Technical Specifications and Operating Procedure

PILATUS3 S 6M-NSRRC Detector System

Version: V1.0
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1. Document History

1.1. Current document

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>status</th>
<th>prepared</th>
<th>checked</th>
<th>released</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>02.11.2015</td>
<td>draft</td>
<td></td>
<td></td>
<td>BL</td>
</tr>
</tbody>
</table>

Table 1: Document history.

1.2. Changes

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>02.11.2015</td>
<td>First version based on Technical_Specifications_PILATUS3S_6M_V3_0.</td>
</tr>
</tbody>
</table>

Table 2: List of changes.
2. General Information

Before operating the PILATUS3 S 6M-NSRRC 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
5404 Baden-Daettwil
Switzerland
Phone: +41 56 500 21 00
Fax: + 41 56 500 21 01
Email: 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.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>☐</td>
<td>Important or helpful notice.</td>
</tr>
<tr>
<td>☐</td>
<td>Caution. Please follow the instructions carefully to prevent equipment damage or personal injury.</td>
</tr>
<tr>
<td>☐</td>
<td>Ground.</td>
</tr>
</tbody>
</table>

Table 3: Safety symbols.
2.4. Use of the PILATUS3 S 6M-NSRRC

The PILATUS3 S 6M-NSRRC 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.

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

⚠️ Do not modify the detector system in any way (hardware, software, electronics, …) without the consent of DECTRIS Ltd. Failure to do so will void the warranty.

2.5. 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 Ltd. detector system.
### 3. Technical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of modules</td>
<td>5 x 12 = 60</td>
</tr>
<tr>
<td>Sensor</td>
<td>Reverse-biased silicon diode array</td>
</tr>
<tr>
<td>Sensor thickness</td>
<td>1000 μm</td>
</tr>
<tr>
<td>Quantum efficiency</td>
<td></td>
</tr>
<tr>
<td>at 5.4 keV (Cr):</td>
<td>&gt; 80%</td>
</tr>
<tr>
<td>at 8.0 keV (Cu):</td>
<td>96%</td>
</tr>
<tr>
<td>at 17.5 keV (Mo):</td>
<td>76%</td>
</tr>
<tr>
<td>Readout chip</td>
<td>PILATUS3 with instant retrigger technology</td>
</tr>
<tr>
<td>Pixel size</td>
<td>172 x 172 μm²</td>
</tr>
<tr>
<td>Module size</td>
<td>83.8 x 33.5 mm²</td>
</tr>
<tr>
<td>Format</td>
<td>2463 x 2527 = 6'224'001 pixels</td>
</tr>
<tr>
<td>Area</td>
<td>423.6 x 434.6 mm²</td>
</tr>
<tr>
<td>Intermodule gap</td>
<td>x: 7 pixels, y: 17 pixels, 8.5% of total area</td>
</tr>
<tr>
<td>Dynamic range</td>
<td>20 Bits (0:1'048'573)</td>
</tr>
<tr>
<td>Counter overflow state</td>
<td>1'048'573</td>
</tr>
<tr>
<td>Counting rate per pixel</td>
<td>10⁷ X-ray/sec (incoming X-rays)</td>
</tr>
<tr>
<td>Energy range</td>
<td>5 – 36 keV</td>
</tr>
<tr>
<td>Energy resolution</td>
<td>500 eV</td>
</tr>
<tr>
<td>Adjustable threshold range</td>
<td>2.7 – 18 keV</td>
</tr>
<tr>
<td>Threshold dispersion</td>
<td>50 eV</td>
</tr>
<tr>
<td>Readout time</td>
<td>2.03 ms</td>
</tr>
<tr>
<td>Maximum frame rate</td>
<td>25 Hz</td>
</tr>
<tr>
<td>Point-spread function</td>
<td>1 pixel (FWHM)</td>
</tr>
<tr>
<td>Data formats</td>
<td>Raw data, TIF, EDF, CBF</td>
</tr>
<tr>
<td>External trigger/gate</td>
<td>5 V TTL</td>
</tr>
<tr>
<td>Software interface</td>
<td>Through socket connection;</td>
</tr>
<tr>
<td></td>
<td>Clients for EPICS, SPEC and stand-alone</td>
</tr>
<tr>
<td></td>
<td>operation are available</td>
</tr>
</tbody>
</table>
### Technical Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooling</strong></td>
<td>Closed circuit (2/3 distilled water 1/3 Ethyleneglycol) unit for temperature stabilization at 23°C. The maximum allowable coolant pressure in the cooling circuit is 2 bar.</td>
</tr>
<tr>
<td><strong>Coolant</strong></td>
<td>Use mixture of 2/3 distilled water and 1/3 Ethyleneglycol</td>
</tr>
<tr>
<td><strong>Power consumption</strong></td>
<td>580 W</td>
</tr>
<tr>
<td><strong>Dimensions (W x H x D)</strong></td>
<td></td>
</tr>
<tr>
<td>Detector head</td>
<td>836 x 880 x 654 mm³</td>
</tr>
<tr>
<td>Detector electronics</td>
<td>590 x 603 x 447 mm³</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>Detector head: approx. 500 kg</td>
</tr>
<tr>
<td>Detector electronics: approx. 50 kg</td>
<td></td>
</tr>
<tr>
<td><strong>Overvoltage category</strong></td>
<td>II</td>
</tr>
<tr>
<td><strong>Pollution degree</strong></td>
<td>II</td>
</tr>
<tr>
<td><strong>Maximum altitude</strong></td>
<td>2000 m a.s.l.</td>
</tr>
</tbody>
</table>

