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Technical Specifications

DECTRIS PILATUS®3 X 100K-M Detector System

Document Version v1.2.2

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CONTENT

DOCUMENT HISTORY

Current Document

Table 1: Current Version of this Document

Version	Date	Status	Prepared	Checked	Released
v1.2.2	2022-09-05	release	MM	LG	MM

Changes

Table 2: Changes to this Document

Version	Date	Changes
v1.2.2	2022-02-08	New Server O.
v1.2.1	2020-09-15	Adjustment of Low Energy Options
v1.2.0	2020-07-09	New Linux Distribution
v1.1.3	2020-01-16	Low Energy Calibration Option
v1.1.2	2019-12-03	New Server J.
v1.1.1	2019-10-03	New Server O.
v1.1.0	2019-07-09	Update of corporate design of PILATUS R, S and X series.
v1.0.0	2019-06-28	First Release.

1. GENERAL INFORMATION

1.1. Contact and Support

Address:	DECTRIS Ltd. Taefernweg 1 5405 Baden-Daettwil Switzerland
Phone:	+41 56 500 21 02
Fax:	+41 56 500 21 01
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

Danger #0

Danger blocks are used to indicate immediate danger or risk to personnel or equipment.

Warning #0

Warning blocks are used to indicate danger or risk to personnel or equipment.

Caution #0

Caution blocks are used to indicate danger or risk to equipment.

Information #0

Information blocks are used to highlight specific information.

1.3. 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.

Caution	#1

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.

1.4. 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.

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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. USE OF THE PILATUS3 X 100K-M

The PILATUS3 X 100K-M detector system has been designed for the detection of X-rays produced by synchrotrons or laboratory sources. It is intended for indoor use only. For other applications, please contact DECTRIS® technical support for additional information.

Caution	#2

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

2.1. Vacuum Option

Caution	#3

Only detectors purchased with optional vacuum compatibility may be operated in vacuum. Warranty void otherwise! When using the detector in vacuum strictly follow the in-vacuum instructions given in this document.

For detector systems purchased with the optional vacuum compatibility, the detector can be operated in vacuum. To check if the vacuum compatibility option has been purchased for your detector, please refer to the order confirmation, or, check for the presence of the label "vacuum tested" on the serial number sticker at the detector backside. A check in the box of "vacuum tested" implies the available vacuum option of the PILATUS3 X 100K-M detector.

Please avoid organic materials and highly out-gassing compounds inside the vacuum chamber as they tend to deposit on sensitive detector components and may affect the functionality of the detector.

A vacuum feedthrough set is optional available. Please contact support@dectris.com for further information.

Warning	#1

The PILATUS3 100K-M detector electronics unit is not vacuum compatible. Do not use it in vacuum.

2.2. Product Return and Recycling

We recycle DECTRIS® detector systems that are no longer suitable for use. If you are not using your DECTRIS® 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® detector system.

3. TECHNICAL SPECIFICATIONS

3.1. Specifications

3.1.1. Quantum Efficiency

Table 3.1: Quantum Efficiency

Sensor thickness[1]		450 µm	1000 µm
Quantum efficiency at	5.4 keV (Cr)	94 %	> 80 %
	8.0 keV (Cu)	98 %	96 %
	17.5 keV (Mo)	47 %	76 %

3.1.2. Detector

Table 3.2: Technical Specifications

Number of modules (W x H)	1 x 1 = 1
Sensor	Reverse-biased diode array
Sensor material	Silicon (Si)
Pixel size (W x H)	172 µm x 172 µm
Module size (W x H)	83.8 mm x 33.5 mm
Pixel array format (W x H)	487 pixels x 195 pixels = 94 965 pixels
Intermodule gap [pixel]	hor. -, vert. -
Image bit depth	32 bit
Readout bit depth	20 bit
Counter overflow state	1 048 575
Maximum count rate	1 × 10^7 photons/s/pixel
Energy range[2]	5 keV to 36 keV
Adjustable threshold range[2]	2.7 keV to 18 keV
Number of thresholds	1
Maximum frame rate	500 Hz

Information #1

When using the external trigger or external enable mode, the detector will not acquire an image if the effective frame rate is above 500 Hz.

[1] The sensor thickness of your actual system can be found in the order confirmation and in the file header of recorded images
[2] Extended low energy and ultra low energy calibrations offering lower minimal thresholds (1.9 keV and 1.6 keV respectively) are optionally available. The energy calibration of your actual system can be found in the order confirmation and in the factory acceptance test sheet. Please read carefully the "Low Energy Calibration" technical specification add-on before using thresholds lower than 2.7 keV.

Table 3.2: Technical Specifications - continued

Readout time	0.95 ms
Point-spread function	1 pixel (FWHM)
Connection to control unit	1 x 10GBase-T Ethernet
Power supply	External power supply
Data format (file writer)	Raw data, TIF, EDF, CBF
Software interface	Through socket connection; Clients for EPICS, SPEC and stand-alone operation are available
Dimensions (W x H x D)	Detector Head: 114 mm x 69 mm x 118 mm, Detector Electronics Unit: 156 mm x 155 mm x 210 mm
Weight	Detector Head: 0.9 kg, Detector Electronics Unit: 2.5 kg
Overvoltage category	II
Means of protection	I (External TreNew (SINPRO) power supply)
Pollution degree	II
Maximum operating altitude	2000 m a.s.l.
Cooling	Closed circuit thermal stabilization unit

3.1.3. Power Supply Unit

The PILATUS3 X 100K-M is delivered with the power supply unit TreNew (SINPRO) MPU130-105. It is a switching power supply. Use only the included power supply. Please consult the user documentation of the TreNew (SINPRO) MPU130-105 power supply unit for details.

3.1.4. Detector Control Unit

The PILATUS3 X 100K-M is delivered with the detector control unit DELL PowerEdge R450. It is a rack-mounted (1U) high performance server. Please consult the user documentation of the DELL PowerEdge R450 server for details.

3.1.5. Thermal Stabilization Unit

The PILATUS3 X 100K-M is delivered with the thermal stabilization unit SMC HEC 002-A5B. It is a closed circuit air-water thermal stabilization unit. Please consult the user documentation of the SMC HEC 002-A5B thermal stabilization unit for details.

3.2. Ratings

3.2.1. Detector

Table 3.3: Power Ratings

Detector power input	+12 V DC, 30 W
Fuse	4 A slow-blow fuse. Type: Schurter 5 mm x 20 mm, 4 A, 250 V AC Part No. 0001.2510 **Warning #2** ⚠ Always replace fuses with the same type.
Detector external trigger input	2.1 V to 5.0 V high level 0.0 V to 0.8 V low level **Caution #4** ⚠ Absolute maximum is 5 V. Applying a higher voltage will damage the detector.
External trigger input impedance	50 Ω
Detector trigger output	5 V (max. current 100 mA)

3.2.2. Power Supply Unit

Table 3.4: Power Supply Unit Ratings

Power input	100 VAC to 240 VAC, 47 Hz to 63 Hz, 1.58 A to 0.64 A
Power output	12 V DC, max. 10.84 A, 130 W
AC connector	IEC-320-C14 input inlet
Dimensions	89.5 mm x 49.3 mm x 188.0 mm
Weight	0.8 kg

3.2.3. Detector Control Unit

Table 3.5: Detector Control Unit Ratings

Power input	2 x 100 VAC to 240 VAC, 50/60 Hz, 9.2 A to 4.7 A, 800 W (Platinum) 1+1 redundant, hot swappable power supply unit
Dimensions (W x H x D)	482.0 mm x 42.8 mm x 748.79 mm
Weight	14.9 kg
Chassis	1U

3.2.4. Thermal Stabilization Unit

Table 3.6: Thermal Stabilization Unit Ratings

Power input	Single phase 100 VAC to 240 VAC, allowable voltage range ±10 %, 50/60 Hz, 8 A (100 VAC) to 3 A (240 VAC)
Dimensions (W x H x D)	270 mm x 393 mm x 436 mm
Weight	17.5 kg
Typical flow	3 L min^{-1}
Maximum operation pressure	3 bar

3.3. Ambient Conditions

The PILATUS3 X 100K-M detector is equipped with a temperature and a humidity sensor. When either sensor detects that the operating conditions are not met, the detector will shut off. However, as the sensors may not prevent damage, temperature and humidity should be monitored to avoid breaching the operation limits.

