Peter Ford: 17.03.06 to 22.03.06

# CMS ECAL - Assembly and Integration Tests (version 2)

For the week of 13.03.06 to 22.03.06 a series of tests were proposed to investigate the early assembly of the crystal components (alveolars, inserts, Interface plates, housings and positional spacers – not including the super crystals) and the integration of a maximum of ten of these assemblies onto the (Dee) back-plates. The principal purpose at this stage is to ensure that the environmental screen can be integrated to the back-plate without interference with any of the other components mounted on the back-plate.

A secondary test was also foreseen to examine the support structure and mechanism that is used to rotate a fully populated back-plate through the desired rotation angle of 90 degrees.

## 1. INTEGRATION OF CRYSTAL ASSEMBLIES AND SCREEN TO BACK-PLATE

The four 'Dees' are paired to form essentially two discs. The identity of each Dee is paired using the following notations:

Dee 3 (notation 1.2) is paired with Dee 4 (notation 1.1)
Dee 2 (notation 2.2) is paired with Dee 1 (notation 2.1)

**Required Actions:** Each Dee must be assigned an identity, and an aluminium plaque must be engraved with the necessary identity and fastened to each Dee, e.g. **'EE-F (DEE 4)'.** Labelling of lifting frames, screen, blue brackets and all associated parts must also bb carried out. Positional spacers will have bar codes assigned to them, and the right-angled perpendicular edges must be marked up so that they are clear to see. Survey of the fixing holes on the screen is also required to reference the Dees (contact Frederique and Raphael in Metrology). The side screens will also be tested and these too will require labelling. Gareth Smith (PPD) to be contacted to obtain permission to be able to access the web area for placing photograph images for our test records. All environmental shields will require an Alochrom coating on their external surface. Due to its hazardous properties, great care must be taken to ensure that the application is performed without it dripping into regions where damage may result. Screw-holes, overlaps and mating surfaces must be screened and masked.

### 1.1 Trial fitting of environmental screen

Of the ten available dummy super-crystal assemblies, the locations of their mountings on the back-plate were chosen to represent the worst possible case for potential assembly collisions and interferences. There are three particular regions that require attention and consequently three separate tests are envisaged, since at this time there are only a limited number of the correct sizes of dummy crystal assemblies available. Of the assemblies those that are currently available are:

4 off standard 5x5,
1 off 4x5,
2 off 5x4,
2 off 2x5,
2 off 5x2.

### 1.2 Trial fitting of environmental screen

The first of the Dees to have a trial assembly of the environmental screen was **EE-N (DEE 3)'**. This Dee was supported horizontally on its support ring with the surface supporting the super-crystals uppermost.

It was observed, when lifted from its container, that the open-shell nature of the environmental screen made the structure somewhat compliant. Therefore special care would be necessary in handling when manoeuvring it into position with the super-crystals mounted on the back-plate.

It was decided to carry out the trial fitting of the environmental screen before the super-crystals were positioned on the back-plate. It was clear during placement of the screen that as it came into contact with the back-plate there were significant movements at the interfaces. This was caused by the distortions within the structure resulting from the gravity induced loads through lifting.

After placement of the screen and removal of the hoist, the screen required a certain amount of manipulation to bring it into alignment with the fixing holes. It was concluded that when performing this operation with the super-crystal assemblies in place that stops should be provided to keep the screen away from coming into contact with them. One idea was to use the set of three holes on the outermost edge of the back-plate to be fitted with dowels thus acting as a sort of guide during assembly of the screen. One of these holes can be seen in the image on FIG. 1.2.2.

Initial checks when installing the environmental screen should include:

- Checking that all screw hole positions are aligned and if not, marking up those regions where there may be poor fit problems

- Check the alignment of adjacent and mating edges and surfaces are correct to the drawings, marking up regions that show excessive deviations
- Before tightening screws ensure that edges and surfaces of adjacent parts required to be aligned are moved to their correct positions within the limits of the play in the holes' clearances. This can be done by levering or jacking and then tightening to secure to the correct position.

- All environmental shields will require an alochrom coating on their external surface. Due to its hazardous properties, great care must be taken to ensure that the application is performed without it dripping into regions where damage may result. Screw-holes, overlaps and mating surfaces must be screened and masked.

- It is recommended that an initial trial fitting of the environmental shield should be performed without the crystals in place for all four shields.

- Keep Rob Loos informed of progress during the assembly tests, reporting any faults or misalignments. Ensure he is able to inspect each one so he is happy about the positioning of the pre-shower assembly.

- Carefully inspect the material coating of the cooling tubes for possible defragmentation caused by the flexing of the shield during assembly. This issue may require further serious thought in how to reduce the friability of the material.

### 1.3 Trial fitting of super-crystal assemblies

For checking the clearances of the screen around the super-crystal assemblies three separate tests were carried out due to the limited number of each type of super-crystal assembly available. The locations chosen for each test are shown in FIG. 1.2.1. For all of these tests it was possible to mount all super-crystal assemblies without the removal of the environmental shield.

