

(status end-December 2001)

## In Orbit

PROJECT		1998	1999	2000	2001	2002	2003	2004	COMMENTS	
		JFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON		
SCIENCE PROGRAMME	SPACE TELESCOPE	[Main Development Phase]								LAUNCHED APRIL 1990
	ULYSSES	[Main Development Phase]								LAUNCHED OCTOBER 1990
	SOHO	[Main Development Phase]								LAUNCHED DECEMBER 1995
	HUYGENS	[Main Development Phase]								LAUNCHED OCTOBER 1997
	XMM-NEWTON	[Main Development Phase] ▲								LAUNCHED DECEMBER 1999
	CLUSTER	[Main Development Phase] ▲▲								RE-LAUNCHED MID 2000
APPLICATIONS PROGRAMME	MARECS-B2	[Main Development Phase]								POSSIBLE NEW LEASE
	METEOSAT-5 (MOP-2)	[Main Development Phase]								OPERATED BY EUMETSAT
	METEOSAT-6 (MOP-3)	[Main Development Phase]								OPERATED BY EUMETSAT
	METEOSAT-7 (MTP)	[Main Development Phase]								OPERATED BY EUMETSAT
	ERS - 2	[Main Development Phase]								LAUNCHED APRIL 1995
	ECS - 4	[Main Development Phase]								OPERATED FOR EUTELSAT
	ARTEMIS	[Main Development Phase] ▲								LAUNCHED JULY 2001

## Under Development

PROJECT		1998	1999	2000	2001	2002	2003	2004	COMMENTS	
		JFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON	DJFMAMJJASON		
SCIENTIFIC PROGRAMME	INTEGRAL	[Main Development Phase] ▲								LAUNCH OCTOBER 2002
	ROSETTA	[Main Development Phase] ▲								LAUNCH JANUARY 2003
	MARS EXPRESS	[Main Development Phase] ▲								LAUNCH MAY 2003
	SMART-1	[Main Development Phase] ▲								LAUNCH END 2002
	HERSCHEL/PLANCK	[Main Development Phase]								LAUNCH FEBRUARY 2007
COMMS/NAV. PROG.	GNSS-1/EGNOS	[Main Development Phase]								INITIAL OPS. END 2003
	GALILEOSAT	[Main Development Phase]								FIRST LAUNCH 2003
EARTH OBSERV. PROGRAMME	EOPP	[Main Development Phase]								
	EOEP/CRYOSAT/GOCE	[Main Development Phase] ▲								LAUNCH GOCE OCT. 2005
	ENVISAT 1/POLAR PLATFORM	[Main Development Phase] ▲								LAUNCH MARCH 2002
	METOP-1	[Main Development Phase] ▲								LAUNCH 2nd HALF 2005
	MSG-1	[Main Development Phase] ▲								LAUNCH JULY 2002
MANNED SPACE & MICROGRAVITY PROGRAMME	COLUMBUS	[Main Development Phase] ▲								LAUNCH OCTOBER 2004
	ATV	[Main Development Phase] ▲								LAUNCH SEPTEMBER 2004
	X-38	[Main Development Phase]								V201 TEST FLIGHT FEB. 2005 (UNDER REVIEW)
	CRV	[Main Development Phase]								UNDER REVIEW
	NODE-2 & -3	[Main Development Phase] ▲								LAUNCHES FEBRUARY 2004 & JULY 2005
	CUPOLA	[Main Development Phase]								LAUNCH JAN. 2005 (UNDER REVIEW)
	ERA	[Main Development Phase]								LAUNCH UNDER REVIEW
	DMS (R)	[Main Development Phase] ▲								LAUNCHED JULY 2000
	MELFI	[Main Development Phase] ▲								LAUNCH JANUARY 2003
	GLOVEBOX	[Main Development Phase] ▲								LAUNCH MAY 2002
	HEXAPOD	[Main Development Phase] ▲								LAUNCH SEPTEMBER 2004
	EMIR	[Main Development Phase] ▲								
	MFC	[Main Development Phase] ▲								BIO, FSL, EPM, in COLUMBUS
LAUNCHER PROGRAMME	ARIANE-5 DEVELOP.	[Main Development Phase] ▲								OPERATIONAL
	ARIANE-5 PLUS	[Main Development Phase] ▲								FIRST LAUNCH JULY 2002
	VEGA	[Main Development Phase]								LAUNCH END-2005
	FESTIP	[Main Development Phase]								REUSABLE LAUNCHER DEFIN.
	FTLP	[Main Development Phase]								TECHNOLOGY DEVELOPMENT

- DEFINITION PHASE
- MAIN DEVELOPMENT PHASE
- ▲ LAUNCH/READY FOR LAUNCH
- OPERATIONS
- ADDITIONAL LIFE POSSIBLE
- ▼ RETRIEVAL
- STORAGE

## ISO

With the end of the Post-Operations Phase in December 2001, ISO has entered its five-year Active Archive Phase. This phase will focus strongly on increasing the 'off-the-shelf' usability of the ISO archive products, while continuing to support and encourage the scientific community in the exploitation of the ISO data. The work will be pursued in close collaboration with the National Data Centres (NDCs) that are funded for the Active Archive Phase, and with groups in the community.

Over the past few months, ongoing wrap-up activities for Post-Operations Phase have been directed towards the release of a reference Legacy Archive, to contain all ISO data products automatically reprocessed with the latest calibrations and software. That bulk reprocessing has already been completed and refinement of the explanatory documentation is also nearing completion.

There are now over 1200 registered external users of the ISO Data Archive.

### Science highlights

As ISO's Post-Operations Phase came to a close, exploitation of the ISO archive continued with around 120 refereed papers being published during the year.

Recent highlights included the finding of thirty brown dwarfs, elusive objects at the boundary between planets and stars, in the rho Ophiuchi cloud. ISO results suggested they form star-like, by accretion from a gaseous sphere, rather than forming planet-like, out of a disk orbiting a star. Many brown dwarfs have their own disks.

The discovery of more than 30 Earth masses of carbonates in two planetary nebulae has suggested formation mechanisms not associated with the presence of liquid water. This calls into question the previously assumed role of water (aqueous alteration) in the formation of carbonates in the early Solar System, with strong implications for estimates of the time of first appearance of liquid water, and of liquid-water-bearing planets, in the system.

