Minutes of SPIRE Detector Array Group Meeting
Saclay, September 29, 30 1999

Attendance:

Patrick Agnese	CEA/LETI
Jean Louis Augueres	CEA/SAp
Jean-Paul Baluteau	LAS
Jamie Bock	JPL
James Caldwell	GSFC
Christophe Cara	CEA/SAp
Colin Cunningham	UKATC
Eric Doumayrou	CEA/Sap
Lionel Duband	CEA Grenoble (day 2)
Matt Griffin	QMW
Peter Hargrave	QMW
Viktor Hristov	Caltech
Ken King	RAL
Jerry Lilienthal	JPL
Jerome Martignac	CEA/SAp
Harvey Moseley	GSFC
Seb Oliver	Imperial College (day 2)
Vincent Reveret	CEA/SAp
Juan Roman	GSFC
Rick Shafer	GSFC
Sunil Sidher	RAL
Bruce Swinyard	RAL
Neal Todd	Imperial College (day 2)
George Voellmer	GSFC
Berend Winter	MSSL

Note: These minutes are to be read in conjunction with the viewgraph package (Annex A), which contains most of the detailed information.

1. Aims of the meeting; status of FIRST and SPIRE; future meetings (Matt Griffin)

1.1 Aims of the meeting

The aims of the meeting were summarised as follows:

- to review the technical status of the array options
  - test results
  - readiness for final test phase
  - system design
- to plan the final phase of the array test programme
- to prepare for the Warm Electronics Review in early December
- to review status of instrument modelling and simulation work
  - major results so far
  - agree programme leading up to detector selection meeting

1.2 Status of FIRST

- The available data rate (averaged over 24 hrs) per instrument is now 100 kbs - not as high as the 200 kbs that we hoped for. An increase in this figure would reduce our on-board processing needs.

- The Dornier Cryostat Interface Study has started. It appears to be very limited in scope, involving no radical re-examination of the cryostat design. The study will examine problems with interfaces associated with the detector options, making it important that we participate and clarify our cryoharness needs. This applies in particular to the TES option. The next study progress meeting will be in Ottobrun, near Munich, on October 20.

1.3 Status of SPIRE

- July PDR Phase 1 was a success overall
- The Review Board report has been received and SPIRE has responded to it (the document is on DMS)
- The PDR plan has been revised (see Ken King's presentation)
- The FTS options narrowed down (see Bruce Swinyard's presentation)
- The detailed optical design and layout now available
- The division of the focal plane between the three FIRST instruments is now finalised
- Areas in need of urgent attention are
  - Electronic system designs of array options
  - Operating modes and their implications for the warm electronics

1.4 Schedule of future meetings

• Warm Electronics Review	Dec. 6, 7	Rome	(PDR Phase 2)
• Detector Array Selection Meeting	Jan. 31/Feb. 1	RAL	(Detector System PDR)
• PDR Completion	March 2000	TBD	
• Detailed Design Review	Sept. 2000	RAL	

2. SPIRE Review Plan (Ken King)

The SPIRE review plan was summarised, including the purposes and dates of the major reviews. In the short term, the need to complete the Detailed Design Review a matter of six months after the final PDR in March will present a major challenge for the project.

The PDR Plan has been revised following the July PDR Phase 1. It now involves the following stages:

Stage 1: Cold FPU (July 7-9, 1999)
External Review

Stage 2: Warm Electronics (December 6, 7, 1999)
Internal Review with participation of ESA and PACS

Stage 3: Detector Array Selection Meeting (Jan. 31, Feb. 1 2000)
PDR on subsystem and electronics
Participation by external advisers and ESA

Stage 4: Delta PDR
To cover: Structure, BSM, FTS, OBS (URDs), Internal Calibrators, Test and Calibration Facilities, Support, Equipment, Complete Development Plan.
Decision to be made in consultation with ESA on whether or not this should be a formal review.

3. PDR Review Board Response (Matt Griffin)

The SPIRE response to the Board's report has been submitted and circulated within the consortium (and is now available on DMS). Most of the main issues raised by the review are being actively addressed. One conclusion of particular relevance for the Detector Array Group is that the array selection should not be delayed.

