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Technical Specifications
DECTRIS QUADRO®

Document Version v1.7.2

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1. GENERAL INFORMATION

1.1. Contact and Support

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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, 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 important information.

1.3. Warranty Information

Caution	#1



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

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

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

2. USE OF THE DECTRIS QUADRO®

The DECTRIS QUADRO® detector system has been designed for the detection of electrons. 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.

Caution	#3
	When operating the detector system on a Transmission Electron Microscope strictly follow the instructions given in this document.

2.1. 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. Detector

Table 3.1: Technical Specifications

Number of modules (W x H)	1 x 1 = 1
Sensor	Reverse-biased silicon diode array
Sensor material	Silicon (Si)
Sensor thickness	450 µm
Pixel size (W x H)	75 µm x 75 µm = 5625 μm^2
Pixel array format (W x H)	512 pixel x 512 pixel = 262 144 pixel
Active area (W x H)	38.4 mm x 38.4 mm = 1474.56 mm^2
Image bit depth	8 bit, 16 bit, 32 bit
Readout bit depth	16 bit
Maximum count rate	1 × 10^7 electrons/pixel/s
Electron energies	30 keV to 200 keV [1]
Number of thresholds	1
Readout time	continuous readout, with 100 ns dead time
Maximum frame rate	2250 Hz, 16 bit, full frame 4500 Hz, 8 bit, full frame
Point-spread function	1.1 pixel at 100 keV
Connection to control unit	1 x LC/UPC duplex connectors
Power supply	External power supply unit
Software interface	HTTP REST interface (via network connection)
Dimensions (W x H x D)	198 mm x 360 mm x 222 mm
Weight	22.6 kg
Overvoltage category	II
Means of protection	I (power supply)
Pollution degree	II
Maximum operating altitude	2000 m a.s.l.

[1] Count-rate correction available for 30, 40, 60, 80, 100, 120, 160 and 200 keV

3.2. Ratings

3.2.1. Detector

Table 3.2: Power Ratings

Detector power input	+12 V DC, 60 W
Detector external trigger input	High level: 2.1 – 5.0 V Low level: 0.0 – 0.8 V **Caution #4** Absolute maximum is 5 V. Applying a higher voltage will damage the detector.
External trigger input impedance	47 kΩ
Detector trigger output	High level: 2.3 V to 3.3 V Low level: 0.0 V to 0.6 V Max. current: 24 mA

3.2.2. Power Supply Unit

Information #1

The detector comes with either a Mean Well GST160A12 (grounded) or GST160B12 (floating) power supply unit. Please consult the user documentation of the provided power supply unit for details.

Caution #5

Only use the power supply delivered with the DECTRIS QUADRO®.

Table 3.3: Power Supply Unit Ratings

Power supply unit power input	Input 85 VAC to 264 VAC (GST160A12) 80 VAC to 264 VAC (GST160B12) 47 Hz to 63 Hz 1 A to 1.85 A Output 12 VDC max. 11.5 A 138 W
AC connector	IEC-320-C14 input inlet (GST160A12) IEC-320-C8 input inlet (GST160B12)
Case dimensions (W x H x D)	72 mm x 35 mm x 175 mm
Weight	0.7 kg

3.2.3. Detector Control Unit

Information	#2
Please consult the user documentation of the DELL PowerEdge R440 for details.	

Table 3.4: Detector Control Unit Ratings

Detector control unit power input	2 x 100 VAC to 240 VAC, 50/60 Hz, 3.7 A to 7.4 A, 550 W (Platinum) 1+1 redundant, hot swappable power supply unit
Dimensions (W x H x D)	482.4 mm(434.0 mm without rack latches) x 42.8 mm x 715 mm
Weight	16.73 kg to 19.9 kg
Chassis	1U

3.2.4. Thermal Stabilization Unit

The DECTRIS QUADRO® detector is optionally equipped with one of the two Thermal Stabilization Units given in 3.5.

Information	#3
Please consult the user documentation of the thermal stabilization unit for details.	

