Advances on Plasma and Radiation Monitoring Workshop: Introduction and context

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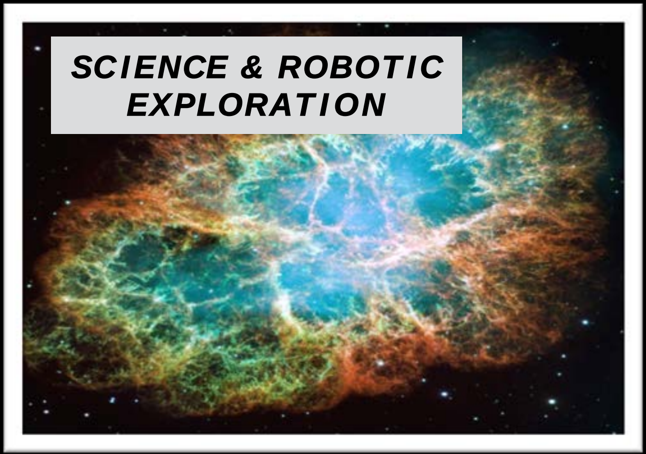
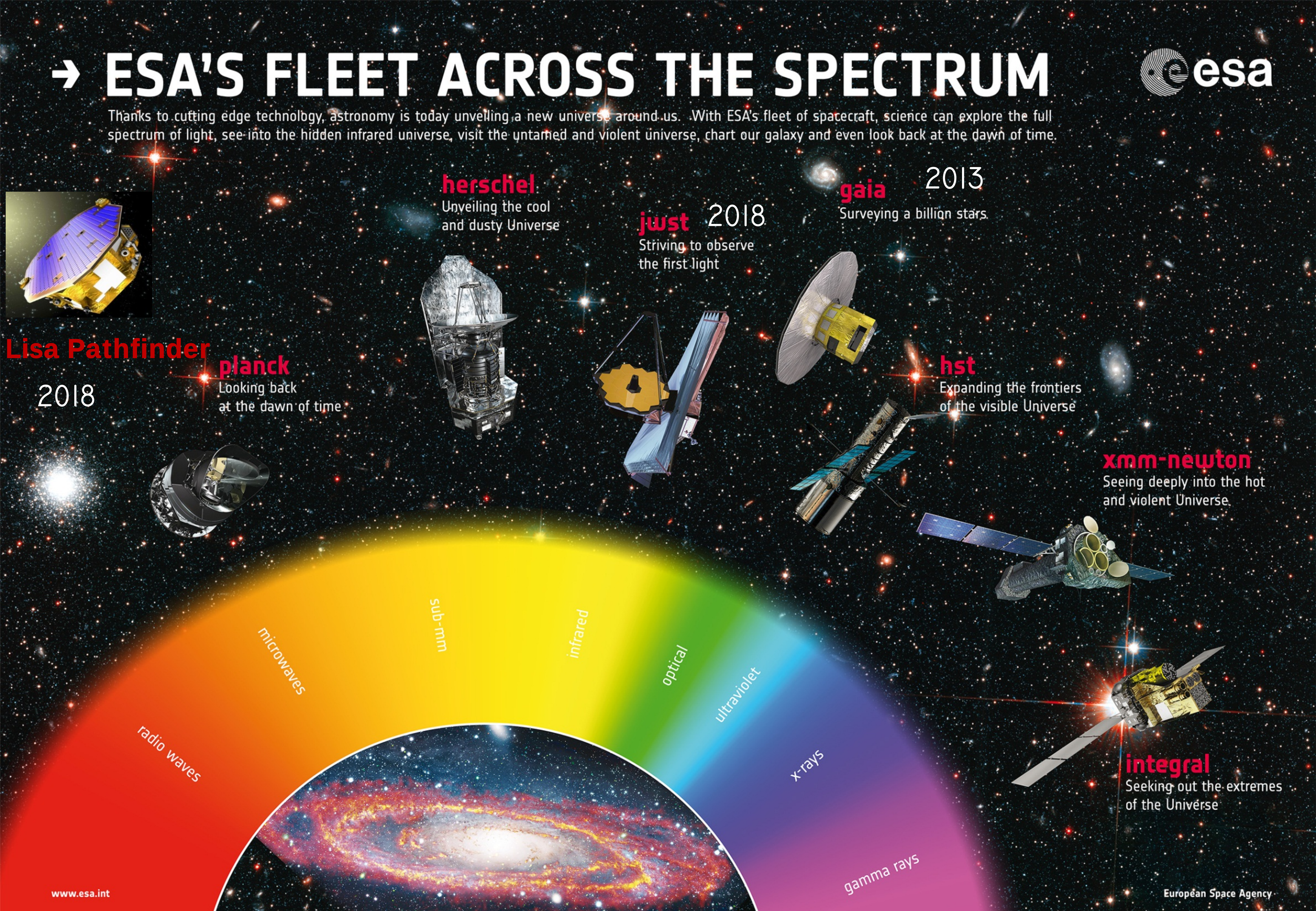
Outline

