# The *PLANCK* Newsletter

**Issue 5** *Information and news for the Planck community* **November 2003**


## Preparing for extragalactic sources

**M. Rowan-Robinson and B. Partridge**

Following a kick-off meeting in Paris in November 2002, involving mainly sub-group leaders, Working Group 6 "Extragalactic Sources" held a plenary meeting at Imperial College, London, in September 2003, attended by 16 people.

Planck Working Group 6 on Extragalactic Sources has two complementary goals. The first is to prepare ourselves to extract the maximum scientific benefit from Planck's unprecedented, multi-frequency survey of the entire sky. We expect thousands of extragalactic sources to appear in the final Planck Point Source Catalog, many of them extreme and particularly interesting sources. Extragalactic point-source science may turn out to be one of the major achievements of Planck. Our second goal is to characterize the extragalactic sources that Planck will detect, since these constitute one source of foreground noise to the CMB. Our best estimate of their number, distribution and spectral/polarization properties is a crucial ingredient to pre-launch simulations and to the extraction of clean CMB maps. In addition, certain sources, particularly at HFI frequencies, will be useful for pointing reconstruction.

The second goal has dominated effort in WG6 over the past two years. One of our subgroups is actively formulating a Planck Pre-launch Catalog, to contain all sources likely to be visible in any one of the Planck maps. This catalog will contain entries from current and planned large survey missions (available radio surveys like NVSS and future surveys like that to be conducted by Astro-F), as well as sources specifically targeted for study. Members of our Working Group are actively investigating known or suspected sources whose flux and spectrum makes them likely candidates for Planck detection, and several ground-based surveys are being specifically planned in support of Planck. Ideally, the Pre-launch Catalog will contain information about the location, SED, angular size, redshift and polarization of every known source likely to be detected by Planck. Since many of these sources, particularly those dominating the higher frequency LFI and lower frequency HFI channels, are likely to be variable, some information about variability would also be useful. Of course we will have no such complete catalog, particularly as far as HFI sources are concerned. Instead, we are piecing together available all sky surveys and making extrapolations; investigating subsets of particularly interesting sources; and trying to draw statistical inferences about the overall properties of classes of sources.

Another important activity of the Working Group is conducting simulations of the point-source sky. There are several competing simulations of the distribution and properties of star-forming galaxies and some models for radio sources. The next step is to combine these so as to have a full LFI-HFI simulation. Several new issues were identified at the Working Group meeting, for example how to release newly discovered variable sources for follow-up, the need for a better understanding of polarization in dusty galaxies, how to respond to the Astro-F launch delay, and the need for preparation of Herschel follow-up proposals. The feeling was that good progress had been made on the tasks identified at the November 2002 meeting.

## Moving steadily forward

**J. Tauber**

As we approach the L-3 year mark, the current atmosphere is dominated by concerns on the development schedule of Planck. Every party involved in this enterprise (LFI, HFI, ESA, industry) is making all possible efforts to keep to the agreed targets, leading up to the launch date of February 2007. This requires a lot of detailed and continuing effort, to optimize the integration sequences, and to cope with the many hiccups and small delays in the sub-system-level development which reflect the fact that real hardware is being produced and tested.

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# News from the LFI

**R. Mandolesi, M. Bersanelli, F. Pasian**

The process for funding the Italian Institutes participating in Planck-LFI has been initiated and is progressing fast. The actual availabilty of funds is expected within the end of the year.

For what concerns the instrument, in the past few months the LFI instrument team has established a rather detailed plan for the overall calibration activity, ranging from unit level to system integrated level. The plan covers the measurement and/or adjustment of instrument parameters which are needed to support science measurements and data analysis, and has been carried out in full collaboration with the LFI DPC. In parallel, the hardware and cryofacilities needed to run calibration tests have been designed and are now being built under Laben contract. Testing at unit level has started on the QM models for passive components (at IFP-CNR, Milano, Italy), for front-end and back-end radiometer modules (at Millilab and Yilinen, Finland; at Jodrell Bank, U.K.; at University of Cantabria, Santander, Spain).

The LFI calibration strategy is based on a complementary approach that includes both pre-launch and post-launch activities. Ideally one would like to calibrate all the instrument parameters in flight, i.e. measure the parameters value actually taken during observation. In practice, this will be possible only for some of the parameters, such as the photometric calibration or the measurement of the detectors main beams. Several other parameters will be characterised by ground measurements carried out at different integration stages: at unit level, at the level of Radiometer Chain Assembly, at LFI level (Radiometer Array Assembly) and at PPLM "System" level. In general, calibration will be performed at the last possible place of the integration chain to give the most accurate measurement.

The data obtained during the on-ground calibration will be stored and archived with the support of the LFI Data Processing Center (DPC). Detailed work is ongoing to define the on-line and off-line calibration analysis software and archiving strategy. The end result of the calibration activity will be the compilation of the LFI Calibration Matrix, which will include all the parameters necessary to run the instrument during operation and to analyse the LFI data.

As for DPC activities, the main efforts of the distributed DPC team have concentrated upon the evaluation of the systematic effects to be detected and, possibly, removed from the data stream by the LFI pipeline. This is being done using simulated data. The prototypes being developed will be integrated early next year at the main DPC site in Trieste and will constitute the Development Model (DM) of the pipeline.

The Trieste team, with the Bologna, Milano and Geneva groups, have mostly dealt with the handling of data to be acquired during the instrument tests on ground. In particular, the main aspects tackled are those related to the real-time analysis and storage of the housekeeping and science data obtained from the radiometers, before and after binning. In the latter case, data will be handled after packetization: the developed tools constitute a first version of the Level 1 of the LFI DPC, allowing the ground test data to go through all the levels of the pipeline.

