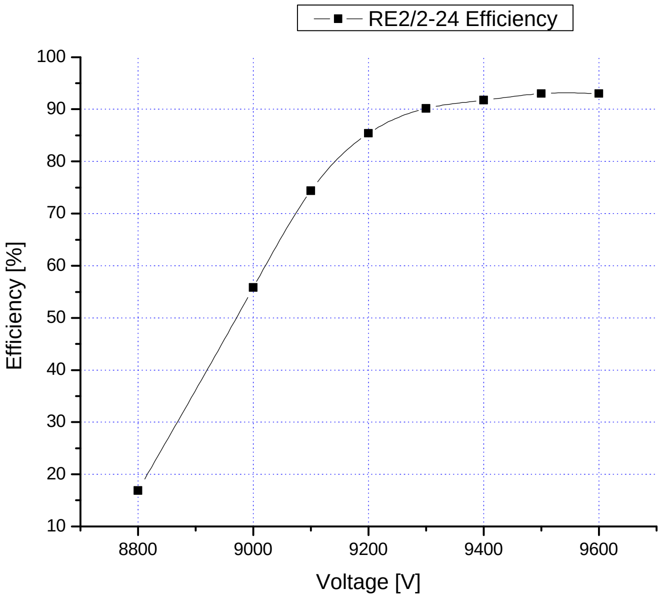
Some Comments on Assembly and Performance of pre-series RE2/2 chambers

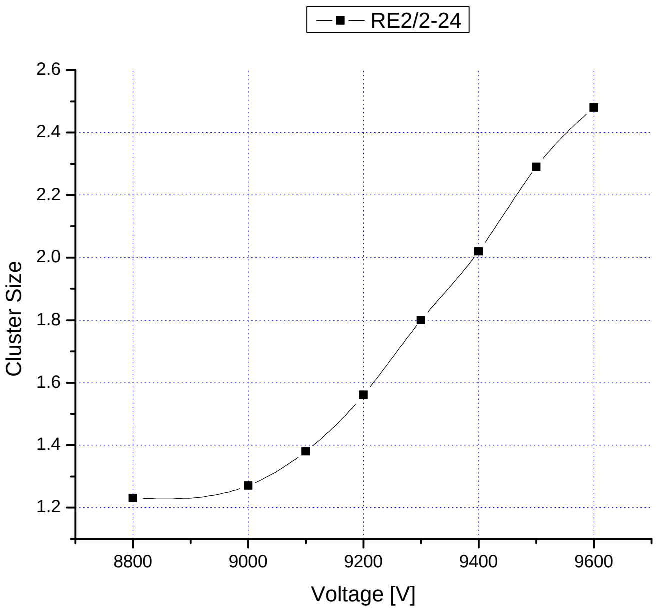
With input and comments from colleagues in the ISR lab and PH-CMM

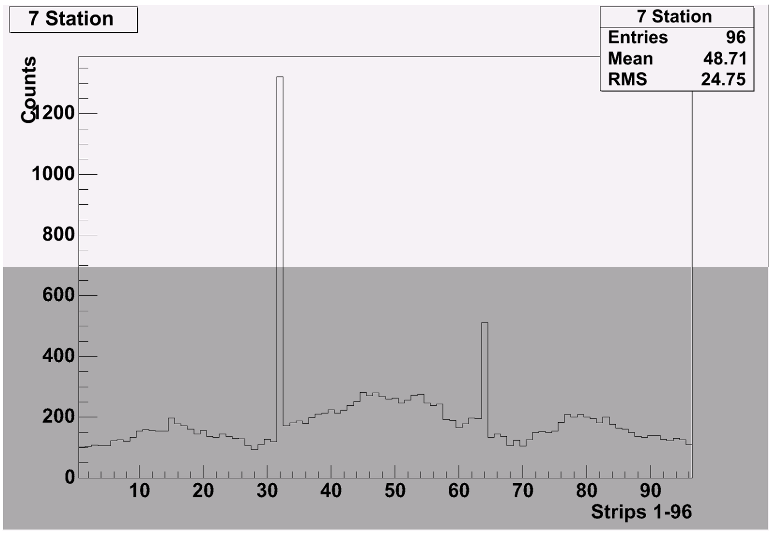
The 3 Chambers were received at CERN on the 2nd June 2005.

