

Report compiled, using inputs from Study and Project Scientists by Jean Clavel, head Astrophysics & Fundamental Physics Missions Division,

6 Satellites in orbit

6.1 Herschel: Göran Pilbratt

Herschel is gradually making the transition into routine science operations. The PACS and SPIRE instruments have completed their Performance Verification and most of their Science Demonstration Phase (SDP) activities. The vast majority of observing modes have been commissioned and the 2 instruments are now performing routine science observation. Measurement of the Helium content performed on November 25 indicates a mission lifetime in excess of 3.5 years

HIFI, unavailable since its malfunction on 2 August 2009, was switched back on and functionally verified in the period 10-14 January 2010. The instrument is fully operational and ready for commissioning and performance verification. In the next couple of months, half of the Herschel observing time will be reserved to HIFI in order for it to catch-up with the other instruments. The reason for the failure of the prime warm electronic unit is understood and measures have been implemented to prevent a similar malfunction of the redundant unit.

A total of 220 scientists attended the Herschel Initial Results workshop in Madrid on 17 and 18 December. There were 37 presentations, 33 of which presenting new scientific results obtained from SDP data. All presentations have been posted on the web immediately following the workshop [http://herschel.esac.esa.int/SDP_IR_wkshop.shtml]. Participants were impressed with the wealth of new scientific results seven months only after launch. In that respect, Herschel is setting a new standard for infrared observatories.

The results presented covered a wide range of topics e.g. water in a comet, the first far-infrared detection of a Trans-Neptunian Object in our solar system, star formation in our galaxy, line emission in star-burst galaxies, resolving the cosmic infrared background into its constituent galaxies to a degree never achieved before, including the detection of the most distant quasar known to date ($z=6.42$).



Two photogenic examples of galactic star formation from the SDP Initial Results: (left) low-mass star formation in Aquila (André et al.) and (right) high-mass star formation in the Rosette nebula (Motte et al.).

A hands-on Science Demonstration Phase Data Processing workshop took place at ESAC on 14-16 December, with over 100 participants guided step by step by 40 “instructors” (see http://herschel.esac.esa.int/SDP_DP_wkshop.shtml). A similar workshop is currently in progress at the NASA Herschel Science Centre in Pasadena from 25 to 29 January.

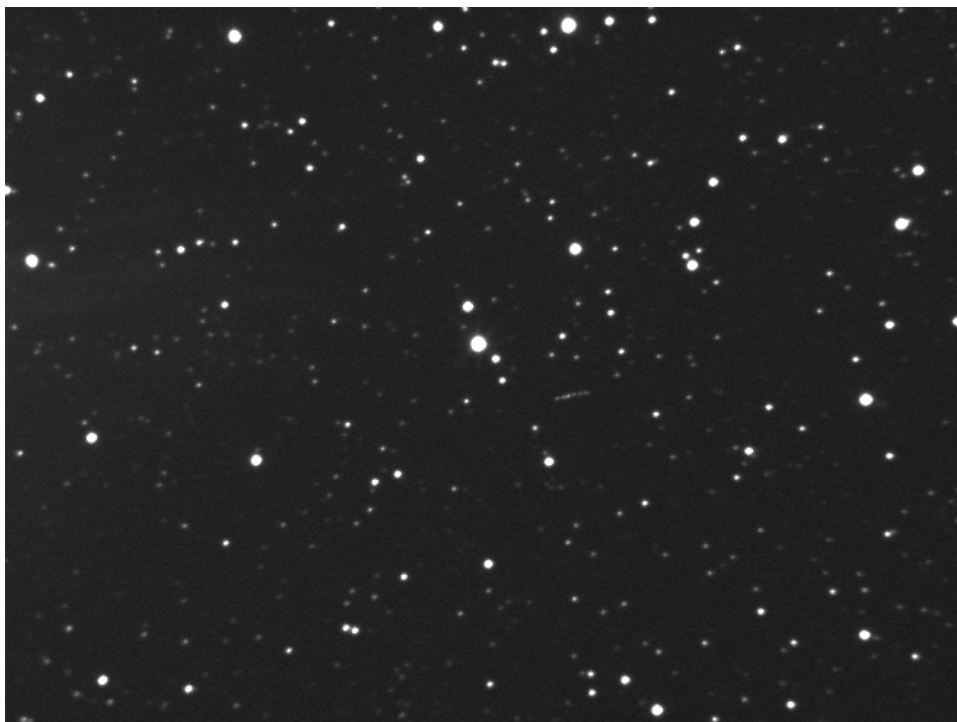
A media event was organised at ESAC on the 16th of December to highlight Herschel first results (see http://herschel.esac.esa.int/Docs/PR/Herschel_PRevent_16Dec2009.pdf). This was picked-up by the BBC (<http://news.bbc.co.uk/2/hi/science/nature/8416263.stm>).

A shorter version of the SDP Initial Results workshop was presented on 5 January 2010 at a special session of the AAS#215 meeting in Washington DC (stated to have been the largest astronomy meeting ever). The session was allocated a very large venue in one of the “ballrooms”.

