

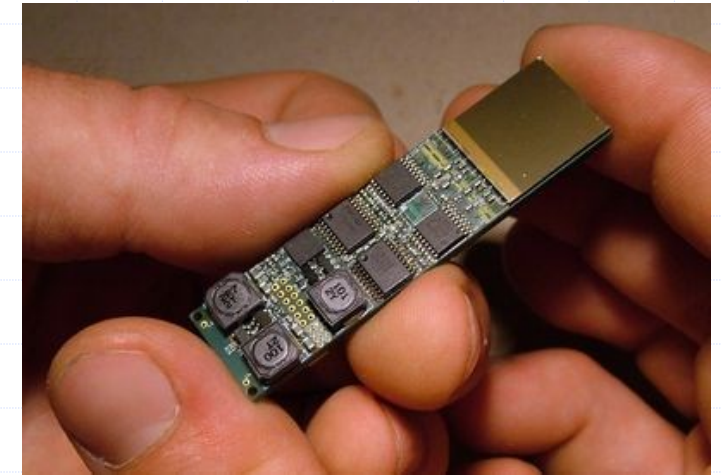
# Space research overview of IEAP CTU

**Robert Filgas**

# Timepix in space



- ◆ 6 Timepix-Lite detectors deployed onboard ISS in 2012 in collaboration with NASA and University of Houston.
- ◆ Monitoring radiation environment inside the station. Important for the crew safety and protection of the electronic equipment.

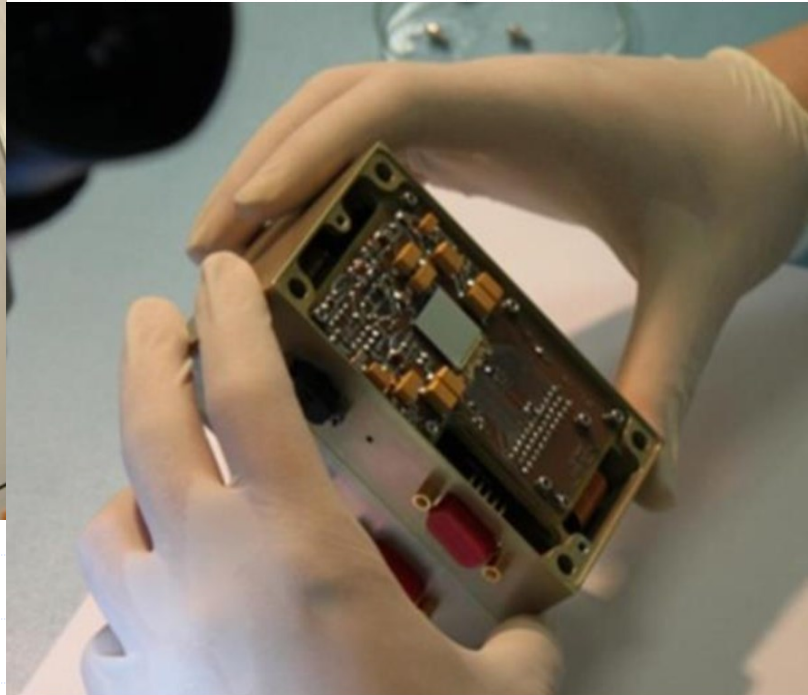
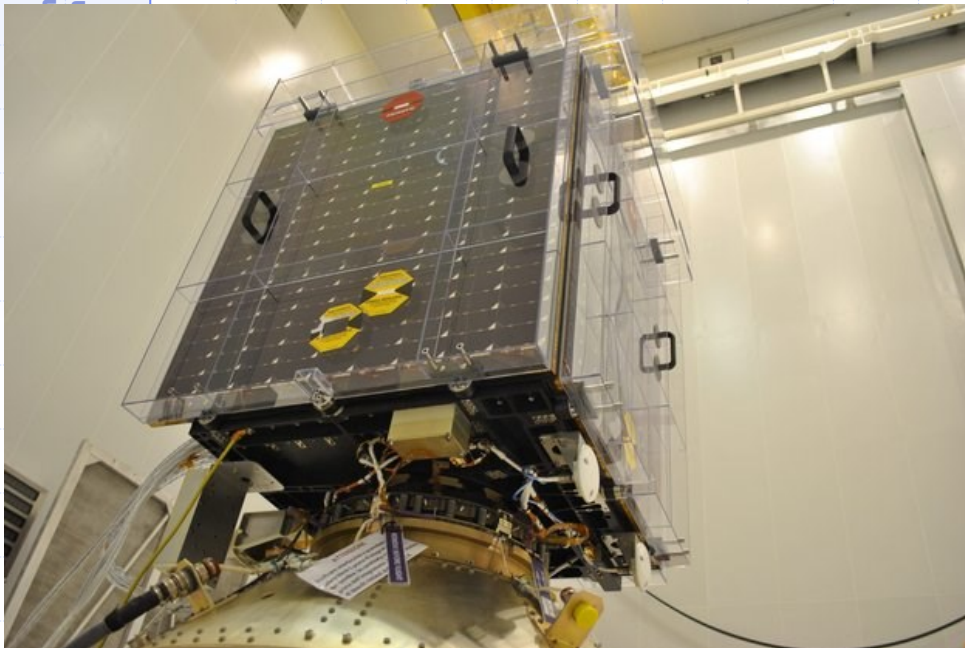




