Dataviewer Overview

Method note

MCT-093

1. Introduction

This method note is intended as a “getting started” document. It will address how to…

(1) open and browse through data.

(2) save /rename data.

(3) measure densities and distances.

(4) register data.

(5) customize DataViewer.

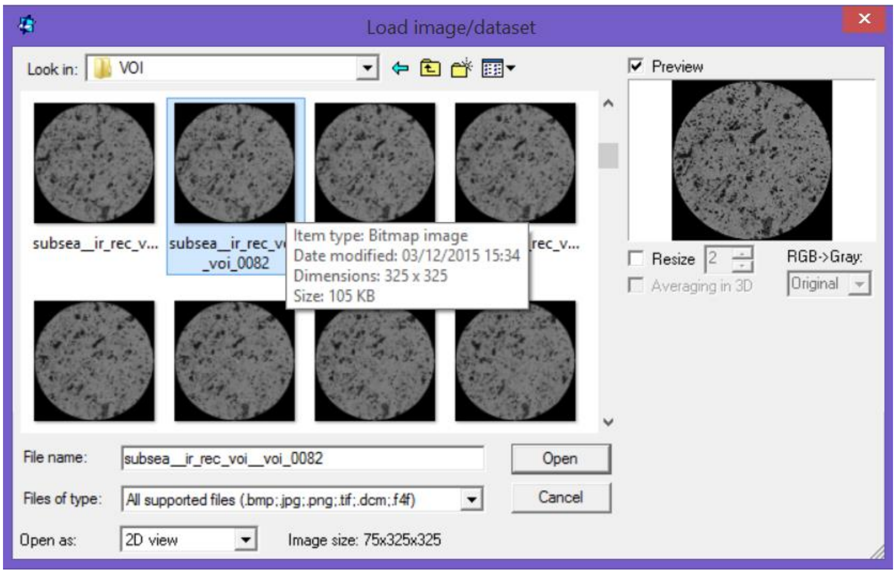
As it is an introduction to DataViewer, it will not cover in detail all advanced techniques that are available but rather provide an overview of the functions and help you to learn quickly how to fluently navigate through a microCT dataset, and save (region of interest) data with and without reorientation. More information can be found in help-file provided with DataViewer.

2. Open and navigate through a dataset.

2.1. Open a dataset.

There are several ways to open a dataset in DataViewer. Firstly, one can simply drag and drop a cross-section or other valid data file to the DataViewer icon or a running DataViewer program, which will load the entire dataset. Alternatively, after starting DataViewer software, loading a dataset can be done using the ‘open…’ function in the *actions* menu, or alternatively by clicking the ‘open’ icon  from the Toolbar. This action will prompt a pop-up window (see below) that provides options for resizing the data in case of very large datasets. When one wants to open a previously opened dataset, there is the option to ‘open recent…’ datasets in the *actions* menu. Finally, other SkyScan programs may start DataViewer as well, for example NRecon. Multiple instances of DataViewer on the same PC are allowed.

By default, datasets are opened in 2D mode as shown below. However, it is possible to load datasets by default in 3D (see section 1.4) by activating this function in the ‘preferences at loading' window under the *options* menu or by corresponding selection in drop-down menu 'Open as' on shown dialog.

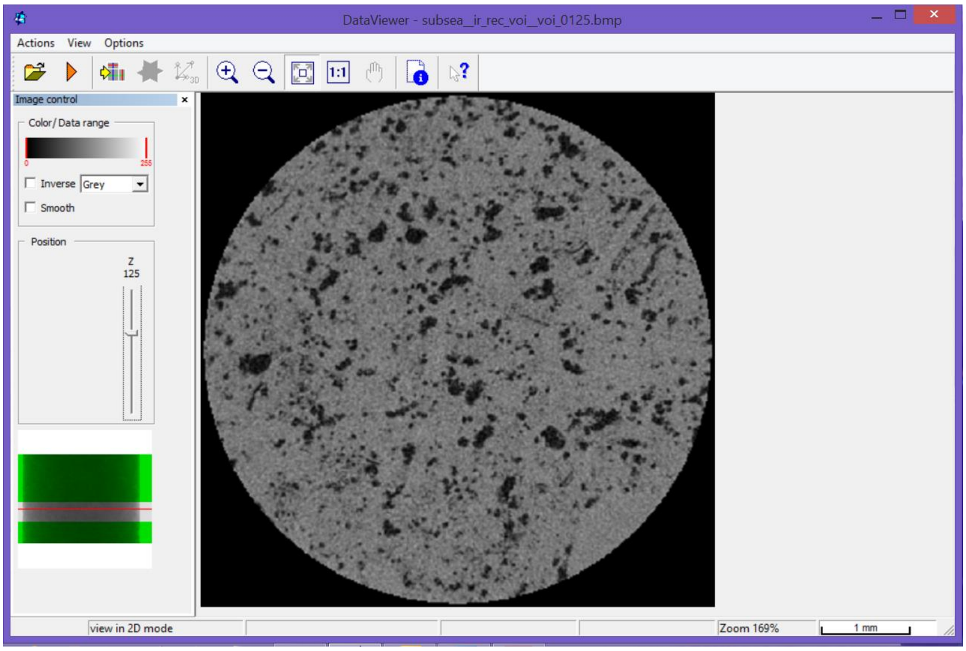


3. The layout of DataViewer

The layout of the DataViewer interface after opening a dataset (in 2D) is shown below. The ***toolbar*** can be found at the top of the application window, under the menu bar. It provides quick mouse access to frequently used program functions. Most of the tools can also be accessed via the *Actions* menu or the *View* menu.

More information about the loaded dataset, such as pixel size and acquisition/reconstruction parameters, can be viewed by clicking on the info icon  on the toolbar. The information is obtained from the image file itself and/or from the log file.

The ***image control window*** is the main control window of DataViewer. Though it can be toggled on or off via the *view* menu, it is recommended to keep it visible. It can be dragged out of the sides of the main window (floating), or repositioned. Keep the 'Ctrl' button pressed during movement if you want to avoid docking to the sides of main program window. This image control window allows to change the color/data range as well as the z-position (and as will be illustrated later also the position in x, y and time/force/temperature).



The color palette drop-down list allows to invert the displayed image or apply a false color palette, with a dual range mark on the color bar for range adjustment. The color/data range applies to all virtual slices shown in the central part of the program window, but not to the reference projection image which is shown at the bottom of this control pane. Changing the color/data range can be done by dragging on the red/green line in the color scale window. Dragging the vertical lines on the color palette allows you to change the minimum/maximum of the shown range. This is similar to tuning in brightness/contrast. Use the drop-down menu to select color scale among: original, grey, color 1, color 2, black body, binary and gamma. Please note: the minimum/maximum selection is disabled when original is selected. The gamma LUT is a non-linear LUT (unless ⍰=1.0). The ⍰-value can be changed by dragging the blue line. Double-click on the lines on the color scale window will set them to their default values. When the check box *Inverse* is checked, the corresponding color scale is inverted.

A grey value image can be displayed in maximum 256 levels: from 0 to 255 (8-bit). To be able to display 16-bit data (from 0 to 65535), the values are linearly converted from [0, 65535] to [0, 255] by default. Subtle variations in the image may get lost in this conversion. To view the image in a chosen range, you can click on the button ‘Range...’ (only available for 16-bit data). A pop-up window will allow you to choose a range interactively. Please note that you may specify the x-axis unit in grey value, HU, or attenuation coefficient.

