FIRST/ESA/M/0043.01

FIRST/ Planck

Payload Meeting

@ ESA/HQ -- 03/07/98

FIRST/Planck Project

3 July 1998 PT-05628

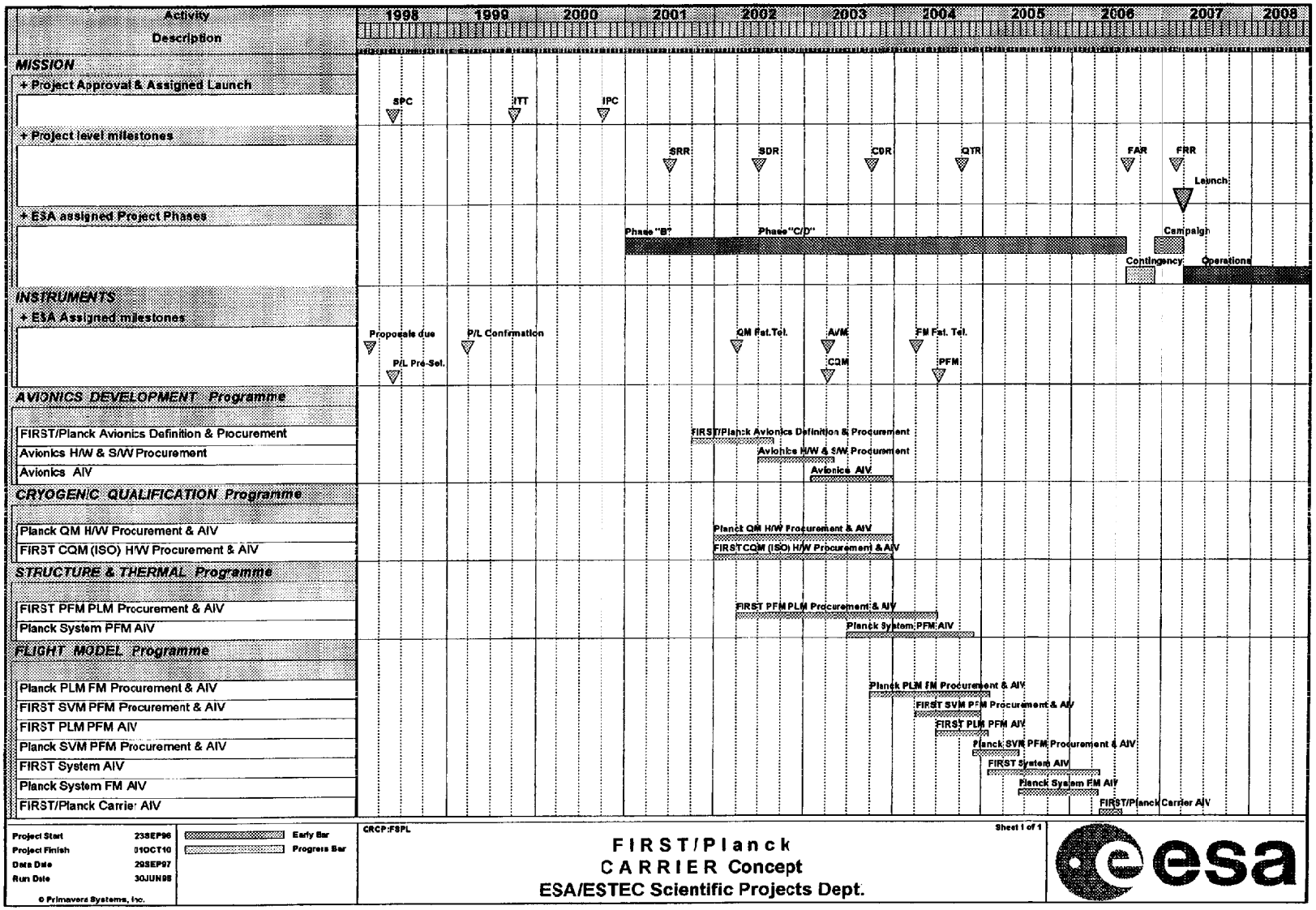
FIRST/ Planck

Payload Meeting

Schedule Update

3 July 1998

PT-05628


Activity Description
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
MISSION
+ Project Approval & Assigned Launch
SPC
ITT
IPC
+ Project level milestones
SRR
SDR
CDR
QTR
FAR
FRR
Launch
+ ESA assigned Project Phases
Phase "B"
Phase "C/D"
Campaign
Contingency
Operations
INSTRUMENTS
+ ESA Assigned milestones
Proposals due
P/L Pré-Sel.
P/L Confirmation
QM Fat.Tst.
A/M
CQM
FM Fat. Tst.
PFM
AVIONICS DEVELOPMENT Programme
FIRST/Planck Avionics Definition & Procurement
Avionics H/W & S/W Procurement
Avionics AIV
FIRST/Planck Avionics Definition & Procurement
Avionics H/W & S/W Procurement
Avionics AIV
CRYOGENIC QUALIFICATION Programme
Planck QM H/W Procurement & AIV
FIRST CQM (ISO) H/W Procurement & AIV
Planck QM H/W Procurement & AIV
FIRST CQM (ISO) H/W Procurement & AIV
STRUCTURE & THERMAL Programme
FIRST PFM PLM Procurement & AIV
Planck System PFM AIV
FIRST PFM PLM Procurement & AIV
Planck System PFM AIV
FLIGHT MODEL Programme
Planck PLM FM Procurement & AIV
FIRST SVM PFM Procurement & AIV
FIRST PLM PFM AIV
Planck SVM PFM Procurement & AIV
FIRST System AIV
Planck System FM AIV
FIRST/Planck Carrier AIV
Planck PLM FM Procurement & AIV
FIRST SVM PFM Procurement & AIV
FIRST PLM PFM AIV
Planck SVM PFM Procurement & AIV
FIRST System AIV
Planck System FM AIV
FIRST/Planck Carrier AIV
Project Start 23SEP96
Project Finish 01OCT10
Data Date 29SEP97
Run Date 30JUN98
© Primavera Systems, Inc.
Early Bar
Progress Bar
CRCP:FSPL
Sheet 1 of 1
FIRST/Planck
CARRIER Concept
ESA/ESTEC Scientific Projects Dept.
esa

