

**Status Reports to the Solar System Working Group**  
**on Planetary Missions and the Planetary Science Archive**

(G. Schwehm, 15<sup>th</sup> April 2005)

**Cassini/Huygens**

Cassini Status

Following the Probe mission successfully carried out on 14 January, Cassini performed flybys of several icy moons of Saturn, including Enceladus (twice), Tethys. A tenuous atmosphere was discovered around Enceladus by the Imperial College magnetometer team. Targeted Titan flybys were successfully performed on 15 February and 31 March. The next targeted Titan flybys are planned on 15 April, 31 May and 27 October. During the 15<sup>th</sup> February Titan flyby, the Orbiter radar observed surface features that resemble the ones observed from close by Huygens. Cassini results are regularly released on the NASA/JPL web site: <http://saturn.jpl.nasa.gov/>

Huygens Status

A detailed analysis of the as-run probe operations was performed by the ESOC Flight operations team and documented in a Huygens Mission Operations Report. All events occurred on the Probe side as and when expected. On the Probe Support Avionics side – the Huygens element that remained attached to Cassini-, it has now been established that channel A receiver did not function due to that fact that the telecommand to switch ON the DWE Receiver Ultrastable Oscillator was not included in the sequence. The report from the Lessons-Learned Working Group established by ESA's Director General will be released mid-April.

The Huygens industrial consortium led by Alcatel in close coordination with the Huygens Mission Team has been carrying out the engineering analysis of the Probe performance. The following aspects are addressed: software performance, entry detection, thermal behavior, power budget, parachute performances, spin and attitude profiles, radar altimeter calibration, and radio link budget.

The Huygens Project Scientist Team has performed the calibration of the radar altimeter measurements. Data obtained during the CETP/IPSL Balloon flight carried out as part of the November-December 2004 CNES/ESA ENVISAT balloon campaign which included the two Huygens radar flight spare units proved to be very valuable. The balloon data allowed evidencing a minor malfunction of the digital radar interface above around 17 km. They also showed altitude errors which were function of the radar electronics temperature and of the altitude. The now calibrated Huygens radar measurements are available from about 45 km down to 150 m above the surface. They will be ingested by the Descent Trajectory Working Group, which is in charge of reconstructing the

trajectory of the Probe using selected data sets provided by all instruments. The DISR team will be independently reconstruct the landing site coordinates by comparing images obtained by DISR with those obtained by the Orbiter instruments ISS and VIMS. The current landing site coordinates are 10.4S, 191.8W.

The Huygens VLBI observations were very successful. The analysis of single dish recordings from both GBT (West Virginia) and Parkes (Australia) was performed in support of the analysis of the data obtained by the JPL-led Ground Doppler Wind Team. A wind profile was obtained within a month after the mission and published by the Huygens DWE team on the web.

The processing of the 47 Terabytes data set is on schedule. Fringes are obtained on all baselines (formed by the 17 telescopes). The mass correlation has been completed in late March. Post-correlation processing started in early April; results are expected in May. The VLBI team is confident that an accuracy of a few km or better will be achieved in reconstructing the descent trajectory.

#### Huygens science highlights

Each experiment team is working hard and provided many scientific results that were partly presented and discussed at the following meetings and conferences:

- Huygens Science Working Team #29, Florence, February.
- Cassini Project Science Group, Florence, March.
- LPSC conference, Houston, March.

A selection of results includes:

- Atmosphere structure (temperature, density and pressure) from the surface up to 1500 km. The atmosphere was found highly structured during the whole entry phase, and turbulent in the lower stratosphere and in the upper troposphere.
- First detection of the cosmic-ray ionized layer at round 60 km altitude
- Methane concentration in the atmosphere of 1.5 % in the stratosphere and the upper troposphere. The methane concentration increased in the last 20 km of the descent and reached 5% near the surface. The evaporation of methane after touch-down indicates that the surface at the landing site was soaked in methane.
- 120 m/s wind at high altitude, but winds are in general lower than expected. A peculiar layer was detected in the altitude range between 80 and 60 km where the wind decreased to a very low value. Meteorologists are working on finding an explanation for this unexpected finding.

Data analysis of the optical ground-based measurements of Titan around or during the Huygens descent is ongoing. Outstanding observations by the VLT, showing high

contrast, were reported in a press release issued by ESO end of February. Those data are complementary to the information gathered by Cassini-Huygens. It is anticipated that a significant ground-based observations programme will be pursued during the rest of the Cassini mission.

A series of Huygens publications is under preparation for submission to Nature. It will include a Team paper written by each of the Huygens PI Team and an overview paper led by the Project Scientist. An additional radar altimeter science paper is under consideration. Submission of the papers is expected within the 2<sup>nd</sup> half of April.

