SPIRE

STATUS REPORT
FIRST Science Team Meeting 6
6, 7 July 2000

- **INSTRUMENT DESIGN UPDATE AND PROGRESS REPORT**
- **OBSERVING MODES**
- **PDR/ISVR COMPLETION AND OUTCOME**
- **ICC DEVELOPMENT**
- **CONSORTIUM WORK BREAKDOWN STRUCTURE AND FUNDING**
- **PHOTOMETER WAVELENGTH BANDS**

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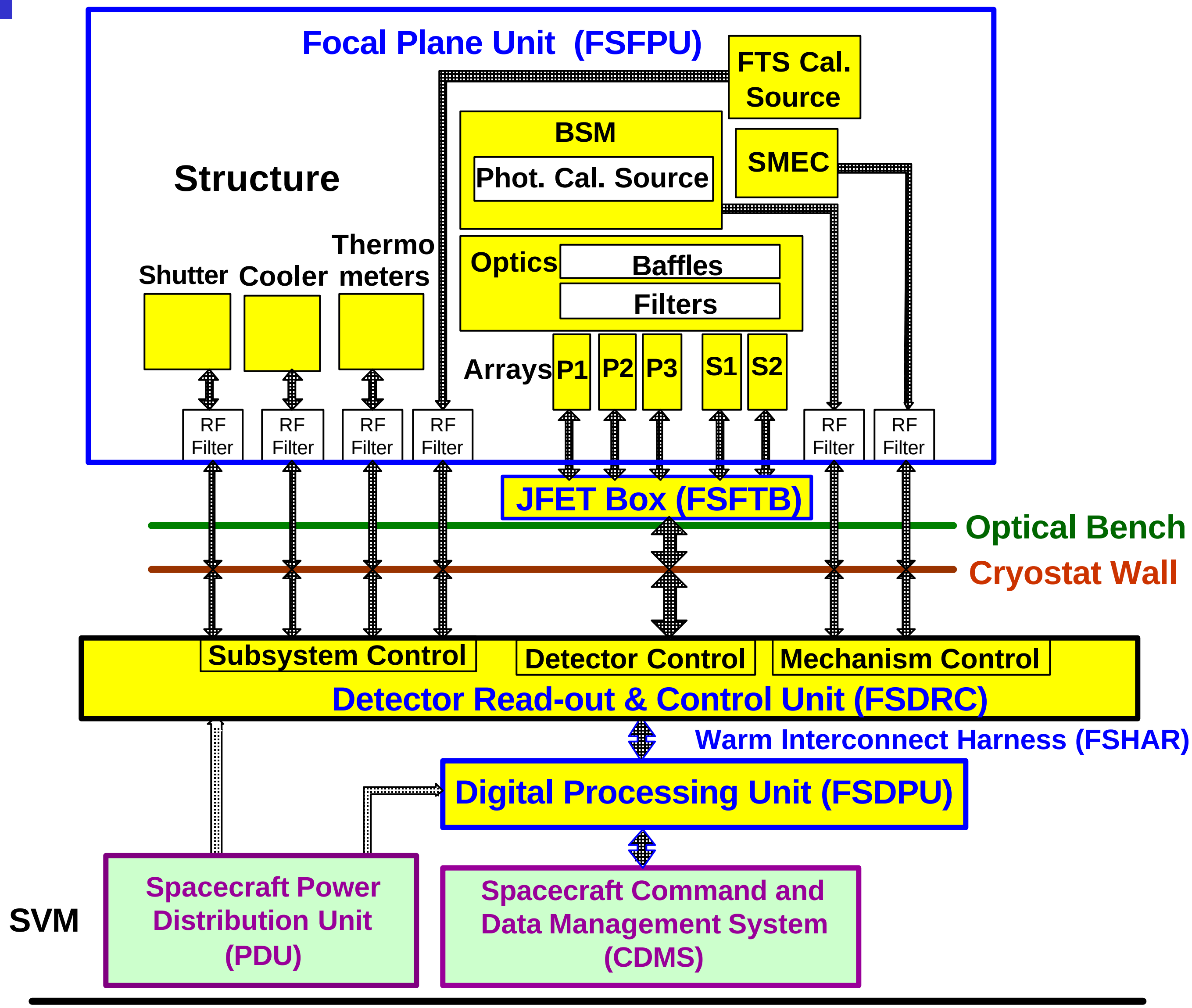
SPIRE Block Diagram



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Design Update

- **Detector selection made in January: feedhorn-coupled NTD bolometer arrays.**
- **Implications for system design have been considered:**
  - **Low number of detectors Þ lower data rate is possible - avoiding the need for data compression**
  - **No microprocessor needed in DRCU for array readout**
  - **Simplified electronics architecture and DPU/DRCU interfaces**
  - **Differential outputs from the JFET amplifiers - evaluation of this has led to the deletion of the BAU but with a tight specification on the cryoharness**

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Design Update (continued)

- **Cryostat interface study results and choice of aluminium for FIRST optical bench Þ stainless steel mounts for the FPU structure**
- **Requirement for an instrument cover at Level 2 (10 K) was reviewed - cover has been deleted as the FIRST optical bench cover performs same purpose**
- **Both these make mechanical interface and integration much simpler**
- **But RF shielding is more complex, especially at the interface between JFET box and FPU**
- **RF filters for mechanism and housekeeping harnesses now mounted inside common structure**

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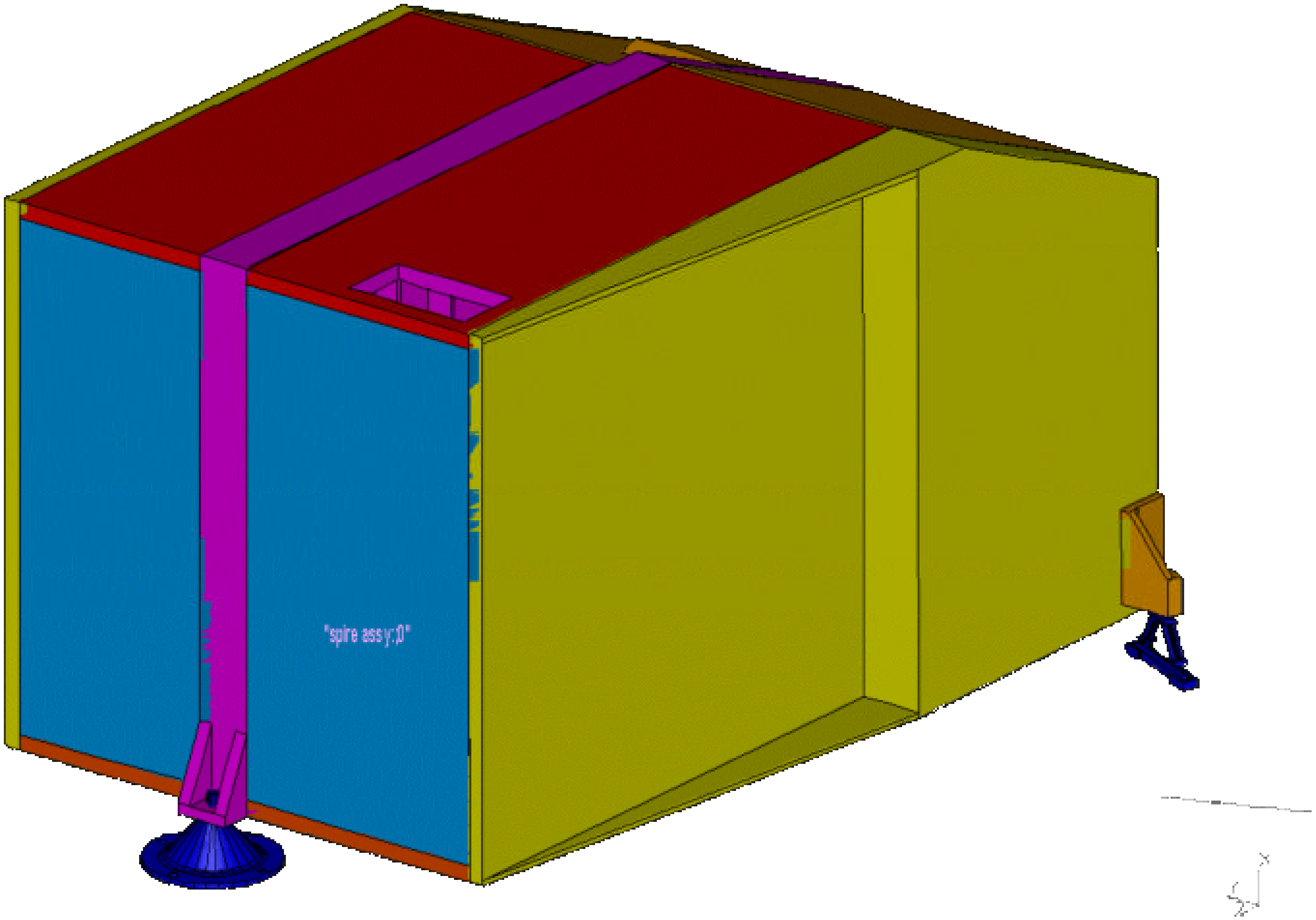
FPU: Outer Cover



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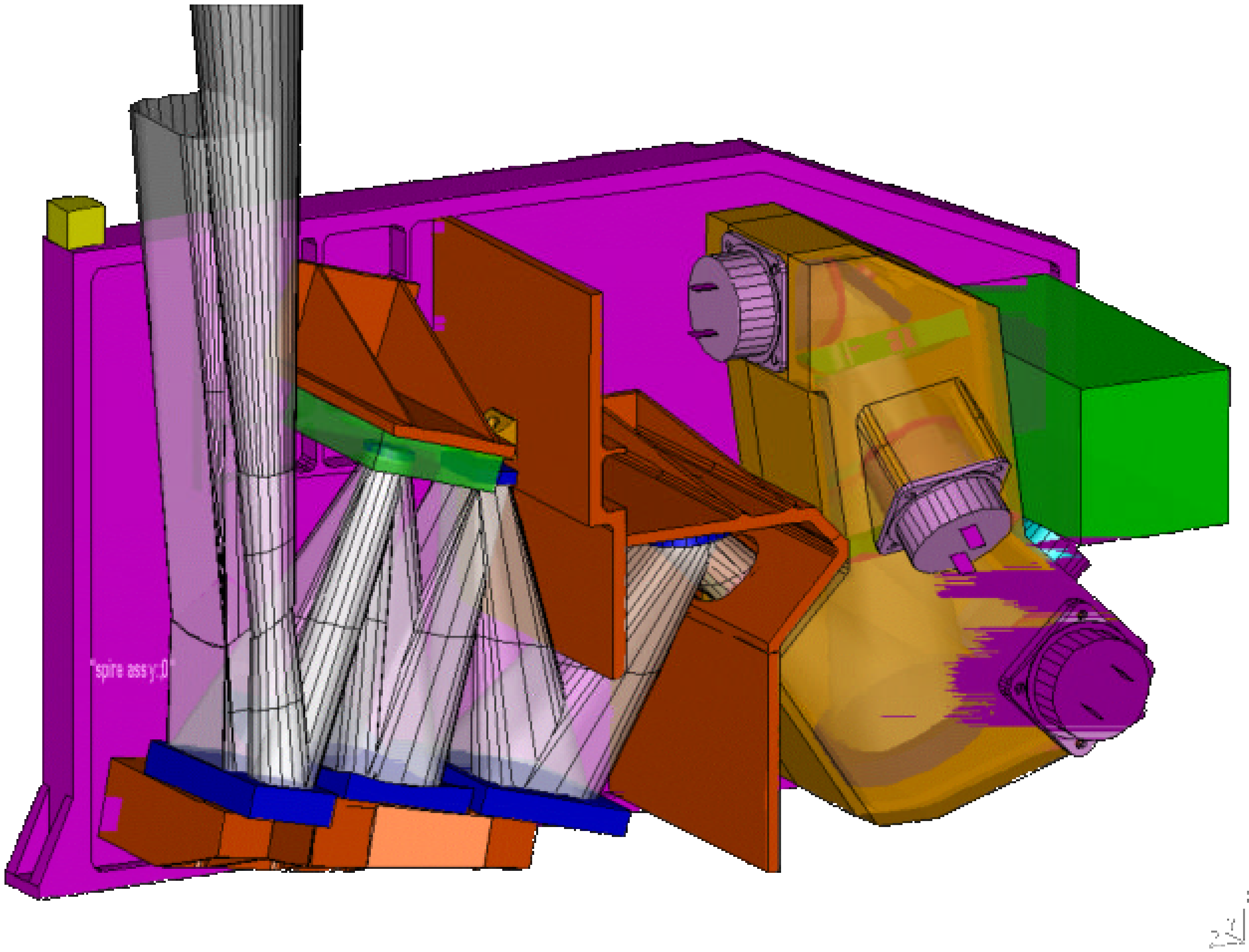
FPU: Photometer