Results

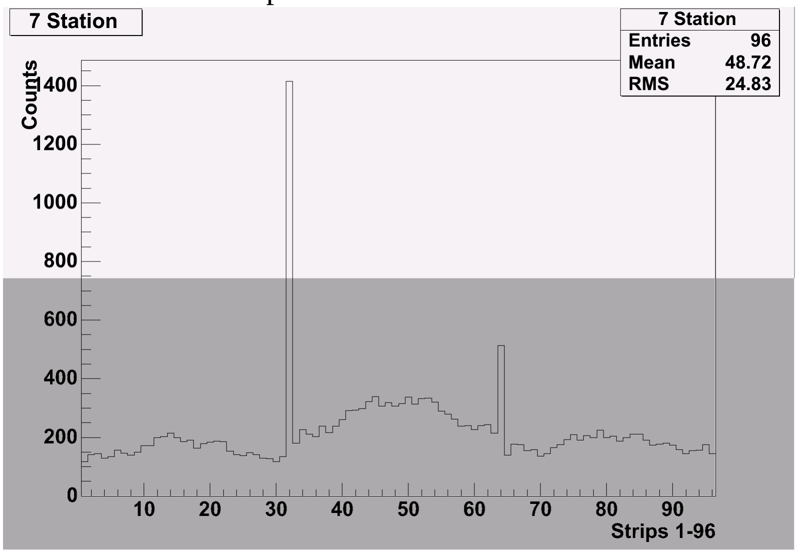
After some corrections and improvements of grounds in preparation for the cosmic stand we can report that the RE22 chamber number 24, is at least 92-93%.efficient The low value may be due to geometrical acceptance which has been optimized for RE1/2 and RE1/3. Overall, the chamber is fine and behaves just like any RE1 chamber. Some plots are shown below. Strips 32 and 64 (edges) are noisy, as is the case of RE1 and RB chambers.



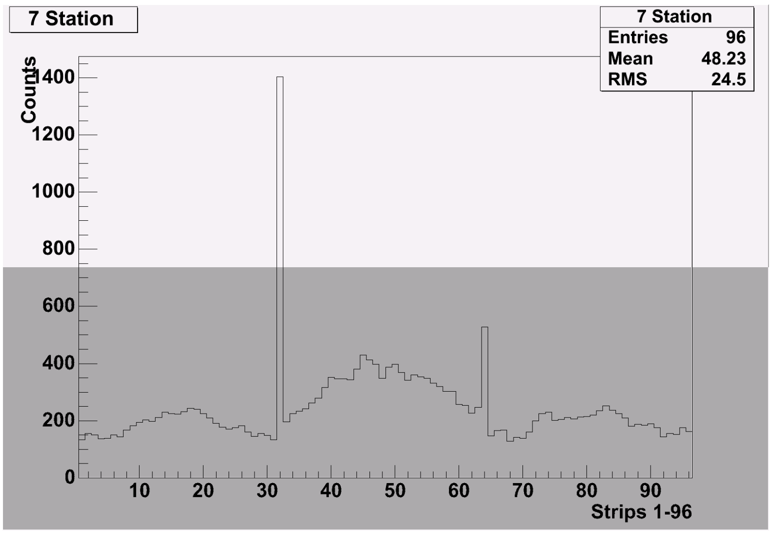




Three sectors TDC spectrum with 9.4 kV



HV 9.5 kV



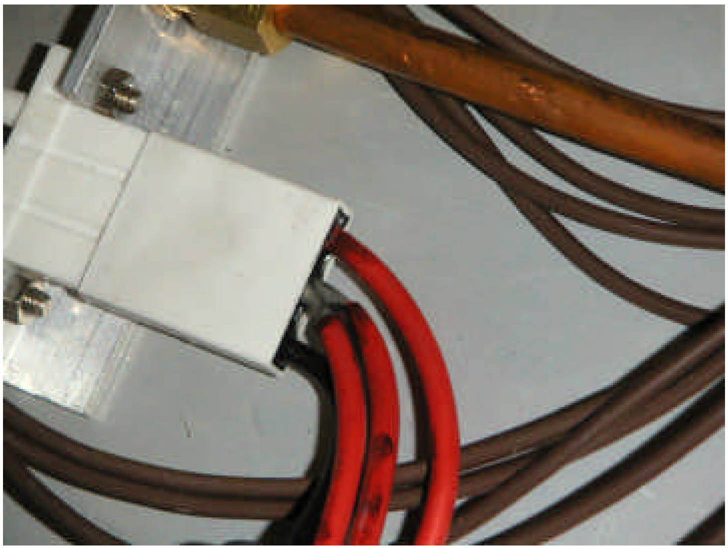
HV 9.6 kV

Some comments and suggestions based on examination and tests of the first three RE2/2 chambers received. It is recommended that all completed chambers in Pakistan be examined for similar features and corrections made where necessary. The production procedures should simultaneously be adapted to eliminate any systematic faults observed. Retrofitting at CERN must be minimized.

Cabling.

- HV connector.

