The PLANCK Newsletter

Issue 6 — *Information and news for the Planck community* — June 2004

Planck, the Virtual Observatory and the Grid

R.G. Mann, A.J. Banday and K.M. Gorski

Planck's newest Working Group - WG8: Virtual Observatory - has been set up to coordinate the interface between the Planck consortia and the rapidly developing Virtual Observatory and Grid computing communities. A number of areas of Planck activity might benefit significantly from advances coming from those domains, but to do so will require active engagement with them. It is the task of WG8 to lead that engagement, but its success depends on input from across the full Planck community.

The VO and the Grid

The Virtual Observatory (VO) concept centres on the federation of the world's significant astronomical data sources, and is likely to provide the environment within which much astronomical research is undertaken by the time that Planck flies. It would be useful, therefore, that some parts of Planck infrastructure are made "VO-compliant" so that scientists – including Planck consortium members within the proprietary period – can access Planck data using the same tools and standards as they employ in the rest of their research. Conversely, the Planck consortia should ensure that their specific science requirements help inform the definition of those VO standards.

The VO's infrastructure builds, in part, on ideas from the world of "Grid Computing", a term used to cover a range of technologies being developed within both the academic computer science and commercial IT sectors to aid distributed computation: if the Web provides you with information distributed over the network, then the Grid will give you access to computational resources located elsewhere. A number of Planck activities – notably pre-launch simulations, but also, perhaps, some aspects of DPC operations –

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Busy times ahead

J. Tauber

The year started very auspiciously with a well-attended and stimulating 2nd Planck Symposium which highlighted the undiminished expectations for Planck.

However, the most exciting aspect of the current year is the production of the first sets of flight-like hardware. Both at spacecraft and at instrument level, qualification models have been built of almost all subsystems (see the reports elsewhere in this issue). The sorption cooler pipework and cold end qualification model are the first instrument hardware delivered to ESA, and JPL is rightfully proud of that fact. It feels very good to start seeing and touching the fruits of so many years of work by so many people!

The preparations for the instrument-level qualification campaigns are now in full swing, and the LFI and HFI teams are expecting a very busy summer with this activity. By the autumn both instrument qualification models (QMs) should have been tested and calibrated. The HFI QM will then be delivered to ESA for integration into a satellite QM, which will be cooled down to operational temperatures (~ 40 K) in a large vacuum facility at the Centre Spatial de Liège, and end-to-end testing will take place. All of this will happen before the end of the year.

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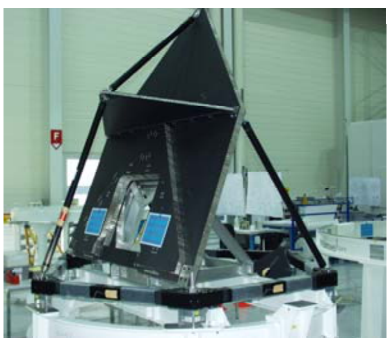
News from the H/P Project Team

Gerald Crone and Thomas Passvogel

Industrial activities for both Herschel and Planck have progressed sufficiently to plan to allow the start of the System level Critical Design Review (CDR) cycle in April. It was decided to treat the CDR in two steps with a review of both Payload modules (PLMs) by the ESA project, together with Alcatel preceding and leading into the second step, the full Space Segment CDR conducted at ESA level with the Director of Science and the ESA Inspector General chairing the review board. The PLM CDR for Planck has already started in April and will be completed in June, whilst the Herschel one will start one month later and be concluded in July. The conclusions of each review will be fed into the ESA level review running from mid August until October.
This review cycle marks the end of the industrial detailed design phase and ensures that the design is complete, frozen, and compliant with the mission needs. The review will further verify that all internal and external interfaces between modules (i.e. PLM's and Service Module - SVM), the telescope, the instruments, launcher segment, and ground segment are now detailed and complete. The verification approach at system level including the testing of both the CQM and FM modules and spacecraft must be adequate and commensurate with the launch date. For Planck, this marks the go-ahead for the integration of the HFI CQM and the LFI structural thermal model with the CQM payload module, and the beginning of the cryogenic system level tests and associated instrument performance tests, to be followed by the structural test campaign on the full spacecraft.



The qualification model of the telescope structure assembled at Alcatel

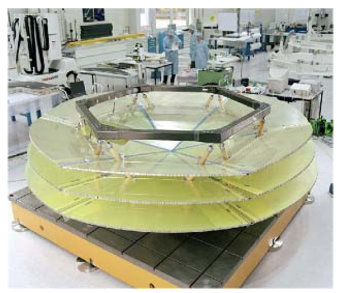
The instrument hardware design review (IHDR) cycle, which approves the instruments' AVM and CQM programme, the hardware for instrument level testing and the On-Board software, is almost completed. The LFI follows a proto-flight development and not participating in the system CQM programme. The instrument is currently in the middle of its IHDR which nonetheless is reviewing the instrument's own internal QM programme. This review will be completed in June. The Sorption cooler is progressing well. Readers may recall that a sorption cooler simulator will be used for the system CQM testing: the simulator comprises a full flight quality pipe-work assembly and cold-end (PACE) from JPL driven by a hydrogen supply furnished by Industry. The delivery of the CQM PACE by JPL to ESA and industry in April marked the first instrument delivery for Planck, to be followed in September by the HFI CQM instrument. Deliveries of the two sorption cooler proto-flight (PFM) units are anticipated for November this year and March next year. The next review cycle, the Instrument Qualification review, will be initiated in the autumn and will be in line with completion of the instrument level QM and sorption cooler level PFM test campaigns.

The overall spacecraft development is driven by availability of the service module and finalization of the service module structure. Parallel manufacturing is ongoing and the SVM will be ready for its review in August. Development of the Planck Payload Module is progressing well with the manufacture of the QM hardware completed and FM manufacturing already started last year. The qualification model testing of the two parts, telescope structure and cryostructure, is well advanced. The telescope structure has already been thermo-elastically tested using videogrammetry at liquid nitrogen temperatures at Alcatel with vibration and acoustic testing nearing completion.

The baffle before coating.

The Planck reflectors are a joint ESA/DSRI undertaking. The QM secondary mirror has completed its cryogenic profile measurement tests at CSL using an infrared interferometer. The campaign has taken longer than expected, both in setting up the optics and the processing and interpretation of the results. The limitation of the measurement technique to resolve areas of high surface slope was already known and expected. Investigations are ongoing to determine if the detected high frequency surface errors are due to physical deformations of the reflector at cryogenic temperatures or produced by the set-up. This is currently being resolved to enable to proceed with the Primary reflector QM test and the release of flight model manufacture.

