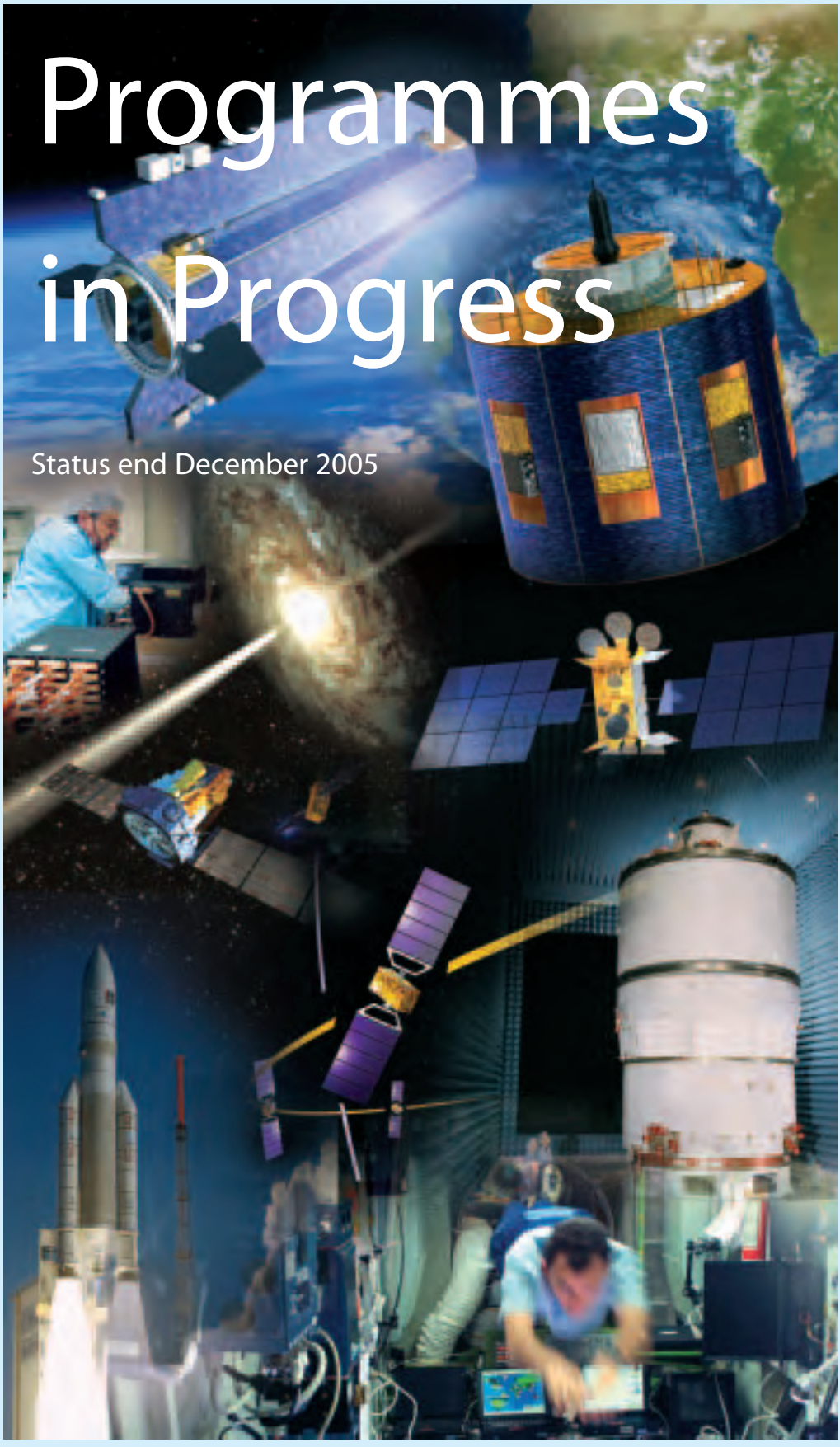
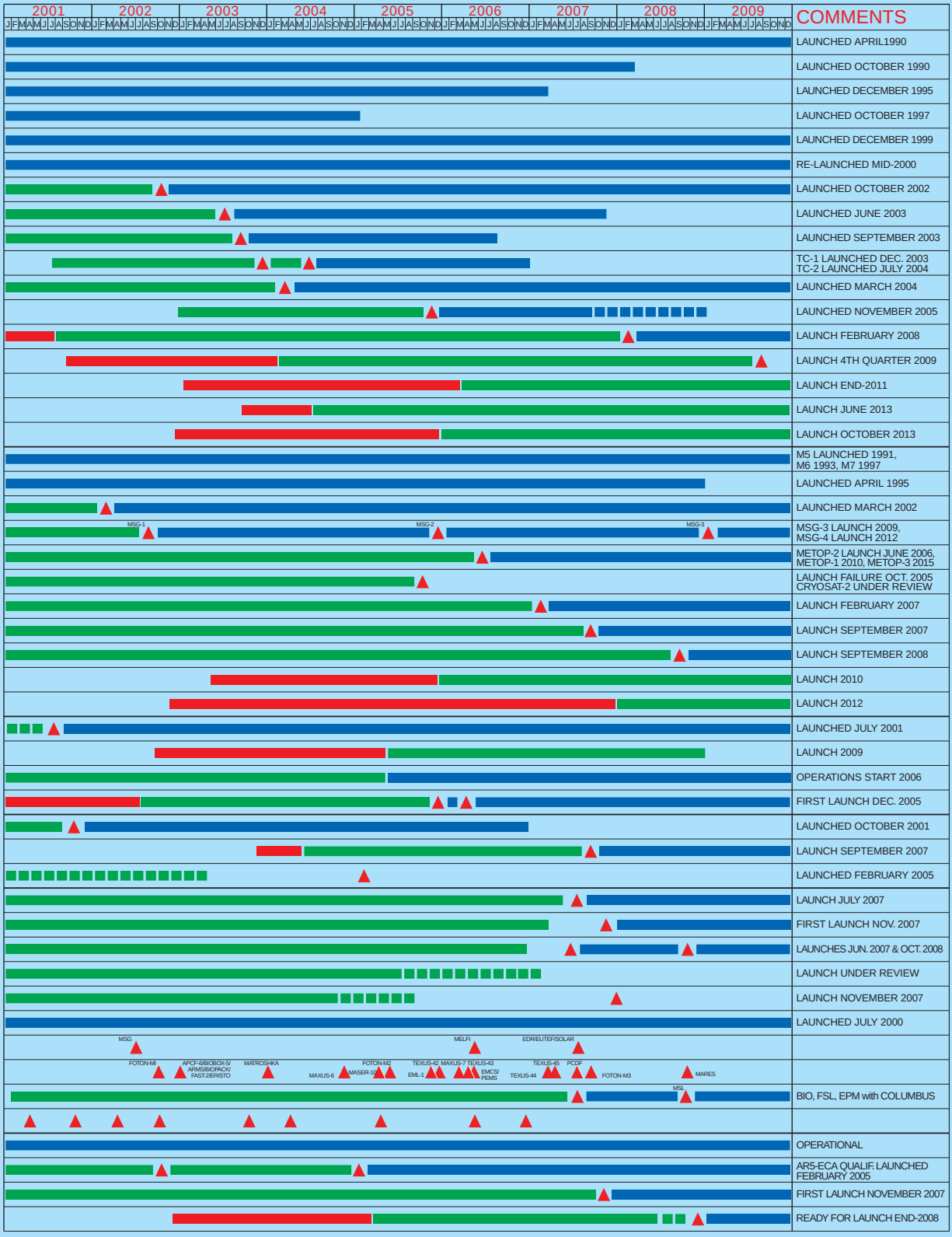
Programmes in Progress

