Program of work using The New Barrel 3 Sector

Draft 5/24/2002

1. Introduction

It is proposed to use the new barrel 3 sector to perform detailed mechanical, thermal and electrical measurements before moving onto the final assembly and testing. Specific goals are:

- Measure and verify the mechanical precision and stability of the brackets
- Establish a realistic envelope for the harnesses by mounting and temperature cycling
- Measure and verify the mechanical precision and stability of the cooling
- Verify the thermal performance of the module cooling
- Verify the thermal performance of the harness cooling
- Verify the electrical performance of the harnesses using 1 or more modules
- Demonstrate the ability of the robot assembly station to safely mount modules
- Verify the electrical performance of the 48 mounted modules
- Validate the electrical integrity of a prototype sector of the thermal screen by repeating the noise injection program established at the system test. In addition verify the design of the feed-throughs, connectors & patch panel PP1

All components will be pre-series or first production parts or made with final tooling. The thermal-screen sector needs to be modified so that it can be used with the B3 sector and be closed off (see proposal in Sections 3 and 4.

In the initial phase the performance of all parts within the thermal screen would be validated i.e. measured and compared with the requirements and expected behaviour. In particular it is important to establish that the mechanical envelopes assumed for the harnesses are realistic, that there are no surprises in the thermal or electrical performance of the harnesses and that the cooling of dummy modules meets requirements. The first electrical tests should be done with one module mounted on the sector. Mounting of a single module could be done by hand. This will test the full electrical functionality of the PPB1 PCB, low mass tapes and doglegs. This will allow the 'release' of the harness & cooling production.

In the second phase, the sector will act as the lead item to develop and validate the module assembly. Again a series of measurements will be needed to verify that the sector of 48 modules has the required electrical and thermal performance. These electrical tests could start with a few modules mounted on the sector.

A final phase would be to use the sector of 48 modules to revisit the optimisation of the grounding & shielding by injecting noise signals. In addition, the thermal performance of the feed-throughs, the heater spreader plates, PP1 and the cooling inlet and outlets would be measured. The thermal and electrical tests to be performed are discussed in Section 5.

2. Work Packages and Items Required

This program requires the following items and work:

Item/Work-package	Responsible	Location	Status	
Mfr B3 sector	E. Perrin	Geneva	Complete	
Mfr 48 pads & brackets & assemble	E. Perrin	Geneva	In progress	
Metrology of brackets	S. McMahon	RAL	In progress	
Mfr 48 thermo-mechanical modules	R. Apsimon	RAL/Oxford		
Metrology of t-modules on brackets	S. McMahon	RAL		
Mfr 8 pre-series harnesses	A. Weidberg	Taiwan	In progress	
Mount harnesses to sector & test	J. Matheson	RAL		
Metrology of harnesses on sector	S. McMahon	RAL		
Environmental chamber to cycle sector				
Thermometry & readout for sector	L. Batchelor			
Thermal cycling of harnesses				
Supply 4-fold cooling circuit	A. Nicholls	RAL		
Mount cooling circuits & leak test	A. Nicholls	RAL		
Metrology of t-modules & cooling circuit	S. McMahon	RAL		
Measure module cooling performance	L. Batchelor	RAL		
Measure harness cooling	L. Batchelor	RAL		
Measure harness electrically	J. Matheson	RAL		
Mount 48 modules with robot	G. Viehauser	Oxford		
Metrology of mounted modules				
Readout hardware for 48 modules				
DAQ for 48 modules				
DCS for 48 modules				
Design/mfr thermal screen sector	A. Nicholls	RAL		
Design/mfr thermal sides & ends	A. Nicholls	RAL		
Design/mfr heat-spreaders & PP1	A. Nicholls	RAL		
Assemble thermal screen to sector				
Thermal measurements in/out of sector				
Electrical performance of modules				
Noise injection studies				

3. Outline of Mechanical Parts

The trials could start with the sector mounted on the assembly table so that the system test could be done in situ. This would allow rapid dismounting of modules which will be required for some of the tests (e.g. changing the grounding option with the shunt shield). When the two assembly tables are required for assembly of barrel 4 and 6, the sector could be moved to the 'clean room' adjacent to the assembly room. The sector must be mounted on the assembly table spindle at its correct radius, so that when rotated the brackets are at the correct orientation for module mounting.

Since the sector is of barrel 3 radius it cannot be mounted in the "correct" relationship with the Thermal Enclosure sector prototype, as it is considered that for the system test the T.E. should be mounted so that it mimics (for one row of modules) the position of the T.E. relative to barrel 6. Figure 1 shows approximately the required relationship between the spindle, the barrel sector and a 90 degree sector of the T.E. I assume that the sector of the T.E. and the Bulkhead sector would be of the "correct" radius, ie that required for Atlas.

A complete enclosure of the barrel sector is require for shielding purposes. Also, if the sector is in a gas-tight enclosure filled with dry nitrogen then the sector can be operated with cooling (at say +10 degrees as at the CERN system test) independent of the cold room temperature. I believe this would be an enormous advantage. The enclosure is represented in fig 1 purely symbolically. It could be made of eg fibreglass covered with Al foil of appropriate thickness.

