TomoCon 3.0

User's Manual

TatraMed

TomoCon 3.0 Workstation
TomoCon 3.0 Viewer
TomoCon 3.0 Lite

User's Manual

Version 3.0.16

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All patient names used in this manual are fictitious.

TomoCon PACS

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Table of Contents

1 General note 9
1.1 Intended use 9
1.2 TomoCon PACS client applications 9
1.3 Medical device class and CE mark 9
1.4 Safety precautions 9
2 Getting started 11
2.1 Installing and uninstalling TomoCon 11
2.1.1 System installation requirements 11
2.1.2 Installing TomoCon 12
2.1.3 Uninstalling TomoCon 12
2.1.4 Installing licenses 12
2.1.5 Installation verification 13
2.2 Starting TomoCon 13
2.3 Logging in to TomoCon 14
3 Using TomoCon 15
3.1 Working area 15
3.1.1 Working area layout 15
3.1.2 Organizing your layouts 18
3.1.3 Current view 20
3.2 Tools panel 20
3.2.1 Navigating through the tools panel 22
3.2.2 Quick access toolbar 23
3.3 Thumbnails palette 24
3.3.1 Working with thumbnails palette 26
3.4 Main menu 29
3.5 Main toolbar 32
3.6 Status bar 33
3.6.1 Scope panel 33
3.7 Coordinate 34
3.7.1 Current point 34
3.7.2 The limits of accuracy in measurements 34
4 Setting up the application 36
4.1 General options 37
4.1.1 Application language 37
4.1.2 Application look 37
4.1.3 Scaling application fonts and dialogs 37

4.1.4 View options 38
4.1.5 Mouse options 39
4.1.6 ROI options 40
4.2 Modality options 41
4.3 View texts 42
4.4 Colors options 43
4.5 Keyboard shortcuts 43
4.6 Quick access toolbar 45
4.7 DICOM options 46
4.7.1 Local studies properties 47
4.7.2 DICOM receiver settings 47
4.7.3 External DICOM device configuration 47
5 Retrieving and Opening study 49
5.1 Finding studies 49
5.2 Local studies 50
5.3 Opening multiple studies 51
5.4 TomoCon PACS server 52
5.5 DICOMDIR 52
5.6 External data acquisition devices 53
5.7 Send study to external data device 53
5.8 Monitoring and controlling the send/receive jobs 54
5.9 Save a patient study 55
5.10 Close a patient study 55
6 Viewing images 56
6.1 Display image in view 56
6.2 Image sequence 58
6.3 Series synchronization 60
6.4 Play multi-frame images 62
7 Manipulating images 64
7.1 Window and level manipulations 64
7.1.1 Window/level tool 64
7.1.2 Presets 65
7.1.3 Adjusting Window/Level with the mouse 66
7.2 Zooming image views 66
7.2.1 Zoom tool 67
7.2.2 Zooming with the mouse 67
7.2.3 Panning with the mouse 67

7.2.4 Magnifying glass 68
7.3 Image filters 68
7.4 DSA - Digital Subtraction Angiography 69
7.4.1 Automatic DSA mode 70
7.4.2 Manual DSA mode 70
7.5 Cutlines 71
7.5.1 Hide cutlines 73
7.5.2 Auto mode 73
7.5.3 Print cutlines 73
7.6 Key image notes 73
7.6.1 Add key image note 74
7.6.2 Review and edit key image note 74
7.6.3 Load and save key image note 75
7.7 Exporting images 76
7.7.1 Export images 76
7.7.2 Export images to AVI format video file 77
7.8 Adding and removing images of series 77
8 Hanging protocols 81
8.1 Apply hanging protocol 81
8.2 Importing and exporting of hanging protocols 82
8.3 Creating and modifying hanging protocol 83
8.3.1 Hanging protocol properties dialog 83
8.3.2 Identification of criteria and properties 85
9 Annotations and measurements 86
9.1 Text annotations 88
9.2 Marker annotations 88
9.3 Distance 89
9.4 Distances and angle 89
9.5 Probe 90
9.6 Density spot 90
9.7 Density profile 91
9.8 Ellipse 92
9.9 Rectangle 92
9.10 Free area 93
9.11 Cobb angle 94

9.12 Calibration....94
9.13 Hide / show annotations....95
9.14 Discard annotations....96
9.15 List of annotations....96
10 Contouring the patient – create ROIs....98
10.1 Creating new ROIs....99
10.2 Selecting ROI and contour....100
10.3 Saving ROIs....102
10.4 Deleting ROI....102
10.5 ROI administration....102
10.5.1 Copy ROI....104
10.5.2 Simplify ROI....105
10.5.3 Resample ROI....105
10.5.4 Smoothen ROI....106
10.5.5 ROI algebra....107
10.5.6 Export ROI to DXF or VTK file....108
10.6 Accept and delete contour....108
10.7 Edit ROI properties....110
10.8 Edit contours with drawing tools....111
10.8.1 Freehand drawing tool....112
10.8.2 Polygon drawing tool....113
10.8.3 Magic wand drawing tool....113
10.8.4 Brush drawing tool....114
10.8.5 Automatic contouring drawing tool....115
10.8.6 ROI margin drawing tool....117
10.8.7 Bolus ROI defining drawing tool....119
11 MPR - Multi Planar Reformatting....122
11.1 Arbitrary MPR....123
11.2 Online MPR....123
11.3 Interactive moving and rotating....123
11.4 Export MPR to series....124
12 MIP - Maximum Intensity Projection....126
13 DRR Reprojection....127
14 Multi-modality fusion....128

14.1 Create a multi-modality image fusion 128
14.2 Fusion method 130
14.3 Export a fusion to a series 130
15 Three-Dimensional Visualization 132
15.1 Rotation, spatial orientation 133
15.2 Cropping volume of interest 134
15.3 Moving MPR plane 135
15.4 Volume rendering 136
15.4.1 Point selection in volume rendering and intensity projections 137
15.4.2 Volume rendering settings 137
15.4.3 Create and use color presets 138
16 Registrations 142
16.1 Defining registration 142
16.1.1 Identity 143
16.1.2 Patient-related (CA-CP) 143
16.1.3 Surface matching 144
16.1.4 Landmark 144
16.1.5 Manual 145
16.1.6 MIR 147
17 Print images 149
17.1 Microsoft Windows printer 149
17.2 DICOM printer 150
17.2.1 DICOM print working area 151
17.2.2 DICOM print Thumbnail palette 151
17.2.3 DICOM print menu 152
17.2.4 DICOM print standard toolbar 152
17.2.5 DICOM print status bar 153
17.2.6 DICOM printer installation 153
17.2.7 Setting up DICOM print interface properties 154
17.2.8 Edit images 155
17.2.9 Images for print 155
17.2.10 Edit and move films 156
17.2.11 Monitoring and controlling the print process 156
18 ECG/HD 158
18.1 Navigating through opened ECG/HD waveforms 158
18.2 Viewing and diagnostics of ECG/HD 159
18.2.1 Status bar 159
18.2.2 Customizing displayed channels and time interval 159

18.2.3 Time cursor in ECG/HD 160
18.2.4 Marker measurement in ECG/HD 161
19 Touch screen mode 163
19.1 Open a patient study 164
19.2 Close a patient study 164
19.3 Window, level, shape settings 164
19.4 Move and zoom images 165
19.5 Working area layout 166
19.6 Play multi-frame images 166
20 Reports 168
20.1 Create a new template 168
20.2 Create a new report 168
20.3 View report 171
20.4 Edit a report 172
20.5 Save a report 172
20.6 Delete a report 172
21 Study anonymization 173
22 Create a new patient study/series 174
23 Archive images on CD 176
24 Contact 180

1 General note

1.1 Intended use

TomoCon PACS is a PACS system intended to be used for patient image data storage, handling, transport, visualization and diagnostics. It allows DICOM data import and export and visualization of stored images for diagnostic purposes.

1.2 TomoCon PACS client applications

TomoCon 3.0 Workstation, TomoCon 3.0 Viewer, TomoCon 3.0 Lite (hereinafter as TomoCon) are client applications of TomoCon PACS system. All three client applications provide the same basic functionality (as declared in the intended use). The applications also provide advanced functionality in various levels depending on the license. Where appropriate, the user is notified to a difference from basic functionality.

1.3 Medical device class and CE mark

TomoCon PACS has been classified as a Class IIb medical device, according to Directive MDD 93/42/EEC as amended by Directive 2007/47/EC and has been certified so. Written declaration of conformity is available on request (see 24 Contact).

CE 0434

1.4 Safety precautions

TomoCon user interface is written in English language; therefore the knowledge of English on an appropriate level is required.

The software is running on Microsoft Windows XP, Windows Vista or Windows 7, therefore good knowledge of the used operation system is recommended.

Good understanding of installation instructions in this document (see 2.1.2 Installing TomoCon) is mandatory before installing TomoCon for clinical usage. Good understanding of the whole user's manual is mandatory before using TomoCon clinically.

Diagnosing users should be aware that certain views might display interpolated data. Interpolated data, although based on the original data set, may give the appearance of healthy tissue in situations, where 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 real pathology.

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

2 Getting started

2.1 Installing and uninstalling TomoCon

2.1.1 System installation requirements

TomoCon requires 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)

2.1.1.2 Additional hardware recommendation

- **Printer port** or **USB port** for attaching hardware protection dongle
- **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:

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

TomoCon Viewer, TomoCon Lite:

- **Operating System** Microsoft Windows XP SP3, Windows Vista SP2, Windows 7
- **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 be displayed automatically after a while, allowing you to select **TomoCon** to install. If it displays, proceed to step 3. If it does not display, follow step 2.
2. Run `SETUP.EXE` from the installation CD. You can do this by double-clicking on '`My Computer`' icon on your desktop, then double-clicking the icon of your CD-ROM drive ('`D`' for example), and finally double-clicking '`Setup`' or '`Setup.exe`' executable file.
3. Follow the instructions given by the Setup program of **TomoCon**.

2.1.3 Uninstalling TomoCon

To uninstall **TomoCon**, click the Microsoft Windows **Start** button, go through **Settings**, **Control Panel** and start **Add/Remove Programs**. From the list of currently installed programs select **TomoCon** and press the **Change/Remove** button.

2.1.4 Installing licenses

Application TomoCon Advanced Workstation provides the following licenses:

- MIR – **Mutual Information Registration** license (see 16.1.6 MIR).
- Extended **Volume Rendering** license (see 15.4 Volume rendering).
- License for saving RT structures in DICOM format (**RTSTRUCT Export**).

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

- **Advanced Contouring** license for contouring by advanced Bolus and Margin tools (see 10.8.6 ROI margin drawing tool and 10.8.7 Bolus ROI defining drawing tool). This license already includes license for saving RT structures in DICOM format.

To install a license to TomoCon follow these steps:

1. Click on the **Licenses...** item in **Help** menu.
2. In **Licenses** dialog (see Figure 1), which will be displayed with already installed licenses, you can install new license (click on the **Install** button) or you can remove selected license from list (select the license and click on the **Remove** button).

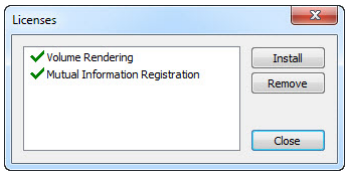


Figure 1 – Licenses dialog

2.1.5 Installation verification

To verify installation process of TomoCon Viewer or TomoCon Workstation, you follow these steps:

1. Install the application.
2. Check if the icon of the application is placed on the Microsoft Windows desktop.
3. Check if the application shortcut is contained in the Microsoft Windows Start menu:
   - TomoCon Viewer: **Start / Programs / TomoCon 3.0 Viewer / TomoCon Viewer**.
   - TomoCon Workstation: **Start / Programs / TomoCon 3.0 Workstation / TomoCon Workstation**.
4. Launch the application and check the following steps in TomoCon.
   - If the application is installed for the first time (it is not upgraded) the dialog **Select TomoCon 3.0 Language** will be displayed. Then select language and click on the **OK** button.
   - If the DICOM receiver is not configured correctly, the warning message "Could not start DICOM receiver" will be displayed. The possible reason can be, that the TomoCon's DICOM receive port is used by another application. Then click on the **OK** button.
   - Check if the main window of application is displayed.
   - Click on the **About...** item in **Help** menu. The **About box** of TomoCon will be displayed.
   - Check if the build number in the displayed **About box** is 3.0.16.

2.2 Starting TomoCon

To start TomoCon, click the Microsoft Windows **Start** button; go through **Programs**, **TomoCon 3.0** and finally **TomoCon**.

Optional start-up parameters:

- /**t** - to start TomoCon in touch screen mode, (see 19 Touch screen mode).

2.3 Logging in to TomoCon

TomoCon application provides to you with following possibilities of access authorization:

- Non-authorized access, when each user logged on computer can launch TomoCon.
- Authorized access with user name and password. When user is launching application, he has to enter his user name and password in **Log On to TomoCon** dialog (see Figure 2) and press **OK** button to confirm and start application.

Figure 2 – Log On to TomoCon dialog

3 Using TomoCon

The TomoCon consists of the following parts (see Figure 3):

- 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)

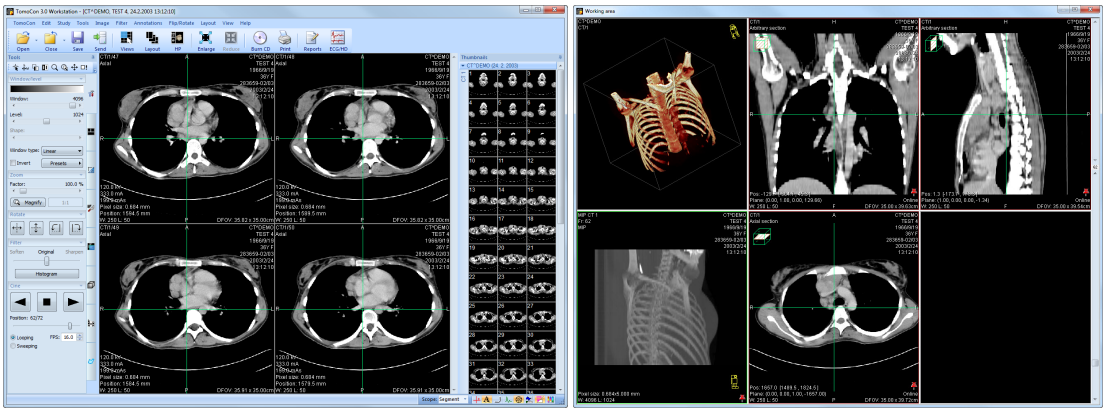


Figure 3 – Application TomoCon

3.1 Working area

Working area an area for visualization and diagnostics of patient data (displays images of examination, MPR, 3D, etc.). Main working area is bound to main application window. If you want to expand existing working area, you can anytime create new independent working area with variable size and place it on next free monitor. You can create new working area with a click on the **Create new working area** item in the **View** menu. New working area will be automatically created and placed on the first free monitor.

3.1.1 Working area layout

A newly created working area consists of one segment, which covers the whole working area and can be divided into views. Segment is a defined part of working area with resizable bounds and it can be divided into other smaller segments. After having created a new working area, you can divide it into the desired layout by

dividing segments and defining views layout for each of from them (by default the segment contains one view). You can also change the existing layout anytime by resizing or deleting segments, which have been defined previously. This way you can create all kinds of layouts for your viewing and diagnosing.

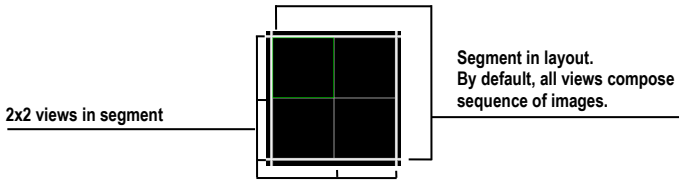


Figure 4 – Four views in segment

TomoCon allows you define a requested layout in simple and quick way by using the tools docked in the **Define layout** tool in the tools panel. **Define layout** tool (see Figure 5) is initially docked in the tools panel in the third tab. You can get to it at any time by clicking the tab with icon. All these functions are also available over the **Layout** system menu.

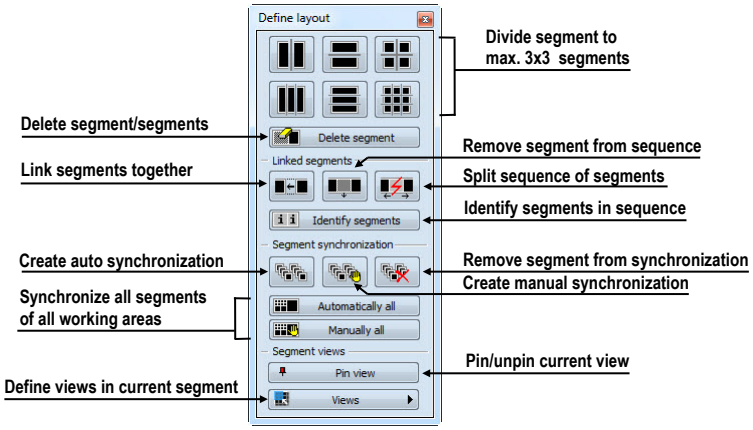


Figure 5 – Define layout tool

To divide an existing segment into other smaller segments (see Figure 6a):

1. Select the requested type of division from the **Define layout** tool.
2. Click with the left mouse button on the segment, which you want to divide.

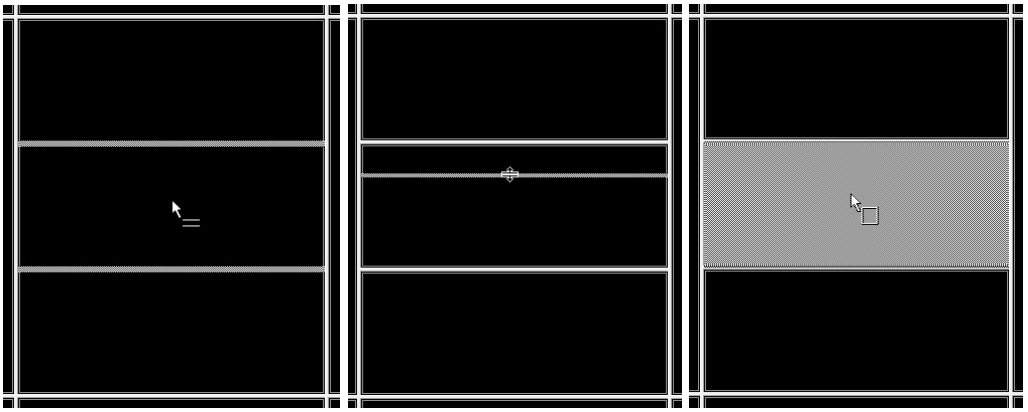
Segments are divided by thick moveable separation lines. Size of each segment can be simply modified by dragging and moving them with the mouse cursor.

To resize adjacent segments (see Figure 6b):

1. Move the mouse cursor on the boundary (separation) line, which you want to move.
2. Press the left mouse button, move the line to the requested place and release the mouse button.

To remove existed segment/segments (see Figure 6c):

1. Click on the **Delete segments** button in the **Define layout** tool.
2. Move mouse cursor on segment/segments, which you want to delete (the segment/segments will be marked with white color) and click with left mouse button.



(a) **(b)** **(c)**

Figure 6 – Definition of segments in working area, divide segment (a), move bound of segment (b), delete segment (c)

When you have defined layout of segments in working area, you can change layouts of their views. Each new segment has one default view, which covers whole area of the segment. At any time, you can change this and define new views layout with up to 8x8 views in one segment.

To define layout views in segment (see Figure 7):

1. Click with left mouse button into the selected segment.
2. Click on the **Views** button in the **Segment views** part of the **Define layout** tool or click on the **Views** button in the main toolbar of TomoCon.
3. Select requested layout of views in grid, which has been displayed.

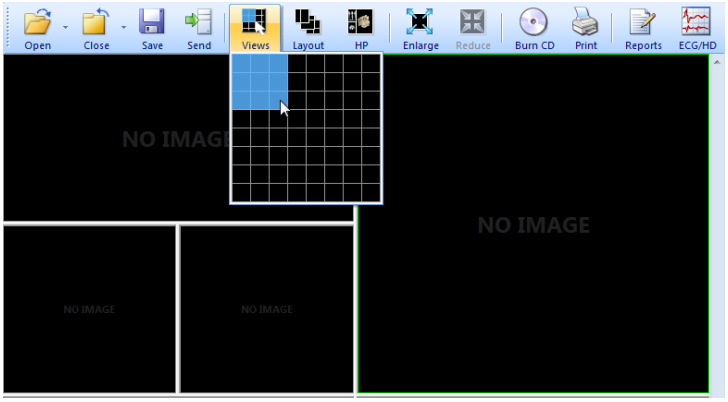


Figure 7 – Definition of views for segment

3.1.2 Organizing your layouts

When you have finished the creation of working areas and segment definition on each of them, you can save the whole layout in application for next use. Application allows you to manage your layouts in the following lists and use any from them:

- **Recent layouts -** list of four last used layouts.
- **Favorite layouts -** list of favorite layouts (any saved layout can be added into or removed from this list with **Layouts manager**).
- **Others layouts** - list of others layouts, which is not in favorites list. From this list you can move any layout to **Favorite layouts** list.

3.1.2.1 Save layout

To save current layout of application:

1. Click on the **Add layout...** item in **Layout** menu.
2. Enter new layout name in the **Add layout** dialog (see Figure 8), which will be displayed.
3. Press the **Add** button.

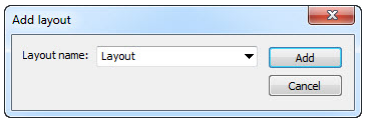


Figure 8 – Add layout dialog

Current layout with entered name will be automatically added to particular list of layouts (**Others layouts**). If you want to rewrite some layout, which has been already saved, enter the name of this layout (or select it from already defined layouts list, which is displayed after pressing the button ▼, see Figure 9) and press the **Add** button to confirm.

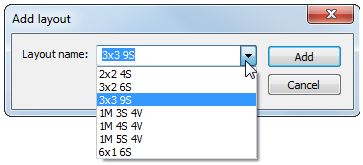


Figure 9 – Overwrite already defined layout

3.1.2.2 Load layout

To load any saved layout from selected list:

1. Click on the **Layout** item in main toolbar or on the **Favorite**, **Recent** or **Others** button in the **Layouts** tool of the tools panel (see Figure 10).

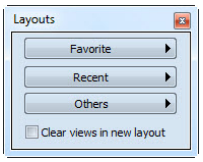


Figure 10 – Layouts tool

2. Click with left mouse button on the requested layout in window, which will be displayed. Selected layout will be automatically loaded to application.

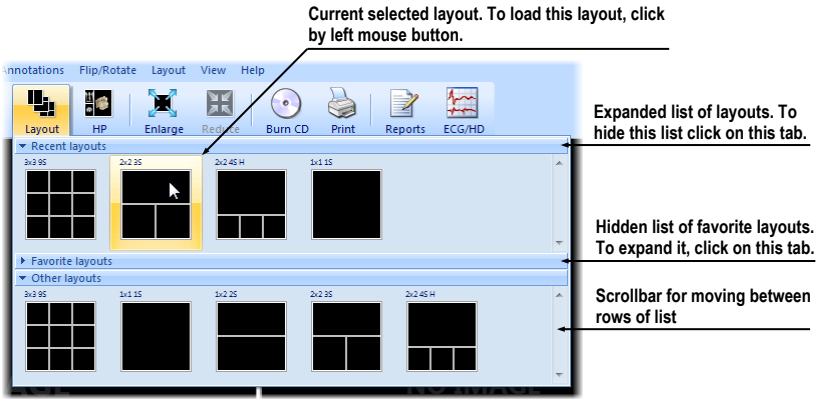


Figure 11 – Layouts list

3.1.2.3 Layouts manager

Layouts manager allows you to change base properties of already saved layouts with **Layouts manager** dialog (see Figure 12). In this dialog, which will be displayed, when you click on **Layouts manager…** item in **Layout** menu, you can delete (**Delete** button), or rename (**Rename** button) selected layout and move it from/to list of favorite layouts (**Favorite** check box).

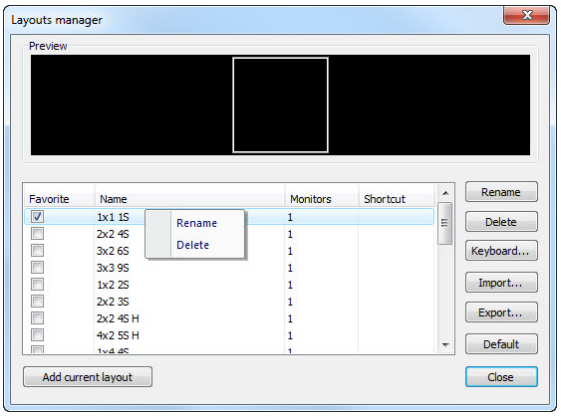


Figure 12 – Layouts manager dialog

3.1.3 Current view

Current view is the most recently selected view from all existed working areas, which you have selected by clicking with any mouse button. When you select one view and make it current, all actions, which you will perform, will be applied just to this view.

To change current view, move mouse cursor to another view and click with any mouse button (see Figure 13). Current view is outlined with a colored frame according to the TomoCon settings (you can change the color of the frame, see 4.4 Colors options).

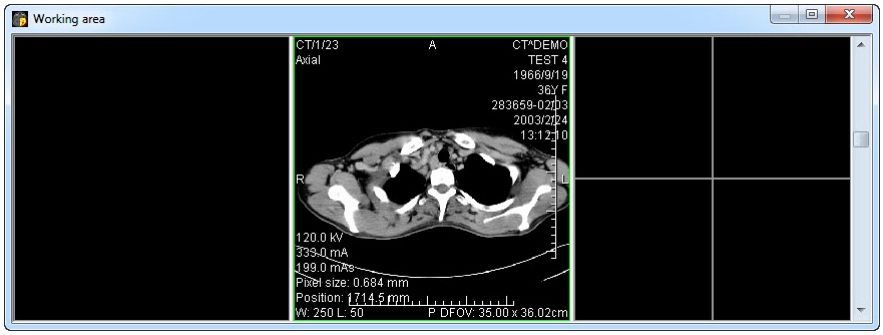


Figure 13 – Working area

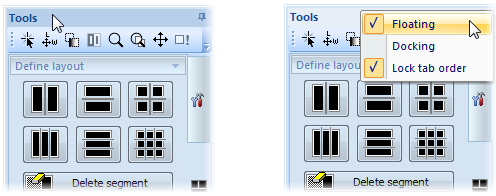
3.2 Tools panel

The tools panel contains the main tools to view and diagnose loaded images in TomoCon. It is highly configurable and you can easily move its parts around and even hide/show them altogether. This panel can be useful for maximizing your actual working area.
You can place it to any position on the screen in floating state or dock it to the left or right side of the main workspace. The panel is docked on the left side by default.

To undock a panel into the floating position using the drag and drop method, drag the panel's title bar (see Figure 14a) and move the panel to a new position on the screen. Then release the mouse button on requested position.

To undock a panel into the last floating position, click with right mouse button on the tools panel title bar. Then select the **Floating** item in displayed context menu (see Figure 14b).

To dock tools panel to last docked position, move mouse cursor on the tools panel title bar and click with right mouse button. Then select the **Docking** item in displayed context menu (see Figure 14b).



(a) **(b)**

Figure 14 – Tools panel undocking, by drag and drop method (a), by context menu (b)

To dock tools panel to a new dock position, drag the panel's title bar and move the panel. While moving the tools panel, docking navigators will be displayed in the application window. Each navigator shows an available docking position for the panel. When the mouse cursor hovers over any docking navigator, a new docking position for the tools panel will be displayed (see Figure 15). To dock the panel on the displayed place, just release the mouse button while the cursor is placed over the navigator.

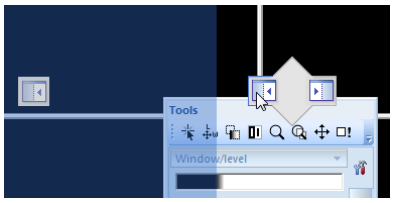
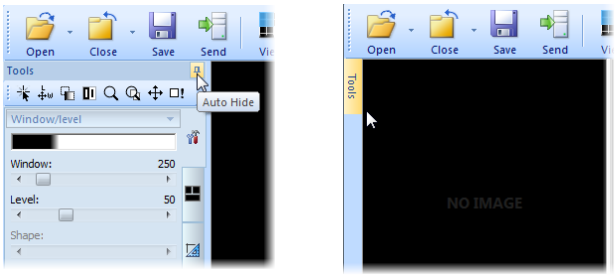


Figure 15 – Docking tools panel to left TomoCon's side

In addition, to maximize your workspace you can also turn on auto hide mode of docked tools panel. Then, tools panel will be represented by thin bar on the particular side of TomoCon.



(a) **(b)**

Figure 16 – Auto hide mode of the Tools panel, turn on auto hide (a), display hidden panel (b)

To activate auto hide mode, click with left mouse button on icon placed in the right corner of tools panel title bar (see Figure 16a). When the mouse cursor is moved over bar (see Figure 16b), the tools panel will be automatically displayed and you can use any docked tool in the panel. When the mouse cursor is moved outside displayed tools panel, it will be automatically hidden.

3.2.1 Navigating through the tools panel

The tools panel (see Figure 17) is a very simple topmost dialog, composed from three parts. The first part is a quick access toolbar and the second one is a title bar. The third, main part consists of a selected group of tools for viewing the images and diagnosing using them. The main part is divided into simply labeled sections for easy tool selection and one section for thumbnail palette. Each section is organized as a separate tab page with docked tools in specified arrangement.

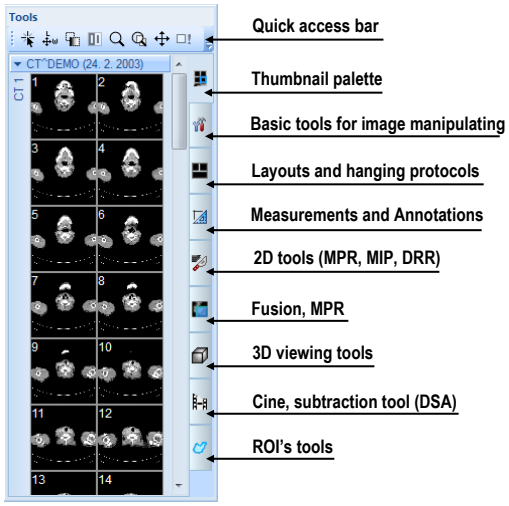
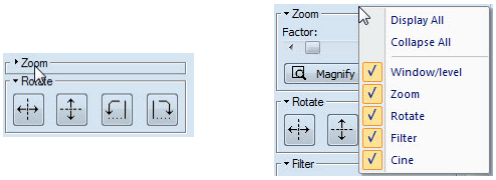


Figure 17 – Tools panel

The Tools panel can be customized to display the tools you use most often. 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.

To collapse or display the selected docked tool in the tools panel, click on its title bar (see Figure 18a) or use the tools panel's context menu (see Figure 18b). To display the context menu, click on any tab page in the tools panel with the right mouse button.

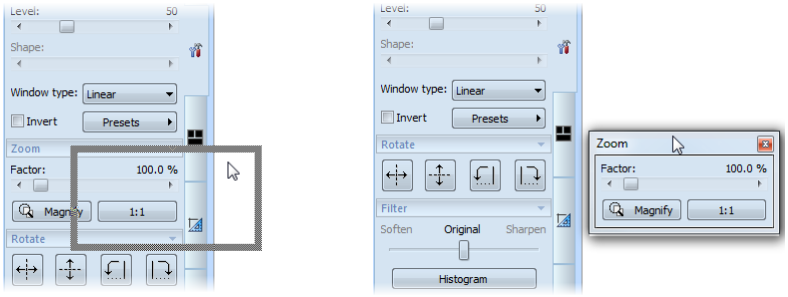


(a) **(b)**

Figure 18 – 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's title bar, tool will be displayed as only empty frame (see Figure 19a), and drag it to a new position on the screen. Then release the mouse button on requested position. Undocked tool will be automatically changed to floating

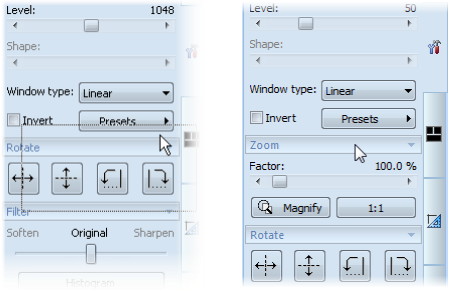
tool dialog and content of tools panel will be automatically rearranged (see Figure 19b).



(a) **(b)**

Figure 19 – Undocking 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 the tools panel on a preferred position (see Figure 20a) and release the mouse button. The tool window will be automatically docked to the tab page where it belongs to (see Figure 20b).



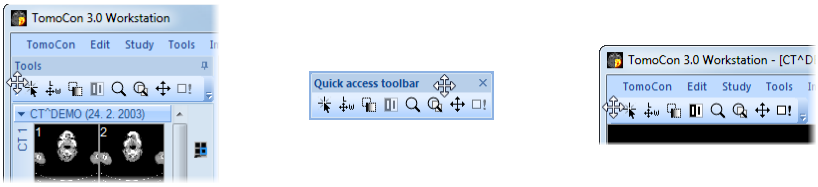
(a) **(b)**

Figure 20 – Docking Zoom tool in tools panel (a), docked Zoom tool (b)

3.2.2 Quick access toolbar

The Quick access toolbar is a customizable toolbar initially docked in the top of the tools panel, which contains a set of commands that are independent of the tool or menu that is currently displayed. You can move the Quick access toolbar from initially docked location in tools panel to any floating position or dock it to any side of application window. If you don't want the Quick access toolbar to be displayed in its current location, you can move it to the other location by drag and drop method at any time.

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



(a) **(b)** **(c)**

Figure 21 – Undocking toolbar (a), moving toolbar to floating position (b), docking toolbar to top side of TomoCon (c)

Quick access toolbar is fully customizable toolbar, which allows you to add or remove buttons that represent commands in TomoCon at any time. You can add or remove a command in the Quick access toolbar by **TomoCon options** dialog, which will be directly displayed after pressing icon in this toolbar and selecting the **Add or remove commands...** item in displayed context menu (see Figure 22).

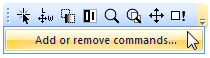


Figure 22 – Displaying TomoCon options dialog for add/remove commands

To add or remove command to/from **Quick access toolbar** by **TomoCon options** dialog see 4.6 Quick access toolbar.

3.3 *Thumbnails palette*

The thumbnails palette is a powerful navigation tool (see Figure 26), which lets you select images to be displayed in the working area. It always contains images of all opened studies displayed as thumbnail previews. The thumbnails palette may be resized and can be docked inside the application border, but it can be also floating, placed anywhere on the screen. When starting the application, the thumbnails palette is docked in the tools panel by default.

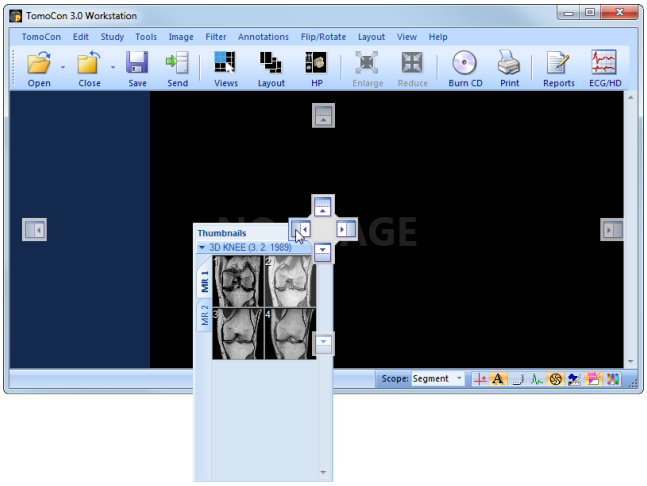


Figure 23 – Docking thumbnails palette to left side of TomoCon

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

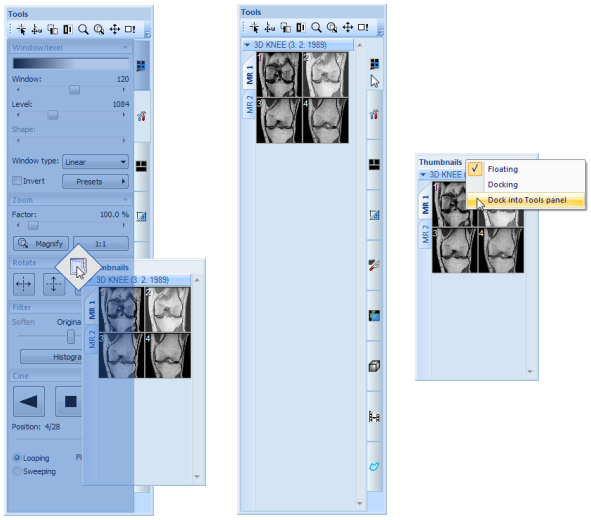
1. Drag the thumbnails panel's title bar and move the panel over the displayed docking navigators. Each navigator represents a possible docking position.
2. Move the panel over the left docking navigator . A new docking position for the thumbnails palette will be displayed with blue translucent color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

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

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

or using the thumbnail's context menu:

1. Click with right mouse button on the thumbnails panel's title bar.
2. Select the **Dock into Tools panel** item in displayed context menu of thumbnails bar (see Figure 24c).



(a) **(b)** **(c)**

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

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

1. Press the left mouse button on the thumbnails panel's tab with icon (see Figure 24b) and drag the panel outside the tools panel.
2. Thumbnails palette will be undocked from the tools panel immediately and you can place it to any desired position. To finish the undocking process, release the mouse button.

or using the Tools panel's context menu:

1. Click with right mouse button on the active thumbnail's tab in the Tools panel.
2. Select the **Undock thumbnail** item in displayed context menu (see Figure 25).
3. Thumbnail bar will be undocked from Tools panel and moved to its last undocked position immediately.

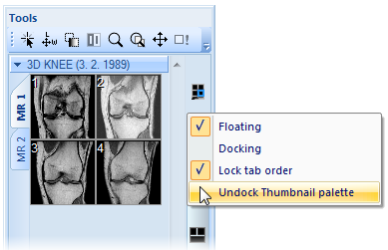


Figure 25 – Undock thumbnail bar from Tools panel by context menu

3.3.1 Working with thumbnails palette

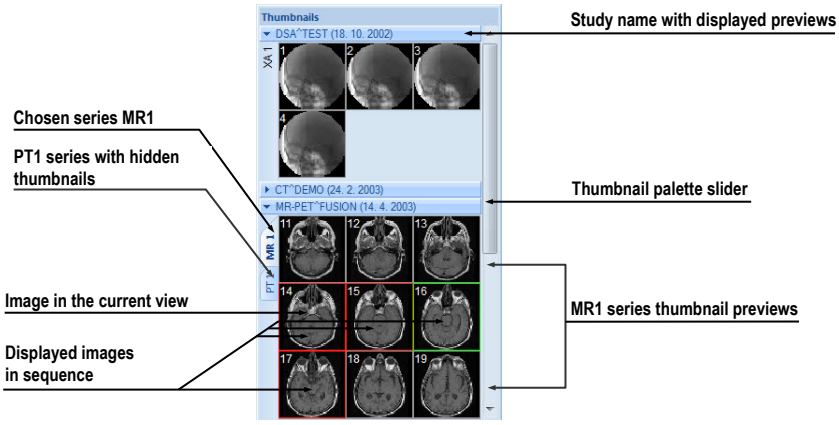


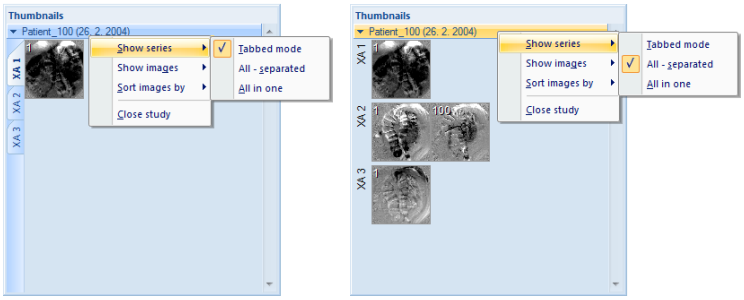
Figure 26 – Thumbnails palette (Tabbed mode)

Each study is displayed in the thumbnails palette (see Figure 26) as a tab with patient name and an examination date (date of creating the study), if the date is available. Under these tabs there are reduced images of the series displayed according to the selected series representation type for the study in the thumbnails palette. Selection of this representation type is possible using the thumbnails palette's context menu (after

pressing right mouse button on the selected study in the thumbnails palette and selecting the **Show series** item).

Thumbnails palette supports 3 different series representation types for the study:

- **Tabbed mode**, selection of the series, which thumbnails are to be displayed, can be selected by clicking with the left mouse button on the button with the series name in the list of series. Only one series from the study can be displayed at a time (see Figure 27a).
- **All - separated**, thumbnails of all series of the study are displayed at once, sorted according to series (see Figure 27b).
- **All - in one**, reduced thumbnails of all series of the study are displayed at once one after another without dividing them into series (see Figure 28).



(a) **(b)**

Figure 27 – Displaying series in Tabbed mode (a), All – separated (b)

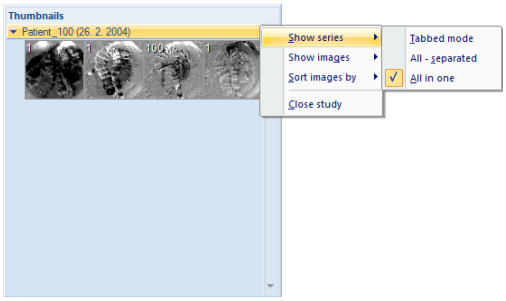


Figure 28 – Displaying series in All – in one mode

Similar to the selection of the series representation type in the thumbnails palette, it is also possible to select the image representation type in the series. Image representation type is possible using the thumbnails palette's context menu and selecting the **Show images** item (see Figure 29). Thumbnails palette supports following image representation types for the series:

- **Show all images**, when all images of each series of the selected study are displayed.
- **1 image out of**, when selected number specifies the image interval of each series of the selected study to display.

- **One image only**, when first image of each series of the selected study is displayed.
- **First, middle and last**, when the first, middle and last image of each series of the selected study is displayed.

