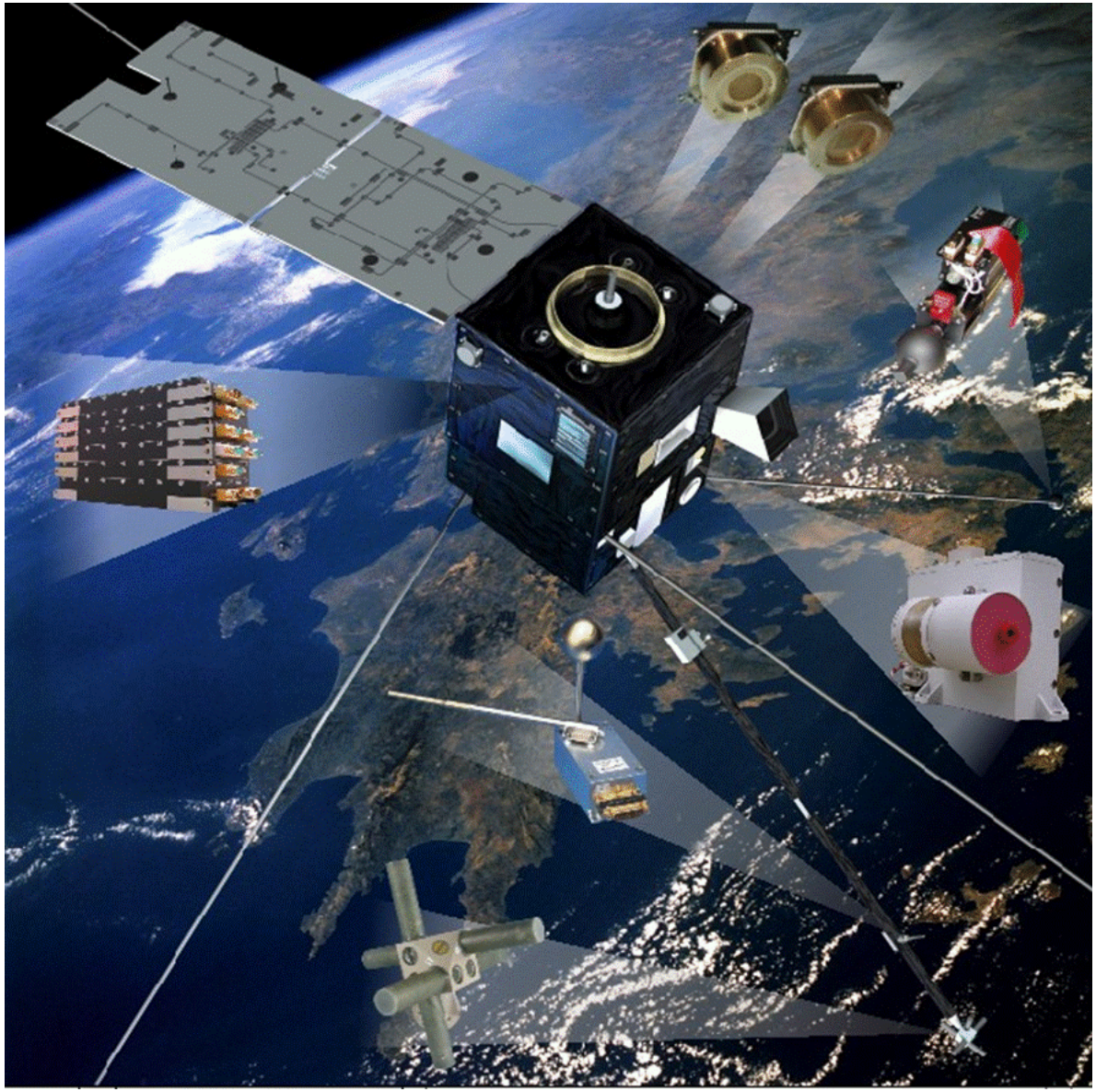
ESA Plasma instrument activities

Langmuir probes (ESA/ESTEC/RSSD)
•ESA Lead Scientist: J-P. Lebreton
•Collaboration with P. Travnicek et al., Astronomical Institute, Prague, CNRS, Czech Space Research Centre
•Demeter: ISL (Instrument Sonde de Langmuir)
•Proba-2: DSLP (Double Segmented Langmuir Probe)

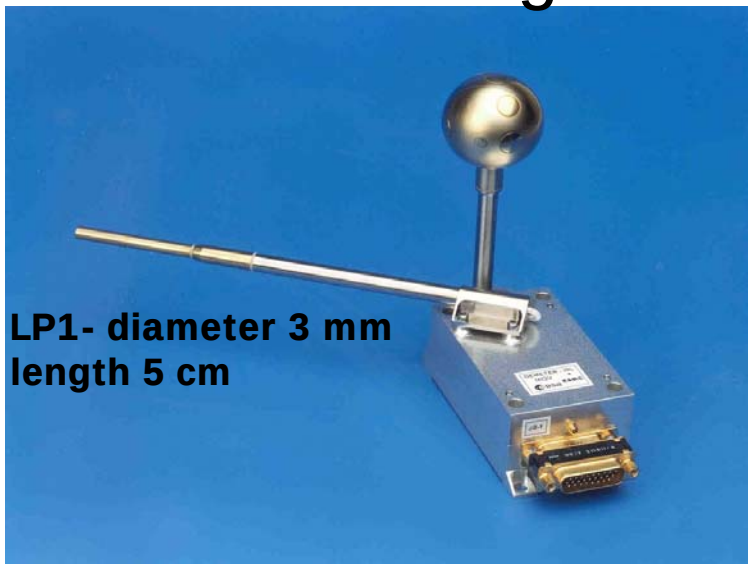
SEPS (TEC-EES GSTP development)
•ESA Tech Officer G.Drolshagen
•Design: G.Schmidtke et al, Fraunhofer Institute, Freiburg,
•Development: Astrium Germany



