

Space RADIATION Environment and its Effects

In the last 20 years the area of R&D centred on the study of space radiation environment and effects was created and consolidated at LIP

Students:

3 Master students – 2023

Igor Gago- Mars subsurface Environment

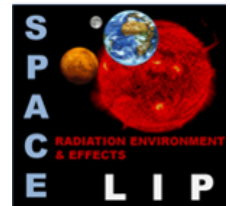
Francisca Santos – RADEM JUICE Spectrometer Data Analysis and Calibration Review preparation

António Gomes - Flight data analysis of the BERM radiation monitor aboard the BepiColombo mission to Mercury

~4 FTE in 2023



2023/06/27 15:10:42 08:14:35:33 UT





LIP ESA SpaceRad contracts

ESA JUICE mission

- RADEM – Radiation Hard Electron Monitor
- EEE component testing for Jovian environment

ESA Mars Energetic Radiation Environment Models

Expert support to BERM and RADEM radiation monitors
From Mercury to Jupiter

GEO (Geosynchronous) Radiation Environment:

- Radiation Environment Measurement (MultiFunctional Spectrometer)
- EEE component test bed (Component Technology Test Bed)

Lines of work

Radiation Monitors as windows to the Heliosphere

Planetary radiation environments: Human Space Flight and Astrobiology

Instruments and methods: from Particle and Nuclear Physics to Space and Health Applications

Space Radiation Environment and Effects activities

2020	2021	2022	2023	2024	2025
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projects and contracts

RADEM ESA JUICE mission Radiation monitor with EFACEC , PSI (CH) and IDEAS (NO)

BARD – Expert support for RADEM and for BERM (BepiColombo mission radiation monitor) contract

BARD follow up?

Future Plans – applications for space weather, human space flight, astrobiology ...

Low Cost Radiation Monitor (with EFACEC, PSI, IDEAS...)

An integrated Radiation environment Model for the Moon and Mars (Future European project ?)

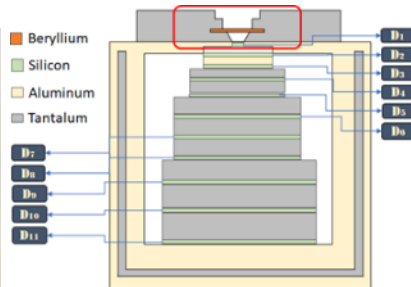
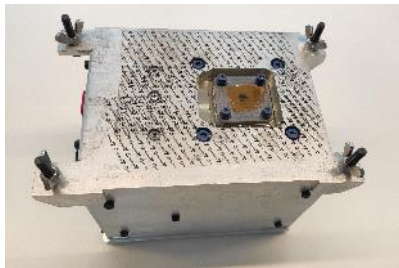
The radiation environment in the solar system: from Mercury to Jupiter

To Mercury – BepiColombo Mission (2018)
BERM – BEpiColombo Radiation Monitor

Measurement

- electron, proton and ion spectra

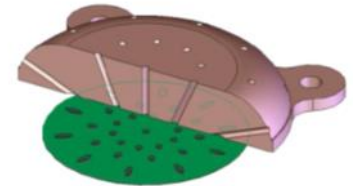
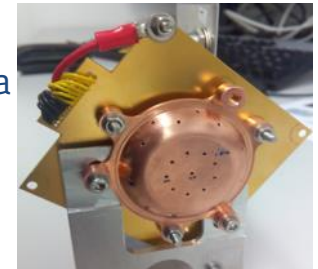
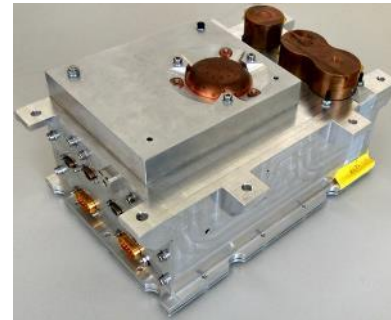
Earth radiation belts measurements in 2021
Now near Mercury



