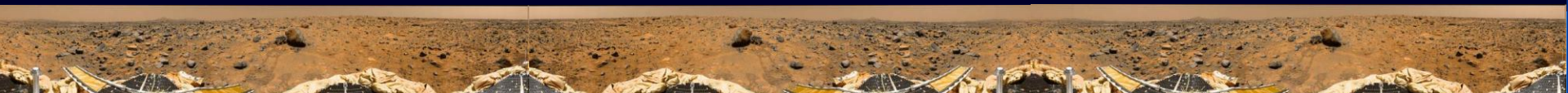
Space Radiation Environment & Effects @ LIP

What next ?

Patrícia Gonçalves

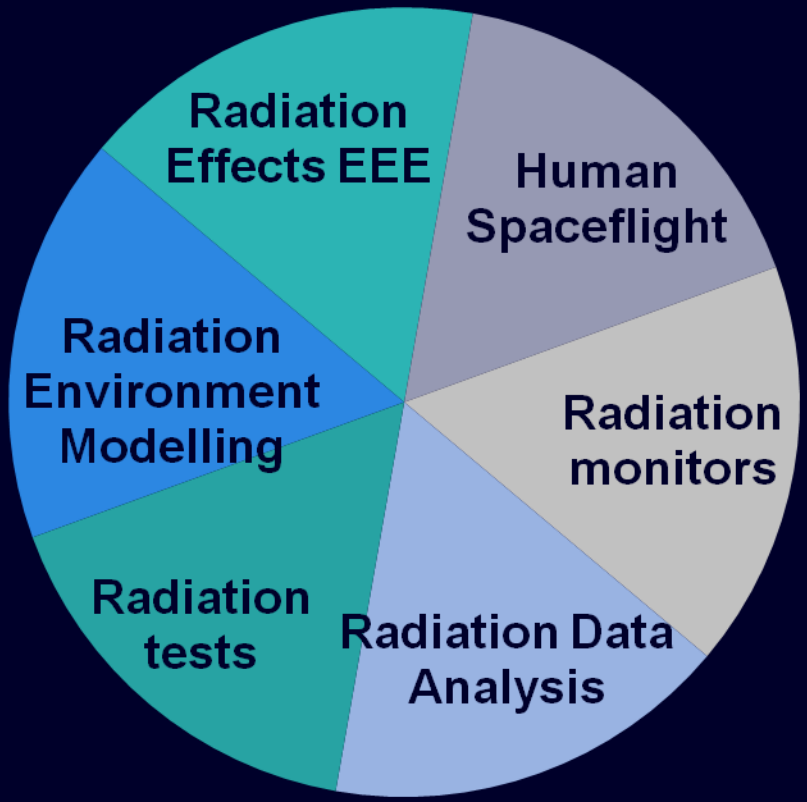


Space radiation

Radiation is the single major *show stopper* for manned missions beyond LEO.
It is also responsible for damage in spacecraft systems, EEE components and materials