Preparations are now underway for the next two major Herschel science-related events: the [Herschel First Results Symposium](#) (aka ESLAB 2010) to be held in ESTEC on 4-7 May 2010, and the next Announcement of Opportunity (AO) for Herschel observing time, also planned in May. As for all other ESA missions in operations, a Herschel Users’ Group is also in the process of being set up. The XMM-Newton OTAC has agreed to set aside up to 500 ks (5.8 days) of XMM-Newton observing time for allocation by the Herschel Time Allocation Committee for programmes that require simultaneous observations in the sub-mm and X-ray regime (e.g. Young Stellar Objects).

6.2 Planck: Jan Tauber

Planck continues to operate in very good conditions. The cryo-chain and the two instruments have been running stably since the start of routine operations in mid August. Satellite operations are also very smooth and uneventful. The Calibration & Performance Phase Completion Review has been successfully closed.



Planck at L2 as observed in January by an amateur astronomer
(<http://www.astrosurf.com/ubb/Forum3/HTML/023898.html>).

About 80% of the sky has been surveyed so far by all detectors, with no coverage gaps. The major planets have been observed and the data is being reduced to extract beam shapes - a key calibration element. The Crab, Planck's main polarisation calibrator, has also been observed once (two observations 6 months apart are needed to complete the calibration of the detector polarisation angles). LFI and HFI are now exchanging data regularly for cross-calibration and joint processing.

The case for a mission extension of Planck was presented to the SPC on October 2 and subsequently to the AWG on October 28, 2009. The mission extension was approved by SPC, including "an additional year of Planck operations (resulting in two additional sky surveys), subject to confirmation by the SSAC of satisfactory in-orbit performance". A procedural problem meant that the SSAC could not make this confirmation in November, but it finally did so at its January Meeting. The 12-month extension is now fully approved.

The future major milestones for Planck therefore are:

- End of nominal operations: 27 November 2010
- End of extended operations: 27 November 2011
- Delivery to ESA of first set of major science products: 27 November 2012
- Delivery to ESA of second set of major science products: 27 November 2013

The first *internal* data release from the 2 Data-Processing Centres (DPC) to their own scientific consortia took place as planned at the end of December via the Planck Internal Archive (PIA). The PIA is developed by ESA as a prototype for the Planck Legacy Archive (PLA) which will be put into operation in January 2011 for distribution of Planck data products to the scientific community. This first release includes data from the first two weeks of survey, the so-called First Light Survey. This set of data is not yet science-grade, but is meant to allow scientists from the Consortia to exercise their tools. The first science-grade internal release, covering the first 2.5 months of the survey, will take place in March.

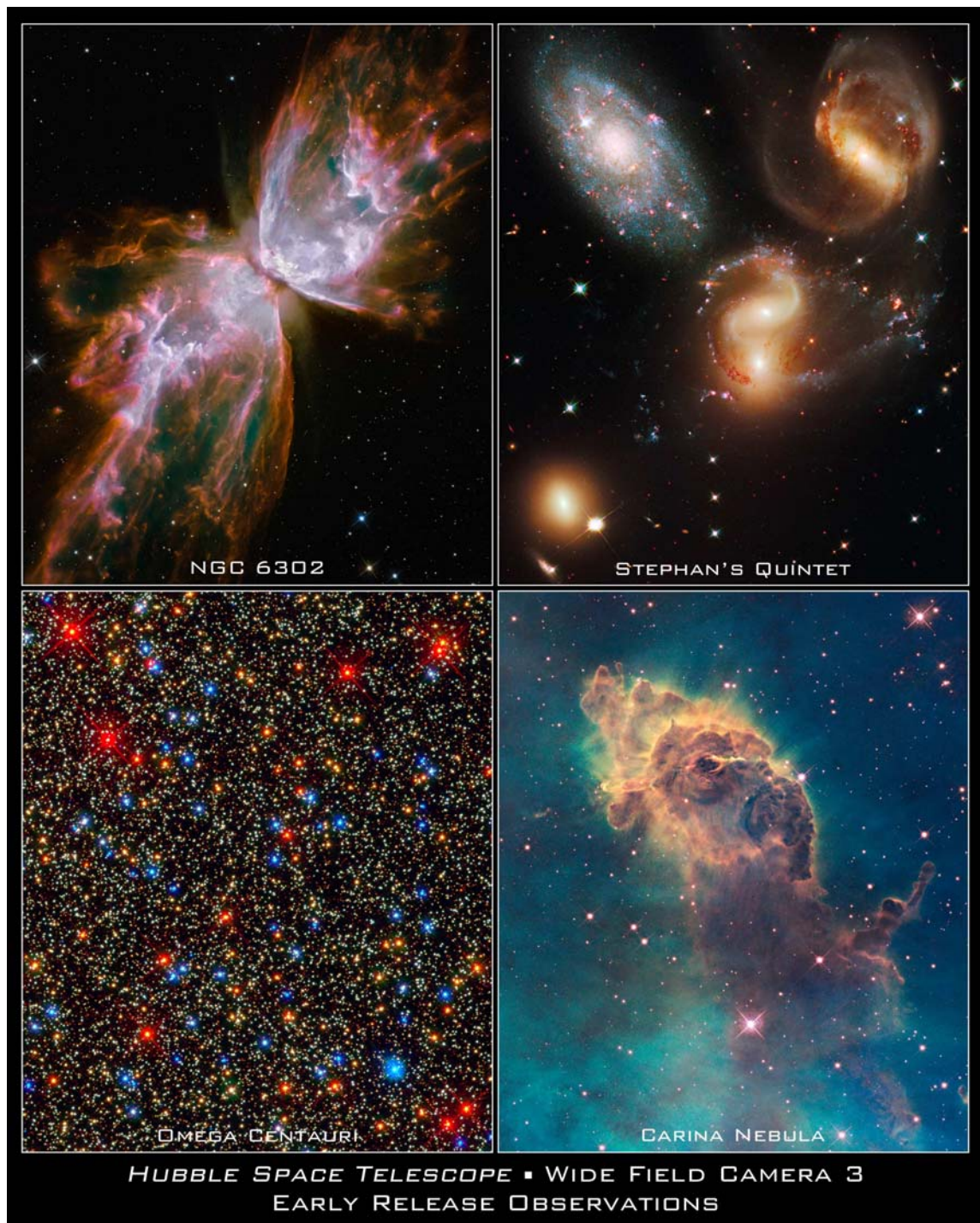
The data processing pipelines in each of the two DPCs are working almost routinely from end to end, and their sophistication grows regularly. Preliminary scientific results are being discussed internally at bi-monthly meetings within each instrument consortium and at 6-month intervals jointly by the two consortia.

