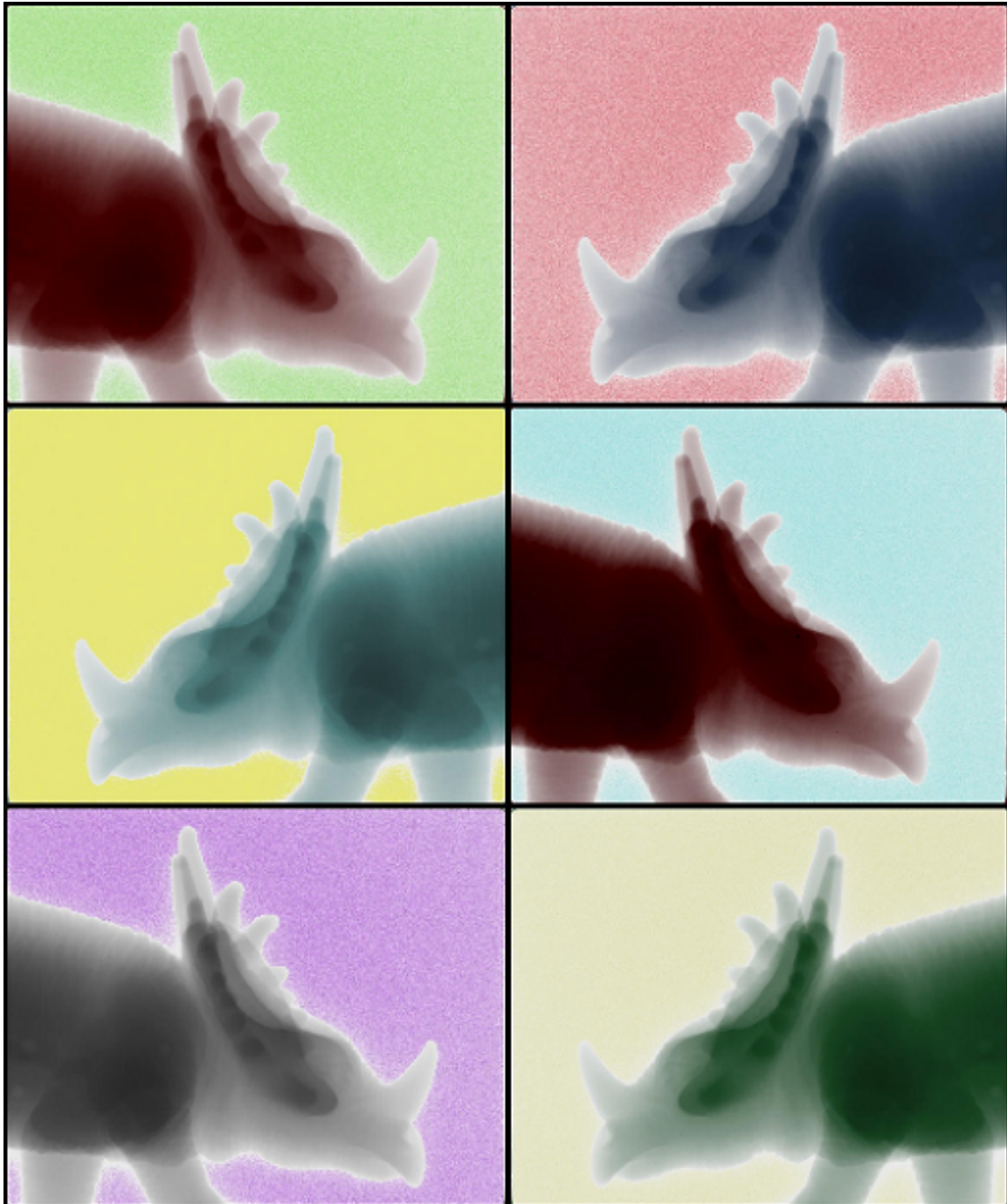


XACT SOFTWARE

- USER MANUAL -



September 14, 2016

Contents

1	Introduction	4
2	Software Presentation	5
2.1	Start-up and general presentation	5
2.2	Remote Desktop	6
2.3	Hardware configuration	6
2.4	Version and License	6
2.5	Menus	7
2.5.1	File	7
2.5.2	Window	8
2.5.3	Settings	8
2.5.4	Help	9
2.5.5	Calibration	9
2.5.6	Image	9
2.5.7	Script	10
2.6	Toolbars	10
2.6.1	Main Toolbar	10
2.6.2	Drawing Toolbar	12
2.6.3	Overlay Toolbar (“overlays”)	13
2.6.4	Motorized door tool bar (optional)	14
2.7	Customization	14
2.8	Configuration	15
2.8.1	Application	16
2.8.2	Advanced	17
2.9	Viewing of Images	18
2.9.1	User Interface	18
2.10	Image Formats	18
2.11	File Systems	20
3	Plugins	21
3.1	Xray 150kV	21
3.2	Flat panel imager	23
3.2.1	User Interface	23
3.2.2	Black calibration	24
3.2.3	Gain calibration	25
3.3	Axis	27
3.3.1	Control tab	27
3.3.2	Maintenance tab	28
3.4	Histogram	29
3.4.1	Generalities about images	29

3.4.2	Histogram and Look up table	29
3.5	MacroEditor	32
3.5.1	Plugin interface	32
3.5.2	Examples of macro execution	33
3.5.3	Macro Point content	34
3.5.4	Create a macro with a grid of points	35
3.5.5	Example to create a macro for a sample holder with 5 lines and 4 columns.	35
3.5.6	Scan order	36
3.6	RunScript	38
3.7	Sleep	39
3.8	Video	40
3.9	Geometry Viewer	41
3.10	Console	42
3.11	Error Logger	43
4	Scripts	44

1. Introduction

The X-Act 2.0 software, developed by RX Solutions, is a dedicated software package for the utilization of the X-ray equipment manufactured by RX Solutions, the tomographic reconstruction and basic image processing.

The software is made up of a shared base allowing visualization and handling of images or a series of images made up of 16 bits per pixel. These images can come from peripherals controlled by the software or files. X-Act allows their posting, the modification of the contrast levels and the color setting, the application of filters, and the export of these image files in a compressed format.

Each peripheral of the equipment is controlled in X-Act by a module (plugin). The electric X-ray generator, the imager, the motorized axes etc., are made up of independent modules. The software also consists of several modules called functional which relate to a particular usage of the equipment (macro control, tomography, etc.).

The construction of this software allows the addition of new and additional plugins to control additional equipment (cameras, system mechanics, temperature regulates etc.).

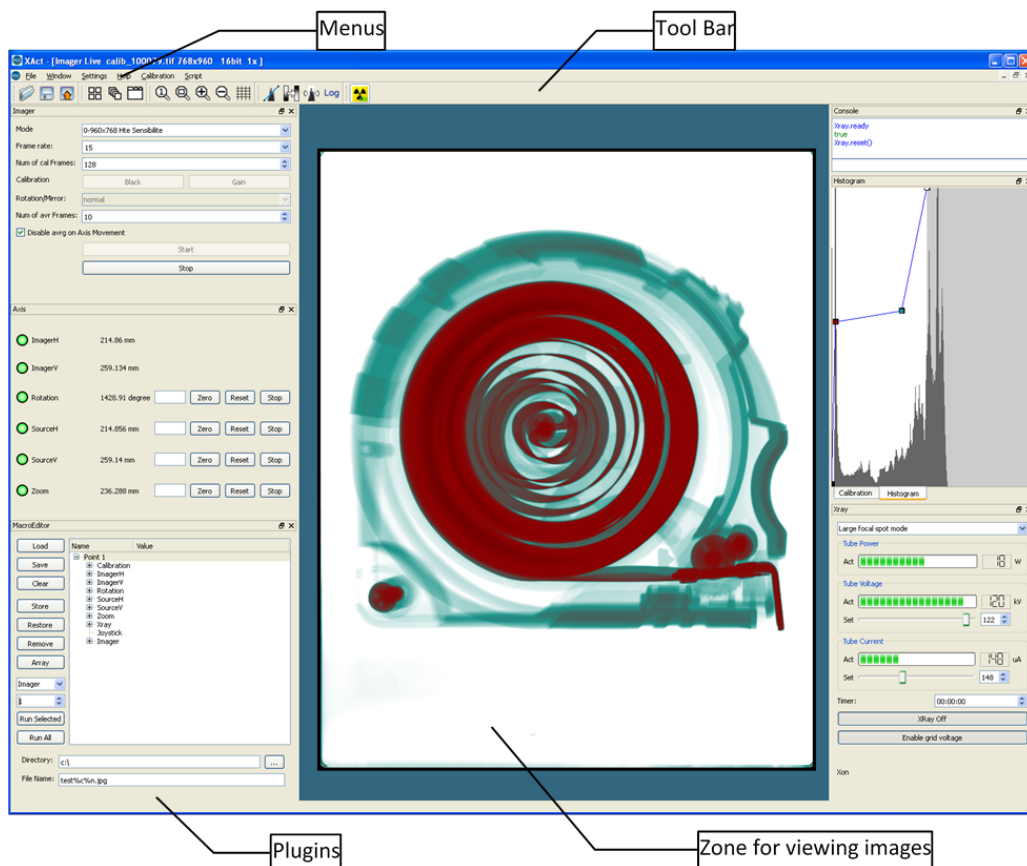
The objective of this manual is to present in detail the operation of the X-Act Software. For the technical information regarding the X-Ray equipment please refer to the appropriate documentation.

The manual consists of a general presentation of the software interface for the image processing, each module is then detailed.

2. Software Presentation

2.1 Start-up and general presentation

The Software X-Act is installed at the point of delivery by RX Solutions onto the computer supplied with the equipment. To launch the software double click on the icon on the desktop or on the start menu



Warning: opening multiple instances of X-Act simultaneously can be problematic in particular on the control computer (for connection to hardware for instance). It is possible to force a single instance of X-Act in the software configuration.

The interface by default displays a zone of displayed images, additional plugins such as the histogram, macro editor and the tools for image processing (filters, measurement tools, overlaying, etc). This part is free and be installed on other computers.Plugins necessary for the operation of the equipment are specific to each machine and configured by X-ray Solutions. They appear on the graphical interface in different zones (see below paragraph Personalization).

2.2 Remote Desktop

X-Act software can be used from remote desktop. However, it cannot be started from a Windows remote desktop session by a simple double click (the application crashes at start up). A specific BAT file must be used which can be found in the software directory. The remote session is closed automatically during start up. The user needs to log in again to continue working.

2.3 Hardware configuration

Hardware minimum configuration for running X-Act 2.0 is: a graphic card which support OpenGL 2.1. Depending on the installed plugins and the data handled, more specific hardware can be requested:

- UniCT and Reconstruction plugins: Nvidia Graphic card with GPU, CUDA support. Consult RX Solutions for the list of supported drivers.