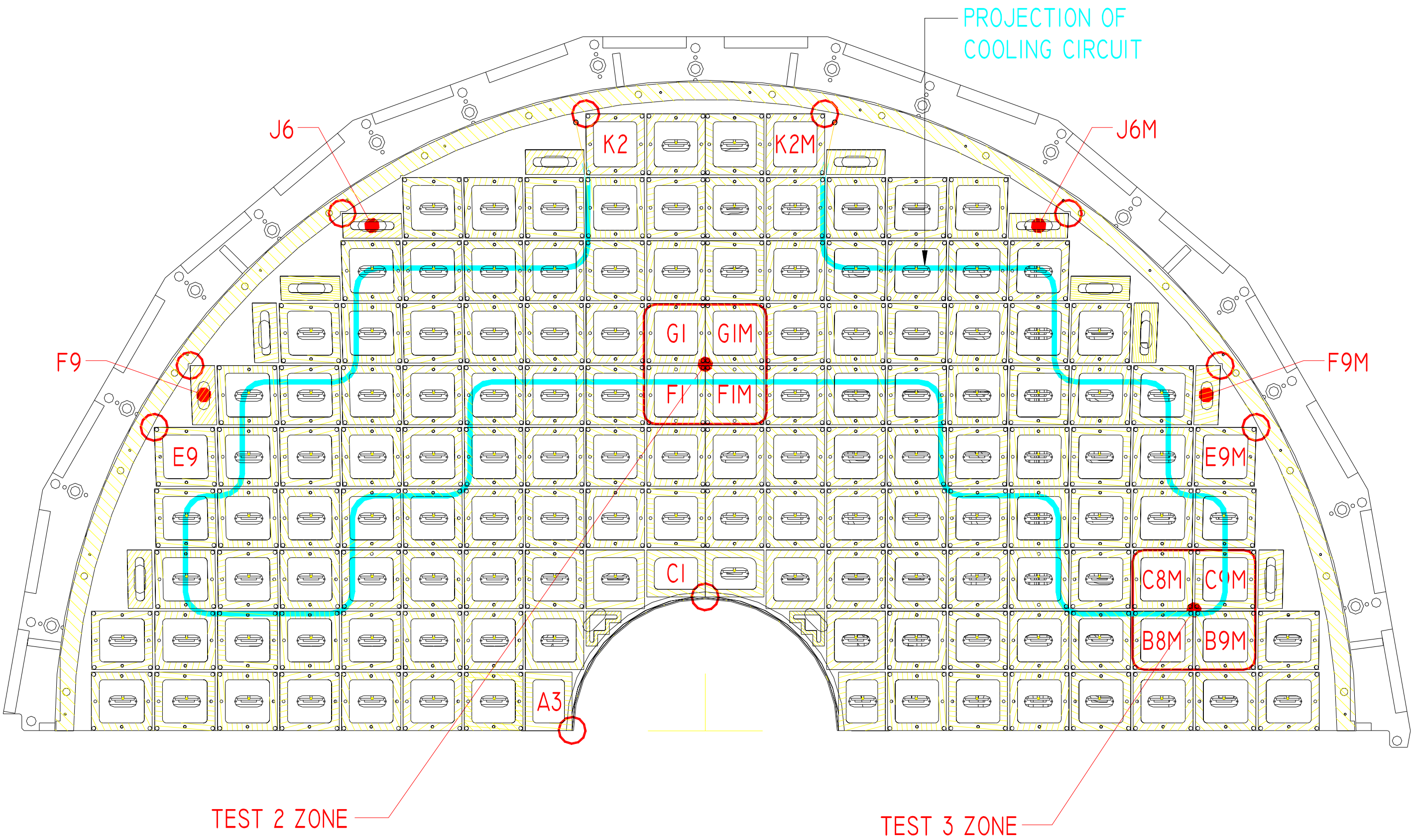


FIG. 1.2.1

The first of the tests was to look at the super-crystal assemblies mounted at the outer and inner extreme regions on the Dee, where there may be risk of contact with the outer wall of the screen or outer surface of the shield surrounding the beam-pipe. The red circles on FIG. 1.2.1 show the regions of principal concern where the super-crystal assemblies would come closest to the surrounding structures.

The remaining two tests were to observe the regions lying underneath the cooling pipes within the shield. These are shown as Test 2 zone and Test 3 zone in FIG. 1.2.1 where the projected position of the cooling circuit is shown superimposed.

Numerous photographs were taken at all of these locations, not all of which show in very clear detail their proximities to the screen since the enclosed volume was very restricted. All of these images (numbering 41 in total) can be viewed on the CMS ECAL website under “Installation”.

With some difficulty, approximate measurements were also made of the distances of the closest points of the super-crystal assemblies from all parts of the surrounding structures.

