Integration and qualification of the Mini-EUSO telescope on board the ISS

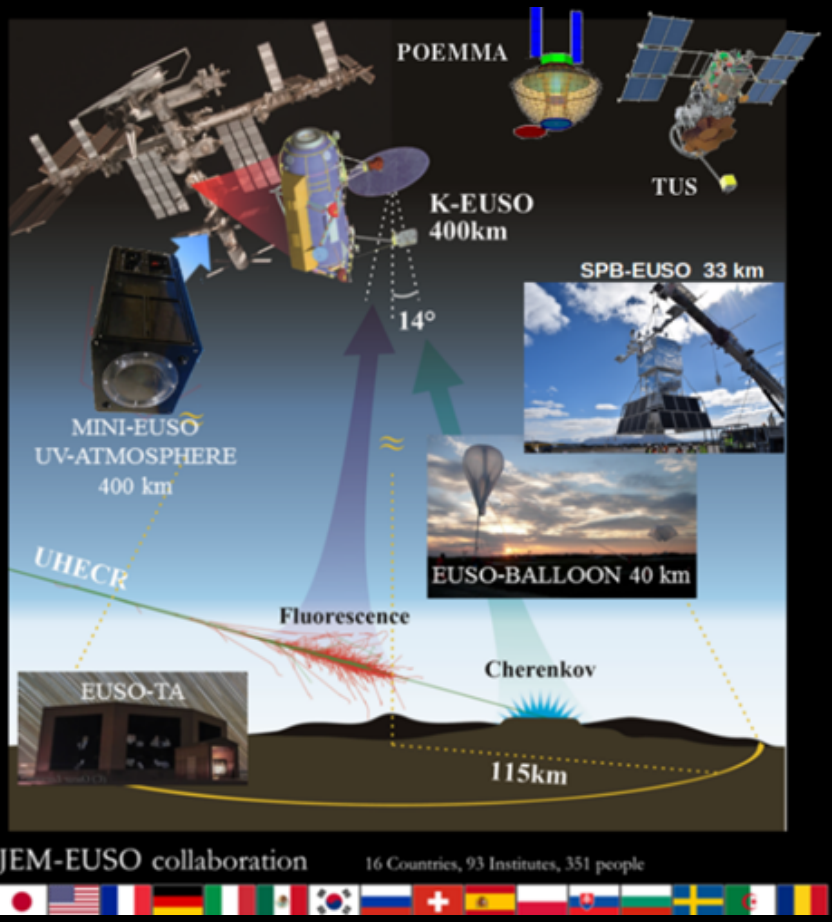
PhD student Cambiè Giorgio – University of Rome Tor Vergata and INFN section of Rome 2

ICRC 2021 – Berlin, Germany 12-23 July 2021

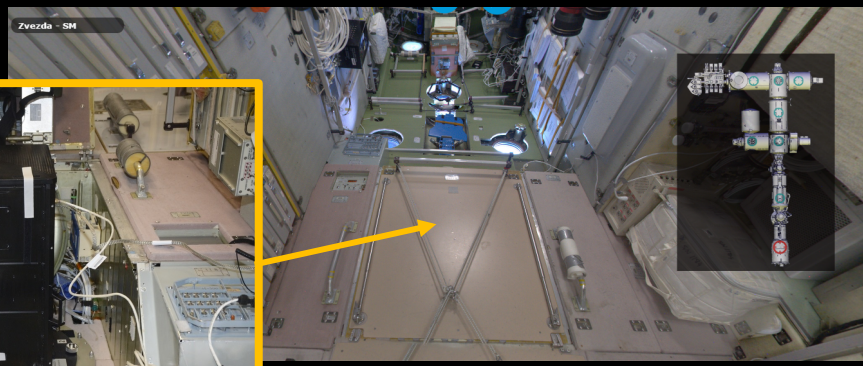
MINI-EUSO mission

Multiwavelenght Imaging New Instrumentation Extreme Universe Space Observatory

Launched in 08/19/2019 on board the Soyuz MS-14 from Baikonur Cosmodrome



- JEM-EUSO collaboration project
- Russian module Zvesda
- 80 % UV transparent window
- 44° FoV in Nadir mode
- 27 V power supply - Power 60 W
- 30 kg – 37x37x62 cm^3
- Night time duty cicle