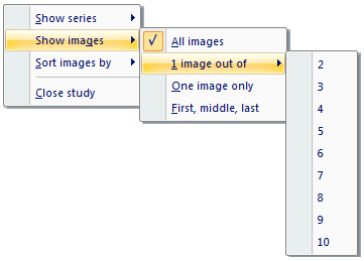


Figure 29 – Context menu for selection of the image representation type

Additionally, image thumbnails from the selected study can be sorted in the Thumbnails palette using the **Sort images by** context menu item (see Figure 30):

- **Index number** - as opened in TomoCon
- **Instance number** - instance number value in DICOM data
- **Image position** - image sorted by position
- **Reverse sort mode**

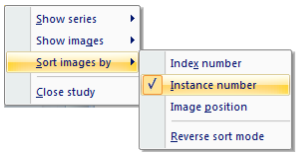


Figure 30 – Context menu for sorting images

Tabs with opened patient studies can be folded/unfolded by moving the mouse cursor over the patient's name and clicking the left mouse button at the chosen study. When the triangle arrow in front of the patient name directs to the patient's name, the thumbnails are folded; when the triangle arrow points down, the thumbnails are unfolded and can be seen (see Figure 26).

NOTE! When there is only one patient study opened in TomoCon, the thumbnails are always visible and it is not possible to fold them.

When opening a new patient study in TomoCon all studies already in TomoCon will be automatically folded and the first series of the new patient will be displayed. Use the scrollbar on the right side of the thumbnails palette to select from the series (thumbnails) that could not be seen on the screen.

3.4 Main menu

The whole TomoCon functionality and features can be found in the main menu. It provides direct access to all functions for viewing and diagnosis of images. As with other Microsoft Windows applications, the items in main menu are divided into groups (sub-menus) according to the type of their usage. The TomoCon main menu consists of the following sub-menus:

- **TomoCon** – main application sub-menu for defining application settings, printing (image data printing on Microsoft Windows printer, DICOM printer, logging in to or out from the application or terminating it), see Figure 31.

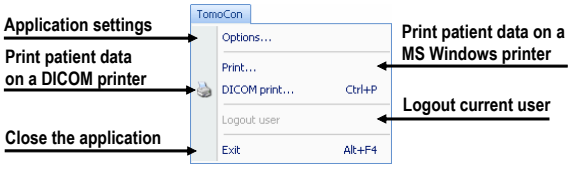


Figure 31 – TomoCon menu

- **Edit** – clipboard operations with image in current view and selected ROI contour, see Figure 32.

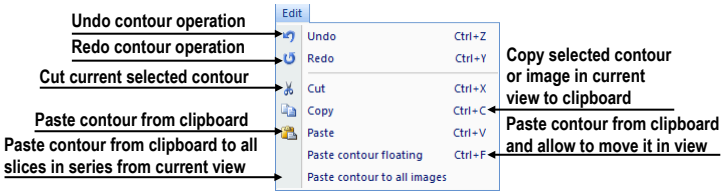


Figure 32 – Edit menu

- **Study** - patient study handling, it contains functions for opening/closing/saving studies, anonymizing and burning studies, exporting images and creating/viewing structured reports about studies (see Figure 33).

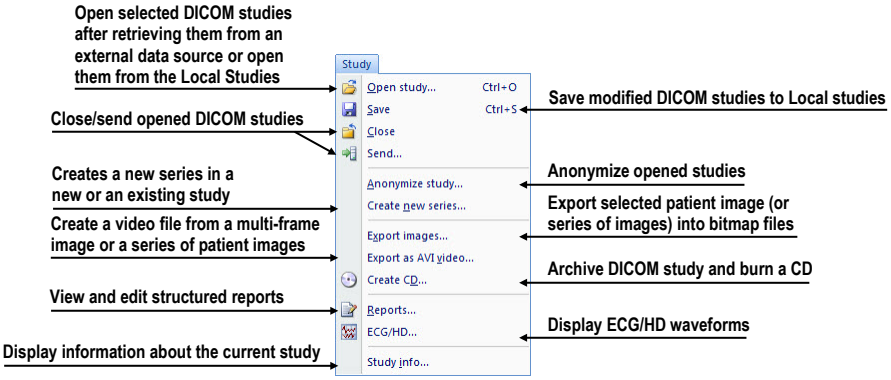


Figure 33 – Study menu

- **Tools** - tools for image data handling like windowing/zooming, 3D viewing, reconstructed viewing (MPR, MIP, DRR), subtraction viewing (DSA),

creating regions of interests and registrations, defining multimodality registrations (see Figure 34).

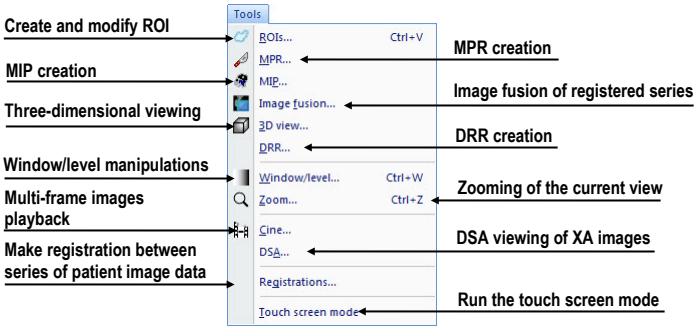


Figure 34 – Tools menu

- **Image** - viewing and manipulation of images. It contains a complex group of functions for windowing and zooming images in a view, creating shutters and reading raw DICOM data of images (see Figure 35).

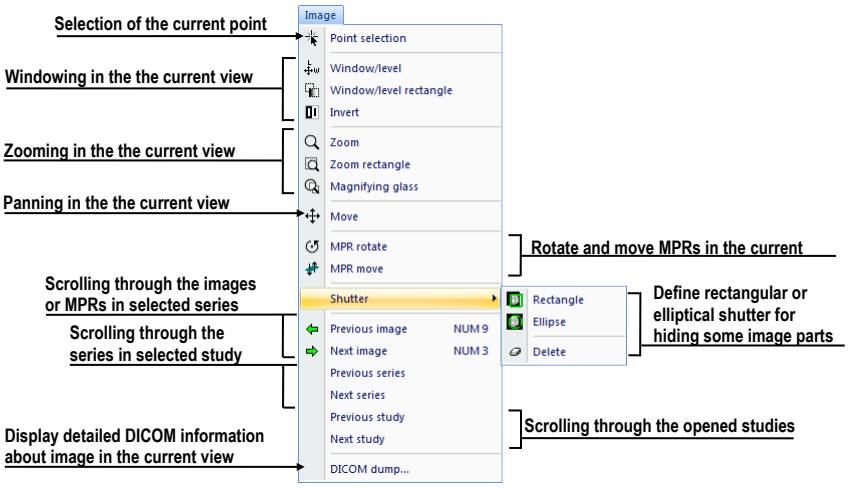


Figure 35 – Image menu

- **Filter** - filters for softening or sharpening of image in the current view (see Figure 36).

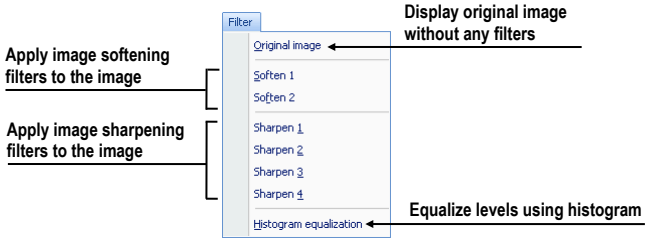


Figure 36 – Filter menu

- **Annotations** – function for managing annotations in TomoCon. It allows you to create each type of annotation or measurement in the current view and to remove or edit selected annotation (see Figure 37).

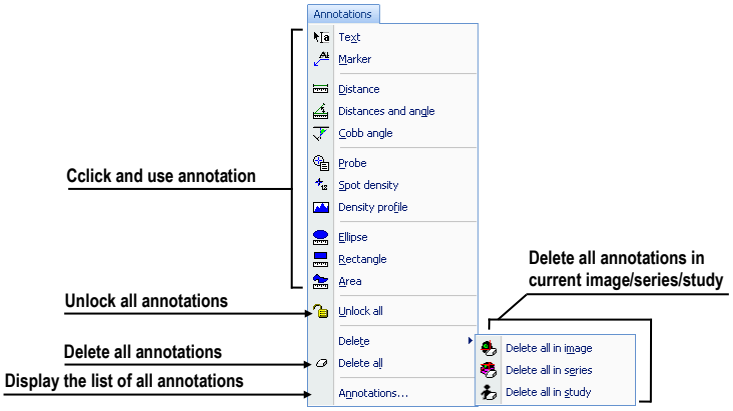


Figure 37 – Annotations menu

- **Flip/Rotate** – flipping and rotation of the image in the current view (see Figure 38).

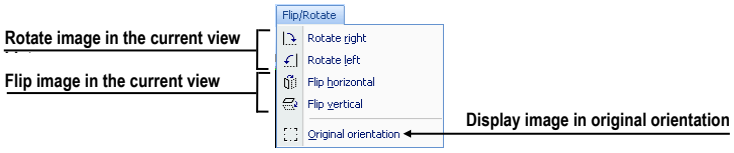


Figure 38 – Flip/ Rotate menu

- **Layout –** functions for managing layouts and hanging protocols in TomoCon, like creating a layout or hanging protocol, defining sequences or synchronizations, etc. (see Figure 39).

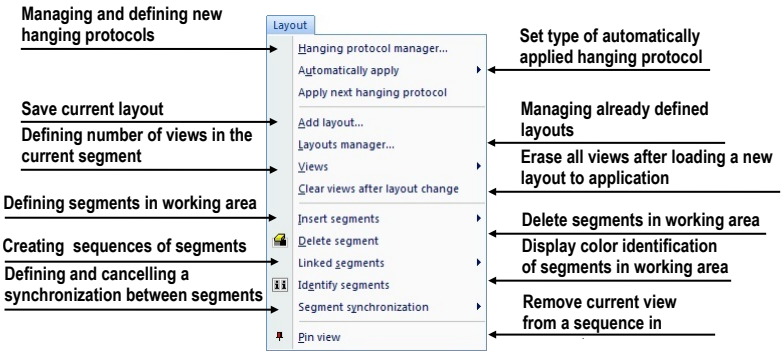


Figure 39 – Layout menu

- **View** – displaying/hiding toolbars, image descriptions, cutlines, changing the current view size, deleting views, creating new working areas or thumbnails palettes and changing alignment of images in views (see Figure 40).

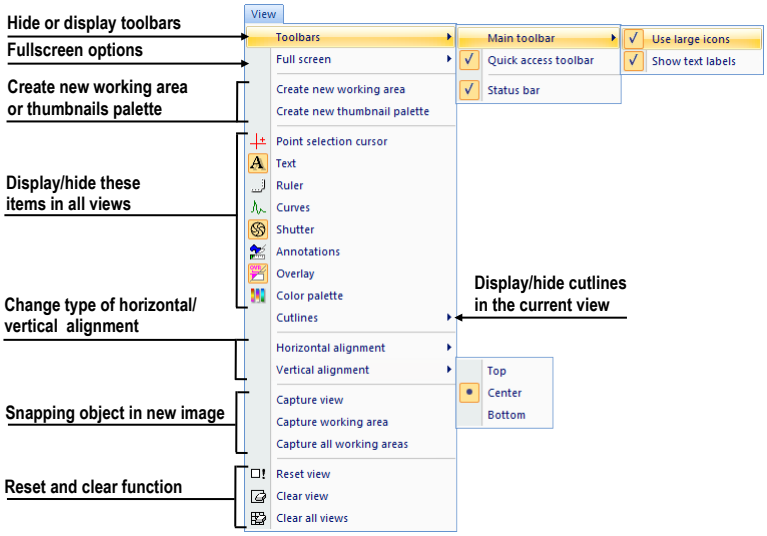


Figure 40 – View menu

- **Help** – display the application version, install licenses or browse the electronic version of the user's manual (see Figure 41).

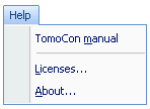


Figure 41 – Help menu

3.5 Main toolbar

TomoCon allows you to use the main toolbar (called as **Standard** toolbar) buttons for tasks you perform frequently. The main functions for viewing images in TomoCon are grouped in main toolbar (see Figure 42), which is always visible and can be positioned at any side of the application window.

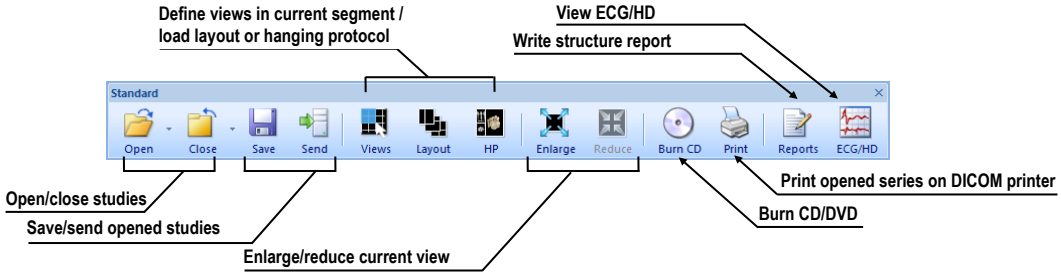


Figure 42 – Standard bar (big version)

To customize visibility of the main toolbar (button icon and text) in TomoCon use the **View/ Toolbar/ Main toolbar** submenu in application menu (see Figure 43).

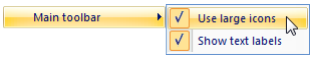


Figure 43 – Sub-menu for customize the visibility of main toolbar

3.6 Status bar

The Status bar (see Figure 44) 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. By default, it is visible, but TomoCon allows you to hide it.

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 side:

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

In the case, the TomoCon application is receiving or sending studies through queue management, the count of reaming studies for transfers will be displayed on the left side of the Status bar by icon or .

Moreover, if the TomoCon application is printing selected studies on a DICOM printer, the actual state of these printing tasks will be displayed on the left side of the Status bar by icon .

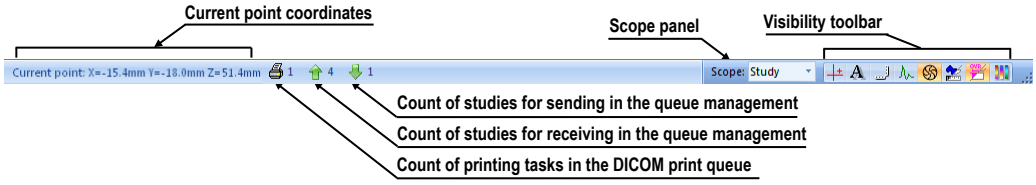


Figure 44 – Status bar

3.6.1 Scope panel

When adjusting your images, sometimes you might want to change just one image in the working area. Other time you might want to change all the images in a series or study at once. To do this, you can use the **Scope** panel (see Figure 45), which is permanently available on the right side of the **Status bar**.

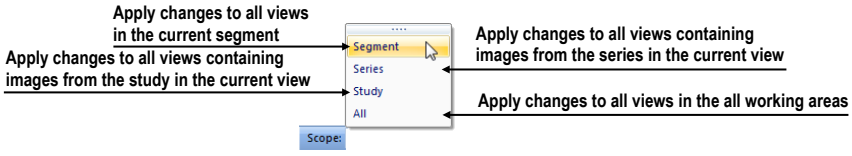


Figure 45 – Scope panel

3.7 Coordinate

To be able to display the image position in the patient coordinate space a transformation between images and the real 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.

Orientations used in TomoCon: **A**nterior, **P**osterior, **L**eft, **R**ight, **H**ead and **F**eet.

TomoCon's coordinate system:

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

The coordinates are displayed in millimeters, angles in degrees.

3.7.1 Current point

After clicking into an image, when the point selection mode is activated, the global current point of TomoCon is automatically calculated and it is displayed as a red cross in the current view. When the image in the current view has the image transformation defined, the current point will be calculated as 3D point in the current series and it will be displayed with the red cross in all views related with the current view in TomoCon (see Figure 46).

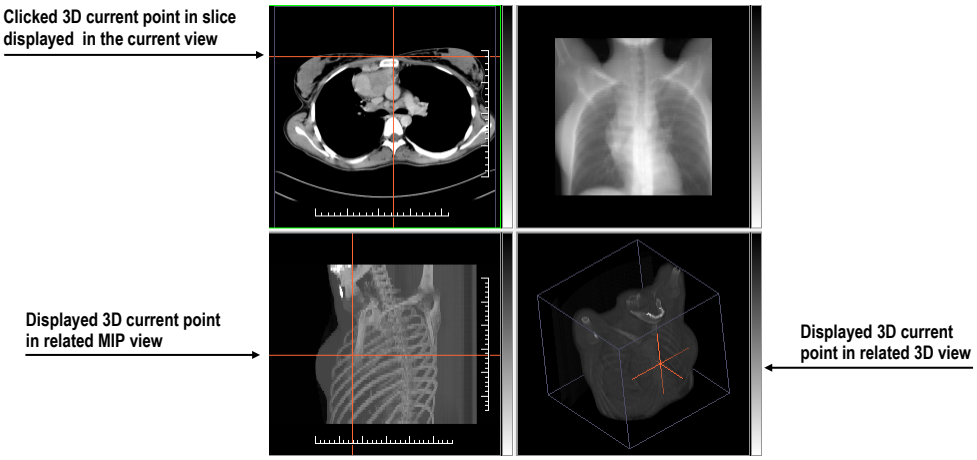


Figure 46 – Displayed 3D current point in TomoCon

3.7.2 The limits of accuracy in measurements

The image pixel size affects precision of all measurements (the bigger pixel size, the lower 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 measured distance and P_s is pixel size.

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

Where S is area, S_m is measured area and P_s is pixel size.

4 Setting up the application

The TomoCon gives you an access to many of your settings through **TomoCon options** dialog. It allows you to customize application according to your preferences and provides categories of options (TomoCon general settings, shortcuts, modality settings, display features, etc.).

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

The **TomoCon options** dialog (see Figure 47) consists of two main parts. The left side displays the category names while the right side shows the options available in the selected category. The options of the selected category having similar task or functionality are categorized under a heading on the right side.

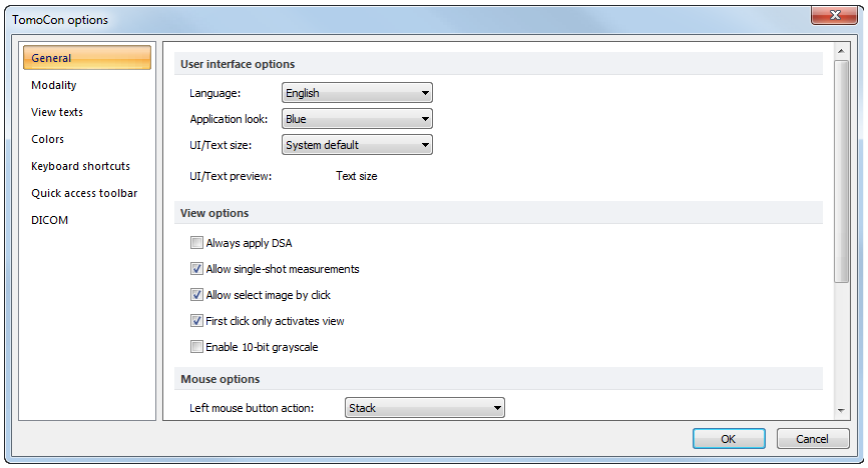


Figure 47 – TomoCon options dialog

The **TomoCon Options** dialog (see Figure 56) allows you to set up options for the following categories:

- **General** - to set up the general application options (see 4.1 General options)
- **Modality** – to define modality dependent settings (see 4.2 Modality options)
- **View Texts** – to display/hide text types in views (see 4.3 View texts)
- **Colors** – to set up color shades and shape of TomoCon's objects (see 4.4 Colors options)
- **Keyboard shortcuts** – to create shortcuts (see 4.5 Keyboard shortcuts)
- **Quick access toolbar** – to configure buttons in Quick access bar (see 4.6 Quick access toolbar)
- **DICOM** – to define DICOM settings of TomoCon (4.7 DICOM options)

4.1 General options

4.1.1 Application language

TomoCon allows you to select the application language selecting one of the options in the **User interface options** part in **General** category page in the **TomoCon options** dialog (see Figure 48). The language will be automatically changed after restarting the application.

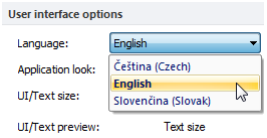


Figure 48 – User interface options part in General category

4.1.2 Application look

You can customize the look of the TomoCon application according to your requirements. TomoCon allows you to change the interface completely to match any of the broadly used Microsoft Windows applications. To change the user interface, use the **User interface options** part in **General** category page in the **TomoCon options** dialog (see Figure 49).

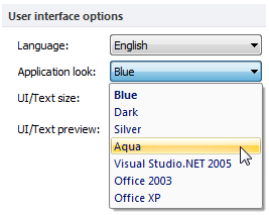


Figure 49 – User interface options part in General category

4.1.3 Scaling application fonts and dialogs

TomoCon is designed to work with monitors with all resolution presently in use. It can works with resolution from 1024x768 up to multi-monitor systems with high resolution. And especially if you use the monitors with high resolution, you may wish to adjust the size of all fonts in order to make the application more readable. Or you can only want to create more space for viewing on a small monitor. In TomoCon you can change the size of fonts used in all windows (dialog boxes, menus, etc.). To do so, change the scale degree of TomoCon's GUI in the **User interface options** part in **General** category page in the **TomoCon options** dialog (see Figure 50).

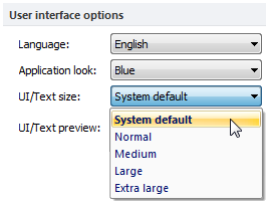


Figure 50 – User interface options part in General category

To change the scale of fonts used in TomoCon, click on the combo box (see Figure 50). The list of all possible font sizes will be displayed ordered from the minimum size. Then click on the required size. A preview of the selected size will be automatically displayed bellow the combo box (**Text preview**). To apply the new user interface scale, you have to restart TomoCon.

4.1.4 View options

The following application settings for views in displayed working areas can be set up in the **View options** part in **General** category page in the **TomoCon options** dialog (see Figure 51):

- Turn on/off DSA mode automatic activation (**Always apply DSA**) - if the image in the current view contains DICOM structure for DSA.
- **Allow single-shot measurements**, when the defining process of measurement in current view is finished, the actual view mode (with selected type of measurement) will be automatically turned off..
- Turn on/off the possibility of image selection into the current view by left mouse button click on image in the thumbnails palette (**Allow select image by click**).
- **First click only activates a view**, after clicking into an inactive view it will only become an active view. If this check box is not selected, after clicking into an inactive view it becomes an active view and selected action will be triggered in it immediately.
- Turn on/off 10-bit grayscale (**Enable 10-bit grayscale**), which allows you to see more detail in views when doing a fine diagnostic work in very dark and very light images.

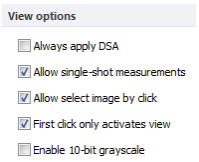


Figure 51 – View options part in General category

4.1.5 Mouse options

All TomoCon functions are designed to make the standard mouse buttons usable to the maximum extent possible. It allows you to customize the use of mouse by mapping pre-defined actions on selected mouse buttons, including the scrolling wheel. These actions will be active anytime when you press the mouse button, without a need to somehow activate it. The mapping process is very simple when using the **Mouse options** part in **General** category page in **TomoCon options** dialog (see Figure 52).

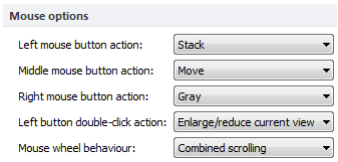


Figure 52 - Mouse options part in General category

After mapping the pre-defined action, following mouse button behavior will remain:

Left mouse button is by default used to:

- Select items (study, image in thumbnails palette, select current view, etc.).
- Perform a clicking task (on the buttons, menu items, etc).
- Perform a primary action (window/level, zoom, etc.). Primary action is actually selected action in the current view and you can activate it by pressing the left mouse button. When you release it, the primary action will be deactivated.

Right mouse button is by default used to:

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

To map a pre-defined action on the left mouse button, click on the **Left mouse button action** combo box (see Figure 53). The list of all possible actions will be displayed. Then click on the required action to confirm. To remove a mapping, click on the **--No action--** item in this list.

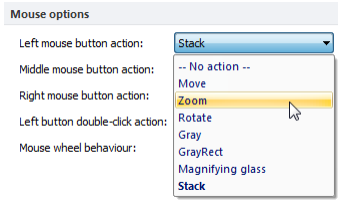


Figure 53 – Selection of the left mouse button action

To define behavior of the left mouse double clicking in the current view, select an item from the list of predefined functions (see Figure 54) in the **Left button double-**

click action combo box. To cancel mapping for left mouse double click select the –**No action**– item.

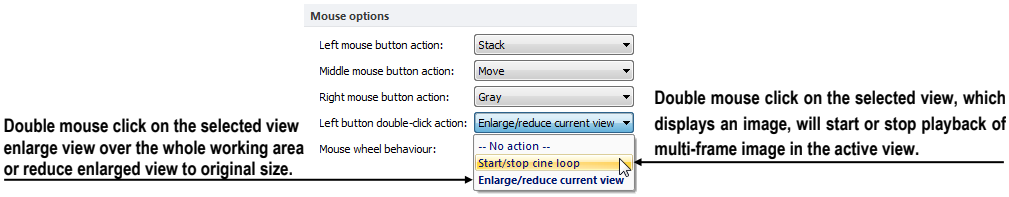


Figure 54 – Mapping action for left mouse double click

To define the scrolling behavior of the mouse, click on the **Mouse wheel behavior** combo box (see Figure 55). The list of all possible scrolling types will be displayed. Then click on the required behavior to confirm.

- **Scroll by images -** move the images within the series in the current view backwards and forwards.
- **Scroll by frames** - move the images of the multi-frame image in the current view backwards and forwards; the function is not available for single images.
- **Combine scrolling** - move the single and multi-frame images in the current view within the series backwards and forwards.

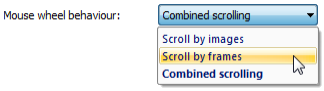


Figure 55 – Mouse wheel behaviour combo box

4.1.6 ROI options

TomoCon allows you to set-up the number of vertices of the currently defined ROI using the **ROI options** part in **General** page in **TomoCon options** dialog (see Figure 56). These settings will be applied only when drawing ROIs in TomoCon.

To simplify the contour of ROI to a maximum of "x"points after editing select check the **Always reduce the number of vertices in a contour after editing** (where "x" is the "**Max. number of vertices in contour**" value that can be entered).

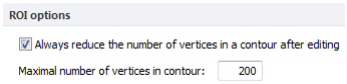


Figure 56 – ROI options part in General category

4.2 Modality options

Use the **Modality** page in the **TomoCon options** dialog (see Figure 57) to set up properties separated for each modality:

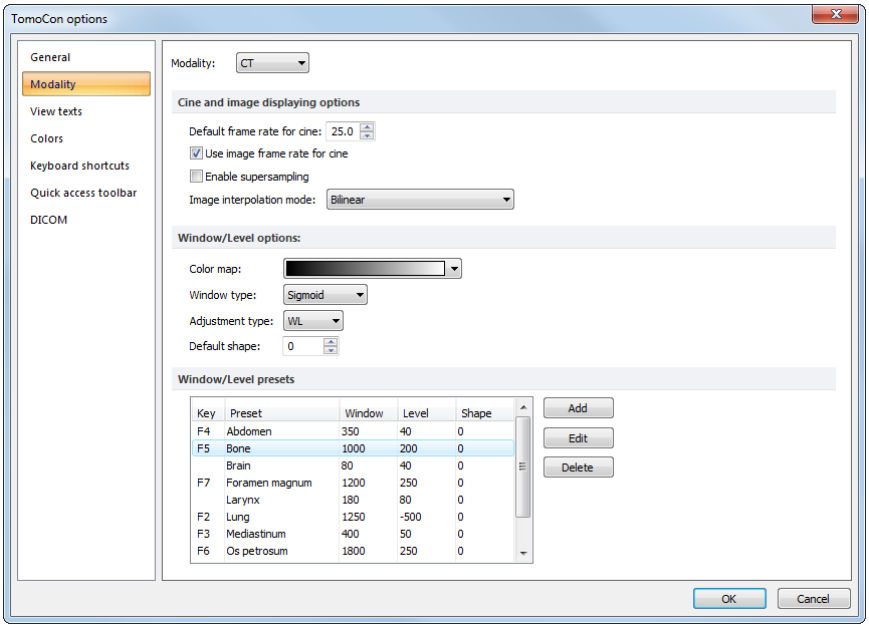


Figure 57 – Modality page in TomoCon options dialog

It is possible to set up the following properties for each modality:

- **Cine and image displaying options**:
  - define default Cine frame rate **(Default frame rate**, **Use image frame rate)**
  - **Image interpolation mode** - specify bitmap interpolation mode for image data visualization: **None**, **Bilinear**, **Bicubic**
  - turn on/off supersampling function in views (**Enable supersampling**)
- **Window/Level options**:
  - select **Color map** palette for selected modality
  - select adjust grayscale type (**Adjustment type**)
  - select palette gradation type (**Window type** and **Default shape**),
- **Window/Level presets**, which collect user-defined window, level and shape combinations for each modality, used in image grayscale settings. These combinations may be bound to keyboard function keys F2 to F9 as accelerators.

New presets can be added after pressing the **Add**. A combination chosen from the **Window/Level presets** list can be deleted after pressing the **Delete** button or edited by pressing the **Edit** button. When pressing the **Edit** button the **Window/Level preset** dialog (see Figure 58), which allows you to make the changes, will be opened.

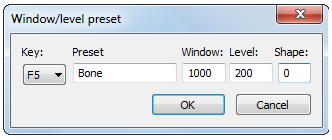


Figure 58 – Window/level preset dialog

4.3 View texts

Each user may have their own specific requests for information displayed in various views. TomoCon comes with pre-configured set of texts, which will be displayed in each type of view and are freely user-adjustable by you (see Figure 59). In addition, you can also define your own texts, which will be displayed together with the predefined texts in views.

To define displayed texts in view use the **View texts** page in the **TomoCon options** dialog (see Figure 59).

Select a view type to be adjusted. Four identical square areas represent four view corners and contain description texts to be displayed in the corresponding corner. The fifth rectangular area on the left side contains unused description texts. The descriptions can be moved with mouse per drag-and-drop between the five areas.

Press the **Apply** button to use the selected settings.

The **Default** button returns to the factory defaults.

The **Font** button allows selection of different fonts or font sizes for the description texts. New font settings will be applied immediately.

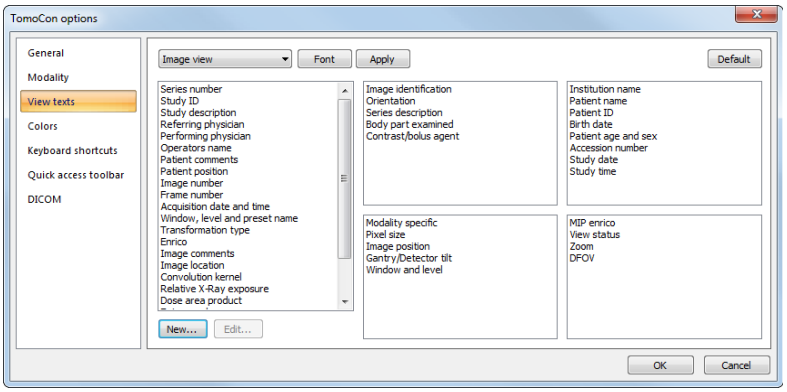


Figure 59 – TomoCon setup dialog, View texts tab

To define your own texts to be displayed in a view, press the **New…** button in this dialog. **Custom view text** dialog (see Figure 60) will be displayed, in which you can select particular DICOM element for displaying and assign some description to its. To confirm your new text, press on the **OK** button and this text will be automatically added to predefined text in the **View texts** tab.

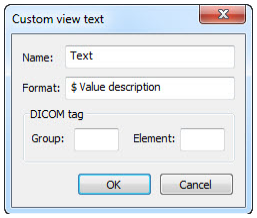


Figure 60 – Custom view text dialog

4.4 Colors options

Default colors of certain displayed objects in TomoCon can be changed in the **Colors** page in the **TomoCon options** dialog (see Figure 61).

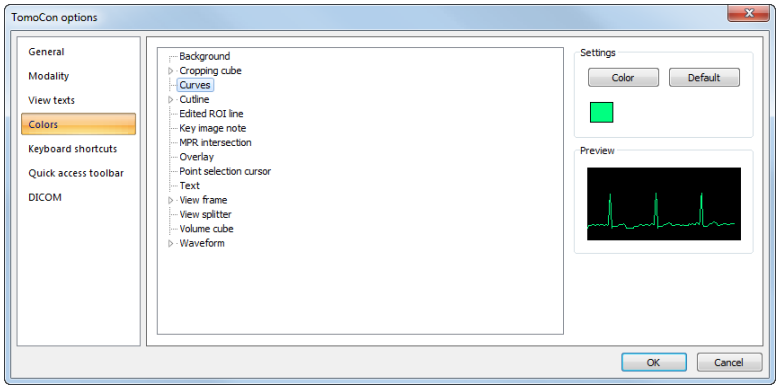


Figure 61 –Colors page in TomoCon options dialog

To change color of selected object, click on the **Color** button or the current object's color box in **Settings**. A dialog will be opened with default color palette or a palette created by the user. In **Preview** the subject with changed color or shape will be displayed.

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

4.5 Keyboard shortcuts

Keyboard shortcuts let you perform tasks by pressing a simple key combination. This method can be much faster than using a mouse. TomoCon provides you with own predefined shortcuts and accelerator keys for many tasks. Off course it also lets you define your own shortcuts for any task you would like to do. A complete listing of predefined shortcuts is described in the following table.

Shortcut description	Shortcut
Open TomoCon manual	F1
Quit the application	Alt+F4
Open patient study...	Ctrl+O
Save currently opened studies	Ctrl+S
Close currently opened studies	Ctrl+F4
Next image	Page Down, Num 3
Previous image	Page Up, Num 9
Insert new series into selected study	Ctrl+N
Copy selected image to clipboard	Ctrl+C
Select all images from series (DICOM print interface)	Ctrl+A
Deselect all images from series (DICOM print interface)	Ctrl+D
Invert selection (DICOM print interface)	Ctrl+I
Show working area for DICOM print interface	Ctrl+P

TomoCon allows you to define your own shortcuts using keyboard shortcuts management in the well-arranged **Keyboard shortcuts** page in the **TomoCon options** dialog (see Figure 62).

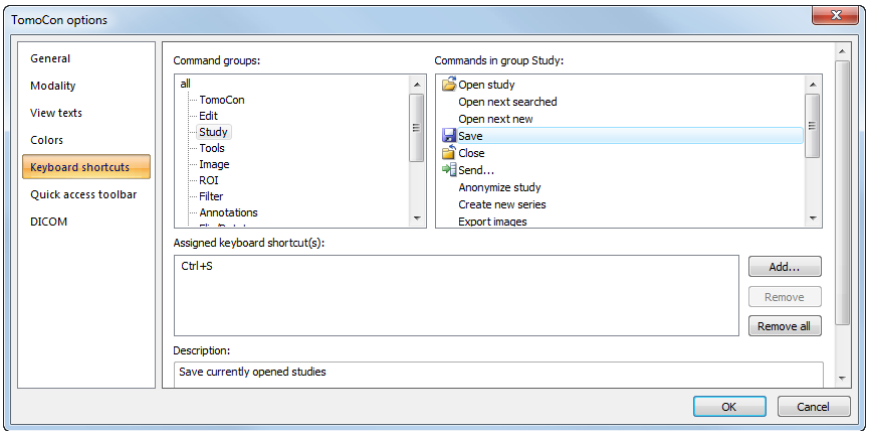


Figure 62 – Keyboard shortcuts page in TomoCon options dialog

To create your own shortcut in the **Keyboard shortcuts** page:

1. Look through the **Command groups** in the list on the left side of the dialog. To see, which commands belong to a group, click on group and look at the list on the right side.
2. When you find a command (in the list of commands on the right side) for which you would like to create a shortcut, select the command and click on the **Add**... button.

3. The **Define shortcut keys** dialog will be displayed (see Figure 63). Then press the key combination for your shortcut. The pressed keys will appear in the **Pressed key(s)** box.
4. If you wish to add the entered shortcut, click on the **Apply**.
5. If you want to add multiple shortcuts, click on the **Assign** button. The shortcut will be assigned to a command and you can define a new one into the **Pressed key(s)** box. Repeat the steps for each of your defined shortcuts. Finally click on the **Apply** button.

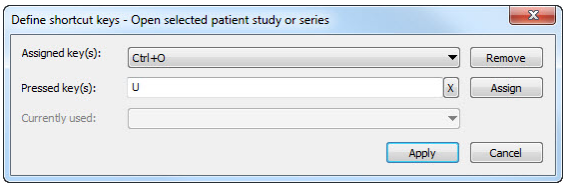


Figure 63 – Define shortcut keys dialog

To remove a keyboard shortcut in the **Shortcut keys** dialog:

1. Find the command group in the list on the left side of the dialog (see Figure 62), into which the shortcut (to be removed) belongs.
2. Select the specific command (to be removed) in the command list on the right side of the dialog.
3. Click on the **Remove** button.

The **Remove all** button removes all defined and predefined keyboard shortcuts in TomoCon.

The **Default** button restores all predefined keyboard shortcuts. The shortcuts you have previously assigned will be removed.

4.6 Quick access toolbar

The **Quick access toolbar** is a customizable toolbar, which allows you to add or remove buttons that represent commands in TomoCon.

To add a command to **Quick access toolbar** in displayed **TomoCon options** dialog:

1. Select a command in **Available commands** list. Selected item will be highlighted with blue color.
2. Click by the left mouse button on already added command in **Customize Quick access toolbar** list, which will define the position for inserting a new command.
3. Click on the **Add >>** button (see Figure 64).

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

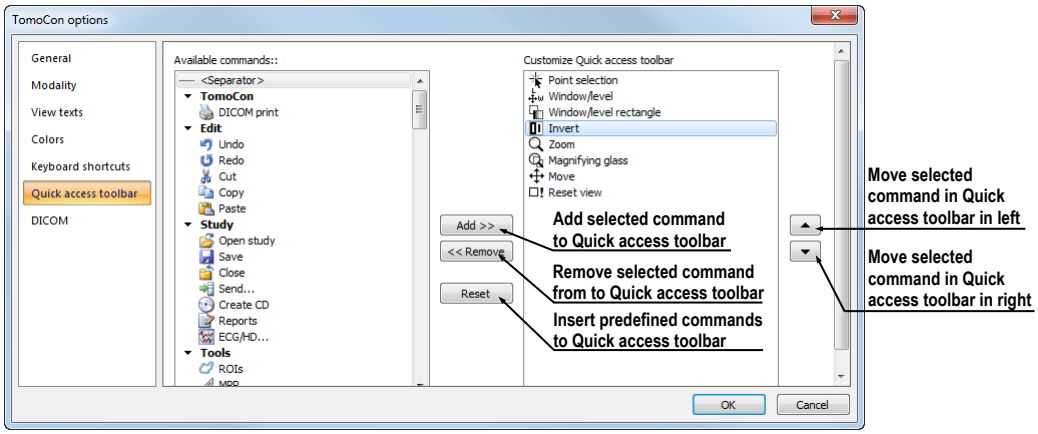


Figure 64 – Inserting Close command after Invert command in Quick access toolbar

To remove a command from Quick access toolbar in displayed **TomoCon options** dialog select command in **Customize Quick access toolbar** list and click the **<< Remove** button. Removed command will be moved to the **Available commands** list.

To change the order of commands in Quick access toolbar use the ▲, ▼ buttons. Select the requested command in **Customize Quick access toolbar** list and move it up by ▲ button or down by ▼ button.

4.7 DICOM options

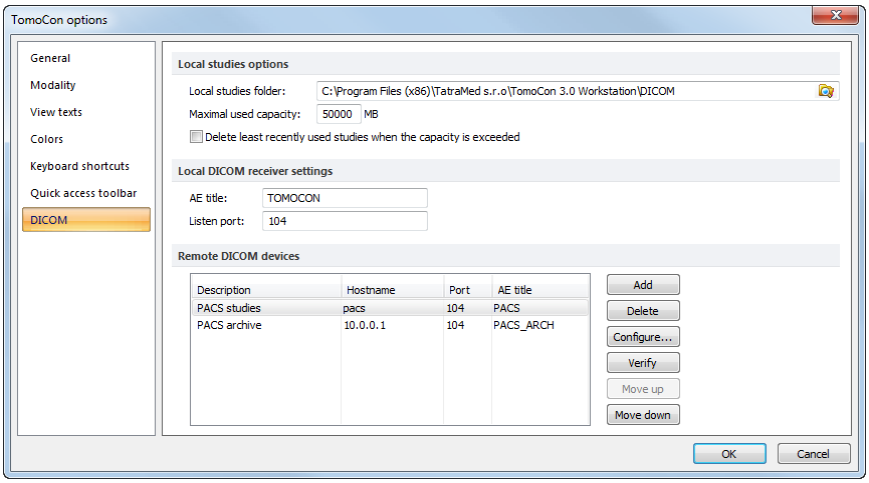


Figure 65 – DICOM page in TomoCon options dialog

Following settings of DICOM receiver and DICOM local studies of TomoCon are available through the **DICOM** page in **TomoCon Options** dialog (see Figure 65):

- **Local studies options** – local studies folder properties (see 4.7.1 Local studies properties).

- **Local DICOM receiver settings** - settings for receiving DICOM data to **TomoCon** (see 4.7.2 DICOM receiver settings).
- **Remote DICOM devices -** external devices settings for DICOM data exchange (see 4.7.3 External DICOM device configuration).

4.7.1 Local studies properties

It is possible to define a folder and its options for local studies of TomoCon in the **Local studies options** part in **DICOM** category (see Figure 66).

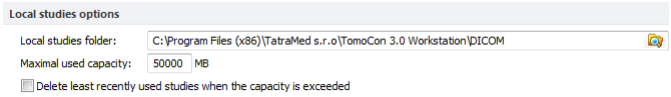


Figure 66 – Local studies options part in DICOM category

To define the local studies folder click on the icon. Then, the **Browse for folder** dialog will be opened, where you can define new local studies folder. When any study is actually opened in TomoCon, this option is disabled.

If the **Delete least recently used studies when the capacity is exceeded** option is checked, local saved data size in the local studies folder cannot exceeds entered **Maximal used capacity**. The least recently used studies in local studies folder exceeding this size will be deleted automatically.