To Jupiter – ESA JUICE Mission (2023)
RADEM – RADiation hard Electron Monitor

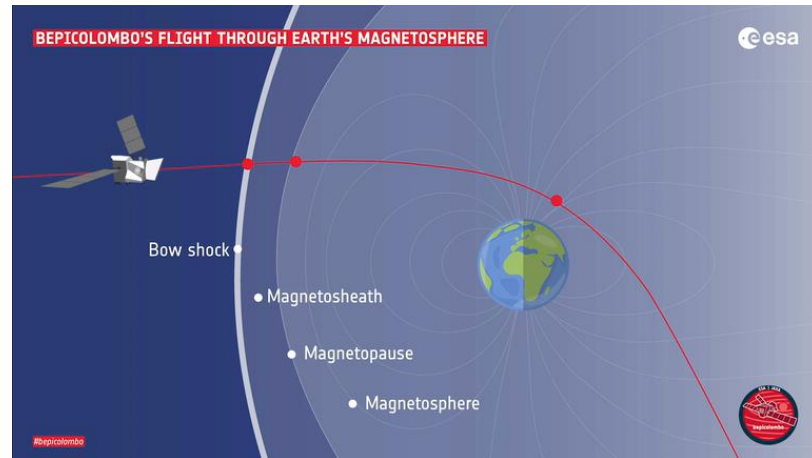
Measurement

- electron and proton spectra
- ion LET
- electron directionality

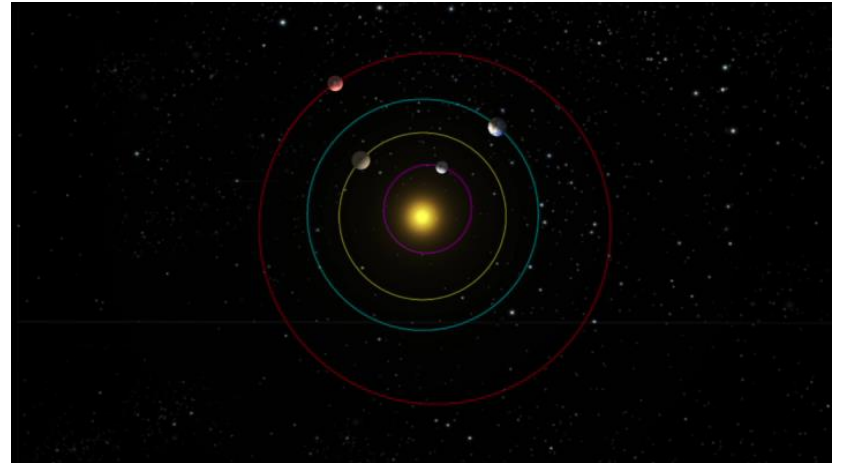


The radiation environment in the solar system: from Mercury to Jupiter