Table 4: Technical specifications.
### 3.1. Ratings

<table>
<thead>
<tr>
<th>Device</th>
<th>Definition</th>
</tr>
</thead>
</table>
| Detector power input                  | 2 x 100 – 240 V AC, 50 – 60 Hz  
Power supply 1 (modules): 360 W  
Power supply 2 (electronics): 220 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                | 5 V TTL (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                          | 100 V AC (50 Hz), 100 – 115 V AC (60 Hz), 1 kW  
Coolant flow: >20 l/min @ 1.0 bar  
Coolant pressure: max. 1.9 bar |

Table 5: Ratings.
3.2. Ambient Conditions

The PILATUS3 S 6M-NSRRC 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 N₂ supply are different. They are described in section 5.6 and section 6.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating ambient temperature</td>
<td>+20°C to +35°C</td>
</tr>
<tr>
<td>Operating ambient humidity</td>
<td>&lt; 80% at 20°C, non-condensing</td>
</tr>
<tr>
<td>Storage ambient temperature</td>
<td>+15°C to +40°C</td>
</tr>
<tr>
<td>Storage ambient humidity</td>
<td>&lt; 40% at 20°C, non-condensing</td>
</tr>
</tbody>
</table>

Table 6: Detector operating conditions.

⚠️ 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 S 6M-NSRRC is equipped with a temperature and humidity sensor.

3.3. Vacuum Conditions

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

<table>
<thead>
<tr>
<th>Condition</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chamber pressure during operation</td>
<td>$10^{-3}$ mbar or less than $10^{-2}$ mbar</td>
</tr>
<tr>
<td>Chamber temperature during operation</td>
<td>+10°C to +25°C</td>
</tr>
<tr>
<td>Chamber temperature during “bake-out” (unpowered)</td>
<td>max. +60°C (for temperatures &gt; 40°C make sure the cooling unit is set to +40°C and running)</td>
</tr>
</tbody>
</table>

Table 7: Vacuum field codes.
4. **Detector Dimensions and Connectors**

Figure 1: Rendering of the PILATUS3 S 6M-NSRRC detector consisting of detector head (left, with the front side facing down and the back side facing up) and detector electronics (right).

Figure 2: Drawing of the PILATUS3 S 6M-NSRRC detector head (printed separately in the user documentation folder).
4.1. The PILATUS3 S 6M-NSRRC Detector

4.1.1. Front Side of the Detector Head

For operation the detector head is flanged directly onto the vacuum system. The detector head comes with a blank flange as a protective cover during e.g. storage, transport or vacuum tests/bake-out. Once the blank flange is removed the sensors are unprotected from humidity, dust and touch.

The separate Mylar window, a 12 μm thick Mylar® (PET) foil coated with 100 nm aluminum, is to be installed in front of the sensors. It protects the sensors from light and particles.