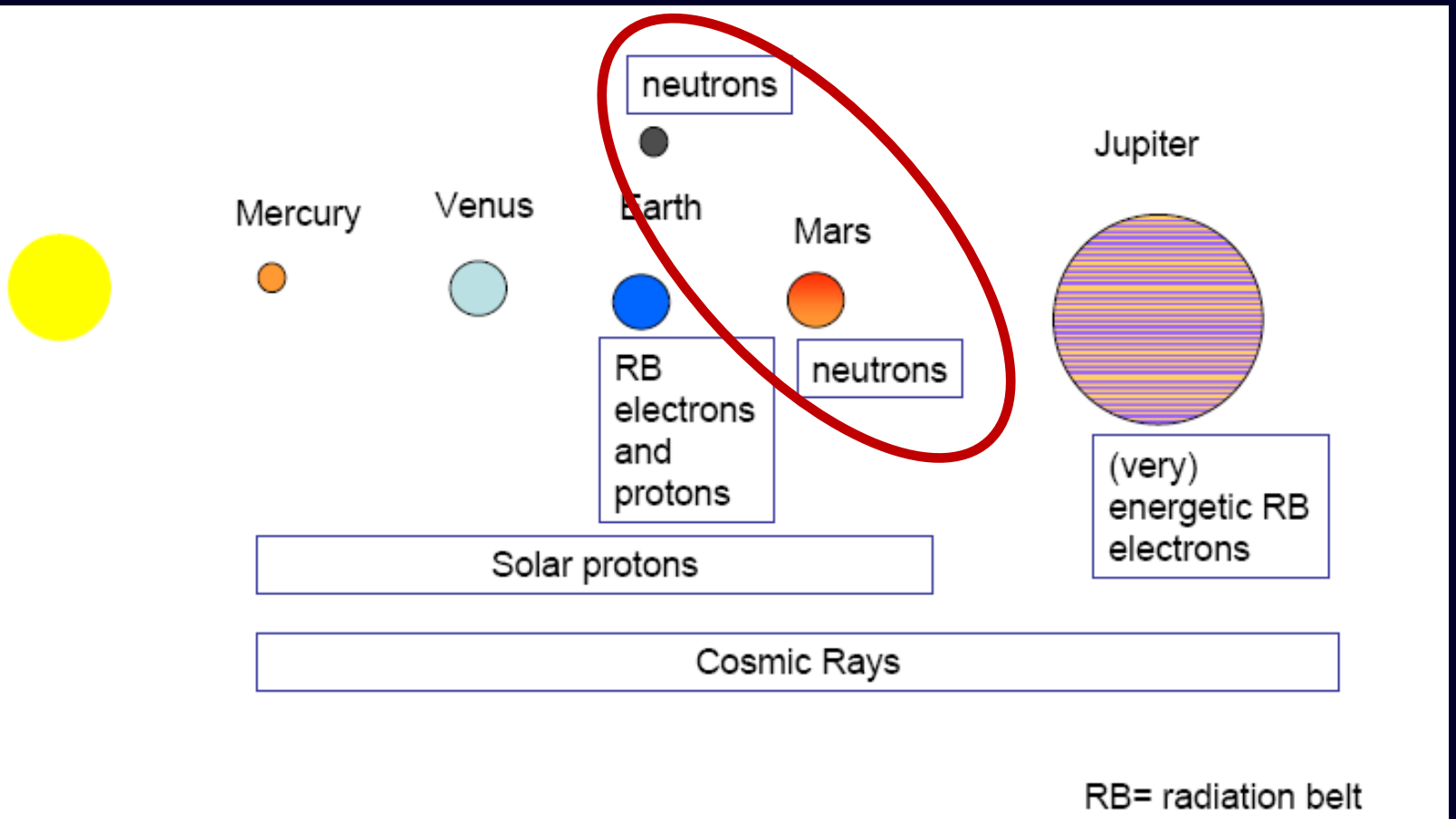
Knowledge of the radiation environment for different mission scenarios, interplanetary and planetary, manned or un-manned is fundamental for radiation hazard assessment and for the development of mitigation strategies

Activities


Radiation Effects EEE
Human Spaceflight
Radiation Environment Modelling
Radiation monitors
Radiation tests
Radiation Data Analysis

Radiation Environment

Mission specifications and requirements are variable !!



Credits to Eamonn Daly
ESA Space Environments and Effects Section, ESTEC, The Netherlands

… Mars and the Moon share similar characteristics!