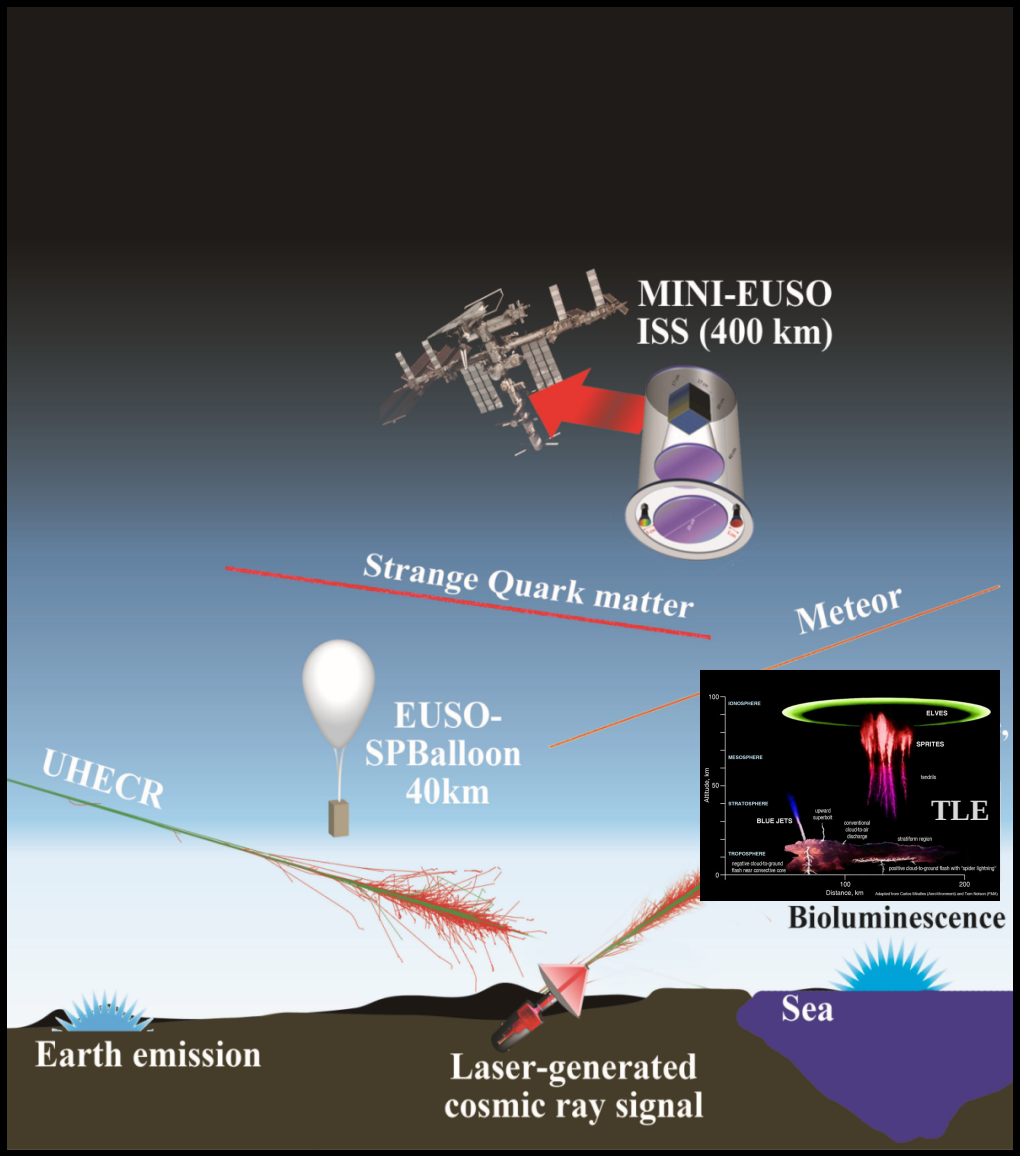


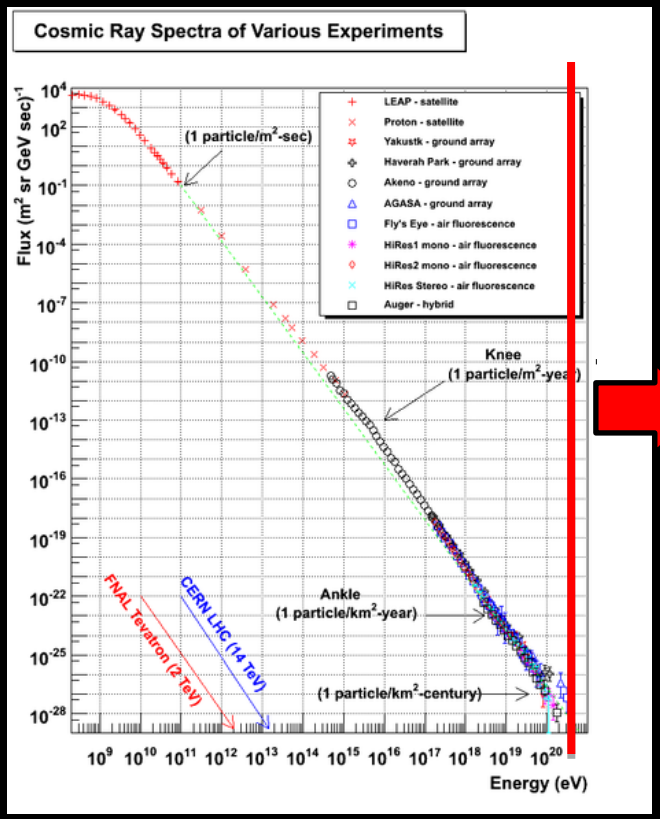
https://www.youtube.com/watch?v=lXedBGVHc4o&t=62s&ab_channel=%D0%A0%D0%9A%D0%9A%D0%AD%D0%BD%D0%B5%D1%80%D0%B3%D0%B8%D1%8F

https://www.youtube.com/watch?v=QincAp4V-SM&ab_channel=AsiTV

Mission Objectives

Mini-EUSO >10^{21} eV



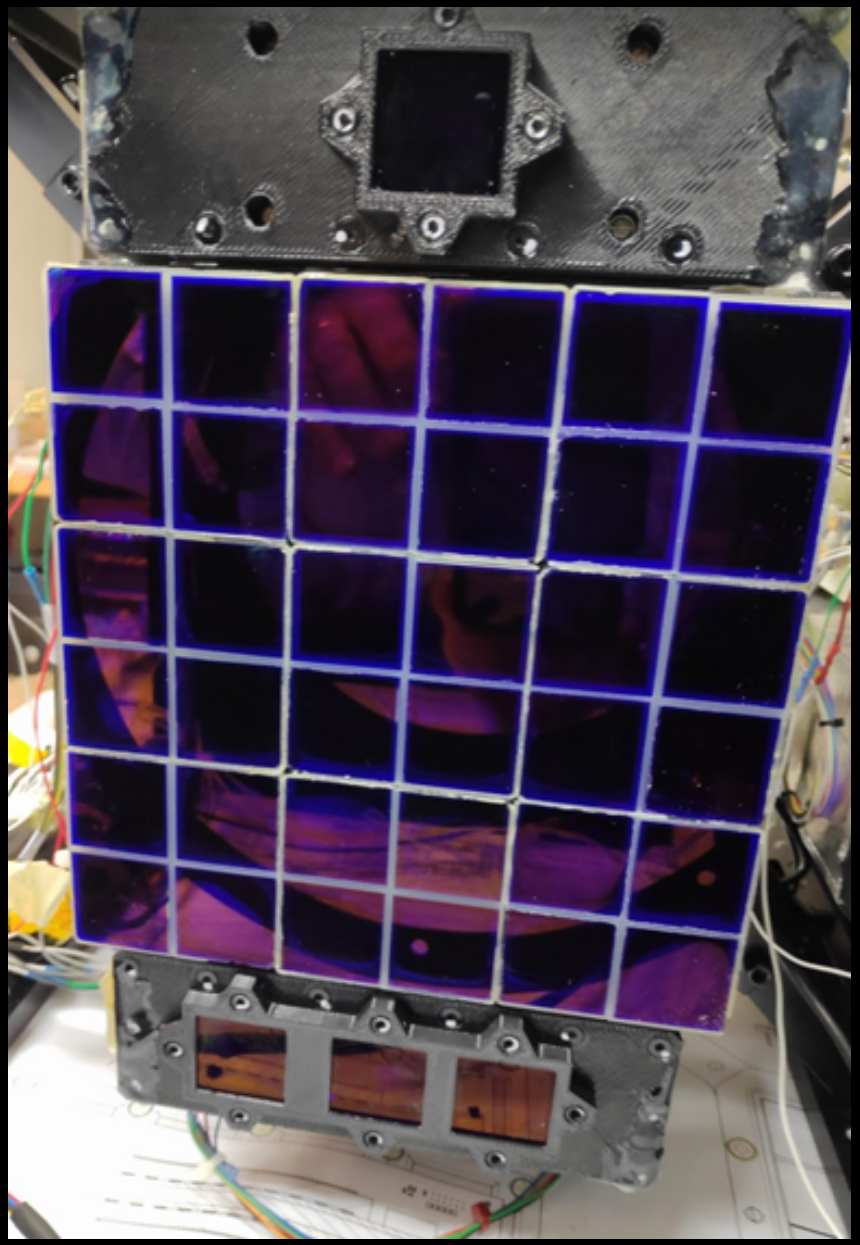


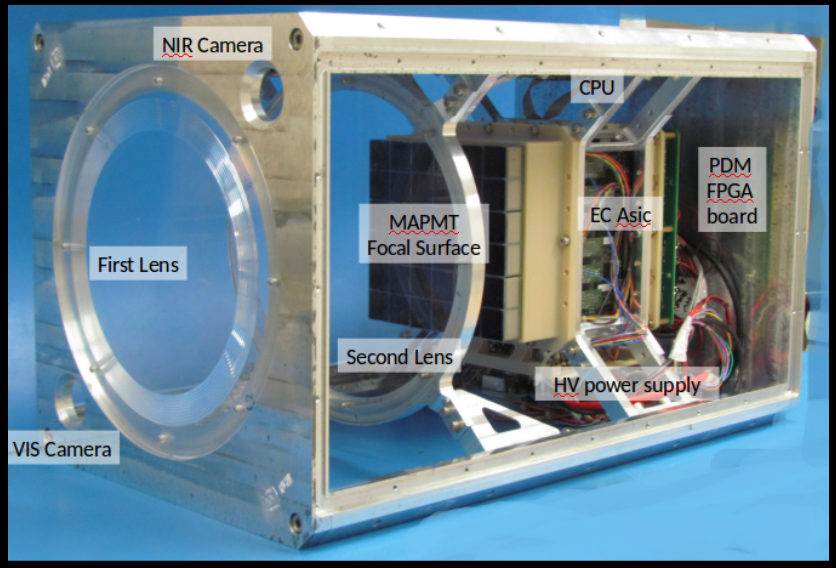
Technological Objectives

- First time use of Fresnel lens & SiPM for UV detection in space
- TRL (Technological Readyness Level) improvement
- Optimization of EUSO missions performances

