

# Spacecraft Charging European overview

- **European Space Agency**  
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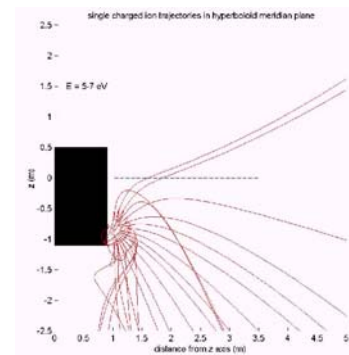
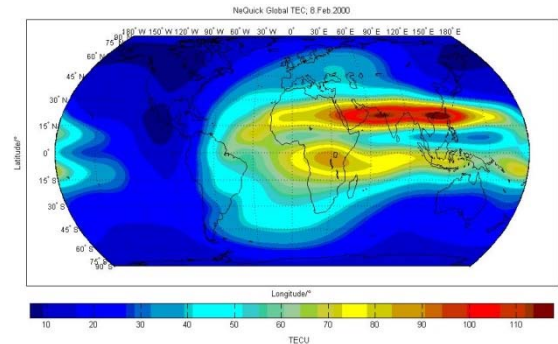
# ESA's relation to spacecraft charging

- ESA runs a space programme on behalf of its 20 member states + associated.
  - Science
  - Applications
  - Launcher
  - Technology
  - Education
  - Other ...
- in collaboration with National agencies
- Plasma is a factor to take into consideration in mission preparation and operation



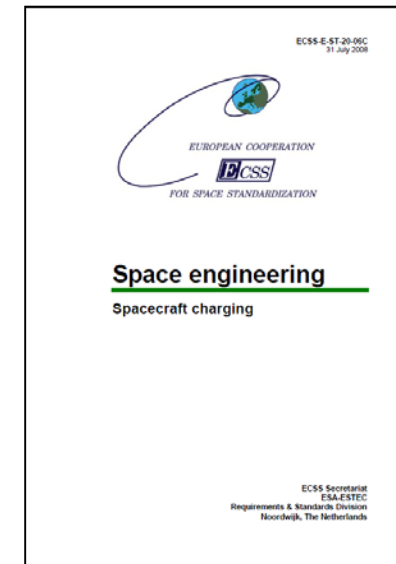
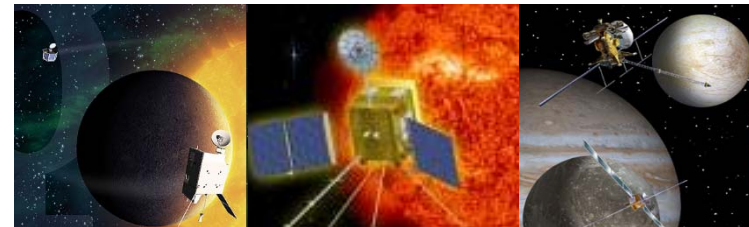
# Plasma interactions with space systems

- Useful:
  - Detection of particles and fields
  - Remote sensing
  - Propulsion
- Harmful:
  - Contamination and interferences
  - Electrostatic discharges