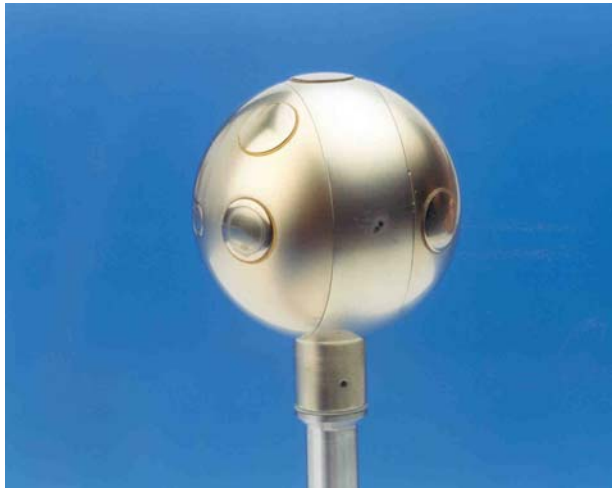
Demeter: Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions

- CNES microsatellite
- Sun-synchronous 715km orbit
- ISL (Instrument Sonde de Langmuir)

ISL Langmuir Probes

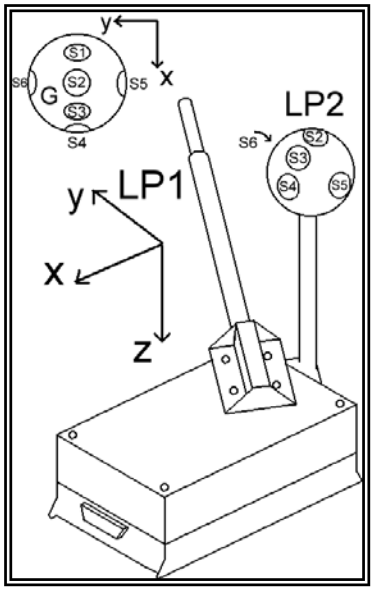


LP1- diameter 3 mm
length 5 cm

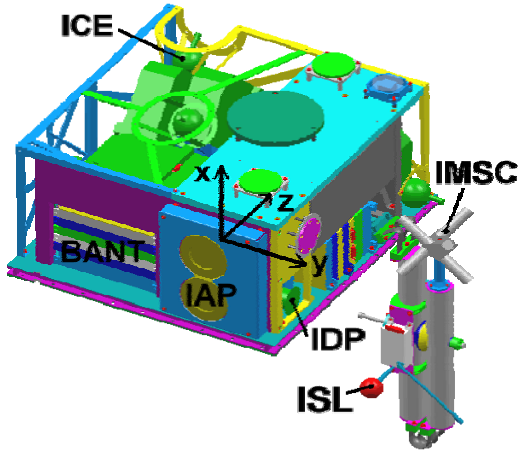


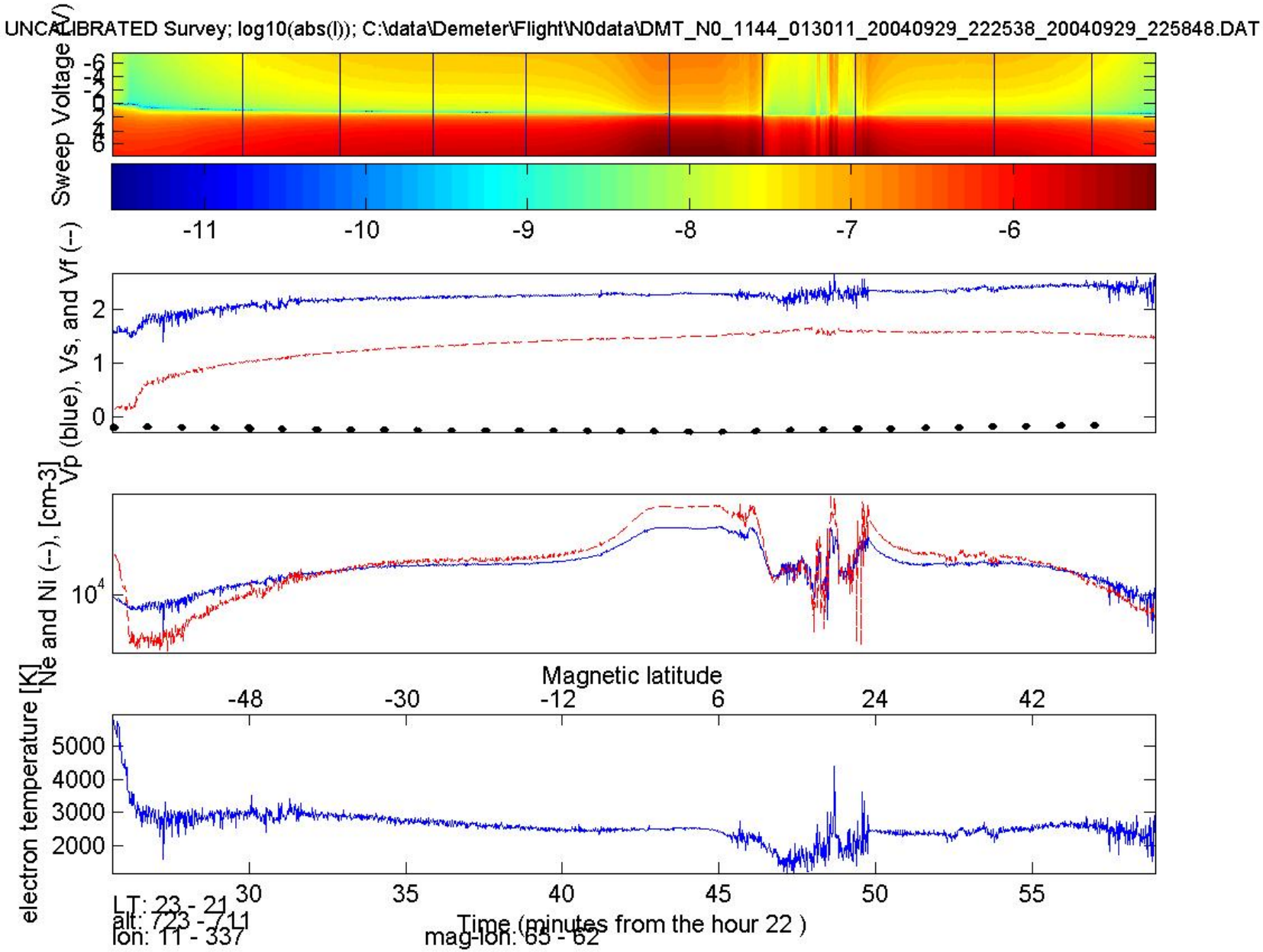
LP2 - ball diameter 4 cm
six surface sectors of diameter 1 cm