*1.3.1 Test 1*

The following locations were chosen for this test, using all ten of the super-crystal assemblies (crystal configurations shown in brackets):-

Location **E9** (5x5)
Location **E9M** (5x5)
Location **F9** (5x2)
Location **F9M** (2x5)
Location **J6** (2x5)
Location **J6M** (5x2)
Location **K2** (5x5)
Location **K2M** (5x5)
Location **A3** (5x4)
Location **C1** (4x5)

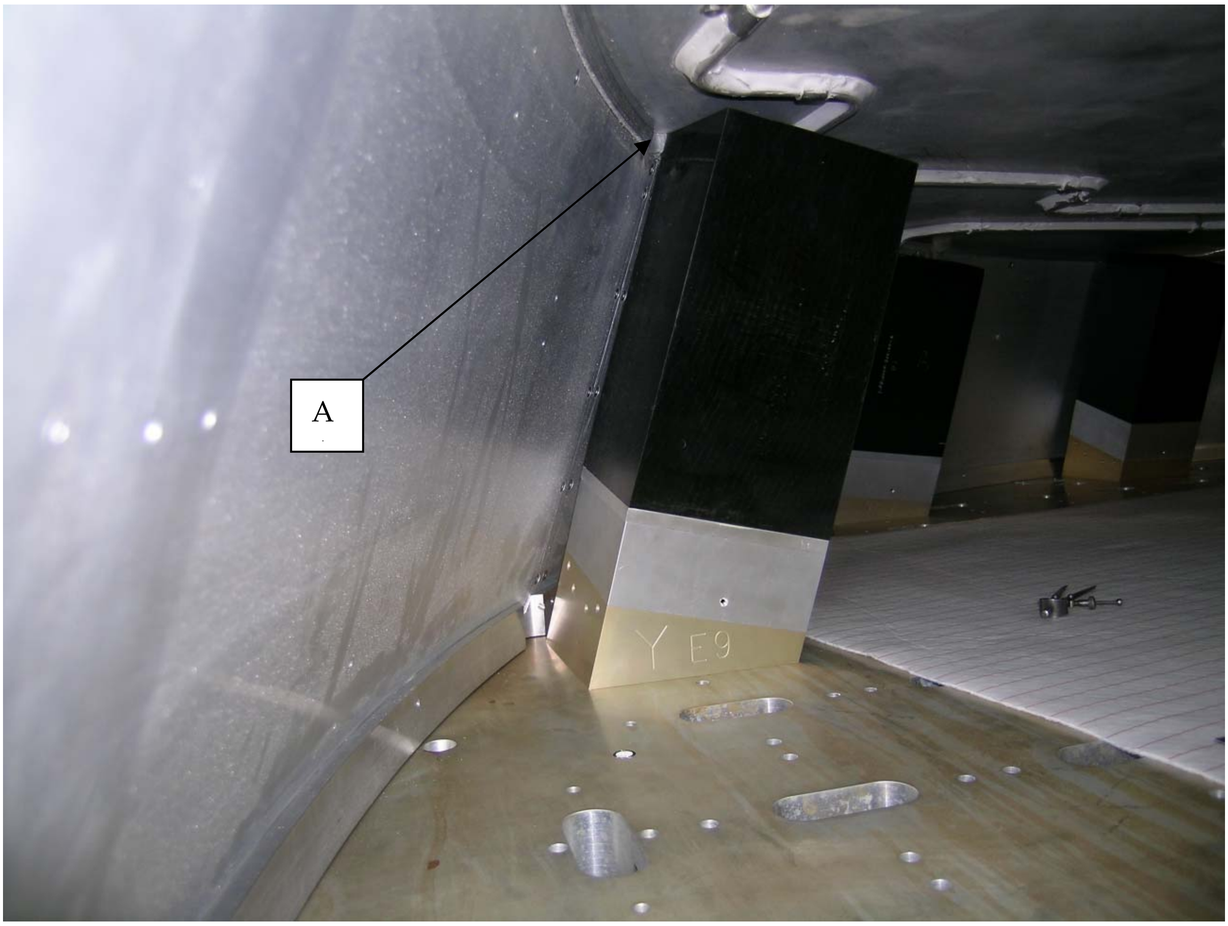


FIG. 1.2.2

For checking the clearances between each of the super-crystal assemblies and their surroundings, each location was carefully inspected with a torch from inside the shield (access was quite straightforward, if not a little uncomfortable). A steel rule was used to best obtain an approximate distance of the closest region of each of the assemblies to the screen and beam-pipe shield components. The following observations and measurements were made at each position:

**E9:** 7mm from outermost upper corner of alveolar (as indicated by arrow 'A' in FIG. 1.2.2) to the top panel vertically above.

**E9M:** 5mm from outermost upper corner of alveolar (as indicated in a mirrored sense by arrow 'A' in FIG. 1.2.2) to the top panel vertically above.
16mm from the same point to the edge of the machined clearance pocket in the screen wall.

**F9:** 27mm from outermost upper corner of alveolar (similar to previous cases) to the top panel vertically above, within the machined clearance pocket in the screen wall.

**F9M:** 27mm from outermost upper corner of alveolar to the top panel vertically above, within the machined clearance pocket in the screen wall.

**J6:** 9mm from outermost upper corner of alveolar to the edge of the machined clearance pocket in the screen wall.

**J6M:** 10mm from outermost upper corner of alveolar to the edge of the machined clearance pocket in the screen wall.

**K2:** 7mm from outermost upper corner of alveolar to the top panel vertically above.
11mm from the same point to the edge of the machined clearance pocket in the screen wall.