Information	#2
The relative humidity within the module chamber must be lower than 30 % during operation and lower than 25 % during start up (use of dry air or nitrogen advised).	

The PILATUS3 X 100K-M detector is designed for indoor use only. The ambient conditions shown in table 3.7 must be satisfied. The stated values are for the ambient conditions.
Values inside the detector, in particular due to the dry-air or nitrogen supply, are different. These are described in section 5.4 and chapter 6.

Table 3.7: Detector operating ambient conditions

Ambient Condition	Value
Operating temperature	+20 °C to +35 °C
Operating humidity	<30 % at + 20 °C, non-condensing
Storage temperature	+15 °C to +40 °C
Storage humidity	<40 % at +20 °C, non-condensing

Please consider following points when storing the detector:

- Make sure the temperature and the humidity inside the transport box do not exceed the specified range (use of a drying agent is required).
- Ensure that no condensation moisture develops if the detector is stored at low temperature.

3.4. Vacuum Conditions for Detectors with Optional Vacuum Compatibility

DECTRIS® detectors can be provided for vacuum operation. The typical reachable vacuum is 10^{-3} mbar (read-out electronics in vacuum) or 10^{-6} mbar (only detector head in vacuum). The out-gassing rate and content are not specified. The vacuum compatibility option guarantees that the detector will operate in the mentioned vacuum range. Detectors ordered with a vacuum compatibility option have been tested in vacuum.

To see if a detector is vacuum compatible, check the conditions mentioned in section 2.1

Warning	#3

Only systems with a vacuum compatibility option are allowed to be operated in vacuum. Please contact support@dectris.com for information regarding vacuum compatibility upgrade.

For in-vacuum operation of the detector following conditions must be fulfilled:

Table 3.8: In-Vacuum Operating Conditions

In-Vacuum Condition	Definition
Pressure during operation	atmospheric pressure or less than 0.01 mbar 
Detector mounting plate temperature during operation	+10 °C to 25 °C
Thermal stabilization unit set temperature in vacuum	10 °C
Chamber temperature during "bake-out" (detector unpowered)	max. +60 °C (for temperatures > 40 °C make sure the thermal stabilization unit is set to +40 °C and running)

4. DETECTOR DIMENSIONS AND CONNECTORS

4.1. PILATUS3 X 100K-M Detector

4.1.1. Technical Drawing

The PILATUS3 X 100K-M detector consists of the detector head (figure 4.1) and the detector electronics unit (figure 4.3). For in-vacuum applications electrical and cooling vacuum feedthrough sets (figure 4.4 and figure 4.5) are optionally available.

Information	#3

3D step files of the PILATUS3 X 100K-M detector are available on request. Please contact DECTRIS® technical support for more information.

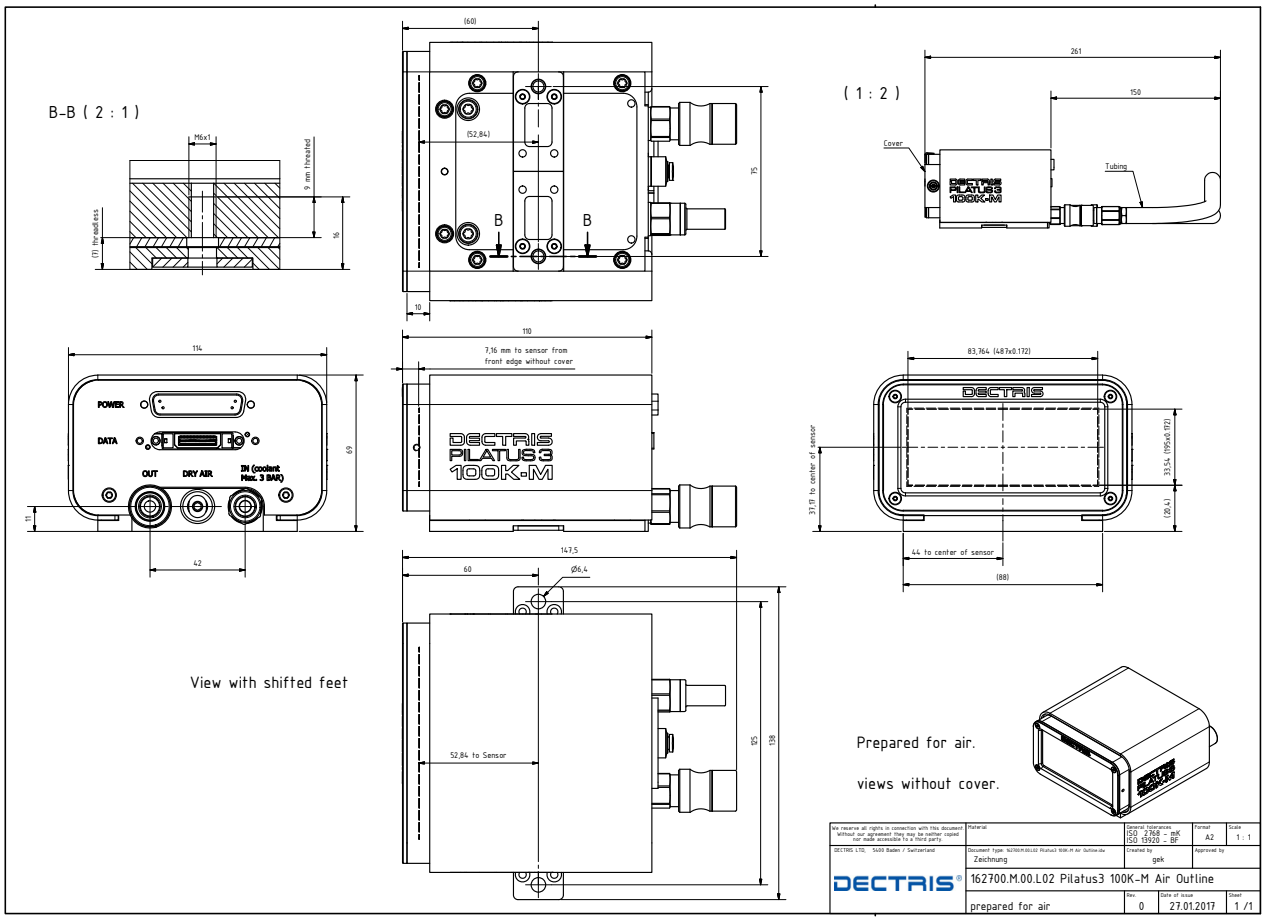

Figure 4.1: Drawing of the PILATUS3 X 100K-M Detector (also printed separately in the user documentation folder.)