To Mercury – BepiCOlombo Mission (2018)
BERM – BepiColombo Radiation Monitor

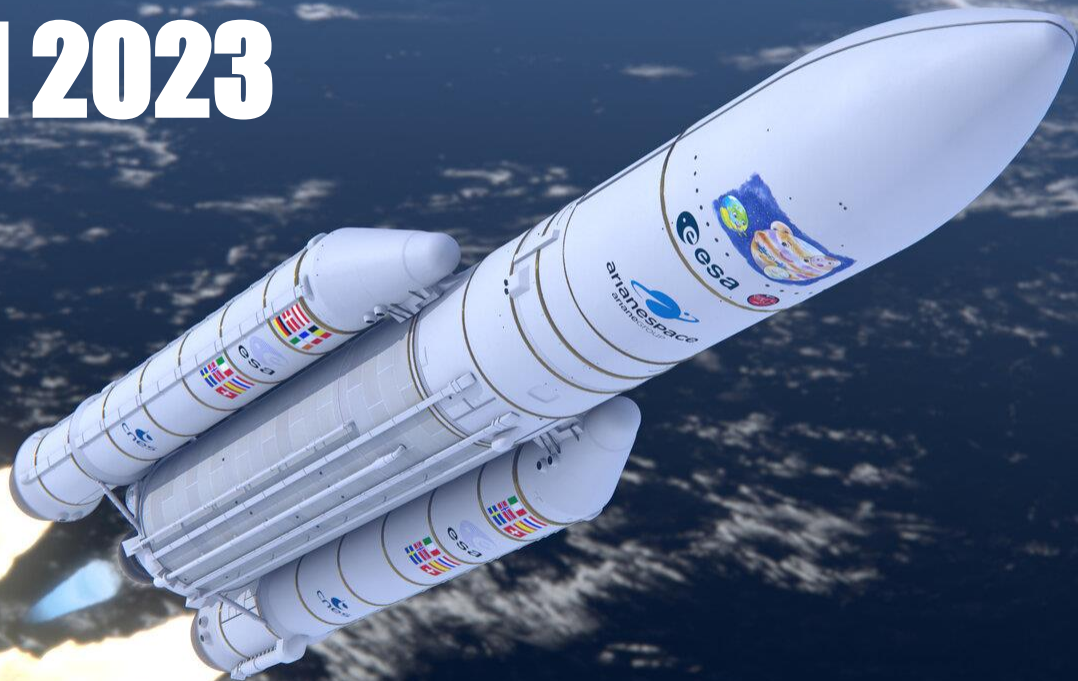


To Jupiter – ESA Juice Mission (2023)
RADEM – RADiation hard Electron Monitor

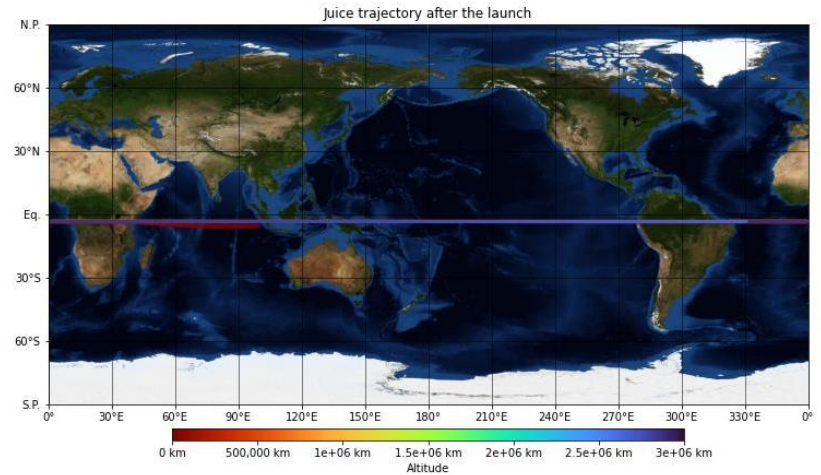
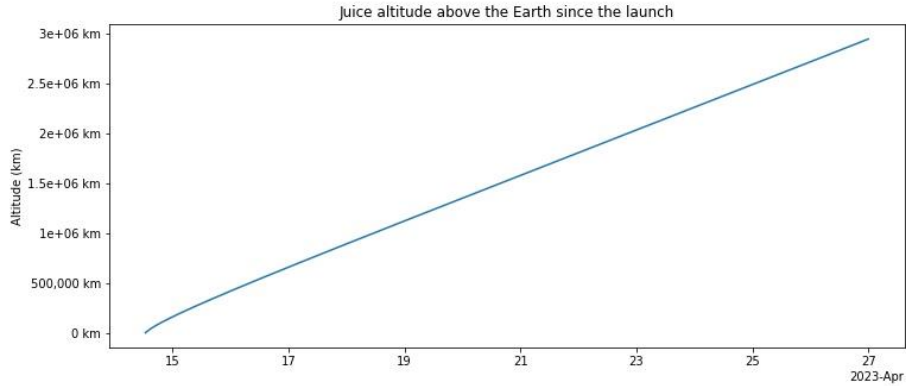