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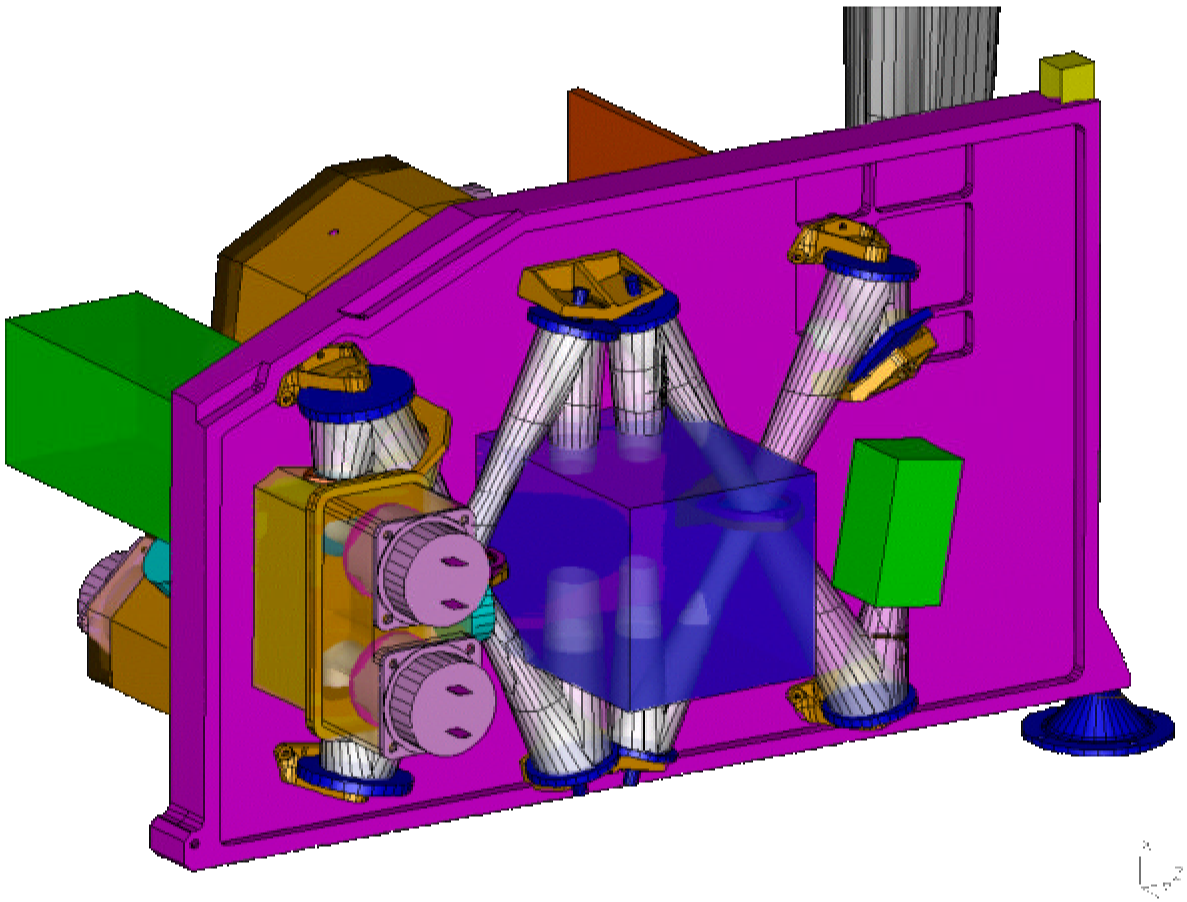
FPU: Spectrometer



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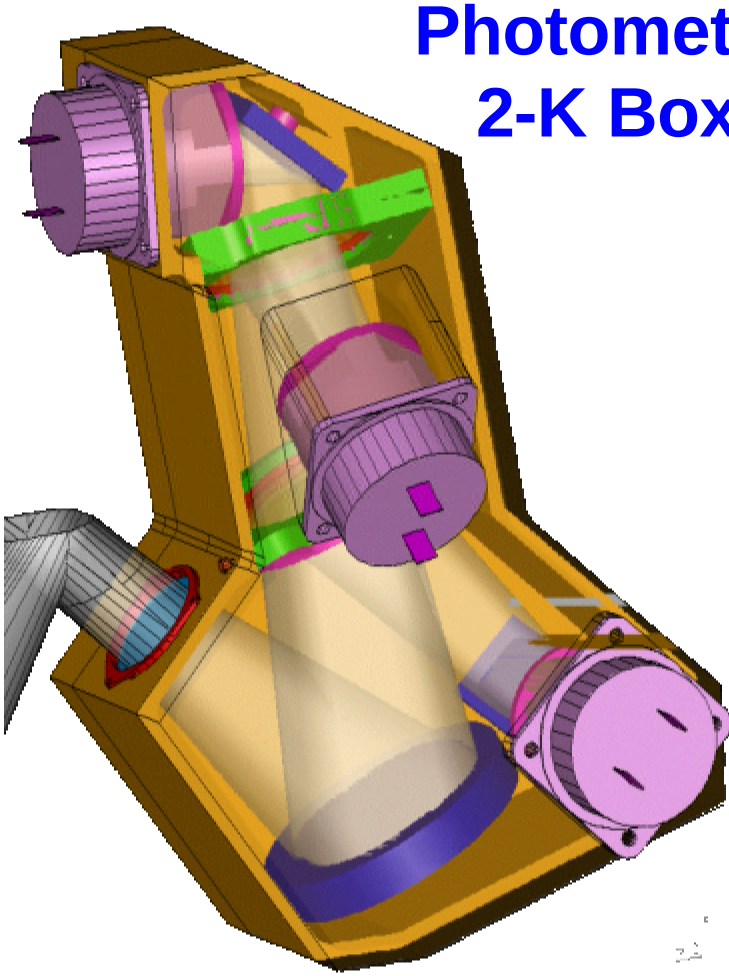
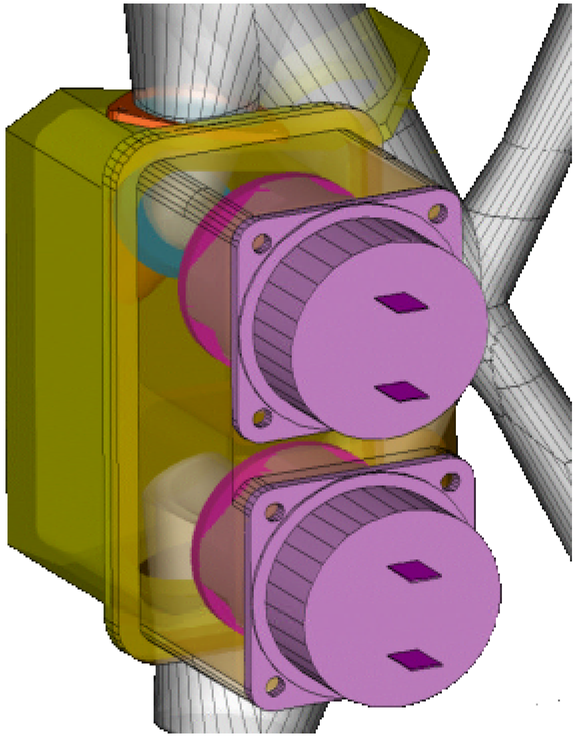
Photometer 2-K Box



Spectrometer 2-K Box



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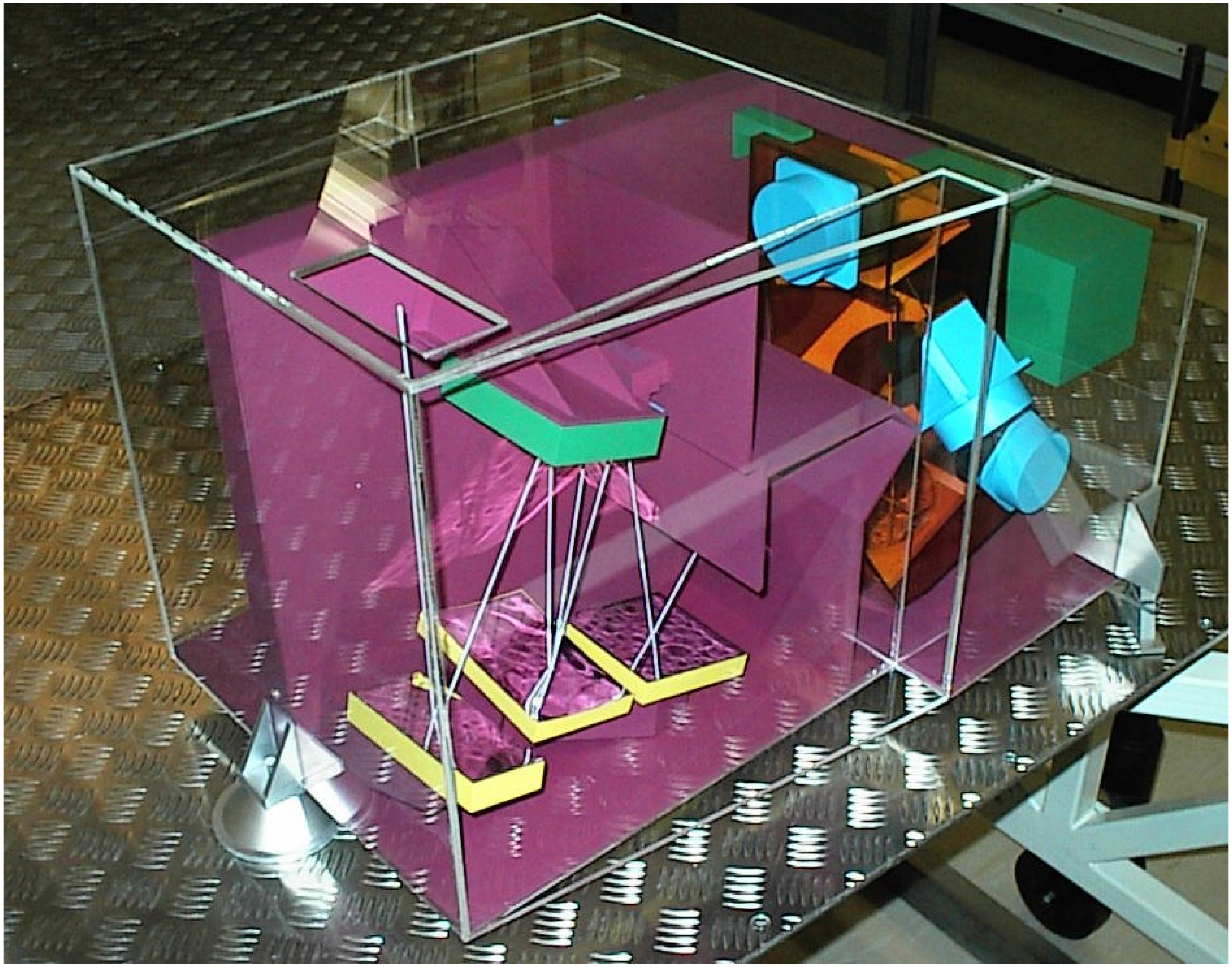
Virtual Reality