Some areas are receiving specific attention, due to the need for follow-up observations with other observatories, namely galactic Cold Cores and Sunyaev Zeldovich (SZ)-detected galaxy clusters. For the former, a Key Programme is in place for follow-up with Herschel and the first three sources have already been observed with Herschel during its Science Demonstration Phase. The XMM-Newton OTAC has agreed to set aside 500 ks for the X-ray follow-up of the first set of Planck-detected SZ clusters in 2010. These are sources which will appear in the Planck Early Release Compact Source Catalogue (ERCSC), and XMM-Newton observations will serve to validate the Planck SZ catalogue properties. The X-ray data will be published at the same time as the catalogue. The ERCSC will be the first product released by Planck to the astronomical community. Its delivery will take place in January 2011, in good time for the community to prepare follow-up observing proposals in response to the 2011 Herschel AO.

6.3 HST: Antonella Nota

Following a very successful Servicing Mission 4, Hubble underwent an intense commissioning period, the Servicing Mission Orbital Verification (SMOV). SMOV activities formally ended in November 2009 and Hubble is now performing routine

scientific observations again, with a full complement of instruments. Beside 3 temperature-related NICMOS requirements, all SMOV4 requirements were met. Both Wide Field Camera 3 and the Cosmic Origin Spectrograph are performing beautifully. The repaired spectrograph STIS and Advanced Camera for Surveys (ACS) are also fully operational. The first Hubble science results were showcased on January 5 at the American Astronomical Society meeting in Washington DC. For example, with the new, more sensitive panchromatic camera WFC3, Hubble has been able to push the look-back time to galaxies that formed just 600-800 million years after the Big Bang. These galaxies are so blue that they must be extremely deficient in heavy elements, a characteristic predicted for the first generation of stars.



A Call had been released for Multi-Cycle Treasury (MCT) Programs, with a deadline of November 18, 2009. Up to 750 orbits per cycle, starting in Cycle 18, were made available for MCT Programs. The intent was to provide astronomers with the opportunity to tackle key scientific questions that cannot be fully addressed through the standard time allocation process. By definition, MCT programs must request between 450 and 1,000 orbits. Thirty-nine MCT proposals were submitted, including four that have a European Principal Investigator (PI). These proposals requested a total of 26,801 orbits spread over two to three proposal cycles. For a 3-cycle allocation, the over-subscription ratio is 12-to-1; for a 2-cycle allocation, 17:1. The proposals requested all available HST instruments except NICMOS. It is also interesting to note that the proposals list a total of 746 unique Co-Investigators (Co-Is). The MCT Time Allocation Committee (TAC) met in Baltimore in early January 2010, and their recommendations together with the STScI Director's decisions will be announced soon. Unsuccessful proposers will have the possibility to recast their programs for HST Cycle 18, the deadline of which is 26 February 2010.

A conference entitled "Science with Hubble –III" will be held in Venice, Italy, from 11 to 14 October 2010. Largely sponsored by ESA, with NASA participation, the conference will be organised as a high profile event to celebrate Hubble's 20th anniversary in orbit. Antonella Nota and Bob Fosbury co-chair the Scientific Organizing Committee.

