FIRST/Planck Payload

Summary Minutes of the meeting held on 3rd July 1998 at ESA Headquarters, Paris

The Agenda is attached as well as the list of participants (Annex 1).

F. Felici, Project Manager, was unable to attend due to his involvement as leader of the SOHO recovery team.

1. Introduction

The Chairman, S. Volonte, clarified the scope and aims of the meeting. Following the decision at the SPC meeting of 28-29 May to implement the FIRST/Planck carrier as the preferred option, this was the first opportunity for the funding agencies, PI teams and the Executive to address payload and science ground segment issues such as project schedule, instrument development programme, delivery dates, funding situation, repartition of tasks, management, etc., taking into account the recommendations of the Evaluation Committees.

The aim was to initiate a series of activities, both at project level as well as in the instrument consortia, leading to a start of phase B in early 2001. To achieve this goal, it was imperative to finalise the instrument definitions in order to freeze the spacecraft interfaces in time for the release of the ITT phase.

The other goal was to lead to the confirmation of the payload by SPC not later than the February 1999 time frame.

2. Schedule update

The Project (T. Passvogel) presented the new project schedule based on the carrier option, leading to a launch in early 2007.

A more detailed schedule was given for the preparatory activities leading to the start of phase B in early 2001. ESA was in the process of selecting a payload architect for the definition of the Planck module.

With regard to FIRST, dedicated studies would be initiated somewhat later than Planck. The schedules are shown in the attached handouts (Annex 2).

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Inputs from the FIRST and Planck instrument teams are needed for both studies by the end of the year.

3. Presentation of the Proposals

3.1 The proposals were introduced by the respective PIs, emphasising the main scientific objectives, the instrument concepts, the division of responsibilities within the consortia and the critical developments.

The presentations are summarised in the attached handouts (see Annex 3). The PIs were asked to highlight the complementarity of the FIRST instrument capabilities and science objectives with those of NGST.

3.2 The Project Scientists summarised the conclusions of the FIRST and Planck respective Evaluation Committees, emphasising the most saliant recommendations.

The point was made regarding the need to demonstrate as soon as possible the instrument on board data compression (PI task) and settle the question of the maximum available spacecraft telemetry rate (ESA task).

The recommendations are summarised in the handouts attached as Annex 4.

3.3 The work breakdown for each proposal, emphasising the involvement of each Member State was presented by the Project (M. Anderegg) with the aid of coloured diagrams. The Project also detailed the repartition of tasks. It was noticed that, for some instruments, the division of responsibilities needed to be updated. The relevant PIs agreed to provide the corresponding information by the end of the following week. The handouts are attached as Annex 5.

The same information was provided by the Project (P. Estaria) regarding the FIRST and Planck science ground segments. The handouts are also attached (see Annex 6).

A payload cost overview was presented which included the repartition among the Member States of the total cost estimates (hardware, software, manpower) as derived from the proposals. This is also attached (see Annex 7).

4. Funding status and priorities

Each delegation in turn clarified its position as to the funding support to each instrument, the schedule and priorities. This is summarised below:

Belgium Belgium will be heavily involved in the PACS instrument. A funding request for the full Belgian involvement will be made in

1999 in preparation for a decision to be made in the time frame of the next Ministerial Council meeting in 1999. In the meantime, a small funding slice will be made available through Prodex.

Denmark

Denmark is providing the 2 telescope reflectors. There are 2 sources of funding: DSRI and the National Science Research Council. The DSRI funding is secured but the delayed launch to a 2007 date is introducing a problem since the Research Council cannot commit on such long time scales (<5years). An early agreement with ESA on the Telescope Reflector Programme Plan is now essential.

Finland

The involvement is in the LFI for which no decision has been taken as to the budget allocation. At present, the request detailing the work foreseen is under preparation for a formal decision to be made in 1999. There is no funding problem for the short-term work.

France

By order of decreasing priorities, the largest French involvement is in HFI, with a French PI. There will be a significant involvement in SPIRE, followed by a smaller involvement in PACS and finally also in HIFI.

The launch delay to 2007 has allowed to introduce a contingency margin but there are problems with the spending profile (delivery dates).

Regarding HIFI, a modified proposal is being discussed with the French CoPI to make it compatible with the available funding. Regarding the planned vibration tests foreseen at LAS Marseilles for PACS, SPIRE and HIFI, CNES considers that these should all be carried out at single facility which could be ESA provided. Moreover, CNES believes that each instrument consortium should have a Steering Committee involving the funding bodies. This Committee should not be involved in scientific or technical issues.

Germany

Based on the 1997 strategic paper establishing its new space policy, Germany is preparing a space plan for the period 1999-2005. However, on the basis of the funding existing until 2002, no funding will be available before 2000. For 1998/1999 solutions are being sought.

Regarding Planck, the funding for the German involvement exists and no schedule problems are foreseen.

For PACS, uncertainties remain as to the level of industrial involvement. No proposal from industry has yet been provided.

The new schedule, with a launch in 2007, requires a new spending profile to be agreed.

Regarding HIFI, the level of the French participation needs to be clarified and the question of the participation of DLR Berlin must be resolved.

The overall situation is that currently the total level of funding is 15 to 20 % too low up to 2002, the main problem being the funding need for the period 1998/1999.

It was stated that DLR was no longer involved in PACS.

In addition, a request for riders to two TRP contracts (FIRSA, Ge:Ga detectors for PACS and mixer developments for HIFI) has been made in April. A decision is still pending. These riders are very important for the future development of both instruments. ESA is asked to look into this issue.

Italy — The participation in the FIRST/Planck programme is supported by the Italian science community. The highest priority is the LFI instrument on Planck, followed by participation in all three FIRST instruments and ICCs. A decision regarding the level of involvement, especially the confirmation with respect to the FIRST instruments, will be taken in the September/October 1998 time frame.

Netherlands — The Dutch involvement is in the HIFI instrument. This has been included in the SRON long term plan, which extends up to 2006/2007. The bulk of the necessary funding will be covered. A special request has been made to the Ministry of Science for the remainder. The formal approval is expected for the end of 1998. However, the spending profile is not compatible with the FIRST/Planck schedule. Pre-financing will be needed.

Spain — The Delegation confirmed its support to the Spanish involvement in FIRST/Planck. A request for funding has been made and can be considered as approved although formal approval will not take place before end 1998 / early 1999.

Sweden — The Swedish involvement is secured for SPIRE and the HIFI correlator. The level of funding for the HEMT of HIFI and LFI is not yet secured. Still under discussion are the Onsala tests for HIFI. Finally, the HEB development for HIFI will be on a best effort basis.

Confirmation for the HEMT involvement is expected by the SPC meeting in early 1999.

Switzerland The Swiss involvement is essentially in the ground science segment of Planck. It will ensure level 1 processing for both LFI and HFI DPCs. The level of funding is being agreed. A formal decision will be coming by the end of 1998.

UK UK proposals cover both the FIRST and Planck payloads. Science and cost reviews have already been carried out and have resulted in a prioritisation of the proposals.

At present, two main packages are expected to have a firm funding commitment; the HFI focal plane system with the 4 K cooling stage and data processing, the PI-ship for SPIRE with the overall management, detector system, AIV, chopper, data processing and ICC (at a level equivalent to that provided to ISO).

A funding decision has yet to be made for the following three packages: the receivers for the LFI, the SPIRE focal plane unit structure, the SPIRE ICC activities equivalent to those funded by ESA on ISO. However, the present planning assumptions allow only one of these three activities to be supported. The level of support will depend on a formal decision on the total budget envelope to be made by early 1999.

All the other proposals (PA support for cooler activities of HFI, LFI engineering support, HIFI 800-1120GHz detectors and EGSE for HFI) will not be funded.

5. Discussion

Following the statements made by the delegations, some PIs commented on their areas of concern.

The SPIRE PI was very concerned as to the level of funding in the UK, in particular for the SPIRE focal plane unit structure which, considering the other areas to be supported, was short of funding by as much as 20-30 %.

The FIRST PIs were collectively concerned with two problems; the possible unavailability of LAS for the cold vibration tests (pending decision by CNES) and the level of Italian involvement in the DPUs for the three instruments.

With regard to the schedule, the delegations indicated a general problem with the spending profiles, in particular the need for early funding in 1998/1999.

Commonality in the ground segments and flight hardware was stated to be very important. Co-ordinated Parts procurement was mentioned as a way to achieve savings across the board.

6. Plans for the next 6 months

The Project presented again the schedule of activities leading to start of phase B in early 2001, emphasising the inputs needed from the instrument teams in the period mid 98 – mid 99. It was agreed that the Project would arrange separate technical and programmatic meetings with each PI to agree on the planning of the studies and development schedule for the period up to phase B. It was also agreed that a next payload meeting would be arranged in the October time frame, to review the situation. In any case, a report would be made by the Executive at the November 1998 SPC meeting.

***

FIRST/Planck Payload meeting
3rd JULY 1998
ESA, HQ, Paris
Room 123 (Cinema)
*(starting **09.00** hrs)*

DRAFT AGENDA

1.	Introduction by ESA		ESA
2.	Schedule Update		Project
3.	Presentation of the Proposals		
	3.1	Summary of the Proposals	PI's
	3.2	Summary of FSEC and PSEC recommendations	Project Scientists
	3.3	Presentation of Work Breakdown Structure - Payload hardware - Payload ground segment	Project
	3.4	Identification of critical developments	PI's and Project
4.	Funding status and priorities		SPC Delegations
5.	Discussion		
6.	Plans for the next 6 months		

ANNEX 1

FIRST/Planck Payload meeting

3rd July 1998
ESA Headquarters

LIST of PARTICIPANTS

SPC Delegations	Participants
Belgium	J. Bernard
Denmark	E. Friis-Christensen
Finland	S. Urpo K. Ahola
France	R. Bonneville M. Rougeron M. Joubert
Germany	M. Otterbein A. Himmes
Ireland	B. O'Donnell
Italy	G. Setti
The Netherlands	J. Bleeker
Spain	C. Hernandez M. Serrano
Sweden	P. Magnusson
Switzerland	S. Berthet
United-Kingdom	D. Hall M. Cruise

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***Participants** (cont'd)*

PI teams

HIFI	T. de Graauw	E. Caux
	H. Aarts	J. Stutzki
PACS	A. Poglitsch	
	C. Waelkens	
	O. Bauer	
SPIRE	M. Griffin	K. King
	L. Vigroux	R. Carvell
HFI	J.-L. Puget	J. Charra
	G. Efstathiou	
LFI	N. Mandolesi	S. White (also member of HFI team)
	R. Rebolo	J. Tuovinen
TP	H.U. Nørgaard-Nielsen	
	P. R. Christensen	

ESA

S. Volonte	T. Passvogel
M. Anderegg	G. Pilbratt
P. Estaria	J. Tauber

FIRST/Planck Payload meeting – 3rd July 1998
ESA HQ, Paris

Summary Minutes

ANNEX 2

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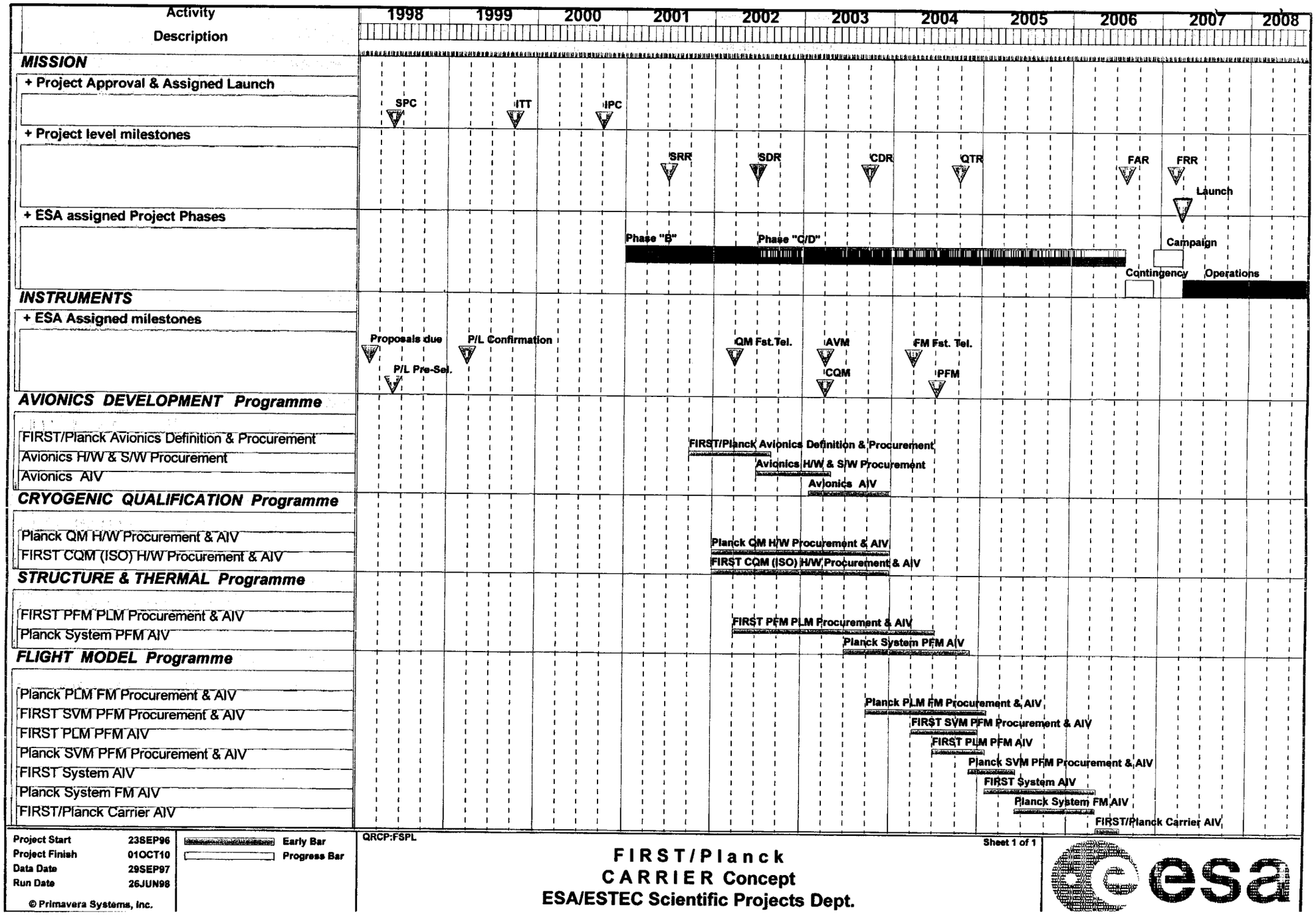
FIRST/Planck

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 Pre-Sel.
P/L Confirmation
QM Fst.Tel.
AVM
CQM
FM Fst. Tel.
PFM
AVIONICS DEVELOPMENT Programme
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
STRUCTURE & THERMAL Programme
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
Project Start 23SEP96
Project Finish 01OCT10
Data Date 29SEP97
Run Date 26JUN98
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Early Bar
Progress Bar
QRCP:FSPL
Sheet 1 of 1
FIRST/Planck
CARRIER Concept
ESA/ESTEC Scientific Projects Dept.
esa

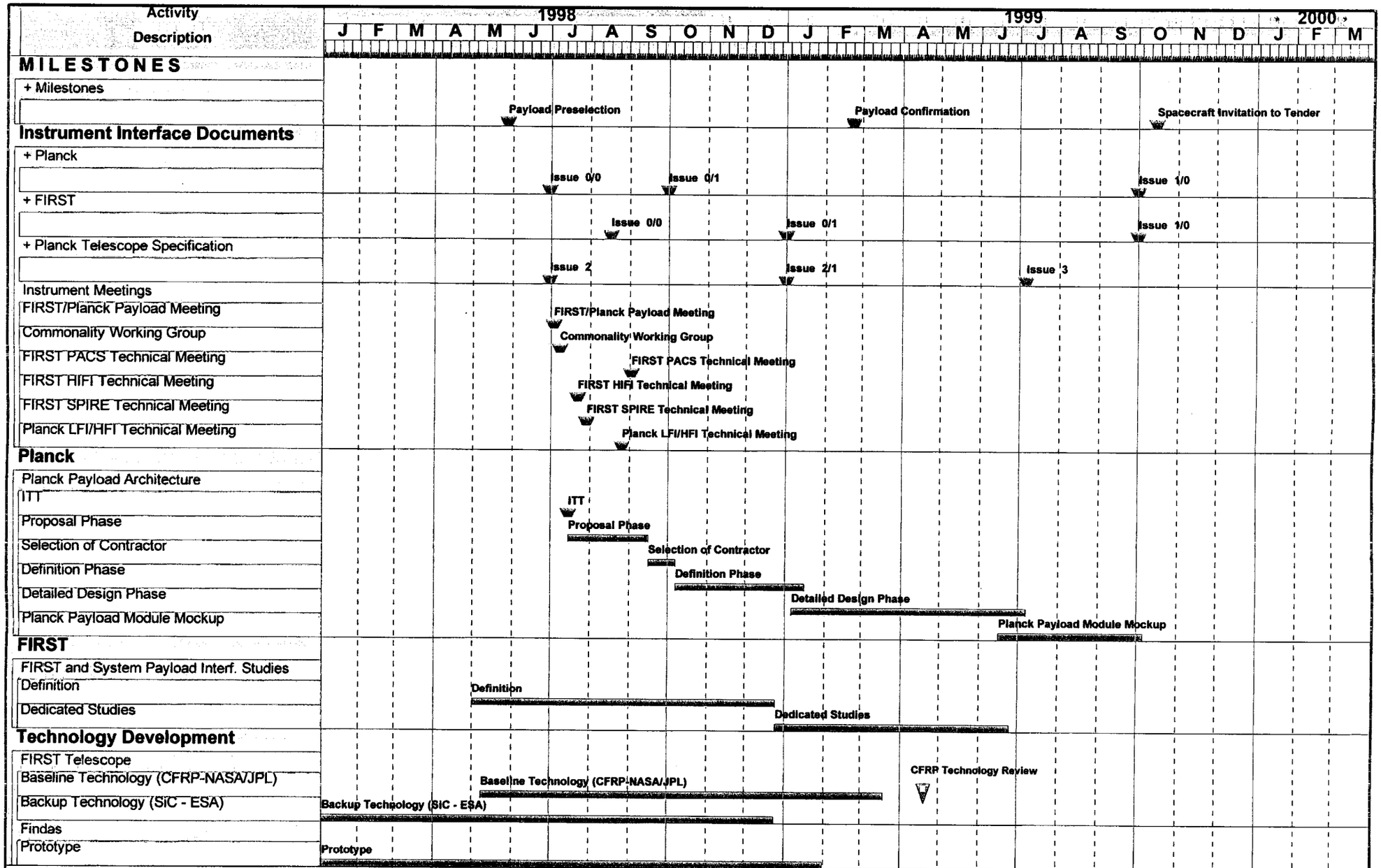
FIRST/Planck Near Term Planning

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 0/1
Issue 1/0
+ Planck Telescope Specification
Issue 2
Issue 2/1
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 29SEP97
Run Date 02JUL98
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Early Bar
Progress Bar
FPD1
Sheet 1 of 1
FIRST/Planck Carrier Concept
Pre Phase "B"
esa

