User Manual

DECTRIS MYTHEN®2 Detector Systems

Version 9

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Document Version V9

Contents

Document History

Current Document

Version	Date	Status	Prepared	Checked	Released
9	13.01.2021	draft	LG	LW, NP	LG

Changes

Version	Date	Changes
9	13.01.2021	Added information of vacuum warranty and update framerate of R systems
8	03.11.2020	Updated registered trademarks
7	09.04.2019	Updated Corporate Design
5	30.10.2017	Updated web links
4	28.11.2016	Updated references
3	05.07.2016	Support for editing the bad channel files Custom flat-field upload explanation
2	27.10.2015	Major update and documentation rework • Document versioning system changed • Contact information updated • Figure 43 exchanged • Module and DCS4 photos updated (screw lock cable and fixation kit)
1	04.09.2014	Old versions

1. General Information

1.1. Contact and Support

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Homepage:	http://www.dectris.com/
Email:	support@dectris.com

Should you have questions concerning the system or its use, please contact us via telephone, e-mail or fax.

1.2. Explanation of Symbols

Symbol	Description
	Important or helpful notice
	Caution. Please follow the instructions carefully to prevent equipment damage or personal injury.
	DC-current
	AC-current
	Ground
	Functional earth

1.3. Explanation of Terms

Term	Description
ASIC	Application-Specific Integrated Circuit
DAC	Digital Analog Converter
GUI	Graphical User Interface
DCS4	Detector Control System for up to 4 detector modules
Detector Module	The smallest fully functional unit of the detector (1280 or 640 channels for DECTRIS MYTHEN®2)
P2P	Peer to Peer connection (fixed IP address)
MCB	Module Control Board
FIFO	Storage working according to First In – First Out
keV	Kilo electron Volt

1.4. Warranty Information

Should your detector require warranty service, contact DECTRIS® for further information. Before shipping the system back, please contact DECTRIS® to receive the necessary transport and shipping information. Make sure that the original packaging is used when returning the system.

⚠ **Do not ship the system back before you receive the necessary transport and shipping information.**

When returning the detector system for repair, be sure to fill out and include the service form at the back of this document to provide the support division with the necessary information.

1.5. Disclaimer

DECTRIS® has carefully compiled the contents of this manual according to the current state of knowledge. Damage and warranty claims arising from missing or incorrect data are excluded.

DECTRIS® bears no responsibility or liability for damage of any kind, also for indirect or consequential damage resulting from the use of this system.

DECTRIS® is the sole owner of all user rights related to the contents of the manual (in particular information, images or materials), unless otherwise indicated. Without the written permission of DECTRIS® it is prohibited to integrate the protected contents in this publication into other programs or other websites or to use them by any other means.

DECTRIS® reserves the right, at its own discretion and without liability or prior notice, to modify and/or discontinue this publication in whole or in part at any time, and is not obliged to update the contents of the manual.

2. Safety Instructions

Please read these safety instructions before operating the detector system.

- Before turning the power supply on, check the supply voltage against the label on the power supply. Using an improper main voltage will destroy the power supply and damage the detector.
- Use only the power supply delivered by DECTRIS®
- Power down the detector system before connecting or disconnecting any cable.
- Make sure the cables are connected and properly secured.
- Do not use any other cables than delivered by DECTRIS®
- Avoid pressure or tension on the cables.
- The detector system should have enough space for proper ventilation. Operating the detector outside the specified ambient conditions could damage the system.
- The detector is not specified to withstand direct beam at a synchrotron. Such exposure will damage the exposed pixels.
- Place the protective cover on the detector when it is not in use to prevent the detector from accidental damage.
- Opening the detector or the power supply housing without explicit instructions from DECTRIS® will void the warranty.
- Do not install additional software or change the operating system.
- Do not touch the entrance window of the detector.
- Do not connect any device to the USB plugs of the DCS4 except the detector modules.
- Do not connect the detector module to any other USB device than the DCS4.

Vacuum Operation
Only detectors purchased with optional vacuum warranty may be operated in vacuum. Warranty void otherwise!
When using the detector in vacuum strictly follow the in-vacuum instructions given in the additional Vacuum Specifications document!
To see if a detector has a vacuum warranty check whether the vacuum warranty option is included in the order confirmation.

3. System Description

3.1. Hybrid Photon Counting (HPC) Technology

3.1.1. Overview

All X-ray detector systems produced by DECTRIS® operate in single-photon-counting mode, and are based on Hybrid Photon Counting (HPC) technology.

The main difference to traditional detectors is that the X-rays are directly converted into an electric charge in the silicon sensor (Figure 1). The signal is then processed in the CMOS readout chips that are directly connected to the senor pixels/stripes.

This technology has no dark current or readout noise and allows for a high dynamic range (1:16’777’216 (24 bits) per channel per image), a short readout time (< 0.1 ms), A higher frame rate (up to 1000* frames/s) and an excellent spatial resolution (channel width 50 µm). Three available silicon sensor thicknesses (320 µm, 450 µm or 1000 µm) and two strip lengths (4 mm or 8 mm) ensure optimal quantum efficiency for experiments in the energy range from 4 – 40** keV (Figure 2, Table 1). However, detectors can be used for higher X-ray energies with the corresponding lower efficiency. In order to handle the high flux of modern synchrotron light sources, count rates > 10^6 counts/s/channel are supported. However, the detector cannot withstand a direct synchrotron beam due to potential radiation damage.

*Frame rates up to 1000 Hz are possible only for the DECTRIS MYTHEN®2 X-series (synchrotron applications).

**In order to optimize signal-to-noise ratio, energies as low as 4 keV can be reached only with sensor geometry corresponding to 320 µm thickness and 4 mm strip length (Table 1).

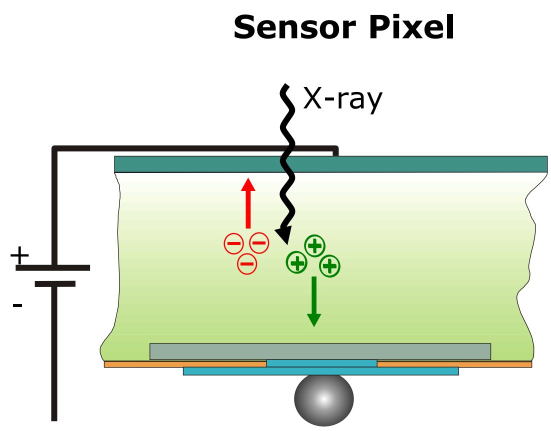

FIGURE 1: PRINCIPLE OF DIRECT X-RAY DETECTION BY HPC DETECTORS. CONVERSION OF X-RAY INTO AN ELECTRICAL CHARGE IN THE SENSOR PIXEL/STRIPE.

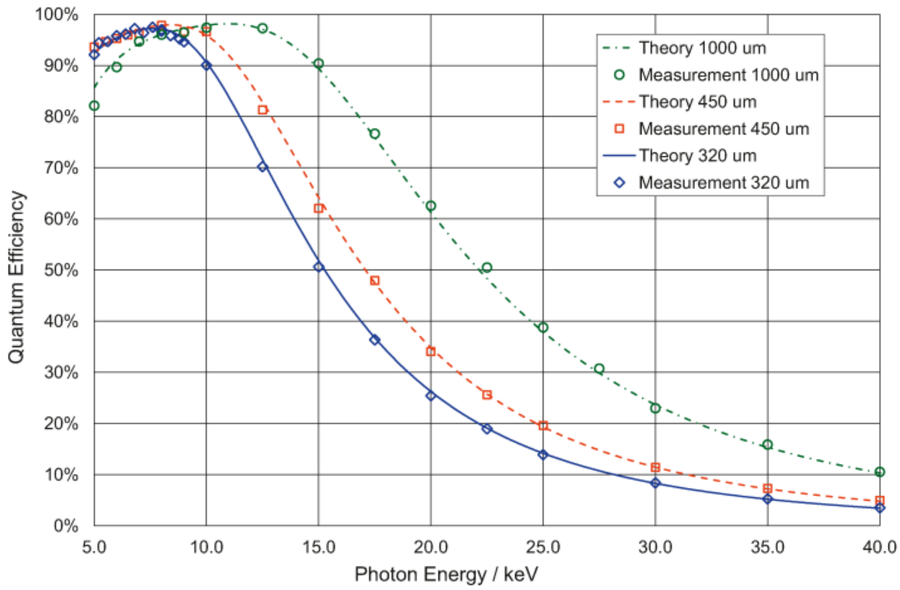

FIGURE 2: QUANTUM EFFICIENCY AS A FUNCTION OF X-RAY ENERGY, CALCULATED FOR THREE SENSOR THICKNESSES

TABLE 1: ENERGY AND THRESHOLD RANGES FOR THE FOUR AVAILABLE COMBINATIONS OF SENSOR THICKNESS AND STRIP LENGTH.

	320 µm x 4 mm	320 µm x 8 mm	450 µm x 8 mm	1000 µm x 8 mm
Energy [keV]	4.0 – 40.0	5.0 – 40.0	6.6 – 40.0	7.4 – 40.0
Threshold [kev]	3.5 – 20.0	4.5 – 20.0	5.5 – 20.0	6.0 – 20.0

3.1.2. Basic Functionality

Hybrid Photon Counting (HPC) technology enables direct detection of X-rays, by converting them into charge. This process requires a specific sensor and readout chip.

All DECTRIS® detectors are based on the HPC technology. They are composed of a segmented silicon or CdTe sensor and the corresponding ASIC readout chip.

In the case of DECTRIS MYTHEN®2, the sensor is a one-dimensional array of silicon micro strips (channels). These are reverse biased, depleted pn-junctions that are processed in high-resistivity silicon. Each detecting unit (each strip) in such a silicon array is connected to its corresponding readout channel, designed with advanced CMOS technology. Connection is based on a one-by-one wire-bonding technique.

In comparison with traditional detector technologies, the great advantage of HPC technology is that this approach is optimized for X-rays and the sensors exhibit high quantum efficiency for a wide range of X-ray energies. Moreover, the small size of the channel and of the interconnection results in a very low capacitance, which has the beneficial effect of reducing the noise and power consumption of the channel readout electronics.

Standard technologies used for the silicon sensor and the CMOS readout chips guarantee the highest quality of the product.

Single Photon Counting

Single-photon counting describes a mode in which signals are processed in the readout chip (Figure 3). In the following paragraph, the principle of single-photon counting will be described on the example of DECTRIS MYTHEN®2 (micro strip detector).

A hybrid channel of the DECTRIS MYTHEN®2 detector comprises a charge-sensitive preamplifier (Figure 3) which amplifies the collected charge signal, generated in the sensor by the incoming X-ray. The preamplifier is followed by two shaping gain stages and a comparator with a globally adjustable threshold (comparator in Figure 3). The comparator produces a digital signal if the incoming charge exceeds the pre-defined threshold. The output signal of the comparator feeds a 24-bit counter, which leads to completely digital storage and noiseless readout of the number of detected X rays in each channel.

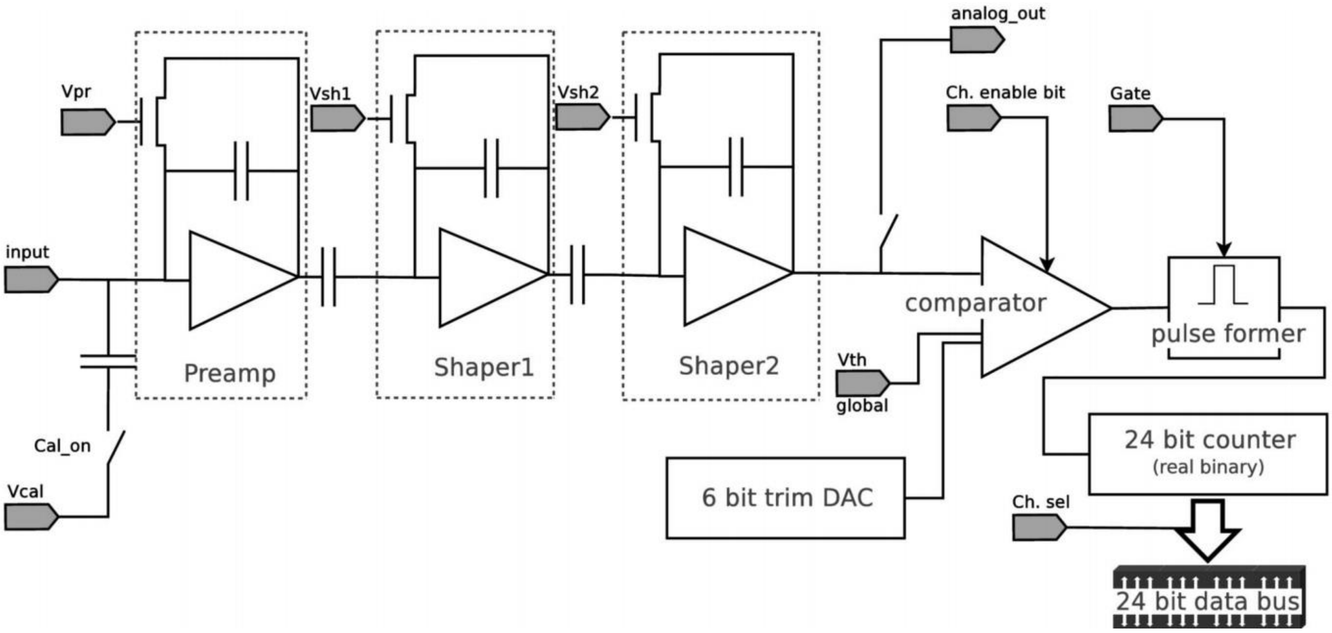

FIGURE 3: DESIGN OF THE READOUT ELECTRONICS OF EACH CHANNEL.

The globally set threshold can exhibit some channel-to-channel variations. In order to correct for these variations, each comparator threshold is adjusted by six individual trim bits. This process is called “Threshold trimming” and it is described in more detail in the Section 3.3 Threshold Trimming.

In order to clarify the functional principle of single-photon-counting detectors, comparison with the integrating mode of e.g. CCD detectors is presented in the following paragraph, and depicted in Figure 4.

The first plot in Figure 4 shows the X-ray photons deposited on the sensor surface randomly in time. In the second plot, corresponding charge pulses are depicted. The green line corresponds to user-defined threshold that acts as an acceptance criterion. The third plot illustrates the operating principle of integrating detector: all charges collected over a certain time, including the leakage current of the sensor, are integrated. Compared to this, plot four demonstrates the functional principle of the single-photon-counting mode. Only the charge pulses that are higher than the pre-defined comparator threshold cause a pulse at the output of the comparator. The counter then enumerate this pulse. The readout of the counters is done digitally and has no impact on the result of the measurement.

A big advantage of the single-photo-counting mode with the adjustable threshold is that the background and fluorescence can be successfully suppressed once the threshold is properly set (plot two in Figure 4).

