

## Project and Study Scientist Reports for AWG # 130

13-12-2007\*

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

### 8. Satellites in orbit

#### 8.1 HST: Antonella Nota

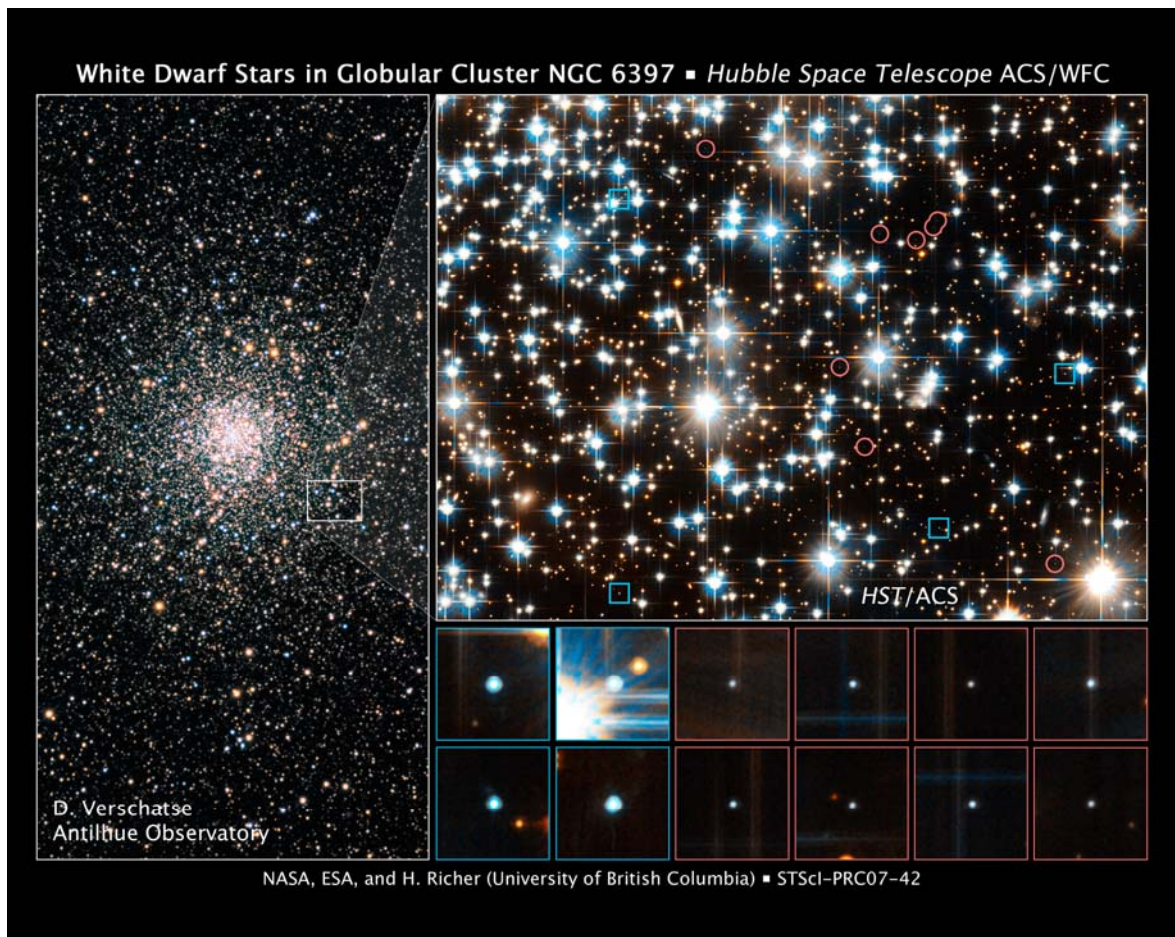
The HST spacecraft continues to operate nominally. Activities continue in preparation of Servicing Mission 4 (SM4), currently planned for August 2008. The manifest for Servicing Mission 4 includes two new instruments, the Wide-Field Camera 3 (WFC3) and the Cosmic Origins Spectrograph (COS), as well as several life-extending items such as gyroscopes and batteries. The astronauts will also attempt to repair the Space Telescope Imaging Spectrograph (STIS), which failed in August 2004, and the Advanced Camera for Survey (ACS), which failed in early 2007. After a period of spacecraft and instrument commissioning, scientific observations will resume with the start of Cycle 17.