ANNEX 3

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HIFI

HIFI: Heterodyne Instrument for FIRST

A proposal to the European Space Agency in response to the Announcement of Opportunity for participation in the FIRST and Planck Missions (D/SCI/RMB/SV/2940)

Executive Summary

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1. Instrument Definition - Overview

Specifications

- 6 channel (band) heterodyne receiver
- two types of superconducting mixers
  - SIS tunnel junctions for bands 1 - 5
  - hot-electron bolometer mixers for band 6

Table 1.1 Frequency Coverage

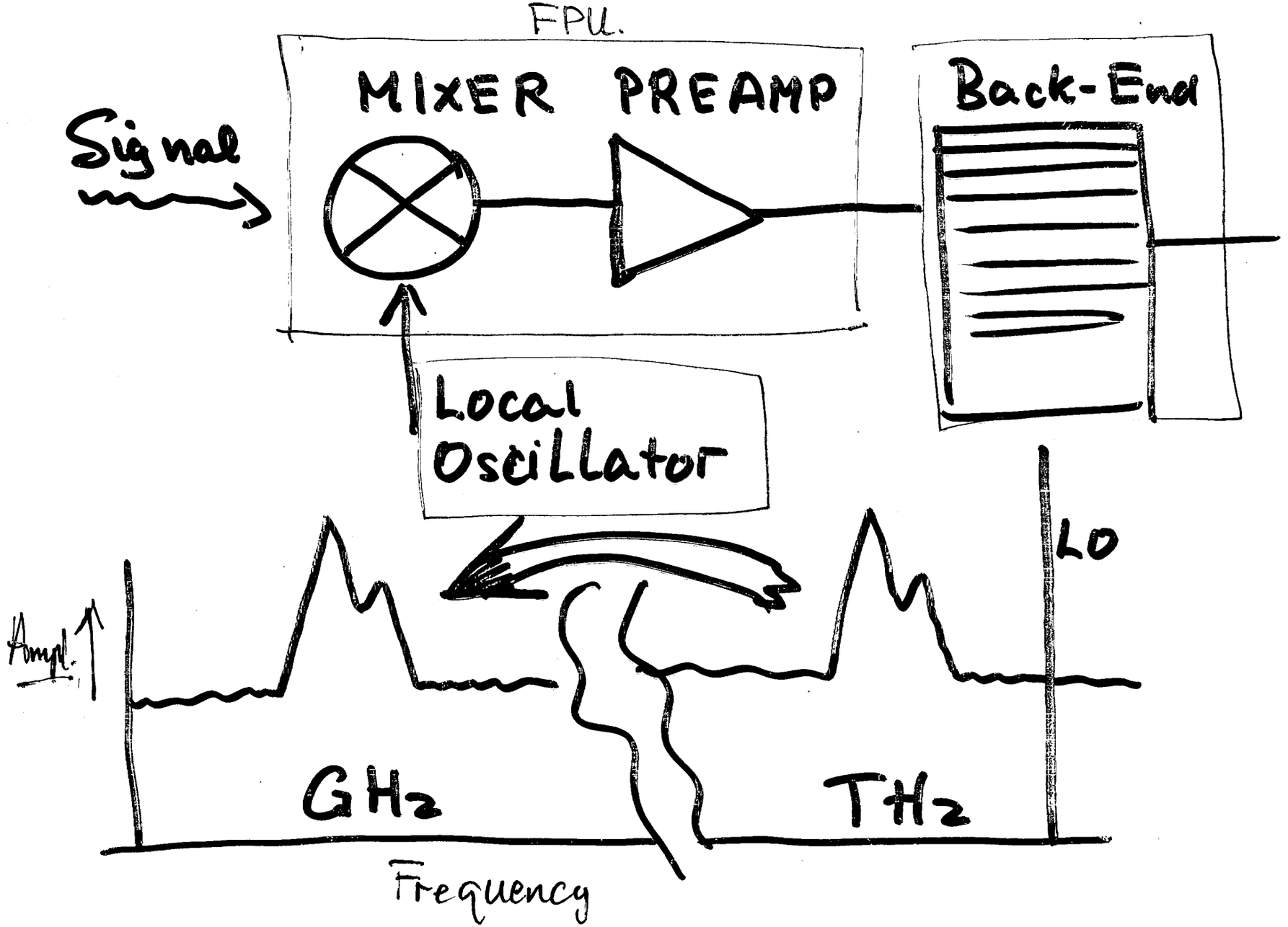
Band	lower freq.	upper freq.	polarisations
1	490 GHz	642 GHz	dual
2	640 GHz	802 GHz	dual
3	800 GHz	962 GHz	dual
4	960 GHz	1122 GHz	dual
5	1120 GHz	1250 GHz	dual
6a	1400 GHz (TBC)	1800 GHz (TBC)	single
6b	2400 GHz (TBC)	2600 GHz (TBC)	single

- two spectrometer types
  - wide band spectrometers — acousto-optic technology
  - high resolution spectrometers — high-speed digital technology

Table 1.2 Spectrometer Characteristics

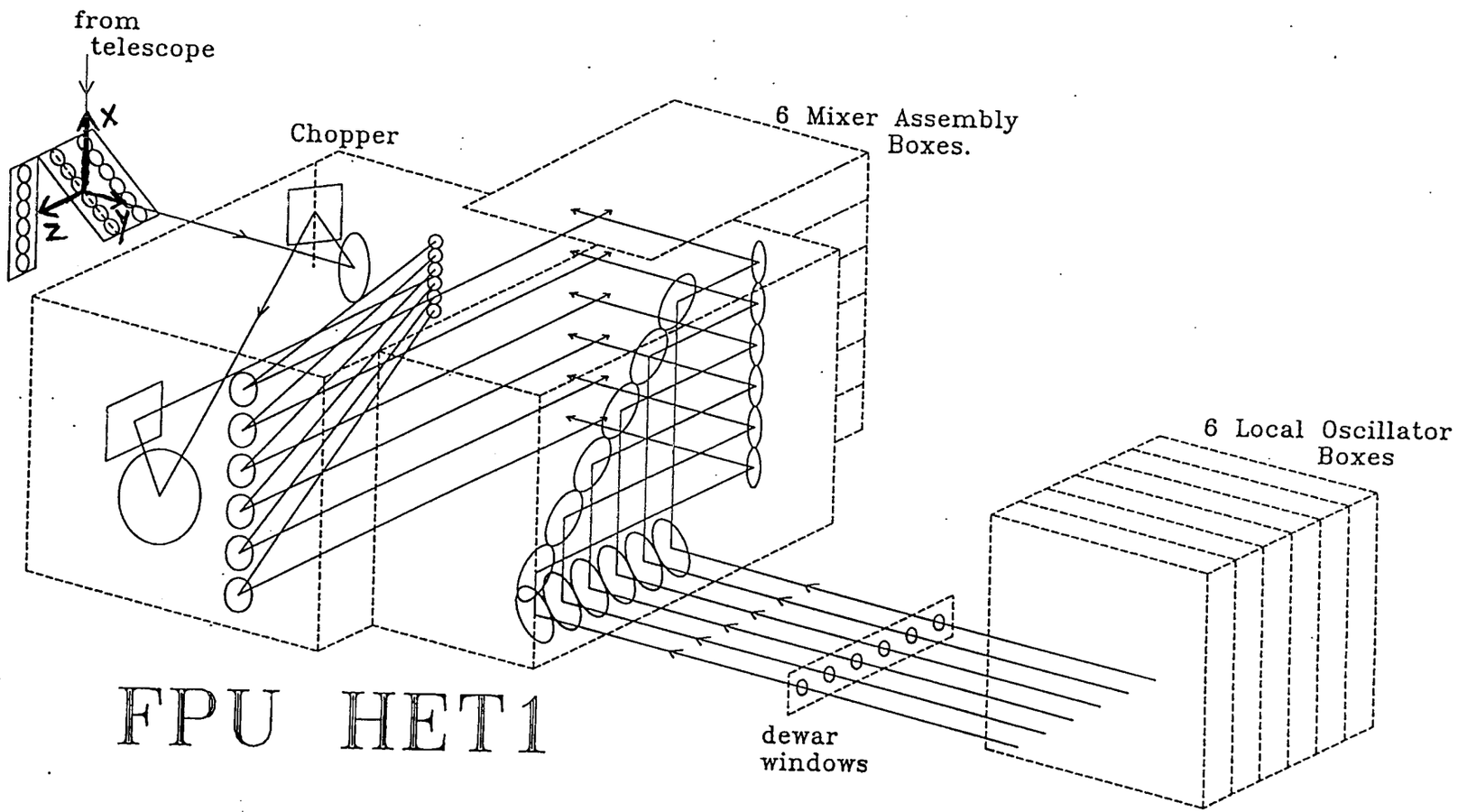
Type	Total bandwidth	Frequency resolution
Wide Band Spectrometer	2x4 GHz	1 MHz
High Resolution Spectrometer	2x1.1 GHz	100 kHz

HETERODYNE DETECTION:



HIFI Schematic Diagram

2 Nov '97.



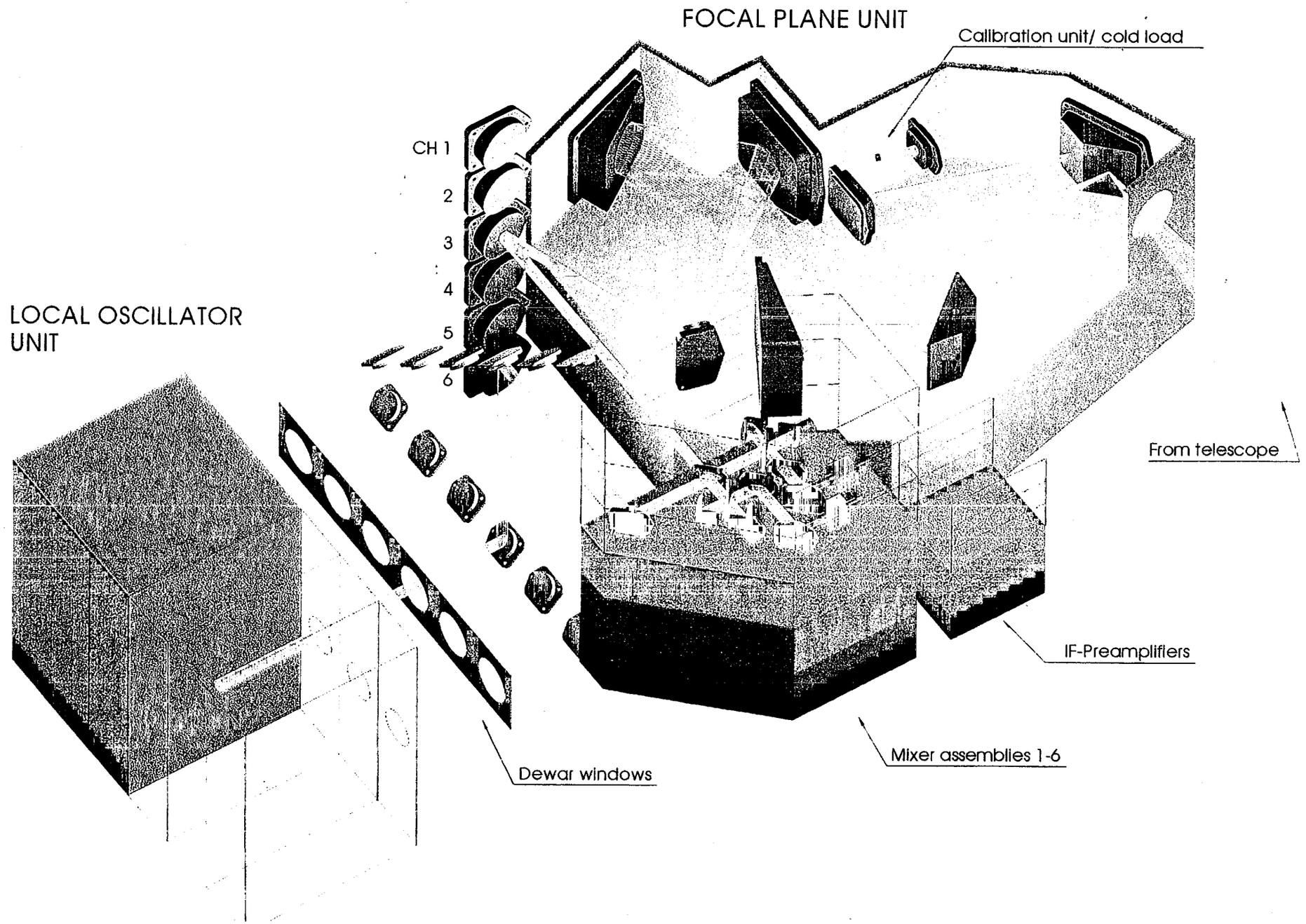

FOCAL PLANE UNIT
Calibration unit/ cold load
CH 1
2
3
4
5
6
LOCAL OSCILLATOR UNIT
From telescope
IF-Preamplifiers
Mixer assemblies 1-6
Dewar windows

Table 1. ***HIFI*** **DSB receiver noise temperature for 3 cases and probable mixer types: (i) State-Of-the-Art Performance (SOAP), (ii) Baseline values and (iii) Goal values. The last column indicates the baseline mixer type: WG – waveguide, QO – quasi-optical.**

band	range,	DSB noise temperature, K			mixer technology			mixer type
	GHz	SOAP	Baseline	goal	SOAP	Baseline	goal	
1	480 640	80 130	70 110	70 110	Nb–SIS	Nb–SIS	Nb–SIS	WG
2	640 800	130 500	110 150	110 130	,,	NbTiN–SIS	NbTiN–SIS	WG
3	800 960	500 700	150 190	130 160	,,	,,	,,	WG
4	960 1120	700 1600	190 230	160 190	,,	,,	,,	WG
5	1120 1250	1600 1900	230 510	190 210	,,	,,	,,	WG
6a	1410 1910	2100 2100	650 650	300 300	Nb–HEB	Nb–HEB	Al–HEB	QO
6b	2400 2700	2500 2500	800 800	450 450	,,	,,	,,	QO

75K in Lab. ; 1GHz

150KΩ telescope; 2GHz
< 700GHz

Jens Ready for testing.

HIFI SCIENCE SUMMARY (1):

1. ***HIFI*** **will probe the physics, kinematics and energetics of star forming regions through their cooling lines, including H_2O, the major coolant.**
2. ***HIFI*** **will survey the molecular inventory of such diverse regions as shocked molecular clouds, dense Photo-Dissociation Regions (PDRs), diffuse atomic clouds, Hot Cores and proto-planetary disks around newly formed stars, winds from dying stars and toroids interacting with AGN engines.**
3. ***HIFI*** **is uniquely suited to search for low-lying ro-vibrational transitions of complex species such as PAHs and, thus, to investigate the origin and evolution of the molecular universe.**
4. ***HIFI*** **can provide the out-gassing rate of comets through H_2O rotational lines and determine the vertical distribution of H_2O in the giant planets.**

HIFI SCIENCE SUMMARY (2):

5. ***HIFI*** **can measure the mass-loss history of stars which, rather than nuclear burning, regulates stellar evolution after the main sequence, and dominates the gas and dust mass balance of the ISM.**

6. ***HIFI*** **will measure the pressure of the interstellar gas throughout the Milky Way and will resolve the problem of the origin of the intense galactic [CII] 158 μm emission measured by COBE.**

7. ***HIFI*** **can determine the D/H, 12C/13C, and 14N/15N isotope ratios as a function of galactic radius in the Milky Way and other galaxies, through the HD line at 112 μm and the hyperfine splitting of atomic fine-structure lines. One can thus constrain the parameters of the Big Bang and explore the nuclear processes that enrich the ISM.**

8. ***HIFI*** **will measure the FIR line spectrum of nearby galaxies as templates for distant, possibly primordial galaxies.**

HIFI CRITICAL (DEVELOPMENT) ITEMS

CRITICAL DEVELOPMENT ITEMS	DEVELOPMENT ISSUES		
Cryo-Amplifiers	Bandwidth/Noise/Stability		
Junctions/Mixers: - NbTiN SIS mixers - Al HEB mixers	 Junction Technology/Sensitivity Technology/Sensitivity		
Local Oscillators: - Solid State Multipliers - Laser mixer LO	 Fixed Bandwidth/Output Power/Reliability Output Power/Stability		
CRITICAL ITEMS (Schedule)			
AOS Development: - Bragg Cell development - CCD Development - ASIC Development	 Reliability/Space Qualification Four line CCD CMOS ASIC for read-out		
FINDAS	Availability/Compatibility		
FUNDING	1998-2001		

HIFI SCHEDULE 1998-2000 MILESTONES

- NOV. 1998: DEVELOPMENT REVIEW:

- EVALUATION OF DEVELOPMENT PLAN
- REVIEW OF PROJECT ORGANISATION AND METHODOLOGY
- REVIEW SPECIFICATIONS AND REQUIREMENTS
- PRESENTATION INTEGRATION AND TEST PLANS
- IDENTIFICATION CRITICAL INTERFACES AND SCHEDULE

