



FIRST Science Team Mtg1 (FST1) - Minutes of Meeting

held at ESTEC, Noordwijk, 18 December 1998 09.15-18.30 hours

1. Welcome and presentation of members

All members of the FST were present:

Peter Barthel, MS (PB)
José Cernicharo, MS (JC)
Pierre Encrenaz, MS (PE)
Thijs de Graauw, HIFI PI (TdG)
Matt Griffin, SPIRE PI (MG)
Paul Harvey, MS (PH)
Martin Harwit, MS (MH)
Thomas Paßvogel, Project (ThP)
Tom Phillips, HIFI Co-PI (TP)
Göran Pilbratt, PS (GP)
Albrecht Poglitsch, PACS PI (AP)
Laurent Vigroux, SPIRE Co-PI (LV)
Christoffel Waelkens, PACS Co-PI (CW)

The chairman (GP) welcomed everyone on this the momentous occasion of the 1st FST meeting (FST1). It turned out that some people's memories of FIRST went almost two decades back in time.

Each member briefly introduced himself. It was decided to put a list of the FST members with professional affiliation, address, telephone and fax numbers, and email address on the web, and in addition to compile and circulate - within the FST only - a list containing private contact details.

Action 1: GP to put list of FST members on the FIRST web page.

Action 2: All members of the FST to supply GP with private contact details.

Action 3: GP to compile list with professional and private contact details and circulate within the FST only.

2. Agenda and objectives of the meeting

The chairman proposed an updated version - with timelines - of the earlier circulated agenda. The meeting adopted the proposed agenda (cf. Appendix 1).

The mandate, responsibilities, and tasks of the FST are described in the FIRST Science Management Plan (SMP) section 3.2.2. The FST has a mandate which it can and should use to fulfil its overall responsibility to 'safeguard the scientific interests of the FIRST mission'. The objective of this, the initial, meeting is to get the FST started and to discuss how to best use the FST, and to identify the corresponding tasks to reach the stated objectives.



3. Responsibilities and tasks of the FST

The FIRST SMP lists the responsibilities of the FST in section 3.2.2. Of the listed tasks bullets 2-5 and the last bullet (SMP page 10) are the most important at this point in time. The FST has a duty to the science community to advocate on what it believes. It normally reports back to ESA, but can decide to report elsewhere if judged to be appropriate and helpful in fulfilling its tasks.

4. Responsibilities and tasks of the MS

The FIRST SMP lists the responsibilities of the MSs in section 4.4. GP stressed that particular responsibilities of the MSs is to represent the interests of the wide user community in the FST and to provide independent (from the instrument consortia) assessment and advice on matters arising.

The MSs were asked to present their interests as MSs briefly in real time.

PB: I have a strong and active interest in active and starburst galaxies, their nature, their interrelation and their cosmic evolution; in addition strong and active interest in astronomical outreach. Proposed FST contribution is to ensure that the unique science goals of FIRST concerning the detection and subsequent investigation of the earliest proto-galaxies and the cosmologically evolving AGN-starburst symbiosis are being met, and that these goals and the results of the FIRST mission are being conveyed to the general public in an optimal way. Hence, both the survey and the detailed observations of SPIRE and PACS are prime areas of interest, as is ESA/FIRST outreach in general.

JC: to come

PE: I will try to address the calibration/pointing issues of the three instruments, in particular the DSB observation mode and full frequency surveys of HIFI. I hope to contribute to the definition of the common goals between FIRST and Planck. My interest lies in the Interstellar Medium in our and nearby galaxies, and also in primordial molecules. I hope to contribute to the definition of the core programme. I will work with E. Lellouch all issues related to system solar system objects. My plan is to devote approximately 30% of my time in the period 2002 to 2007 for FIRST (my teaching load will diminish then). I hope to contribute to the dissemination to the public of the results and discoveries coming from FIRST.

PH: My interests' are first of all, to be useful where needed. Most of my experience is in the area of infrared instrumentation and galactic studies of star formation and circumstellar material. In my proposal to FIRST, I stated (and still feel) that it may be easier to make a contribution in areas where close contact with the instrument teams is not so important. This led me to propose to play a significant role especially in the design of the key programs and large scale surveys where I think FIRST will make very exciting contributions.

MH: I am very concerned about the synergy between Planck and FIRST. I would like to make sure that these two missions derive the greatest mutual benefits from each other. (This was one of the concerns already voiced in the FSEC review we conducted a year ago.) I want to contact Jean-Loup Puget, who had expressed similar concerns to me, and work with him to see whether we could come up with recommendations, to our respective science teams, for the best way for the two teams to coordinate their activities. I have rather wide interests in astrophysics, and would be glad to take on any tasks that are not covered by other mission scientists. To some extent I played this same role on ISO. Science teams do not always have experts on all possible matters, and it is often useful to have someone who is willing to look at odd matters, study them, and make a recommendation for further steps that might be taken if greater depth is required: As one example of this, I would be glad to take on the problem of surveys, at least on an interim basis, until it is considered necessary to fill this position with someone full-time and such a person can be found to take on responsibility. Half of my observing time on ISO has been dedicated to deep surveys, both with the camera and the photometer.

LV reported from the AWG that there was concern voiced in the AWG that there was no FIRST MS dedicated to 'surveys'. It was believed that the AWG was looking for an additional MS rather than to 'dedicate' an



existing one. The FST takes note of this; as spelled out in the SMP there is the possibility for D/Sci (to which the AWG reports) to add an MS should he wish to do so.

5. Short 'status reports' on FIRST and its instruments

Since the Project Manager Fabrizio Felici (FF) had not yet arrived, this point started with the presentation of HIFI by TdG (Appendix 2). Some points mentioned:

- The Consortium is large, approximately 22 institutes in 10 countries are involved in the hardware effort.
- The FPU has been redesigned, the current design is somewhat smaller compared to the design in the proposal. The seven bands are now labelled 1 to 7, (6a, 6b now 6, 7) the seven mixer assemblies are different but similar (bands 1-5 employ SIS mixers, bands 6 and 7 HEB mixers), 1 band providing 1 pixel on the sky at any one time, passive power combiners.
- Decision about 0.5 K cooler (for HEB mixers) to be taken in autumn 2000.
- Preferred delivery schedule QM 7/2003, FM 12/2004; HIFI wants full QM EMC test with some representative spacecraft parts.
- Design and concept review 1-3 February 1999 (NASA-JPL, Pasadena)
- Funding. The LO subsystem work planned for by DLR Berlin is not supported, it will be taken over by MPIFR Bonn, SRON, and JPL. For the spectrometer subsystem there are serious French funding problems. There could be Swiss participation in the mixer assembly.

Overall FIRST update by Fabrizio Felici (no handout):

- The FIRST (and Planck) payload confirmation is planned for the SPC meeting to be held 15-16 February 1999. In preparation the 3rd ESA/PIS/Delegations meeting will take place on 11 January.
- The FIRST telescope JPL/COI 2 m 'demonstrator' is scheduled to be ready by mid-1999, the testing to be completed by end-1999. The SiC backup technology 1.35 m mirror demonstrator is currently being polished at Opteon (Finland), a cold test is scheduled for January 1999 at CSL, Liège (Belgium), to be followed by vibration in Jan-Feb 1999.
- The ITT for FIRST and Planck is scheduled to be issued in Q4 1999.

In the discussion concerns were voiced whether payload funding is still the major issue. A worry is that if/when payload funding is sorted out, spacecraft funding (problems) could introduce delays which then would be very difficult to accommodate for the payload consortia.

It was also stated that (at least some) funding agencies are not convinced that 2.5 years is needed between FM delivery and launch. They need to be convinced and/or the schedule updated - otherwise we risk the same non-productive discussion in the 11 January meeting as in the previous meeting.

Action 4: ThP to organise a telecon with the PIs on 6 January 1999 at 18.00 hours to discuss technical and schedule aspects of AIV.

Action 5: PIs to supply telephone numbers for telecon by 12.00 hours on 4 January 1999.

PACS update by AP (Appendix 3). Some points mentioned:

- The focal plane curvature creates a problem when chopping because you get different distances from the centre of the focal plane in the two chopping positions. PACS would want to go into the centre of the focal plane. SPIRE also has the same need - the whole issue of focal plane sharing should be (re-)discussed.
- Three different industry FPU offers, the plan is to make a choice and get DLR blessing before 11/1/1999 meeting.