- Space Environment Monitoring in the various ESA programmes
- Role of in-situ Measurements
- Issues and things to aim at
- Harmonisation, coordination and networking

Space Environment Monitoring in ESA Programmes





→ ESA'S FLEET ACROSS THE SPECTRUM
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Lisa Pathfinder
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planck
Looking back at the dawn of time
herschel
Unveiling the cool and dusty Universe
jwst 2018
Striving to observe the first light
gaia 2013
Surveying a billion stars
hst
Expanding the frontiers of the visible Universe
xmm-newton
Seeing deeply into the hot and violent Universe
integral
Seeking out the extremes of the Universe
radio waves
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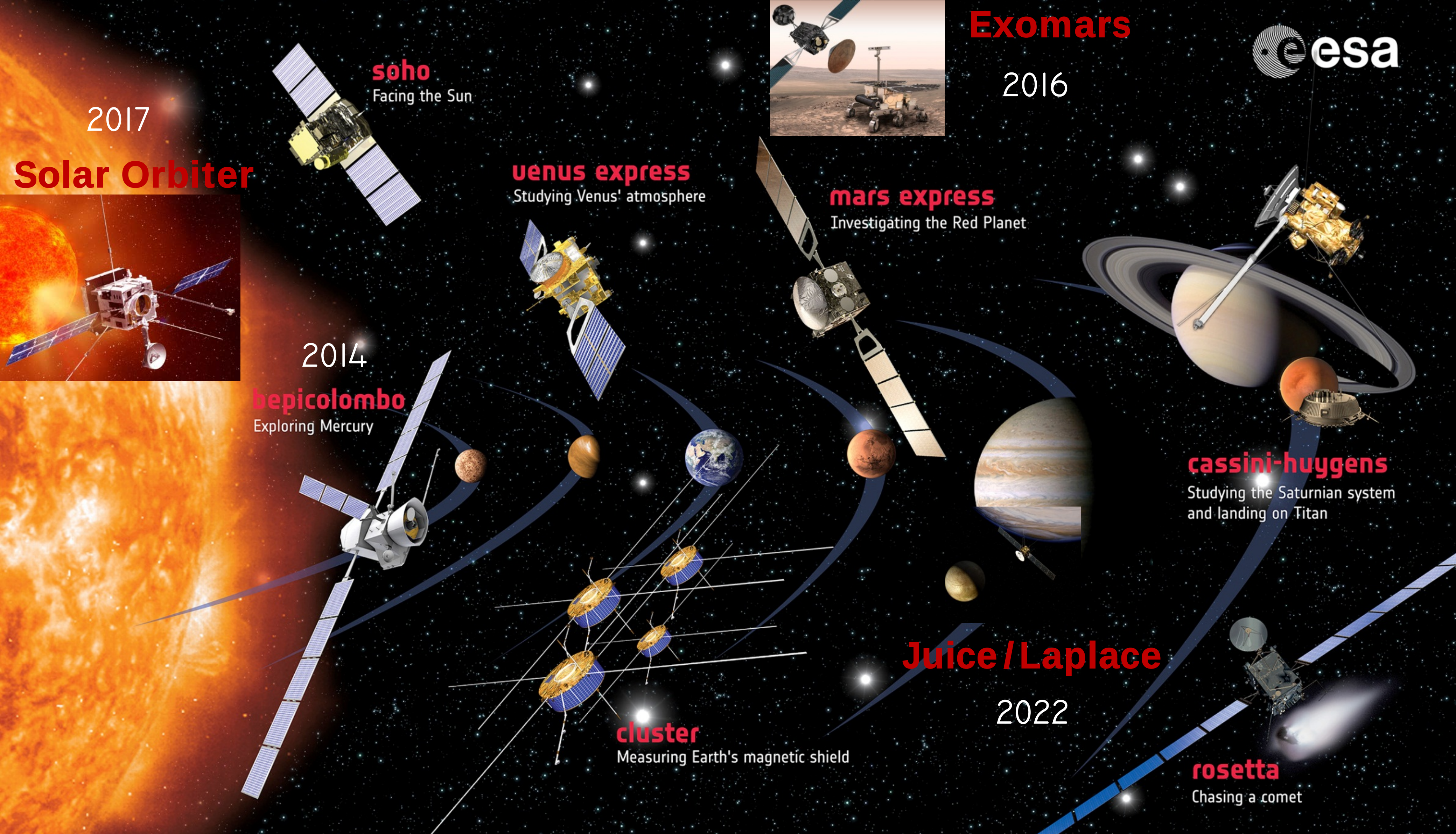