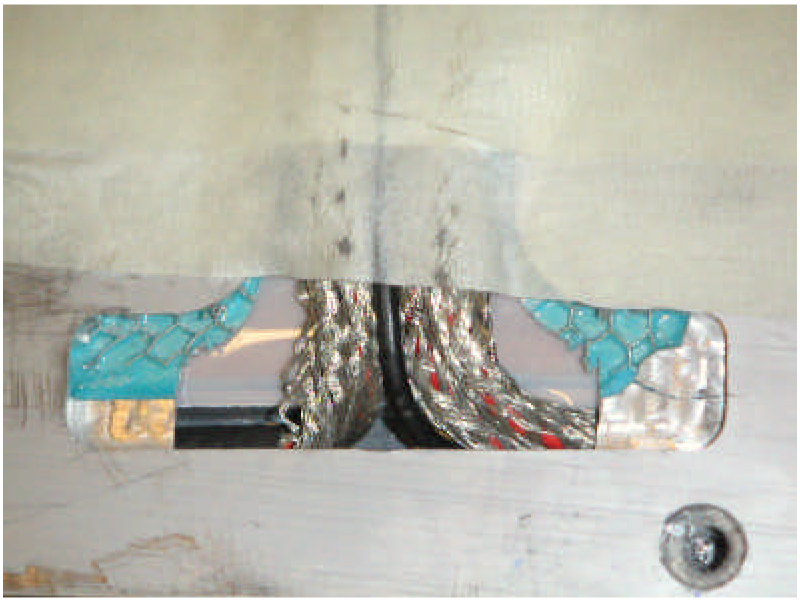
Great care must be taken in removing the insulation from the Cable leads. Here the insulation has been removed outside the connector, so compromising the HV breakdown strength.



Sharp edges could compromise the insulation of the Faraday cage Cu shield wrt the chamber structure. Tape (polyester) is a solution. Hot melt run along the edges is more laborious but gave some reasonable results requiring additional refining in the procedure.

(NB. The insulation between the chamber ground and the signal reference/Faraday cage is in fact very good on this chamber.)

The opening for these cables is well calculated and executed.



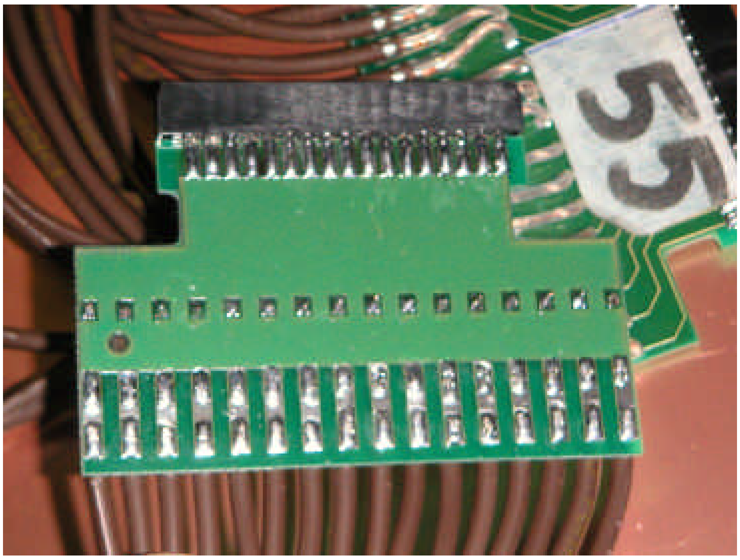
Some of the 0V return lines for the gaps were of thicker section ($2mm^2$) than those used on the RE1 chambers ($0.75mm^2$). This makes cable routing more difficult, HV connector assembly is not possible with both wires and more critically it weakens the 0V connection on the gap. This is already a weak point and may explain the failure that we found. There is no solder on this failure! Similar failures have occasionally been identified on RE1 gaps.

- Signal Cabling

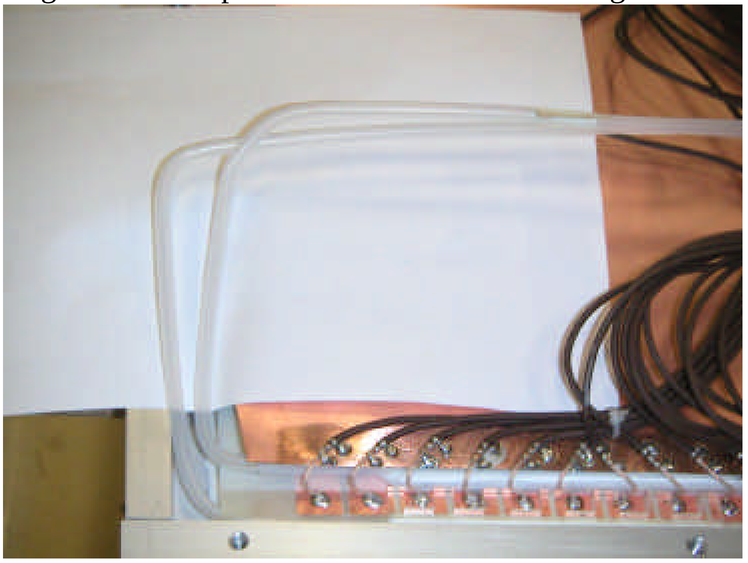
The soldering of the ferrule to the thick copper sheet is done well considering the difficult conditions. Thermal damage to the insulation of the centre conductor is minimal, amazingly.
However the wetting of the surface is not optimal and should improve considerably with the arrival of the Cu from Italy. If additional flux has been used then this should be washed off with acetone and isopropyl alcohol.

