

Project and Study Scientist Reports for AWG # 139

01-05-2010

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

10 Ongoing studies

10.1 IXO (formerly XEUS): David Lumb

The industrial contractors (ThalesAlenia Space and EADS Astrium UK) continued to consolidate the system designs following the Mission Definition Reviews. No showstoppers have been identified. Efforts were made to address mass growth in various sub-systems, including the instrument payload. In order to recover mass margins, industry was instructed to investigate a reduction in the mirror outer diameter. A reduction in mirror mass would be compounded by significant savings in the accompanying support structure and Service Module cylinder masses. For the European-led silicon pore optics, a diameter reduction also allows for better convergence with designs resulting from the NASA study, ensuring better compatibility between launchers envelopes and facilitating the exchange of data between studies. Good cooperation continues between the ESA study team and their counterparts at NASA and JAXA.

While the IXO Study Coordination Group agreed that the effective area requirement at 1 keV could be slightly relaxed, improvements in the optical design and module packing densities eventually allowed the original requirements to be met. The system mass margins reported at the latest industry progress meetings are now well within limits.

Instrument assessment studies have passed their mid-term review and the teams were instructed to prevent any further resource growth. A number of open issues were identified that must be closed by the end of the study in July. Consolidated Payload Definition and Mission Requirements Documents have been issued which are applicable to the remainder of the industry studies.

D. Barret has led the organisation of an IXO science meeting that was held in Paris from 27 to 29 April. This meeting allowed a final identification and consolidation of the science topics to be addressed in the IXO Yellow Book. A first draft of the sciences case based on the “White Papers” submitted to the US Decadal Survey has already been produced. Initial discussions about the implementation of a Science Operations Centre in a European-led context have begun.

10.2 LISA: Oliver Jennrich

The LISA community in the US and Europe is anxiously awaiting the report of the Astro2010 survey committee in September. Preparation of the Assessment Study report - akin to “Yellow Book” (YB) - is in full swing.

The 8th International LISA Symposium will take place in Stanford at the end of June. The general assembly of COSPAR in Bremen includes a session on the technology for fundamental physics missions prominently featuring LISA. This session attracted more than 70 abstracts, the most so far of any fundamental physics commission. The session has been extended to 5 half-days to better accommodate all the contributions.

The Mock LISA Data Challenge (MLDC) is halfway through its fourth round, with a submission deadline at the end of 2010. This round focuses on the global-fit problem of detecting and analyzing sources of different types superposed in the LISA data stream. The global-fit character of this challenge encourages collaborations between groups which have developed algorithms for detecting different types of gravitational wave sources. As of today, the MLDC has resulted in 32 publications in peer-reviewed journals, out of a total of more than 600 for LISA in general. Groups actively working on the MLDC in Europe comprise collaborations in Germany, the UK, France, Spain, and Poland.

The LISA technology programme has been adversely affected by the introduction in January of a new ESA management and accounting system. The contracts for the laser development and the telescope structure could not be kicked-off, despite the fact that the contractors have been selected. It is doubtful that the results of these two activities will be available on time for the L-Missions technology review planned at the end of 2010. Of the activities that were already running before January 2010, development of the optical bench is proceeding, albeit with significant delays. The delays are mostly due to the overlap with the construction of the LISA Pathfinder (LPF) flight model and are not critical at this point of time since the basic technology is demonstrated with the successful construction of the LPF optical bench. The activity on the telescope point-ahead mechanism - which compensates for aberration - yielded excellent results and is now completed by one contractor while the mechanism developed by the second contractor is still under test.

10.3 Euclid: René Laureijs

At its February meeting, the SPC selected Euclid for definition phase studies. The mission nevertheless had to be optimised in order to meet programmatic constraints, in particular for what concerns mass and schedule. The optimisation process is carried out under ESA leadership, with the support of industry, and the scientific supervision of an ad hoc team of 6 scientists, the Euclid Optimisation Advisory Team (EOAT). The team also advises on the Science Management Plan (SMP) which has been prepared for approval by the SPC at its June meeting. When elements of the upcoming Announcement of Opportunity (AO) for the Euclid Payload have been consolidated in June, the EAOT will have completed its task

The ESA study team has investigated possible options for optimising the Euclid payload. A merging of the NIR photometric and spectroscopic channels into one single instrument with a reduced number of ~12 NIR detectors meets the recommended 100 kg mass reduction while safeguarding the mission performances. Other trade offs and optimisations were also investigated, such as a smaller size SiC or zerodur primary mirror and magnetic bearing reaction wheels versus cold gas actuators. The EOAT is currently assessing the performances of the optimised reference payload and verifying that it meets the scientific requirements and objectives of the mission. The Invitation to Tender for two competitive industrial Euclid definition phase studies has been released in early May.