Table 3.5: Thermal Stabilization Unit Options

Thermal stabilization unit	SMC HEC 002-A5B Closed circuit air-water thermal stabilization unit
Thermal stabilization unit	SMC HEC 003-W5B Closed circuit water-water thermal stabilization unit

Table 3.6: Thermal Stabilization Unit Ratings

	SMC HEC 002-A5B	SMC HEC 003-W5B
Power input	Single phase 100 VAC to 240 VAC, allowable voltage range ±10 %, 50/60 Hz	
Current consumption	8 A (100 VAC) to 3 A (240 VAC)	5.5 A (100 VAC) to 2.5 A (240 VAC)
Dimensions (W x H x D)	270 mm x 393 mm x 436 mm	246 mm x 390 mm x 482 mm
Weight	17.5 kg	12 kg
Typical flow	3 L min^{-1}	5 L min^{-1}
Maximum operation pressure	3 bar	3 bar

3.3. Ambient Conditions

The DECTRIS QUADRO® detector is designed for indoor use only. The ambient conditions shown in table 3.7 must be satisfied.
Values inside the detector are different.

Table 3.7: Detector Operating Ambient Conditions

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

Caution #6

Please consider the following points when storing the detector

- Make sure the temperature and the humidity inside the transport box does 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.

4. DETECTOR DIMENSIONS AND CONNECTORS

4.1. DECTRIS QUADRO® Detector

4.1.1. Technical Drawing

Information	#4

3D step files of the DECTRIS QUADRO® detector are available on request. Please contact DECTRIS® technical support for more information.