Figure 2 shows a section through the spindle axis with the sector positioned for module mounting. It indicates the position of the robot and the necessity of ensuring that there is adequate space for the robot to mount modules at all positions along all staves, while the bulkhead remains in position.
It is clear from the sketch that this would not be possible if the radial spreader plates were fixed to the bulkhead during module mounting. It is proposed, therefore, that the radial plates should be mounted approximately vertically, as indicated in Figure 3. When mounting or removing modules the sector has to be rotated to line up the bracket with the robot, see Figure 4. In order to do this the type 2 cables have to be disconnected at PP1, the LMTs removed from the spreader plates and fixed to a "service cage sector". The cooling/environment sensors cable(s) have to be disconnected or rearranged. The radial spreader plates have to be moved so that they do not foul the bulkhead. The cooling supply/exhaust pipes have to be disconnected or rearranged.

The structure required to support the sector, T.E. and sector enclosure off the assembly table spindle should be electrically non-conducting. The SCT interlinks will be carbon fibre and hence conducting/resistive, but the support structure required for this setup is more complex. If we start with a non-conducting structure we can later simulate the resistive interlinks with foil or conductive paint. That part of the support structure which is outside of the enclosure may be either conductive or non-conductive. A sketch of the support structure for PPB1 and a longitudinal view of the sector and radial heat spreader plates is shown in Figure 5.

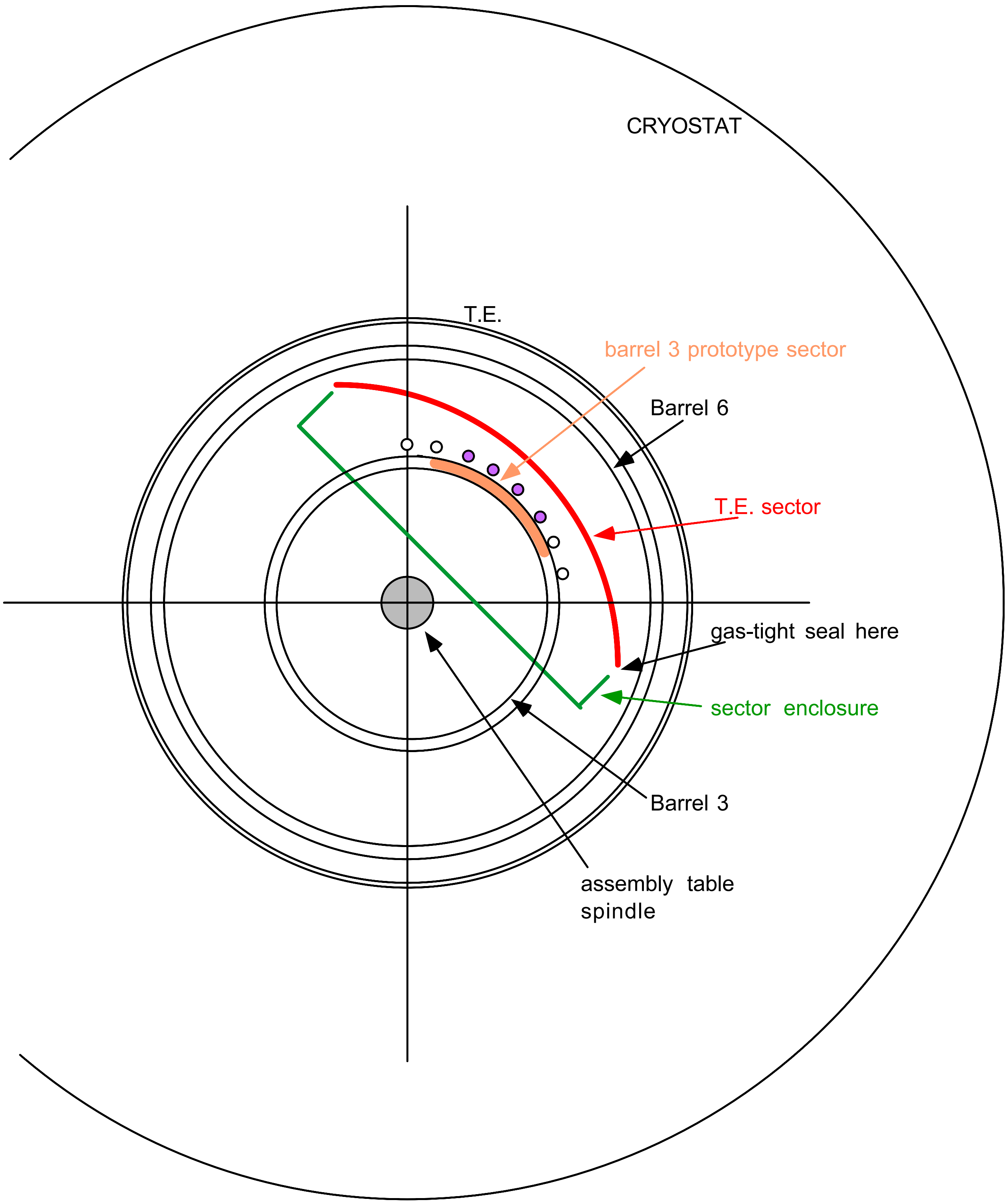

Figure 1 Schematic view of sector mounted on assembly table spindle, with the thermal enclosure.

Figure 2 Schematic longitudinal view of the sector showing the bulkheads and end closure for the thermal shield.

