DECTRIS®

detecting the future

Technical Specifications and Operating Procedure

PILATUS3 X 2M Detector System

Version: V7

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1. Document History

1.1. Current document

Version	Date	status	prepared	checked	released
7	21.01.2016	Released	DJ	SB	DJ

Table 1: Document history.

1.2. Changes

Version	Date	Changes
7	21.01.1016	Cooling unit adaption
6	09.11.2015	Nitrogen flow, update contact information
5	23.04.2015	Revision for PILATUS3 X 2M
4	16.06.2014	Updated drawings, minor changes
3	02.04.2014	Update images and cover picture
2	04.12.2013	Final CD, complete revision
1	02.07.2013	First version.

Table 2: List of changes.

2. General Information

Before operating the PILATUS3 X 2M detector system please read this technical specification and the user manual thoroughly. The technical specification and the user manual together form the user documentation.

2.1. Warranty and Support

Should your detector require warranty service, contact DECTRIS Ltd. for further information. You are not allowed to return the detector without prior written authorization by DECTRIS Ltd.

Before shipping the system back, please contact DECTRIS Ltd. to receive the necessary transport and shipping information. Make sure that the original packaging is used when returning the system!

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.

2.2. Contact Information

DECTRIS Ltd.
Taefernweg 1
5405 Baden-Daettwil
Switzerland
Phone: +41 56 500 21 00
Fax: + 41 56 500 21 01
Email: mailto:support@dectris.com

If you have questions concerning the system or its use, please contact us via phone, mail or fax.

2.3. Safety Symbols

The following symbols and terms are used in this document.

Symbol	Description
	Important or helpful notice.
	Caution. Please follow the instructions carefully to prevent equipment damage or personal injury.
	Ground.

Table 3: Safety symbols.

2.4. Explanations of Terms

Term	Description
MCB	Module Control Board
DCB	Detector Control Board
BCB	Bank Control Board
DAC	Digital to Analog Converter

2.5. Use of the PILATUS3 X 2M

The PILATUS3 X 2M detector system has been designed for the detection of X-rays from synchrotrons or laboratory sources. It is intended for indoor use only. For other applications, please contact DECTRIS Ltd. for additional information.

The PC can be mounted in a standard 19-inch rack, which has to be properly grounded.

 Make sure that the PC has adequate ventilation.

 Do not use the detector in vacuum.

 Improper use of the DECTRIS detector system can compromise safety and its functionality is also no longer guaranteed.

2.6. Product return and recycling

We recycle DECTRIS Ltd. detector systems that are no longer suitable for use. If you are not using your DECTRIS Ltd. detector system any more, send it back to us. We will make sure that your system is responsibly and safely recycled. This is free for customers who purchased a new DECTRIS Ltd. detector system.

3. Technical Specifications

Number of modules		3 x 8 = 24		
Sensor		Reverse-biased silicon diode array		
Sensor thickness		320 µm	450 µm	1000 µm
Quantum efficiency	at 5.4 keV (Cr):	94%,	94%,	> 80%
	at 8.0 keV (Cu):	97%,	98%,	96%
	at 17.5 keV (Mo):	37%,	47%,	76%
Readout chip		PILATUS3 with instant retrigger technology		
Pixel size		172 x 172 µm^2		
Module size		83.8 x 33.5 mm^2		
Format		1475 x 1679 = 2'476'525 pixels		
Area		253.7 x 288.8 mm^2		
Intermodule gap		x: 7 pixels, y: 17 pixels, 8.0% of total area		
Dynamic range		20 Bits (0:1'048'573)		
Counter overflow state		1'048'573		
Counting rate per pixel		10^7 X-ray/sec (incoming X-rays)		
Energy range		5 – 36 keV		
Energy resolution		500 eV		
Adjustable threshold range		2.7 – 18 keV		
Threshold dispersion		50 eV		
Readout time		0.95 ms		
Framing rate		250 Hz		
Point-spread function		1 pixel (FWHM)		
Data formats		Raw data, TIF, EDF, CBF		
Software interface		Through socket connection; Clients for EPICS, SPEC and stand-alone operation are available		
Cooling		Closed circuit (2/3 distilled water 1/3 ethylene glycol) unit for temperature stabilization at 23°C.		