# SATRAM

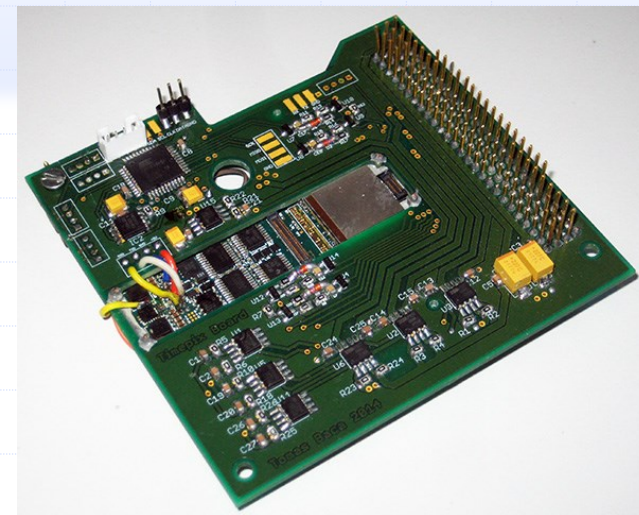
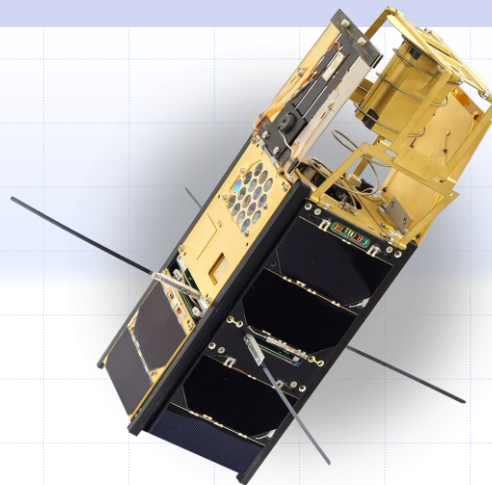


- ◆ SATRAM with Timepix detector onboard ESA satellite Proba-V, launched to LEO in 2013. The first deployment of Timepix in open space. Still functioning, providing invaluable space heritage.
- ◆ Cooperation of IEAP and BD Sensors.