1 Hz sweep frequency, [-7.38 .. 7.62 V]
128 sweep points → 8 ms time steps.



Different modes:
- **ISL1-1, LP1 sweep**
- **ISL1-2, LP1 offset sweep**
- **ISL1-3, LP1 vs. LP2**
- **ISL2, LP2 & LP1 sweep**
- **ISL3, surface control**





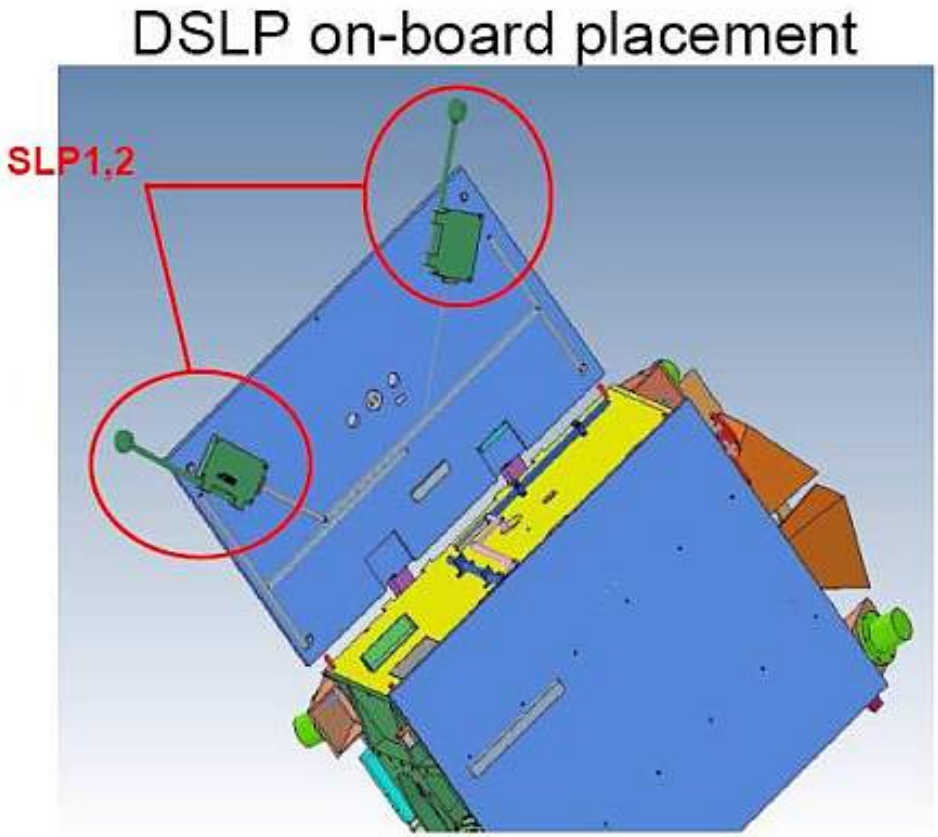
Typical measurements during a 1/2 orbit

Proba-2

- Technology mission
- Solar observatory
- Launch Nov 2009
- ~700km Sun-synchronous orbit
- DSLP (Double Segmented Langmuir Probe)