Rocky planets

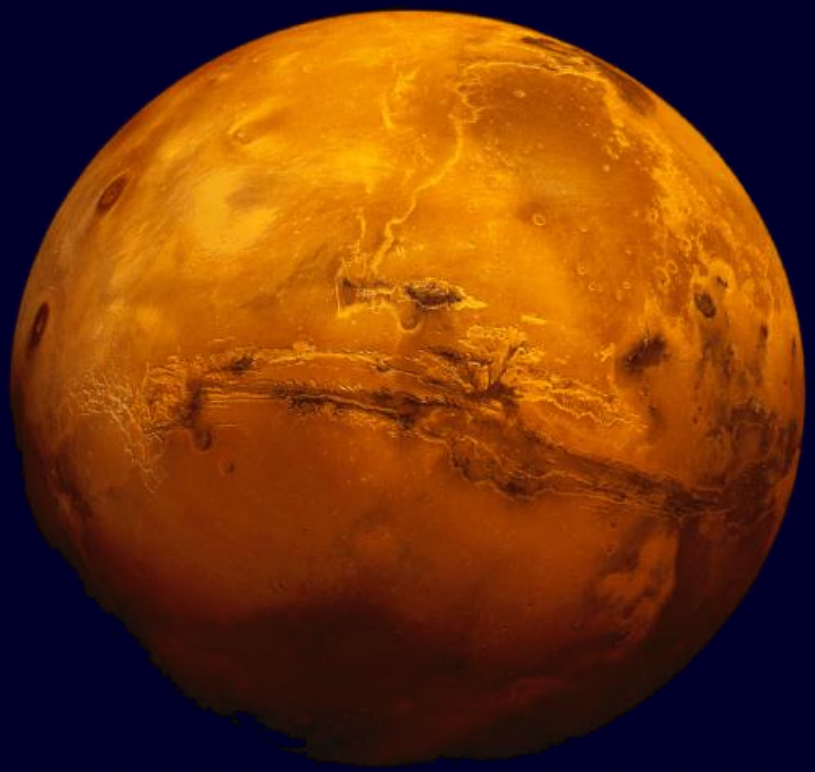
Sparse or non existing atmosphere

No dinamo -> no magnetosphere

The case of Mars

Relevant Variables
for Radiation Environment modelling

- Surface topography
- Soil and sub-soil composition
- Radiation environment @ ~1.5 AU
  - I.e SEP and GCR spectra
  - GCR variability with sun cycle
  - GCR particle species
  - SEP worst cases, etc...

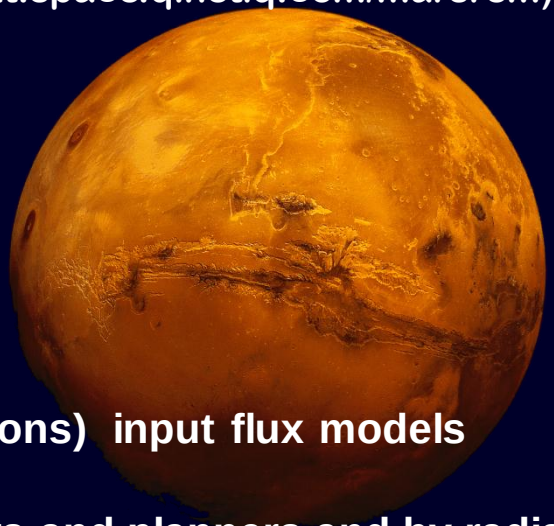


- Atmospheric depth and composition (> 95% CO_2): seasonal & day/night variations
- Localized crustal magnertic fields (umbrellas)

MarsREM: the Mars Energetic Radiation Environment Models

Work sponsored by the ESA Technology Research Programme (http://reat.space.qinetiq.com/marsrem) 2009

dMEREM : detailed Mars Energetic Radiation Environment Model



eMEREM : engeneering Mars Energetic Radiation Environment Model

- interfaced to SPEs , GCR (p,α, ions) input flux models
- to be used by mission designers and planners and by radiation experts
- web-based and interfaced with existing radiation shielding and effects simulation tools: SPENVIS (spenvis.oma.be)

The Moon Case

Relevant Variables

for Radiation Environment modelling

- Surface topography
- Soil and sub-soil composition
- Radiation environment @ 1AU:
  - i.e SEP and GCR spectra
  - GCR variability with sun cycle
  - GCR particle species
  - SEP worst cases, etc...

