ALCATEL SPACE

REF. : H.P.ASPI-MN-164	
DATE : 27.06.01	PAGE : 1/9
LIEU / PLACE : Oxford - RAL	

COMPTE RENDU DE REUNION / *MINUTES OF MEETING*

OBJET / PURPOSE :

SPIRE - Technical progress Meeting n° 1.

CLASSIFICATION :

PARTICIPANTS *ATTENDEES*	SOCIETE *FIRM*	SIGNATURE *SIGNATURE*	PARTICIPANTS *ATTENDEES*	SOCIETE *FIRM*	SIGNATURE *SIGNATURE*
A. HESKE	ESTEC		J. DELDERFIELD	RAL	
J. BRUSTON	ESTEC		B. WINTER	UCL	
H. FAAS	ASTRIUM		M. GRIFFIN	QMW	
G. LUND	ALCATEL		J. RAWTAKOSKI	ESTEC	
B. COLLAUDIN	ALCATEL		D. GRIFFIN	RAL	
K. KING	RAL				
B. SWINYARD	RAL				

REDACTEUR / WRITTEN BY :

CONCLUSION :

DISTRIBUTION :	
PARTICIPANTS / ATTENDEES	POUR ACTION : *FOR FURTHER ACTION*
	POUR INFORMATION : *FOR INFORMATION*

APPROUVE PAR / APPROVED BY

NOM / NAME				
SIGNATURE / *SIGNATURE*				

M052-1

ALCATEL SPACE	SPIRE Technical Progress Meeting n°1	REF. : HP-ASPI-MN-164	
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COMPTE RENDU DE REUNION / *MINUTES OF MEETING*		LIEU / PLACE : RAL	

SUITE / CONTINUED : | ACTION

Review of Action items

- HP-ASPI-MN-41 - n°1 (I/P lines sensitive to LCL failure).
  -> 5.10.1.4 of IIDB - wording is not clear. — *Action:* Rewrite this § in the IIDB A

  Do the DPU's have unique remote terminal identifiers on the 1553?

- HP-ASPI-MN-41 - n°2 (LCL dimensioning)
  -> See IIDB §5.9.3 / Fig. 5.2.1 - closed.

- HP-ASPI-MN-41 - n°3 (DC/DC synchronisation).
  closed by EMC working group meeting.

- HP-ASPI-MN-41 - n°4 (Thermistors). IIDB §5.7.5.2
  -> Alcatel still needs to look into the resolution and accuracy of the thermistors ... this is normal work.

- HP-ASPI-MN-41 - n°7 (common ground) - open
  Main concern is bonding of chassis to SVM.
  Grounding straps supplied by Alc. Bonding stud needed on SPIRE boxes.

- HP-ASPI-MN-41 - n°8 - CLOSED (EMC - Power W.G.).

- " " - n°9 - Supply of "on-target" signal is confirmed, See also discussion of IIDB - §5.13.3

- HP-ASPI-MN-22 - n°2 - Sketch of I/F + feet has been supplied. - CLOSED.

- " " n°3 - Config. drawings of FPU layout.
  -> geometry / envelope model has been made available in IGES format. Closed

ACTION

SUITE / CONTINUED:

- HP-ASPI-MN-22 n°4 Harness / routing.

Astrium has completed review of SPIRE harness definition doc. (V.3). - Comments will be supplied by end of this week (29.06).
Preliminary cryo-harness design will be ready, end of July, according to schedule.

- HP-ASPI-MN-22 n°8. - Accommodation of units. - Still open. — n° 2
SPIRE to provide information about box size & mass — Date:

SPIRE Design & Devt. Status

→ presentation by M. Griffin of Science Team Meeting slides (20-22 June 01) - See annex.

o FMECA should become available in Sept. 01.
- Sorption cooler is considered a critical SPF item.
- See Criticality Analysis doc. - in IIDR data package.

Thermal design

progress made on 300mK temp. ctrl. implementation.
Routing identified.
300mK thermal strap. initial testing starting in next days, test model has been delivered.

SCHEDULE

- Tight schedule means limited time available for testing + calibration of FM. - SPIRE might consider doing this on the FS (- BCl - depends also on funding).

- V. important for SPIRE to identify CQM test plan ASAP, and therefore to hold planned meeting soon (~ mid July - TBC / ESA).

SUITE / CONTINUED : | ACTION

Influence of background levels on SPIRE performance:
- analysis shows this is not as critical as previously thought.

Microvibrations - See IIDB 5.6.1.1 Specified level of ~ 40 µg appears unacceptable for system.
System level analysis (Herschel) has been initiated.
M.G. would expect the Planck requirements (0.1 to 1 mg) to be somewhat more stringent than for Herschel.
- Analysis for Planck shows the reaction wheels and coolers produce similar levels of perturbation.

Internal Monitoring and Reporting
Steps are being made to improve this throughout the consortium.
Importance of Alcatel receiving monthly Reports on a regular basis. (even when some internal reports are missing).

Discussion of parallel Mode (PACS + SPIRE)
- impacts on data rate for both instr. working together.
- " " dual 300 mK cooling / -> lifetime issue
- major interest is for large sky area surveys.
- System level parameter analysis will be needed to see whether this mode is efficient in terms of overall lifetime / science data collection.
- First cut "guestimate" of possible duration of the parallel obs. mode is ~ 3 months (M.C.).

SPIRE to produce tech. report on Parallel Mode observations, what parameters have influence, etc. | Action n°3

SUITE / CONTINUED :

ACTION

Similar tech. report on impacts / usefulness of the Serendipitous observations. (n°4)

Discussion of thermal models & performance

- see M.E. presentation p. 34 (impact on lifetime of 50 mW dissipation of JFETs – shown to be ~ -3.3%.
- Analysis appears to show that there is virtually no science advantage achieved with JFETs run with 50 mW, rather than 33 mW. In fact, it implies almost 20% worse science / l of He
- JPL is still working towards the 3 mW baseline.

Background Signal

- see slides of M.E. presentation.
  Analysis valid for SPIRE only (not PACS).
- Achieving reduction in telescope ε and temp can enable significant improvement in lifetime to be achieved (observing time reductions).
- Design of SPIRE bolometers wrt expected background level is not as sensitive as originally thought (and appears less sensitive than in the case of PACS).
- SPIRE will provide details of their model to PACS.
- Astrium will used simplified "box" to represent SPIRE FPU in their simplified thermal model.

ACTION

SUITE / CONTINUED:

SPIRE states that it does not have the resources to convert their APART optical model to ASAP standard for straylight analysis. SPIRE could do the translation (~ 3 weeks) but would request funding for this.

Same situation could also arise with translation to NASTRAN of SPIRE's FPU / mech. model, since SPIRE is not (yet) sure the translation is valid and works – this will soon be known.

- ASAP model does not include baffles & structures.

note
- ESA will be supplying the ASAP model for HIFI
- PACS has the beginnings of an ASAP model.

This pt should be addressed by the Telescope (optical System) W.G.

Discussion of IIDB / Discrepancies, actions. — ACTIONS

(Chapter references relate to PDF version of SPIRE IIDB 2/1 – 19-06-01).

§5.5 Include size and mass properties of SVM boxes. ← SPIRE

§5.5.1-2 Mass

Mass-reduction exercise is needed to bring the "Estimate + contingency" mass down to the total allocation (Total mass allocation = 90,0 kg – ex IIDA). ← SPIRE

§5.6.1.1

10 μg requirement appears very severe. This needs to be checked (Planck sensitivity indicates 1 to 2 orders of magnitude higher can be tolerated). ← SPIRE

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SUITE / CONTINUED :

		ACTION
§5.7.1.1	Astrium to confirm - asap - details of cryostrap cross-sections.	←
	~~PACS~~ SPIRE to define / agree details of stress relief support brackets for cryostraps.	←
§5.7.1.2	Table needs clarification, or replacement by required thermal conductances of each strap.	←
§5.7.5.2	For information, include resolution and accuracy performance	←
~~§5.9.3~~ §5.3	Astrium will look into the possibility of distributing an "early version" of the OB layout to all instruments (in July 01). This is intended to allow feedback from instruments.	~~AM~~
§5.9.1	AST/ESA to update IIDA max. ave heat load budget figures. "When powered" and "when not powered" (i.e. off) heat loads should be provided, taking into account the conductive loads of the "off" instruments. It is proposed to provide a table with "current status" of SPIRE heat loads, with the caveat that this is not ~~of~~ a requirement on Prime. Further OB modeling is needed by Astrium before this can be validated.	
§5.13.2	To be modified such that it is clear that this data is provided to ground.	←

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SUITE / CONTINUED : ACTION

§5.10.1.4 – Clarify – (LCL fault conditions)

§5.10.2. – remove text (Keep chapter N°).

§5.11.2 – Alcatel is not in favour of clock line, bundled with 1553 bus.

§5.13.1.1 – Not consistent with IIDA. / or correct "Science data rate" to "Total data rate" – clarify table.

§5.13.1.2 – Qualify the exact meaning of "Short duration", and provide the "Maximum average" requirement over this period.

§5.13.1.3 – Clarify exact requirement.

§5.13.2. – Housekeeping data is sent to ground. Clarify.

§5.13.3 – Clarify exact requirements for scan synchronisation.

§5.14.1 – Raster Mode 1.7 arcsec is not applicable to S/C, only to BSM.

~~Remove, as it is an internal instrum. reqt, not an I/F reqt.~~

S/C System spec reqt. is for 2.0 arcsec Steps – not 1.7 arcsec.

§5.17.3.1 replace "class 10000" by "class 100000"

ACTION

SUITE / CONTINUED :

PA

ESA will send PA information to SPIRE this week.
Meeting to be arranged, after 05 July.
SPIRE states that cleanliness reqts. pose no problems to them, and agree with these.

Vibration levels - FPU.

Random vibration spec. appears far too high for SPIRE, with potentially disastrous implications for the instrument.

Prime is working on this issue, and outcome of 1st run with mathematical model will be supplied to SPIRE. It is expected that the load figures will be reduced - TBC. ← ALC.
IIDA would then be updated accordingly.

Look into possibility of a dedicated meeting with instruments, once first analysis run has been completed.

ALCATEL SPACE	SPIRE Emc / Cryostat Splinter	REF. : HP-ASPI-MN-164
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COMPTE RENDU DE REUNION / *MINUTES OF MEETING*		LIEU / PLACE : RAL

SUITE / CONTINUED : — ACTION

1. Cryostat shields and shutter
   - what is the heat flux on the shutter during testing from the lid — Astrium #1
   - joint of instrument cover to optical bench: what are the characteristics in order to reduce EMC problems

2. Thermal model
   - the budget for the JFET dissipation in the released reduced Spire thermal model is 49.8 mW. The project baseline is 33 mW
   - material of thermal straps (copper or aluminium) and what are the characteristics of sapphire (thermal characteristic of the joint) — Astrium #

Peak heat load:

IID-A specifies 100 mW, but SPIRE produces up to 600 mW over a period of about 10 minutes. (see Thermal-TN released 20 June 2001). What are impacts on the cryostat thermal model? — Astrium #

ALCATEL SPACE	SPIRE EMC / Cryostat Splinter	REF. : HP-ASPI-MN-164
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COMPTE RENDU DE REUNION / *MINUTES OF MEETING*		LIEU / PLACE : RAL

SUITE / CONTINUED : ACTION

Harness routing between FPU and JFET need to clarified. RAL need to identify their requirements to Alcatel / Astrium concerning the harness routing and fixing to the optical bench. In the instant the harness is clamped every 10 mm due to microphonic signals due to micro vibrations.

Minutes of Meeting

Purpose	Meeting	Ref	Date	Origin	Action n°	Description	Responsible	Due	Status	Close date	Document	Closing Reference	Remark	Days to closure	Overdue ?
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**1**	Include the text resulting from HP-ASPI-MN-42 / Action Item n°1 (concerning **I/P Lines sensitive to LCL failure**) into § 5.10.1.4 of the SPIRE IID-B.	SPIRE	13-Jul-01	OPEN					4	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**2**	Provide ALCATEL with details of **SVM warm electronics boxes : mass & dimensions.**	SPIRE	13-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf		Doc = Proposed IID-B update, sent by mail by JD.	0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**3**	Provide a **Technical Report** on **Parallel Mode Observations**, and requirements.	SPIRE	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**4**	Provide a **Technical Report** on objectives, constraints & requirements of **Serendipitous mode observations**.	SPIRE	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**5**	**IIDB** - §5.5.1-2 (20.06.01) : **Mass reduction exercise** needed to bring the "stimate + contingency" total mass down to the ESA allocation of **90 kg.**	SPIRE	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**6**	**IIDB** - §5.6.1.1 (20.06.01) : **Random vibration** acceleration reqt. of **10 µg** to be checked, and justified with a technical note.	SPIRE	20-Jul-01	OPEN		SPIRE_IIDB5(JD)_2_3.pdf			11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	SPIRE	**7**	**IIDB** - §5.7.1.1 (20.06.01) : Confirm details of **cryostrap cross-sections.**	ASTRIUM	6-Jul-01	OPEN					-3	Overdue
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ASTRIUM	**8**	**IIDB** - §5.7.1.1 (20.06.01) : Define, in accordance with Astrium, details of **stress-relief** brackets for the **cryostraps**.	SPIRE	6-Jul-01	OPEN					-3	Overdue
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**9**	**IIDB** - §5.7.1.2 (20.06.01) : Table (interface temp. Reqts.) needs clarification, or replacement by **thermal conductance** of each strap.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**10**	**IIDB** - §5.7.5.1 - 2 (20.06.01) : **Temperature sensors** : include specification of **resolution** & **accuracy** requirements.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**11**	**IIDB** - §5.10.1.4 (20.06.01) : **LCL fault conds**. : clarify phrasing.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**12**	**IIDB** - §5.10.2 (20.06.01) : **KAL** : remove requirement.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**13**	**IIDB** - §5.13.1.1 (20.06.01) : **Data rate** : replace "science data rate" by "Total data reate".	SPIRE	6-Jul-01	OPEN					-3	Overdue
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**14**	**IIDB** - §5.13.1.2 (20.06.01) : **Data rate** : Qualify exact meaning of "short duration", and provide "Maximum average" reqt. Over this period.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**15**	**IIDB** - §5.13.1.3 (20.06.01) : **Data packets** : Qualify exact requirement.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**16**	**IIDB** - §5.7.13.2 (20.06.01) : Modify phrasing, such that it is clear tha this housekeeping data is provided to **ground** (only).	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**17**	**IIDB** - §5.13.3 (20.06.01) : **Scan synchronisation** - clarify exact requirements.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**18**	**IIDB** - §5.14.1 (20.06.01) : **Raster Mode** : S/C System reqt. = **2.0 arcsec** steps, not 1.7 arcsec. Clarify.	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	ALCATEL	**19**	**IIDB** - §5.17.3.1 (20.06.01) : **Transport Container** : Replace "Class 10 000" by "**Class 100 000**".	SPIRE	6-Jul-01	Closed	02-Jul-01	SPIRE_IIDB5(JD)_2_3.pdf			0	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	SPIRE	**20**	**Random vibrations** spec. for the **FPU** : Current reqt. appears dangerously high. Produce 1st run of pechanical model, to check on random levels really expected.	ALCATEL / ASTRIUM	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	SPIRE	**21**	**Cryostat shields & shutter** : Provide expected thermal heat flux on the shutter during tests.	ASTRIUM	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	SPIRE	**22**	**Thermal Straps** : Define material used to make these straps (copper or Al), and thermal characteristics of the **sapphire insulating spacer**.	ASTRIUM	20-Jul-01	OPEN					11	
Herschel	SPIRE Technical meeting #1	HP-ASPI-MN-**164**	27-Jun-01	SPIRE	**23**	Check out the **impacts** on the **cryostat thermal model** of : up to **600 mW** thermal load from SPIRE - during up to 10 minutes.	ASTRIUM	20-Jul-01	OPEN					11	

