PHYWE
excellence in science

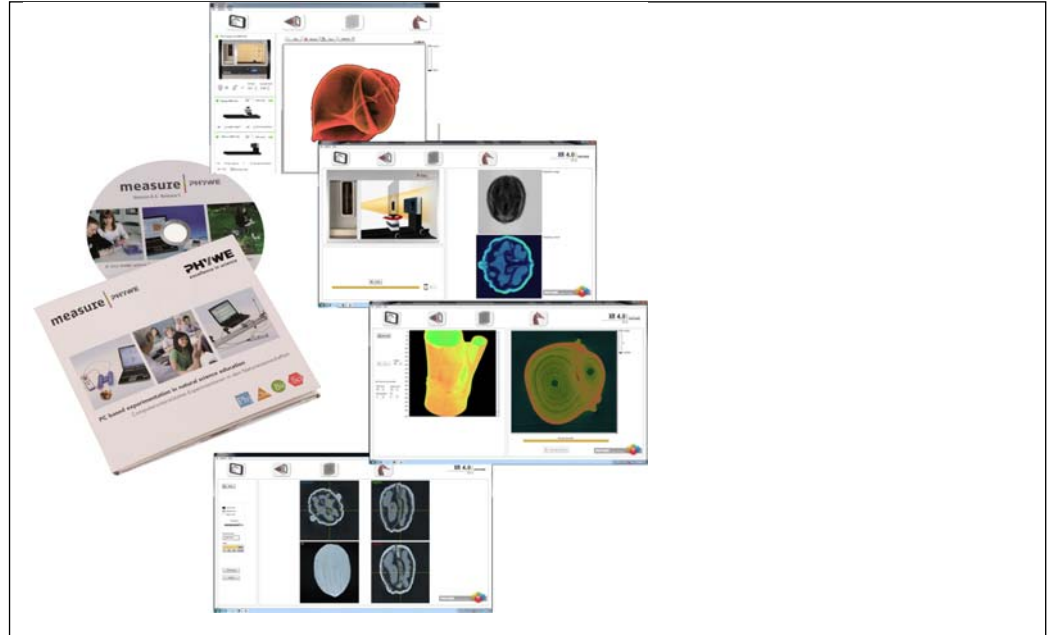XR 4.0 Software measure CT

14421-61

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Operating Instructions

CE   The unit complies
with the applicable
EC regulations

Fig. 1: 14421-61

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GENERAL

Set-Up

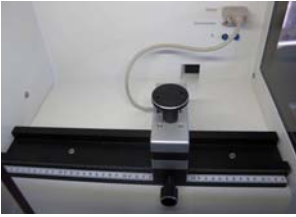- Connect the rotating stage XRstage to the x-ray device

Fig. 1: Connection to the X-ray unit

- Connect the X-ray unit via USB cable to the USB port of your computer (the correct port of the X-ray unit is marked in Fig. 2).
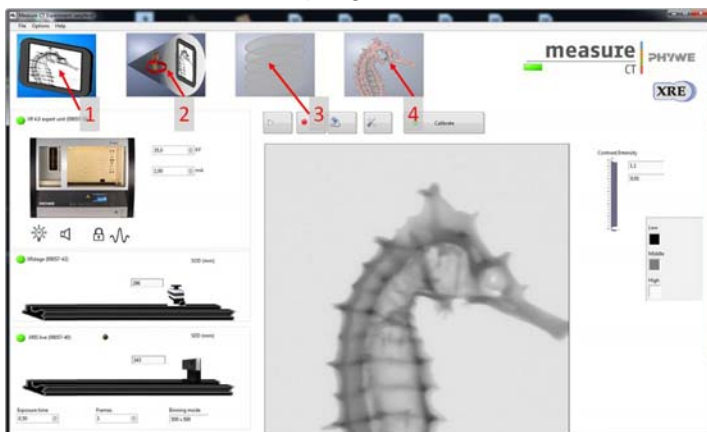

Fig. 2: Connection of the computer

Install the digital x-ray detector XRIS in the experimentation chamber of the X-ray expert unit and connect the USB cable of the detector to the computer

Fig. 4: X-ray sensor XRIS in a holder mounted on the optical bench of the X-ray unit

- Start the "measureCT" program.

User Interface.

The software consist of 4 operation modes (1-4) and the control bar (5) on top of the user interface. You can change the operation mode by clicking on one of the big buttons 1-4.

1	Live view and parameters
2	CT Scan
3	Reconstruction
4	3D View

Activation of the software

To start a CT Scan, the software must be activated. Click on "options" in the control bar choose "activation assistant" and enter your code.