- PACS is willing to meet the schedule required by the Project; AVM/CQM delivery 3/2003, PFM 6/2004, and FS assemblies 6/2005.
- The cryovibration is an open issue - it is not included in the PACS budget.
- The Belgium funding situation has become worrying; the CREs are both technically and financially worrying. Efforts are underway to address both problems.

Action 6: CW to find out whether the FST can be of any assistance; and to contact the PS with a request if that is the case.

SPIRE update by MG (Appendix 4). Some points mentioned:

- The focal plane sharing is indeed an issue also for SPIRE - need a 'Tiger Team' type meeting on short timescale.
- SPIRE Science Requirements Document is being prepared. It raises issues relevant to mission as a whole e.g. survey strategies. It should be in a 'circulable' form by end-1999.
- On the question on how the FST could help the SPIRE consortium at this point in time MG suggested a pleading to the SPC for clarity regarding funding and schedule issue. PI consortia have problems resulting from the present schedule uncertainties, e.g. they cannot commit to letting contracts.

The FST decided to plead to all the participants in the 11 January meeting for clarity regarding funding and timescales.

Action 7: GP to produce and circulate a draft by Monday morning, FST members to comment Monday in the afternoon. GP to send the final document to Sergio Volonte on Tuesday for distribution in the meeting on 11/1/1999.

6. FIRST spacecraft constraints

ThP gave a presentation (Appendix 5) covering telescope, pointing accuracy and observing modes, solar aspect angle restrictions, telemetry (data production) rates, lifetime. Some points discussed:

- Pointing. TdG expressed concern re. tracking of solar system objects, there was also a feeling of not having sufficient information especially with respect to pointing modes. ThP pointed out that the two relevant documents are the IID-A, and FIRST Scientific Pointing Modes (PT-SP-04673).

Action 8: ThP to make these two documents available in the FIRST-Planck (Project) domain on the SA-DMS.

Action 9: TdG to comment in writing on the concerns of the HIFI consortium with respect to the tracking of solar system objects.

- Science data production rate. The potential gain of a factor of 4 in data rate has a major impact for SPIRE as no onboard data reduction would be required if SPIRE could downlink four times more data. The FSC made the following recommendations on this subject:

Recommendation 1: The FST strongly urges ESA to take full advantage of the potential data rate increase made possible by going to X-band.

Recommendation 2: The FST urges ESA to come to a (positive!) decision on data rate as soon as possible.

- Cryostat. FIRST is being designed to offer (a minimum of) 3 years lifetime in L2, in addition to the transfer time which is in the range 3-6 months. However, the current increases in FPU masses (87 kg in model payload, current value 150 kg) and dissipation (2.5 mW allocated now has become 9.4 mW) could become a problem.

The rate of boil-off can also change the temperatures in the focal plane. In this context it was pointed by MG that SPIRE needs to know the total telescope/instrumental background well (within approximately a factor of



2) in order to match to detectors (most critical for the Saclay detector array lternative). This information is needed at the time of detector selection.

7. FSEC recommendations

GP presented a summary of the FSEC recommendations (Appendix 6). At this point in the meeting the time was running out and there was no real discussion. It was agreed that the three specific recommendations (surveys vs. detailed observation, FIRST and Planck synergies, onboard data reduction) warranted special attention and will have to be discussed extensively in near future FST meetings. It is also clear that we need to talk jointly with the Planck Science Team re FIRST/Planck synergies, and this needs to be arranged.

Action 10: FIRST PS to talk to Planck PS re. FIRST-Planck synergy

Action 11: MH/PE/GP later to consult with J-L. Puget on the same subject

On the subject of onboard data reduction there was a very brief discussion re. SIRTf which faces a similar (possibly worse?) problem.

Action 12: TP to gather information on how SIRTf/MIPS is addressing this issue.

8. ESA discussions with NASA re. cooperation on FIRST

GP explained that (as seen from a formal ESA point of view) NASA is contributing to the FIRST mission in two ways: NASA is supporting the PI effort (which is funded directly by ESA member states) by collaborating in two PI consortia, and NASA is collaborating directly with ESA on the FIRST spacecraft by providing the telescope.

The NASA 'return' from being involved in the instrument consortia is outside ESA influence, but the ESA/NASA collaboration needs to be formalised in a Memorandum of Understanding (MOU). GP summarised the ongoing discussions (Appendix 7) that ultimately will lead to a MOU.

GP explained the issue brought up by NASA in the MOU discussions regarding FIRST 'key project' time. Guaranteed time (GT) holders are required (as described in the FIRST SMP) to 'spend' part of their GT in any key project they apply for time for. This could be regarded as a disadvantage for somebody who is proposing for key project time, but who does not have any GT to 'spend'. GP has an action from the ESA/NASA discussions to bring this up in the FST. This issue will have to be discussed in future FST meetings.

9. Optimisation of information flow

GP showed one viewgraph (Appendix 8) giving some information about the SA-DMS system. It will be used for the time being as a repository for documents enabling access for all registered users in ESA and in the PI consortia. No time to discuss further.

Action 13: GP to enable SA-DMS access for those FST members who do not already have access.

10. PR/outreach

John Zarnecki gave a hurried presentation of his role (Appendix 9). It was considered a good idea to invite Mónica Salomone, the FIRST (and Planck and ISO) science writer, for the next FST meeting.

Action 14: John Zarnecki to supply the D/Sci survey mentioned in his presentation.



11. Dates of next two meetings

The rate of having FST meetings, and the length of the meetings were discussed. It was concluded that at this stage the FST should meet four times a year, and we should reserve two days for each meeting.

It was decided to hold the 2nd FST meeting (FST2) on 22-23 March 1999 and FST3 on 23-24 June 1999, both in ESTEC.

12. AOB

As there was no any other business the chairman thanked everone and closed the meeting.

List of Actions:

FST1-A1: Put a list of FST members with professional contact details on the FIRST Web page. **Actionee:** GP. **Deadline:** 31/01/1999.

FST1-A2: Supply GP with private contact details. **Actionee:** All FST members. **Deadline:** 31/01/1999.

FST1-A3: Put together and circulate list of private contact details within the FST. **Actionee:** GP. **Deadline:** 28/02/1999.

FST1-A4: ThP to organise a telecon with the PIs on 6 January 1999 at 18.00 hours to discuss technical and schedule aspects of AIV. **Actionee:** ThP. **Deadline:** 6/01/1999.

FST1-A5: PIs to supply telephone numbers for the 6/1/1999 telecon by 12.00 hours on 4 January 1999. **Actionee:** All PIs. **Deadline:** 12.00 hours on 4/01/1999.

FST1-A6: CW to find out whether the FST can be of any assistance re. the Belgian PACS situation; and to contact GP with a request if that is the case. **Actionee:** CW. **Deadline:** 31/01/1999.

FST1-A7: GP to produce and circulate a draft by Monday morning, FST members to comment Monday in the afternoon. GP to send the final document to Sergio Volonte on Tuesday for distribution in the meeting on 11/1/1999. **Actionee:** GP / All FST members / GP. **Deadline:** 21/12/1998 / 21/12/1998 / 22/12/1998.

FST1-A8: ThP to make these two documents available in the FIRST-Planck (Project) domain on the SA-DMS. **Actionee:** ThP. **Deadline:** 31/01/1999.

FST1-A9: TdG to comment in writing to GP on the concerns of the HIFI consortium with respect to the tracking of solar system objects. **Actionee:** TdG. **Deadline:** 15/02/1999.

FST1-A10: FIRST PS to talk to Planck PS re. FIRST-Planck synergy. **Actionee:** GP. **Deadline:** 15/02/1999.

FST1-A11: MH/PE/GP later to consult with J-L. Puget on the same subject. **Actionee:** MH/PE/GP. **Deadline:** 28/02/1999.

FST1-A12: TP to gather information on how SIRTF/MIPS is addressing this issue. Send this information in electronic form to GP. **Actionee:** TP. **Deadline:** 31/01/1999.