JUICE Launch

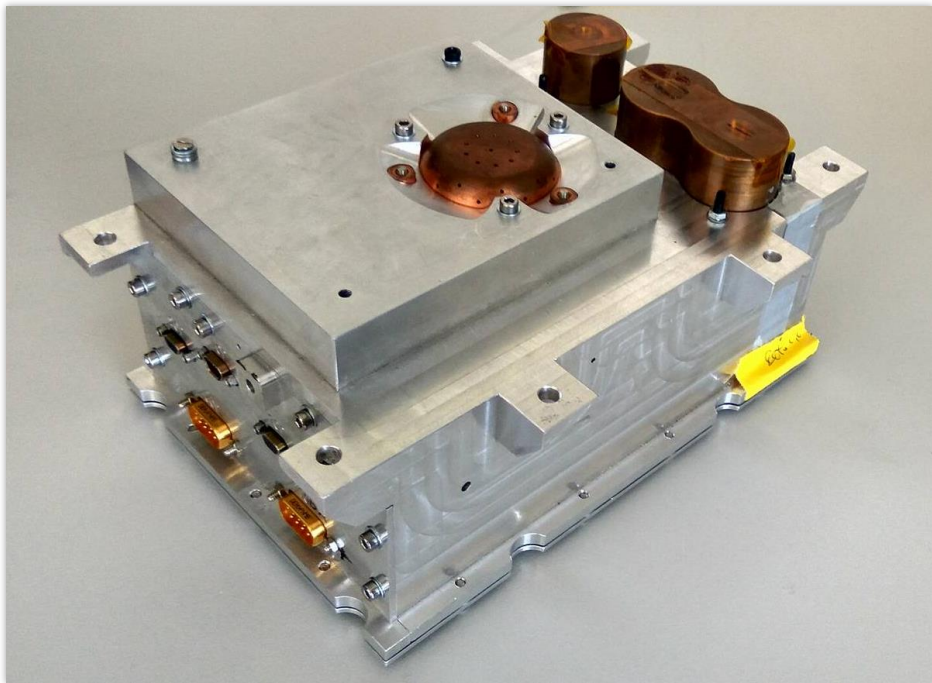
14 April 2023



JUICE Position 27 April 2023

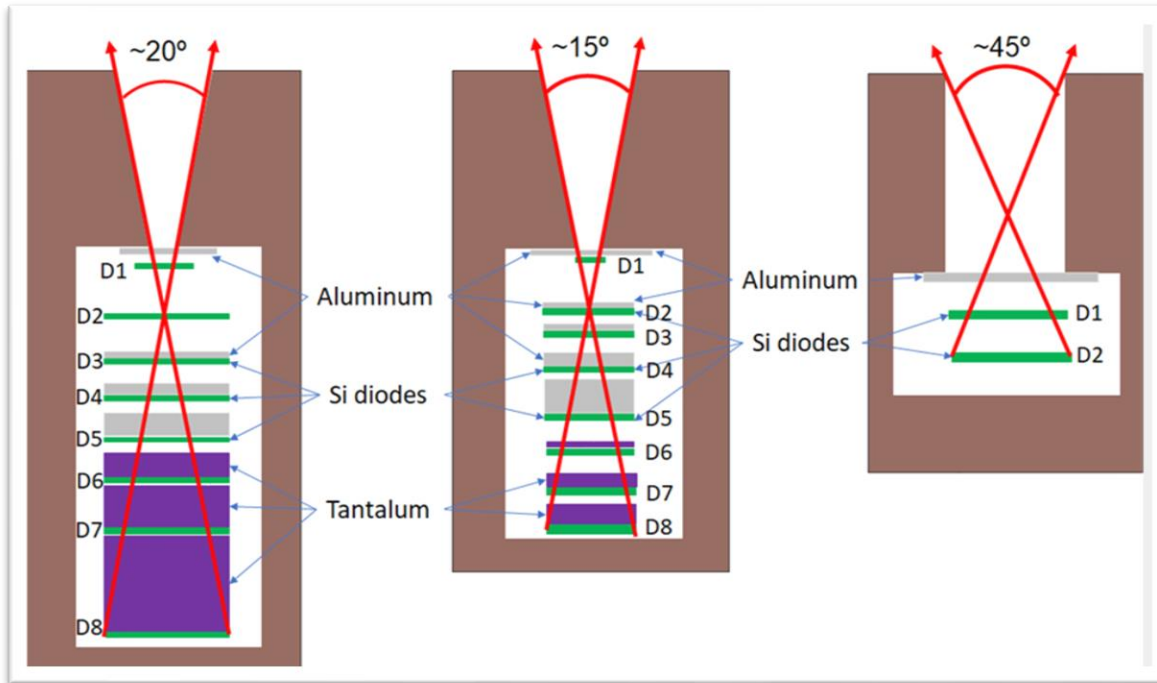


RADEM

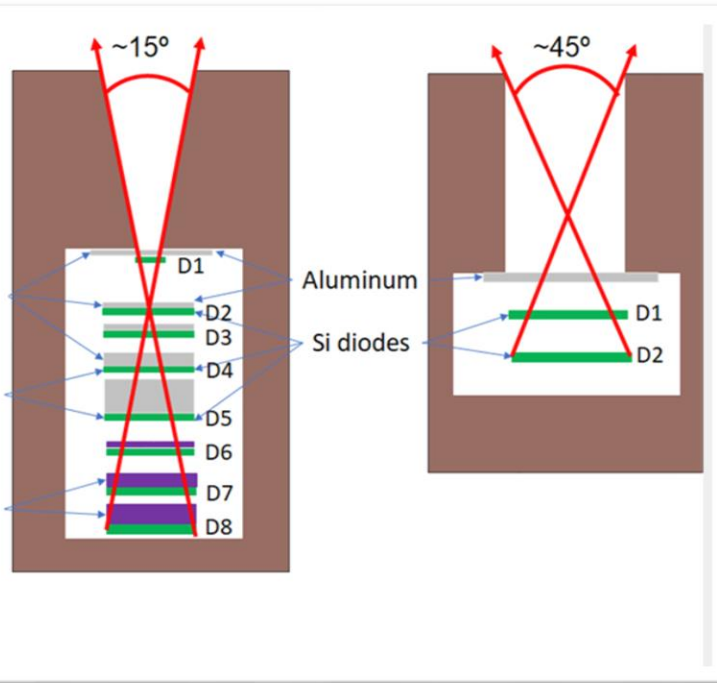