Driver configuration:

- Disable multi-GPU support (if multi GPU card)
- PhysX processor: “Processor”
- Simple datasets visualization: minimum 8GB of RAM
- Large datasets for reconstruction and processing: large amount of RAM: minimum 32 GB
- Very large datasets (64GB or more): large amount of RAM (minimum 64 GB) and SSD configured for swap in X-Act (optional).

2.4 Version and License

The X-Act 2.0 software is available for Windows XP, 7 and Linux (without support), in versions 32 and 64 bits.

Certain plugins are free and can be installed on any work station. Certain plugins (piloting of the peripherals, functional plugins) require a license on a dongle key provided by RX Solutions. Only the plugins whose license is present on the key connected to a computer are able to launching these software plugins. If the dongle key is not plugged at software start-up on a computer where licensed plugins are configured, a message box will pop-up for warning.

The X-Act software can be used on one computer from any user account. Under Windows OS it is possible yet not recommended to use X-Act from a non-administrator user account but it requires specific configuration. Ask RX solutions for more information.

The dongle key can be moved from one computer to another and represents a floating license.



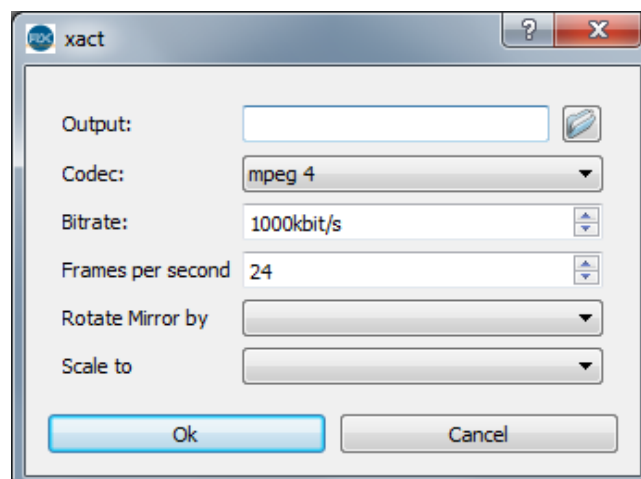
Warning: Certain functionality of the X-Act software require particular data-processing characteristics and are likely not to function on a station other than that provided by RX Solutions.

- Do not start X-Act with more than one license keys.
- Do not disconnect the key when the software is open.

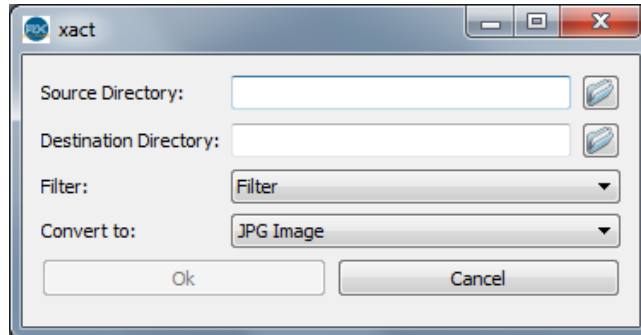
2.5 Menus

2.5.1 File

- Open: Open one or multiple 16 bit tiff images in a new window. Select one file to open one image in a new window. Select several files to open them as stack in a new window (press ctrl or shift key for multiple selection). With a stack of images a cursor appears at the bottom of the window to browse the stack, together with a “play” button. To browse manually: move the cursor, roll the mouse wheel or press the right and left arrows on the keyboard.
- Save: Save the image in the active window in the 16bit tiff format and conserve the current name of the file.
- Save as: Save the image in the active window in the 16bit tiff format, whilst having the option to rename and save in a different location.
- Export:
 - From images: Save the image in the active window in a different format (see Image Formats)
 - From volume viewer: Save one direction slices of the volume in tiff 16bits
- Import: Import into the X-Act software an image of another format such as jpg, png or 8 bit tiff or a volume form his slices in one direction (tiff 16bits). Attention, the software can import only gray scale images. Any color image will be displayed as gray scale by X-Act.
- Export Array: Save on disk a stack of images into jpg, png or 8 bit tiff files.
- Export Array as Video: Save on disk a stack of images into a video file. Select File name for output file. Select Codec: mpeg4 for more universal format, motion jpeg for higher compression quality but larger file. Change bitrate and frames per second if necessary. Select a rotation or mirror, or scaling factor if necessary. Exporting a video can take a lot of computing power and some time. The progression is displayed in the title bar of the image.



- Save Array: Save on disk the stack of images into 16 bit tiff file.
- Quit: Quit the software package.
- Convert Images: Convert the current 16bit tiff images in a folder into one of the following formats:



- Source directory: Contain the source projections (projection need to be filtered or remapped, projections with the correct Xact tiff format or old Xact format projections).
- Destination Directory: Will contains the conversion output (projection filtered or remapped, projection modified by a other program and with a wrong Xact Tiff format or projections converted to the new Xact format)
- Convert to:
 - * jpg or png : possible to apply a filter to all images,
 - * 16bit tiff with half resolution
 - * 16bit tiff with bad pixels interpolation to remove defective pixels, based on a color map (png image with color pixels to mark bad pixels)
 - * Restore X-Act tiff format: reimport proprietary information in 16bit tiff files after processing by a third party software. Necessary for reconstruction with UniCT. Requires original and processed files
 - * Remap: apply a distortion map (useful when using a distorted image like CCD imager with non shearless taper for instance)

2.5.2 Window

- Toolbars: Open or close the available utility bars
- Dock Tools: Open or close the plugins available
- Sub windows: Access the different image windows open
- Tile: Arrange the image windows into a tiled mosaic
- Cascade: Arrange the image windows into a cascade arrangement
- Tabbed: Place the image windows into different tabs
- Close all: Close all the open image windows

2.5.3 Settings

Config: Access the settings/configuration window.

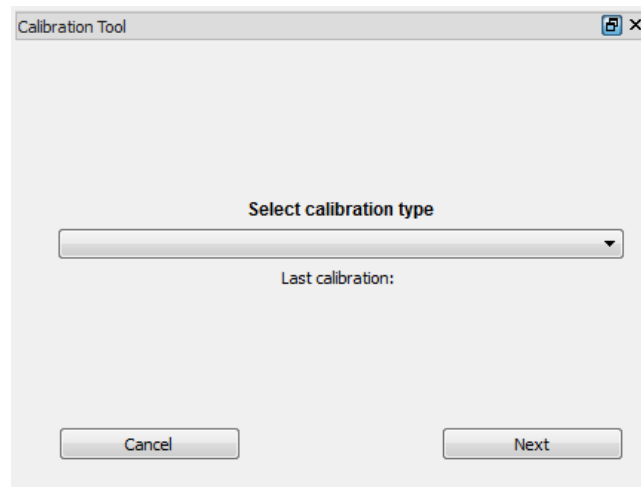
2.5.4 Help

- About: View legal information and information regarding the software version.
- View help: Show the XAct helper.

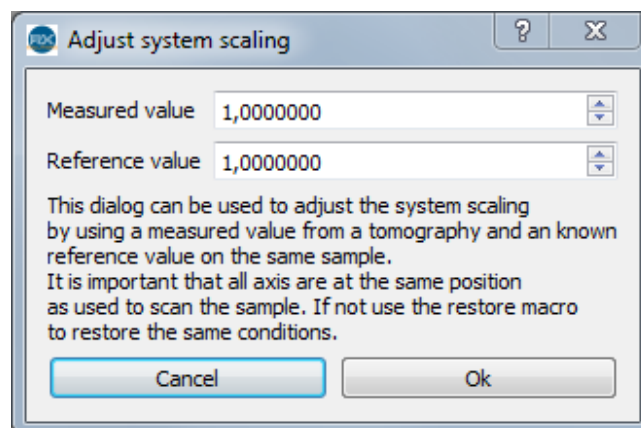
2.5.5 Calibration

Displays the utilities allowing the geometrical calibration of the machine:

- Calibrate Machine: Open the plugin of calibration for the equipment. See Calibration paragraph for detail.



- Adjust system scaling: Open a dialog box to adjust the global scaling factor of the system. The user has to type a value measured with the uncorrected machine (on a reconstructed volume or with the 3D radioscopic measurement tools) and the real value measured by another methodology (reference value).



2.5.6 Image

Displays some single mathematical operations on images.

For a processing between 2 single images, first select the image and click on Set current image as operand. That image (single, even if from a stack) is recorded by the X-Act as the

first operand for all the following operations.

To apply an operation, select an image or stack of images (second operand) and select the option in the list of proposed processing. The result of the processing is displayed in a new window.

The following processing are proposed:

- Array to Image: transform a stack of images into a single image. Each pixel of the resulting image is the result of the selected operation on the corresponding pixel over the stack (minimum, maximum, average, etc.). No use of the set operand.
- Image to Image: image to image operation (active image in the case of a stack). It is possible to process two images from a single stack.
- Array to Array: image to image operation between the selected operand and every image of a stack.

2.5.7 Script





Open script: open a execute script (caution: the script will be carried out directly after selecting).














2.6 Toolbars



The toolbars appear under the menus. You can choose the toolbars that you require to add (under Windows/Toolbars or right click on the menu bar) you can alter their position or the contained shortcuts to the functions most frequently used.

2.6.1 Main Toolbar



File	
	Clone: Duplicate an image or a stack of images in the active windows and create in a new window.
	Open: Allows the opening of one or a stack of images in a new window. Press on the Ctrl or Shift key to select multiple files.
	Save in the 16 bit tiff format (keyboard shortcut ctrl + s)
	Save in the format jpg, png or 8 bit tiff (keyboard shortcut ctrl + e)

Windows	
	Auto-adjust the windows into a mosaic.
	Auto-adjust the windows into a cascade.
	Arrange the window into tabs.
View	
	Show the image in its original format 1:1 scale (with no zoom 1 pixel of the screen = 1 pixel of the image).
	Adjust the image to fit the window.
	Increase the zoom.
	Decrease the zoom.
	Choose a filter to apply to the image. The result of the filter is saved. The result of filtering is recorded on the images exported in jpg, png, 8 bit tiff but not if the image is saved in 16 bit tiff.
Histogram	
	Reset the LUT.
	Reverse the histogram (show in “negative”).
	Auto adjust the LUT and histogram.
	Click on this button to apply to all the images in the stack the settings of the histogram for the current image.
	Show the coordinate axis of the histogram in logarithmic scale. This enables the user to emphasize value with weak variableness (less pixels in differing levels of gray allowed).
Error	

	The red explanation mark indicates an error in the software The details of the error can be found in the error logger, The explanation mark will return to gray once the list of errors is empty.
X-ray	
	Activate or Deactivate the X rays.

2.6.2 Drawing Toolbar






The Drawing toolbar allows the user to realize the layouts and measurements on the screen on 2D X-ray radiographies or on reconstructed slices. The images displayed on the screen reflect the radiographies performed by the machine and contain the required information required to display 3D measures in real time. Refer to specific chapter for more information.












