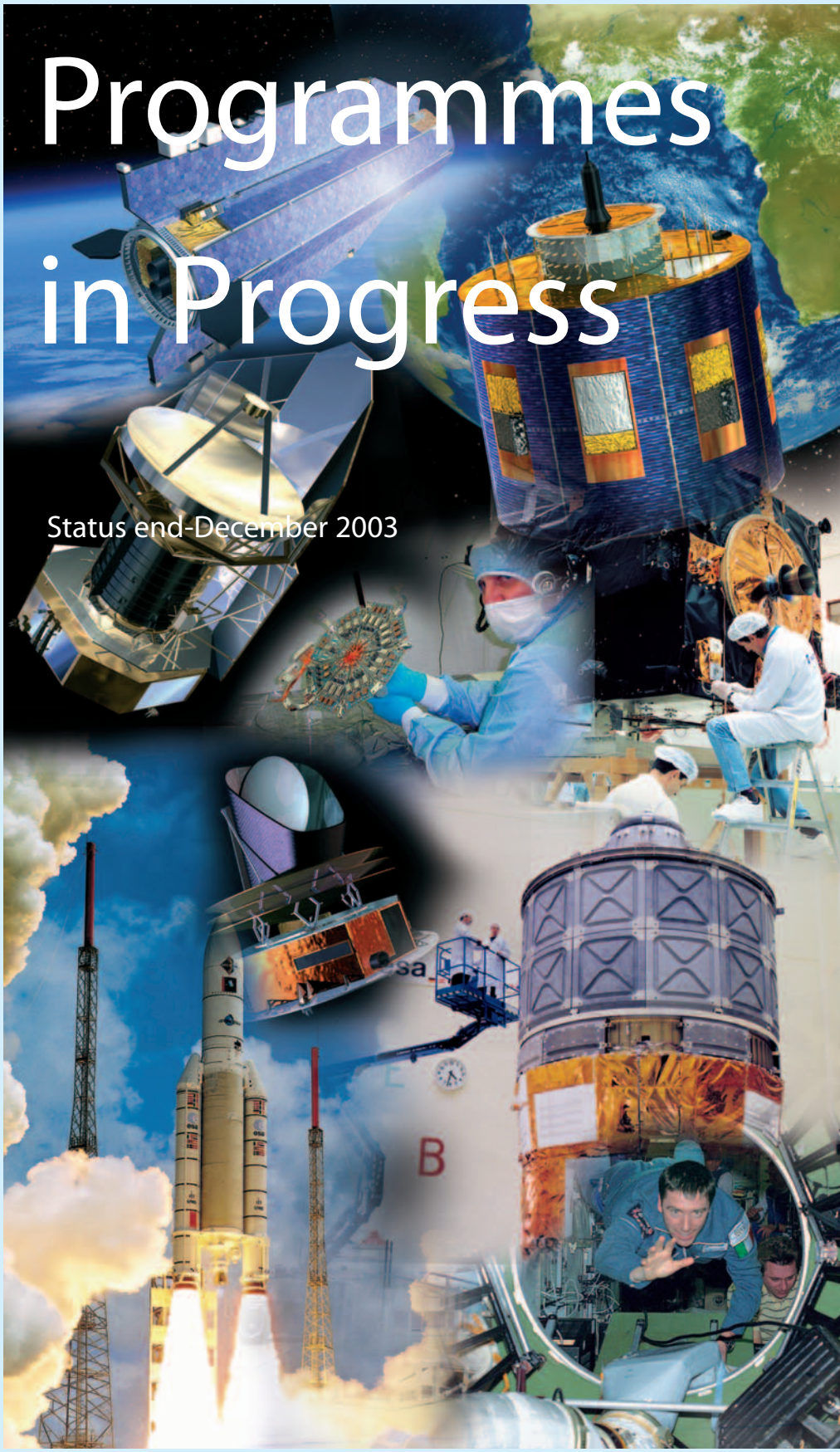
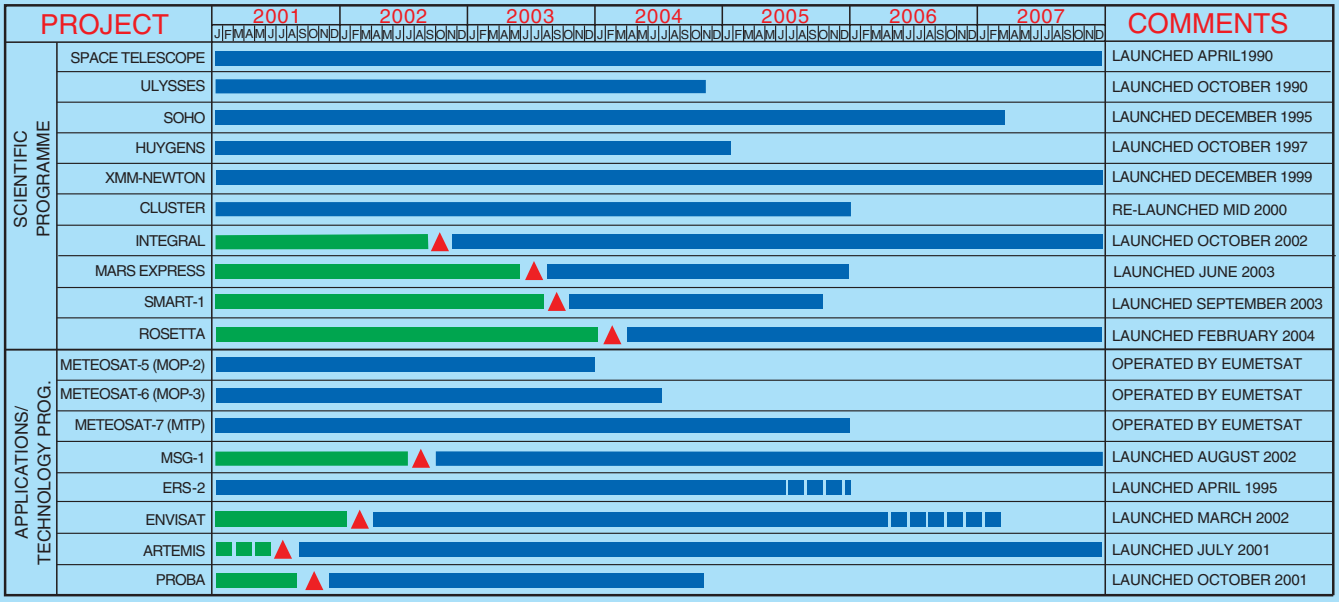
Programmes in Progress

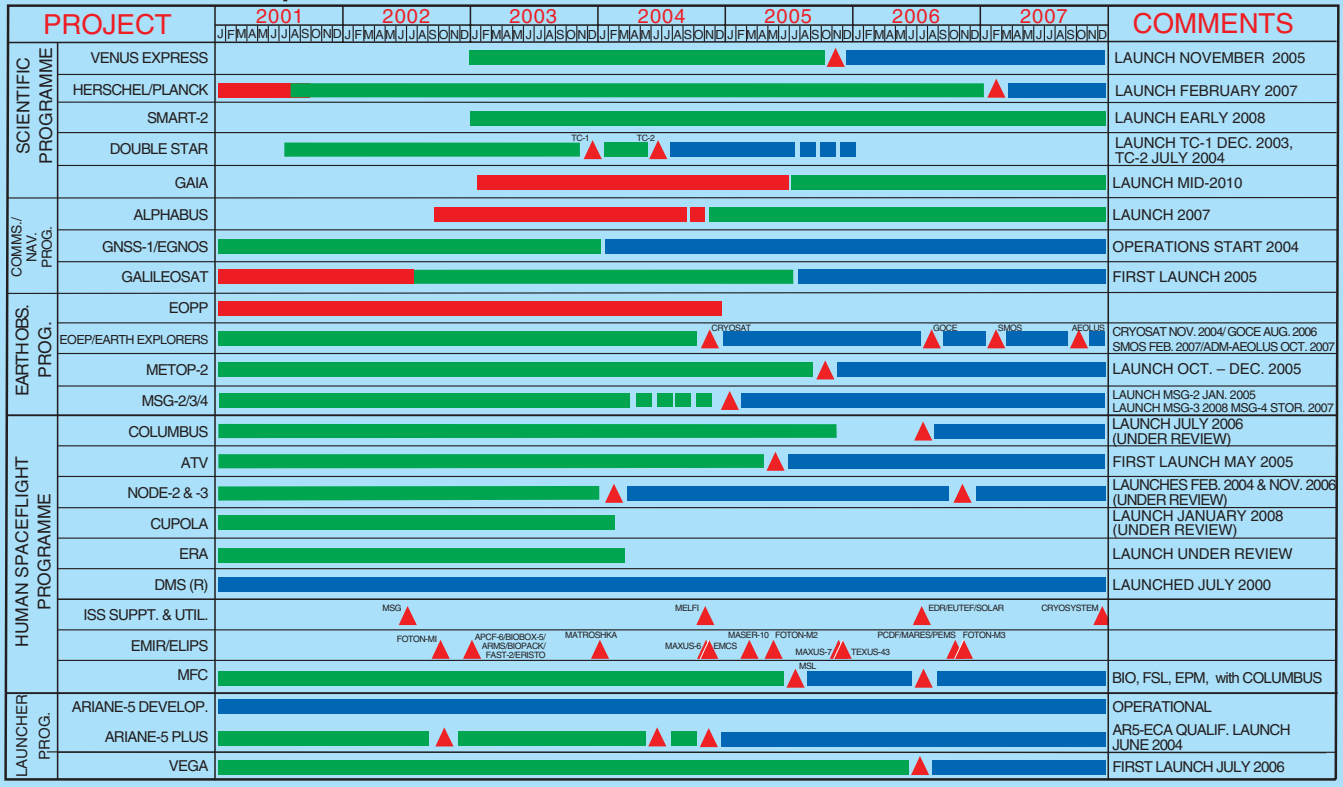
Status end-December 2003



In Orbit



Under Development



DEFINITION PHASE — MAIN DEVELOPMENT PHASE — LAUNCH/READY FOR LAUNCH

OPERATIONS — ADDITIONAL LIFE POSSIBLE — RETRIEVAL — STORAGE

Infrared Space Observatory

The ISO Data Centre Active Archive Phase activities continue to run smoothly. A new version of the ISO Data Archive (IDA V 6.1) has been released, associated with a new interoperability mechanism, fully compliant with the Virtual Observatories standards. It was demonstrated at the XIII ADASS Conference in Strasbourg in October, and will be an important element of the second demonstration of the Astrophysical Virtual Observatory planned for 27/28 January 2004.