An additional task carried out is the definition of the tests to characterize at the DPC the on-board compressor. A full range of test signals, including "breaking cases" has been devised and is being simulated.

Finally, the DPC team is active in defining and implementing the Planck data structure on top of the chosen object-oriented database management system, common to both Consortia. After the first delivery, which covered telemetry and time series objects, the end-of-October delivery includes maps, beams and tabular data (e.g. catalogues).

# Moving steadily forward

*(Continued from Page 1)*

The last few months have seen in particular:

- The regularization of the LFI Italian funding situation, which is now almost complete, with final signatures on the funding of participating institutes expected imminently.
- The final confirmation of the conversion of the HFI spider-web bolometers at 100 GHz to polarization-sensitive devices. This eagerly-awaited development has restored the polarization capability of Planck at this important frequency, which had been feared lost together with the LFI 100 GHz channel.
- The completion of instrument reviews (Baseline Design Review for LFI and sorption cooler, and Hardware Design Review for HFI).
- The establishment of a mission planning concept.

We can therefore say that Planck is moving steadily forward. In the coming months we can look forward to some significant milestones:

- The results of the cryogenic tests of the Planck qualification reflectors (already underway).
- The start of the integration of HFI's CQM, to be followed by the qualification test and calibration campaign.
- The completion of prototype DPC pipelines (the so-called Breadboard Model for HFI and Development Model for LFI).
- The 2nd Planck Symposium (in Paris end of January).
- The issue of the Bluebook containing the updated science case for Planck.

More details on all of the above in the articles within this Newsletter.

# News from the HFI

**J.-L. Puget**

**Instrumentation**

The design has been modified in a number of places in minor but critical ways following a very detailed study of the electromagnetic interactions of the HFI instruments with its electromagnetic environment in the satellite. This study, conducted by Guy Guyot with the HFI system group and with a very critical contribution from J. Pahn from CNES, was very extensive including both modeling and testing of key elements. It generated a number of modifications of the instrument design. These make the very weak signals from the bolometers immune from conductive or radiative interferences from the environment (satellite elements, LFI, or HFI elements like the coolers electronic drive). All these modifications are now agreed and being implemented.

The construction of the Cryogenic Qualification Model (CQM) is well under way. The bolometers for this model have all been built and tested at JPL and are being delivered to Cardiff. In fact all Planck bolometers including the flight model ones have been produced and are being tested at JPL. The 100 GHz polarization sensitive bolometers are now included in the baseline design (see furtheron and also the contribution by J.-M. Lamarre in this Newsletter). The horns and filters are manufactured or in the manufacturing phase at Cardiff. The preamplifier readout and readout electronics units have been integrated successfully and are undergoing qualification tests. The cold plates have been manufactured and are being tested and delivered to Cardiff for the integration of the bolometers.

The dilution cooler breadboard has been tested successfully showing adequate cooling power following the modification of the heat exchanger introduced. The 4K, 1.6 K boxes and 0.1K plate of the CQM will be integrated by Air Liquide with elements produced at IAS (such as thermometers, cryogenic harnesses,…) and going through qualification testing before delivery to IAS in March 2004. Many of these elements are late with respect to the initial schedule due to various problems one of them being the time taken to define all the interfaces with the rest of the payload and the spacecraft which took much longer than expected.

The measurements of temperature stability on the coolers breadboard models indicate that the requirements will be met although uncertainties remain on the margins with respect to the required stability. The CQM HFI focal plane unit is expected to be put in the cryogenic chamber at IAS in May after the final integration in March and April. The qualification tests will be carried out in late May or early June with the final calibration taking place between June 20$^{th}$ and July 15$^{th}$. This is a delay of about 4 months with respect to the expected date in Spring 2004. The flight model construction has been kept within roughly the same schedule.

**DPC progress**

Most of the DPC L1 including the real time analysis software (RTA) must be ready for the testing of the HFI CQM next spring. These elements, developed by two physics laboratories heavily involved in the HFI (Lab. de Physique Corpusculaire et Cosmologie in Paris and Lab. de l'Accelerateur Linéaire in Orsay) are in good shape and should be fully operational in time. The science oriented quick look analysis software (QLA) which is part of level 2 has also progressed well (CITA in Canada is in charge of it).

After the restructuring decided under the leadership of François Bouchet at IAP, the DPC L2 is finalizing its breadboard model within the expected schedule (early December 2003). There is now a working pipeline with its software environment allowing configuration control and efficient input-output of very long time lines. It will be used to carry out a new generation of simulations following those done mostly by the same group of people before the COBRAS-SAMBA selection or the HFI proposal.

**Polarization Sensitive Bolometers at 100 GHz** *(see also pg 4)*

The importance of polarization measurements with Planck is clearly growing following the WMAP results. Some degeneracies in the determination of the cosmological parameters cannot be lifted with temperature data only. Furthermore, the WMAP data raised a lot of new questions: the E polarization-temperature correlation shows a surprising high level at low l. It could be the sign of a surprisingly early reionisation (as early as $z$=17). The inflation paradigm has been reinforced by the WMAP data as well as the combination of COBE data with balloon experiments such as Boomerang, Maxima or Archeops, which show a nearly flat geometry for the universe on large scale and a primordial spectrum with an index close to one. The study of the inflation physics will require both very detailed measurement of the primordial spectrum which can only done by Planck but also B polarization measurements at a level predicted by the inflation model.

The loss of the LFI 100 GHz channels was a serious blow to the capabilities of Planck in this respect. After investigation by the instrument working group, the HFI steering group as well as the Planck Science Team has approved a plan to replace the 4 Spider web bolometers at 100 GHz by 4 polarization sensitive bolometers. This increases in fact the total number of individual detectors by 4 which is made possible by removing a number of doubly redundant thermometers.