FST1-A13: GP to enable SA-DMS access for those FST members who do not already have access. **Actionee:** GP. **Deadline:** 31/01/1999.

FST1-A14: John Zarnecki to supply the D/Sci survey mentioned in his presentation. **Actionee:** John Zarnecki/GP. **Deadline:** 31/01/1999.



List of Recommendations:

FST1-R1: The FST strongly urges ESA to take full advantage of the potential data rate increase made possible by going to X-band.

FST1-R2: Recommendation 2: The FST urges ESA to come to a (positive!) decision on data rate as soon as possible.



Appendix 1

Proposed AGENDA for the 1st FIRST SCIENCE TEAM meeting

Friday 18 December 1998, 09.15-17.00, ESTEC room Cf113

1. 09.15-09.30 Welcome, presentation of members
 2. 09.30-09.45 Agenda and objectives of the meeting
 3. 09.45-10.00 Responsibilities and tasks of the FST
 4. 10.00-10.15 Responsibilities and tasks of the MSs

 - 10.15-10.30 COFFEE BREAK

 5. 10.30-12.30 Short “status reports” on FIRST and its instruments

 - 12.30-13.45 LUNCH BREAK

 6. 13.45-14.30 FIRST spacecraft constraints
 7. 14.30-15.00 FSEC recommendations

 - 15.00-15.15 COFFEE BREAK

 8. 15.15-15.45 ESA discussions with NASA re cooperation on FIRST
 9. 15.45-16.00 Optimisation of information flow within the FST, and to ‘the community’
 10. 16.00-16.30 PR/outreach
 11. 16.30-16.45 Date(s) of next meeting(s)
 12. 16.45-17.00 AOB
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Appendix 2

HIFI presentation by Thijs de Graauw

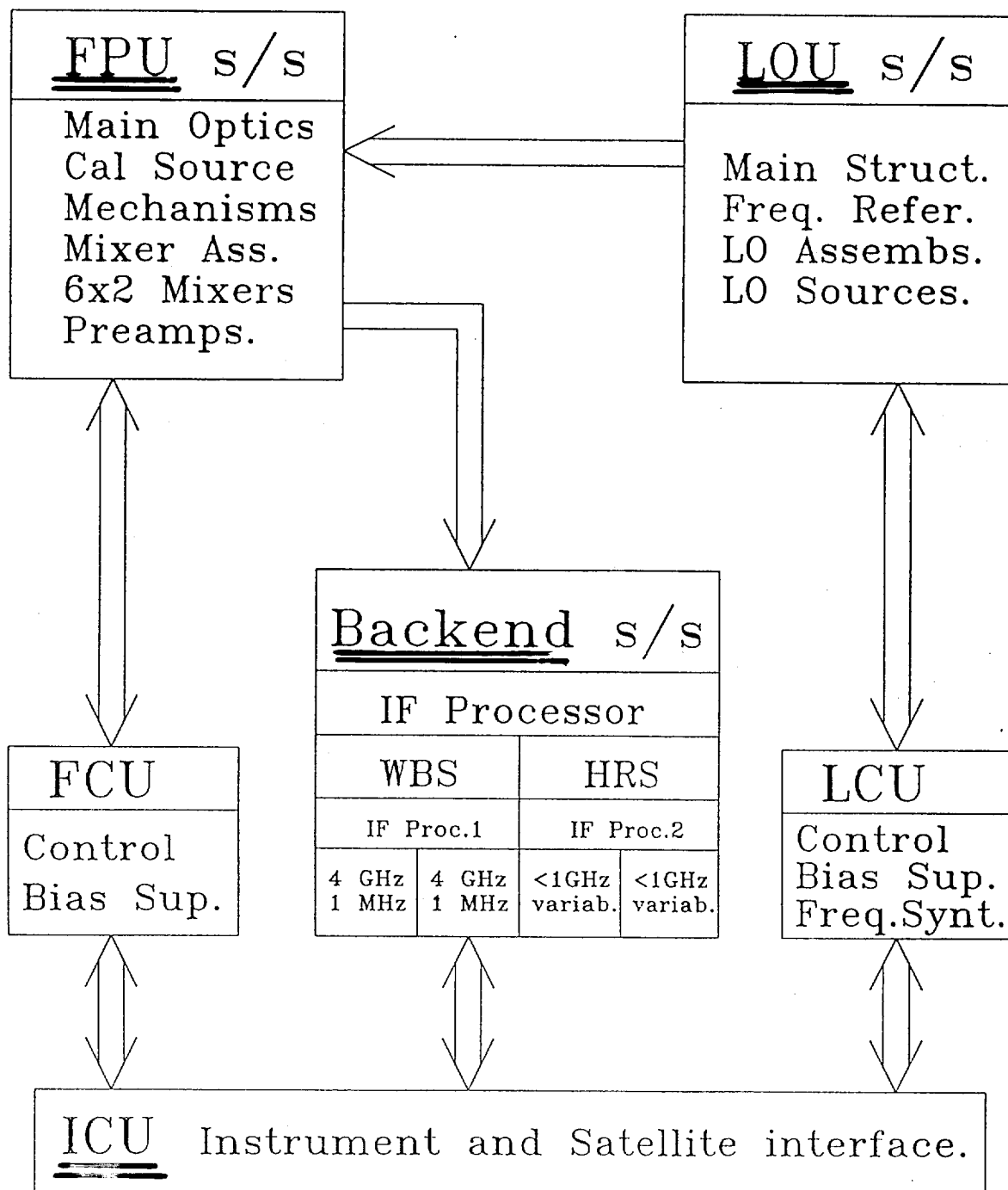
FIRST-HIFI STATUS REPORT for FST-1

- Consortium Composition
- Design and Technical Development
- Instrument Development

HIFI CONSORTIUM MATTERS:

- LO Sub/system Management
WS-Berlin---→MPIfR
Plus contributions by JPL and SRON
- Back-End Rationalisation:
Design and Interfaces
IFP----WBS----HRS(ACS)
Meudon--Kosma/IFSI—CESR/SSC
- Still some issues open, to be settled by
January/February

HIFI blockdiagram.

