu). The ten most often used protocols of the group of predefined hanging protocols are initially selected in the configurable hanging protocol toolbar (see Figure 449) which is permanently located in the mammography toolbar on the left monitor. If a patient study contains only standard images (i.e. up to ten images with MLO and CC left and right, the prior and current images), it is possible to use the protocols from this toolbar to display all lateralities at a glance or easily switch to different tailings. Otherwise, if the initially selected protocols in the hanging protocol toolbar do not meet requirements, it is possible to configure the toolbar content on the **Mammography workflow** tab of the **Options** dialog (see 28.8.2 Workflow properties).







Figure 449 – Configurable hanging protocol toolbar (initial state)

By default, the hanging protocol toolbar offers the following buttons for displaying various combinations of mammography images:

-  – the CC and MLO images with priors
-  – the CC and MLO images
-  – the CC images
-  – the MLO images
-  – the right CC image with prior
-  – the right MLO image with prior



-  – the left CC image with prior
-  – the left MLO image with prior
-  – the right MLO image and the right CC image
-  – the left MLO image and the left CC image

### 28.7.3 Customizing hanging protocols

For the immediate display of mammography images, predefined or customized hanging protocols are available. For customized protocols, it is possible to define preferred properties using the simple editor of mammography hanging protocols (the **Hanging protocol properties** dialog) where all the parameters of a selected protocol can be defined.

Each defined mammography hanging protocol must meet the following conditions:

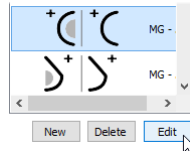
- The hanging protocol contains two workspaces (for two monitors).
- Each working area can only be divided into 1x1, 2x1 or 2x2 segments, each with one view.
- Each working area view can display only a mammography modality image (not reconstruction, 3D, etc.).

To create a new hanging protocol for mammography using the **Hanging protocol properties** dialog, choose from the following options:

- Click the **New** button on the **Mammography workflow** tab of the **Options** dialog,
- or proceed as follows:
  1. Select the **Layout/Hanging protocol manager...** item in the main menu.
  2. Click the **New...** button in the displayed **Hanging protocol manager** dialog and select the layout for the protocol in the displayed popup menu. The **Hanging protocol properties** dialog is then displayed in which all properties of each protocol type is possible to set, not only the one for mammography (see 8.3 Manually creating and modifying a hanging protocol).
  3. Click the **Mammography** button to specify the particular mammography properties of the new protocol. The **Mammography** button is enabled only for layout with two monitors.

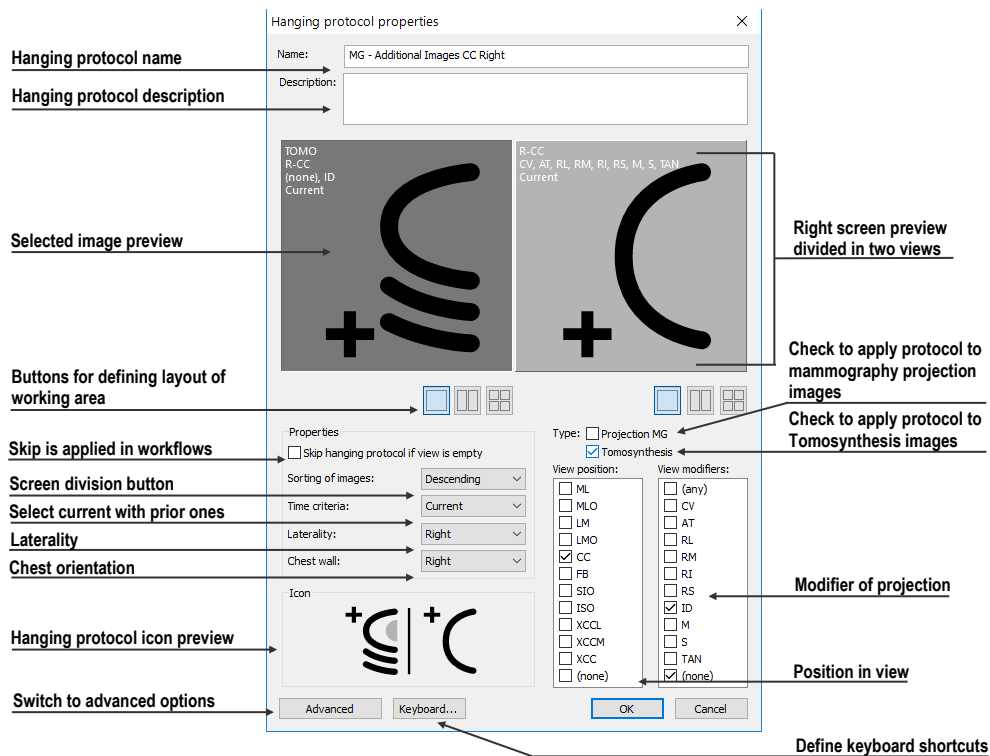
To edit an existing hanging protocol using the **Hanging protocol properties** dialog for mammography, proceed as follows:

- Select the hanging protocol in the list of all protocols on the **Mammography workflow** tab of the **Options** dialog, and click the **Edit** button (see Figure 450).



**Figure 450 – Editing a selected hanging protocol**

- Alternatively, select the **Hanging protocol manager...** item in the **Layout** menu to open the **Hanging protocol manager** dialog in which you select the protocol, and click the **Edit...** button.



**Figure 451 – Hanging protocol properties dialog for mammography**

In the **Hanging protocol properties** dialog (see Figure 452) for mammography, it is possible to set the following parameters for a mammography hanging protocol according to preferences:

- **Name** – the name of the hanging protocol.
- **Description** – a detailed description of the hanging protocol.