SPIRE Presentation from Herschel Science Team Meeting / 20-22 June 2001

Updates & Status

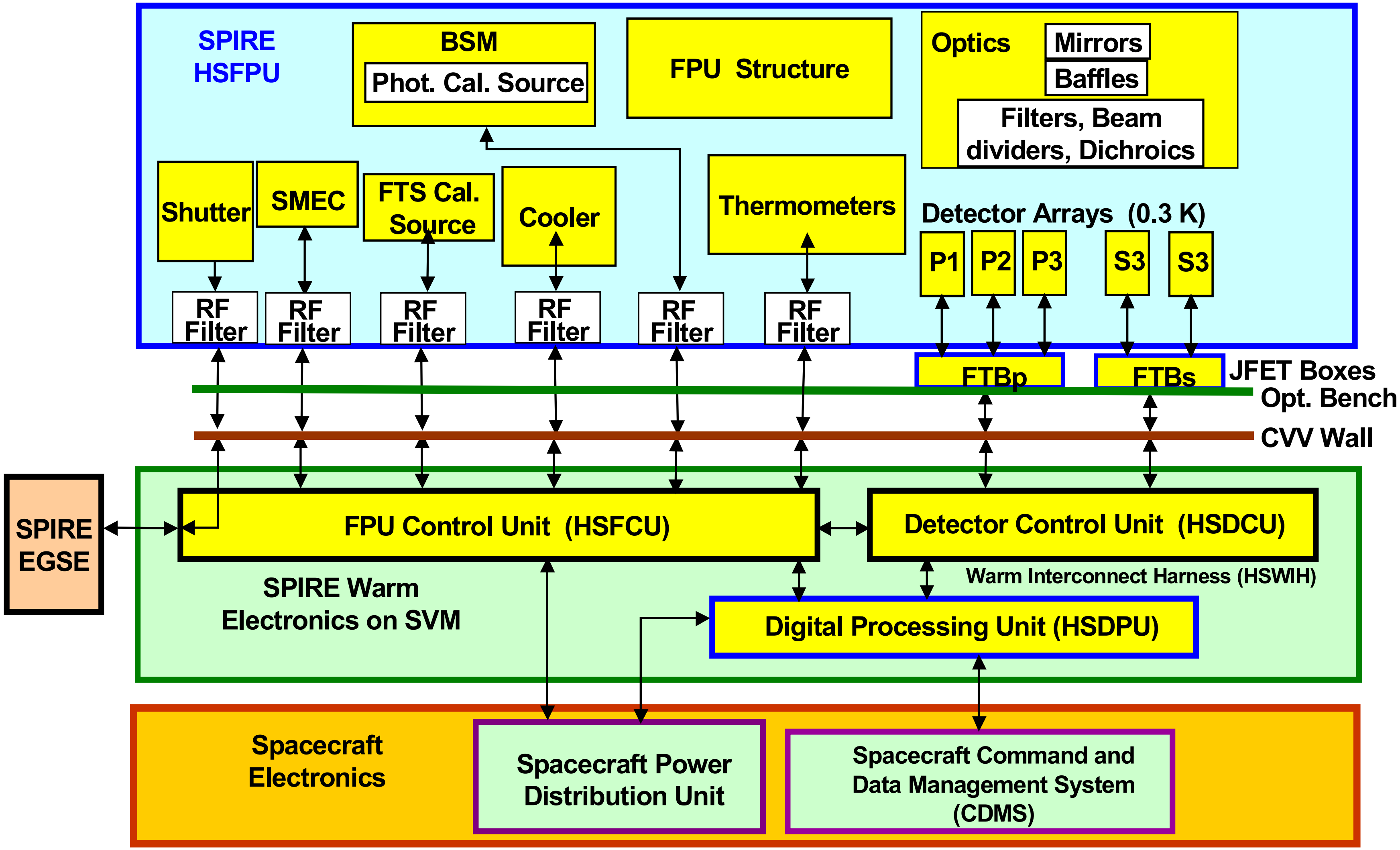
SPIRE

STATUS REPORT

Herschel Science Team Meeting 9
Groningen, June 19-21 2001

- **INSTRUMENT DESIGN UPDATE AND PROGRESS REPORT**
- **IIDR AND FOLLOW-UP**
- **BACKGROUND POWER AND BOLOMETER DESIGN**
- **PHOTOMETER AND FTS BANDS**
- **ICC DEVELOPMENT**
- **SCHEDULE**
- **IMPORTANT ISSUES**
- **SPIRE CONSORTIUM MEETING IN JULY**

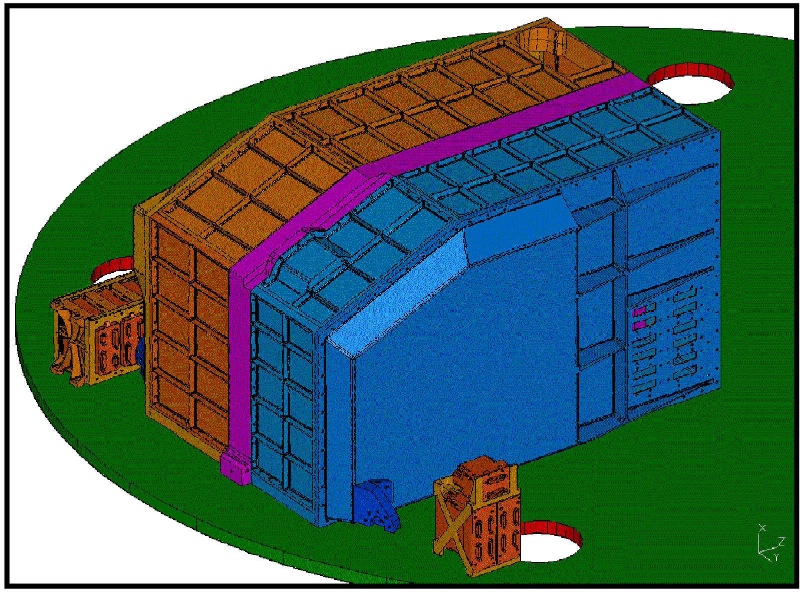
SPIRE Block Diagram



SPIRE

FPU Structure

- **Schedule has slipped in some areas due to late interface finalisation, but work in other areas compensates.**
- **Structure Detailed Design Review planned for 31 July**
- **300-mK thermal strap prototype is under manufacture by MSSL for thermal testing at Cardiff**



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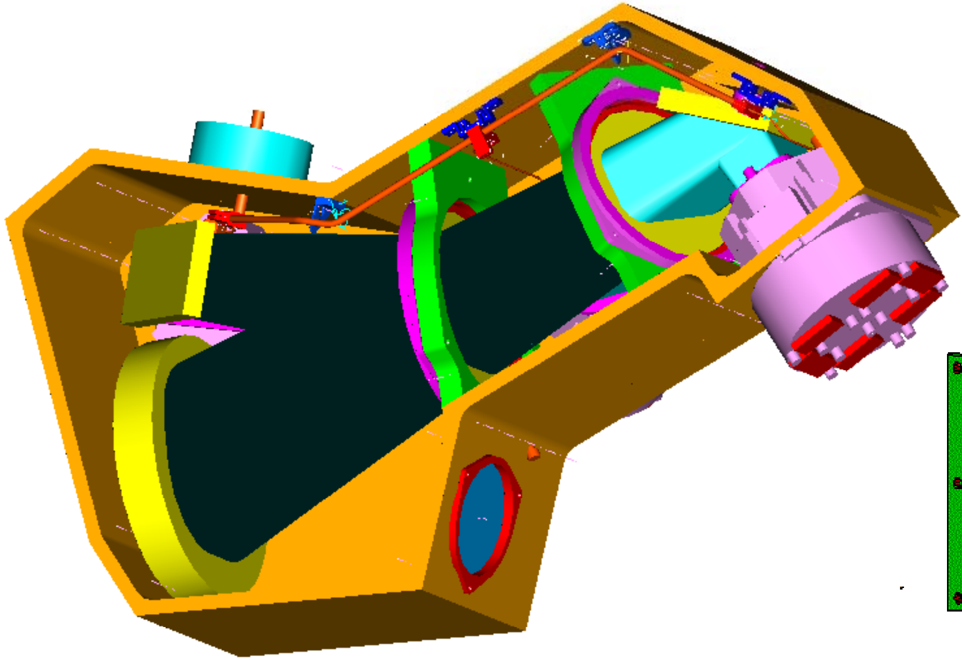
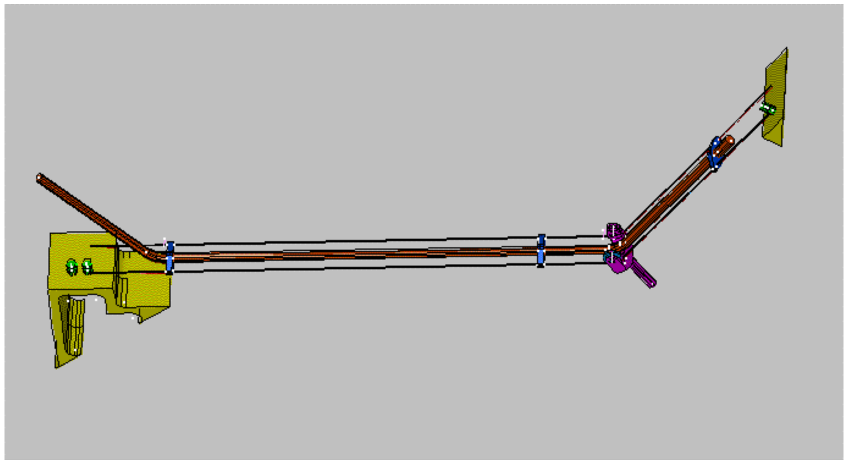
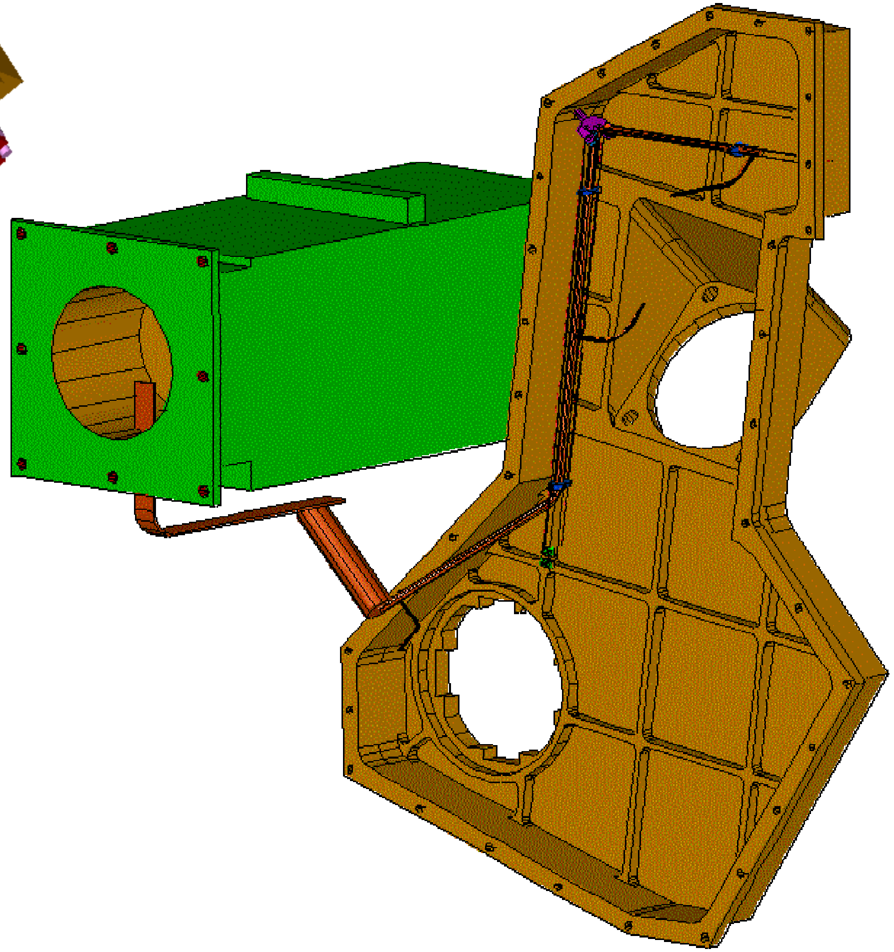
300-mK Straps

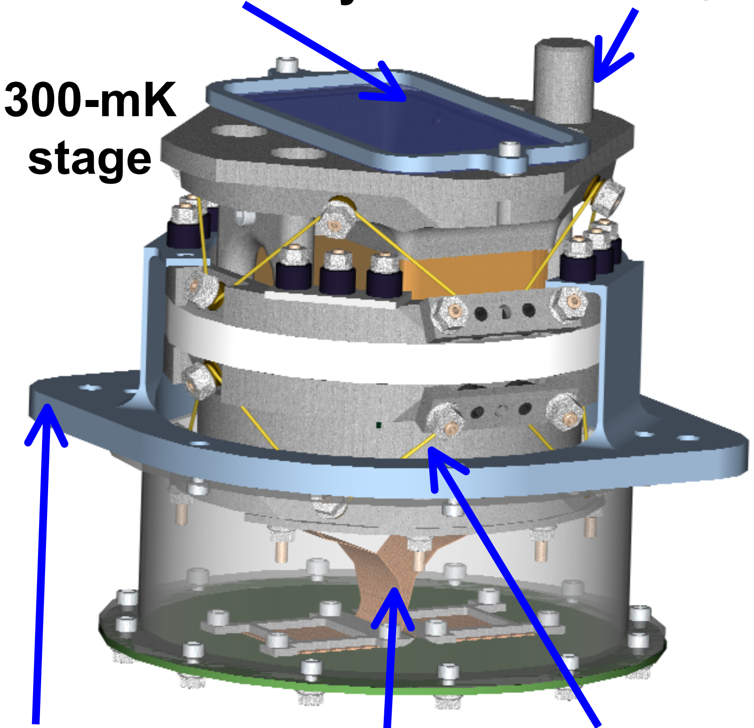






SPIRE

Detector Arrays

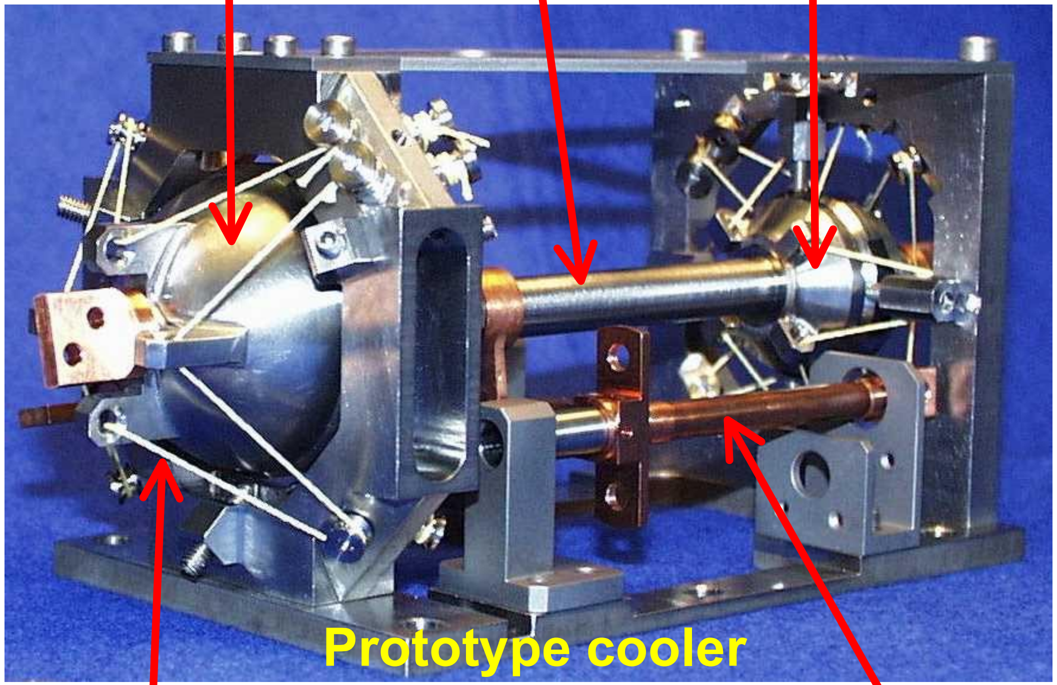


- Prototype Kapton cable thermally cycled with good results
- Thermal modelling of BDA with Kevlar supports + Kapton cables: 6.5 μW for 5 arrays (budget = 10 μW)
- Problems have been experienced with Kevlar not achieving rated tensile strength: A/L may be increased and capstan design changed
- Successful warm vibration at full qualification level
- Cold (77-K) vibration test + 300 mK characterisation this week

SPIRE

^3He Cooler

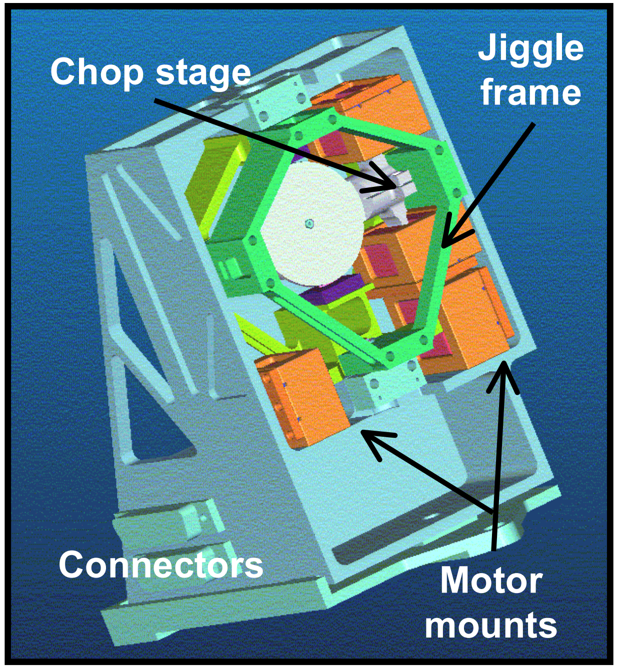
- SPIRE/PACS Cooler DDR held on 17 May
- Review was "successful"
- General problem highlighted: reviewing of units (as delivered by institutes) vs. subsystems (which can include multiple units)

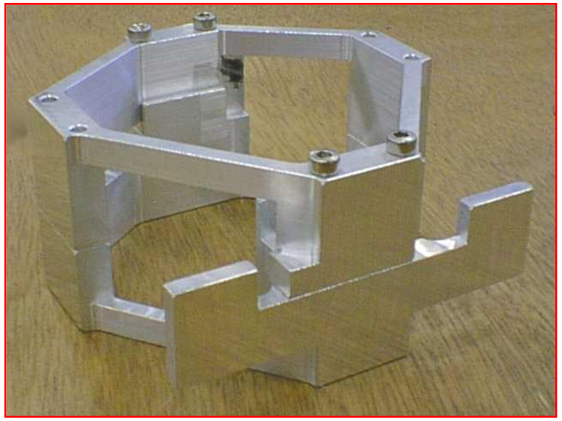


SPIRE

Beam Steering Mirror

- Top-level electronics design is complete
- Cost of Lucas flex pivots and Zeiss motors higher than expected
- Options for cost reduction are being studied
- BSM de-scope may be necessary
- Interfaces defined
  - Harness
  - Structure
  - Baffle/Optics
  - PCAL