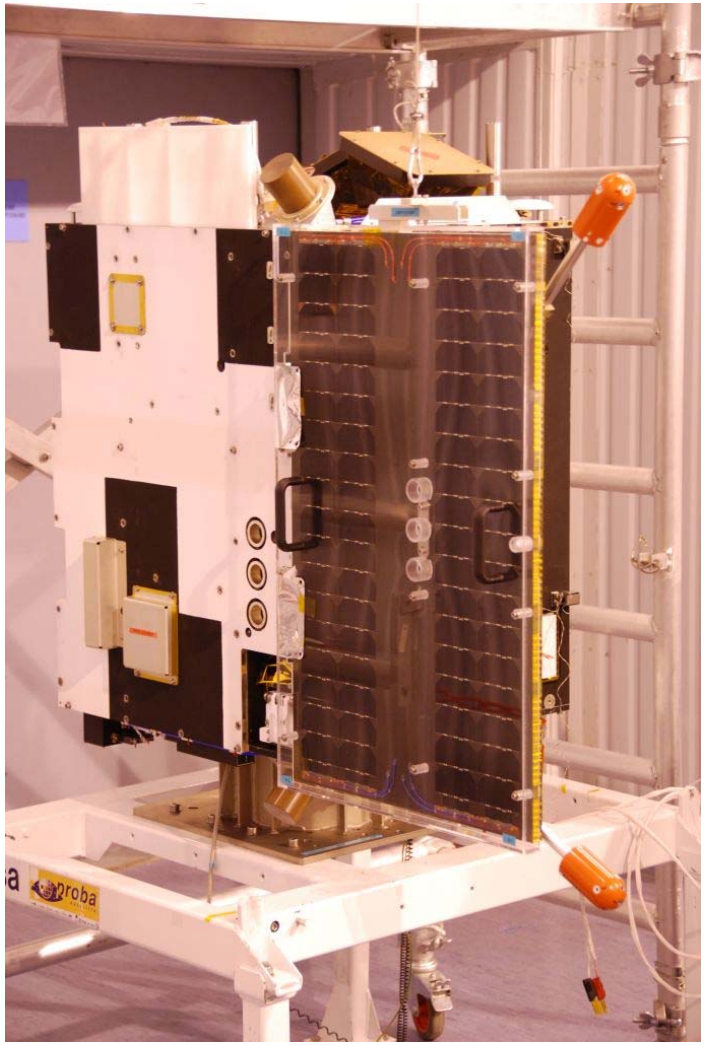
DSLP

- mounted on solar panels
- will measure ambient plasma characteristics

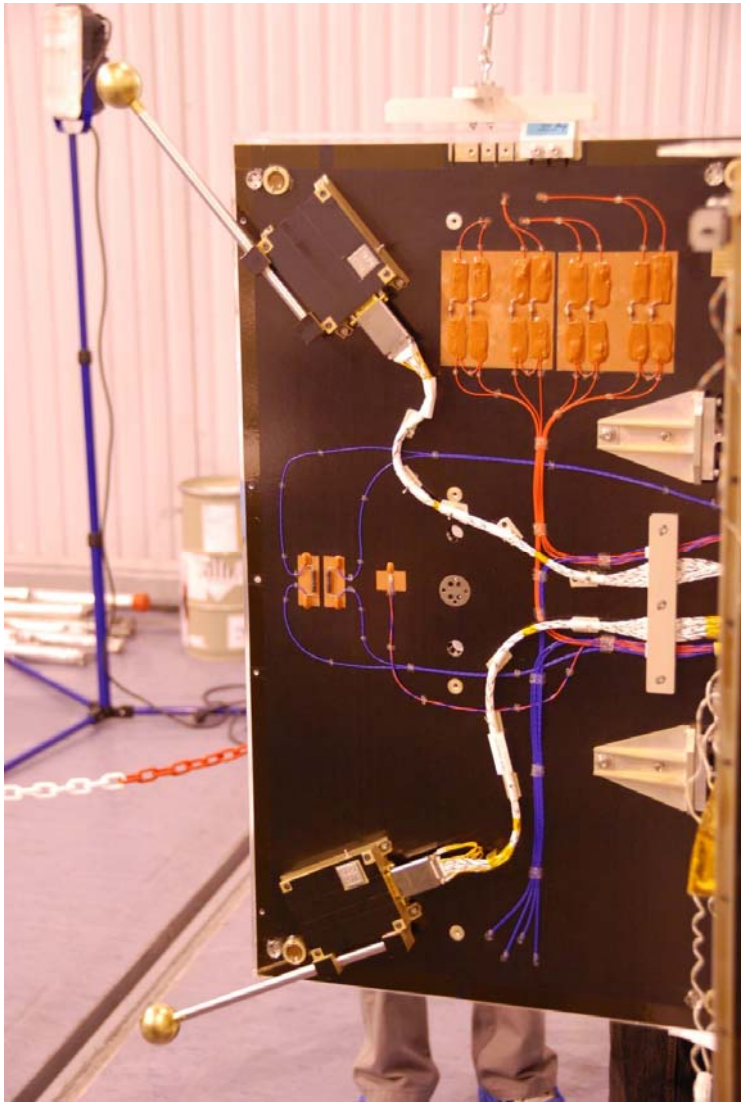


Proba-2 Post-shipment activities in Baikonour, Sept. 2009

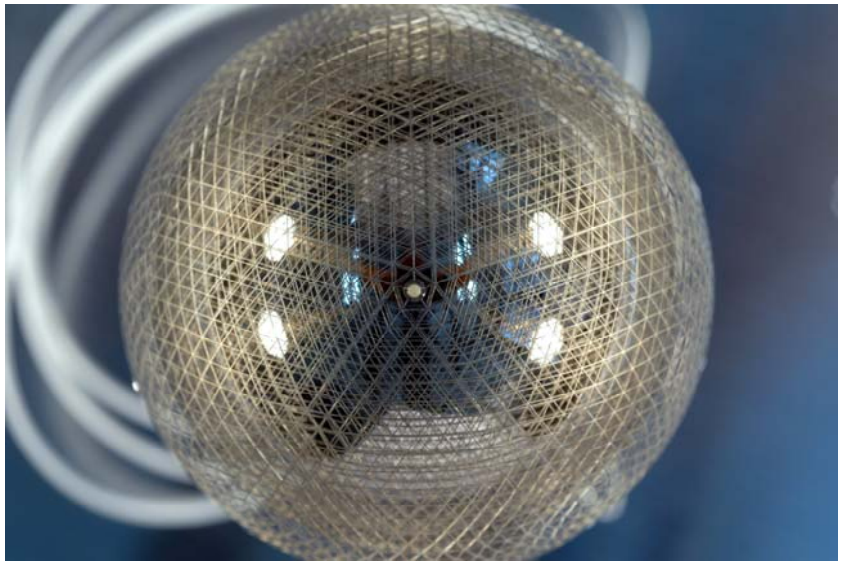
DSLP sensors with Protective Covers



DSLP in flight configuration



Spherical EUV and Plasma Spectrometer (SEPS)