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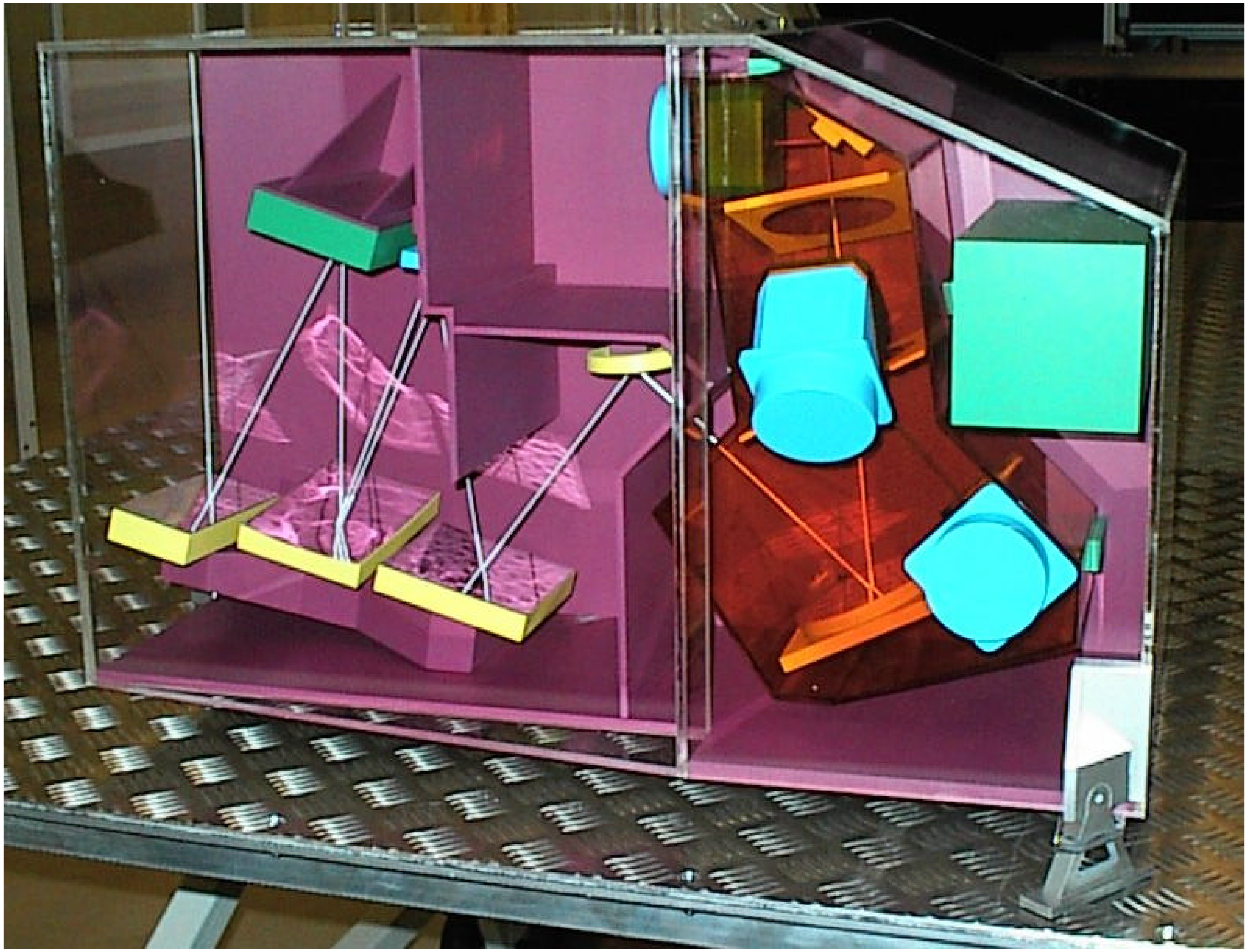
Photometer Side



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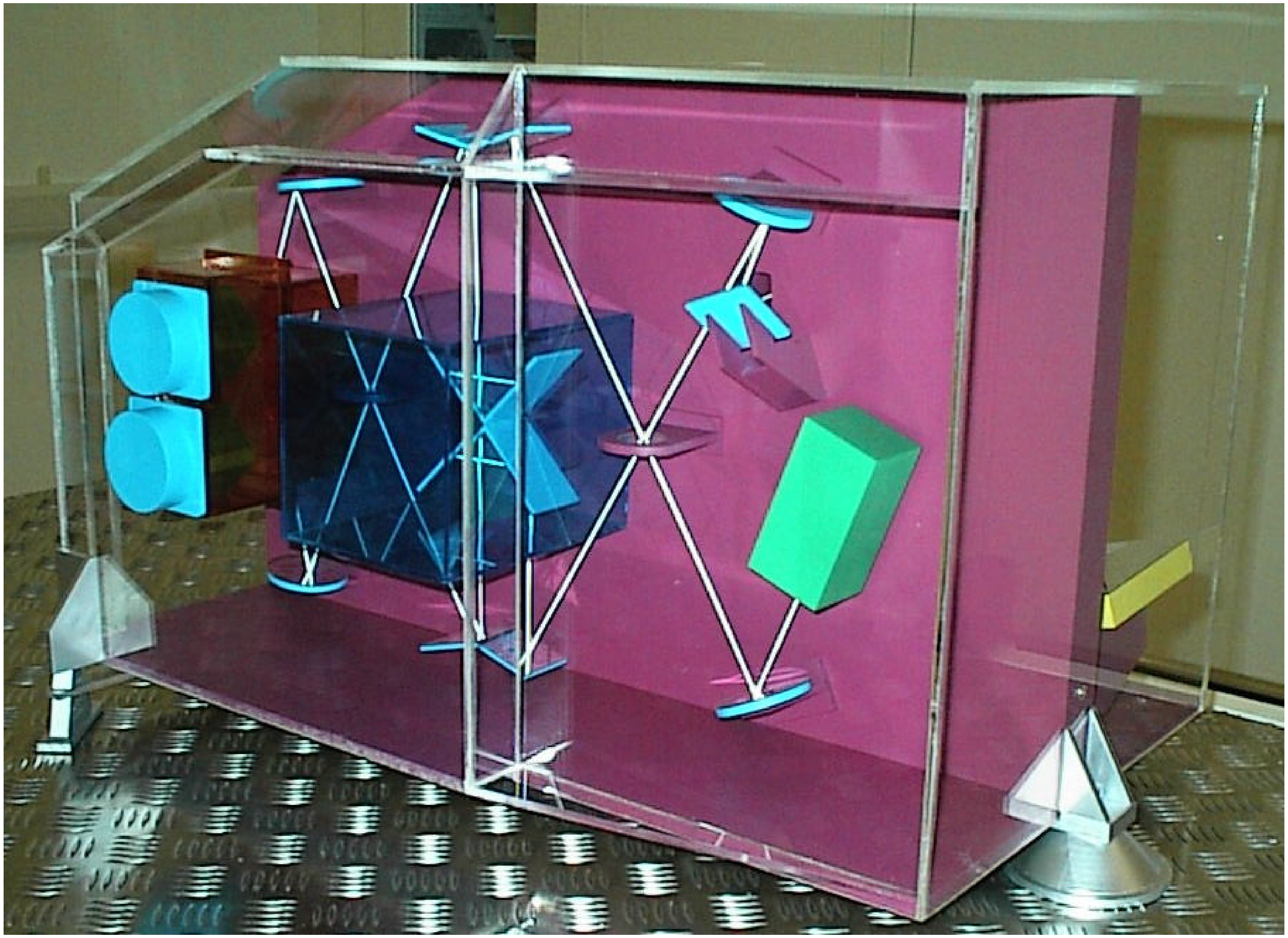
FTS Side



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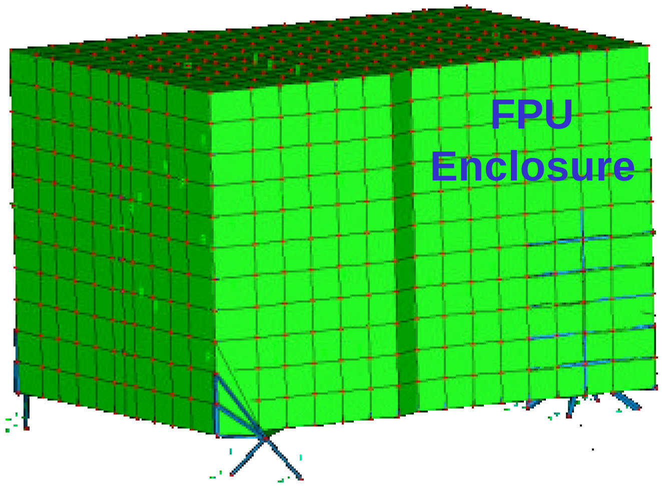
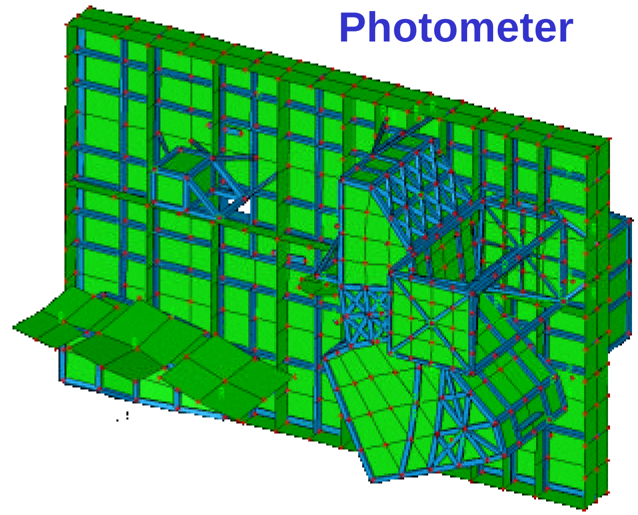
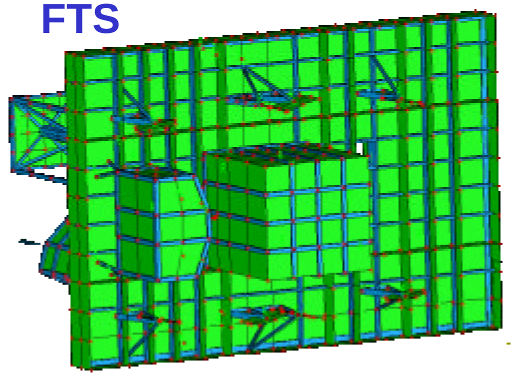
FEA Results - Structure