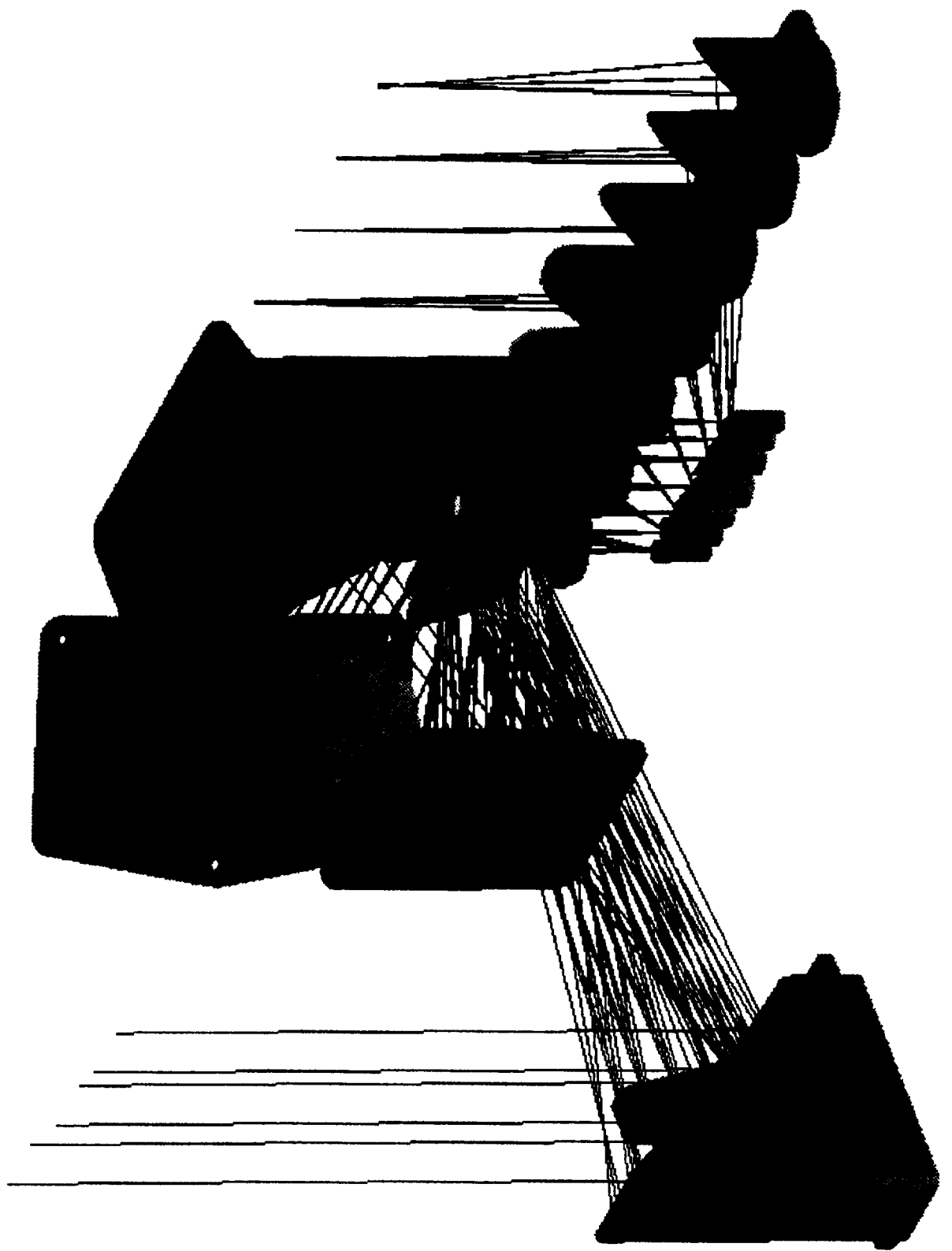


DESIGN /TECHNICAL DEVELOPMENT

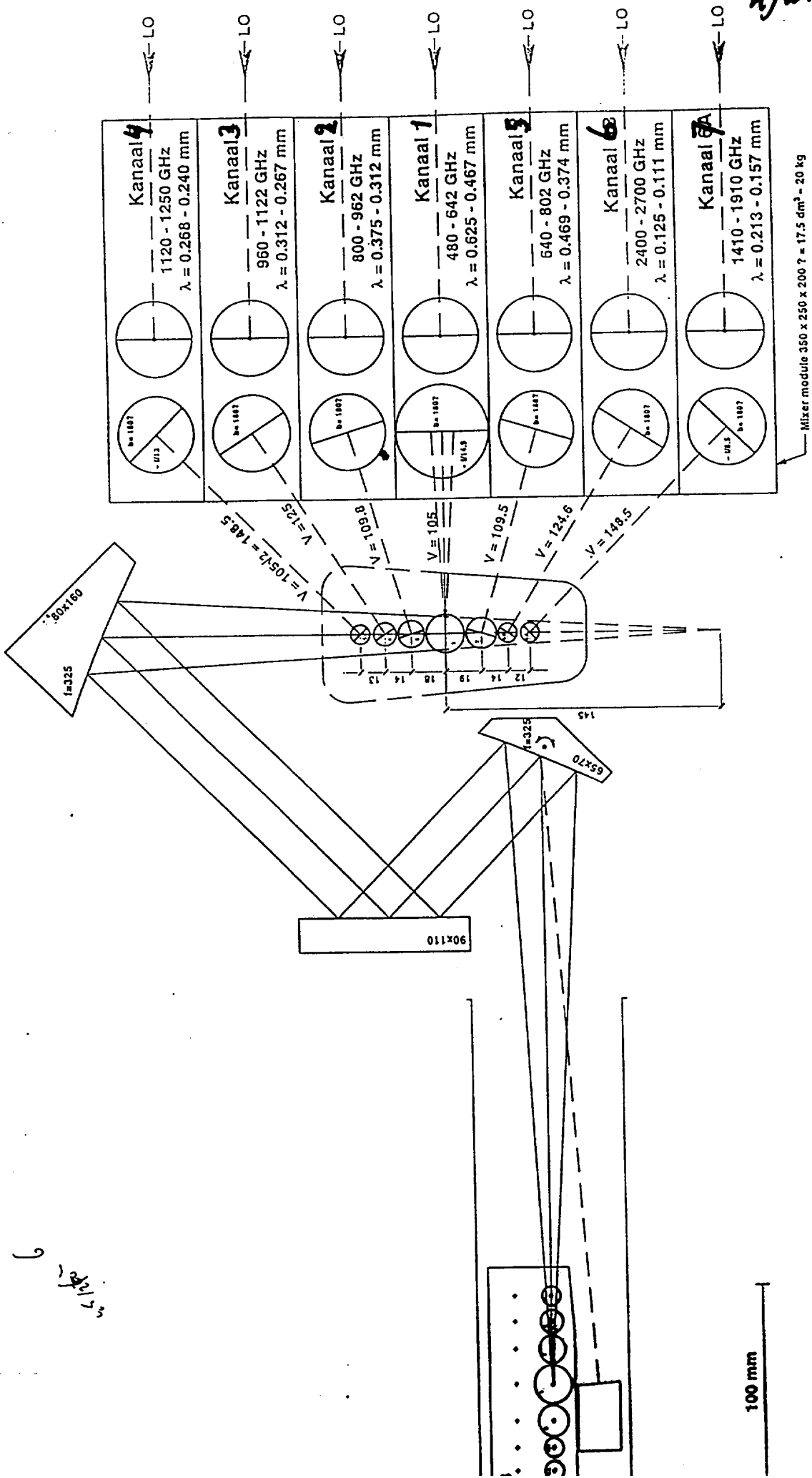
- **FPU/LO Design Progress**
- **Cryo-Pre-Amp development Excellent**
- **Mixer Development full force:**
 - Aim 2000: 4 GHz/tunerless**
 - Aim 2001: Baseline Sensitivity**
 - Aim 2003: Goal Sensitivity**
- **LO Multipliers Development:**
 - High Frequency Bands started (JPL)**
 - Bands 1, 2 awaiting TRP funding**
- **ACS Chips under development**
- **Bragg Cell Development started**

INSTRUMENT DEVELOPMENT

- **Design Concept and Plan Review**
1,2,3 February 1999
- **Delivery Schedule Update:**
QM: 7/2003; FM: 12/2004
- **Organisation Start-Up Slow (Funding)**



kjwildema



9
1/2/23

HO: 20dm³ ≈ 20 kg
installatie

n ... 1

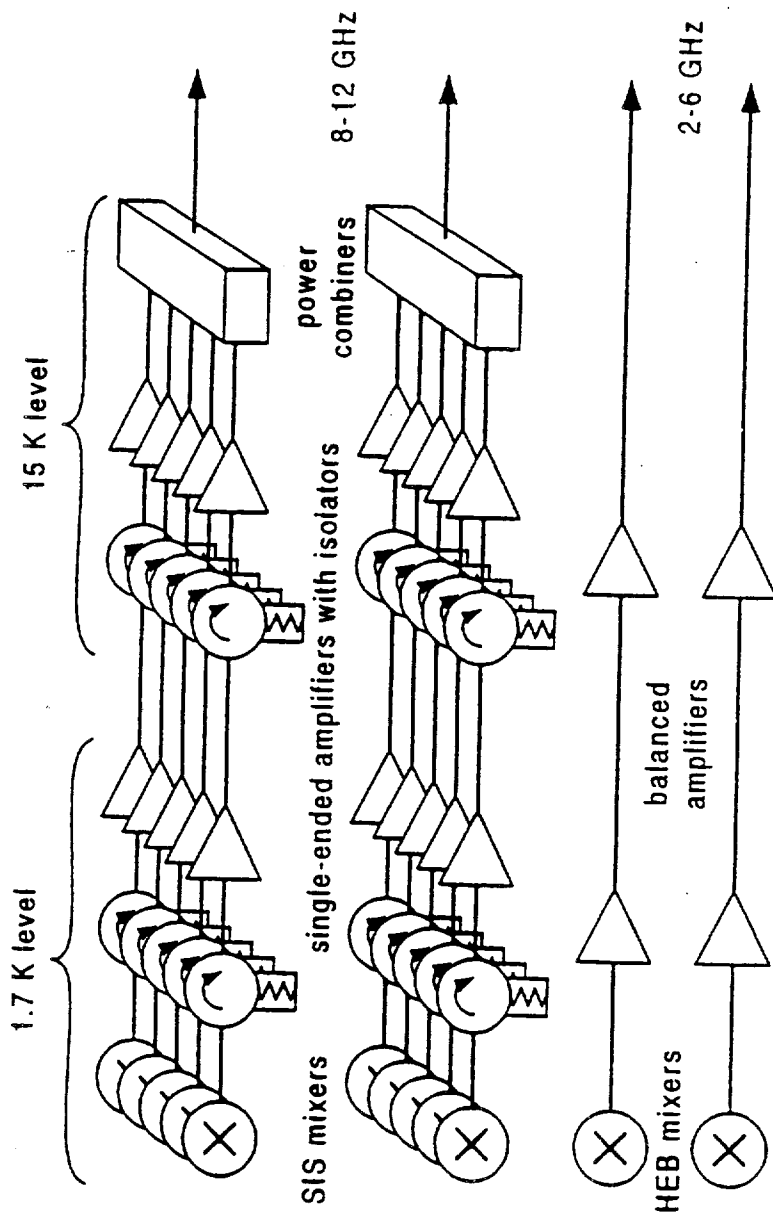


Figure 27. Block diagram of IF pre-amplification scheme.