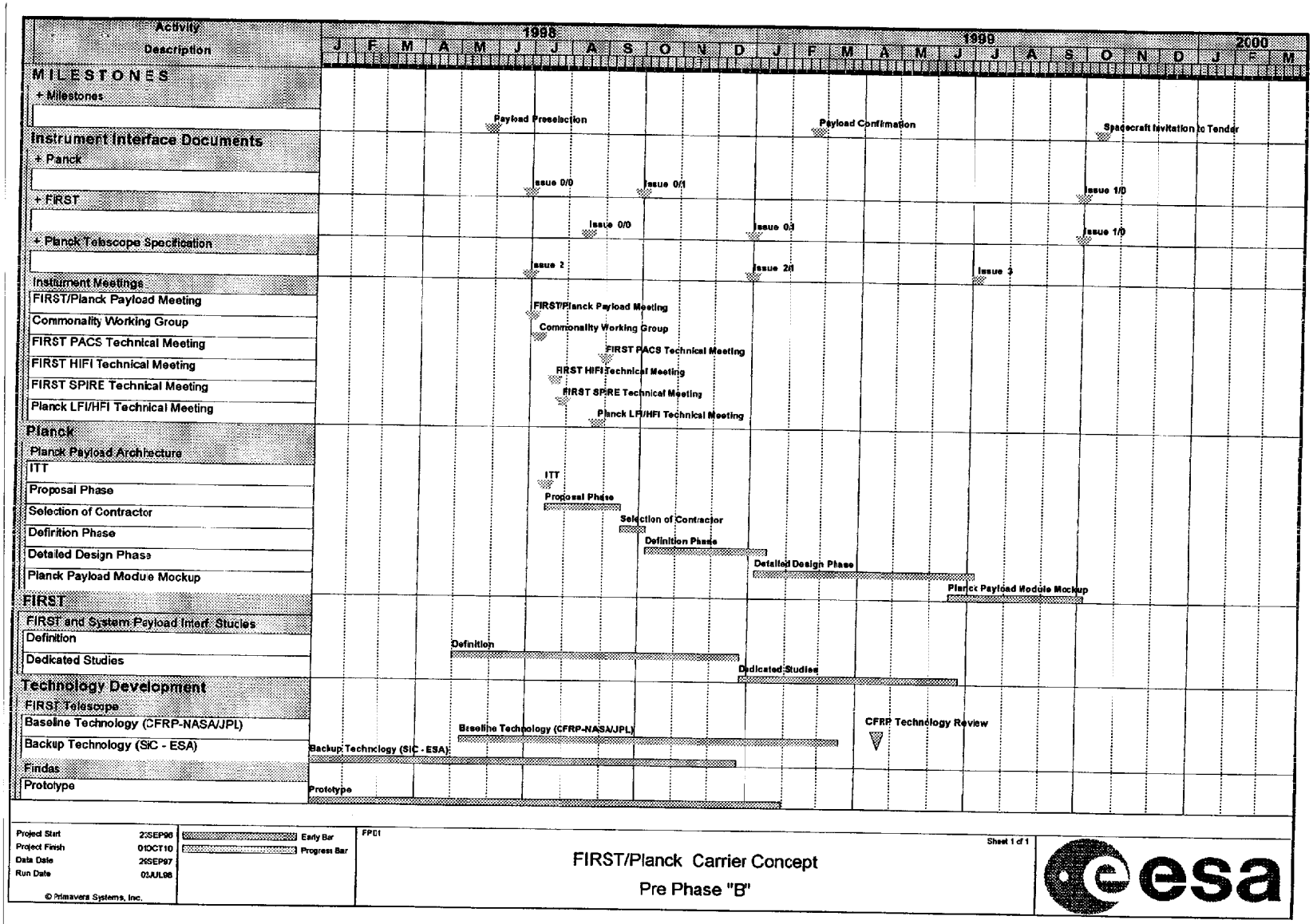
FIRST/Planck Near Term Planning

Milestones:

- Payload Confirmation → Feb. 1999
- Spacecraft Invitation to Tender → Oct. 1999

Activities:

- Project:
  - Freeze Instrument Interfaces
    - Planck Payload Architect / FIRST Payload Interface Studies
  - Technology Development (e.g. FIRST Telescope)
- Instruments:
  - Implementation of PSEC/FSEC Recommendations
  - Clarification of Funding Issues
  - Commonality Efforts
  - Technology Development (e.g. Detectors, Coolers,...)


Activity Description
1998
1999
2000
J F M A M J J A S O N D J F M A M J J A S O N D J F M
MILESTONES
+ Milestones
Payload Preselection
Payload Confirmation
Spacecraft Invitation to Tender
Instrument Interface Documents
+ Planck
Issue 0/0
Issue 0/1
Issue 1/0
+ FIRST
Issue 0/0
Issue 0/3
Issue 1/0
+ Planck Telescope Specification
Issue 2
Issue 2/f
Issue 3
Instrument Meetings
FIRST/Planck Payload Meeting
Commonality Working Group
FIRST PACS Technical Meeting
FIRST HIFI Technical Meeting
FIRST SPIRE Technical Meeting
Planck LFI/HFI Technical Meeting
Planck
Planck Payload Architecture
ITT
Proposal Phase
Selection of Contractor
Definition Phase
Detailed Design Phase
Planck Payload Module Mockup
FIRST
FIRST and System Payload Interf. Studies
Definition
Dedicated Studies
Technology Development
FIRST Telescope
Baseline Technology (CFRP-NASA/JPL)
Backup Technology (SiC - ESA)
Findas
Prototype
CFRP Technology Review
Project Start 23SEP96
Project Finish 01OCT10
Data Date 26SEP97
Run Date 03JUL98
© Primavera Systems, Inc.
Early Bar
Progress Bar
FPD1
Sheet 1 of 1
FIRST/Planck Carrier Concept
Pre Phase "B"
esa

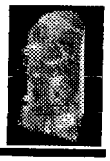
FIRST/ Planck

Payload Meeting

Summary of FSEC Recommendations

3 July 1998

PT-05628



FIRST instrument proposals reviewed by FSEC on behalf of AWG

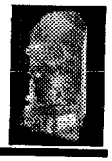
FSEC composition and meetings

Dr. M. Harwit	Cornell Univ., Ithaca, NY, USA (chairman)
Dr. P. Barthel	Kapteyn Astr. Inst., Groningen, NL
Dr. T-J. Curvoisier	ISDC, Versoix, CH
Dr. E. Kreysa	MPIfR, Bonn, D
Dr. J. Lequeux	Obs. de Paris, F
Dr. K. Menten	MPIfR, Bonn, D
Dr. S. Volonte	ESA HQ, F (secretary)

Members of FIRST project team and the project scientist provided technical support. FSEC met on four occasions: **5** and **17 March**, **6** and **17 April**. On 17 March the **PIs were invited**, and there was **continuous correspondance** between FSEC and the instrument teams.

FSEC overall conclusions:

- FSEC unanimously agrees that a **spectacularly exciting, astronomically rewarding** FIRST mission is **technically feasible**. However, ...
- **Funding** for science instruments needs to be **rapidly formalized** and realistic funding schedules defined, ...
- ... The instruments must be **capable** of **both exploring** the sky in this new wavelength regime, and **following up with more detailed**, astrophysically informative observations. ...
- ... data will have to be **processed and compressed onboard by a factor of up to 100** ... This scale of compression is **mission critical**. Its **feasibility needs to be demonstrated** at the earliest opportunity. ...
- ... the large international teams ... will require **tight management structures** ...
- ... **complementarity** offered by FIRST and Planck in mind as planning proceeds
- in view of **funding uncertainties** ... wide range of developments planned ... list of **"minimum-acceptable-capabilities"** ... encouraged to **exceed** these minimum requirements ... mission will **fall short** ... prime objectives if the payload fails top attain **any** of the listed capabilities.



FSEC defined minimum acceptable capabilities:

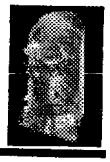
With proposed configurations as baseline, maximum acceptable restrictions:

PACS
- the size of each the 2 arrays must be at least 4x16 pixels
- the spectrometer must have at least R = 1000 (300 kms^{-1})

SPIRE
- proposed backup detector array
- spectrometer must have at least R = 100 (3000 kms^{-1})
- separate photometer and spectrometer not a requirement

HIFI
- all proposed frequency bands at (current) state-of-art performance (SOAP)
- minimum instantaneous bandwidth of 4 GHz
- velocity resolution 1 kms^{-1} ($R = 3x10^5$) or better

These are <u>not</u> proposed instrument configurations! This list is intended as a safeguard against 'indiscriminate cutting' beyond a critical point - seriously undermining the astronomical rationale - in an attempt to develop new technologies or to alleviate funding problems.



FSEC main recommendations:

FSEC recognised that **instrument technical development** and **definition, funding** (profile), and overall **FIRST mission schedule** are **all linked** and depending on each other.

Funding: - PIs: Critically assess instrument designs vs. science return and development effort
- Delegations: Ensure appropriate levels funding, ramped up sufficiently early
- ESA: Investigate whether it could find means to support ICCs

Data rates: - PIs: Demonstrate feasiblity of onboard data processing/compression
- ESA: Consider increasing allowed data production (=> increase telemetry) rate

Interfaces: - PIs/ESA: Agree on resources and interfaces - and comply

Schedules: - PIs: Delivery dates are critical - project delays in phase C/D extremely costly

Management: - PIs: Managerial task of handling complex instruments built by large dispersed teams requires rigorous management procedures agreed to by ESA

FSEC individual instrument points:

PACS:

- Ge:Ga detectors wellknown - but sensitivity to **radiation** needs thorough assessment (FIRST's environment more favourable than that of ISO)
- # of pixels vs. **beamsampling strategy** (fully efficient vs. fully sampled) / detector technology / data rate
- required **onboard processing** (re. radiation!) and **compression** feasibility

SPIRE:

- cf. PACS points **2** and **3** above
- assess **incorporating** a low resolution **spectrophotometer** (R ~ 20) into the photometer rather than having a separate spectrometer
- assess whether the chosen **spectrometer design** is optimal

HIFI:

- science impact of **gaps in frequency coverage** (band 1-6 i.e. 480-2700 GHz) acceptable
- assess science need for R ~ 10^7 (30 ms^{-1}) velocity resolution - optimise **backend complement**
- compatibility with spacecraft **pointing** requirements

FIRST/Planck
Payload Meeting
Summary of PSEC Recommendations

3 July 1998

PT-05628

Recommendations of the Planck Scientific Evaluation Committee (PSEC)

- The Planck mission of ESA is a uniquely important scientific programme for many aspects of cosmology. All cosmologists agree that it is the most important experiment for the first decade of the next millennium.