See

MINI-EUSO telescope

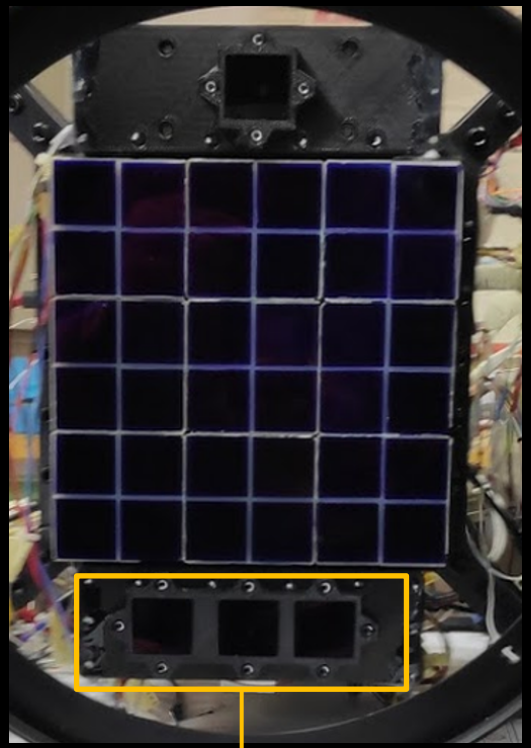




Optics

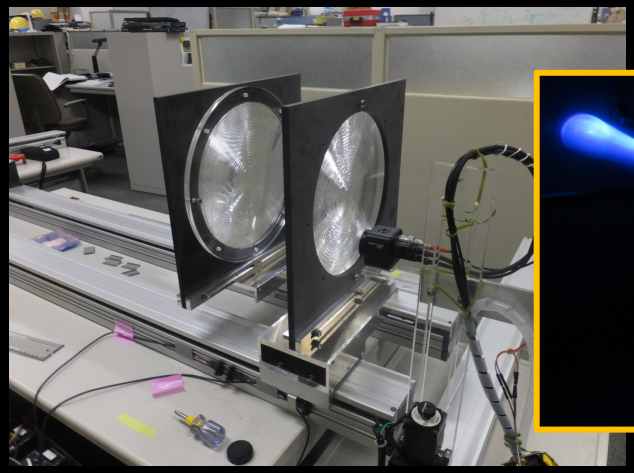
Multi-Anode PhotoMulTipliers (MAPMT) *High Voltage (1100V)*

- UV main camera
- 48*48 pixels (2304)
- FoV 0.8°/pix
- Time resolution: 2.5 µs and above



UV sensors (Hamamatsu):

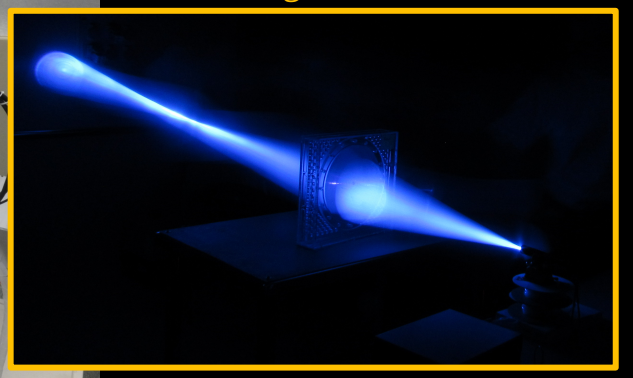
- S1226-5BQ log 190-1000nm
- ML8511 linear 280-400 nm
- C13365 SiPM single pixel

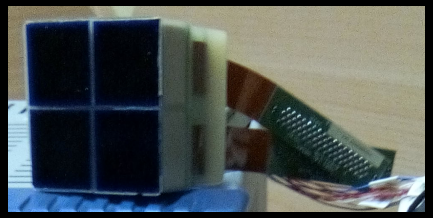


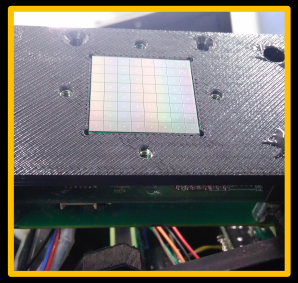
Riken, Tokyo (Japan)

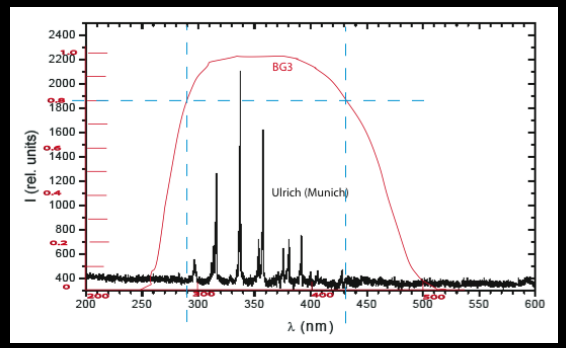
2 PMMA Fresnel lenses

- 25 cm diameter
- 11 mm thickness
- 3 kg





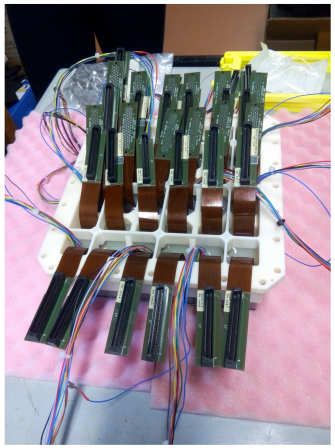




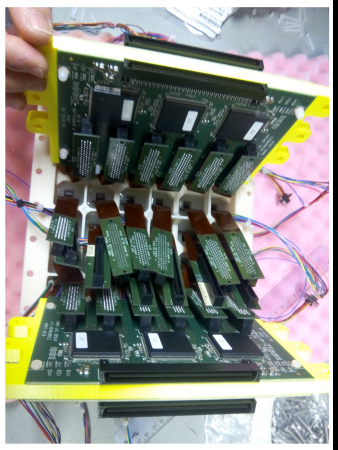
Multi Pixel Photon Counter (MPPC) Silicon PhotoMultipliers

- 3x3 mm²/pix
- Low voltage (<70 V)
- 8*8 pixels (64)

Mini-EUSO integration

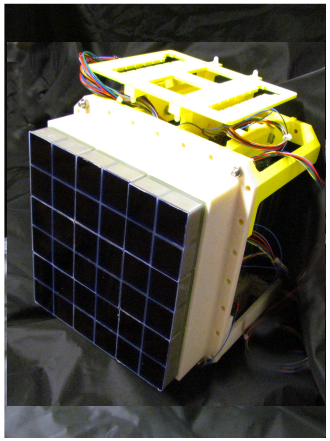


a) EC-UNITs



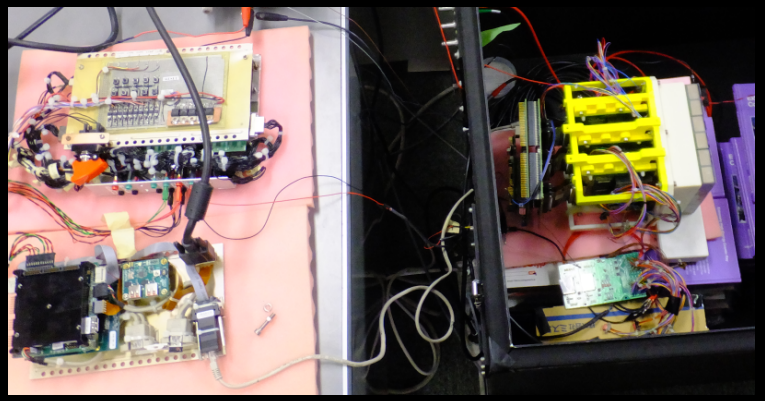
b) EC-ASICs

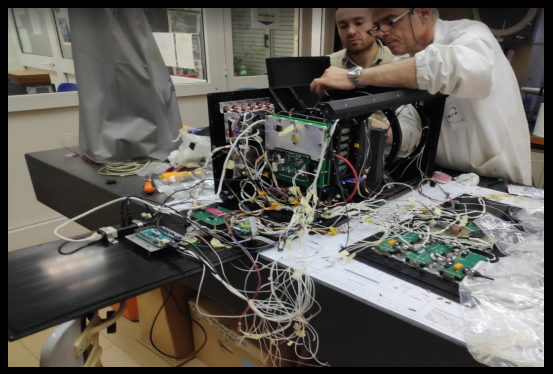
c) Zynq Board



d) PDM

Riken (Wako, Japan)