	The maximum allowable coolant pressure in the cooling circuit is 3 bar.
Coolant	Use mixture of 2/3 distilled water and 1/3 ethylene glycol.
Power consumption	250 W
Dimensions (W x H x D)	384 x 424 x 456 mm^3
Weight	Approx. 46 kg
Overvoltage category	II
Pollution degree	II
Maximum altitude	2000 m a.s.l.

Table 4: Technical specifications.

3.1. Ratings

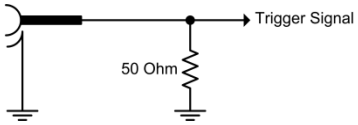
Device	Definition
Detector power input	100 – 240 V AC, 50 – 60 Hz, 250 W Can be connected to all common supply voltages.
Detector external trigger input	 2.1 V – 5.0 V high level 0.0 V – 0.8 V low level 50 Ω impedance ⚠ 5.0 V absolute maximum. Applying a higher voltage will damage the input circuit.
Detector enable output	TTL Level (5V, max. 100 mA)
PC	100 – 240 V AC, 50/60 Hz, 900 W, hot-plug power supplies, can be connected to all common supply voltages.
Cooling unit (chiller standard)	Single phase 100 – 240 V AC, 50/60 Hz, 10 A (100 V AC) – 4 A (240 V AC) Typical coolant flow: 3 l/min Dimensions (W x H x D): 300 x 390 x 455 mm^3 Weight: 27.5 kg

Table 5: Ratings. The specifications are subject to changes.

3.2. Ambient Conditions

The PILATUS3 X 2M detector is designed for indoor use only. The following ambient conditions must be satisfied. Please note that the below stated values are for the ambient conditions. Values inside the detector, in particular the dry-air or N_2 supply, are different. They are described in section 5.6 and section 6.

Condition	Range
Operating ambient temperature	+20°C to +35°C
Operating ambient humidity	< 80% at 20°C, non-condensing
Storage ambient temperature	+15°C to +40°C
Storage ambient humidity	< 40% at 20°C, non-condensing

Table 6: Detector operating conditions. Note that the interior humidity under operating conditions must be < 25%.

 Note that the interior humidity under operating conditions must be < 25%.

 When storing the detector make sure the temperature and humidity inside the transport box does not exceed the specified range. Use drying agent.

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

 The PILATUS3 X 2M is equipped with a temperature and humidity sensor.