SPIRE

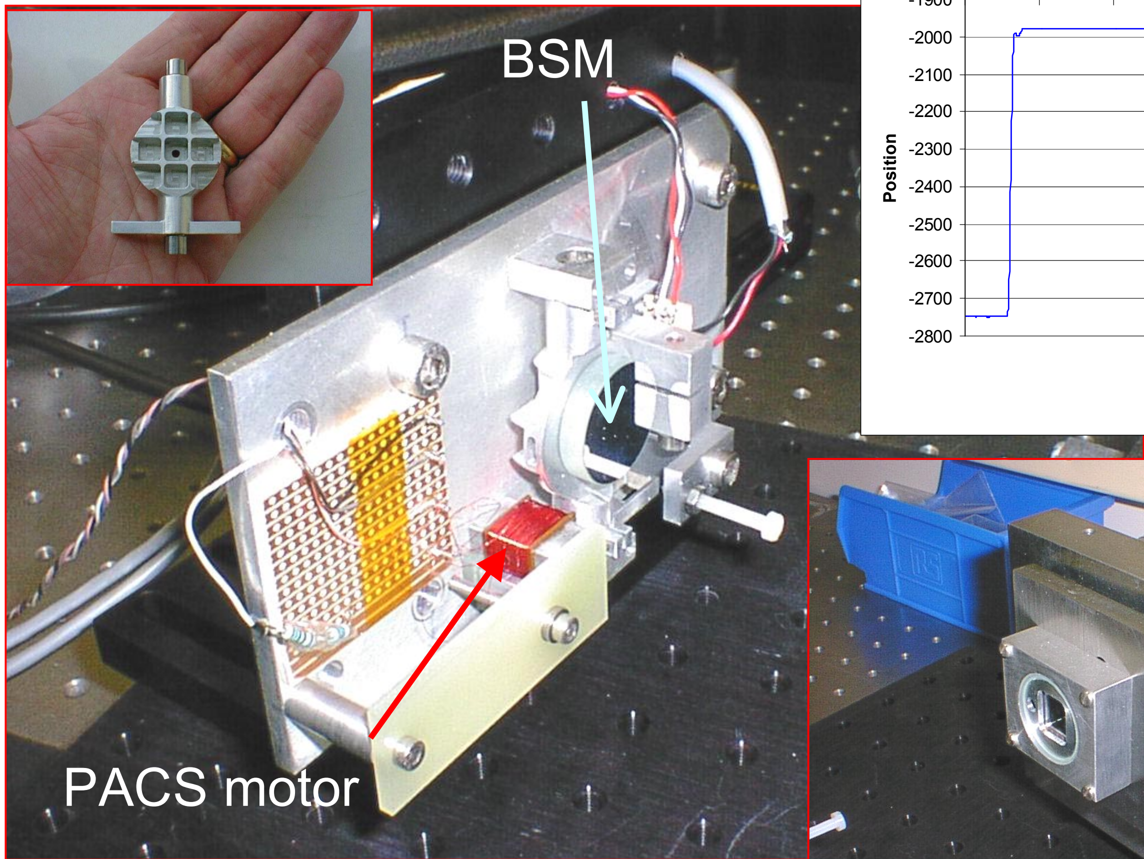
BSM Prototype Testing

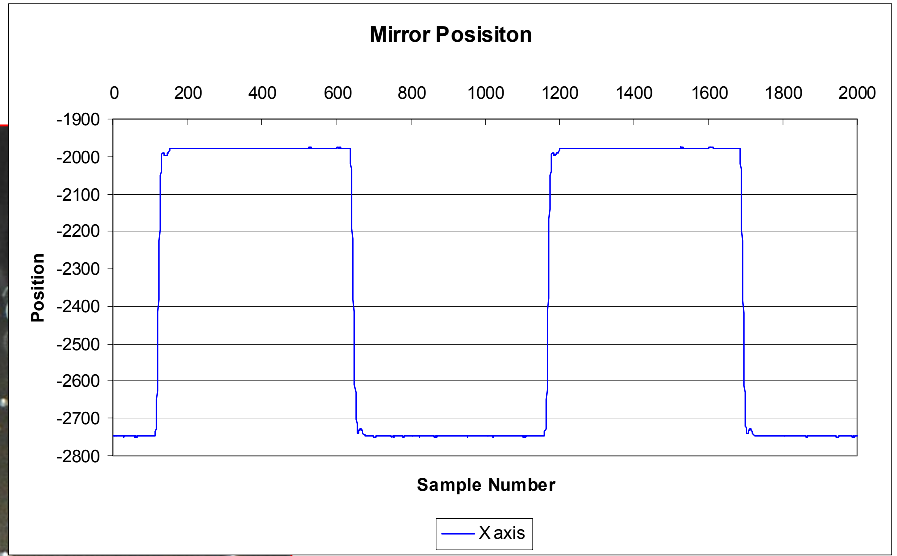
- **Single axis prototype**
  - **Motors obtained from PACS via MPIA**
  - **Laser tilt measurement device delivered**
  - **Prototype tested under closed loop control**

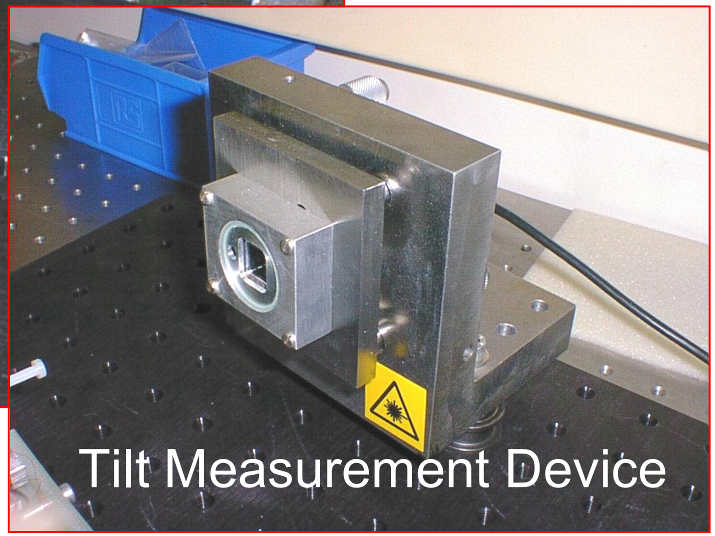
- **Test dewar commissioned**
  - **10-16hr hold time, for prototype tests only**
  - **closed cycle cooler dewar will be used for QM testing**

SPIRE

BSM Single Axis Prototype

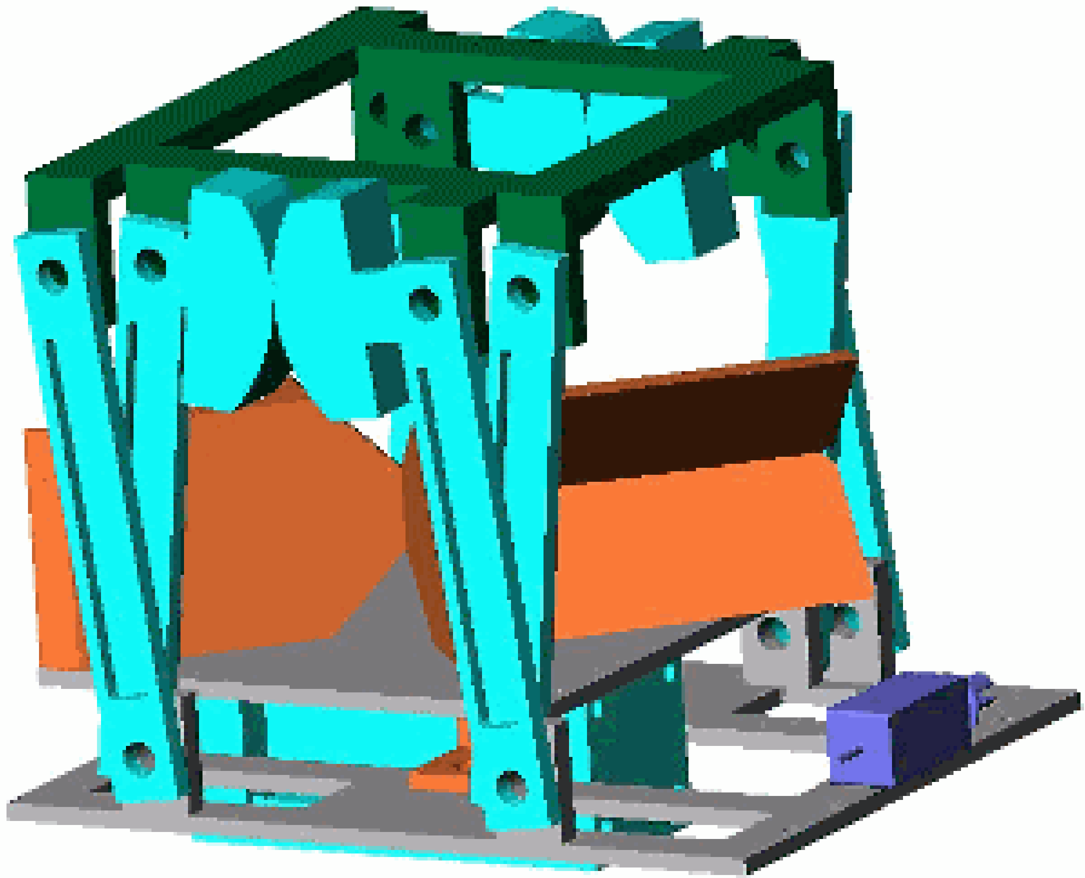






SPIRE

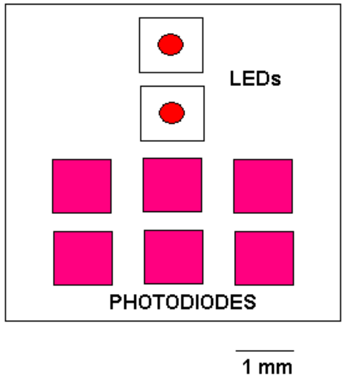
Spectrometer Mechanism (SMEC)

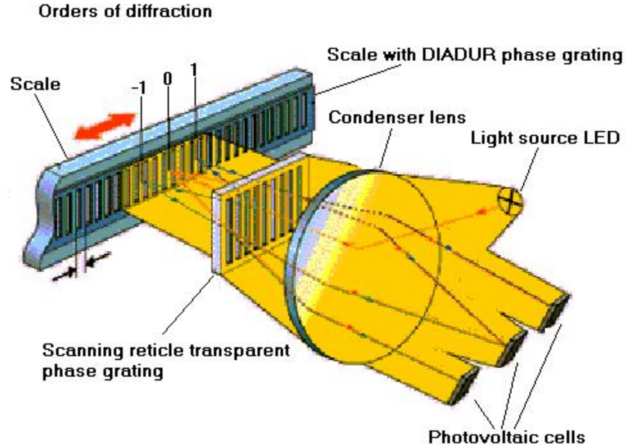


SPIRE

SMEC Optical Encoder

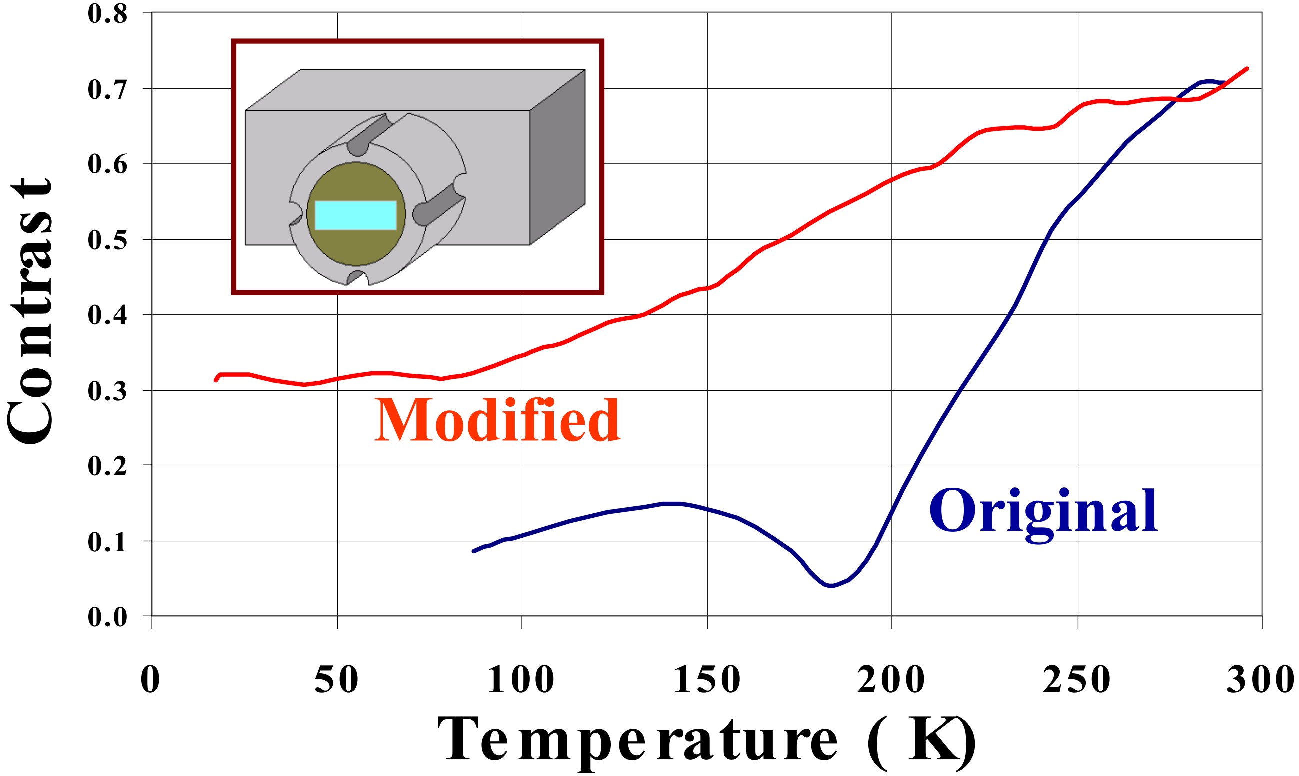
- **Redundancy within single optical unit**
- **LED source and photodiode sensors with 4-K MOSFET TIA amplifier (change from JFET previously baselined)**





• **Range**	**35 mm**
• **Resolution**	**0.01 microns (estimated)**
• **Operating temp.**	**4 K**
• **Power dissipation**	**0.5 mW (including preamplifier)**
• **Vibration**	**No loss of initial contrast after 3-axis random vibration test (10g rms)**

SMEC Optical Encoder

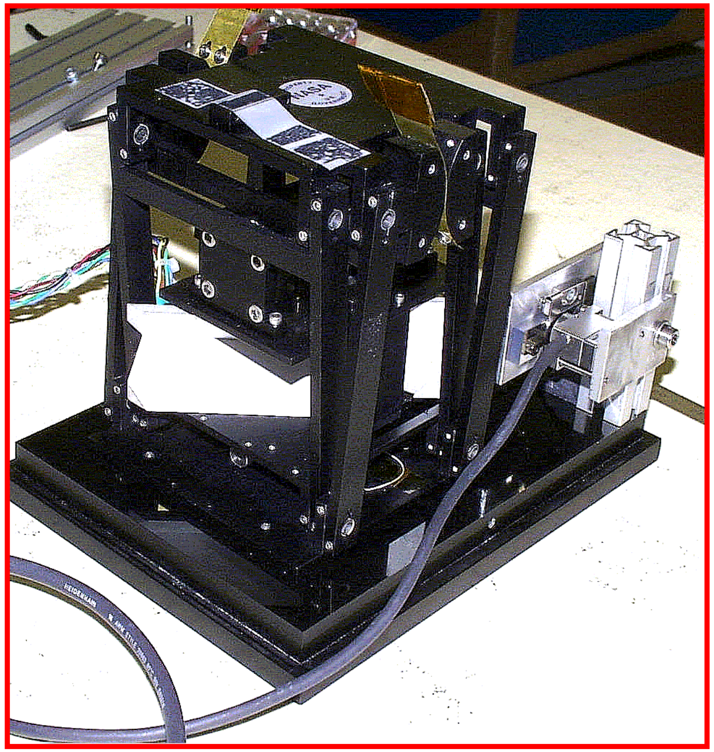


- **Mechanical modification of Heidenhain optical head reduces radial stress around the front end transmission grating.**
- **Reduces contrast loss when cooling - factor of 3 vs. 15.**
- **Allows for an easy trade off between power dissipation, accuracy, and bandwidth.**

SMEC Carriage

Actuator:

- Linear actuator with samarium cobalt magnet, dual windings
- Power consumption allocation < 1.6 mW
- No feasability problem foreseen
- Detailed definition after pivot selection



Launch lock:

- Small actuator + pin
- Detailed definition after pivot selection

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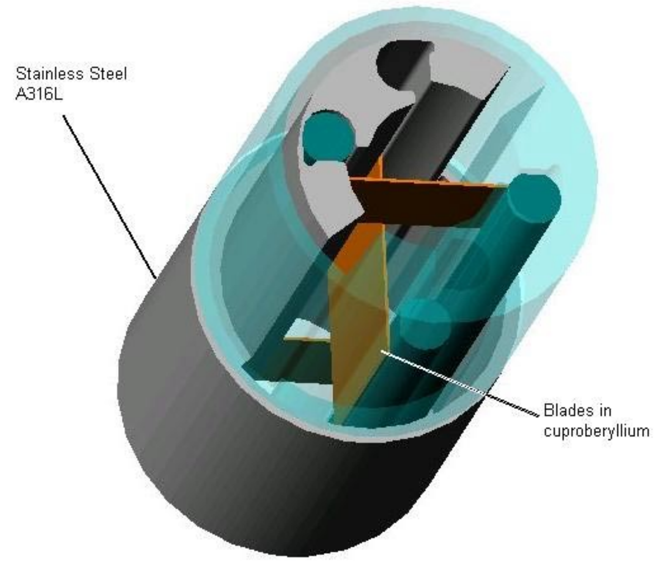
SMEC Pivots

- BE System pivots under qualification
- Recent modelling reveals buckling problem with random launch vibration levels for either BE System or Lucas pivots.
- LAM looking at possible solutions:
  - Additional launch lock for the upper plate.
  - Allow the mecanism a degree of freedom along the travel axis to allow a rotation of the pivots.
  - Lightweighting of the upper plate

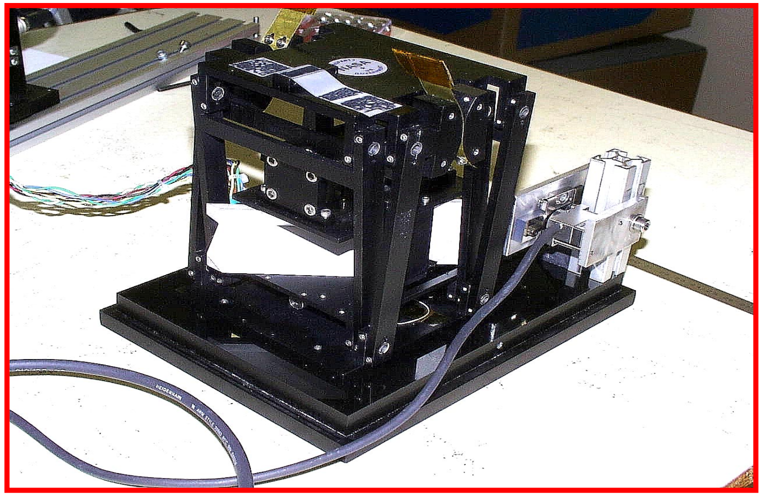


BE System Pivot

SPIRE

SMEC Testing at LAM

- SMEC prototype has been tested under closed loop control using a real-time DSP fast prototyping workshop (Matlab/dSpace) to:
  - identify the mechanical modes and transfer function
  - specify the control algorithms
  - assess the velocity control stability.



