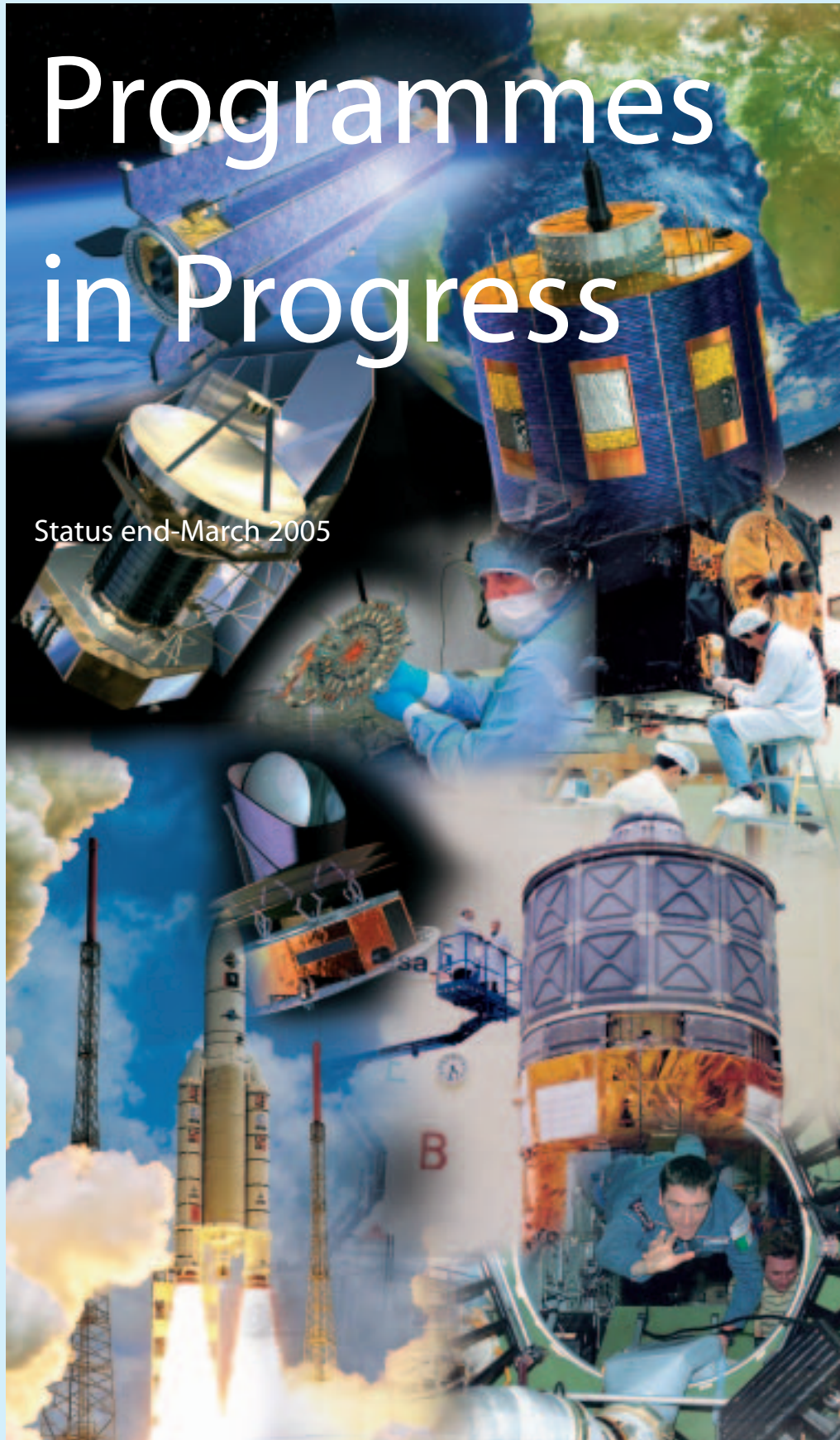
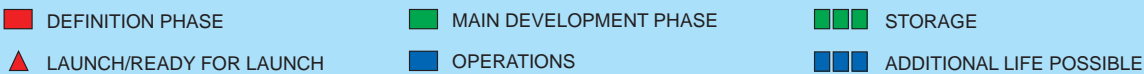
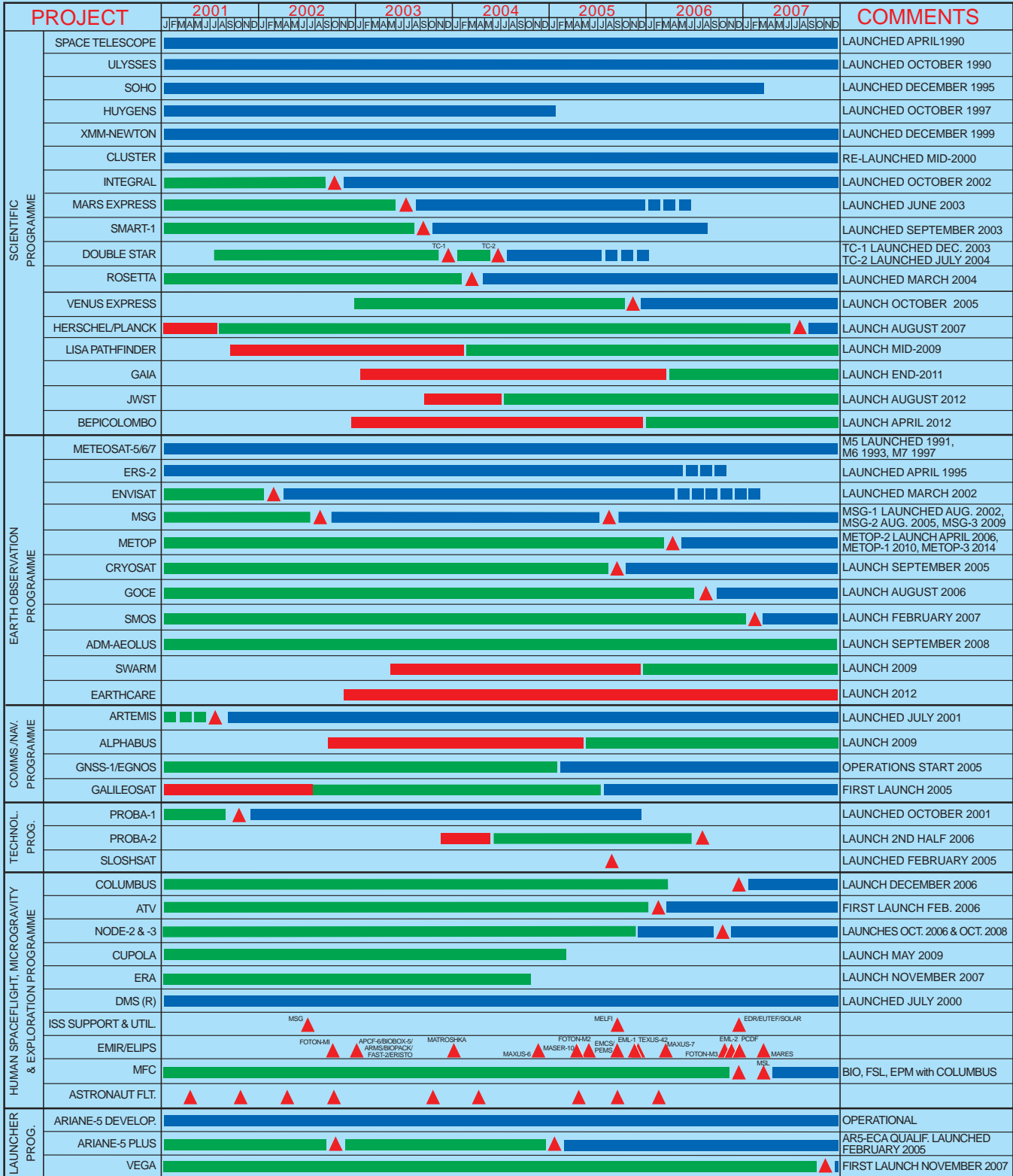


Programmes in Progress

Status end-March 2005





ISO

Recent highlights include direct evidence from ISO data that shock waves generated by galaxy collisions excite the gas from which new stars will form. This is revealed in the Antennae galaxies pair by exceptional H₂ rotational line emission at a wavelength of 9.66 microns, detected via ISOCAM Circular Variable Filter observations. The H₂ line luminosity, normalised by the far-infrared luminosity, exceeds that of all other known galaxies, and the strongest H₂ emission is spatially displaced from the known starburst regions. This result also provides important clues as to how the birth of the first stars was triggered and speeded-up in the early Universe. Published in the April issue of *Astronomy & Astrophysics* by Haas *et al.*, the findings are also reported on the ESA News portal as an outreach story.