Systematic data-reduction projects for ISO spectroscopic modes have been completed and the products ingested into the Archive. Detailed requirements for the observation data-quality reports have been consolidated, for the next major release of the IDA, planned for spring 2004.

The legacy version of the ISO Handbook (5 volumes, 1200 pages) has been released on the Web and is being distributed in hardcopy to all Principal Investigators of ISO observing proposals, as well as to some 300 libraries worldwide.

Ulysses

The spacecraft and all scientific instruments are in good health. Preparations are underway for the Jupiter Distant Encounter campaign that will take place between the end of January and mid-March 2004. During this 50-day period, 24 hour per day real-time coverage by the Deep Space Network has been scheduled to allow the on-board tape recorders to be switched off. This in turn will permit the majority of the scientific payload to be operated continuously, without the need for power-sharing. 'Closest approach' to Jupiter occurs on 4 February, at a distance of 1684 Jupiter radii (~0.8 AU or 120 million km) from the planet.

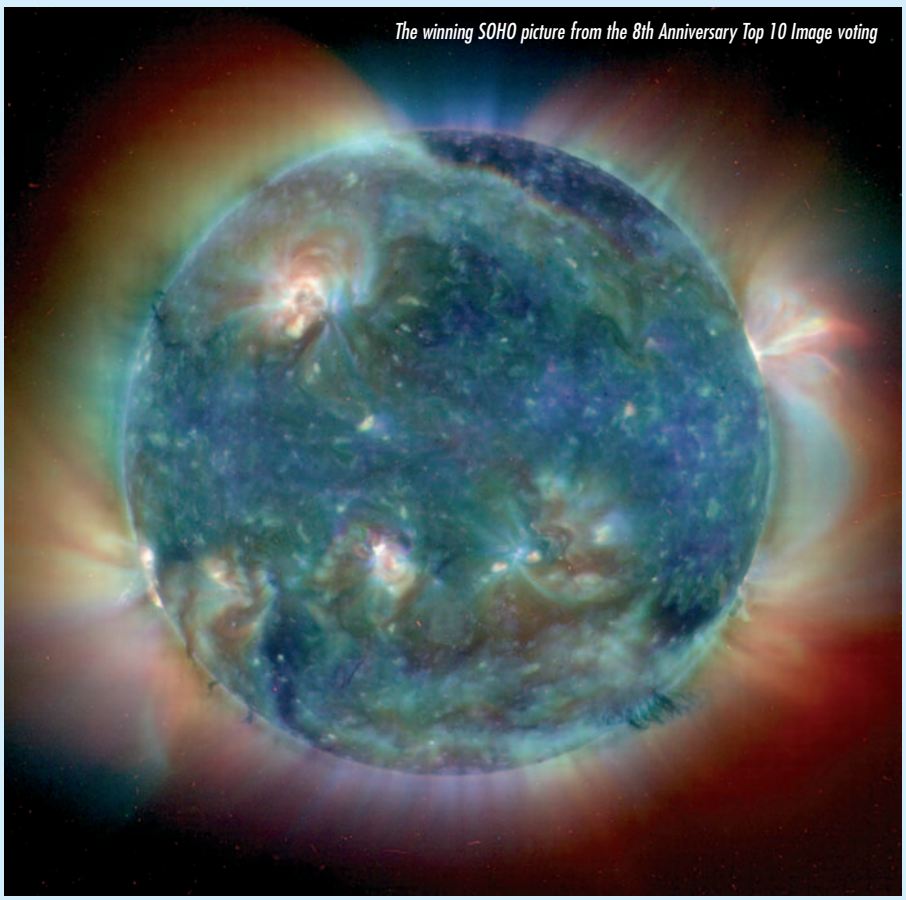
Even though the sunspot maximum of the current solar cycle (23) occurred in mid-2000, the Sun recently underwent a major surge in activity, starting at the end of October. Strong outbursts in the form of solar flares and coronal mass ejections (CMEs) are often seen during the declining phase of a solar cycle; however, the recent activity was unusual both in its intensity, and its relative lateness. The largest solar flare of the series, rated at X28, occurred on 4 November while the responsible active region was on the Sun's west limb, rotating off the visible disc.

Although quite far from the Sun (5.3 AU), Ulysses was well-placed to observe the effects of this violent outburst, being more or less in the 'line of fire'. Analysis of data from the event is still underway, but indications are that the fast CME that was associated with the X28 flare swept over Ulysses, driving a significant interplanetary shock wave. Impressive enhancements in the flux of energetic particles were seen at Ulysses throughout the period of increased activity. This unusual period of solar activity appears to have been the Sun's final outburst before settling into a more stable configuration, leading up to the next solar minimum.

SOHO

On 2 December, the Solar and Heliospheric Observatory celebrated the anniversary of its eighth year in space. As part of this celebration, 24 000 participants voted to select the top 10 images from the SOHO mission. The winning picture is shown here.

SOHO attracted lots of attention during the autumn as the Sun turned from an almost spotless orb, into an ominously scarred source of mighty fireworks in just a few days. Over a two-week period, it featured three unusually large sunspot groups (including the largest of this solar cycle), 11 X-class flares (including the strongest ever recorded; see accompanying image), numerous halo coronal mass ejections (CMEs) and two with near-record speeds, and two significant proton storms, which lasted for a total of five days. Satellites, power grids, radio communications and navigation systems were all significantly affected during this period.

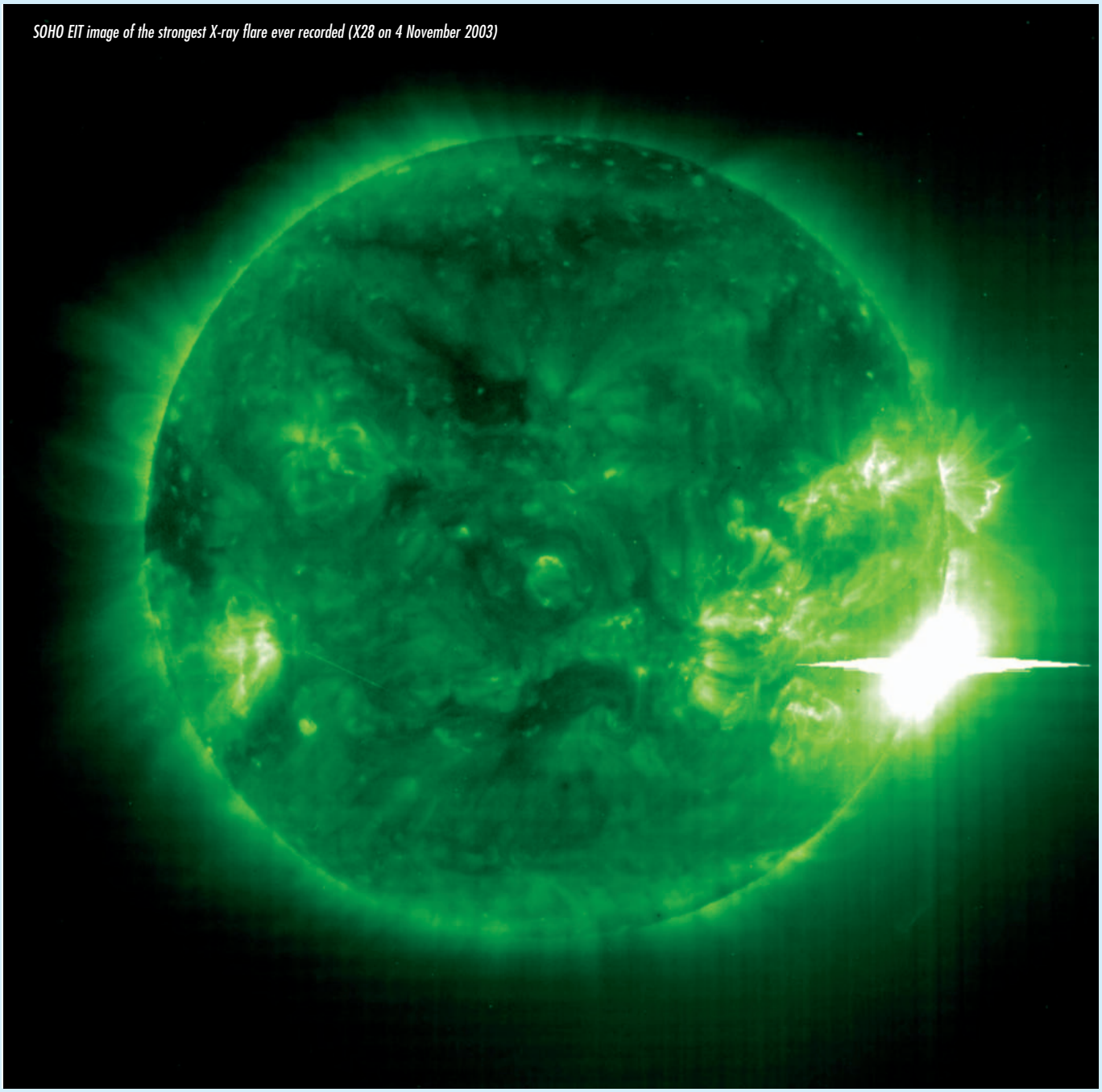


The winning SOHO picture from the 8th Anniversary Top 10 Image voting

Thanks to the invocation of a special Max Millennium coordinated observing campaign, these events are also among the best ever observed, with data available from multiple spacecraft and ground-based observatories. These data will be the subject of scientific analyses for years to come.

The spectacular events attracted unprecedented attention from the media and the general public. Images from SOHO as well as quotes from SOHO scientists were disseminated by nearly every major news outlet (CNN, BBC, Associated Press, Reuters, etc.). The amount of attention surpassed all previous SOHO web-traffic records (requests/ data volume) – monthly (31 million/ 4.3 TB), weekly (16 million/2.6 TB), daily (4.8 million/ 0.7 TB), and hourly (0.4 million/33 GB). In fact, the daily and hourly volumes became bandwidth-limited.