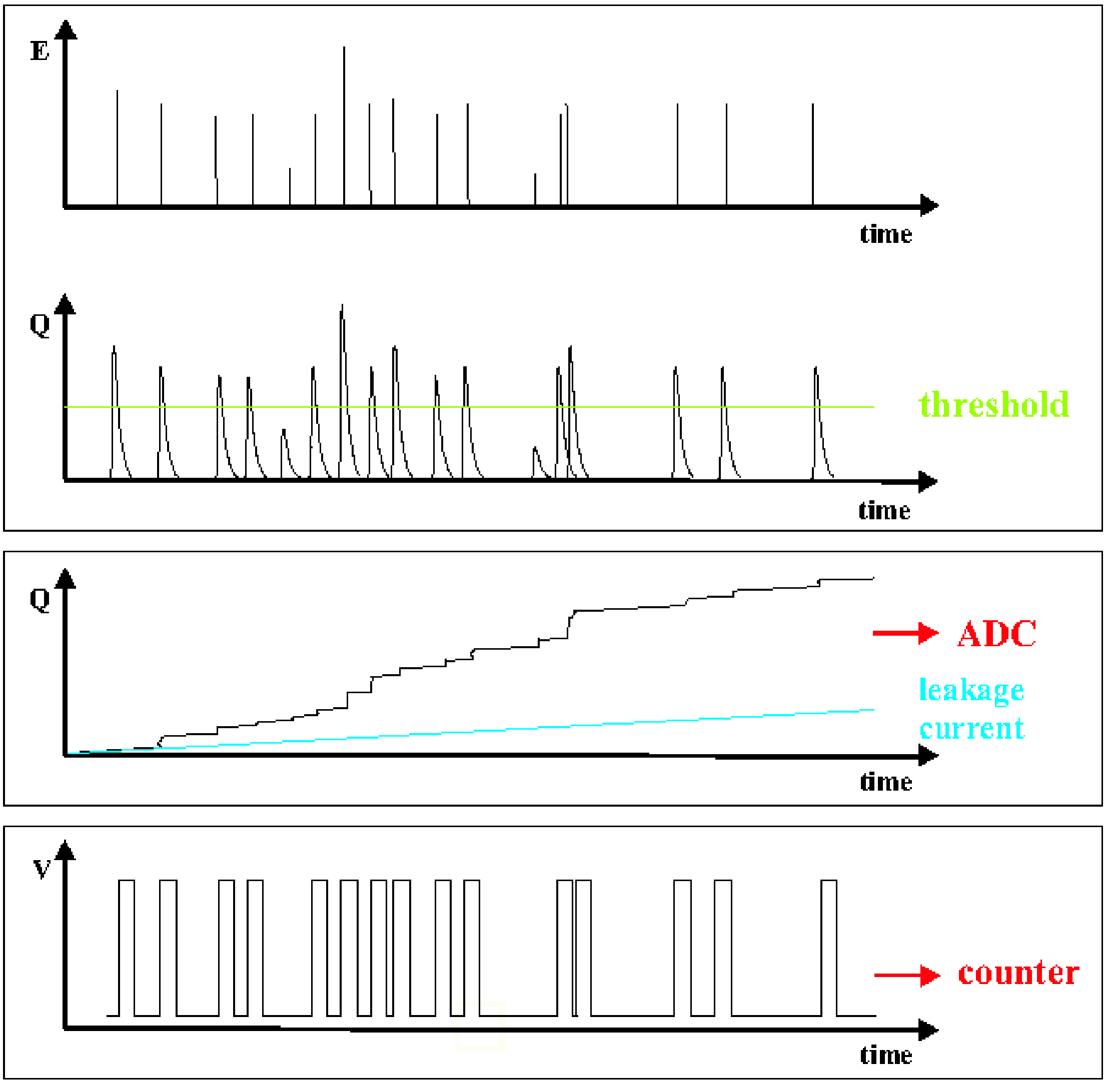

FIGURE 4: DETECTION OF X-RAYS: COMPARISON OF THE SINGLE-PHOTON-COUNTING MODE AND INTEGRATING MODE.

In principle, there are only two possibilities of background counts: (i) background due to the high-energy cosmic counts, or (ii) noise counts that are caused by the readout chip intrinsic electronic noise. The former cannot be circumvented, and the latter could be suppressed by setting the threshold appropriately. However, if the X-ray energy is quite low compared to the electronic noise level, the threshold has to be set even lower, and therefore noise counts have to be taken into account.

3.2. Detector Settings

The analog part of the readout electronic of each channel is shown in Figure 3, Section 0. The gain and therefore the shaping time of each amplifier stage can be adjusted by the globally set DAC values: V_{rgpr}, V_{sh1} and V_{sh2}. A high gain is related with a longer shaping time τs, resulting in a low maximal counting rate. Furthermore, the gain is related to the electronic noise of the readout chip. A high gain correlates with a lower intrinsic electronic noise level and therefore enables to measure lower X-ray energies.

The DECTRIS MYTHEN®2 software will always chose the optimal gain settings based on the threshold energy in use (Figure 5). For a given threshold energy, the gain is set as low as the electronic noise level allows to. This effectively suppresses noise counts from the electronics while keeping the shaping time as low as possible and maximizing the count rate of the detector.

In most cases, for optimal results the user only specifies the X-ray energy and lets DECTRIS MYTHEN®2 software choose a suitable energy threshold. For energies above molybdenum (17.8 keV), the threshold energy is half of the X-ray energy. Below 17.8 keV, the threshold energy is set according to Figure 5.

An expert user can customize the threshold. In that case, the user specifies the X-ray energy and threshold energy independently.

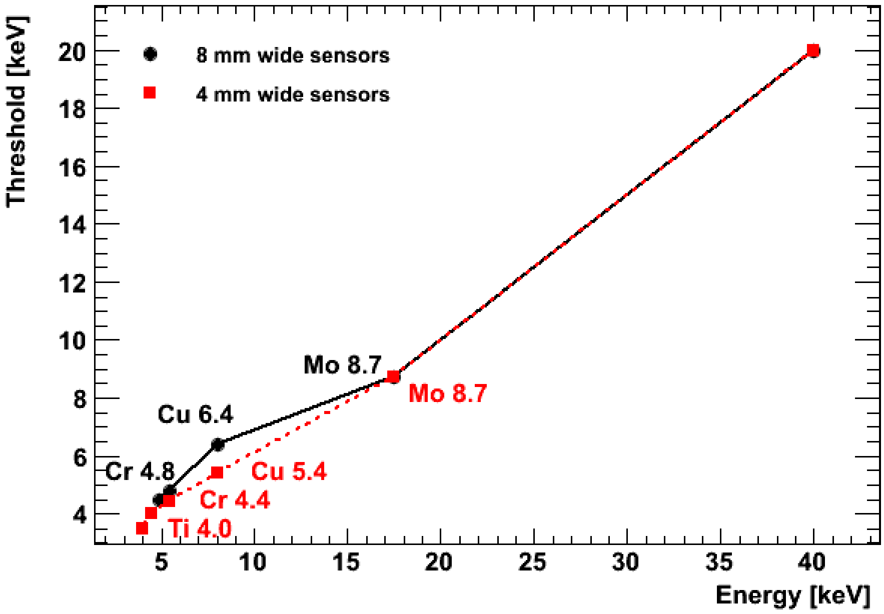

FIGURE 5: THRESHOLD ENERGIES FOR ENERGY RANGE FROM 4 TO 40 KEV FOR 8 MM WIDE SENSORS (BLACK) AND 4 MM WIDE SENSORS (RED).

3.3. Threshold Trimming

The analog part of the readout electronics of each channel is shown in Figure 3, Section 0. The globally adjustable threshold of the comparators of a module is set by a 14-bit DAC, placed on the module control board. Therefore, all channels of a module have the same threshold in DAC values. However, due to the transistor variations caused by the production process of the CMOS wafers of the readout chips, the threshold varies between individual channels in terms of X-ray energy. In order to minimize the threshold dispersion on the module, a threshold equalization technique (trimming) is applied, using the internal 6-bit DAC of each channel. In principle, the trimming is a kind of fine adjustment of the comparator thresholds on a channel-by-channel basis.

A correct trimming of the detector reduces the threshold dispersion by a factor of about 10. Since the channel-to-channel variations depend on the energy threshold, trim files for different energy thresholds are delivered with each DECTRIS MYTHEN®2 detector system. The DECTRIS MYTHEN®2 control software ensures that optimal settings for a chosen X-ray energy are chosen automatically

3.4. Flat-Field Correction

Variations in (i) the charge collection efficiencies of the sensor and (ii) geometrical effects (e.g. channels next to the edge of the sensor collect charge from a larger sensor volume) cause differences in the number of counted X-rays on a channel-to-channel basis. Since these variations are stable in time, they can be corrected. The flat-field correction is based on uniformly illuminated images with high statistics. DECTRIS® provides flat-field files for typical monochromatic X-ray energies, which are used to correct acquired images. In some cases, it can be beneficial to record setup specific flat-fields. Please contact DECTRIS® support for guidelines on how to record customer specific flat-fields and upload them to the DECTRIS MYTHEN®2 system.

3.5. Count Rate Correction

At high fluxes, a photon-counting system will not detect a certain fraction of photons due to pulse pile-up. The count rate behavior, i.e. the observed count rate as a function of incoming rate, of the DECTRIS MYTHEN®2 detector can be modeled by an ideal, paralyzable detector, for which each photon leads to a dead-time of fixed length. In this model, the observed rate $N_{observed}$ depends on the incoming rate $N_{incoming}$ according to:

$$N_{observed} = N_{incoming} e^{-N_{incoming}\,\tau}$$

where τ is the detector dead time, which depends on the shaping time.

As explained above, the choice of gain (and therefore the shaping time) is based on the threshold energy. Therefore, the dead time depends on the threshold energy. The exact values can differ from module to module, especially for modules with thicker sensors. It should be noted that when applying a rate correction based on the above formula, the incoming rate can still be determined up to a rate about 15 times higher than the recommended rate.

4. DECTRIS MYTHEN®2 Detector Systems

The MYTHEN2 detector family comprises MYTHEN2 R laboratory series and DECTRIS MYTHEN®2 X series for synchrotron use. Difference between the two is the maximal frame rate that can be obtained. For X systems, maximal frame rate corresponds to 1000 Hz, and for R systems 100 Hz. Both R and X series are available in various sensor geometries (Table 2).

This manual covers both systems (X, R) and all sensor geometries. For simplicity, in most cases DECTRIS MYTHEN®2 R 1D figures will be used to represent the complete DECTRIS MYTHEN®2 family of detectors.

TABLE 2: DECTRIS MYTHEN®2 DETECTOR FAMILY AND AVAILABILITY OF VARIOUS COMBINATIONS OF SENSOR THICKNESS AND STRIP LENGTH.

Sensor Geometry	MYTHEN2 R		MYTHEN2 X	
	1D	1K	1D	1K
Number of channels per module	640	1280	640	1280
Sensor thickness/ strip length				
320 µm / 4 mm	Yes	No	Yes	No
320 µm / 8 mm	No	Yes	No	Yes
450 µm / 8 mm	Yes	Yes	Yes	Yes
1000 µm / 8 mm	No	Yes	No	Yes

All DECTRIS MYTHEN®2 detector systems consist of:

- 1 – 4 detector modules (depending on the system type)
- Detector Control System (DCS4)
- Fixation kit
- Power supply for the DCS4
- USB 3.0 data cable(s)[2] with a screw-lock for connecting the detector modules to DCS4

Fixation kit can be mounted on DCS4 to ensure fixed position of the USB cable on the DCS4. In order to make figures simple, in this manual DCS4 will be represented without the fixation kit.

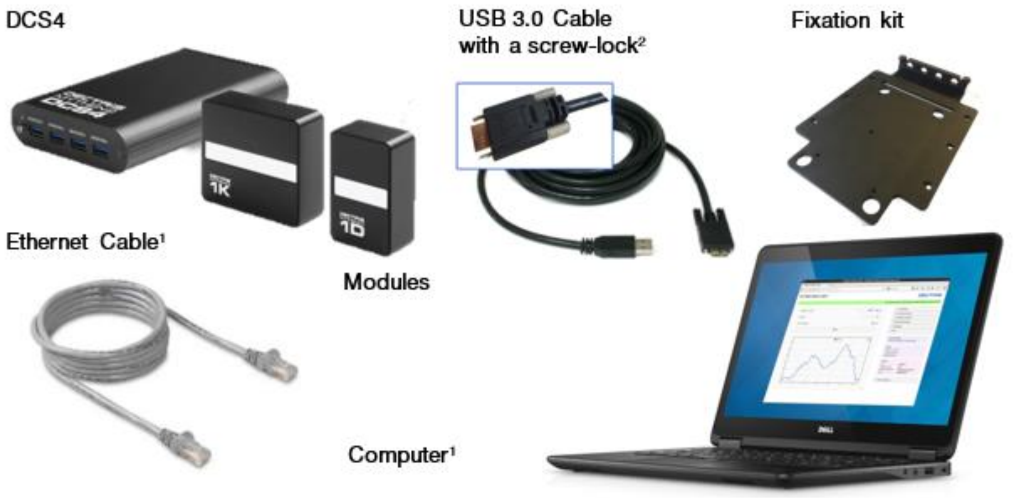

FIGURE 6: COMPONENTS OF THE MYTHEN2 DETECTOR SYSTEM AND THE COMPUTER[1] FOR OPERATING THE DETECTOR SYSTEM.

[1]Computer and Ethernet cable are not included in the system.
[2]USB connectors are used with proprietary protocol.

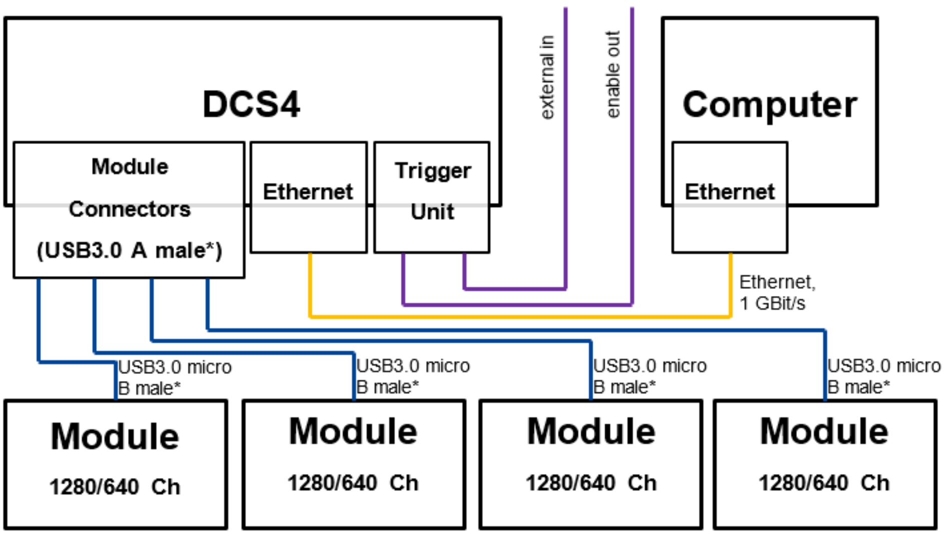

FIGURE 7: SCHEMATIC OVERVIEW OF MYTHEN2 DETECTOR SYSTEM.

⚠ Connect only devices delivered by DECTRIS® to DCS4. Do not connect any other devices or USB devices to DCS4 - this might destroy the devices and the DCS4. "USB Warning: Only approved for DECTRIS® modules. Connection of any other devices will result in damage."

⚠ Always switch off power before connecting or disconnecting a module. Disconnect DCS4 side plug first.

*USB connectors are used with proprietary protocol.

5. Technical Specifications

5.1. Quantum Efficiency

TABLE 3: QUANTUM EFFICIENCY OF DECTRIS MYTHEN®2 DETECTOR SYSTEM.