- **Screen previews** – clickable previews of the left and right working areas; for each selected preview, you can define differing properties that are graphically displayed in the preview.
- **Layout buttons** – buttons allowing to divide each working area into one, two or four segments, each with one view.
- **Skip hanging protocol if view is empty** – if this check box is checked and no image from the study meets the conditions of the hanging protocol, the workflow skips this hanging protocol and the next step is applied.
- **Sorting of images** – this defines the order of the images selected from the study to the view.
- **Time criteria** – this defines whether the view displays only the current image or priors or both (current, all priors, 1<sup>st</sup> prior, 2<sup>nd</sup> prior, etc.).
- **Chest wall** – the chest orientation (left, right, undefined).
- **Icon** – the icon displayed in the hanging protocol list and in the toolbar.
- **View position** – the type of the image position displayed in the view.
- **View modifiers** – modifiers applied to the projection of the image.

#### 28.7.4 Overview

The arrangement showing all mammography images of a standard mammography study is called an overview. The images in an overview are displayed in the views on both monitors, from the upper left view on the left monitor to the lower right view on the right monitor (see Figure 452). Each workspace in an overview contains 1, 2 or 4 views which depends on the number of images in the study. If a study contains more than 8 images, the image iterator is added to the last view (the lower right view on the right monitor). To view the next images in the study, click the image iterator (see Figure 453).

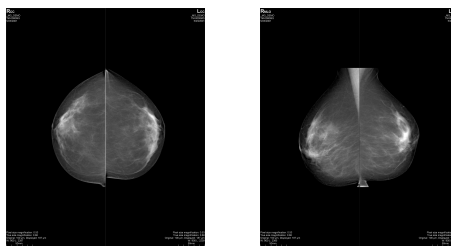


Figure 452 – Overview of a study containing 4 images

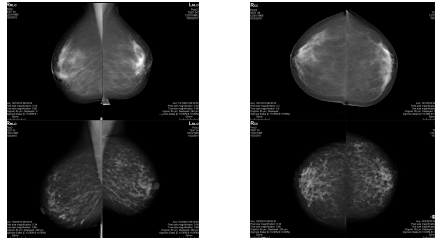


Figure 453 – Overview of a study containing more than 8 images

To activate the overview in the mammography mode, click the **Overview** button in the toolbar on the left monitor.



### 28.7.5 Image selector

When a hanging protocol is applied in the mammography mode and multiple images from the mammography study meet the criteria for view display, the image selector control is displayed in the lower left-hand corner of the view (see Figure 454). The image selector allows to navigate within an entire image set and to display each image from this set in descending or ascending order as defined in the hanging protocol.

The image selector is displayed in the view as a special information text whose position or visibility can be set on the **View texts** tab of the **Options** dialog (see 4.3 View texts). It consists of the following:

- **Navigating arrows** ◀▶ for navigating forward and backward within the image set.
- **Image order indicator** 1/3 which indicate the part of the image set that is currently being displayed in the view.

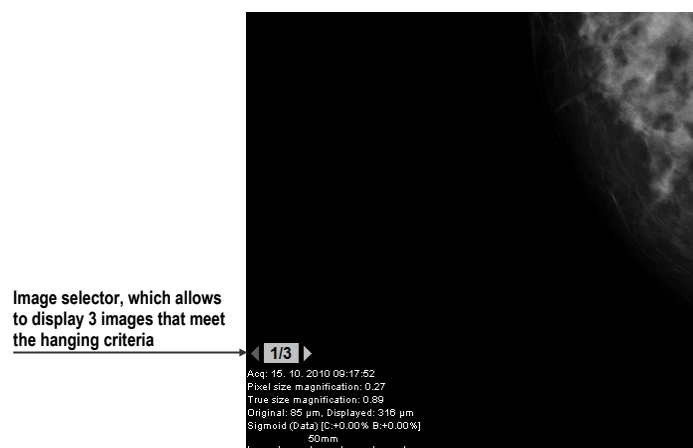


Figure 454 – Image view with image selector

## 28.8 Workflows

A workflow is a group of predefined hanging protocols and other functions (closing studies, closing the image navigator, etc.) which can be applied at any time during the diagnosing process to the currently opened study. A workflow allows to fully automate the process of study viewing. Using a workflow, it is possible to display all study mammography images step by step according to viewing preferences.