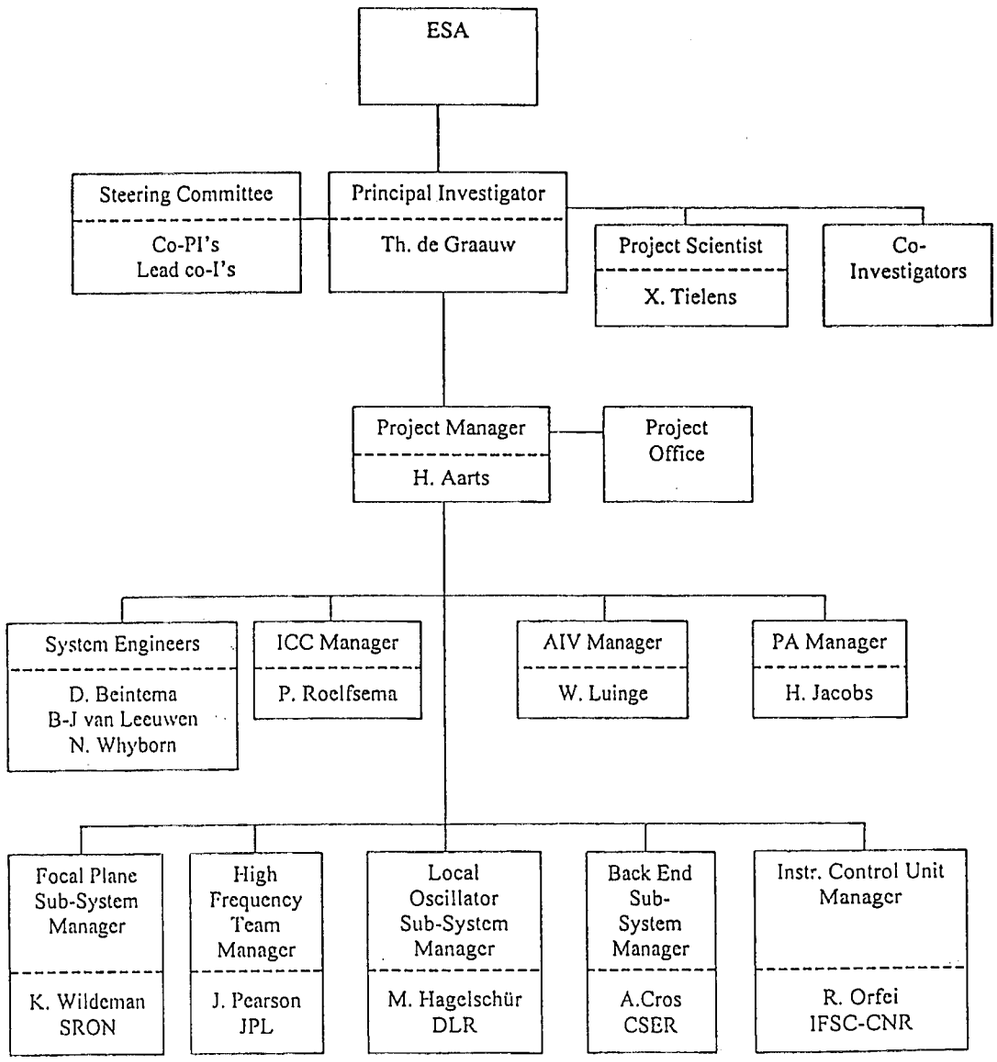
- Oct. 1999: MID-TERM DEVELOPMENT REVIEW

- JULY 2000: FINAL DEVELOPMENT REVIEW

- EVALUATION OF DEVELOPMENT RESULTS
- REVIEW OF SPECIFICATIONS
- INSTRUMENT DESIGN EVALUATION
- FINALISATION OF SPACECRAFT INTERFACES

HIFI MANAGEMENT APPROACH

- Management along sub-systems
- Experienced persons on key positions (see org. plan) in HIFI project team
- Balance between control and delegation



HIFI Project Organization, Key Persons

CONTROL OF FUNDING

* Agreements with Funding Agencies; following a meeting between PI's and PI countries, to be arranged by ESA.

* Changes in Funding Requirements handled by Steering Committee

* The composition of the Steering Committee is:

- Th. de Graauw; PI, SRON, NL.
- T.G. Phillips; co-PI, Caltech, USA
- E. Caux; co-PI, CESR, FR.
- J.Stutzki; co-PI, KOSMA, GE
- G. Tofani; lead co-I for Italy, CAISMI, IT.
- L. Nordh; lead co-I for Sweden, Stockholm, SW
- J. Martin-Pintado; lead co-I for Spain, OAN, SP.
- R. Hills; lead co-I for the UK, Cambridge, UK
- C. Wilson; lead co-I for Canada, McMaster Univ., Canada

SRON

DLR-Berlin t.b.c.

MIXERS { DEMIRM/IR
KOSMA
SRON/...
NASA.

CHT? =

Amps { CAY =
CHT? }

Poland t.b.c

← { DLR
NASA

? CESR { Bordeaux
Arpages
Sweden.

? KOSMA/
CND.

Italy

POLAND t.b.c.
CANADA?

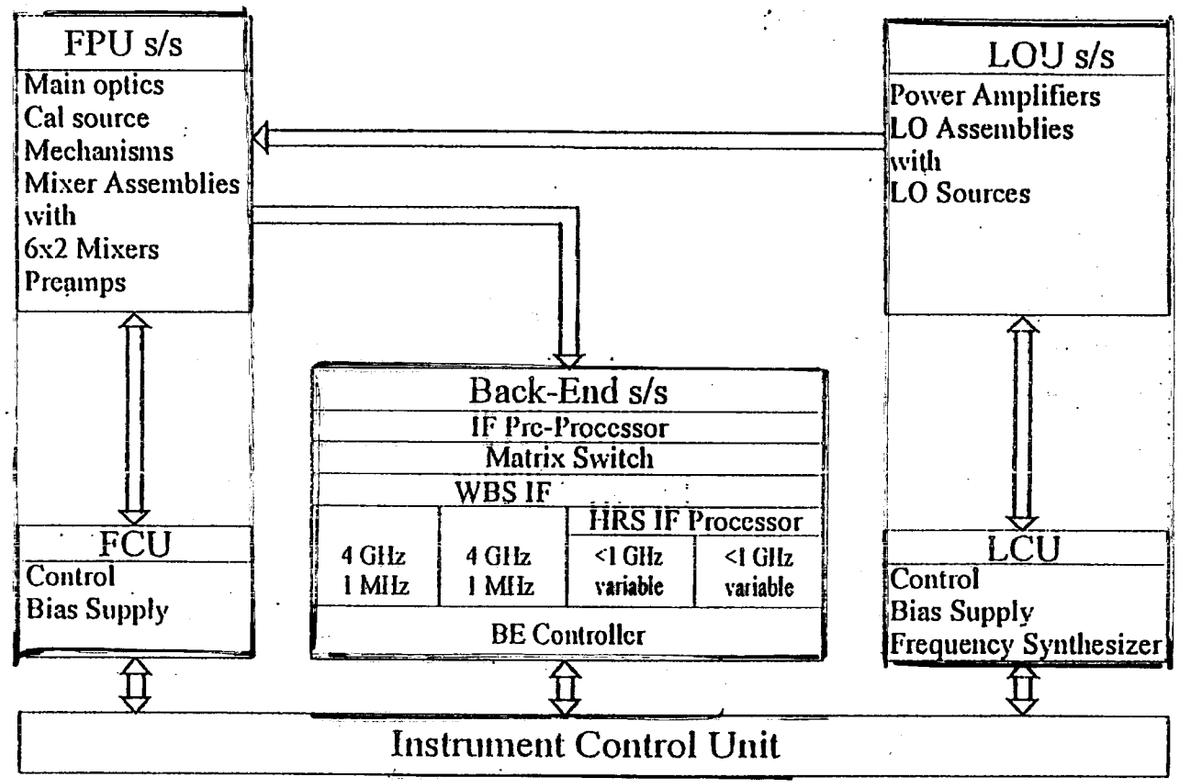


Figure 3. Block diagram of the *HIFI* instrument showing its sub-systems and ICU

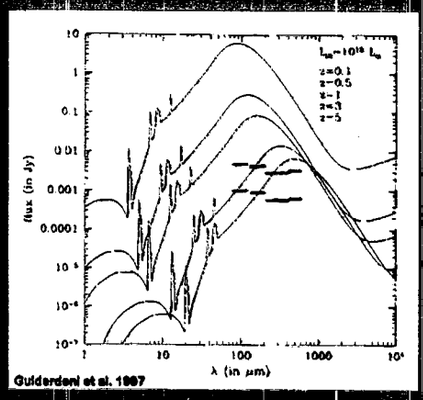
PACS

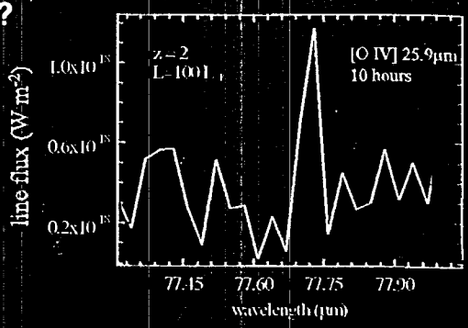
PACS Scientific Objectives

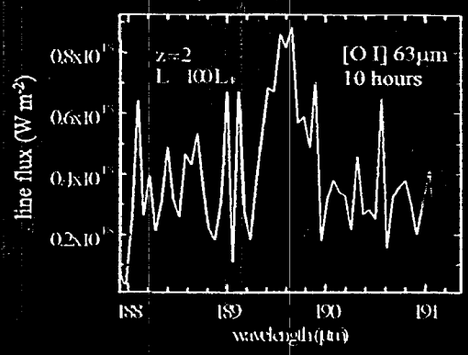
- **How and when have galaxies formed in the Universe?**

  Deep photometric surveys (together with SPIRE): search for high-z FIR-luminous galaxies

  Follow-up spectroscopy: nature of sources (AGN/starburst)







- **What powers luminous galaxies including AGNs and how do they evolve?**

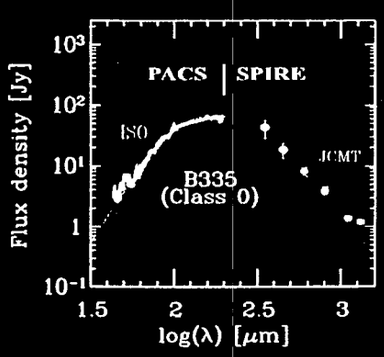
  FIR hosts diagnostic lines to characterize ionizing continuum (AGN vs starburst)

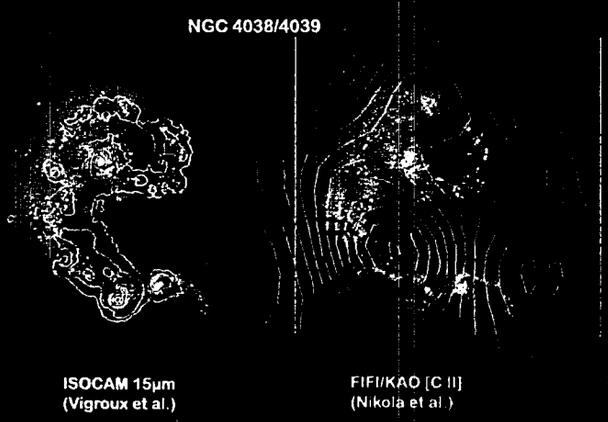
  FIR spectral energy distribution: tori and AGN unification model

  Starburst evolution and the starburst - AGN connection

- **How do stars form out of the interstellar medium (Galactic/extragalactic)?**

  Photometric surveys of nearby molecular clouds (together with SPIRE): unbiased search for protostars down to 0.03 $M_\odot$





Local galaxies: star formation and ISM. Photometric and spectral line mapping for detailed studies of star formation on galactic scales (trigger mechanisms, metallicity effects)

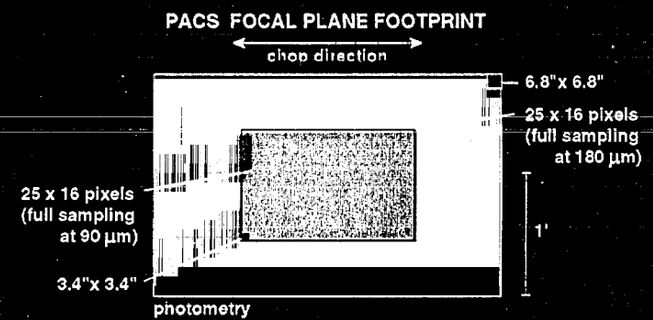
- **What has been the history of our Solar System?**

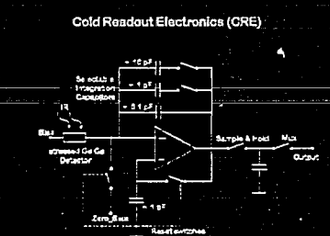
  Giant planet atmospheres: composition, profile, origin of water

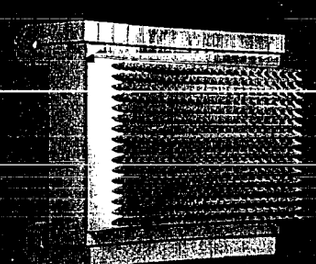
  HD line: D/H ratio in Solar System bodies probing the composition of of pre-solar grains

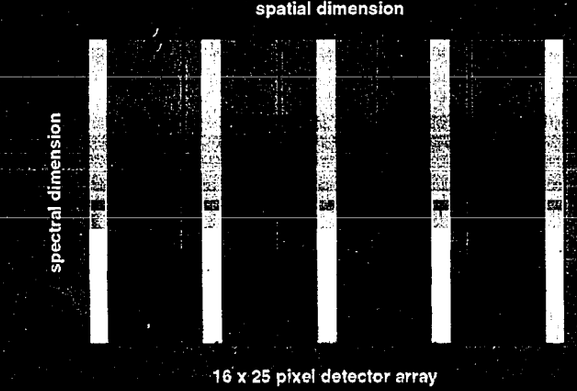
The PACS Concept:

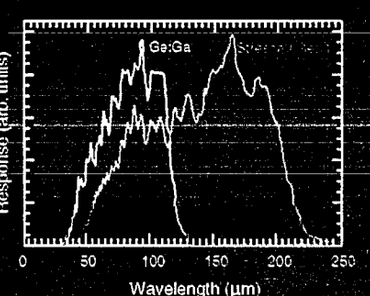
- Imaging photometry in two bands simultaneously (80 - 130 μm and 130 - 210 μm) with dichroic beam splitter
- Imaging line spectroscopy over the range 80 - 210 μm with image slicer and long-slit grating spectrograph (R ~ 1500)
- Two 16x25 Ge:Ga photoconductor arrays (stressed/unstressed)
- Point source detection limit ~5 mJy or ~2×10^{-18} W/m^2 (5σ, 1h)

