R&D requirements for future studies

Round Table Discussion

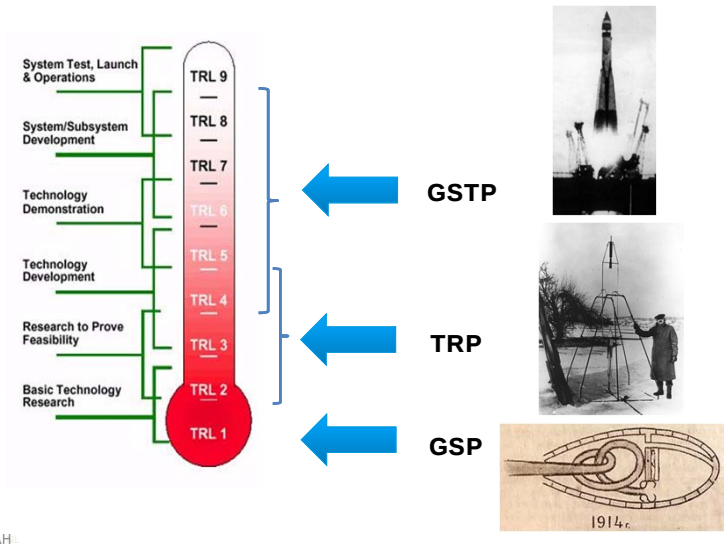
Animator: A. Hilgers

R&D programmes

- GSP, General studies programme: concept studies
- TRP, The Basic Technology Research Programme: early development stages across all service and technology domains, taking cutting-edge ideas and testing their suitability for space applications.
- GSTP, The General Support Technology Programme takes previously proven innovations through to succeeding stages of engineering, finally evolving fully-tested hardware ready for adoption by future missions.

- Other technology programmes serve specific fields:
  - the Advanced Research in Telecom Systems (ARTES) programme supports the evolution of satellite telecommunication systems and services.
  - The Future Launchers Preparatory Programme (FLPP) develops new technologies and capabilities for European launchers
  - GNSS evolution programme

Technology Readiness Levels



Technology Research Programme

TRP organized in Service Domains (SDs):
SD1: Earth Observation
SD2: Science
SD3: Human Space Flight
SD4: Launcher and Space Transportation
SD5: Telecommunication
SD6: Navigation
SD7: Generic Technologies
SD8: Civil Security (responsible for SSA technology development)
SD9: Robotic Exploration

- Last Call for Proposal for 2011-2013 plan covered SD1, SD4, SD5, SD6, SD7

General Studies Programme

Examples of planned GSP studies:

- Passive discharging of electrical potential by electron field emission
- Plasma induced antenna noise spectroscopy for space weather monitoring
- Detection of micro-particle impacts on spacecraft via their plasma effects

Near-Earth Minimum System (NEMS)

- Dusty Plasma Near-Surface Environments

TRP

- Lunar dust environment…

General Support Technology Programme

Recently approved GSTP-5 activities:

- Next Generation Radiation Monitor (NGRM)
- Next Generation Space Environment Information System
- High-Fidelity 3-D Energetic Electron Spectrometer (3DEES)
- Service-Oriented Spacecraft Magnetometer Set (SOSMAG)

General Support Technology Programme

Some studies requiring support from member states:

- 3-D solar wind plasma monitor
- Distributed Environmental Data-Driven Analysis System

Space situational awareness pp

- SSA is investigating flight opportunities for space weather monitoring payloads.
- A study has been initiated under SSA-PP for studying the design change to host secondary space weather payloads (i.e., no cost to hosting platform programme).
- Any other cost incurred by the hosting activity is planned to be covered by the next phase of the SSA programme.
- Next phase of programme should include a R&D element.