Finally we must address the overall schedule of the Herschel/Planck Programme. The H/P Project Manager has recently defined a new set of delivery dates of instruments to Industry, which are later than those defined for the PDR. These dates are the baseline for the CDR exercise and industry have planned their assembly, integration and test campaign (including double shift working) to maintain the 15th February 2007 launch date. □



V-grooves before coating

Planck, the Virtual Observatory, and the GRID

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would benefit from being undertaken on computational resources of a scope beyond that available at any one Planck institution. The Grid may provide access to them, and Planck simulations represent an ideal application for Grid testbeds to implement.

WG8 Initial Report and Future Plans

The membership of WG8 includes those Planck consortium members already active in the VO and/or Grid worlds, plus additional individuals working on those Planck activities (e.g. IDIS) most likely to benefit from the application of VO and Grid technologies. WG8 is currently preparing an Initial Report to be based in part on the results of a questionnaire circulated to the coordinators of all Planck WGs last summer. The responses to this questionnaire, plus presentations from the WG8 Kick-Off Meeting in January 2004, can be found within the WG8 folder in Livelink, which will be the primary medium for exchange of information between WG8 and the wider consortia. One of WG8's first activities has been to contribute comments to the recent review of the IDIS User Requirement Documents. A crucial next step will be to develop Use Cases based on Planck scientific requirements, which will be circulated within the Interoperability Working Groups of the International Virtual Observatory Alliance, to ensure that VO standards meet the needs of Planck. Those interested in the work of WG8 are invited to contact any of the authors of this piece, who are the WG's coordinators. □

Busy Times Ahead

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In the meantime the Planck telescope qualification reflectors have already been manufactured and are being tested at cryogenic temperatures.

Currently the whole mission is going through a Critical Design Review in multiple stages, with the whole process to be completed around January of next year. The satellite is being reviewed between April and October, the Mission Operations Centre will be reviewed in September, the Instruments in October, the Data Processing Centres and the Planck Science Office in November.

Altogether a very busy time in the next few months, with the expectation of even higher levels of activity next year! □

Post-doc Opportunity

Research Fellowships at ESTEC- post-doctoral positions in Submm/CMB astronomy will be open within the Planck group at ESA, starting in October of 2004. In principle any Planck-related topic will be considered, though Interstellar Medium is of particular interest to the group. Interested scientists please contact directly J. Tauber – jtauber@rssd.esa.int.

Planck Reflector Development Status

H.U. Nørgaard Nielsen

In order to verify the optical performance of the secondary reflector qualification model at cryogenic temperatures, tests have been conducted at the Centre Spatial de Liège (CSL) using a 10 micron interferometer system. Starting in September 2003, four temperature cycles have been performed, each cycle going from room temperature down to 40 K and back. Wave front error maps have been obtained at the extreme temperatures and at a few temperatures in between. The interpretation of these measurements is under discussion. CSL is preparing the setup for similar tests of the primary reflector qualification model (PRQM). Moisture pick - up tests of the PRQM at Astrium in Friedrichshafen have been ongoing for the last 6 months. □

Facesheet of the Primary Reflector Qualification Model.

News from the LFI

R. Mandolesi, M. Bersanelli, F. Pasian

The manufacturing of all LFI Qualification Model parts enters completion. Testing is carried out at successive stages of integration. All the front-end passive components (feedhorns and associated OMTs) have been successfully manufactured and tested, as well as the first sets of full waveguide assemblies. Each assembly is 1.4 m long and comprises four waveguides connecting the 20 K front-end to the 300 K back-end portion of the radiometers. Array elements at all frequencies, and waveguide assemblies at 30 and 44 GHz have been extensively tested at the Microwave laboratory at Istituto di Fisica dei Plasmi, CNR, Milano, and show radiometric properties (insertion loss, return loss) in good agreement with the model predictions.

The 70 GHz radiometer chain assemblies (RCAs) for the LFI QM are built and tested at Millilab and Ylinen (Finland) in a dedicated cryofacility. The front-end and back-end modules are connected with representative waveguides and coupled with the QM OMT and feedhorns, which were tested in Italy. Two 70 GHz RCAs can be tested simultaneously in the cryochamber, which is equipped with black-body sky loads and QM reference loads cooled at 4K. After completion of the RCA test campaign, the radiometers will

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News from the LFI

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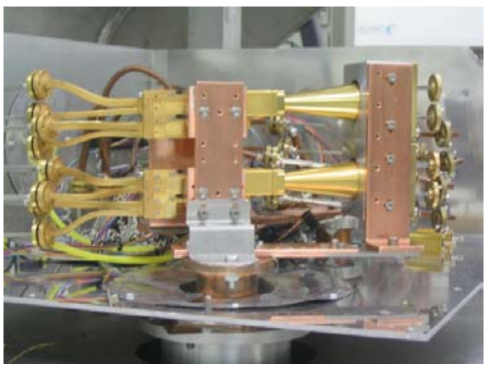
be shipped to Laben, in Italy, and integrated in the LFI QM together with the 30 and 44 GHz radiometers.

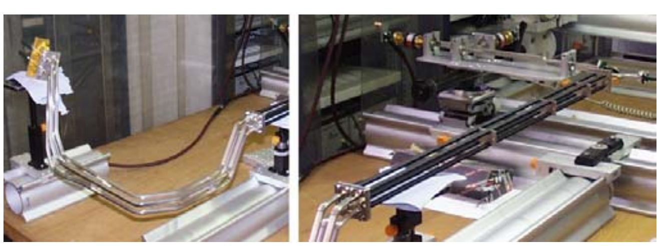
The test campaign of the QM 30 GHz front-end and back-end modules carried out at Jodell Bank, UK, and at Santander, Spain, respectively, is completed. The units have been delivered to Laben for RCA integration with the 30 GHz waveguides. Work on the QM 44 GHz elements is now ongoing in both Teams.

Testing of the 30 GHz (and, later on, of the 44 GHz) QM radiometers will be carried out in Laben in a cryofacility dedicated to the 30 and 44 GHz RCA calibration and test. The tests of the QM parts show that the performances of the 30 GHz and 70 GHz radiometers are adequate for instrument qualification and for the optimisation of critical test procedures at RCA and Instrument level. Similar performances are expected for the 44 GHz QM.