Hubble Space Telescope

The 15th anniversary of the launch of HST was celebrated on 24 April 2005. The Telescope continues to operate exceptionally well, and during its lifetime has changed the paradigm and understanding in all areas of astronomical research. Operational efficiency remains high at ~50%, which means that even in its current low-Earth-orbit HST is observing for 50% of the time. Scientific observations are processed within a few hours, and accessibility to the data and archival information is assured within just a few hours also.

To assess the impact of Hubble observations on astrophysical research, standard objective measures of productivity and impact need to be used. One of these is the number of papers published annually based on Hubble data. The numbers for 2004 became available in February. Following a strong and regular increase during the first eight years of Hubble, the number of papers published continued to increase, although at a slower pace. However, 2004 saw another significant increase, with a record 601 papers published, over 100 more

than in 2003. The current total of refereed papers based on Hubble data is over 4700.

Current projections for the lifetime of HST are that it should continue to be scientifically operational until late 2008, if the deliberate switch to a 'two-gyro science mode' is implemented sometime this summer. The lifetime of the observatory may ultimately be decided by that of the batteries, which are now 15 years old but continue to degrade gracefully. The current prediction is that they should continue to operate until 2010, thus giving considerable time for either a robotic or Shuttle servicing mission to be implemented, should this course of action be decided upon.

Ulysses

The spacecraft and its scientific payload are both in good health, with no anomalies having occurred during the last quarter. The budgetary situation regarding NASA's contribution to the mission is, however, a concern, as a number of operational missions, including Ulysses, are presently under threat of termination. It is hoped to resolve this question at a NASA Review to be held later this year, and that the mission will continue as agreed until the end of the next polar passes in March 2008.

All science operations during the reporting period have been nominal. A proposed switch-on of the Ulysses' Gamma-Ray Burst (GRB) instrument to support post-launch calibrations of instruments on NASA's Swift satellite was deemed unnecessary based on the satisfactory in-orbit performance of its payload. GRB will therefore remain switched off until the onboard power/thermal situation improves (probably not before April 2007).

One of the principal goals of the Ulysses mission is to achieve a deeper understanding of how energetic charged particles are transported through the complex plasma environment created by the solar wind. Jupiter's location with respect to the source of the magnetised solar wind – the Sun – is both non-central and precisely known, making the

electrons that it emits ideal test particles for studying particle propagation throughout the inner heliosphere. Ulysses electron observations during the close (1992) and distant (2004) Jupiter encounters have recently been analysed to study the time-dependence of the particle transport parameters. Since the observations from both periods were obtained during the declining phase of the solar cycle, it was expected that the electron intensities in 2004 would vary in the same way as in the 1992 observations.

This was found not to be the case, however. In mid-2002, the electron flux started increasing and displaying large short-term variations. These features lasted throughout the distant encounter, making the electron intensities less obviously correlated with the proximity to Jupiter compared with the first (close) Jovian encounter in 1992. The suggestion is that the transport parameters, and in particular those governing movement perpendicular to the magnetic field in the polar direction, are highly time-dependent.

Ulysses is presently some 5 AU (astronomical units) from the Sun, on its way to the 3rd passage over the solar south pole.

Cassini/Huygens

The Huygens industrial consortium, led by Alcatel in close coordination with the Huygens Mission Team, is carrying out an engineering analysis of the Probe's performance. The aspects being addressed include: software performance, entry detection, thermal behaviour, power budgets, parachute performances, spin and attitude profiles, radar-altimeter calibration, and the radio-link budget.

An anomaly has been observed in the Probe's direction of spin under the parachutes. It separated from the Orbiter with the expected spin rate and direction. A value of 7.5 rpm was measured by the Cassini magnetometer and confirmed by JPL after post-mission analysis of the separation dynamics using Orbiter attitude data. At the end of the entry phase, the Probe was still rotating at about 7.5 rpm, but the spin rate slowed more than expected

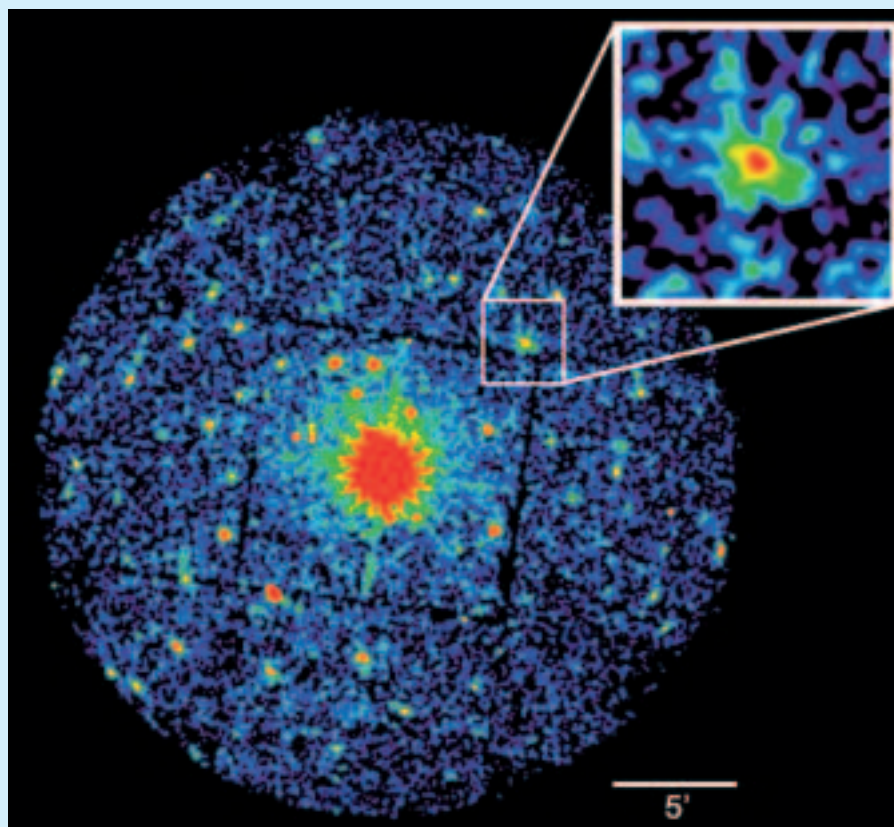
under the main parachute. In fact, it stopped spinning after about 10 min and began to spin in the reverse direction. It then kept spinning in that direction with the expected spin profile for the rest of the descent. No explanation has yet been found for this anomalous behaviour, which is still under investigation. The Sun sensor of the DISR instrument was affected by the fact that the solar disc came into its field of view from an unexpected direction.

Highlights from among the many unique scientific results already gleaned from Huygens include:

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

XMM-Newton

XMM-Newton operations continue to run smoothly, with the exception of an anomaly in one of the EPIC MOS cameras. On 9 March, XMM-Newton registered an event in the focal plane of the EPIC MOS-1 instrument, the characteristics of which were reminiscent of very similar events registered earlier in the mission. Those were attributed to micro-meteoroid impacts scattering debris into the focal plane. It seems likely that CCD-6, one of the six peripheral MOS-1 CCDs, will not be usable for scientific observations in



The massive, X-ray-luminous cluster of galaxies, designated XMMU J2235.3-2557, detected from an XMM-Newton observation

future. Evidence of a limited number of new hot pixels elsewhere in the focal plane of MOS-1 was also found. These other effects are relatively minor. XMM-Newton scientific observations are continuing normally, including those with MOS-1, but with CCD-6 switched off. Investigations are underway to fully characterise changes in the instrument's status.

For the scientific output of the mission, it is important to point out that MOS-1 is operated in parallel with the MOS-2 and the pn cameras. Therefore, the sky area that is no longer covered by CCD-6 is still covered by the two remaining cameras. The net effect of the loss of CCD-6 is therefore limited to only 3% of the total grasp of EPIC, and as such will not have a significant impact on the mission's scientific output.

The ground segment is still being run with SCOS-1b and SCOS-2000 in parallel. At a review on 14 April, the final switchover to SCOS-2000 was set for 1 June 2005.

The completion status of the observing programme is as follows:

AO-2 programme:	99.9% completed
AO-3 programme:	92.0% completed
AO-4 programme:	4.6% completed.

The AO-4 observations have been started slightly ahead of schedule, largely for sky-visibility reasons. Currently, over 3920 observation sequences have been executed and the data for 3801 of these have already been shipped.

In March, 1200 separate data sets were downloaded from the XMM-Newton Science Archive (XSA) by 115 external users.

The *Astrophysical Journal* has accepted a letter by C.R. Mullis *et al.* reporting the discovery of a massive, X-ray-luminous cluster of galaxies at $z = 1.393$, which makes it the most distant (X-ray selected) cluster found to date. This source, designated XMMU J2235.3-2557, was serendipitously detected as an extended X-ray source in an archival XMM-Newton observation.

