Characterization setups

Overview and performances

Summary

- General overview
- Cryostats description
- Cryostats performance validation
- Environment monitoring and control
- Critical situation handling
- Arrival and departures of detectors
- General organization
- Conclusions and open work

General Overview

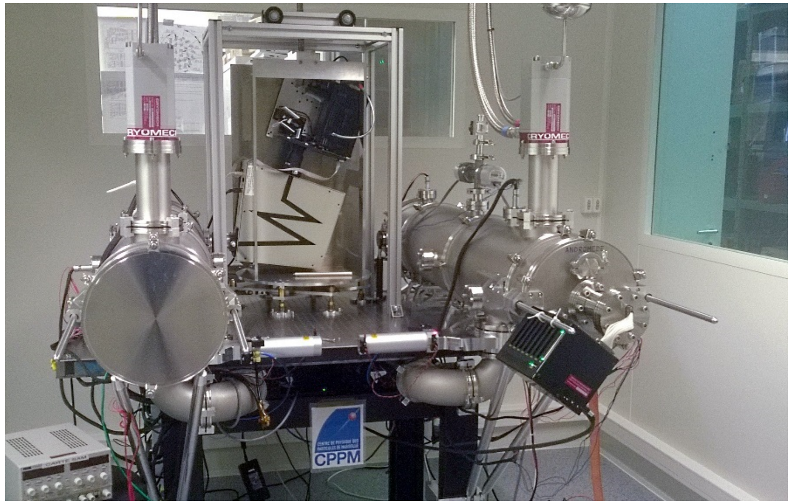
General overview

- All the operations on the SCS from unpacking (when they arrived from NASA) to packing after characterization are done in an ISO 7 clean room (T= 21 °C ± 0.5, Hyg.= 50% ± 10%).
- All operations on the unprotected SCS (incoming verifications, mounting in cryo Focal plane) are done in an ISO 5 laminar bench
- Characterization of the SCS is done in 2 identical cryostats (Pegase and Andromede) , hosted in the same clean room and fully independent (control, vacuum, cryocooler, acquisition system ..) but sharing the same monochromator
- 2 SCS at time can be mounted in each of these 2 cryostats allowing to acquire data simultaneously from 2 detectors at time in each cryo
- These cryostats control/command (vacuum, regulation, alarm ..) is done by a Monitoring and Control program (Slow-control) developed at CPPM using Labview environment
- All the system (but cryocooler) is powered by an UPS allowing several minutes of function in case of power outage. After ≈ 10 mn a hardwired system triggers an emergency warm up of the detectors.

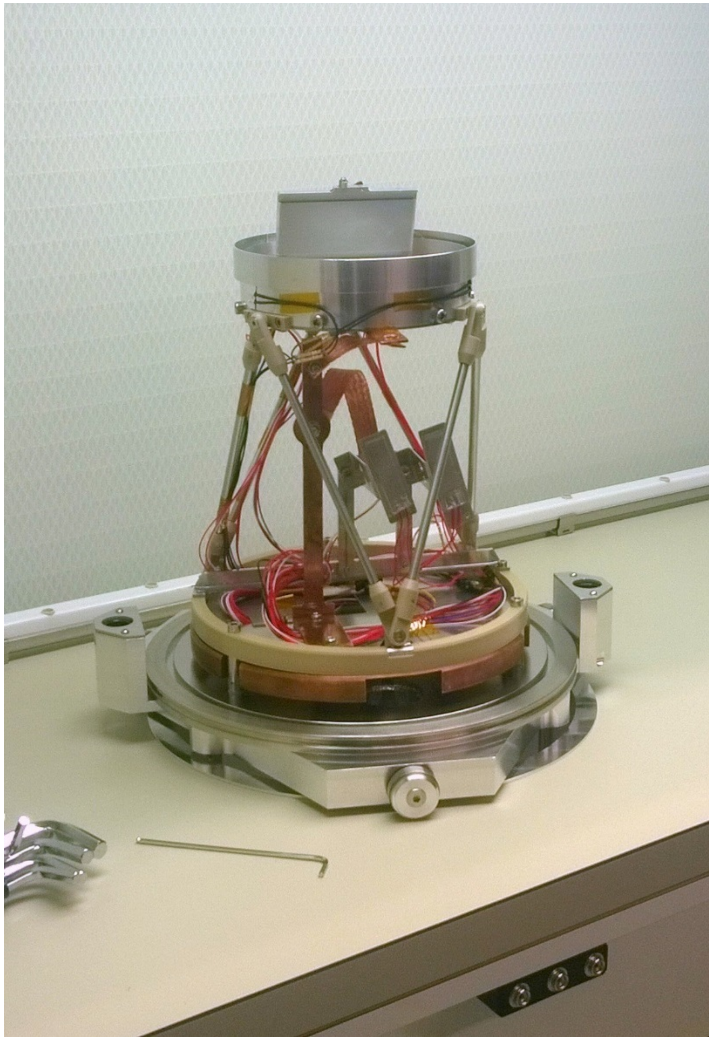
General overview

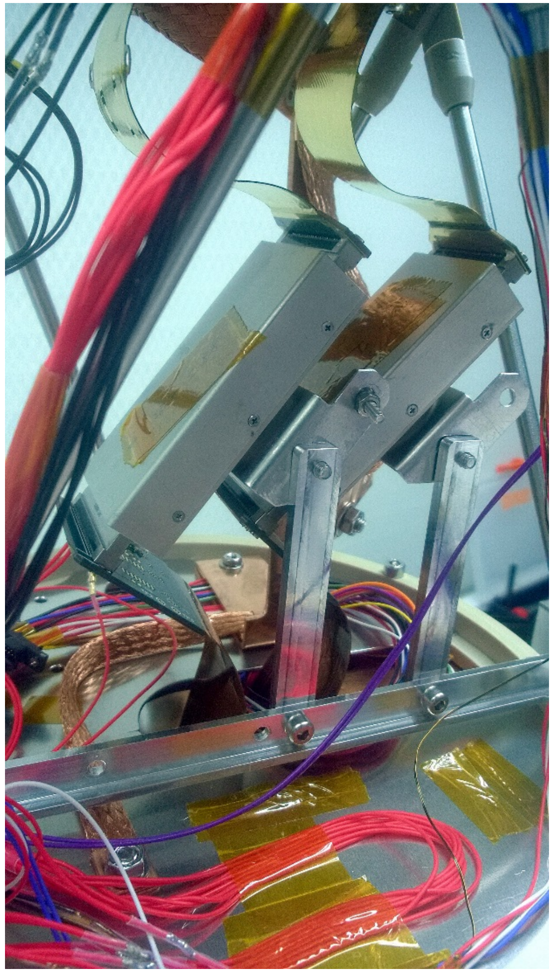
- WE is based on Markury electronics cards (2 separate systems) with Matrox frame grabbers hosted in PC under Linux OS and with the DAS software made by IPNL
- Data storage is done locally on 2 x 100 TB servers with RAID3 redundancy. Data are also copied at CCIN2P3 (In Lyon) for safety. A DataBase has been started at CPPM.
- Data Quality check (developed by IPNL) is done just after an acquisition in order to validate the dataset.
- The systems are able to run 24/24, 7/7 unattended. Alarms send automatically a SMS to local Euclid team.
- Full remote operation of the system is possible