Announcement of the HIFI Design Concept and Plan Review 1,2,and 3 (morning* only) February 1999 at NASA-JPL

Meeting Objectives:

To provide expert opinion and advice on:

- the status of the HIFI Design Concept**
- the designed instrument's capability to meet the scientific and functional requirements**
- the project plans for developing the critical technologies, and for qualification and construction of the instrument**
- the project organisation and management plans**

The documents to be prepared and to be made available for reference are:

- 1. Instruments specs and requirements**
- 2. Sub/system specs and requirements**
- 3. Description of the HIFI design concept**
- 4. HIFI critical technology development plan**
- 5. HIFI AIV plans**
- 6. HIFI management and development plan**
- 7. An update of the IID-B**
- 8. HIFI internal interface document**



Appendix 3

PACS presentation by Albrecht Poglitsch

(not available)



Appendix 4

SPIRE presentation by Matt Griffin

SPIRE FSEC RECOMMENDATIONS

- FSEC approved of the SPIRE photometer capabilities and design
 - Higher resolving power (> 100) was not seen as essential.
- R > 100 is no longer a design driver but we will implement if it means little extra cost or complexity.*
- We were urged to try to improve spectrometer efficiency by recovering light lost at the input.

Alternative option is being studied.

- We were encouraged to see if we can incorporate the spectrometer into the photometer.

We examined this possibility and judged it to be impractical.

- We were advised to study in detail the relative merits of full sampling of the diffraction spot (filled arrays vs. feed-horn fed arrays).

We are doing detailed simulations as part of the detector array evaluation/selection programme.

- On-board data processing was seen as a problem for all FIRST instruments – FSEC recommends that convincing and detailed plans be drawn up at an early stage.

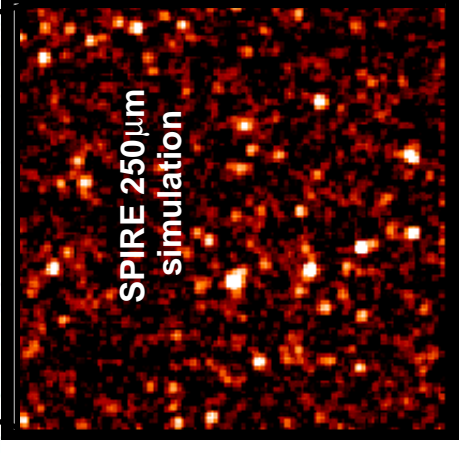
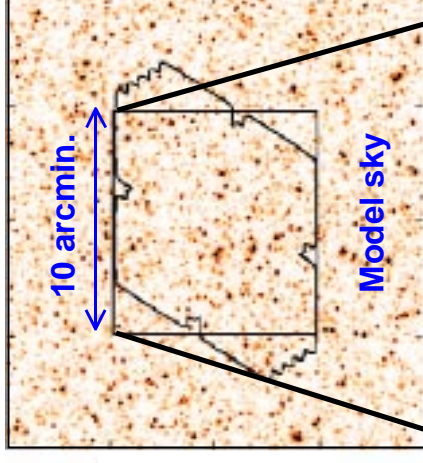
We are studying this.

- Minimum acceptable SPIRE capabilities were listed as:
 - Photometer with fall-back arrays
 - Spectrometer: whole wavelength range but $R = 100$
 - Separate photometer and spectrometer not a scientific requirement

OK – but this is not being taken as a recommendation to de-scope the instrument.

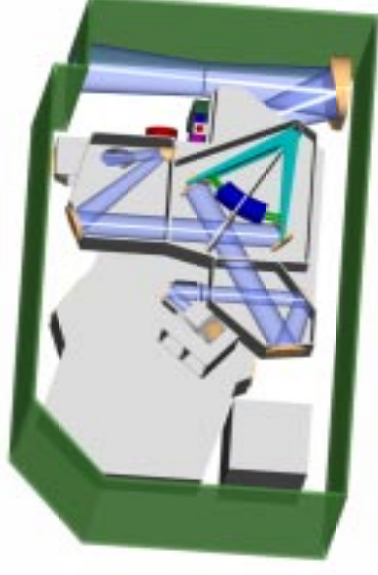
SPIRE INSTRUMENT DESIGN: PHOTOMETER

- Optical design needs to be optimised: tradeoff between image quality and throughput. Operation so far off axis poses problems.
- Stray light model developed and will be extended to include telescope, cryostat, and detailed representation of SPIRE optics and physical layout
- Work started on end-to-end modelling of sky, telescope, instrument, observing modes, data reduction and analysis
 - Initial aims: use as a tool to inform detector array selection
 - Ultimate aims: instrument sensitivity prediction and time estimation, optimisation of observing modes and survey strategy
- Possible need for cold shutter for ground testing



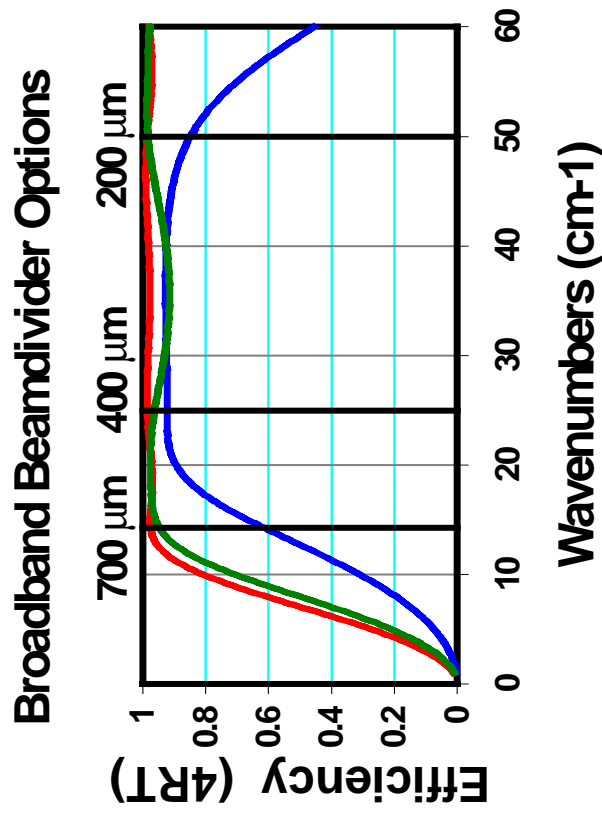
SPIRE INSTRUMENT DESIGN: SPECTROMETER

- Design study of two options:
 - (a) Similar to baseline in AO proposal except linear rather than swinging arm mechanism
 - (b) Broadband intensity beam divider option