## THE FOUR MODES OF OPERATION

The software consist of 4 operation modes (1-4) and the control bar on top of the user interface. You can change the operation mode by clicking on one of the big buttons 1-4.

| 1	Live view and parameters
2	CT Scan
3	Reconstruction
4	3D View

Live view and parameters

1. Overview

- Use the active buttons under the virtual X-ray expert unit to switch on and off X-rays or light etc. of the x-ray device.
- The Live view (3) is activated clicking on button 2
- To optimize the result and before starting a CT-Scan the detector (XRIS) must be calibrated. Use button 4 to calibrate the Detector.
- Use Scroll bar 6 to optimize the contrast of the image - during CT-Scan the contrast is set automatically!
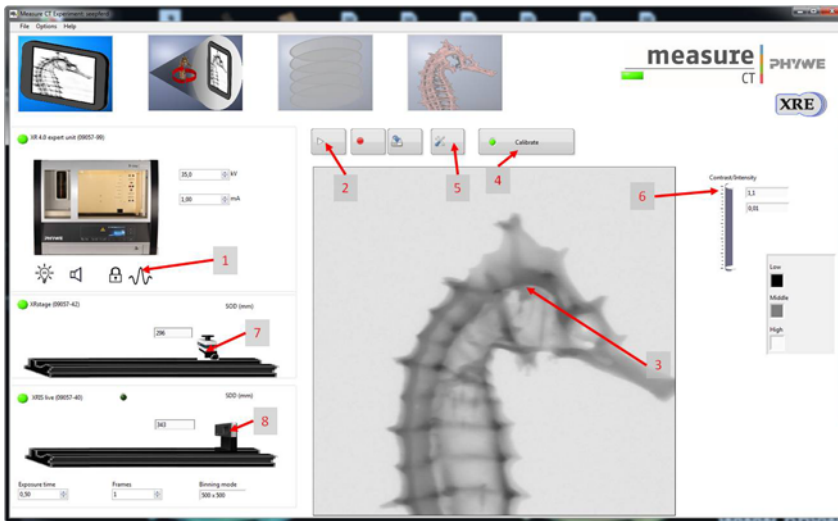
Details

- A virtual X-ray unit, rotation stage and detector are displayed on the screen. The green indication LED on the left of each components indicates that its presence has been detected (See figure below)
- You can change the High Voltage and current of the X-ray tube in the corresponding input windows or manually on the unit. (See figure below)
- When clicking on the unit pictogram additional information concerning the unit can be retrieved(See figure below)
- The status pictogram indicate the status of the unit and can also be used to control the unit such as switching on and off the light or the X-rays (See figure below)
- The position of the digital detector can be adjusted to its real position either by moving the XRIS pictogram or by filling in the correct value in the input window. (See figure below)
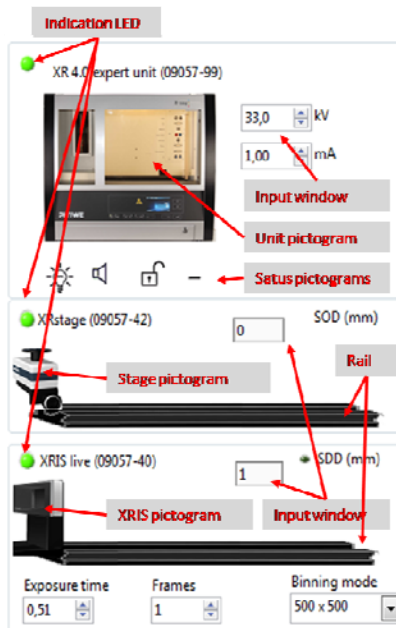

The settings of the XRIS can be adjusted using the input windows:

- **The exposure time controls the time between two frames are retrieved from the detector.**
- **the number of frames defines how many frames are averaged**
- **with the binning mode the charge of neighbouring pixels is averaged to reduce the total amount of pixels in one frame.**