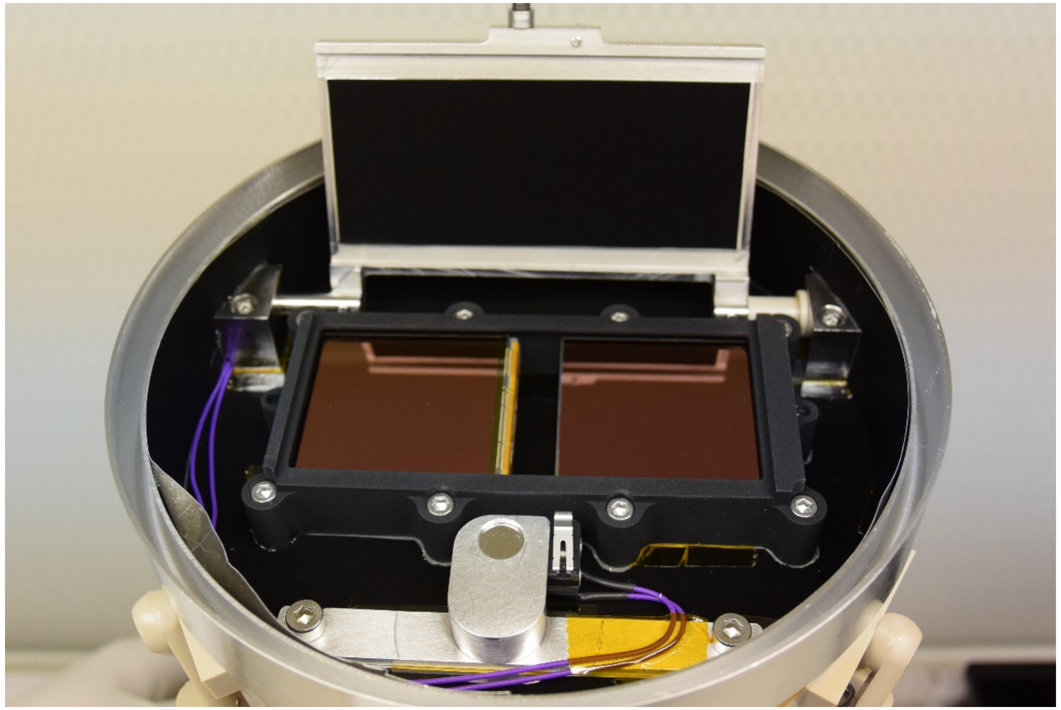
General overview : clean room



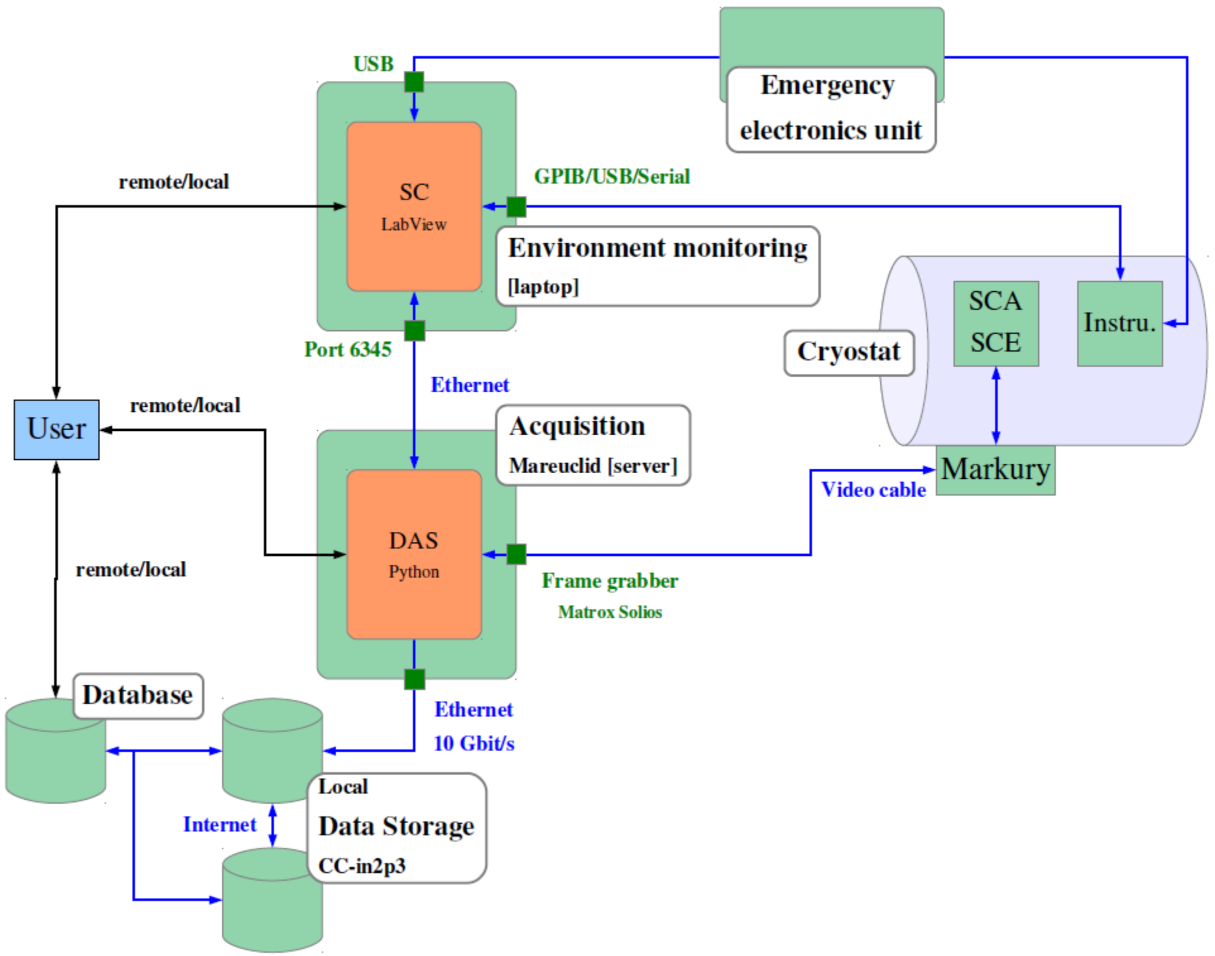
General overview : focal plane



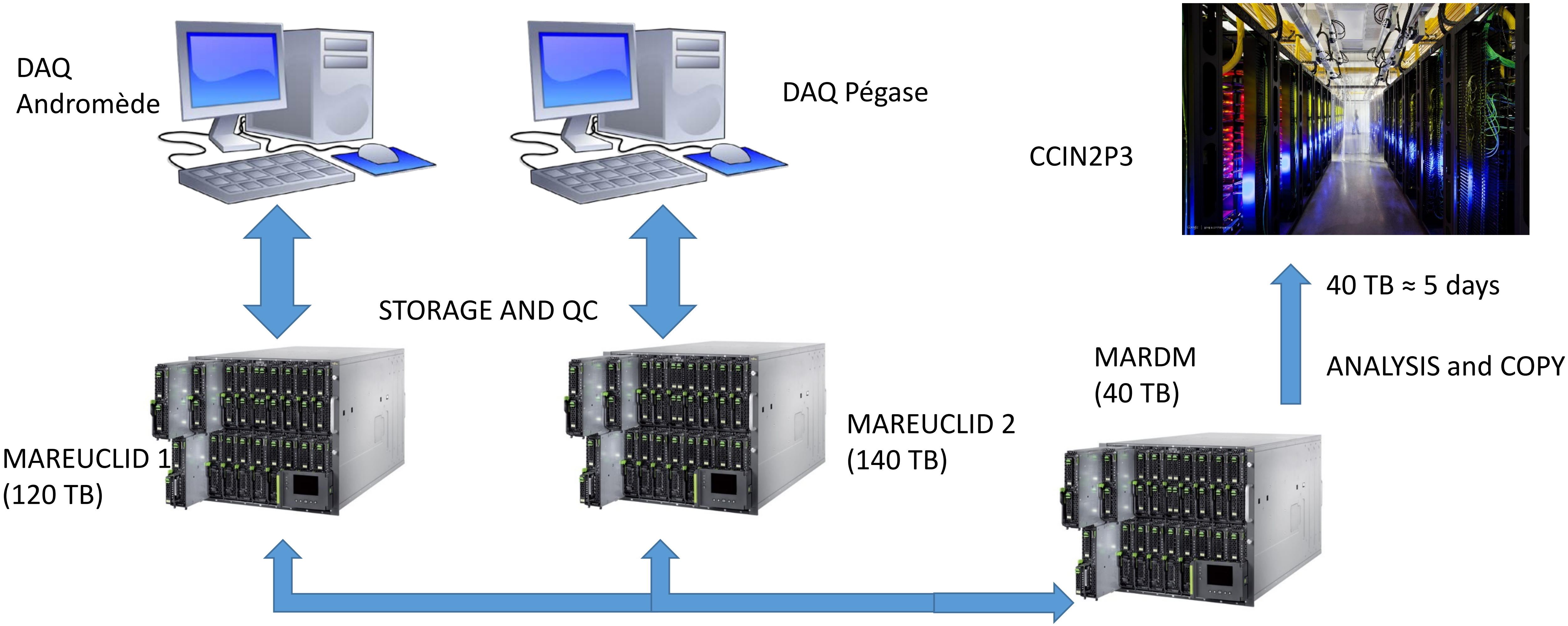




General overview: SC and DAQ

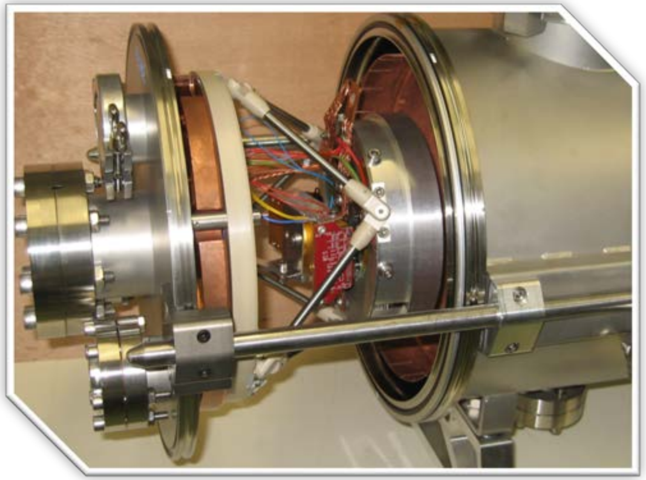


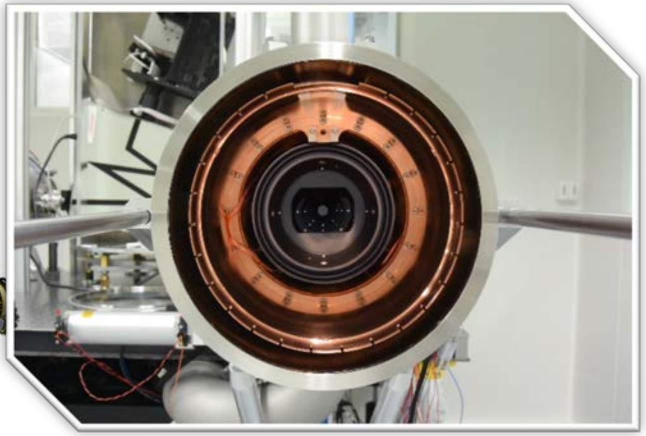
General overview : Data storage

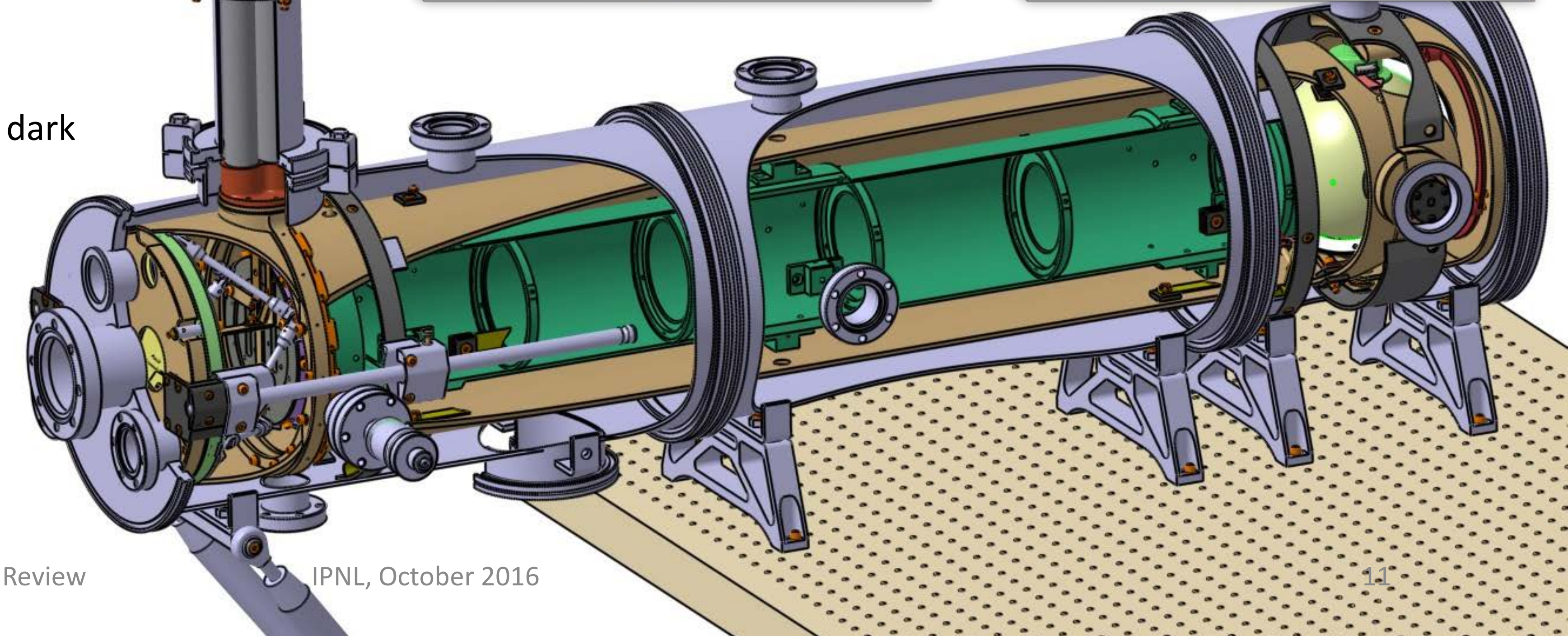


Cryostats

Pegase & Andromede







Focal plane

- 2 H2RG detectors + motorized dark lid for dark

Cryostat

- Achieve secondary vacuum (10-6 mbars)

Cold head

- Copper cold ring
- Thermalize everything

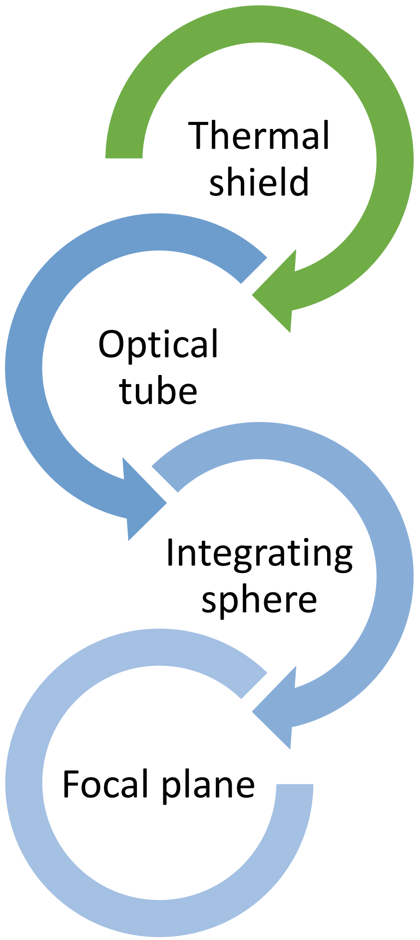
Optical baffle + Integrating sphere

- Flat field (with 2µm LED)

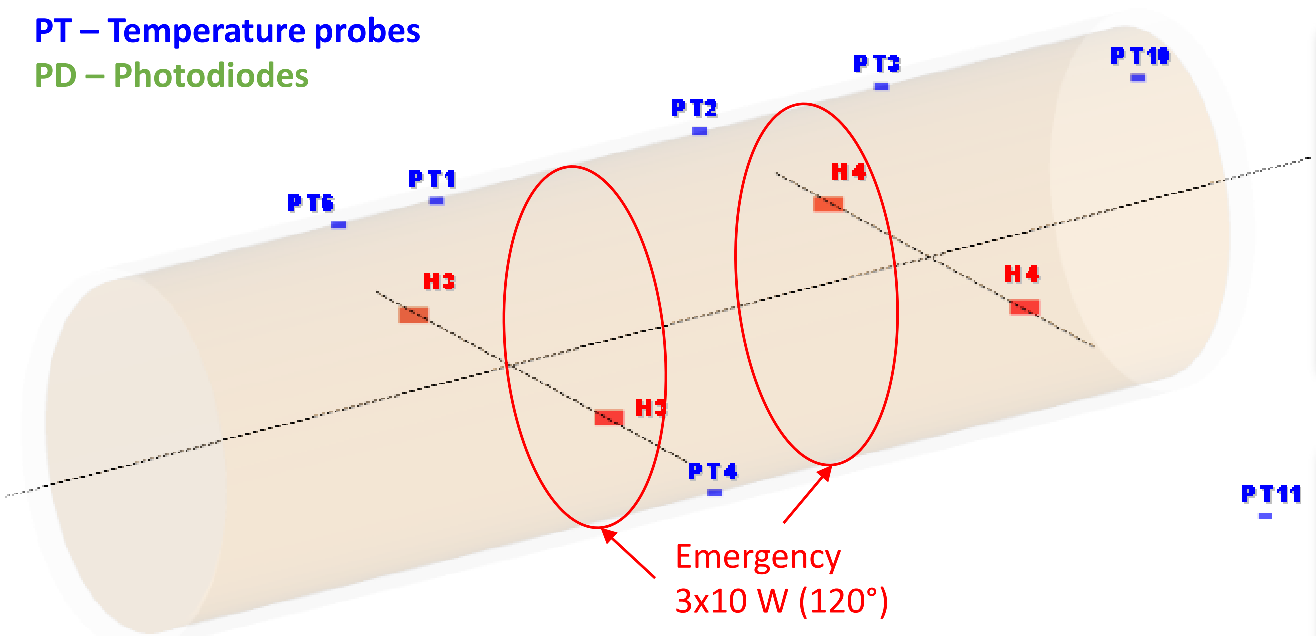
Monochromator

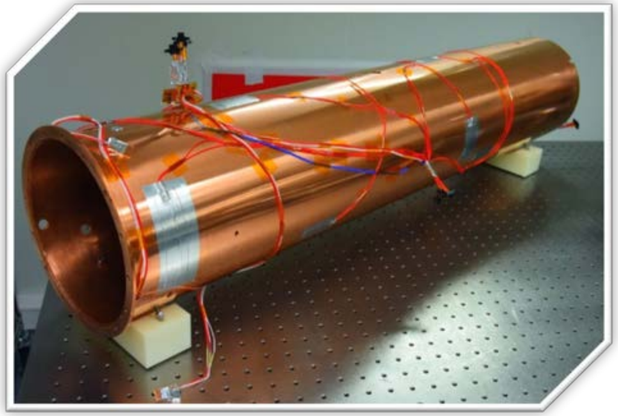
- Monochromatic illuminations

Instrumentation



H – Heaters
PT – Temperature probes
PD – Photodiodes





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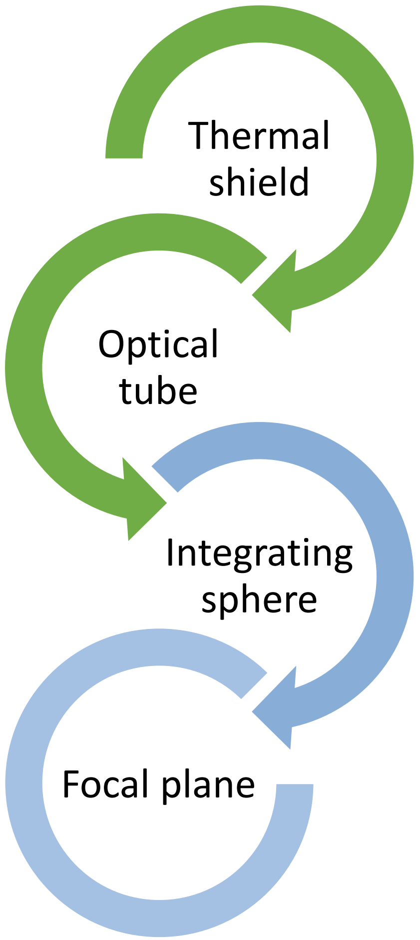
PD1 - Hamamatsu G8372-010K (λc=2.1µm)
PD2 - Hamamatsu G12183 (λc=2.6µm)
PD3 - Hamamatsu G12181 (λc=1.9µm) x

LED1 - Thorlabs 2050P

Instrumentation



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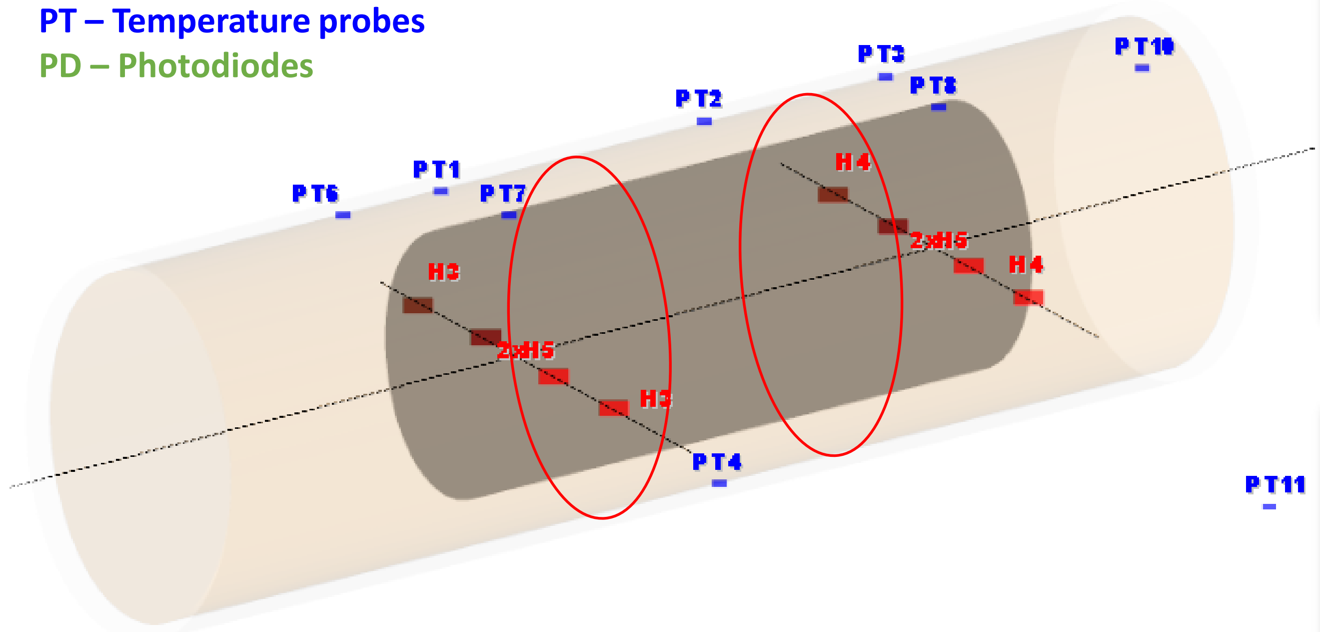

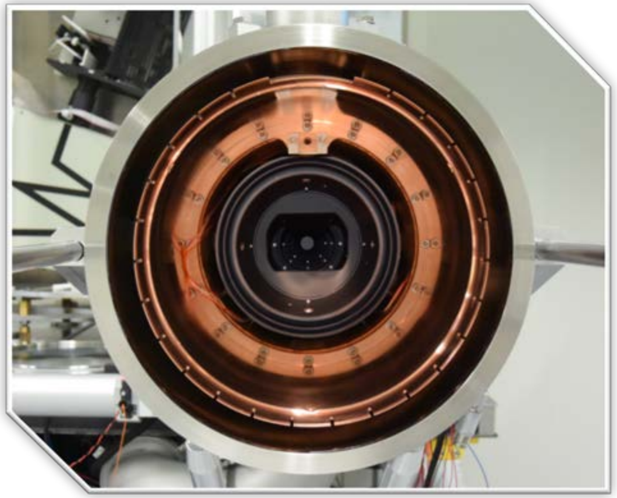

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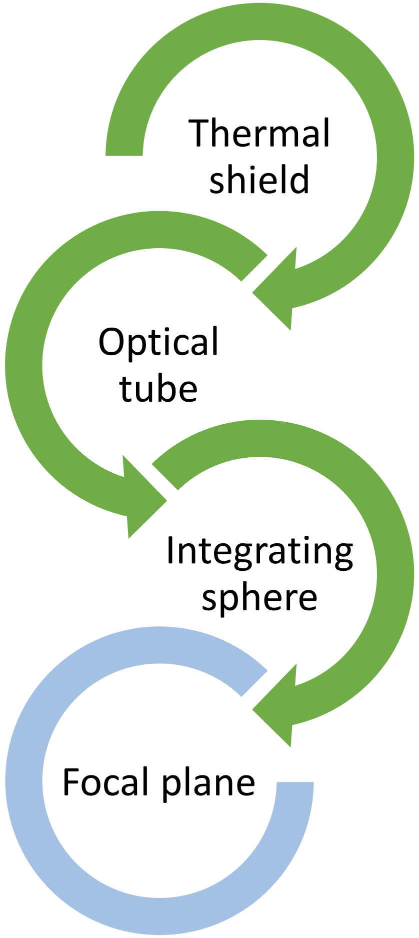

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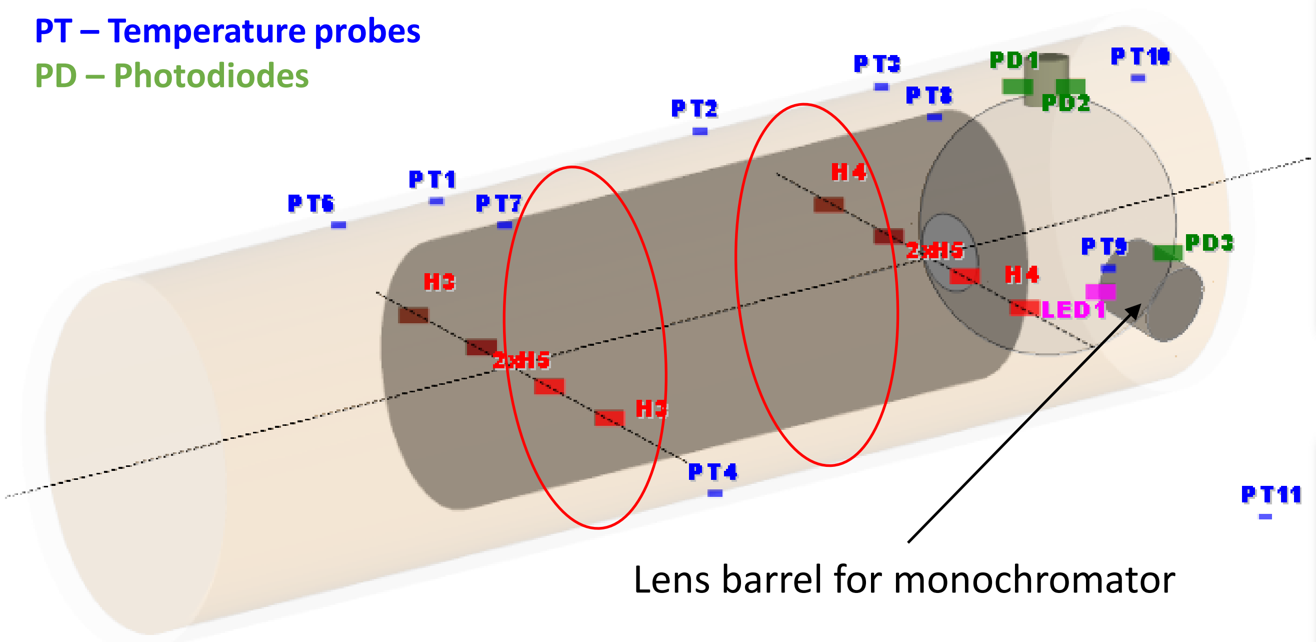

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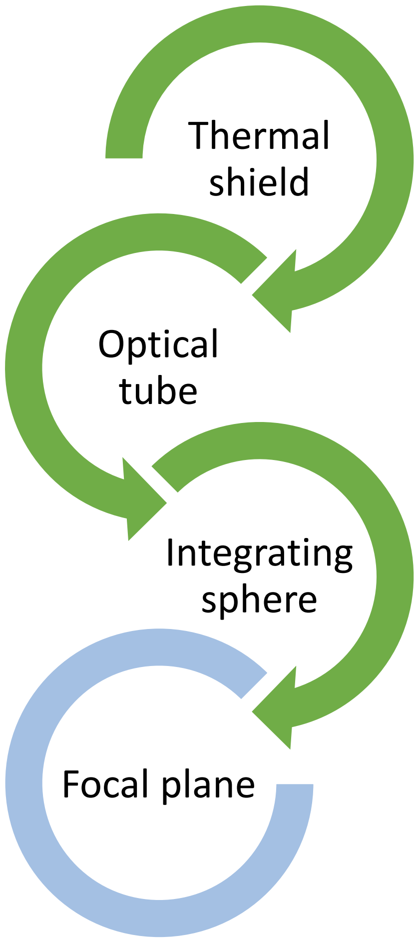