Detail of the 70 GHz radiometers in the Ylinen/Millilab RCA cryofacility. Two Radiometer chains are simultaneously tested. The two conical feedhorns are on the right, coupled with the 4K sky loads.

The two RCA cryofacilities in Laben and Finland will be coupled with Data Acquisition Electronics units, the DAE "breadboards", which Laben has produced to ensure a near-flight-like interface and operation at an early stage of instrument integration. The DAE breadboard will be coupled with acquisition software, called "Rachel". This software is produced at IASF-INAF Bologna and allows real-time visualization and analysis and produces standard format data files. The final stage of the radiometer calibration analysis is carried out with the Radiometer Analysis Software (RANA) designed and produced by LFI team members.



LFI QM waveguide assembly at 30 GHz under test at Istituto di Fisica dei Plasmi, CNR.. Each assembly includes 4 waveguides connecting a front-end and a back-end module. Left: Copper section. Right: Stainless steel section.

The cryogenic front-end low noise amplifiers (LNAs) which are the most critical parts for the LFI flight model (FM) have been selected and tested. At 30 and 44 GHz LNAs of type NGST CRYO-03, and at 70 GHz LNAs of type CRYO-04 will be used. These devices are expected to give best sensitivity and low power consumption. LFI team work has been organised to support in the most efficient way the final optimisation of the instrument and calibration activity. Two additional dedicated teams have been set up, one supporting the 30 and 44 GHz activities, and the other supporting the 70 GHz activities. These teams are working together and involve scientists from Finland, Italy, Spain, UK, and USA.

The development of the REBA (radiometer electronics box assembly) is progressing at IAC, Tenerife, and the recent test carried out on the compression and decompression software shows performances compliant with the LFI needs.

The QM instrument test and calibration activity is producing lots of data, and more will be produced in the future. These data are organised and collected at the LFI DPC in Trieste, where they can be accessed remotely by LFI team members for analysis and crosscheck.

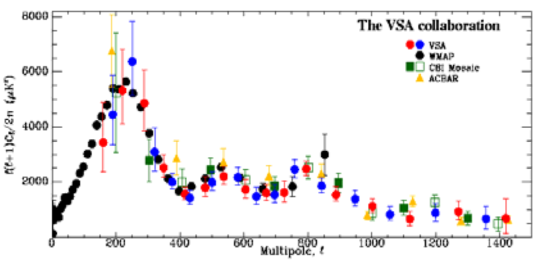
Besides the above support to instrument activities, the LFI DPC has continued its development of the data reduction pipeline, aiming at the release of its Demonstration Model (DM) foreseen by the end of the summer. The OAT team has adapted the instrument database to handle the new telemetry format, including the new naming convention and all the definitions needed to interface correctly to the SCOS2000 system needed to manage telemetry and telecommands. The Geneva group is finalizing the development of the Level 1 software, basically the telemetry-handling tools, which allow the inspection of scientific telemetry, and the conversion of the telemetry itself into time-ordered streams. Such activity relies on the successful experience the group has gathered with INTEGRAL. Canada is contributing to a tool for analysing the time series output from Level 1; the display capabilities are provided by the KST tool developed for HFI - a good example of commonality - while the trending functionality is being scoped. Most of the effort for the LFI pipeline DM has been geared toward the understanding, simulation and removal of systematic effects. These include thermal effects, spikes, a refined treatment of $1/f$ noise, different kinds of beam shape, etc. The pipeline modules for the calibration of data were also refined, as were the map-making algorithms which are now able to handle polarisation. Furthermore, the FastICA approach for component separation was further refined, as were the modules dealing with the detection of compact sources. Many teams have contributed to this effort, located in Italy (Milan, Bologna, Trieste, Rome, Pisa), Garching and Santander, with a strong contribution of the US team as well.

Much prototype code has been developed, using the interim standard for data structures (FITS). The code is now integrated in Trieste, using the IDIS Process Coordinator, and all software configuration management utilities needed to build a traceable product. □

Planck activity at Jodrell Bank Observatory

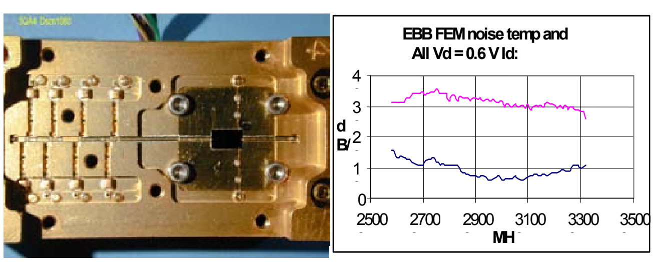
Rod Davies and Richard Davis

The Jodrell Bank team has been involved in the search for fluctuations in the Cosmic Microwave Background (CMB) for 25 years. The MkII 35x25-m telescope was used at 5GHz to set a limit of $\Delta T/T < 2.3\times10^{-4}$ (Lasenby & Davies 1983) - the tightest limit at the time. Subsequent investigations were conducted in the high dry site of the Teide Observatory, Tenerife, in collaboration with the IAC using low noise receivers in beamswitching radiometers and interferometers up to frequencies of 33GHz. Individual CMB fluctuations features were identified in the early 1990s, which provided the impetus to construct the 30 GHz Very Small Array (VSA) in collaboration with Cambridge University and IAC.



C_l spectrum obtained with the VSA and other experiments extending to l=1400; there is remarkable agreement between observers over the whole l-range: this is the range to be covered by

Jodrell Bank Observatory (JBO) Univ. of Manchester, is building the 30 and 44 GHz front end modules (FEMs) for Planck LFI. This is based on heritage gained in building the VSA receivers at 30 GHz. All of this work has been in collaboration with M. Pospieszalski at NRAO. The amplifiers have been re-optimized to the Planck bandwidths and to the lower noise transistors being used.

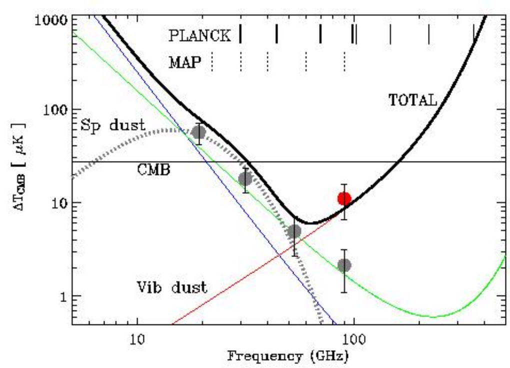


Left: Four stage amplifier together with its MMIC phase switch. Right: the extremely low noise achieved together with its gain when the amplifier is cooled to 20K.