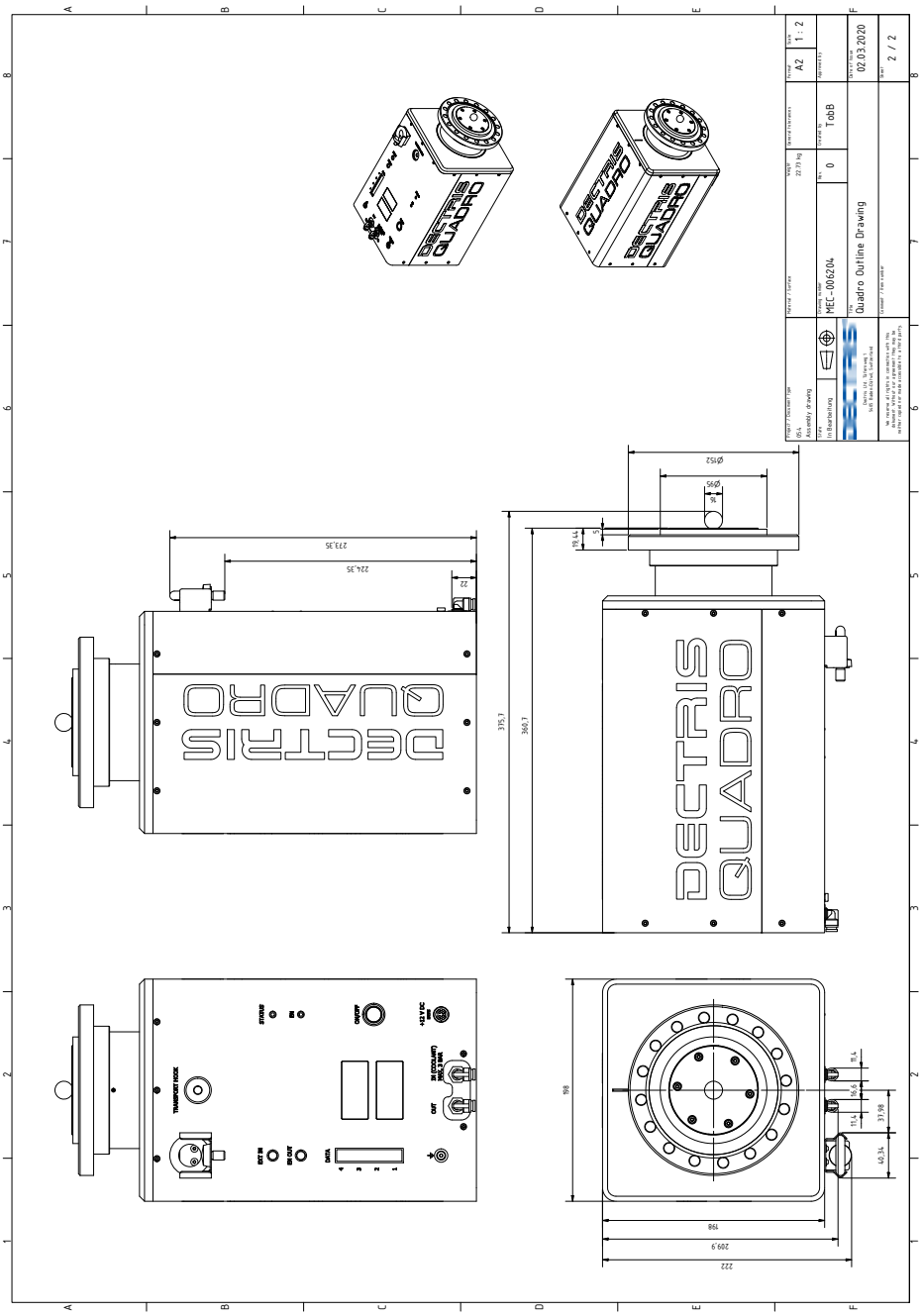


Figure 4.1: Drawing of the DECTRIS QUADRO® Detector (also printed separately in the user documentation folder)

4.1.2. Front Side of the Detector

Danger	#1

Danger of electric shock. The sensor is operated at high voltages. Do not touch the sensor. Touching the sensor can cause an electrical shock.

The detector comes with a protective cover for the front window. It protects the sensor from dust and being touched.



Figure 4.2: The DECTRIS QUADRO® Detector with the Cover Removed (front view)

4.1.3. Connector Side of the Detector

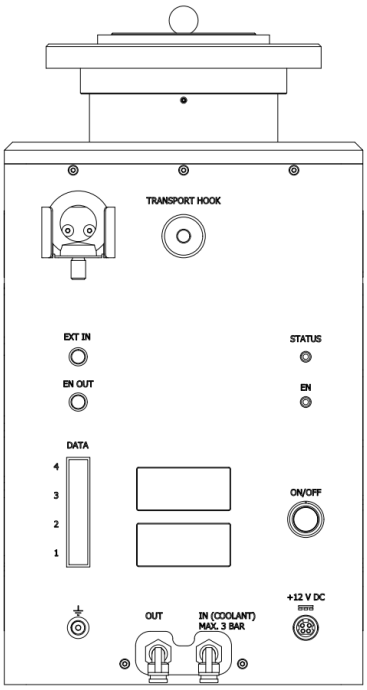


Figure 4.3: The DECTRIS QUADRO® Detector (side view, schematic)

4.1.4. Status LEDs

Table 4.1: The Meaning of the Status LEDs on the Detector

LED	Behavior	Description
EN	Orange	Indicates the detector is in counting mode.
STATUS	Green steady	Detector running and hardware OK.
	Green blinking	Detector hardware OK, detector in Standby or Startup mode. ⇒ Press power button to turn on the detector.
	Red blinking	Detector may be overheating ⇒ Check cooling system
	Off	Detector has no power ⇒ Check the power adapter and mains connection.

4.1.5. Connectors and Connecting Cables/Pipes

Table 4.2: Electric Connectors and Connecting Cables

Connector	Description
DATA	1 x LC/UPC duplex connectors DATA 1 -> detector control unit port 1 The unused data ports are closed with an EMI plug. Do not remove the plugs. Use Single Mode fiber optic patch cable with LC/UPC duplex connectors at both ends. We recommend to use the optic patch cables that are supplied with the detector system. Detector and detector control unit are equipped with 10GBASE-LR Single Mode SFP+ optical transceivers. Do not replace the optical receivers, as proper function of the detector system cannot be guaranteed otherwise. Please contact support@dectris.com if you need replacement transceivers. Caution #7 ⚠ There must be a 1 x LC/UPC duplex connectors point-to-point connection between detector and detector control unit.
POWER	DC power connector (see tables 3.2 and 3.3)
EXT IN	External trigger input (see table 3.2) Use a Lemo® Type 00 (NIM/CAMAC) cable.
EN OUT	Enable out, high when counting is enabled. Use a Lemo® Type 00 (NIM/CAMAC) cable.