CT Scan

- Just click on the symbol on the interface and enter the mode CT Scan. Please refer to chapter "Start CT-Scan" if you want to learn more about how to perform a scan.
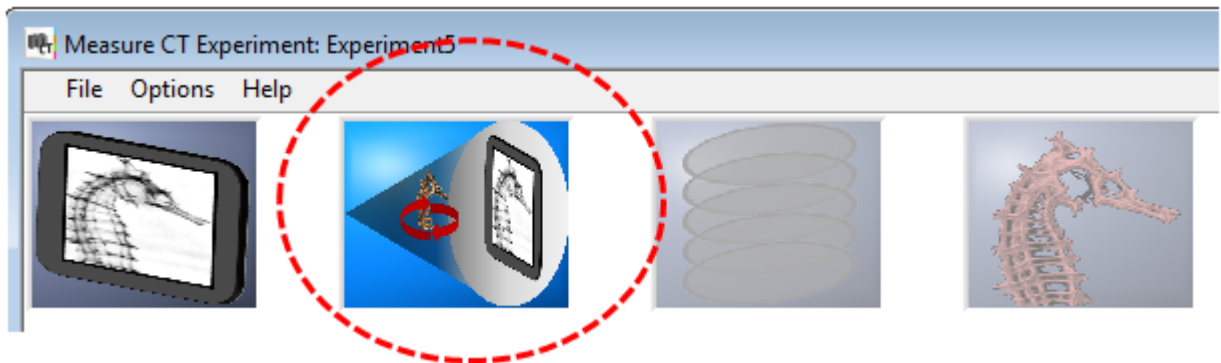
- By clicking on "Scan" (1) you start the scan. During the CT scan the progress (2) as well as the remaining time (3) is displayed. The current image (4) being recorded is shown and the temporary result (5) is calculated during the scan. It is also possible to track the position of the rotation (6).
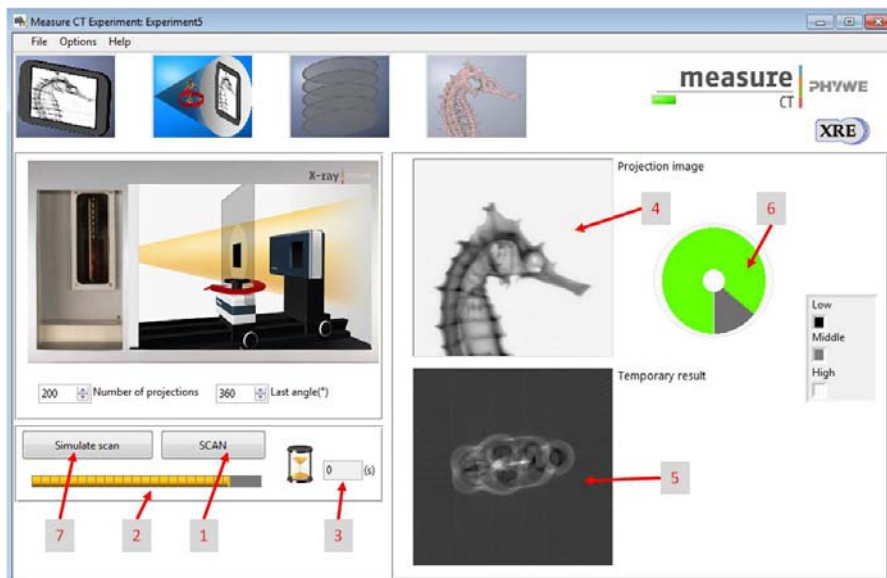
- When the CT scan is finished it is possible to proceed to the reconstruction. Go from the "CT scanning page" to the "Data reconstruction page". The page button will turn blue when the page is activated.
- You can also click on "simulate Scan" to rerun the Scan as a simulation. If you confirm the following pop-up window with yes, all intermediate reconstruction images will be saved. Use the image viewer to create a video of these pictures.
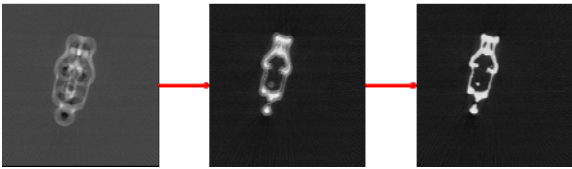
"Reconstruction"

In this mode, you can either load the data from the last CT Scan or you can analyse and reconstruct the data from a former project.

Prior to reconstructing the entire volume, it is important to define the correct reconstruction parameters. When the XRstage or the XRIS are moved, slight changes to the parameters will occur. For the best reconstructions it is advisable to test the parameters.