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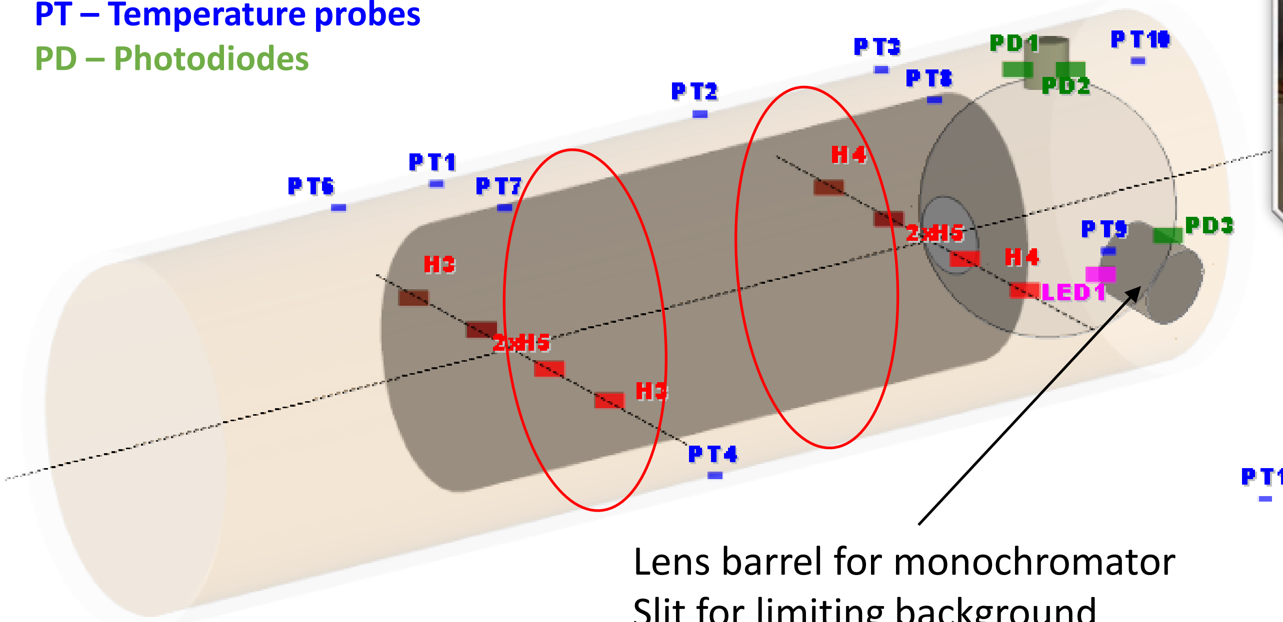

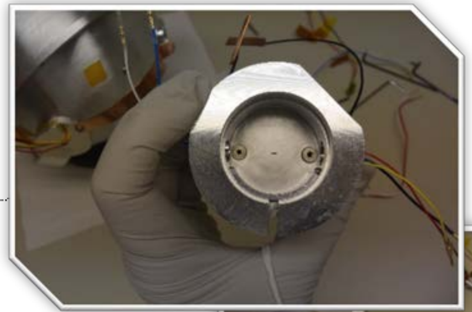

Lens barrel for monochromator
Slit for limiting background

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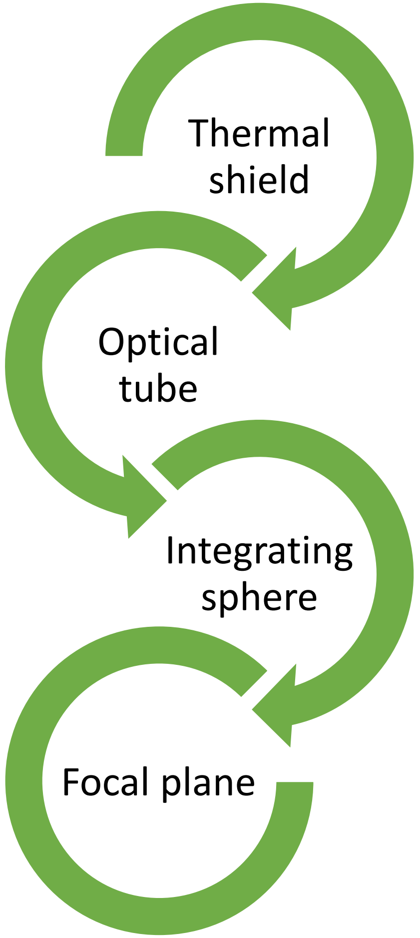

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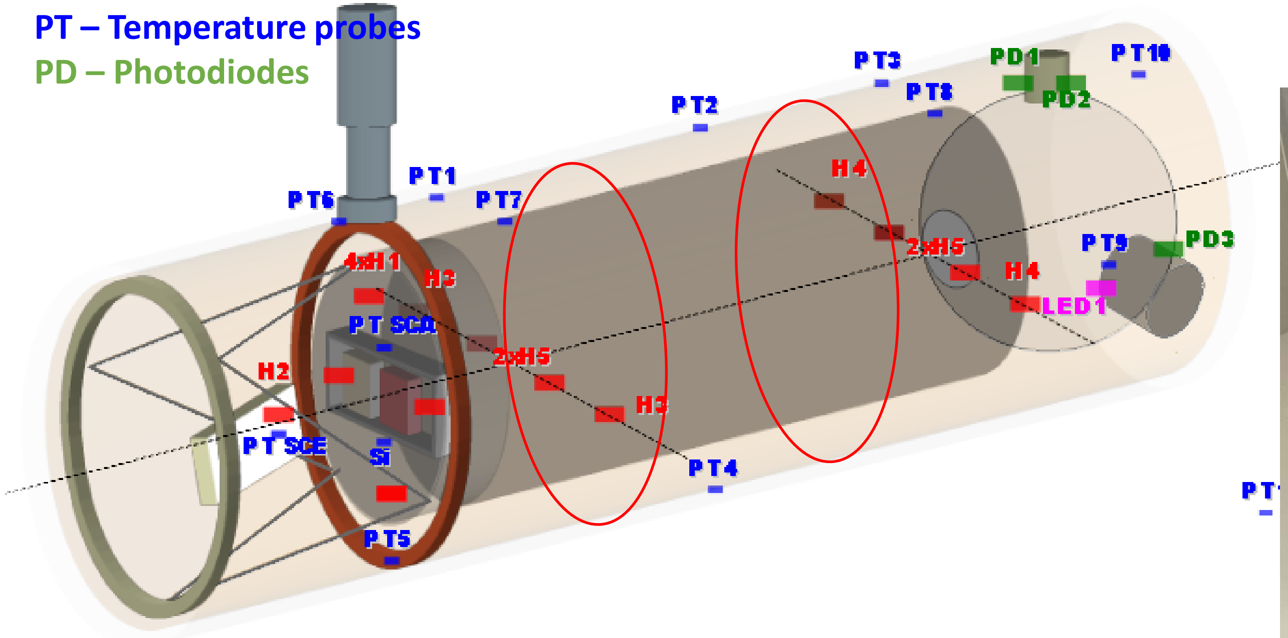

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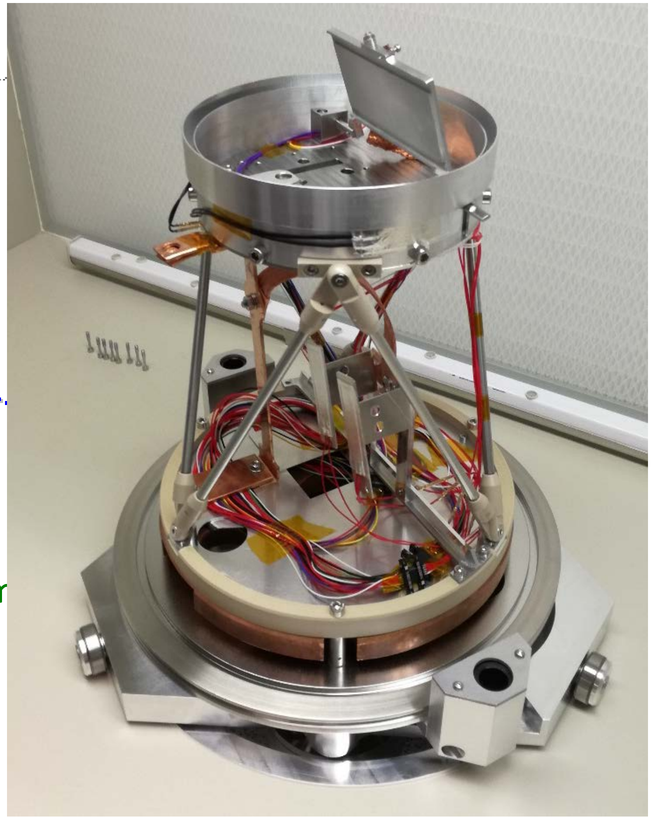
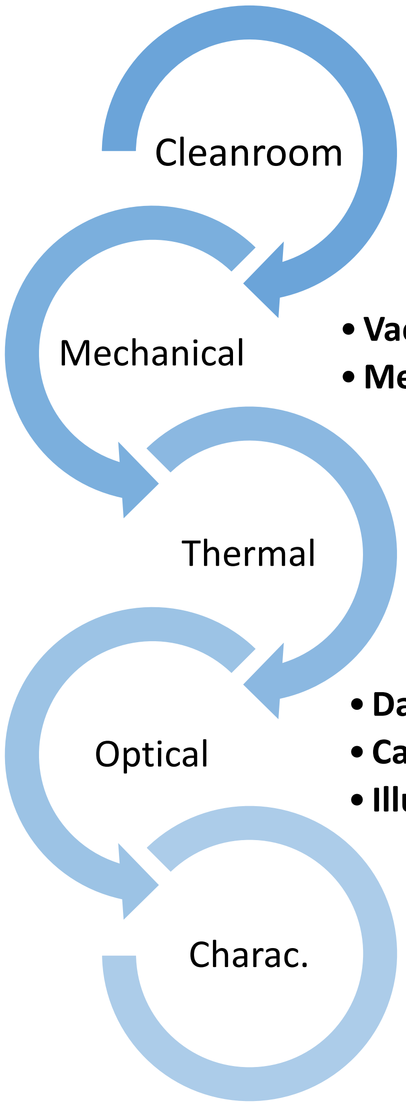


Hardware versioning : ATRIUM-128927
Pégase v3 (PR1:v2b), Andromède v4 > saved in DAS datafile

Cryostat performances validation

Performances validation flowdown



- **Pressure**
- **Humidity**
- **Temperature**

- **Vacuum**
- **Mechanism**

- **Stability**
- **Repeatability**
- **Calibrations**

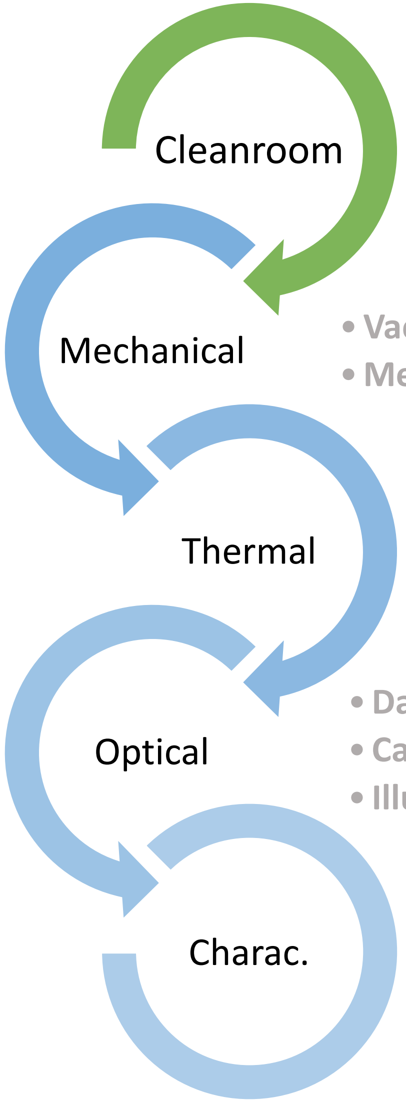
- **Dark current**
- **Calibrations**
- **Illuminations**

Cryostat performances within margins for flight detectors?

Several aspects in this overview: mechanical, thermal, electrical, optical

Validating behavior of cryostats on timescales equiv. to characterization

Cleanroom parameters stability



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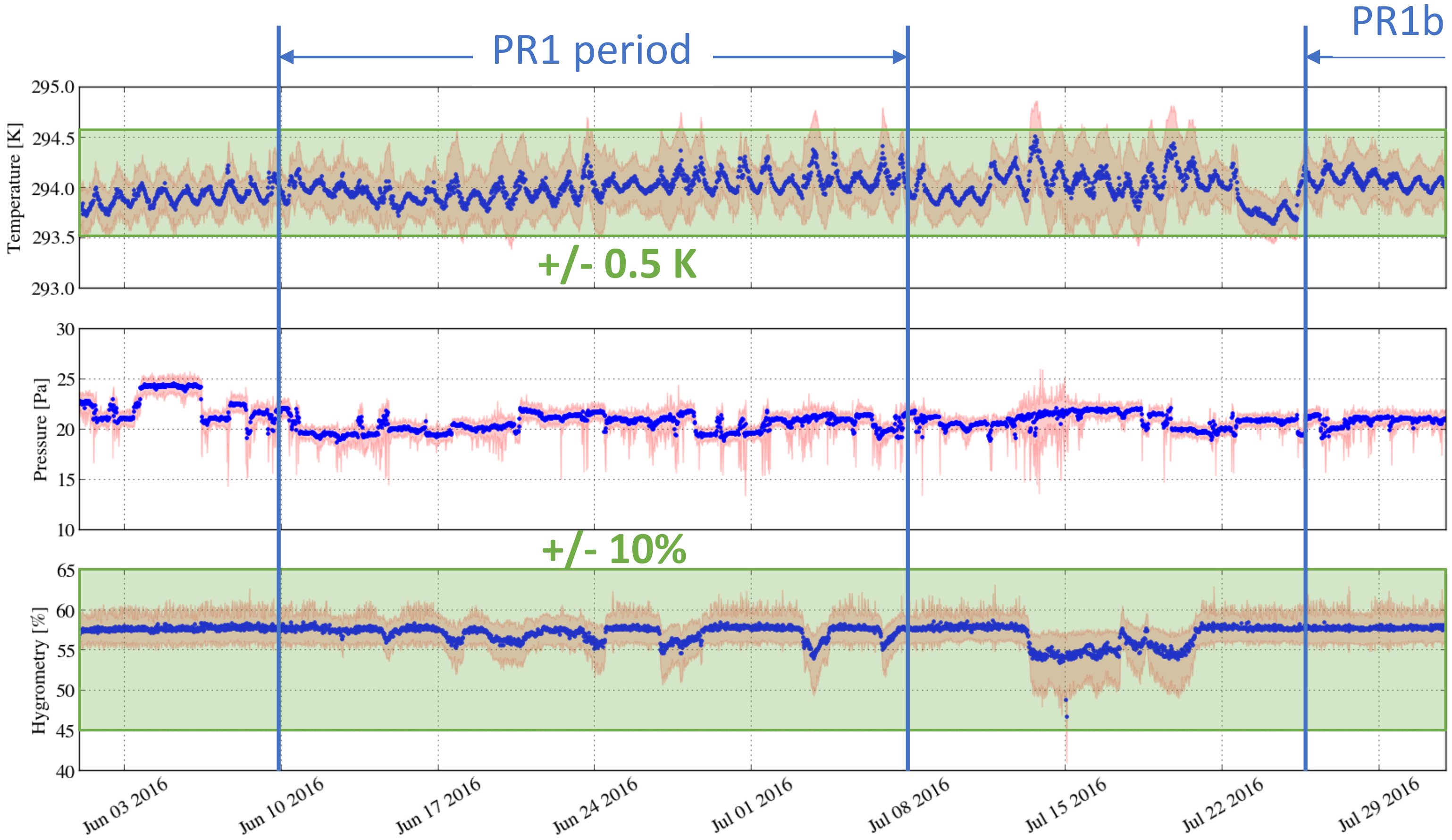
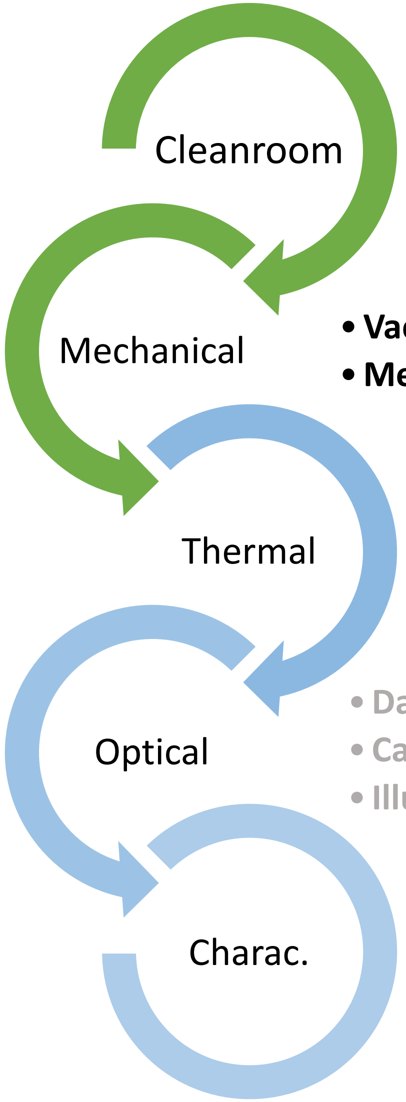