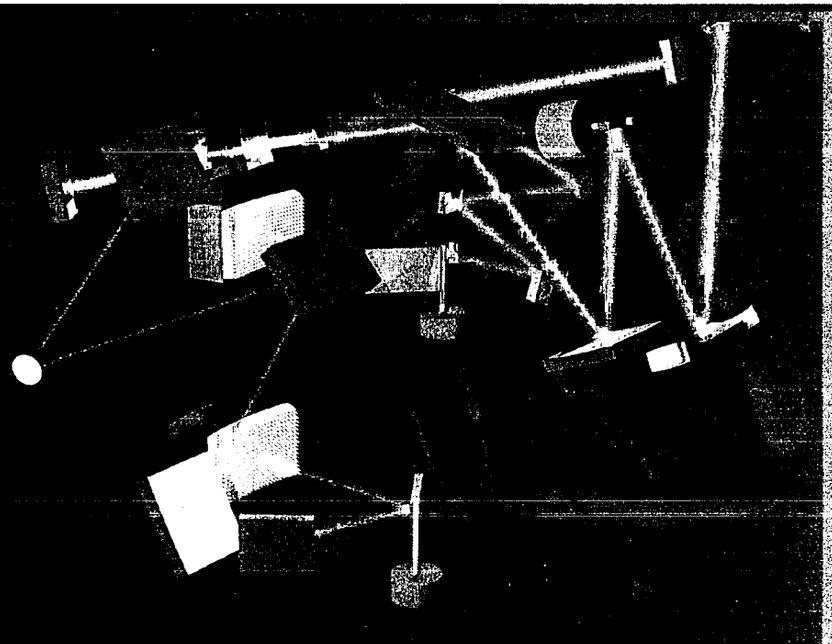


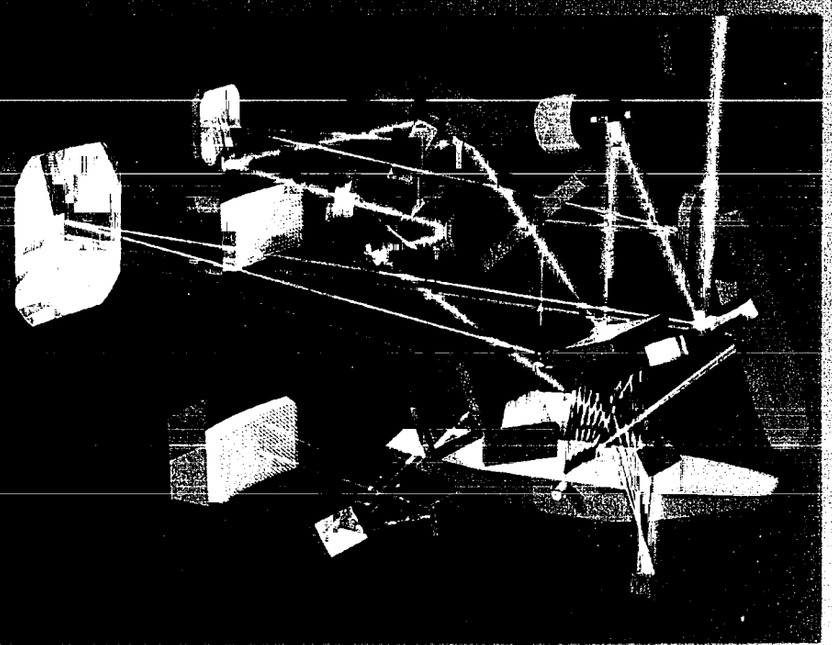








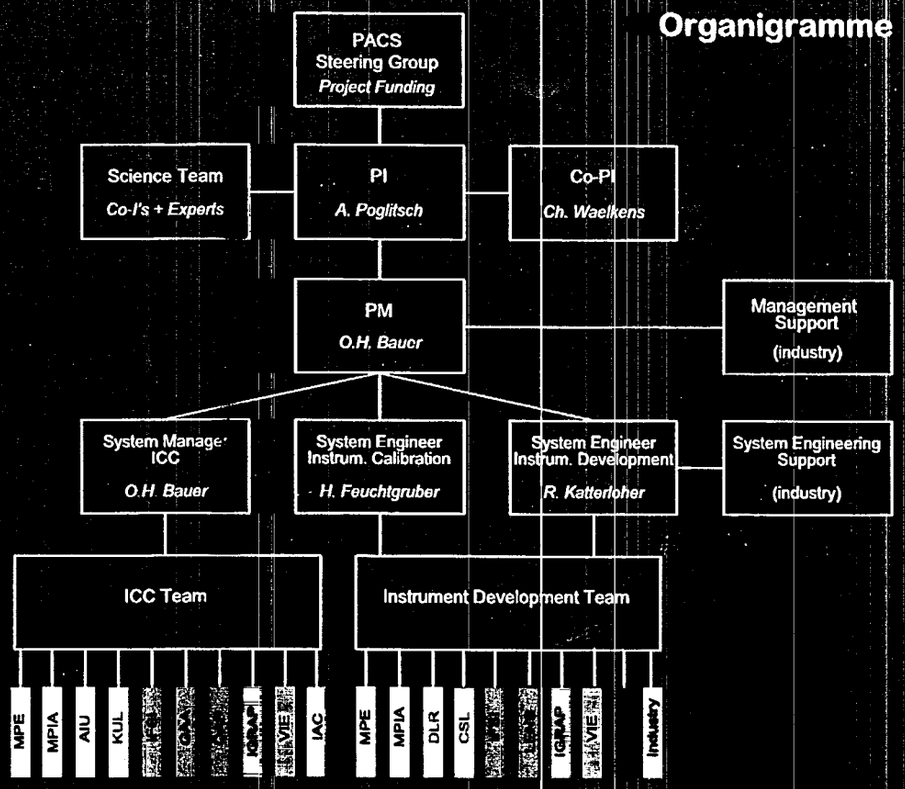




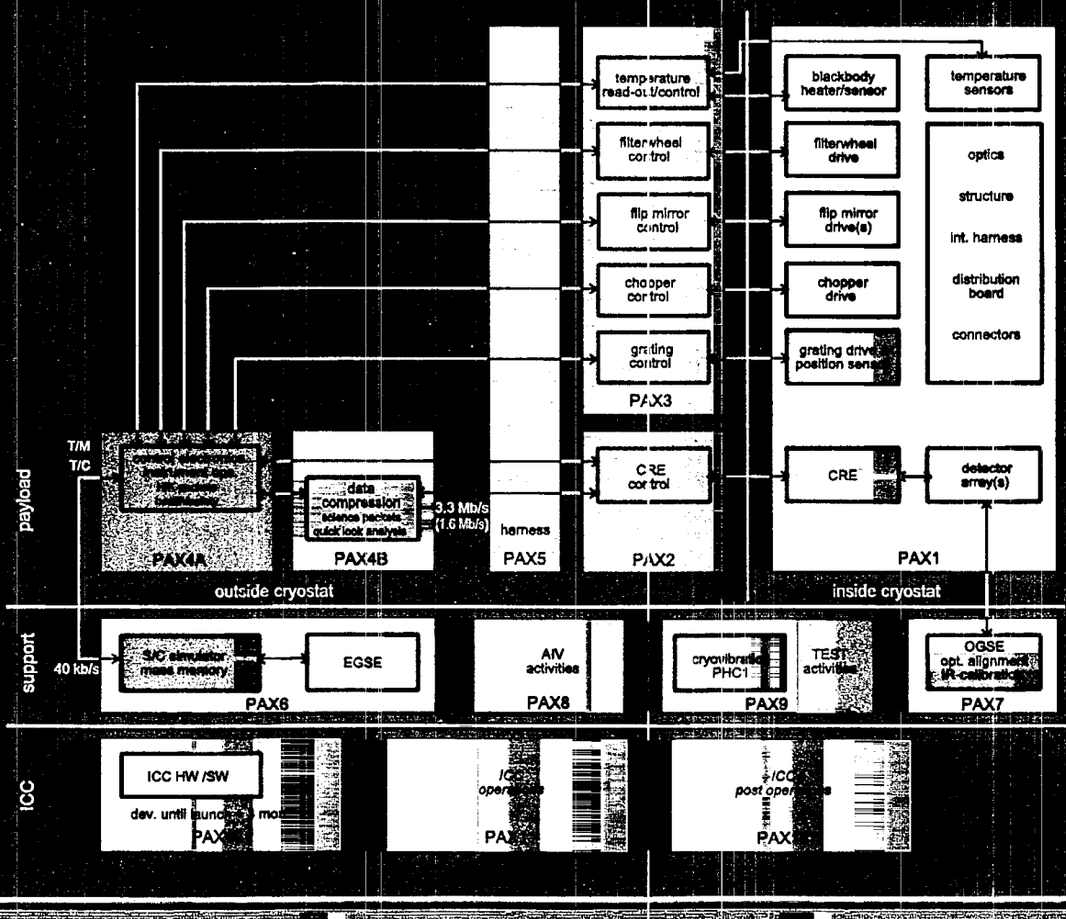
The PACS Consortium

- Germany
- Belgium
- Italy
- Spain
- France
- Austria

Organigramme



Division of Responsibilities



PACS Critical Developments

- **Stressed Ge:Ga detector array**

  Homogeneous stress in 16-element linear detector modules
  Optimum detective quantum efficiency (cavity design, fore optics)
  Optimum detector volume (cosmic ray susceptibility vs. quantum efficiency)
  Radiation tests with relativistic protons under realistic FIR background

  Development started 98/07/01, TRP funding requested 98/04/08 (status ?)

- **Cryogenic readout electronics**

  Warm telescope: high dynamic range / stability requirements
  Minimum debiasing: high open-loop gain
  Low output impedance with low dissipation

  Task force set up to monitor progress and give advice

- **Grating drive**

  Large scan range (±20°) with high positioning accuracy requirements
  Low-dissipation, high precision torquer motor and angular encoder

  Task force established

- **On-board data compression/reduction**

  Cosmic ray glitch recognition
  Strategy for combination of data reduction and (lossless) compression
  Verification of algorithms with data from detector radiation tests

Plans for the next 6 months

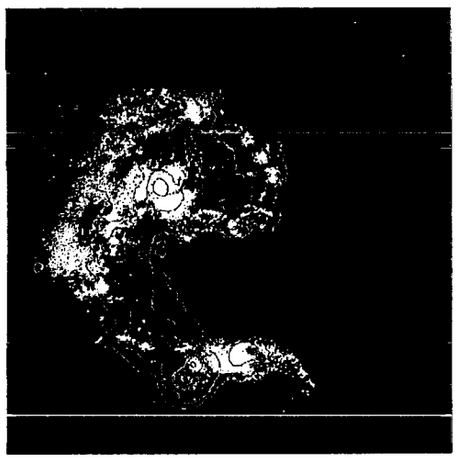
- Start of detector development 98/07/01. Funding?
- Invitation to tender for PAX-1 (Cryogenic Focal Plane Unit)
- Straylight analysis
- Development of strategies for data compression/reduction
- Identification and exploitation of commonality between FIRST/Planck payload instruments
- Clarification meetings with project
- Fabrication and test of next generation CRE

SPIRE

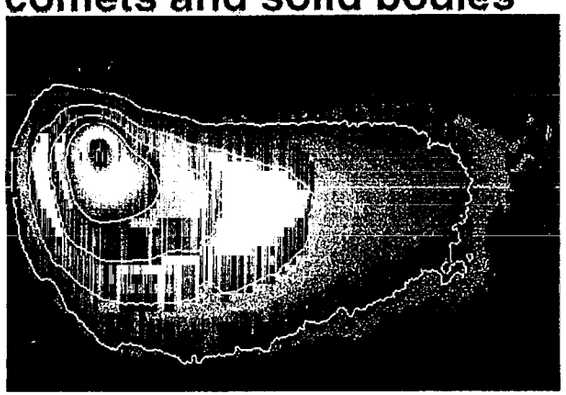
SPIRE

MAIN SCIENTIFIC AIMS

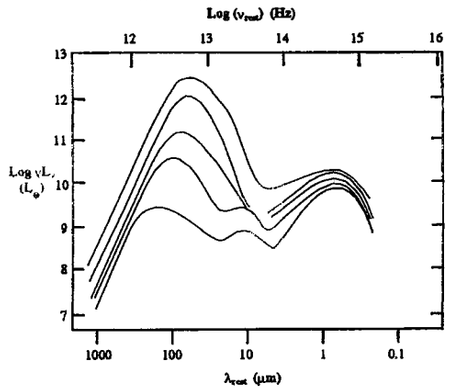
Galaxies – normal, starburst and AGN

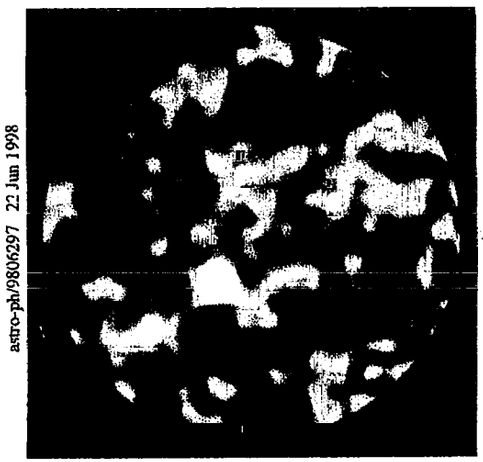


Solar system: giant planets, comets and solid bodies

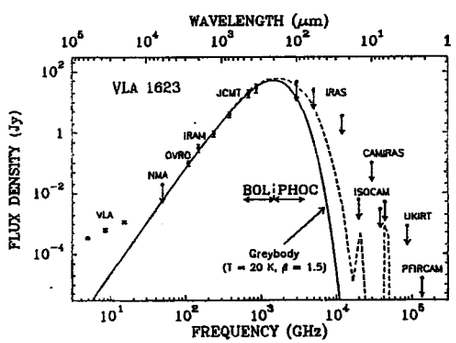


Statistics and physics of galaxy formation in the early universe

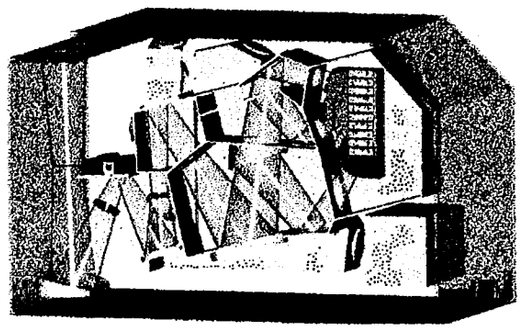




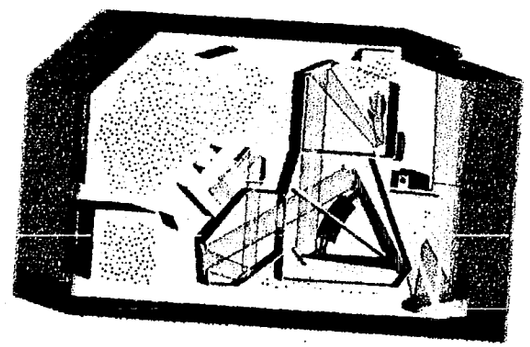
Star formation and interstellar matter



SPIRE THE INSTRUMENT

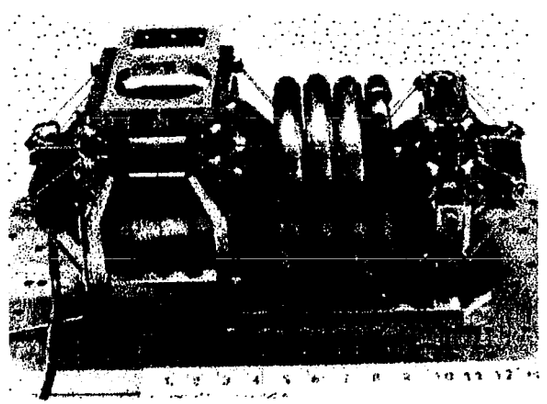


- **3-band Imaging Photometer**
  - 250, 350 and 500 μm (simultaneous observation)
  - Optimised for deep mapping surveys
  - 4 x 4 arcminute field of view
  - Planar bolometer arrays for full spatial sampling



- **Imaging Fourier Transform Spectrometer**
  - 200 - 670 μm
  - Requirement: $\lambda/\Delta\lambda$ = 100 at 400 μm
    1 x 1 arcminute field of view
  - Goal: $\lambda/\Delta\lambda$ = ~~1250~~ at 400 μm
    2 x 2 arcminute field of view

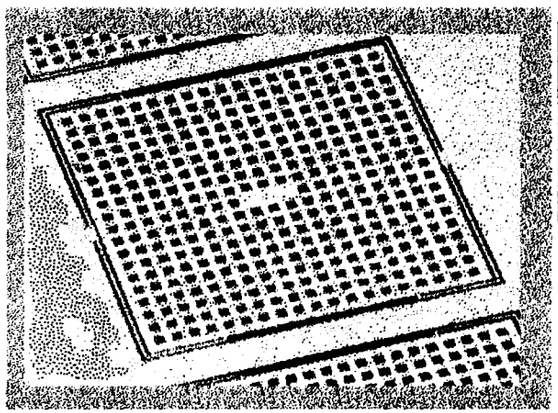
625



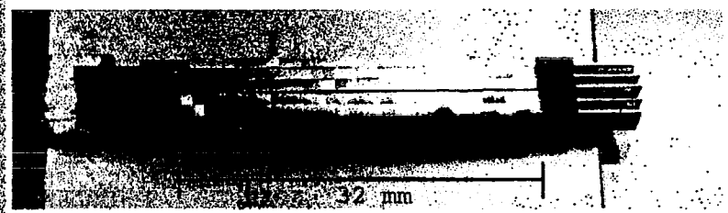
- **^{3}He fridge cools detector arrays to 0.3 K**
- **Minimal use of mechanisms**
- **Sensitivity limited by thermal emission from FIRST's 80-K low-emissivity telescope**

SPIRE TECHNICAL DEVELOPMENTS

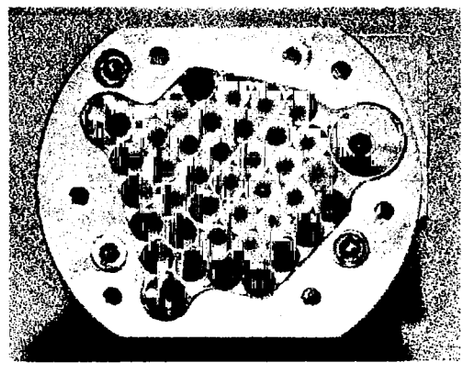
- **Development and demonstration of planar bolometer arrays**
  - **Coordinated evaluation programme with selection before Jan. 2000**



CEA/LETI planar bolometerarrays



Goddard "Pop-Up" planar arrays with superconducting bolometers



Back-up: SCUBA-type feedhorn arrays with Caltech/JPL "spider-web" bolometers arrays

- **Stray light and thermal background control for planar arrays**
- **Thermal/mechanical engineering**
  - **Support of FPU enclosures with limited thermal budgets**
  - **Lightweighting of FPU**
  - **Low power mechanisms**
- **On-board data processing**

SPIRE THE CONSORTIUM

THE INSTRUMENT

UK	**QMW/RAL**	• Project management • Focal plane arrays • Filters, dichroics, polarisers • AIV & Ground Calibration
	MSSL	• FPU structure
	ROE	• Chopper
France	**CEA**	• Bolometers (option) • Warm elect. & sig. proc. S/W • ^{3}He cooler
	LAS	• Optics & FTS mechanism • Cold vibration testing
	DESPA	• FTS control electronics
	IAS	• Ground calib. support
Italy	**IFSI**	• Digital Processing Unit
USA	**GSFC/Caltech**	• Bolometers (option) • On-board calibrators
Spain	**IAC**	• Signal Proc. Electronics
Canada	**Saskatoon**	• EGSE (TBC)

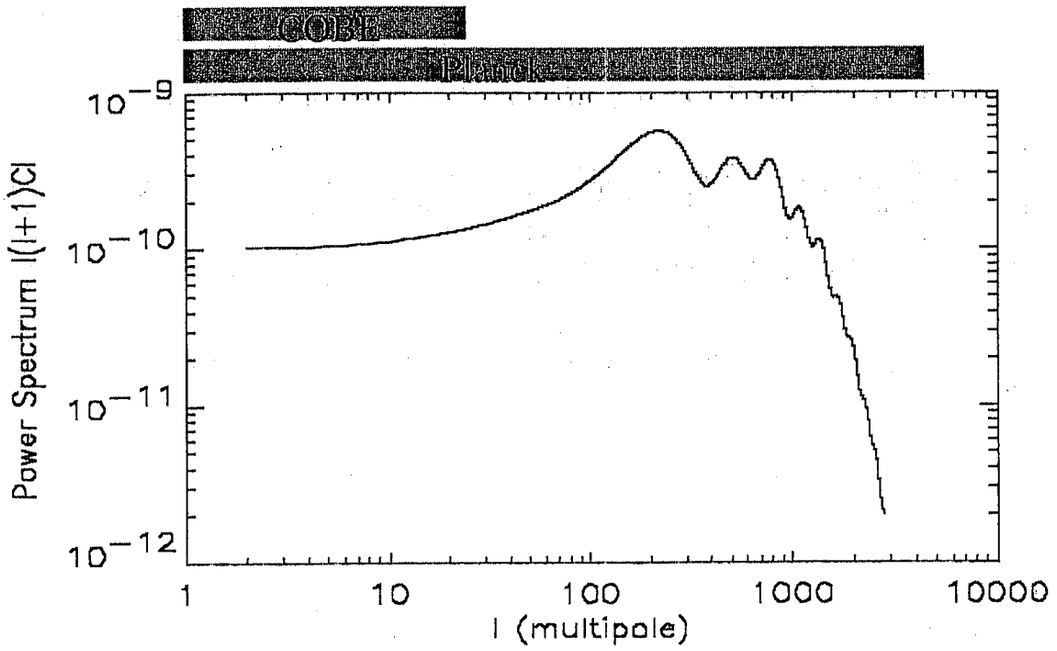
THE ICC

UK	**RAL**	• Operations Centre
	ICSTM	• DAPSAS Centre
France	**CEA**	• DAPSAS Centre
Other SPIRE institutes		• ICC effort + Operations Centre support