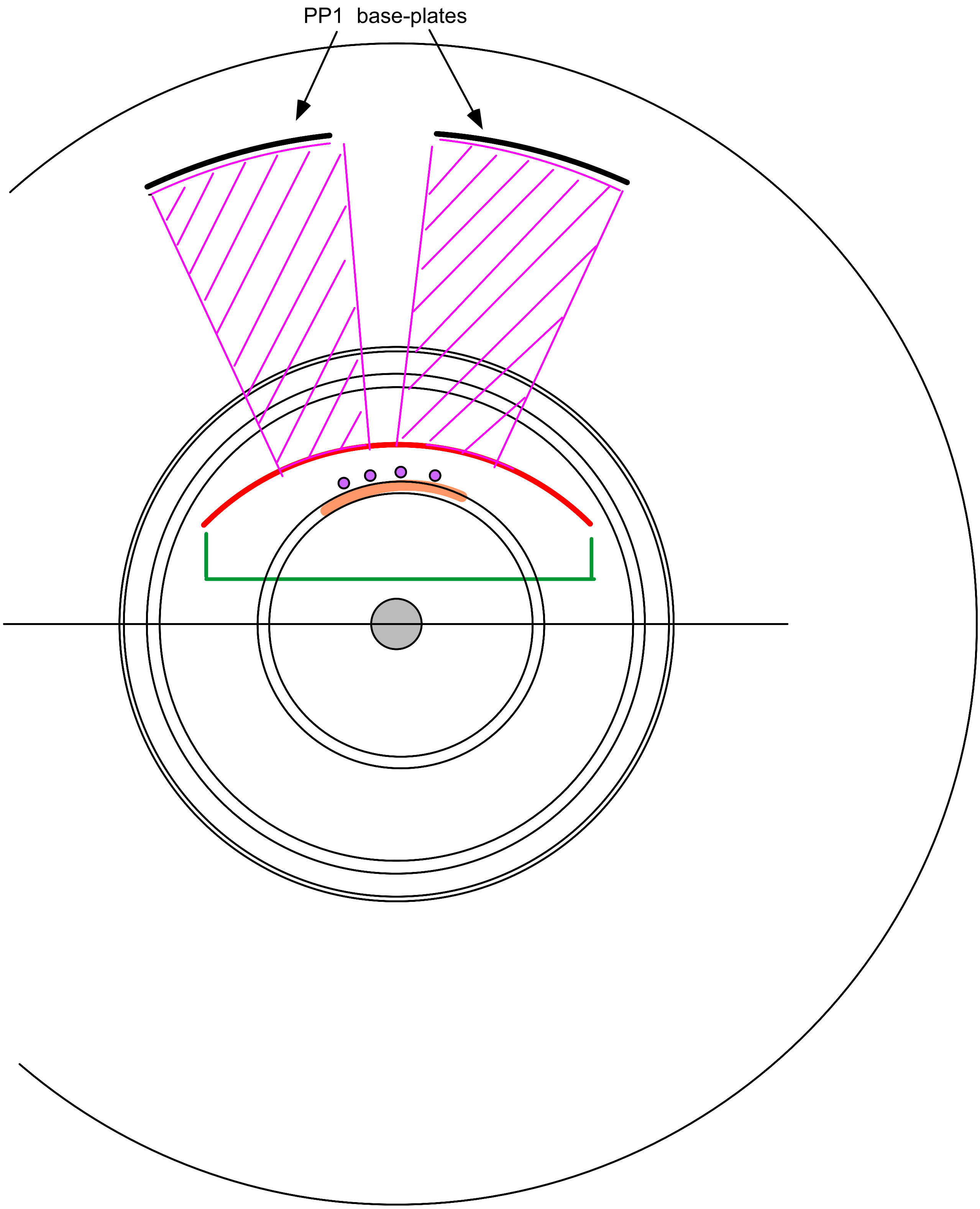

Figure 3 Schematic view of the sector with the thermal enclosure and the radial heat spreader plates.