4. Detector Dimensions and Connectors

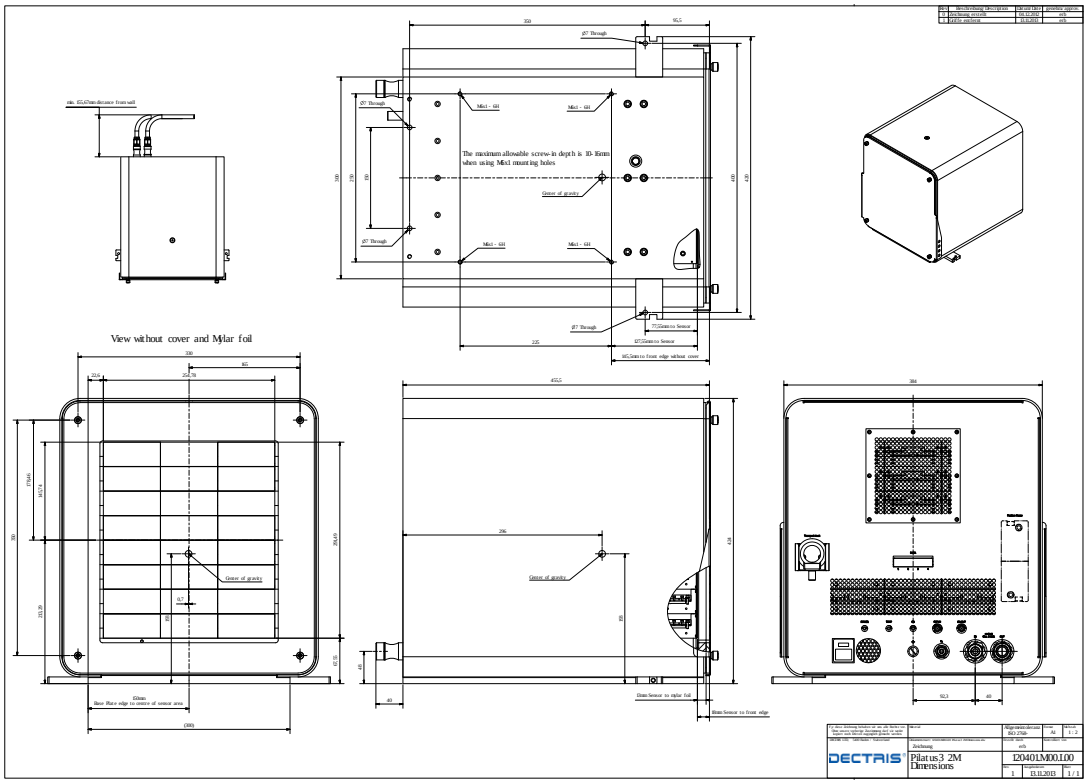


Figure 1: Drawing of the PILATUS3 X 2M detector (printed separately in the user documentation folder).

4.1. The PILATUS3 X 2M Detector

4.1.1. Front Side of the Detector

The detector comes with a protective cover (2 mm, low carbon steel sheet metal 1.0330, St12) for the front window, which should only be removed for operation. The sensors are behind a 12 µm thick Mylar® (PET) foil coated with 100 nm aluminum to protect them from light, dust and touch. The cover has a mounting edge on top and can be removed by carefully pulling at the bottom (see figure below) and lifting it away.

When mounting the cover, make sure it is first hooked on the mounting edge centered and then slowly lowered.

⚠ Do not touch the Mylar® foil. Contact Dectris support in case of any contamination of the window.

⚠ The cover may not protect the detector from the direct synchrotron beam.

Figure 2: The PILATUS3 X 2M detector with the cover in place (front view).

Figure 3: The PILATUS3 X 2M detector with the cover removed (front view).

4.1.2. Back Side of the Detector

Figure 4: The PILATUS3 X 2M detector viewed from the back.

4.1.3. The Status LEDs

LED	Description
EN	Yellow, if the detector is in counting mode.
TEMP	Normally green. Turns red if the detector temperature or humidity is out of the limits.
POWER	Normally green. Turns red if there is a power failure or if the detector temperature or humidity is out of the limits.

Table 7: The meaning of the status LEDs on the detector back plane.

4.1.4. Connectors and Connecting Cables/Pipes

Connector	Description
DATA 1, 2 (left to right, Figure 4)	RJ45 Cat 6 S/FTP cables for data transfer (DATA 3, 4 unused).
POWER	Main voltage 100 – 240 VAC; 50/60 Hz, Fuse 6.3A UL recognized to UL 60950/CSA 22.2 No. 60950-00, and TUV approved to EN 60950-1 Cable: Power cable with an IEC/C13 connector.
EXT IN	External trigger input. Use a Lemo® Type 00 (NIM/CAMAC) cable.
EN OUT	TTL Level (5V) output signal; high when counting is enabled. Use a Lemo® Type 00 (NIM/CAMAC) cable.
⏚	Functional ground of the detector system. ⚠ Although the detector might be grounded via the mounting bolts, the detector can be grounded additionally via the functional ground connector at the back (M4 screw-in tap hole) to establish a defined grounding.
DRY AIR	Dry air or nitrogen for humidity control. For details see section 5.6. Pipe: Use a pipe with outer diameter of 6 mm.
IN coolant	Coolant inlet. Use 2/3 distilled water and 1/3 ethylene glycol for cooling.
OUT	Coolant outlet.

Table 8: Connectors and connecting cables/pipes.

4.2. Computer

The PILATUS3 X 2M detector system comes with a detector server and a PILATUS Processing Unit (PPU). The detector server is a high power server with propriety software to communicate with the detector. The PPU ensures stable and highly reliable high-speed data transfer and may offer additional computing capacities.