An announcement for the Cycle 17 Call for Proposals for HST observations and funding for Archival Research and Theoretical Research programs was issued by STScI at the beginning of December. This solicitation for proposals will be open through March 07, 2008. For Cycle 17, proposers should assume that HST will operate with the full complement of post-SM4 instruments in three-gyro mode. HST has been operating in two-gyro mode since 29 August 2005.

In late September 2007, STScI issued a Call for White Papers on a potential new category of very large multi-cycle HST observing programs, the Multi-Cycle Treasury Programs (see <http://www.stsci.edu/institute/org/spd/HST-multi-cycle-treasury>). By the submission deadline of Friday, November 30, STScI received a total of 22 submissions. The white papers will be considered by a small advisory committee composed of members internal and external to STScI. That committee will make a recommendation to the STScI Director on whether the Institute should proceed with this new type of program. If the decision is positive, STScI will consult with the Space Telescope Users Committee and the broader HST community on the detailed implementation.

A Workshop is being planned in Bologna, Italy, on January 29-31, to raise awareness about the expanded scientific capabilities of the HST after SM4. The workshop is being sponsored by INAF, in collaboration with ESA and NASA (STScI and ST-ECF). Additional information on this Workshop can be found at the following url: <http://www.iasfbo.inaf.it/bawhst/>

Hubble Space Telescope is providing strong evidence that white dwarfs, the burned-out relics of stars, are given a "kick" when they form. The sharp vision of Hubble's Advanced Camera for Surveys uncovered the speedy white dwarfs in the ancient globular star cluster NGC 6397. Before the stars burned out as white dwarfs, they were among the most massive stars in NGC 6397. Because massive stars are thought to gather at a globular cluster's core, astronomers assumed that most newly minted white dwarfs dwelled near the centre. Hubble, however, discovered young white dwarfs residing at the edge of NGC 6397, which is about 11.5 billion years old.



This distribution of young white dwarfs is the exact opposite of what was expected. The idea was that as aging stars evolve into white dwarfs, they are given a kick of 3 to 5 kilometres a second, which rockets them to the outer reaches of the cluster. On the basis of these observations, astronomers suggested that white dwarfs propel themselves by ejecting mass, like rockets do. Before stars evolve into white dwarfs, they swell up and become red giants. Red giant stars lose about half their mass by shedding it into space. If more of this mass is ejected in one direction, it could propel the emerging white dwarf through space, just as exhaust from a rocket engine thrusts the rocket from the launch pad. The idea that young white dwarfs are born with a kick was suggested 30 years ago to explain why there were so few of them in open star clusters.

## 8.2 XMM-Newton: Norbert Schartel

The XMM-Newton observatory continues to operate nominally. As of December 5, 2007, the overall completion status of the observing programme is as follows:

- AO-6 programme: 70.6 % (A and B priority)
- AO-6 programme: 1.3 % (C priority)

The completion of the AO-6 programme is expected by April 2007, in line with the planned start of AO-7 observations.

Several Targets-of-Opportunity were observed during the reporting period, namely XMMSL1 J070542.5-381, X070610 and IGR J20188+3647.

The meeting of the chairpersons of time allocation committees for the XMM-Newton seventh Announcement of Opportunity (AO7) took place on the 29th and 30th of November 2007 at ESAC. It is planned to finalize the results and to inform Principal

Investigators (PIs) before Christmas. Successful PIs will be asked to specify the observation details during the second phase submission, which will run from the 14<sup>th</sup> of January to the 8<sup>th</sup> of February 2007.

AO7 investigators were for the first time offered the opportunity to submit very large proposals, which request between 1 Ms and 3 Ms. Ten such very large programs were submitted but only one was accepted by the TAC and granted 1.3 Ms of observing time, or ~10% of the total available time. Its goal is to perform one single ultra-deep XMM-Newton observation of the Chandra deep-field south and obtain the most sensitive view of the hard X-ray sky to date. Estimates show that the observation will contain high-quality spectra of more than 100 heavily obscured active galactic nuclei, which will enable a detailed study of Compton-thick AGN at the peak of their activity around redshifts ~1-2. This project targets can be considered as a pathfinder for future X-ray missions, such as XEUS.

V. Trimble and J.A. Ceja published an article in *Astronomical Notes* (2007, AN 328, 983) which compares the productivity and impact of astronomical facilities. It compiles statistics on publications and citations for the year 2001 and 2002. With 31.4 citations per article, XMM-Newton has the highest citation rate of all observatory type missions. It is surpassed only by the 4 special purpose facilities, SDSS, Boomerang, Maxima, and DAS1.

