Horizon 2020
European Union Funding
for Research & Innovation

UNIVERSITÉ
DE GENÈVE
FACULTÉ DES SCIENCES
Département de physique
nucléaire et corpusculaire

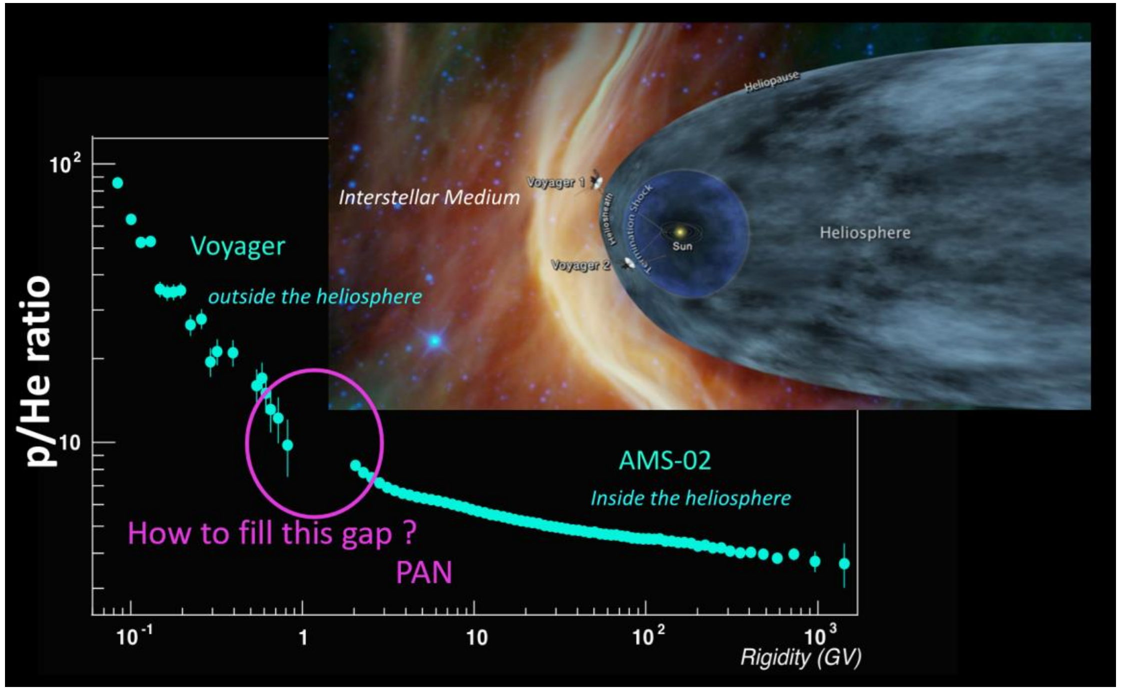
Explore deep space with Penetrating particle ANalyzer

- Pengwei Xie
- University of Geneva
- pengwei.xie@unige.ch
- On behalf of PAN Collaboration

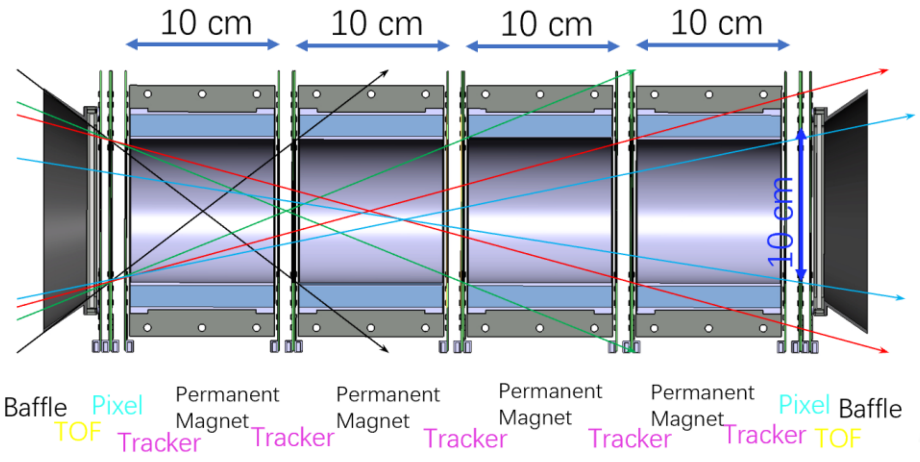
Penetrating Particle Analyzer
www.pan-space.eu