Cleanroom environment stable

Mechanical design - Vacuum



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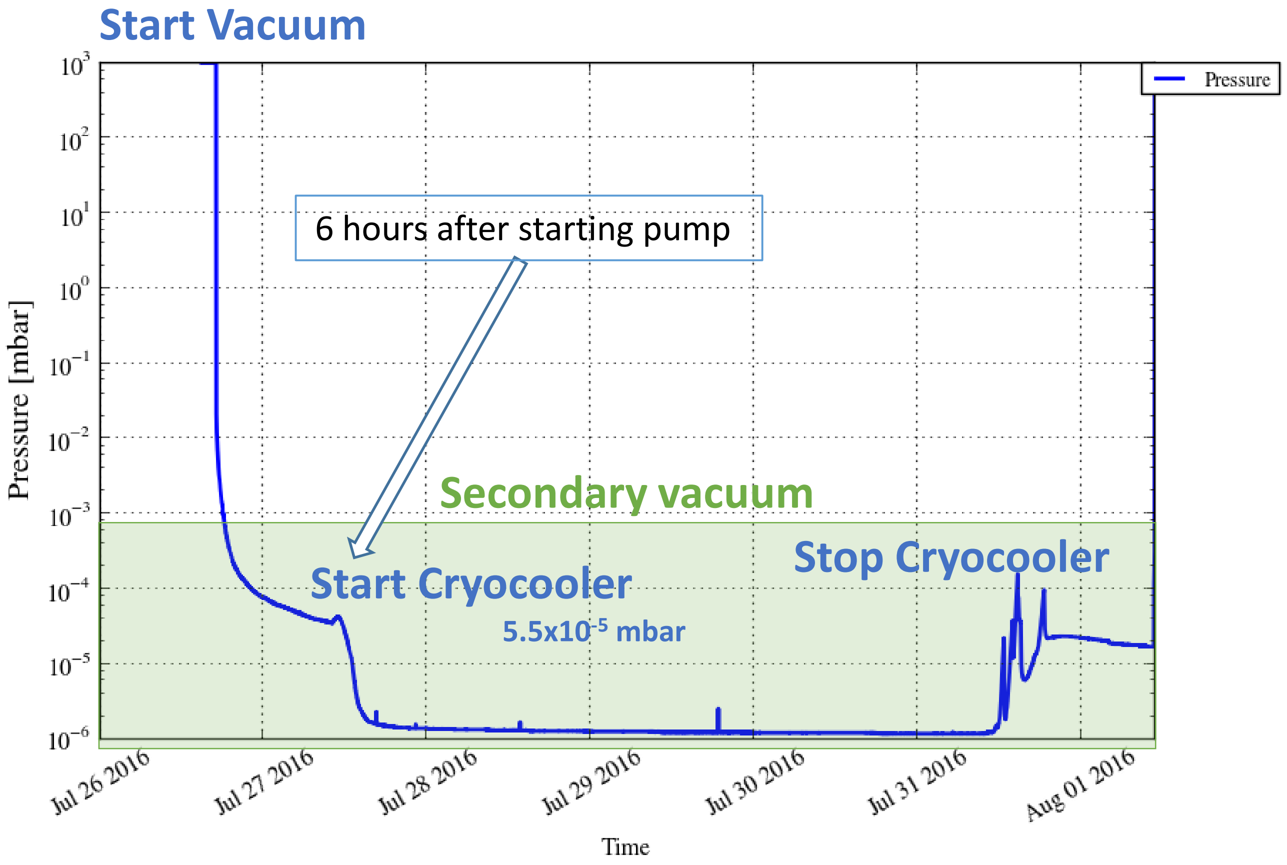
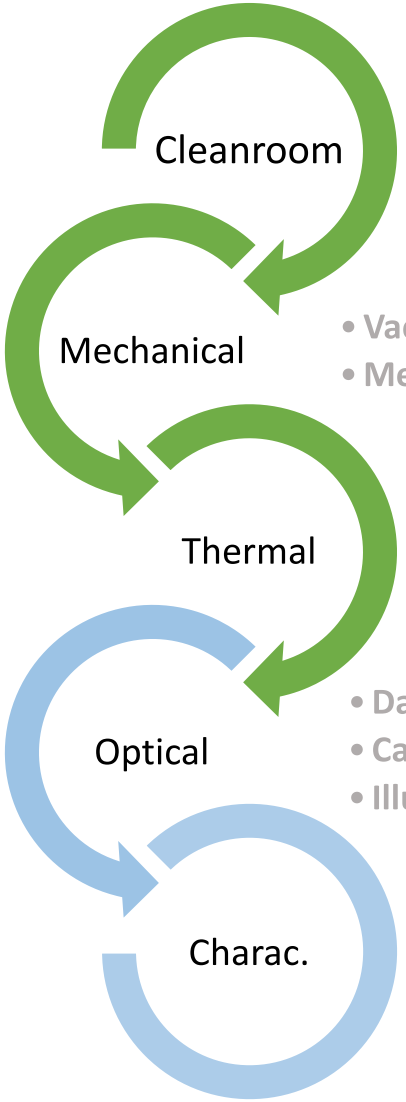


Cryostat ready for acquisitions in less than 1.5 days

Thermal design – Stability & Repeat.



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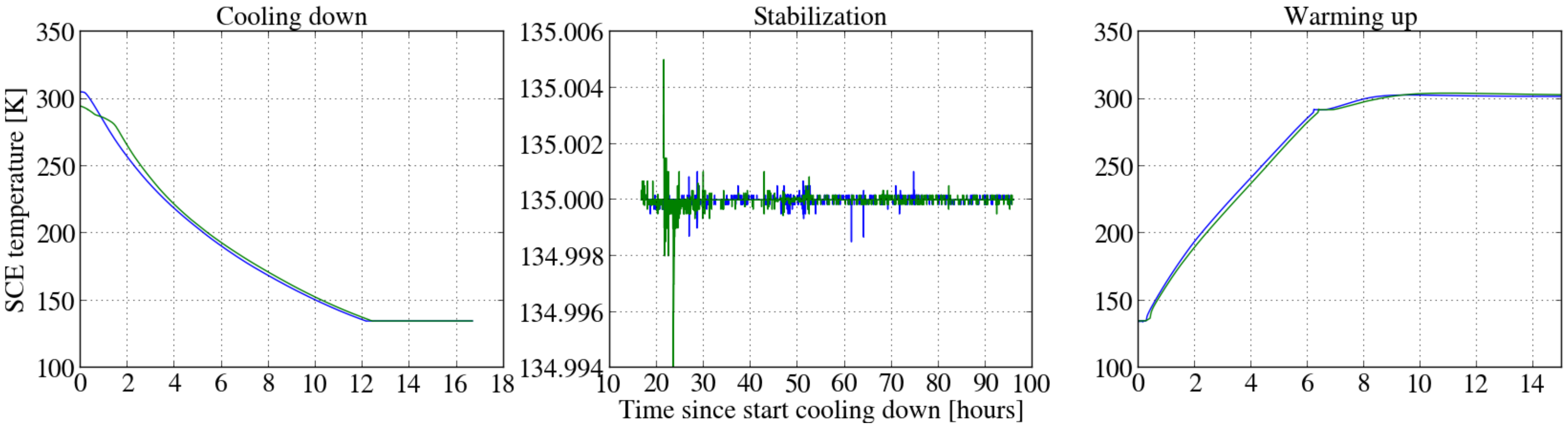
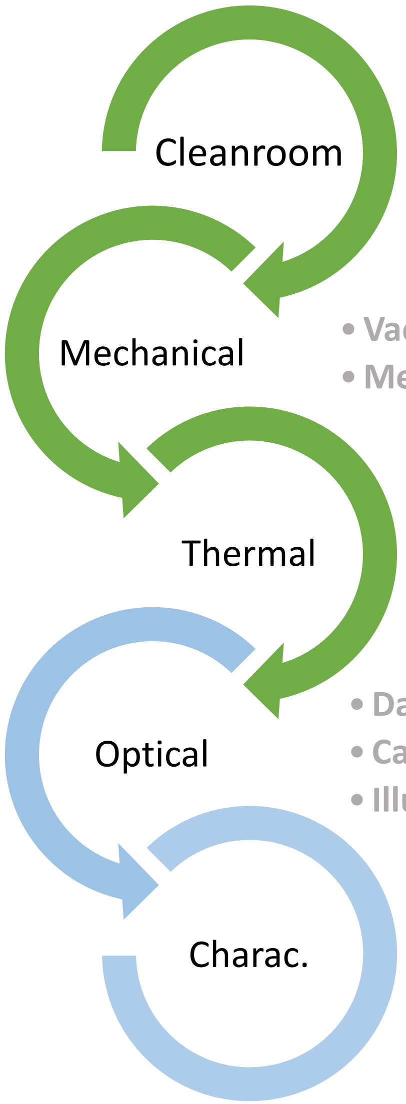


SCE - Pegasus

Thermal design – Stability & Repeat.



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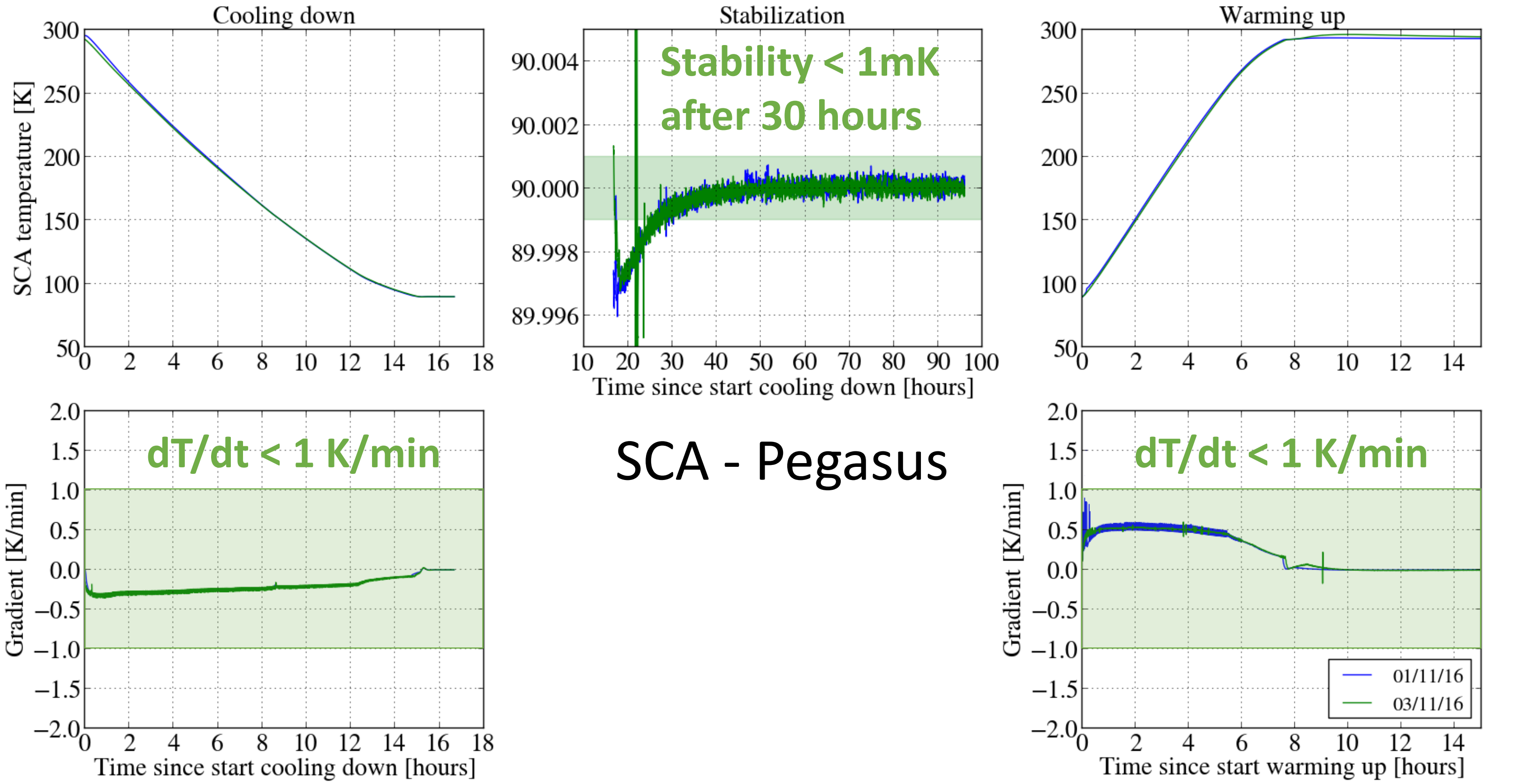
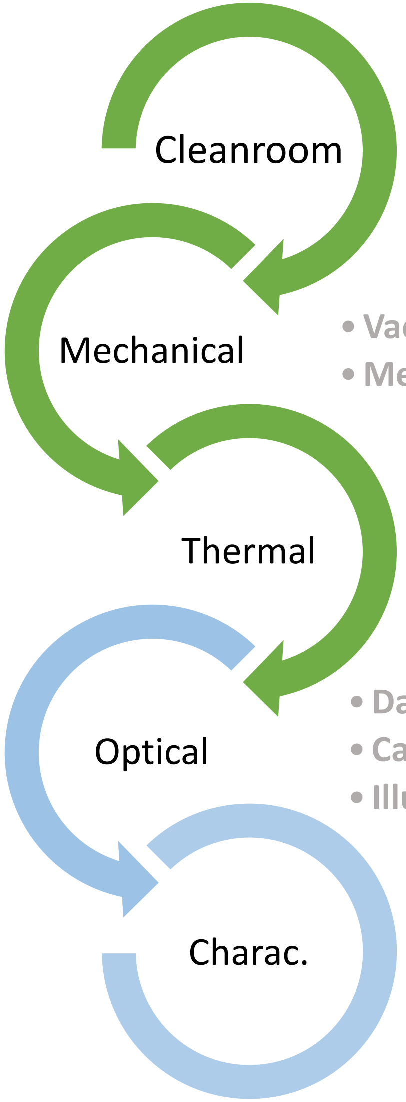


FPA does not cool down faster than 1 K/min

FPA regulated (<1 mK) and stable within 30 hours after cooling down started

Thermal design – Stability & Repeat.



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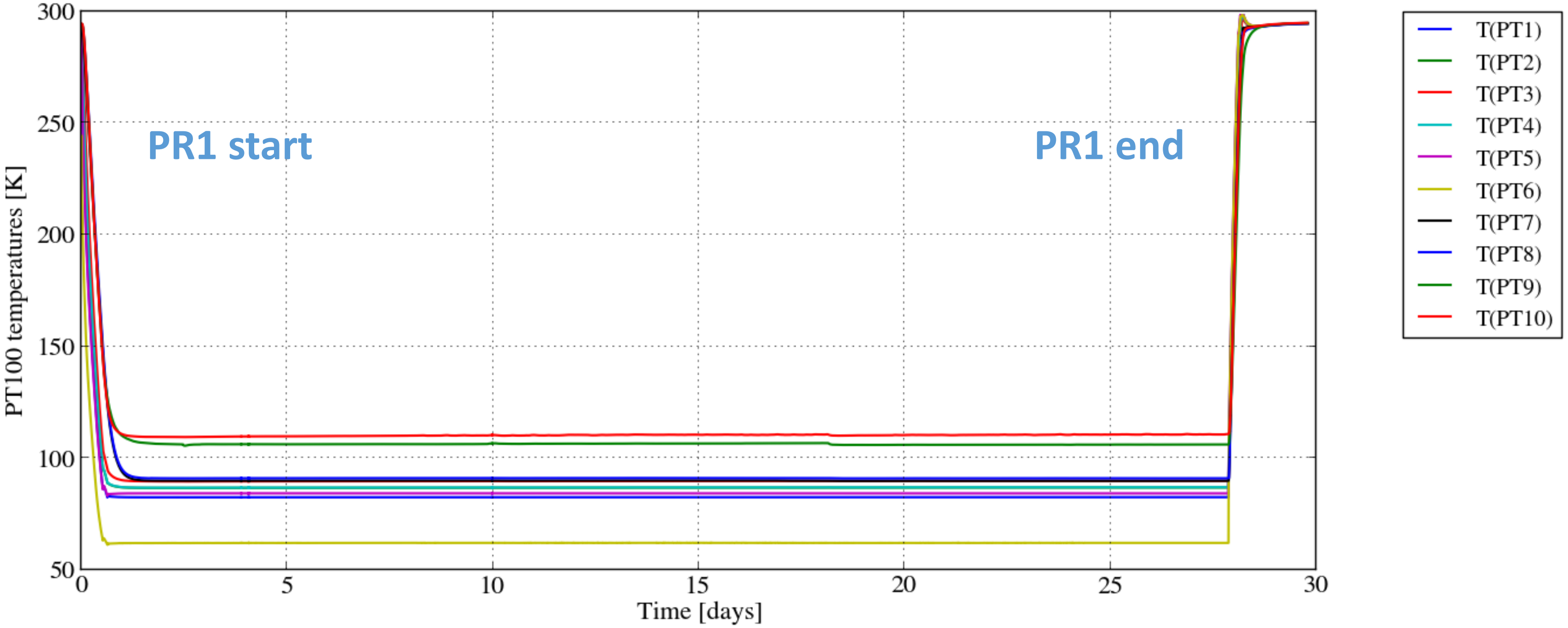
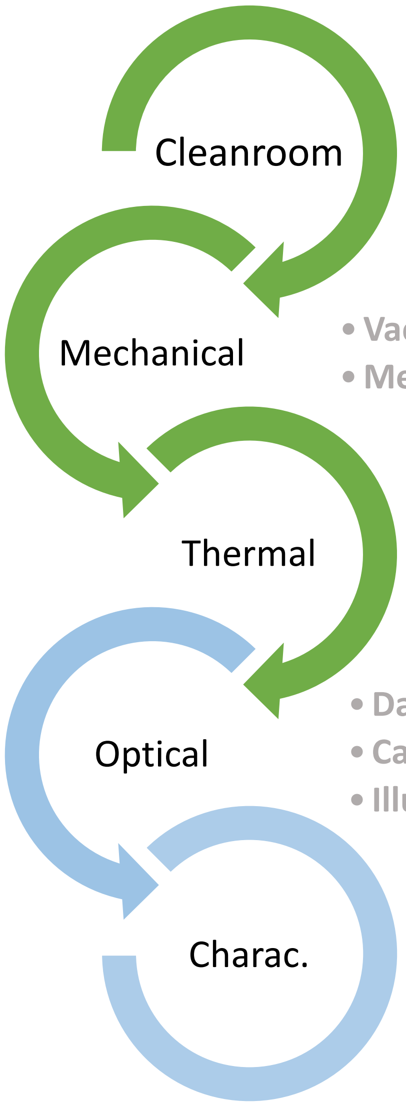


Thermal screen is "software regulated" at 100 mK level in order to have stable conditions during long periods

Thermal design – Stability & Repeat.



