TomoCon

User's Manual

TatraMed

TomoCon Workstation
TomoCon Viewer
TomoCon Lite

User's Manual

Version 20

Last revision: December 12, 2014

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TomoCon PACS

TatraMed Software s.r.o., Líščie údolie 9, 841 04 Bratislava, Slovak Republic

Tel.: +421 (2) 60202301   Info@tatramed.sk
Fax: +421 (2) 60202352   www.tatramed.sk   CE 0434

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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 (as outlined in the section above). The applications also provide advanced functionality that varies depending on the license. Where appropriate, the user is advised of divergence from the basic functionality (see 1.4 Markings used in this manual).

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 28 Contact).

$$CE_{0434}$$

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 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 saving to 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 (recommendations are in parenthesis).

2.1.1.1 Hardware requirements

- **CPU**   Pentium 4, 2.5 GHz
- **Memory**   2 GB
- **CD-ROM**
- **Hard Disk**   250 MB free disk space for software installation (at least 50 GB for patient image data)
- **Display**   19" color monitor (two monitors with dual-head graphics adapter, 3D-accelerated graphics adapter)

The mammography mode in TomoCon assumes the resolution of the monitors connected to the workstation is at least 3Mpx (recommended are 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

TomoCon Workstation, Viewer, Lite:

- **Operating System** Microsoft Windows XP SP3, Windows Vista SP2, Windows 7 SP1, Windows 8, Windows 8.1
- **Microsoft Internet Explorer** version 6.0 or higher

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 your desktop, then double-clicking the icon of your 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 operating system:

1. Go to **Start** screen by pressing Windows key.

2. Right click on **TomoCon** icon and click on the **Uninstall** item in the **Options** part.

3. Follow the uninstalling steps and remove the application.

2.1.4 License administration

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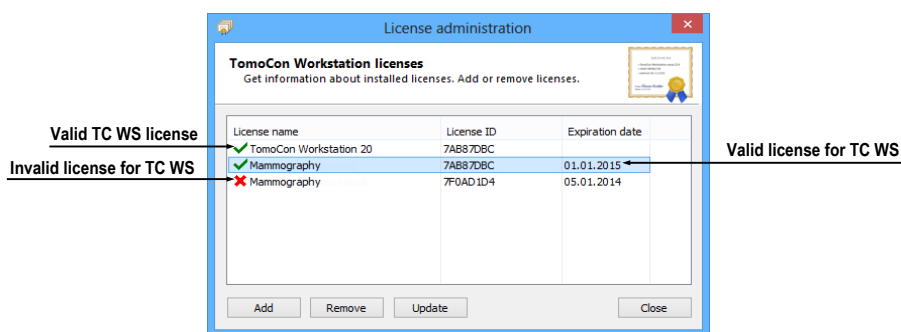
Figure 1 – License administration

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 17.1.6 MIR)

- License for saving RT structures in the DICOM format (RTSTRUCT Export)

> *i* 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 mammography mode (see 26 Mammography mode)

To install licenses in TomoCon Workstation:

1. Start License administration application.

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 for this hardware key are removed.

4. To update TomoCon licenses for all currently connected hardware keys, click **Update** button in the License administration tool. The licenses are downloaded automatically via the Internet (providing the connection is available) and 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.

6. 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 installed licenses will be displayed.

To install new licenses, click the **License administration…** button and follow the steps outlined in the previous section.
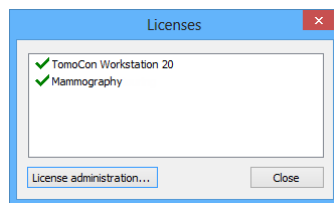
Figure 2 – Licenses dialog

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:

   o 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.

   o 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.

   o Check that the main application window is displayed.

> o   Select the **About...** item in the **Help** menu. The TomoCon **About box** will be displayed.
>
> o   Check whether the version number in the **About box** is 20.

2.2   *Starting TomoCon*

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

- 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 21 Touch screen mode).

- /**m** or –**m** to start the TomoCon mammography mode (see 26 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 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 28 Contact); the problem can be one of the following:

    o   HASP is damaged.

    o   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 on any computer where a Windows user is logged on.

- 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.
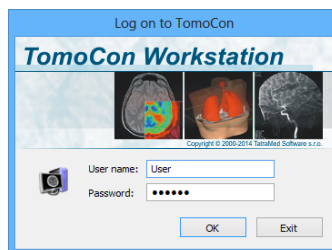
Figure 3 – Log On to TomoCon dialog

3 Using TomoCon

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

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

- Working area (see 3.1 Working area)

- Tools panel (see 3.2 Tools panel)

- Thumbnail palette (see 3.3 Thumbnails palette)

- Main menu (see 3.4 Main menu)

- Toolbars (see 3.5 Main toolbar)

- Status bar (see 3.6 Status bar)
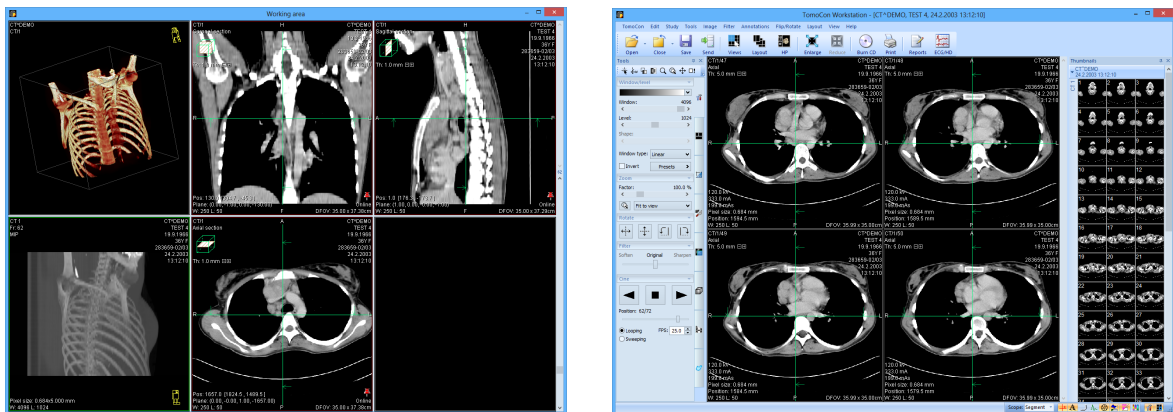
Figure 4 – TomoCon application

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 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** menu. 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. Segment is a defined part of working area with resizable bounds and it

can consist of either multiple smaller segments or of one or multiple views (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 or deleting segments defined previously. This way all kinds of layouts can be created for viewing and diagnosing.
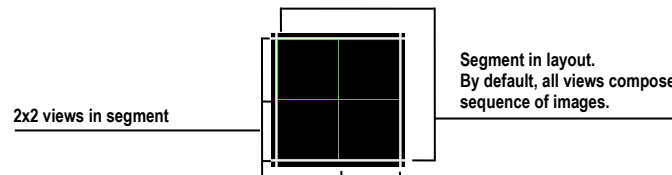
Figure 5 – Four views in a segment

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 (see Figure 6) is initially docked in the tools panel as the third tab. It can be displayed anytime by clicking the ▉ icon tab. All these functions are also available via the **Layout** system menu.
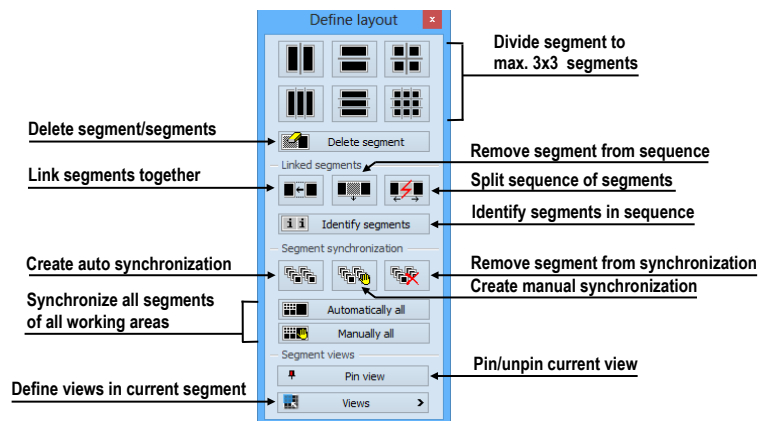
Figure 6 – Define layout tool

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

1. Select the requested layout type from the **Define layout** tab.

2. Click on the segment to divide.

Segments are divided by thick moveable separation lines. Size of each segment can be simply modified by dragging and moving them with the mouse cursor.

To resize adjacent segments (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 **Define layout** tool tab.

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.

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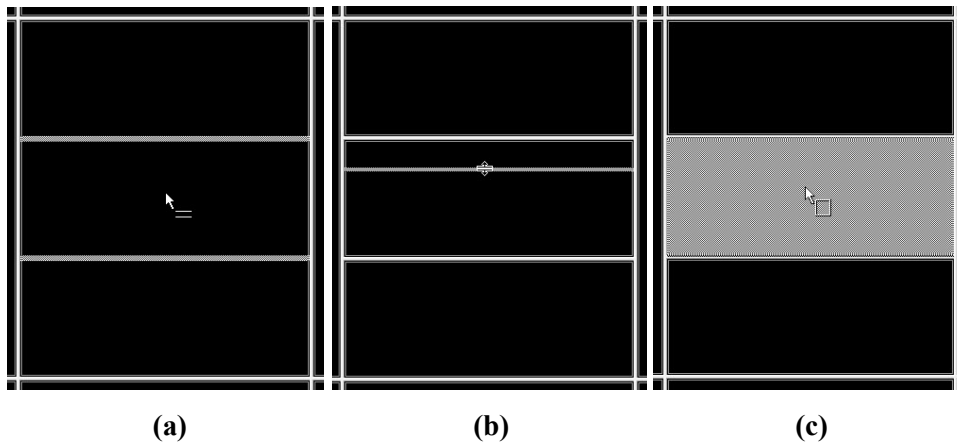
Figure 7 – Definition of segments in working area, divide segment (a), move boundary of segment (b), delete segment (c)

Once the layout of segments is defined, the layout of the views can be subsequently changed. There is one view by default in a newly created segment, which covers the whole area of the segment. The layout can be changed up to 8x8 views in each segment.

To define layout of the views in segment (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 click ▦ **Views** button in the main toolbar of TomoCon.

3. Select requested layout of views in grid.

4. Select the new desired display mode for the current segment (stack, matrix or all mode described in 6.2 Segment display mode) in the toolbar above the grid selector.
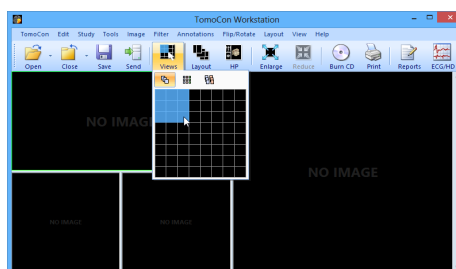
Figure 8 – Definition of views in a segment

3.1.2 Organizing layouts

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

- **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).
3. Click **Add**.
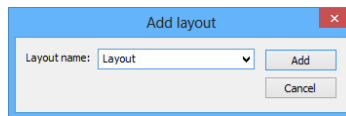
Figure 9 – Add layout dialog

Current layout will be automatically added to **Other layouts** list using the name entered. To overwrite an existing layout definition, enter a name already in use (or select it from the previously defined layouts list, which is displayed after clicking▼, see Figure 10) and click **Add** button to confirm.
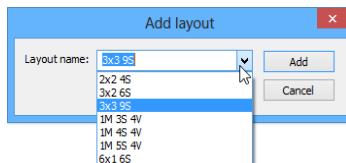
Figure 10 – Overwrite already defined layout

3.1.2.2 Load layout

To load a saved layout from a layout list:

1. Click 🖳 **Layout** item in the main toolbar or the **Favorite**, **Recent** or **Others** buttons in the **Layouts** tool of the tools panel (see Figure 11).
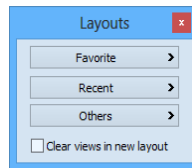
Figure 11 – Layouts tool

2. Select the desired layout in the displayed window (see Figure 12). Selected layout will be loaded.
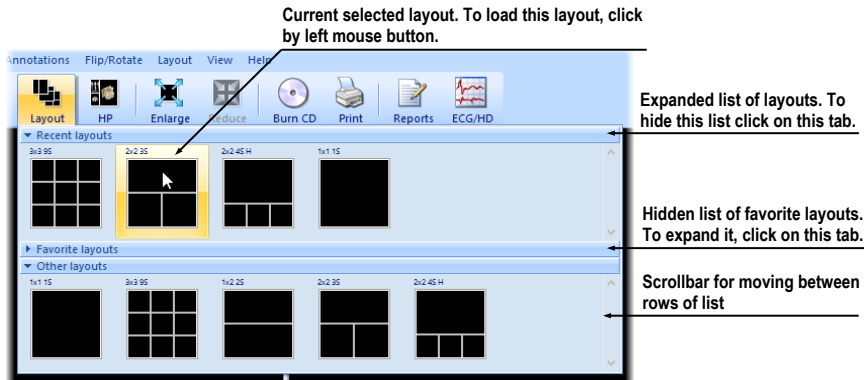
Figure 12 – Layout list

3.1.2.3   *Layouts manager*

Layouts manager allows changing elementary properties of existing layouts using **Layouts manager** (see Figure 13).
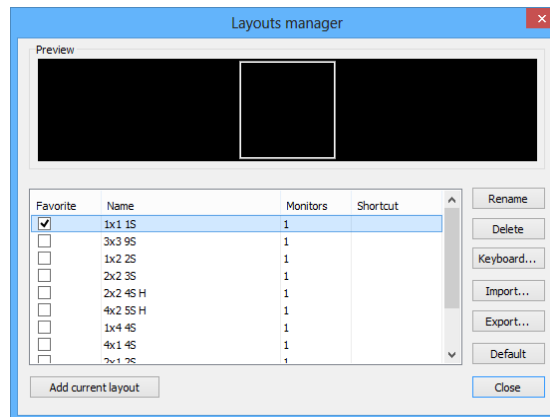
Figure 13 – Layouts manager dialog

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. Current view (see Figure 14) is outlined with a colored frame according to the TomoCon settings (see 4.4 Color and style options).
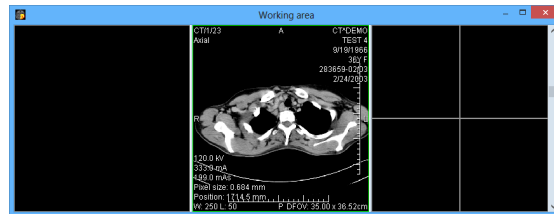
Figure 14 – Working area

3.1.4 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 toolbar, mini-toolbar, is shown together with the context menu. Use mini-toolbar to show or hide additional texts in the current view (ruler, texts, current point) and to control the slab projection properties in the current view.
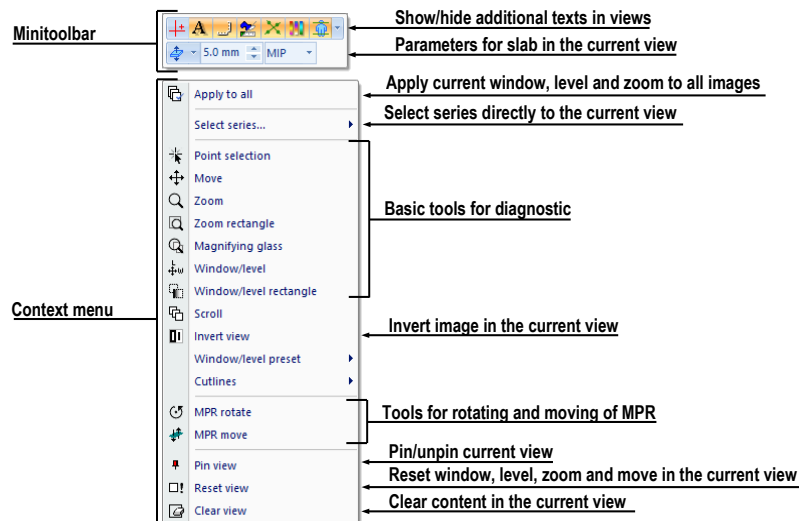
Figure 15 – View context menu with mini-toolbar

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 15).

The context menu will hide automatically and selected command will be performed, or selected tool will be activated in the current view.

When a tool is active, the context menu shows an additional option to stop the tool easily. The **Stop…** item with the tool name is shown at the top of context menu (see Figure 16). The **Stop…** item is not shown if no tool is active. Alternatively, a keyboard shortcut can be used to deactivate selected tool (for defining keyboard shortcuts see 4.5 Keyboard shortcuts).
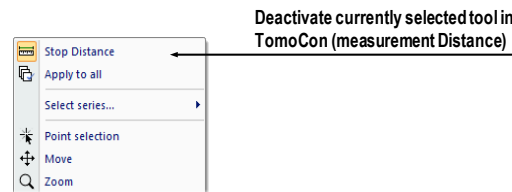
Figure 16 – Deactivating currently selected tool in TomoCon

3.2 Tools panel

Tools panel contains basic tools for viewing images and performing diagnosis in TomoCon. It is highly configurable and its parts can easily be moved around or hidden and shown, which 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 (make it floating) using the drag and drop method, drag the panel's title bar (see Figure 17a) and move the panel to a new position on the screen, then release the mouse button.

To undock a panel and restore its last floating position, right-click the tools panel title bar, then select **Floating** in the context menu (see Figure 17b).

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 17b).

(a)   **(b)**
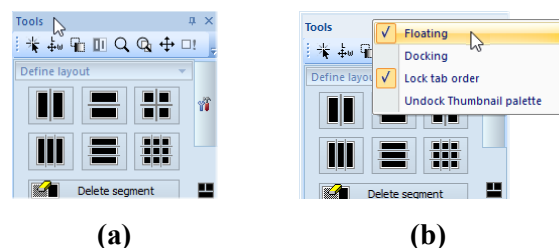
Figure 17 – Tools panel (a) and docking context menu (b)

To dock tools panel 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 18). To dock the panel, just release the mouse button while the cursor is placed over the navigator.
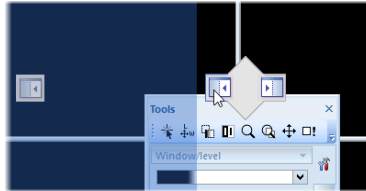
Figure 18 – Docking tools panel to the left edge

In addition, 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.

| (a) | (b) | (c) |
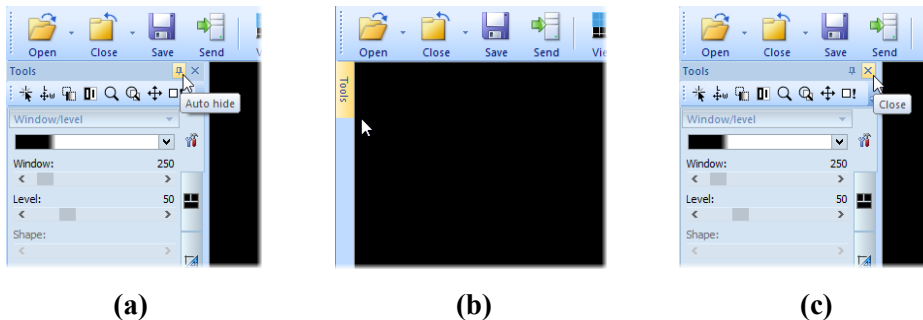
Figure 19 – Turn on auto hide mode of the Tools panel (a), display hidden panel (b), close the Tools panel (c)

To activate the auto hide mode, click ⏚ icon in the right corner of tools panel title bar (see Figure 19a). When the mouse cursor is moved over the bar (see Figure 19b), 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.

To hide tools panel, click ✖ icon in the right corner of tools panel title bar (see Figure 19c). The panel can be displayed again by clicking **Tools panel** in the **View** menu.

3.2.1 Navigating through the Tools Panel

Tools panel (see Figure 20) consists of three parts. Title bar and quick access toolbar are on the top. 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. Each section is organized as a separate tab page with the tools docked in a specified arrangement.

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

undocked from tools panel. The tools are separated by title bars with tool's titles in the left-top corner.
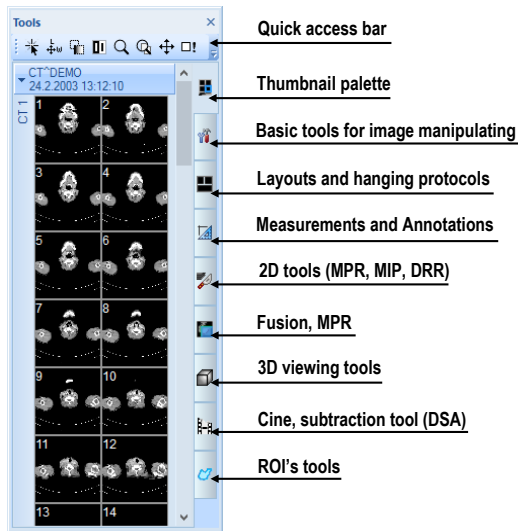
Figure 20 – Tools panel

To collapse or display the selected docked tool in the tools panel, click on its title bar (see Figure 21a) or use the tools panel's context menu (see Figure 21b). To display the context menu, right-click any tab page in the tools panel.

(a)   **(b)**
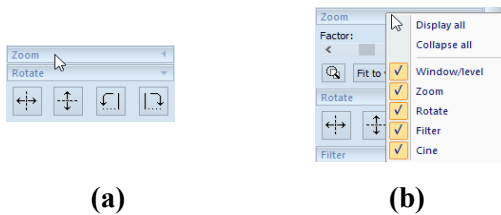
Figure 21 – Collapsed Zoom tool (a), displayed context menu of the tools panel (b)

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 22a), and drag it to a new position on the screen, then release the mouse button. Undocked tool will be automatically changed to floating tool dialog and content of tools panel will be automatically rearranged (see Figure 22b).

(a)   **(b)**
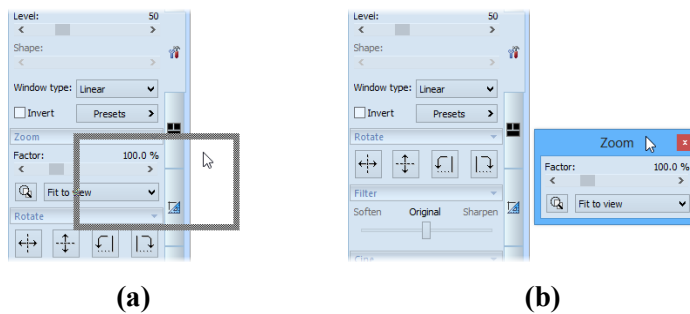
Figure 22 – Undocking the Zoom tool (a), undocked Zoom tool (b)

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 (see Figure 23a) and release the mouse button. The tool will be automatically docked to the appropriate tool tab (see Figure 23b).

(a)   **(b)**
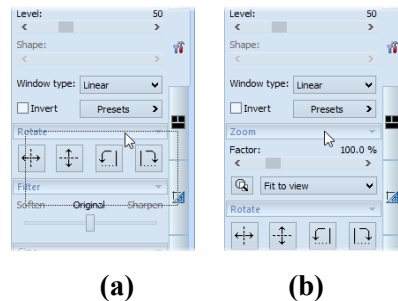
Figure 23 – Docking the Zoom tool in the tools panel (a), docked Zoom tool (b)

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 that are independent of the tool or menu that is currently displayed. 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.

(a)   **(b)**   **(c)**
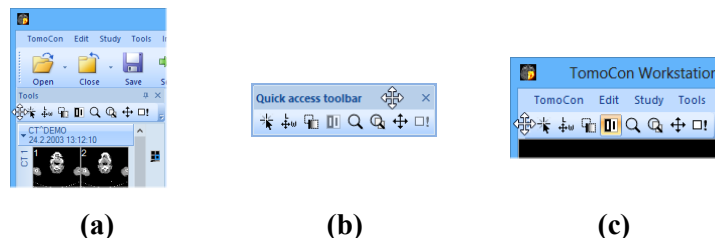
Figure 24 – Undocking Quick access toolbar (a), moving to floating position (b), docking to the top edge of the application window (c)

To undock Quick access toolbar from tools panel, press down the ⋮ icon in Quick access toolbar (see Figure 24a) and drag it to a new position on the screen (see Figure 24b, c). Then release the mouse button on requested position.

Commands can be added or removed to/from Quick access toolbar using **TomoCon 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 25).
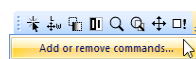
Figure 25 – Displaying TomoCon options dialog to add/remove commands

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

3.3 Thumbnails palette

Thumbnails palette is a powerful navigation tool (see Figure 29) 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. The thumbnails palette is docked in the tools panel by default.
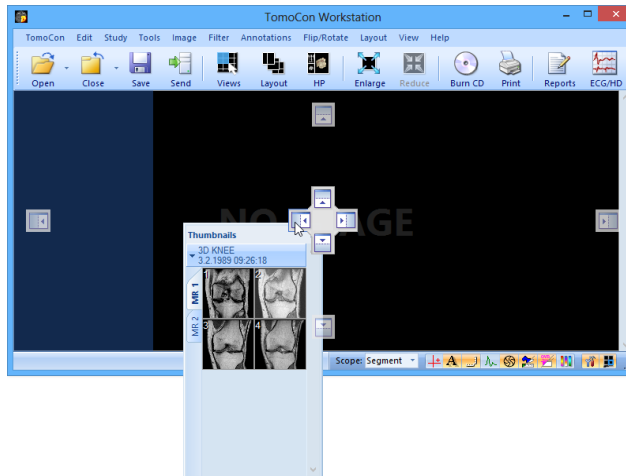
Figure 26 – Docking thumbnails palette to the left edge of TomoCon

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 26).

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 27a).

3. Move the thumbnails palette over the navigator ⬚. A new docking position for the thumbnails palette will be displayed in translucent blue (see Figure 27a).

4. Release the mouse button to dock the thumbnail palette (see Figure 27b).

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 27c).

(a)   (b)   (c)
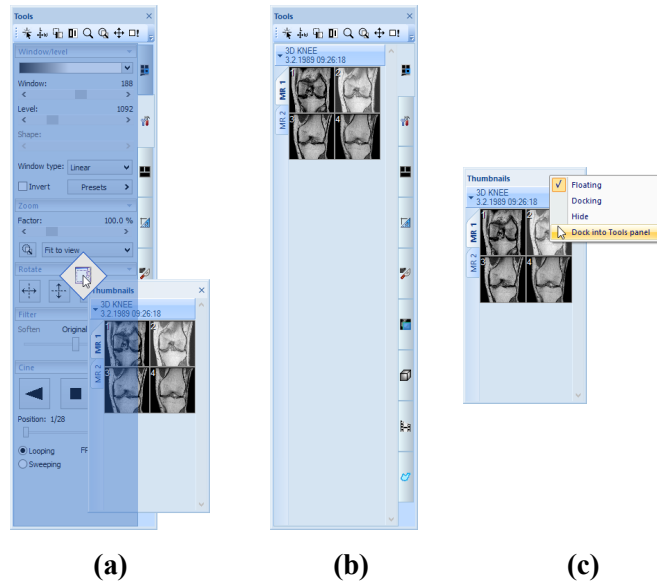
Figure 27 – Docking thumbnails palette to the tools panel (a), docked thumbnails palette (b), context menu of thumbnails bar (c)

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 27b) 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:

1. Right-click the active thumbnail tab in the Tools panel.

2. Select the **Undock thumbnail** item in the context menu (see Figure 28).

3. The thumbnail bar will be undocked from the Tools panel and immediately moved to the last undocked position.
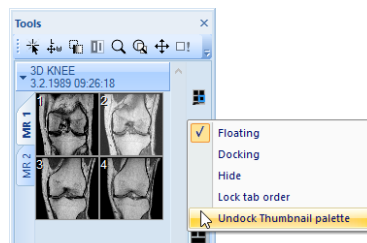
Figure 28 – Undocking thumbnail bar from Tools panel via context menu

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 29a). Below, reduced images (see Figure 29b) of the series are displayed according to the selected series representation type for the study in the thumbnails palette (see 3.3.2 Display options). Selection of the representation type is possible using the thumbnails palette context menu (which opens by right-clicking the selected study in the thumbnails palette and selecting the **Show series** item).

(a)   (b)
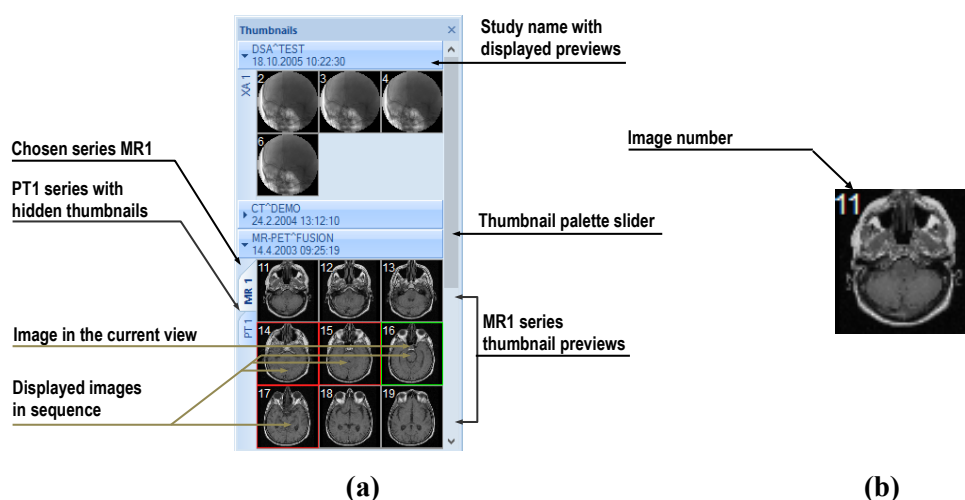
Figure 29 – Thumbnails palette in Tabbed mode (a), image thumbnail (b)

Multiple studies are ordered by the examination date and time, so that the newest one is at the top in the thumbnail palette. 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 right (see Figure 29a).

> i If a single patient study is open in TomoCon, the thumbnails 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 30). Keyboard shortcuts can be defined for collapse, expand and collapse/expand all actions using TomoCon Options (see 4.5 Keyboard shortcuts).

By double-clicking any of the study tabs all studies will collapse. To restore the previous state, double-click the study tab again.

(a)   (b)
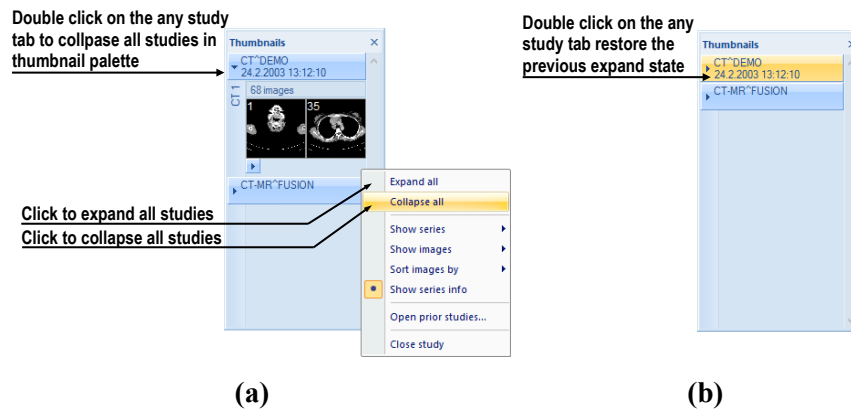
Figure 30 – Thumbnails palette context menu (a), Thumbnail palette in the collapsed all state (b)

When opening a new patient study in TomoCon, the first series of the newly open study is automatically expanded in the thumbnail palette. 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:

- **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 (see Figure 31a).

- **All - separated**; the thumbnails of all series of the study are displayed at a given time, sorted according to series (see Figure 31b).

- **All in one**; the thumbnails of all series of the study are displayed together, without division into series (see Figure 31c).

(a)   (b)   (c)
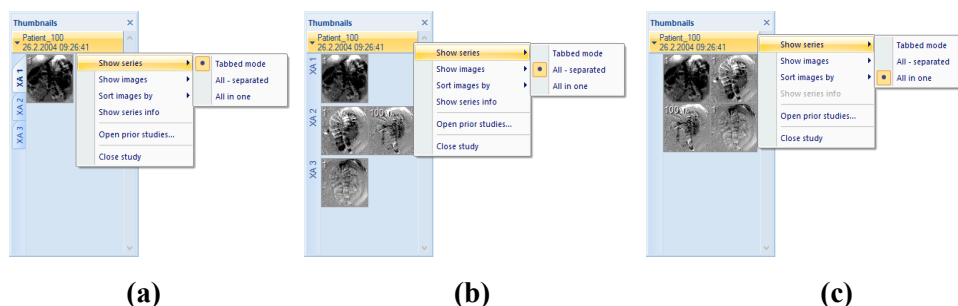
Figure 31 – Displaying series in the Tabbed mode (a), All – separated (b), All in one (c)

Moreover, 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 32).
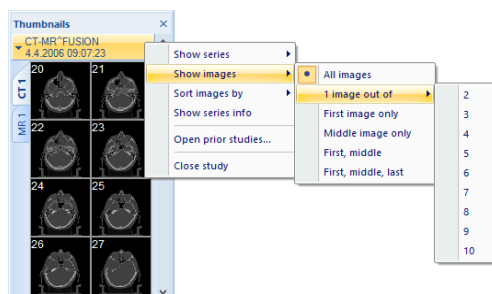
Figure 32 – Context menu for selection of the image representation type

The thumbnails palette supports the following image representation types for the series:

- **Show all images** - all images within the series of the selected study are displayed.

- **1 image out of** – every n^{th} image will be displayed.

- **First image only** - the first image of the series of the selected study is displayed (see Figure 33).

- **Middle image only** – the middle image of the series of the selected study is displayed.

- **First, middle** - the first and middle images of the series of the selected study are displayed.

- **First, middle and last** - the first, middle and the last images of the series of the selected study are displayed.
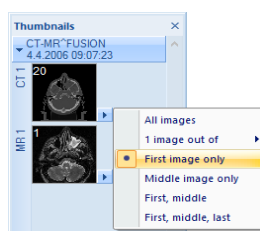
Figure 33 – First image only display (all separated series mode)

Thumbnails can be sorted in the Thumbnails palette by selecting the **Sort images by** item in the context menu (see Figure 34):

- **Index number** – ordered as open in TomoCon

- **Instance number** – sorted by the instance number value in DICOM data

- **Image position** – sorted by the image position

- **Reverse sort mode** – select to show the images in reversed order.
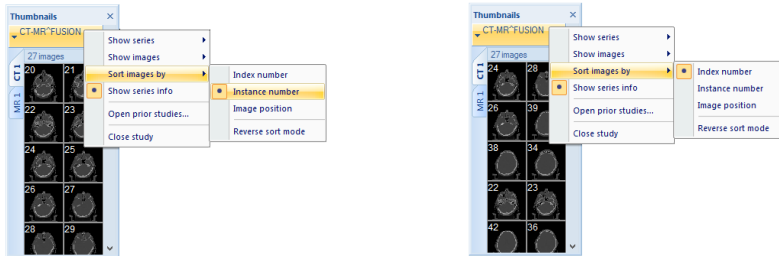
Figure 34 – Sorted images by Instance number and by Index number

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.

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 in TomoCon, 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 35).
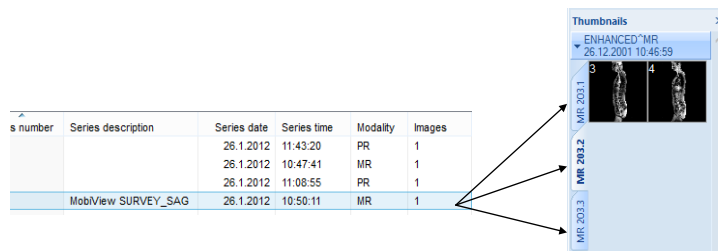
Figure 35 – Multidimensional series MR in the Study search dialog and displayed as virtual series in the thumbnail palette (b)

3.3.4   Filtering images with measurements and key notes

Thumbnails palette offers a special image filter for quick identification of measurements and key notes in the images. It allows showing just the images and MPRs containing one or more measurement(s) or key note(s). If a study contains a measurement (in an MPR or an image) or a key note (in an image), the study header in the thumbnail palette contains the orange filter check box in the right-hand corner (see Figure 36).

Study contains some key image notes or measurements.
Click on the check box to filter key images and measurements.

Key images with notes

Study without key image notes or measurements.

Active filter for images with image notes or measurements

(a)   (b)
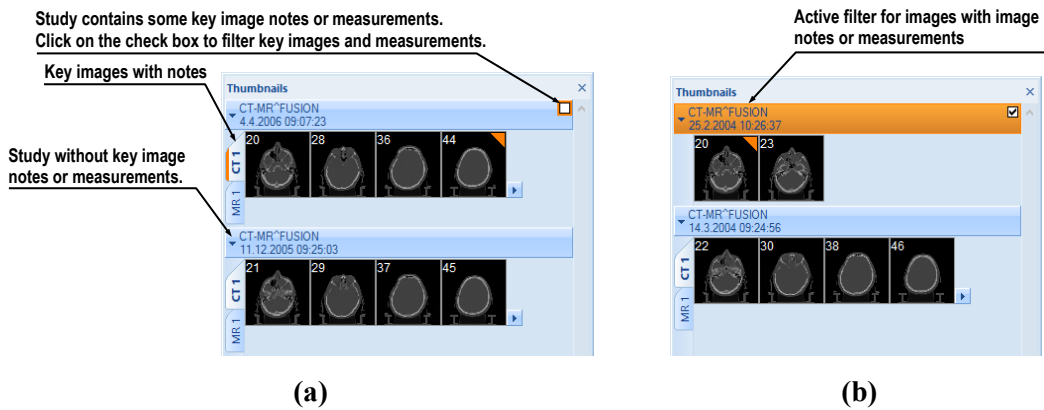
Figure 36 –The thumbnails palette, (a) filter is disabled, (b) filter is activated

To filter images with key notes or measurements:

1. Click the check box in the right-hand corner of the study header (Figure 36a).

2. Only the images with measurements or key notes are displayed (Figure 36b).

3.4 Main menu

All 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 on a Microsoft Windows printer or DICOM printer), logging into and out of the application and closing TomoCon; see Figure 37.

Print patient data on a MS Windows or DICOM printer

Directly print working area on a MS Windows printer

Application settings

Logout current user

Close the application
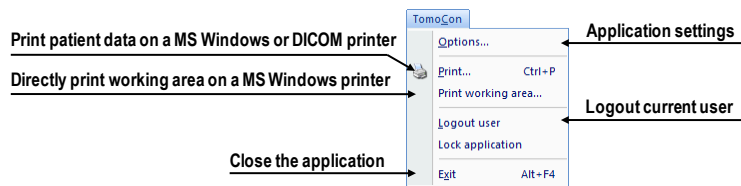
Figure 37 – TomoCon menu

- **Edit** – clipboard operations with images in the current view and the selected ROI contour, see Figure 38.

Undo contour operation

Redo contour operation

Cut current selected contour

Paste contour from clipboard

Paste contour from clipboard to all slices in series from current view

Copy selected contour or image in current view to clipboard

Paste contour from clipboard and allow to move it in view
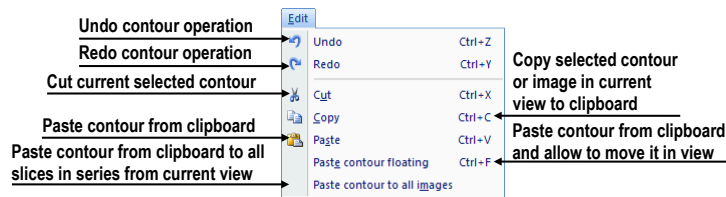
Figure 38 – Edit menu

- **Filter** – filters for image softening or sharpening in the current view (see Figure 39).
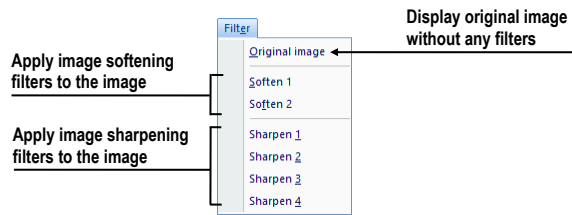
Figure 39 – Filter menu

- **Study** – patient study operations containing the functions for opening/closing/saving studies, anonymizing and burning studies onto a CD, exporting images and creating/viewing structured reports (see Figure 40).
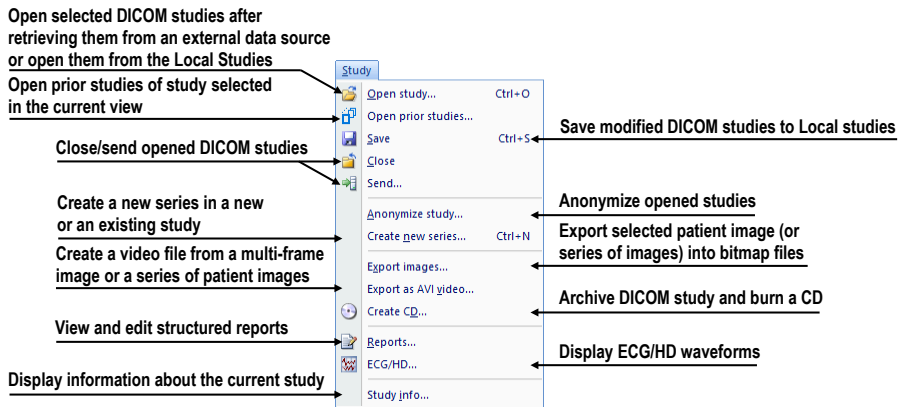
Figure 40 – Study menu

- **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, defining multi-modal registrations and launching the touch screen and mammography modes (see Figure 41).
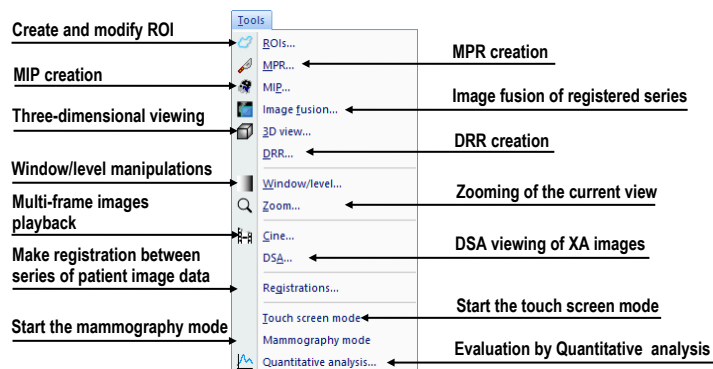
Figure 41 – Tools menu

- **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 42).
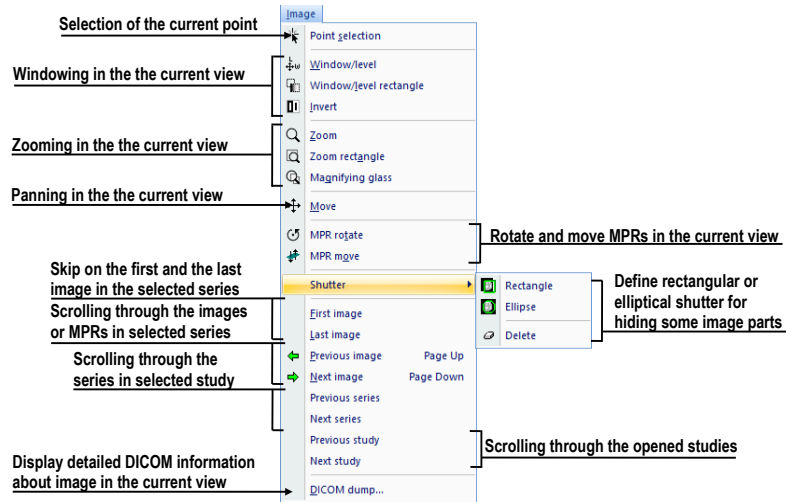
Figure 42 – Image menu

- **Annotations** – functions for annotation management in TomoCon. Creating various types of annotation and measurements in the current view and removing and editing selected annotations (see Figure 43).
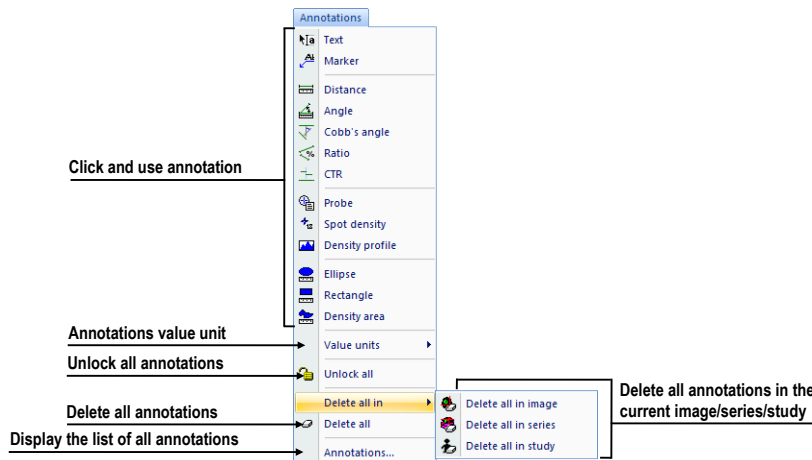
Figure 43 – Annotations menu

- **Flip/Rotate** – flipping and rotating the image in the current view (see Figure 44).
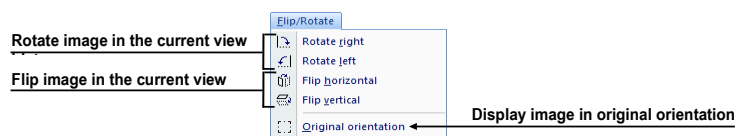
Figure 44 – Flip/ Rotate menu

- **Layout –** the functions for managing layouts and hanging protocols in TomoCon, such as creating a layout or hanging protocol, defining sequences or synchronizations, etc. (see Figure 45).
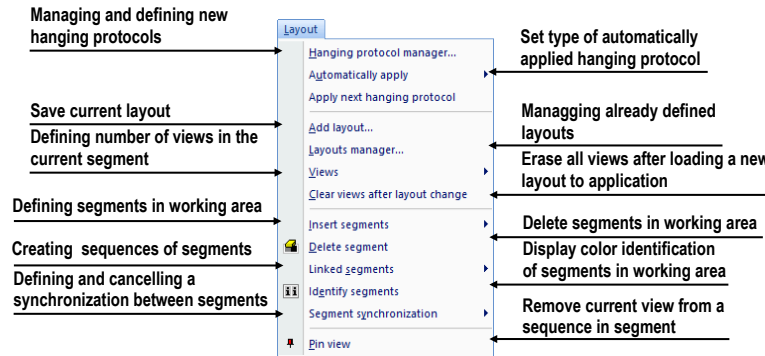
Figure 45 – Layout menu

- **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 46).
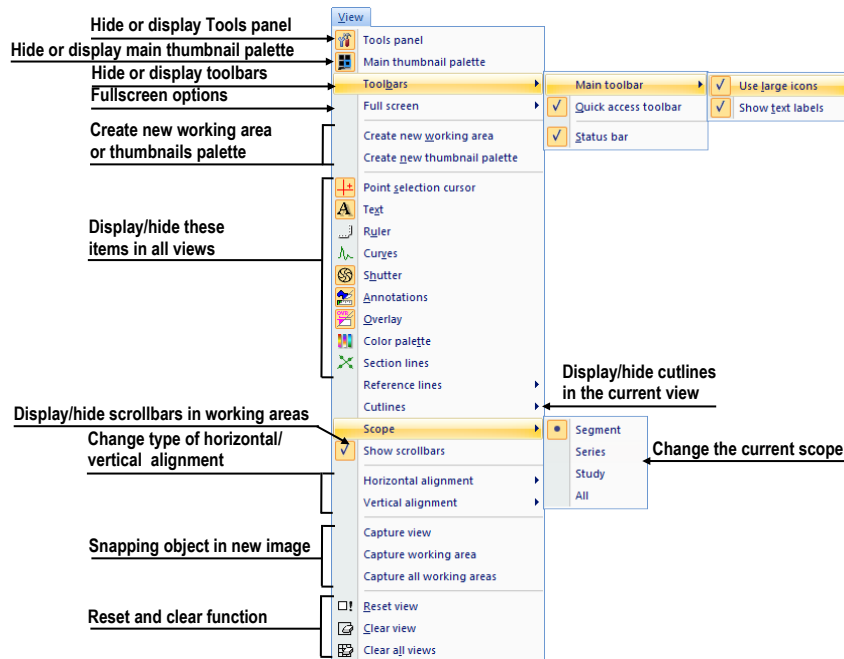
Figure 46 – View menu

- **Help** – displaying the application version, installing licenses and browsing the electronic version of the user's manual (see Figure 47).
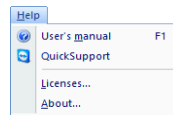
Figure 47 – Help menu

3.5 Main toolbar

Main toolbar (also called the **Standard** toolbar) buttons are used for frequently carried out tasks. The main functions for viewing images in TomoCon are grouped in the main toolbar (see Figure 48), which is always visible and can be positioned at any edge of the application window.
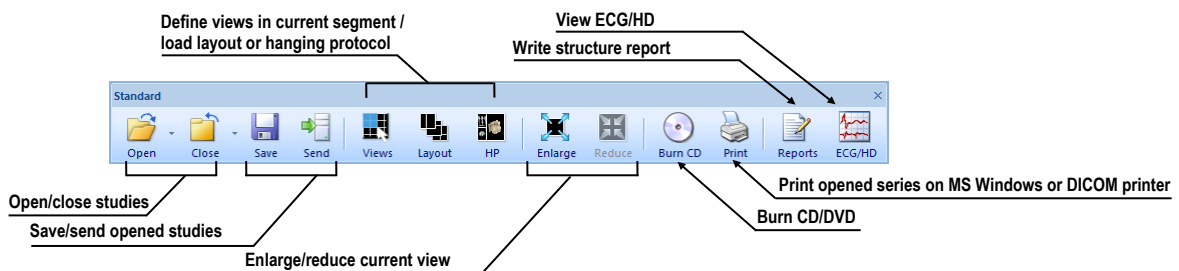
Figure 48 – Standard bar (big version)

To customize the visibility of the main toolbar, use the **View/ Toolbar/ Main toolbar** submenu of the application menu (see Figure 49).
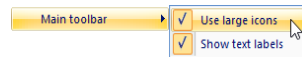
Figure 49 – Sub-menu for customizing the visibility of the main toolbar

3.6 Status bar

The Status bar (see Figure 50) is a horizontal bar at the bottom of the application window which displays the visibility toolbar, the scope panel and the progress of selected current task in TomoCon. 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** sub-menu of application 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 to 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.

Moreover, 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.
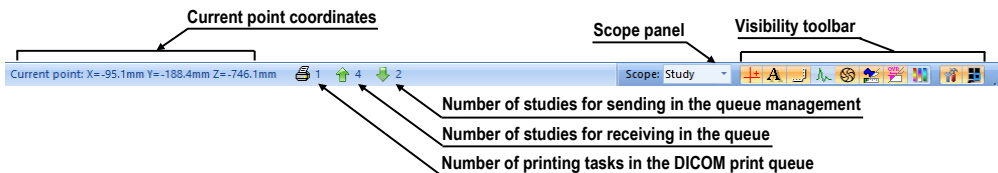
Figure 50 – Status bar

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 or a study at one time. To control the behavior, use the **Scope panel** (see Figure 51), which is always available on the right-hand side of the **Status bar**.
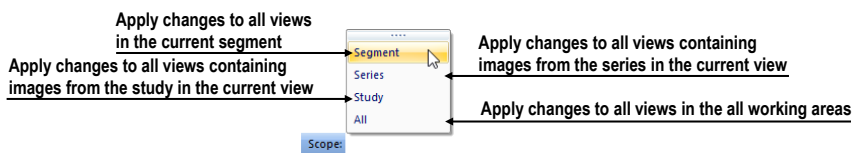
Figure 51 – Scope panel

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 **A**nterior, **P**osterior, **L**eft, **R**ight, **H**ead and **F**eet.

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 of TomoCon 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 in TomoCon (see Figure 52).
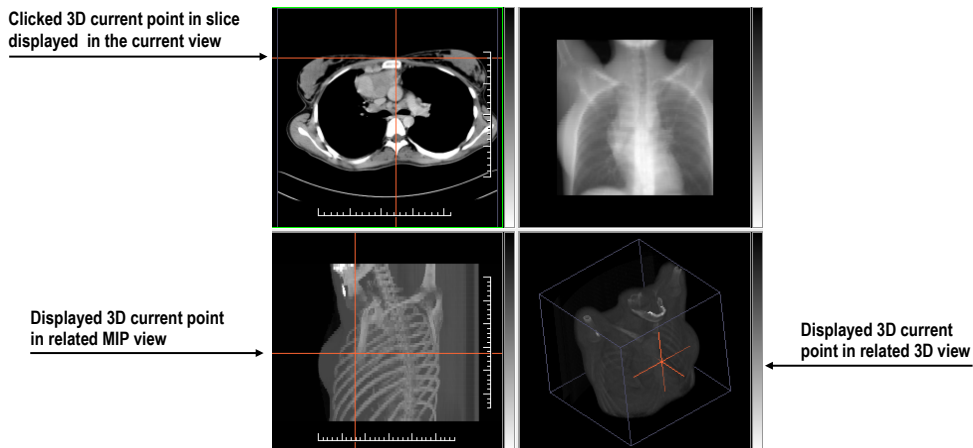
Figure 52 – Displayed 3D current point in TomoCon

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 **TomoCon options** dialog (see 4.4 Color and style options).

3.7.2 Limits of accuracy in measurements

The image pixel size affects the precision of all measurements (the larger the pixel size, the lower the measurement precision).