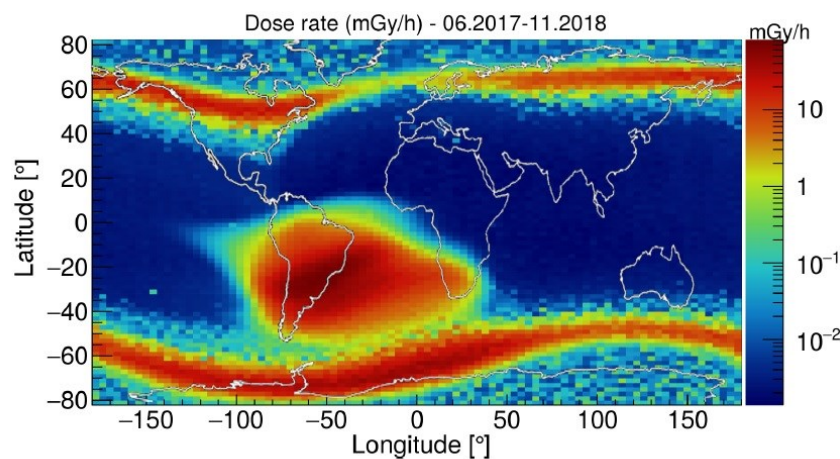


# VZLUSAT-1

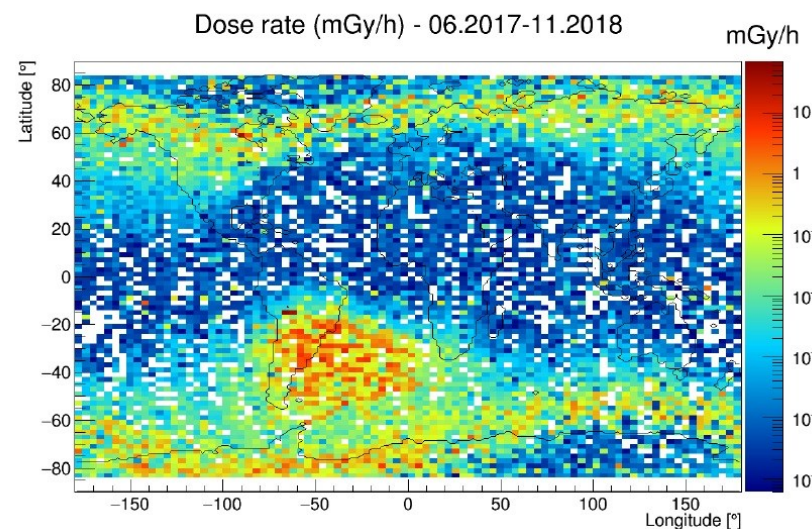
- ◆ Timepix part of the X-ray telescope onboard VZLUSAT-1, launched in 2017.
- ◆ Cooperation with VZLU a FEL.



Dose rate 6/2017 – 11/2018



Detector total exposure time ~340 days  
SATRAM



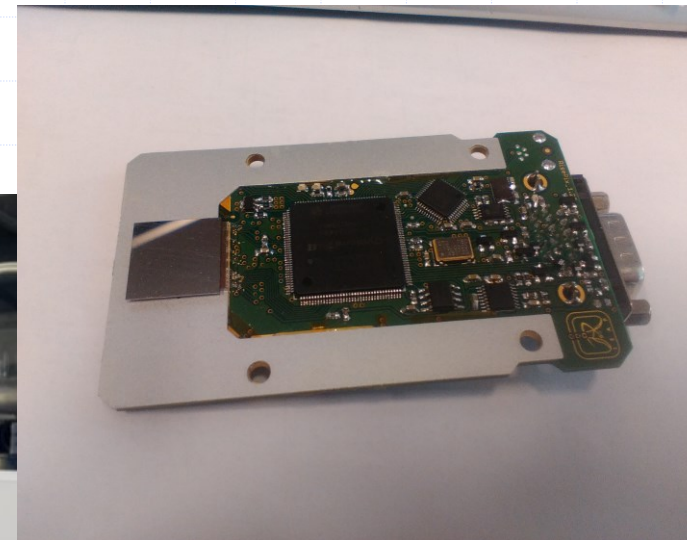
~11 hours  
VZLUSAT-1



# REX



- ◆ Two Timepix detectors part of X-ray telescopes onboard NASA sounding rocket launched in 2018.