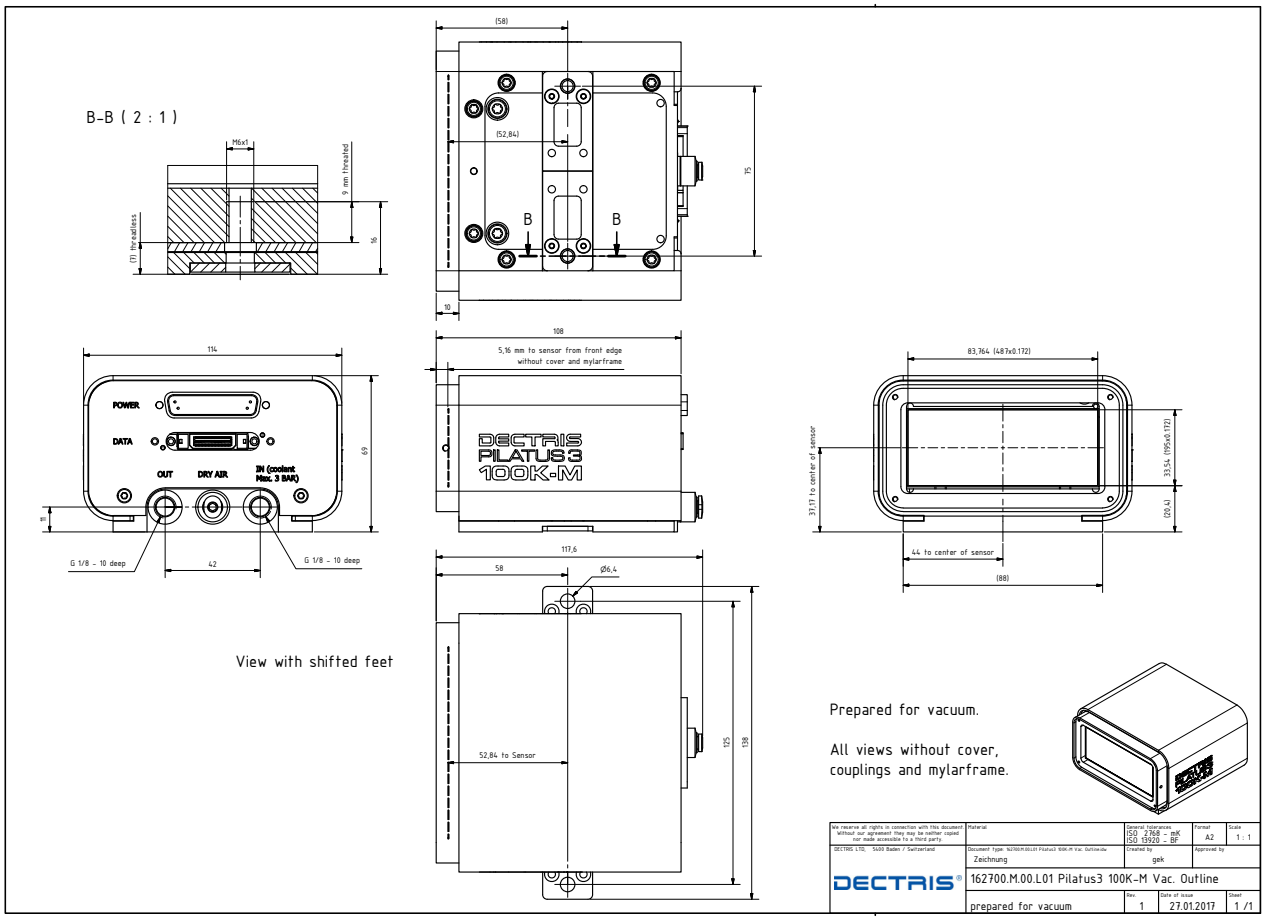

Figure 4.2: Drawing of the PILATUS3 X 100K-M Detector head configured for in-vacuum operation (also printed separately in the user documentation folder.).

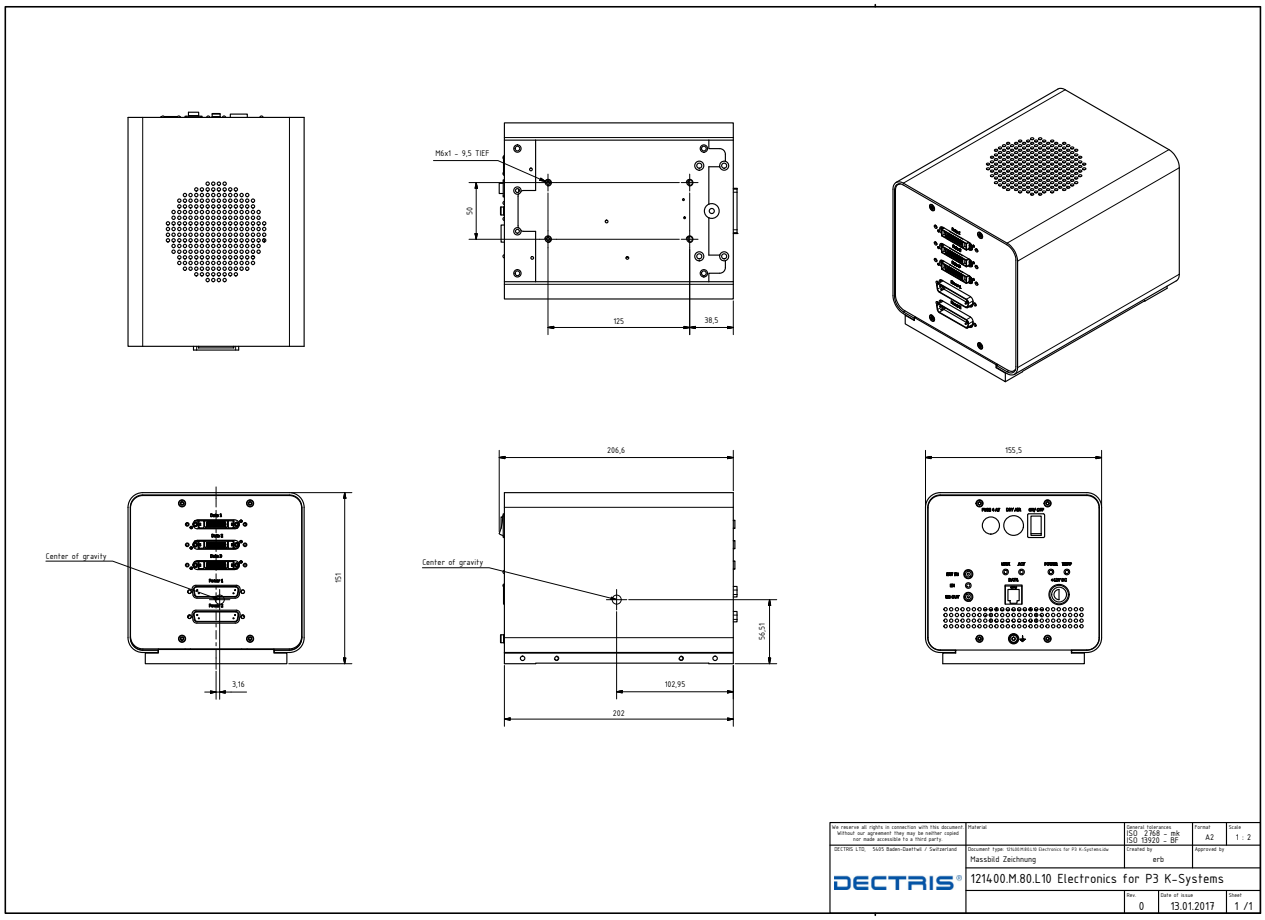

Figure 4.3: Drawing of the PILATUS3 X 100K-M Detector electronics unit (also printed separately in the user documentation folder.)

