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HAL Authorization

A cryogenic facility to characterize detector-particle interactions

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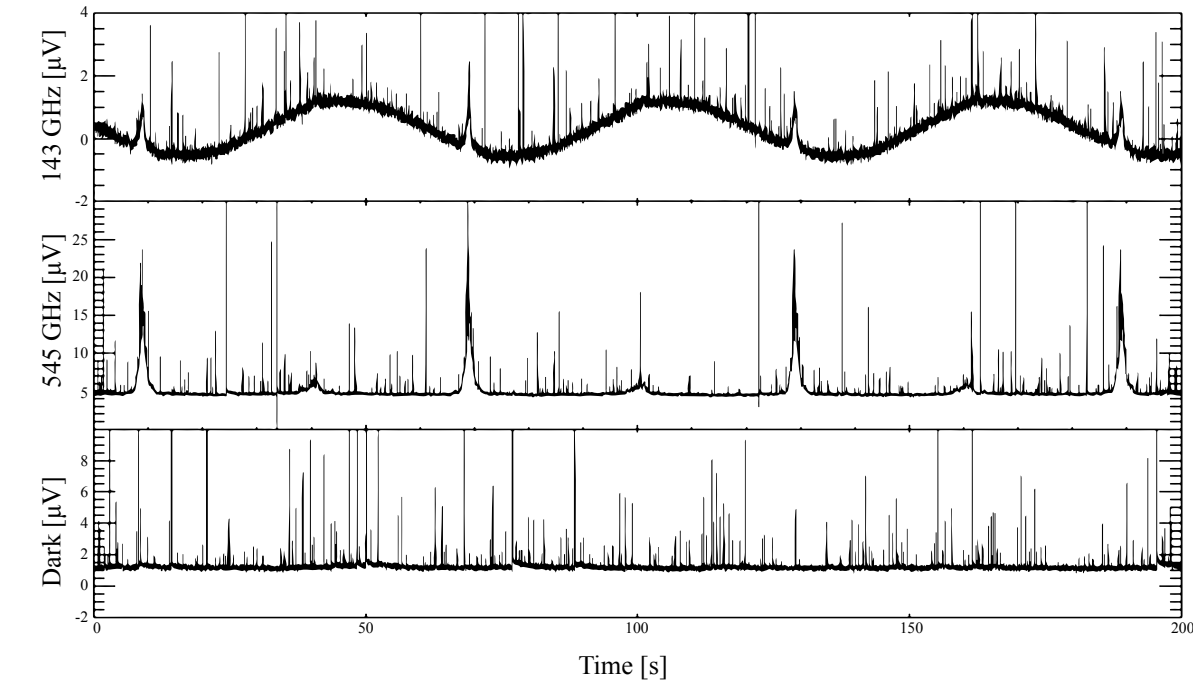


Fig. 1 : Glitches measured by Planck HFI [1]

Abstract

A large cryogenic facility has been developed allowing to irradiate cryogenic detectors and part of focal planes with particles such as protons of various energies with either an internal radioactive source or by connecting it to a particle accelerator [2]. Our facility DRACuLA (Detector irRADIation Cryogenic facility for Astrophysics) has been operated in front of the ALTO particle accelerator [3] during May 2024 to study the effect of irradiating particles with different energy levels on TES (Transition Edge Sensor).