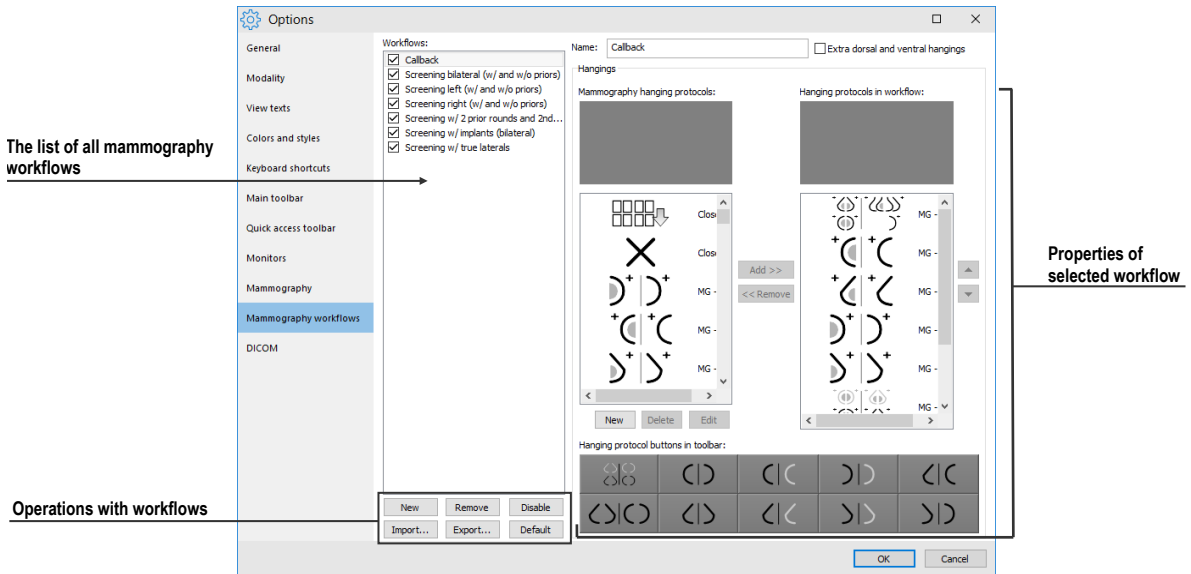


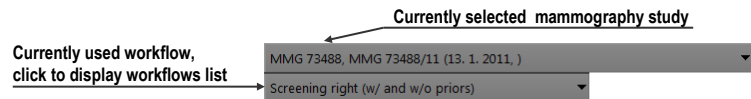
Figure 455 – Mammography workflows tab

In addition to the possibility of creating own customized workflows, TomoCon supplies with a group of predefined (the most recently used) workflows that make work with mammography studies easier immediately after the first launch of TomoCon. For easier management of all defined workflows, TomoCon offers a management which is available on the **Mammography workflows** tab of the **Options** dialog (see

Figure 455).

### 28.8.1 Applying a workflow




Each selected workflow is applied step by step to the currently opened study. All predefined workflows remain available in the mammography mode through the combo box located in the mammography toolbar on the left monitor (see Figure 456). When you activate the mammography mode, the default selected workflow is the most recently selected workflow (or the first one if you are using workflows for the first time).

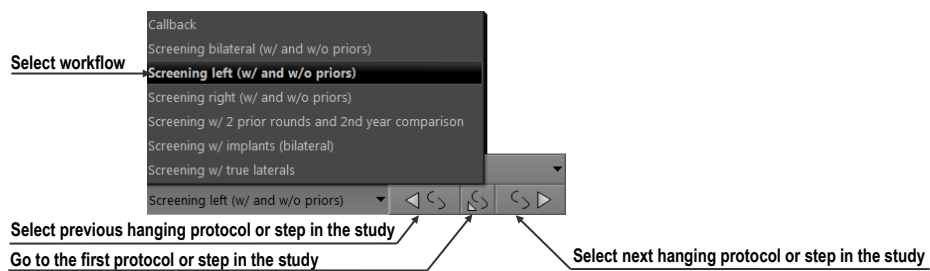


**Figure 456 – Selecting the current study and workflow in the mammography mode**

After selection a workflow in the mammography mode, all hanging protocols and the workflow subsequent functional steps can be applied simply by clicking the navigation buttons (see Figure 457).

To apply hanging protocols or functional steps of a mammography workflow to the currently selected study, proceed as follows:

1. Select the required mammography workflow in the combo box.
2. Navigate linearly step-by-step through the selected workflow as follows:
  - Proceed to the subsequent step in the selected workflow by clicking the **Select next hanging protocol in workflow** button  until the last step of the workflow is carried out.
  - Click the **Select previous hanging protocol in workflow** button  to return to the previous step until the first step of the workflow is carried out.
  - Click the **Set first hanging protocol in workflow** button  to return to the first step of a workflow at any time.
  - You can deviate from the current workflow by initiating another function in TomoCon (e.g. another hanging protocol) at any time. TomoCon stores the current position, and proceeds with the next step after clicking the **Select next hanging protocol in workflow** button again.



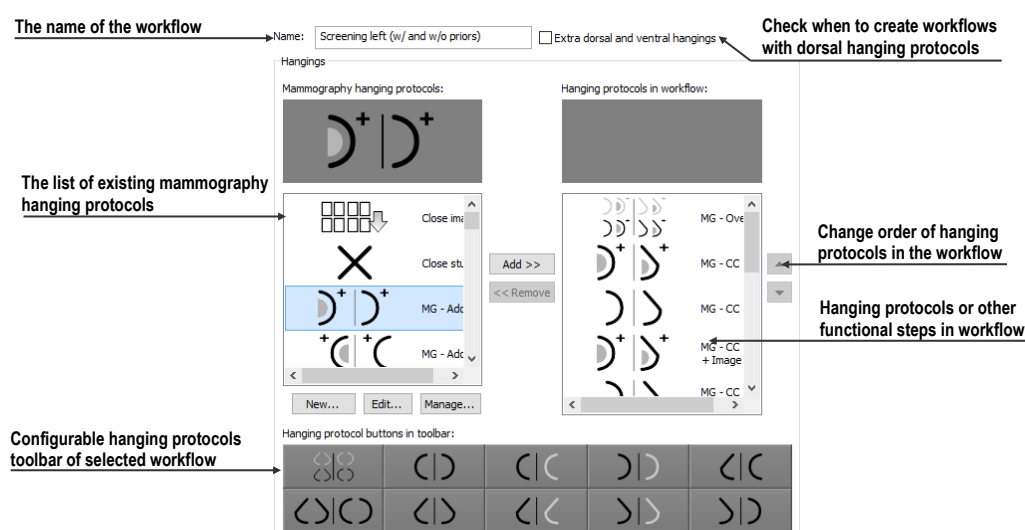
**Figure 457 – Navigating in a selected workflow**

If a hanging protocol in a workflow cannot be applied to the currently selected study (e.g. due to improper image orientation), then the corresponding view in the workspace remains empty. This default behavior can be changed by setting the **Skip hanging protocol if the view is empty** parameter in the hanging protocol properties (see 28.7.3 Customizing hanging protocols). If the parameter is set, hanging protocols that display empty views are skipped.