- Mechanical modes @ 50Hz and ~ 100 Hz (frame stiffness)
- Specification of 10 ms^{-1} rms velocity stability has been met in laboratory environment (~ 10 mg)
- The velocity stability depends on external vibration level

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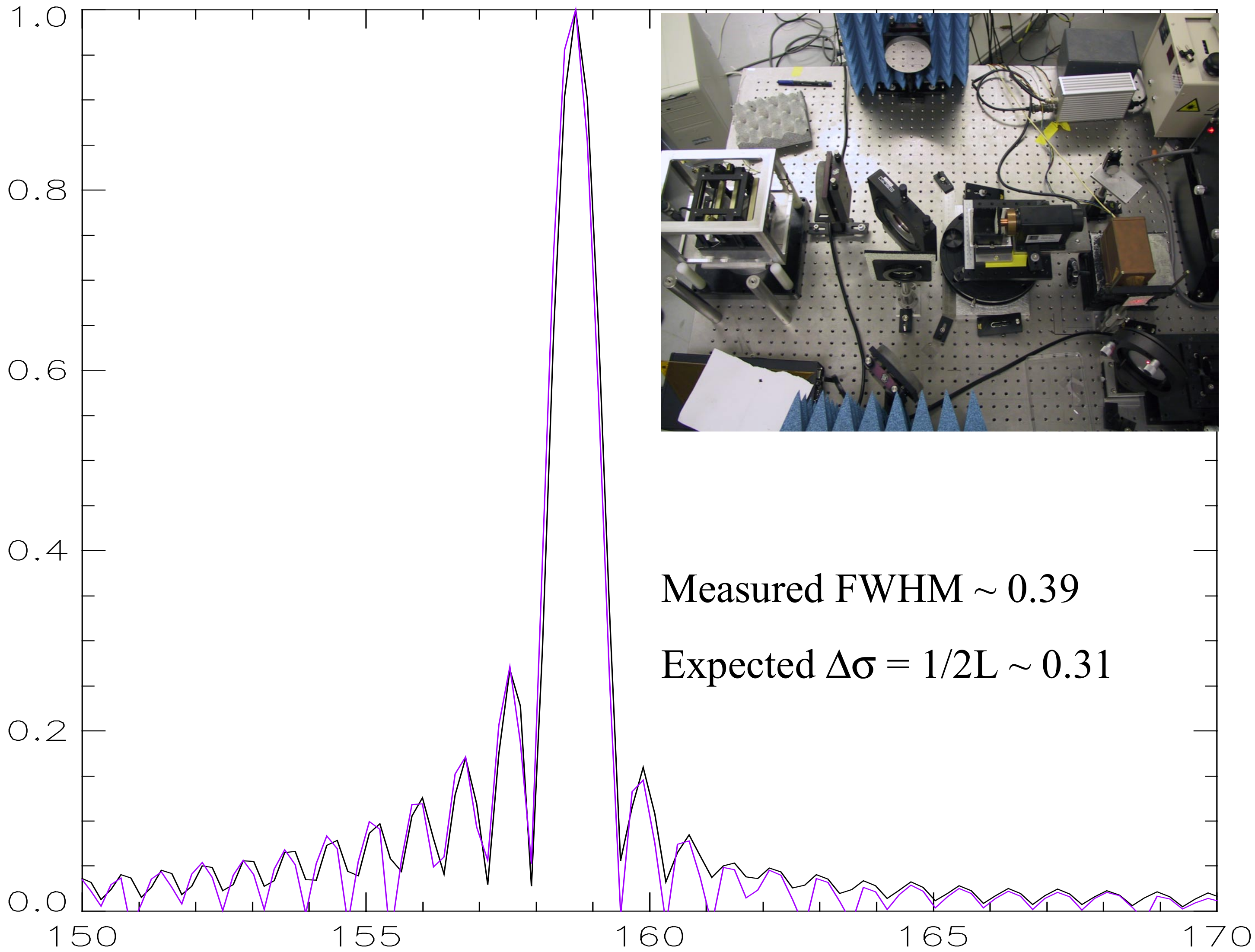
SMEC Testing at RAL



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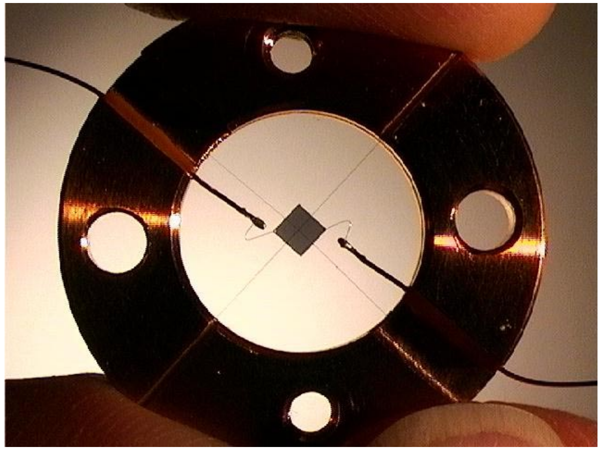
Internal Calibrators

PCAL Prototype No. 5:

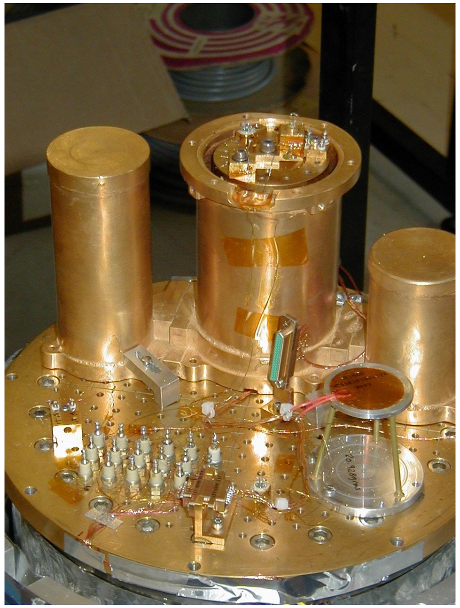
- 1x1 mm Mica, 6 mm thick, 100 Angstrom NiCr on one side

  25-mm dia. brass leads, 0.5 mm length
- Single time constant behaviour: $\tau \sim$ 20 - 40 ms.
  90% settling time increases with power:
  $t_{90\%} \sim$ 50 - 100 ms.
- Equiv. black body temperature ~ 40 K with $P_{applied}$ = 3 mW.
- Next generation will trade speed for reduced dissipation



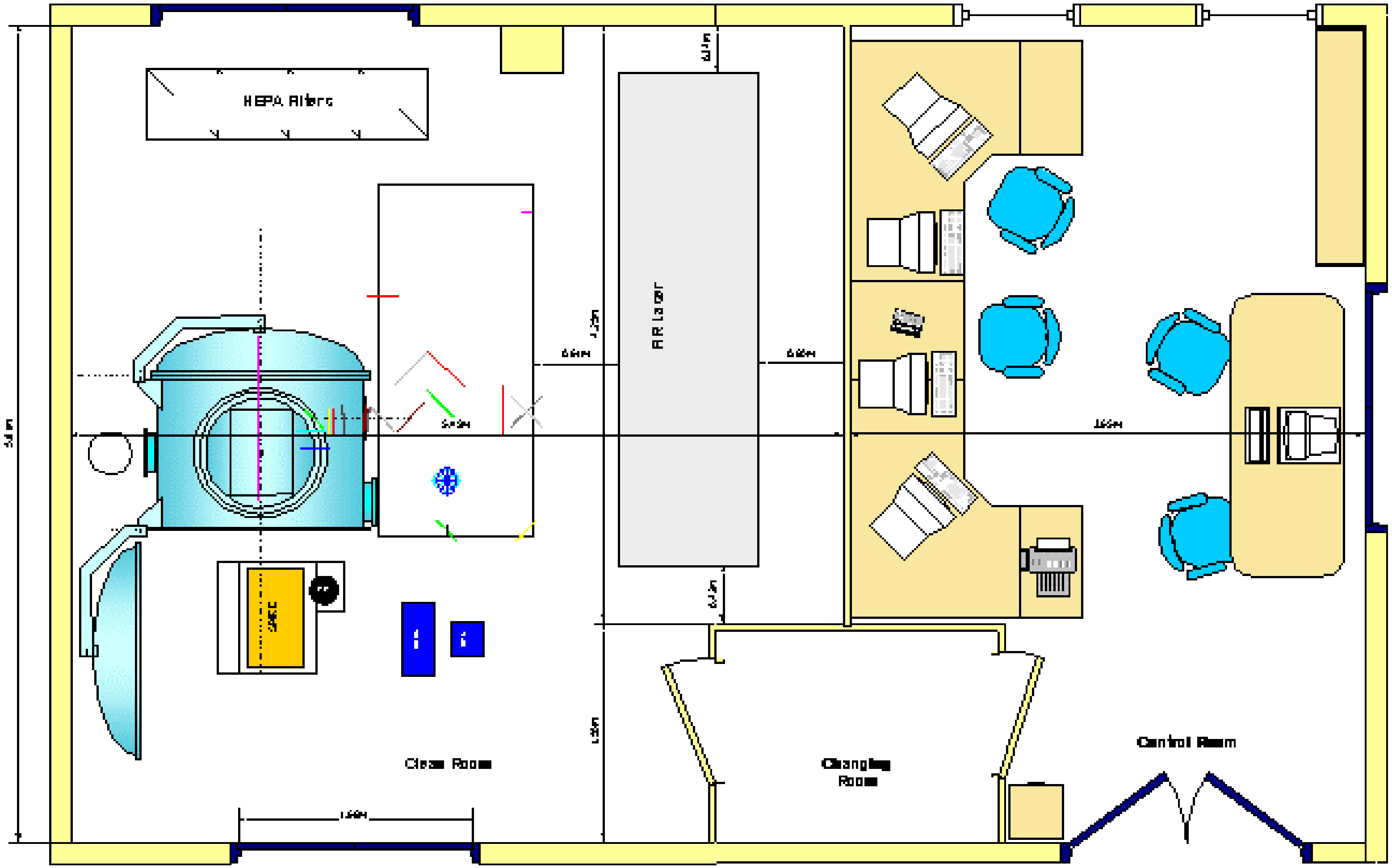
SCAL Prototype No. 2:

- Heated Al table (30 mm dia.) on three Torlon legs
- Achieves up to ~ 80 K with $P_{applied}$ = 2 mW
- Resonant frequency (modelled) > 400 Hz
- Thermal isolation needs to be optimised (length, diameter of legs)