Experimental set-up

1. Cryogenic test facility

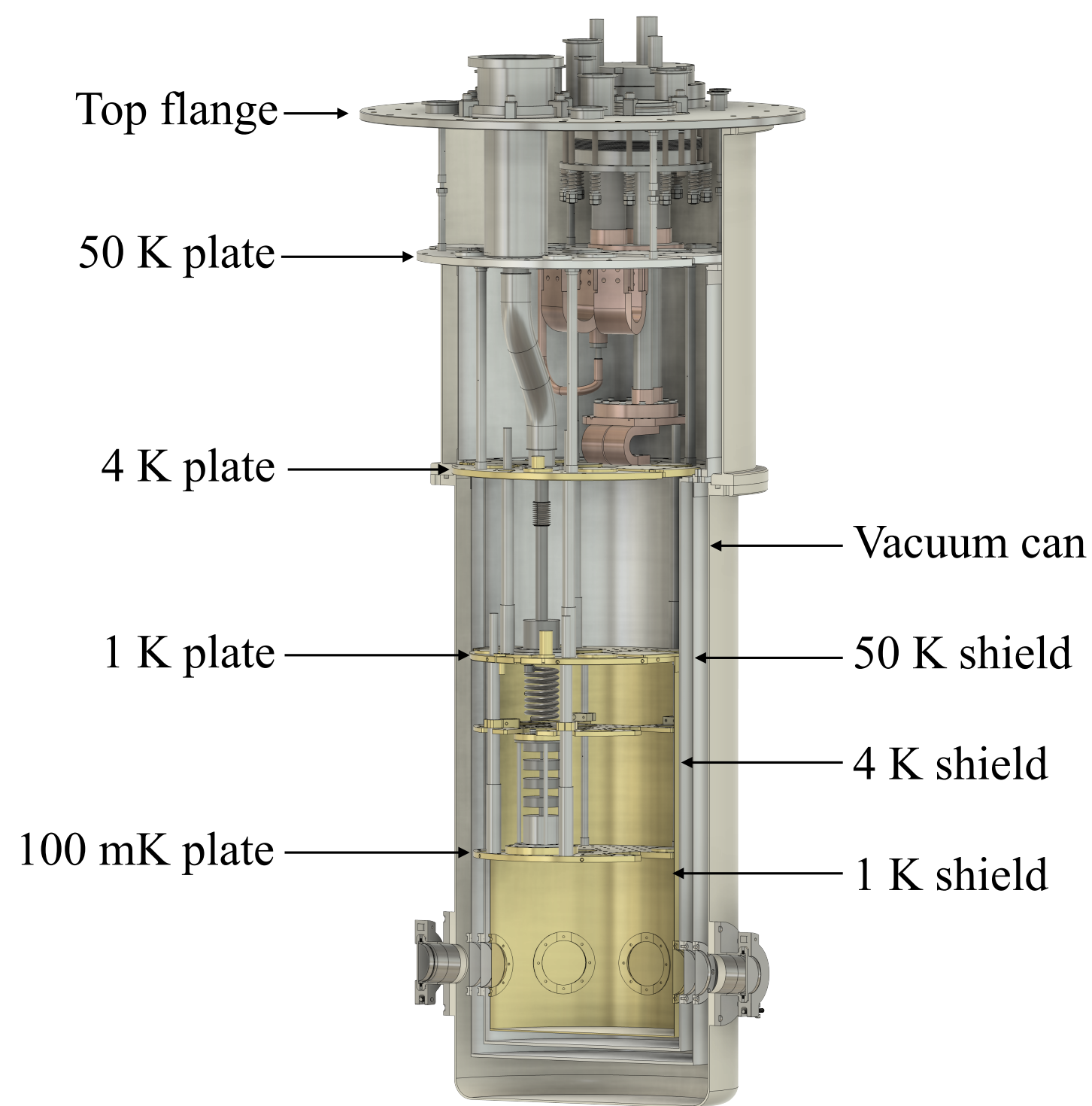


Fig. 2 : Anatomy of DRACuLA

Adaptable to any particle accelerator

- Compact frame with wheels
- Micro-vibration attenuator
- 4 KF-50 ports (at 0° 45° 90° & 180°)
- 24 low-pass filtered lines
- Superconducting coax wires
- 4 temperatures measurement bridges