6.4 XMM-Newton: Norbert Schartel

The XMM-Newton observatory continues to operate nominally. As of 14 January 2010, the overall completion status of the observing programme is as follows:

- AO-8 programme: 86.4 % (A and B priority)
- AO-8 programme: 12.4 % (C priority)

The completion of the AO-8 programme is expected by end of April 2010, in line with the planned start of AO-9 observations.

The chairpersons of the XMM-Newton AO-9 Observing Time Allocation Committees (OTAC) met on the 26th and 27th of November 2009 at ESAC. The result of their deliberations was announced to the proposal Principal Investigators on December 15. Fourteen Very Large Proposals (requesting more than 1 Ms) had been submitted but none was awarded time by the OTAC. Successful investigators are currently busy entering the details of their observations before the deadline of February 5.

The AO-10 schedule has been agreed with the OTAC chairperson, Prof. C. Cesarsky:

- 24 August 2010: announcement of opportunity
- 8 October 2010: due date for proposals
- 17-18 November 2010: meeting of OTAC chairpersons
- 15 December: publication of the OTAC recommended programme.

The schedule has been published in XMM-Newton Newsletter #102.

In total, 120 persons attended the XMM-Newton 10th anniversary celebration held at ESAC on December 10. Outreach material was distributed to the participants, including an educational poster, a movie and a paper model of the satellite. Prof. X. Barcons presented a note from the ESO Council congratulating the Science & Robotic Exploration Directorate of ESA for the remarkable achievements of XMM-Newton. The 10th anniversary was publicised in a "web story" that appeared on the ESA SciTech web site. It was well covered by the media, including the BBC which published an excellent audio slideshow on its web site <http://news.bbc.co.uk/2/hi/science/nature/8404574.stm>

In its December 24 issue, Nature published a review article entitled “The first decade of science with Chandra and XMM-Newton” by M. Santos-Lleo, N. Schartel, H. Tananbaum, W. Tucker and M. C. Weisskopf.

A total of 314 refereed articles based on XMM-Newton data were published in 2009. As January 15, the cumulative number of refereed publications since launch is 2291.

6.5 Integral: Christoph Winkler

INTEGRAL science operations continue smoothly with the spacecraft, instruments and ground segment performing nominally.

Target of Opportunity (ToO) observations were performed on the flaring blazars 3C 454.3 (6 to 12 Dec) and PKS 1510-089 (Jan 17). Both observations were triggered following alerts from the very high-energy missions AGILE and FERMI. Five gamma-ray bursts were observed in the field of view: GRB 091015, GRB 091111, GRB 091202, GRB 091230 and GRB 100103A.

Contrary to naïve expectations, only 14 of the 205 bright sources detected by FERMI/LAT above 1 MeV coincide with one of the 720 sources in the INTEGRAL/IBIS catalogue (20-100 KeV). It is interesting that, out of the 14, 10 sources are optically selected Blazars, while 2 are isolated pulsars (Crab & Vela) and 2 are high mass X-ray binaries (P. Ubertini et al., ApJL, 2009, 706, 7).

The 8th INTEGRAL workshop “The restless gamma-ray universe” will take place in Dublin/Ireland from 27 to 30 September 2010. More information is available at:

http://ssmr.ucd.ie/8thintegralworkshop/INTEGRAL_Workshop/8th_INTEGRAL_Workshop.html

Since launch, 498 articles based on INTEGRAL data have appeared in the refereed literature, with 90 published in 2009 alone.

6.6 Suzaku (ASTRO-E2): Arvind Parmar

Suzaku, the Japanese-US X-ray astronomy mission, was launched in July 2005 and following the early failure of its prime instrument, is performing astronomical observations with the remaining X-ray CCD cameras and hard X-ray detector. Scientists from institutes located in the ESA Member States appear as authors of 74-refereed papers based on Suzaku observations. The data for many of the above papers have been obtained through four annual European Suzaku Announcements of Opportunity.

The 5th Suzaku European Announcement of Opportunity (EAO-5) closed on 20 November 2009 and covers observations to be performed between April 2010 and March 2011. A total of 30 proposals were received for the 8% of observing time allocated to Europeans. This corresponds to an oversubscription in time of 3.9. The figures for the last AO were broadly similar – 31 proposals and a temporal oversubscription of 3.6. Interestingly, the European oversubscription factor is higher than for Japan (132 proposals with a factor 3.25) and the US (83 proposals and 3.45). The European proposals have been ranked by the ESA appointed TAC and the results forwarded to JAXA for merging with the Japanese and US proposal selections. The final results should be announced in early March.