# Activities

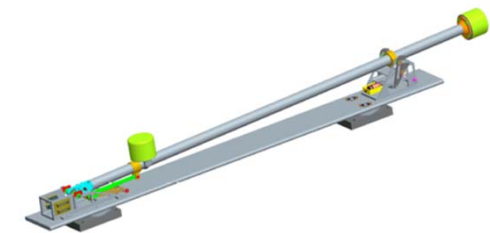
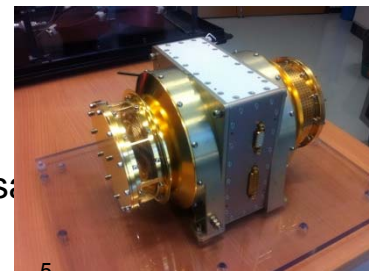
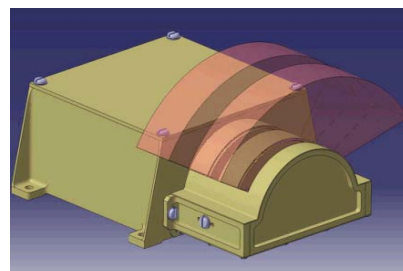
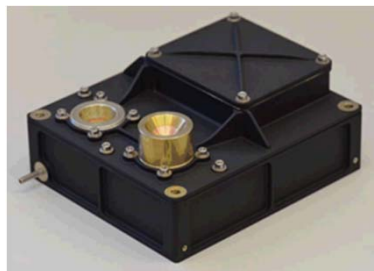
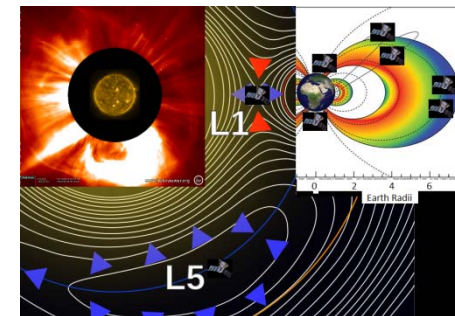
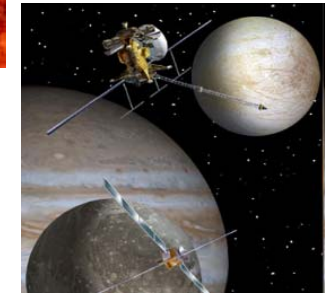
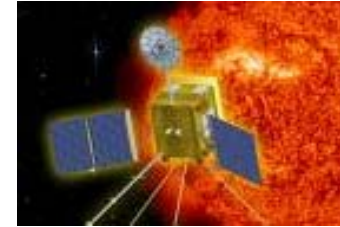
- Coordination activities
  - Define European space programme in coordination with member states :
    - Space missions
    - Support R&D activities
  - Reinforced coordination on spacecraft-plasma interactions :
    - SPINE
    - -> Harmonisation board -> MS programmes
    - -> ESA Technical dossier -> R&D programme
    - Coordination with EU
  - International collaborations:
    - Standards: ECSS, ISO
    - Support to SCTC-1998, 2001, 2003, 2005, 2007, 2010, 2012, 2014, 2016?



SCTC13, Pasadena, Ca , Jun. 2014

# Highlights since last SCTC: Missions

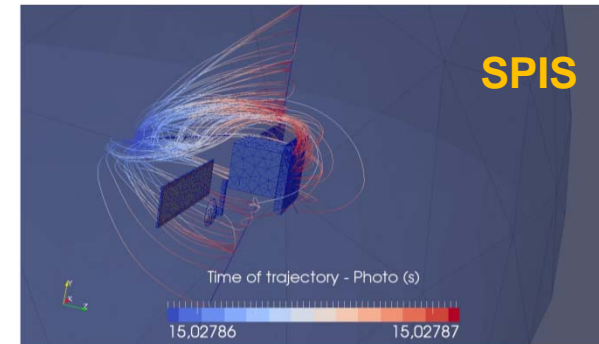
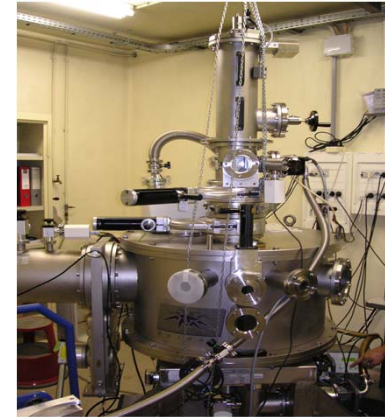
- Solar Orbiter : thorough analysis of charging impact on plasma instruments in early phase.
- JUpiter ICy moons Explorer (JUICE): critical issues (very cold surfaces, high MeV) related to deed-dielectric charging but also surface and space charge effects on plasma environment
- ESA space situational awareness programme preparation :
  - A service segment with prototypes running
  - A space segment architecture with dedicated satellites and hosted payloads:
    - Hosted payloads include high energy: EMU on Galileo, NGRM on MTG and EDRS
    - and low energy: Plasma spectrometer (Hope) on Proba-3
    - and magnetometers
- Note: Also national missions and EU (e.g. QB50)





