THOR

TGF and High energy astrophysics Observatory for gamma Rays

Space Radiation in Low Earth Orbit and Space Weather on Board the Space Rider

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Space Rider

Space Reusable **I**ntegrated **D**emonstrator for **E**urope **R**eturn

- The Space Rider (SR) is ESA's new **reusable shuttle** that will be **launched by the Vega-C rocket** from Kourou in Q4 2026.
- Each flight will have a **duration of 2 months** allowing up to **600 kg of payloads** to perform their missions in **LEO conditions** (**400 km altitude**; **Orbital Period ∼90 min; 5º inclination**).

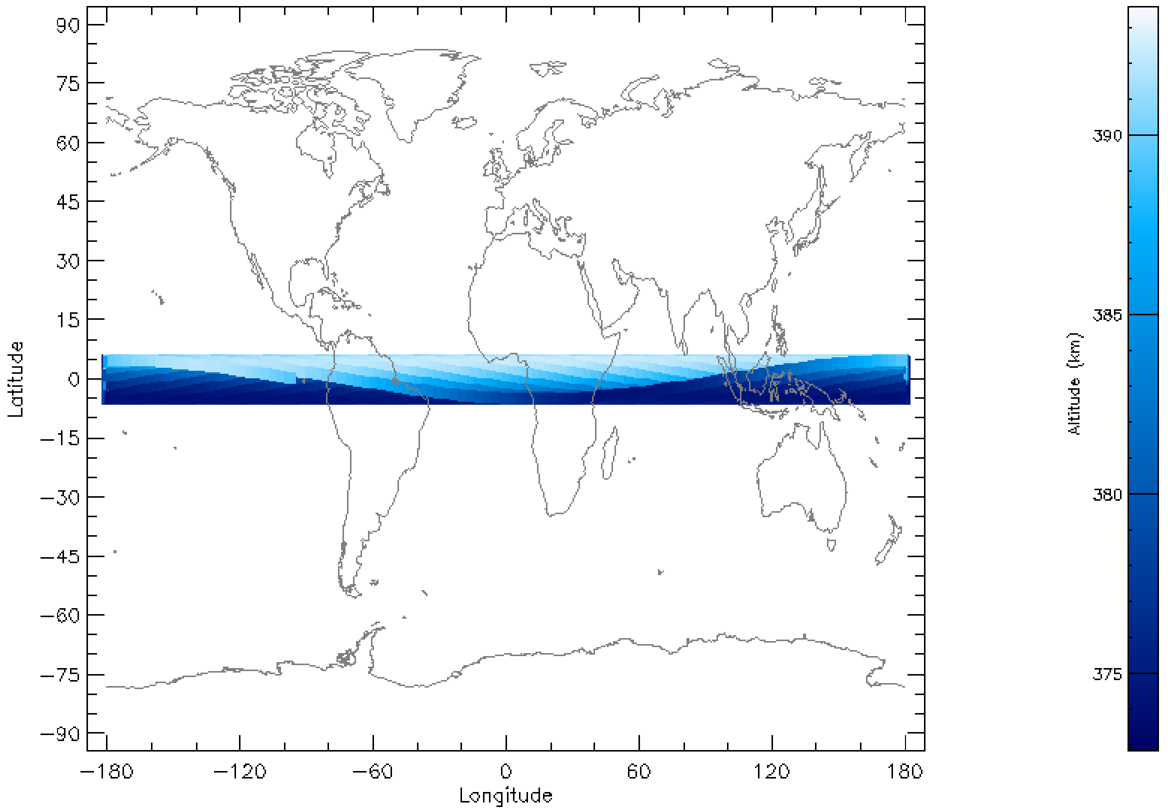


Figure 1. SR orbit for the maiden flight. 400 km, 5º inclination. REF: SPENVIS

THOR-SR Mission

TGF and High-energy astrophysics Observatory for gamma-Rays on-board Space Rider

- Developed by the iAstro group at LIP-Coimbra.
- Scientific payload to map the light (electron) and heavy (proton, ions) charged particle components in terms of particle species, deposited energy, and direction:
  - **CdTe Stack Detector** (16 sensors) – observation of gamma-ray sources
  - **Si Particle Tracker** (2 sensors) – particle telescope for SW and a high-resolution radiation monitor for radiation effects