2. Cryostat/beam line interface

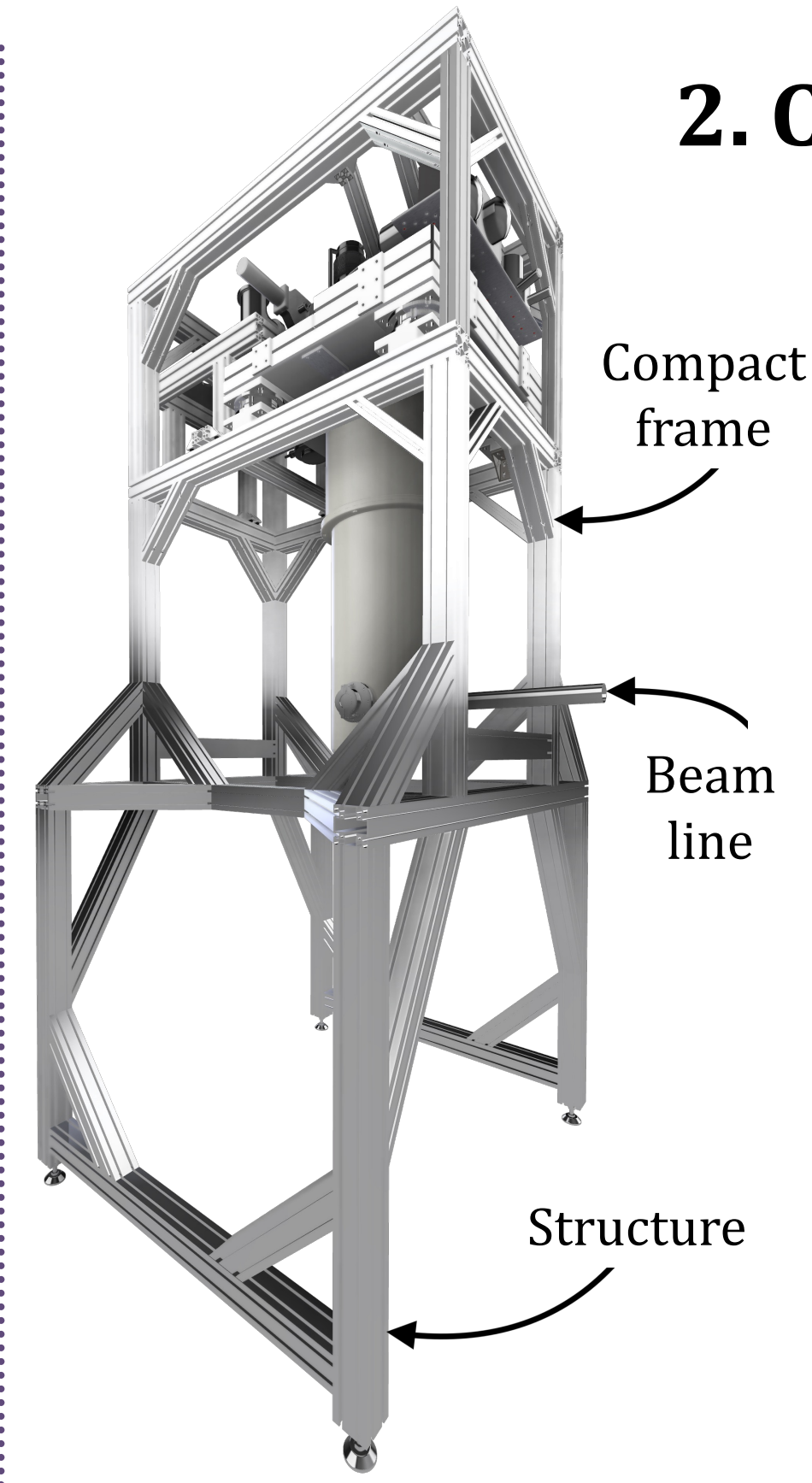


Fig. 3 : Structure

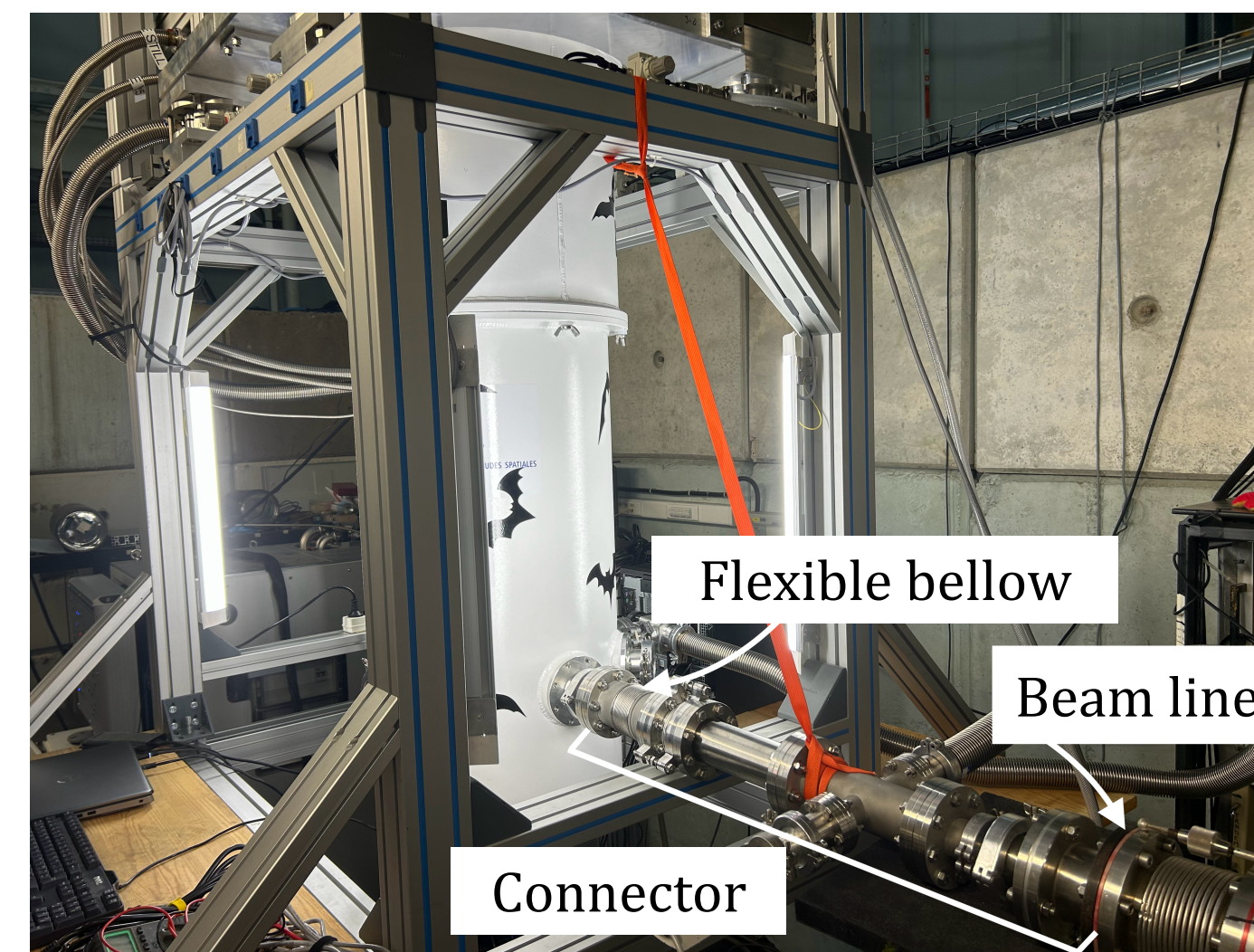


Fig. 4 : Connection between the cryostat and the beam particle

To avoid pollution of the cryostat's vacuum :
→ 60μm polypropylene window between the vacuum can and the connector

To avoid thermal loads :
→ Mylar filters on 4 K & 1 K shields

3. Alignment procedure

Improvement of the alignment system since the first campaign ⇒ significantly easier and finer

- Steel plates placed
- Thrust ball bearing fixed under the feet
- Alignment on XY axis and rotation around Z axis
- Adjust elevation with the screws
- Re-adjust elevation after proceeding to vacuum