Sensor Thickness		320 µm	450 µm	1000 µm
Quantum efficiency at (calculated)	Ti 4.5 keV**	90%	-	-
	Cr 5.4 keV	93.9%	93.9%	93.9%
	Cu 8.0 keV	97.1%	97.9%	98.0%
	Mo 17.5 keV	36.8%	47.5%	76.0%
	Ag 22.2 keV	19.8%	26.7%	49.8%

** X-ray energies down to 4 keV are available only with 320 µm x 4 mm sensors.

5.2. DECTRIS MYTHEN®2 Detector Module

The basic unit of the DECTRIS MYTHEN®2 detector is a module, comprising 1280 or 640 silicon strips (channels). The detector module is mounted in a metal housing. The entrance window for X-rays is protected with a cover. This cover should be removed after mounting the detector system module for regular operation. Once the cover is removed, the detector window is visible. The sensor is located behind a 12 µm thick aluminized Mylar® foil to protect it from dust and light.

The detector is connected to Detector Control System DCS4 by USB 3.0 cables, and the DSC4 is connected to the computer via Ethernet cable (Figure 7, Section 4). The DECTRIS MYTHEN®2 detector system offers different possibilities for communication. The detector system can be operated as a stand-alone device, using a Web Client. For details, please see Section 7.4 of this document. For integrating the detector system in a specific environment, the Socket Interface is recommended. For details, please see Socket Interface Specifications, available from DECTRIS® (see Section 1.1 for support).

a) b)

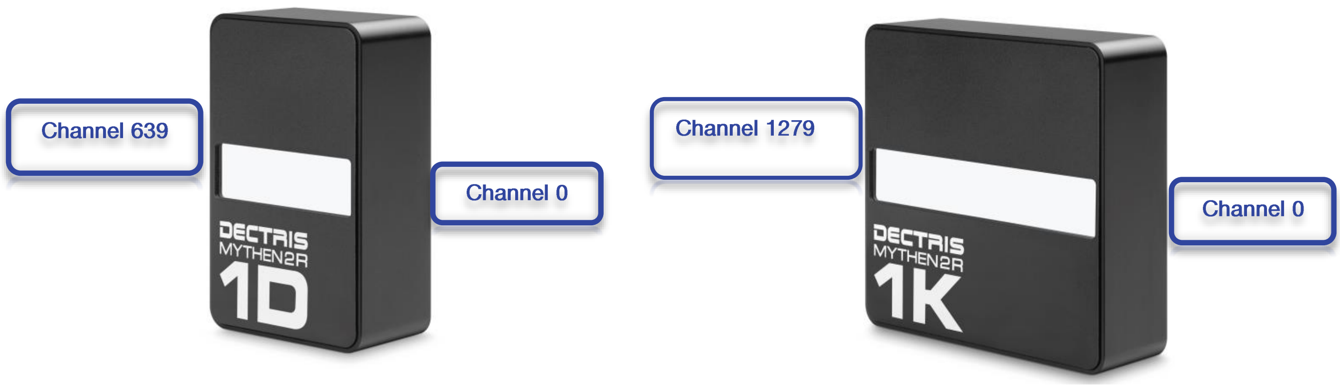

FIGURE 8: (A) DECTRIS MYTHEN®2 1D AND (B) DECTRIS MYTHEN®2 1K DETECTOR (COVER REMOVED) WITH POSITION OF CHANNELS.

Make sure that the detector modules have adequate ventilation.

Make sure that the cover is removed for detecting X-rays.

Do not connect the detector module to any other device than the DCS4 delivered by DECTRIS®. Connecting to different devices than the DCS4 might destroy the devices.

"USB Warning: Only approved for DECTRIS® modules. Connection of any other devices will result in damage."

TABLE 4: TECHNICAL DATA OF THE DECTRIS MYTHEN®2 DETECTOR MODULE.

Sensor material	Silicon	
Sensor	Reverse biased pn-junction array	
Detection principle	Single photon counting	
Sensor thickness [µm]	320, 450, 1000	
Arrangement of channels	One dimensional, single row	
Dimensions of one channel (width x length) [µm]	50 x 8000 50 x 4000*	
Readout time [µs]	89	
Maximal count rate per channel [X-rays/s]	> 1×10^6	
Dynamic range [bit]	Selectable: 4, 8, 16, 24	
Energy range [keV]	4 – 40**	
Point-spread function	1 channel	
Cooling	Air cooled, thermal stabilization is recommended for $E_{threshold} \leq 4.5$ keV	
CE certification	Yes	
Connector	USB 3.0 micro-B female (with a screw-lock)	
Housing	1K	1D
Number of channels/module	1280	640
Sensor thickness [µm]	320, 450, 1000	320, 450
Sensitive area (width x length) [mm]	64 x 8	32 x 8, 32 x 4*
Power consumption [W]	< 1.7	< 1.7
Dimensions (WHD) [mm]	70 x 62 x 22	38 x 62 x 22

Weight [g]	180	107
Photo		

*Only with 320 µm x 4 mm sensors.
** X-ray energies down to 4 keV are available only with 320 µm x 4 mm sensors

5.3. Detector Control System DCS4

The Detector Control System DCS4 supplies the detector modules with power and enables the communication with the detector system. Furthermore, it controls the detector modules and handles the detector module data.

The detector modules are connected to the DCS4 (Table 5) via USB 3.0 device cables (Figure 7).
A fixation kit is mounted on DCS4 (Figure 6 and Figure 16). This kit enables USB cables to be locked on the DCS4 side. In the following paragraphs, figures representing DCS4 will be presented without fixation kit, for clarity.

TABLE 5: TECHNICAL DATA OF THE DECTRIS MYTHEN®2 DETECTOR CONTROL SYSTEM DCS4.

Frame rate [Hz]	1000 (X series); 100 (R series)
External Trigger/Gate	CMOS 5V levels
Power consumption DCS4 [W]	6.25
Cooling	Air cooled
Dimensions (WHD) [mm]	111 x 31 x 160
Weight [kg] excl. detector module and data cabeling	0.42
Operation voltage DCS4 [V DC]	12
Power consumption of detector system consisting of DCS4 and 4 detector modules [W]	15
Power supply	external power supply 12 V DC / 5 A

6. Detector Dimensions and Connectors

6.1. DECTRIS MYTHEN®2 1D

Do not touch the Mylar® foil to avoid damage of the sensors

Danger of electric shock. Do not touch the Mylar® foil. The sensors behind the Mylar® foil are operated at high voltages. Touching the Mylar® foil can cause an electrical shock.

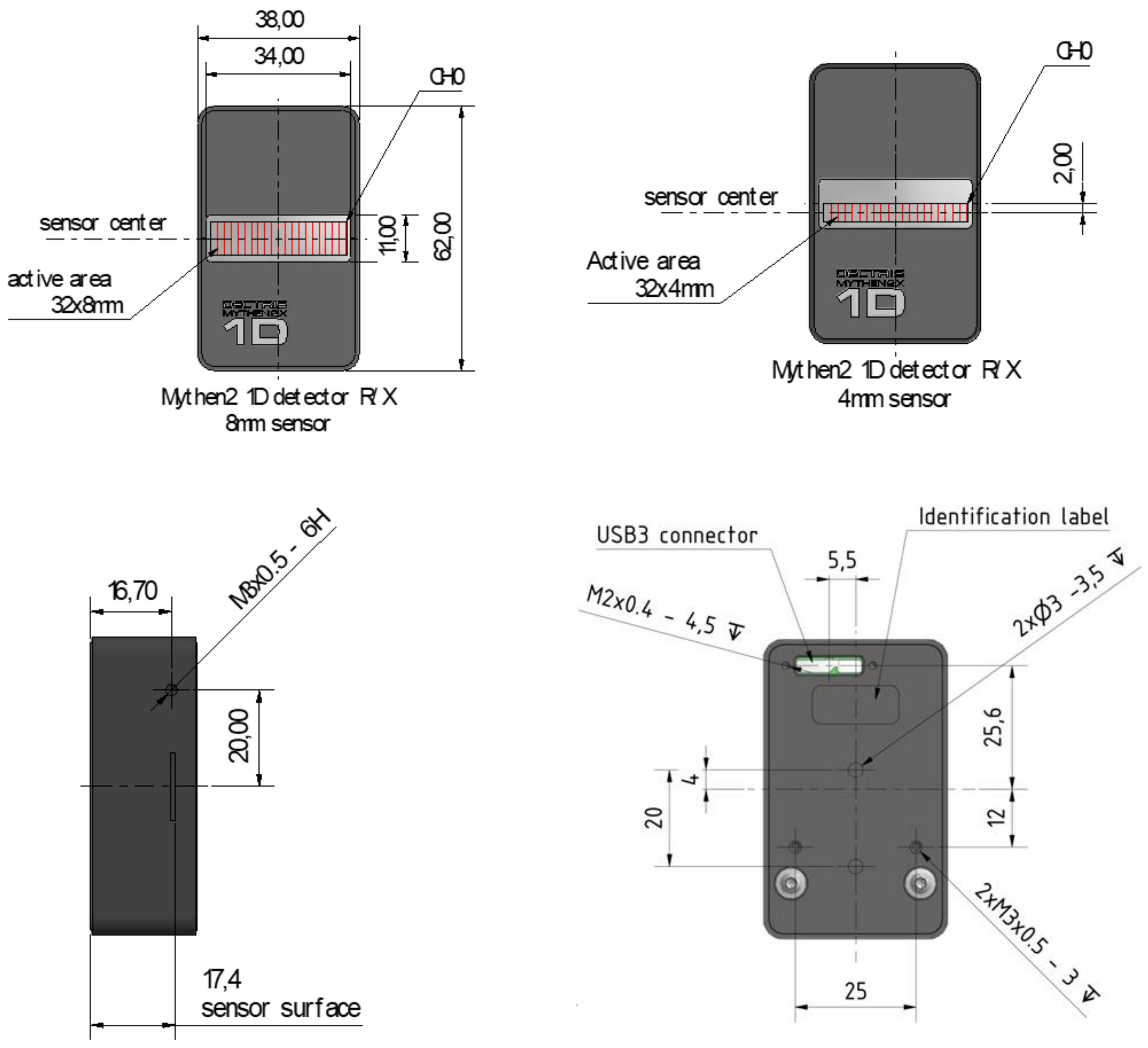

FIGURE 9: DECTRIS MYTHEN®2 1D: DIMENSIONS OF THE MODULE HOUSING AND POSITIONS OF THE TAP HOLES FOR MOUNTING THE DETECTOR.

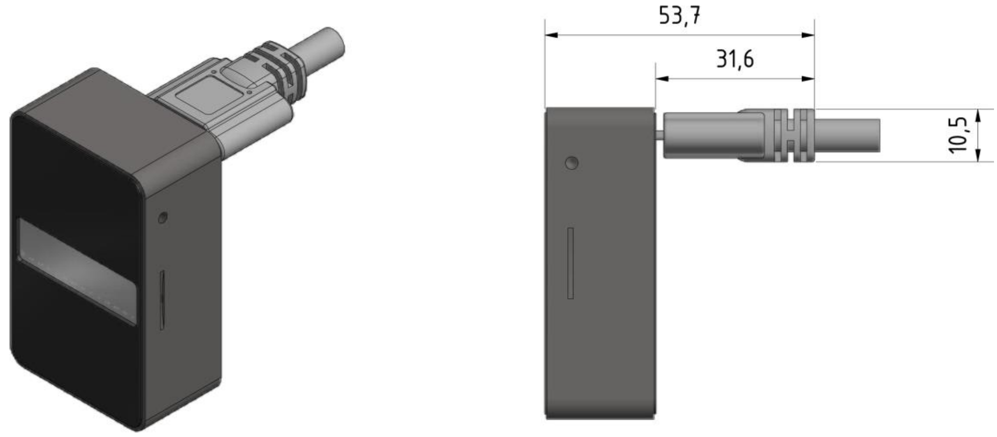

FIGURE 10: MOUNTING THE PLUG OF THE USB 3.0 CABLE TO THE DETECTOR HEAD. FIGURE REPRESENTS MYTHEN2 1D, BUT THE SETUP IS ALSO VALID FOR MYTHEN2 1K SYSTEMS. PLEASE NOTICE THE GAP BETWEEN THE DETECTOR HEAD AND USB CABLE.

6.2. DECTRIS MYTHEN®2 1K

⚠ Do not touch the Mylar® foil to avoid damage of the sensors

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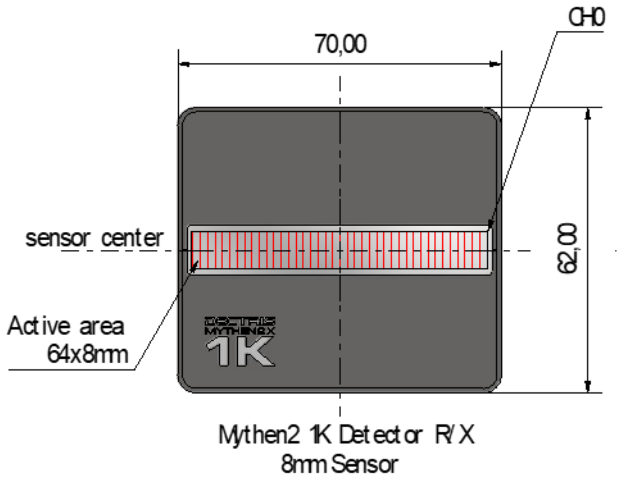
⚠ Danger of electric shock. Do not touch the Mylar® foil. The sensors behind the Mylar® foil are operated at high voltages. Touching the Mylar® foil can cause an electrical shock.