With its High-Gain Antenna z-axis-parked, SOHO continues to experience 'keyhole periods'. Unlike the autumn keyhole, the winter keyhole saw significant data losses due to overwhelming competition for the 34 and 70 metre ground stations from the Mars and Stardust missions. Important total-solar-irradiance calibrations were secured by carefully planned use of the onboard recording capacity. All in all, these keyhole operations are going very smoothly.



SOHO EIT image of the strongest X-ray flare ever recorded (X28 on 4 November 2003)

Huygens

Implementation of the Huygens recovery mission is progressing well. The decision was taken in September to proceed with the 'preheating option' as the baseline, i.e. to upload the required software patches to the flight Probe after a complete validation and testing campaign on the ground. The Probe onboard computer and payload software patches were therefore uploaded in early December and tested a few days later. The in-flight tests on 10 and 13 December demonstrated that all of the required patches had been successfully installed and were compatible with either option: preheating or no preheating. An Agency-level review of the new Huygens mission was kicked-off on 4 December, and the final Review Board Meeting is planned for 13 February.

Cluster

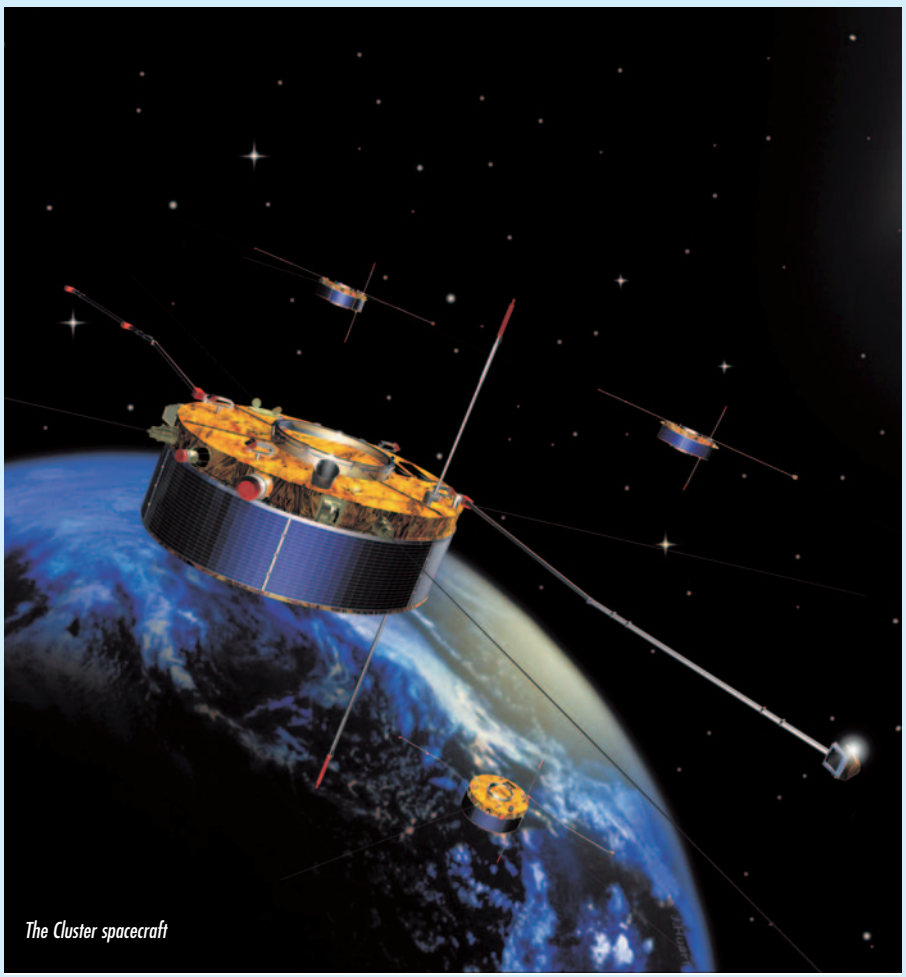
The fourth year of Cluster operations has started at the beginning of February. The four spacecraft are working nominally and the instruments are returning data as expected according to the Master Science Plan. The data return averaged 99.6% between September and December. The Vilspa-1 and Maspalomas ground stations are both operating nominally. The separation distance between the spacecraft is now 250 km, in order to investigate the small structures and measure the electric current at the Earth's magnetopause and bow shock.

Attitude manoeuvres were performed at the beginning of January for all four spacecraft. Their orbits are more stable than preliminary estimates suggested and a combination of large constellation manoeuvres with a decrease in perigee argument will allow the quartet of spacecraft to stay in orbit until at least mid-2009.

Recent scientific highlights include precise measurements of the size of the Earth's bow shock, and determination of the speed of magnetic flux ropes propagating towards Earth. Shock waves are very important for planetary and astrophysical objects since they accelerate particles to very high energies so that they can then be detected in-situ near the Earth or through x-rays for distant objects. Detailed study of the terrestrial bow shock is therefore one of the main objectives of the Cluster mission: measurements of the speed of the shock using the four spacecraft allow its thickness to be derived for the first time. A recent study of 98 bow-shock crossings has shown that the shock front's thickness is best parameterised by the gyro-radius of a small population of solar-wind ions trapped by, and gyrating around, the shock front itself. This is in contrast to earlier studies that suggested that the shock front was best characterised by a wave in a fluid.

Reconnection in the magnetotail is believed to occur at around 40 Earth radii from our planet. One of the consequences of the reconnection process is the release of plasmoids and flux ropes, big magnetic bubbles, which propagate away from the reconnection point. Cluster is located at a maximum distance of 20 Earth radii and is therefore ideally located to study the flux ropes propagating towards Earth. Recently, by using the four spacecraft, the speed and direction of propagation of such a rope could be determined very accurately (mean speed about 413 km/s). In addition, the centre of the magnetotail, the plamasheet, became thicker by about 1 Earth radii (6400 km) as the flux rope was passing by.

Preparations for archiving the Cluster data are progressing well. The Cluster Active Archive system specification review was successfully completed in November. The Review Board made recommendations regarding the archiving plans for the various instruments and the selection of the archiving team. The target for the end of 2004 is to have archived the data from the first year of operations (2001).



The Cluster spacecraft

Integral

The routine operations continue to run smoothly, except for an interruption due to high solar activity between 26 October and 7 November, when the instruments were switched-off. This interval included an X28 solar flare – one of the brightest seen this century. Other than the occasional loss of a guide star due to the enhanced background and increased solar-panel degradation (equivalent to that during about four months of normal operations), the spacecraft safely survived the enhanced solar activity. In particular, the energy resolution of the SPI detectors was unaffected, indicating that the Anti-Coincidence Shielding effectively protected them against the increased flux of solar protons.

On 6 December, one of the 19 SPI detectors suddenly stopped operating. Various attempts at recovery have been unsuccessful and analysis indicates that the fault is most likely a component failure in the detector's pre-amplifier.

A special issue of Astronomy & Astrophysics dedicated to Integral (Volume 411, November 2003) contains 73 papers covering mission and instrument descriptions and performances, and early science results.

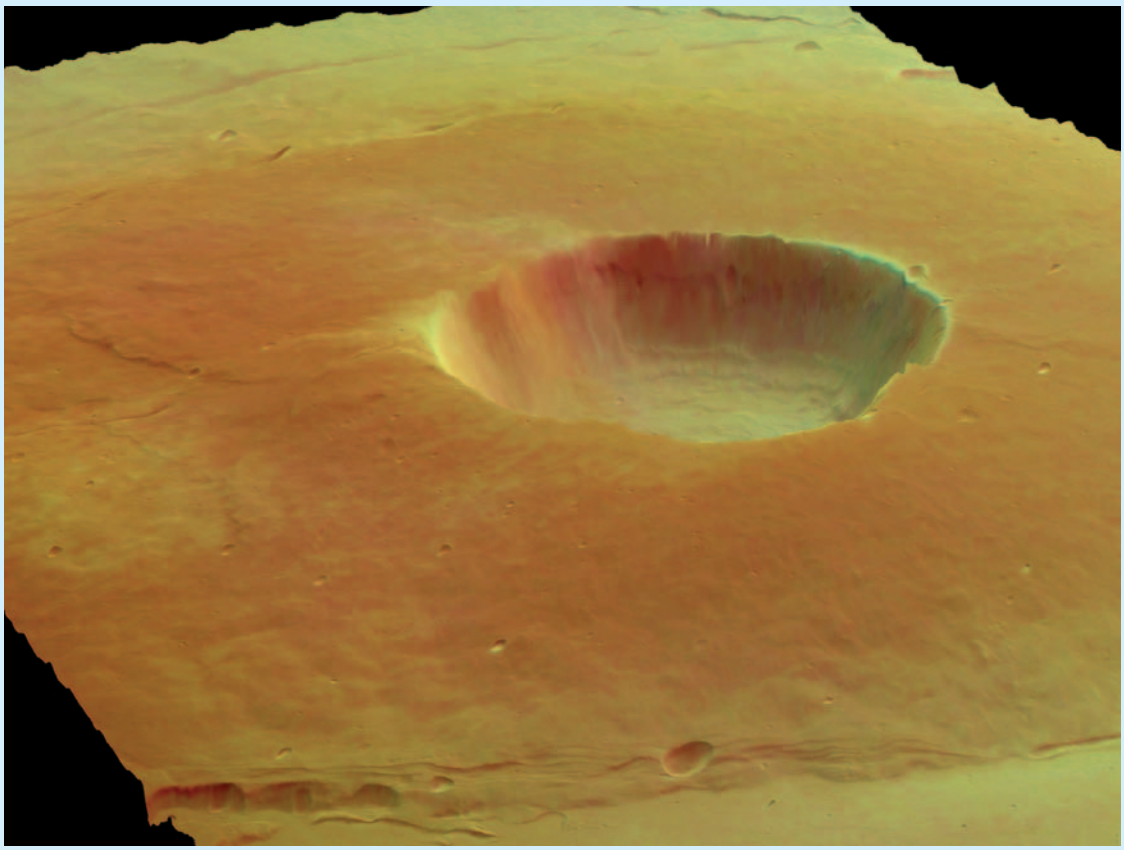
After observing one gamma-ray burst per month in Integral's field of view during the first six months of the mission, astronomers had to wait another six months before observing the seventh! This burst, GRB 031203, was detected and positioned automatically by the Burst Alert Software (IBAS) running at the Integral Science Data Centre. An alert was sent out within 20 seconds of the burst occurring and with an uncertainty radius of only 2.7 arcminutes. This allowed ESA's XMM-Newton spacecraft to observe the field within 6 hours of the event occurring, making it its fastest Target of Opportunity response to date.