→ ESA'S FLEET IN THE SOLAR SYSTEM

The Solar System is a natural laboratory that allows scientists to explore the nature of planets. ESA's missions to our planetary neighbours have transformed our view of the celestial neighbourhood. The planets that exist today are the result of 4.6 billion years of formation and subsequent development. Studying how they appear now allows us to unlock the mysteries of their past and to predict how they will change in the future.

Space Environment Monitoring in Science Missions

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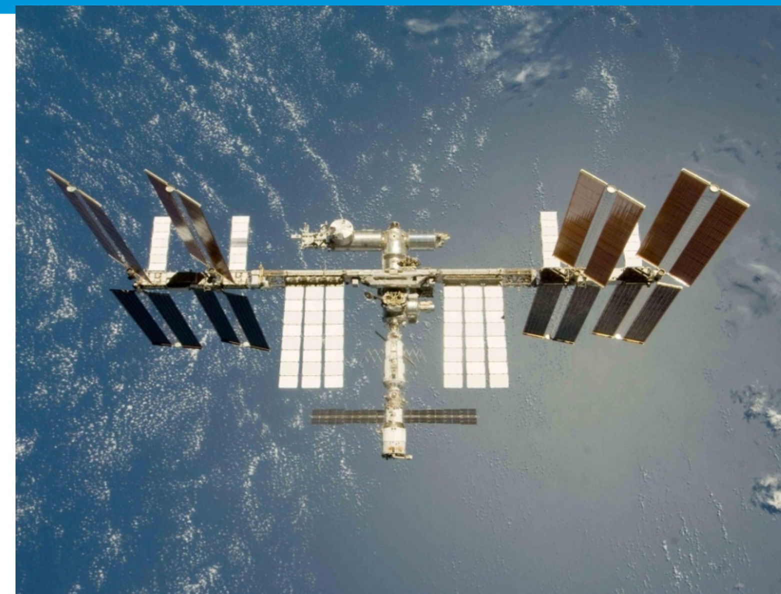
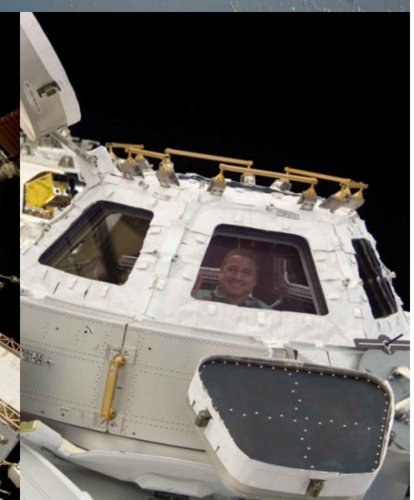
- Each mission has special requirements and responds to the space environment in a different way
- Known issues:
  - "background"
  - instruments damage
  - charging
- **Past** missions: often in orbits passing through the Earth radiation belts
  - Missions carrying radiation monitors are producing valuable data that are key for improving models and tools for the benefit of the whole space community
- Current generation of major missions take place at **L2**:
  - JWST (IR), Herschel (Far-IR), Planck (sub-mm), GAIA (visible)
- Next generation missions go to poorly known environments
  - Solar Orbiter (Sun), Laplace (Jupiter)
- Radiation exposure minimization major mission design driver
  - Radiation and Plasma Monitoring is a necessary component of the overall system reliability assurance