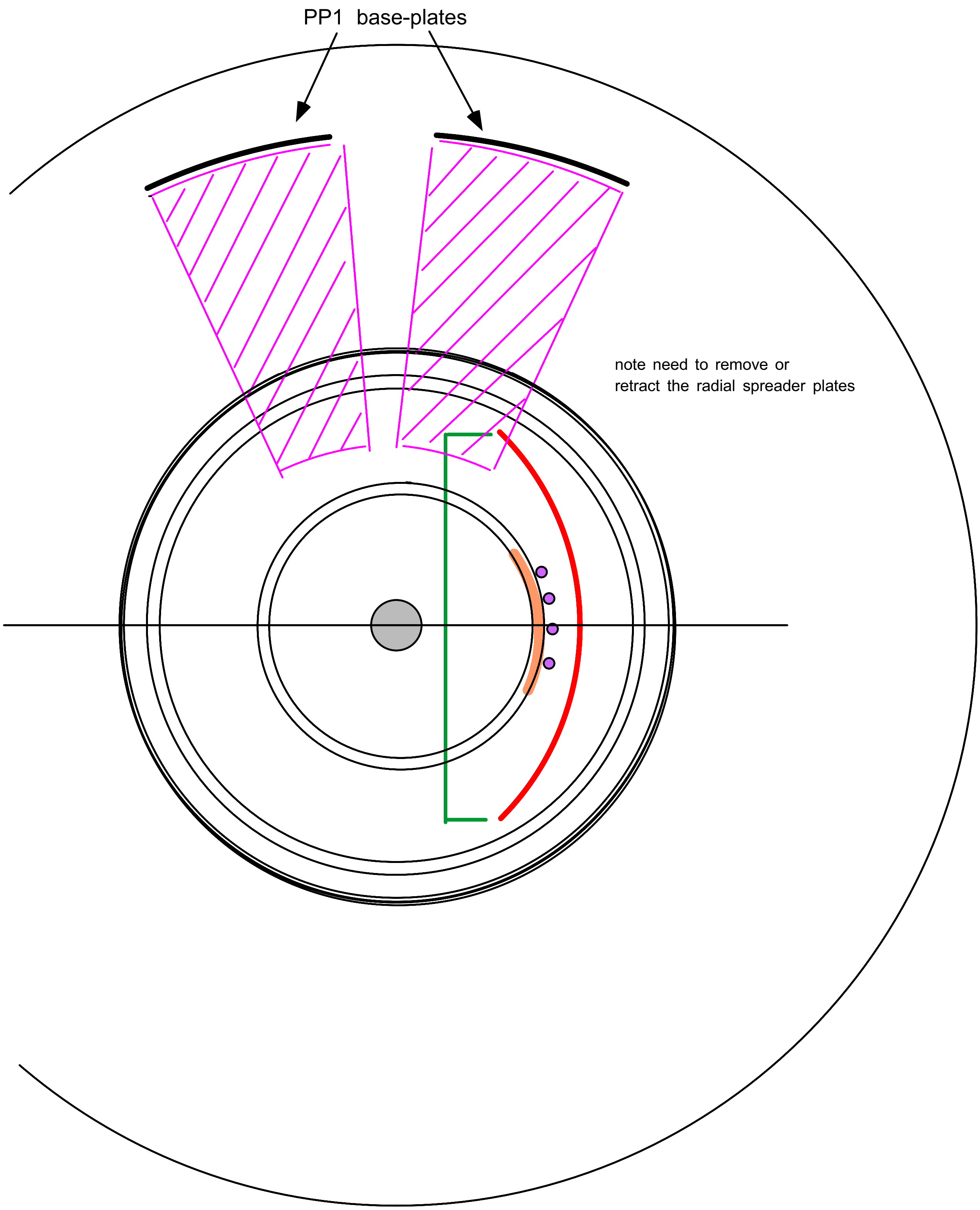

Figure 4 schematic view of the sector rotated by 90º to allow the robot to mount/dismount modules.