A fading X-ray afterglow was detected, surrounded by an expanding ring of emission. Although predicted, such an expanding ring has never been seen before, and is most likely due to X-rays scattered off dust grains in our own Galaxy.

Mars Express

Mars Express went through its most difficult period between 19 and the 25 December without experiencing any problems. On 19 December, the release of Beagle-2 took place. At that time, the knowledge of the Mars Express trajectory was so accurate that the predicted landing ellipse for Beagle-2 could be reduced to just 30 km by 6 km. The release itself was problem free and an image taken seconds later confirmed the stable attitude of the Lander on its way to Mars. The Orbiter then flawlessly executed a series of manoeuvres that led it into a polar orbit with a period of 12 hours at the time of writing. The final orbit with a period of 7.5 hours will be reached by late January. The switch-on sequence for the scientific instruments has commenced and impressive early results were presented at a Press Conference on 23 January. Further results are being released on the web as they become available.

Unfortunately, the search for a signal from Beagle-2 has not yet been successful, but will continue until all possible search scenarios have been executed.



This image was taken by the High Resolution Stereo Camera (HRSC) onboard ESA's Mars Express orbiter on 19 January 2004. It shows a three-dimensional oblique view of the summit caldera of Albor Tholus, a volcano in the Elysium region. The volcano is 160 km in diameter and 4.5 km high, while the caldera is 30 km across and 3 km deep. On the far-left rim, a bright 'dust fall' seems to flow from the surrounding plateau into the caldera.
Credit: ESA/DLR/FU Berlin (G. Neukum)

SMART-1

After the launch on 27 September, the spacecraft has been successfully operated by ESOC in Darmstadt (D). The initial part of the mission, involving SMART-1's exit from the Earth's radiation belts, was finally completed on 7 January. In October-November, the intense solar activity created disturbances in some spacecraft subsystems. The electric-propulsion system shut down several times due to the effects of the radiation on sensitive electronic components, and the star trackers suffered from the intense proton environment, causing the detection of false stars.

Despite these problems, which have been investigated and solutions identified, the spacecraft was able to thrust for more than 1500 hours, increasing the semi-major axis of its orbit by more than 14 000 km from the initial geostationary transfer orbit (GTO) to the present one with almost a 40 000 km semi-major axis. The engine's performance has been an average of 1.5% better than predicted. Power availability onboard is also higher than expected, and the other subsystems are also functioning very well, after some software patching was performed. The instruments have been pre-commissioned, verifying their electrical interfaces and basic functions.

The ground-control team has recently entered the routine operations phase, and the baseline of contacting the spacecraft only twice a week for 8 hours will be applied as soon as the few remaining anomalies have been fixed.

The Science and Technology Operations coordination team at ESTEC in Noordwijk (NL) is now handling instrument-operations requests in collaboration with the Principal Investigators. The seven instruments will be fully commissioned in the coming two months, when the electric-propulsion activities become less intense.

Arrival at the Moon is expected at the end of 2004. Detailed trajectory optimisation, taking into account the electric-propulsion performance and the scientific needs, will be performed shortly.

PROBA

PROBA operations are proceeding nominally and all instruments are providing good data. The operations plan in December also included analysis of the effect of the latest solar storms on the spacecraft hardware. Some degradations were observed, but they were found to have no significant impact on spacecraft performance or lifetime.

ESA is revising the CHRIS/PROBA acquisition plan to reflect the completion of some past projects and to possibly involve new participants. The CHRIS instrument and the High-Resolution Camera have also continued to be used for general-interest Earth-observation imaging.

Image from PROBA's CHRIS instrument showing the flooding of the city of Arles (F) in December

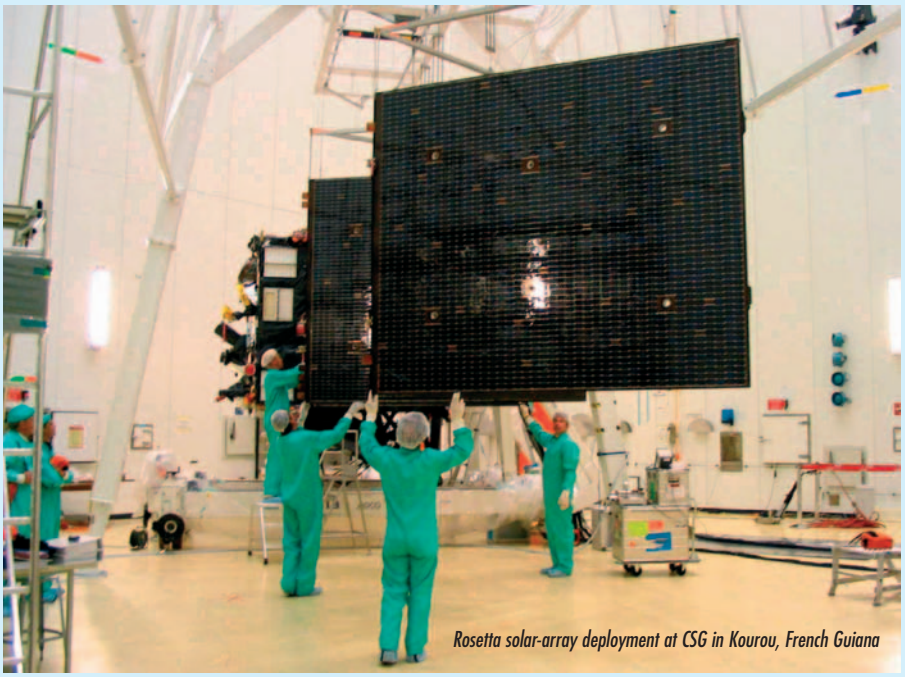
Rosetta

The Rosetta flight spacecraft, which has remained in Kourou (French Guiana) since the launch postponement in January 2003, entered its new launch-preparation campaign at the end of October. The solar arrays and high-gain antenna have been remounted and final functional tests have been performed to re-verify all spacecraft and payload elements. Final preparations, including the closure of all thermal blankets and the mounting of the anchoring harpoons on the Lander, are underway, so that the spacecraft will be ready for re-fuelling at the end of January.

A Mission Flight-Readiness Review in December confirmed that all spacecraft, payload and ground-segment elements were ready for flight.

At ESOC, the simulation campaign has restarted and the preparation of all ground-segment elements is on schedule.

The Ariane-5 launch vehicle has arrived in Kourou where, after a successful Acceptance Review, its launch campaign started in mid-January. The launcher qualification status has been completely re-addressed and the capability to launch the Rosetta mission has been confirmed. The launch window opens on 26 February.



Rosetta solar-array deployment at CSG in Kourou, French Guiana

Venus Express

The flight propulsion stage has been integrated into the spacecraft structure. Delivery of the flight model to Alenia (I) is planned for late February. The most critical tests on the new-technology solar array have been successfully completed and its flight-model production has been released.

Delivery of the flight-model instruments will commence shortly and their integration is planned over the next few months. Implementation of the ground segment and the provision of launch services is proceeding according to plan.

Herschel/Planck/ Eddington

The fourth quarter of 2003 saw finalisation of the last stages in the buildup of the Herschel/ Planck industrial consortium. As a result of this effort, which started in the summer of 2001, over 140 contracts have been awarded at various levels in 16 countries.

The main industrial activity in the reporting period has been the manufacture and assembly of engineering models for all electronic units, and the manufacture of structural/qualification-model cryostat hardware. The Planck Payload Module qualification-model structure has been assembled and is ready for testing. Similarly, manufacture of the flight-model hardware for the Herschel cryostat (e.g. helium tanks and cryostat vacuum vessel) is almost complete. Some details of the overall design baseline have been confirmed, e.g. cryo-interfaces for the Herschel instruments, Herschel star-tracker accommodation and corresponding pointing performance, LFI instrument back-end electronics design and accommodation on Planck.

The launcher Preliminary Design Review process has continued with Arianespace. The spacecraft injection strategy has been optimised taking into account the Ariane-5 ECA baseline, and the Sylda-5/Long Fairing launcher configuration has been agreed and worked into the spacecraft design.

Development of the scientific instruments is progressing with the assembly and start of testing of the qualification models. Some problems with national funding support still persist, but their resolution is expected soon.

Assembly of the Herschel primary mirror for the brazing process

The Herschel telescope has successfully passed a major milestone with the completion of the brazing of the twelve petals of the primary mirror. It will be finalised before the summer with the grinding and polishing of the new monolithic mirror. The Planck Telescope development effort is progressing well with good progress on the qualification model of its secondary reflector. After successful completion of the mechanical testing, it is now undergoing cryogenic optical performance tests. The primary reflector of the qualification model has been assembled and is undergoing mechanical testing.

Following the ESA Science Programme Committee (SPC) decision in November not to recommend the Eddington mission for implementation, the Project is closing down the development and design activities. The parallel Eddington system-definition studies have reached a good level of maturity and will be completed early in 2004. As far as development of the CCDs for the Eddington cameras is concerned, the first set of hardware has been delivered for characterisation and testing.

Double Star

The launch campaign for the first Double Star satellite, TC-1, began as planned on 25 November. All functional tests and preparation activities were completed with the support of a small ESA and Astrium team. The launch by an LM-2C/SM vehicle took place successfully on 29 December at 19:06:18 UTC from the Xichang launch site in southwestern China.

The orbit achieved has a higher apogee than originally planned, giving an orbital period of about 27.5 hours instead of the expected 22.3 hours. The scientific return is, however, maintained because the reduced number of spacecraft conjunctions is compensated for by longer coordinated observations with Cluster.