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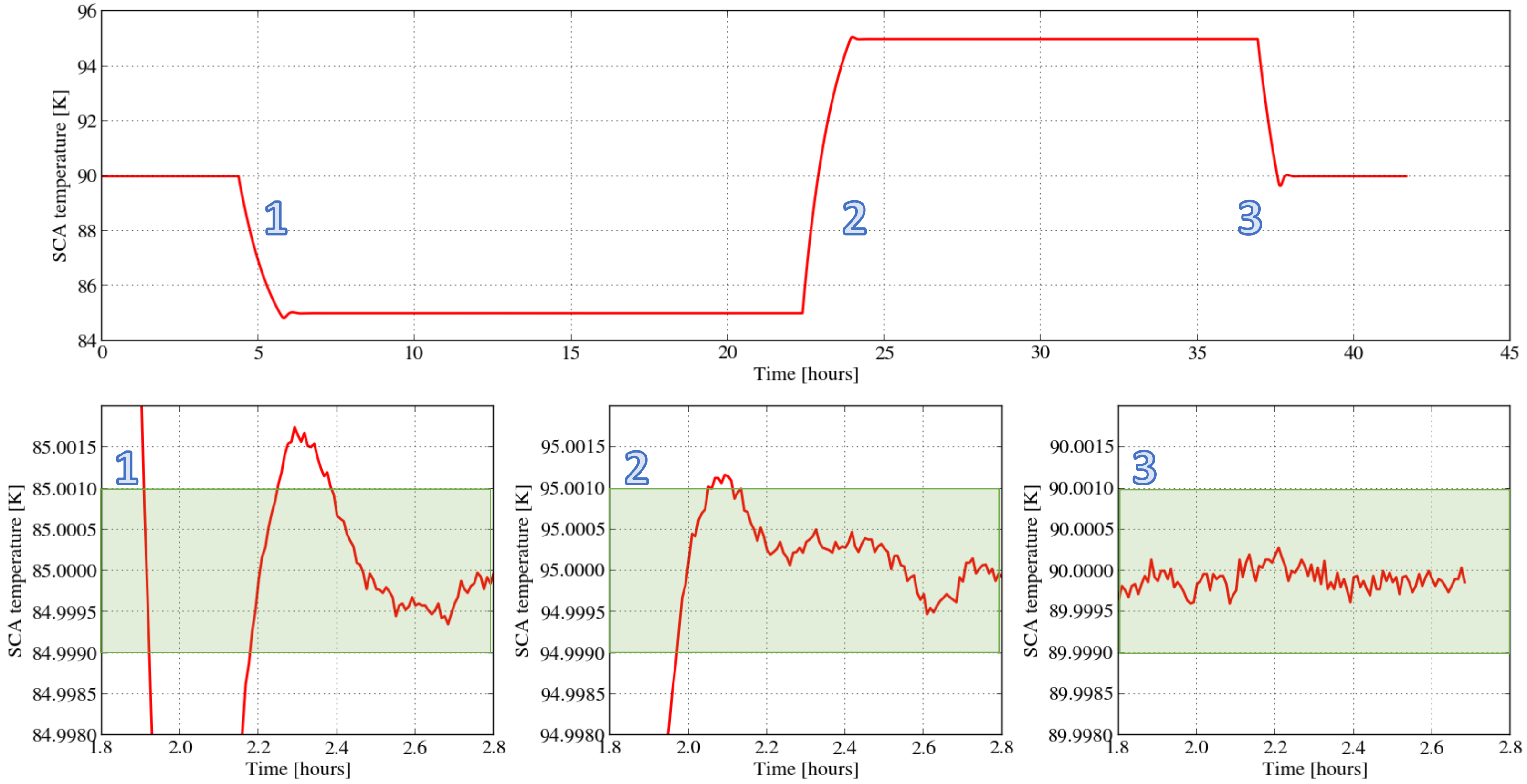
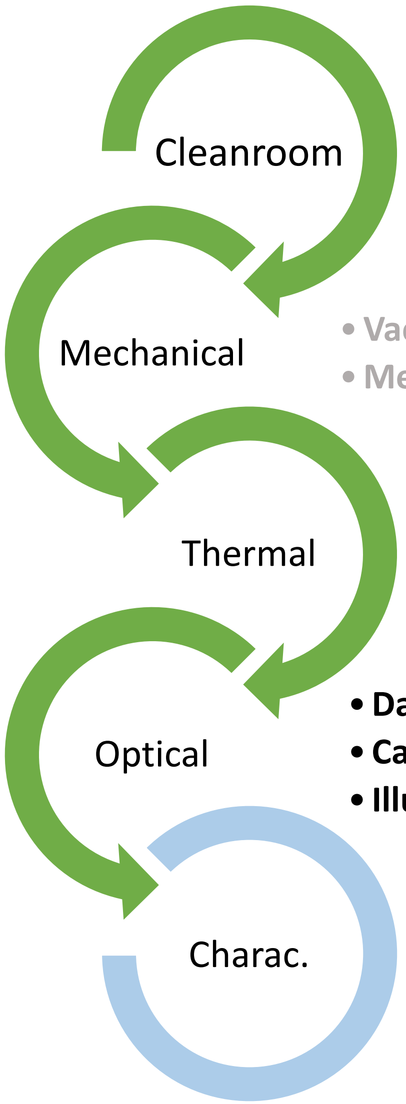


FPA temperature can be manually set to values in between 85 K and 95 K without changing the overall cryo temperature.

FPA stabilization occurs within 2.5 hours

Global cryostat maximum variation is less than 100 mK after stabilization

Optical design - Calibrations



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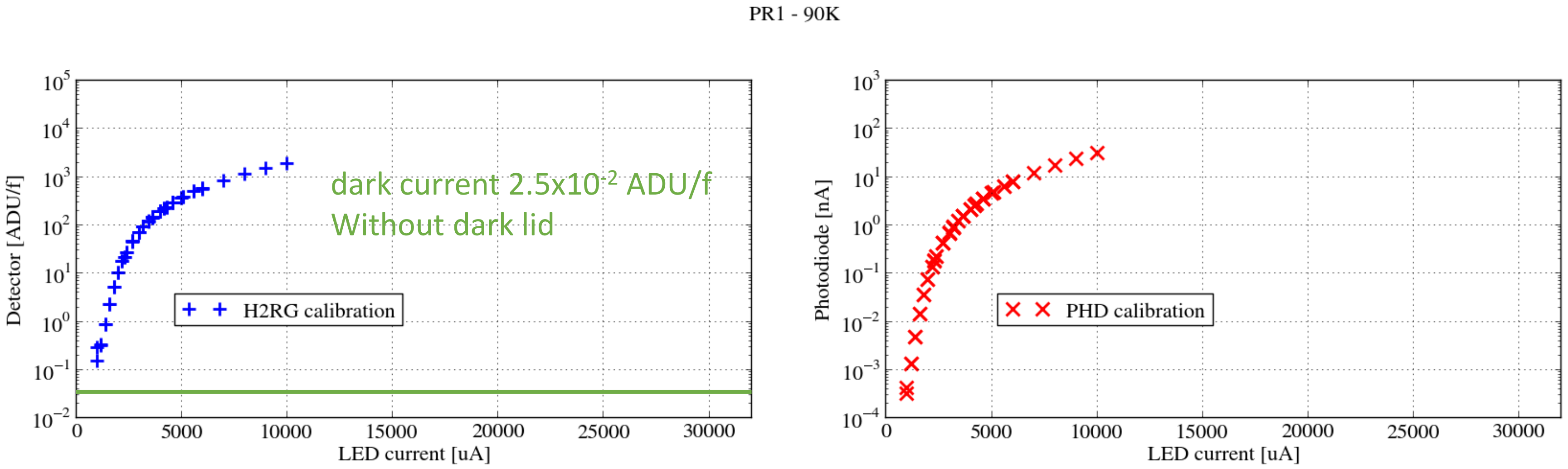
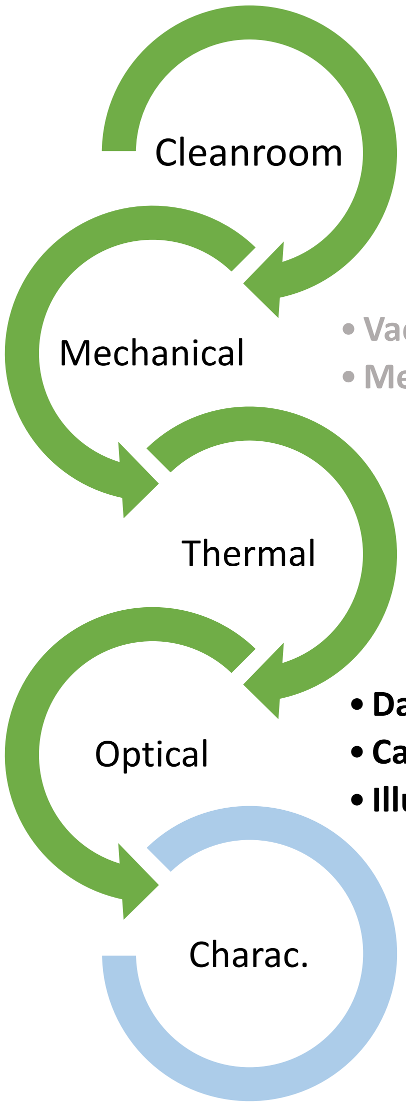


Calibration done 1 month before PR1 @ T_{SCA}=90K
Conversion law between LED[µA] and detector/photodiode flux
Two thermal cycles of Pegasus separating calibration from PR1 data

Reminder:

- PHD : Hamamatsu G12183
- H2RG : Detector #17188
- LED : Thorlabs 2050P

Optical design - Calibrations



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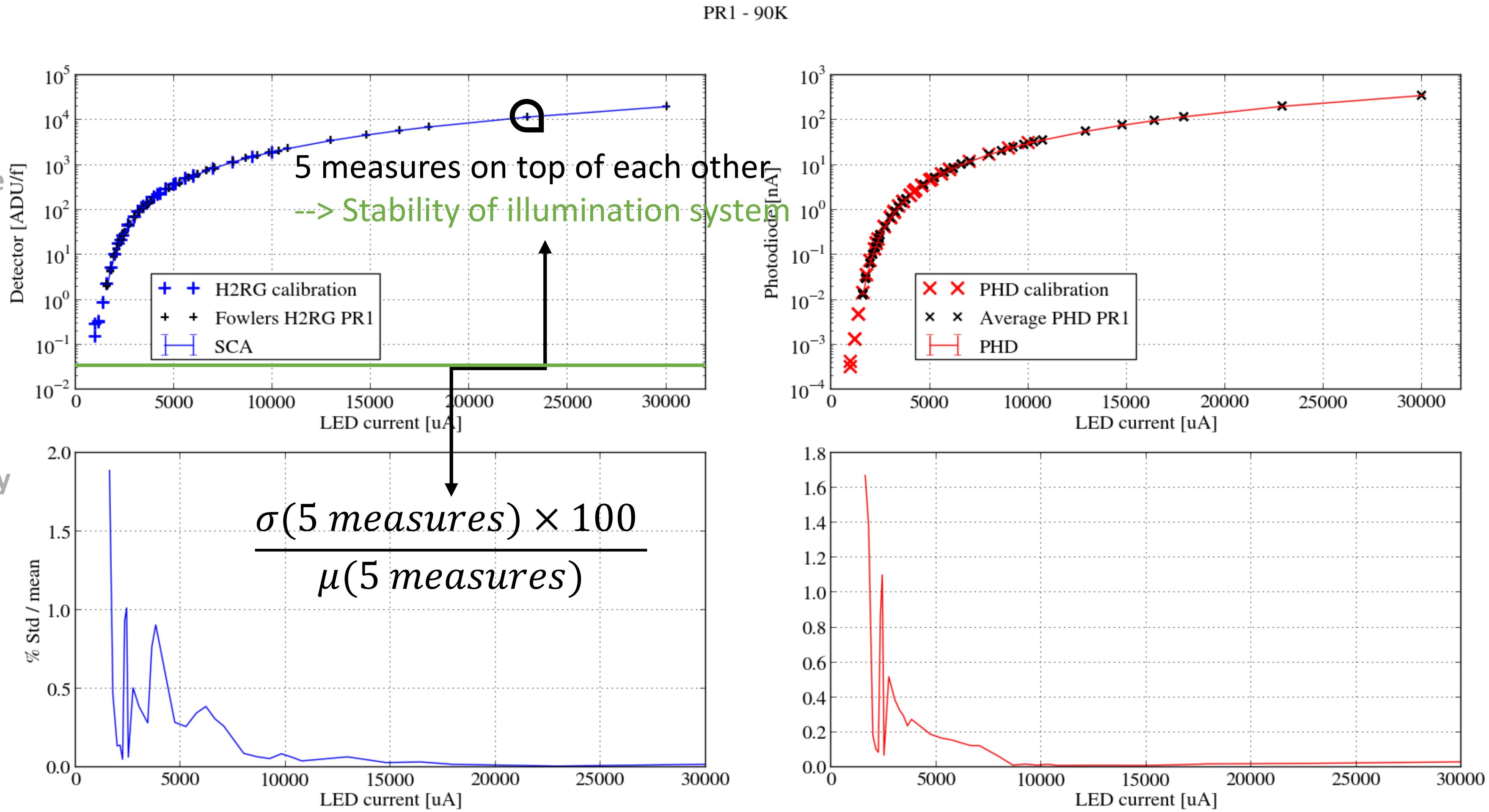
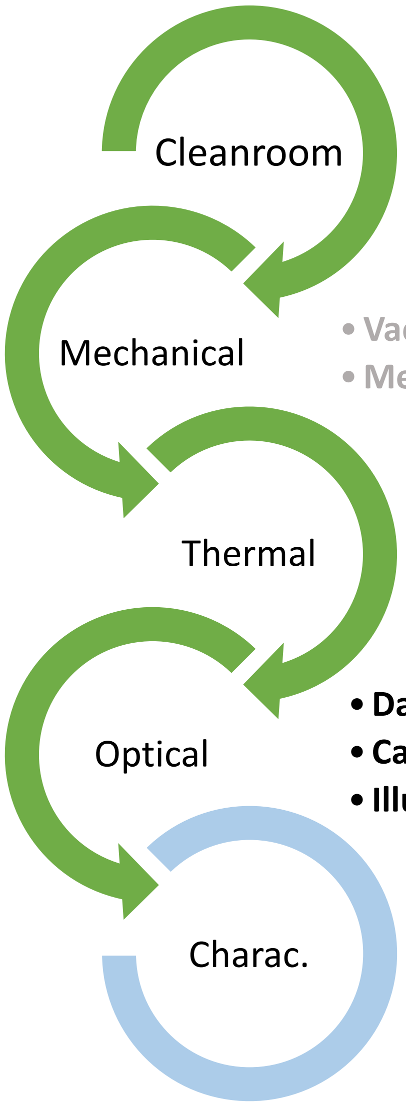


$$\frac{\sigma(5\ measures) \times 100}{\mu(5\ measures)}$$

Illuminations stable within a few months

Optical design - Calibrations



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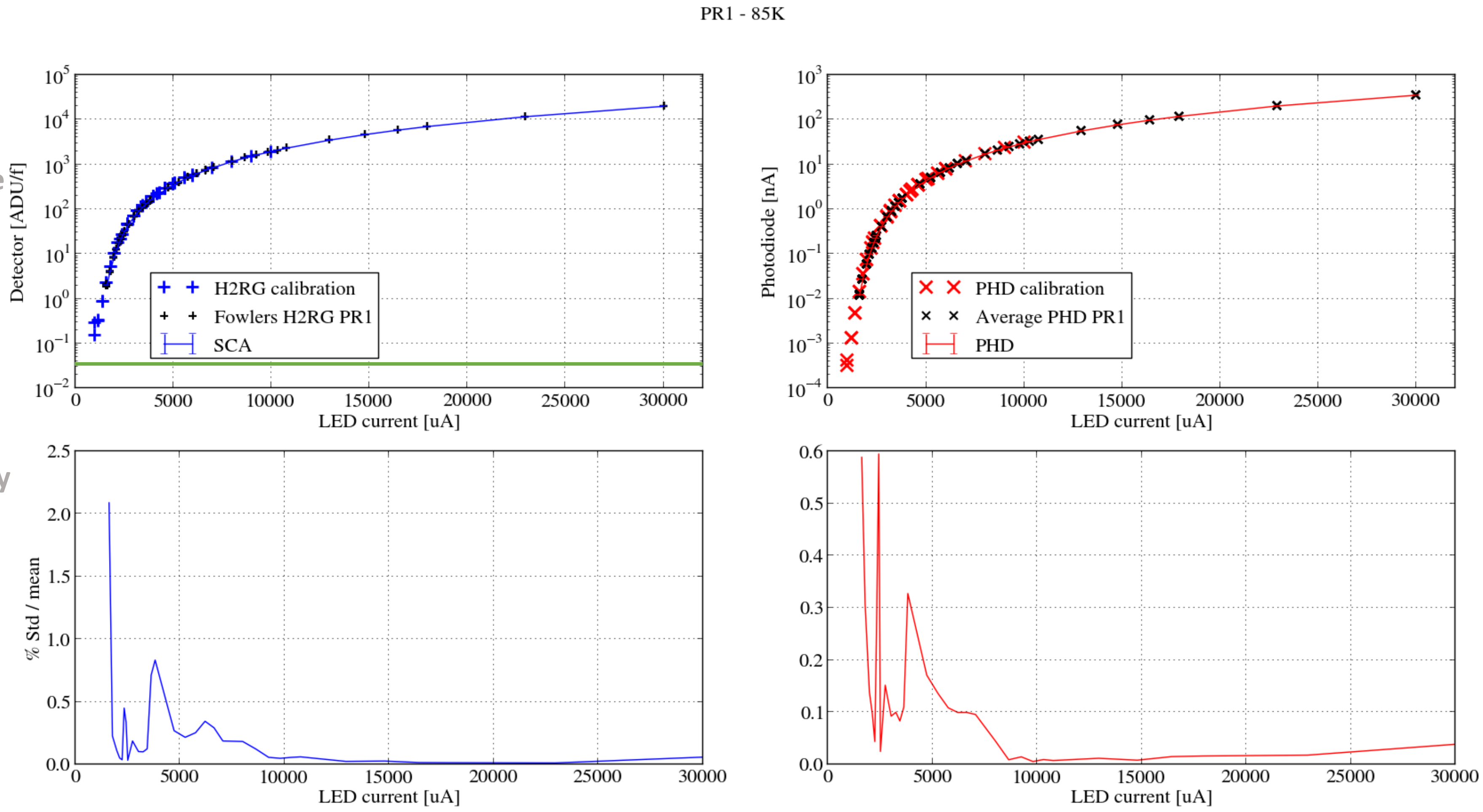
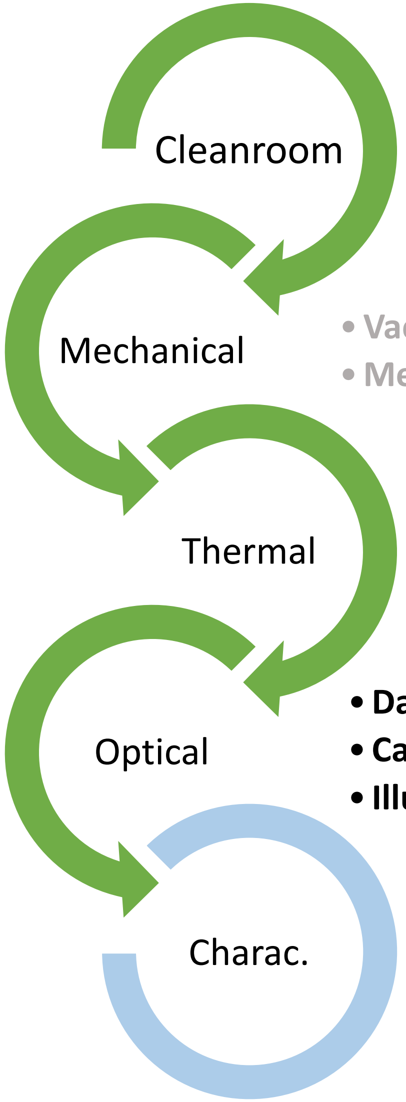