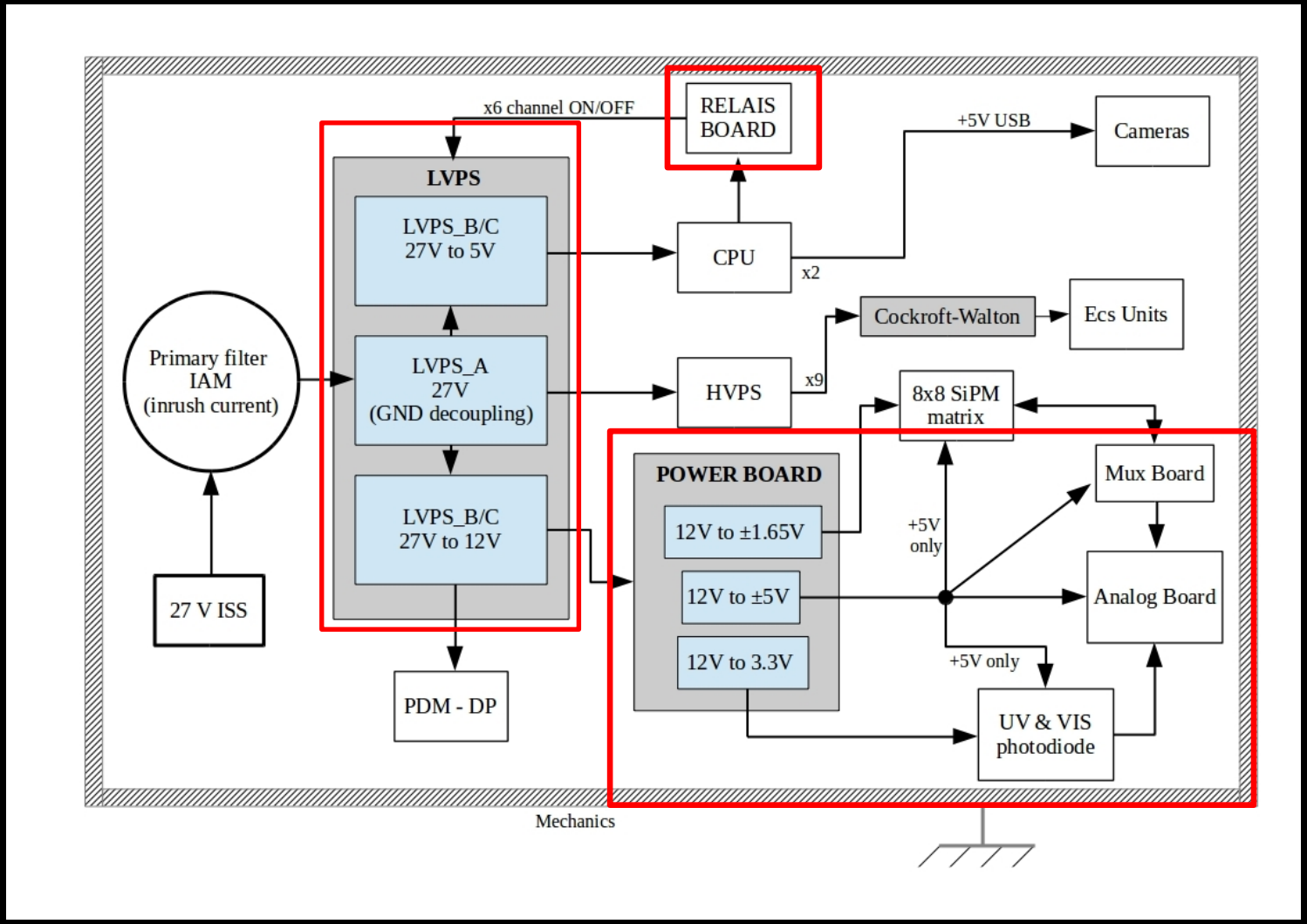




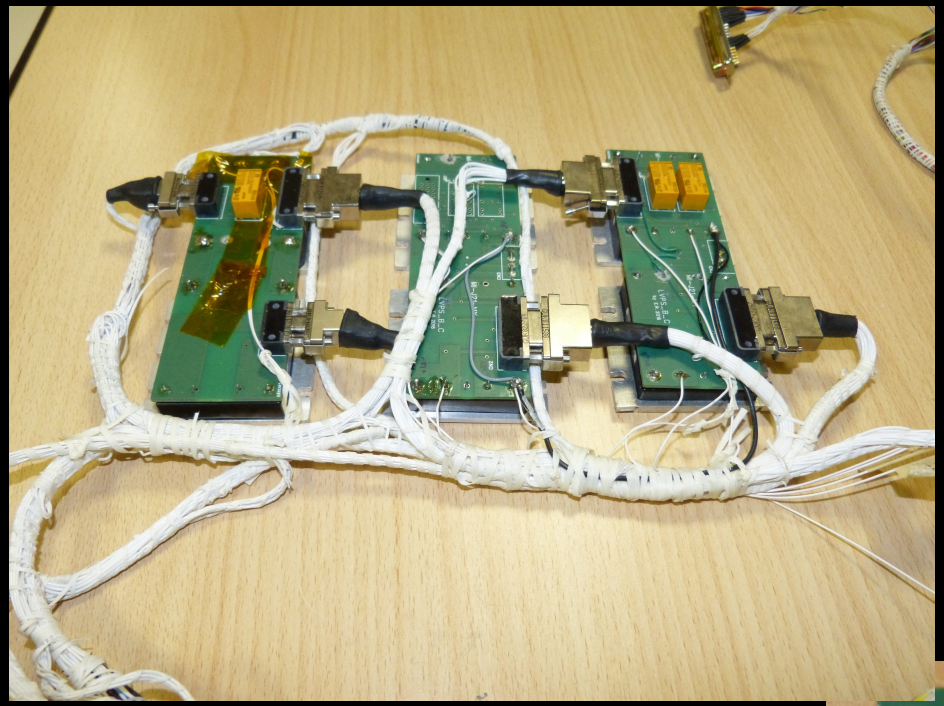
Laboratoire Astriparticule & Cosmologie (Parigi)

Tor Vergata (Roma) and Frascati (INFN -LNF)