Table 4.2: Electric Connectors and Connecting Cables - continued

Connector	Description
⏚	Functional ground

Information #5

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

4.2. Detector Control Unit

4.2.1. Configuration

Caution #8

Do not access or modify the operating system of the detector control unit.

The user interface of the detector control unit is accessible using a web browser. The detector control unit does not need any connections other than the power and Ethernet cables.

The detector control unit has to be connected point-to-point to the detector via 1 x LC/UPC duplex connectors. The detector control unit can be integrated into the site network infrastructure using one of the interfaces described in table 4.3. The detector control unit is optimized 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. The detector control unit must not be operated in an environment where unauthorized access is possible. The detector control unit does not provide authentication mechanisms and is not protected against malicious acts by unauthorized third parties.

Using the web front end, it is possible to restart the QUADRO control service, trigger an update, and to shut down and to reboot the detector control unit. Any further control of the detector is carried out via the SIMPLON API (see separate documentation).



Figure 4.4: Front view of detector control unit.

Caution #9

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 #6

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

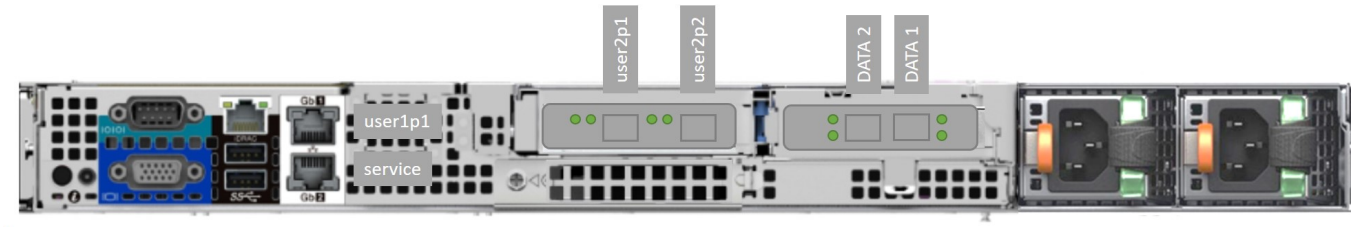


Figure 4.5: Back view of detector control unit with network interfaces.

4.2.2. Connectors

Table 4.3: Detector Control Unit Connectors

Connector	Description
user1p1	Inteface Name: user1p1 (1 GBase-T) User configurable GbE Network Interface Preconfiguration: DHCP
service	Inteface Name: service (1 GBase-T) Service GbE Network Interface Fixed configuration: Static 169.254.254.1 (Netmask 255.255.255.0)
user2p1	Unused
user2p2	Unused
DATA1	Detector Interface Port1
DATA2	Unused
2 x Power	AC Connector

See DELL owner's manual for further details.

4.3. Thermal Stabilization Unit

A thermal stabilization unit is required for the operation of the DECTRIS QUADRO® detector system. This can be the cooling circuit of the Electron Microscope or one of the thermal stabilization units given in 3.5.
The detector comes with an adapter that provides self-sealing valves. The adapter is required to connect the detector to one of the optionally available thermal stabilization units.

The tubing should be kept as short as possible to ensure the best flow.

Table 4.4: Operating Conditions

Condition	Definition
Operating temperature	The thermal stabilization unit has to be set to a temperature of 20 °C for normal operation.
Maximum operating pressure	3 bar

Table 4.4: Operating Conditions - continued

Condition	Definition
Coolant	Use 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 safety instructions provided by your local supplier.

Information #7

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

Caution #10

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

Caution #11

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).

Caution #12

Use opaque hoses to avoid the growth of algae.

Caution #13

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

5. INSTALLING THE DETECTOR SYSTEM

5.1. Transport Considerations

Warning	#1



Avoid vibration and shock when moving the detector.

Caution	#14



Use the included lifting eye for transporting the detector where applicable.

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 should be assembled to the Transmission Electron Microscope by qualified personnel only. Please contact support@dectris.com for support.

5.3. Grounding of the Detector

Caution	#15



The main plug of the detector control unit has 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 in order to establish a defined grounding.

6. OPERATION PROCEDURE

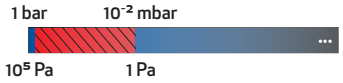
6.1. Operation at a Transmission Electron Microscope

Before operating the detector, make sure you have read the Technical Specifications and the User Manual.
The typical reachable vacuum for the detector head is 10^{-6} mbar. The outgassing rate and content are not specified.