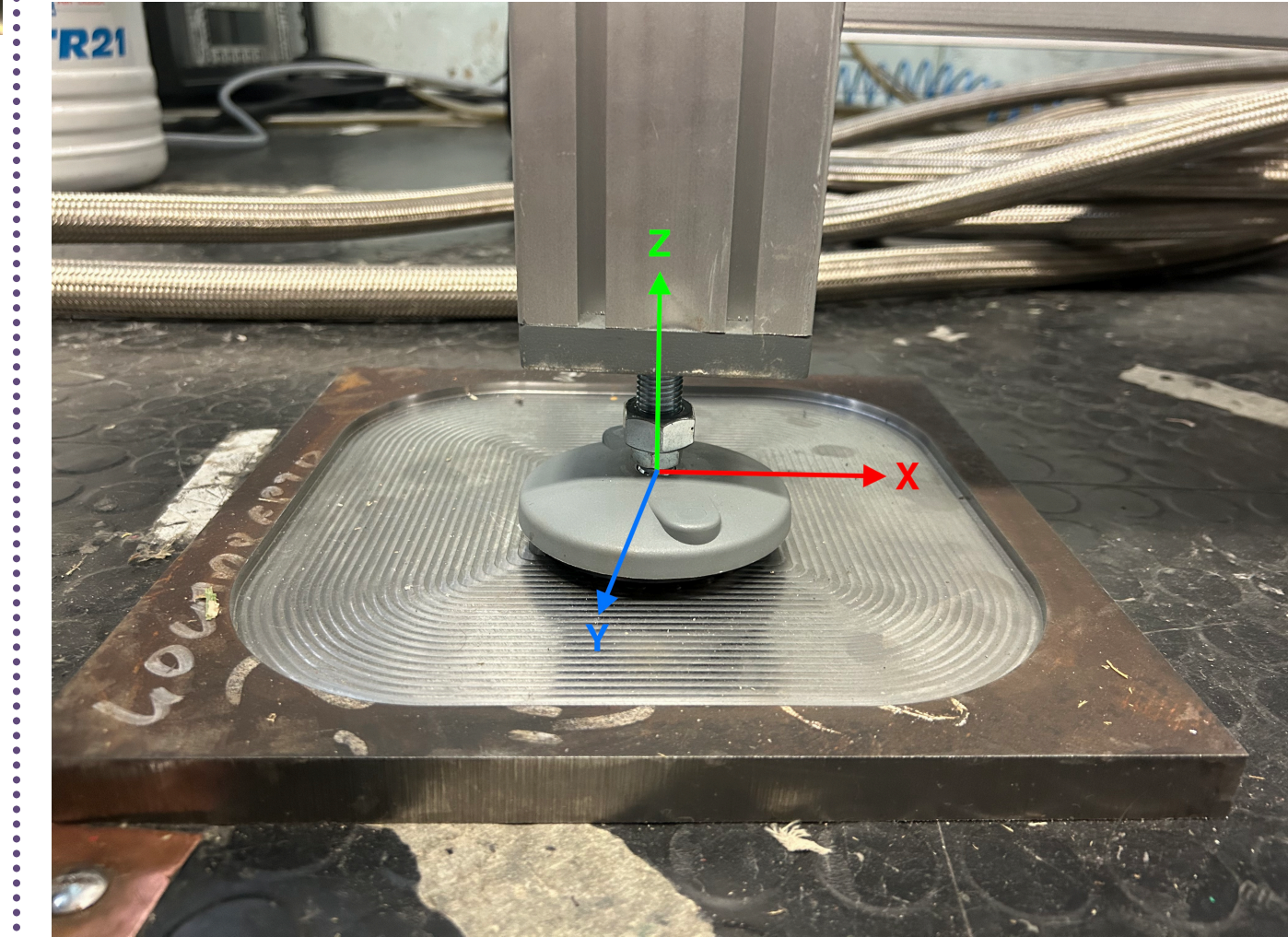


Fig. 5 : Modifications of the structure's feet



Fig. 6 : Details