Human Spaceflight programme

- After Apollo Era Earthlings have not made it further than International Space Station.
- Radiation effects on astronauts are acknowledged to be the show-stopper for missions outside the magnetosphere
- The two key European contributions to ISS are the **Columbus** laboratory and the **Automated Transfer Vehicle** (ATV). Europe has also provided almost 50% of the pressurised part of the ISS, including **Cupola, Node-2** and **Node-3**.





Radiation effects and monitoring for astronauts

- Human Spaceflight missions have their own special radiation issues.
- Radiation exposure on long duration missions is one of the main mission design drivers
  - *design of habitats should minimize doses from Cosmic Rays*
  - *special measures to warn and protect from solar particle events will also be necessary*
- Electronic and other systems supporting Human Spaceflight missions also have to have high reliability & radiation hardness.
- **Dosimetry and radiation monitoring is an essential component for reducing the biological effects uncertainties**

SPACE SITUATIONAL AWARENESS

The **Space Situational Awareness (SSA)** initiative aims to provide Europe with services to protect satellites and Earth. The initiative supports Europe's independent utilisation of space, through provision of timely and accurate information about the space environment.

Within the Space Weather Segment developments of a number of key instruments has been initiated including instruments designed for in-situ measurement of the solar wind and space environment at critical Earth orbits.

EARTH OBSERVATION AND METEOROLOGICAL MISSIONS

- Most of the earth Observation missions use polar orbits (~600-900 km) with a challenging Mixed environment (Earth Radiation Belts + Cosmic rays)
  - E.g. MetOp: a series of three satellites to monitor climate and improve weather forecasting, the space segment of Eumetsat's Polar System (EPS). Metop-B launch due summer 2012
- Other missions (e.g. Meteosat Third Generation) will face the challenges of long duration (~15 years) in GEO.