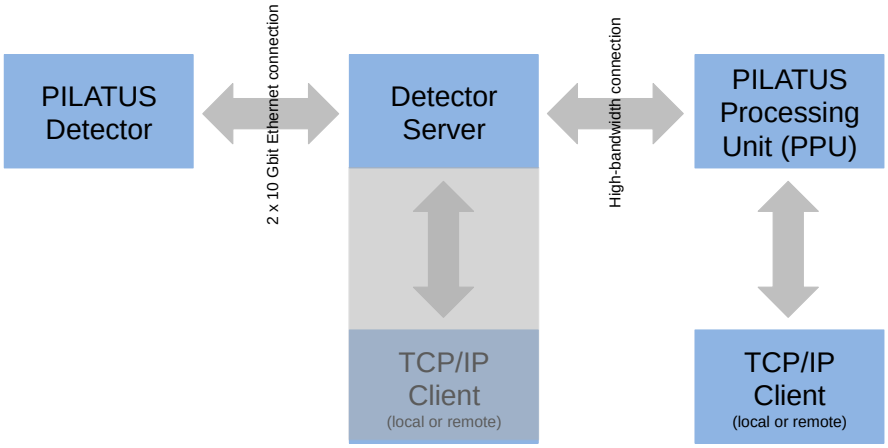


Figure 5: Configuration of the PILATUS3 X 2M detector system.

The installation of distributed control systems and/or other software packages on the PPU is encouraged but it is explicitly advised that the PILATUS3 detector server itself should not be altered. General software installations on the PPU can be done without risking the data collection stability of the PILATUS3 X 2M detector system.

⚠ Do not install or run any other software on the detector server.

The detector server and the PPU are set up with the latest release of the RHEL-based CentOS 6.x Linux distribution.

⚠ Regular system updates can be made. However, to avoid operational deterioration do not update the system while the detector is taking data.

For more information please refer to the documentation of the PPU or consult www.dectris.com.

4.3. Cooling unit

A cooling unit is required for the operation of the PILATUS3 X 2M detector system.

The tubes and the detector are equipped with self-sealing valves to avoid dripping when connecting or disconnecting the tubes.

There is no fixed limitation on the length of the tubing.

⚠ Before operating the cooling unit, please read the user manual of the cooling unit.

⚠ When connecting or disconnecting the cooling hoses, turn off the detector and the cooling unit.

⚠ When operating the detector, the cooling unit must be always on.

⚠ Use opaque tubing to avoid the growth of algae.

Operating temperature	The cooling unit has always to be set to a temperature of 23°C.
Operating pressure	0.5 bar

Do not set the temperature of the cooling unit below the recommended operating temperature. Condensing moisture can develop and damage the detector.

⚠ Good air circulation is essential to prevent internal heat build-up and prolong the life of its components. Place the detector in a location with adequate air circulation. Make sure the detector has enough space for proper ventilation (minimum wall distance: 170 mm). Do not operate the detector in a closed environment.

5. Installing the Detector System

5.1. Carrying

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

The detector has a transport hook which has to be used for lifting the detector.

Only use an appropriate lifting device with a carrying capacity of at least 150 kg to move the detector.

Make sure 2 persons always move the detector.

When using the transport hook, make sure it is properly tightened.

When moving the detector, make sure the protection cover is mounted.

When moving the detector, make sure that all cables and hoses are disconnected.

5.2. Mounting

The detector can be mounted in two ways:

5.3. Mounting from Above

Use the detachable mounting brackets, which are stored on the back of the detector. These mounting brackets have to be mounted on the base plate of the detector. Then use the 7mm holes in the mounting brackets and the two 7mm holes in on the back side of the detector, marked in Figure 6, to bolt the detector down.

Make sure the mounting brackets are mounted and properly tightened using the four optional M4 screws.

Do not place the detector near heat sources or in a place subject to direct sunlight, excessive dust or mechanical shock.

Good air circulation is essential to prevent internal heat build-up and prolong the life of its components. Place the detector in a location with adequate air circulation. Make sure the detector has enough space for proper ventilation (minimum wall distance: 170 mm). Do not operate the detector in a closed environment.