## 28.8.2 Workflow properties

A workflow consists of a list of the hanging protocols and the subsequent operations which help simplify work. These protocols are applied, and the operations are carried out in a strictly defined order in the workflow, and are always applied to the currently opened study. TomoCon also allows to define all workflow properties including the buttons of the configurable hanging protocol toolbar displayed on the left monitor.

To display or edit the workflow properties, select the mammography workflow from the list on the **Mammography workflows** tab of the **Options** dialog (see 4.9 Mammography workflows). The properties of the selected workflow are then displayed on the right-hand side of the tab (see Figure 458).




**Figure 458 – Mammography workflow properties**

The displayed workflow properties on the **Mammography workflows** tab allow to carry out the following operations:

- Changing the workflow name in the **Name** text box.
- Creating dorsal workflows if the **Extra dorsal and ventral hangings** check box is checked. A new tab will be added for the dorsal hanging protocols.
- Modifying a workflow. You can add and remove hanging protocols or other functional steps included in a workflow using the **Mammography hanging protocols** list (which contains the available protocols and functions) and the **Hanging protocols in workflow** list (which contains the content of the workflow). To do so, use the **Add>>** and **Remove<<** buttons or the drag-and-drop technique to move items from one list to the other.

- Reordering the hanging protocols or other functional steps in the **Hanging protocols in workflow** list using the up and down arrow buttons.
- Modifying previously defined mammography hanging protocols displayed in the **Mammography hanging protocols** list. If you select a required protocol and then click the **New** or **Edit** button, the **Hanging protocol properties** dialog will then be displayed in which you can change the properties. Clicking the **Delete** button removes the selected hanging protocol. For detailed information concerning the hanging protocol properties, see 28.7.3 Customizing hanging protocols.
- Customizing the configurable hanging protocol toolbar. You can choose the hanging protocols to be used as shortcut buttons in the toolbar using the drag-and-drop technique between the **Mammography hanging protocols** list and the **Toolbars buttons** list. For a detailed description, see 28.7.3 Customizing hanging protocols.

## 28.9 Image navigator

Additional possibilities exist for displaying an image in the mammography mode. You can use the predefined or customized workflows and hanging protocols, but you also can use another image tool called the Image navigator. This tool is integrated in the floating window in the mammography mode, and is accessible by clicking the image navigator  button in the mammography toolbar on the right screen (see Figure 459).



**Figure 459 – Displaying the Image Navigator window**

The basic functionality of the image navigator is to display a comprehensive list of the previews of all opened mammography images. Moreover, the image navigator provides with the following advanced functionalities:

- Displaying an arbitrary mammography image in an arbitrary view using the select and place method.
- Identifying the current placement of the workspaces including the displayed images in the views.
- Changing the layout of the working areas.
- Identifying the read status of each image to check whether it has been displayed or not.



The image navigator window (see Figure 460) consists of two basic parts: the studies list (see 28.9.2 Studies list in the image navigator) and the screen layout (see 28.9.3 Screen layouts in the image navigator). The study overview displays the ordered list of all opened mammography images (a tree list containing the series and images) which can be displayed in the views on the left and right screens of the monitors. Graphical symbols identifies the currently displayed images. The screen layout allows to divide the layout of each workspace into one, two or four segments.

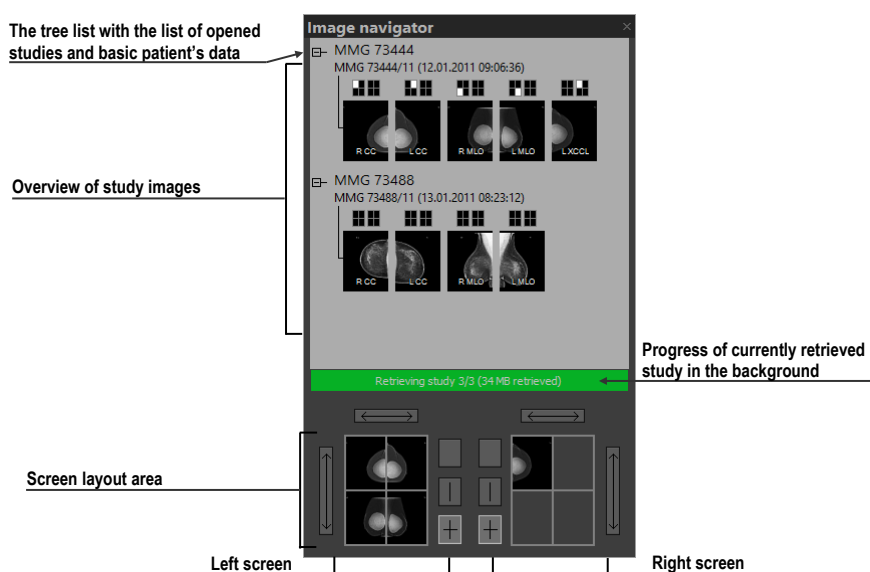









Figure 460 – Image navigator

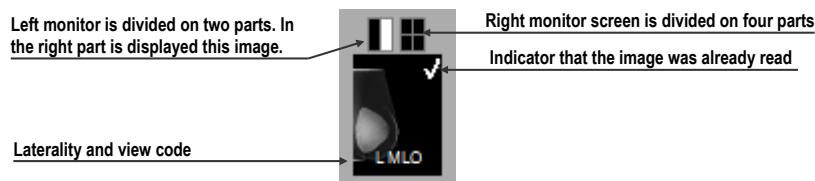
### 28.9.1 Opening and closing the image navigator

To open the image navigator window, click the image navigator  button in the mammography toolbar on the right monitor. The image navigator window (see Figure 460) is displayed in the same position where it was last closed. The displaying of the image navigator window can also be scheduled as a separate workflow step. To close the image navigator, click the close  button or the image navigator  button in the mammography toolbar.