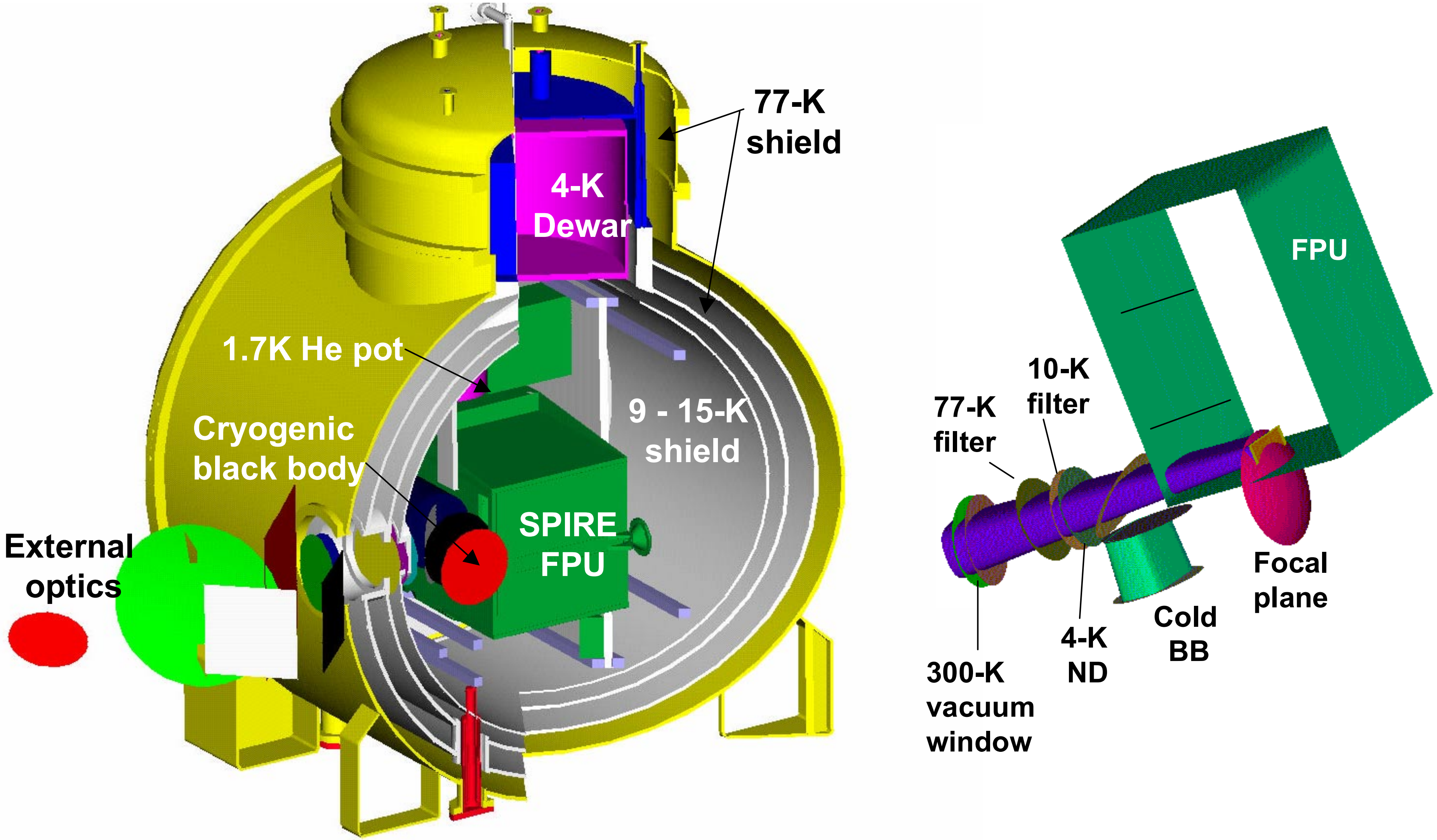


SPIRE

AIV Facility



AIV Cryostat and Filtering Scheme



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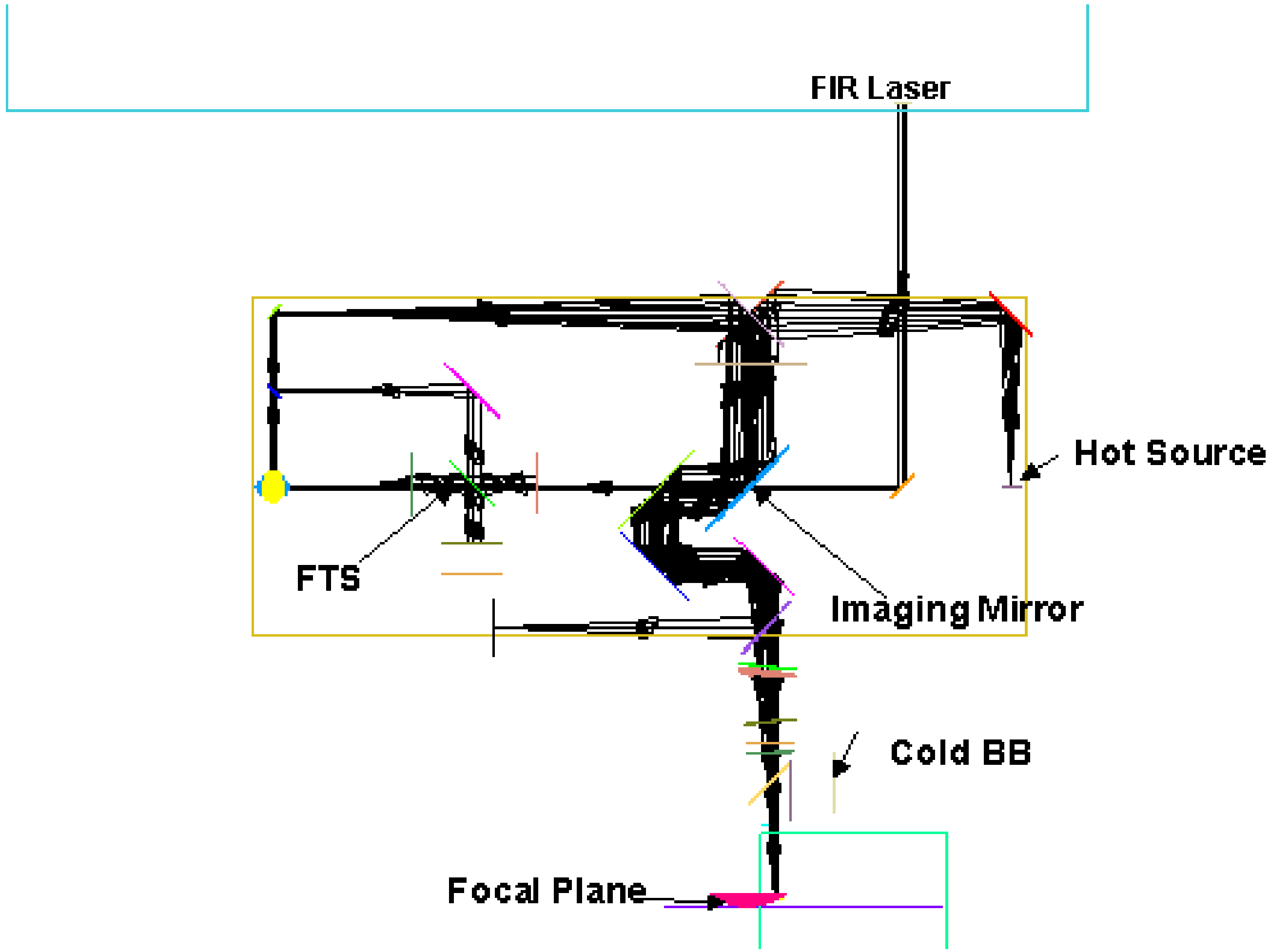
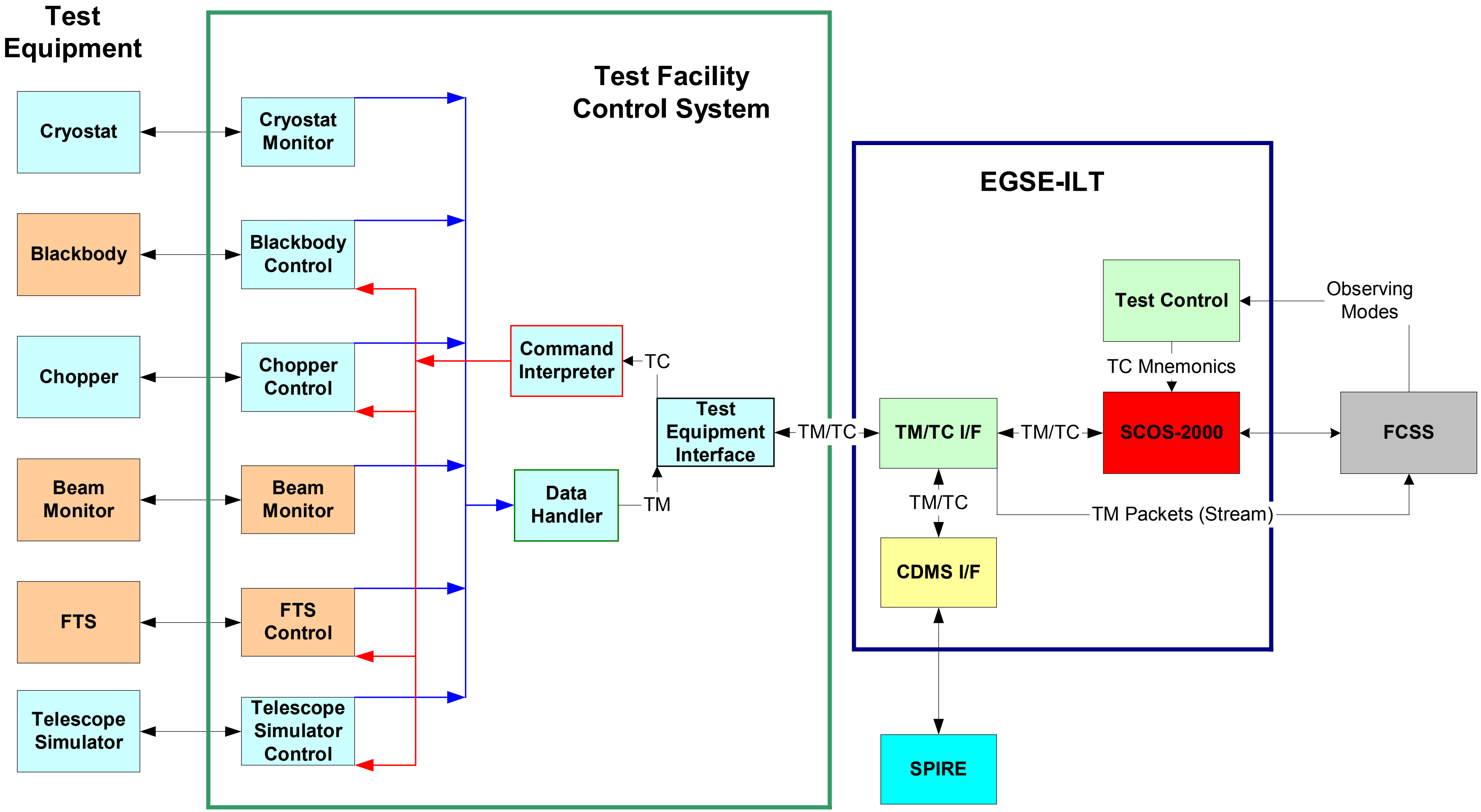
Telescope Simulator



SPIRE Test Facility Control System



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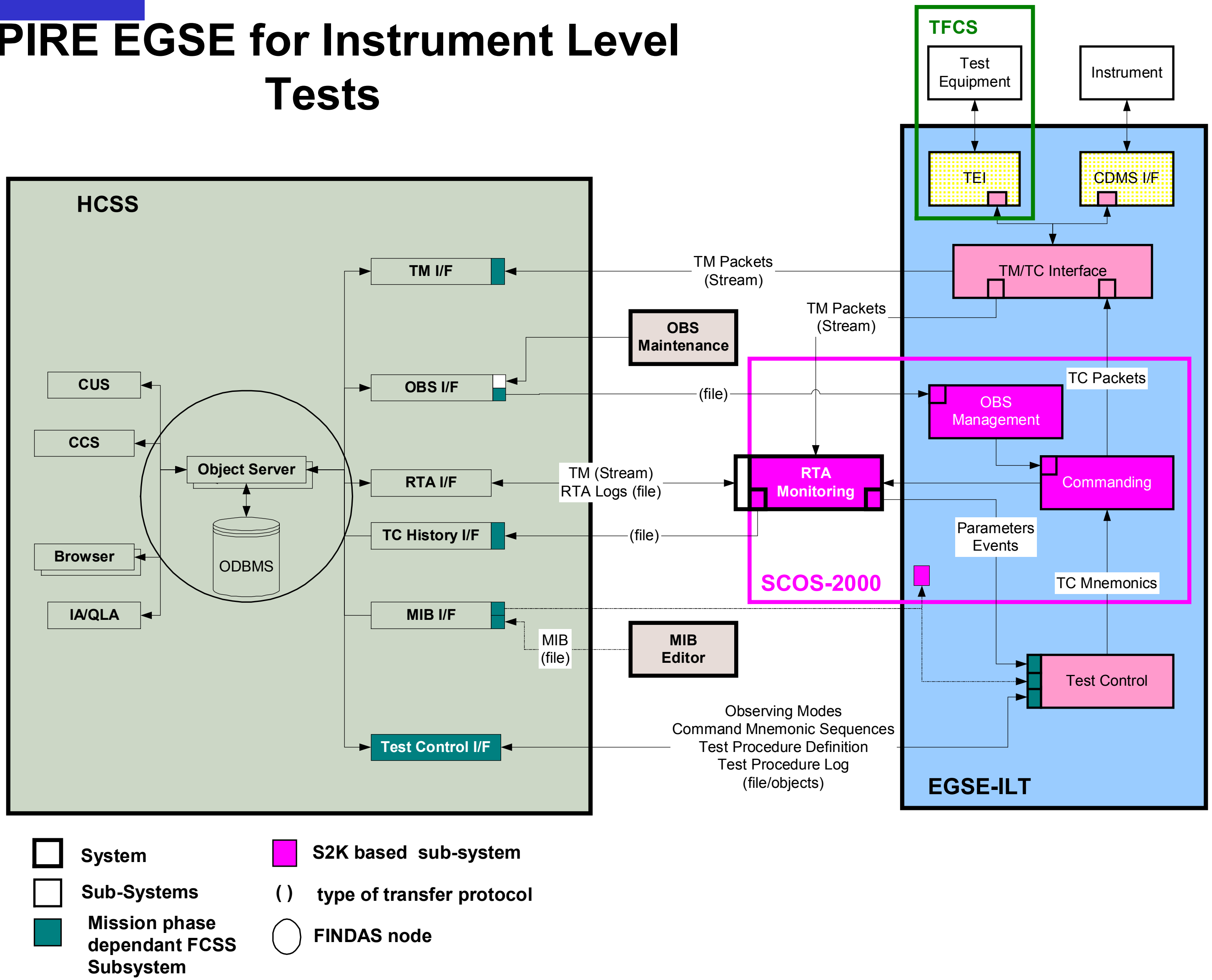
SPIRE EGSE for Instrument Level Tests



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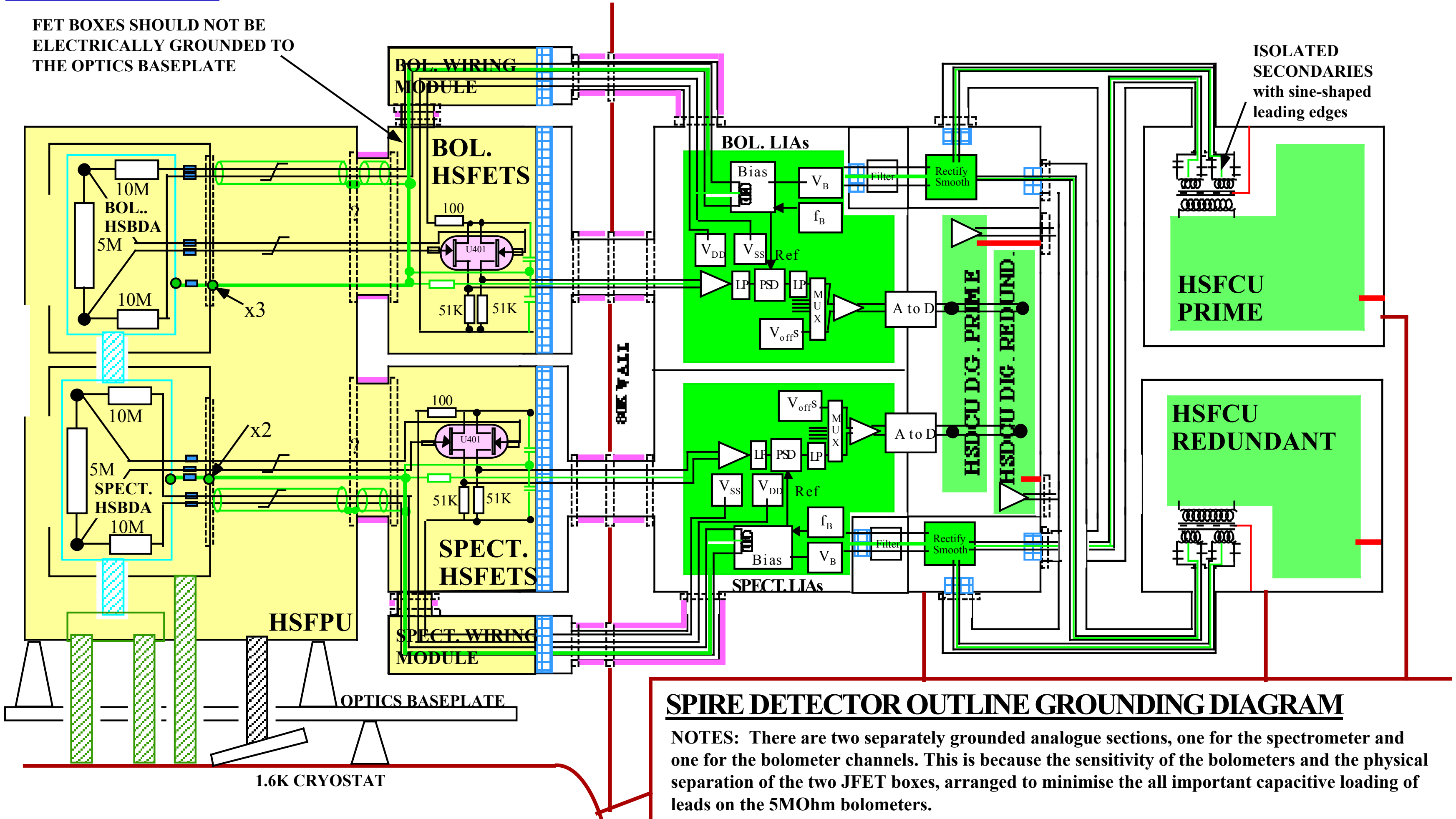
Warm Electronics

- **Long delivery time for DC/DC converter poses schedule problems. Specification to be finalised for industrial tender by end of June.**

- **Late delivery of DPU cards from industry (late November, vs. Early September) place DPU close to critical path - IFSI reviewing their schedule to see if they can avoid delivery slip**

SPIRE

Grounding Scheme



R.F. TIGHT ENCLOSURE

R.F. FILTERING

R.F. EMCLOSURE MAINTAINED BY HARNESS BRAID & BACKSHELLS.

CONNECTOR

SPIRE DETECTOR OUTLINE GROUNDING DIAGRAM

NOTES: There are two separately grounded analogue sections, one for the spectrometer and one for the bolometer channels. This is because the sensitivity of the bolometers and the physical separation of the two JFET boxes, arranged to minimise the all important capacitive loading of leads on the 5MOhm bolometers.

The high level of signals on the biases and the distribution of cryogenic harness contacts cause the biases & FET supplies to be routed through different leadthroughs in the 80K cryostat wall from the balanced channel signals, although the harnesses should be bundled together to minimise loop area. There is a resistor shown for each ground section in each groundloop, which requires to be of optimum value.

There is not quite a classical unipoint for each ground but rather a joining to each BDA 2K section within the r.f. free enclosure, TBC by modelling.

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SPIRE IIDR

- Held at RAL on April 23/24 2001
- Review Board

Pierre Estaria	(Chairman)	ESA
Göran Pilbratt		ESA/HST
Astrid Heske		ESA
Otto Bauer		MPE
Pierre Olivier		ESA
Gordon Stacey		Cornell University

- Attended by Alcatel representatives
- Review based on documentation placed on *Livelink*
- Draft Review Board Report has been produced

SPIRE

Highlights of IIDR Board Report

1. Main recommendation of November 2000 review well addressed
   - Consolidate the Design, Development and Verification Plan
   - Resolve the subsystem and overall schedule problem
   - Resolve and consolidate the proposed model philosophy

   But problems remain in schedule, model philosophy and PA

   Agree (except we believe model philosophy is the optimum solution given all the constraints)

- Progress made to identify critical areas but presentations didn't identify solutions.

  Agree. In many cases solutions require joint effort by SPIRE, ESA and Prime.

- Progress on subsystem level since System Design Review was not easily visible to the Board

  Late availability of IIDR documentation didn't help.
  November review was not a subsystem review.

SPIRE

Highlights of IIDR Board Report

4. **PA activity too low and FMECA should be used as a working design tool**

   Agree. We are addressing this, but are resource-limited at Project Team level. Highest priority at present is to assist subsystems in closing off interfaces to allow procurement of long-lead items.

5. **Serious concern over thermal design:**

- Validity of the model presented	See later
- No margins wrt ^{3}He cooler operation	No (or clarification needed)
- JFET design not optimised to reduce dissipation.	See later
Present figure will significantly reduce lifetime.	No (see later)
- 300-mK temp. control implementation is not clear	Agree
- 300-mK strap programme is much less mature than it should be	Agree

6. **Instrument development schedule and model programme are still very tight**
   - FPU structure still on critical path
   - Shedule for integration, testing and calibration is too compressed
   - Very small margin in need date for cryo-vibration facility

   Agree. These are all serious problems.

SPIRE

Highlights of IIDR Board Report

7. **DRCU desing is lagging behind. PSU procurement spec. must be frozen soon.**
   Agree. Addressing DRCU schedule is high priority for Project Team and SAp. PSU spec. to be finalised by next week.

8. **Other points**

- Need to define cryoharness	Agree!
- Instrument-specific OBSW (esp. autonomy) not addressed yet	Agree
- Progress on IID-B but more needed	Agree
- Calibration requirements need to be written as formal document	Agree
- Bolometer optimisation depends on background	Agree (see later)
- Possible stray light impact of optical encoder	Agree
- EMC issues not yet properly addressed	Agree, but . . .
- More control needed over system budgets, margins	Agree
- Sensitivity to microvibrations needs to be studied	Agree

9. **Internal reporting and monitoring of subsystems is still not satisfactory**

   Agree. Improvement needed and there are no valid excuses.

SPIRE

Highlights of IIDR Board Report

- Board notes option to make small changes to photometer and FTS bands. SPIRE is urged not to let this deflect attention from critical issues.

  Agree.

- Schedule is needed showing how and when parallell and serendipity modes will be settled before the end of the year.

  Parallel mode issue can't be decided on that timescale. It is baselined and should remain so.