6.7 Akari (ASTRO-F): Alberto Salama

AKARI is currently in the warm (post-helium) phase of its mission and continues to observe at 2–5 microns. By the end of December, 79 AO-3 European Open Time observations have been successfully executed. The MIR survey catalogue has been

released to the Project Teams in November 2009. An AKARI special issue of Astronomy & Astrophysics is being prepared for publication in spring 2010. Currently 25 papers have been submitted, of which 9 are from Europe. ESAC has been highly involved in an article on the MIR All-sky survey catalogue by Ishihara et al. The sky coverage is more than 90% for both bands at 9 and 18 microns. A total of 877,091 sources are included. The detection limit for point sources is 50 mJy for the 9 micron band and 120 mJy for the 18 micron band. The position accuracy, derived by the ESA supplied pointing reconstruction, is better than 2 arcseconds. This catalogue is planned to be publicly released in spring 2010, in parallel to the Far Infrared catalogue. The AKARI survey is superior to that of IRAS in sensitivity, spatial resolution and wavelength coverage.

6.8 CoRoT: Malcolm Fridlund

After more than 1100 days in space, CoRoT continues to operate nominally but with only one half of its initial Field-of-View following the failure of one of the two data processing units. A newly found exoplanet, CoRoT-9b, is the subject of an article accepted for publication in Nature. Slightly less massive than Jupiter, it has a low eccentricity orbit with a period of 95 days. Given its host star luminosity, the planet surface temperature should be in the range 300 to 500 K. A further four articles on new Neptune-size to Jupiter-size planets have been submitted for publication. Several candidates are awaiting final confirmation while around 100 further potential exoplanets are being followed-up for photometric and spectroscopic confirmation.

About 20 hours of ESA observing time on the OGS 1m telescope in Tenerife is assigned to such follow-up programmes each month. CoRoT exoplanetary candidate host stars are observed at the expected time of the transit as well as out of eclipse. The OGS data are then transmitted to ESTEC for reduction and analysis. This turns out to be an efficient method to screen-out false candidates triggered by a background eclipsing binary in the large CoRoT pixel.

7 Projects under development

7.1 JWST: Peter Jakobsen

The JWST telescope and sunshade have passed their Critical Design Reviews (CDR) – the last major JWST observatory subsystems to do so. The final JWST Mission Level Critical Design Review is scheduled for April 12-16. The launch date remains at June 2014.

The JWST primary mirror Engineering Development Unit (EDU) segment is undergoing final cryo-testing at the XRCF at NASA MSFC. The results of this test are not known yet, but the EDU will be the first JWST mirror segment to complete the entire end-to-end cryogenic mirror manufacture, grinding and polishing process, closely followed by the first of the sixteen flight Primary Mirror Segments. The Tertiary and Fine Steering Mirrors are in final polishing, and the remaining flight mirrors are in various stages of rough polishing and smooth-out grinding.

The assembly and delivery of the instrument subsystems to the MIRI Flight Instrument is progressing satisfactorily. The flight Imager has completed its acceptance test campaign and is ready for delivery to RAL for integration. The flight Dichroics/Grating Wheel Assembly has successfully passed its second vibration test following reassembly. The deliveries of three MIRI subassemblies are outstanding: the Input Optic Calibration and the JPL-supplied Detector System are presently undergoing their final acceptance testing, while the Spectrograph Pre-Optics is waiting for the delivery of the grating wheels to complete its integration.

Build-up of the NIRSpec Flight Model is also making progress. All principal optics together with the refocusing mechanism have now been successfully integrated. “First light” was seen in October, yielding excellent image quality. Next up is the Calibration Assembly, followed by the Filter Wheel Assembly. The critical outstanding subsystems remain the Grating Wheel Assembly and the NASA-supplied Micro-Shutter Array and Detector Array Systems.

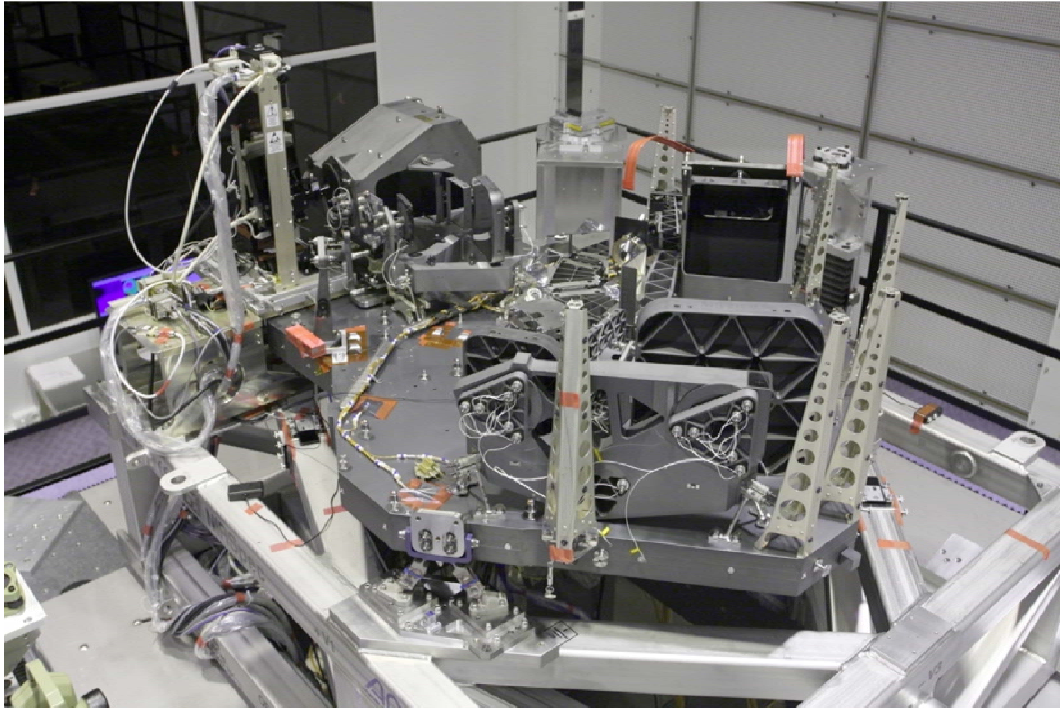
Although Zeiss has recently succeeded in manufacturing a full set of high-quality flight gratings for NIRSpec, problems are now being encountered with the mechanical mounting of the gratings onto the wheel. The mounts are seemingly introducing mechanical stresses to the gratings, resulting in large wavefront errors both at cryo and ambient temperatures. This problem was not seen previously with the breadboard models of the grating mounts.