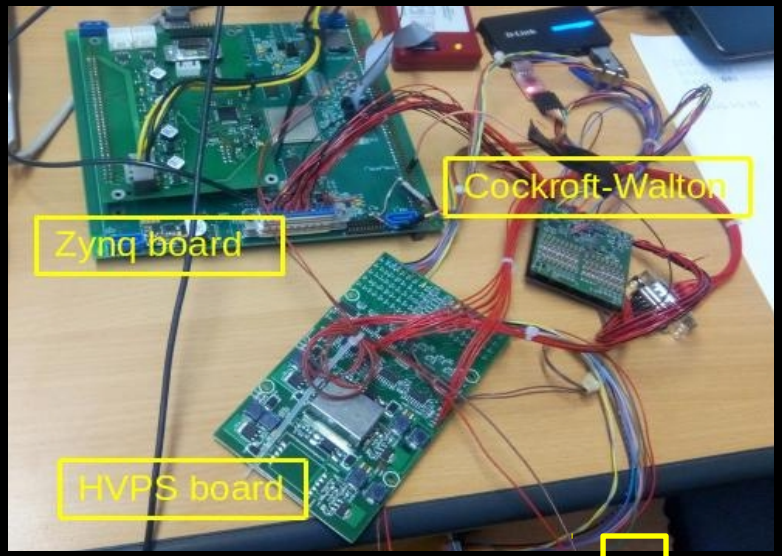
Functional scheme

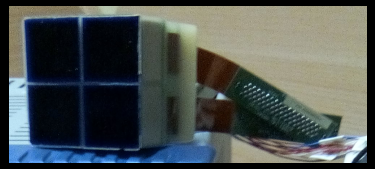


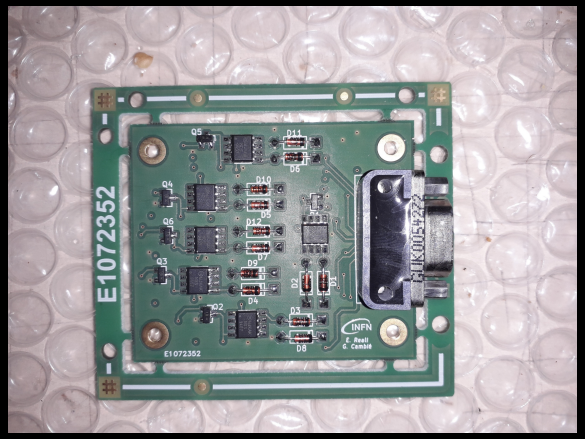
Power Supply



Low Voltage Power Supply







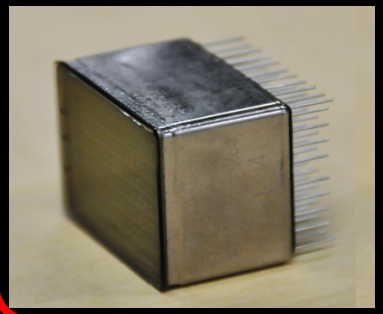
Relè board

Power board

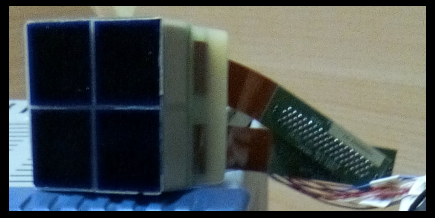
PDM Data Acquisition Chain

Photodetectors

PMT
- Hamamatsu 64-ch MAPMT
- BG3 filter

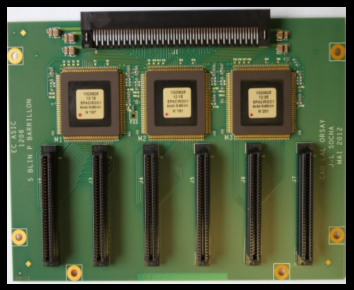


EC-Unit
- 4 PMTs (256-ch) readout
- Cockroft-Walton circuitery inside potting



Front-end Electronics

EC-ASIC
- 6 x ASICs
- readout
- int/discriminator

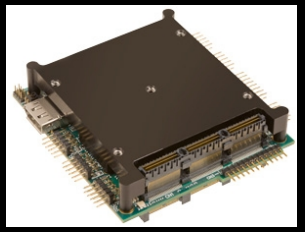


PDM-DP (MSU)
- Slow control
- Level 1 (L1, track) trigger

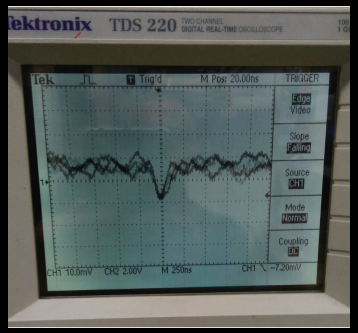
- 330 kB data every128 GTU downloaded to USB sticks
- No link with ISS
- Transport of mass storage devices during crew return missions

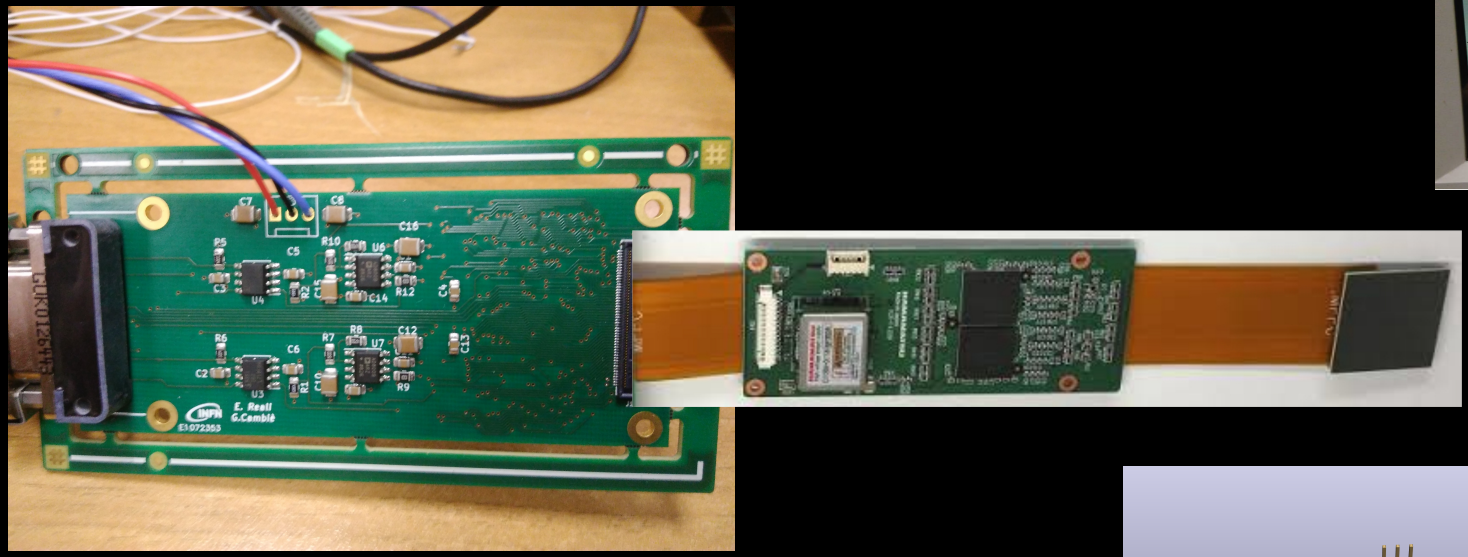
Data Processing (DP)

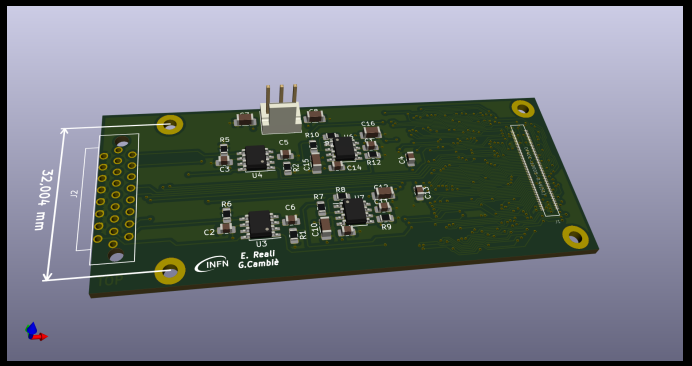
- start/poweroff
- FTP server / telnet conf
- Data processing
- Data storage