## XMM-Newton

XMM-Newton operations continue to run smoothly. In the last quarter of 2001, some science time was unavoidably lost due to solar activity, but recently there have been almost no interruptions.

In December 2001, the ESA Science Programme Committee (SPC) unanimously approved the extension of XMM-Newton operations for four years until March-2006. During the extension discussions it was agreed that the so-called 'guaranteed-time programme' would be completed as soon as possible. This is important to the overall observing programme, as it will prevent important celestial targets from being 'proprietary' for too long a period. Implementation of this will mean a delay of six months in starting the Second Announcement of Opportunity (AO-2) observations, and a delay of approximately three months in their completion.

A successful observation of a gamma-ray burst, following a BeppoSAX trigger, took place on 12 December 2001. XMM-Newton was on target approximately 10 h after the burst was detected. This was an excellent (overnight) achievement by ESA's VILSPA (E) and ESOC (D) teams. An electronic circular giving the precise position (10") was issued some 7 h after the start of the observation. The data, which were processed and made public on 27 December, are still being analysed, but a preview is available at: <http://xmm.vilspa.esa.es/news/GRB011211/grb011211.html>

The overall XMM-Newton data-processing and data-shipment activities are going according to plan. So far 1427 observation sequences have been executed, and the data for 1282 of these have been shipped. A new, improved-calibration version of the XMM-Newton Science Analysis Software (SAS), developed jointly by ESA and the Survey Science Centre (SSC), will be released at the end of February 2002.

The XMM-Newton satellite will enter its fifth eclipse season in March 2002, and



*The impressive rho Ophiuchi cloud, located 540 light-years away in the constellation Ophiucus, as seen by ISO*

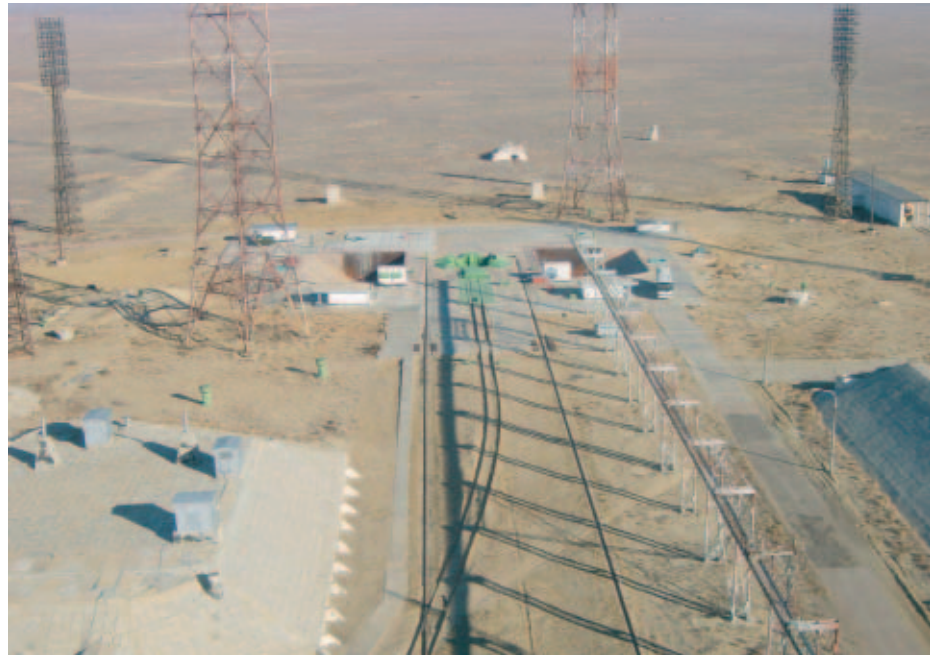
*The Integral launch pad in Kazakhstan ten months before launch*

preparations for this have already been started. Work on the development of the XMM-Newton Science Archive (XSA) continues, and it will be released in the first quarter of 2002.

A very successful symposium, attended by some 330 astronomers, entitled 'New Visions of the X-ray Universe in the XMM-Newton and Chandra Era', was held at ESTEC (NL) from 26 – 30 November 2001. The Proceedings will be published shortly by ESA Publications Division as ESA SP-488 (on paper and CD-ROM).

## Integral

The two remaining flight-model instruments – the IBIS imager and the JEM-X X-ray monitor – have been delivered and integrated on the spacecraft. Integral is therefore now complete and ready for the final phase of its environmental test



campaign at ESTEC. The current status of work in all areas is compliant with the October 2002 launch date.

The electromagnetic-compatibility test and subsequent system tests, the first such tests with the complete payload integrated