HFI

Planck-HFI : Scientific objectives

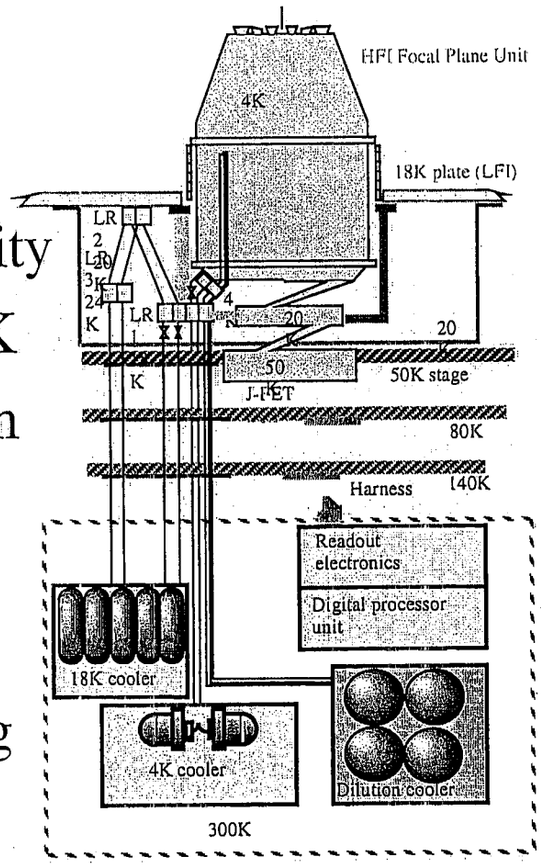
- Full sky map of CMB anisotropies (incl. polarization) with sensitivity $\Delta T/T < 2\mu K$ and angular resolution better than 5 arcmin
  - → constraints on cosmological parameters with accuracy better than 1%
  - → fundamental physics at ultra high energies
- All-sky maps in 6 bands (100-900 GHz)
  - → accurate foreground subtraction
  - → catalog of several thousands of clusters of galaxies (S-Z effect)
  - → catalog of more than 20000 infrared galaxies
  - → maps of galactic dust emission



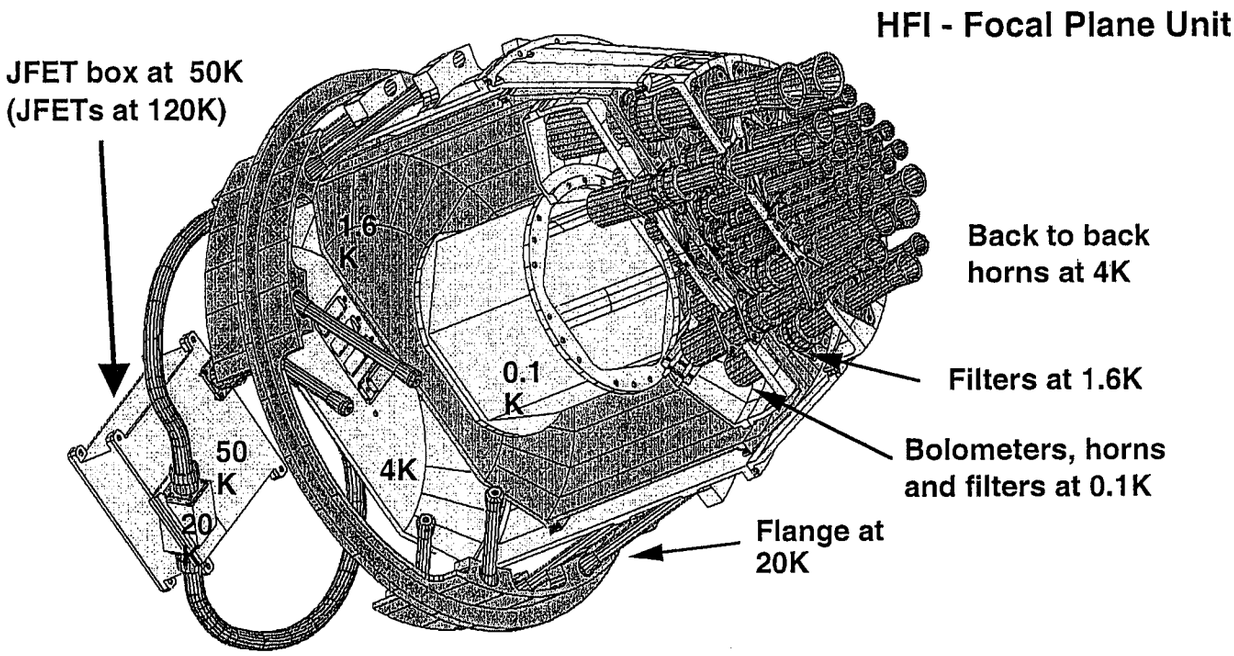
ESA, 1998 July 3rd Meeting, J.-L. Puget

Planck-HFI : Instrumental concept

- 6 frequencies
- Polarisation measurement capability
- 48 bolometers at 0.1K
- Horns and filters from 4K to 0.1K
- Total power readout electronics
- 3-stage active cooling



Frequency	(Ghz)	100	143	217	353	545	857
Beam	(arcmin.)	10.7	8.0	5.5	5.0	5.0	5.0
DT/T (Intensity)	μK/K	1.7	2.0	4.3	14.4	147	6670
DT/T (U and Q)	μK/K		3.7	8.9		208	


HFI - Focal Plane Unit
JFET box at 50K
(JFETs at 120K)
1.6
K
0.1
K
50
K
4K
20
Back to back
horns at 4K
Filters at 1.6K
Bolometers, horns
and filters at 0.1K
Flange at
20K

Planck-HFI :Critical developments

- **Complex cryogenic chain: 0.1K/4K/20K**
  - → 0.1K demonstrator mockup (full chain)
  - → Development model of 0.1K dilution stage
  - → Development model of 20K sorption cooler

- **Control of noises (EMI, Thermal, low frequency electronic noise, ...)**
  - → Compatibility to be demonstrated by mockup, integration and test plans

- **Some components : horns, 4K load**
  - → Theoretical and experimental on-going developments

- **Overall payload integration**
  - → Very close collaboration needed between P/L architect and PI teams

- **Iterative, massive and complex extraction of both sky signal and instrument parameters (beam patterns including far side lobes, low frequency noise, calibrations,...)**
  - → Extensive simulations to validate the different stages of data processing and progressive construction of the pipeline

Planck-HFI : Organization

- **PI, PM, IS, DPCM, SM and Calibration manager in the same institute (IAS)**
- **Instrument: work distribution following major subsystems** :
  - management, thermal architecture, mechanics, integration, final testing : IAS
  - cold optics : QMW
  - 4K cooler : RAL
  - bolometers and 20K coolers : Caltech/JPL
  - JFETs : Roma
  - readout electronics : CESR
  - general electronics : LAL
- **DPC : for each level a single institute is in charge of integrating and running the pipeline :**
  - level 1 : Geneva (common with LFI)
  - level 2 : IAS (POSDAC)
  - level 3 : Cambridge (CPAC)
  - level 4 : MPA (common with LFI)

but several institutes contribute to development tasks and pipeline infrastructure (IDIS)

- **Budget : Major contributors for the development phase (1999-2005) :**

instrument	internal	external	DPC	internal	external
France	16.1	14.6	France	4.4	2.6
UK		9.6	UK		5.3
USA		4.4	Germany	0.4	1.8
Italy	0.9	2.1	SSD		1.1
			Switzerland		0.8
Total	**17.0**	**30.7**	**Total**	**4.8**	**12.0**

LFI

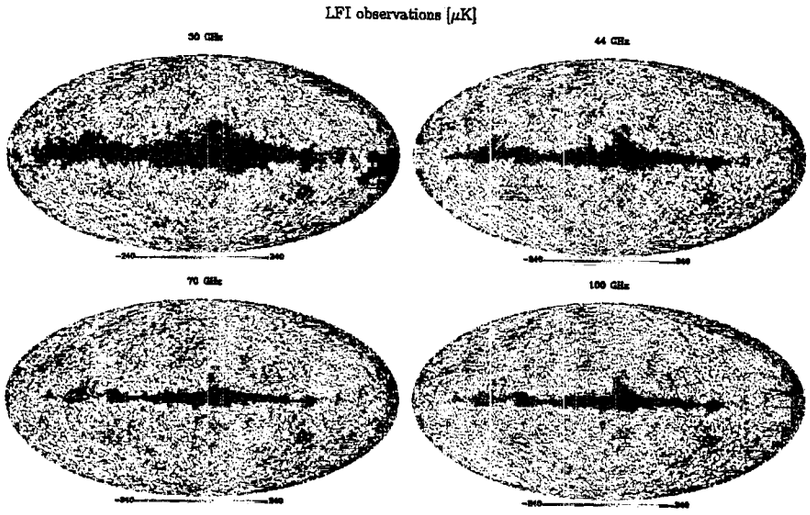
LFI

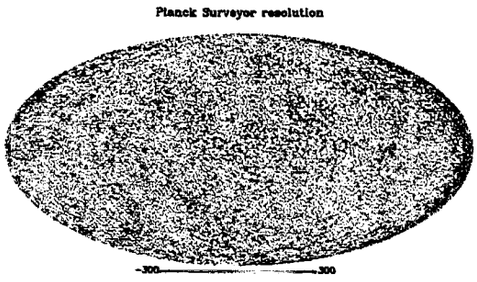
MANIFESTO

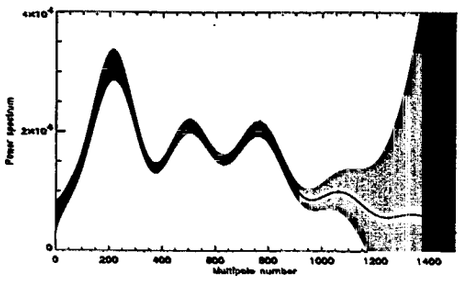
- KILL SYSTEMATICS

- PLANCK INSTRUMENTS WITH FULL & INDEPENDENT COSMOLOGICAL CAPABILITIES

Planck - LFI



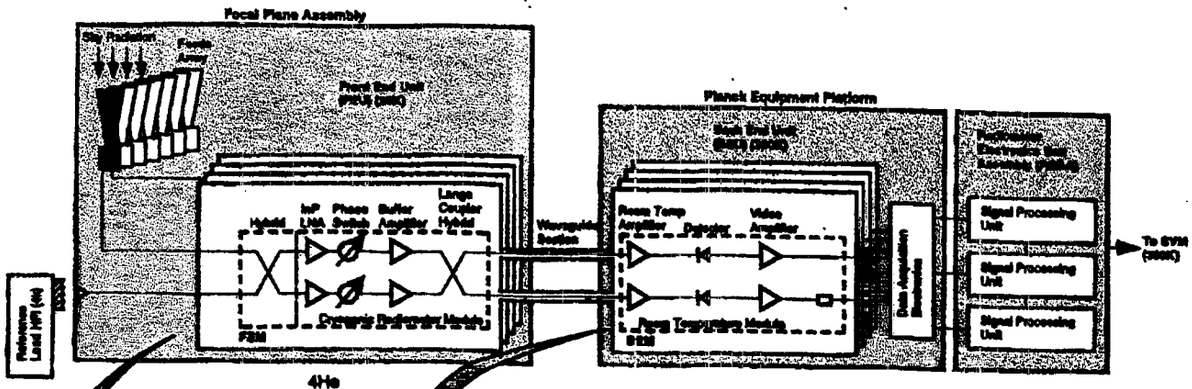


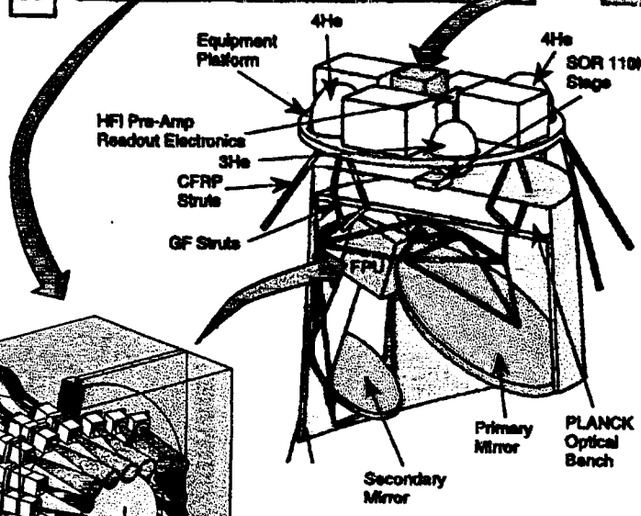


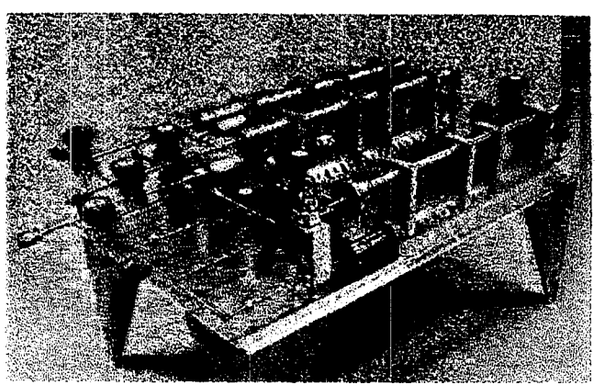
Scientific Goals

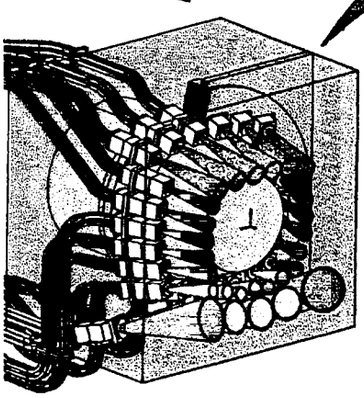
- **Physics at $t < 10^{-35}$ sec, $E > 10^{15}$ GeV**
- **Test of inflation**
- **Fundamental cosmological parameters H_0, Ω_0, Ω_b, Λ,... to a precision of a few percent**
- **Evolution of fluctuations and origin of large scale structure of the Universe**
- **Nature of dark matter**
- **Astrophysics**

Planck - LFI

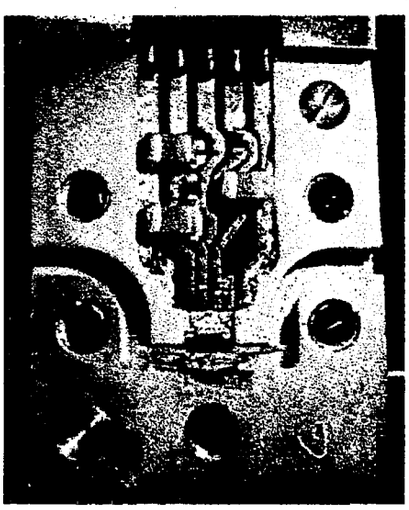








HEMT InP Technology

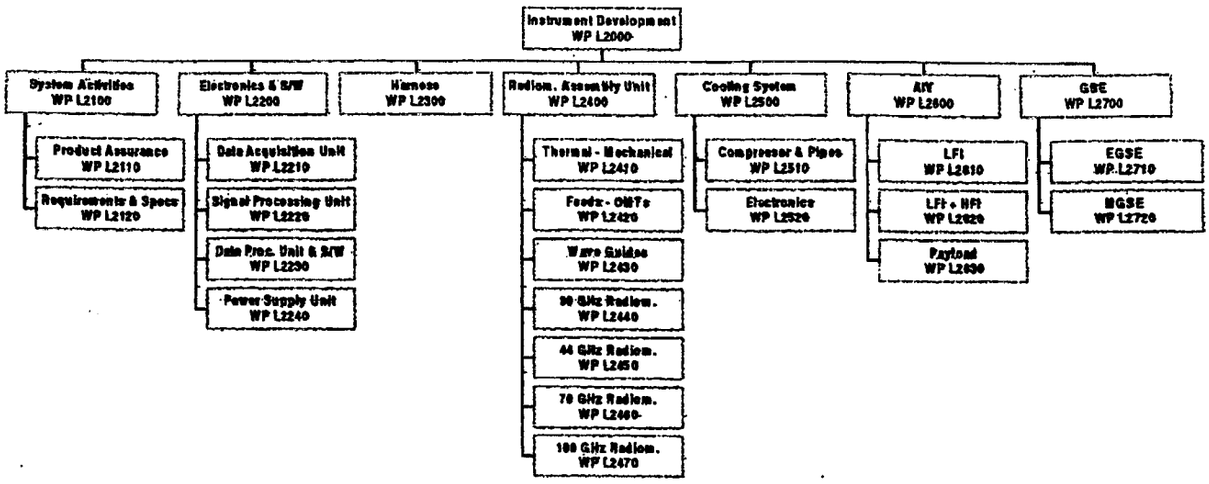


LFI Performance

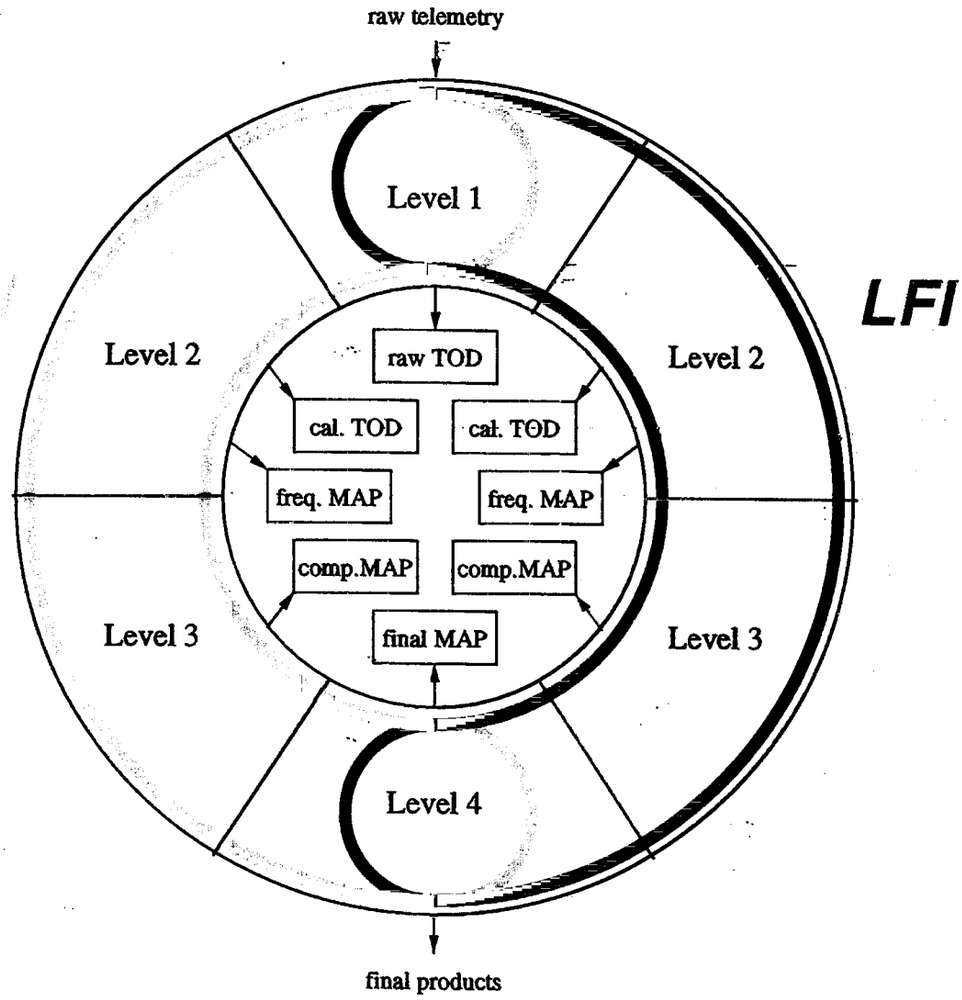
Frequency (GHz)	**30**	**44**	**70**	**100**
Angular resolution FWHM (')	**33**	**23**	**14**	**10**
Polarization	**yes**	**yes**	**yes**	**yes**
Sensitivity ($10^6 \Delta T/T$)	**1.6**	**2.4**	**3.6**	**4.3**

Planck - LFI

Instrument



DPC



Planck – LFI

Critical Developments

- **LNA MMIC noise performance at high frequencies**
- **Radiometer stability (1/f noise)**
- **4 K reference load**
- **20 K sorption cooler (lifetime, space qualification)**
- **Waveguides (rigid, dielectric)**
- **Data rate**
- **LFI/HFI Interfaces**
- **Beam Pattern (sidelobes)**

PLANCK LFI CONSORTIUM

ITALY
DENMARK
FINLAND
GERMANY
NORWAY
SPAIN
SWEDEN
SWITZERLAND
UK
USA
SSD/ESTEC

ANNEX 4

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Agence spatiale européenne

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ASTROPHYSICS FIRST

FSEC report summary

FIRST PIs /SPC Delegations/Executive meeting

ESA HQ, 3 July 1998

Göran L. Pilbratt

ESA Astrophysics Division, Space Science Department

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. Courvoisier	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 feasibility 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.