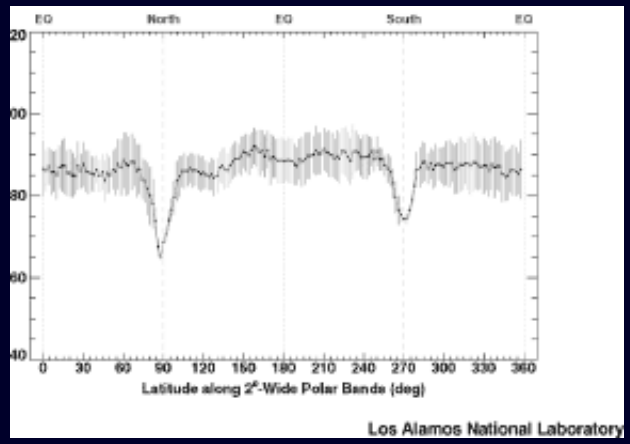
- No Atmosphere
- Very weak localized crustal magnetic field

Lunar Radiation Environment Model

Map the radiation Environment on the Moon as a function of latitude-longitude & season

Inputs:

- data characterizing the topography & the soil composition for the whole moon (with good spatial resolution)
- GCR and SEP fluxes @ 1 AU
  (from different data & models)



Validation:

- **With existing data**
  (instruments in orbiters: LEND, CRATER,RADOM)
- Comparison with other models (Langley, etc.) **benchmarking**

Further work - measurements on the Lunar surface:

- Knowledge of the Radiaton Environment of the moon has to be improved

monitor in Lunar lander payload? many small detectors on the surface ?

Lunar Lander

Science Objectives

esa human spaceflight and operations

Research Area	Investigation Topic
Human health	Toxicity of lunar dust associated risks to humans
	Radiation environment and likely hazards to humans
Environment and effects	Characterisation of an important landing site for future exploration
	Dust properties and effects on systems
	Plasma environment and its coupling with charged dust and the lunar surface and resultant effects
Resources	Availability and distribution of water, other volatiles and mineralogical species
	Physical properties of potential resources and their source materials
Preparations for future human activities	Characterise the surface bounded exosphere before it is permanently altered by human activities.
	Feasibility assessment of the Moon's surface for astronomical exploitation, particularly in radio

John Carpenter, Directorate of Human Spaceflight and Operations, in Scientific Preparations for The Lunar Lander, ESTEC Feb. 2012

Moon to Mars & Beyond

Prepare Lunar exploration

(Lunar Lander, other?)

Model the Lunar radiation environment

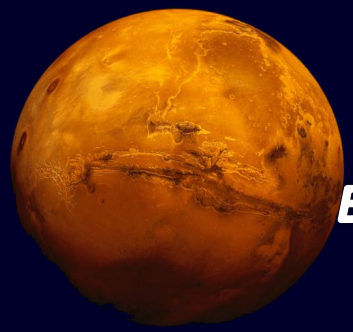
Analyse data from Lunar missions

Monitor the Lunar Radiation environment

(contribute to the design of a dedicated instrument?)

Assess human Lunar missions hazards and mitigation strategies

Validate Mars Radiation Environment Models & prepare for Mars



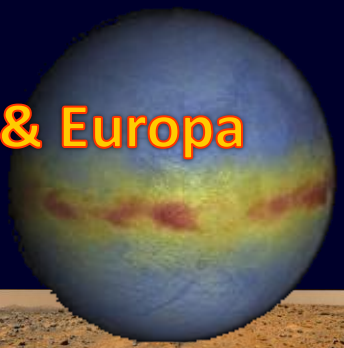
(Exomars mission)

NO radiation data from Mars surface

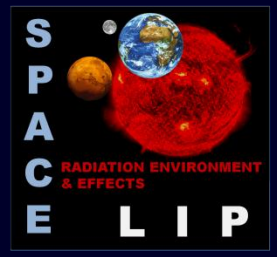
BUT Curiosity (NASA) will land in August 2012 !