Ground-based imaging using VLT-FORS2 R- and z-band snapshots revealed an over-density of red galaxies in both angular and colour spaces coincident in the sky with the X-ray emission. Subsequent VLT-FORS2 multi-object spectroscopy unambiguously confirmed the presence of a massive cluster based on 12 concordant red shifts in the interval $1.38 < z < 1.40$ (i.e. when the Universe was about 40% of its current age). Though this cluster is likely to be the first confirmed $z > 1$ cluster found with XMM-Newton, the relative ease and efficiency of the discovery demonstrates that it should be possible to build up large samples of such clusters through the joint use of XMM-Newton and large ground-based telescopes.

A total of 795 papers based completely or partly on XMM-Newton observations had been published in the refereed literature by 1 April 2005.

Cluster

The four spacecraft and their instruments are operating according to plan. The short eclipse (less than 1 h) season has been passed successfully. On spacecraft 1, one of the two batteries suffered a voltage drop about 3 min before the end of eclipse and the second battery was not powerful enough to keep the spacecraft and instruments working. A switchover from the main to the redundant onboard computer was triggered and all instruments were switched off. They were successfully switched on again after reconfiguring the spacecraft. To prevent this problem from happening again, a third battery was brought on line on each of the four spacecraft.

JSOC and ESOC operations are continuing nominally, and the data return from January to early March was more than 99.1%.

The Cluster Active Archive is progressing well. The first data have been delivered and it is planned to have most of 2001 data available by May 2005. The startup phase has been slower than expected, but with the formats and metadata dictionary now defined for all instruments the delays should soon be

recovered. The implementation review is planned for end-May 2005.

Magnetic reconnection at the Earth's magnetopause is considered to be the most efficient mechanism for solar material to penetrate the Earth's magnetic shield. Complex geometrical properties of a transient and spatially confined type of reconnection have been observed in the past but so far not explained, due to the high velocity of the magnetopause and the use of single-spacecraft measurements. A case study based on multipoint measurements by Cluster reveals, for the first time, a direct observation of a 3D magnetic field topology at the magnetopause, resulting from magnetic reconnection at multiple sites, which could explain these geometrical properties. It also provides a direct picture of the entry of particles through the magnetopause.

High-speed flows of plasma (BBFs), propagating from the magnetotail to the Earth at velocities greater than 300 km/s, are the carriers of decisive amounts of mass, energy and magnetic flux. A statistical study based on multipoint measurements by Cluster reveals their typical spatial scales for the first time. More than 1600 data points of earthward flow events were used to deduce the size of the BBFs around $2\text{--}3 R_E$ in the dawn-dusk direction, and $1.5\text{--}2 R_E$ in the north-south direction.

Integral

The galactic bulge is a region rich in bright and variable X- and gamma-ray sources. From 17 February onwards, as part of an approved AO-3 programme, Integral has been observing this region every 3 days. As a service to the scientific community, light curves and images are made publicly available as soon as possible after the monitoring observations have been performed. More information about the programme and its results can be found at: <http://isdc.unige.ch/Science/BULGE/>.

On 27 December the Earth was hit by a huge wavefront of gamma- and X-rays. It was the strongest flux of highly energetic gamma

radiation ever recorded from an astronomical object. It was detected by the Integral Burst Alert System (IBAS) and the anticoincidence shield of the SPI spectrometer. Within the first 0.2 s of the burst, the same amount of energy was emitted as comes from the Sun in about a quarter of a million years. An even more remarkable aspect of this discovery is the origin of this radiation: it comes from a tiny celestial body with an extremely high density, a neutron star, or so-called 'magnetar'. These are objects with incredibly strong magnetic fields – about 10^{14} times stronger than on the Earth's surface. The magnetar that emitted this burst, known as SGR 1806-20, is located on the other side of our Milky Way galaxy, at a distance of about 50 000 light years. Astrophysicists are confident that this event will cast new light on the physics of magnetars and contribute to solving the puzzle of the origin of gamma-ray bursts.

Mars Express

The first quarter of 2005 was marked by the start of the mission's 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. As the eclipse durations got shorter again, science data taking was gradually resumed at full speed.

A problem in maintaining the correct thermal environment for the OMEGA instrument resulted in a week of missed science operations in February. The problem has subsequently been fixed. A Solid-State Mass Memory (SSMM) anomaly, this time only affecting HRSC data taking, also occurred and was investigated. A new delivery of the SSMM software (fixing known anomalies) has been received and should be ready for uploading to the spacecraft towards the end of June.

Preparations for the MARSIS radar's deployment have almost been completed and an overall schedule has been agreed. A final review on 12 April confirmed the start date for the deployment window as 2 May. A number of activities associated with data recovery and the implementation of new procedures for

Radio Science and new pointing modes have been postponed to free sufficient manpower to prepare for the MARSIS deployment operations.

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

The first version of the Planetary Science Archive, containing the public Mars Express data, was released in February. While not all data that should have been available were actually delivered by the Principal Investigator teams, the archive is already being actively exploited.

After more than one year of Mars Express in-orbit operations, the First Mars Express Science Conference took place on 21-25 February at ESA/ESTEC in Noordwijk (NL), attracting some 250 participants from Europe, the United States, Japan, Russia, etc. 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 included 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. There was also a special session on exobiology and the search for life.

A series of papers based on the results from OMEGA, focusing mainly on Mars surface diversity and seasonal measurements of the polar caps, have been published in the journal *Science*. These papers were also discussed in a session of the recent Lunar and Planetary Science Conference (LPSC, 14-18 March) dedicated to OMEGA. A number of HRSC results on the presence of a 'frozen sea' close to the Martian equator and recent glacial and volcanic activity on Mars, have been published in the journal *Nature*. These results were also discussed at the LPSC, making it clear that the Mars Express results are having an important impact on current thinking about Mars and its (recent) past.

Double Star

The two spacecraft and their instruments are operating well. The magnetometer data are being used to derive spacecraft attitude, while the satellite manufacturer, CAST, has modelled the attitude's evolution. The spin axis of TC-1, the equatorial spacecraft, will have drifted by about 9 deg by the end of 2006. TC-2's spin axis is drifting faster, and it will reach 30 deg by July 2006. There will therefore be enough power beyond the nominal end of mission (end-July 2005), and an extension until the end of 2006 will be proposed.

The European instruments are operating nominally. Resets on PEACE (electron sensor) are still occurring, and it is now being switched off and on regularly along the orbit to be able to recover from eventual resets.

The European Payload Operation System (EPOS) co-ordinates the operations for the seven European instruments on TC-1 and TC-2 and is running smoothly. ESA/ESOC acquires data for an average of about 3.3 hours per day with the VILSPA-2 antenna, availability of which was above 99% between December and February.

Previous Cluster observations have shown that the flapping motions of the Earth's magnetotail are of internal origin and that waves are emitted from the central part of the tail and propagate toward the tail flanks. Using conjunctions between Double Star and Cluster, simultaneous observations were made both at 10-13 and 16-19 Earth radii (R_E). Neutral-sheet oscillations were observed by the Cluster and Double Star satellites on 5 August 2004. Their study showed that such waves can be observed as close to the Earth as 11 R_E , in the neighbourhood of the magnetotail hinge point.

Rosetta

Rosetta performed its first Earth-swingby manoeuvre on 4 March. The sequence started with a successful trajectory-correction manoeuvre on 17 February to put the

spacecraft on its final course towards Earth. It was then gradually configured for the swingby, which included the activation of the fourth reaction wheel, switching the radio-frequency link from X-band to S-band, and 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. VIRTIS and MIRO operations were initiated on 4 March. 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-swingby operations included various open-loop tracking tests with the navigation cameras, using the Moon as a target. The closest approach to Earth occurred at 22:09 UTC on 4 March at an altitude of 1954 km. Shortly afterwards, at 01:00 UTC on 5 March, the spacecraft was commanded into Asteroid Flyby Mode, using the navigation camera pointed to the Moon for attitude control. This was the first and actually the only inflight-test opportunity for this mode, which will be used during the flybys of asteroids Steins and Lutetia in 2008 and 2010, respectively. The test, which lasted 9 hours, was a complete success. The spacecraft survived the radiation-belt crossings and the Earth-proximity manoeuvres very well, with all systems working as expected.



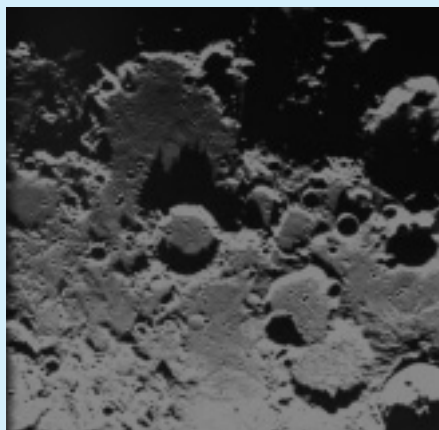
Artist's impression of the Rosetta spacecraft and lander

At the end of the test, the spacecraft was re-pointed to allow the payload and the navigation cameras to observe the Earth. It was also reconfigured to nominal mode, and by 10 March all of the science data generated had been transmitted to Earth.