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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.

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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.

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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.

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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

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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.

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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

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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.

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ANNEX 5

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FIRST/Planck

Payload Meeting
Payload Hardware

3 July 1998

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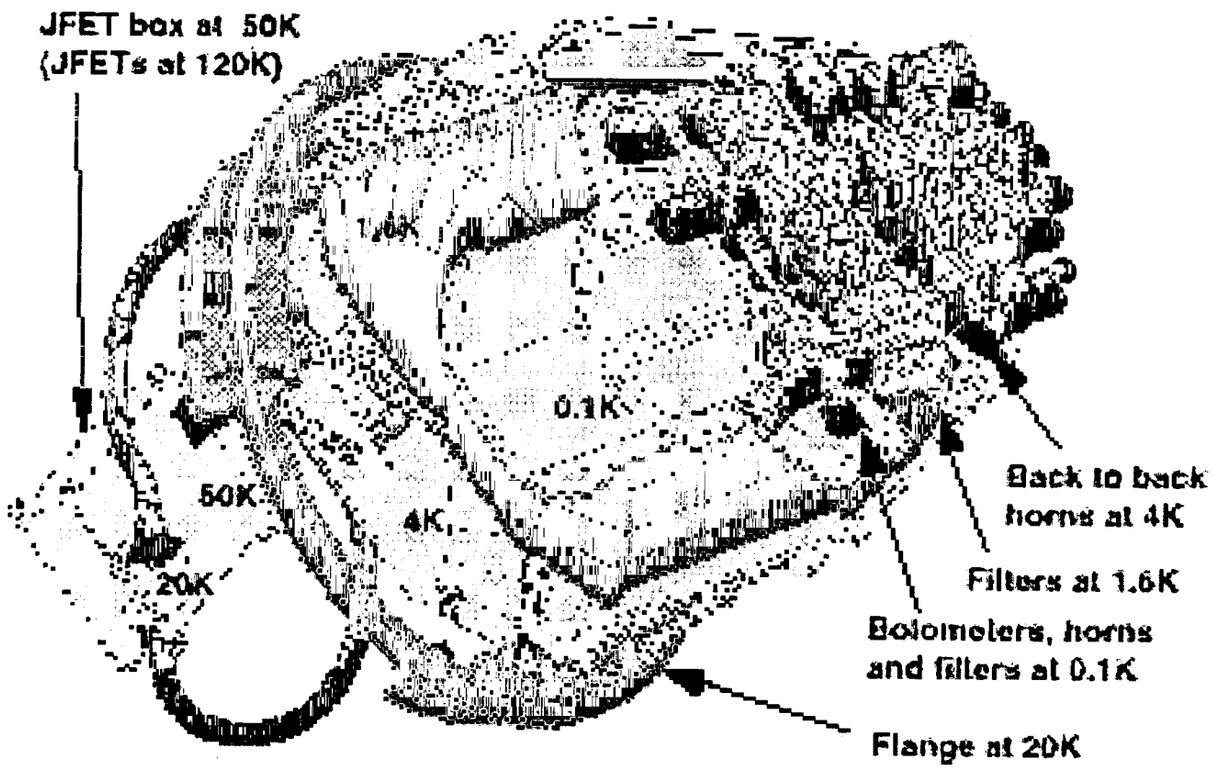
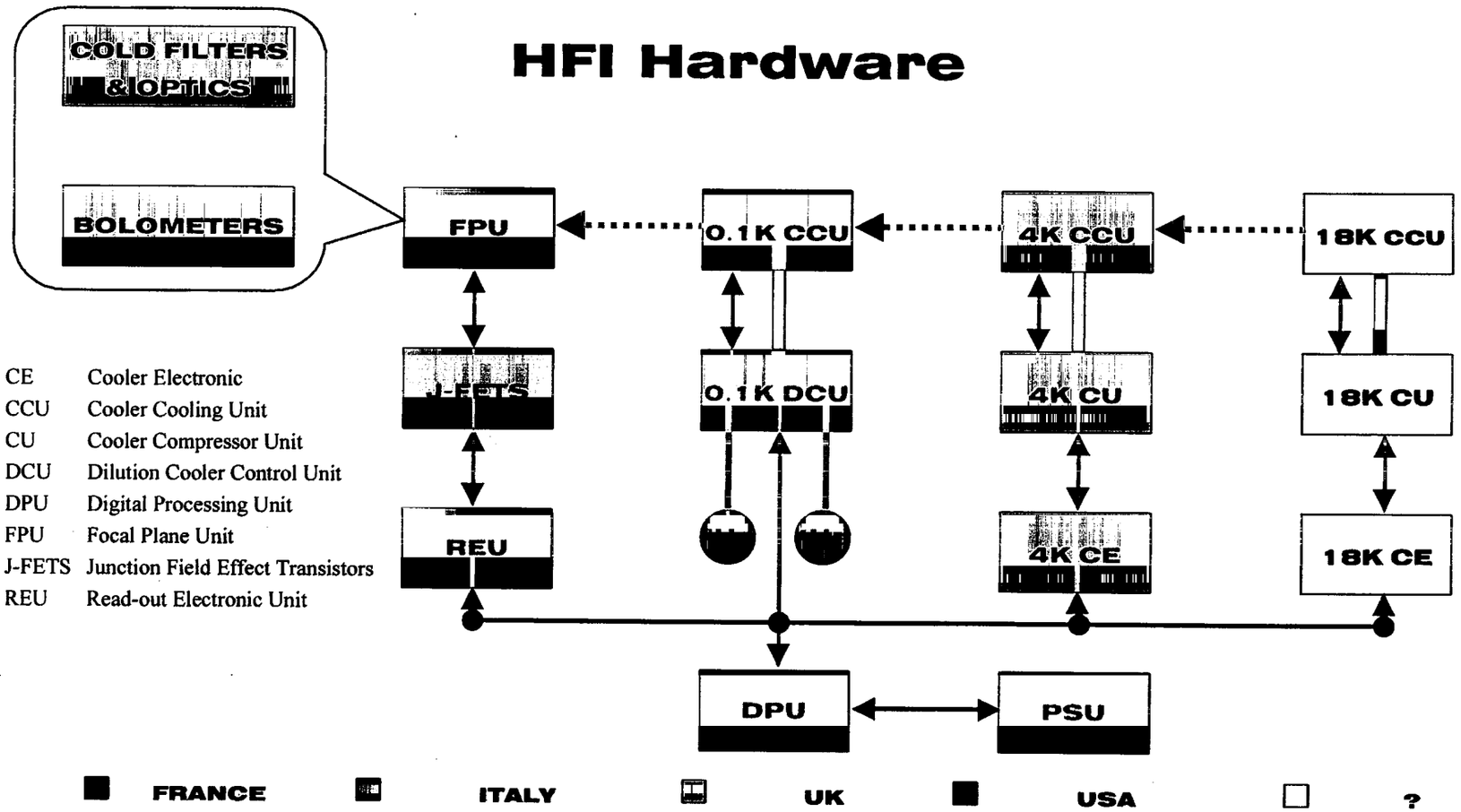
HFI Focal Plane Unit (FPU)



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

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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**
USA	**High Frequency S/S Design, AIV, Calibration**

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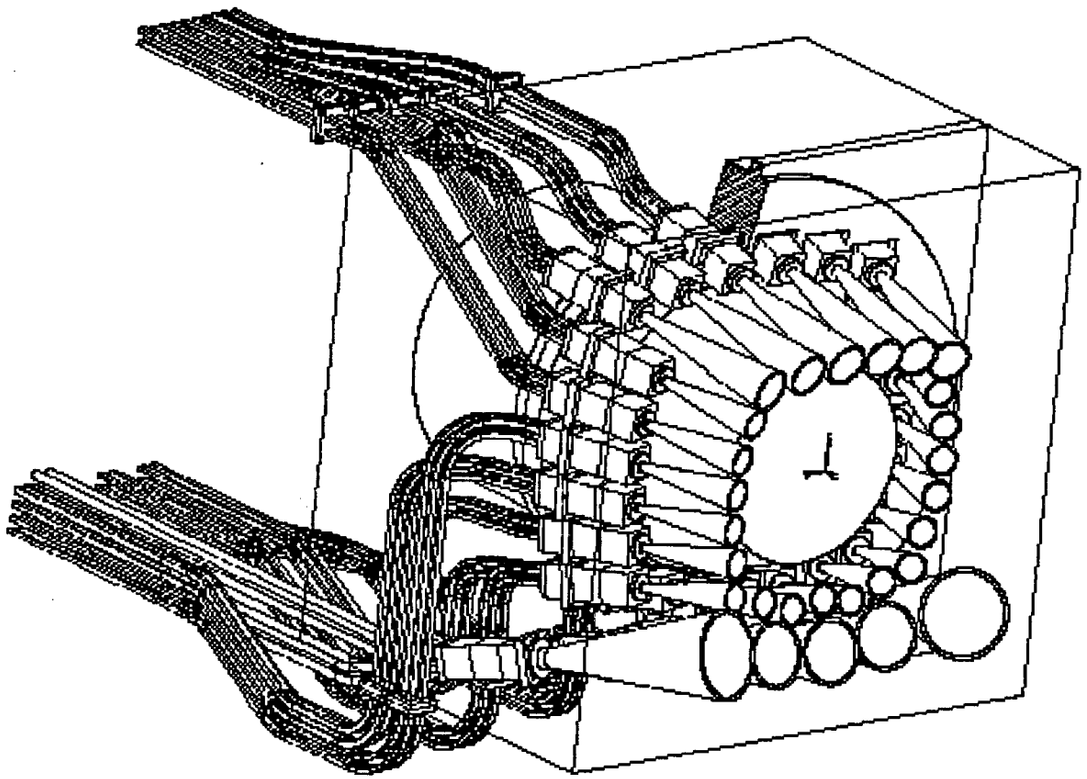

LFI Focal Plane Unit

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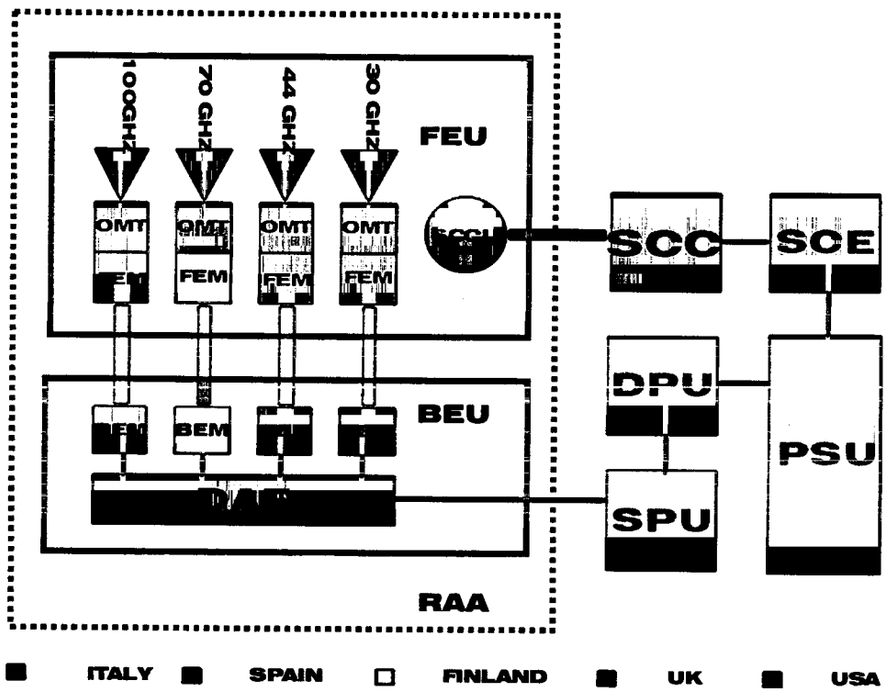
BEM	Back End Module
BEU	Back End Unit
DAE	Data Acquisition Electronic
DPU	Data Processing Unit
FEM	Front End Module
FEU	Front End Unit
OMT	Orthomode Transducer
PSU	Power Supply Unit
RAA	Radiometer Array Assembly
SCC	Sorption Cooler Compressor
SCE	Sorption Cooler Electronic
SCCU	Sorption Cooler Cooling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

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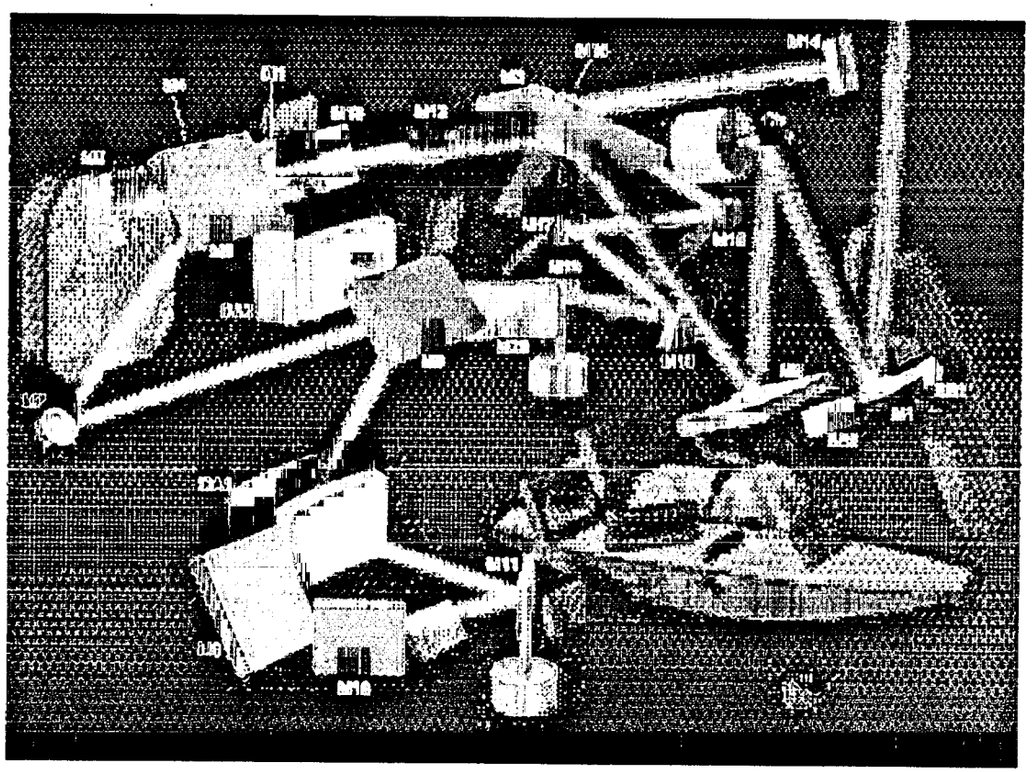

PACS Optics in Photometry Mode.