6.1.1. Ambient Conditions for In-Vacuum Use

For operation of the detector the following conditions must be fulfilled:

Table 6.1: In-Vacuum Operating Conditions

Operation Condition	Definition
Pressure during operation	atmospheric pressure or less than 0.01 mbar 
Detector mounting plate temperature during operation	16 °C to 25 °C
Thermal stabilization unit set temperature in vacuum	20 °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)

6.1.2. Getting Started

Make sure the vacuum conditions in table 6.1 are met and follow below procedures for venting and pumping down the detector chamber of the Transmission Electron Microscope.

Warning #2

Prior to pumping down (and venting):
Always make sure the detector has NO POWER and is WARMED UP to room temperature. Otherwise it could be damaged through electrical discharge or condensation.

Detector Installation

- Mount the detector properly on the Transmission Electron Microscope.
- Connect the detector power, data, trigger, and coolant lines.
- Connect the detector control unit and the detector data cables.
- Make sure the standby button on the back of the detector is in its depressed state.
- Make sure the detector is POWERED OFF by disconnecting the power supply.
- Pump down the detector chamber.
- Once the pressure inside the vacuum chamber is below 1×10^{-2} mbar set the temperature on the thermal stabilization unit to 20 °C and turn on the thermal stabilization unit (pumping down a warm detector prevents condensation issues).

Startup Procedure

- Make sure the thermal stabilization unit has reached the set value and the pressure inside the vacuum chamber is sufficiently low to meet the operating conditions
- Power up the detector.
- Turn on the detector control unit. Wait at least 5 min before trying to connect.

The detector is now ready to use.

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

Venting the Detector Chamber

- Turn OFF the power to the detector by disconnecting the power supply.
- Set the temperature to 20 °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.

6.2. Turning Off the Detector

To turn off the detector:

- Press the standby button to bring the detector to the standby state.
- The detector power cable can now be disconnected if needed.
- Turn OFF the detector control unit.

Warning	#3
As long as the detector power cable is connected, the detector has to be considered under power.	

6.3. Storing 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.

6.4. Cleaning and Maintenance

Caution	#16
The sensor must not be touched or cleaned. If it is damaged, please contact DECTRIS® technical support.	

The housing can be cleaned with a soft tissue.

The DECTRIS QUADRO® detector does not require any maintenance.

Please refer to the user documentation of the thermal stabilization unit for detailed information about the maintenance of your thermal stabilization unit.

7. SAFETY INSTRUCTIONS FOR RADIATION SHIELDING

The radiation shielding is made of lead (Pb). In order to prevent injuries, please follow these safety precautions.

Danger	#3



- Do not disassemble the detector or tamper with the radiation shielding
- Do not inhale dust when the detector or any of the radiation shielding component is broken or burnt
- Do not ingest lead
- Avoid skin contact

For recycling, see section 2.1.

8. TROUBLESHOOTING

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

The LEDs at the side of the detector can provide valuable information for troubleshooting. Check section 4.1.4 for further informations.

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 3.2.3).
Communication error, the detector is not found at startup.	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 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).
Detector shuts down and cannot be initialized.	Temperature error.	Check that the detector is properly supplied with coolant and check the temperature of the coolant at the front panel of the thermal stabilization unit. Wait until the detector cools down. Restart the detector again.
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 LED on the external power supply.
Image acquisition not possible.	Detector is not properly initialized.	Initialise the detector via the SIMPLON API. (See API Reference)
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. CREATE SUPPORT REQUEST

If you have any specific question you can request technical support with the contact information provided in chapter section 1.1 or by sending an Email to support@dectris.com.
DCU logs often play an important role in the process of solving technical issue as they contain useful information for debugging and identifying system misbehavior. It is therefore recommended to provide these logs when contacting our support support team.
The following step-by-step instruction guides the user through the process of creating a tarball of the present log files on the DCU.