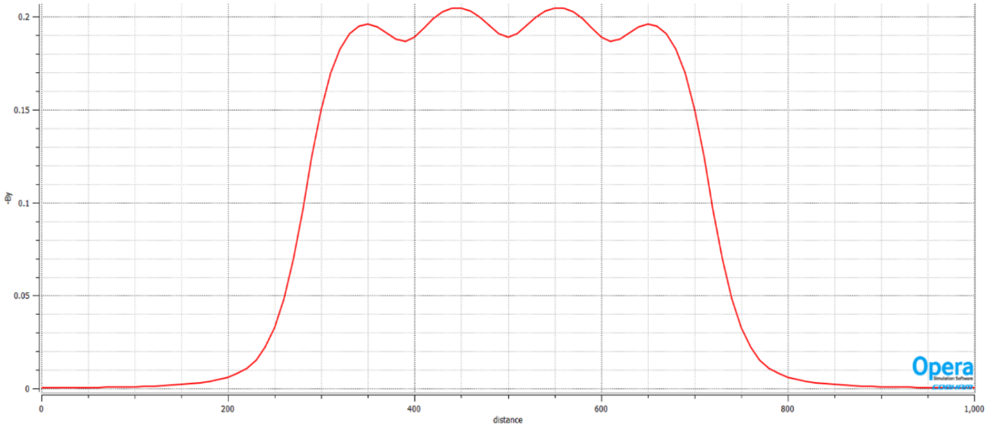
Motivation

- *Cosmic ray physics*: fill an in situ observation gap of **galactic cosmic rays** (GCRs) in the GeV region in deep space
  - → understanding of the origin of the GCRs and their interplay with solar activities
  - → antimatter searches
- *Solar physics*: provide precise information on solar energetic particles
  - → study the physical process of solar events, in particular those producing intensive flux of energetic particles.
- *Space weather*:
  - → improve **space weather models** from the energetic particle perspective
- *Planetary science*:
  - → develop a full picture of the **radiation environment of a planet**, in particular as a **potential habitat.**
- *Deep space travel*: Penetrating particles are difficult to shield. PAN can **monitor the flux and composition of penetrating particles during a space voyage**. PAN can become a standard on-board instrument for deep space travel.



PAN Instrument





- ***Tracker:***

five silicon modules will provide excellent rigidity resolutions, particle direction measurement with an angular resolution of 0.2 deg, a trigger and the measurement of Z

- ***The Magnet:***

four permanent magnet sectors with a 0.2 T magnetic field. Each sector will be 10 cm long with diameter of 10 cm

- ***TOF detectors:***

made of plastic scintillator readout by SiPMwill provide a trigger, particle counter (max. ~10 MHz), charge measurement (Z = 1 -26), and time measurement (< 100 ps)

- ***Pixel Detector:***

made by two modules providing Time of Arrival (ToA) and Time over Threshold (ToT) measurement, will avoid measurement degradation for high rate solar events and at lower rate solar events gives one extra 3d point with 55um Si pixels