The XMM-Newton Gallery is a collection of astronomical images and spectra obtained with XMM-Newton ([http://xmm.esac.esa.int/external/xmm\\_science/gallery/public/](http://xmm.esac.esa.int/external/xmm_science/gallery/public/)). Since August 24, the images can be displayed in the latest version of Google Earth in association with the celestial target objects. At the time of writing this report the corresponding Google format (KML) file available at the XMM-Newton SOC home page ([http://xmm.esac.esa.int/external/xmm\\_science/gallery/images/xmm\\_gallery.kmz](http://xmm.esac.esa.int/external/xmm_science/gallery/images/xmm_gallery.kmz)), was downloaded about 2400 times. The XMM-Newton Gallery is also listed on the "Google Earth" web page as one of the "featured files in the Google Earth Gallery" in category "Google Earth KML: Sky", see [http://earth.google.com/gallery/kml\\_entry.html#XMM-Newton%20Gallery](http://earth.google.com/gallery/kml_entry.html#XMM-Newton%20Gallery).

At the time of writing of this report about 1659 papers – either completely or partly based on XMM-Newton observations – have been published in the refereed literature, of which 316 are from 2007.

Following a positive recommendation from the AWG and SSAC, the SPC at its 120<sup>th</sup> meeting in November unanimously approved the extension of XMM-Newton operations to 31 December 2012.

### **8.3 Integral: Christoph Winkler**

INTEGRAL continues to operate nominally. At its 120<sup>th</sup> meeting, the SPC also unanimously approved the extension of Integral operations to 31 December 2012. It further recommended to Council to approve a modification of the Science Management Plan that reflects the termination of the Integral Core Programme (CP, akin to guaranteed time) after 2008 as well as the dissolution of the Integral Science Working Team (ISWT) and its incorporation into the Integral Users Group (IUG). In its new configuration, the IUG consists of 6 independent scientists, the TAC Chair, the ESA Project Scientist and Mission Manager and the former members of the now defunct ISWT.

The new IUG, chaired by Prof Hermesen (SRON, Utrecht) held its first meeting on 15 and 16 November. It reviewed and agreed its updated terms of reference. It then recommended an observing strategy and data policy (all data immediately available publicly) for Galactic and nearby Supernovae. Finally, it defined observations for the remaining CP time in 2008. The IUG minutes will be made publicly available on the ISOC web pages.

The Announcement of Opportunity AO-6 for INTEGRAL open time Key Programme observing proposals closed on 30 November 2007. The available observing time was oversubscribed by a factor 6.2. In total, thirteen KP proposals were submitted, out of which 6 require multi-year observations, lasting from one year up to four years beyond AO-6. The TAC peer review is in progress, until January 2008. The AO-6 observing cycle will start on 16 August 2008 for a duration of 12 months. Meanwhile, preparations are underway to issue the standard open time AO-6 in March 2008.

During the reporting period a selected number of scientific highlights include: (i) discovery of an asymmetric distribution of positron annihilation in the Galactic disk (Nature, 2008, in press); (ii) non-thermal hard X-ray emission from  $\eta$  Car (A&A, 2008, in press); (iii) non-thermal hard X-ray emission from the Ophiuchus cluster (A&A, 2008, in press); (iv) a new model to explain fast outburst mechanisms for SFXT (A&A, 2008, in press).

The total number of refereed publications using INTEGRAL scientific data since launch is 311, with 72 refereed papers during 2007. Eight ESA press releases on INTEGRAL science have appeared so far in 2007, and three new releases will be published between mid December and end January.

On the occasion of the 5<sup>th</sup> launch anniversary, a workshop entitled “INTEGRAL – the first five years” took place in Sardinia on 17-19 October 2007 attended by more than 140 participants. All presentations are available on-line via <http://integral.esac.esa.int/>. The 7<sup>th</sup> INTEGRAL workshop, focussing on compact (Galactic) objects, will take place in the period 08 - 11 September 2008 in Copenhagen.

#### **8.4 Suzaku (ASTRO-E2): Arvind Parmar**

The third European AO for observing time on the JAXA/NASA X-ray observatory Suzaku closed on 30 November 2007. JAXA kindly offered astronomers from institutes located within the ESA Member States 8% of the observing time. A total of 30 valid European proposals were received corresponding to an over-subscription in observing time of 3.3. The European TAC will meet in January to select the proposals to be forwarded to JAXA and the final results of the merging process with the NASA proposals are expected in March next year.

