

XIS Reference Book

X-Ray Imaging Software



Table of Contents

1	General	8
1.1	References	8
1.2	About the program XIS	8
1.3	Software License Agreement	9
1.4	Getting Started - The first image.....	12
1.4.1	Introduction.....	12
1.4.2	General considerations	12
1.4.3	Connection of the X-Ray Detector.....	12
1.4.4	The first image.....	13
1.5	How to perform corrections.....	14
1.6	Mathematical description of corrections	15
1.6.1	Offset correction	15
1.6.2	Gain correction	15
1.6.3	Multi Gain correction (Gain Sequence).....	15
1.6.4	Pixel correction.....	15
1.7	Sorting schemes overview	16
1.8	How to acquire data from several sensors in parallel	16
1.9	How to use function keys.....	16
1.10	What is new?.....	17
2	XRD Hardware Interfaces	18
2.1	Image acquisition	18
2.1.1	PCI Framegrabber XRD-FG	18
2.1.2	PCI Express Framegrabber XRD-FGe.....	19
2.1.3	PCIe Framegrabber XRD-FGe Opto.....	21
2.1.4	Features of the Framegrabbers with optical interface	21
2.1.5	Gigabit Ethernet Interface	22
2.1.6	XRpad Interfaces.....	22
3	Installation.....	23
3.1	Installation of X-Ray Imaging Software / Installation of the Framegrabber	23
3.1.1	Framegrabber.....	23
3.1.2	Gigabit Ethernet / WLAN Interface	23
3.1.3	Software Installation on Windows.....	25
3.2	Trouble Shooting	26
3.3	Downloads	27
	X-Ray Imaging Software.....	28
4	Overview of the Menu Commands	28
4.1.1	File Menu Commands.....	28
4.1.2	Edit Menu Commands	28
4.1.3	Acquire Menu Commands	28
4.1.4	Detector Menu Commands	29
4.1.5	View Menu Commands.....	29
4.1.6	Window Menu Commands.....	29
4.1.7	Options Menu Commands	29
4.1.8	Help menu commands.....	29
4.2	File menu.....	30
4.2.1	New command.....	30
4.2.2	Open command	30
4.2.3	Close command	31
4.2.4	Print command	31
4.2.5	Print Preview	31

4.2.6	Print Setup.....	32
4.2.7	Save command.....	32
4.2.8	Save As command	32
4.2.9	Save Correction files.....	32
4.2.10	Exit command.....	32
4.2.11	Import command.....	32
4.2.12	1, 2, 3, 4 command.....	32
4.3	Edit menu.....	33
4.3.1	Edit build sequence.....	33
4.3.2	Edit Math	33
4.3.3	Copy.....	34
4.3.4	Copy Frames.....	34
4.3.5	Average.....	34
4.3.6	Select by Value.....	34
4.3.7	Select All.....	34
4.3.8	Deselect All.....	34
4.3.9	Set Value.....	35
4.3.10	Select Rect.....	35
4.3.11	Create Pixel Map.....	35
4.4	Acquire menu	36
4.4.1	Single Shot.....	36
4.4.2	Sequence Command.....	36
4.4.3	Continuous Command	37
4.4.4	Get Offset Image.....	37
4.4.5	Get Gain/Offset Image	38
4.4.6	Get All Offset Images	38
4.4.7	Link Offset Correction.....	38
4.4.8	Link Gain Correction.....	38
4.4.9	Link Gain Sequence Correction	38
4.4.10	Link Pixel Correction	39
4.4.11	Acquire Build GainSequence.....	39
4.4.12	Acquire Convert to Gain Image.....	40
4.4.13	Acquire End Acquisition	40
4.4.14	Acquire Set Soft Trigger.....	40
4.5	Detector.....	41
4.5.1	Timings menu.....	41
4.5.2	Detector Mode	41
4.6	View menu.....	41
4.6.1	Status Bar	41
4.6.2	Toolbar.....	41
4.6.3	Acquisition Bar	42
4.6.4	LUT - Look-Up-Table	42
4.6.5	Player.....	42
4.6.6	ZoomBox.....	42
4.6.7	View Control Box.....	43
4.6.8	View Image Data.....	45
4.6.9	View Plot Box.....	45
4.7	Window menu.....	46
4.7.1	New Window.....	46
4.7.2	Cascade.....	46
4.7.3	Tile Horizontal	46
4.7.4	Tile Vertical.....	46
4.7.5	Window Arrange Icons.....	46
4.7.6	1, 2, ... command	46
4.8	Options menu.....	47
4.8.1	Acquisition	47
4.8.2	Sorting.....	52
4.8.3	View	53
4.8.4	Options Active Sensor	53
4.8.5	Options Sensor.....	54
4.8.6	Switch on/off Service Mode.....	54
4.8.7	Detector Options.....	55
4.8.8	Set Detector Offset	56
4.9	Help.....	56
4.9.1	Contents.....	56
4.9.2	About	56
4.10	Toolbar	57
4.11	Acquisition Toolbar.....	57
4.12	Status Bar	57

4.13	Title Bar.....	58
4.13.1	Scroll bars.....	58
4.13.2	Size command (System menu).....	58
4.13.3	Move command (Control menu).....	58
4.13.4	Minimize command (application Control menu).....	58
4.13.5	Maximize command (System menu).....	59
4.13.6	Next Window command (document Control menu).....	59
4.13.7	Previous Window command (document Control menu).....	59
4.13.8	Close command (Control menus).....	59
4.13.9	Restore command (Control menu).....	59
4.13.10	Switch to command (application Control menu).....	59
4.14	Standard Dialogs.....	60
4.14.1	File Selection Dialog.....	60
4.14.2	Overwrite data dialog.....	61
4.14.3	Choose Directory Dialog.....	61
5	Application.....	62
5.1	Mathematical Expressions	62
5.1.1	Parsing expression:.....	62
5.2	Image Correction	65
5.2.1	Use of the Offset Correction	65
5.2.2	Use of the Gain/Offset Correction.....	66
5.2.3	Use of the Multiple Gain Correction.....	66
5.2.4	Use and generation of the Pixel Correction	67
5.2.5	Correct already acquired images.....	67
5.3	Acquisition Control Modes	67
5.4	Warning table by using the detector and its status	69
6	Details for the Hardware	70
6.1	Readout schema	70
6.1.1	Free Running	70
6.1.2	External Trigger.....	70
6.1.3	Internal Trigger.....	70
6.1.4	Software Trigger.....	72
6.1.5	Auto Trigger	72
6.1.6	Trigger-modes.....	73
6.1.7	Trig Out Options	75
6.1.8	External trigger inputs/outputs.....	79
6.1.9	XRpad trigger inputs/outputs	80
6.2	Sectional Readout.....	81
6.3	Field of View	82
6.4	How to use the detector gain setting.....	82
6.5	How to use the detector binning setting.....	82
6.6	XIS File format.....	83
6.7	Description of Hardware Header.....	84
6.8	Row types.....	84
6.9	Software Operation Modes (Interrupt vs. Polling)	85
6.9.1	Interrupt Mode	85
6.9.2	Polling Mode.....	86
6.10	Technical details for Interrupt sources.....	87
6.11	Sorting.....	88
6.11.1	Sorting schemes overview	88
6.11.2	Sorting XRD 512-400 A1/A2 // XRD 0840	89
6.11.3	Sorting XRD 512-400 E	90
6.11.4	Sorting XRD 1640 A // XRD 1620 AJ // XRD 0820	91
6.11.5	Sorting XRD 1620 /21 AM/AN.....	92
6.11.6	Sorting XRD 1620 / 40 AN CS.....	93
6.11.7	Sorting XRpad, XRD 0822, XRD 1622, XRD 1642.....	94
6.12	Detector Options Overview	95
7	X-Ray Imaging Software Library SDK	96
7.1	X-Ray Imaging Library Overview	96
7.2	Demo application.....	96
8	XRpad Configuration through Webinterface.....	97

8.1	Viewing System Information	98
8.2	Login.....	98
8.3	Network Settings	100
8.4	Administration.....	101
9	Detector SD-Card access (RO)	103
9.1	Login for SD-Card write access	103

List of Figures

Figure 1: Connections of the XRD 1620.....	12
Figure 2: Multi Gain correction	15
Figure 3: Image of the XRD-FG Frame Grabber	19
Figure 4: Image of the XRD-FGe Frame Grabber	19
Figure 5: Image of the XRD-FGe Opto Frame Grabber	21
Figure 6: Front view of the Gigabit Detector XRD0822	22
Figure 7: New File Dialog.....	30
Figure 8: Build Sequence Dialog	33
Figure 9: Select Pixel by Value Dialog.....	34
Figure 10: Enter new Value Dialog.....	35
Figure 11: Acquire Sequence Dialog (Seq. of averaged Frms / Seq. one buffer)	36
Figure 12: Continuous Acquisition Dialog.....	37
Figure 13: Build GainSequence Dialog.....	39
Figure 14: Zoom Box.....	43
Figure 15: Control Box	44
Figure 16: Plot Box – Plot Rows.....	45
Figure 17: Plot Box – Plot Histogram.....	45
Figure 18: Initialization dialog.....	47
Figure 19: List of found detectors shown by Enum GbIF Sensors dialog	48
Figure 20: Configuration of the selected GigE-Detector	49
Figure 21: Configuration of the selected GigE-Detector – Force IP	51
Figure 22: Dialog for the Acquisition Options	52
Figure 23: View Options Dialog.....	53
Figure 24: Sensor Options Dialog.....	54
Figure 25: Set Detector Options.....	55
Figure 26: Choose File Dialog	60
Figure 27: Overwrite Data Dialog.....	61
Figure 28: Choose Directory Dialog	61
Figure 29: Mathematical Expressions Dialog	62
Figure 30: timing diagram for 'Data Delivered on Demand' triggered mode	73
Figure 31: /Trig Out Option 0: 'Framewise'	75
Figure 32: /Trig Out Option 1: 'Framewise, signal inverted'	75
Figure 33: /Trig Out Option 2: 'Exposure Pulse'	77
Figure 35: /Trig Out Option 4: 'Data Delivered On Demand'	78
Figure 36: /Trig Out Option 5: 'Data Delivered On Demand inverted'	78
Figure 37: /Trig Out Option 6: 'TrigOut signal on low edge'	78
Figure 38: /Trig Out Option 7: 'TrigOut signal on high edge'	79
Figure 39 External Trigger inputs/outputs of the XRD 512-400, XRD 1640 AL/AG, XRD 0822 and XRD 1622 detector series.....	79
Figure 40: External Trigger inputs/outputs of the XRD-FG Frame Grabber (TTL signals).....	79
Figure 41: Trigger inputs/outputs of the XRD 08xx yN and XRD 16xx yN detectors	79
Figure 42 Scheme of the ROI sections XRD 0822 xP	81
Figure 43 Select Region of Interest dialog (0822AP).....	81
Figure 44: Interrupt sources at a) sequence acquisition mode (4 frames) b) continuous mode.....	87
Figure 45: Sorting overview of the XRD 512-400 A1/A2.....	89
Figure 46: Sorting overview of the XRD 512-400 E.....	90
Figure 47: Sorting overview of the XRD 1640 A / 1620 AJ.....	91
Figure 48: Sorting overview of the XRD 1620 AN / 1621 AN.....	92
Figure 49: Sorting overview of the XRD 1620/40 AN CS.....	93
Figure 50 Sorting scheme of the XRD 0822.....	94
Figure 51 Start Screen Webserver	97
Figure 52 About Dialog / Version Information.....	98
Figure 53 Authentication	98
Figure 54 Overview Network Settings.....	100
Figure 55 Menu Administration.....	101
Figure 56 Language Settings for Webserver.....	101
Figure 57 System Clock Dialog.....	102
Figure 58 Change Passwords Dialog.....	102
Figure 59 Administration – Wireless Country Code.....	103
Figure 60 FTP SD-Card write access login.....	103
Figure 61 FTP SD-Card write access login dialog.....	104

List of Tables

Table 2: X-Ray adjustments	14
Table 3: Sorting Schemes	16
Table 4: Function Keys	16
Table 5: Supported hardware interfaces and operation systems.....	18
Table 6: File menu	28
Table 7: Edit menu	28
Table 8: Acquire menu	28
Table 9: Detector menu.....	29
Table 10 : View menu	29
Table 11: Window menu.....	29
Table 12: Options menu.....	29
Table 13: Help menu.....	29
Table 14: Settings of the New File Dialog.....	30
Table 15: Settings of the Print Dialog.....	31
Table 16: Settings of the Print Preview Dialog	31
Table 17: Settings of the Sequence Dialog	33
Table 18: Settings of the Select Pixel by Value Dialog.....	34
Table 19: Displaying different Timings	41
Table 20: Zoom settings of the Control Box.....	43
Table 21: ROI settings of the Control Box.....	44
Table 22: Settings of the View Options Dialog.....	53
Table 23: Windows Toolbar.....	57
Table 24: Acquisition Toolbar	57
Table 25: Status Bar	58
Table 26: Switch Command Dialog	59
Table 27: Parsing symbols	62
Table 28: Type Operators	63
Table 29: SUM - function parameters.....	63
Table 30: Parameters for 'Exposure Pulse /Trig Out' Option	77
Table 31: Description of the trigger input/output signals	79
Table 32: PIN assignment of Trigger signal for the XRD 08xx yN and XRD 16xx yN detectors (LVDS Signals)	80
Table 33: LVDS connector Pin assignment (GP_** use LVDS signaling standard) XRD FG[X][e] Opto.....	80
Table 34: Overview of the detector binning modes	82
Table 35: Single image and file sequence format	83
Table 36: File header description	83
Table 37: Type of Data.....	83
Table 38: Timing diagram of the row types.....	84
Table 39: Sorting schemes overview	88
Table 40: Sorting overview of the XRD 512-400 A1/A2	89
Table 41: Sorting overview of the XRD 512-400 E.....	90
Table 42: Sorting overview of the XRD 1640 A / 1620 AJ.....	91
Table 43: Sorting overview of the XRD 1620/21 AN//AM	92
Table 44: sorting overview of the XRD 1620/40 AN CS	93
Table 45: Sorting scheme of the XRD 0822.....	94
Table 46: Detector Options Overview	95
Table 47 Overview Webserver Menu.....	99

1 General

1.1 References

Document Name	Document #
XRpad 4336 Reference Manual	27505
XRpad 4343F Reference Manual	39256
XRD 0822 Reference Manual	1002698
XRD 1622 Reference Manual	1002704
XRD 1642 Reference Manual	1000951
XRD 1620 Reference Manual	81245
XRD 1621 Reference Manual	1002929
XRD 1611 Reference Manual	36224
XRD 4343 Reference Manual	60924
XRpad2 3025 Reference Manual	69568
XRpad2 4336 Reference Manual	69652
XRpad2 4343 Reference Manual	179888
XRpad2 Series Integration Manual	86437
XRD 4343 Detector Integration Guide	98712
XISL API Description	89695

Table 1 References

1.2 About the program XIS

The program XIS **X-Ray Imaging Software** is capable to demonstrate the functions of the digital amorphous Silicon **X-Ray Detector** (former **RID Radiation Image Detector**) and XRpad series detectors. It can be used with any type of XRD/XRpad in combination with the installed PCI, PCIe or PCI-X frame grabber boards and with X-Ray detectors with Gigabit Ethernet /WLAN interface. It automatically detects the size of the sensor and receives RAW 14bit or 16bit Grayscale images from the detector with up to 65535 Gray levels. The images are displayed on the screen with 256 grey levels.

Offset, Gain/Offset and **Gain Sequence/ Offset Images** can be used to correct the image data for the specific dark current of the detector and the irradiation of a specific x-ray source. The use of the Offset, Gain/Offset or Gain Sequence/ Offset Images is required for best image quality. A **Pixel Correction** allows the 'software repair' of defect pixels to enhance the image quality.

The detector allows the setting of different frame times. The shortest possible frame time in Free-Running-mode is selected at startup, but any timing can be set to optimize the system capabilities.

The program XIS is embedded in the Windows® 32 environment and can be handled in the same manner as other standard WINDOWS programs. It allows limited image processing to present the acquired images.

To present acquired images or sequences of images, the program allows the storage of images in various formats.

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1.4 Getting Started - The first image

1.4.1 Introduction

This chapter describes the procedures to get the first x-ray images with adequate quality. It explains how one can use correction files with the appropriate settings of the detector integration time and x-ray source parameters.

1.4.2 General considerations

Basically the detector is able to produce images without any correction. These images contain the offset of the readout electronics, the individual offsets of each pixel (dark current) as well as the electronics and pixel gain differences, apart from the x-ray source non-uniformities. Each column is connected to one channel of the readout electronics with the specific channel offset. This results in a dark image with vertical stripes caused by the individual channel offsets. The dark image may also contain pixels which are brighter than the others caused by a higher dark current. The detector is arranged in groups of multiple readout channels. The groups can deviate in their gain such that one can distinguish blocks of multiple channels in a bright image caused by this gain difference. The panel itself may contain pixels and perhaps row or columns which are defective (totally black or white). To eliminate these detector specific effects and to obtain good quality results each image should be 'offset' and 'gain/gainsequence' corrected and if it is required the defective pixels should also be corrected. The creation of the correction files is described in the chapter 1.5 *How to perform corrections*. The mathematical procedures which are applied to each pixel are described in chapter 1.6 *Mathematical description of corrections*.

1.4.3 Connection of the X-Ray Detector

Before starting the connection between X-Ray Detector and host PC please ensure that the frame grabber and the software are installed correctly (chapter 3). If not please begin with the frame grabber and software installation.

In case of a GigE detector (0822/ 1622) please ensure you have installed a Gigabit Ethernet network card and finally connect the detector to it. When a XRpad detector is used please refer to the corresponding model XRpad Reference Manual and Integration Guide for connection details.

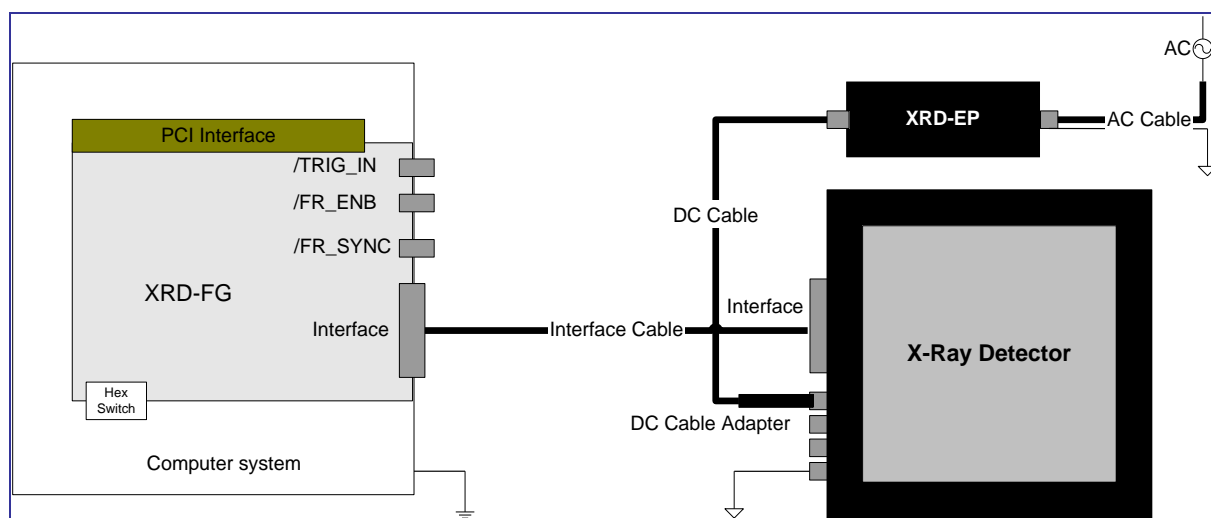


Figure 1: Connections of the XRD 1620

The computer with the frame grabber and the monitor need to be grounded through the protection earth conductors within the power cords. The required potential equalization of the Detector and the XRD power supply has to be managed through the labeled connectors and the potential equalization between both devices is managed through the XRD DC Cable. For safety reasons only original cables and connectors should be used.

The X-Ray detector should be connected as described in the following manner and as shown in Figure 1

1. Shut down the computer
2. Connect the **Detector** and the **power supply** with the potential equalization
3. Connect the **Detector** to the **Frame Grabber** via **Interface Cable** or in case of a **GigE Detector**, connect it to the **network adapter** of your host system
4. Connect the **DC Cable** with the Power Connector of the **Detector**
5. Connect the **power supply** and the **DC Cable**
6. Connect the **power supply** with the mains via **AC Cable**.
7. Switch on the **power supply**
8. Switch on the Computer

1.4.4 The first image

Frame-grabber connected Detector	GigE Detector	XRpad[2] Detectors
<p>The detector is powered on and all cable connections are performed. At startup the frame grabber board will be initialized and afterwards a dialog appears to select the mode of the frame grabber board. "Yes" enables the Interrupt Mode, "No" enables the Polling Mode. In both cases the system attempts to initialize the frame grabber board(s) and the connected detectors. The "Cancel" button starts the program without initialization. The initialization can take some time depending on the number of frame grabber boards and detectors. You can follow up the initialization process via the info box on the lower right corner of the window.</p>	<p>Connect the detector directly to the network adapter of the host PC and to the power supply. Then switch on the power supply and the PC. Now wait until the connection between the GigE-Detector and the Host system is established by Windows. When starting the XIS a dialog appears to select the working mode of the system. "Yes" enables the Interrupt Mode, "No" enables the Polling Mode. In both cases the system attempts to initialize the frame grabber board(s) and the connected detectors. The "Cancel" button starts the program without initialization. The initialization can take some time depending on the number of frame grabber boards and detectors. Alternatively you can setup and configure the detector with "Enum / Setup GbIF Detector".</p> <p>You can follow up the initialization process via the info box on the lower right corner of the window</p>	<p>Find all available XRpad detectors by selecting "Enum XRpad". When a detector is found a dialog appears showing the current IP configuration as well as the selected path (LAN / WLAN) for the image transfer.</p> <p>The dialog offers following options:</p> <ul style="list-style-type: none"> • "Refresh" – update the list • "open detector config" – open the detectors configuration website if the detector IP-settings match the ones from the network adapter¹. () • "Back" – returns to setup dialog. <p>To initialize the detector and to acquire images follow the steps in the sections 'Getting the first image' of the corresponding model XRpad reference manuals.</p> <p>The XRpad detectors are operating similar to the GigE Detectors in the triggered modes, but do not support the Free-Running-Modes.</p>

Multiple Detectors:

If more than one detector is connected and initialized a dialog appears that contains a list of all recognized detectors and an active detector has to be selected. All following actions correspond to that active sensor until a different one is selected.

Acquire images:

Now the system is ready to acquire the first image.

The Acquire\Single Shot command acquires a single image. If the detector was not irradiated only a dark image is displayed. The image can be enhanced by the brightness and contrast settings. As explained above the uncorrected dark image contains vertical stripes caused by the electronics

¹ the IP address can be also entered directly into the installed web-browser for configuration. It must be ensured that the 2 internal network adapters for LAN and WLAN (if applicable) are in different IP subnets

offset. By choosing the Continuous acquisition mode the image is refreshed on the display in the selected frame rate.

In the next step the detector should run in the continuous mode and the x-ray source should be switched on to irradiate the detector. The brightness and contrast should be set to default (F2-KEY: 0-65535). If the gray image is displayed the parameters of the x-ray source and detector are in a good range. If a white or a black image is displayed the x-ray source has to be adjusted in the following way:

Displayed image -->	white	black	
Action -->	decrease	increase	-the x-ray tube current
	increase	decrease	-the distance
	append	remove	-additional filters
	decrease	increase	-the x-ray tube voltage

Table 2: X-Ray adjustments

1.5 How to perform corrections

The XRD works as an independent detector to acquire X-ray images. After starting the XIS.EXE software, the detector is automatically initialized and sends out images in its fastest frame time (TIMING-0) among all available ones (Timings menu: list of possible frame times). Please note that XRpad detectors show a blank image in free running mode since it can only be used in triggered mode so an appropriate trigger mode has to be selected before offset and gain images can be acquired.

The X-Ray Detectors (XRD) needs an Offset correction to take into account the dark current of each pixel. In particular, during the warm-up phase of the detector, the Offset is not stable and during this time period the detector use is not recommended. During operation it is recommended to refresh periodically the Offset.

Additionally, a Gain correction is necessary to homogenize differences in pixel sensitivities or to take into account the X-ray beam illumination; therefore it is very important that the whole image area is illuminated homogenously. The Gain correction should be carried out in an optimum dynamic range of the sensor (70-80 % of the full scale range FSR) or in the dynamic range of interest. The radiation intensity used to create the gain image can depend on the application, e.g. if the typical grey level is about 10.000 ADU and the remaining area is saturated, it is recommended to use a gain image created at 10.000 ADU. The use of an Offset and Gain calibration eliminates offset dependency and therefore any stored Gain correction file can be used for a specific frame time for longer time periods.

The image performance can be enhanced by using the Multiple Gain Correction. For each dynamic range of interest a separate offset corrected and averaged bright image is used as an interpolation point. The maximum number of interpolation points depends on the installed computer memory. It is important that each bright image is completely and homogenously illuminated.

The Pixel correction allows a 'software repair' of defective pixels to enhance image quality. Improper pixel values are replaced with the averaged value of the surrounding eight adjacent pixels where defective pixels are not used. The pixel correction is only performed on specific pixels, mapped in the file PXLMASK.HIS. The delivery package includes the PXLMASK.HIS file for the specific detector. The user can also generate his own correction file. Please be aware that the number of pixels used for the mean correction should be minimized. The pixel correction procedure requires CPU time and depending on its speed, a slower presentation of the acquired images on screen might occur in relation to the selected timing mode of the system. The main screen of the XIS software sends out a warning message displayed on the screen if all of the acquired images are not accepted by the computer.

1.6 Mathematical description of corrections

All correction files are saved in the HIS file format. Offset and pixel correction files use unsigned 16 bit integer to store the pixel data while gain files use unsigned 32 bit integers.

1.6.1 Offset correction

To create the offset correction image an averaged image of a sequence of dark images has to be acquired. These image data are subtracted from the incoming pixel data at acquisition time.

1.6.2 Gain correction

To create the gain image an averaged image of a sequence of Offset-corrected bright images has to be acquired. Afterwards the median value of the pixel data of the whole sensor is evaluated and the entries in the gain image are derived by the following formula

$$\text{entry} = \text{median} * 65536 / (\text{bright_value} - \text{offset_value})$$

For performance reasons the correction is done using integer arithmetic. To improve the precision of the calculation the gain data bits are shifted to left by 16 bits. The gain correction is performed by multiplying the offset corrected pixel data with the gain data and shift the result back.

Please note that optical framegrabber driven detectors and XRpad2 series detectors using onboard corrections shall be gain corrected with a gain sequence using a single image since the algorithms rely on an offset corrected bright image.

1.6.3 Multi Gain correction (Gain Sequence)

To create a Sequence for the Multi-Gain correction an offset corrected averaged bright image has to be acquired for each range of interest.

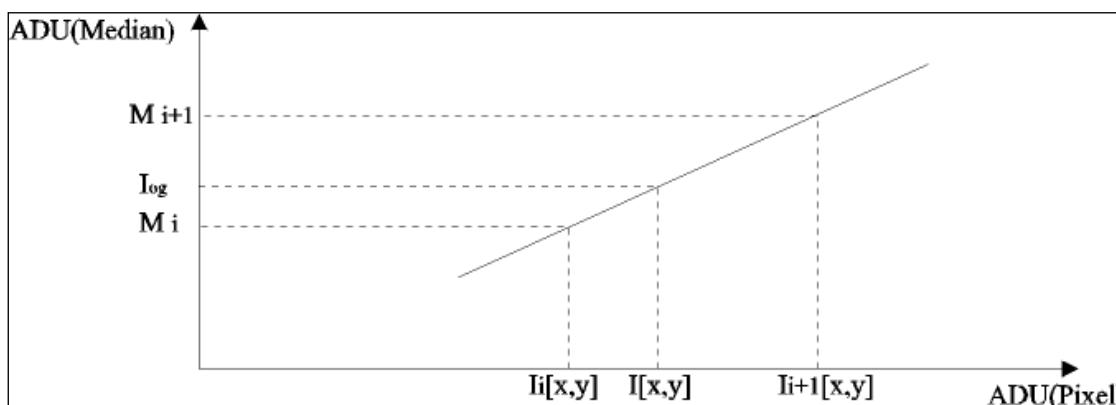


Figure 2: Multi Gain correction

M_i :	Median Value of the offset corrected Image i
$I_i[x,y]$:	Intensity of pixel (x,y) of the offset corrected image i
$I[x,y]$:	Intensity of pixel (x,y) of the offset corrected input image
$I_{og}[x,y]$:	Intensity of pixel (x,y) of the offset-gain corrected output image

The pixel value $I_{og}[x,y]$ is calculated with the following formula:

$$I_{og}[x, y] = M_i + \frac{(M_{i+1} - M_i)}{I_{i+1}[x, y] - I_i[x, y]} * (I[x, y] - I_i[x, y])$$

1.6.4 Pixel correction

The pixel correction is done by the XISL function Acquisition_DoPixelCorrection or online when a pointer to a pixel-correction list is passed to Acquisition_AcquireImage. The pixel correction information is stored in a simple HIS file, where the bad pixels are set to a value of 65535 and the others are set to zero. When the pixel correction image is linked to the acquisition unit the XIS derives the correction data from the pixel correction file using the API function

Acquisition_CreatePixelMap. For that purpose the pixel marked as defects are corrected by the average of the neighboring good pixels.