4.7.2 DICOM receiver settings

TomoCon contains the local DICOM receiver, which saves the received patient data to Local studies automatically. It is possible to set following properties in the TomoCon options dialog (see Figure 67):

- **AE Title** – an application title of TomoCon, which will be used for DICOM connection
- **Listen port** – a port for receiving DICOM connection and DICOM data

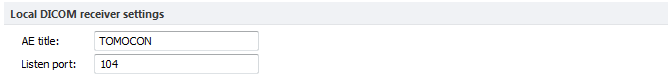


Figure 67 - Local DICOM receiver settings part in DICOM category

4.7.3 External DICOM device configuration

Any DICOM compatible device can be added as separated DICOM peer in TomoCon. Each configured device will be represented with a new tab in **Studies search** dialog (see 5.6 External data acquisition devices).

A new DICOM device definition can be added with the **Add** button and configured with the **Configure…** button in the **TomoCon options** dialog (see Figure 68).

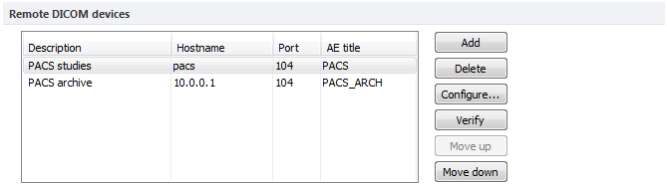


Figure 68 – Remote DICOM devices part in DICOM category

After pressing one of these buttons a device configuration dialog will be opened (see Figure 69). A new device, defined in the **Description** column, will be displayed in the **Remote devices** list and in the **Search studies** dialog. It is possible to access the DICOM studies stored in this device in the same way as the other data sources (PACS studies).

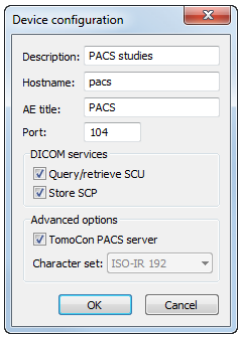


Figure 69 – Device configuration dialog

5 Retrieving and Opening study

TomoCon application provides to you with studies management on all available storages in one clearly-arranged dialog (see Figure 72). You can display this dialog clicking on the **Open** icon in main toolbar or by select **Open study…** item in the **Study** menu (see 3.4 Main menu).

TomoCon enables handling patient image data, archived on following data storages:

- **Local studies** (see 5.2 Local studies)
- DICOM format source (CD, HD, etc.) (see 5.5 DICOMDIR)
- PACS system (see 5.4 TomoCon PACS server)
- Device with DICOM protocol (see 5.6 External data acquisition devices)

TomoCon application saves all data in the local studies on the local workstation. It is also possible to export the data from this storage to other external data storage

5.1 Finding studies

When opening a study from any type of data source (except DICOMDIR), only studies meeting selected requirements will be displayed. Select requirements at the top of the **Search studies** dialog, the **Filter** part (see Figure 70):

Following criteria are available:

- **Patient name**, **Accession number**, **Patient ID,**
- Examination date: **Today**, **Yesterday**, **From – To,**
- **Date of birth**, **Sex,**
- **Modality** (**All Modalities**, Select a modality).

After pressing the **Search** button the search process will be started and a list of studies will be displayed in the **Search studies** dialog window.

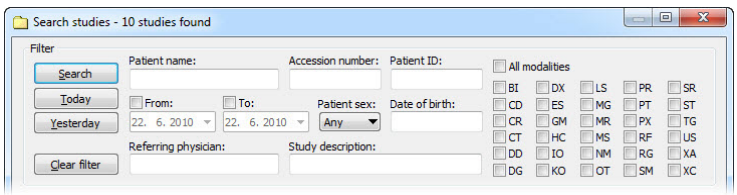


Figure 70 – Filter condition for searching studies

In addition, it is possible to search studies according to the selected study (see Figure 71). Search parameter is defined in **Search by** item in selected study's context menu (to display context menu, click with right mouse button on selected study).

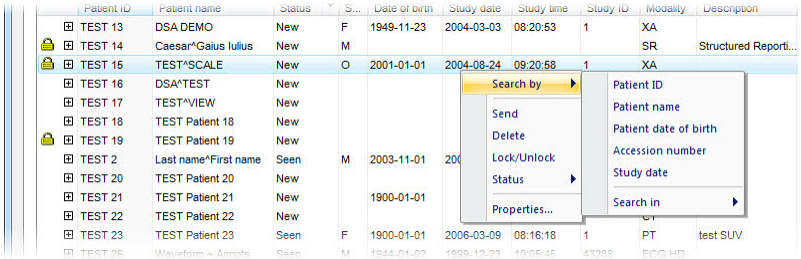


Figure 71 – Search study by selected study

These studies can be then sorted according to the selected study parameter (by clicking at the column header, where is the selected parameter displayed).

For each study it is possible to unfold a list of series by clicking on the ⊞ symbol or fold the list by clicking on the ⊟ symbol. Unfolded series list displays basic series information including number of images in the series.

Studies can be selected by marking the particular study in the list (by clicking at the study) or marking multiple studies while holding the **Ctrl** key (selection of more single studies) or the **Shift** key (selection of a group of studies between two clicked studies).

5.2 *Local studies*

DICOM data is retrieved from external data sources and stored locally in the **Local studies** area. All studies stored in this area can be searched in the **Local studies** tab (see Figure 72) and after select they can be opened.

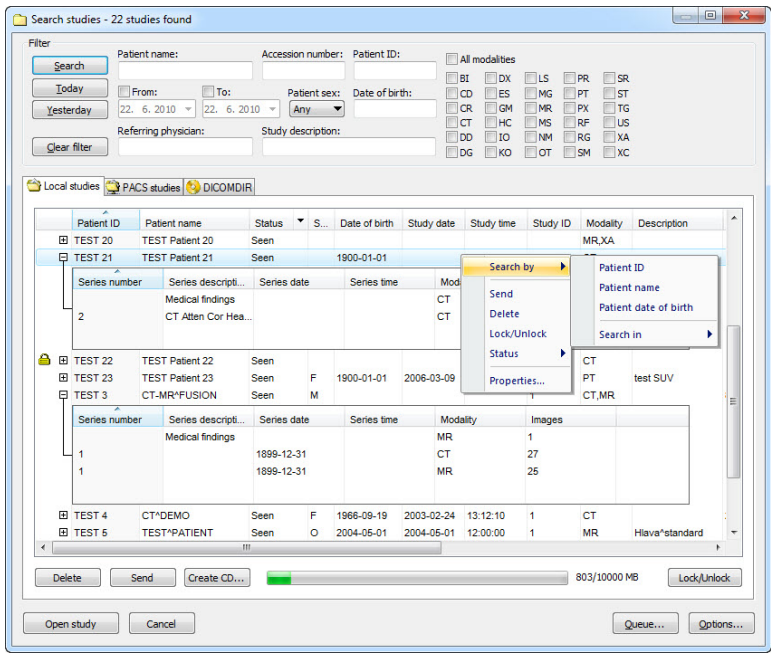


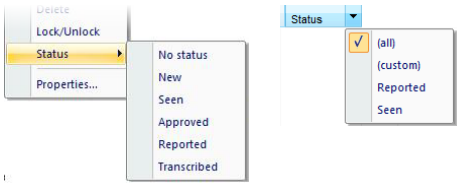
Figure 72 – Search studies dialog

After pressing the **Search** button the searching process will start and studies fulfilling the specified criteria will be displayed.

Selected studies can be opened in TomoCon (after pressing the **Open study** button).

The dialog also supports following operations with each selected study in this list:

- Lock study against automatic deletion (after pressing the **Lock/Unlock** button).
- Send study to external PACS server (after pressing the **Send** button).
- Delete study (after pressing the **Delete** button).
- Burn study on CD (after pressing the **Create CD** button the **Create CD** dialog will be opened (see 23 Archive images on CD), after pressing the **Add** button the selected study will be added to the list of studies, ready to be burned).
- Define study status by item **Status** (see Figure 73a) in context menu of selected study (to display context menu click by right mouse button on selected study). Defined status is displayed in studies list in the **Status** column and it is also possible to search studies according to it (to search studies for status, click on the icon in **Status** column header and select specific status, see Figure 73b).



(a) **(b)**

Figure 73 – Define study status (a), Search studies by status (b)

5.3 Opening multiple studies

Multiple patient studies can be opened simultaneously in TomoCon. When opening another study, a dialog will be opened (see Figure 74). Select the **No** button if you want to keep the currently opened studies. Press **Yes** to close the studies.

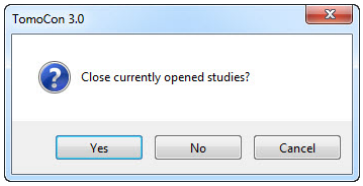


Figure 74 – "Close currently opened studies?" message box

5.4 TomoCon PACS server

TomoCon can be connected to any standard PACS server for data acquisition. The default one is **TomoCon PACS** server, pre-configured for the immediate use. Detailed information is accessible through the **PACS studies** tab, the **Search studies** dialog (see Figure 75).

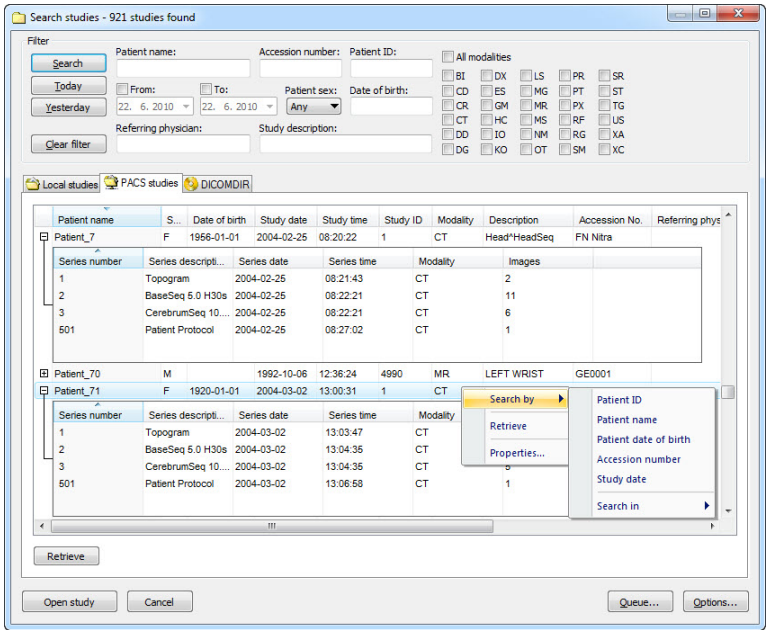


Figure 75 – Search studies on PACS server dialog

The selected study can be retrieved from PACS server into Local studies area by pressing the **Retrieve** button. After pressing the **Open study** button instead of **Retrieve**, the study will be automatically opened in TomoCon immediately after being retrieved from the PACS server.

5.5 DICOMDIR

This functionality is available only in TomoCon Workstation.

Any data stored in DICOM format, whether on CD, HD or shared network server directory, can be accessed over the **DICOMDIR** tab (see Figure 76).

After pressing the **Search** button, TomoCon will ask for the directory pointing to the DICOM data.

In the **DICOMDIR** area it is not possible to specify settings in the **Filter** box for data selection.

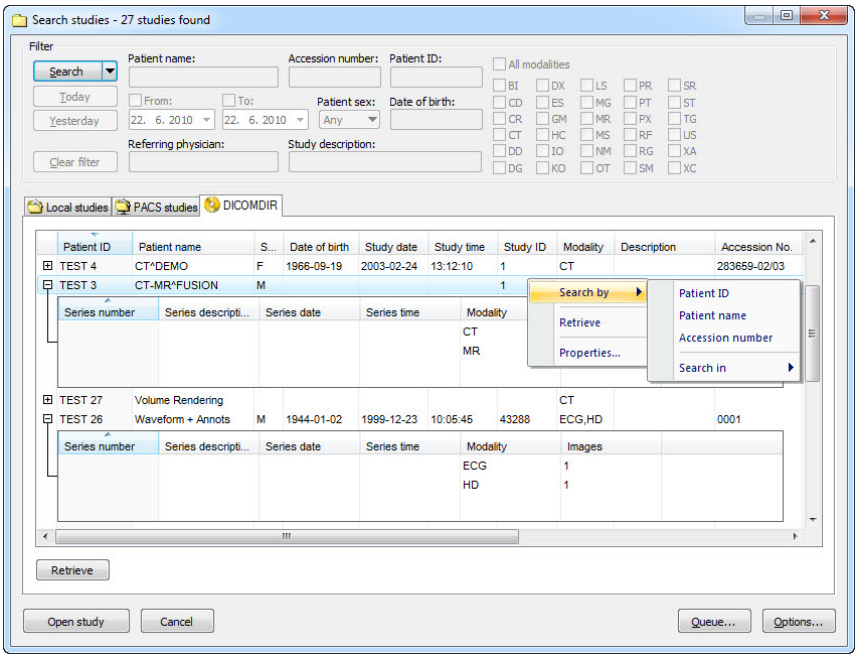


Figure 76 – Search studies in DICOMDIR dialog

5.6 External data acquisition devices

Multiple available data acquisition devices and PACS servers can be defined and accessed over network. They can be specified after pressing the **Options…** button. After the specification (see 4.7.3 External DICOM device configuration), the new DICOM device will be displayed as new DICOM data source (a new tab with the source name) in the **Search studies** dialog (see Figure 77).

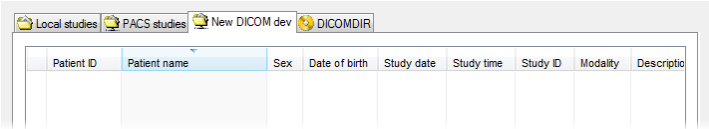


Figure 77 – New configured DICOM device in TomoCon (New DICOM dev tab)

5.7 Send study to external data device

Patient data can be sent over network to any PACS server or other DICOM data storage device. In the **Local studies** area, the **Search studies** dialog, select a study and press the **Send** button. If multiple remote devices are available and defined, the **Select remote device** dialog (see Figure 78) will pop up to specify the target device. Select the desired remote device and press the **OK** button. The study will be sent. To define DICOM data source see the **TomoCon Options** dialog (see 4.7.3 External DICOM device configuration).

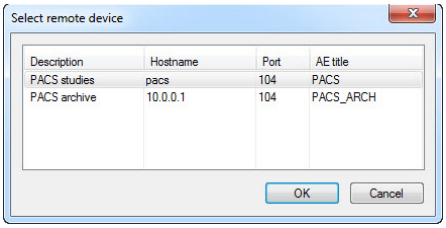


Figure 78 – Select remote device dialog

5.8 Monitoring and controlling the send/receive jobs

There is a possibility in TomoCon to monitor and control the job of sending or receiving studies between the local studies storage and external data storages including the PACS system by using the dialog **Queue management** (see Figure 79). This dialog will be displayed after click on the **Queue** button in the **Search studies** dialog. In this dialog you can monitor jobs of the receiving studies (**Receive queue** tab), jobs of the sending queue (**Send queue** tab) and history about all transmission (**History** tab). Each selected job in the **Receive queue** or in the **Send queue** can be by restarted (**Restart**), suspended (**Stop**), and consequently continued (**Continue**) or deleted (**Remove**) by clicking on the functional buttons in this dialog. Eventually, details about selected job can be displayed by clicking on the **Details** button.

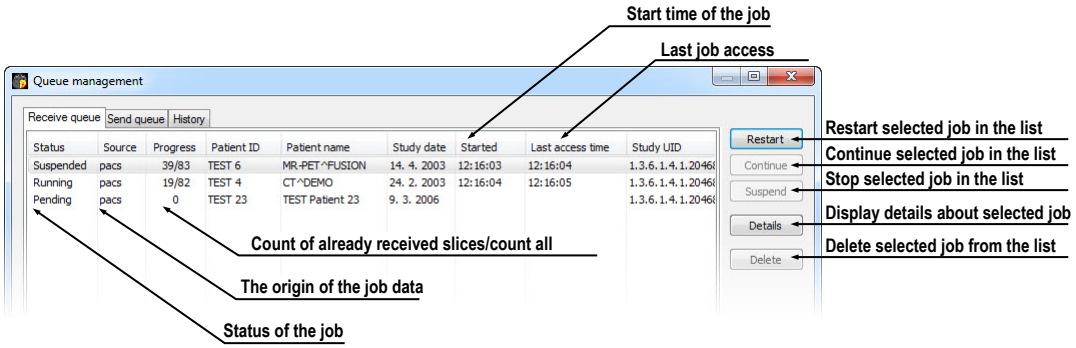


Figure 79 – Queue management, Receive queue tab

Job of receiving/sending selected studies to/from **Local studies** storage can be moved to the **Queue management** by clicking on **Move to Queue** check box during receive/send job (see Figure 80). Consequently, receive/send job will be moved to Receive/Send queue.

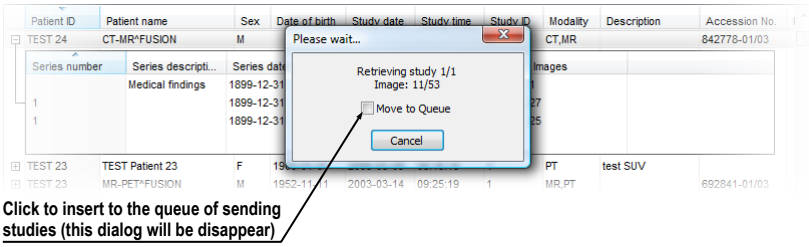


Figure 80 – Search studies dialog, sending of selected study from Local studies

5.9 Save a patient study

To preserve changes made on the opened study of patient (defined ROIs, registrations, description texts) save the patient data prior to closing the patient or exiting the application. (Note: it is not possible to save patient data in TomoCon Lite version).

Study changes can be saved by clicking on the **Save** button in the **Study** menu.

Wait a moment while saving the data. Depending on amount of data to be saved it can take few seconds to half a minute. The **Please wait…** dialog (see Figure 81) will inform you about the ongoing progress.

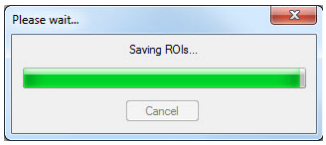


Figure 81 – Saving modified study data in progress…

5.10 Close a patient study

Open DICOM studies can be closed by clicking on the **Close studies** icon in the **Standard** toolbar or on the **Close** submenu in the **Study** menu. When closing the study a dialog will be opened (see Figure 82) allowing you to save unsaved changes (ROIs, registrations, annotations).

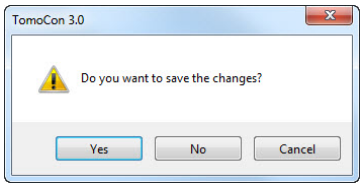


Figure 82 – "Do you want to save changes?" dialog

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 6.2 Image sequence) or series synchronization possibilities (see 6.3 Series synchronization).

6.1 Display image in view

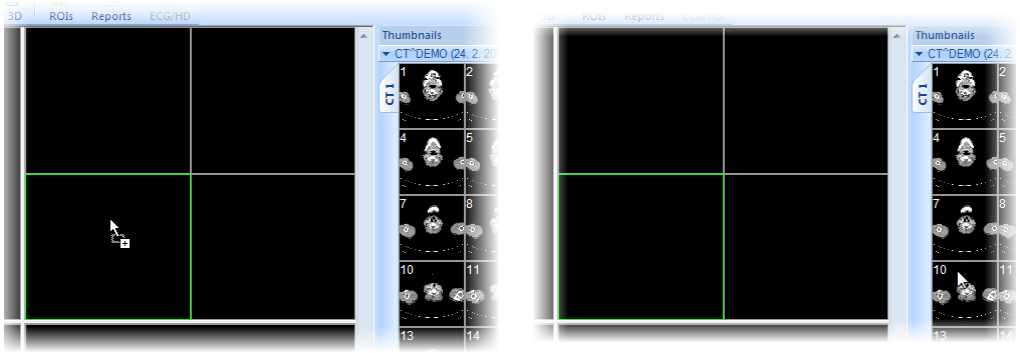
There are various ways to display an image in a view. You can use the selection of images in the thumbnails palette or move them by drag and drop method within TomoCon.

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

1. Move mouse cursor over the requested view and click by left mouse button (this view will be changed to current view).
2. Move mouse cursor over the requested image in thumbnails palette and click by left mouse button (see Figure 83b). The image will be displayed in the current view.

or by drag and drop method:

1. Move mouse cursor over the requested image in thumbnails palette and press and hold left mouse button.
2. Move mouse cursor over the requested view and release mouse button. Image will be displayed in this view and the view will be changed to current (see Figure 83a).



(a) **(b)**

Figure 83 – Display image in view by drag&drop (a) Select image to display in current view (b)

There is also a simplified version of selecting a series into the current view. You can quickly select the exact series you want to view using the context menu.

1. Move the mouse cursor over the requested view and click with the left mouse button (this view will be changed to current view).
2. Click with the right mouse button to display its context menu (see Figure 84).
3. Select requested series in the top sub-menu **Select series…**. The first image of the selected series will be displayed in this view immediately.

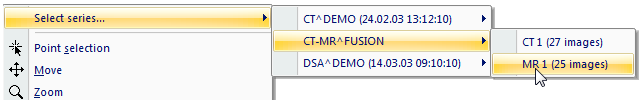


Figure 84 – Series selection by context menu

When you select image in the current, non-pinned view, application will automatically create a sequence (see Figure 85), which will contain all non-pinned views from current segment and from all others segments, linked with it (see 6.2 Image sequence).

Identification of image order in series, which is displayed in the current view, is indicated by scrollbar on the right side of the working area. Its position represents approximate image position in the series.

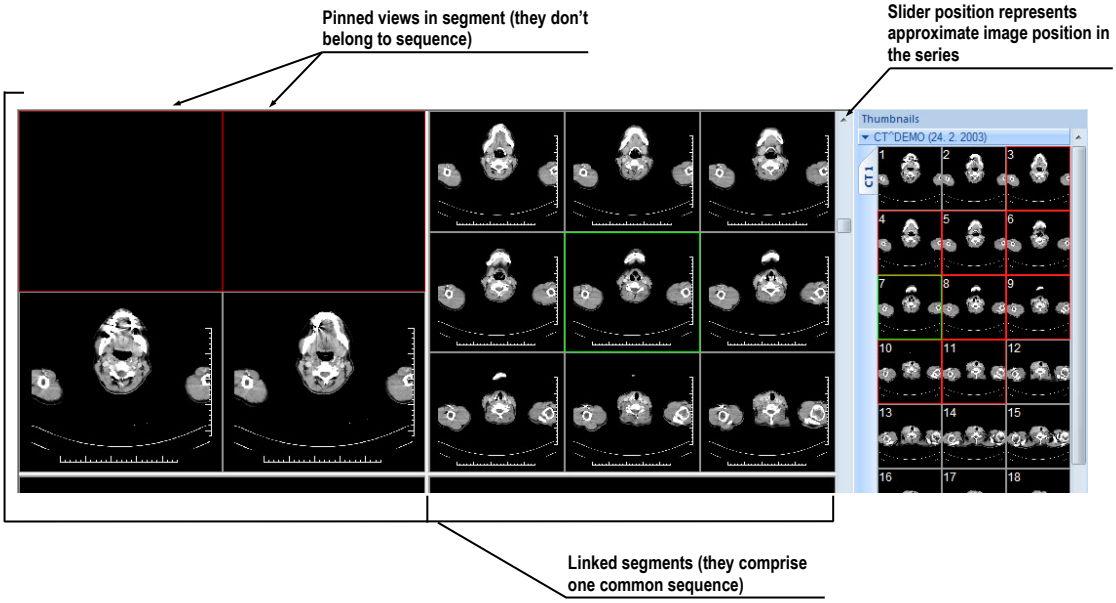


Figure 85 – Working area with non-multiframe image in current view

When a multi-frame image is displayed in the current view, the scrollbar is divided into two parts separated with a square box (see Figure 86).

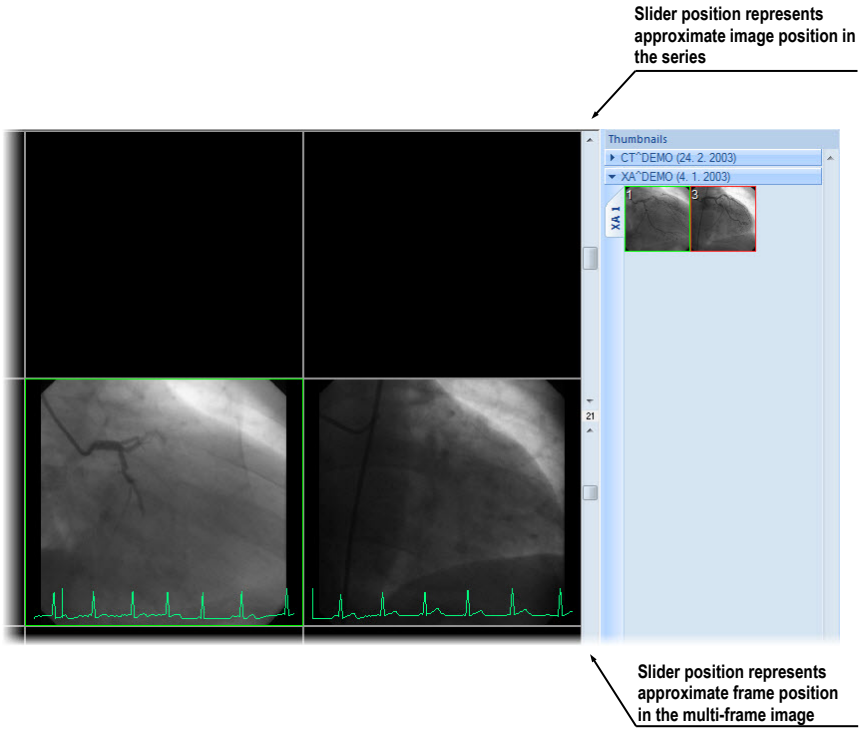


Figure 86 – Working area with multiframe image in current view

Use the scrollbar in the upper part to move between the images of the chosen series in the current view. The scrollbar in the bottom part is used to move between the frames of the multi-frame image in the current view. In the box between the scrollbar the current frame number of the multi-frame image is displayed.

6.2 Image sequence

When new image in the current view is selected, TomoCon creates a sequence of images in the current segment automatically. This sequence will contain all views from this segment (linked by rows), with the exception of pinned views. Pinned view can be used to display arbitrary image without changing the sequence, eventually to display MPR, 3D, etc. This view is outlined with a colored frame (default color is red, but you can change the frame color, see 4.4 Colors options).

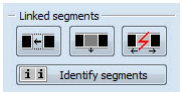


Figure 87 – Linked segments part of Define layout tool

To manually pin/unpin current view, click on the 📌 item in the context menu. It will be displayed after clicking by right mouse button. Status of this icon is displaying the pin status of current view (see Figure 85).

If you want to create sequence, which will contain more than one segment, TomoCon allows you to link selected segments (see Figure 88).

Follow these steps:

1. Click with left mouse button on the first segment in sequence.
2. Click on the button in the second tab (icon) of the tools panel (see Figure 87).
3. Move cursor over the working area. The first segment in sequence will be marked with number 1.
4. Move mouse 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 with left mouse button. If you want to add additional segments into the sequence, keep the **Ctrl** key pressed while clicking with the mouse.
5. To add next segment, repeat step 4 with the **Ctrl** key pressed. If you want to finish linking of segments, press **Esc** key.

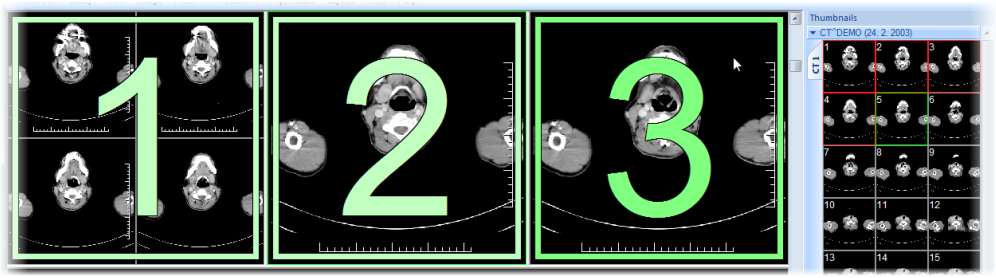


Figure 88 – Linking of segments to sequence

To remove linked segment from sequence (see Figure 89):

1. Click on the button in the second tab (icon) of the tools panel (see Figure 87).

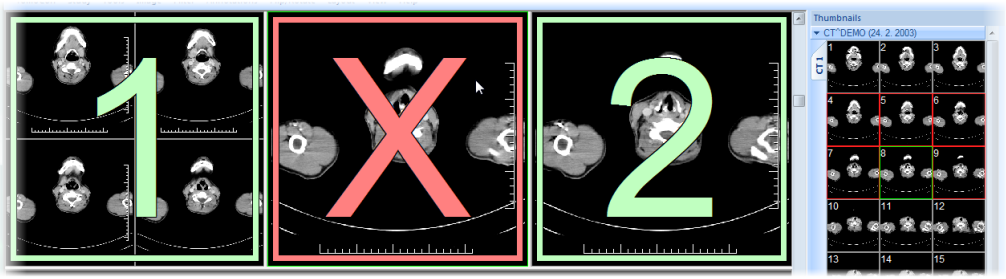


Figure 89 – Removing segment from sequence

2. Move mouse cursor over the segment, which you want to remove (segment will be marked with cross) and click with left mouse button.
3. If you want to remove multiple segments from a sequence, keep the **Ctrl** key pressed while clicking with the mouse.

To split already existing sequence (see Figure 90):

1. Click on the button in the second tab (icon) of the tools panel (see Figure 87).
2. Move mouse cursor over the first segment of next sequence (segment will be marked with number 1 and next linked segments with next numbers in new sequence) and click with left mouse button.

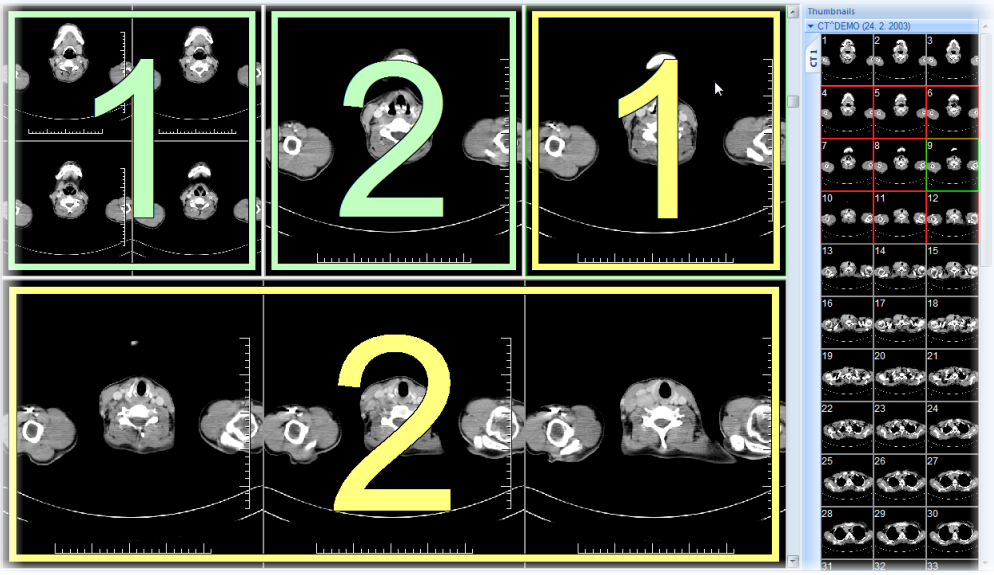


Figure 90 – Dividing existed sequence

6.3 Series synchronization

Multiple series can be "locked" together to scroll synchronously in segments. This mode can be selected by clicking on the **Segments synchronization** part in the third tab (tab with icon) in the tools panel (see Figure 91).

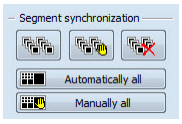


Figure 91 – Segments synchronization part of Define layout tool

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

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

In manual mode the displayed images in segments are considered as "currently being displayed at correct positions". While scrolling one segment, images in other segments are scrolled by approximately same offsets.

To define automatic/manual synchronization of selected segments (see Figure 92):

1. Select layout of working area with at least two segments, which have the same layout of views.
2. Display desired series in these segments (in manual synchronization mode, set position of series in segments).
3. Select segment, which will be used as the primary (set current view in it).
4. Click on the button for automatic synchronization or the button for manual synchronization and move mouse cursor over the working area.
5. Click on another segment in working area with same layout like the primary segment, which should be synchronized with it (primary segment will be marked like **Pri.**). If you want to add additional segments into the synchronization, keep the **Ctrl** key pressed while clicking with the mouse.
6. To add other segments to this synchronization, repeat step 5 with the **Ctrl** key pressed.

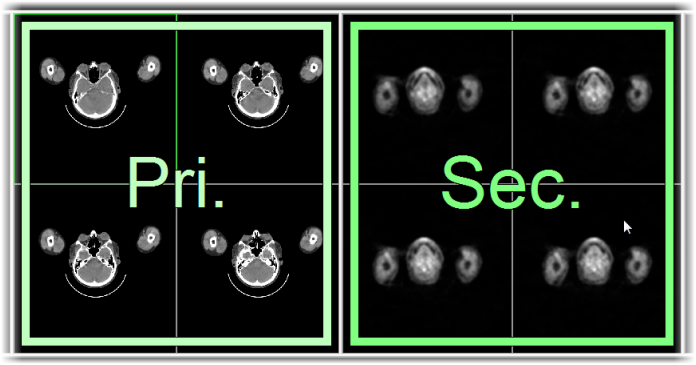


Figure 92 – Definition of synchronization for selected segments

To cancel synchronization of selected segments:

1. Click on the button and move mouse cursor over the working area.
2. To remove whole synchronization move mouse cursor over the primary segment (segment will be marked with red frame and **Pri.** title) and click with left mouse button.
3. To remove only one segment from synchronization move mouse cursor over it (segment will be marked with red frame and with **Sec.** title) and click with left mouse button.

To synchronize/cancel synchronization of all segments in all working areas, simply click on the **Automatically all**/ **Manually all** button in the **Define layout** tool (see Figure 91) at any time.

When you insert segment to series synchronization, views in this segment will be marked with colored icons. These icons identify synchronization status of segments (see Figure 93). To define the location of these icons in the view see 4.3 View texts, text type **View status**.

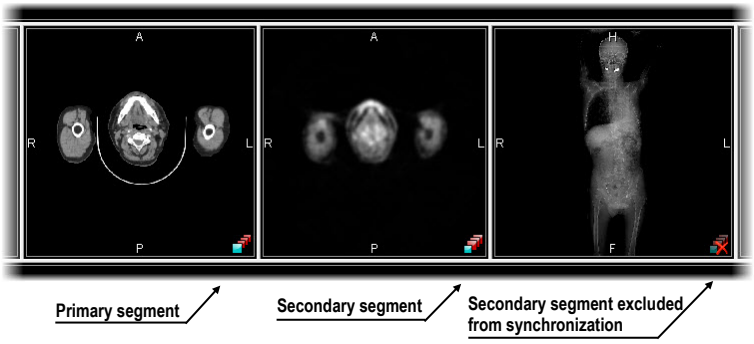


Figure 93 – Segment status in synchronization

6.4 Play multi-frame images

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

TomoCon allows you to quickly create and manipulate cine loops in any view of your working area by using the **Cine** tool in the tools panel. **Cine** tool (see Figure 94) is docked in tools panel and you can get to it at any time by clicking the tab with icon.

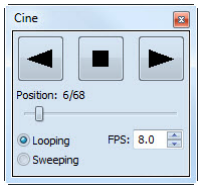


Figure 94 – Cine tool

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)

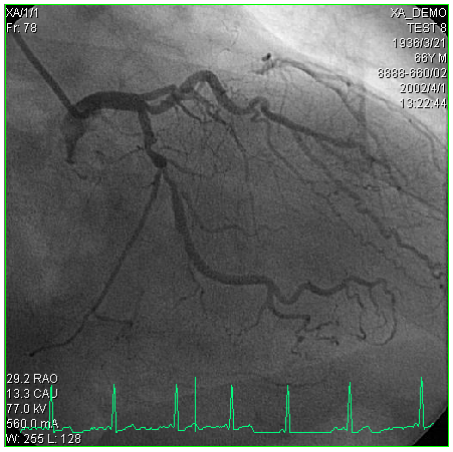


Figure 95 – Cine view playing multi-frame image with ECG curve

If a multi-frame image contains curves (like ECG), these can be drawn into the image selecting the **Curves** option in the **View** menu (see Figure 95). While playing, the current position in the sequence of frames will be 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 playback of multi-frame image in the current view by simple double click with the left mouse button.

7 Manipulating images

7.1 Window and level manipulations

Window and level manipulations is one of the most common tasks in digital medical imaging. They allow you to see patient image data with correct contrast and image details in some particular grayscale range.

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

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

Changes of window and level in the current view are automatically and immediately applied to all images according to the selected limit in the **Scope** tool. You can limit changes to a single segment, a series or a study.

The window/level changes from the current view can be also applied to the image (which will be also displayed in the thumbnail preview). Press **Apply** in the current view's context menu to apply this changes to the image. Press **Apply to all** to apply this changes to all images and views of the current series.

7.1.1 Window/level tool

Window/level tool (see Figure 96) is initially docked in the tools panel and you can get to it at any time by clicking on the tab with icon.

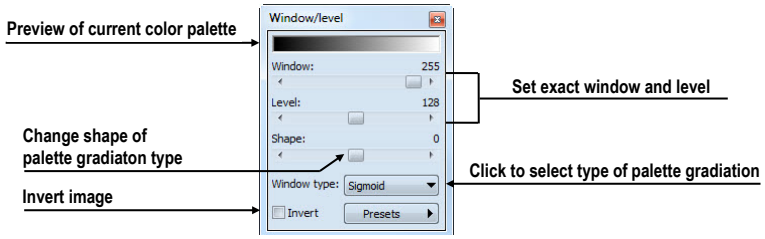


Figure 96 – Window/level tool

To adjust the window/level using this tool, select a view in the working area, where you want to change the grayscale values. Then drag and move sliders to the desired position. Window/level values will be changed in the current view immediately and actual values will be automatically displayed at the right side above each slider.

Changes made with **Window** and **Level** sliders define the current contrast level of the displayed data. These changes remain valid in the view until a new image from the

thumbnails palette is copied into the view. Window and level values in the **Window/level** tool will be then set up according to the values in the newly chosen image.

The palette gradation **Shape** slider modifies the gradation curve of the selected palette. It can be used only for a non-linear type of color map palette gradation (exponential, sigmoid). To change the type of gradation, click on the **Window type** combo box.

7.1.2 Presets

You can create and use your own "predefined window, level and shape settings". You can define these for a specific modality or you can use pre-defined presets in TomoCon.

To use a preset on image, select a view in the working area, on which you want to apply it. Then display drop-down list of all applicable presets by clicking on the **Presets** button in the tools panel, **Window/level** tool, or by clicking on the **Window/level preset** item in the current view's context menu. Select the preset you want.

If you have mapped any of keyboard shortcut keys F2 to F9 onto your preset, simply activate the view and press the keyboard shortcut.

To create your own preset:

1. Adjust the window/level/shape values in the current view.
2. Click on the **New preset…** item in the drop-down list of all applicable presets in the **Window/level** tool. You can display the list by pressing the **Presets** button.
3. The **Window/level preset** dialog with grayscale values from current view will be opened (see Figure 97).
4. Optionally select any of keyboard shortcuts F2 to F9 from the **Key** combo box to be bound to the selected preset.
5. Fill the preset name in **Preset name** edit box. Then press the **OK** button.

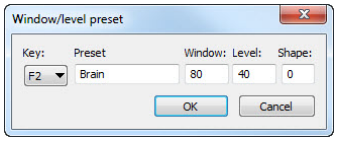


Figure 97 – Window/level dialog – defining new Window/level/Shape preset

To remove a defined preset, click on the **Delete preset…** item in the drop-down list of presets in the **Window/level** tool. You can display the list by pressing the **Presets**

button. Then click on the preset you want to remove in the displayed list of removable presets.

Use the same process to set up, edit or remove preset for each modality in **Modality** page, the **TomoCon options** dialog (see 4.2 Modality options).

7.1.3 Adjusting Window/Level with the mouse

To modify window and level simultaneously without the **Window/Level** tool, click on the **Window/Level** icon in the **Image** menu or on the **Window/Level** item in context menu of the view (mouse cursor will change to form). Then click at the view and move the mouse (with the left mouse button pressed) horizontally (window) and vertically (level). Level and window are changed immediately.

For optimal level and window setting for the patient images you can also use the **Window/Level Rectangle** function in the **Image** menu or in the context menu. Click on the **Window/Level Rectangle** icon. The mouse cursor will change to form. Click into the image and hold the mouse button. Move the cursor (shaped) across the area. A rectangle will be drawn around the area. You can cancel the dragged rectangle by pressing the **Esc** button on the keyboard. After releasing the mouse button, window and level will be set for optimal contrast in the area within the rectangle.

7.2 Zooming image views

Zooming the image allows you to change the zoom factor in the current view for displaying selected details, e.g. while contouring small structures or clicking reference points. To change this factor, you can use zooming functions in the context menu, the magnifying glass tool, the **Zoom** tool in the tools panel or the mouse wheel with pressed **Ctrl** key.

Changes of zoom in the current view are automatically and instantly applied to all images according to the selected limit in the **Scope** tool. You can limit changes to a single segment, a series or a study.

The zoom and move changes from the current view can be also applied to the image (which will be also displayed in the thumbnail preview). Press **Apply** in the current view's context menu to apply this changes to the image. Press **Apply to all** to apply this changes to all images and views of the current series.

7.2.1 Zoom tool

Zoom tool (see Figure 98) is initially docked in the tools panel and you can get to it at any time by clicking on the tab with icon.

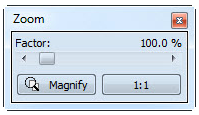


Figure 98 – Zoom tool

The **Zoom factor** can be changed by moving the slider in this dialog and it can be varied between 50% and 1600%. New zoom value will be changed in the current view immediately and actual values will be automatically displayed at the right side above the slider. The same effect has scrolling the mouse wheel while the **Ctrl** button is pressed on the keyboard. The image is zoomed from the middle of the view equally to all directions.

To set a pixel-for-pixel in the current view, click on the **1:1** button. The image in the current view will be centered and displayed with this ratio (one pixel of original image data will be identical to one displayed pixel). To cancel the pixel-for-pixel spacing, click on the on the **1:1** button again.