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 **TomoCon options** dialog. Options that can be changed are grouped into several categories (TomoCon general settings, shortcuts, modality settings, display features, etc.).

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

The **TomoCon options** dialog (see Figure 53) 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.
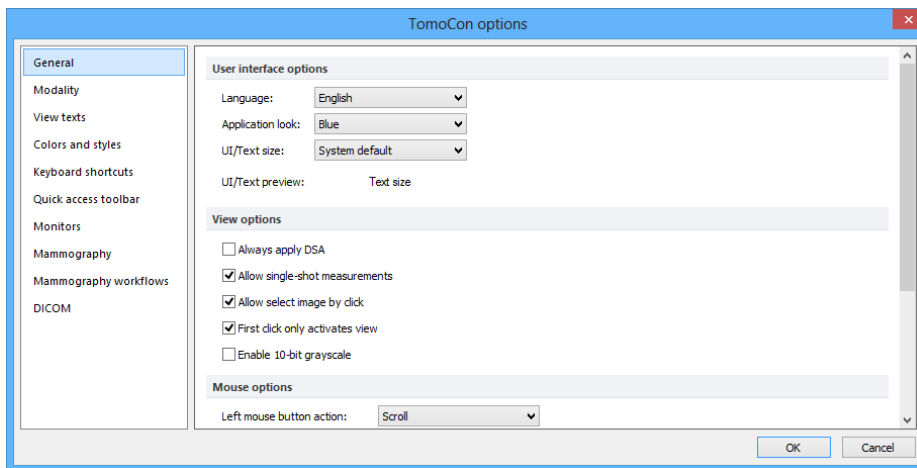
Figure 53 – TomoCon options dialog

The **TomoCon options** dialog (see Figure 53) 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 TomoCon views (see 4.4 Color and style options)

- **Keyboard shortcuts** – for the creation of shortcuts (see 4.5 Keyboard shortcuts)

- **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 **TomoCon options** dialog (see Figure 54). The language automatically changes when the application is restarted.
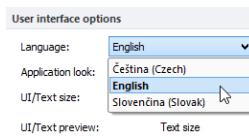
Figure 54 – User interface options section of the General tab

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 in the **User interface options** section on the **General** tab of the **TomoCon options** dialog (see Figure 55).
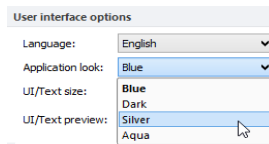
Figure 55 – User interface options section of the General tab

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.) in TomoCon, change the scale degree of TomoCon GUI in the **User interface options** section on the **General** tab of the **TomoCon options** dialog (see Figure 56).
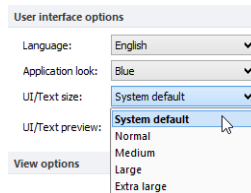
Figure 56 – User interface options section of General tab

In order to change the scale of text used in TomoCon, select the desired size from the combo box (see Figure 56), where all the available text sizes are listed ordered by size. 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 **TomoCon options** dialog (see Figure 57):

- Turn on/off DSA mode automatic activation (**Always apply DSA**) – as long as the image in the current view contains DICOM structure for DSA.

- **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.

- 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 you to see more detail in views when doing diagnostic work with very dark and very light images.
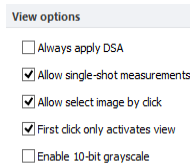
Figure 57 – View options section of the General tab

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, without the need to activate it in any other way. The mapping can be done in the **Mouse options** section on the **General** tab of the **TomoCon options** dialog (see Figure 58).
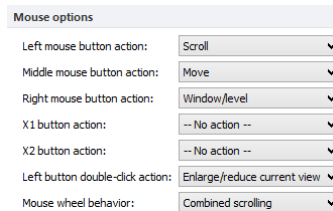
Figure 58 - Mouse options in General category

In addition to the selected actions, 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 59). The list of all possible actions is displayed. Select the required action.
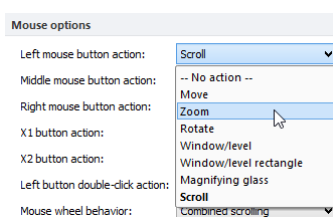
Figure 59 – Selection of left mouse button action

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

To define the behavior of left mouse button double-click in current view, select the item from the list of predefined functions (see Figure 60) in the **Left button double-click action** combo box.
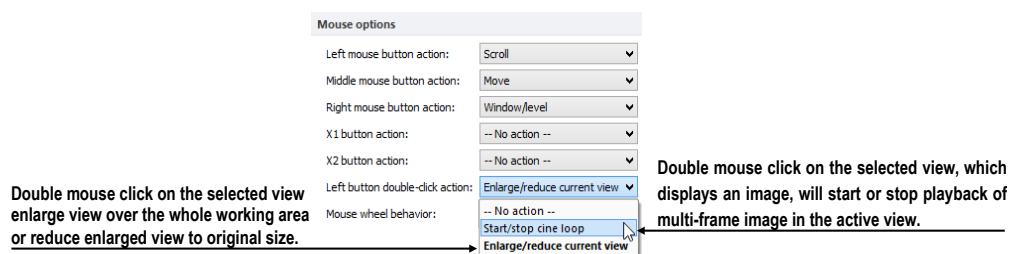
Figure 60 – Mapping action for left mouse double-click

To cancel a mapping for a mouse button, select --**No action**-- in the combo box.

To define the behavior of mouse wheel, click the **Mouse wheel behavior** combo box (see Figure 61). 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.
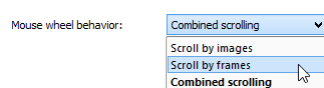
Figure 61 – Mouse wheel behavior combo box

4.1.6   ROI options

The **ROI options** section on the **General** tab of the **TomoCon options** dialog (see Figure 62) allows setting up the number of vertices to be used for ROI contours. The settings only apply to contours drawn or modified in TomoCon.

To simplify the contour of an 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 "**Max. number of vertices in contour**".
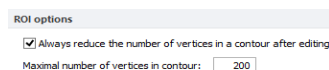
Figure 62 – ROI options part in General category

4.2 Modality options

The **Modality** tab of the **TomoCon options** dialog (see Figure 63) is used to set up the properties for each individual modality type.
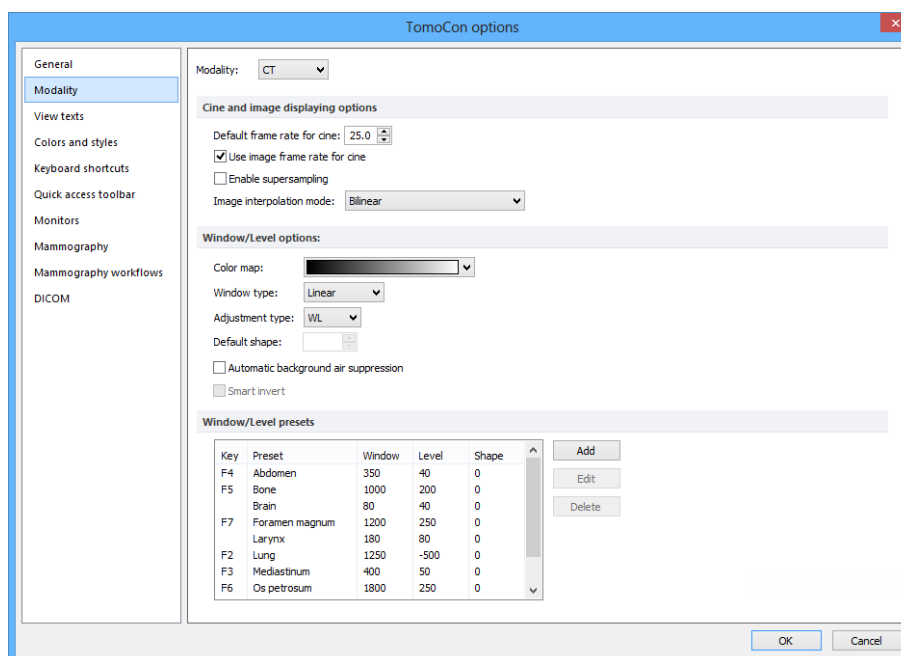
Figure 63 – Modality tab of the TomoCon options dialog

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)**
  - **Image interpolation mode** – specifying the bitmap interpolation mode for image data visualization: **None**, **Bilinear**, **Bicubic**
  - switching the supersampling function in views on/off (**Enable supersampling**)

- **Window/level options**:
  - selecting **Color map** palette for the selected modality
  - adjusting the grayscale notation type (**Adjustment type**) (Window Width/Level, Low/Up or relative Low/Up
  - selecting the palette gradation type (**Window type** and **Default shape**)
  - 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 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**. 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 (see Figure 64) in which the preset can be changed.
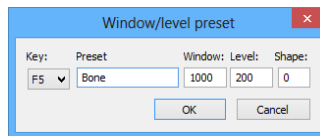
Figure 64 – The Window/level preset dialog

4.3 View texts

TomoCon provides a pre-configured set of information texts to be displayed on views, which is fully user-adjustable per each view type. It is also possible to define additional information to be displayed along with the predefined texts in the views.

To modify the information displayed in views, select **View texts** tab of the **TomoCon options** dialog (see Figure 65). Select a view type to be adjusted and define the required view texts to be displayed. 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.

To change the currently used font for all view texts, push the **Font** button.
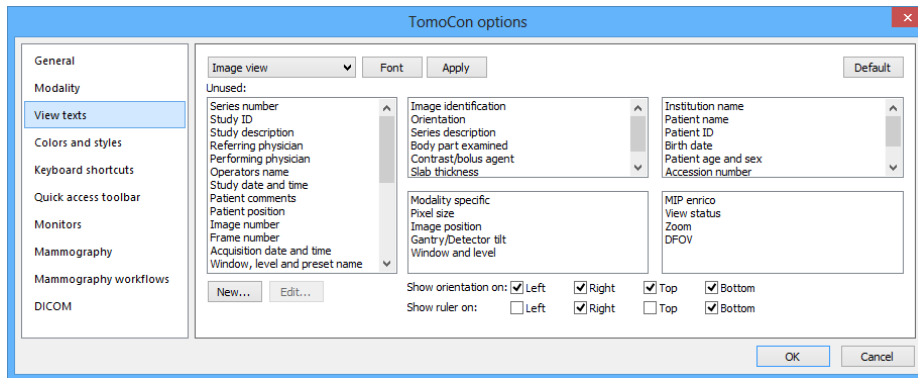
Figure 65 – TomoCon setup dialog, the View texts tab

Additional types of displayed information – orientation and ruler – can also be defined. Use the check boxes at the bottom (see Figure 66) to show the ruler and the orientation information at the left, right, top and/or bottom of the view (see Figure 67). The ruler and the position are designed to enhance the identification of the displayed image.

Figure 66 – Defining ruler and position

To apply the changes, click **Apply**. To restore the default view texts, click **Default**.
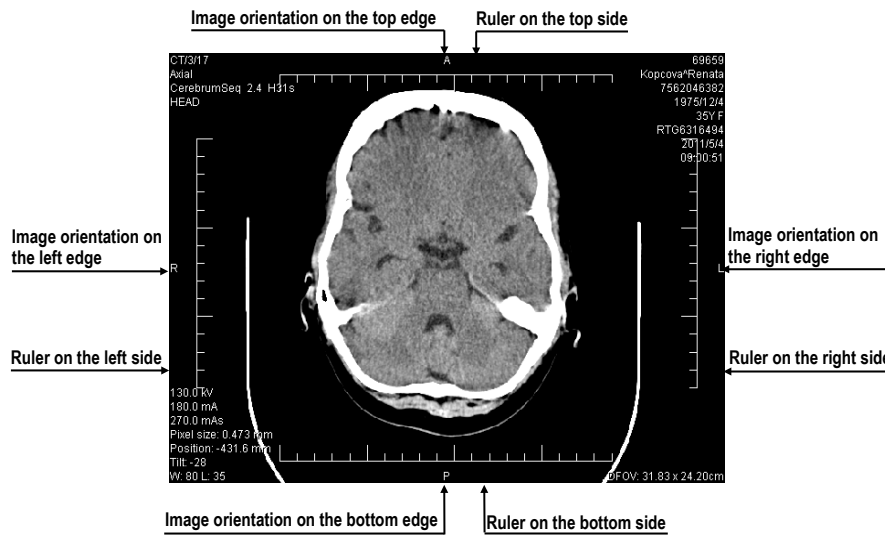
Figure 67 – Displayed view texts in view

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.
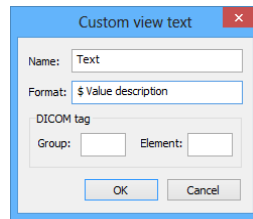
Figure 68 – Custom view text dialog

4.4 Color and style options

The default colors and styles of certain displayed objects in TomoCon can be changed on the **Colors and styles** tab of the **TomoCon options** dialog (see Figure 69).
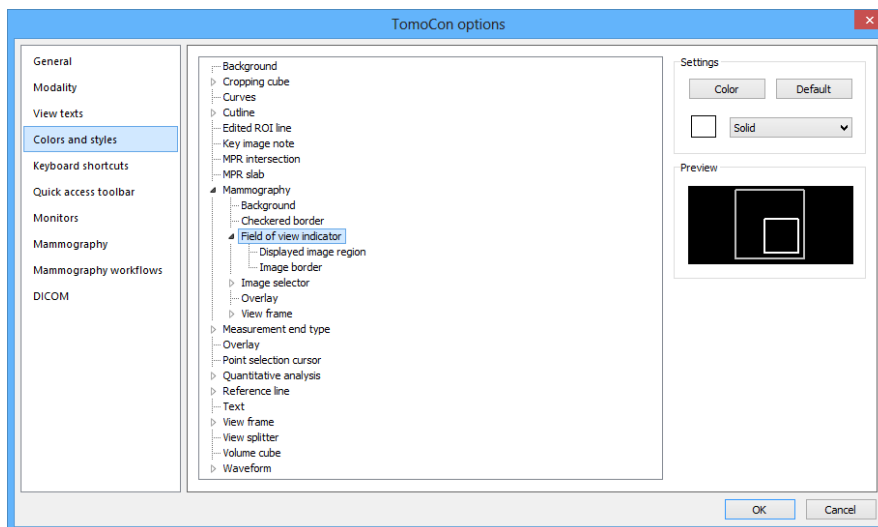
Figure 69 – The Colors and styles tab of the TomoCon options dialog

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

To change the style of a selected object, use the style selection in the **Settings** section. The display style can only be changed for some of the objects.

To restore the default color and style of the selected object, click the **Default** button.

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.

In addition, scope of each shortcut can also be defined (the type of view or mode). Combined, the shortcuts can make work with TomoCon easier, more efficient and user-friendly.

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; alternatively, identical shortcut can be used for different actions in different view types. 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.

The shortcut scope (see Figure 70) 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.
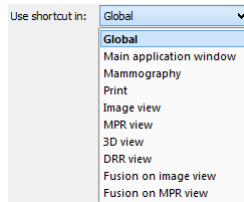
Figure 70 – Shortcut scopes

4.5.2   Managing keyboard shortcuts

TomoCon allows the definition of custom shortcuts using keyboard shortcuts management on the **Keyboard shortcuts** tab of the **TomoCon options** dialog (see Figure 71).

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.
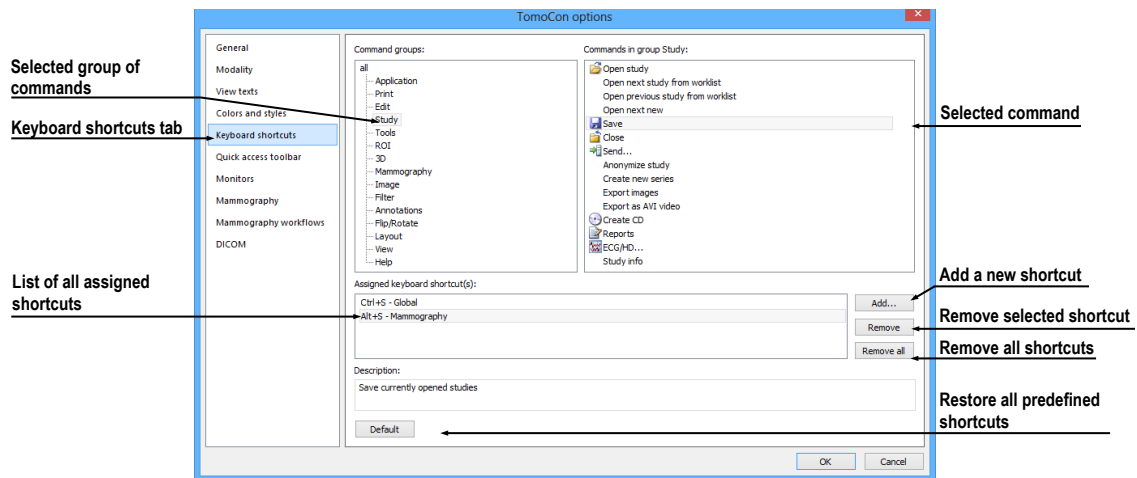
Figure 71 – The Keyboard shortcuts tab of the TomoCon options dialog

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

1. Select the desired command as described above.

2. Click **Add**. The **Define shortcut keys** dialog is then displayed (see Figure 72).

3. 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.
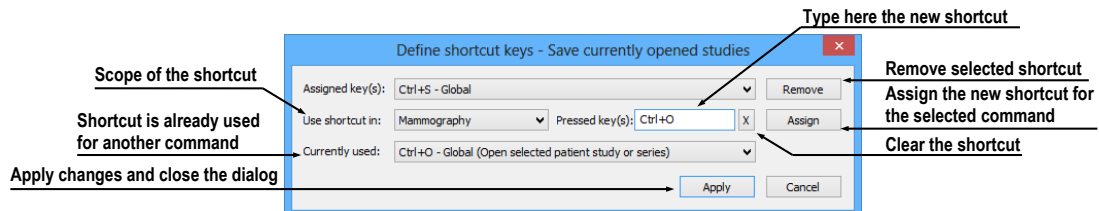
Figure 72 - Define shortcut keys dialog

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**.

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 in TomoCon (see Figure 73).
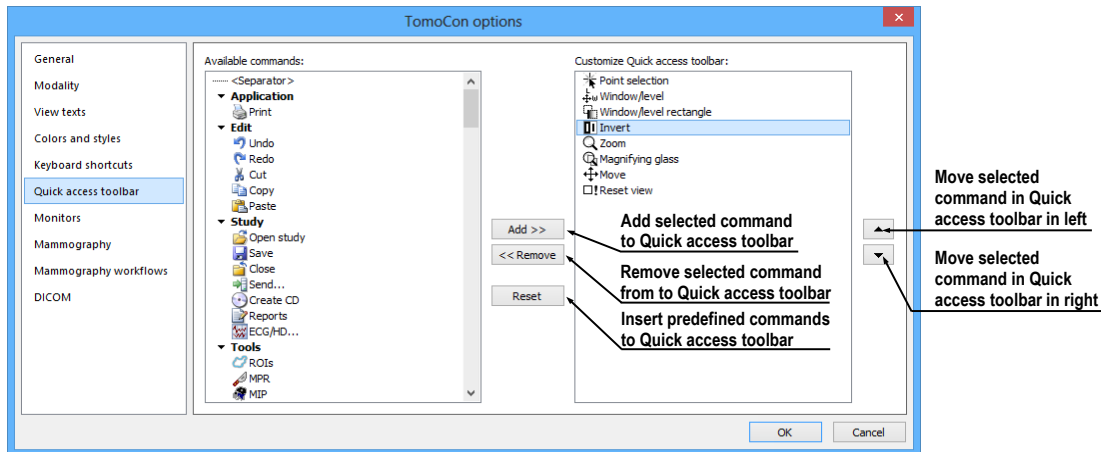
Figure 73 – Configuring the Quick access toolbar

To add a command to the **Quick access toolbar**:

1. In **TomoCon options** dialog, select the command in the list of **Available commands**. The selected item will be highlighted.

2. Click a previously added command in the **Customize Quick access toolbar** list; this defines the position for inserting the new command.

3. Click **Add >>** (see Figure 73).

4. New command will be inserted after the selected command in the **Customize Quick access toolbar** list.

To remove a command from the Quick access toolbar:

1. In **TomoCon options** dialog, select the command in the **Customize Quick access toolbar** list and click **<< Remove**.

2. The removed command will be moved to the list of **Available commands**.

To change the order of the commands in the Quick access toolbar, use the ▲ and ▼ buttons. Select the required command in the **Customize Quick access toolbar** list and move it upwards with the ▲ button or downwards with the ▼ button.

4.7 Monitors

The **Monitors** tab (see Figure 74) allows calibrating any monitor connected to the computer by defining the physical dimensions of its display area. Calibration is the first and necessary step in setting up the actual size viewing mode in TomoCon (see 7.2 Zooming an image). This mode allows viewing images in their actual physical dimensions on the calibrated monitor. This means, for example, that 10x10 cm of a displayed image measures 10x10 cm exactly on the calibrated monitor.
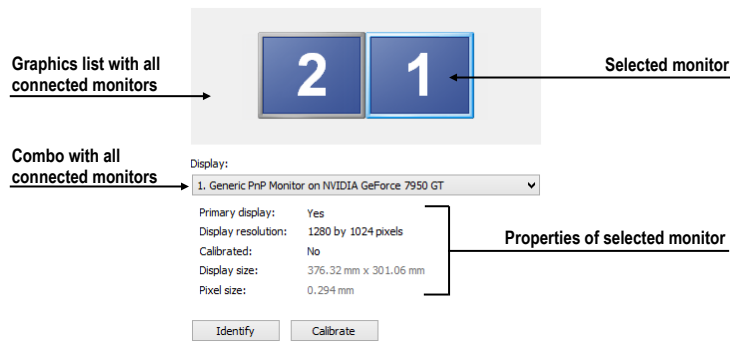
Figure 74 – Monitor settings

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

1. Select the required monitor in the preview frame and click **Calibrate**. For assistance, use the identify function to determine the desired monitor – click **Identify** to show the number on each connected monitor, corresponding to the number noted in the preview frame.

2. The **Full screen calibration** dialog is displayed on the selected monitor (see Figure 75).

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).
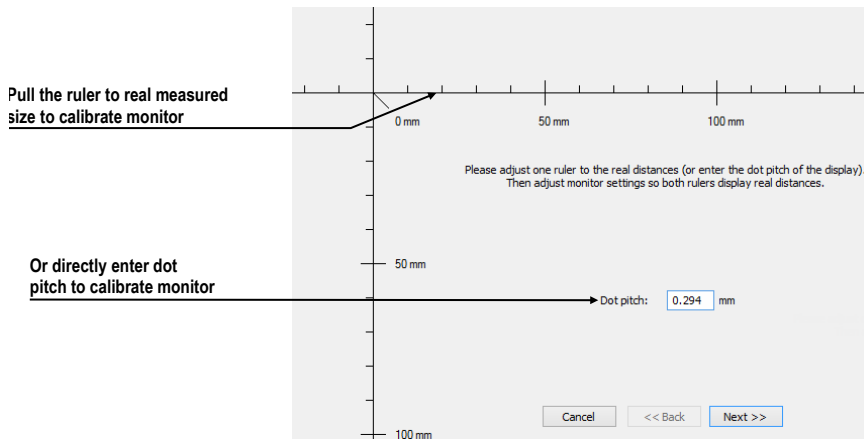
Figure 75 – Monitor calibration

4. Click **Next**.

5. Verify the calculated calibration size with the actual physical distance measurement tool (ruler) and click the **Finish** (see Figure 76).
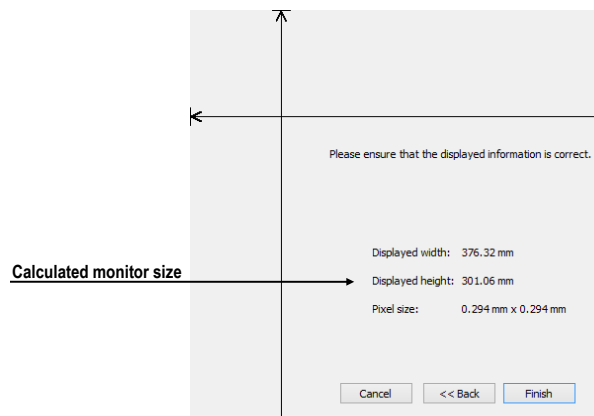
Figure 76 – Monitor calibration verification

4.8   Mammography

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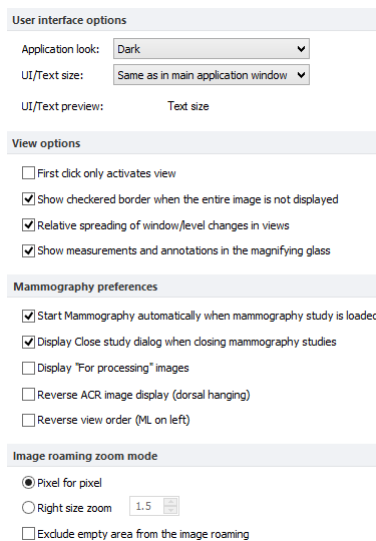
Figure 77 – The Mammography tab of the TomoCon options dialog

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 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 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 dashed 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 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 checked, the magnifying glass in mammography is displayed with additional view objects such as measurements and mammography graphic annotations.
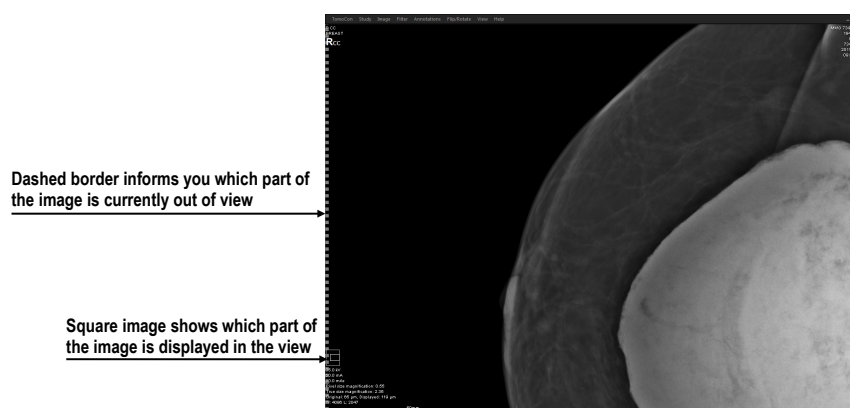
Figure 78 – Active checkered border

Mammography preferences:

- The **Start Mammography automatically when mammography study is loaded** check box – if checked, the mammography study is opened in the mammography mode.

- The **Display Close study dialog when mammography study is being closed** check box – if checked, the **Close study** dialog is displayed to confirm study closing when attempting to close a study.

- The **Display "For processing" images** check box – if 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 checked, the image is displayed in dorsal orientation.

- The **Reverse view order (ML on left)** check box – if checked, the ML images are placed at the first positions in the image navigator.

Image roaming zoom mode:

- The **Pixel for pixel** radio button – if selected, each image is displayed so that one pixel in the display corresponds to one image pixel.

- The **Right size zoom** radio button – if 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 checked and the image contains areas with air only, and then these areas are skipped when image roaming is being used.

4.9   Mammography workflows

The **Mammography workflows** tab of the **TomoCon 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 26.8 Workflows.

4.10 DICOM options

The following settings of the DICOM receiver and DICOM local studies in TomoCon are available through the **DICOM** tab of the **TomoCon Options** dialog (see Figure 79):

- **Local studies options** – the local studies folder properties (see 4.10.1 Local studies options).

- **Database maintenance** – tools for compacting and rebuilding the database of local studies (see 4.10.2 Database maintenance).

- **Studies worklist** – the settings of the patient worklist that contains the studies important for the user (see 4.10.3 Studies worklist).

- **DICOM receiver settings** – the settings for receiving DICOM data in TomoCon (see 4.10.4 DICOM receiver settings).

- **Remote DICOM devices** – the external devices settings for DICOM data exchange (see 4.10.5 Remote DICOM devices).
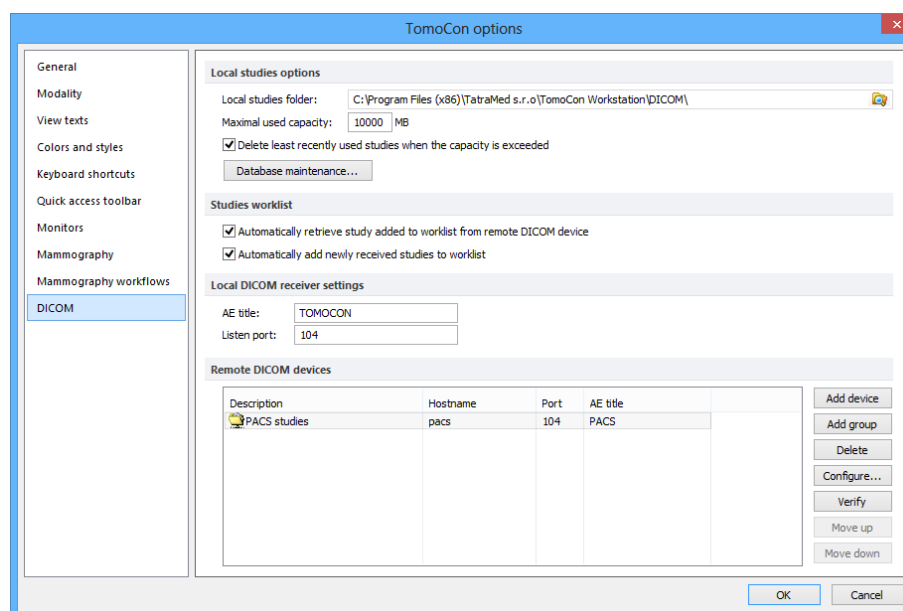
Figure 79 – DICOM page in TomoCon options dialog

4.10.1 Local studies options

It is possible to define a folder and its options for local studies in TomoCon in the **Local studies options** section of the **DICOM** tab (see Figure 80).
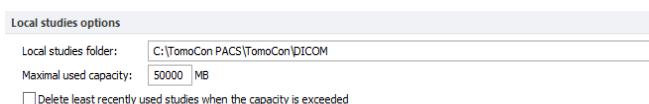
Figure 80 – Local studies options section of the DICOM tab

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

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

TomoCon 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. In such cases, the studies become no longer readable. To overcome this problem, TomoCon provides compacting and repairing functionality for the local studies database (called database maintenance).

To access database maintenance, click **Database maintenance** button in the **Local studies options** section. The **Database maintenance** dialog (see Figure 81) opens.
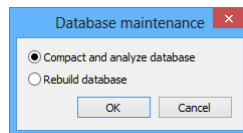
Figure 81 – Database maintenance

To avoid excess amounts of wasted disk space in local studies, select the **Compact and analyze database** option and click **OK.** The progress dialog will be displayed as the database will be optimized.

To repair a damaged database, select the **Rebuild database** option and click **OK.** The progress dialog will be displayed and the database will be recreated.

4.10.3 Studies worklist

Worklist is a list of studies to be examined in TomoCon. The worklist can refer to local studies, as well as studies on any remote DICOM device. This list is accessible in the **Search studies** dialog.

Worklist can be managed manually (see Figure 82). Alternatively, check **Automatically add newly received studies to worklist** check box on the **DICOM** tab of the **TomoCon options** dialog (see 5.9 Patients worklist) to automatically add all the retrieved studies to the worklist.
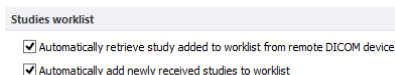
Figure 82 – Studies worklist section of the DICOM options tab

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 the following properties in the TomoCon options dialog (see Figure 83):

- **AE Title** – TomoCon application title to be used for DICOM connection
- **Listen port** – a port for receiving DICOM connection and DICOM data

Figure 83 - Local DICOM receiver settings section of the DICOM tab

4.10.5   Remote DICOM devices

Each remote DICOM device configured in TomoCon (PACS, 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 84 – 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 **TomoCon options** dialog (see Figure 84):

- To add a new DICOM group, click the **Add group** button. Enter the group name into the edit box and confirm with the **OK** button.
- To add a new DICOM device as a separate item, click **Add device** button to display the **Device configuration** dialog (Figure 85). Fill in the fields and click **OK** to confirm.
- 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 (Figure 85) is displayed. Fill in the fields and click **OK** to confirm.

- To modify a group or a DICOM device, click **Configure…**. The **Device configuration** dialog is displayed, where the information concerning a group or device can be modified (see Figure 85).

- To verify the connection to a configured DICOM peer, click **Verify**.

- To change the order of configured devices and groups, or to move devices into/from groups, use the **Move up** and **Move down** buttons.
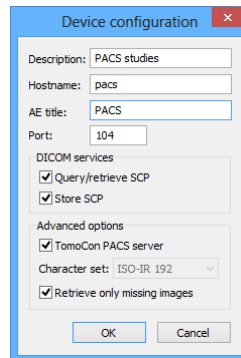
Figure 85 – Device configuration dialog

5 Managing studies

For the management of DICOM studies, TomoCon provides the **Search studies** dialog (see Figure 86) 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 CD/DVD discs and to manage the worklists of studies.

To display the **Search studies** dialog, click **Open** 📂 in the main TomoCon toolbar or select the **Open study…** item in the **Study** main menu (see 3.4 Main menu).
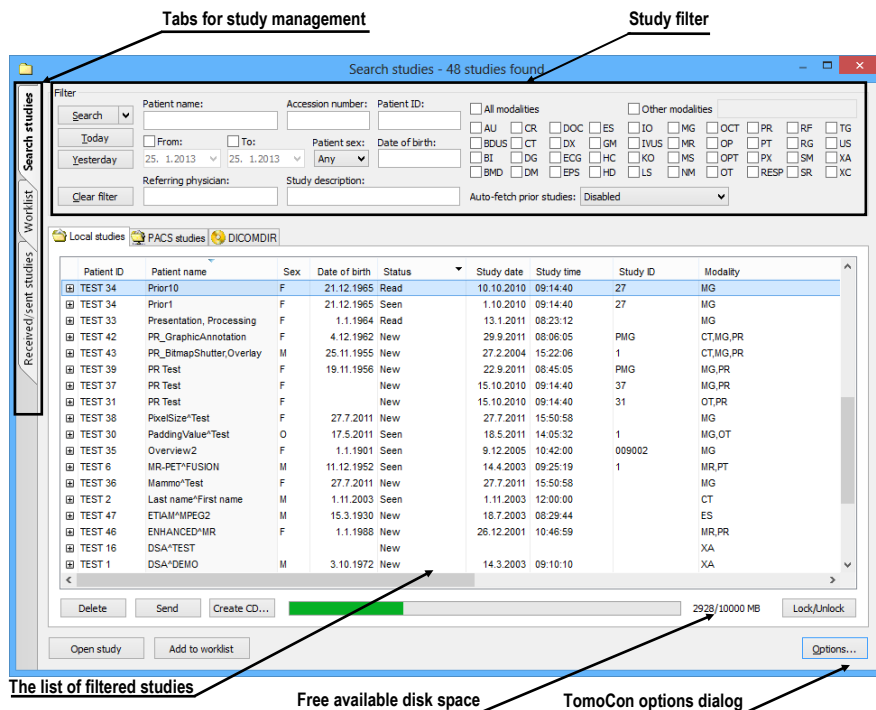
Figure 86 – Main parts of Search studies dialog

The **Search studies** dialog (see Figure 86) contains the following main 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 5.9 Patients worklist).

- A tab for monitoring sent and received studies (see 5.8 Monitoring and controlling send/receive jobs).

- Tabs for configurable DICOM devices, including a tab for local studies of TomoCon and DICOMDIR. Each device is represented by a separate tab on which TomoCon displays the searched studies (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.

Figure 87 – Rearranging columns in the Search studies dialog 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 88). The series list can be hidden by clicking on the ⊟ symbol.

Figure 88 – 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 89). Each prior study can also be expanded to show the series list by clicking the ⊞ symbol.

Figure 89 – 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 90). Check the columns to make them visible, or uncheck them to hide.

Figure 90 – 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 as a separate tab with its own list of searched studies (see Figure 91).

Figure 91 – 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 92), then click **Search** to start the search process.

TomoCon provides the following parameters for criteria specification:

- **Patient name**, **Accession number**, **Patient ID**

- Examination date: **Today**, **Yesterday**, **From – To**

- **Date of birth**, **Sex**

- **Modality** (**All Modalities**, Select a modality)
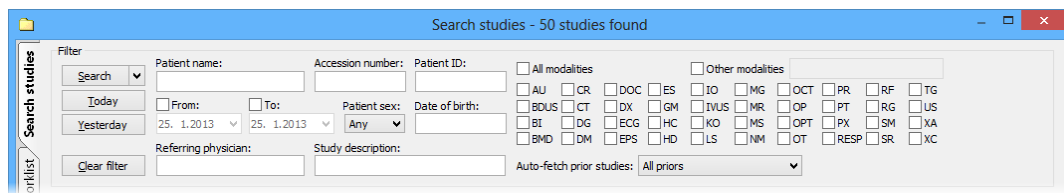
Figure 92 – Search section of the Search studies dialog

5.2.1   Managing search filters

Search filters allow defining custom group of predefined search criteria and providing more efficient study search in TomoCon. 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 93).

To display the **Search** menu, click ⌄ icon on the **Search** button in the **Search studies** dialog. The list of all stored search filters is then displayed above the **Search** button, where the required filter can be selected.
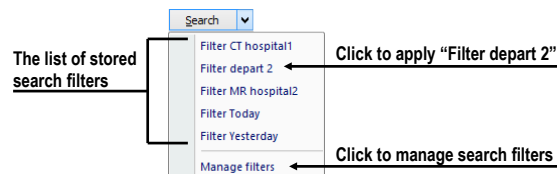
Figure 93 – Search menu with stored search filters

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 93). The **Manage filters** dialog (see Figure 94) 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:

1. Click **New**.

2. Define the name of the filter in the **Filter name** edit box and define the searching criteria in the **Filter** section.

3. 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.
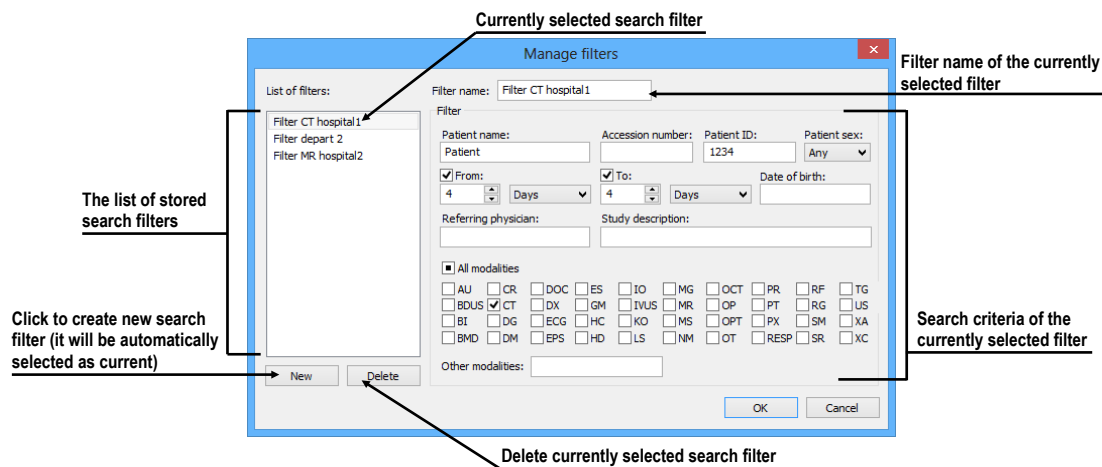
Figure 94 – Manage filters dialog

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**.

5.2.2   Search by selected study

In addition, it is possible to search studies according to the main parameters of the selected study (see Figure 95) in the **Search studies** dialog.
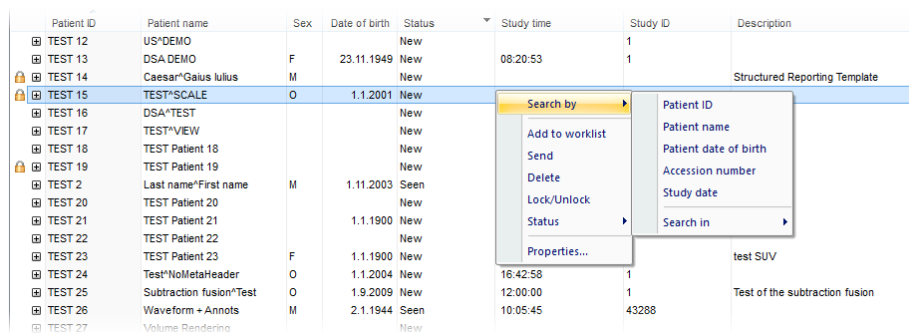
Figure 95 – Searching studies according to a selected study parameter

The search parameter is defined in the **Search by** item 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.

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 (see Figure 96).
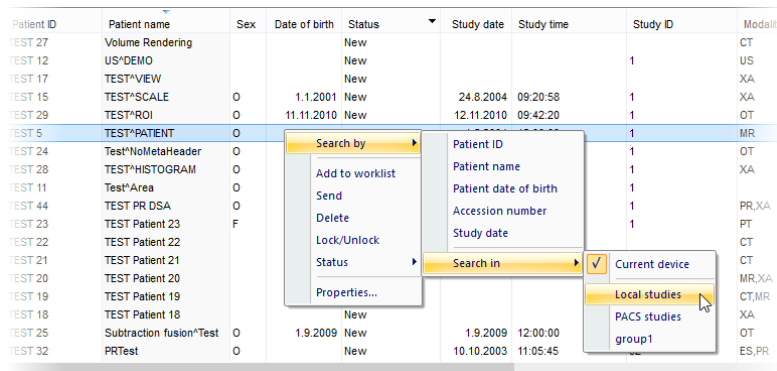
Figure 96 – Searching in a specific storage

5.2.3   Local studies

TomoCon saves all open/retrieved DICOM data in a local DICOM storage (stored on the 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 in TomoCon by clicking **Open study**.

- Locking a study against automatic deletion; by clicking **Lock/Unlock**, the study becomes locked against automatic deletion.

- Sending a study to an external PACS server; a selected study can be sent to a configured 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 25 Archiving images on a CD) in which you can add a selected study to the list of studies ready for burning.

- Defining and searching by study status (see 5.2.4 Study status).
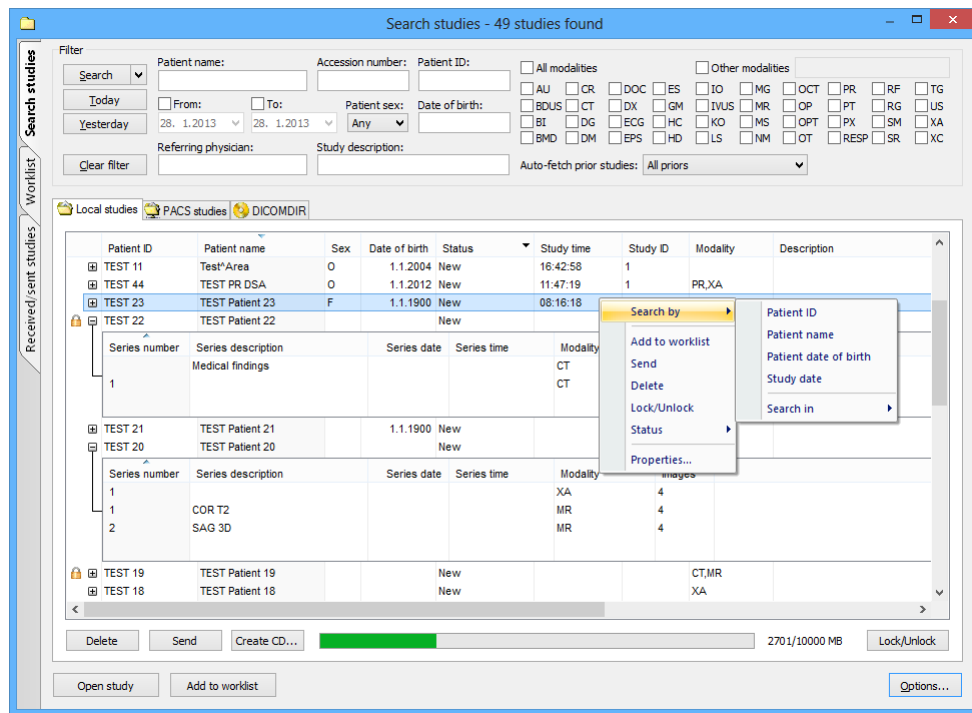
Figure 97 – Search studies dialog, the Local studies tab

While receiving/sending a study to/from Local studies, the retrieving process can be moved to the **Queue management** by checking the **Move to Queue** check box (see Figure 98). The process will run in the background in **Receive/Send** queue, not blocking any further work with TomoCon.
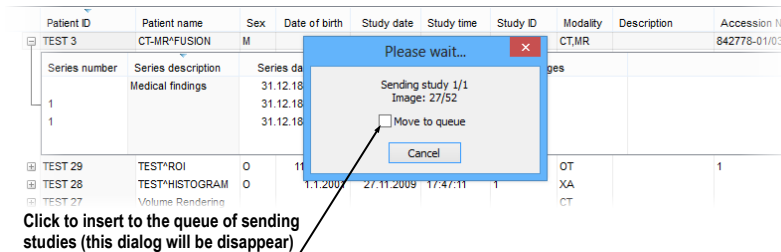
Figure 98 – Search studies dialog; receiving a study from a remote device to the Local studies

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 in TomoCon yet and to identify viewed, read and reported studies in Local studies of TomoCon. 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 in **Search studies** dialog.
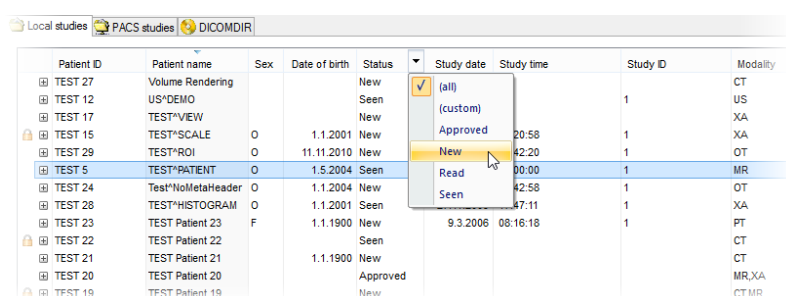
Figure 99 – Filtering by study status in the local studies

To filter studies on the **Local studies** tab, 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 in TomoCon, its status automatically changes to **Read** or **Seen** (according to the study closing process). In addition to automatic change, you can also manually set each type of study status according to the currently performed diagnosing steps.

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 (see Figure 100).
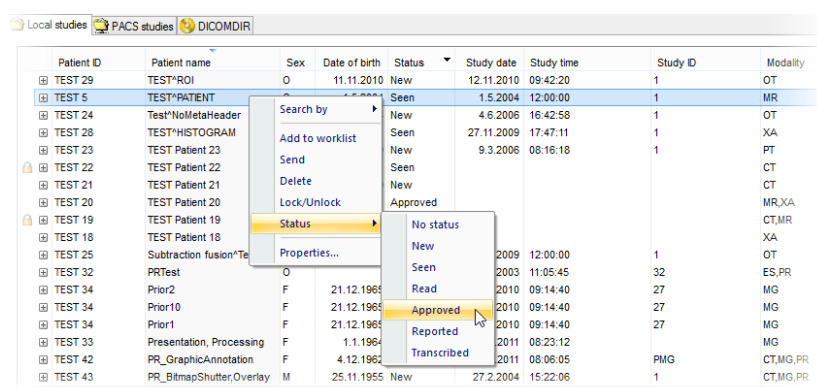
Figure 100 – Setting study status

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 – PACS servers. 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 (a PACS server, modality, etc.), 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.

Additionally, 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 101).
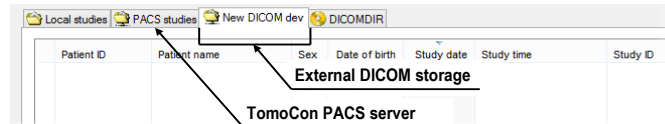
Figure 101 – New configured external DICOM storage

It is possible to merge multiple external DICOM storages into named groups. In this case, the tab in the **Search studies** dialog represents the entire group of configured external DICOM devices (see Figure 102). The search process of the studies is carried out step by step on all storages in the group. During this process, it is possible to exclude duplicate searched studies. To do so, check the **Hide duplicate studies** check box. In order to configure groups of external DICOM devices, go to the **DICOM** tab of the **TomoCon options** dialog (see 4.10 DICOM options).
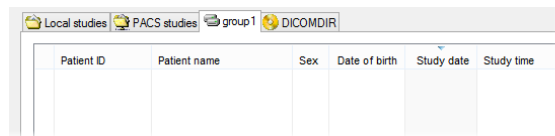
Figure 102 – Group of external DICOM devices

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

1. Set the filter and 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 103).
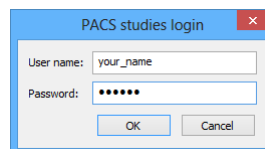
Figure 103 – PACS studies login dialog

2. The studies stored on the server that meet the filtering conditions will be included in the list (see Figure 104).

3. Select the study from the list and carry out one of the following operations:

   o Click the **Retrieve** button to only store the study in the local studies.

    o   Click the **Open study** button to store the study in the local studies and open it in TomoCon.

    o   Click the **Add to worklist** button to add the study to the patient worklist (see 5.9 Patients worklist).
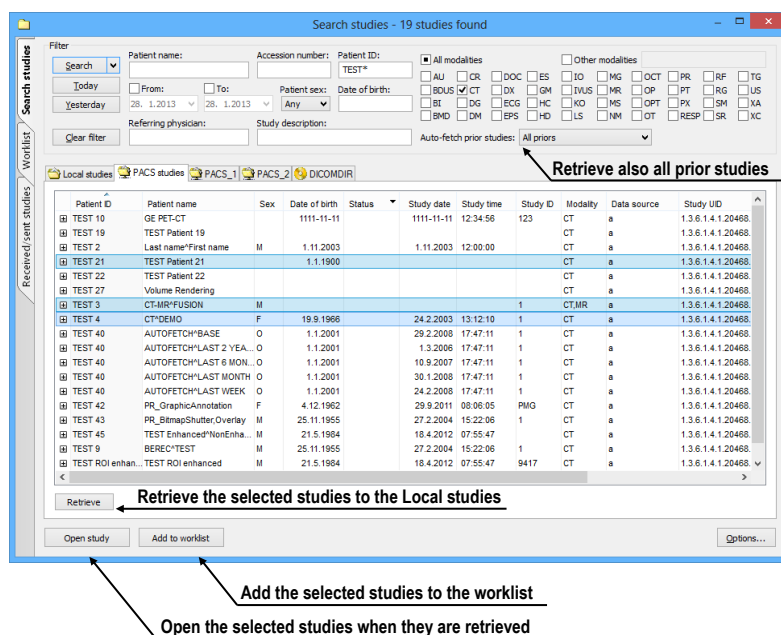
Figure 104 – Retrieving studies from the PACS server to the Local studies

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).

5.2.6   DICOMDIR

> *i*   This functionality is only available in TomoCon Workstation.

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 in the TomoCon application (see Figure 105).

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 (you will be asked to confirm this step).

4. All DICOM files found in the specified folder (or defined in the DICOMDIR file) are displayed in the studies list.
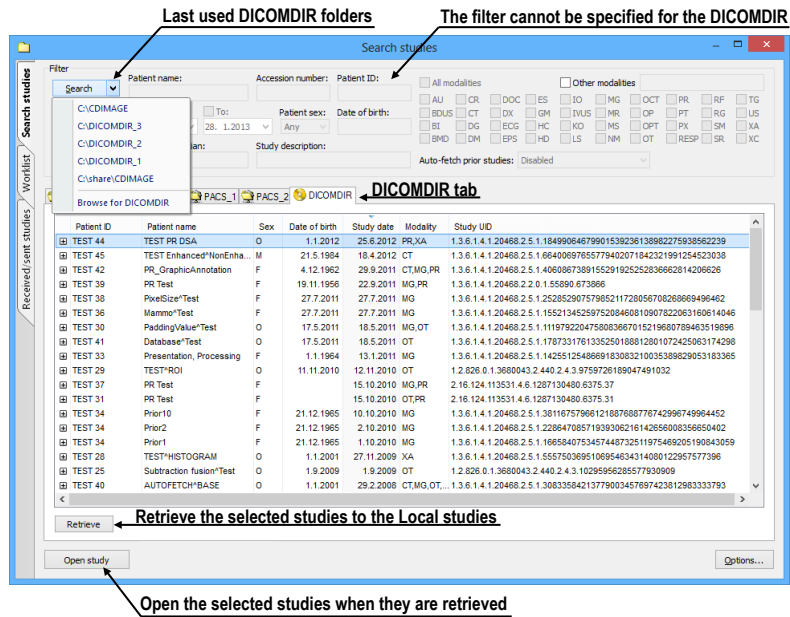
Figure 105 – DICOMDIR in the Search studies dialog

5.3 *Auto fetch prior studies*

The TomoCon application allows using auto-fetching of prior studies for a selected study in the **Search studies** dialog when the following operations are carried out:

- the study is opened

- the study is added to the worklist (see Figure 106)

- the study is retrieved from the remote DICOM device

Figure 106 – Study in the worklist with 2 priors

This functionality makes it possible to work with the study and its priors as an entire package. 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 are displayed (see Figure 107) in which you can select the studies that are to be considered as priors.
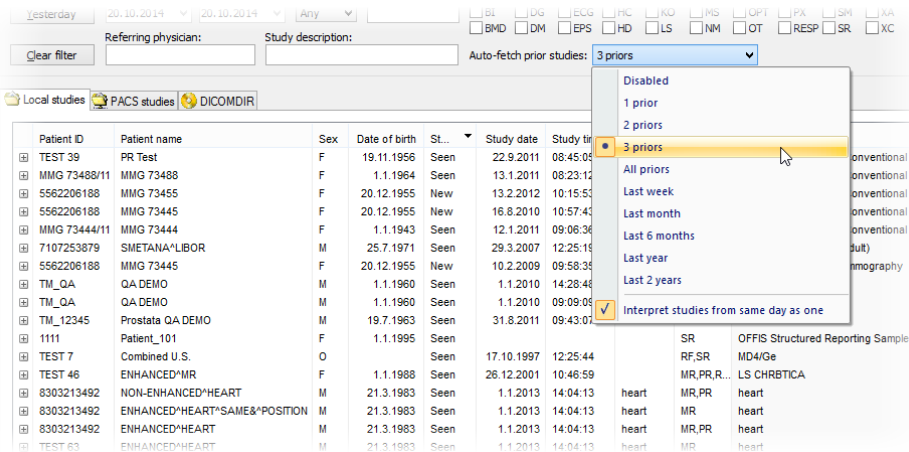
Figure 107 – Selecting Auto-fetch prior criteria

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.