1.7 Sorting schemes overview

Depending on the sensor and detector type the data come in different orders from the detector. The XISL sort the data in an internal buffer with highly optimized routines written in machine code. Normally the user does not need to care about sorting because the data returned in the acquisition buffer defined in Acquisition_DefineDestBuffers are in the correct order. If the sensor and detector type is unknown the XIS comes up with a detector type dialog at initialization, where the correct sorting has to be entered. The following detector types and sortings are supported:

XRD 0822, XRD 1622, XRD 1642; XRpad[2] detectors, XRD 1611	0 (no sort)
XRD512-400 A1/A2, XRD 0840	6
XRD512-400 E	7
XRD 1640 , XRD 0820	8
XRD 1620 AJ	8
XRD 1680 A	9
XRD 1620/21 AM/AN, XRD 1621	11
XRD 16x0 CS	12
XRD 4343	15

Table 3: Sorting Schemes

1.8 How to acquire data from several sensors in parallel

This feature of the XIS can be used by plugging in two or more frame grabber boards and connecting them to suitable detectors. But it is not recommended to use different types of frame grabbers together. Each frame grabber has to be set to a unique sensor number at the hex switch (unequal to zero). When using multiple XRpad detectors it is possible to select multiple detectors in the “Enum GbIF detectors”-dialog and press “Init”. During the XIS initialization the active sensor has to be selected. Choose Acquire/Continuous to start a continuous data acquisition or acquire correction images or link the correction data before. By the dialog Active Sensor in the Options menu another sensor from the list can be selected. The following actions correspond to the new active sensor. But now new correction files have to be acquired or to be linked for the new sensor. The command Window/Tile shows both acquisition windows.

1.9 How to use function keys

Function keys are available in the acquisition mode for an easy image presentation. The function key **F2** allows the display of the full range of the image, presented in 256 gray levels. The function key **F7** allows to switch to on-line Offset, **F8** to on-line Offset/Gain, **Shift F8** to on-line the Multi-Gain and **F9** is used for on-line Median correction.

F1	HELP	Displays the About Box
F2	DEFAULT	Set to default display mode. Reset brightness and contrast settings.
F3	InfoBox	Displays the initialisation Infobox
F7	OFFSET	Enable/disable Offset correction.
F8	OFFSET/GAIN	Enable/disable Gain/Offset correction.
Shift F8	OFFSET/GAINSEQUENCE	Enable/disable GainSequence/Offset correction.
F9	BAD PIXEL	Enable/disable Pixel correction.
<ESC>	STOP	Stop Acquisition
F11	HEADER	Display of the last acquired HwHeader
Shift F11	Frame Counter	Reset of the detector frame-counter (available for detectors with Header-ID>13

Table 4: Function Keys

1.10 What is new?

- Refer to the file 'CHANGELOG' which is accessible in the root folder of the XIS install package for a detailed description of the changes in the SDK.

2 XRD Hardware Interfaces

2.1 Image acquisition

Following hardware interfaces and windows operation systems are supported by the software:

Interface	OS 32Bit	OS 64Bit	
	Windows 7	Windows 7	Windows 10
PerkinElmer XRD FG (95510214H)	X	-	-
PerkinElmer XRD FGe (95510217H)	X	X	X
PerkinElmer XRD FGe Opto (V1: 95510216H, V2: 95510218H, V3 :95510220H)	X	X	X
PerkinElmer Gigabit Ethernet	X	X	X
PerkinElmer WLAN	X	X	X

Table 5: Supported hardware interfaces and operation systems

Note: XIS Demo-Software is a 32bit application only. Please check the product note/reference manual for supported windows versions of a specific detector/detector interface.

2.1.1 PCI Framegrabber XRD-FG

IB – XRD Interface Bus

- 1 – /TRIG IN
- 2 – /FR_EN (Begin of frame)
- 3 – /FR_SYNC
- 4 – Status LEDs
- 5 – HEX Switch

1,2 and 3 operate with TTL signals. Details can be found in chapter 6.1.8.

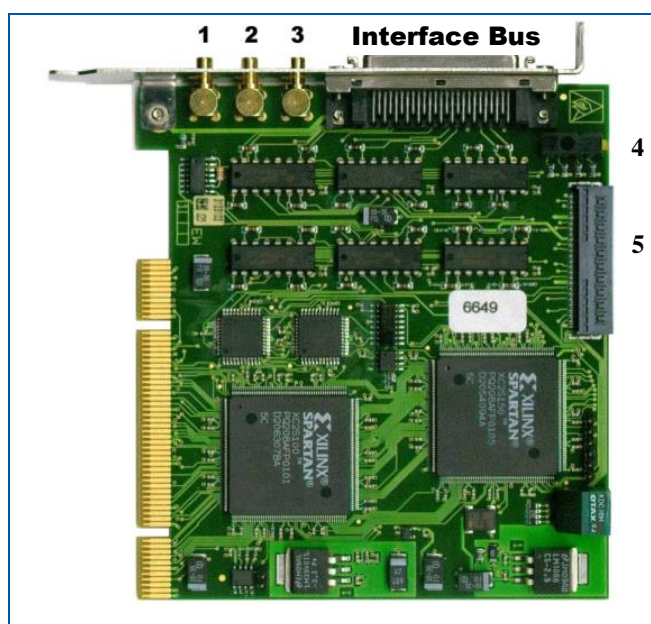


Figure 3: Image of the XRD-FG Frame Grabber

2.1.2 PCI Express Framegrabber XRD-FGe

PCIe –x1

1 – HEX Switch

2 – Status LEDs

3 – XRD Interface Bus

4 – D-Sub connector (details in chapter 6.1.8)

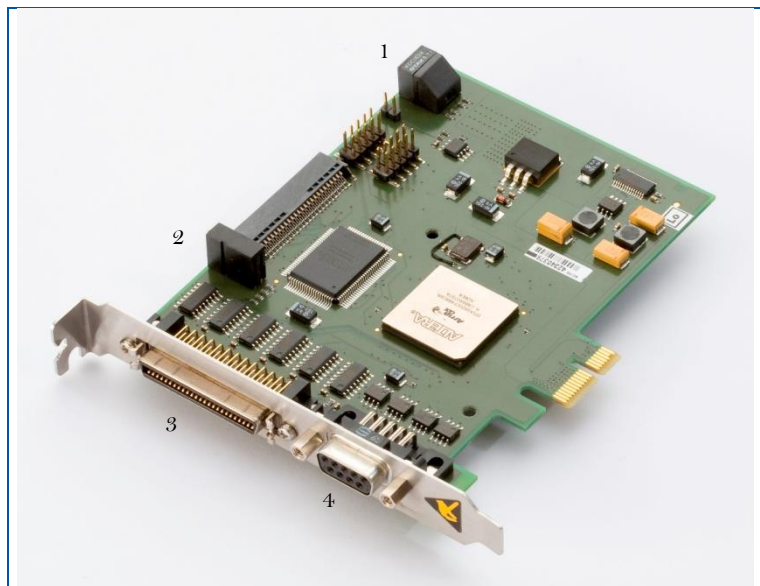


Figure 4: Image of the XRD-FGe Frame Grabber

2.1.3 PCIe Framegrabber XRD-FGe Opto

PCIe –x4

1 – HEX Switch

2 – D-Sub connector (details in chapter 6.1.8)

3 – Optical Transceiver Out

4 – Optical Transceiver In

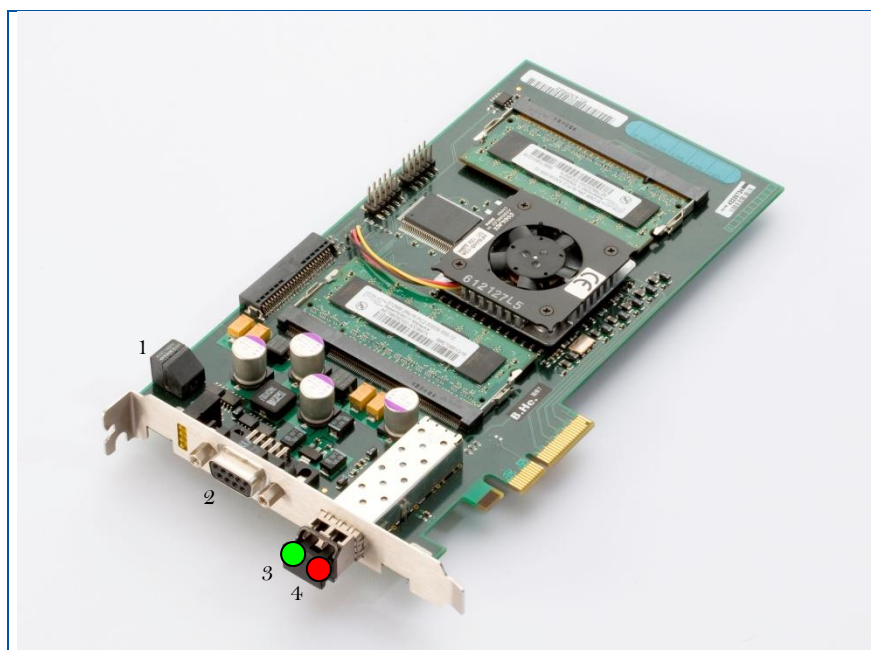


Figure 5: Image of the XRD-FGe Opto Frame Grabber

2.1.4 Features of the Framegrabbers with optical interface

The detector types XRD 1621/41AN, XRD 1611, and XRD 4343 are equipped with an optical Interface. Features are:

- Data Rate up to 15fps @ 2k x 2k x 16bit / 4 fps @ 4k x 4k x 16bit
- Hardware Image correction (offset/gain/mean) w/o loss of frames up to 10 calibration points for non linear correction.
- 5-Level Pixel correction (XRD-FGe Opto only)
- Online image rotation for images with image size up to 2k x 2k pixels
- Glass fiber Interface (galvanic isolation, robust, detector plug type IP68)
- There are three types of the XRD-FGe Opto:
 - 95510216H supports detectors with up to 2k x 2k pixels (XRD 1621)
 - 95510218H supports detectors with up to 4k x 4k pixels (sdk libraries from installation 3-3-2-4 or higher required) (XRD 1611, XRD 1621)
 - 95510220H supports XRD 4343 with 3GHz optical interface (sdk libraries from installation 3-3-3-12 or higher required)

2.1.5 Gigabit Ethernet Interface

The Gigabit Ethernet Interface is embedded into the detector and is able to interact with standard Gigabit Ethernet network interfaces (RJ45). The recommended way to use this interface is in direct (Point-to-Point) connection to the hosting system to guarantee that no additional network traffic arises for this connection. To connect the Detector with the host device the PKI CAT5e/CAT6 (shielded twisted pair, stranded or solid copper conductor) cable should be used.



Figure 6: Front view of the Gigabit Detector XRD0822

- 1 – Potential Equalization
- 2 – Power Input
- 3 – Trigger Input
- 4 – Gigabit Ethernet Connector
 - Left LED (orange) Traffic
 - Right LED (green) indicates Gigabit Link for 2Seconds after Power On
- 5 – Power LED
- 6 – Status LED
 - OFF – no open software connection
 - Flashing green Free Running mode with active software link
 - Flashing amber Triggered mode with active software link
 - Red Error during Self-Test

2.1.6 XRpad Interfaces

The XRpad detectors can be connected via the Interface and Power Unit XRpad IPU with LAN or via WLAN (if applicable). Please refer to the corresponding XRpad model Reference Manual for further details.

3 Installation

3.1 Installation of X-Ray Imaging Software / Installation of the Framegrabber

3.1.1 Framegrabber

To install the frame grabber it is recommended to shut down the computer and unplug the power supply as electricity may cause severe damage to both your motherboard and the frame grabber. In most cases the mainboard has an onboard LED which shows the power OFF mode or the soft-off mode (Power is still on). Hold the grabbers by the edges and try not to touch the chips, leads or connectors. Please place the frame grabber on a grounded antistatic pad whenever the grabbers are separated from the system.

. If more than one frame grabber has to be used in the system the switch on the left side of the grabber has to be set to a unique number for every board.

Please read the readme.txt on the installation CD for the latest information before installing the frame grabber driver and the application software.

1. Shut down the computer
2. Unplug the power supply and remove the computer system's cover
3. Turn the switch of the grabber to a unique number for every board
4. Carefully align the frame grabber's connectors and press firmly
5. Secure the card(s) on the slot with a screw
6. Replace the computer system's cover
7. Restart the computer system
8. Log on to Windows using the administrator account
9. Use the Windows device manager to install the drivers for the framgrabber out of the installation CD folder [drive]\xisl\win32/64\[Grabber type]
10. Restart the computer

Note: in case the driver shall be updated please uninstall the driver including the delete driver files option before the update

3.1.2 Gigabit Ethernet / WLAN Interface

If detector with Gigabit Ethernet or WLAN interface is used please connect the detector to a Gigabit network or WLAN interface of your computer system.

In case of a XRpad detector different IP subnet settings for LAN and WLAN are mandatory (e.g. use IP: 192.168.2.123 subnet 255.255.255.0 for detector LAN and IP: 192.168.22.123 subnet 255.255.255.0 for WLAN which means that the LAN subnet is 192.168.2. and the WLAN subnet is 192.168.22).

For the Ethernet drivers it is necessary to install the redistribution package which is also located on the installation package folder XISL

Windows Firewall Settings:

Before a Ethernet Detector can be used you have to ensure that either the Windows Firewall is disabled for the application (XIS.EXE / XISL_Demo.EXE / "Your_App.EXE") or the following ports are excluded from the firewall:

80	web server access XRpad[2]
21	ftp XRpad[2]
22	ssh XRpad[2] only for remote access / update
1234 (UDP)	always
3956 (UDP)	always
3957(TCP)	for XRpad2
57635(UDP)	always for XRpad[2]
1000 (UDP)	always (for 1 detector) (1024 on Linux)

1001 (UDP)	always (for 1 detector) (1025 on Linux)
1002 (UDP)	if a second detector is used (1026 on Linux)
1003 (UDP)	if a second detector is used (1027 on Linux)
1004 (UDP)	if a third detector is used (1028 on Linux)
1005 (UDP)	if a third detector is used (1029 on Linux)
...	

Detector IP Setup:

For the Gigabit Detector Setup with XIS please refer to Page: 47 Chapter: Automatic Initialization

3.1.3 Software Installation on Windows

Before you install the XIS software (32bit only), please make sure either a framegrabber is installed or you use a detector with Gigabit Ethernet interface.

1. Insert the XIS Installation CD-ROM into your CD drive. The installation will start automatically. If not, go to the root directory of the CD and run the executable START.EXE.
2. The XIS SETUP program will lead you through the installation process of the XIS demo software with the option to install the Gigabit Driver and the 32/64bit SDK additionally. 32bit compatibility drivers for XRD FGe [opto] frame grabbers allowing the use of the frame-grabber in a combination with a 32bit application. This can be installed by selecting the adequate option.
3. Restart the computer system.
4. The XIS is now ready to start.
5. If the initialization of the frame grabber and the detector is successful a corresponding message appears in the status bar.

3.2 Trouble Shooting

XIS: Setup:

Color Resolution:

The setup informs you, that the selected color resolution is different than 256 colors.

Please choose "Settings/Control Panel" in the Windows "Start" menu and double click the icon "Display". Several property sheets appear. Select "Settings" and enter at least "256 color" in the "Color Palette" list box.

XIS and Zooming:

Some computer systems have problems with the XIS zoom functionality in combination with the Microsoft direct draw drivers.

As a workaround you can switch of Direct Draw and Direct3D.

For that please perform the following steps:

- Open the DOS-Box
- enter dxdiag and press Return (now the direct control panel starts)
- go to the 3rd tab (display/view)
- deactivate DirectDraw and Direct3D

XIS on 64 bit systems:

In case of running the 32bit XIS on a 64bit operating system the software will show a memory error message when one tries to acquire a sequence or in continuous mode. To avoid that please run the XIS.exe in WindowsXP or Windows7 compatibility mode by selecting the option in the options of the shortcut or the executable.

XIS: Detector Initialization:

XIS Error 39

- check whether the correct frame grabber/ethernet driver files are installed
- Check whether the redistribution packages for 32/64 bit are installed. The packages can be found in the folder XISL\Redistributables Visual Studio 2013
- Check whether library files from other installations are still available after removal of the hardware (e.g. pcgr200.dll, pcgr200_x64.dll, eleye400.dll, eleye400_x64.dll, eleye300.dll, gbif.dll, gbif64.dll)

XIS Error 2 // Eltec Error -303

IRQ-Problem

Change the IRQ-Settings in the System Settings Control Panel or in the BIOS. Use another PCI-Slot without IRQ-Sharing or remove not absolutely necessary PCI-boards or use the polling mode.

XIS Error 2 // Eltec Error 1:

The system is unable to initialize Framegrabber. There might be a problem with the software driver

XIS Error 2 // Eltec Error -41:

Virtual device driver not present

No framegrabber driver is loaded or an old driver is still installed in the system but the frame-grabber card is already removed .In that case you can use the DriverDeinstaller-Tool to clean up the system.

XIS Error 23:

Hardware header invalid

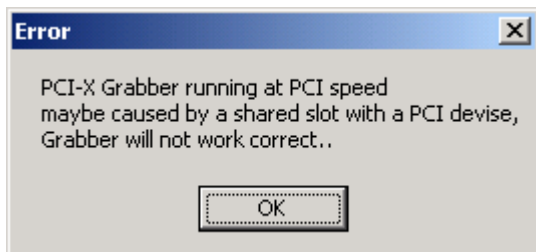
- Check the connections of the detector and the frame grabber board.
- Check if there are older libraries of an earlier installation in the path then delete or rename it.
- Try the detector setup by the Option/Acquisition dialog

- Write down the header information and contact your vendor

Optical Grabber only:

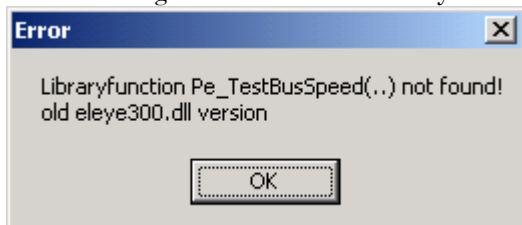
PCI-FGX Opto – PCI Problem

- This Message occurs when the PCI-X Slot is only in 32Bit mode or running with 66MHz in place of 100/133MHz. This may be caused by a PCI card connected to a PCI-X slot. So the PCI-X Grabber will not work correct. Please try using another PCI-X slot with 100/133MHz to avoid this sharing problem.



PCI-FGX Opto – Driver Version Problem

- This Message occurs when the Library function Pe_TestbusSpeed is not found. Please try to install the latest driver. Be sure that all files of the old driver are removed / uninstalled before. You can use the **new DriverDeInstaller.exe** which is located on the xis-cd to search and remove frame grabber libraries from the system32 directory.



XISL: Image acquisition:

XISL Error 1:

- If the function Acquisition_Acquire_Image returns 1, one possible reason can be the memory situation of the host system:
Please check your "boot.ini" file if the flag /3GB is set. If this is the case please remove this flag and try to acquire image data after rebooting the system.
However, if the function is not able to allocate enough memory for image acquisition (which at least is the size of the internal, 8 images comprising ring buffer) it also returns this error.

GigE Latency Problems:

- Latency issues during image acquisition have been observed using LLA in combination with Windows. It is recommended, to use the DHCP or the Static IP setup for continuous/sequent image acquisitions rather than the LLA solution.

3.3 Downloads

Note: Please contact Varex Imaging applications engineers to verify which driver/software version applies to your detector/grabber configuration and how to receive or download the latest software release!

X-Ray Imaging Software

4 Overview of the Menu Commands

4.1.1 File Menu Commands

The File menu offers the following commands:

New	Creates a new document.
Open	Opens an existing document.
Close	Closes an opened document.
Save	Saves an opened document using the same file name.
Save As	Saves an opened document to a specified file name.
Save Correction files	Saves all loaded correction files.
Import	Imports an existing uncompressed document
Print	Prints a document.
Print Preview	Displays the document on the screen as it would appear printed.
Print Setup	Selects a printer and printer connection.
Exit	Exits XIS.

Table 6: File menu

4.1.2 Edit Menu Commands

The Edit menu offers the following commands:

Copy	Copies data from the document to the clipboard.
Math	A dialog comes up that gives you the possibility to manipulate sensor data by sophisticated build in functions.
Copy Frames	Copies frames from one document to an empty document.
Average	Averages over the images of a sequence.
Select by value	Selects image pixels by their data values.
Select all	Selects all image pixels.
Deselect all	Deselects all image pixels.
Select Rect	Selects a rectangle of pixels by coordinates
Set value	Sets all selected pixels to a specified value.
Create pixel map	All selected pixels are marked as defects and a pixel correction map is created.

Table 7: Edit menu

4.1.3 Acquire Menu Commands

The Acquire menu offers the following commands, which enable the user to acquire images of the detector and to perform suggested corrections to achieve best image quality:

Continuous	Acquires and displays images continuously in the selected timing mode. (Default TIMING0: shortest acquisition time of the detector.)
Single Shot	Acquires a single image.
Sequence	Acquires a sequence of images.
Link Offset Corr	Linking of a stored Offset correction file to acquire images corrected with the loaded Offset file.
Link Gain Corr	Linking of a stored Gain correction file to acquire images corrected with the loaded Gain file.
Link Gain Sequence	Linking of a stored Gain-Sequence correction file to acquire images corrected with the loaded Gain-Sequence file.
Link Pixel Corr	Linking of a stored Pixel correction file to acquire images corrected with the loaded Pixel file.
Get Offset Image	Acquires a new Offset image for later Offset corrected image acquisition.
Get Gain/Offset Image	Acquires a new Offset corrected Gain image for later Gain/Offset corrected image acquisition.
Get All Offset Images	Acquires all Offset images for later Offset corrected image acquisition. (All frame times available in the Timings menu are automatically acquired)
Build Gain Sequence	Creates a Gain-Sequence correction file to be used with the Gain Sequence correction.
Convert to Gain Image	Creates a new gain image from an offset and a bright image. In the bright image a region of interest can be selected to optimize the gain image regarding best presentation of this area.
Set Soft Trigger	Opens a Dialog from which a Single Softtrigger or a repeated SoftTrigger can be send to the Detector.

Table 8: Acquire menu

4.1.4 Detector Menu Commands

The Detector menu offers the following commands:

Mode	Selects the Detector mode. The detector is able to operate the following modes: free running, triggered by external sources triggered by an customized internal timing triggered by software auto triggered (XRpad only)
Timings	Selects the currently active frame time for detector operation.

Table 9: Detector menu

4.1.5 View Menu Commands

The View menu offers the following commands:

Acquisition Bar	Shows or hides the acquisition toolbar
Toolbar	Shows or hides the toolbar.
Status Bar	Shows or hides the status bar.
LUT	Shows or hides the LUT window.
Control	Shows or hides the Control window.
Player	Shows or hides the Player bar (available using Acquire Sequence command).
Zoom Box	Shows or hides the Zoom Box window
Image Data	(obsolete) Shows or hides image data saved to the file
Plot Box	Shows or hides the plot box which displays a graph containing the values of the currently selected image data for each Row, Column or as a histogram.

Table 10 : View menu

4.1.6 Window Menu Commands

The Window menu offers the following commands, which enable arranging multiple views of multiple documents in the application window:

New Window	Creates a new window that views the same document.
Cascade	Arranges windows in an overlapped fashion.
Tile	Arranges windows in non-overlapped tiles.
Arrange Icons	Arranges icons of closed windows.
Window 1, 2, ...	Goes to specified window.

Table 11: Window menu

4.1.7 Options Menu Commands

The Options menu offers the following submenus:

Acquisition	Allows to enter specific acquisition options.
View	Allows to enter specific view options (zooming etc.).
Active Sensor	Allows changing the currently active sensor if more than one sensor is connected to the system.
Sensor	Gives information and allows to set some options for the active sensor

Table 12: Options menu

4.1.8 Help menu commands

The Help menu offers the following commands.

Help Topics	Displays the About Box
About	Displays the version number of this application.

Table 13: Help menu

4.2 File menu

4.2.1 New command

This command creates a new document in XIS. The type of the file can be selected in the New File dialog box.



Toolbar:

Keys: CTRL+N

The following dialog appears if the user creates a new document

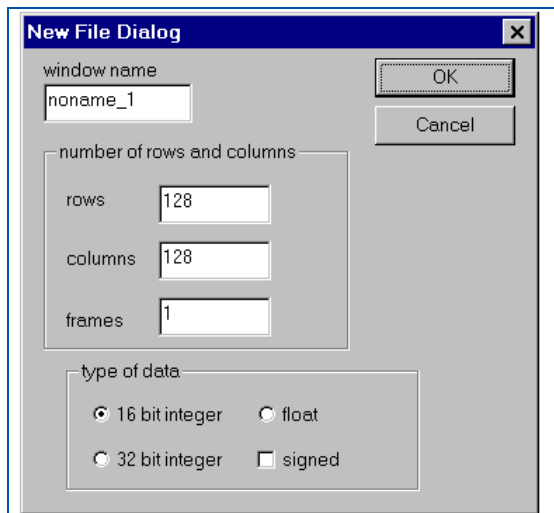


Figure 7: New File Dialog

Window name	This name specifies the name of the new document.
rows, columns, frames	This input numbers specify the number of columns, rows and frames of the new document. All data values are set to zero.
type of data	The XIS supports different data types for data acquisition and evaluation. The suitable type could be specified here. All operations done by the XIS are type safe. If a data type isn't suitable for the desired operation a warning is given out and the data type is changed allocating a new suitable data buffer. In this case all old data are lost.

Table 14: Settings of the New File Dialog

4.2.2 Open command

This command opens an existing document in a new window. Multiple documents can be opened at once. Use the Window menu to switch among the multiple open documents.

See Window 1, 2, ... command.



Toolbar:

Keys: CTRL+O

4.2.3 Close command

The Close command closes all windows containing the active document. XIS suggests that the changes of document should be saved before closing it. If a document is closed without saving, all changes made since the last time of saving are lost. Before closing an untitled document, XIS displays the Save As dialog box and suggests to name and save the document. A document can also be closed by using the Close icon on the document's window.

4.2.4 Print command

This command prints a document. First a Print dialog box appears to specify the range of pages to be printed, the number of copies, the destination printer, and other printer setup options.



Toolbar:

Keys: CTRL+P

The following options can be used:

Printer	This is the active printer and printer connection.	
Setup	Displays a Print Setup dialog box to change the printer and printer connection.	
Print Range	Specify the pages you want to print:	
	All	Prints the entire document.
	Selection	Prints the currently selected text.
	Pages	Prints the range of pages you specify in the From and To boxes.
Copies	Specify the number of copies you want to print for the above page range.	
Collate Copies	Prints copies in page number order, instead of separated multiple copies of each page.	
Print Quality	Select the quality of the printing. Generally, lower quality printing takes less time to produce.	

Table 15: Settings of the Print Dialog

4.2.5 Print Preview

This command displays the active document as it would appear when printed. When this command is called, the main window will be replaced with a print preview window in which one or two pages will be displayed in their printed format. The print preview toolbar offers you the following options:

Print	Bring up the print dialog box, to start a print job.
Next Page	Preview the next printed page.
Prev Page	Preview the previous printed page.
One Page / Two Page	Preview one or two printed pages at a time.
Zoom In	Take a closer look at the printed page.
Zoom Out	Take a larger look at the printed page.
Close	Return from print preview to the editing window.

Table 16: Settings of the Print Preview Dialog

4.2.6 Print Setup

This command presents a Print Setup dialog box to specify the printer and its connection.

4.2.7 Save command

The Save command saves the active document to its current name and directory. Saving a document for the first time, XIS displays the Save As dialog box to name the document. To change the name and directory of an existing document before saving, choose the Save As command.



Toolbar:

Keys: CTRL+S

4.2.8 Save As command

Use this command to save and name the active document. XIS displays the Save As dialog box to name the document.

To save a document with its existing name and directory, use the Save command.

4.2.9 Save Correction files

Use this command to save all currently loaded correction files. The files are stored in the correction folder defined in the Options/Acquisition dialog.