FTS



f_o = 131 Hz

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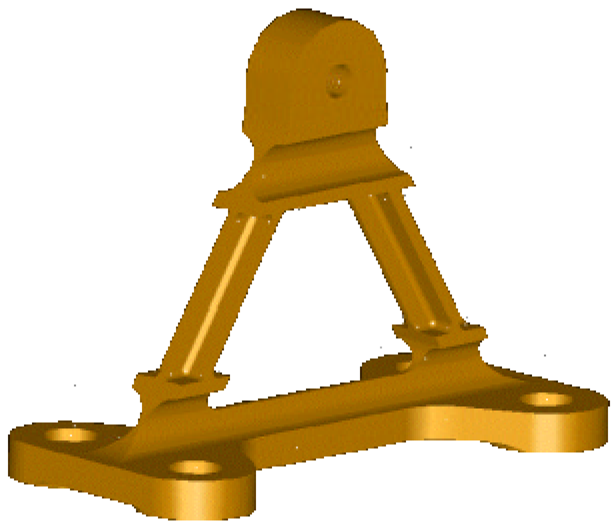
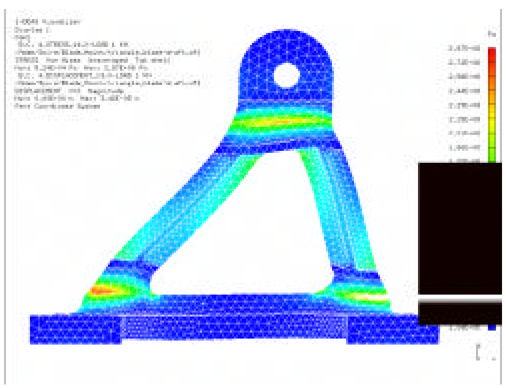
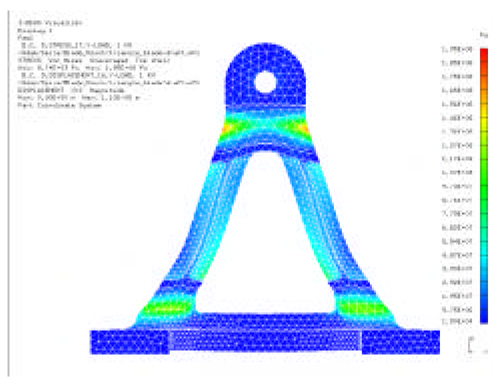
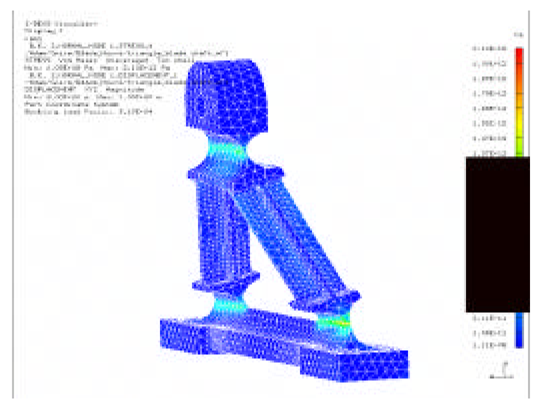
FEA Results: FPU Mounting









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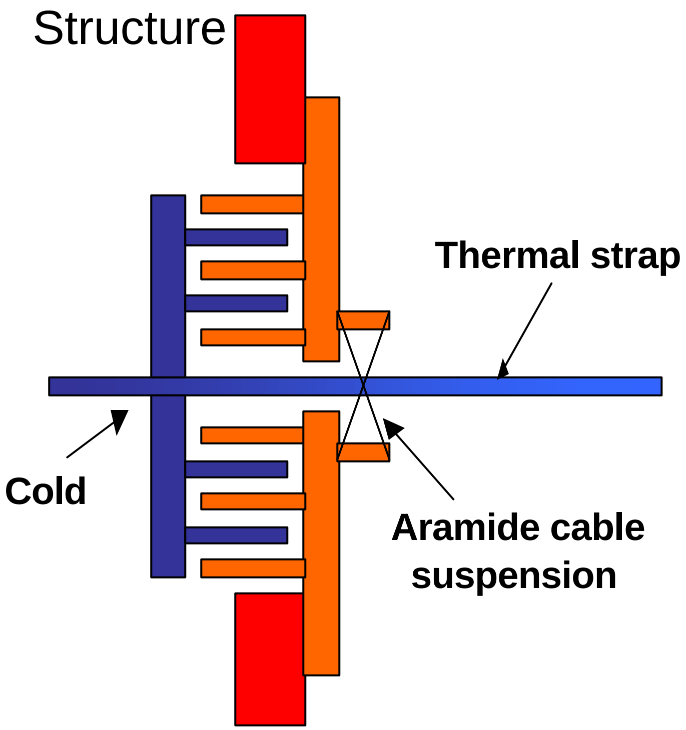
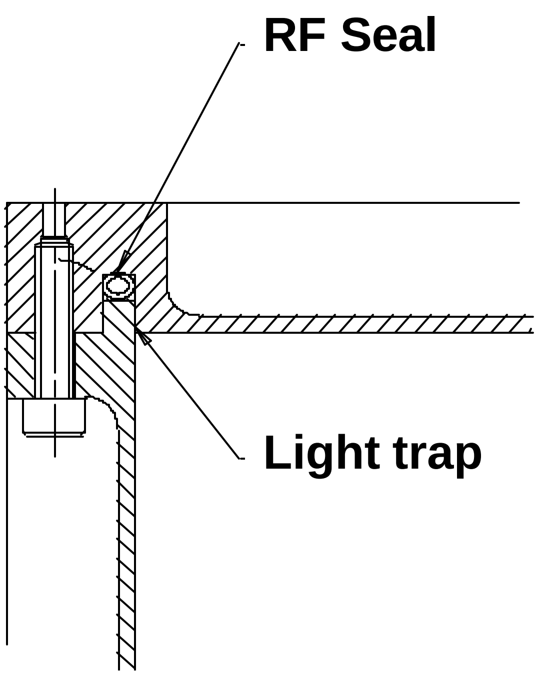
Straylight Baffles and RF Seals



Proposed straylight baffle for thermal straps



Proposed RF seal and light trap

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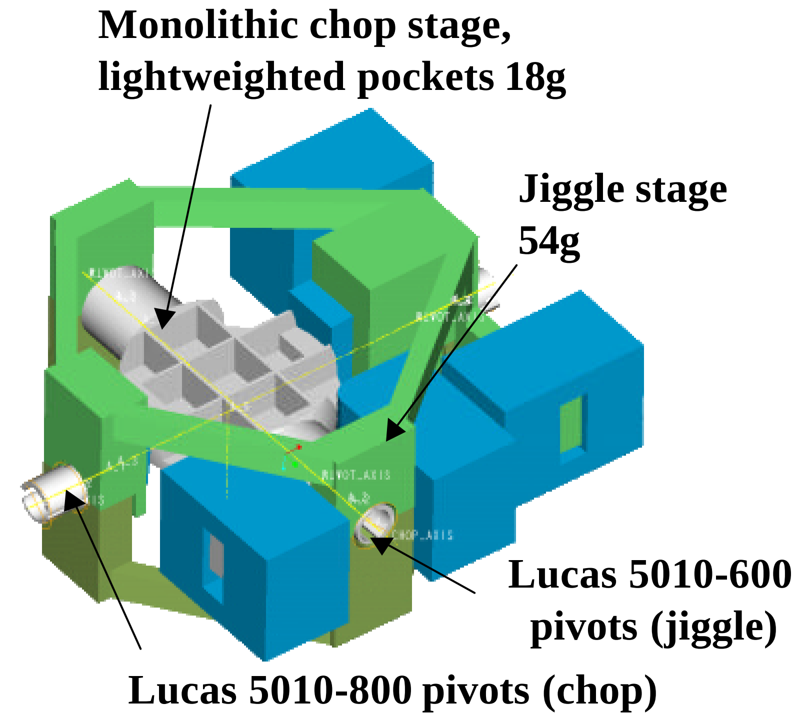
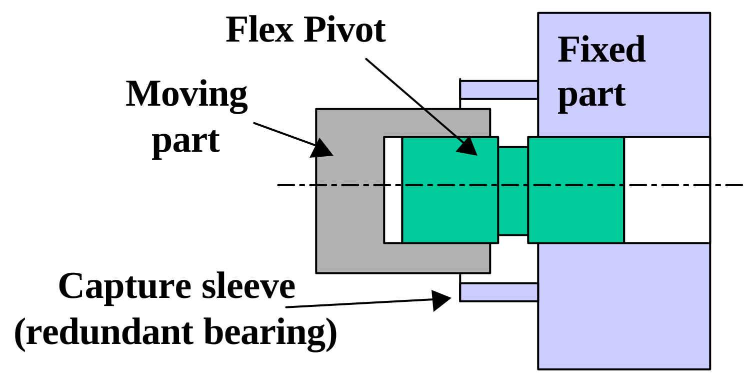
Beam Steering Mechanism

- **Aluminium structure**
- **Motors: design TBD (ISOPHOT or PACS)**
- **Magneto-resistive sensors (ISOPHOT)**
- **Lucas flex pivots**
- **Resonant frequencies**
  - **23Hz (chop); 18 Hz (jiggle)**
  - **1st parasitic resonance at 729 Hz.**
- **Same DSP in the DRCU will control BSM and FTS mechanism**





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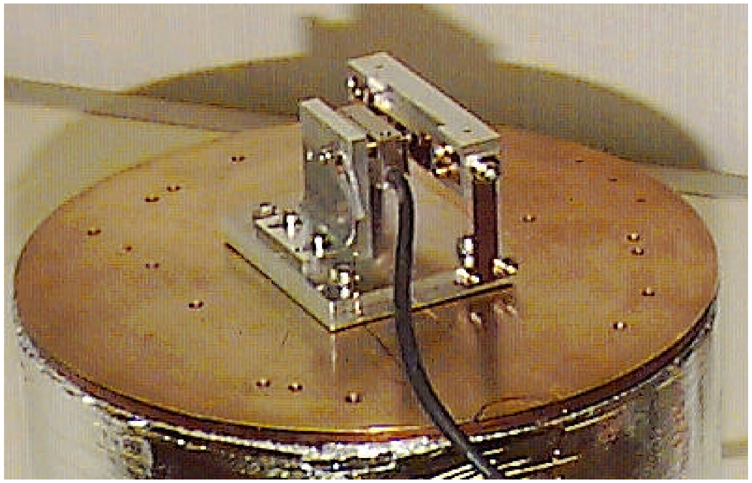
Heidenhain Moiré Fringe Position Sensor



Tests (DESPA/CEA) at 300K and 4 K using standard and modified Heidenhain commercial products