5.4   Opening a study

To open a study in TomoCon using the **Search studies** dialog, select the required tab (storage), click the row of the study (see Figure 108) and click the **Open study** button or double-click the row. The study immediately opens with all of its series. If the study is stored on storage other than the local studies, the study is firstly downloaded in the local studies.
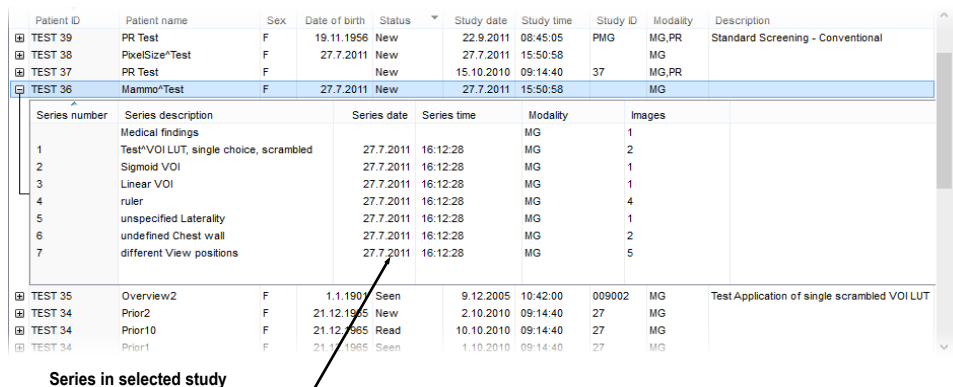
Figure 108 – Expanded series of a selected study

To open only a certain series of a selected study, expand the study (by clicking the ⊞ symbol), select the series you want to open 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 (see Figure 109) or series; by pressing the **Shift** button, you can select a group of studies.

Figure 109 – Multi selection of series with enhanced CT images

5.5 Opening prior studies

Once a study of patient is opened into TomoCon, 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 TomoCon 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 menu or the **Open prior studies…** item in **Open** context menu in the main toolbar (see Figure 110 a)

- or 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 110 b).

(a)   (b)
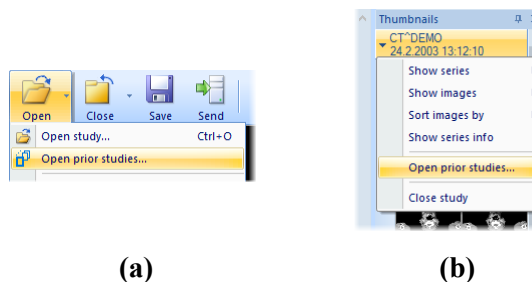
Figure 110 – Display Open prior studies dialog, using Open context menu, b) using thumbnail palette

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

The second part of the dialog contains action buttons and list of currently searched 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 (**Update**).
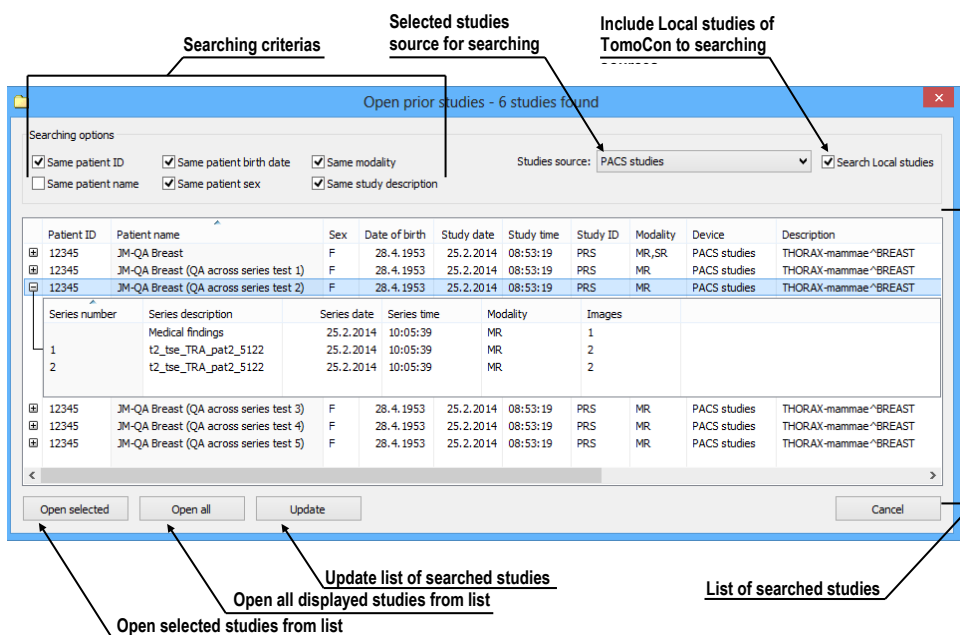
Figure 111 – Open prior studies dialog

5.6   *Closing and saving a study*

> *i*   The saving functionality is not available in TomoCon Lite.

Usually, the final step in the viewing and diagnosing process with opened study images in TomoCon 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 is initiated automatically.

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

- Click Close button in the main toolbar (see Figure 112a).

- Expand **Close** button in the main toolbar and select the **Close all studies** item in the drop-down menu (see Figure 112b).

- Select **Study**/**Close** item in the main menu (see Figure 112c).

(a)   (b)   (c)
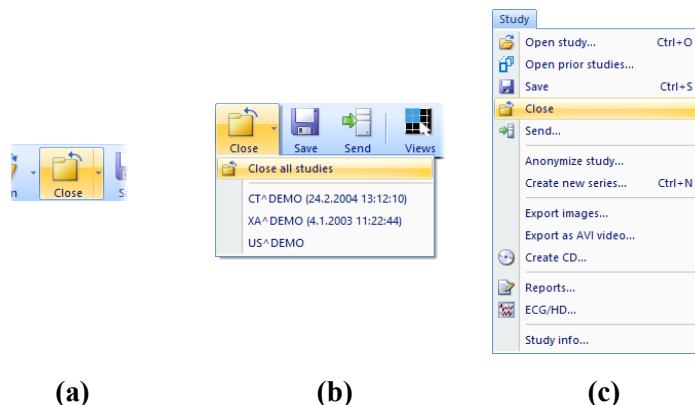
Figure 112 – Closing all studies

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 113a).

- 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 (see Figure 113b).

(a)   (b)
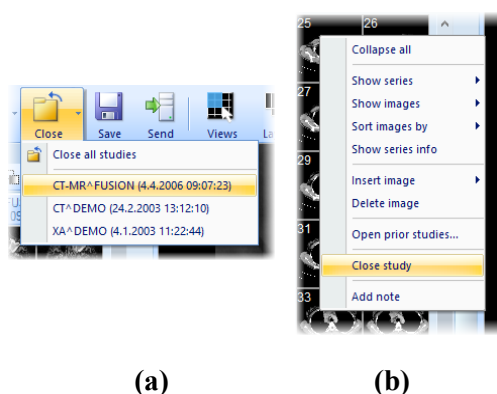
Figure 113 – Closing a selected study

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.

If none of the studies to be closed have been changed, all the studies are immediately closed. If changes have been made to any of the objects mentioned above, a

confirmation dialog containing the question "Do you want to save the changes?" is displayed (see Figure 114).
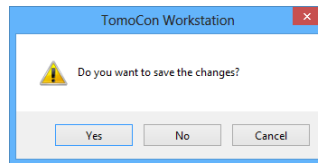
Figure 114 – Change confirmation dialog when saving a study

If you click the **Cancel** button, neither saving nor closing will be carried out. If you click the **No** button, the study will be closed without the saving of any of the changes. If you click the **Yes** button, all changes will be saved (on your local storage) and the study will be closed.

When changes are being saved, the **Please wait…** dialog is displayed (see Figure 115) in which you can monitor the progress of the saving process.
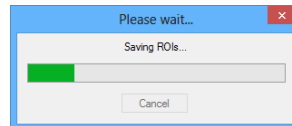
Figure 115 –Please wait… dialog when saving changes

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 (see Figure 116):

- Click the **Save** button in the main toolbar (see Figure 116a).

- Select the **Study**/**Save** item in the main menu (see Figure 116b).
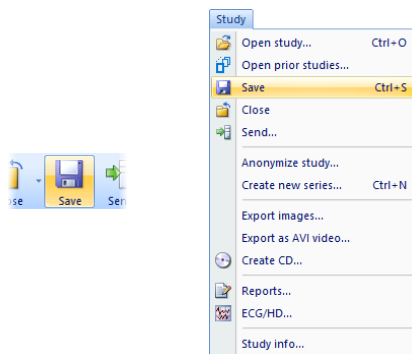
(a)   (b)

Figure 116 – Saving changes without closing a study

5.7 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 117) 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 **TomoCon options** dialog (see 4.10.5 Remote DICOM devices).
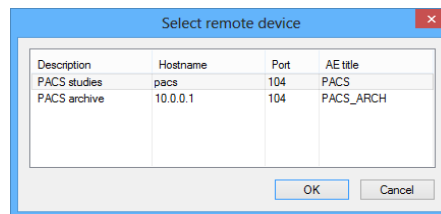
Figure 117 – Select remote device dialog

5.8 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.
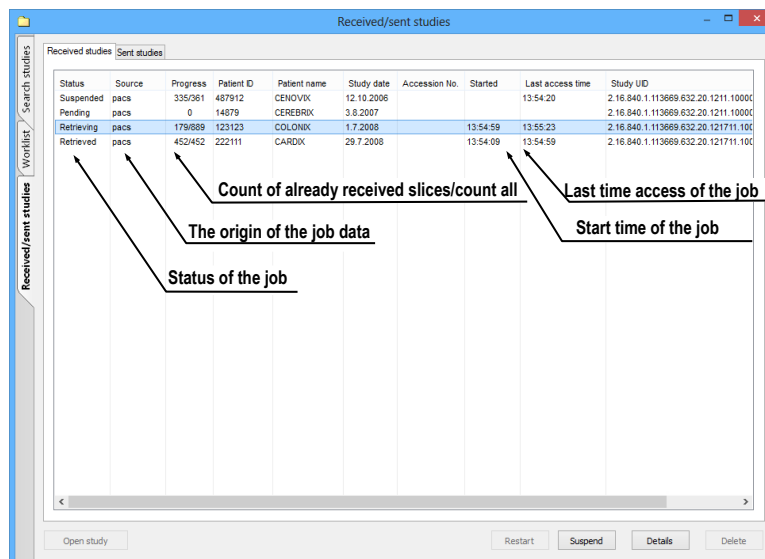
Figure 118 – Received studies tab

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, and displays all sending/sent jobs. Each list on the tabs displays the main pieces of information concerning received/sent studies (see Figure 118) 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).

5.8.1 Managing receiving/sending jobs

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

To manage a receiving job in the **Received studies** list, you can select from the following operations (see Figure 119):

- Suspending an active job (by clicking the **Suspend** button).

- Restarting a job from the suspended status (by clicking the **Restart** button).

- Deleting a job if it is not in the receiving status (by clicking the **Delete** button).

- Displaying detailed information concerning a job (by clicking the **Details** button).

- Opening a study in TomoCon if its job is already in the received status (by clicking the **Open study** button).
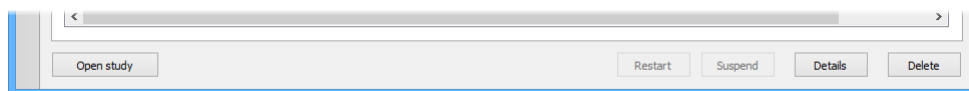
Figure 119 – Manage buttons on the Received studies tab

To manage a sending job in the **Sent studies** list, you can select from the following operations (see Figure 120):

- Suspending an active job (by clicking the **Suspend** button).

- Restarting a job from the suspended status (by clicking the **Restart** button).

- Continuing with a job from the suspended status (by clicking the **Continue** button).

- Deleting a job if it is not in the sending status (by clicking the **Delete** button).

- Displaying detailed information concerning a job (by clicking the **Details** button).
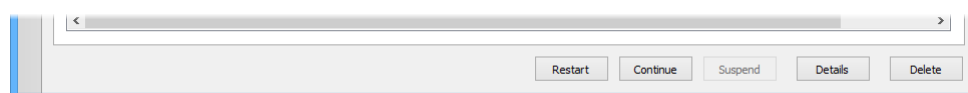
Figure 120 – Manage part of the Sent studies tab

Clicking the **Details** button (or double-clicking an item in list) opens the **Task details** dialog (see Figure 121) 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.
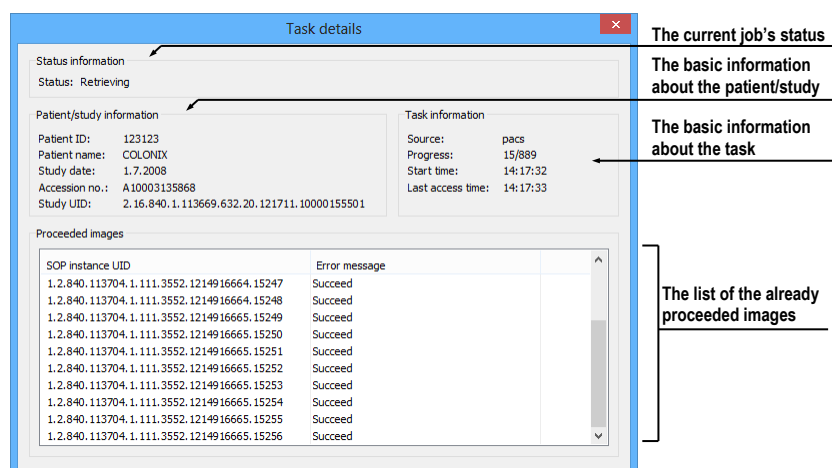
Figure 121 – The Task details dialog displaying detailed information concerning a job and study

5.8.2   Jobs notification

The TomoCon application also provides you 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 122).

Figure 122 – Tool tips containing 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 (see Figure 123). You can then decide whether to cancel the job(s) and exit TomoCon or to wait until the process is complete.
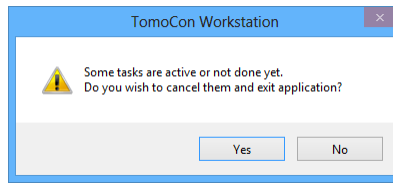
Figure 123 – When attempting to exit TomoCon, you can cancel any running jobs or wait until the process is complete

5.9 Patients worklist

When you need to load a patient study into TomoCon, 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, which contains the studies designated for viewing in TomoCon. The patient worklist is the list from you can sequentially open prepared patient studies. 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 in TomoCon.

To display the patient worklist, go to the **Worklist** tab of the **Search studies** dialog. To display the **Search studies** dialog, see 5 Managing studies.

The patient worklist tab contains the list of the studies queued in the worklist and all tools for managing the content of the worklist (see Figure 124).
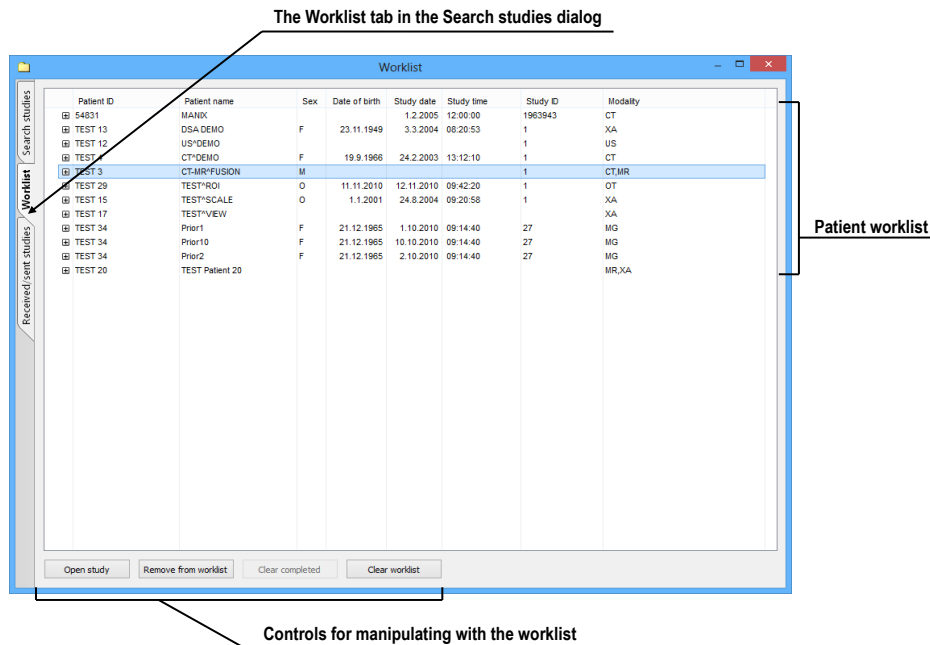
Figure 124 – The Worklist tab of the Search studies dialog

This studies list is the same as the studies list on the **Search studies** tab. The main rows in the list represent the studies (see Figure 125). 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.

Figure 125 – Studies in a worklist

5.9.1 Adding a study to a worklist

It is possible to add a study to the worklist from your 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 TomoCon to display the **Search studies** dialog.

2. Set the filtering parameters and carry out the search on your local studies location or any remote PACS storage.

3. Click the **Search** button and select the studies you want to add to the worklist.

4. Set the parameters of the prior studies filter (see Figure 126), which defines the group of automatically added prior studies of the selected study in the worklist.

5. Click the **Add to worklist** button or select the **Add to worklist** item in the context menu.
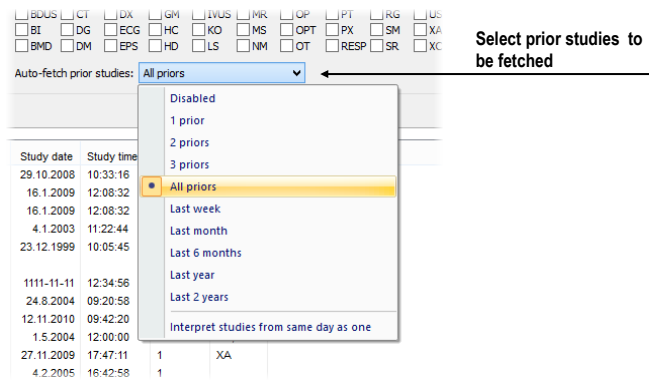
Figure 126 – Specifying which prior studies should be received

To activate automatic addition of all received studies in TomoCon, enable the **Automatically add newly received studies to worklist** option on the **DICOM** tab of the **TomoCon options** dialog (see Figure 127).
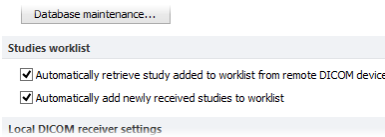
Figure 127 – Settings for automatic receiving for the worklist

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 128). As a result, whenever you add a new study to the worklist, the retrieval process starts automatically. To activate this option, check the **Automatically retrieve study added to worklist from remote DICOM device** option in the **TomoCon options** dialog.
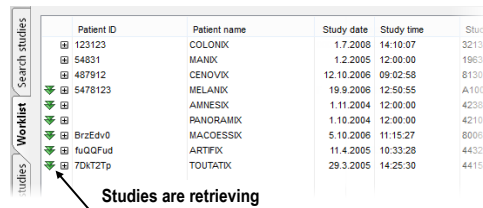
Figure 128 – Automatic retrieval of a study being added to the worklist

5.9.2 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 130) 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 129).

Figure 129 – Four read 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.

    4. The selected item(s) will be moved upward or downward within the table.
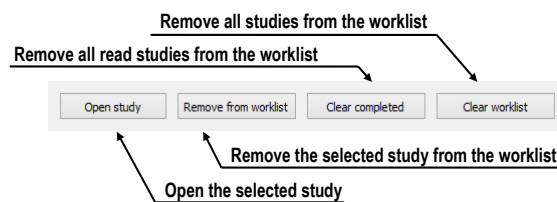
Figure 130 – Manage part of the Patient worklist tab

- Removing a selected study from the worklist (by clicking the **Remove** button, see Figure 130).

- 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 you to access all worklist studies automatically. 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 (see Figure 131).
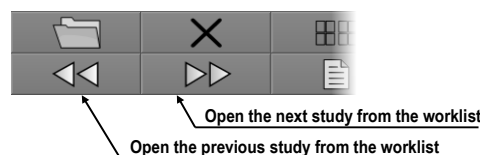
Figure 131 – Worklist buttons in the mammography toolbar

6 Viewing images

TomoCon application allows you to review images of all loaded studies, in any view of your working area (see 6.1 Display image in view). For displaying possibilities 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, proceed as follows:

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 (see Figure 132b). The image will be displayed in the current view.

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 image will be displayed in this view and the view will change to the current view (see Figure 132a).
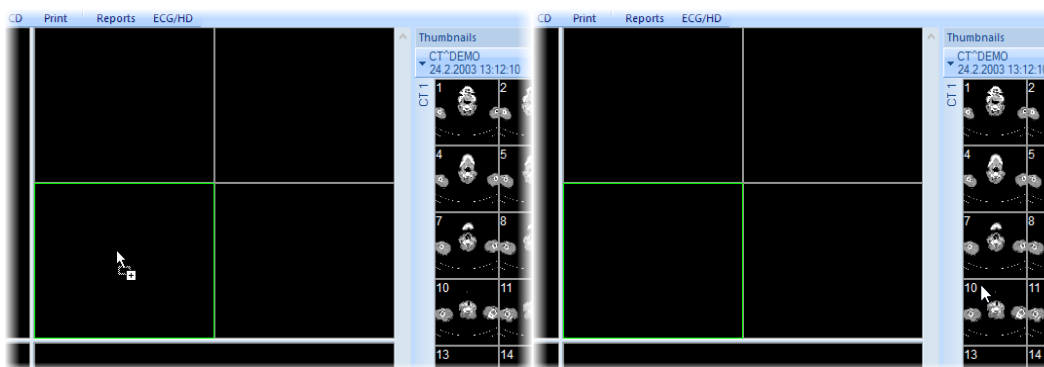
(a)   (b)

Figure 132 – Displaying image in view using drag&drop (a), by selecting image (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 in 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 133).

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.
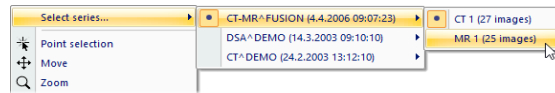
Figure 133 – Series selection using the context menu

When you select an image in the current, non-pinned view, the application automatically creates a sequence (see Figure 134) containing all non-pinned views from the current segment and from all other segments linked to it (see 6.3 Image sequence).

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.
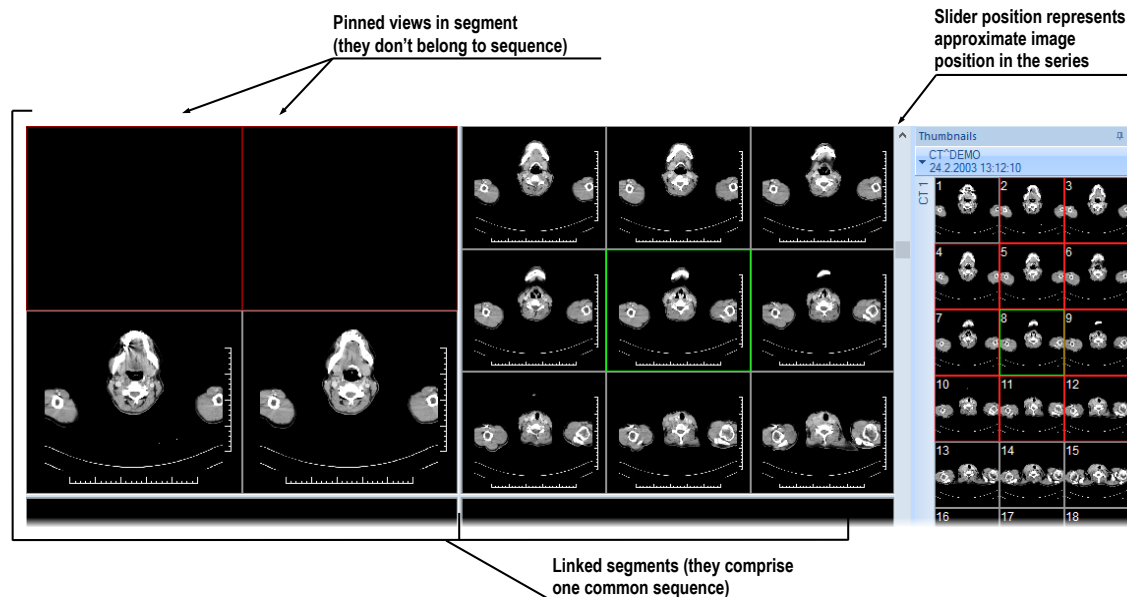
Figure 134 – Working area with non-multiframe image in current view

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 135). The upper part of the scrollbar represents the image in the current series and the lower part of the scrollbar represents the frames 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.
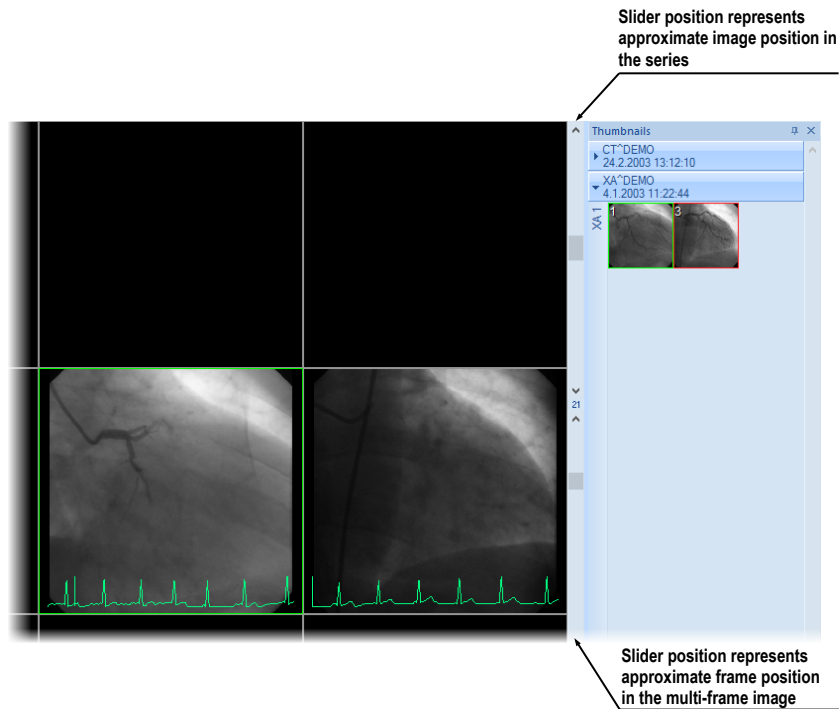
Figure 135 – Working area with multiframe image in current view

6.1.2 Multidimensional series

When a multidimensional series is loaded into the TomoCon application, 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 136).
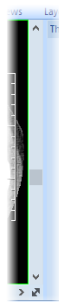
Figure 136 – Standard scrollbar of the current view

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 137). 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.
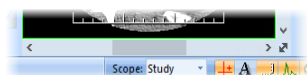
Figure 137 – Dimension scrollbar of the current view

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 (see Figure 138).

- 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.
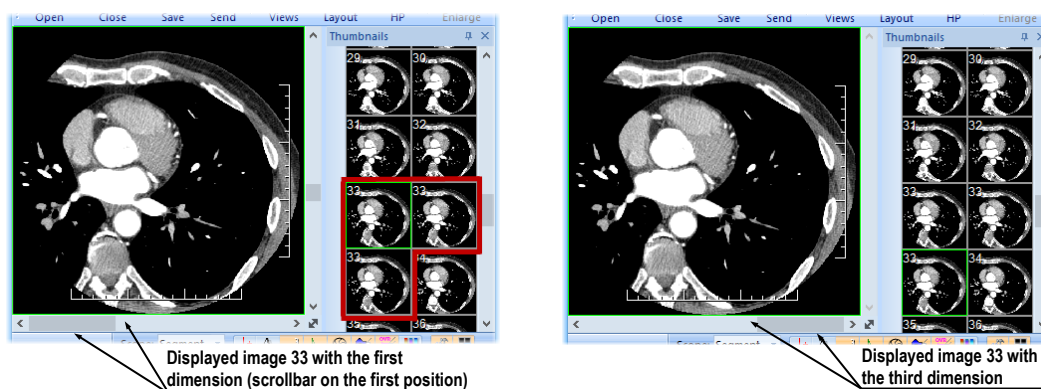
Figure 138 – Displayed image with the first and the third dimension in the current view

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 you to scroll in the current view by moving the mouse. Horizontal movement allows you 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 139). When the scroll mode is active, the mouse cursor is displayed as ⬍.
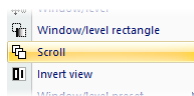
Figure 139 – Scroll item in the context menu

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 140).
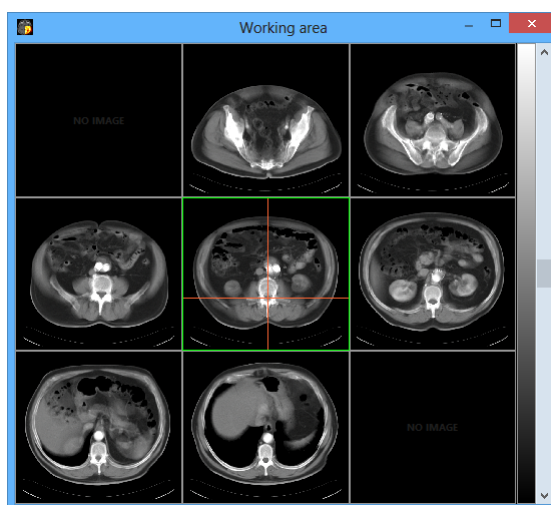
Figure 140 – Automatic fill-in of a 9-view segment

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.

To select the view mode, click ■ **Views** in the **Segment views** section of the **Define layout** tool or click ■ **Views** in the main toolbar of the application (see Figure 141).
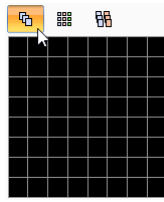
Figure 141 – Selecting the display mode

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.

As an 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 142).
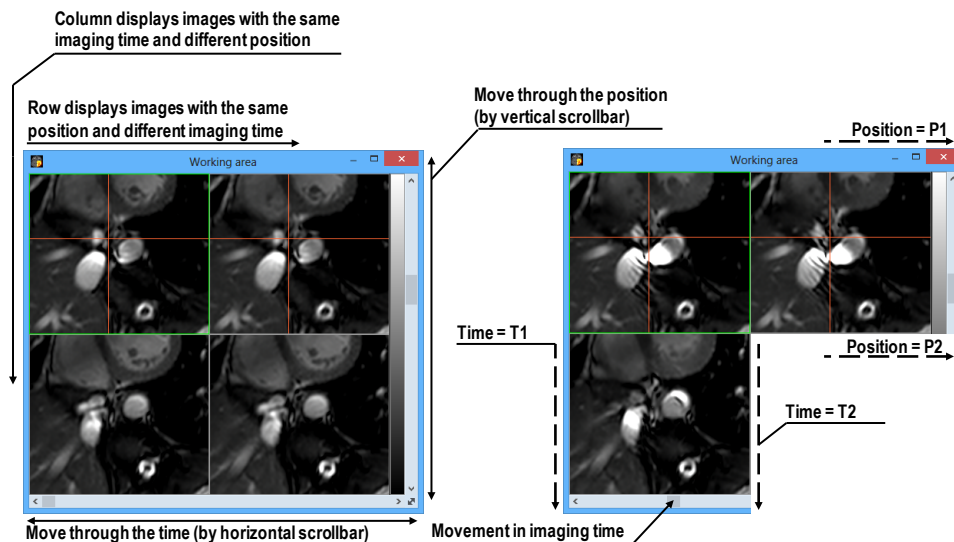
Figure 142 – Multi-dimensional series in a segment in the Matrix mode

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), while 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 143).
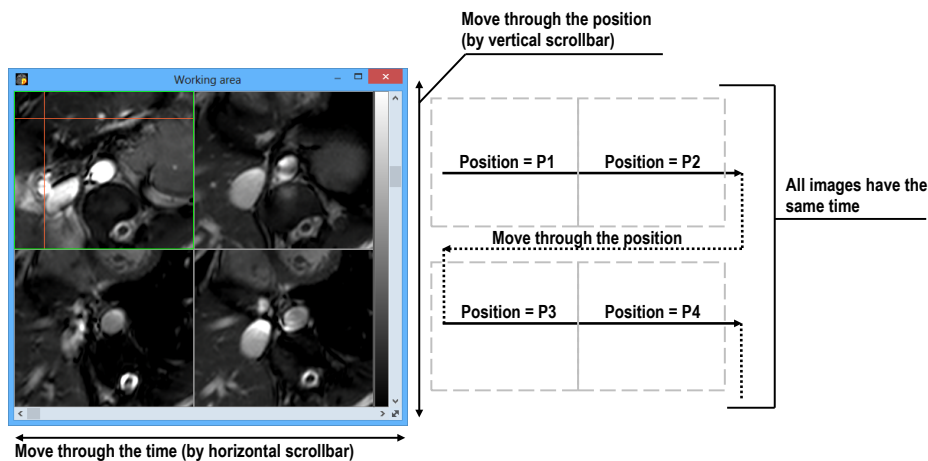
Figure 143 – Multi-dimensional series in a segment in the Stack mode

6.2.3 All mode

In the **All** mode, the images are ordered in a traditional way – the ordering is the same, as in the thumbnail palette. The ordering is independent on any multi-dimensional properties of the series.
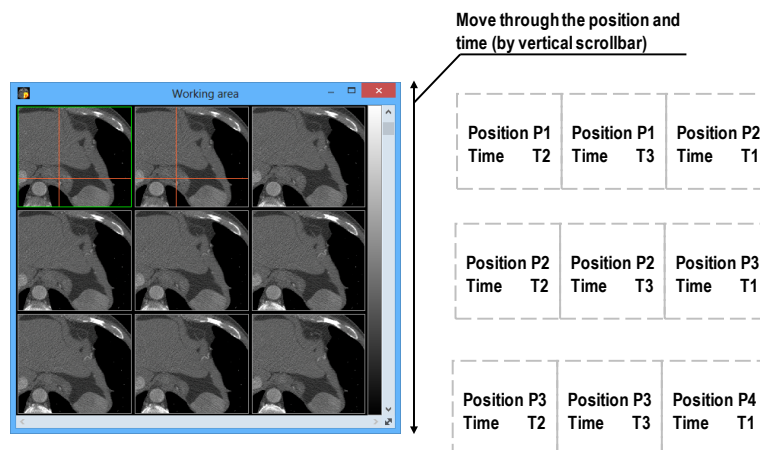
Figure 144 – Multi-dimensional series in a segment in the All mode

The horizontal scrollbar is disabled in this mode. The vertical scrollbar controls the image index in the current view (see Figure 144).

6.3   Image sequence

When a new image is selected in the current view, the TomoCon 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).

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 (see Figure 134).

If you want to create a sequence containing more than one segment, TomoCon allows you to link selected segments (see Figure 146). Proceed as follows:

1. Click the first segment in the sequence.

2. Press the ▣ button on the second tab (the ▬ icon) of the tools panel (see Figure 145).
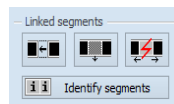
Figure 145 – Linked segments section of the Define layout tool

3. Move the cursor over the working area. The first segment in the sequence will be marked with the number 1.

4. 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.
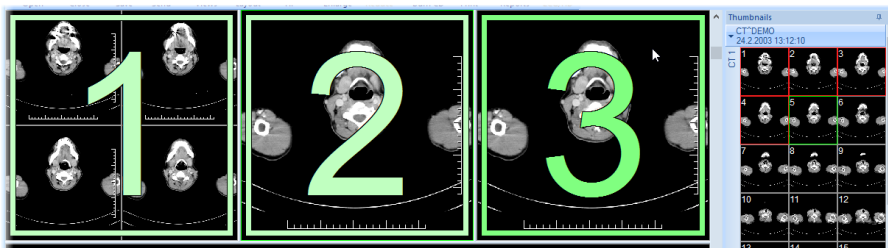
Figure 146 – Linking of segments to a sequence

5. To add further segments, repeat step 4 with the **Ctrl** key pressed. To end the process of linking segments, press the **Esc** key.

To remove a linked segment from a sequence (see Figure 147), proceed as follows:

1. Press the ▣ button on the second tab (the ▣ icon) of the tools panel (see Figure 145).
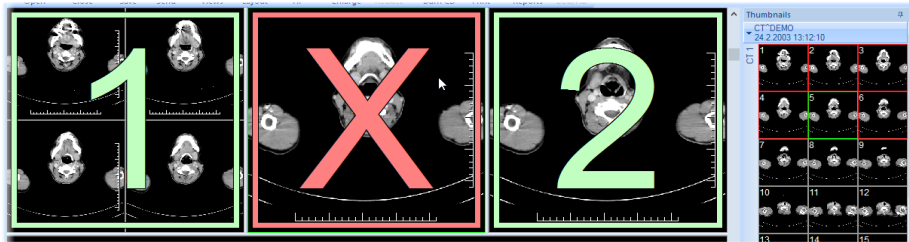
Figure 147 – Removing a segment from sequence

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.

To divide an existing sequence (see Figure 148), proceed as follows:

1. Press the ▣ button on the second tab (the ▣ icon) of the tools panel (see Figure 145).
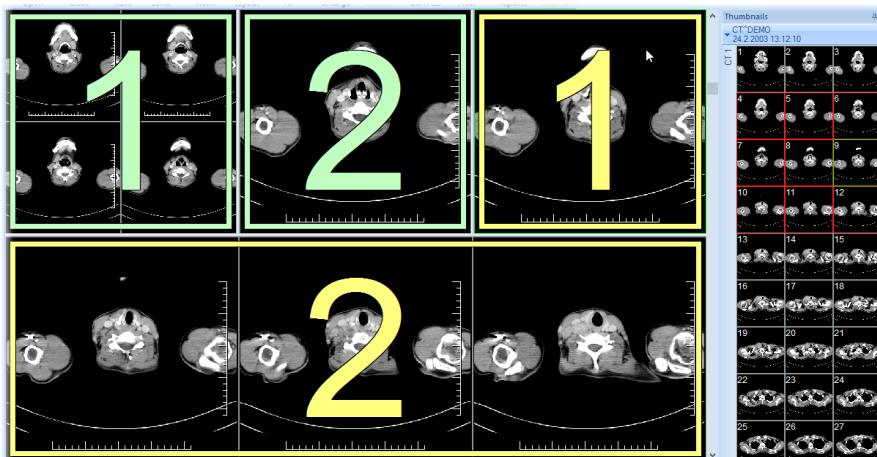
Figure 148 – Dividing an existing sequence

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 they will be in numbered in the new sequence) and click.

6.4   Series synchronization

Multiple series can be "locked" together in order to scroll synchronously within segments. This option is selected by means of the **Segments synchronization** section on the third tab (the tab with the ■ icon) in the tools panel (see Figure 149).
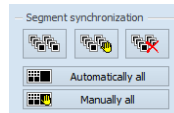
Figure 149 – Segments synchronization section of the Define layout tool

Two synchronization modes are available: the automatic and manual mode for the selected segments and the automatic (**Automatically all**) and manual (**Manually all)** mode for all working areas.

In the automatic mode, images from different series are displayed at the same or corresponding positions. When scrolling one segment, the images in the other segments are also scrolled at the same or corresponding positions. (It is not possible to use this mode when the patient is positioned differently during series scanning.)

In the manual mode, the displayed images in the segments are considered as "currently being displayed at the corresponding positions". When scrolling in one segment, the images in the other segments are scrolled in roughly the same degree.

To define automatic/manual synchronization of selected segments (see Figure 150), proceed as follows:

1. Select the layout of the working area with at least two segments which have the same layout of views.

2. Display the desired series in these segments (in the manual synchronization mode, set the position of the individual series according to your requirements).

3. Select the segment that is to be used as the primary segment (select the current view).

4. Press the ▦ button for automatic synchronization or the ▦ button for manual synchronization and move the cursor over the working area.

5. Click another segment in the working area with the same layout as the primary segment that is to be synchronized with it (the primary segment will be marked as **Pri.**). If you want to add additional segments to the synchronization, hold down the **Ctrl** key while clicking.

6. To add further segments, repeat step 5 with the **Ctrl** key pressed.
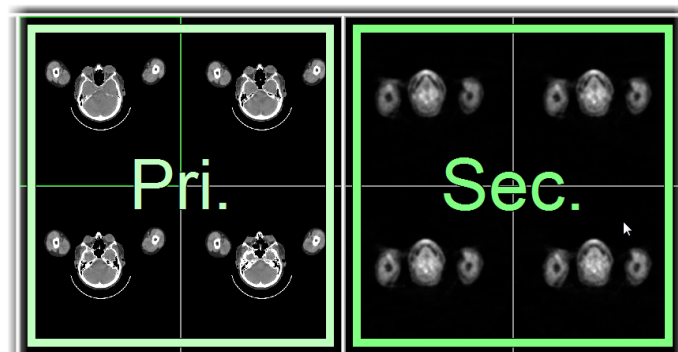
Figure 150 – Definition of synchronization for selected segments

To cancel synchronization of selected segments, proceed as follows:

1. Press the ![button] button and move the cursor over the working area.

2. To remove an entire synchronization, move the cursor over the primary segment (the segment will be marked with a red frame and the label **Pri.**) and click.

3. To remove only one segment from synchronization, move the cursor over it (the segment will be marked with a red frame and the label **Sec.**) and click.

It is possible to synchronize/cancel synchronization of all segments in all working areas at any time simply by pressing the ![icon] **Automatically all**/ ![icon] **Manually all** button in the **Define layout** tool (see Figure 149).

When you insert a segment into series synchronization, the views in this segment are marked with colored icons. These icons identify the synchronization status of the segments (see Figure 151). To define the location of these icons in the view, see 4.3 View texts **-** the **View status** text type.
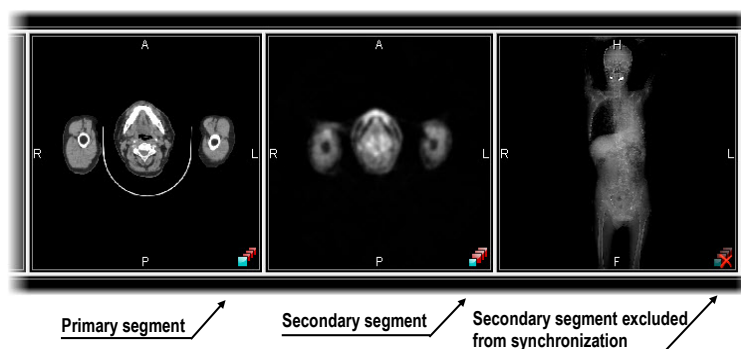
Figure 151 – Segment status in synchronization

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 in the TomoCon application. 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.

TomoCon allows you to quickly create and manipulate cine loops in any view of the working area using the **Cine** tool in the tools panel. The **Cine** tool (see Figure 152) is docked in the tools panel and is accessible at any time by clicking the tab with the 👥 icon.
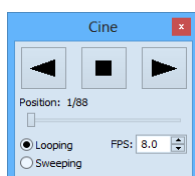
Figure 152 – Cine tool

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.

The **Cine** dialog allows:

- play images in selected direction : forward ▶ or reverse ◀
- stop playing ■
- play images repeatedly: in one selected direction (**Looping**) or in back and forth (**Sweeping**)
- change the frame rate - **FPS** (frames per second)

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 153).
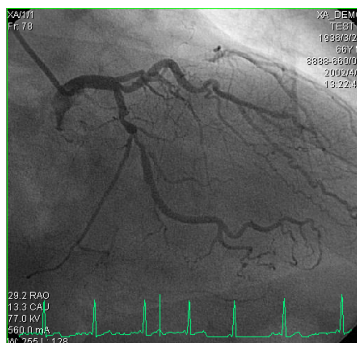
Figure 153 – Cine view playing multi-frame image with the ECG curve

When playing, the current position in the sequence of frames is marked with a small vertical line inside the curve. If the **Double click starts/stops playback** option is allowed in the TomoCon settings (see 4.1.4 View 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 you to view patient image data with appropriate contrast and image detailing in a particular grayscale range.

Each view in TomoCon uses its own window/level setting for image display. The window/level setting is defined by the window and level values and the palette graduation type with a defined shape.

To change the window and level values, you can 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. You can limit changes to a single segment, series or study.

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 154) is initially docked in the tools panel and is accessible at any time by clicking the tab with the 👬 icon.

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. Additionally, 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/unchecking the **Invert** check box.
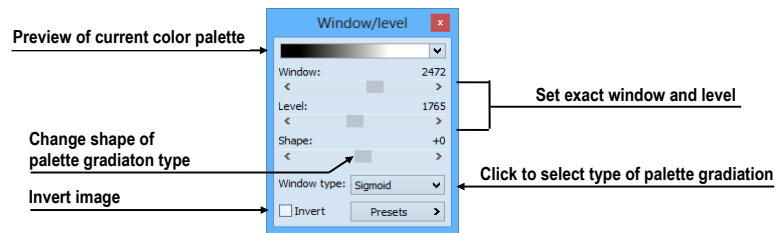
Figure 154 – Window/level tool

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 155).

Note that the palette change will affect all the views in the current segment, with the exception of the pinned views, where the palette settings is individual.
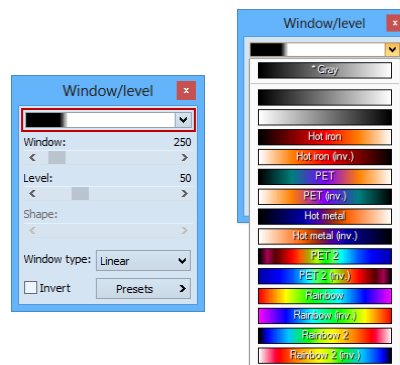
Figure 155 – Selecting color palette

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.

- 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.
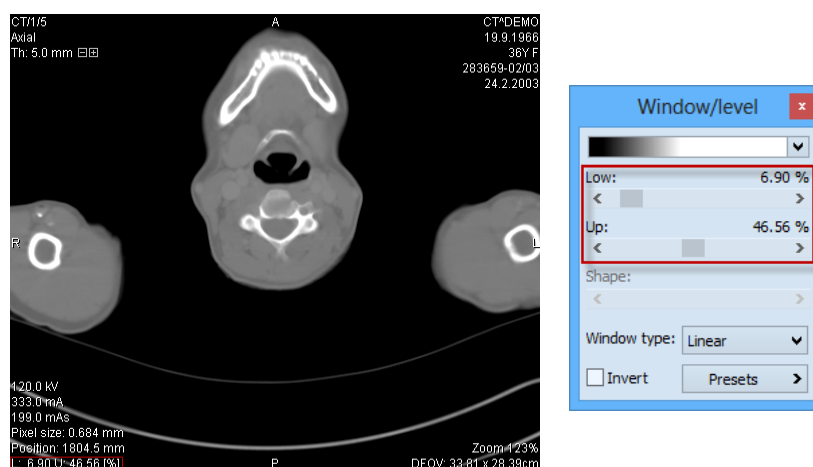
Figure 156 – Window/level tool and a view with the LU[%] adjustment type

To change the current adjustment method, select the required method in the **Adjustment type** combo box in the **TomoCon 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 156).

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 you with the

possibility to refine the details displayed in the view. The TomoCon application offers base linear, sigmoid and exponential types of color graduation. Additionally, 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 157). As mentioned above, you can 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.
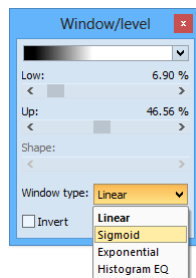
Figure 157 – Changing the palette graduation type

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 158). 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.
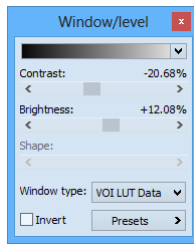
Figure 158 – Changing a VOI LUT Data preset

Once the graduation type is changed from one VOI LUT to another in the **Window type** combo box, it cannot be set back. You would instead have to reset the entire view settings or set the VOI LUT preset manually.

7.1.6   Presets

For quick and convenient adjustment of the window/level values, the TomoCon application provides you with the preset functionality. A preset is a set of the exact values for the window, level and shape. When you apply a preset, all values are applied to the view at one time. The preset values can also be defined inside any image as part of DICOM information. In addition, TomoCon provides a number of predefined presets for each modality and also offers you the possibility to create and use your own presets. Additionally, 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 you have assigned any of the keyboard shortcut keys (F2 to F9) to your 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, which displays the drop-down list of all presets.

3. Select the **New preset…** menu item (see Figure 159) in the displayed list. The **Window/level preset** dialog (see Figure 160) 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.
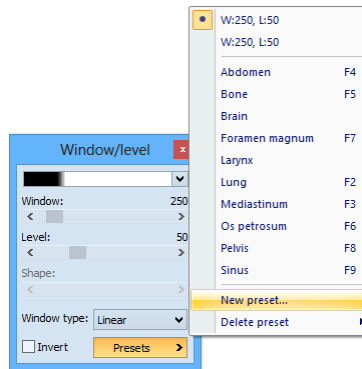
Figure 159 – Creating a new window/level preset

4. If necessary, enter a new preset name into the **Preset** edit box and enter the new values for the window, level and shape into the **Window**, **Level** and **Shape** edit boxes.

5. Optionally, you can select a keyboard shortcut (F2 to F9) from the **Key** combo box to be assigned to the new preset.

6. To save the preset, click the **OK** button.
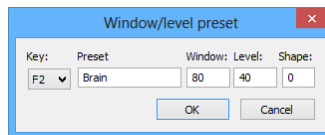
Figure 160 – Window/level preset dialog – defining a new preset

To remove a defined preset, proceed as follows:

1. Click the **Presets** button in the **Window/level** tool.

2. The drop-down list is then displayed. You can find all the defined presets in the **Delete preset…** submenu.

3. Select the preset you want to remove in the displayed submenu list (see Figure 161).

Alternatively, you can create a new (or edit and remove an existing) preset for each modality on the **Modality** tab of the **TomoCon options** dialog (see 4.2 Modality options).
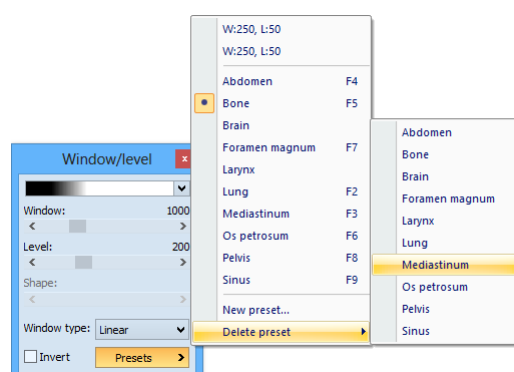
Figure 161 – Deleting a window/level preset

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.
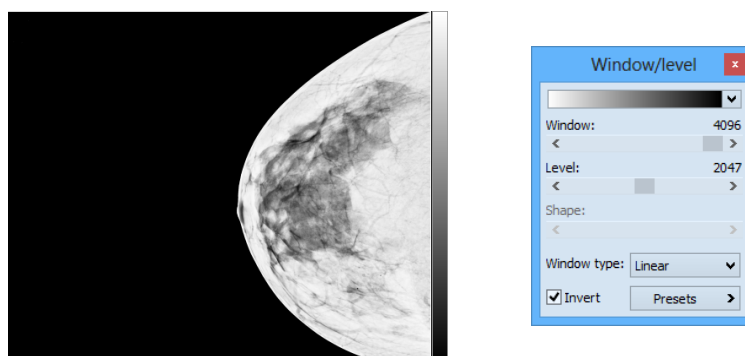
Figure 162 - Inverted view (Smart invert is activated)

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 162).

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** ⊹w icon in the **Image** menu or select the **Window/level** item in the context menu of the view (the cursor changes to the ⊹w 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.

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 you 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. TomoCon offers the following ways in which to change this factor when zooming in/out within images:

- moving the cursor within the current view using the zoom or zoom rectangle function (see 7.2.2 Zooming with the mouse)

- 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 **TomoCon 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 163).

Figure 163 – Zoom view text (fit to view, true size, right size, and pixel for pixel)

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 in TomoCon. You can restrict the changes to a single segment, series or study, or you can apply the changes 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 you 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 164) is initially docked in the tools panel and can be accessed by clicking the 🔍 icon.
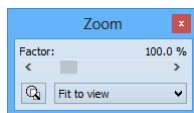
Figure 164 – Zoom tool

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 165). When the current zoom mode is pixel for pixel, the **Zoom factor** slider is disabled. It becomes enabled again when the zoom factor of the current view is changed using the mouse (using the zoom or zoom rectangle function), using the mouse wheel while holding down the **Ctrl** key or when a different zoom mode is set as the current one.
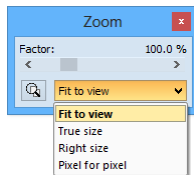
Figure 165 – Zoom mode combo box

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. You can cancel the dragged rectangle 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 function, which is accessible in the view's context menu or in the **Image** submenu of the main menu, and proceed as follows:

1. Select the **Move** ✛ item to activate the move function (the cursor changes to the ✊ form).

2. Click in the current view (the cursor changes to the ✋ form) and move the mouse (holding down the left mouse button) within the view.