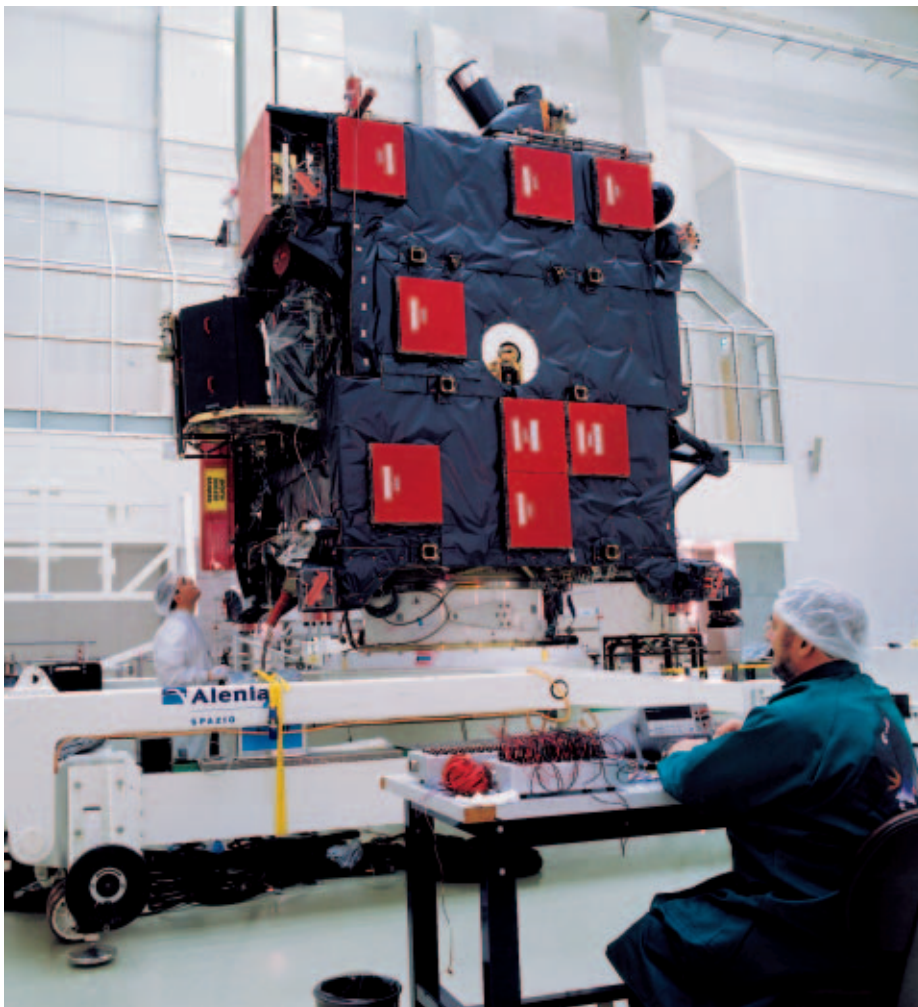
on the spacecraft, have been successfully completed. The payload-calibration campaign, during which the performances of the various scientific instruments will be verified using radioactive sources, has been kicked off.

The next major environmental test will be the acoustic test planned for the first quarter of 2002. It will be followed by thermal tests and final functional testing. The Flight Acceptance Review is scheduled for July 2002.

The manufacture of the Proton launcher by the Russians is progressing satisfactorily. A recent visit to the Baikonur Cosmodrome in Kazakhstan showed that the Integral-specific adaptation work needed at the launch site has also been progressing according to schedule.

## Rosetta

The flight-model spacecraft is now fully integrated and is undergoing final functional testing before the environmental test programme begins. It was moved from Alenia in Turin (I) to ESTEC in November 2001 and thermal-vacuum testing will commence there at the end of January 2002. Many minor problems have occurred which have necessitated three-shift-per-day working. The transponders



*The Rosetta flight model under test at ESTEC in Noordwijk (NL)*

have now been delivered, and also the onboard software required for the test phase. The electrical qualification model programme is continuing in parallel and is being used to debug all system functional test sequences before they are run on the protoflight model.

The scientific performance problems with the COSIMA instrument have now been identified and a new unit is being manufactured, which will be substituted later in the programme. The rest of the scientific payload is operating nominally on the spacecraft.

The Lander is integrated on the spacecraft, but some problems were experienced during final testing with the deployment of the landing gear. Solutions to improve the gear's robustness are being investigated and retrofits to the existing gear will be introduced later.

The Ground Segment Implementation Review successfully took place during November 2001 at ESOC in Darmstadt (D). Most ground-segment elements are progressing according to plan, but the operational readiness of the New Norcia ground station, which is now planned for August 2002, is a cause for concern.

The Launcher Preliminary Mission Analysis Review has successfully taken place with Arianespace. The launcher's performance for the Rosetta mission is now confirmed, but some aspects of this unique Earth-escape mission need still to be qualified on the ground.

## Mars Express

One of the major events in the project's life cycle took place in October, namely the successful completion of the mechanical qualification of the structural model at Intespace in Toulouse (F). In the case of Mars Express, the structural model is the final flight model, except that mass dummies replace the electronics boxes and the solar arrays. All other elements of the spacecraft are already of flight quality, including the main structure and the entire propulsion system.

After successful completion of the campaign, the model was transported back to Alenia (I), where the flight-model test programme started in early

November. By the end of December the harness and several flight-model sub-systems had been integrated onto the platform.

As regards the scientific payload, the sequence of Instrument Delivery Reviews started before Christmas. Their main objective is to review the completeness of all instrument activities and release them for integration on the spacecraft.

As far as the ground segment and the launch services are concerned, there has been nominal progress towards readiness for the launch of Mars Express on 23 May 2003.

## SMART-1

### Spacecraft

The development work has made good progress in the last months of 2001. After completion of the second phase of electrical system testing, involving the payload and most of the spacecraft equipment, including the electric-propulsion electrical models, the third phase involving the flight models has started. The development and integration of the onboard software has been completed. The system tests are now proceeding at Spacebel (B) for the data-handling part, and at Swedish Space Corporation for the application cores.

The flight-model structure has been manufactured and painted by APCO (CH) and sent for integration to Saab Ericsson Space in Linköping (S). The spacecraft Critical Design Review was held in September and followed by a Mission Critical Design Review in November, where all of the mission elements were

closely scrutinised. The current plan foresees launch-readiness by December 2002. However, a firm launch date cannot yet be committed to by Arianespace, as this is driven by the main passenger with whom SMART-1 will share the Ariane-5 ride.

### Payload

The development of all six payload instruments is generally proceeding according to plan. All the electrical-model tests have been completed. The Critical Design Reviews have also been successfully held for all instruments. Three instrument flight models – AMIE, EPDP and SPEDE – have been electrically and shock tested.

### Propulsion

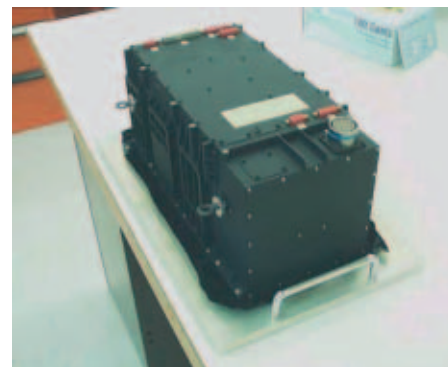
The qualification of the new electric-propulsion engine (PPS-1350G) has been completed, but the lifetime test will run until the end of 2002. The SMART-1 thruster firing test has been successfully performed (see accompanying photo). The Power Processing Unit (PPU) flight model has been manufactured and tested by ETCA (B). All other flight-model units have also been manufactured, with the exception of the Pressure Regulation Electronics (PRE); being a new development, a PRE qualification model has been made for further testing with the SMART-1 system unit at Swedish Space Corporation.