The dies to implement the new 4 pixels do exist at JPL (they were built for the 143 GHz channel which uses now dies built for higher frequencies because their time constant are better and the cross polarization still within specifications). The modifications of the cold plates, horns, harnesses and JFET boxes have all been designed and are being built under European funding. The JPL work on these 100 GHz PSB pixels has been approved by NASA. The bolometers will be integrated at JPL, tested and delivered to Cardiff in April 2004 in time to be integrated in the FM focal plane.

# HFI polarisation sensitive bolometers

**Jean-Michel Lamarre**

Among the devices that have been developed for the High Frequency Instrument of Planck, the Polarization Sensitive Bolometers (PSBs) are the most innovative. In its etymological meaning, a bolometer is a device that is sensitive to all radiation. The principle is very simple: the energy of the radiation or particle is absorbed and heats the detector. The change of temperature is then detected by a thermometer. Herschel (the scientist), who discovered infrared radiation thanks to a thermometer situated farther than the red in the light scattered by a prism, used this same principle.

For the sophisticated bolometers of Planck, the absorber is a resistive mesh made of metal deposited on a very thin film. For wavelengths larger than the grid constant, it behaves like a continuous film of resistive metal. The electromagnetic field develops currents that deposit heat in the metal layer. The temperature change is detected by a doped germanium thermometer. The advantage of using a mesh instead of a continuous layer is a lower sensitivity to cosmic rays, thanks to a smaller cross section. This has been successfully demonstrated with the "spider web" bolometers that are sensitive to radiation with any polarization.

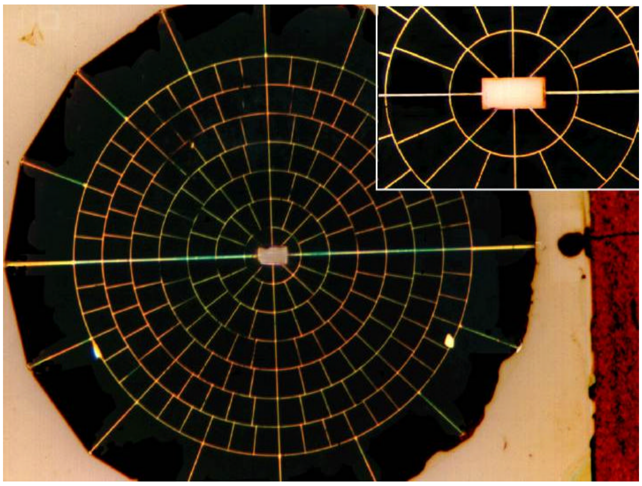
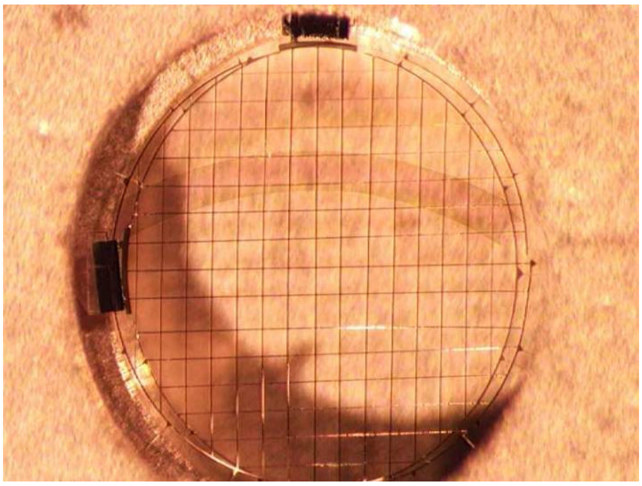


*Image of a spider web bolometer. The radiation absorber is the web of resistive metallic struts. The thermometer is at the center of the web. Diameter: 3mm*

At the very beginning of the project, only spider web bolometers were considered for HFI. Then the Caltech/JPL team came with the idea of the PSBs. The selection of one linear polarization of the radiation is achieved by the absorber, made of parallel resistive wires. The radiation with electric fields parallel to the wires develop currents and dissipate power in these wires. For the perpendicular polarization, the interaction with the absorber is negligible. This polarization component can be detected by mounting, just behind the first bolometer, a second one with perpendicular absorbing wires.



*Photograph of a pair of polarization sensitive bolometers. The two bolometers are in the same mechanical and optical housing. The thermometers are at the upper and left edges of the two bolometers.*

The advantages of detecting both polarizations in the same assembly are important. The detected radiation goes through the same optical chain, i.e. telescope, horns, filters. The various types of parasitics are similar because they concern identical detectors at very proximate positions. The effectiveness of this solution was demonstrated during the last Boomerang flight that made maps of the polarization of the CMB.

It was recently decided to mount 4 pairs of PSBs instead of the 4 Spider Web Bolometers of the 100GHz channel of HFI. Although it does not replace the redundancy lost with the LFI descoping, this decision restores the capability to measure polarization at 100GHz. *(see also pg. 3)*

### The Planck Blue Book

As many of you know, the "Bluebook" is the nick-name which is being given to the update of the Science Case for Planck (the "Redbook" written in 1996). This update has grown out of the scientific proposals presented by all members of the Planck collaboration in 2001. The Bluebook will in the future be the public face of Planck vis-à-vis the astronomical and scientific community, and is therefore an important document for our collaboration. The initial drafts of each Chapter were provided by the Working Group Coordinators, based on your proposals, and reviewed and updated by the Planck Science Team. Although the document was already quite advanced in the early part of this year, the Science Team decided to delay its publication for some months to allow the incorporation of the recent results of WMAP; as well as of the important modifications of the instruments which took place this year. This effort is now almost finished, and it is expected that preliminary copies of the Bluebook will be released to the Planck community at the upcoming Symposium in Orsay. The final issue should occur shortly after that, depending on the publication process.