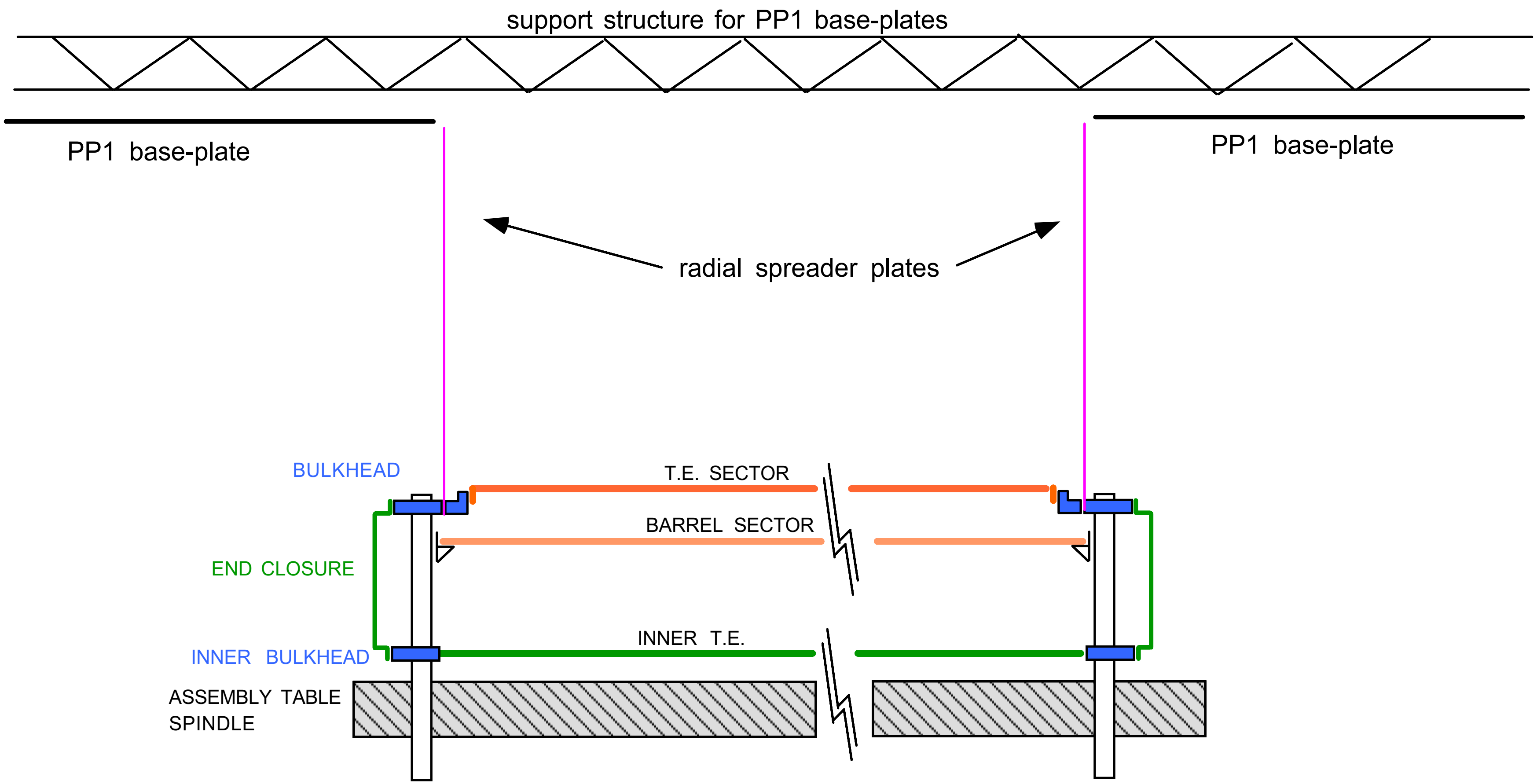

Figure 5 Longitudinal view showing the radial heat spreader plates and the PP1 base plate.

4. Engineering Drawings

Some more detailed engineering drawings of the parts to be prototyped in these trials are given in this section.

Firstly the overall scheme from the electrical grounding point of view is shown in Figure 6 below.

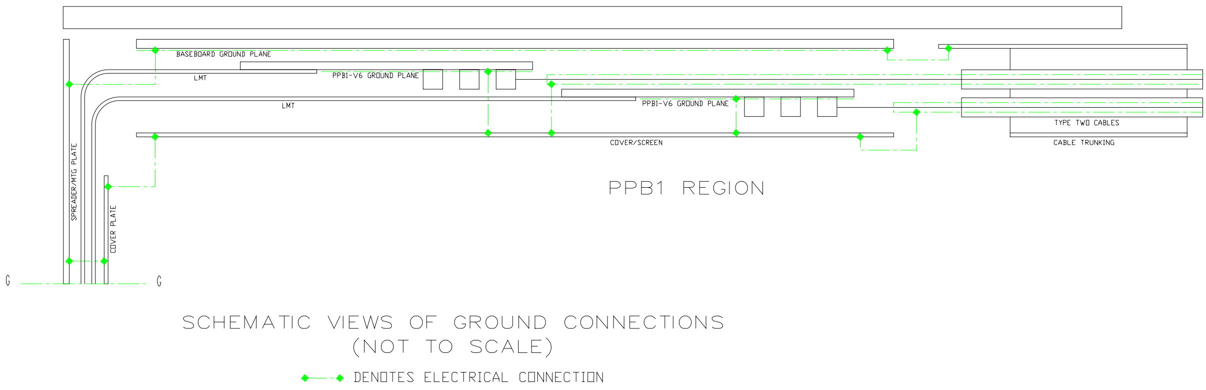

Figure 6 Electrical connections for grounding and screening.

An Alochrome treatment will be used to ensure good electrical connections between aluminium plates and foils. Some of the details of the scheme showing the LMTs passing through the bulkhead are shown in Figure 7 below.