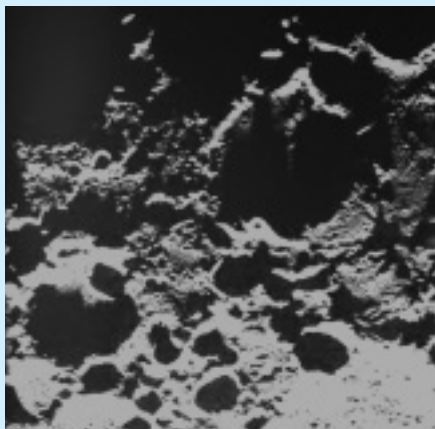
After successfully completing further testing, the spacecraft was put into near-Sun hibernation mode in order to make the most efficient use of onboard resources. Preparations have started for monitoring the Deep Impact spacecraft encounter with comet Tempel-1, for which a two-week payload operations sequence starting on 28 June has been introduced into the mission timeline. All of Rosetta's remote-sensing instruments, including OSIRIS, will be used.

SMART-1

SMART-1 reached its final lunar-observation orbit at the end of February. After an inadvertent electric-propulsion thrusting, the orbit had to be re-established with a correction manoeuvre on 12 March, after which a detailed calibration phase could begin. Unfortunately, this first part of the science phase has been further disrupted by another glitch, which caused some delay in the observation campaign. The mass memory store concerned has subsequently been downloaded and most of the science data



A 275 km wide area close to the Moon's north pole (upper-left corner) observed by SMART-1 on 29 December 2004 from a height of 5500 km. It indicates heavily cratered highland terrain, and can be used to monitor the illumination of polar areas, and the long shadows cast by large crater rims.



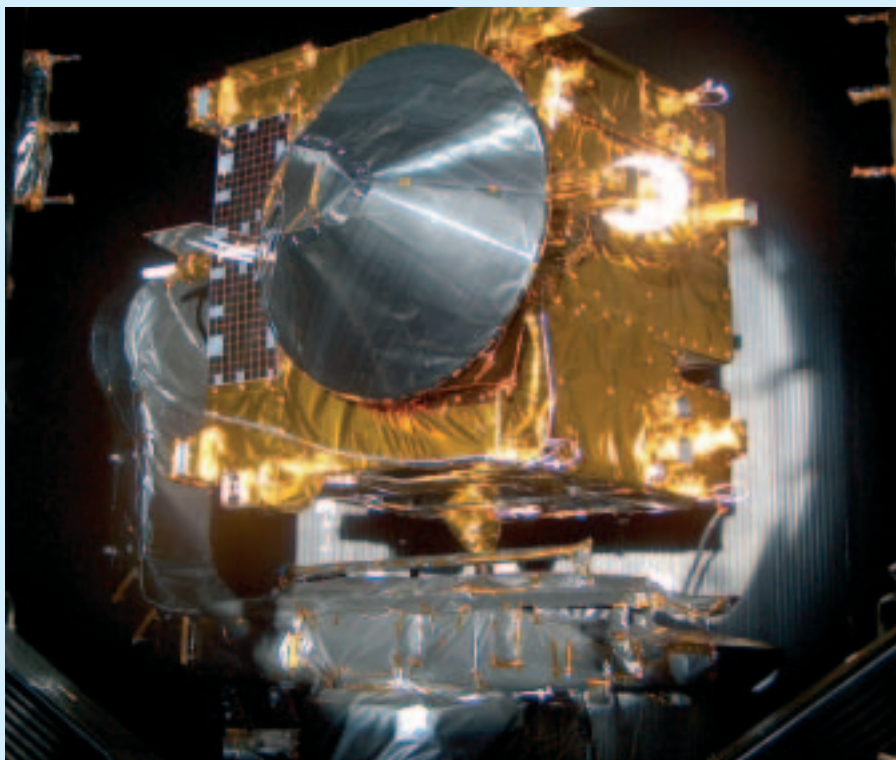
This image shows a 250 km-wide area at the lunar north pole observed by SMART-1 on 19 January 2005 (close to the northern winter solstice) from a height of 5000 km. The illuminated part of the crater rim at the very top of the image is a candidate for having peak eternal sunlight

recovered. The planned observations were promptly restarted on 16 April. The Moon's surface illumination is now approaching the optimum, and it is therefore imperative to have the instruments well-calibrated.

Venus Express

The project continues to progress according to plan, with the spacecraft having successfully completed its crucial thermal-balance/thermal-vacuum test at Intespace in Toulouse (F) to prove its flight-worthiness for the hot Venus environment. The only remaining environmental test to be performed is that for electromagnetic compatibility. The spacecraft has also successfully passed two command and data compatibility tests with the ESA/ESOC Mission Operations Centre in Darmstadt (D), thereby successfully demonstrating its functionality within the overall Venus Express mission system.

The Venus Express ground segment is also progressing well, and interface testing with the scientific community is showing positive results. The new ESA station at Cebreros in Spain, which will be the Venus Express operations station, continues to advance well.



The Venus Express spacecraft mounted in the vacuum chamber at Intespace in Toulouse (F) and illuminated by simulated solar beam

The Venus Express launch will take place on 26 October 2005 from the Baikonur Cosmodrome in Kazakhstan. The agreed launch mass for the spacecraft and adaptor is 1270 kg.

Herschel/Planck

Significant progress is now apparent in the development of the spacecraft hardware. All of the Service Module structures built by CASA in Madrid (E) - the Herschel structural model and the Herschel and Planck flight models - have been delivered to Alenia in Turin (I) and a significant part of the mechanical integration activities have already been completed. The Herschel structural and thermal model will be shipped to ESA/ESTEC in Noordwijk (NL) in April to start its environmental test campaign. Testing activities on the electrical spacecraft models, and the avionics model of Herschel and Planck continue in parallel. The qualification model of the Planck Payload Module has been equipped with the qualification model of the HFI instrument and is presently being prepared at Alcatel Space in Cannes for the most significant environmental test, namely the cryogenic performance test.



The Herschel telescope's primary mirror polished at Opteon in Finland

The Herschel proto-flight model cryostat is in the final integration phase at Astrium in Friedrichshafen (D).

The polishing of the Herschel telescope's primary mirror at Opteon in Finland has now been completed and the next step will be the coating of its surface. The hardware development for the Planck reflectors has been completed and all mechanical testing successfully carried out. Both Planck reflectors are now ready for optical verification testing at cryogenic temperatures at the CSL facilities in Liege (B).

With the qualification models delivered, all instrument teams have already started the flight-model development phase.

The LTP is the spacecraft's 'core instrument'. Its development is being carried out under a multilateral agreement between ESA and seven of its Member States: Germany, Italy, United Kingdom, Spain, Switzerland, France and The Netherlands. The various arrangements required for the procurement of the different elements of the LTP by the Member States involved and ESA took considerably longer to complete than was expected. Consequently, the project team is now concentrating on redressing the situation, with the help of the industrial contractors and the national partners involved.

Given these circumstances, the launch is not expected to take place before the first half of 2009.

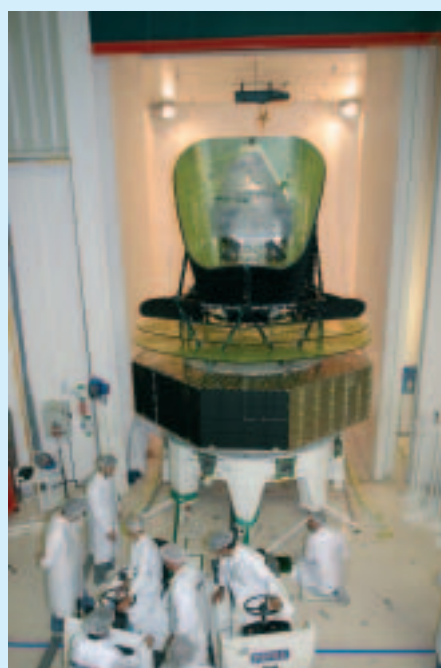
Microscope

The CNES Preliminary Design Review (PDR) at spacecraft level is planned for November 2005, though inertial-sensor development delays could shift it to the end of the year. The launch is now scheduled for December 2008, with the Critical Design Review in April 2007. The PDR, co-chaired by ESA and CNES, for the ESA-provided Electrical Propulsion System is scheduled for end-May/early-June 2005.

The activities at thruster and subsystem level are progressing well. In particular, a second engineering-model slit emitter test has logged more than 1300 hours of continuous operation, representing more than 400 Ns of total thrusting. This is the highest impulse ever achieved using this type of thruster. The test is providing important data about lifetime expectations.

Gaia

Both competing study contractors have reworked their designs to make them compatible with the available resources. Although this delayed the completion of the studies, the results now emerging clearly confirm the benefit and timeliness of the redesign effort.