The complete FEM is made in one integrated block with a double input magic T followed by four amplifiers and four phase switches and a further double magic T. The block also houses all the DC bias circuits and bias protection and potentiometers needed to run the transistors safely and from a minimum of connections to the outside world. Thus each FEM receives two polarizations from the sky and two reference 4K load signals derived from the HFI outer surface. The extremely low 1/f knee frequency of a few 10s of mHz is achieved by a double differencing technique which causes many systematic signals to be removed. The Planck receiver work is managed by Althea Wilkinson and the engineering is supervised by Neil Roddis.

JBO staff are strongly involved in a range of Planck Working Groups, particularly WG2 and WG7 on Galactic and Solar System science. A JBO research activity in recent years has been in understanding the Galactic foregrounds to the CMB. Since Planck is expected to achieve ~1% accuracy in its C_l values over its *l* range, a knowledge of intensity and spectral index of the four foreground components (synchrotron, free-free, vibrational and anomalous dust) is critical. We have concentrated on the free-free component, using the Hα surveys of the WHAM and SHASSA teams (Dickinson, Davies & Davis 2003). Clearly it is not possible to reconstruct the intrinsic Hα emission close to the Galactic plane because of the large absorption there. To overcome this problem we are investigating the use of radio recombination line (RRL) data at low Galactic latitudes contained within the Parkes and JBO HIPASS and HIJASS HI surveys (Auld et al. 2004).

As well as the millimetre wave emission from spinning dust there is now strong evidence for anomalous radio emission in the region 10 to 40GHz. Originally seen in the Tenerife data, this has been quantified in a recent analysis of the COBE and 19GHz data (Banday, Dickinson, Davies, & Gorski 2003).



Foreground contamination for the standard Galactic cut b>20° at angular scales >7°.

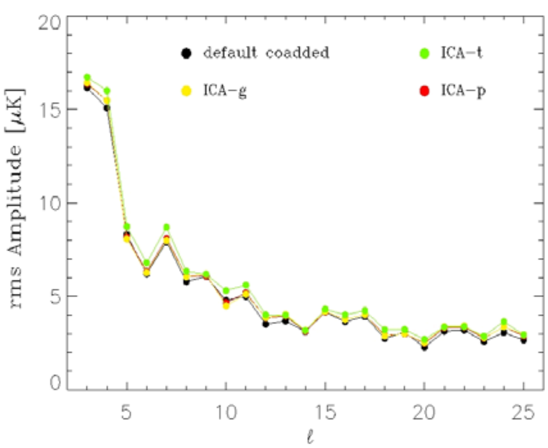
Work is continuing on the identification of anomalous emission in VSA and WMAP data. It is also interesting to note that the minimum Galactic foreground emission occurs in the range 40 to 90GHz.

Paddy Leahy and Johan Hamaker (ASTRON) have made a detailed study of many aspects of the polarization performance of Planck (more on this in a future issue of the Newsletter). Other JBO activity in Planck science includes Richard Battye's work on non-Gaussianity (WG4) and collaborative radio polarization observations with the Bonn MPIfRA group (Paddy Leahy). The JBO OCRA team led by Peter Wilkinson is building a multi-beam receiver system for the studies of the log *N*-log *S* relation at 30GHz. VSA data are being used to investigate calibrator sources for the Planck mission (Hapez et al. 2004). □

Successful component separation on real satellite data

Carlo Baccigalupi, Davide Maino

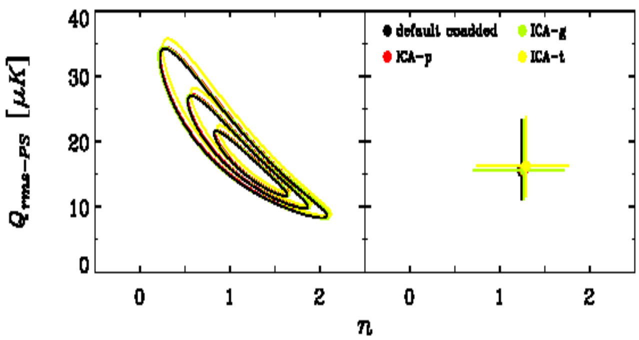
The study of component separation algorithms designed for cleaning the CMB signal from diffuse foreground emission registered recently a significant progress. Maino et al. 2003 (MNRAS 344, 544) applied the FastICA component separation algorithm to the COBE-DMR data, recovering the correct amplitude and spectral index of the total intensity CMB anisotropy. The adopted technique exploits the newest concepts in signal processing science, based on Independent Component Analysis (ICA) and introduced in astrophysics recently (Baccigalupi et al. MNRAS 318, 769, 2000). The results of the separation process are unbiased by prior knowledge of any sort about the signals to be recovered. These tools operate on a multi-frequency database, maximizing the statistical independence of the underlying emission processes (blind component separation). That is most suitable for the extraction of the CMB, as it is uncorrelated with the foreground emission. High angular resolution CMB data provide ideal statistical samples which these algorithms can exploit to reconstruct the CMB emission pattern with remarkable faithfulness.



Power spectrum estimation based on the COBE CMB anisotropy pattern extracted through the FastICA procedure. Different colors represent three different FastICA architectures, while black dots show the original COBE team results obtained coadding the 90 and 53 GHz frequency channels data.

The separation was achieved in real space, and the recovered CMB template was then processed through a conventional analysis and angular power spectrum estimation, shown above. From that, the normalization and spectral index of the primordial density fluctuations was recovered, in close agreement with the original results achieved by the COBE team.

Component separation techniques are improving substantially because of the application to real data. However, instrumental systematics unavoidably challenge their performance in non-ideal conditions. That requires the design of new criteria and procedures for quantifying the level of degradation of the separation outputs with respect to the performance achieved in nominal conditions. Some of these procedures become part of the package itself, in fact improving and specializing the software for operating effectively for the particular problem at hand, i.e. the recovery of most faithful image of the true CMB emission from the multi-frequency mixing with foregrounds.