### Operations

The ground-segment preparations are proceeding according to schedule, despite some difficulties in the interface verification with the spacecraft simulator and database. The Science and Technology Operations Coordination has been established at ESTEC (NL), sharing the facilities with the Rosetta Science Operations Centre.



The SMART-1 thruster during firing tests at SNECMA (F)



The flight model of the SMART-1 PPU at ETCA (B)

## Launcher

All launcher activities are on schedule. Work is also proceeding on the planning of the launch campaign in Kourou, to be conducted in parallel with that for Rosetta.

## Herschel/Planck

The system-design activities for both spacecraft are progressing as expected. The first major system-design review, the System Requirements Review, was completed on 12 October with the successful conclusion of the Review Board Meeting. The results of that review and the action items that resulted from it dominated much of the subsequent system-engineering work during the remainder of the year.

The Herschel/Planck procurement activities also progressed during the last quarter. The first subcontractors were brought onboard following successful evaluation of the first batch of offers and the decisions of the Senior Procurement Board. Invitations to Tender (ITTs) and Requests for Quotation (RFQs) for the second of a total of five batches were issued and the evaluation of the offers received is nearing completion. The decisions on this second set will be taken at the end of January 2002, leading to a new round of contract negotiations with the selected contractors and a further enlargement of the Herschel/Planck industrial team.

Regarding the procurement process, it is worth noting that, following a training programme between ESA's Contracts Department and the main contractors, Herschel/Planck is the first ESA programme for which Industry can issue procurement actions directly using the ESA EMITS computer-based system. A second major milestone has been the approval to place a contract with a Portuguese company for the supply of Documentation Control and Planning Support, making it the first contract awarded by the Herschel/Planck project to ESA's newest Member State.

The mid-term review for the large, 3.5 m-diameter Herschel silicon-carbide telescope was successfully completed at the end of November at Astrium SAS in Toulouse (F). All items being developed under this contract are progressing according to plan.

Regarding the Planck reflectors, the Agency's participation in the procurement of these items together with the Danish Space Research Institute was approved by ESA's Industrial Policy Committee (IPC) in early December, and the technical progress on this activity at Astrium GmbH is going according to plan.

With respect to the payload, the work on updating the instrument interface documents continued during the last quarter of 2001, with the aim of completing the revision process and achieving approval and signature of the documents in the near future. The development status of the instruments will be reviewed as part of the upcoming Instrument Baseline Design Review, to verify compliance with the spacecraft development programme. This Review will also formally release the start of manufacture of the first hardware development models.

The co-ordinated parts procurement for Herschel and Planck, now part of the industrial contract for spacecraft development, is running smoothly. Activities are at present centered around the parts procurement for the scientific instruments and will more and more include the parts procurement for the two spacecraft.

## Artemis

Following its arrival in the parking orbit at an altitude of 31 000 km, all of Artemis's subsystems were commissioned and found to be working normally. The satellite is still in Earth-pointing mode. Its orbital period of 19 h means that it is over a given point on the equator every 5 days. This allows payload performance testing, albeit with limitations since not all frequencies are allowed to be used from the spacecraft's non-nominal position. Nevertheless, it has been demonstrated that all payload functions are available and that the communication programmes can be executed as planned, once the satellite reaches its nominal orbital position.

The two main and most complex functions are working nominally: the large inter-orbit antenna operating at Ka-band is able to follow its partner satellite in low Earth orbit in both programmed tracking and closed-loop RF tracking mode. Most

spectacular has been the demonstration of the SILEX system, the inter-orbit data link operating at laser wavelengths. The SILEX terminal on SPOT-4 transmitted its image data via a laser link to Artemis, which then retransmitted the data to the Spot Image processing centre in Toulouse. Up to now, all 26 links commanded have been successfully established and maintained. The communication link's quality is almost perfect, with a bit error rate of better than  $10^{-9}$ .

The preparation of the new software needed to support the contingency orbit raising using the spacecraft's ion thrusters took more time than expected. It was therefore not possible to start this phase in September as initially hoped. The final software was delivered by the middle of January 2002 and is now being validated using the satellite simulator at Telespazio, in Fucino (I). Nevertheless, the electrical propulsion system has been checked out and the availability of all hardware elements for the orbit-raising manoeuvre confirmed.

The orbit raising will be performed by the almost continuous firing of two ion thrusters, each delivering a thrust of just 15 millinewton. Due to their low thrust, it will take about 200 days for Artemis to reach its final orbital position, during which less than 20 kg of xenon will be consumed. This will still leave enough gas in the tanks to support a 5 to 7 year mission. Once Artemis is on station, the xenon will be used for north-south station keeping, and chemical fuel for east-west station keeping and wheel desaturation.

## Earth Observation Envelope Programme (EOEP)

Three Earth Watch elements were subscribed to at the ESA Ministerial Council in Edinburgh (UK) in November:

- The GMES services element: This element is meant to ensure a sustained European supply of EO-based information products and services derived from current and future EO missions, in line with the goals of the joint European Commission-ESA GMES initiative. This will be achieved by

supporting the putting into operation of these EO-based services. In the initial phase, this element will necessarily concentrate on services derived from current missions.

- The InfoTerra/Terrasar consolidation element: InfoTerra is an initiative aimed at exploiting the requirements for geo-information services for institutional and commercial users. It is based on the exploitation of the Terrasar system, and includes satellites flying L-band and X-band SAR instruments. The consolidation phase will ensure completion of the system studies prior to the InfoTerra/Terrasar implementation. Activities related to the pre-development of the L-band SAR have been started at the end of 2001 and will provide an L-band SAR demonstrator.
- The Fuegosat consolidation element: Fuegosat is intended to be a demonstration mission for the Fuego constellation, aimed at providing early warning for and monitoring of forest fires in the Mediterranean areas and at similar latitudes in the rest of the world. The consolidation phase will prepare for Fuegosat's implementation. These activities are planned to start in 2002.