Status end December 2005



	PROJECT
SCIENTIFIC PROGRAMME	SPACE TELESCOPE
	ULYSSES
	SOHO
	HUYGENS
	XMM-NEWTON
	CLUSTER
	INTEGRAL
	MARS EXPRESS
	SMART-1
	DOUBLE STAR
	ROSETTA
	VENUS EXPRESS
	HERSCHEL/PLANCK
	LISA PATHFINDER
	GAIA
	JWST
	BEPICOLOMBO
EARTH OBSERVATION PROGRAMME	METEOSAT-5/6/7
	ERS-2
	ENVISAT
	MSG
	METOP
	CRYOSAT
	GOCE
	SMOS
	ADM-AEOLUS
	SWARM
	EARTHCARE
COMMS./NAV. PROGRAMME	ARTEMIS
	ALPHABUS
	GNSS-1/EGNOS
	GALILEOSAT
TECHNOL. PROG.	PROBA-1
	PROBA-2
	SLOSHSAT
HUMAN SPACEFLIGHT, MICROGRAVITY & EXPLORATION PROGRAMME	COLUMBUS
	ATV
	NODE-2 & -3
	CUPOLA
	ERA
	DMS (R)
	ISS SUPPORT & UTIL.
	EMIR/ELIPS
	MFC
	ASTRONAUT FLT.
LAUNCHER PROG.	ARIANE-5 DEVELOP.
	ARIANE-5 PLUS
	VEGA
	SOYUZ AT CSG


2001
2002
2003
2004
2005
2006
2007
2008
2009
J F M A M J J A S O N D
COMMENTS
LAUNCHED APRIL1990
LAUNCHED OCTOBER 1990
LAUNCHED DECEMBER 1995
LAUNCHED OCTOBER 1997
LAUNCHED DECEMBER 1999
RE-LAUNCHED MID-2000
LAUNCHED OCTOBER 2002
LAUNCHED JUNE 2003
LAUNCHED SEPTEMBER 2003
TC-1 LAUNCHED DEC. 2003
TC-2 LAUNCHED JULY 2004
LAUNCHED MARCH 2004
LAUNCHED NOVEMBER 2005
LAUNCH FEBRUARY 2008
LAUNCH 4TH QUARTER 2009
LAUNCH END-2011
LAUNCH JUNE 2013
LAUNCH OCTOBER 2013
M5 LAUNCHED 1991,
M6 1993, M7 1997
LAUNCHED APRIL 1995
LAUNCHED MARCH 2002
MSG-1
MSG-2
MSG-3
MSG-3 LAUNCH 2009,
MSG-4 LAUNCH 2012
METOP-2 LAUNCH JUNE 2006,
METOP-1 2010, METOP-3 2015
LAUNCH FAILURE OCT. 2005
CRYOSAT-2 UNDER REVIEW
LAUNCH FEBRUARY 2007
LAUNCH SEPTEMBER 2007
LAUNCH SEPTEMBER 2008
LAUNCH 2010
LAUNCH 2012
LAUNCHED JULY 2001
LAUNCH 2009
OPERATIONS START 2006
FIRST LAUNCH DEC. 2005
LAUNCHED OCTOBER 2001
LAUNCH SEPTEMBER 2007
LAUNCHED FEBRUARY 2005
LAUNCH JULY 2007
FIRST LAUNCH NOV. 2007
LAUNCHES JUN. 2007 & OCT. 2008
LAUNCH UNDER REVIEW
LAUNCH NOVEMBER 2007
LAUNCHED JULY 2000
MSG
FOTON-MII
APCF-6/BIOBOX-5/
ARMS/BIOPACK/
FAST-2/ERISTO
MATROSHKA
MELFI
EDR/EUTEF/SOLAR
FOTON-M2
MASER-12
MAXUS-6
TEXUS-42
EML-1
MAXUS-7
TEXUS-43
EMCS/
PEMS
TEXUS-45
TEXUS-44
PCDF
FOTON-M3
MARES
MSL
BIO, FSL, EPM with COLUMBUS
OPERATIONAL
AR5-ECA QUALIF. LAUNCHED
FEBRUARY 2005
FIRST LAUNCH NOVEMBER 2007
READY FOR LAUNCH END-2008
DEFINITION PHASE
MAIN DEVELOPMENT PHASE
STORAGE
LAUNCH/READY FOR LAUNCH
OPERATIONS
ADDITIONAL LIFE POSSIBLE

Hubble Space Telescope (HST)

The Hubble Space Telescope continues to provide excellent data that not only enable advances in science, but also excite and engage the public. Two recently released examples include an image of the star cluster NGC 346 and its surrounding star-formation region, and an image of the Crab Nebula. The NGC 346 image was obtained by an ESA astronomer on assignment to the Space Telescope Science Institute in Baltimore, Maryland, using the HST Advanced Camera for Surveys. Located 210 000 light-years away in the Small Magellanic Cloud, a satellite galaxy of our own galaxy, the cluster is one of the most dynamic and intricately detailed star-forming regions in space. A dramatic structure of arched, ragged filaments with a distinct ridge encircles the cluster. The Crab Nebula is a six-light-year-wide, expanding remnant of a star's supernova explosion. Japanese and Chinese astronomers recorded this violent event nearly 1000 years ago in 1054, as did, almost certainly, Native Americans. This composite image was assembled from 24 individual exposures taken with Hubble's Wide Field and Planetary Camera 2. It is one of the largest images taken by HST and is the highest resolution image ever made of the entire Crab Nebula (see front cover of this Bulletin).

To extend the lifetime of HST, preparations were made over the last year to switch off one of the gyroscopes and operate in a two-gyro configuration. Since the switch to two-gyro mode in late August 2005, operations have continued successfully and without any problems. 'Operational trending' began immediately to evaluate the new mode and identify potential areas for improvement. A meeting in October identified several opportunities for efficiency improvements, which were quickly implemented. With the two-gyro mode operating well, work shifted to evaluating the potential for a one-gyro operating mode. An initial study by pointing-control engineers confirmed the feasibility of the mode, and work began in earnest to define the operational concept and requirements. Following a successful preliminary design review took place in November and the various teams began moving forward on detailed design activities for implementing this contingency one-gyro mode.

Plans for a servicing mission to Hubble using the Space Shuttle continue, but the final decision on whether to actually fly the mission will only be made after a successful second flight of the Shuttle after the 'Columbia' accident, now expected in early spring 2006. The manifest for this Servicing Mission 4, planned for late 2007, now includes two new instruments, the Wide-Field Camera 3 (WFC3) and the Cosmic Origins Spectrograph (COS), as well as many life-extending items such as gyroscopes and batteries. Repair of the Space Telescope Imaging Spectrograph (STIS) – the instrument that failed in August 2004 – may also be attempted by the astronauts. A de-orbit module and the Aft-Shroud Cooling System are no longer part of the plans for this servicing mission, due to a general consensus that they are either not needed at all (cooling system), or at least not until 2020 (de-orbit module).

From the operational point of view, the Hubble spacecraft is operating nominally. All of the scientific instruments – with the exception of STIS – are delivering data that will continue to advance our knowledge of the Universe.

Star cluster NGC 346 and its surrounding star-forming region as seen by HST's Advanced Camera for Surveys (Courtesy of NASA, ESA & A. Nota)

Ulysses

Ulysses was one of the missions reviewed by NASA's Sun-Solar System Connections Senior Review Panel at its meeting on 14 and 15 November. The purpose of the Review, which focused on the period 2007/8, was to rank the expected scientific return from the various

projects on a 'science per dollar' basis. A positive outcome for Ulysses is needed to safeguard NASA's participation up to the end of the mission, presently foreseen for 31 March 2008. (The corresponding decision on ESA's part was taken by the Science Programme Committee in 2004). Presentations were given by the NASA Project Scientist and the ESA Mission Manager, and focused on recent science highlights not included in the formal proposal and the status of the Ulysses project in ESA. These presentations were well received, and the formal recommendations from the Review are expected to be made known early in the New Year.

All spacecraft subsystems are operating nominally. On 1 February 2006, Ulysses will be at a radial distance of 4.35 AU from the Sun and a heliographic latitude 40 deg south of its equator.