- PSEC is confident that instruments can be constructed which will enable the ambitious goals of the mission to be achieved.

Recommendations of PSEC: Performance

- *Sensitivity* (stability): development and testing plans to be established for all critical components
- *Foreground subtraction*: all LFI and HFI channels are required; more simulations/surveys if possible
- *Straylight*: more work needs to be carried out before the impact and requirements (e.g. testing) can be considered to be understood
- *Telescope*: current design is adequate -- but if possible accommodate a slightly larger one

Recommendations of PSEC: Technical issues

- Waveguides (LFI)
- Reference loads (LFI)
- Telemetry (LFI + HFI)
- Coolers (LFI + HFi)
- Thermal noise emission (HFI)

Integrated Data and Information System (IDIS)

- IDIS must emphasize "minimum objectives"
- IDIS and FINDAS must coordinate and/or share developments
- IDIS must be under strong management and have the full backing of both Consortia

Recommendations of PSEC: Management

- The instrument development management approach must be reviewed
- The management structures must provide a high level of coordination
- DPC organisation must be rationalised (smaller number of locations)
- Scientific responsibility must remain within the Planck Science Team

Recommendations of PSEC (2): Telescope

PSEC strongly believes that the current design of the telescope will be able to fulfil the scientific goals of the mission

PSEC was made aware of the possibility that a somewhat larger telescope could be accommodated within the spacecraft. The PSEC gives the highest priority to ensuring that the Planck mission proceeds on as fast a time-scale as possible, and that it remains within budget. During the forthcoming development phase, increase of the telescope aperture could be investigated by ESA, under the constraint that the very high performance of the current design is not compromised. The PSEC is unanimous in asserting that such studies should in no way delay the programme or result in increased cost.

Recommendations of PSEC (3): Performance

- *Sensitivity* is one of two areas of the proposals that causes the PSEC the most concern. For both the LFI and HFI, the issue is *stability*.
- Milestones and timeframes must be established to test the performance, and in particular the stability, of each of the many receiver units and of the complete system. A development with regular reviews should be established for all the critical components and their integration at system level.
- So far as is practical, the overall system should be tested in the laboratory and on ground-based telescopes.

Recommendations of PSEC (4): Performance

Good subtraction of foregrounds from the observed signal is a crucial step in the analysis of CMB observations. ... The PSEC therefore recommends that:

- *both LFI and HFI with all their frequency channels are included in the Planck scientific instruments*
- Simulations should be carried out on the assumption that rising-peak-falling-spectrum sources occur with peaks throughout the Planck range, and with realistic zodiacal and comet contributions.
- It will be of great value to the project if patches of the sky are surveyed from the ground at high resolution at as many of the Planck frequencies as possible, so that the contributions of unsubtracted foregrounds can be estimated.

Recommendations of PSEC (5): Performance

The issue of *straylight* analysis, control, and measurement is one of concern to PSEC, and one that must be well understood before the success of the mission can be guaranteed. ... Further simulations and analysis need to be carried out and confirmed by experimental measurements...

PSEC recommends that, within the next year, an increased effort is undertaken by all parties: ESA, industry and the LFI and HFI Consortia, the objective being to arrive at a common straylight control strategy, to ensure that the overall payload design is considered adequate from the straylight point of view before it is frozen, and to put in place a realistic on-ground and in-flight straylight measurement, test, and verification plan.

Recommendations of PSEC (6): Technical issues

- *Polarisation*: the PSEC endorses the attempt to measure small scale polarisation with both instruments.
- *Coolers*: the PSEC recommends, that the cooler developments, that is the 20 K sorption cooler, the 4 K cooler and the 0.1 K dilution cooler are covered by an adequate separate development plan and are systematically reviewed up to instrument delivery
- *Thermal noise emission (HFI)*: the PSEC recommends a joint effort between the HFI and the Project to simulate the magnitude of the effects and to implement a feasible technical solution

Recommendations of PSEC (7): Technical issues

- *Waveguides*: the PSEC recommends that the LFI systematically review the possibility of using flexible waveguides, or introducing short sections of flexible waveguides for this interface, instead of rigid ones.
- *Reference Loads (LFI)*: the PSEC recommends that the LFI considers reference loads at 20 K and conducts a thorough joint investigation with HFI of the possibility of using the 4 K loads, before any decision is taken on implementation.
- *Telemetry*: the PSEC recommends a common sampling and transmission policy for both the HFI and the LFI to promote operational and data processing flexibility

Recommendations of PSEC (8): DPCs

The DPC manpower levels remain high and rather uncertain. The DPC figures also appear to include no contingency...

- Producing a realistic and more detailed plan for Planck processing and the actual resources required must be a high priority item.
- IDIS and FINDAS: The PSEC supports the project recommendations, supported by both instrument Teams, that efforts continue to coordinate and wherever possible, share development of common elements of these two systems.

Recommendations of PSEC (9): DPCs/IDIS

- IDIS development should emphasize the setting of common standards for data storage, data transfer and program control based, as far as practical, on current practice.
- IDIS development should avoid the creation of new software tools where adequate tools already exist.
- The Planck teams should ensure that IDIS development is under strong management control, and that at all times the direction IDIS is taking has the full backing of the teams.
- The Project team should generate an overall management and implementation plan and a schedule with major milestones/deliveries

Recommendations of PSEC (10): DPCs/Management

Although the PSEC recognises that the Planck teams have already made compromises to make their consortia viable, it recommends that:

- continuing efforts are made further to rationalise the organisation of the data processing so as to involve a smaller number of geographical locations;
- emphasis is placed on ensuring that the necessary management structure is in place to provide the required high level of coordination between the different parts of the data processing teams
- Public networks: availability, total available bandwidth, behavior under load conditions, costs, security, and so on, need to be properly assessed.

Recommendations of PSEC (11): Management

The development of... LFI and HFI, involves contributions from a considerable number of institutions, comparable to ESA spacecraft developments, and requires effective and strong management structures. ... The PSEC considers that the proposed organisations are not yet optimised...

The PSEC recommends that the proposed management approaches should be reviewed, in conjunction with the ESA project, to identify possible improvements and changes during the build-up of the teams for the development phases of the instruments

Recommendations of PSEC (12): Science/Management

...the Instrument Teams have proposed that the Planck Science Team set up an International Science Committee with the aim of coordinating the activities of the LFI, the HFI and the Telescope Provider through the development, commissioning, operational and post-operational phases...

The PSEC supports the view that the coordination of scientific activities associated with the mission is of central importance, particularly in the organisation of workshops to inform the community of progress and the scientific capabilities of the mission. It believes, however, that these responsibilities should remain with the PST, which should make appropriate arrangements for coordinating all scientific activities associated with the project.