4.2.10 Exit command

Use this command to end the XIS session. The same effect has the Close command on the application Control menu. XIS prompts to save documents with unsaved changes.

Mouse: Double-click the application's Control menu button.

Keys: ALT+F4

4.2.11 Import command

This command opens an existing file containing raw data in a new window. In the appearing dialog the number of columns, rows, frames and the data type can be selected.

4.2.12 1, 2, 3, 4 command

Use the numbers and filenames listed at the bottom of the File menu to open the last four documents you closed. Choose the number that corresponds with the document you want to open.

4.3 Edit menu

4.3.1 Edit build sequence

This menu entry opens the “Build Sequence” dialog to edit available sequences of images by inserting or appending data from other images or to create a new sequence from existing images. The “Build Sequence” dialog looks like the following image:

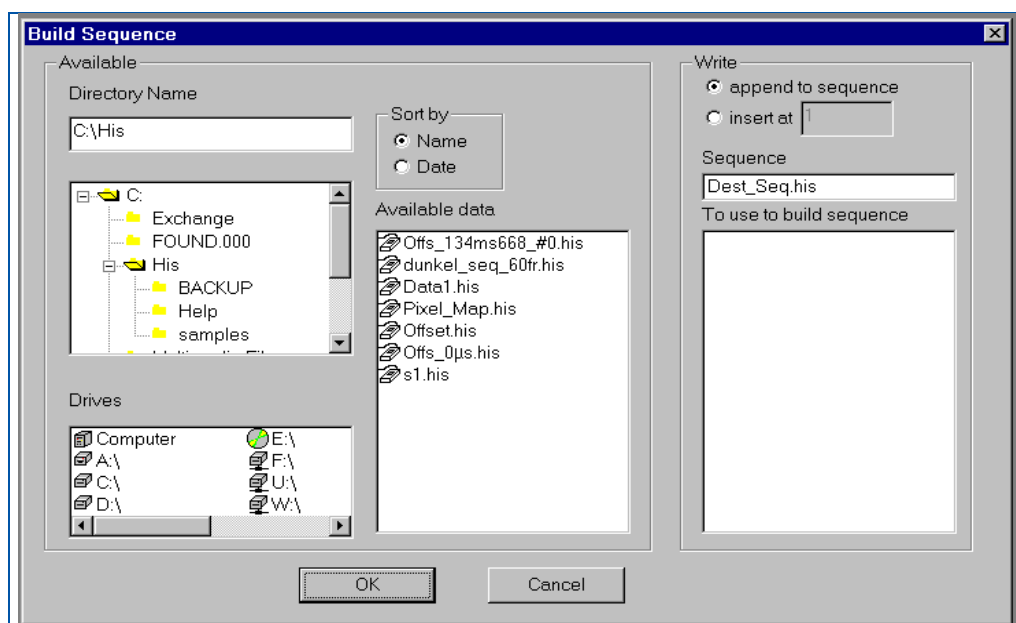


Figure 8: Build Sequence Dialog

The available group box shows all available drives, directories and files. The currently loaded images are listed under the drive "computer" in the drives list box. To list stored images click on the items of the drive box and the entries of the above tree control that displays the directory structure.

Sort by radio buttons	Change the sorting of the available images by the corresponding radio buttons
append to sequence	Check this radio button to append images to a sequence.
insert at button	Check this radio button to insert images at a specified location in the data stream. The last frame of the sequence is specified by the “insert at” edit box.
Sequence edit box	Drag and drop a sequence file from the "available data" box or edit the name. If the file name isn't loaded and not available on the storage media a new data window is created and the data are appended.
To use to build sequence box	This list contains the files which will appended to or inserted into the sequence. Drag and drop files from the "available data" list box.

Table 17: Settings of the Sequence Dialog

4.3.2 Edit Math

The Edit Math menu entry opens the “enter expression” dialog box. The build in parser supports several mathematical image calculations, e.g. addition of image data to numbers or other image data, the subtraction of images and numbers, the division and multiplication of images and numbers and averaging of different images and numbers.

The status of the parser is shown in the Status Bar.

The details of the parser are described in the chapter “Mathematical expressions”.

4.3.3 Copy

This command copies selected data into the clipboard. If no data selected, the Copy command is unavailable. Copying data to the clipboard replaces the previously stored data.



Toolbar:

Keys: CTRL+C

4.3.4 Copy Frames

This command copies a number of frames into a new document. In the appearing dialog the range of frames can be specified.

4.3.5 Average

This command derives the average of the frames provided in the active document and copy the result into a new empty document.

4.3.6 Select by Value

This command selects all pixels of the active document that are within or out of a specified range. The selected pixels appear on the screen in the manner, which is adjusted by the control box. All following actions are related to this selection.

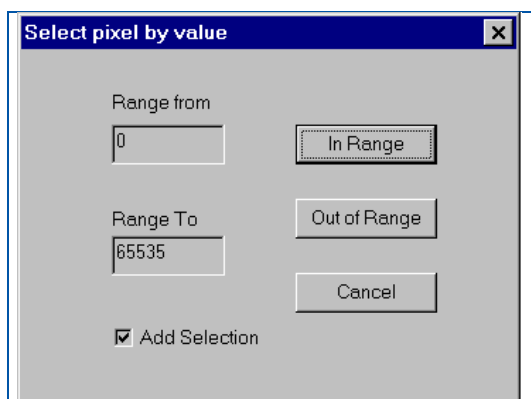


Figure 9: Select Pixel by Value Dialog

Range from	This edit control specifies the lower limit of the selection range.
Range to	This edit control specifies the upper limit of the selection range.
Add Selection	By this button the new selection is added to an older one.
In Range	By this button all pixels within the specified range are selected.
Out of Range	By this button all pixels out of the specified range are selected.
Cancel	This button aborts the selection process.

Table 18: Settings of the Select Pixel by Value Dialog

4.3.7 Select All

This command selects all pixels of the active document. The selected pixels appear on the screen in the manner, which is adjusted by the control box. All following actions are related to this selection.

4.3.8 Deselect All

This command deselects all pixels of the active document.

4.3.9 Set Value

The Set Value command allows the change of pixel values manual. This function is useful for editing pixel maps (see create pixel map).

After selecting this menu entry the following dialog appears:

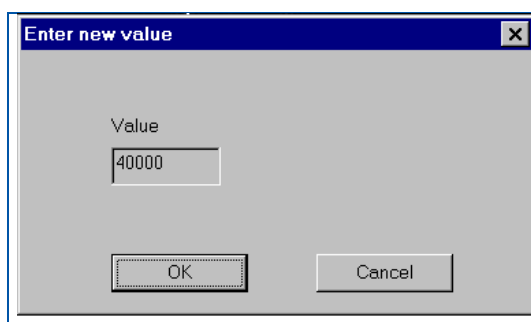


Figure 10: Enter new Value Dialog

Value	Enter the new value of the pixels.
Ok	Press this button to accept the new value.
Cancel	This button aborts the selection process.

4.3.10 Select Rect

Selects a rectangle of pixels by coordinates

4.3.11 Create Pixel Map

This command creates a pixel map from a data file.

A pixel map is a normal data document that can be used for a pixel correction. Defective pixels are distinguished from working pixel by their values in the pixel map. Defective pixels have values of 65535, the values of working pixels are different from this value.

This menu entry creates an empty data document and all selected pixels of the source document are marked as defect pixels in the new created pixel map.

4.4 Acquire menu

4.4.1 Single Shot

One single image of the detector at the selected frame time (see Timings menu) is acquired by the Single Shot command. The image buffer contains the data of the acquired image.

The Function keys are not available during single shot acquisition, only the ESCAPE key can be pressed to interrupt this action. The Image corrections are Offline available (Offset, Gain or Pixel correction) for details see the chapter “image corrections”. Before the next shot a dialog appears to choose the manner of further processing of the actual image frame (see also Overwrite Data). If the next data's are acquired into a new window, the last actual correction setting is performed during the next image acquisition cycle. To change the current correction setting the Windows menu can be used to close the correction files or the Acquire menu to link other files.



Toolbar:

4.4.2 Sequence Command

By this command a defined image sequence at the selected frame time (see Timings menu) is acquired. The image buffer contains the data of all specified acquired images. The Function keys are not available during sequence acquisition, only the ESCAPE key can be pressed to interrupt this action. The image corrections (Offset, Gain or Pixel correction) can only be enabled or disabled before starting the sequence. If the image corrections are disabled it is possible to use the corrections Offline, for details see the chapter “image corrections”. The sequence mode offers different options to acquire a sequence of images, which can be set in the dialog below:

- Seq. of averaged Frms: A sequence of averaged frames is acquired. In the example below a sequence is created consisting of 30 images, each of them is an average of 4 subsequently acquired images.
This function is only available for XRD-FGe OPTO and XRD-FGX OPTO. The amount of Frames to average must be 2 to the power of n.
- Seq. one buffer: Acquire a sequence of n images. If desired, a number of *skipframes* frames can be skipped before each acquired one.
- Average: Acquire a sequence of n images and create an average image as result. In case of the XRD-FGe OPTO and the XRD-FGX OPTO the averaging is done onboard when the amount of Frames to average is 2 to the power of n.

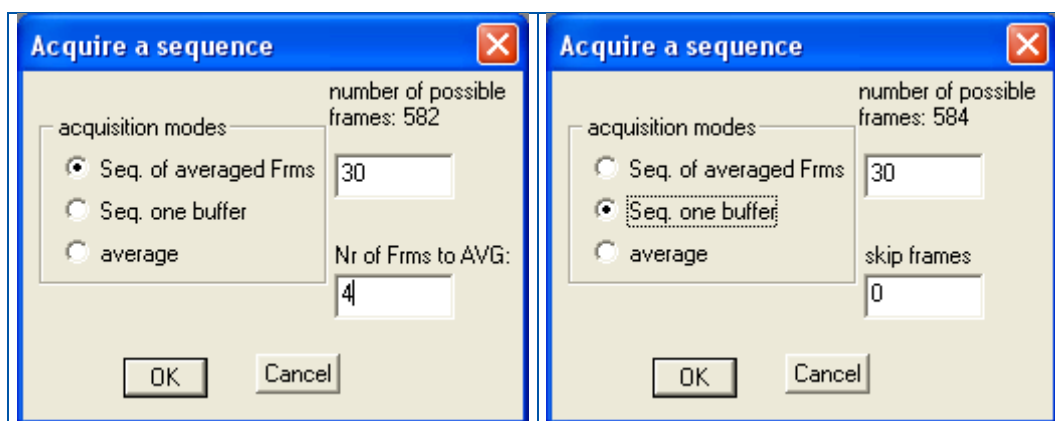


Figure 11: Acquire Sequence Dialog (Seq. of averaged Frms / Seq. one buffer)

Additionally: If there has already been data acquired but not stored, a dialog pops up whether to override the old data or acquire into a new window.

To change the current correction settings the Windows menu can be used to close the correction files or the Acquire menu to link other files.



Toolbar:

Keys: CTRL+SHIFT+S

4.4.3 Continuous Command

The **Continuous** command acquires continuously images of the detector at the selected frame time (see Timings menu). The image buffer contains always the data's of the last acquired image cycle. The next acquired image clears the current frame buffer and overwrites the old image. The call of the **Continuous** command appears in a dialog where the number of images per cycle can be edit. The number of frames per cycle can be selected between one and the displayed maximum number of possible frames, which are depending of RAM and open windows. For memory reasons the default number is recommended. The number of skipped frames can also be edit in the dialog. With the Function keys the online corrections can be enabled or disabled (Offset, Gain or Pixel correction). The image presentation can be changed using the View menu. To stop the continuous acquisition the user can press the **ESCAPE** key or call **End Acquisition**. The last acquired image is displayed and can be further processed. If more than one frame is in the buffer images of this cycle can be selected by the **Player** command in the View menu. The image presentation can be changed using the View Options. Before next acquiring of images a dialog appears to choose the manner of further processing of the actual sequence (see also Overwrite Data). If the next data's are acquired into a new window, the last actual correction setting is performed during the next image acquisition cycle. To change the current correction setting the Windows menu can be used to close the correction files or the Acquire menu to link other files.

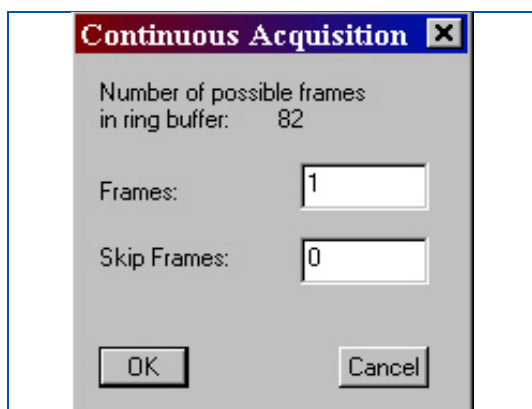


Figure 12: Continuous Acquisition Dialog



Toolbar:

Keys: CTRL+SHIFT+C

4.4.4 Get Offset Image

The **Get Offset Image** command generates a new Offset Image file of the detector at the selected frame time (see Timings menu). The number of frames to average for the Offset image can be edit in the appearing dialog. The new correction image is used to perform later the correction of the new acquired images. Please be aware, that a corrected image should not be corrected twice. See also: Use of the Offset Correction.

The Offset image is automatically linked and used for the next acquired images. To switch between correction and non correction of a running acquisition the Function key (F7) can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

Keys: CTRL+SHIFT+O

4.4.5 Get Gain/Offset Image

The **Get Gain/Offset Image** command generates a new Gain-Offset Image file of the detector at the selected frame time (see Timings menu). The number of frames to average for the new Gain image can be edit in the appearing dialog. The new correction image is used to perform later the correction on the new acquired images. Please be aware, that a corrected image should not be corrected twice. See also: Use of the Gain/Offset Correction.

The Gain/Offset image is automatically linked and used for the next acquired images. To switch between correction and non correction of a running acquisition the Function key (F8) can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

Keys: CTRL+SHIFT+G

4.4.6 Get All Offset Images

This command generates a set of new Offset Image files of the detector at **all** available frame times. The number of frames to average for the new Offset image files can be edit in the appearing dialog. The new correction image files are used to perform later the correction on the new acquired images. Please be aware, that a corrected image should not be corrected twice.

The Offset image files are automatically linked concerning their frame time and used for the next acquired images. To switch between correction and non correction of a running acquisition the Function keys can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

4.4.7 Link Offset Correction

The **Link Offset Correction** command loads defined Offset correction files of the detector for the selected frame time (see Timings menu). The linked file is used to perform directly the correction for the actual frame. Please be aware, that a corrected image should not be corrected again. The file is selected by the File Selection dialog box. To acquire Offset correction files see Get Offset Image. This file is also used for the next acquired images. To switch between correction and non correction of a running acquisition the Function key (F7) can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

4.4.8 Link Gain Correction

The **Link Gain Correction** command loads defined Gain/Offset correction files of the detector for the selected frame time (see Timings menu). The linked file is used to perform directly the correction for the actual frame. Please be aware, that a corrected image should not be corrected again. The file is selected by the File Selection dialog box. To acquire Gain/Offset correction files see Get Gain/Offset Image. This file is also used for the next acquired images. To switch between correction and non correction of a running acquisition the Function key (F8) can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

4.4.9 Link Gain Sequence Correction

The Link Gain Sequence Correction command loads defined GainSequence/Offset correction files of the detector for the selected frame time (see Timings menu). The linked file is used to perform directly the correction for the actual frame. Please be aware, that a corrected image should not be corrected again. The file is selected by the File Selection dialog box. To acquire Offset correction files see Get Offset Image. The Gain Sequence correction file must be created with the command Acquire Build GainSequence command. This file is also used for the next acquired images. To switch between correction and non correction of the acquired images the Function Key (Shift+F8) can be used or to stop generally the correction close the linked correction files by using the Window menu commands.

4.4.10 Link Pixel Correction

The Link Pixel Correction command loads a defined pixel correction file of the detector. The linked file is used to perform directly the correction for the actual frame. Please be aware, that a corrected image should not be corrected again. The file is selected by the File Selection dialog box. This file is also used for the next acquired images. To switch between correction and non correction of a running acquisition the Function key (F9) can be used. To stop generally the image correction close the linked correction files by the Window menu commands.

4.4.11 Acquire Build GainSequence

This menu entry opens the "Build Sequence" dialog to create a sequence of offset-corrected bright images to be used with the GainSequence-correction. The selected images will be sorted by median. Beware that the XRD-FGX/FGc OPTO can handle a sequence with up to 10Frames. The "Build Sequence" dialog looks like the following image

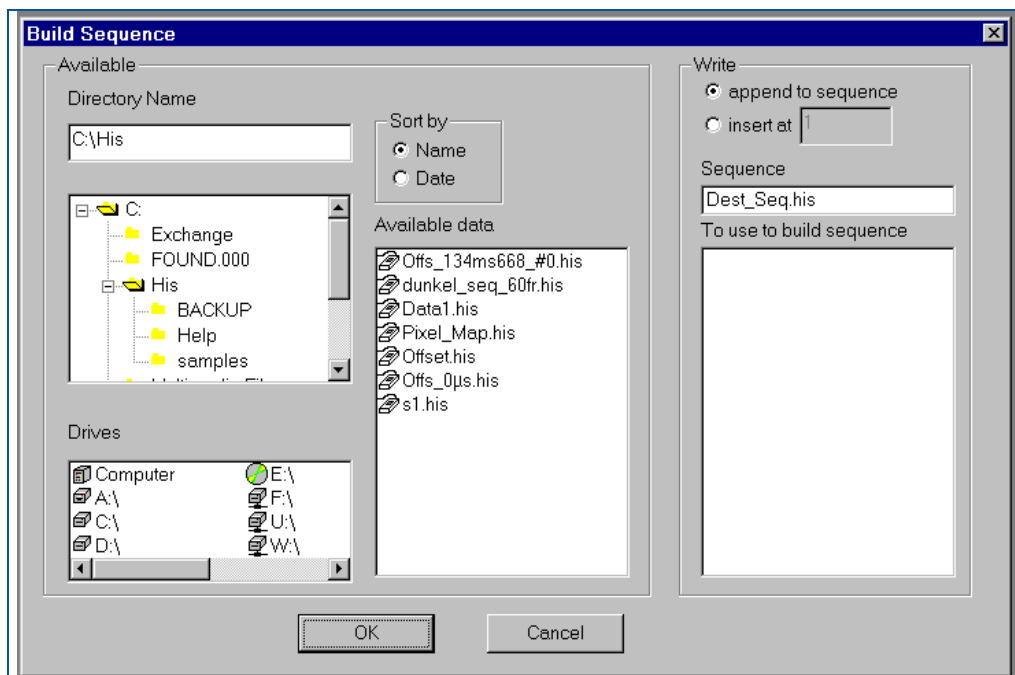


Figure 19: Build GainSequence Dialog

The available group box shows all available drives, directories and files. The currently loaded images are listed under the drive "computer" in the drives list box. To list stored images click on the items of the drive box and the entries of the above tree control that displays the directory structure.

The "write" group provides all controls regarding the destination sequence.

Sort by radio buttons	Change the sorting of the available images by the corresponding radio buttons
append to sequence	Ignored!
insert at button	Ignored!
Sequence edit box	Drag and drop a sequence file from the "available data" box or edit the name. If the file name isn't loaded and not available on the storage media a new data window is created and the data are appended.
To use to build sequence box	This list contains the files which will be appended to or inserted into the sequence. Drag and drop files from the "available data" list box.

Press the Ok-Button to create a Sequence of the selected files sorted by Median.

4.4.12 Acquire Convert to Gain Image

This function creates a new gain image from a dark image file and a bright image file. Compared to the automatic creation of the gain image by Get Gain/Offset Image this routine has the advantage that the user can select a region of interest in the bright image to optimize the gain image regarding best presentation of data in this area. Afterwards the new gain image has to be linked by Link Gain Correction.

The call of Convert to Gain Image comes to a dialog where the dark, the bright and the new gain image has to be named. The available data files can be shown by selecting one edit box and pressing the insert key on the keyboard. In the appearing File Selection dialog the files can be found and entered.

4.4.13 Acquire End Acquisition

This command stops the continuous acquisition. The last acquired image is displayed and can be further processed.

Keys: Esc

4.4.14 Acquire Set Soft Trigger

This command opens a Dialog from which a Single Softtrigger or a repeated SoftTrigger can be send to the Detector when the detector is in Softtrigger-Mode.

4.5 Detector

4.5.1 Timings menu

The Timings menu enables the setting of different frame times for the image acquisition of the detector. Eight different frame times are available. TIMING0 is the shortest possible frame time of the specific detector. The detector starts automatically in the first timing.

Example of the default timings menu for the XRD/RID 512-400 A:

(TIMING 0)	134 ms	(Shortest available frame time of the detector.)
(TIMING 1)	200 ms	
(TIMING 2)	400 ms	
(TIMING 3)	800 ms	
(TIMING 4)	1600 ms	
(TIMING 5)	3200 ms	
(TIMING 6)	6400 ms	
(TIMING 7)	12800 ms	

Table 19: Displaying different Timings

4.5.2 Detector Mode

Five different acquisition modes are available. They are called "free running", "external triggered", "internal triggered", "soft triggered" and "AutoTrigger".

- The free running mode means that the detector sends out continuously frames according to the selected frame time. This is the default mode.
- The external triggered mode means that the detector is synchronized by an external trigger pulse. The X-ray detector ignores all other incoming trigger pulses until the selected frame time has elapsed. After that the detector can be triggered by a new pulse.
- The internal triggered mode means that a frame time between the fastest timing and 5 seconds can be selected.
- The soft triggered mode means that the detector is synchronized by a trigger pulse that is generated by the Software. A frame time between the fastest timing and 5 seconds can be selected. This can be realised by sending a trigger signal via the software API or the Menu Item `Acquire=>Set Softtrigger`.
- The AutoTrigger mode also called **Auto Exposure Detection (AED)** is only supported by the XRpad detector series. The XRpad detector is automatically synchronized once the X-ray source starts with the exposure. The X-ray detector ignores all other incoming trigger pulses until the selected frame time has elapsed.

Note: All three trigger sources except auto trigger can be used with the trigger modes framewise, start/stop and DDD which can be selected by the detector option dialog (chapter 4.8.5)

Note: Not all acquisition modes are available for each detector. Please refer to the corresponding model Reference Manual for more details.

4.6 View menu

4.6.1 Status Bar

The left area of the status bar shows online information for the menu or Tool Bar entry where the cursor is above or shows the status of an executed command. A check mark appears next to the menu item when the Status Bar is displayed.

For details see the chapter Status Bar.

4.6.2 Toolbar

The Toolbar command displays and hides the Toolbar, which includes buttons for some of the most common commands in XIS, such as File Open. A check mark appears next to the menu item when the Toolbar is displayed.

For details see the chapter Toolbar

4.6.3 Acquisition Bar

The Acquisition Toolbar command displays and hides the Acquisition Toolbar, which includes buttons for some of the most special commands in XIS, such as Acquisition. A check mark appears next to the menu item when the Toolbar is displayed.

For details see the chapter Acquisition Toolbar

4.6.4 LUT - Look-Up-Table

Hides or Shows the LUT - Look-Up-Table.

The Lock-Up-Table represents the currently selected LUT range in a graphic bar within 256 gray levels. The lowest intensity is represented black, the brightest intensity white. The fading uses the 16 bit range for the actual values.

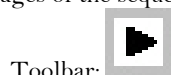
NOTE:

Exceptionally the values for Gain/Offset correction images are represented in a 32 bit integer mode.

4.6.5 Player

This command is only available if sequences are loaded or acquired.

To show the images and to select a specific frame of the sequence the **Next** and **Previous** button are used. In contrast to the step by step representation the **Play** button starts a continuous playing of all images of the sequence.



4.6.6 ZoomBox

The ZoomBox is a utility to zoom into the area located at respective the cursor position. The zoom can be intensified using the mouse wheel². Starting at a size of 101*101 pixels being up-scaled, the zoom level can be changed up to 5*5 pixels maximum zoom.

Below the section showing the scaled pixels the ZoomBox provides other features.

Considering image data these are

Position	Current cursor position.
Value	Pixel value at the cursor position.
Window Size	Size n^2 of the currently zoomed section.
Median	Median of the currently zoomed n^2 section.
Sigma	Sigma of the currently zoomed n^2 section.

In case the document considered is a fault mask provided values are:

Position	Current cursor position.
Value	Fault which is set at the current cursor position.
Window Size	Size n^2 of the currently zoomed section.
Fault Density	Fault Density of the currently zoomed n^2 pixels (which is the ratio of good and fault pixels within the n^2 window).

² During usage of the ZoomBox the mouse wheel functionality for image scrolling is deactivated. The image can still be scrolled by moving the scroll bar at the window rim though.

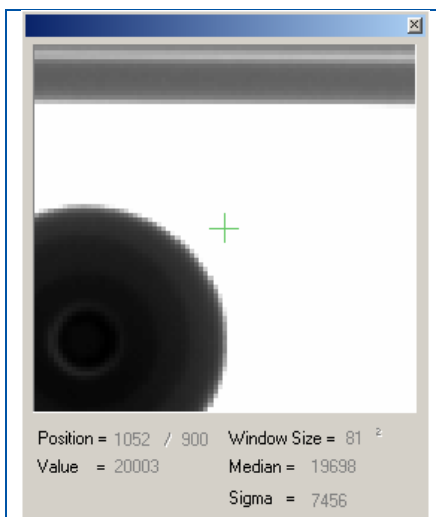


Figure 14: Zoom Box



The ZoomBox can also be activated by clicking the Toolbar button

4.6.7 View Control Box

The View Control Box appears automatically when an image is acquired opened or imported. To hide and recall the Control Box the menu entry **View** in the View menu can be used.

The detector acquires images of 16Bit, but Windows based computers can only display 8Bit. By the View Control Box the interested grey levels can be selected and displayed on the screen. The selection can be done automatically or manually (zooming).

The Control Box contains the following features:

Brightness	Select brightness for image presentation.
Contrast	Select contrast for image presentation.
LUT Range	Select Bright and Dark values for image presentation.
Full Range	This box represents always the minimum (0) and maximum (65535) values in 16 bit range.
Invert	Inverts the actual image presentation.
Track Range	Automatic tracking within a region of interest based on evaluated minimum and maximum value of this region. It is recommendable to use this function in the Continuous Acquisition mode for viewing interesting sample parts under X-ray illumination.
Zoom	If this radio button is checked the program evaluates the minimum and maximum pixel values of the selected region of interest and presents this value range in 256 gray levels.
Equalize	Performs image enhancement by equalizing all gray levels in a region of interest.
Full	Allows jumping into the full presentation mode of the LUT Range.
Standard	Selection type Standard
Diagonal	Selection type Diagonal
X1 / y1	Upper left coordinates (absolute) of Standard Selection
X1 / y1	Lower right coordinates (absolute) of Standard Selection
Add Selection	If checked, add Standard selection to existing one. Else delete existing one.

Table 20: Zoom settings of the Control Box

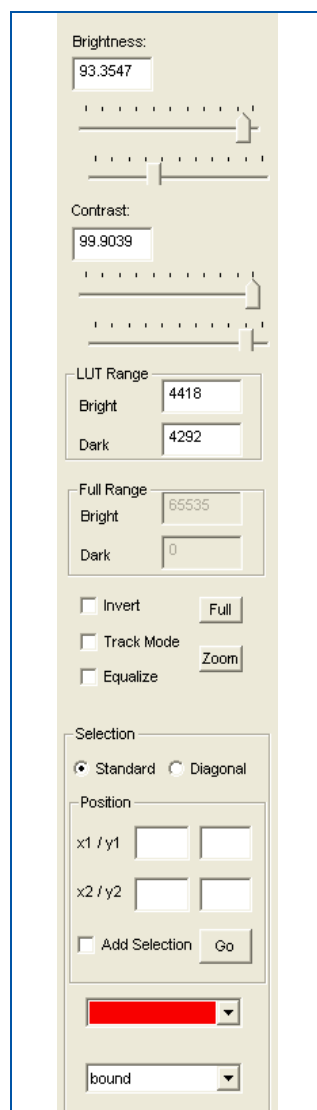


Figure 15: Control Box

To mark **the region of interest** within the image the mouse pointer has to be moved to the starting point and the left button has to be pressed while moving to the end point.

By moving from the upper left to a desired lower right point, the user selects a rectangular shaped window, presented in inverted values.

By moving from lower left to upper right a horizontal line is selected.

By moving from upper right to lower left, a vertical line is selected.

The color and the mode presenting the region of interest can be changed in the listbox on the bottom of the color control window. The different modes are:

Fill	The region of interest is filled with the selected color, it is default
Bound	The region of interest is bounded by the selected color.
And	The selected color will be combined with the corresponding pixel values by a logical and operation within the region of interest.
Or	The selected color will be combined with the corresponding pixel values by a logical or operation within the region of interest.
Hide	Region of interest is hidden.