When the check box *Smooth* is checked, the displayed views are smoothed (2D) according to the settings in the preferences menu. Note that the images are smoothed just before shown, and therefore the original data remain unchanged. Though the smoothing can be applied to all 3 views, it is not a true 3D smoothing. The smoothing is therefore not consistent in the sense that the same pixel at different views may have different values, due to the independent smoothing procedure for each view.

The image shown at the bottom of this control pane is the ***reference image*** (*_spr.bmp) and is used to indicate the location of the displayed transaxial cross-section. The inactive area or slices of the current dataset are highlighted in this image in green. The currently shown slice can be selected by a mouse click inside this image. DataViewer reads the reference image from a SPR file. If not found, no reference image will be shown. Instead a button will be available to create a new shadow projection Create SPR shadow image. By means of a maximum intensity projection (along the x-axis) a new image is generated which is applicable as a reference image. It is automatically saved as *_spr.jpg. This is only meaningful if the dataset is a set of reconstructed images. The presence of labels or scales will corrupt the result.

The ***status bar*** is usually displayed at the bottom. Though you may show/hide it via the *View* menu, it is recommended to leave it on. The left area of the status bar describes actions of menu items as you point the mouse cursor to a menu/toolbar item. The right area of the status bar shows the viewing mode (2D view, or 3D view with resizing information), the 3D distance, the pixel information (x, y, z coordinates and the pixel grey value, HU, or attenuation coefficient, and percentage relative to the display maximum) and zoom factor whenever applicable. The image zoom can be changed by mouse wheel with mouse cursor on the imaging area.

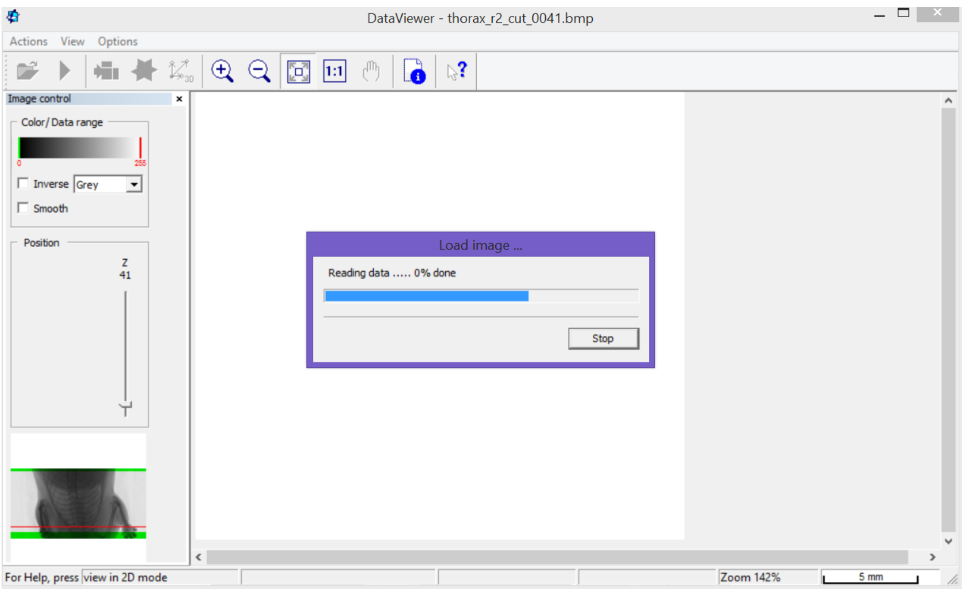
3.1. Navigate through the dataset

The active cross-section is indicated with a red line on the reference image (shadow projection image). The numerical position of the cross-section is shown above the z-slider in the image control window. You can change the active cross-section by moving the slider up and down, or clicking on the slider bar and pressing the up and down arrow. The play button from the tool bar will toggle the animation. The shortcut for this is to press the spacebar for start/stop. The 'tab' key will invert the direction of navigation. When using shortcuts, be sure that the main window has got the focus (e.g., by clicking anywhere on the main window).

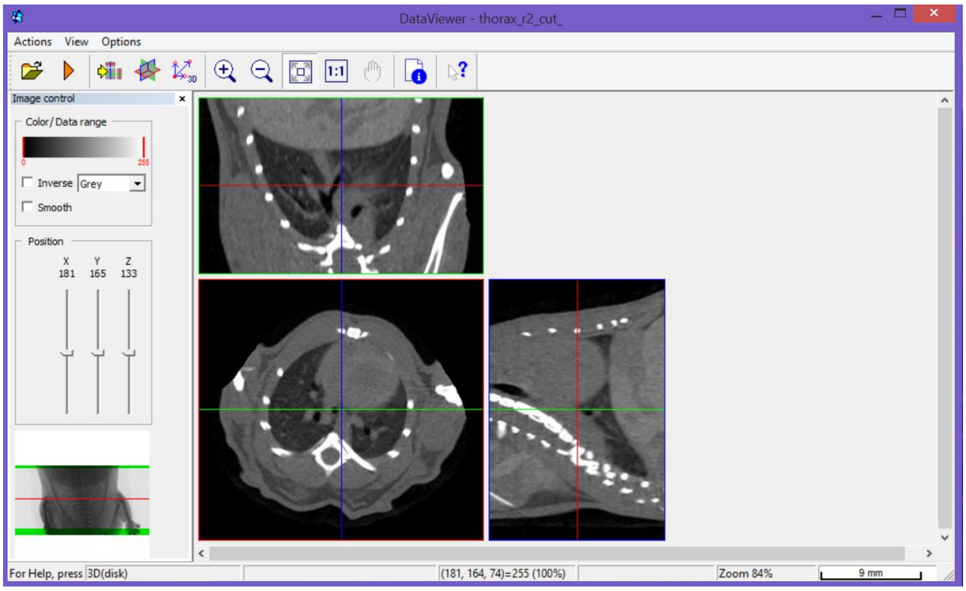
As in most viewing programs, one can view the images with variable zooming factor. Four functions are provided: zoom in , zoom out , actual size and fit-to-window . These functions can be invoked by the menu *View*, the corresponding buttons on the toolbar, or by using the keyboard shortcut keys: zoom in (+), zoom out (-), actual size (=), fit-to-window (*). When using shortcuts: be sure that the main window has got the focus (e.g., by clicking anywhere on the main window); please note that for most laptops, the NumLock has to be switched on for these shortcuts to function correctly.

3.2. Load data for 3D viewing

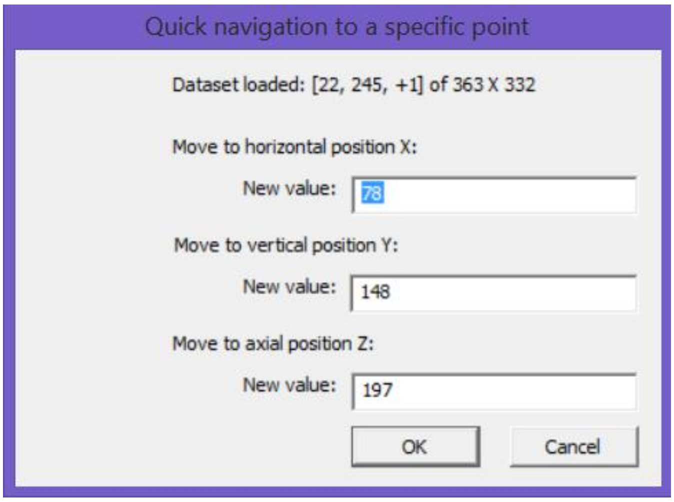
When a dataset is loaded in 2D mode, only the given slice is read and shown. The button on the toolbar will load the dataset for 3D viewing by means of 3 orthogonal planes. In 3D mode, the whole dataset has to be loaded into memory (memory-mapped disk file) first. A progress bar will appear. For large dataset, it might be too slow to show 3D images smoothly, therefore an option is given to resize data when you load data. If a dataset is loaded with resizing, a volume-of-interest (VOI) tool is provided to view a certain part of data in full resolution (see section 2.2).