7.2.2 Zooming with the mouse

To modify the zoom factor using the mouse (without the **Zoom** tool), click on the **Zoom** icon in the **Image** menu (mouse cursor will change to form). Click in the view and move the mouse (with the left mouse button pressed) in the image vertically. The image will be zoomed immediately and the clicked point will stay at the same position. This is useful when zooming a particular detail.

Use the **Zoom rectangle** function in the **Context** toolbar or in the **Image** menu to zoom an exact image area to the whole view size. Click on the icon (mouse cursor will change to form), then click into the image and hold the mouse button. Move the cursor with mouse across the area, a rectangle will be drawn around the area. You can cancel the dragged rectangle by pressing the Esc button on the keyboard. After releasing the mouse button, the area within the rectangle will be zoomed to fill the view.

7.2.3 Panning with the mouse

You might need to move the zoomed part of the image to the side with the **Move** function in the **Image** menu or by pressing the **Move** icon in the **Context** bar to see desired detail (mouse cursor will change to form).

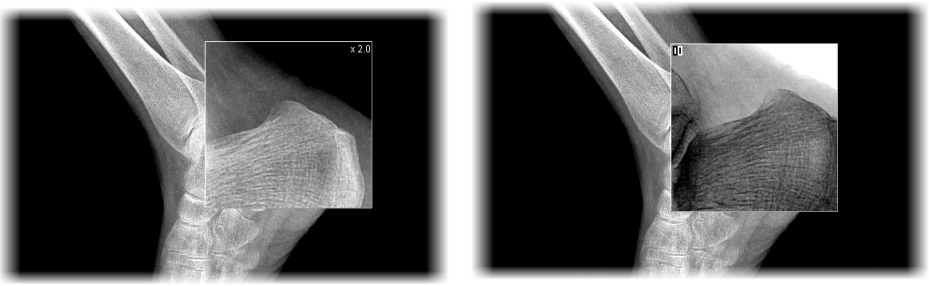
To move the image in the current view press and hold left mouse button over the desired place. Mouse cursor will change to form. Move the mouse to desired position and release the mouse button.

7.2.4 Magnifying glass

Magnifying allows you to magnify an area of interest within a small, separate magnification window that moves together with the cursor.

To activate the magnifying glass:

1. Click on the **Magnify** button in the **Zoom** tool or on the **Magnifying glass** item in context menu of current view (mouse cursor will change to form).
2. Press and hold the left mouse button over the area of the image you want to magnify.
3. The magnifying window appears and follows the mouse cursor (see Figure 99b).
4. To change the zoom factor of magnifying glass press the **Ctrl** key on keyboard and scroll the mouse wheel. The current zoom factor of magnifying glass is displayed in the right top corner of the magnification window.
5. To invert zoomed image in displayed magnification window press and release the **Tab** key on keyboard (see Figure 99b). To turn off the invert mode press and release the **Tab** key again.
6. To close the magnifying glass window release the mouse button.



(a) **(b)**

Figure 99 – Active Magnifying glass window, normal (a), invert (b)

7.3 Image filters

TomoCon includes a lot of image processing filters for noise removal and small structures enhancement. They can be applied onto any image in the working area using the **Filter** tool (see Figure 100) in the tools panel.

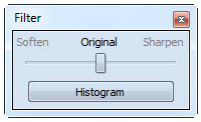


Figure 100 – Filter tool

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

To apply histogram equalization, click on the **Histogram** button in **Filter** tool.

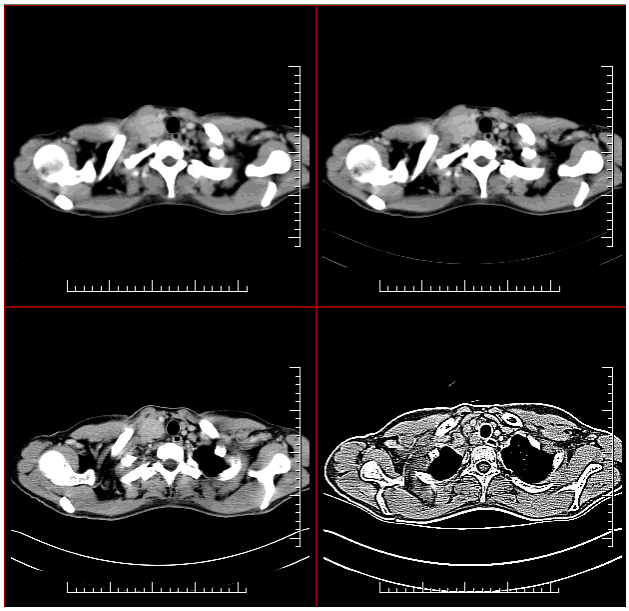


Figure 101 – The effects of the various filters available in TomoCon

7.4 DSA - Digital Subtraction Angiography

The DSA mode supports displaying multi-frame images with image sequence taken with the contrast media and without it. The final DSA image is then displayed as a difference between the base image (with the contrast media) and mask image (without the contrast media).

To separate the base and mask images, use the following modes:

- Automatic - the images contain DICOM information from the patient examination and the separation is realized automatically after opening the patient in TomoCon (see 7.4.1 Automatic DSA mode).
- Manual - the image separation has to be made manually (see 7.4.2 Manual DSA mode).

7.4.1 Automatic DSA mode

Open a patient study with a multi-frame image containing DICOM information about DSA examination. After displaying this image, depending on the **Always apply DSA** setting in **General** page in the **TomoCon options** dialog (see 4.1 General options), DSA mode is turned on automatically in all views for all image types. After selecting the image into the current view all modification available in the application can be used to work with the image (see Figure 102).

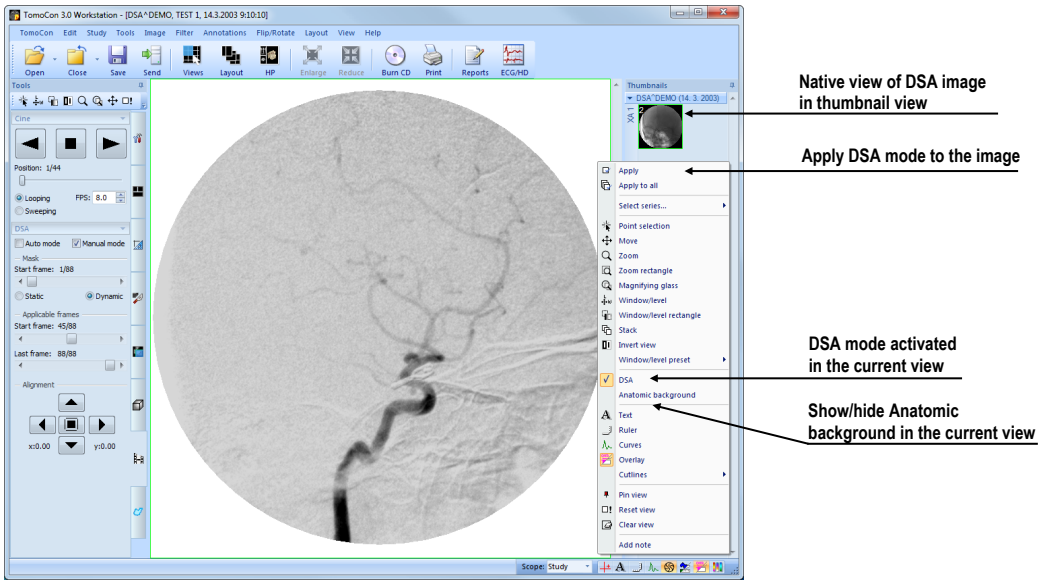


Figure 102 – Automatic DSA mode

DSA mode in the current view can be turned off using the view's context menu. Click on the **DSA** item. The changes made in the current view can be applied to the image's thumbnail preview by pressing **Apply** in the current view's context menu. Apply the changes to all images in the current series by clicking on the **Apply to all** items in the current view's context menu.

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 and you can get to it at any time by clicking on the tab with icon or by clicking on the **DSA…** item in the **Tools** menu in TomoCon. Follow these steps:

1. Open a patient study containing a multi-frame image without DICOM information about DSA examination and select the multi-frame image in the current view.

2. Click on the **Manual mode** in the **DSA** tool (see Figure 103). The manual DSA mode will be active in the current view according to the following parameters of the **DSA** tool:
   - **Mask frame** - starting image number in the mask (image sequence without the contrast media):
     - **Static mask** - mask frame is static for all chosen frames
     - **Dynamic mask** - mask frame is changed dynamically according to the chosen current frame
   - **Applicable frame** - image sequence with the contrast media covered with the mask image(s):
     - **Start** - first sequence image number
     - **Count -** number of sequence images
   - **Alignment** - move the mask image relative to the base image (**U** - up, **L** - left, **R** - right, **D** - down, **C** - centre, original position)

   The changes of these parameters will be applied to the image in the current view immediately.

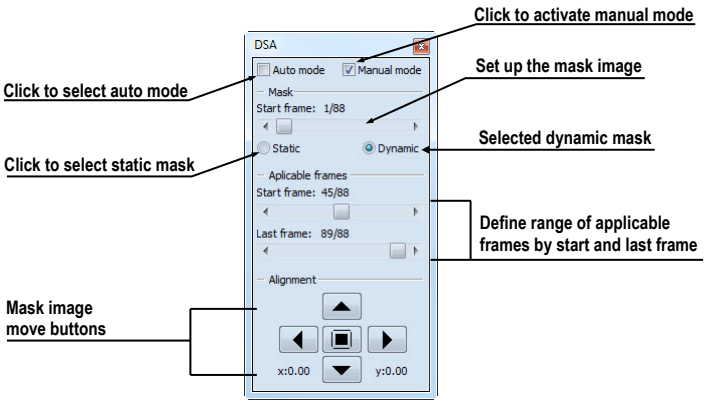


Figure 103 – DSA tool

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

To return to the original settings, click on the **Auto mode** item and the settings will return to the image original DICOM setting.

7.5 Cutlines

Cutlines are intersections of image planes in one series and a plane of a chosen image from another series where they are displayed.

The **Cutlines** function can be used between two series only if there is created registration between them (see 16 Registrations).

Open a patient study with more series and registrations between them. Select an image in the thumbnails palette where the cutlines should be displayed. Click on the **Cutlines** option in the view's context menu or the **View** menu/**Cutlines** to activate the **Cutlines** function (see Figure 104).

Select a patient series from the **Cutlines** menu. The cutlines of chosen series will be displayed in the current view immediately, called standard cutlines (if the planes are not parallel). Standard cutlines are displayed as lines with series and image description (see Figure 104). Set up the cutlines color and the line shape in the application settings (see 4.4 Colors options).

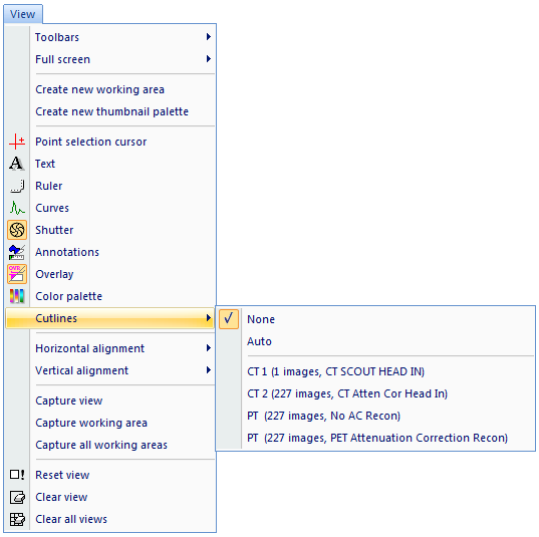


Figure 104 – View/Cutlines menu

Load an image from the chosen series into another view; its position will be displayed in the view with displayed cutlines (current cutline). The current cutline is displayed as a line; set up the color and the line shape in the application settings (see 4.4 Colors options). The cutline will be automatically changed when choosing another image of the chosen series. They will be also displayed when scrolling the images of the series with displayed cutlines (if the planes are not parallel).

It is possible to present cutlines of more series in one image. Select series you want to display in the image in the **Cutlines** menu.

It is also possible to display cutlines in more views at a time (see Figure 105). In each view, click on the context mouse button; select **Cutlines** and the registered series.

When the cutlines can not be displayed, it means:

- There are no registrations defined between the series.
- Section planes are parallel (they do not intersect).

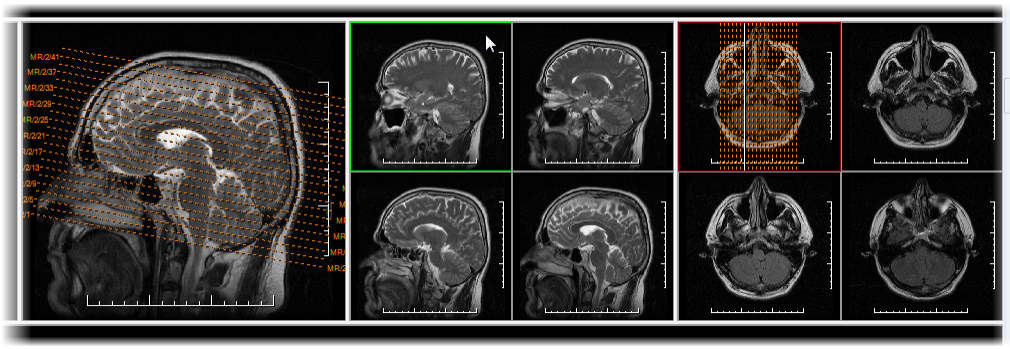


Figure 105 – Displayed cutlines at the working area

7.5.1 Hide cutlines

The **None** option in the **Cutlines** menu (see Figure 104) is predefined, that means no cutlines will be displayed. Once the cutlines have been activated, click at **None** to turn the displayed cutlines off. (Click on the context mouse button, select **Cutlines/None**).

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

7.5.2 Auto mode

Click on the right mouse button in the current view and select **Cutlines**/**Auto** item in the context menu (see Figure 104). Open an image from any patient series in a new window. The cutlines of the new series will be displayed automatically in the view with the **Auto** mode. The chosen image will be displayed as a current cutline. Current cutlines will be changed automatically when changing an image in the current view.

7.5.3 Print cutlines

Defined cutlines can be printed out with the image on a standard Microsoft Windows printer (see 17.1 Microsoft Windows printer) and a DICOM printer (see 17.2 DICOM printer).

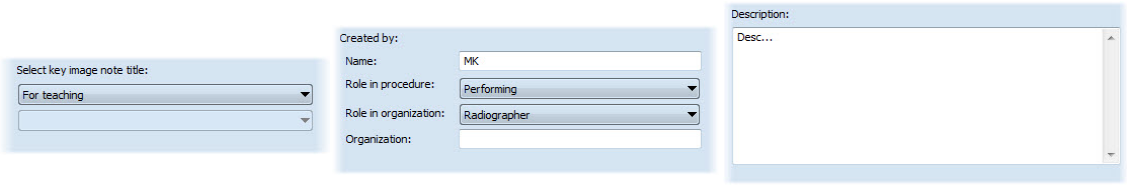
7.6 Key image notes

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

7.6.1 Add key image note

To add key image note:

1. Move mouse cursor over the thumbnail preview of image, which is dedicated to define key image note.
2. Press right mouse button to show context menu of thumbnail pallet.
3. Select item **Add note** (dialog **Key image note** for define new note will be displayed).
4. Fill information about new note into displayed dialog. Fill firstly title of new note (see Figure 106a) and click on the **Next** button. Next fill information about creator (see Figure 106b) and click on the **Next** button. In the end write description about new note in this dialog (see Figure 106c) and click on the **Finish** button. New note will be automatically added to the image.

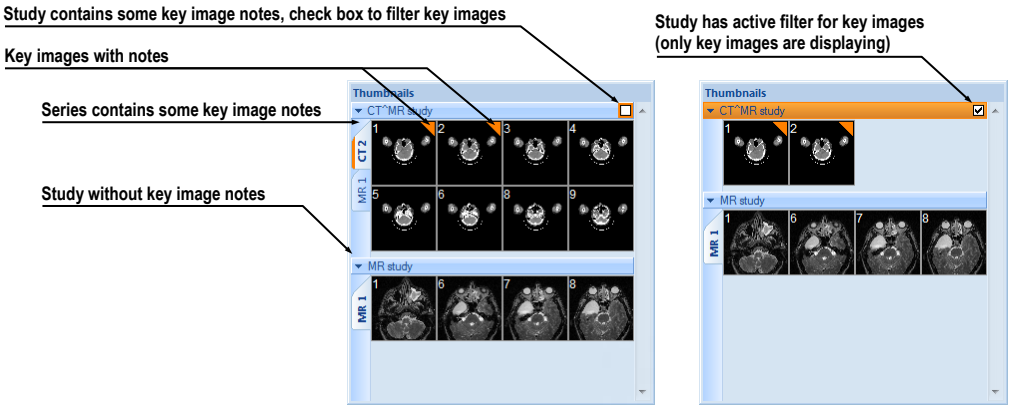


(a) **(b)** **(c)**

Figure 106 – Key image note dialog, Note title (a), Information about creator (b), Description (c)

7.6.2 Review and edit key image note

Each key image note belongs to just one image. If the image has defined one or more notes, the small triangle of defined color will be displayed in the thumbnail preview of this image (see Figure 107).



(a) **(b)**

Figure 107 – Key image notes in thumbnails palette, (a) filter for key images id disabled, (b) filter for key images is enabled

When mouse cursor move over this triangle and left mouse button double clicks, detailed information of key image notes will be displayed in **Key image note** dialog (see Figure 109). If the image has more than one note, **Key image notes** dialog (see Figure 108) will be displayed to select note by double click.

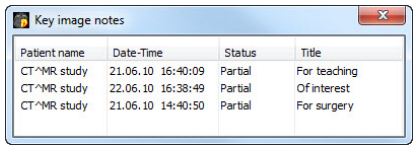


Figure 108 – Key image notes dialog to chosen concrete note

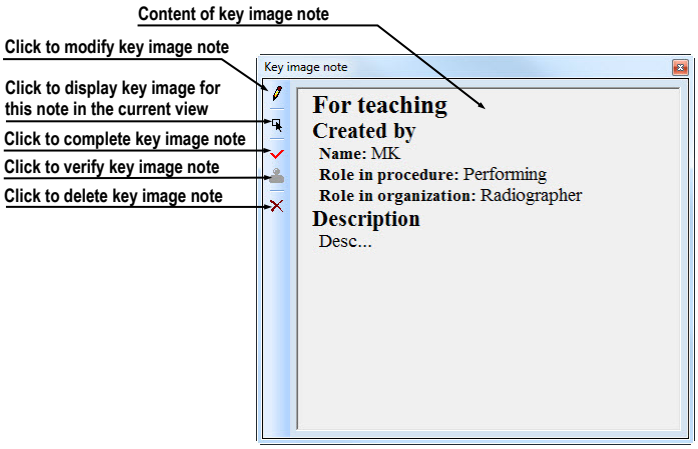


Figure 109 – Key image note dialog

7.6.3 Load and save key image note

TomoCon allows you to save the notes of all opened studies as a DICOM objects to the Local studies storage. The notes can be further sent to the PACS. Key images notes can be saved by clicking on the **Save** button in the **Study** menu or when closing TomoCon a dialog will be opened allowing you to save unsaved changes.

If the series has some key image notes, they will be displayed in the **Search studies** dialog as objects with KO modality (see Figure 110). When study with some key image notes will be opened, associate key image notes to this study also will be automatically opened.

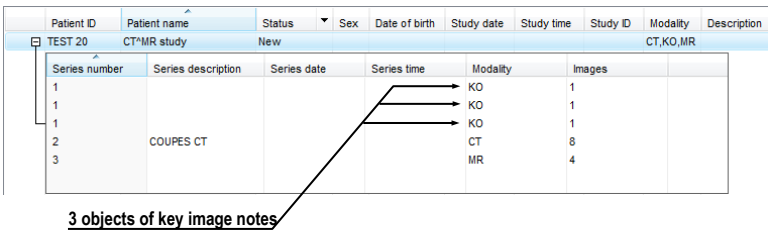


Figure 110 – Search studies dialog, study with key image notes

7.7 Exporting images

TomoCon offers to export the image patient data to the following formats:

- JPEG, DICOM, TIFF, BMP (see 7.7.1 Export images)
- AVI (see 7.7.2 Export images to AVI format video file)

7.7.1 Export images

It is possible to export a selected patient image (or the whole series of patient images) into bitmap file or DICOM file. The **Export** dialog can be opened by clicking on the **Export images…** submenu in the **Study** menu (see Figure 111).

Available bitmap file formats are: JPEG, BMP, TIFF, and DICOM. Select an appropriate **Image dimensions** for the bitmap file or **Use** the **original image dimensions** supplied by the dialog.

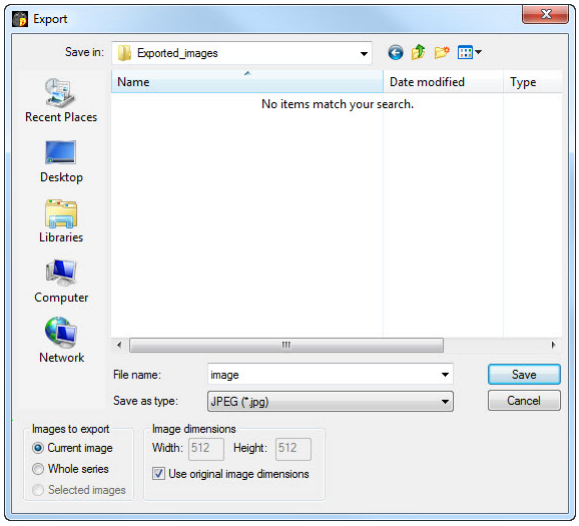


Figure 111 – Export images dialog

If you have selected the whole series option in this dialog and pressed the **Save** button, **Images to export** dialog will be displayed and you can define the range of images to be exported in this dialog (see Figure 112).

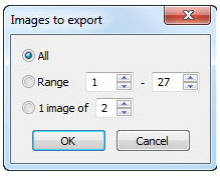


Figure 112 –Images to export dialog

7.7.2 Export images to AVI format video file

Sometimes it might be useful to create a video file from a series of patient image data to play back the data on another computer.

The **Create AVI** dialog (see Figure 113) will be opened by clicking on the **Export as AVI video…** submenu in the **Study** menu.

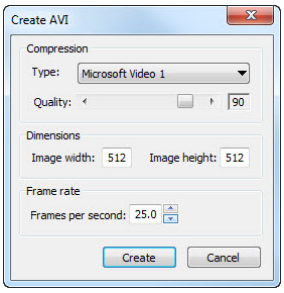


Figure 113 – Create AVI dialog

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

- **Compression -** current 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 another computer to play back the video file, otherwise it will not be possible to play back the file.
- **Dimensions** - image dimensions.
- **Frame rate** - playback speed.

You can also keep the defaults values supplied by the dialog.

When you are finished with definition of video parameters in this dialog, click on the **Create** button. In **Frames to export** dialog, which will be displayed (see Figure 114), you can define the range of images to be exported.

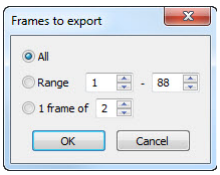


Figure 114 – Frames to export dialog

7.8 Adding and removing images of series

Sometimes, it is necessary to remove irrelevant images from a series or append some images to a series, or add a screenshot or a copy of the working area as a separate image. You can use the functionality of the thumbnail palette or capture functions in the main menu of TomoCon to perform these tasks.

To insert screenshot of working area by thumbnail palette (see Figure 115):

1. Select desired working area (click to any view in this working area).
2. Move the mouse cursor over the images, belonging to target series, where you wish to add the screenshot.
3. Press the right mouse button and select the **Insert image/Insert working area screenshot** item in the context menu (see Figure 118). Image from the current view will be inserted to the end of the target series automatically.

or by main menu of TomoCon:

1. Select desired requested working area (click to any view in this working area).
2. Select the **View/Capture working area** item in the main menu of TomoCon.
3. The screenshot of the working area will be inserted to the end of the OT series in the current study (if the OT series does not exist, it will be created).

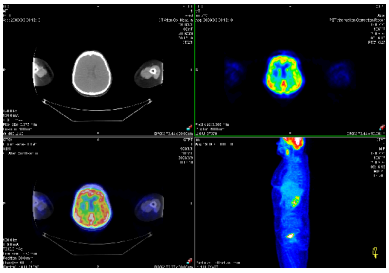


Figure 115 – New image created as a screenshot from the current working area

To insert screenshot of the current view (see Figure 116) by thumbnail palette:

1. Prepare an image for the screen shot in the current view.
2. Move the mouse cursor over the thumbnail previews of images from series, where the new image shall be inserted.
3. Press the right mouse button to display the context menu and select the **Insert image/Insert view screenshot** item (see Figure 118). The screenshot of the current view will be automatically inserted to the end of this series automatically.

or by main menu of TomoCon:

1. Prepare an image for the screenshot in the current view.
2. Select the **View/ Capture view** item in the main menu of TomoCon.
3. The screenshot of the current view will be automatically inserted to the end of the OT series in the current study (if the OT series does not exist, it will be created).

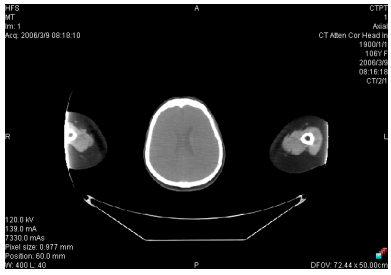


Figure 116 - New image created as a screenshot from the current view

To insert a screenshot of all working areas (see Figure 117) using the main menu of TomoCon:

1. Select the **View/Capture all working areas** item in the main menu of TomoCon.
2. The screenshot of all working areas will be automatically inserted to the end of the OT series in the current study (if the OT series does not exist, it will be created). One separated image will be created from each working area.

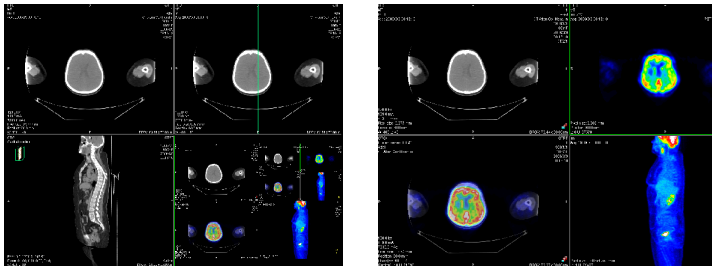


Figure 117 – New images created from two working areas

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

1. Select the image to insert to the current view.
2. Move the mouse cursor over the thumbnail previews of images from the series, where the new image shall be inserted.
3. Press the right mouse button to display the context menu (see Figure 118) and select the **Insert image/Insert image copy** item (see Figure 118). The image from the current view will be inserted to the end of this series automatically.

To delete selected image from series:

1. Move the mouse cursor over the thumbnail preview of an image, which should be deleted. If you want to delete a group of images from the same series, press the right mouse button on the first image, move to last image and release the mouse button. The images for deletion will be marked with blue color.
2. Press right mouse button to display context menu (see Figure 118) and select **Delete image** item. Image will be automatically deleted from series.

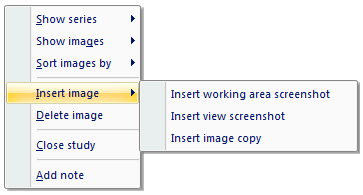


Figure 118 – Context menu of thumbnails palette

8 Hanging protocols

If you frequently work with same kind of data series of particular patients, TomoCon offers you the possibility of display images from these series by your entered rules. Such group of rules defines a hanging protocol, which can be saved in application for later usage. You can later view or edit all stored hanging protocols or define new ones with the Hanging protocols manager (**Hanging protocols manager** dialog, see Figure 119). To display **Hanging protocols manager** dialog click on the **Hanging protocols manager…** item in the **Layout** menu.

You can manually apply the defined and stored hanging protocols on already loaded studies in TomoCon or you can turn on their automatic usage according to the first loaded studies.

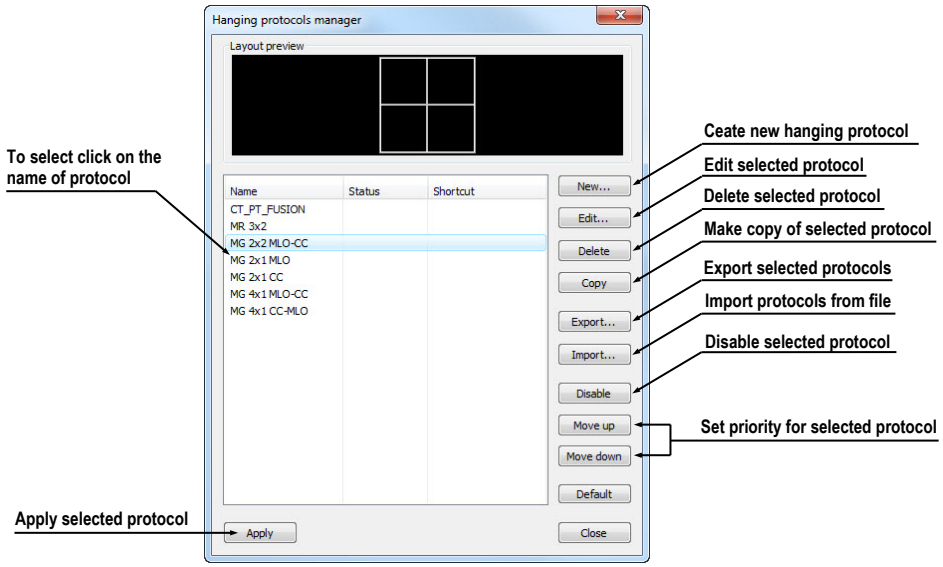


Figure 119 – Hanging protocols manager dialog

8.1 Apply hanging protocol

TomoCon application offers you the possibility of manually or automatically applying selected hanging protocol to current working area.

To automatic applying of hanging protocol check at least one of the following items in the **Layout** menu:

- **Automatically apply/Auto-apply hanging protocol -** selection of protocol is done by priority. Application checks all protocols step by step beginning from highest priority and applies first protocol, whose criteria are conforming to already open study.

- **Automatically apply/Apply last used hanging protocol -** when you open the first study in application, the most recently used protocol will be automatically applied to this particular study.

To manual application of hanging protocol (see Figure 120):

1. Click on the **HP** icon on the main toolbar.
2. In the displayed window click with left mouse button on requested hanging protocol, which will be subsequently applied.

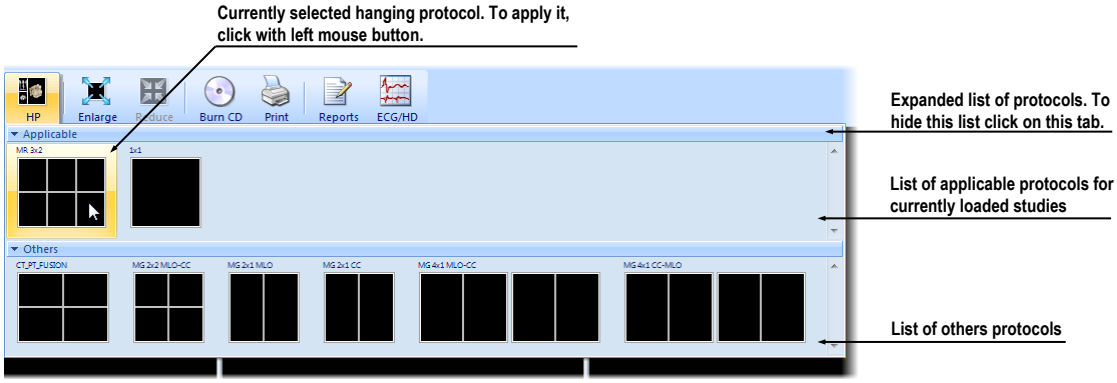


Figure 120 – Hanging protocols list

8.2 *Importing and exporting of hanging protocols*

To transfer already defined hanging protocols from one computer to another, you can use import and export function in **Hanging protocol manager** dialog (to display **Hanging protocol manager** dialog click on the **Hanging protocol manager…** item in **Layout** menu).

To export hanging protocols:

1. Select required protocols for export in displayed list (for multiple selections hold the **Ctrl** key).
2. Press **Export…** button and enter the name of protocol in dialog, which will be opened.

To import hanging protocols:

1. Press **Import…** button and select requested file.
2. Imported hanging protocols will be automatically added to list of all protocols. If some of the imported protocols already exist, you can leave it or overwrite it.

8.3 Creating and modifying hanging protocol

Hanging protocol manager dialog allows you to define new protocol or edit already existing protocols. To display **Hanging protocol manager** dialog, click on the **Hanging protocol manager…** item in **Layout** menu.

The main part of each protocol is layout of working area (to define layout see 3.1.1 Working area layout). When you apply selected protocol to opened study, current application layout will be automatically replaced by this layout and consequently all properties of the protocol will be applied to particular parts of working area.

To define new hanging protocol:

1. Press **New…** button and select the layout of working area in displayed list.
2. In **Hanging protocol properties** dialog, which will be displayed, define particular properties of new protocol and press **OK** button to finish.

To modify properties of hanging protocol:

1. In the list of all protocols, click on the hanging protocol to be changed and click on the **Edit…** button.
2. In **Hanging protocol properties** dialog, which will be displayed, change requested properties and press **OK** button to confirm the changes.

8.3.1 Hanging protocol properties dialog

In this dialog (see Figure 121) you can attach some criteria and properties to selected hanging protocol.

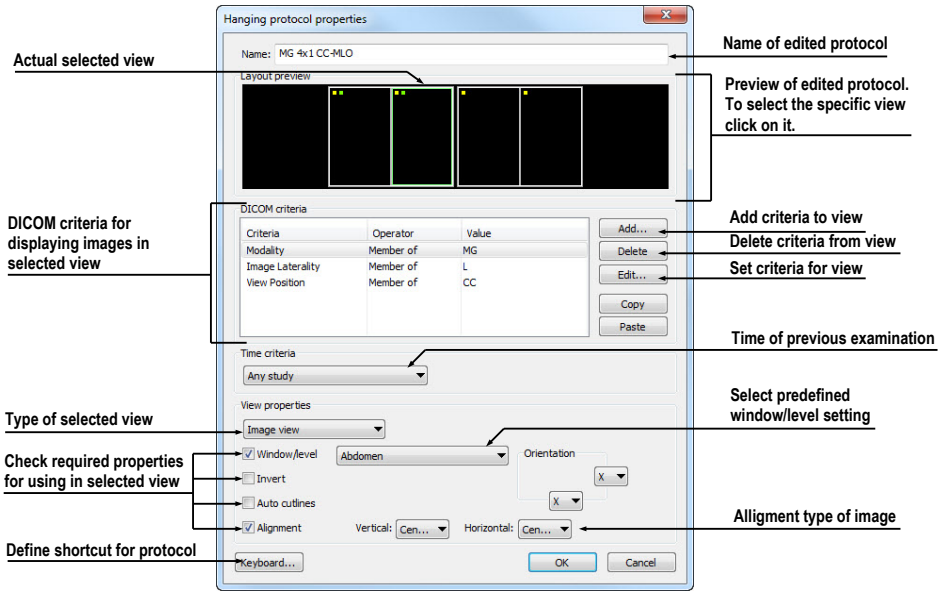


Figure 121 – Hanging protocol properties dialog

These criteria and properties are related to particular view from layout of this protocol and they can be different for each view. Therefore you have to first select the view in **Layout preview** window, before you define these criteria and properties.

Assigning hang criteria

The hang criteria determine, which images can be displayed in particular view. They can be formulated using DICOM tags (list **DICOM Criteria**) or specifying the time order (**Time Criteria**).

To add/edit DICOM criteria, click on the **Add…/Set…** button and define properties of criteria in **Hanging protocol selector** dialog, which will be displayed (see Figure 122).

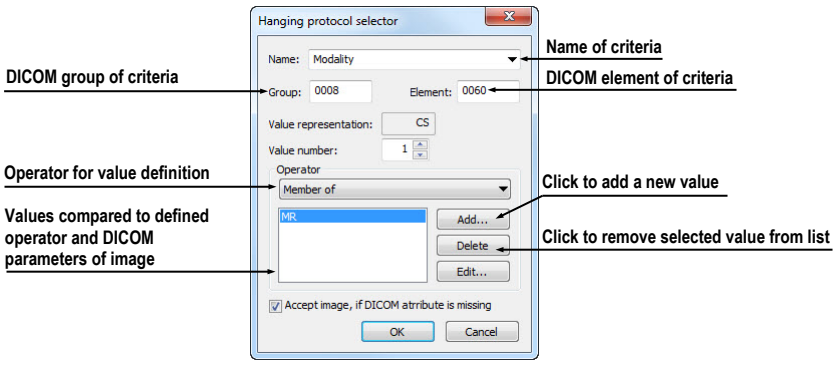


Figure 122 – Hanging protocol selector dialog

To remove criteria, select particular DICOM criteria in list by left mouse click and press **Delete** button.

To define time order criteria, select time constraint from displayed list. If there is a time constraint defined in a view, all images which should be displayed in this view, have to meet the time constraint.

Assigning view properties

These properties will be applied to the images displayed in particular view. To apply selected properties, check particular named properties in dialog and eventually set their parameters (see Figure 121). You can set following properties:

- **Window/level** (select specific type of window/level preset)
- **Invert**
- **Auto cutlines**
- **Alignment** (select type of alignment for horizontal and vertical direction)

8.3.2 Identification of criteria and properties

When you assign hang criteria and properties to particular views, small colored squares will appear in corresponding views (in their upper left corner) in **Hanging protocol properties** dialog in **Layout preview** window (see Figure 123), describing its properties. The colors signify:

- yellow - view has defined DICOM criteria
- red - view has defined time criteria
- green - view has defined some properties

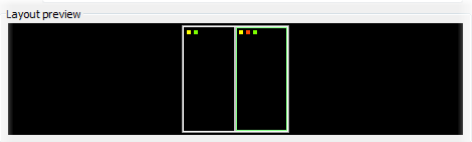


Figure 123 – Color identification of criteria and properties

9 Annotations and measurements

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

- **Text -** detailed information on text description (see 9.1 Text annotations)
- **Marker -** text description with a marker pointing to the point described (see 9.2 Marker annotations)
- **Distance -** distance between two points (see 9.3 Distance)
- **Distances and angle** (see 9.4 Distances and angle)
- **Cobb angle -** angle between two independent lines (see 9.11 Cobb angle)
- **Probe -** tracking circle tool to display point level values in the specified round area (see 9.5 Probe)
- **Density spot -** desired point level values (see 9.6 Density spot)
- **Density profile -** characteristics of all image points between two points (see 9.7 Density profile)
- **Ellipse** - characteristics of all image points included in the elliptical area (see 9.8 Ellipse)
- **Rectangle** - characteristics of all image points included in the rectangular area (see 9.9 Rectangle)
- **Area** - characteristics of all image points covered by a free area (see 9.10 Free area)

All annotations and measurements can be found in the **Annotations** menu (see Figure 124). It is also possible to activate them in the tools panel (tab with icon).

After using an annotation and measurement tool, it is possible to set up its properties through the annotations and measurements context menu (see Figure 124). It will be appeared when moving the cursor over the tool (it will be highlighted and cursor will be changed from an arrow to a cross) and pressing the mouse context button. The following actions are available:

- **Font** settings and **Color** settings
- **Keep settings -** color and font settings for newly created annotations and measurements (**For all** tools, **For same type** tools)
- **Edit label**, **Delete** a tool and **Locked** a tool in the image against moving, deleting or above mentioned actions

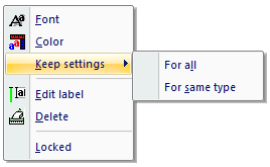


Figure 124 – Annotations and measurements context menu

When using a tool defining an area (Ellipse, Rectangle, Free area), the **Show text** option is added (see Figure 125), which allows to show or to hide **Size** of the outlined area, **Min value**, **Max value**, **Mean value** and **Deviation**.

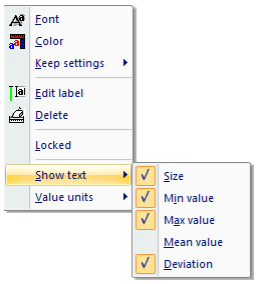


Figure 125 – Context menu for ellipse, rectangle and free area

In case of using Density profile, the **Show/Hide graph** option is added (see 9.7 Density profile).

If the image selected in the current view contains DICOM information of the measurements value units, **Value units** item will be added to the context menu of selected measurement to change actual value unit.

To move the annotation and the measuring tool to a different position within the view, move the mouse cursor over the annotation and the measuring tool until its highlighted (the cursor will change from an arrow to a cross). Hold the left mouse button and release when desired. The annotation text will be moved together with the tool. In addition, if selected measurement type is Density spot, Density profile, Rectangle, Ellipse or Density area and the image within the current view will be changed while the left mouse button is pressed, selected measurement tool will be moved to the new image.

When moving angle and distance measuring tool, it is also possible to move only one point at the end of the measuring line. When moving the mouse cursor over the chosen end point, this will change into a red circle (see Figure 129). Press the left mouse button and move the point to a different place within the current view.

After replacing the annotation and the measurement tool or its point the displayed values will be recalculated immediately.

With each annotation you can use an edit box to write necessary notes about the annotations and measurements. When moving across the edit box with mouse cursor, it will be highlighted with rectangle in the same color as the annotation connected

with it. The mouse cursor will change its shape from an arrow to a cross. Hold the left mouse button and relocate the edit box in position with the annotation. When moving the whole annotation the edit box will move with the annotation in the changed position.

TomoCon calculates the real point distances or area automatically for patient images with transformation automatically. Images with no transformation rarely contain sufficient information in the patient study data needed for these calculations. The calculations are therefore given in pixels. In this case you can convert pixel units to length units (mm) or area units (cm^2) manually using the calibration tool (see 9.12 Calibration).

9.1 Text annotations

Short text descriptions can be written directly inside the image, near the important structure or object using the **Text annotation**. **Text annotation** mode can be initiated by clicking on the **Text** item in the **Annotations** menu or by clicking on the **Text** button in the **Annotations** tool of the tools panel (see Figure 126).

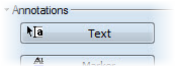


Figure 126 – Annotations tool

Click at the point in the image, which should be annotated. Small white text line editing box will be opened (see Figure 127). Type in the description text and press **Enter**.

Figure 127 – Image with Text annotations

9.2 Marker annotations

Short text descriptions pointing at the important structure or object can be written directly inside the image using the **Marker annotation** mode. It can be initiated by clicking on the **Marker** item in the **Annotations** menu or by clicking on the **Marker** button in the **Annotations** tool of the tools panel (see Figure 128).