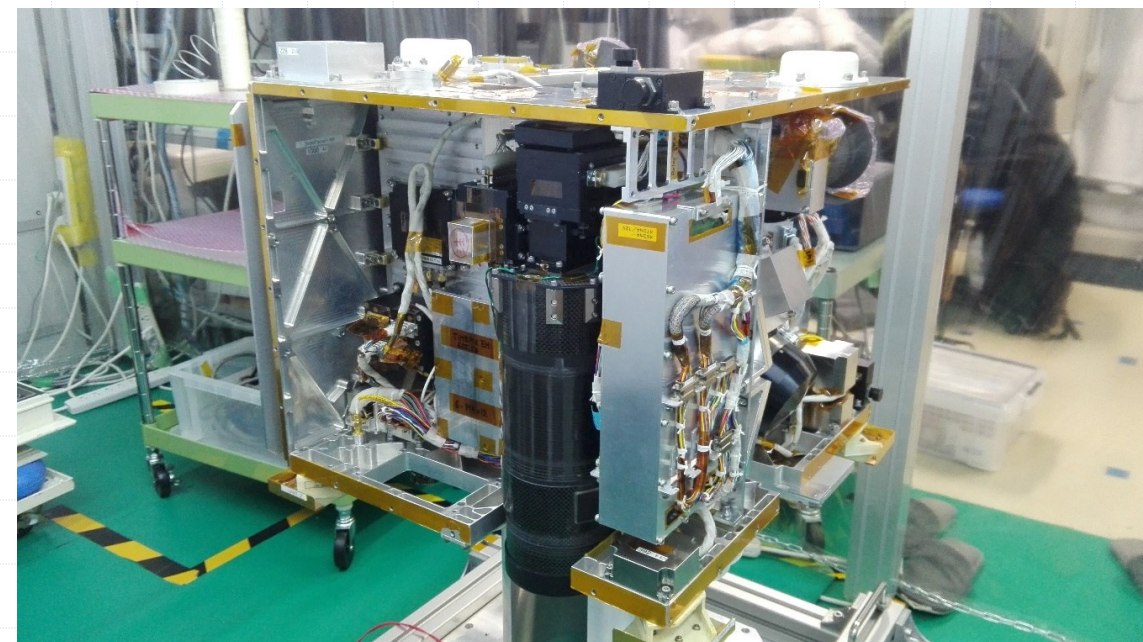
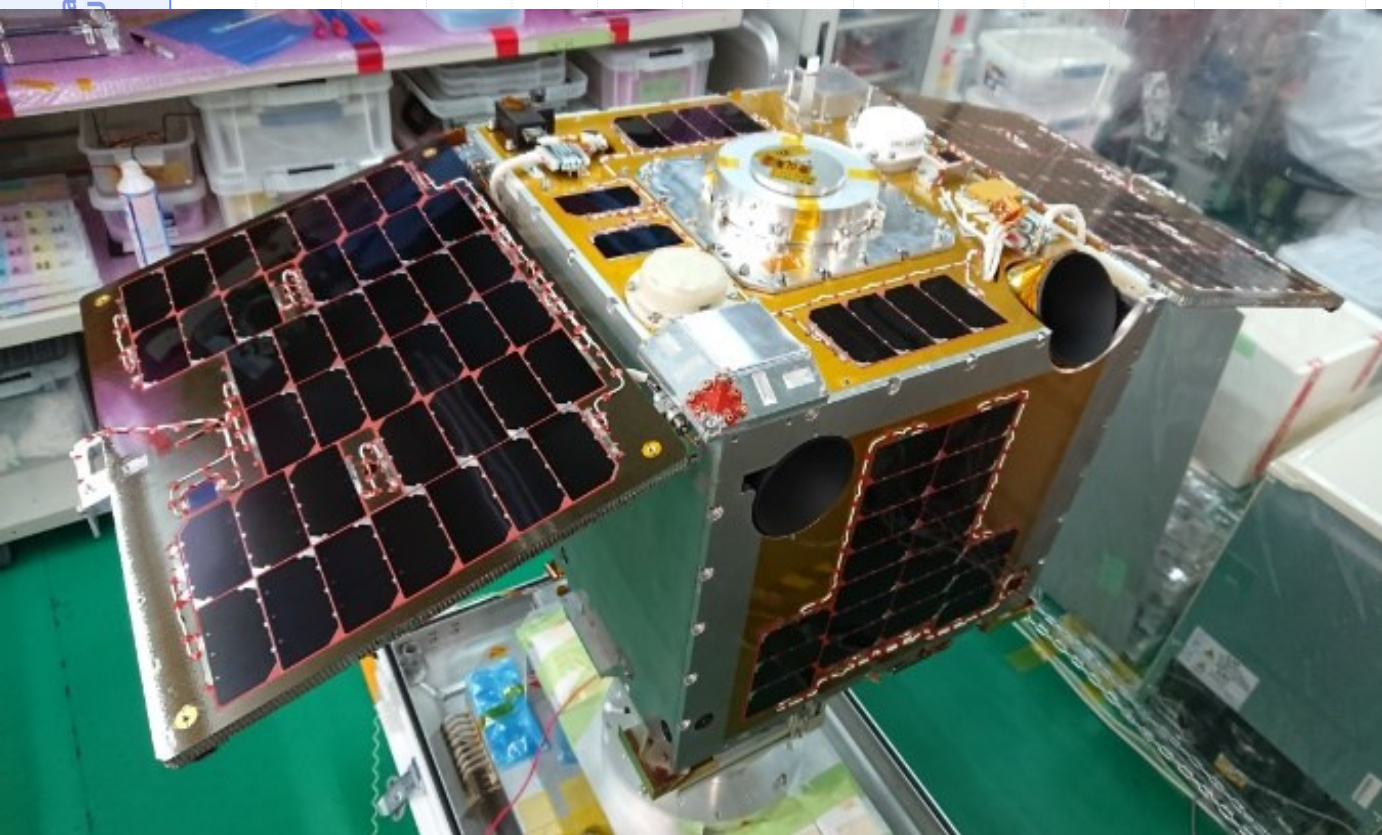