The metallic particle contamination and electrical shorting that was encountered during acoustic testing of a non-flight qualification Micro-Shutter chip was deemed by the investigation board to be peculiar to the design of that particular chip, which had undergone an extra metallic coating compared to flight arrays. Since then, one of the four arrays (Q4 #103) of the flight Micro-Shutter System unexpectedly developed mechanical cracks during a precautionary vibration test of the device and is no longer considered suitable for flight. The cause of the failure is not yet known, nor is it clear whether the problem is generic in nature. A formal Failure Review Board has been set up by NASA, but has yet to report on its findings. The damaged array is in the process of being replaced in the Flight Unit with a spare device (#116). This leaves only three spare arrays remaining should further mishaps occur.

While the two NIRSpec HgCdTe detector chips selected for flight have been available for some time now, selection of the associated flight ASICs (Application Specific Integrated Circuit) will occur only in mid-February. Measurement of the end-to-end performance of the assembled NIRSpec flight Detector System will be carried out at NASA GSFC as soon as the flight ASICs become available.

The engineering prototypes of both NIRSpec and MIRI will be delivered to NASA GSFC in February. Deliveries of the flight instruments are expected in late 2010 or early 2011. With the delivery of the NIRSpec and MIRI flight-models within sight, several meetings have been held with NASA to discuss the optical tests of NIRSpec and MIRI that need to be carried out at ISIM level after integration of the instruments. A comprehensive review of ISIM-level tests for all JWST instruments will be held at NASA GSFC on March 22-26.

Development of NIRSpec and MIRI operations are progressing nominally, with routine support being given to all STScI & Instrument Team working groups.



The NIRSpec flight instrument undergoing assembly.



JWST Primary Mirror Segments being prepared for optical cryo-testing.

7.2 GAIA: Timo Prusti

A major technological and scientific milestone was reached when the engineering models of the Focal Plane Assembly (FPA) and Payload Module (PLM) were successfully tested in vacuum. In the PLM test, two CCD rows were equipped with the electronics, Video Processing Units (VPU) and On-board Clocks. A mask with pinholes creating artificial star

images was moved across the focal plane at the same speed Gaia will scan the sky once in orbit. The pseudo-stars were detected by the CCDs and tracked by the VPU which recorded their signal in the correct CCD windows and with the appropriate timing. The successful completion of the tests is the first full validation of the Gaia detection chain.

The test data were also used to calibrate the non-uniformity of the CCD response which was mentioned in previous reports. For memory, the non-uniformity manifests itself as a change in the CCD bias level. The amplitude of this change depends on the duration of the flushing (fast read-out where no signal is expected) in the empty windows that precedes the star. Analysis of the test data confirm that the effect is deterministic, reproducible and can be calibrated-out to the level of 1.5-1.7 electron-per-pixel residual noise. This should be compared with the ≈ 4 electrons-per-pixel total noise expected from the CCD and its electronics. These promising results indicate that the way forward is to refine the method further and plan operations and data analysis around this so called pre-calibration scheme.

The CCD irradiation tests will continue in 2010, with two major test campaigns foreseen. The first series of tests is designed to evaluate the impact which neighbouring stars have on Gaia targets as far as radiation-bias and charge-loss are concerned. The second campaign will concentrate on testing the effect of radiation on the CCD serial registers. Serial registers are read and flushed very quickly through the read-out node which means that the Charge Transfer Efficiency (CTE) is low. The tests will explore the impact of particle radiation on the CTE of serial registers by exposing them to doses comparable to those expected at the end of the mission. This information, among other, is needed to calculate the end-to-end scientific performance of Gaia. The Gaia performances will be presented at the PLM Critical Design Review (CDR) and Mission level CDR toward the end of 2010.