Likelihood contours for CMB anisotropy quadrupole and primordial density perturbation spectral index in the reconstructed CMB template with FastICA. Different colors represent the three different FastICA architectures, while black lines show the original COBE results obtained by coadding the 90 and 53 GHz channels.

Specifically, Maino et al. 2003 developed a criterion to recognize the physical components extracted by the algorithm exploiting the signal to noise ratio on separation outputs. They also checked the results with or without the use of priors on the foreground emission. A Monte Carlo chain was implemented to quantify the level of stability of the separation performance in an environment corresponding to the characteristics and systematic features of the COBE satellite, such as the noise distribution in the sky. These studies led to the confidence regions and error bars plotted below; this is most important since a quantitative evaluation of the confidence on the separation products is a crucial step in order to develop the existing techniques from the present and promising test phase to the role of ordinary data analysis tools in the next generation CMB imaging science.

More results were presented at the Planck Symposium review of the diffuse component separation working group: Bayesian techniques were applied to the COBE-DMR data as well (Maximum Entropy, Barreiro et al. MNRAS 2004, in press), while a novel ICA based technique designed to be flexible with respect to the use of available priors (Delabrouille et al. MNRAS 346, 1089, 2003) is being applied to the Archeops data with promising preliminary results.

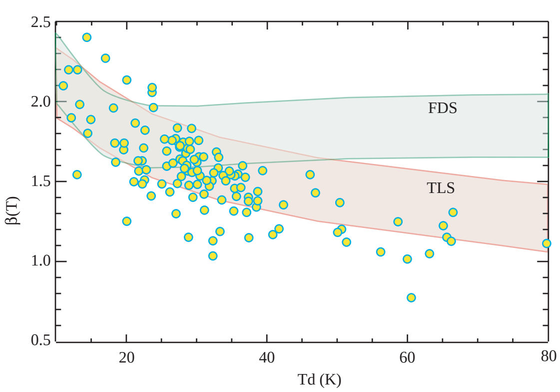
Encouraged by these achievements, the diffuse component separation development and test phase is now following two mainstreams: the application to WMAP data and the extension of the working domain to include polarisation. □

Pronaos/Archeops balloon experiments: A preview of dust emission for Planck and Herschel

J.-P. Bernard, D. Paradis, C. Meny, N. Boudet and the Archeops team

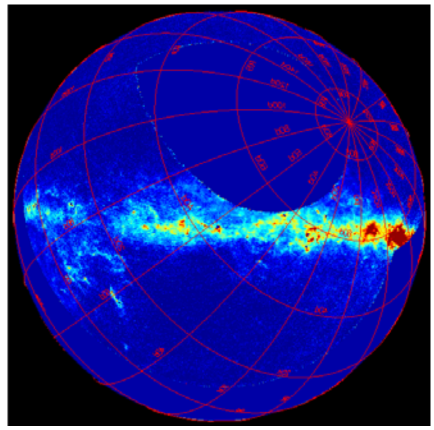
The foreground emission from dust in the interstellar medium (ISM) is poorly known in the far-infrared (FIR) to millimeter wavelength range. Strong millimeter excess with respect to a single grey-body law has been evidenced with FIRAS towards both the diffuse ISM and the Galactic plane. The excess is strongly correlated with the FIR dust emission. Two interpretations have been put forward for this excess (Reach et al. 1995, Finkbeiner et al. 1999 - FDS). They both argue for very cold dust emission, whose nature is not well identified. FDS argues that the two components could be graphite and silicates heated by the general ISRF at 16 K (β=2.7) and 9.5 K (β=1.7) respectively. This model, which reproduces well the FIRAS data, remains phenomenological, in the sense that it is not explicitly linked to the optical properties of any given material composing the grains. Further anticipating what Herschel and Planck will bring to our understanding of dust emission requires sensitive data at λ>100 µm, on arcminute scales or better.

In the FIR (200-600 µm), the balloon-borne French experiment Pronaos has mapped several tens of square degrees in four photometric bands at 3′ resolution. Pronaos data show that the spectral index of the emission changes systematically with dust temperature (see Figure below). The spectrum of cold dust (e.g. in cold molecular clouds) is found to be steeper than that of the warmer dust (e.g. in the vicinity of star forming regions). This is interpreted as a steepening of the dust emissivity law, which is intrinsic to the dust material. The effect was not noticed in the FIRAS data, because of the confusion between cold and warm regions in any 7° FIRAS beam.



Correlation between the dust temperature (Td) and emissivity index (β) observed by Pronaos (dots, Dupac et al. 2003) compared to predictions of two dust models (see text).

The Archeops experiment has mapped a large fraction of the sky in the submm/mm from $\lambda \approx$500 µm to 2 mm, at an angular resolution comparable to that of Planck (about 10'). The region mapped during the flight from Kiruna in 2002 encompasses the outer Galactic region (Benoit et al. 2004). The average FIR/mm spectrum of dust emission in this region is in basic agreement with the FIRAS spectrum, which it extends at longer wavelengths and with better angular resolution. The FDS model reproduces precisely the observed spectrum. However, it fails to reproduce the β(T) correlation measured by Pronaos.



Map of the sky at 217 GHz, as observed by Archeops (Benoît et al. 2004).

To explain the available observations, we are developing alternate models for the dust emission. Assuming that the dust is amorphous in nature, we promote a model where the millimeter excess is intrinsic to the dust material, and does not require the existence of separate dust populations (Mény et al. 2004). The excess emission is caused by transitions involving tunneling through a potential barrier between Two Level Systems (TLS) caused by partial disorder in the grain structure. Within this framework, the mm excess is temperature dependent and is superimposed to a temperature-independent emission, which dominates in the FIR and is intrinsically very steep. The flattening of the spectrum with increasing temperature is due to a progressive growth of the TLS emission over the T-independent component.