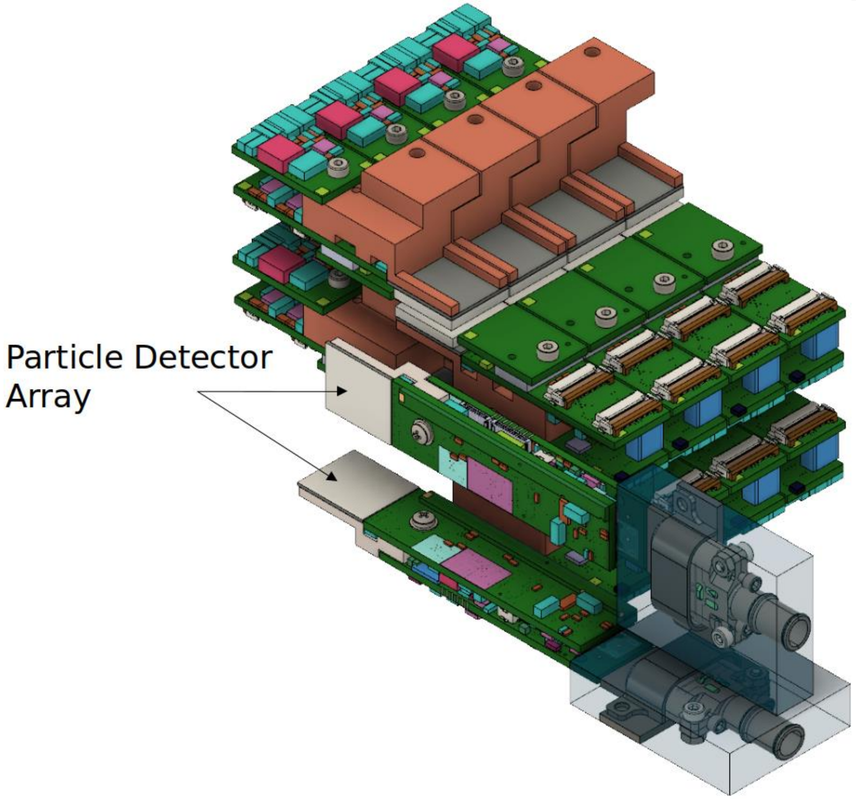


Figure 2. Particle detectors geometry alongside THOR Gamma Tracker Array, in an orthogonal array in order to cover with a full wide field-of-view, spectral, and directional tracking resolving power the complex and variable space radiation along the orbit of the SR mission.

THOR-SR's two-month space mission addresses three different objectives:

1) **Space Orbital Radiation and SW Monitoring**
2) **Radiation Effects Monitoring**
3) **Technology Demonstration**

My PhD Work

- Data selection process for a machine learning algorithm that enhances the data analysis and interpretation
- Simulating the performance of the detector using GEANT4 software to predict what the detector will observe during flight.
- Work directly with the flight data:

Connecting the observations to Space Weather indicators and parameters → More detailed understanding of the radiation environment in LEO