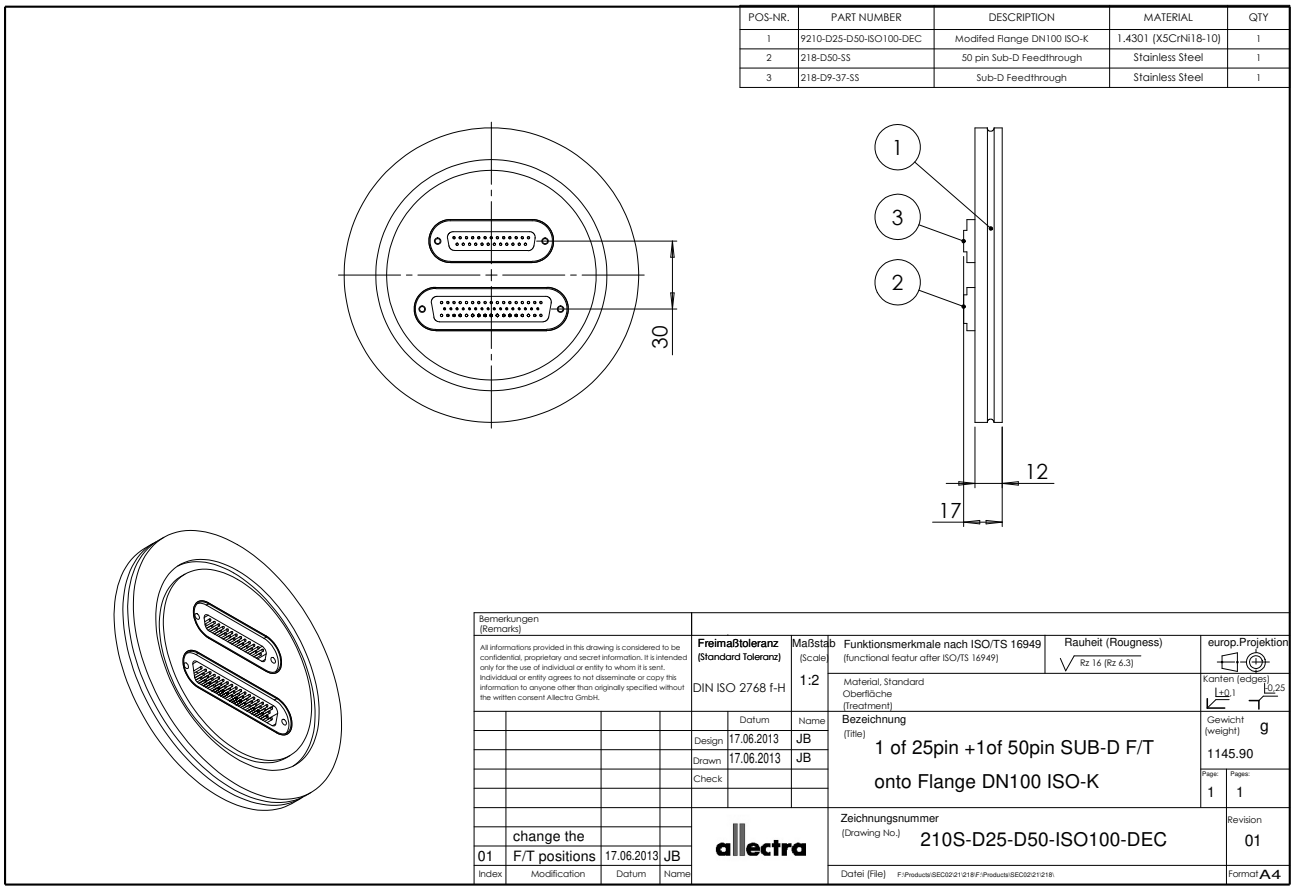

Figure 4.4: Drawing of the optional PILATUS3 X 100K-M electrical vacuum feedthrough. Please note, that this drawing does not show the adapter boards for the data cables.

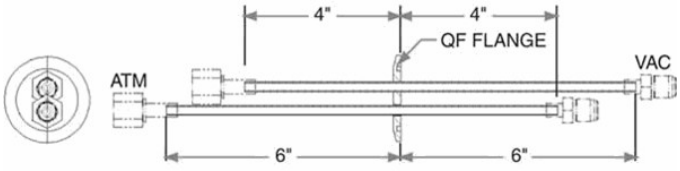

Figure 4.5: Drawing of the optional PILATUS3 X 100K-M cooling vacuum feedthrough.

4.1.2. Detector Head

The detector head comes with a protective cover (1 mm, stainless steel) for the front window (figure 4.6), which should only be removed during operation (figure 4.7). The sensors are behind a 12 µm thick Mylar® (PET) foil coated with 100 nm aluminium to protect them from humidity and ambient light.

Figure 4.6: The PILATUS3 X 100K-M detector head with the protective cover in place (front view)

Danger	#1
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 and damage of the sensors.	

Caution	#5
The cover may not protect the detector from a direct beam.	

Figure 4.7: The PILATUS3 X 100K-M detector head with protective cover removed (front view)

Removing the Mylar® Window for Detectors with Optional Vacuum Compatibility

For operation in vacuum and when the vacuum chamber is light-tight, the Mylar window is not required and can be removed for higher detection efficiency at low X-ray energies. The Mylar® window can be removed by loosening four screws located in the corners of the Mylar® window and carefully pulling the frame straight out.

Caution	#6

Once the Mylar® window is removed the sensors are unprotected from humidity, dust and touch. Remove the Mylar® window in a clean, dust-free, ESD protected and low-humidity environment. Minimize the time the sensors are exposed without protection.

Be very careful when mounting and removing the Mylar® window and avoid touching the sensor under all circumstances, as this will most likely result in a damaged sensor. Make sure the Mylar® window does not tilt inward through the opening at any time. Stay clear of the detector volume with any kind of object (screw-driver, finger, …). This operation should be restricted to trained personnel. Damage caused by improper handling is not covered in the warranty. After mounting or removing the Mylar® window immediately attach dry air (in-air operation) or pump down the system (in-vacuum operation) to keep humidity as low as possible.

Figure 4.8: The PILATUS3 X 100K-M detector head without the Mylar® window (front view)

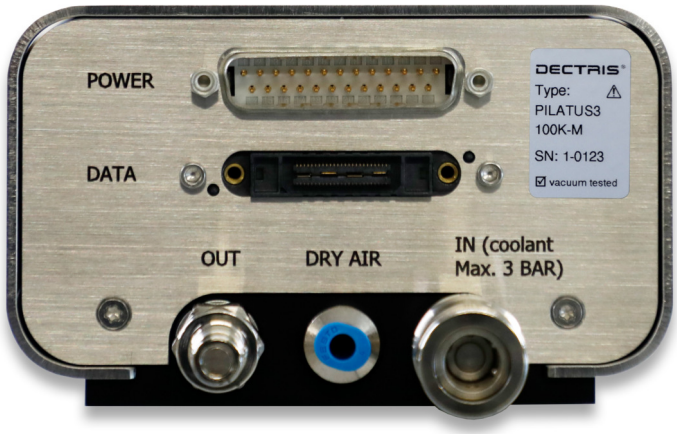

Figure 4.9: The PILATUS3 X 100K-M detector head viewed from the back

Table 4.1: Connectors for cables/pipes on the detector head

POWER	Power cable (2m) to the detector electronics unit/vacuum feedthrough (grey or white D-Sub cable).
DATA	Data cable (2m) to the detector electronics unit/vacuum feedthrough (blue Samtec SQCD ribbon cable).
DRY AIR	Dry air or nitrogen for humidity control. For details see (section 5.4). Pipe: Use a pipe with outer diameter of 4 mm.
IN	Coolant inlet.
OUT	Coolant outlet.

4.1.3. Detector Electronics Unit

Figure 4.10: The PILATUS3 X 100K-M detector electronics unit viewed from the front (left) and back (right).

Table 4.2: Connectors for cables on the front plane of the detector electronics unit

Connectors	Description
DATA1	Data cable to the vacuum feedthrough / detector head (blue Samtec SQCD ribbon cable)
POWER1	Power cable to the vacuum feedthrough / detector head (grey Sub-D cable)

Table 4.3: Status LEDs on the detector back plane

LED	Description
LINK	Orange if detector and PC are powered and connected via the RJ45 data cable.
ACT	Flashing green, if there is activity on the data line between detector and DCU.
EN	Orange, if the detector is in counting mode.