3. The image then moves immediately as you move the mouse. When finished moving the image, release the mouse button.

7.2.4   Magnifying glass

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

(a)   (b)
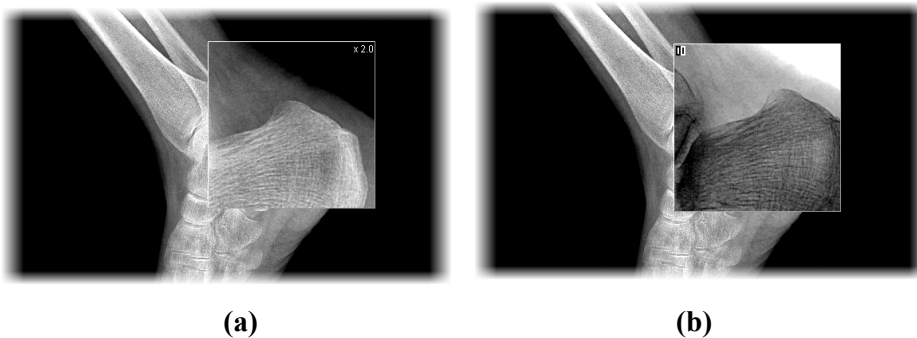
Figure 166 – Active Magnifying glass window, normal (a), invert (b)

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 (the cursor will not be visible); see Figure 166b. 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 (it disappears after a few seconds).

4. To invert the zoomed image in the magnification window, press the **Tab** key (see Figure 166b). 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 167) in the tools panel.
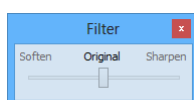
Figure 167 – Filter tool

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).
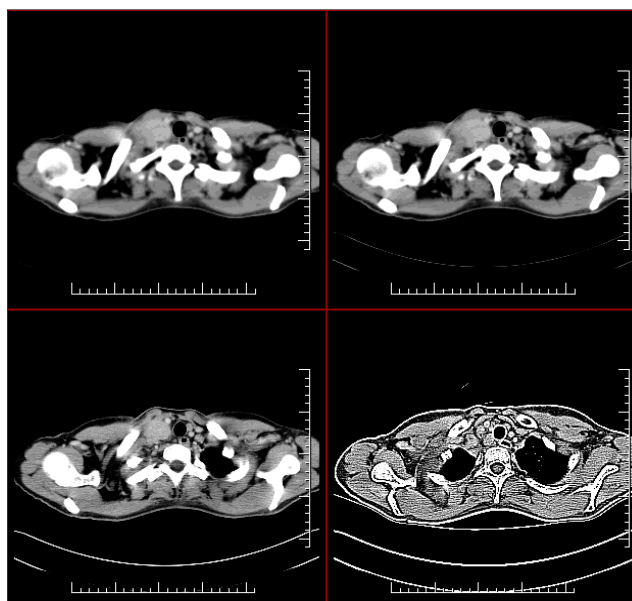
Figure 168 – The effects of the various filters available in TomoCon

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 – the images contain DICOM information from the patient examination and the separation occurs automatically after opening the patient data in TomoCon (see 7.4.1 Automatic DSA mode).

- Manual – 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 **TomoCon options** dialog (see 4.1 General options), is turned on automatically in all views for all image types. After selecting the image in the current view, all modification operations available in the application can be used to work with the image (see Figure 169).
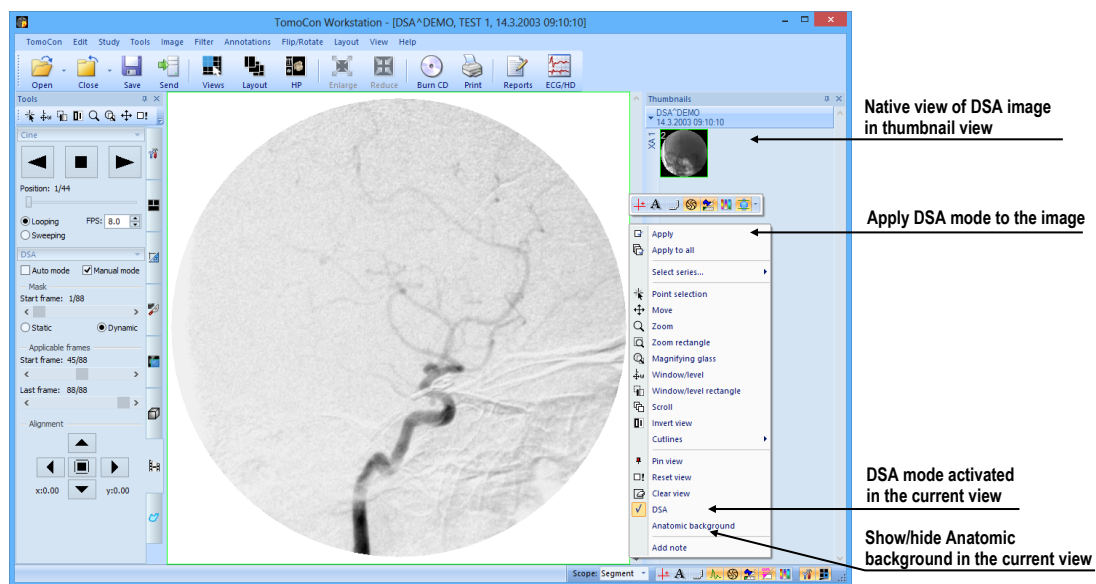
Figure 169 – Automatic DSA mode

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** menu in TomoCon. 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 170).
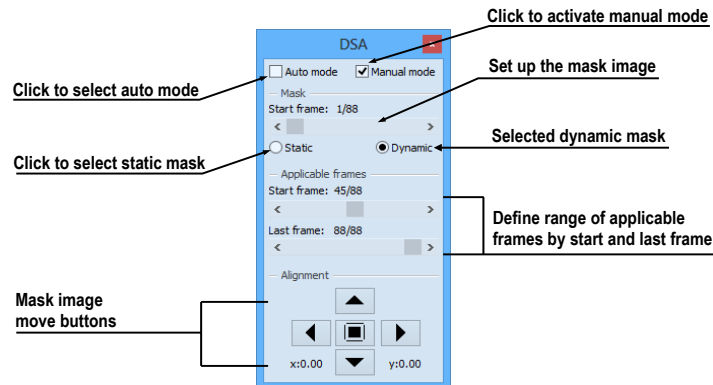
Figure 170 – DSA tool

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

- **Mask frame** - the starting image number in the mask (image sequence without contrast media):

    o **Static mask** - the mask frame is static for all selected frames

    o **Dynamic mask** - the mask frame changes dynamically according to the currently selected frame

- **Applicable frame** - the image sequence with contrast media covered with the mask image(s):

    o **Start** - the first sequence image number

    o **Count -** the number of sequence images

- **Alignment** - movement of the mask image relative to the base image (▲ - up, ◀ - left, ▶ - right, ▼ - down, ■ - center, original position)

The changes to these parameters are then applied immediately to the image in the current view.

You can switch from the automatic DSA mode of the image with DICOM information to the manual mode wherever appropriate. DSA setting changes can be made using the **DSA** tool.

To return to the original setting, select the **Auto mode** item and the settings will revert back to the original DICOM setting.

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 17 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** option in the view's context menu or the **View**/**Cutlines** menu to activate the **Cutlines** function (see Figure 171).

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 171). You can set up the cutline color and line shape in the application settings (see 4.4 Color and style options).
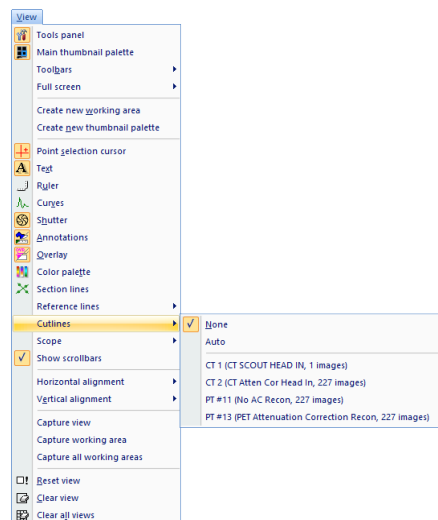
Figure 171 – View/Cutlines menu

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 views at one time (see Figure 172). In each view, right-click and select the **Cutlines** and the registered series.

If the cutlines cannot be displayed, one of the following is true:

- There are no registrations defined between the series.

- The section planes are parallel (they do not intersect).
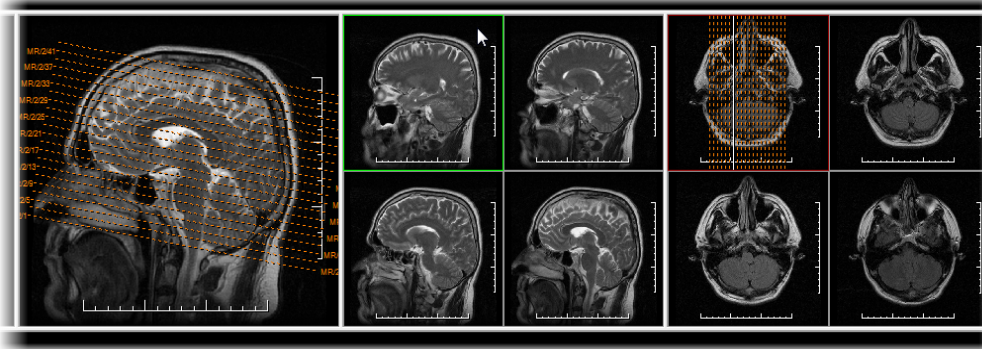
Figure 172 – Displayed cutlines in the working area

7.5.1   Hiding cutlines

The **None** item in the **Cutlines** menu (see Figure 171) 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 171) 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 18 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 173).

To control the visibility of reference lines:

1. In the main menu, select **View**/**Reference lines**.

2. Select ⚓ **Current** to show or hide the intersection with the current view plane, or

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 Context menu) or the **Quick access toolbar** (see 3.2.2 Quick access toolbar), once configured.
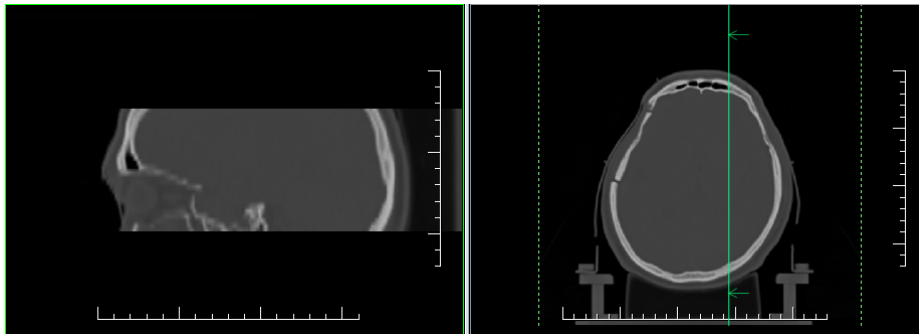
Figure 173 – Reference lines of the current view (sagittal MPR, left) shown on transversal view (right)

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.

Note that the reference lines are not displayed between different series, unless a registration exists.

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 image notes*

Key image notes provide a mechanism for indicating the importance of an image to a group of viewers. Each key image note is comprised of various attributes including a reason code signifying the basis for the note, an optional text description supplied by the user and a reference to the image to which the key image note refers.

7.7.1   Adding a key image note

To add a key image note:

1. Move the cursor over the thumbnail preview of the image for which the key image note is to be defined.

2. Right-click to display the context menu of the thumbnail palette.

3. Select the **Add note** item (the **Key image note** dialog for defining the new note is then displayed).

4. Enter the information concerning the new note into the displayed dialog. First, enter the name of the new note (see Figure 174a) and click the Next button. Next, fill in the information about the creator (see Figure 174b) and click the Next button. Finally, type in the description of the new note (see Figure 174c) and click the **Finish** button. The new note is then automatically added to the image.
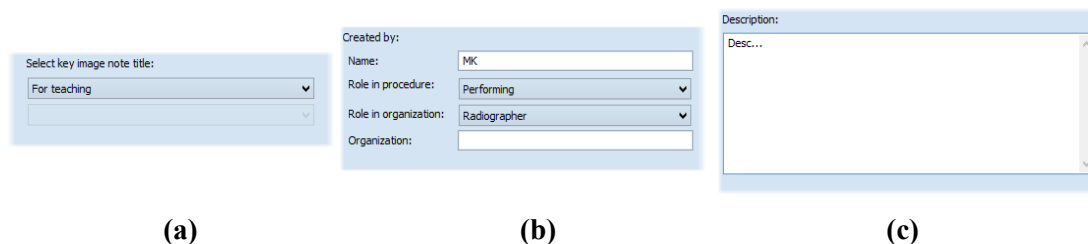
(a)   (b)   (c)

Figure 174 – Key image note dialog, Note title (a), Information about creator (b), Description (c)

7.7.2 Reviewing and editing a key image note

Each key image note belongs to just one image. If one or more notes have been defined for the image, a small triangle of the defined color is displayed in the thumbnail preview of the image (see Figure 175).

(a)   (b)
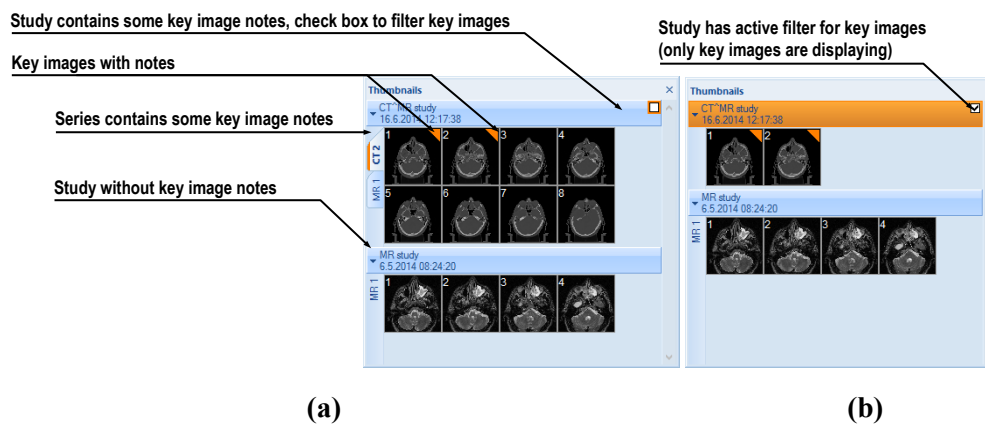
Figure 175 – Key image notes in the thumbnails palette, (a) the filter for key images is disabled, (b) the filter for key images is enabled

By moving the cursor over the triangle and double-clicking, detailed information of the key image note is displayed in the **Key image note** dialog (see Figure 176).
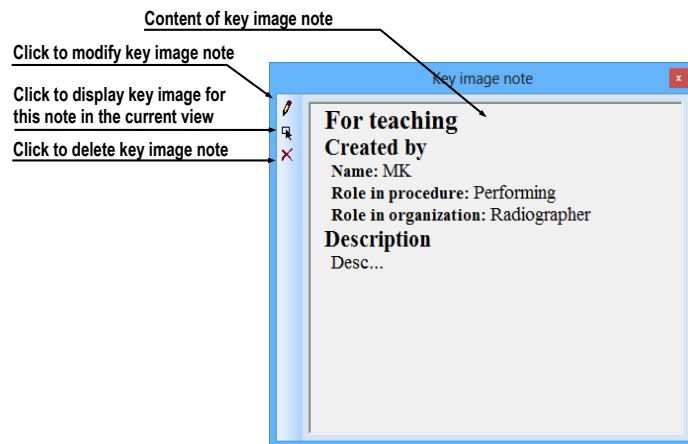
Figure 176 – Key image note dialog

If the image has more than one note, the **Key image notes** dialog (see Figure 177) is displayed in which you select the note by double-clicking.
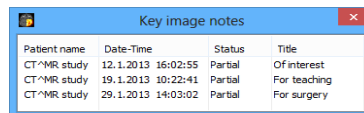
Figure 177 – Key image notes dialog for note selection

7.7.3   Loading and saving a key image note

The TomoCon application allows you to save the notes of all opened studies as DICOM objects in the Local studies storage. The notes can further be sent to the PACS. Key image notes can be saved by selecting the **Save** item in the **Study** menu or, when attempting to close the TomoCon application, a dialog is displayed allowing you to save unsaved changes.

If a series has key image notes, these are displayed in the **Search studies** dialog as objects with KO modality (see Figure 178). When a study with key image notes is opened, the key image notes that belong to the study also open automatically.
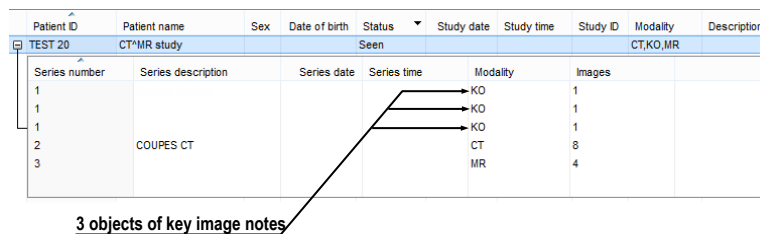
Figure 178 – Search studies dialog, study with key image notes

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** menu (see Figure 179).

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 and then press the **Save** button, the **Images to export** dialog will be displayed in which you can define the range of images to be exported (see Figure 180).
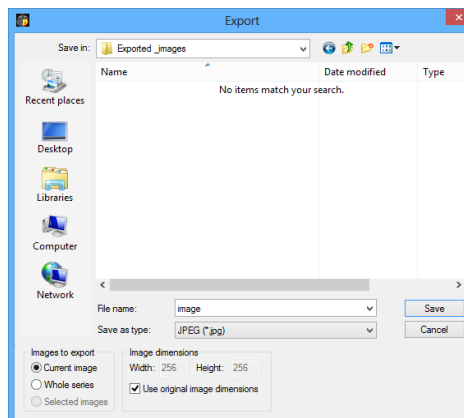
Figure 179 – Export images dialog
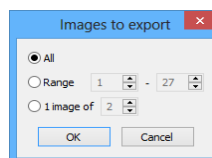
Figure 180 –Images to export dialog

7.8.2　Exporting images to an AVI format video file

At times, it is useful to create a video file from a series of patient image data in order to play back the data on another computer.

The **Create AVI** dialog (see Figure 181) opens by selecting the **Export as AVI video…** item in the **Study** menu.
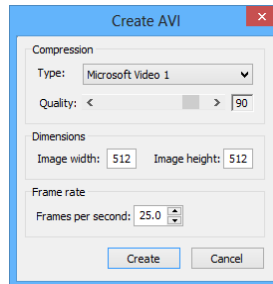
Figure 181 – Create AVI dialog

The **Create AVI** dialog allows you to define the following:

- **Compression -** series video compression of any available type to create an AVI format video file. Please keep in mind that the used codec (or an equivalent one) should be available on the other computer in order to play back the video file; if not, it will not be possible to play back the file.

- **Dimensions** - the image dimensions.

- **Frame rate** - the playback speed.

You can also choose to retain the default values supplied in the dialog.

Once you finish defining the video parameters in the dialog, click the **Create** button. In the **Frames to export** dialog that is then displayed (see Figure 182), you can define the range of images to be exported.
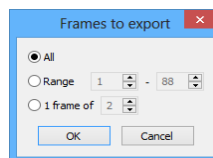
Figure 182 – Frames to export dialog

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 menu of the TomoCon application to carry out these tasks.

To insert a screenshot of the working area by means of the thumbnail palette (see Figure 183), 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 186). The image from the current view is then automatically inserted at the end of the target series.
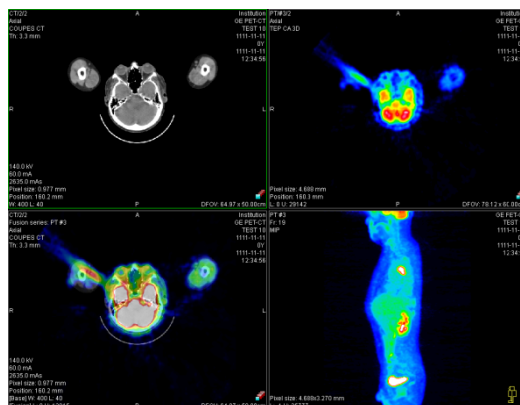
Figure 183 – New image created as a screenshot from the current working area

Alternatively, you can use the main menu of the TomoCon application 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 menu.

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 (see Figure 184), 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 186). The screenshot of the current view is then automatically inserted at the end of the series.

Alternatively, you can use the main menu of the TomoCon application as follows:

1. Prepare the image for the screenshot in the current view.

2. Select the **View/Capture view** item in the main menu.

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).
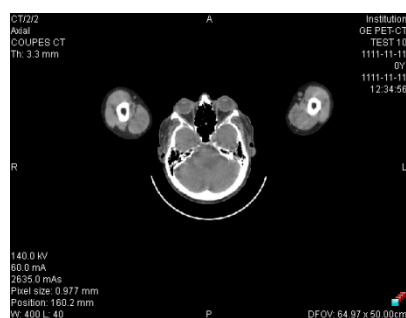
Figure 184 - New image created as a screenshot from the current view

To insert a screenshot of all working areas using the main menu of the TomoCon application (see Figure 185), proceed as follows:

1. Select the **View/Capture all working areas** item in the main menu.

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.
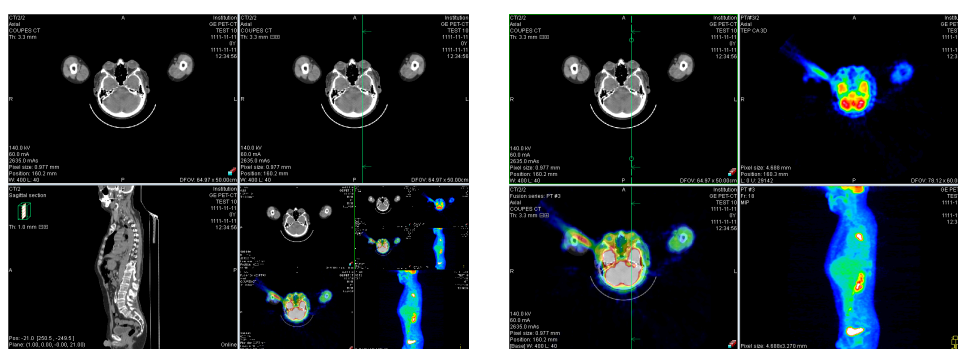
Figure 185 – New images created from two working areas

To insert a copy of a selected image into 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 (see Figure 186) and select the **Insert image**/**Insert image copy** item (see Figure 186). 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 186) and select the **Delete image** item. The image is then automatically deleted from the series.
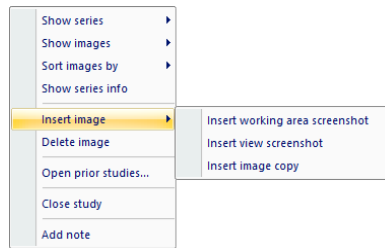
Figure 186 – Context menu of the thumbnails palette

8 Hanging protocols

If you frequently work with the same type of data series of individual patients, the TomoCon application provides you 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 in the application 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 187). To display the **Hanging protocols manager** dialog, select the **Hanging protocols manager…** item in the **Layout** menu.

You can apply defined and stored hanging protocols to the loaded studies in TomoCon manually or you can activate the option for them to be applied automatically according to the first loaded study.
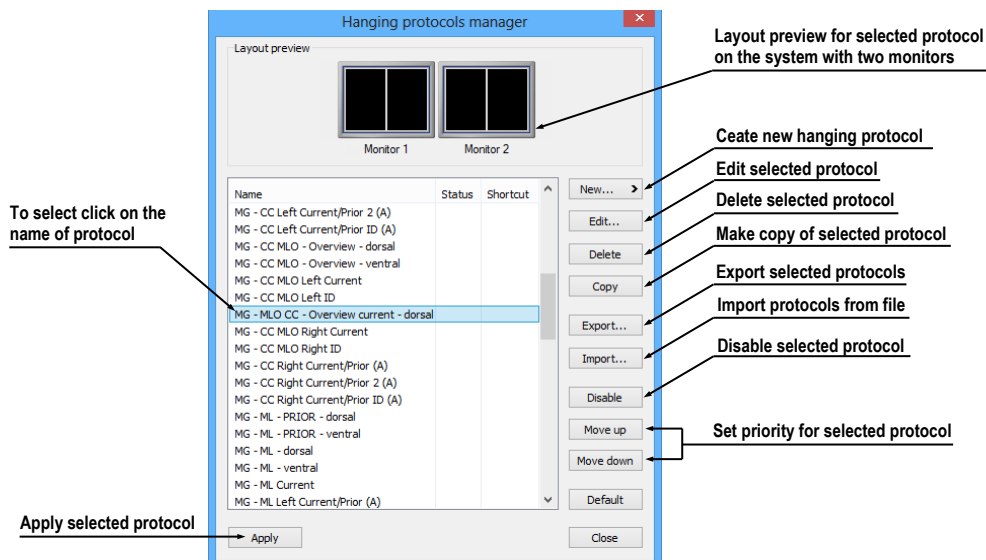
Figure 187 – Hanging protocols manager dialog

The layout preview in the **Hanging protocol manager** dialog enables advanced drag-and-drop functionality, which can be used for moving working areas to a selected monitor. You can move the working areas between the monitors and place multiple working areas from one monitor onto another (see Figure 188). The number of working areas depends on the number of monitors connected to the workstation.
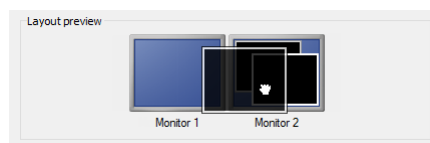
Figure 188 – Drag-and-drop functionality in the layout preview

8.1 Applying a hanging protocol

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

To apply a hanging protocol automatically, check 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 you open the first study in TomoCon, the most recently used protocol is applied to the given study automatically.

To apply a hanging protocol manually, proceed as follows (see Figure 189):

1. Click the 🖼 **HP** icon in the main toolbar.

2. In the displayed window, click the required hanging protocol to be subsequently applied.
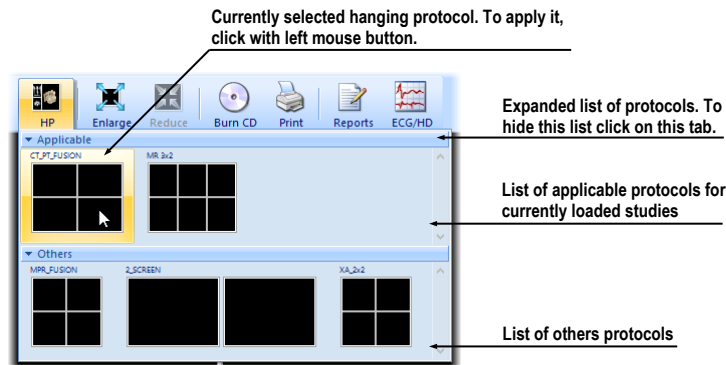
Figure 189 – List of hanging protocols

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, you can 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 you 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** menu.

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 select the working area layout in the displayed list.

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 190) allows you 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.
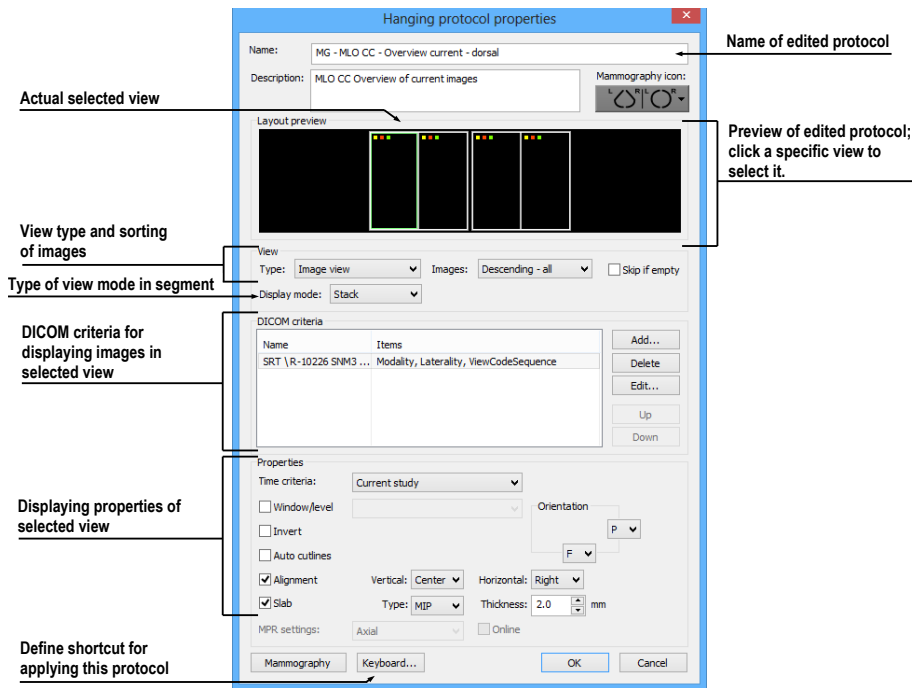
Figure 190 – Hanging protocol properties dialog

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.
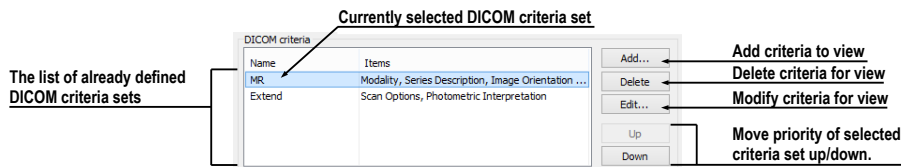
Figure 191 – Hanging protocol properties dialog

To add new sets of DICOM criteria, click the **Add…** button in the DICOM criteria section (see Figure 191). The **DICOM criteria set** dialog (see Figure 192) 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 (see Figure 192) and make a selection in the displayed menu:

- **(custom)** – to add a new criterion defined by the DICOM group and element.
- **(from DICOM dump)** – to add a new criterion by selecting it directly in the DICOM dump of the image displayed in the current view in TomoCon. This option is allowed only when the layout of hanging protocol is the same as current layout in TomoCon and current view contains some displayed image.

- One of the predefined criteria (**Modality**, **Image Laterality**, **View Position**).
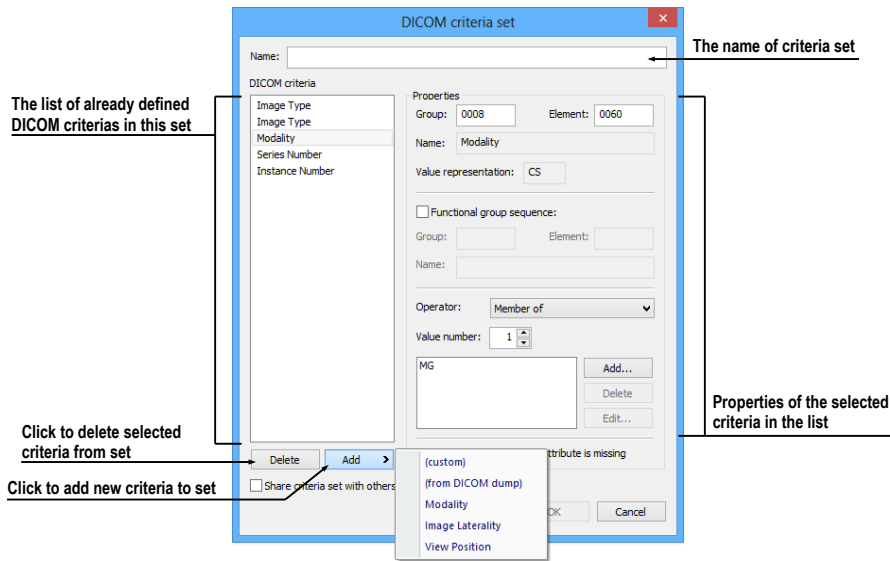
Figure 192 – DICOM criteria set dialog

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 193):

    - 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.
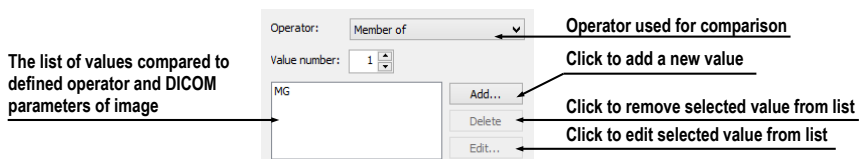
Figure 193 – DICOM criteria set dialog

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 this part of the **Hanging protocol properties** dialog (see Figure 194), you can specify various properties for the selected hanging protocol DICOM criteria set.
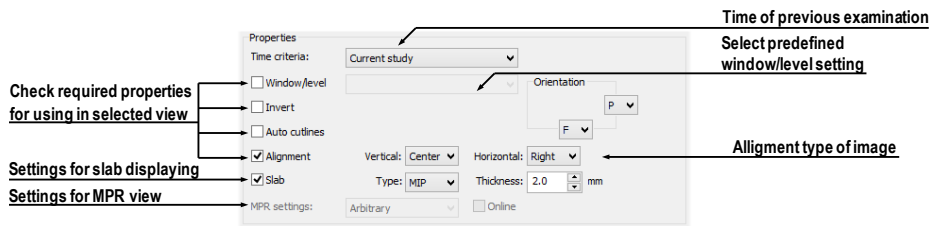
Figure 194 – Hanging protocol properties dialog

To define time sequencing criteria, select the time constraint in the displayed list (see Figure 195). 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.
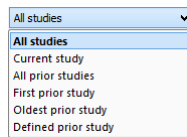
Figure 195 – Time criteria list

To apply the properties, check the checkbox next to each of the properties to be applied and, if necessary, set the corresponding parameters (see Figure 194). These properties can be set:

- **Window/level** (select the specific type of window/level preset)
- **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 corresponding views (in the upper left-hand corner of each view) in the **Hanging protocol properties** dialog in the **Layout preview** window (see Figure 196) 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 196 – Color identification of criteria and properties

8.4 Automatically creating a hanging protocol

The TomoCon application allows you 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 in TomoCon 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** menu in TomoCon. The **Hanging protocol manager** dialog will be displayed.

2. Click the **New…** button. The menu with the previously defined layouts will be displayed.

3. Select the **(current layout and views)** item in the displayed menu (see Figure 197).
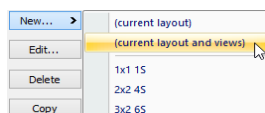
Figure 197 – Current layout and views item

4. 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 -** for a detailed description concerning a specific location in an image (see 9.2 Text annotations)

- **Marker -** for a description along with a marker (an arrow) pointing to the point described (see 9.3 Marker annotations)

- **Distance -** the distance between two points (see 9.4 Distance)

- **Distances and angle** (see 9.5 Distances and angle)

- **Cobb angle -** an angle between two independent lines (see 9.12 Cobb angle)

- **Probe -** a tracking circle tool for displaying point level values in the specified circular area (see 9.6 Probe)

- **Density spot -** desired point level values (see 9.7 Density spot)

- **Density profile -** characteristics of all image points between two points (see 9.8 Density profile)

- **Ratio -** relative lengths of two lines in relation to each other (see 9.13 Ratio)

- **CTR -** Cardio-thoracic Ratio (see 9.14 CTR)

- **Ellipse -** characteristics of all image points included in the elliptical area (see 9.9 Ellipse)

- **Rectangle** - characteristics of all image points included in the rectangular area (see 9.10 Rectangle)

- **Area** - characteristics of all image points covered by a free area (see 9.11 Free area)

All annotations and measurements are included in the **Annotations** menu (see Figure 198). It is also possible to activate them in the tools panel (the tab with the 🖼 icon).

> ⓘ 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 198). The context

menu is displayed by moving the cursor over the tool (it will be highlighted and the cursor will change from an arrow to a cross) and pressing the mouse context button. The following operations are available:

- **Font** settings and **Color** settings

- **Keep settings -** the color and font settings for newly created annotations and measurements (**For all** tools, **For same type** of tools)

- **Edit label -** it describes the measurement or annotation (see 9.1 Label editing)

- **Delete** (a tool) and **Locked -** the latter for locking a tool in an image to prevent moving, deleting or the operations mentioned above
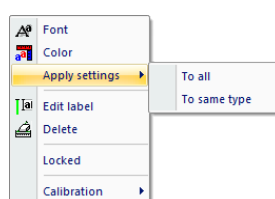
Figure 198 – Annotations and measurements context menu

When using a tool defining an area (Ellipse, Rectangle, Free area), the **Show text** item is added to the context menu (see Figure 199). This option allows you to display or hide the **Size** of the outlined area, the **Min value**, the **Max value**, the **Mean value** and the **Deviation**.
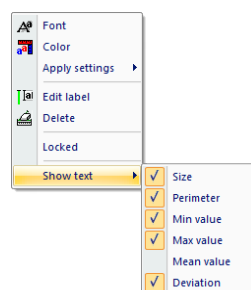
Figure 199 – Context menu for ellipse, rectangle and free area

When using the Density profile tool, the **Show/Hide chart** item is added (see 9.8 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.

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 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 204). 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.

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^2) manually, using the calibration tool (see 9.15 Calibration).

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

9.1 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 200). 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.
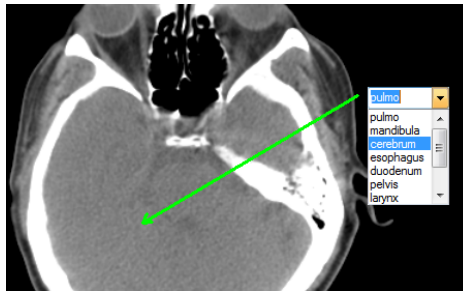
Figure 200 - Editing a label using recently used labels

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.

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

9.2 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 (with the ▶a icon) in the **Annotations** menu or click the **Text** button in the **Annotations** tool (the tab with the ▨ icon) in the tools panel (see Figure 201).
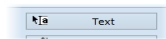
Figure 201 – Text annotation button

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 202). Press the **Enter** key to confirm the change and to complete the editing process (see 9.1 Label editing).
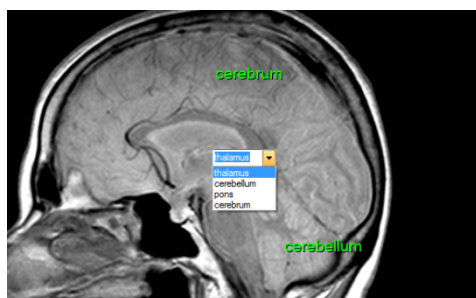
Figure 202 – Image with Text annotations

9.3 Marker annotations

A short text description for an important structure or object can be written directly inside an image using the **Marker annotation** mode. The mode is activated by

selecting the ✐ **Marker** item in the **Annotations** menu or by clicking the **Marker** button in the **Annotations** tool (the tab with the ◢ icon) in the tools panel (see Figure 203).
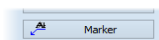
Figure 203 – Marker annotation button

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. An edit box then opens in which you can type in the description (see Figure 204). Press the **Enter** key to confirm the change and to complete the editing process (see 9.1 Label editing).

Figure 204 – Image with Marker annotations

9.4   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 205).
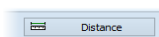
Figure 205 – Distance measurement button

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 206).
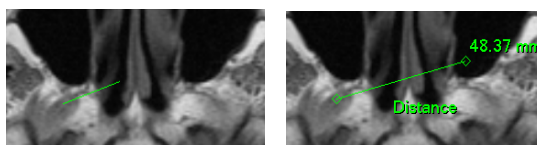
Figure 206 – Distance between 2 points

9.5   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 207).
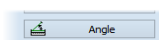
Figure 207 – Angle measurement button
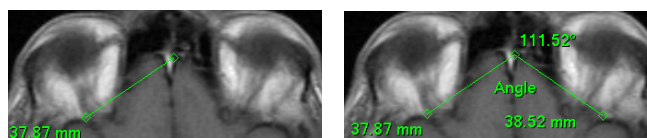
Figure 208 – Distances and angle between 3 points

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 208).

9.6   Probe

The Probe tool is a special circular measurement tool for tracking an actual pixel value at a specified location within a selected view. 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 209).

Figure 209 – Probe measurement button

Click the desired point and, holding down the left mouse button, move the measurement through the image within the selected view and the Probe will display the current minimal pixel value, the maximal pixel value and the mean value of the pixels that lie within the probe's circle (see Figure 210). To finish displaying the values, release the left mouse button and the Probe measurement tool will be hidden. Additionally, if the selected image within the view is changed with the left mouse button pressed, the Probe will display the actual pixel values on the newly selected image.

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.
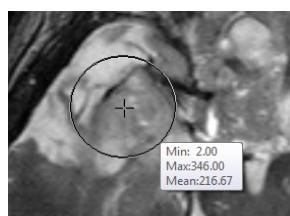
Figure 210 – Probe measurement

9.7　Density spot

The density spot measurement tool can be used after selecting the ✛ **Density spot** item in the **Annotations** menu or clicking the **Density spot** button in the **Measurements** tool in the tools panel (see Figure 211).


Figure 211 – Spot density measurement button

Click the desired point. The value of the image point is then displayed next to the defined point (see Figure 212).
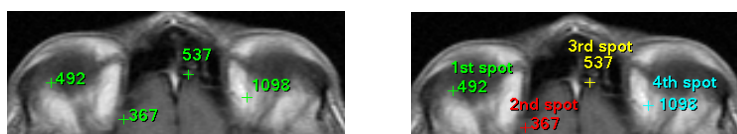
Figure 212 – Density spot at various points

9.8　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 213).


Figure 213 – 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 214).
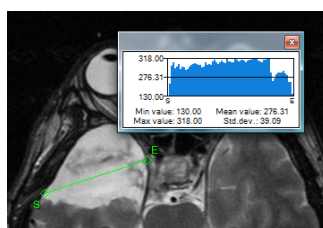
Figure 214 – Density profile of a line between 2 points

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 (see Figure 215).
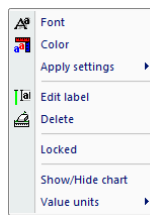
Figure 215 – Density profile context menu

9.9 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 216).
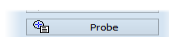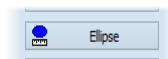

Figure 216 – Ellipse measurement button

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 217).
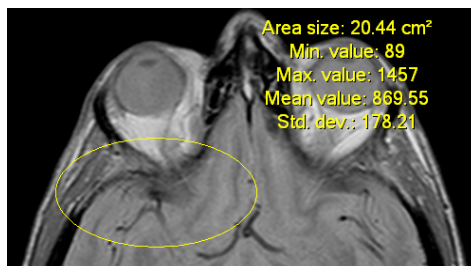
Figure 217 – Elliptical area profile

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.

9.10 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 218).
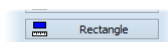
Figure 218 – Rectangle measurement button

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 219).

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.
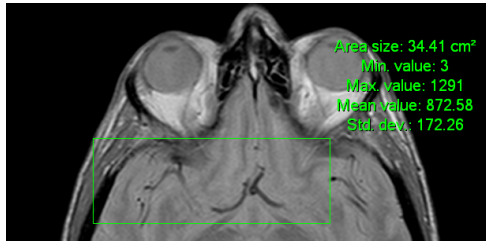
Figure 219 – Rectangular area profile

9.11 Free area

Free area drawing is activated by selecting the ![icon] **Density area** item in the **Annotation** menu or by clicking the **Density area** button in the **Measurements** tool in the tools panel (see Figure 220).
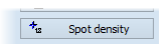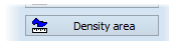

Figure 220 – Density area measurement button

An area can be outlined by dragging the ![cursor] 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 221).
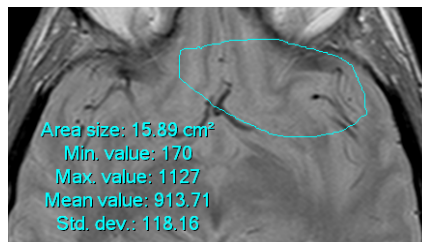
Figure 221 – Free Area

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

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

9.12 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 222). This measures the angle between two independent lines.
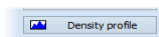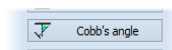

Figure 222 – Cobb's angle measurement button

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 223).
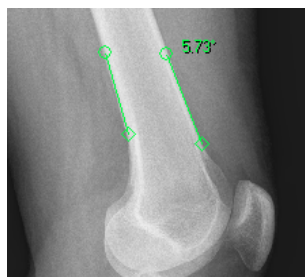
Figure 223 – Cobb's angle

9.13 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 224). 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.
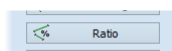
Figure 224 – Ratio measurement button
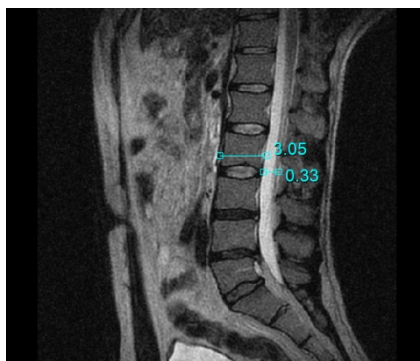
Figure 225 – Ratio

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 225).

9.14 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 226).

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 using the widest point of the chest and measuring as far as the lung pleura. CTR measurement can only be used on CR and DX modalities.
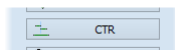
Figure 226 – CTR measurement button

The tool displays lines representing the left heart midline, the right heart midline and the diameter of the thorax (see Figure 227). Adjust the lines manually in the image to get accurate sizes of heart and thorax. The length of each line can be changed by dragging the line endpoints. Vertical guidelines are displayed to aid in the precise positioning.

To move the lines in vertical direction, position the mouse cursor over the line so that it changes to arrow. Then move the line vertically. Calculated cardio thoracic ratio is shown in the middle of the longest (thorax diameter) line.
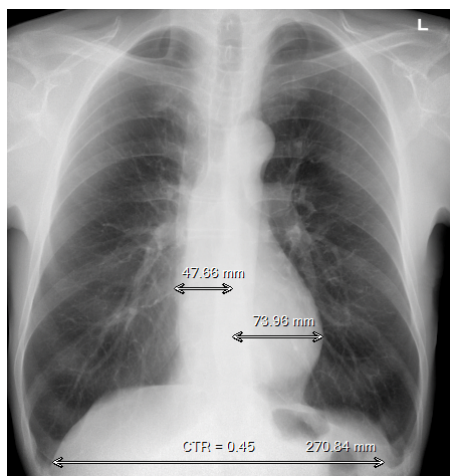
Figure 227 – CTR measurement

To change the guideline color or style, right-click on the defined CTR measurement and select **Guideline style** item in the displayed context menu (see Figure 228).
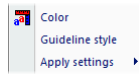
Figure 228 – CTR measurement context menu

9.15 Calibration

i   Calibration cannot be used for images containing transformation.

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

To activate calibration, select the **Calibration** item (see Figure 229) in the **Annotations** context menu, which is displayed by pressing the mouse context button on the Distance measurement.

The following two options are available:

- **Calibrate measurement -** to open the **Calibration** dialog in order to define the calibration (see Figure 229).

- **Apply to whole series -** to apply a defined calibration to a series.
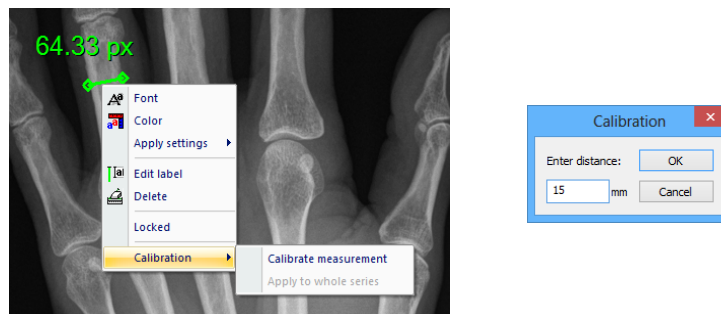
Figure 229 – Calibration context menu and the Calibration dialog

The **Calibration** dialog allows you 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.

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 (see Figure 230).
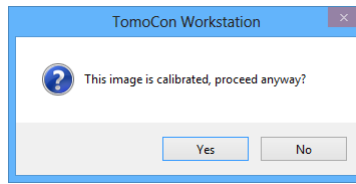
Figure 230 – Calibration dialog: This image is calibrated, proceed anyway?

If you want to change the calibration in a series with previously calibrated images, select the **Apply to whole series** option. If other images in the series are already calibrated, a warning dialog will be displayed (see Figure 231).
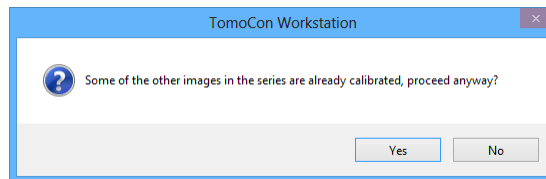
Figure 231 – Some of the other images in the series are already calibrated, proceed anyway?

9.16   *Hide / show annotations*

To hide or display existing annotations in all views and TomoCon working areas, select the ![icon] **Annotations** item in the **View** menu or click the **Hide all** button on the third tab (the tab with the ![icon] icon) of the tools panel (see Figure 232).
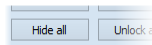
Figure 232 – Hide all buttons

9.17   *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. Alternatively, you can select the **Annotations…** item in the **Annotations** menu (see 9.18 List of annotations).

To discard all annotations defined in all opened patient studies, select the ![icon] **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:

- ![icon] **Delete all in image**
- ![icon] **Delete all in series**
- ![icon] **Delete all in study**

9.18 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 233) on the **Annotations** tab (the tab with the ▨ icon) of the tools panel (see Figure 234).
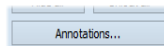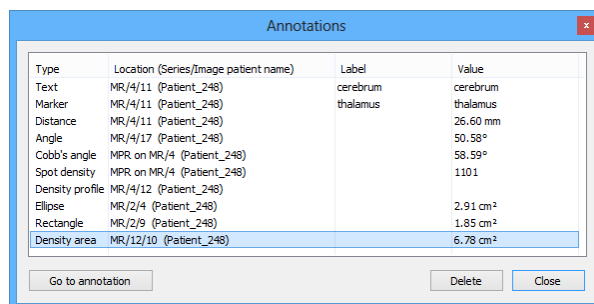
Figure 233 – Annotations… button

The list contains the type, the location (in the "series/image" format), the description and the value 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.

Figure 234 – 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.

By clicking the **Delete** button, the selected annotation is deleted from both the list and the image.

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 235). When creating contours on multiple images, an ROI (Region of Interest) is automatically created, along with the automatically calculated volume (in cm^3), which can be displayed in the space in three-dimensional (3D) patient presentation (see Figure 235).

> **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 you 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 236. 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 an ROI definition can be a DICOM RT Structure set (with an installed DIOCM RT Structure license in TomoCon), which can be sent to another DICOM-compatible system (e.g. the Treatment Planning System).

(a)   (b)
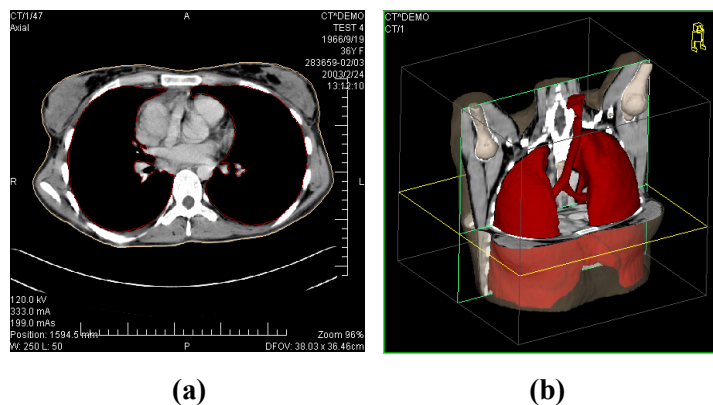
Figure 235 – Displaying ROI, (a) contour in 2D, (b) ROI in 3D

The ROI tab of the tools panel consists of the following three main parts (tools) that simplify work with ROIs and ROI contours (see Figure 236):

- **ROIs** tool - it allows you to set the currently selected ROI in TomoCon, to delete an ROI or to create a new one as well as to manage previously defined ROIs in the **Administration** dialog.

- **ROI properties** tool - for defining the properties of 2D and 3D visibility of the currently selected ROI in TomoCon.

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

Selecting and managging tools for ROIs

Properties of current selected ROI

Manual tools for defining contours of current selected ROI

Automatic tools for defining contours of current selected ROI
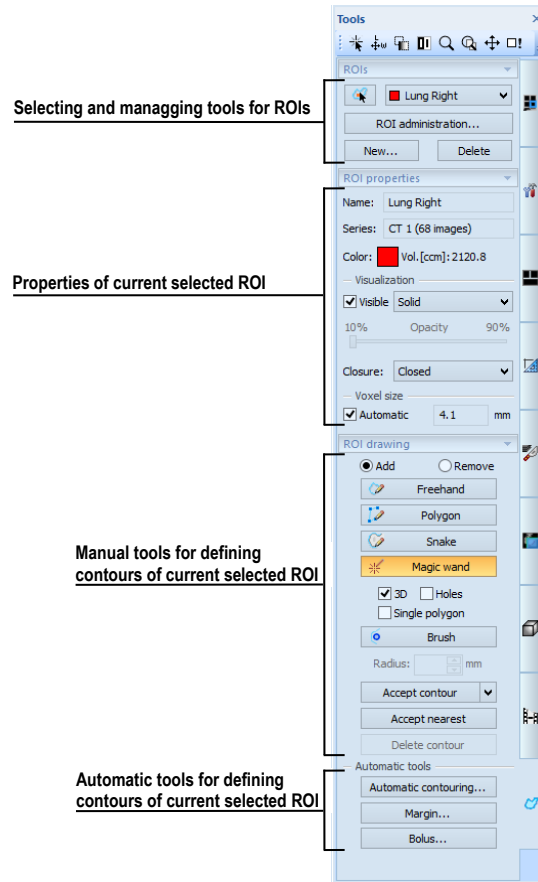
Figure 236 – ROI tab of the Tools panel

10.1 Creating new ROIs

TomoCon allows you 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 237). The newly created ROI will automatically be added to the ROI list and set as the currently selected ROI in TomoCon. You can then immediately define the ROI contours using the **ROI drawing** tool in the tools panel.
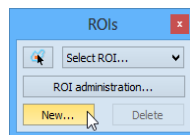
Figure 237 – Creating a new ROI in ROIs tool

To create a new ROI in TomoCon, 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 238).