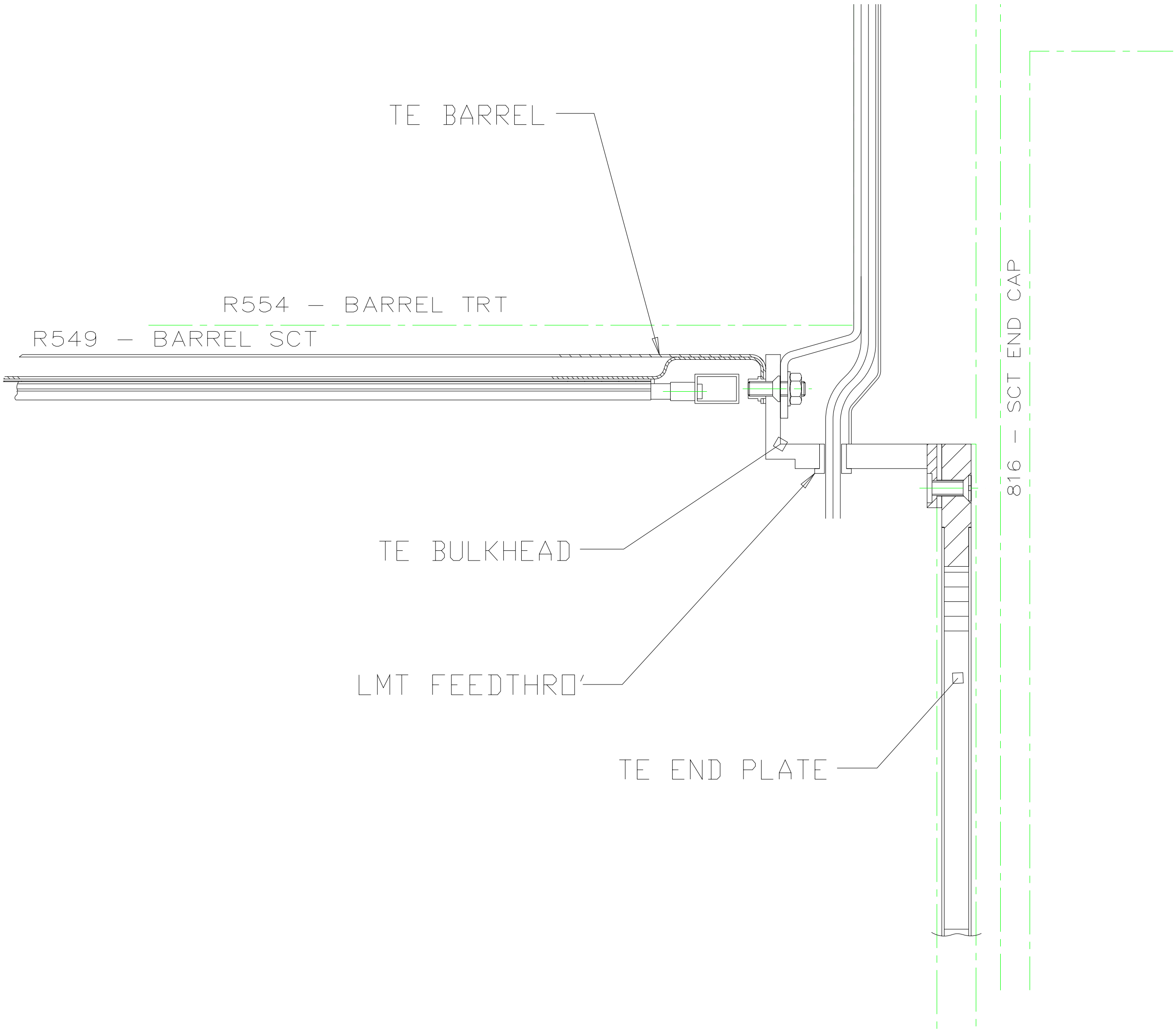

Figure 7 Bulkhead and end of thermal enclosure.

The structure of the radial heat spreader plates and the LMTs is shown in Figure 8. The electrical connection between the inner and outer plates is done with a conductive foam which also acts as a protection for the LMTs. The electrical connection of the screening from the radial heat spreader plates to the cover of the PPB1 region is made with an aluminium foil as shown in Figure 9 below. The base plate for the PPB1 should be a FR4 PCB with Cu on one side to provide the electrical screening.

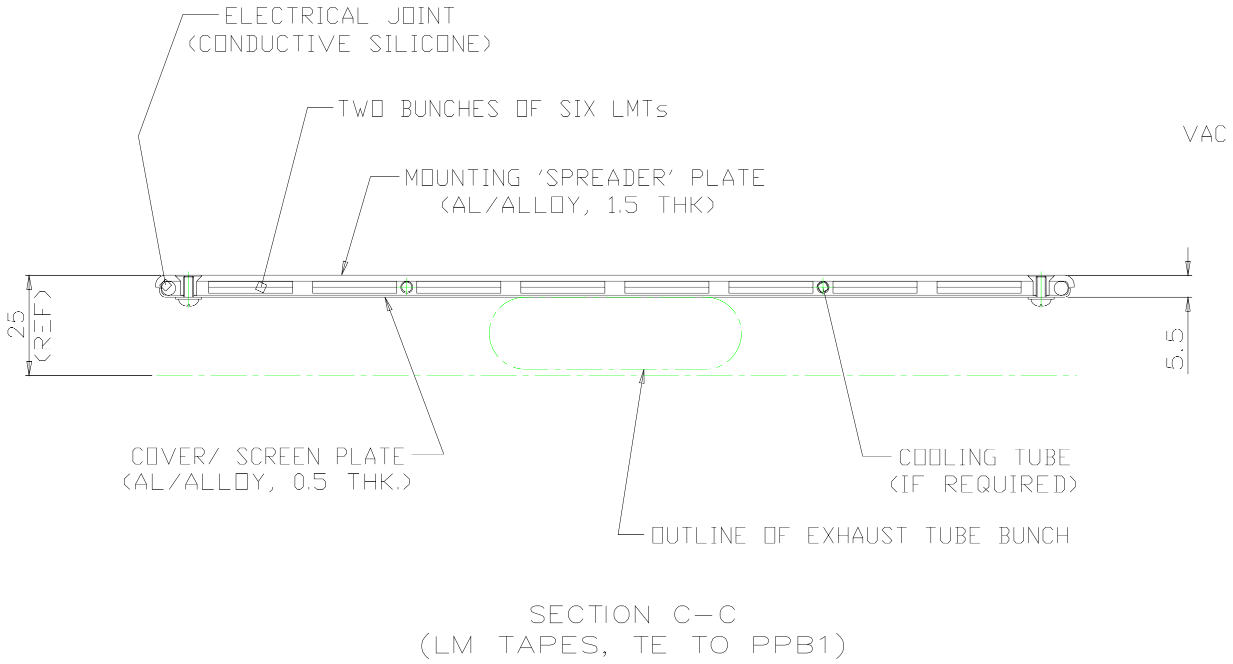

Figure 8 Radial heat spreader plates and LMTs.