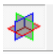


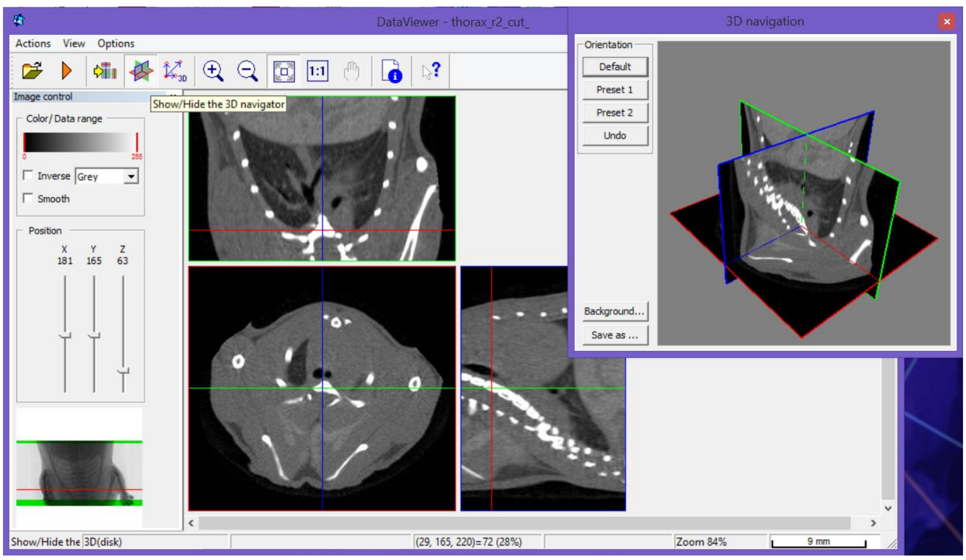
After the data are loaded for 3D viewing, the control window will display 2 additional sliders for x and y movement. As a result, the whole stack of images can now be browsed in x ,y or z direction. At each 3D location (shown as cross-hair with a green, red and blue line) three orthogonal views are retrieved from the whole dataset and shown. The top view is the x-z or coronal view and shows the data as if it was cut along the green line. The bottom left image is the x-y or coronal view and shows the cross-sections as reconstructed. The bottom right image shows the y-z or sagittal view, as if the data is cut along the blue line. In the *Options* menu under 'preferences at viewing' you can choose to display the names on the planes, as well as specify in which nomenclature. Also the visualization and size of the cross-hair can be adjusted. To navigate in 3 dimensions one can click on any point on any of the planes to view the 3 orthogonal planes crossed in that point.



One can also navigate to a specific x,y and z plane by entering the x, y and z coordinates in the 'Navigate to...' window, which can be accessed through the *View* menu, or by pressing the 'Ctrl+N' shortcut.

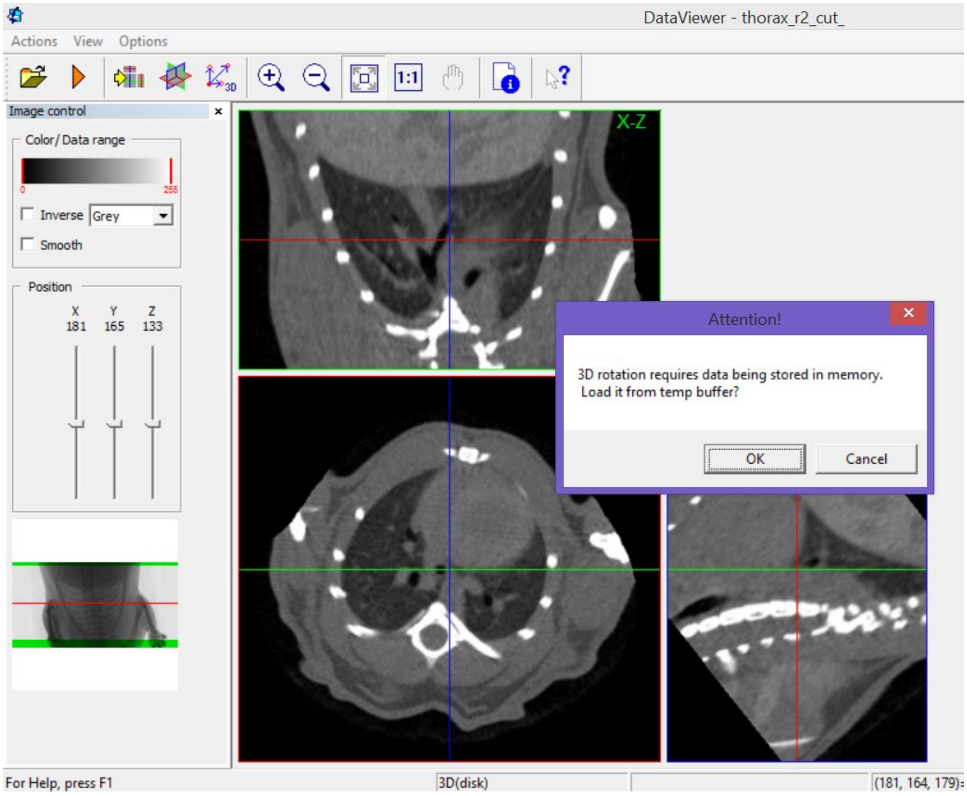


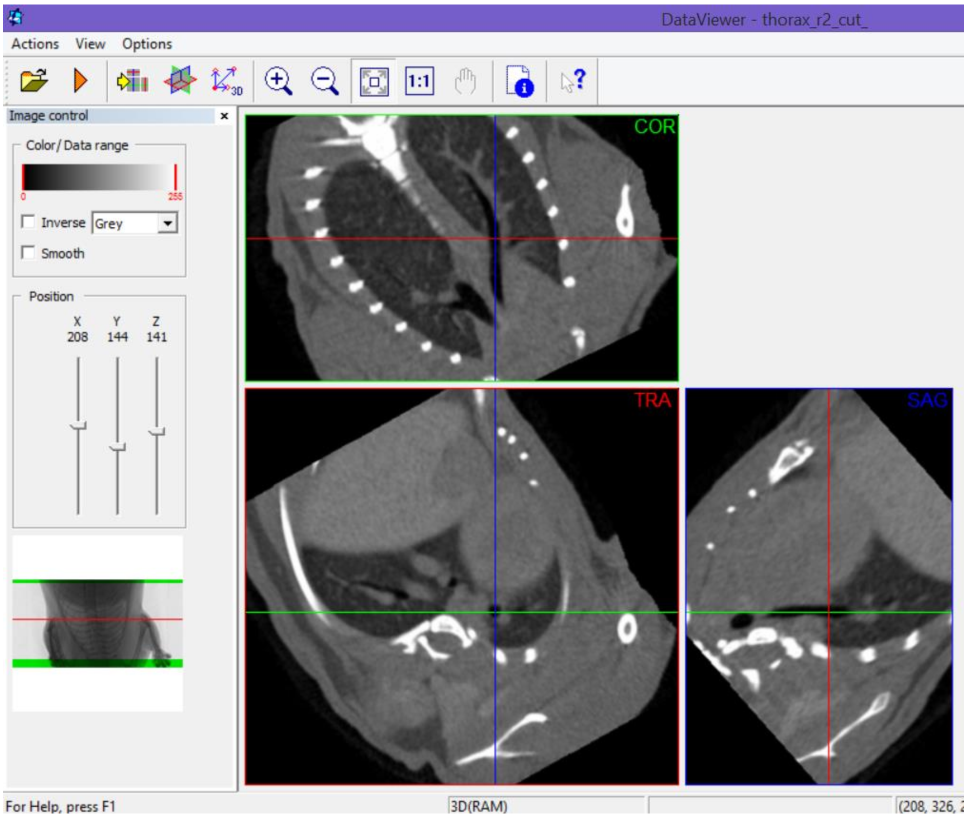
An alternative way of viewing a dataset in 3D is the 3D navigator, which is activated by pressing 'show/hide the 3D navigator'  in the toolbar. This will give a more intuitive feel. The views are shown in their relative positions to help you understanding what you see in the main window. Navigation through these planes can be done by dragging planes by mouse. Zoom of the image in 3D navigation window can be changed by mouse wheel. The 3 planes are color-coded: the red frame shows the transaxial or x-y view, the green frame represents the coronal or x-z view, and the blue frame finally the sagittal or y-z view. The whole structure can be rotated by using right-mouse button. There are 3 preset orientations. The background color may be customized. The image shown can be saved as a .bmp or .jpg color image. Note that the views shown in this window are often resized by a large factor, so you would have to go back to the main window for fine details. Although you can rotate the planes in this window, the image itself remains stationary, i.e., no interpolation/rotation in shown slices is involved and you cannot save a new dataset in another orientation by this way.