SPIRE

Conclusions of IIDR Board Report

- **Good progress but more needed, and several important issues to be addressed for the IBDR**
- **Delta-IIDR not deemed appropriate**
- **IIDR Board is satisfied with SPIRE response to System Design Review Board report except for PA activities**
- **Review documentaion should be produced on time in future**

SPIRE Thermal Modelling and JFET Dissipation

- **SPIRE thermal model presented at Systems Design Review and IIDR was based on static cryostat model provided by ESA**
- **Assumption that boiloff reacts to SPIRE Level-2 dissipation now known to be invalid – boil-off will be very slow to respond to changes in instrument dissipation**
- **Boiloff will stay ~ constant and optical bench and 4-K temperatures will rise.**
- **This could pose problem for SPIRE temperature stability, detector operating temperature and cooler performance.**

- **JFET dissipation (in photometer mode) is ~ 50 mW (increase from 33 mW originally quoted at June 1999 PDR:**
  - **Thermal performance not yet experimentally verified**
  - **Elimination of BAU requires low output impedance and correspondingly higher dissipation**
  - **JFET noise increases sharply if the JFETs get too cold**
  - **33 mW is still the goal**

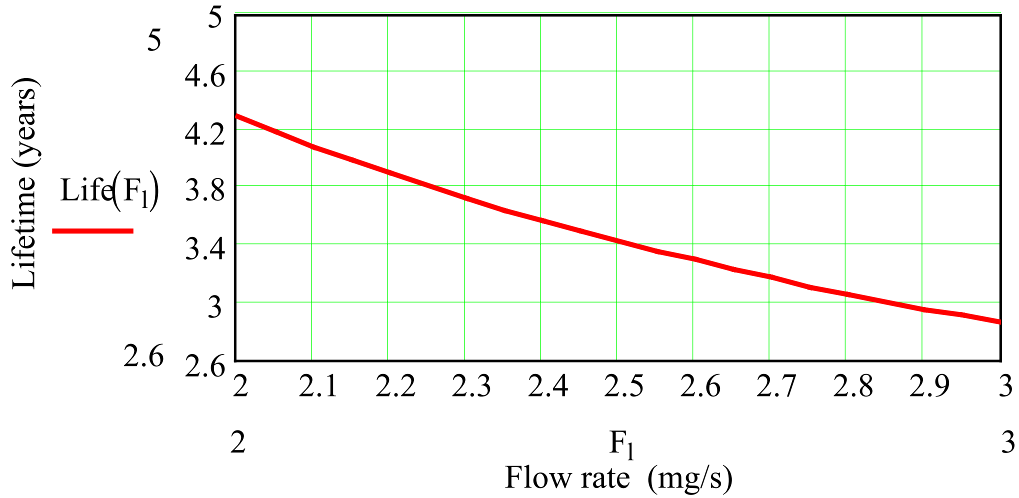
SPIRE Thermal Modelling and JFET Dissipation

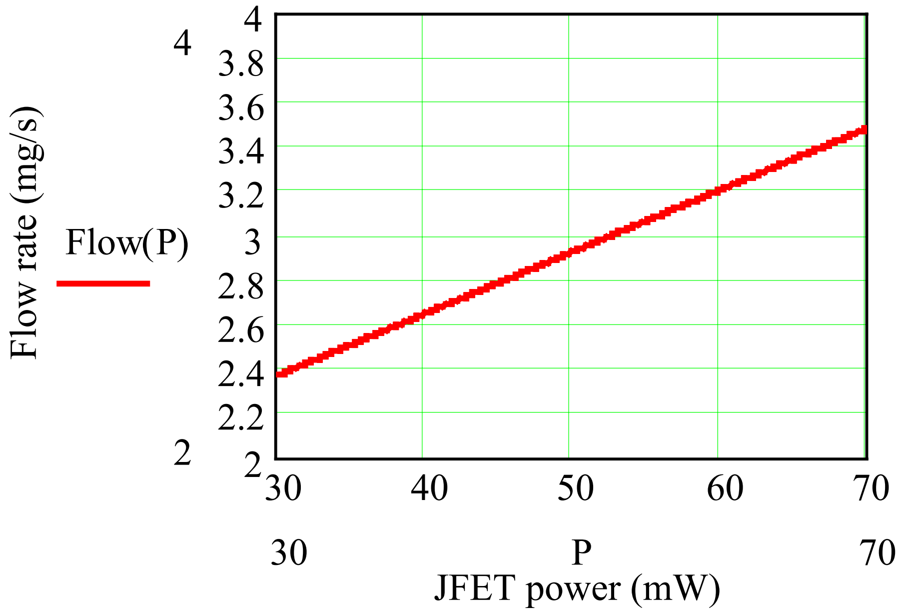
Running model at 2.45 vs. 2.91 mg s^{-1}

HOB Temp	**11.6 K to 13.7 K**
FPU L1 Temp:	**5.1 K to 6.0 K**
FPU L0:	**1.88 K to 1.97 K**
Max Detector Temperature:	**324 mK to 329 mK**

Actual steady-state flow rate likely to be 2.2 – 2.3 mg s^{-1} - somewhat worse than above.

SPIRE Thermal Modelling and JFET Dissipation





SPIRE Thermal Modelling and JFET Dissipation

Fraction of Herschel time used by SPIRE $F\_SPIRE := 0.33$

Fraction of SPIRE time used by Photometer $F\_Phot := 0.7$

Fraction of Photometer time used in Mapping mode $F\_Map := 0.5$

Fraction of mission time during which SPIRE is operating in Photometer Map mode

$$Fraction := F\_SPIRE \cdot F\_Phot \cdot F\_Map$$
$$Fraction = 0.115$$

Average flow rate for 49.5 mW:

$$Favg33 := Fo \cdot (1 - Fraction) + F33 \cdot Fraction \qquad Favg33 = 2.229$$
$$Favg50 := Fo \cdot (1 - Fraction) + F50 \cdot Fraction \qquad Favg50 = 2.282$$

Lifetime for the 33 and 49.5 mW options

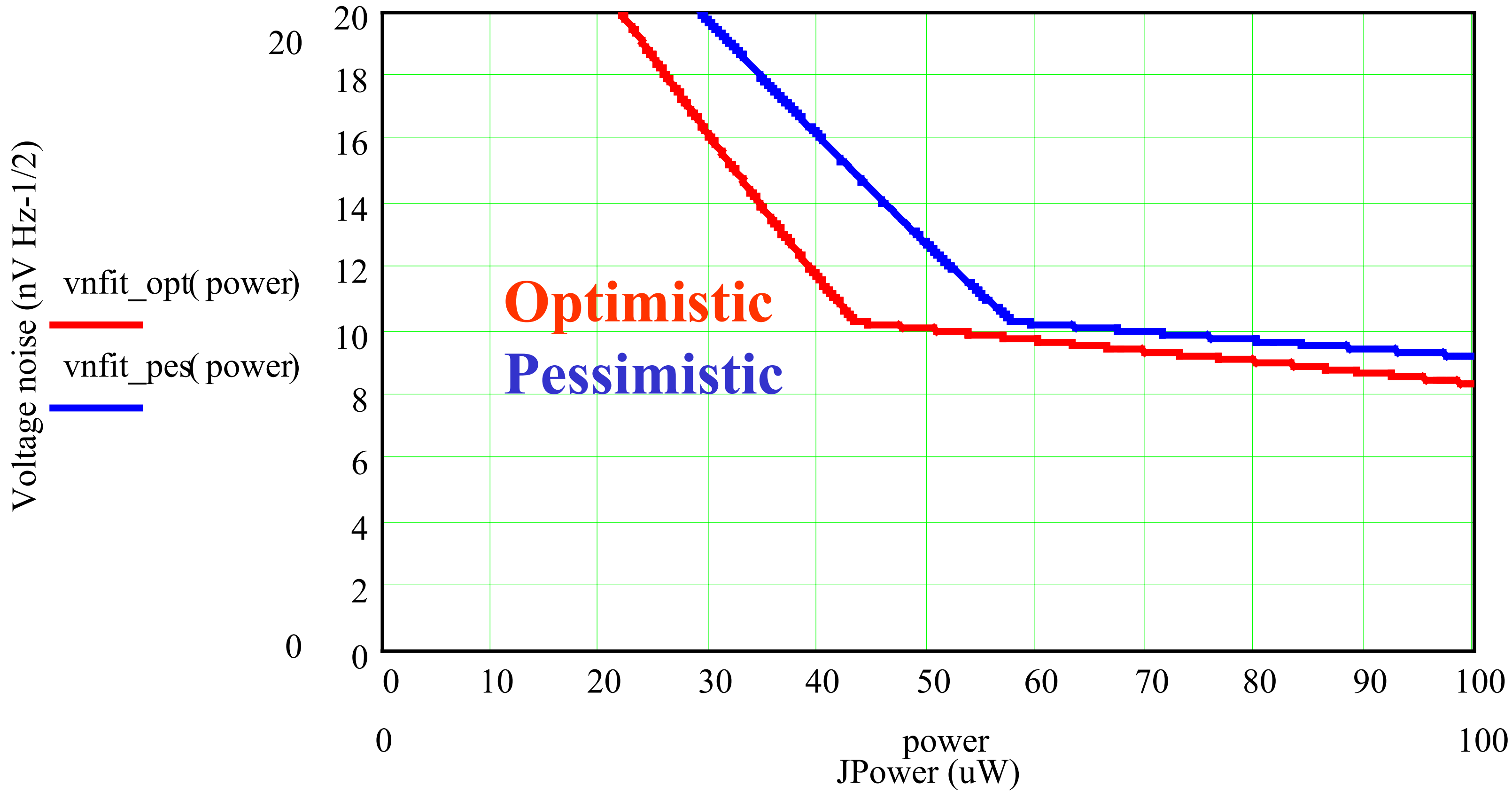
$$Life(Favg50) = 3.749 \qquad Life(Favg33) = 3.838$$

Percentage difference

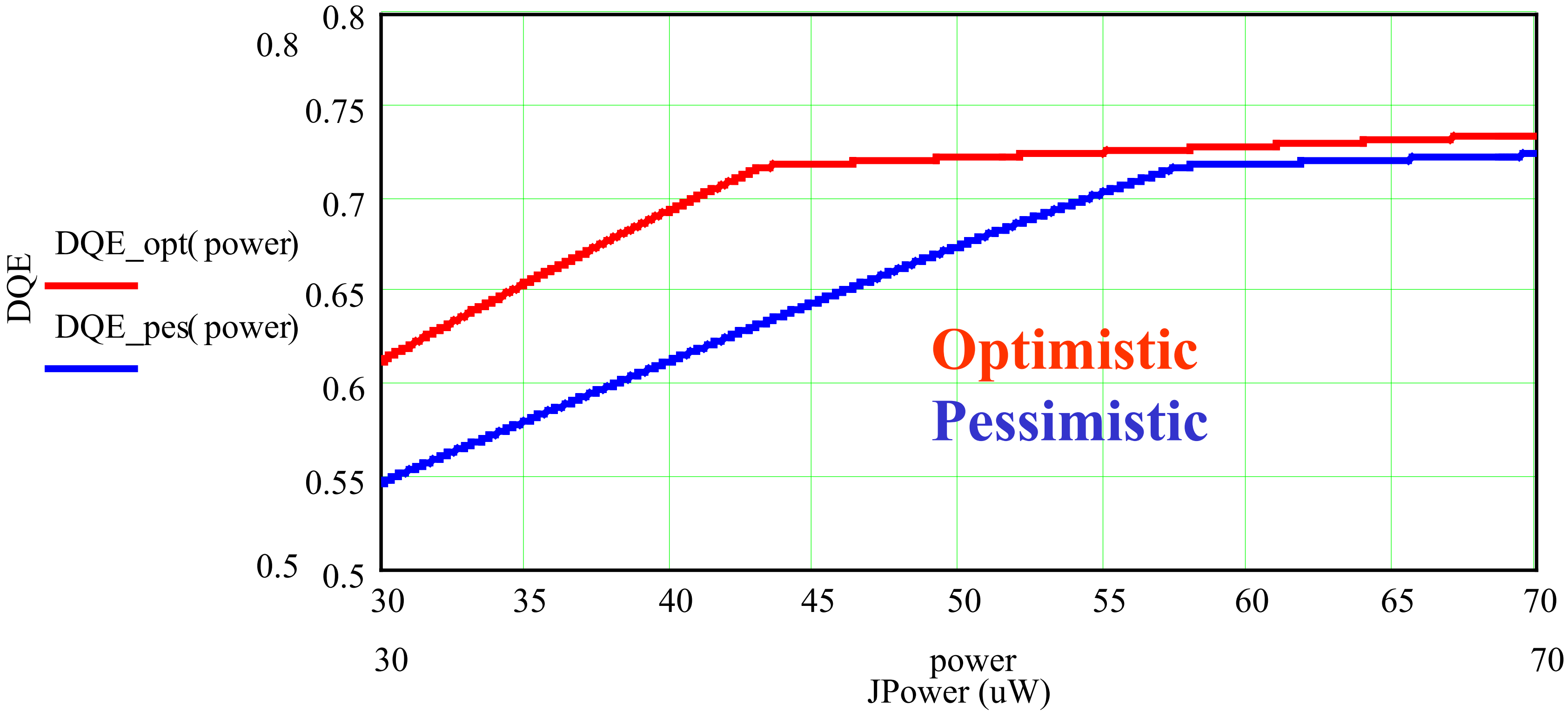
$$\frac{Life(Favg33) - Life(Favg50)}{Life(Favg33)} \cdot 100 = 2.3$$

So the impact on mission lifetime of running at 49.5 vs. 33 mW is around 2.3% at the very most.

SPIRE Thermal Modelling and JFET Dissipation



SPIRE Thermal Modelling and JFET Dissipation



SPIRE Thermal Modelling and JFET Dissipation

Results of simple model:

- Powering the JFETs at 50 mW rather than 33 produces a 10 - 15% better observing speed (assuming 330 mK detector temperature)
- If actual detector temperature is higher, then the difference is not so great. E.g.: for 350 mK vs 330 mK, the difference is only 1 - 4% difference - basically equivalent performance.
- Relative efficiency in helium usage (50 mW vs. 33 mW): (2.91/2.45) = 1.19
- This outweighs the mapping speed advantage of running at 50 mW

SPIRE Thermal Modelling and JFET Dissipation

Preliminary conclusion:

Even with pessimistic assumptions about the JFET noise vs. power, operating them at 33 mW dissipation is preferable because:

1. Although total mission lifetime is not a big issue, it provides more efficient use of the liquid helium taking into account mapping speed and helium boiloff rate.

- **Lower temperatures and better stability for all stages**
  - **Superior ^{3}He hold time (and may be necessary to keep it > 46 hrs)**
  - **Probably much reduced problems with thermal gradients and settling times**
  - **No need to change to more complex JFET box thermal design with "hot finger" to dump the heat to a higher temperature.**

Still needed:

- **Better model of JFET performance vs. dissipation**
- **Full thermal transient thermal model of the whole system**
- **Analysis of temperature stability requirements and operational implications**
- **Analysis of cooler performance vs. Level-1 temperature**

SPIRE

Telescope Background Power

Uncertainties:

1. ε, T of telescope mirrors and wavelength dependence
   - Spec is total throughput > 0.97 so worst case should be ε = 3%.
   - T likely to be 60 – 90 K

2. Stray light properties of the Herschel system have not been fully modelled, and are unlikely to be thoroughly analysed in the near future. Such modelling is extremely difficult in any case, and the results would never be completely reliable . . .

3. Overall optical efficiency of SPIRE depends on properties of mirrors, the filters, dichroics (Photometer), beam dividers (FTS), feedhorns and detector coupling efficiencies. In some cases we would hope to do better than the assumed values (e.g., filter transmission), in others we could end up doing worse (e.g., feedhorn efficiency).