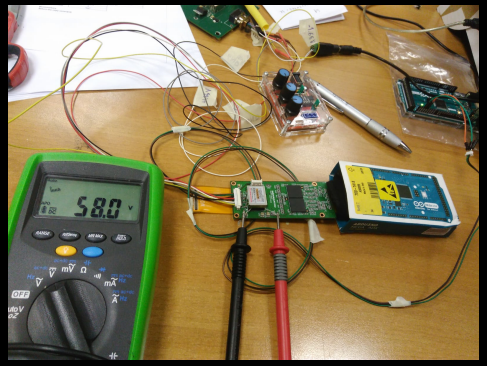
SiPM read out



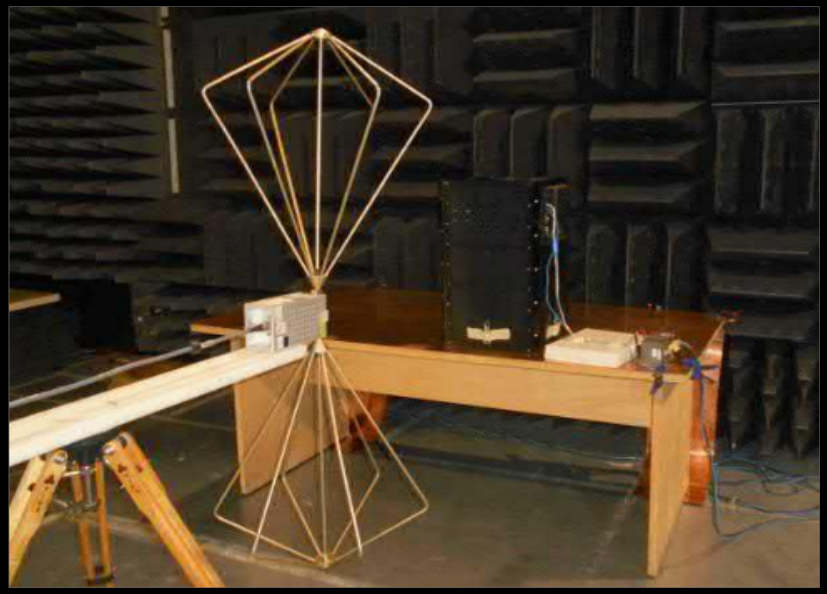


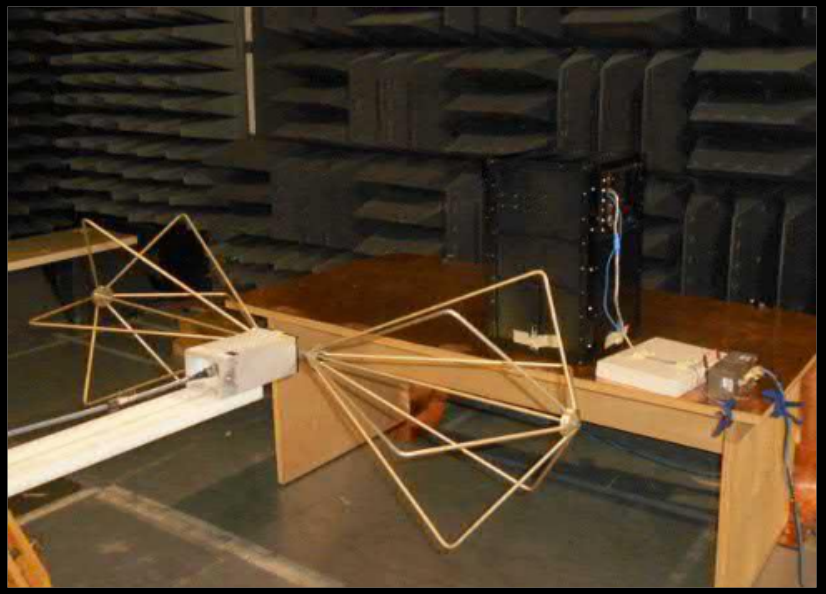


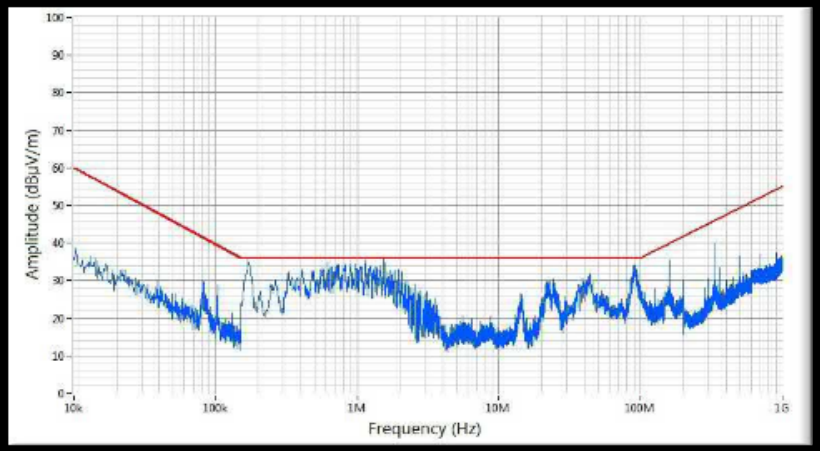
- Parallel read out – 32 channel each through MUX
- Signal amplification and holding
- ATmega2560 chip board (10-bit ADC)
- Read out time up to the S&H controlled via software (no integration system – fast signal)
- Adjustable HV through serial protocol (40 – 80 V)

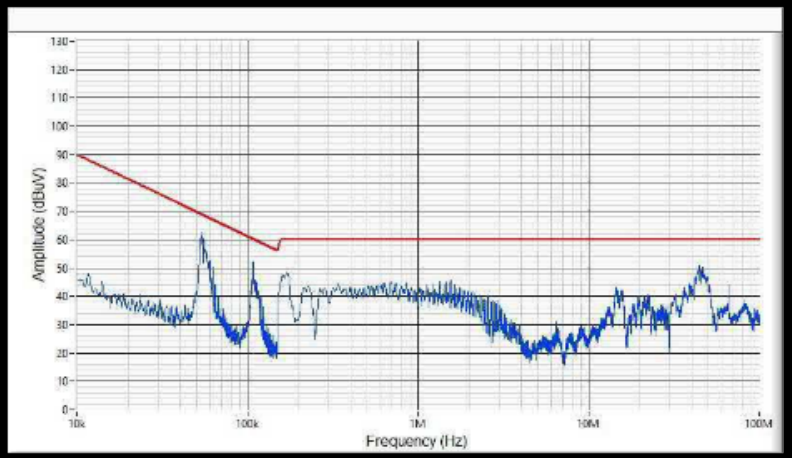


EMC/EMI test



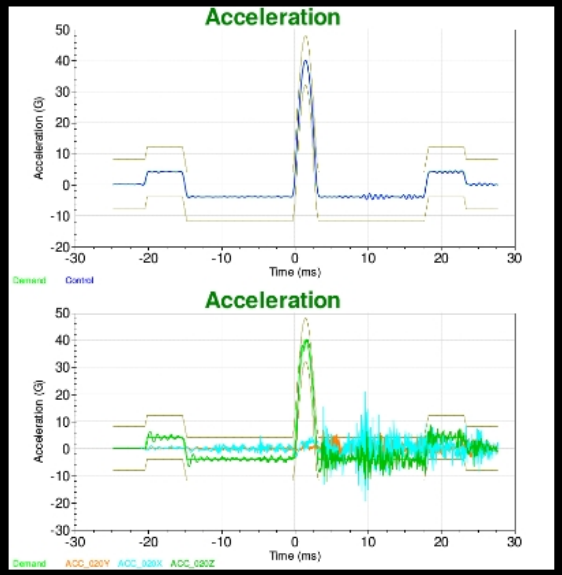


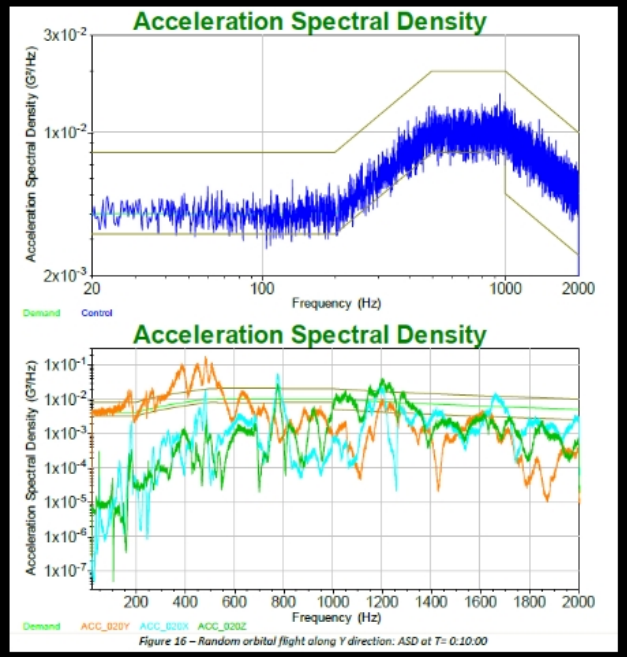


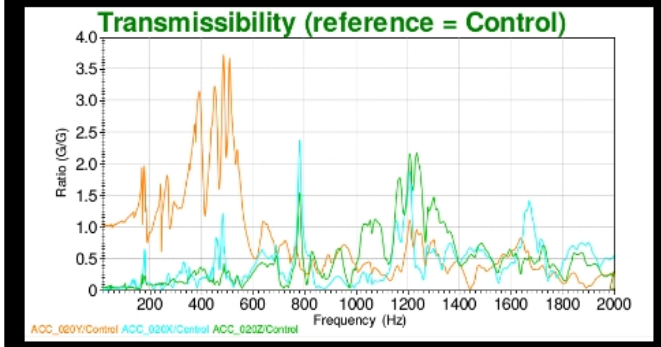


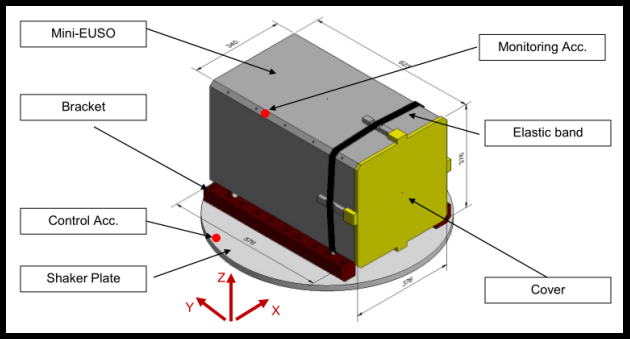
- Detector frequencies response when an external electric field is applied
- High frequencies response conducted in normal operations