- The effect of the reconstruction parameters can be tested with the test button (1). The result is displayed (2) for a certain slice (3) which corresponds to a certain line of the detector (4). The SOD and SDD (5) parameters should not be altered if they correspond to the physical position of the XRstage and XRIS. The most important parameter is the 'Centre of rotation' (6).
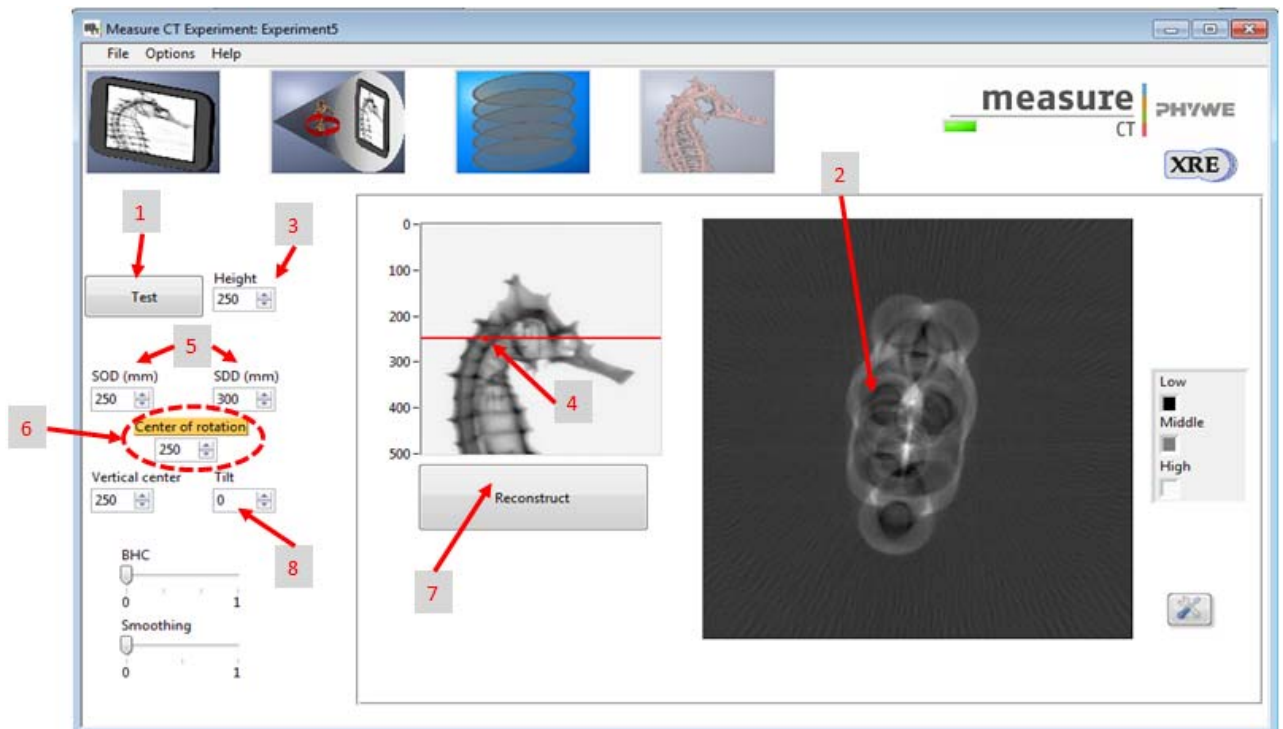
- The centre of rotation relates to physical rotation axis. Ideally, this is identical to the central column of pixels (250 for binning 500x500) but it might be different. Modify this value (6) and click on test (1), the adjusted result is shown (2). Change this value until the result looks sharp:

- With the remaining parameters it is possible to optimise the quality of the results. When the result looks satisfying press 'reconstruct'. The software will now reconstruct all slices of the recorded volume from top to bottom. the result are displayed while it progresses.

3D-Viewer

- When the reconstruction is finished it is possible to investigate the reconstructed volume. Go from the "Reconstruction" to the "3D view". The indication bar underneath the page button will turn blue when the page is activated.