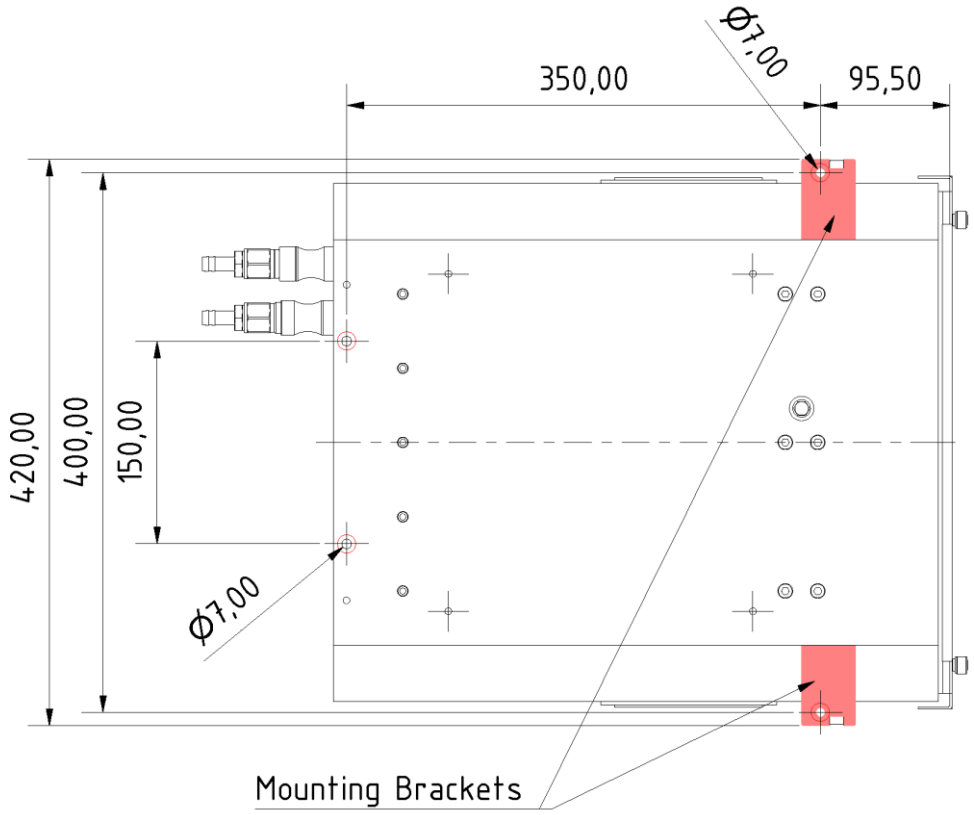


Figure 6: Drawing of the PILATUS3 X 2M detector base plate (printed separately in the user documentation folder).

5.4. Mounting from Below

The detector should be mounted using the four internal threads (M6 x 1).

⚠ The four M6 screws must not intrude into the detector more than 16 mm.

⚠ Make sure the detector is properly mounted.

⚠ It is strictly forbidden to add any threads to the detector base plate or to the detector housing.

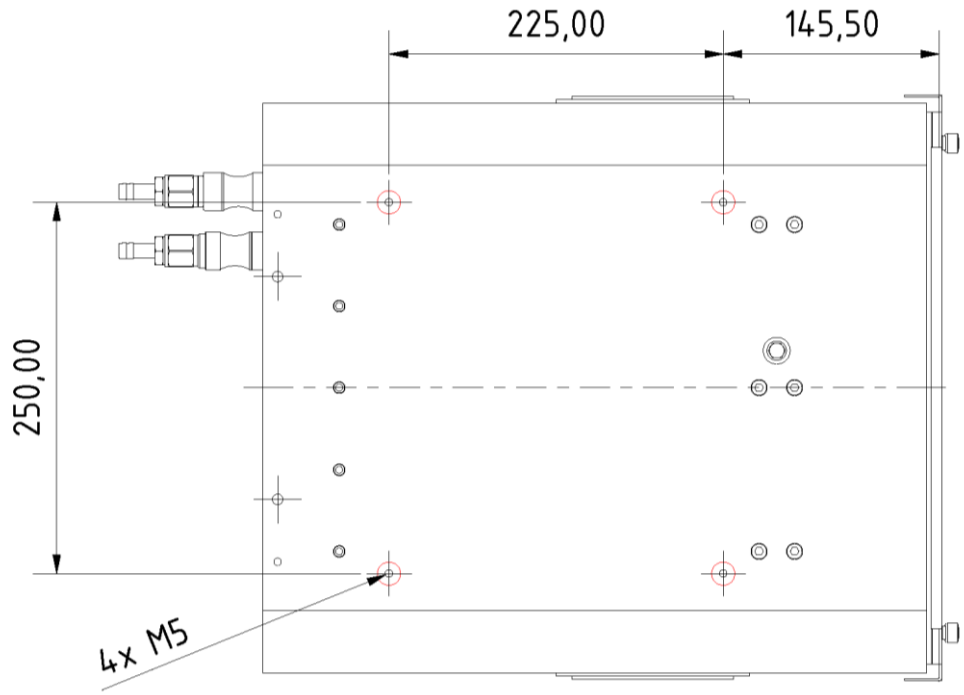


Figure 7: Mounting from below, bottom view.