All primitives are created in 3D space. Right click on the control point to open the rotation widget and change the orientation of the shape in space.

If the displayed image is a projection (in the case of a radiosopic image), the design is the projection for the shape onto the projection plane of the image.

If the displayed image is a slice the blue line is the parallel projection onto the slice plane, the pink line is the intersection between the shape and the slice plane (if any).








	Overlay synchronization : Apply the overlay of the active image to all the open image windows: display the shapes of the active window on all the other image windows.
	Cancel the selection of tool and return to the mode viewing by default and click on the mouse to permit the movement of images or points. The mouse pointer switches to an arrow cross to indicate the detection of a point under the cursor.
	Select a group of points. Selected points are displayed in red.
	Delete all the selected points.
	Delete the shapes not the points from selected points.

	To fix all the points along the rays of projections.
	Undo / Redo list of single operations.
	Add a point with custom text by the operator. Text can be empty.
	Design a line: click then drag to expand the length and click again. Two entries in the drop down menu for with and without distance measurement (distance value in mm).
	Draw a sphere: two entries in the drop down menu: first click to center circle expand with the mouse and click again to add a second point on the circle path, type sphere diameter (in mm) the click to place circle center in the image.
	Draw a horizontal rectangle : one click for the first corner, another for the opposite corner.
	Draw a cylinder: enter the diameter of the cylinder in mm and click for each extremity, adjust orientation with rotation widget.
	Draw a cone: enter the angle of the opening of the cone in degrees click to place the summit and the second click to place the base, adjust orientation with rotation widget.
	Measure an angle: 3 clicks for the 3 highest points of the angles.
	Measure the distance perpendicular: 3 clicks for placing 3 points forming 3 segments perpendicular to measure the lengths of the two last sections.
	Load a file STL (requirement: unit in mm, binary format and closed STL). Select a file from disk, click on image to place the center, adjust orientation with rotation widget.

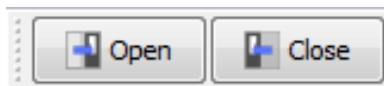
2.6.3 Overlay Toolbar (“overlays”)

All the buttons on this Toolbar are buttons bi directional: Selecting or de-selecting these buttons will place or remove the overlay on the image.



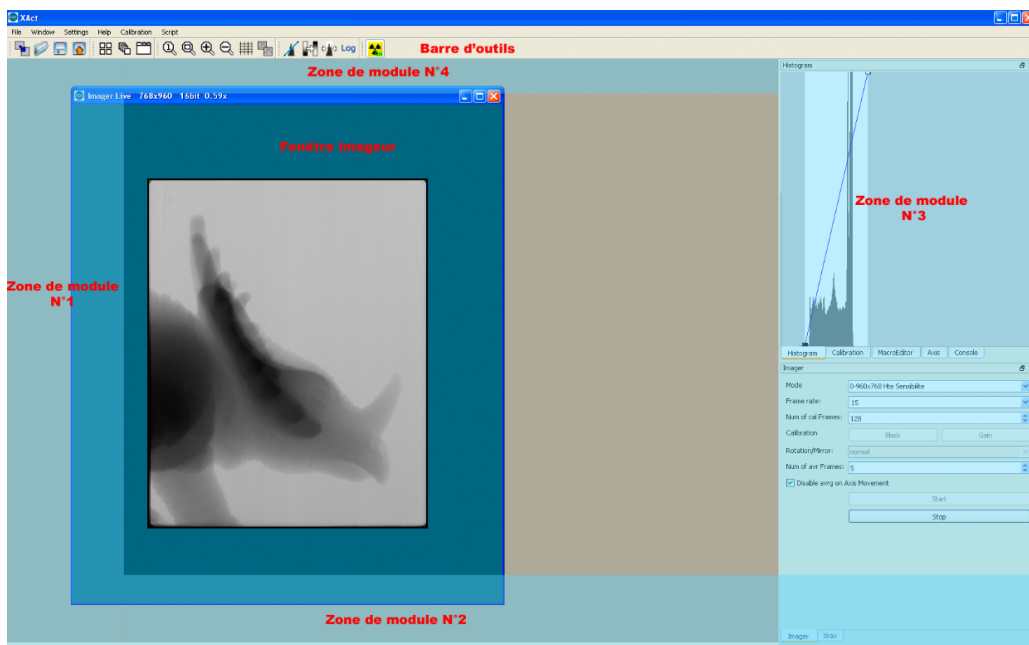
	Positional grid in the image. Visual help for sample alignment.
	Display Tripod Axis X, Y, Z.
	Enable / Disable Design.
	Sphere detection (used specifically for calibration).
	Enable / Disable the display of the macro point name when running a macro.

2.6.4 Motorized door tool bar (optional)



- Open: Simple click, open the door.
- Close: Hold click, close the door as long as the button is clicked.

2.7 Customization



- All different plugins or “docktools” can be entered in one of the 4 plugin’s zones. To move a plugin, click on the title bar and drag the plugin into the center of the chosen zone. If the movement is possible, the zone will change and the plugin will get inserted. Some movements are not permitted by the software, eg; if the chosen zone isn’t large enough.
- The tabs will appear if there are multiple plugins within one zone.
- They can be “floating” too, for example, by moved onto a second screen. To deactivate this option click on the pin in the top right corner of the bar.
- The images viewing windows cannot be out of the main application window.
- There is the possibility to view or hide a plugin via the menu Window/Docktools or by right clicking on the tool bar.

2.8 Configuration

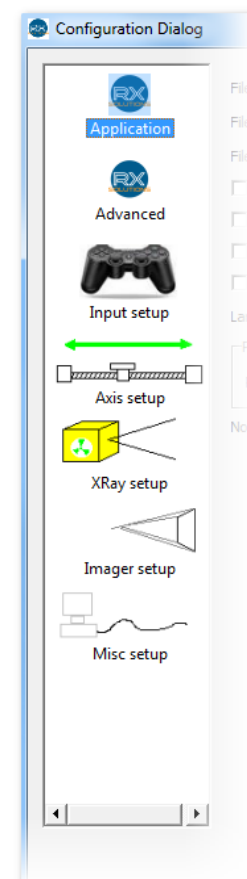
The settings for the software are accessible in the configuration Dialog window: Settings/Config.

The administrator has access to the software configuration with a password. These modifications can allow the operator to adapt the machine to your requirements, but may also compromise the performance level of the machine. All configurations changes need to be made with precaution.

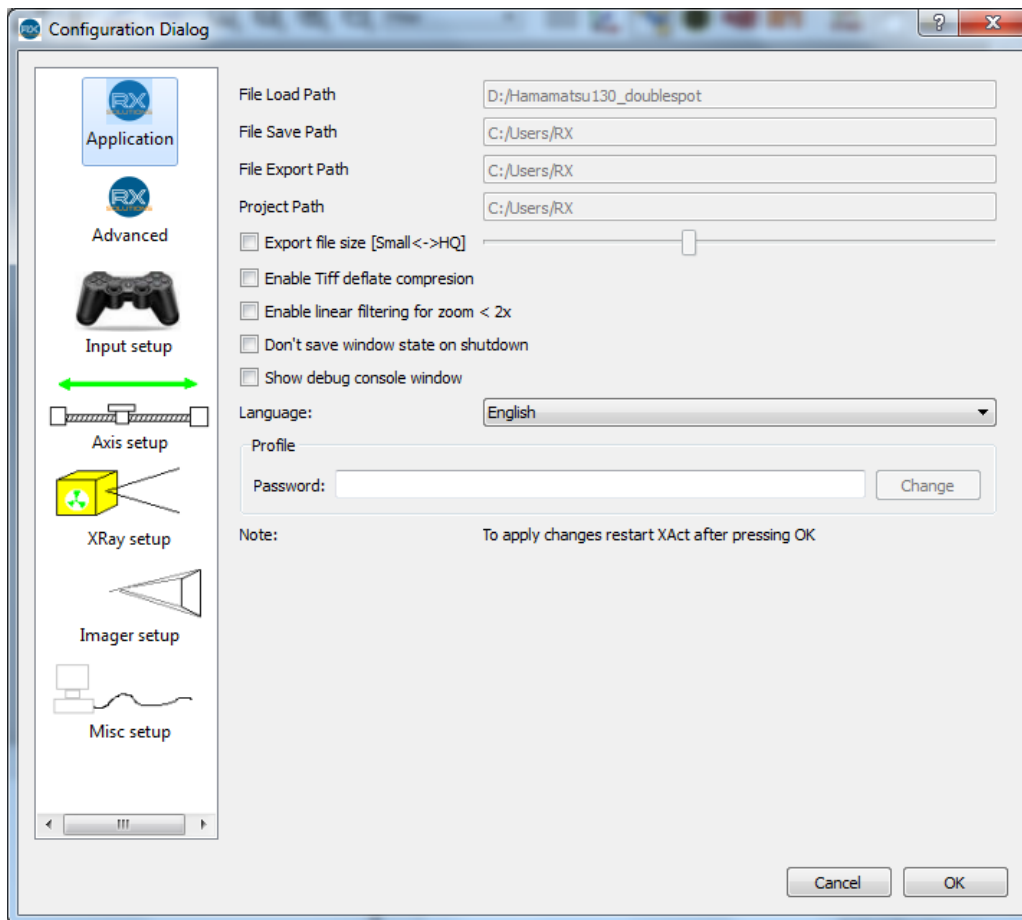
A backup is automatically saved if the configuration is modified with the date in the file name. Note that successive backups on a given day overwrite the file.

To restore a backup configuration: close the X-Act software, open the “back” directory in the configuration folder on disk, copy the file you wish to restore (after the date in the filename) and paste it in the configuration folder. Rename the file to “xact.ini”.

In the left-hand column, various categories gather the configurable elements of the software.



2.8.1 Application



This category groups various general parameters of the software.