4. Instrument Design Status (Bruce Swinyard)

- **FTS:**
  - The FTS/Optics group met in September and has narrowed down on the FTS options.
  - The GSFC carriage is baselined for the FTS mechanism. Its funding status is uncertain as yet. It may be delivered by GGSFC or built by LAS with GSFC design input.
  - The baseline is that no tachometer will be used.
  - A launch lock may be needed for the carriage.
  - There is a need to open up the pupil stop to cope with pupil size changing as the mirror moves.
  - Extension to lower wavelengths is very difficult to accommodate
  - The long wavelength sensitivity will depend depends on the detector choice and has yet to be properly evaluated for any of the options
  - A back-up step and integrate mode is being investigated.
- **Alignment plan:** Kjetil Dohlen is working on the alignment requirements. A meeting on the alignment plan in August produced a draft plan which needs to be refined and detailed.
- **FTS calibrator:** The calibrator design as presented at the PDR may be changed as it is thought to be potentially vulnerable to standing waves. A proposed alternative comprises a black plate to terminate the beam with a central hole containing a hot calibration source. This concept will be tested using the QMW breadboard FTS.
- **Detector modules:** The detector module size is posing problems with the mechanical layout (see later presentation by Berend Winter).
- **Telescope design:** The baseline is now the "thick primary" as proposed by JPL/COI and the optical prescription has been specified.(see *FIRST Telescope Optical and Optomechanical Report*, available on DMS). The design of the 8" hole in the primary is important for SPIRE stray light control.
- **Cryostat study:** SPIRE will press for a colder interface temperature to simplify the structural design. This would have implications for the JFET box - but for the moment there is no point in developing a detailed alternative design until the interface temperature constraints become clear. Dornier have flagged the high thermal load from TES wires. Dornier have commented on the SPIRE IID-B and a response has been sent including our assessment of the thermal loads and SPIRE's influence on the lifetime.
- **Outstanding issues:** Several aspects of the detector system designs are still in great need of attention:
  - BAU requirements
  - JFET/Filter Box requirements
  - Grounding scheme and EMC
  - Getting from raw detector readout to 40 Hz; synchronisation, bias and control lines etc.
  - Thermal interfaces - getting from finger to the evaporator; temperature control
  - Mechanical constraints - lack of space; accessibility
  - Why do kangaroos have such short front paws?

Comments on Bruce's presentation:

- The TES option may not need the BAU.
- A real BAU for the TES option might need more than the 2.5 mW baselined.
- These issues should be raised this at the next Cryostat Study meeting

5. Actions (Ken King)

The outstanding actions from previous meetings were reviewed – see section 10 below for a summary of actions including those from this meeting.

5.1 QMW (Peter Hargrave)

See viewgraphs for details. Major points were:

- Three CEA devices have been tested (see Louis's presentation)
- The QMW BACUS has been commissioned and all filters and other components have been delivered to JPL and GSFC
- A single pixel spider web detector has been tested with an ISO-style illuminator. The results will act as a benchmark for the forthcoming tests on a CEA array
- Tests on illuminators are being given lower priority and are being delayed due to shipping problems at Goddard.
- The QMW lab. is ready for the major test campaigns
- A detailed schedule exists for the TES arrays
- The JPL schedule is to be clarified at the meeting
- The interfaces for the FTS and telescope simulator measurements are also to be discussed in the splinter meeting

5.2 CEA (Louis Rodriguez)

See viewgraphs for details. Major points were:

- Recent work concentrated on four areas:
  - Comparison of implanted and mesa thermometers
  - Measurement of the response to a cold black body of monopixels of 5 x 10 arrays
  - Work on the cold multiplexing scheme
  - Refinement of simulation models
- Problems, some of which, which affected initial tests at QMW have now been solved:
  - ESD sensitivity of MOS readout - changed procedures
  - Adherence of the arrays on the copper plate
  - MUX and readout contact on main chip
- Implanted and mesa thermometers: measurements have been made of the electric field effect for fixed temperatures. Values of To = 120 K and α = 10 are derived at 300 mK at low bias.
- Measurements using a cryogenic (unfiltered) black body imply a responsivity of 1.1. x 10^{10} V W-1 and an optical NEP of 7 x 10^{-17} W $Hz^{-1/2}$ (resistance = 10 GΩ; background = 70 pW; bias = 1.2 V). The noise is dominated by the MOSFET readout and may be reduced by modulation.
- Plans for the immediate future are:
  - to use an InSb source for fast modulation
  - to use passband filters produced by IAS
  - to test new arrays every two weeks
  - to test new electronics just received
  - to test the 99-20 array in the QMW BACUS facility

Comments on Louis's presentation:

JJB: The bias voltage at the operating point of 200-400 mV means that there will be a significant electric field dependent non linearity effect

HM: In measuring Z(ω), the bolometer dynamic resistance, it is important to make reference measurements with the detector absent also to account for the properties of the embedding circuit.