The soldering to the strips (35µm Cu) is generally good but there is room for improvement in consistency.
The cut out to access this solder point is a better concept than in RE1

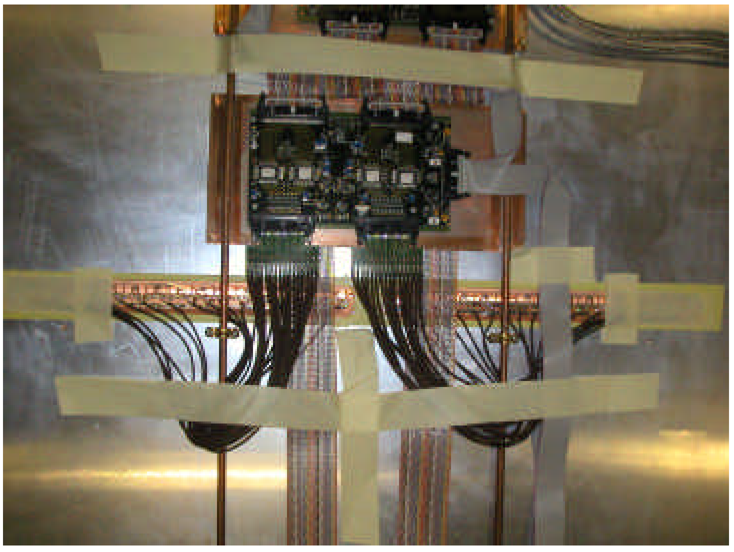
The soldering to the adaptor boards appears well done .

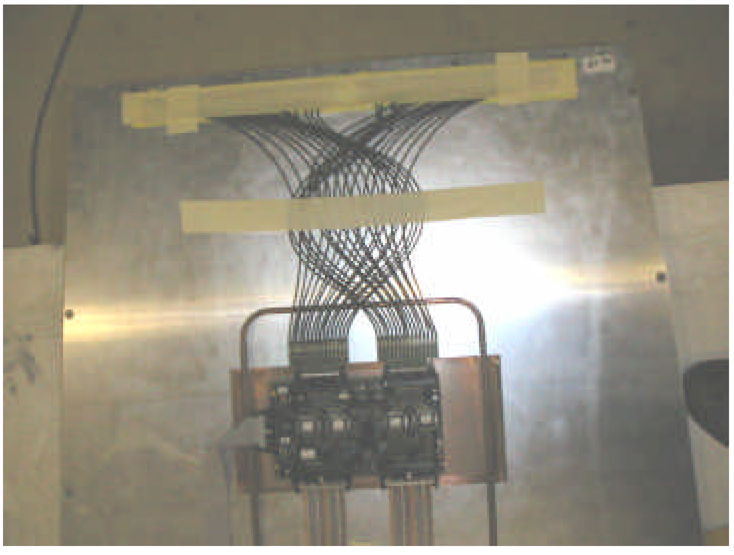


Securing the cables is good as is the orientation of the ferrules upon soldering to the Cu sheet. This angle is most important as it dictates the routing .



We recommend revisiting the routing to obtain a more repeatable result as illustrated below on these RE1 chambers.



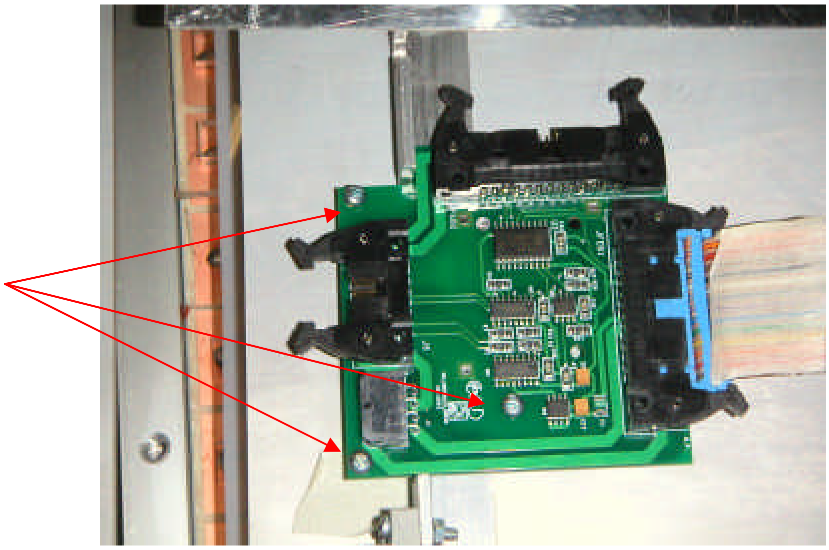


The Mylar film has been cut back as little as possible so that it acts as a protection to the coaxial cables, this is good solution and could be extended to cover both the lower and upper sharp edges of the HCP.(Honey comb Panel). However where the cables must run along inside the channel before exiting, an additional solution is required.