Commissioning of the three Chinese and five European scientific instruments started in early January, and will address in particular the spacecraft's background noise performance in view of the failure of one rigid boom to deploy initially. The spacecraft's attitude is nevertheless reported as stable and compatible with the mission design.

Delivery of the European payload (three instruments) for the DSP-Polar (TC-2) spacecraft started in November and will be completed by the end of January 2004. Subsequently, these three will be integrated together with five Chinese experiments and subjected to spacecraft-level testing. TC-2 will be launched on 20 July 2004 from Tai Yuan.

SMART-2

The Invitation to Tender (ITT) for the SMART-2/LISA Pathfinder Implementation Phase was released in April 2003. Two bids were received and a Tender Evaluation Board recommended entering into negotiation with one of the two bidding teams, headed by Astrium Ltd. (UK). In parallel, work has progressed on the definition of some critical subsystems, namely the drag-free attitude control, the micro-propulsion technologies, the avionics architecture, and the definition of the experiment interface documents.

The satellite will be designed for satellite-to-ground data communication via a 15 metre ground station operating at X-band. The Mission Operations Control Centre will be based at ESOC in Darmstadt (D), while the Science and Technology Operations Coordination will be performed from ESTEC in Noordwijk (NL), following the positive experience with SMART-1.

The development of the LISA Test Package, the main experiment and the core of the mission, which is presently at the engineering-model stage and being managed under Technology Research Programme (TRP) and Core Technology Programme (CTP) contracts, is experiencing some delays. These technology developments and associated tests will be completed in mid-2004 and will be followed by development of the flight model by a European consortium of industries and institutes, overseen by a dedicated management structure currently under discussion between ESA and the national agencies.

The kick-off of the satellite development contract is planned for February 2004, and the SMART-2 launch is foreseen for early 2008.

Gaia

Gaia builds on ESA's extremely successful Hipparcos mission (1989-93). Its goal is to map the three-dimensional positions and motions of more than a billion stars - a kind of 'Human Genome Project' for our Galaxy, impacting on all areas of astronomy and astrophysics. After its approval within the Science Programme in 2000, and confirmation during the Programme's re-evaluation in October 2003, Gaia is now halfway through a technology-development phase, in which the most critical elements of the payload and spacecraft are under detailed assessment. These studies will be completed at the end of 2004.

Among the challenges for the payload are the large (1.4 m x 0.5 m) telescope mirrors, which are being manufactured from silicon carbide, and for which a successful detailed design review was held in October. The focal plane comprises a large array of state-of-the-art CCD detectors. A feasibility study of the large, custom-made CCDs and the associated focal-plane assembly is in progress. The first batch of CCD wafers has been completed at e2v technologies in Chelmsford, UK. Among the largest area CCDs produced to date, they are nearly 50% bigger than the e2v astronomy products used so successfully in ground-based telescopes around the World.

Like all of ESA's 'Cornerstone' missions, Gaia poses great engineering challenges, but also great challenges in the area of data analysis. A large team of European scientists is participating in the active development of the mission, preparing for the hundreds of terabytes of data that will be sent to the ground during its five-year operational lifetime. A highlight during the last quarter of the year was the successful execution of tests of a

Some members of the e2v (UK) wafer-fabrication group which produced the initial batch of Gaia CCDs. Inset (and magnified): two CCDs on a silicon wafer

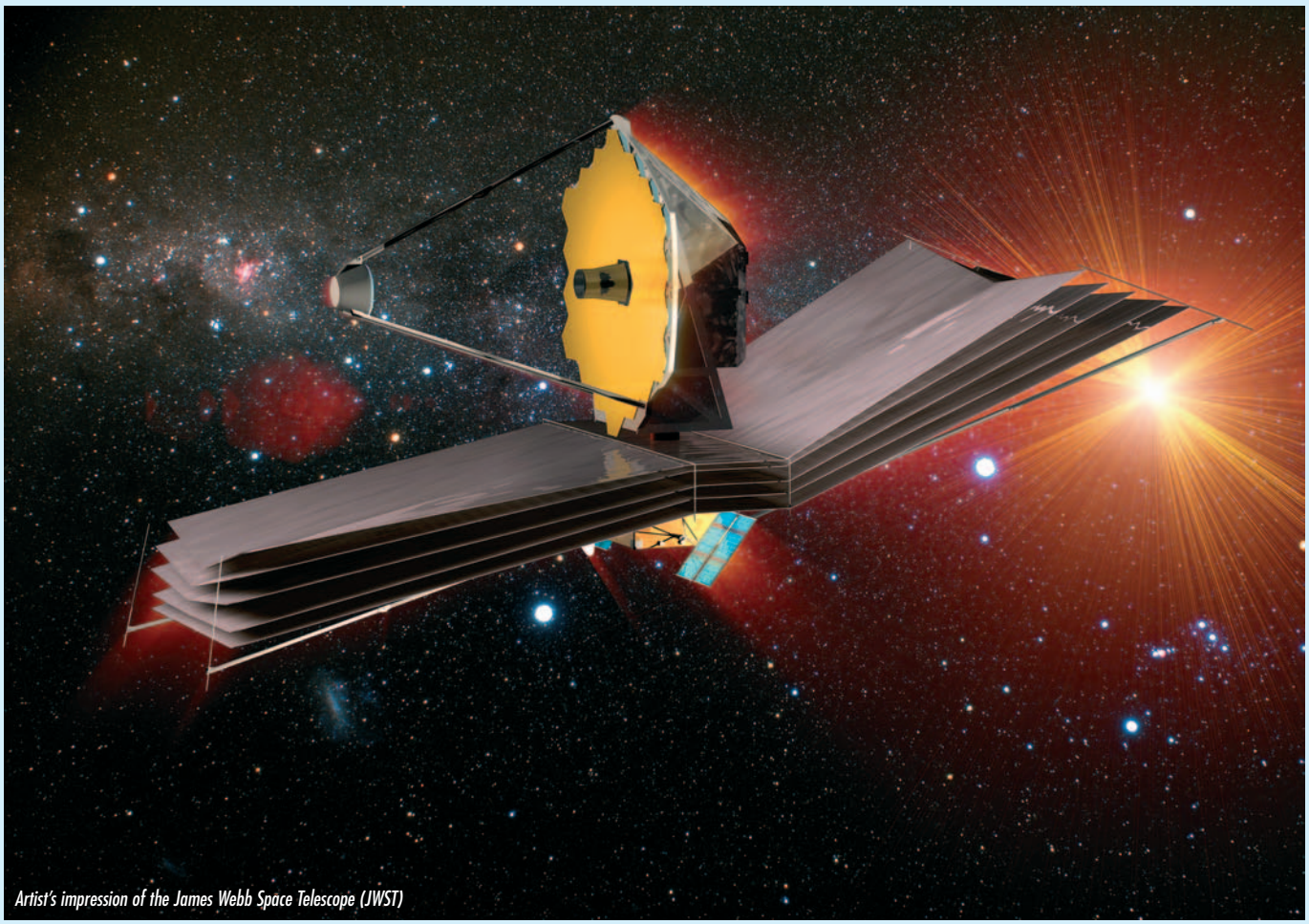
simplified global analysis of data, simulating six months of observations and comprising one million stars. These experiments, led by GMV (Madrid) and supported by the Gaia community, especially those at the University of Barcelona, are being run on super-computers in Barcelona and Madrid.

JWST

The James Webb Space Telescope, formerly called the Next Generation Space Telescope, is the follow-on mission from the Hubble Space Telescope. It is a large observatory-class mission with the primary task of exploring the early Universe back in time to the epoch of the birth of the very first stars and galaxies.

JWST features a deployable 6.6 metre-diameter primary telescope and a suite of three scientific instruments covering imaging and spectroscopy in the near- and mid-infrared wavelength range, from 1 to 28 microns. This payload is protected by a deployable sunshield in order to achieve an operating temperature of 35 K by passive means. The telescope, which will be operated at the L2 Lagrangian point, will be launched by an Ariane-5.

The JWST is a NASA-led mission with participation from ESA and the Canadian Space agency (CSA). The design phase (Phase-B) began last August, after a successful Mission Design Review that was preceded by a long re-planning effort on NASA's part and minor re-scoping activities.



Artist's impression of the James Webb Space Telescope (JWST)

Apart from providing the launcher, ESA is responsible for:

- the Near-Infrared Spectrograph (NIRSpec), which is a 200 kg instrument, the optics and structure of which are to be built using a ceramic material; and
- the optical assembly for the Mid-Infrared Instrument (MIRI), which is being developed by a consortium of European institutes. MIRI will be actively cooled to 7 K using a solid-hydrogen cryostat. The cryostat, detectors and instrument software are the responsibility of Jet Propulsion Laboratory (JPL) in California. Provision of the MIRI instrument is based on a 50/50 partnership between ESA and NASA. The MIRI design phase (Phase-B) was kicked off in June 2003.

ESA will also support the scientific operations phase.

The definition phase is competitive and is being carried out by two consortia, led by EADS-Astrium GmbH (D) and Alcatel Cannes (F). The implementation phase is due to start in July 2004.

Since August, there has been significant progress at both NASA and ESA. All of the major JWST system architectural design decisions related to the telescope's design and technology and the active cooling of MIRI have been taken. All of the NIRSpec-related technology studies are progressing on schedule, aiming for a conclusion in February 2004. The MIRI European Consortium is fully in place, with firm commitments from all participants.

The JWST, which is due for launch in mid-2011, is designed to operate for five years.

Alphabus

The Alphabus programme will establish the production line for a new European telecommunications platform. A multi-purpose platform capable of accommodating telecommunications payloads in the 12 –18 kW power range, it will be the top of the range product for both the Alcatel Space Spacebus and the EADS Astrium Eurostar series.

A combined team drawn from the two prime contractors is conducting the Alphabus preparatory phase. The Baseline Design Review (BDR) was completed in early November. The preparatory phase will continue until mid-2004 and will be finalised with a Preliminary Design Review (PDR). As part of the on-going activities, the prime contractors will also select equipment providers for the build-up of the industrial consortium for the platform's main development phase.

The new Alphabus platform will require the introduction of advanced technologies in several areas. To date, ESA has awarded seventeen contracts to European equipment providers as part of the preparatory activities for the platform's main development phase. A further set of critical developments will be secured in 2004. In parallel, work is also progressing on preparing the Request for Quotation for the main development phase.