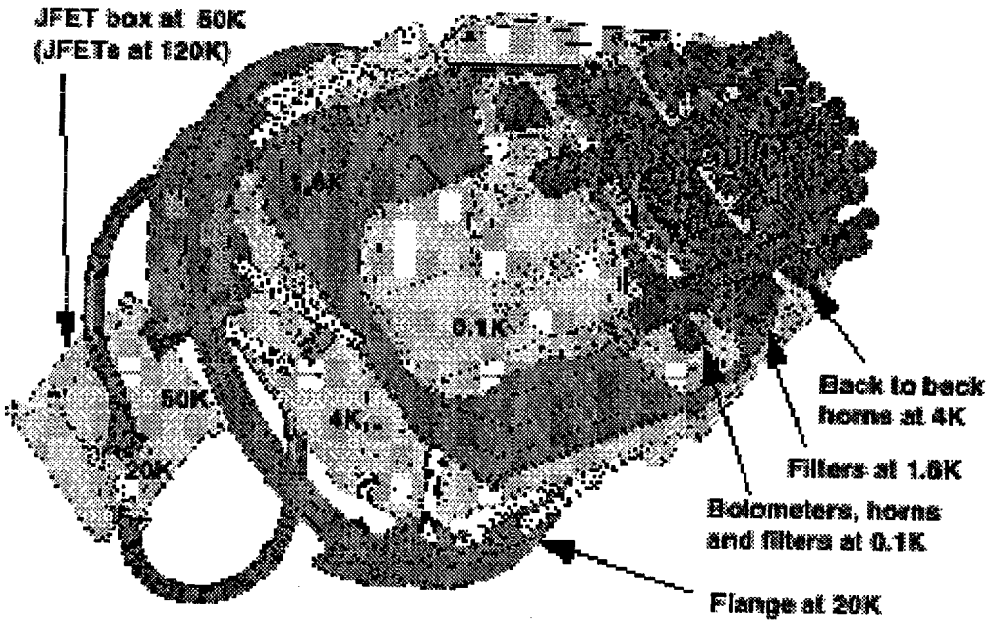
FIRST/ Planck

Payload Meeting
Payload Hardware

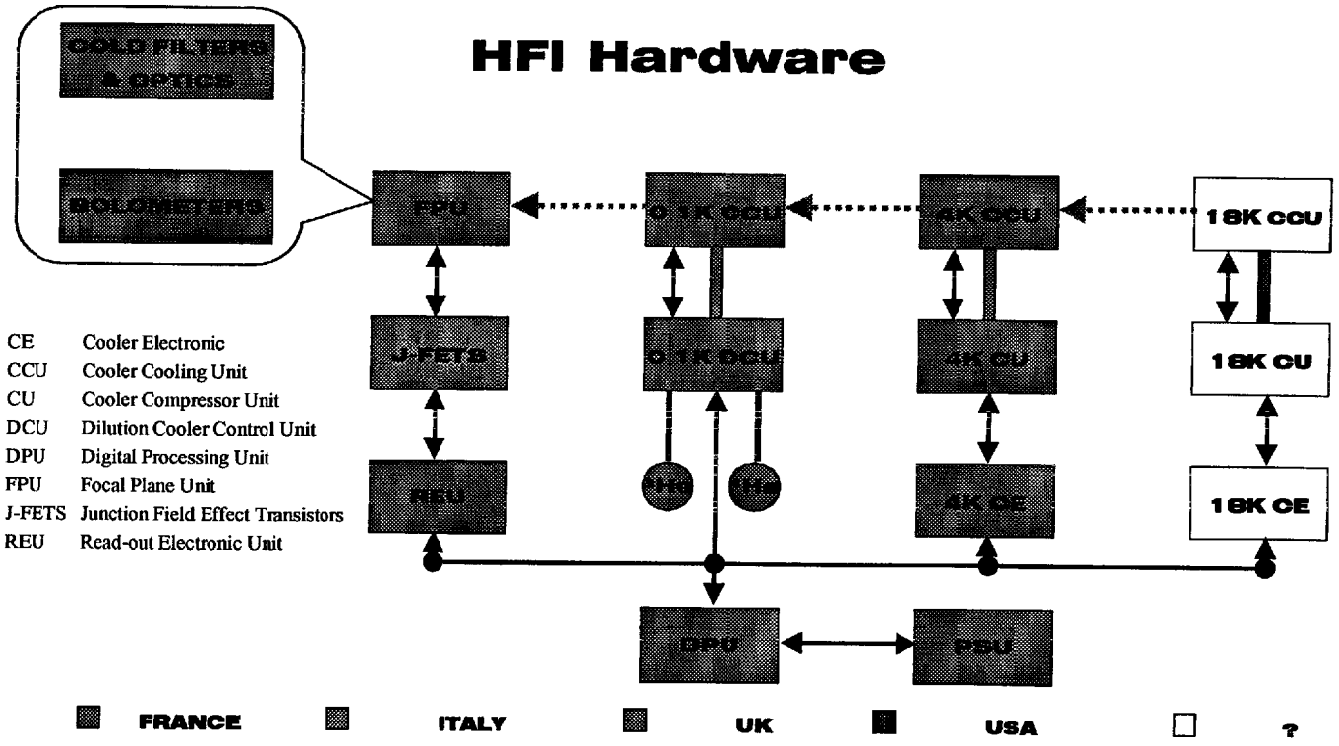
3 July 1998

PT-05628

HFI Focal Plane Unit (FPU)



HFI Hardware



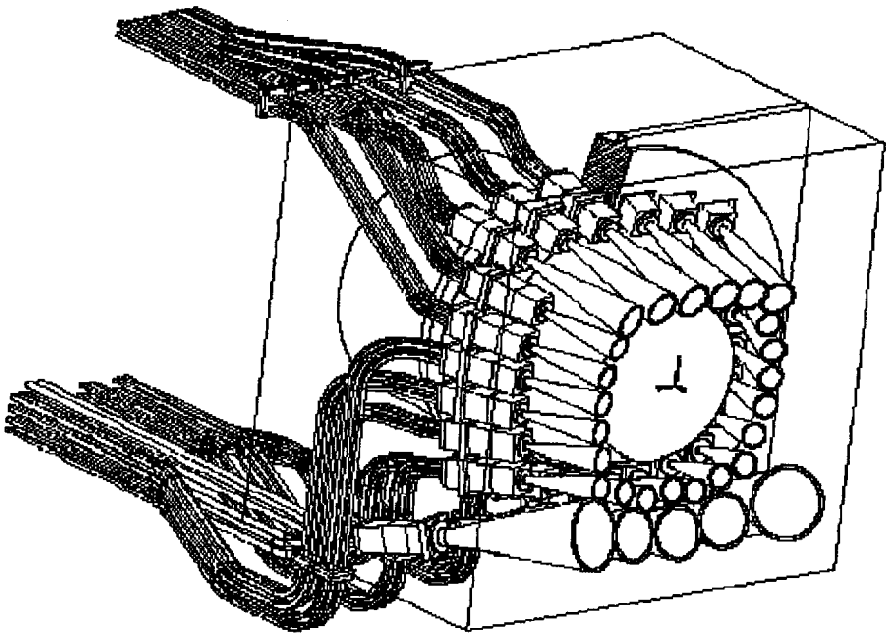
CE	Cooler Electronic
CCU	Cooler Cooling Unit
CU	Cooler Compressor Unit
DCU	Dilution Cooler Control Unit
DPU	Digital Processing Unit
FPU	Focal Plane Unit
J-FETS	Junction Field Effect Transistors
REU	Read-out Electronic Unit

HFI Main Tasks

FRANCE	**Project Management**
	Product Assurance
	System Design
	On_board Software
	AIV & Calibration
	EGSE
UK	**Integration & Tests of Detectors Block**
	Integration & Tests 18K & 4K Coolers
IRELAND	**Feed-Horn Design**