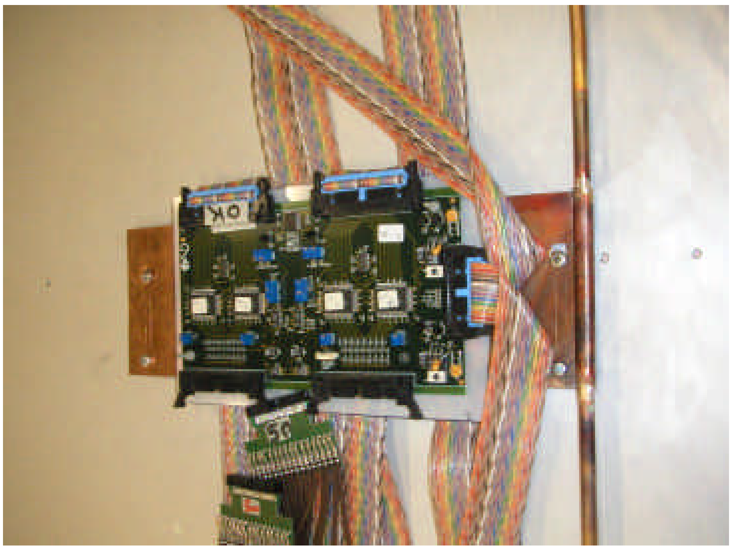
If this solution is retained, then the positioning of the Mylar is critical to avoid modifications being needed later in assembly process (as evidenced by these irregular edges).

- LV

The LV Distribution Board was not fitted to these three pre-series chambers . This should be secured directly to the HCP using small and short (!!) self tapping screws. A similar solution works extremely well on RE1 for securing the small Alu panels covering the coaxial cables outside the shield box. Here 8mm long PA stand-offs have been envisaged with self tapping screws of 2.9 x 13mm. The lower screw will require an insulating washer as it is very close to a conductor trace.



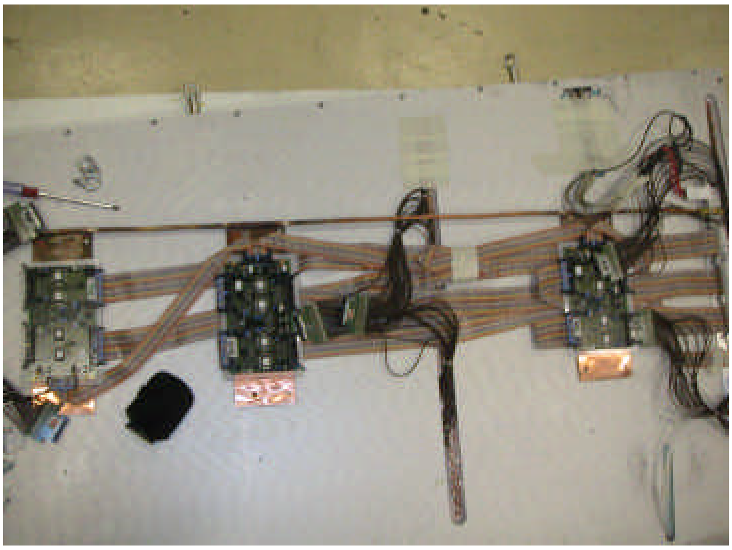
Little advantage can be obtained by folding the cable at a traditional 90 degrees. Here a slight reduction in length is obtained with a consequent lose in esthetic appeal !



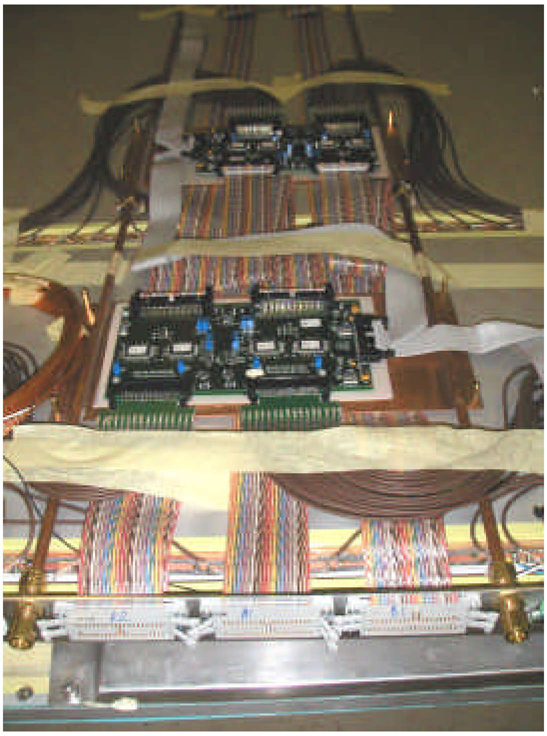
The use of twist and flat cable for the power cables imposes 50cm cutting intervals. A flat untwisted cable is adequate and easier to install as the length is not constrained to discrete values. They should be kept, where possible, away from the signal flat cable.