#### Huygens Science Working Team (HSWT) future role

Several science synergy topics have already been identified between the Huygens and the Cassini Orbiter Titan flyby data sets. Updates of the future Titan observations following the Huygens Mission are being considered. The Cassini-Huygens Project Science Group (PSG) unanimously agreed that the Huygens Science Working Team should serve as a forum for discussing Titan science. The HSWT will therefore be active until at least the end of the Cassini-Huygens nominal mission. This will require that the Huygens PI-teams be adequately funded until at least mid-2009.

### **Mars Express**

#### Mission Status

The first months of the year were marked by the start of the missions' second eclipse season. Some of the longest eclipses left only very little margin in which science operations could be conducted, yet this was successfully achieved and, with the eclipse durations getting shorter, science data taking was gradually resumed at full speed.

A problem in maintaining the correct thermal environment for OMEGA caused 1 week of no science operations for OMEGA in February. The problem has been fixed since.

Preparations for the MARSIS deployment were performed with great effort to cope with the agreed schedule of the decision process. The MARSIS deployment review took place on April 8<sup>th</sup>. The Director announced the decision to go for the deployment in May to the Mars Express PIs during an Executive SWTM at ESTEC on 12 April. The deployment will be performed on 4, 8 and 12 May, respectively.

#### Operations and archiving

Science operations have been proceeding well. Illumination conditions are gradually degrading and start to favour the nightside observations.

A number of activities (regarding data recovery and the implementation of new procedures for Radio Science and new pointing modes) have had to be suspended to free sufficient manpower for the preparation of the MARSIS deployment operations.

The first version of the Planetary Science Archive, containing the public Mars Express data, was released in February 2005. While not all data, which should have been contained in the archive, were actually delivered by the PI teams, the archive is actively being used, and we expect to be able to generate some statistics on its use soon.

### Science highlights

After more than one year of operations around Mars, the First Mars Express Science Conference took place on 21-25 February at ESTEC. Registration reached 244 people (excluding media) from Europe, the United States, Japan, Russia and other countries. The programme included 120 oral presentations and 120 posters covering all scientific aspects of the mission, from an historical perspective to the latest intriguing findings. The topics addressed include results from the interior and subsurface of Mars; Mars geology, mineralogy and surface chemistry; the polar regions and their ice caps; the climate and atmosphere of Mars and the interactions between surface and atmosphere; the space environment around Mars, and the planet's moons. A special session on exobiology and the search for life was also held. All in all the conference was a great success, and about 260 participants saw a full week of exciting new results and interesting debates.

A series of papers on OMEGA results, largely focusing on Mars surface diversity and seasonal measurements of the polar caps, was published in the journal *Science*. These papers were also discussed in an OMEGA dedicated session of the Lunar and Planetary Science Conference (LPSC; March 14-18, 2005).

A number of HRSC results, on the 'Frozen Sea' story and recent glacial and volcanic activity on Mars were published in *Nature*. Also these results were discussed at the LPSC where, in general, it was clear that the Mars Express results have an important impact on the current thinking about Mars and its (recent) past.

### **Rosetta Mission Status**

Rosetta has entered the Near- Sun Hibernation Mode mid April, which actually is the start of a quiet routine phase. However, the reporting period was very busy and dominated by the preparation and execution of the first Earth swing-by manoeuvre of the Rosetta spacecraft. The sequence started with a trajectory correction manoeuvre successfully executed on 17 February, which had put the spacecraft on its final course to Earth. Thanks to the precision of this manoeuvre, a back-up manoeuvre planned for 24 February could be skipped. The spacecraft was gradually configured for the swing-by, which included e.g. the activation of the fourth reaction wheel on 25 February, switching the RF link from X-band to S-band, and on 2 March from the High Gain to the Low Gain antenna. On 1 March the first two instruments of the payload were activated, RPC and PHILAE ROMAP. SREM remained active as usual. On 4 March operations of VIRTIS

and MIRO were initiated. PHILAE CIVA was operated for three hours around closest approach to Earth. The OSIRIS Imaging System did not participate in the observations due to some still unresolved problems with the instrument cover.