Same conversion law applicable @ T_{SCA}=85K

Optical design - Uniformity



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Fowler on detector #17188 <PR1>

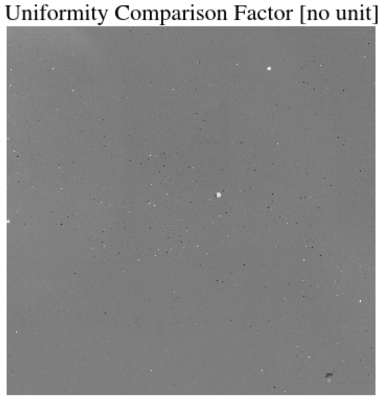
Repeated on both setups

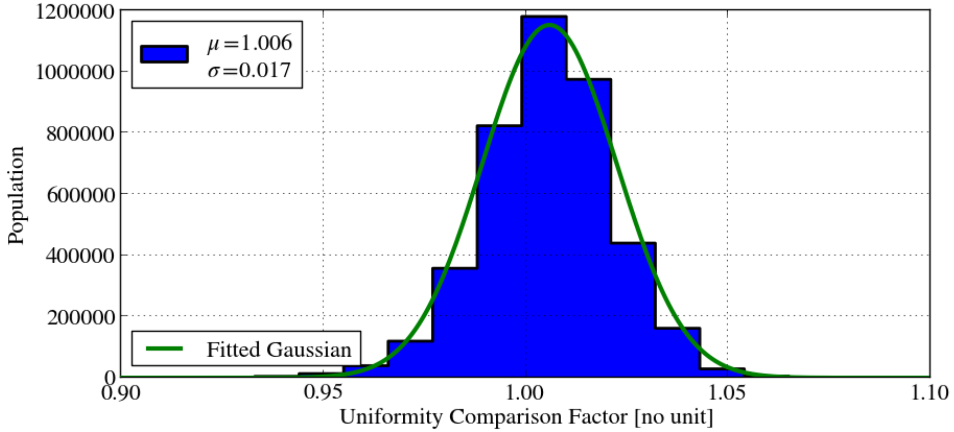
Using data with the same total int. charges

Normalization of Fowlers (median)

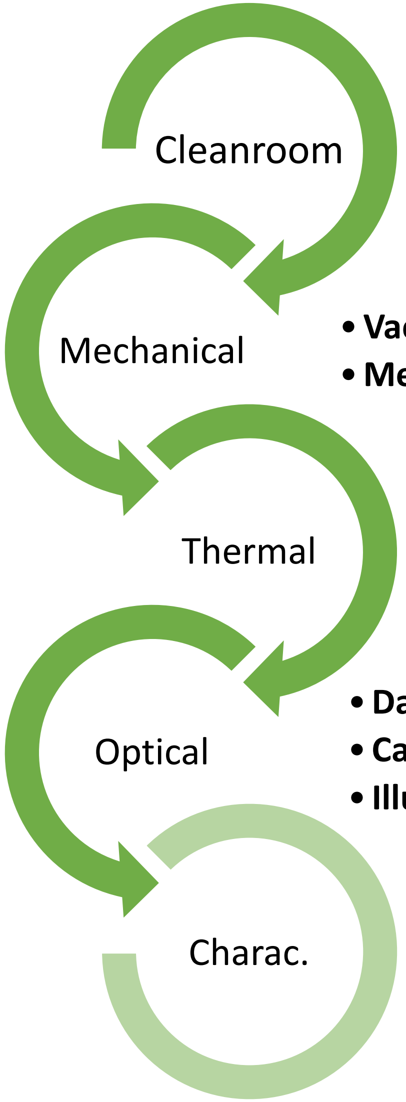
Divide two Fowlers:
> Uniformity Comparison Factor

Illuminations on both setups show no difference in spatial distribution





Validation flowdown



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Cleanroom
- Cleanroom environment stable

Vacuum
- Cryostat ready for acquisitions in less than 1.5 days

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- FPA does not cool down faster than 1 K/min
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- FPA stabilization occurs within 2.5 hours, global cryostat maximum variation is less than 100 mK after stabilization

Optical
- Illuminations stable within a few months
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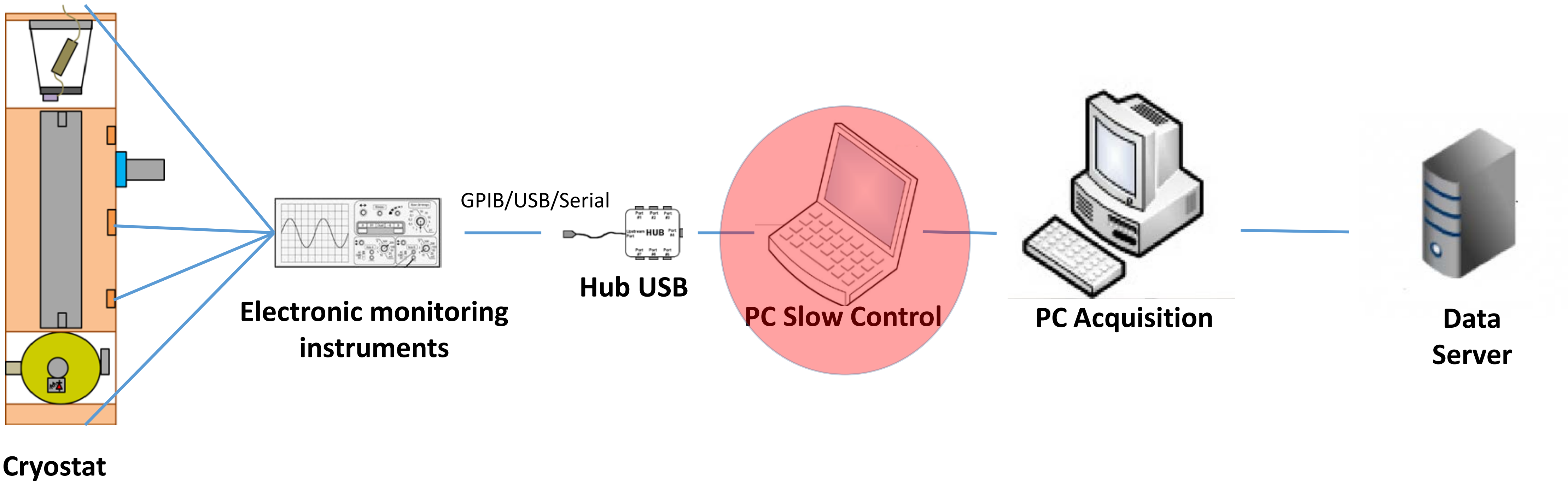
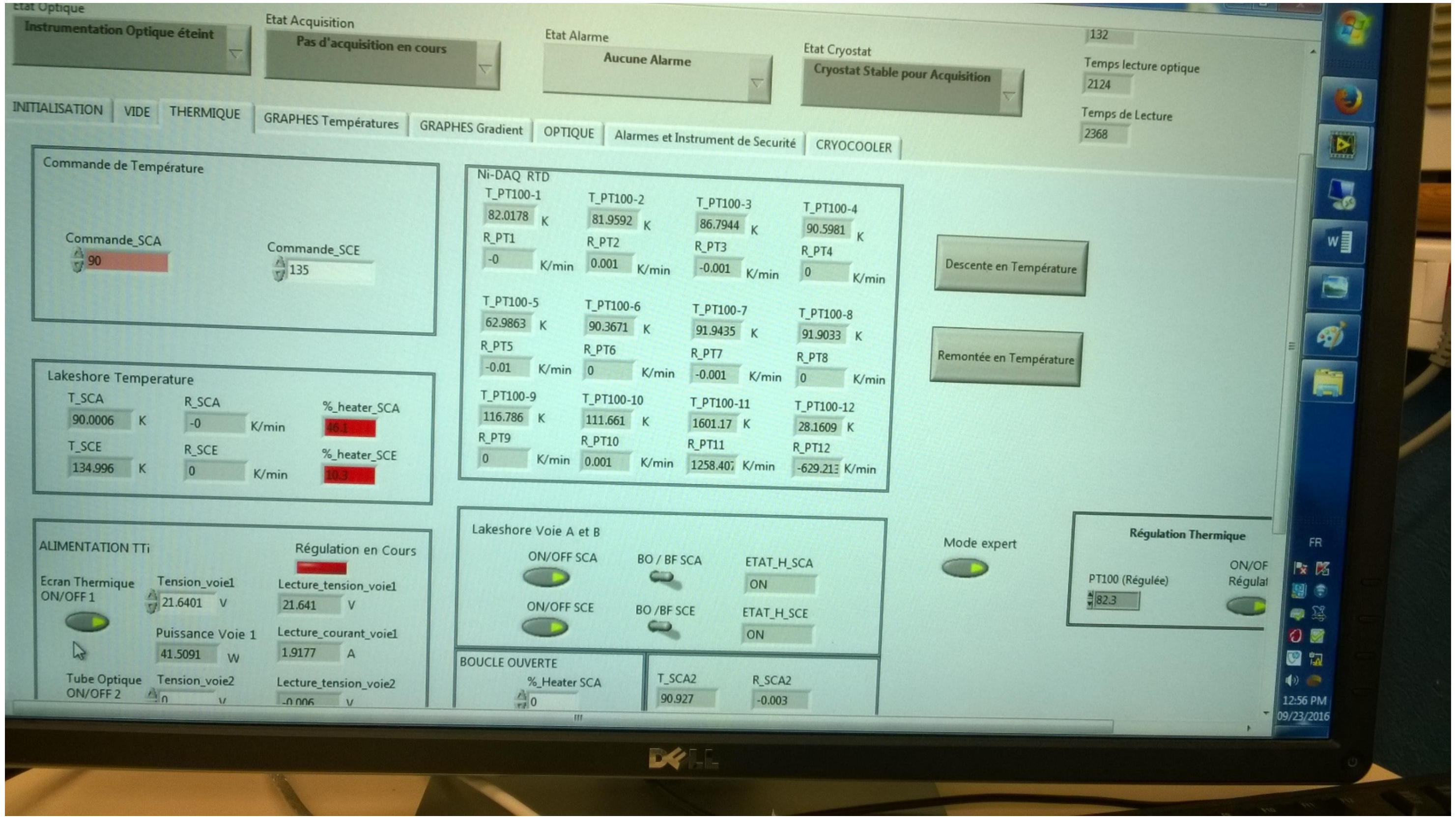
- Illuminations on both setups show no difference in spatial distribution

Environmental monitoring and control

General overview



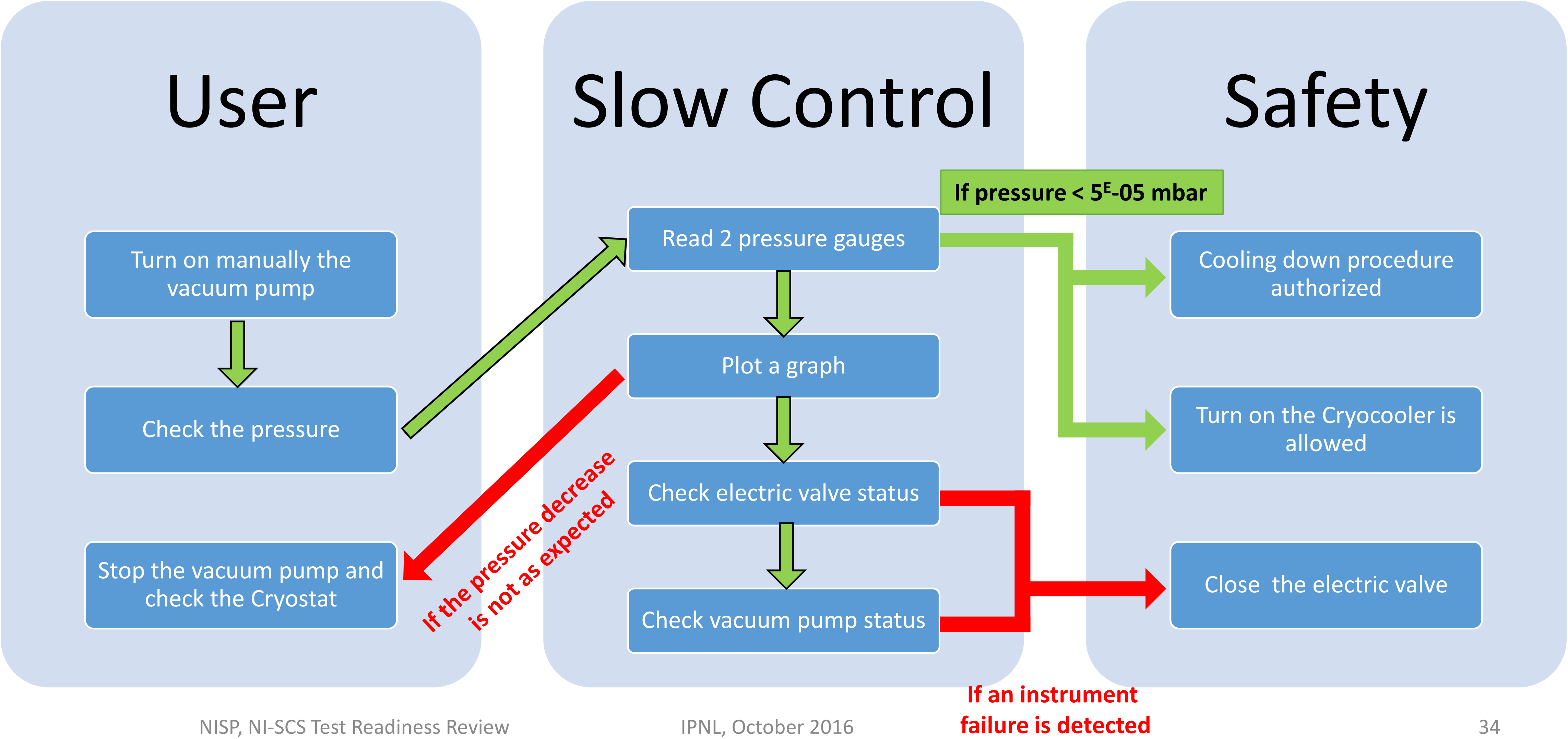
Monitoring Instruments



Monitoring Instruments

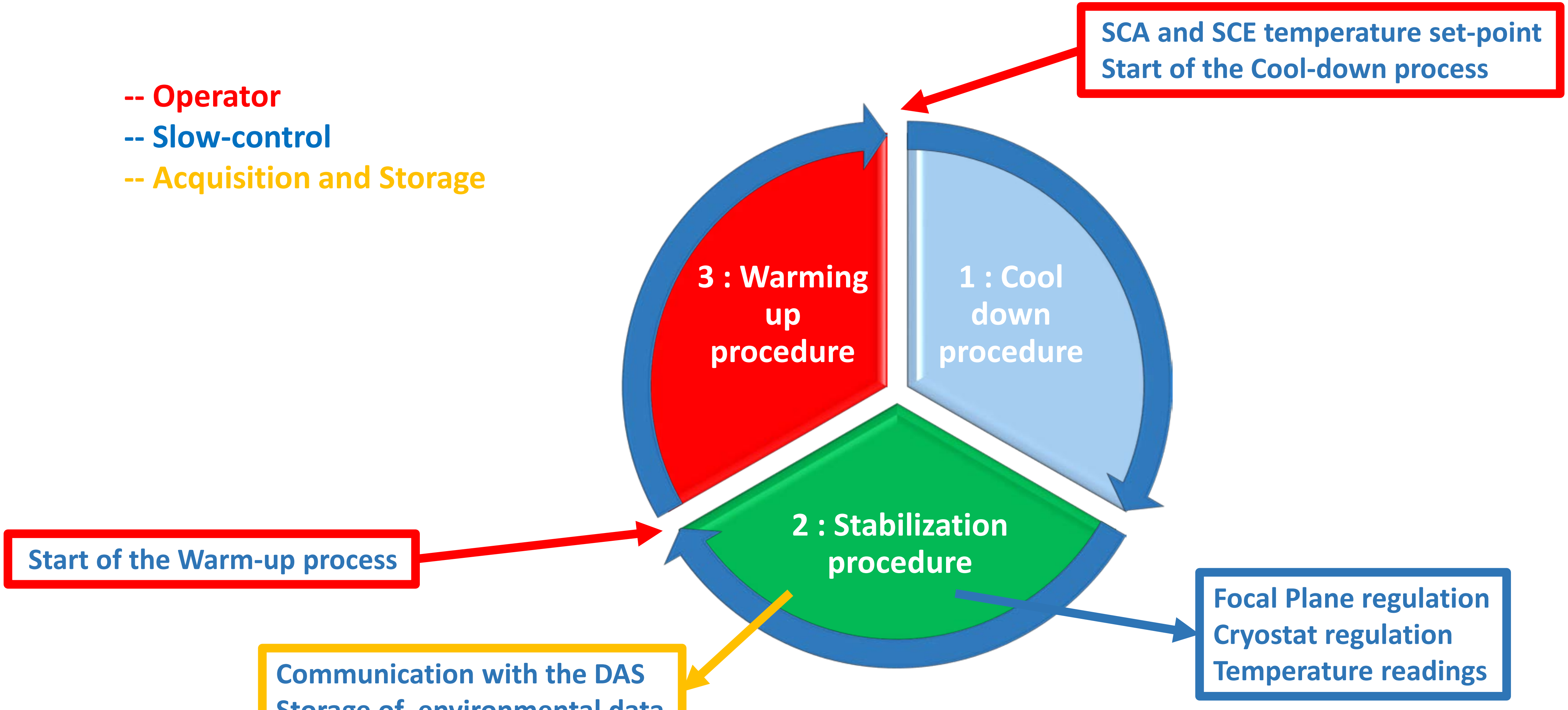
Instrumentation	Company	Reference	Description
Thermal			
Cryocooler Compressor	Cryomech	PT-90	Cryo-cooler
Temperature Controller	Lakeshore	336	Focal plan temperature control
TTi	TTI	PL303 QMD	Heater's power control
NI-DAQ	National Instruments	Module 9217	Temperatures reading
Vacuum			
Vacuum Pump	Edwards	NEXT240	Primary and turbomolecular pumps
Pressure Gauge * 2	Edwards	WRG	Pressure measure
Optical			
Monochromator	Newport	Cornerstone 260 1/4m	Illumination source by wavelength sweeping
Photodiodes sourcemeter	Keithley	2636B	Current measure
LEDs sourcemeter	Keithley	2614B	Illumination source by flow sweeping
Safety System			
Emergency electric unit	CPPM	-	
Electric Valve		DN100	Valve of preservation of the vacuum