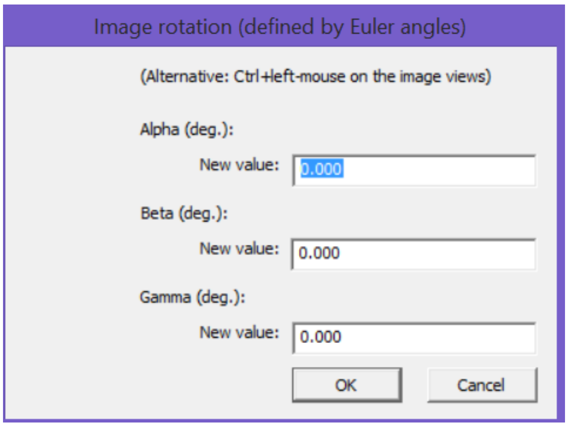
4. Reorient a dataset

Sometimes one wants to view or analyze data in a different orientation. Positioning the object differently inside the scanner before scanning would be an option, but this is not always possible or doing so would result in a lower image quality from a physics point of view. Therefore, DataViewer allows to rotate a reconstructed dataset freely in 3 dimensions by clicking and holding down the left-mouse button while 'Ctrl' key is pressed down. A warning message will appear about temporary data storage. Confirm by clicking 'OK'.





The ‘Rotate to...’ window under the *view* menu allows a rotation over 90, 180 or 270 degrees and also any other orientation (defined by Euler angles), or going back to the original orientation.

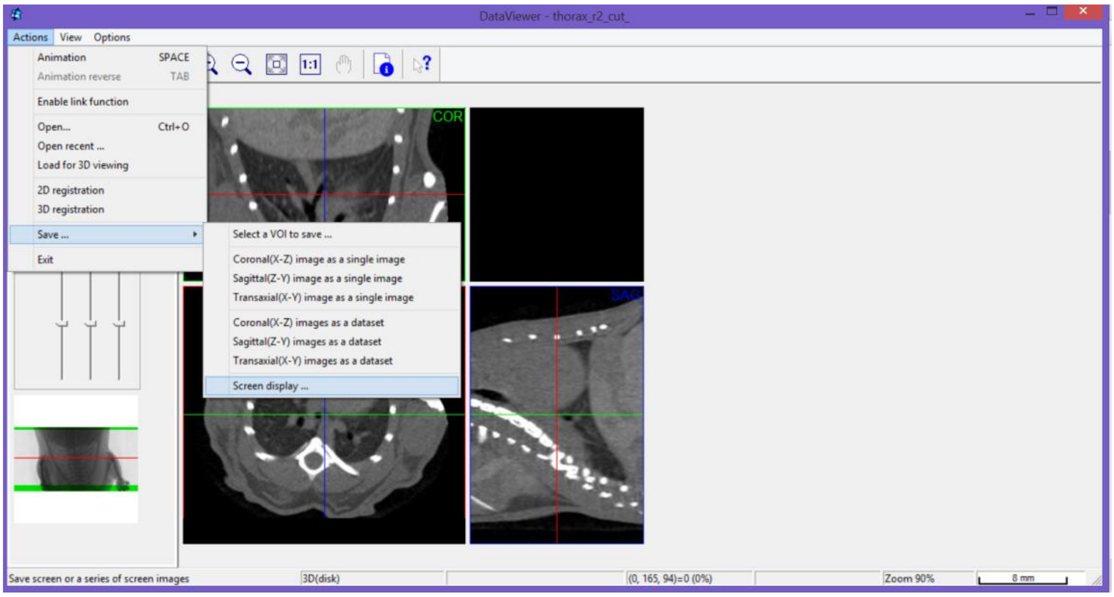


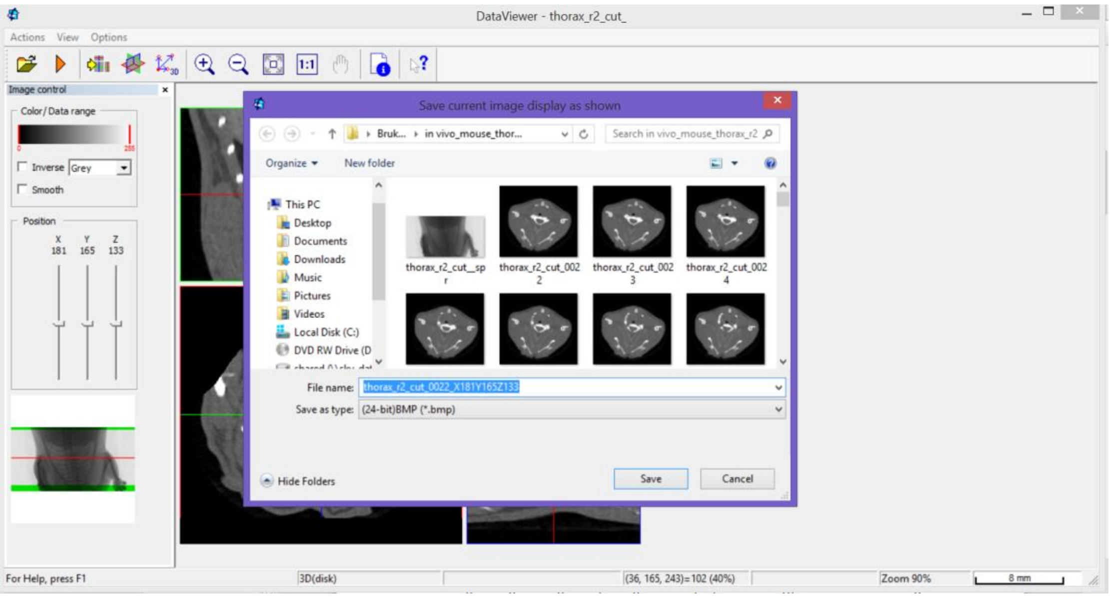
4.1. Save / rename data

4.1.1. Save data without region of interest selection

There are various ways to save the data which adds value to the visualization/analysis.