Table 21: ROI settings of the Control Box

4.6.8 View Image Data

Shows or hides image data previously saved to the file. This function is obsolete

4.6.9 View Plot Box

The Plot Box is a utility to Show a Graph for the currently selected image data for each row, column or as a histogram. It will be updated when a new area is selected or a new frame has been acquired.

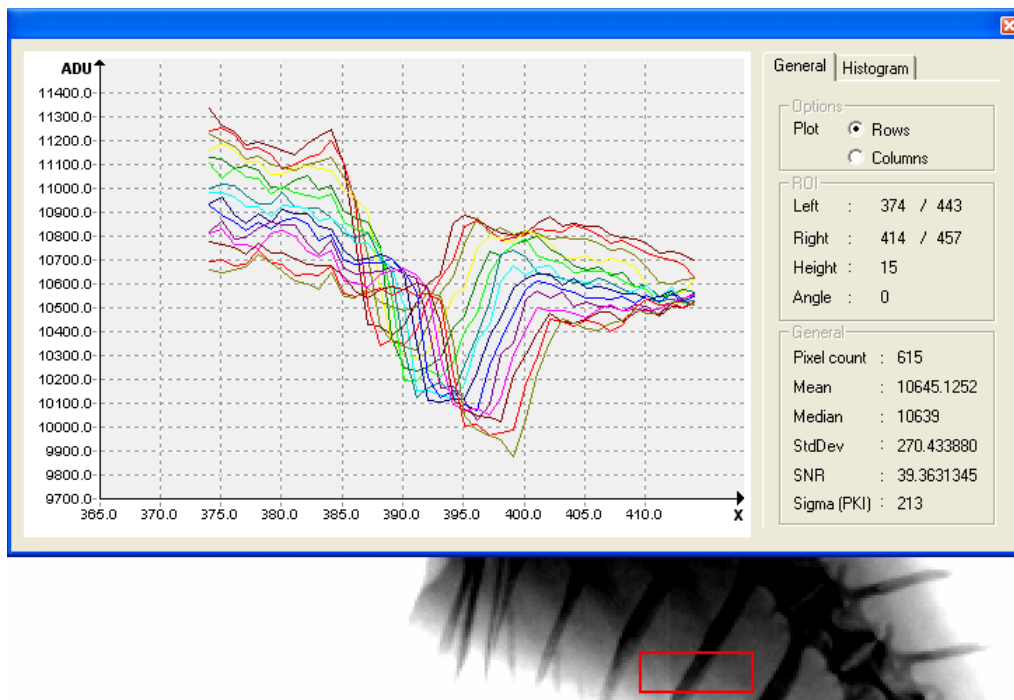


Figure 16: Plot Box – Plot Rows

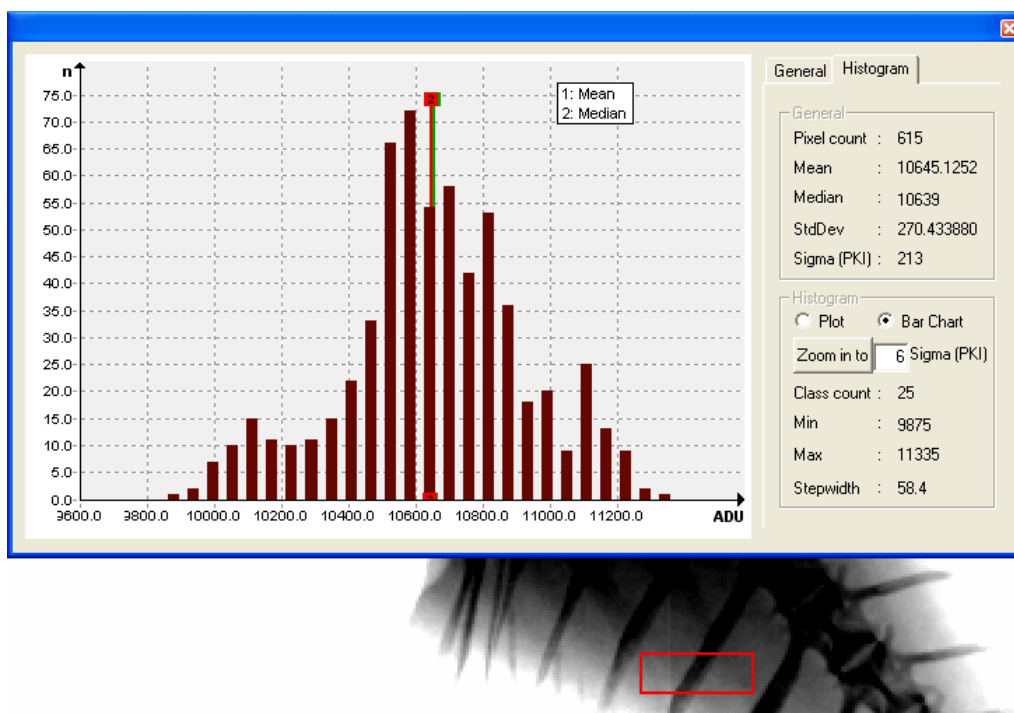


Figure 17: Plot Box – Plot Histogram

4.7 Window menu

4.7.1 New Window

The New Window command opens a new window with the same contents as the active window. Multiple document windows can be displayed in different parts or views of a document at the same time. If the contents in one window are changed, all other windows containing the same document reflect those changes. When a new window is created, it becomes the active window and is displayed on top of all other open windows.

4.7.2 Cascade

This command arranges multiple opened windows in an overlapped fashion.

4.7.3 Tile Horizontal

This command arranges multiple opened windows in a non-overlapped fashion.

4.7.4 Tile Vertical

This command arranges multiple opened windows side by side.

4.7.5 Window Arrange Icons

This command arranges the icons for minimized windows at the bottom of the main window. If there is an open document window at the bottom of the main window, some or all of the icons displayed below this document window are not visible.

4.7.6 1, 2, ... command

XIS displays a list of open document windows at the bottom of the Window menu. A check mark appears in front of the document name of the active window. Choose a document from this list to make its window active.

4.8 Options menu

4.8.1 Acquisition

This command restarts the sensor initialization and allows selecting the initialization type: “yes” for automatic initialization, “no” for manual setup or “Enum / Select GbIF Detector” to initialize/configure a GigE Detector. The “Cancel” button starts the XIS without initialization of the detector.

4.8.1.1 Automatic Initialization

The selection of automatic initialization leads to a dialog asking for the mode in which the frame grabber will run.

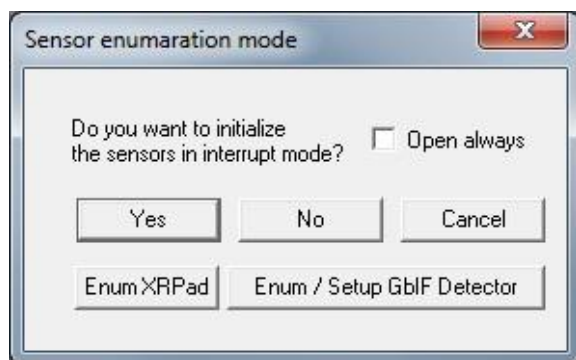


Figure 18: Initialization dialog

Select “**yes**” to run the hard- and software in Interrupt Mode and “**No**” to use the Polling Mode. If the “Open always” radio button is checked the XIS opens the requested communication channel regardless if it has been already captured by another process running on the system. It isn’t recommended to use this option except for debugging because the XISL can’t free all resources in one process that were allocated by another process.

When automatic initialization is chosen XIS scans the PCI[X][e] bus for plugged in frame grabbers and tries to detect connected detectors. If it recognizes more than one detector it asks you to select a default one. The initialization process is ready if the message “initialization successful” appears in the status bar.

Note: This function also tries to open Gigabit Ethernet Detectors if the Standard Gateway of the Detector is zero. This is for example the case when the detector is connected Point to Point per LLA (detector default) or when a static IP is used without a defined Standard Gateway.

If “**Enum / Select GbIF Detector**” is chosen the software searches for detectors with ethernet interface that are connected to the computer via Point to Point or the LAN and displays the results in the Dialog “Enum GbIF Detectors” which is described below.

“Enum XRpad” sends a network broadcast through all available network adapters and provides a list of recognized XRpad detectors which can be initialized with “Enum GbIF Detectors”

4.8.1.2 Enum GbIF Detectors

This dialog shows all Gigabit Ethernet Detectors connected to the system via Point to Point or LAN. This list can be retrieved using the functions `Acquisition_GbIF_GetDeviceCnt` in combination with `Acquisition_GbIF_GetDeviceList`. In case a detector is connected but not listed please check whether your firewall does not block the required ports and the connection has finished establishing (refer to chapter 3.1.2 Gigabit Ethernet / WLAN Interface. XRpad detectors connected via LAN and WLAN will also be listed in this dialog.

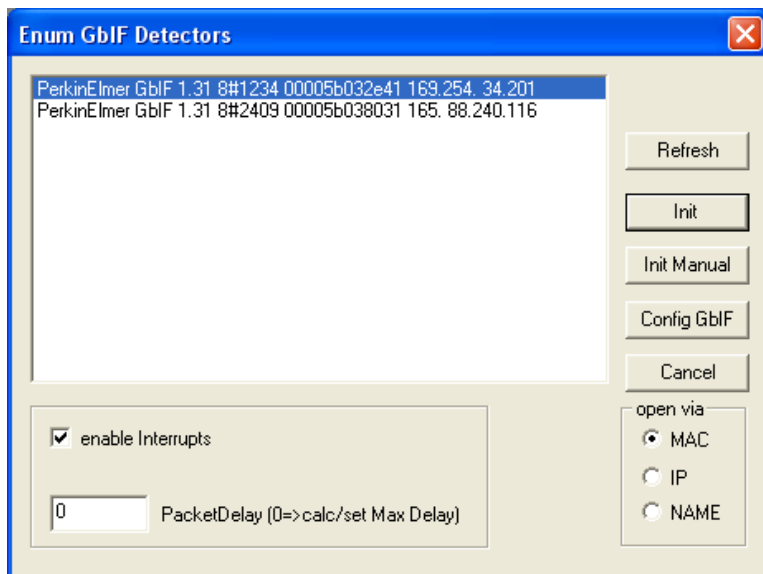


Figure 19: List of found detectors shown by Enum GbIF Sensors dialog

Refresh:

Update the detector list.

Init:

Retrieve the detector settings and initialize the selected detector.

Init Manual:

Initialize the selected detector but enter the detector size and sorting manually like described in Chapter

Manual Setup below.

Config GbIF:

Configure the Ethernet IP setting for the selected Detector like described in Chapter **Configure GbIF** below.

Cancel:

Close this Dialog without initialization a GbIF Detector.

enable interrupts:

Checked - use interrupts

Unchecked - use polling mode

Packet Delay:

This parameter describes the Packet Delay in 16nSec Ticks between two IP-Data-Frames.

If this parameter is zero – XIS checks for an adequate Packet delay depending on the actual network speed and detector type using `Acquisition_GbIF_CheckNetworkSpeed` and passes a valid value to the library using `Acquisition_GbIF_SetPacketDelay`.

When the Parameter is above zero the value is set using `Acquisition_GbIF_SetPacketDelay`. Valid numbers are e.g.

8000 – WLAN 420x3556 pixels, 5s transfer time preset value,

293 – LAN 420x3556 pixels, 500ms transfer time via 1GBit ~80% load,

1935 – LAN 1024 x 1024pixels at 15fps via a 1GBit connection

8000 – LAN 1024 x 1024pixels at 1fps via a 100Mbit connection. ~80% load

Open via:

This parameter describes which parameter is passed to `Acquisition_GbIF_Init`. The detector can be open by passing the MAC Address, the IP-Address or the Detector Name.

4.8.1.3 Configure GbIF

This dialog allows the user to change the IP Settings of the selected Detector if the detector and the Network adapter are in the same Subnet. In case of a XRpad the dialog will only show the current settings. Please use the integrated web-server to configure the ip-settings and the image-transfer-path (LAN/WLAN) of the XRpad.

Change IP-Settings:

Figure 20: Configuration of the selected GigE-Detector

The user can set the mode to LLA (Local-Link Address), DHCP (Dynamic Host Configuration Protocol) or Static IP – Address. LLA and DHCP can also be combined (see figure above). The changes will be valid after the Dialog is closed with “OK” and restart of the detector (power cycle).

Note: There has been discovered some issues. Please see [Trouble Shooting](#) for more information.

Force IP:

The screenshot shows the 'Configure GBif' dialog box with the following fields and options:

- Device Parameter:**
 - Sensor Name: 16#5119
 - MAC: 00005b032e52
- Boot Options:**
 - ☒ DHCP
 - ☒ LLA
 - ☐ Static IP
- IP Settings:**
 - ☒ Force IP
 - Sensor:**
 - IP: 192.168.1.2
 - Subnet Mask: 255.255.255.0
 - Standard Gateway: 0.0.0.0
 - Adapter:**
 - 0.0.0.0
 - 0.0.0.0
- Update Flash:**
 - FW file: [Empty field]
- Detector information:**
 - Type: n/a
 - Date (MM·YYYY): n/a - n/a
 - Production-Place: n/a
- Buttons:**
 - OK
 - Abbrechen

Figure 21: Configuration of the selected GigE-Detector – Force IP

If the detector has an address which cannot be opened due to incompatible network settings the user can force the device temporarily to connect with a custom IP-Address, but out of the same subnet and with the gateway like the network card of your computer system. For that check the Option “Force IP” (which can also be found within the “Config” dialog) and enter the temporary settings in the fields “IP”, “Subnet Mask” and “Standard Gateway”. After that press “OK”. After the addresses are set this way, PC and detector should be able to connect with each other. Now configure the boards permanent address settings as described above. With restart of the detector the device will loose the temporary IP and behave as configured (e.g. IP per DHCP or LLA or Static IP).

Note: This option is not available for the XRpad detector family.

4.8.1.4 Manual Setup

During the manual initialization the XIS asks for the communication channel to open, more than one are possible. The communication channel can be set by the hex-switch of the frame grabber board, if only one frame grabber inside the default channel is zero. The following dialog requests parameters to initialize the sensors connected to these channels.

Size of the detector

Define upper and bottom left and right X, Y dimension of the detector.

4.8.2 Sorting

The following sorting schemes are possible

(see also sorting overview):

No Sort (e.g. XRpad, 0822, 1611, 1622 and 1642)

XRD 0820/40

XRD/RID 512-400

XRD 1640 A / 1620 AJ

XRD 1680 A

XRD 162X AM/AN

XRD 16X0 AN CS

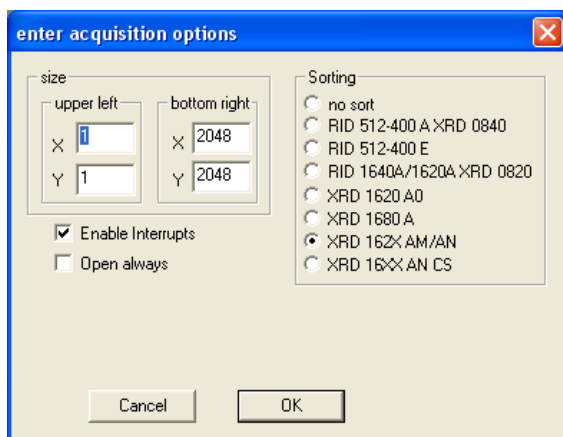


Figure 22: Dialog for the Acquisition Options

Enable Interrupts

The setting of different interrupt sources allow an efficient data transfer between I/O board and the memory of the PC (for further explanation see interrupt sources). If no interrupts are enabled the detector is running in polling mode. It is recommended to use the interrupted mode for a frame synchronization. (XRpad[2] and xx22 detectors only provide the interrupt mode and will ignore this parameter)

Open always

This option opens the requested communication channel regardless if it has been already captured by another process running on the system. It isn't recommended to use this option except for debugging because the XISL can't free all resources in one process that were allocated by another process. If you initialized more than one sensor the XIS asks now a default detector to that all the further instructions correspond.

4.8.3 View

The View command comes to the “Enter View Options” dialog, where the presentation of the actual window can be optimized.

Toolbar: 

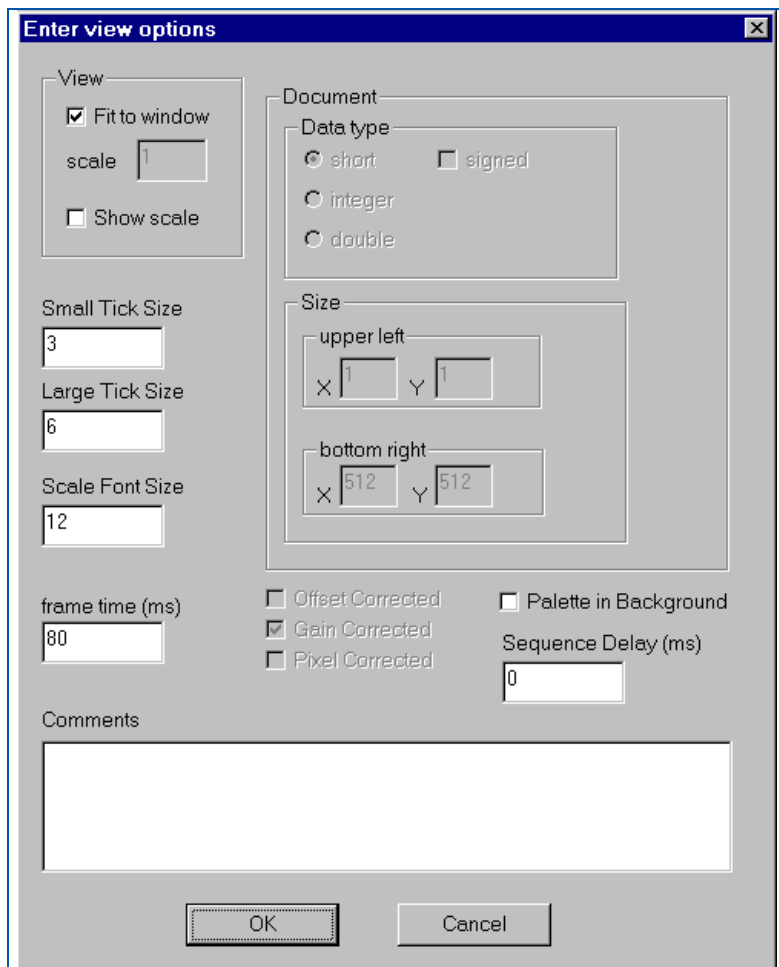


Figure 23: View Options Dialog

View - Fit to window	Defines the scale of the image window.
View - Show Scaling	To be switched ON for scaling the edges of the image Small Tick 2 (default) Large Tick 4 (default) Scale Font 12 (default)
Document - Data type	Information of the used data type. Short Integer Double Signed
Document - Size	Information on upper and bottom left and right X, Y dimension of the detector.

Table 22: Settings of the View Options Dialog

4.8.4 Options Active Sensor

The appearing dialog shows the connected sensors in a list box. The active sensor is highlighted. The sensors are identified by the frame grabber type they are plugged in and a unique number. To change the active sensor for acquisition another sensor can be selected from the list box.

Toolbar: 

4.8.5 Options Sensor

This menu entry comes to the “Sensor Options” dialog contains information about the active sensor.

- The communication channel edit box gives information about the frame grabber board which is connected to the active sensor.
- In the correction directory the correction files are stored by the Save correction files command. If the Auto Correction Load radio button is checked suitable correction files are loaded from the correction directory at startup and if a different timing is selected.

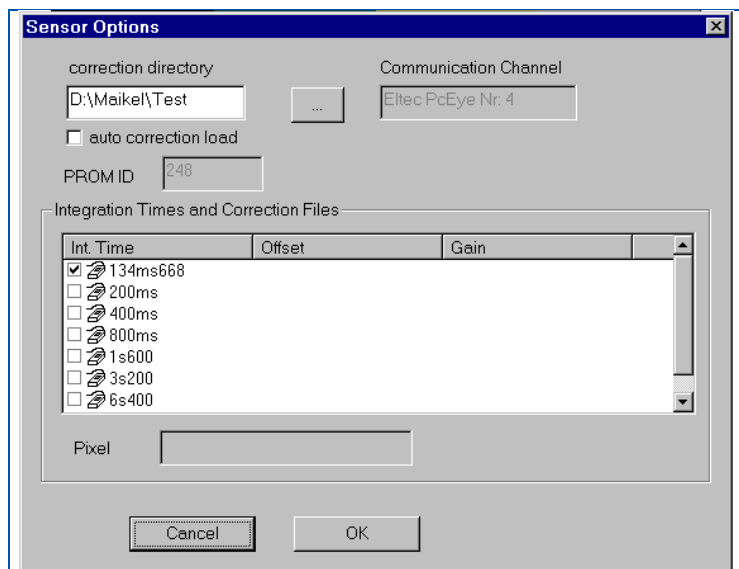


Figure 24: Sensor Options Dialog

- The PROM ID is the identifier of the actual used detector PROM. This information is important to get support at hardware problems concerning the detector or the frame grabber.
- In the group “Integration Times and Correction Files” all available integration times are listed. The selected one is checked in the list control. If correction files are attached for the different timings there will be corresponding entry in the list control. If a pixel correction file is attached it is displayed in the “Pixel” edit box.

4.8.6 Switch on/off Service Mode

Enabling the Service Mode means that special Service data is displayed into the first row of acquired images. These images can be analysed by Varex Imaging for the purpose of detector troubleshooting.

This function can also be implemented into customer application software API function Acquisition_ActivateServiceMode. The advantage for your application is that images can be stored in any raw data format (i.e. without compression!!) and, in spite of that, can be analysed by Varex Imaging. Currently this function is not supported by all detector types. (Refer to the API description for further details.)

4.8.7 Detector Options

In the “Set Detector Options” dialog the detector internal parameters will be set. The available settings for each detector are described in the corresponding model Reference Manual. Examples of the parameters are:

- Binning-mode
- Trigger-mode
- Gain
- Timing (Frame Time)
- Special TriggerMode (Section 6-“Details for the Hardware”).
- ‘Data Delivered on Demand Options’ to set the delaytime or exposure time of the DDD-Trigger Mode
- ‘Select /TriggerOut Signal’ to set different /TriggerOut signal options
- ‘Select Region of Interest (ROI)’ to select a specific region of the full field of view (Sectional Mode XRD 0822, XRD 1642)
- ‘Select FOV’ to select a specific region of the full field of view (XRD 4343)

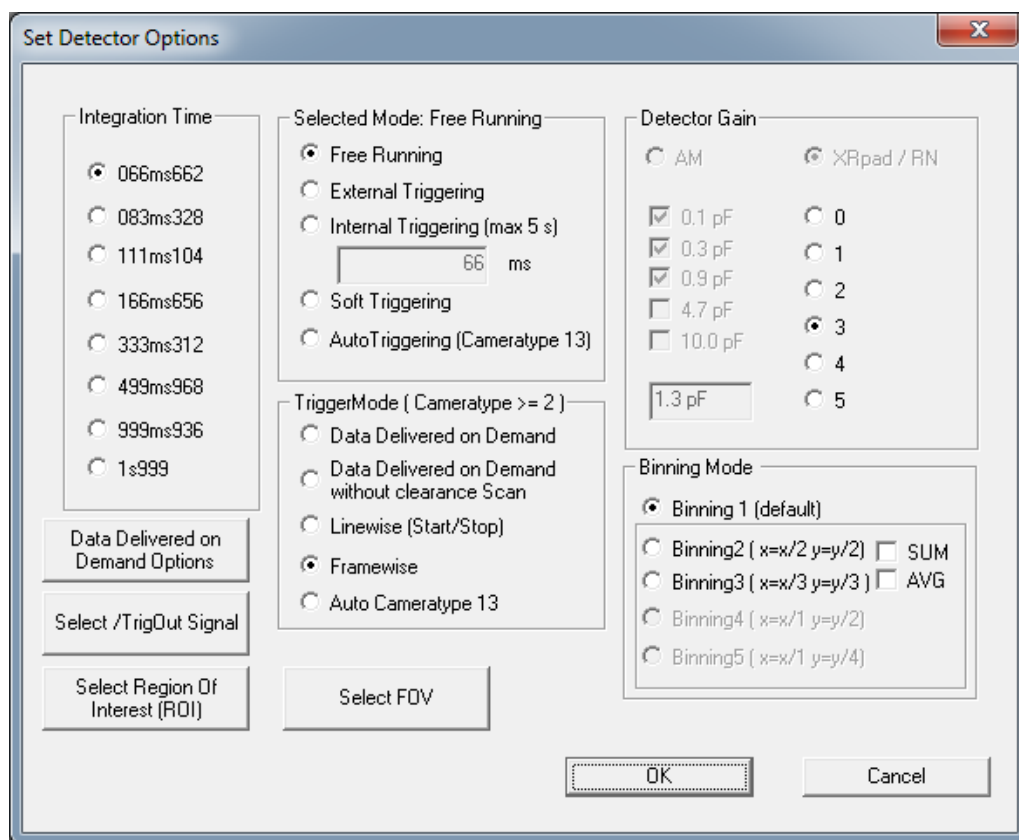
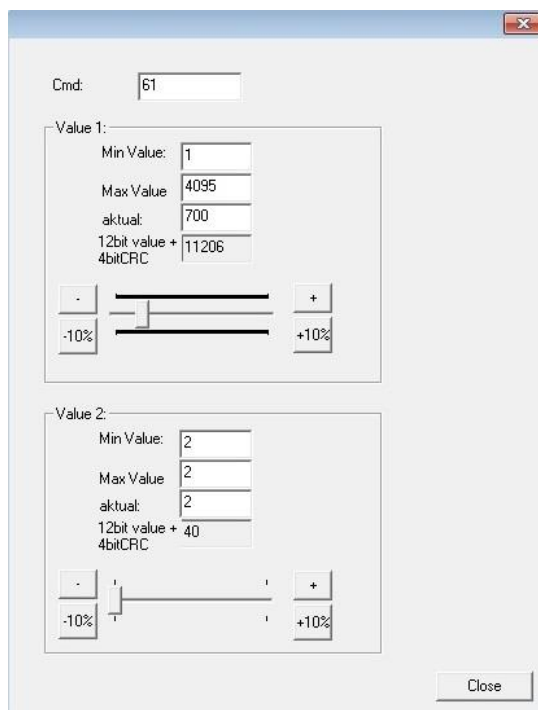


Figure 25: Set Detector Options

4.8.8 Set Detector Offset

The XRD 4343 detector supports a high range of settings to achieve an optimal image quality for a certain application. To perform this high range for settings the detector provides the possibility to adjust the offset floor. The setting of the offset floor will be described in the XRD 4343 Integration Guide.



In the text box “actual” in the section “Value 1” type in the offset floor value used for the intended imaging mode which are described in the Reference Manual and Integration Guide. XRD 4343 Firmware Subrevision >=118 also support setting the offset via Cmd62 which is recommended.

4.9 Help

4.9.1 Contents

This command displays the About Box.

4.9.2 About

This command displays the version number and copyright notice of XIS.

4.10 Toolbar



The toolbar is displayed across the top of the application window and below the menu bar. The toolbar provides quick mouse access to many tools used in XIS.

The Toolbar can be hide or displayed by the command Toolbar in the View menu (ALT+ V, T).

Click	Application
	Open a new document.
	Open an existing document. XIS displays the Open dialog to find and select the files.
	Save the active document or template with its current name. If the file is not named XIS displays the Save As dialog box.
	Print the active document.
	Copy the selection to the clipboard.
	Insert the contents of the clipboard at the insertion point.
	Display the About Box.

Table 23: Windows Toolbar

4.11 Acquisition Toolbar



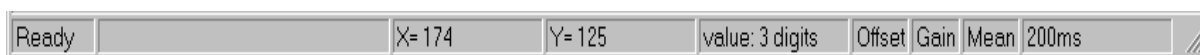
The toolbar is displayed across the top of the application window and below the menu bar. The toolbar provides quick mouse access to many tools used in XIS.

The Toolbar can be hide or displayed by the command Toolbar in the View menu (ALT+ V, A).

Click	Application
	Starts the continuous Acquisition. Shortcut: CTR+SHIFT+C
	Opens the Sequence Dialog
	Starts a Single Shot
	Opens the Player Dialog.
	Opens the View Dialog
	Opens the Active Sensor Dialog

Table 24: Acquisition Toolbar

4.12 Status Bar



The status bar is displayed at the bottom of the XIS window. To display or hide the status bar the Status Bar command in the View menu can be used.

The left area of the status bar shows online information for the menu or Tool bar entry where the cursor is above or shows the status of an executed command.

The right areas of the status bar give extended information regarding acquisition status, pixel values and frame times.