RADEM detector heads

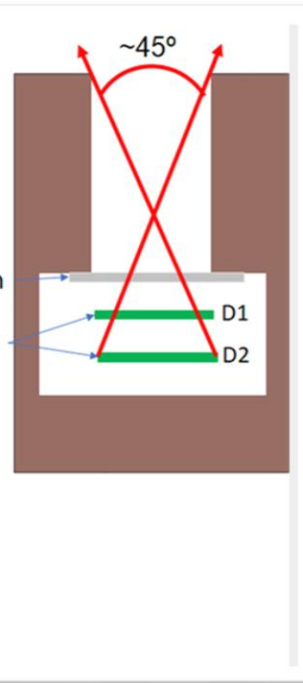
Proton stack



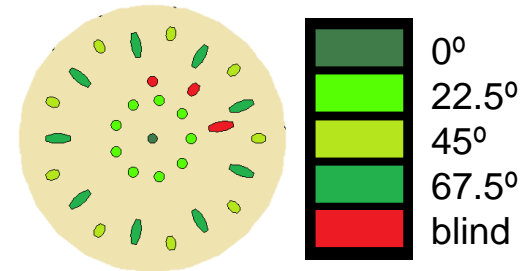
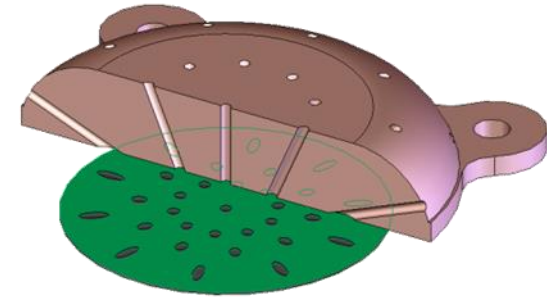
Electron stack