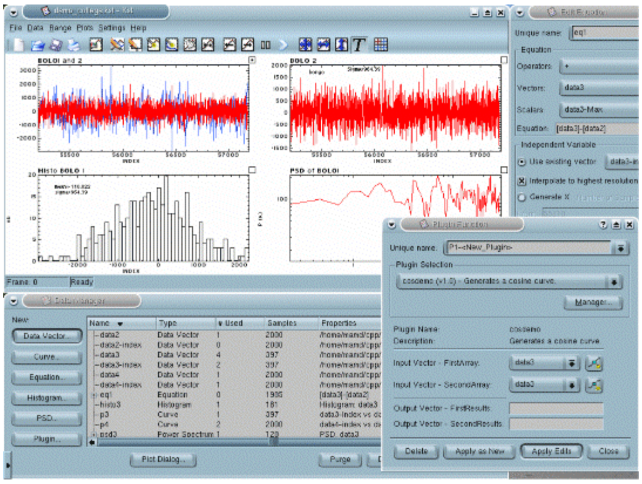
Some time ago we asked in a Newsletter for suggestions for an interesting cover design. With the current delays the offer is still open. If you have ideas, please contact us!

# Planck Activity in Canada

**Dick Bond**

Canada contributes both to HFI and LFI. Marc-Antoine Miville-Deschênes, Peter Martin, Barth Netterfield and Ue-Li Pen are Canadian Planck HFI Associates at Toronto and Dick Bond is an HFI co-I and PI on the Toronto Canadian Space Agency (CSA) contract. The Toronto contingent come from CITA and the Department of Astronomy and Astrophysics. Dmitry Pogosyan of the University of Alberta and Mark Halpern of the University of British Columbia are also part of the HFI consortium, Douglas Scott of UBC is an LFI co-I and the PI of the UBC CSA contract. Russ Taylor of the University of Calgary, a lead with Peter Martin in the Canadian Galactic Plane Survey (CGPS), is also involved with Planck. Marc-Antoine is a Senior Research Associate, the rest are professors. We expect further growth at the research associate level, and, hopefully, at the faculty level.

The CMB and the ISM have been a focus of attention for many years in Toronto, in theory, experiment, phenomenology and analysis, in particular of Boomerang, the Cosmic Background Imager (CBI), BLAST and the CGPS. Strong historical collaborative links exist with Caltech/JPL/IPAC, IAP/IAS, Cambridge, Imperial, among other Planck centres, and we are finding ways to optimize people-flow within Planck to and from Canada, building on these links.

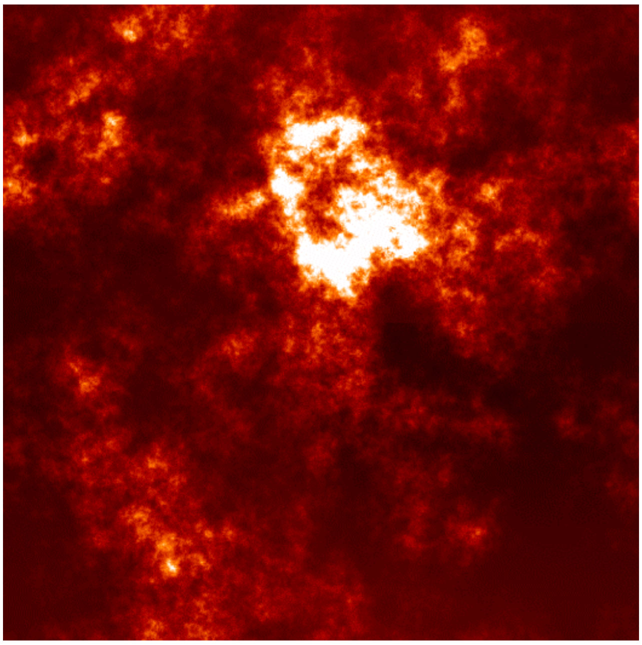


*An example of the QLA in action on simulated data.*

Toronto is in charge of the Quick Look Analysis software (QLA) of Planck-HFI, building on our Boomerang and Blast experience. The QLA is a powerful data viewer and analysis program, designed and developed by Barth Netterfield, Marc-Antoine Miville-Deschênes and George Staikos, a professional KDE programmer. It allows one to display very efficiently timeline data, in real time or not. Many analysis functions have already been built in (power spectrum, histogram,...) and, since the QLA has a very open architecture, other functionality can be "plugged-in'" easily by the user. The QLA will be heavily used in the HFI calibration phase, as well as for rapid monitoring during flight. At UBC, the QLA is being adapted for use with the LFI. The current version of the QLA, dubbed KST, is available at www.kde.org

CITA will also participate in other HFI Level 2 operations. CITA has a 512 Beowulf LINUX cluster. among other computational resources, which is now being applied to parallel CMB pipelines for polarization data from CBI and Boomerang, including map-making, power spectrum estimation, non-Gaussian analysis and parameter estimation software, with natural application to simulated Planck timelines for the Planck mission. For the QLA as well as for Level 2 developments, all the software developed by CITA is done in close interaction with the HFI data processing and the ground calibration teams.

Apart from our cosmological interests in primary and secondary CMB anisotropies from Planck, we expect Toronto to also play an effective role in the ISM/CMB interface for Planck. Efforts at CITA on Galactic diffuse emission include studies of the general statistical properties (power spectrum, non-gaussianity) of dust (far-infrared) emission and HI (21 cm) emission and a focus on the properties of regions of the sky probed by ISO or SIRTF. One result, in collaboration with the IAS group, showed the importance of having high-sensitivity 21 cm observations to remove localized foreground emission in low-column density fields. Computation of realistic simulated maps of diffuse interstellar clouds are underway and will also be highly useful for testing component separation methods. Canada is also proposing a high Galactic latitude survey explicitly motivated by Planck to be conducted at the Dominion Radio Observatory, as a follow-on to the CGPS.