MJG: Tests with ionising radiation should be done at QMW during the first run in BACUS to characterise the speed of response

5.3 GSFC (Harvey Moseley)

See viewgraphs for details. Major points were:

- BACUS is now configured for the "pathfinder" (1x8) arrays and is operating routinely. Some modifications are needed (heat switch, paddle installation, completion of wiring)
- The MKII electronics are working well at NIST and GSFC
- Software to run the system has been developed at GSFC
- Cooling He-3 stage slow
- The downselect array fabrication is complete. PUD folding has been successfully done at NIST and GSFC. A procedure for accurate PUD positioning is being developed
- Mo:Au TESs have demonstrated reliable Tc and good contacts between bonding pads and the TES NIST has produced and tested 4 devices with Al/AU bi-layers and GSFC has produced two with Mo:Au
- Optical tests by Eric Grossman at NIST resulted in an efficiency > 1, implying some stray light in the system - measures are being taken to improve the stray light rejection.
- A 2-Tc test popup device (Tc1 = 265 mK; T_{c2} = 528 mK) has been successfully made and tested

5.4 JPL/Caltech (Jamie Bock)

See viewgraphs for details. Major points were:

- The 350-µm downselect array has been fabricated with good yield
- BACUS is operating, but the fridge has been replaced with a Duband-type system to improve the cycle time.
- A 24-channel BACUS DAQ system is running, capable of doing automated load curves and signal demodulation. its end-end noise performance is within 3 nV Hz-1/2 down to 60 mHz with 200 Hz bias and analogue lock-in.
- Several cold tests have been done on a demonstration array.
  - The bolometers are well matched in T_g, with some spread in Ro
  - Electric field effects are negligible
  - The mean Go is 70 pWK-1 (Go = thermal conductance at the bath temperature). This compares with the nominal value for SPIRE of 100 pWK-1.
  - The mean Ro is 213 Ohms
  - Including a conservative amplifier noise contribution results in an NEP of ~ $3E^{-17}$, which meets the SPIRE requirements
  - An electrical evaluation of the time constant is ~ 5 ms, also meeting the requirement (optical confirmation is expected in the near future)
  - The demodulated noise performance (with an unregulated ^{3}He fridge) is on spec. at ~ 25 nV Hz-1/2
  - Optical measurements have been made with a cryogenic black body filling the beam. The measured efficiencies a bit lower (at 40-50%) than achieved in other instruments. Possible

explanations are losses in the feedhorns or interaction (fringing) between the filters and feedhorns. An unfiltered experiment has just been done with the cryogenic black body, but the results are not available yet.

- HFSS simulations (now verified in several other instruments) give good absorption which is relatively insensitive to absorber impedance (but is sensitive to the alignment)
- Spectral measurements are essential to identify whether fringing is a problem
- The focal plane structure and JFET module design is progressing, although a bit slower than planned.
- A prototype JFET module has been made. A mounting ring for the 2-K interface has been included in the array module design; a structural analysis has been done and the array module subjected to a successful internal design review at JPL. Machine-level drawings have been sent out for bid.

6. Electronic system design updates

6.1 CEA (Christophe Cara)

See viewgraphs for details. Major points were:

- Detector sampling and synchronisation:
  Column selection
- Pixel oversampling by switching between signal and reference
- WE includes clock sequencers (design common to the photometer and FTS)
- Flexibility in how the arrays are read out
- test pattern generation by the sequencers
- Implementation of H/W on anti-fuse FPGA+RAM
- Synchronous running of all sequencers with the clock
- Array parameters (16x16 arrays with bias, supplies, clock, signal lines)
- Array clock sequencer configuration and redundancy philosophy
- Array controller electronics block diagram
- Cold redundant clocks and separate bias voltage generators for each array
- Two sub-arrays sharing clock and supply lines
- Reliability analysis
- Detector wiring and grounding
- DRCU electronics box layout
- Possible need for different electronics to sample the FTS at 200Hz

Comments on Christophe's presentation:

The question of RF susceptibility and the need for an RF filter box for the CEA option was raised. MJG noted that *all* options should baseline the RF filter box unless it was demonstrated that this is not needed

6.2 GSFC (Jim Caldwell)

See viewgraphs for details. Major points were:

- Sampling at 20,000 frames/sec with on-board deglitching and co-addition to form an image