Indicator	Description
Box 1:	Describes the main status of the software. (Online Help)
Box 2:	Warnings by using detector and its messages.
Box 3:	Selected X-value of the detector array.
Box 4:	Selected Y-value of the detector array.
Box 5:	Actual value in digits between 0 - 65535.
Box 6:	Marker for Offset ON/OFF.
Box 7:	Marker for Gain/Offset ON/OFF.
Box 7a:	Marker for GainSeq/Offset ON/OFF.
Box 8:	Marker for Pixel correction ON/OFF.
Box 9:	Selected frame time.

Table 25: Status Bar

4.13 Title Bar



The title bar is located along the top of a window. It contains the name of the application and document. To move the window, drag the title bar. Note: You can also move dialog boxes by dragging their title bars.

A title bar contains the following elements:

- Application Control-menu button
- Document Control-menu button
- Maximize button
- Minimize button
- Name of the application
- Name of the document
- Restore button

4.13.1 Scroll bars

Displayed at the right and bottom edges of the document window. The scroll boxes inside the scroll bars indicate your vertical and horizontal location in the document. You can use the mouse to scroll to other parts of the document.

4.13.2 Size command (System menu)

This command displays a four-headed arrow to size the active window with the arrow keys. This command is unavailable if the window is maximized.



After the pointer changes to the four-headed arrow:

1. Press one of the DIRECTION keys (left, right, up, or down arrow key) to move the pointer to the border you want to move.
2. Press a DIRECTION key to move the border.
3. Press ENTER when the window is the size you want.

Shortcut

Mouse: Drag the size bars at the corners or edges of the window.

4.13.3 Move command (Control menu)

This command displays a four-headed arrow to move the active window or dialog box with the arrow keys. This command is unavailable if the window is maximized.




Shortcut

Keys: CTRL+F7

4.13.4 Minimize command (application Control menu)

Use this command to reduce the XIS window to an icon.

Shortcut


Mouse: Click the minimize icon  on the title bar.

Keys: ALT+F9

4.13.5 Maximize command (System menu)

Use this command to enlarge the active window to fill the available space.

Shortcut

Mouse: Click the maximize icon  on the title bar; or double-click the title bar.

Keys: CTRL+F10 enlarges a document window.

4.13.6 Next Window command (document Control menu)

Use this command to switch to the next open document window. XIS determines which window is next according to the order in which you opened the windows.

Shortcut

Keys: CTRL+F6

4.13.7 Previous Window command (document Control menu)

Use this command to switch to the previous open document window. XIS determines which window is previous according to the order in which you opened the windows.

Shortcut

Keys: SHIFT+CTRL+F6

4.13.8 Close command (Control menus)

Use this command to close the active window or dialog box.

Double-clicking a Control-menu box is the same as choosing the Close command.

Note: If multiple windows opened for a single document, the Close command on the document Control menu closes only one window at a time. All windows can be closed at once with the Close command on the File menu.

Shortcuts

Keys: CTRL+F4 closes a document window

ALT+F4 closes the current window or dialog box

4.13.9 Restore command (Control menu)

Use this command to return the active window to its size and position before you chose the Maximize or Minimize command.

4.13.10 Switch to command (application Control menu)

Use this command to display a list of all open applications. Use this "Task List" to switch to or close an application on the list.

Keys: CTRL+ESC

Dialog Box Options of the Switch command

Task List	The next application can be selected.
Switch To	Makes the selected application active.
End Task	Closes the selected application.
Cancel	Closes the Task List box.
Cascade	Arranges open applications as overlapped windows whereby the title bars are visible. This option has not effect on applications reduced to icons.
Tile	Arranges open applications into not overlapping windows. This option has no effect on applications reduced to icons.
Arrange Icons	Arranges the icons of all minimized applications across the bottom of the screen.

Table 26: Switch Command Dialog

4.14 Standard Dialogs

4.14.1 File Selection Dialog

This dialog shows all available data files stored on hard disk or loaded in the RAM. This dialog appears by the commands Link Offset Correction, Link Gain Correction and Link Pixel Correction.

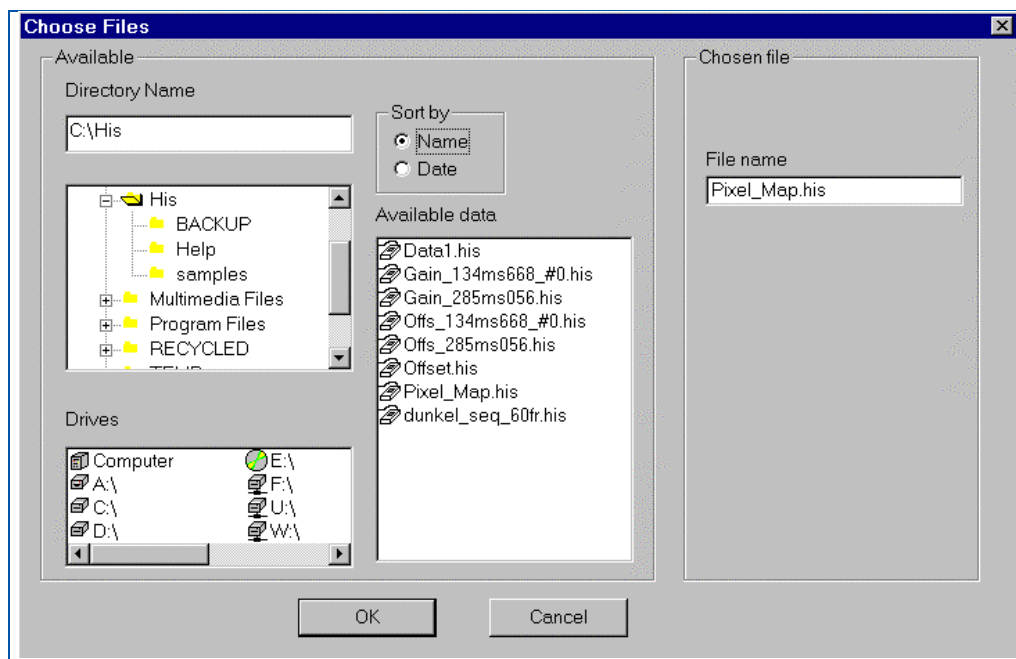


Figure 26: Choose File Dialog

The available group box shows all available drives, directories and files. The currently loaded data's are listed below the drive "computer".

By pressing one of the "sort" radio buttons one can influence the way the available data are sorted in the "available data" list box.

Double click the selected file from the "available data" box and the file will be displayed in the "Chosen file" box. The process will be executed by pressing the "Ok" button or the "enter" key

4.14.2 Overwrite data dialog

This dialog appears if new data has to be acquired into an unsaved window.

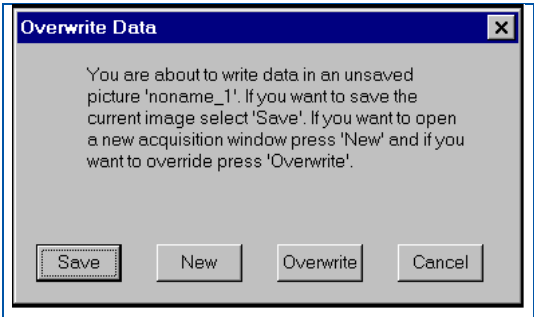


Figure 27: Overwrite Data Dialog

Save	Saves the current data and writes the new data in the window buffer
New	A dialog appears to define the new document type
Override	Overwrites the existing data without any saving
Cancel	Cancels the dialog

4.14.3 Choose Directory Dialog

This dialog appears if a directory has to be selected.

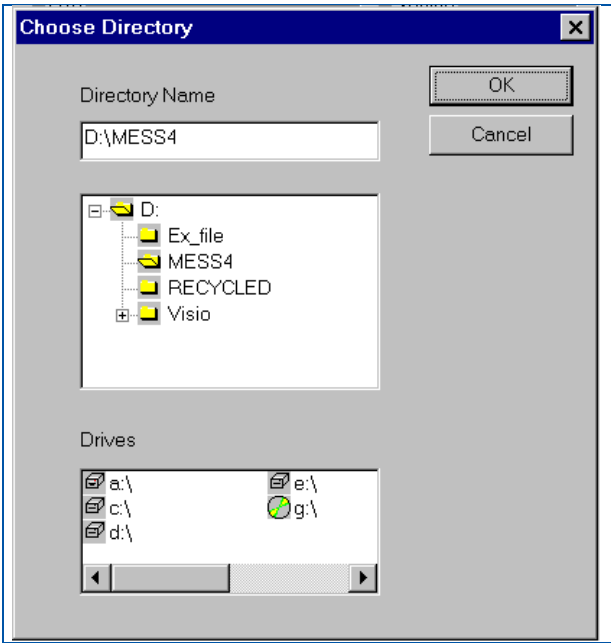


Figure 28: Choose Directory Dialog

directory name	This edit line specifies the selected directory. It's connected to a directory tree and all current available folders are listed.
drives	All current available drives are listed here. If a drive is selected the directory name and its directory tree is actualized.

5 Application

5.1 Mathematical Expressions

This dialog enables the easy input of mathematical expressions for image processing.

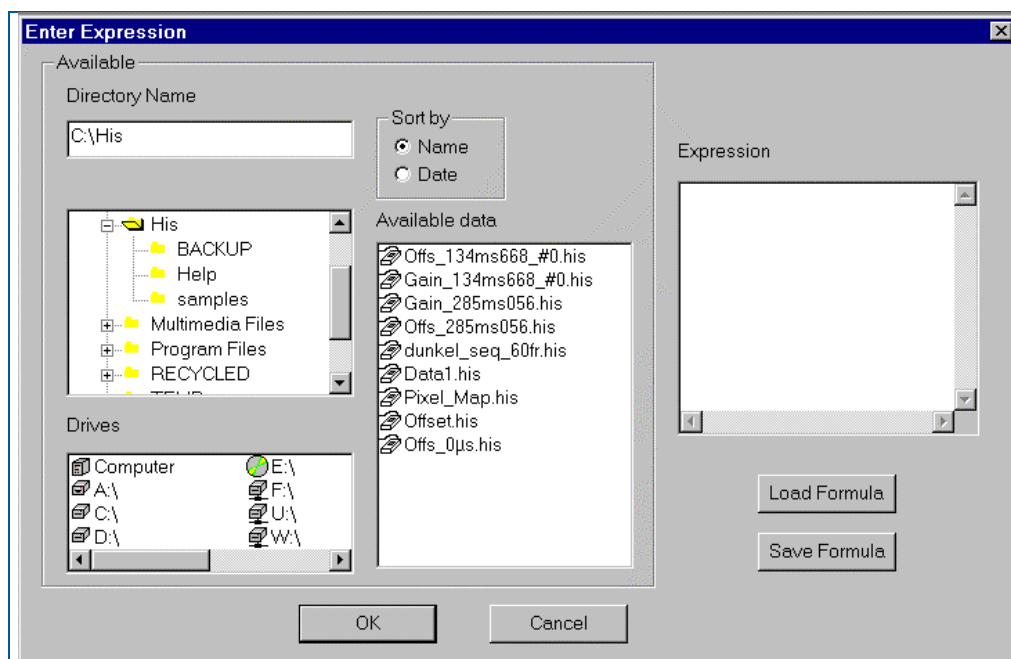


Figure 29: Mathematical Expressions Dialog

The available group box shows all available drives, directories and files. The currently loaded data's are listed below the drive "computer". To list stored images click on the items of the drive box and the entries of the above tree control displaying the directory structure.

By pressing one of the "sort" radio buttons one can influence the way the available data are sorted in the "available data" list box.

The mathematical expression can be added in the "Expression" edit box. Images can simply inserted by drag and drop files from the "available data" list to the edit box. The file name is inserted at the current cursor position. Soft line breaks can be set by pressing the "enter" key while holding the "Control" key.

Note: All file names need to have the extension "HIS" and symbols like "+" and "-" are not allowed in the file name.

5.1.1 Parsing expression:

Reserved symbols are:

+	Addition operator
-	Subtraction operator
*	Multiplication operator
/	Division operator
(open parentheses
)	close parentheses
=	Assign operator
...	dots used to specify a range of frames in a data sequence
[open square brackets to specify a range of frames in a data sequence
]	close square brackets to specify a range of frames in a data sequence
(USHORT)	cast operator, converts an arbitrary data type to the required data type (unsigned short)
SUM	summation function
AVG	Average function.
ABS	Absolute function

Table 27: Parsing symbols

+ operator:

If both operands are numbers the result is also a number. If one operand is a number and the other is an image then the number is added to every data entry. If both operands are images the data are added pixel by pixel.

- operator:

If both operands are numbers the result is also a number. If one operand is a number and the other is an image then the number is subtracted from every data entry. If both operands are images the data are subtracted pixel by pixel.

*** operator:**

If both operands are numbers the result is also a number. If one operand is a number and the other is an image then the number is multiplied with every data entry. If both operands are images the data are multiplied pixel by pixel. A matrix multiplication is not performed!!!

/ operator

If both operands are numbers the result is also a number. If one operand is a number and the other is an image then the number is divided by every data entry. If both operands are images the data are divided pixel by pixel. If a division by zero is recognized the parser returns with an error message.

= operator

If the result of an arithmetic expression is an image then this result has to be assigned to a result window.

For instance: `Dest.his = data1+40000`

is a valid expression. To the data entries of "data1" a value of "40000" is added and the result is written into "Dest.his".

The expression `Dest.his = 40000`

returns an error because the result is a number.

The expression `data1+50000-data2`

also causes a parse error because the result is an image and the assignment to a result window is absent.

(Type) (cast operator)

This operator converts an arbitrary data format into the required ones. Type can be one of the following words:

SHORT	signed 16 bit integer
USHORT	unsigned 16 bit integer
LONG	signed 32 bit integer
ULONG	unsigned 32 bit integer
DOUBLE	8 byte floating point number

Table 28: Type Operators

`Dest.his = (ULONG) (data1+data2/16-SUM(FRAMES, data5[2...4]))`

`[a...b]` operator (range operator)

Syntax: `Data.his[a...b]`

This operator returns a sequence of b-a frames extracted from the source sequence (here Data.his) starting at frame a and ending at frame b.

`Dest.his = data1[3...7]`

SUM function:

The sum function derives the sum of numbers, the sum of different images, the sum of rows or the sum of columns of different images. The entries in this function are separated by comma. The first parameter has to be one of keywords.

FRAMES	Derives the sum of different frames.
ROWS	Derives the sum of different rows. If the following arguments represent more then one frame, the result is a sequence of frames containing the summed rows of the frames.
COLUMNS	Derives the sum of different columns. If the following arguments represent more then one frame, the result is a sequence of frames containing the summed columns of frames.

Table 29: SUM - function parameters

If an entry is a sequence of several frames the sum of the sequence is evaluated and after that the resulting images are summed. Valid expressions are for instance:

```
Dest.his = SUM(FRAMES, data1[3...6], data2, 40000, -30000)
```

```
Dest.his = SUM(ROWS, data1[3...6], data2, 40000, -30000)
```

```
Dest.his = SUM(COLUMNS, data1[3...6], data2, 40000, -30000)
```

AVG function:

The average function derives the average of numbers as well as the average of different images or both. The entries in this function are separated by comma. If an entry is a sequence of several frames the average of the sequence is evaluated and after that the resulting images are averaged.

Valid expressions are for instance:

```
Dest.his = AVG(data1, data2, 40000, -30000)
```

ABS function:

The absolute function derives the absolute values of numbers or data entries. A valid expression is for instance:

```
Dest.his = ABS(data1)
```

General remarks:

All data or numbers are converted to floating point numbers before the expression is evaluated.

The result images contain floating point data (if not casted).

5.2 Image Correction

The X-Ray Detectors needs an Offset correction to take into account the dark current of each pixel. In particular, during the warm-up phase of the detector, the Offset is not stable and during this time period the detector use is not recommended. During operation it is recommended to refresh periodically the Offset.

Additionally, a Gain correction is necessary to homogenize differences in pixel sensitivities or to take into account the X-ray beam illumination; therefore it is very important that the whole image area is illuminated homogeneously. The Gain correction should be carried out in an optimum dynamic range of the sensor (70-80 % of the full scale range FSR) or in the dynamic range of interest. The radiation intensity used to create the gain image can depend on the application, e.g. if the typical grey level is about 10.000 ADU and the remaining area is saturated, it is recommended to use a gain image created at 10.000 ADU. The use of an Offset and Gain calibration eliminates offset dependency and therefore any stored Gain correction file can be used for a specific frame time for longer time periods.

The image performance can be enhanced by using the Multiple Gain Correction. For each dynamic range of interest a separate offset corrected and averaged gain image is used as an interpolation point. The maximum number of interpolation points depends on the installed computer memory and the **XRD FG[X][e] Opto** frame grabber can operate with up to 10 gain points (offset corrected bright images). It is important that each gain image is completely and homogeneously illuminated. The radiation intensity used to create the gain images can depend on the application, e.g. if the typical grey level is between 5.000 ADU and 10.000 ADU and the remaining area is saturated, it is recommended to use gain images created at 5.000 ADU, 10.000 ADU and 45.000 ADU.

The Pixel correction allows a 'software repair' of underperforming pixels to enhance image quality. Underperforming pixel values are replaced with the averaged value of the surrounding eight adjacent pixels where underperforming pixels are not used. The pixel correction is only performed on specific pixels, mapped in the file PXLMASK.HIS. The delivery package includes the PXLMASK.HIS file for the specific detector; the user can also generate their own correction file. Please be aware that the number of pixels used for the mean correction should be minimized. The pixel correction procedure requires CPU time (**XRD FG[e]** Frame Grabber / **GbIF**) and depending on its speed, a slower presentation of the acquired images on screen might occur in relation to the selected timing mode of the system. The main screen of the **XIS** software sends out a warning message displayed on the screen if all of the acquired images are not accepted by the computer.

All Corrections are very similar for the **XRD FG[e]/GbIF** and **XRD FG[X][e] Opto** Frame Grabbers. All procedures can be used in the same manner and the XRD driver will automatically select the software or hardware correction.

5.2.1 Use of the Offset Correction

The offset correction of images is recommended to eliminate the influence of pixel dark currents in the acquired image. To get an Offset correction file the following steps have to be performed:

1. Select the desired integration time, readout mode and gain setting.
2. Switch off the X-ray source so that the detector only transfers its "dark image".
3. Wait a few seconds until the detector achieves an equilibrium.
4. Start the Get Offset Image. / Start All Offset Images.
5. Select a number of frames.
It is recommended to use between 20 to 100 frame cycles which will be averaged. The averaged image is qualified as the new Offset Image of the selected frame time and automatically linked to later acquired images.
6. Control the new acquired image using the Options/View command and/or Brightness, Contrast or LUT range.
7. The Offset correction file can be saved if desired.
Note: A warning appears if the program is left without saving new acquired Offset correction files.

The Offset correction should be repeated periodically. In particular during the warming-up period of the system, the dark current of the pixels may change considerably.

To interrupt the procedure the <ESC> key can be used.

5.2.2 Use of the Gain/Offset Correction

The Gain/Offset correction of images is recommended to eliminate the influence of pixel sensitivities and influences of the used X-ray source in the acquired image. To get a Gain/Offset correction file the following steps have to be performed:

1. Select the desired integration time, readout mode and gain setting.
2. Acquire a new Offset correction image.
3. Switch on the X-Ray source and control the brightness of the acquired image in the desired read out settings. The detector's acquired intensity should be between 70-80 % of FSR or in the range of the ROI. The gain intensity depends on the application, but the whole image area should be illuminated homogenously.
4. Start Get Gain/Offset Image.
5. Select a number of frames.
It is recommended to use between 20 to 100 frame cycles which will be averaged. The averaged image is qualified as the new Gain/Offset Image of the selected frame time and automatically linked to later acquired images.
6. Control the new acquired image by using the Options/View command and/or Brightness, Contrast or LUT range.
7. Store the Offset correction file if desired.
Note: A warning appears if the program is left without saving new acquired Offset correction files.

To interrupt the procedure the <ESC> key can be used.

NOTE: The Gain image is automatically Offset corrected with the currently linked Offset correction file. To get best quality of the correction file, please perform a new Offset correction before starting Gain/Offset correction. If the number of averaged frames for the gain file is too small then the limited SNR is also limiting the SNR of the corrected image.

5.2.3 Use of the Multiple Gain Correction

The Multiple Gain Correction is recommended to eliminate the influence of pixel sensitivities and influences of the used X-ray source in the acquired image. To get a Multiple Gain Correction file the following steps have to be performed:

1. Select the desired integration time, readout mode and gain setting
2. Acquire a new Offset correction image.
3. Switch on the X-Ray source and control the brightness of the acquired image in the desired read out settings. The detector's acquired intensity should be in the range of the ROI. The whole image should be illuminated homogenously.
4. Start the Acquire Sequence.
5. Select a number of frames and the average mode.
It is recommended to use between 20 to 100 frame cycles which will be averaged.
6. Control the new acquired image by using the Options/View command and/or Brightness, Contrast or LUT range.
7. Store the Offset corrected bright image.
8. Repeat the steps 3-7 for each intensity of interest.
9. Create a Gain-Sequence with Acquire/Build Gain Sequence
10. Start a new acquisition.
11. Link the created Gain-Sequence file with Acquire/Link Gain Sequence
12. Store the Offset correction file if desired.

Note: A warning appears if the program is left without saving new acquired Offset correction files. If the number of averaged frames for the gain files is too small then the limited SNR is also limiting the SNR of the corrected image.

5.2.4 Use and generation of the Pixel Correction

The Pixel Correction of images is recommended to eliminate the influence of underperforming pixels of the detector in acquired images. To get a Pixel correction file the following steps have to be performed:

1. Select the desired integration time, readout mode and gain setting.
2. Link correction files (Offset, Gain).
3. Switch on the X-ray source and in the continuous mode, control the brightness of the acquired image. The detector's acquired intensity should be between 70-80 % of its maximum signal.
4. Start an image acquisition as for the Get Gain/Offset Image (no sample in front of the detector).
5. Control the new acquired image by using the Options/View command and/or Brightness, Contrast or LUT range.
6. The window should show a homogenous corrected image. Intensity deviations are a sign of not fully working pixels.
7. Change the x-ray source such that the intensity acquired by the detector should be about 50 % of its maximum signal.
8. Go to Select by Value in the Edit Menu.
9. Enter desired range of good pixels (e.g. 15000-45000 out of 0-65535).
10. Select "Out of range" button. (All selected pixels are marked.)
You can also select pixels using "strg+ LeftMouseButton".
11. Call Create Pixel Map in the Edit Menu.
12. The Pixel Map is created and can be stored as new PXLMASK.HIS.

NOTE: The new PXLMASK.HIS is automatically linked to new acquisitions and the acquired start-up image (see 4.) is also corrected. Beware that each binning mode requires an individual PixelMask.

5.2.5 Correct already acquired images

It is possible to correct already acquired uncorrected images. Select the desired image by the Window Command and use one of the Link Commands (Link Offset Correction, Link Gain Correction, Link Gain Sequence Correction or Link Pixel Correction). The active image is automatically corrected.

These settings are also used for the next acquisitions.

NOTE: It is not recommended to close linked correction files during a running acquisition. This can lead in a closing application.

5.3 Acquisition Control Modes

Five different acquisition control modes are available. The **Free Running** mode is the default mode which means that the detector sends out continuously frames according to the selected frame time. The **External Trigger** mode means that the detector sends out a frame after triggering by an external pulse and ignores all other incoming trigger pulse until the selected frame time has elapsed. After that the detector can be triggered by a new pulse. Details of the trigger pulse are described in the chapter External Trigger. The third mode is the **Internal Trigger** mode. In this case a fixed pulse frequency between the fasted free running mode of the detector and 5 seconds in steps of 1µs can be selected. These pulses are send via frame grabber board to the detector or , in case a GigE detector is used, generated in the detector using the internal clock.

The fourth mode is the **Soft Trigger** mode. In this case one single pulse is send from the workstation to the detector generated by software via Network/Optical/HIIB I/F. The fifth mode is the **Auto Trigger** mode (only available with the XRpad detectors series). In this mode the detector acquires an image when a defined exposure level is reached.

The control mode can be selected in the submenu **Mode** and the integration time can be selected in the submenu **Timings** of the menu **Detector**. The selected integration time and mode are marked by a check mark on the right side of these items. The trigger pulse can be send as well to the PC frame grabber boards **XRD FG[e]** and **XRD FG[X][e] Opto** as to the detector (see: External Trigger) or the Interface Power Unit (XRpad IPU).

The trigger modes are recommended if a pulsed x-ray source is used. If the x-ray pulse appears during the readout time of the detector the information are split into two frames. Also if these

frames are summarized there could be artifacts which are not correctable. The trigger mode realizes an expose during the delay of the readout structure.

To start external triggering the following steps have to be performed:

1. Connect the trigger cable with the detector or with the frame grabber board
2. Power on the detector
3. Startup **XIS**
4. Select an initialization of the detector (Interrupt or Polling Mode)
5. Select the desired integration time (Timing Menu)
6. Select the **External Trigger** Mode
7. Link adequate correction image (Offset, Gain/Offset and PixelMask) for the current detector settings (Timing/Gain/Binning).
8. Send trigger pulses
9. Start the desired acquisition mode (Continuous or Sequence)
10. Send trigger pulses

In case of internal triggering the steps are similar to the free running mode. To start the internal trigger mode the mode has to be selected and the frequency has to be inserted in the appearing dialog. After that the detector sends out frames in the desired frequency and the frames can be acquired continuously, in a sequence or as a single shot.

Note: In the external trigger mode the detector is waiting for a new acquisition until the trigger pulse is sent. During the desired frame time a new trigger pulse has no effect. The correction files have to be created with the same frequency of trigger pulses for best results.

Example: If the detector is set to the integration time 400ms and the trigger pulse is sending every 200ms, the detector nevertheless runs with ≥ 400 ms. But if the pulse appears every 450ms the detector runs with 450ms. The selected integration time should always be below the desired period time of the trigger pulse frequency. The lower limit is the shortest free running timing (Timing 0) which can be selected.

5.4 Warning table by using the detector and its status

Warning: You are losing frames

Based on CPU speed and used correction mode, the monitor cannot present all received images from the detector.

=> Change to a longer integration time per frame or use less on-line corrections.

Black or white value out of range

If the user selects values out of the allowed range of 0 - 65535 digits. This is not allowed.

Board initialization failed

Starting the software, the detector could not be initialized.

=> Check power cords and interface cables and restart Acquisition in the Options menu.

Board initialization successful

The I/O board was successfully initialized, continue with Acquiring images.

Not all functions available

This message appears if no detector or no I/O board can be detected. The XIS software can be used for image presentation of stored images and further processing of these images.

In the manual initialization of the detector some additional features are also not available.

Acquisition done

This message appears if a started acquisition of images is done. The user can continue using further XIS commands.

Ready

This message appears if one of XIS commands is done. The user can continue using further XIS commands.

6 Details for the Hardware

6.1 Readout schema

This section describes the different readout and trigger modes. Not all modes are available for each detector. Please refer to the corresponding model Reference Manual for more details.

6.1.1 Free Running

Generally the detector is in free running mode after powering up. The detector will automatically perform in its fastest full resolution in timing T0 and continuously scan the images. The other available timings T1 up to T7 differ from T0 in an increased time in between frames to artificially reduce the frame rate and to extend the integration time.

For example the first timing (Timing 0) of the XRD0820 detector needs a minimum of 132.977 ms for one frame. This means that each pixel is read out every 132.977 ms. During this time the pixel collects radiation. The longer timings (Timing 1-7) consist of a readout followed by a delay. The delay time is the time of the selected integration time minus the time of the first timing (Timing 0). As an example the timing two of the XRD0820 is 199.708 ms, this means the first 132.977 ms stand for the readout of the detector. The following 66.731 ms is an additional delay in which the detector is only integrating radiation.

Some detector versions have different row types for the timings (1-7) to enhance the image quality at lower speed. For more details concerning the different readout timings see the detector manual.

The integration time of one frame for each timing can read out with the function

Acquisition_GetIntTimes. To realize a delay using the fastest readout the internal trigger mode can be used with a frame time of the selected timing plus delay time. For more details see the paragraph Internal Trigger.

Note: If a pulsed x-ray source is used it is recommended to expose during the delay of the detector. If the x-ray pulse appears during the readout time the information is split into two frames. Also if these frames are summarized there could be artifacts which are not correctable. To realize an exposure during the delay the detector allows the triggering of the x-ray source and the detector itself.

6.1.2 External Trigger

Triggering the detector is the attempt to synchronise the detector to other devices e.g. x-ray sources having their specific schemes of radiating x-ray pulses. The default trigger mode is the frame wise which means that the detector sends a frame after triggering by an external pulse and ignores all other incoming pulses until the selected frame time has elapsed. After that the detector can be triggered by a new pulse. Other available modes are DDD and Start/Stop which are described in the next chapter.