# RISEPix



- ◆ RISEPix with two Timepix detectors onboard Japanese satellite RISESAT, launched to LEO in 2019. Collaboration with Tohoku University.
- ◆ Majority of Timepix-based detectors in space developed by IEAP.



# Current space projects – HardPix

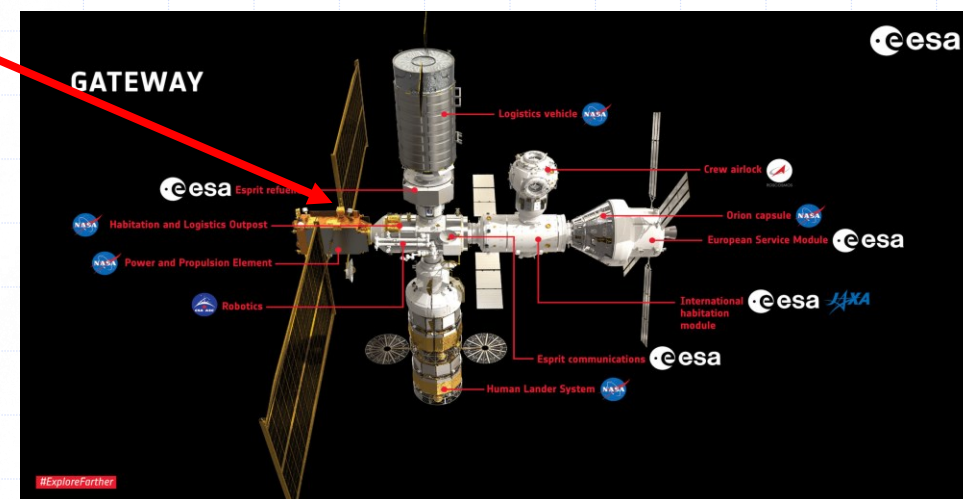
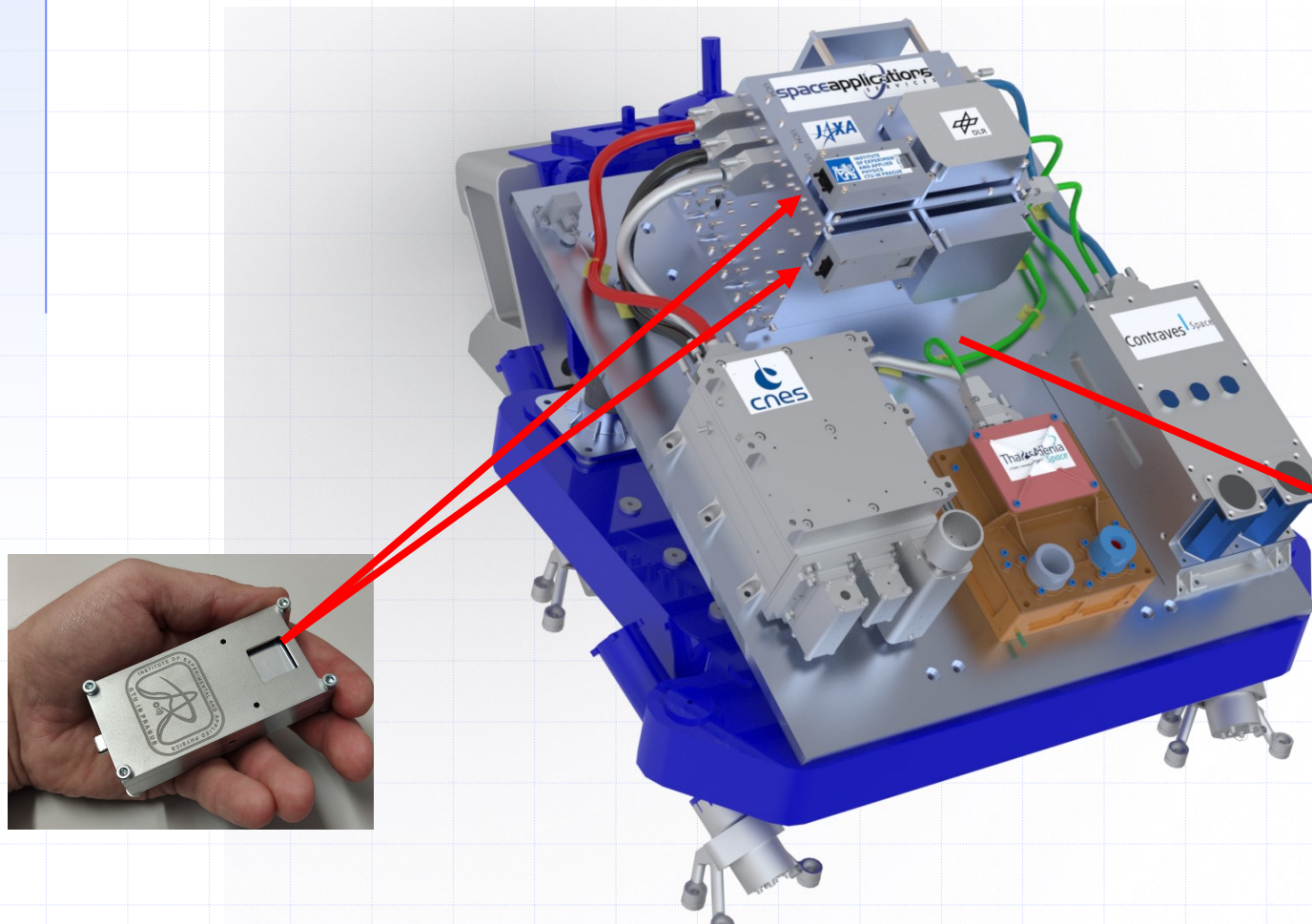
- ◆ New generation of detector – 1 or 2 Timepix3 sensors, onboard processing, modularity. Developed under ESA project.
- ◆ Identifies protons, electrons, ions
- ◆ Provides flux and energy of each particle type and TID
- ◆ HardPix onboard ESA mission GOMX-5. Planned launch 2023.