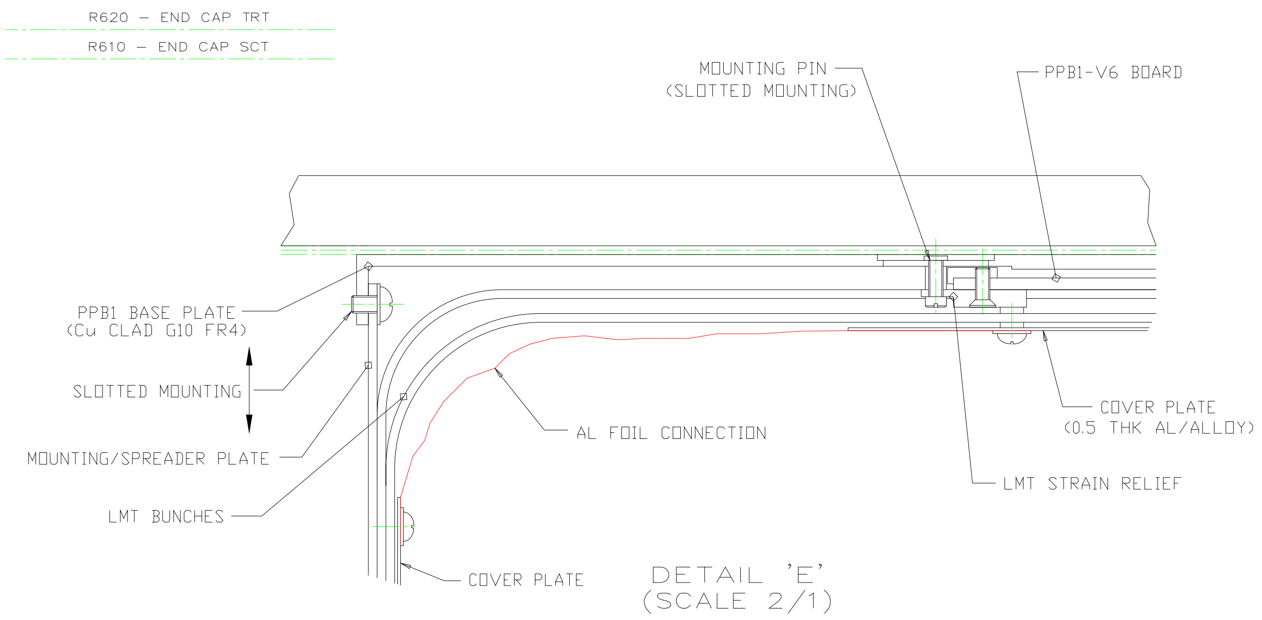

Figure 9 Radial heat spreader plate to PPB1 cover region.

A detail of part of the PPB1 region showing the routing of the Type II cable is shown in Figure 10 below.

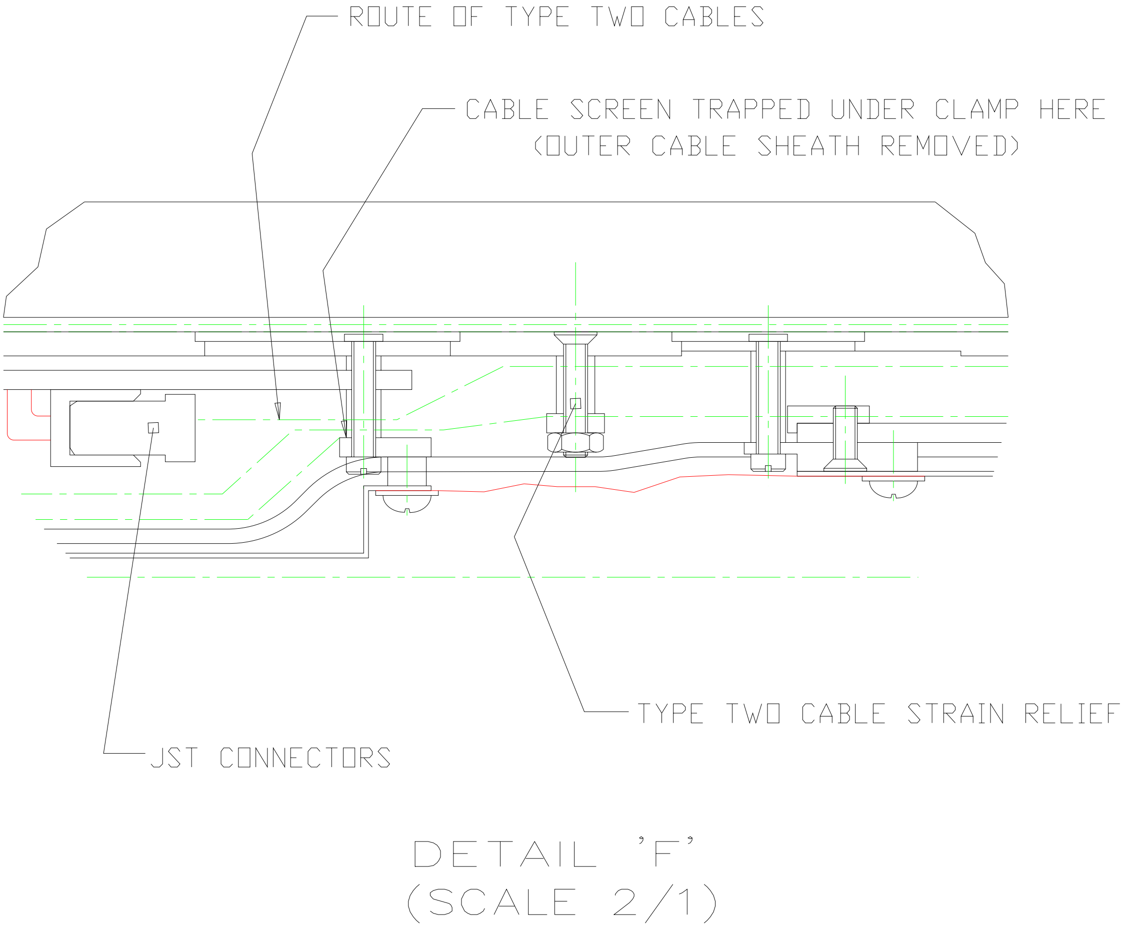

Figure 10 Detail of PPB1.