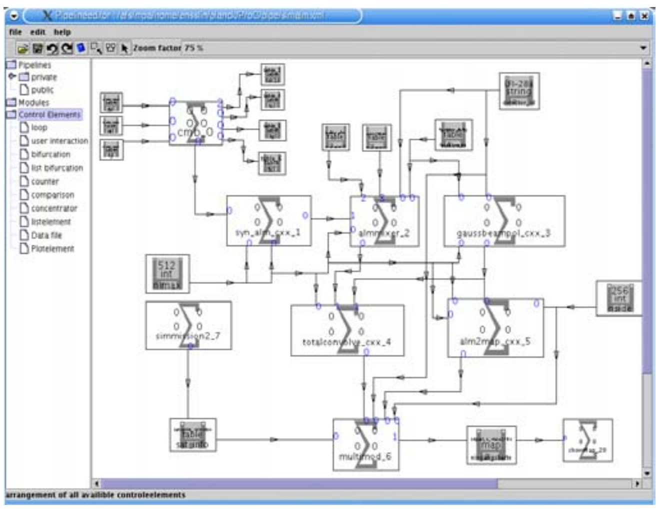
These effects have been described in detail in the solid-state physics literature. The combined effect of the mm excess and the temperature invariant component have actually been invoked to explain the β(T) variations observed in laboratory for some silicate materials, which may be similar to those observed with Pronaos. The TLS model is able to reproduce the average observed ISM spectrum, but, unlike the FDS model, accounts naturally for the observed β(T) correlation.

Planck and Herschel will operate in the same spectral domain as Archeops and Pronaos. Therefore the departures from a single gray-body law will be observed with unprecedented sensitivity and extensive spatial coverage. This will enable to test the validity of the proposed models. The improved angular resolution in the FIR will resolve the hotter regions of the ISM where the models make the most distinctive predictions. Polarization measurements will also help to differentiate between models.

ProC: a work flow engine for Planck-supercomputing

Torsten Ensslin

A huge computational task has to be performed in order to get from the raw PLANCK detector signals to the CMB temperature fluctuation maps, power spectra and the precision measurement of the cosmological parameter set. A large number of different computer programs written in a number of different languages and running on a variety of computer platforms have to digest Terabytes of data in a coordinated, efficient, and transparent fashion. It is the task of the Process Coordinator (ProC), which is under development at the Max-Planck-Institute for Astrophysics, as one part of the Integrated Data and Information System (IDIS) to provide the necessary software infrastructure allowing to build, administer, and execute complex data processing pipelines.



Screen shot of the pipeline editor window of the Process Coordinator. Displayed is the current Planck-simulation pipeline which is already fully operable under ProC control.

The ProC user can construct software pipelines using a graphical editor. Computer programs written in different native languages (e.g. C/C++/FORTRAN); in the following called pipeline modules - can be connected via data streams if their output and input channels have a common data type. Logical control elements such as loops, bifurcations, counters, comparison elements and the possibility of having sub-pipelines enable very complex pipeline functionalities. Importing a given computer program into the ProC environment is easy: Only a predefined XML-form has to be filled in, in which the input and output data types and parameters are described in a standardized way, for a module to be integrated in any ProC-pipeline. Ideally, the module's input and output routines are part of a common I/O library, such as the IDIS Data Management Component (DMC) allowing for transparent access to a data base system, however this is not enforced by the ProC.

cutable module and submits it to a scheduling system, which distributes the workload onto the available computers. A module is executable as soon as all the required input data are available. Once a module has finished and delivered its output data, any follow-up module waiting for that data is started. ProC pipelines are therefore data-flow driven processes. The data flow from module to module itself is envisaged to go through the DMC, which is interfaced with a data base system. The ProC mediates the necessary communication between the different modules, and the DMC ensures that all relevant data products can be found afterwards. Since the ProC-pipeline definitions will also be stored within the DMC, a complete reconstruction of the history of any data product will be possible at any later time.

The "SUN GRID Engine" and "GLOBUS" are planned to be interfaced with the ProC as scheduling systems for the computational workload. Both scheduling systems represent different development stages towards an envisaged universal GRID computing technology allowing a potential world-wide computing network to be accessed. Thus, by connecting the ProC to GRID technology, its computational resources will be provided to PLANCK data processing pipelines. However, the ProC can also be run without a scheduling system, for example for pipeline development on a private laptop. Once tested, a pipeline can be transferred to a Data Processing Centre or Planck Analysis Centre for production runs on a powerful computer network, and its run can be monitored and controlled remotely through the ProC Session Manager.

To summarise, the ProC provides a convenient environment to build, maintain and execute complex data processing pipelines of the PLANCK project. Its platform-independent design allows it to be used as a pipeline development and testing system on a private laptop and simultaneously to be a powerful supercomputing work flow engine for the ambitious PLANCK data processing tasks. □

Calendar of (some) Events

Reviews

Science Ground Segment Design Review, 2/3 November 04 (Bologna)

Sorption Cooler Review, September 04 (TBC)

Instrument Qualification Review, October 04 (TBC)

Planck Science Team meeting

ST20: 21/22 June, 2004; ESTEC

ST21: 22/23 September, 2004

ST22: 20/21 December, 2004

ST23: 31 March – 1 April, 2004

Other Meetings

- WG7: 11-13 October 04; CNR-INAF Sezione di Noto, Italy
- HFI Common meeting of the Instrument and Calibration working groups, 22/23 July, 2004; IAS, Orsay

The 2nd Planck Symposium: Setting the Scene

François Couchot and Jan Tauber

A Symposium gathering the Planck community took place in Orsay (France) between 28 and 30 January 2004, this being the second time that such an event was held. These meetings have as objective to bring up to date the many individuals involved in all facets of the mission development, and stimulate discussion across Planck-related topics. This particular Symposium carried the title "Setting the Scene", as it was believed timely by the organizers to take a detailed look at what would be the state of the art of the field at the time of the launch date in 2007. More than 200 people attended from the current number of ~400 scientists of the Planck collaboration.

The Symposium took place on the premises of the Laboratoire de l'Accélerateur Linéaire (part of the Institut National de Physique Nucléaire et de Physique des Particules), and was very ably organized by the host institute, led by François Couchot and many local collaborators. The scientific organization was provided by the Planck Science Team with the help of many prominent members of the Planck community. The organizers were able to find a large number of key speakers; in addition, many participants proposed contributed talks, though some had to submit posters instead due to the limited time available.

David Southwood (left) before his presentation exchanging thoughts with Reno Mandolesi

The occasion of this Symposium was used by the two largest Planck Consortia to hold their yearly meetings, where are discussed all technical and management issues related to the instrument development and that of their associated Data Processing Centres. In addition, a full day was dedicated to working meetings of the so-called Planck Working Groups. These diverse Groups have been put in place by the Planck Science Team to address a number of specific technical and scientific problems which need to be resolved before launch, ranging from evaluation of detector-specific aspects to preparation of data analysis algorithms.

