



European Space Agency

Science &amp; Technology

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## No. 32 - SMART-1 completes its first orbit around the Moon

19 Nov 2004

**Today, 19 November 2004, at 10:58 UTC, SMART-1 passed its second perilune and successfully completed its first orbit around the Moon. The first orbit started on 15 November at 17:47 UTC when SMART-1 passed its first perilune.**

The next perilunae will occur with increasingly shorter intervals as the orbital period of the spacecraft continuously decreases. This is due to the thrust provided by the electric propulsion system, which is used to reduce the semi-major axis of the orbit.

The first firing of the electric propulsion engine started on 15 November at 05:23 UTC and the engine has performed flawlessly since. It will remain on until 17:48 UTC today, providing a total thrust time of 108 hours.

### Upcoming events

#### Perilune passages

Event	Day and Time (UTC)	Period (h)
Perilune Passage 1	15-11-2004 @ 17:47:38.825Z	89
Perilune Passage 2	19-11-2004 @ 10:58:46.976Z	75
Perilune Passage 3	22-11-2004 @ 14:09:38.299Z	69
Perilune Passage 4	25-11-2004 @ 11:11:06.898Z	59

#### Electric propulsion burns

Event	Day and Time (UTC)	Duration (s)
EPP Start	15-11-2004 @ 05:23:53	390 299
EPP End	19-11-2004 @ 17:48:52	0
EPP Start	20-11-2004 @ 19:09:52	39 095
EPP End	21-11-2004 @ 06:01:27	0
EPP Start	21-11-2004 @ 22:54:03	27 651
EPP End	22-11-2004 @ 06:34:54	0
EPP Start	22-11-2004 @ 13:15:54	26 268
EPP End	22-11-2004 @ 20:33:42	0
EPP Start	23-11-2004 @ 19:11:49	33 388
EPP End	24-11-2004 @ 04:28:17	0
EPP Start	24-11-2004 @ 18:30:12	87 455

#### Eclipse period

Another important event in the near future is a fairly long eclipse caused by the satellite crossing

the Moon's umbra for 1 hour and 50 minutes on 22 November starting at 08:52 UTC. The spacecraft has proved, during the transfer orbit, to be able to withstand even longer eclipses. However, since the batteries have not been discharged for that long since many months, the ESOC flight control team and the ESTEC and industry specialists will closely follow the event.

**Orbital/Trajectory information**

The following osculating orbital elements of the first orbit have been determined by a tracking campaign:

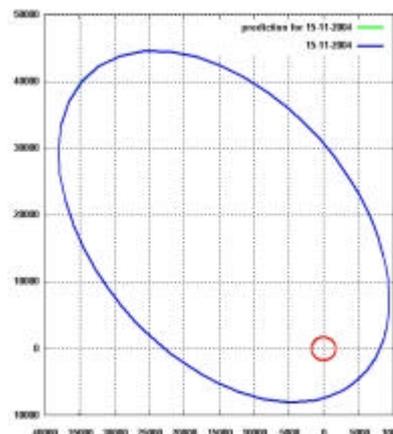
EPOCH (UTC) 2004/11/15 17:47:38.7

**Elements WRT Moon and its equator of date**

Pericentre Distance (km)	6 704.286533
Apocentre Distance (km)	53 207.630341
Semi Major Axis (km)	29 955.958437
Eccentricity	0.776195
Inclination (deg)	81.077151
Asc. Node (deg)	246.524941
Arg. of Pericentre (deg)	308.011816
True Anomaly (deg)	0.000000
Osc. Orbital Period (h)	129.234981

These elements are extremely close to the calculated elements of the planned orbit (see Status Report No. 31). This accurate prediction is evidence of both the good performance of the electric propulsion engine (about 1% above nominal) and the accuracy of the trajectory calculation by the flight dynamics team. In the diagram the predicted and measured osculating first lunar orbits are plotted. The accuracy is so good that the two lines coincide (the difference is smaller than the thickness of the lines).

One interesting point to note is that although the osculating orbital period is 129 hours, the actual orbit was only 89 hours. This illustrates the significant impact that the engine burns have on the orbit and marks the meaning of the osculating orbit, which is the orbit that would be travelled by the spacecraft if at that instant all perturbations, including EP thrust, would cease.



SMART-1 first lunar orbit, both predicted (green line) and measured (blue line)

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