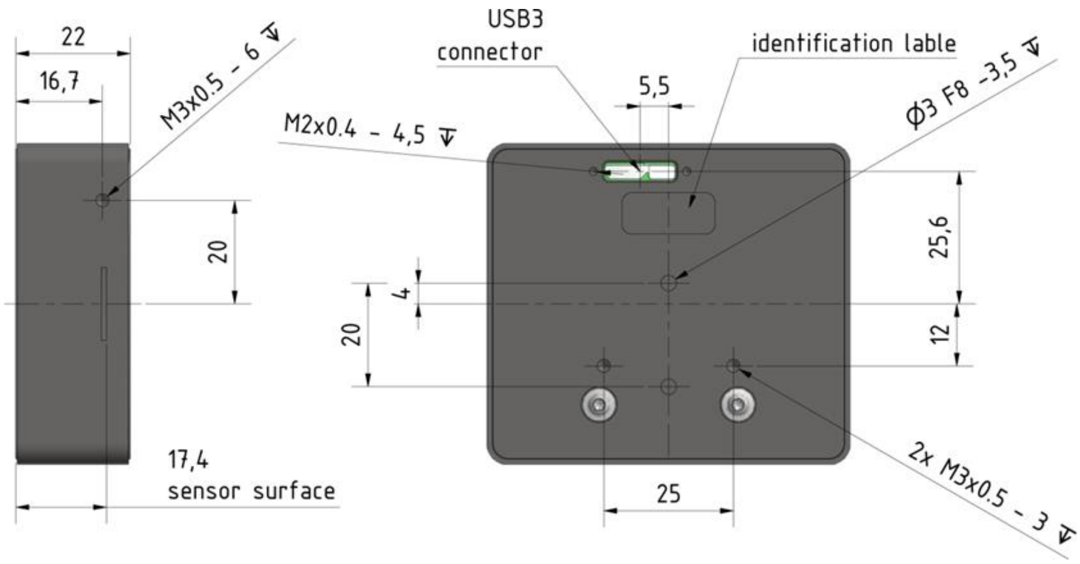
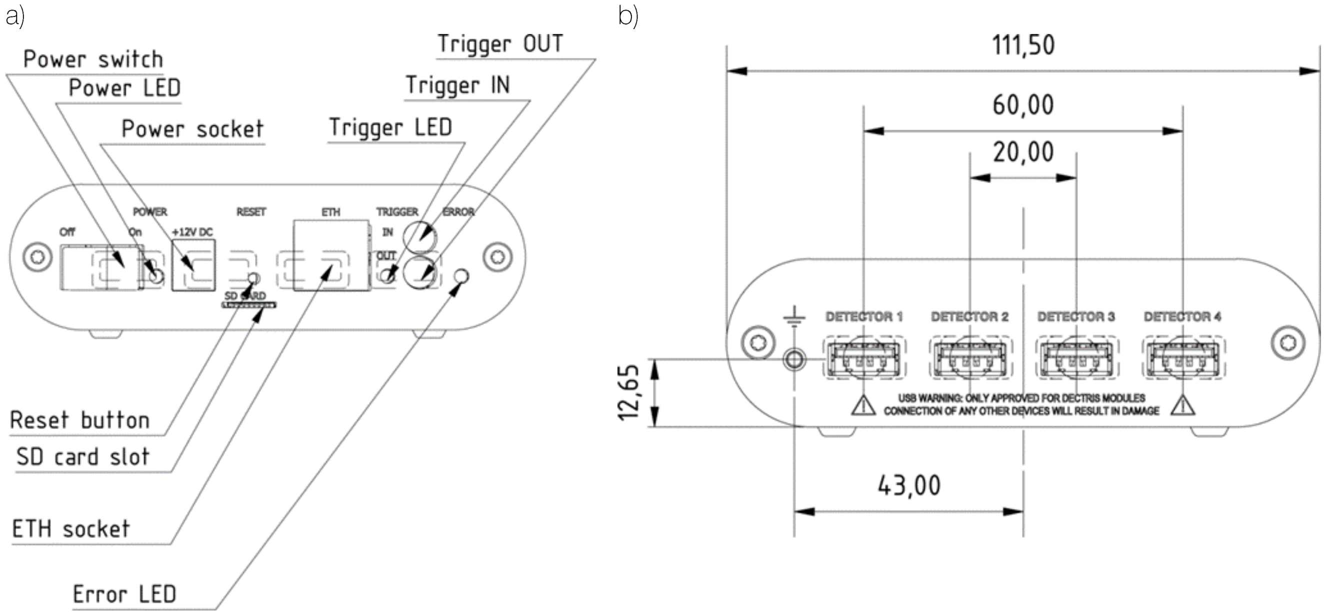


FIGURE 11: MYTHEN2 1K: DIMENSIONS OF THE MODULE HOUSING AND POSITIONS OF THE TAP HOLES FOR MOUNTING THE DETECTOR.

6.3. Detector Control System DCS4



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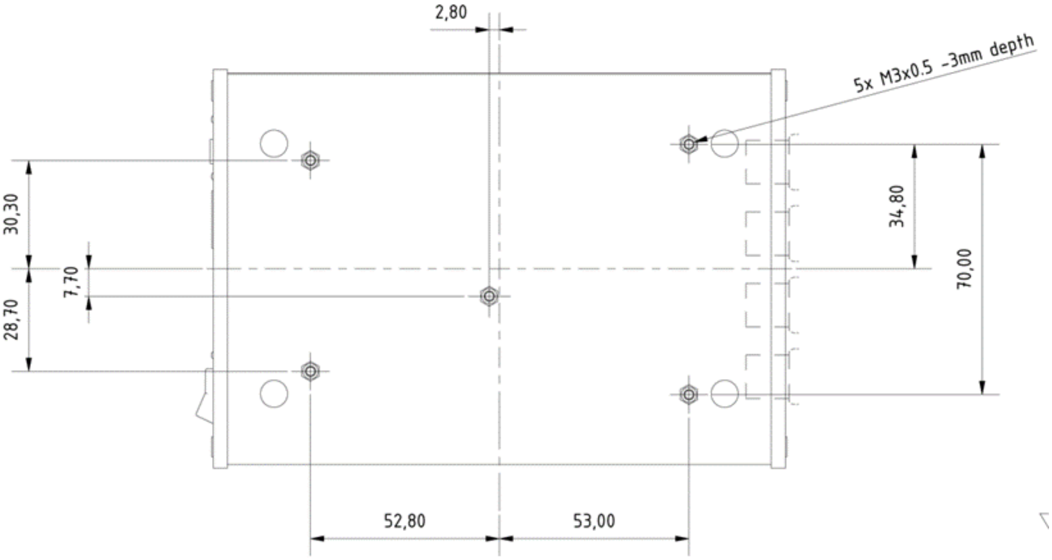


d)

FIGURE 12: DETECTOR CONTROL SYSTEM (DCS4): DIMENSIONS AND POSITIONS OF THE TAP HOLES FOR MOUNTING THE DCS4: (A) FRONT PANEL (B) BACK PANEL (C) DOWN AND (D) RENDERING MODEL OF DCS4.

6.4. Connectors and Connecting Cables DCS4

6.4.1. DCS4 Rear Panel

FIGURE 13: REAR PANEL OF THE DECTRIS MYTHEN®2 DETECTOR CONTROL SYSTEM DCS4.

TABLE 6: CONNECTORS AND LABELS OF THE DCS4 REAR PANEL.

Connector	Description
DETECTOR 1 - 4	Data connection of DCS4 to detector modules via USB 3.0 device cable. Connector: USB A 3.0 female ⚠ Do not connect devices to DCS4 other than ones delivered by DECTRIS®. Connecting different devices to DCS4 might destroy the devices and the DCS4. "USB Warning: Only approved for DECTRIS® modules. Connection of any other devices will result in damage."
⏚	Functional earth of the detector system (M4 screw-in tap hole). ℹ Although the detector may be grounded via mounting bolts, the detector system can be grounded additionally via this functional earth connector to establish a defined grounding.

6.4.2. DCS4 Front Panel

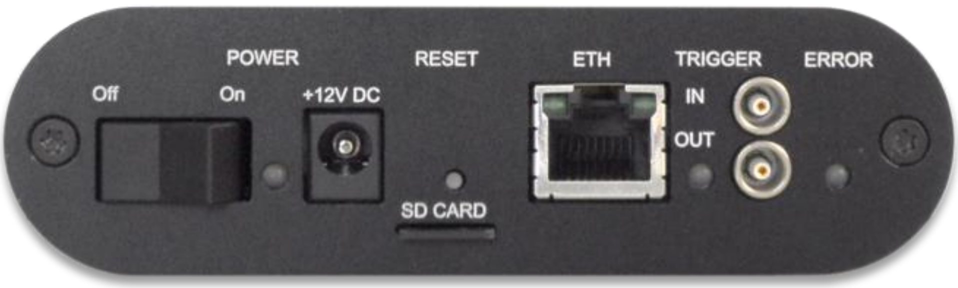


FIGURE 14: FRONT PANEL OF THE DECTRIS MYTHEN®2 DETECTOR CONTROL SYSTEM DCS4.

TABLE 7: CONNECTORS, LABELS AND LEDS ON THE DCS4 FRONT PANEL.

	Labeling	Description
Power	On - Off	Power switch
	LED	After switching on the DCS4 the power LED is green. During FW loading it is orange. During the flash process, the LED is flashing. After completing the booting/initialization phase the LED becomes green again.
	+12V DC	+12V DC power connection ⚠ Use only the power supply delivered by DECTRIS®.
Reset	SwitchS	Reset switch for the DCS4. ⚠ Pressing the RESET switch reboots the operating system of the DCS4. This procedure may take a few minutes.
	SD Card	Micro SD card memory slot. ⚠ Do not connect any SD cards/devices to DCS4 other than ones delivered by DECTRIS®. Connecting different SD cards/devices to DCS4 might destroy the SD card/device and the DCS4.

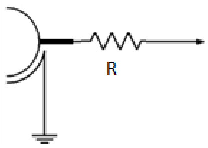
ETH

ETH

Local area network connector RJ45.

Cat 5 network cable is recommended.
The initial network settings are mentioned on the Factory Acceptance Test (FAT) sheet delivered with the detector system.

Trigger

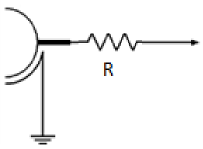


The trigger input circuit connected to the IN connector expects a CMOS 5V signal level.

- High level: > 3.5 V
- Low level: < 1.5 V
- Impedance: R = 500 kOhm
- Connector: LEMO EPY.00.250.NTN
- Appropriate plug: LEMO FFA.00.250.NTAC22

There are LEMO – BNC adapter available (LEMO ABF.00.250.CTA). Ask DECTRIS®. support for details (see Section 1.1 for support).

5.0 V is the maximum voltage.
Applying a higher voltage will destroy the input.



The trigger output circuit connected to the OUT connector delivers a CMOS 5V signal level.

- High level: > 4.4 V
- Low level: < 0.5 V
- Impedance: R = 10 – 40 Ohm
- Connector: LEMO EPY.00.250.NTN
- Appropriate plug: LEMO FFA.00.250.NTAC22

The trigger output is on high level when the detector is making an exposure (“active high”).

There are LEMO – BNC adapter available (LEMO ABF.00.250.CTA). Ask DECTRIS®. support for details (see Section 1.1 for support).

	LED	The trigger LED is orange when the detector is taking data
Error	LED	The Error LED is normally off. In case of missing files for initializing the detector module, it becomes orange. In case of a readout error, it becomes red.

6.5. Power Supply

The DECTRIS MYTHEN®2 detector system is delivered with a power supply.
The output cable length is 1.8 m. The length of the input power cord is 2 m. The input cord connector is C7.

TABLE 8: POWER RATINGS FOR POWER SUPPLY OF DETECTOR CONTROL SYSTEM DCS4.

Power Supply DCS4	Input range specified on the back of the power supply. Input: 100 – 240 VAC +10/-10%; 50 – 60 Hz / 400 mA ⚠ Connecting to the wrong supply voltage will destroy the power supply and could damage the detector. ⚠ Use only the power supply delivered by DECTRIS®. The output voltage is +12 VDC / 5 A.

⚠ Make sure that the power supply has adequate ventilation.

6.6. Data Cable

The CE certified USB 3.0 device cable with ferrite bead is 3 m long.

TABLE 9: SPECIFICATION FOR CE CERTIFIED DATA AND POWER CABLE.

Connector	Description
-	Data and power connection of detector module to DCS4 is done via CE certified USB 3.0 device cable. This cable comes with a screw-lock plug. Connector at DCS4 end of the cable: USB A 3.0 male Connector at detector module end of the cable: USB micro-B 3.0 male The ferrite beads are 2 cm away from the USB connectors.

Be aware of:

- Connector polarity
- Deforming connector pins by accident
- Connecting detector module if DCS4 is powered off

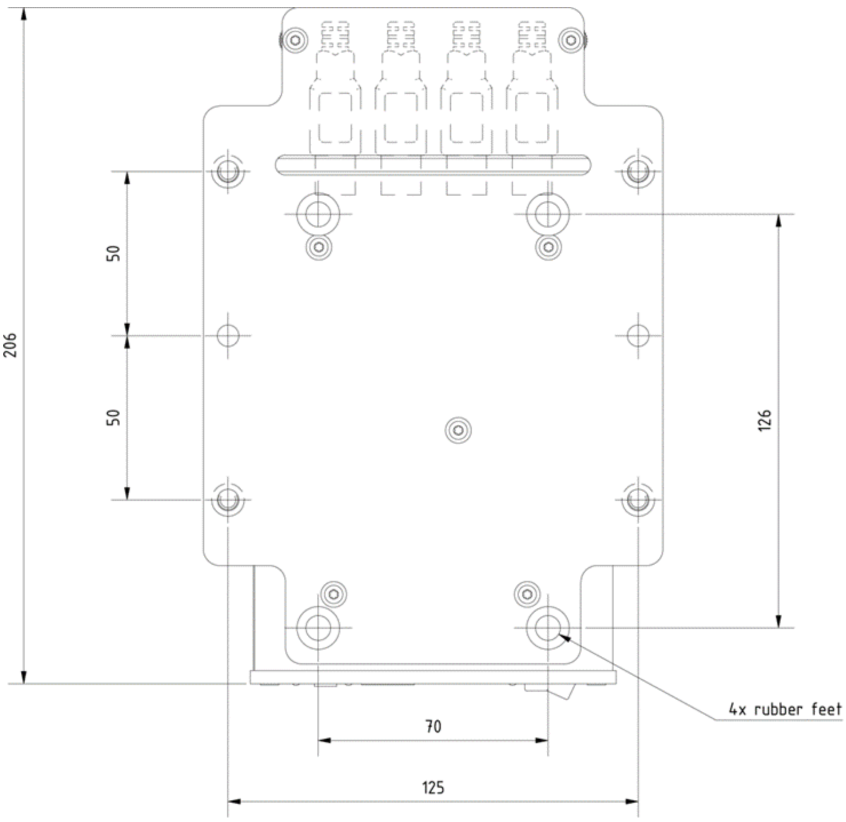
Use only the CE certified data and power cables delivered by DECTRIS®.

"USB Warning: Only approved for DECTRIS® modules. Connection of any other devices will result in damage."

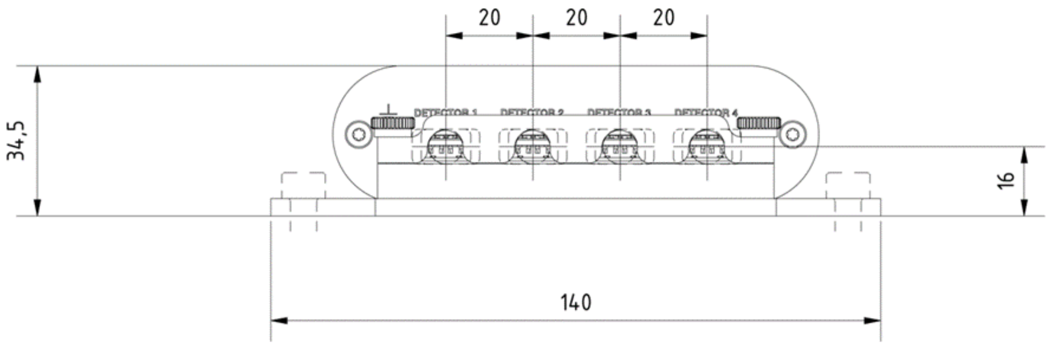
While connecting USB cable to detector head and DCS4, make sure to handle it with care. Screw-lock system is fragile.