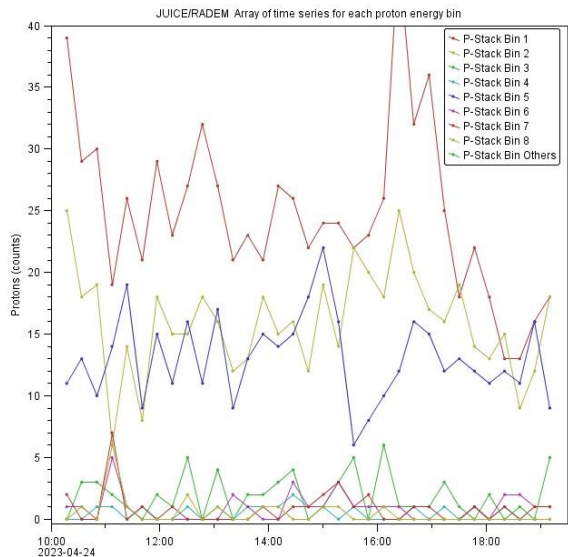
HI stack



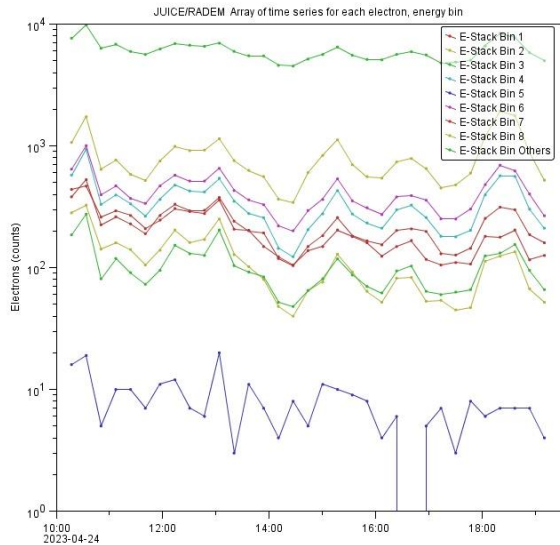
Electron Directionality Detector



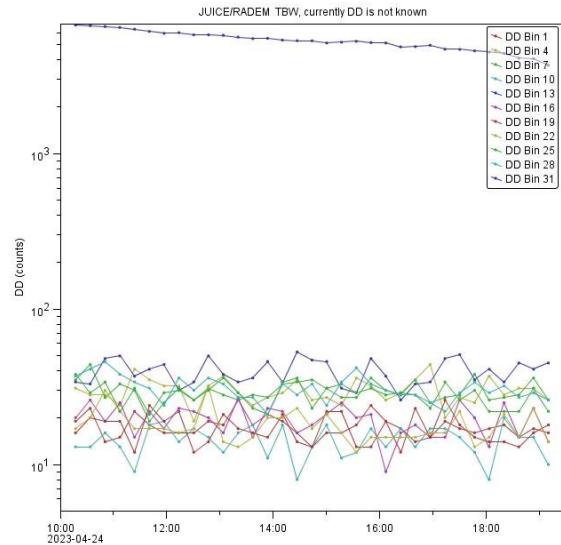
RADEM flight data – commissioning phase



Proton stack



Electron stack



Electron Directionality Detector

Strengths

- Expertise in Geant4 for Space Applications, data Analysis and detector design
- Solid Physics competences
- **20 years of activity with several contracts completed:**