Study and prepare for other scenarios: Jupiter & Europa

(Juice mission)



Space radiation environment and effects @ LIP: an assessment



- Consolidated: knowhow and expertise developed @ LIP for 9 years
- Self sustained: financed by contracts with ESA or in consortiums with ESA
- Interesting and motivating for students!

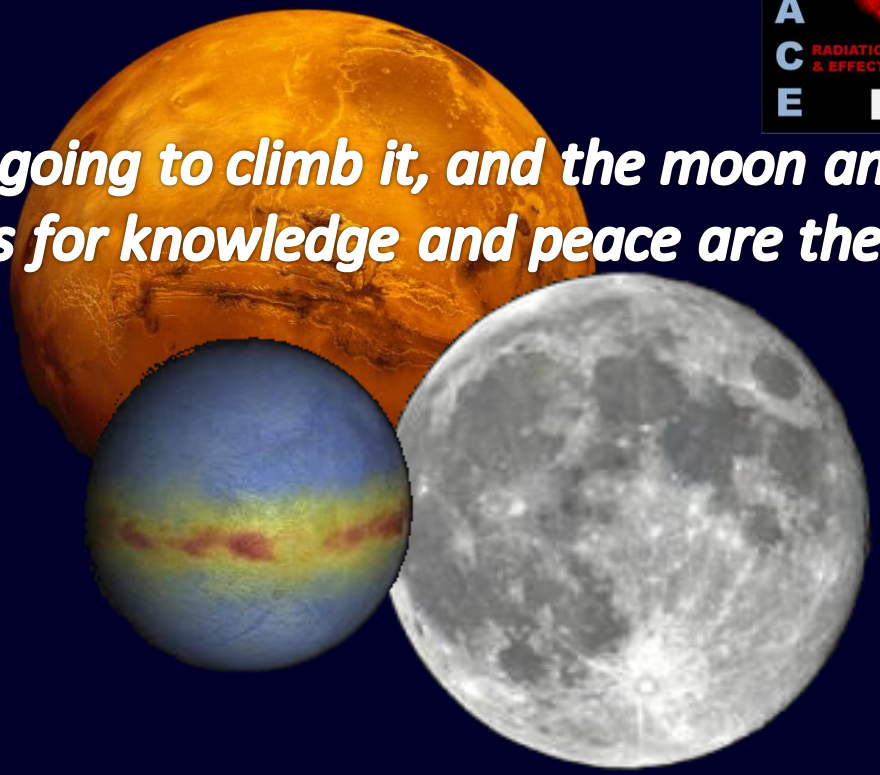
- ESA contracts (1-2 years) -> difficult to follow up activity
- Contract burocracy -> time consuming
- Difficulty on obtaining information -> may be missing opportunities...

- Multidisciplinary area (geophysics, planetary science, materials, biology, instrumentation and electronics...)
- Collaboration with other institutes and scientists and with the industry (eg.EFACEC)

- Apply to ESA calls in open competition or obtain national support for activities of interest to ESA. FP7 financing is also possible / Horizon 2020...

...Well, space is there, and we're going to climb it, and the moon and the planets are there, and new hopes for knowledge and peace are there...