Performances of the test facility

1. Thermal stability

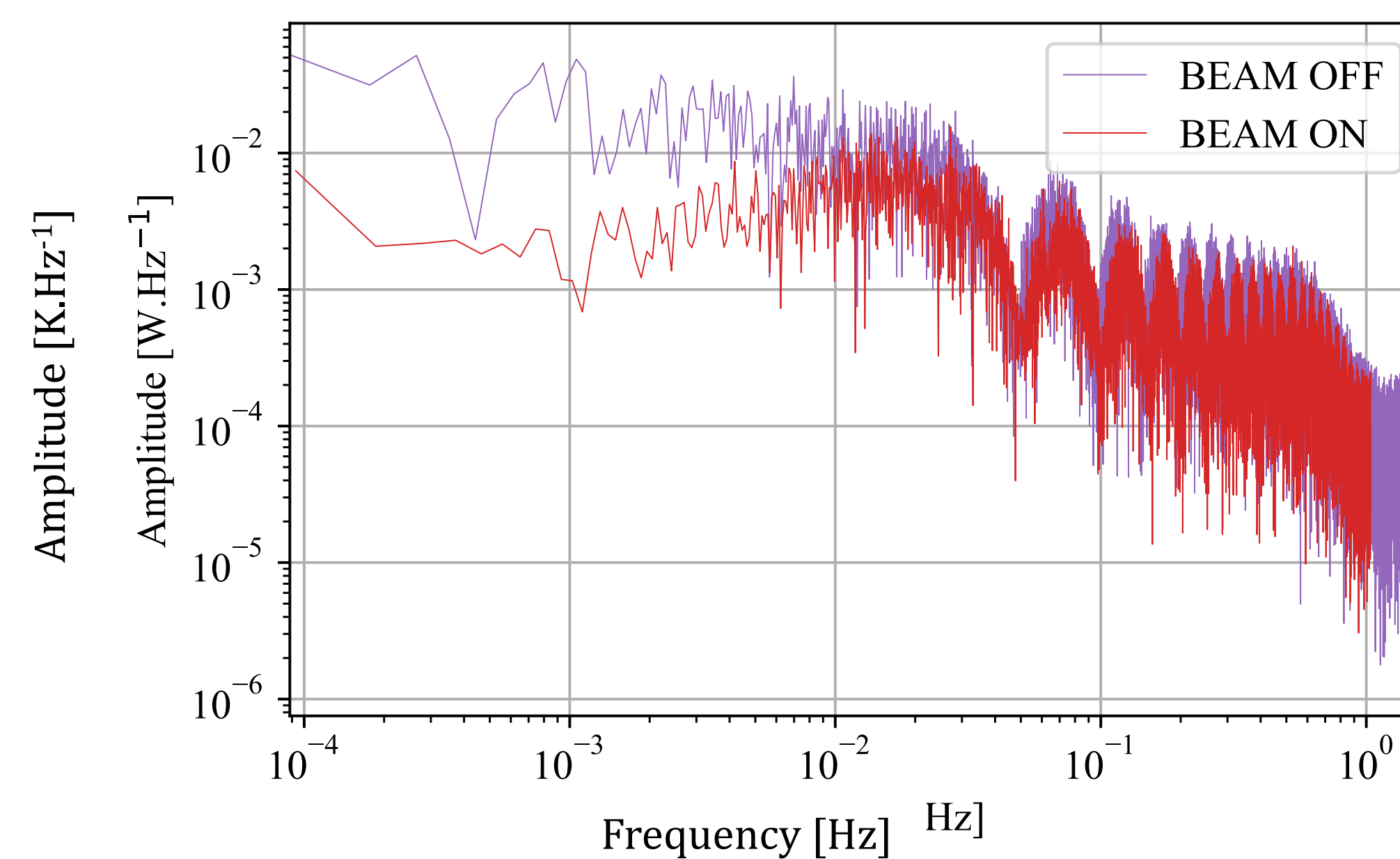
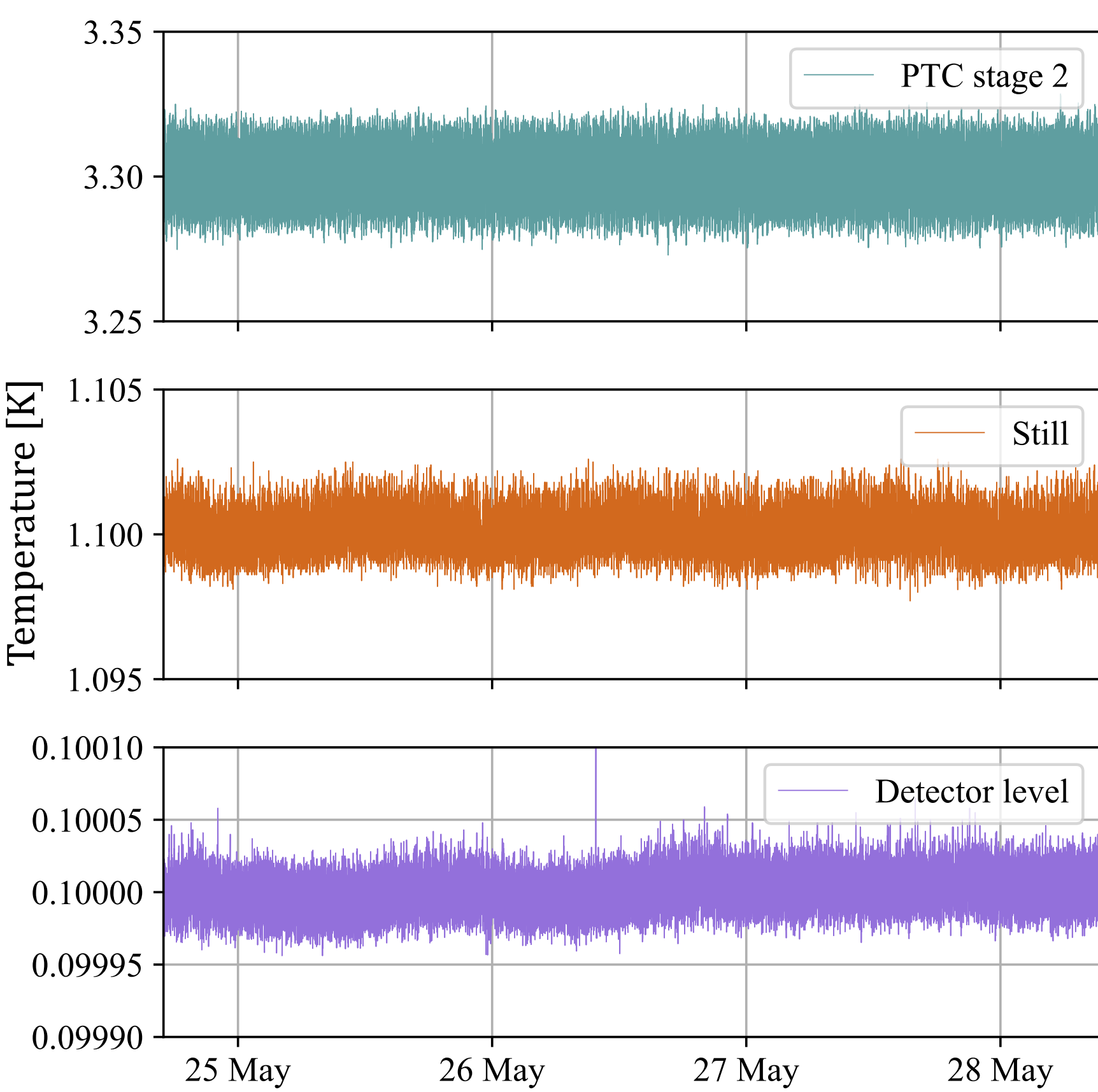