Refer to section 5.2 for mounting of the detector head.
4.1.2. Back Side of the Detector Head

Figure 5: The PILATUS3 S 6M-NSRRC detector head viewed from the back (left) and its connection layout (right).
4.1.3. Front Side of the Detector Electronics

![Front Side of the Detector Electronics](image)

Figure 6: PILATUS3 S 6M-NSRRC detector electronics viewed from the front (left) and its connection layout (right)

![Connection Layout](image)

4.1.4. Back Side of the Detector Electronics

![Back Side of the Detector Electronics](image)

Figure 7: The PILATUS3 S 6M-NSRRC detector electronics viewed from the back.
4.1.5. The Status LEDs

<table>
<thead>
<tr>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN</td>
<td>Yellow, if the detector is in counting mode.</td>
</tr>
<tr>
<td>TEMP</td>
<td>Normally green. Turns red if the detector temperature or humidity is out of the limits.</td>
</tr>
<tr>
<td>POWER</td>
<td>Normally green. Turns red if there is a power failure or if the detector temperature or humidity is out of the limits.</td>
</tr>
</tbody>
</table>

Table 8: The meaning of the status LEDs on the detector back plane.

4.1.6. Connectors and Connecting Cables/Pipes

<table>
<thead>
<tr>
<th>Connector</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA 1 (left, Figure 7)</td>
<td>RJ45 Cat 6 S/FTP cable for data transfer (DATA 2, 3, 4 unused).</td>
</tr>
<tr>
<td>POWER</td>
<td>Main voltage 100 – 240 VAC; 50/60 Hz, Fuse 6.3A</td>
</tr>
<tr>
<td></td>
<td>UL recognized to UL 60950/CSA 22.2 No. 60950-00, and</td>
</tr>
<tr>
<td></td>
<td>TUV approved to EN 60950-1</td>
</tr>
<tr>
<td></td>
<td>Cable:</td>
</tr>
<tr>
<td></td>
<td>Power cable with an IEC/C13 connector.</td>
</tr>
<tr>
<td>EXT IN</td>
<td>External trigger input TTL.</td>
</tr>
<tr>
<td></td>
<td>Use a Lemo® Type 00 (NIM/CAMAC) cable.</td>
</tr>
<tr>
<td>EN OUT</td>
<td>TTL output signal; high when counting is enabled.</td>
</tr>
<tr>
<td></td>
<td>Use a Lemo® Type 00 (NIM/CAMAC) cable.</td>
</tr>
<tr>
<td>INTERLOCK</td>
<td>Functional ground of the detector system.</td>
</tr>
</tbody>
</table>

⚠️ 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.

Possibility to prevent high voltage discharges in case of vacuum leaks
- in-air operation: Interlock not necessary, use the shorting-plug provided
- in-vacuum operation: only short-circuit the two contacts, when the vacuum is in a safe regime (either 1e+3 mbar or <1e-2 mbar) to protect the detector

⚠️ Use an interlock circuit, which is electrically isolated from the detector and simply connects (high voltage on) or disconnects (high voltage off) the two
contacts. Do not inject noise, voltages or currents into the detector system.

<table>
<thead>
<tr>
<th>Coolant IN</th>
<th>Coolant outlet.</th>
</tr>
</thead>
<tbody>
<tr>
<td>(at the detector head back)</td>
<td>Use 2/3 distilled water and 1/3 Ethylenglycol for cooling.</td>
</tr>
</tbody>
</table>

| Coolant OUT (at the detector head back) |

Table 9: Connectors and connecting cables/pipes.

### 4.2. Computer

The PILATUS3 S 6M-NSRRC 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 8: Configuration of the PILATUS3 S 6M-NSRRC 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 S 6M-NSRRC 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](http://www.dectris.com).
4.3. Cooling unit

A cooling unit is required for the operation of the PILATUS3 S 6M-NSRRC 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.

<table>
<thead>
<tr>
<th>Operating type</th>
<th>In-air or vented vacuum</th>
<th>In-vacuum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature</td>
<td>The cooling unit has always to be set to a temperature of 23°C.</td>
<td>Prior to and during pumping down and venting the cooling unit has to be set to a temperature of 23°C for at least 30 minutes. Prior to powering up and operating the detector in-vacuum the cooling unit has to be set to a temperature of 10°C for at least 30 minutes.</td>
</tr>
<tr>
<td>Operating pressure</td>
<td>0.5 bar</td>
<td>0.5 bar</td>
</tr>
</tbody>
</table>

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 head has four transport hooks, which have to be used for lifting the detector head. For tilting/rotating the detector head, two hooks can be used: Lift the detector head up so it hangs diagonally, then set it down towards the other side.

⚠️ Only use an appropriate lifting device with a carrying capacity of at least 1000 kg.

⚠️ Make sure 2 persons always move the detector head.

⚠️ When using the transport hooks, make sure they are properly tightened.

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

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

⚠️ Only use an appropriate lifting device with a carrying capacity of at least 100 kg.