**K2M:** 9mm from outermost upper corner of alveolar to the top panel vertically above.
12mm from the same point to the edge of the machined clearance pocket in the screen wall.

**C1:** 11mm from outermost upper edge of alveolar to the top panel adjoining strip vertically above (both indicated by arrow 'A' in FIG. 1.2.3).
2mm from point 'B' (indicated in FIG. 1.2.3) to the fillet weld on the outer surface of the beam-pipe outer shield.
There is contact between the inner edge at the bottom of the positional spacer and the weld on the outer surface of the beam-pipe outer shield as shown in the image in FIG. 1.2.4. This edge will be bevelled as for position A3.

**A3:** There was contact between the inner edge at the bottom of the positional spacer and the weld on the outer surface of the beam-pipe outer shield as shown in the image in FIG. 1.2.5. This edge was bevelled as shown in the image in FIG. 1.2.6.

After re-fitting there was adequate clearance between the positional spacer and the weld on the outer surface of the beam-pipe outer shield (approximately 2mm - FIG. 1.2.7).

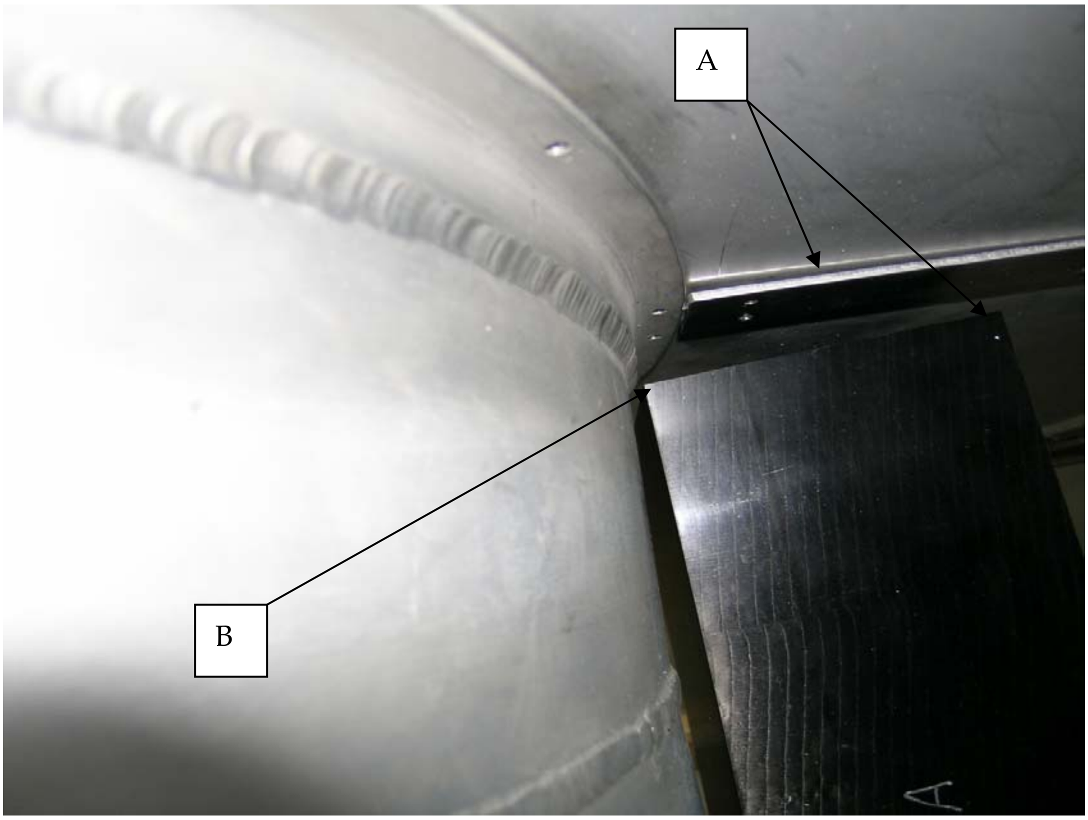


FIG. 1.2.3

FIG. 1.2.4

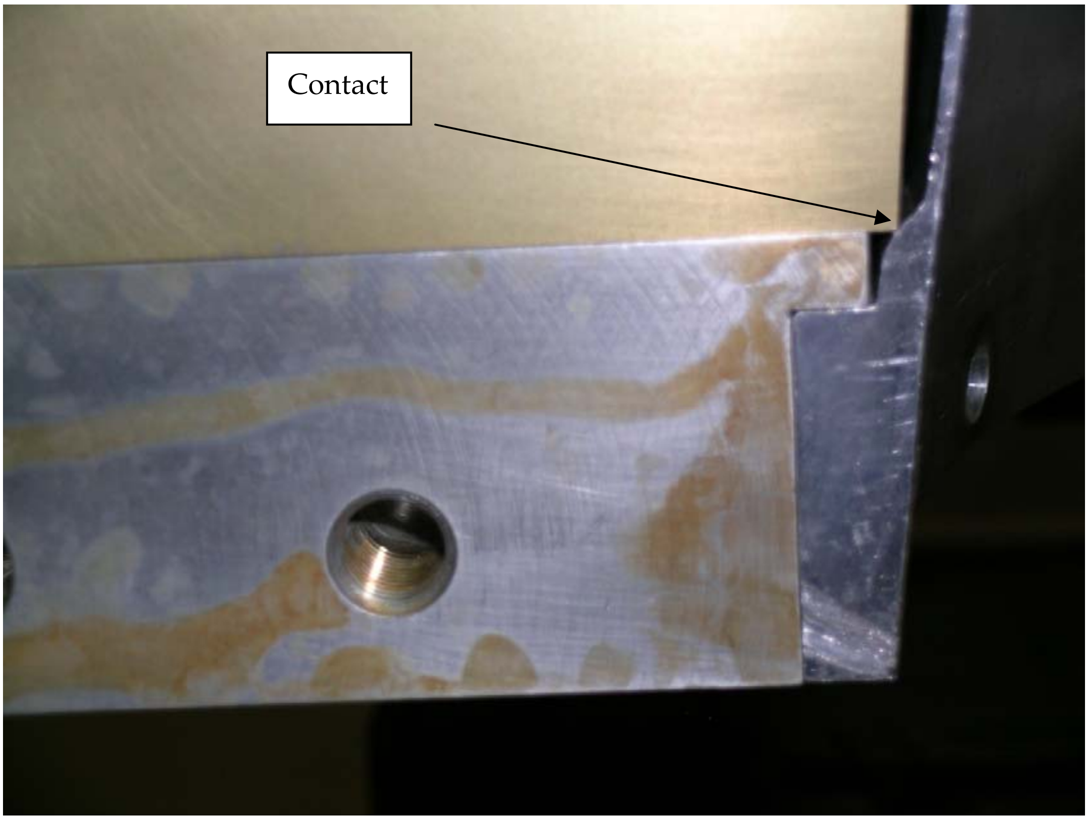


FIG. 1.2.5

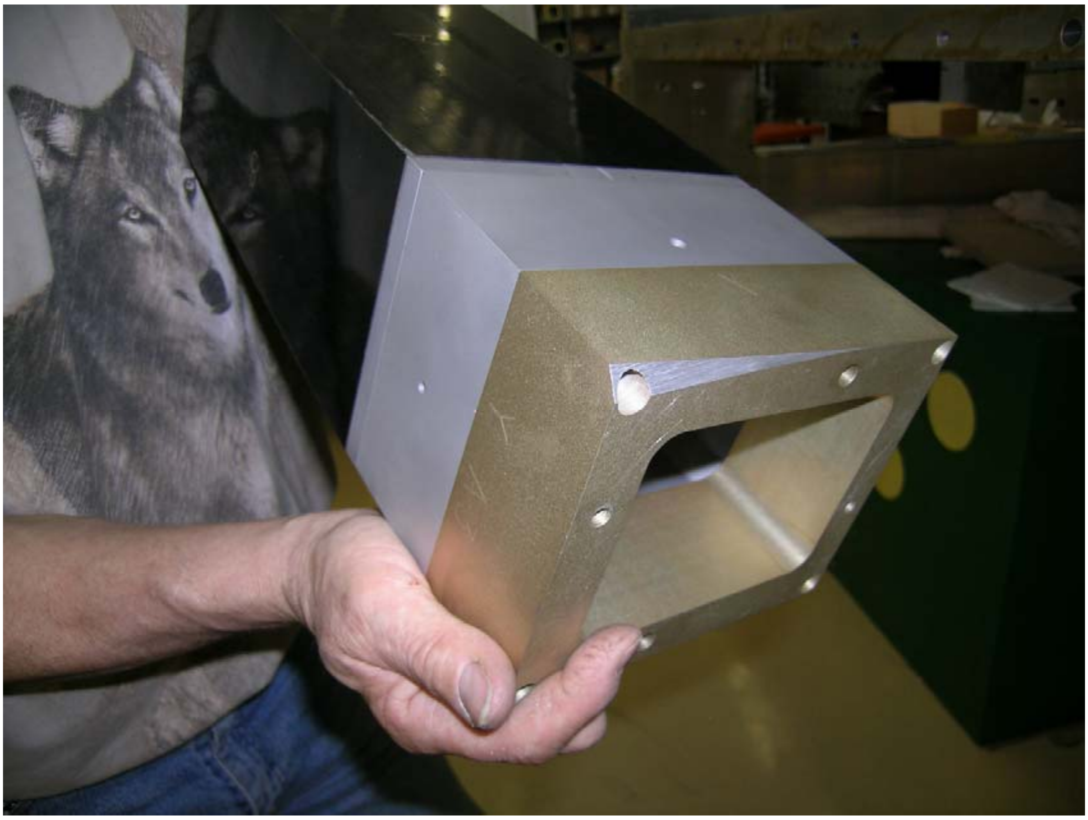

FIG. 1.2.6

FIG. 1.2.7

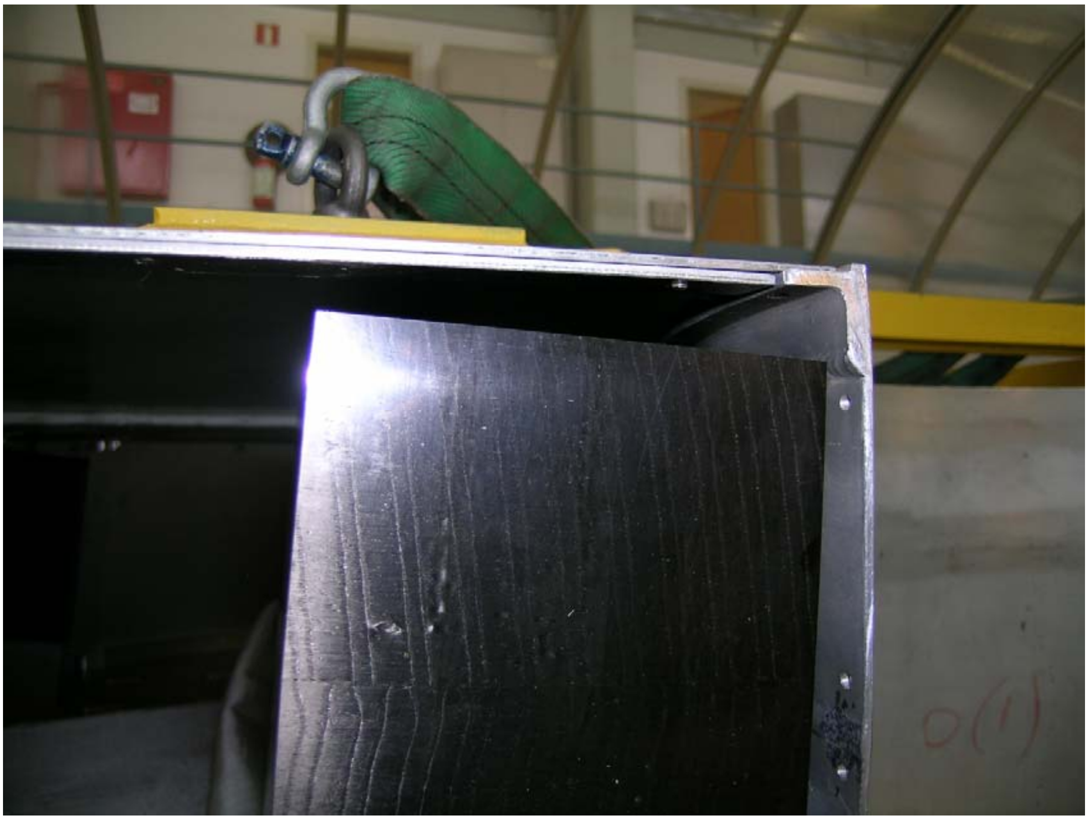

FIG. 1.2.8

As for Test 1, for checking the clearances between each of the super-crystal assemblies and their surroundings, each location was carefully inspected with a torch from inside the shield. A steel rule was used as before to best obtain an approximate distance of the closest region of each of the assemblies to the screen and beam-pipe shield components including the cooling circuits mounted on the underside of the top plate of the screen. The following observations and measurements were made at each position:

#### *1.3.2 Test 2 zone:*

FIG. 1.2.9 shows an image of all four super-crystal assemblies mounted underneath the screen. Gravity induced loads acting on the upper part of the screen caused a noticeable sagging of approximately 5-6mm. This would have brought the screen into contact with the upper parts of the super-crystal assemblies. A wooden baton was cut to length to prop up the screen and restore it to the correct height at this region.

FIG. 1.2.9

**F1 & G1:** The image in FIG. 1.2.10 shows super-crystal assemblies F1 andG1. For each assembly the closest proximities are between the highest points on the alveolar (points 'A' although not very clear in the image) and the adjoining strip running along the screen. There is a clearance here of approximately 4-5mm.