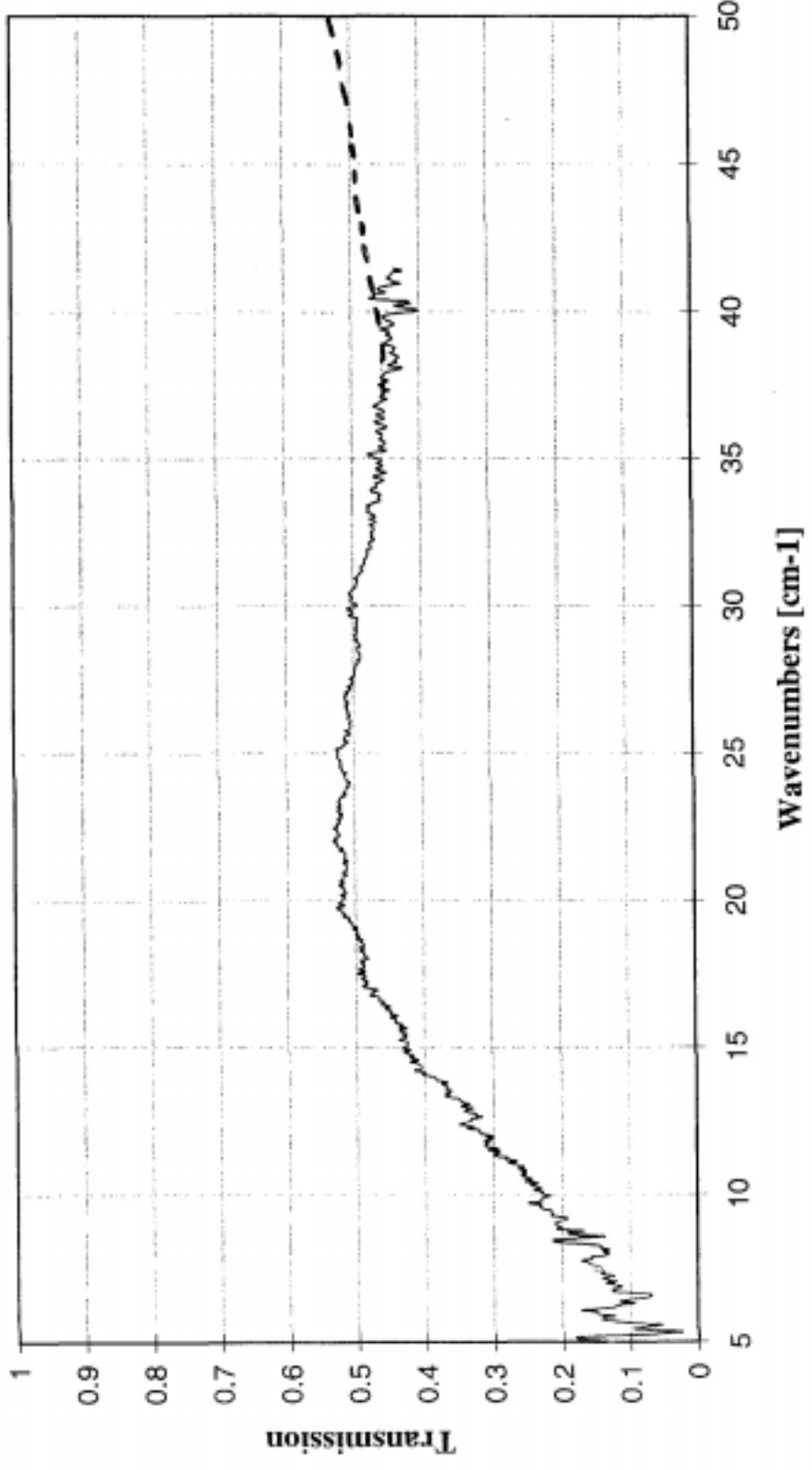


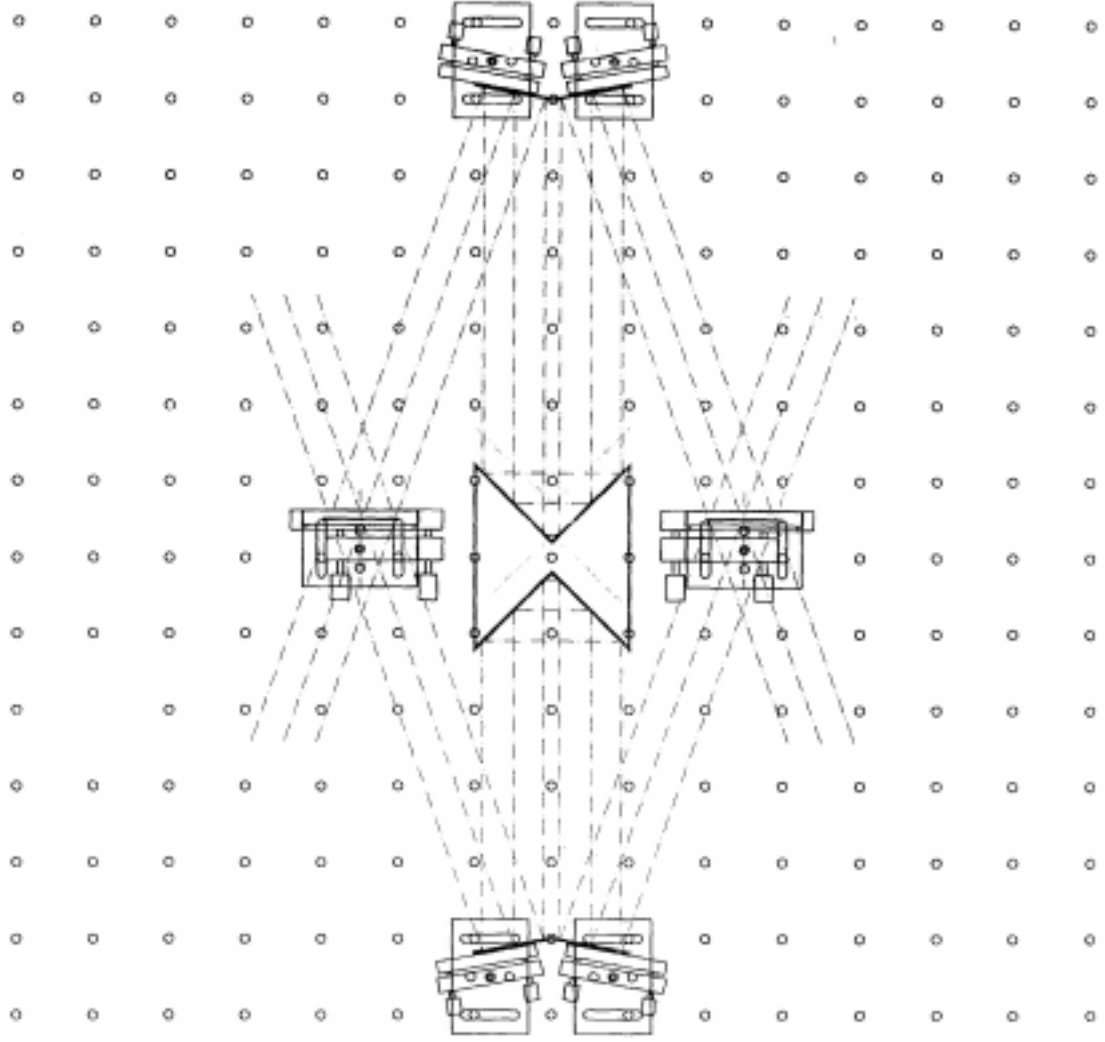
Decision in January 1999 followed by detailed optimisation of chosen option.