Types of instruments to embark as hosted payload

- Low Energy Particle Monitors (<3 kg, <3 W)
  - Langmuir Probe
  - Ionosphere/magnetosphere plasma analyser (e.g. AMBER)
  - Solar Wind plasma analyser
- Medium and High Energy Particle Monitors (<3 kg, <3 W)
  - Universal Monitors (e.g. NGRM)
  - Monitors designed for MEO (e.g. EMU)
- Dust Detectors (e.g. AIDA) (<2 kg, <9 W)
- Effects Monitors (e.g. IDDM)
- GNSS Receivers (2.4 kg, 15 W)
- Magnetometers (e.g. SOSMAG) (2kg, 3W)
- Imagers
  - Solar imagers (e.g. ESIO)
  - Earth imagers
- Solar EUV and X-ray Radiometers/Spectrometers (e.g. EUFM/XFM) (1.5kg, 4 W).
- Accelerometers (<3kg, 3W)

Example List of ESA Missions

SSA SWE is fundamentally interested in all orbits where spacecraft operate and some others for remote observations. However, for piggybacking we can consider:

- LEO Orbits
  - MetOp-C (SSO – 825 km [2015/2016])
  - Metop 2nd generation
  - Jason CS (PEO 1200 km [2017]).
  - Proba-V (already plan an ESA energetic particle spectrometer, EPT)
- MEO Orbits
  - Galileo FOC (23,222 km [tbc]) [already plan ESA radiation monitor – EMU]
- GEO Orbits
  - EDRS-C [end of 2015]
  - Alphabus
  - MTG [already plan an ESA radiation monitor, NGRM. Need plan on data dissemination]
- L2 Orbits
  - Euclid [2018]
- L1 Orbit
  - LPF [2014]

CNES approved activities 2012

- Framework agreement with ONERA:
  - Conductivité des céramiques (pour les tubes à onde progressive) Emission électronique secondaire (pour les composants RF et les spacecraft charging)
  - Charge par électrons de haute énergie (conductivités des diélectriques irradiés, PEA…)
  - Vieillissement électriques de matériaux (études physico-chimiques)
  - Arcing - flash-over Décharges électrostatiques et arc sous tension (sur coupon de GS)
  - Physique de la décharge électrostatique (ESD déclenchée, spéctro optique)
  - Anomalie composant Single Event par ESD en charge interne (couplage EMC)
- Other:
  - Amber development
  - Comparison SPIS – NASCAP 2K

Technical Dossier inputs

18th SPINE workshop
7th March 2012, ESTEC

- Environment
- Tools
- Hardware

Environment: modelling

- Research areas
  - Development of statistical models of plasma environment in Earth orbit including the Galileo orbit.
  - Develop continuous models covering plasma and high energy electron environment to allow simultaneous consideration of surface and internal charging.
  - Identify, preserve and utilise the various science plasma datasets that are relevant for plasma model development.
  - Develop plasma environment model for Jupiter.
  - Model distribution of charged dust around airless bodies
  - Predictive models of plasma enhancements
  - Global modelling from point measurements

Environment: understanding

- Research areas
  - Dust/plasma interactions, Dust motion under natural fields on the moon and asteroids. Charged dust behaviour around spacecraft/astronauts.
  - Dust control methods using fields
  - Prediction of plasma and high energy electron enhancements from space weather

Environment: observations

- Research areas
  - Fly plasma monitors in GEO and MEO
  - Characterise ESD/transients in spacecraft
  - Observe link between environment, charging, ESD and anomalies
  - Long-term (~solar cycle) observations

Tools

- Research areas
  - Improved engineering tools with simplified standard GEO/MEO charging simulation tools, simulation of 3-d effects in internal charging, and prediction of ESD characteristics both for surface and internal charging.
  - Allow exchange of geometry information between charging and other analyses.
  - Address combined effects of internal and surface charging.
  - Allow more accurate calculation of non-ESD related charging levels for science missions.
  - Develop tools for better simulation of electric propulsion design and interaction of electric propulsion with s/c.
  - Validation of surface and internal charging tools against experiment and other tools used by industry and others.

Inputs from spine based on discussions

- Sensitivity/ error analysis of spis models
- Cf list of spine dev by Astrium
- More massive parallelisation
- Good interface to extensive material database
- E field enhanced conductivity model accuracy
- DDC at very low dose in thick dielectric (such as mirror).
- Validation of charging code with Freja (or other) observations

Hardware

- Research areas
  - Active and passive emitters for spacecraft potential control
  - Leaky insulators for charge mitigation
  - Plasma monitors
  - ESD/transient monitors
  - Electrodynamic tethers
  - Plasma test facilities