esa

FIRST/ Planck



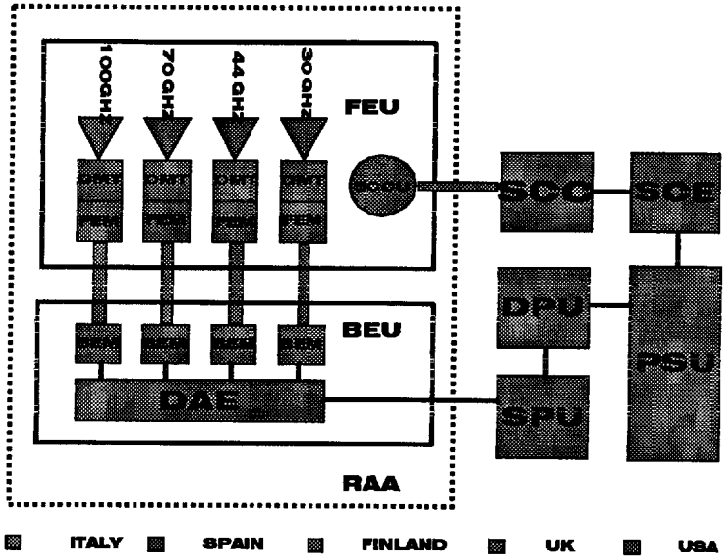
LFI Focal Plane Unit

3 July 1998

PT-05628

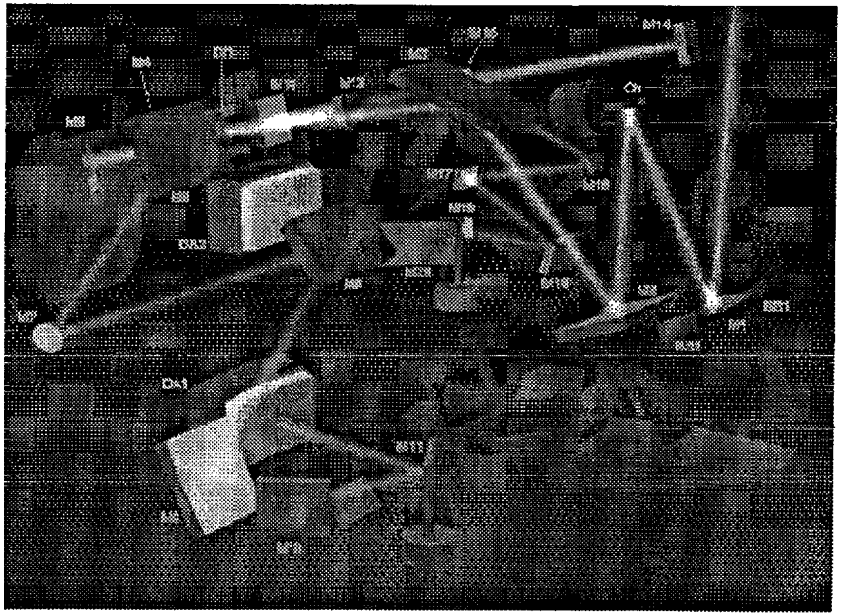
BEM	Back End Module
BEU	Back End Unit
DAE	Data Acquisition Electronic
DPU	Data Processing Unit
FEM	Front End Module
FEU	Front End Unit
OMT	Orthomode Transducer
PSU	Power Supply Unit
RAA	Radiometer Array Assembly
SCC	Sorption Cooler Compressor
SCE	Sorption Cooler Electronic
SCCU	Sorption Cooler Cooling Unit

LFI HARDWARE



LFI Main Tasks

ITALY	**Project Management** **Product Assurance** **AIV & Calibration** **System Design** **Thermal and structural Analysis**
ITALY or NORWAY	**EGSE**
FINLAND	**Pre-Integration of 70GHz Radiometer**
UK	**Pre-Integration of 30 & 44GHz Radiometers**
SWEDEN	**MMIC Engineering & Design**
USA	**Radiometer Design & Prototyping**

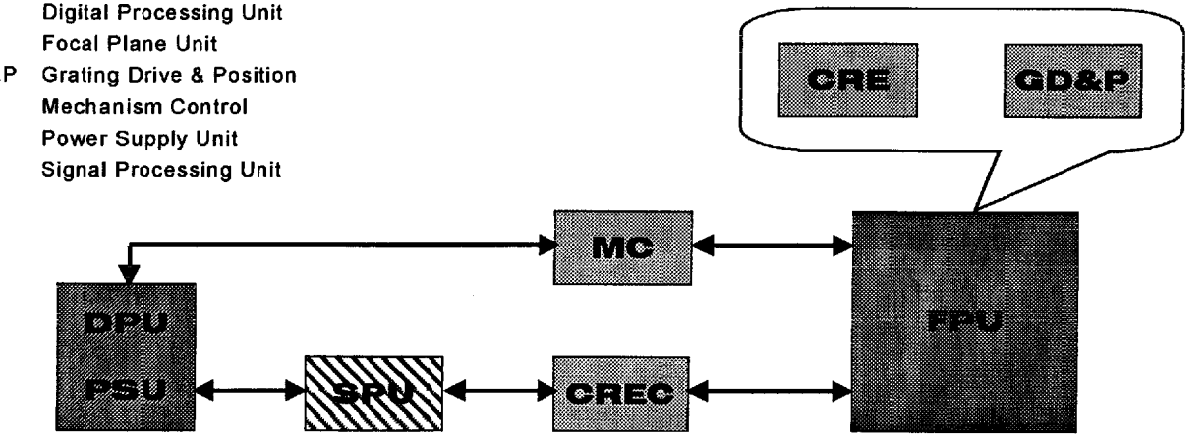


PACS Optics in Photometry Mode.

3 July 1998 PT-05628

PACS HARDWARE

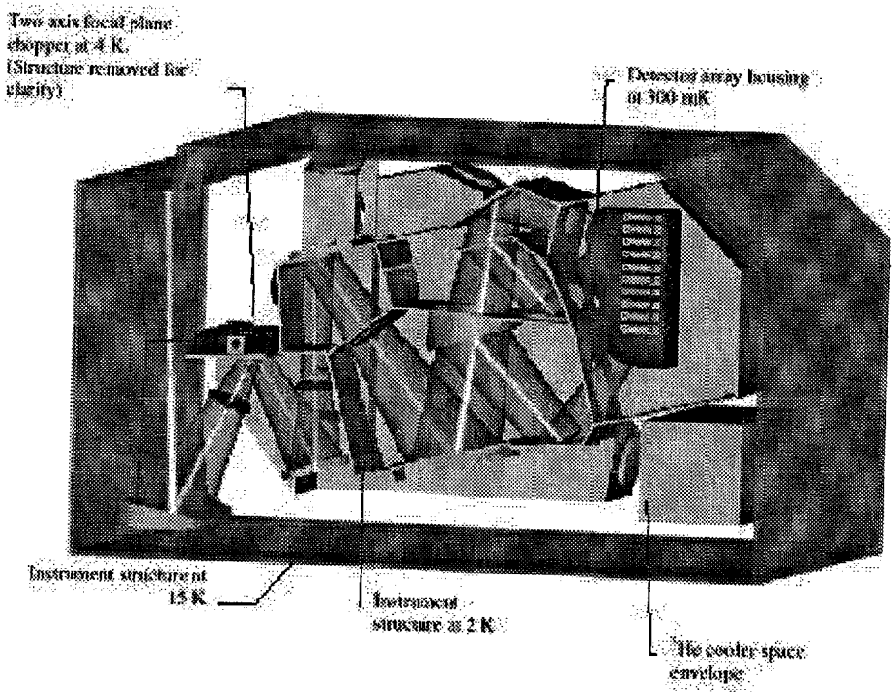
CRE	Cold Read-out Electronic
CREC	Cold Read-out Electronic Control
DPU	Digital Processing Unit
FPU	Focal Plane Unit
GD&P	Grating Drive & Position
MC	Mechanism Control
PSU	Power Supply Unit
SPU	Signal Processing Unit



GERMANY BELGIUM ITALY SPAIN & AUSTRIA

PACS Main Tasks

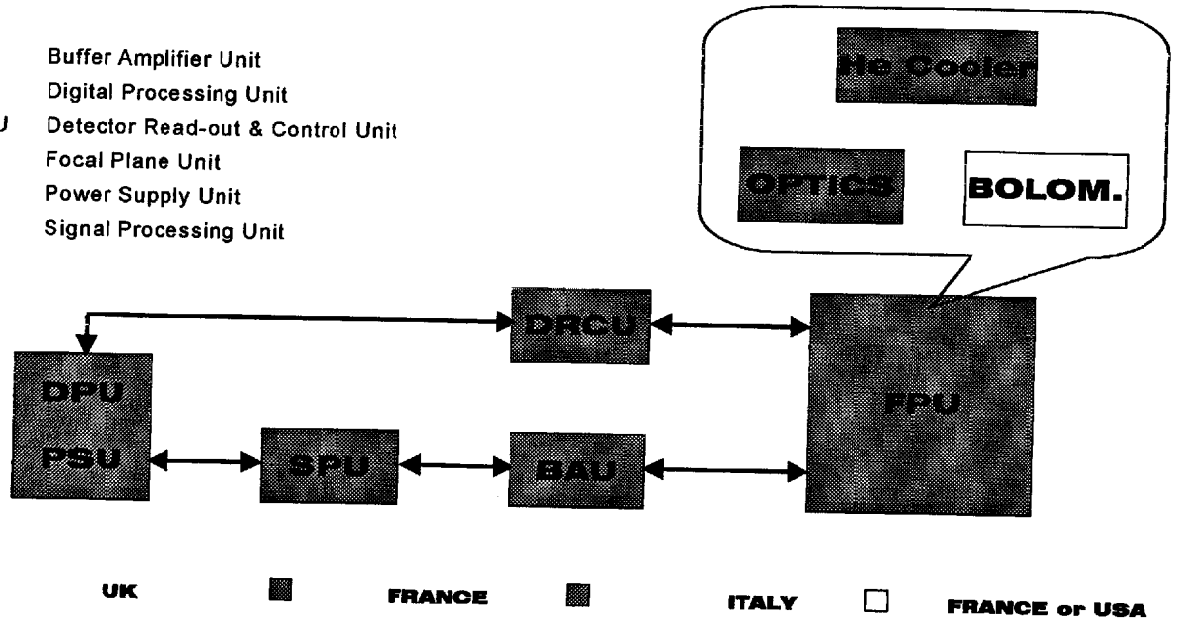
GERMANY	**Project Management**
	Product Assurance
	System Design
	EGSE
	AIV & Calibration
BELGIUM	**Support to AIV & Calibration**
FRANCE	**Cryo-vibration of FPU**
AUSTRIA	**Signal Processing Software**
ITALY	**Spacecraft Simulator**
	Support to AIV & Calibration



SPIRE . Conceptual Drawing.