6.7. Fixation Kit

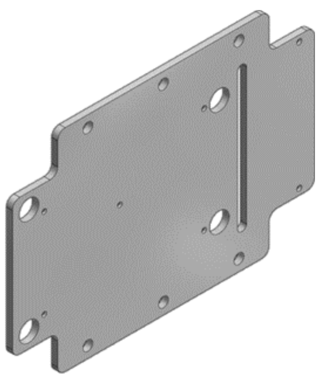
a)



b)



c)



d)

FIGURE 15: FIXATION KIT: DIMENSIONS AND POSITIONS OF THE TAP HOLES (A) ADAPTER PLATE (B) BASES AND RENDERINGS OF (C) ADAPTER PLATE (D) BASES.

a) b)

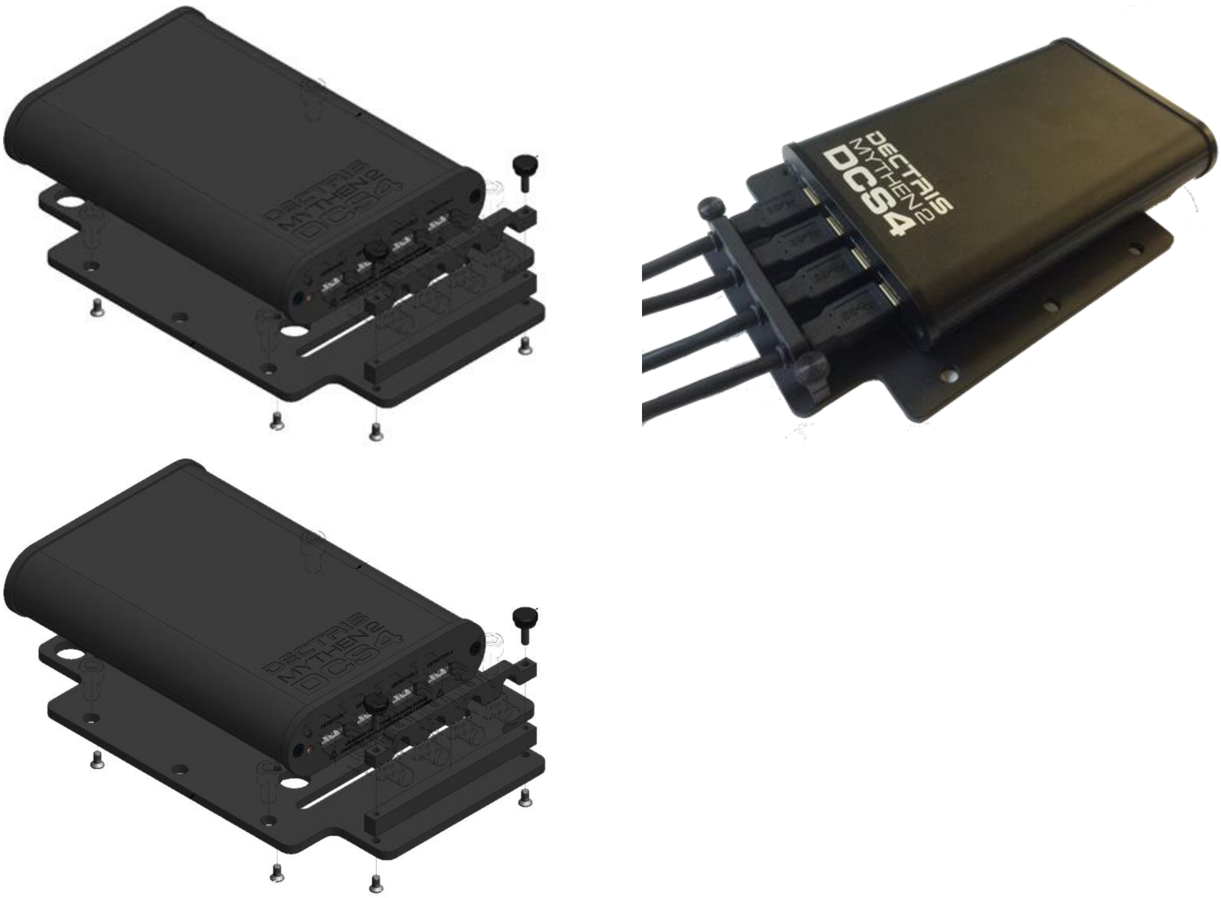


FIGURE 16: FIXATION KIT (PLATE AND TWO BASES, UPPER AND LOWER ONE) AND DCS4 (A) SCHEMATIC DRAWING AND (B) FIXATION PLATE INSTALLED ONTO DCS4.

7. Installing the Detector System

7.1. Transport Considerations

Avoid vibration and shock when moving the detector.

The detector has been delivered in a robust transport box. Please keep this transport box for transport or storage purpose.

7.2. Mounting the Detector System

The detector module can be mounted in any position using the holes in the rear panel (M3 screws).

The Detector Control System (DCS4) and the power supply can be mounted in any position. For mounting the DCS4, the holes on its bottom can be used (M3 screws). For applications that require USB cables to be fixed to the DCS4, the fixation kit can be mounted on the DCS4 (M3 screws, Figure 15 and Figure 16). For mounting DCS4 with the fixation plate into desired position, M6 crews can be used.

After mounting the detector module(s) and the detector control system (DCS4) mechanically, the modules have to be connected to the DCS4 using the USB cables shipped with the detector system. Make sure to leave 1 mm gap between the USB cable and detector head (Figure 10).

For powering the detector system, the DCS4 has to be connected to the proper power supply. The power supply has to be connected to the proper main. For details, please see Section 0 (Technical Specifications).

Make sure that the Detector Control System (DCS4), the detector module(s) and the power supply have adequate ventilation.

Make sure that the USB device cable connecting the Detector
Control System (DCS4) and the detector module has a proper strain relief at both connectors.

Use only the USB device cables delivered by DECTRIS®.

“USB Warning: Only approved for DECTRIS® modules. Connection of any other devices will result in damage.”

Vacuum Operation
Only detectors purchased with optional vacuum warranty may be operated in vacuum. Warranty void otherwise!
When using the detector in vacuum strictly follow the in-vacuum instructions given in the additional Vacuum Specifications document!
To see if a detector has a vacuum warranty check whether the vacuum warranty option is included in the order confirmation.

Use only the power supply delivered by DECTRIS®.

While connecting the USB cable to detector head and DCS4, make sure to handle it with care. The screw-lock system is fragile. Do not push the USB cable onto the detector head. Mind the 1 mm gap between the detector head and USB cable (see **Figure 10).**

Although the entire detector system might be grounded via the mounting bolts, the detector system can be grounded additionally via the functional earth connector at the DCS4 to establish a defined grounding.

7.3. Setting up the Computer

To control the DECTRIS MYTHEN®2 detector system, a computer with a LAN connection is required. The DCS4 is delivered with the fixed IP 192.168.0.90. The network card of the computer has to be configured to be in the same subnet as the DCS4, e.g.

- IP: 192.168.0.100
- Subnet mask: 255.255.255.0

After setting up the computer and connecting it with the DCS4 network port using an Ethernet cable, the computer will be able to communicate with the DCS4.

To power the detector system, the DCS4 has to be connected to the power main with to the proper power supply. For details, please see Section 0, technical specifications, in this document. To communicate with the DCS4, the computer has to be connected by a network cable:

- To a local area network (LAN) in case of DHCP running on DCS4.
- Directly to the control PC in case of a fix IP of the DCS4.

Operate only detector module(s) with the corresponding DCS4, delivered by DECTRIS®. as a part of detector system.

See Factory Acceptance Test sheet delivered with the detector system for reference:

- DCS4 with detector serial number e.g. M-1002
- Detector module e.g. SN1004

In case of using the DECTRIS MYTHEN® Web Client, continue reading the following Section 7.4, DECTRIS MYTHEN® Web Client.

In case of using your own integration software to control the DECTRIS MYTHEN® detector system, go on with the example code described in the document Socket Interface Specifications, available from DECTRIS®.

7.4. DECTRIS MYTHEN® Web Client

All graphics in this document show the Web Client as it appears in the case of one detector module connected to DCS4, but the description is valid for all DECTRIS MYTHEN®2 detector configurations (1 to 4 modules).

7.4.1. Software Installation

The only prerequisite to run the DECTRIS MYTHEN® Web Client is a browser that supports JavaScript and WebSockets. DECTRIS® recommends using Google Chrome 16+, but Firefox 11+ is also compatible.

7.4.2. Starting the Web Client

Open the web browser and enter the IP of the DCS4 in the address bar (by default 192.168.0.90). You should see the DECTRIS MYTHEN® start screen, as shown in Figure 17. If you do not see the start screen, please check that the system is powered and that it is properly connected to the PC. Make sure that the network settings of your PC are correct. Next, choose the menu item "Use MYTHEN Web Client".

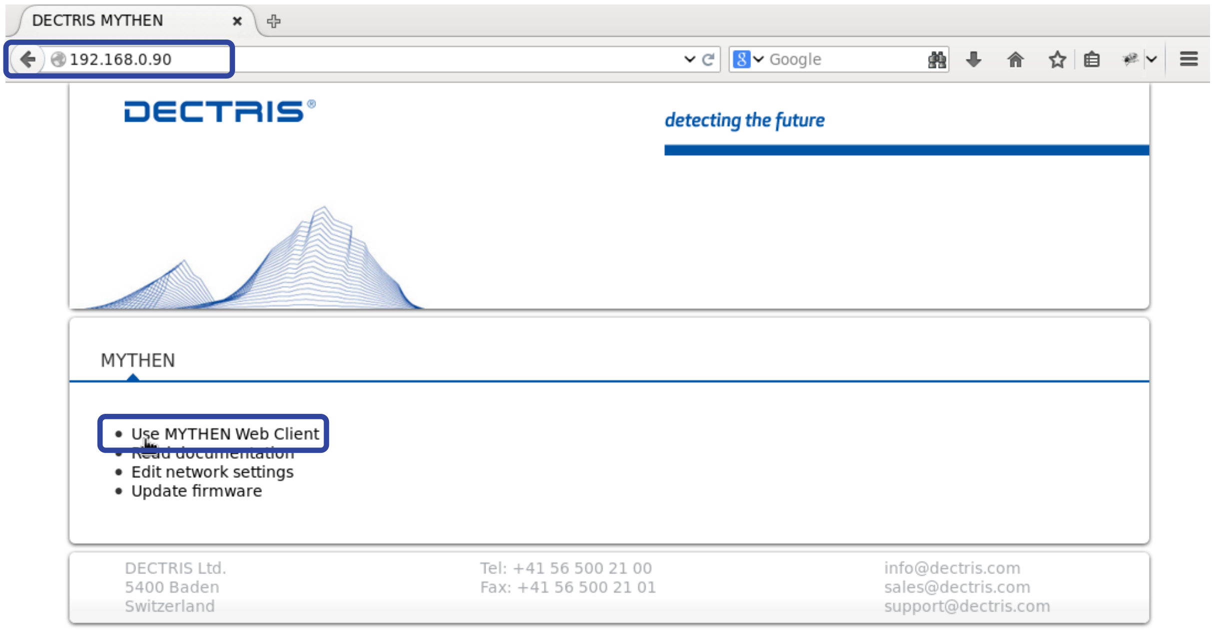


FIGURE 17: MYTHEN WEB CLIENT START SCREEN.

After a few seconds, the DECTRIS MYTHEN® Web Client will show up in the browser (Figure 18). The green bar on the top indicates that a connection to the DECTRIS MYTHEN®2 detector system has been established successfully. The serial number of the system is displayed on the upper right part of the screen. In case the status bar does not turn green, make sure that you use a supported browser version.

FIGURE 18: MYTHEN WEB CLIENT.

7.4.3. Acquisitions with Web Client

When the connection has been established, the system is ready for data collection. In general, an acquisition consists of several frames. In the left part of the screen (Figure 18 and Figure 19), main settings can be specified: the exposure time of one frame, the number of frames to be acquired, and the energy of your X-ray source.

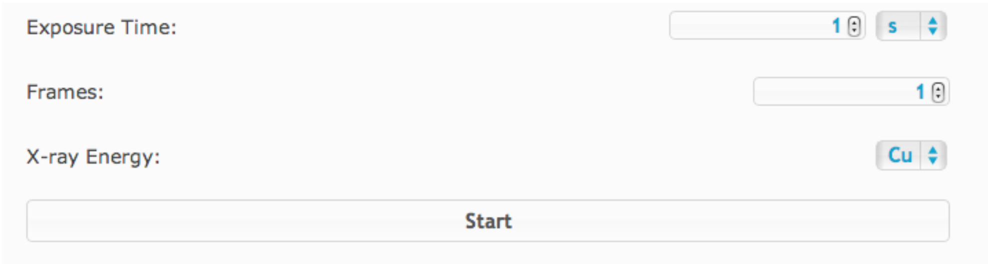


FIGURE 19: MAIN ACQUISITION PARAMETERS.

In order to start an acquisition, click the "Start" button. After the exposure has finished, the recorded counts are displayed as a function of channel number. Without an X-ray source, only very few counts due to background radiation like natural radioactivity or cosmic rays can be observed (Figure 20).

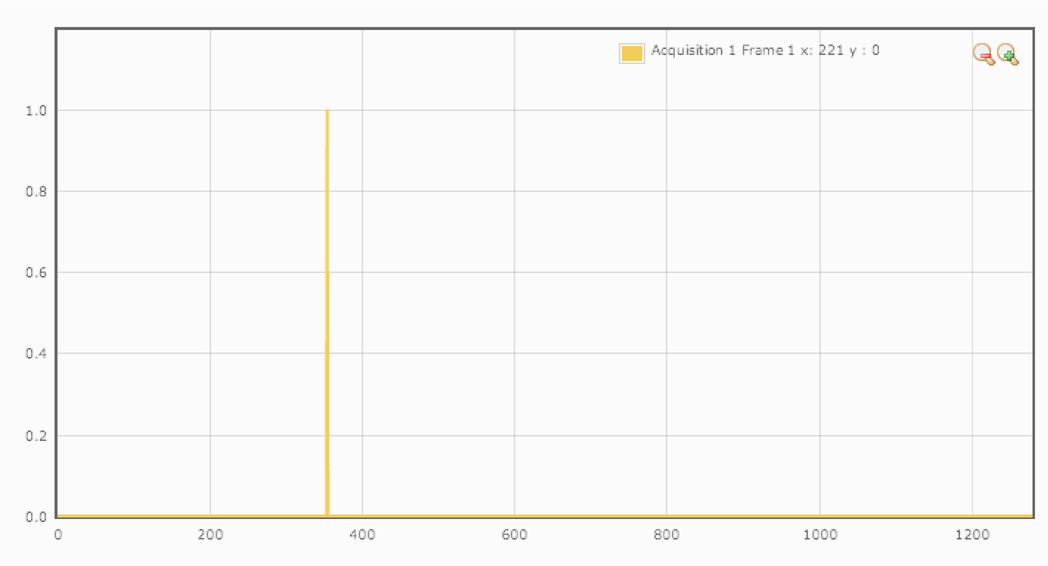


FIGURE 20: RESULT OF A SHORT ACQUISITION USING DECTRIS MYTHEN®2 1K SYSTEM (1280 CHANNELS) WITHOUT X-RAY SOURCE.

The data of all frames and acquisitions can be accessed in the "Acquisition" accordion, on the right part of the screen (Figure 21). The data can be downloaded as compressed ZIP file by pressing the "Save" button (due to technical limitations the saved file may not have a proper file extension when using older versions of Firefox).

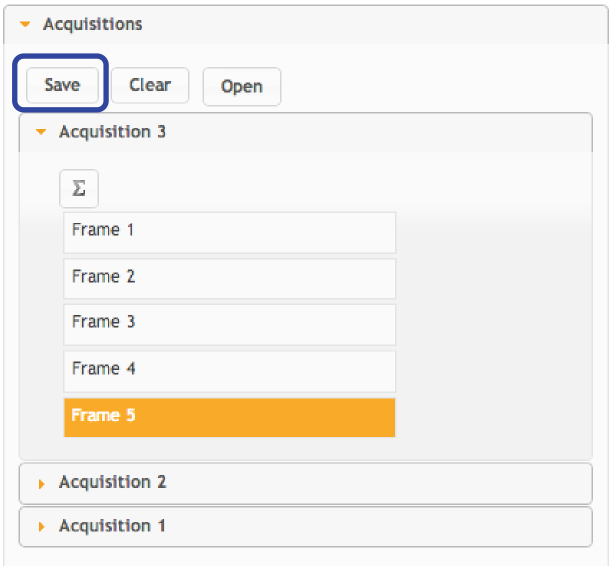


FIGURE 21: THE ACQUISITION ACCORDION.