- **Fixed scale and scanning reticle must be of the same material**
- **Scanning reticle must not be stressed by its mechanical housing**
- **Preamplifier as near as possible to the encoder to amplify the encoder output signals**
- **Detailed design, component selection and qualification to be done in 2000 - 2001**
- **Options:**
  1. **Commercial housing with remachined mechanical mounting for the scanning reticle**
  2. **Redesigned housing (not yet clear that Heidenhain is ready to sell the optical components separately)**

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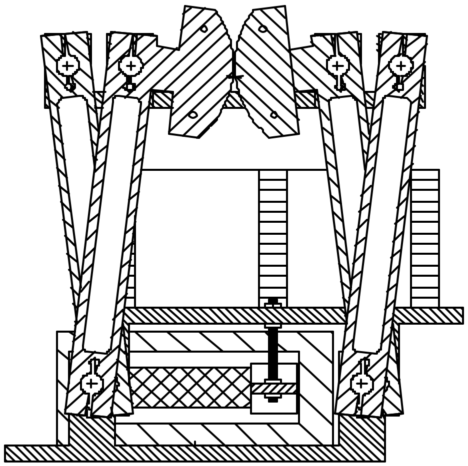
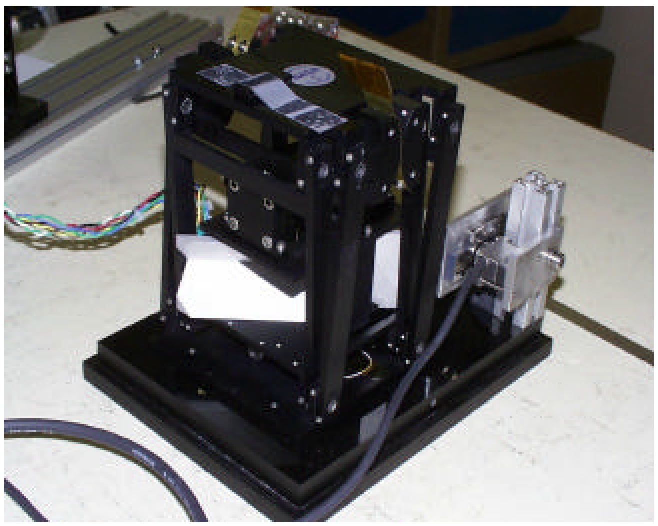
FTS Mirror Carriage

Prototype 1 designed and built by GSFC and tested at LAM





- **Mass and geometry OK**
- **Prototype tested at 300K**
- **Optical encoder successfully mounted at LAM**
- **Control loop closed at up to 20 Hz**
- **Problems with higher resonance frequencies 30, 55, 120 Hz, etc...**
- **Actuator mean power consumption < 100 mW at 300K (est. 1 mW at 4 K)**
- **Protection during launch needed**

Basic design OK

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Instrument Systems Definition

- **Opto/mechanical design nearly complete (detailed definition of aperture sizes, baffle positions and sizes, filter positions to be finalised in next 1-2 months)**
- **Mechanical interfaces being documented – to be complete by October for all major sub-systems**
- **Electrical system architecture is defined, and detailed DRCU/DPU interface definition is in progress – to be finished by October**
- **Detailed specification of DRCU sub-units is in progress**
- **Concept for instrument commanding and operation is being defined**
- **Architectural design for the ground test facility is complete – detailed specification and design now in progress**
- **Requirements on CQM are being defined**

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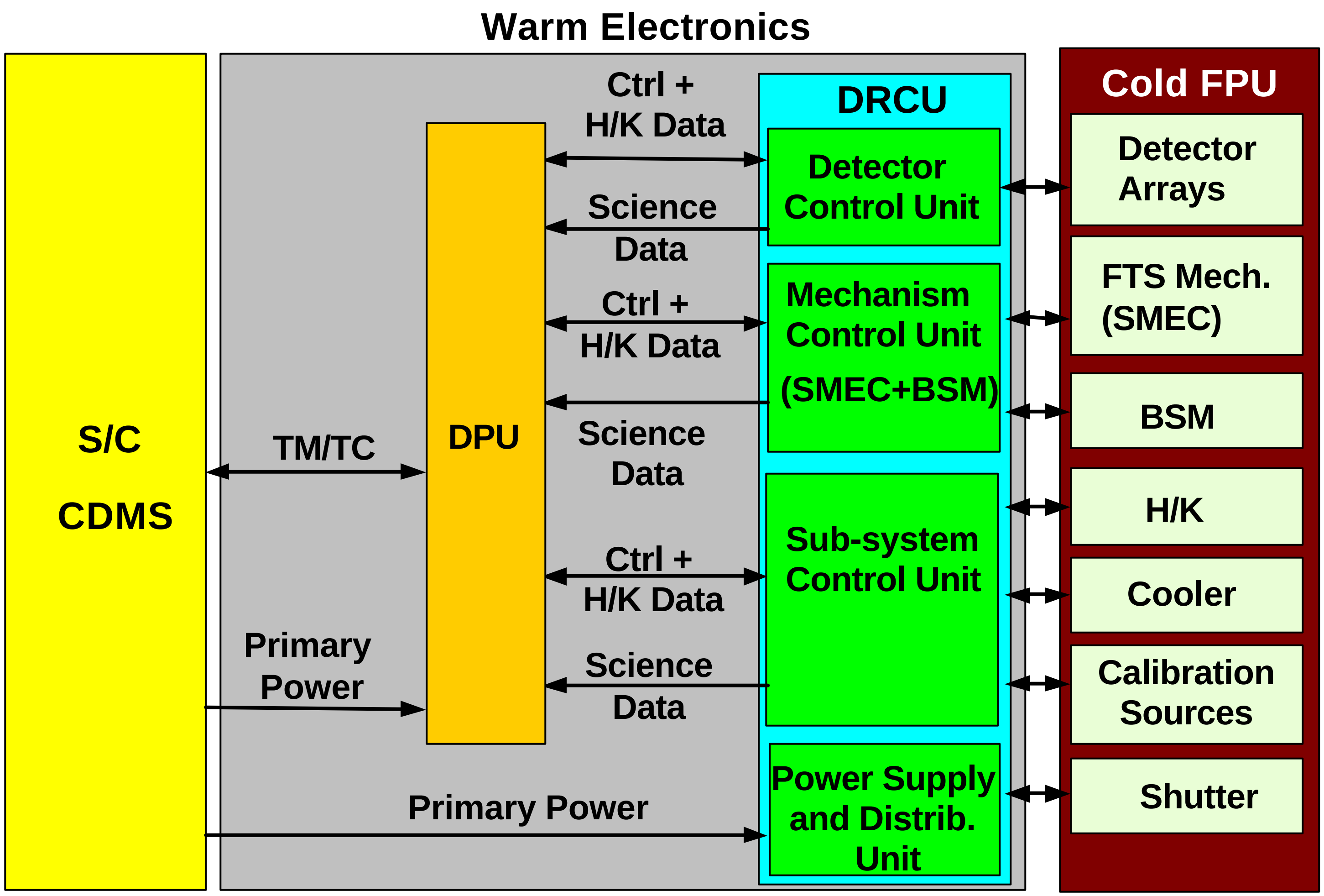
Electrical System Overview



Power Supply and

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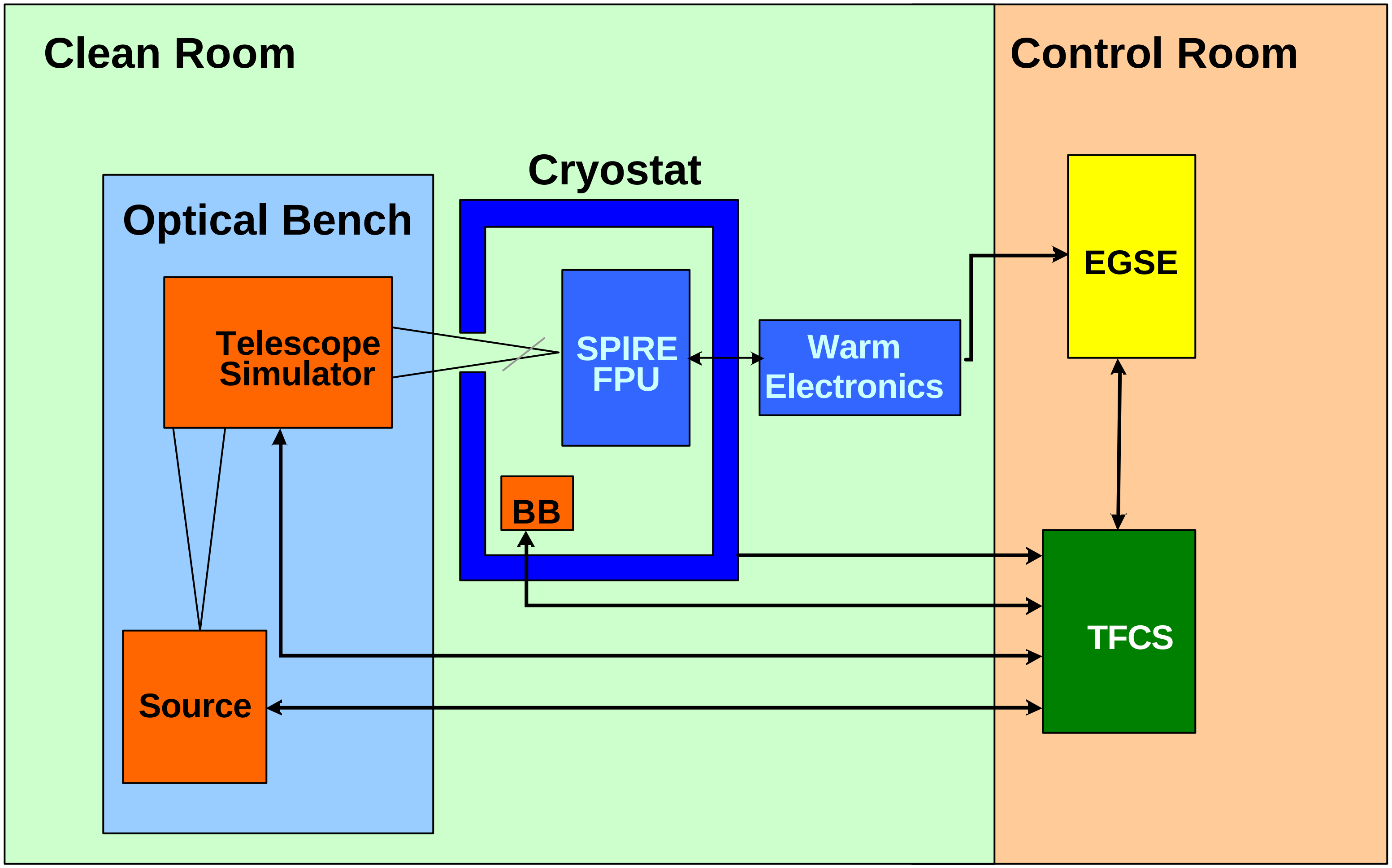
AIV Facility Layout