Fig. 8 : Comparison of the thermal stability of the 100 mK stage with beam on and beam off

Thermal stabilities obtained beam off during five days :

- 100 mK stage : 100 mK ± 11 μK
- 1 K stage : 1.1 K ± 665 μK
- 4 K stage : 3.3 K ± 11 mK

Excellent thermal stability beam off and beam on

← Fig. 7 : Thermal stabilities and their FFT of each thermal stages in the cryostat, beam off

2. Beam alignment with thermal loads

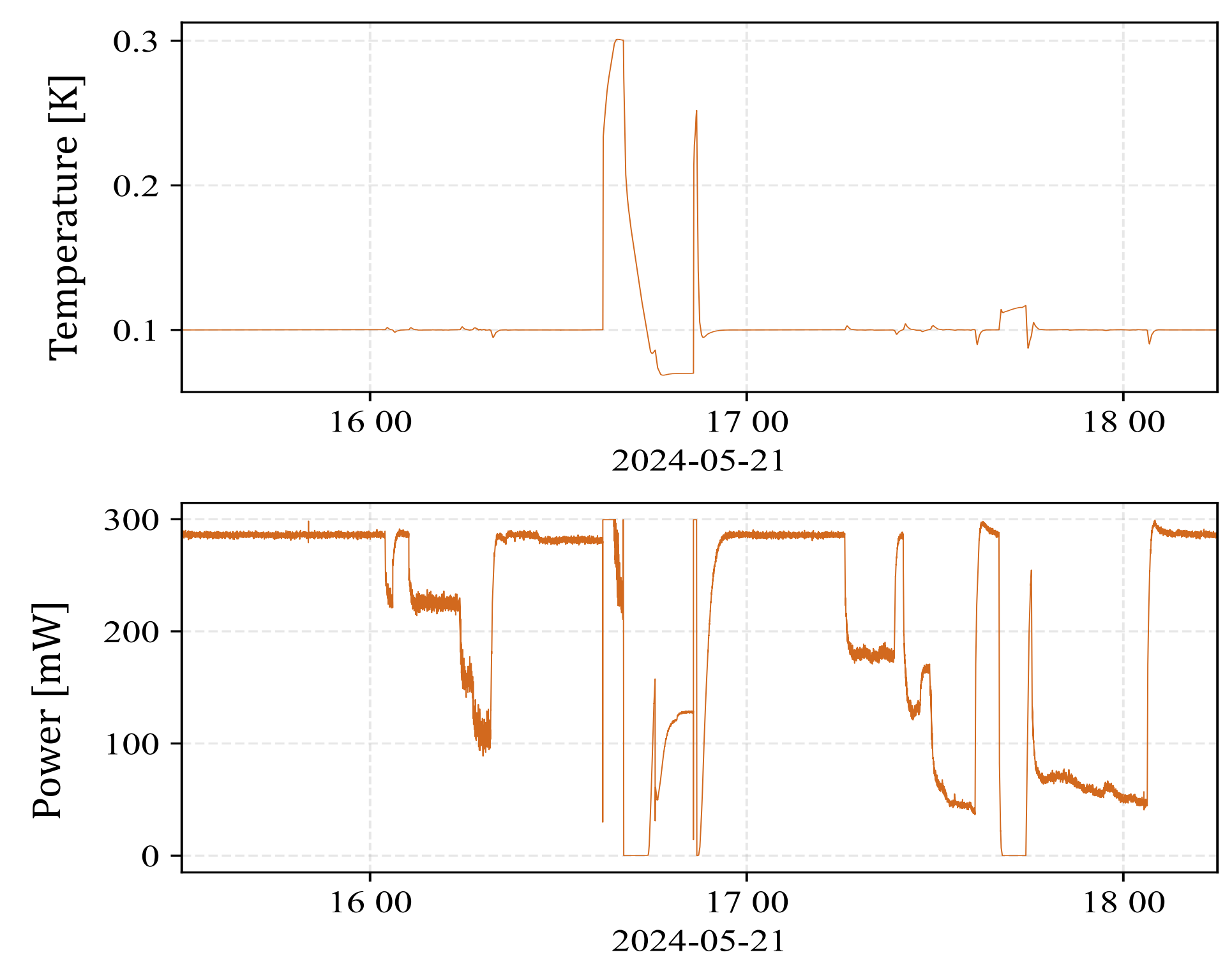


Fig. 9 : Thermal stability and cooling power available during beam alignment

Beam misaligned with experiment :