7.4.4. Customizing the Acquisition Settings

The acquisition can be fully customized in the "Acquisition Settings" accordion. For example, the dynamic range, the applied data corrections (treatment of bad channels, flat-field) and the delay after each acquired frame can be defined (Figure 22). For more details, please see the complete documentation (Section 7.4.5).

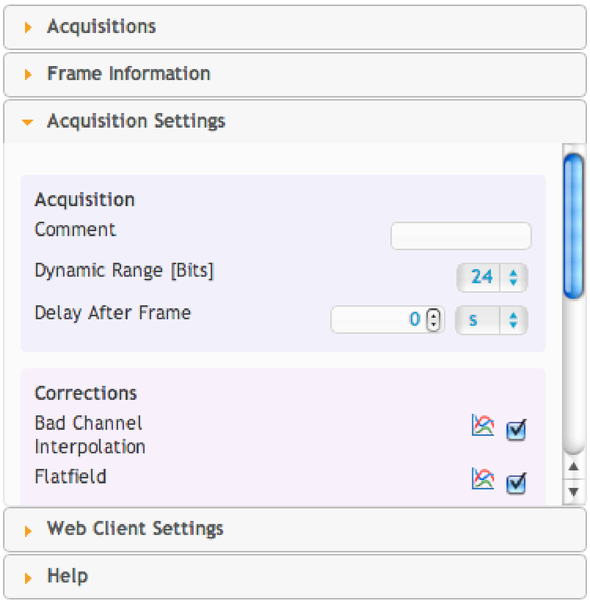


FIGURE 22: ACQUISITION SETTINGS ACCORDION.

In order to individually adjust the threshold energy and the X-ray energy, the "Expert Mode" has to be enabled in the Web Client Settings accordion. Two sliders for these parameters will become available in the main panel, as presented on Figure 23 and Figure 24.

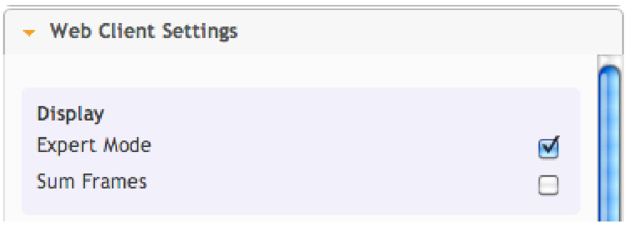


FIGURE 23: ENABLING THE EXPERT MODE.

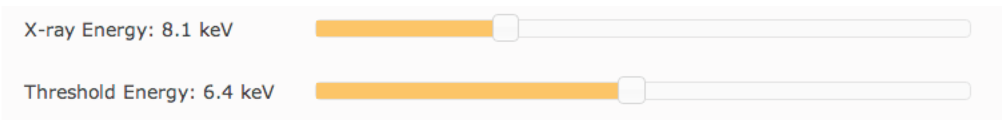


FIGURE 24: SLIDER FOR ADJUSTING THE X-RAY ENERGY AND THE THRESHOLD ENERGY.

7.4.5. Complete Documentation

The complete documentation of the Web Client can be found in the "Help" accordion on the right (Figure 25).

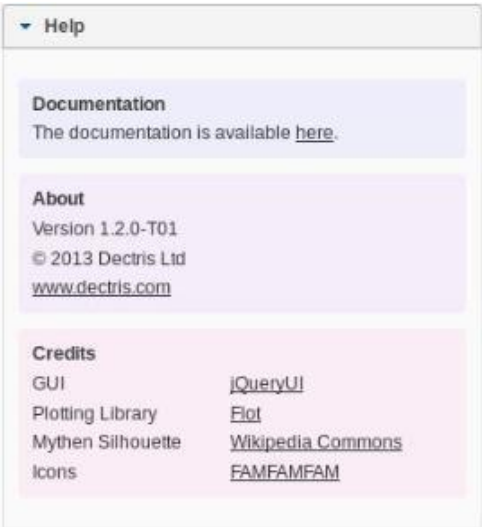


FIGURE 25: ACCESS TO THE FULL DOCUMENTATION.

8. Changing Network Settings

The DCS4 hosts an embedded Linux, delivered with the static IP address 192.168.0.90. The initial configuration of your system, its IP address and MAC address, are described on the System Information Sheet (SIS; delivered with each system). In the following paragraphs, the method to change the network settings is described for the case that the DCS4 has its default IP address 192.168.0.90.

Depending on the network settings of the DCS4, in the following, the IP 192.168.0.90 has to be replaced by the current IP address of your DCS4.

Changing the network configuration of the DCS4 can cause malfunction of the communication, in which case the DCS4 will be no longer accessible. If you are not sure, do not change the network settings. If the communication to the DCS4 is lost, it can be reset to factory settings as described in Section 10.

Access your DCS4 with your web browser and your current IP address (Figure 26).

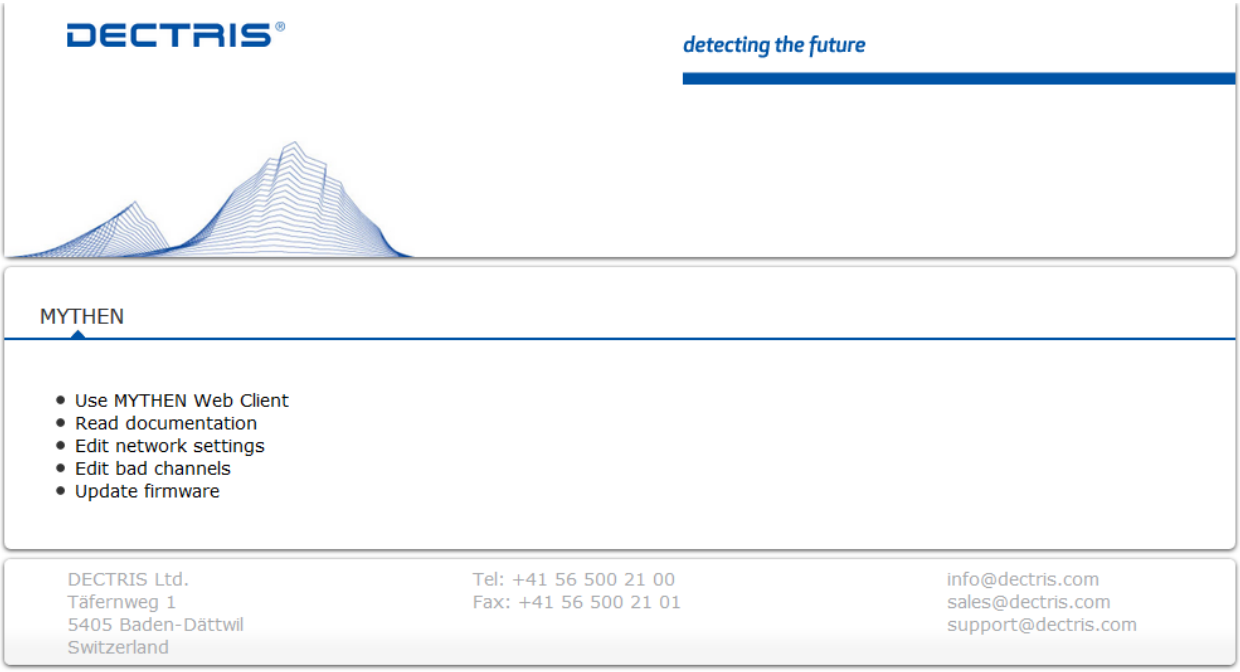


FIGURE 26: LOGIN TO THE DCS4 VIA THE WEB BROWSER.

By clicking on "Edit network settings" you will be prompted to enter your username and password. The username is "admin" and the password is given on the system information sheet (Figure 27).

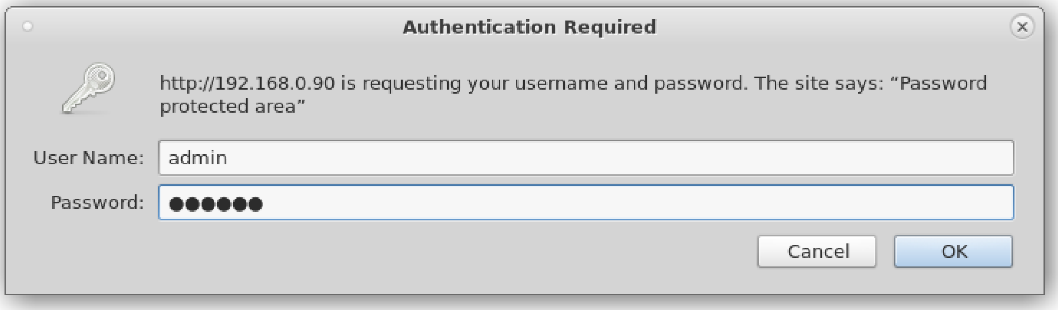


FIGURE 27: ENTERING YOUR CREDENTIALS.

After entering your credentials, a web page opens where you can change the boot protocol (either fixed IP or DHCP), the IP, the net mask, broadcast, the gateway and the MAC address.
After making your changes and checking that all settings are correct, press the submit button. In order to activate the changes, the DCS4 has to be power-cycled.

9. Triggering and Gating

For synchronization purposes, DECTRIS MYTHEN®2 detector systems can be triggered or gated externally. The detector control system has an external input connector, which is located at the front panel of the Detector Control System (DCS4) and labeled EXT IN (for technical details, please see Section 4, DECTRIS MYTHEN®2 detector system, and Section 0, technical specifications).

In trigger mode, the detector system is sensitive to the rising edge of the trigger signal. In gating mode, the detector system is sensitive to the length of a gating pulse. The length of the pulse defines the acquisition time.

The signal connected to the EXT IN connector is sampled with the internal clock frequency of 50 MHz. Consequently, a time jitter has to be taken into account (see Section 9.1.5).

The connector labeled EN OUT at the front panel of the Detector Control System (DCS4) gives access to an activity signal, which is on high level ("active high") during an acquisition. The corresponding LED next to the EN OUT connector indicates the activity of the detector system i.e. during an acquisition of the detector system the LED is switched on. The EN OUT signal can be used e.g. to synchronize other equipment with the DECTRIS MYTHEN®2 detector system.

The trigger or gate mode can be activated in the DECTRIS MYTHEN® Web Client, or by software commands sent to the Socket Server. This document covers the former, for the latter see the document "Socket Interface Specification", available from DECTRIS®.

The described timing and level aspects of the externally applied trigger/gate signal is valid for both cases independent of the two different activating methods.

⚠ The Detector Control System expects at the TRIGGER IN connectors a trigger or gate signal which is not constant in time i.e. this input is sensitive on rising or falling edge of the signal.

9.1. Triggering

⚠ All following graphs were recorded using DECTRIS MYTHEN®2 hardware and firmware version 2. New graphs will be added in future versions of this document. Please contact DECTRIS® support (see Section 1.1) for details.

9.1.1. Overview Trigger Modes

The DECTRIS MYTHEN®2 has three different trigger modes:

- The internal trigger mode: a single frame or a set of multiple frames can be recorded without the need of an external signal.
- The single trigger mode: a single frame or a set of multiple frames can be recorded with one external trigger signal.
- The continuous trigger mode: a set of multiple frames can be recorded. For each frame, an external trigger signal is needed.

9.1.2. Internal Trigger

By default, the acquisition starts automatically after the socket server receives a "-start" command from the Web Client or a user application. Between the receipt of the "start" command and the start of the acquisition, the server configures the detector for data collection. Depending on the enabled data corrections, this may take up to a few seconds.
After a "-start" command, the programmed acquisition sequence is executed. An acquisition consists of a number of frames, each lasting for the programmed acquisition time, t_{acq}. The acquisition time and the number of frames can be programmed in the main panel of the DECTRIS MYTHEN® Web Client or by the commands "-time" and "-frames".
The delay between two frames, t_{after}, is given by the "Delay after frame" setting in the DECTRIS MYTHEN® Web Client or the "-delafter" command. This delay cannot be shorter than the readout time of the ASIC. The readout time depends on the number of bits read out (default is 24 bits), but is always shorter than 100 µs. The readout times can be read out with the command "-get readouttimes". The user interface allows the delay between two frames to bet set below the readout time, which results in a delay between two frames equal to the readout time. Figure 28 represents the case where acquisition consists of three frames.

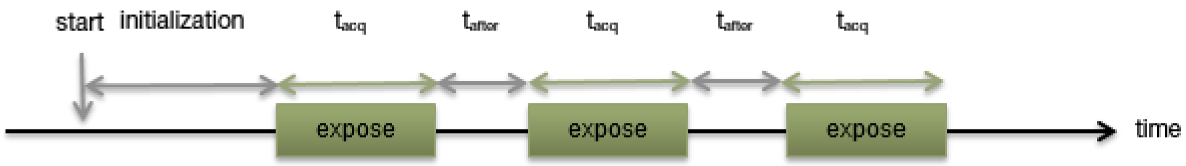


FIGURE 28: DATA ACQUISITION CONSISTING OF THREE FRAMES.

The delay between two frames must be long enough, so that the actual frame rate does not exceed the maximum frame rate f_{max} that is allowed for the detector system. In the internal trigger mode, the following equation must be met for acquisitions with more than one frame: $t_{acq} + t_{after} > 1/ f_{max}$.

9.1.3. Single Trigger

In the single trigger mode, the detector system waits for an external trigger after the "start" command. After detecting the trigger signal, the system waits for a time t_{bef}, before starting the exposure of the first frame.

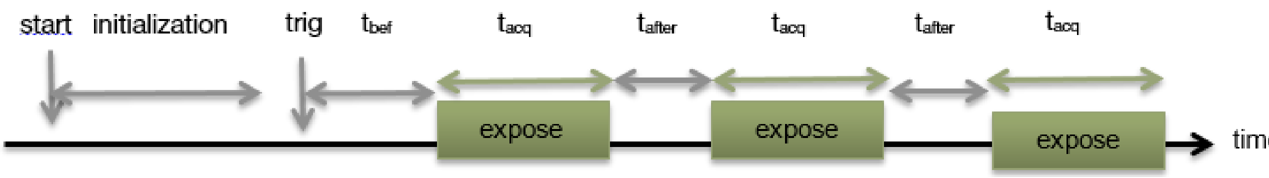


FIGURE 29: SINGLE-TRIGGER MODE.

In single trigger mode, the following equation must be met: $t_{acq} + t_{after} > 1/ f_{max}$ for acquisitions with more than one frame.

9.1.4. Activating the Trigger Mode

The trigger and gate options can be found in the “Acquisition Settings” accordion. By default, the external triggering mode is not activated. In order to activate the trigger mode, open the “Acquisition Settings” accordion and select the “Single” trigger mode (Figure 30 a, b).