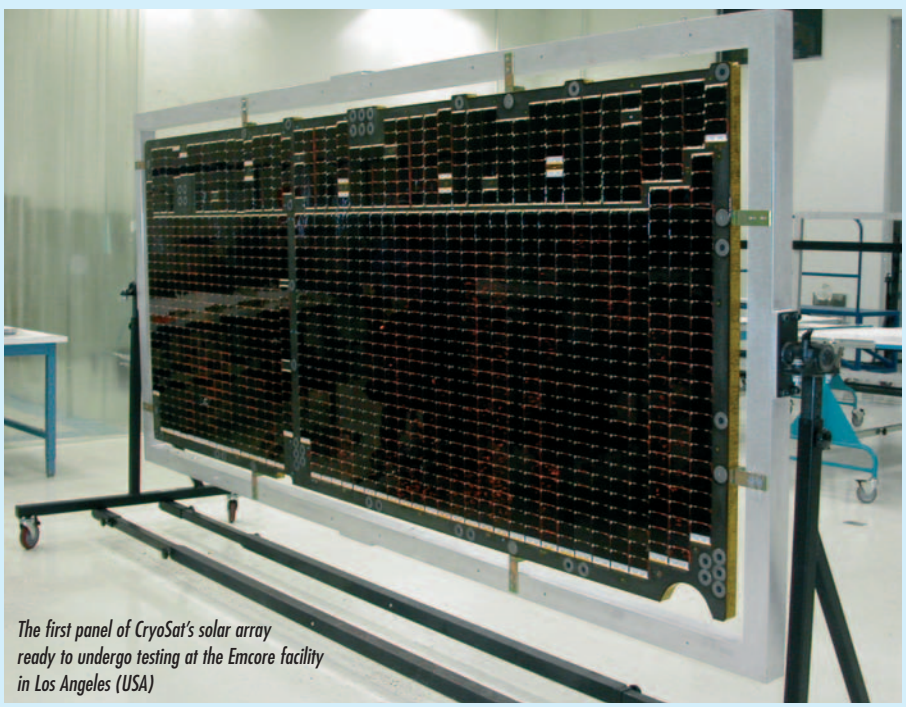
CryoSat

Development of the satellite is progressing well and all flight-model equipment items (except the solar array and onboard mass memory) have been delivered to EADS Astrium's facility in Friedrichshafen (D). Testing of the electronic boxes on the CryoSat Satellite Test Bed is also making good progress. This preliminary integration of the key spacecraft elements has proved to be very useful: a few anomalies have been detected and corrective actions applied, with minimum impact on the schedule. On the mechanical structure, integration of the cold-gas system and the electrical harness is almost complete.

On the payload side, manufacture of the flight model of the SIRAL altimeter is close to completion. Extensive testing of the engineering model is making good progress, and one can anticipate from the preliminary results obtained that excellent performance will be achieved with the flight model.

The activities related to the CryoSat ground segment are also progressing according to plan. The Instrument Processing Facility hardware has been installed in Kiruna (S) and the on-site acceptance of the second version of the Payload Data Segment software was successfully completed in December.

The plans for the launch campaign are now being finalised, with lift-off scheduled to take place from Plesetsk in November 2004.



The first panel of CryoSat's solar array ready to undergo testing at the Emcore facility in Los Angeles (USA)

Artist's impression of the CryoSat spacecraft on its Eurockot launcher

Finally, a launch-services procurement contract has been signed with Eurockot and the related activities were kicked-off at the end of the year.

SMOS

The Phase-C/D proposal received from EADS CASA (E) for the SMOS payload has been evaluated and found to be acceptable. The contract proposal subsequently submitted to the Industrial Policy Committee (IPC) was endorsed unanimously, permitting the industrial work to get underway in December. Full contract signature is expected early in 2004.

GOCE

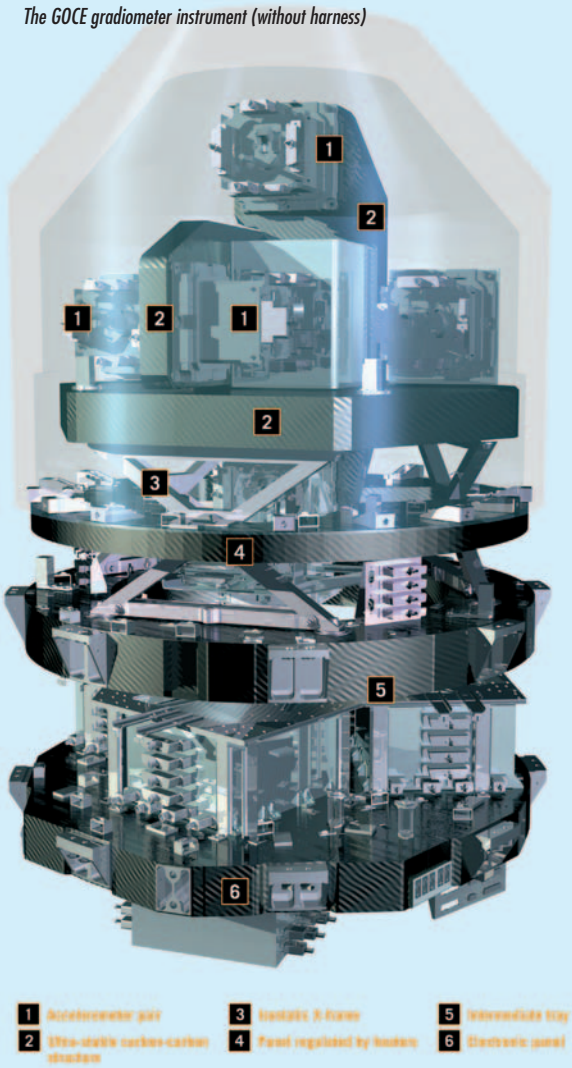
Work on the space segment has entered the main development phase (Phase-C/D), characterised by the execution of unit-level testing and the related Critical Design Reviews (CDRs). Such CDRs have been successfully completed for the battery, the first version of the platform software, the primary structure, the S-band antenna and several ground-support elements, and are about to commence for other units. Manufacturing and testing of various equipment breadboards have been successfully completed. In particular, the first compatibility check between the breadboards of the Ion Propulsion Control Unit (IPCU) and of the Ion Thruster Assembly (ITA) has been run successfully.

The design consolidation and equipment selection for the simplified cold-gas system to be used during the gradiometer calibration phase have been finalised. A new gradiometer calibration method has been worked out and validated through an extensive simulation campaign. Manufacture and testing of the structural model of the gradiometer has been completed. The electrical testing of the Accelerometer Sensor Head (ASH) demonstration model has started, and the first levitation of the proof-mass under 1-g conditions was successfully performed in October.

At platform level, preparatory activities have started for the integration of the engineering-model test bench that will be used to verify the platform's functional and electrical performance, including real-time closed-loop tests with the pre-validated flight software. In the solar-generator area, the substrate supplier has resumed manufacturing activities after completion of the investigation into the problems encountered during the testing of the samples used to validate the manufacturing process.

All ground-segment development activities are progressing according to plan. The System Requirements Review (SRR) for the Payload Data Segment has been concluded successfully. The in-depth study of the tasks to be performed by the Calibration and Monitoring Facility (CMF) is nearing completion. The ESA Industrial Policy Committee (IPC) has unanimously approved the procurement proposal for the Level-1 to Level-2 data-processing facility and the related Request for Quotation (RFQ) has been released to the European GOCE Gravity Consortium.

The GOCE gradiometer instrument (without harness)



In parallel, the technical baseline for the payload was reviewed in a Preliminary Design Review (PDR) at the end of 2003, and was generally found to be mature enough to start with the full implementation phase. Some areas identified as needing improvement (calibration, EMC) are being addressed by joint ESA/CNES/industry/science working groups.

The discussions with CNES about the Implementation Agreement between the two agencies are progressing, with the aim of submitting the finalised document to the ESA Programme Board in March. Progress is being made regarding the development effort for the science data processing at ESA's Villafranca station (E). Industrial contracts are expected to be placed in the first half of 2004.

ADM-Aeolus

The contract for the major spacecraft development effort (Phases-C/D and E1) was signed in October. Most of the subcontracts for both the satellite and instrument have already been kicked-off.

An assessment of the behaviour of the solid-state laser pump diodes under vacuum has shown no dramatic differences compared with similar tests in air. Information from NASA regarding the pump-diode failure on IceSat shows that it was due to diode construction failures, rather than the vacuum. The Aeolus diodes are free of the defect discovered. Despite this, a back-up design has been developed for a pressurised laser, which could be accommodated, if necessary, without changing the rest of the instrument or satellite design.

Delivery of the first flight-model pump diodes, which are on a critical path for the launch, is expected in January. An adequate number of the constituent solid-state diode bars have successfully passed their burn-in test.

The two halves of the 1.5 metre silicon-carbide flight mirror have been successfully brazed together. The mirror is therefore ready for the lengthy polishing process to begin.

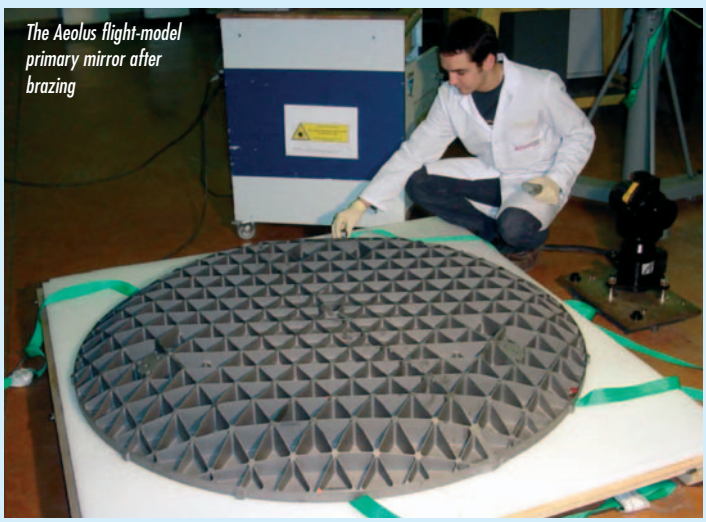
All critical-path activities are proceeding nominally towards the Critical Design Review (CDR) planned for May 2005.