*Simulation of far-infrared interstellar emission with appropriate power spectrum and non-Gaussian properties (M.-A. Miville-Deschênes and F. Boulanger)*

# Recent Reflector Developments

**H.U. Nørgaard - Nielsen**

Astrium (Germany) has now produced the first full - scale reflector for the Planck telescope. It is the secondary reflector. It has an elliptical surface with dimensions 1051 mm x 1104 mm. It is made of two face-sheets and a hexagonal honey-comb structure in between, all out of Carbon Fiber Reinforced Plastic. The structure of the reflector can clearly be seen in the picture below.

*The first full scale (secondary) reflector for Planck.*

Mechanical measurements have shown that the optical surface is well within the required tolerances at ambient temperatures. A map of measured deviations is presented below.

To assure the high reflectivity required for observations in the submillimetre area, the reflector has been coated with Aluminum at the Calar Alto Observatory in Southern Spain. On top of the aluminum a layer of Plasil is deposited to protect the reflective surface. In the same period ASTRIUM will have finished the first model of the primary reflector.

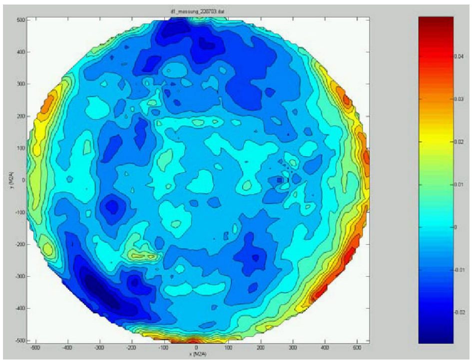
The main purpose of this first set of reflectors is to be used in an extensive test programme which will assure that the flight models are able to withstand the harsh conditions during launch and in space. The secondary reflector has already passed successfully a number of vibration and acoustic tests.

## Call for publications

Starting with the next Newsletter, we would like to include a list of recent publications of interest to the Planck community. These publications could be scientific papers or technical notes.

Of course such a list can only be created with your cooperation!

For this purpose we have set up a special email address. If you would like to see your paper or technical note listed in the next Planck Newsletter, please email the full reference plus a link to where the paper can be found (e.g. astro-ph or Livelink) to: planck@rssd.esa.int .



*Map of the deviations, the scale on the right is in mm*

In early October 2003 the secondary reflector was transported to the Centre Spatial de Liège, where it will be cooled down to cryogenic temperatures. The surface deformations will be measured using infrared interferometry, to assure that it will keep its good optical performance at operational conditions. This test campaign is underway.

# European plans for detecting B-mode signals

**W. Gear**

An informal workshop was held in Cardiff on June 23 and 24 (2003) to discuss possible future plans amongst European groups to detect the gravity-wave contribution to the primordial fluctuations in the Universe through the detection of a curl component in the polarization signal from the CMB, commonly referred to as the B-mode signal.

Some 30 researchers from the UK, France and Italy attended, and there was universal agreement on the importance of detecting, or placing a stringent upper limit, on this signal, as probably the only currently viable test of the energy scale of inflation. Important secondary science goals, including an accurate measurement of the polarization signal induced by lensing, were also identified. Various possible experimental techniques were presented and discussed as to how the challenging sensitivity and systematic control requirements might be met. It was agreed that a programme of technology development and pioneering ground-based experiments should begin now in order to be able to meet these requirements on a reasonable timescale. A list of key technologies was compiled, with highly-sensitive detectors arrays, and low-loss components for polarization-separation, phase-switching and signal transmission being the most important.

Outline plans to field ground-based experiments in Antarctica were discussed and will move forward. However, it was generally agreed that the case was extremely strong for the most sensitive and systematic-free experiment being an all-sky satellite. The outcome was a plan to organise a larger, more formal meeting, probably in September 2004 to present and discuss within the wider community the science case and technology requirements for a post-Planck CMB satellite experiment whose primary goal is detection of the B-mode signal. A small committee chaired by Prof Walter Gear of Cardiff University has been set up to facilitate this meeting.

# IDIS: what it does for you

**K. Bennett and the RSSD IDIS group**

Large amounts of information, data and software will be generated during the various stages of the Planck project. These include the development, test and operation of the Planck instruments, and the subsequent processing of the data. These tasks are the responsibility of the Planck instrument consortia (HFI, LFI and Telescope), who have agreed to the development of IDIS, an Integrated Data and Information System designed to provide the infrastructure and the tools necessary to manage the processing and carry them out efficiently. IDIS is developed for the Planck consortia in general and for the DPCs in particular. Interoperability is a key word in this widespread effort, which is why many interfaces are browser-based to circumvent the problems of heterogeneous computing environments.

It's easiest to imagine that IDIS consists of several components that can work stand-alone as they do at present. There is a goal to "federate", i.e. integrate, these components, but at present the degree of federation is not fully scoped.