Mini.PAN Demonstrator

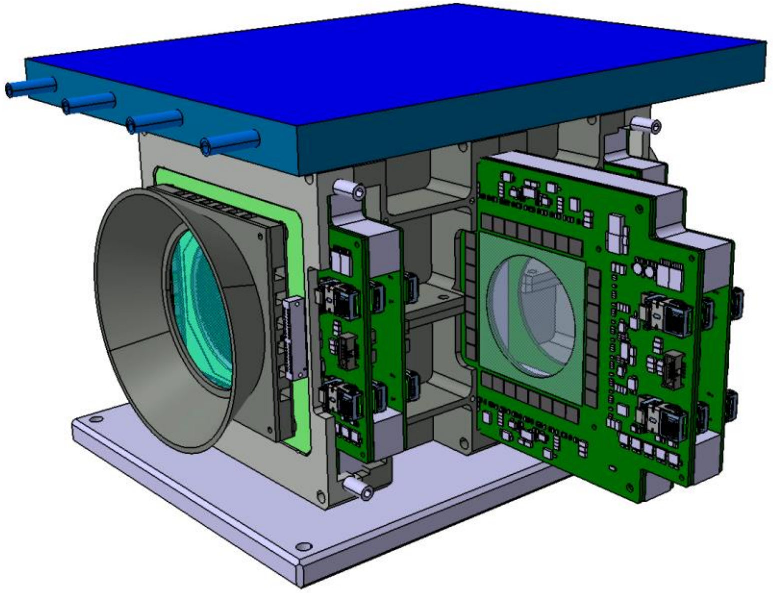
Mini.PAN is funded by EC as a technology demonstrator

Consortium:

- University of Geneva (coordinator)
- INFN Perugia
- Czech Technical University in Prague

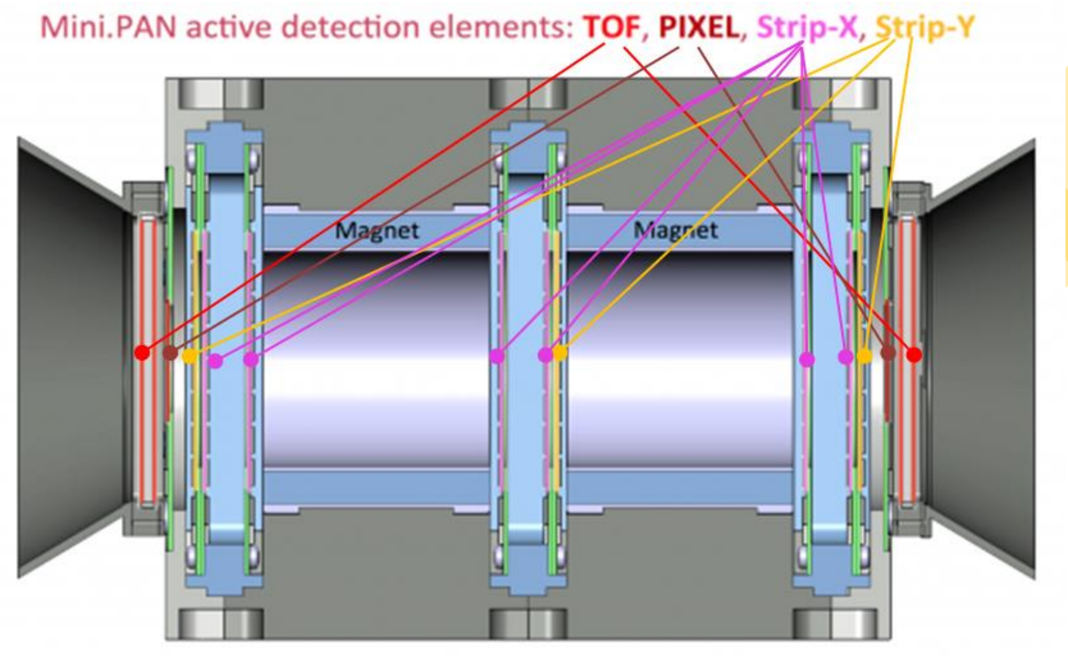
Magnet design and tests: Pierre Thonet, Carlo Petrone and Guy Deferne - (CERN)