In order to trigger the detector a 20µs wide low active trigger pulse has to be transmitted to the device. The trigger signal has to be generated externally and can then be connected to either pin one of the 7-pin round connector (/TRIG_IN) located directly at the detector device or connected to the sub-click located on the rear side of the **XRD-FG** (/TRIG_IN converted to RS422 signal as /FR_SYNC) respectively the D-Sub connector of the **XRD-FG[X][e][Opto]** (/TRIG_IN as LVDS signal converted to /FR_SYNC). (For connector details refer to 6.1.8)

Trigger pulses are accepted from both sources. Prior to this the detector has to be set per command into the external trigger mode. The waveform of the trigger pulse as shown in chapter 'Trigger-modes' describes the triggering mode on a frame by frame base. The period of the trigger waveform determines the integration time.

6.1.3 Internal Trigger

The internal trigger mode works similar to the external trigger mode and is also triggering the detector on a frame by frame basis which means that the detector sends a frame after it has been triggered by a trigger pulse and ignores all other incoming pulses until the selected frame time has elapsed. After that the detector can be triggered by a new pulse.

The trigger pulse is either delivered by the frame grabber or generated by an internal clock. It is a fixed integration time between the fastest free running mode of the detector and 5 seconds in steps of 1µs.

Note: Due to internal processing the start of a frame after the trigger pulse was recognized can jitter $\sim 2\mu\text{s}$.

6.1.3.1 How to use the internal trigger mode

The following method describes how the internal trigger can be used to implement different integration times or to use one of the readout schemes with a customized delay. If the interface is connected and the power is switched on, the detector runs in the first free running mode. To use the internal trigger mode the following steps have to be performed:

1. The detector has to be set to the desired readout time using the Timings menu
XISL: Acquisition_SetCameraMode(hAcqDesc, 0.7)
 -> The detector runs continuously (free running) in the desired timing and readout scheme.
2. The detector has to be set to the internal trigger mode using the Detector Mode menu
XISL: Acquisition_SetFrameSyncMode(hAcqDesc, HIS_SYNCMODE_INTERNAL_TIMER).
 -> The detector aborts the current frame and waits for a trigger signal.
 -> The shortest repeat time of an trigger pulse is the selected timing (readout time).
3. Select the frame rate (readout plus delay time) in the appearing dialog (readout time ... 5s).
XISL: Acquisition_SetTimerSync(hAcqDesc, integration_time).
 The frame grabber sends the /FR_SYNC signal directly via the HIIB/Optical Link to the detector in the selected integration time or generates an internal signal in the selected integration time (GigE Detectors).
 -> The detector runs "continuously" with the selected integration time.
4. Start the acquisition
XISL: Acquisition_AcquireImage(hAcqDesc, frames, ...)
 -> The frame grabber grabs the data into the memory.

6.1.4 Software Trigger

The software trigger mode works similar to the external trigger mode. The Software sends a Trigger Signal to the detector which will start a readout on base of the selected trigger mode (Framewise, DDD, Start/Stop, Auto).

6.1.5 Auto Trigger

The AutoTrigger mode also called **Auto Exposure Detection (AED)** is a unique acquisition mode as it detects the presence of applied x-rays by itself. Upon detection of an x-ray exposure the firmware halts the XRpad for a predefined time to allow for a longer x-ray exposure interval and then resumes operation deriving the image. After acquiring an image the detector returns into the condition where it checks for the next x-ray exposure. Thus it is possible to acquire multiple images.

It is also permissible to use the Auto-Trigger as acquisition mode and to select any other trigger source i.e. the soft trigger to trigger the firmware in absence of real x-rays in order to artificially retrieve an image for offset correction.

In order to invoke the Auto-Trigger the Auto-Trigger needs to be selected as acquisition mode and secondly the signal that is generated when x-rays are detected needs to be selected as trigger source, similarly as selecting any other trigger source to artificially trigger the firmware.

Note: After finishing the image or image sequence it is mandatory to switch back into the free running mode to reduce power dissipation and improve the battery lifetime.

6.1.6 Trigger-modes

6.1.6.1 Frame-wise (default)

This is the most general trigger mode. Once the detector has been set to trigger mode the detector will synchronize to trigger events and perform a complete detector scan and transmit one image. This is a frame wise trigger mode which allows the operator to take control of the integration time of the detector. Trigger events during the scan process are ignored. Thus the shortest possible integration is ideally equivalent to the integration time of the fastest mode in free running.

6.1.6.2 Data Delivered on Demand triggered mode

Trigger with DDD mode is available for detectors with HeaderID 14 and CameraType >2

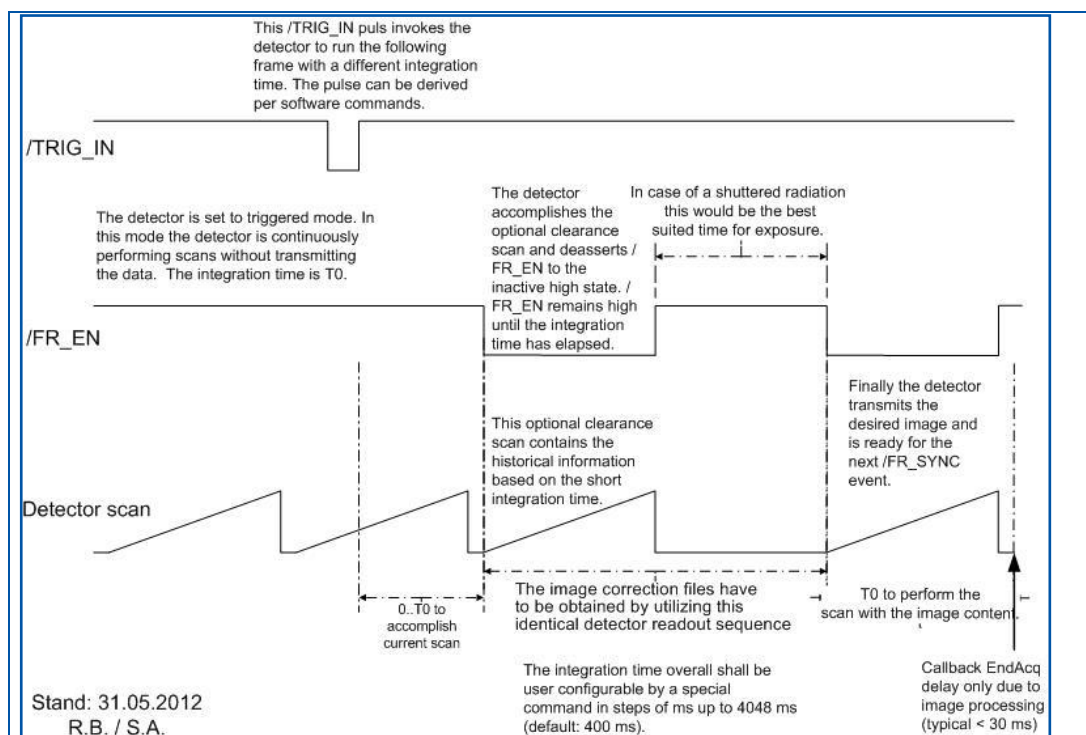


Figure 30: timing diagram for 'Data Delivered on Demand' triggered mode

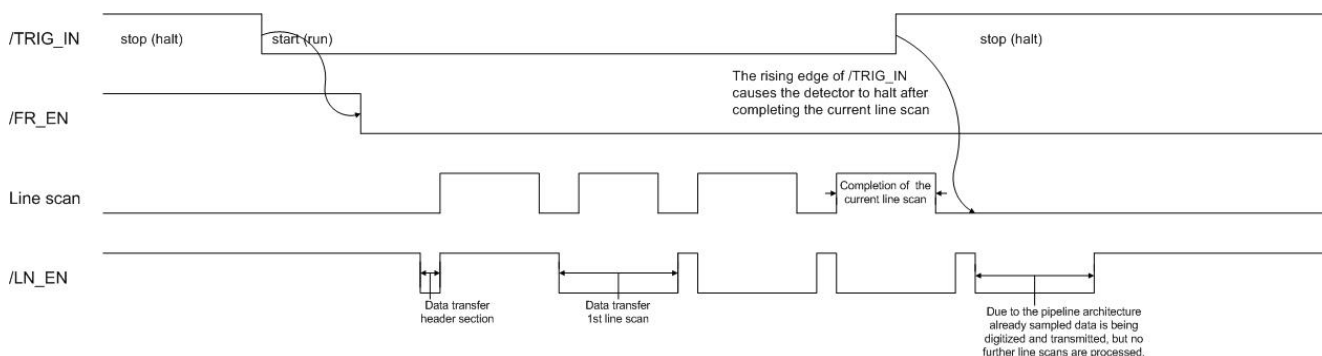
The detector is running in a "silent" mode, like free running mode but without transferring image data. If the user application (Software, Frame Grabber or external Source) sends a triggers signal to the detector, the detector accomplishes the current frame. The next frame (clearance scan) is processed also with the fastest integration time. After that the detector waits until a customer defined time has elapsed (delay time). In this time gap the detector shall be exposed in case of pulsed or shuttered radiation. After the delay time the detector performs the image scan and transfers the desired data. After this the detector returns to the silent mode until the next trigger pulse is sent.

Note: If desired, the transmission of the clearance scan can be skipped. For that chose Trigger mode 1 with `Acquisition_SetCameraTriggerMode(..)`. In this mode xx22 / 1642 Detectors skip the read out and the transmission of the clearance scan.

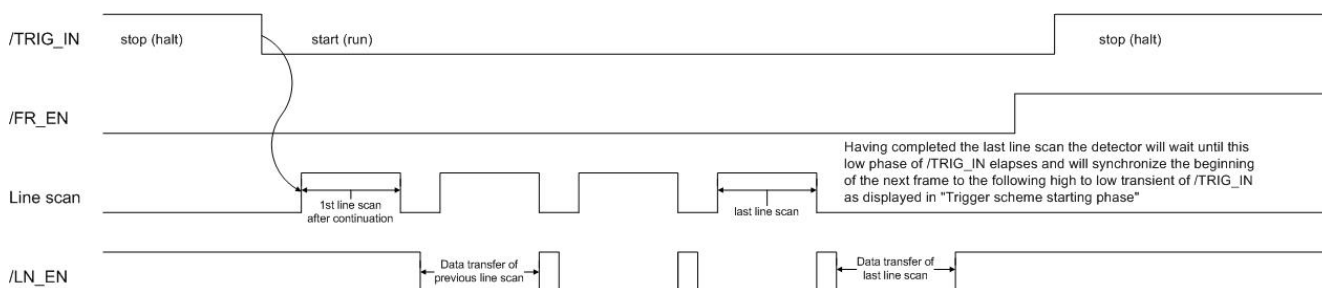
6.1.6.3 Start/Stop trigger-mode

One approach to use the detector in conjunction with pulsed x-ray sources is the start/stop trigger mode. It provides the possibility to improve the detector performance by synchronizing the detector operation to the pulses on a line or a group of line scans per trigger event basis. It is the attempt to fit a suitable amount of line scans in between consecutive pulses. The goal is to achieve good detector performance by doing offset- and gain corrections in a highly synchronized manner on a line by line basis

At first the detector is on halt and is waiting for the /TRIG_IN signal to transition to the active low state. Once this has happened there will be a delay based on internal processing of preceding lines until eventually the first real image line scan occurs. Due to the pipeline architecture of the detector it takes another cycle until the first digital converted data can be transmitted to the computer host system.



The detector will continue consecutive line scans until the /TRIG_IN signal is released again. Upon this the detector will complete the current scan activity and change to halt mode. The already sampled data will nevertheless be digitized and transmitted. The detector will reside in halt mode until the next transition of the /TRIG_IN signal to the low state which is described in the following picture:



Towards the end of the image acquisition when having the last scan line completed the detector will wait until /TRIG_IN gets released and will resynchronise the beginning of the next frame to a new trigger sequence. This prevents static image distortions to scroll through sequences of images giving a chance to offset and gain correct.

It is the user's task to provide the run / stop signal as /TRIG_IN taking into consideration that the system has a latency of up to a row (line) read time to go into halt. In order to achieve less image distortion it is important to keep the stop phase as short as possible.

6.1.6.4 Auto Trigger

Please refer to 6.1.5

6.1.7 Trig Out Options

The trigger output signal, of the detectors trigger connector can be driven by multiple sources. Please refer to the detector manual whether the detector type you have attached can switch the TriggerOut Source.

These options can be set using the library function `Acquisition_SetTriggerOutSignalOption`. All XRD 0820 AN, XRD 1620 AN, XRD 1621 AN, XRD xx22 AO/AP, 1642, XRpad[2] and XRD 4343 detectors support the function.

This is the complete listing of available Trigger Output Signal assignments:

- 0: FRM_EN_PWM (default)
- 1: FRM_EN_PWM_INV
- 2: EP (Exposure Pulse)
- 3: EP_INV
- 4: DDD_PULSE
- 5: DDD_PULSE_INV
- 6: GND
- 7: VCC

Independent from the operating mode the trigger output selections 0, 1, 2, 3, 6 and 7 are available. The selection 4, the DDD_PULSE is constantly low during free running mode and the option 5 is accordingly constantly high. The DDD_PULSE will only lead a signal in triggered mode.

Note: The detector must not be used in a situation where it controls the X-ray dose delivered to the patient.

Note: The trigger signals from the detector must not be the sole activation means for X-ray delivery, and must be used in association with other control inputs: for example, a hand switch, safety interlocks, and a means of controlling the beam duration

6.1.7.1 Framewise /TrigOut Option

By default the frame enable signal /FR_EN is attached to the output. The nature of this signal is that it transitions to the low state as soon as the scanning of the image starts. And as soon as the image is finished it toggles back to the high state. So the high state is an indicator when the panel is not actively being scanned which is a good timing to do the x-ray exposure. The good thing about this output signal is that its high pulse width automatically modulates – gets extended – with the increase of the time in between frames when going to slower frame rates or when triggering the camera.

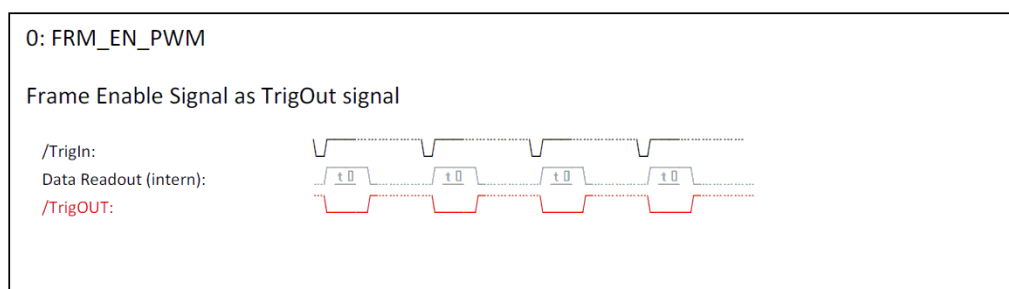


Figure 31: /Trig Out Option 0: 'Framewise'

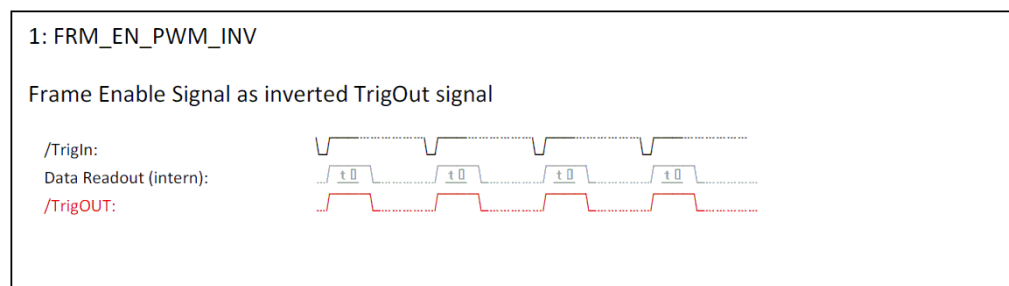


Figure 32: /Trig Out Option 1: 'Framewise, signal inverted'

6.1.7.2 Exposure Pulse /TrigOut Option

Using the Exposure Pulse /TrigOut option one is capable to expose certain subsequent images within a sequence. By defining the length of this sequence this behaviour will be continuously repeated every *cnt* images. The parameter *i1* and *i2* define which subsequent images are considered for triggering, the length of the /TrigOut edge itself can be adjusted by *d1* and *d2* ($length=d2-d1$). Figure 33 shows the general flow of the 'Exposure Pulse' option, Table 30 describes the individual parameters in detail.

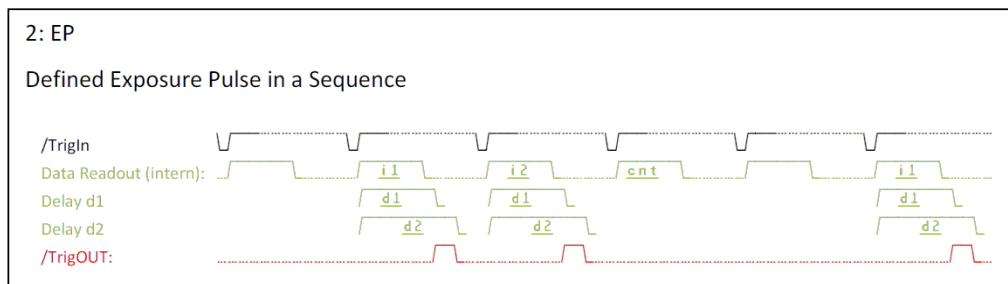


Figure 33: /Trig Out Option 2: 'Exposure Pulse'

Parameter	Description
cnt	The total number of frames of the sequence to be repeated (here: cnt=4)
i1	Index for the first frame within the sequence a trigger out pulse shall be fired (zero-based). (here: i1=1)
i2	Index for the last image within the sequence a trigger out pulse shall be fired. Thus, every frame between <i>i1</i> and <i>i2</i> incl involves a /TrigOut (zero-based). (here: i2=2)
d1	Delay [in ms] from the begin of a frame that shall be exposed until the trigger out is activated. The delay can be counted from the rising or from the falling edge of the /TrigIn signal. It can be set within the XIS dialog (Menu entry Options->Detector Options->Select /TriggerOut Signal) or using the API function Acquisition_SetTriggerOutSignalOptions)
d2	Delay [in ms] from the begin of a frame that shall be exposed until the trigger out is deactivated. The delay can be counted from the rising or from the falling edge of the /TrigIn signal. It can be set within the XIS dialog (Menu entry Options->Detector Options->Select /TriggerOut Signal) or using the API function Acquisition_SetTriggerOutSignalOptions)

Table 30: Parameters for 'Exposure Pulse /Trig Out' Option

Note that this option can also be applied in free running mode. In that case the /TrigIn pulse in Figure 33 would be the begin of frame having the selected integration time.

Furthermore there is the possibility to invert the /TrigOut signal:

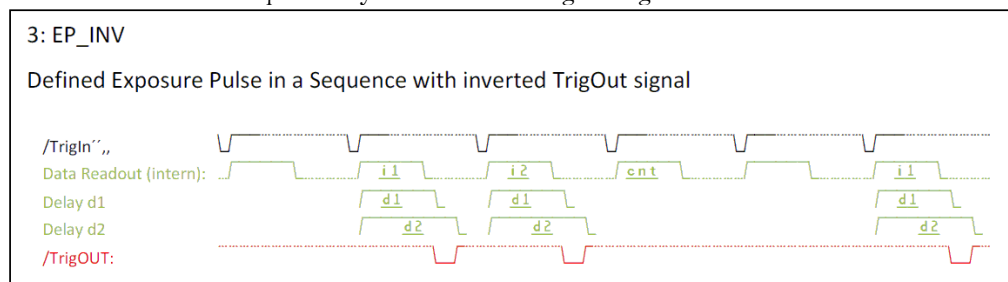


Figure 34: /Trig Out Option 3: 'Exposure Pulse inverted'

6.1.7.3 DDD /TrigOut Option

The detector is running in a “silent” triggered mode, as if in free running mode T0 but without transferring the image data. Eventually the user application triggers the detector. The detector accomplishes the current frame. At the end of the next frame a predefined pause is added allowing the user to radiate the image. A pulse indicating this pause is available at the trigger output. After this pause the detector performs the final image scan and returns to the silent mode. The duration of this pulse is per default set to 400 ms. The DDD Triggerout Option is suggested to be used also in autotrigger-mode

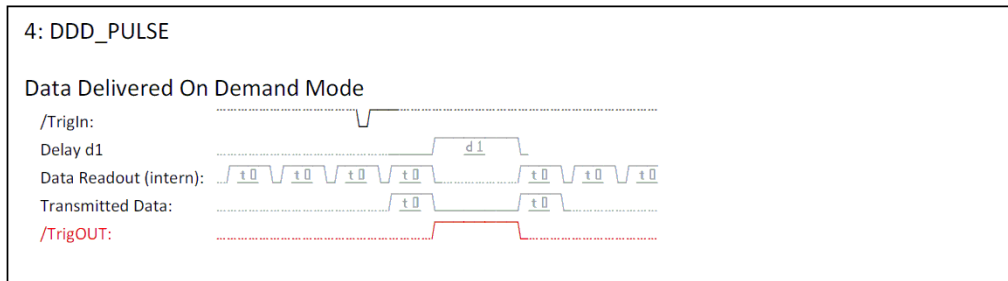


Figure 35: /Trig Out Option 4: ‘Data Delivered On Demand’

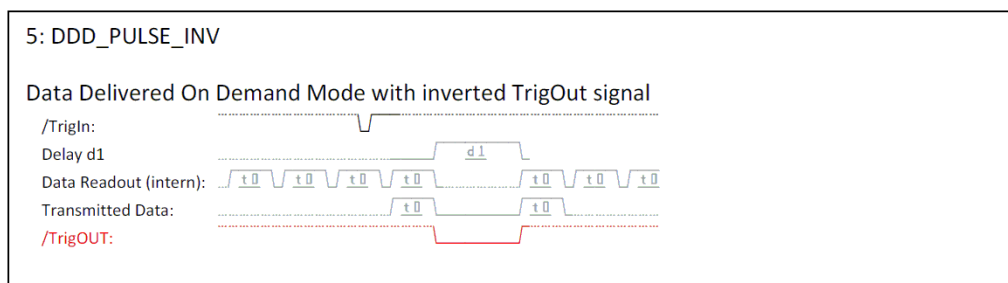


Figure 36: /Trig Out Option 5: ‘Data Delivered On Demand inverted’

6.1.7.4 Constant Trigger Output /TrigOut Option

In case no detector-generated TrigOut signal is required, it might be desired to select the state of the output signal being a constant high or constant low. This can be set by the TrigOut options 6 and 7, respectively.

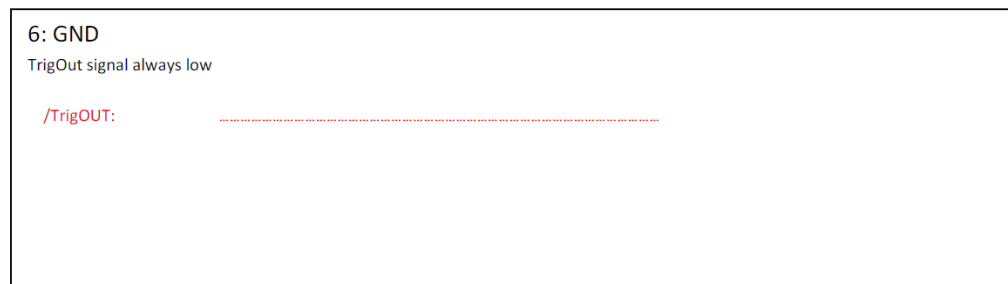


Figure 37: /Trig Out Option 6: ‘TrigOut signal on low edge’

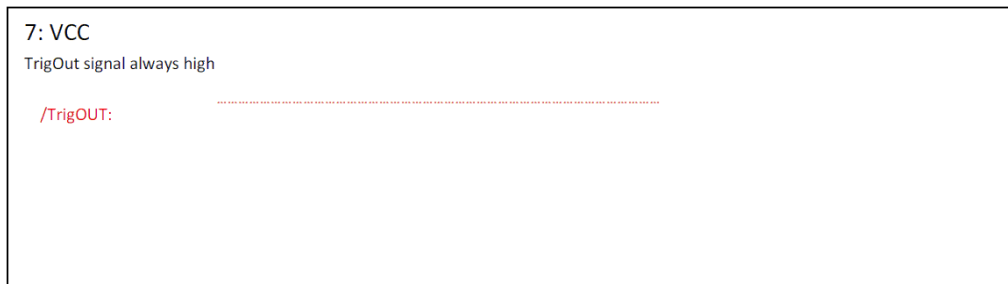


Figure 38: /Trig Out Option 7: 'TrigOut signal on high edge'

6.1.8 External trigger inputs/outputs

The /TRIG IN, /TRIG OUT, /LN_EN and /FR_EN signals are low active /TTL signals for the XRD 512-400, XRD 1640 AL/AG, XRD 0822, 1622, XRD 4343 detectors and all detectors with the suffix TS.

XRD 08x0 and XRD 16xx detectors provide LVDS Signals. These signals are described in the Table 31. Detailed descriptions of the trigger ports are in the detector manuals.

/FR_ENB	indicates a new frame (detector output)
/FR_SYNC	frame synchronization signal, generated by the frame grabber to externally control the frame rate (detector input)
/LN_ENB	indicates a new line (detector output)
/TRIG_IN	External trigger signal to synchronize the frame rate (detector input)
/TRIG_OUT	The /TRIG_OUT signal indicates the start of a new frame and can be used to synchronise the x-ray source (detector output)

Table 31: Description of the trigger input/output signals

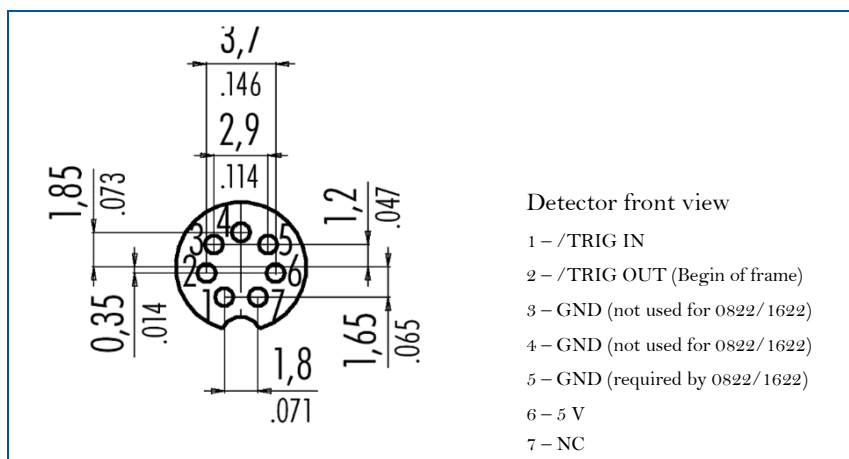


Figure 39 External Trigger inputs/outputs of the XRD 512-400, XRD 1640 AL/AG, XRD 0822 and XRD 1622 detector series

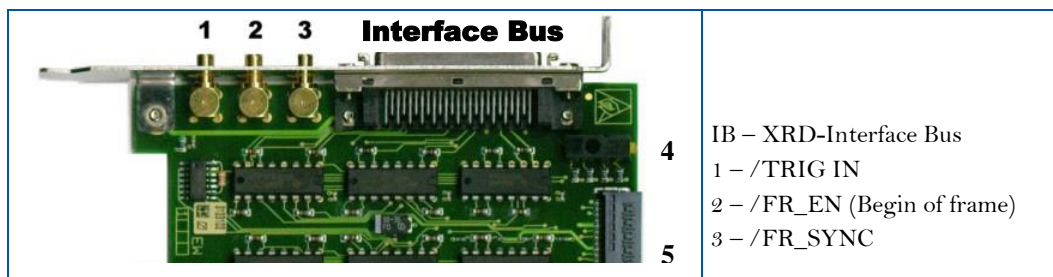


Figure 40: External Trigger inputs/outputs of the XRD-FG Frame Grabber (TTL signals)

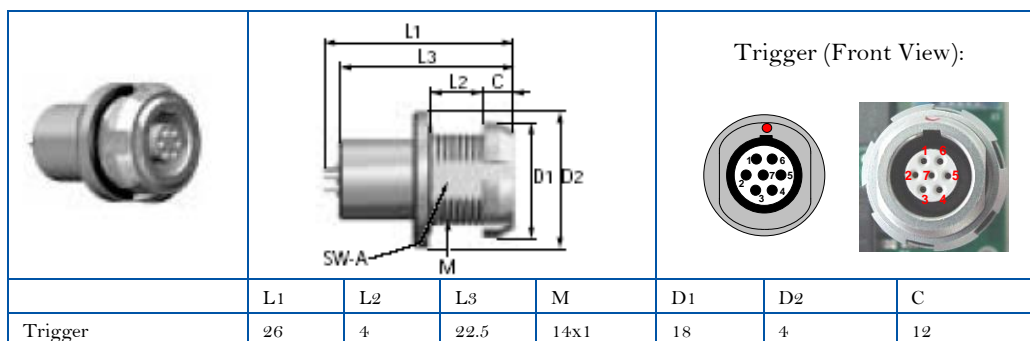


Figure 41: Trigger inputs/outputs of the XRD 08xx yN and XRD 16xx yN detectors

PIN	Colour	Connection
1	Black	TRIGIN_+
2	Brown	TRIG_IN_-
3	Red	TRIGOUT_+
4	Orange	TRIGOUT_-
5	Yellow	FGND
6	Blue	5PF
7	Magenta	

Table 32: PIN assignment of Trigger signal for the XRD 08xx yN and XRD 16xx yN detectors (LVDS Signals)

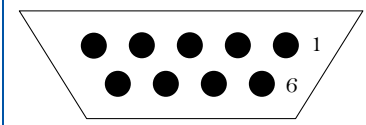
	PIN	DESCRIPTION	
	1	GP_OUT0+	frame enable
	2	GP_OUT1+	frame sync
	3	GP_IN0+	trigger in
	4	GP_IN1+	na
	5	GND	
	6	GP_OUT0-	frame enable
	7	GP_OUT1-	frame sync
	8	GP_IN0-	trigger in
	9	GP_IN1-	Na

Table 33: LVDS connector Pin assignment (GP_** use LVDS signaling standard) XRD FG[X][e] Opto

6.1.9 XRpad trigger inputs/outputs

The XRpad provide no trigger connectors. Please use the “Interface Power Unit” to connect external trigger signals to the detector as described in the corresponding XRpad model Reference Manual or use the software trigger function.