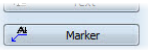


Figure 128 – Annotations tool

Click at the point in the image, which should be annotated. Drag a thin line to the place, where the annotation text should be placed. Click the mouse button, a small

white text line editing box will be opened. Type in the description text and press Enter (see Figure 129).

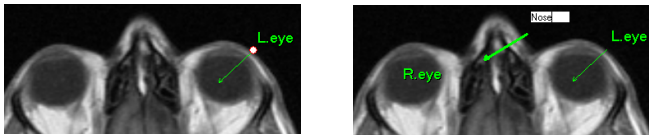


Figure 129 – Image with Marker annotations

9.3 Distance

Distance measurement can be used after clicking on the **Distance** item in the **Annotations** menu or by clicking on the **Distance** button in the **Measurements** tool of the tools panel (see Figure 130).

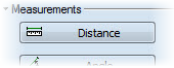


Figure 130 – Measurements tool

Click at the first and at the second point, while dragging the measurement line. The distance between these two points is displayed near the second point (see Figure 131).

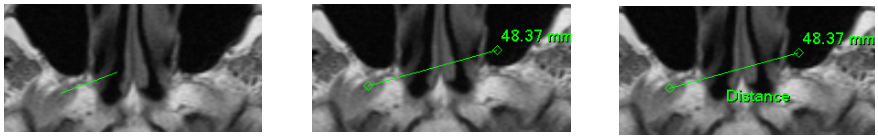


Figure 131 – Distance between 2 points

9.4 Distances and angle

Distances and angle measurement can be used after clicking on the **Distances and angle** item in the **Annotations** menu or by clicking on the **Angle** button in the **Measurements** tool of the tools panel (see Figure 132).

Figure 132 – Measurements tool

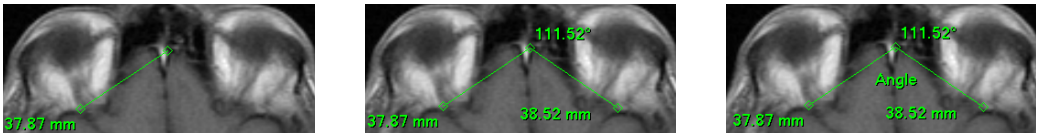


Figure 133 – Distances and angle between 3 points

Using this measurement is similar to using Distance measurement, except the additional third point has to be defined. Both distances and an angle between distance-lines are displayed (see Figure 133).

9.5 Probe

Probe is a special circle measurement tool for tracking actual pixel value at specified place in the selected view. This measurement can be used after clicking on the **Probe** item in the **Annotations** menu or by clicking on the **Probe** button in the **Measurements** tool of the tools panel (see Figure 134).

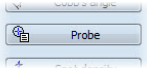


Figure 134 – Measurements tool

Press left mouse button at the desired point and move measurement through image within selected view and Probe will display current minimal pixel value, maximal pixel value and mean value from pixels, which are lying within probe's circle at actual place (see Figure 135). To stop to display these values release left mouse button and Probe measurement will be hidden. In addition, if selected image within the view will be changed while left mouse button is pressed, Probe will be displayed actual pixel values on new selected image.

To change circle size of this measurement press **Shift** key with pressed left mouse button on arbitrary place within selected view and move mouse. The size of Probe measurement will be changed according to actual movement of mouse. To stop change the size, release left mouse button or **Shift** key and new specified size will be remembered.

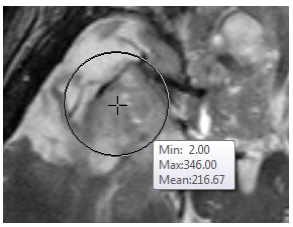


Figure 135 – Probe measurement

9.6 Density spot

Density spot measurement can be used after clicking on the **Density spot** item in the **Annotations** menu or by clicking on the **Spot density** button in the **Measurements** tool of the tools panel (see Figure 136).

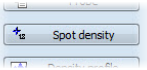


Figure 136 – Measurements tool

Click at the desired point. The value in the image point is displayed near the defined point (see Figure 137).

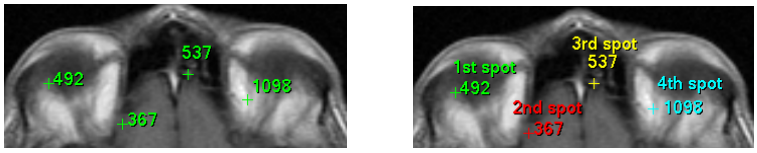


Figure 137 – Density spot at various points

9.7 Density profile

Line Density profile can be measured after clicking on the **Density profile** item in the **Annotations** menu or by clicking on the **Density profile** button in the **Measurements** tool of the tools panel (see Figure 138).

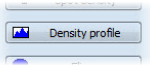


Figure 138 – Measurements tool

Click at the first point with the left mouse button, hold it and drag a measurement line, until the mouse button is released. Characteristics of all image points covered by the line are summarized and displayed as a tool tip (see Figure 139).

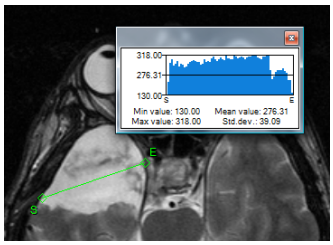


Figure 139 – Density profile over a line between 2 points

In open studies there can be more measurement lines created in the images. Their Density profiles can be temporarily hidden by clicking on the button at the right top of the graph. After clicking at the measurement line with context mouse button, the Density profile will reappear by choosing the **Show/Hide graph** option (see Figure 140).

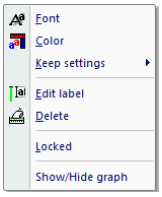


Figure 140 – Density profile's context menu

9.8 Ellipse

Ellipse drawing will be activated by clicking on the **Ellipse** item in the **Annotations** menu or by clicking on the **Ellipse** button in the **Measurements** tool of the tools panel (see Figure 141).

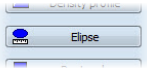


Figure 141 – Measurements tool

Click at any point with the left mouse button, move the mouse to desired position and click again to define second point of the ellipse. Characteristics of all image points covered by the elliptical area are summarized and displayed above the ellipse (see Figure 142).

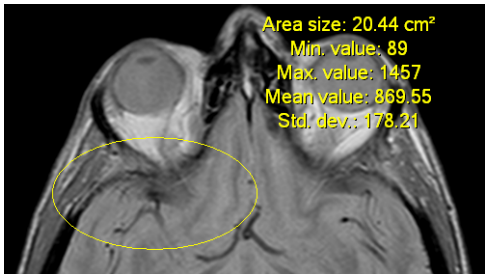


Figure 142 – Elliptical area profile

You can move the ellipse to any place inside the image simply by grabbing it with mouse or resize it by grabbing its corners. The displayed values will be recalculated.

9.9 Rectangle

Rectangle drawing will be activated by clicking on the **Rectangle** item in the **Annotations** menu or by clicking on the **Rectangle** button in the **Measurements** tool of the tools panel (see Figure 143).

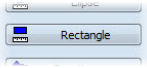


Figure 143 – Measurements tool

Click at any point with the left mouse button, move the mouse to desired position and click again to define second point of the rectangle. Characteristics of all image points, covered by the rectangular area, are summarized and displayed above the rectangle (see Figure 144).

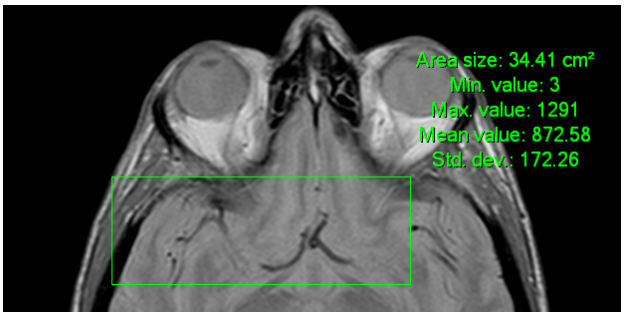


Figure 144 – Rectangular area profile

You can move the rectangle to any place inside the image simply by grabbing it with mouse or resize it by grabbing its corners. The displayed values will be recalculated.

9.10 Free area

Free **Area** drawing will be activated by clicking on the **Area** item in the **Annotation** menu or by clicking on the **Density area** button in the **Measurements** tool of the tools panel (see Figure 145).

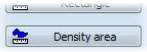


Figure 145 – Measurements tool

Outline an area dragging the cursor with the left mouse button pressed. Characteristics of all image points covered by the free area are summarized and displayed next to the free area (see Figure 146).

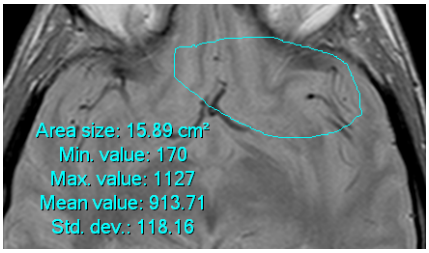


Figure 146 – Free Area

Press the **Area** icon, hold the **Ctrl** key and with the left mouse button pressed add an extra area (the mouse cursor will have form) to the already existing area. Press the icon again, hold Shift key and with the left mouse button pressed subtract a part of the area (the cursor will have form).

You can move the area to any place inside the image by grabbing it with mouse. The displayed values will be recalculated.

9.11 Cobb angle

Cobb angle measurement can be used after clicking on the **Cobb's angle** item in the **Annotations** menu or by clicking on the **Cobb's angle** button in the **Measurements** tool of the tools panel (see Figure 147). It measures angle between two independent lines.

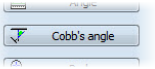


Figure 147 – Measurements tool

Click at the first and at the second point of first line and then at the first and second point of second line. Smaller angle between these defined lines will be displayed near the end of one of them (see Figure 148).

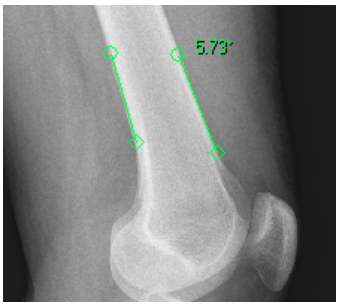


Figure 148 – Cobb's angle

9.12 Calibration

In images with no transformation, where pixel size is unknown, calibration can be used to calculate approximate distance between two points.

Select **Calibration** item (see Figure 149) in the **Annotations** context menu to activate calibration. The context menu will be displayed when pressing mouse context button at the Distance measurement.

Two options are available:

- **Calibrate measurement -** open the **Calibration** dialog to define the calibration (see Figure 149).
- **Apply to whole series -** apply the defined calibration to the series.

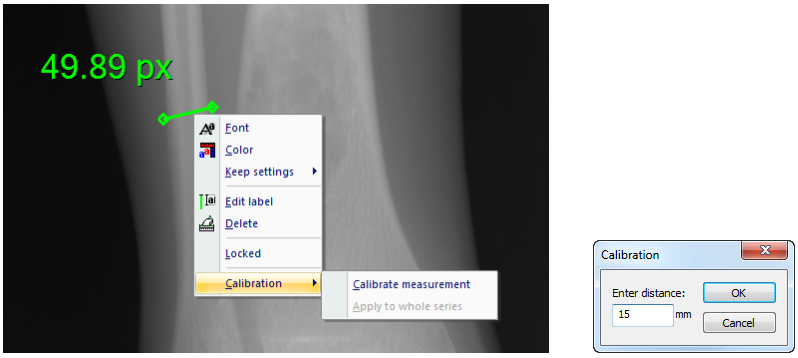


Figure 149 – Calibration context menu and Calibration dialog

The **Calibration** dialog allows you to define the calibration by entering the chosen line length in millimeters in the **Enter distance** box. After pressing the **OK** button, all measured distances and areas in the image will be calculated according to the defined calibration.

The calibration of already calibrated images with no transformation can be changed again using the **Calibration** dialog. A dialog will be open informing that the image is already calibrated (see Figure 150).

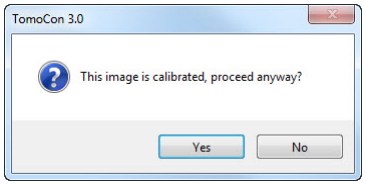


Figure 150 – Calibration dialog: This image is calibrated, proceed anyway?

If you want to change the calibration in the series with already calibrated images, use the **Apply to whole series** option. If any other image in the series is already calibrated, a warning dialog will be opened (see Figure 151).

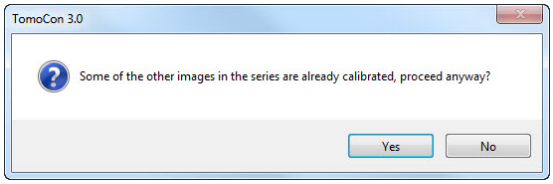


Figure 151 – Some of the other images in the series are already calibrated, proceed anyway?

NOTE! Calibration can not be used for images containing the transformation.

9.13 Hide / show annotations

To hide or show existing annotations in all views and TomoCon working areas, select the **Annotations** icon in the **View** menu or click on the **Hide all** button in the third tab (tab with icon) of the tools panel.

Figure 152 – Hide all button

9.14 Discard annotations

A single annotation can be deleted by clicking at it with the context mouse button and selecting the **Delete** entry in the opened **Annotations** context menu. You can also select the **Annotations…** item in the **Annotations** menu (see 9.15 List of annotations).

To discard all defined annotations, defined in all opened patient studies, click on the **Clear all annotations** icon in the **Annotations** menu.

It is also possible to discard annotations in the current image, series or study using the respective entries in the **Annotations/Delete** menu:

- **Clear all in image** icon
- **Clear all in series** icon
- **Clear all in study** icon

9.15 List of annotations

Click on the **Annotations…** item in the **Annotations** menu or click on the **Annotations…** button (see Figure 153) in **Annotations** tab (tab with icon) of the tools panel to open a dialog with the list of all annotations defined in the opened studies (see Figure 154).

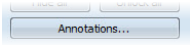


Figure 153 – Annotations… button

The list contains a type, location (series/image) and description of the annotations.

After selecting one of the annotations and pressing the **Go to annotation** button, the image with the selected annotation will be displayed in the current view.

By pressing **Delete** button the selected annotation will be deleted both from the list and the image.

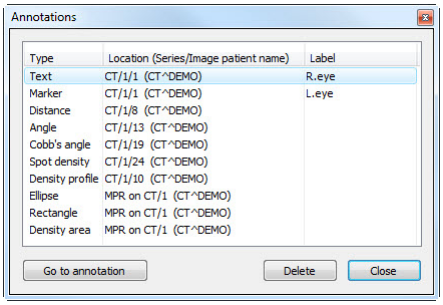
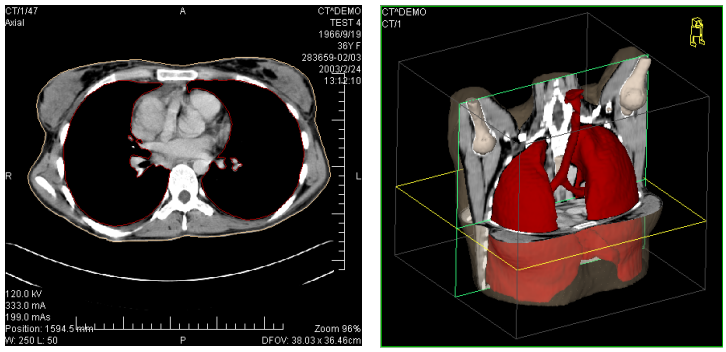


Figure 154 – Annotations dialog

10 Contouring the patient – create ROIs

Patient contouring is used with two-dimensional (2D) display for better description and better recognition of patient anatomical structures through their colored outlining in the image (see Figure 155). When creating contours on multiple images an ROI (Region of Interest) will be created with automatically calculated volume size in cm^3 and which can be displayed in space in three-dimensional (3D) patient presentation (see Figure 155).

NOTE! Calculated volume of ROI in TomoCon is depending on actual setting of resolution for specific ROI (see 10.7 Edit ROI properties).



(a) **(b)**

Figure 155 – Displaying ROI, (a) contour in 2D, (b) ROI in 3D

TomoCon allows you to create Region of Interests (ROI) of various types using manual and automatic tools accessible in ROI tab in the tools panel (tab with icon), see Figure 156. 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 ROI definition can be a DICOM RT Structure set (with installed DIOCM RT Structure license in TomoCon), which can be sent to another DICOM compatible system (e.g. Treatment Planning System).

The ROI tab in the tools panel consists of three following main parts (tools), which simplify your work with ROIs and their contours (see Figure 156):

- **ROIs** tool, which allows you to set the currently selected ROI in TomoCon, delete ROI or create a new one and manage already defined ROIs in the **Administration** dialog.
- **ROI properties** tool for defining visibility 2D and 3D properties of currently selected ROI in TomoCon.

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

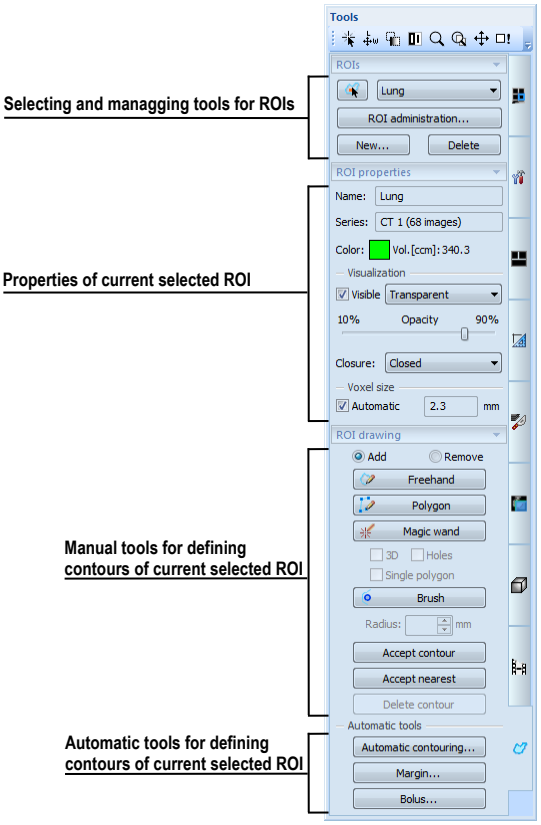


Figure 156 – ROI tab in the Tools panel

10.1 Creating new ROIs

TomoCon allows you to create an new ROI on image of selected series by one click on the **New...** button in the **ROIs** tool (in the tab with icon) in the tools panel (see Figure 157). Newly created ROI will be added into the ROI list automatically and set as currently selected ROI in TomoCon, so you can define ROI's contours using the **ROI drawing** tool in the tools panel immediately.

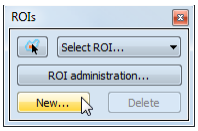


Figure 157 – Creating new ROI in ROIs tool

To create an new ROI in TomoCon follow these steps:

- Press the **New...** button in the **ROIs** tool in the tools panel.
- The **New ROI** dialog for defining the main properties of the new ROI will be opened (see Figure 158).

- Select series for the new ROI in the **Series** combo box. The default selected series is the series from the current view.
- Select an ROI catalog type from the **Type** drop down list and/or type a name in the **Name** box. If no name is inserted, the new ROI will be default named as "New ROI …".
- Select a color of the new ROI pressing the color button next to **Name** box. The default color of ROI is set randomly.
- Press the **OK** button. The new ROI will be created automatically and set as the currently selected ROI in TomoCon.

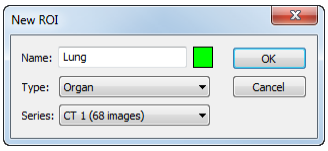


Figure 158 – New ROI dialog

10.2 Selecting ROI and contour

The currently selected ROI in TomoCon is already created ROI, which is currently selected in **Select ROI...** combo box in **ROIs** tool in the tools panel (see Figure 159). Its properties are displayed in the **ROI properties** tool in the tools panel. All ROI drawing tools can be used only on this ROI in TomoCon.

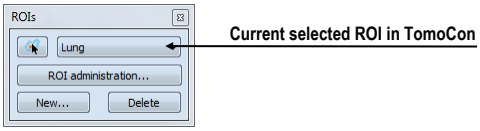


Figure 159 – Current selected ROI in TomoCon

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

- Select an ROI from the **ROIs** drop-down list in the **ROIs** tool in the tools panel (see Figure 160).

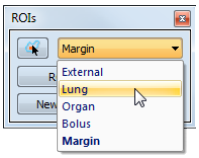
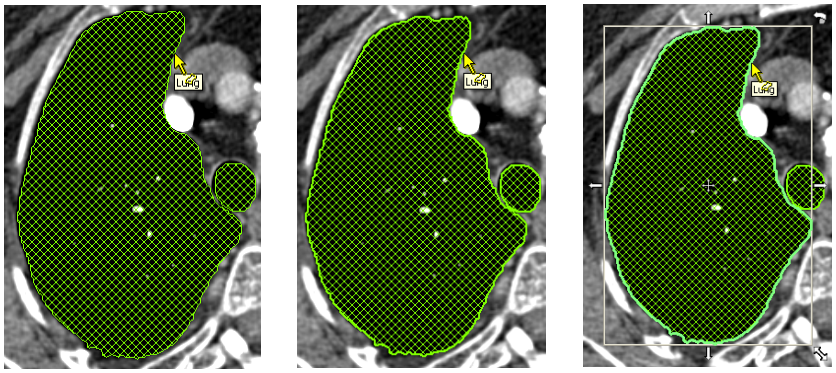


Figure 160 – Select current ROI in TomoCon

- Use the Select contour tool for selecting a contour of ROI. When a contour is selected, the appropriate ROI will be set in the **Select ROI ...** combo box in the **ROIs** tool as the currently selected.

To select contour with the Select contour tool in the view follow these steps:

1. Press the button in the **ROIs** tool in the tools panel and move the mouse cursor close to the contour until the contour area is highlighted with a check pattern (see Figure 161a). The contour must be drawn with a continuous line – an interpolated contour drawn with a dashed line is not accepted.
2. Click once on the highlighted contour (see Figure 161b) to select the ROI (if it is not selected in the **Select ROI...** combo box already).
3. Click again to select the contour (see Figure 161c).



(a) **(b)** **(c)**

Figure 161 – Selecting contour in TomoCon

If you switch on the select Contour tool while an ROI is selected in the **Select ROI...** combo box, first ROI's polygon on current slice is selected automatically.

When the contour is selected (see Figure 161c), it can be moved, rotated, resized or deleted:

- To delete the selected contour entirely, press the **Delete** key on the keyboard.
- To move the selected contour, move the mouse cursor in the middle of the contour until the mouse pointer changes into an arrow cross✣. Drag the contour to where you want it.
- To rotate the selected contour, move the mouse cursor over a rotate arrow (↻) until the mouse pointer changes to the same arrow shape. Press the left mouse button and rotate contour keeping the mouse button pressed until the desired position is achieved.
- To resize the selected contour, move the mouse cursor over a resize arrow (⤡, ↔, ↕) until the mouse pointer changes to the same arrow shape. Drag the corner/side of the contour selection frame out (to enlarge it) or in (to make it smaller).

10.3 Saving ROIs

When any changes with ROIs have been performed in opened studies in TomoCon, an asterisk (*) is displayed after the study time in the TomoCon's title bar at the top of the page (see Figure 162).

Figure 162 – TomoCon's title bar with asterix

If there are unsaved changes with ROIs in an opened studies when closing it, you are asked whether to save these changes or not. If you wish to save changes when the study is still open, press the keys combination **Ctrl+S** on the keyboard or select the **Save** item in the **Study** menu of application menu. Performed changes of ROIs will be automatically saved in Local studies storage of TomoCon. To send these changes from TomoCon to PACS select the **Send...** item in the same menu.

10.4 Deleting ROI

To delete an ROI in ROIs tool in the tools panel:

1. Select the current ROI in the **ROIs** drop-down list in the **ROIs** tool in the tools panel.
2. Press the **Delete** button in the same tool. After confirming the delete operation, the currently selected ROI will be removed.

To delete an ROI in the **ROI administration** dialog see 10.5 ROI administration.

10.5 ROI administration

All ROI administration functions, like rename, algebra, copy of ROI, etc..., can be performed using the **ROI administration** dialog in TomoCon (see Figure 163).

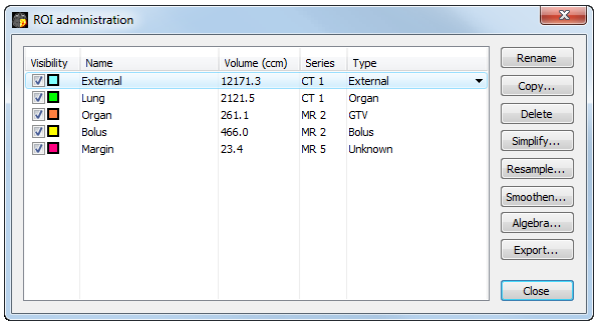


Figure 163 – ROI administration dialog

The **ROI administration** dialog contains the list of all defined ROIs in TomoCon including the visibility indicator, color, name, image series name and ROI type. It is possible to perform the following operations with ROIs displayed in this list:

- renaming, deleting, changing visibility, color and DICOM ROI type
- copying an ROI to the same or another series (see 10.5.1 Copy ROI)
- simplifying ROI's contours (see 10.5.2 Simplify ROI)
- resampling ROI's contours (see 10.5.3 Resample ROI)
- smoothening ROI's contours (see 10.5.4 Smoothen ROI)
- algebra between two ROIs (see 10.5.5 ROI algebra)
- exporting an ROI to external files (see 10.5.6 Export ROI to DXF or VTK file)

To change the visibility of an ROI, click with the left mouse button on the check box left to colored box in appropriate row (see Figure 164). The new visibility state of the ROI will be applied to all views in TomoCon immediately.

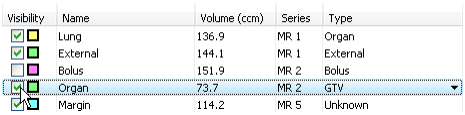


Figure 164 – Hiding the Organ ROI

To change the color of an ROI, double-click with the left mouse button on the colored box in appropriate row (see Figure 165). Then select the color in the **Color** dialog, displayed afterwards. The new color of the ROI will be applied to all views in TomoCon immediately.

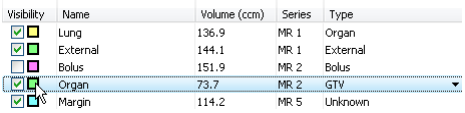


Figure 165 – Changing color of Organ ROI

To change the DICOM type of an ROI, display the drop down list (clicking on the button) in the **Type** column in the appropriate row and select desired DICOM type item there (see Figure 166).

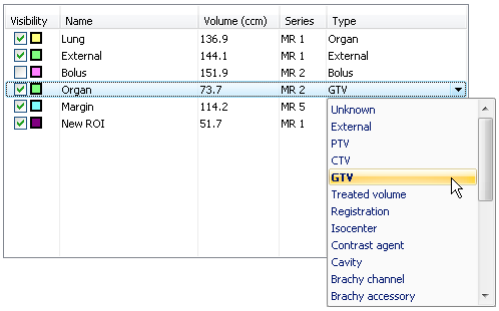


Figure 166 – Changing DICOM type of ROI

To rename an ROI, select the ROI in the ROI list and press the **Rename** button. Type a new name in the displayed name box (see Figure 167), and press the **Enter** key.

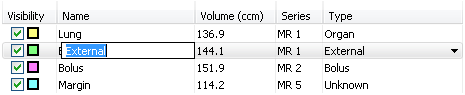


Figure 167 – Renaming selected ROI in ROI administration dialog

To delete an ROI, select the ROI in the ROI list and press the **Delete** button. Confirm the operation in the dialog displayed afterwards (see Figure 168).

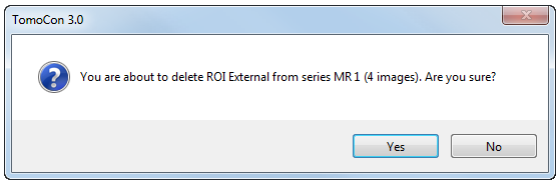


Figure 168 – Delete confirmation dialog

10.5.1 Copy ROI

To copy an ROI to another or the same series using the **ROI administration** dialog:

1. Select the ROI in the ROI list.
2. Press the **Copy...** button. The **Copy ROI** dialog will be opened.
3. Type an new ROI name in the **ROI name** box.
4. Change color of an new ROI clicking on the colored box right to the **ROI name** box.
5. Select a target series from the **Series** drop down menu, if desired (see Figure 169). It is possible to select only target series registered with the series of source ROI. The default target series is the series of the "source ROI".
6. Press the **OK** button to finish the copying process.

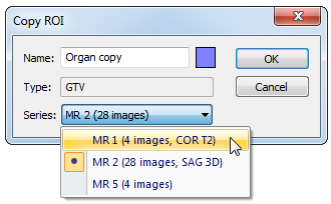


Figure 169 – Copy ROI dialog - selecting target series

The new ROI created as a copy from source ROI will be added as visible ROI to the end of ROIs list in the **ROI administration** dialog (see Figure 170).

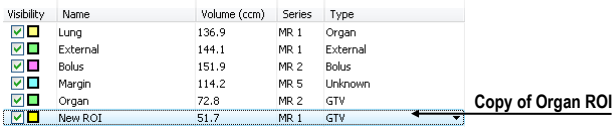


Figure 170 – New ROI created as copy from Organ ROI

10.5.2 Simplify ROI

To simplify all contours of ROI using the **ROI administration** dialog:

1. Select an ROI in the ROI list.
2. Press the **Simplify...** button. The **Simplify ROI** dialog will be opened (see Figure 171).
3. Select a type of simplification method in the displayed **Simplify ROI** dialog:
   - **Remove holes** - each hole will be removed from all contours of ROI.
   - **Single polygon** - only one polygon will be leaved and each hole will be removed from each image.
   - **Reduce number of vertices** - all polygons of each contour will be reduced to reach value bellow the entered number of vertices.
4. Press the **OK** button to finish the simplification process.

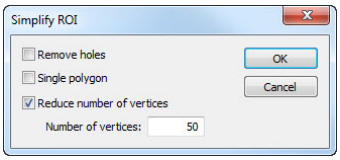


Figure 171 – Simplify ROI dialog

10.5.3 Resample ROI

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

To resample contours of an ROI using the **ROI administration** dialog:

1. Display the image in the current view in the desired direction, in which the ROI shall be resampled.
2. Select the ROI to resample in the ROI list and press the **Resample...** button. The **Resample...** dialog will be displayed (see Figure 172).
3. Type the number of contours you wish to be drawn in the new direction (how many planes will be used to cut the original ROI).
4. Select the target series in the **Into series** drop down menu, where the resampled ROI shall be created. The default series is the series of source ROI.
5. Check the **As new ROI** check box to create an new ROI from resampled data and leave the source contours as they are.

6. Check the **Original slices** check box to resample only to original slices (number of slices option stays disabled, as this decided by the number of original slices intersected by the ROI).
7. Press the **OK** button to resample.

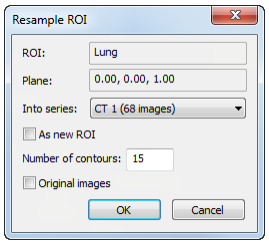


Figure 172 – Resample ROI dialog

The result of resampling process is resampled ROI in your chosen direction with drawn contours in as many slices as you have chosen (intermediate slices will get dashed contours).

10.5.4 Smoothen ROI

Smoothing makes jagged contours rounder. The more smoothened, the more ellipse-like shape each contour of the ROI has.

To smoothen contours of ROI using the **ROI administration** dialog:

1. Select an ROI to smoothen in the ROI list and press the **Smoothen...** button.
2. The **Smoothen ROI** dialog will be displayed (see Figure 173).

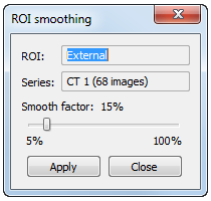


Figure 173 – ROI smoothing dialog

3. Drag the handle or click in the slide bar to set the **Smooth factor** (5-100%).
4. Press the **Apply** button as many times as needed to achieve a satisfying result. Result is displayed in the current view immediately (see Figure 174).
5. When you are satisfied, press the **Close** button.

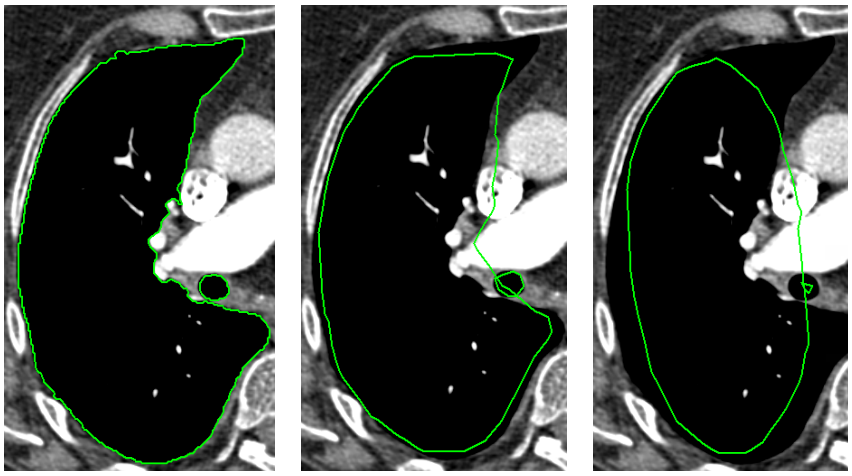


Figure 174 – (a) Source ROI, (b) smoothen ROI (1st applied), (c) smoothen ROI (5th applied)

10.5.5 ROI algebra

If there are any two ROIs defined in same series, TomoCon allows you to make basic algebraic operations like Union, Intersection or Subtraction between them using the **ROI algebra** dialog (see Figure 175). The result of specified algebraic operations can be saved to the new ROI or to the ROI, which has been selected as the first ROI for this operation.

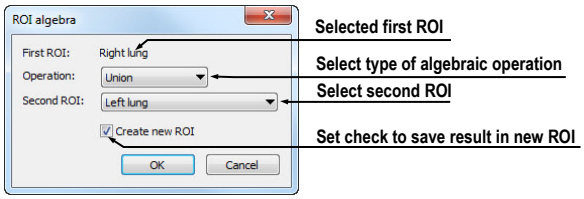


Figure 175 – ROI algebra dialog

To perform algebra operations between two ROIs using the **ROI administration** dialog:

1. Select the first ROI to perform algebra operation in the ROI and press the **Algebra...** button.
2. The **ROI Algebra** dialog will be displayed.
3. Select algebra operation in the **Operation** combo box (see Figure 176).

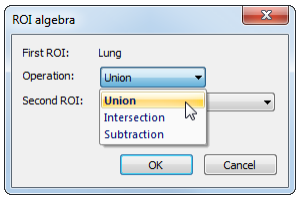


Figure 176 – ROI algebra dialog, defining the algebra operation

4. Select the second ROI in the drop down list displayed when the **Second ROI** button is pressed (see Figure 177).

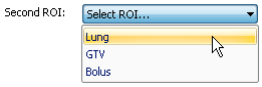


Figure 177 – Selecting the second ROI for algebra

5. To save the algebra result as an new ROI check the **Create new ROI** check box.
6. Press the **OK** button to perform specified algebra operation with defined parameters.

10.5.6 Export ROI to DXF or VTK file

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

To export an ROI using the **ROI administration** dialog:

1. Select the ROI to export in the ROI list and press the **Export...** button.
2. Select desired file format, file name and target folder in the **Export** dialog (see Figure 178), which will be opened.
3. To save the file, press the **Save** button.

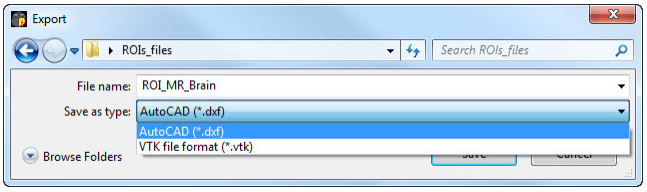


Figure 178 – Export dialog

10.6 Accept and delete contour

Accept contour operation in TomoCon allows you to accept interpolated or nearest contour in the displayed image using the **ROI drawing** tool (see Figure 179). The accepted contour will be inserted to the current selected ROI in TomoCon as a new 2D contour.

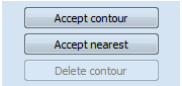
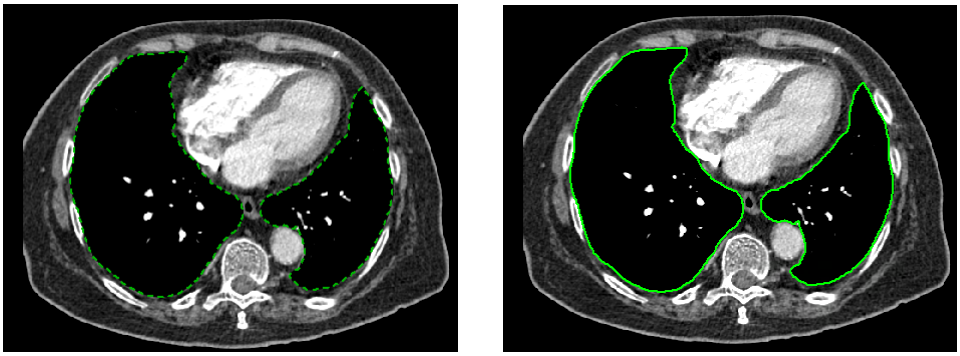


Figure 179 – Accepting part in the ROI drawing tool

To accept an interpolated contour:

1. Display image with interpolated contour (see Figure 180a) in the current view. The interpolate contour is outlined with a dashed line.
2. Press the **Accept contour** button in the **ROI drawing** tool.
3. The interpolated contour will be inserted to the currently selected ROI (see Figure 180b).
4. The dashed line will be changed to a continuous line and the interpolated contour will be changed from proposed to a real one.

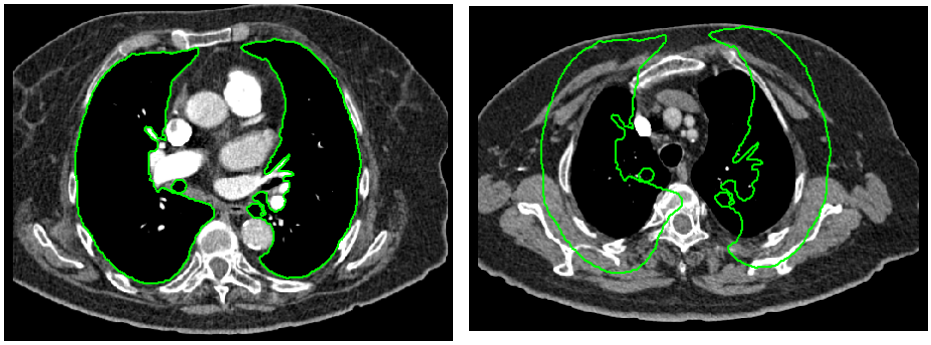


(a) **(b)**

Figure 180 – Interpolated contour (a), Accepted interpolated contour (b)

To accept the nearest contour:

1. Check if there is no contour drawn for the ROI in the current view.
2. Press the **Accept nearest** button in the **ROI drawing** tool.
3. The nearest drawn contour will be automatically copied to the current image (see Figure 181).



(a) **(b)**

Figure 181 – 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, press the **Delete contour** button in the **ROI drawing** tool in the tools panel.

10.7 Edit ROI properties

All 2D and 3D visibility properties of currently selected ROI in TomoCon can be changed using the **ROI properties** tool in the tools panel (see Figure 182).

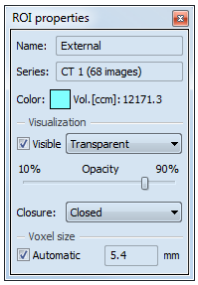


Figure 182 – ROI properties dialog

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

- **Name**/ **Series**: name of the currently selected ROI and the image series where the ROI is drawn.
- **Vol.[ccm]**: volume size of the currently selected ROI in cubic centimeters. The volume calculation will not be 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 – press the **Color** button to change the color of currently selected ROI
- Visibility – check/uncheck **Visible** check box to display/hide currently selected ROI in views
- Visualization type – specifies the rendering types (surface presentation) for currently selected ROI in the 3D view:
  - **Solid** – the ROI is displayed as an opaque object. Clicking on the ROI object surface in the 3D view, a new current point can be defined.
  - **Transparent** – the ROI will is displayed as a transparent object with the transparency ratio, which is defined with the **Opacity** slider (10 to 90% opacity). It is not possible to define the current point clicking on the transparent surface of drawn ROI in the 3D view.
  - **Stripes** – the ROI is displayed as a set of contours laying in parallel planes (wire-frame model).
  - **Transparent with stripes** – the ROI is composed from transparent and wire-frame model object.
- **Closure** – by default, the ROI is displayed in the 3D view with closed end surfaces. However, it can be displayed also with Bottom open, Top open or

Open (both ends open). If the ROI is not displayed with closed end surfaces, you can see inside the ROI through the open ends.

- Voxel size – The voxel size determines the granularity of the 3D reconstruction of the ROI. The 3D reconstruction is a procedure processing the ROI contours and creating 3D representation out of the 2D contours.
    - To set voxel size manually, enter the required size in the **Voxel size** box. To get the highest precision, the voxel size should be set to the minimal acceptable number (0.1 cm).
    - To calculate the voxel size automatically, check the **Automatic** check box. The voxel size will be set to a value based on a voxel/cm³ ratio automatically.

10.8 Edit contours with drawing tools

Each ROI consist of separate contours, which can be edited or created with manual and automatic drawing tools of TomoCon. All tools are available in the **ROI drawing** tool in the tools panel (see Figure 183).

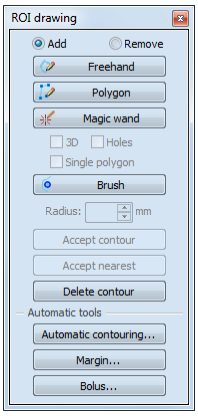


Figure 183 – ROI properties dialog, Contours tab

TomoCon provides you the following four manual and three automatic drawing tools for contours editing in the displayed image in the current view:

- manual drawing tools:
    - **Freehand** – to contour an area with free hand (see 10.8.1 Freehand drawing tool).
    - **Polygon** – to contour an area using a polygon (see 10.8.2 Polygon drawing tool).
    - **Magic wand** – to contour an area by joining adjacent image pixels with similar gray level values (see 10.8.3 Magic wand drawing tool).

- **Brush** – to contour an area using a circle (see 10.8.4 Brush drawing tool).