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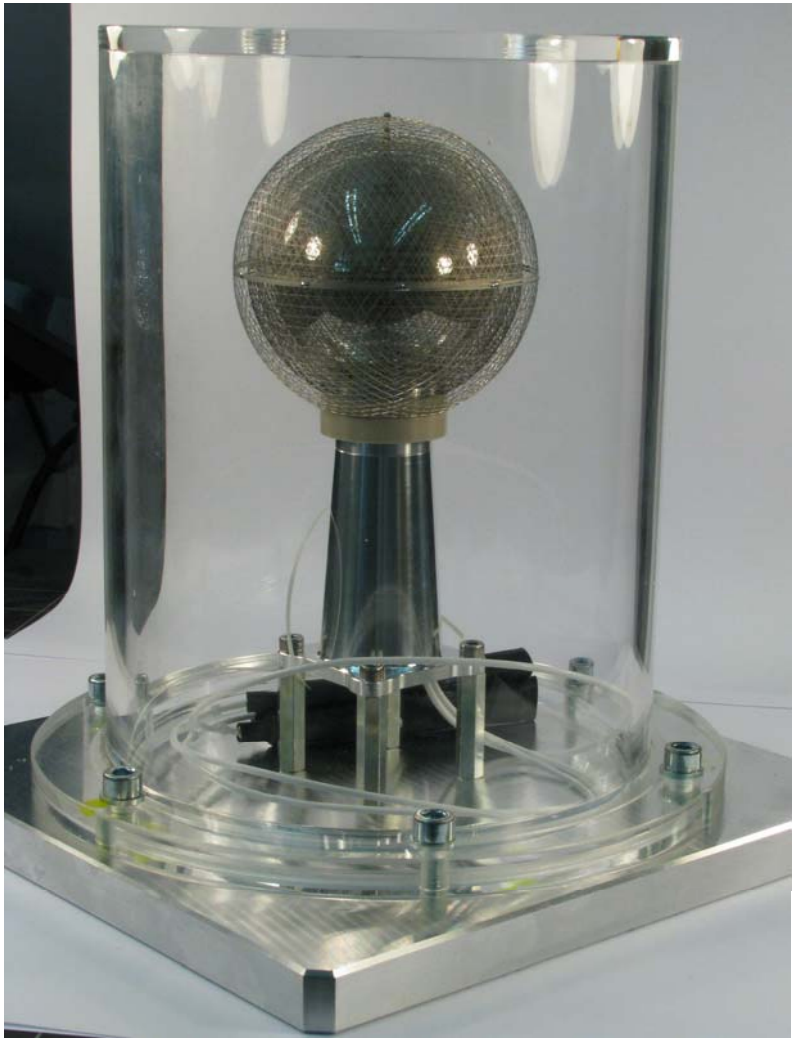
Optimized Design of Plasma Spectrometer

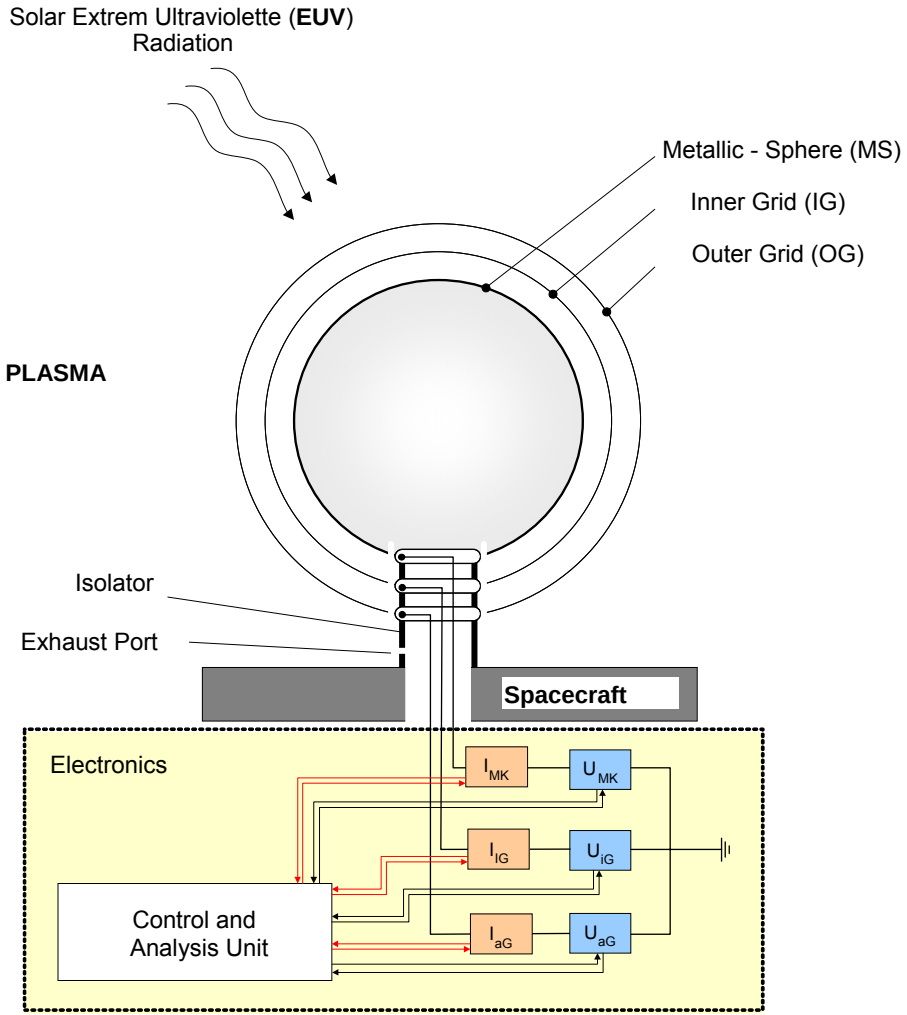
SEPS Sensor with
protection cover (Plexiglas)
without electronics.

A spehreical sensor plus spherical grids (Ni), optimized for best optical transparency.