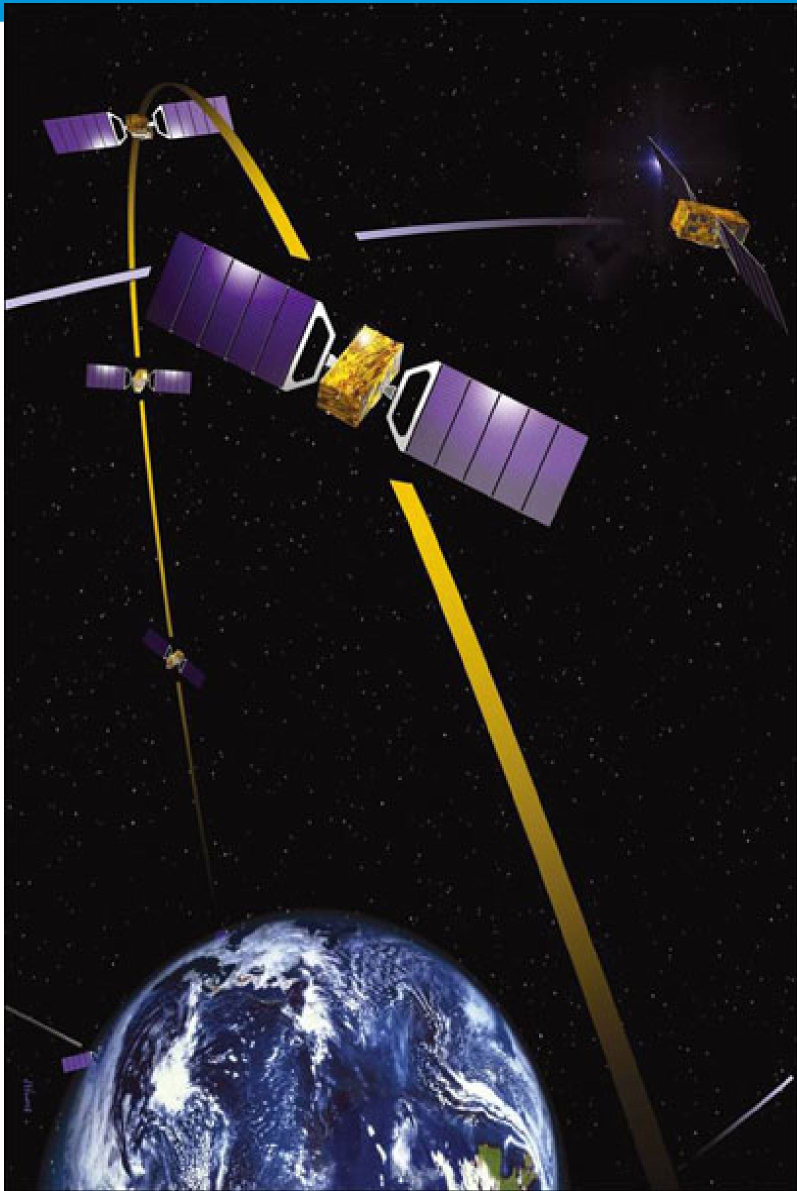
TELECOMMUNICATIONS

- Telecommunications spacecraft in GEO:
  - environment dominated by energetic electrons of the outer radiation belt;
  - High lifetime dose
- For example Alphabus (multipurpose platform exploited by European industry to build future high-power communication satellites) on its first mission, Alphasat due for launch in 2013 will carry radiation in-flight experiments

- Low altitude constellations (e.g. Globalstar at 1400km)
  - Mixed environment
  - High lifetime dose