- automatic drawing tools:
  - **Automatic contouring** – to generate contours of ROI in several adjacent images at the same time automatically (see 10.8.5 Automatic contouring drawing tool).
  - **ROI margin** – to generate margin with defined properties of already created ROI automatically (see 10.8.6 ROI margin drawing tool).
  - **Bolus ROI** – to generate bolus type of ROI placed on the surface of already created ROI automatically (see 10.8.7 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, which allows drawing outline of contour by dragging the cursor.

To use the Freehand drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to edit a contour.
2. Select the adding mode (see Figure 184). To add a drawn contour in an ROI, check the **Add** radio button. To remove drawn contour from ROI, check the **Remove** radio button.

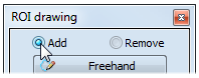


Figure 184 – Set Add/Remove mode for contour editing

3. Press the **Freehand** button in the **ROI drawing** tool.
4. Press and hold the left mouse button and draw a contour (see Figure 185).
5. Release the mouse button to close the contour.

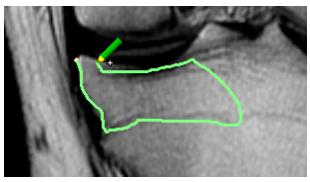


Figure 185 – Drawing contour with Freehand tool

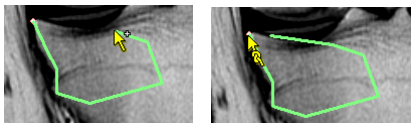
When the freehand drawing process of contour is finished, the contour is closed with a straight line between the starting point and the ending point.

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:

1. Select an ROI (as currently selected ROI), for which you want to edit a contour.
2. Select the adding mode (see Figure 184). To add a drawn contour in an ROI, check the **Add** radio button. To remove drawn contour from ROI, check the **Remove** radio button.
3. Press 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 mouse and click for every other polygon vertex (see Figure 186a).
6. To close the polygon, move the mouse close to the starting point until the mouse pointer changes to a closing symbol and click (see Figure 186b).



(a) **(b)**

Figure 186 – Drawing polygon contour (a), clicking end point of polygon contour (b)

10.8.3 Magic wand drawing tool

The Magic wand tool draws a contour of the currently selected ROI around a consistently colored area (including any off-color areas surrounded by the chosen area). Choose the range of color nuances (scope of grayscale) the contour shall enclose.

To use the Magic wand drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to edit a contour.
2. Select the adding mode (see Figure 184). To add a drawn contour in an ROI, check the **Add** radio button. To remove drawn contour from ROI, check the **Remove** radio button.
3. Press the **Magic wand** button in **ROI drawing** tool.
4. Select 2D or 3D mode:

- To create a contour in the current view only, uncheck the **3D** check box.
- To create contours in the whole volume, when the current view displays original image (not reconstructed) check the **3D** check box.

5. If only one compact polygon from contoured region shall be chosen as a final contoured area, check the **Single polygon** check box.
6. Check the **Holes** check box to accept holes in contours. It excludes any off-color areas enclosed in the area of the defined color range and creates holes in the contour instead.
7. Hold down the left mouse button to define the starting point and drag out from the starting point until the marked area covers what you want to define. The longer away you drag from the starting point, the wider range of color will be included (see Figure 187).
8. Release the mouse button.
9. Check if the contours are correct scrolling through slices and/or rotating ROIs in the 3D view.

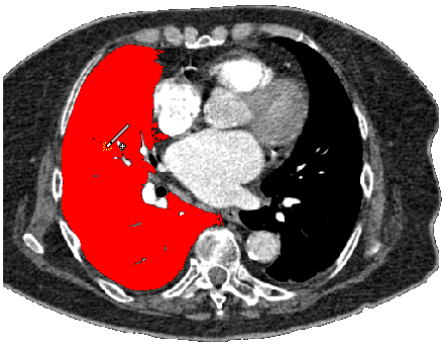


Figure 187 – Defining the area for Magic wand drawing tool

10.8.4 Brush drawing tool

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

To use the Brush drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to edit a contour.
2. Select the adding mode (see Figure 184). To add a drawn contour in an ROI, check the **Add** radio button. To remove drawn contour from ROI, check the **Remove** radio button.

3. Press the **Brush** button in the **ROI drawing** tool.
4. If necessary, adjust the size of brush tool by defining the **Radius** value in the box below the **Brush** button.

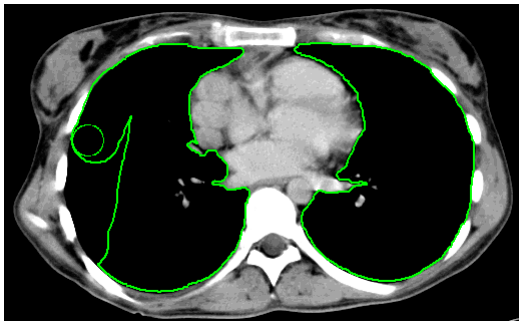
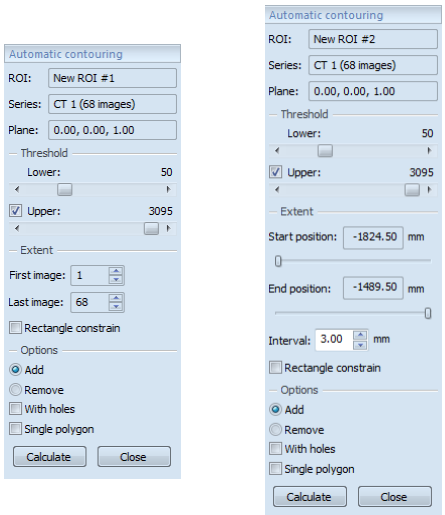


Figure 188 – Adding area to contour by Brush drawing tool

5. To add/remove contour, press the left mouse button and move the brush cursor to create the desired shape (see Figure 188).
6. Release the mouse button to end the creation of the contour.

10.8.5 Automatic contouring drawing tool

This ROI definition tool generates draws contours in several adjacent images at the same time automatically. It is especially suitable for defining the outline of the patient (the skin surface). Image area (whole image or limited rectangle) and image set volume (entire or subset of images selected by defining base image and extent) can be specified before creating contours.



(a) **(b)**

Figure 189 – Auto ROI tool for original images (a), for reconstructed images (b)

To use the Automatic contouring drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to edit a contour.
2. Press the **Automatic contouring...** button in the **ROI drawing** tool.
3. The **Auto ROI** tool will be displayed as a new tab in the tools panel automatically. You can define options for automatic contouring there (see Figure 189).
4. Select the **Lower** and **Upper** grayscale values for the search process. All grayscale values beginning within the selected threshold value range will be considered as matching. You can see this in the current view – matching regions are displayed red, the rest is black (see Figure 190).

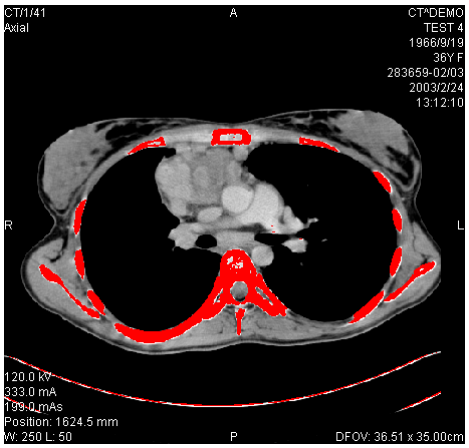


Figure 190 – Segmented image with threshold selection, contouring bones

5. Select the range of images (**Extent** part in the tool), which shall be used for automatic contour search, selecting an appropriate **First image** and **Last image** values or **First position** and **Last position** on reconstructed images.
6. Define which part of image shall be used (a limited rectangle or whole image).
   - Whole image: Creates an outline based on the whole image (default setting).
   - Rectangle: Only limited area of image will be used. To select the area:
     - Check the **Rectangle constraint** check box.
     - Move the rectangle or drag sides to change its size until covers desired area (see Figure 191).
     - Check if the desired are is correctly covered in all slices scrolling them in the current view.

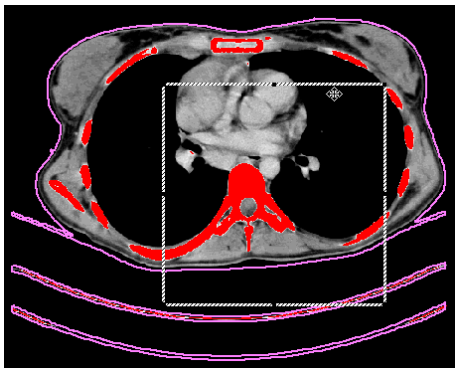


Figure 191 – Moving the rectangle constraint

7. Select the adding mode. To add all created contours in the currently selected ROI, check the **Add** radio button. To remove them, check the **Remove** radio button.
8. Select advanced options for automatic contouring:
   - **With holes** - looks for holes in each image according to setting of minimal and maximal threshold value.
   - **Single polygon** - only one polygon in each image without holes according to setting of minimal and maximal threshold value is used.
9. Press the **Calculate** button.

10.8.6 ROI margin drawing tool

This functionality is available only with Advanced Contouring license in TomoCon Workstation.

The ROI margin tool creates margin around the source ROI with defined dimensions and constraints of selected risk ROIs automatically.

To generate an ROI margin using the margin drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to create a margin.
2. Press the **ROI margin...** button in the **ROI drawing** tool.
3. The **ROI margin** tool will be displayed as a new tab in the tools panel automatically. You can define options for ROI margin there (see Figure 192).
4. Set margin size as desired along x-axis, z-axis, and y-axis. The sizes can be set individually for minus and plus directions on each axis or jointly for all directions at the same time with the **Grow** scrollbar (from -1cm to 10cm).
5. If desired – select one, or several **Risk ROI** (usually 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 will take precedence over the margin you are creating.

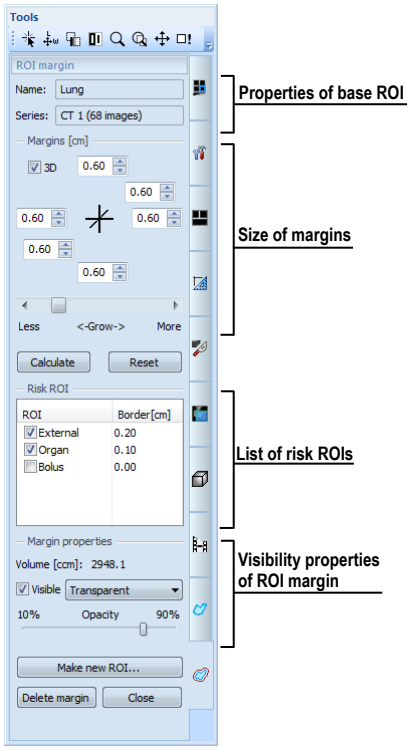
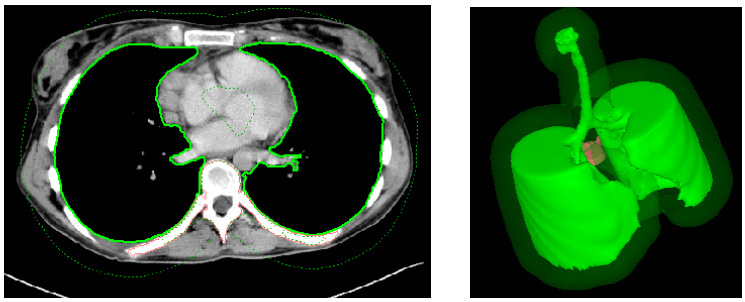


Figure 192 – ROI margin tool

6. Press the **Calculate** button. The created margin will be drawn by dash line (see Figure 193).



(a) **(b)**

Figure 193 – Created ROI margin in 2D (a), in 3D (b)

7. Examine the result in the images and the 3D view. Adjust margin properties if necessary. If the result is dissatisfying, adjust the settings in the ROI margin tool and re-create the margin.
8. To create an new ROI from generated margin, press the **Make new ROI...** button. The **Create structure from margin** dialog (see Figure 194) will be opened, where:

- Select image series if other than default shall be used (only possible if registration has been made).
- If not resampled into original images, uncheck the **Original images** check box and type a value in **Number of contours** box.
- Press the **Create** button to create the ROI.

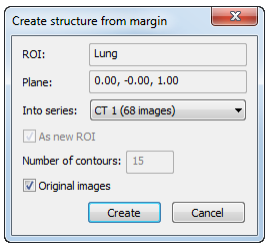


Figure 194 – Create structure from margin dialog

Now you can assign a new color to the margin ROI, resize it and do anything you can do with a manually drawn ROI. The margin ROI is no longer connected to the source ROI it was based on.

10.8.7 Bolus ROI defining drawing tool

This functionality is available only with Advanced Contouring license in TomoCon Workstation.

The define bolus tool allows you define a rectangular ROI of a certain thickness. The bolus ROI must be placed on the surface of a previously defined ROI. Base parameters for ROI bolus calculation are four markers in the current view. The two first (left and right) must be placed on an image, where the base ROI is drawn. The two following markers (top and bottom) can be placed in any image (original or reconstructed).

To generate the bolus ROI with bolus drawing tool:

1. Select an ROI (as currently selected ROI), for which you want to create bolus.
2. Press the **Bolus ROI...** button in the **ROI drawing** tool.
3. The **Define bolus** dialog (see Figure 195) will be opened, where you can:
   - Type a name of the bolus ROI and its color.
   - Define height of bolus in cm in the **Height** box.
   - If you finished with settings, press the **OK** button to continue.

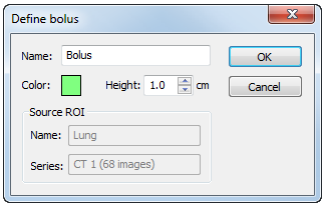


Figure 195 – Define bolus dialog

4. Define left, right, top and bottom point of the bolus clicking in the current view:

   - Define leftmost point of bolus clicking on the contour. The mouse 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 196).

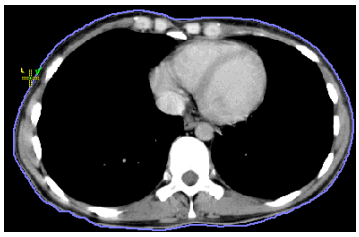


Figure 196 – Defining the left point of bolus

   - The mouse cursor is now marked as **R**. Click in the rightmost point of the bolus like above (see Figure 197).

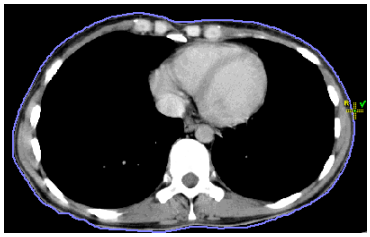


Figure 197 – Defining the right point of bolus

   - The top and the bottom point (mouse cursor marked as **T** and **B**) can be chosen in any image in the current view. It is not necessary to locate these points on the contour line, just in a view displaying the same image series (see Figure 198). The cursor will not be displayed as a green tick for **T** and **B**.

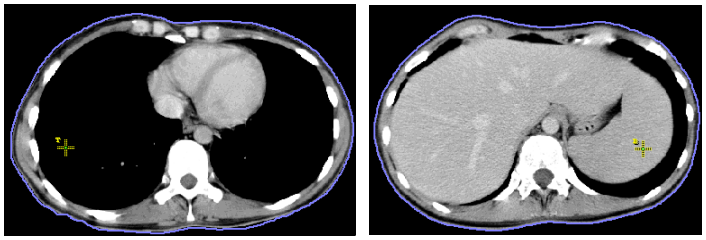


Figure 198 – Defining the top and bottom point of bolus

The bolus calculation process will be started after the fourth point has been defined in the current view automatically. The bolus will be generated and displayed as contours in the image series and as a volume in the 3D view (see Figure 199)

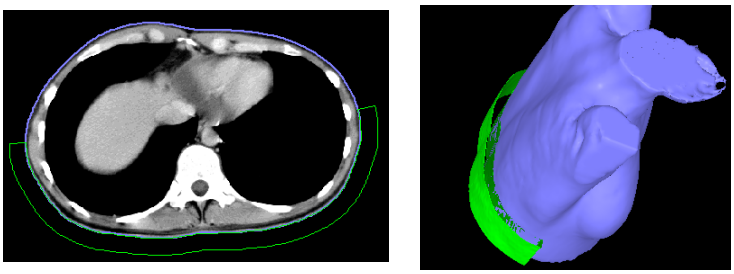


Figure 199 – Generated bolus ROI around the skin surface

11 MPR - Multi Planar Reformatting

MPRs show sections in patient's body using the defined plane. They provide special way of looking at medical imaging data and give you additional insight during viewing. MPR allows you to view three-dimensional volume along a direction other than direction of the original images. You can start MPR simply and quickly on any suitable study you have selected in the current view by using the **MPR** tool in tools panel.

NOTE! Diagnosing users should be aware that MPR views display **calculated data**. Calculated data, although based on the original data set, may give the appearance of healthy tissues in situations, where pathology, which is smaller than the image distance, may be present. Occasionally, calculated data may also include image artifacts, which should not be interpreted as real pathology.

MPR tool (see Figure 200) is initially docked in the tools panel (the fourth tab). You can get to it at any time by clicking the tab with icon. To start using this tool select image of series, which you would like to view with MPR, in requested view of working area. Then click by left mouse button on the requested type of MPR in this tool.

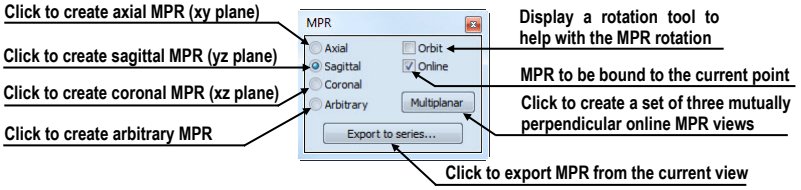


Figure 200 – MPR tool

For better spatial orientation, small box-like indicator in the upper right corner of the MPR view displays the approximate position and orientation of the MPR plane in patient image data (see Figure 201). Additionally, plane position of each displayed MPR is indicated by a colored line (see 4.4 Colors options) in all views, which are intersected by this plane.

Figure 201 – Indicator of MPR plane position and orientation

11.1 Arbitrary MPR

MPR is not necessarily oriented parallel to main patient axes. It can be rotated into any orientation. This can be done by clicking on the **MPR rotate** icon (in the context menu or in the **Context** toolbar) and moving mouse with pressed left mouse button directly in the current view. Base MPR plane (axial, sagittal or coronal) will be change to **Arbitrary** plane in **MPR** tool.

To use the image rotation more comfortable, click on the **Orbit** check box. MPR view will be overlaid by set of blue circles that mark image areas with different rotation functionality. Check the mouse cursor when it hovers over these areas (, ,). It describes the rotation axis, which will be used if the left mouse button is used to rotate the plane.

11.2 Online MPR

The **Online** check box in the **MPR** tool defines the online MPR to be bound to the current point (see Figure 202). All online planes are automatically shifted to intersect the current point. If the current point is changed by clicking into one of the views, all online planes will be shifted immediately.

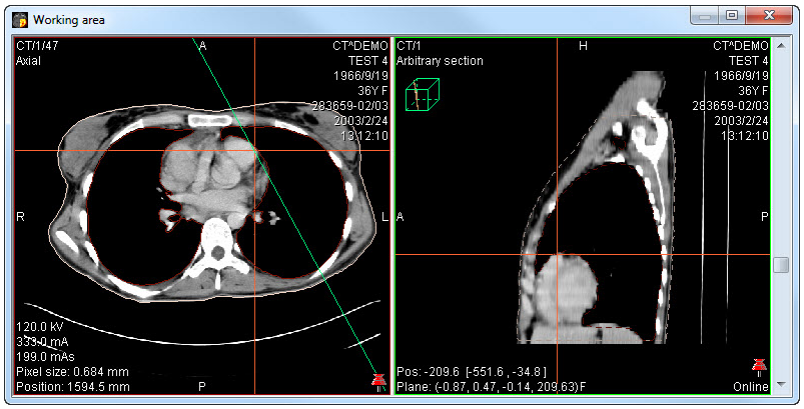


Figure 202 – Arbitrary MPR view and intersected axial MPR plane

11.3 Interactive moving and rotating

TomoCon application allows you to move and rotate MPR displayed in one view, from another view, by moving and rotating intersection lines. These lines are displayed automatically in all views, which planes are intersected with plane of this MPR. To move and rotate MPR (see Figure 203):

1. Display requested MPR in current view.
2. Select another view and display image or MPR in it, which intersects plane with MPR plane from step 1.

3. Intersection of planes will be displayed in current view.
4. If you move mouse cursor over this intersection line and press left mouse button, you can move plane of MPR in the first view (its frame is colored with blue color). To finish moving of plane, release mouse button.
5. If you move mouse cursor over circles on the intersection line and press left mouse button, you can rotate plane of MPR in first view (its frame is colored with blue color). To finish rotating of plane, release mouse button.

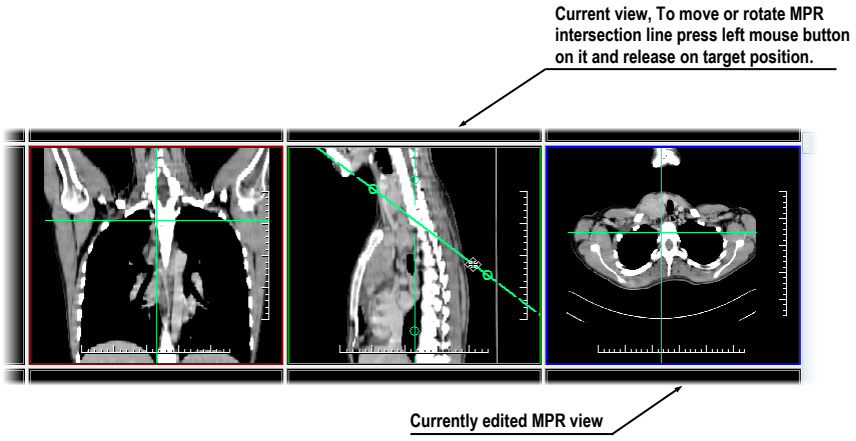


Figure 203 – Interactive moving of MPR

11.4 Export MPR to series

TomoCon allows to save an MPR view as an additional series in a study. Selecting parameters for the exported MPR it is possible to select exact properties of the new series (resolution, position of the first MPR, position of the last MPR). Once saved, the created MPR series can be sent to PACS as a new series or reopened for viewing.

To export a MPR view to a study:

1. Display the requested MPR in the current view.
2. Click on the **Export to series…** button in the **MPR** tool.
3. The **Export to series** dialog will be displayed. In this dialog you can set the parameters for the MPR export (see Figure 204).
4. After setting up the parameters, press the **OK** button.

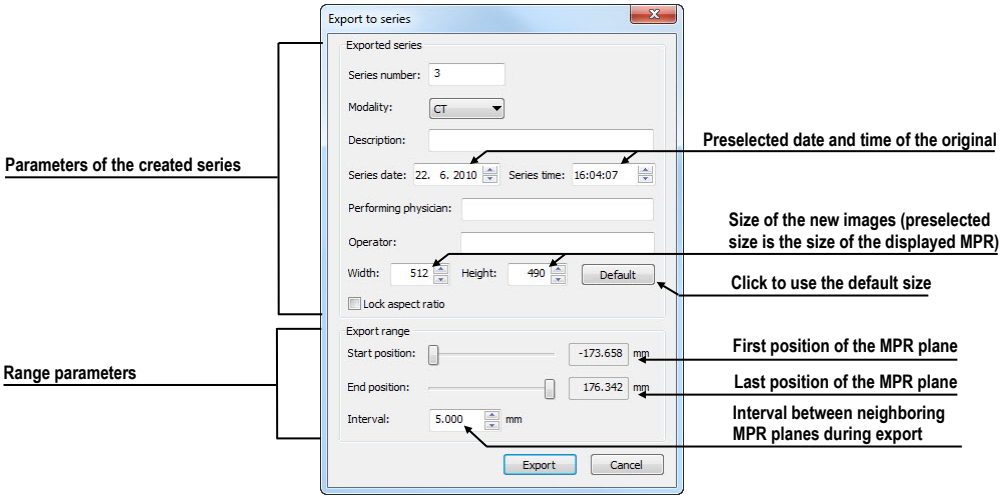


Figure 204 – Export to series dialog

12 MIP - Maximum Intensity Projection

MIP is a spatial method for displaying patient data. This method displays a projection of maximum values from particular images to 3D space. It looks for maximum pixel values and displays these as is projected onto a plane. Result of this projection is a multiframe image with frames creating an impression of a MIP object rotating in front of you. Except the usual MIP visualization, calculated from maximum values, TomoCon allows you to create a visualization which calculated from minimum values, and called a MinIP.

You can create MIP visualization simply and quickly on any suitable study you have selected in the current view by using the **MIP** tool in tools panel.

By default, the **MIP** tool (see Figure 205) is docked in the tools panel in the fourth tab by default. You can get to it by clicking on the tab containing icon.

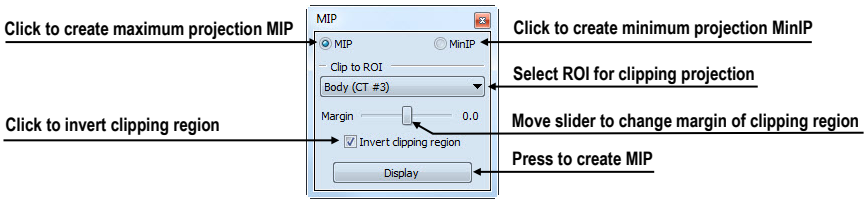


Figure 205 – MIP/MinIP dialog

To start using this tool, select image of series, which you would like to use for MIP visualization, in any view in working area. For the standard projection (MIP), select the **MIP** option, for a minimal projection (MinIP) select the **MinIP** option. To start the calculation process, press the **Apply** button. The calculated projection will be displayed in the current view immediately (see Figure 206).

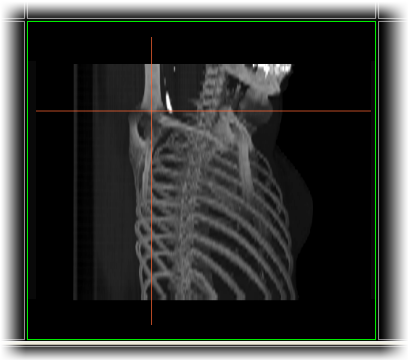


Figure 206 – MIP in the current view

13 DRR Reprojection

Digitally reconstructed radiograph (DRR) plays a more and more important role for clinical applications. It is a reprojection of a conventional 2D X-ray image, created from computed tomography data. TomoCon allows you to create DRR by summing CT intensities along a ray from each pixel (**View**) to simulated X-ray source (**Targed**).

To create **DRR** (Digitally Reconstructed Radiograph) reprojection from the patient image data use the **DRR** tool (see Figure 207), which is initially docked in the tools panel in the fourth tab. You can get in at any time by clicking on the tab with icon.

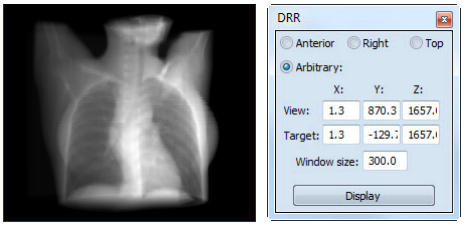


Figure 207 – DRR Reprojection image and tool

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

- **Viewport settings** - setting up the DDR position to the patient's position (**Anterior**, **Right**, **Top**, **Arbitrary** when DDR position using parameters **View** and **Target)**
- **Window size**

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

14 Multi-modality fusion

Multi-modality fusion allows to display the data from two registered series combined or overlapped in one image view.

The ability to correlate 3D images (see 16 Registrations) from various common modalities (CT, MRI, PET) has become a valuable tool in the radiology. TomoCon supports multimodality fusion and provides users with the ability to identify structures in one imaging modality and then spatially locate the structures in the different modality (for example CT-PET, CT scans with contrast media and without it, MRI series taken with different parameters, scans before the treatment and after the treatment and others).

To create a fusion from a two-modality image series, use the **Fusion** tool in the tools panel. It provides controls for fusion settings like base series, fusions series, color palettes, translucency, fusion method, etc. **Fusion** tool (see Figure 208) is initially docked in tools panel in the fifth tab. You can get to it by clicking the tab with icon.

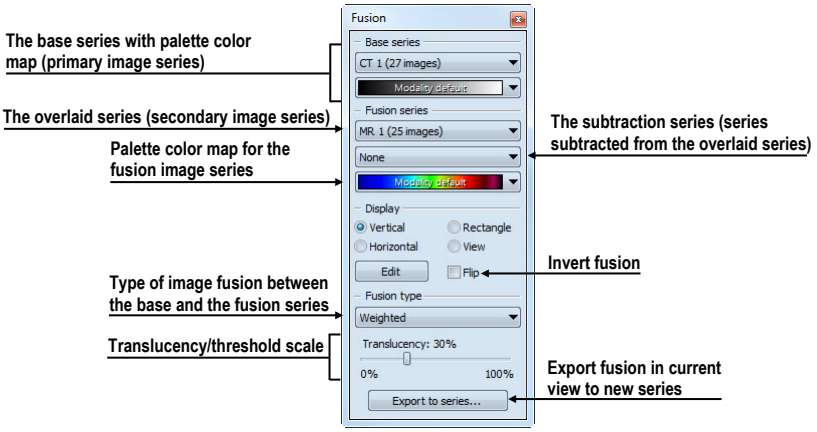


Figure 208 – Fusion tool

14.1 Create a multi-modality image fusion

To create a fusion from a two-modality image series, use the **Fusion** tool (see Figure 208):

1. Click on the **Base series** combo box to select the primary series.
2. Click on the **Base color map** to select the primary color map.
3. Click on the **Fusion series** combo box to select the secondary series.
4. Click on 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 be automatically set up according to the most recently used fusion.

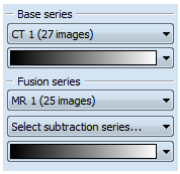


Figure 209 – Series and color maps selection

To add a subtraction series to a multi-modality fusion:

1. Click on the subtraction series combo box to select the subtraction series.
2. The color palette will be automatically changed to subtraction palette.
3. If you want to change the used subtraction palette, click on the fusion color map to select it.
4. To remove the used subtraction series from a fusion, select the **None** item in the **Select subtraction series…** combo box.

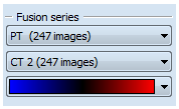


Figure 210 – Subtraction series and color map selection

To change the way how the fusion is displayed in the current view, click on the requested type in display part of fusion tool (see Figure 211). TomoCon provides following types of displaying:

- **Vertical** - the view is divided with a vertical line, image from the fusion series is on the right side (see Figure 212, right)
- **Horizontal** - the view is divided with a horizontal line, image from the fusion series is at the bottom
- **Rectangle -** the image from overlaying series is inside the rectangle (see Figure 212, left)
- **View -** the image from overlaying series is covering whole view
- **Edit -** after choosing this option (or double-clicking on the separation line or inside the rectangle) and holding the left mouse button, drag the rectangle, its frame or border to modify the border position, rectangle frame position and its size.

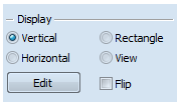


Figure 211 – Display part of Fusion tool

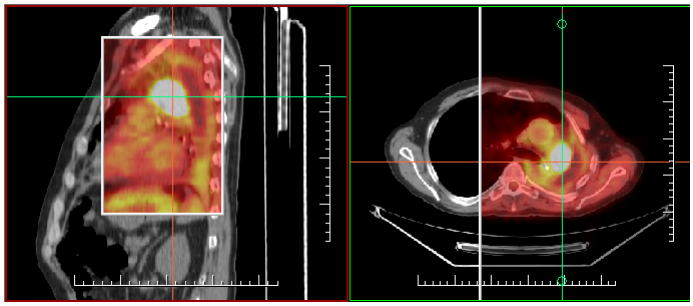


Figure 212 – Fusion images between MR and PET series

14.2 Fusion method

TomoCon provides following 5 ways of mixing the primary and secondary series in a multi-modality fusion. For each fusion method the series mixing scale can be changed using the fusion level (**Threshold/Translucency**).

- **Mask** – image data of the secondary series with pixel values above the defined *Threshold* will be displayed as *(primary + secondary color) / 2*.
- **Weighted** – the primary and secondary images are blended from full primary image (*Translucency = 0%*) to full secondary image (*Translucency = 100%*).
- **Merge** – calculated as *(primary + secondary color) / 2*.
- **Threshold** – image data of the secondary series with pixel values above the defined *Threshold* will be displayed in the defined color.
- **Contours** – provides an anatomic image with contours of data from the secondary series having the threshold value.

To change the fusion method type, click on the **Fusion type** combo box (see Figure 213) and select the method from the displayed list.

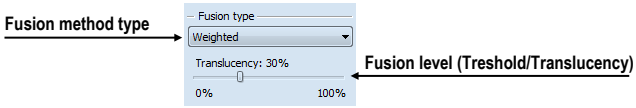


Figure 213 – Fusion type part of Fusion tool

14.3 Export a fusion to a series

TomoCon can save a fusion view as an additional series in a study. Also, it is possible to select the specified properties of exported new series by selecting parameters for

the exported fusion in the **Export to series** dialog (see Figure 214). Once saved, the created fusion series can be sent to PACS as new series or reopened for viewing.

To export a fusion view to a new series:

1. Display requested fusion in current view.
2. Click on the **Export to series…** button in the **Fusion** tool.
3. The **Export to series** dialog will be displayed, where you can set the parameters for the fusion export.
4. After setting up the parameters, press the **OK** button.

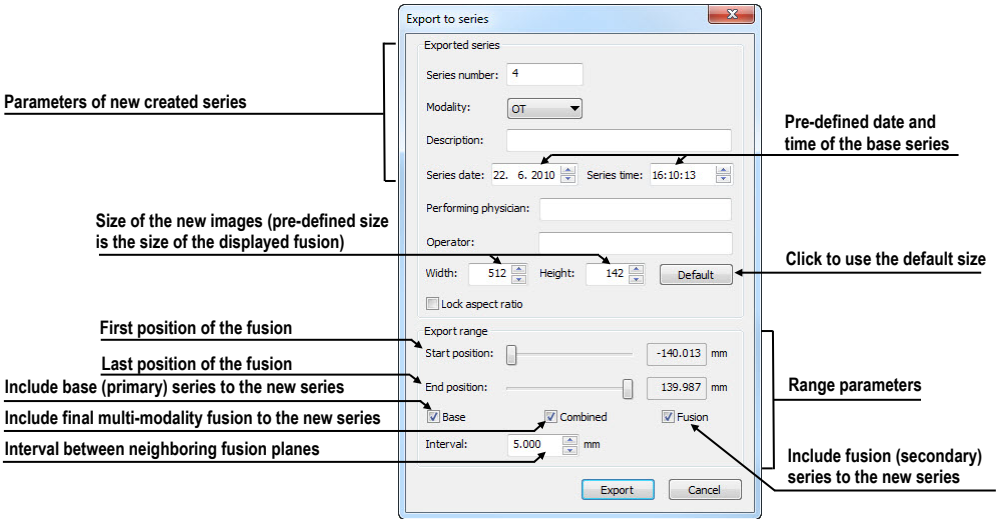


Figure 214 – Export to series dialog (parameters of the created series)

15 Three-Dimensional Visualization

A typical patient data is acquired as a set of two-dimensional (2D) images. Anyway, the data can be interpreted as a three-dimensional (3D) volume. TomoCom provides a possibility to view and navigate through 3D patient data as follows.

- Display interactive MPRs in 3D.
- Display ROI defined by segmentation in 3D (see 10 Contouring the patient – create ROIs).
- Use automatic volume rendering tool for 3D visualization of volume data (see 15.4 Volume rendering).

To define parameters of the 3D view use the **3D** tool (see Figure 215) in the **Tools** pane. It is initially docked in tools panel in the sixth tab. You can get to it at any time by clicking the tab with icon or by clicking on the **3D View** item in the **Tools** menu of TomoCon.

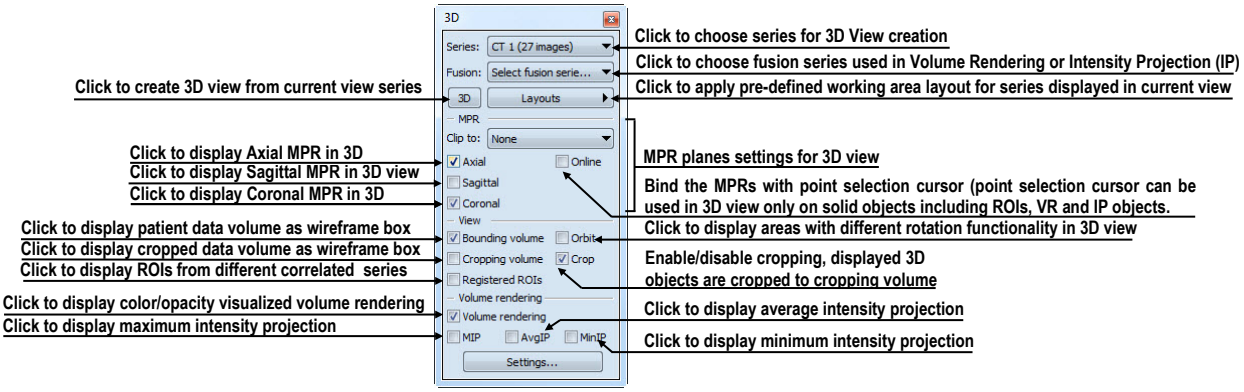


Figure 215 – 3D tool

To start using this tool, select series, which you would like to view with 3D, in the **Series** combo box or select any image of this series in requested view. Then, to create 3D view click by left mouse button on the requested 3D visualization method in this tool:

- To display ROIs in 3D view (see Figure 216) click on **3D** button.
- To create 3D visualization of volume data using Volume rendering click on the **Volume rendering** check box.
- To angiographic display of volume data in 3D click on the **MIP** check box (maximum projection), **AvgIP** (average projection) or on the **MinIP** check box (minimum projection).

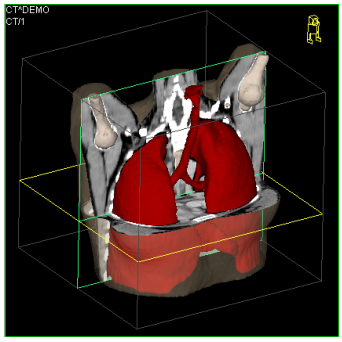


Figure 216 – 3D view

15.1 Rotation, spatial orientation

Click on the **Rotate** item in the 3D view's context menu or to activate rotate action. Mouse cursor will change to form. 3D view can be rotated using the left mouse button pressed.

Orbit item in the 3D view's context menu gives visual help to image rotation. 3D view will be overlaid by set of blue translucent spheres (see Figure 217). This marks image areas with different rotation functionality – check the mouse cursor changes when it hovers over these areas (, ,). Though, it describes the rotation axis, which will be used for rotation.

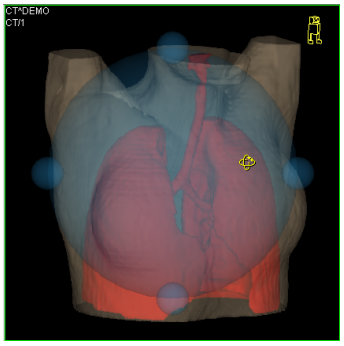


Figure 217 – 3D view with Orbit function

To return to the initial viewing angle and zoom, select the **Reset view** item in the 3D view's context menu.

For better spatial orientation, a small robot-like icon (called Enrico) is displayed in a chosen corner of 3D view. In correctly oriented studies, its orientation should match the patient's orientation. In case it disturbs you, you can hide it in the **TomoCon setup** dialog (see 4.3 View texts).

To rotate objects in 3D view, use the **Rotate** tool in the tools panel. Two rotation modes are available:

- rotation in screen coordinates (see Figure 218)

- rotation in patient coordinates (see Figure 219)

Screen coordinates rotation mode using buttons is similar to rotation in 3D view, screen coordinates system is used. Patient rotations mode using buttons rotates volume around patient coordinate system axes. Patient coordinates system axes differ by color: x-red, y-green, z-blue. Rotation control with Enrico works in the same manner as rotation in 3D view, for better orientation orbit is always displayed.

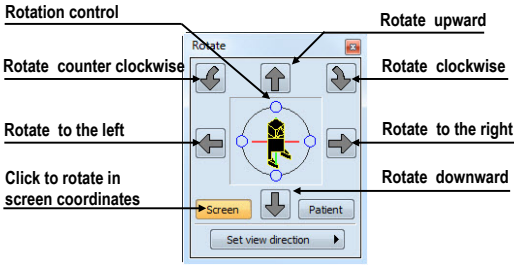


Figure 218 – Rotate tool (Screen mode)

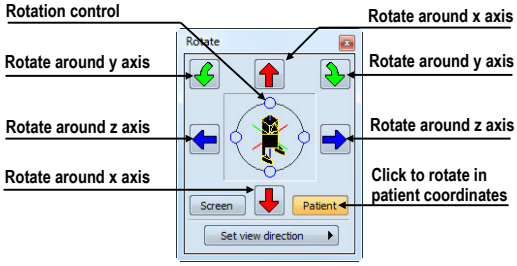


Figure 219 – Rotate tool (Patient mode)

15.2 Cropping volume of interest

Initially, 3D view displays the entire series bounding volume. For sake of faster rendering, removing parts out of interest, it might be efficient to view only a partial series volume. Volume cropping (see Figure 220) can be achieved in 3D view as well as in linked image, fusion or section view.

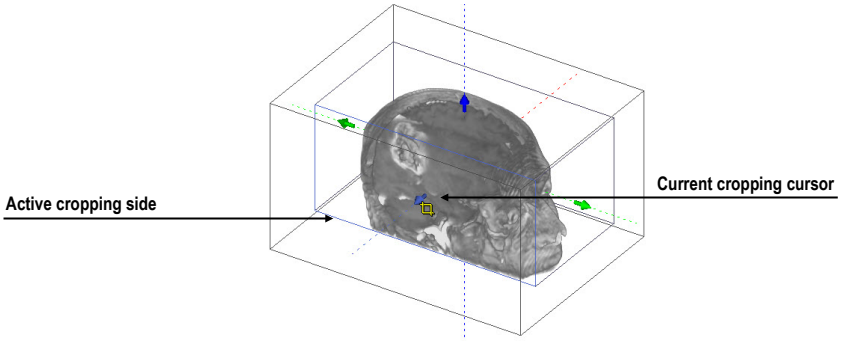


Figure 220 – Active cropping mode

To start cropping select the cropping tool in the 3D view's context menu (see Figure 221). Then drag selected object (cropping arrow, cropping cube edge) on the view and move it to desired position (see Figure 220).