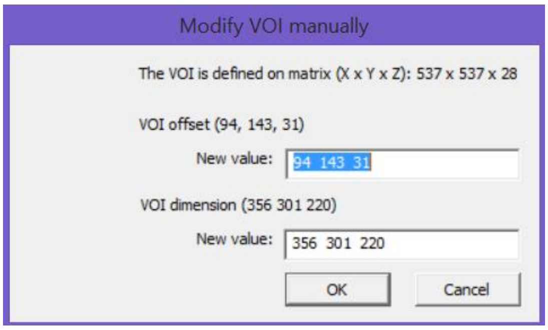
The option 'select a VOI to save' is explained in section 2.2 and allows reducing the dataset size for faster analysis and smoother visualization in volume rendering or surface rendering software packages. Any of the 3 shown orthogonal planes (with or without re-orientation) can be saved as a single image, or as a full dataset in the *Actions* menu. The filename prefix will be automatically adjusted by adding Sag_ or Cor_ or Tra_ to the original file name, depending on which of the planes is saved. The final option 'screen display' allows to save the 3 orthogonal views as displayed in one image. Note that this function does not work under remote desktop access. The file name index is adjusted automatically, the x, y and z coordinates of the current position of the cross-hair are added to the file name of the active cross-section, for example MySample_2500_X111Y222Z333_.



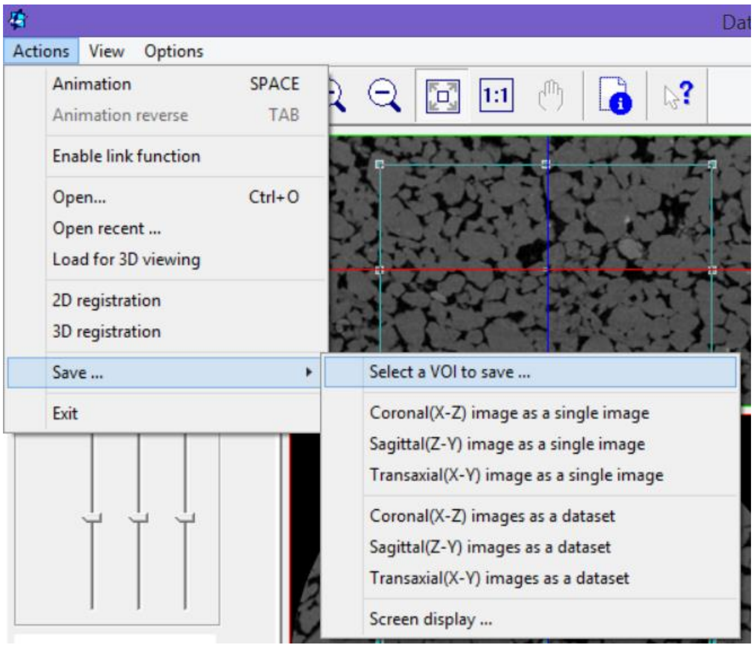


4.1.2. Save data inside a region of interest selection

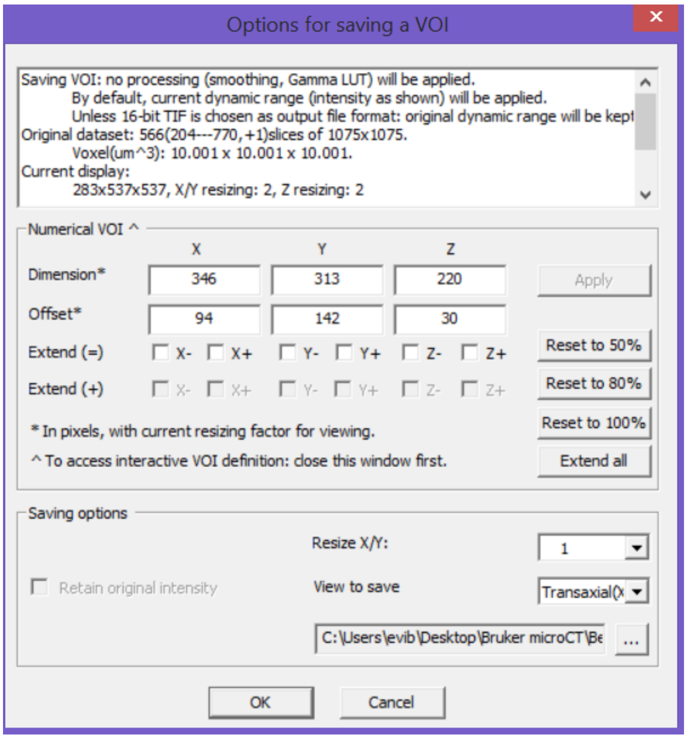
A volume (VOI, 3D) or region (ROI, 2D) of interest can be activated from the *View* menu and is displayed as a blue box superimposed on the cross-sections. This ROI or VOI can be translated with a left-mouse click. Changing the dimensions is possible by dragging the corner of the ROI/VOI with the left-mouse button. Alternatively, its size and position can be modified by entering predefined values in the pop-up window that appears after right-clicking inside the ROI or VOI shape.



A new dataset from the ROI or VOI can be saved using the 'Select a VOI to save…' under the *Actions* menu.



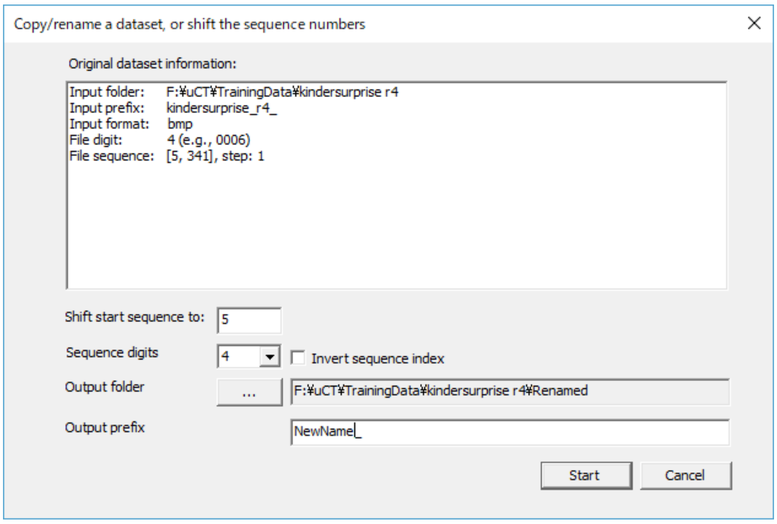
This interface again allows to numerically enter a VOI (as can be done by right-clicking inside the VOI itself, see above) as well as choosing a default size of 50 or 80% or reset to the full 100%. Under 'current display' the current resizing factor can be found. In the following 'Options for saving' dialog window one can choose a different resizing factor. A value of 1 will save the dataset at its original resolution. 'Extend' will extend the VOI to the boundary of the image dataset in either one or multiple directions for x, y and/or z. Under 'view to save', a different direction of slicing can be chosen. This allows to save data in a different orientation. This feature is useful for analyzing the evolution of a morphometric parameter or density as a function of height, x, y,… Typically, in such applications a 2D analysis is performed per slice and the orientation of the slices determines in which direction the analysis is carried out.



Each time you enter the VOI mode, the portion of data around the cross-hair pixel will be loaded into memory-mapped disk file. Each time you leave VOI mode, the memory-mapped disk file is cleared/released. During all these operations, the original memory mapped file for the whole dataset is kept, so that you don't have to re-load when you return to the whole-image mode from VOI mode. This also means: in VOI mode, the temporary disk or memory usage by DataViewer is doubled.