Vacuum Procedure



Thermal Cycle

-- Operator
-- Slow-control
-- Acquisition and Storage



Thermal Cycle

Cooling Down Procedure

Specifications

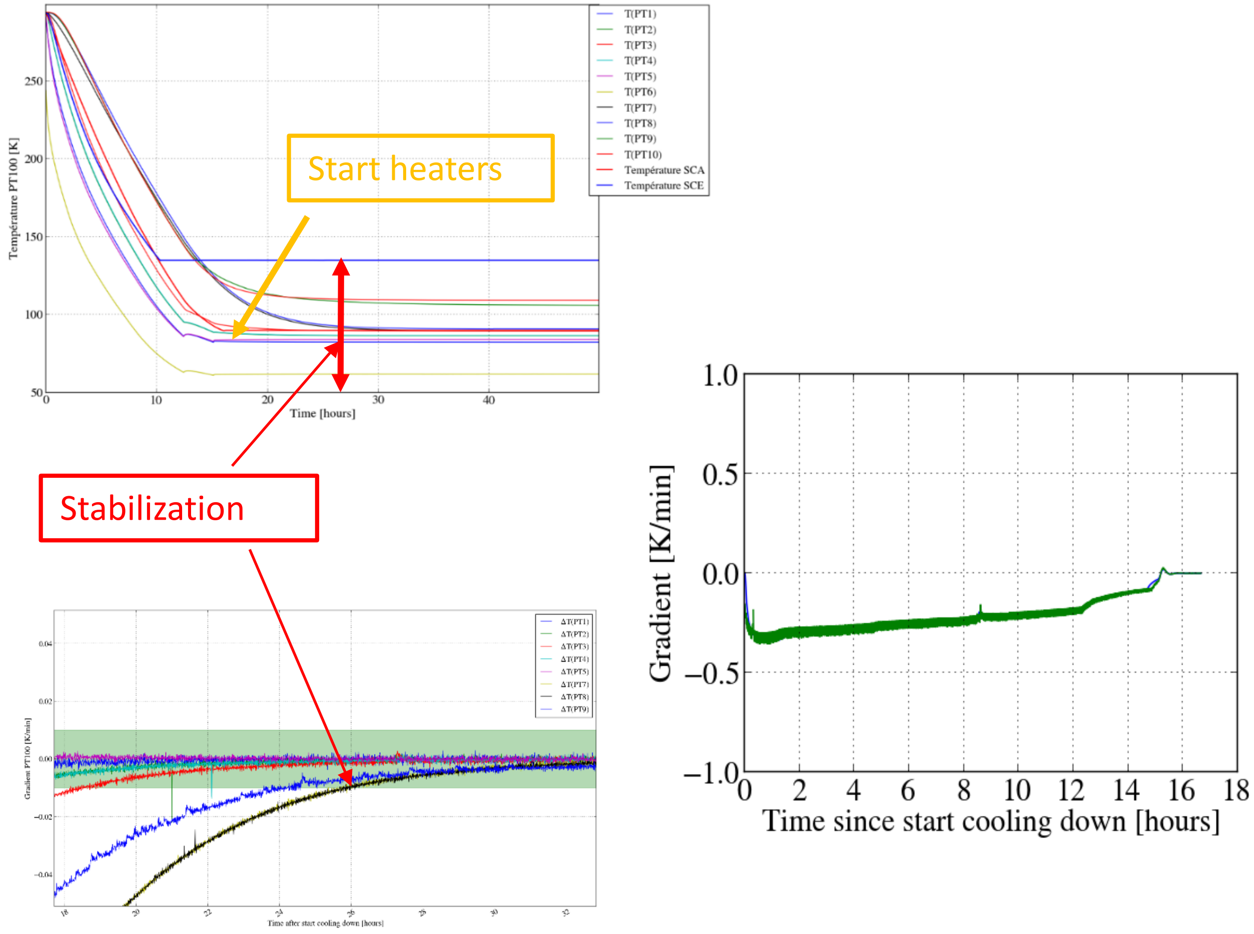
- SCA gradient < 1 K/mn
- Cooling down as fast as possible

Action Test

- Heat sources are disabled
- Cryocooler on
- SCA/SCE setpoints on the allowed range
  - 70 K < SCA < 120 K
  - 120 K < SCE < 150 K

Results

- Maximum SCA gradient : **0,4 K/mn**
- Average cooling time : **30 hours**
- All Temperature gradients **< 10mK/mn**



Stabilization Procedure

Specifications

- SCA temperature variation< 1 mK
- Overall Cryostat "software regulated"

Action Test

- The Lakeshore (PID) stabilize the focal plane at 1 mK accuracy

Results

- Lakeshore stabilization during a **3 weeks period has been proven**

Warm-up Procedure

Specifications

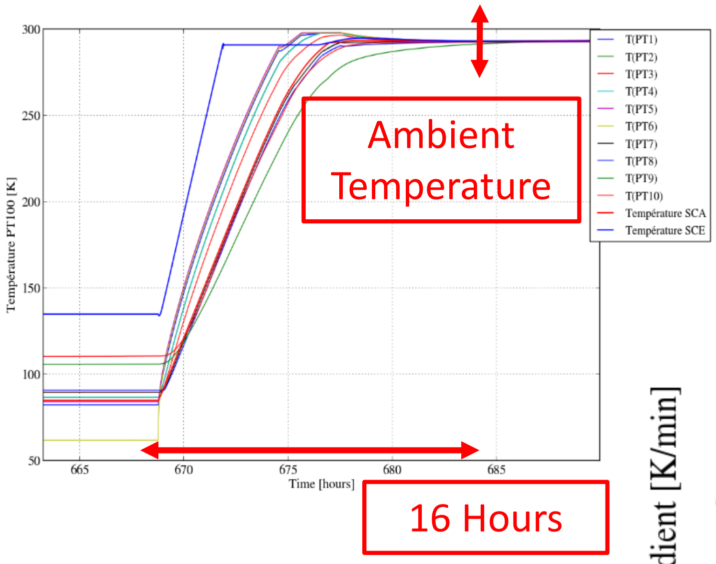
- SCA is not the coldest point of the Cryostat
- Warming as fast as possible
- SCA temperature variation< 1 mK

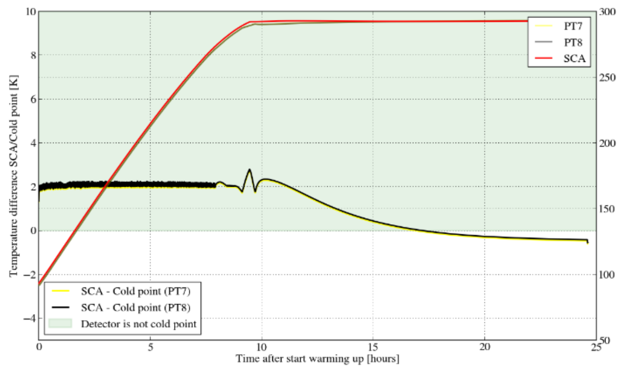
Action Test

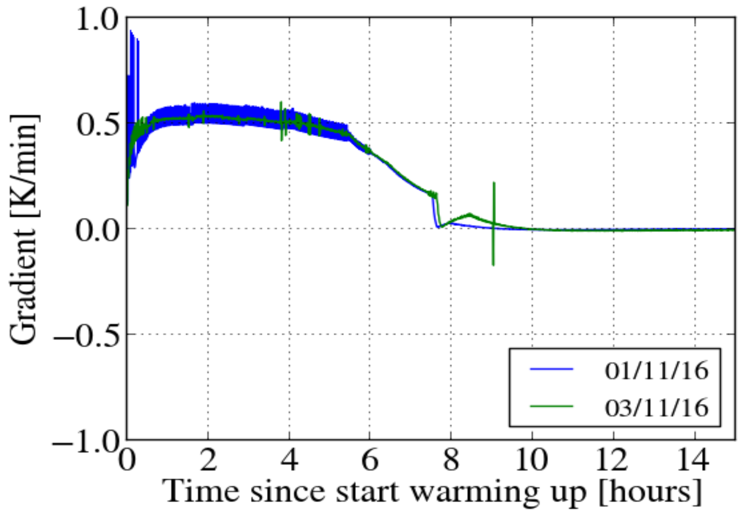
- Thermal screen heaters at maximum power
- Optical tube temp. maintained under the SCA
- Cryocooler off

Results

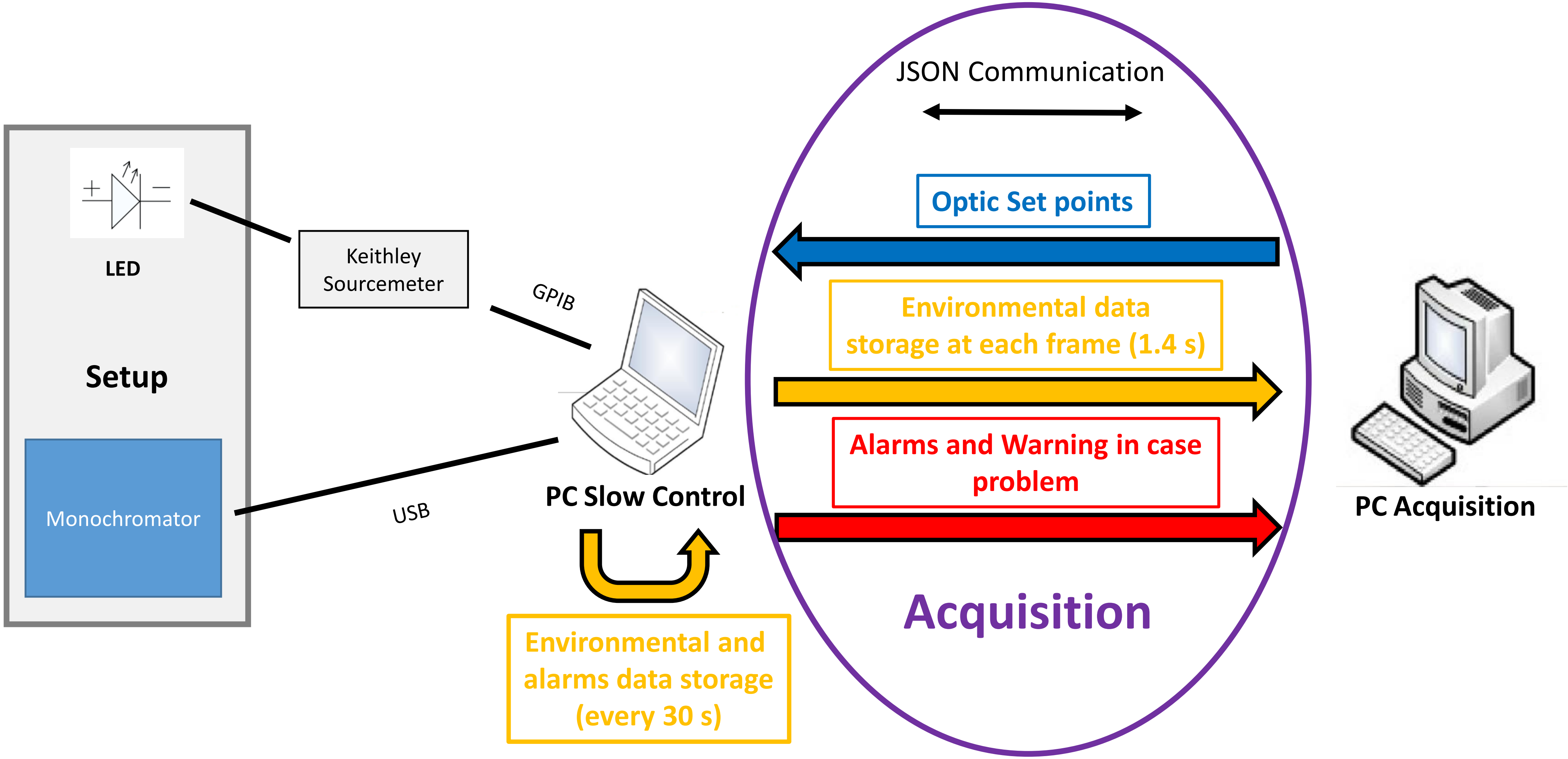
- Maximum gradient of the SCA is **0,6 K/mn**
- Average time of the warming up : **16 hours**
- All temperature **> 292 K**