Table 4.3: Status LEDs on the detector back plane - continued

LED	Description
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 4.4: Connectors for cables on the back plane of detector electronics unit

Connectors	Description
DATA	RJ45 Cat 6A S/FTP cable for data transfer. **Caution #7** Note that there must be a 1 Gbit point-to-point connection between detector and PC (Gb2).
+12 V DC	Main voltage 12 V DC from the external power supply
EXT IN	External trigger input. Use a Lemo® Type 00 (NIM/CAMAC) cable.
EN OUT	TTL Level (5 V) output signal; high when counting is enabled. Use a Lemo® Type 00 (NIM/CAMAC) cable.
⏚	Functional ground **Information #4** Although the detector might be already grounded via the mounting bolts, the detector should be grounded additionally via the functional ground connector at the back to establish a defined grounding.
FUSE 4 AT	Fuse (see table 3.3)

4.1.4. Vacuum Feedthroughs (Optional)

For vacuum applications separate electrical and cooling feedthrough sets are optionally available.

The mechanical interface of the electrical feedthrough is a standard DN100ISO-K flange and for the cooling feedthrough it is a standard DN40ISO-KF flange. In the standard configuration the cable length is 1 m in-vacuum and 1 m in-air.

Caution #8

The functionality of the system with a cable length of >2 m is not guaranteed

The cooling hoses are convoluted stainless steel tubes, suitable for static applications, but not for dynamic/flexing applications.

Caution	#9

The cable of the feedthrough set should not be combined with the default cables of the detector system.

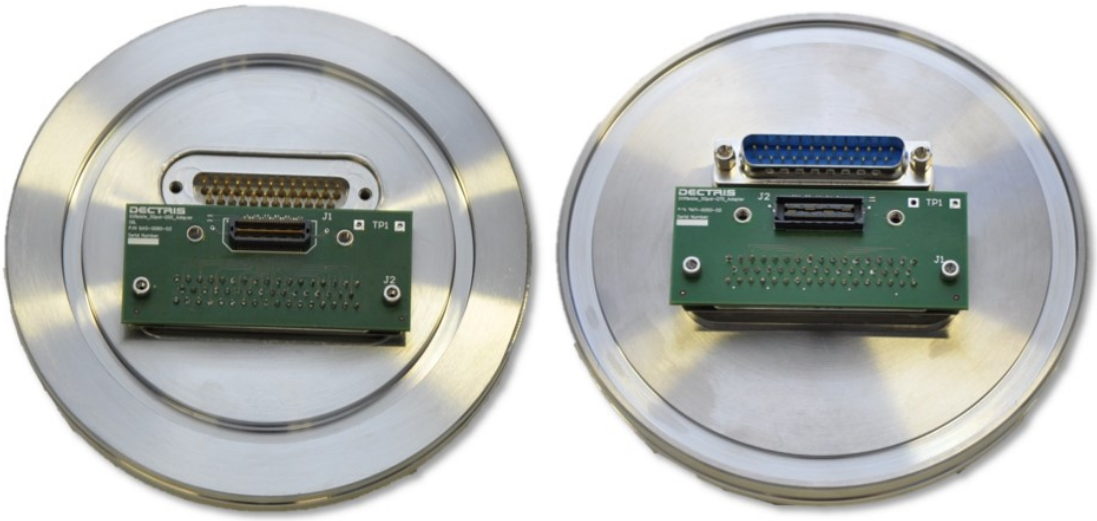

Figure 4.11: Picture of the optional PILATUS3 X 100K-M electrical vacuum feedthrough viewed from the vacuum (left) and air side (right).

Figure 4.12: Picture of the optional PILATUS3 X 100K-M cooling vacuum feedthrough set with tubes through a standard DN40ISO-KF flange, and straight and elbow connectors for the detector head.

4.2. Detector Control Unit

4.2.1. Configuration of the Detector Control Unit

Please do not install or run any other software on the computer, except tools and software which are necessary for configuring your data acquisition protocol.
The detector control unit is set up with a standard installation of the CentOS 7.x distribution. Regular system updates can be made. However, to avoid operational deterioration do not update the system while the detector is taking data.

Caution #10

Do not remove the symbolic link in the directory `~/p2_det/images`, which points to the `images` directory.

The detector control unit has to be connected point-to-point to the detector via 1 x 10GBase-T Ethernet. The detector control unit can be integrated into the site network infrastructure using one of the interfaces described in section 4.2.2. The detector control unit is optimised for performance and stability of operation. In order to achieve these goals we deliver the detector control unit with fixed firmware (bios etc.) and software (OS) version.

Figure 4.13: PILATUS3 X 100K-M detector control unit as seen from the front.

Caution #11

Pushing the power button on the front panel longer than 2 seconds will immediately halt the detector control unit. All image data on the detector control unit will be permanently lost.

Information #5

Briefly pushing the power button on the front panel will shut down the detector control unit. May take up to 1 min.

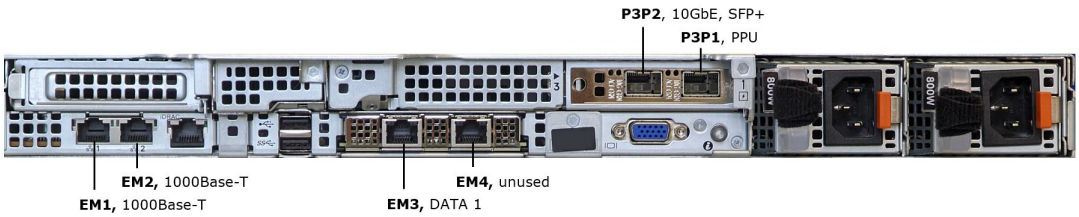

Figure 4.14: PILATUS3 X 100K-M detector control unit as seen from the back.

4.2.2. Connectors

Table 4.5: Detector Control Unit Connectors

Connector	Description
EM1 (Embedded, figure 4.14)	1 GBase-T adapter labeled as LAN User configurable GbE Network Interface Preconfiguration: DHCP

Table 4.5: Detector Control Unit Connectors - continued

Connector	Description
EM2 (Embedded, figure 4.14)	1 GBase-T adapter labeled as SERVICE Preconfigured Service Port Preconfiguration: static IP 169.254.254.1
EM3 (OCP Slot, figure 4.14)	10 GBase-T Ethernet Detector Interface Port1 labelled as DATA 1 Static 10.0.10.1 The start-up script /etc/rc.local disables ARP. Do not change this!
EM4 (OCP Slot, figure 4.14)	Unused
P3P1 (Slot 2, figure 4.14)	10 Gbit SFP+ Ethernet adapter labeled as PPU (if available) is reserved for the PILATUS Processing Unit (PPU) static IP address (10.10.10.10) The start-up script /etc/rc.local disables ARP. Do not change this!
P3P2 (Slot 2, figure 4.14)	Unused
2 x Power (figure 4.14)	AC Connector

See DELL owner's manual for further details.
Note: ARP is re-enabled if the network service has been restarted. In this case execute the startup script /etc/rc.local as super user or reboot the system. To assure stable operation of the detector system the configuration file /etc/sysctl.conf is changed such that the Ethernet rx and tx buffers are larger than the standard setting.

The firewall and SE Linux are disabled by default (otherwise the following ports must be open for UDP: 52010, 52011, 52012). The following firewall port must be open if you want to connect to Camserver with a TCP/IP socket connection from the outside: 41234

4.2.3. Samba Share

There is a Samba share configured on the DCU. The Samba service is enabled by default and running after the system boots.
The storage directory for the images, /home/det/p2_ det/images, which is a symbolic link to /home/det/images, can be accessed from a Samba client. You need the same user name and password as for the normal console or ssh login.
From a Linux or Mac OSX terminal window issue the following command:

smbclient

server-ip-or-hostname/images -U det

To browse the Samba share from Windows, type
server-ip-or-hostname/images in the Windows Explorer address bar.

4.3. Thermal Stabilization Unit

A thermal stabilization unit is required for the operation of the PILATUS3 X 100K-M detector system. The hoses 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, but it should be kept as short as possible to ensure the best flow.