Planck structural model in the acoustic chamber at Alcatel Space in Cannes (F)

SMART-2/LISA Pathfinder

The SMART-2/LISA Pathfinder implementation-phase activities are progressing well in industry. The main activity at the contractor's site is the preparation of the System Preliminary Design Review to be held in July 2005. Another important activity is the preparation and issuing of the various Invitations to Tender for the spacecraft subsystems and equipment. Earlier this year, however, a slowdown in activities was required to keep the spacecraft's development in phase with the delayed start-up of the LISA Technology Package (LTP) consortium. The project is now investigating with industry how best to adapt the spacecraft's development schedule to the LTP delivery delays in order to minimise the impact on cost and launch date.

As regards the front-end electronics with interfaces to the CCDs, a new technology activity has been initiated via a Call for Proposals to industrialise, i.e. mass-produce, these modules. The response from companies was overwhelming, and two contractors have been selected to work in competition. Early procurement of the flight CCDs was also initiated to safeguard the overall schedule of the Gaia project.

Meetings of the Gaia Science Team are continuing on a regular basis, and members of this body frequently provide advice to the Gaia Project.

The Invitation to Tender (ITT) for the Gaia development phase is in preparation for its release this summer.

James Webb Space Telescope (JWST)

As a result of a NASA internal JWST review (especially of the total spacecraft mass), a number of decisions were made that also affect the NIRSpec and MIRI instruments. In particular, the MIRI cooling system has been changed from a cryostat to a cryo-cooler. As the changes mainly affect the design of the spacecraft and its instrument compartment,

the most critical path in the overall programme, namely the primary mirror manufacturing, is not affected. The overall programme has recently been slowed down by NASA due to financial constraints, resulting in a one-year delay and a new launch date of August 2012.

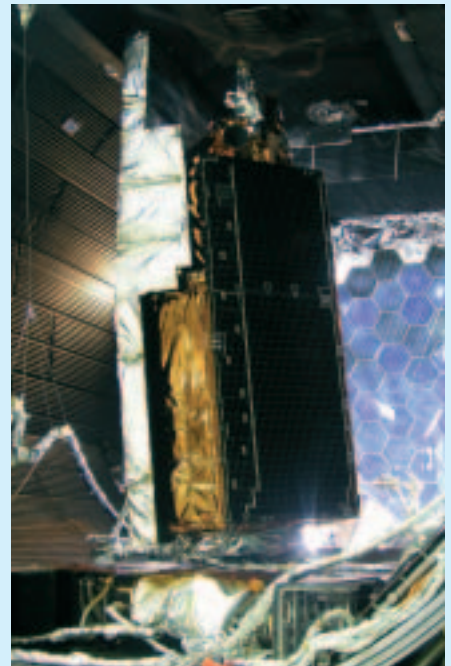
NIRSpec

The procurement activities for NIRSpec are now well underway, with the industrial proposals for the mechanisms under evaluation. Instrument-to-system interfaces could not yet be finalised, which has prevented initiation of the manufacturing of ceramic mirror substrates and several structural parts. Schedule delays will therefore be unavoidable.

MIRI

The MIRI Cryostat and MIRI System PDRs have been successfully completed. Unfortunately, this work has now been made partly obsolete, as the Cryostat will no longer be implemented. A cryo-cooler consolidation study is now underway with the aim of freezing the cooler performance specification and interface requirement to the MIRI Optical Assembly (OA), thus avoiding significant impact and delay on the development of the European-provided Optical Assembly. The cryo-cooler contractor is expected to be selected by the end of the year. The MIRI Optical Bench structural model was successfully vibration tested in January.

CryoSat



The CryoSat satellite ready to undergo a thermal-vacuum test at IABG in Ottobrunn (D)

Good progress has been made in recent months on the development of the CryoSat satellite, particularly with the testing programme conducted by the Prime Contractor, EADS Astrium GmbH (D), at IABG in Ottobrunn (D). The spacecraft is now being prepared to undergo the two major remaining tests: a thermal-vacuum/thermal-balance and an acoustic test. However, to improve the reliability of the SIRAL radar altimeter, the test sequence will be interrupted in mid-May to allow the replacement of a critical electronic component that has recently been found to be potentially sensitive to vibration during launch.

Activities associated with the CryoSat ground segment are progressing nominally. The fourth Satellite Validation Test (SVT-2) has been successfully performed by ESA/ESOC (D) in February. A full Ground Segment Overall Validation (GSOV) has also been performed at system level. These two major test campaigns have demonstrated that the CryoSat ground segment is in a healthy state.



Full-scale model of the James Webb Space Telescope (JWST)

To prepare for the CryoSat level-2 product-validation activities, a complementary scientific campaign involving scientific experts from Finland was performed early in March in the Gulf of Bothnia.

Overall, there has been significant progress in the development of the CryoSat mission over the past months. Unfortunately, 'repair' activities are hampering overall progress, and the launch, which will take place from the Plesetsk cosmodrome on a Rockot vehicle, has now been re-scheduled for 15 September 2005.

GOCE

The main emphasis in the space-segment development activities continues to be on the conclusion of payload and equipment-level testing, and on the execution of the corresponding series of Critical Design Reviews (CDRs).

Alcatel Space has successfully completed the electrical integration of the Gradiometer engineering model, and functional testing is also close to completion. The stiffness anomaly detected in three flight-model accelerometer sensor heads integrated at ONERA (F) continues to be investigated through tests and analysis based on an agreed fault-tree.

Following completion of the electrical integration of the platform Engineering Model Test Bench, Astrium GmbH is focusing its efforts on the Bench's functional testing. In addition, the platform flight-model integration activities have continued with the installation of the electrical harness, the propulsion pipework and the heater lines.

As reported in the previous issue, experience from other ESA missions currently under development has shown a potential problem with the qualification of the European triple-junction gallium-arsenide (GaAs) solar cells used in the GOCE solar array, with the cell shunt diode showing anomalous behaviour during testing at high temperatures. This issue continues to be addressed by an ESA ad-hoc

working group. In parallel, a life test is being conducted with a simulated GOCE thermal environment to assess the suitability of the baseline GaAs solar cells for the GOCE application. Also, a case of substrate delamination has occurred during the thermal-vacuum qualification testing of a solar-wing panel, for which recovery and backup solutions are currently under investigation.

On the ground-segment side, all development activities are progressing according to plan. The Preliminary Design Review (PDR) for the Calibration and Monitoring Facility (CMF) and the CDR for the PDS and the related Instrument Processing Facilities have been successfully concluded.

SMOS

The payload development programme is progressing according to plan. The 'reduced engineering model' involving a complete set of electronic payload elements is being assembled step-by-step. Only two more elements are still to be delivered in the second quarter of 2005 to complete the entire end-to-end chain.

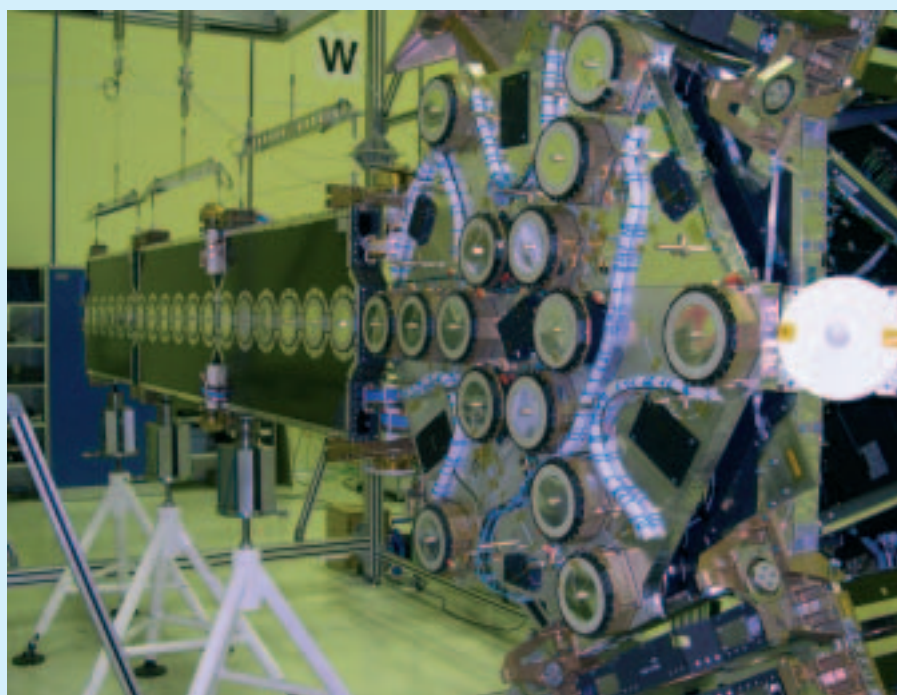
In parallel, a full-sized structural/thermal model has been built in order to achieve full environmental qualification of the payload. After the completion of some initial tests (pyro-shock, arm deployment) it is now at ESA/ESTEC in Noordwijk (NL) ready for the test campaign to start in the last week of April.