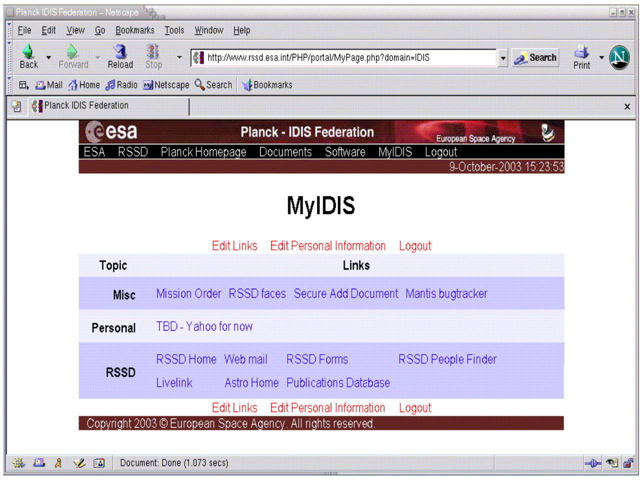
*Documents*: this is the most obvious component. Livelink was adopted over two years ago. The system is based at RSSD and is accessible through most browsers on Windows, Unix and Mac. There being already 2000 items in Livelink, it is probably familiar to the majority of the collaboration, having been used as the knowledge base for much of the HFI and LFI activities. In a sense one should consider Livelink as the one-stop shop for Planck consortia documentation, but unfortunately this is not fully realized. There are many reasons for this, one of which is said to be "confidentiality". However access control on Livelink is very powerful and can be controlled at all levels of granularity even by the owners of an individual document. In recent months Livelink has been speeded up and more performance options are under test. Version 9.2, in which many user complaints have been addressed, is on the bench and under test at RSSD.

*Software*: Software development is widespread, and sharing is an issue. For this reason a software repository was established, based at RSSD. Software that is checked in by developers is accessible to all authorized users. The CVS (Concurrent Version System - the product selected) tracks changes and accesses. The repository is entered at a central point but users can navigate the tree to find sites that exist physically at other institutes. Used primarily by IDIS developers (common software) and HFI developers this system is available to all who share software including the Working Groups. Work is under way to define the operation of a "release repository" for the official versions. MPA have developed a "Java Wrapper" to allow non-java programmers to interface with java methods, this is being tested (especially for aspects of speed and efficiency) at the DPCs.

*Process Coordinator*: this is a software system which allows to easily build and run the data processing pipelines. These complex pipelines are needed for qualifying or simulating Planck data. Version 0.3 has recently been released by MPA. It is user friendly and a pipeline editor is provided to define the tasks that are run and all the run-time parameters.

*Data Management* : this component may be seen as a database (actually Versant has been adopted) and a data access layer. The processing applications never access the database directly but use instead an Interface Layer called the DMC-I. A prototype of the DMC-I was released in February. Using the experience acquired from that prototype, a more mature version is to be released by OAT in October 2003, to support the on-going DPC pipeline developments.

*Federation:* the first sign of the federation of all these items is the occasional need to authenticate through the MyIDIS portal. It is the intention that once authenticated, users will have access to the services without further need for authentication. Please don't consider this a nuisance, it will turn out to be timesaver, as it will avoid multiple logins.




*Screenshot of the "MyIDIS" portal, which currently gives access to the document and software components of IDIS.*

Recently it was recognized that there was some divergence in the development of a number of items, in particular the DMC came under scrutiny. For this reason an independent "IDIS Manager", Julian Sternberg, has been assigned to try to keep the IDIS activities on track and in scope. A review was held in the summer, the results of which are now available in Livelink. The year ahead promises to be challenging for IDIS developers!

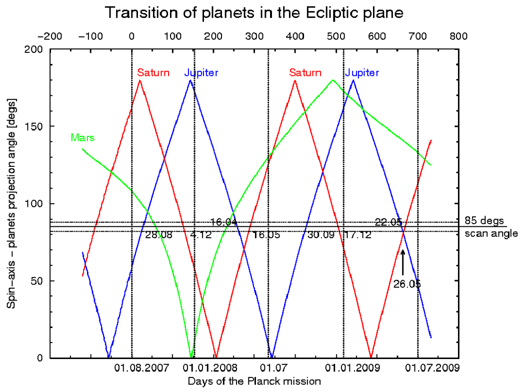
In general, if you get stuck with a particular application you may email the developer, if the contact address is published, or more generally e.g. for access control, to: question@rssd.esa.int.

On IDIS in general, see also http://www.rssd.esa.int/IDIS

# Beam reconstruction using planet transits

**P.D. Naselsky, O.V. Verkhodanov, P.R. Christensen and L.-Y. Chiang**

To achieve the scientific goals of the Planck mission, it is necessary to carefully account for all potential systematic features in the data. One of the systematic effects is related to the in-flight beam shape and its reconstruction. Jupiter and Saturn transits seem to be the best candidates for the main beam shape calibration down to -25 to -32.5 dB (Burigana et al, 2001 Exper. Astr. 12, 87; Chiang et al, 2002 A&A 392, 369; Naselsky et al, 2002 astro-ph/0211093). The purpose of this note is to show when the future PLANCK mission can observe Jupiter and Saturn and to point out some of the restrictions and problems to be solved on the in-flight beam calibration using planets.




*Connection between transit of Saturn, Jupiter and Mars and scan angle. The red, blue and green curves represent Saturn, Jupiter and Mars's paths, respectively. The upper horizontal axis is in days annotated origin set on 01.08.2007. A horizontal line demonstrates a scan angle of 85 deg, dashed horizontal lines demonstrate scan angles of 82 deg, and 88 deg, respectively. The dates correspond to the Jupiter and Saturn crossings of the 85 deg scan angle.*

Using the planets ephemerides from XEphem Version 3.5.2 (Downey, 2002), we show that Jupiter can be observed 3 times (28.08.07, 16.04.08 and 30.09.08) and Saturn 2 times (04.12.07 and 16.05.08), assuming the beginning of data taking to be August 1, 2007 and a length of the data taking period of 15 months. The Mars transits (28.09.07 and 20.03.-08) seem not to be useful for beam shape calibration because Mars is highly variable in mm and sub-mm bands due to Martian storms (Moiseev et al, 1985 Bull. Crimean Astrophys. Obs. 73, 137; Orton & Burgdorf, 2003 in "The calibration legacy of the ISO Mission", eds. L. Metcalfe et al, ESA-SP481, p147).