Vibration and Shock test



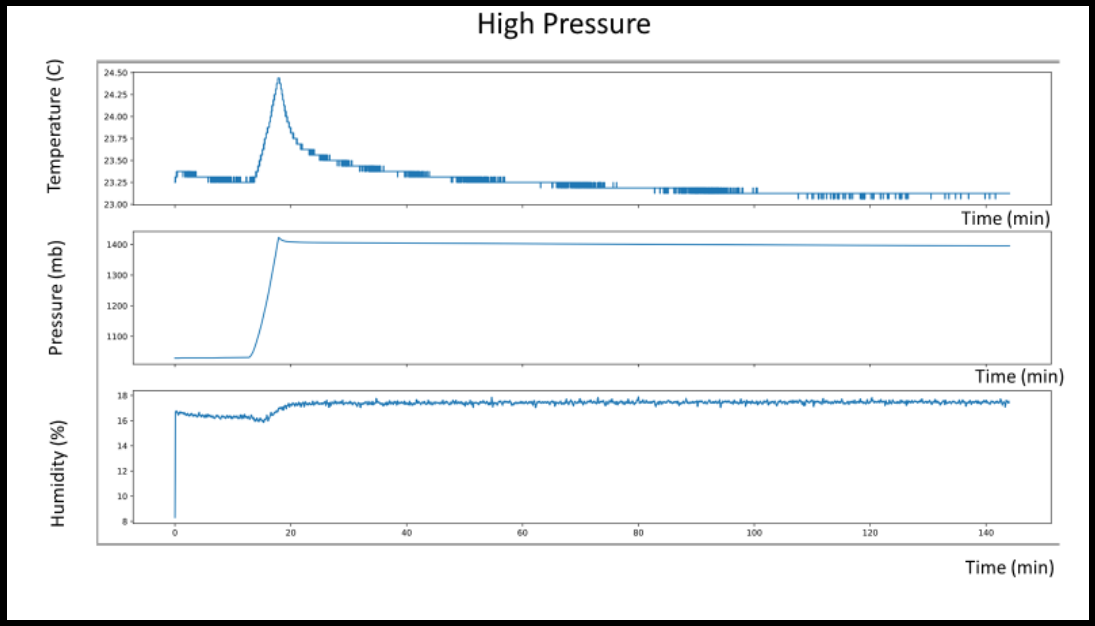


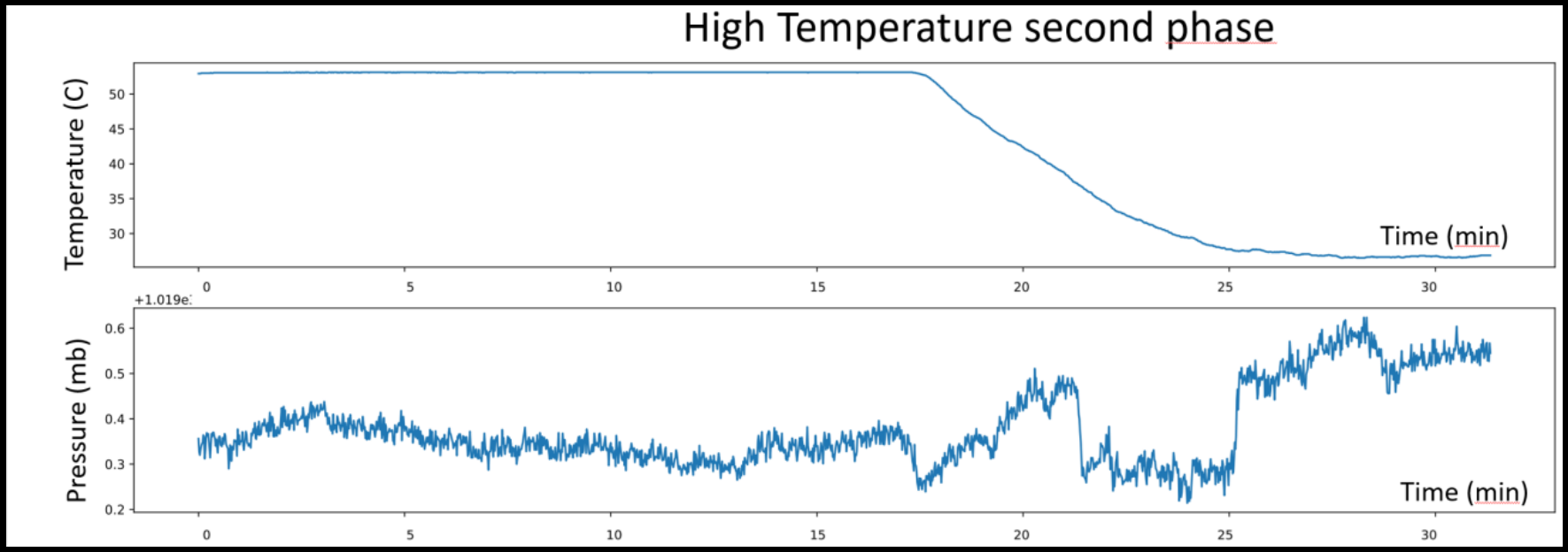




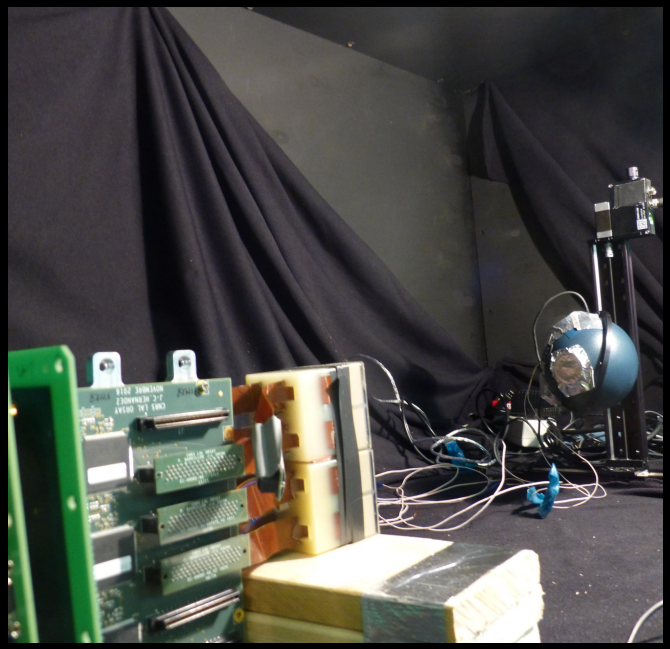
Bottom Left: Acceleration response (X, Y and Z) during shock along Y axis. Right: Squared PSD for vibration along Y axis (top) and overall trasmissibility (bottom)

