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No. 43 - End of Electric Propulsion Operations

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Report for period 15 August to 18 September 2005

SMART-1 has completed one of the last milestones of the mission: the Electric Propulsion operations have been terminated. During the past few weeks ESA and industry have worked together pushing the technology of SMART-1's engine to the limit. As a result the flight control team successfully operated the engine until almost the last drop of fuel was consumed.

The engine was finally shutdown on 17 September. From now on, SMART-1 will be left in a natural orbit determined by lunar gravity and perturbations caused by gravitational influence of the Earth and Sun. The preliminary orbit propagation done by Flight Dynamics indicates that SMART-1 will end its life naturally, through impact with the Moon's surface, around mid August 2006.

Scientific operations will be resumed on 1 October aiming at the conduction of push-broom operations from 20 October 2005, 00h, to 19 December 2005 when the Sun will be within 30° of the orbit plane. Payload activities during the reporting period have been restricted to SPEDE/EPDP monitoring of the EP thrust. The other instruments remained inactive during the EP operations.

Electric Propulsion System operations history

Number of Pulses	844
Total number of hours fired (h)	4958.3
First Pulse	12:25 UTC, 30 Sep 2003
Last Pulse	18:45 UTC, 17 Sep 2005
Cathode A firing time (h)	3865
Cathode B firing time (h)	1106
Number of nominal BB activations	1 256 505
Xenon at launch (kg)	82.5
Remaining Xenon (g)	280
Remaining useable Xenon (g)	~ 60
EP Power set range used during the mission (W)	649 - 1417
Number of OSET (Opto-coupler Single Event Transient)	38

Future Activities

- Start work for next phase of ground automation activities
- Forced Thermal Low after the eclipse season
- SMART-1 presentations at international conferences:

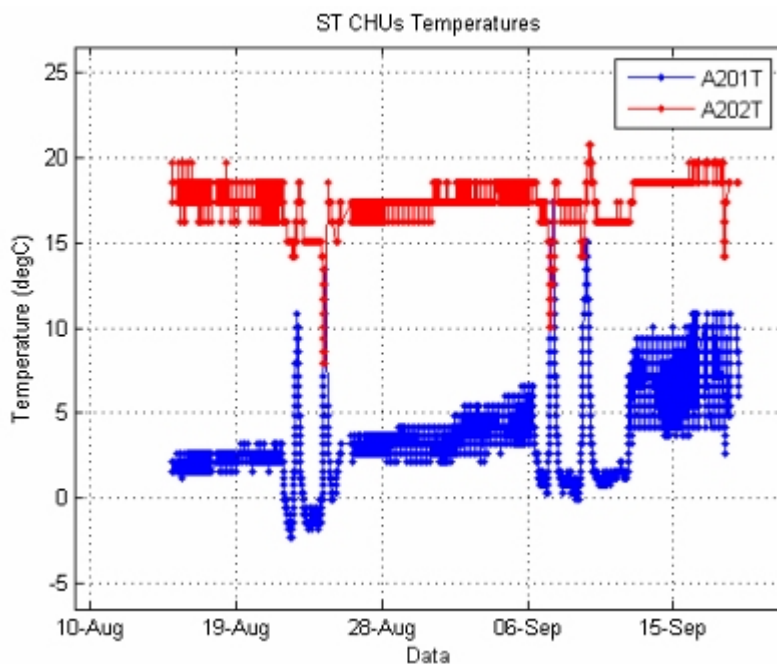
SMART-1 Lunar Mission: Reducing Mission Operations Costs	Kyoto, Japan	11-13 October
SMART-1 Operations	Fukuoka, Japan	17-21 October
SMART-1 Lunar Mission: Operational experience with its Automatic Attitude and Orbit Control Subsystem and its relation with Electric Propulsion System	Loutraki, Greece	17-21 October
SMART-1 Lunar Mission: Startracker Operations Experience	Loutraki, Greece	17-21 October
Operationally Enhanced Electric Propulsion Performance on Electrically Propelled Spacecraft	Princeton, USA	1 November

Spacecraft Status

AOCS

The AOC subsystem has done well in the period covered by this report. The figure shows the startracker (ST) CCD temperatures for the reporting period. The temperature for the Camera Head Unit 2 (CHU2) CCD has been relatively high during the entire period with an average temperature of 17.38 °C and a maximum temperature of 20.8 °C. The reason for the CHU2 CCD temperature being this high is that the spacecraft has been pointing with its +X axis to the Sun during most of this period except for four occasions when the spacecraft was pointing with the +X to Earth for high rate communications using the Medium Gain Antenna (MGA).

It is known that pointing the +X axis to the Sun exposes the CHU2 inner baffle slightly which is enough to get the CHU2 CCD temperature close to or above the operational limit. Temperatures for CHU1 have been low for most of the reporting period with temperatures below 10 °C except for the four occasions that correspond to MGA pointing to Earth where the peak temperatures reached 17.38 °C.



ST CCD Temperatures (A201T= CCD1; A202T=CCD2)

The following table lists the temperature statistics for this period.

Camera Head Unit	Min. T (°C)	Max. T (°C)	Average (°C)
CHU1	-2.27	17.38	3.6
CHU2	7.92	20.8	17.38

Electric Propulsion, Power and Thermal

The Power Subsystem has been working very well during the reporting period including the eclipse of 42% of the solar disk during an occultation on 18 September between 01:59:57 and 02:16:09.

To achieve the mission extension orbit, the ion drive was activated throughout the period 10:23 (UTC), 2 August 2005 to 18:45 (UTC), 17 September 2005, creating an outwardly spiralling orbit. More details on these activities will appear in a future report.

The orbital status at the start of the re-boost phase was:

Radius of Perilune (km)	2172
Radius of Apolune (km)	4634
Inclination (°)	90.264
Right Ascending Node (°)	237.344
Argument of Perigee (°)	243.860
Amount of Xenon left (kg)	~ 6.0

Orbital Information

SMART-1 OD360 Close to Apolune 1216
Epoch (UTC) 2005/09/19 08:32:45.6

Elements WRT Moon and its equator of date

Pericentre Distance (km)	2189.702737
Apocentre Distance (km)	4644.003693
Semi Major Axis (km)	3416.853215
Eccentricity	0.359146
Inclination (°)	90.188741
Ascending Node (°)	237.721939
Argument of Pericentre (°)	292.930856
True Anomaly (°)	180.000008
Osculating Orbital Period (h)	4.978457

The changes since apolune 1182 are as follows:

- semi-major axis -2.0 km
- perilune height +2.5 km
- apolune height -6.5 km
- orbital period -0.3 min

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