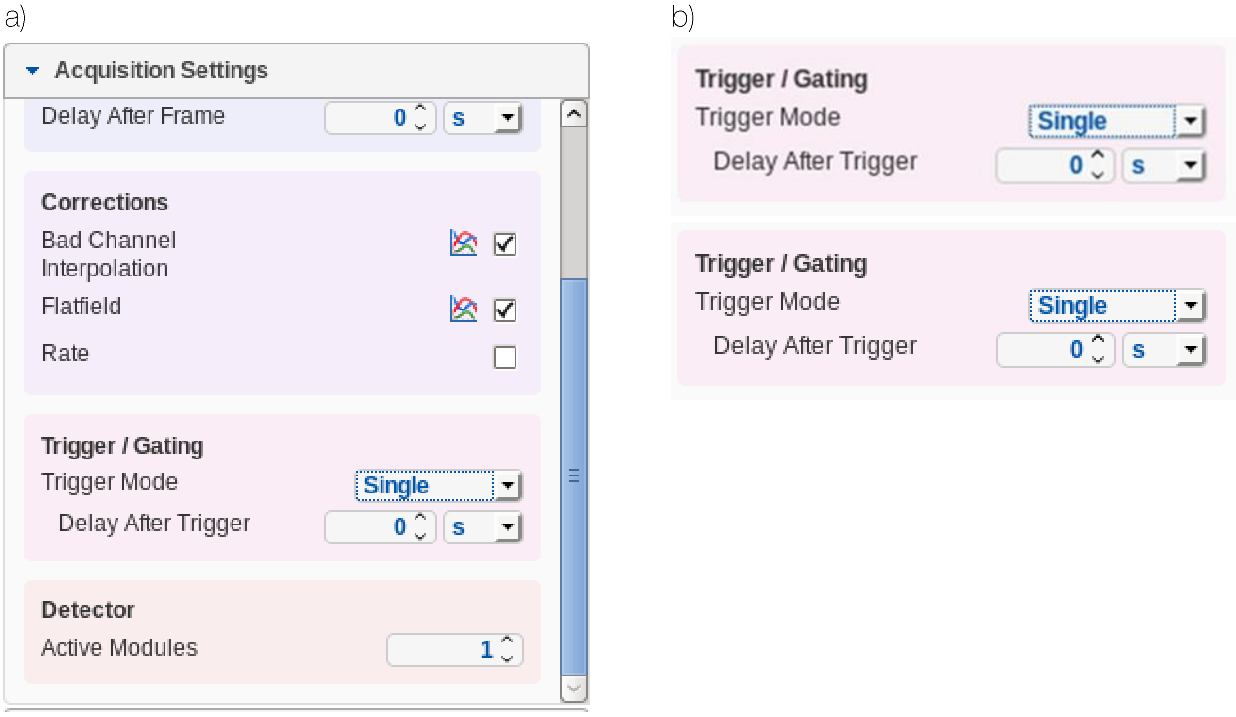


FIGURE 30: (A) TRIGGER AND GATING OPTIONS IN THE ACQUISITION SETTINGS ACCORDION AND (B) USING THE SINGLE-TRIGGER MODE.

Figure 31 shows EXT IN and the EN OUT signals during a measurement of 1 ms. The blue signal is the trigger signal connected to the EXT IN, and the green signal is the EN OUT signal, which is on high level during an acquisition. By default, the rising edge of the EXT IN signal is used for triggering the acquisition.
When using the Socket Interface, the “Single” trigger mode can be activated with the command “-trigen 1”.

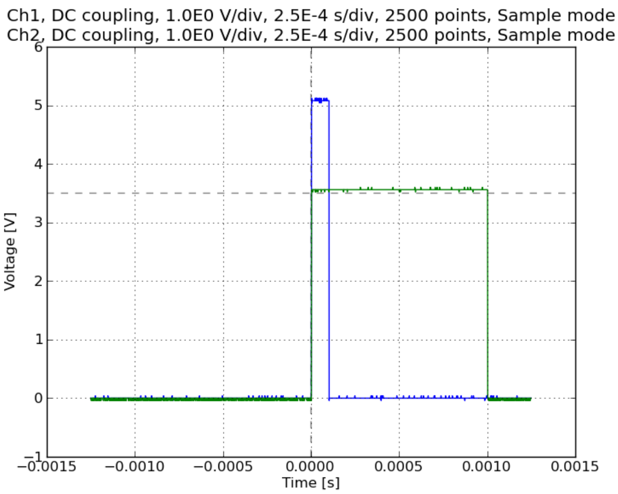


FIGURE 31: THE EXT IN SIGNAL (BLUE) AND THE EN OUT SIGNAL (GREEN) DURING AN ACQUISITION.

9.1.5. Trigger Level and Time Jitter

Figure 32 shows trigger signal EXT IN and the corresponding EN OUT signal. The overshoot on the EN OUT signal is an artifact of the setup used. There is a time delay from the moment when the signal EXT IN reaches 3.5 V to the starting point of the data acquisition (rising edge of EN OUT). In addition to this delay there is a variable time jitter of 20 ns. The reason for this is that the Detector Control System samples the EXT IN signal with its internal clock frequency of 50 MHz. The external EXT IN signal is normally not synchronized with the internal clock frequency, and therefore a time jitter of 20 ns can be caused. Depending on the edge steepness, this time jitter causes an apparent variation in the trigger level.

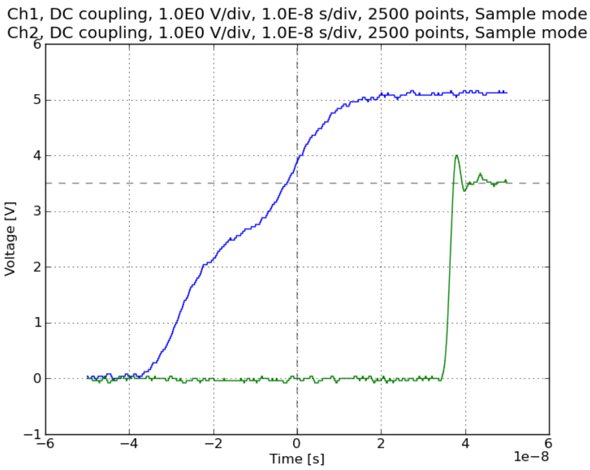


FIGURE 32: TRIGGER LEVEL: EXT IN SIGNAL (BLUE) AND EN OUT SIGNAL (GREEN).

9.1.6. Delay Before Frame

In the Trigger / Gating section the "delay after trigger" time (equivalent to the delay before frame and denoted above as t_{bef}) can be set. It defines the time between the activating edge of the trigger pulse and the start of the measurement (Figure 33, Figure 34).

When using the Socket Interface, the delay before the frame can be set with the command "-delbef <time>".

FIGURE 33: DELAY TIME (2 MS), AFTER WHICH THE EXPOSURE IS STARTED.

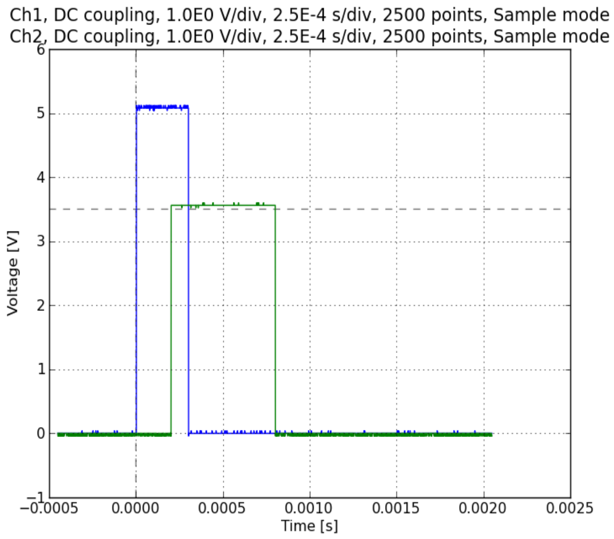


FIGURE 34: TIMING OF THE EXT IN TRIGGER SIGNAL (BLUE) AND EN OUT SIGNAL (GREEN) FOR RISING AND FALLING EDGE WITH ADJUSTED DELAY TIME OF 200 µS.

9.1.7. Trigger Signal and Multiple Readouts

The detector system can be set to perform several readouts consecutively, started with one trigger pulse. In order to perform this kind of measurement, the "single" trigger mode has to be chosen, and the number of frames has to be set (Figure 35).
If the "Sum Frames" check-box in the Web Client settings accordion is marked, the results of the consecutive readouts are summed up and the sum is displayed in the Web Client after individual read-outs. Apart from the "Sum Frames" check box, there is always a separate data file per frame.

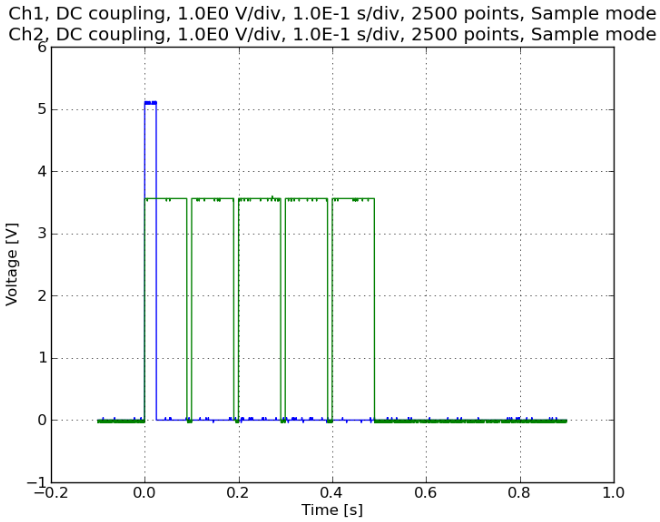


FIGURE 35: EXT IN SIGNAL (BLUE) AND EN OUT SIGNAL (GREEN) OF FIVE CONSECUTIVE READOUTS.

The delay between two frames can be set to a certain value by using parameter "Delay after frame" option (Figure 36). For a detector operating in 24-bit mode, the minimal delay given by the readout time of the ASICs is 89 µs. If a shorter delay is set in the Web Client or the Socket Server, the actual delay between two frames is equal to this readout time.

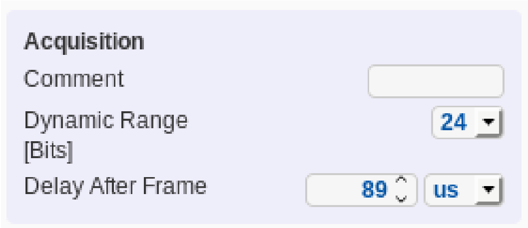


FIGURE 36: DELAY OF 0.89 µS AFTER EACH FRAME.

9.1.8. Continuous Trigger

In this mode, for each frame a trigger pulse is required (Figure 37). In the continuous trigger mode, the following equation must be met for acquisitions with more than one frame: $t_{acq} + t_{bef} > 1/ f_{max}$.
With the trigger-mode combo-box the "Continuous" mode can be activated (Figure 38). Setting up a measurement of 5 frames (readouts), each with 10 ms exposure time and continuous trigger signal of 5 pulses is shown on the Figure 40. The corresponding EXT IN and EN OUT signals are depicted in Figure 41.

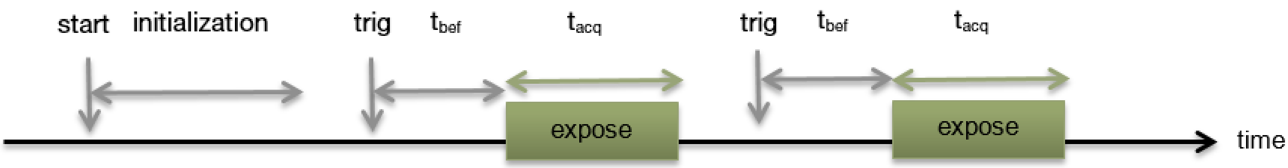


FIGURE 37: PRINCIPLE OF CONTINUOUS TRIGGER MODE.

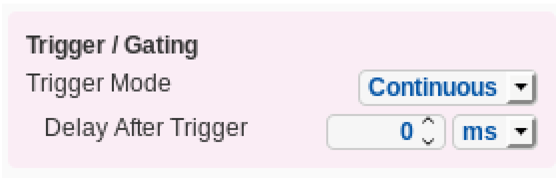


FIGURE 38: CONTINUOUS TRIGGER MODE.

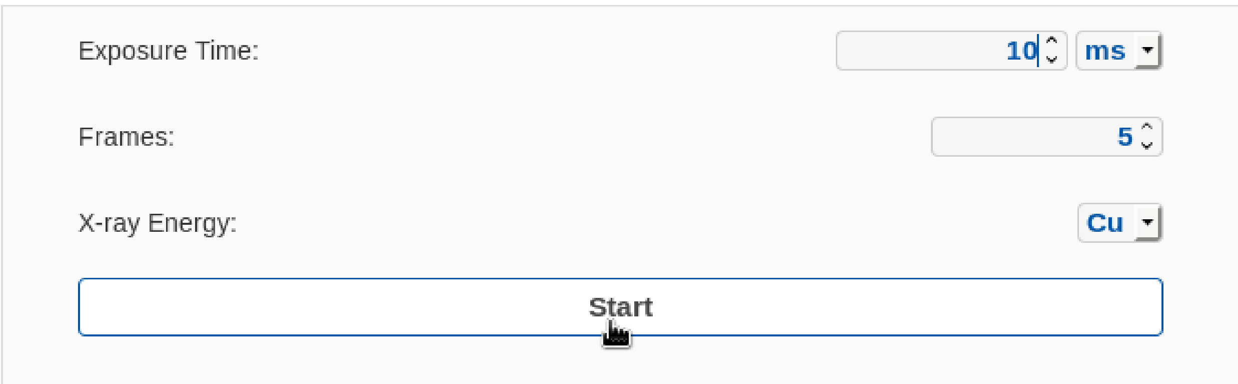


FIGURE 39: MEASUREMENT WITH 5 READOUTS, EACH 10 MS.

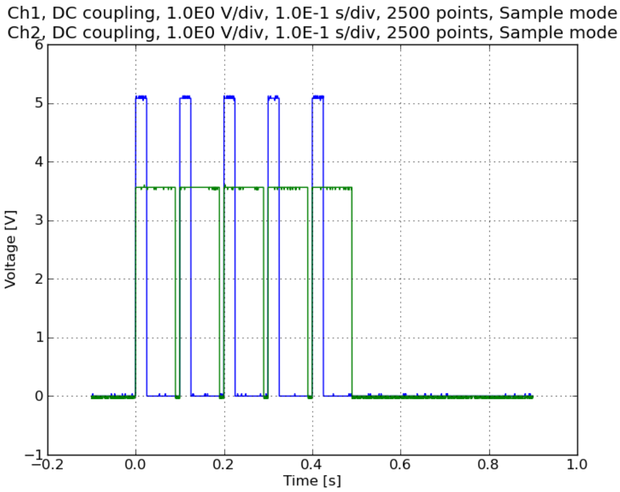


FIGURE 40: EXT IN (BLUE) AND EXT OUT (GREEN) SIGNAL FOR 5 READOUTS AND A CONTINUOUS TRIGGER SIGNAL.

If the measurement is set up for five frames and the "Continuous" trigger mode is activated, the measurement stays unfinished until five trigger pulses are recognized or the acquisition is stopped.
The possibility to set a "delay after trigger" time is also given in the continuous trigger mode. Figure 41 displays EXT IN and EN OUT signals for a measurement with "Continuous" trigger mode and "delay after trigger" 20 ms.