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 in TomoCon.
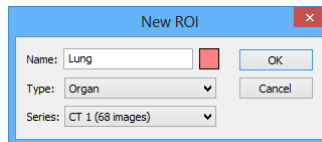
Figure 238 – New ROI dialog

10.2 Selecting ROI and contour

The currently selected ROI in TomoCon is a previously created ROI that is currently selected in the **Select ROI...** combo box in the **ROIs** tool in the tools panel (see Figure 239). Its properties are displayed in the **ROI properties** tool in the tools panel. All ROI drawing tools can only be used for this ROI in TomoCon.
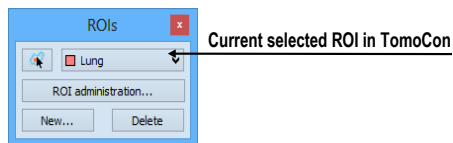
Figure 239 – Currently selected ROI in TomoCon

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

- Select the ROI from the **ROIs** drop-down list in the **ROIs** tool in the tools panel (see Figure 240).
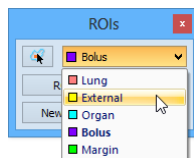
Figure 240 – Selecting the current ROI in TomoCon

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- 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 in the **ROIs** tool.

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

1. Click the ![button] button in the **ROIs** tool in the tools panel and move the cursor ![cursor] towards the contour until the contour area is highlighted with the mesh pattern (see Figure 241a). 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 241b) to select the ROI (if the ROI is not yet selected in the **Select ROI...** combo box).

3. Click again to select the contour (see Figure 241c).

| **(a)** | **(b)** | **(c)** |
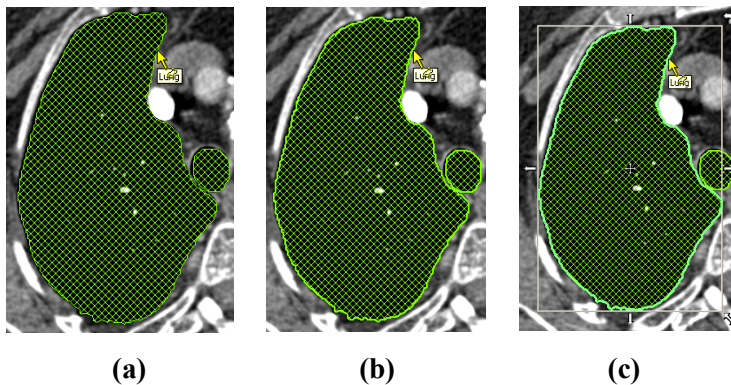
Figure 241 – Selecting a contour in TomoCon

If you activate the Select contour tool when an ROI is selected in the **Select ROI...** combo box, the first polygon of the ROI in the current slice is selected automatically.

When a contour is selected (see Figure 241c), 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.

- 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).

10.3 Saving ROIs

When any changes to ROIs have been made in the opened studies in TomoCon, an asterisk (*) is displayed after the study time in the TomoCon title bar at the top of the window (see Figure 242).

Figure 242 – TomoCon title bar with asterisk

If any unsaved changes to ROIs exist in opened studies when attempting to close them, you are asked whether or not you wish to save the changes. 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** menu of the main application menu. The changes to the ROIs will automatically be saved in the Local studies storage of TomoCon. To send these changes from TomoCon to a PACS, select the **Send...** item in the same menu.

10.4 Deleting an ROI

To delete an ROI in the ROIs tool in the tools panel, proceed as follows:

1. Select the current ROI in the **ROIs** drop-down list in the **ROIs** tool in the tools panel.

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 an 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 243).
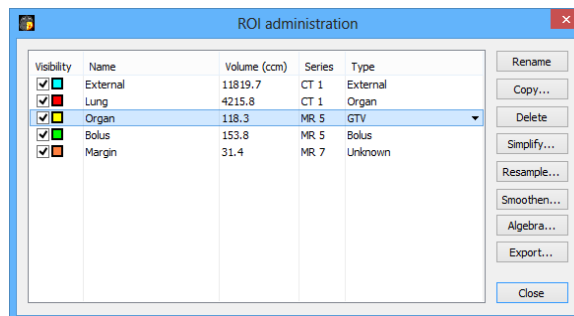
Figure 243 – ROI administration dialog

The **ROI administration** dialog contains a list of all defined ROIs in TomoCon including the visibility indicator, color, name, image series name and ROI 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 an ROI to the same series or to another series (see 10.5.1 Copying an ROI)

- simplifying ROI contours (see 10.5.2 Simplifying an ROI)

- resampling ROI contours (see 10.5.3 Resampling an ROI)

- smoothening ROI contours (see 10.5.4 Smoothing an ROI)

- carrying out an algebraic operation between ROIs (see 10.5.5 ROI algebra)

- exporting an ROI to external files (see 10.5.6 Exporting an ROI to a DXF or VTK file)

To change the visibility of an ROI, check the check box to the left of the colored box in the relevant row (see Figure 244). The display or hiding of the ROI is then immediately applied to all views in TomoCon.

Figure 244 – Hiding the Organ ROI

To change the color of an ROI, double-click the colored box in the relevant row (see Figure 245) and then select the color in the displayed **Color** dialog. The new color of the ROI is then immediately applied to all views in TomoCon.

Figure 245 – Changing the color of the Organ ROI

To change the DICOM type of an 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 246).

Figure 246 – Changing the ROI DICOM type

To rename an ROI, select the ROI in the ROI list and click the **Rename** button. Type the new name into the displayed name box (see Figure 247) and press the **Enter** key.

Figure 247 – Renaming a selected ROI in the ROI administration dialog

To delete an 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 (see Figure 248).
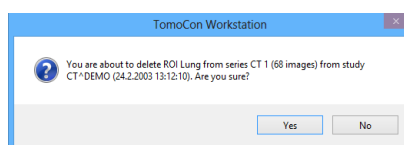
Figure 248 – Delete confirmation dialog

10.5.1 Copying an ROI

To copy an 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.

3. Type the name of the new ROI into the **ROI name** box.

4. Change the color of the new ROI by clicking the colored box to the right of the **ROI name** box.

5. Select the target series from the **Series** drop-down menu, if desired (see Figure 249). It is only possible to select a target series that is registered with the source ROI series. The "source ROI" series is the default target series.

6. Once the copying process is complete, click the **OK** button.
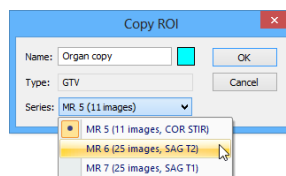
Figure 249 – Copy ROI dialog - selecting the target series

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 250).

Figure 250 – New ROI created as a copy from the Organ ROI

10.5.2　Simplifying an 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 251).

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.

4. Once the simplification process is complete, click the **OK** button.
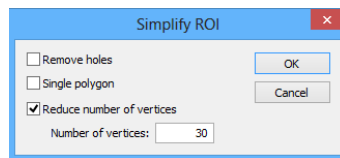
Figure 251 – Simplify ROI dialog

10.5.3　Resampling an ROI

TomoCon allows you to resample contours in original slices onto reconstructed slices. As a result, an ROI in any direction can be drawn and modified.

To resample the contours of an ROI using the **ROI administration** dialog, proceed as follows:

1. Display the image in the current view in the direction in which the ROI is to be resampled.

2. Select the ROI to be resampled in the ROI list and click the **Resample...** button. The **Resample...** dialog is then displayed (see Figure 252).

3. 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).

4. 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.

5. Check the **As new ROI** check box to create the new ROI from the resampled data and leave the source contours as they are.

6. Check the **Original slices** 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).

7. Click the **OK** button to apply resampling.
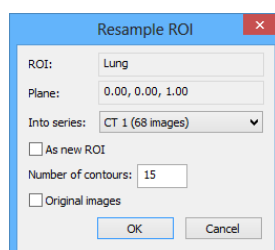
Figure 252 – Resample ROI dialog

The result of the resampling process is a resampled ROI in your selected direction with drawn contours in as many slices as you have chosen (dashed contours are applied to intermediate slices).

10.5.4   Smoothing an ROI

Smoothing makes jagged contours rounder. The more smoothened, 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 253).
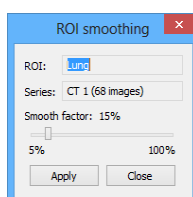
Figure 253 – ROI smoothing dialog

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. The result is immediately displayed in the current view (see Figure 254).

5. When finished, click the **Close** button.

(a)   (b)   (c)
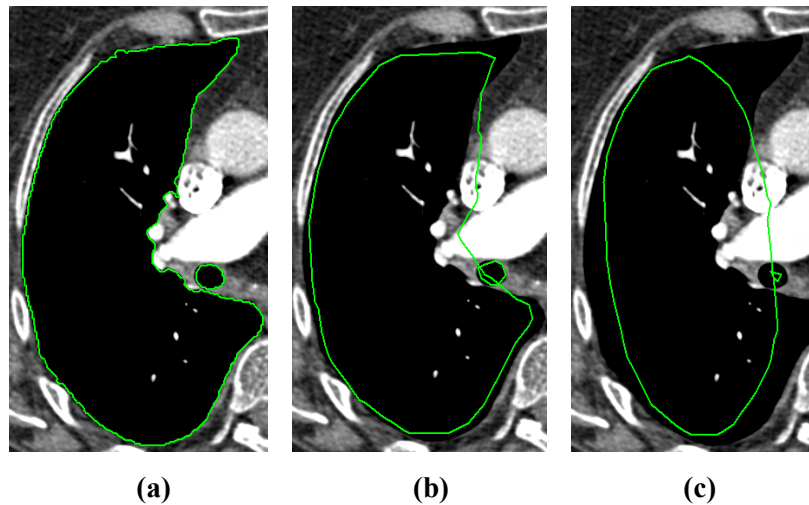
Figure 254 – (a) Source ROI, (b) smoothen ROI (applied once), (c) smoothen ROI (applied 5 times)

10.5.5　ROI algebra

If any two ROIs are defined in the same series, TomoCon allows you to carry out basic algebraic operations such as Union, Intersection and Subtraction between them using the **ROI algebra** dialog (see Figure 255). 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.
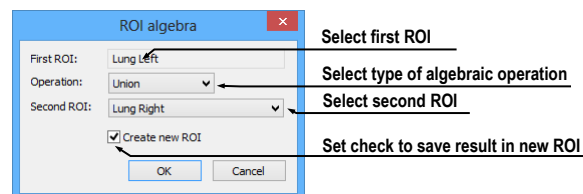
Figure 255 – ROI algebra dialog

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.

3. Select the algebraic operation in the **Operation** combo box (see Figure 256).
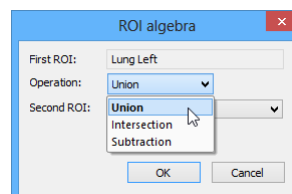
Figure 256 – ROI algebra dialog, defining the algebraic operation

4. Select the second ROI in the drop-down list that is displayed by clicking the **Second ROI** button (see Figure 257).
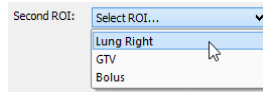
Figure 257 – Selecting the second ROI for algebra

5. To save the algebra result as a new ROI, check the **Create new ROI** check box.

6. To carry out the specified algebraic operation with the defined parameters, click the **OK** button.

10.5.6 Exporting an ROI to a DXF or VTK file

All defined ROIs in TomoCon can be exported to external files in the AutoCAD DXF or VTK format.

To export an ROI using the **ROI administration** dialog, proceed as follows:

1. Select the ROI for export in the ROI list and click the **Export...** button.

2. Select the desired file format, the file name and the target folder in the displayed **Export** dialog (see Figure 258).

3. To save the file, click the **Save** button.
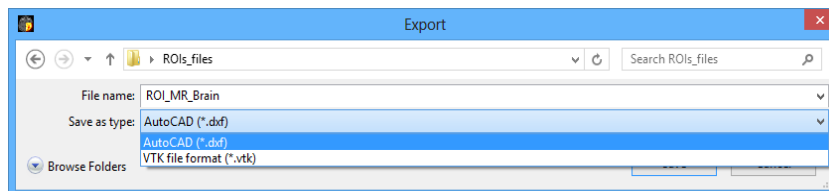
Figure 258 – Export dialog

10.6 Accepting and deleting a contour

The accepting contour operation in TomoCon allows you to accept an interpolated contour or the nearest contour in the displayed image using the **ROI drawing** tool (see Figure 259). The accepted contour is then inserted into the currently selected ROI in TomoCon as a new 2D contour.
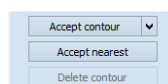
Figure 259 – Accepting section of the ROI drawing tool

To accept an interpolated contour:

1. Display the image with the interpolated contour (see Figure 260a) 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 260b).

4. The dashed line changes into a continuous line and the interpolated contour is changed from a proposed contour to an actual contour.

(a)   (b)
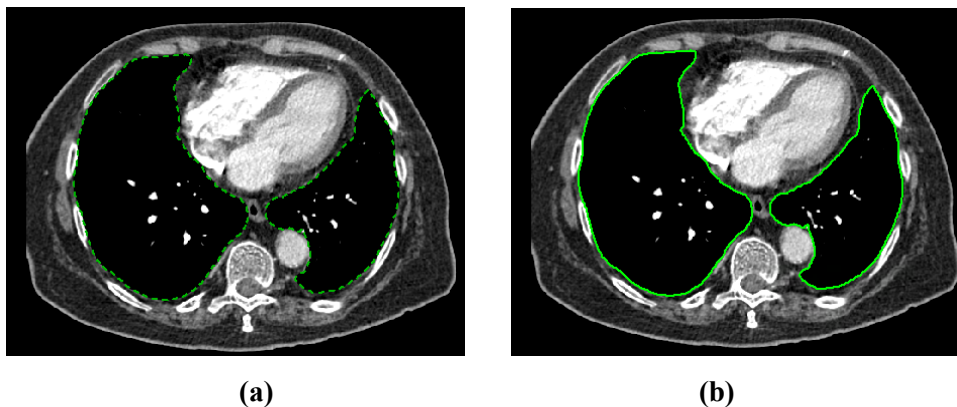
Figure 260 – Interpolated contour (a), Accepted interpolated contour (b)

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 261).

(a)   (b)
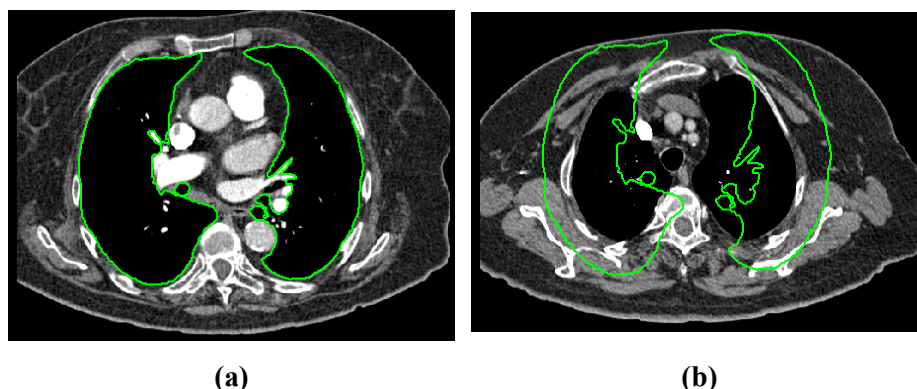
Figure 261 – Contour on the last image (a), Accepted nearest contour from the last image into the 1st image (b)

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 in TomoCon can be changed using the **ROI properties** tool in the tools panel (see Figure 262).
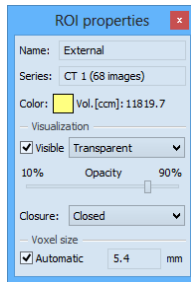
Figure 262 – ROI properties tool

The currently selected ROI in TomoCon is labeled with the following in the **ROI properties** tool:

- **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** tool allows you to change the following properties of the currently selected ROI in TomoCon:

- **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 (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 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 an 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/cm³ 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 of the TomoCon application. All the tools are accessible in the **ROI drawing** tool in the tools panel (see Figure 263).
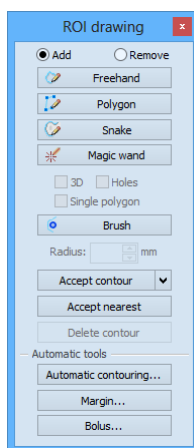
Figure 263 – ROI drawing tool

The TomoCon application provides you with five manual and three automatic drawing tools for contour editing in the displayed image in the current view, as listed below.

- Manual drawing tools:

  o **Freehand** – to contour an area freehand (see 10.8.1 Freehand drawing tool).

  o **Polygon** – to contour an area using a polygon (see 10.8.2 Polygon drawing tool).

  o **Snake** – to contour an area using a semi-automatic tool called Snake (see 10.8.3 Snake drawing tool).

  o **Magic wand** – to contour an area by joining adjacent image pixels with similar gray level values (see 10.8.4 Magic wand drawing tool).

  o **Brush** – to contour an area using a circle (see 10.8.5 Brush drawing tool).

- Automatic drawing tools:

  o **Automatic contouring** – to generate ROI contours in several adjacent images at the same time automatically (see 10.8.6 Automatic contouring drawing tool).

  o **ROI margin** – to generate a margin with defined properties of a previously created ROI automatically (see 10.8.7 ROI margin drawing tool).

  o **Bolus ROI** – to generate the bolus type of an ROI placed on the surface of a previously created ROI automatically (see 10.8.8 Bolus ROI defining 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 in TomoCon 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 264). 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.
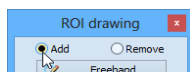
Figure 264 – Set Add/Remove mode for contour editing

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 265).

5. Release the mouse button to close the contour.

Figure 265 – Drawing a contour with the Freehand tool

When the freehand contour drawing process is complete, the contour closes with a straight line between the starting point and the ending point.

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 in TomoCon.

To use the Polygon 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 264). 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 266a).

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 266b).
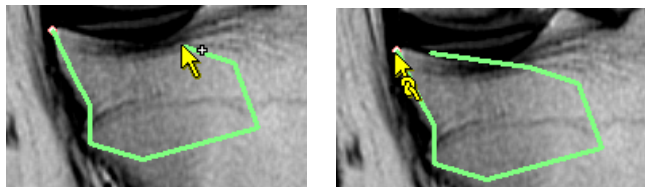
(a)   (b)

Figure 266 – Drawing a polygon contour (a), clicking the end point of 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 in TomoCon. The edges are detected in the image 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 (as the currently selected ROI) for which you want to edit a contour.

2. Select the adding contour mode (see Figure 264). 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 267a).

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 267b).
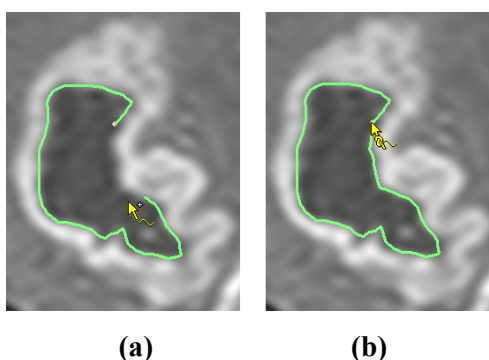
(a)   (b)
Figure 267 – Drawing a snake contour (a), clicking the end point of the snake contour (b)

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 (including any off-color areas surrounded by the chosen area).

To use the Magic wand 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 264). 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:

   o To create a contour in the current view only, uncheck the **3D** check box.

   o 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 268).

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.
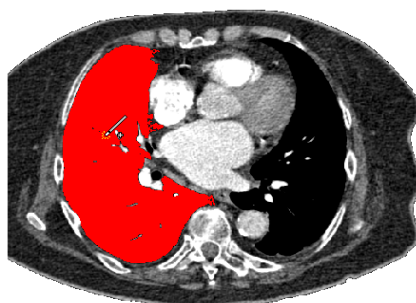
Figure 268 – Defining an area using the Magic wand drawing tool

10.8.5   Brush drawing tool

Using the Brush drawing tool, you can move the circular cursor with the defined size to project contour lines into the currently selected ROI. The Brush has the color of the currently selected ROI.

To use the Brush drawing tool, proceed as follows:

1. Select the ROI (as the currently selected 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.
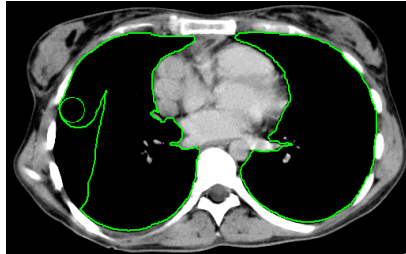
Figure 269 – Adding an area to a contour using the Brush drawing tool

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 269).

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 images at the same time. It is especially suitable for defining an outline of a patient (such as the skin surface). The image area (the entire image or a limited rectangle) and the image set (all images or a subset of images selected by defining the base image and extent) can be specified prior to contour creation.
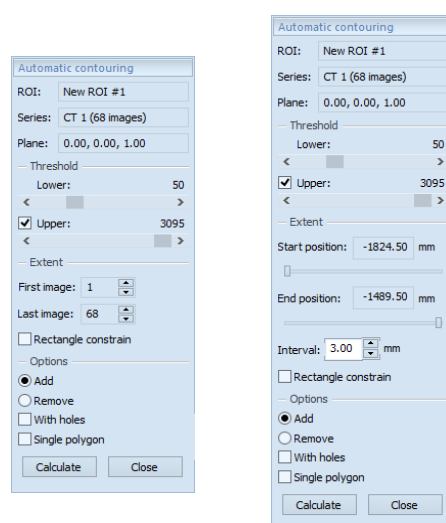
(a) (b)

Figure 270 – Auto ROI tool for original images (a), for reconstructed images (b)

To use the Automatic contouring drawing tool, proceed as follows:

1. Select the ROI (as the currently selected ROI) for which you want to edit a contour.

2. Click the **Automatic contouring...** button in the **ROI drawing** tool.

3. The **Auto ROI** tool is then automatically displayed as a new tab in the tools panel where you can define the parameters for automatic contouring (see Figure 270).

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 271).
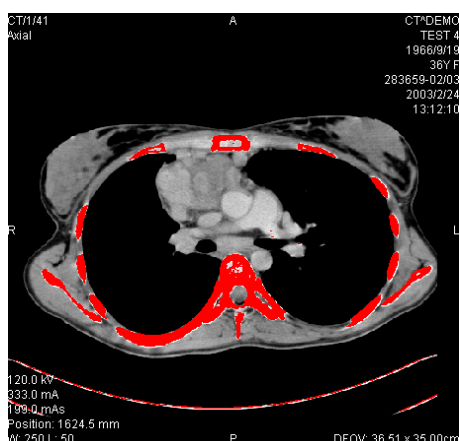
Figure 271 – Segmented image with threshold selection, contouring bones

5. Select the range of images (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 **First position** and **Last 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 – only a limited area of the image will be used. To select the area, proceed as follows:

        o   Check the **Rectangle constraint** check box.

        o   Move the rectangle or drag the sides to change its size until the desired area is demarcated (see Figure 272).

        o   To check that the desired area is properly demarcated in all slices, scroll through them in the current view.
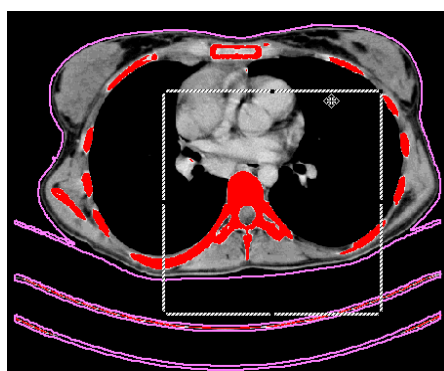
Figure 272 – Moving the rectangle constraint

7. Select the contour adding mode. 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** – this option is used to search for holes in each image according to the setting of the minimal and maximal threshold value.

    *   **Single polygon** – this option specifies the use of only one polygon in each image without holes according to the setting of the minimal and maximal threshold value.

9. Click the **Calculate** button.

10.8.7   ROI margin drawing tool

> **i** 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 an ROI margin using the margin drawing tool, proceed as follows:

1. Select the ROI (as the currently selected ROI) for which you want to create a margin.

2. Click the **ROI 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 273).
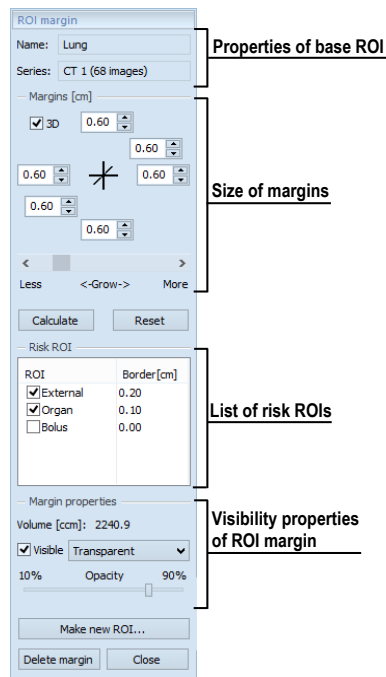
Figure 273 – ROI margin tool

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).

5. If desired, select one **Risk ROI** or several Risk ROIs (typically an organ at risk) and set the **Border** of its safety margin. The margin of the risk ROI will not be created but its extension in space will be considered when calculating

the ROI margin. The risk ROI and its safety margin then take precedence over the margin you are creating.

6. Click the **Calculate** button. The created margin will be displayed as a dashed line (see Figure 274).

(a)   (b)
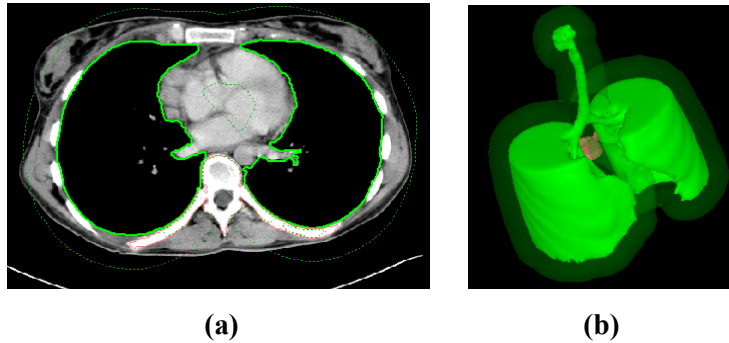
Figure 274 – Created ROI margin in 2D (a), in 3D (b)

7. Check the result in the images and the 3D view and adjust the margin properties if necessary. If the result is unsatisfactory, adjust the settings in the ROI margin tool and 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 275) 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.
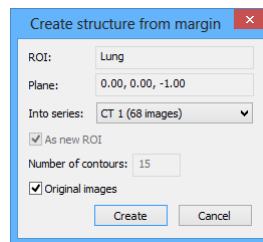
Figure 275 – Create structure from margin dialog

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

> **i** This functionality is only available if the Advanced Contouring license is installed in the TomoCon Workstation.

The Bolus ROI defining tool allows you 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 (as the currently selected ROI) for which you want to create a bolus.

2. Click the **Bolus ROI...** button in the **ROI drawing** tool.

3. The **Define bolus** dialog (see Figure 276) is then displayed in which you carry out the following:

    - Enter the name of the bolus ROI and its color.

    - Define the height of bolus in cm in the **Height** box.

    - When finished making the settings, click the **OK** button to continue.
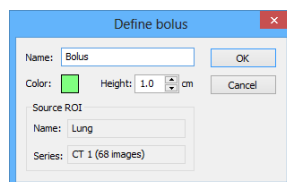
Figure 276 – Define bolus dialog

4. 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 277).

Figure 277 – 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 278).
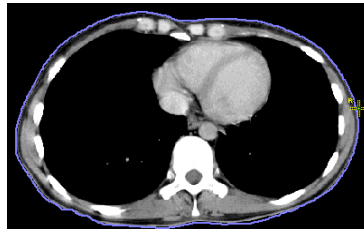
Figure 278 – Defining the right point of the bolus

- 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 279). The cursor will not be displayed as a green tick for **T** and **B**.
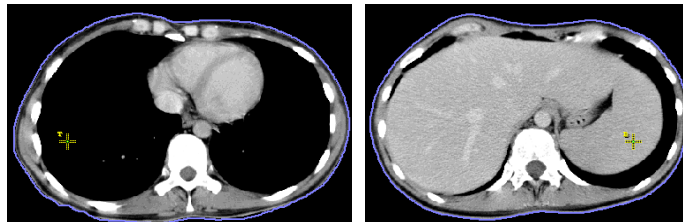
Figure 279 – Defining the top point and bottom point of the bolus

5. 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 280).
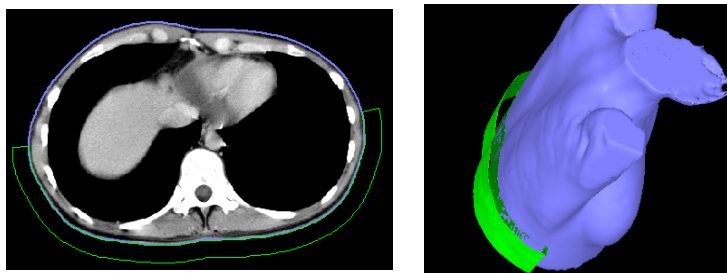
Figure 280 – Generated bolus ROI around the skin surface

11 Slab projections

Slab is a planar projection of image data within a defined extent of the image data volume (see Figure 281). Slabs can be created on slices and on MPRs and the projection method can be chosen to be one of MIP, MinIP, AvgIP algorithms.

(a) **(b)**
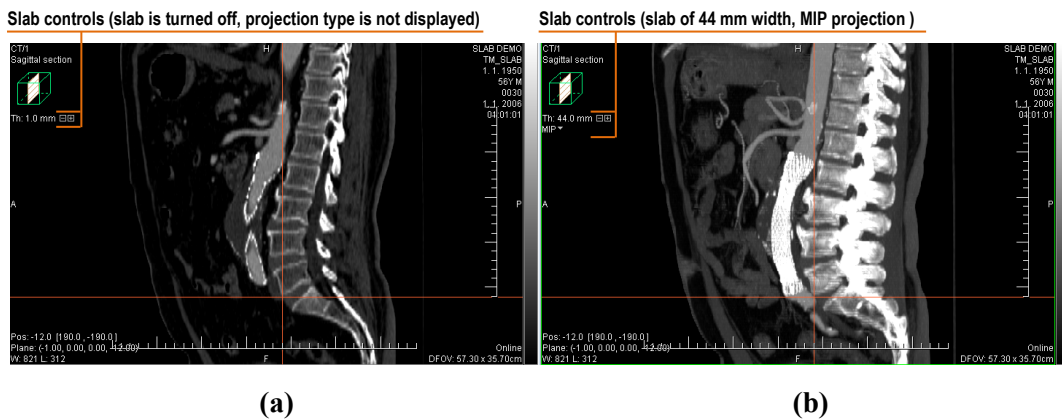
Figure 281 – Sagittal MPR, a) slab is turned off, b) slab with MIP projection of 44mm width

11.1 Creating slab projections

To create a slab projection:

1. Select series with slices where an MPR can be created.

2. Display arbitrary slice or an MPR the in the current view.

3. 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.

4. Select the method for the slab pixel values calculation (see Figure 282).
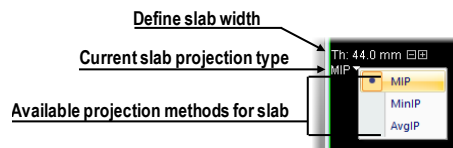
Figure 282 – Controls for defining slab in the current view

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 283), the slab mode can be toggled on or off, the exact slab width can be set and the projection algorithm can be selected.

Figure 283 – 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 284).
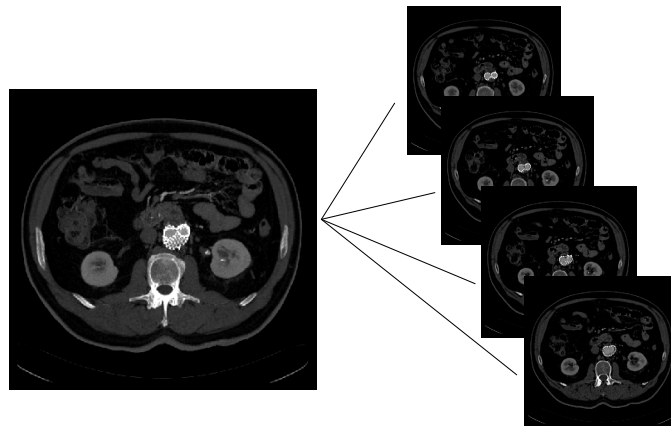
Figure 284 – Slab with 12 mm width composed by 4 slices (each with 3mm thickness)

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 285).

Figure 285 – 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 286). The checkbox is only displayed when **Orthogonal MPR** working area is selected.
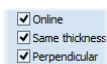
Figure 286 – Same thickness option in the MPR tool

11.4 *Slab projections on fusion images*

A slab can be created on fusion images, however, some limitations apply. 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.
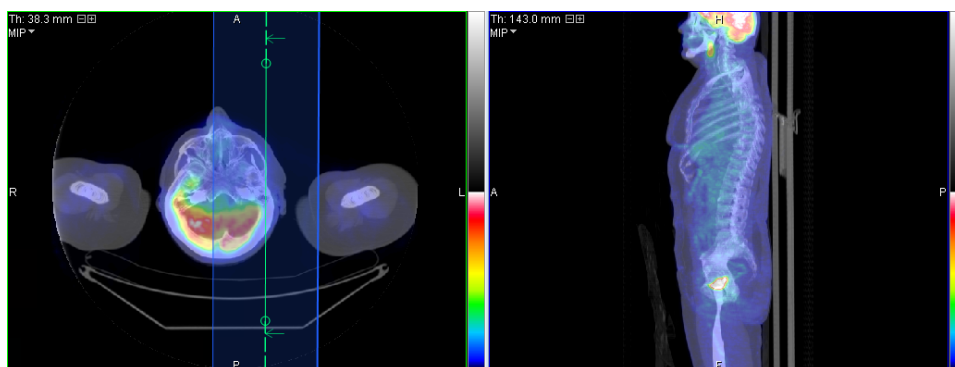
Figure 287 – Slab on fusion images and MPR

11.5 *Measurements and ROIs on slab projections*
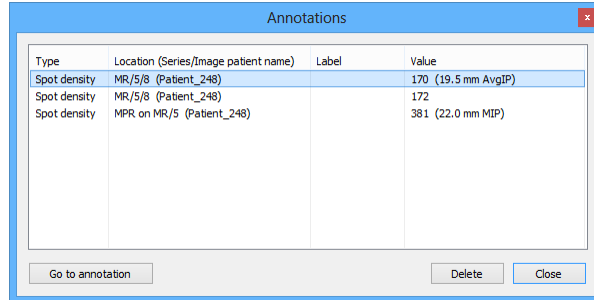
Measurements, ROIs and quantitative analyses can be created and used on slab projections. In all the situations, the position of the image is considered to be in the middle of the slab volume, thus all the measurements and ROIs are created on that slice/MPR (reference slice / reference MPR).

> 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.

The measurement values shown on the image are the values calculated using the slab projection, as seen on the screen. 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 288). There is no additional information for the annotations created on images without the slab projection.

Figure 288 – Annotations list with defined spot density on slab

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 you 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 289) is initially docked in the tools panel (on the fourth tab). 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. An 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.
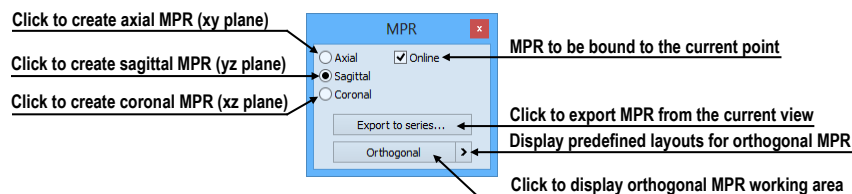
Figure 289 – MPR tool

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, situated in the upper-left corner. The indicator displays a general position and orientation of the MPR plane in the patient image data volume (see Figure 290).

- 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 290).
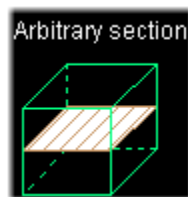
Figure 290 – Indicator of MPR plane position and orientation

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 291).
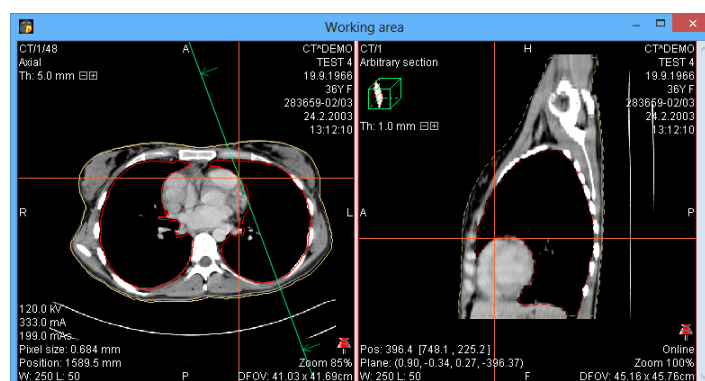
Figure 291 – Arbitrary MPR view and intersected axial MPR plane

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. Its main advantage is that it allows to display MPRs without any changes to overlapped working area and possibly maintain their orthogonality easily. 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.
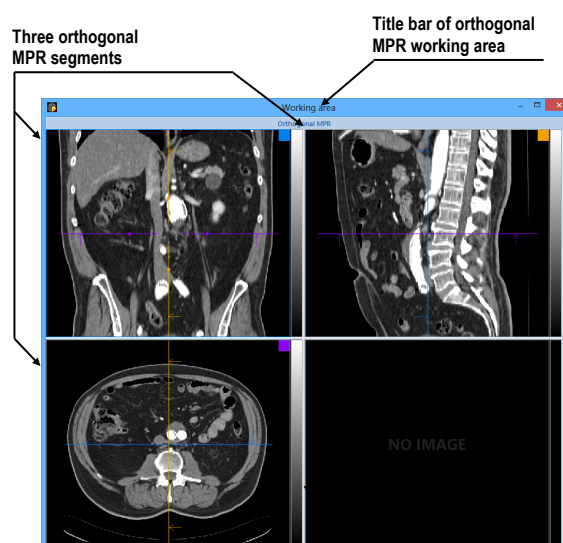
Figure 292 – Initial layout of orthogonal MPR working area

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 294a) 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** list in the main toolbar (see Figure 294b). New orthogonal MPR working area will overlap the whole original working area to which the current view belongs.

(a)   (b)
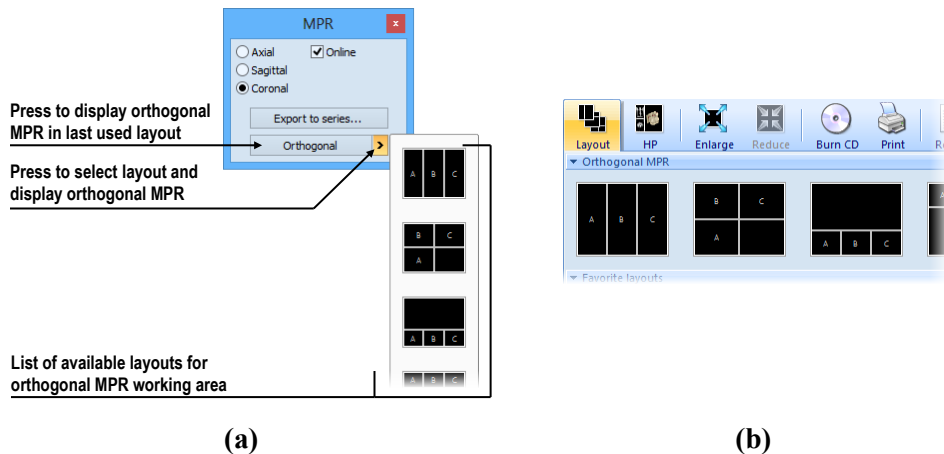
Figure 293 – MPR tool (a), Layout list in the main toolbar of TomoCon (b)

To close orthogonal MPR working area, click the close button (see Figure 294) in the title bar of the working area. The working area will be immediately closed and the content of the original overlapped working area will be displayed.

To move orthogonal MPR working area, drag it by the title bar over another area, which should be overlapped; then release the mouse button.
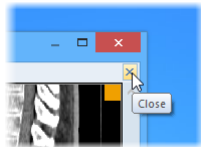
Figure 294 – Closing the orthogonal MPR working area

Each layout of orthogonal MPR working area consists of three segments showing MPRs of selected series. The orthogonality of these segments can be preserved regardless on the operation performed, depending on **Perpendicular** checkbox state. To force the MPRs to be always perpendicular to each other, check the **Perpendicular** checkbox (this is the initial state, when the orthogonal working area is created). When the checkbox is not checked, the manipulation of MPRs is similar as when in standard working area. The **Perpendicular** check box is found in the MPR tool and is only displayed while orthogonal working area is selected.

The slab widths of MPR views in the orthogonal working area can be synchronized – for more information see 11.3 Slab projections on MPRs.

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 295). The predefined colors can be changed in the **Colors and styles** tab of the **TomoCon 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.
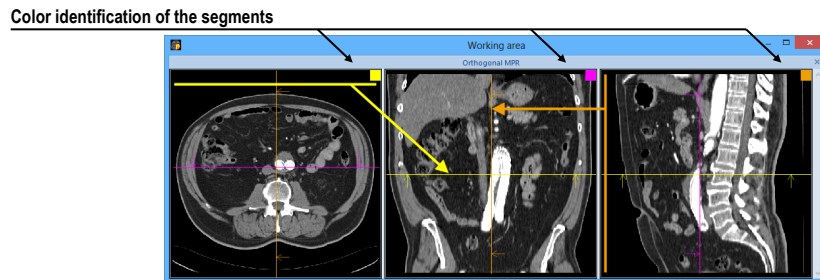
Figure 295 – Color identification of MPR segments

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. These are displayed automatically for each MPR visible in the working area (see Figure 296). 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.
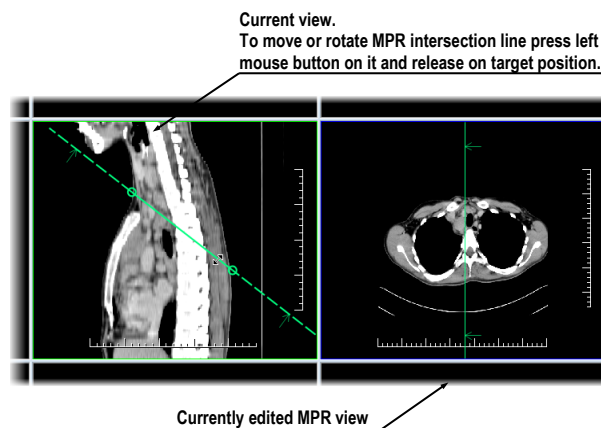
Figure 296 – Interactive moving of MPR

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 297). The MPR view coupled to the line is highlighted in blue. Then drag the line to requested position, releasing the mouse button when done.

<div align="center">(a)   (b)</div>
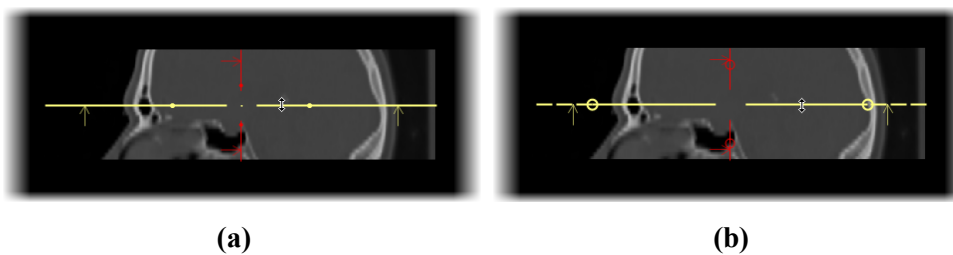
Figure 297 – Interactive moving of MPR, a) orthogonal section lines, b) other section lines

Rotating a plane of an MPR is slightly different depending on whether the MPR is in an orthogonal working area with **Perpendicular** option on, or not.

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 298).
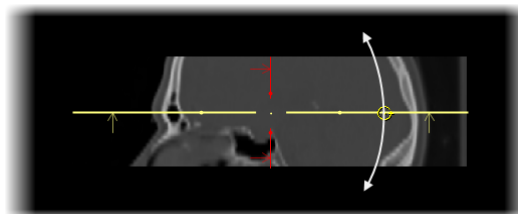
Figure 298 – Interactive rotating of section lines with Perpendicular option on

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 299a). To move rotating point of line represented by circle, drag and drop it to another position on line (see Figure 299b).

<div align="center">(a)   (b)</div>

Figure 299 – Interactive rotating, Perpendicular option is off, a) section line rotation, b) changing the rotation center

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.
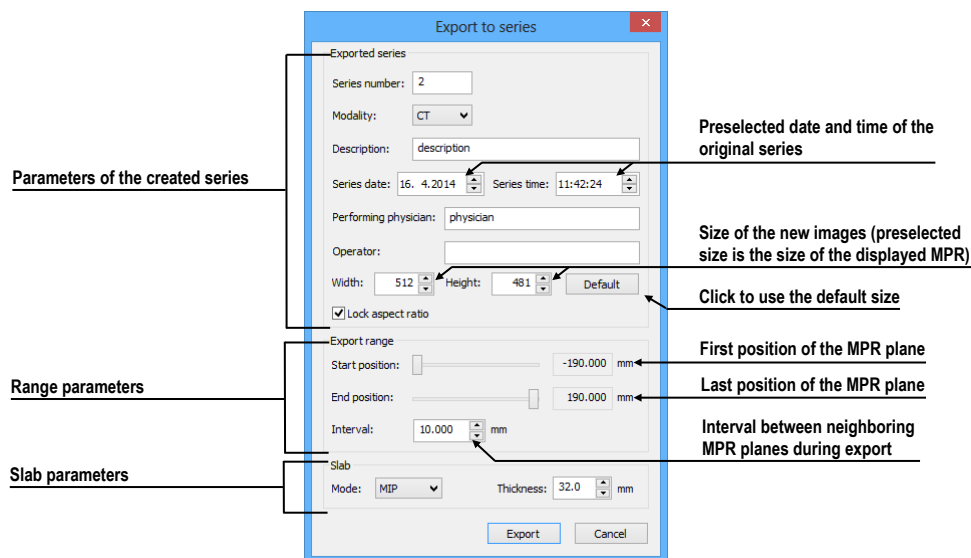
Figure 300 – Export to series dialog

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 300).

4. After setting up the parameters, press the **OK** button.

13   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 in front of you. Although it usually displays MIP calculated from maximum values, the TomoCon application also allows you 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 301) is docked in the tools panel (on the fourth tab) by default. You can access it by clicking the tab with the ✎ icon.
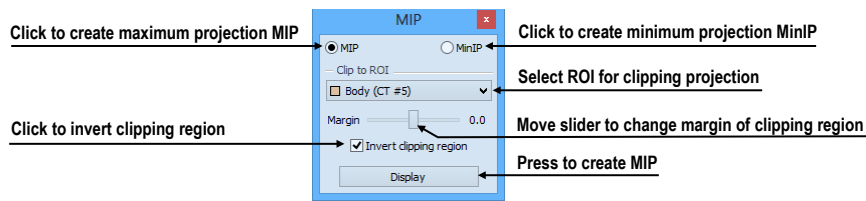
Figure 301 – MIP/MinIP dialog

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 **Apply** button. The calculated projection is then immediately displayed in the current view (see Figure 302).
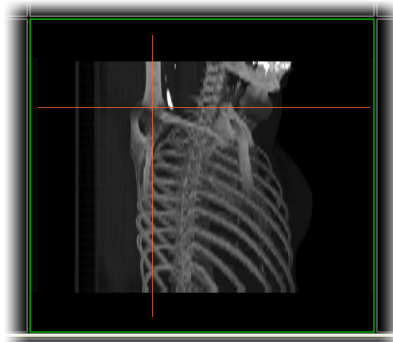
Figure 302 – MIP in the current view

14   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 you 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 303), which is initially docked in the tools panel (on the fourth tab). You can access it at any time by clicking the tab with the ![icon] icon.

Figure 303 – DRR Reprojection image and tool

You can set the following parameters for DRR reprojection in the **DRR** tool:

- **Viewport settings** - setting up the DDR position to the patient's position: **Anterior**, **Right**, **Top** and **Arbitrary (**DDR position determined by the **View** and **Target** parameters)

- **Window size**

To start the process of DRR reprojection creation, press the **Display** button.

15 Multi-modality fusion

Multi-modality fusion makes it possible to display data from two registered series in combination or overlapping in one image view.

The ability to correlate 3D images (see 17 Registrations) 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 in the tools panel. It provides the controls for fusion settings such as the base series, fusion series, color palettes, translucency, the fusion method, etc. The **Fusion** tool (see Figure 304) is initially docked in the tools panel (on the fifth tab). You can access it by clicking the tab with the icon.
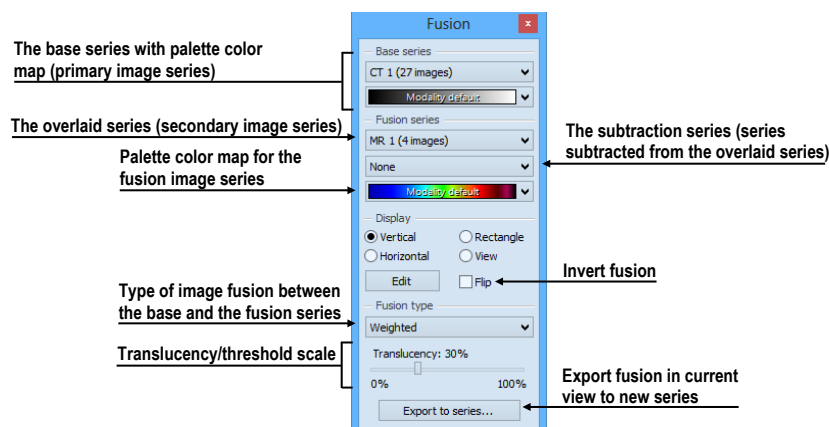
Figure 304 – Fusion tool

15.1 Creating multi-modality image fusion

To create fusion from a two-modality image series, use the **Fusion** tool (see Figure 304) as follows:

1. Click the **Base series** combo box to select the primary series (see Figure 305).
2. Click the **Base color map** to select the primary color map.
3. Click the **Fusion series** combo box to select the secondary series.
4. Click the **Fusion color map** to select the secondary color map.

5. 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.
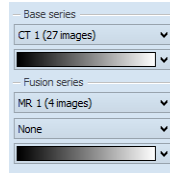
Figure 305 – Series and color map selection

To add a subtraction series to a multi-modality fusion, proceed as follows:

1. Click the subtraction series combo box to select the subtraction series.

2. The color palette will automatically change to the subtraction palette.

3. If you want to change the used subtraction palette, click the fusion color map to select it.

4. To remove a used subtraction series from a fusion, select the **None** item in the **Select subtraction series…** combo box.
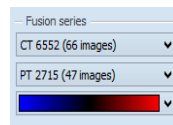
Figure 306 – Subtraction series and color map selection

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 307). 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 308, 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 308, 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.
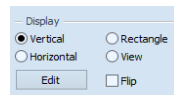
Figure 307 – Display section of the Fusion tool
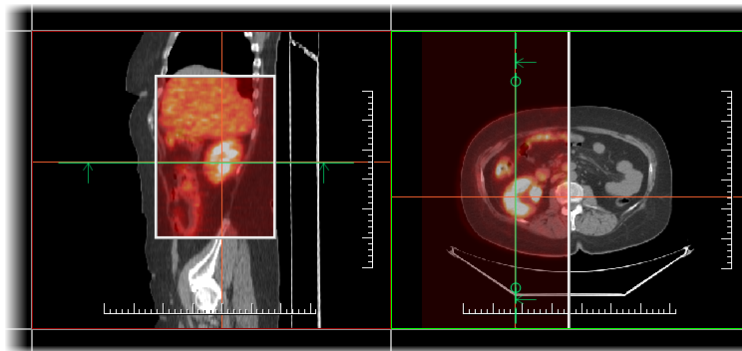
Figure 308 – Fusion images between CT and PET series

15.2 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 309) and select the method from the displayed list.
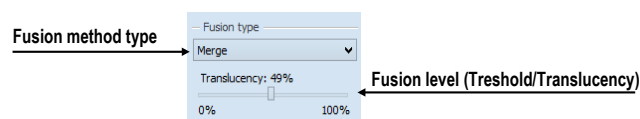
Figure 309 – Fusion type section of the Fusion tool

15.3 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 310). 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 **OK** button.
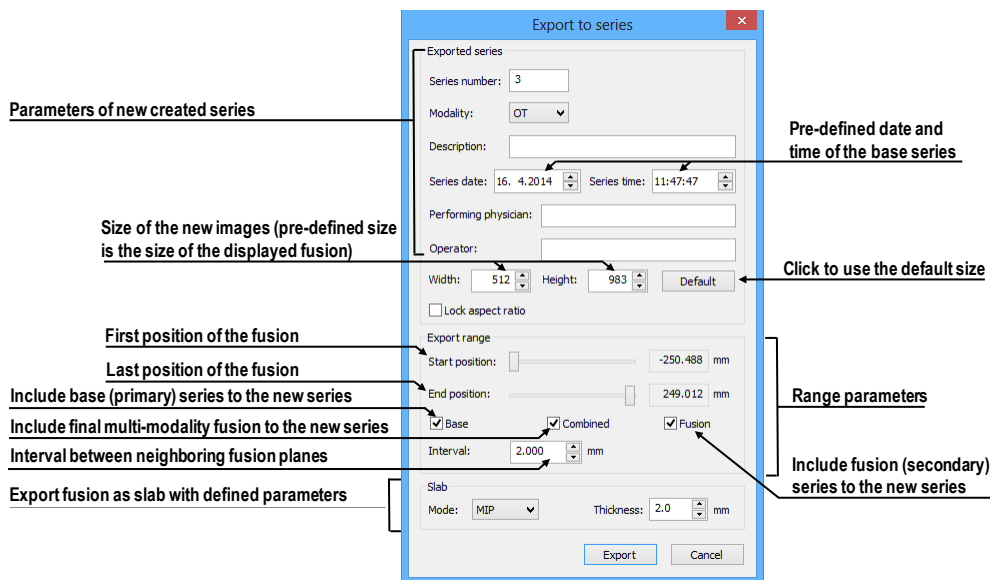
Figure 310 – Export to series dialog (parameters of the created series)

16 Three-dimensional visualization

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 16.4 Volume rendering).