# Lunar Gateway

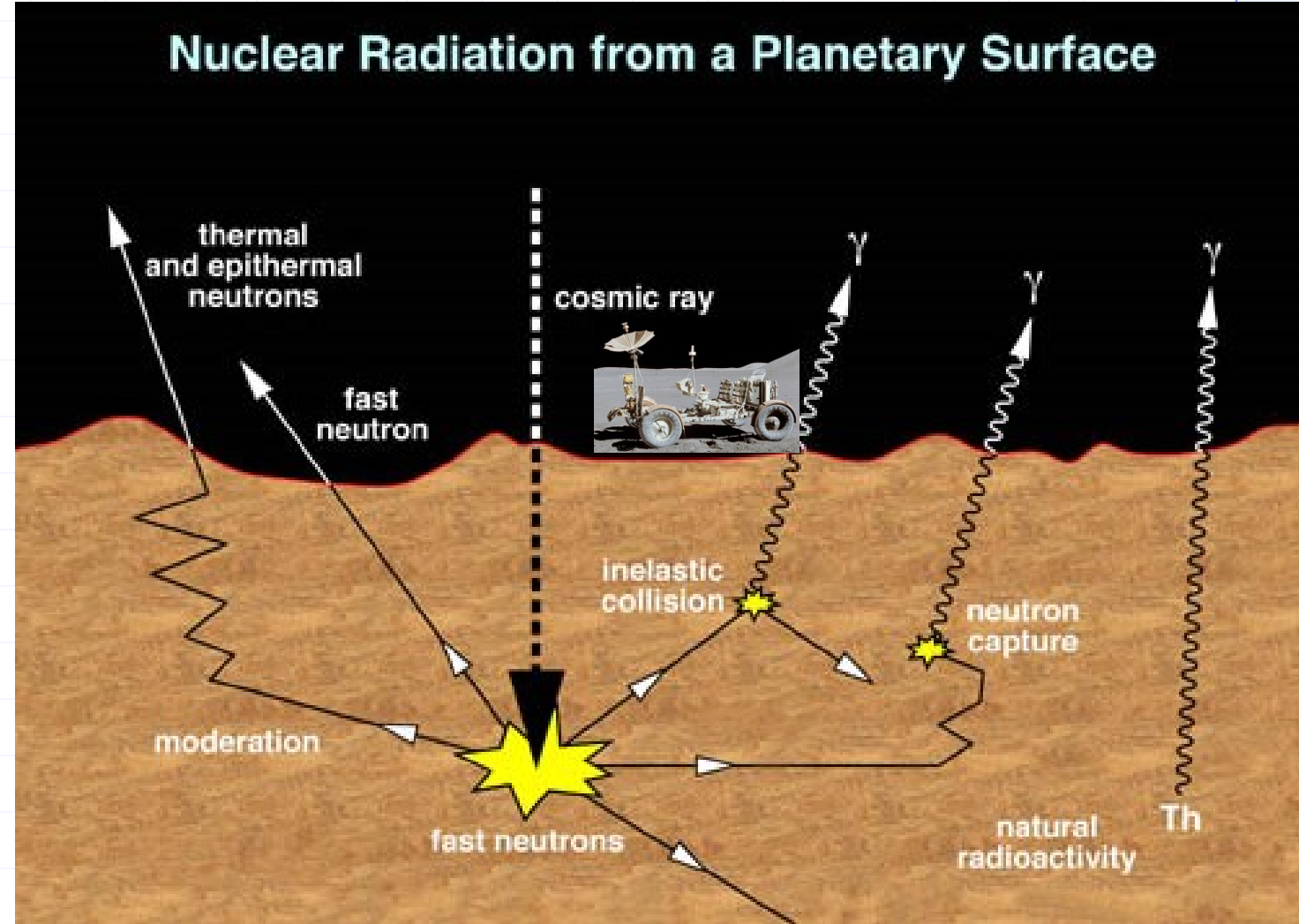
- ◆ 2 HardPix units selected by ESA to be part of the European Radiation Sensors Array (ERSA) externally mounted to Lunar Gateway. Planned launch 2024.