At the bi-lateral ESA-NASA meeting in March, NASA agreed to study the possibility of becoming junior partner in Euclid, with a maximum contribution capped to 20% of the total mission costs. NASA has informed the US decadal Survey committee which will have the final say in whether or not to proceed with the decision to join the Euclid collaboration. Among the possible US contributions, provision of the near-IR focal plane detectors, readout electronics and related flight software is considered to be a top candidate. Two US scientists have been appointed by NASA to join the 6 European members of the EOAT.

Members of the former DUNE and SPACE teams who contributed to the Assessment studies agreed to merge into one single team, the “Euclid Consortium”. This consortium will provide one single consolidated reply in response to the upcoming AO for the provision of the Euclid payload and data analysis system.

10.4 PLATO: Malcolm Fridlund

Following its selection by the SPC in February, PLATO went through a payload consolidation and optimisation phase under the leadership of the ESA study team and the scientific supervision of the ad hoc PLATO Optimisation Advisory Team (POAT). As for Euclid, the main drivers were the need to streamline the development schedule and recover mass margins. The definition phase of PLATO is planned to start in July and continue until June 2011. The Invitation to Tender (ITT) to industry has been issued at the beginning of April. The Science Management Plan (SMP) has been drafted and will be submitted to the SPC for its approval in June.

The PLATO reference payload now consists of 34 refractive cameras (i.e. telescope & detectors) each with a 120 mm entrance pupil and 6 lenses (including one aspheric lens). Cameras are grouped in 4 subsets with slightly different Lines-of-Sight (LoS) but with significant overlap of their Field-of-VIEWS (FoV). Thirty-two of the cameras are aimed at stars fainter than magnitude 8 while 2 “fast” cameras are optimised for stars brighter than $m_v = 8$. The total FoV of PLATO is 2180 deg^2 . The Focal Plane Assembly (FPA) of each camera consists of four CCDs of 4510^2 pixels with $18\mu\text{m}$ pixel pitch, for a total 136 CCDs.

The current mission scenario is to launch PLATO with a Soyuz Fregat into a large-amplitude libration orbit around the Sun-Earth second Lagrange point, L2. The nominal lifetime of 6 years is divided into three phases: 2 long-duration observations (3 & 2 years respectively), each focusing on a particular part of the sky with a high density of F, G and K dwarf stars, plus a one year long step-and-stare phase where a small number of selected fields will be monitored for a few months each.

At the bi-lateral ESA-NASA meeting in March, NASA agreed to study the possibility of becoming junior partner in PLATO, with a maximum contribution capped to 20% of the total mission costs. The US decadal Survey committee has been informed accordingly. Potential U.S. contributions to PLATO may come in one of the following categories: (1) scientific investigations and contributions to the payload; (2) non-payload hardware components such as spacecraft subsystems or launch segment contributions; (3) U.S. scientific or institutional contributions (not funded by NASA) to a European-led proposal in response to the upcoming AO for the payload and data processing. Two US scientists have been appointed by NASA to join the POAT.

10.5 SPICA: Kate Isaak

Work by the SPICA study team has continued notwithstanding the decision by the SPC to defer a vote on the selection of SPICA for a definition phase. ESA and the SAFARI consortium are investigating the impact of reducing the mirror effective diameter to 3 m on the scientific output of the mission. The initial conclusions are that the scientific goals of SPICA will still be met despite a slightly reduced sensitivity, lower angular resolution and larger confusion limit. Drafting of the SPICA Science Management Plan (SMP) has started including the definition of the inter-agency advisory structure and the mechanisms by which ESA will participate in JAXA Project reviews. The ITT for two, short (4 months) parallel industrial studies are about to be released for the detailed design of the new telescope geometry. The studies will also address other important issues such as stray-light analysis and reduction, the impact and mitigation of system level contamination, the cryogenic design of

the telescope assembly and the design of the cryogenic optical test facilities required for verifying the telescope performances. The output of these studies will be used to consolidate and freeze the interface of the telescope with the SPICA spacecraft and as input to the upcoming ITT for the definition study proper.