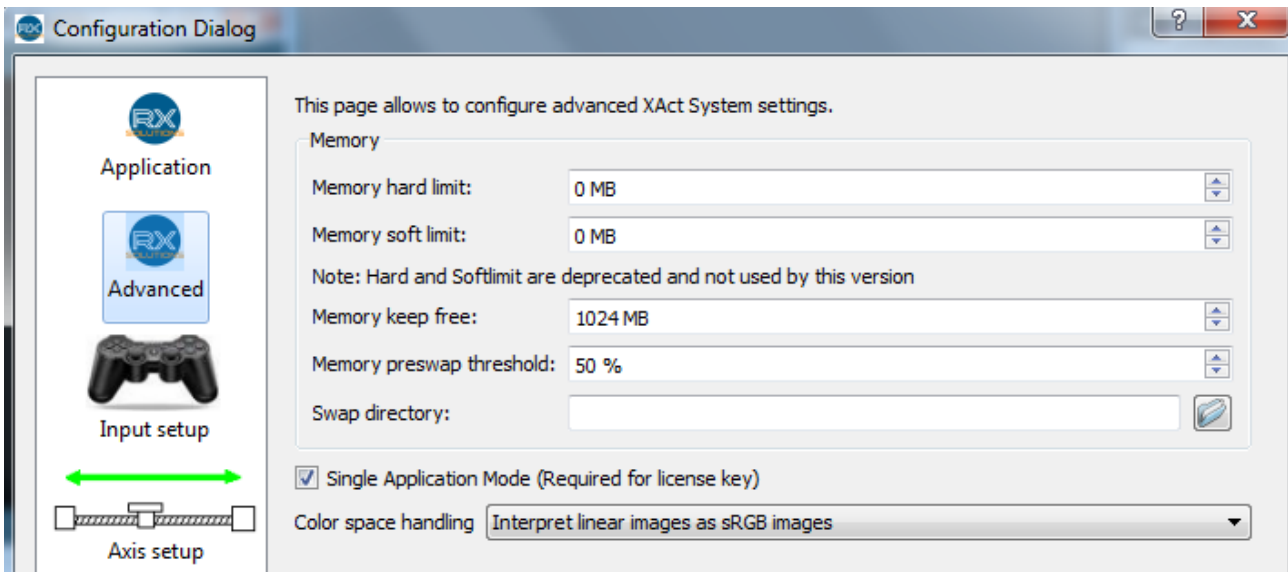
- File load path: Directory path of the last loaded file (nonadjustable)
- File save path: Directory path of the last file saved in tiff (nonadjustable)
- File Export path: Directory path of the last file saved in jpg, png or 8bit tiff (nonadjustable)
- Export file size: Set the compression rate for exported files in the jpg format (The further to the left the slider the higher the compression but the lower quality of image)
- Enable Tiff deflate compression: To activate compression without loss of tiff files. In practice: This will consume a large amount of processor resources for a minimal gain in disk space.
- Enable linear filtering for zoom <2x: Activate the anti-aliasing filter for viewing of images: reducing the effect will increase the jaggedness of the image.
- Don't save window state on shutdown: Deactivate the safeguard of the software settings on closing of the window. This is advised if X-Act is used on the same account by several users having tendency to modify various aspects of graphical interface.
- Show debug window: Activate the debug console.
- Language: Select the language for the software.

- Profile: Password: Password to unlock the software configuration. Enter the password and tap enter to access. The box will reset blank if the password is incorrect. The default factory password is: “password”.



Warning: Restarting of the software is required to apply all of the modifications.

2.8.2 Advanced



Memory Configuration of the memory manager: X-Act software includes a memory manager to handle datasets larger than the RAM. Data is swapped on hard disk to save RAM by X-Act when necessary. This process is independent from operating system’s swap.

Memory hard limit: Set the maximum size of random access memory (RAM) usable by the X-Act software. This is determined by the maximum amount of memory installed in the PC, normally this should be set 1 to 2 GB below the total RAM installed. If set to zero it is left to the operating system to manage the RAM given to the X-Act.



Deprecated: Only for backward compatibility

Memory soft limit: This is the value for which software uses the hard drive to store information including virtual RAM. This value should be lower than the Memory hard limit above. If set to zero this will be left to the operating system to manage the memory.



Deprecated: Only for backward compatibility

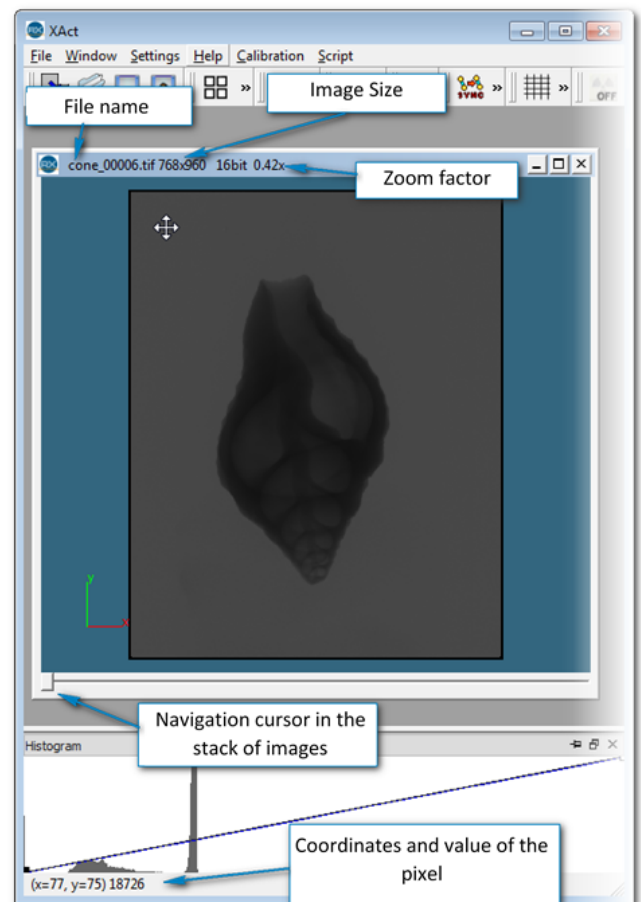
Memory keep free: Amount of RAM X-Act will not use. Should be large enough for other software and Operating system. 1024 MB is a minimum.

Memory preswap threshold (%): Rate of authorized RAM to start preswap. When memory used by X-Act reaches the configured amount of RAM, the software starts I/O file transfers to prepare swapping. The recommended value is 75%. If the value is too low, swapping may be slower. If the value is too high, I/O operations on disk might conflict and slow down image saving or loading.

Swap directory: Select the location on a hard disk for the SWAP file directory used by the software. It should be located on a drive with an excellent read/write performance.

2.9 Viewing of Images

The first functionality of the X-Act software is for viewing d' images acquired from a peripheral or coming from a file. The software allows handling of images alone or in a stack of images in multiple windows independent from each other. The histogram of the active image is posted in real-time in the plugin of the same name.



2.9.1 User Interface

Simple tasks with the mouse on an image:

- Zoom: ctrl + scroll wheel
- To move: left click or maintained right and move
- Browse the pile: rotate the scroll wheel

2.10 Image Formats

The X-Act software uses various image formats described below. All these formats are standard and compatible with the majority of the software for viewing and editing. The image format

tiff 16 bits was however modified to add information suitable for the X-Act software.

Extension	Coding	Information	Description
TIFF (save/ save as)	16 bits/pixel	Saved: <ul style="list-style-type: none"> • Original Image • Histogram Settings • Acquired Geometry Lost: <ul style="list-style-type: none"> • Overlays • Filters 	Tagged Image File Format. This image format allows recording the native images resulting from the acquisition, without compression, in a format of 16 bits per pixel (format delivered by the majority of X-Ray imagers). Extra information is written by the software in heading of the file ("Look up Table" (LUT) etc.). This data, specific to the X-Act software, will be reloaded and the adjustments applied if the file is reloaded later on in X-Act. The images can also be open with any image software capable of opening tiff 16 bits, but this information will not be taken into account. The most complete format but which also creates the largest files.
JPG (export)	RGB	Saved: <ul style="list-style-type: none"> • Posted image with : <ul style="list-style-type: none"> – LUT – Filters – Overlays Lost: <ul style="list-style-type: none"> • Acquired Geometry 	Compressed image. The compression rate is a parameter of the software which can be regulated by the user. The image saved is the one displayed in the window (application of the LUT: gray scales, colors, filters, etc.). Smallest file format.
PNG (export)	RGB	Saved: <ul style="list-style-type: none"> • Posted image with : <ul style="list-style-type: none"> – LUT – Filters – Overlays Lost: <ul style="list-style-type: none"> • Acquired Geometry 	Image compressed without loss. The saved image is that which is displayed in the window (application of the LUT: gray scales, colors, filters, etc.).

Extension	Coding	Information	Description
TIFF (export)	8 bits/pixel	Saved: <ul style="list-style-type: none"> • Posted image with : <ul style="list-style-type: none"> – LUT gray scales only – Filter Lost: <ul style="list-style-type: none"> • Acquired Geometry • Overlays • LUT Colors 	Tagged Image File Format. Image in gray scale, large loss of image quality when saved of 256 levels of gray per pixel instead of 65356.

2.11 File Systems

The X-Act software uses and generates system files necessary to its operation.



Warning: These should not in any case be modified manually by the user without instruction given by RX Solutions. Any modification or deleting can result in failure or damage of the equipment.

In Windows 7, the system files are located in the following folder:

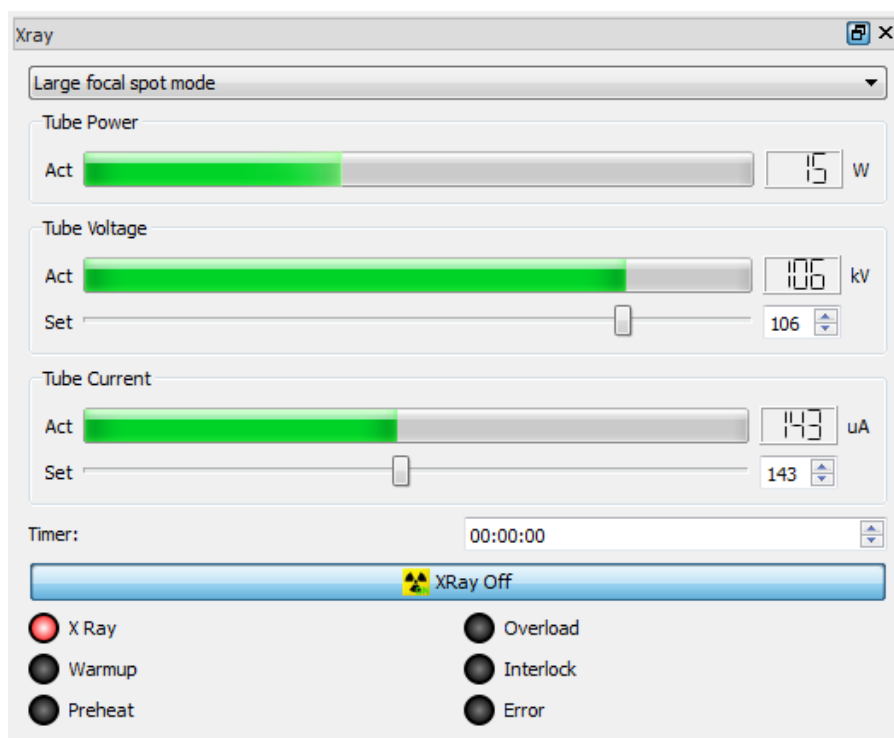
C:\ProgramData\RX-Solutions

In addition the configuration of the graphical interface (plugins, dimension of the window, etc.) is saved in the individual user profiles, and so can be different for every user account.

3. Plugins

3.1 Xray 150kV

This module allows the regulation of the 150 kV generator installed into the equipment and configured by the software.