Like water droplets from a rotating garden sprinkler, the magnetic field carried away from the rotating Sun by the radially out-flowing solar wind is on average wound into a spiral pattern (an Archimedean spiral) in the heliosphere. A recurring theme in many of the results obtained by Ulysses, however, is the unexpectedly large degree to which the instantaneous heliospheric magnetic-field direction measured at the spacecraft deviates from this pattern. Theories exist to explain such systematic deviations, but these require radial distances of several astronomical units (AU) for a deviation of order 1 AU to develop. However, observations of 'jets' of energetic electrons from Jupiter's magnetosphere, acquired by Ulysses during its distant encounter with the planet in 2003/4, show that such deviations are common within a radial interval of as little as 0.1 AU. Electron jets were discovered during Ulysses's first Jupiter flyby in 1992, and were identified as brief (lasting minutes to hours), highly focused bursts of MeV electrons flowing away from Jupiter along the heliospheric magnetic field. Jets were observed up to distances of an AU from Jupiter and were interpreted as evidence for direct magnetic connection to Jupiter's magnetosphere. In the recent cases, the position of Ulysses relative to Jupiter was such that magnetic connection along the average spiral field could not have occurred, implying large deviations. If such large deviations are indeed common, they may play a significant role in the distribution of charged particles throughout the heliosphere. It is not yet clear how or why such large-scale deviations develop, whether they are consistently present throughout the solar cycle, or how to incorporate them into current theories of particle propagation.

XMM-Newton

XMM-Newton operations are continuing smoothly, with the spacecraft, instruments and ground segment all performing according to plan. The launch of MSG-2 had an impact on XMM-Newton operations with the loss of six science orbits, because the XMM-Newton ground stations were required to support the meteorological satellite's launch and early-orbit phase.

The completion status of the observing programme is currently as follows:
- AO-3 programme: 99.7%
- AO-4 programme: 73.5%.

Completion of both programmes is expected by April 2006, in line with the planned start of AO-5 observations.

The Fifth Announcement of Opportunity (AO-5) closed on 14 October. A total of 632 valid proposals were submitted, requesting 106 737 kiloseconds of science time, implying that 7.4 times more observing time was requested than is available. The meeting of the chairpersons of the Observing Time Allocation Committee took place on 13-14 December at ESAC (E) in order to select the AO-5 observing programme.

A total of 996 papers based either completely or partially on XMM-Newton observations had been published in the refereed literature by 30 December, 276 of them in 2005.

Cluster

The four spacecraft and their instruments are operating nominally. Phasing manoeuvres were executed in November 2005 to change the spacecraft multi-scale configuration (C1, C2 and C3 spacecraft separated by 10 000 km and C3 and C4 separated by 1000 km) to a perfect tetrahedron of side 10 000 km in order to observe the polar cusp in February/March 2006. The solid-state recorder capacity was increased from 5 to 7.5 Gbit by switching on the third memory module. This will allow greater flexibility in the data dumping that will be required for the switch from Villafranca (Spain) to the Perth (Aus.) ground station in January 2006.

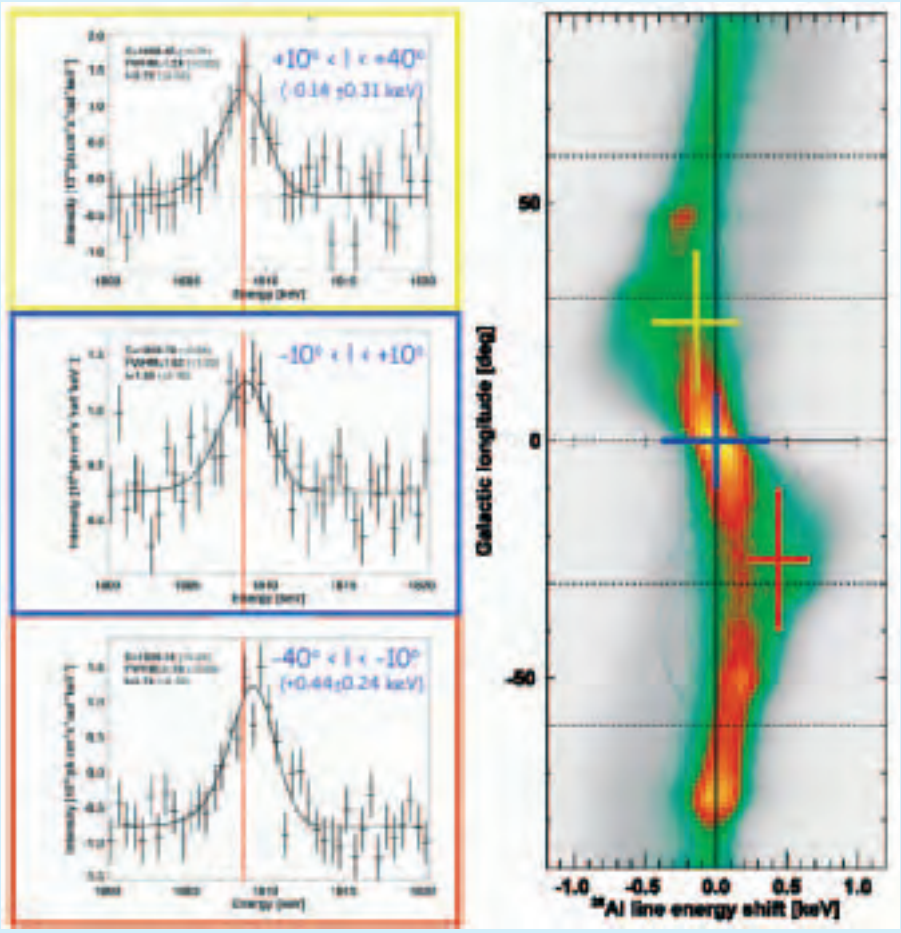
JSOC and ESOC operations are continuing according to plan. Work is progressing for the switch to the Perth ground station starting early in 2006. The data return from September to mid-November 2005 averaged 99.8%.

The Cluster Active Archive (CAA) has been in a beta-testing phase since 26 September. Up to now, 63 software problems have been reported, of which 19 are still open but none of them are critical (mostly related to the ingestion processes). The CAA will be officially opened on 1 February 2006. A new activity on cross-calibration between different instruments has been started; the first meeting was held in September and the next one will be in February 2006.

A new multi-spacecraft method to estimate the magnetic reconnection rate has been developed and applied to the Cluster data. This requires at least two spacecraft to be in the reconnection layer at the same time. The results from one magnetopause crossing by Cluster showed that the reconnection rate is significantly lower than that obtained from previous observations. This finding could stem from the fact that a particular type of reconnection called 'component reconnection' was occurring at that time.

Integral

The results of detailed studies using the Integral Spectrometer (SPI) of the diffuse galactic line emission from the radioactive decay of ^{26}Al (1.81 MeV) have been reported in the journal *Nature* by Roland Diehl (MPE)



The left panels show the line profiles obtained by the Integral Spectrometer at different locations. A clear shift in the line positions in the top and bottom panels compared to the centre panel (l = 0) is visible. Detailed modelling shows that this shift is fully consistent with the Doppler shift expected from galactic rotation. The map on the right shows this expectation based on modelling of the galactic rotation curve and a three-dimensional distribution of ^{26}Al sources, together with the measured values (crosses)

and collaborators. This emission is a key tracer of recent star formation, as ^{26}Al is produced during core collapse supernovae and in the preceding intense stellar winds. The emission rapidly decays within about a million years as the radioactive ^{26}Al is converted to magnesium, and so traces the very recent star formation history of our Galaxy. The line has been observed by Integral at high significance in the inner Galaxy and, for the first time, small energy shifts (of the order of one tenth of a keV) due to galactic rotation have been measured. This supports a Galaxy-wide origin for the ^{26}Al emission and allows an independent estimate of the galactic core collapse supernova rate of 1.9 ± 1.1 per century. This rate corresponds to a star-formation rate of ~4 solar masses per year, or ~7.5 stars per year, and is typical of spiral galaxies similar to our own.