#### **8.5 Akari (ASTRO-F): Alberto Salama**

Preparations for the AKARI warm phase (Phase 3) continue with a view to start observations in April 2008. Following an adjustment of the telescope focus in October, the performance of the NIR camera at 40 K has been evaluated on the basis of observations of standard stars. The results were discussed at a guaranteed time (Mission Program) workshop on 27 November. The guaranteed time observing schedule will be fixed in March 2008, enabling the release of the Open Time AO in April 2008. An orbit change manoeuvre was performed in the first week of December, to recover the initial Sun-synchronous orbit. Further to temperature stabilisation, a focus adjustment is planned for early February 2008, followed by a second performance evaluation. The ISAS Space Science Steering Committee shall meet in mid December 2007 to endorse the Phase 3

operations.

ESA ground station support was maintained until the planned end date of 31 October. ESAC user support activities are focused on updates of the instrument data user manuals, planned for January 2008, incorporating user feedback. ESAC will play a role (not envisaged earlier) in the production of the IRC catalogue at 9 and 18 microns, as the pointing reconstruction software uses IRC detections as an input. A plan has been proposed to ISAS, to meet the first issue deadline of April 2008. During the survey, there have been 4.6 millions detections, of which 63% are matched with the FSTS input reference catalogue (based on 2MASS) and 25% with the IRC reference catalogue (based on MSX). 11% of the detections have either a double match (2%) or are unmatched (9%). These are currently being investigated with the aim of enhancing the input reference catalogues and perform a second run of the software on the whole survey at the end of 2007. It is expected that the IRC survey catalogue will contain in excess of 800,000 sources (about 4 times more than IRAS).

A copy of the PASJ AKARI special issue has been distributed to the European Open Time PIs. A second issue is planned to contain Open Time results, and is expected to be released in the summer of 2008, with a deadline for inputs of February 2008.

## **8.6 CoRoT: Malcolm Fridlund**

Corot is continuing to work well. On December 10, data from the first 60-days (“medium run”) observation performed in February-April 2007 were formally handed over to all 62 CoRoT Co-Investigators at CNES HQ in Paris. This marked the start of their one year proprietary period. The data still suffer from limitations due to imperfect data processing. The next release will occur on January 15, when the first half of the data resulting from the first 150 days “long-run” observation performed in May - October 2007 will be handed over to the Co-Is. Thereafter, data from long runs will be released in three batches of 50 days, instead of two. This change in data release policy is motivated by the large number of planet candidates detected and the difficulty to perform follow-up observations. Indeed, the two main viewing zones, or “CoRoT-eyes”, are hidden behind the Sun for about 150 days per year. During this period, they are unavailable for follow-up observations. This period happens almost immediately after the 150 days CoRoT long-run observation, which means that confirmation of a candidate may have to wait for as long as 300 days. With the new release policy, it will become possible to organise follow-up observations while the long run is still in progress and before the area becomes inaccessible. The official start of the proprietary period will however remain at the end of the 150 day long-run since the complete light curve is required for a detailed analysis.

Three articles on exoplanets have been submitted for publication in *Astronomy & Astrophysics*. To celebrate the first release of CoRoT data and present new light-curves, CNES is organising a press conference at Paris observatory on 20 December 2007. On this occasion, Annie Baglin, the CoRoT Project Scientist, will be awarded the French aeronautic medal.

## **9. Projects under development**

### **9.1 Herschel: Göran Pilbratt**

The three Herschel flight instruments have been mechanically and electrically integrated in the payload and service modules (PLM and SVM) of the Herschel spacecraft at Astrium, Friedrichshafen (FN). In the course of the electrical integration and associated warm

functional testing a number of issues were dealt with. Physical damage to the cabling of the HIFI auto-correlator was discovered, necessitating replacement; a current ripple on the satellite power line to the HIFI local oscillator control unit required hardware modifications. Just prior to the start of a functional test, it was discovered that half of the PACS blue spectrometer array was not connected; fortunately, it appears that no damage was caused. When the cryostat was finally closed in early November, contamination was discovered on the PACS entrance optics. After opening up the cryostat to provide access, investigations quickly established that only the unvignetted (as seen from outside the focal PACS plane unit) parts of the first two mirrors suffered contamination; the mirrors were then successfully cleaned, and the cryostat closed again. In parallel investigations are underway to establish the exact nature and cause of the contamination.