- Mode focal: Pull-down menu to choose the operating process (makes it possible to limit the size of the emission of x-rays).
 - Small focal spot mode: maximum power 10 W, size of focal spot 8 μm
 - Middle focal spot mode: maximum power 30 W, size of focal spot 20 μm
 - Large focal spot mode: maximum power 75 W, size of focal spot 40 μm

The selected mode limits the power of the tube and guarantees a size of focal spot. According to the resolution of work, select the mode adapted to obtain sharp images with the highest flow of photons.

- Tube Power displays the power in Watts used by the generator (Power = Tension of acceleration x Current of the cathode)

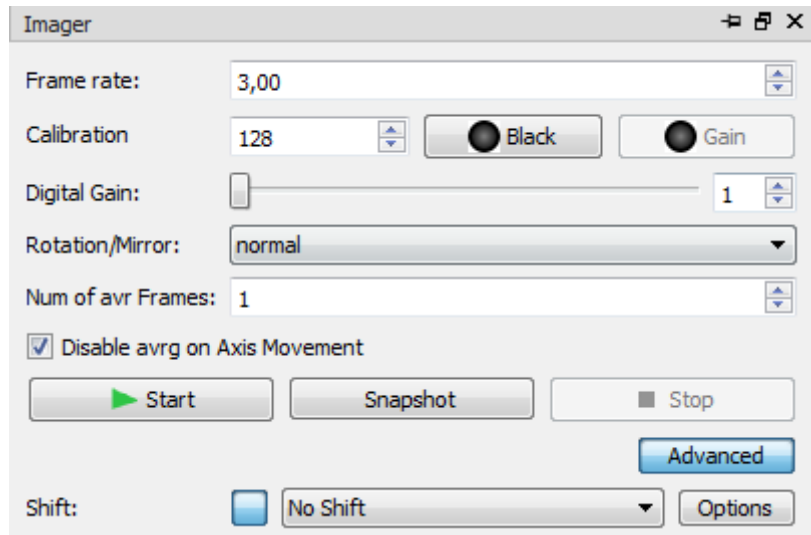
For the two following parameters, the line called “ Act ” displays the instantaneous measured value from the source and the “ Set ” line allows to give a setting.

- Tube Voltage: Tube voltage from 0 to 150 kV. The tube voltage defines the energy of the photons emitted. Voltage setting depends on the materials to observe
- Tube Current: Cathode current from 0 to 500 μA . The intensity of the beam, i.e. the number of photons is proportional to current. Intense beam produces images with better signal to noise ratio
- Timer: Format HH:MM:SS switch off the source after a given timer. The timer is reset to 0 after the execution of a macro point
- Button Xray On / Xray OFF: Same effect as the button in the toolbar 
- Generator state LEDs:
 - X-Ray: production of X-ray
 - Warmup: warmup cycle in progress
 - Preheat: cathode warmup in progress, X-ray production disabled
 - Overload: tube overload
 - Interlock: interlock circuit open
 - Error: operating or communication error
- Context Menu:
 - Hide Power
 - Hide Timer
 - Reset X-ray Source: reset the source after an error occurred

3.2 Flat panel imager

This module allows the management of the flat panel imager.

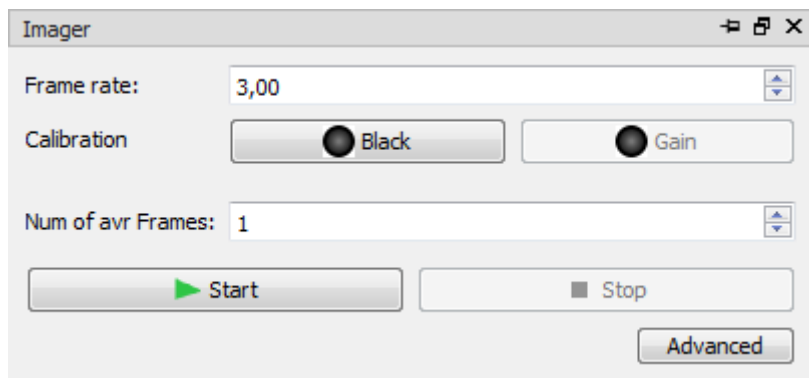
3.2.1 User Interface



- Mode: Imager-mode selection: (depending on imager)
 - 960x768 high sensitivity: binning 2x2 mode or half-resolution: the pixels are grouped by 4. Acquisitions are faster but resolution is degraded by a factor of 2, 254 μ m pixels, maximum speed 30 FPS
 - 1920x1536 high sensitivity: full resolution mode, 127 μ m pixels, maximum speed 12.5 FPS
 - 480x384 high sensitivity: binning 4x4 mode, 508 μ m pixels, maximum speed 60 FPS
 - 960x768 high capacity: binning 2x2 mode with high capacity (lower gain) for high X-ray flux
 - 1920x1536 high capacity: full resolution mode, 127 μ m pixels, maximum speed 12.5 FPS with high capacity (lower gain) for high X-ray flux
 - 480x384 high capacity: binning 4x4 mode, 508 μ m pixels, maximum speed 60 FPS with high capacity (lower gain) for high X-ray flux.
- FrameRate: Number of images per second. Enter the value in the input field via the keyboard or by selecting from the values already used. Displayed value will turn red if the value entered is not applicable.
- Calibration: Number of images used for black and gain calibration. A high value (typically 128) lengthens calibration time but improves the image quality.
- Black: Run a black calibration to eliminate offset to obtain an image with values close to 0 when no X-rays are received. The LED indicates whether it is advisable to run the calibration: black if no calibration at all is available for the current mode, green if the calibration is in principle correct, yellow if it is advisable to repeat. Start calibration and click on Stop to reset calibration. Switch OFF X-rays before starting black calibration.

After switching off X-rays, it is recommended to wait until the ghost image has disappeared, in particular before starting a long tomographic acquisition. It can take a few minutes. To remove black calibration and view non corrected image: start calibration and click on Stop before it finished.

- Gain: Run a gain calibration: acquire a sequence of “ white images ” (no sample in the field of view) and use them as reference for flat field. Imager sensitivity depends on dose so the gain calibration should be run in the correct working conditions (voltage, current, framerate, etc.). The LED indicates whether it is advisable to run the calibration: black if no calibration at all is applied for the current mode, green if the calibration is in principle correct, yellow if it is advisable to repeat. Switch ON X-rays with the right setting before starting gain calibration. After turning on X-rays, it is recommended to wait until the beam has stabilized in particular before starting a long tomographic acquisition. It can take from a few minutes up to 30 minutes or more depending on the X-ray settings. To reset calibration start calibration and click on Stop before it finished.
- Digital Gain: digital gain. Facilitate work with very low flux.
- Rotation/Mirror: Change image display orientation. Use only with a manual rotation axis for the imager orientation (portrait / landscape).
- Num of avr Frames: Number of frames used to build a single averaged image.
- Disable avrg on axis movement: Disable average when axes are moving. Recommended.
- Start / Stop: Stop / Start image grab and live display of images with sliding average.
- Snapshot: Start the acquisition of a series of images (using number of averaged frame) and display the result. A progress bar is displayed if the acquisition is longer than 1 second.
- Advanced: Switch plugin interface from advanced to simple.



3.2.2 Black calibration



Warning: Never run a black calibration with X-rays On.

The imager produces continuously a signal even without X-rays. The black calibration purpose is to eliminate this offset to obtain pixel values near to 0 when imager is not exposed to X-rays.

The calibration consists in the acquisition of a sequence of images without X-rays. The higher the number of images, the better the quality, but the longer the calibration time.

Black calibration should be run regularly, especially when temperature changes (typ. Every 30 minutes).

3.2.3 Gain calibration



Warning: Never run a gain calibration with saturated imager.



Warning: Never run a gain calibration with a sample in the field of view.

The sensitivity of each pixel of the imager is slightly different. In addition the photon flux on the imager surface is not homogeneous (Poisson noise of the X-ray production, varying distance from pixel to focal spot on the panel). The gain calibration goal is to produce a uniform image from the beam at a given dose.

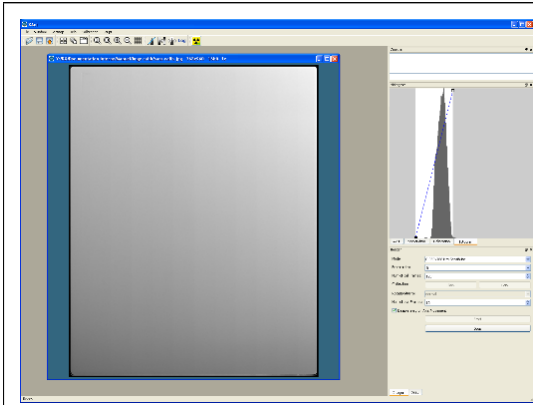
It also detects defect pixels and interpolates their value from the neighbors.

Gain calibration consists in the acquisition of a sequence of images with X-rays ON but with no sample in the field of view. Since the sensitivity of X-rays depends on the dose, the gain calibration depends on many parameters including voltage, current, imager mode and framerate.

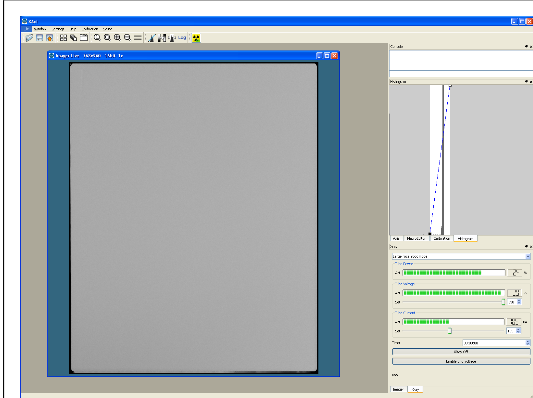
Gain calibration should be run at working voltage and framerate, with current tuned so that the dose received by the imager best simulates the dose transmitted by the sample being observed.

Gain calibration should be run regularly in particular if the dose has strongly changed (voltage, framerate) or if defect pixels appear on the image.

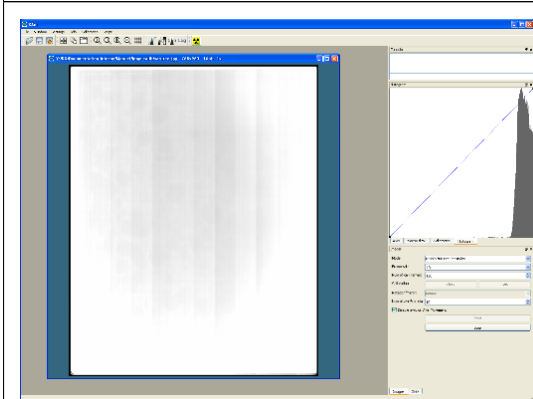
Image examples:



Uncalibrated image: pixel values are not uniform. The peak in the histogram is wide.



Calibrated image: uniform pixel values. The peak in the histogram is thin.



Saturated imager: strips appear on the image. The peak in the histogram is truncated at the right. Too many photons than the detector can handle: increase framerate or decrease X-ray flux.