4.1.3. *Rename data*

To rename the dataset, you can use 'Rename / Copy / Shift dataset' function under the *Actions* menu. A pop-up dialog appears and you can specify a new filename prefix in the 'Output prefix' field. By default, a new folder named 'Renamed' is created and the renamed dataset will be saved in there. You can also specify the digits and the first number of the filename sequence. If 'Invert sequence index' option is checked, the file sequence numbers will be reversed and as a result, the renamed data will be displayed upside-down. However, because the reference image (*_spr.bmp) remains the same (unrotated), the indication of the transaxial position in the reference image will be wrong. In that case, you can delete the reference image file (*_spr.bmp) manually and create a shadow projection as described in 1.2.

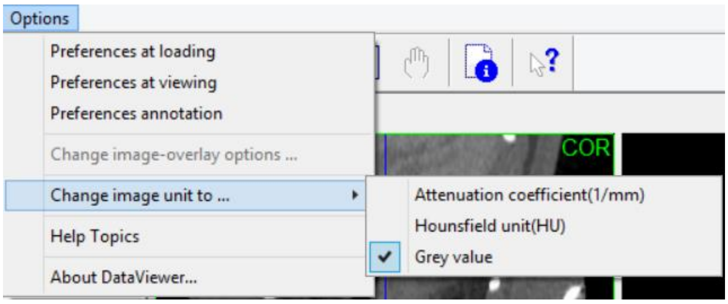


5. Measurements in DataViewer

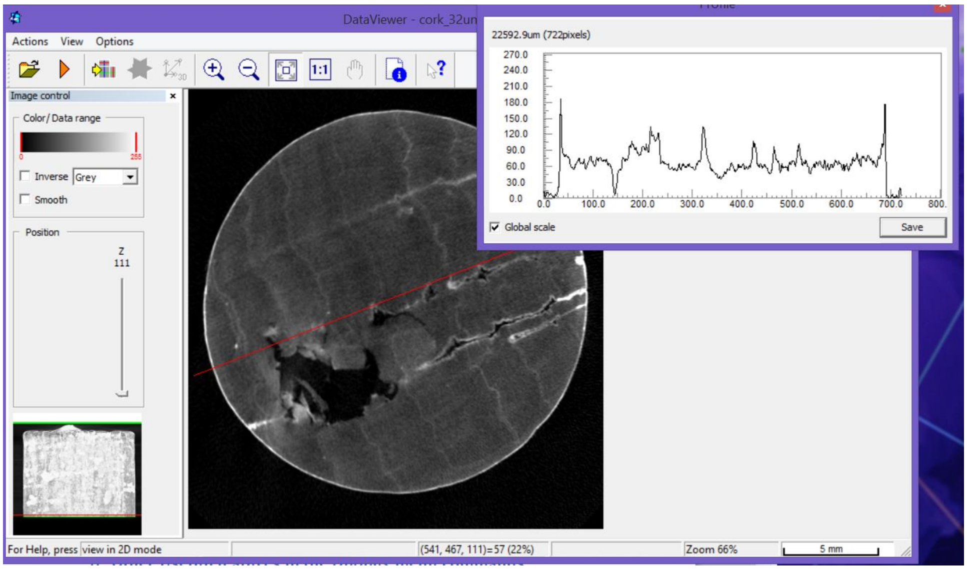
5.1. Measure density

The grey value of the pixel under the mouse cursor is measured and shown in the status bar (usually located at the bottom of the main window) when you move the mouse around. The pixel value can be shown in different units: grey value as it is stored in original file, HU if the calibration factor is available, or attenuation coefficient in 1/mm if applicable and necessary scaling factors are available.

Changing the image units can be done in the *Options* menu as shown below. Which units are available is dataset-dependent: the scaling factors have to be retrieved from a log file or from the header of an image file. All 3 units are linearly related to each other.



In addition, a profile line can be drawn anywhere on any of the planes by keeping the right-mouse button down while drawing the desired profile line. The profile window will pop up showing the measured grey level at each pixel along this profile line. Whether the values are measured in grey value, attenuation coefficients or HU again depends on what is specified in the *Options* menu. The checkbox 'Global scale' allows switching vertical scaling between full range and minimum/maximum in the current profile.

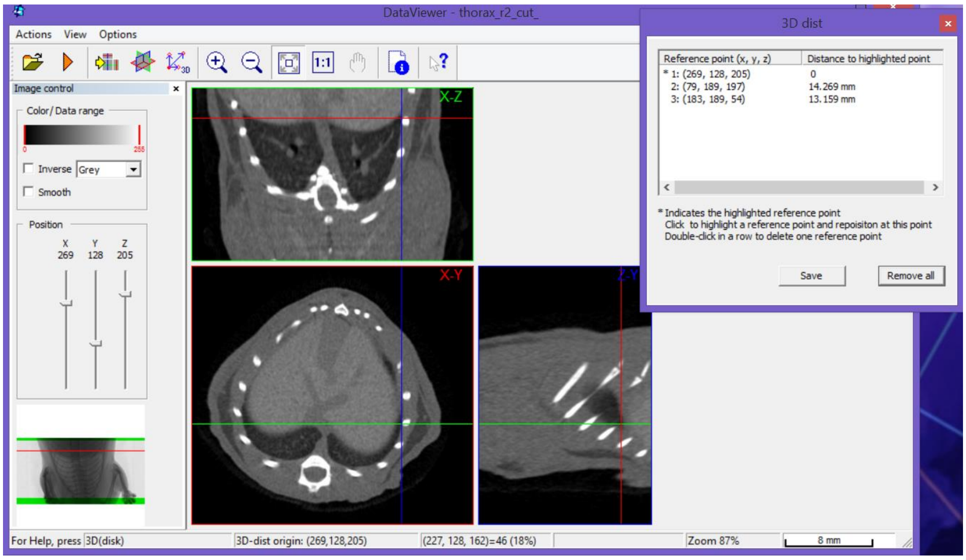


5.2. Measure distances

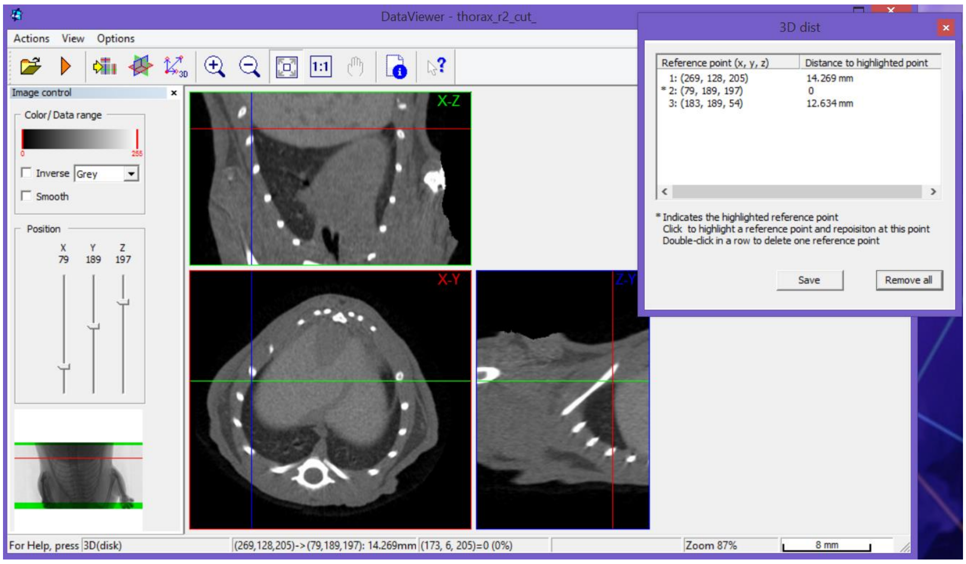
When drawing a profile line as described above (see point 3.1), also the length of the profile line is shown above the plot allowing measurement of distances within one plane or slice using the profile line.