Mars Express

Final commissioning operations for the MARSIS instrument – primarily the commissioning and calibration of the monopole antenna – have been planned and will start in February 2006, after which the MARSIS radar will be fully operational.

At the end of November, a successful orbit-correction manoeuvre was performed in order to return from the current free-drift orbit to a frozen orbit. Operations generally are proceeding well. During some so-called 'SPICAM Sun' pointings in November 2005, a worse than expected reduction in solar-array power was observed. Analysis has shown this to be due to an unforeseen shading of part of the solar array by one of the MARSIS antenna booms when in a specific attitude.

The Planetary Fourier Spectrometer (PFS) is back in operation after a malfunction was encountered a few months ago. The recovery was made possible by exploiting internal instrument redundancy. After switching to the instrument back-up motor (more powerful than the primary motor), the instrument is able to produce science data as before. Following this recovery action, PFS began to routinely acquire new measurements in early November.

Science operations are proceeding well and planning of future observations is progressing smoothly. Further instrument data deliveries were recently made to the mission's data archive, and a new map-based interface was added to the search capabilities of the Planetary Science Archive.

A paper on the ionospheric structure of Mars by the Radio Science team has recently been published in Science. A very successful Press Conference, highlighting the acceptance of one OMEGA instrument article by *Nature* and two MARSIS articles by *Science*, was held at ESA Headquarters in Paris on 30 November.

Double Star

The two spacecraft and their instruments are operating nominally. The drift of their spin axes is continuing as predicted, with the spin axis of TC-1 about 3.5 degrees from the ecliptic pole and that of TC-2 around 16 degrees. This should not cause problems before July 2006 for TC-2 and December 2006 for TC-1. TC-1 has entered the eclipse season, which will last 7 months, and payload operations will be reduced during those eclipses lasting longer than one hour.

The European Payload Operation System (EPOS) co-ordinates operations for the seven European instruments on TC-1 and TC-2 and this is running smoothly. The new contract for the extension of EPOS, starting on 1 January 2006, is in place with RAL. ESOC has acquired an average of about 3 hours of data

per day using the Vilspa-2 ground station and has covered around 80% of the passes. The rest of the passes were acquired by the Chinese stations in Shanghai and Beijing.

Twenty-four Double Star based papers have been published in the special November 2005 issue of Annales Geophysicae, including mission and instrument descriptions and the first results.

On 27 December 2004, radiation from the biggest starquake on a neutron star ever recorded reached Earth. Unique data obtained by Double Star TC-2 and Cluster satellites have shown the first observational evidence of cracks in the neutron star crust, during the initial phase of the starquake. The intensity of this major peak was hundreds of times stronger than any other observed so far (only two other giant flares have been recorded in the past 35 years). For the first 200 ms, it saturated almost all instruments on satellites equipped to observe gamma-rays. Although designed to study the Earth's magnetosphere, the PEACE instruments onboard the Double Star TC-2 and Cluster satellites performed unsaturated observations of this initial flare growth and decay. This result, published in the Astrophysical Journal, will help to discriminate between current theories regarding the physical origin of such massive starquakes.

Venus Express

Venus Express was successfully launched from Baikonur on 9 November aboard a Soyuz rocket. The launch phase was concluded with a nominal separation and injection of the spacecraft onto an interplanetary trajectory to Venus by the Fregat upper stage. The ESOC Flight Control Team then proceeded with the activation of the spacecraft, which went extremely smoothly and was concluded on 11 November.

The next phase of the mission was dedicated to near-Earth commissioning. Each subsystem of the spacecraft was checked out to verify its in-flight performance, with positive results in all cases. On 22 November, the imaging payloads took images of the Moon and the Earth, demonstrating the spacecraft's ability to point to a given target, perform observations, store the data, and transmit it back later to Earth. The remaining payload instruments were then also successfully activated, except for the Planetary Fourier Spectrometer (PFS), a mechanism of which appeared to have stuck due to the very low temperature environment. Near-Earth commissioning activities were concluded on 14 December when, aside from the PFS issue under investigation, the spacecraft's behaviour was declared to be nominal.

The various teams in industry and ESA will now focus on the preparations for testing the main engine in February, and on the spacecraft's insertion into a Venus orbit, planned for 11 April 2006.

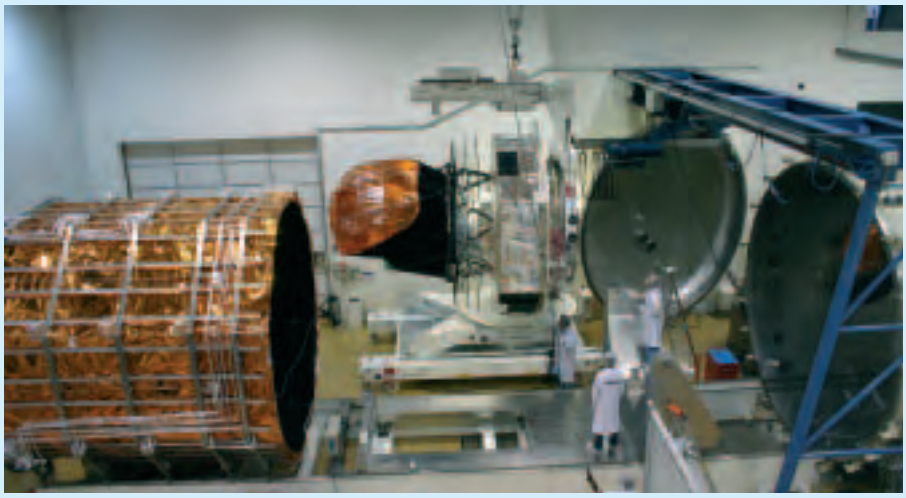
Herschel/Planck

The development efforts in industry for both the Herschel and Planck spacecraft are progressing at a good pace. The flight-model integration of the Planck spacecraft has continued at Alcatel Alenia Space in Cannes (F), and it is now well on the way to the first thermal vacuum test on the flight satellite. During this test, one of the two flight models of the NASA-supplied hydrogen sorption coolers will also undergo flight acceptance tests (both coolers having already been delivered).

On the Herschel spacecraft, after completion of the cryo thermal testing of the protoflight model of the Payload Module, it was mated with the structural model of the Herschel Service Module and is presently being prepared for system mechanical testing in early 2006. The flight model of the Herschel Service Module has been integrated during this period at Alcatel Alenia Space in Turin (I) and its functional testing has also started. The functional, performance and electromagnetic compatibility testing of the Herschel instrument qualification models in the modified ISO cryostat has also been completed.

The development of the flight-model instruments has experienced some delays, but a close monitoring has been put in place. The Planck instruments are now progressing towards delivery in mid-2006, and the

The Herschel spacecraft in the Large Space Simulation (LSS) facility at ESTEC (NL) for the cryogenic lifetime test



The Planck Cryogenic Qualification Model at the CSL facilities in Liege (B)

Herschel instruments towards delivery before end-2006.

The hardware activities on the Herschel telescope were completed during the last quarter of 2005 and the telescope is now fully assembled and aligned. All environmental testing has been successfully completed, with the cryogenic optical testing remaining to be completed in early 2006. For the Planck telescope, the flight-model reflectors have completed all testing and will soon be integrated onto the telescope structure for the final cryogenic optical testing of the telescope assembly.

In mid-December, ESA and Arianespace signed the contract for the provision of the Ariane-5 ECA launcher that will lift the Herschel and Planck spacecraft to their intended orbits around the second Lagrangian point (L2). Taking into account the accumulated delays and the recovery actions in place, the launch is presently foreseen for February 2008.

LISA Pathfinder

The SMART-2/LISA Pathfinder Implementation Phase work is well underway at Astrium Ltd., with all activities proceeding according to schedule. The main activity by the spacecraft engineering team in the reporting period has been the implementation of the actions derived from the System Preliminary Design Review (PDR) and the preparation of the Mission PDR. Work has also progressed on the LISA Technology Package (LTP), on the NASA's Disturbance Reduction System (DRS) interface definition, and on the procurement of the various subsystems and equipment. At the time of writing, fifteen Invitations to Tender (ITTs) have already been issued. Nine subsystem/equipment items have been kicked-off, while the others are at various stages in the selection process. The few remaining ITTs are in a late stage of preparation and will be issued during the first quarter of 2006.