The angular velocity relative to the focal plane is approximately 1 deg per day for Jupiter and Saturn and 0.5 deg per day for Mars. Therefore, the span of ±3 deg around the nominal scan angle of 85 deg means that Jupiter and Saturn will take 6 days to move from one side of the focal plane to the other, while Mars will take 12 days. To reach -30 dB, the time for the HFI horns with 5 arcmin resolution (217 GHz and higher) will be approximately 8 hours, while the time for the 33 GHz LFI horns will be approximately 1.8 days.

According to the discussed scan strategy, the telescope will rotate with 1 rpm with a central boresight of 85 deg relative to the spin axis. The orientation of the spin axis, apart from a small nutation with a period of around 1 min, is fixed for about one hour, after which the pointing is changed by 2.5 arcmin. During this one hour Jupiter or Saturn will move only ~0.2 arcmin perpendicular to the scan direction, to be compared to the 2.5 arcmin scanning steps.

Assuming that each beam will be sampled 3 times per FWHM and with the planned repointing of 2.5 arcmin every hour, one gets that for the HFI 217 GHz (and higher frequency) horns only ~36 pixels (each 2.5 arcmin by 2.5 arcmin) will be available for beam shape reconstruction, which probably is not enough to accurately determine the beam shape ellipticity, particularly if the ellipticity is no larger than 1.2.

The variability of the planet flux plays also a crucial role for the in-flight beam shape reconstruction, but very recent Jupiter measurements at 30 GHz with the RATAN-600 radio telescope (Y.N. Parijskij et. al., priv. comm.) shows a highly stable flux (within 0.1 %) over a period of 34 days.

# The 2nd Planck Symposium: Setting the Scene

The 2nd Planck Symposium will be held in Orsay between 26 and 30 January 2004, hosted by the Institut d'Astrophysique Spatiale and the Laboratoire de l'Accélerateur Linéaire. Despite great efforts by IAC, logistic difficulties prevented the meeting to be held in Tenerife, which was the initial plan. The 1st and 2nd announcements have been sent.

The 1st Symposium at Estec in 2001 was aimed at establishing a Baseline Core Programme for Planck. This has crystallized in the "Bluebook", to be presented at the 2nd Symposium. It is the intention of the organizing committees to make the 2nd meeting almost fully science-oriented. Out of the 5 days, half a day only will be dedicated to (separate) Consortium meetings, and one day to Working Group meetings. As for the latter, the coordinators have been asked to plan, to the extent possible, joint meetings of two or more WGs. The Symposium title indicates its broad objective: to "attempt to situate Planck in the current and future context of CMB and foreground science". The state-of-the-art of CMB science and experiments, and how they project into the future, will therefore figure prominently. In addition, all Planck-related topics will be covered (non-CMB science, instrumental and data processing). A number of key invited talks have been suggested by the Planck Science Team, and the individual session organizers are hard at work setting up each programme. The LOC and SOC will be very pleased to receive your proposals for contributed talks and/or posters.
See also: http://events.lal.in2p3.fr/conferences/planck04/

# News from the H/P Project Team

**T. Passvogel and G. Crone**

Since the successful close-out of the Herschel/Planck System Preliminary Design Review (PDR) held in December 2002, which was followed by the highest level review, the Mission PDR, in January/February this year, the project has moved into the next phase of development that will lead to the System Critical Design Review (CDR) in Spring 2004.

The situation with the LFI has been stabilized early 2003. The financial problems with the Italian Space Agency were unblocked for the industrial contract with Laben, which was kicked off in April. ESA initiated a joint engineering team with LFI, Laben, and Industry in order to catch up with the overall system definition and to detail the model philosophy. The activity is running to plan and the model philosophy of LFI is now “proto-flight” with qualification activities being limited to instrument level only. As a consequence, HFI alone will be tested in the System Level Test of the Cryogenic Qualification Model (CQM). The LFI will be represented by a mass/thermal model to be provided by Alcatel, in close collaboration with the instrument team and Laben.

The Herschel and Planck instruments are now preparing for their instrument level qualification phase with delivery to ESA for system level testing next year. The next cycle of instrument reviews is under way, namely, the Instrument Hardware Design Reviews (IHDR’s). These reviews are essentially to approve the programme for the avionics model (AVM) and CQM, the hardware for instrument level testing, and the on-board software (OBSW) development. In the case of Planck, the IHDR for HFI was recently held. The review board will be making a number of recommendations, with close follow up of a few issues (OBSW, product assurance, and coolers). The LFI review is planned for next year with adapted objectives to reflect the above mentioned model philosophy. For the IBDR, the sorption cooler and the cooler electronics were reviewed separately from the instruments and this will also be the case for the IHDR.

Due to known schedule slippages, JPL are delivering the two flight coolers at the end of the year and early 2005, respectively. For the CQM test, JPL will deliver a pipework assembly and cold end (PACE) that will be operated by a simulator that is being procured by ESA. At the sorption cooler IBDR, it has been agreed that in addition to the normal bi-weekly telecons, ESA will chair bi-monthly progress meetings with JPL/LPSC on the sorption cooler subsystem. We have held two meetings since this agreement, which involved a combination of physical presence and videoconference. The feedback is that this improves the overall communication between all parties and should be fully maintained. The recently reported cooler lifetime problems were addressed in the last meeting in preparation for a full review after the completion of the JPL analysis.