To measure the distance between 2 points which are not in the same x-y, x-z or y-z plane, one can rotate the dataset (see point 1.5) to position them in the same plane. An alternative solution is to use a 3D reference point, which offers a simple way to measure distance to any other points in a 3D image. This is done with the cross-hair position: once the starting point is initialized or reset to the current cross-hair position, the distance between the current cross-hair position and the starting point is always given on the status bar when you move the cross-hair position around in the 3D image. Note that no visible line is however drawn between the 2 points.

In practice, first set the cross position at desired starting point/pixel , then click on the button 'add current position as 3D-distance reference point'  to record the current cross position as the reference point, then set the cross position at desired end point/pixel. The distance between the start point and the end point is displayed in the corresponding pop-up window. Multiple points can be saved. By opening the 'View 3D-distance reference points' window in the *View* menu, one is offered with the possibility to go back to a previous reference point or remove one of them. The active reference point is indicated with *. For each other point in the list, the distance between this point and the highlighted reference point is displayed.



To choose a different point as a reference point, double-click on it.



6. Data registration in 2D and 3D

DataViewer provides a powerful tool for comparing different CT scans after image registration both in 2D and 3D. In both cases, only rigid transformation is considered. Two sets of images are required as input: a reference image which stays stationary, and a target image which needs to be transformed to match the reference image. The aim of the registration option is to provide a basic tool for volume registration. The emphasis is more on visualization, speed and interactivity, rather than a fully automatic registration which is extremely challenging. A user guide on image registration is available online. A step by step explanation on how to perform image registration in DataViewer can be found in our method notes “MN063_Image and dataset registration in DataViewer - Expanded clay” and “MN044_Image and dataset registration in DataViewer – Tooth”. The first method note makes use of a granule of expanded clay before and after moistening while the second method note uses a tooth before and after root canal treatment.

Registration also allows 4D CT or time-resolved CT, which images dynamic processes in full 3D, where “time” is considered the 4th dimension. Method notes on these applications are also available “MN087_Fast, real-time CT in geosciences”, “MN088_Time-lapse CT imaging for geomaterials”. Image registration makes it possible to compare data pore-to-pore or grain-to-grain.

7. Customize your DataViewer program

7.1. Preferences at loading

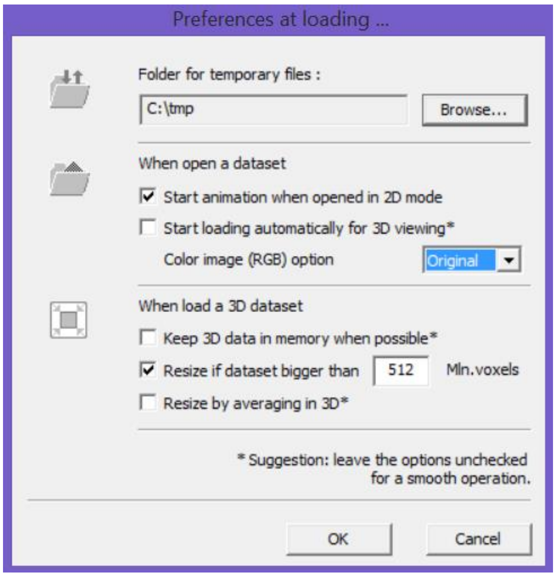
The ***Folder for temporary files*** defines the location of the file to store dataset during program operation. Keep this file on a drive with enough available space for swapping data with dataset displayed. This file will be removed after closing program. Use the ‘Browse...’ button to specify a directory.

The button ‘***Start loading automatically for a 3D dataset***’ can be checked to start loading data for 3D viewing immediately upon opening a dataset.

When load a 3D dataset section allows adjustment of the dataset size to be displayed in 3D. For large datasets, it is recommended to resize the data during loading to avoid a "blocking" effect during viewing. Resizing attempts to get an isotropic pixel size in x,y,z directions. The resizing criteria is defined in millions of voxels (1024 x 1024). Typical values are 200...1000, depending on the speed of the computer and the data depth (8 or 16-bit). This value should be decreased if viewing becomes slow or less responsive.

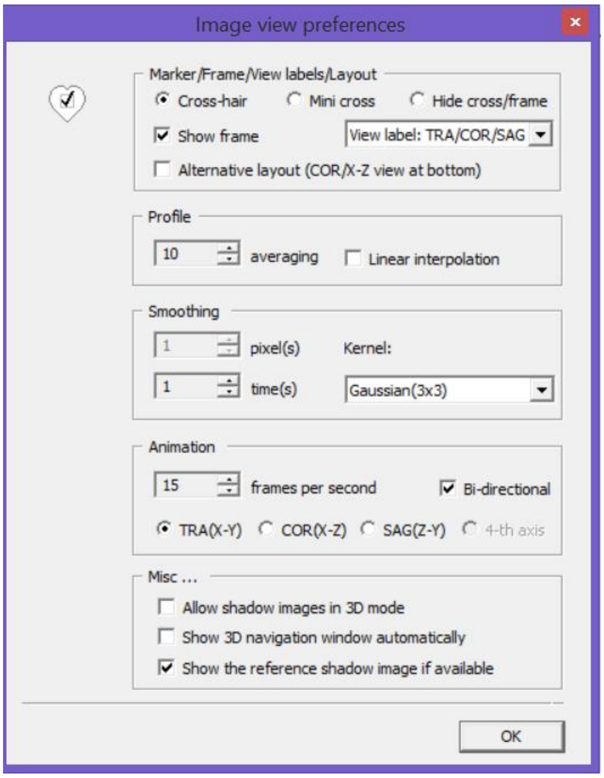
The resizing is done by averaging. To compromise speed and quality, resizing can be done by averaging in 2D or 3D. 3D-resampling is slower since all image files have to be read, but it provides nicer and more consistent images. 2D-resampling is faster. Note that, you should use 2D-resampling to avoid averaging from different angles if you want to view non-reconstructed projection data! In both cases, the text and scales embedded in the images may be distorted or blurred.

Both the resizing criteria and the resampling method can be still modified when you open a dataset using the opening dialog.

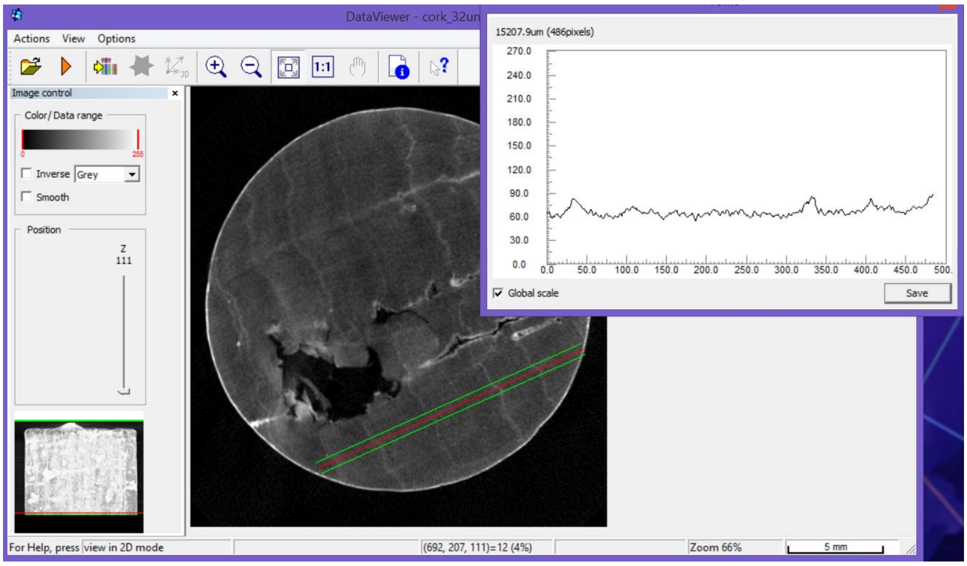


7.2. Preferences at viewing

This menu allows you to change the appearance of the cross-hair, as well as the frame and its labels. By default, the coronal (X-Z) view is displayed at top. An ***'alternative 3D layout'*** is provided: in this layout, the coronal (X-Z) view is shown at bottom.