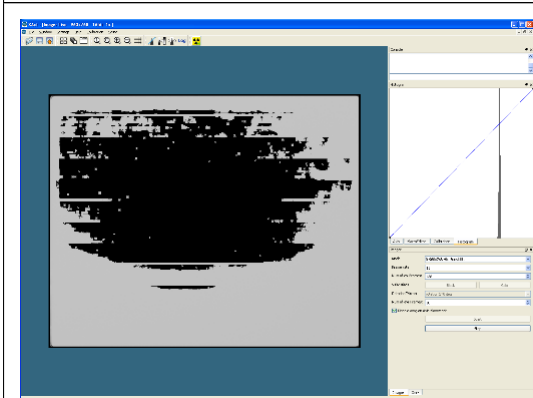
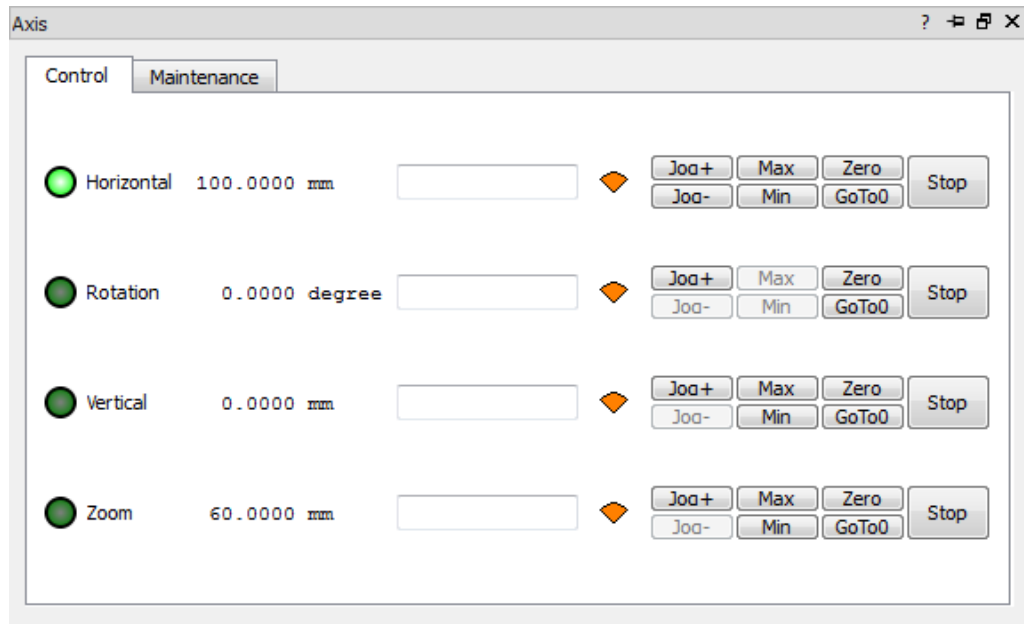


Image resulting from a gain calibration with saturated imager.

3.3 Axis

This plugin displays the list of axes configured in X-Act.



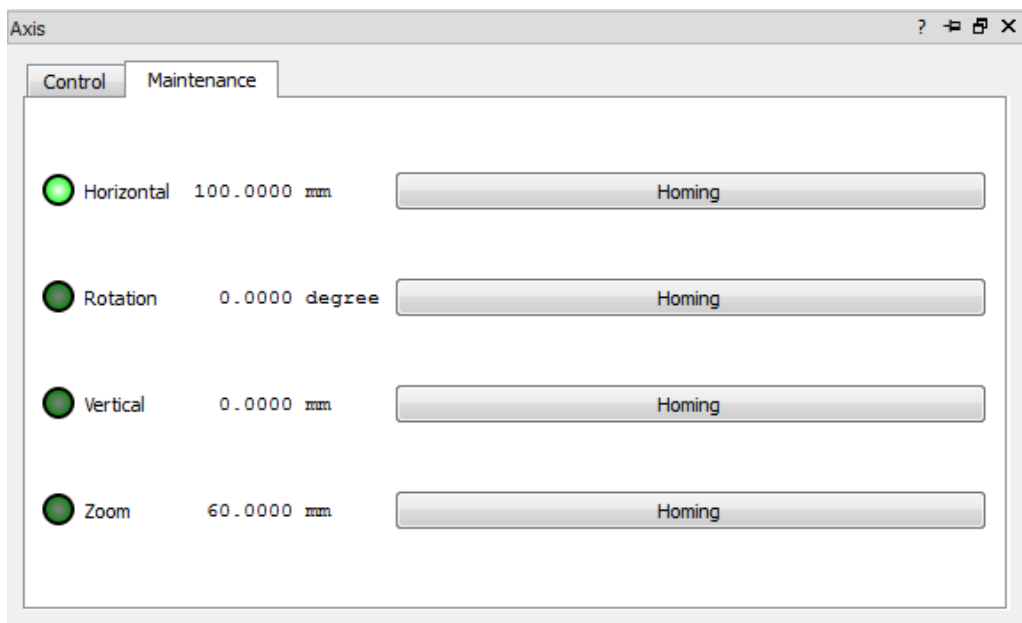
3.3.1 Control tab

- Axis name and current state. For every axis the LED indicates its current state:
 - Black: axis is not connected or not correctly detected by X-Act
 - Light green: axis has reached its position and is stable
 - Yellow: axis is moving
 - Dark green: the setting value exceeds the axis limits. The axis has stopped without reaching its setting value
 - Red: communication error
 - Dark blue: axis disabled
- Numerical label: displays the current position.
- Edition zone: Can be used to enter a setting value to move an axis. Type the setting value and press enter.
- Speed gauge: Indicates the maximum speed level of the axis for manual movement (joystick or JOQ buttons). Click on the gauge to toggle speed (3 different levels). Can also be toggled from the joystick.
- Button Joq+ Joq-: move axis step by step (0.1 mm or 0.1° per click) or continuously. Be careful of the increasing speed with continuous jogging.
- Button Max / Min: 2 state buttons. Click to activate software limit at the current position. The limit is disabled after restarting X-Act.
- Button Zero: toggles from encoder absolute value to relative value. Reset to 0 the value displayed in the numerical label when toggle from absolute (button not pressed) to relative (button pressed).

- Button GoTo0: same as typing 0 in the edition zone.
- Button Stop: Stop the axis motion.
- Context menu Enable Axis: Check/Uncheck to enable or disable an axis. Can be used to land axis on air bearing or disable an unplugged axis.

3.3.2 Maintenance tab

- Homing: Move axis to this reference position (home). The homing button will be transform to Stop Homing button as long as the homing action is performed.
- Stop Homing: Stop an homing action. If an homing action has been stoped, it need to be finished to enable the control tab.



Depending on the machine, axes can also be controlled from the joystick.

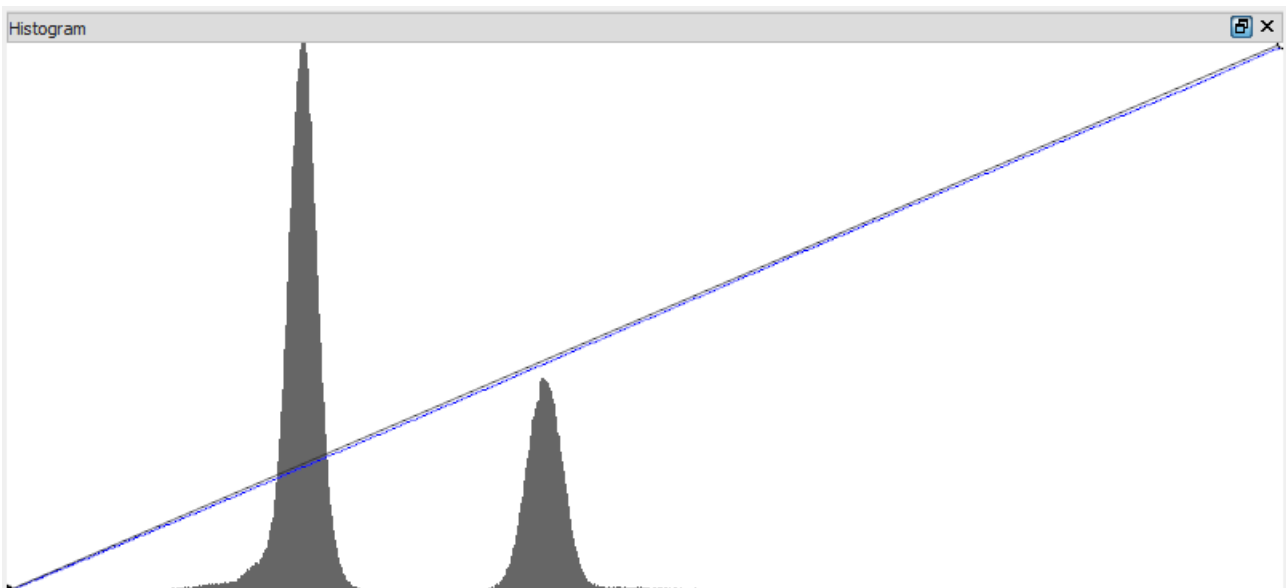
3.4 Histogram

3.4.1 Generalities about images

A digital image is an array (usually 2D) of numbers. Each element of this array is represented on screen by a square called a pixel whose color depends on its numerical value.

In the case of digital radiology, the numerical value of pixels represents the quantity of X-ray photons received by the sensor. The unexposed pixels have a low value, usually represented by black, the pixels exposed to radiation have a high numerical value, and they generally appear in light gray or white.

3.4.2 Histogram and Look up table



The histogram shows the distribution of digital pixel values: the element "i" of the histogram indicates the number of image pixels whose numerical value is "i".

The histogram is represented as a bar diagram with as abscissa "i" and as ordinate "f (i)" the number of pixels with value i in the image.

The peaks correspond to the most represented values in the image (eg white background = peak to the right of the histogram, opaque object = peak to the left of the histogram).

The images from the sensor have a numerical value between 0 and 65535 (16-bit encoded value).