Organisation of the LTP procurement according to the Multilateral Agreement between ESA and the participating Member States (D, I, UK, E, CH, F and NL) is now fully in place, with all contracts between the funding agencies and the relevant contractors negotiated and signed. After the programme re-shaping, performed in the last months in cooperation with the industrial contractors and the national partners involved in the LTP, a series of subsystem reviews is taking place to assess technical and programmatic consistency. These reviews are still ongoing and will be completed in February 2006. Good progress has been made in many areas, but it is evident that the activities leading to a timely delivery of the LTP remain very challenging and will require the full commitment of all parties involved.

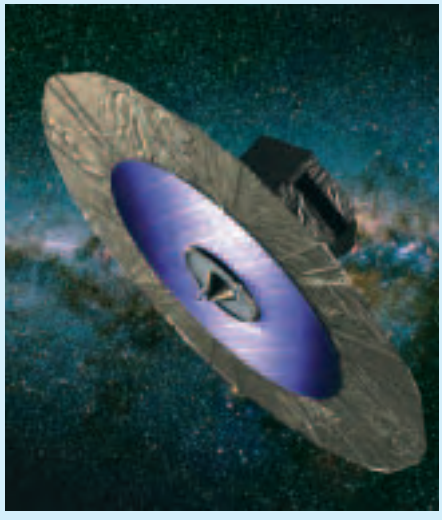
Following a series of reviews at JPL and NASA Headquarters, the American contribution to the LISA Pathfinder mission, the DRS, has been descoped by NASA. It now consists of only the colloidal micropropulsion subsystem and the computer with the drag-free software. In this new configuration, the DRS will make use of the European gravitational sensor, embedded within the LTP, for its operation.

The launch is now expected to take place in the fourth quarter of 2009.

Gaia

Two industrial consortia submitted proposals in response to the Invitation to Tender (ITT) for the implementation and early operational phase of the spacecraft. The proposals were received on 4 October and a detailed assessment by a team of more than 70 ESA experts followed. The Tender Evaluation Board formulated its recommendations on 12 December and these are now being submitted to ESA's advisory structure for formal approval.

The ongoing technology-development efforts on a cold-gas micro-propulsion system are progressing smoothly and giving good confidence regarding the feasibility of such a novel system. The technology activity related to the grinding and polishing of the big, rectangular-shaped SiC primary mirror is nearing completion.



Artist's impression of Gaia

James Webb Space Telescope

JWST continues to be the highest-priority NASA astronomy mission. However, due to the increased cost to completion and the NASA budgetary situation, the launch date has been delayed to June 2013. The JWST System Definition Review was, however, successfully completed in January. All of the critical developments are well advanced in terms of design and verification approach.

NIRSpec

The procurement process for the instrument critical elements has been completed. Manufacturing readiness reviews for the first SiC ceramics qualification and flight parts were held in late December, marking a major milestone in the NIRSpec project.

NASA, which is responsible for developing the Micro Shutter Assembly (MSA) for the NIRSpec instrument, has made significant progress in the development of a full-sized MSA. Problems with shutter stiction remain to be solved.

MIRI

The MIRI Structural Thermal Model test programme has been completed. A thermal leak anomaly during the 7 K thermal balance test is under investigation. Intense preparation for the unit-level Critical Design Reviews (CDRs), leading up to the optical system CDR in summer 2006, is underway. The manufacture of parts for the verification model is in progress.

Launcher

NASA has confirmed its decision to use an Ariane-5 ECA, provisioned by ESA, for the JWST launch. The corresponding Memorandum of Understanding (MOU) between ESA and NASA is being finalised.

LISA

Phase-2 of the Mission Formulation study led by Astrium GmbH is in progress. The next milestone will be the Mid-Term Review in April 2006. The interface with NASA is very effective, with technical matters presented and discussed regularly at Technical Interchange Meetings and via weekly teleconferences, leading to the finalisation of the project baseline architecture. The top-level risk list is being compiled and a joint ESA-NASA Technology Plan has been prepared.

Microscope

The Phase-B of the Microscope project at CNES, kicked-off in October 2004, is devoted to the completion of the technical requirements, and the specification of the internal and external interfaces. The Preliminary Design Review (PDR) that will close Phase-B is planned for January/February 2006. Prior to the spacecraft PDR, the main milestones related to the development of the critical technologies were the Electric Propulsion System (EPS) Delta-PDR held in July 2005, and the ONERA Inertial Sensor PDR in November/December 2005. The launch is presently scheduled for March 2009.

The EPS, to be provided by ESA, is now in Phase-C, after successful completion of the Delta-PDR. The next milestone is the validation key-point, related to the successful completion of the engineering-model tests, including a partial-life demonstration of 2000 hours. The engineering-model test programme, started in September, includes functional and performance testing at thruster and at subsystem level, environmental, direct thrust measurement, and lifetime testing. All of the contracts for the EPS flight-hardware critical procurement activities are ongoing.

GOCE

Following the recommendations of the July meeting of the System-Level Critical Design Review (CDR) Board, a close-out report on the system's development status was presented to the Board on 8 December. This report included a revised schedule that seeks to mitigate as much as possible the consequences of the delay incurred in the production of the Accelerometer Sensor Head (ASH) flight models (FMs). The Board acknowledged that satisfactory progress had been made on all the issues identified at the July meeting and confirmed the closure of the GOCE System CDR. The Board also noted the significant progress achieved in the development of the various elements of the ground segment and in launcher procurement.

Concerning the long-standing accelerometer anomalous-stiffness problem, following the positive results on ASH FM3 reported in the previous ESA Bulletin ASH FM4 was

The MIRI Structural Thermal Model before starting a cryogenic test at RAL (UK)

successfully integrated and tested, showing nominal stiffness both before and after environmental testing. Additionally, ASH FM1, which had previously revealed a non-compliant stiffness, was reassembled and tested before environmental vibration, again exhibiting nominal stiffness behaviour. The significant conclusion from this is that, with the adoption of special cleanliness precautions, fully compliant ASHs can be manufactured and/or integrated. Unfortunately, technical problems in the subsequent functional and performance testing of ASHs both individually and at pair level have led to a further delay in the acceptance testing of the flight models. It is estimated that about six months of work is still required to complete the acceptance of the full set of six ASH FMs. In view of this, the Board made recommendations on possible improvements in the manufacturing process, such as increasing the number of available spare parts and undertaking parallel testing activities. On the positive side, the first part of the flight-model electronics functional testing involving the Gradiometer Accelerometer Interface Electronics Unit, one FEEU and the Gradiometer Thermal Control Unit has been successfully completed.

On the platform side, the first series of closed-loop functional tests of the Drag-Free Attitude Control System on the Platform Engineering Model (EM) Test Bench (TbH) was performed. In parallel, the debugging of the platform EM TbH to payload EM (i.e. the SSTI Engineering Qualification Model (EQM) and the Gradiometer EM) interfaces is progressing at a good pace. Moreover, the platform flight-model integration activities have progressed according to plan, with the integration of all FM units (except that of the Ion Propulsion Assembly) completed and functional testing of the data handling underway. Testing of the Ion Propulsion Assembly (IPA) EM has successfully verified its overall performance and, in particular, the compatibility between the EQMs of the Ion Thruster, the Ion Propulsion Control Unit and the Xenon Feed System. Concerning the solar array, the four FM body-mounted panels and the two FM wing panels have been acceptance tested after the installation of the solar cells. All panels successfully passed these tests, with the exception of one wing panel whose substrate had already shown a weakness in a specific porous area that had been previously reinforced. Unfortunately, the injection of additional glue into the weak area proved to be inadequate and a small delamination has occurred in the affected area. Investigations are being carried out to establish a suitable repair method and, in parallel, a backup solution of having a new wing panel manufactured is also being assessed.