- Flat cables

The placement of the FEB can be offset in phi so as to obtain parallel paths for the flat cables with no crossover and little excess length. This is the reason why the Cu cooling plates are so ‘wide‘ in phi.

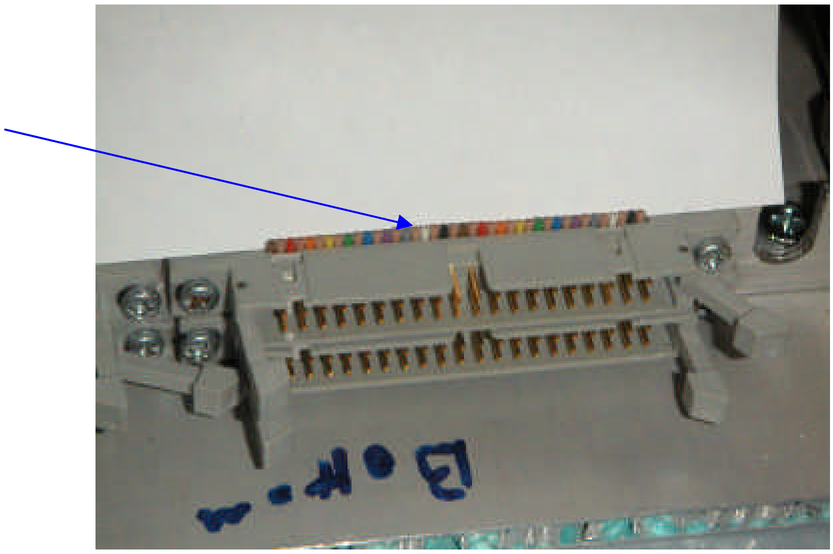


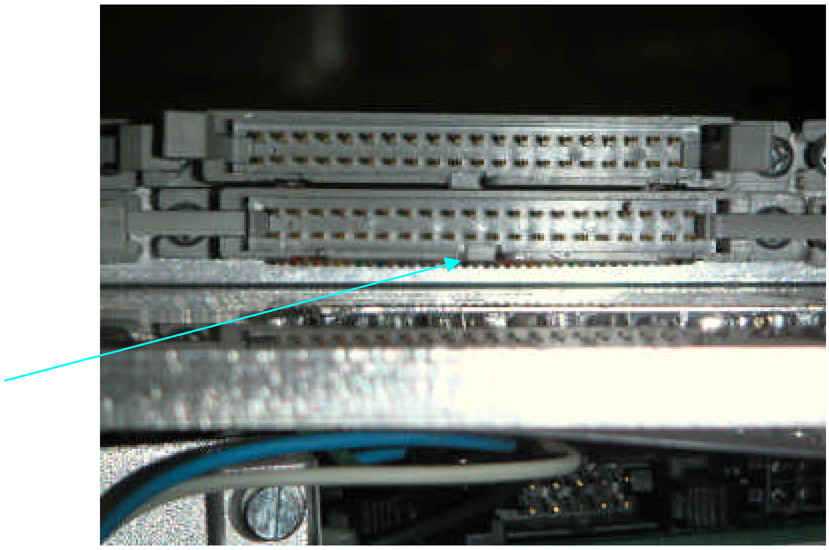
Here the cables run parallel with no crossing and only 2 thicknesses under the Cu cooling plates.



The cables to one FEB <u>must</u> be of the same length. The signal timing compensation to the Link board box is done off the chamber in the ‘skew clear’ cables .

The cable should be cut off flush with the connector as in some cases shorts could occur. Possibly to the HCP or an adjacent connector.

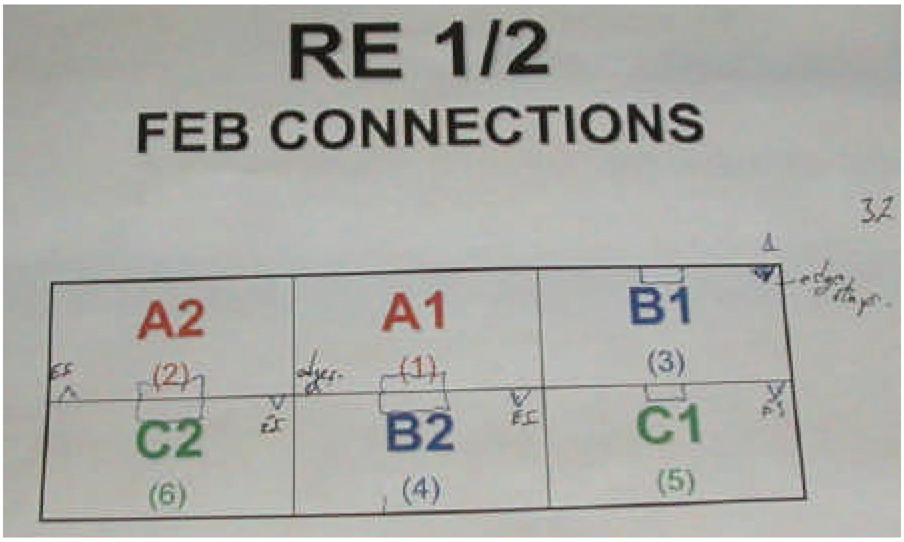




Crimping of the connectors is most important as this will influence reliability and operational life time. Care must be taken and the operation followed closely.