JAXA has initiated the system requirements review aimed at fixing top-level requirements on the mission. ESA has been invited as an observer. The focal plane instrument (FPI) review has also started, during which the technical readiness, design maturity and scientific capabilities of the Japan-led instruments will be assessed. SAFARI and any NASA-provided instrument will be reviewed later this year, with ESA participation. JAXA is preparing a proposal that will be submitted in June to the Japanese Ministry of Finance for funding the development, launch and operations of SPICA.

At the SAFARI consortium meeting in March, it was clear that the consortium had regained the momentum which had been temporarily lost during the transfer of Piship from the UK to NL. The instrument development schedule and delivery date in late 2016 are fully compatible with the JAXA spacecraft schedule. Selection of the SAFARI detector technology will take place at the end of June. The SAFARI team is preparing for the JAXA FPI review in September and for the response to a future ESA AO for the payload that will hopefully be issued once the SPC approves the definition phase of SPICA.

11 Satellites in orbit

11.1 Herschel: Göran Pilbratt

During the ground contact period on 29 March 2010, the star tracker CCD operating temperature was permanently lowered from +13°C to -10°C. This has dramatically reduced the occurrences of temporary pointing aberrations which occurred during scan mapping because of “warm” CCD pixels.

The PACS and SPIRE instruments have successfully completed their Performance Verification and Science Demonstration Phase (PVP and SDP) activities. They are mostly performing Routine Science Phase (RSP) observations. HIFI was allocated half the available observing time in the February-April period in order to catch up and to enable consolidation of the HIFI-dominated Key Programme observations, on time for the release of the open time AO on 20 May 2010. HIFI has now carried out its PVP activities and “Priority Science Programme” (PSP), part of which included HIFI SDP observations.

On March 20, the Herschel Science Archive (HSA) and the Herschel Interactive (data) Processing Environment (HIPE) were released to the worldwide scientific community. This was one of the last remaining milestones on the road to achieving the status of an astronomical observatory. A data processing workshop was held at the NASA Herschel Science Centre (NHSC) in Pasadena on 25-29 January 2010 with support from the Herschel Science Centre (HSC). A HIFI specific data processing workshop was jointly conducted by HSC and the NHSC in ESTEC on 8-9 April 2010. A “HIFI Initial Results” meeting was held in Leiden on 12-13 April 2010, where the results from the HIFI SDP and PSP observations were presented (along the lines of the [SDP Initial Results workshop held on 17-18 December 2009](#) in Madrid).

Registration for the [Herschel First Results Symposium \(ESLAB 2010\) to be held in ESTEC on 4-7 May 2010](#) had to be closed due to the venue reaching the limit of its capacity. After various safety inspections, the limit was increased to accommodate the 420 registered participants. The scientific programme features 32 plenary and 72 parallel-

session oral presentations and over 100 posters. On the occasion of the symposium, a media event is being organised on the 6th of May in the Space Expo adjacent to ESTEC. Attendance is by invitation only.

By the deadline of March 31, 153 articles had been submitted for publication in the Special Issue of A&A dedicated to Herschel first results. A subsequent volume will contain a further 50 articles based on results obtained with the HIFI instrument. The deadline for these papers is the 31st of May.

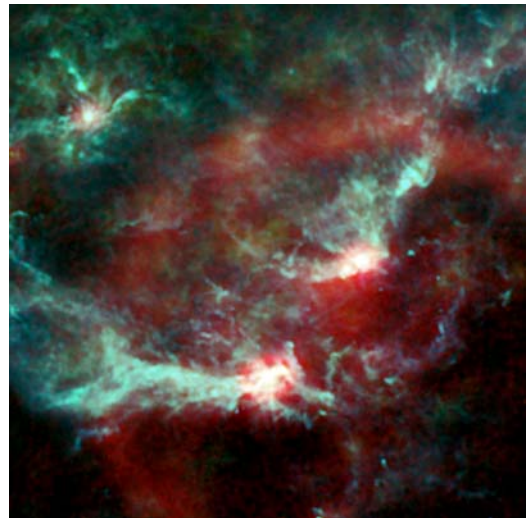
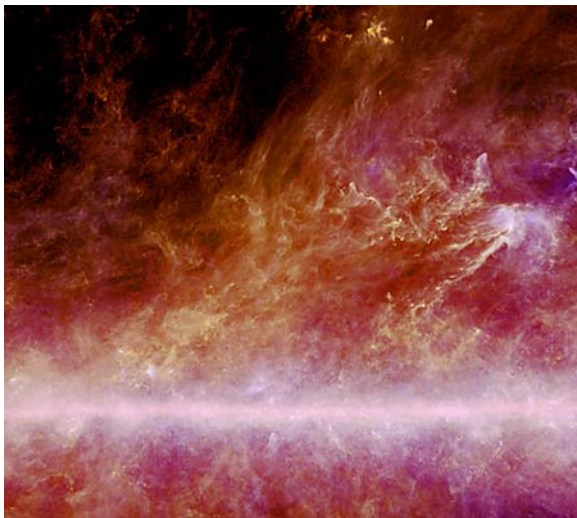
The Herschel Users' Group has been set up, but did not hold its first meeting yet. The group is chaired by Robert Kennicutt from Cambridge, UK.