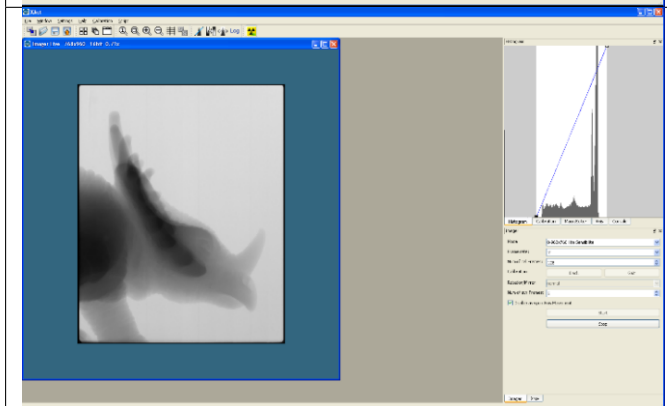
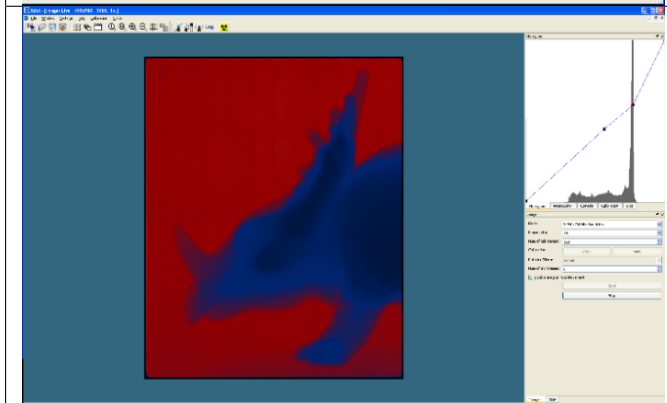
The default behavior is: 0 is displayed as black pixel, and the maximum value 65535 as white pixel. Intermediate values have a shade of gray varying linearly between these two extremes. This is represented by the blue diagonal line between the ends of the diagram. The latter represents the "Look up table" (LUT) or mapping between numeric values and pixel colors on the screen.

You can move the sliders by click and drag the handles to adjust the grayscale to the numerical values actually present in the image. If you move the left handle to right, the dark gray pixels are gradually becoming black. Conversely, if one moves the right handle to left, light gray pixels are gradually becoming white.






An area of the histogram whose background is gray indicates that all pixels represented by that area of the histogram are represented on the screen of the same color.

To change the LUT (apply a nonlinear contrast, use colors...) modify the blue line:

- Double click on the line to add a handle
- Right click on the handle to open a dialog box to change the color.
- Click and drag to move handle in the histogram.

	<p>Image displayed with default LUT setting.</p>
	<p>Image displayed after contrast enhancement.</p>
	<p>Image displayed using colors.</p>

The following functions are available in the “ Histogram ” toolbox.

	Reset LUT: reset linear LUT between 0 and 65535.
	Revert LUT (corresponds to film view).
	Auto adjust contrast using minimum and maximum numerical values found in the image. It ignores poorly represented value.
	Switch the ordinate scale to logarithmic values. Better representation of poorly represented values.
	Apply the same LUT for all the images of an array.

3.5 MacroEditor

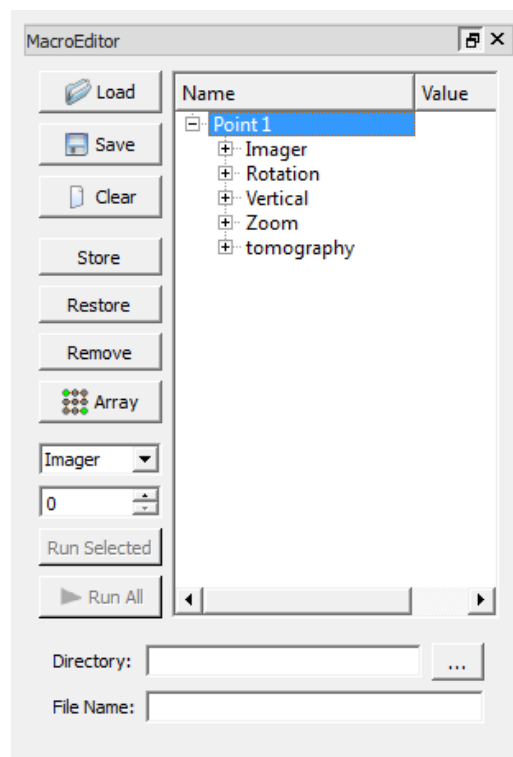
A macro is a list of macro points.

This plugin allows you to save the machine state at a given time as a "macro point". All the machine parameters are stored so that it can reproduce the image capture (position of the axes, X-ray, imager ...). You can store a point and save it to disk at any time, and use the "array" button to create a grid of points to control series of parts.

Macros can also be used to acquire a sequence of tomography including imager calibrations, execution of scripts, etc.

One must distinguish the manual use of macro points to restore the equipment state at a given time, and executing a macro which allows running fully automated and autonomous sequence of operations.

3.5.1 Plugin interface



- Load: Load a macro file from disk
- Save: Save a macro on disk
- Clear: Clear all points from the current macro
- Store: Create new point. Records the current machine state
- Restore: Apply the selected macro point: restore all machine parameters to the value stored in the selected point.

- Remove: Delete selected point from the macro
- Array: Create an array of points
- Imager: Select imager used to grab images during execution (in case of multiple imager, deprecated)
- 0: Counter (from successive execution of a macro)
- Run selected: Execute only the selected point
- Run all: Execute the full macro
- Directory: Path to directory for image storing
- File name: Pattern for image file type (jpg/png/tif) and name :
 - %n: point name (A1, A2, A3...)
 - %d: date
 - %t: time (hhmmss)
 - %c: counter value

File extension is mandatory (.jpg // .png // .tif)

- Right click on a point :
 - Copy (“ Ctrl+c ”): Copy the selected point in the buffer
 - Paste (“ Ctrl+v ”): Paste the point in the buffer up to the selected point.
 - Cut (“ Ctrl+x ”): Suppress the selected point and copy it in the buffer.
 - Suppress (“ Suppr ”): Suppress the selected point.

Each point can be moved by a mouse drag. Select the point to move and stay clicked on it move the mouse to the end place and release the mouse click.

3.5.2 Examples of macro execution

4 points on 2 lines (A & B) Counter value is 0

File name: Test_%c_%n.jpg

Click on “ Run all ” produces the following output:

Test_000000_A1.jpg Test_000000_A2.jpg Test_000000_B1.jpg Test_000000_B2.jpg

Counter increments to 1. New click on “ Run all ” outputs:

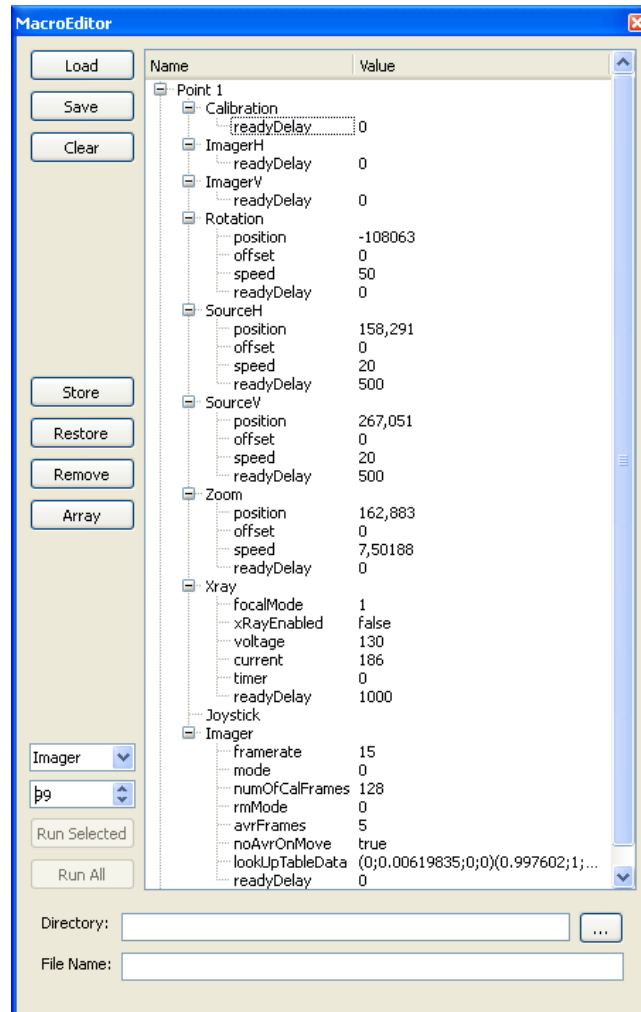
Test_000001_A1.jpg Test_000001_A2.jpg Test_000001_B1.jpg Test_000001_B2.jpg

3.5.3 Macro Point content

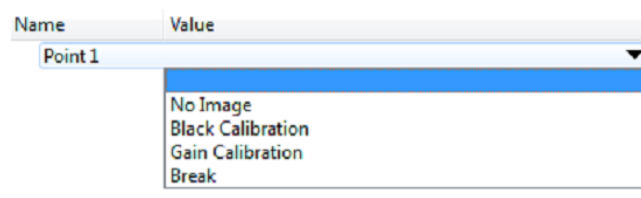
Each point can be expanded to display and modify the value of each parameter. Double-click on a value to modify it (including point name).



Warning: manually changing some values can damage equipment and/or sample.



Every point as a type used during macro execution:



- No Image: No image grabbed
- Black Calibration: runs a black calibration
- Gain Calibration: runs a gain calibration
- Extended Tomography or Tomography starts a tomographic acquisition

- Break: hangs the macro execution (to open the machine for loading samples for instance)
- Default: default behavior: restore parameters and grab an image using the file name pattern.
- Other functionalities according configured plugins (sleep, runscripts...)

3.5.4 Create a macro with a grid of points

An automatic control sequence (macro) is made of a list of points. These points can be stored manually one by one or can be generated as an array from 2 existing points. This operation requires to:

1. Store 2 points
2. Interpolate a 2D array of points. For the generated points all parameters will be identical to the first point, except position value of the two interpolated axes. Only 2 axes can be interpolated.

For 1 dimensional interpolation, select any axis and 1 as number of points for the second dimension.

It is possible to mix both methods: manually stored point and generated points.

3.5.5 Example to create a macro for a sample holder with 5 lines and 4 columns.

Step 1

Align equipment to visualize the first part to control, set up all parameters to take an image (imager, Xray, histogram, filter...). You may display the grid overlay to help centering the part.

Click on “Store” to create a point.

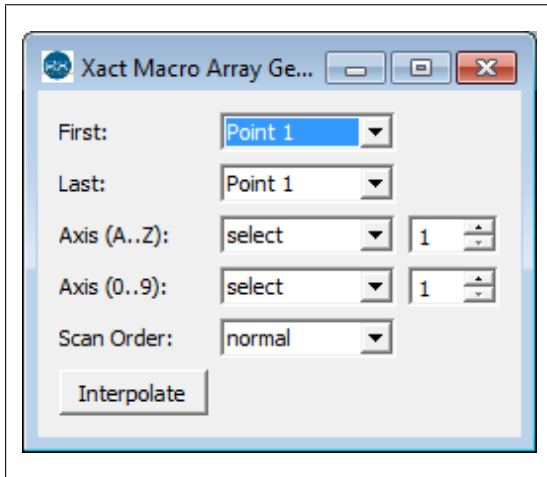
Step 2

Align equipment to visualize the last part to control.

Click on “Store” to create a point.

Step 3

Click on Array



- First: Select start point
- Last: Select end point
- Axis (A...Z): First interpolation axis
Axis (0..9): Second interpolation axis
- Enter number of interpolated positions for each axis.
- Scan Order: see below

Click on Interpolate to generate the array of points.