Telescope Background Power

Assumptions:

- NTD bolometer model: ideal thermal behaviour
- Electronics chain contributes a fixed noise level
- Optimum design impedance for bolometer is ~ 5 MΩ
- Bias can be adjusted to the optimum at the actual background

- Nominal bolometer design parameters:

Band	λo (μm)	Qexp (pW)	GS0 pW K^{-1}	τ (ms)	3-dB Freq. (Hz)
P/SW	250	4.0	62	11.4	14
P/MW	350	3.2	51	13.9	11
P/LW	500	2.4	40	17.8	8.9
S/SW	250	9.0	144	4.9	33
S/LW	350	7.4	123	5.7	28

R_s = 180 Ω T_g = 41.8 K   To = 300 mK e_n = 10 nV Hz$^{-1/2}$

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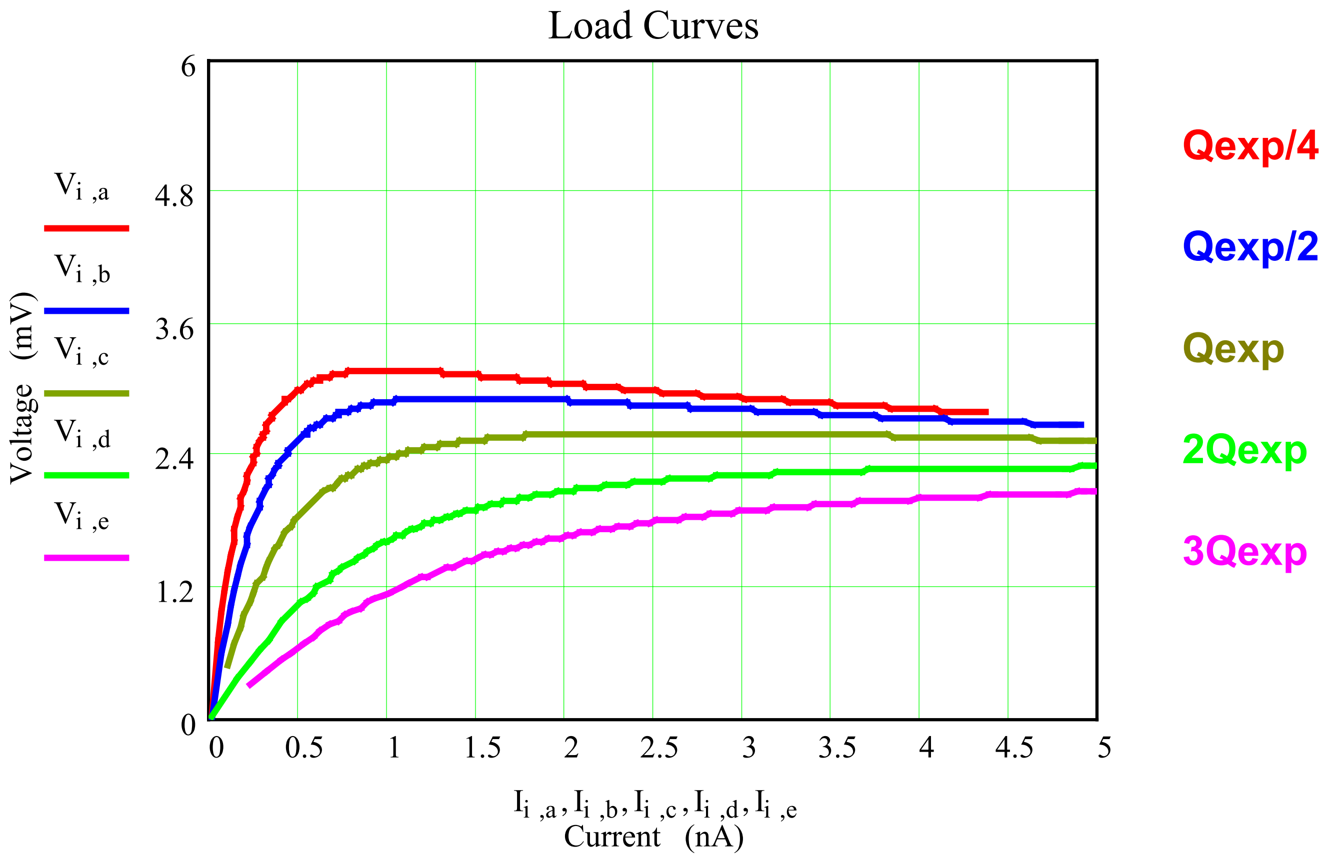
Telescope Background Power

Example: 350 μm Q_{exp} = 3.2 pW Q_{des} = 1.6 pW

Load curves



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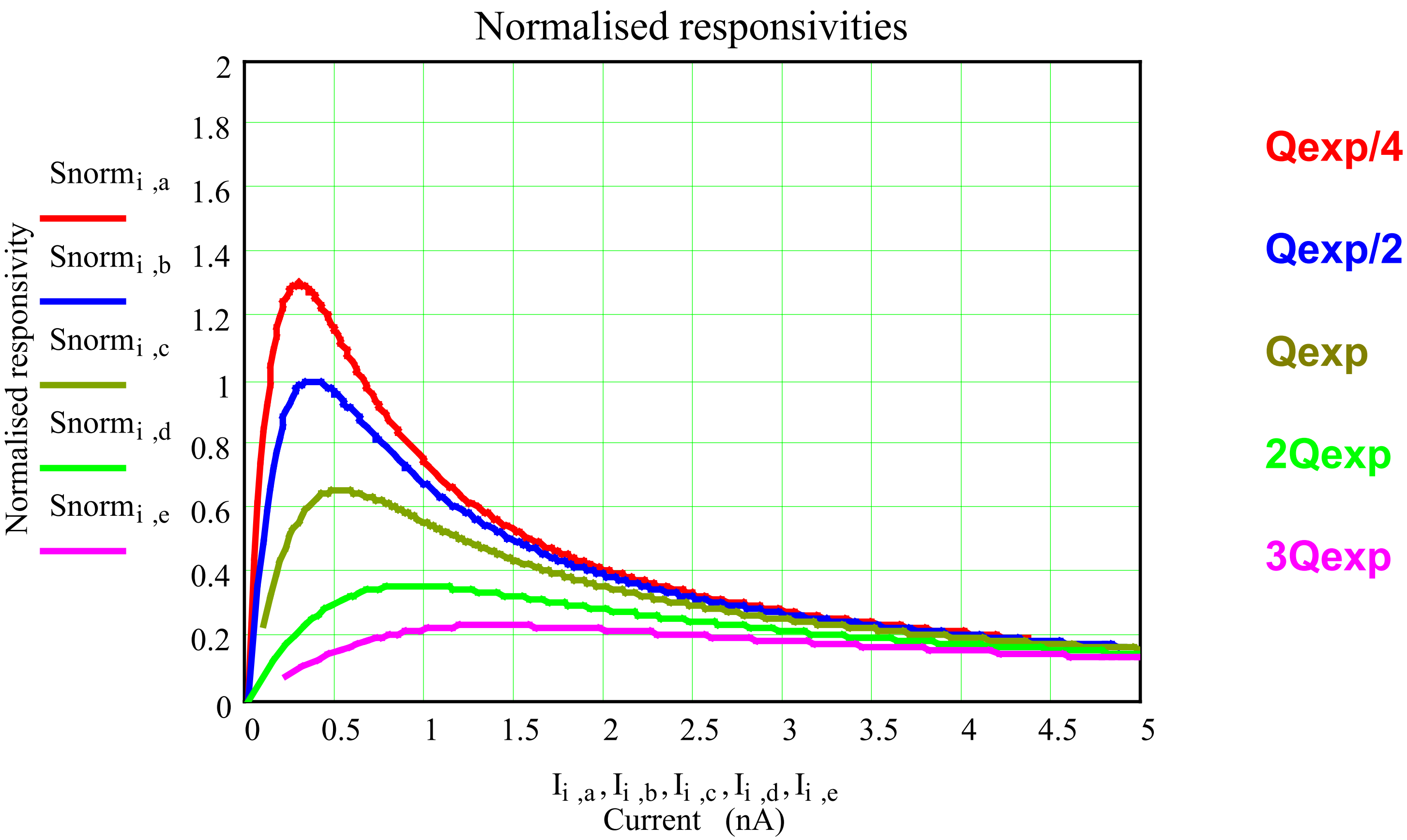
Telescope Background Power

Responsivity vs. bias



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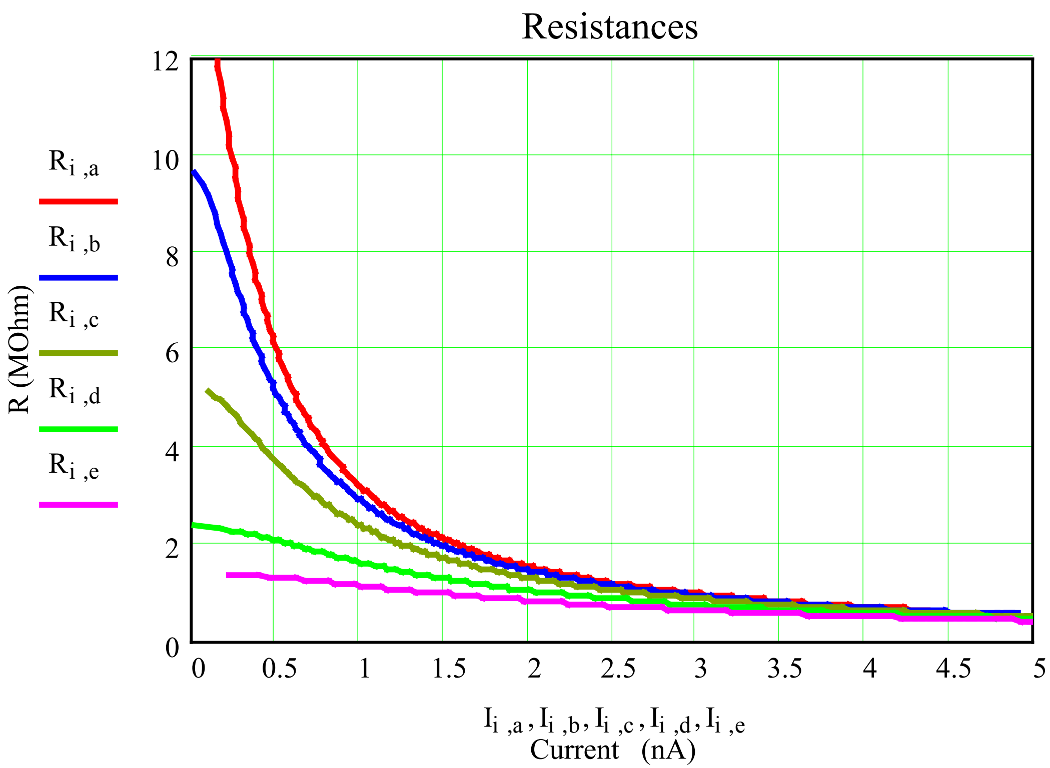
Telescope Background Power

Resistance vs bias



Qexp/4

Qexp/2

Qexp

2Qexp

3Qexp

Resistance at the optimum bias point for Q = Qdes is about 6 MΩ.

It rises to around 8 MΩ if Q = Qdes/2

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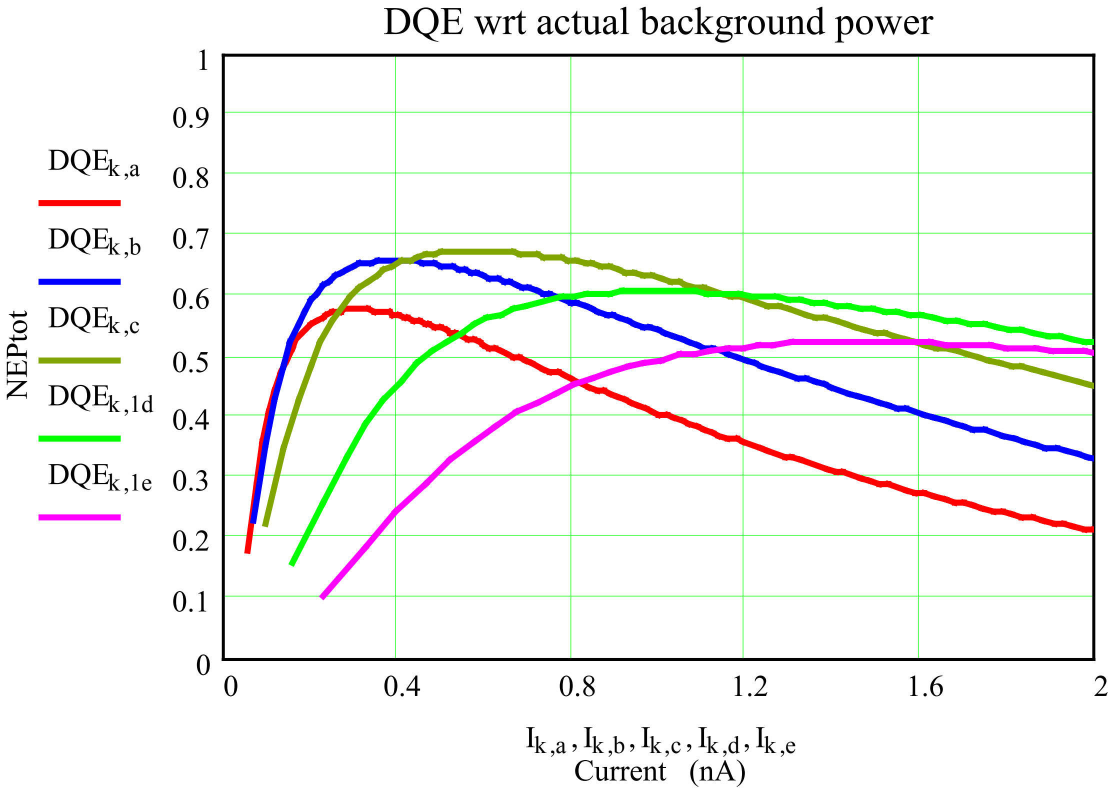
Telescope Background Power

DQE (at actual background power) vs. actual background power



Qexp/4

Qexp/2

Qexp

2Qexp

3Qexp

DQE is insensitive to the bias current as long as it's not too small

DQE is relatively insensitive to the background as long as the bias is adjusted to optimise at the actual background

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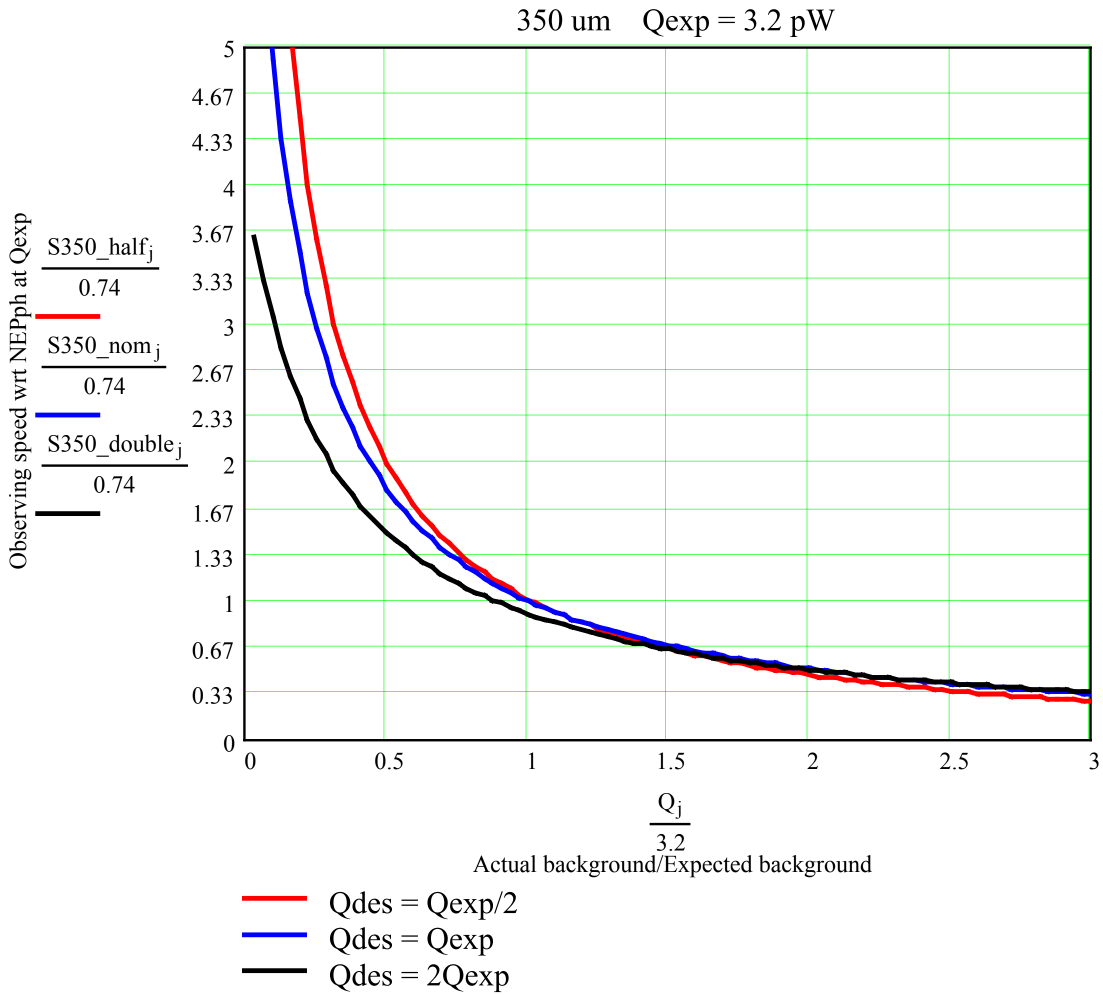
Telescope Background Power

Observing speed vs. actual background power (350 μm)



Qdes (pW)	GS0 (pW K-1)
Qexp/2	26
Qexp	51
2Qexp	102

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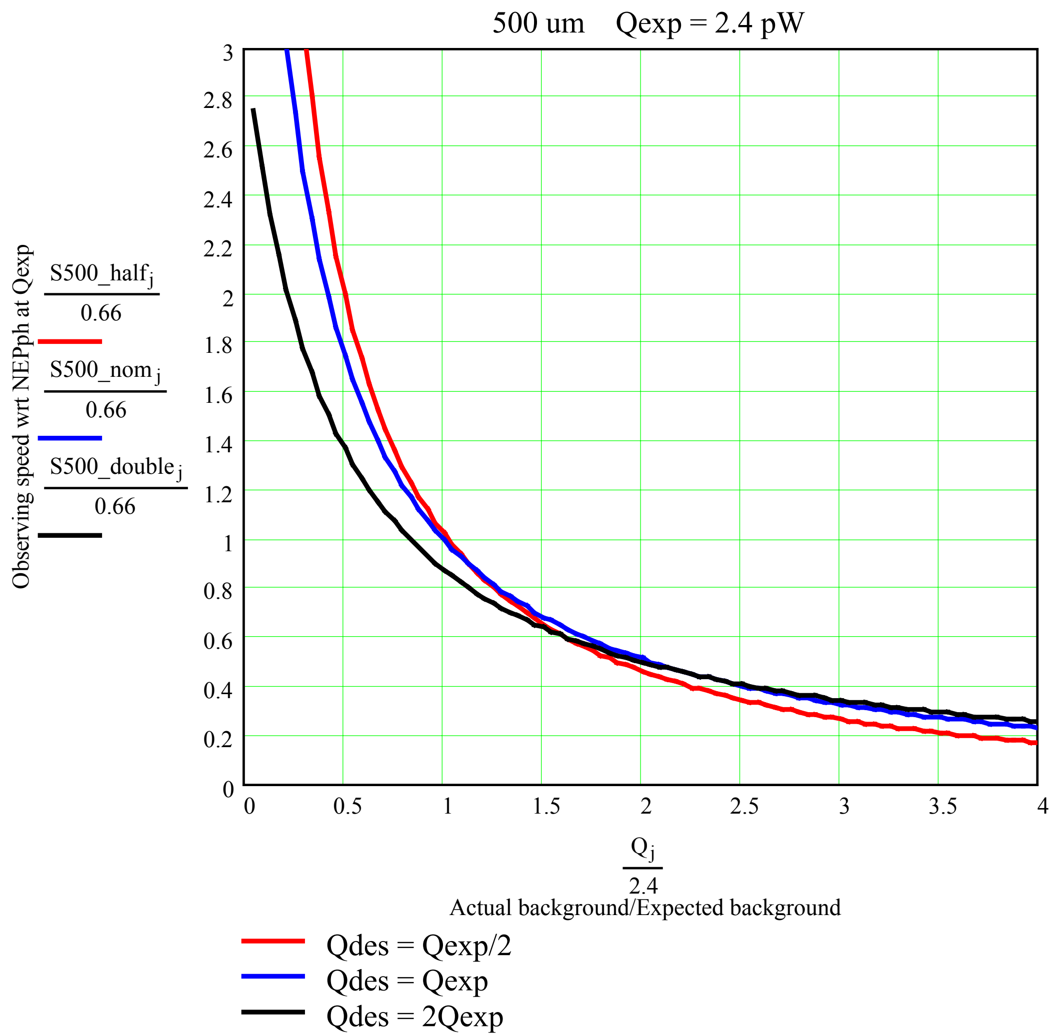
Telescope Background Power

Observing speed vs. actual background power (500 μm)



Qdes (pW)	GS0 (pW K-1)
Qexp/2	20
Qexp	40
2Qexp	80

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Telescope Background Power

Conclusions

1. **Sensitivity improves or degrades smoothly with background power.**

2. **If the background is excessively high we lose sensitivity due to additional photon noise, with the bolometer design (GSo) making very little difference.**

   If the background is lower than expected, we will gain accordingly.