11.2 Planck: Jan Tauber

The Planck survey continues to progress nominally. The cryogenic chain and the two instruments have been operating quite stably since the start of routine operations. Satellite operations are smooth and generally uneventful.

Essentially the whole sky has been surveyed so far, with no coverage gaps. About 30% of the sky has already been surveyed a second time. The major planets have been observed more than once 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 twice. LFI and HFI are exchanging data regularly for cross-calibration and joint processing. Discussions have started on cross-calibration between Planck (HFI) and Herschel (SPIRE).

Two releases of images for public relations purposes have taken place so far, one in mid-February and one in mid-April. Highlights are given below.



Left: a three-color image near the Galactic centre, combining the 557 and 858 GHz channels of HFI with the 100 μ m channel of IRAS, illustrates the power of Planck to study in detail the galactic interstellar medium. Right: a three colour image of the Orion A and B molecular clouds, combining the 30, 353, and 857 GHz channels of Planck, illustrates the power of Planck to study some of the major emission mechanisms operating in the interstellar medium of our Galaxy.

The operation of Planck has been assured until end of 2011, when its open cycle 0.1 K cooler is expected to exhaust its ³He cryogenic fluid. Attention has now turned to what science, if any, could be done thereafter. The HFI will no longer be useable, but the LFI could in principle operate for several years. A proposal is being prepared which describes

the potential scientific return of such a “warm phase” and will be presented to the advisory structure this fall as part of the 2012-2014 mission extension process.

The data processing pipelines at each of the 2 Data Processing Centres (DPC) work 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-monthly intervals jointly by the two consortia.

The second *internal* data release (i.e. from the two DPCs to their own Consortia) took place as planned at the beginning of March via the Planck Internal Archive (PIA). This second release contains data from the first 2.5 months of the survey and does not yet include polarization products. The PIA is developed by ESA as a prototype for the Planck Legacy Archive, which will start operating in January 2011 for distribution of the Planck data products.

XMM-Newton has awarded discretionary time to Planck for follow-up of 10-20 Sunyaev-Zeldovich (SZ) clusters of galaxies. A few sources have already been observed. They will serve to validate the early Planck SZ catalogue. Optical follow-ups with ground observatories have been proposed and collaboration with WISE is being implemented.

The Early Release Compact Sources Catalogue (ERCSC) will be the first data product to be released to the astronomical community. Its delivery will take place in January 2011, in time for the community to prepare follow-up observing proposals to the Herschel 2011 AO. The ERCSC was recently reviewed, and its status was found to be according to plans.

J.-L. Puget, the PI of HFI, is leading the organisation of the first Planck conference entitled “The mm and sub-mm sky in the Planck era”. It will take place in Paris between 10 and 14 January of 2011 and focus on foreground science. The public release of the ERCSC will be announced at this conference.

11.3 HST: Antonella Nota

On April 24, 2010, Hubble celebrated its 20th anniversary in orbit. Following the very successful Servicing Mission 4, Hubble is now operating with its full complement of instruments. However, it is now apparent that the throughput of all far ultraviolet (FUV) channels for the Cosmic Origin Spectrograph is decreasing at a rate that is larger than expected, between 3% and 14% per year, with the loss being larger at the longest wavelengths. Analysis of existing data and a special engineering test have shown that FUV sensitivity degradation is not due to aging effects caused by cumulative photon exposure.

The Time Allocation Committee (TAC) met in Baltimore in early January 2010. Three Multi-Cycle Treasury (MCT) programs were approved for more than 2100 orbits. Out of the 145 successful co-investigators, 26 (18%) belong to an ESA country. The Space Telescope User Committee (STUC) met at STScI on April 13-14. The STUC is chaired by Mario Mateo and includes two ESA representatives, Goran Ostlin and Eline Tolstoy.