Weaknesses

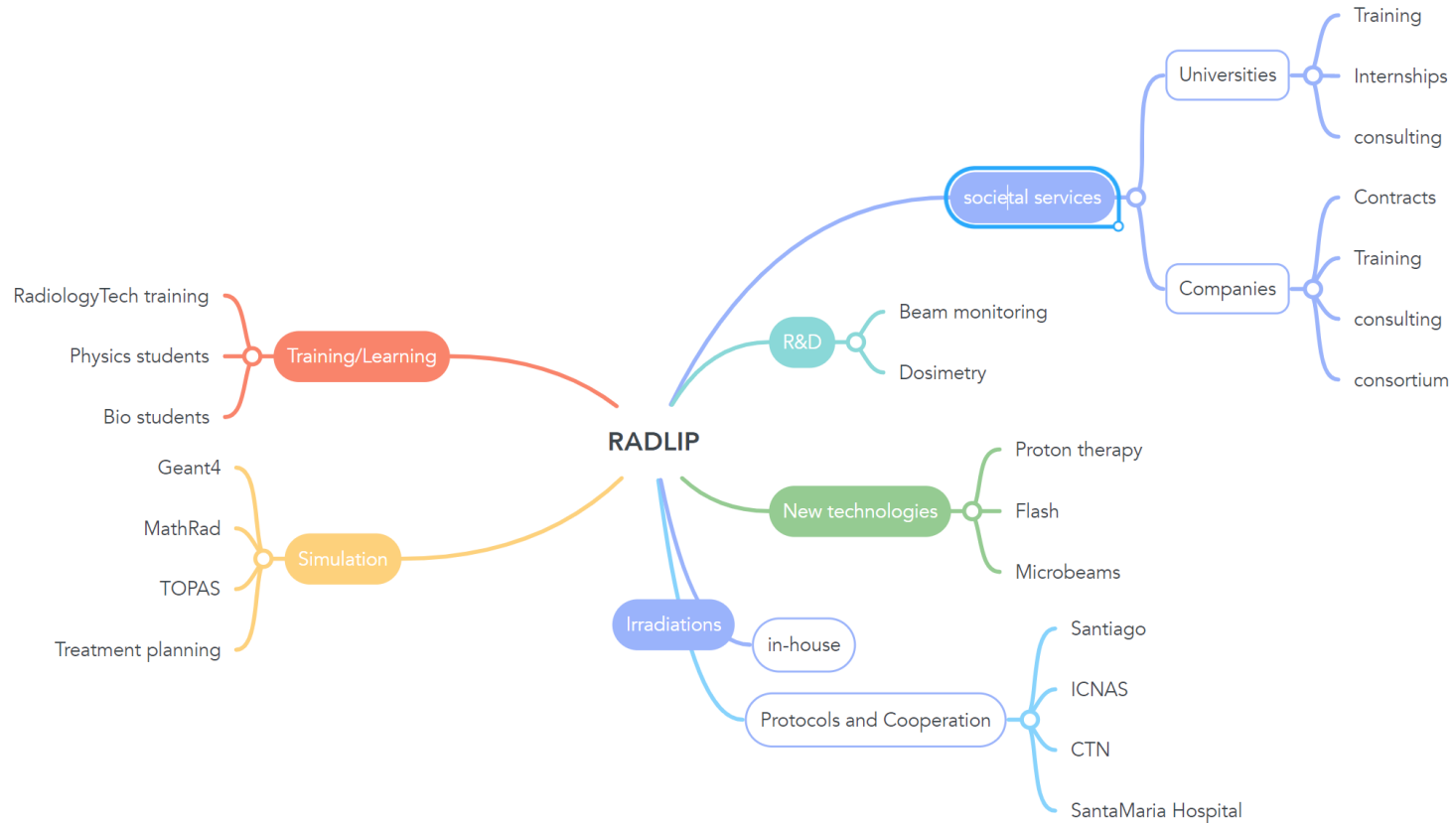
- **No straightforward undergraduate training in Portuguese Universities**
- Slow Learning curve for students - larger than duration of contracts
- Low nr of Senior Researchers in Group
- RH Profile is not easy to find...