5.5. Grounding of the Detector

The main plug of the PC and the power supply of the detector have to be connected to the grounded power outlet.

Although the detector might be grounded via the mounting bolts, the detector can be grounded additionally via the functional ground connector at the back to establish a defined grounding.

5.6. Connection to Nitrogen or Dry Air

The PILATUS3 X 2M detector has to be connected to a nitrogen or dry air flow to avoid humidity and condensation when it is outside the storage box. For connection see section 4.1.4. For storage see section 9 and section 3.2.

Humidity can damage the detector. Make sure that the detector is operated in the specified range.

Nitrogen or dry air can be used for humidity control. Dry air has to be oil free with a relative humidity < 20%. For reliable operation we recommend dry air of < 5% relative humidity.

A flow of 5 to 10 l/h is usually sufficient for humidity control. If gas consumption is a concern, for instance when a bottle of nitrogen is used as a supply, it is recommended to connect a flow meter on the outside of the detector and adjust the gas flow to 5 to 10 l/h.

The gas pressure must not exceed 2 bars. The minimum gas pressure is 1 bar.

6. Temperature and Humidity Control

The PILATUS3 X 2M detector has one combined temperature and humidity sensor. The temperature and humidity control shuts down the power of the detector modules when the humidity or the temperature of the sensor exceeds the following limits:

Channel	Location	Shutdown Temperature [°C]		Shutdown Humidity [%]
		Low limit	High limit	High limit
1	Base plate	15	35	30 (25 for start-up)

Table 9: Temperature and humidity limits.

The communication with the PC will remain active after a temperature shut down (only shuts down the power of the modules).

To start the detector correctly, please refer to section 7 and execute the correct startup procedure.

⚠ If the humidity is outside the specified range, the software will prevent powering up the modules and exit with a corresponding message.

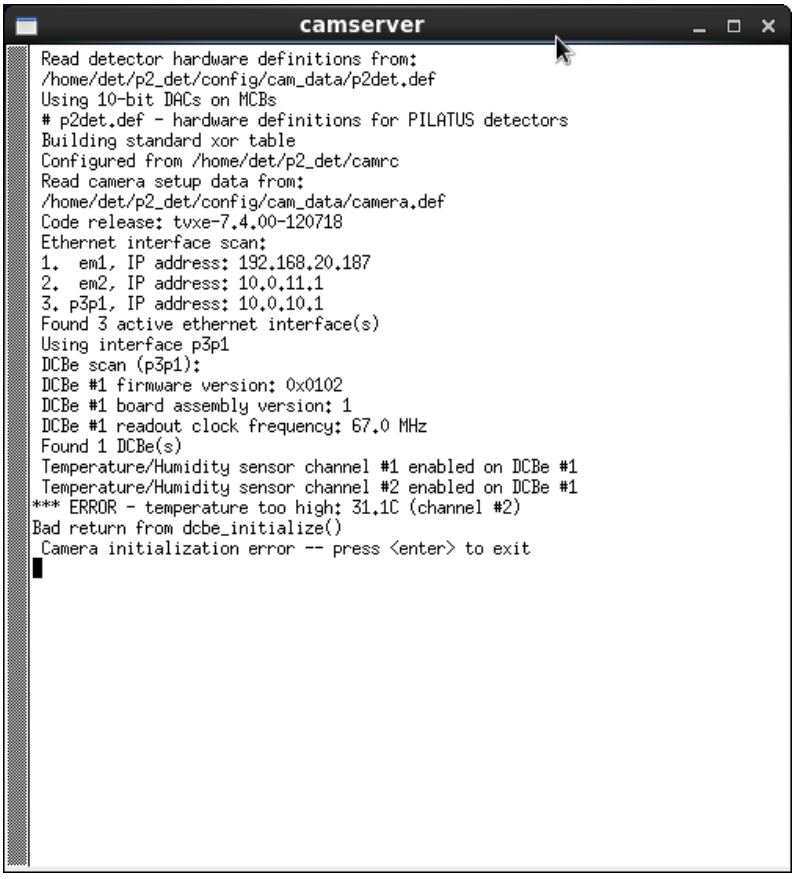


Figure 8: Error message when temperature or humidity is out of range.