The project team has held discussions with Eumetsat about a desire to deliver Aeolus data, at least for the North Atlantic and Europe, within about half an hour of acquisition. The satellite as designed is able to meet this need, provided it is supported by an adequate number of X-band ground stations. The stations forming part of the Aeolus nominal mission will already allow half-hour delivery from this zone on ascending orbits. Eumetsat may be prepared to fund the corresponding capability for descending orbits. In any event, Aeolus data is likely to be provided to meteorological users via the Eumetsat broadcast system.

Discussions are also in progress with the European Centre for Medium-Range Weather Forecasting (ECMWF) concerning its involvement in the production of Level-2 Aeolus data products (winds). They intend in any case to assimilate Aeolus data and determine its effects on Numerical Weather Prediction.

MetOp

Excellent progress continues to be made on the integration of the MetOp-1 proto-flight spacecraft, with the completion of the acoustic and sine-vibration tests at Intespace in Toulouse (F). Preliminary results indicate that, as expected, the levels of excitation are lower than for the structural-model test, due to increased damping in the (fully representative) flight model. As a consequence, pending confirmation from the detailed analyses and post-vibration testing, the qualification for flight of the spacecraft and, especially, the US instruments appear to be assured.



The Aeolus flight-model primary mirror after brazing

MetOp-1 mounted on the shaker at Intespace in Toulouse (F)

After completing the mechanical test programme with the Starsem-executed launcher-separation shock test, MetOp-1 will enter its final set of functional and performance testing in the run-up to the Flight Acceptance Review, scheduled for May/June 2004. After this, MetOp-1 will go into storage, whilst MetOp-2, the first of the spacecraft to be launched, is prepared.

In parallel with the work on MetOp-1, integration of the MetOp-2 Payload and Service Modules continues, with their respective thermal-vacuum tests being prepared.

An important milestone was reached with the successful completion of the first Satellite System Verification Test, whereby the Eumetsat Ground Segment Mission Control System commanded MetOp directly.

Following Eumetsat's earlier request to examine the possibility of enhancing the MetOp-3 payload, sketch proposals were provided for an AVHRR-type replacement instrument, the VIRI-M, and for a range of spacecraft payload-complement adaptations, via Eumetsat to their Council meeting in November. Further activities in this respect await the completion of discussions between Eumetsat and NOAA.

Meteosat Second Generation (MSG)

MSG-1

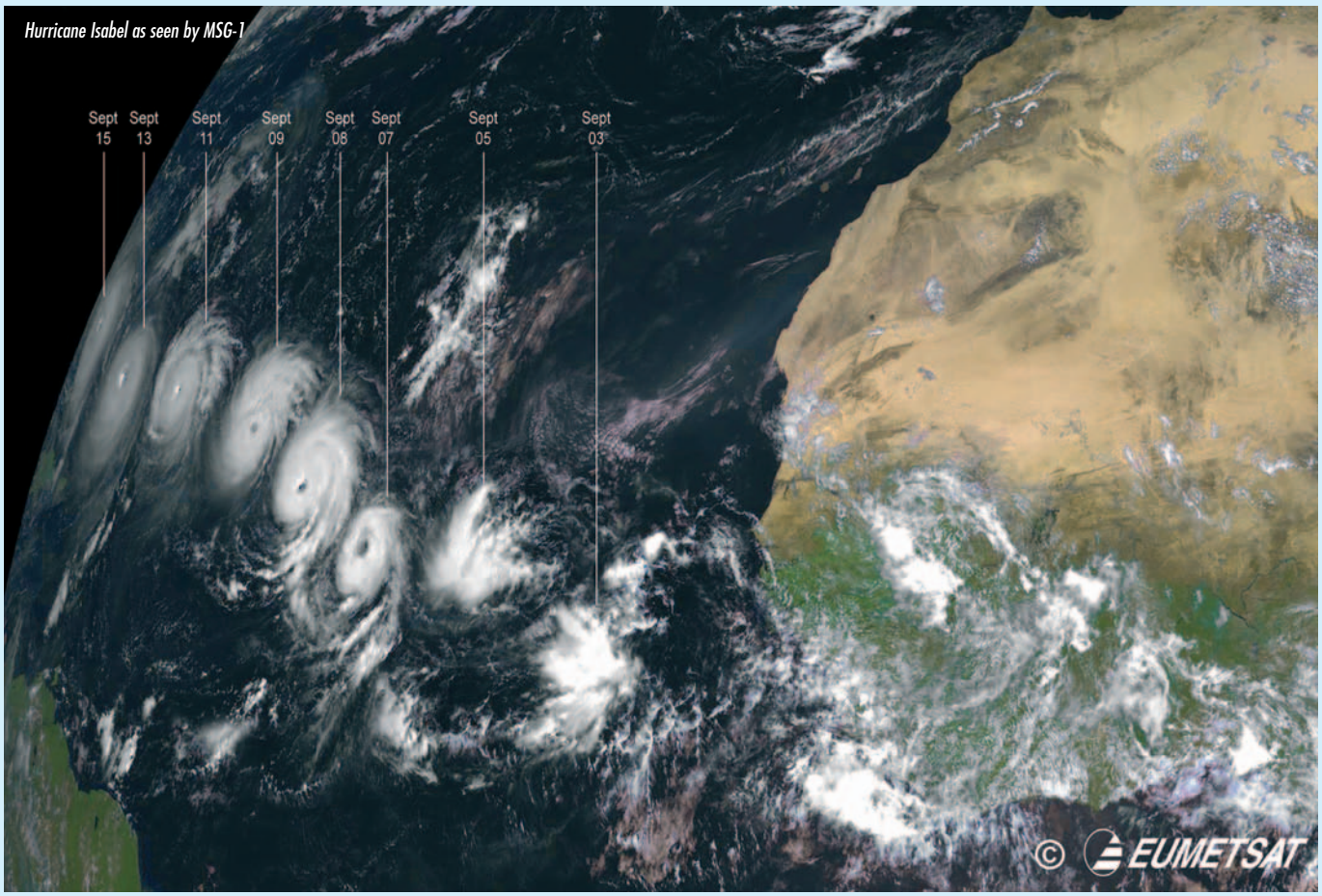
A period of commissioning, intensive in-orbit testing, ground-segment preparation and performance testing for the various MSG missions has been completed successfully. This was confirmed by the System Commissioning Results Review, which was held at Eumetsat. A successful Routine Operations Readiness Review, also held at Eumetsat in the same period, gave the green light for the MSG Routine Operations phase. This will start once the satellite has reached its operational longitude, which is currently planned for the end of January 2004.

MSG-2

The MSG-2 spacecraft is still in its storage configuration. The launch window is currently January-June 2005. Assuming a launch at the beginning of the window, de-storage activities and preparations for the launch will begin on 1 April.

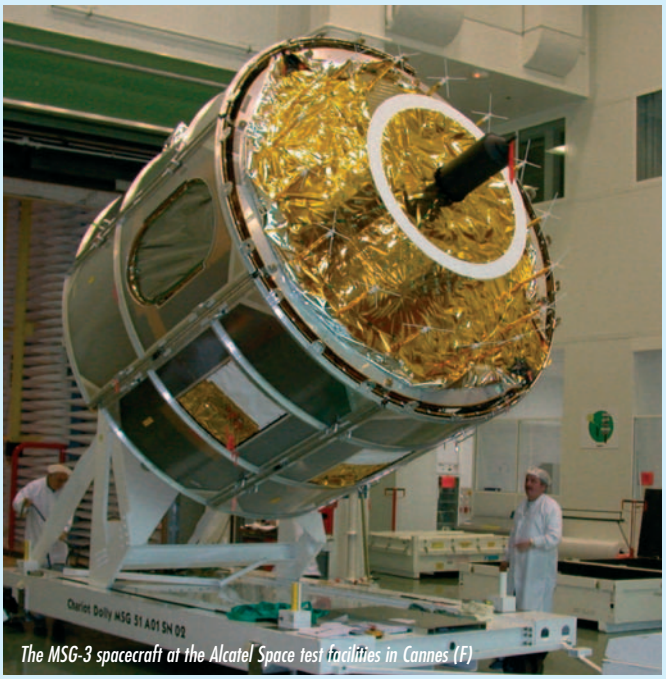
MSG-3

During the last quarter, the MSG-3 satellite has successfully completed a number of important system tests at the Alcatel Space test facilities. The thermal cycling, a complex mechanical test sequence, and the optical vacuum test were performed in just two months. MSG-3 is planned to be stored before the start of MSG-2 de-storage activities for the assumed launch in January 2005. However, with this planning it does not seem to be feasible to



Hurricane Isabel as seen by MSG-1

MSG-2 in the Compact Antenna Test Range


The MSG-3 spacecraft at the Alcatel Space test facilities in Cannes (F)

finalise all MSG-3 performance tests before storage.

MSG-4
The delivery schedule for the EEE parts for the MSG-4 units is critical and has been analysed in detail. All other activities are going according to plan.

Artemis

The satellite has continued to provide data-relay, land-mobile and navigation services to the users as planned:
- SPOT-4 uses one optical link per day for SPOT Image data collection
- Envisat uses seven Ka-band links per day for background mission ASAR and MERIS data collection
- Telespazio uses 50% of the L-band payload (LLM) capacity under the EMS contract
- ESA advanced mobile applications have been using up to 50% of the LLM capacity experimentally
- The Navigation payload has been used by EGNOS for Scanzano station calibration and system phase tests.

Service statistics for the months of November and December were very good, with 100% service quality to SPOT-4, Telespazio and EGNOS. The service provided to Envisat has also been excellent, apart from two link failures in November due to spurious anomalies affecting the Artemis antenna controller.

The total data-relay-link operating time accumulated since 1 April 2003 reached 360 hours (1100 Ka-band links) for Envisat and 50 hours (260 optical links) for SPOT-4 by year's end.

As a result of the L-band operators meeting, which coordinates and allocates the L-band spectrum annually, Artemis will continue to use the same frequency bands in 2004 as in 2003. This situation is very satisfactory for the business demands of Telespazio and Eutelsat, and contracts with both parties are being finalised.