The Aladin instrument second phase (manufacturing and testing of pre-development model) was kicked off in October. The PDM development and test contract should last two years. The instrument developed will be flown on the ADM/Aeolus mission, planned for launch in 2007.

The APEX Phase-C/D proposal was not fully accepted by the Tender Evaluation Board, and so the bidder will submit an amended proposal at the beginning of 2002. To ensure optimum coordination with the EOEP-funded elements, ESA will perform the technical management of Phase-C/D.

The L-band SAR predevelopment activity has been kicked off in January 2002 with Astrium Ltd. as the main contractor. This activity is planned to last 28 months, roughly in line with the expected completion of the activities within the Earth Watch InfoTerra/Terrasar consolidation element.

In the Market Development area, the five new short-term and five new longer-term activities, selected as a result of two Invitations to Tender (ITTs) issued in May

and July 2001, were started in November. All of these activities target the exploitation of the new capabilities offered by Envisat. An Earth Observation Market Development Workshop was held at ESRIN in Frascati (I) in October.

## Earth Observation Preparatory Programme (EOPP)

The Earth Science Advisory Group (ESAC) has recommended three Earth Explorer Core Missions, following the Third Earth Explorer Consultation Meeting held in Granada last October:

- EarthCARE (Earth Clouds, Aerosol and Radiation Explorer), carrying a cloud radar, a lidar, an imager, a radiometer and a spectrometer, will peer closely at the interaction between clouds, aerosol and radiation to better understand their impact on climate. It is a joint ESA/NASDA mission.
- SPECTRA (Surface Processes and Ecosystem Changes Through Response Analysis), carrying a high-performance imaging spectrometer and a thermal imager, will study the relationship between vegetation and climate change, across the entire world's ecosystems.
- WALES (Water vapor and Lidar Experiment in Space), carrying a differential-absorption lidar (DIAL), will map atmospheric water-vapour concentrations. It will provide improved insights into the distribution of atmospheric water vapour and information on aerosols in the troposphere and lower stratosphere.

Following the ESAC's recommendation, the Executive submitted the Phase-A study implementation proposal to the November meeting of the Agency's Earth-Observation Programme Board (PB-EO) and secured its approval. The relevant ITTs will be issued in the first quarter of 2002.

Comments were sent to the Lead Investigators of 29 outline proposals for Earth Explorer opportunity missions received in September. As a result, 25 consolidated full proposals were subsequently received by the 8 January deadline. They will be evaluated in the coming months and the recommendations submitted to ESAC in April.

The Phase-A for SMOS has been completed. The Preliminary Requirements Review took place successfully in October. Following the results of the scientific review, ESAC recommended to proceed with the mission beyond Phase-A. The Earth-Observation Programme Board will decide on the Phase-B authorisation in January.

## Meteosat Second Generation

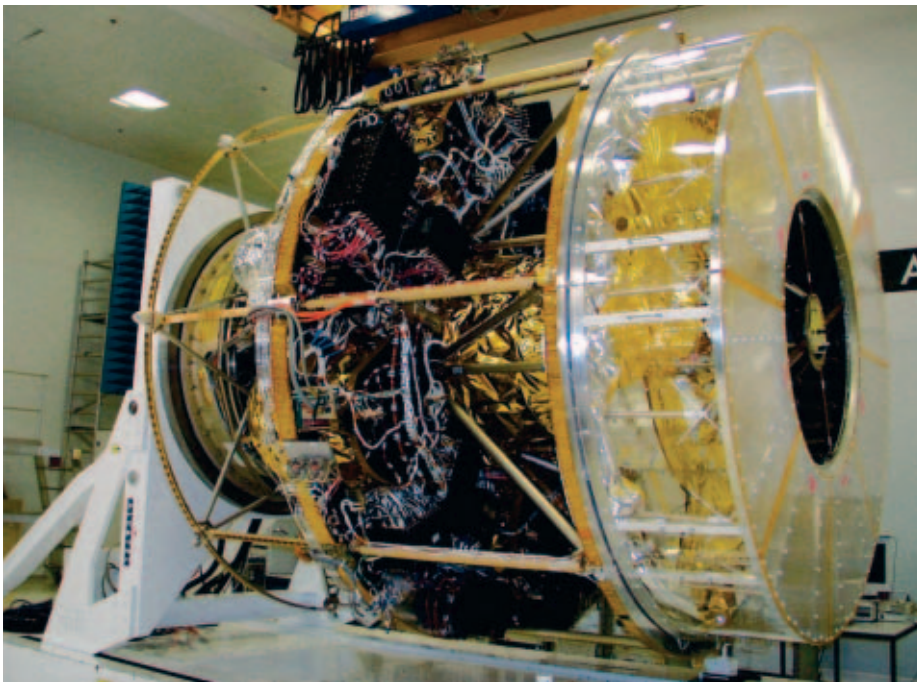
The preparation of the MSG-1 spacecraft for a July 2002 launch on an Ariane-4 launcher is proceeding on schedule. Consent to ship to the Kourou launch site in French Guiana is being sought in the March 2002 timeframe. During January 2002, System Verification Tests are being executed with the spacecraft located in Cannes (F), but monitored and commanded via telephone lines from ESOC and Eumetsat, both of which are located in Darmstadt, Germany.

MSG-2 and MSG-3 and the engineering model will remain in storage until after the MSG-1 launch.

## MetOp

The satellite Critical Design Review (CDR) was successfully concluded in October 2001, and an action plan has been agreed with the MetOp Prime Contractor Astrium (Toulouse) to address the CDR Board's recommendations.

The final step in the implementation of MetOp Assembly, Integration and Verification (AIV) restructuring programme has been achieved, with the approval of the related contract proposal by Eumetsat's Council in December 2001. The space-segment integration baseline now accommodates the extended Eumetsat ground-segment development period, as well as the recently announced delivery dates for the third-party instruments. Subject to the timely delivery of the IASI instrument's proto-flight model, MetOp-2 is now earmarked as the first MetOp satellite for launch in 2005. MetOp-1 will complete its nominal AIV programme without the IASI instrument and will go into storage in 2004. The integration of the IASI flight-model



*The MSG-2 spacecraft under integration at Alcatel Space Industry in Cannes (F)*

Within the framework of the Soyuz launcher activities, the Preliminary Mission Analysis Review (PMAR) has been completed with the launcher authority Starsem (F). In parallel, Astrium has completed the first phase of the satellite/launcher compatibility study.