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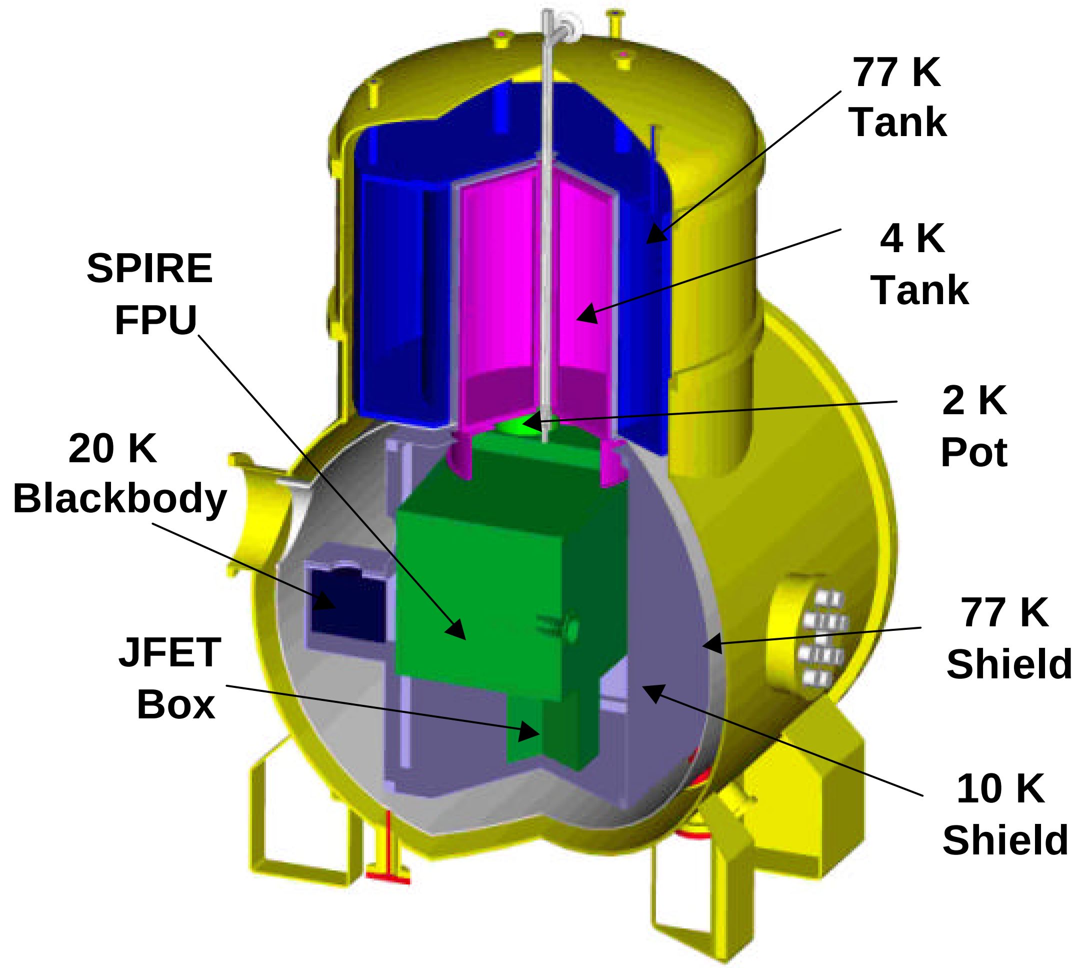
AIV Facility Cryostat



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Observing Modes and Instrument Commanding

- **Operating and observing modes are now well defined (*SPIRE Operating Modes Document*)**
- **Implementation as (not many) AOTs is to be defined**
- **Instrument commanding concept is simple**
  - **Basic operations are by commands sent from CDMS to DPU**
  - **DPU explodes these to give instructions to DRCU**
  - **Number of instructions to DRCU is intended to be as few as possible**

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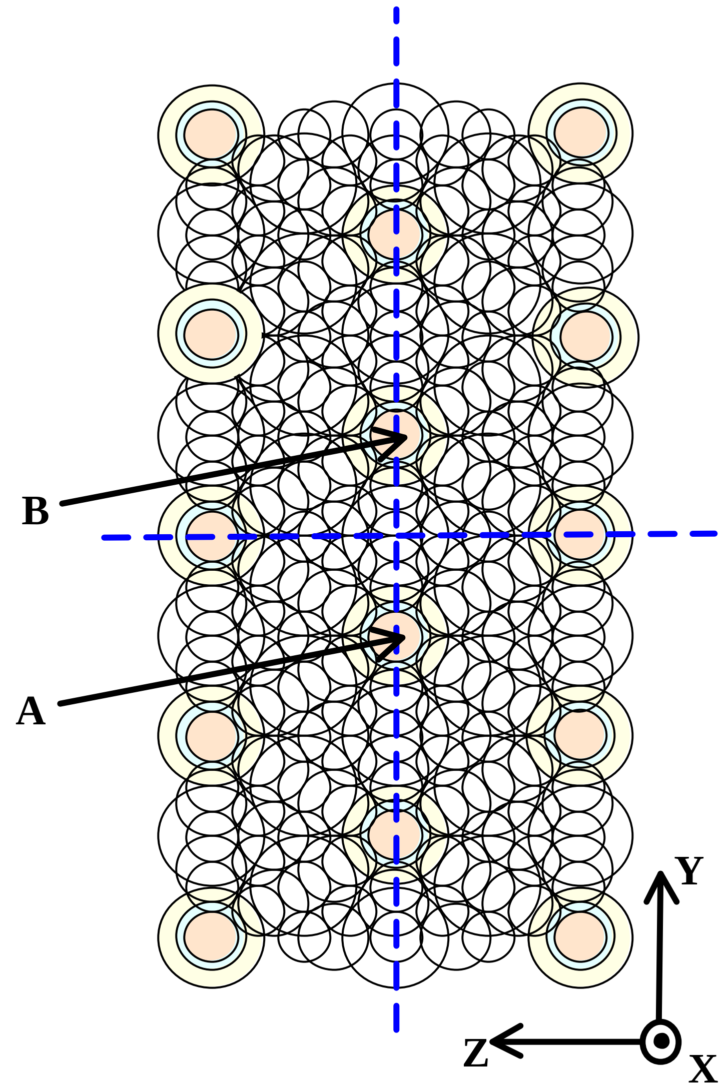
Point Source Photometry (POF 1 or 2)

- **Telescope pointing fixed**
- **SPIRE BSM chopping in Y-direction between A and B (126 arcsec.)**
- **Nominal f_{chop} = 2 Hz**
- **Nodding is optional (nod interval est. ~ 1 - 3 minutes)**
- **POF1 (Chop without jiggling) is OK if the pointing is accurate enough**



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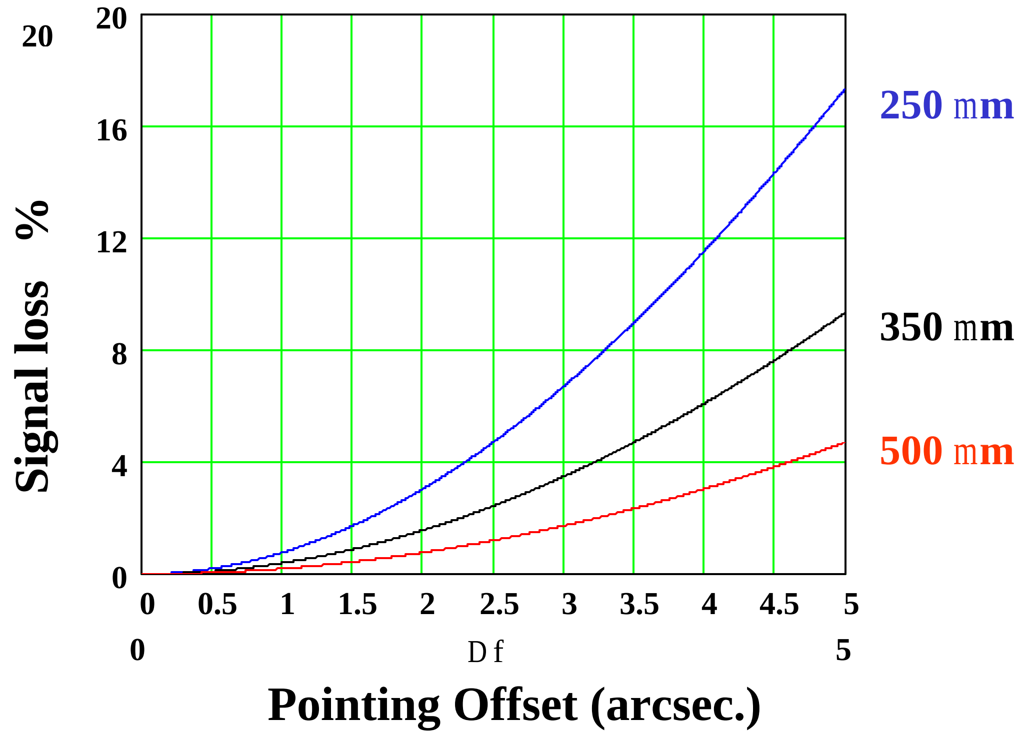
Pointing or Source Position Uncertainties

- **Error of ~ 2 arcsec. or more can result in unacceptable signal uncertainty**
- **Solutions: (a) Seven-point jiggle (baseline) - POF2**
  (b) Peak up using, adjust pointing, then chop without jiggle (POF1)
  (c) Good pointing accuracy (goal of 1.5” is OK)



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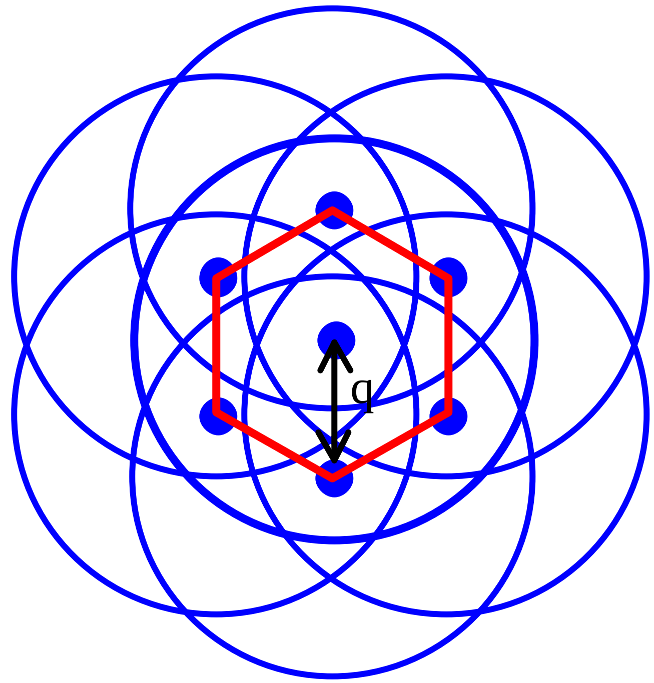
7-point Jiggle Map (POF2)

- **SPIRE BSM chops 126" as for POF1**
- **BSM also does 7-point pattern**
- **Angular step q ~ 4-6 arcseconds (> APE)**
- **Total flux and position can be fitted**
- **Compared to single accurately pointed observation, the S/N for same total integration time is degraded by**