Cross-sections through the Type II cable bundles are shown in below.

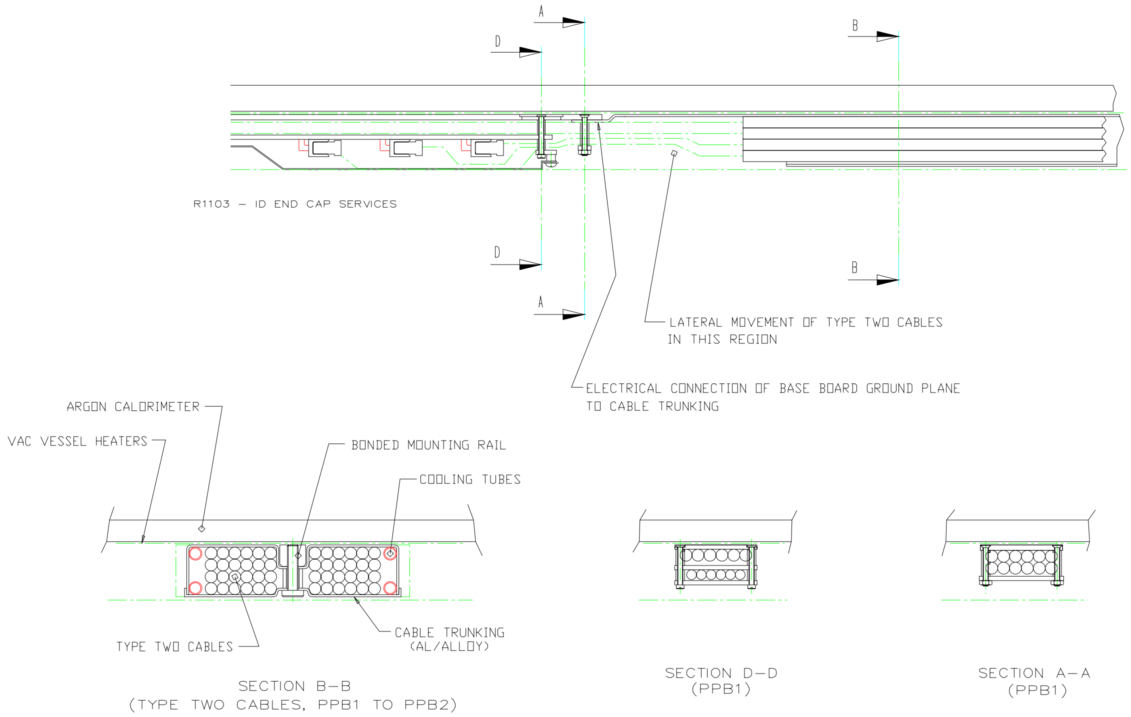

Figure 11 Cross-sectional views through the Type II cable.

5. Thermal and Electrical Tests

Thermal Measurements

Apart from measuring the temperature of the modules on the sector, we should measure the following:

- The air temperature inside the thermal shield.
- the LMTs inside the heat spreader plate sandwich
- the LMTs in the bends between the radial and longitudinal heat spreader plates
- the LMTs at the PPB1 patch panel.
- inside the bundles of type II, III and IV cables.

Electrical Measurements

The aim will be to have a very complete and realistic mock-up of the complete system for modules with the final style harnesses through all the types of cables and patch panels up to the final power supplies. This will allow us to make very detailed studies of the grounding and shielding problems. The detailed engineering must be carried out to find practical solutions to the requirement of having a very high conductivity path between the PPB1s at opposite ends of the barrels. There should also be good continuous screening of the LMTs between the thermal shield and PPB1, PPB1 itself and the type II, III and IV cables all the way from PP1 to the power supplies. First tests of the use alochromed Aluminium look very encouraging but we need to try this with the realistic prototypes in order to assess the viability of the connections between:

- Thermal shield to thermal shield bulkhead
- Thermal shield bulkhead to radial heat spreader plates.
- PPB1 cover to ground plane of PPB1.

Some conductive foam type solution will be needed to ensure low inductance connections between the two radial heat spreader plates (this should also prevent the LMTs from being damaged when the plates are closed up). A conductive wrap will be needed around the LMTs between the radial and longitudinal heat spreader plates.

This system would allow us to prototype the implementation of the single point earth tie. It would also allow for more realistic noise injection studies as noise signals could be injected between the two PP1s as well as onto the different types of cable screening. It will allow us to study many questions about the configuration inside the thermal shield such as:

- the use of the shunt shields to connect the cooling blocks to the analogue grounds on the doglegs;
- the electrical split in the cooling pipe at the centre of the barrel;
- the referencing of the cooling pipe at one end or both;
- the connections of the bracket to the cylinder;
- the connections of the bracket to DGND or AGND on the dogleg;
- connection of the barrel to the shield at one end or both ends;
- isolation of the capillaries at entry to the thermal shield

This system would also allow a systematic evaluation of all the components outside PP1 from the point of view of grounding and screening. It should also allow us to evaluate the impact of the electrical safety grounding connection on the grounding and screening performance of the system. It will also allow the implementation of the concept of a fully isolated floating power supply to be evaluated properly by studying the effect of direct noise injection onto the power supply ground system (relative to the module ground).