## Envisat

Throughout the fourth quarter, Arianespace was striving to understand and correct the launch anomaly that afflicted the EPS upper-stage engine on flight 510. More than two hundred tests have now been performed on two test

instrument is foreseen as part of the subsequent de-storage campaign.

Meanwhile, the Payload Module integration work at Astrium in Friedrichshafen (D) continues on the proto-flight model. Several ad-hoc adaptations of the integration sequence have allowed these activities to cope with new instrument-delivery problems.

Following the interleaving logic of the restructured AIV baseline programme, the integration of the Payload Module FM-2 model has also commenced with the installation of the flight avionics.

The IASI engineering model – comprising the instrument avionics units IMS and DPS and an IASI sensor interface simulated by EGSE – has completed testing at the premises of the instrument manufacturer Alcatel in Cannes (F), and is now on its way to Astrium in Friedrichshafen. The status of the IASI flight model's development will be subject of the instrument Critical Design Review planned to take place during the first two months of 2002.

The Delivery Review Board for the SMMS proto-flight model – representing the structural, thermal and propulsion sub-systems as well as the harness of the MetOp Service Module (SVM) – has been successfully concluded in December at Astrium (Stevenage). The further integration of the Service Module proto-flight model will take place at Astrium in Toulouse, starting with the avionics integration.



*Envisat in the integration hall at Centre Spatial Guyanais (CSG) in Kourou*

engines, and Arianespace believes that it understands the most likely causes and has established a clear calendar for the Envisat launch campaign. The latter was resumed on 3 January 2002, leading to a launch on 28 February 2002 (Kourou time).

In the meantime, Envisat has remained in storage in Kourou. A two-week maintenance campaign was carried out starting in late October, with completely satisfactory results.

Taking full advantage of the launch delay, the ground-segment and industrial-support teams have concentrated their efforts on the Ground Segment Overall Validation (GSOV) and the training of operators. The Flight Operation Procedures within the Flight Operations Segment (FOS) are complete and have been reviewed and validated by simulations at ESOC, with support from the project team and industry. The remaining simulations have been re-phased to adapt to the launch delay.

As far as the Payload Data Segment (PDS) is concerned, efforts have been concentrated on:

- The GSOV, with all external interfaces tested, realistic operation scenarios exercised jointly by the mission planning facilities at FOS and PDS, and recently an overall data-product circulation and dissemination test.
- The training of the operation teams in Kiruna (S) and at ESRIN (I) for the early operations after instrument switch on.
- The integration of the Processing and Archiving Centres (PACs), which were initially accepted as standalone items and have subsequently been integrated successfully within the PDS.

In terms of preparation for the satellite Commissioning Phase, the Expert Support Laboratories and the Principal Investigators (PIs) have reorganised the planning of their activities to cope with the launch delay, and have been working to improve the quality and readiness of the tools to be used for the calibration and validation activities.

## CryoSat

The CryoSat project has now entered in the core of its main development phase (Phase-C/D). After a detailed review of the satellite's design during November 2001, the industrial partners of the Prime Contractor, Astrium GmbH, are now preparing their manufacturing files.

Within the ground segment, development of the Payload Data Segment has also been initiated. The development of the algorithms for the processing of the scientific data (up to Level-1b) is also progressing nominally. An Announcement of Opportunity (AO) for the Calibration and Validation activities has also been issued.

## GOCE

The contract for the GOCE space segment was signed at Alenia Spazio in Turin (I) on 23 November. The contract covers Phases-B/C/D/E1 of the GOCE satellite project, but only the Phase-B and advanced Phase-C/D activities have been released so far.

Good progress has been achieved in the competitive selection process involving the various equipment suppliers, although the micro-propulsion area remains problematic. On the basis of the results of the breadboard testing carried out by the various bidders and of the analyses performed at platform/system level, it has finally been decided to select the Field-Emission Electric Propulsion (FEED) technology. However, due to lack of sufficient lifetime-test evidence, the final

supplier has not yet been selected. It was concluded that specific lifetime-demonstration testing with the two FEED suppliers was needed before making the final choice. During December, those test activities have been agreed and kicked-off with both potential suppliers.

The Gradiometer Preliminary Design Review (PDR) was carried out between mid-November and mid-December. The Board concluded that, despite the progress achieved, additional efforts had to be made before the Review could be considered successfully closed. The majority of the related actions are planned to be completed by end-January 2002.

The GOCE Preliminary Design Review (PDR) is scheduled for the second half of February 2002.

The GOCE Web site has been released as a part of the new ESA Earth Explorer site under ESA's Living Planet Programme (<http://www.esa.int/livingplanet/goce>).

## International Space Station

### ISS Overall Assembly Sequence

Three assembly and logistic flights were made to the ISS during the last quarter of 2001. A Soyuz 'Taxi' Flight 3S, launched on 21 October, took ESA astronaut Claudie Haigneré to the ISS. The following Progress flight was launched on 26 November, while Assembly Flight UF1



ISS in-orbit configuration, December 2001



(STS-108) launched on 5 December was the fourth MPLM flight (uploading experiment and storage facilities) and third crew rotation, with the Expedition Four crew taking over.

#### **Columbus Laboratory**

Integration work continues. The Qualification Review for the Data-Management System (DMS) has been completed, and all flight-model hardware has been delivered and is being integrated. Qualification testing on the electrical test model is continuing.

#### **Columbus Launch Barter**

##### *Nodes-2 and -3*

Node-2 flight-unit integration is progressing, with the secondary-structure and harness deliveries required for module integration having been completed. Node-3 primary-structure manufacturing continues, and the harness and secondary-structure Critical Design Reviews (CDRs) have been completed.