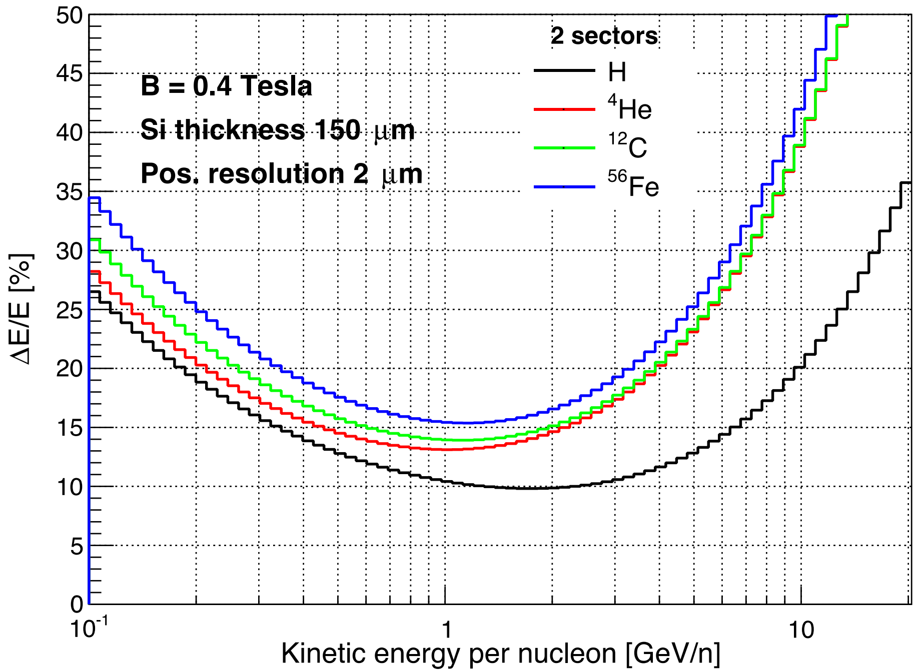
- Max 8 kg
- 20 W
- 2 Sectors with smaller dimensions with the same instrumentation (ToF, pixel, strip)
- Mini.PAN is suitable for space weather and planetary radiation measurements