⚠️ Make sure 2 persons always move the detector electronics.

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

⚠️ When moving the detector electronics, make sure that all cables are disconnected.

5.2. **Mounting of the Detector Head**

Install the Mylar® window inside the beamline sample chamber before mounting the detector head.

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

With the blank flange still attached rotate the detector head so the x-ray sensor points downward (see above how to rotate). Remove the blank flange and mount the detector head on top of the sample chamber.

⚠️ Remove the blank flange in a clean, dust-free and humidity-controlled environment. Minimize the time the sensors are exposed without protection.

⚠️ BE VERY CAREFUL when installing the detector head or the blank flange and avoid touching the sensor under all circumstances, as this will most likely result in a damaged sensor. Make sure the blank flange does not tilt inward through the opening at any time. Stay clear of the detector head volume with any kind of object (screw-driver, finger, …). This operation is restricted to trained personnel. Damage caused by improper handling is not covered in the warranty.

⚠️ After installation immediately flush the chamber with dry air or pump down the system to keep humidity as low as possible.
5.3. Mounting of the Detector Electronics

The detector electronics can be mounted in two ways:

5.4. 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 9, 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 9: Drawing of the PILATUS3 S 6M-NSRRC detector base plate (printed separately in the user documentation folder).
5.5. 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 10: Mounting from below, bottom view.
5.6. Connection to Nitrogen or Dry Air

When the PILATUS3 S 6M-NSRRC detector head is outside the storage box (for storage see section 9 and section 3.2) and not under vacuum has to be connected to a nitrogen or dry air flow to avoid humidity and condensation. There is no dedicated inlet or outlet for nitrogen or dry air on the detector head itself, but any vacuum chamber ports can be used for this. Contact DECTRIS support if you need more details.

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

⚠️ Make sure the volume around the sensor is enclosed (e.g. by the vacuum chamber), otherwise the inside humidity cannot be controlled. The flow of nitrogen should be adjusted such that the humidity is kept below 25% relative humidity (see section 6 for how to measure humidity). As an alternative to nitrogen, oil free, dry air of < 20% relative humidity can be used. For reliable operation we recommend a dry air of < 5% relative humidity. Since this gives more margin from humidity fluctuations.

⚠️ Make sure the gas outlet is free and use moderate gas pressure. It is recommended to use e.g. a burst disk to prevent over-pressure inside the vacuum chamber.

For in-vacuum operation no nitrogen or dry air flow is necessary.

⚠️ To avoid condensation always make sure the detector is turned OFF and at room temperature prior to pumping down or venting. Use nitrogen or dry air for venting the vacuum chamber.

5.7. 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.

⚠️ The detector head has to be grounded via the mounting bolts.

⚠️ Although the detector electronics might be grounded via the mounting bolts, the detector electronics can be grounded additionally via the functional ground connector at the back to establish a defined grounding.
6. **Temperature and Humidity Control**

The PILATUS3 S 6M-NSRRC 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:

<table>
<thead>
<tr>
<th>Channel</th>
<th>Location</th>
<th>Shutdown Temperature [°C]</th>
<th>Shutdown Humidity [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low limit</td>
<td>High limit</td>
</tr>
<tr>
<td>1</td>
<td>Base plate inside</td>
<td>5</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>vacuum chamber</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10: 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.

⚠️ In-vacuum operation: 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 to room temperature prior to pumping down / venting / opening the vacuum system and only use dry air or nitrogen for venting.

⚠️ If the humidity is outside the specified range, the software will prevent powering up the modules and exit with a corresponding message (Figure 11).

Make sure that the cooling unit is running at the recommended temperature (according to section 1.1) and that Nitrogen or dry air flow is turned on at the recommended flow rate (for in-air operation only, according to section 5.6). Then restart the software.

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 in Figure 12.
Figure 11: Error message when temperature or humidity is out of range.

Figure 12: Correct start-up message.
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:

**In-air operation:**
- Mount the detector head and the detector electronics properly.
- Connect the data, power and temperature cables between the detector head and the detector electronics.
- Connect the detector electronics to power; make sure the detector electronics power switch is OFF.
- Connect the detector head to nitrogen or dry air at the recommended flow rate.
- Connect the water tubes to the detector head. 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.