For those subsystems for which the engineering-model programme has been completed, Critical Design Reviews (CDRs) have been held to release flight-unit production. Some of the first flight units – elements of the structure, bandpass filters and antennas for the LICEF receivers – have already been delivered.

The Preliminary Design Review at satellite level is being conducted in cooperation with CNES (F). Once successfully concluded, it will authorise assembly of the recurrent Proteus platform used by SMOS.

The launcher for SMOS is under procurement from Eurokot in Bremen (D) and Khruichev in Moscow (Russia).

Significant progress has been made on the ground segment. The algorithm approach for the level-1 processor has been selected and is



SMOS Payload Module structural/thermal model during deployment testing

now under implementation. For the level-2 processors, two consortia have been selected and are now getting up to speed. The overall ground segment within which these processors will have to work is the subject of a Request for Quotation for the main development phase (Phase-C/D) addressed to a Spanish consortium led by INDRA (Madrid).

Unfortunately, a major airborne campaign called 'COSMOS', intended for collecting representative data for algorithm and processor development, had to be postponed due to unavailability of the aircraft. Recovery possibilities are presently being investigated.

ADM-Aeolus

The structural model of the Aeolus platform has been delivered to ESA/ESTEC in Noordwijk (NL). The optical structural thermal model of the instrument is currently being tested in the optical vacuum chamber in Liège (B). It will be delivered to ESTEC in early May for mating with the platform and mechanical testing.

Progress with the majority of flight-model satellite units is good, and most will be delivered in mid-year. However, the challenges posed by the onboard laser remain significant. Preparations are well underway, but the physical integration of the engineering qualification model will not start until June. The laser pump chambers for this model are working.

The first two batches of pump diodes for the flight-model laser have been delivered. However, manufacture of the pump chambers for the flight model is delayed as a result of new information concerning the susceptibility of the coatings of the YAG bars to laser-induced damage. A number of different solutions are being investigated.

The first results from the LID testing of other coatings in vacuum at DLR (D) show that at least the low-fluence optics are likely to achieve the necessary lifetime. Tests on high-fluence surfaces are continuing.

A first version of the flight software has been delivered and is working on the Software Verification Facilities.

The Aeolus Critical Design Review (CDR) will take place as scheduled in August and September 2005. The difficulties with the laser, and other less-critical delays, have led to April 2008 being the earliest possible launch date. A further five-month contingency in the contract with the prime contractor, Astrium, means that the launch is now scheduled for September 2008.

MetOp

The integration campaign for the first MetOp satellite to be launched, MetOp-2 (MetOp-A), is now drawing to a close, and the Flight Acceptance Review (FAR-2), aimed at declaring readiness for launch, will be held in the coming months. Thereafter, MetOp-2 will be stored for a short period alongside MetOp-1 (already in storage since end-2004) until its re-activation and preparation for shipment to the Baikonur launch site. These activities are presently planned for early 2006, with the launch slot retained as April 2006. Currently, all elements – satellite, ground segment and launcher – are on track to achieve this.

The IASI second flight model (FM-2) was delivered on time and exchanged for the non-flight-ready FM-1 on MetOp-2 without difficulty.

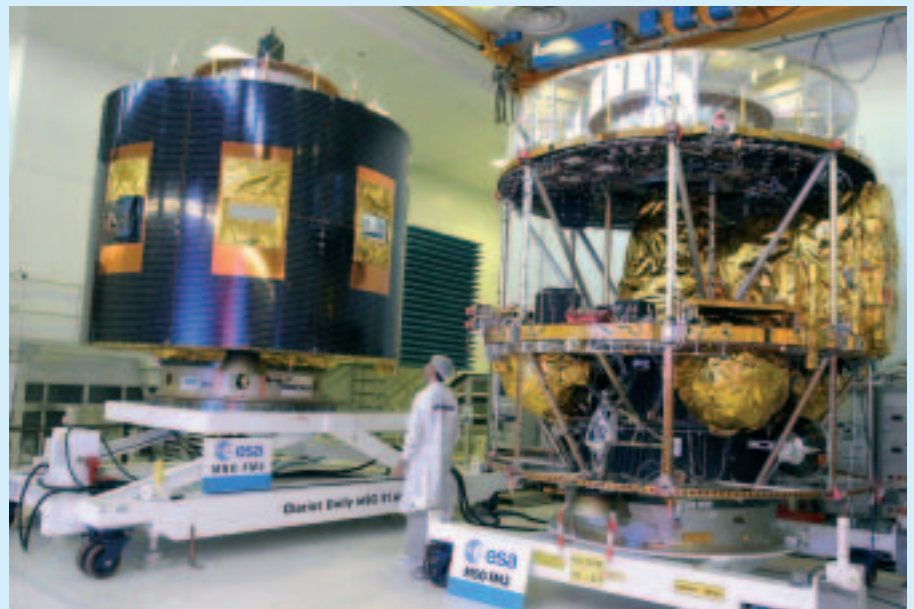
Preparations are well advanced for MetOp-2's launch campaign and the subsequent Commissioning Phase, and more specifically for the Satellite In-Orbit Verification subphase which will check correct functioning of the satellite after launch but prior to the (extensive) calibration/validation activities required.

Following completion of the in-orbit commissioning, the MetOp programme will nominally go into 'hibernation' until 2008, when the team will be re-activated to de-store MetOp-1, complete its integration and make it ready for launch. The industrial proposals for these activities and the MetOp-3 activities in the 2014 time frame are currently being iterated.

Meteosat Second Generation (MSG)

MSG-1 (Meteosat-8)

Meteosat-8 has been operating nominally, with no spacecraft behavioural anomalies reported. De-contamination of the SEVIRI instrument



Flight models of MSG-2 and MSG-3 in the clean room at Alcatel Space in Cannes (F)

optics was performed at the beginning of 2005, followed by an east/west station-keeping/spin-rate manoeuvre on 8 February. The instrument's performance remains excellent.

MSG-2

The satellite remains in a short-term-storage configuration, awaiting its Consent to Ship to the Ariane-5 launch site in Kourou (Fr. Guiana). Launch is currently foreseen in August 2005, but timely availability of the co-passenger, the launch vehicle and the satellite's shock compatibility with the Ariane-5 GS launcher cannot be taken for granted.

MSG-3

MSG-3 remains in short-term storage in the clean-room at Alcatel Space (F). After the re-integration of missing units, some UHF investigations will still have to be performed. The MSG-3 spacecraft will be kept available as a source of spares for MSG-2 during its launch campaign. Thereafter, it will be put into long-term storage awaiting its own launch, currently foreseen in 2009.

MSG-4

Progress with the MSG-4 assembly, integration and test activities is nominal. The propellant subsystem has been delivered and mated and the complete harness has been delivered and integrated. The antenna platform has been delivered to Alenia. The SEVIRI instrument is in the final stages of integration.

Human Spaceflight, Research and Applications Programmes

Highlights

Agreements have been reached with Roskosmos and NASA for a seven-month ESA astronaut mission on Shuttle flight ULF1.1 to the ISS in 2005, and return on flight 12A.1 in early 2006.

The Heads of Space Agencies, who met in Montreal on 26 January, have endorsed the ISS

configuration and reaffirmed their commitment to meet all of their ISS obligations, to complete ISS assembly by the end of the decade, and to use and further evolve the ISS in a manner that meets their research and exploration objectives.

As a result of this meeting, the launch of Columbus is now formally advanced in the assembly sequence, such that it immediately follows the launch of Node-2. The assembly sequence also now foresees the establishment of a permanent crew of six in January 2009 and the completion of the ISS assembly in 2010, at which time NASA plans to retire the Space Shuttles from service.

The Russian cargo spacecraft Progress 17P was launched on 28 February and docked with the ISS on 2 March.

Space infrastructure development

All payload facilities have been removed from Columbus and returned to their developers for storage/risk-mitigation testing, and the Columbus module has entered a hibernation phase.

In January, the Automated Transfer Vehicle (ATV-1) *Jules Verne* Crew Equipment Interface Test and the Late Cargo Access Means Test were successfully performed. The initial part of the System Qualification Review will start in mid-April. The last outstanding hardware needed before the arrival of ATV-1 at the ISS has been installed. The Global Positioning System (GPS) antennas were installed outside the Russian Zvezda module during a four and a half hour Extra Vehicular Activity (EVA) on 28 March. Current *Jules Verne* planning leads to an earliest possible launch-availability date of end-February 2006.

The Element Leak Test on Node-2 was successfully performed in February. Meanwhile manufacturing and assembly activities for Node-3 are progressing, with cone assembly having started in March.

Leak testing of the Cupola spare window was successfully completed in February, and manufacture of a top window flex-hose protective box to prevent leakage, as occurred in the USLab several months ago, started in March.