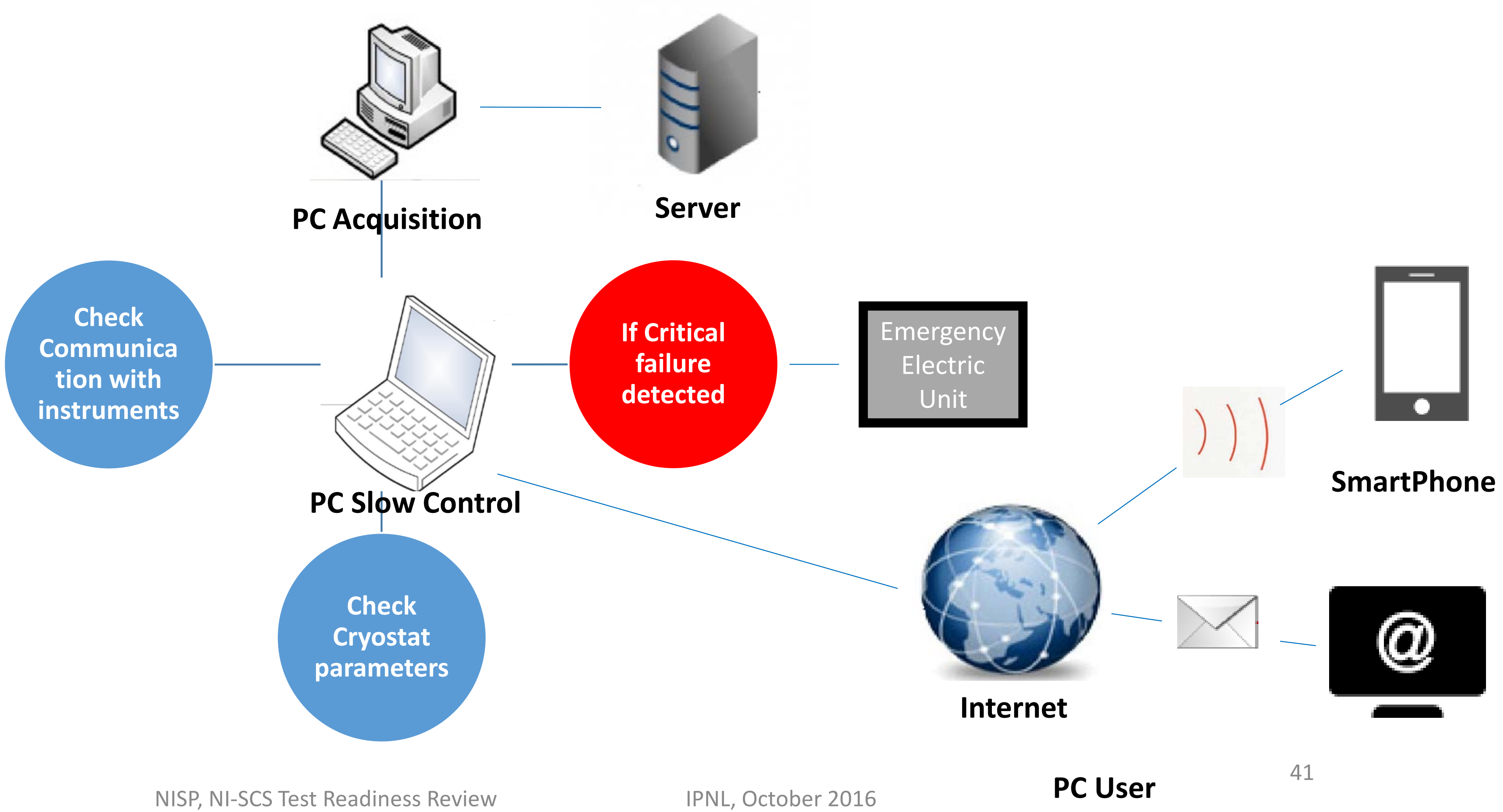


Acquisition and Storage



Critical situation handling

General Safety



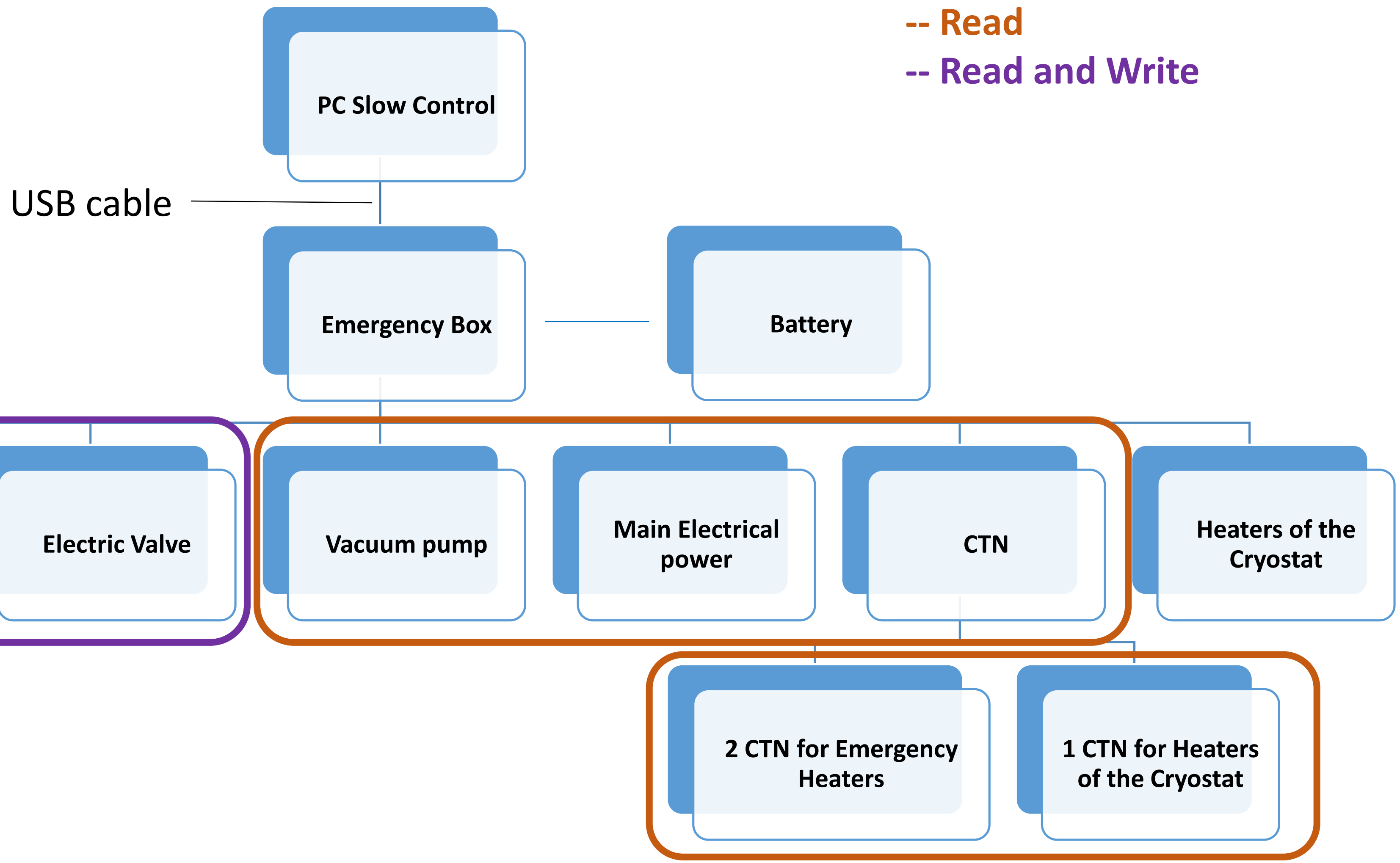
General safety

- **Cold and Vacuum state**
  - Thermal risks (too low at too high)
  - Electrical power shutdown
  - Vacuum risks
  - **EUCL-CPP-TN-7-0210 : Characterization Setup Study Report**

- **Uninterruptible Power Supply**
  - All the instruments (except the Cryocooler Compressor) are connected on an UPS
  - If an electrical power shutdown < 10 minutes : only temperature variation

- **Emergency electric Unit**
  - The general safety operation is handled by the Slow Control software
  - An electric unit developed by the CPPM, monitor the safety instruments (vacuum pump, Cryocooler, Electric valve, heaters)
  - A battery supplies the electric unit to take over the Slow Control if there is long power outage

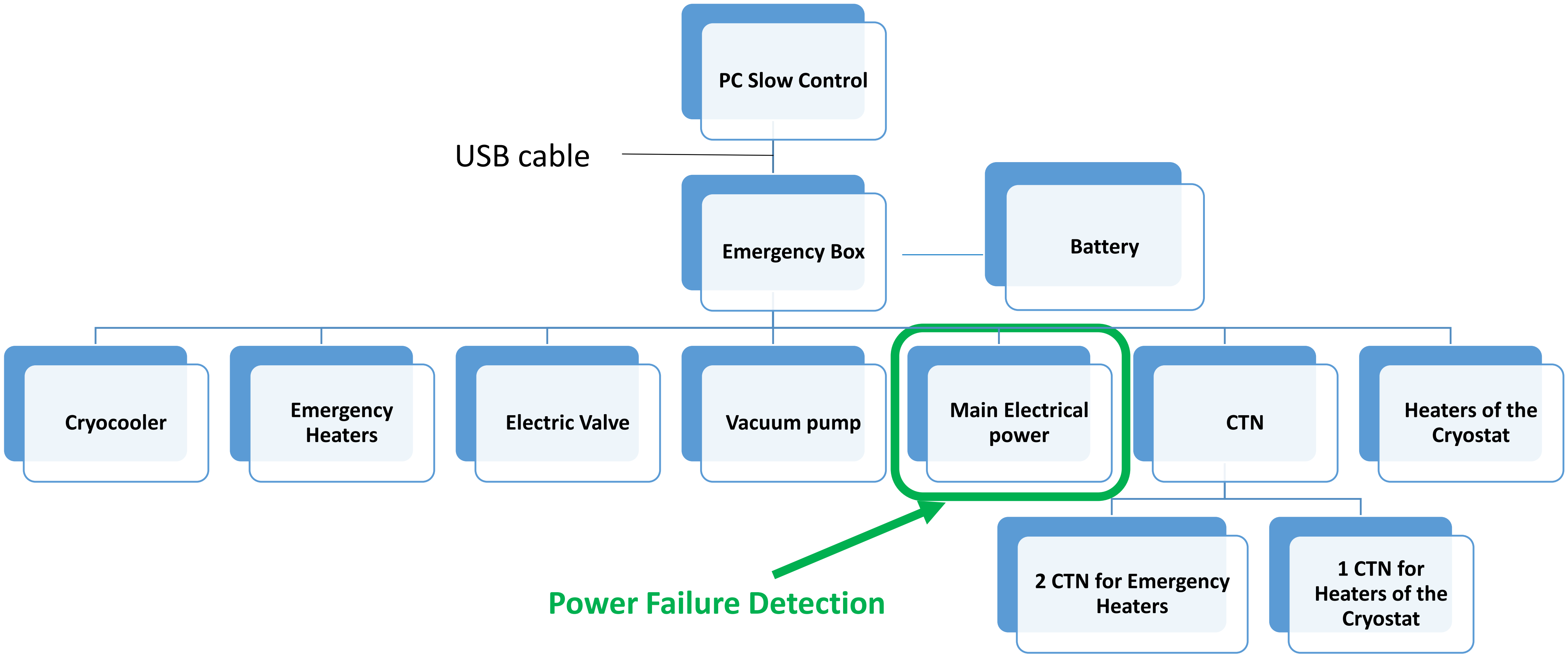
Emergency electric unit



Examples of Failures

- **Critical Case : Main electrical power shutdown**
  - ➢Managed by the Emergency Electric unit (hardware)
- **Other Critical Case**
  - ➢Managed by the Slow Control (software) if possible
- **Safety approach**
  - ➢Only one problem at a time

Main Electrical Power Shutdown detection



Main Electrical Power Shutdown

Power Failure

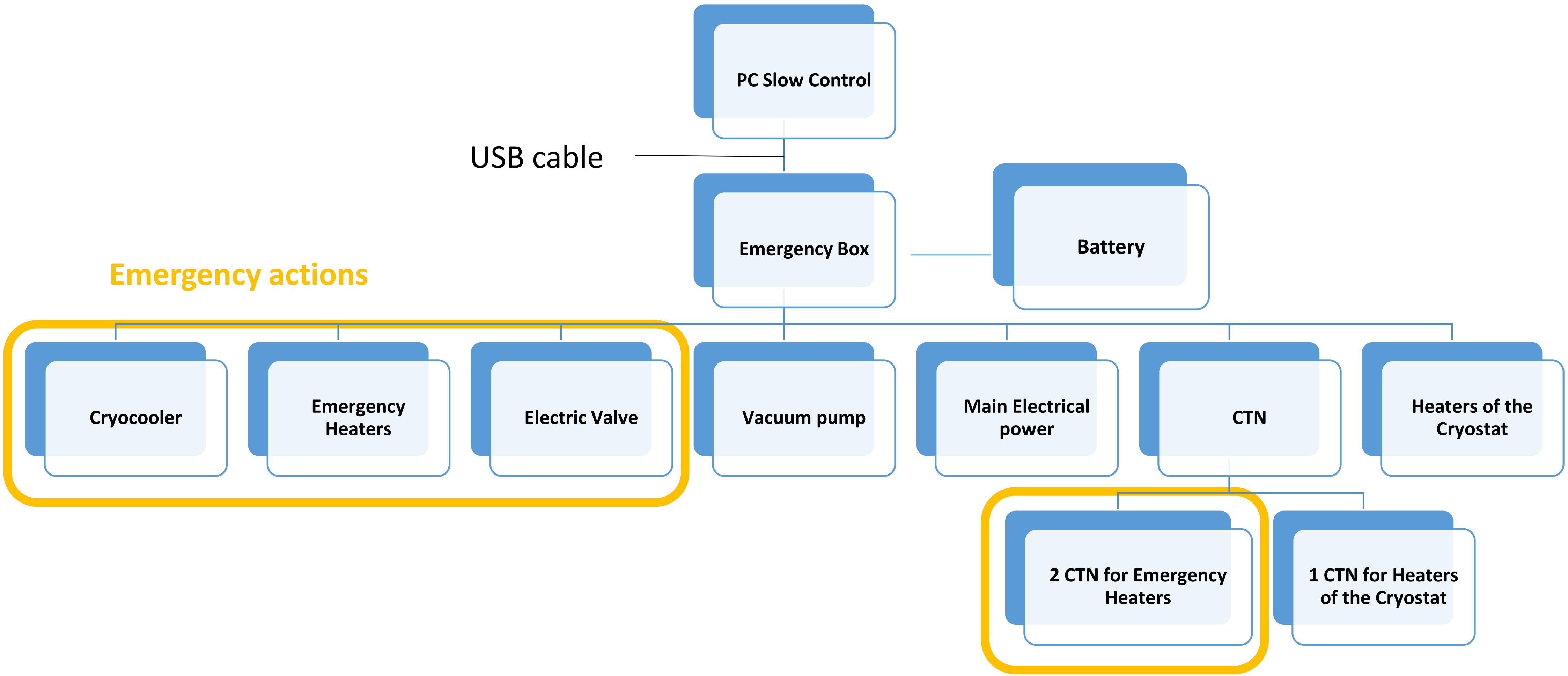
Slow Control Action

- Wait few minutes (short or long failure > **10 minutes**)
- For a long failure, start an **emergency warm-up procedure**

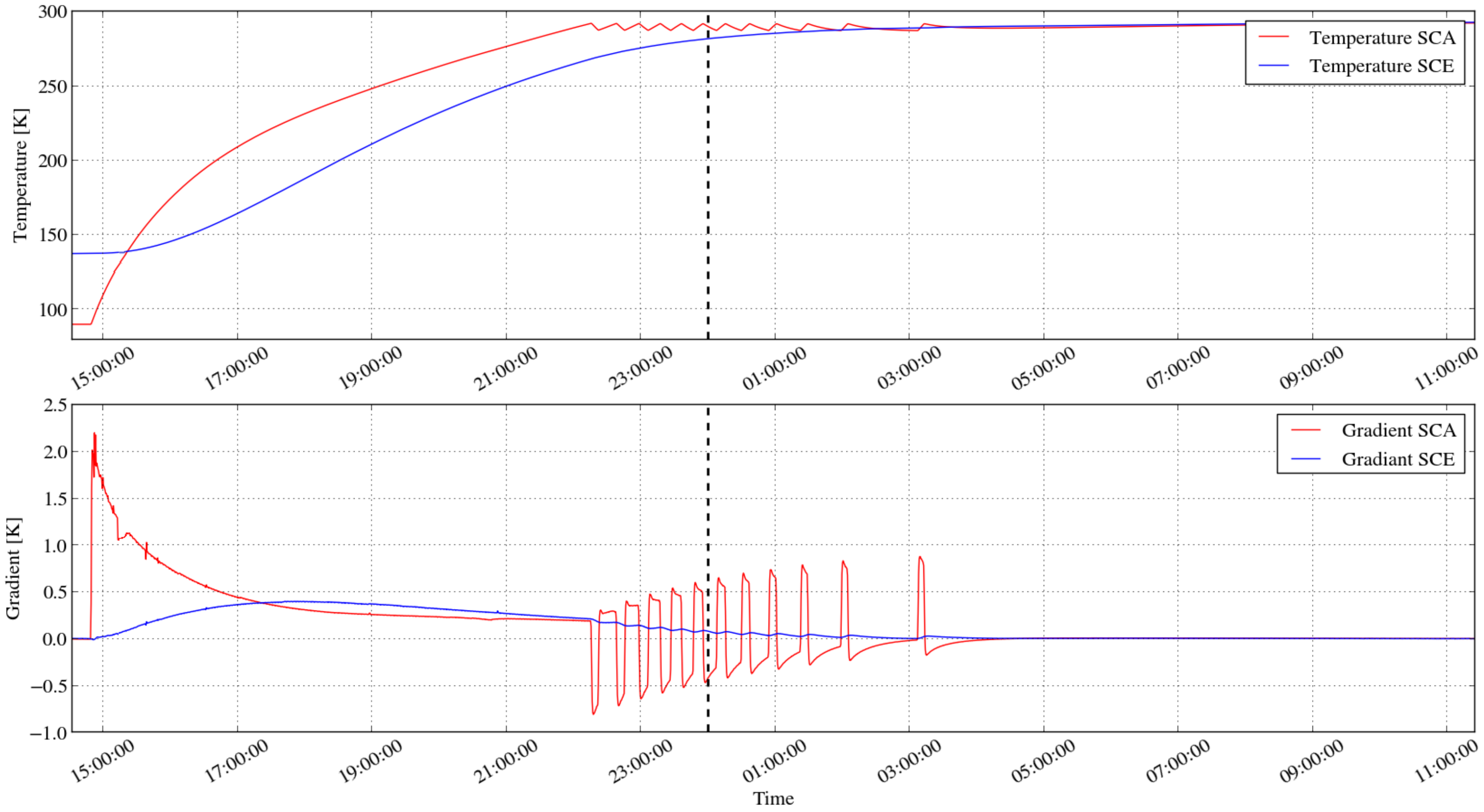
Results

- All the instruments will be cut off if the power failure is longer than **15 minutes (UPS limit) → Battery supplied Emergency heating**

Emergency Electrical Unit actions



Emergency warm-up



Average Time : ~18 hours
Maximum gradient on SCA : 2.2 K/min

Other Critical Case

- **Safety Condition**
  - Keep the vacuum in the Cryostat
  - Keep the SCA temperature between 75 and 300 K

- **Safety Procedure**
  - Stop the Cryocooler
  - Close Electric valve
  - Start a Warm-Up process
  - A CTN stop Heaters in case of too high temperature

Other Critical Case

- **Software and Hardware Safety**
  - Critical failure automaticly manage by the Slow Control
  - Emergency Electric Unit assist the Slow Control and can take the hand to make the Detectors automaticly in a safety condition
  - The user can take the hand at all time on the Slow Control

Operators warning

- **Operator communication (Critical and Warning failure)**
  - **Send Mail/SMS (with description)**
  - **Display on the Slow Control**
  - **Storage of safety data (alarm logbook)**

Arrival and Departure of detectors

Travel

- Transport between GSFC and Roissy is carried on by NASA (JPL)
  - Baseline is to have SCS travelling in passenger cabin in 2 pelican cases type 1650
  - A data logger for vibration, shock, temperature, humidity is placed in each case
  - Custom clearance will be done at Roissy airport by SETCARGO (ESA brooker)
  - Travel will continue by train (TBC) (from Roissy to Marseille)

Incoming inspection

- Unpacking, incoming inspection will be done at CPPM (*EUCL-CPP-PR-7-001*)
  - Under the control of JPL and CPPM PA/QA
    - Pictures of active area and connectors *(EUCL-CPP-PR-7-009)*
    - Good health test (interconnection of pixels) (*EUCL-CPP-PR-7-008, TBU)*
      - Dedicated SAM setup with TIS software
    - Data logger (TBW)
    - Data Set Control (TBW)

General organization

Organization

- The Shifter team :
  - As described, shifts can be done remotely. The main tasks are
    - The monitoring of cryostat's main parameters and local team call in case of problem
    - The quality check of the data and the workflow interruption/restart if needed
    - The logbook filling
    - Anybody interested (and motivated) is welcome

- The local SCS team:
  - 5 people (JC Clémens, W. Gillard, R. Legras, A. Secroun, B. Serra) trained to handle, mount, dismount the detectors and handle HW/SW issues.
    - At least one of them on call every time during charcterization

Conclusions and remaining work

Conclusions

- Cryos Pégase and Andromède are almost continuously running since June (PR1 and PR1b) with extensive use of remote operation and without failure
- 10 TB of data for 2 SCS has been acquired (PR1 and PR1b)
- Automation of critical situation handling allow this remote operation without local attendance
- Cryos have demonstrated that stability in all parameters is OK
- Main opens issues remains in workflow finalization (IPC for instance) and schedule (to be addressed in another talks)

Open work is normal work

- Real test of 4 SCS acquisition
- Stress tests to be done in final configuration
- Procedure check and updates
- SC hanging when no acquisition is running
- Contamination control to be done again