→ PID compensates thermal loads by reducing the heat delivered by the heaters

Beam aligned with experiment :

→ PID does not compensates thermal loads > 286 μW
→ cooling power reaches its limit
→ rapid warm-up

Beam's alignment can be **adjusted thanks to thermal loads**. Minimum flux available (5 pA) too powerful ⇒ requires improvements for future test campaigns.

Conclusion

The primary outcome of this experiment is the demonstration of an exceptional thermal stability with the beam particle off for five days at each temperature. Additionally, we discovered that the alignment of the beam line could be adjusted with the detector by utilizing thermal perturbations. Due to the inability to acquire data with the beam perfectly aligned, we opted to slightly misalign the beam to reduce the flux. This adjustment allowed us to measure substantial thermal stability even with the beam on. Nevertheless, resolving this issue is crucial for future test campaigns.

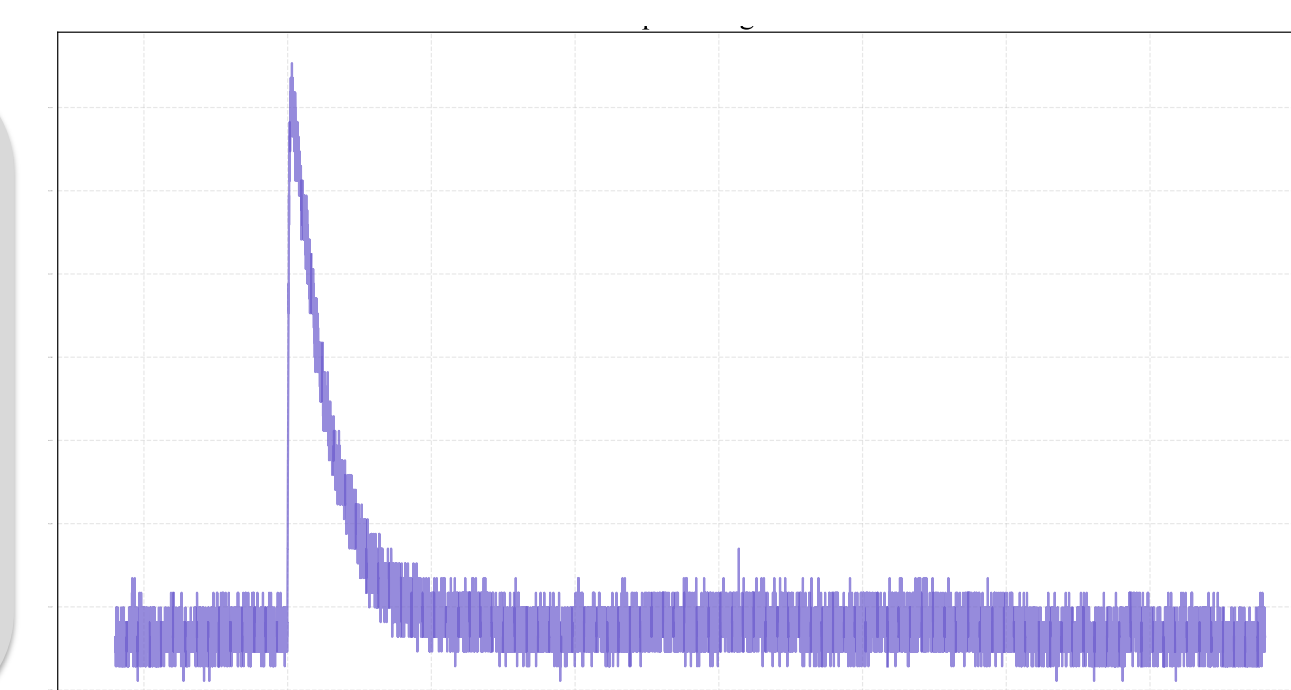


Fig. 10 : Glitch measured during the campaign

References

- [1] Characterization and Physical Explanation of Energetic Particles on Planck HFI Instrumen, *Catalano et al.*
- [2] Commissioning of a common-user test facility to evaluate the effects of high-energy particles on next-generation cryogenic detectors, *Janssen et al.*
- [3] Tandem physics in orsay, *Vergnes*