The AIV (Assembly Integration & Verification) strategy in terms of the order and location for the activities is constantly being updated in order to optimise the schedule in light of the actual progress. Evacuation of the cryostat is about to start. As previously reported, the transport of Herschel to ESTEC is still foreseen for early January 2008. An important change however is that it will now be transported warm, before the cool-down, and thus before any instrument testing has been performed at spacecraft level. Integration of the solar shield and of the telescope will take place during cool-down at ESTEC. The initial spacecraft level tests of the warm payload will start in January 2008, followed by cold tests from mid-February to mid-March 2008. The official launch date remains 31 July 2008, though Herschel is now running approximately 2 months behind schedule.

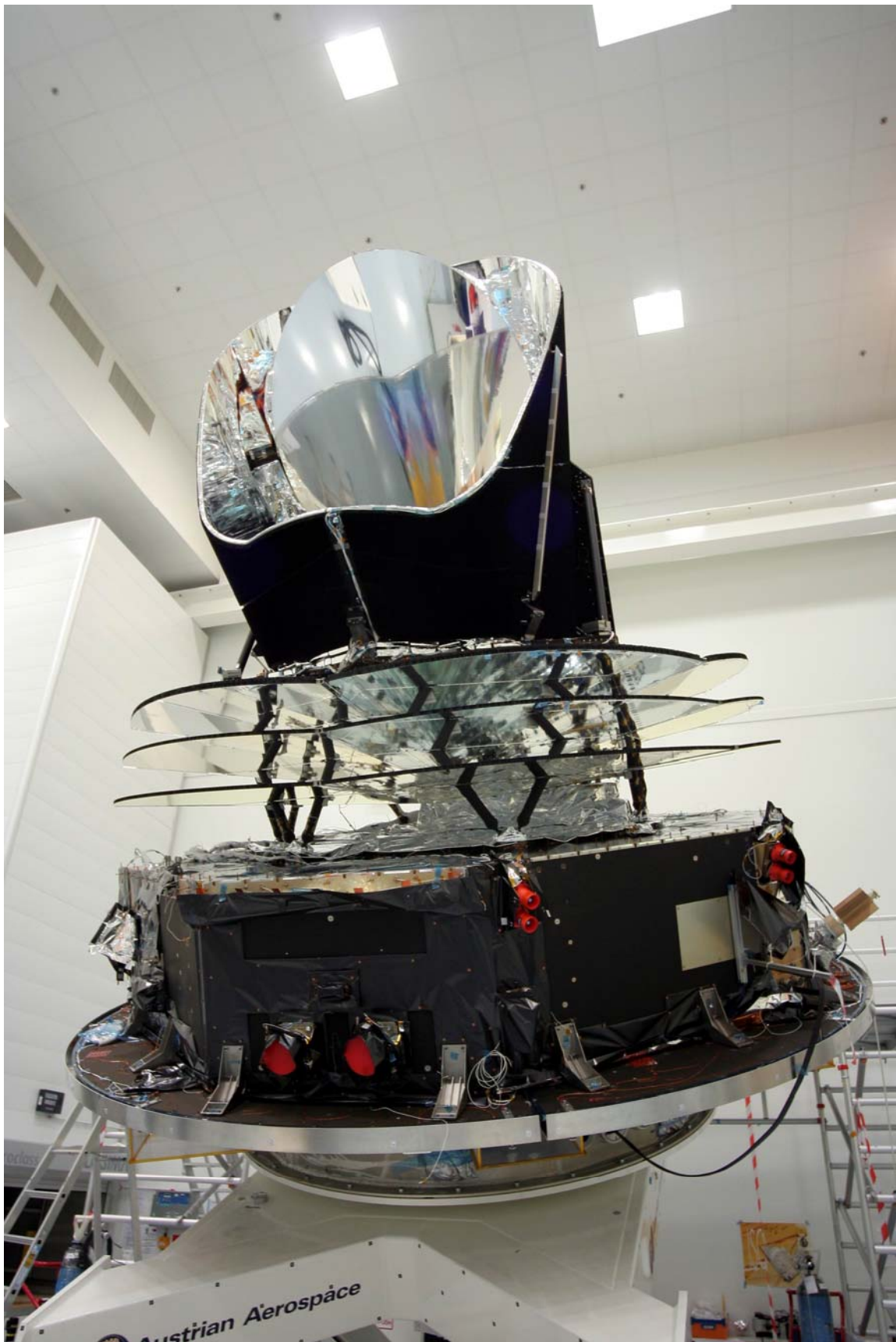
A status review of the calibration part of the in-flight Performance Verification (PV) plans took place at RAL from 19 to 20 November 2007.