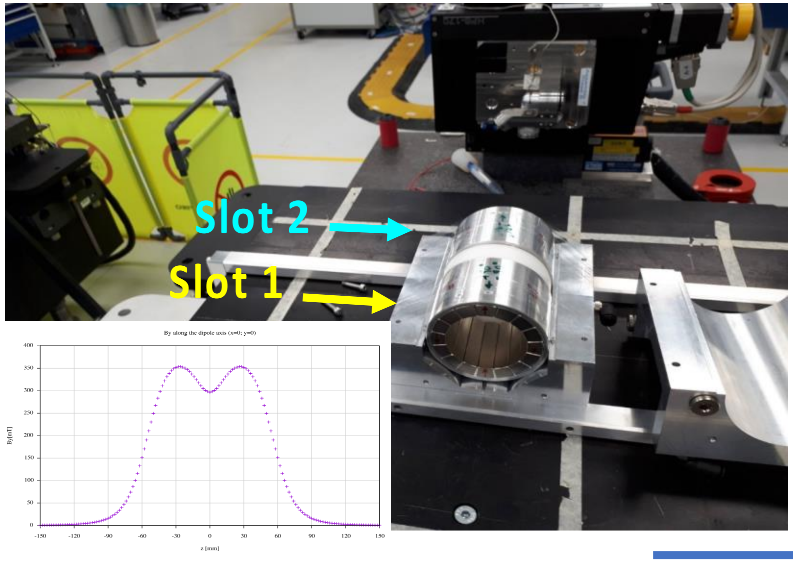
Expected performance

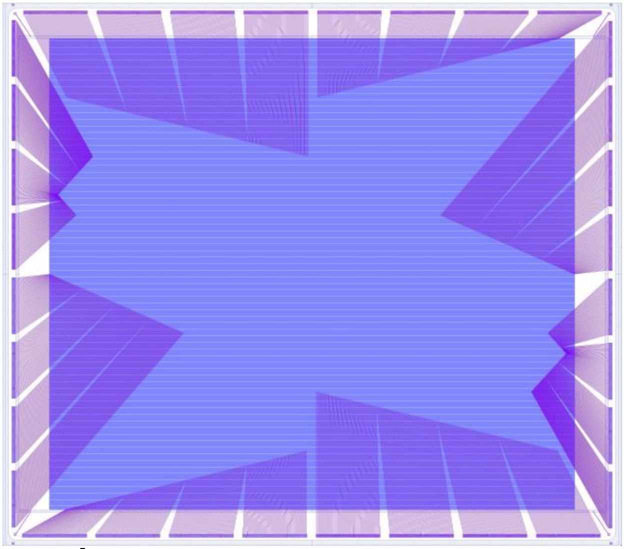
- 2 Halbach permanent magnet sectors, each f = 5 cm, L = 5 cm, provide a dipole magnetic field of ~0.4 Tesla, magnet weight ~2 kg
- GF: ~6.3 or 2.1 cm^2sr (x2 for isotropic sources, for crossing 1 or 2 sectors)
- Energy resolution for 1-sector acceptance same as PAN (<20% for protons of 0.2 – 2 GeV)
    - Shorter sector length compensated by stronger B field