6.2 Sectional Readout

This paragraph describes the Sectional Readout which is available for detectors with Cameratype 10 and 12. With this function predefined sections of the detector field of view can be selected and combined to one adjacent readout Section. Each of the four sections has a size of 1024 columns and 255 rows (XRD 0822 xP) respectively 128 Rows (XRD 1642 xP).

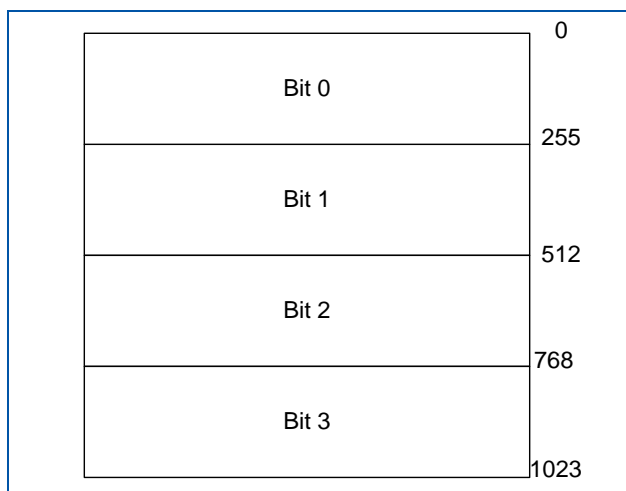


Figure 42 Scheme of the ROI sections XRD 0822 xP

The reduced amount of data according to the selected ROI results in an enhancement of acquisition speed. However, when the Sectional Readout is used the x-ray beam should be collimated to the selected ROI.

Location and size of the region can be set bitwise with the API function Acquisition_SetCameraROI.

Within the XIS application these values can be set within the dialog 'Select ROI'. This dialog is called by selecting the menu entries **Options/Detector Options/Select Region of Interest (ROI)**.

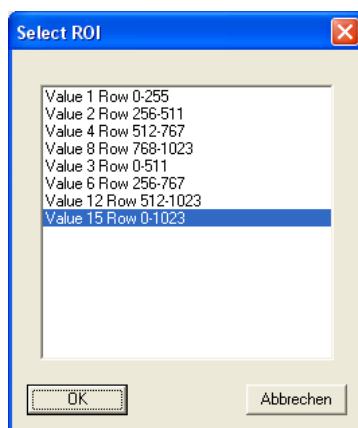


Figure 43 Select Region of Interest dialog (0822AP)

6.3 Field of View

XRD 4343RF detectors provide the functionality of reading and transferring a selected field of view which is a predefined section of the full image. This is available in binned and non binned mode which reduces the data rate and increases the readout speed (fps). Please refer to the detector manual for detailed information. The field of view can be selected by the adequate api function call.

6.4 How to use the detector gain setting

This paragraph describes the change of the detector gain. The **x-ray** detectors are supporting different gain settings depending on the detector type (Details in the corresponding Detector Reference Manual). When the detector is powered on the X-ray detectors starts with the Detector specific default capacity (e.g. 1pF) . The detector gain can be set by the **XIS** dialog **Options/Detector Options** or by the library function `Acquisition_SetCameraGain(hAcqDesc, 1..5)`. It is very important for the image quality that the correction files were obtained in the same gain setting as in the current working operating mode.

6.5 How to use the detector binning setting

This paragraph describes the change of the detector binning modes. The **X-Ray detectors** are supporting different binning mode settings depending on the detector type (Details in the corresponding Detector Reference Manual). When the detector is powered on it runs without binning (default mode). The detector binning will be set by the **XIS** dialog **Options/Detector Options** or by the library function `Acquisition_SetCameraBinningMode(..)`.

Note: It is very important for the image quality that the correction files are obtained in the same binning mode, gain setting and integration time as for the measurements.

Also be aware that the active mode is always a combination of the actual mode plus the value for averaged or accumulated binning e.g. No binning + Averaged has the value $1 + 256 = 257$. This option is not available for all detector types.

Active bits	Value	Binning mode
0	1	No binning
1	2	2 x 2 binning (averaged or accumulated)
0 + 1	3	4 x 4 binning (averaged or accumulated) 3x3 binning (averaged or accumulated) for 4343RF
2	4	1 x 2 binning (only accumulated binning)
2 + 1	5	1 x 4 binning (only accumulated binning)
8	256	Averaged binning
9	512	Accumulated binning

Table 34: Overview of the detector binning modes

6.6 XIS File format

Each pixel is digitized in 16 bit resolution (2 byte information) and saved as 16 bit unsigned integer for acquired frames. Gain images are stored as unsigned 32 bit integers and there are also double precision floating point data (8 byte) representations supported by the software. All data can be signed or unsigned in general. The data are preceded by a file header of 68 byte and an image header of 32 byte respectively 2048bytes for onboard stored and correction files for XRpad2,. If we consider a sequence of n images acquired by a 512x512 detector we get the file sizes listed in the table below:

File		Single Image		Sequence	
Header		68	byte	68	byte
Image Header (HeaderVersion 100)		32	byte	32	byte
Image Header (XRpad2 onboard) (HeaderVersion 101)		2048	byte	2048	byte
Image Data	512x512x2 byte	524288	byte	524288	byte * n

Table 35: Single image and file sequence format

The **file header** allows the reading of the data by any other software module and has the following description:

Information	Description
File header	68 byte
WORD FileType	// File ID (0x7000)
WORD HeaderSize	// Size of this file header in bytes
WORD HeaderVersion	// 100 traditional his file header and header version use to store images in XIS // 101 file header to be used for onboard corrections and used for autosave images on XRpad2 using 2048Bytes image Header
ULONG FileSize	// Size of the whole file in bytes
WORD ImageHeaderSize	// Size of the image header in bytes
WORD ULX, ULY, BRX, BRY	// bounding rectangle of the image
WORD NrOfFrames	// number of frames
WORD Correction	// 0 = none, 1 = Offset, 2 = Offset+Gain
double IntegrationTime	// frame time in microseconds
WORD TypeOfNumbers	// short, long integer, double, signed/unsigned, inverted, fault map, Offset/Gain correction data, pixel correction data
BYTE x[WINRESTSIZE]	// fill up to 68 byte

Table 36: File header description

The file header has a size of 68 byte. It consists of several entries to describe the organization of the stored data. Most of the entries are self-explanatory except the TypeOfNumbers entry, which can have any combination (OR) of the following values:

Fault Map	1 (to be OR-ed with 32)
64 bit double precision floating point number	2
16 bit integer	4
data is signed	8
Pixelmap for onboard correctionon XRpad2 detectors (1bit per Pixel)	16
32 bit integer	32

Table 37: Type of Data

One can get the values of the bounding rectangle by ULX, ULY, BRX, BRY. The number of rows and columns results from the formula:

$$\text{rows} = \text{BRY} - \text{ULY} + 1$$

$$\text{columns} = \text{BRX} - \text{ULX} + 1$$

6.7 Description of Hardware Header

The hardware header is transferred by the detector at initialization time of the frame grabber board and at the end of acquisition time.

For a detailed description of the Hardware-Header refer to the document 89695_XISL_API_Description.

To get all Timings use the Acquisition_GetIntTimes(..)-function while Detector is in FreeRunning-Mode.

6.8 Row types

The following pages describe the available row read out schemes and the corresponding value of RowType (see Hardware Header).

All time values are given in microseconds. In sync mode the timer of the first row starts at synchronization time with a possible time tolerance of 32 nanoseconds. The trigger input is low active. The minimal pulse duration is 1 microsecond and the trigger event is done at the rising edge. This table is obsolete for the latest detector generations (Header ID > 10).

RowType	Row time
0	300
1	300
2	312.5
3	390.625
4	781.25
5	310
6	387.5
7	781.25
8	2500
9	524.0
10	524.0
11	310.0
12	3333
14	2500
15	2500
16	2500
17	2500
18	1536
19	261.0
20	472.0
21	315.9
22	945.0
23	630.0
24	264.0
25	528.0
26	266.0
27	796.0
28	524.0

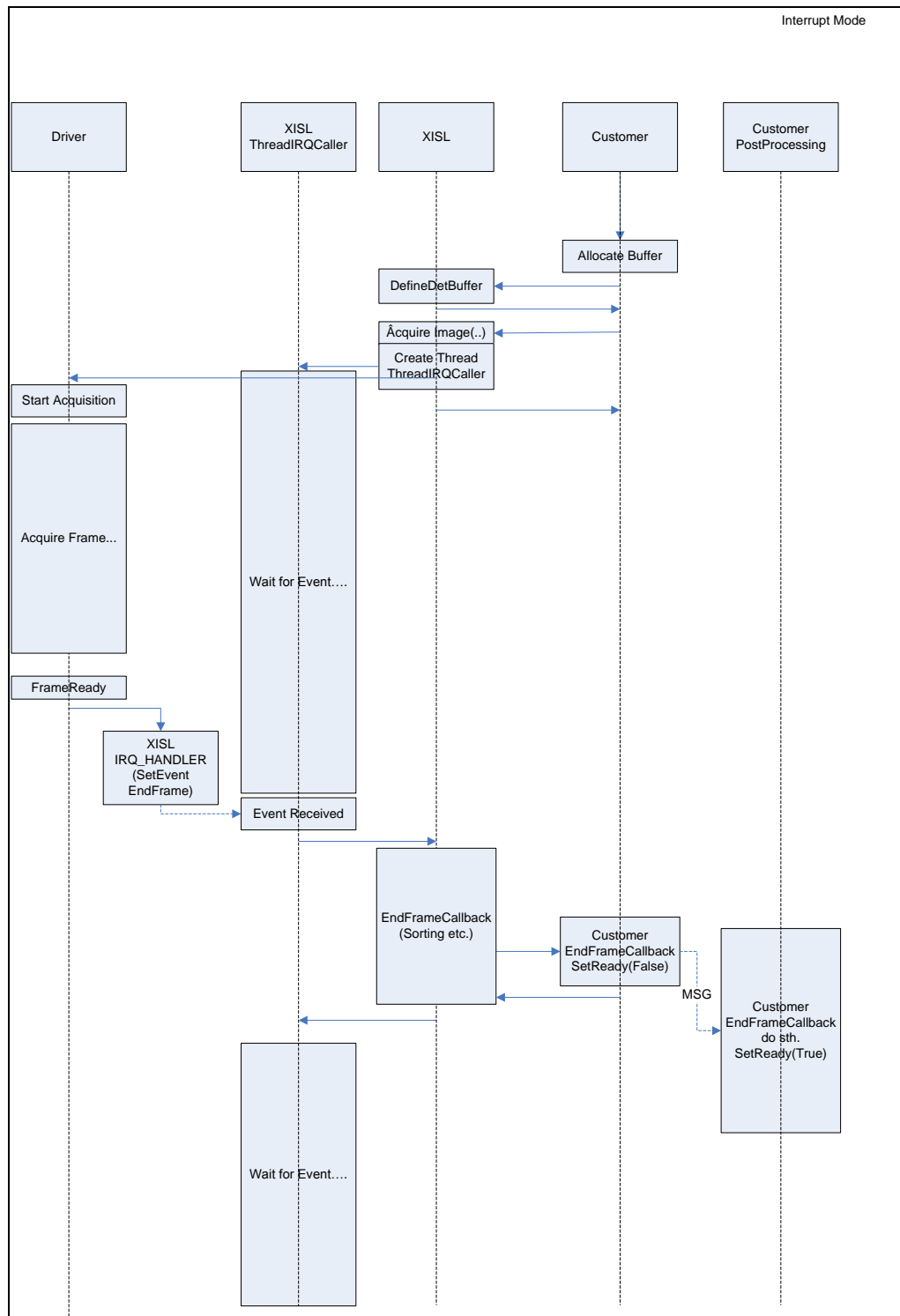
Table 38: Timing diagram of the row types

6.9 Software Operation Modes (Interrupt vs. Polling)

The following diagrams show the interaction between the PKI Framegrabber Library (XISL) and the customer application.

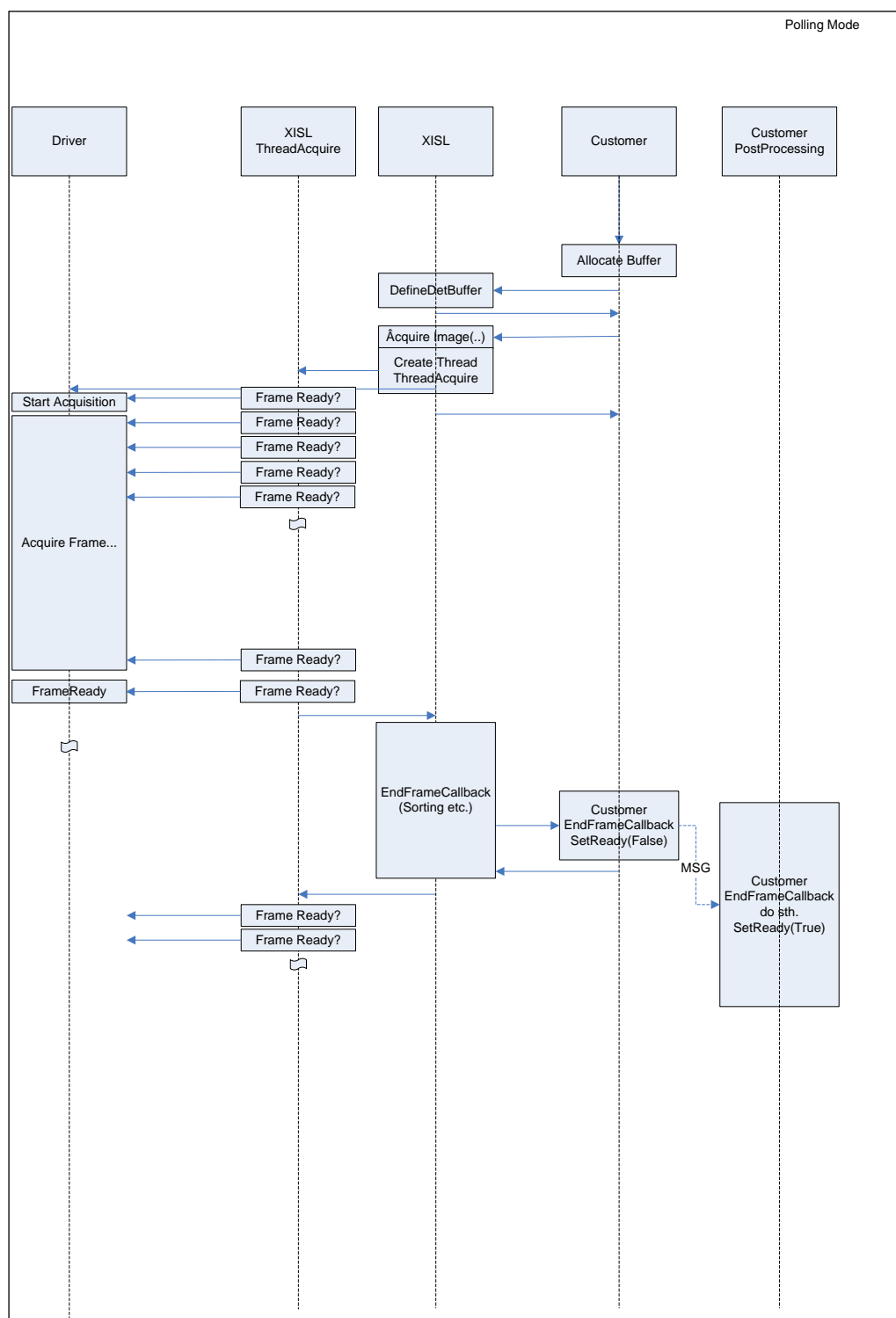
6.9.1 Interrupt Mode

Interrupts allow the application to wait passively for changes in the acquisition status of the hardware.



6.9.2 Polling Mode

If no interrupts are enabled the acquisition is running in polling mode. This is a time consuming task because the application actively asks the acquisition driver for its status..



6.10 Technical details for Interrupt sources

There are four interrupt sources:

start of DMA, end of DMA, end of sequence, end of acquisition

These interrupts occur if the acquisition status changes to allow the application to react.

The acquisition mode (Continuous, Single Shot, Sequence) influences the data flow and therefore the acquisition status. The following diagrams illustrate the internal data flow framegrabber and XISL.DLL and the corresponding interrupts.

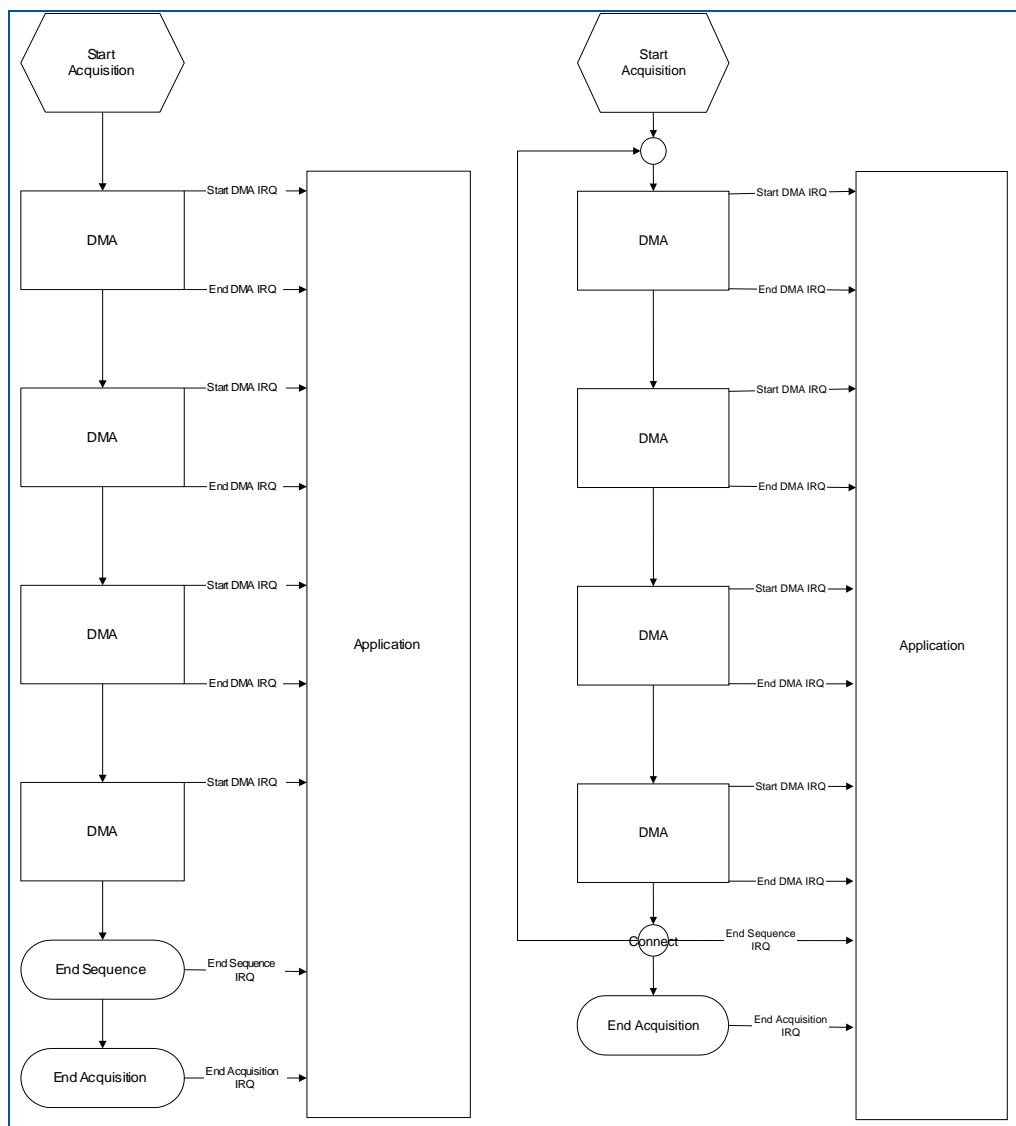


Figure 44: Interrupt sources at a) sequence acquisition mode (4 frames) b) continuous mode.

After the application started the acquisition one interrupt is caused by the beginning of DMA (start DMA interrupt). If the whole frame data is transferred the end of DMA interrupt is fired. Both interrupts show the same behavior in all acquisition modes. What happens if the end of DMA buffer is reached depends on the acquisition mode. In sequence or single shot acquisition mode an end of sequence interrupt occurs and after that an end of acquisition interrupt is caused. In continuous acquisition mode an end of sequence interrupt is caused and the data transfer continuous at start of DMA buffer. If interrupts are enabled, the end of frame, the end of sequence and the end of acquisition interrupts are used. A cancel of acquisition sets the end of frame interrupt.

6.11 Sorting

6.11.1 Sorting schemes overview

Depending on the sensor and detector type the data come in different orders from the detector. The XISL sort the data in an internal buffer with highly optimized routines written in machine code. If the sensor and detector type is unknown the XIS comes up with a detector type dialog at initialization, where the correct sorting has to be entered. The following detector types and sortings are supported:

No Sort (e.g. XRpad, 0822 and 1611, 1622, 1642)	0
XRD 512-400 A1/A2	6
XRD 0840	6
XRD 512-400 E	7
XRD 1640 A	8
XRD 0820	8
XRD 1620 A	8
XRD 1680 A	9
XRD 1620/21 AM/AN	11
XRD 1620/40 AN CS	12
XRD 4343	15

Table 39: Sorting schemes overview

6.11.2 Sorting XRD 512-400 A1/A2 // XRD 0840

The figure demonstrates the read out scheme of the sensor.

The whole sensor is divided into an upper and a lower part. Both parts are electrically separated. The data of every part are transferred by four "read out groups" (ROG). The upper groups scan the sensor columns from left to right. The lower groups scan from right to left. At first the upper groups are transferred and after that the lower ones. The upper groups start their read out from the upper row. The lower ones start read out from the last row. This results in the following Table 40:

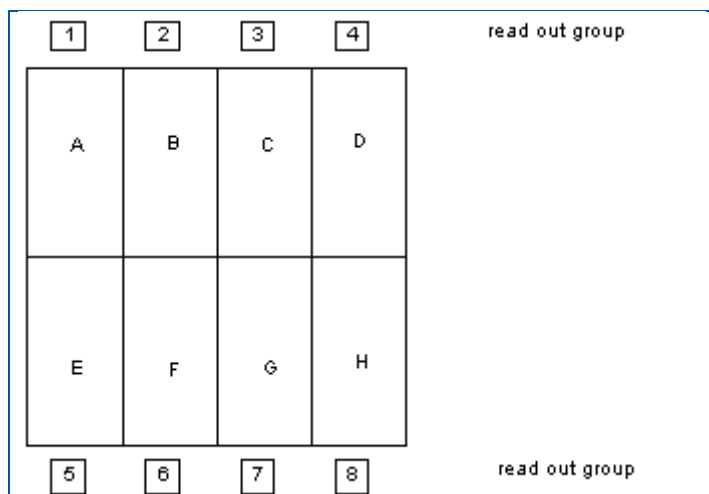


Figure 45: Sorting overview of the XRD 512-400 A1/A2

data stream no.	sensor pixel (row, column)	ROG no.
1	(1,1)	1
2	(1,129)	2
3	(1,257)	3
4	(1,385)	4
5	(512,128)	5
6	(512,256)	6
7	(512,384)	7
8	(512,512)	8
9	(1,2)	1
10	(1,130)	2
...
262135	(257,258)	7
262136	(257,386)	8
262137	(256,128)	1
262138	(256,256)	2
262139	(256,384)	3
262140	(256,512)	4
262141	(257,1)	5
262142	(257,129)	6
262143	(257,257)	7
262144	(257,385)	8

Table 40: Sorting overview of the XRD 512-400 A1/A2

6.11.3 Sorting XRD 512-400 E

The figure demonstrates the read out scheme of the sensor.

The whole sensor is divided into an upper and a lower part. Both parts are electrically separated. The data of every part are transferred by four "read out groups" (ROG). The upper groups scan the sensor columns from left to right. The lower groups scan from right to left. At first the lower groups are transferred and after that the upper ones. The upper groups start their read out from the upper row. The lower ones start read out from the last row. This results in the following list:

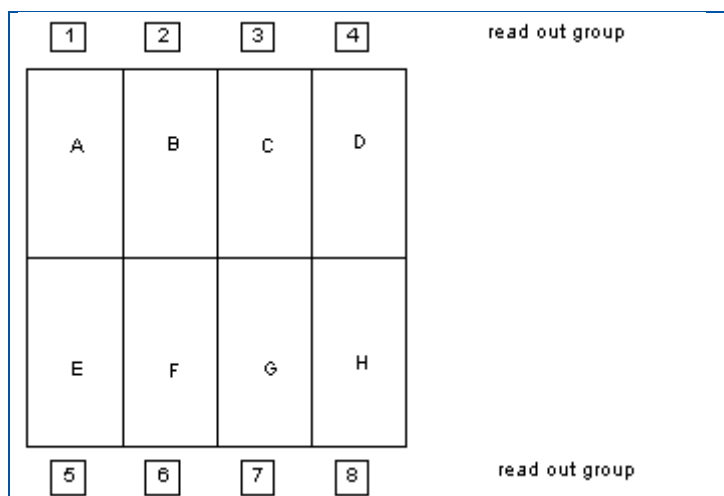


Figure 46: Sorting overview of the XRD 512-400 E

data stream no.	sensor pixel (row, column)	ROG no.
1	(512,128)	5
2	(512,256)	6
3	(512,384)	7
4	(512,512)	8
5	(1,1)	1
6	(1,129)	2
7	(1,257)	3
8	(1,385)	4
9	(512,127)	5
10	(512,255)	6
11	(512,283)	7
12	(512,511)	8
13	(1,2)	1
...
1022	(1,384)	3
1023	(1,512)	4
1024	(511,128)	5
1025	(511,256)	6
1026	(511,384)	7
1027	(511,512)	8
1028	(2,1)	1
1029	(2,129)	2
...
262137	(257,1)	5
262138	(257,129)	6
262139	(257,257)	7
262140	(257,385)	8
262141	(256,128)	1
262142	(256,256)	2
262143	(256,384)	3
262144	(256,512)	4

Table 41: Sorting overview of the XRD 512-400 E

6.11.4 Sorting XRD 1640 A // XRD 1620 AJ // XRD 0820

The figure demonstrates the read out scheme of the sensor. The sensors XRD 1620 AJ and XRD 1640 have a similar sorting.

The whole sensor is divided into an upper and a lower part. Both parts are electrically separated. The data of every part are transferred by eight "read out groups" (ROG). Each ROG has 128 channels for the XRD 1640/0820 and 256 for the XRD 1620 AJ. The upper groups scan the sensor columns from left to right. The lower groups scan from right to left. At first the upper groups are transferred and after that the lower ones. The upper groups start their read out from the upper row. The lower ones start read out from the last row.