Also in March, ESA was informed that the European Robotic Arm (ERA) spares would be launched on an 'as needed' basis after ERA's launch. The industrial proposal for the launch of ERA onboard the Russian Multipurpose Laboratory Module will be evaluated in May/June 2005.

Operations and related ground segments

The Columbus Control Centre (COL-CC) Distributed Monitoring and Control System V2 Factory Acceptance Test was successfully completed in January, and the Test-Readiness Review was successfully performed in March. In February, the first of a series of three COL-CC stand-alone simulations for Columbus started.

The Data Gateway V2.0 and the Monitoring and Control System V3.2 for the ATV Control Centre (ATV-CC) have passed the Site Acceptance Test.

Deactivation of the Interconnected Ground Subnet Phase-1, and migration to Phase-2, has been completed.

A new ESA Control Room at TsUP (Russian Mission Control Centre) has been outfitted to support Soyuz and ATV missions.

The Data Management System onboard the Russian Service Module (DMS-R) continues to perform flawlessly.

In March, in-orbit science operations using the external Matroshka payload were stopped due to repeated communication failures. Troubleshooting measures are in preparation.

Utilisation planning, payload developments and preparatory missions

In January, the accession contracts for all 40 academic and industrial partners in the IMPRESS Integrated Project (Material Science) were signed at ESTEC (NL).

In March, the TMA-Bridge Interoperability Workshop was concluded and the mid-term review of the project was successfully held at the European Commission.

Agreement on the participation of the Canadian Space Agency (CSA), through ESA,

in the CNES-ESA-NASA Womens' International Space Simulation for Exploration (WISE) Bed-Rest Study on females, was reached on 3 March, and the three-month study is now underway.

Peer review of the proposals received following the 2004 Announcement of Opportunities (AO) in Life and Physical Sciences has been concluded, and the Microgravity Application Promotion (MAP) project proposals are being evaluated.

Definition studies for human-physiology projects, received following the 2004 International Life Sciences Research Announcement, are ongoing.

The implementation of upgrades and robustness testing on the Columbus payload-rack facilities is progressing towards final delivery of the flight models to Columbus in September. The Acceptance Reviews for the Science Reference Models of Biolab and of the Fluid-Science Laboratory were successfully performed in February. The overall breadboard architecture of the Bone-Analysis Module for the European Physiology Module was defined, and work is proceeding according to schedule. Acceptance Reviews for the Ground Model-1 and the Baseline Data-Collection Model were completed in March. Following recovery after failure of the European Drawer Rack (EDR) engineering-model Video Management Unit, final system tests for both the EDR engineering and flight model re-started, and the flight-model Acceptance Review was kicked-off at the end of March.

Following NASA's cancellation of its Materials-Science Research Rack utilisation, the Materials Science Laboratory (MSL) engineering model was shipped back to Europe from Marshall Spaceflight Center. Meanwhile integration of the MSL flight model has progressed and testing has started.

Columbus system and payload stowage integration with the European Transport Carrier (ETC) is progressing.

In March, tests on the integration of the European Modular Cultivation System (EMCS)

facility flight model into an Express rack, were successfully completed at Kennedy Space Centre (KSC), and the EMCS is now being prepared for launch with flight ULF1.1 this summer. The Percutaneous Electrical Muscle Stimulator was shipped from Johnson Space Center to KSC in preparation for launch on the same flight.

Integration and refurbishment at KSC of the MELFI Flight Unit 1 (FU-1) was completed and the module is currently being prepared for launch on ULF1.1. Some corrosion-repair activities are being carried-out on FU-2, and FU-3 activities are on hold pending resolution of the Brayton machine problem.

The Protein Crystallisation Diagnostics Facility (PCDF) engineering-model Preliminary Acceptance Review was successfully closed in January. The flight-model Acceptance Review, delayed due to technical problems, will take place in May.

In January, the Muscle Atrophy Research and Exercise System (MARES) Critical Design Review (CDR) was closed and qualification of the ground model started in March.

The Engineering Change Request to improve the design of the Flywheel Exercise Device for utilisation in Columbus has been issued, and delivery of the device is planned for the autumn.

The Pulmonary Function System (PFS) will fly on Shuttle flight LF1 in May. Breadboard development of the Portable PFS (Phase-B) is proceeding according to plan.

Acceptance of instruments for SOLAR and EuTEF continued during January and the second Batch of EuTEF instruments is currently being reviewed. Integration of both of these Columbus external payloads is progressing, and the System Validation Test-2 involving the Columbus module is planned for July.

The Atomic Clock Ensemble in Space (ACES) Authorisation to Proceed has been extended in order to continue Phase-C1/D activities up to 31 January 2006. The status review for the Swiss Hydrogen Maser was concluded in

February, and the Software System Readiness Review Board meeting was successfully held. In March, CNES confirmed its commitment to fund the PHARAO engineering model and confirmed a plan towards commitment to fund the flight model. Agreement was also reached on the execution of a Mission System Requirements Review, planned for the second quarter of this year.

The preliminary agreement for EXPOSE-R has been reached and the draft contract is being finalised. Testing and verification of the experiments is ongoing.

After completion of the CDR, development of the Portable GloveBox is progressing with both training- and flight-model deliveries on schedule for a launch with ATV-1 as an ESA upload.

In February, programmatic discussions about NASA requirements for the CryoSystem were concluded, and a Phase-C/D industrial proposal is being evaluated.

The Crew Refrigerator development activities and contract are being closed-out with the delivery of the hardware to NASA Johnson Space Center.

The 39th ESA Parabolic Flight campaign, with 12 experiments, was successfully performed from 14 to 25 March 2005.

The final integration/testing for the FOTON-M2 payload complement was successfully completed at TsSKB/Samara and the final preparations are taking place in Baikonur for a launch on 31 May. The FOTON-M3 payload agreement was approved and signed by ESA, TsSKB-Progress and Roskosmos, and the development of two new payloads started.

The Maser-10 sounding-rocket mission, with five experiments, is approaching readiness for launch on 30 April. Work for Texus-42 and Texus EML-1 is progressing according to schedule for a launch in November. The Maxus-7 contract rider was placed with Industry and development of the experiment module is ongoing.

ISS education

In February two new funding members joined the ISS Education Fund with a contribution of 61.5 kEuro.

In early February, a Workshop was held in order to solicit feedback from teachers on new projects concerning the ISS Education Kit on the Web and the 3D Education Tool. A new DVD lesson titled 'Mission 2: Body Space' is now available in 12 languages, and all education products continue to be in great demand.

The Dutch authorities have confirmed their sponsorship of the first Dutch European Space Education Research Office in the Erasmus User Centre at ESTEC.

In the framework of the Erasmus-supported Life in Space Project, a 'virtual campus' was established, consisting of a network of five universities and ESA sharing information and lectures on-line. The first interactive on-line session was successfully held on 16 February.

In March, the education experiments for FOTON-M2 and the Italian Soyuz mission were proceeding as planned and good candidate experiments have been selected for the Long Duration Mission and the ATV-1 mission.

Commercial activities

The Prime Contractor EADS-ST has joined the ISS Business Club (IBC).

On 11 March, the first commercial event in the Erasmus User Centre at ESTEC was successfully conducted for the Swiss company Phonak, who launched their new product line.

The trademark label for the ESA Health Care Network has been deposited in March.

Astronaut activities

The training of R. Vittori for the Soyuz mission 'Eneide' in April 2005 was successfully completed by end-March and both the ESA prime and back-up crew (R. Thirsk from the Canadian Space Agency) for the 10S mission were certified by the Russian Medical Commission.

T. Reiter and his backup for the Long Duration Mission, L. Eyharts, have received training both at Johnson Space Center and the Gagarin Cosmonaut Training Centre (GCTC).

The training of C. Fuglesang for STS-116 is intensifying. ESA astronauts P. Nespoli and H. Schlegel are also currently training at NASA.

Numerous training courses have been held at the European Astronaut Centre (EAC), including: the first part of the ATV Pilot Course with international participation (February); Columbus User-Level Training for ground-support personnel (February), and for an international class of astronauts (March); and Columbus Payload Advanced Training for Facility Responsible Centre personnel and EAC biomedical engineers (March).

AlphaBus

The Phase-C0 released in February is providing a bridging period for industrial system activities until the placement of the full Alphabus development contract (Phase-C/D).

Besides the ESA contribution, in March CNES secured further national funding for the Alphabus programme as agreed under the terms of the cooperation between the two agencies. The ESA Programme Declaration is open to Member States for subscription until the end of April, with the Phase-C/D planned to start in June, towards the end of the bridging period.

Final selection of design-driving elements for the chemical propulsion architecture is a last critical hurdle before consolidation of the Phase-C/D industrial consortium and AlphaBus technical implementation.