##### *Crew Refrigerator/Freezer (RFR)*

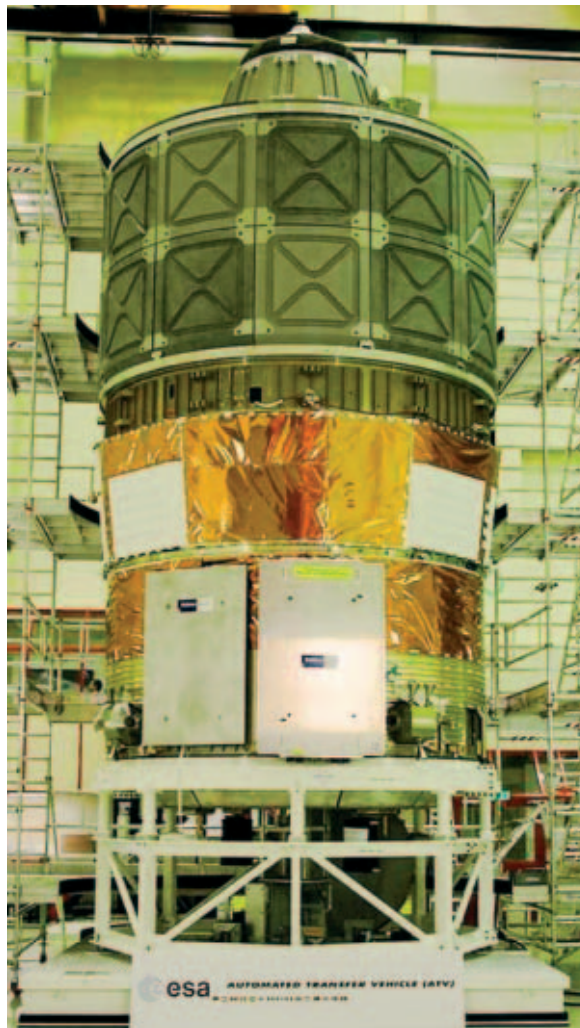
The Preliminary Design Review (PDR) for the RFR has been successfully completed. Cryogenic Freezer (CRYOS) negotiations with NASA, to agree on a final configuration, have continued.

##### *Cupola*

The Cupola CDR and Safety Review-I/II have been successfully completed. Preparations for the Structural Test Article (STA) vibro-acoustic test are underway. It will be the last qualification test on this unit prior to its delivery to NASA in March 2003.

#### **Automated Transfer Vehicle (ATV)**

The contract rider has been signed and the ESA/NASA Segment Specification, reflecting the Preliminary Design Review (PDR) results as agreed with NASA, has been finalised and signed by ESA. All elements of the structural/thermal model (STM) have been delivered to ESTEC and assembled, and the acoustic test – the first in a series of environmental tests – was performed successfully in December. The spacecraft electrical test model (ETM) integration is progressing, but the propulsion-subsystem schedule is being impacted by additional Ariane-5 tests that are occupying the same test facility.



#### **X-38/CRV and Applied Re-entry Technology (ART)**

A further drop test with the V131R vehicle was successfully completed in December 2001. Work is continuing in industry for the delivery of the European contributions to the X-38 vehicle, and a contract amendment has been signed allowing further industrial activities. The US Congress has approved a \$40 million budget line for X-38 continuation in 2002, and NASA has tentatively re-scheduled the X-38 flight to 2005.

#### **Ground-segment development and operations preparation**

The submission and evaluation of the Columbus Control Centre subsystem proposals is continuing and should be completed by end-March 2002. Implementation is proceeding incrementally to avoid schedule delays. The Request for

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*The Automated Transfer Vehicle (ATV) structural/thermal model at ESTEC, in Noordwijk (NL)*

*The X-38 parafoil descent, December 2001*



*Claudie Haigneré on board the ISS, October 2001*

Quotation (RFQ) for the ATV Control Centre has been released.

The ATV-CC Operations Preparation Definition Phase has been kicked off with CNES. The offer for the equivalent contract with DLR has been received and is being evaluated.

## Utilisation

### Preparation

A significant number of the Microgravity Applications Promotion (MAP) projects have successfully passed their mid-term reviews. Of the 44 projects selected, 39 had been fully initiated by end-2001 and a further four are foreseen to start early in 2002.

### Payloads and their integration

The industrial proposal for the main development phase (Phase-C/D) of the Atomic Clock Ensemble in Space (ACES) has been received, but it indicated a considerably higher cost than expected for part of the industrial work, and negotiations with industry are continuing. The earliest launch date for ACES now appears to be February 2006. For other



external payloads, i.e. Solar, Export and EuTEF (European Technology Exposure Facility), the Phase-C/D activities have been running according to plan. Preparations for design (Phase-A) studies of two space-science instruments (Lobster and EUSO) that could also use the Space Station have been in progress. The Phase-A accommodation study for a commercial Earth-observation instrument (RapidEye) was completed. The PDR for the Matroshka radiation-measurement facility baselined for the Russian segment of the

ISS was completed. The unit is planned for flight in 2003.

Analytical integration of the Microgravity Facilities for Columbus (MFC) – Biolab, Fluid-Science Laboratory and the European Physiology Modules – and for the European Drawer Rack (EDR) has continued. The Requirements and Design Definition Phase for the User Support and Operations Centres (USOC) is also in progress, with completion planned early in 2002. The schedule and budgetary planning for USOC implementation has been initiated.



## Astronaut activities

The French/Russian Andromède mission with ESA astronaut Claudie Haigneré onboard as Soyuz Flight Engineer was successfully launched on 21 October. The Soyuz vehicle docked with the ISS on 23 October, and then returned safely to land in Kazakhstan on 31 October.

ESA astronaut R. Vittori has continued his training in Star City for a Soyuz Taxi Flight to the ISS in April 2002. F. de Winne, who will fly on a later mission, joined him in training. They have successfully completed the first round of examinations on Soyuz systems.

*ESA astronauts R. Vittori and F. de Winne in training for flight in a Soyuz vehicle*

The second period of ISS Advanced Training at Johnson Space Center (NASA/JSC) was successfully concluded on 16 November. The Advanced Training continued at NASDA on 12 December, with one week of training for each of the participating ESA astronauts - P. Nespoli, P. Duque, L. Eyharts and T. Reiter - and one NASDA colleague. The first ISS Advanced Training session at the European Astronaut Centre (EAC) is in preparation and will take place in July 2002.