- Top-level block diagram of the system
- Packaging concept
- Column Controller block diagram
- Frame formatter controller and FPGA configuration
- Power summary (est. total = 99 W - update on 75 W in current IID-B)
- SQUID multiplexer and addressing scheme
- Wire count (total of 621 wires + 20 shields)
- Results of computer simulations of the system of biasing and addressing, showing significant margin on the rise time (15 ns rise time vs. available 200 ns)
- Need for the BAU is still TBD (maybe not but leaving it in for now)
- XQR FPGA no longer baselined Now looking at ACTEL alternative

Comments on Jim's presentation:

LV: Why is on-board deglitching assumed - it should not be necessary? - HM: Probably right.
BMS: Everything should go through the RF filter box.
LR: Are SQUIDs sensitive to ionising radiation?
HM: GPB tests show that glitches can occur but no damage is caused
MJG: A quantitative assessment of the sensitivity of the SQUIDS should be made so that the overall effect on integration time of all hits (Tees plus SQUIDs) can be estimated.

6.3 JPL/Caltech (Viktor Hristov)

See viewgraphs for details. Major points were:

- The overall scheme
- The FPGA demodulator configuration (multiplexing of 3 channels into each FPGA)
- Proposed component list (mainly Analog Devices) and details of FPGA and multiplexer Measured preamplifier transfer function , noise and power (< 30 mW in agreement with PDR figures)
- Command interfaces
- Proposed frame scheme (including some compression) - for discussion in WE splinter

Comments on Victor's presentation:

BMS: Class-S components may not be required may be unnecessarily expensive.

7. Array Mechanical Interfaces (Berend Winter)

Berend Winter gave a presentation explaining the difficult requirements on the design loads for the internal subsystems (see viewgraphs):

- The acceleration levels at which we are required to test include a sine sweep of 15g up to 100 Hz.
- With an eigenfrequency close to 100 Hz this inevitably produces high internal acceleration levels.

  Potential solutions to this problem are:

  (i) designing for higher eigenfrequency of the structure (perhaps with some thermal penalty)

  (ii) negotiating a relaxation of the current spec., which is not considered physically realistic for FIRST

There are good hopes for both of these approaches, and discussion with ESA continues (currently in the context of the cryostat interface study).

- The Photometer and FTS 2-K box designs are being worked on at MSSL. There are difficult accommodation problems with fouling on the beams being difficult to avoid. MSSL would prefer a smaller diameter for the array modules.

Comments on Berend's presentation, and conclusions of the discussion:

- It was agreed that a realistic spec for the array groups to design for would be 40-50g with an eigenfrequency of 300 Hz. The structure should be designed for at least 120 Hz, and we should press ESA to reduce the 100-Hz sine vibration level by at least a factor of 3. Berend will produce a document for ESA outlining our favoured solution.
- The focal planes (array planes) are not at the front face of the modules, as MSSL have been assuming - this makes things harder.
- The beam envelopes are 20% oversized with respect to the field size, which may be too generous - this could make things easier.
- There may be scope for tweaking of the optical design or expansion of the SPIRE envelope to relieve the accommodation problems.
- The detailed design and/or orientation of the array modules could perhaps be adjusted (although a reduction in the overall diameter is not viewed with relish by the array groups).
- All of these avenues need to be explored to evaluate whether there is an intractable problem. If there is, then the trade-off will need to be made based on the overall system performance.

8. Simulations

8.1 Beam Modelling (Bruce Swinyard)

This presentation summarised the results and conclusions of Martin Caldwell’s modelling of the SPIRE photometer beam profiles on the sky for the filled array and feedhorn options. Major points were:

- The model does not include the new telescope design yet, but this will be a minor modification
- Tony Richards is working on the instrument stray light model and it is planned to have the results available before the detector array selection
- Martin is working on modelling the beam profiles for the FTS feedhorn case using horn models provided by Anthony Murphy and TBD of Maynooth.
- The FWHM beamwidths for the feedhorn option are 17.6”, 24.7”, and 35.4” at 250, 350, and 500 μm, respectively – very close to what we have been assuming up to now. The beamwidths for the filled array options are very similar - the filled arrays produce marginally narrower beams with somewhat higher sidelobes.
- Bruce will distribute the modelled profiles in profiles in ASCII format

Comments on Bruce’s presentation:

It was agreed that these beam profiles should be used for future simulations.

8.2 Operating modes (Bruce Swinyard)

The draft Operating Modes Document which was circulated before the meeting was briefly outlined (see viewgraphs).