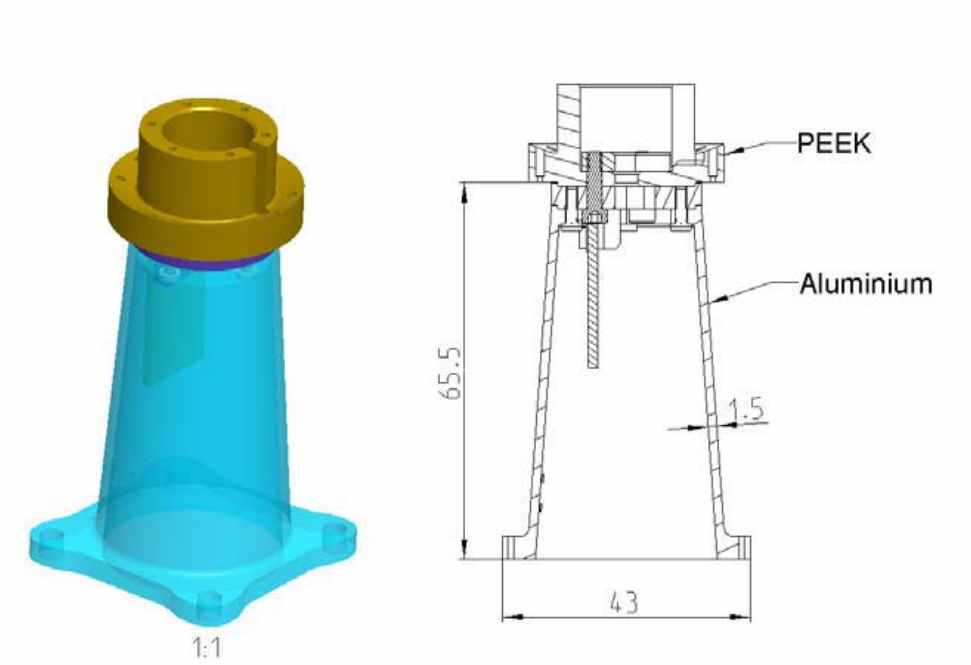
Measurement principle of SEPS

The device consists of three isolated spheres, the metallic sphere (MS), a highly transparent Inner Grid (IG) and Outer Grid (OG). Each one is being connected to sensitive floating electrometers. Simply by setting different potentials to the outer grid as well as to the sphere and varying the voltage to the inner grid, measurements of the ambient plasma parameters and of the extreme ultraviolet (EUV) radiation can be achieved. To reach a more compact configuration of the stack of the spheres from an electromagnetic point of view, the Inner Grid consists of two layers with a distance of about 2 mm.

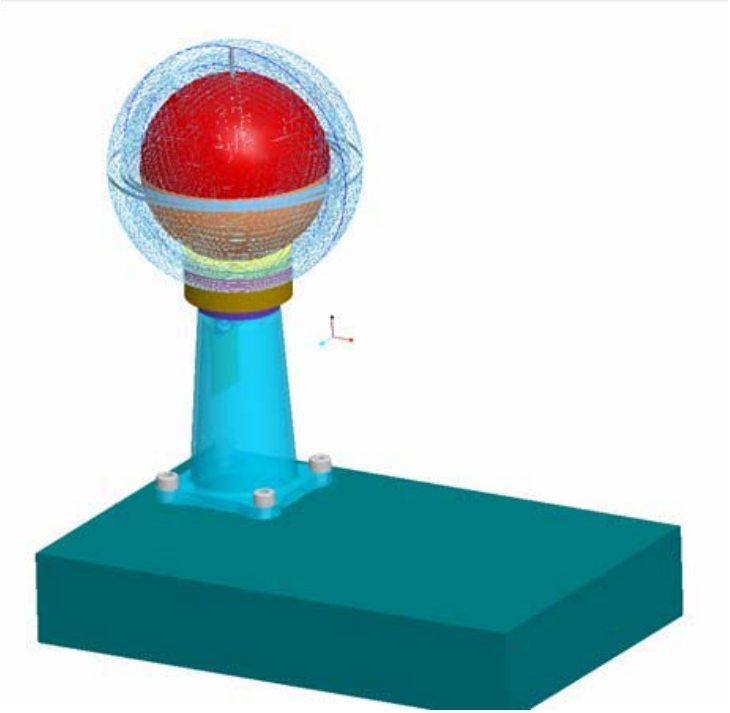


3 x Electrometer: 100 pA – 10 µA
3 x DC: – 70 V to + 70 V

Schematic views of SEPS



Technical drawing of the socket part of the sensor.



Model of the mounting principle on top of the electronic box.

Measurement modes

	Voltage		
Mode	**sphere**	**inner grid**	**outer grid**
Langmuir	+8…-8 =	+8…-8 =	+8…-8
Plasma shielded Langmuir	+20…-70	V_{pl} =	V_{pl}
RPA plasma electron	+20	+10…-70	V_{pl}
RPA plasma ion	-20	+70…-10	V_{pl}
EUV	+70…-70	-50	+50
Calibration	0	-70	+70
Debris (side effect, under evaluation)	different voltage between IG and OG		--

V_{pl}: plasma potential, also determined by the sensor
RPA: Retarded Potential Analyzer

Deduced Parameters

	Description
Parameter	(derived from different measurement modes)
η_e, η_i	electron density, ion density
T_e	plasma temperature
E_e, E_i	energy distribution of electrons and ions
V_{sc}, V_{pl}	space craft potential, plasma potential
EUV	EUV spectra, important range ~ 6 – 70 eV, spectral resolution for intensity in specific spectral ranges
TEC, $EUV_{sun\ activity}$ …	several deduced indices like total electron content, sun activity etc.
δ_{debris}	density of debris dust (1-100µm) (detection of impact plasma events – **under evaluation**!)