SMOS

The payload Critical Design Review/ Qualification Results Review has been successfully completed and flight-unit production is in full swing. As one of the first activities, a deployable arm of three segments from the STM has been equipped with flight receivers to undergo very accurate measurement of the 'on farm' antenna pattern.

After the Calypso launch (another CNES Proteus-based project) was delayed to at least February 2006, the Ground Support Equipment was returned to Alcatel so that the SMOS platform assembly work can start in January. Major mechanical interfaces have been agreed with the selected launch-service provider, Eurockot. The CryoSat launch failure is assumed to have no impact on the general viability of the launcher.

All technical and contractual issues have been agreed with Indra (E), the prime contractor for the ESA part of the ground segment, and contract signature is imminent. An overall ground-segment Preliminary Design Review, including the adaptation of the Proteus-generic satellite-control elements, is scheduled for Spring 2006.

ADM-Aeolus

The flight-model structure of the spacecraft has been delivered to Astrium in Stevenage (UK). The first stage of integration of the flight platform, namely that of the Reaction Control Subsystem, has begun.

The flight-model structure of the payload instrument has also been delivered to Astrium in Toulouse (F). The first flight models of the instrument's electrical equipment are also arriving.

The polishing of the silicon-carbide primary mirror has been completed at Opteon in Finland, and the mirror is now being coated

The laser qualification model is being readied for testing, including the first two weeks of vacuum operation, which will take place shortly. Resistance to laser-induced damage has been demonstrated for the majority of components and coatings for flight, but some questions still remain with respect to the frequency-tripling crystal. Alternatives are on order as a backup.

The Aladin Airborne Demonstrator, a version of the instrument compatible with airborne and ground operation, was flown for the first time aboard DLR's Falcon aircraft. The instrument produced the first Mie and Rayleigh returns from the atmosphere below the aircraft. It will now be used for the first ground campaign in April of this year.

Launch of the satellite remains scheduled for September 2008.

The Aladin Airborne Demonstrator aboard the DLR Falcon aircraft

Swarm

Swarm is the fifth ESA Earth Explorer Mission. The mission concept involves placing a constellation of three satellites in three different near-polar orbits at altitudes of 450 to 530 km, which will provide high-precision and high-resolution measurements of the strength and direction of the Earth's magnetic field.

The Phase-B satellite activities have been kicked off with the prime contractor EADS Astrium GmbH at the end of November. The Absolute Scalar Magnetometer (ASM) Phase-B was begun by CNES in mid-October.

The risk-reduction activities funded by the Canadian Space Agency (CSA) for the Canadian Electrical Field Instrument (C-EFI) are ongoing. A design that increases the lifetime of the phosphor screen has been successfully tested, while work on the shutter design needed to limit the ion flux under extreme conditions and preserve the lifetime of the micro-channel plates is still in progress. The Phase-B1 is ongoing with ComDev (Cnd) as the instrument prime contractor, together with the University of Calgary for the sensor head's definition and the University of Uppsala (S) for the Langmuir probe.

The direct-injection capability of the Vega launcher for the three Swarm satellites is under investigation with the Arianespace team.

The Preliminary Design Review is planned for January 2007.

MetOp

ESA and Eumetsat have continued to monitor closely the status of preparations for the launch of the first MetOp satellite, and have concluded that a 30 June 2006 launch is still a feasible baseline. Reviews held in the last months included that of the Satellite In-Orbit Verification (SIOV) programme, and the provisional acceptance review for the core Ground Segment.

Lift-off on 21 December of the Ariane-5G vehicle carrying MSG-2 and Insat-4A

The next milestones to be achieved before giving the satellite formal consent-to-ship to Baikonur include:

- a successful outcome to the (Eumetsat) Launch and Operations Readiness Review to be held mid-February 2006
- a successful outcome to the (first) satellite system verification test in March
- the completion of the launch vehicle's qualification
- satisfactory resolution of the thruster flow-control-valve anomaly.

It is now confirmed that the required retrofits affecting the AMSU-A1 and A2 instruments will be performed at EADS Astrium in Toulouse (F) at the end of January/early February 2006, together with the re-integration of the re-calibrated SEM sensors.

The qualification process for the new elements of the Soyuz ST/Fregat launch vehicle continues, with mechanical testing of the Fregat, launcher intermediate bay and the fairing underway. A pre-shipment review for the thee-stage Soyuz ST, including the fairing, was held at TsSKB (Samara) in late December. The launcher has been shipped to Baikonur for the 'dry run' activities needed to validate the modified launcher infrastructure at the cosmodrome.

Activities in the systems and operations area are intensifying, focusing on the performance of a number of final system tests to guarantee safe spacecraft in-orbit operability and the ability to generate flawless level-0 data. The review by industry and the Eumetsat Partners of all critical LEOP, SIOV and routine procedures has been initiated. These procedures are all being validated on a satellite simulator that has recently been upgraded to better model appendage deployment during LEOP.

Meteosat Second Generation (MSG)

MSG-1

Meteosat-8 (formerly MSG-1) operations have been nominal over the last quarter. Instrument performance remains excellent.

MSG-2

After a difficult period of permanent standby and an interrupted launch campaign, MSG-2 was successfully launched on 21 December at 7:33 p.m. Kourou time (22:33 GMT) by a standard Ariane-5G launcher. The latter put the satellite into a near-perfect transfer orbit. After launch, ESOC assumed control of the satellite for the Launch and Early Operations Phase activities and ensured its safe arrival at 6.5°W longitude in geostationary orbit.

Eumetsat subsequently took control of the satellite on 2 January to start the commissioning activities. Activation of the SEVIRI and GERB instruments and verification of the Mission Communication Package's performance are now in progress.

The first MSG-2 signal was received by the Eumetsat commissioning team on 28 December from the MSG ground station in Usingen. During the commissioning period, which will last until Summer 2006, the satellite and ground systems will be carefully tested and tuned in preparation for routine operations. The first image from MSG-2 is expected to be transmitted at the end of January 2006, and the dissemination of imagery to the meteorological user

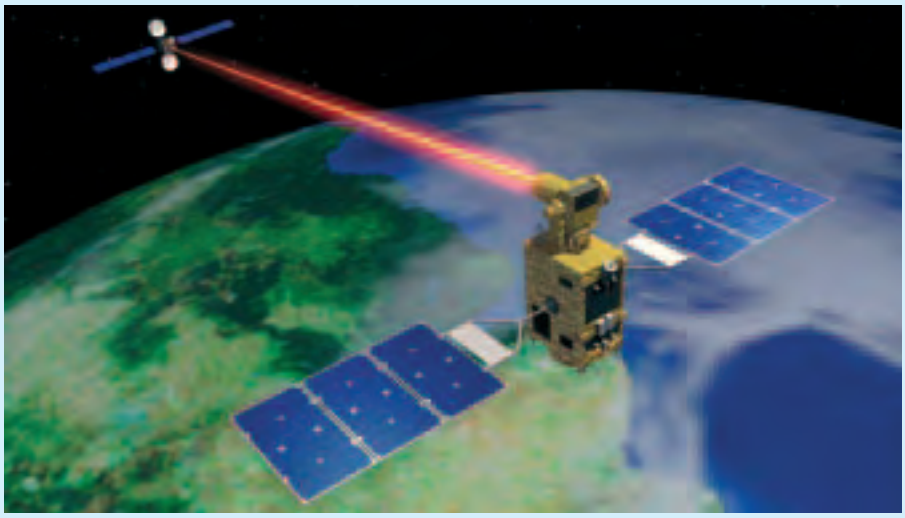
communities for evaluation purposes is expected to start in the Spring.

MSG-3

MSG-3 has remained in short-term storage in the Alcatel clean room. Open work will be completed after the team's return from the MSG-2 launch campaign, after which MSG-3 will be put into long-term storage while awaiting its own launch, which is currently foreseen for 2009.

MSG-4

The MSG-4 assembly, integration and test activities are proceeding according to plan.