The following table displays the data stream for XRD 1640:

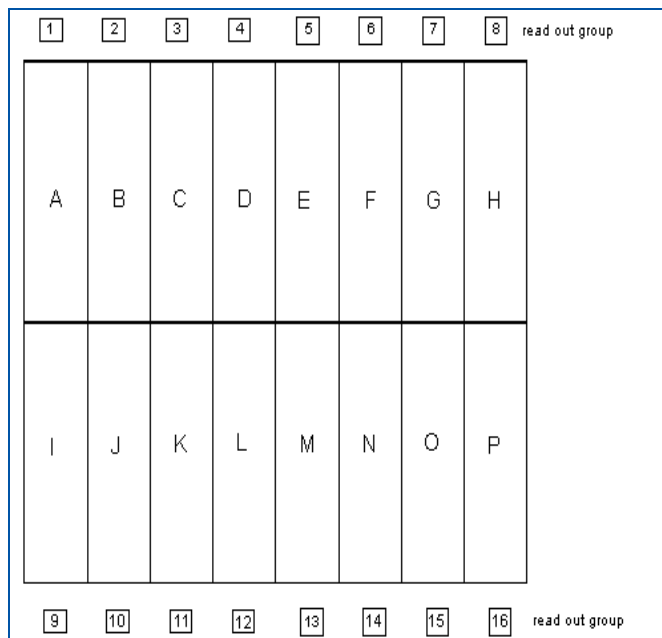


Figure 47: Sorting overview of the XRD 1640 A / 1620 AJ

data stream no.	sensor pixel (row, column)	XRD1620 AJ	ROG no.
1	(1,1)	(1,1)	1
2	(1,129)	(1,257)	2
3	(1,257)	(1,513)	3
4	(1,385)	(1,769)	4
5	(1,513)	(1,1025)	5
6	(1,641)	(1,1281)	6
7	(1,769)	(1,1537)	7
8	(1,897)	(1,1793)	8
9	(1024,128)	(2024,256)	9
10	(1024,256)	10
11	(1024,384)		11
12	(1024,512)		12
13	(1024,640)		13
14	(1024,768)		14
15	(1024,896)		15
16	(1024,1024)		16
17	(1,2)		1
18	(1,130)		2
...
1048570	(513,129)		10
1048571	(513,257)		11
1048572	(513,385)		12
1048573	(513,513)		13
1048574	(513,641)		14
1048575	(513,769)		15
1048576	(513,897)		16

Table 42: Sorting overview of the XRD 1640 A / 1620 AJ

6.11.5 Sorting XRD 1620 /21 AM/AN

The figure demonstrates the read out scheme of the sensor.

The whole sensor is divided into an upper and a lower part. Both parts are electrically separated.

The data of every part are transferred by 16 “read out groups” (ROG). Each ROG has 128 channels. The upper groups scan the sensor columns from left to right. The lower groups scan from right to left. At first the upper groups are transferred and after that the lower ones. The upper groups start their read out from the upper row. The lower ones start read out from the last row.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32

Figure 48: Sorting overview of the XRD 1620 AN / 1621 AN

The following table displays the data stream for XRD 1620 AM:

data stream no.	sensor pixel (row, column)	ROG no.
1	(1,1)	1
2	(1,129)	2
3	(1,257)	3
4	(1,385)	4
5	(1,513)	5
6	...	
15	(1,1793)	15
16	(1,1921)	16
17	(2048,128)	17
18	(2048,256)	18
19	(2048,384)	19
20	(2048,512)	20
...

Table 43: Sorting overview of the XRD 1620/21 AN//AM

6.11.6 Sorting XRD 1620 / 40 AN CS

The figure demonstrates the read out scheme of the sensor.

The data are transferred by 16 “read out groups” (ROG). Each ROG has 128 channels (64 for 1640). The groups scan from right to left. The rows start read out from the last row.

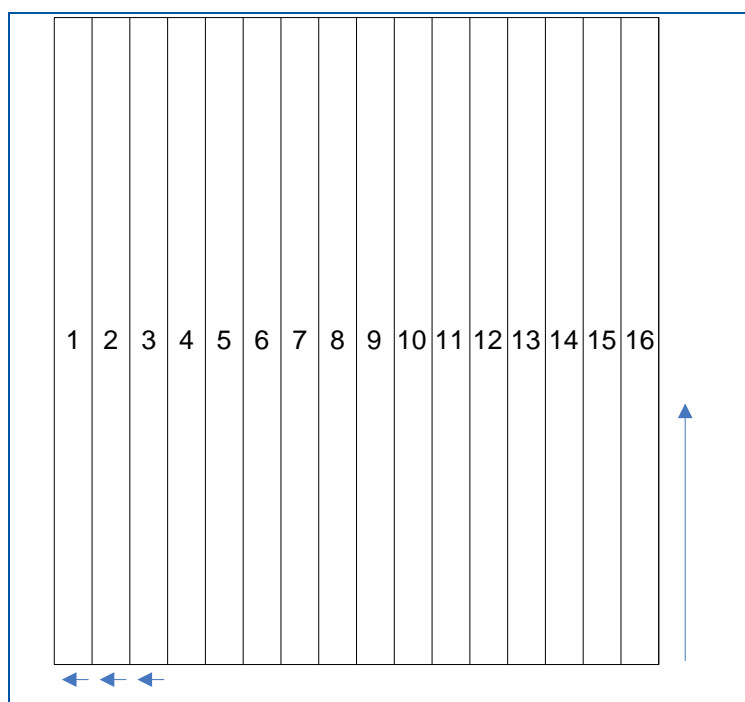


Figure 49: Sorting overview of the XRD 1620/40 AN CS

The following table displays the data stream for XRD 1620 AN CS:

data stream no.	sensor pixel (row, column) 1620	sensor pixel (row, column) 1640	ROG no.
1	(2048,128)	(1024,64)	1
2	(2048,256)	(1024,128)	2
3	(2048,384)	(1024,192)	3
...
16	(2048,2048)	(1024,1024)	16
17	(2048,127)	(1024,63)	1
18	(2048,255)	(1024,127)	2
19	(2048,384)	(1024,191)	3
...
32	(2048,2047)	(1024,1023)	16
...

Table 44: sorting overview of the XRD 1620/40 AN CS

6.11.7 Sorting XRpad, XRD 0822, XRD 1622, XRD 1642

The image data comes already sorted from the detector. No additional sorting is necessary.

Internal readout scheme:

The data are transferred by 8 (0822, 1642) / 16 (1622) / 56 (XRpad) “read out groups” (ROG).

Each ROG has 128 / XRpad 64/63 channels. The groups scan from right to left. The rows start read out from the last row.

The following Figure 50 shows the read out scheme and the Table 45 displays the data stream for **XRD 0822**:

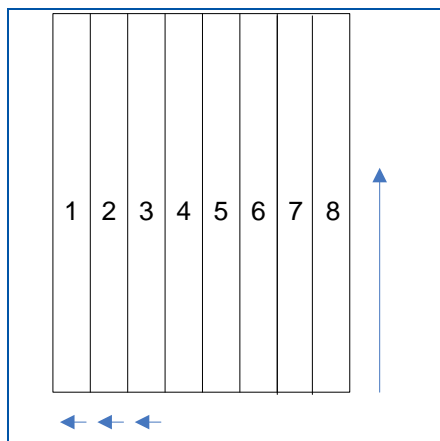


Figure 50 Sorting scheme of the XRD 0822

data stream no.	sensor pixel (row, column)	ROG no.
1	(1024,128)	1
2	(1024,256)	2
3	(1024,384)	3
...
8	(1024,1024)	8
9	(1024,127)	1
10	(1024,255)	2
11	(1024,384)	3
...
16	(1024,1023)	8

Table 45: Sorting scheme of the XRD 0822

6.12 Detector Options Overview

Detector Model	Data Interface	Header ID	Camera Type	Bit Depth	Frame rate [fps]						Gain [pF]					Trigger Modes	Trigger Output	Sectional Readout	
					1x1	Binning				Modes	0,25	0,5	1	2	4				8
						2x2	3x3	4x4	1x2										
XRD 0820 xN	HiIB	14	1	16	7,5	15	-	-	-	AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 0820 xN ES	HiIB	14	2	16	15	30	-	-	-	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 0820 BE ES	HiIB	14	2	14	15	30	-	-	-	SUM, AVG	x	-	-	-	-	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 0840 xN	HiIB	13	-	16	15	-	-	-	-	-	-	x	x	x	x	FW, LW+	FW, FW-, EP, EP-, Constant	-	
XRD 0840 BE	HiIB	13	-	14	30	-	-	-	-	-	-	-	-	-	-	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1620 xN	HiIB	13	-	16	3,5	-	-	-	-	-	-	-	-	-	-	FW	FW	-	
XRD 1620 xN CS	HiIB	14	2	16	3,75	7,5	-	-	-	SUM, AVG	-	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1640 xN ES	HiIB	13	-	16	15	-	-	-	-	-	-	-	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1640 xN ES	HiIB	14	7	16	15	-	-	-	-	-	-	-	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1640 xN CS	HiIB	13	-	16	15	-	-	-	-	-	-	-	x	x	x	FW	FW, FW-, EP, EP-, Constant	-	
XRD 1640 xN CS	HiIB	13	-	16	7,5	-	-	-	-	-	-	-	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1621 xN	OPT	14	1	16	7,5	15	-	-	-	AVG	x	x	x	x	x	FW	FW, FW-, EP, EP-, Constant	-	
XRD 1641 xN	OPT	14	1	16	15	30	-	-	-	AVG	-	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1621 xN ES	OPT	14	2	16	15	30	-	-	-	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 0822 xO	GbIF	14	8	14	15	30	-	-	-	SUM, AVG	-	-	-	-	-	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 0822 xP	GbIF	14	10	16	25	50	-	100	50	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	1024x512 1024x256	
XRD 1622 xO	GbIF	14	9	14	1	-	-	-	-	SUM, AVG	-	-	-	-	-	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1622 xP	GbIF	14	11	16	1	4	-	2	-	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1642 xP	GbIF	14	11	16	15	30	-	-	30	-	SUM, AVG	x	x	x	x	FW, DDD, LW+	FW, DDD, LW+	-	
XRD 4343RF	OPT	14	14	16	Refer to the detector manual for selectable options (Gain, Binning, FOV and Frame Rate)											FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-	
XRD 1611 xP	OPT	14	15	16	3,75	7,5	-	15	7,5	15	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	-
XRD 1642 xP	GbIF	14	12	16	15	30	-	-	30	-	SUM, AVG	x	x	x	x	x	FW, DDD, LW+	FW, FW-, EP, EP-, DDD, DDD-, Constant	1024x512 1024x256 1024x128
Refer to the Xrpad[2] XRD4343 reference manuals for selectable detector options (Gain, Binning and Frame Rate)																			
XRpad 4336	GbIF / W/LAN	14	13	14/16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
XRpad 4343 F	GbIF	14	13	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
XRpad 4343	GbIF / W/LAN	14	13	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
XRpad?	GbIF / W/LAN	15	16	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	

Table 46: Detector Options Overview

The table provides information about the capabilities of the different detector models. The soft- and firmware identify the functionality of a detector by the camera type. This number can be retrieved within the header data for recent detectors which support Header ID ≥ 14 . Earlier detector models with Header ID < 14 do not support this feature.

The features in the columns *Trigger Modes* and *Trigger Output* are implemented in firmware as listed.

The supported features may differ based on the individual firmware.

Definitions

FW	Frame Wise
PW-	Frame Wise, Pulse Inverted
DDD	Data Delivered on Demand
DDD-	DDD - Pulse Inverted
LW	Line Wise w/ fixed lines
LW+	Line Wise with Start Stop
EP	Exposure Pulse
EP-	Exposure Pulse Inverted
TL	Trigger Loss
TM	Trigger Mode
TS	Trigger Source 1=Intern 0=Extern
SM	Service Mode
HiIB	Copper based interface (Framegrabber required)
OPT	Optical data interface (Framegrabber required)
GbIF	Gigabit Ethernet data interface

7 X-Ray Imaging Software Library SDK

The X-Ray Imaging Software Library (XISL) makes it easy to integrate flat panel functionality into the user application. The SDK for 32 as well as for 64bit can be selected as an installation option during the XIS Setup.

The SDK comprises a selection of Standard C-functions to allow the user to put into action the desired mode of operation. The SDK provides functions for image acquisition and detector control such as triggering, binning, setting gain and more.

Please ensure to include the adequate `acq.h` (32 or 64bit) into your project. For 32bit you can find this file in the folder `[XIS]\SDK32`, the 64bit version is located in `[XIS]\SDK64` if the option to copy the sdk was selected during install.

7.1 X-Ray Imaging Library Overview

The X-Ray Imaging Software Library provides the basic functionality to acquire images and control the X-Ray detectors of the XRD and XRpad families. To get an impression of the tasks you have to implement to acquire images by help of the XISL look at XISL demo. Detailed information and description of the API functions are provided in the document `XISL_API_Description` which is part of the XIS installation distribution and can be found in the folder 'Manual'. Demo codes with examples of the detector initialization, image acquisition, detector control are part of the SDK package.

7.2 Demo application

The XISL demonstration application is a simple console application running under Windows OS. It demonstrates how to acquire data continuously, how to acquire a sequence, how to create correction files and how to acquire corrected images.

You can install the demo sourcecode and the demo application by selecting **XISL SDK (32bit Windows)** or **XISL SDK (64bit Windows)** during the XIS installation process.

Files:

The 32/64bit demonstration program was build with MS Visual C++ .NET 2013. The name of the project file is "XISL_DEMO__VS2013.vcxproj". If you want to use your own development environment insert `XISL.lib` in your project. The header file declaring the required function prototypes is named "`Acq.h`". The main application program source is called "`main.c`".

8 XRpad Configuration through Webinterface

The detector hosts a web server you can use to configure a wide range of settings for the detector. The web server offers options for supporting specific applications, battery handling, and wireless connectivity.

Default Webaddress (LAN) :<http://192.168.2.158/>

Default Webaddress (WLAN) :<http://192.168.22.1/>

The Welcome page includes three modules:

- Network — Includes settings for common, LAN, WLAN, image transfer, and services.
- Administration —Includes system information, such as, software and firmware versions for the detector.
- About — Includes additional information about the system.

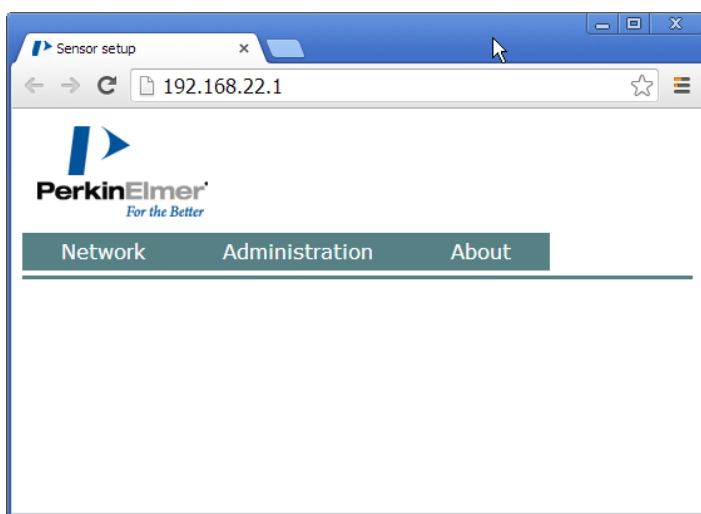


Figure 51 Start Screen Webserver

8.1 Viewing System Information

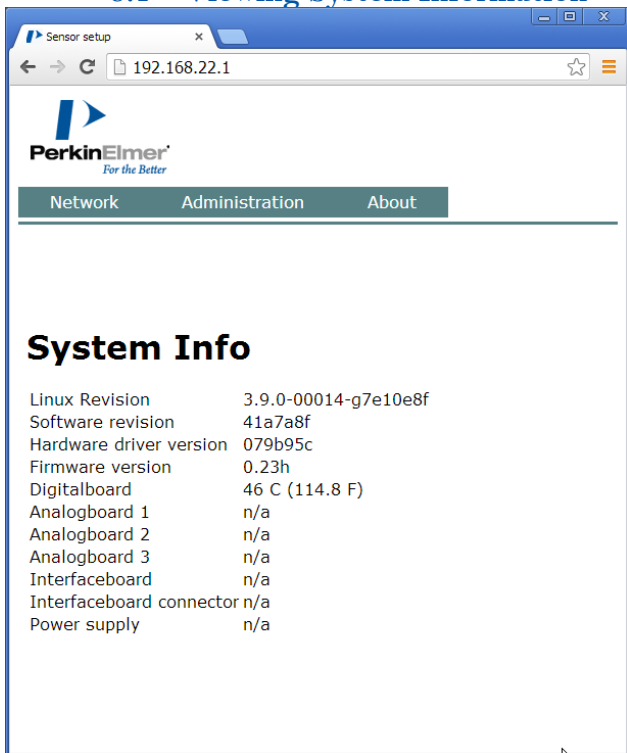


Figure 52 About Dialog / Version Information

The System Information page displays the software and firmware versions of the XRpad detector. These are important information for detector tracking. The FPGA PKI Firmware version is not displayed in the System Info area on all XRpad types; however, you can retrieve it using the Hardware Header.

8.2 Login

To change the detector settings on the integrated web server a username and a password are required. There are three levels of service levels available (Table 47).

Some of the Administration menu topics are for PKI usage only and require enhanced user rights. The next chapters are requiring the admin/cadmin-rights.



Figure 53 Authentication

Menu title	Menu entry	User Rights	Default password
Network			
	Network settings	Admin	PerkinElmer
Administration			
	Language settings	Admin	PerkinElmer
	System clock	Admin	PerkinElmer
	Passwords	admin/cadmin	PerkinElmer / changeMe
	Wireless country code	cadmin	changeMe
About			
	System information	Everybody	N/A

Table 47 Overview Webserver Menu

8.3 Network Settings

The Network module of the web server includes options for configuring network settings (see Figure 14) to allow the detector to be integrated into a facilities network of any size. You can fully configure two interfaces—one wired GbIF, the other wireless 802.11n—to Internet standards. The Wi-Fi configuration adopts routines known from commercial APs. This allows you to optimize your radio transceiver performance (within regional regulatory limits set elsewhere).

The screenshot shows the 'Sensor setup' web interface in a browser window. The address bar shows '192.168.22.1'. The PerkinElmer logo is at the top left. Below it are tabs for 'Network', 'Administration', and 'About'. The 'Network' tab is active. On the left, there is a sidebar with 'Show all' and a list of settings: 'Common settings', 'LAN settings', 'WLAN settings', 'Image transfer', and 'Services'. The main content area has a 'Choose configuration' dropdown set to 'Configuration 2', with 'Save as default' and 'Restart network' buttons. The settings are organized into sections: 'Common settings' (Configuration name, Hostname), 'LAN network settings' (Mode, IP address, Netmask, Gateway, Nameserver), 'WLAN type' (Type), 'WLAN network settings' (Mode, IP address, Netmask, Gateway, Nameserver), 'WLAN accesspoint settings' (Country, WLAN mode, Channel, SSID, WPA2 password, Repeat WPA2 password), 'Image transfer settings' (Image transfer), and 'Service settings' (SSH server checkbox). At the bottom are 'Apply' and 'Reset' buttons.

Section	Setting	Value
Common settings	Configuration name	Configuration 2
	Hostname	4336#ESWT
LAN network settings	Mode	Manual
	IP address	192.168.2.158
	Netmask	255.255.255.0
	Gateway	
	Nameserver	
WLAN type	Type	Accesspoint
WLAN network settings	Mode	Manual
	IP address	192.168.22.1
	Netmask	255.255.255.0
	Gateway	
	Nameserver	
WLAN accesspoint settings	Country	US
	WLAN mode	11NA 40MHz (+)
	Channel	36 (5180 MHz)
	SSID	PerkinElmer
	WPA2 password	
	Repeat WPA2 password	
Image transfer settings	Image transfer	use LAN
Service settings	SSH server	<input checked="" type="checkbox"/>

Figure 54 Overview Network Settings

You can configure up to 15 configurations (set of user preferences) for the X-ray detector. We recommend you use at least one configuration for the wired and at least one configuration for the wireless image transfer. We recommend to leave the Gateway and Nameserver text boxes for WLAN and LAN blank.

8.4 Administration

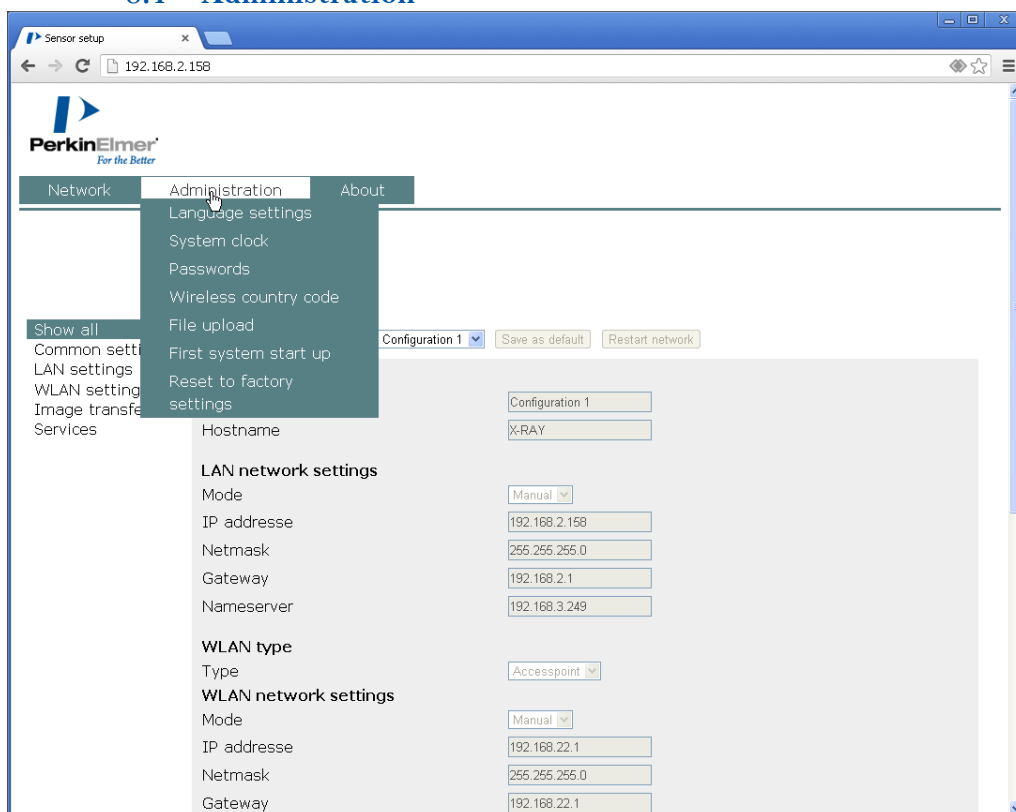


Figure 55 Menu Administration



Figure 56 Language Settings for Webserver

Default language is determined by browser language settings which can be overwritten by selecting a different language in this dialog.

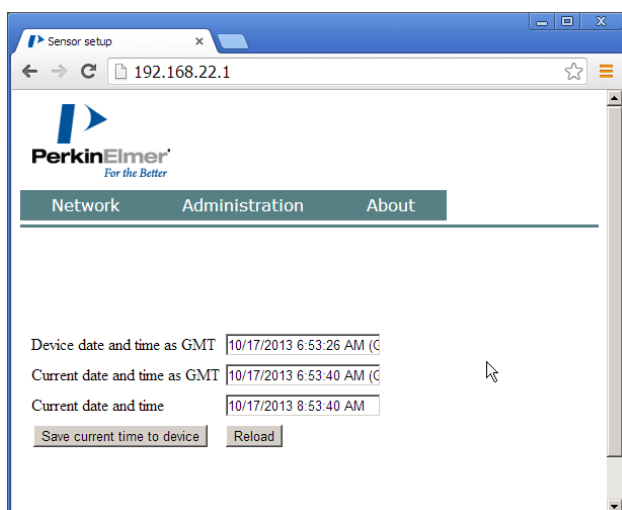


Figure 57 System Clock Dialog

Hint: the time is displayed in timezone GMT!

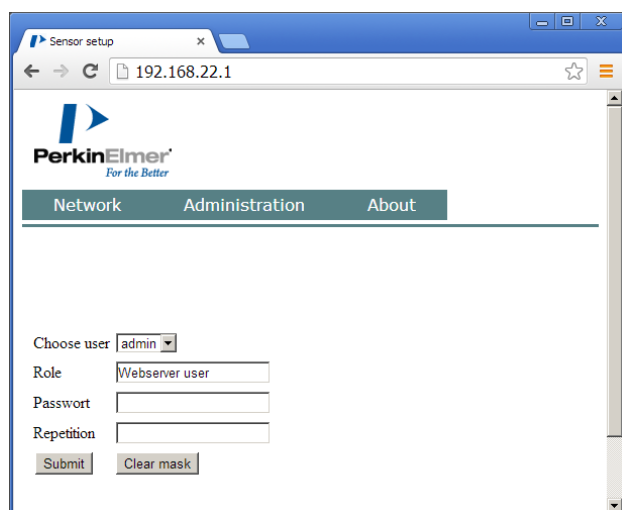


Figure 58 Change Passwords Dialog

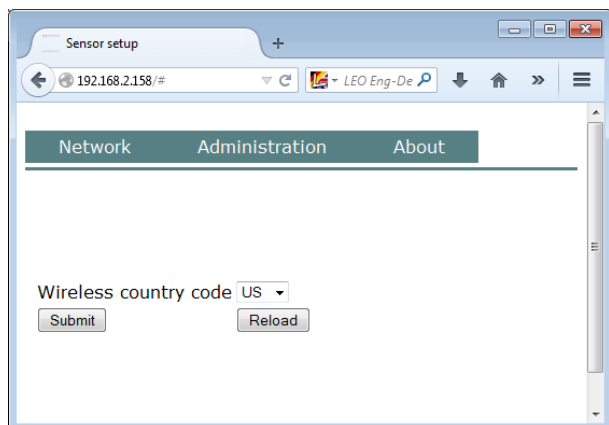


Figure 59 Administration – Wireless Country Code

You use the Wireless country code menu to set the wireless country code. To access the menu, go to:

http://xxx.xxx.xxx.xxx/cadmin/country_code.html
 where xxx.xxx.xxx.xxx is the IP address of the detector.

Regional regulatory limitations affect the available choices of wireless channels in the network settings. Conformity with regulations is easy to achieve by choosing one of the prepared Country Codes. Do not choose inapplicable selections because unlicensed bands differ from country to country, and device operation could be unlawful otherwise.

9 Detector SD-Card access (RO)

XRpad detector contains an internal SD-Card for data and software storage. Its possible to read and write to/from the detectors SD-Card via software or explorer.

The SD-Card can be read with an explorer from the ftp adress <ftp://192.168.2.158> (default ip - or your active ip-adress). The explorer will show the content of the SD-Card (Read Only).

9.1 Login for SD-Card write access

To get write access to the SD-Card follow the steps below:

- open the explorer and enter <ftp://192.168.2.158> (default ip - or your current active ip-adress)
- select "File" => "Login As..."

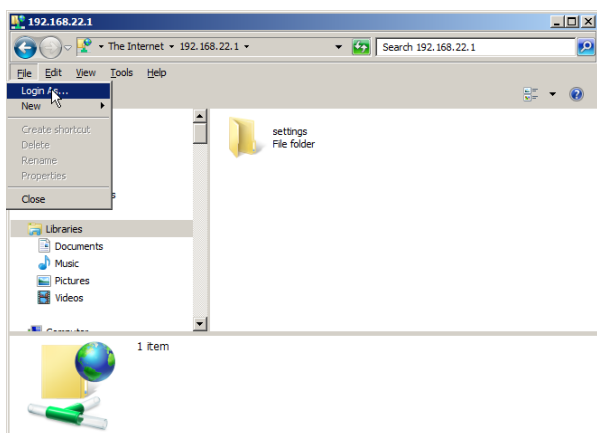


Figure 60 FTP SD-Card write access login

- enter user name – "sdaccess" and password – "PerkinElmer" (default – changeable via web-server)

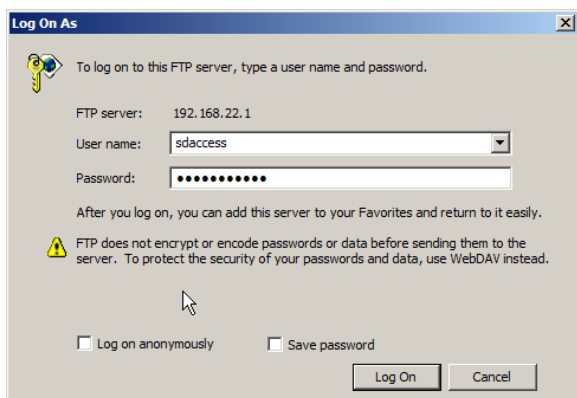


Figure 61 FTP SD-Card write access login dialog

- The explorer will show the content of the SD-Card for read/write from/to the SD-Card

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