Some specifications

SENSOR		
sensor dimension	180 mm (sensor height) + 50 x 180 x 120 mm (E-Box)	
sphere diameter	80 mm	
surface of inner sphere	electro plated platinum	
grid material	nickel	
weight	180 grams sensor + 1500 grams electronic (incl. radiation shielding)	
ELECTRONICS		
electrometer	100 pA – 10 µA, 16 bit A/D (2 adustable ranges 125nA/100µA, 0.05% resolution)	
electrical potential range	± 70 V, ~ 10 mV resolution	
power consumption	~ 4,5 W (mean value) @ 28V input voltage Stand-By 2,8 Watt	
data rate	~ 10 kbit/s total	
Serial Interface	RS422 (Command and Data interface) Flexible command interface for other modes	
Data storage	256 MB internal memory for instrument data	

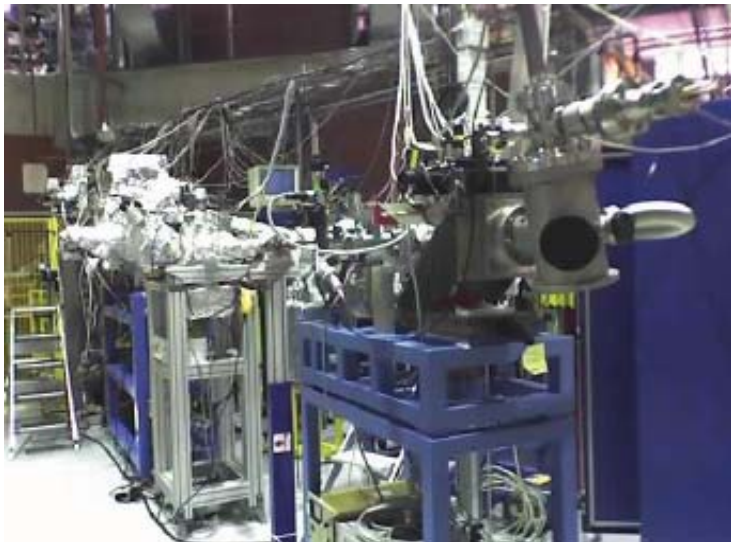
Some specifications

ELECTRONICS cont.		
internal generated power supplies:	+2.5V	FPGA core voltage
	+3.3V	SDRAM supply voltage
	+5V	FPGA I/O voltage, Supply voltage for Data Interfaces
	+/-12V	Supply voltage for 3 D/A Converter and Supply voltage for 3 Voltage Amplifiers
	+/-100V	Basic high supply voltage as input for the 3 voltage amplifiers
	+5V_E1	Isolated supply voltage for Electrometer 1 and A/D-Converter 1
	+5V_E2	Isolated supply voltage for Electrometer 2 and A/D-Converter 2
	+5V_E2	Isolated supply voltage for Electrometer 3 and A/D-Converter 3

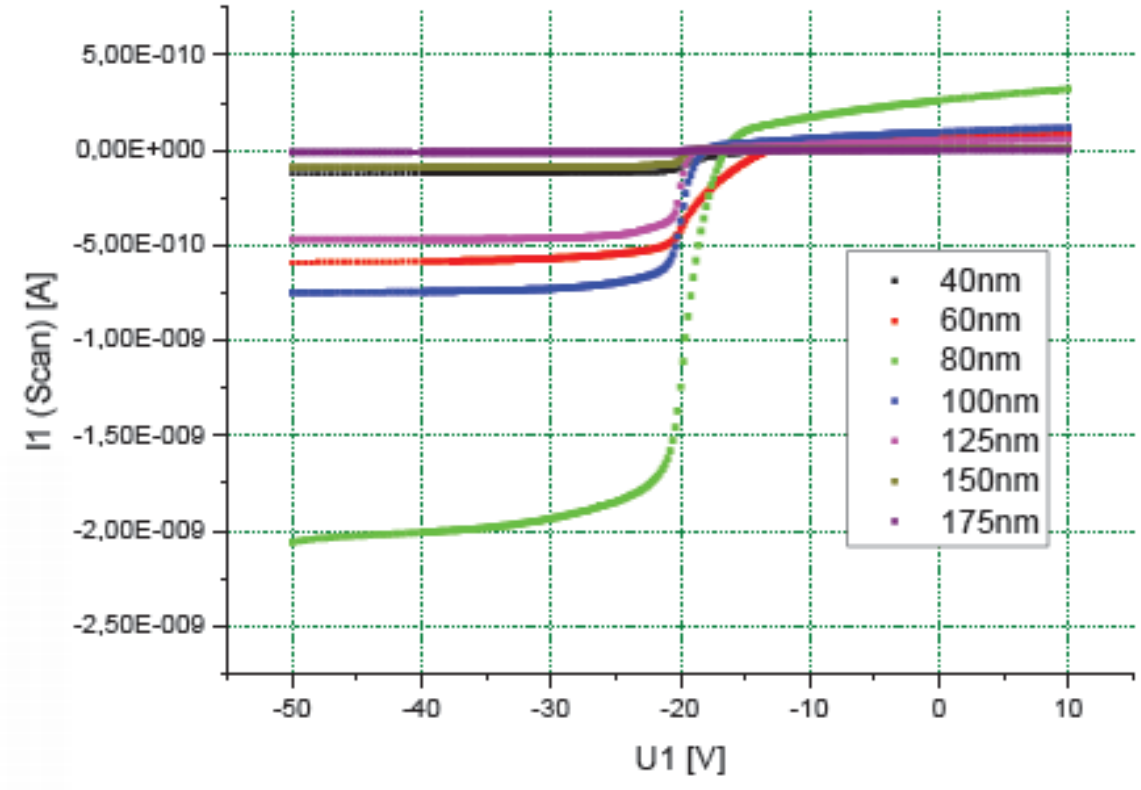
Design for Develoment Model finished

Development Model manufactured and tested including electronics :