- In the 3D viewer the 3D dataset is displayed in 4 views. In the 'Axial', 'Saggital' and 'Coronal' view windows (1), three slices in different directions through the volume are shown according to the slicer indicator (3). When this indicator is moved around in either one of the three views, the corresponding slice is updated in the two other views. The fourth window (2) displays a 3D representation of the volume, by moving the 'projection angle' cursor (6) , views from another direction are calculated. It is also possible to generate more elaborate 3D views with the third party freeware Volview by clicking on the Volview button (7). The software will first generate bmp files which are necessary for this software.
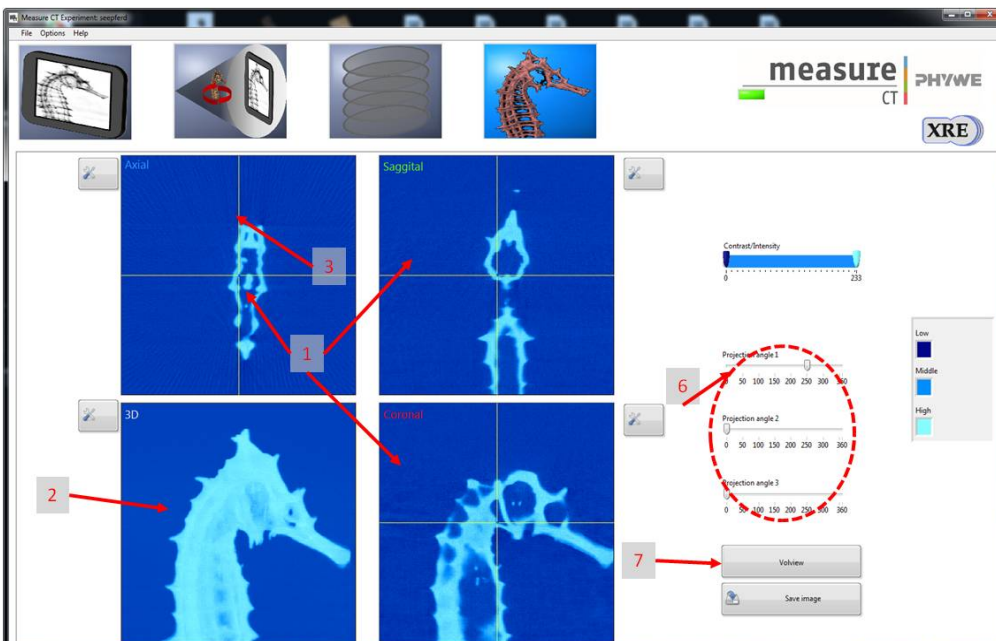
TAKE AND SAVE PICTURES

Once the detector is calibrated, good quality images can be displayed, recorded and saved.

- Place one of the demo objects between the source and the detector, switch on the X-rays and activate the life view. To place the object in front of the detector, a stand can be used. Adjust the contrast if desired.

- To save the resulting image, stop the live view and click on save. Four formats of images can be saved (tif, png, jpg and bmp). For the three later image formats, the contrast adjustments are retained during saving while this is not the case for the tif format. For tif, the images are saved in a raw format. **If the images will be used for further processing or measuring in the measureCT software it is important to save them as tif.**
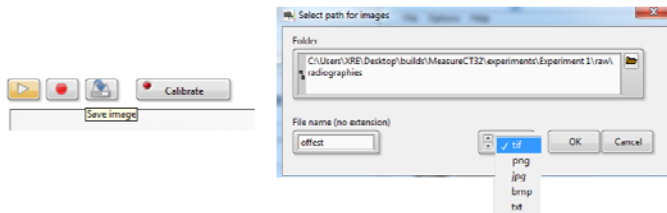
- To save a sequence of image, stop the live view and click on record sequence. Four formats of images can be saved (tif, png, jpg and bmp). For the three later image formats, the contrast adjustments are retained during saving while this is not the case for the tif format. For tif, the images are saved in a raw format. **If the images will be used for further processing or measuring in the measureCT software it is important to save them as tif.**
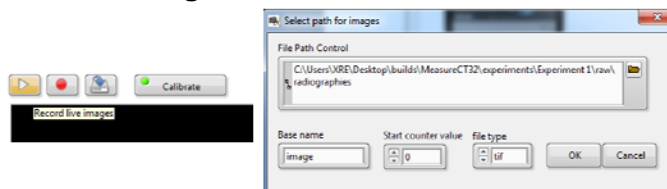

To further process an image you need to open the image viewer

IMAGE VIEWER

General

- To further process an image you need to open the image viewer. When the viewer is opened, the image that is present in the frame display will be transferred automatically to the image viewer. The image viewer can be opened in two ways, either from the taskbar or using the shortcut button. When you are finished with the viewer, close it, otherwise the next time you open it the remaining image will still be present.
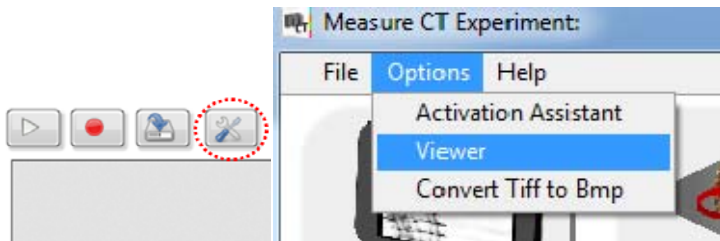
To process images that were saved as tif, open the destination directory. All the tif images that are present in the folder will be displayed in the list. Alternatively, it is also possible to open only one image (load image). The viewer will typically open while listing the current operational folder and the current operational image for ease of use.
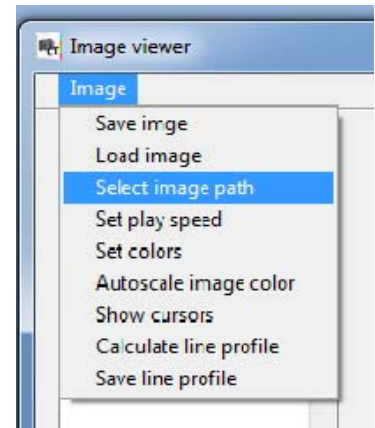

The image viewer has several functions available.