To define the parameters of the 3D view, use the **3D** tool (see Figure 311) in the **Tools** panel. It is initially docked in tools panel (on the sixth tab). 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 of the TomoCon application.
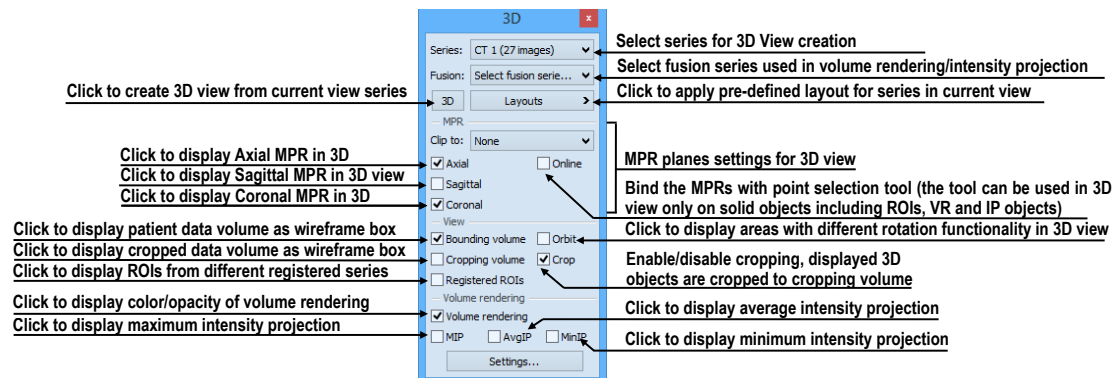
Figure 311 – 3D tool

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 312), 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.
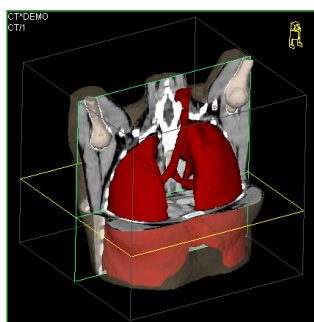
Figure 312 – 3D view

16.1 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 313). 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.
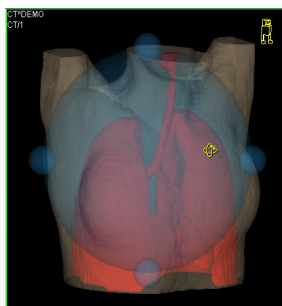
Figure 313 – 3D view with the Orbit function

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. If you prefer that the icon is not displayed, it can be hidden in the **TomoCon setup** dialog (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 (see Figure 314)

- rotation in patient coordinates (see Figure 315)

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; for enhanced orientation, the orbit is always displayed.
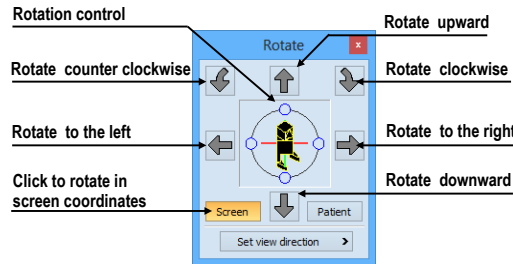
Figure 314 – Rotate tool (Screen mode)
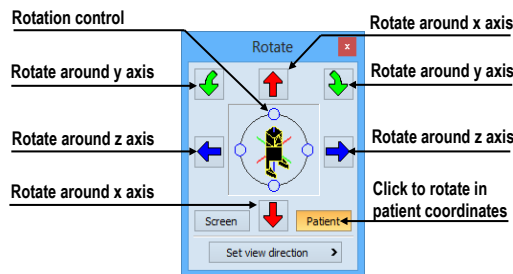
Figure 315 – Rotate tool (Patient mode)

16.2 Cropping volume of interest

Initially, the 3D view displays the entire bounding volume of the selected series. It is however possible, in order to speed up rendering and to increase efficiency, to display only partial series volume. Volume cropping (see Figure 316) can be used for the 3D view as well as a linked image, fusion or section view.
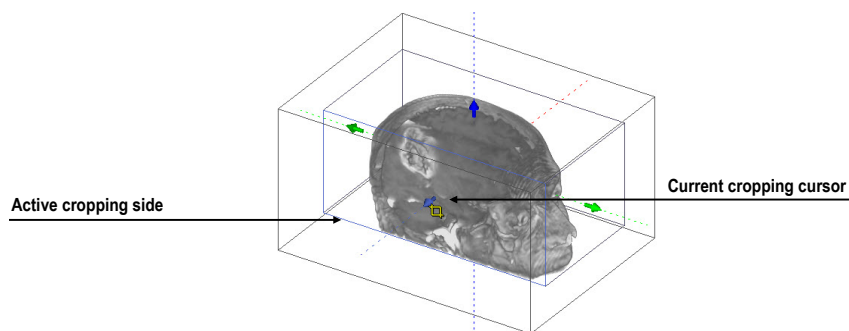
Figure 316 – Active cropping mode

In order to begin cropping, select the cropping tool in the context menu of the 3D view (see Figure 317). Next, drag selected object (the cropping arrow or cropping cube edge) in the view and move it to desired position (see Figure 316).
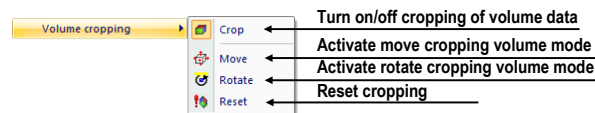
Figure 317 – Cropping menu

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.

16.3 *Moving an MPR plane*

It is possible in the TomoCon application to move an MPR plane interactively in a view (see Figure 318). When the cursor is placed at an MPR edge of the MPR plane, the cursor takes the form of 🔆 and the border of the MPR plane is highlighted in yellow. You can then press and hold down the left mouse button to move the MPR plane.
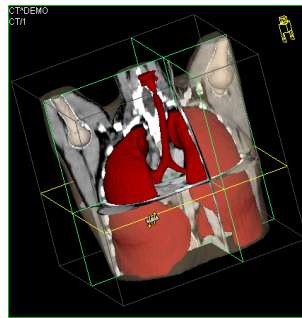
Figure 318 – 3D view with highlighted MPR plane

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.

16.4 Volume rendering

> ⓘ This functionality is only available in TomoCon Workstation.

To display volume rendering visualization, you can use one of the following methods:

- Select the series of interest for volume rendering in the **Series** combo box of the **3D** tool and check the **Volume rendering** check box (see Figure 319a).

- 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 319b) and then check the **Volume rendering** check box.

(a)   (b)

Figure 319 – Selecting series for volume rendering, a) selecting series via combo box, b) using pre-defined layout

The volume rendering visualization (see Figure 320) 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, and AvgIP) is similar to that of volume rendering described above.

To change the parameters of volume rendering visualization, you can use the following tools and dialog in TomoCon:

- The **Rotate** tool enables spatial manipulation of the current 3D view (see 16.1 Rotation, spatial orientation).

- The **Color and opacity** tool is used for defining and using pre-defined color presets (see 16.4.3 Creating and using color presets).

- The **Volume rendering settings** dialog allows you to change the basic parameters of volume rendering visualization in the current view (see 16.4.2 Volume rendering settings).
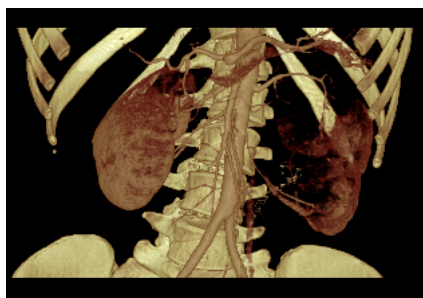
Figure 320 – Volume rendering 3D view

16.4.1 Point selection in volume rendering and intensity projections

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 321). 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.

(a)   **(b)**   **(c)**
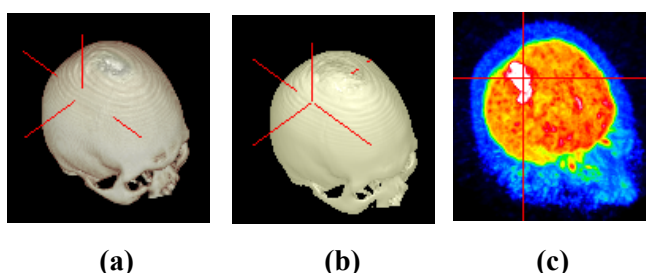
Figure 321 – Point selection, (a) inside, (b) on surface, (c) in MIP

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.

16.4.2 Volume rendering settings

This dialog allows you 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 322)

Define number of samples along volume side. The more samples per side, the better VR quality is achieved. NOTE: drawing FPS (frames per second) rate is strongly hardware dependent. Higher sampling rates can rapidly decrease interactivity (FPS) on lower standard graphic hardware

Define lower quality drawing, when slower graphic hardware is in use, or increase interactivity for high quality VR images. Fast drawing coefficient defines decrease in quality.

Use voxel sizes for gradient computation. It is most accurate and recommended setting.

Use constant sizes for gradient computation, which correspond to minimum size of voxel

Method of volume rendering shading

Use constant sizes for gradient computation, which correspond to average of voxel sizes

Figure 322 - Volume rendering settings, the first tab

- lighting settings used in volume rendering on the second tab (see Figure 323)

Define the amount of ambient (diffuse, specular) light . Turn ambient light on/off.

Define width of specular reflection. Higher values produce narrow reflection and small values produce wide reflection.

Exponential behaviour of fog opacity. Higher values are used for optically dense material; lower values indicate thin fog.

It is used when isosurface is defined. Inner and outer sides of an isosurface are differently shaded for better recognition. Outer side is in direction from less dense medium toward denser medium.

Figure 323 – Volume rendering settings, the second tab

- settings for color corrections and advanced ray casting settings on the third tab (see Figure 324)

Increase or decrease brightness

Setting for color correction. It is applied only to volume rendered data. Though, other objects are not affected.

Increase or decrease saturation

Faster drawing. Outer parts of view are rendered with lower resolution

Improve image quality of volume rendering

Reduction of "planes" effect
Reduction of cube sides effect
Faster and higher quality isosurface rendering

Figure 324 – Volume rendering settings, the third tab

16.4.3   Creating and using color presets

The TomoCon application allows you 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.
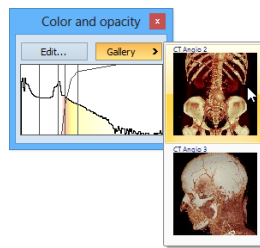
Figure 325 – Gallery of presets

To apply a color preset, click the **Gallery** button in the tools panel of the **Color and opacity** tool (see Figure 325). 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 your customized presets.

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 326) is then displayed. Define the color, the opacity and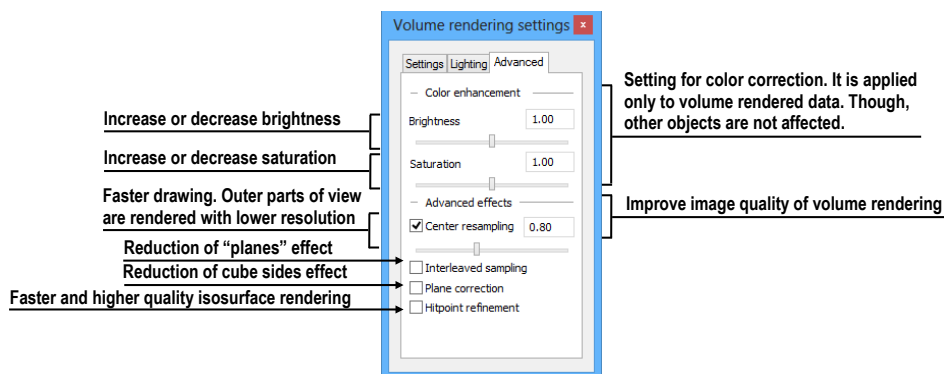 the interval parameters for the new preset in the **LUT** control of the **Color/opacity settings** dialog (see Figure 326).

To modify the effects, use the **Effects** menu.

Figure 326 – Color/opacity settings dialog

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 you can enter a name for it (see Figure 327).

Figure 327 – 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 328).
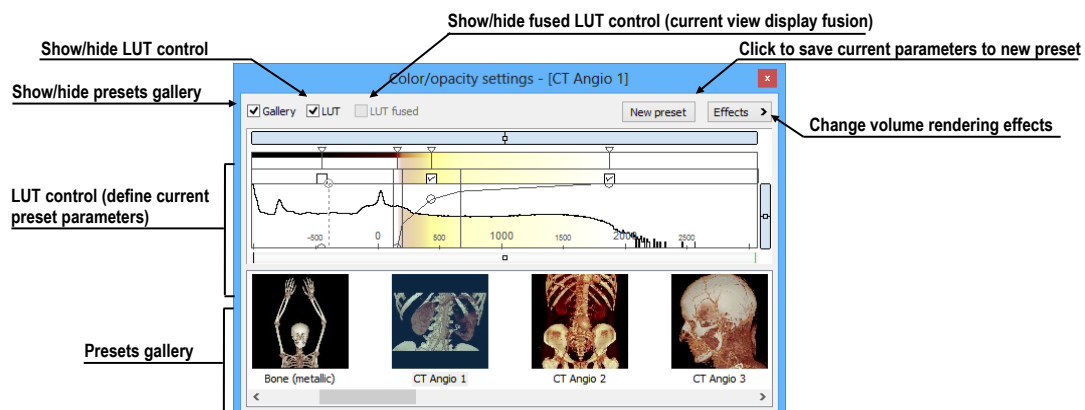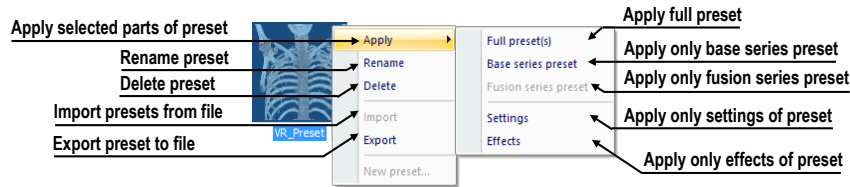

Figure 328 – Context menu of the gallery of presets

To set the color parameters for the preset, use the **LUT** control of the **Color/opacity settings** dialog (see Figure 329). 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.
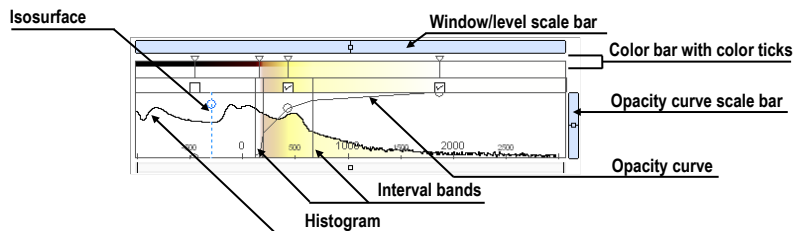
Figure 329 – LUT control part

The **Window/level scale bar** is used to change the window and level values of the color table. To change the level value, place the cursor over the **Window/level scale bar** and press and hold down the left mouse button while moving the **Window/level scale bar**. To change the window value, proceed as described above for the level value while additionally holding down the **Ctrl** key.

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. The following operation is available for modifying the color properties in the *simple mode*:

- To change the color in the color palette, move the cursor over the color position marker until it changes to ◇ and then:

  - double-click, or

o right-click to display the context menu and select the **Edit** item

The color dialog is then displayed.

The following operations are available for modifying the color properties in the *advanced mode*:

- To change the color in the color palette, move the cursor over the color position marker until it changes to $\leftrightarrow$ and then:

  o double-click, or

  o right-click to display the context menu and select the **Edit** item

  The color dialog is then displayed.

- To move a color in the **Color bar** by moving the color position marker, move the cursor over the color position marker until it changes to $\leftrightarrow$ and press and hold down the left mouse button while moving it.

- To insert a new color position marker in the **Color bar**, place the cursor at the desired location for the insertion of the new color position marker and then:

  o double-click, or

  o right-click to display the context menu and select the **Insert** item

- To set the interpolation mode between color position markers, right-click the **Color bar** to display the context menu and select the **Interpolation** sub-menu. Next, choose from among the **Box**, **Linear** and **Cosine** items.

- To delete a color position marker, move the cursor over the color position marker until it changes to $\leftrightarrow$, right-click to display the context menu and select the **Delete** item.
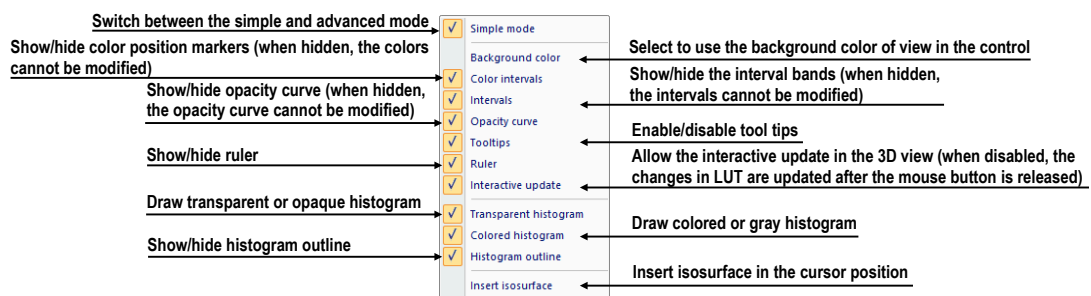

Figure 330 – LUT context menu

The **LUT** context menu (see Figure 330) 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. The color palette within the interval is displayed along with the defined transparency. If the interval display is turned off, the opacity for the given interval is considered to be zero.

The following operations are available for modifying the interval bands:

- To change an interval band, move the cursor over the interval band until it changes to ⊹ and press and hold down the left mouse button while moving the band. Release the band at the desired position.

- 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, move the cursor to the interval band color scale and right-click.

- To delete an interval band, select the **Delete** item in the interval band context menu.

- To display the interval band context menu, move the cursor over the interval band until it changes to ⊹ and right-click.

The opacity curve defines the opacity used in volume rendering. Unlike in the *advanced mode*, the opacity curve in the *simple mode* is fixed to the center of the interval and automatically moves along with the interval band.

The following operations are available for modifying the opacity properties:

- To modify the opacity, move the cursor over the opacity curve point until it changes to ↕ or ✛ and press and hold down the left mouse button while moving it.

- To change the curve slope (tangent) in the intersection point with the closest interval band, press the **Alt** key, move the cursor over the opacity curve until it changes to ✍ and press and hold down the left mouse button while changing the curve slope.

- The opacity curve can be moved/scaled using the opacity curve scale bar.

- In the *advanced mode*, you can move the opacity curve. To move the opacity curve, press the **Alt** + **Shift** key combination and move the cursor over the opacity 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.

The following operations are available for modifying the isosurface properties:

- 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.

17   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 15 Multi-modality fusion).

TomoCon allows you to define your own registration between selected series by the group of registration tools described in chapter 17.1 Defining registration. Using the **Registrations** dialog (see Figure 331), you can define a new, edit or remove exist registration. 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.

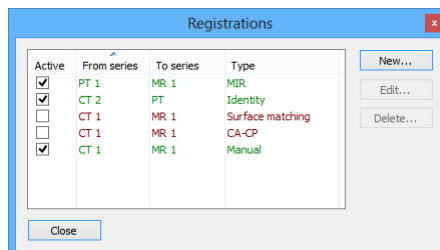To open the **Registrations** dialog (see Figure 331), click the **Registrations…** item in the **Tools** menu.

Figure 331 – Registrations dialog

The following operations are available in the **Registrations** dialog:

- **New…** - defining a new registration between two series (see 17.1 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 (highlighted in green and checked). Other registrations between the series are inactive (highlighted in red and unchecked). Using the check box, it is possible to temporarily undefine a registration or to select a different one as active.

17.1 *Defining registration*

In order to define a relation between two series, press the **New…** button in the **Registrations** dialog (see Figure 331). The **Define registration** dialog opens (see Figure 332).
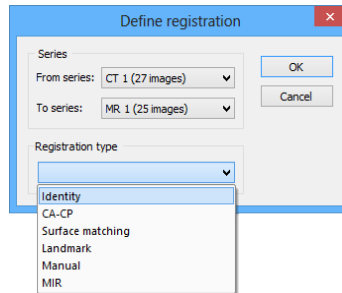

Figure 332 – Define registration dialog, selecting the Registration type

The **Define registration** dialog (see Figure 332) specifies the following:

- **Series** – the two series and the registration type between them:
  - **From series**
  - **To series**
- **Registration types**:
  - **Identity** (see 17.1.1 Identity)
  - **CA-CP** (see 17.1.2 Patient-related (CA-CP))
  - **Surface matching** (see 17.1.3 Surface matching)
  - **Landmark** (see 17.1.4 Landmark)
  - **Manual** (see 17.1.5 Manual)
  - **MIR** (see 17.1.6 MIR)

17.1.1 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.

17.1.2 Patient-related (CA-CP)

CA-CP registration (see Figure 333) 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.
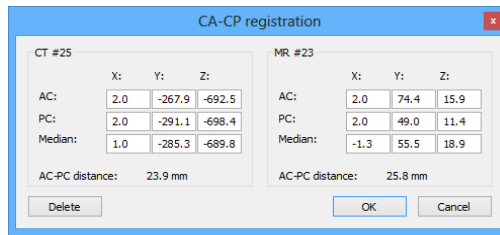

Figure 333 – CA-CP registration dialog

17.1.3 Surface matching

Surface matching registration (see Figure 334) 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.
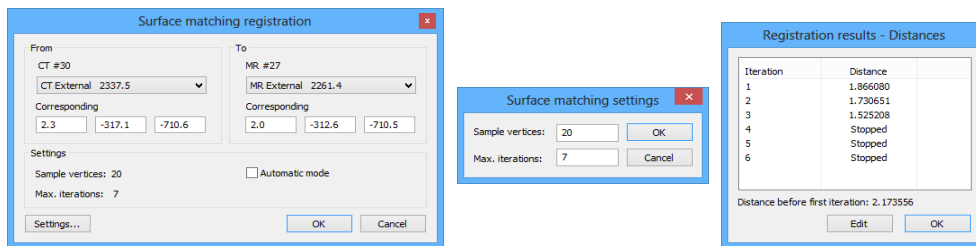

Figure 334 – Surface matching registration dialog, Surface matching settings dialog, Registration results - Distances dialog

17.1.4 Landmark

Landmark registration (see Figure 335) uses the coordinates of multiple landmarks to establish series registration.
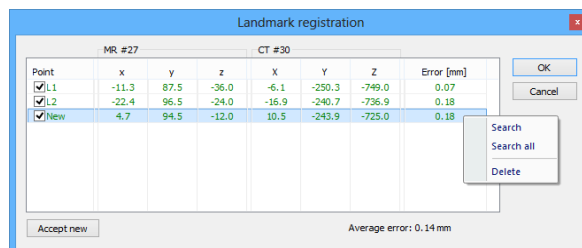

Figure 335 – Landmark registration dialog

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 ✣Marker2 with its respective name.

17.1.5 Manual

Manual registration concerns the mutual manual movement of the three base planes in two registered series. After selecting manual registration in the **Define registration** dialog, the **Registration initialization** dialog is displayed (see Figure 336) 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)

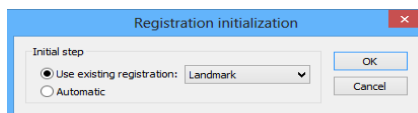- **Automatic** (the centers of the 3D coordinate systems of the two series are assumed identical)

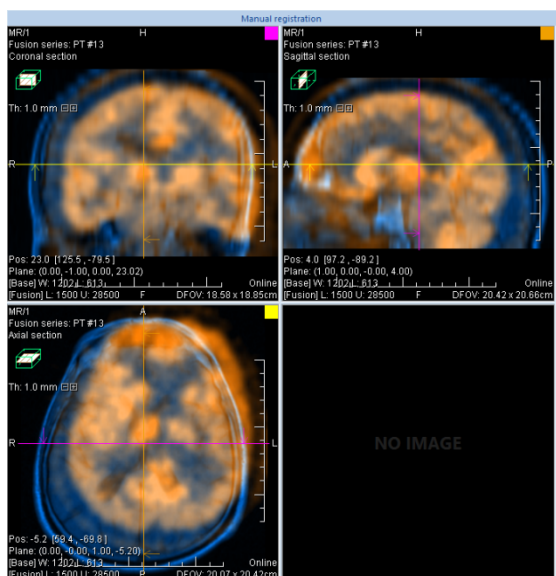
Figure 336 – Registration initialization dialog

Figure 337 – Manual registration working area layout

After confirming the initial step with **OK** button, the **Manual registration** dialog (see Figure 338) is displayed, and the current working area is overlapped with orthogonal MPR working area (see Figure 337). This special working area is placed over the existing working area and it is independent from other working areas displayed at the time.

Manual registration working area initially contains three orthogonal MPRs (see 12.3 Orthogonal MPR working area), 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 338).
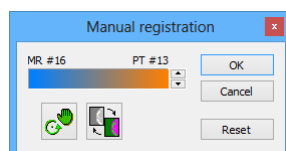

Figure 338 – Manual registration dialog

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 339a). 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 339b). 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).

| (a) | (b) |

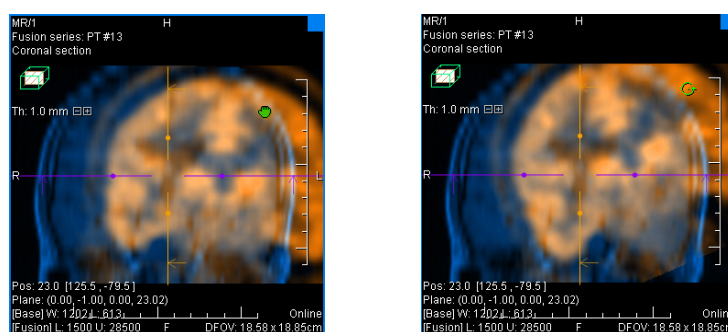**Figure 339 – Panning (a) and rotating (b) an MPR during manual registration**

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 and fusion MPR can be moved and/or rotated to desired position (see Figure 340a). After pressing again, manual

registration mode is turned on and it is possible to continue editing the registration (see Figure 340b).

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.
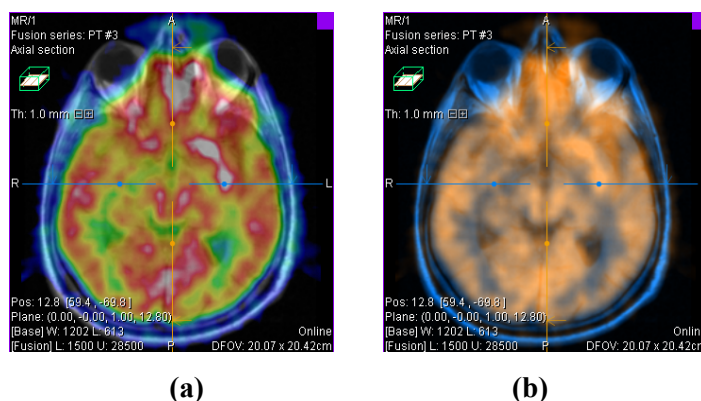

(a)　　　　　　　　　　**(b)**

Figure 340 – Moving the Base MPR's plane (a), manual registration with shifted plane of the Base MPR (b)

17.1.6　MIR

> ℹ️ 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 341). 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)
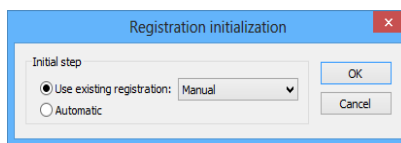
Figure 341 – MIR registration initialization dialog

After confirming the initial step with the **OK** button, the MIR dialog is displayed (see Figure 342) 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. To stop the registration process, 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.
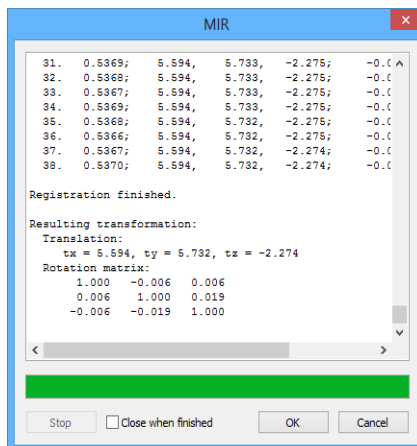

Figure 342 – MIR dialog

18 Print images

The TomoCon application provides printing capabilities that offer you more printing functions than other Microsoft Windows applications. With TomoCon, you can print any selected images from the opened series on monochrome, on a color Microsoft Windows printer or on any DICOM printer. The printing interface of TomoCon can be configured to work with a number of printers. The printing area can be divided according to your required layout and TomoCon allows you to monitor and control the printing process and review everything that has already been printed.

Printing in TomoCon is carried out in the background and will not impede your system operation and thus you can continue viewing while your print jobs are running.

TomoCon allows you to combine various images on virtual print films which you can then print out through the special TomoCon print interface (see 18.1 TomoCon print window) that is displayed by selecting the **Print...** item in the TomoCon main menu. This selection provides you with a high degree of flexibility for combining images from different studies or series on the same virtual print film or process images (such as zoom, filter, window/level, etc.) before they are printed.

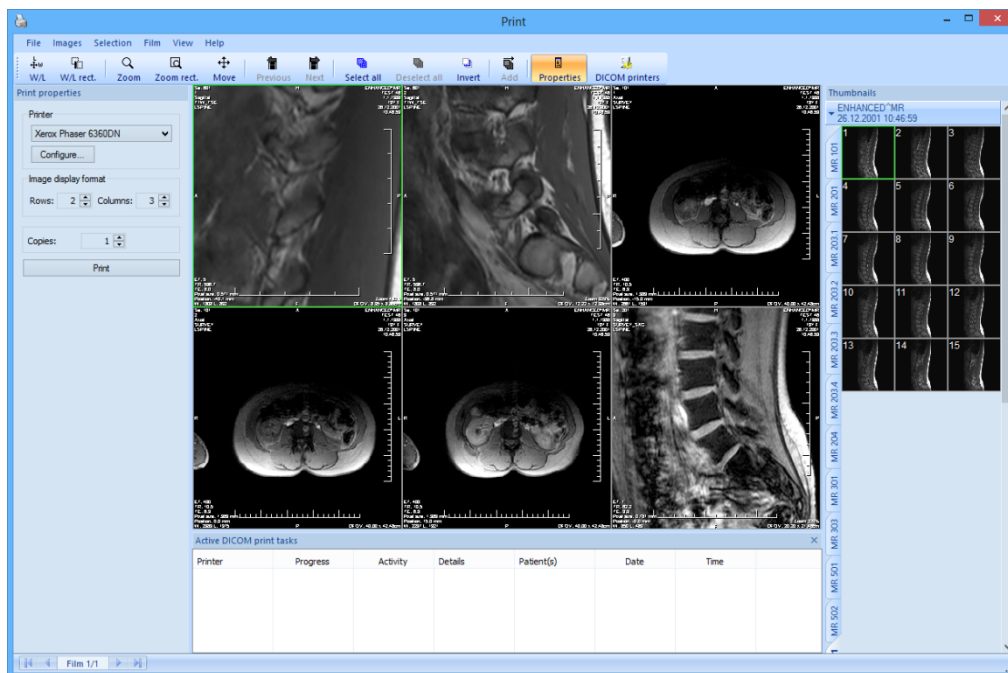## 18.1 TomoCon print window

Figure 343 – TomoCon print interface

The TomoCon print interface window (see Figure 343) consists of the following main parts:

- Print working area (see 18.1.1 Print working area)

- Thumbnail palette (see 18.1.2 Main menu)

- Print queue (see 18.4 Start printing)

- Menu (see 18.1.2 Main menu)

- Standard toolbar (see 18.1.3 Toolbar)

- Status bar (see 18.1.4 Status bar)

18.1.1   Print working area

The print working area is a large black area representing one print film and is similar to the TomoCon 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 Figure 344).
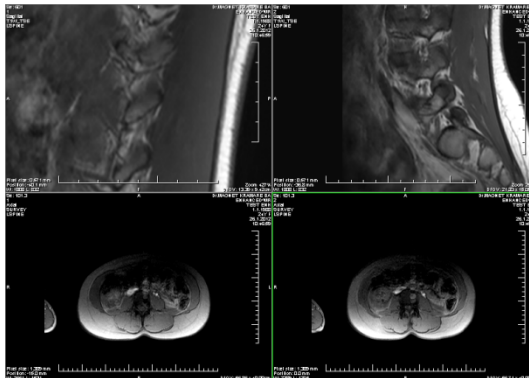

Figure 344 – Working area with 2 rows and 2 columns

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, TomoCon automatically creates a new film into which it inserts the remaining images.

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 18.1.4 Status bar) or by clicking the **Previous**/**Next** button in the toolbar (see 18.1.3 Toolbar).

When composing a print film on the current print working area, you can view and modify the images 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 345). Additionally, you can show/hide the additionally displayed

objects (ruler, overlays, texts, etc.) in all views using the **View** menu in the print window.
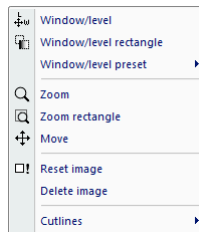

Figure 345 – Context menu in the current view

18.1.2   Main menu

The main menu takes the form of a system menu in the print window (see 3.4 Main menu) and provides you with direct access to all functions for printing images. As with a typical Microsoft Windows application, the items in the main menu are logically grouped into submenus. The main menu consists of the following submenus:

- **File -** for DICOM printer installation (the **Printers…** item, see 18.5.2 Configuring a DICOM printer) and completing work in the print window (the **Exit** item).

- **Images -** for image modification (window/level, zoom, move, etc.) in the current view (see 18.3 Manipulating image for print).

- **Selection -** for selecting images from the thumbnail palette to be displayed in the print working area (see 18.1.6 Select images for print).

- **Film -** for navigating between films (see 18.2 Navigating between films).

- **View -** for hiding/displaying sub-windows (toolbar, status bar, etc.) in the print window and additional objects in views.

- **Help -** for browsing the electronic version of the user's manual.

18.1.3   Toolbar

The print window of the TomoCon application allows you to use the **Standard** toolbar buttons for frequently performed tasks in the printing preparation process. This toolbar (see Figure 346) is located above the print menu by default and its visibility can be changed by checking/unchecking the **Toolbar** item in the **View** menu. The **Standard** toolbar in the print window contains two groups of buttons. The first contains the buttons for activating the standard TomoCon tools for image viewing while the second contains the special printing buttons for inserting images into the working area and the buttons for moving between the print films.
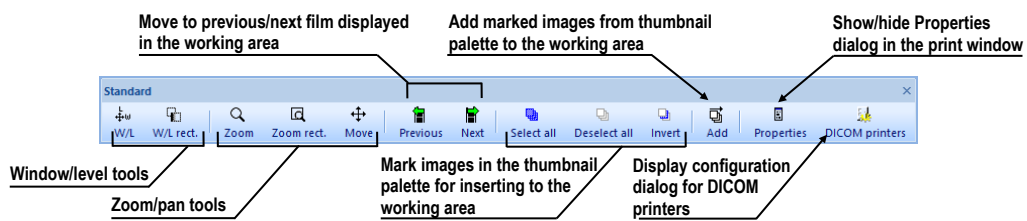
Figure 346 – Print Standard toolbar

18.1.4 Status bar

The Status bar (see Figure 347) is a horizontal bar in the lower part of the print window that displays the move panel which is used for moving between the print films displayed in the working area and for displaying the progress of the current printing tasks. It is visible by default although TomoCon allows you to hide/show it by the unchecking/checking the **Status bar** option in the **View** main menu.
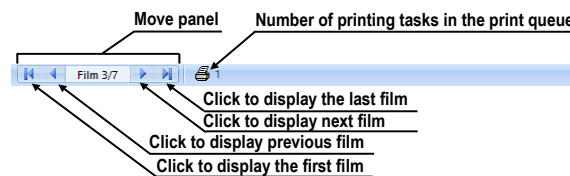

Figure 347 – Print Status bar

18.1.5 Thumbnail palette

The thumbnail palette, which is located on the right-hand side of the print window, enables you to select and add images to the print films (see Figure 348). All series of opened studies in the TomoCon application are also displayed in this palette and the work with it is identical to the work with the main thumbnail palette in TomoCon (see 3.3 Thumbnails palette).
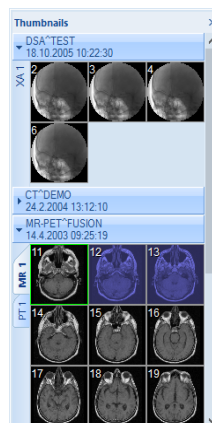

Figure 348 – Thumbnail palette in the print window

18.1.6 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 349a).

3. Click the **Add** button (the ⬚ icon) in the **Standard** toolbar. The selected images will automatically be added following the last image in the working area.
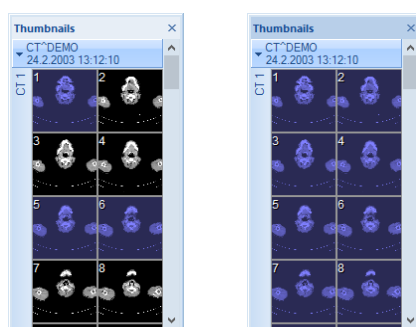

(a)   (b)

Figure 349 – Selected images in the thumbnail palette, a) three selected images, b) all selected images

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 **Standard** toolbar. All of the images displayed in the thumbnail palette will be highlighted in blue (see Figure 349b).

2. Click the **Add** button (the ⬚ icon) in the **Standard** 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 **Standard** toolbar in the print window.

18.2 Navigating between films

When launching the TomoCon print interface, one empty film without images becomes available. 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 350a) or you can use the **Previous** (⬆)/ **Next** (⬆) buttons in the **Standard** toolbar (see Figure 350b).
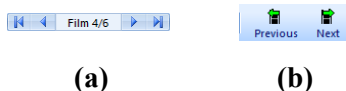

(a)   **(b)**

Figure 350 – a) Move panel, b) Previous/Next buttons

To delete an image in the current view in the working area, select the **Delete image** item in the **Film** main menu (see Figure 351). The images following the deleted image will be shifted by one position.
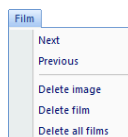

Figure 351 – Film menu

To delete an entire film that you have created, select any view in the film to be deleted and select the **Delete film** item in the **Film** main menu. Similarly, to delete all films, select the **Delete all films** item.

18.3 *Manipulating image for print*

While composing a film, you can view and modify the images in the same manner you do in TomoCon (zoom, pan, window/level, etc.). To modify the image data in the current view, use the **Images** menu (see Figure 352) that contains the following tools:

- **Window/Level** and **Window/Level rectangle**

- **Zoom** and **Zoom rectangle**

- **Move**

The activation/use of the modifications is the same as those of the options of the TomoCon **Image** menu (see Figure 352).
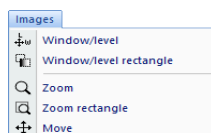

Figure 352 – Images menu

18.4 Start printing

Once you have finished composing your films, use the options in the **Printer properties** dialog to change the printer, the print orientation and the film or paper size (see 18.5 Print properties). Once you have configured the printer properties, click the **Print** button to submit the print job.

After printing starts on any DICOM printer, the current status of the printing process is displayed in the **Preparing data** dialog (see Figure 353). Once the process is complete, a new print task is then added to the DICOM print queue. During the DICOM print process, you can at any time check in detail which studies are being printing in the **Active DICOM print tasks** list located above the working area (see 18.4.1 Monitoring and controlling the print process).
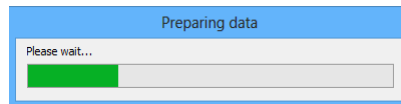

Figure 353 – DICOM printing…

18.4.1 Monitoring and controlling the print process

Using the list of **Active DICOM print tasks** (see Figure 354), which can be displayed/hidden by selecting the **Print queue** item in the **View** menu, you can see if and how many studies are awaiting print (pending), whether any are currently being printed and whether any errors have occurred. In addition to the current status of each task displayed in the **Activity** column, information is displayed concerning each task, such as the name of the printer (the **Printer** column), the progress of the status of the current task (the **Progress** column), the task **Details**, etc.

The context menu of each task displayed in the list allows you to restart, remove, stop or delete your print jobs. To carry out these actions for a job in the printer queue, you first need to select the job in the list and right-click to display the context menu and then select the required action.

Figure 354 – List of active DICOM print tasks

18.5 Print properties

The **Print properties** dialog, which is docked in the left-hand side of the print window, allows you to configure the print options of the currently selected printer in

the printer combo box. This box contains the list of all available Microsoft Windows printers installed on your computer and all of your configured DICOM printers (see Figure 355).
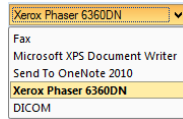

Figure 355 – The list of printers in print window

For the currently selected printer, you can configure the following (see Figure 356):

- 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, you can configure the settings as described in chapter 18.5.3 Configuring a Microsoft Windows printer; for a DICOM printer, you can configure the settings as described in chapter 18.5.2 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.
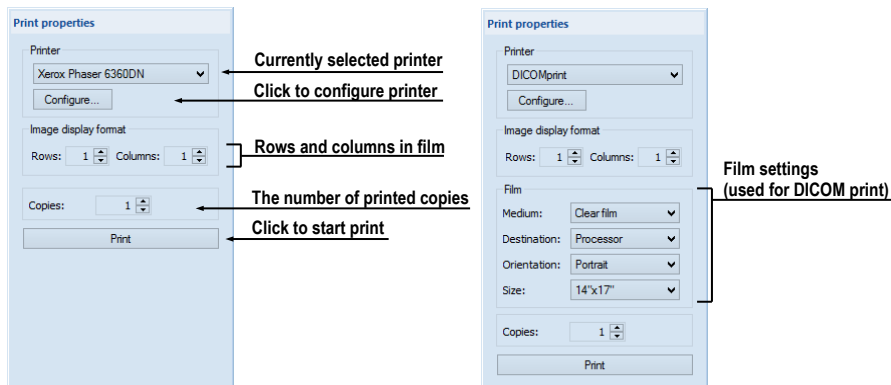

Figure 356 – Print properties dialog

18.5.1   Installing a printer

The TomoCon application allows you to print on standard Microsoft Windows printers or on DICOM printers. While the Microsoft Windows printer comes installed as part of the Microsoft Windows operating system, it is necessary to install DICOM printers in TomoCon manually.

To install and configure a DICOM printer in the TomoCon print interface, select the **DICOM Printers...** item in the **File** menu of the print window (see Figure 357) and

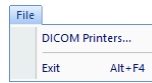define the printer parameters in the displayed **DICOM printers** dialog (see Figure 358).

Figure 357 – File menu

The **DICOM printers** dialog contains the list of the installed DICOM printers. Here it is possible to configure previously installed printers, to install new printers and to verify DICOM connection to a printer (see Figure 357).
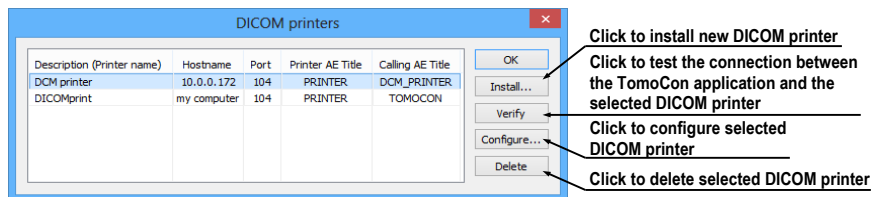

Figure 358 – Printers dialog

To install a new DICOM printer, click the **Install...** button to open the **Printer installation** dialog (see Figure 359) in which you can set the properties of the new printer (**Printer name**, **Hostname**, **Port**, **Printer AE title**, **Calling AE title**).
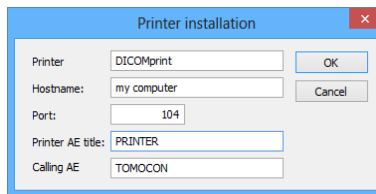

Figure 359 – Printer installation dialog

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 18.5.2 Configuring a DICOM printer).

18.5.2   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 360) 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
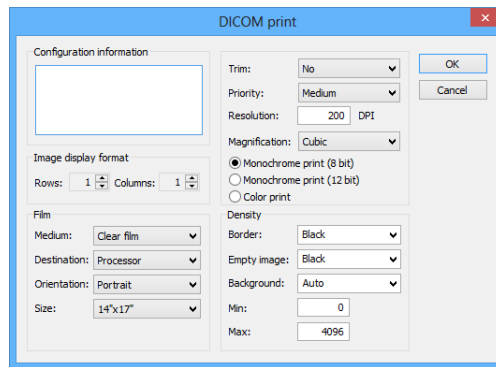

Figure 360 – Configuration dialog

18.5.3 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 361).
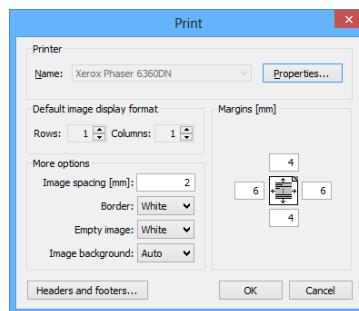

Figure 361 – Print dialog

The **Print** configuration dialog allows you to define the following settings of the Microsoft Windows printer:

- Microsoft Windows **Properties** of the printer such as the appropriate paper size and orientation, layout, color management and other preferences

- **Default image display format** (**Rows, Columns**) – 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

- Color of **Border** and **Empty image** 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, you can define the following types of texts for the page header and footer:

For print	Type
Horizontal line after header or before footer	**&h**
Version of TomoCon	**&v**
Date in short type	**&d**
Date in extended type	**&D**
Time	**&t**
Time in 24 format	**&T**
Current page number	**&p**
Total pages count	**&P**
Right alignment of text	**&b [aligned text]**
Center of text	**&b [centered text] &b**
Prints a single ampersand	**&&**

These types format the text to be printed. An example is depicted in Figure 362 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.
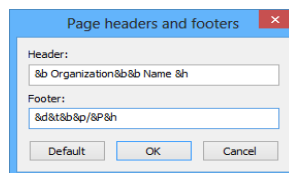

Figure 362 – Page headers and footers dialog

19 Quantitative analysis

Quantitative analysis offers the means to perform statistical evaluation of signal changes in the image. 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).

19.1 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 controls the way the images are combined into a proper image set which is suitable for quantitative analysis. These rules are not customizable and are slightly different for different types of image series.

The measurement 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 (across or within series or series row) also determine the parameter used for navigation within the measurement later.

- **Single-dimensional image series** – the application searches for the images of the same spatial positions across all the available series within the study.

  This for example allows to evaluate 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 363).

  The navigation among the images in the measurement 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.
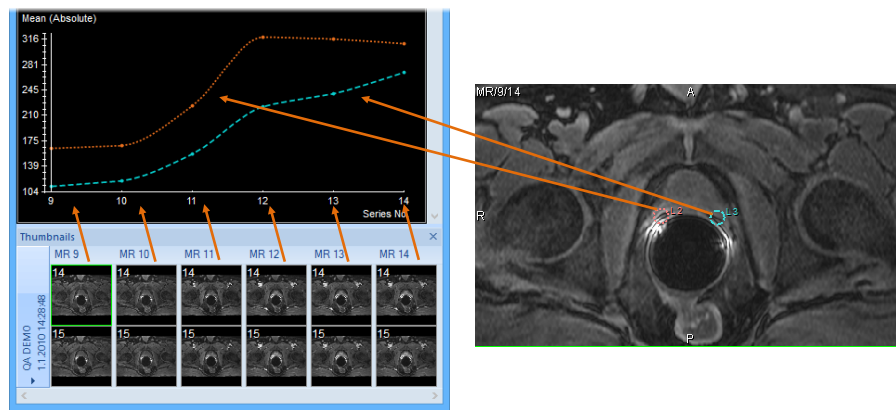
Figure 363 – Analysis calculated on the MR9 – MR14 series, ROIs defined on the primary image (9th image in the 14th series)

- **Multi-dimensional image series** – the application looks for the images within the multi-dimensional series 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 364).

  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.
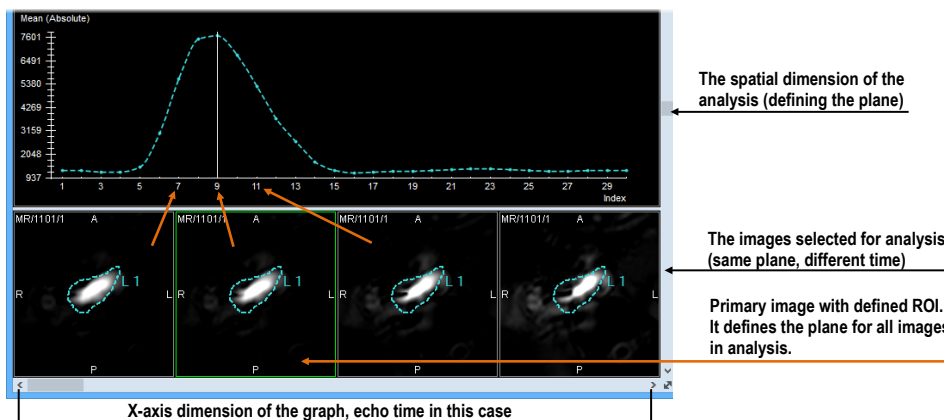

Figure 364 – Analysis calculated on the images of a single multidimensional series

If, in the case of single-dimensional series, the image series selected by default by TomoCon to belong to the analysis should not belong to the measurement, it is possible to unselect individual image series from the analysis (see 19.5.5 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:

- Trigger time
- Echo time
- Normal time
- Slice position

19.2 Quantitative analysis tool tab

The Quantitative analysis tool tab (see Figure 365) provides the access to quantitative analysis functionality.
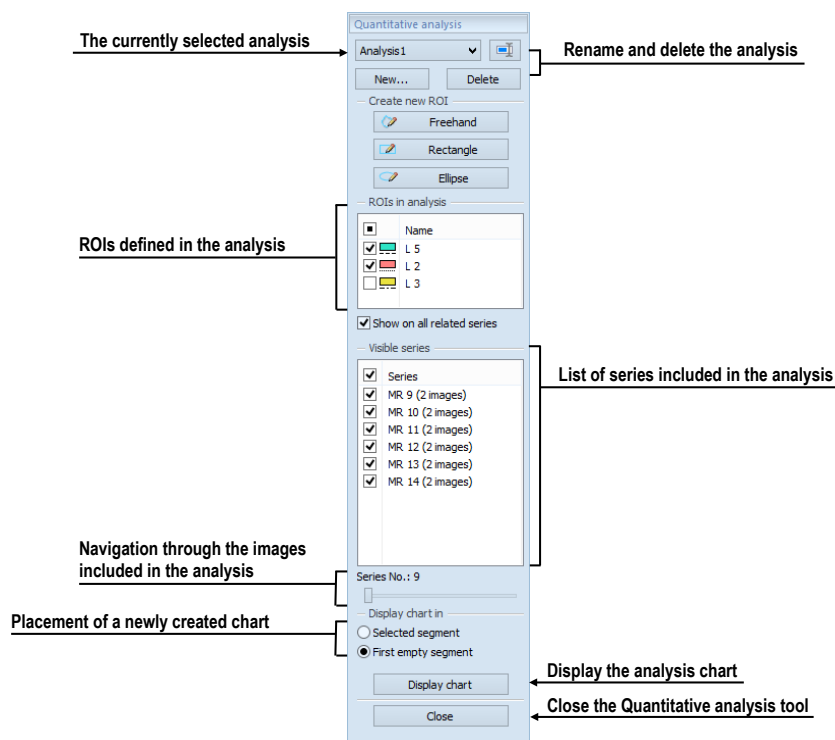
Figure 365 – Quantitative analysis tool tab

The tool tab is hidden by default. To show the tool tab, select **Tools / ⩗ Quantitative analysis…** in TomoCon menu. If a quantitative analysis measurement exists in an open study, the tool tab is also accessible via tools panel by clicking ⩗ tab.

19.2.1   Selecting a quantitative analysis

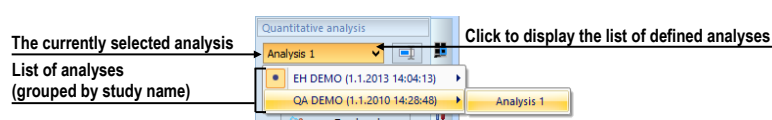If multiple analyses exist within the loaded studies, the tool tab allows the selection of the current one.