Artemis is now being operated under the routine-phase part of the overall satellite contract. The development and launch-phase part of the satellite contract will be formally closed in the near future. The additional operational support for system engineering required from Alenia and its main subcontractors is under negotiation. Preparations are also underway for the next big data-relay user – ESA's Automated Transfer Vehicle (ATV).

International Space Station

Highlights
The Space Shuttle programme management has recently reaffirmed that the Return to Flight (RTF) plans are based on a flight within a 12 September to 10 October 2004 window.

The in-orbit status of the ISS continues to be good, with all systems and equipment continuing to operate correctly, and just minor anomalies occurring from time to time.

The Expedition 8 crew launched by Soyuz flight 7S on 18 October will stay aboard the ISS until April 2004. The same Soyuz flight also hosted the Spanish Soyuz mission 'Cervantes' with ESA astronaut Pedro Duque, who conducted a successful programme of scientific, technological and educational experiments during his stay at the Station (see his article elsewhere in this issue). The next Soyuz flight, 8S, is still planned for April 2004, and will carry ESA astronaut André Kuipers who will conduct the 10-day Dutch Soyuz mission 'DELTA'.

Space infrastructure development
Columbus system qualification testing is still in

progress. The Materials Review Board has discussed a cold-plate manufacturing deficiency and a resolution to the issue has been proposed. The Microgravity and Audible Noise testing has been completed, and preparation of the System Validation Testing (SVT) has started.

Progress has been made on the Automated Transfer Vehicle (ATV) flight hardware, with all main assemblies now being at the integration site in Bremen (D). There are, however, significant delays in the completion of the flight software, and a flight-readiness date of mid-2005 has been assessed.

Significant amounts of debris (foreign objects) were found in Node 2 at Kennedy Space Centre. A contamination Technical Interchange Meeting has since identified an acceptable approach for solving the problem.

Both the updated Flight Safety Data Package and the Preliminary Design Review (PDR) Data Package for the Cryogenic Freezer (CRYOS) have been received and are under evaluation.

The flight-unit proof pressure test for the Cupola has been performed successfully and integration of the windows has started. The top window has already been installed and successfully leak-tested.

Regression testing on the Mission Preparation and Training Equipment (MPTE) for the European Robotic Arm (ERA) has been successfully completed, and closeout of the MPTE acceptance is now part of the ongoing System Level Acceptance Review.

Operations and related ground segments
The Automated Transfer Vehicle Control Centre (ATV-CC) Critical Design Review (CDR) and Columbus Control Centre (COL-CC) Systems Design Review Part 1 were successfully completed on 14 November, and the first System Validation Test 1a for the ATC-CC successfully took place from 18 to 20 November. Installation of the Wide Area Network for the Mission Control Center in Houston and the ATV-CC has also been completed.

The Ground Segment Data Services System Site Acceptance Review (SAR) for the Columbus Control Centre (COL-CC) was successfully completed on 16 December. The COL-CC Operations Preparation frame contract has been signed and the System Requirements Review for the Operations Planning System has been successfully conducted.

On 20 October, the Expert Panel reviewed the four Microgravity Applications Projects (MAP) continuation proposals received in September, recommending two for continuation, one for re-submission, and that the fourth not be continued.

A software update has been installed to correct errors encountered during the European Drawer Rack (EDR) functional testing, and a new set of performance tests is planned to start by mid-January 2004. Integration of the first sub-rack payload, the Protein Crystallisation Diagnostic Facility, is now foreseen for April 2004.

The Safety Review III for the European Transport Container (ETC) was successfully held at ESTEC on 4/5 December.

Biolab flight-model testing has been completed, and the training model has been installed and accepted at the European Astronaut Centre (EAC) in Cologne (D). Preparation of the Phase-3 Flight Safety Data Package is progressing and delivery is planned for mid-January 2004.

The Crew Review for the European Physiology Module (EPM), with ESA and NASA astronauts participating, was successful. The Cardiolab Data Management Control Unit was delivered and integrated successfully into the EPM rack, and the EPM Science Verification Test was also successful. Sustaining-engineering tasks are ongoing for the Human Research Facility (HRF-2), including the ESA Pulmonary Function System. Integration of science module of the Multi-Electrode Electroencephalogram Mapping Module (MEEMM) into the EPM carrier has been successfully completed.

The Rack-Level Test Facility (RLTF) interface-test campaign for the Fluid Science Laboratory (FSL) was successfully completed and completion of the flight-model functional testing has been adapted to match with the postponed delivery for Columbus integration in April 2004. Completion of the FSL Training Model Acceptance Review, and delivery to the EAC, is planned for end-January 2004. Delivery of the Microgravity Vibration Isolation System (MVIS) from the Canadian Space Agency is expected in early 2004.

NASA has confirmed that Flight Model 1 (FM-1) of the –80 degC Freezer (MELFI) will not now fly in LF-1, but in ULF1.1. The Test Readiness Review for FM-2 was completed in October, the system test campaign is progressing, and compatibility tests with the Japanese Experiment Module (JEM) were completed by mid-December. The integration of FM-3 is almost complete. An ESA/NASA Agreement, relieving ESA of the need to integrate the fourth MELFI flight unit, in return for compatibility verification of MELFI in the JEM, testing of the Human Research Facility in Bremen (D), and clarification on sustaining engineering and maintenance, was signed by both parties in early December.

Project activities for the Hexapod pointing system are proceeding, with the final testing taking place.

The SolACES instrument audit was successful and implementation of the SolACES recovery plan has commenced. The SOLAR CDR Second Board and Review closeout were held on 13 November.

The qualification tests for EXPOSE have been completed and the experiment hardware configuration has been agreed with all Principal Investigators. The fifth Interface Working Group was held on 20/21 November, and the Flight Acceptance Review is planned for 27/28 January 2004. The EXPOSE flight model (with dummy trays) is ready for delivery to the EuTEF (European Technology Exposure Facility) for system integration; production of the flight trays will start in January 2004.

Flight-model hardware manufacturing for EuTEF has continued and the Experiment

Flight Model Acceptance Review procedure is currently being finalised. The Atomic Clock Ensemble in Space (ACES) Payload Preliminary Design Review Board's report was issued on 11 October, and the PDR closeout activities have continued, aiming at completion in February 2004. A management meeting was held with the contractor and an outline plan was discussed for covering the period of the ceiling-price to firm-fixed-price conversion in May 2004. A proposal covering advanced Phase-C1/D tasks was received and evaluated, resulting in an Authorisation to Proceed (ATP). Evaluation of the technical and programmatic impacts induced by the ACES scientific verification plan commenced in November.

The Columbus External Payload Adaptor (CEPA) developed by NASA, which is required for mounting the external payloads, has been delivered to the contractors for Post Shipment Incoming Inspection (PSII) in Europe.

All 21 in-flight investigations/activities were successfully completed during the Spanish Soyuz mission 'Cervantes' to the ISS in October. Acceptance Test 2 for the Dutch Soyuz mission 'DELTA' was successfully completed in Moscow on 17-19 December, and all hardware has been accepted and declared ready for delivery and launch. Preparations for this mission are proceeding well.

The contract for Foton-M2 and -M3 (retrievable satellites) has been negotiated with Rosaviakosmos and was signed in Moscow on 21 October. A full Foton-M2 payload complement has been fixed and payload development has been started for a planned launch in May 2005.

The contract for the Maxus-6 sounding rocket has been finalised and signature is planned for January 2004.

The environmental test campaign and the full functional test for the European Modular Cultivation System (EMCS) flight model have been completed. Some software interface problems between the EXPRESS rack and the EMCS are currently under investigation.

Testing on the Protein Crystallisation Diagnostics Facility (PCDF) engineering module is in progress and assembly of the flight model has started. Delivery of the latter is planned for April 2004. The training model was accepted at EAC in December 2003.

ISS education

The first ESA education programme associated with an ESA/European astronaut ISS mission, 'Habla ISS', was conducted for the Spanish Soyuz mission 'Cervantes', with activities for all school levels. ISS Education was also represented at the 'Physics on Stage 3' festival at ESTEC (NL) in November, which attracted 450 European science teachers. The final version of the ISS Education Kit in English has now been distributed to more than 1200 teachers, with more than 700 requests received online.

Commercial activities

The first public-relations activity for prospective members of the ISS Business Club took place during the 'Cervantes' mission. ESA has delivered the second draft of the Partner Agreement on the Global Brand Management Programme to the ISS Partners. Contacts with major European companies regarding prime and mission sponsorship are continuing.

The Phase-A study for ISS-RapidEye has been concluded, and the programme will not be pursued.

Astronaut activities

The Spanish 'Cervantes' mission to the ISS was supported by EAC staff during launch and landing as well as during the mission itself, at TsUP (Russian mission control centre), EAC and ESTEC. The post-flight activities were completed in December.

Training models for the Biolab and the Fluid Science Laboratory (FSL) were delivered to EAC in October. In the same month, a Space Medicine Workshop, organised by EAC and the ESA Education Office with the support of the European Medical Association, was held at the EAC. Participants comprised space-medicine experts, scientists, astronauts, and 45 students, mainly from Europe. The objective of the Workshop was to foster a two-way exchange between experts and students.

Agreement has been reached with the Canadian Space Agency (CSA) that a Canadian astronaut could be assigned as backup for the first European Soyuz Mission 1 (ESM1). In exchange, an ESA astronaut would become backup for the Canadian increment.

Vega

The Vega main development contract has seen a number of subsystem Preliminary Design Reviews (PDRs), and progress in the negotiation of the subcontracts between the Vega Prime Contractor (ELV) and the other partners of the industrial consortium. The first major tools have arrived at the premises of ELV and Avio, the motor designer and manufacturer, respectively, at Colleferro, near Rome.

The System Design Review has been further postponed after a checkpoint before the Review's kick-off assessed the status of the documentation and compliance with the defined prerequisites as insufficient. Work is in progress to define recovery measures and minimise overall schedule impacts.

Work on the P80 first stage is also progressing, with the first major manufacturing tooling and machines having been pre-accepted at the supplier's premises.

Evaluation of the four Invitations to Tender for the various aspects of the Vega launch base was due for completion in December, after a number of actions requested by the Tender Evaluation Board had been completed. esa