

Planck/LFI: The Data Processing Centre

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The success of the Planck mission heavily relies on careful planning, design and implementation of its ground segment facilities. Some aspects related to the control of the LFI instrument, to the data flow and to the data processing for Planck are described in this poster, which provides an overview of the activities being carried out for the LFI Data Processing Centre.

Definitions

Planck is the M3 mission of the ESA Horizon 2000+ programme and it is in its phase B/C both for the spacecraft and the payload components. It is due to be launched in February 2007 together with Herschel (previously known as FIRST); the two missions will be jointly operated by ESA. The major elements of the Herschel/Planck ground segment are the ESA Mission Operations Centre (MOC) and the ESA Herschel Science Centre (HSC), together with two Data Processing Centres (DPCs), operated by the teams responsible for building the two instruments (LFI and HFI) which form the scientific payload of Planck. The Consortium in charge of the LFI is formed by 33 institutes located in 12 different countries and is led by N.Mandolesi of IASF/CNR, Sezione di Bologna.

Tasks in the Planck Scientific Ground Segment

The responsibility of the MOC is to uplink commands to Planck and receive from the Ground Station telemetry from spacecraft and instruments, check it to guarantee safety, and make it available to DPCs.

The HSC is in charge of receiving from the DPCs the final results of the mission and storing them in the Planck Long Term Archive.

The Planck DPCs are responsible for operating the respective instruments and for the delivery of the following scientific data products, which can be considered as the deliverables of the mission:

- Calibrated time series data, after removal of systematic features and attitude reconstruction.
- Photometrically and astrometrically calibrated maps of the sky in the observed bands.
- Sky maps of the main astrophysical components.
- Catalogs of sources detected in the sky maps of the main astrophysical components.

A key to the production of an integrated set of Planck products is the exchange of data between DPCs. This is essential to the proper understanding and removal of the systematic effects in the data, and to properly build a merged set of homogeneous results. Data exchanges between the LFI and the HFI DPCs is evidenced with yellow arrows in the figure on the right.

The DPC and the LFI Instrument Development Team

Others can be added to the formally defined products of Planck mentioned above, e.g.:

- Data sets defining the estimated characteristics of each detector and the telescope (e.g. detectivity, emissivity, time response, main beam and side lobes, etc.).
- "Internal" data (e.g. calibration data sets, data at intermediate level of processing), to be shared among members of the LFI Consortium and/or to be exchanged with the HFI Consortium.
- Ground Calibration and AIV Databases produced during the instrument development; and gathering all information, data and documents relative to the overall payload and all systems and sub-systems.

Most of this information is crucial for processing flight data and updating the knowledge and the performances of the instrument. This second set of tasks imply a high level of coordination with the LFI Instrument Development Team, to harmonize properly instrument knowledge and data processing tasks. The DPC Team is implementing the telemetry-handling software to be used for the LFI ground tests.

Simulation activities

It is furthermore clear that all above activities will need a phase of detailed simulations. An important point for the development philosophy is that successively more and more realistic simulations of the data (and housekeeping) flow which will be used as inputs to the pipeline for tests before launch need to be built. Complete coordination of the LFI Simulations, Modeling and Prototyping Teams with the DPC is absolutely essential. To achieve such coordination, the production of simulated data is run operationally at the DPC, as one of its "Levels" (Level S, in the figure at the right).

Tests on simulated data are important for the development of data processing algorithms, but also to define the instrumental setup, or the impact on science of specific technical choices; as an example, the analysis of the impact of the quantization factor on the CMB power spectrum.



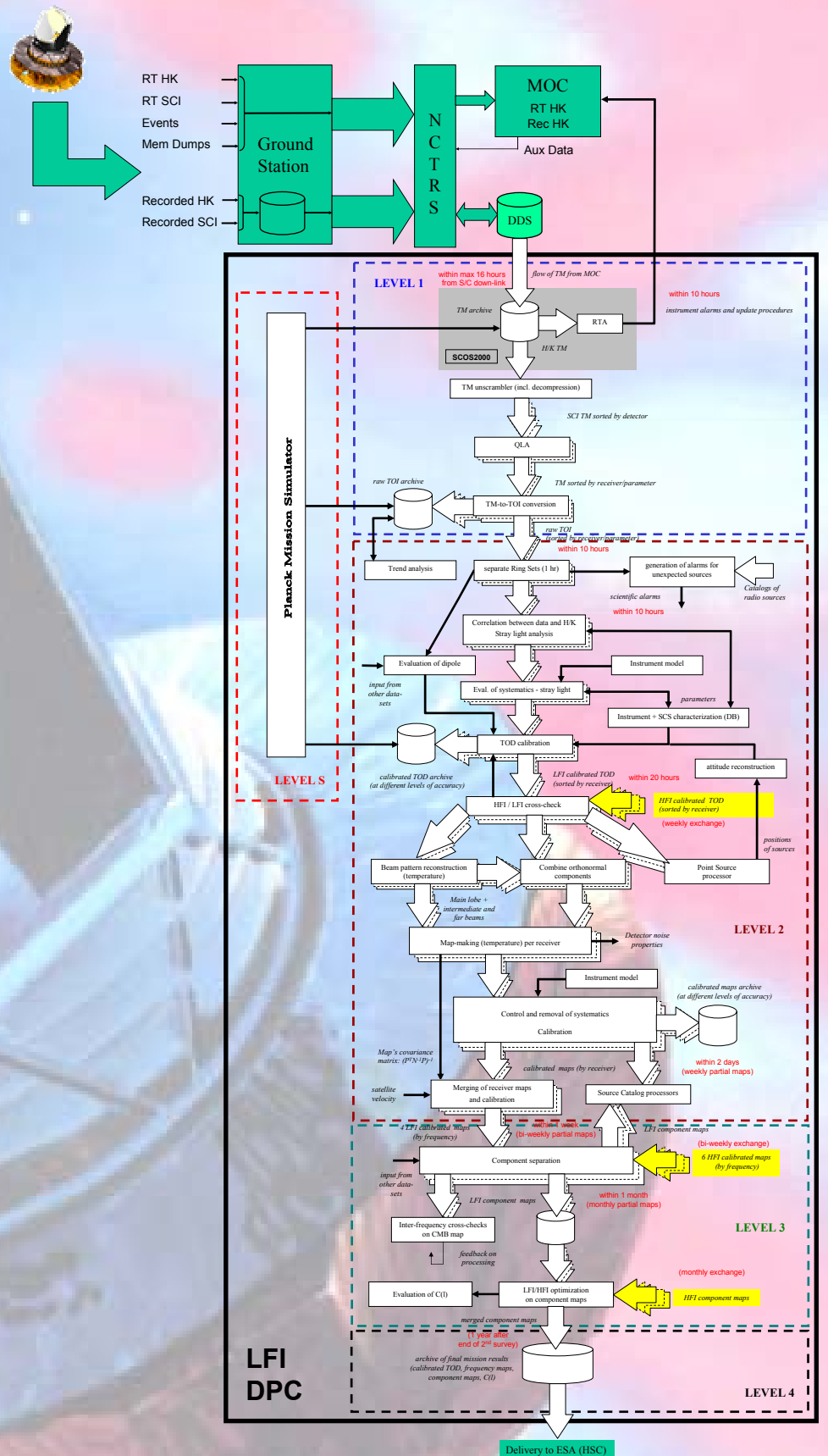
The Integrated Data and Information System (IDIS)