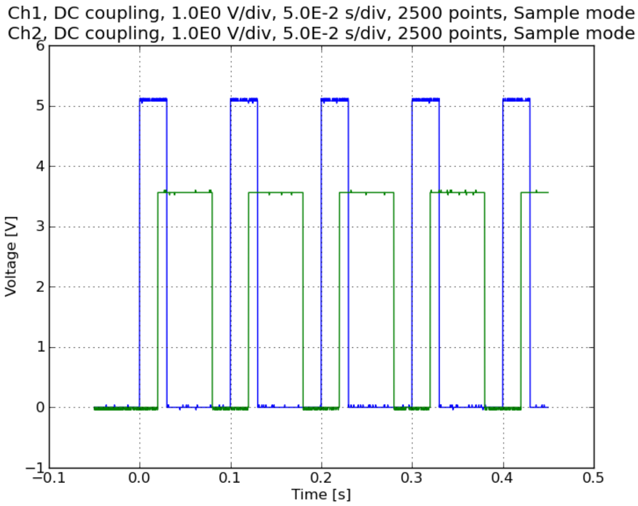


FIGURE 41: EXT IN (BLUE) AND EN OUT (GREEN) SIGNAL FOR TRIGGERED READOUTS WITH A DELAY TIME OF 20 MS.

When using the Socket Interface, the "Continuous" trigger mode can be activated with the command "-conttrigen 1". The number of frames is set with the command "-frames <n>".

9.2. Gating/ External Enable

9.2.1. Activating the Gating Mode

In order to activate the gating mode, the Gating check-box has to be activated (Figure 42). By default, the gating mode is not active. After activating the gating mode, the Web Client looks somewhat different: the input field labeled “Exposure Time” is no longer available. The “Gates” input field defines the number of gates within a frame.

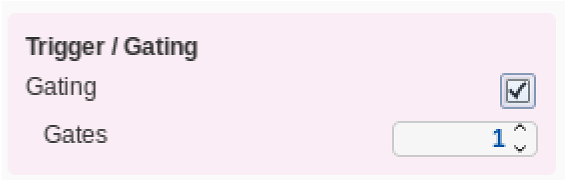


FIGURE 42: WEB CLIENT WITH A MARKED GATING BOX. THIS CONFIGURATION CORRESPONDS TO ONE FRAME THAT CONSISTS OF ONE GATE.

If the measurement is started by pressing the “Start” button, the detector system is in a status in which it is waiting for an external gating signal to start the acquisition.

Figure 43 depicts the EXT IN and the EN OUT signals during the measurement. The lower signal is the gating signal connected to the EXT IN and the upper signal is the EN OUT signal, which is on high level during an acquisition. The detector system is active when the gating signal is on high level at the EXT IN connector.

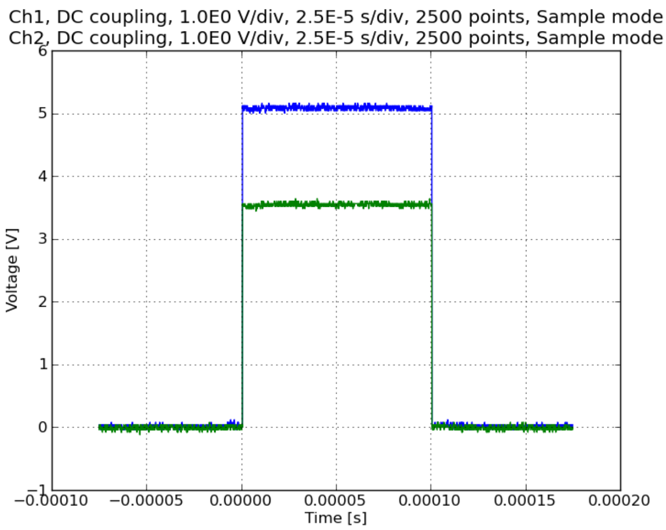


FIGURE 43: EXT IN SIGNAL (GREEN) AND EN OUT SIGNAL (BLUE) DURING AN ACQUISITION IN THE GATING MODE.

When using the Socket Interface, the gating mode can be enabled with the command “-gateen 1”.

If more than one readout should be gated, the number of frames has to be changed to the required number of frames (Figure 44).

FIGURE 44: NUMBER OF FRAMES CAN BE ADAPTED IN THE MAIN PANEL ON THE LEFT.

In this case, the measurement is finished after three gate signals have been given to the control system. Three separate data files are generated. The length of the different gating signals can be chosen independently.

Alternatively, several gates and one frame could be set. For example, three gates and one frame would result in one data file after receiving three gate signals.

Another option would be to set several gates and several frames. For example, in order to complete the measurements defined by three gates and three frames, nine gating signals are required. After receiving a package of three gating signals, one frame is completed and a data file is written. Finally, there would be three data files each containing the results of three gating signals.
The readout of a frame is triggered as soon as the system detects the falling edge of the last gating signal in a frame. It must be ensured that the readout does not occur faster than the maximal allowed frame rate of the detector system. If the falling edge of a gating signal occurs too early, no readout will be triggered.
When using the Socket Interface, the number of gates is set by the command "-gates <n>".

9.2.2. Minimal Gating Time and Time Jitter in Gating Mode

Due to the internal clock frequency of 50 MHz of the detector system, the minimal gating time is 20 ns. The total gating time is effectively a multiple of 20 ns.
Since the external gating signal at the EXT IN connector is not synchronized with the internal clock frequency of the detector system, which is used for sampling the gating signal, a time jitter of maximal 20 ns for the beginning and finishing of the acquisition occurs.

10. Bad Channels

When individual detector channels are defective, they can be marked as bad. In the data returned after an acquisition, they are either marked with a special value (i.e. -2) or interpolated from the values of their neighboring channels, depending on the status of the bad channel correction. This behavior can be controlled in the "Acquisition Settings", see Section 7.4.4. This section describes how the user can add or remove channels from the list of bad channels.

- Access your DCS4 with your web browser (Figure 26)
- By clicking on "Edit bad channels" you will be prompted to enter your username and password. The username is "admin" and the password is given in the system information sheet.
- After entering your credentials, a web page opens where you can add or remove bad channels.

Whether a channel is defective and thus should be marked as bad is, among other variables, a function of the energy threshold. Several files store the channel markings, each for a specific threshold energy. The k_{Alpha} energy of the element in the filename indicates for which threshold energy the file is valid. The bad channels for a threshold energy for which there is no specific file are comprised of the union of the set of bad channels of the next higher and next lower available energies. The file BadNoise.snxxx corresponds to the lowest available threshold energy. See Figure 45 for a screenshot of the user interface.

Example: Data is taken with Cu Settings with a 320 µm thick and 4 mm wide sensor. The system automatically sets the optimal threshold to 5.4 keV. The "Bad Channel File" – drop down list (Figure 45) offers the following files, in parentheses the corresponding k_{Alpha} energy (not shown on the GUI).

BadNoise.sn1234 (0 keV)

BadV.sn1234 (4.95 keV)

BadMn.sn1234 (5.89 keV)

BadCu.sn1234 (8.05 keV)

BadGe.sn1234 (9.89 keV)

BadMo.sn1234 (17.48 keV)

Thus, in this case, the files for thresholds of V and the Mn File have to be edited. Enter the channel numbers (only one at a time) into the corresponding fields and press submit query. The channels are numbered starting from 0. The interface will indicate whether the changes were successful. In order to activate the changes, the DCS4 has to be power-cycled.

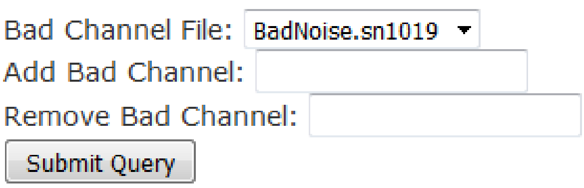


Figure 45: Mask to add or remove bad channels from the bad channel files. Only

11. Firmware Update

The DECTRIS MYTHEN®2 Detector Control System (DCS4) hosts an embedded Linux system, on which the DECTRIS MYTHEN®2 socket server is running. In this document, the entire Linux system is called firmware.

- Normally, the DCS4 and its firmware is maintenance free.
- New functionality and bug fixes can be accessed by updating the embedded Linux (firmware) with new packages.
- If the DCS4 is no longer accessible, it is necessary to reset the system to factory settings (see Section 13).

To take advantage of new functionality and bug fixes, you will have to update the embedded Linux system (firmware). Firmware update is possible only if the DCS4 is accessible.
In order to update the firmware of your DCS4, please follow these steps:

1. Connect the DCS4 to your PC and turn it on.
2. Open a browser on your PC.
3. Enter the IP address of the DCS4 system. By default the DECTRIS MYTHEN®2 systems are delivered with the IP 192.168.0.90. You should now see a screen like the one shown on Figure 46.
4. Choose “Update Firmware”.
5. When prompted for the username and password, enter the values given on your System Information Sheet.
6. Click on “Choose File”.
7. Chose a firmware update package file delivered by DECTRIS®. Packages not signed by DECTRIS®. cannot be installed
8. To install the update, press “Submit”.
9. The successful installation is confirmed by a green message.
10. After the update, the DCS4 has to be rebooted. In case the module firmware was updated, the modules have to be connected and the boot cycle can take up to 1.5 minutes per module (indicated by a flashing power LED).

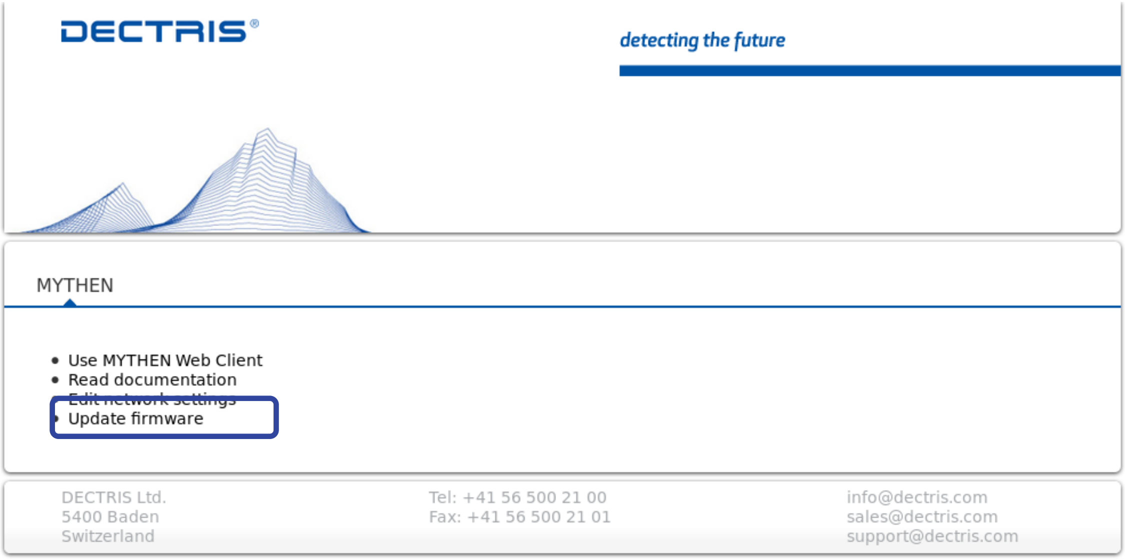


FIGURE 46: LOGIN TO THE DCS4 VIA YOUR WEB BROWSER.

12. Web Interface Update

If you are using the web interface, it might be necessary to update the web interface after a firmware update to take advantage of new firmware features. To update the web interface, first install the firmware following the procedure outlined in Section 11. After the firmware was successfully installed, use the same upload procedure to update the web interface. This will result in a "The connection was reset" warning in the browser as shown in Figure 47. This warning can safely be ignored. Power cycle the DCS to complete the update.

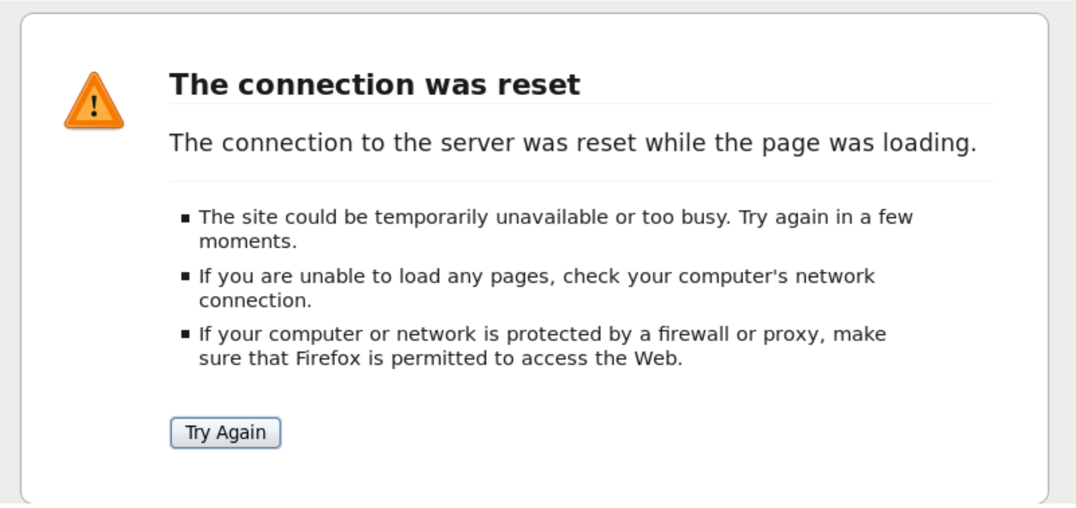


FIGURE 47: WARNING SHOWN AFTER WEB INTERFACE UPDATE.

In case of problems, the DCS4 can be set back to factory settings with help of the delivered micro-SD card. System reset takes five to ten minutes.

13. Factory Reset

In order to power down the DCS4, please follow these steps:

1. Insert the micro-SD card delivered with the system into the card slot on the DCS4 (the backside of the card with the contact pads have to be oriented upwards).
2. Power on the DCS4 while pressing the reset button with a small pin.
3. After half a minute, the power LED starts to blink indicating the reset process. Do not interrupt this process, since it would leave the system in a corrupted state.
4. After a few minutes, the LED stops blinking and the system shuts down.
5. Power off the DCS4.

When booting the next time, the system will come up with its factory settings.

14. Temperature and Humidity Control

The DECTRIS MYTHEN®2 Module has combined temperature and humidity sensor. The recommended temperature range for operation is shown in Table 10.

TABLE 10: AMBIENT CONDITIONS.

Condition	Range
Operating temperature	18°C to 28°C
Operating humidity	< 75% RH @ 23°C
Storage temperature	15°C to 40°C
Storage humidity	< 75% RH @ 23°C

⚠ If the detector system is stored at low temperature, make sure that no condensation moisture develops.

⚠ **Vacuum Operation**
Only detectors purchased with optional vacuum warranty may be operated in vacuum. Warranty void otherwise!
When using the detector in vacuum strictly follow the in-vacuum instructions given in the additional Vacuum Specifications document!
To see if a detector has a vacuum warranty check whether the vacuum warranty option is included in the order confirmation.

15. Cleaning and Maintenance

⚠ The Mylar® foil must not be touched or cleaned. If it becomes dirty or is damaged, please contact DECTRIS® technical support

The DECTRIS MYTHEN®2 detector system has been designed for the detection of X-rays from synchrotron sources or laboratory sources. For other applications, please contact DECTRIS® for additional information.

DECTRIS MYTHEN®2 detector system is designed only for indoor use according the following ambient conditions.

The DECTRIS MYTHEN®2 detector system is essentially maintenance free.

The housing can be cleaned with a soft tissue.

16. Appendix

16.1. Referenced Documents

All the following documents are available through DECTRIS®. Homepage (https://www.dectris.com/support/manuals-docs/overview).

TABLE 11: REFERENCED DOCUMENTS.

Term	Description
Socket Interface Specifications	socket_interface_specifications-mythen2-mai_2020.pdf
DECTRIS MYTHEN®2 Vacuum Specifications	DECTRIS_MYTHEN2_Vacuum_Specifications.pdf