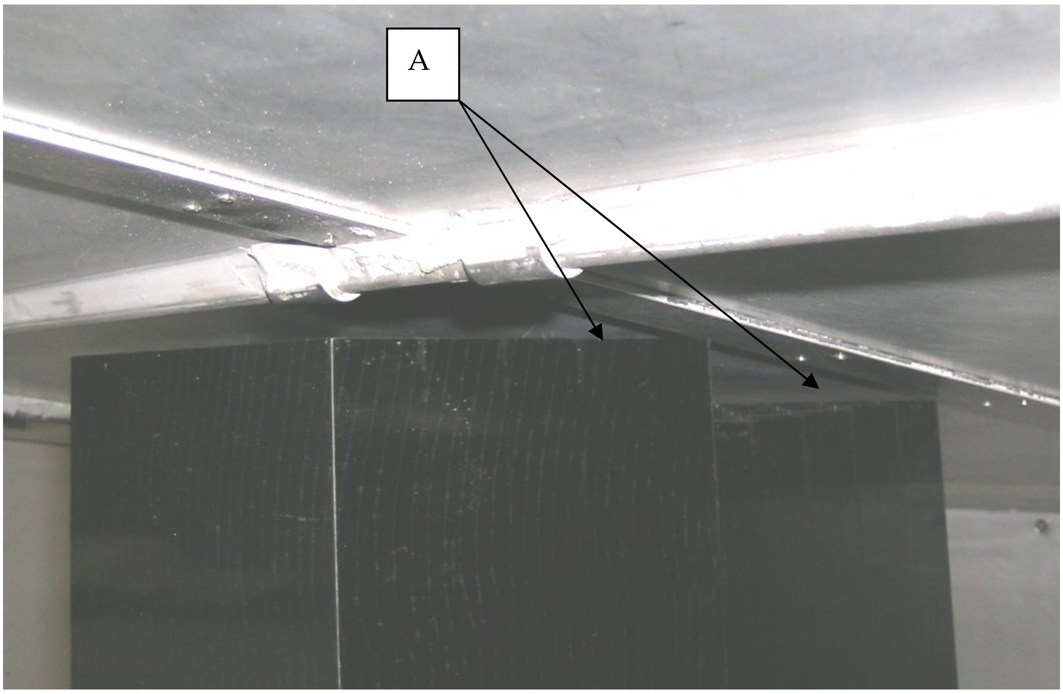


FIG. 1.2.10

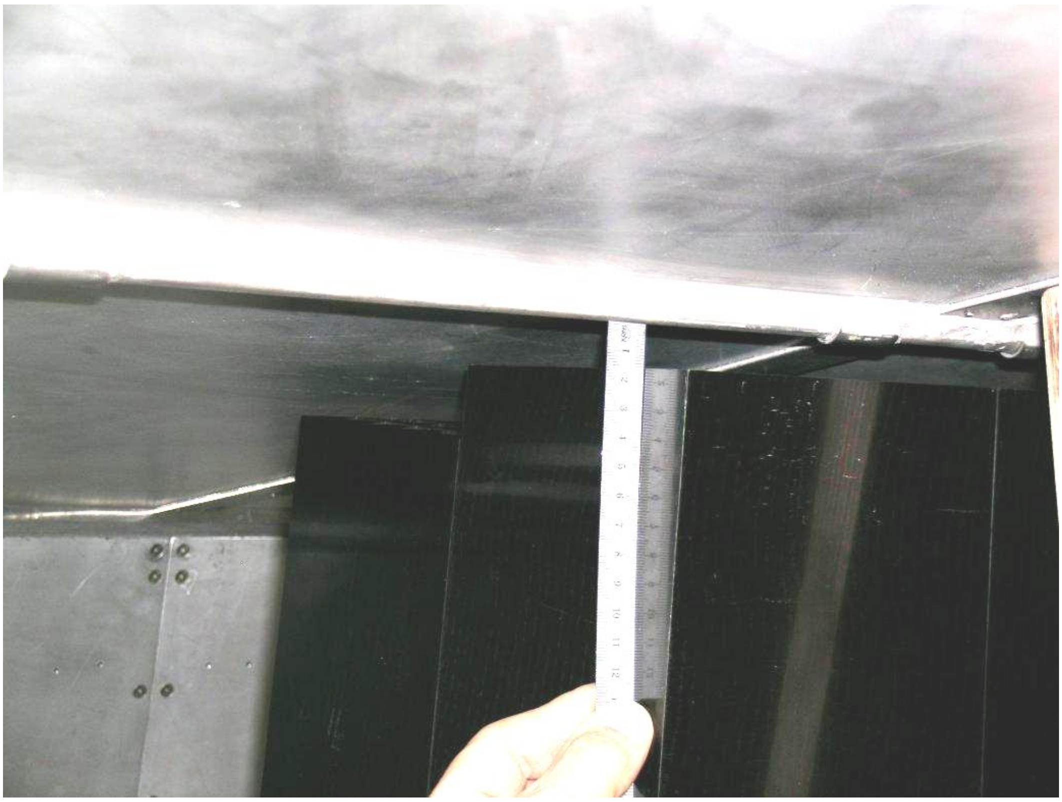

FIG. 1.2.11

In FIG. 1.2.11 the closest that the alveolar comes to the cooling pipe is approximately 15mm

**F1M: & G1M:** Due to symmetry measurements at these locations were similar to F1 and G1 above.

### *1.3.3 Test 3 zone:*

FIG. 1.2.12 shows an image of all four super-crystal assemblies mounted underneath the screen. Gravity loads acting on the upper part of the screen caused much less sagging at this region, since the location is much closer to the supported side of the screen. The wooden baton was left in its previous location propping up the screen at its centre.