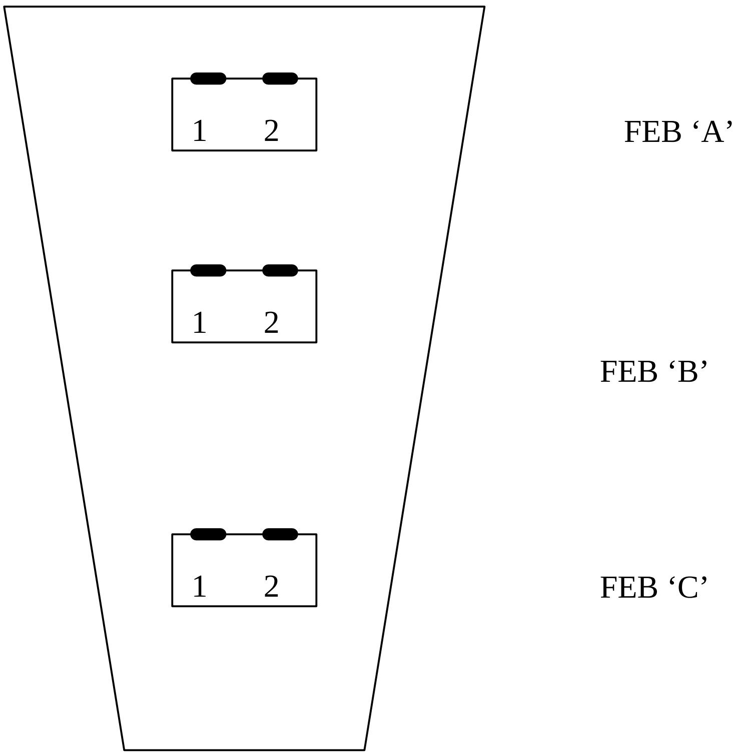
The routing of the flat cables is not trivial and if at all possible must agree with those chambers already made, namely RE1. This is necessary as the read out is entirely dependant upon the cable routing and consequent connector layout on the patch panel.

The diagram of connector to FEB allocation should be kept in mind.



Chamber FEB layout

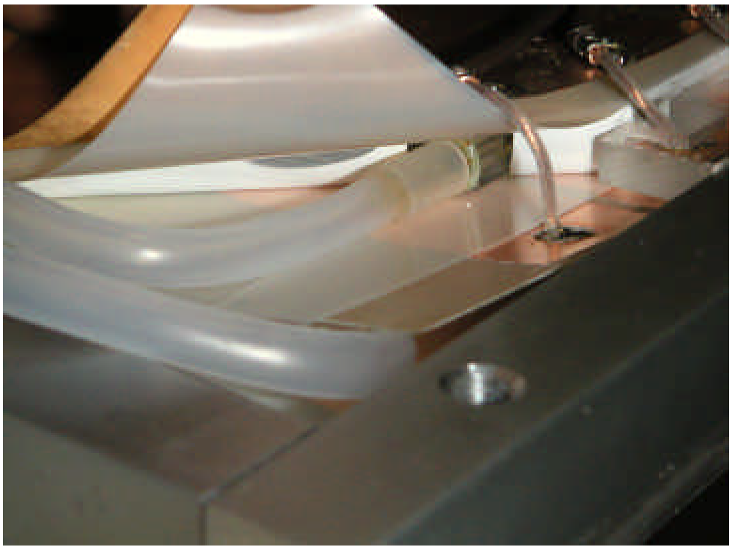
As viewed from the front face of the chamber in all cases inc RE1 and RE2