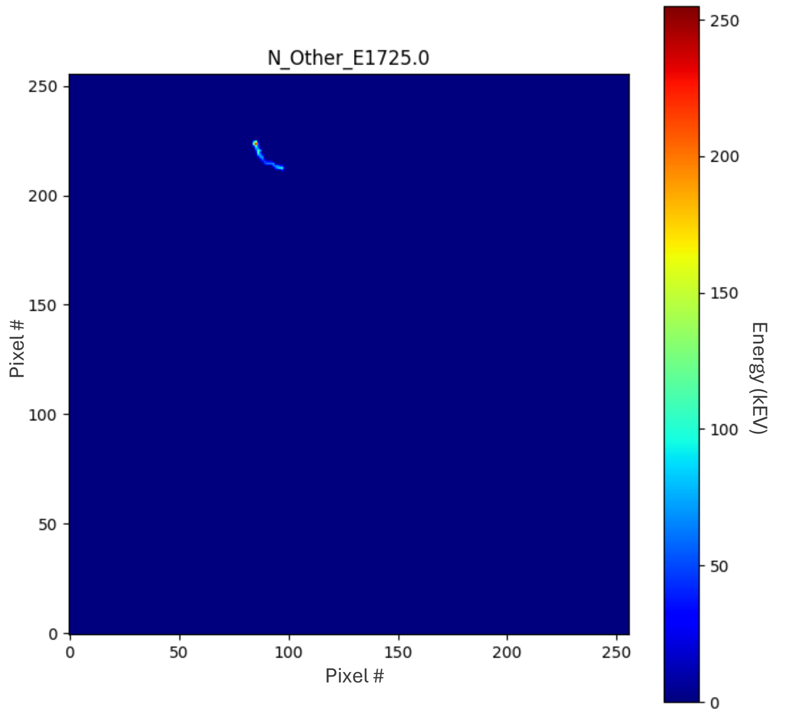


Figure 3. Example of data fed into the machine learning algorithm.

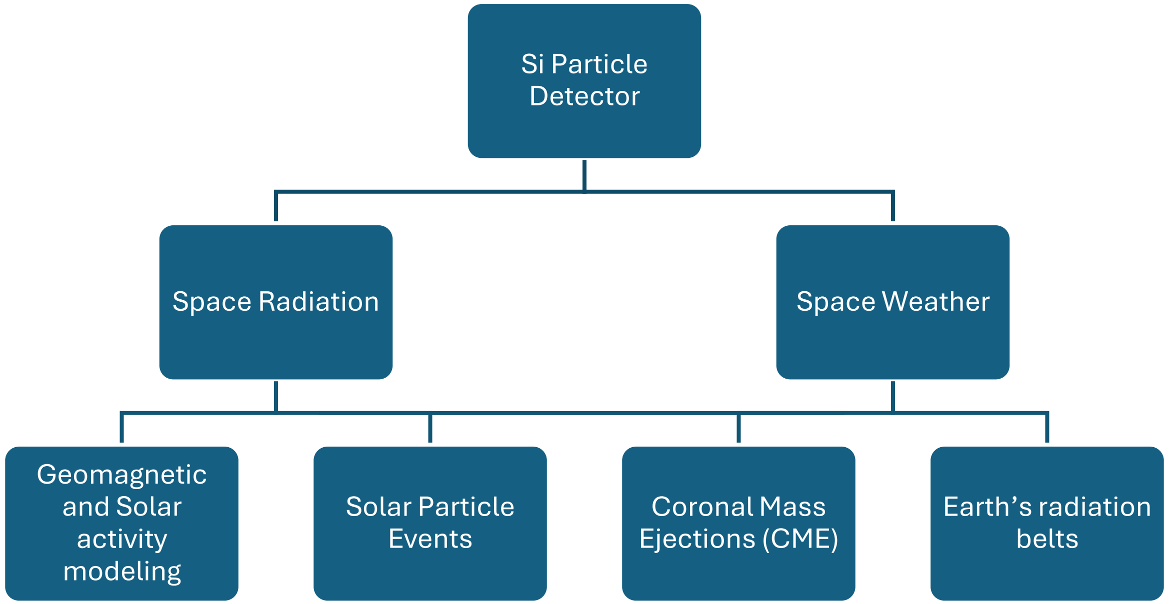
My PhD Work

Space Radiation in LEO:

1) **Galactic Cosmic Rays** (GCRs): High-energy particles from outside our solar system.

2) **Solar Energetic Particles** (SEPs): High-energy particles released during solar events like flares and coronal mass ejections.

3) **Trapped Radiation**: Particles that are caught in Earth's magnetic field, forming the Van Allen radiation belts.



Space Weather Phenomena:

- How **space weather events** (solar flares, geomagnetic storms, and CMEs) can rapidly increase radiation levels, sometimes posing immediate risks.

My Timeline

2024

- Scientific Objectives Consolidation
- Particle Tracker Performance Simulation
- Implementation, Integration & Test

2026

- Space Rider Mission
  - Pre-Flight Operations
  - **Launch**
  - Orbital and Solar particle measurements

2027

- Post-Flight Tests and Data Analysis
- Thesis Writing

Thank you!

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Conclusion

- My research, as part of the THOR-SR project, focuses on understanding the space radiation environment in Low Earth Orbit and how space weather influences it.
- This work is vital for improving spacecraft design, protecting astronauts, and ensuring the success of future space missions.