Astronaut A. Kuipers has continued with the complementary Basic Training courses during his stay in Star City.

The mechanical configuration of the Columbus Trainer for EAC has been delivered and was installed in December.

### Early deliveries

#### *Data Management System for the Russian Service Module (DMS-R)*

The DMS-R is continuing to be problem-free in operation. The accumulated run time in orbit (24 h per day) reached 18 months at the end of December.

#### *European Robotic Arm (ERA)*

The ERA flight-model functional qualification testing at the prime contractor Fokker (NL) is continuing. The pre-flight Mission Preparation and Training Equipment (MPTE) has been accepted by ESA.

The ERA launch date, which is also heavily influenced by the current US budgetary situation, is still open. A credible schedule is not now expected before late-2002.

#### *Laboratory Support Equipment (LSE)*

The Microgravity Science Glovebox (MSG) verification testing at Kennedy Space Center (KSC) has continued to be problem-free. The use of MSG for ESA's experiments is under discussion with NASA, as is the possible location of the ground model in Europe (at ESTEC) to support preparations and initial training for European experiments to be carried-out on upcoming Taxi Flights.

The verification test campaign for Flight Unit 1 (FU1) of MELFI (-80 degC Freezer) has continued. The Final Safety Review was successfully completed in November, and the FU1 launch is now scheduled for January 2003.

The qualification test campaign on the Hexapod linear actuator started in November.

### ISS Exploitation Programme

All five International Partners have agreed the text of the multi-lateral ISS guidelines document for commercial ISS use. Formal programme approval is planned for early 2002.

Although approval of the Commercialisation Programme Proposal by the ESA Ministerial Council was postponed in November, activities are continuing to define and implement pathfinder projects, and to safeguard the proposed industrial contribution under the co-operation agreement. A first commercial experiment has been agreed with ASI to fly on the upcoming Italian Taxi Flight mission.

Due to NASA's budgetary problems and to changes in the content of the Programme Proposal for Exploitation Continuation, the ESA RFQ sent out earlier was no longer fully valid. Following the approval of the Exploitation Continuation for Period 1 by the Ministerial Council meeting in Edinburgh in November 2001, ESA will update the RFQ and industry will submit a binding offer in April 2002.

The Exploitation Programme Continuation and in particular the Period 1 funding were approved in Edinburgh, but with 60% of that funding blocked until October 2002, contingent on the US reconfirming its commitment to the implementation of the Inter-Governmental Agreement (IGA). The available funding is sufficient to start the time-critical procurement of spare parts, the ATV production programme, as well as maintenance and sustaining-engineering activities.

## Microgravity

The Microgravity Programme Board has approved the experiments selected from the Physical Sciences 2001 Announcement of Opportunity (AO), the ESA payload for the April 2002 Taxi Flight, and the replacement of the Maser-10 sounding-rocket flight by the more powerful Maxus-6 within the EMIR-2 Extension Programme. The related Maxus-6 experiments were also approved.

Preparation of the ESA microgravity research facilities for flight on the STS-107

Space Shuttle mission has continued. This mission is now scheduled for June 2002 and the six ESA facilities for this flight are currently in various stages of readiness. Similar preparations have been continuing for the flight of ESA facilities (Fluidpac, Biopan and Stone) on the Russian Foton-M1 recoverable-capsule mission, which is now scheduled for launch in October 2002. The flight of the Maser-9 sounding-rocket mission originally planned for November 2001 has been postponed to March 2002. The 31st parabolic-flight campaign took place successfully in October, with 10 experiments including two student experiments being conducted.

As the flight of the R-2 Spacehab mission, which would have represented a major new flight opportunity for ESA payloads, has become increasingly less likely, alternative flight opportunities are being sought.

The development within the EMIR programmes of facilities for use on the ISS has continued. These include the European Modular Cultivation System (EMCS), the Expose facility for exobiology research, the Mares facility for muscle research, and the PCDF facility for protein-crystallisation research.

The Advanced Protein Crystallisation Facility (APCF), which had been flying on the ISS since August 2001, was returned to ground in December and analysis of the results has started. APCF was ESA's first microgravity facility to fly on the ISS, enabling 108 days of protein crystal growth.

The Granada protein-crystallisation box, which had been flying on the Space Station and which was recently returned to Earth on a Russian Taxi Flight, has been opened and the crystallised proteins removed for analysis.

### Microgravity Facilities for Columbus (MFC)

Within the Microgravity Facilities for Columbus (MFC) Programme, the various experimental facilities are well into their development. The Biolab engineering model has been accepted, the Science Reference Model Critical Design Review (CDR) has been concluded, and flight-model subsystem procurement/manufacturing is proceeding well. For the Fluid Science Laboratory (FSL), the

engineering-model integration tests on all subsystems have been completed, with the exception of the facility core element, and the FSL baseline CDR has been closed-out. For the Materials Science Laboratory (MSL) in the US Lab, the Solidification and Quench Furnace (SQF) CDR was successfully concluded and the engineering-model system testing preparation is almost complete. The contract for Phase-B of the Electromagnetic Levitation Furnace in MSL has been signed. For the European Physiology Modules (EPM), the CDR was in preparation. For the EPM contribution to HRF-2, the flight model was delivered to NASA at the end of November and integration initiated in its HRF-2 facility.

## PROBA

Following launch on 22 October 2001, the in-orbit commissioning of the spacecraft platform lasted until early January. It has confirmed that all of PROBA's subsystems are performing as intended.

The commissioning team, composed of ESA and Verhaert engineers, is now busy

with the validation of the payload and the most advanced autonomous onboard functions. All of the instruments (SREM, DEBIE and CHRIS) have already been switched to acquisition mode and have returned excellent data, which are now being analysed by the scientists.

PROBA is currently being operated from its dedicated ground station and control centre at ESA's Redu station in Belgium, with additional support from the Kiruna (S) station. However, extension of the ground segment with the installation of a second identical ground station at Kiruna or Svalbard has been initiated. This will greatly enhance the imaging capability for the Earth-observation community exploiting data from the CHRIS instrument.



*Image of the coast of Cuba reconstructed from data in three spectral bands acquired with PROBA's CHRIS instrument*