- Bench-top FTS set up to test concept experimentally



Trial FIRST-SPIRE Intensity Beamsplitter

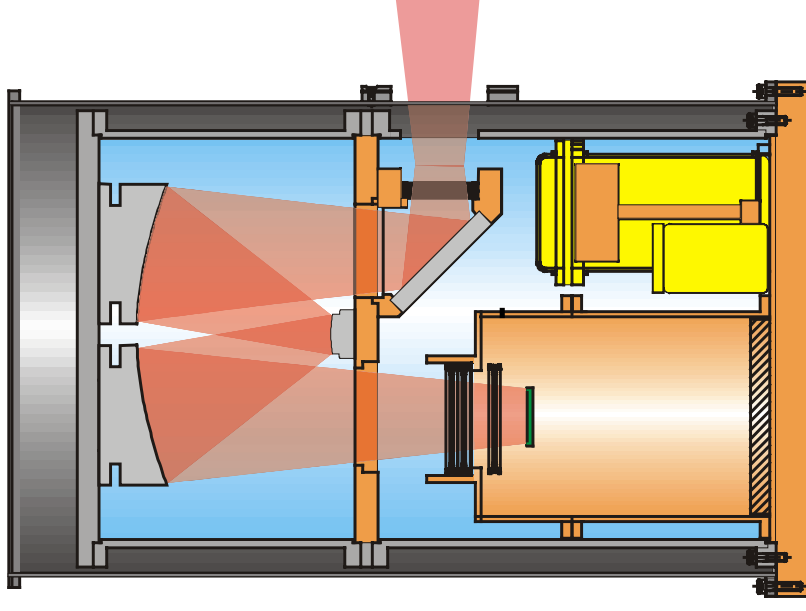




SPIRE **DETECTOR ARRAY PROGRAMME**

- **Experimental evaluation in 1999**
- **Very tight schedule for development and testing**
- **Selection in January 2000 based on**
 - **Experimental results**
 - **Detailed simulations of survey observations**
 - **Detailed system designs**
- **Informal review in January with external experts**
- **Regular meetings and tests throughout 1999**

**BACUS Bolometer
Array Test Facility**

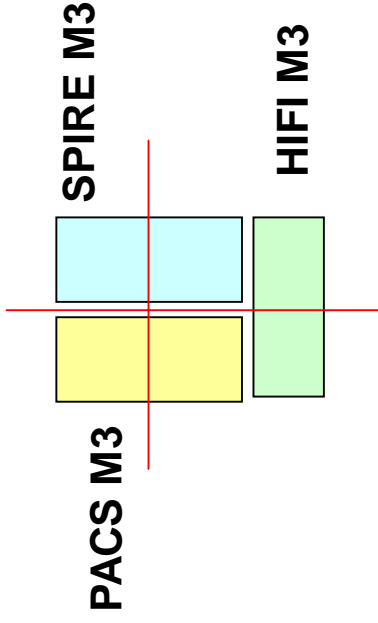


SPIRE DATA PROCESSING DEFINITION

- **FTS requirements (most severe) being studied initially**
- **Simulations, including use of processor with representative processing power, indicate that capabilities of on-board Signal Processing Unit (SPU) are adequate.**
- **Memory requirements for SPU are being defined.**
- **Improvement of factor of ~ 5 in data rate would allow all individual interferograms to be sent to the ground**

SPIRE **USE OF THE FIRST FOCAL PLANE**

- **Alternative to current arrangement is highly desirable:**
 - **Improved image quality - better science**
 - **Simpler optical design**
- **Outcome of recent study by HIFI not positive but SPIRE favours further investigation of tradeoffs, working towards a better solution acceptable to all.**



SPIRE SCIENCE REQUIREMENTS DOCUMENT

- **High level requirements document being prepared by the SPIRE Project Scientists in consultation with the consortium**
- **Defines requirements from a scientific rather than technical perspective**
- **Raises some issues relevant to SPIRE design and to the mission as a whole (e.g., SPIRE/PACS survey strategies)**

SPIRE **TECHNICAL CHALLENGES**

- **Detector array programme**
- **Instrument structural and thermal engineering**
- **Stray light/microphonics/EMC**
- **Optimisation of the optical design**
- **Payload funding uncertainty: could undermine the ability of the consortium to make progress unless the situation is clarified early in the new year**

STEIDEL ET AL. ASTRO-PH/9811399

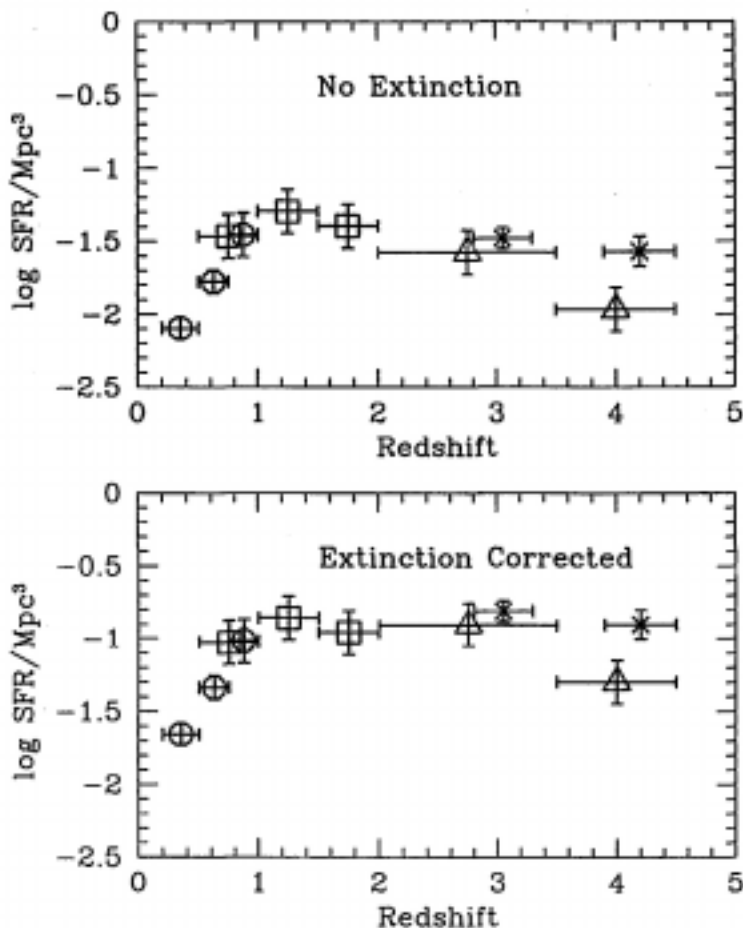
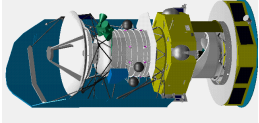
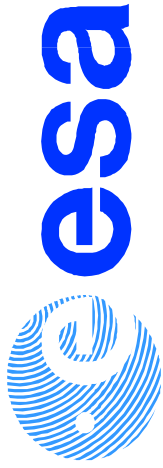


Fig. 9.— The UV luminosity density as a function of redshift, following Madau *et al.* 1996 (also using $H_0 = 50 \text{ km s}^{-1} \text{ Mpc}^{-1}$ and $q_0 = 0.5$, for consistency). The different points come from Lilly *et al.* (1996) [circles], Connolly *et al.* (1997) [squares], and Madau *et al.* 1997 (triangles). The new points from this work are shown as crosses. See text for details.)



Appendix 5

FIRST presentation by Thomas Paßvogel



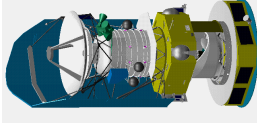
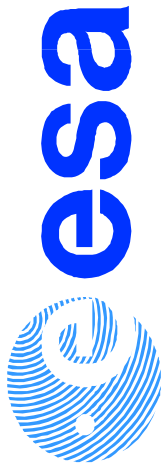
FIRST Telescope

Main parameters of baseline telescope

- diameter of primary mirror: 3.5 m
- operational temperature: 70 - 90 K
- total WFE at op. Temperature: 10 μm (RMS)
- spectral transmission: 97 % (BOL)
- temperature gradients: 13 mK/min (z direction)
1.3 mK/min (y direction)

Considerations:

- improve WFE: 6 μm (RMS)
- increase size: 3.8 m

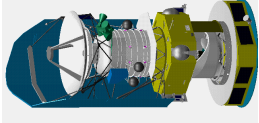
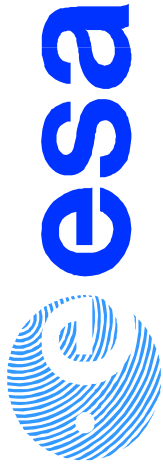


FIRST Pointing

Pointing Requirements:

Pointing requirements and special pointing modes are given in Instrument Interface Document (IID-A) and technical note on pointing modes (PT-SP-04673)

It has been agreed to include in addition to the requirements goals in the specification



FIRST Pointing (cont'd)

Absolute Pointing Error (APE)

- angular separation between commanded direction and actual direction

Pointing Drift Error (PDE)