The Symposium was opened by Prof. David Southwood (ESA's Director of Science) with an inspirational talk about "Planck and the future", which was followed by reviews of the current status of the hardware and data pipeline developments, highlighting in particular the results of recent hardware built and performance measured. The bulk of the Symposium - three days - was devoted to scientific talks examining the probable scientific return of Planck in view of currently ongoing and planned experiments. These talks covered the spectrum of Planck science – not only CMB-based cosmology, but also extragalactic science, as well as the exploitation of observations of our own Milky Way. Critical issues of instrument technology and data processing were also addressed. Finally, a large number of high-quality posters gave insight into many detailed aspects of Planck.

The discussion which was held in the various sessions confirmed that the scientific potential of Planck remains of the highest caliber, even in view of the recent release of WMAP data, and of new and very powerful ground- or balloon-based experiments which are planned in the coming decade. Although it was clear that in just three days it was impossible to cover all the potential scientific return of Planck, the Symposium fulfilled its objectives and served as a valuable milestone on the road towards the launch of Planck. The next meeting is likely to be held in 2006, in preparation for the satellite's operation.

One of the many lively moments at the conference dinner

There will be no written proceedings of the symposium, but the talks and posters are available under Livelink in the "Symposium, Paris 2004" project workspace. Nearly all symposium talks (32 out of 36) have been submitted and pdf files of 26 posters can be retrieved. The presentations given during the instrument consortium meetings are available in the dedicated livelink folders of HFI and LFI.

Call for Papers

For the special issue on "Applications of Signal Processing in Astrophysics and Cosmology"
Important: formal deadline on June 1, 2004, but late submissions, not beyond the month of June shall be accepted.

EURASIP Journal on Applied Signal Processing
http://asp.hindavi.com/si/cosmo.html

Editor's Note: our apologies that unexpectedly late issue has made this call obsolete

News from the HFI

Jean-Loup Puget

The HFI cryogenic qualification model (CQM) is in its final integration phases and will be tested and calibrated in the period from August to the first half of September 2004.

The focal plane system, which consists of the focal plane unit without the horns and bolometers, has been fully integrated at Air Liquide in Grenoble. After some hiccups due to minor manufacturing and integration problems, tests have confirmed that the performance of the caging system of the focal plane and the cooling power of the dilution cooler are according to expectations.

Signals from blind bolometers and calibrated resistors in the focal plane were obtained at the end of the full read-out electronic chain. During the last few months, a very extensive analysis of the electromagnetic compatibility and interferences has led to a number of design modifications particularly in the grounding scheme. This activity has resulted in a clean signal spectrum over the whole useful frequency range.

The JPL/Caltech bolometers are reaching the goal in terms of noise figures, which is equal or below the background photon noise. The detector time constants are all within specification. In addition, full pixel chains, which consist of horns, filters and bolometers, have been tested in Cardiff. The overall optical efficiency is about the highest expected value. It is thus more and more likely that the HFI will reach its goal performances in flight.

Center Frequency (GHz)	100	143	217	353	545	857
Number of Unpolarised Detectors	0	4	4	4	4	4
Number of Linearly Polarised detectors	8	8	8	8	0	0
Angular Resolution (FWHM, arcmin)	9.5	7.1	5	5	5	5
Bandwidth (GHz)	33	47	72	116	180	283
Average $\Delta T/T_I^*$ per pixel# (μK/K)	2.5	2.2	4.8	14.7	147	6700
Average $\Delta T/T_{U,Q}^*$ per pixel# (μK/K)	4.0	4.2	9.8	29.8	-	-
Flux sensitivity per pixel (mJy)	12	10	14	27	43	49

Table of predicted HFI performances based on the most recent laboratory measurements.

The 4K RAL/Astrium cooler compressors have been slightly modified to correct for a weakness in the wiring. They will be tested in July 2004. Most of the electronics boxes have already been delivered to IAS and the full HFI CQM will be delivered to ALCATEL in Cannes before the end of September.

The DPC is progressing according to plans: the "BreadBoard Model" (BBM), which is the first, almost complete, even if minimal, incarnation of the data pipeline, was released in December 2003 and was in the debriefing phase during the first semester of 2004. Most of the pipeline infrastructure (document management, data management, software versioning, distribution system and configuration management, collaborative tools, etc…) together with early versions of the scientific algorithms have been put in place in this BBM. The next two years (2004-2005) will be devoted to the "Development Model" (DM), for which baseline algorithms will be written, tested and integrated.

The HFI development teams are also busy finishing the so called "Level-1" software, which is the data acquisition part of the HFI DPC pipeline. Level 1 will be used during the on-ground calibration activities of the HFI CQM model at Orsay starting in August 2004.

Planck related publications

In the previous issue of this newsletter we invited authors to notify us about their recent Planck related publications which might be of interest to the Planck community. For this purpose we have set up the email planck@rssd.esa.int. The reference and title of the paper will be listed in the upcoming issue of the Planck Newsletter. We received only a few inputs. Most entries in the list of publications in this Newsletter (page 11) have been compiled from the lists sent by the DPC managers. If you want to be sure that your paper is in the list, send your entry to planck@rssd.esa.int .

About the Authors

C. Baccigalupi - LFI Scientist (SISSA, Trieste)
A. Banday - HFI/LFI Associate (MPA, Garching)
J.P. Bernard – HFI Associate (CNRS, Toulouse)
M. Bersanelli – LFI Instrument Scientist (Univ. of Milan)
F. Couchot – HFI Co-Investigator (LAL, Paris)
G. Crone – Herschel/Planck Payload Manager (ESTEC)
R. Davies – LFI Co-Investigator (JBO)
R. Davis – LFI Co-Investigator (JBO)
T. Ensslin – HFI/LFI Associate (MPA, Garching)
K.M. Gorski – LFI Co-Investigator (JPL, Pasadena)
D. Maino – LFI Associate (Milan)
R. Mandolesi – LFI Principal Investigator (INAF, Bologna)
R.G. Mann – HFI Associate (IfA, Edinburgh)
H.U. Nørgaard Nielsen – DK-Planck Principal Investigator (DSRI, Copenhagen)
T. Passvogel – Herschel/Planck Project Manager (ESTEC)
J.-L Puget – HFI Principal Investigator (IAS Orsay)
J. Tauber – Planck Project Scientist (PSO/ESA)

Editors: R. Laureijs & J. Tauber (PSO/ESA)
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.