The OICETS/Artemis optical link

Artemis

Artemis has now been operating for almost three years since its final arrival in geo-stationary orbit. Services to the main data-relay, land-mobile and navigation users have been consolidated and preparations for new users are now underway. All current users have expressed their satisfaction with the reliability and quality of service.

Envisat has relied heavily upon Artemis since June 2004 for the acquisition of both real-time and recorded data, and two-thirds of the science data is now downloaded via Artemis. Envisat has now accumulated more than 10 000 radio-frequency (RF) links, or a total of 5000 hours. This heavy-duty scenario has proved the value of in-orbit data relay for the fast delivery of high volumes of Earth-observation data. Many of the scenes taken over areas beyond Europe are now acquired directly via Artemis at the Envisat data-processing centre at ESRIN in Frascati (I).

Spot-4 is still making relatively modest but steady use of Artemis with two optical data links per day, recently reaching a total of 1200 links, or 230 hours. Many additional optical and RF links have been made via Artemis for the evaluation of system performance and the testing of interfaces with future users. Both service availability and success rate are now consistently above that required for reliable data acquisition.

The L-band land-mobile capacity of Artemis is leased to Telespazio and Eutelsat. These operators are continuing the European Mobile System (EMS) and related services started by ESA some years ago. There has been a steady growth in new users and the full capacity of the L-band payload is now being exploited. In addition to the integrated voice and data services initially foreseen, new services emerging include voice conferencing, mobile broadband Internet.

The Artemis navigation payload is now being used continuously by EGNOS for its Initial Operations Service. The navigation payload has been fully available for EGNOS transmissions from its NLES earth terminals at Scanzano and Torrejon, and the EGNOS operator reports that good results are being obtained from the payload.

Recently, a significant effort has been devoted to the preparation of the operations interfaces for the new ATV, USV, LOLA and OICETS users:

- The Automated Transfer Vehicle (ATV) will make extensive use of the Artemis S-band service during the free-flight, rendezvous-and-docking and attached phases of the Jules Verne mission. S-band links have been established between the ATV flight model and Artemis and linked via the Artemis earth terminal at Redu in Belgium to the ATV Control Centre in Toulouse (F).
- Artemis will also provide an S-band link for telecommand and flight-data reception during the balloon ascent phase and the drop and free-flight phase of the Italian USV (Unmanned Space Vehicle) mission developed by the CIRA aerodynamic research institute. The USV is an aerodynamic test vehicle for the evaluation of re-entry conditions. USV data will be transmitted and received by the Artemis earth terminal at Redu (B), and transferred to the CIRA control centre and launch base in Italy.
- EADS-Astrium, prime contractor for the SILEX development, is building an improved optical terminal to be flown on an aircraft for the transmission of image data via Artemis. This project (Liaison Optique Laser Aeroporté, or LOLA) will demonstrate optical communication between an unmanned reconnaissance vehicle (UAV) and Artemis under particular conditions of aircraft dynamics and atmospheric propagation. The project is well advanced and the first flights will take place in 2006.
- One of the highlights of recent months has been the success of the OICETS optical-link experiment with Artemis. It represents the culmination of several years of cooperation between ESA and JAXA in the area of data relay and free-space optical communication. Following the launch of OICETS in August, and its subsequent commissioning, the first optical links were established at the end of December. All links up to now have been successful, with very short acquisition times and excellent

tracking performance. This is the second optical user for Artemis and the first demonstration of an optical inter-operability between agencies. The in-orbit experiment will run until late 2006 for the detailed qualification of the OICETS technology.

The Artemis satellite has continued to perform nominally since its commissioning in 2003, and its lifetime expectation is ten years. New funding arrangements have been agreed for the cost of operations in 2006 and beyond for the continuation of its demonstration and operational mission objectives.

Human Spaceflight, Research and Applications

Highlights

In a Multilateral Coordination Board (MCB) teleconference on 25 October, NASA's Associate Administrator for Space Operations confirmed that 18 Shuttle flights to the International Space Station (ISS) is the NASA baseline. Subsequently, multilateral technical meetings have taken place to evaluate the ISS final configuration and assembly sequence, aiming at establishing the feasibility of advancing the launch of Columbus and its payloads (as well as the Japanese JEM and the Canadian SPDM, 'Dextre' and the six-person crew equipment). This evaluation has shown that an advancement of three flights of Columbus in the sequence is barely feasible technically, but a two-flight advancement – leading to Columbus being the six flight – is feasible.

2 November 2005 marked the fifth anniversary of continuous human presence aboard the International Space Station.

The flight of the Texus-42 sounding rocket, on 1 December, carrying an experimental payload, the Electromagnetic Levitator (EML), marked a major step forward in zero-g experimentation for the Intermetallic Materials Processing in Relation to Earth and Space Solidification project (IMPRESS). IMPRESS is a multi-million euro materials-science project co-funded by ESA and the European Commission, involving 150 materials scientists from across Europe and Russia.

The Russian Progress Cargo spacecraft (20P) docked with the ISS on 21 December, carrying supplies for the crew.

Space infrastructure development

The Columbus Preliminary Acceptance Review (PAR), covering the module without payloads, has been completed successfully. Preparation of the Final Acceptance Review 1 (FAR1), covering the module outfitted with its payload complement, is progressing well. The module has been weighed (and is some 350 kg below specification mass), the payload rack facilities have been re-integrated, and the final system test campaign has been successfully completed. The external payload complements have been integrated physically and functionally with the module and interface tests successfully performed. They were subsequently returned to their developers for final integration testing. The integrated Columbus module is due to arrive at Kennedy Space Center on 1 June 2006.

The retrofitted latch valves on the ATV 'Jules Verne' are being re-integrated. Qualification and functional tests, and de-bugging on the Functional Simulation Facility (FSF), are ongoing. A simulation of the ATV approach and docking with the ISS has been successfully performed on the software verification facility, this being the first significant operational 'end-to-end' functional simulation to have been performed with the flight software.

Closeout activities for Node 2 are ongoing at Kennedy Space Center (KSC). Mechanical integration of all of the major internal subsystems of Node 3 has been completed and electrical testing has started.

On 27 October, a contract was signed for the launch preparations and first operations of the European Robotic Arm (ERA) on the ISS. The Mission Preparation and Test Equipment (MPTE) sets for Russia are ready for shipment following inspection by RSC-Energia experts.

The second three-week training course for Russian instructors was completed in December.

Operations and related ground segments

The in-orbit commissioning of the ESA Pulmonary Function System (PFS) payload was successfully performed on 18 October in the US laboratory by the NASA astronaut W. McArthur. Three ESA experiments (MOP, SAMPLE and MUSCLE) were successfully conducted by G. Olsen – Soyuz 11S Spaceflight Participant – in October. Two ESA experiments NOA and CARDIOCOG 2 have been started by the Russian cosmonaut V. Tokarev, who is part of the Increment 12 Russian Expedition Crew. A third experiment IMMUNO will be performed later in the increment.

The passive Matroshka (human phantom) radiation dosimeters were returned to Earth with the Expedition 11 crew, who landed safely on 10 October; new detectors were uploaded in December with the Progress 20P flight.

ATV Control Centre qualification has almost been completed and interface testing with Houston, Moscow, the Columbus Control Centre, and Kourou is nearly finished.

The Columbus Control Centre (COL-CC) Qualification Review Part 1 (QR-1) was successfully completed; QR-2 is now planned for mid-2006. A major system validation between the Columbus flight segment and the COL-CC has been conducted. The docking of the 19P Progress and 11S Soyuz missions was successfully supported from the COL-CC using the ESA ground segment for the routing of live video. This service will be provided for all future Soyuz, Progress and ATV missions.

The procurement of ATV-2 equipment is practically complete. Some ATV-3 equipment has also been procured. The ATV production contract is being renegotiated to reflect the reduction from six to four ATVs, the different launch dates, and to provide bridging of the production teams until production can be restarted.