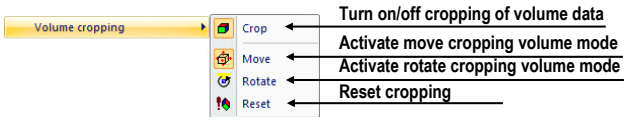


Figure 221 – Cropping menu

Volume cropping can be used in linked 2D views (2D views with the same series). In 2D view drag the edge of cropping volume polygon - an intersection of cropping volume and current image plane.

15.3 Moving MPR plane

In TomoCon it is allowed to move MPR plane interactively in the view (see Figure 222). When mouse hovers over an MPR edge of the MPR plane, cursor will change to and the border of the MPR plane is highlighted to yellow. Then press the left mouse button and move mouse to move the MPR plane.

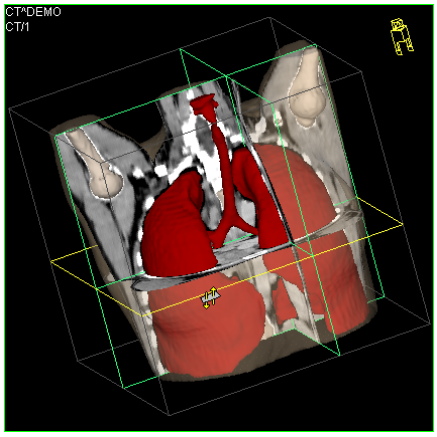


Figure 222 – 3D view with highlighted MPR plane

Moving MPRs can be used in linked 2D views (2D views with the same series). In 2D view drag the intersection line of given MPR - an intersection of the MPR and current image plane.

15.4 Volume rendering

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

- Select series of interest for volume rendering in the **Series** combo box of the **3D** tool, and then click on the **Volume rendering** check box (see Figure 223a).
- Select arbitrary image from series, which is intended to view with volume rendering to requested view, and click on the **Volume rendering** check box in the 3D tool.
- Select arbitrary image from series, which is intended to view with volume rendering to requested view and select pre-defined layout in 3D tool (see Figure 223b). Then click on the **Volume rendering** check box.

(a) **(b)**

Figure 223 – Select series to volume rendering, (a) select series by combo box, (b) use pre-defined layout

The volume rendering visualization (see Figure 224) with default or latest color preset for given modality will be automatically calculated and displayed in the current view. Applying intensity projections (MIP, MinIP, and AvgIP) is similar to volume rendering.

To change parameters of volume rendering visualization you can use following tool and dialogs in TomoCon:

- **Rotate** tool, which allows spatial manipulation of current 3D view (see 15.1 Rotation, spatial orientation).
- **Color and opacity** tool for defining and using pre-defined color presets (see 15.4.3 Create and use color presets).
- **Volume rendering settings** dialog, which allows you to change basic parameters of volume rendering visualization in the current view (see 15.4.2 Volume rendering settings).

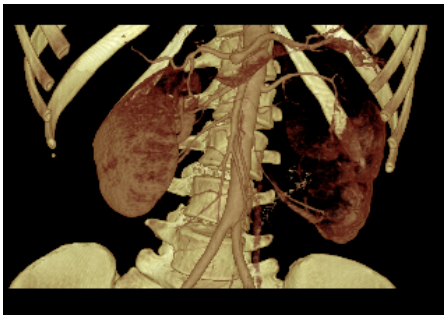
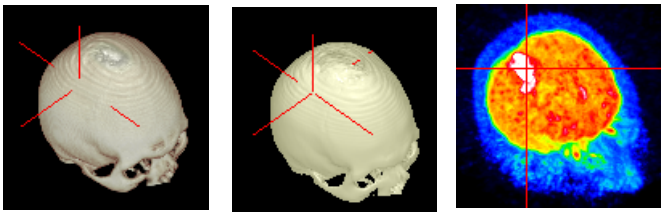


Figure 224 – Volume rendering 3D view

15.4.1 Point selection in volume rendering and intensity projections

Point selection in volume rendering is set to 3D point in cropped data volume, where the summed opacity is opaque. This is dependent on opacity defined for data values. For example, for the CT modality this might be inside bone, because the transfer function used in common presets does not define the whole interval for bones solid (see Figure 225). When solid isosurface is used, the point selection stops on isosurface. If point selection does not hit any solid point along the ray in cropped volume, the point selection is set to back face of the cropped volume.



(a) **(b)** **(c)**

Figure 225 – Point selection, (a) inside, (b) on surface, (c) in MIP

Point selection in MIP and MinIP is set to a point in 3D data volume, where the value is maximum in MIP or minimum in MinIP along the ray. Point selection for AvgIP in 3D view is not defined. Though, it is set to back face of cropped volume.

Point selection cursor in MIP, MinIP, AvgIP is displayed as 2D cross (similarly to image views), in contrary to 3D visualization optionally with volume rendering, where point selection is 3D cross.

15.4.2 Volume rendering settings

This dialog allows you to define custom adjustments of volume rendering quality and lightning in the current view. Following parameters can be set:

- basic volume rendering quality in the first tab (see Figure 226)

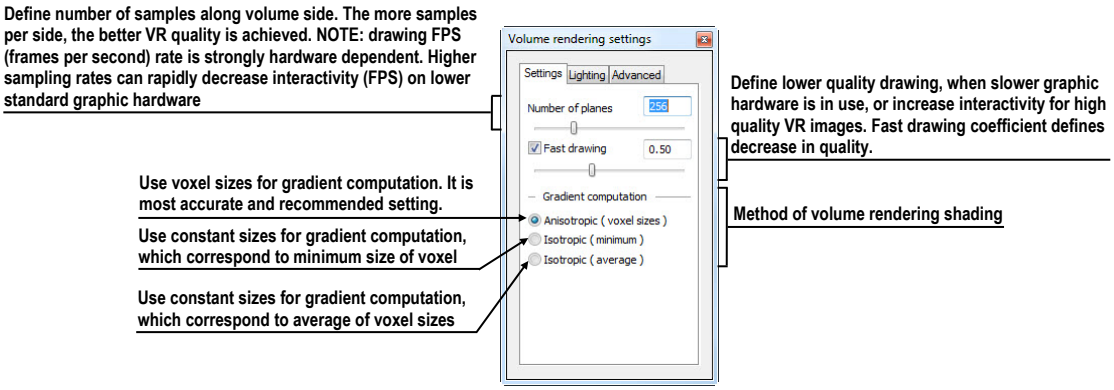


Figure 226 - Volume rendering settings, the first tab

- lighting settings used in volume rendering in the second tab (see Figure 227)

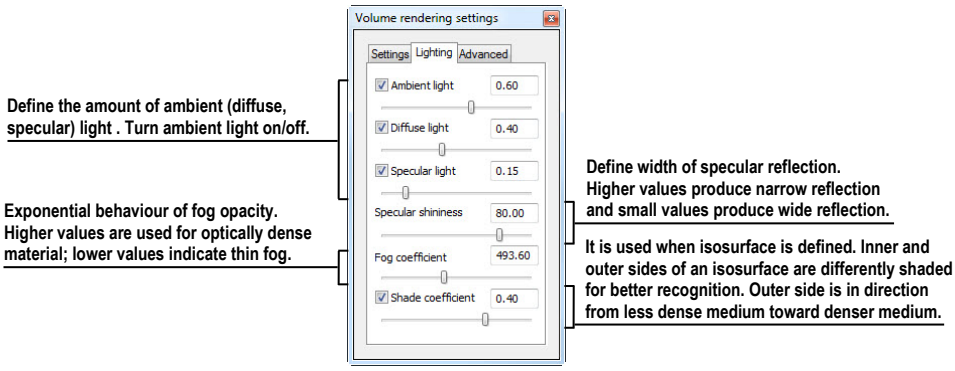


Figure 227 – Volume rendering settings, the second tab

- settings for color corrections and advanced ray casting settings in the third tab (see Figure 228)

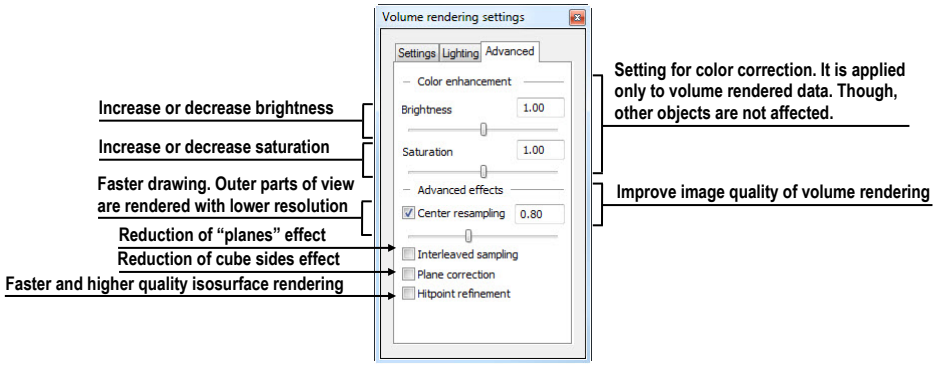


Figure 228 – Volume rendering settings, the third tab

15.4.3 Create and use color presets

TomoCon allows you to change the color, opacity and lighting of the volume rendering in current 3D view using saved color presets. TomoCon provides predefined color presets gallery. It gives a possibility to define custom color presets for special volume rendering visualization in 3D view.

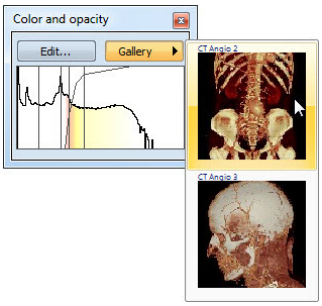


Figure 229 – Gallery of presets

To apply a color preset click the **Gallery** button in the **Color and opacity** tool (see Figure 229) in the tools panel. Then select requested preset in the displayed gallery list. Gallery contains default presets, included in installation (default presets cannot be modified), and all your own defined presets.

To create new color preset click on the **Edit…** button in the **Color and opacity** tool in the tools panel. **Color/opacity settings** dialog (see Figure 230) will be displayed. Define color, opacity and interval parameters for new preset in LUT control of the **Color/opacity settings** dialog (see Figure 230).

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

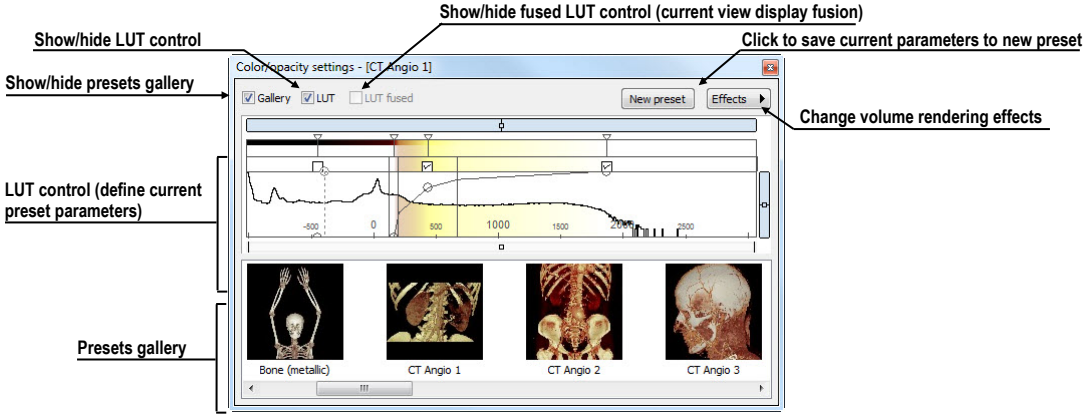


Figure 230 – Color/opacity settings dialog

To save color parameters for new preset click on the **New preset** button. New preset is automatically added to the end of presets gallery (bottom gallery part in dialog), and user is asked to enter a name for new preset (see Figure 231).

Figure 231 – New saved preset

To rename or delete saved color preset click on the preset in presets gallery control of **Color/opacity settings** dialog. Click the right mouse button to display context menu of selected preset. Then click on the **Rename**/**Delete** item in this menu.

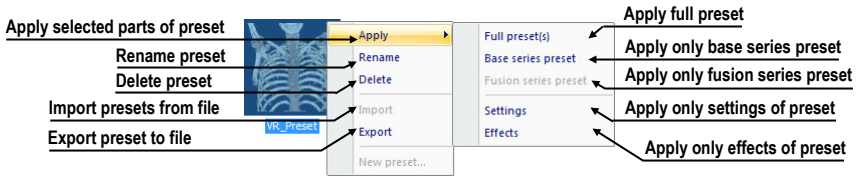


Figure 232 – Context menu of presets gallery

To set color parameters for preset use the LUT control part of the **Color/opacity settings** dialog (see Figure 233). It is control for defining the lookup table and/or isosurfaces used in volume rendering. LUT can be used in simple or advanced mode. In simple mode color ticks and opacity curve is fixed to interval bands. Advanced mode gives more flexibility in defining custom color table, enabling to modify opacity curve and color table independently from interval bands.

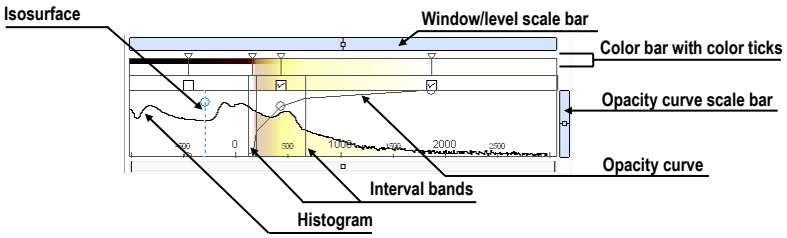


Figure 233 – LUT control part

Window/level scale bar is used to change Window/level of color table. Moving left mouse button changes level, **Ctrl** key + left mouse button moving changes window. Double click inside Window/level scale bar resets Window/level.

Window/level scale bar menu is displayed by clicking by right mouse button on bar. It defines which objects shall be moved simultaneously with W/L scale bar (**Color**, **Opacity**, **Check**, **Iso**). Each of the selected objects can be moved separately, or all the selected objects can be moved together.

Color bar with color ticks shows the current color palette. Colors can be modified by double clicking on color tick when cursor changes to ◇ or ⇿. In advanced mode you can move color ticks, when cursor changes to ⇿ and insert new color tick by double clicking inside color bar. Right button click inside color bar opens color table context menu, where you can insert new color tick and change interpolation between color ticks. Right button click on color tick (cursor is ⇿) displays color tick menu for delete and change color of current tick.

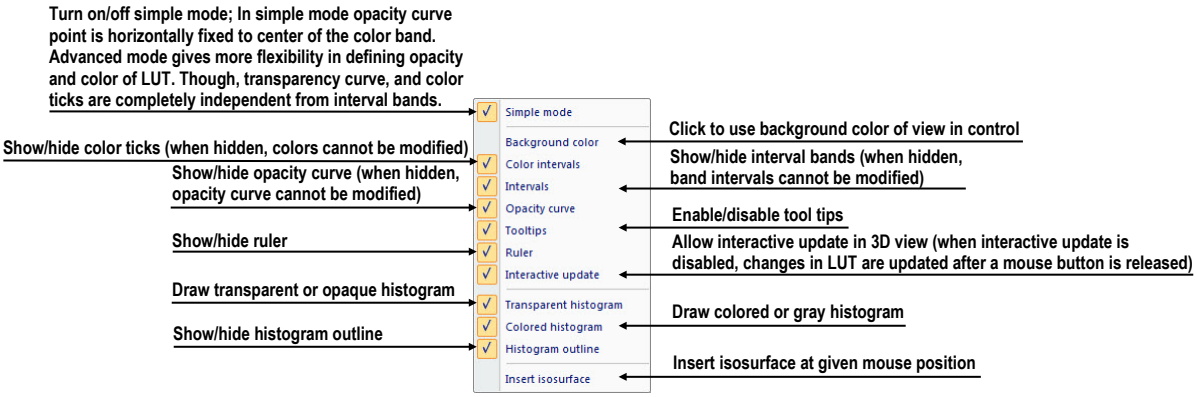


Figure 234 – LUT context menu

LUT context menu (see Figure 234) contains base properties of LUT control part. Display LUT context menu by right mouse button clicking inside LUT control.

Interval bands define custom interval band. Move interval band, when cursor changes to ⇹. When interval is turned off, opacity for given interval is considered zero. To add interval band, double click inside colored interval band, or right click inside colored interval bend select **Insert**. To delete interval right click on interval line, when cursor changes to ⇹, and select **Delete** item in context menu. Color palette inside interval bend is always shown with defined transparency.

Opacity curve defines opacity used in volume rendering. In simple mode the opacity curve is fixed to the center of an interval band, and automatically moved together with interval band. Modify opacity using mouse when cursor over opacity curve point changes to ⇳ or ✣. Press **Alt** key, and after the cursor over opacity curve changes to ⇜, using mouse modify the curve sharpness. Advanced mode: Opacity curve can be moved when **Alt** + **Shift** key is pressed and cursor over opacity curve changes to ⇿. Opacity curve can be moved/scaled using opacity curve scale bar (see Figure 234).

Isosurface is displayed in histogram area. To insert isosurface, use right button click on desired isosurface position and select **Insert isosurface** item in displayed context menu. Isosurface transparency is defined by circle position. Move isosurface, when cursor changes to ⇹. Change isosurface transparency, when cursor over circle changes to ⇳. Circle diameter can be adjusted using + and – keys (control window must have focus).

16 Registrations

To map one series onto another and define a relation between them, they have to be registered (matched one to another). It is then possible to transfer coordinates between the series bi-directionally, to check the same position in two series and to display the data overlaid from both series in the **Image fusion** mode (see 14 Multi-modality fusion).

To open the **Registrations** dialog (see Figure 235) click on the **Registrations…** item the **Tools** menu.

Figure 235 – Registrations dialog

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

- **New…** - define a new registration between two series (16.1 Defining registration).
- **Edit...** - edit the selected registration.
- **Delete… -** delete selected registration from the list of registrations.
- **Show Frame of reference registrations** - hide/display registrations between two series - if a Frame of reference is defined in patient data. When opening patient study (with the Frame of reference) the registration will be created automatically between the two series.

It is possible to define multiple registrations between two series. In this case, only one of them may be active (marked with green color and checked). Other registrations between the series are inactive (marked with red color and unchecked). Using the check box, it is possible to undefine temporarily a registration or to select one of the registrations defined for a pair of series.

16.1 Defining registration

Press the **New…** button in the **Registrations** dialog (see Figure 235) to define the relation between two series. The **Define registration** dialog will be opened (see Figure 236).

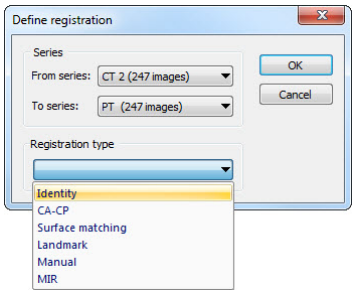


Figure 236 – Define registration dialog, selecting Registration type

The **Define registration** dialog (see Figure 236) specifies:

- **Series** - two series and the registration type between them:
  - **From series**
  - **To series**
- **Registration types**:
  - **Identity** (see 16.1.1 Identity)
  - **CA-CP** (see 16.1.2 Patient-related (CA-CP))
  - **Surface matching** (see 16.1.3 Surface matching)
  - **Landmark** (see 16.1.4 Landmark)
  - **Manual** (see 16.1.5 Manual)
  - **MIR** (see 16.1.6 MIR)

16.1.1 Identity

Identity registration assumes the coordinate systems of the two image series are identical. Use this option, if patient coordinate systems have been established in both image series (Frame of reference has been defined) or if with other means the coordinate systems were kept identical.

16.1.2 Patient-related (CA-CP)

CA-CP registration (see Figure 237) uses the coordinates of patient's CA, CP and Median points to establish a series registration.

The distance between **CA** and **CP** points must lie between 21.0 and 28.5 mm.

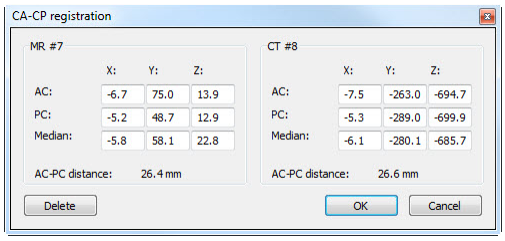


Figure 237 – CA-CP Registration dialog

16.1.3 Surface matching

Surface matching registration (see Figure 238) uses ROIs to establish a series registration. It is suitable for cases where the same structure ROI was defined in both image series. These two ROIs will then be matched.

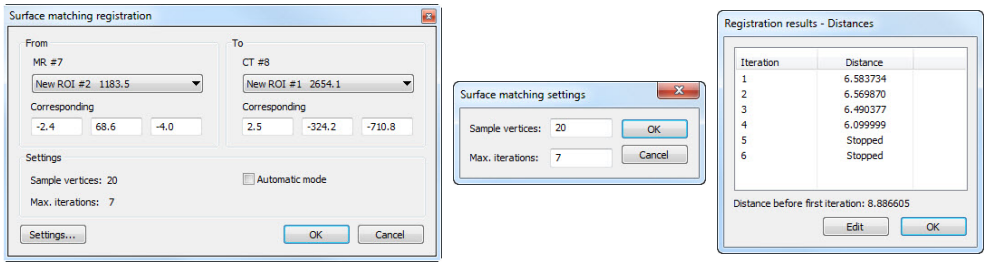


Figure 238 – Surface Matching Registration dialog, Surface matching settings dialog, Registration results - Distances dialog

16.1.4 Landmark

Landmark registration (see Figure 239) uses the coordinates of several landmarks to establish a series registration.

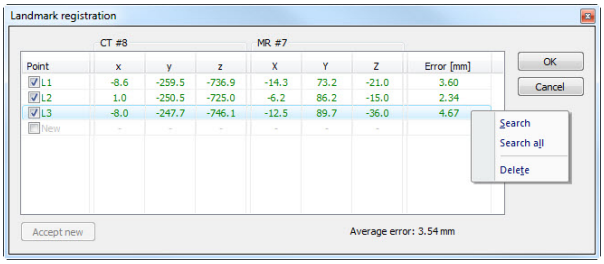


Figure 239 – Landmark Registration dialog

Wrong landmark couple with error exceeding an acceptable value can be disabled without deleting them from the list by unmarking in the check box.

Landmarks may be renamed according to the names of the marked significant points. To do so, click at the landmark name (default automatic names are **L1**, **L2**, etc.) and overwrite it to match the marked structure or pin (e.g. **Marker2**). All enabled landmarks are displayed in the image Marker2 with their respective name.

16.1.5 Manual

Manual registration of two different series uses relative manual movement of their three base planes. After selecting manual registration in the **Define registration** dialog, the **Manual registration initialization** dialog will be displayed (see Figure 240) for initial settings of manual registration. In this dialog, you can define one of these starting relations between the series:

- **Use existing registration** (select existing registration from list)
- **Automatic** (centers of 3D coordinate systems of both series will be assumed identical)

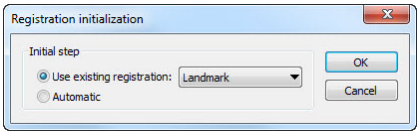


Figure 240 – Manual registration initialization dialog

After confirming the initial step with **OK** button three views for manual registration will be displayed in workspace (see Figure 241) together with the **Manual registration** dialog (see Figure 242).

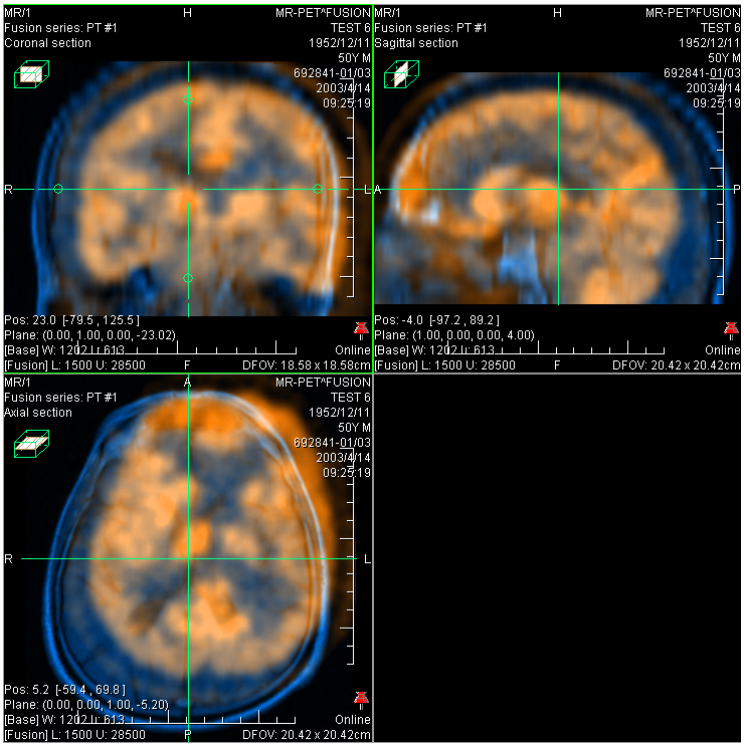


Figure 241 – Manual registration working area layout

The registration layout contains three independent views, each view displaying a pair of MPRs (each MPR is for different series) in one base plane (axial, sagittal, coronal). MPRs of registered series have different colors and they are transparent. The color of

MPR of each series is displayed in **Manual registration** dialog and you can change it at anytime.

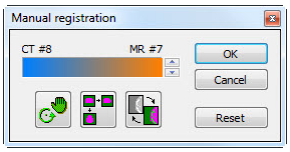
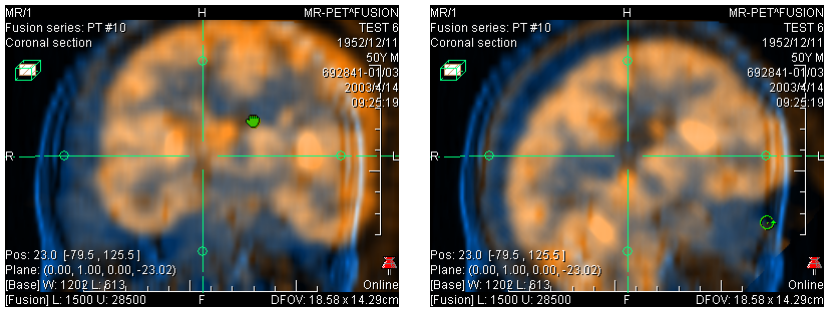


Figure 242 – Manual registration dialog

Activate the first view. A circle for moving and rotating the MPR will be displaying in this view. When the mouse cursor lays inside the circle, we can move the MPR (cursor is displayed as). Press the left mouse button, move the MPR to required position in view and release the mouse button (see Figure 243a). Out of this circle we can rotate MPR around the centre of view (cursor is displayed as). Press the left mouse button, rotate the MPR to required orientation in view and release the mouse button (see Figure 243b). We can only move/rotate MPR of one series. MPRs of the second series (called Base MPR) are left unchanged in view. After releasing mouse button the registration is automatically recalculated and the other views are redrawn automatically.

While editing the manual registration, it is anytime possible to enter the move and rotate mode by pressing the button (e.g. other operation type is used in the view).



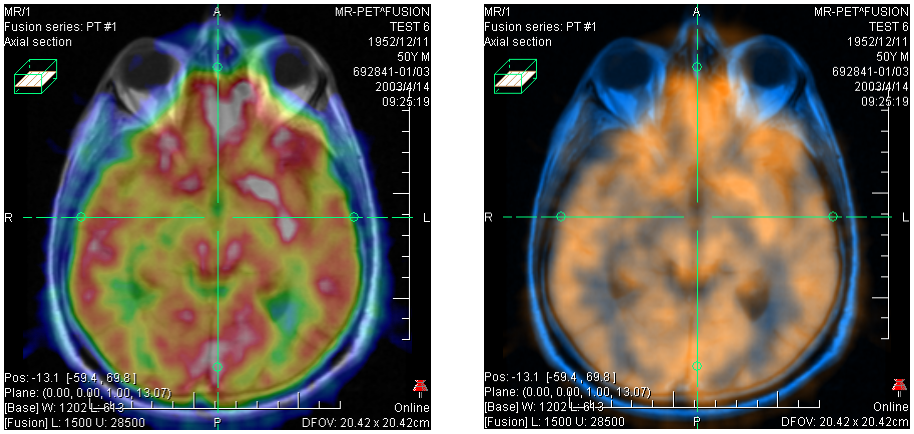
(a) **(b)**

Figure 243 – Pan (a) and rotate (b) MPR during manual registration

If necessary it is possible to modify the plane of the Base MPR in any view. To do so, activate the view, where the MPR plane should be changed and press the button in the **Manual Registration** dialog. MPR will be displayed in the current view (see Figure 244a), which can be moved and rotated (standard MPR display, see 11 MPR - Multi Planar Reformatting). After pressing the button once more it is possible to continue editing the manual registration view (see Figure 244b).

While editing the manual registration, it is anytime possible to revert to initial registration settings by pressing the **Reset** button in the **Manual Registration** dialog.

After the manual registration being successfully defined, press the **OK** button to add the registration to the list of existing registrations. Otherwise, after pressing the **Cancel** button, the registration will be discarded and will not be used.



(a) **(b)**

Figure 244 – Moving the Base MPR's plane (a), manual registration with shifted plane of the Base MPR (b)

16.1.6 MIR

> This functionality is available only with MIR license in TomoCon Workstation.

MIR (**M**utual **I**nformation **R**egistration) is probability method for calculation of registration between two series, where the final registration is calculated automatically.

After selecting MIR registration in the **Define registration** dialog, the **Registration Initialization** dialog will be displayed (see Figure 245) for initial settings of MIR registration. Initial transformation can be defined as:

- **Use existing registration** (select existing registration from list)
- **Automatic** (centers of 3D coordinate systems of both series will be assumed identical)

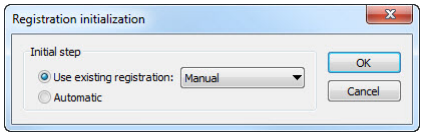


Figure 245 – MIR registration initialization dialog

After confirming the initial step with **OK** button, the **Mutual Information Registration** dialog will be displayed (see Figure 246). Calculation of the registration starts automatically. Registration progress is displayed in log window. By clicking **Stop level** button calculation for current level can be stopped manually, if the desired

accuracy is reached (changes in translation or rotation components are below 0.01; in log translation components are denoted *tx[y, z]*, rotation versor components *vx[y, z]*). To stop registration process click on the **Stop** button. Checking **Close when finished** check box causes, that registration dialog is automatically closed, when registration is finished.

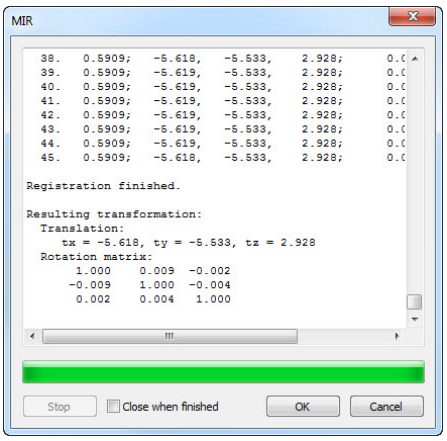


Figure 246 – MIR Registration dialog

17 Print images

17.1 Microsoft Windows printer

Patient image data can be printed on an Microsoft Windows printer using the **Print** dialog (see Figure 247) that will be opened by clicking at **Print…** in **TomoCon** menu.

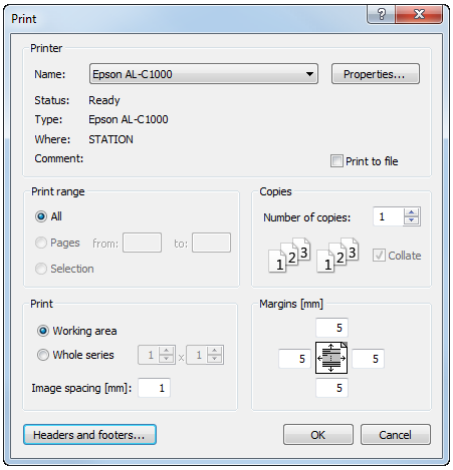


Figure 247 – Print dialog

It is possible to choose from following settings in the **Print** dialog:

- **Printer Name**
- **Margins**
- **Print**:
  - **Working area**
  - **Whole series**:
    - Number of **rows**
    - Number of **columns**
- Header and footer, which will be inserted to each printed paper. To define header and footer, press **Headers and footers** button. In **Page headers and footers** dialog, which will be displayed, you can define following types of text for 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**
One type &	**&&**

These types are formatting the text, which shall be printed. On the Figure 248 you can see an example of this text, where header contains name of the organization in the middle and name of the doctor on the right side. When you have finished with your definition, press **OK** button to confirm.

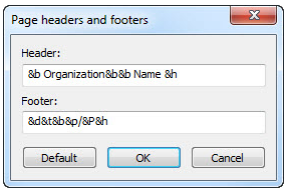


Figure 248 – Page headers and footers dialog

Note! Do not forget to select an appropriate paper orientation and other preferences in the **Properties…** dialog.

Set up the parameters, press the **OK** button; the printing process will start.

17.2 DICOM printer

Patient image data can be printed on a DICOM printer using the DICOM print interface (see Figure 249) that will be displayed after pressing the **DICOM print...** submenu in **TomoCon** menu.

DICOM print interface consists of:

- Working area (see 17.2.1 DICOM print working area)
- Thumbnail palette (see 17.2.2 DICOM print Thumbnail palette)
- Print queue (see 17.2.11 Monitoring and controlling the print process)
- Menu (see 17.2.3 DICOM print menu)
- Standard toolbar (see 17.2.4 DICOM print standard toolbar)
- Status bar (see 17.2.5 DICOM print status bar)

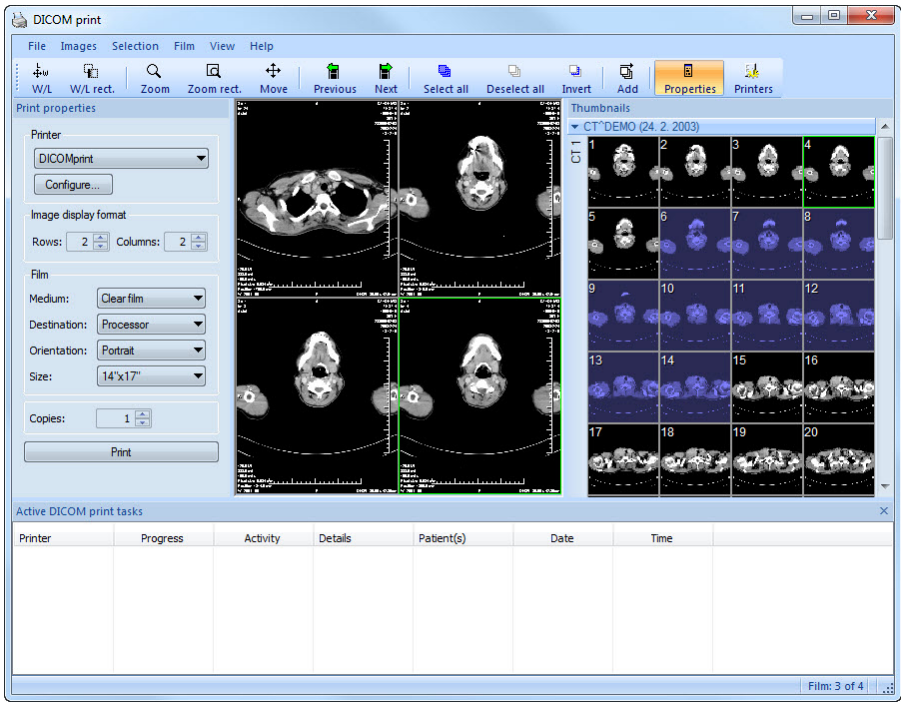


Figure 249 – DICOM print interface

17.2.1 DICOM print working area

DICOM Print working area is a big black area representing one print film. It is similar to the TomoCon's working area. It is divided into smaller windows (views) depending on row and column settings in the **Print properties** dialog, **Image Display Format** (see 17.2.7 Setting up DICOM print interface properties).

Use the mouse to move between the views, the current view is highlighted in a colored frame (see 4.4 Colors options). Use the actions in the DICOM Print view's context menu, **Standard** toolbar (see 17.2.4 DICOM print standard toolbar) or program menu (see 17.2.3 DICOM print menu) to operate with the image in the current view.

17.2.2 DICOM print Thumbnail palette

The thumbnails palette is located at the right side of the DICOM print interface (see Figure 249) and it is a copy of a thumbnails palette in the application. All series of opened studies in TomoCon are displayed in the palette and the work with it is identical to the work with thumbnails palette in TomoCon (see 3.3 Thumbnails palette).

17.2.3 DICOM print menu

DICOM Print menu is located as a DICOM Print window system menu (see Figure 249). It has following sub menus:

- **File -** DICOM printer installation (the **Printers…** submenu, see 17.2.6 DICOM printer), stop working in DICOM Print interface (**Exit**)
- **Images -** image modification in the current view (see 17.2.8 Edit images)
- **Selection –** select images from the thumbnails palette to the working area (see 17.2.9 Images for print)
- **Film -** edit and move between the films (see 17.2.10 Edit and move films)
- **View -** hide/display: **Toolbar**, **Status bar**, **Thumbnail palette**, **Print properties** dialog, **Print queue** list,

  and following information in all images of the films: **Text, Ruler, Curves, Shutter, Overlay, Annotations, Help**

17.2.4 DICOM print standard toolbar

The **Standard** toolbar (see Figure 250) is located under the DICOM Print interface system (to display/hide the dialog see 17.2.3 DICOM print menu, **View/Toolbar**). The **Standard** toolbar contains:

- Tools for changing gray, window and level in the current view (**W/L**, **W/L rect.**).
- Tools for image zooming in the current view (**Zoom**, **Zoom rect.**).
- Tools for moving the image in the current view (**Move**).

Activation and using the tools is identical to the tools of TomoCon toolbars (see 3.5 Main toolbar):

- Move to the previous film (**Previous**)
- Move to the next film (**Next**)
- Select all images in the thumbnails palette (**Select all**)
- Deselect all chosen images in the thumbnails palette (**Deselect all**)
- Invert the chosen images from the thumbnails palette (**Invert**)
- Add all chosen images from the thumbnails palette to the working area (**Add**)
- Display/hide the **Print properties** (**Properties**) dialog
- Display DICOM printers installation dialog (**Printers**)

Figure 250 – DICOM print standard toolbar

17.2.5 DICOM print status bar

The **Status** bar is located at the bottom of the DICOM Print interface (to hide/display the dialog see 17.2.3 DICOM print menu, **View/Status bar**). If the user selects a menu or a button from the toolbar, its description appears on the left side of the **Status** bar (instead of the "TomoCon 3.0 Ready" text). The number of the current film is displayed on the right side of the **Status** bar which represents the DICOM Print interface working area.

17.2.6 DICOM printer installation

Use the **Printers** dialog (see Figure 252) to install a DICOM printer. Click on the **File/Printers...** in the DICOM print interface program menu to open the dialog (see Figure 251).

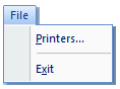


Figure 251 – File menu

The **Printers** dialog contains a list of installed DICOM printers. It is possible to configurate them using the Configuration dialog of a chosen printer (see Figure 253) that will be displayed after clicking on the **Configure...** button. Using the **Verify** button it is possible to test the connection between TomoCon and the chosen DICOM printer. Use the **Delete** button to delete a printer from the list.

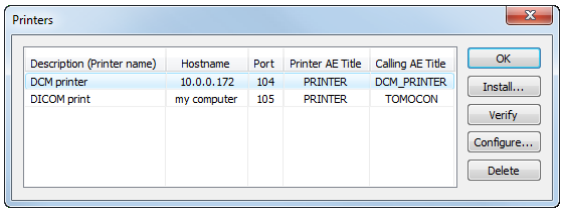


Figure 252 – Printers dialog

To install a new DICOM printer click on the **Install...** button to open the **Printer installation** dialog (see Figure 254). Then, specify the new printer's properties (**Printer name**, **Hostname**, **Port**, **Printer AE title**, **Calling AE title**).

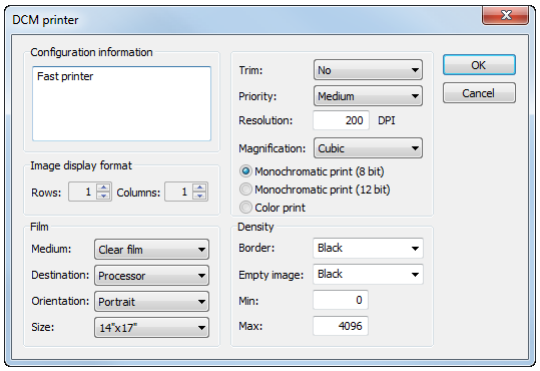


Figure 253 – Printer configuration dialog

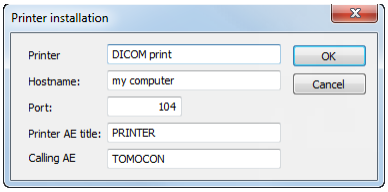


Figure 254 – Printer installation dialog

17.2.7 Setting up DICOM print interface properties

Use the **Print Properties** dialog to set up DICOM Print interface preferences (to display/hide the dialog see 17.2.3 DICOM print menu**, View/Print properties**). This dialog (see Figure 255) is placed on the left side of the working area. It can be docked anywhere inside the area in the same way as the thumbnails palette.

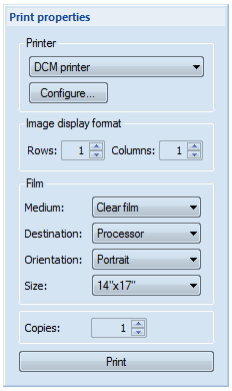


Figure 255 – Print properties dialog

Using the **Print properties** dialog (see Figure 255) it is possible to set up the following DICOM Print interface properties:

- **Printer –** the printer can be selected from a drop-down list of installed printers and configured after pressing the **Configure…**button.
- **Image Display Format (Rows, Columns) –** the number of rows and columns in the working area that match the image layout in the film.

- **Film** (**Medium**, **Destination**, **Orientation**, **Size**) - film properties.

Press the **Print** button when the film is ready for printing. The current state of process will be displayed in **Preparing data** dialog (see Figure 256) and when this process will be finished, a new print task will be added to the print queue (see 17.2.11 Monitoring and controlling the print process).