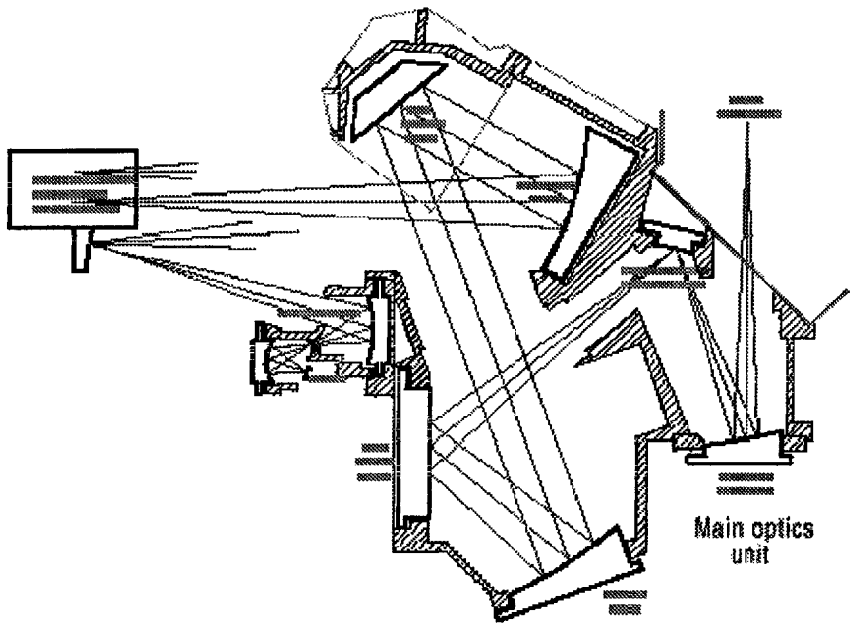
SPIRE HARDWARE

BAU	Buffer Amplifier Unit
DPU	Digital Processing Unit
DRCU	Detector Read-out & Control Unit
FPU	Focal Plane Unit
PSU	Power Supply Unit
SPU	Signal Processing Unit



SPIRE Main Tasks

UK	**Project Management**
	Product Assurance
	System Design
	AIV & Calibration
	EGSE
FRANCE	**Participation to System Design**
	Support to Calibration
	Cryo-vibration of FPU
SWEDEN	**Instrument Simulator**

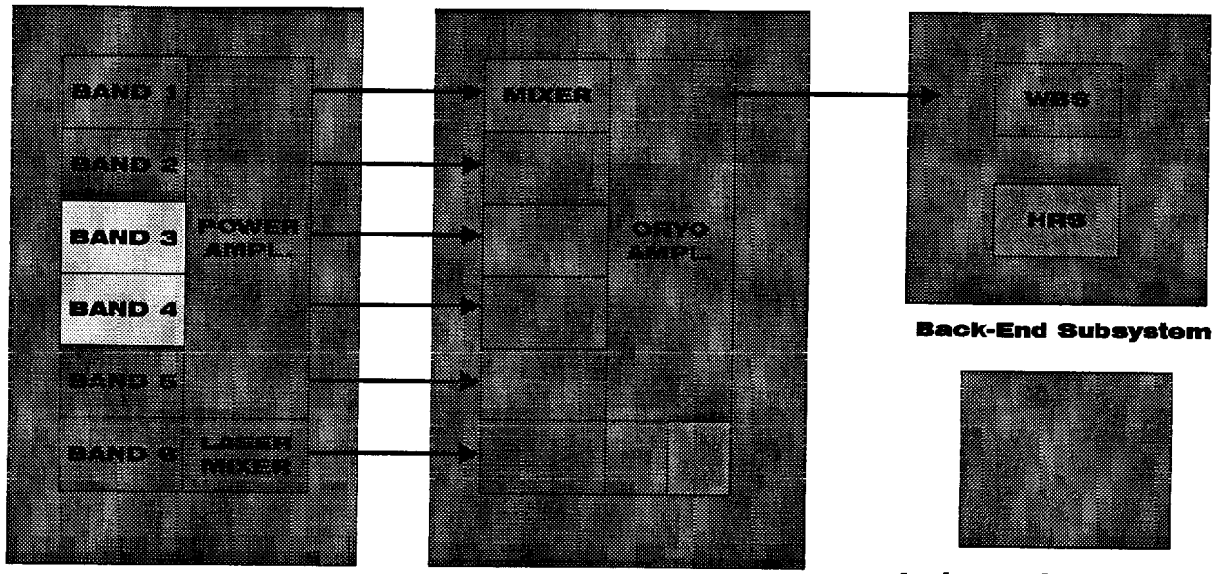


HIFI Common Optics Layout

3 July 1998

PT-05628

HIFI HARDWARE



HIFI Main Tasks

NETHERLANDS	**Project Management**
	Product Assurance
	System Design, AIV & Calibration
	Focal Plane Unit: Design, AIV, Calibration
GERMANY	**Local Oscillator S/S: Design, AIV, Calibration**
	Wide Band Spectrometer Design, AIV, Calibration
FRANCE	**Back-End Subsystem: Design, AIV, Calibration**
SWEDEN	**Testing of Optics and Mixers**
CANADA	**Local Oscillator Control Unit**

FIRST/ Planck

Payload Meeting

Payload Ground Segment

3 July 1998

PT-05628

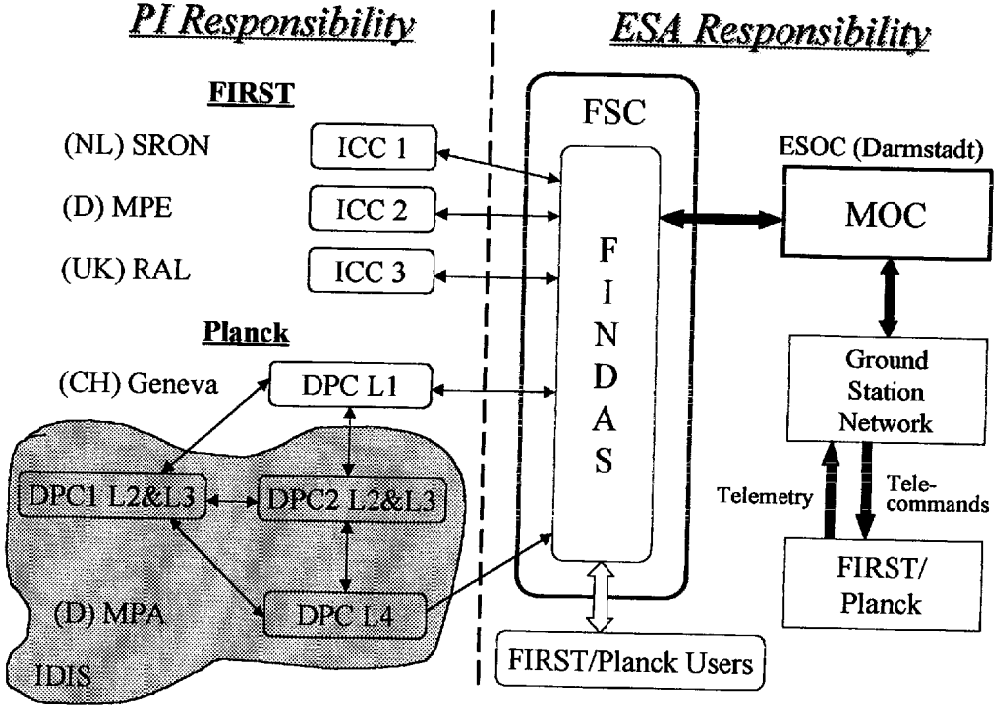


Fig. 1 FIRST/Planck Ground Segment (Simplified View)

ICCs (Instrument Control Centres) FIRST

Main Features:

- Set-up and operated by the Instrument Teams
- One ICC per Instrument (located @ PI Institute)
- Optimum use of Instrument Team expertise
- No direct interaction with Observers (FSC task)