The Gaia Data Processing & Analysis Consortium (DPAC) is gearing up to the end-to-end tests which will take place throughout 2010. The purpose is to test and debug the overall Gaia processing system by exercising the data flow across all major interfaces between different databases and software components. DPAC will also be reviewed in the framework of the mission level CDR.

For the second time, the Gaia Science Team (GST) held a joint meeting with the DPAC executive committee. This provided a useful forum to review the current status of spacecraft development since many of the complex issues encountered by industry and the way they are resolved are intimately linked to the way the data are processed and the impact this has on the scientific performances of Gaia. At the meeting, a unanimous decision was taken to concentrate all efforts at refining and implementing the above mentioned pre-calibration of the CCD non-uniformity and capitalise on the promising results obtained so far. At the next meeting, the GST will examine the scientific requirements on the intermediate releases of the Gaia catalogue. These need to be defined in order to scope the amount of work required for developing the catalogue access software and associated documentation.

7.3 Lisa Pathfinder: McNamara

Most flight units, with the exception of the transponders and micro-Newton thrusters have now been integrated to the spacecraft at the premises of the industrial prime contractor, Astrium UK. In addition, the NASA provided Disturbance Reduction System has also been successfully integrated. The next major milestone in the integration and test flow is the first magnetic test campaign. The spacecraft was shipped from Astrium UK to the

magnetic testing facility at IABG (Berlin) on the 19th of January. The test campaign is scheduled to start on the 3rd of February.

Several flight units of the LISA Technology Package (LTP) have been delivered during the reporting period, with others in final thermal-vacuum testing. The main exception is the test-mass Caging Mechanism Assembly (CMA). The engineering qualification model (EQM) of the CMA with associated ground support equipment (test mass, mounting structure) was shipped to the testing facility in mid January, and testing is now in progress. Delivery of the CMA flight units is scheduled for May 2010.

ESA appointed a Tiger Team to investigate the failure of the FEEP micro-Newton Thruster which happened during previous tests. The investigation has been completed and a report is in preparation which is expected to focus on the geometry and material of the accelerator plate, and on the propellant feed system. In parallel, a series of extensive tests is being prepared to measure the work function of different materials coated with Caesium. These tests are expected to last for approximately six months. The FEEP micro-thruster assembly will therefore not be available for final EQM testing before the end of summer 2010.

During the reporting period, the science community effort focused on the delivery of the LTP data analysis software. Version 2.1 of the toolbox is now installed and in use at the Science and Technology Operations Centre (STOC) at ESAC. The effort has now shifted toward the preparation and validation of the detailed sequences of telecommands (TC) that will be executed in orbit to validate and characterise the LISA Technology Package. These sequences are “uplinked” onto the STOC performance simulator and the output telemetry is then processed with the LTP data analysis software. Analysis of the resultant data products is then fed-back to the TC sequences in order to optimise the command parameters.

The alternative highly elliptical orbit (HEO) mentioned in previous reports is still under assessment. A candidate orbit has been generated by flight dynamics, giving more than 15 days of continuous science operations around apogee. From a purely gravitational standpoint, this orbit allows all scientific requirements to be met, although it necessitates a slightly longer operational phase. The ESA project team are currently investigating the impact of earth illumination at perigee on the thermal stability of the spacecraft. A decision concerning the HEO will be taken at the Mission-Level Critical Design Review (CDR) in late spring. The launch of LISA Pathfinder is scheduled for mid 2012.

8 Ongoing studies

8.1 LISA: Oliver Jennrich

After the successful third round of the Mock LISA Data Challenge (MLDC) that closed earlier in 2009, the fourth round of the MLDC opened on 20 November 2009. While the third round of the MLDC focused on increasing the complexity and variety of GW sources, this iteration is devoted to the global-fit problem of detecting and analyzing sources of different types superposed in the LISA data. All source classes from the third round are represented - including 60 million galactic binaries – but with a larger numbers of extreme mass-ratio inspirals (EMRI) and cosmic-string bursts and a wider parameter range for massive black hole binaries and EMRIs. The tentative dead-line for the fourth round is in late fall 2010.

This year's main event for the LISA community is the 8th International LISA Symposium, a biennial conference that will take place at the end of June in Stanford. The week-long Symposium is typically attended by ~250 researchers and is one of the major conferences for gravitational wave research. The general assembly of COSPAR in Bremen will feature a session on the technology of current fundamental physics missions, including LISA.

The LISA technology programme is progressing well. Development of the point-ahead mechanism that is required to compensate for aberration yielded excellent results. A breadboard of the mechanism developed by one of the two contractors has been successfully validated while that of the second contractor is still under tests. Development of the optical bench and the telescope structure is in progress. Proposals for the development of high power lasers have been received from industry and are currently under evaluation. The industrial mission formulation study, a joint ESA-NASA activity, continues in parallel, with regular coordination meetings between the two agencies.