Recent Planck Related Publications

Amblard, A., Hamilton, J.-Ch., 2004 A&A 417, 1189, "Noise power spectrum estimation and fast map making for CMB experiments"

Amblard, A., Vale, C., White, M., astro-ph/0403075, "Weak Lensing of the CMB by Large-Scale Structure"

Basu, K., Hernández-Monteagudo, C., Sunyaev, R.A. 2004 A&A 416, 447, "CMB observations and the production of chemical elements at the end of the dark ages"

Benoit A. et al., astro-ph/0306222, "First Detection of Polarization of the Submillimetre Diffuse Galactic Dust Emission by Archeops"

Burigana. C., Saez, D., 2003 A&A 409, 432, "Beam deconvolution in noisy CMB maps"

Challinor, A., Chon, G., Hivon, E., et al., 2003 NAR 47, 995, "Fast quad. power spectrum estimators and E-B decomposition"

Chon, G., Challinor, A., Hivon, E., et al., 2003 NAR 47, 845, "Fast estimation of polarized CMB power spectra"

Dickinson, C., Battye, R.A., Cleary, K. et al. astro-ph/0402498, "High sensitivity measurements of the CMB power spectrum with the extended Very Small Array"

Efstathiou, G., 2004 MNRAS 349, 603, "Myths and truths concerning estimation of power spectra: case for a hybrid estimator"

Efstathiou, G., 2003 MNRAS.346, L26, "The statistical significance of the low cosmic microwave background multipoles"

Ensslin, T.A., Hansen, S.H., 2004 astro-ph/0401337, "Searching for the relativistic SZ effect with the PLANCK experiment"

Eriksen, H.K., Banday, A.J., Gorski, K.M., Lilje, P.B., astro-ph/0403098, "Foreground removal by an Internal Linear Combination method: limitations and implications"

Eriksen, H.K., Hansen, F.K., Banday, et al. 2004 ApJ 605, 14 "Asymmetries in the CMB Anisotropy Field"

Eriksen, H.K., Novikov, D.I., Lilje, P.B., et al., 2004 astro-ph/0401276, "Testing for non-Gaussianity in the WMAP data: Minkowski functionals and the length of the skeleton"

Gallegos, J.E.; Martínez-González, E.; Sanz, J.L., Wavelets X conf., *Proceedings of SPIE* Vol. #5207, "Detection of features in 1-D data data streams and noise simulation using wavelets"

Hamilton, J.-Ch., astro-ph/0306222, "CMB map-making and power spectrum estimation"

Harrison, D.L., van Leeuwen, F., Rowan-Robinson, M., 2004 MNRAS 348, 1241, "Methods for the pointing reconstruction of the Planck satellite"

Hernández-Monteagudo, C., Rubiño-Martín, J.A., 2004 MNRAS 347, 403, "On the presence of thermal SZ induced signal in the first-year WMAP temperature maps"

Lama, N., Vuerli, C., Pasian, F. 2003 MSAIS 3, 359, "A pipeline-oriented DMS: design and implementation with OODBMS"

Leroy, C., Bernard, J.-P., Trouilhet, J.-F, 2003 Proc. IEEE Int. Workshop on Neural Networks for Signal Proc., p159, "Thermal modelling with neural network applied to Planck space mission"

Maris, M., Maino, D., Burigana, C., et al., 2003, A&A 414, 777, "The effect of signal digitization in CMB experiments"

Maris, M., Burigana, C., Cremonese, G., et al., 2003 MSAIS 3, 318, "Diffuse and point-like foregrounds from the Solar System environment in the Planck mission"

Mennella, A., Bersanelli, M., Seiffert, M., et al., 2003 A&A 410, 1089, "Offset balancing in pseudo-correlation radiometers for CMB measurements"

Mukherjee, P., Banday, A.J., Riazuelo, A., et al., 2003 ApJ 598, 767, "COBE-DMR-normalized dark energy cosmogony"

Ohno, H., Takada, M., Dolag, K., et al., astro-ph/0404067, "Superposition of blackbodies and the dipole anisotropy: A possibility to calibrate CMB experiments"

Platania, P., Burigana, C., Maino, D., et al., 2003 A&A 410, 847, "Full sky study of diffuse gal. emission at dm wavelengths"

Platania,P., Paladini,R., Cappellini, B., et al., 2004 AIPC 703, 405, "Probing Galactic Plasma with Radio Measurements"

Poutanen, T., Maino, D., Kurki-Suonio, H., et al., astro-ph/0404134 "CMB power spectrum estim. with destriping techniques"

Rebolo, R., Battye, R.A. , Carreira, P. et al. astro-ph/0402466, "Cosm. parameter estimation using VSA data out to *l*=1500"

Rubino-Martin, J.A., Hernandez-Monteagudo, C., Ensslin, T.A., astro-ph/0402525, "Measuring Dark Matter Flows in Merging Clusters of Galaxies"

Sandri, M., Bersanelli, M., Burigana, C., et al., 2003, 3rdESA Workshop on mm wave technology and applications, WPP-212, "The performances of the Planck Telescope at LFI frequencies"

Sandri, M., Villa, F., Bersanelli, M., et al., 2003, 3rdESA Workshop on mm wave technology and applications, WPP-212, "Advanced simulation techniques for straylight prediction of high performance mm-wave reflecting telescope"

Savage, R., Battye, R.A., Carreira, P. et al, 2004 MNRAS 349, 973, "Searching for non-Gaussianity in the VSA data"

Stompor, R., White, M., 2004 A&A 419, 783, "The effects of low temporal freq. modes on min. variance maps from Planck"

Tauber, J.A., 2004, Procs. of the conference "The Magnetized Interstellar Medium", Eds: B. Uyaniker, et al., Copernicus GmbH, Katlenburg-Lindau., p191, "Projects for Polarimetry of the ISM with the Planck Satellite"

Tristram, M., Hamilton, J.-C., Macias-Perez, J. et al., astro-ph/0310260, "Asymfast, a method for convolving maps with asymmetric beams"

Vale, C., Amblard, A., White, M., astro-ph/0402004, "Cluster Lensing of the CMB"

White, M., 2003, ApJ 597, 650, "Studying clusters with Planck"

Zacchei, A., Fogliani, S., Maris, M., et al. 2003 MSAIS 3, 331, "HouseKeeping and Science Telemetry: Planck/LFI"