Report on SPIRE AIV DDR at RAL 6 September 2001-09-11

Panel
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Overall, the panel was impressed by the progress that has been made in specifying the requirements of the AIV facility. It is clear from the voluminous package and presentations that much effort has been put into specifying the requirements of all the subsystems and we appreciated the helpful presentations at the review. The following comments and notes, some of which are harsh, are intended to help with prioritising the tasks still to be done and to act as a prompt for what is currently missing from the documentation pack. We hope it is useful. Given that there are ongoing actions and missing interfaces (FTs,hot BB, etc) we would suggest a delta DDR before the end of 2001, which would also provide an opportunity to review the overall AIV schedule.

The panel was deeply concerned about the following points:

- In the documentation provided there was no flowdown from the SPIRE scientific requirements to the proposed instrument tests that are to be carried out in the test facility to verify performance.
- There was no documentation or presentation about what tests will be carried out.

It was therefore impossible for the panel to review the detailed design of the AIV facility.

Given that some of the panel were aware of the nature and scope of the tests which needed to be performed in the facility we continued.

The Panel noted that 24 of the 70 Work Packages had David Smith's name against them - the WPs do not require excessive labour, but they all take time. Further, the manpower chart on page 24 of the SPIRE AIV Development Plan refers loosely to resources at RAL. The Panel felt that the project is too light on 'assigned and committed' manpower. There has to be an active and 'tight-in' team (it doesn't have to be very large) if this facility is to be delivered on time. What we see are 'virtual resources' and not a committed team taking 'ownership' of the facility's design and build.

In respect of these comments we would recommend that a manpower chart detailing the 'core' team (including technicians) with their time commitments (percentage of the next 12 months) and their assigned responsibilities be produced. We recommend that David Smith be given the authority as well as the responsibility for building the test facility, and in particular, signatory power for all purchases and contracts up to a reasonable amount.

We also recommend that the Project consider the option to use external design houses and contractors (optical, mechanical, electrical etc) whenever and wherever appropriate - it could prove cheaper.

In closed the panel session, raised major concerns about the cryostat procurement. The cryostat manufacturer, AS Scientific, had stated during the review that until the specification was complete work was not proceeding and other projects on their books had got ahead of ours. If the specification is fixed within the next month the earliest they could deliver would be May 2002 (We had little confidence that they would meet this). Delivery of the cryostat in May would just give RAL sufficient time to get the facility ready for Instrument testing in August 2002 but with no margin. We were also aware that changes to the specification now could result in cost increases from AS Scientific which the project would find hard to meet. Basically it appears that the cryostat manufacturer was brought on too early before the requirements were agreed.

The panel discussed remedial action that would allow a subcontractor, Stainless Metalcraft, to proceed with the detailed design of the outer vacuum vessel. The following were identified:

- Ensure that there is sufficient room for shield filters, including the wedge angles as specified in the optics, and the blackbody module.
- Need verification that the SPIRE interface is in the correct position with respect to the axis of the vacuum window when cold.

In addition, the subcontractor needs to be aware that because of the confined location of the AIV facility health and safety regulations may require:

- Venting of gas from the chamber to the outside.
- Burst discs and pressure release valves also to be vented outside.

With these actions completed the detailed design of the dewar shell can commence.

Further, to agree the start of manufacture of the cryostat the panel recommends the following actions should be completed:

- Place a temperature specification on the various stages - range and stability (I believe this has been done but not communicated to AS Scientific).
- Specify surface finishes within the Cryostat, electro-polished on the inside of the vacuum vessel, plus MLI.
- The cryostat design uses tube-in-tube cryogenic supports. The Panel suggested that a mechanical resonance analyses was carried out with the C-of-G of the 'dummy mass' placed at the correct height above the plane of the mounts (rocking as well as translation modes).
- Draining of the 210 litres of LN2 at the end of a calibration run rather than boiling off will produce a faster turn around. The LN2 could be drained into an empty dewar.
- Thermal loads need to be revisited with the new temperature specification.
- Confirmation of thermal design which appears not to have been checked by any independent party. This has been done at conceptual level only.
- Update procurement specification.

Further concerns which we believe must be addressed before the go-ahead for cryostat manufacture can be given are listed below:

- A firm manager of the whole procurement process is needed.
- The contract with AS Scientific needs to be revisited and any cost hikes or schedule slips must be mitigated by bringing in other contractors or doing more work in-house.

The above are all fundamental problems which if not addressed will lead to the delivery of a cryostat which does not meet the AIV requirements.

There are several other issues, which the panel noted which are detailed below. All need to be addressed in a timely manner.

Facility overview
There should be a clear overview of the flow-down of requirements for the AIV facility.

- List key requirements and where they come from.
- List Functional and implementation requirements.

(Bruce Swinyard wrote a note on the subject who is a good guideline.)

It would help if to distinguish between the important requirements like key and functional requirements on one side and the implementation requirements on the other (also important but depending on implementation).

All in all the downflow of the key requirements for this facility should be clearly visible/transparent. Otherwise there is no way of telling if the facility is capable of meeting the real design goal(s). Indeed, it is impossible to focus on the important aspect of the design. Further, it is impossible to trace back a consequence of not being able to meet a certain specification. (Like a temperature range definition/ requirement)

The mechanical background noise during the operation of the facility should be considered. We should estimate/measure what the background is (frequency/amplitude or psd). Analyse the structure with a simple model (hand calculations will likely do). Check transmitability of vibrations. Implement an attenuator if needed. Doesn't need to be bulky.