Opportunities

- **Participation on BERM and RADEM data analysis BARD contract**
- Space Science and Technologies minor in Instituto Superior Técnico
- Collaboration with industry, Contracts with European Space Agency
- Creation of PT Space (Portuguese Space Agency)
- PT-Space PhD Grants – started in 2021 (small number)

Threats

- Timing and duration of typical projects/contracts
- Projects submitted to FCT calls evaluated by the Physics panels: no specific panel for space applications
- PI is heavily involved in LIP effort for Proton therapy and in LIP management
- **Career Prospects for post-docs and young researchers :**
 - **Competition from industry**
 - **International opportunities**





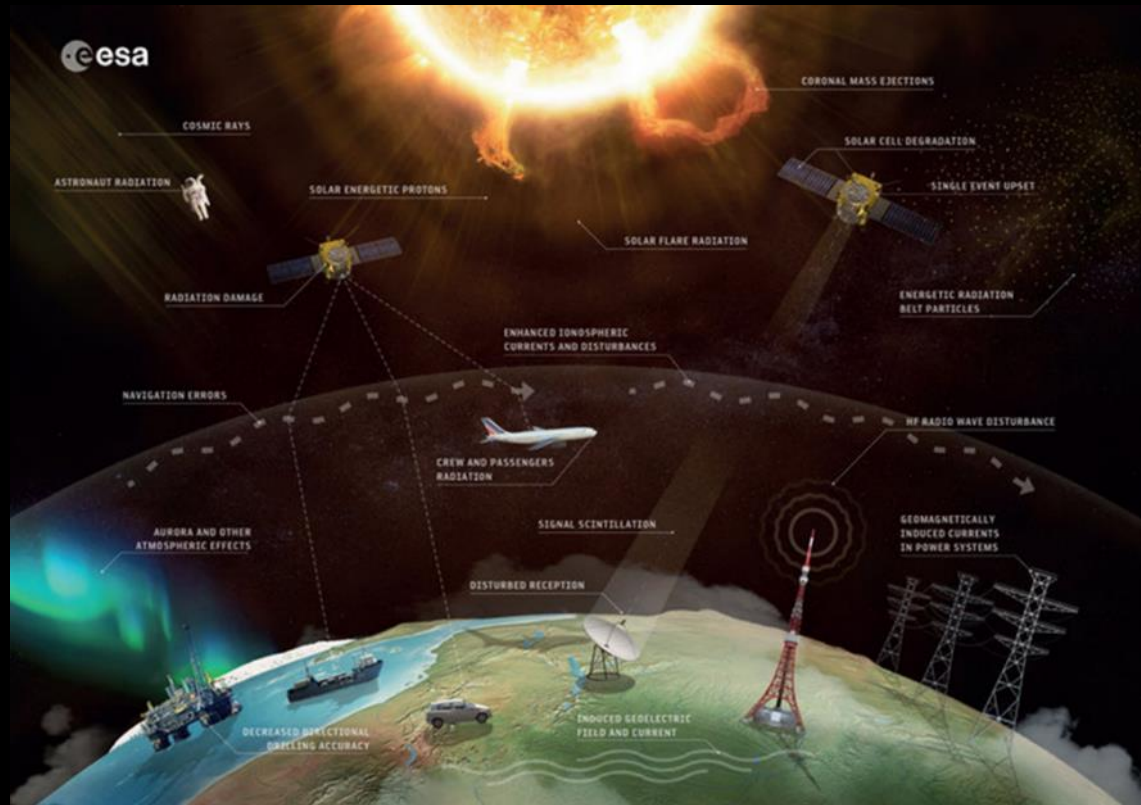
LABORATÓRIO DE INSTRUMENTAÇÃO
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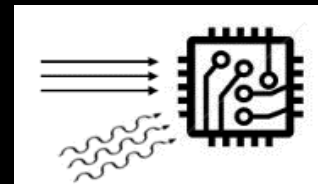


Backup

SPACE Radiation Environment and Effects



Test, Characterization and Radiation Hardness Assurance of EEE components



- Electronics
- Instrumentation
- Beam-lines



Electronics lab LIP-Lisboa



**In Space, accelerators
are larger and
detectors are ...
smaller**