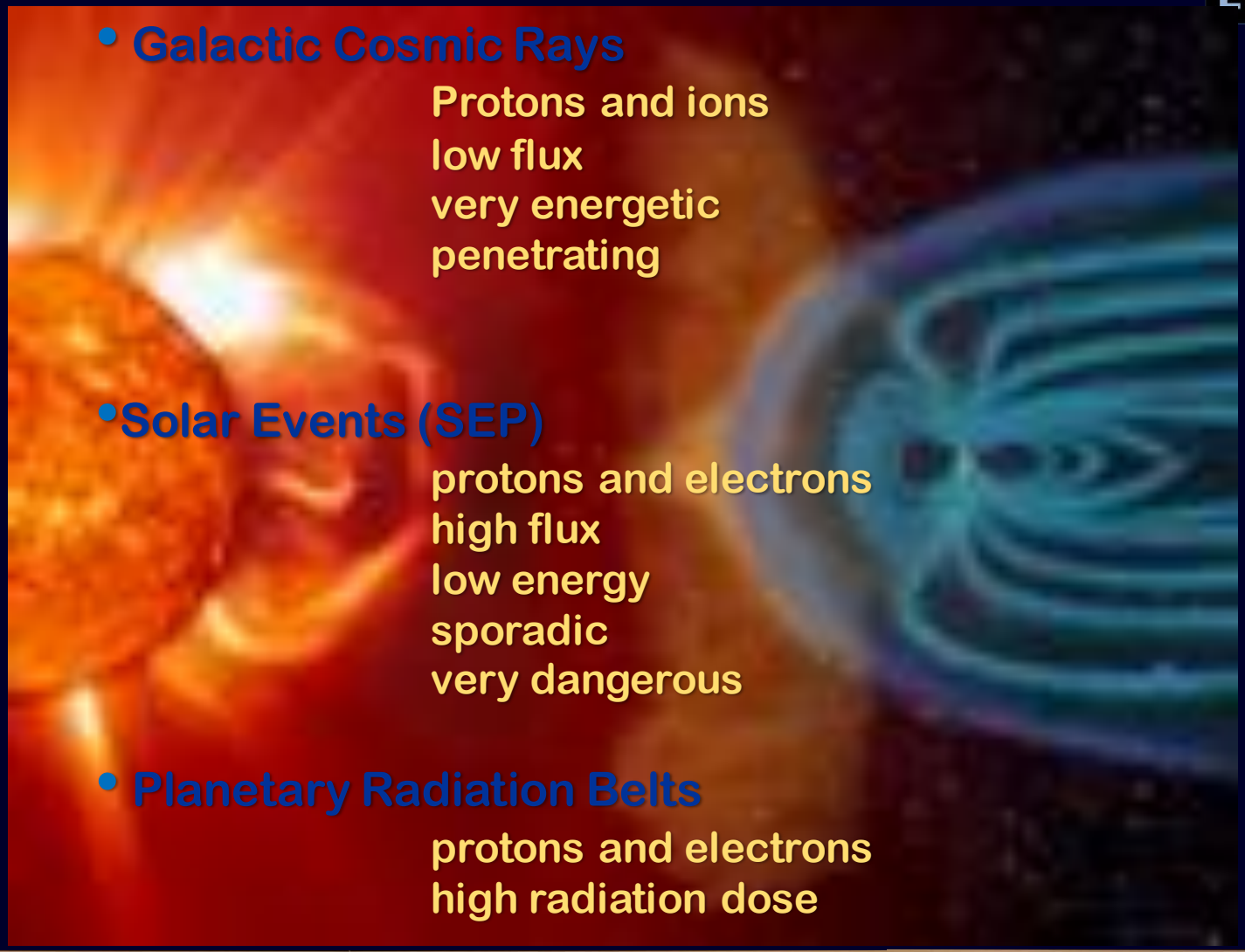
John F. Kennedy, September 12, 1962



50 years latter, the radiation environment in Space is known to be the single major show stopper for manned missions beyond LEO

THERE IS WORK TO BE DONE!

Three sources of radiation



- **Galactic Cosmic Rays**
  - Protons and ions
  - low flux
  - very energetic
  - penetrating
- **Solar Events (SEP)**
  - protons and electrons
  - high flux
  - low energy
  - sporadic
  - very dangerous
- **Planetary Radiation Belts**
  - protons and electrons
  - high radiation dose

Past & on-going Lunar Missions