~ 20%	**at**	**250 mm**
~ 13%	**at**	**350 mm**
~ 6%	**at**	**500 mm**

This ignores time needed for peak-up so degradation is actually less

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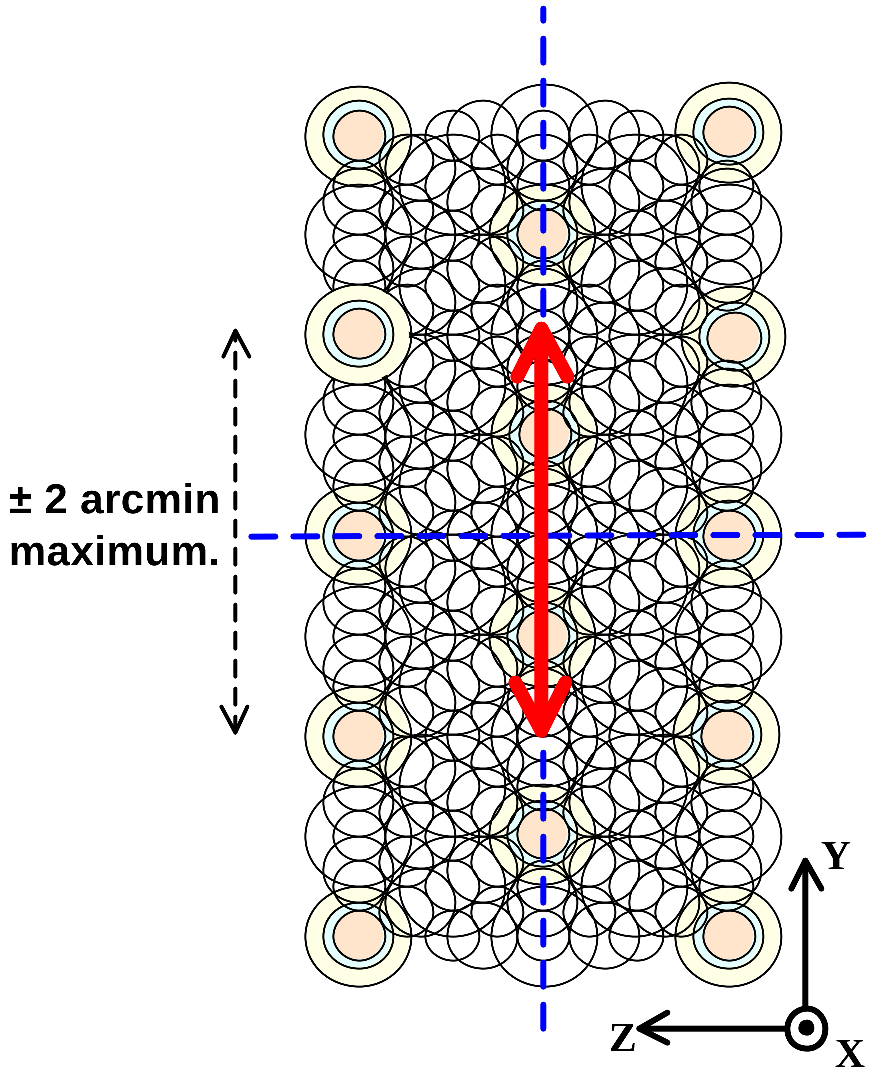
Field Mapping

- **Telescope pointing fixed (POF3) or in raster mode (POF4)**
- **Nodding is optional**
- **SPIRE BSM chops up to 4 arcmin amplitude in Y direction at ~ 2 Hz**
- **BSM also executes 64- point "jiggle" pattern at ~ 1 Hz for full spatial sampling**
- **Minimum duration ~ 1 min.**
- **Telescope pointing accuracy is not a problem**



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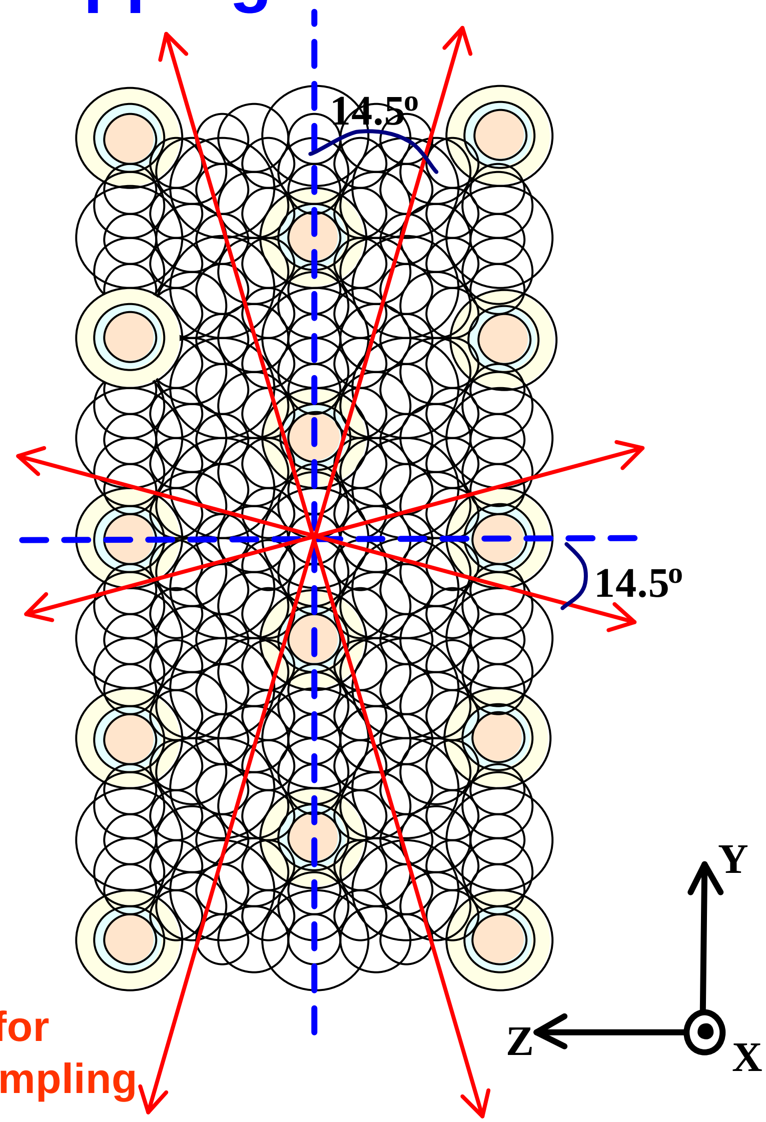
Scan Mapping

- **Telescope in line scanning mode, with scan direction in spacecraft coordinates**
- **BSM can be off (POF5) or chopping (POF6)**
- **Scan rate TBD (likely 5 - 60 arcsec/sec.)**
- **Maximum scan length: 20°**
- **Map of large area is built up from overlapping parallel scans**



Scan directions for instantaneous full sampling

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FTS: Point Source Observation (SOF1)

- **Telescope <u>already accurately pointed</u> with the source on the central pixel**
- **FTS mirror is scanning**
  - **Scan length sets spectral resolution**
  - **Number of scans sets integration time**
- **If telescope pointing accuracy not adequate, then:**
  - **SOF1 must be preceded by photometer peak-up (POF7)**

    or

  - **SOF2 must be implemented**

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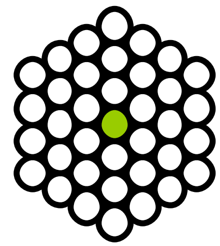
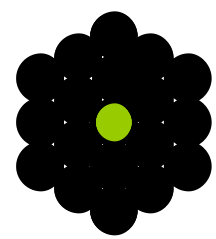
FTS: Map (SOF2)

- **Telescope pointing fixed**
- **Spectral scans taken at a number of BSM positions**
- **Point source:**
  BSM pattern is 5- or 7-point to allow for pointing error
- **Extended source:**
  BSM pattern is as for N-point jiggle to provide full sampling over the 2.6-arcminute field

200-300 μm
37 detectors



300-670 μm
19 detectors



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SPIRE PDR/ISVR

Phase 1: 7-9 July 1999 at RAL

- Scientific Requirements and Instrument Requirements
- FPU system design
- Detector array modules: thermal/mechanical design
- ^{3}He cooler
- Optics and filters

Phase 2: 6, 7 December 1999 at IFSI

- Warm electronics

Phase 3: 29 Jan. - 2 Feb. 2000 at RAL

- Detector Array Selection meeting

Phase 4: June 26, 27 2000 at SAp

- Review of all items not previously covered
- Update on design progress/changes
- Review of Instrument Development Plan and schedule

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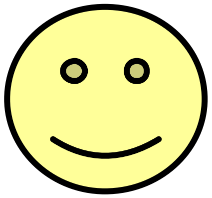
PDR Outcome (Informal Feedback)

- **SPIRE ISVR is deemed to be successfully completed**
- **Areas in which SPIRE is regarded as in good or satisfactory state**
  - **Optical design and diffraction analysis**
  - **Design status of many subsystems**
  - **FPU mechanical analysis**
  - **Thermal analysis**



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Serious Concerns (in order of importance)

- **Project/Systems Engineering Team is understaffed and not working effectively**
- **Development schedule**
  - **Complete bottom-up schedule only now available for the first time - not yet conolidated or consistent**
  - **Lack of margin - margins with respect to the required delivery dates must be found**
- **Funding status**
  - **Need to make sure that the above problems are covered**

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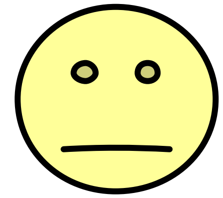
Other Concerns/Items Needing Attention



- **Instrument *Design Description Document* should be drawn up and kept up to date**
- **Comments will be made on the *Science Requirements Document***
- **Documentation Tree, especially related to Systems Engineering: e.g., can the large number of ICDs be reduced?**
- **Black coatings: can all FIRST instruments use the same material?**
- **Important information requested by SPIRE:**
  - **microvibration environment**
  - **cryoharness implementation for AIV facility**
  - **cryostat thermal model**
  - **telescope design, etc.**

  Noted by ESA and information will be provided.

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Review Board Report and Follow-up

- **Report will be issued in ~ two weeks**
- **RIDs will be raised for various particular items (around 20)**
- **Other minor comments will be made informally**
- **Some issues will require closure soon:**
  - **Failure mode analysis**
  - **Software instrument simulator**
  - **Desirability/feasibility of PACS-SPIRE parallel mode**

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SPIRE Response to Major Concerns

- **UK Project Team:**
  - Experienced Instrument Systems Engineer to be appointed, based at RAL
  - Possible additional hire of assistant to Instrument Scientist and Systems Engineer
  - Systems Engineering participation by SAp and JPL
- **Development Plan and Schedule:**
  - Will be examined/iterated to establish consistency and margin where possible
  - CQM programme is being re-examined in an effort to establish margin (but must avoid increasing risk or descoping ability to verify scientific performance)
- **Funding status**
  - Priority will be given to above issues, within current funding constraints

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Detailed Design Review Plan

- **October 2000: Formal review (3 days)**
  - **Instrument System Design**
  - **Freezing of all interfaces**
  - **Qualification status and plans**
  - **Subsystem Development Plans**
  - **Identification of long lead time items**

- **October - Feb. 2001: series of specific technical reviews**
  - **Structure, Optics, Cooler**
  - **Detector arrays and calibrators**
  - **Warm electronics**
  - **FTS mechanism, Beam Steering Mirror, Shutter**
  - **AIV and Ground Calibration facility (including EGSE)**
  - **On-Board Software**

  Each of these to release the subsystems for manufacture

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ICC Definition

- **The SPIRE ICC Definition Team has decided to design the ICC using the Object Oriented (OO) approach**
  - **Efficiency, adaptability, re-useability**
  - **Proven concept - e.g. ORAC (Observatory Reduction and Acquisition Control)**
  - **Approach being used by other ICCs, FSC and for the common ground segment**
  - **FINDAS will be OO so software should be OO**
  - **It's what the programmers will like**
- **Timetable:**
  - **End of July:** **Drafts of ICC URDs**
  - **End of September:** **First versions of ICC URDs**
  - **End of October:** **URDs broken down into use-cases**
  - **End of October:** **Work-packages and costings from use-cases**