To harmonize inter-Consortia and intra-Consortium activities, a common set of tools for the sharing of information, documents, common software and data is being designed and built. This set of tools is called IDIS (Integrated Data and Information System).

An Integrated Data and Information System (IDIS) is thus being developed to allow proper intra-Consortium and inter-Consortia information exchange. The IDIS is a set of tools to act as an infrastructure both for the processing and sharing of data among DPC levels and between DPCs, and for the exchange of documentation and common software throughout the Consortia. Therefore, although being developed under the coordination of the two DPCs, the IDIS tools are useful within the whole Planck collaboration. IDIS is composed of five major blocks:

- a Documentation Management component;
- a Software Management component (repository and configuration management);
- a Data Management component (yielding common data definitions, formats, archives, databases);
- a Process Coordinator component;
- a Federation Layer component, allowing all of the above components to inter-relate to each other.

In addition to the basic IDIS components, experience has shown that the use of other tools ("Collaboration Tools") is beneficial to the development and maintenance of the IDIS and Planck software and hardware as well as the collaboration as a whole.



The Planck/LFI Scientific Ground Segment and LFI data processing

The figure above represents the Planck Ground Segment. The green section at the top corresponds to the Ground Station Network and the Mission Operations Centre (MOC), managed by ESA. The Scientific part starts with the delivery of telemetry data from the MOC to the Data Processing Centres (DPC). The scheme is both a data flow and a data processing flow diagram.

The DPC structure has been divided in five logical levels:

- Level 1: telemetry processing and interface with the MOC (no scientific processing of the data);
- Level 2: data reduction and calibration (requires detailed instrument knowledge);
- Level 3: component separation and optimization (requires HFI and LFI data to be analyzed jointly);
- Level 4: generation of final products (reception, archiving, preparation of public release material);
- Level S: during the pre-launch phase, simulation of data acquired from the Planck mission.

Although contributions to the LFI DPC, in terms of data on instrument characteristics and prototype software come from many Institutions throughout the Consortium, the operations are mainly centralized in Trieste, where they are run by the OAT and SISSA. Only Level 4 is operated by MPA, Garching.

By the end of July 2002, a Breadboard Model (BBM) of the whole DPC is going to be ready. It will then be operated on a year's worth of simulated telemetry generated by Level S to produce results, which will be used to evaluate the data flow, the processing load, and the processing algorithms used.

The LFI is funded by the national space agencies of the Institutes of the Consortium. In particular the Italian participation is funded by ASI.

The work of the following Italian members of the LFI Consortium is gratefully acknowledged: N.Mandolesi (2), M.Bersanelli (5), R.C.Butler (2), G.Albetti (1), C.Baccigalupi (3), A.Balbi (4), F.Bottega (1,11), C.Burigana (2), P.Cabella (4), B.Cappellini (5), L.Danese (3), G.DeGasperi (4), G.DeZotti (6), F.Finelli (2), S.Fogliani (1), N.Lama (1), M.Magliocchetti (3), D.Maino (1), M.Malaspinga (2), M.Maris (1), S.Matarrese (7), A.Mennella (8), G.Morgante (2), L.Moscardini (7), P.Natoli (4), R.Paladini (3), F.Perrotta (6,3), P.Platania (5), M.Sandri (2), M.Sgorlon (1), R.Smarglia (1), M.Sandri (2), E.Taddei (9,2), M.Terenzi (2), G.Umana (10), L.Valenziano (2), F.Villa (2), N.Vittorio (4), C.Vuerli (1,11), A.Zacchei (1)

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