The Earth swing-by operations included various open-loop tracking tests with the Navigation Cameras, using the Moon as target, on 4 March. All operations were successful. Closest approach to Earth occurred at 22:09 UTC on 4 March at an altitude of 1954 km. Shortly after, at 01:00 UTC on 5 March the spacecraft was commanded into Asteroid Fly-by mode, using the Navigation Camera pointed to the Moon to control the attitude. This was the first and actually only in-flight test opportunity for this mode, which will be used during the fly-bys of asteroid Steins in 2008 and Lutetia in 2010, respectively. The test lasted 9 hours and was a complete success. The Navigation Camera tracking performance was constantly within less than 50 mdeg from the estimated direction and the estimated attitude deviation during the test stayed always below 0.1 deg. The final off-pointing at exit was of the order of 0.05 deg. No increase in background in the Camera could be detected towards the end of the test, when the Sun angle reached 45 deg; i.e. no straylight was detected. The spacecraft survived well the radiation belt crossings and the Earth proximity. Only a few SEU counts were reported, the reaction wheels sustained the gravity gradient torques, the Star Tracker immediately acquired patterns after having exited the proton belt. One can summarize that all systems worked nominally.

After the end of the test the spacecraft was pointed back to Earth to allow the payload and the Navigation Cameras to observe the Earth. The spacecraft was reconfigured into nominal mode and by 10 March all generated science data had been transmitted to Earth. The next major event will be the monitoring of the Deep Impact encounter with comet Tempel 1, where a two week payload operations sequence, starting 28 June, has been introduced into the mission timeline.

## **Venus Express**

Work on the spacecraft is progressing well and the programme has entered the Thermal Balance/ Thermal Vacuum tests. For VMC the decision was taken to produce a Flight Spare. The SOIR part (from Belgium) of Spicav was delivered to SA, Verrières, just before Easter for integration into Spicav. SOIR has successfully past vibration testing and a test and integration schedule has been worked out that should lead to a delivery of the complete instrument to ASTRIUM in May.

The preparations for the science operations, and in particular for the pre-flight end-to-end tests and early commissioning are progressing well – all this work is done in very close collaboration with the experiment teams.

NASA's view on the collaboration in VEX has turned to become very positive and support to US Co-Is in the mission will materialize. NASA recently has established a

Venus Exploration Analysis Group (VEXAG) in order to investigate possibilities for future Venus Exploration.

## **SMART- 1**

SMART 1 has reached its final science orbit peri-lune altitude. It will drift slowly to a 300 km peri-lune close to the end of the nominal mission. Lunar orbit commissioning has been slowed down by a number of onboard problems, which puts a lot of extra workload onto the Mission Operations Team at ESOC and the STOC at ESTEC. Two contractors have been hired to support science operations planning. A test to operate AMIE and SIR in parallel was completed successfully. This will simplify science operations planning considerably and will eventually improve the science output from the mission.

The Orbit Readiness Review (ORR) has now been confirmed for 28 April at ESOC. After the ORR the management of the mission will be handed over to SCI-S.

## **BepiColombo**

The preparation of the mission is progressing according to schedule. The ITT for the industrial contract has been prepared and is currently under review. Review meetings of the ongoing industrial study activities by Astrium and Alenia took place at ESTEC early April.

The kick-off meetings with the 12 selected PI teams were all completed.

It was agreed with JAXA to issue a joint AO for Interdisciplinary Scientists before the end of 2005.

A Magnetometer Workshop was held at ESTEC on 3 February to discuss the scientific goals with respect to the planet's interior structure that can be achieved given the constraints on the magnetic cleanliness for the MPO spacecraft. The PI of the selected MERMAG team invited members of the two competing teams to join his investigation. However, new developments with regard to the funding available to support the UK instruments will lead to a new scenario in this area and the BepiColombo Project Scientist will inform the SSWG at the meeting on the actual payload status.

Meetings at JAXA took place 7 March, the MMO SWG meeting, and 8/9 March, MMO PRR, respectively.

The first BepiColombo SWT took place in ESTEC on 16/17 March. It was attended by about 80 scientists (about 80% related to MPO and 20 % to MMO ). The AO for BepiColombo IDS was discussed. The SWT composed the attached resolution and agreed on the wording of the core piece of the AO for IDS, which describes the role of the IDS's and shall be inserted in the AO document.

‘Resolution of the BepiColombo SWT on IDS:

The BepiColombo SWT welcomes the upcoming call for BC IDS. The SWT stresses unanimously that the IDS should increase the scientific return of the mission by bringing in new ideas or observations not foreseen or included in the original proposals and not already planned by the SWT.’

### **Planetary Data Archive**

The main activities in the past months were all related to the preparation of the MEX science data archive, which since the beginning of the year is accessible to the public. The independent science archive review pointed to a number of problem areas that in the near future will have to be solved on a more general level. All is linked to the support we can expect from the science teams and their acceptance of some basic rules like data rights and data processing levels.

As part of the support we provide to the Experiment Teams a Spice Workshop for all planetary missions was organized by SCI-SB at ESTEC, 12-15 April.

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