- The document is in its infancy – the initial draft has been circulated for comments by the Detector Group and the Systems Team on the format and structure of the document as much as the content (which concentrates on the feedhorn option as an example).
- Important guidelines are:
  - to have a system that doesn't lose flexibility as happened with ISO
  - to make knowledge of the instrument-specific details invisible and non-essential to the astronomer
- The forthcoming Ground Segment workshop (13-15 October in Vilspa) will be an important forum to
- present our ideas, and perhaps get them adopted as standards for the project.
- The logical structure of the observing modes is similar to the scheme devised originally by Christophe Cara

Comments on Bruce's presentation:

- HM: Scan with dither using the BSM is probably best for TES arrays – it will be necessary to examine the BSM capabilities in this respect.
- JJB: A useful mode would be scanning with a shift of the BSM position between rows
- There is no fundamental requirement to synchronise the BSM and the data samples as long as the timing can be reconstructed. Asynchronous sampling of the data is much to be preferred if it can be achieved. But there may be problems with sampling at the highest BSM chopping frequencies.
- JJB : It will be important to be able to interleave calibrations within long mapping observations
- LV: The Line Scanning with OFF position (as specified in the FSPMD) could be a good way of implementing this.
- KJK: There was a problem with ISO having a restriction of only one telescope pointing per observation. We should require capability of more than one pointing per observation in case we need it.

9. Simulations

9.1 Simulations at Imperial College (Seb Oliver)

See the viewgraphs for details. Major points were:

- He covered the basic method (as outlined at the Caltech meeting in May) and the simulations of scanning observations started recently, based on a set of assumptions agreed at a meeting at QMW and circulated to the Detector Array Group – these are also attached to the minutes).
- Scanning is currently simulated as a fine raster (with no smearing of the data due to detector time constant effects).
- The area simulated is 3^o x 1^o with 3" spatial resolution
- The simulated observing time is 10 days total (1.25 hrs per position on the sky, which is long compared to the time needed to integrate down to the confusion limit)
- A finer resolution map has also been simulated as a trial (5040 x 1 pointings with 1" resolution)
- On a 450-MHz Pentium, the simulation takes 30 minutes for the map generation; 40 minutes for the simulation and stage 1 data reduction, and another; 20 minutes for stage 2.
- Field distortion can easily be introduced, but variations of the beam profile across the field cannot be easily simulated as this would make the convolution of the sky with the beam response much more complicated.

- The data reduction involves flux estimation for isolated point sources (with any desired weighting function - can be assigned to be optimal Weiner filter). This corresponds to the case where one knows where the point sources are, which is probably OK for what we're interested in now. So far, the psf has been used as the filter.
- Theoretical studies of the limits to super-resolution imposed by noise and finite sampling base on Leon Lucy's work) show that the improvement factor is proportional to Nphotons4. In the case of confusion-dominated data, this is probably closer to closer to Nphotons8. The inevitable conclusion is that unless the S/N is very high, none cannot do much better than the telescope diffraction limit: super resolution requires super signal-to-noise.
- As noted at the previous presentation at the Caltech meeting, chopping degrades confusion-limited sensitivity, and using a square footprint on the sky rather than the psf gives poorer results.
- The trimmed rms figure of merit presented at the Caltech meeting is not the best, and should be replaced with a new ($flux^2$) criterion.
- A simple detection criterion Is used to pick out point sources – identification of peaks in the map above a certain threshold
- Comparison of the input and reconstructed source lists allows the reliability (N_{true}/N_{total}) and completeness ($N_{true\ detected}/N_{true\ input}$) to be estimated. The completeness drops gradually dip if one adopts a lax threshold, but the reliability exhibits a sharp drop.

Comments on Seb's presentation (see also section 10.4 below):

- HM: For FIRST and other new survey instruments, the science will be in the is in the surface brightness distribution as much as in the attempt to extract point sources from it.
- BMS: why not just use reliability/completeness as the figure of merit? SJO: need to be able to compare different options without getting bogged down in details.
- HM: optimal matched filter about sqrt2 wider than the diffraction limited psf. Must use same filter for estimating sensitivity as for confusion.
- LV: A shorter integration time per position would be OK (about 15 min rather than 1.25 hrs) as this should be adequate to get down to the confusion limit.