In parallel with the core AlphaBus Programme, up to 25 pre-development contracts have been running with selected suppliers as part of the preparatory programme providing critical technology for the Phase-C/D and enabling-technology for growth potential. The critical technology areas include high-specific-energy Li-Ion cells, and primary-structure developments, an improved apogee-boost engine, and

new gyroscopes and star-trackers. Enabling technologies address such issues as high-thrust electric propulsion, deployable radiators, thin-film solar arrays, improved heat pipes, and active-fluid-pump systems. Critical elements are encompassed for further development within the AlphaBus Phase-C/D, whilst promising enabling-technologies for AlphaBus product-line growth potential will be continued through parallel technology development, once the relevant pre-development contracts gradually run out in 2005/2006.

Vega

During January through March, several important milestones have been achieved, including the holding of the Critical Design Reviews (CDRs) for the launcher's fairing, multi-functional unit, onboard computer, and main safety unit.

The documentation for several key stages/assemblies – aimed at verification of assembly/stage layout, as recommended in the System Design Review – has been delivered, allowing the first key point to be addressed at the beginning of April.

Negotiations with Sabca (B) on the Zefiro and Avum thrust-vector-control subcontract have been concluded.

The Recovery Plan for the Zefiro inert motor cases has made significant progress. The authorisation to start Z9 DM0 manufacture was released at the beginning of February, and the model subsequently manufactured is now undergoing non-destructive inspection. Manufacture of the second model of Zephyr 23 started in early April in the Avio (I) workshops.

A major decision at system level has been to implement a new device using hydrazine thrusters to control the launch vehicle's roll during the solid-rocket propulsion phases. Such a device could be located on Interstage-2/3 or on the AVUM fourth stage.

The recovery plan relating to the P80 motor case is proceeding satisfactorily. Improvements to the Bolentz machine used to wind the case

have been validated, and the manufacture of a full size skirt model has been started. The proof pressure test on the technological model takes place in mid-April.

The contract change for the integrated and expanded Sabca (B) thrust-vector-control activities has been agreed and implemented. The first battleship tests on the P80 igniters have been performed with good results.

A package issued by Vitrociset (I) in response to the Agency's request for clarifications

regarding the ground segment, has been assessed by an Evaluation Board. Contract negotiations are ongoing.

The industrial Preliminary Design Reviews for the mechanical (mobile gantry and mast), civil-engineering and fluids infrastructures have now been completed.

A number of demolition and refurbishment activities have been completed in the launch zone foreseen for Vega at the Guiana Space Centre in Kourou.

A Vega Industry Day held at ESA/ESRIN in Frascati (I) on 11 March was attended by all of the industrial companies working on Vega. The goal was to review the overall status of the programme and to present the way forward for the initial step of the Vega exploitation phase.



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ALCATEL ETCA

Power Conditioning and Distribution, Power electronics for satellite platforms, DC/DC converters, Electronic Power Conditioner for Travelling Wave Tubes, Safety and control boxes for launchers, Overall check-out systems for boosters and launchers.

AMOS

Design and manufacturing of mechanical and optical systems for ground and space applications: Large vacuum chambers and space simulators, Large mirrors light weighting and polishing.

CSL

Design and development of space optical instruments for astrophysics and geophysics. ESA coordinated facilities for tests in simulated space environment (thermal vacuum and vibrations). Research in opto-electronics, optical metrology, radar imagery, interferometry, holography.

EHP

Design, development, manufacturing and testing of thermal control equipments for satellites and spacecrafts. Heat pipes, "two-phase loops".

EURO SPACE CENTER

Initiation and space education - Space school, Space Camp, Astro Camp, Rocket Camp, Earth Camp and Space Odyssey.

GDTech

Customized Solutions in Engineering: Design (CAD), Dimensioning (Structural and Fluid FEA), Manufacturing (Prototype), Validation (Management of Tests), Production (Tools), Documentation (Manuals), Management (of Projects / Teams).

GILLAM- FEI

Telecom network synchronization, remote control (SCADA) for satellite communications - Development and production of atomic clocks for synchronization and navigation.

PROBEL SPACE

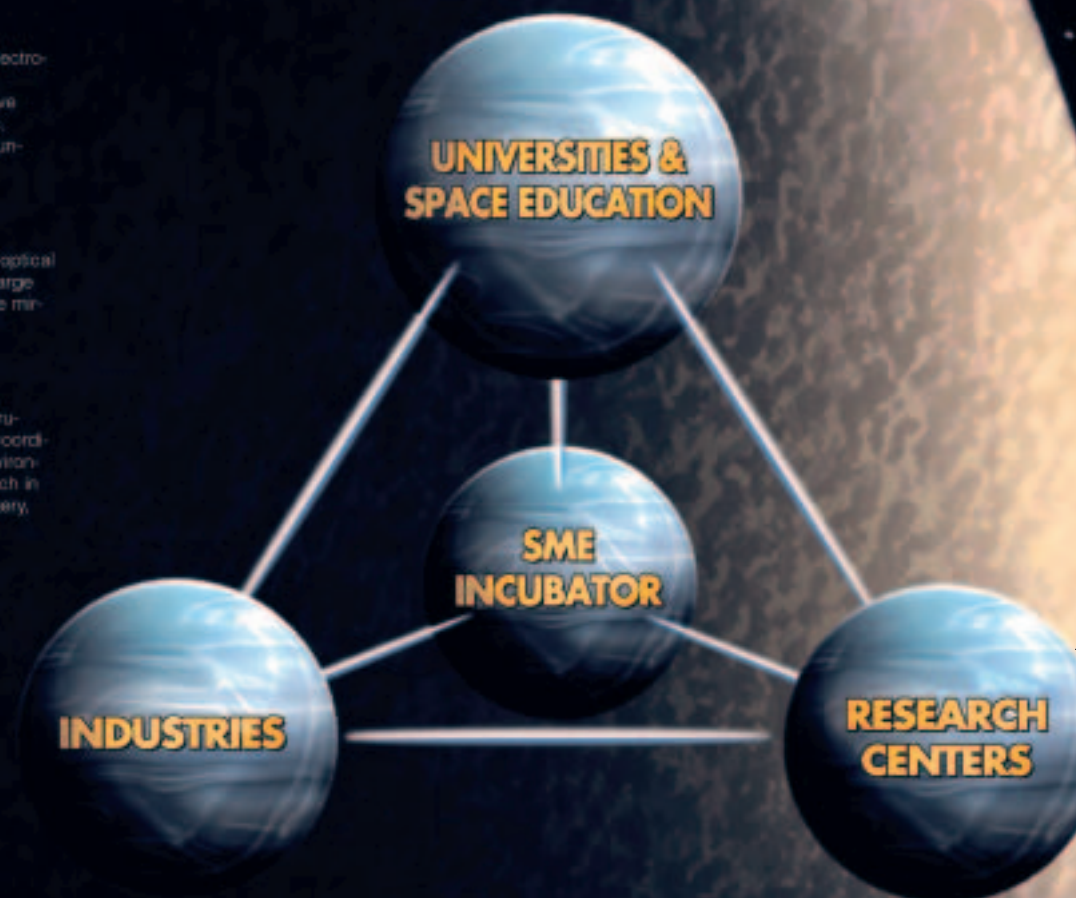
Space consulting services for new applications and spaceconcept.

SABCA

Thrust vector actuation systems for space launchers. Design and production of complex structures for spacecrafts. Damping devices for Ariane 5 boosters.

SONACA

Development and manufacturing of lightweight, high-stability and critical space structures. Spacecraft platform and optical benches structures, meteoritic and debris protection systems.



SPACEBEL

Space mission definition. Design, development and implementation of "tailor-made" software systems for aerospace: on-board and ground segment; simulators. Development of land-use and environmental management information systems.

TECHSPACE AERO

Design, development, and production of flow control equipment for liquid propulsion (engines and stages). Expertise from cryogenics to hot gases, from vacuum up to 400 bars. Studies on advanced propulsion concepts for reusable launch vehicles.

UCL (Catholic University of Louvain)

Earth-satellite channel modelling. Technological support for satellites communications. Earth observation data management. Space radiation center for ESA tests.

ULB (University of Brussels)

Fluid physics experiments in microgravity (capillary interfaces, phase change and diffusion). Experiments and numerical investigations of heat transfer processes (boiling and evaporation). Holographic metrology for protein crystal growth, temperature and concentration mappings. Medical experiments.

ULG (University of Liège)

Space astrophysics; atmospheric and planetary physics. Vibration and space environment testing facilities; aerospace structures. Exploitation of satellites. Biomedical technologies in space.

VITROCISET EPB

Ground station system engineering. M & O ESA Red Station. Services and facilities provided: Satellite Mission and Payload control, Backup handling, TT&C, IOT & Earth Station Validation. Development, installation and validation of satellite ground facilities for Data, TT&C & IOT operations.

WSL

Incubator of actually 17 SMEs exploiting space innovative technologies and services for commercial purposes.