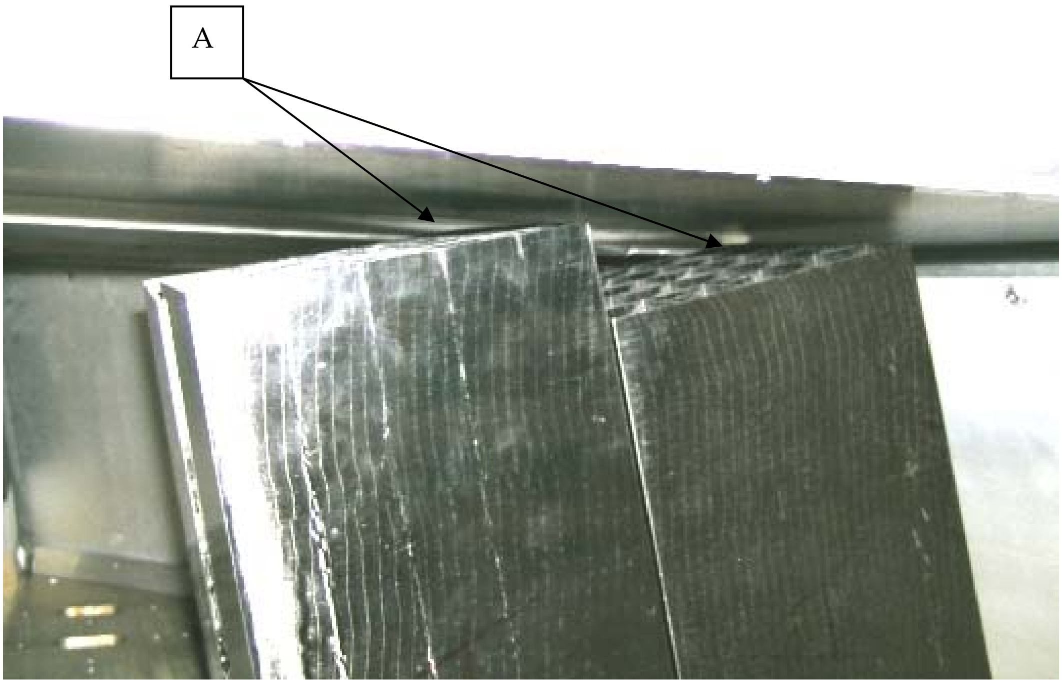


FIG. 1.2.12

**B8M & B9M:** These are the two super-crystal assemblies most visible in the above figure. The points closest to the screen are the highest corners indicated by arrows 'A', and the closest feature was the cooling tube in both cases. For B8M this distance was measured at very close to 1mm. For B9M the distance measured was approx. 3mm. The other high corners measured approximately between 13mm to 16mm for both locations

FIG. 1.2.13

**C8M & C9M:** The image in FIG. 1.2.13 shows these two super-crystal assemblies with the previous assemblies (B8M & B9M) removed. Again the cooling tube is the closest feature for both assemblies, with a distance of 3mm measured for C8M.

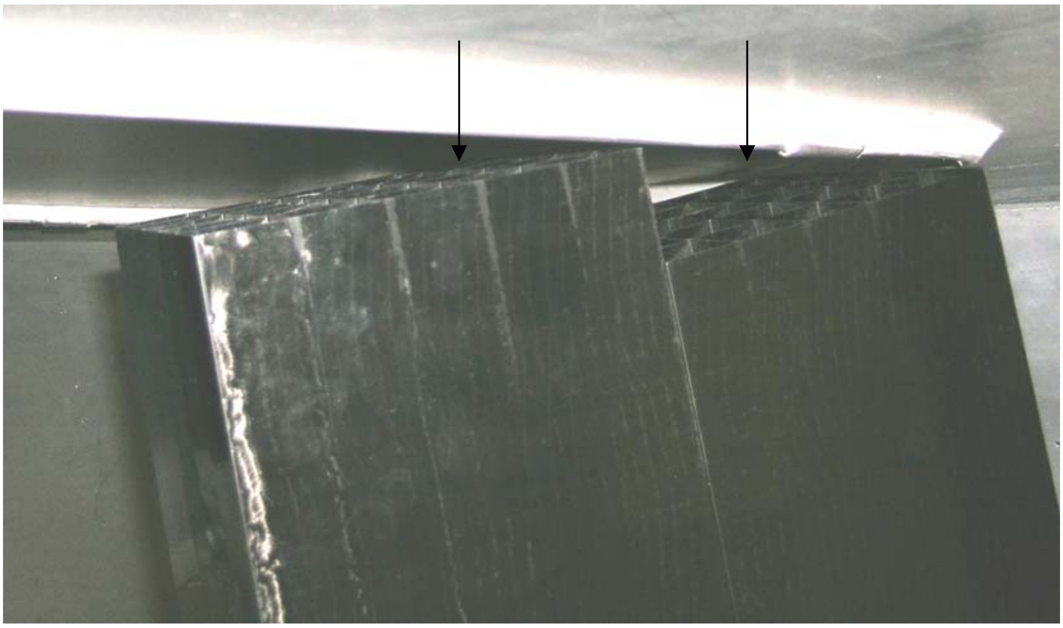

FIG. 1.2.14

In FIG. 1.2.14, the highest corner points of the alveolar are shown by the arrows. These are both clear of the tubes with the distance to the screen directly above measuring approximately 5mm in both cases.