Preliminary conclusions of 13th SPINE Meeting regarding the specifications for space plasma environment and effects monitoring

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Types of instruments

- Depending on their use and their performance, plasma and effects monitoring devices can be classified into 2 general classes and 4 categories.
- Devices designed for providing in-situ environment data to the host spacecraft :
  - • (1) Coarse housekeeping sensors
  - • (2) Alert and safeing function
  - • (3) Support to platform and payload systems
- Devices designed for providing data usable for engineering models improvement or for general space weather services :
  - • (4) Future mission preparation and provision of science data
  - • (5) Effects experiments
- Categories (3) and (4) have quite similar specifications (see below). This similarity rises, in particular, a further interest in collaboration between agencies and industries because most of the data used for spacecraft support can also be used for model improvement purposes, with the medium term common benefit of better environment models.
- Specifications for the four classes are detailed below. The specification for category 4 monitors is followed by a tentative specification for measurement mission plans proposed to space agencies and industrial partners.

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Coarse ES-ESD house-keeping

- by means of simple electrostatic sensors (LP, current measurement, potential measurement, charged contaminants measurements, deep-dielectric charge sensor).
  - Industry have problems with complex powered assemblies (e.g., Solar Arrays)
  - Measurement of potential, currents, detection of discharge occurrence, however not enough information on the cause to completely reproduce/elucidate the phenomenon.
  - Specifications include:
    - -1000 V to +100 V for potential wrt to plasma
    - -1000 V to +1000 V for differential potential
    - Current transient counter
    - Current or potential measurement on one electrode behind shielding (range ?, shielding thickness)

Alert and Safeing function

- Could be based on plasma environment monitor and house keeping sensor such as potential sensor and deep-dielectric charge sensor
  - Specifications for plasma environment monitor include:
    - Coarse electron spectrum 100 eV to 50 keV (~10 logarithmically spaced & overlapping energy channels)
    - Core thermal plasma density (0-100eV)
    - Ion spectrum 100eV to 50keV (~10 logarithmically spaced & overlapping energy channels)
    - Deep-dielectric charging sensor (multipled depth current or potential measurements).
    - Coarse EUV integrated flux monitor

Support platform and payload system

- A plasma environment and effects monitor shall monitor plasma in order to provide the alerts required and in addition:
  - to provide data for evaluation of instrument behaviour,
  - for processing of data and for general platform effects housekeeping, including solar array degradation.
- minimum performance (to be tailored for specific platform and payload and orbit):
  - Coarse electron spectrum 0 eV to 50keV (~20 logarithmically spaced & overlapping energy channels)
  - Ion spectrum 0 eV to 50 keV (~20 logarithmically spaced & overlapping energy channels)
  - EUV
  - ESD detector (radio frequency, transient detector?)
  - Contamination detectors (Witness plate, QCM, …).
  - Deep-dielectric charge sensor
  - For EP sub-system generated plasma:
    - LP
    - ES ion energy spectrometer (0 – 100 eV)
    - QCM

Future mission preparation and provision of science data

- The instrument shall provide data for future mission preparation and scientific purposes, including validation of or improvement of models, and also satisfying all previous requirements. The minimum performance of the instrument shall be as follows:
- minimum performance:
  - Coarse electron spectrum 0 eV to 50 keV (~20 logarithmically spaced & overlapping energy channels)
  - Ion spectrum 0 eV to 50 keV (~20 logarithmically spaced & overlapping energy channels)
  - EUV
  - ESD detector (radio frequency, transient detector?)
  - Contamination detectors (Witness plate, QCM, …).
  - Deep-dielectric charge sensor
- Ideally, same set of sensors in different orbits.
- In case of use of EP:
  - Set of:
    - LP
    - Ion energy spectrometer
    - QCM

EFFECTS EXPERIMENTS

- PEA and other deep charge distribution measurements.
- ESD and their effects characterisation
  - Camera
  - Radio antenna
  - Characterisation of effect on material properties and components (incl. solar cells).
- Active neutralisation experiments
- In-orbit EP plume characterisation
- Material property (conductivity, secondary electron emission) changes

Current Developments

Parameter	Name	Technique	Type	Mass	Power
Surface or s/c potential	LP (e.g., SMART1 SEPE, Cluster/LP, Demeter/LP, EPDP/LP) Spot4/Sillage	LP Vibrating plate			
Integrated thermal plasma	Various LP (Cluster/LP, SMART1/LP, DEMETER/LP, SEPS)	LP			
Thermal plasma energy distribution	EPDP Various ES analyser (e.g., Cluster/PEACE, SIS)	Retarding grid			
keV plasma	LEED AMBER	MeV electron current behind shielding			
MeV electrons	SREM, CEDEX, ICARE/CARMEN SURF CDE	Solid state radiation detector Current behind shielding Charge behind shielding			
ESD	DDE PlegPay	?			
EUV	SolAces SEPS MEDET/EUV	Spectrophotometer LP ?			

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Issues and gaps

- Develop low mass coarse EUV sensor.
- Develop standard flexible plasma monitor covering the required energy range.
- Develop low mass unobtrusive ESD monitors
- Require ground facilities for verification
- Require flight opportunity for in-orbit verification
- Require data analysis programme (incl. distribution policy) and funding