In this settings menu, an averaging can be applied to the profile bar (in red). Adjacent profile bars will be calculated (widest ones shown in green) and the profiles are averaged. This results in a smoother profile. When linear interpolation is not checked, nearest-neighbor interpolation applies to create a profile.



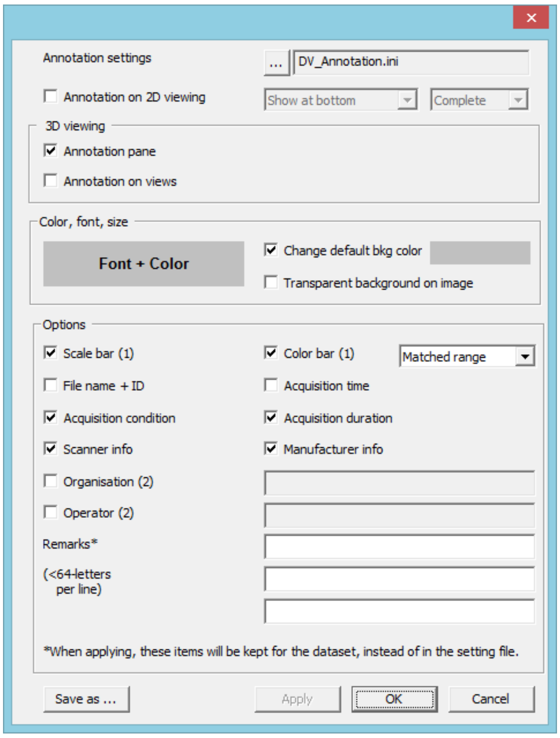
A value for smoothing the image itself is also possible, as well as a range of smoothing kernels. A Gaussian smoothing kernel is most recommended.

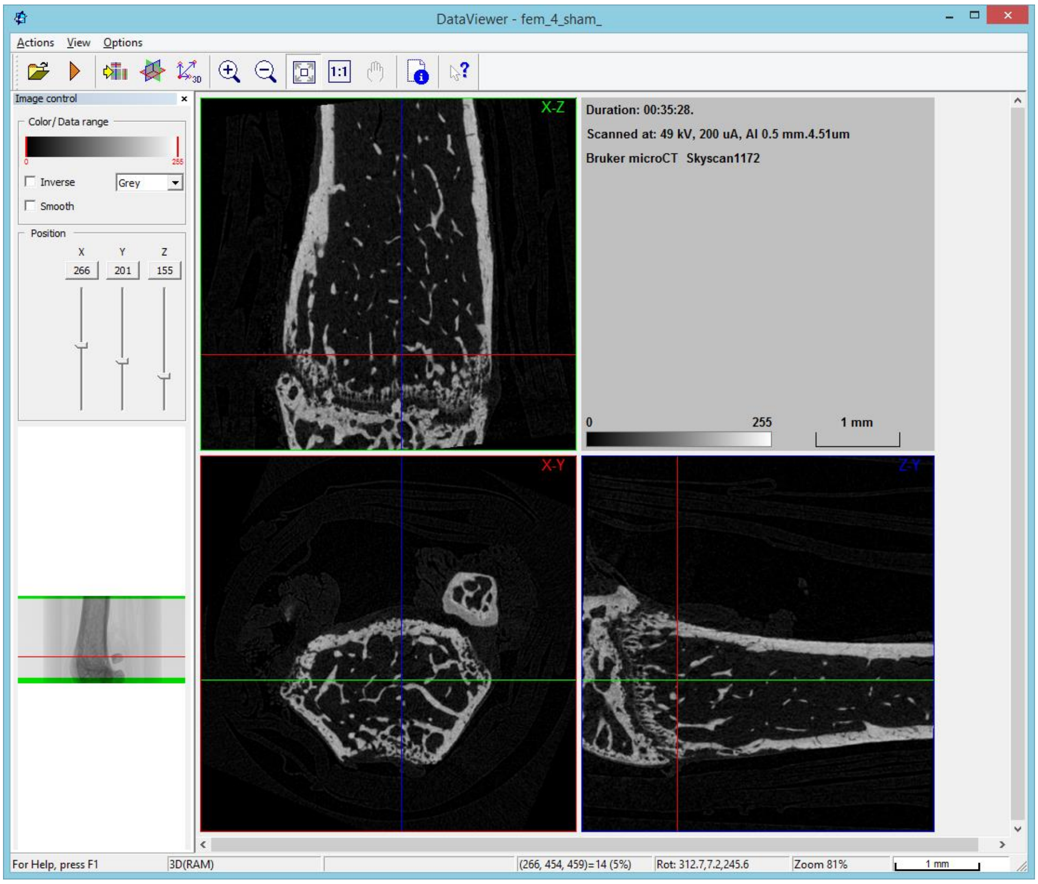
The speed of the animation can be adjusted by increasing/decreasing the number of ***frames per second***. Ticking the '***bi-directional'*** box will reverse the direction when the animation reaches the end of the image stack. Leaving it unchecked will keep the direction and make the animation 'jump' to the other end of the dataset. Animation is possible along any axis by ticking cor, sag or tra axis.

You may choose to switch off the reference projection image to limit usage of computer resources: then check/ uncheck '***Show reference shadow image if available'***.

7.3. Preferences Annotations

The annotation function activates an annotation pane which fills the empty space in 3D viewing mode, and optional annotations on the image itself (in both 2D viewing and 3D viewing). The annotations include information about the scan and the images including the scan parameters, the file name, the acquisition date, a scale bar, the color bar, etc.


Annotation settings
DV_Annotation.ini
Annotation on 2D viewing
Show at bottom
Complete
3D viewing
Annotation pane
Annotation on views
Color, font, size
Font + Color
Change default bkg color
Transparent background on image
Options
Scale bar (1)
Color bar (1)
Matched range
File name + ID
Acquisition time
Acquisition condition
Acquisition duration
Scanner info
Manufacturer info
Organisation (2)
Operator (2)
Remarks*
(<64 letters per line)
*When applying, these items will be kept for the dataset, instead of in the setting file.
Save as ...
Apply
OK
Cancel


DataViewer - fem_4_sham_
Actions View Options
Image control
Color / Data range
Inverse
Grey
Smooth
Position
X Y Z
266 201 155
X-Z
Duration: 00:35:28.
Scanned at: 49 kV, 200 uA, Al 0.5 mm.4.51um
Bruker microCT Skyscan1172
0 255 1 mm
X-Y
Z-Y
For Help, press F1
3D(RAM)
(266, 454, 459)=14 (5%)
Rot: 312.7,7.2,245.6
Zoom 81%
1 mm