A conference with the title “Science with Hubble –III” will be held at Palazzo Cavalli Franchetti in Venice, Italy, on October 11-14, 2010, sponsored largely by ESA, with NASA participation. The scientific program has been finalised, the invited speakers have been contacted, and all but one have accepted. Invited talks represent 50% of the oral presentations. The conference website is active and the first announcement has been circulated to the community. A public exhibit will be held in a palace adjacent to the

conference, Palazzo Loredan. The goal is to create an aesthetic presentation of Hubble hardware and images to celebrate the 20 years of the mission, its amazing impact on science and culture, and the very successful partnership between ESA and NASA. The Hubble exhibit will be open for one month between September 15 and October 15, 2010.



Pillar and Jets HH 901/902
Hubble Space Telescope • WFC3/UVIS

NASA, ESA, and M. Livio and the Hubble 20th Anniversary Team (STScI)

STScI-PRC10-13a

A 20th Anniversary Hubble image of a portion of the star forming region, the Carina Nebula. Three light-year-tall towers of cool hydrogen laced with dust rise from the wall of the nebula.

The "IMAX Hubble 3D" movie was released to the public on March 19. The 43-minute movie follows the 20-year life of the Hubble Space Telescope and includes highlights from the May 2009 servicing mission, with footage taken by the astronauts.

11.4 XMM-Newton: Norbert Schartel

The XMM-Newton observatory continues to operate nominally. As of April 19, the overall completion status of the AO-8 observing programme was as follows:

- A & B priority observations: 96.7 %
- C priority (“fillers”): 43.3 %

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

Several Targets-of-Opportunity were observed during the reporting period, namely GRB100117A, U Sco, RX J0049.0-725 (3 times) and Holmberg II X1. In addition there were several triggered observations performed, namely PKS 0537-441 (3 times), SGR 1833-0832 (3 times), GX 339-4 and XTE J1752-223.

At the time of writing, 70 participants have registered to the workshop “Ultra-Luminous X-ray sources and Middle Weight Black Holes”, which will be held at ESAC from 24 to 26 May. The conference programme and abstracts are available at the [XMM-Newton website](#).

Using RGS spectra of the A1835 cluster, Sanders et al. (2010, MNRAS 402, L 11) were able to set the first constraint on the turbulent velocity of the intracluster medium in the core of a cluster of galaxies. They obtain an upper limit on the line-of-sight non-thermal velocity broadening of 275 km/s at the 90% confidence level. They infer a 13% upper limit for the ratio of turbulent to thermal energy density in the cluster core and derive an upper limit of $140 \text{ M}_\odot \text{yr}^{-1}$ for the cooling flow rate.

EuroNews devoted its first 2010 "Space" episode to the 10 years anniversary of XMM Newton and the role of X-ray observations in modern astronomy. It was transmitted from the 22nd of January onwards.

At the time of writing, 2379 articles based on XMM-Newton observations have appeared in the refereed literature, of which 93 are from 2010.

11.5 Integral: Christoph Winkler

INTEGRAL operations continue smoothly with the spacecraft, instruments and ground segment performing nominally. The 15th SPI annealing was carried-out successfully during April.

Target of Opportunity (ToO) observations of the flaring blazar PKS 1510-089 continued, following an AGILE report about enhanced gamma-ray emission. The black-hole transient GX 339-4 was observed on March 4-6 as part of a large multi-wavelength campaign. Other ToO observations included the accreting binary pulsar 1A 0535+262, the black hole candidate GX 339-4 (change in spectral state) and the new X-ray binary XTE J1752-223. The recurrent Nova U Sco was serendipitously observed by the Optical Monitor Camera on board INTEGRAL a few hours only after a new outburst was detected from the ground. The gamma-ray burst GRB 100331A was detected in the IBIS field-of-view during the reporting period.

The AO-8 call for observing proposals was released on 15 March as planned. By the April 23 deadline, 64 proposals had been received including 26 for ToOs, 12 for observations shorter than 1 Ms each, and 26 proposals requesting more than 1 Ms observing time each

(Key Programmes). The total requested time amounts to 103 Ms, corresponding to an oversubscription of 3.8, comparable to that of AO-7 (3.7).

Three new members of the INTEGRAL Users Group, Drs M. Hernanz (Barcelona,) M. Falanga (ISSI), M. McConnell (UNH) have been appointed for a two-year term starting in July 2010. Appointments of the Mission Scientists Drs. W. Hermsen (SRON,) N. Gehrels (NASA) and G. Palumbo (Bologna) are being extended for another three-year term.