### 28.9.2 Studies list in the image navigator

The studies list is the graphical tree list control in the image navigator containing the mammography images of all opened studies. Each opened mammography study is displayed in a separate tree node which can be collapsed or expanded. To collapse a node, click the minus  symbol; to expand it, click the plus  symbol. This allows to display only images that you need. Each tree item (see Figure 461) consists of the following parts:

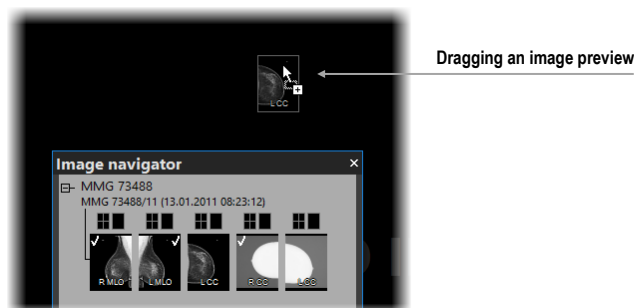
- **Screen position indicator**  identifies the displayed image in the view in the workspace. Each workspace (on the left monitor and right monitor) is displayed as a rectangle which is proportionally divided according to its current layout. The current placement of the image is highlighted in white.
- **Information text about image orientation** **R MLO** describes the laterality view code of the mammography image.
- **Read mark indicator**  indicates whether the image has been displayed in any view in the mammography mode.



**Figure 461 – The image preview item of the image navigator**

The image navigator allows to place images directly into the views in the workspaces without applying a hanging protocol. To display a selected image in the studies list, proceed in one of the following ways:

- Use the drag-and-drop technique to drag the image from the study overview to the view in the workspace on the left or right monitor (see Figure 462).



**Figure 462 – Dragging an image from the study preview to the screen**

- Use the drag-and-drop technique to drag the image to the screen preview in the screen layout area in the image navigator (see Figure 463). The image is displayed in the appropriate view in the workspace on the left or right monitor.



**Figure 463 – Dragging an image from the study preview to the layout area**

- Click the desired rectangle in the screen position indicator representing the view in the working area (see Figure 464). The image is displayed in the appropriate view in the workspace on the left or right monitor.

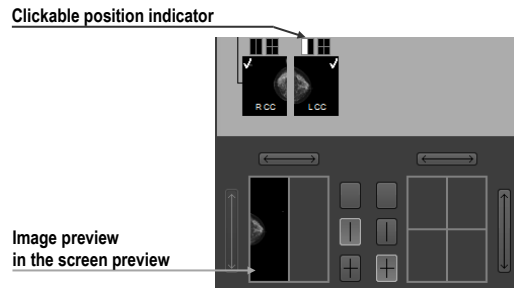


Figure 464 – Selecting an image to view using the rectangle indicator

### 28.9.3 Screen layouts in the image navigator

The screen layout area of the image navigator (see Figure 465) displays the screen previews of both monitors, and allows to set the workspaces on the left or right monitor to one view or to divide them into two or four equally sized views and to toggle the views of the same workspace.

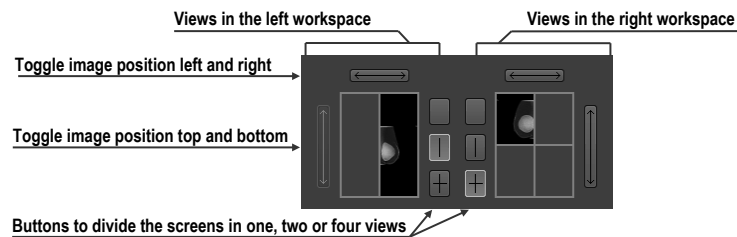


Figure 465 – Screen layout section of the image navigator

### 28.9.4 Image order

All displayed studies and their images are sorted in the image navigator according to predefined rules. The order of all items displayed in the studies list part is defined according to the following rules, from the lowest level to the highest level:

- By laterality and orientation of images – the images are ordered in groups by view position (default is CC before ML) and by laterality (default is right before left) within the groups; from the left RCC, LCC, RML, LML, etc.
- By image type – the images designated for presentation are displayed prior to the images designated for processing.
- By date and time of study – the ordering is from the newest study to the oldest study.

The default sorting order of the images in the image navigator can be changed (see Figure 466) by adjusting the **Reverse view order** parameter on the **Mammography** tab of the **Options** dialog. This parameter allows to change the order of the laterality and orientation (ML on the left and laterality left before right). You can also turn off the display of images of the “for processing” type. For a detailed description of the image navigator settings, see 4.8 Mammography.

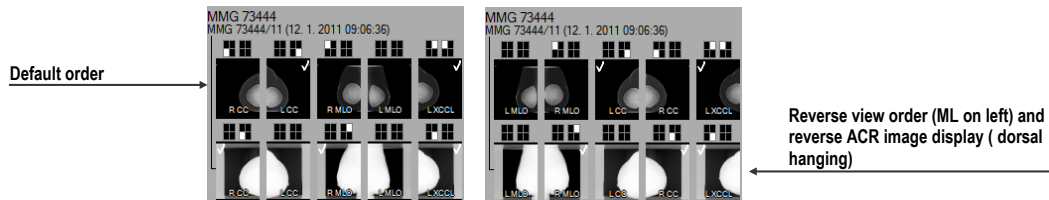


Figure 466 – Changing the order of images when changing the sorting order

## 28.10 Manipulating images

With respect to the nature of mammography, it is not possible to carry out operations related to volume, such as cutlines, DRR, MIP, MPR, 3D, ROIs, etc. However, it is possible in the mammography mode to carry out the main image operations that allow to perform full mammography diagnosis using mammography studies.