3. **Potential gain in performance is higher if we design for a <u>lower</u> background than the expected one, but not dramatically so.**

4. **Designing for low background involves compromising speed of response somewhat in order to take advantage of the potential sensitivity gain.**

Preliminary recommendation: design for $Q_{des} = Q_{exp}$

SPIRE Scientific Optimisation – Open Issues

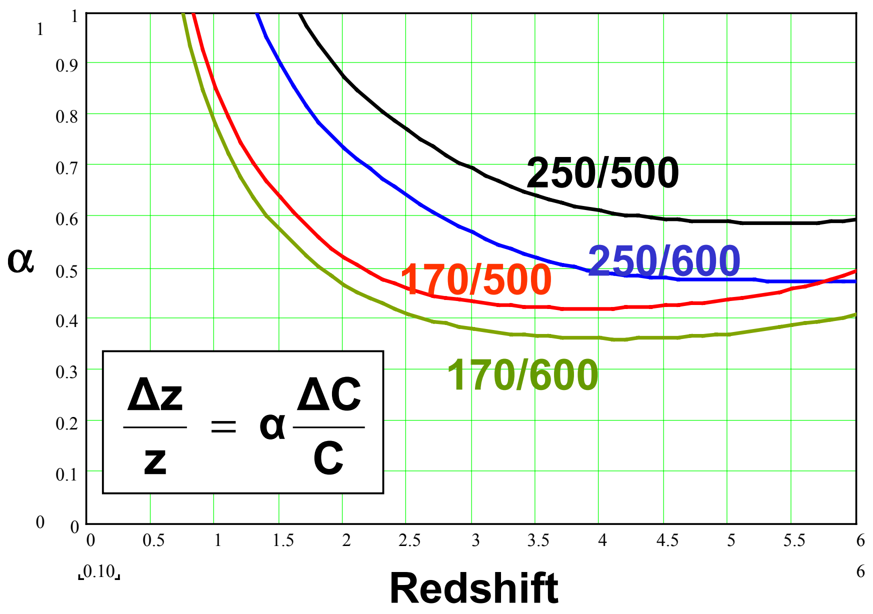
1. Photometer bands

- Current :	250	350	500 μm
- Proposed :	250	350	~600 μm

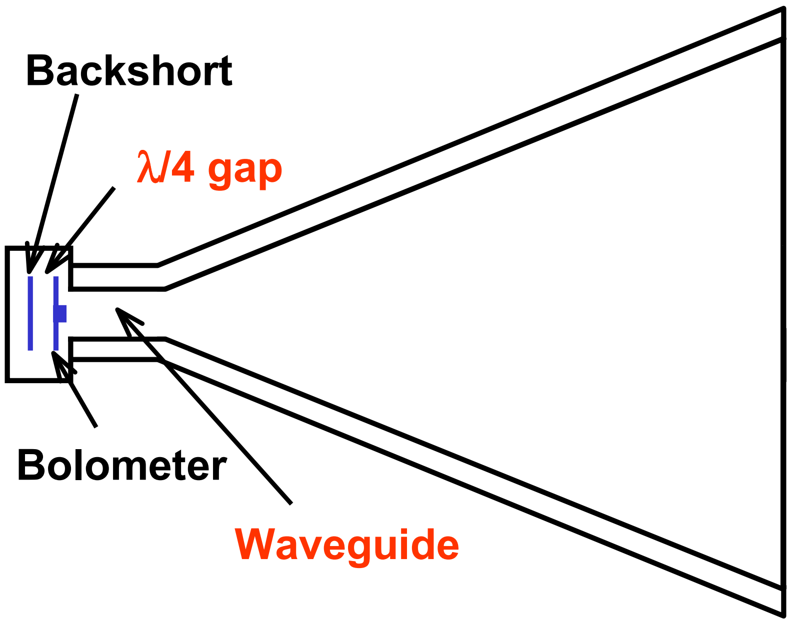
- **Possible advantages:**
  - Improved ability to identify high-z galaxies from SPIRE colours
  - Ability to detect S-Z increment
- **Disadvantages:**
  - Larger beamwidth (43” at 600 μm vs. 36” at 500 μm)
  - Lower sensitivity and some loss of field due to vignetting
    ⇒ Reduced mapping speed for large surveys
- **Constraints:**
  - No changes to any budgets or interfaces (minimal internal changes to BDAs and filters only)
  - No change for CQM
  - No impact on schedule will be allowed
- **Plans:**
  - Study of scientific and technical trade-offs and impact of making the change

Photometer LW Band Options

Redshift Discrimination (Starburst-type SED)



Internal design change to waveguide diameter and backshort gap



SPIRE Scientific Optimisation – Open Issues

2. FTS bands

- Current : 200 - 300 300 - 670 μm
- Proposed : 200 - 350 350 - 670 μm

- **Possible advantages:**
  - Better overall optimisation of performance across the full band
- **Disadvantages:**
  - Some compromise to short-wavelength performance
- **Constraints:**
  - No changes to any budgets or interfaces (minimal internal changes to BDAs and filters only)
  - No impact on schedule will be allowed
- **Plans:**
  - Change should be made for CQM
  - Instrument optical and sensitivity modelling will be done
  - Scientific impact to be studied
  - Decision needed soon

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FTS Bands

(See note distributed on 9 May)

Up to now: SW: 200 - 300 μm optimised for 250 μm

LW: 300 - 670 μm optimised for 350 μm

Proposed change:

Array	Des λ_o (μm)	λ_L (μm)	λ_U (μm)	$\lambda/\Delta\lambda$	Horn aperture (mm)	Waveguide Diameter (μm)	No. of Horns
S/SW	275	200	355	1.79	2.15	208	37
S/LW	450	345	670	1.56	3.80	393	19

- Loss of sensitivity for SW band (10-20%) due to higher background
- Gain in sensitivity for LW band (~30%) due to lower background and narrower band

SPIRE

ICC Status

- ICC Staff
  - Ken King is yet to take on ICC Development Manager role as Eric Sawyer has been involved in Rosetta FM deliveries
  - Matthew Graham has started work as replacement for Neal Todd at ICSTM
  - We are still waiting for additional effort from Italy

- Committed S/W effort available for ICC for 2001 is 2.5 FTE
  - Effort is shared between HCSS s/w development and ICC S/W design

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HCSS Development

- ICSTM are developing the interface to the 'out-of-limits' and 'Command History' files generated by SCOS2000. They have been looking at these files from other missions and will use these to define the ICD for ingestion of this information into the HCSS

- RAL are dealing with the telemetry interface to the HCSS. Java classes written describing the SPIRE data frames and successfully generated and stored in the HCSS prototype.

- Current progress is compatible with the schedule.

SPIRE

SPIRE ICC Development

- Activity concentrating on production of the SPIRE Science Implementation Plan (SIP), including resource estimation
- Review of SIPs now in September, but delivery required by end June (new draft is almost ready)
- ICC User Requirements have been consolidated, from the SIRD and the URDs.
- Summary-level Use Cases have been generated, covering the requirements
- Work package definition is in progress. Definition of how they will be divided up within the consortium ~ September.
- SIP will cost the ICC in terms of manpower required

SPIRE

Schedule

- Schedule remains as previously reported:
  - "Realistic" CQM delivery date = 1 Oct. 2003
  - PFM delivery 'on time'

- STM delivery schedule driven by Structure
  - Currently on schedule

- Problem with DRCU DC/DC converter procurement time may cause delay to PFM delivery
  - options being investigated to speed up process
  - alternative is to separate the PSU from the rest of the DRCU and integrate at a late stage

- Reported 80 work day delay in DPU board delivery should not affect SPIRE schedule but further delays would

- CQM AIV testing in with spare ISO cryostat needs to be studied
  - SPIRE has distributed a discussion note on CQM AIV

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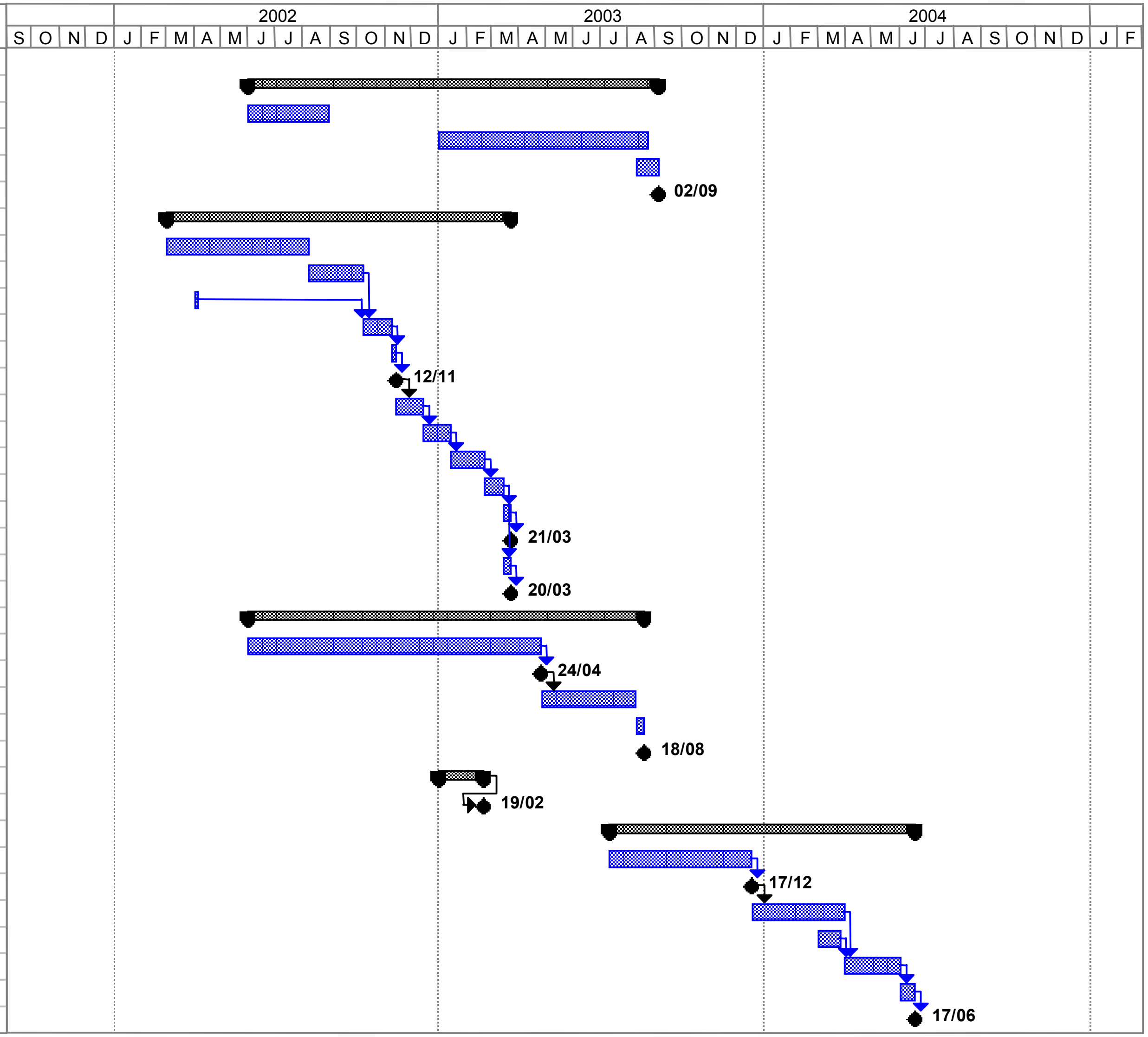
SPIRE Schedule - Overview

ID	Task Name
75	**AIV**
76	**Avionics Model**
77	**Preliminary Integration**
85	**AVM Verification**
90	**Delivery**
94	AVM Delivery to ESA
95	**Structural Thermal Model**
96	**STM FPU Subsystem deliveries**
126	**STM FPU Alignment**
152	**STM FTB Integration**
160	**STM Warm Environmental Test**
173	Review Preparation
174	STM Interim Review
175	**STM Cold Thermal Verification**
187	**STM EMC Testing**
192	**STM Cold Vibration**
200	**STM Cold Verification**
207	**STM De-Integration**
211	CQM Structure and FTBs available
212	Review Preparation
213	STM Review
214	**Cryogenic Qualification Model AIV**
215	**CQM Integration**
279	CQM Test Readiness Review
280	**CQM Verification**
323	**CQM Delivery Preparation**
328	Delivery of CQM to ESA
329	**Warm Electronics Qualification Model**
339	WE Critical Design Review
340	**Proto-Flight Model AIV**
341	**PFM Integration**
403	PFM Test Readiness Review
404	**PFM Verification**
424	**PFM Warm Electronics Integration**
434	**PFM Instrument Calibration**
441	**PFM Delivery Preparation**
447	Delivery of PFM to ESA



SPIRE

Forthcoming Reviews

- **Internal Detailed Design Reviews between now and September**
  - **Freeze the subsystem design and release for manufacture of subsystem STM, AVM, CQM, MGSE, OGSE and EGSE**
  - **Freeze subsystem software requirements**
  - **Proposed schedule**

- Mirrors	9 July (TBC)
- FTS	30 Sept
- Cooler	17 May - Complete
- DRCU & WIH & FPU Simulator	July, TBD
- Structure & Thermal Straps	End July
- DPU & OBS and DRCU Simulator	TBD
- AIV Facility & EGSE	31 July (TBC)
- BDAs , FTB & RF Filters	30 July
- Filters & Calibrators	6-7 August
- BSM	24 July
- Shutter	15 July

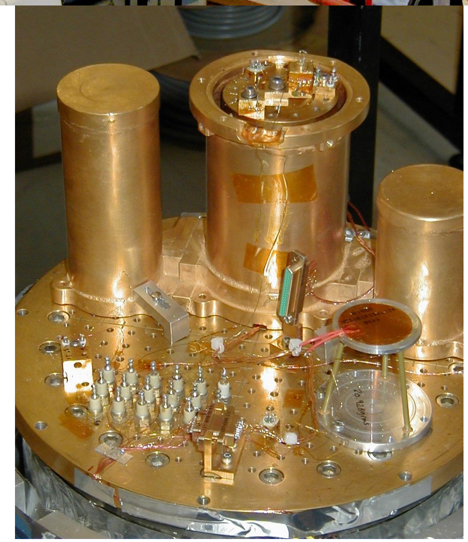
- **IBDR: TBD (November)**

SPIRE

Management

- Instrument Development Manager
  - Eric Sawyer on board as from the beginning of July
  - Ken King remains overall PM and will be the ICC Development Manager
- Operation and organisation of Project Team has been clarified
- Management and project control important issue for consortium meeting
- PI institute is now Cardiff University
  - Matt Griffin and Peter Ade are now Cardiff employees
  - SPIRE and HFI labs. have moved and are now fully operational
  - Filter production and testing activity also now located at Cardiff
  - Same relationship with RAL as before

SPIRE Lab. in Cardiff



SPIRE

Critical Areas and Challenges (as presented at IIDR)

- Stray light minimisation and prediction
    - Potential problem with any low background instrument
    - Systems issue - involves telescope provider, satellite Prime Contractor, ESA, and three instrument teams
    - Early modelling/prediction of photon background is important for SPIRE and PACS
- FPU mechanical/thermal engineering
    - STM programme will provide early verification of performance and mitigate risk
- Mechanisms (esp. FTS)
    - FTS mechanism is challenging with stringent specifications
- Schedule and overall AIT programme for the Herschel satellite
    - SPIRE has issued discussion note on this
- Avoiding a budget-driven descope
    - BSM
    - Flight Spare integration and test

SPIRE

SPIRE Consortium Meeting
4-6 July in Cardiff

Main issues:

- **Project management and organisation**
- **Scientific optimisation (bands, bolometer design, etc.)**
- **First discussion of SPIRE GT programme**
- **Consortium "Scientific Constitution" (draft has been circulated to Co-Is)**
- **Meeting of SPIRE Steering Group**