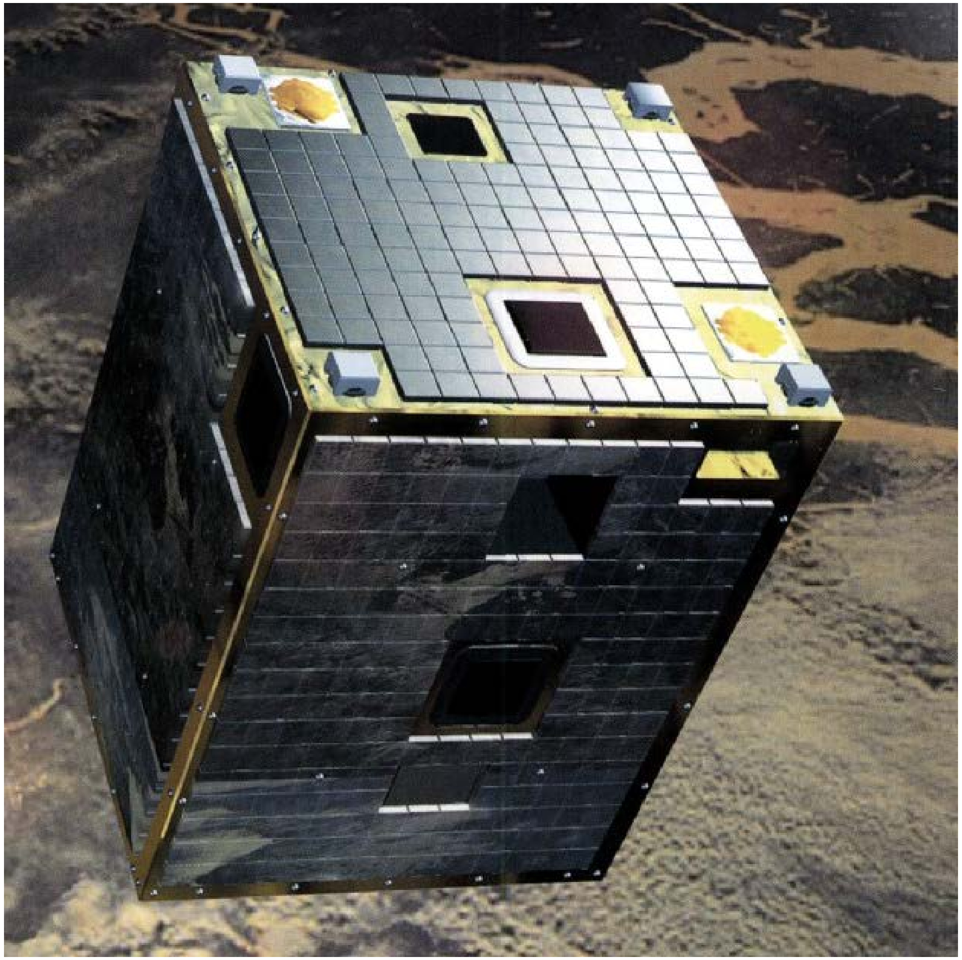
GALILEO: SATELLITE NAVIGATION

- Navigation systems fly at
  medium altitude with highly inclined,
  circular orbits.
  → heart of the radiation belts.
- The full Galileo system will consist of 30 satellites and the associated ground infrastructure.
- Space environment effects are a key design driver and the major potential cause of failures but overestimation of margins has big impact on industrial costs → need to accurately characterize the environment



In-orbit demostration: PROBA

- Proba satellites are part of ESA's In-orbit Technology Demonstration Programme.
- New technology products need to be demonstrated in orbit, particularly when users require evidence of flight heritage or when there is a high risk associated with the use of the new technology.
- **Proba-1** (2001–) and **Proba-V** (2012) are both carrying radiation monitors



Space environment measurements role

- Monitors should address platform requirements (alerts, operations, housekeeping)
- Provide data to investigate effects
  - e.g. Technology effects test-beds
- Provide data for key or poorly known environment:
  - e.g. Galileo; Globalstar; GEO; PEO; Jupiter; Mercury; Mars
- Provide data for wider "community" application
  - e.g. Space Weather Segment of SSA
- Dedicated "science-class" instruments on appropriate platform
  - ultimate solution to modelling needs
- Keeping in mind the costs of (miniature, standard, "science") equipment and integration
- Develop policies for data distribution

Issues and things to aim at

- In-flight experiments must address
  - Environment models
  - Transport of radiation/plasma interaction simulation
  - Space Environment Effects
  - validation of methods of analysis (computational tools, models) and ground-based testing with the objective of identifying uncertainties and margins
- Funding strategies & programme issues
  - perennial problem with "valley of death" (difficulty to go from relatively low funding for prototypes to qualified and embarked flight models);
  - specific project needs have to be addressed - opportunities growing for project-specific support (often with specific national constraints);
  - SSA promoting a broader view and foreseen to allow instrumentation development and deployment
  - national interests that benefit the European community through collaborations

Harmonisation, coordination and networking (I)

- ESA & member states agreed to better coordination of activities in technology domains (TDs)
- TD 4 = **space environments and effects;**
- Formal harmonisation in 2006, updated 2009;
- Review of
  - Needs (future European programmes)
  - Global landscape
  - Activities in member states
  - Capabilities in member states
- Preparation of a **roadmap** of coordinated ESA, national developments
- Used to support R&D programme preparation (ESA TECNETs, etc.)

Harmonisation, coordination and networking (II)

- Work done within **SEENoTC** (Space Environments and Effects Network of Technical Competences) to identify, discuss, propose R&D: http://space-env.esa.int/index.php/SEENoTC.html
- Community events:
  - Round tables (e.g. radiation monitors RT)
  - Workshops (e.g. SEENoTC workshops like this)
  - Final Presentation Days
  - Conferences (e.g. RADECS, European Space Weather Week)