Unlike the general mode, the mammography mode does not provide tool dialogs for such operations. All the operations are accessible in the main menu or the view context menu. On the other hand, the mammography mode provides with the possibility to quickly activate the most frequently used operations using the buttons in the mammography toolbar (see Figure 467).





Figure 467 – Image operations section in the mammography toolbar

The following image manipulation operations can be carried out using the buttons available in the mammography toolbar:

- Changing the window/level settings
- Applying the WL presets
- Inverting a view
- Applying gamma correction
- Using the advanced magnifying glass

The character of the work in the mammography mode does not require the altering of various scope limits (segment, series or study). However, it is possible to apply the changes carried out using these operations (WL, invert, etc.) in the currently selected

view to other images in the mammography mode by clicking the **Scope**  button in the mammography toolbar (see 28.10.3 Applying window/level and zoom changes). If you wish to limit the effects of the changes only to the selected view, turn off the Scope mode by deactivating the **Scope** button.


All changes carried out in the view using these operations (window, level, invert, zoom, etc.) can be discarded at any time by clicking the **Reset...**  button in the mammography toolbar.

### 28.10.1 Window and level manipulations


Any change made to the window/level settings is immediately applied to the selected view or to other views according to scope setting (see 28.10.3 Applying window/level and zoom changes).

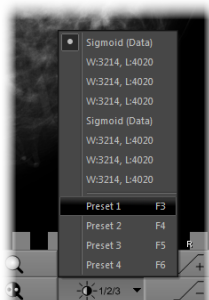
To change the window/level settings of displayed mammography images, use one of the following methods:

- Adjusting the window/level values with the mouse.

To activate the window level function, click the **Window/level**  button in the mammography toolbar. Next, press and hold down the mouse button, and move the cursor to change the window and level values (see 7.1.8 Adjusting window/level using the mouse).

- Applying a predefined window/level preset.

To select a preset, click the presets  button. The drop-down menu (see Figure 468) of all predefined applicable window/level presets then opens in which you can select the desired preset. The preset is then immediately applied.





**Figure 468 – Displayed window level presets drop-down menu**

- Inverting the current color palette in the image.

To apply inversion, click the **Invert**  button in the mammography toolbar.

- Increasing or decreasing the gamma correction factor.

It is not possible to change the palette graduation type or shape in the mammography mode. However, you can refine an image by adjusting the gamma correction factor which can be increased or decreased by the 0.1 constant. Click the  button to increase it, or click the  button to decrease it. The minimum value you can set for the gamma factor is 1/2.5; the maximum is 2.5. The current value of the gamma correction factor as part of the window/level string is displayed in the view text (see Figure 469).

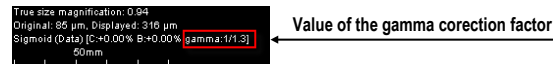




Figure 469 – The gamma value in the view text

Any changes made to the window, level or contrast values can be discarded at any time by clicking the **Reset window/level**  button in the mammography toolbar.

## 28.10.2 Zooming an image

The current view zoom factor in the mammography mode can be changed using the zoom function or the zoom rectangle function. Function activation is carried out by selecting the **Zoom** item or the **Zoom rectangle** item in the view context menu or in the **Image** submenu of the main menu. Next, move the cursor within the current view while holding down the action mouse button. Alternatively, the zoom factor can be changed by scrolling the mouse wheel while holding down the **Ctrl** key. For a full description of image zooming, see 7.2 Zooming an image.

The mammography mode supports four zoom modes. The currently selected zoom mode (which alternates the interpretation of the zoom factor) can be changed by clicking the **Zoom mode**  button in the mammography toolbar. The zoom mode menu then opens (see Figure 470) in which you can choose a new zoom mode.

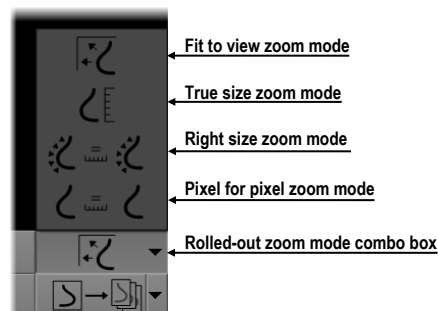
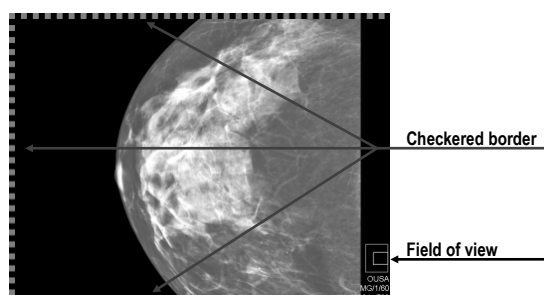


Figure 470 – Available zoom modes in the mammography mode

It can happen that after changing the current zoom mode or the zoom factor or moving the image, a certain part of the image will no longer be visible in the view. In the

mammography mode, there are two different ways in which you can be informed about not viewing an entire mammography image:


- The appearance of a checkered border which can be activated/deactivated by checking/unchecking the **Show checkered border when the entire image is not displayed** check box on the **Mammography** tab of the **Options** dialog (see 4.8 Mammography). If the check box is checked, the part of the image that is not visible within the view is indicated by a checkered border on the corresponding edge of the view (see Figure 471).