8.2 IXO (formerly XEUS): Arvind Parmar

The two industrial contractors responsible for the System Studies (Thales-Alenia Space and EADS Astrium UK) presented the outcomes of the first parts of their studies at Mission Definition Reviews. Both studies indicated that the mission is feasible, but highlighted the difficulty of meeting the scientific requirements whilst retaining mass margins appropriate to this stage of the design. In some cases, the performance figures exceed requirements. The contractors have therefore been asked to consolidate their designs so as to regain adequate mass margins. The IXO Study Coordination Group agreed that the contractors should look at all aspects of the science requirements in investigating ways to save mass. However, they stress that the effective areas of the mirrors ≥ 6 keV should only be reduced as a last resort. The reason is that several key scientific objectives of the mission involve studies of the Fe-K 6 keV line variability which cannot be recovered through longer observing times.

After Munich, Boston and Otaru, a fourth open IXO science meeting will take place at the Cité Universitaire of Paris next April 27-29. The meeting will focus on the synergy between IXO and future major observing facilities such as ALMA, ELTs, JWST, SKA etc.

Finally, there have been some changes to the ESA study team, with Dr David Lumb taking over from Arvind Parmar as IXO Study Scientist and Nicolas Rando taking over from Philippe Gondoin as IXO Study Manager.

8.3 Euclid: René Laureijs

A two-day conference entitled "Observing the dark Universe with Euclid" was held in Noordwijk, on 17-18 November, 2009. The objective was to present the Euclid mission to the international scientific community and to encourage feedback in advance of the Cosmic Visions selection process. Some 100 people attended the conference, mostly astronomers affiliated to the instrument consortia, but also representatives from industry and funding agencies. In total 30 presentations were given. The conference addressed the main cosmological objectives of the mission, its scientific legacy, the synergies with ground based projects, and the plans for the scientific data processing. All presentations are available on the internet.

The Euclid science case was presented to the scientific community at the Oceanographic Institute in Paris on December 1 jointly by A. Réfrégier (CEA), A. Cimatti (Bologna Univ.) and D Lumb (ESA). The presentation, together with the Assessment Study Report

and the Technical Review Report has been posted on the ESA web site. The Euclid science study team received 75 questions from the advisory working groups. In the written reply, the questions related to slit (or DMD) spectroscopy were treated separately from other questions to clearly indicate that slit spectroscopy is not part of the baseline mission. Slitless spectroscopy fulfils all scientific objectives of Euclid including the need to have more than one cosmological probe.

The Euclid ESA study team is currently investigating options to implement the risk mitigating measures recommended by the Technical Review while safeguarding most of the scientific capabilities of the mission. This entails a reassessment of the optical design.

8.4 Plato: Malcolm Fridlund

The outcome of the assessment study of PLATO was presented to the community and ESA advisory structure on December 1, 2009. The Science Study Team received 95 questions from the AWG and SSEWG. Detailed answers were provided on January 6.

At the AAS meeting in January, the Kepler team reported on the results of the characterisation of the parent star of exoplanet HAT-P-7b by astroseismology. This characterisation allowed constraining the density of the planet to 5 % accuracy and its age to 250 Myr. Kepler will be able to repeat such a study for the 100 or so brightest stars in their FOV, which may lead to a precise characterisation of one or possibly two additional exoplanets. This clearly illustrates the power of PLATO which will be able to perform the same analysis for a much larger sample of 21,000 cool dwarf stars, potentially leading to the accurate characterisation of 200 to 400 new planets.

The PLATO ESA study team is currently investigating options to implement the risk mitigating measures recommended by the Technical Review while safeguarding most of the scientific capabilities of the mission.

8.5 SPICA: Ana Heras

The recent activities of the SPICA team have focused on the preparation of the SPICA Assessment Study Report, the December 1 public presentation to the community and on responding to the questions raised by the AWG and SSEWG.

The ESA Study team continues having regular teleconferences with the Japanese SPICA team. The System Requirements Review is in progress at JAXA until mid March. JAXA has requested a feasibility study on a cost reduction plan which would involve the replacement of the nominal launcher HIIB/5S-H by an HIIA-204/5S. Fitting the satellite into the smaller HIIA fairing would require shrinking the distance between the M1 and M2 mirrors and reducing the effective diameter of M1 from 3.35 m to about 3.0 m. ESA is currently assisting JAXA in assessing the consequences this would have on the performances, cost and schedule of the mission. At the same time, it evaluates - together with the SAFARI consortium - the impact on the scientific capability. The Japanese SPICA Science Working group has already stated that this model meets the scientific requirements of the mission. A final decision is expected by end of March.

In December 2009, JAXA issued an AO for the Japanese led instruments: the mid infrared camera (MIRACLE), the mid-infrared spectrometers (MIRMES, MIRHES) and the mid-infrared coronagraph (SCI). Each instrument team has been requested to submit a design report by the end of April. A Review committee will evaluate the scientific potential and technological readiness of each instrument and issue its recommendations by July 2010.

The SAFARI team at SRON is being consolidated. Several members of the team visited JAXA in November. The Proceedings of the Joint European/Japanese SPICA Workshop held at Oxford from July 6 to 8, 2009 contains 47 articles which have been published and are available at <http://spica.edpsciences.org/>.