3 July 1998

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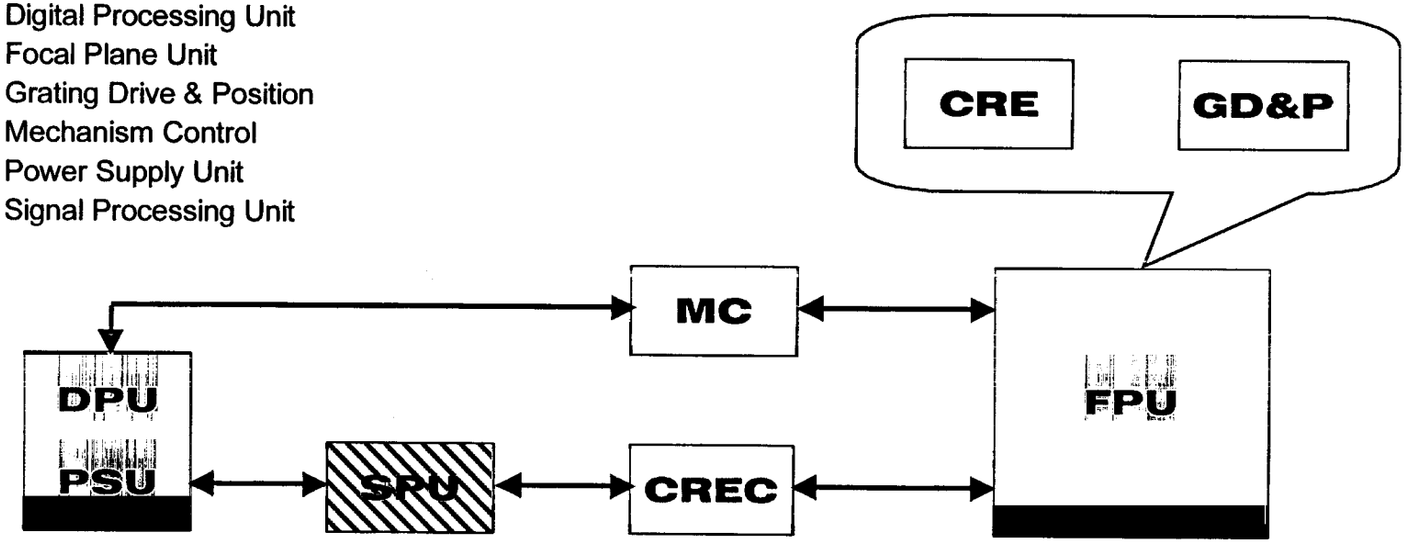
PACS HARDWARE

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

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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

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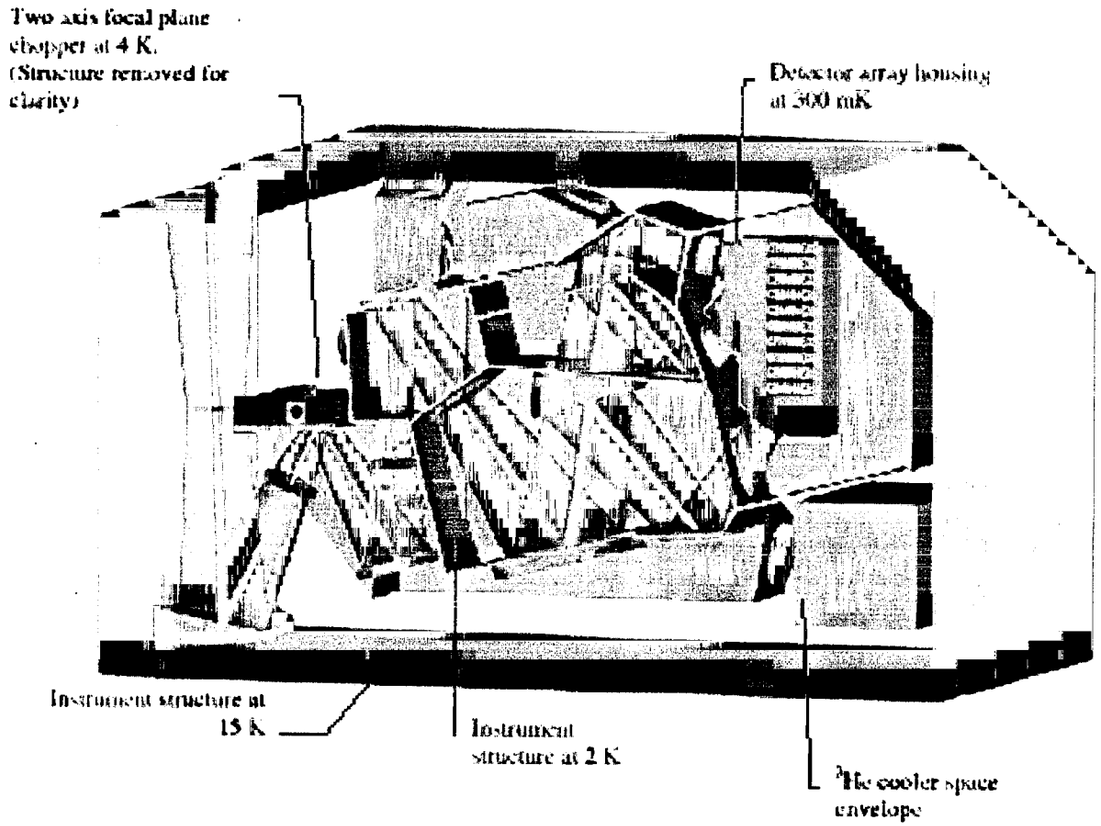


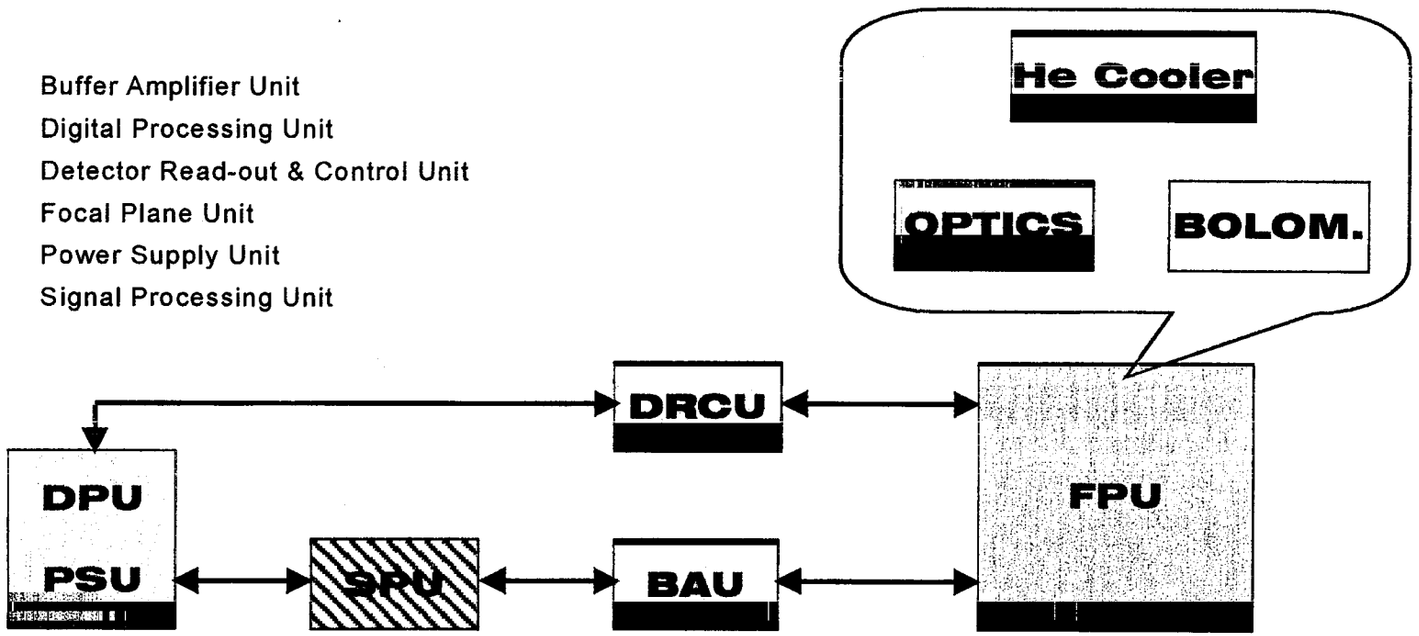
SPIRE . Conceptual Drawing.

3 July 1998

PT-05628

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



UK FRANCE SPAIN & FRANCE ITALY FRANCE or USA

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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**

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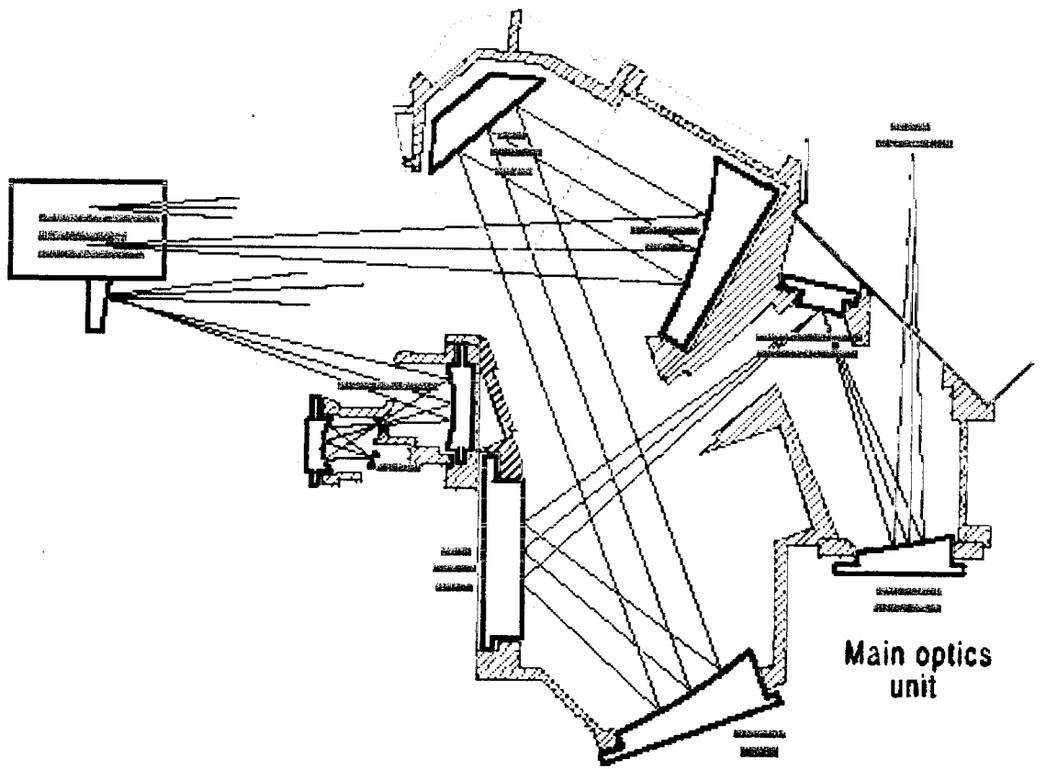

HIFI Common Optics Layout

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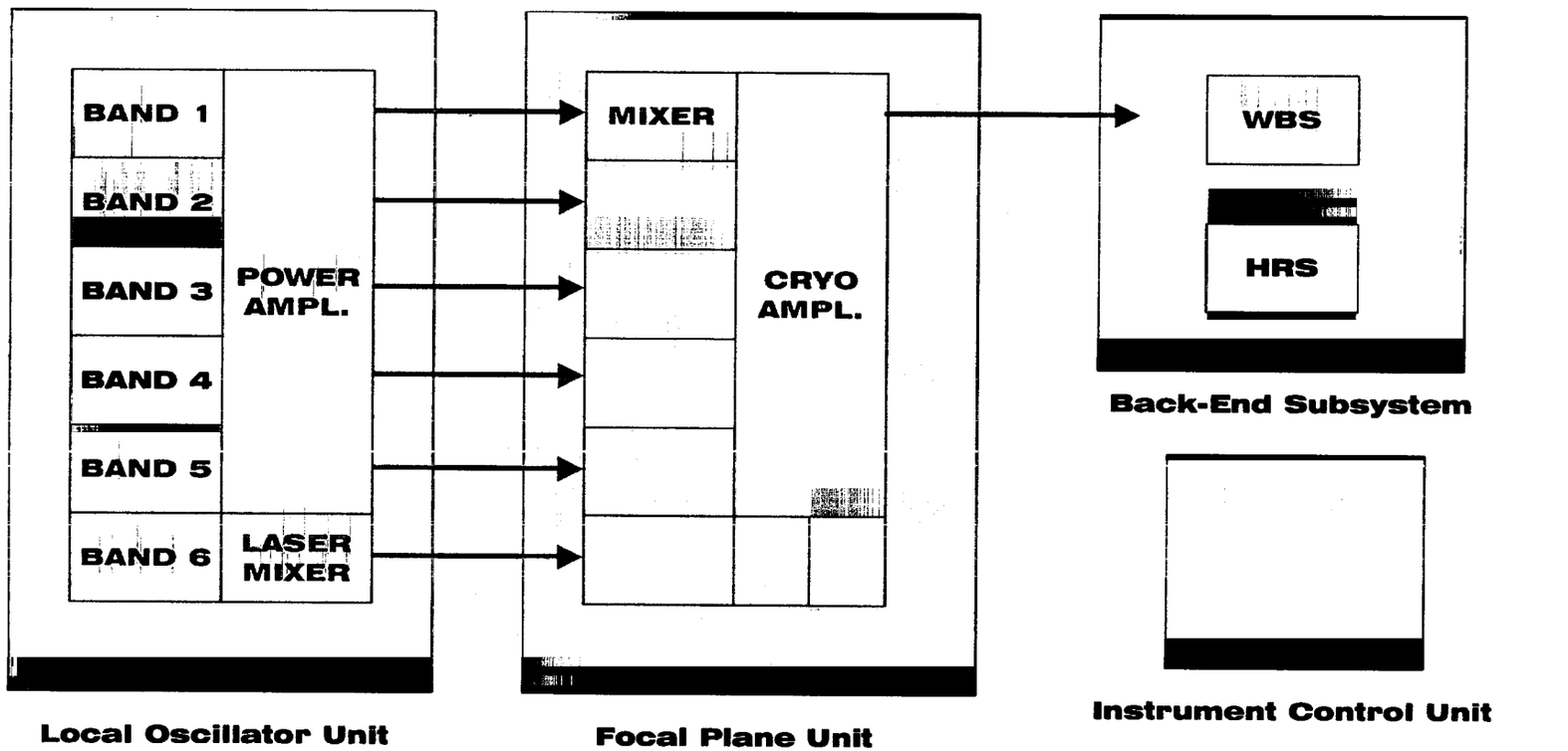
HIFI HARDWARE



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**

ANNEX 6

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FIRST/Planck

Payload Meeting
Payload Ground Segment

3 July 1998

PT-05628

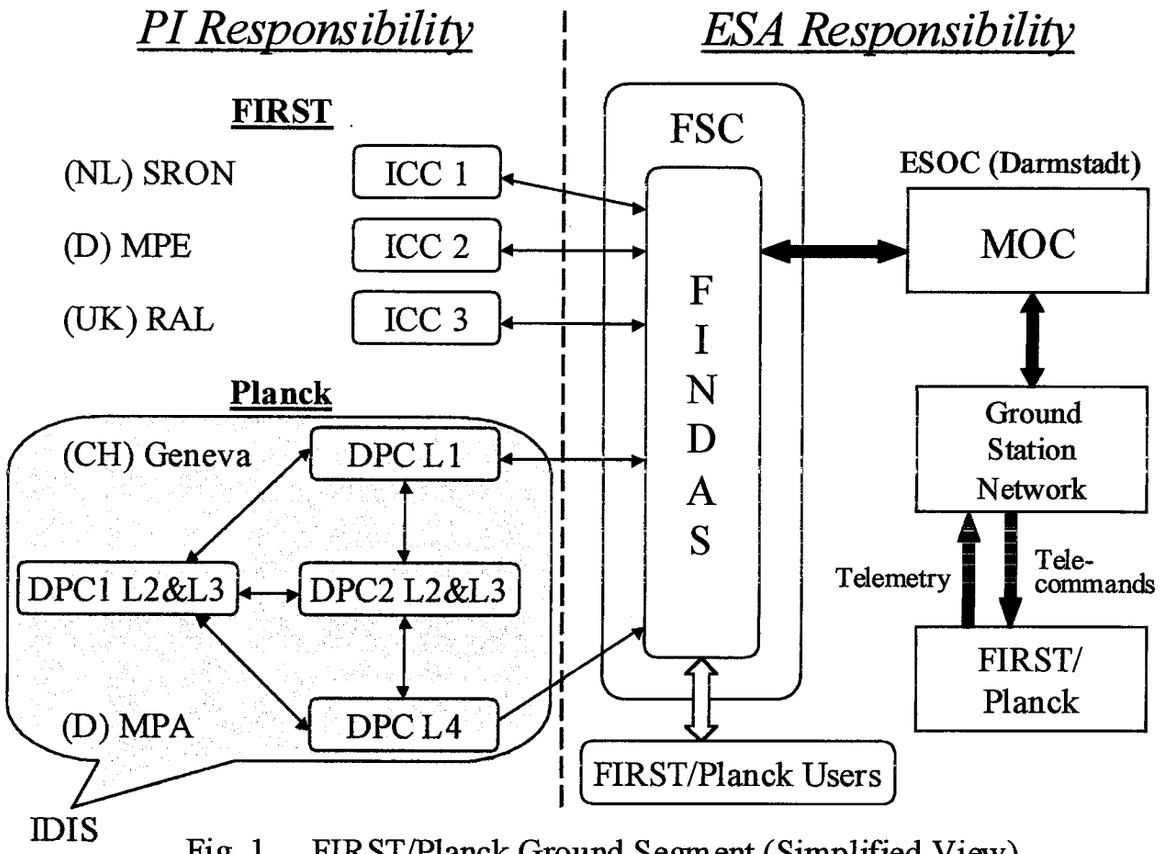


Fig. 1 FIRST/Planck Ground Segment (Simplified View)

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, Telecommandand 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

