Missions in Operation
Report to SSWG by H/SRE-OS
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Science operations activities for solar system missions continued smoothly and without major problems. The highlight in the reporting period was undoubtedly the flyby of Rosetta at asteroid Steins and not to be forgotten: **Ulysses has just completed 18 years in space!!!**

Quite some effort was spent in preparing the Mission Extension Proposals, done jointly by the Project Scientists from SRE-S and the Mission Managers in SRE-O. **Four missions are up for extension: SOHO, Cluster, Mars Express and Venus Express,** which all will be presented at the meeting individually.

Ulysses: Predictions regarding the remaining operational lifetime of Ulysses made earlier in the year following the failure of the X-band transmitter in January have proven to be pessimistic, and the science mission is still ongoing at the time of writing, despite the low on-board temperatures. This is largely due to the introduction of "fuel bleeding", whereby two oppositely-directed thrusters are fired simultaneously every two hours, causing hydrazine fuel to move through a short length of pipe-work where fuel is likely to freeze. Spacecraft operations and science data acquisition will continue using the same strategy until no more fuel remains (which, given the uncertainties in the amount of fuel left, could be any time between early October and December), or freezing occurs. Because of the increasing distance between the spacecraft and Earth, the S-band downlink has deteriorated to the point that playback of recorded data can no longer be supported and only spacecraft data received in real-time during a tracking pass are now able to be acquired.

Real-time operations were temporarily interrupted on 19 September by an unexplained switch-off of the sun sensors and resulting autonomous closure of the fuel valves. Corrective actions were carried out and normal operations resumed, apparently without negative impact on the state of the hydrazine fuel. Investigation into the cause of the anomaly is ongoing, but is hampered by the lack of data resulting from the real-time only nature of the spacecraft operations.

SOHO: The spacecraft status is nominal, with the High Gain Antenna (HGA) Z-axis in a fixed position. All SOHO instruments are nominal and science operations are progressing smoothly. A nominal station keeping manoeuvre and 180 degree roll was performed on 21 August 2008. 0.059 kg of fuel was used. The remaining hydrazine is 117 kg. The solar array degradation after 153 months of flight is 19.8%, which corresponds to 1.55% per year.

Hinode: The X-band system anomaly has not been resolved yet. Data downlink is continued via S-band and the data rate had to be cut back to about 25% of the nominal volume. As the Agency was providing the support for the crucial ground station coverage via the Svalbard station, we are discussing with our colleagues in Norway to see if we can switch to other stations to cope with the new requirements.

Cluster and Double Star: The tilt of Cluster 3 (45 deg. with respect to Cluster 4) has been successfully performed in May 2008. The 3D electric field could be measured for the first time by combining both spacecraft measurements and preliminary results show the successful measurement of parallel electric field in the auroral zone. The tilt also improved significantly the localization of the sources of radio waves in the magnetosphere.

Cluster constellation phasing manoeuvres have been completed as of early August. The constellation has been targeted at the neutral sheet with C1, C2, C3 separated by 10000 km and C3, C4 separated by 3000 km. A slight acceleration of the degradation of solar array has been observed since March-April due to the lower perigee (below 10000 km) and the longer time spent in radiation belts.

The Cluster long eclipse season has begun on 17 Sept. and will finish 10 Oct. Across all 4 spacecraft, there will be a total of 12 nominal eclipses (all payload off), 6 "Decoder only" eclipses (C1, C3 and C4) and 5 complete power down (C1). So far everything went according to plan and all spacecraft could be recovered after eclipses.

Like last year, the Double Star TC2 spacecraft is out of contact. The Chinese now understand the problem and hope to recover it in November. The batteries are not supplying enough power during the eclipses and the spacecraft telemetry system cannot encode the data properly. A weak signal is still received from the spacecraft like last year. Early November, the eclipses will be finished and the power should go back to nominal values. The Chinese investigated the possibility to extend further the mission. It turned out that the spacecraft should be able to support payload operations when there is no eclipse and when the power given by the solar panels is sufficient. These conditions will be met during 3 periods of 2 months each from Nov 2008 to end Dec 2009. In view of the good science that could be performed during this time in particular the good conjunctions with Cluster, THEMIS and Twins, the SWT recommended to extend the mission up to end 2009. After that time the spacecraft engineer confirmed that it would be the end of the mission since there will not be enough power to support payload operations any longer. On ESA side the operations of European instruments can be done at no extra cost by using synergies with Cluster at RAL.

The Cluster Active Archive (CAA) continues to distribute data to the user community. The CAA has currently 713 registered users with an average of 20 new users every month. Duplicated users (people who registered twice or more times) were deleted from the database during the summer. From April 08 to Sept. 08, the averaged data download rate was 300 GB per month.

Mars Express: The MELACOM, and pre-EDL support by PFS to the NASA Phoenix mission were carried out as planned and without a single problem.
The two science observations, which attempted to detect the fireball at Phoenix' atmospheric entry, did not return the results we had hoped for. The SPICAM observation failed for a technical reason, and the HRSC field did not contain any visible 'fireball' as it apparently was not bright enough.
Post-EDL ESA was alerted to a potential need for Phoenix on-surface support by Mars Express in case of additional failures on either Odyssey itself or on its UHF

radio. In order to be ready to support such an eventuality it has been decided to have a permanent backup pointing plan available at ESOC to allow Mars Express to respond within a few days, if not less.
Following a dedicated maneuver end-June 2008, the High Resolution Stereo Camera on board Mars Express took the highest-resolution full-disc image yet of the surface of the moon Phobos on 23 July 2008. The image data were acquired from a distance of 97 km with a spatial resolution of about 3.7 m/pixel. These images have surpassed all previous images from other missions in continuous coverage of the illuminated surface at the highest spatial resolution.
After D/SRE sent a letter to the SPC delegations, expressing concern about the archiving situation for a number of instruments, a large amount of new data has been delivered to the archive. Given the limited manpower available for the archive ingestion at ESAC, a dual approach has been taken. For data which are immediately ready to be ingested into the archive (i.e. fully compliant) they are made available through the PSA interface. For all other data, this is (temporarily) being made available through the FTP interface only. As soon as all technical and other issues for such datasets are resolved, they will also be released through the PSA interface.
The preparations to concentrate all Mars Express Science Operations activities at ESAC in case of approval of a mission extension beyond end-April 2009, has been progressing as planned.