A contract for all industrial operations services

up to end-2007, including launch and commissioning of Columbus and the Columbus payloads, has been placed with the industrial operator as an end-to-end service.

Utilisation planning, payload developments and preparatory missions
The second stage of the Women's International Space Simulation for Exploration (WISE) Bed Rest Study has been completed.

Following the European Commission's selection of ESA's proposal to use the ISS as a research infrastructure (SURE project), negotiations with the EC have been completed and the Announcement of Opportunity (AO) has been released. Contacts with 12 EU countries are ongoing and visits to selected countries are foreseen for January/February 2006.

The 41st ESA Parabolic Flight Campaign took place between 3 and14 October and all 12 experiments were conducted successfully. The 42nd and 43rd campaigns are currently under preparation and both are now planned for March 2006.

The drop-tower campaign plan for 2005 has been completed as scheduled; three campaigns are currently scheduled for 2006.

The launch of the Texus 43 sounding rocket is planned for May and preparations for the launch of Maxus-7, which is scheduled for April/May, are progressing.

New payload developments and refurbishment activities for Foton-M3 are in progress; the launch is planned for September 2007.

The -80°C Freezer (MELFI) and the European Modular Cultivation System (EMCS) are being re-integrated into the Multi-Purpose Logistics Module (MPLM) prior to launch on ULF-1.1 (after final refurbishment).

The flight models of the European Physiology Module (EPM), Biolab, Fluid-Science Laboratory (FSL) and the European Drawer Rack (EDR), including the Protein Crystallisation Diagnostic Facility (PCDF), have been delivered to Bremen (D) where they have been integrated into Columbus and have successfully completed interface testing.

A request has been sent to NASA to launch the Portable Glove Box, which is needed for experiments in Autumn 2006, on a Shuttle flight; launch on a Russian Progress in mid-2006 is also under investigation as an alternative.

The flight models of the two Columbus External Payloads, SOLAR and EuTEF, have been successfully integrated and interface tested on Columbus, and subsequently returned to their developers.

A detailed study of the Atomic Clock Ensemble in Space (ACES) payload's accommodation on Columbus has started.

ISS education
The new European Master Course in Aeronautics and Space Technology (EuMAS), an initiative of the European Commission through the Erasmus Mundus programme, started on 3 October. ESA, largely through the ISS Education Fund, is the main non-academic contributor and sponsor.

The SUCCESS competition university student visit to ESTEC took place 9-12 October; experiments have been selected and endorsed by the Life and Physical Sciences Advisory Committee (LPSAC).

ARISS Radio contact was made with ISS and six schools from Norway, Italy, Belgium, Portugal and Greece on 22 November.
The preparation of selected future student experiments for the Long Duration Mission and ATV-1 is in progress.

Commercial activities
The ISS Business Club General Meeting and workshop took place in November. The presence of Dr. G. Olsen, the latest spaceflight participant on the ISS, drew a lot of participants, including selected press representatives. The event also marked the official entry into the Club of three new members. A nutritional company has expressed interest in testing a new product with a bed-rest and on the ISS.

The commercial proposal concerning the utilisation of ESA assets for training and corporate events to be held at the European Astronaut Centre (EAC) and at the Erasmus User Centre (ESTEC) has been negotiated.

Astronaut activities
The trilateral protocol between ESA, NASA and Roskosmos on the implementation of the ISS Increment mission by an ESA astronaut (T. Reiter) foresees launch to the ISS on the next Shuttle flight (STS 121), with a Shuttle or Soyuz return flight, and that the ESA astronaut will perform an EVA in an Extravehicular Mobility Unit (US EVA suit). Training for this EVA will be provided by NASA.

T. Reiter and L. Eyharts have continued with their Astrolab training, and A. Kuipers and F. de Winne received ISS and robotics training at Johnson Space Center (JSC).

The first Columbus simulation in the Integrated Simulation Set-Up was performed in October. The simulation was run on the Columbus Trainer at EAC, with the Flight Control Team in the Columbus Control Centre commanding the module.

Columbus Payload Advanced Training was provided at EAC from 24 to 28 October for 12 ground-support personnel and training engineers. A first NASA-ESA EVA training workshop was also held at EAC from 5 to 9 December, resulting in significant progress in the development of an ESA EVA pre-familiarisation training course.

Vega

The first firing test of Vega's Zefiro-9 third-stage solid-rocket motor was successfully performed on 19 December. This test was particularly important because the data collected will allow verification of:

- the ballistic performances (pressure and thrust curves)
- the internal thermal-protection efficiency
- the performance of the thrust-vector control system
- the induced thermal and dynamic environment.

A first assessment of the data shows that the test ran according to plan and all expected data have been recorded.

Analysis of the data from the AVUM engine firing test in October has confirmed performances in line with expectations. An anomaly caused by the test facility itself is under investigation.

Several other milestones have also been achieved in recent months:

- The P80 nozzle flex-seal models and thrust-vector control units and actuators have been manufactured.
- The compression test on the Z23 development model has been successfully completed.
- The Z23 development-model winding has been completed.
- The interstage 2/3 vibration tests have been successfully conducted.
- The Review Board for the half-fairing stiffness test met on 1 December and confirmed its complete success.
- The AVUM structure and 3/4 inter-stage have been manufactured.
- The interface database for the ground segment has been delivered. The consolidated analyses of the environment at lift-off and related dimensioning cases for the ground segment design have been completed.
- The new mobile-platform design has been accepted and the mobile gantry design has been revised to be compatible with the existing foundations and maximum loads.

The P80 winding test should start by mid-January 2006, after validation of the modifications to the winding machine. The Vega Industrial Day took place on 4 November in Colleferro (I), together with a visit to the facilities there. The first Vega Customer Day took place on 4 November in Rome.

At the ESA Ministerial Council in December, the Vega follow-up programme Verta was approved, which includes five launches between 2008 and 2010 and a number of activities to improve customer service and to keep launcher design and quality under close scrutiny, based on similar criteria to those established for Ariane.

Soyuz at CSG

Austria joined the Programme in October as a Participating State.

As far as technical achievements are concerned, the earthworks at the future Soyuz Launch Site (ELS) have advanced at a rapid pace, thanks to a very favourable dry season in French Guiana. Completion of the ground works is now expected more than six months ahead of schedule. The construction site was officially 'opened' on 16 November and work on the excavation of the exhaust ducts began immediately.

Following the complementary Preliminary Design Review at the end of June 2005, the main open issue remains the safety review by CSG. A detailed analysis of the safety environment during launch operations has been carried out and several meetings have taken place in cooperation with the Russian partners. The final results are expected in February 2006.

On the contractual side, CNES has now secured the so-called 'European activities' concerning the ground-segment infrastructure: a major contract was signed on 9 December with a consortium of companies representing all of the Participating States. As a consequence, and in order to facilitate the interaction of all companies involved as well as CNES staff, a project group (Plateau Project) is being assembled in Toulouse (F) to improve the coordination of the construction work between all partners, including the Russians.

The contract for the manufacture and assembly of the mobile gantry has been awarded. Insurance cover for the construction phase has finally been negotiated, so that all companies and organisations working on the site are now fully covered.

FLPP

The Future Launchers Preparatory Programme (FLPP) agreed in 2004 has the objective of performing preparatory activities for the development of the Next Generation Launcher (NGL), to be operational from 2020 onwards. Activities in 2005 focused on the finalisation of the FLPP Period-1 contracts for system-level activities, technology development (rocket propulsion, materials and structures, aerothermodynamics), as well as efforts related to the preparation of Ariane-5's evolution. Within this framework, an arrangement between ESA and the Russian Space Agency regarding cooperation on research and technology for future launchers was signed on 19 May.

During the ESA Ministerial Council in December, Member States subscribed to Step-1 of Period-2 of FLPP. This additional FLPP slice, which received a substantial financial allocation, focuses on preparing the ground for a decision to be taken in 2008 regarding the future evolution of the European launcher sector and the development of the Next Generation Launcher (NGL). esa

The earthworks at the future Soyuz Launch Site (ELS)