Warning: Do not forget to save macro on disk.

3.5.6 Scan order

The scan order defines the order of the generated points in the list. The order affects the execution time. Three different scan orders are available.

	<p>Normal: Points are scanned line by line.</p>
	<p>Bidirectional : Points are scanned to go the shortest path from first to last point.</p>
	<p>Return : Points are scanned to go the shortest path from first point to back to the first point. Should be preferred for large number of executions of the same macro.</p>

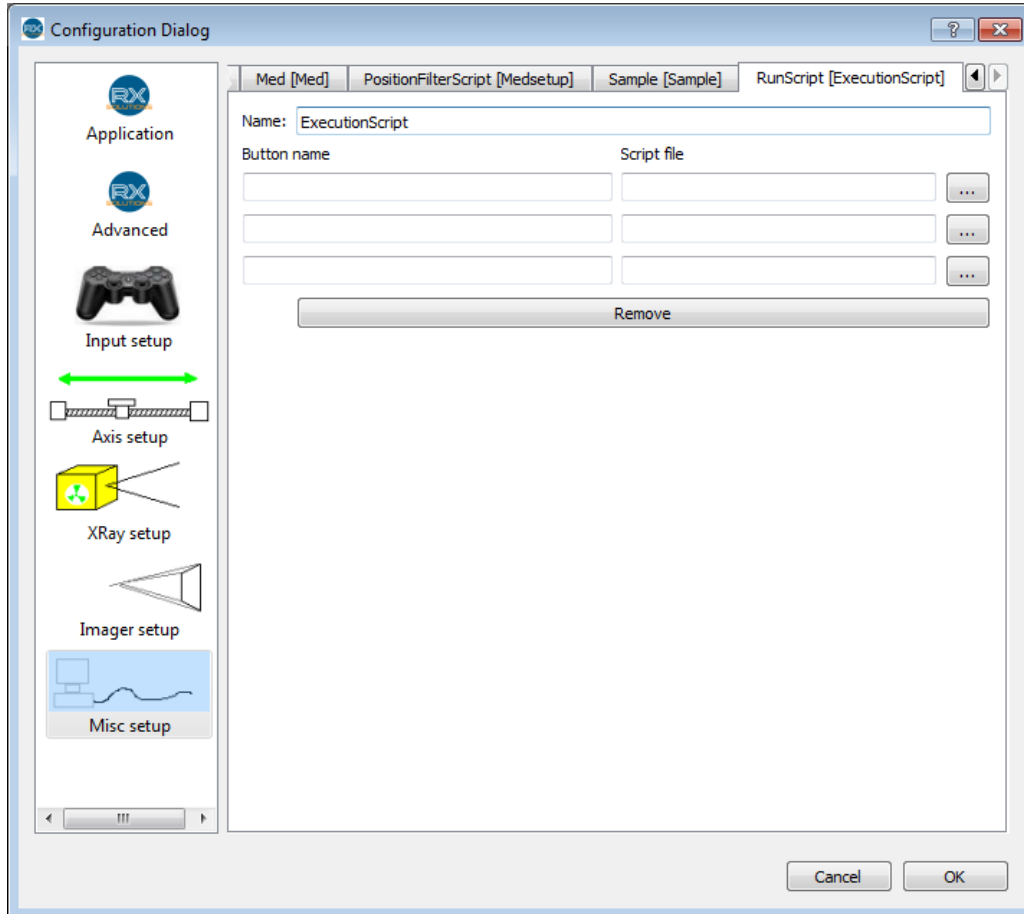


Warning: When executing a macro for the first time, stay by the machine and watch axes displacements to stop the execution of the macro in case of risk of crash (emergency button).

3.6 RunScript

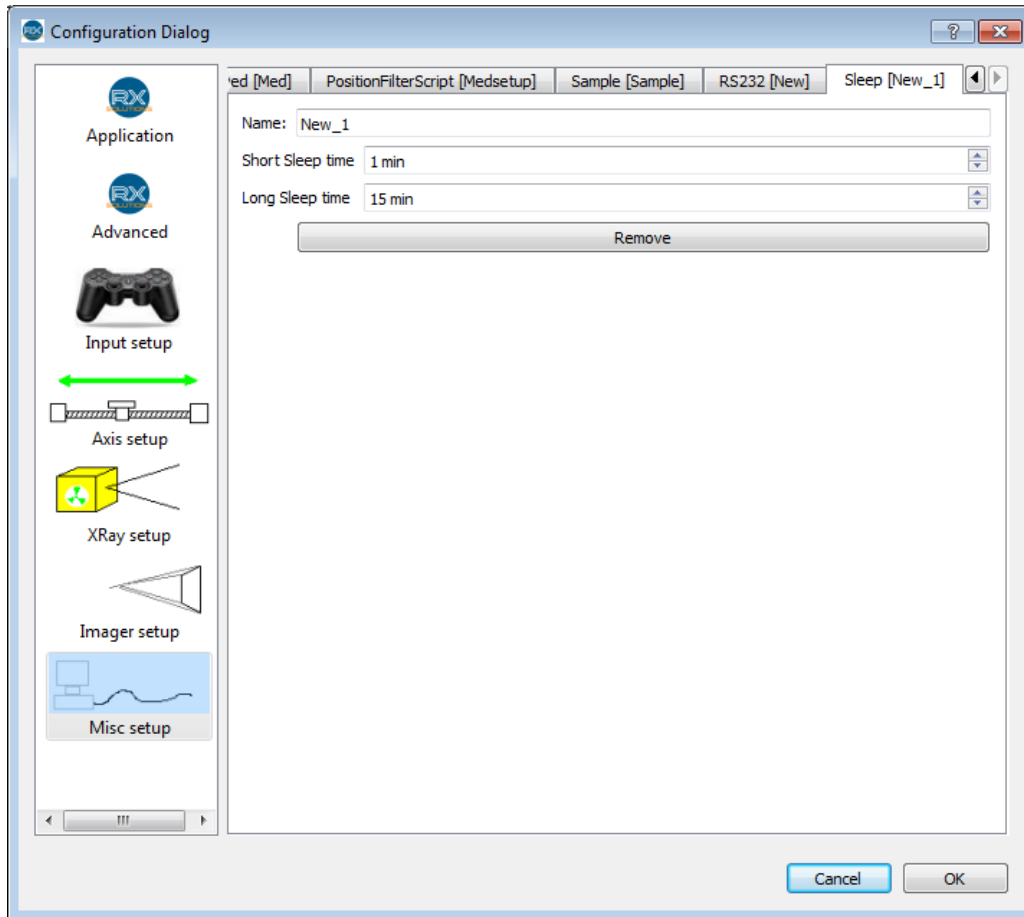
This plug-in add 1 to 3 buttons to run a scrip file connected to the button. It add also the possibility to run the scrip in a macro.

The connection to the scrip file is set in the XAct settings.



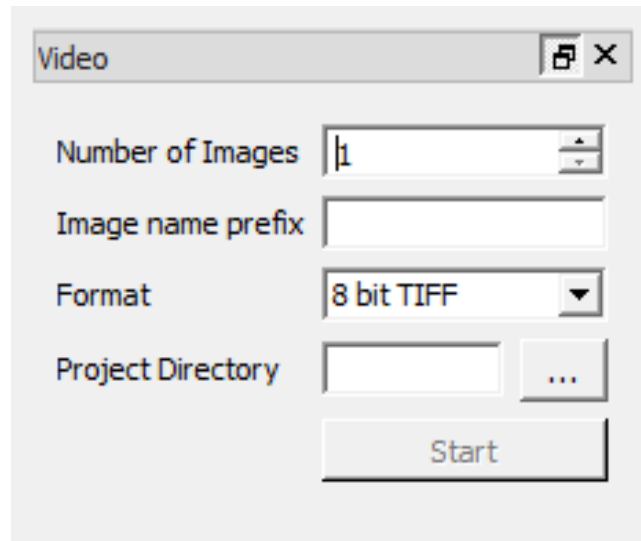
3.7 Sleep

This module add two sleep options (waiting time) in the macros module, a short sleep (default value 1min) and a long sleep (default value 15min). This values can be configured in the XAct settings panel.



3.8 Video

This plugin enables the acquisition of an image sequence and store images to disk.



- Number of Images: Maximum number of images in the sequence. Maximum value: 99 999.
- Image name prefix: file name prefix
- Format: image file format (see paragraph “ Software presentation ”)
- Project Directory: directory for saving files. The directory should be empty to quickly find the data. Hardware selected should be as fast as possible to avoid losing images.
- Start: Start storing an image sequence
- To convert the image sequence into a video file, load the images in an array and convert it to video file format (File / Export as Video Array, see section “”Software presentation”).

3.9 Geometry Viewer

This plugin displays the geometrical configuration of the equipment. Used by RX Solutions for maintenance.

3.10 Console



Warning: restricted to highly skilled users

The console plugin lets you directly manipulate the various objects of the interface. The functions available are the same as from the script (see paragraph “Script”).

The user enters the name of an object (as it appears in the “Name” field of the configuration or in the plugin title for example), followed by a period. The list of available members or functions appears in a drop-down menu. Enter the term you want or select from the list and enter a semicolon if you want to enter several commands, press Enter to execute the command line.

It is possible to manipulate the objects remotely from another software via a Tcp connection. Connection parameters :

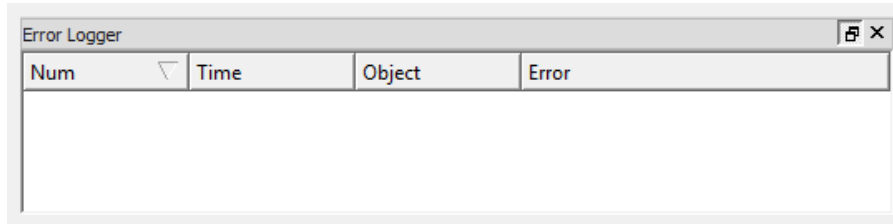
- *Server* : localhost
- *port* : 9876



Warning: For safety reason it is not possible to connect to XAct from another computer

3.11 Error Logger

Display area of the errors detected by X-Act as a chronological list. The list of errors is stored on disk automatically every day. You can access the context menu by right clicking on the module: Save to save the list in xml file. Clear to empty the list.



Num	Time	Object	Error

- Num: Error Index. Start at 0 after reset
- Time: Time of the error occurrence
- Object: Name of the object sending the error
- Error: Description

Some errors are only informative and do not impact the equipment.

4. Scripts



Warning: restricted to advanced users

Scripts can program the machine to perform a well-defined sequence of actions, which may be more complex than a simple macro and more appropriate than the functionalities covered by the plugins.

Scripts are java script files. The user must create a .js file with a text editor (notepad++ can be used to display the language keywords in color and easily read and write scripts). The instructions will be executed one by one by the software when running the script.

To execute a script select Script/Open Script from the menu, select the script file in the file browser. The execution of the script starts immediately.