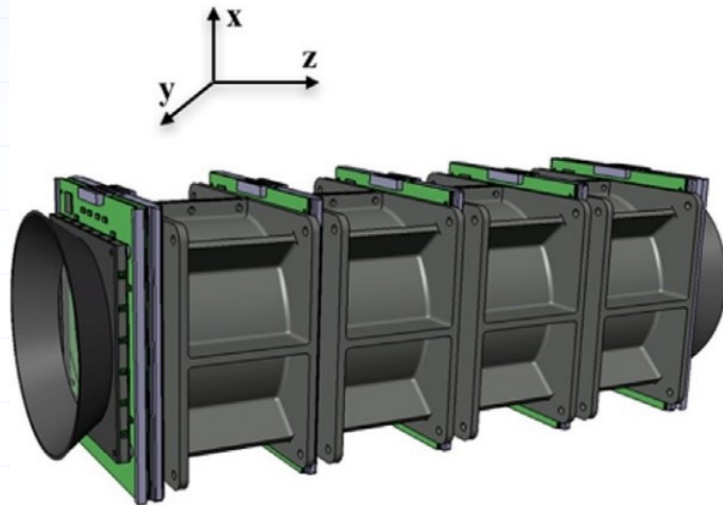
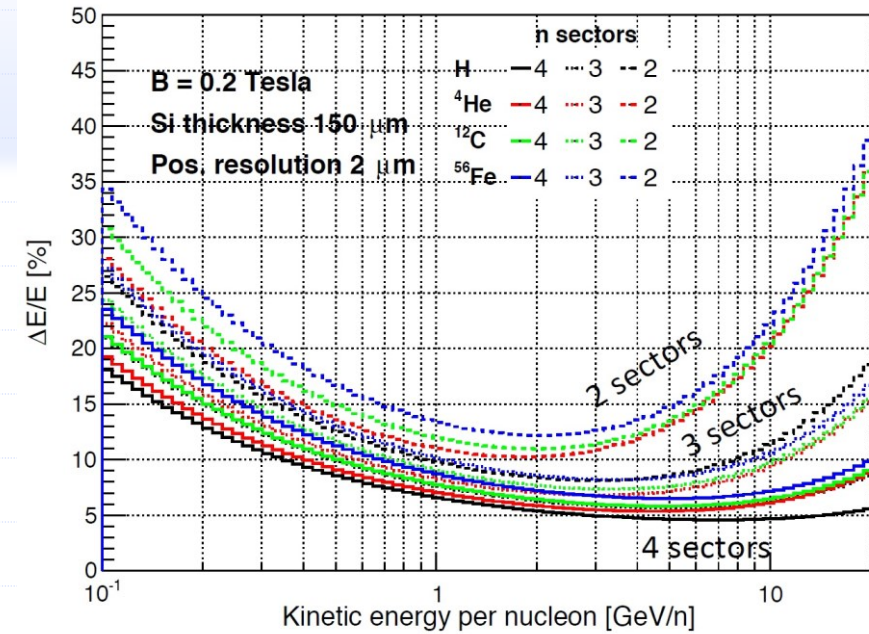
# Mapping the presence of water on the Moon