Venus Express: From 13-Jul-2008 until 4-Aug-2008 a series of maneuvers was executed to lower the VEX pericenter to ~185 km. These maneuvers were flawlessly executed. However, from the orbit determination observations it was determined that the amount of drag experienced by the spacecraft is less than expected from the standard Venus atmosphere model used in such predictions. Besides that this means the standard atmosphere model should be revised, it also meant a small change in the orbit maintenance strategy was required. The new strategy has been discussed and agreed with the project scientist.
One of the reaction wheels on the spacecraft recently showed a 30% increased friction torque. Similar behaviour has been observed in the past on Mars Express. There is no reason for immediate concern and the situation is being monitored.
Detailed preparations for the next quadrature season, starting on 19-Dec-2008, have started.
The first datasets, from VIRTIS, VMC, MAG and SOIR, are ready and were released in the Venus Express archive on Monday 22 September. The release of the first SPICAV data will follow early October and the ASPERA and VERA data in November.
Like for Mars Express, a dual approach to data release was necessary, with regard to the PSA compliance of the data delivered to ESA. This means that for data which are immediately ready to be ingested into the archive (i.e. fully compliant) they will be made available through the PSA interface. All other data will (temporarily) be made available through the FTP interface only. As soon as all technical and other issues for such datasets are resolved, they will also be released through the PSA interface.

Rosetta: The Rosetta spacecraft passed asteroid Steins on 5 September 2008 at 18:38:20 UTC at the targeted encounter distance of 800 km. The spacecraft worked flawlessly. All science data from the encounter were provided to the PI teams within days after the event. The Navigation Cameras had been tested in the weeks prior to the encounter and the two cameras could detect the asteroid from a large distance, however, the tracking data delivered were not satisfactory for the enabling of the autonomous tracking mode. The background noise was disturbing the measurements

thus delivering a distorted set of data. On the day of the encounter the control team spent several hours in finding a set of parameters that could allow the camera to properly track the asteroid. The final set of parameters included a window size of 350 pixels, 0.01 seconds integration time, and the filter in defocused-not attenuated position. In this configuration the camera data were satisfying all the criteria set for the transition to autonomous tracking. The preliminary analysis of the NAVCAM data indicates nominal performance throughout the fly-by. However, as can be seen from the flyby movie prepared based on the OSIRIS WAC image the asteroid wasn't tracked in the center of the FOV, which has been confirmed by the Alice, MIRO and VIRTIS measurements. Most of the problems might be related to the small size of the target, i.e. its relatively low brightness.
The targeting of the spacecraft based on the observations with the OSIRIS science camera was excellent. The final trajectory control manoeuvre was executed about 36 hours before closest approach.
Most of the payload provided excellent data from the encounter and worked without problems. OSIRIS was crucial during the optical navigation campaign and provided excellent images. However, during the critical phase of the encounter the Narrow Angle Camera failed to operate. The instrument entered safe mode about 9 minutes before closest approach, however, started to operate automatically again a couple of hours after closest flyby. The instrument generated a significant amount of shutter error events already in the approach phase and it is believed that the onboard software failed to find a solution for the shutter settings and aborted the operations. The anomaly is under investigation with expert support provided by the Agency.
Based on the observations of the Wide Angle Camera the team did produce within a few hours an impressive flyby movie that could be presented to the media and the public at the press conference on 6 September at ESOC.
OSIRIS remained active until end of September for a gravitational microlensing experiment.
All the other instruments that operated during the encounter, especially Alice, Miro and VIRTIS reported excellent data, which are currently being analyzed.

Preceding the flyby phase was the Payload Active Check Period 8 that started on 4 July and ended 4 August. With the end of the payload check-out Rosetta entered the Steins fly-by navigation campaign. Already in the first asteroid observation sessions with both the navigation cameras and OSIRIS images were acquired by the navigation camera that for the first time were used for spacecraft navigation. Initially problems were encountered with storing the OSIRIS images in the Solid State Mass Memory (SSMM), however, this was solved very quickly after running and testing revised procedures on the EQM. The accuracy and the consistency of the measurements have been such that the operations team had the confidence to use them already for the execution of the first trajectory correction manoeuvre on the 14th of August, which was executed with high precision and targeted the spacecraft onto the 800 km miss distance from asteroid Steins.
The ground segment performance except for one incidence was nominal during the reporting period. Just hours prior to the encounter NASA Goldstone announced a technical problem for DSS 14, which meant that we had no ground station to track the spacecraft after the closest flyby when contact was again possible. It was decided to use Cebreros again for a couple of minutes again, which followed the spacecraft below the 10 deg elevation angle and could confirm the successful flyby. Also DSN

reacted very quickly and provided DSS-15 after the MEX tracking had been completed to keep the delay in science data downlink to two hours – unfortunately Voyager had to sacrifice a few bits.
The spacecraft is back into active cruise mode and will go through the solar conjunction and aphelion phase of its current heliocentric orbit to head back to Earth for the third and last swing-by in November 2009.

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