The tif files that are present in the current operational directory are listed (See figure, no 1) and the current operational image is displayed in the image viewer display (See figure, no 2). In this display, the line profile rulers are present (See figure, no 3). Additional functionalities can be accessed through the menu (See figure, no 4). The histogram of the image and the contrast settings are listed on the right (See figure, no 6) as well as the line profile data (See figure, no 7) and the region parameters (See figure, no 8). Saving and exporting options are available through several buttons (See figure, no 9).
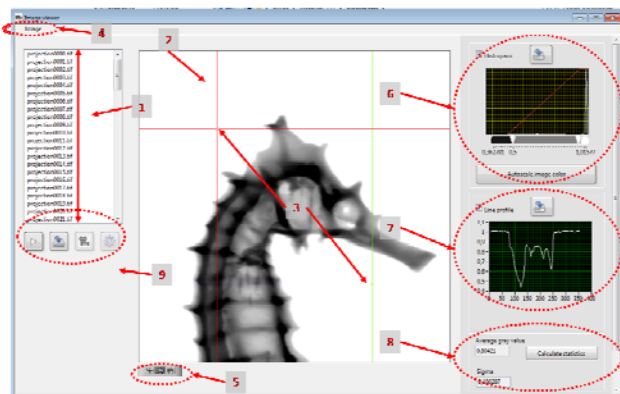

Using the image buttons (See figure, no 5) it is possible:
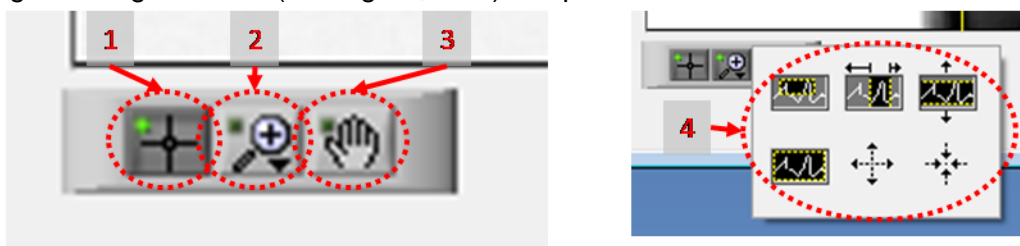
- To select the ruler function (See figure, no 1) which allows to change the line profile rulers from position (See figure, no 3).

- To select several zoom functions (See figure, no 2 and 4) to zoom in on a region of the image

- To select the move function (See figure, no 3) to change the position of the image once it is zoomed in on.

Histogram

The histogram of the current image is displayed in the histogram display (1). Such a histogram refers to the number of pixels (Y-scale) with a certain grey-value (X-scale) that are present in the image. By adjusting the lower and/or upper level (2), the image contrast can be altered and with the autoscale button (3), the lower and upper contrast level are reset to optimal conditions. The histogram can be saved as an excel file (4).
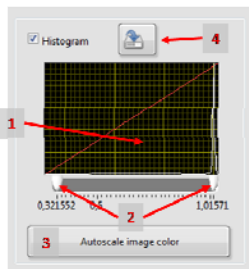

Line profile

The line profile function calculates the gray-value of each pixel along a line from the centre of one ruler to the centre of the other ruler . The result is displayed in the line profile display (1). The line profile can be saved as an excel file (2).
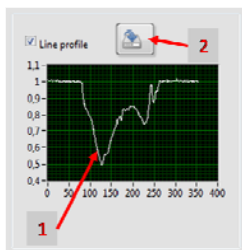
Regions parameters

The rulers of the line profile also define a square region. By clicking on the calculate button from the region parameters, the average grey value and the spread of that region are calculated.
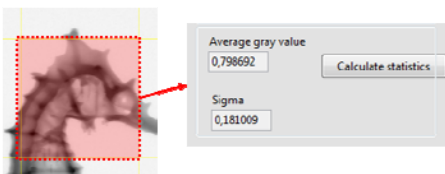

Play, Save, AVI and Convert

With the play button (1), the images that are listed in the directory are subsequently displayed, starting from the first selected image. It is possible to save one single image under a different formats or with other colours (2). A series of images that are selected can be saved as an avi-movie using the AVI-button (3) and a series of images can be converted to a different file format using the convert button(4).