- ◆ Evidence of water presence on lunar poles. Hydrogen moderates the flux of thermal and epithermal neutrons.
- ◆ HardPix with neutron conversion layer thanks to its miniature size, low mass, low power consumption and low cost can be placed onboard lunar rovers (even cuberovers) to map water presence directly on lunar surface.
- ◆ IEAP part of ESA project to study possible use of HardPix onboard EL3 rover.

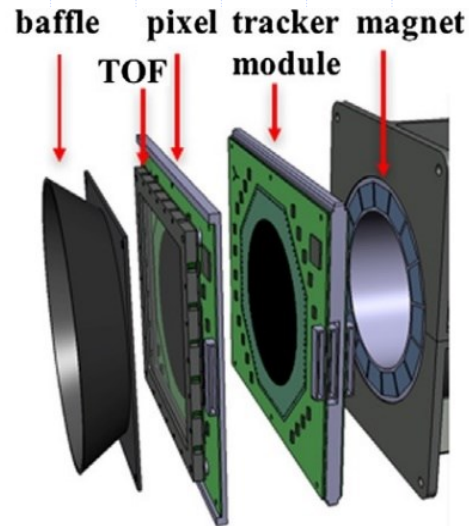


# PAN – Penetrating particle ANalyzer

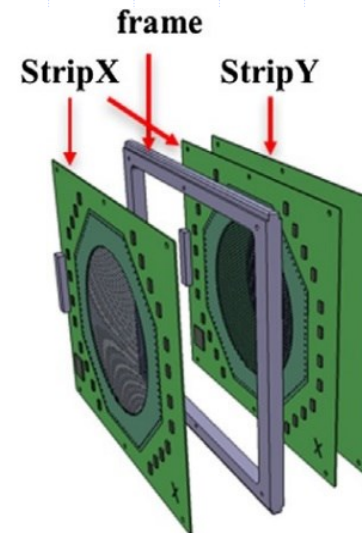
- ◆ Magnetic spectrometer for detection of highly energetic particles (tens of GeV).
- ◆ IEAP part of EC Horizon 2020 project to develop a smaller demonstrator MiniPAN in collaboration with University of Geneva and INFN Perugia.
- ◆ Czech Ambitious project – send MiniPAN and HardPix outside of Earth magnetosphere (L2 or lunar orbit).



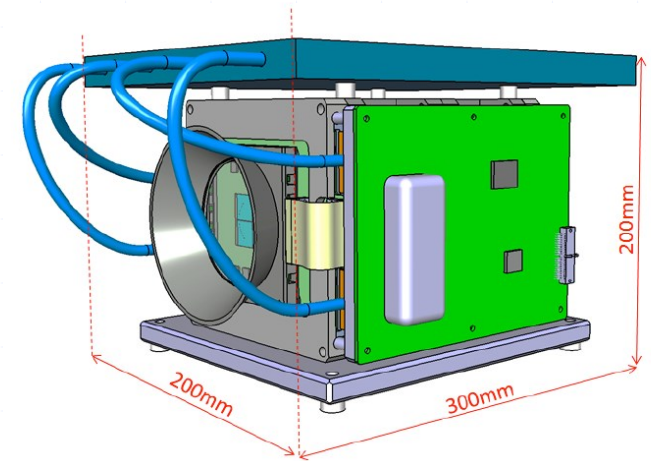
a)



b)



c)





# IEAP CTU



- ◆ Leader in the Czech Republic in the field of space radiation detectors used for:
  - Personal dosimetry and human crew safety (ISS, Gateway)
  - Protection of electronic components in orbit – online warning
  - Science (Space weather, Heliophysics – Gateway)
  - Prospecting (neutron and gamma spectrometers)
  - Imaging (X-rays and gamma-rays)