A total of 62 Key Programme (KP) Open Time (OT) proposals were received by the deadline of October 25. In total, the proposals request 17984.6 hours of observing time, 3.3 times more than the maximum amount of 5379.2 hours available for KP OT allocation. The Helpdesk was manned more or less round the clock during the last days leading up to the deadline, but there were no major problems. Technical reviewing of the proposals by Herschel Science Centre (HSC) staff at ESAC and their scientific ranking by the Herschel Observing Time Allocation Committee (HOTAC) are now well underway. The HOTAC meeting will take place on 18-20 December 2007 at ESTEC. All proposers will be notified in mid-January 2008 and successful proposers will be requested to perform phase 2 observation entry in the coming month, taking HOTAC comments into account. The list of accepted OT KP proposals will be made public on 28 February 2008.

## **9.2 Planck: Jan Tauber**

The Planck satellite is now fully integrated (see picture below). During the month of December, it will undergo mechanical testing (vibration, acoustic, shock). This will be followed by system functional and Electro-Magnetic Compatibility (EMC) testing. The spacecraft will then be shipped to the Centre Spatial de Liège (CSL) for end-to-end cryogenic and instrument testing. The on-board software development and validation remains on the critical path of the Project schedule.

The RFQM “reference horn” test was completed and showed that the method that will be used on the flight model to verify the alignment is mastered; the results are still being analysed to pin down the method sensitivity.



The only instrument flight item not integrated yet on the satellite is the HFI 4 K cooler, which is still under test at the Rutherford Appleton Laboratory. A spare unit has been mounted onto the satellite to allow environmental tests to proceed. The 4 K cooler has shown to be difficult to operate. A “Tiger Team” was appointed to address the problem. It

made specific recommendations for flight operations, among which that of modifying the current software so as to make operations of the 4 K cooler more flexible. The flight unit will be swapped for the spare before the satellite is shipped to CSL for end-to-end testing.

Phase 1 of system-level end-to-end (EE) testing of the scientific data-processing pipelines has been completed by both the LFI and HFI Data Processing Centres; the results are currently being analysed. The simulations infrastructure needed for the second phase of the tests is not yet ready. Current planning foresees a completion of EE tests phase-2 around early April 2008.

Preparation of the first system-level tests of the Ground Segment in early February and mid-March 2008 is ongoing. Planning for the Calibration and Performance Verification Phase is well advanced, with a detailed timeline of activities filling in about 2 months of the mission. Many of these activities are similar to those that will be carried out during the CSL tests. As already stated, the nominal launch date of Planck (and Herschel) remains 31 July 2008.

### **9.3 JWST: Peter Jakobsen**

The NASA JWST Project is presently focused on preparing for the JWST System Level Preliminary Design Review (PDR) and associated Non Advocate Review (NAR), which will take place in March & April 2008. A major milestone toward this event was recently reached with the Optical Telescope Element (OTE) subsystem passing its PDR. The equally critical Sunshield PDR is scheduled for February 2008. All JWST primary and secondary telescope elements have now completed machining, and several elements are undergoing coarse polishing. The overall JWST budget and schedule have remained unchanged since 2005. Peak funding for NASA will occur in 2008.

On the instrument front, a major event has been the stop work order issued by the Canadian Space Agency (CSA) in late October to COMDEV, the prime contractor of the Fine Guidance Sensor & Tunable Filter Imager (FGS/TFI). This action was triggered by Canadian legislation designed to prevent significant cost over-runs in public contracts. Fortunately, the NASA JWST Project was able to quickly provide a stop-gap measure by issuing a contract directly to COMDEV to continue work on the mission-critical FGS part of the instrument. However, work on the TFI and its Etalons remains on hold until the situation is appraised at the Canadian government and treasury level.

Progress on the other JWST instruments remains steady: the MIRI Verification Model passed its Test Readiness Review and is presently undergoing pump-down and cool-down in preparation for the first functional tests. The three MIRI flight candidate detector arrays from Raytheon have also been selected. The Optical Qualification Model of the challenging NIRSpec Fore-optics System has successfully undergone assembly and testing at ambient temperatures at SAGEM. The results were very encouraging in all areas. Cryo-testing will take place at CSL in Liege. The NIRSpec Micro-Shutter Array (MSA) passed its Critical Design Review on December 5. Further development and manufacture of MSAs has been terminated by the NASA JWST Project, and a set of 4 candidate flight arrays have been identified from the available batch of 14 arrays. While not perfect, the candidate flight arrays do fulfil the requirements placed on the maximum permissible numbers of failed open and failed closed shutters inferred from the JWST Level I Science Requirements.