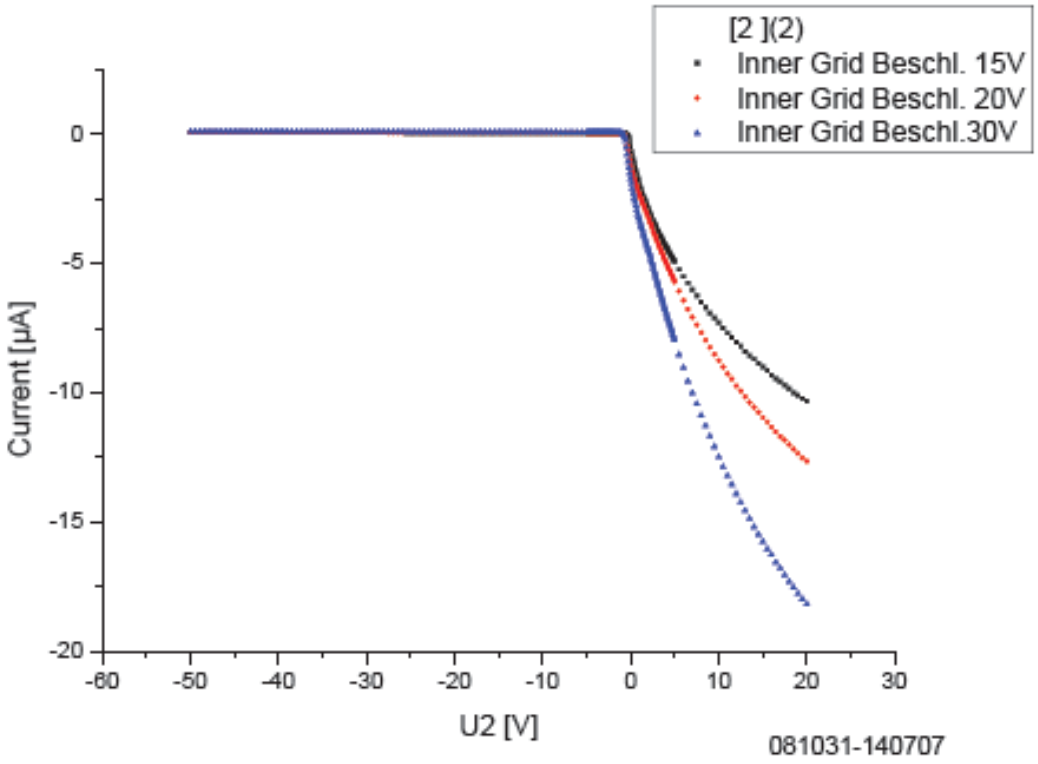
- Measurement of Plasma Parameters at Plasma Chamber ESA/ESTEC
- Measurement of EUV at BESSY and EUV Test Facility IPM Freiburg



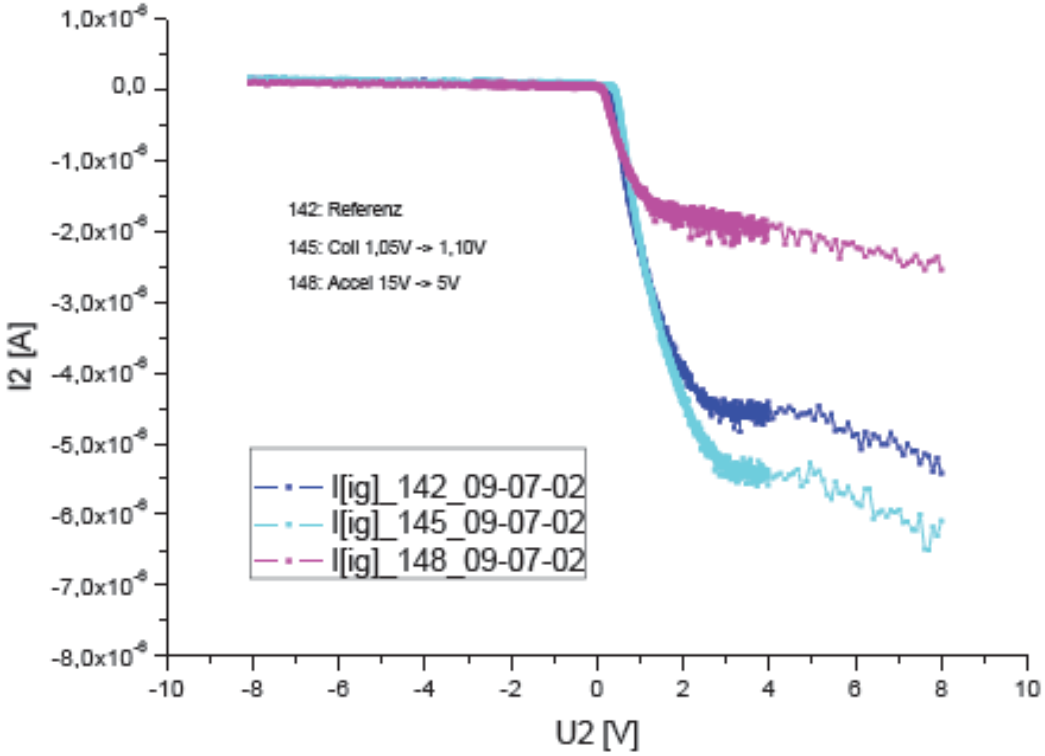
Test Results EUV measurement Bessy (example)



Test Results Plasma measurement RPA Ion Mode



Test Results Plasma measurement Langmuir Mode



Remarks

- LPs simple, flexible, well characterised
  - Good results returned from DEMETER
- SEPS provides added functionality
- For accommodation studies and data interpretation, there is an important role for plasma-spacecraft-sensor simulations
  - DSLP mounted on solar panel
  - SEPS modification of LP currents due to additional grids

END