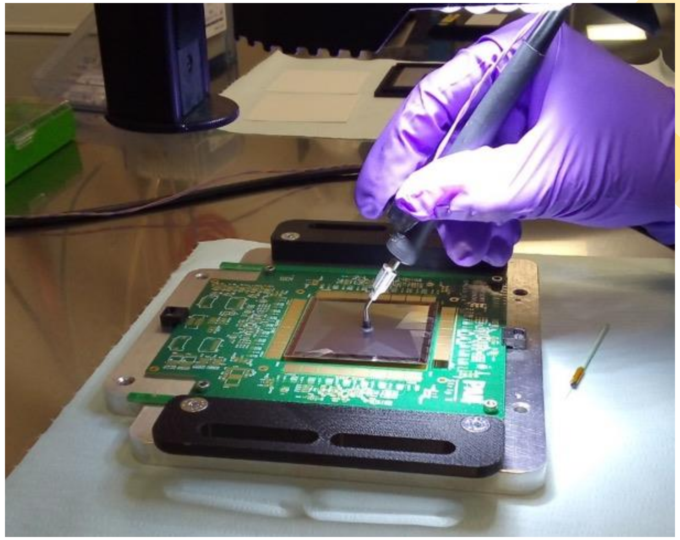




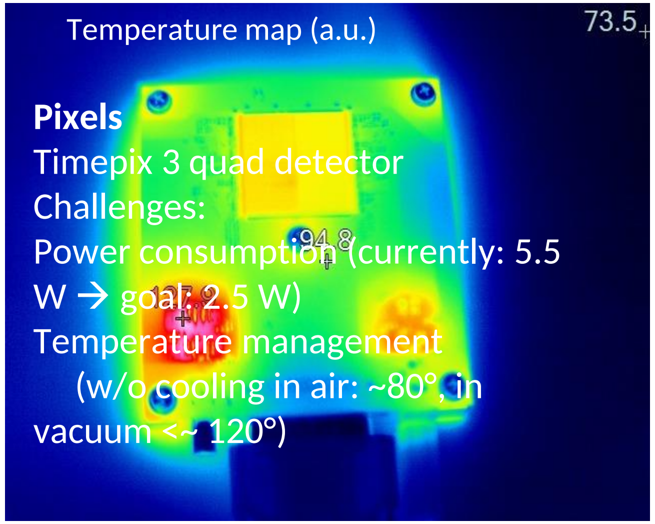
Mini.PAN Detector



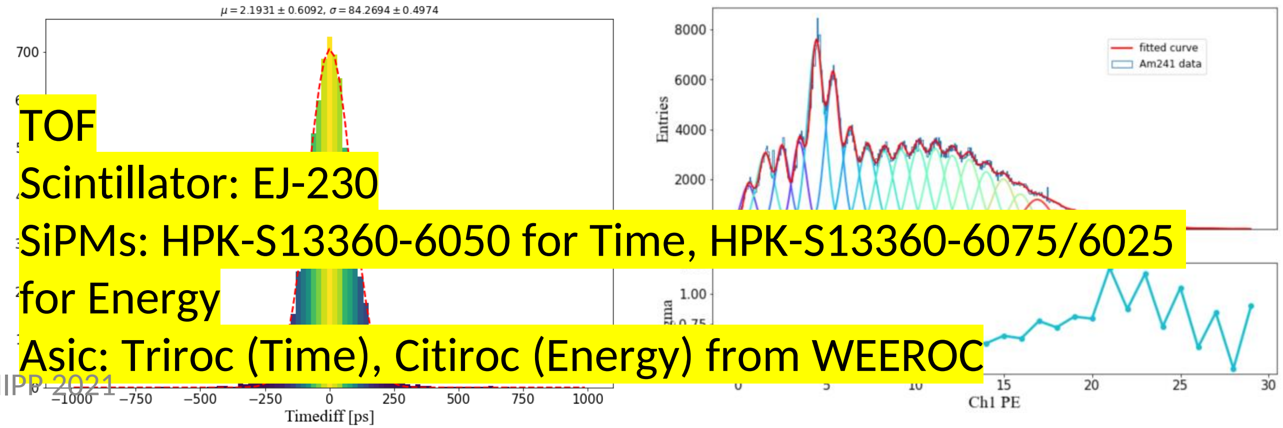




Trackers:
Two Strip-X with 25 µm pitch, 2 µm spatial resolution, 32 VA1140, 2048 channels
One Strip-Y with 500 µm pitch, 115 µm spatial resolution, VATA GT7.2, 128 channels



Pixels
Timepix 3 quad detector
Challenges:
Power consumption (currently: 5.5 W → goal: 2.5 W)
Temperature management
(w/o cooling in air: ~80°, in vacuum <~ 120°)