**In-vacuum operation:**
- Mount the detector head properly to the vacuum system. Mount the detector electronics properly.
- Connect the data, power and temperature cables between the detector head and the detector electronics.
- Connect the detector electronics to power; make sure the detector electronics power switch is OFF.
- Connect the water tubes to the detector head. Make sure they are properly mounted on both sides.
- Start to pump down the vacuum system.
- Once the vacuum is < 10⁻⁵ mbar set the cooling temperature to 10°C and turn on the cooling unit (pumping down a warm detector prevents condensation issues).
- Connect the PC and the detector electronics with Ethernet data cables.
- Attach a monitor, keyboard and mouse to the PC.

⚠️ **In-vacuum operation - 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.
7.1. **Startup Procedure**

- **In-air operation:** 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 electronics.
- **in-vacuum operation:** Let the cooling unit stabilize at 10°C for at least 30 minutes and verify, that the vacuum is < $10^{-2}$ mbar. Then turn ON the power switch at the back of the detector electronics.
- 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**

**In-air operation:**
- Turn OFF the power switch at the back of the detector electronics.
- Do not remove the nitrogen/dry air connection and leave it at the recommended flow rate according to section 5.6.

**In-vacuum operation:**
- Turn OFF the power switch at the back of the detector electronics.
- Keep the detector under vacuum.

⚠️ **In-vacuum operation - prior to venting (and pumping down):**
- Always make sure the detector is SWITCHED OFF and WARMED UP to room temperature. Otherwise it could be damaged through electrical discharge or condensation.

⚠️ 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-air operation) on the detector head or to keep it under vacuum (in-vacuum operation).

To store the detector head: With the blind flange mounted pump down the detector head vacuum chamber and vent it with nitrogen or dry air. Quickly seal the vacuum chamber avoiding as much as possible an exchange between the dry air inside and the humid ambient air.

Then place the detector head 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 3.2.

To store the detector electronics pack them into an air-tight plastic bag and seal the plastic bag. Observe the storage requirements in section 3.2.
10. Cleaning and Maintenance

The housing can be cleaned with a soft tissue.

⚠️ The Mylar® foil must not be touched or cleaned.

The PILATUS3 S 6M-NSRRC 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:

<table>
<thead>
<tr>
<th>What</th>
<th>When</th>
<th>Who</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check and, if necessary, clean the air filter on the back of the PILATUS3 S 6M-NSRRC electronics</td>
<td>Every month</td>
<td>User</td>
</tr>
<tr>
<td>Replace the air filter on the back of the PILATUS3 S 6M-NSRRC electronics</td>
<td>Every 12 months</td>
<td>User</td>
</tr>
<tr>
<td>Check the tightness of the cooling tubes</td>
<td>Every week</td>
<td>User</td>
</tr>
<tr>
<td>Replace the cooling liquid</td>
<td>Every 12 months</td>
<td>User</td>
</tr>
</tbody>
</table>
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 support@dectris.com.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC does not start properly.</td>
<td>PC is not powered.</td>
<td>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.</td>
</tr>
<tr>
<td>Communication error, the detector is not found at Camserver startup.</td>
<td>Data cables are incorrectly connected or defective.</td>
<td>Check the connection between PC and detector. Make sure that there is a direct connection between the PC and the detector.</td>
</tr>
<tr>
<td></td>
<td>The configuration of the 10 Gbit Ethernet adapters is wrong.</td>
<td>Avoid tangling or strong bending of the Ethernet data cables.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check configuration of the Ethernet adapters.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check the status of the LINK LEDs. If PC and detector are powered and correctly connected, the LINK LEDs should be green.</td>
</tr>
<tr>
<td>Detector shuts down.</td>
<td>Temperature or humidity error: See section 6 for the temperature and humidity shut down values.</td>
<td>Check that the detector is properly supplied with coolant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check the flow of nitrogen or dry air.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check the temperature of the coolant at the front panel of the cooling unit.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Check the temperature of the detector with the command in Camserver: type “thread”.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Wait until the detector cools down.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Restart the detector again.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Detector shuts down.</td>
<td>Module over current: The energy threshold level is set too low and the detector starts oscillating.</td>
<td>Increase the threshold level. In Camserver type: setCu.</td>
</tr>
<tr>
<td><strong>Problem</strong></td>
<td><strong>Cause</strong></td>
<td><strong>Remedy</strong></td>
</tr>
<tr>
<td>------------</td>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>The detector fails to turn on.</td>
<td>The power cord is not connected or the plug is incompletely inserted.</td>
<td>Connect the power cord firmly. Check the green LED on the external power supply.</td>
</tr>
</tbody>
</table>
| 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 11: Troubleshooting.
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. __________  
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________
_____________________________________________________________________