Image viewer menu

Apart from opening a new directory, the image viewer menu has also several other functionalities.

- change colour

- set play speed

- other functionalities are available immediately through the buttons
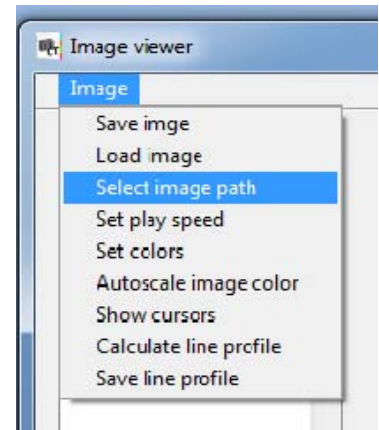
DETECTOR CALIBRATION

After having defined the adequate configuration for the experiment, the detector needs to be calibrated. Each digital detector has a different and variable offset and pixel-specific gain. During the calibration these variations will be measured and stored. Such corrections are performed automatically by the software:

- Automatic correction:
  - Make sure there is no object between the source and the detector, otherwise the calibration will be incorrect.
  - lock the door of the X-ray unit
  - make sure that the x-radiation is **switched off**
  - click on calibrate:

- After successful calibration, the red LED in the calibrate button will turn green. From now on the detector is calibrated and the displayed images will be corrected for offset and pixel gain

- The Load bar will not be visible anymore while the intensity bar is made visible. With the intensity bar the contrast in the displayed frame can be adjusted.
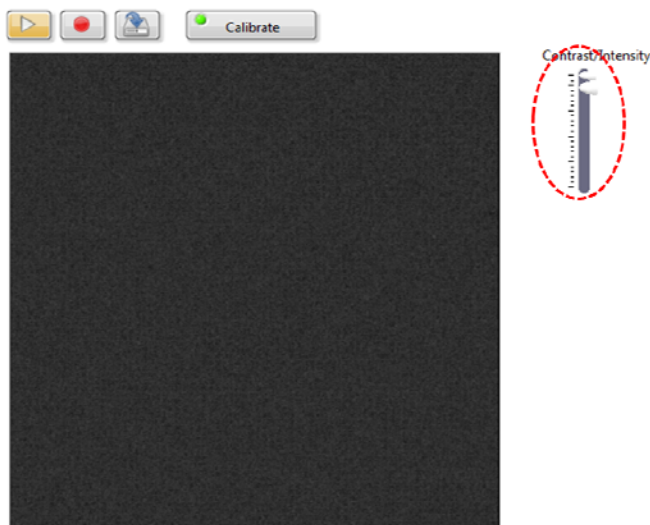
Note: if the configuration is altered, the calibration will be incorrect, this will result in the deactivation of the calibration status. Calibration will have to be performed again.

SHORT DESCRIPTION START CT-SCAN

- **As long as the software is not activated it is not possible to start a CT Scan.**

- **Furthermore, the SOD and SDD have to be set and the detector must be calibrated**.

- **It is only possible to start a CT-Scan if a new experiment is started.**

Procedure

- Adjust the XRIS settings and X-ray unit settings.

Overview of the settings of the XRIS and X-ray unit, that usually lead to good results:

- 35kV, 1.00mA

- exposure time 0.5 sec

- Number of frames: 1

- Binning mode 500x500

- SDD= 300, SOD= 250

- Start a new experiment, give it a unique name and fill in your details. Alternatively it is also possible to load this experiment with pre-recorded images and open this manual. The correct configuration will be loaded automatically as well.
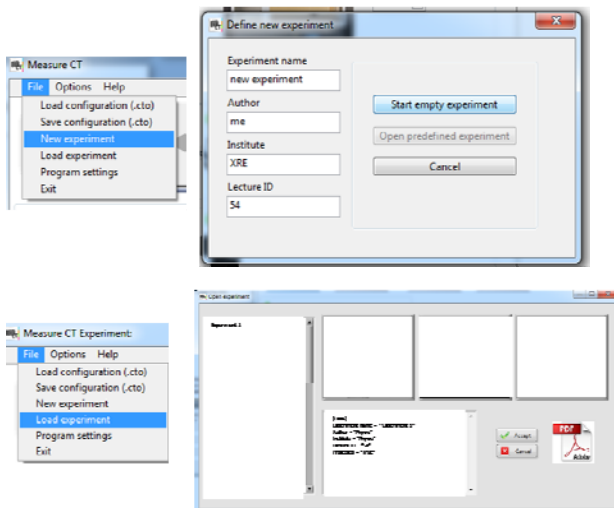