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ICC URDs in Preparation

1.	ICC as a whole system	Neal Todd
2.	Photometer processing	Walter Gear/Seb Oliver
3.	FTS processing	Jean-Paul Baluteau
4.	AIV requirements (ILT, IST etc)	Bruce Swinyard/Ken King
5.	Calibration requirements	Seb Oliver
6.	Instrument operation	Gillian Wright
7.	SPIRE consortium	Seb Oliver
8.	FSC	Neal Todd
9.	Astronomical Obs. preparation	Marc Sauvage
10.	Other ICCs	Marc Sauvage
11.	MOC	Trevor Dimbylow
12.	Instrument engineering	Gillian Wright
13.	Public	Seb Oliver
14.	Common Uplink System	Sunil Sidher
15.	On board software	Sunil Sidher
16.	Interface with simulations	Marc Sauvage

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Funding and Management

- UK
  - Adjustments to UK/JPL programmes will need to be accommodated within fixed UK funding envelope
  - Review and revision of UK programme by September (for endorsement by UK FIRST/Planck Steering Committee)
- France:
  - CNES/CEA funding for SPIRE FTS, DRCU, and ^3He cooler is confirmed
- USA:
  - Peer review on June 8 chaired by G. Rieke
  - Recommendations being addressed (revision of UK/JPL programmes)
  - FIRST/Planck CRR to take place July 18-20
- Canada:
  - Support for shutter and ICC staff effort confirmed
  - G Davis + U. Sask engineer are now visiting UK working on the specification and interfaces
- Others: No change

MoUs are to be drawn up for all participating countries

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Changes to SPIRE Work Breadown Structure

- **Warm Electronics Management and Integration to be done in UK (RAL)**
- **Detector array modules to be delivered directly to RAL by JPL**
  - **UK (QMW) will support the JPL programme**
    - **Test facility design, build and commissioning**
    - **Manpower support for JPL tests**
    - **Feedhorn modelling and testing**
- **UK will build the JFET enclosure**
- **UK (QMW) will take over the Internal Calibrators subsystem (from GSFC). GSFC may provide thermal sources.**

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Photometer Bands

- **Proposal:** **Change the photometer bands to provide wider wavelength coverage**

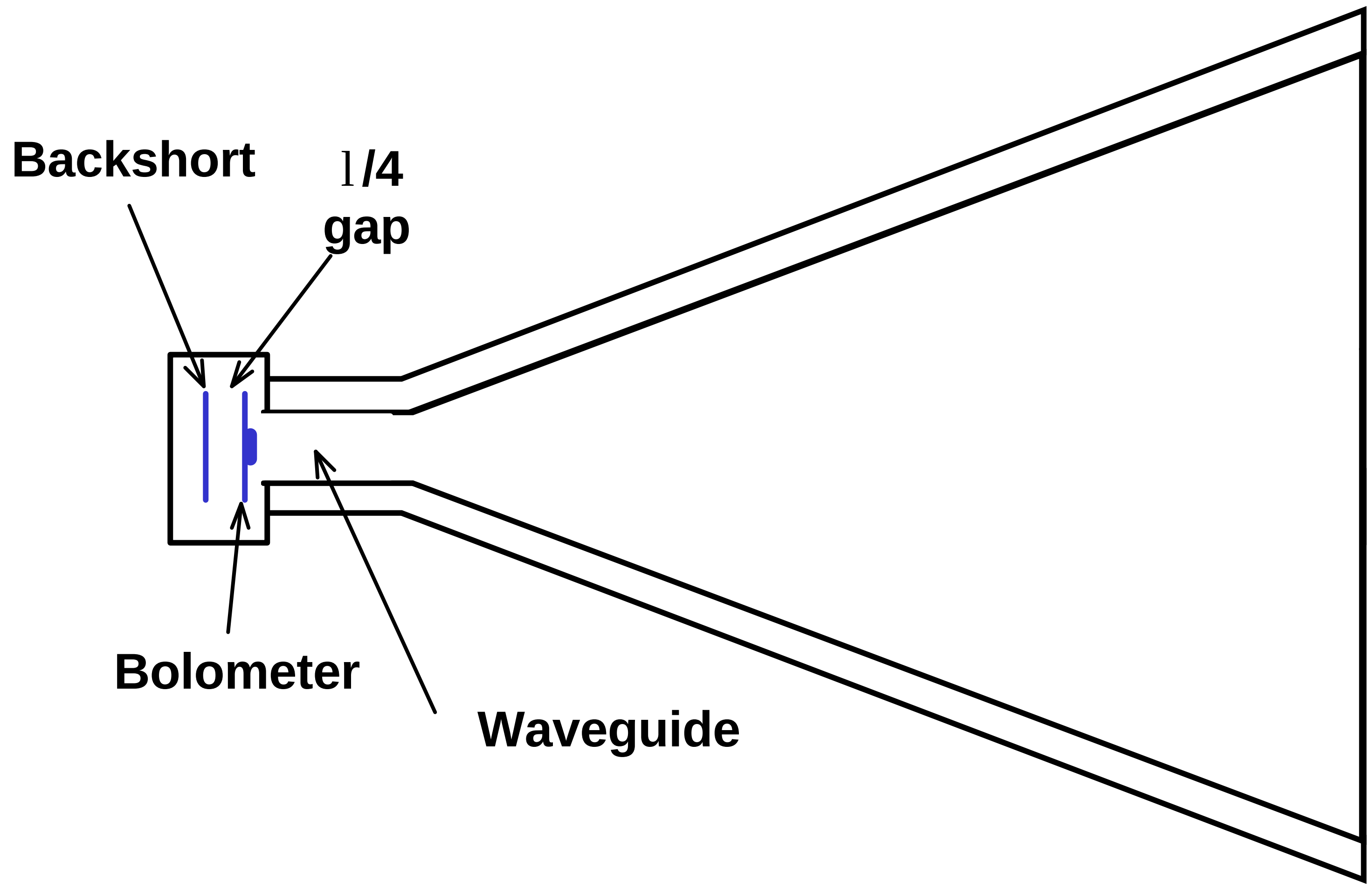
Current	**:**	**250**	**350,**	**500 μm**
Proposed	**:**	**250**	**350 or 425**	**600 μm**

- **Advantages:**
  - **Possibly improved ability to identify high-redshift galaxies from SPIRE colours**
  - **Ability to detect S-Z increment**

- **Disadvantages:**
  - **Larger beamwidth (43” at 600 μm vs 36” at 500 μm)**
  - **Lower sensitivity**
  - **Some loss of field due to vignetting**

- **Constraints:**
  - **Minimal change to FPU design (arrays and filters only)**
  - **No change to the design of any other subsystem**

Modifications to Feedhorn and Bolometer Backshort



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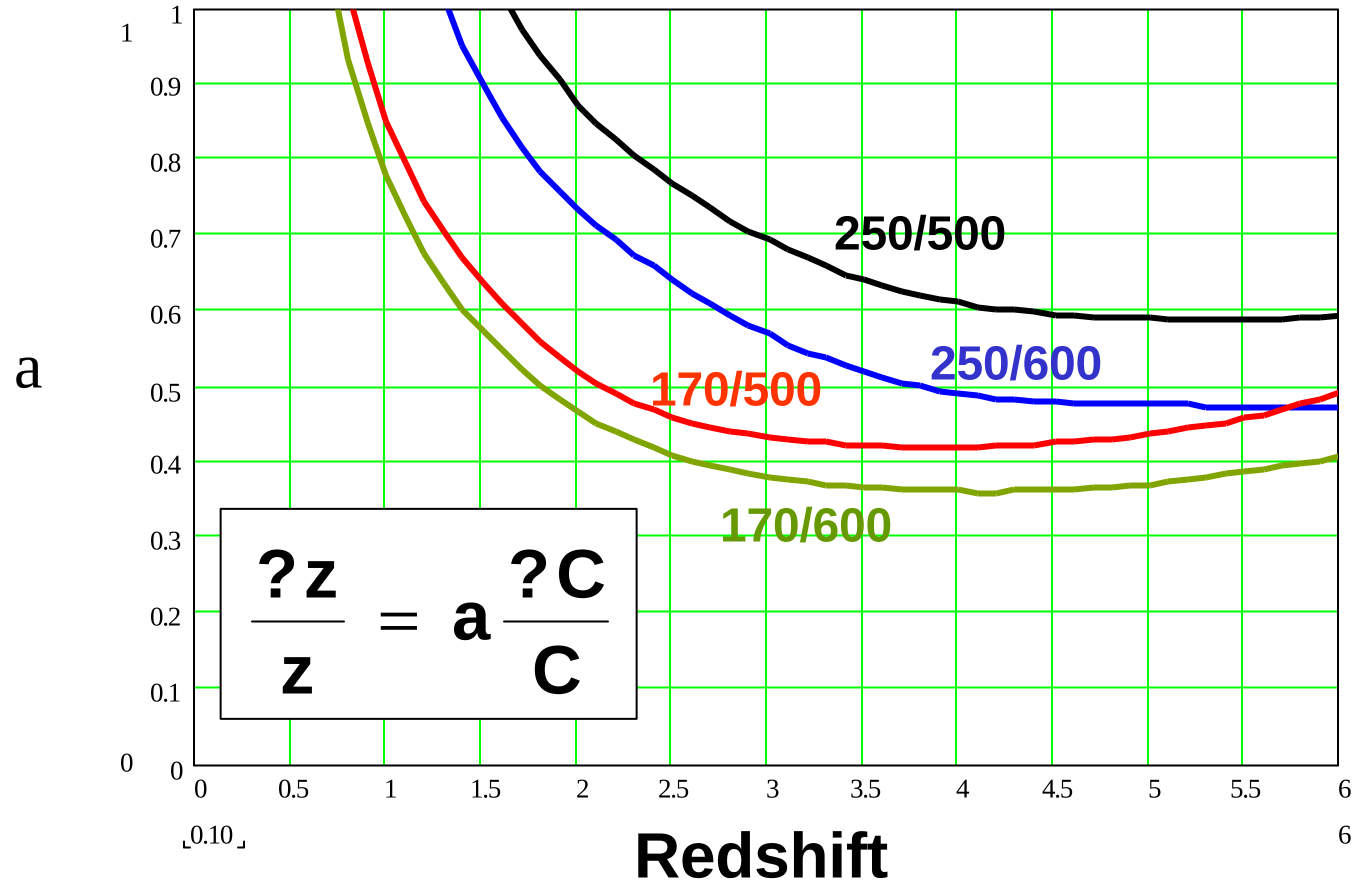
Redshift Discrimination (Starburst-type SED)



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Preliminary Conclusions

- **Could change 500 μm to 600 μm with little or no impact on other aspects of the design or on the observing modes**
- **Mapping speed would be reduced and 600 μm confusion limit is lower ⇒ smaller area surveys**
- **No change for CQM**
- **Issues to be studied:**
  - **Diffraction losses, vignetting (field loss) at 600 μm**
  - **Stray light performance at 600 μm**
  - **Detector sensitivity at 600 μm**
  - **Scientific advantages (?) and technical trade-offs**