Figure 366 – Selecting analysis in the Analysis combo box

To select the analysis select the desired analysis (see Figure 366) 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 the current view at the moment, it switches to show the newly selected analysis.

19.2.2   Renaming a quantitative analysis

To rename a quantitative analysis:

1. In the QA tool tab, next to the analysis selection combo box, click ▭ **Rename**.

2. Rename the analysis right in the selection combo box, where the cursor is shown.

19.2.3   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.

19.3   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**/ $\simeq$ **Quantitative analysis…)** or using the tool tab.

3. Click **New…** to open **New analysis** dialog (see Figure 367)

4. Select a name for the analysis.

5. Select **Across** or **Within series** / **series row** mode for the new analysis (see 19.1 Suitable image sets).

6. In **Across** mode, select or unselect the image series to be part of the quantitative analysis.
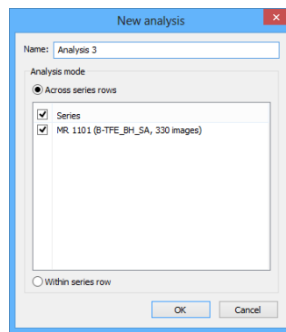
7. Click **Ok** to create the analysis.

Figure 367 – 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 $\nwarrow$ button in the lower right corner of the working area (see Figure 364).

19.3.1   Creating and delineating ROIs

To create an ROI:

- Select an appropriate tool for the ROI definition in the **Create new ROI** section of the tool (see Figure 368).
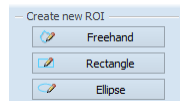

Figure 368 – Quantitative analysis drawing tools in tool tab

Use the tool selected:

- **Freehand** – press and hold the left mouse button while following the path to delineate with the mouse cursor. Release the mouse button when done. The ROI shape is drawn continuously as the mouse is being moved.

- **Rectangle** – press the left mouse button at the corner position and hold it while dragging the mouse cursor to the opposite rectangle corner; then release the button. The rectangle is drawn continuously as the mouse is being moved.

- **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; then release the button. The ellipse is being drawn continuously while the mouse is being moved.

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 369).
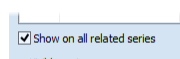
Figure 369 – Show on all related series option

19.4 Evaluating analysis results (using charts and tables)

Once the ROIs are defined, the analysis results can be shown in the graph.

To show the analysis results (see Figure 370):

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.
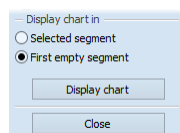
Figure 370 – Displaying analysis chart

19.5 Changing the display of results

19.5.1 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 371). When an ROI is unchecked, it is not shown in the images nor in the chart/table views.
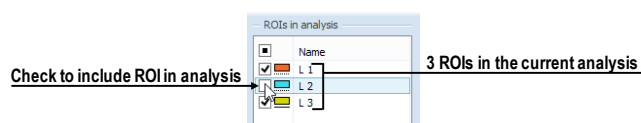
Figure 371 – ROIs in analysis section in the tool tab

19.5.2　Setting ROI style

The color and the line style can be set up for each individual ROI. These are used to display the ROI in the images and in the graph.

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.**

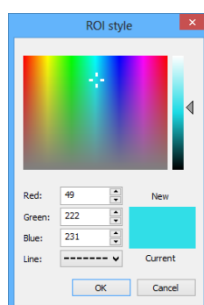3. Select the desired color and line style in the dialog (see Figure 372).

Figure 372 – 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.

19.5.3　Renaming an 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 373).

The name can also be changed by selecting the ROI in the list and clicking the name once.
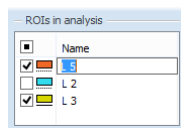
Figure 373 – Renaming the ROI with predefined name L3

19.5.4 Deleting an 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.

19.5.5 Selecting the image series

TomoCon automatically attempts to detect the correct image series to be used in the analysis measurement. If, for any reason, some image series need to be discounted from the measurement, they can be hidden from the analysis.

To hide or show an image series in the analysis:

1. In the **Quantitative analyses** tool tab, in **Visible series** list (see Figure 374), 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.
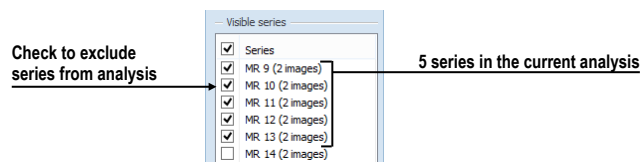
Figure 374 – Series in analysis section in the tool tab

19.6 *Evaluating analysis results (using charts and tables)*

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 375):

1. Select where the chart should appear (either in the current segment or in the first available segment).
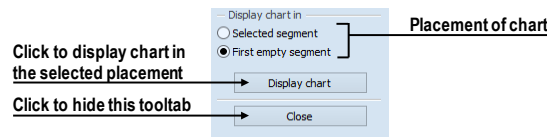
Figure 375 – Display chart in section in the tool tab

2. Click **Display chart** button.

A new analysis chart is shown according to the selected placement (see 19.6.1 Working with the chart).

19.6.1 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 376); however, the scaling can be changed.
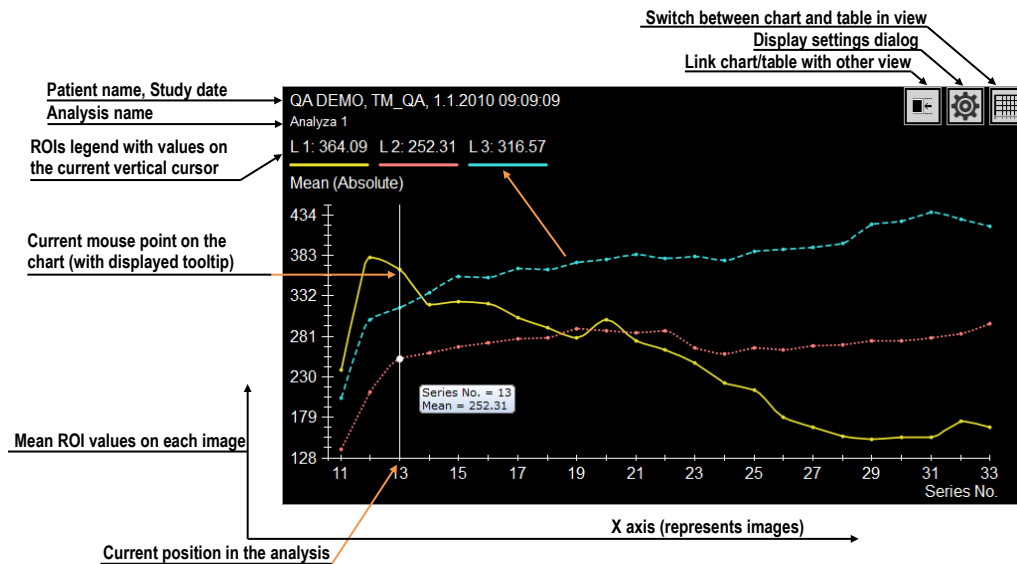

Figure 376 – Displayed analysis chart

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 377) shows the patient and 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.
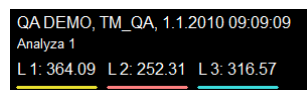
Figure 377 – Upper part of the chart

The vertical line (of the same color as the chart axis) in chart indicates the current position in the analysis and is synchronized with the current image indication in **Quantitative analysis** tool dialog. It can be changed by double clicking on the desired position in the chart (see Figure 378) or by moving by drag and drop method.
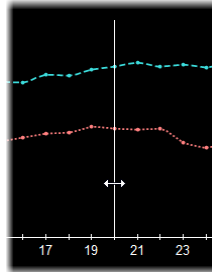

Figure 378 – Current cursor of analysis in chart

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 379).

Figure 379 – Current chart point with tooltip

ROI values are connected using either a straight line or a smooth curve. To select the type of lines used:

1. Right-click in the chart.
2. Check or uncheck **Smooth curve** item in the context menu.

19.6.2   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 is indicated by highlighting the appropriate table row. Current position is synchronized with the current image indication in **Quantitative analysis** tool dialog.

To change the current position in the analysis in the table (see Figure 380):

1. Click on a desired row in the table.

2. The highlighted row will be changed to the newly selected one.

Figure 380 – Analysis table with highlighted current cursor of analysis

19.6.3 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 381):

- the vertical cursor in the chart

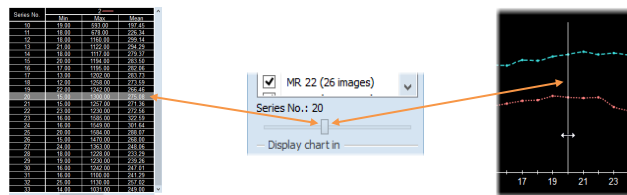- the row highlight in the table

- the position slider control in the **Quantitative analysis** tool tab

Figure 381 – Current position in the analysis in table, tool tab 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 19.6.1 Working with the chart) or by dragging-and-dropping the vertical cursor.

- By double-clicking the appropriate row if the table (see 19.6.2 Working with the table).

- By scrolling to the desired image in the linked segment (see 19.6.2 Using multiple views and synchronizing the selection).

- By using the slider in the **Quantitative analysis** tool tab (see 19.6.2 Using multiple views and synchronizing the selection).

19.6.4 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 values are 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 values are presented as a difference to the value calculated at the position of the reference value.
- *Normalized*
  The values are presented as a difference to the value calculated at the position of the reference value, scaled (normalized) to 100%:

$$Val_{presented} = \frac{Val_{measured} - Val_{reference}}{Val_{reference}}.100\%$$

Note that the reference values are independent for minimum, mean and maximum columns in the table – for example the minimum value presented in differential mode is the difference between the actual value and the minimum value at the reference position. In **Differential** and **Normalized** modes, a horizontal line at the position of the zero value is drawn in the chart.

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 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:

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 19.6.1 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.

19.6.1　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 382). These parameters are customizable in the dialog:

- The evaluation mode (see 19.6.4 Selecting evaluation mode).

- The visibility of the reference value (see 19.6.4 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** for the X-axis. Select one of the available parameters to specify the label on the X-axis. The selected label also controls the ordering of the individual values.
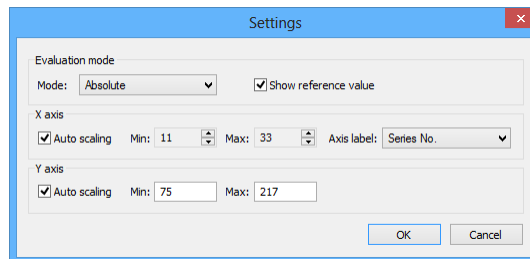
Figure 382 – Settings dialog

19.6.2　Using multiple views and synchronizing the selection

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.
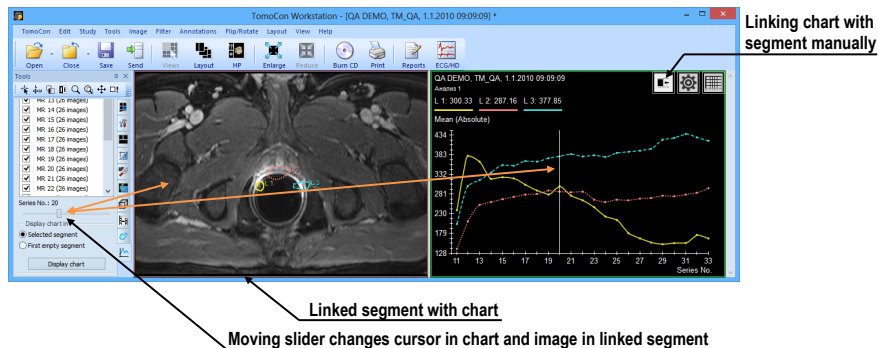

Figure 383 – Linked view with analysis chart

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 384).

3. Release the mouse button.
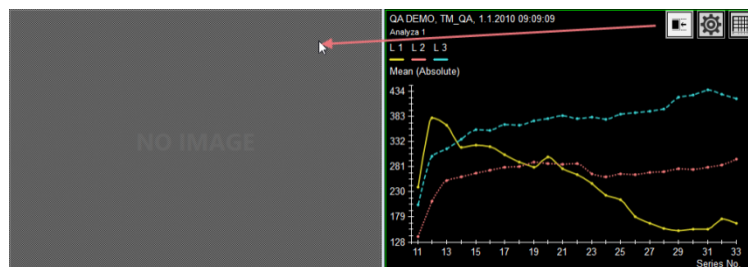
Figure 384 – Linking left segment with analysis chart

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).

> 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.

20 ECG/HD

The TomoCon application offers the possibility to review and enter measurements and diagnoses for ECG waveforms stored in patient DICOM data. As a result, it is very simple to analyze diagnostic patient images along with ECG diagnostic waveforms. The clinician has full access to comprehensive ECG/HD information in TomoCon using the **Waveforms** workspace that is automatically displayed when opening patient data with stored ECG/HD information, or manually by selecting the **ECG/HD...** item in the **Tools** menu.

The **Waveforms** workspace consists of the following three parts (see Figure 385):

- a toolbar with all applicable tools for ECG/HD diagnostics (in the upper left-hand corner)

- a list of all opened ECG/HD waveforms in TomoCon (on the left)

- a preview window for viewing and diagnosing a selected waveform
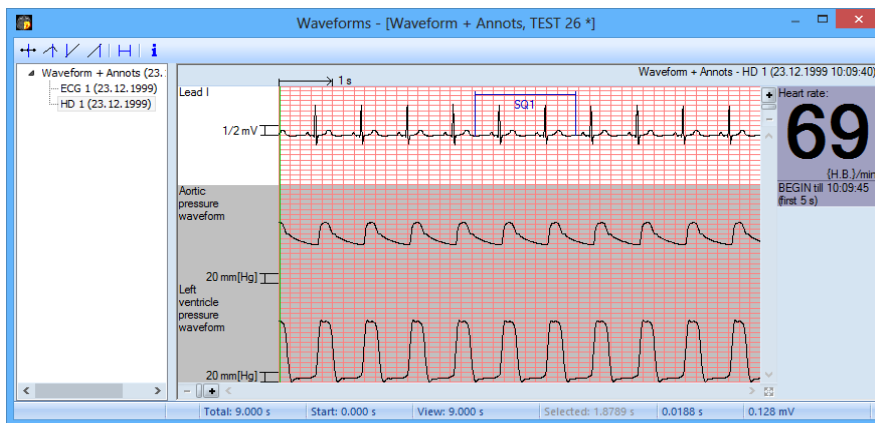
Figure 385 – Waveform workspace

20.1 Navigating through opened ECG/HD waveforms

All opened ECG/HD waveforms are listed on the left side of the **Waveforms** workspace in the TomoCon application. All waveforms are grouped according to the studies to which they belong.

To display a preview of a waveform, proceed as follows:

1. Look through the study groups in the list on the left side of the workspace.

   To find out which waveforms belongs to a particular study, click the [+] symbol in front of the study name. The complete list of all waveforms of the selected study will be displayed.

> To collapse the list of study waveforms, click the [–] symbol in front of the study name.

2. After finding the required waveform in the list, select it by clicking.

3. The selected waveform will be displayed in the preview window on the right side of the workspace.

20.2 Viewing and diagnostics of ECG/HD

After opening the waveform workspace, you can immediately display a desired ECG/HD waveform (see Figure 386). Simply click the name of the waveform in the list on the left side and the selected waveform will be displayed in the preview window on the right side. Work with the preview window is simple and intuitive. The window provides a set of comprehensive and flexible tools for the viewing and diagnosis of ECG/HD waveforms in TomoCon.
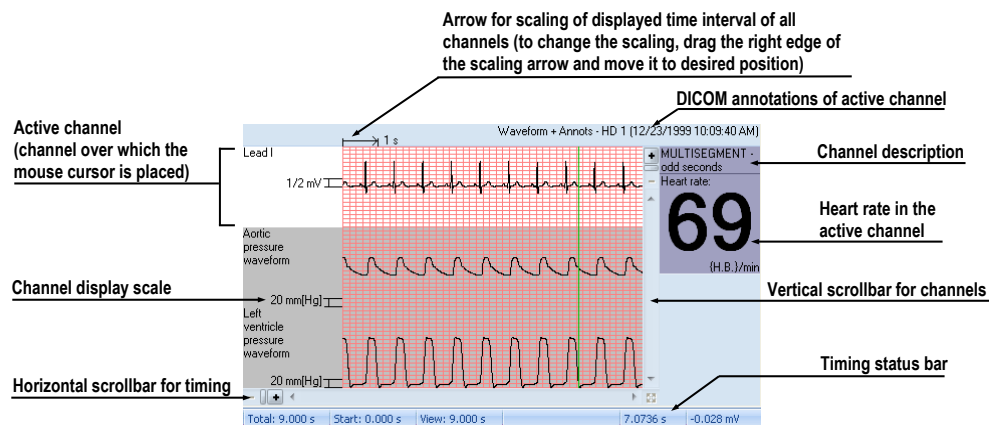
Figure 386 – Preview window for viewing and diagnosis of ECG/ HD

20.2.1 Status bar

The **Timing status** bar (see Figure 387) is the bar at the bottom of the waveform workspace. It displays the main time and value parameters from the displayed ECG/HD channels.

Figure 387 – Timing status bar

20.2.2 Customizing displayed channels and time interval

To customize the displayed time of all channels, use the horizontal timing scrollbar under the channels grid view (see Figure 388).

To customize the number of displayed channels, use the vertical scrollbar on the right side of the channels grid view (see Figure 388).
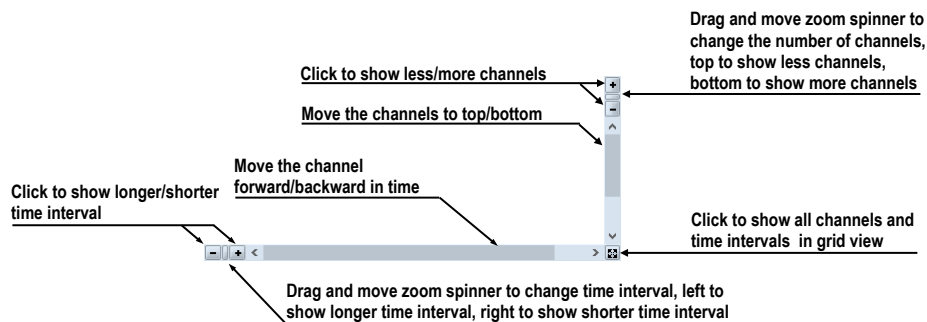
Figure 388 – Waveform workspace scrollbars

To customize the value scaling only for the active channel (the channel where the cursor is placed), use the vertical arrow in front of the active channel. Drag the top edge of the scaling arrow and move it to the desired position. The active channel is automatically vertically adjusted to the selected scale position (see Figure 389).
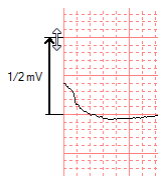
Figure 389 – Active channel value scaling

20.2.3 Time cursor in ECG/HD

When previewing ECG/HD waveforms, it is often necessary to identify the time and value for the active channel in a specific point. For this purpose, TomoCon offers the use of a time cursor tool (see Figure 390).
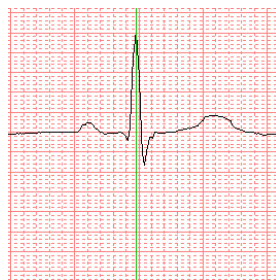
Figure 390 – Time cursor

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. Moreover, it is also possible to find the minimum and maximum values in the active channel using the channel cursor. Simply select the

active cursor mode in the toolbar (in the upper left-hand corner of the waveform workspace) and move the mouse cursor over the desired channel.

To activate cursor snapping:

- to the nearest sample around the cursor, click the ╫ button
- to the nearest extreme around the cursor, click the ↑ button
- to the minimum in the range around the cursor, click the ∨ button
- to the maximum in the range around the cursor, click the ∧ button

20.2.4 Marker measurement in ECG/HD

When diagnosing an ECG/HD examination, it is often necessary to measure or mark only a particular range of a selected channel. For this purpose, TomoCon offers a manual measurement tool of the **Marker** type (see Figure 391). Using this tool, it is possible to graphically write the measured time interval into the examination along with the description. Moreover, the TomoCon application enables its subsequent modification and removal. All defined measurements are available for subsequent use. It is possible to store them along with the patient data or even store it to a PACS.
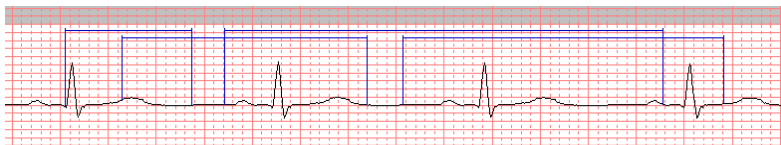
Figure 391 – Markers in selected channel

To create a new range measurement, proceed as follows:

1. Click the ⊢ button on the toolbar in the waveform workspace or the context menu.

2. Move the cursor to the desired start location in a channel.

3. Press and hold down the left mouse button at the start location and move the cursor to the other location where you want the measurement to end.

4. Release the left mouse button. The **Marker properties** dialog is automatically displayed (see Figure 392).
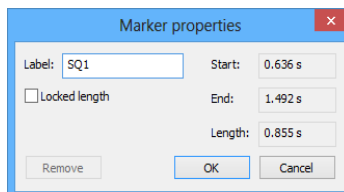

Figure 392 – Marker properties dialog

5. Fill in the **Marker properties** dialog and click the **OK** button. A newly defined range measurement is then automatically created and displayed in the active channel highlighted in blue and labeled with a specified name.

To edit the start or end location of a defined range measurement, proceed as follows:

1. Move the cursor over the vertical start or end line (the measurement will be highlighted).

2. Press and hold down the left mouse button and move the cursor to the new location (see Figure 393). The measurement border will move along with the cursor.

3. Release the left mouse button.
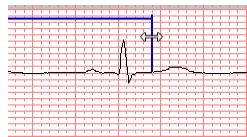
Figure 393 – Editing a defined Marker

To edit the measurement properties or to remove a defined measurement, proceed as follows:

1. Move the cursor over the vertical start or end line (the measurement will be highlighted).

2. Press the right mouse button.

3. To edit the measurement properties, select the **Properties…** item in the displayed context menu (see Figure 394).

To remove a measurement, select the **Remove** menu item in the displayed context menu.
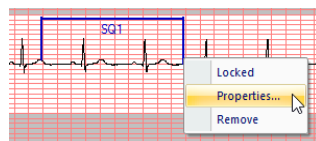
Figure 394 – Marker context menu

21 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 3 Using 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 following two parts (see Figure 395):

- Working area (on the left)
- Panel with control buttons (on the right)

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 21.5 Working area layout). If there are multiple views in the working area, select the view that is to be the current view. If patient studies were opened in TomoCon 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 in TomoCon. 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.
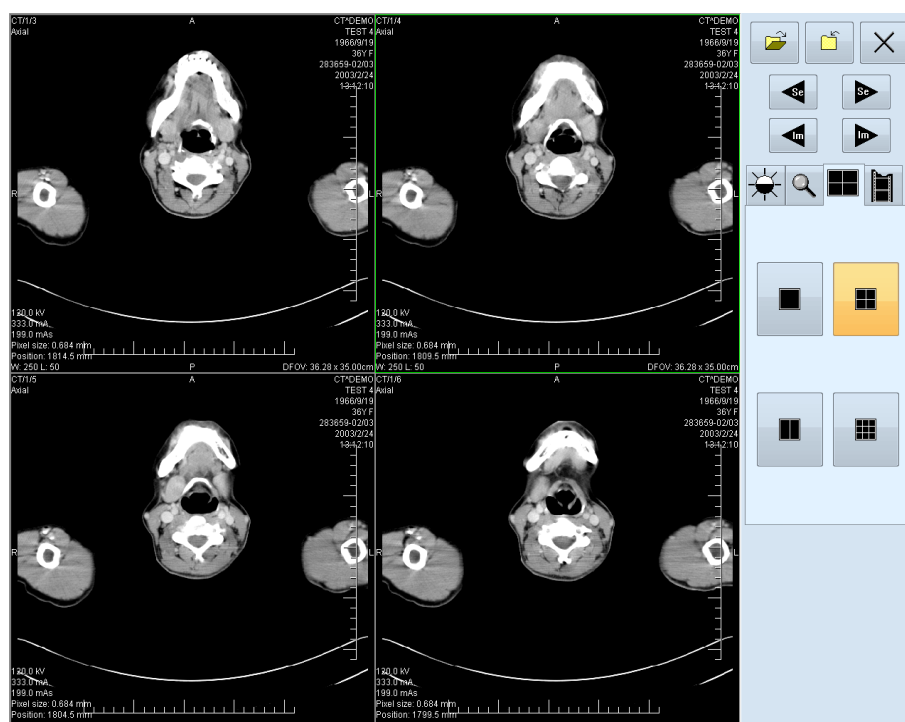
Figure 395 – Touch screen mode – layout

The panel of control buttons is divided into three parts:

1. The upper part of the panel contains the following buttons:

   o Open a patient study ⬚ (see 21.1 Opening a patient study)

   o Close a patient study ⬚ (see 21.2 Closing a patient study)

   o Exit the touch screen mode ⬚

   o Select image series: ⬚ - Move to the previous series, ⬚ - Move to the next series (the series are in the same order in which they were opened in TomoCon)

   o Move images within the series: ⬚ - Move to the previous image, ⬚ - Move to the next image

2. The middle part of the panel contains the following tabs for operation selection:

   o ⬚ - Window, level, shape settings (see 21.3 Window, level, shape settings)

   o ⬚ - Move and zoom images (see 21.4 Move and zoom images)

   o ⬚ - Working area layout settings (see 21.5 Working area layout)

   o ⬚ - Switch to the Cine mode (see 21.6 Playing multi-frame images)

3. The lower part of the panel contains buttons that depend on the selected operation.

21.1 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).

21.2 Closing a patient study

All studies opened in TomoCon 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), a dialog is then displayed allowing the changes to be saved before the studies are closed (see 5.6 Closing and saving a study).

21.3 Window, level, shape settings

After selecting the ☀ tab, the following buttons are displayed in the lower part of the panel (see Figure 396):

- ▲ - accelerating level increase

- ▼ - accelerating level decrease

Clicking the buttons changes the level of the following in the all images of the working area:

- **Window** - ☼

- **Level** - ◑

- **Shape** - ◿

The level changing process is indicated by the slider and the numerical values under the sliders.

The buttons for the following operations are located in the lower part of the panel:

- ◧ - inverting the colors in the image

- Reset - resetting the default values of the window, level and shape in the series

- Apply to all - applying new values of the window, level and shape to the series

Figure 396 – Touch screen mode - gray, W&L settings

21.4 Move and zoom images

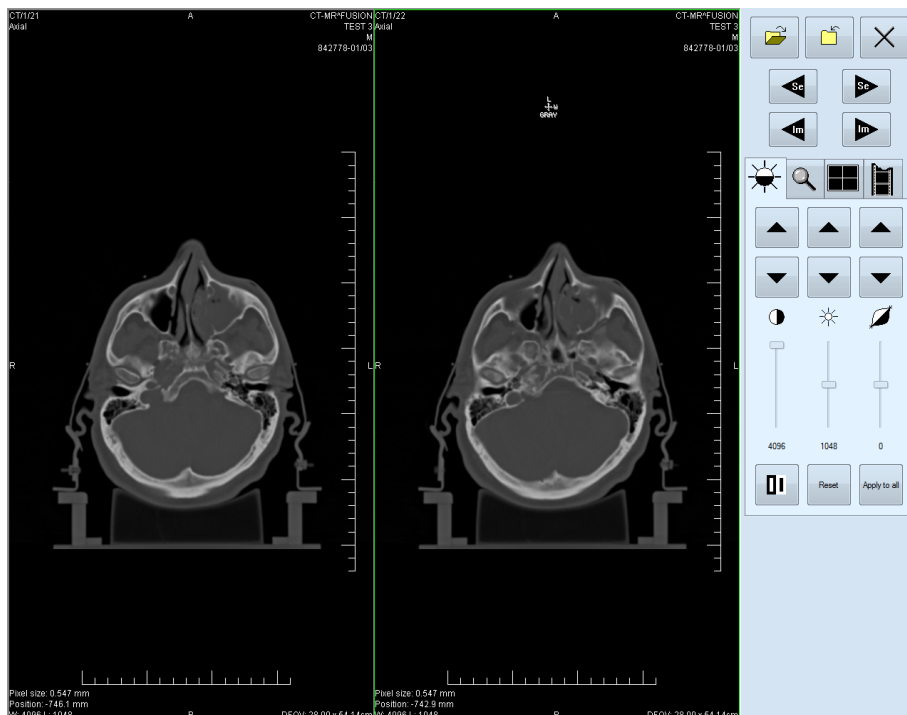After selecting the 🔍 tab, the following buttons are displayed in the lower part of the panel (see Figure 397):

- Zooming the image in the working area from 50% to 800%: 🔍 - zoom out, 🔍⁺ - zoom in (the current image size is displayed under the zooming buttons)

- Moving the image: ▲ - up, ▼ - down, ◀ - left, ▶ - right

- Resetting the default size and position - Reset
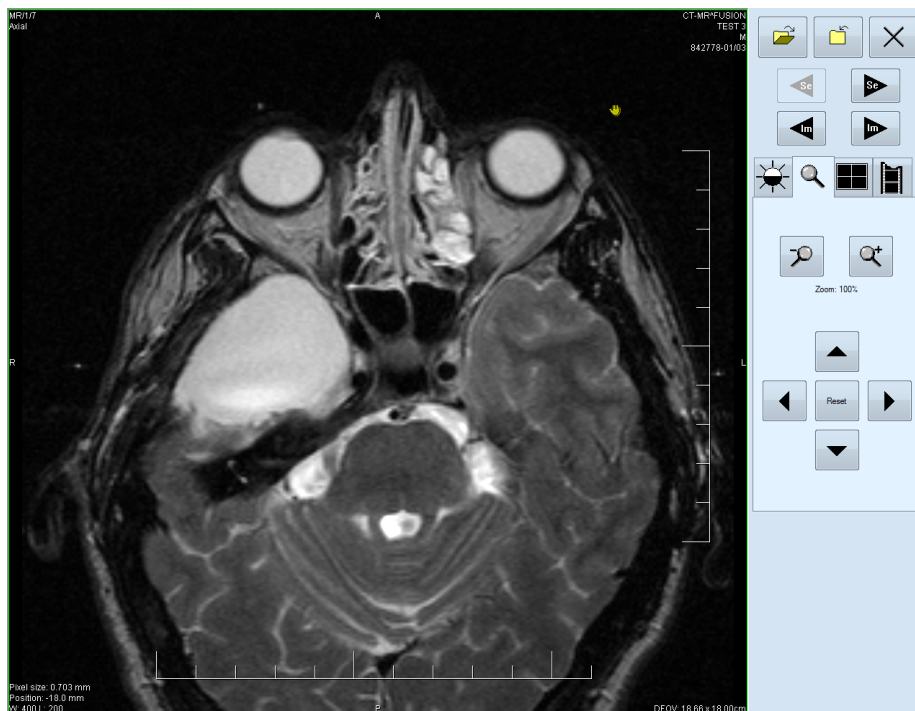
Figure 397 – Touch screen mode - move and zoom images

21.5 Working area layout

After selecting the ⊞ tab, the buttons representing the working area layout are displayed in the lower part of the panel (see Figure 395).

21.6 Playing multi-frame images

After selecting the 📑 tab, the following buttons are displayed in the lower part of the panel (see Figure 398):

- Playing back images: ◄ - play backward, ► - play forward, ■ - stop image playback. (When playing back images, only one view is displayed in the working area in which the images starting with the current image are played back; the slider and the numerical value under the buttons indicate the position of the displayed image in the series)

- Play mode: ⇔ - looping, ⊢⊣ - sweeping

- Changing the frame per second (fps) from 0 to 50 fps in intervals of 2.5: + - increase fps, − - decrease fps (the current speed value is displayed between the buttons)
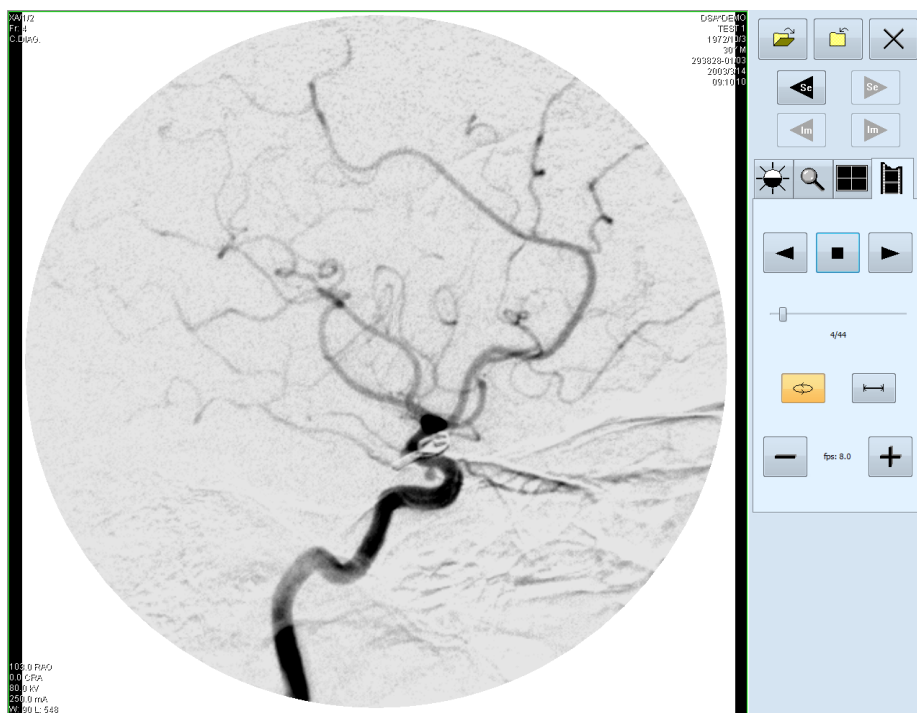
Figure 398 – Touch screen mode - playback of multi-frame images

22 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 you with the functionality for creating new reports and viewing previously written reports. Each structured report can be stored in the PACS system and TomoCon allows you to download/send it directly from/to the PACS system.

All structured reports in TomoCon are accessed through the **Reports** dialog (see Figure 399), which displays the list of all currently loaded or created reports. When you open a study with a previously created structured report, the **Reports...** dialog automatically opens in which you can view the reports. If the dialog is hidden, you can display it at any time by clicking the **Report** button in the main toolbar of the TomoCon application (or by selecting the **Reports…** item in the **Study** menu).
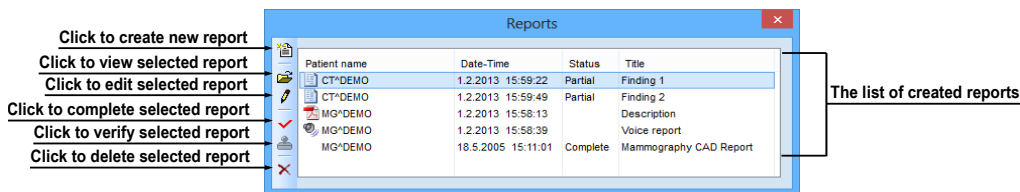
Figure 399 – Reports dialog

TomoCon supports several types of structured reports, which you can open and view using the **Reports** dialog in TomoCon. The main type is a Text report, which is composed of structured text blocks (see 22.1 Viewing a text report) and which allows you to write text information concerning a patient study.

22.1 Viewing a text report

To view a structured report displayed in the **Reports** dialog, select the report in the list and click the 📂 **View report** icon in the **Reports** dialog or double-click the report. The preview of the report heading and body content is then displayed (see Figure 400).

The report heading contains the following information:

- **Patient -** the name and date of birth of the patient along with other predefined identification data

- **Completion flag -** the report status (partial, complete, verified)

- **Predecessor Docs** - the link to the original document

- **Verification Flag -** the report verification (verified, unverified)

- **Content Date/Time** - the date and time of document creation; when editing an incomplete document, the time data does not change (the date/time of the original document is retained)
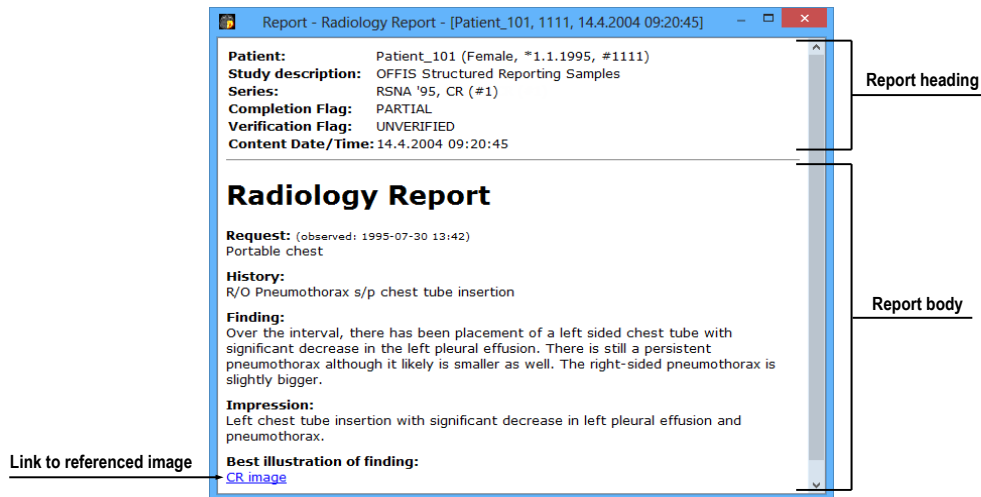
Figure 400 – Report content

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 opened in TomoCon, a dialog is displayed informing you that the referenced image cannot be found.

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.

A report you can close by clicking the button in the upper right-hand corner of the report dialog.

22.2 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 401).

After opening a Mammo CAD report in the TomoCon application, the report is then added to the list of all reports in the **Reports** dialog and all of its CAD markers are automatically displayed on the corresponding mammography images as special annotations with tooltips.
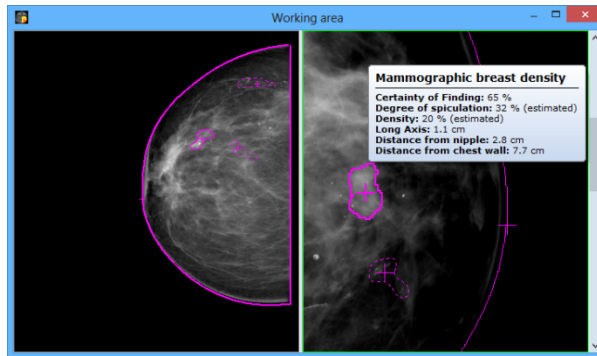
Figure 401 – Displayed CAD markers

To view a Mammo CAD report displayed in the **Reports** dialog, select the report in the list and click the 📂 **View report** icon in the **Reports** dialog or double-click the report. The preview of the report heading and body content is then displayed (see Figure 402).
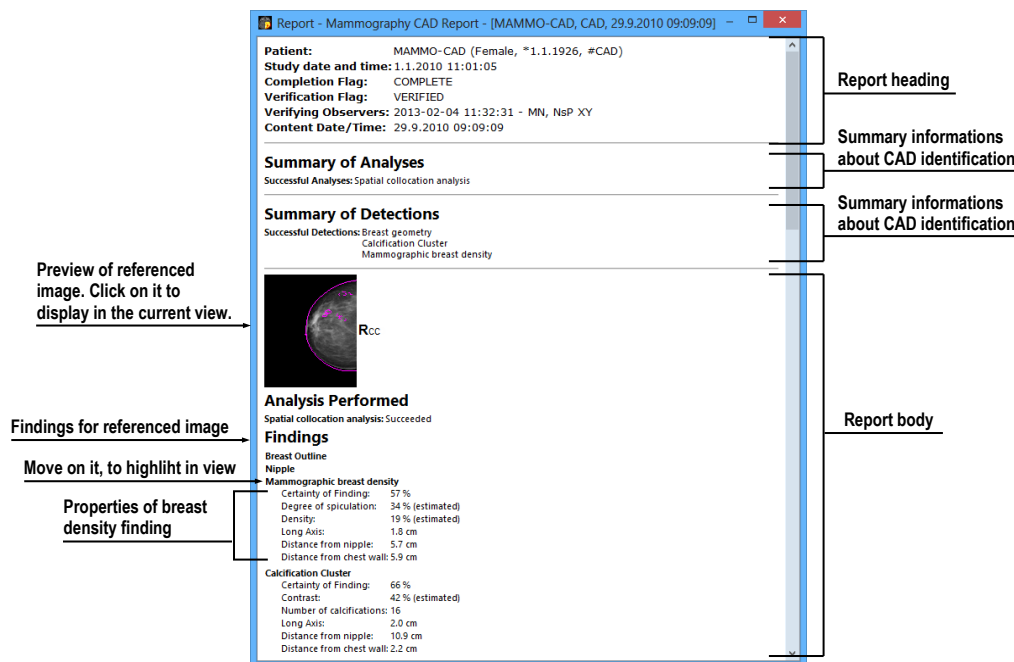
Figure 402 – Report content

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 of TomoCon. If you move to a certain finding in the report and the referenced image is displayed in any view in TomoCon, this finding is then highlighted.

22.3 Creating a new report

TomoCon offers the possibility of creating three types of structured reports. To create a new report, click **Create new report** item (the 🖺 icon) in the left toolbar of the **Reports** dialog. The **New report** dialog is then displayed in which you can:

- Select the template for the new report (see Figure 403) by double-clicking the template icon.
- Simply click OK or press the **ENTER** key to create a new report using the default template (see 22.3.2 Default template).

A new report will be created and can be edited.
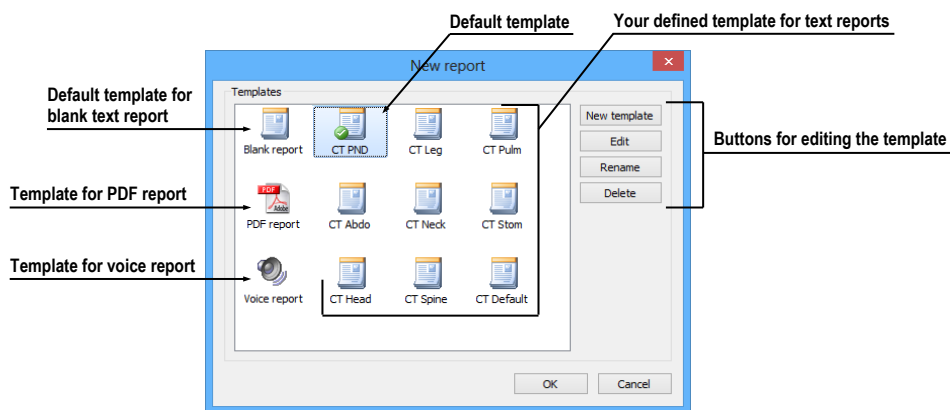
Figure 403 – Template choice dialog

The template defines the type of new report; you can select one of the following:

- Voice report - after double-clicking the 🔊 **Voice report** icon, you can verbally record your report in the recording dialog that is displayed.

- PDF report - after double-clicking the 📄 **PDF report** icon, you can create a report from an existing PDF document stored on the disk.

- Text report - after double-clicking the 📄 text type report icon, you can write a text report in the **Report** dialog that is displayed (see Figure 407). You can select the **Blank report** template or another one of your prepared text templates (Template No.1, see Figure 403). Your text template can define the predefined structure of the new text report.

22.3.1 Report template

The TomoCon application offers you the possibility of using a template to create a new structured report. The template defines the structure of the report and can also contain your predefined texts that are the same in each of your reports. All defined report templates in TomoCon are listed in the **New report** dialog, which you can

display by clicking the ⬚ **Create new report** icon in the left toolbar of the **Reports** dialog.

To create a new template, click the **New template** button (see Figure 404) and enter the name of the report in the displayed dialog. The **Report** editor dialog (22.3.3 Report editor) is then displayed for writing the new template. After you have finished, the newly created template will automatically be inserted into the list of previously defined templates in the **New report** dialog.
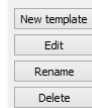
Figure 404 –Buttons for editing templates

To make changes to an existing template, select the template in the list and click the **Edit** button. The **Report** editor dialog (see 22.3.3 Report editor) is then displayed for editing the selected template.

To rename an existing template, select the template in the list, click the **Rename** button and enter the new name for the template (see Figure 405).
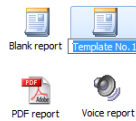
Figure 405 – Entering a new name for a template

To delete an existing template, select the template in the list and click the **Delete** button.

22.3.2 Default template

One of the report templates can be defined as a default template, to make the creation of new reports easier. When creating a new report, the default template is initially selected from the list of templates available. The default template is indicated by ⬚ symbol within the template icon.

To set a template as the default template, right-click on the template icon and select **Make default** in the context menu.
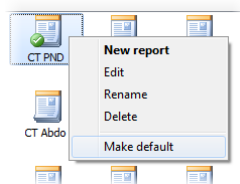
Figure 406 – Set default template

22.3.3   Report editor

The TomoCon application offers you the possibility to create your own text structure report using the report editor. This concerns a special dialog window (see Figure 407) 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, double-click the template icon in the **New report** dialog. If only one set of patient data 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.
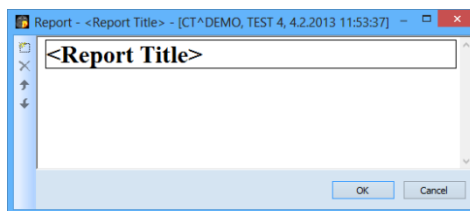
Figure 407 – Report dialog

The report editor allows you 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 you 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 408):

- **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 🔼 and 🔽 **Move section up/down** arrows (container, text, etc.).
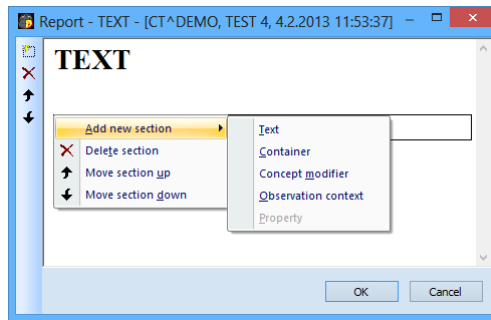
Figure 408 – Report dialog – context menu

22.4 Report status

Each structured report has its own status, which is selected by the writer or reviewer of the report. The current report status is displayed with the report main properties in the **Reports** dialog (see Figure 409). Reports can take the following three statuses:

- **Partial** – the report is open for editing. This status allows you 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 409 – Status of reports in the Reports dialog

To finish editing a report, select the report and click the ✔ **Complete report** icon in the left toolbar of the **Reports** dialog (see Figure 410). The **Complete report** dialog (see Figure 411) is then displayed in which you can add a note to the report concerning the completion process.

Figure 410 – Complete and Verify buttons in the Reports dialog

In order to verify a report, select the report and click the 🏷 **Verify report** icon in the left toolbar of the **Reports** dialog (see Figure 410). The **Verify report** dialog is then displayed (see Figure 411) in which you can fill in the name and organization of the verifying person. Reports can be verified by more than one person. The data concerning the verifying person(s) is displayed when the corresponding report is opened for viewing.
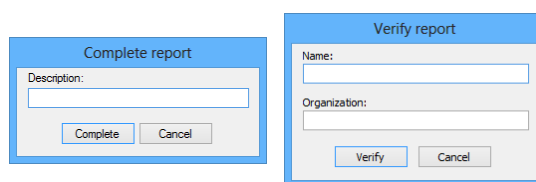
Figure 411 – Complete report and Verify report dialog

22.5 Editing a report

To edit an existing report, select it from the **Reports** list and click the 📝 **Edit report** icon in the left toolbar. The **Report** editor 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.

22.6 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 in TomoCon, an asterisk (*) is displayed after the study time in the TomoCon title bar at the top of the window (see Figure 412).
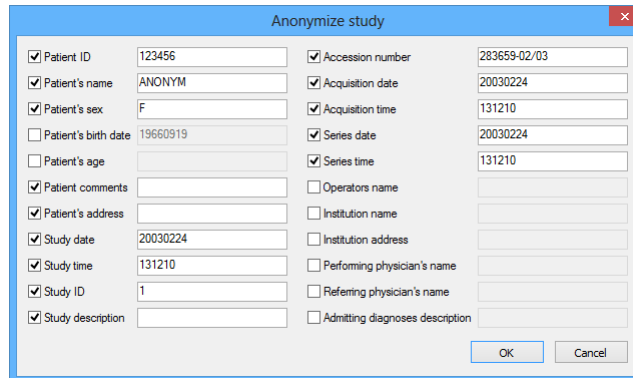
Figure 412 – TomoCon title bar with asterisk

If any changes to structured reports exist in opened studies when attempting to close them, you are asked whether or not you wish to save the changes. 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** menu of the main application menu. The changes to the structured reports will automatically be saved in the Local studies storage of TomoCon. To send these changes from TomoCon to a PACS, select the **Send...** item in the same menu.

23 Study anonymization

The TomoCon application allows you 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 413), which is opened by selecting the **Anonymize study...** item in the **Study** menu.

Figure 413 – 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 you 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 (see Figure 414).
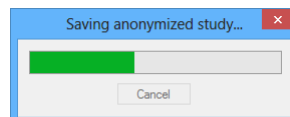
Figure 414 – Saving anonymized study… dialog

24 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 415).

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 (see Figure 416) and click the **OK** button.

4. The new series is then automatically added to the selected study.
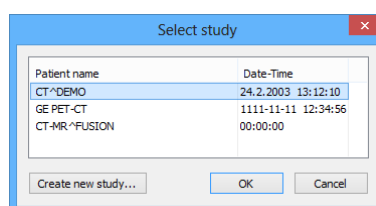
Figure 415 – Select study dialog
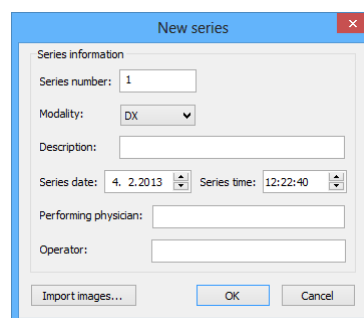
Figure 416 – New series dialog

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 417) 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 416).

4. To import the images that will automatically be 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 automatically be added.

Figure 417 – New study dialog

25 Archiving images on a CD

Patient studies in the TomoCon application can be archived on the CD medium 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.

If your system does not meet either of these requirements, the data can be archived to a selected directory on the disk.

The **Create CD…** dialog (see Figure 418) is opened by selecting the **Create CD…** item in the **Study** menu. The **Create CD…** dialog displays the set of patient data prepared for CD backup. To add the currently opened studies to the prepared data set, click the **Add** button. To remove a study, a series or an image from the set, click the **Remove** button or press the **Delete** key on the keyboard. Clicking the **Remove all** button removes all studies from the prepared data set.
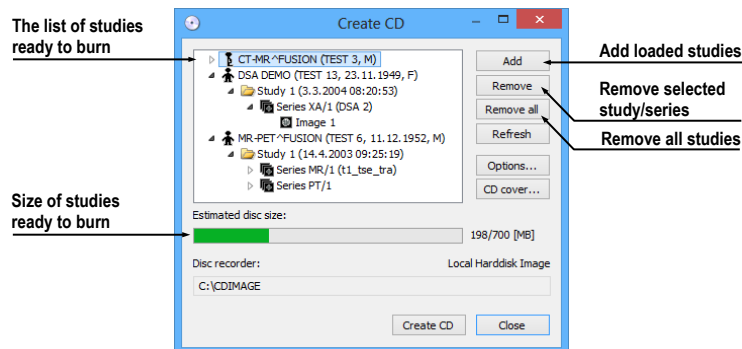
Figure 418 – Create CD dialog

Click the **Create CD** button to place the prepared data set on a CD or the selected directory on the disc (depending on the **Disc recorder** settings).

The **Create CD** dialog closes by clicking the **Close** button; the created data set will be retained for 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. The **Create CD** dialog displays the newly added studies/series along with the previously archived studies (see Figure 419); it is not possible to remove them from the list.
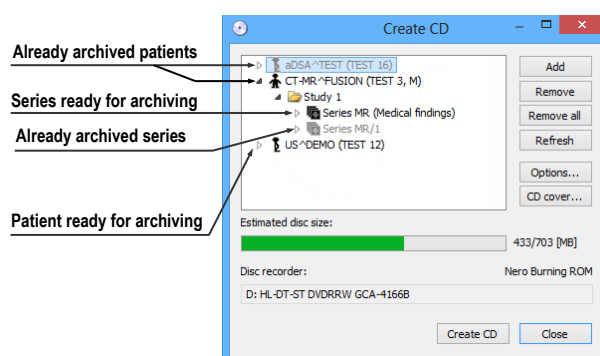
Figure 419 – Create CD dialog (adding a study/series to a CD)

Clicking the **Create CD** button starts the archiving process. You can monitor the burning process in the dialog (see Figure 420).
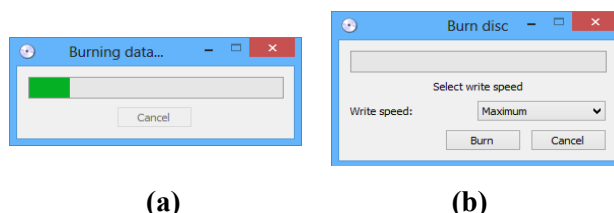
(a)   (b)

Figure 420 – Archiving of patient image data in progress, Windows IMAPI/IMAPI2 (a), Nero Burning ROM (b)

To set the archiving settings, click the **Options…** button. The **Create CD options** dialog then opens (see Figure 421).