- Switch on the X-rays (1) and activate the 'Live view' (2). When the Live view is activated, every new image that is retrieved from the X-ray detector is displayed. The Detector exposure load bar (3) indicates the average degree of fill for each pixel. **It is very important to remain below the maximal fill degree of the detector**. Otherwise the detector will be saturated and won't work properly. If the saturation level is reached, the 'detector exposure' load bar will turn red. (see experiment 1 for more details)
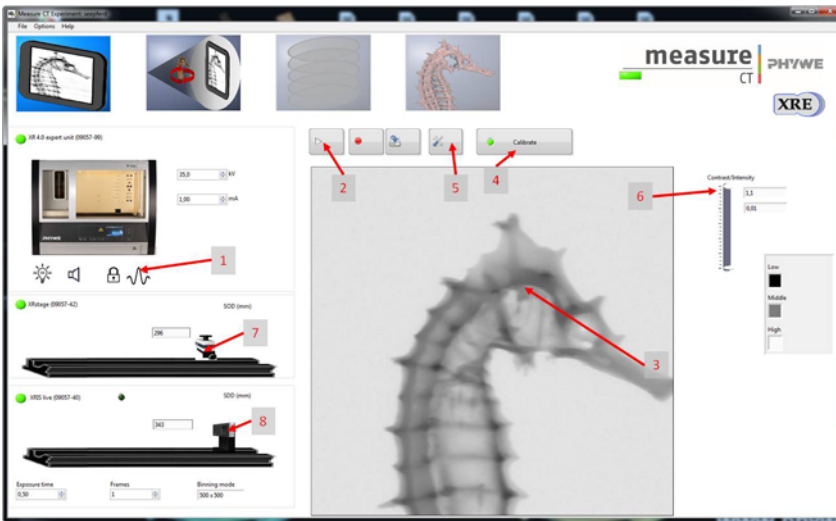
- Calibrate the detector by clicking on "Calibrate".

- Place object on the sample stage and close the door.

- Adjust SOD and SDD in the software according to the actual position.

- Go from the "Live view page" to the "CT scanning page". The indication bar underneath the page button will turn blue when the page is activated.

- Start a CT scan (1). During the CT scan the progress (2) as well as the remaining time (3) is displayed. The current image (4) being recorded is shown and the temporary result (5) is calculated during the scan. It is also possible to track the position of the rotation (6).
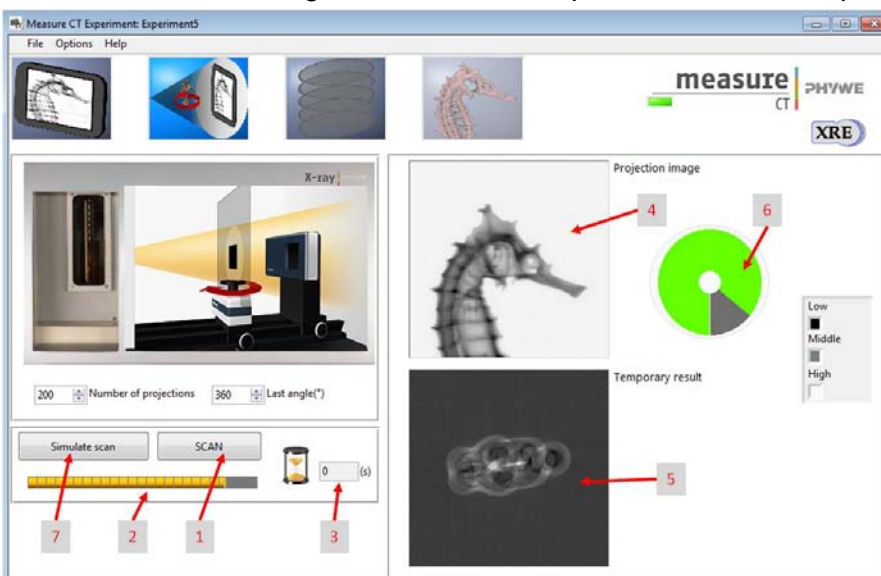
- When the CT scan is finished it is possible to proceed to the reconstruction. Go from the "CT scanning page" to the "Data reconstruction page". The indication bar underneath the page button will turn blue when the page is activated.

- After reconstruction go to the next step "3D-view".

CREATE MOVIES

- Save the images you want to transfer to a movie in an appropriate folder. For example the reconstructed layers give nice videos or save the intermediate reconstruction images (these can be saved by simulating the CT Scan)
- Use the Image viewer to create movies.
- Open the corresponding Image path of the pictures you want to transform to a movie
- Mark the desired pictures and Click on the movie-button.