#### **9.4 GAIA: Timo Prusti**

Since Gaia passed its PDR in June, work at EADS Astrium and sub-contractors has continued according to plans. Negotiations for the Phase C/D contracts is taking longer than anticipated and will not be completed before early 2008.

Initial tests of the red-enhanced CCDs, which are intended to equip the spectrometer and red-photometer, were disappointing. The noise level was found to be unacceptably high, in particular at (cryogenic) operational temperatures. An empirical fix was identified by Astrium, which brings the noise level down to 4 electrons and within specifications. Though the underlying physics is not understood yet, the fix is relatively easy to implement since it most likely requires only a change of resistors. In the mean time however, further tests of radiation damage effects on CCDs have been put on hold and delayed to January 2008.

The system requirements review (SRR) of the Gaia Science Operations Centre (SOC) and Gaia Data Processing and Analysis Consortium (DPAC) is in full swing since November 1. All potential problems identified so far have either been solved or actions are in place to resolve them. The only issue remaining to be raised at Board level is a recommendation to implement urgently the joint DPAC Project Office (PO). The PO plays a crucial role in the day to day management of the data processing effort. Its role and composition are clearly specified in the Project Implementation Plan, which has been agreed by ESA, DPAC and its funding agencies. However, it turns out to be difficult to appoint non-ESA staff in key PO positions. A meeting of the DPAC Steering Committee will take place in mid January to identify a way forward for staffing the PO. One of the external SRR reviewers comes from CERN. He was appointed because of his intimate knowledge of and deep experience with the Large Hadron Collider (LHC) gigantic data processing system. The conclusion from his study is that the DPAC architecture and design choices are fundamentally correct and that the scientific goals and accuracy of Gaia can be achieved with the existing data processing concept.

The new Gaia Science Team (GST) took-up duty on October 1<sup>st</sup>. Several of its members are already deeply involved in Gaia matters –and participating in the SOC/DPAC SRR for instance - where their specific expertise is put to good use for the project.

### **10. Projects under study**

#### **10.1 Plato: Malcolm Fridlund**

The PLATO Science Study Team has been appointed and held its first meeting on November 20. The assessment study started with an internal evaluation of the respective merits and drawbacks of the two proposed mission concepts, "staring" and "spinning". The evaluation is carried out mostly at the Concurrent Design Facility (CDF) in ESTEC, in close interaction with the Science Study Team. The plan is to select a baseline concept by March 2008, so as to be in a position to kick-off the industrial study in mid-May 2008.

#### **10.2 Dark Energy mission: René Laureijs**

Two dark energy related cosmic visions proposals were submitted. The ESA advisory structure recommended studying both proposals initially, with the aim of down selecting the best concept in the spring of 2008. The Dark Universe Explorer (DUNE) mission intends to map the shape and distribution of galaxies in order to measure the effects of

weak gravitational lensing, from which the equation of state and the rate of change of dark energy can be derived. The other proposal, the Spectroscopic All Sky Cosmic Explorer (SPACE), share the same objectives, but its method is to unravel the baryonic acoustic oscillations patterns in the universe from the measurements of the spatial distribution and spectroscopic redshifts of a large number of galaxies.

A Concept Advisory Team (CAT) has been appointed whose mandate is to recommend to ESA which of the two mission concepts should be selected for an assessment study proper. The CAT is chaired by Prof. M. Longair (Cavendish Laboratory) and is composed of 2 members from the DUNE consortium, 2 members from SPACE and 6 independent European scientists. The first meeting of the CAT will take place on 14-15 January 2008. In its evaluation, the CAT will have to take into account not only the scientific and technical merit of each proposal, but also the international context and its potential for collaboration, the expertise of the teams, the complementary ground based facilities required to achieve the stated goals, and of course the cost and potential risks of the mission. The team will be assisted by ESA engineers for all technical aspects. The CAT should complete its activity by May 2008, after which it will be disbanded. The mission concept they will recommend will then be subjected to an assessment study that will last until mid-2009.

### **10.3 SPICA: Ana Heras**

The appointment of the SPICA Telescope Science Study Team is currently being finalised. By the end of January 2008, the team will consolidate the science requirements associated with ESA's contribution to SPICA – the telescope assembly and ground segment - into a Science Requirements Document. The SRD will be used to drive the assessment study.

The internal ESA study will be conducted mainly at the ESTEC Concurrent Design Facility. Several CDF sessions have been planned in April 2008. The results of this internal assessment will be used to prepare the Invitation-to-Tender (ITT) that will be released in early May. The aim is to start the industrial studies in mid-July 2008. An assessment study of the proposed European SPICA Instrument, ESI, will be carried out in parallel. The exact role of ESA in this study is still under discussion.