The following settings can be made in the dialog:

- **Disc recorders** - selection of the burning type and of the **Disc recorders** to be used for archiving.

- **Maximal CD capacity** - user-specified CD capacity.

- **Temp directory** - an auxiliary directory for the temporary storage of studies prepared for archiving.

- **Export directory** - the directory for exporting the image of the prepared CD if the disk recorder is set as Local hard disk image.

- **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.

- **TomoCon Lite** - if this option is checked, 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** - if this option is checked, the **Template directory** will be copied to the archive.
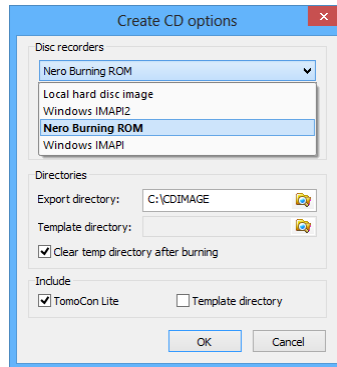
Figure 421 – Create CD options dialog

To create and print a cover for the created CD, use the **CD cover** dialog (see Figure 422), 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.
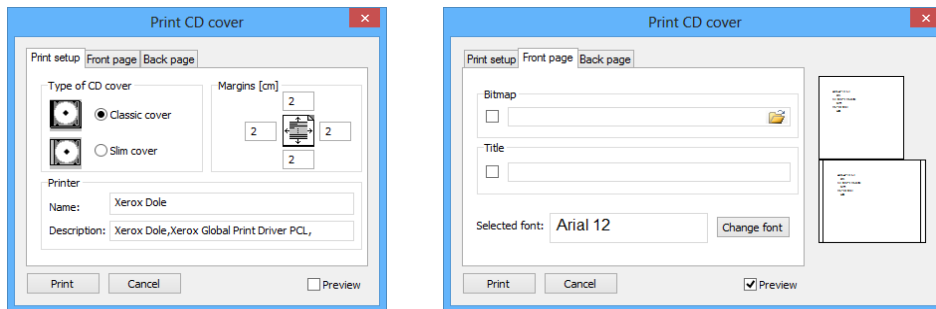
(a)	(b)

Figure 422 – Print CD cover dialog, Print setup tab (a), Front page tab (b)

The following settings are available in the **Print CD cover** dialog:

- **Print setup** tab:
  - Type of CD cover (**Classic cover**, **Slim cover**)
  - Margins

- **Front page** tab:
  - Selecting a picture to accompany the text on the front page (**Bitmap**): Click the button with the 📂 icon to select the picture and click the check box to print the picture on the front 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 page.

- **Back page** tab - the settings are the same as the front page settings.

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.

26   Mammography mode

> ℹ This functionality is only available with the Mammography license in the TomoCon Workstation.

The TomoCon application provides you with 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.

26.1 Starting the mammography mode

You can activate the mammography mode in the following ways:

- Manually

    o by selecting the **Tools/Mammography mode** item in the main menu in TomoCon.

    o by defining and using the custom shortcut in TomoCon (see 4.5 Keyboard shortcuts).

- Automatically

    o by using the **/m** or **–m** command line parameter when launching TomoCon; it is recommended to use this feature when you want to create a desktop shortcut for quick access to the mammography mode in TomoCon.

    o by checking the **Start Mammography automatically when mammography study is loaded** check box on the **Mammography** tab of the **TomoCon options** dialog (see 4.8 Mammography) so that the mammography mode is activated when a mammography study is opened.

It is assumed when activating the mammography mode that the resolution of the monitors connected to your workstation is at least 3Mpx. If you have only one monitor, 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.

26.2 *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 TomoCon mammography mode offers a specially designed workspace allowing you to take advantage of the maximal level of your available high-resolution display monitors connected to your workstation in the dual-portrait mode (see Figure 423).
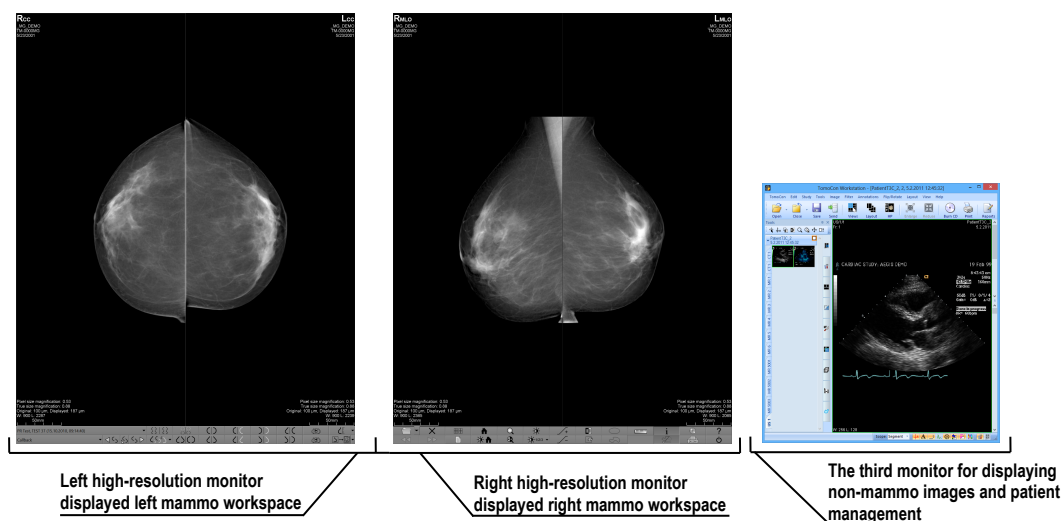
Figure 423 – TomoCon's mammography workspace

The TomoCon 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. 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 424) while the toolbar on the right monitor contains the mammo-patient management and diagnosis tools (see Figure 425).
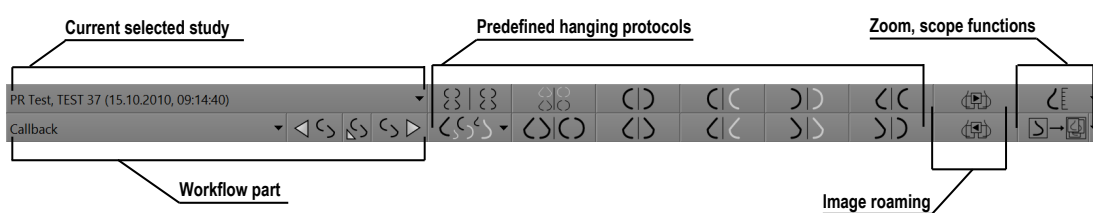
Figure 424 – Mammo toolbar on the left monitor

Figure 425 – Mammo toolbar on the right monitor

All TomoCon 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 in the TomoCon mammography mode, move the cursor to the top of the monitor (see Figure 426). 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 426 – Main mammography menu displayed on the left monitor
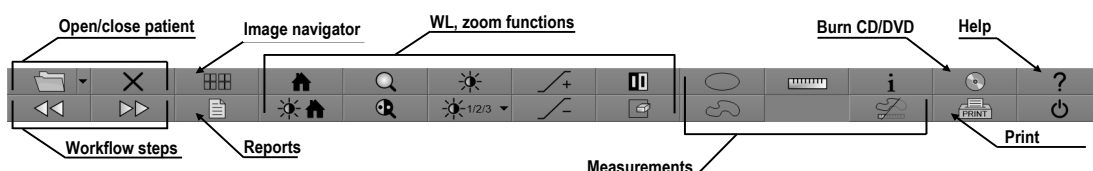
26.2.1   Working area

The working area is the visualization area of the workspace for displaying and diagnosing mammography images in the TomoCon mammography mode. The size of the mammography working area cannot be customized; it is adjusted according to the resolution of your monitor.

In the mammography mode, TomoCon offers you 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 427) in which you can view and diagnose the mammography images.

To change the current working area layout in the mammography mode, you can proceed in one of the following manners:

- Manually, using the mammo image navigator (see 26.9 Image navigator) through which you can change the division of each working area.

- Automatically, using the currently selected hanging protocol (see 26.7 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 26.8 Workflows).
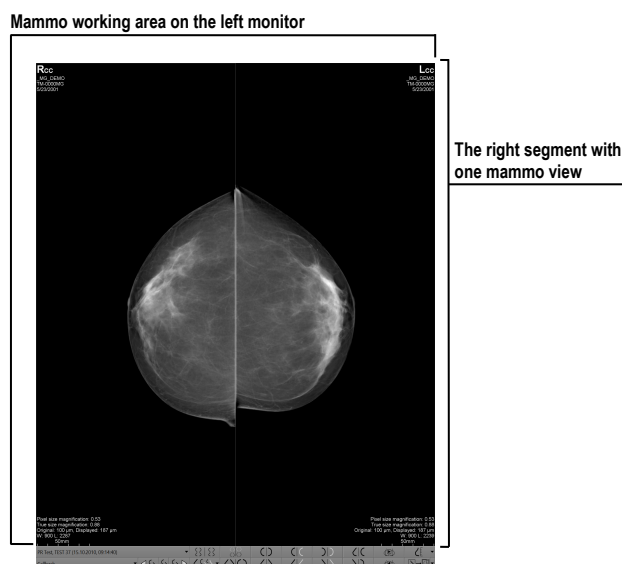

Figure 427 – Initial layout of the left workspace

26.3 Opening a patient study

The TomoCon application provides you with everything required for patient study management in the mammography mode using the **Search studies** dialog (see 5 Managing studies). The dialog offers all of the functions you need 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 left 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 of TomoCon (see Figure 428) 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.

Figure 428 – Opened patient study from the Local studies

- Finding and opening a required study stored in a remote DICOM device (see Figure 429) by taking the following steps:

  1. Activate the remote DICOM device tab (for example, the **PACS 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.
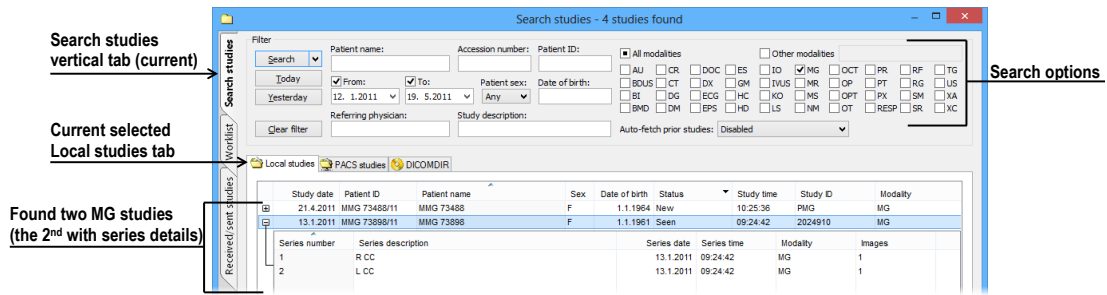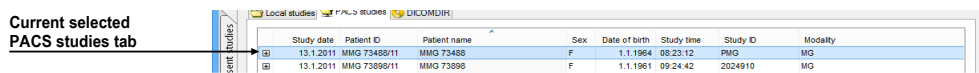

Figure 429 – Opened patient study from the PACS studies

- Managing a worklist and opening patient data from a defined worklist (see 5.9 Patients worklist) by taking the following steps:

  1. Activate the **Worklist** vertical tab of the **Search studies** dialog.

  2. Select the patient data from the worklist and click the **Open study** button.

Click ⬝ in **Open study** button to access additional tools (see Figure 430) for:

- opening prior studies (see 5.5 Opening prior studies),

- opening studies from the worklist,

- opening the next new study.

Figure 430 – Open study menu

26.3.1   Currently selected patient study

The currently selected patient study is the currently selected mammography study for which you actually apply hanging protocols and workflows in the TomoCon mammography mode. 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 431) in the TomoCon mammography mode.
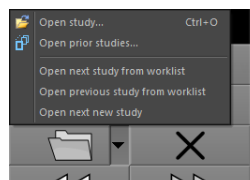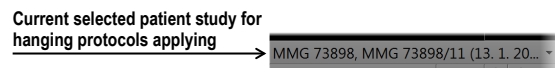

Figure 431 – Selector of current study

When you open an MG patient study suitable for display in the TomoCon mammography mode, it immediately becomes the currently selected study in the mammography mode. If a hanging protocol or workflow is subsequently selected, the images of this new study are displayed in the mammography workspace according to the rules defined in the respective hanging protocol or workflow.

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 432) in which you can select a new current study.
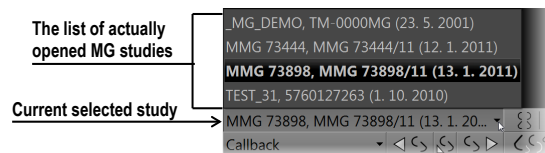
Figure 432 – Changing of the currently selected study

26.4 *Closing and saving a patient study*

As in the general TomoCon mode, you can finish working with opened studies in the mammography mode at any time by saving and closing them. In order to save and close opened studies in the mammography mode, use one of the following methods:

- Select the **Close** menu item in the **Study** menu of the main menu.

- Click the **Close currently open studies** ☒ button in the mammography toolbar on the right monitor.

- You can also close opened studies as long as the currently selected work process contains the close study function. For further information about using workflow, see 26.8 Workflows.

Figure 433 – Close study dialog

For mammography images, TomoCon provides you with a special confirmation dialog (the **Close study** dialog; see Figure 433), which is displayed automatically after the close study operation is selected in the mammography mode. The dialog allows you 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:
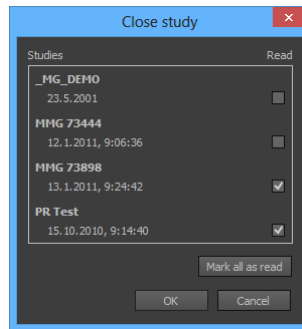
- **Study list** – this list contains all the studies that are to be closed. The corresponding **Read** check box appears for each study. If all images of a study have been previewed, the **Read** check box is checked; otherwise, it is unchecked.

- **Mark all as read** check box – this check box 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 – by clicking this button, you close all studies according to the selected options (the **Read** status and the potential saving of changes).

- **Cancel** button – clicking this button cancels the closing of the studies.

This dialog is not displayed if the **Close study** dialog check box on the **Mammography** tab of the **TomoCon options** dialog is not checked (see 4.8 Mammography). In this case, if any changes have been made to the studies designated for closing, the standard message box asking for confirmation to save the changes is displayed instead (see 26.4 Closing and saving a patient study).

26.5 Displaying images

The mammography mode allows you 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 in any view of the mammography workspace (see Figure 436b). The image navigator is an additional image tool that displays the preview of all opened mammography images in the hierarchical tree and allows you 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 434).
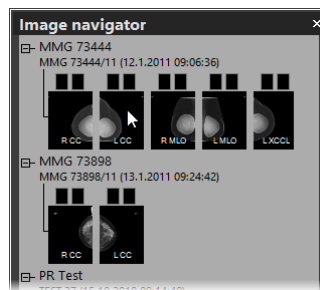

Figure 434 – Display image using the image navigator

For a full description of mammo image navigator functionality, see 26.9 Image navigator.

- Automatic image display adhering to defined hanging protocol rules (see Figure 436a). This option ensures that the images of the currently selected study are placed in the correct order and orientation according to your preferences in each view of the mammography workspace. 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 435).

Figure 435 – Apply hanging protocol section of the toolbar

A full description of how to use hanging protocols in the TomoCon mammography mode can be found in section 26.7 Hanging protocols.
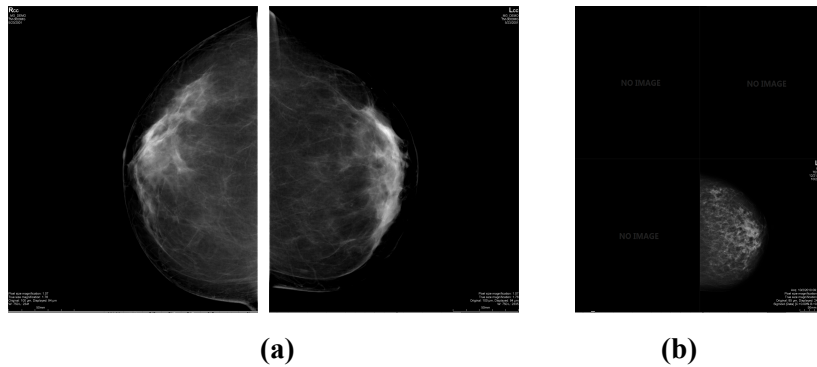
(a)   (b)

Figure 436 – a) Displayed images using a hanging protocol, b) using the image navigator

TomoCon enables you to set numerous properties and parameters for image display in the mammography mode during the viewing and diagnosing process. When you display a mammography image in a view in the mammography mode, 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.

- Air suppression type (see 26.6 Air gap suppression in a view) – defined in the **TomoCon options** dialog (see 4.2 Modality options).

26.6 *Air gap suppression in a view*

When you change the window/level when examining an image, you may need to exclude all parts of the image which are not covered by tissue, i.e. the air gap contained in the image.

TomoCon provides you with support for automatic air gap suppression for images of all modalities using the settings on the **Modality** tab of the **TomoCon options** dialog (see Figure 437).
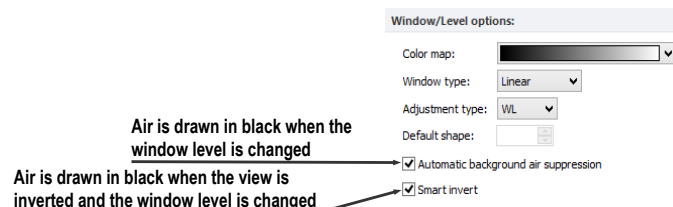

Figure 437 – Air gap suppression settings for the selected MG modality

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 438).
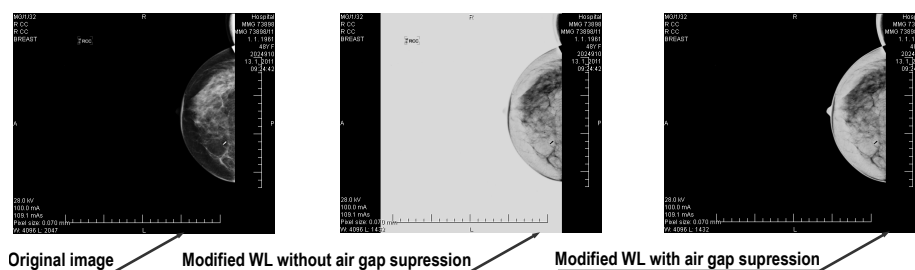

Original image   Modified WL without air gap supression   Modified WL with air gap supression

Figure 438 – 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 439).
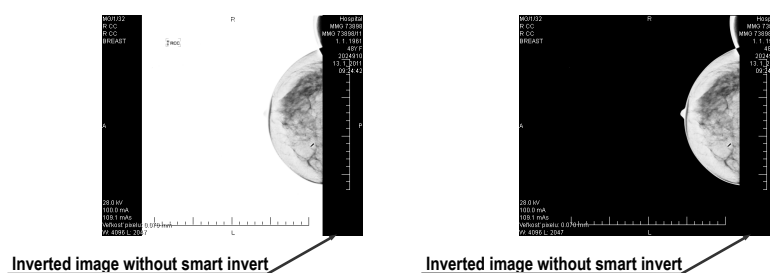

Inverted image without smart invert   Inverted image without smart invert

Figure 439 – Applying smart invert to an image

By default, air gap suppression with the smart invert option is set for all modalities although you can change this option for a selected modality at any time.

26.7 Hanging protocols

When a mammography study is opened in the mammography mode, 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 your preferred image orientation for the right and left views and for the old and new images to be displayed in the mammography mode.

TomoCon provides you with a group of predefined hanging protocols that can be used at any time during the diagnosing process (see 26.7.2 Predefined hanging protocols). You can edit the rules of each hanging protocol or you can define your own protocols for displaying images with your own preferences (see 26.7.3 Customizing hanging protocols).

To apply a hanging protocol in the mammography mode, use the hanging protocol buttons in the mammography toolbar located on the left monitor (see 26.7.1 Applying a hanging protocol).

26.7.1   Applying a hanging protocol

For simple hanging protocol application, TomoCon provides you with the configurable hanging protocol toolbar in the mammography mode that allows you 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 440).
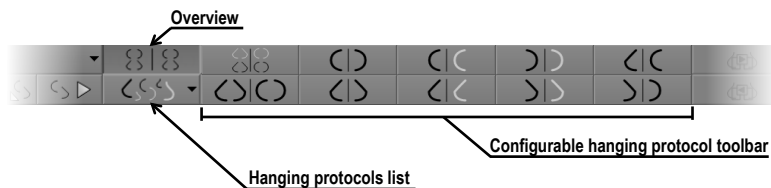

Figure 440 – Toolbar on the left monitor (hanging protocols section)

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 441). The views without matching images remain empty.

The configuration of the hanging protocol toolbar depends on the currently selected workflow in the mammography mode. The workflows allow you to carry out all desired diagnostic steps using the predefined workflows and the corresponding hanging protocols. You can define your own configuration of the hanging protocols toolbar for each workflow in a very simple manner in the **TomoCon options** dialog (see 26.8 Workflows). The TomoCon application supplies you with seven predefined workflows, each with the same predefined hanging protocols. For a complete description of the workflow functionality, see 26.8 Workflows.
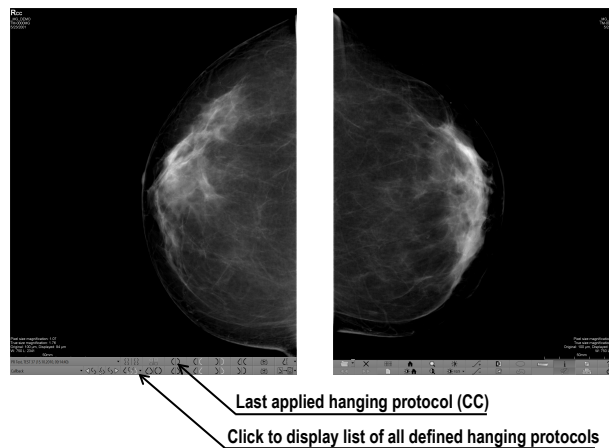
Last applied hanging protocol (CC)

Click to display list of all defined hanging protocols

Figure 441 – Applied CC hanging protocol

TomoCon also provides you with a list of all defined hanging protocols in the mammography mode. You can use it when you need to apply a hanging protocol that is not selectable in the hanging protocols toolbar. To display the hanging protocol list, click the [icon] button in the mammography toolbar on the left monitor. The drop-down menu is then displayed (see Figure 442) 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 row in the list.
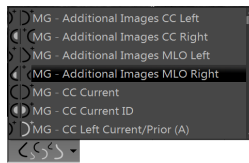

Figure 442 – Hanging protocols list

26.7.2   Predefined hanging protocols

The TomoCon application provides you with a group of predefined hanging protocols for mammography images in the mammography mode, allowing you to display images in the correct order and orientation. To manage all predefined hanging protocols for the mammography mode, use the **Hanging protocol manager** dialog, which is displayed by selecting the **Hanging protocol manager**… item in the **Layout** main menu in TomoCon (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 443), 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), you can 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 your

requirements, you can configure the toolbar content in the **TomoCon options** dialog (see 26.8.2 Workflow properties).

Figure 443 – 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

26.7.3 Customizing hanging protocols

For the immediate display of mammography images in the mammography mode, you can use predefined or customized hanging protocols. For customized protocols, you can define your preferred properties using the simple editor of mammography hanging protocols (the **Hanging protocol properties** dialog for mammography) where you can define all the parameters of a selected protocol.

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 with views.

- 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 **TomoCon 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 you can set all properties of each protocol type, 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 **TomoCon options** dialog and click the **Edit** button (see Figure 444).
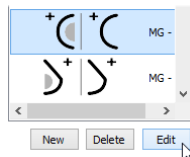

Figure 444 – Editing a selected hanging protocol

- 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.

In the **Hanging protocol properties** dialog for mammography, you can set the following parameters for a mammography hanging protocol according to your own preferences:

- **Name** – the name of the hanging protocol.

- **Description** – a detailed description concerning the protocol functionality.

- **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 you 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, 1st prior, 2nd 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.

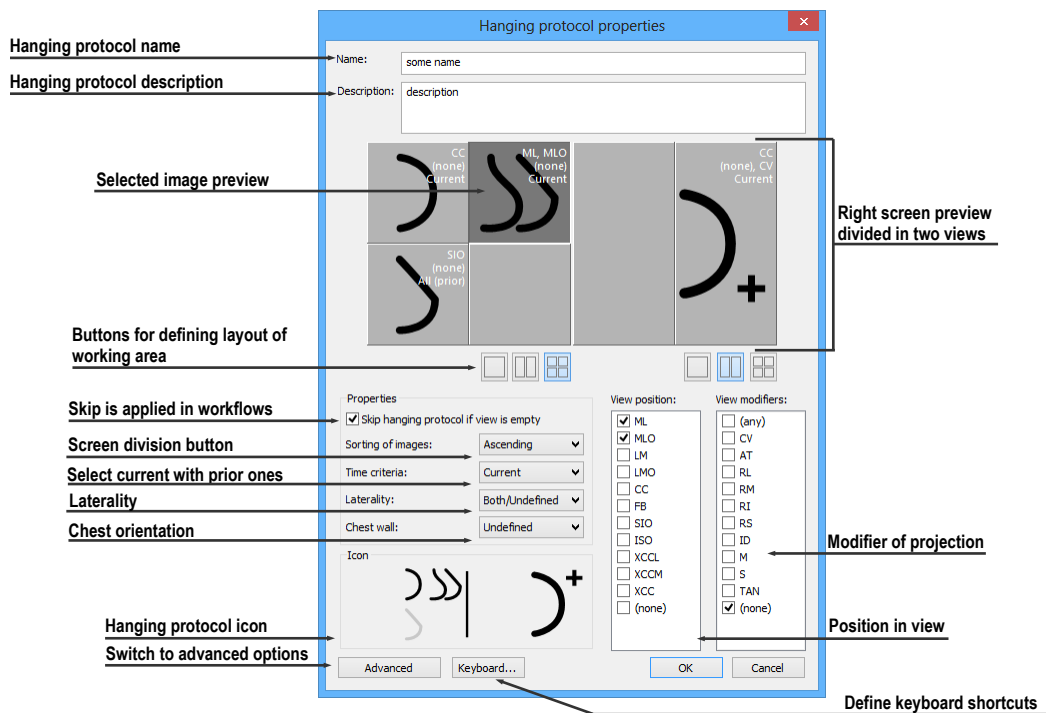- **View modifiers** – modifiers applied to the projection of the image.

Figure 445 – Hanging protocol properties dialog for mammography

26.7.4   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 446). 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). You can click the image iterator to view the next images in the study (see Figure 447).

To activate the overview in the mammography mode, click the **Overview** ▨▨ button in the toolbar on the left monitor.
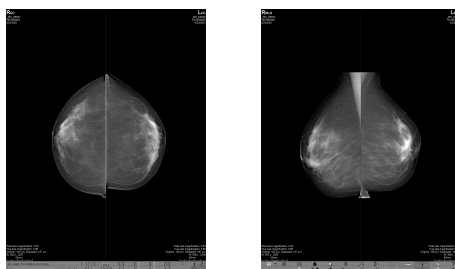

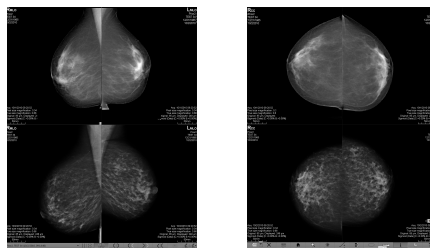**Figure 446 – Overview of a study containing 4 images**

Figure 447 – Overview of a study containing more than 8 images

26.7.5   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 448). The image selector allows you 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 **TomoCon 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 – to indicate the part of the image set that is currently being displayed in the view.
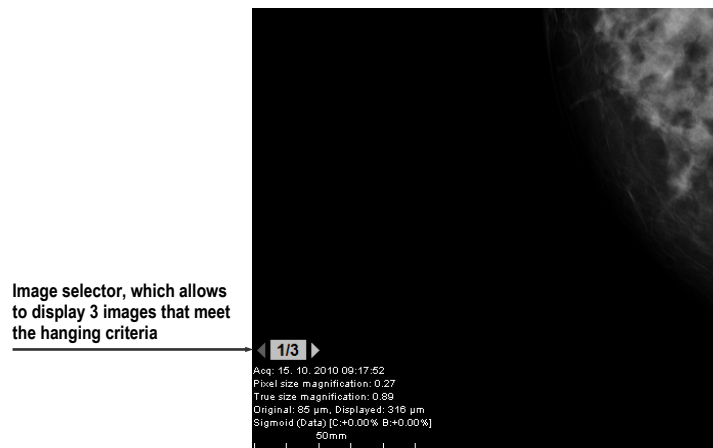
Figure 448 – Image view with image selector

26.8 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 in the TomoCon mammography mode.
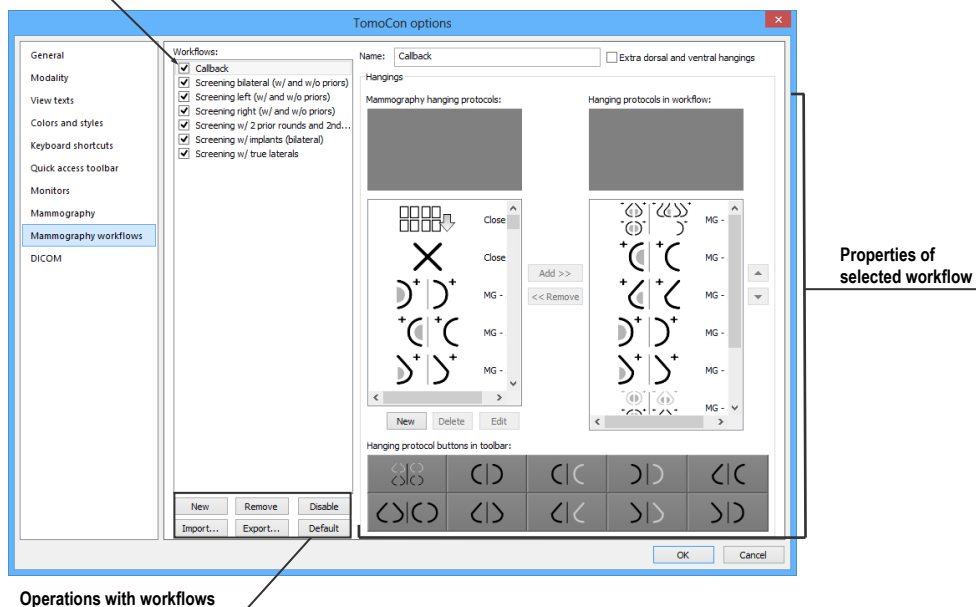

Figure 449 – Mammography workflows tab

A workflow allows you to fully automate the process of study viewing. Using a workflow, you can display all study mammography images step by step according to your viewing preferences. In addition to the possibility of creating your own customized workflows, TomoCon supplies you with a group of predefined (the most

recently used) workflows that make your work with mammography studies easier immediately after the first launch of TomoCon. For easier management of all defined workflows, TomoCon offers a simple management system which is available on the **Mammography workflows** tab of the **TomoCon options** dialog (see Figure 449).

26.8.1 Applying a workflow

Each selected workflow is applied step by step to the currently opened study in TomoCon. All predefined workflows remain available in the mammography mode through the combo box located in the mammography toolbar on the left monitor (see Figure 450). 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).
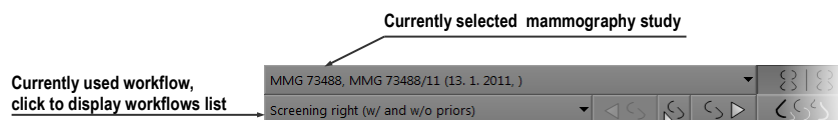

Figure 450 – Selecting the current study and workflow in the mammography mode

After you select a workflow in the mammography mode, you can apply all workflow hanging protocols and the subsequent functional steps simply by clicking the buttons for applying workflow (see Figure 451).
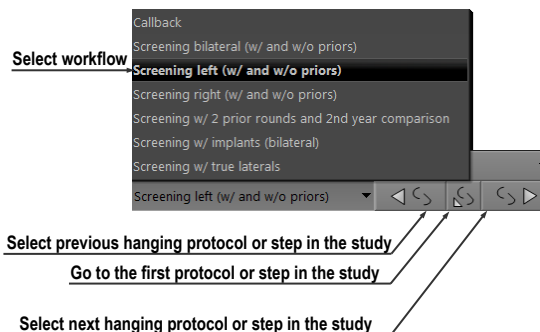

Figure 451 – Navigating in a selected workflow

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. If the workflow is selected for the first time, clicking this button sets the first protocol or functional step.

- 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.

- You can always return to the first step of a workflow by clicking the **Set first hanging protocol in workflow** button (⤺).

- 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 if you click the **Select next hanging protocol in workflow** button again.

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 **TomoCon options** dialog (see 4.9 Mammography workflows). If the parameter is set, hanging protocols that display empty views are skipped.

26.8.2 Workflow properties

A workflow consists of a list of the hanging protocols and the subsequent operations which help you simplify your 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 in the TomoCon mammography mode. TomoCon also allows you to define all workflow properties including the buttons of the configurable hanging protocol toolbar displayed on the left monitor.
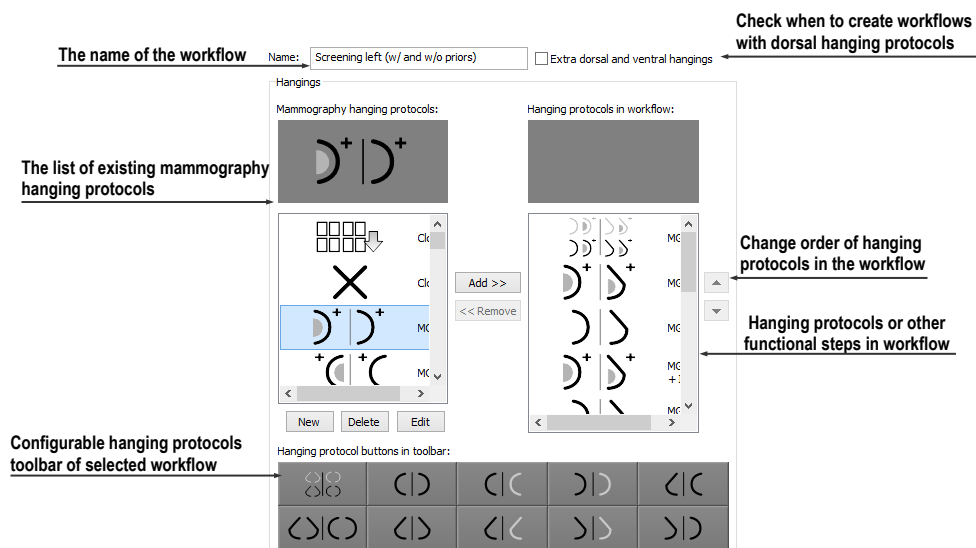

Figure 452 – Mammography workflow properties

To display or edit the workflow properties, select the mammography workflow from the list on the **Mammography workflows** tab of the **TomoCon 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 452).

The displayed workflow properties on the **Mammography workflows** tab allow you 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 and you can then define the workflows 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 26.7.3 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 26.7.1 Applying a hanging protocol.

26.9 *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 453).

Figure 453 – Displaying the Image Navigator window

The basic functionality of the image navigator is to display a comprehensive list of the previews of all mammography images opened in TomoCon. Moreover, the image navigator provides you with the following advanced functionalities:

- Displaying an arbitrary mammography image in an arbitrary view in the mammography mode using the select and place method.

- Identifying the current placement of the mammography workspaces including the displayed images in the views.

- Changing the layout of the mammography working areas.

- Identifying the read status of each image in the mammography mode to check whether it has been displayed or not.

The image navigator window (see Figure 454) consists of two basic parts: the studies list (see 26.9.2 Studies list in the image navigator) and the screen layout (see 26.9.3 Screen layouts in the image navigator).
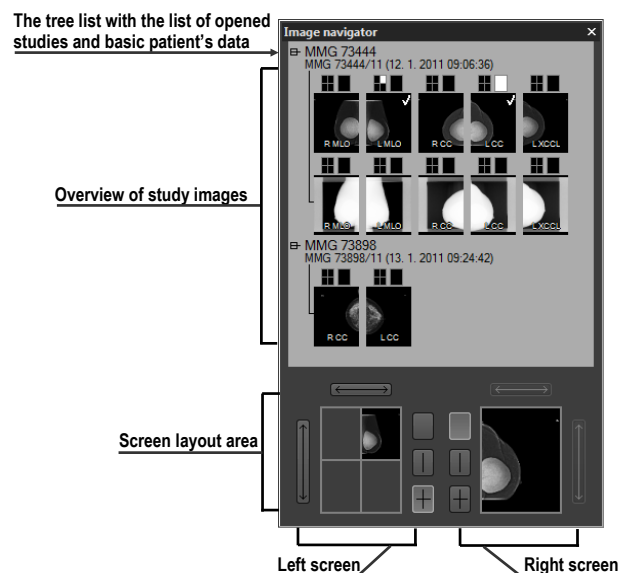

Figure 454 – Image navigator

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 mammography views on the left and right screens of the monitors. It identifies the

currently displayed images. The screen layout allows you to divide the layout of each workspace into one, two or four segments.

## 26.9.1   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 454) is displayed in the same position where it was last closed. You can also schedule the displaying of the image navigator window as a separate workflow step.

To close the image navigator, click the close ✕ button or the image navigator ⊞ button in the mammography toolbar.

26.9.2   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 in TomoCon. 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.

Each tree item (see Figure 455) consists of the following parts:

- **Screen position indicator** ▉ – it 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.

- **Image preview** – the thumbnail of the image

- **Information text about image orientation** R MLO – it describes the laterality view code of the mammography image.

- **Read mark indicator** ☑ – it indicates whether the image has been displayed in any view in the mammography mode.
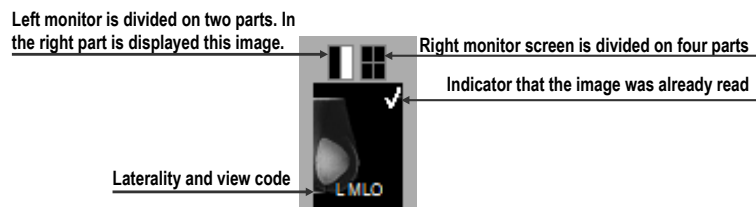

Figure 455 – The image preview item of the image navigator

In addition, you can place images directly into the views in the workspaces without applying a hanging protocol using the image navigator. 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 mammography workspace on the left or right monitor (see Figure 456).
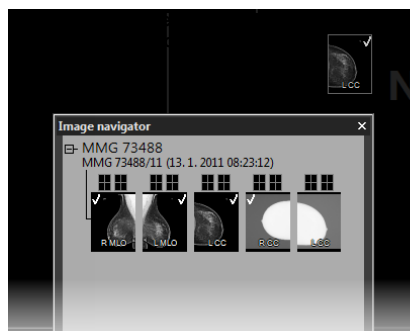

Figure 456 – Dragging an image from the study preview to the screen

- Or, 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 457). The image is displayed in the appropriate view in the mammography workspace on the left or right monitor.
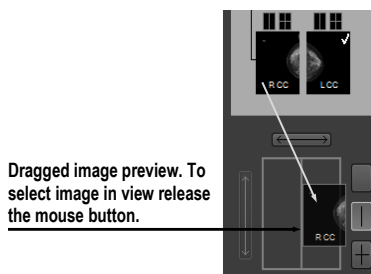

Figure 457 – Dragging an image from the study preview to the layout area

- Or, click the desired rectangle in the screen position indicator representing the view in the working area (see Figure 458). The image is displayed in the appropriate view in the mammography workspace on the left or right monitor.
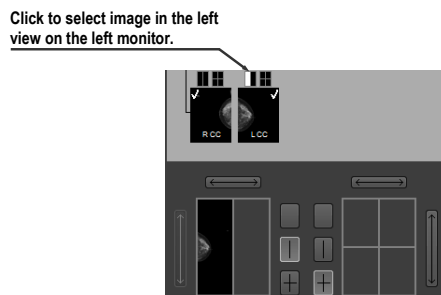

Figure 458 – Selecting an image to view using the rectangle indicator

26.9.3 Screen layouts in the image navigator

The screen layout area of the image navigator (see Figure 459) displays the screen previews of both monitors and allows you 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 toggle the views of the same workspace.
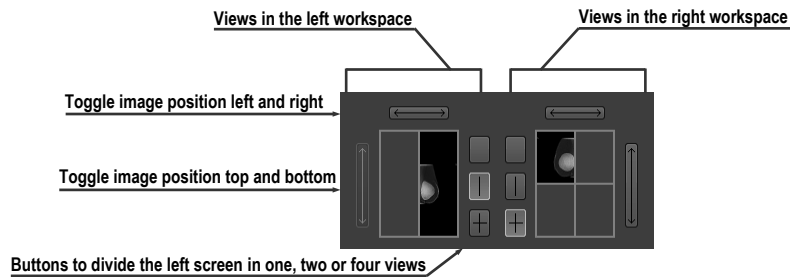

Figure 459 – Screen layout section of the image navigator

26.9.4 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) and by laterality (default is right) 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. The image type is defined in the DICOM data.

- By study and study prior – the ordering is from the newest study to the oldest study. If a study does not contain the study date and time, it is moved to the end of list.
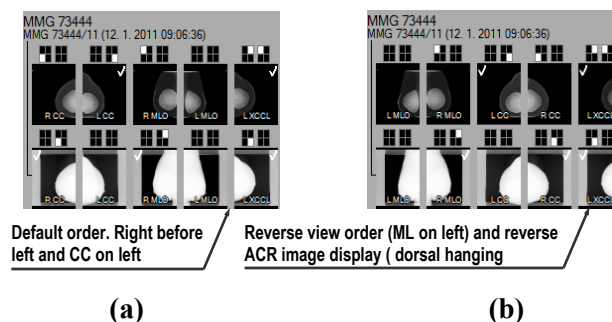

| (a) | (b) |

Figure 460 – Image order in the image navigator; standard order (a), reverse order (b)

The default sorting order of the images in the image navigator can be changed (see Figure 460) by adjusting the **Reverse view order** parameter on the **Mammography**

tab of the **TomoCon options** dialog. By adjusting the setting, you can 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.

26.10 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 you to preform 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 you with the possibility to quickly activate the most frequently used operations using the buttons in the mammography toolbar (see Figure 461).

Figure 461 – 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 all images in the mammography mode. To apply all the changes, turn on the Scope all mode by clicking the **Scope all** button in the mammography toolbar. If you wish to limit the effects of the changes only to the selected view, turn off the Scope all mode by releasing the **Scope all** 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 window/level** button in the mammography toolbar.

26.10.1 Window and level manipulations

Any change made to the window/level settings is immediately applied to the selected view or to all views if the Scope all mode is turned on (the **Scope all** [⬒→⬓] button in the mammography mode is pressed).

To change the window/level settings of displayed mammography images in the mammography mode, you can 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 [☀-1/2/3 ▾] button. The drop-down menu (see Figure 462) of all predefined applicable window/level presets then opens in which you can select the desired preset. The preset is then immediately applied.
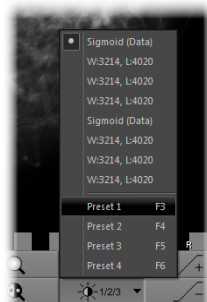

Figure 462 – Displayed window level presets drop-down menu

- 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 463).
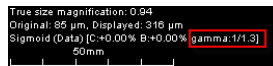
Figure 463 – The gamma value in the view text

Any changes made to the window, level or contrast values can be discarded at any time by clicking the **Reset window/level** [icon] button in the mammography toolbar.

26.10.2 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 all four zoom modes available in TomoCon. The currently selected zoom mode (which alternates the interpretation of the zoom factor) can be changed by clicking the **Zoom mode** [icon] button in the mammography toolbar. The zoom mode menu then opens (see Figure 464) in which you can choose a new zoom mode (each menu item represents a different zoom mode).
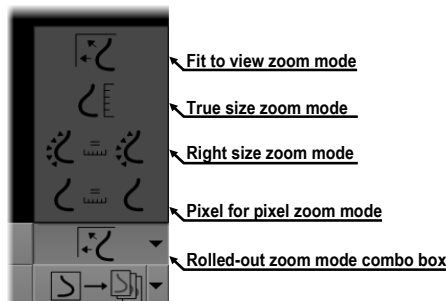

Figure 464 – Available zoom modes in the mammography mode

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 **Indicate that the image is not displayed entire in the view (checkered border)** check box on the **Mammography** tab of the **TomoCon 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 465).
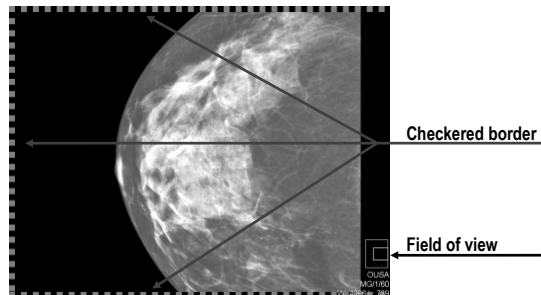

Figure 465 – Only part of the image is visible within the view

- 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 **TomoCon options** dialog (see 4.1 General options).

26.10.3 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 or you can apply the changes to all views in all working areas by pressing the ▼ button (see Figure 466).

To apply the window/level and zoom changes according to the selected scope limit, click the **Scope** button (see Figure 466). To disable the application of these changes to other views in all working areas, deactivate the **Scope** button.
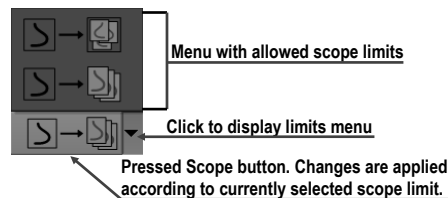

Figure 466 – Only part of the image is visible in the view

26.10.4 Magnifying glass

The magnifying glass allows you 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. 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 (see Figure 467). 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.
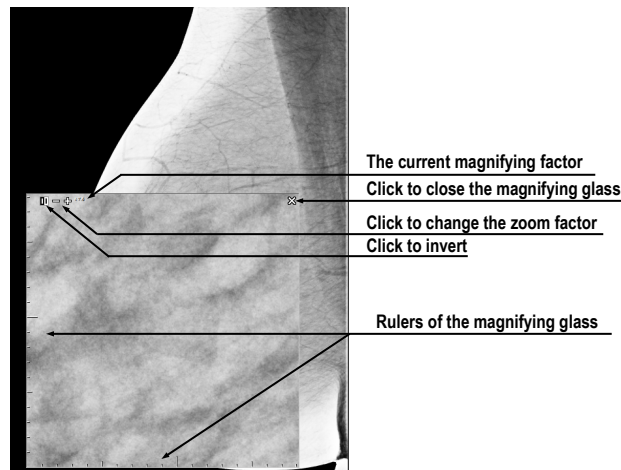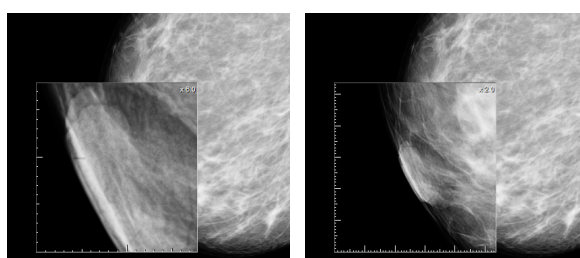

Figure 467 – Inverted magnifying glass with 3x zoom factor

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 468).

To close the magnifying glass window, simply double-click it or click the button in the upper right-hand corner of the magnifying glass window (the ⊠ icon).

(a)   **(b)**
Figure 468 – The same part of an image magnified 6x (a) and 2x (b)
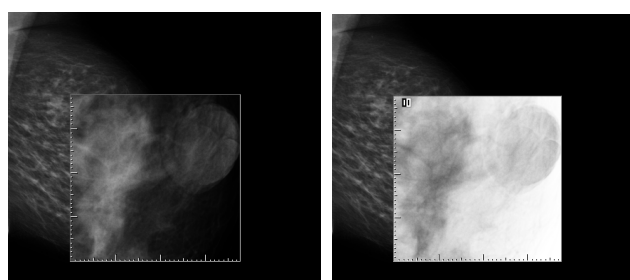
(a)   **(b)**
Figure 469 – Mammography magnifying glass window; normal (a), invert (b)

To invert the zoomed image in the displayed magnifying glass window (see Figure 469), 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.

26.11 Image roaming

For the diagnosis of mammography images in TomoCon, 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 you to automatically proceed step by step through the entire mammography image in the defined resolution (see Figure 470). The image is divided into several non-overlapping (except for the image border) rectangular sub-regions. Using image roaming, you sequentially set these image parts into the view in ascending or descending order. Once you have proceeded 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. 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.
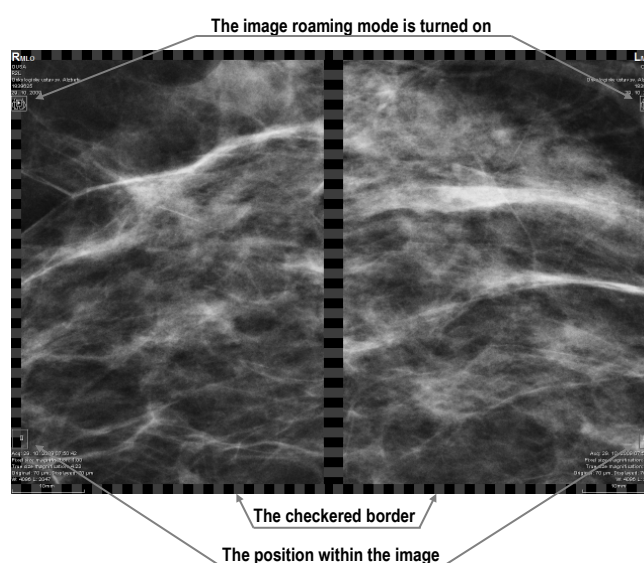
The image roaming mode is turned on

The checkered border

The position within the image

Figure 470 – Image roaming turned on

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.

When image roaming is active, you can use any of the image functions (WL, zoom, move, magnifying glass, etc.). 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.

26.11.1 Image roaming sub-regions

The size, the position and the order of the image roaming sub-regions are determined by certain factors in the mammography mode in TomoCon, 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 **TomoCon 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 471 depicts the order of the roaming sub-regions for a mammography image with right laterality.
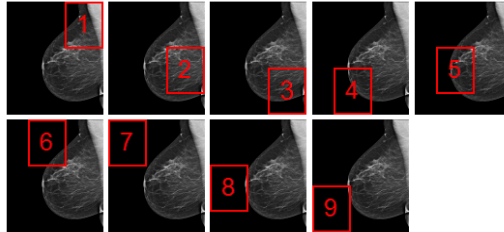

Figure 471 – The order of image roaming regions (image with right laterality)

In certain mammography images, the air, or non-tissue area, can be defined. When previewing such images in image roaming, TomoCon offers you the possibility to skip such air areas. In this manner, the number of steps required to preview an entire image can be significantly reduced (see Figure 472). To enable the skipping of empty air areas, check the **Exclude empty area from the image roaming** option on the **Mammography** tab of the **TomoCon options** dialog (see 4.8 Mammography).
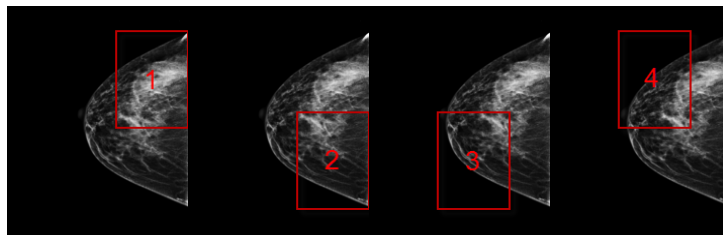

Figure 472 – Image roaming sub-regions not covering air area

26.12 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 473).
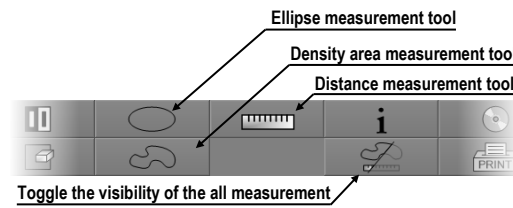
Figure 473 – Measurement tools section of the mammography toolbar

The following buttons are available for measurement activation:

- Clicking the **Ellipse** button activates the ellipse measurement.

- Clicking the **Density area** button activates the density area measurement.

- Clicking the **Distance** button activates the distance measurement.

The button in the measurements part of the mammography toolbar allows you to toggle the visibility of all defined measurements within all views.

27 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 TomoCon menu.

2. Be prepared to provide your ID and password, which are displayed in the TeamViewer QuickSupport application (see Figure 474), and call the TatraMed Software customer support center (see 28 Contact).

3. Provide your ID and password to the technician, who will then work to resolve your problem. You can monitor the work that the Support Center technician is carrying out on your computer.

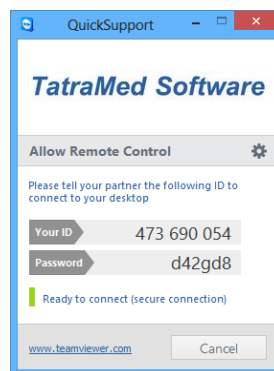4. To end the remote session, simply close the TeamViewer QuickSupport application.

Figure 474 – TeamViewer QuickSupport with your ID and password

28   Contact

If you have any questions or comments, please contact our headquarters:

TatraMed Software s.r.o.
Líščie údolie 9
841 04 Bratislava
Slovak Republic

Tel: +421 2 60202301
        +421 2 60202324 (hotline support, local working days 8:00-16:00)
Fax: +421 2 60202352
E-mail: info@tatramed.com