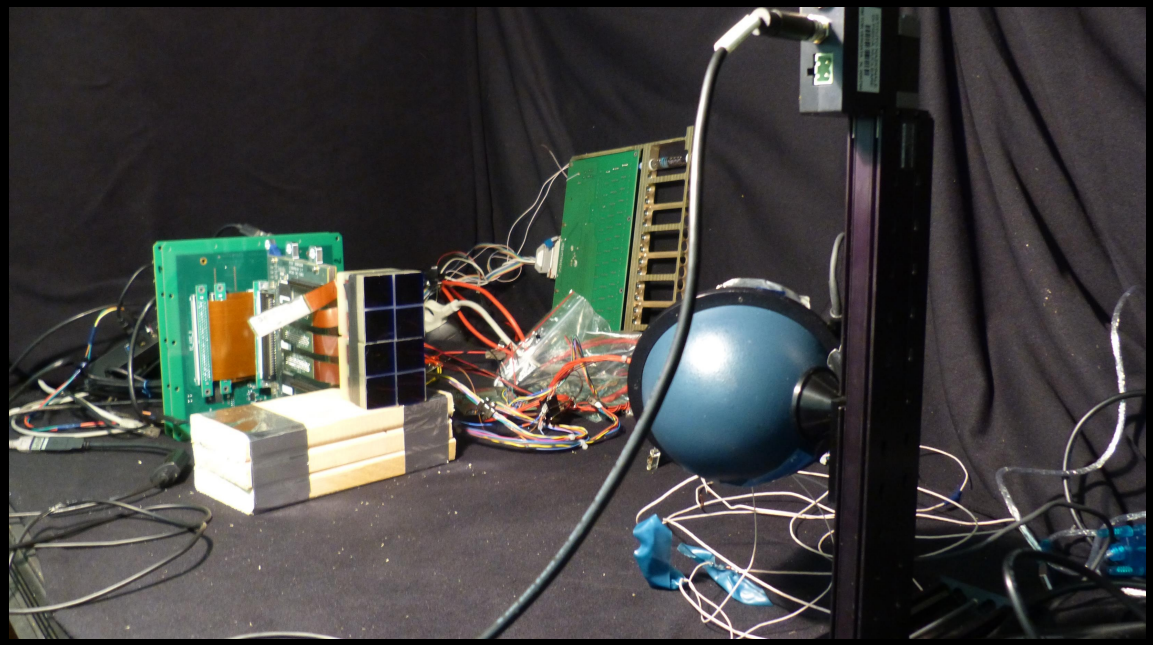
Thermal, pressure and humidity test

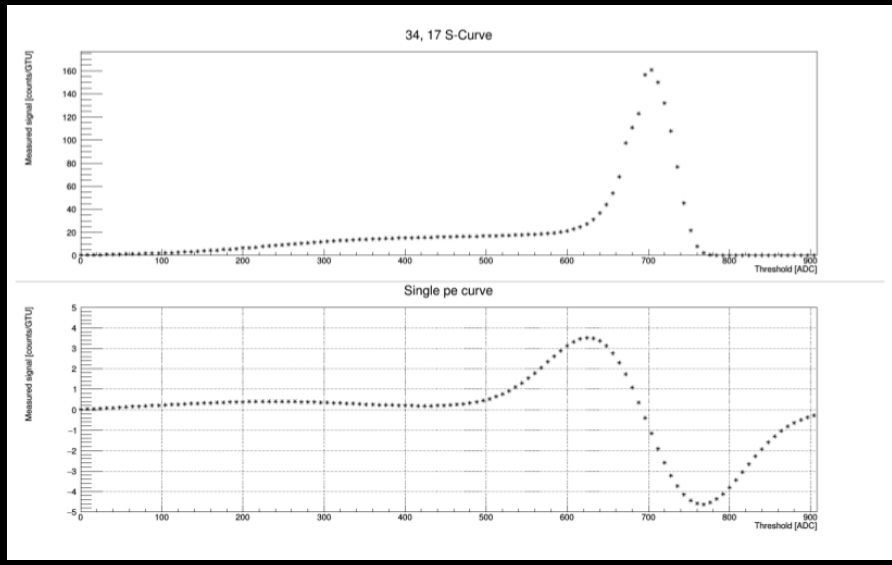


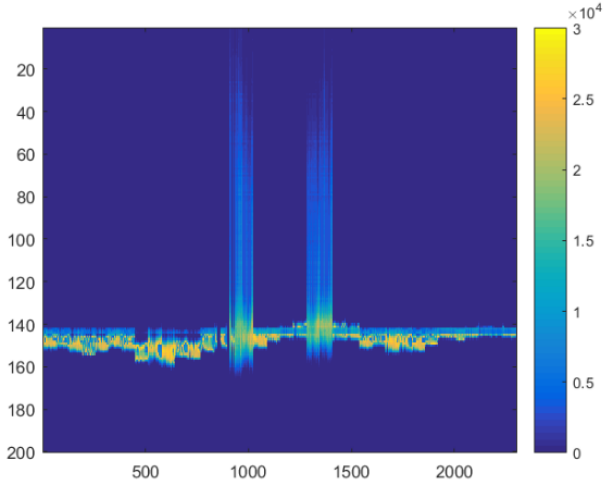


Pixels calibration analysis

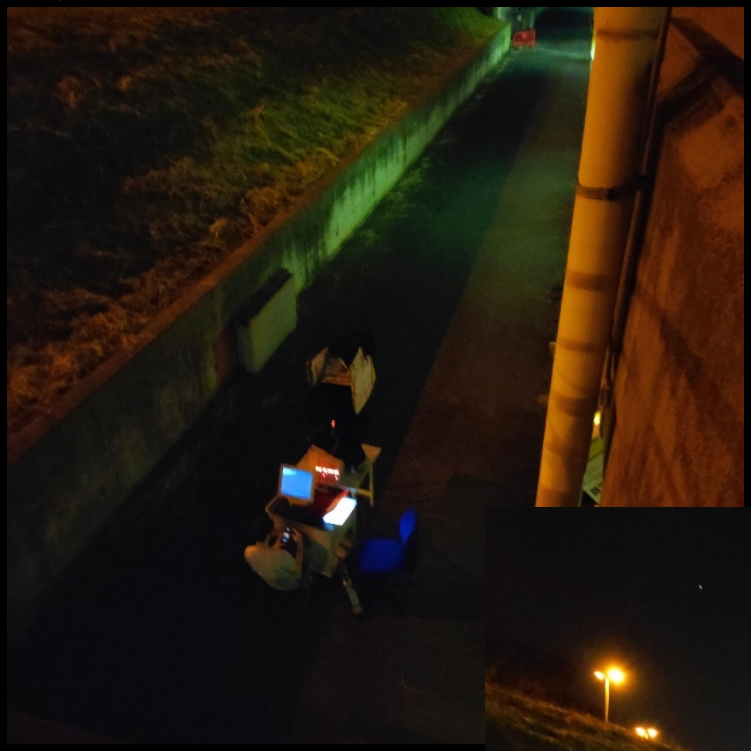


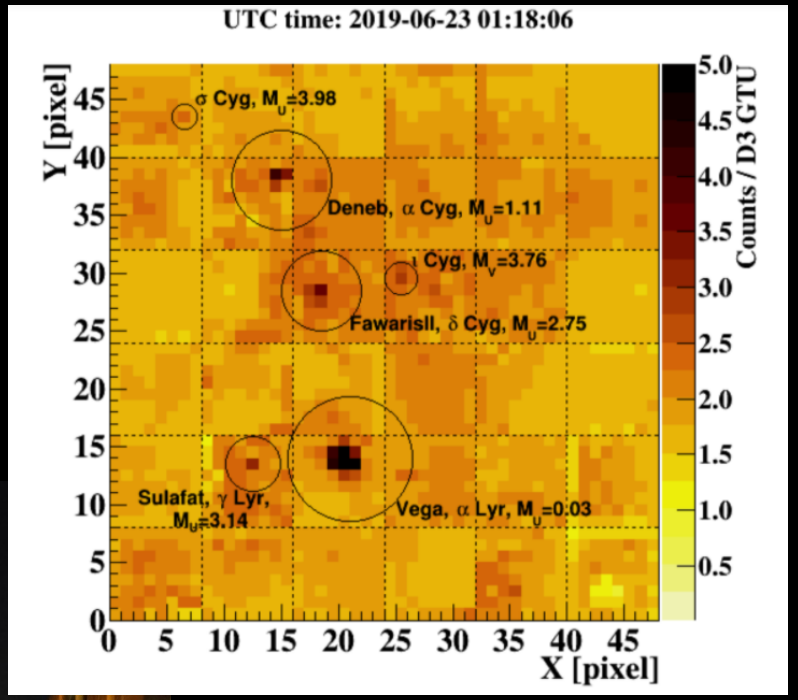






Sky Observations, June 2019, Tor Vergata, Lazio





Thank you