On the industrial spacecraft development, the detailed design of the spacecraft is progressing well. Nearly all units and subsystems have passed their preliminary design reviews with many critical design reviews planned before the end of the year. The service module structure, produced by CASA in Spain, is on the critical path awaiting the freezing of instrument interfaces, a typical situation for nearly every Science and Earth Observation satellite. To maintain the schedule, work-around solutions have been implemented by Alcatel involving a staggered release of manufacturing activities.

The design work on the Planck Payload module, consisting of the telescope and the V-groove shields, is progressing well after completion of the PDR with the industrial contractor in January and the CDR in September. The manufacturing status of the QM is well advanced and the release for manufacturing of the flight hardware is given in November.

The Planck telescope reflector hardware manufacturing makes good progress. The QM secondary and primary mirrors manufacture is complete. The secondary mirror has passed its mechanical testing and is currently at the cryogenic test facility in Liège in Belgium (CSL) for optical cryogenic surface measurements. The technique which was selected is based on infrared interferometry. Early “teething” problems were resolved with joint ESA/DSRI support. The QM primary mirror will undergo qualification until Spring next year and will then be transported to CSL for final testing.

Major work has been carried out in the definition of the Planck system testing, especially for the cryogenic performance test of the payload module at CSL. This test will verify the thermal performance of the V-groove system and will allow functional and performance testing of the instruments. The facility is expected to be ready by April 2004, in time for the CQM test campaign. The ESA project has established and chaired the “Cryogenic Working Group” which completed its current objectives in November. The working group output is an “end-to-end” mathematical model of the Planck thermal behaviour, including the cooling chain, in support of the CQM campaign. The model is under configuration control and maintained by Alcatel. The current version is available to the instrument teams for their ongoing research into operation scenarios. The model shall be updated as theoretical results of individual cooler performances are updated by tests at unit and at CQM system level. The Planck Science team are understood to take the responsibility for operations optimisation, and the working group activity should now be handed over to the instruments.

Finally, we must address the overall problem of schedule and launch dates. The message is not an easy one. The launch date at present is 15th February 2007. The delivery dates for the instruments, derived from this launch date result in instrument schedules with little or no margin left and a streamlined calibration. It has been agreed that any relaxation of instrument need dates, resulting from optimisations or changes in the industry schedule would be made available to the instruments for e.g. extra calibration.

# CTP working group support to DPCs

**Charles Lawrence and George Efstathiou**

The long term goal of the CTP WG is the development of algorithms and methods for use by the Data Processing Centers (DPCs) in the areas of map making, power spectrum estimation, and cosmological parameter extraction for both temperature and polarization data. The CTP working group held its third week-long working meeting at the MPA in Garching the week of Sep. 6. Previous working meetings have concentrated on comparison of various map making codes applied to time-ordered data (TOD) simulated for a single feed, at a single frequency, under several scanning strategies and levels of fidelity of the beam shape.

The specific goal of the Garching meeting was to create a set of simulated TOD with at least two feeds at ALL frequencies, and to analyze it. Such an ambitious goal could only be achieved partially during the week, but progress was excellent during the meeting and has continued since. A number of problems with the Level S simulation pipeline were corrected, and nearly 6 TB of simulated TOD are now available to be analyzed. As these simulations were the fourth set created by the WG, they are known as the "delta simulations".

Several factors made the creation of the delta simulations more challenging than previous efforts: (1) realistic (i.e., imperfect) pointing of the telescope is assumed. This means that the 60 scan circles at a given spin axis pointing cannot be simply added together, compressing the time streams by a factor of sixty. (2) 40 detector time lines were simulated, compared to the previous maximum of 8 detector time lines. (3) 34 of the detector time lines are HFI channels, sampled at more than twice the rate of the LFI channels. The delta simulations are the first to include the high resolution HFI channels.

Altogether, 40 1-year TOD streams were created, including all 8 feeds at 217 GHz for three different scanning strategies (24 TOD), and two feeds for each of the other 8 frequencies for a cycloidal scanning strategy (16 TOD). The detectors were chosen for best sampling of the focal plane along the axis perpendicular to the scanning direction. Four separate time ordered components were simulated: the pointed position of each detector on the sky, the CMB primary anisotropy signal, the foregrounds signal, and the detector noise.

The CMB primary anisotropy signal was based on an angular power spectrum derived from the best fit cosmological parameters from the "WMAP and others" analysis described in table 10 of Spergel et. al. (First Year WMAP Observations: Determination of Cosmological Parameters). The dipole was included. Foreground signals included galactic synchrotron, free-free, and thermal dust emission, plus extragalactic thermal SZ emission and point sources. The latter account for both the low-frequency extragalactic radio sources as well as far infrared galaxies. For the HFI channels, the beam was assumed to be a radially symmetric Gaussian, and for the LFI channels, an elliptical Gaussian beam was used.

The simulations were performed on Seaborg, the 6000-processor supercomputer at NERSC. The volume of data generated, 6 TB, is a challenge even for such a computer, and one of the main reasons for undertaking the delta simulations was to stretch our capability to handle a semi-realistic volume of data.

Analysis of the simulations is now underway.

## Calendar of (some) Events

**The 2nd Planck Symposium: "Setting the Scene"**

Date: 26-30 January, 2004

Place: Laboratoire de l'Accelerateur Linéaire , Orsay

**Science Team meeting**

ST18: 4 Dec, 2003; ESTEC

**Working Group Meetings**

WG2: 24-25 Nov, 2003; Paris

WG8: (Planck Virtual Observatory): 7-8 Jan, 2003; Edinburgh (TBC)

All working groups: see also the 2nd Planck symposium

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As usual, if you have any feedback on this issue, or would like to propose contributions for forthcoming issues, please contact us directly at rlaureij@rssd.esa.int and/or jtauber@rssd.esa.int.