**Figure 471 – Only part of the image is visible within the view**

- The field of view indicator which is a special view text item available only in the mammography mode. Two rectangular areas show the part of the mammography image displayed in the view. However, if you see the entire image, the field of view indicator is not displayed. You can change the default appearance of the field of view indicator (the **Colors** tab) and the position (the **View texts** tab) within the view in the **Options** dialog (see 4.1 General options).

### 28.10.3 Applying window/level and zoom changes

The zoom and window/level changes in the current view can be applied automatically to a selected range of displayed images according to the limit selected in the **Scope** button in the mammography toolbar on the left monitor. You can make the changes applicable to a study (after selecting the **Apply changes to study** scope limit), or you can apply the changes to all views in all working areas (after selecting the **Apply changes to all** scope limit) by pressing the  button (see Figure 472).

To apply the window/level and zoom changes according to the selected scope limit, click the **Scope** button (see Figure 472). To disable the application of these changes to other views in all working areas, deactivate the **Scope** button.

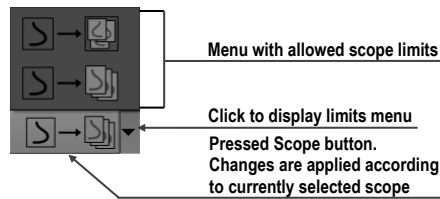




Figure 472 – The Scope button with the scope limits menu

#### 28.10.4 Magnifying glass

The magnifying glass allows to zoom an area of interest within a small, separate magnification window. The current zoom factor of the magnifying glass defines how the selected image part is magnified compared to the image in the view. The position of the magnifying glass in the view defines the current magnified area. As a result, when you move the magnifying glass, the magnified image part displayed in the magnifying glass is automatically updated.

To display the magnifying glass in the view, click the **Magnifying glass**  button in the mammography toolbar on the right monitor (or the **Magnifying glass – inverted**  button). Next, click in the view to place the magnifying glass (see Figure 473). When the mouse button is released, the magnifying glass remains displayed in the view and another magnifying glass can be set in another view.

A displayed magnifying glass behaves as part of the view. As a result, any operation carried out in the view (zooming, moving, adjusting the WL, changing the measurement, etc.) is applied to the zoomed part of the image in the magnifying glass as well.

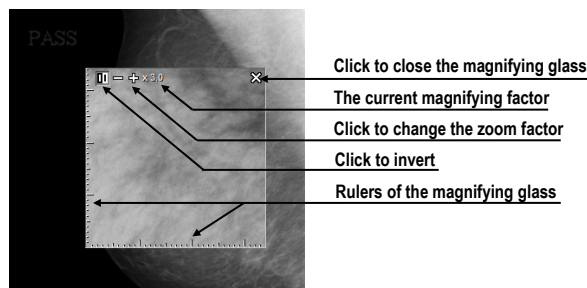




Figure 473 – Inverted magnifying glass with 3x zoom factor

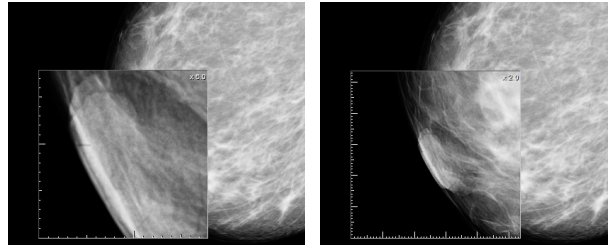
To change the position of a displayed magnifying glass, select the magnifying glass function (by clicking the  or  button) and click in the view to define the new position. You also can hold down the mouse button and move the cursor to the desired position.

To change the zoom factor, click in the magnifying glass window, press and hold down the **Ctrl** key and scroll the mouse wheel. It is possible to set a zoom factor of up




to 8. The current zoom factor of the magnifying glass is displayed in the upper right-hand corner of the magnification window (see Figure 474).

To close the magnifying glass window, double-click it or click the button in the upper right-hand corner of the magnifying glass window (the ✖ icon).






(a) (b)  
**Figure 474 – The magnifying glass in the view - magnifying 6x (a), and 2x (b)**

To invert the zoomed image in the displayed magnifying glass window (see Figure 474b), press the **Tab** key or click the invert button in the upper left-hand corner of the magnifying glass window (the  icon). To turn off the invert mode, press the **Tab** key again.

## 28.11 Image roaming

For the diagnosis of mammography images, a very detailed examination is required. This can be done by using the zoom function or the magnifying glass manually or, alternatively, you can use the image roaming method. This method allows to automatically proceed step by step through the entire mammography image in the defined resolution. The image is divided into several non-overlapping (except for the image border) rectangular sub-regions. Using image roaming, these image parts are sequentially set into the view in ascending or descending order. After proceeding through all of them, it is guaranteed that the entire mammography-related image area is being previewed.

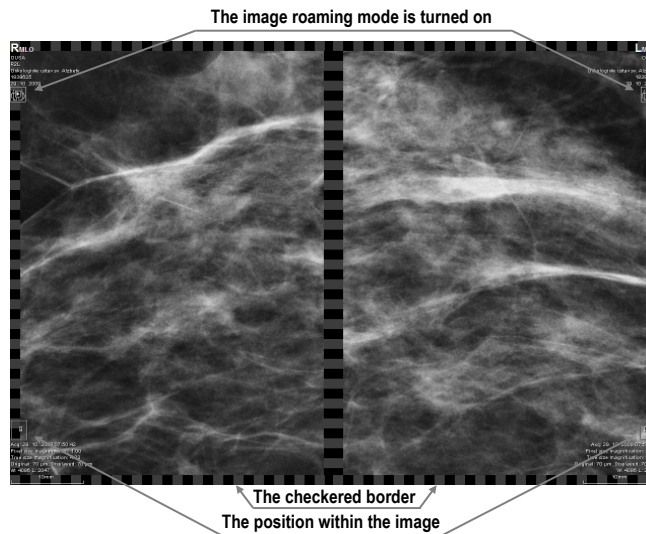
To initiate image roaming, click the **Next image roaming**  button or the **Previous image roaming**  button. The image roaming mode is then activated and the first image sub-region is displayed within the views (see Figure 475). This mode is not bound only to the selected view, but rather to all views in the mammography mode. As a result, this simultaneously changes the image sub-regions in all views.