V. McBride et al. (2010, MNRAS in press, <http://arxiv.org/abs/0912.2951>) report on INTEGRAL/IBIS observations of the Small Magellanic Cloud (SMC) and on the first X-ray survey of the Magellanic Bridge, a stream of neutral hydrogen linking the Small and Large Magellanic Clouds.. Their work reveals five new transient X-ray binaries probably formed in-situ in the Magellanic Bridge. Given the typical X-ray duty cycles of such transients, and the young stellar population of this region, one may, in fact, be observing just the tip of the iceberg of the high-energy population. Understanding the stellar population in this turbulent environment of our Local Group is pivotal to interpreting observations of galaxy mergers in more distant environments.

As of February 2010, there were 523 refereed publications based on INTEGRAL data.

11.6 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 84-refereed papers based on Suzaku observations. The data for many of these papers have been obtained through the annual European Suzaku Announcements of Opportunity.

The fifth Suzaku European Announcement (EAO-5) closed on 20 November 2009. The European proposals were ranked by the ESA appointed TAC and the results forwarded to JAXA for merging with the Japanese and US proposal selections. The approved target list for the European AO-5 observations to be performed between April 2010 and March 2011 can be found at <http://www.rssd.esa.int/suzaku>. There were 11 European proposals in Priorities A & B for a total of 935 ks and 7 Priority C targets (“fillers”) for a total of 520 ks. As in previous AOs, European targets account for ~ 8% of the total observing time.

11.7 Akari (ASTRO-F): Alberto Salama

The AKARI All-sky Survey Catalogues were released on March 30. They contain the positions and flux values of 1.3 million celestial sources detected by the two instruments onboard AKARI: the Infrared Camera (IRC) detected ~870,000 objects in two bands (9 and 18 micrometres), and the Far-Infrared Surveyor (FIS, sensitive to 65, 90, 140, and 160 micrometres) detected ~430,000 celestial sources. The survey was conducted during the cryogenic phase of the mission, between May 2006 and August 2007, and covered 90% of the sky at least twice.

These new catalogues are a significant improvement upon the previous all-sky infrared survey obtained with IRAS. The source positions are known to an accuracy of arcseconds, compared to arcminutes with IRAS and the catalogues are about 10 times deeper at 18 micrometres than that of IRAS. The catalogue release is timely as many of the AKARI sources could be prime candidates for investigation at longer wavelengths with Herschel.

The release of the Catalogues was accompanied by the publication of parallel web stories at JAXA and ESA, highlighting scientific findings on the star formation history in the Universe, the properties of star-forming galaxies, and the search for dust associated with planet formation in debris disks.

A special issue of *Astronomy and Astrophysics* dedicated to AKARI results has been finalised and will be published at the end of April.

On 16 February 2010, a serious anomaly occurred with the one remaining AKARI cryo-cooler. A number of attempts have failed to re-establish the nominal operating conditions. The detector temperature remains at 54 K above the 47 K limit for scientific operations. The Project team is planning to perform one more (probably final) attempt at increasing the cooler driving voltage.

11.8 CoRoT: Malcolm Fridlund

After more than 1225 days in orbit, CoRoT continues to operate nominally but with only half of its original field of view following the failure of one of its two Data Processing Units in April 2009. Pending a major catastrophe, CoRoT will continue to produce useful scientific data at least until the end of the extended mission phase in May 2013. Over 100,000 light curves have been secured so far.

The number of scientific articles published since launch is divided roughly equally between Asteroseismology and Exoplanetology. The detection of a large number of g-modes in the hot young supergiant HD 50230 (B3V, 7 M_{\odot}) was recently reported in the 11 March issue of *Nature*. Such g-modes are interesting since they penetrate right into the stellar core; in this particular case, this yielded a direct measurement of the chemical gradient in the core of HD 50230 which showed that the star had consumed 60% of its original hydrogen.

The discovery of a planet slightly less massive than Jupiter with a 95 days orbital period and low eccentricity was reported in the 18 March issue of *Nature*. Given its host star moderate luminosity, its atmospheric temperature lies in the range 250 to 430K where liquid water could exist. Although the planet itself is too massive to harbour life, its satellites – should they exist – would be prime targets to search for signs of biological activity. A follow-up programme with SPITZER is underway to search for the existence of possible moons around the planet.