A first meeting with representatives from JAXA/SPICA and the ESI consortium took place on 29 November. SPICA is in pre-phase A at JAXA. A Mission Definition Review by the JAXA Space Science Steering Committee is currently in progress. Should the outcome of the review be positive, SPICA will enter full phase-A in 2008.

### **10.4 XEUS: Arvind Parmar**

Following the selection of XEUS for an assessment study as a candidate Cosmic Vision "L" mission, the Science Study Team has been appointed. Their first meeting is scheduled on 9-10 January.

Industrial studies are not expected to start before September 2008. First, it is necessary to establish which elements of the mission will be studied by the different potential partners who expressed support for the XEUS Cosmic Vision Proposal. An appropriate technology development plan also need to be prepared. As part of this process, an open meeting to discuss the XEUS science goals and technology status will take place at ESTEC next March 5-6, 2008. Representatives from the agencies who expressed interest in XEUS will be invited to attend.

## **10.5 LISA**

### **10.5.1 LISA: Oliver Jennrich**

As part of the mission formulation study, the industrial contractor, Astrium GmbH, established a baseline architecture for LISA in 2006. Astrium was then tasked with investigating different alternative payload design options that emerged during the formulation studies and showed potential for mass and cost reduction. This additional study lasted one year and concluded with the Payload Alternative Design Review that took place at the end of October. The findings from the Review are currently under evaluation by the ESA and NASA Project. The selection of a payload design will have an impact on the LISA Technology Development Activities, in particular for what concerns the telescope, the optical bench and the actuation mechanism. A decision is expected soon such that the TDA plan can be firmed-up in early 2008.

The joint re-costing exercise by the ESA and NASA Projects is progressing well. Its aim is to establish a robust Cost at Completion (CaC) for LISA, verify that it fits within a financial envelope of ~1100 M€ (650 M€ to ESA plus 600 M\$ to NASA) and identify cost saving options. Two bilateral meetings have already been held in July and October to agree on a common approach to costing and on a share of work. A third one will take place later in December to establish a preliminary CaC. Discussions will then take place between ESA and NASA to review their respective roles and responsibilities in the development of LISA and possibly adapt them to their respective financial capabilities. In the current working agreement, NASA is responsible for procuring the spacecraft, parts of the payload, the launch and mission operations, while ESA is responsible for the other half of the payload and the propulsion system, and science operations are shared. The re-costing exercise has to be completed by March 2008.

The Mock LISA Data Challenge completed its 'Round 1B' in December 2007. It was essentially a re-run of Round 1 to allow new groups to join in and experienced groups to refine their algorithms and codes. No evaluation of the outcome is available yet.

### **10.5.2 LISA Pathfinder: McNamara**

Work at the spacecraft prime contractor (Astrium UK) is proceeding. Critical Design Reviews (CDR) have been held for most subsystems, and several flight model (FM) units have already been delivered or are awaiting a Delivery Review Board prior to shipment. The spacecraft structure FM was unfortunately broken during static load tests. A new structure has been ordered but integration of the subsystems already delivered will have to wait until it arrives.

Development of the FEEP micro-Newton thruster technology is progressing but not without problems. Two types of thrusters are being developed in parallel: one based on Caesium propellant, and the other on Indium. The Cs thruster has suffered a further setback, this time due to the propellant tank; however, recent success in the priming of a glass coated emitter has significantly increased the confidence in the Cs FEEP. As for the In FEEP, the main issue here is with the manufacturing of the needle emitters. A series of metallurgical investigations have been conducted in ESTEC in order to try and understand the wetting properties of the Indium on Tungsten. It is hoped that the result of these tests will significantly speed up the manufacture of the needle emitters, and hence of the full thruster assembly.

The LISA Test Package (LTP) has successfully passed its CDR. The main issue still open is the test mass caging mechanism. Additional testing is in progress of two different caging mechanism concepts, one based on friction and the other on form-fit. Based on the test results, one of the two concepts will be selected for development and flight before the end of the year.

The development of the Science Ground Segment is proceeding well. The first Science and Technology Operations Centre (STOC) hardware has been ordered and is due for delivery in January 2008. The first official version of the LTP Data Analysis software (including data repository) is scheduled for release and installation at the STOC in February 2008.

The Science Community are preparing to engage in the first of a series of blind *mock data challenges* (MDC) to test the data analysis toolset being developed. It is hoped the wider LTP community will participate in the MDC, providing timely input before the first release of the software.

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