Make sure that the cooling unit is running at the recommended temperature (according to section 4.3) and that nitrogen or dry air flow is turned on at the recommended flow rate, according to section 5.6. Then restart the software.

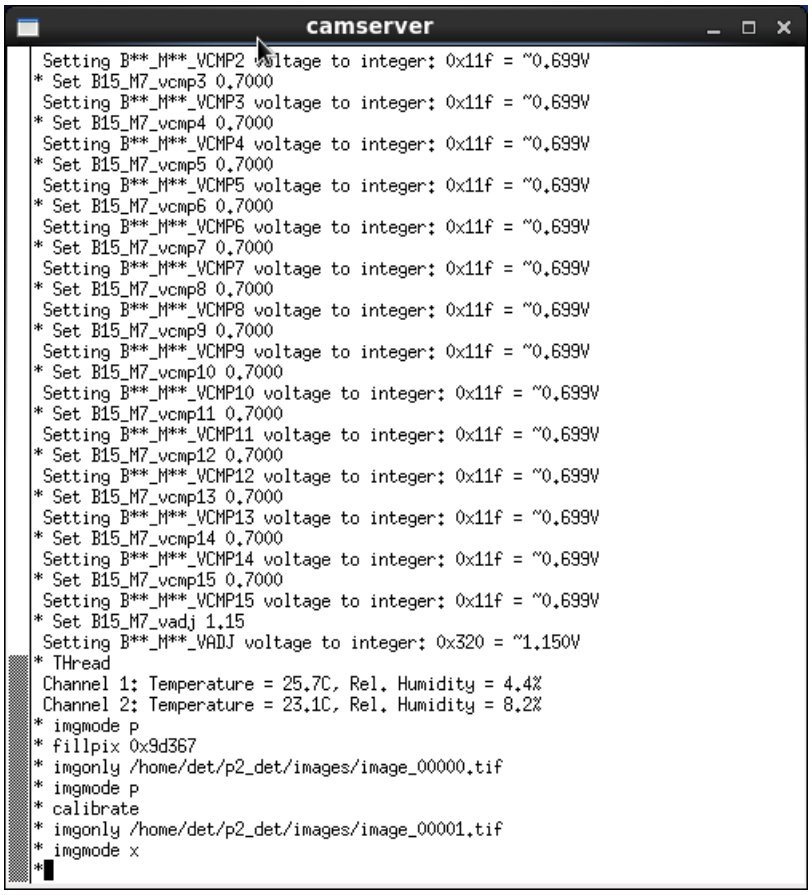


Figure 9: Correct start-up message.

Check the temperature and humidity with the command “THread” in camserver. This reads and displays the actual temperature and humidity of the sensors as shown above.

7. Getting Started

Before operating the detector, make sure you have read the previous chapters in the technical specification and the user manual.


Check these items before turning the detector system on:

- Mount the detector properly.
- Connect the detector to power; make sure the detector power switch is OFF.
- Connect the detector to nitrogen or dry air at the recommended flow rate.
- Connect the coolant tubes. Make sure they are properly mounted on both sides.
- Set the cooling temperature to 23°C and turn on the cooling unit.
- Connect the PC and the detector data cables.
- Attach a monitor, keyboard and mouse to the PC.

7.1. Startup Procedure

- Turn on nitrogen or dry air flow at least 30 minutes before turning on the detector. Then turn ON the power switch at the back of the detector.
- Turn on the PC.
- Start a shell.
- The default path is: /home/det.
- Change the directory to: p2_det/.
- Type ./runtvx (./runtvx starts a script which initializes the detector system and opens the Camserver and TVX windows).


If you want to control the detector with a TCP/IP client, type ./camonly in the directory p2_det/. ./camonly starts a script, which initializes the detector system and opens the Camserver window. Please refer to the user manual for further information.

7.2. First Commands

- See the detailed description of all commands in the user manual.
- Type the following commands in TVX:
  - rbd: self test of the detector (digital part of all pixels).
  - calibdet: self test of the detector (analog part of all pixels).
  - cam setCu: sets the energy threshold of the detector for 8 keV X-rays. It is important that an appropriate threshold is set, otherwise the detector is not trimmed. See the user manual for more information.
  - expose 10: creates an image with an exposure time of 10 seconds.