Table 4.6: In-air operating conditions

Condition	Definition
Operating temperature	The thermal stabilization unit has to be set to a temperature of 23 °C for normal operation.
Maximum operating pressure	3 bar
Coolant	66 % distilled water and 34 % ethylene glycol.

Danger #2

Ethylene glycol can be seriously harmful to your health or fatal if handled incorrectly. Consider the packaging and safefty instructions provided by your local supplier.

Information #6

Before operating the thermal stabilization unit, please read the User Manual of the thermal stabilization unit.

Please consider the following points for installation and usage of the thermal stabilization unit:

- When connecting or disconnecting the cooling hoses, turn off the detector and the thermal stabilization unit.
- When operating the detector, the thermal stabilization unit must always be turned on and the pump has to be activated (see user documentation of thermal stabilization unit).
- Use opaque hoses to avoid the growth of algae.
- Do not set the temperature of the thermal stabilization unit below the recommended operating temperature. Condensing moisture can develop and damage the detector.

4.3.1. In-Vacuum Operation for Detectors with Optional Vacuum Compatibility

For in-vacuum operation unscrew the self-sealing valves from the detector and use vacuum-compatible fittings and o-rings. Before opening the cooling circuit always remove the coolant to avoid dripping.

Table 4.7: In-vacuum operating conditions

Condition	Definition
Operating temperature	Before and during pumping down and venting the thermal stabilization unit has to be set to a temperature of 23 °C for at least 30 min. Prior to powering up and operating the detector in-vacuum the thermal stabilization unit has to be set to a temperature of 10 °C for at least 30 min.
Max.Operating Pressure	2 bar

5. INSTALLING THE DETECTOR SYSTEM

5.1. Transport Considerations

Warning	#4

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.

5.2. Mounting

The detector can be mounted in the ways which are described below.

5.2.1. Mounting the Detector Head

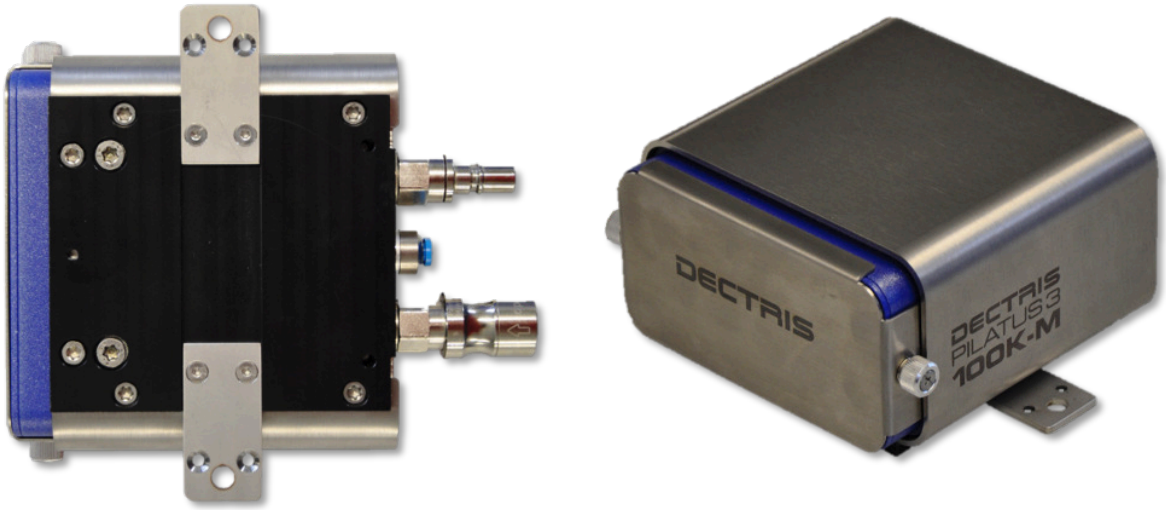

Figure 5.1: Picture of the PILATUS3 X 100K-M detector head with extended mounting brackets viewed from below (left) and front (right).

Mounting the Detector Head from Above

Use the mounting brackets as depicted in figure 5.2. These mounting brackets have to be mounted on the base plate of the detector. The detector should be mounted using both outer 6.4 mm holes (indicated with yellow circles).

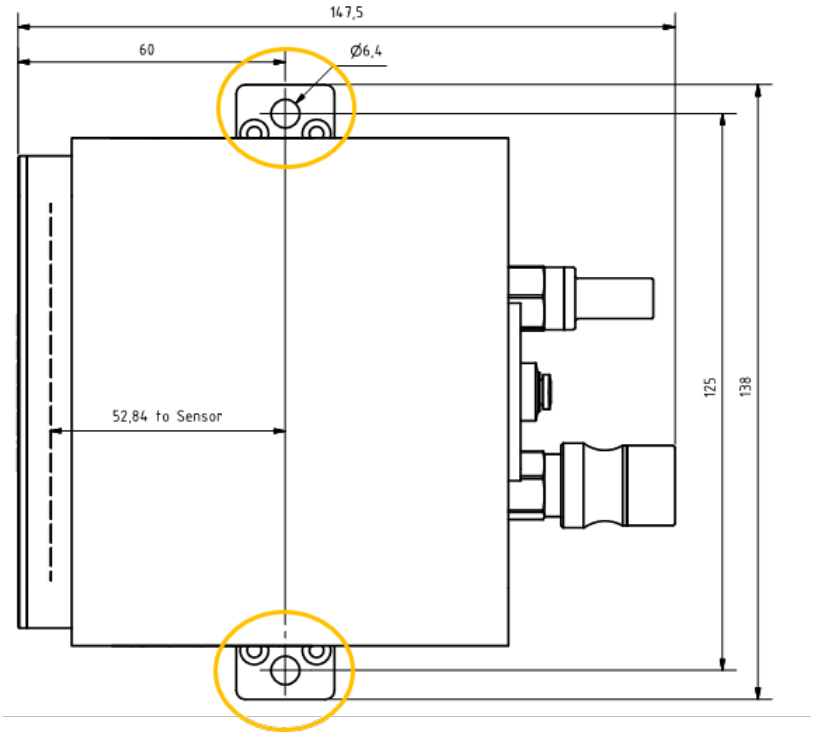

Figure 5.2: Drawing of the PILATUS3 X 100K-M Detector Head with extended Mounting Brackets (top view)

Mounting the Detector Head from Below

Warning	#5

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

The detector should be mounted using the two internal M6x1 threads as shown in figure 5.3 (indicated with yellow circles).

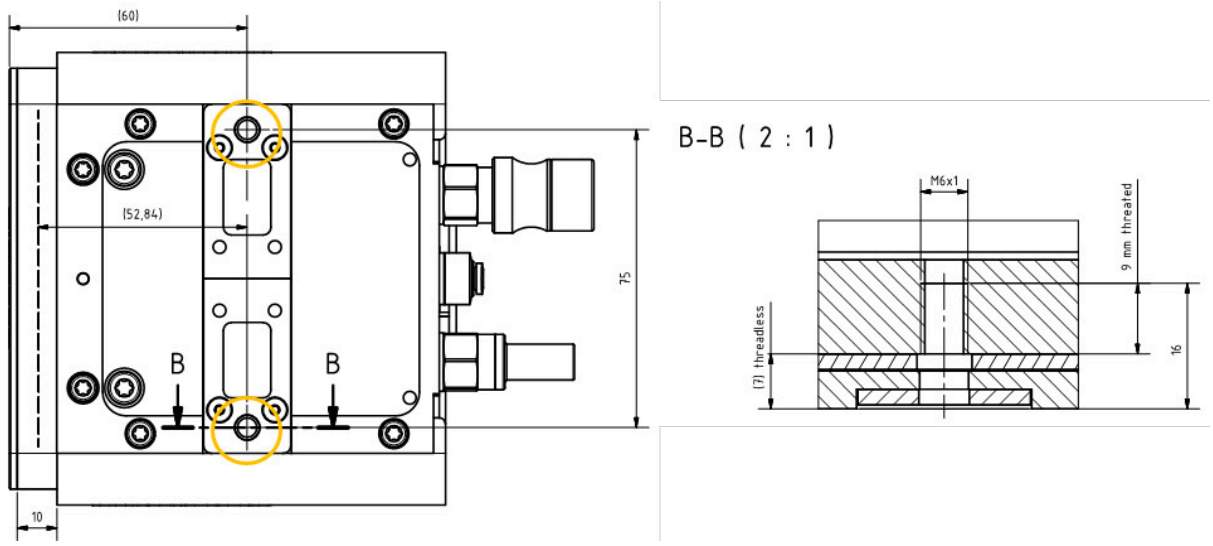

Figure 5.3: Drawing of the PILATUS3 X 100K-M detector head base plate (a printed copy is supplied in the user documentation folder). Left: View from below with retracted mounting brackets for mounting from below. Right: Cross section view through the internal thread to show the 7 mm thread-less and the 9 mm threaded sections.