Other notes:

1. Concerns over some of the items in the exclusion list (FTS, harness, hot BB) and the level of interface definition between some sub systems and the cryostat.
2. Low natural frequency of the internal supports could be susceptible to external disturbance.
3. Movement of the instrument will cause severe noise.
4. A survey of the area is recommended.
5. There may also be internally generated vibration from boil off etc. but this is likely to be small.
6. Temperature stability of the 4.2 K stage is critical and is specified.
7. Temperature changes can be influenced by the pressure changes in the lab.
8. High heat capacity materials may be a way of reducing temperature excursions.
9. Cold black body needs to be integrated to the instrument support structure as part of the instrument integration outside the cryostat.

10. Cardiff to review window interface before release for manufacture.
11. Cut out for cryoharness in the shields could cause a significant heat leak, a soft (MLI) shield is planned.
12. Temperature of BSM is dependent on its view to warm sources, filters will ensure that the BSM environment is close to flight.

Thermal design

1. Original hold time of 100 hours is achievable with the current thermal design.
2. Heater should be planned for helium can - will effect helium temperature stability.
3. A design that gives the required temperature (9 to 20K) without heating the helium should be investigated, as this may give more stable background temperatures.
4. The 46 hours hold time applies to a period of data taking in flight like conditions, i.e. the detectors at 300mK.
5. Temperature gradients and fluctuations within the shields may affect the level and constancy of the background stray light. Some analysis is recommended. A specification for shield temperature stability is required.
6. The most critical areas may be around the input filters/windows, the blackbody and its optics. Responsibility and specification has to be well defined in these areas.
7. Movement of the optics during cool down should be analysed.

Detail cryostat design

1. Heater and temperature on each cold interface.
2. Spec on interface is +/-0.17K not right in spec provided to manufacturer. This will require a PID controller.
3. Sensors should be Cernox for commonality with the rest of the instrument - not specified.
4. 4K stage should be adjustable between 4.2 and 6K using PID control (see initial notes).
5. Likely delivery is May/June if release for manufacture occurs mid September.
6. Supplier does not do the installation.
7. Pumps etc supplied by RAL.
8. Currently, final sign off is planned to after acceptance test at the manufacturers, some acceptance tests at RAL prior to final sign off must be considered.
9. Testing at manufacturers needs to be specified.
10. Provision for storage of the end shields within the open doors to be considered.

Cryo harness

1. Tekdata is the baseline provider. We note this is not identical to the flight harness.
2. Harness specification needs more detail.
3. Harness procurement is not a schedule driver now but will be in the future if not dealt with.
4. Heat sinking the harness needs careful consideration.
5. Stray light down the cables can be a problem; heat sink clamps need to be designed to minimise this.
6. Harness integration with shields needs more thought.

Laboratory

1. A screen to direct air from the HEPA filter is recommended.
2. Protection for the cryostat window to be considered - use a protective cover?

3. A fan should be considered to introduce filtered air from outside or from the corridor or from the control room.
4. Mag lev pump should be run periodically to preserve the bearings.
5. Un-interruptible power supply of some sort is needed to protect the bearings.
6. Escape routs etc in case of large gas leaks are planned.

Telescope simulator

The Telescope Simulator preliminary design and development work by MSc students has been useful. However, this is an essential and sophisticated optical system that needs to be supported by a full-time, experienced systems design engineer.

The design seemed a sensible one. The main difficulties are likely to be in alignment, both of the ellipsoidal mirror and, more particularly, of the simulator/instrument.

Concerns were raised on the distortion of the beam waist at the simulator focal plane. It is mentioned in the documents as small, but not quantified. Does the modelling suggest that this is to be sufficiently small, compared with that from the telescope, that it will not affect the measurement made at Spire focal plane?

Given the reliance upon the reflection of the visible laser from the ellipsoid to position the source pinhole, there will need to be a fairly high polish (but not optical quality surface) on the centre of that mirror. The same high finish would, presumably, be required on other components so that the visible check path can be used.

Other notes:

1. Atmospheric absorption will limit the laser lines that can be used; a purged box is planned.
2. For spectral measurements with the FTS this will be a problem.
3. An atmospheric transmission analysis should be carried out.
4. FTS would be best mounted on its own baseplate.
5. Window filters will be tilted, this is to be accommodated in the filter mounting flange not the cryostat - but the cryostat design must make allowance for the total depth required at the window and on each of the shields.
6. Optical alignment cannot be done through the filters; dummy plates with small windows will be used.
7. Beam steering software still needs a lot of development and needs to be well documented due to likely staff changes. A person who can take charge of this system needs to be identified.

Cold Black body and filters

1. Stability requirements required.
2. Interfaces to be resolved.
3. Filters have no defined edge positions. This will affect the thermal design.
4. Surface finish of filter surrounds is not defined - may need to be black.
5. Stray light analysis of the system has not been addressed.
6. Is there a requirement for alignment marks on the filters?

Laser

Some discussion, no major points.

Hot black body and FTS

Not presented due to lack of specification.
Cardiff is baselined to provide FTS. A detailed schedule and interface document must be drawn up.

Integration and test plan

None discussed during the meeting.

However, RAL has not discussed the integration and its (implementation) requirements with MSSL recently - last time was Oct. 2000. MSSL expected a meeting before the DDR to go through the details. Action - a date must be arranged.

Schedule

Presented schedule was out of date and did not reflect resent delivery estimates of the cryostat.

EGSE

Dave Smith to handle interface with instrumentation.