9.2 Simulations at Saclay and Padova (Laurent Vigroux)

- Herve Aussel has moved to Padova, and has been working on other things
- Laurent has done some work to incorporate scanning into his previous simulations
- There is a proposal by Padova to hire someone to carry on with Herve's work, which needs to be discussed in the context of the division of work within the ICC

9.3 Simulations at GSFC (Harvey Moseley)

This presentation covered work at GSFC on the optimum strategy for spatial sampling of arrays in general (but with particular relevance to the TES detector option). See the viewgraphs for details. Important points were:

- Various dithering schemes can be implemented. Any scheme provides a system of equations that can be inverted to recover brightness, offset, and detector gain.
- It is best to have an ensemble of motions covering a range of angular scales (as in sampling the u-v plane in the case of an interferometer)
- For the TES option, it is expected that the gain can be controlled very well. The offset is expected to vary on a timescale of around 1 second (i.e., this is the 1/f knee)

- The inversion algorithm doesn't require a certain dynamic range if one is not trying to solve for the gain
- Various dither patterns have been studied and a figure of merit estimated. The optimum pattern for the SPIRE TES option is TBD – the capabilities of the BSM will need to be examined (e.g., the details of how the settling time varies with the distance moved).
- Large transients due to the pixels near the edge moving off the sky onto the field stop is regarded as undesirable. GSFC propose having an 80-K 4% emissive border around the inner edge of the field stop, which can also be controlled to provide a calibration reference.
- Two papers treating many of these ideas in detail were made available by Harvey (see Annex B).

9.4 Discussion of simulations work and conclusions

Following the presentations and discussion, Matt Griffin summarised the main conclusions:

- Simulation work will be very important for optimising the observing strategy and the science return, and will be a major activity throughout the project. For the moment, the emphasis is on work that will help inform the detector array choice.
- The beam profiles on the sky are very similar for the feedhorn and filled array options, so there is no significant difference in spatial resolution between them. This will not be an important consideration for the array selection.
- The sky sampling schemes are essentially equivalent for the filled array and feedhorn options. Although they involve different distributions of the samples spatially and temporally, the end result is effectively the same. This too will not be a critical issue for array selection.
- That leaves one important difference in principle between the two generic options - mapping speed. A filled array is faster in principle, and should be faster in practice provided that practicalities such as pixel sensitivity, stray light, RFI, etc. do not degrade the advantage. Mapping speed will be the most important scientific criterion for selection.
- Practical aspects such as 1/f noise and scanning rate constraints, effects of pointing noise, data rate and on-board processing, and many other instrumental and programmatic considerations will also need to be taken into account.
- Simulations should continue to be done to be as representative as possible of the actual properties of the arrays. The priority is analysis of the practical mapping speed differences, taking into account:

  - Investigation of the constraints imposed by 1/f noise and the optimum choice of scanning speed for the different options (including any smearing due to finite detector speed of response)
  - Incorporation of pointing noise
  - Incorporation of the details of the array readout and interleaving of the samples
  - Any significant differences in overheads between the different options
  - Accurate characterisation of the relative mapping speeds
  - Influence of telemetry restrictions

10. List of actions defined at this meeting (see also the list of actions from the Systems Team meeting which followed)

SPIRE Detector Array Group Meeting, Saclay, September 29, 30 1999				
Actions from the main detector meeting				
Action Number	**Description**	**Responsible**	**Due Date**	**Status**
AI-DET-0000-01	Issue formal minutes of Caltech detector meeting	Griffin	Oct. 8	Closed
AI-DET-0000-02	Address issues of array redundancy and specify the redundancy/line commoning philosophy	Voellmer, Bock, Rodriguez	Oct. 31	
AI-DET-0000-03	Discuss grounding philosophy (cold or warm star point) tomorrow and define how it is to be specified for Warm Electronics Review	Systems Team	Oct. 1	Closed: see System Team Minutes
AI-DET-0000-04	Provide a quantitative assessment of the susceptibility of the SQIUDS to ionising radiation	Moseley	Oct. 31	
AI-DET-0000-05	Remind ESA of previous question on warm electronics power constraints	Griffin	Oct. 20	Open
AI-DET-0000-06	Write note summarising assumptions and recommending solution to the problem of what acceleration levels the SPIRE FPU subsystems need to be designed (see minutes for details)	Berend Winter	Oct. 31	Open
AI-DET-0000-07	Specify the location of the foci at each wavelength wrt the front face of the array modules	Voellmer, Bock, Rodriguez	Oct. 8	Open
AI-DET-0000-08	Devise a set of actions on all concerned to sort out the constraints on the array mechanical envelopes and possible problems.	Griffin, Swinyard	Oct. 8	Open
AI-DET-0000-09	Describe how the data stream should be transformed into the telemetry stream	Array Groups	Oct. 31	Open