Caution	#12

The four M6 screws must not intrude into the detector less than 10 mm and more than 15 mm.

5.2.2. Mounting the Detector Electronics Unit

The detector electronics unit can be mounted from below using the four internal threads (M6x1). To mount the detector electronics unit from above, optional mounting brackets are available upon request.

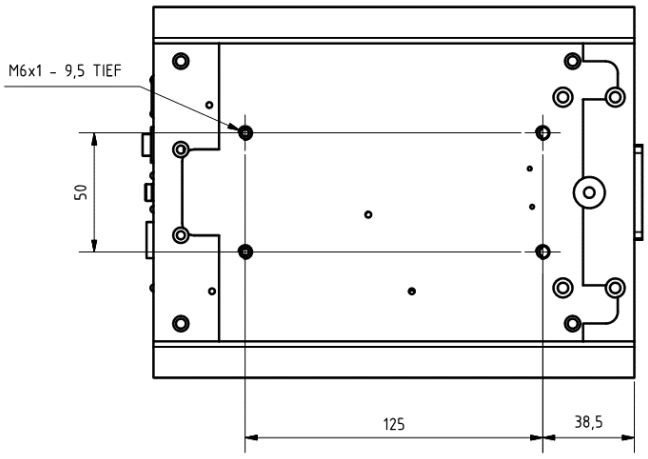

Figure 5.4: Drawing of the base plate of the PILATUS3 X 100K-M detector electronics unit (a printed copy is supplied in the user documentation folder).

Caution	#13

The M6 screws must not intrude into the detector electronics unit more than 9.5 mm. Make sure the detector electronics unit is properly mounted.

5.3. Grounding of the Detector

Caution	#14

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

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

5.4. Connection to Dry Air or Nitrogen

Caution	#15

Humidity might damage the detector. Make sure that the detector is operated within the allowed ambient conditions (see section 3.3).

The PILATUS3 X 100K-M detector has to be connected to a dry air (or nitrogen) source to avoid humidity and condensation damage when it is outside of the storage box. For information on system connections, refer to section 4.1.2 and for storage of the detector system refer to section 7.5.

Please consider the following points for the application of dry air or nitrogen:

- Oil free, dry air of <20 % relative humidity or nitrogen must be used.
- The recommended flow is 5 L h^{-1} to 10 L h^{-1} (at 2 bar).
- For reliable operation we recommend dry air of <5 % relative humidity.
- The gas pressure must not exceed 2 bar.
- The minimum gas pressure is 1 bar.
- The humidity control shuts down the power of the detector modules when the humidity is too high (see chapter 6).

5.4.1. In-Vacuum Use for Detectors with Optional Vacuum Compatibility

The temperature and humidity control cannot prevent condensation issues and resulting damage to the sensor due to improper use. Always make sure that the detector is warmed up (thermal stabilization unit temperature set to 23 °C) prior to pumping down, venting, and opening the chamber. Only use dry air or nitrogen for venting. For in-vacuum operation no nitrogen or dry air flow is necessary.

Warning	#6
When venting with nitrogen, take proper precaution against the risk of asphyxiation caused by oxygen displacement from nitrogen. Ensure sufficient ventilation and oxygen level monitoring. Use compressed dry air for venting large vessels or in confined spaces.	

5.5. Connection to Thermal Stabilization Unit

The PILATUS3 X 100K-M detector is water-cooled and must be connected to a dedicated thermal stabilization unit. Use only the provided thermal stabilization unit.

Warning	#7
For the maximum allowed coolant pressure in the cooling circuit of the detector see table 4.6.	

In Air Operation
Use only the supplied hose couplings (RECTUS 204KL series).

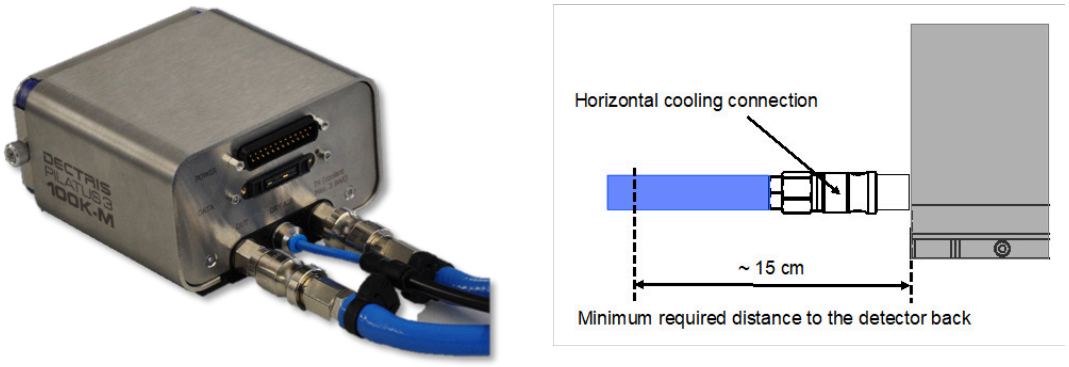

Figure 5.5: Horizontal Coolant Connection for Operation in Air (standard delivery condition).

In-Vacuum Operation
For in-vacuum operation unscrew the supplied hose couplings (RECTUS 204KL series) from the detector and use vacuum-compatible fittings (1/8 inch ISO parallel thread) and o-rings.

Figure 5.6: Examples of cooling connections for operation in vacuum. Depicted are horizontal (left) and vertical (right) connectors from the optional PILATUS3 X 100K-M cooling vacuum feedthrough set (section 4.1.4).

5.6. Mounting the Detector Control Unit

Caution	#16
Make sure that the detector control unit has adequate ventilation.	

The detector control unit can be mounted in a standard 19 inch rack, which has to be properly grounded.

6. TEMPERATURE AND HUMIDITY CONTROL

The PILATUS3 X 100K-M detector has a combined temperature and relative humidity sensor. The temperature and humidity control shuts down the detector when the relative humidity or the temperature of the sensor exceeds the limits in table 6.1.

Table 6.1: Temperature and relative humidity limits

Shutdown Temperature		Shutdown Relative Humidity
Lower Limit	**Upper Limit**	**Upper Limit**
5 °C	35 °C	30 % at operation / 25 % at start-up

The communication with the detector control unit will remain active after a temperature shut down. To start the detector correctly, please refer to chapter 7 and execute the correct start-up procedure.
If the temperature or humidity is out of range, the following error message appears:

[]$_ Camserver Output

```
*** ERROR - temperature too high: 31.1C (channel #2)
Bad return from dcbe_initialize()
Camera initialization error -- press <enter> to exit
```

Make sure that the cooling unit is running at the specified temperature and that nitrogen or dry air flow is turned on at the specified flow rate, given in section 5.4. Then restart the Camserver software.