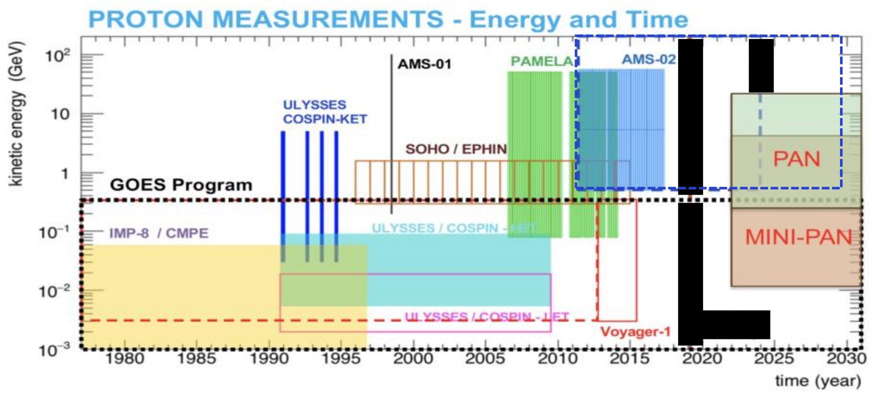


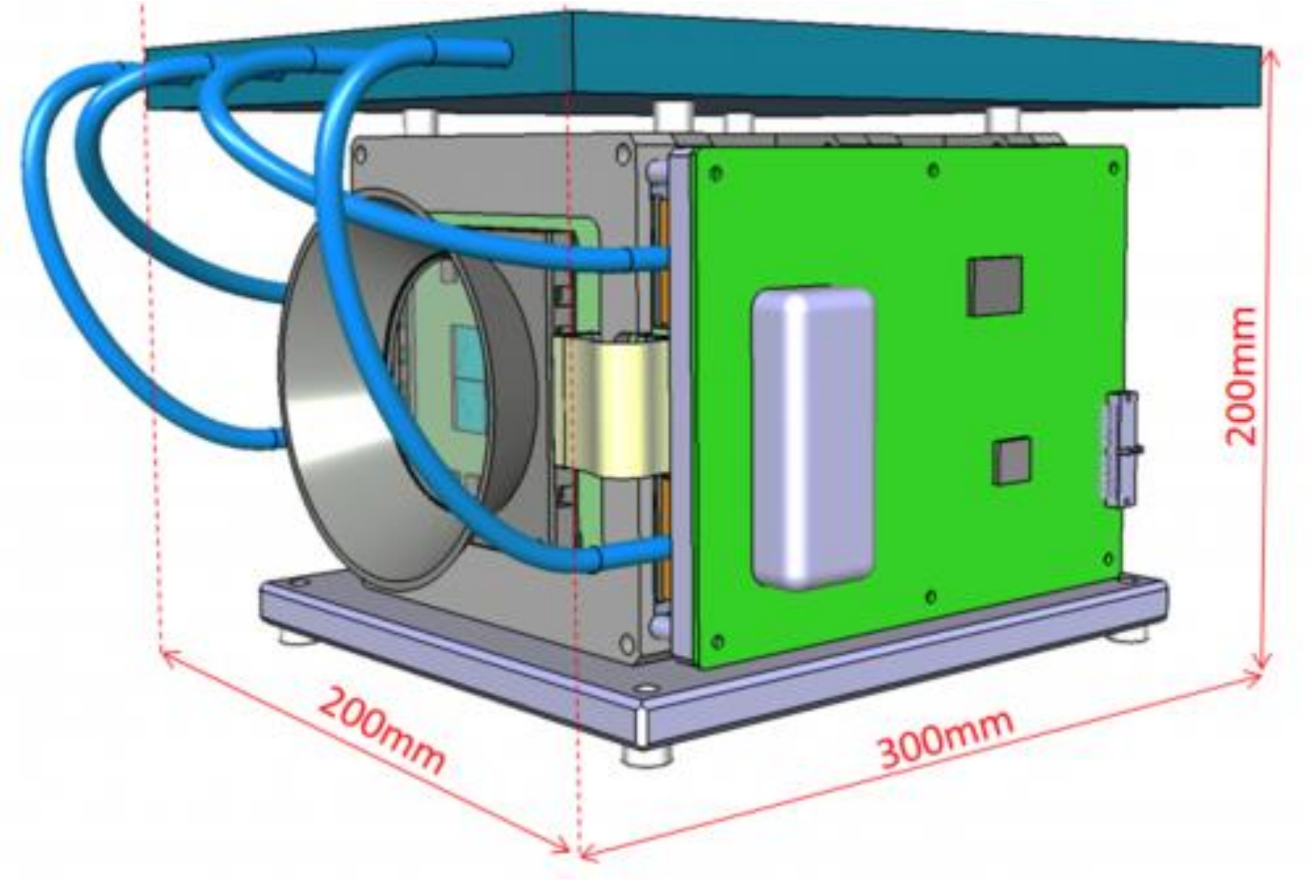
TOF
Scintillator: EJ-230
SiPMs: HPK-S13360-6050 for Time, HPK-S13360-6075/6025 for Energy
Asic: Triroc (Time), Citiroc (Energy) from WEEROC

P. Burian *et*

MiniPAN and PAN prospects

- We are actively looking for flight opportunities (from 2023):
  - Lunar Gateway
  - CubeSat missions
  - Jupiter radiation belt exploration
  - European Large Logistic Lander (EL3) for Moon exploration





Thank you!