Main Tasks:

- Define Instrument Telemetry, Telecommand and modes
- Develop software and procedures for:
  - operations support
  - data analysis and quality checking
- Calibrate Instruments (pre- and post launch)
- Support operations (all phases)
- Support archive phase

FSC (FIRST Science Centre)

Main Features:

- Set-up and operated by ESA
- Located in an ESA member state (e.g. Villafranca)
- Serves both FIRST and Planck

Main Tasks:

- Overall FIRST Science Coordination
- FIRST Science Mission Planning
- Support to Science Community (Helpdesk) and OTAC (FIRST)
- Communication with the MOC (FIRST and Planck)
- Set-up, management and maintenance of FINDAS
- Distribution of Telemetry to ICCs and DPCs
- Systematic Data Quality Control (TBC)
- Archiving of Mission Products

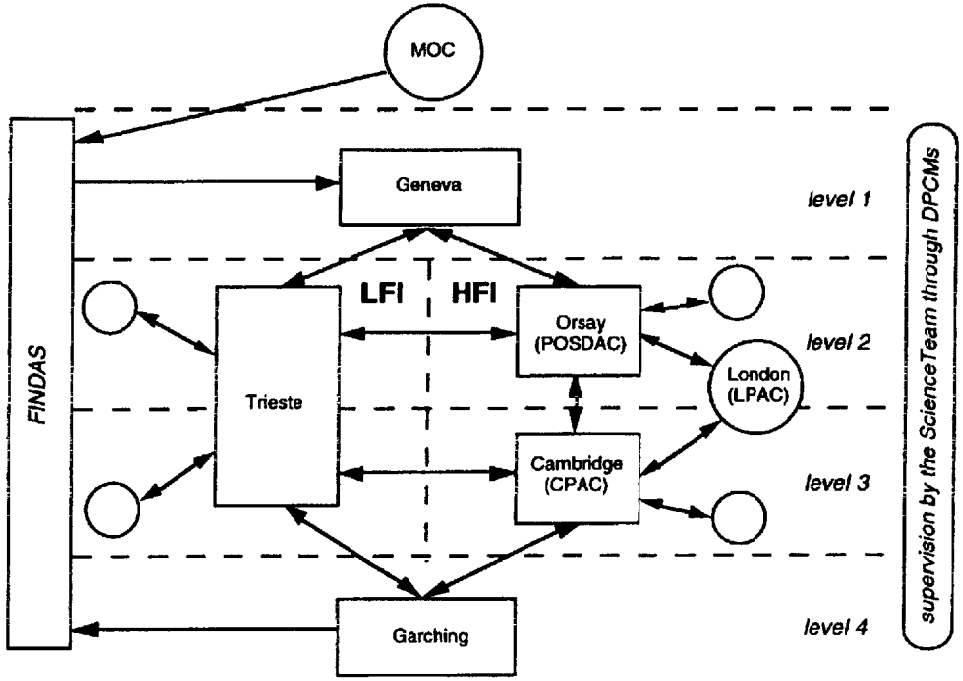


Fig. 2 Planck Data Processing Distributed Structure

DPCs (Data Processing Centres) - Planck

Main Features:

- Set-up and operated by the Instrument Teams and Telescope Provider
- One (distributed) DPC per Instrument
- Four (4) "levels" of Data Processing (L1 to L4)
- IDIS (Integrated Data and Information System) ensures intra- and inter-consortium information exchanges

Main Tasks:

- Telemetry Processing and interaction with MOC (L1) - common
- Data Reduction and Calibration (L2) - one per DPC
- Component Separation and Optimisation (L3) - one per DPC
- Generation and Archiving of final products (L4) - common

MOC (Mission Operations Centre)

Main Features:

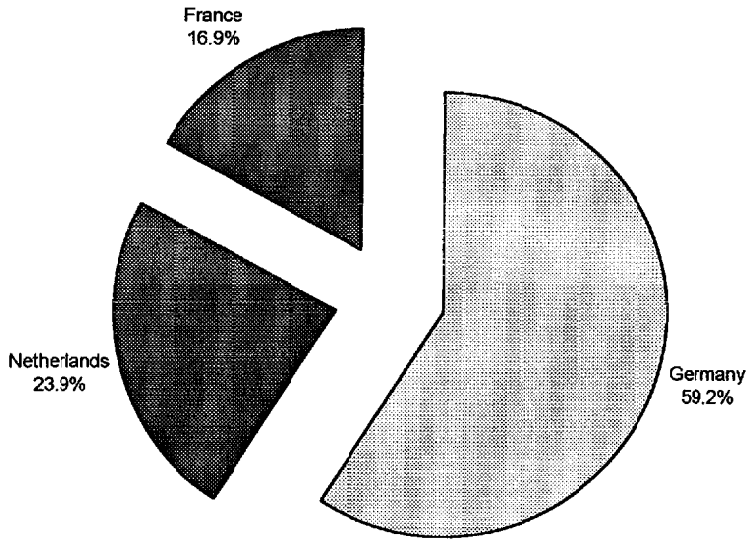
- Located at ESOC (Darmstadt, Germany)
- Supports FIRST and Planck (simultaneously)
- Overall operational responsibility (Spacecraft and Instruments)

Main Tasks:

- Support overall Ground Stations network and communications
- Receive, store and distribute (through FINDAS) all Telemetry (Spacecraft and Instruments)
- Generate and issue all commands (Spacecraft and Instruments)
- Orbits and attitude determination and control

FIRST HIFI Instrument Control Centre (ICC)

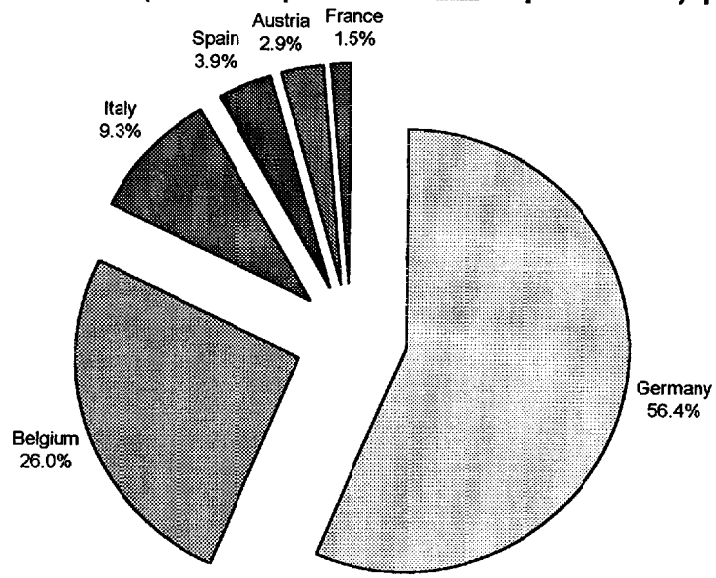
Overall Contributions (Development and Operation) per country



Total Cost: 14.2 MECU (Archive Phase not included)

FIRST PACS Instrument Control Centre (ICC)

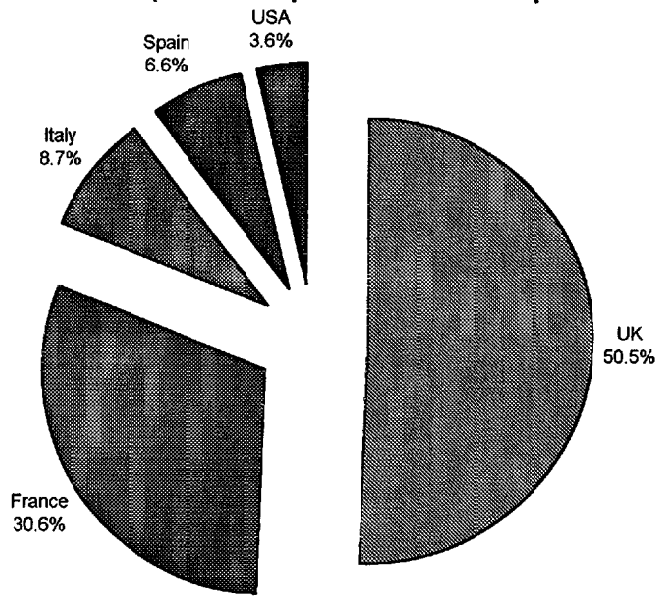
Overall Contributions (Development and Operation) per country



Total Cost: 20.4 MECU (Archive Phase included)