The command *THread* in camserver displays the actual temperature and humidity of the sensors as shown below.

[]$_ Camserver Output

```
THread
Channel 1: Temperature = 25.7C, Rel. Humidity = 4.4 %
Channel 2: Temperature = 23.1C, Rel. Humidity = 8.2 %
```

7. OPERATION PROCEDURE

Before operating the detector, make sure you have read the Technical Specifications and the User Manual of the PILATUS3 X 100K-M detector.

7.1. Getting Started

Before switching on:

- Mount the detector head and the detector electronics unit properly.
- Connect the detector electronics unit to ground potential, using the functional ground connector (see section 5.3).
- Connect the detector electronics unit to power supply; make sure the power switch is OFF.
- Connect the detector to a nitrogen or dry air source, capable of supplying at least the minimum recommended flow rate (see section 5.4).
- Connect the coolant hoses. Make sure they are properly mounted on both sides.
- Set the temperature to 23 °C on the thermal stabilization unit and turn it on. If the detector was not at room temperature, wait until the thermal stabilization unit has reached stable operation.
- Connect the power cable, the local network cable, and the detector data cable to the detector control unit.
- Attach a monitor, keyboard and mouse to the detector control unit.

7.2. Start-up Procedure

Please use the following start-up procedure:

- Turn on the dry air or nitrogen at least 30 min before turning on the detector. Then turn ON the power switch at the back of the detector.
- Turn on the detector control unit. Wait at least till the detector control unit is booted (about 5 min) before trying to connect.
- Start a shell.
- The default path is: */home/det*.
- Change the directory to: *p2_det/*.
- Type: *./runtvx* (it starts a script which initializes the detector system and opens the Camserver and TVX windows).
- Let the detector reach its operation temperature (see section 3.3). This will take between 30 min to 60 min. The operation temperature can be determined by typing the command THread in Camserver (compare chapter 6).

Information	#7
If you want to control the detector with a TCP/IP client, type *./camonly* in the directory *p2_det/*. It starts a script which initializes the detector system and opens the Camserver window. Please refer to the User Manual for further information.	

The detector should now be ready to use.

Information	#8
The software start-up procedure is described in detail in the User Manual.	

7.3. Turning Off the Detector

To turn off the detector:

- Turn OFF the detector electronics unit power switch.
- Do not remove the nitrogen/dry air connection. It is a requirement that it is left at the recommended flow rate according to section 5.4.

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 exit Camserver.

Caution	#17

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

7.4. Vacuum Operation for Detectors with Optional Vacuum Compatibility

Make sure the vacuum conditions in table 3.8 are met and follow below procedures for venting and pumping down the vacuum chamber.

Warning	#8

Prior to pumping down (and venting):
Always make sure the detector is SWITCHED OFF and WARMED UP to room temperature. Otherwise it could be damaged through electrical discharge or condensation.

Pumping Down the Vacuum Chamber

- Mount the detector head properly inside the vacuum chamber.
- Connect the detector power, data, trigger, and coolant lines inside and outside the vacuum chamber.
- Connect the detector control unit and the detector data cables.
- Make sure the power switch on the back of the detector electronics unit is OFF.
- Close the vacuum chamber and start to pump down.
- Once the pressure inside the vacuum chamber is below 1×10^{-2} mbar set the temperature on the thermal stabilization unit to 10 °C and turn on the thermal stabilization unit (pumping down a warm detector prevents condensation issues).
- After the thermal stabilization unit has reached the set value and the pressure inside the vacuum chamber is below 1×10^{-3} mbar, switch on the detector electronics unit.

Start-up Procedure

- Let the thermal stabilization unit stabilize at 10 °C for at least 30 min.
- After the thermal stabilization unit has reached the set value, switch on the detector electronics unit.
- Turn on the detector control unit. Wait at least 5 min before trying to connect.
- Start a shell.
- The default path is: */home/det*.
- Change the directory to: *p2_det/*.
- Type: *./runtvx* (it starts a script which initializes the detector system and opens the Camserver and TVX windows).
- Let the detector reach its operation temperature (see section 3.3). This will take between 30-60 min. The operation temperature can be determined by typing the command THread in Camserver (compare chapter 6).

Information	#9

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

Turning-off Procedure

- Turn OFF the detector electronics unit power switch.
- Turn OFF the detector control unit.
- Keep the detector under vacuum.

Venting the Vacuum Chamber

- Set the temperature to 23 °C on the thermal stabilization unit and let the detector warm up at least 30 min to prevent condensation inside the vacuum chamber.
- Use dry air or nitrogen to vent the chamber.

7.5. Storing the Detector

Information	#10

Even if the detector is not in operation, it is recommended that the dry air or nitrogen flow is maintained to reduce the risk of humidity damage to the detector.

Please follow these instructions:

- Put the detector in a plastic bag, add at least 200 g of drying agent (i.e. silica gel) into the bag and seal it air-tight.
- Check the humidity and change the drying agent frequently for compliance with the storage requirements in section 3.3.

7.6. Cleaning and Maintenance

Caution	#18

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

The housing can be cleaned with a soft tissue.

Please refer to the user documentation of the thermal stabilization unit for detailed information about the maintenance of your thermal stabilization unit.
The following procedures related to the thermal stabilization unit have to be done periodically by the user:

Table 7.1: Cleaning and maintenance procedures

What	When	Who
Check the tightness of the cooling hoses	Every week	User
Replace the coolant	Every 12 months	User

he PILATUS3 X 100K-M detector does not require any maintenance.

8. TROUBLESHOOTING

An overview of possible problems with the detector system and instructions in order to solve the problems is provided in table 8.1. If the problem you are experiencing is not listed below or if the instructions do not help, please contact support@dectris.com.

Table 8.1: Troubleshooting

Problem	Cause	Solution
Detector control unit does not start properly.	Detector control unit is not powered.	Check the User Documentation of the detector control unit (see section 3.1.4). Check the power cable; depending on the type of detector control unit, there are switches on the back and on the front panel of the detector control unit, which have to be in the correct position.
Communication error, the detector is not found at start-up.	Data cable is not connected or defective.	Check the connection between detector control unit and detector. Make sure that there is a direct, peer-to-peer connection between the detector control unit and the detector. Avoid tangling or strong bending of the Ethernet data cable. Check the status of the LINK LED. If the detector control unit and the detector are powered and correctly connected, the LINK LED should be green (Takes up to 30 s after power up)
	The configuration of the Ethernet adapter is wrong.	Check configuration of the Ethernet adapter, see section 4.2.1.

Table 8.1: Troubleshooting - continued

Problem	Cause	Solution
Detector shuts down.	Temperature or humidity error.	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 thermal stabilization 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.
	Module over current: The energy threshold level is set too low and the detector starts oscillating.	Increase the threshold level. In Camserver type: *setCu*.
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 POWER LED.
	The fuse is blown.	Replace the fuse, see table 3.3.
	The temperature is over the critical limit. The thermal protection was triggered.	Check the thermal stabilization unit. The detector will power on again, as soon as the temperature is within the allowed operating conditions.
Image acquisition is not possible.	Detector is not properly initialized.	Run the following commands in TVX: - *setdac* - *calibdet* - *expose 1* Check the status of the POWER LED. If it is red and the TEMP LED is green, there is 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.

9. CERTIFICATION TESTS

The product is in conformity with the following standards:

Table 9.1: Certification Tests for PILATUS3 X 100K-M

EN 61000-6-2:2016 / IEC 61000-6-2:2005 (ed2.0), (industrial)
EN 61000-6-4:2007 + A1:2011 / IEC 61000-6-4:2011 (ed2.1), (industrial)
EN 61010-1:2010 / IEC 61010-1:2010 + AMD1:2016
EN 61326-1:2013 / IEC 61326-1:2012 (ed2.0)

10. 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. _____

_____

_____

_____

_____

_____

_____

_____

_____