# Highlights since last SCTC: Technology

- ESD characterisation and mitigation
  - ESD model (laboratory tests and numerical models)
  - ESD detector
  - ESD mitigation
- Development of modelling capacities
  - Improvement of test facilities (Major CNES supported initiative)
  - New tools for optimisation of scientific payload (SPIS-5.)
- New plasma technology:
  - Major undertaking on electric propulsion systems
  - Plasma and high energy particle sensors
  - Charge mitigation devices
  - Electrodynamics tethers and electric sail mainly funded by the UE framework programme



## See more with ~30 conf papers

- Surface Charging of the Jupiter Icy Moons Explorer (JUICE) - F. Cipriani
- Thierry Paulmier, et al, Analysis of charging kinetics on space dielectrics under representative worst case geostationary conditions
- Study and Simulation of Low Energy Plasma Measurement on Solar Orbiter -Stanislas Guillemant
- Jean-Charles Mateo-Velez GEO spacecraft worst-case charging estimation by numerical simulation
- Design and numerical assessment of a passive electron emitter for spacecraft charging alleviation - Jean-Charles Mateo-Velez
- Worst case of Geostationary charging environment spectrum based on LANL flight data - Denis Payan
- Thierry Paulmier, et al.Experimental test facilities for representative characterization of space used materials
- Thierry Paulmier, et al Charging Properties of Space Used Dielectric Materials
- Measurements of physical parameters characterizing ESDs on solar cell and correlation between spectral signature and discharge position-Inguimbert Virginie
- Siguier Jean-Michel Arcing test on an aged grouted solar cell
- Study of secondary arcing occurrence on solar panel backside wires with cracks -Siguier Jean-Michel
- Radiation Induced Conductivity Of Space Used Polymers Under High Energy Electron Irradiation-Thierry Paulmier, et al.
- ECSS Charging Standards - D. Rodgers, et al.
- Interdependencies Between The Actively Controlled Cluster Spacecraft Potential, Ambient Plasma, And Electric Field Measurements -Klaus Torkar and Rumi Nakamura
- Degradation of solar cells due to in orbit electrostatic discharge? - Andreas Gerhard
- A Panorama of Electrical Conduction Models in Dielectrics, With Application to Spacecraft Charging-Philippe Molinié
- Magnetic Signals Generated by the Interaction of a Swarm Satellite with Space Environment -Saeed-ur-Rehman
- Plasma Thruster Beam Expansion and Impingement in Space Debris-M. Merino, F. Cichocki, and E. Ahedo
- A. Hilgers, et al. - Test results of a spherical Langmuir probe with retarding grids
- Antonio Sanchez-Torres Application of Electrostatic Tethers for Scattering of Relativistic Particles in the Earth's Radiation Belts
- SPIS 5.1, disruptive software technologies in spacecraft plasma modelling -B. Thiébault, et al.
- Survivability of tape tethers against multiple impacts with debris and micrometeoroids-Ricardo García-Pelayo; Shaker Bayajid Khan; Juan R. Sanmartin
- P. Sarrailh, et al., Measurement of the magnetic field and the shape effect on the plasma collection by a positive biased tether
- SPIS 5: new modelling capabilities and method for scientific mission-P. Sarrailh, et al.
- P. Sarrailh, et al., Marple Extension of SPIS to simulate dust electrostatic charging, transport and contamination of lunar probes
- Propulsive Force in an Electric Solar Sail for Outer Planet Missions-Antonio Sanchez-Torres
- M. Belhaj, et al., Xe erosion effect on the electron emission yield of coverglass
- Temperature Effect on the Electron Emission Yield of Bn-SiO2 Under Electron Irradiation-M. Belhaj, et al.
- M. Belhaj, et al., Influence of the Injected Charge Polarity on the Electrical Behavior of CMX 100-AR Cover Glass Submitted to Electron Irradiation
- M. Belhaj, et al., Electron Emission Properties of Space Used Dielectric Materials
- Preliminary conductive-tether design for de-orbiting from given altitude and inclination - Juan R. Sanmartin