FIRST SPIRE Instrument Control Centre (ICC)

Overall Contributions (Development and Operation) per country

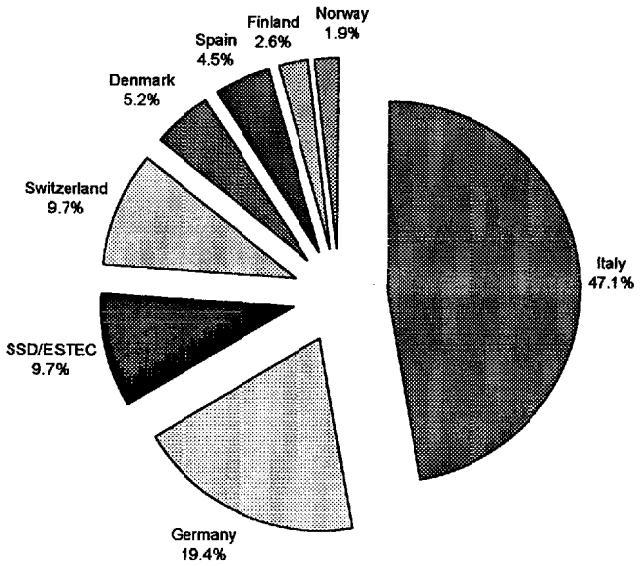


Total Cost: 19.6 MECU

Planck Data Processing Centres (DPCs)

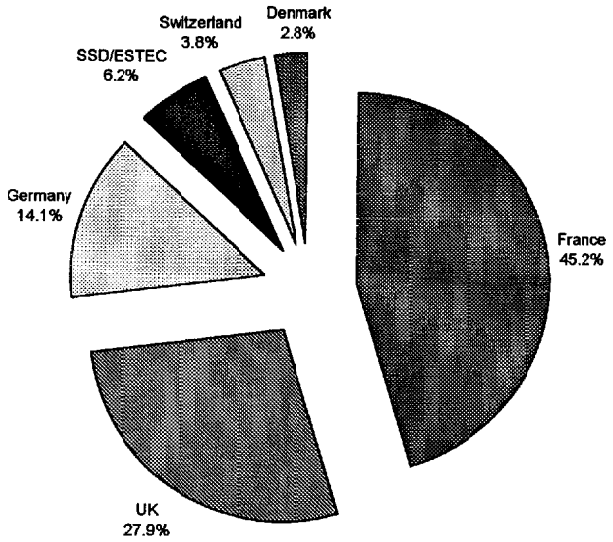
Overall Contributions (Development and Operation) per country

LFI DPC



Total Cost: 15.5 MECU

HFI DPC



Total Cost: 29.0 MECU

Ground Segment related activities for the next 6 months

Project:

- Firm up overall Ground Segment Concept for the "Carrier" baseline
- Complete FINDAS prototype implementation - delivery to ESTEC February 1999

All:

- Strengthen IDIS-FINDAS collaboration - maximise commonality/ synergy
- Pursue "commonality" (hardware and software) efforts

Ground Segment related activities for the next 6 months (cont'd)

All:

- Consolidate FSC, ICCs and DPCs Implementation Plans
- Re-fine manpower / cost estimates taking into account:
  - Launch in 2007
  - "Carrier" baseline
  - Distribution (re-distribution) of work
  - Funding constraints
  - Three programme phases:
    - Development
    - (In-Orbit) Operations
    - Post-operations

FIRST/ Planck

Payload Meeting

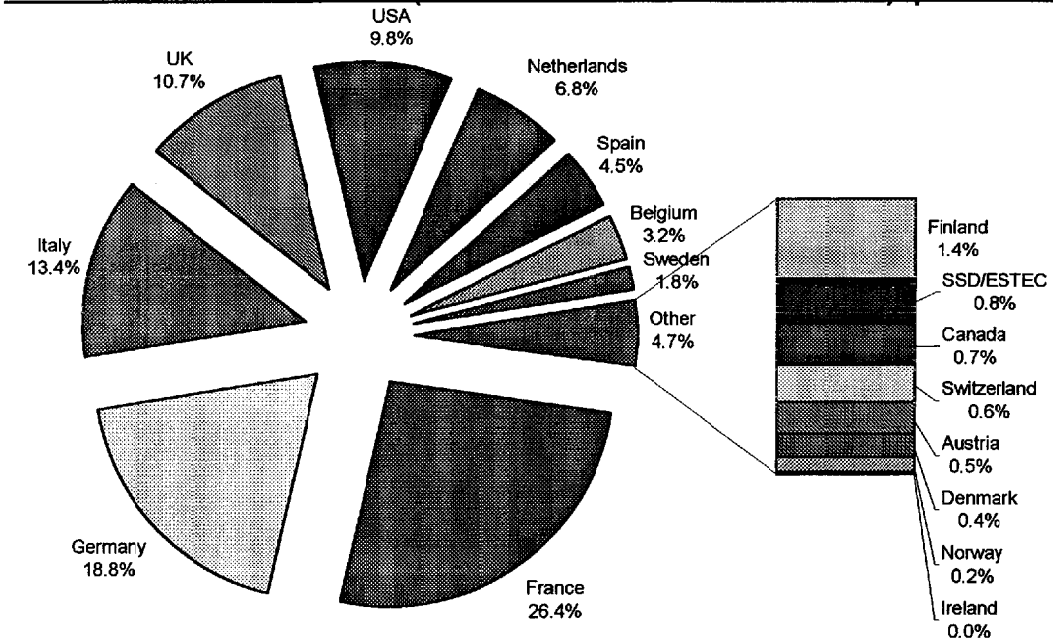
Payload Total Cost Overview

3 July 1998

PT-05628

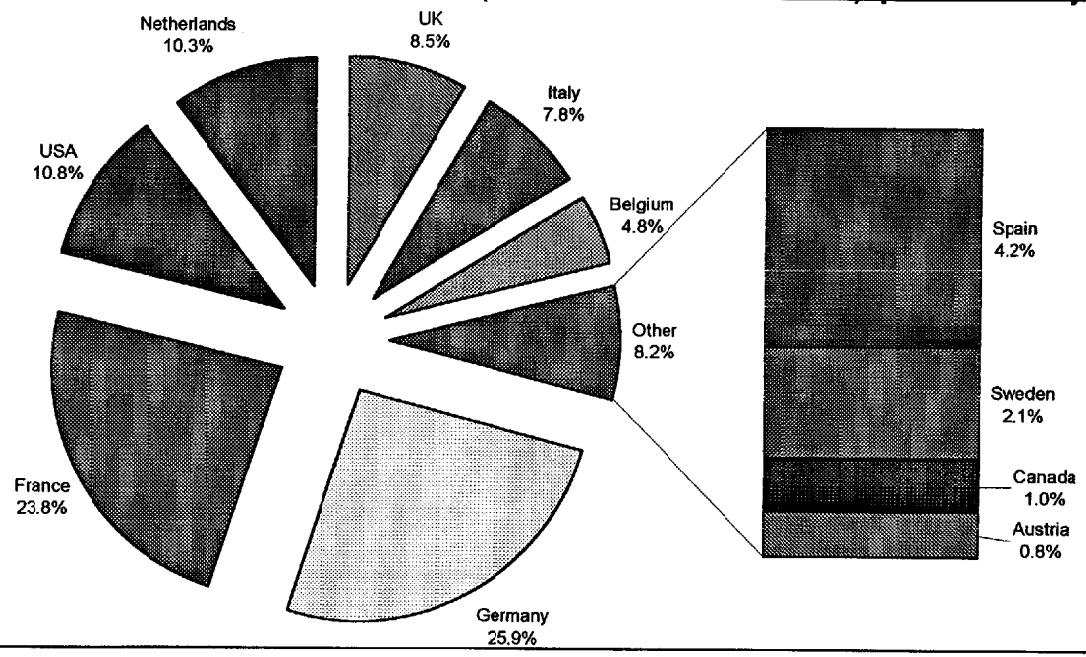
FIRST/Planck TOTAL PRINCIPAL INVESTIGATOR EFFORT

Overall Contributions (Instrument and ICC/DPC) per country



FIRST TOTAL PRINCIPAL INVESTIGATOR EFFORT

Overall Contributions (Instrument and ICC) per country



Planck TOTAL PRINCIPAL INVESTIGATOR EFFORT

Overall Contributions (Instrument and DPC) per country