There are currently 179 planetary candidates being monitored from the ground for photometric and spectroscopic confirmation and characterisation. In many cases, the amplitude of the occultation is small suggesting the existence of a small-size planet, if confirmed. Unfortunately, the host stars are faint and a large amount of observing time on large telescopes is therefore required for the confirmation. A significant fraction of CoRoT data is now public. The list of planetary candidates is regularly published in the hope of attracting additional observers who could potentially assist in this follow-up process.

12 Projects under development

12.1 JWST: Peter Jakobsen

The JWST Mission-level Critical Design Review was held at the premises of the prime contractor Northrop-Grumman on April 12-16. The review board issued a pass to the project, pending resolution of a number of concerns in the areas of verification and risk

reduction, and tight or negative system margins in the areas of structural, thermal and launcher capability. Two points of note are (1) the system margin of the JPL-supplied MIRI-cooler which is still significantly below requirements, and (2) the lift capability of the Ariane V ECA which has not improved as rapidly as expected and is presently 300 kg short of that required for JWST. The board will turn to reviewing the programmatics of the JWST mission (primarily budget and schedule) in mid-May. As the NASA budget is extremely tight, it cannot be precluded that this review will lead to a further launch delay beyond the current date of June 2014.

The final cryogenic testing of the JWST primary mirror Engineering Development Unit (EDU) has been highly successful in demonstrating a residual wavefront error of 16 nm rms, well within the 21.5 nm allocation. This de-facto validates the approach that was adopted of measuring the final mirror error “hit maps” under cryogenic conditions while carrying out the final polishing at ambient temperature. The EDU is being closely followed by the sixteen flight-model Primary Mirror Segments, and the Secondary and Tertiary Mirrors.

The assembly and delivery of the MIRI flight instrument subsystems is progressing satisfactorily. The two outstanding optical subsystems, the Spectrometer Pre-Optics and the Input Optics, have both been assembled and are presently undergoing final testing and bake-out prior to shipment to RAL. The MIRI Instrument Integration Readiness Review has been held, and the start of the integration of the Flight instrument has been kicked off.

A data corruption problem discovered with the JPL-supplied MIRI detector system has been traced to a timing issue in the Spacewire programming of the Detector Electronics Unit. The fix to this problem is expected to come at the cost of higher power dissipation, which could potentially have an operational impact on MIRI.

The three critical subsystems for the build-up of the NIRSpec Flight Instrument remain the NASA-supplied Detector and Micro-Shutter Systems, and, on the ESA side, the Grating Wheel Assembly under subcontract to Zeiss. All other NIRSpec subsystems have now been integrated onto the flight optical bench.

Zeiss continues to encounter problems with the mechanical mounting of the gratings to the NIRSpec Grating Wheel. Repeated vibration and cryogenic tests are being carried out to investigate whether the optical distortions introduced by the mounts of the flight unit are at least stable in time. Efforts are being made to introduce improved grating mounts into the Flight Spare Grating Wheel. Should the distortion problem in the current flight unit persist, it could potentially be exchanged for the flight spare at some later date.

The two flight Application Specific Integrated Circuits (ASIC) for the NIRSpec Detector System have been mated and tuned to their respective flight detector arrays. Following extensive tuning of the devices, radiometric characterization of the complete Detector System is now undergoing at NASA GSFC, with active participation from the ESA side. It is already clear that the ASICs are introducing somewhat more noise into the signal chain than anticipated, but since this noise shows strong temporal correlations, it is hoped that its impact can be significantly reduced through proper use of the non-responsive reference pixels built into the detector arrays.

The failed quadrant of the flight Micro-Shutter Array (MSA), which unexpectedly developed mechanical cracks during acoustic testing, has been replaced successfully with a

spare quadrant (Q4 #116). However, since then a second quadrant (Q1 #137) has inexplicably developed an unacceptably large number of both failed-open and failed-closed shutters and will also need to be replaced. The root cause of the seemingly spontaneous degradation of array #137 is not understood at this time. The overall MSA spare situation is not particularly healthy given that, to reduce costs, NASA management decided to terminate MSA chip production several years ago. The extreme budgetary pressure that the NASA JWST Project is presently experiencing is also not helping in overcoming these technical problems.