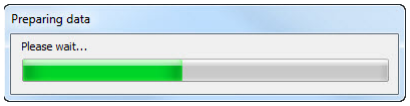


Figure 256 – DICOM printing…

17.2.8 Edit images

Images in the working area can be edited in the same way as the images in TomoCon. To modify the image data in the current view, use the **Images** menu (see Figure 257) containing the following tools:

- **Window/Level**
- **Window/Level rectangle**
- **Zoom**
- **Zoom Rectangle**
- **Move**

Activation and using the modifications is identical to the options of TomoCon's **Image** menu (see 3.4 Main menu).

Figure 257 – Images menu

17.2.9 Images for print

Select images for print in the DICOM Print interface from the thumbnails palette where all series are located. Use the **Selection** menu to select the images and add them to the film (see Figure 258).

Figure 258 – Selection menu

The **Selection** menu allows to:

- Select all images displayed in the thumbnails palette (**Select all**).
- Cancel the choice of all images from the thumbnails palette (**Deselect all**).
- Invert the selected images (**Invert selection**).
- Add chosen images from the thumbnails palette to the film (**Add selected**), the images will be added to the end of the film/films behind the already chosen images.

17.2.10 Edit and move films

When starting the DICOM Print interface an empty film without images is available. After adding the images these are placed one after another to the required number of films. The DICOM Print working area represents one film. Number of images on the film is specified by number of rows and columns in the **Print properties** dialog in the **Image Display Format** option.

Use the **Film** menu to edit and move films (see Figure 259):

- Move to the next film (**Next**).
- Move to the previous film (**Previous**).
- Delete an image in the current view (**Delete image**). Images following the deleted image will be replaced in one position.
- **Delete film** and **Delete all films**.

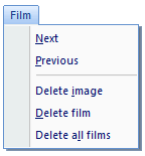


Figure 259 – Film menu

17.2.11 Monitoring and controlling the print process

Using the **Active DICOM print tasks** list (see Figure 260), which you can show/hide by clicking on item **Print queue** in the menu **View**, you can see if and how many studies are waiting to be printed out (pending), whether any are currently being printed and whether any errors have occurred. Besides the current state of each task displayed in **Activity** column, there are displayed information of each task like name of the printer (**Printer** column), progress of the current task's state (**Progress** column), task's **Details**, etc.

The context menu of each task displayed in the list let you restart, remove, stop or delete your jobs. To do these actions with a job in your printer queue, firstly select the job in the list, click right mouse button, that displays context menu and then select requested action.

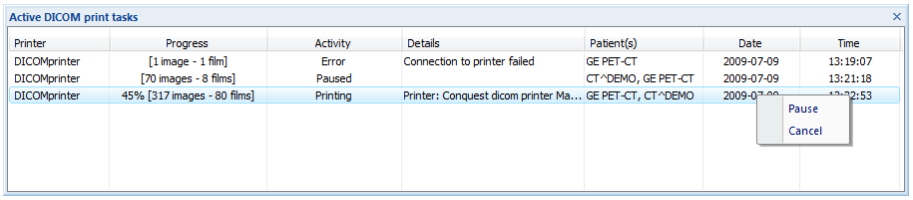


Figure 260 – Active DICOM print tasks list

18 ECG/HD

TomoCon also provides a way to review and enter measurements and diagnoses for ECG waveforms, stored in patient DICOM data. Therefore it is very simple to join diagnostic images of patient with ECG diagnostic waveforms. The clinician has full access to comprehensive ECG/HD information in TomoCon using **Waveforms** workspace that will be displayed automatically after opening a patient with stored ECG/HD information, or manually after pressing the **ECG/HD...** item in the **Tools** menu.

The **Waveforms** workspace consists of the following three parts (see Figure 261):

- toolbar with all applicable tools for ECG/HD diagnostic (upper left corner)
- list of all opened ECG/HD waveforms in TomoCon (left side)
- preview window for viewing and diagnosing of selected waveform

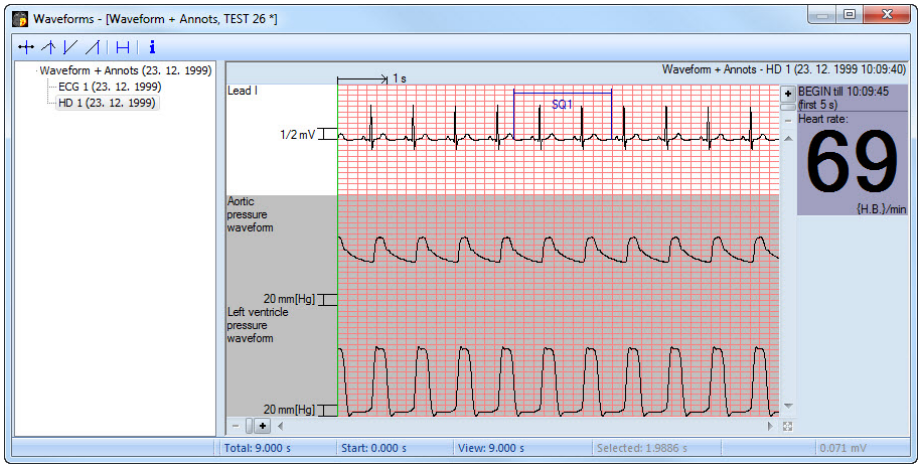


Figure 261 – Waveform workspace

18.1 Navigating through opened ECG/HD waveforms

All opened ECG/HD waveforms are listed on the left side of **Waveforms** workspace in TomoCon. All waveforms are grouped according to the studies they belong to.

To display a preview of a waveform:

1. Look through the all studies groups in the list on the left side of the workspace.

   To see which waveform belongs to a study, click on the [+] symbol in front of the study name. A complete list of all waveforms of the selected study will be displayed.

To collapse the list of study waveforms, click on the [–] symbol in front of the study name.

2. When you find a waveform in the list, select it with a mouse click.

The selected waveform will be displayed in the preview window on the right side of the workspace.

18.2 Viewing and diagnostics of ECG/HD

After opening the waveform workspace, you can display a desired ECG/HD waveform immediately (see Figure 262). Simply left-click on the waveform name in the list on the left side and the selected waveform will be displayed in the preview window on the right side immediately. Use of the preview window is quite easy and intuitive. It provides a set of comprehensive and flexible tools for reviewing and diagnosis of ECG/HD in TomoCon.

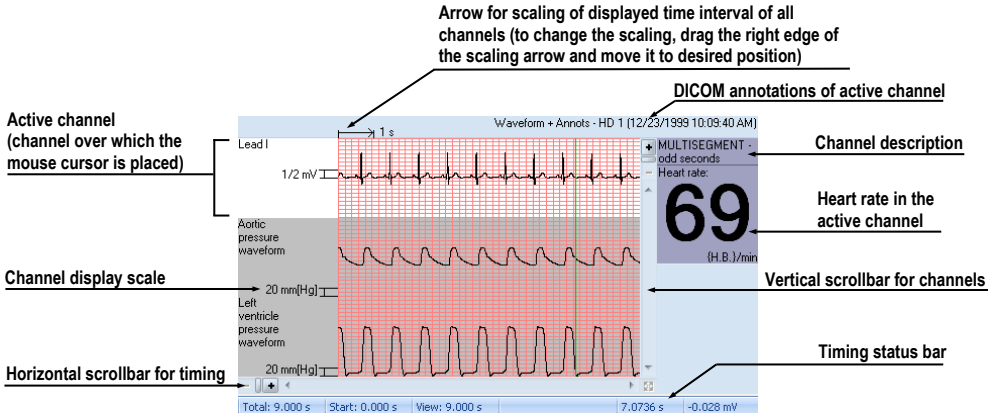


Figure 262 – Preview window for viewing and diagnosing of ECG/ HD

18.2.1 Status bar

Timing status bar (see Figure 263) is the bar at the bottom of the waveform workspace. It displays main time and value parameters from displayed ECG or HD channels.

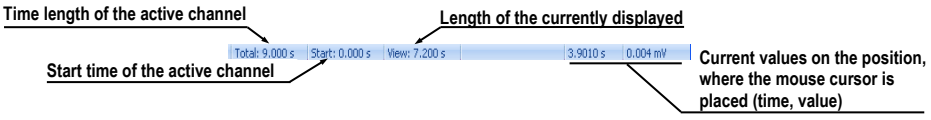


Figure 263 – Timing status bar

18.2.2 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 264).

To customize the number of displayed channels, use the vertical scrollbar on the right side of channels grid preview (see Figure 264).

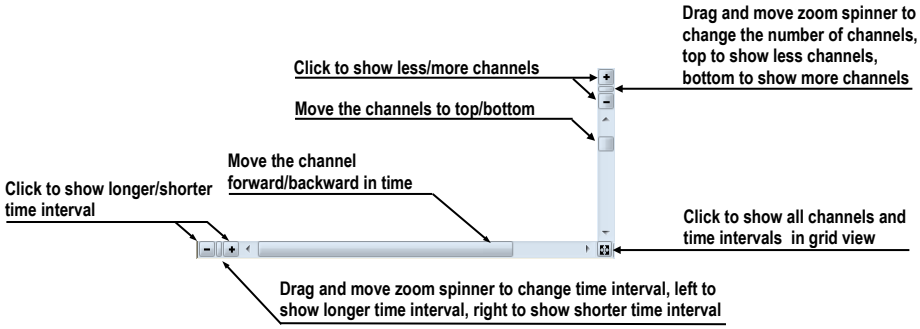


Figure 264 – Waveform workspace scrollbars

To customize the value scaling just for the active channel (the channel where the mouse 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. Active channel is immediately vertically adjusted to the selected scale position (see Figure 265).

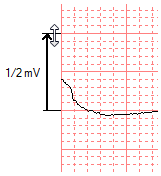


Figure 265 – Active channel value scaling

18.2.3 Time cursor in ECG/HD

During preview of 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 contains a time cursor tool (see Figure 266).

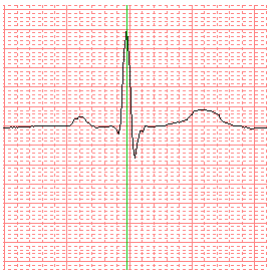


Figure 266 – Time cursor

It is a special mouse cursor, which is activated when the mouse cursor hovers over the grid view. While moving the mouse, the Status bar automatically displays time and value from the current cursor position. Moreover it is also possible to find 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 corner of the waveform workspace) and move the mouse cursor over the desired channel.

To activate snapping to:

- the nearest sample around the cursor, click on the button
- the nearest extreme around the cursor, click on the button
- the minimum in range around the cursor, click on the button
- the maximum in range around the cursor, click on the button

18.2.4 Marker measurement in ECG/HD

While diagnosing an ECG/HD examination it is often necessary to measure or mark just a particular range of a selected channel. For this purpose TomoCon contains a manual measurement tool of type **Marker** (see Figure 267). Using this tool it is possible to graphically write the measured time interval into the examination along with the description. Moreover TomoCon allows 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.

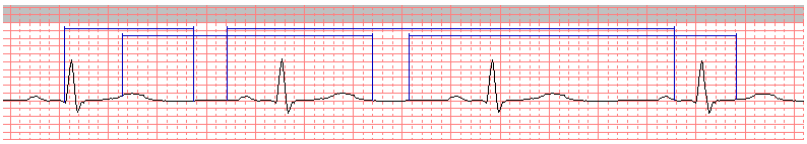


Figure 267 – Markers in selected channel

To create new range measurement:

1. Click on the button on the toolbar in the waveform workspace or context menu.
2. Move the mouse cursor to the desired start location in a channel.
3. Press the left mouse button at the start location and move the mouse cursor to the second location where you want the measurement to end.
4. Release the left mouse button. The **Marker properties** dialog will be displayed automatically (see Figure 268).
5. Fill in the **Marker properties** dialog and press the **OK** button. A newly defined range measurement will be automatically created and displayed in the active channel with a blue color and labeled with specified title.

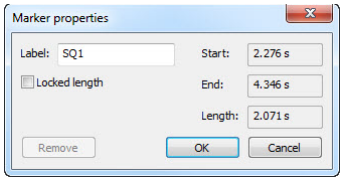


Figure 268 – Marker properties dialog

To edit the start and the end location of a defined range measurement:

1. Move the mouse cursor over the vertical start or end line (the measurement will be highlighted).
2. Press the left mouse button and move the cursor to a new location (see Figure 269). The measurement border will be moved with the mouse cursor.
3. Release the left mouse button.

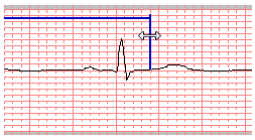


Figure 269 – Editing a defined Marker

To edit measurement properties or remove a defined measurement:

1. Move the mouse 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 click on the **Properties…** menu item in the displayed context menu (see Figure 270).

To remove the measurement click on the **Remove** menu item in the displayed context menu.

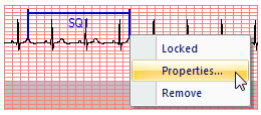


Figure 270 – Marker context menu

19 Touch screen mode

TomoCon offers a special touch screen mode for touch screens used in operating rooms. The touch screen mode will be activated directly when starting TomoCon (see 3 Using TomoCon) or during the work with the application choosing the **Touch screen mode** item in the **Tools** menu. The mode offers chosen functions from the application; these are operated using enlarged control buttons.

The touch screen mode window consists of two parts (see Figure 271):

- Working area (left)
- Panel with control buttons (right)

When starting the mode the working area has only one view, the current view. Press the button to change the working area layout (see 19.5 Working area layout). If there are more views in the working area, select any view to become the current one. If patient studies were opened in TomoCon before switching to the touch screen mode and the current view was empty, the working area will be filled with the image sequence. The first image will be the first image from the last series of last opened study in TomoCon. If there was an image chosen in the current view, the working area will be filled with the image sequence from the current image series beginning with this image. If no patient study was open, the working area will be empty.

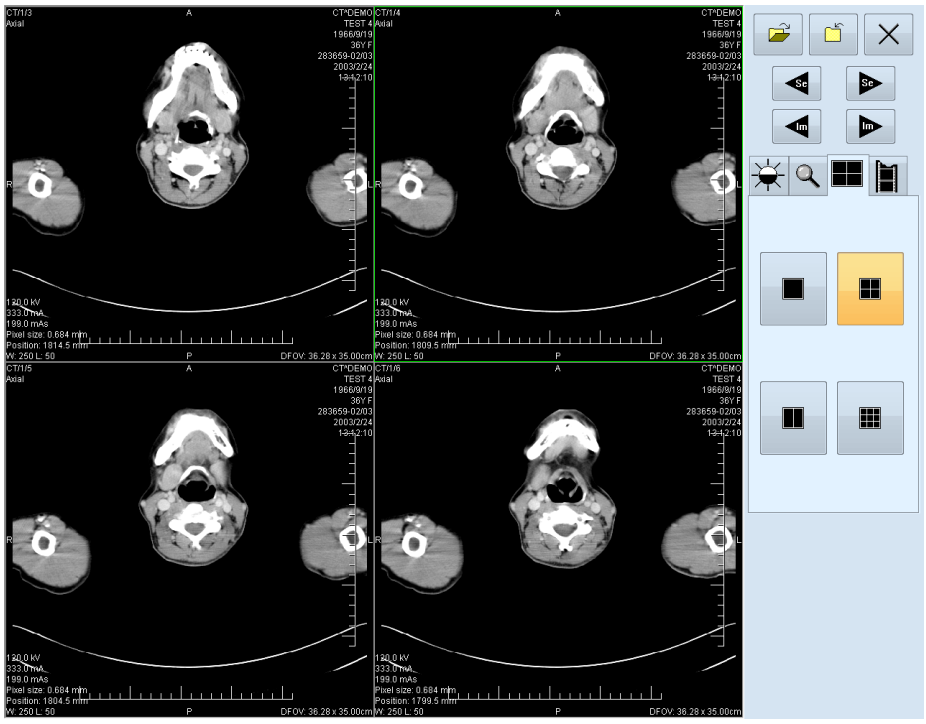


Figure 271 – Touch screen mode – layout

Control buttons panel is divided to 3 parts:

1. The top part of the panel contains the following buttons:

   Open a patient study (see 19.1 Open a patient study)

   Close a patient study (see 19.2 Close a patient study)

   Exit the touch screen mode

   Select image series: - Move to the previous series, - Move to the next series (the series are in the same order as they were opened in TomoCon)

   Move the 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:

   - Window, level, shape settings (see 19.3 Window, level, shape settings)

   - Move and zoom images (see 19.4 Move and zoom images)

   - Working area layout settings (see 19.5 Working area layout)

   – Switch to the Cine mode (see 19.6 Play multi-frame images)

3. The bottom part of the panel contains buttons connected to the action chosen.

19.1 Open a patient study

In the Touch screen mode a patient study will be open after pressing the button. The **Search studies** dialog will be opened (see 5 Retrieving and Opening study).

19.2 Close a patient study

All studies opened in TomoCon can be closed by pressing on the button. If the Touch screen mode was activated while working with the application and changes were made (ROI, registrations, annotations), a dialog will be open allowing saving the changes before closing the studies (see 5.10 Close a patient study).

19.3 Window, level, shape settings

Choosing the tab the following buttons will be displayed at the bottom part of the panel (see Figure 272):

- - accelerating level increase
- - accelerating level decrease

The following levels will be changed in the all images of the working area:

- **Window** -
- **Level** -
- **Shape** -

Level changing process is indicated by the slider and numeric values under the sliders.

At the bottom of the panel, the button allowing following actions are located:

- - invert the colors in the image
- - reset default values of window, level a shape in the series
- - apply new values of window, level and shape to the series

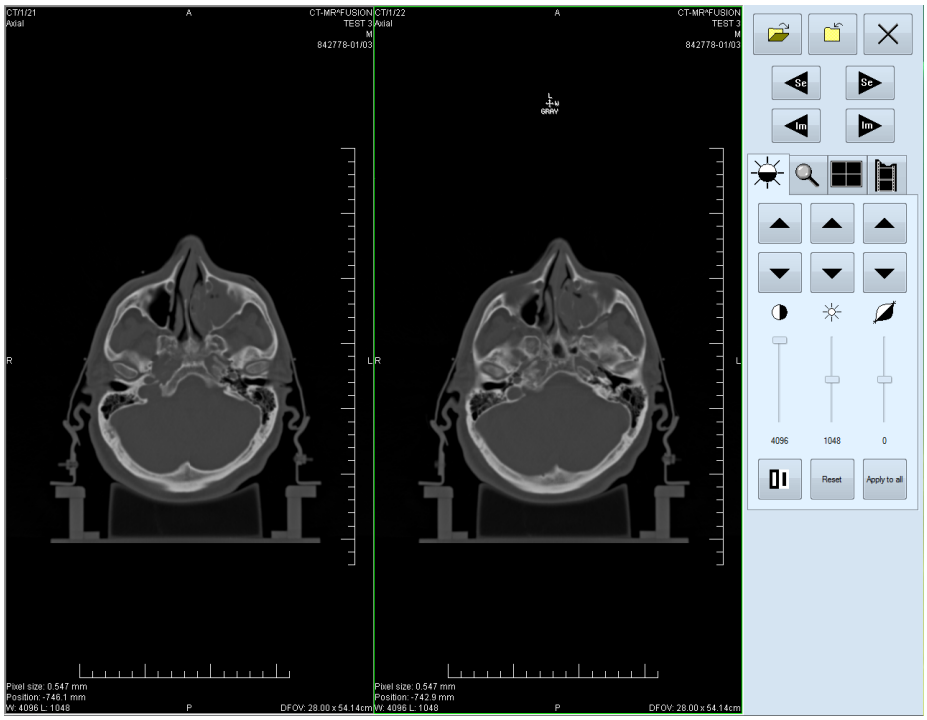


Figure 272 – Touch screen mode - gray, W&L settings

19.4 Move and zoom images

Choosing the tab the following buttons will be displayed at the bottom part of the panel (see Figure 273):

- Zoom the image in the working area from 50 % to 800 %: - zoom out, - zoom in (the current image size is listed under the zooming buttons)
- Move the image: - up, - down, - left, - right
- Return to the default size and position - Reset

Figure 273 – Touch screen mode - move and zoom images

19.5 Working area layout

Choosing the tab the buttons representing the working area layout will be displayed at the bottom part of the panel (see Figure 271).

19.6 Play multi-frame images

Choosing the tab the following buttons will be displayed at the bottom part of the panel (see Figure 274):

- Play back the images: - play backward, - play forward, - stop playing back the images (When playing back the images, only one view will be displayed in the working area where the images starting with the current image will be played back; the slider and numeric value under the buttons indicates the displayed image position in the series).

- Playing mode: - looping, - sweeping
- Change frame per second (fps) from 0 to 50 fps with 2,5 step: - increase fps, - decrease fps (the current speed value is listed between the buttons).

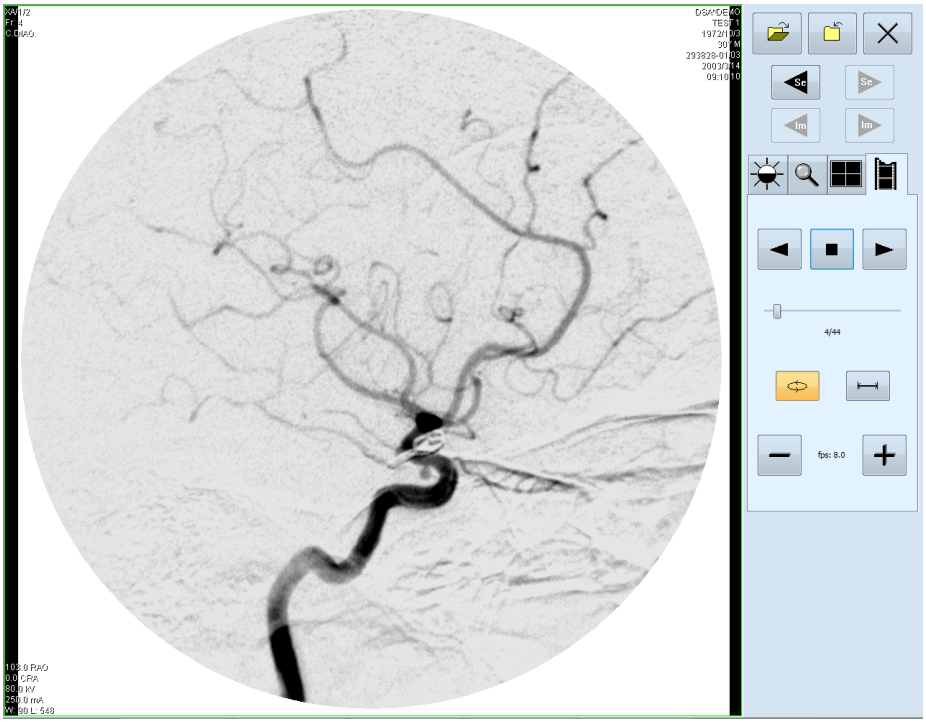


Figure 274 – Touch screen mode - playback multi-frame images

20 Reports

Reports in TomoCon are used to write medical reports, findings and other reports referring to a patient study or an image.

Click on the **Study** menu, **Reports...** to open the **Reports...** dialog (see Figure 275).

The **Reports...** dialogs can be resized and relocated anywhere inside the application.

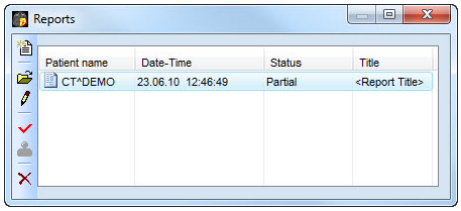


Figure 275 – Reports dialog

20.1 Create a new template

TomoCon provides possibility to use template to create new structured report. Click on the **Create new report** icon in **Reports** dialog to open the list of existing templates (see Figure 276).

To create a new template click on the **New** button and enter the name of the report. There will be the dialog **Report** (see Figure 277) displayed afterwards for writing new template.

To edit already existing template click at **Edit** button (to editing contents of selected template) or click on the **Rename** button (to change name of the selected template).

To delete already existing selected template click on the **Delete** button.

20.2 Create a new report

To create a new report click at the **Study** menu, **Reports…**. or click on the **Report** button in main toolbar of TomoCon. A new report can be created only if there is a study opened in TomoCon.

If there is only one patient opened in TomoCon, after clicking on the **Create new report** icon in the **Reports...** dialog an editing dialog will be opened with the patient's name in the heading. When there are more studies opened in TomoCon, the **Select study...** dialog will be opened. After choosing a patient and pressing the **OK** button, the **New Report** dialog will be opened (see Figure 276) for selection of the template, which will be used to create new report. TomoCon application provides to you with following types of templates:

- Voice report - when you select **Voice report** icon, you can speak your report in recording dialog, which will be displayed.
- PDF report - when you select **PDF report** icon, you can create report from PDF document stored on disk.
- Text report - when you select text type report icon, you can write text report in the **Report** dialog, which will be displayed (see Figure 277).

You can also select and open the template by double-clicking on its template's icon.

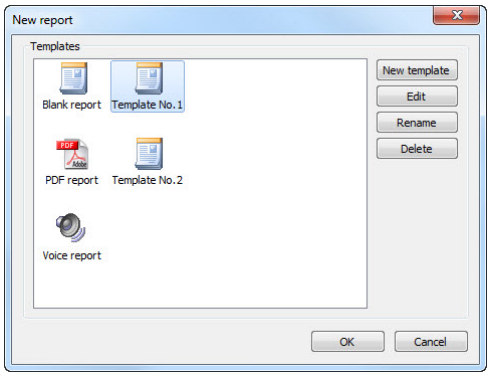


Figure 276 – Template choice dialog

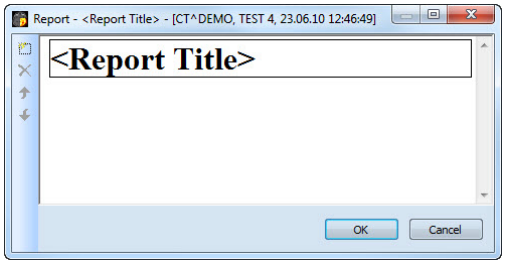


Figure 277 – Report dialog

Click on the **Add new section** icon on the left side of the dialog or select **Add new section** item in the **Report** dialog context menu (click the right mouse button inside the dialog). A menu will be displayed with paragraph types that can be added to the text of the edit dialog (see Figure 278):

- **Text -** subtitle, report text
- **Container** - contains text or another container (max 64 elements)
- **Concept modifier** - specifies the report heading
- **Observation context** - report information (author, examining surgeon etc.)
- **Property** - physical properties of medical finding

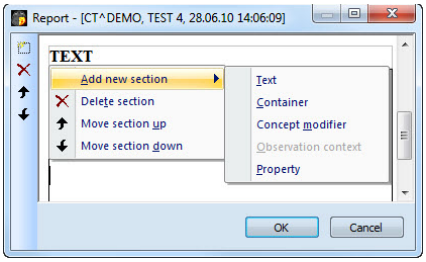


Figure 278 – Report dialog – context menu

In the **Report** dialog, it is possible to move the paragraphs up and down within the levels using and **Move section up/down** icons (container, text, etc.).

Click on the **Delete section** icon to delete a paragraph. A dialog will be opened, press the **OK** button to delete the paragraph from the report (see Figure 279).

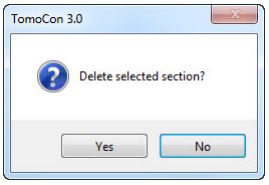


Figure 279 – Are you sure you want to delete selected section? dialog

The reports have three statuses:

- **Partial** - open to editing
- **Complete**
- **Verified** (verifying person + organization)

Click on the **Complete report** icon to finish editing the report. It is possible to add a note to the report in the **Complete report** dialog before closing the report (see Figure 280). The dialog will be opened after clicking on the icon. When clicking on the **Cancel** button or the cross at the right top corner of the dialog, the report will be closed without saving the changes. After pressing the **OK** button, the report will be closed and it will not possible to edit it.

Click on the **Verify report** icon, the **Verify report** will be opened (see Figure 280). Fill in the name and the organization of the verifying person. Reports can be verified by more persons. The data about verifying persons will be displayed when viewing reports.

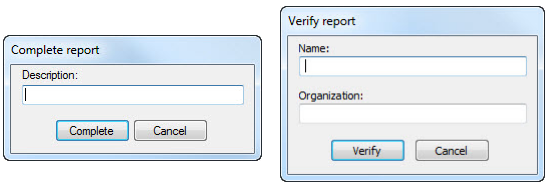


Figure 280 – Complete report and Verify report dialog

20.3 View report

If opening any study with already created structured report, the **Reports...** dialog, where you can viewing reports, will be opened automatically. When this dialog is hidden, you can display it at any time by clicking on the **Report** button in the main toolbar of TomoCon (or by clicking on the **Study** menu, **Reports…** item).

Next, click on the **View report** icon in the **Reports** dialog or click with the right mouse button on the report and select the icon. The report will be opened. The report heading (see Figure 281) contains following information:

- **Patient** - name, date of birth and other predefined identification data
- **Manufacturer**
- **Completion flag** - report status (partial, complete, verified)
- **Predecessor Docs -** link to the original document
- **Verification Flag** - report verification (verified, unverified)
- **Content Date/Time -** date and time of creating the document. When editing a partial document, the time is not changed, the date and time of the primary document is displayed.

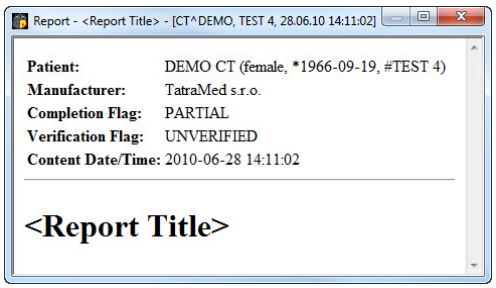


Figure 281 – Report heading

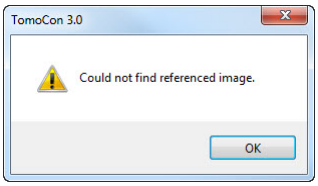


Figure 282 – "Could not find referenced image" dialog

If there is a link to a patient image in the report, click on the link to display the image in the current view. When the study with this image is not opened in TomoCon a dialog will be opened informing that the referenced image can not be found (see Figure 282).

It is also possible to copy the report text to the clipboard or to a text file (MS Word for example). Using the mouse or keyboard shortcut **Ctrl+A** select the text, press **Ctrl+C** to copy and **Ctrl+V** to insert the text into the document.

Open a report and press **Ctrl+P** keys. A standard Microsoft Windows dialog for print will be opened. Using the **Print** dialog the report can be printed on a standard Microsoft Windows printer.

Click on the button at the right top corner of the dialog or press **Esc** key to close the report.

20.4 Edit a report

Select a report from the **Reports** and click on the **Edit report** icon to edit the existing report. Partial documents can be edited anytime. When editing a complete and verified document a new report will be created with identical contents. Before editing a dialog will be open informing about creating a revised version (see Figure 283).

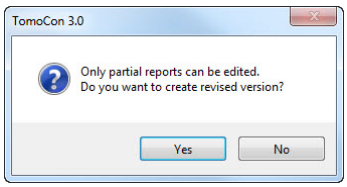


Figure 283 – "Only partial reports can be edited. Do you want to create revised version?" dialog

The original document will not be changed and link to the original document will be added (Predecessor Docs) in the heading of the revised version. If the original report was not loaded into the application, it is not possible to open it.

20.5 Save a report

Open the **Study** menu and select **Save** item to save the report. When closing TomoCon, a dialog will be opened to assure if you really want to save unsaved changes.

20.6 Delete a report

Select a report in the **Reports** list and click on the **Delete report** icon or select **Delete** item in the context menu. A dialog will be opened to assure if you really want to delete the report. Click on the **Yes** button to delete the report from the **Reports...** list.

21 Study anonymization

TomoCon allows you to save the series of all opened studies as a new anonymized study to the Local studies. Use the **Anonymize study** dialog (see Figure 284) that will be opened after clicking on **Anonymize study...** item in the **Study** menu.

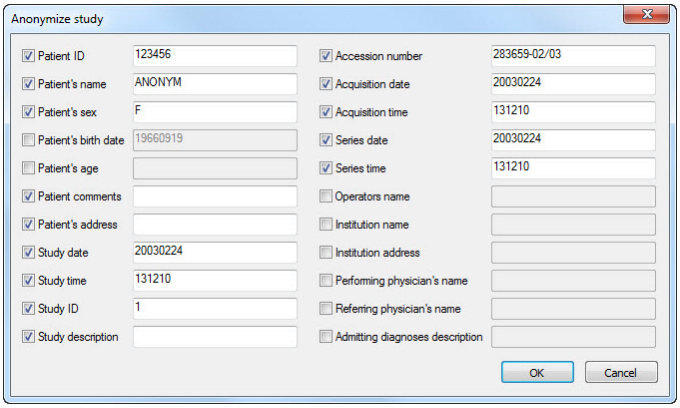


Figure 284 – Anonymize study dialog

The items in the dialog are filled with DICOM data received from the first opened study. Click on the check box next to the item you want to change. This will allow you to write in the text box of the item. Press the **OK** button to save the new anonymized study. Follow the saving process in the **Saving anonymized study...** dialog (see Figure 285).

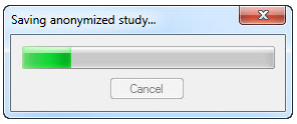


Figure 285 – Saving anonymized study … dialog

22 Create a new patient study/series

New study or new series can be added by **Select study** dialog, which will be displayed after clicking at the **Create new series…** item in the **Study** submenu in the **TomoCon** menu (see 3.4 Main menu).

To create new series in the existing study:

1. Select existing study for insertion of new series from studies list in the **Select study** dialog (see Figure 286).
2. Click on the **OK** button in the **Select study** dialog (**New series** dialog will be opened).
3. Fill information about new series in the **New series** dialog (see Figure 288) and click on the **OK** button.
4. New series will be automatically added to selected study.

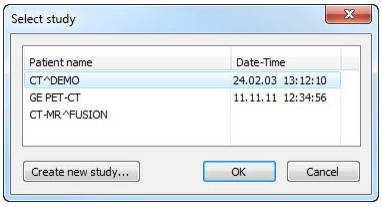


Figure 286 – Select study dialog

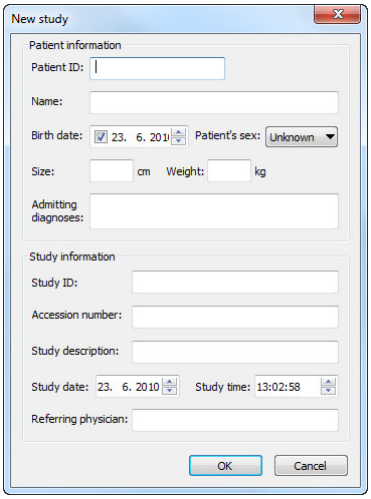


Figure 287 – New study dialog

To create new series in the new study:

1. Click on the **Create new study…** button in the **Select study** dialog (**New study** dialog will be opened).
2. Fill information about new study in the **New study** dialog (see Figure 287) and click on the **OK** button (**New series** dialog will be opened).

3. Fill information about new series in the **New series** dialog (see Figure 288).
4. To import images, which will be automatically inserted to new created series, click on the **Import images...** button. Next, select graphical files on your computer (bitmap, JPEG or TIFF files) in displayed **Open** dialog and click on the **Open** button.
5. Click on the **OK** button in the **New series** dialog.
6. New study with new series will be automatically added.

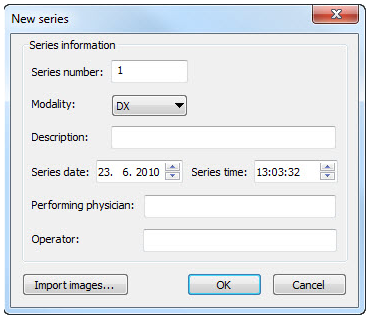


Figure 288 – New series dialog

23 Archive images on CD

Patient studies in TomoCon can be archived on a CD medium using the **Create CD** dialog. To write this data on a CD is necessary to meet one of the following requests:

- Operating system (minimal) Microsoft Windows XP with started "`Windows IMAPI`" or "`Windows IMAPI2`" service.
- Installed Nero Burning ROM 6.3 or higher.

In case that the system doesn't meet any of these requirements, the data can be archived to the chosen directory on the disk.

The **Create CD…** dialog (see Figure 289) will be opened by clicking on the **Create CD…** submenu in the **Study** menu. The **Create CD…** dialog will display the set of patient data prepared for backup at the CD. Press the **Add** button to add the currently opened studies to the prepared data set. To remove a study, series or an image from the set press the **Remove** button or **Delete** button on the keyboard. After pressing the **Remove all** button all studies from the prepared data set will be removed.

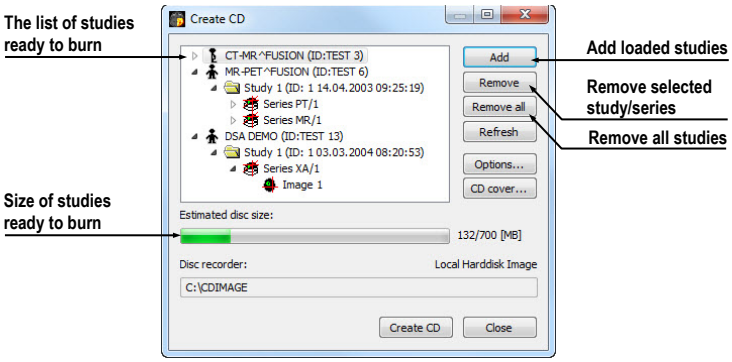


Figure 289 – Create CD dialog

Press the **Create CD** button to write the prepared data set onto a CD or to the chosen directory on the disk (depending on the **Disc recorder** settings).

The **Create CD** dialog will be closed after pressing the **Close** button; the created data set will be kept for archiving. When re-opening the dialog (e.g. when loading new patients to the application), the set will be available and new studies can be added by pressing the **Add** button.

It is possible to add patient studies to a CD with already archived patient data. The **Create CD** dialog will display the newly added studies/series with the already archived studies. It is not possible to remove them (see Figure 290).

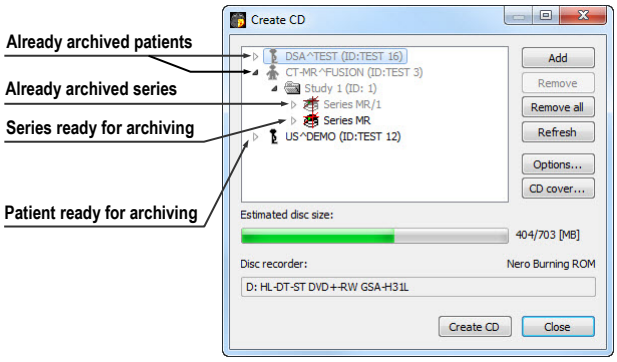
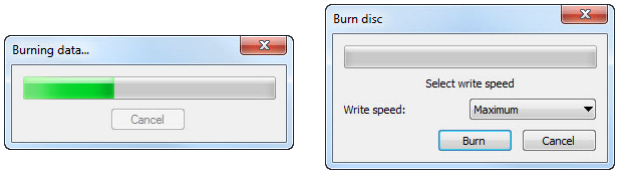


Figure 290 – Create CD dialog (add a study/series to the CD)

Press the **Create CD** button to start the archiving process. Process of burning will be displayed in dialog (see Figure 291).



(a) **(b)**

Figure 291 – Archive patient image data in progress, IMAPI CD-Burning COM (a), Nero Burning ROM (b)

Press the **Options…** button to specify the archiving settings. The **Create CD options** dialog will be opened (see Figure 292).

The following settings are available:

- **Disc recorders** - select one of the available type of burning and select **Disc recorders** to be used for archiving.
- **Maximal CD capacity** - user specified CD capacity.
- **Temp directory** - created automatically in the user's temporary disk region for temporal archiving.
- **Export directory** - directory for export image of CD in case of choosing Local Hard disk Image recorder.
- **Template directory** - directory, which will be copied to CD during the burning process.
- **Clear temp directory after burning** - if this option is checked, user's temporary disk region for temporal archiving will be deleted after burn process.
- **TomoCon Lite** - if this option is checked, the TomoCon Lite viewer will be added to the archive. It contains full TomoCon functionality except the data import. Only the DICOM image archive on the CD can be viewed with it.

- **Template** - if this option is checked, **Template directory** will by copied to archive.

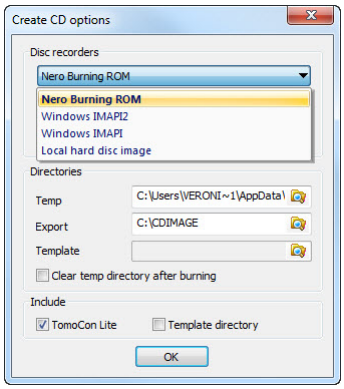


Figure 292 – Create CD options dialog

To create and print the cover for the created CD use the **CD cover** dialog (see Figure 293). Press the **CD cover…** button to open the dialog. The list of the patients from the **Create CD** dialog will be automatically added to the front and the back page of the cover.

Following settings are available in the **CD cover** dialog:

- **Print setup** tab:

  Type of CD cover (**Classic cover**, **Slim cover**)

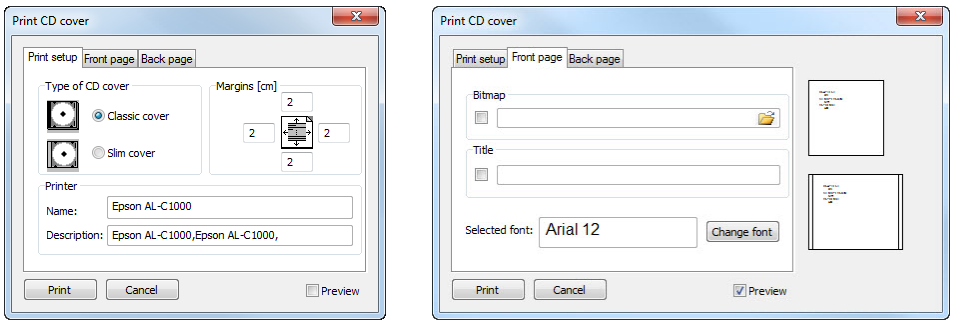
  Margins

- **Front page** tab:

  Setting up the picture that will be laid behind the text on the front page (**Bitmap**). Press the button with icon to select a picture and click on 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 on the check box to print the title on the front page.

- **Back page** tab - the settings are the same as the front page settings.



(a) **(b)**

Figure 293 – CD Cover dialog, Print setup tab (a), Front page and Back page tabs (b)

Press the **Print** button to print the CD cover. A standard Microsoft Windows dialog for print will be opened (the **Print** dialog). Select a printer, specify parameters for print and press the **OK** button to start printing.

24 Contact

If you have any questions or comments, please contact our headquarters:

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