- Open the web interface of the detector
- Navigate to technical support (figure 9.1 step 1)
- Go to the create bug report menu and press CREATE BUG REPORT (figure 9.1 step 2,3)
- Enter title and description and press SAVE (figure 9.1 step 4)
- Press on the download symbol of the newly created report (figure 9.1 step 5)
- Send the tarball as Email attachment to our support team

Information	#9
The bug report is not sent automatically.	

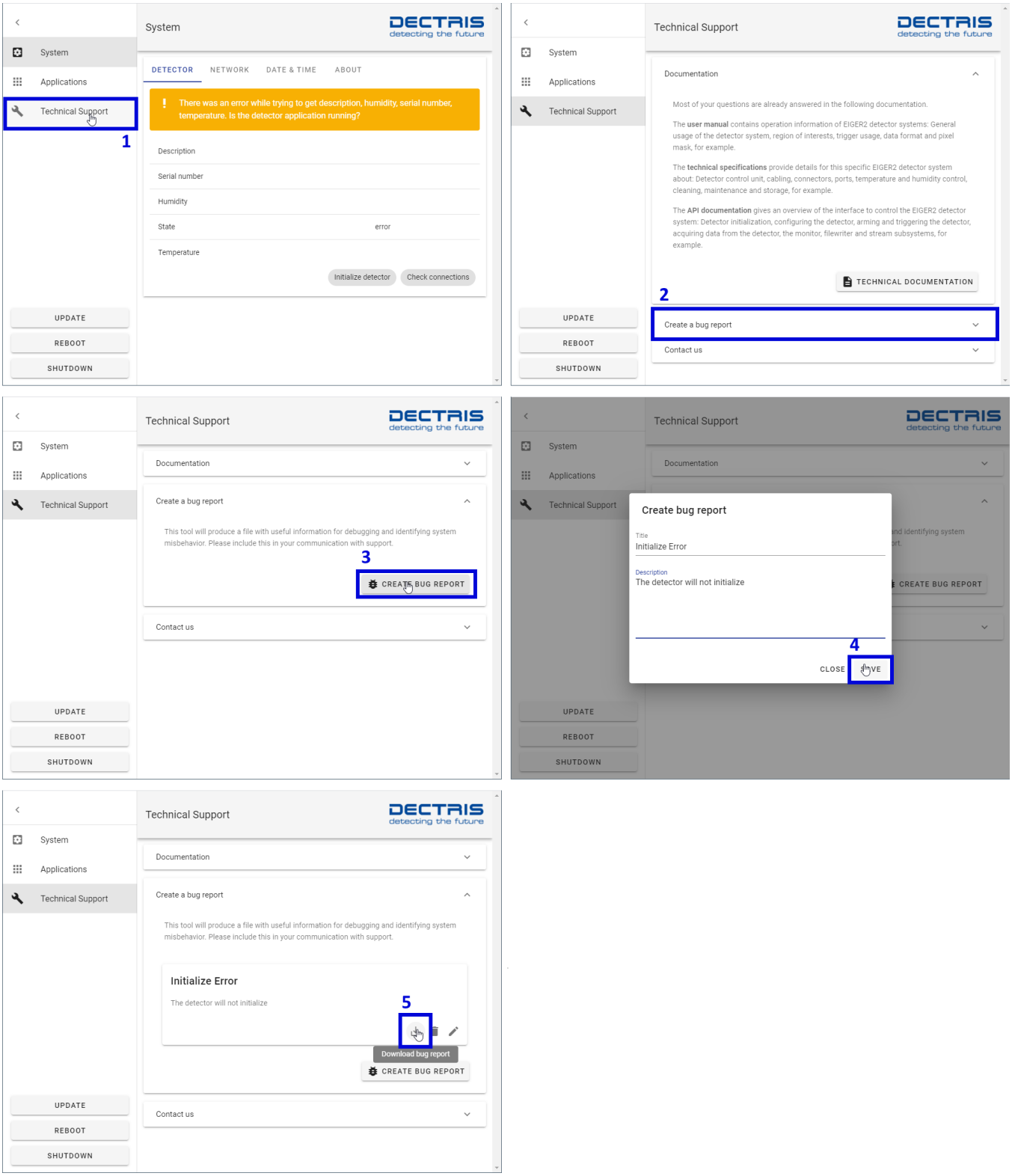


Figure 9.1: Process of creating a bug report tarball

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