12.2 GAIA: Timo Prusti

A major programmatic milestone was reached with the successful completion of the Payload Module (PLM) Critical Design Review (CDR). Formal closure of the review is pending completion of the 240 formal actions which have been placed to resolve identified deficiencies or shortcomings. Most actions are due in June such that their outcome can be incorporated into the spacecraft CDR which will start on the 1st of July. For the first time, the end-to-end performance of the mission was computed taking into account all known physical effects. The only remaining uncertainty concerns the charge transfer inefficiency in the serial register of a CCD after irradiation. The corresponding tests are being executed at the moment and the results will be included in revised scientific performance estimates at the spacecraft CDR.

The estimated astrometric performances are typically 10% worse than specifications, except for stars brighter than magnitude 12 for which parallax errors of 9 μ arcsec are achieved instead of the required 7 μ arcsec. To derive these performances, Astrium used a rather simple engineering approach to calibrate and correct for the CCD degradation induced by particle irradiation. The Astrium figures are confirmed by an independent and more sophisticated analysis carried-out by the Gaia Data Processing and Analysis Consortium (DPAC). Further irradiation tests are planned later this year to improve and consolidate these performances.

The photometric performances estimated by Astrium are all compliant with requirements and often with significant margin. These margins will be needed when calibration residuals are eventually included. The DPAC is now focusing its efforts toward calibrating the spectrophotometric data from Gaia.

Apart from one minor non-compliance, the Radial Velocity Spectrometer (RVS) meets all its sensitivity requirements. Other issues affecting the RVS, among others its resolution, have been identified at the PLM CDR as requiring further clarification and consolidation. Actions have been set to ensure that these are all resolved on time for the spacecraft CDR.

Completion of the PLM CDR marks a milestone and shifts the focus of the project from improving the design to “calibrating” it. The upcoming spacecraft CDR will further consolidate the mission performances and provide a good opportunity to present them to the astronomical community.

12.3 Lisa Pathfinder: McNamara

After successful completion of the magnetic test campaign performed at the IABG (Germany) in February and March, the sciencecraft flight model (FM) has been returned to the industrial prime contractor, Astrium Ltd. Activities at the Prime are now focussed on the next integrated system test, the so-called “Transfer Orbit Thermal Balance & Vacuum Test”. This test campaign will utilise the Structural & Thermal Model (STM) of the

sciencecraft, together with the flight model of the Propulsion Module. Both units have been delivered to IABG and the tests are scheduled to start at the end of May.

The Tiger Team established by ESA to investigate the failure of the FEEP micro-propulsion system has finalised its investigation and issued its report to ESA management. The report includes a complete plan of material characterisation, configuration and system tests that need to be performed in order to bring the thrusters development to the level of an Engineering Qualification Model (EQM). In parallel, tests of a previous thrusters design will be repeated. This design had demonstrated more than 3200 hours (900 Ns) of operation, which is sufficient for the nominal LISA Pathfinder mission (but not for LISA).

The Caging Mechanism Assembly EQM test campaign was successfully completed. However, three out of four pressure-sensors failed during the tests. New sensors are being procured for the Flight Models. The assembled caging mechanism will now be integrated into the inertial sensor EQM and submitted to system level tests that include alignment, vacuum, vibration, and thermal verifications.

The integrated optical bench and photodiodes were delivered to the LISA Technology Package (LTP) architect, Astrium UK. Unfortunately, acceptance testing revealed that three out of eight photodiodes were not working. The optical bench has been returned to University of Birmingham and an investigation is ongoing. As of writing, the cause of the failure is not known. The University of Birmingham and UK Space Agency have initiated the procurement of new photodiodes for the Flight Models. This will however delay the interferometer FM test campaign.

Thermal vacuum testing of the UV light unit revealed corruption of the housekeeping telemetry when the unit was operated at low temperature. The failure was traced to a timing glitch between an FPGA (Field Programmable Gate Array) and the Mil-bus controller chip. The breadboard FPGA was recoded and test confirmed that this solved the problem. The Flight Model FPGAs have now been recoded and the thermal vacuum tests restarted.

Development of the science operations continues at the Science and Technology Operations Centre (STOC). Version 2.2 of the data analysis software was installed at the STOC, and version 2.3 is currently undergoing system tests. Both versions contain all the functionalities required by the STOC for the *on-line* data analysis during operations. The toolbox has been further enhanced to accommodate the *offline* analysis needs of the LPF scientific community. Delivery of version 3 (final) is scheduled at the end of 2010.

The Mission Critical Design Review was kicked-off on April 19th at ESTEC. The review is currently in progress, with the final Board meeting scheduled for June 10th.