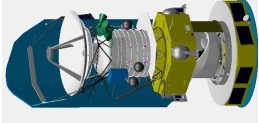
- angular separation between short time average and similar average pointing at later time

Relative Pointing Error (RPE)

- angular separation between satellite fixed axis at time t and reference axis over defined period

Attitude Measurement Error (AME)

- angular separation between actual and measured orientation of satellite fixed axis

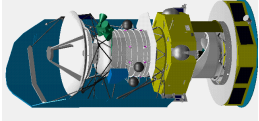


FIRST Pointing (cont'd)

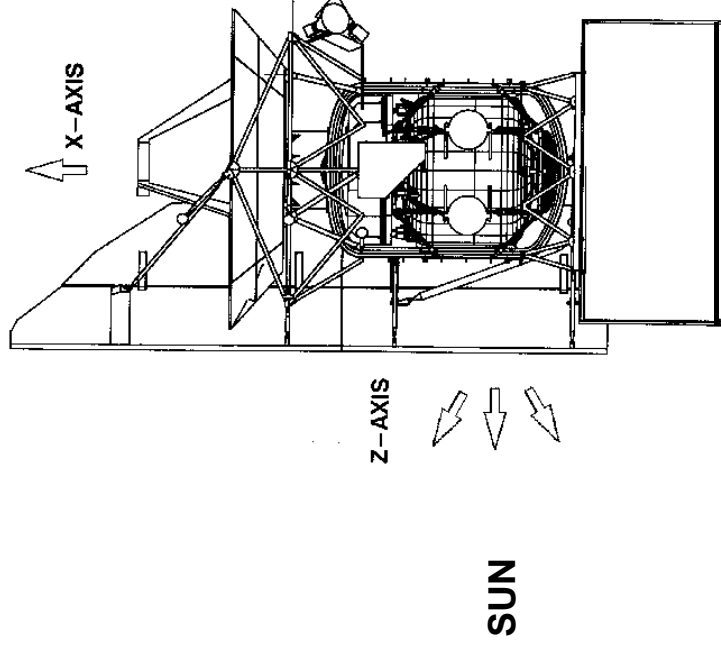
Requirements and goals

ERROR	Optical Axis (arcsec)	Around Optical Axis (arcmin)	Goals (arcsec)	Goals around Optical Axis (arcmin)
APE	≤ 3.7	3.0	≤ 1.5	3.0
PDE(24 hours)	≤ 1.2	3.0	n.a.	n.a.
RPE (1 min)	≤ 0.3	1.5	≤ 0.3	1.5
AME	≤ 3.1	3.0	≤ 1.2	3.0

Specifications expressed as half-cone angles of optical axis and half-angles around the optical axis with temporal probability level of 68 %



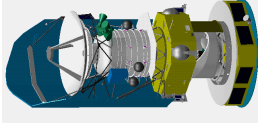
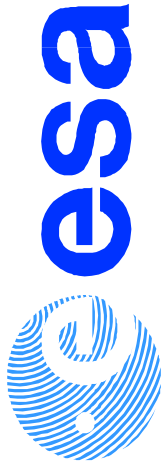
Sky coverage - solar aspect angle



S/C design for SAA of 30° max.

Considerations:

- Solar array height w.r.t. telescope
- Solar array power
- SVM thermal control
- Cryostat protection
- AR5 fairing height limitation



Telemetry Rates

Baseline telemetry system

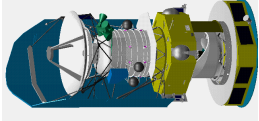
- S-band system
- Data rate 50 kbit/s average (instruments)
- Observation time/downlink time 20 - 22 h / 4 - 2 h

Considerations:

Data compression on instruments critical - try to increase data rate

Status:

- X-band for downlink probable
- Potential increase of factor of 4
- End to End Cost impact under evaluation

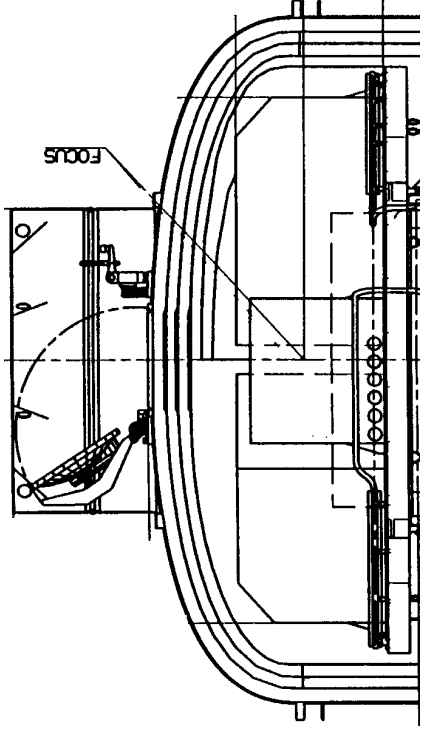


FIRST Cryostat

FIRST Cryostat lifetime: 3 years at L₂

Lifetime affected by instruments (examples):

- mass of focal plane units:
 - 87 kg allocated - 150 kg actual
- heat load to LHe II tank:
 - 2.5 mW allocated - 9.4 mW actual





Appendix 6

FSEC recommendations summary by Göran Pilbratt



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 general conclusions:

- unanimously agrees that a spectacularly exciting, astronomically rewarding FIRST mission is **technically feasible**.
 - **funding** for science instruments needs to be **rapidly formalized** and realistic funding schedules defined,
 - ... the large international teams ... will require **tight management structures** ...
 - 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 to attain **any** of the listed capabilities.
- plus**
- **three specific recommendations**
 - **specific technical comments/recommendations**



FSEC made 3 specific recommendations:

- **Surveys vs detailed observations:** ‘... recommends that the FIRST Science Team, once selected, be asked, at the earliest opportunity, to organize a **workshop** or a series of workshops to define a mission profile that secure the most cost-effective **balance** between survey and detailed observations’.
- **FIRST and Planck synergies:** ‘... recommends that ESA keeps the **complementarity** offered by these two missions in mind as **planning** proceeds.’
- **Onboard data reduction:** ‘... recommends that the three instrument teams provide, at the earliest opportunity, **convincingly detailed plans** for onboard data processing.’



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** ($R \sim 20$) 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 $R \sim 10^7$ (30 ms^{-1}) velocity resolution - optimise **backend complement**
 - compatibility with spacecraft **pointing** requirements



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 km s^{-1})
- SPIRE:**
- proposed backup detector array
 - spectrometer must have at least $R = 100$ (3000 km s^{-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 km s^{-1} ($R = 3 \times 10^5$) or better

These are not 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.



Appendix 7

ESA/NASA FIRST discussions summary by Göran Pilbratt



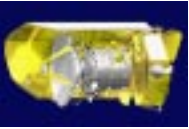
ESA and NASA collaboration:

- NASA to supply **telescope** (‘contribution’ to ESA) - does not demand certain amount of time, does demand representation on every FOTAC panel.
- NASA part of **instrument consortia** (‘contribution’ to ESA member states) - instrument consortia have guaranteed time for ‘internal’ distribution.
- Possibility of ‘US FIRST Science Team’ - status of the FIRST SMP unclear within NASA, ESA position is that the FST (we!) is the (only) **FST** and the **SMP** is valid.
- **Key projects** call for observing time - proposers not owning guaranteed time at potential disadvantage (GT holders forced to use (part of their GT) if asking for key project time.
(Three rounds of call for observing time before launch: key projects (open for all), guaranteed time, open time.)



Appendix 8

SA-DMS summary by Göran Pilbratt



FIRST science ground segment document exchange

- Need for efficient exchange (within and between institutes including ESA) of documents already a fact
- Eventually we plan to do this through FINDAS - but need something now
- The DMS system (initially used internally by ESA projects) is available now
 - DMS is accessed through the WWW (Netscape, IE ?)
 - Allows several 'domains' with different access rights (e.g. private pages)
 - Can be replicated for efficiency
- Adopted (cloned) by Planck instrument teams
 - 'Master' site at ESA SCI-SA, currently replicated at MPA, Garching
 - Simple 'rules', administered by ESA SCI-SA as 'service'
- Adopting SA-DMS for FIRST instrument/ICC teams and FSC for now



Appendix 9

John Zarnecki's presentation

(not available)