8. Turning off the Detector

- Turn OFF the detector power switch.
- Do not remove the nitrogen/dry air connection and leave it at the recommended flow rate according to section 5.6.

 If you turn off the detector while Camserver is running you will get error messages after a few minutes because Camserver cannot communicate with the detector. You may want to exit Camserver.

 You must restart Camserver after the detector has been turned on! Otherwise the detector is not initialized.

9. Storing the Detector

Even if the detector is not in operation, it is recommended to maintain the nitrogen or dry air flow.

In case the detector is stored, please follow these instructions:

For storage of up to 1 week:

Store the detector in the storage box and add 200 g drying agent (i.e. silica gel) into the storage box.

For storage longer than 1 week:

Pack the detector into a plastic bag, add drying agent into the plastic bag and seal the plastic bag. Then place the detector in the storage box and add 200 g drying agent (i.e. silica gel) to the storage box. Check the humidity inside the box frequently for compliance with the storage requirements in section 6.

10. Cleaning and Maintenance

The housing can be cleaned with a soft tissue.

 The Mylar® foil must not be touched or cleaned.

The PILATUS3 X 2M detector system is almost maintenance free.

Maintenance instructions for the cooling unit are provided in the cooling unit's manual.

The following procedures have to be done periodically:

What	When	Who
Check and, if necessary, clean the air filter on the back of the PILATUS3 X 2M	Every month	User
Replace the air filter on the back of the PILATUS3 X 2M	Every 12 months	User
Check the tightness of the cooling tubes	Every week	User
Replace the cooling liquid	Every 12 months	User

11. Troubleshooting

Refer to the table below if your detector does not function properly. If the problem you are experiencing is not listed below or if the instructions do not help, please contact mailto:support@dectris.com.

Problem	Cause	Remedy
PC does not start properly.	PC is not powered.	Depending on the type of PC, there are switches on the back and on the front panel of the PC, which have to be in the correct position.
Communication error, the detector is not found at Camserver startup.	Data cables are incorrectly connected or defective. The configuration of the 10 Gbit Ethernet adapters is wrong.	Check the connection between PC and detector. Make sure that there is a direct connection between the PC and the detector. Avoid tangling or strong bending of the Ethernet data cables. Check configuration of the Ethernet adapters. Check the status of the LINK LEDs. If PC and detector are powered and correctly connected, the LINK LEDs should be green.
Detector shuts down.	**Temperature or humidity error:** See section 6 for the temperature and humidity shut down values.	Check that the detector is properly supplied with coolant. Check the flow of nitrogen or dry air. Check the temperature of the coolant at the front panel of the cooling unit. Check the temperature of the detector with the command in Camserver: type “thread”. Wait until the detector cools down. Restart the detector again. Check the LEDs at the back of the detector: If the TEMP and the POWER LEDs are red, a temperature or humidity error has occurred.
Detector shuts down.	**Module over current:** The energy threshold level is set too low and the detector starts oscillating.	Increase the threshold level. In Camserver type: setCu.

Problem	Cause	Remedy
The detector fails to turn on.	The power cord is not connected or the plug is incompletely inserted.	Connect the power cord firmly. Check the green LED on the external power supply.
Images look strange after initialization.	Detector is not properly initialized.	Run the following commands in TVX: setdac calibdet expose 1 Check the status of the POWER LED at the back of the detector. If it is red and the TEMP LED is green, there may be a problem with the electronics – contact support@dectris.com.
Detector housing is humid.	Ambient humidity around the detector exceeds the operating conditions.	Shut down the detector immediately and check the humidity. Power up the detector only when the ambient humidity has been reduced.

Table 10: Troubleshooting.

12. Certification Tests

The product is in conformity with the following standards:

EN 61326-1: 2013 / IEC 61326-1: 2012

EN 61010-1: 2010 / IEC 61010-1: 2010

Service Form

Model No.: _____ Serial No.: _____ Date: _____

Name and phone No.: _____

Company: _____

List of all control settings. Describe the problem and check boxes below that apply to the problem.

_____

_____

_____

_____

_____

_____

_____

_____

☐ Checked all cables

☐ Problem on power-up

☐ Detector system is unstable

What power line is used? _____

Ambient temperature? _____

Relative humidity? _____

Add additional information. If the user has made special modifications, please describe. _____

_____

_____

_____

_____

_____

_____

_____

_____