To go forward, click the **Next image roaming** button .

To go backward, click the **Previous image roaming** button .

When in the image roaming mode, you can skip to the first image roaming sub-region at any time when you reset the view. Additionally, when you place a different image

into the view while in the image roaming mode, this mode is preserved and the view displays the first image roaming sub-region.



**Figure 475 – Image roaming turned on**

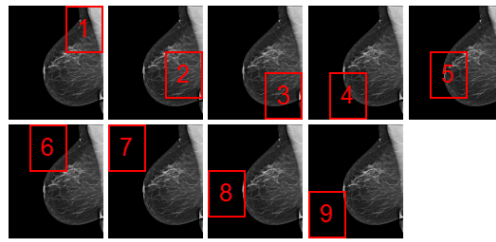
When image roaming is active, any of the image functions (WL, zoom, move, magnifying glass, etc.) can be used. If, when using such a function, a change is made to the position or size of a sub-region of the displayed image, the image roaming mode is canceled. To return to the image roaming mode, click the **Next image roaming** or **Previous image roaming** button again.

### 28.11.1 Image roaming sub-regions

The size, the position and the order of the image roaming sub-regions are determined by certain factors, such as the image and view size, the image laterality and orientation and the roaming zoom mode.

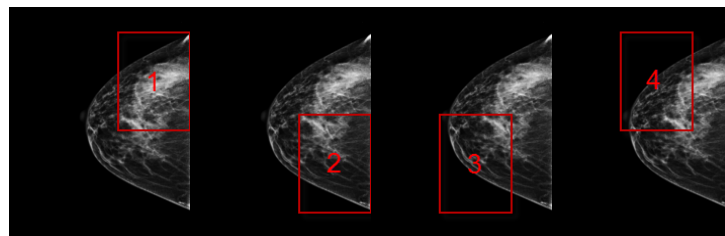
The Pixel for pixel zoom mode or the Right size zoom mode (with a scale factor) can be used for the computation of the image roaming sub-region size. You can toggle between these two options by selecting the **Pixel for pixel** option or the **Right size zoom** option (with the **Scale factor**) on the **Mammography** tab of the **Options** dialog (see 4.8 Mammography). The sub-regions size is then set according to the selected zoom mode.

The mammography image orientation and laterality determine the order of the sub-regions. The first sub-region is always the image's upper chest wall corner after which the sub-regions are ordered so that they continuously follow one another until the lower against-chest wall corner is reached (Figure 476).



**Figure 476 – The order of image roaming regions (image with right laterality)**

In certain mammography images, the air or non-tissue area can be defined. When previewing such images in image roaming, it is possible to skip such air areas by checking the **Exclude empty area from the image roaming** option on the **Mammography** tab of the **Options** dialog (see 4.8 Mammography). In this manner, the number of steps required to preview an entire image can be significantly reduced (see Figure 477).

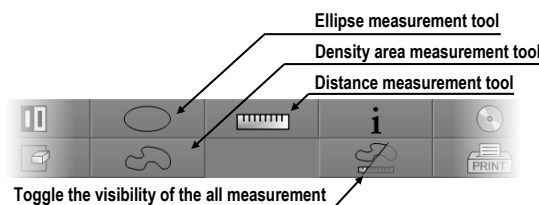


**Figure 477 – Image roaming sub-regions not covering air area**

## 28.12 Measurements




The mammography mode offers the possibility to mark and describe the image details using the measurements in the same way as in the general mode of TomoCon. Because the mammography mode does not support tool dialogs, the only way to activate and use all the measurement types is using the **Annotations** menu in the main menu of the mammography mode.


However, the most frequently used measurements in the mammography mode (ellipse, density area, distance) are accessible in the measurements section of the mammography toolbar on the right monitor (see Figure 478).



**Figure 478 – Measurement tools section of the mammography toolbar**

The following buttons are available for measurement activation:

- Clicking the **Ellipse**  button activates the ellipse measurement (see 9.10 Ellipse).
- Clicking the **Density area**  button activates the density area measurement (see 9.12 Free area).
- Clicking the **Distance**  button activates the distance measurement (see 9.5 Distance)

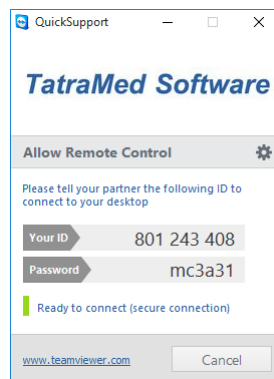
The  button in the measurements part of the mammography toolbar allows to toggle the visibility of all defined measurements within all views.

## 29 Quick support

TeamViewer QuickSupport is a tool of the TomoCon application used to provide remote computer assistance.

To activate QuickSupport in TomoCon, proceed as follows:

1. Select the **QuickSupport** item in the main submenu **Help**.
2. The **QuickSupport** dialog with ID and password is displayed (see Figure 479).
3. Call the TatraMed Software customer support center (see 30 Contact).
4. Provide your ID and password to the customer support who will then work to resolve your problem. You can monitor the work that the Support Center operator is carrying out on your computer.



**Figure 479 – TeamViewer QuickSupport with your ID and password**

To end the remote session, simply close the TeamViewer QuickSupport application by clicking the **Cancel** button.

## 30 Contact

If you have any questions or comments, please contact our headquarters:

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