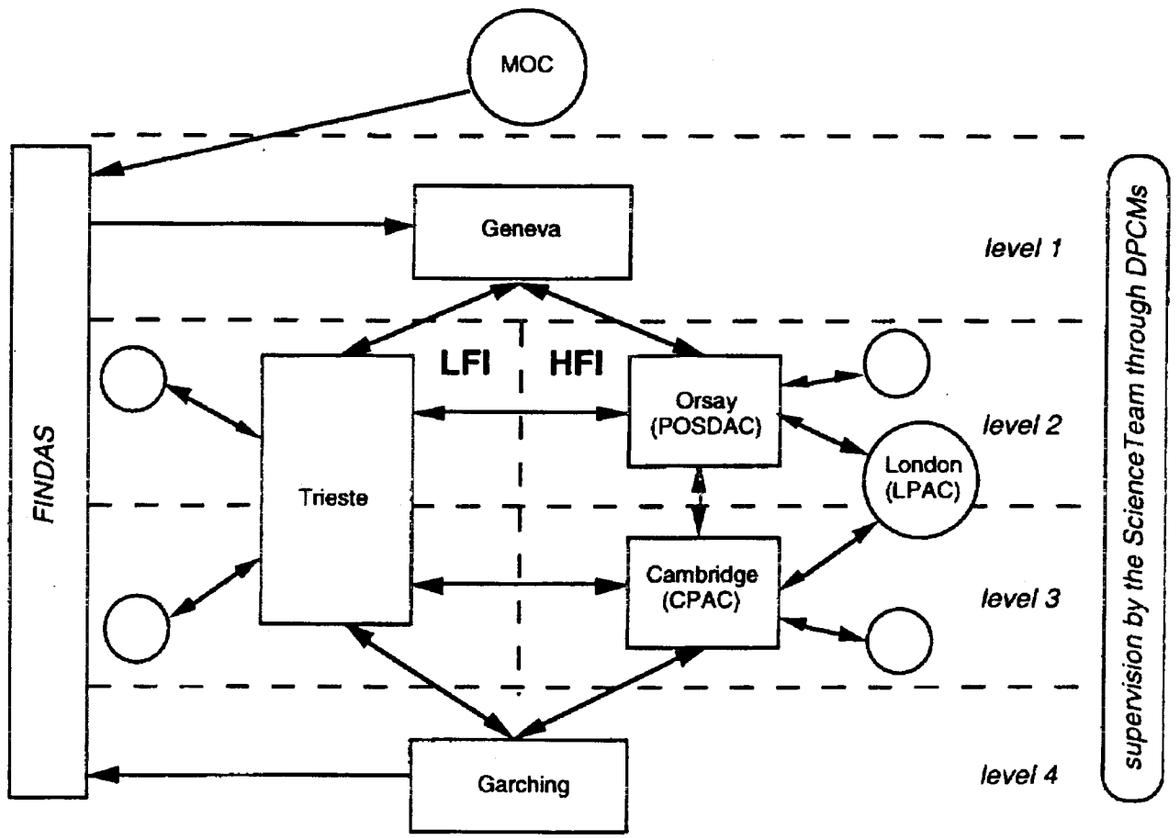


Fig. 2 Planck Data Processing Distributed Structure

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:

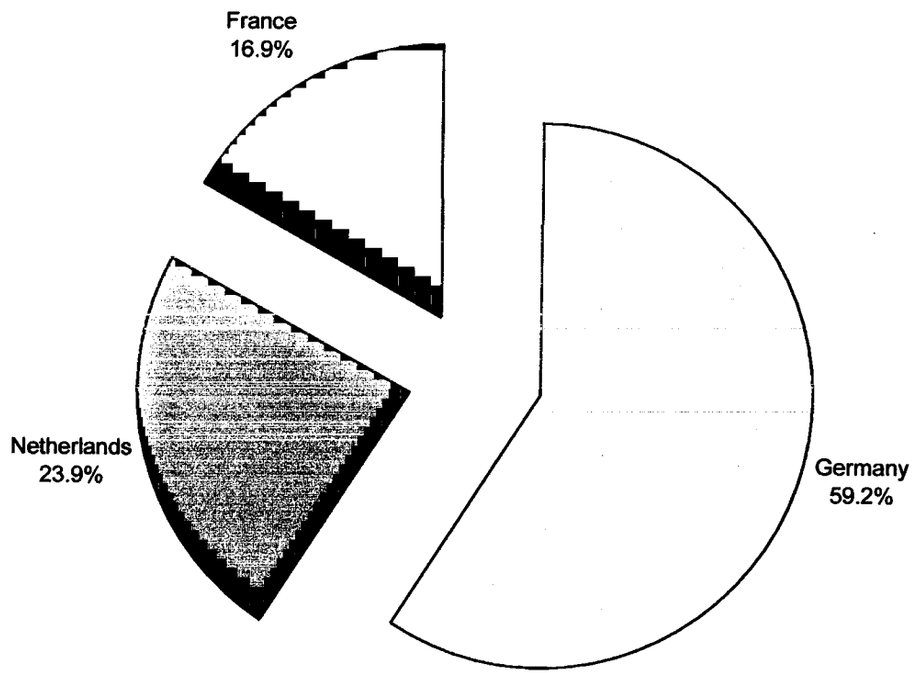
- Located at ESOC (Darmstadt, Germany)
- Supports FIRST and Planck (simultaneously)
- Overall operational responsibility (Spacecraft and Instruments)

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 andOperation) per country

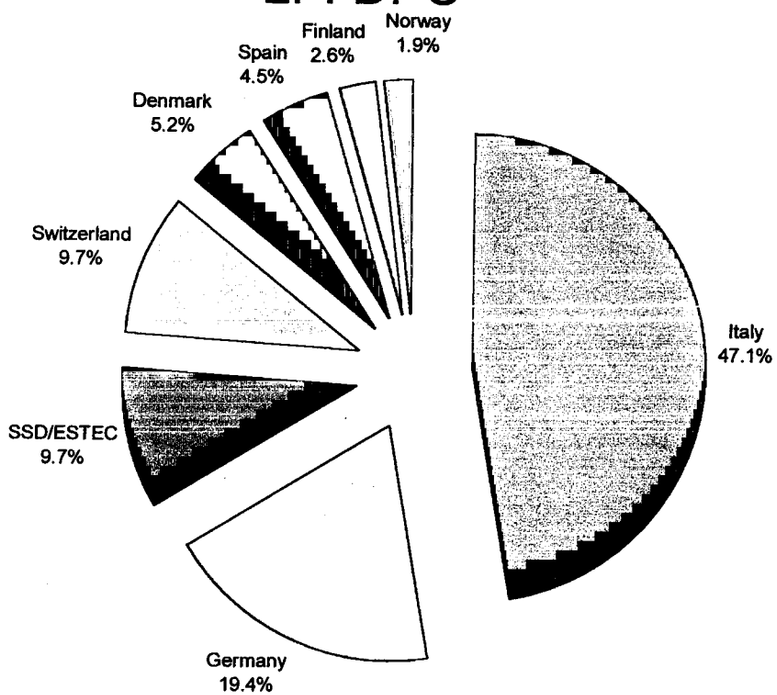


Total Cost: 14.2 MECU (Archive Phase not included)

Planck Data Processing Centres (DPCs)

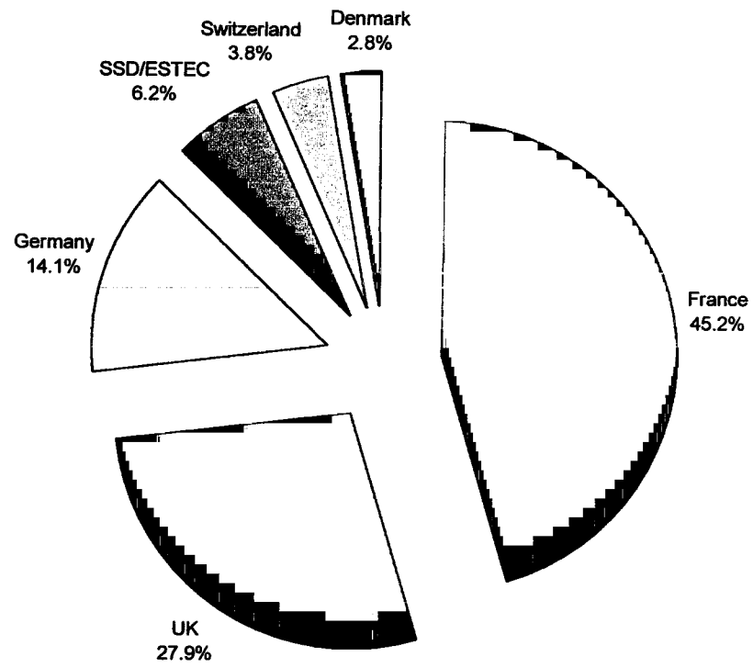
Overall Contributions (Development and Operation) per country

LFI DPC



Total Cost: 15.5 MECU

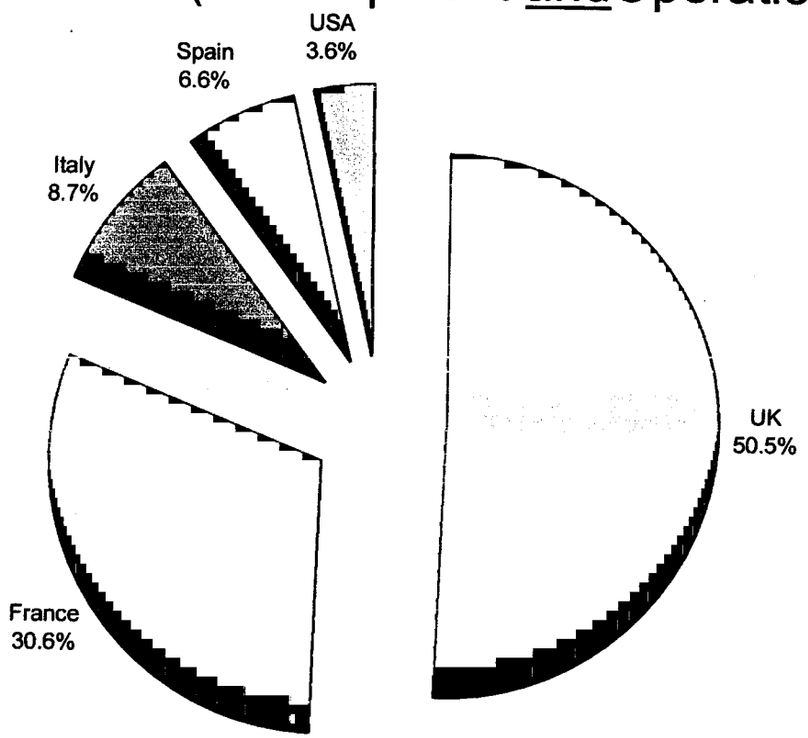
HFI DPC



Total Cost: 29.0 MECU

FIRST SPIRE Instrument Control Centre (ICC)

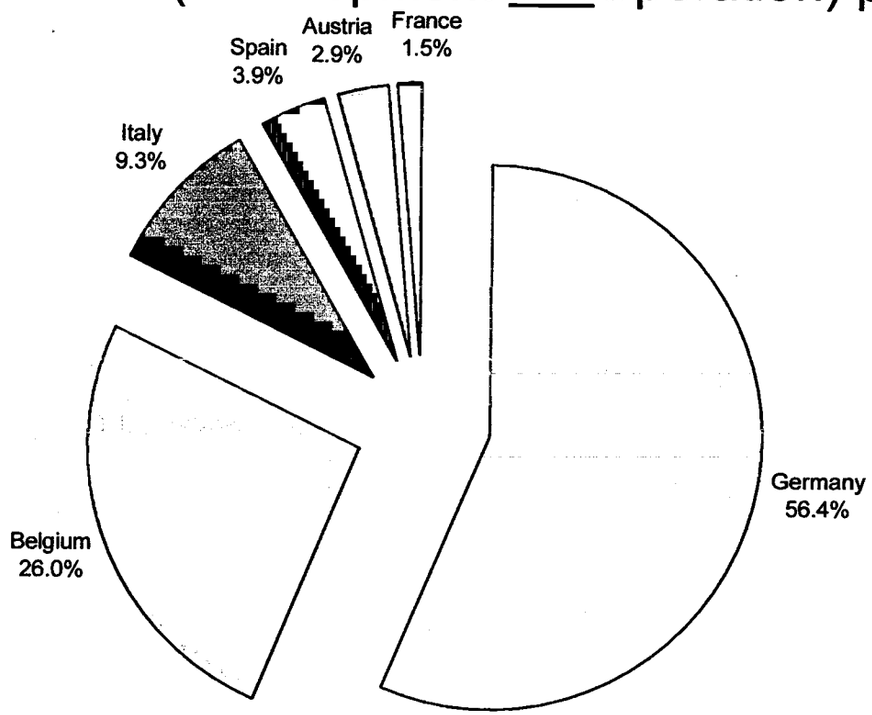
Overall Contributions (Development and Operation) per country



Total Cost: 19.6 MECU

FIRST PACS Instrument Control Centre (ICC)

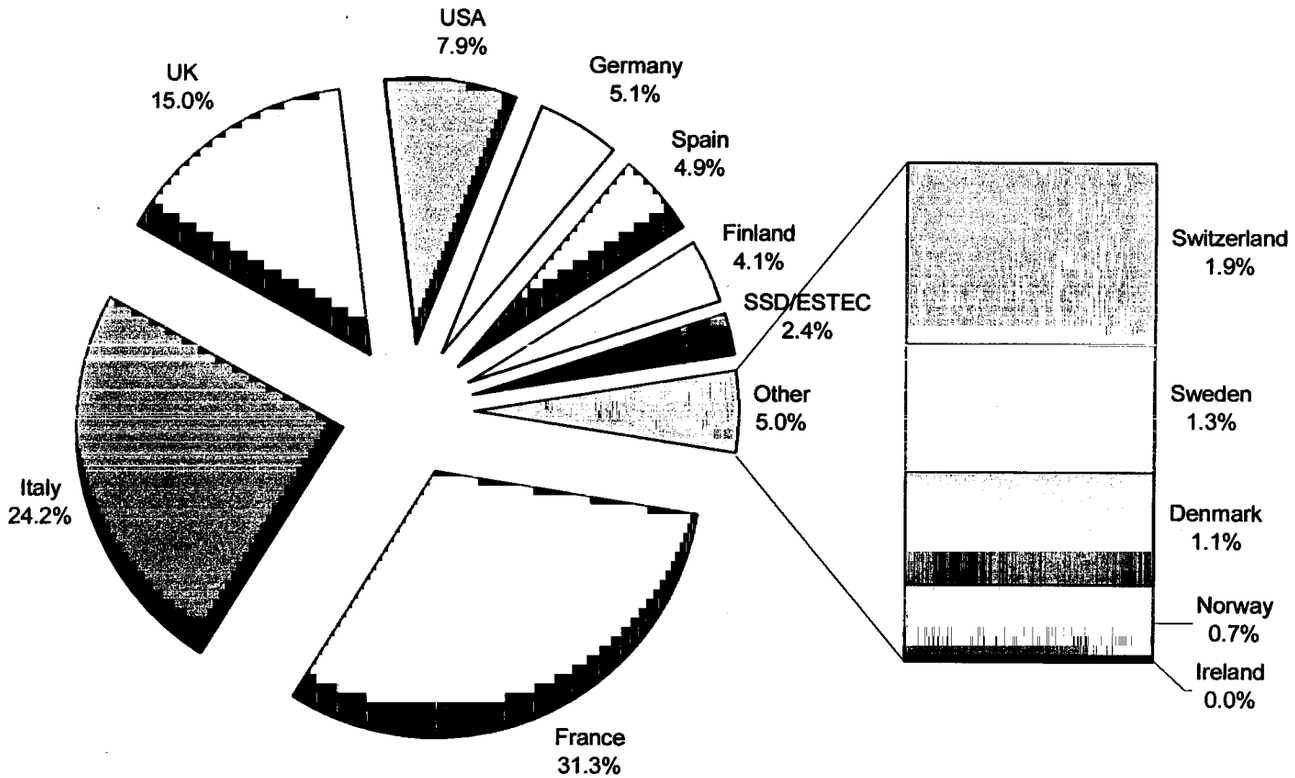
Overall Contributions (Development and Operation) per country



Total Cost: 20.4 MECU (Archive Phase included)

Planck TOTAL PRINCIPAL INVESTIGATOR EFFORT

Overall Contributions (Instrument and DPC) per country



3 July 1998

PT-05628

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

ANNEX 7

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FIRST/Planck

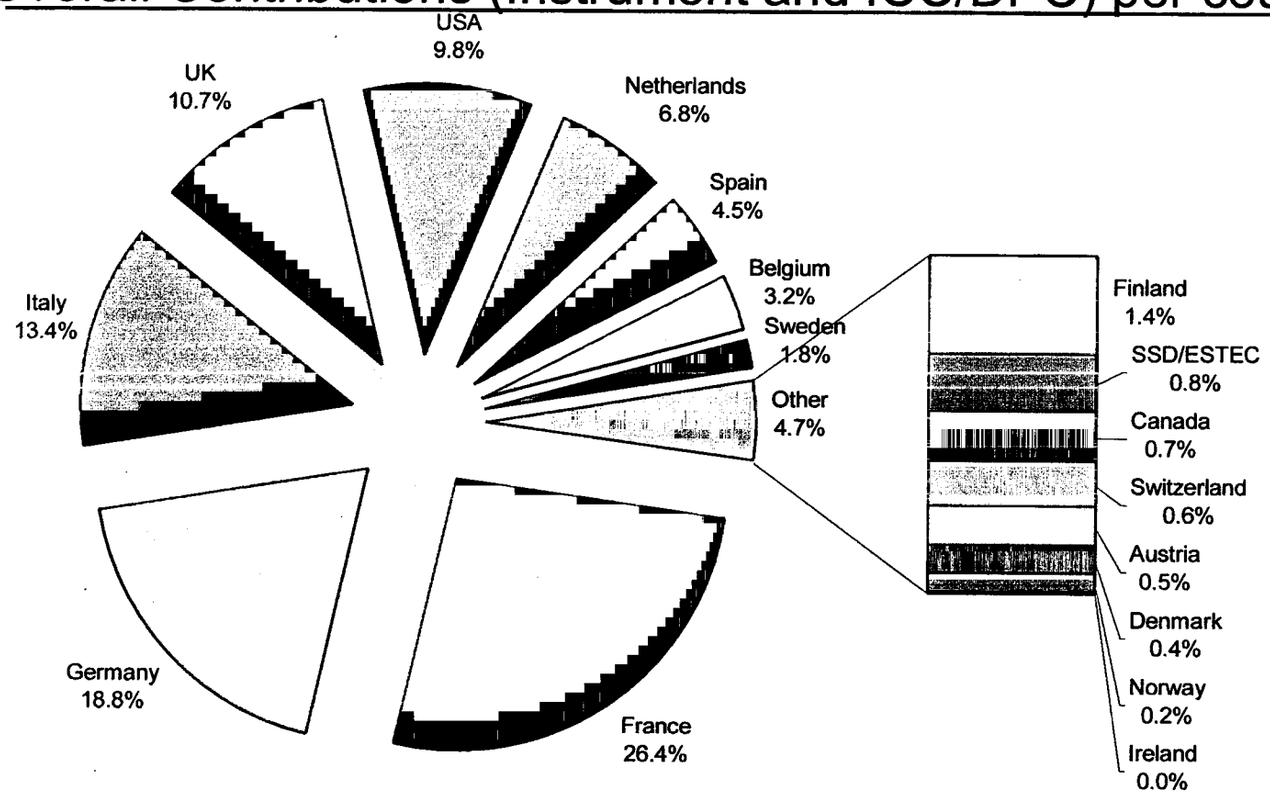
Payload Meeting
Payload Total Cost Overview

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