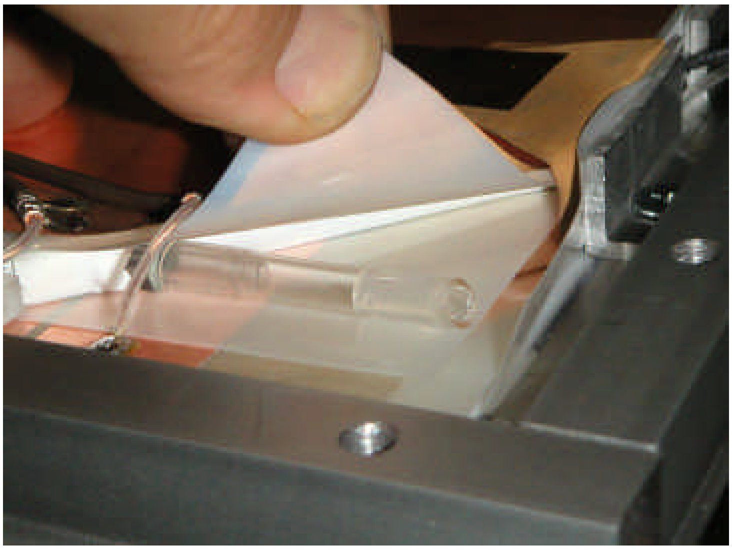
Piping

- Gas

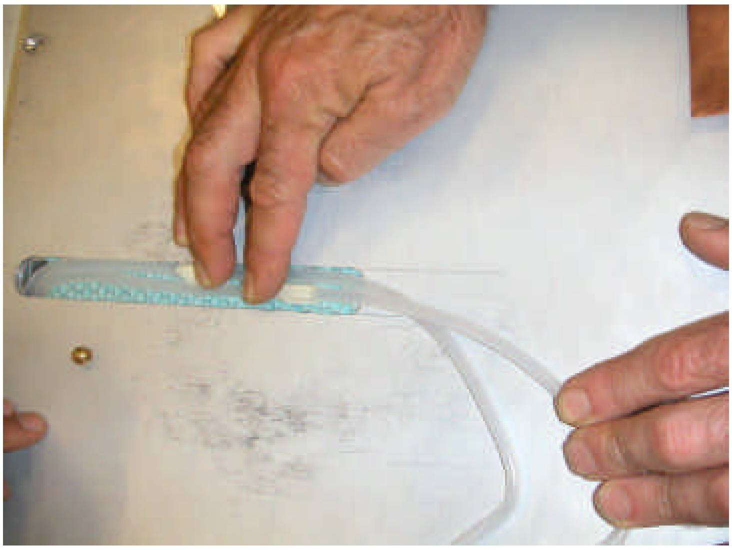
The connections to the gaps seem to be well done. Heat should be used in moderation if not the insert can be weakened.



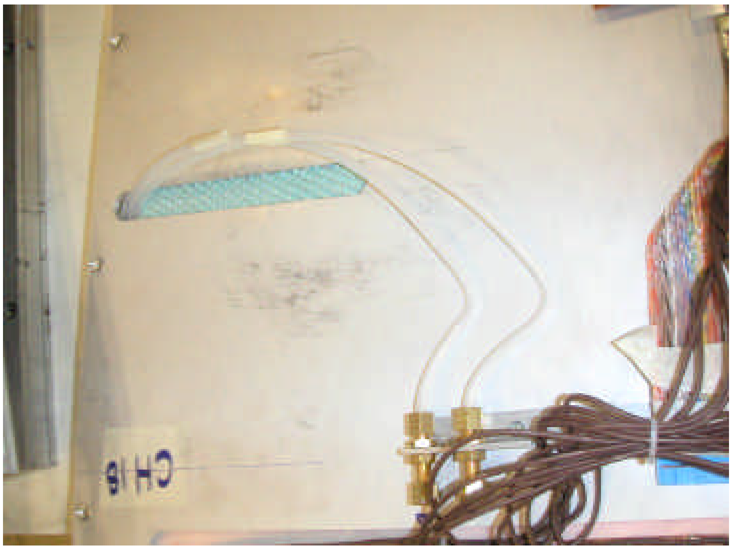
Plugging up of the unused gap connexions should preferably be done with the PE pipe used else where and not PVC. The PVC will resist chemically but may be more liable to hardening in time.



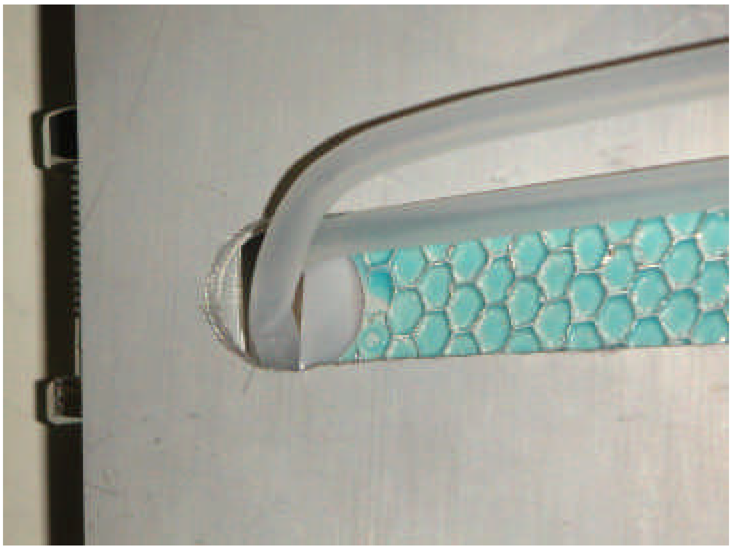
The cut outs in the panel are not deep enough and so leave a rough surface for the pipes to be damaged upon. Taping, remilling or filling with a low viscosity caulking compound should be considered.



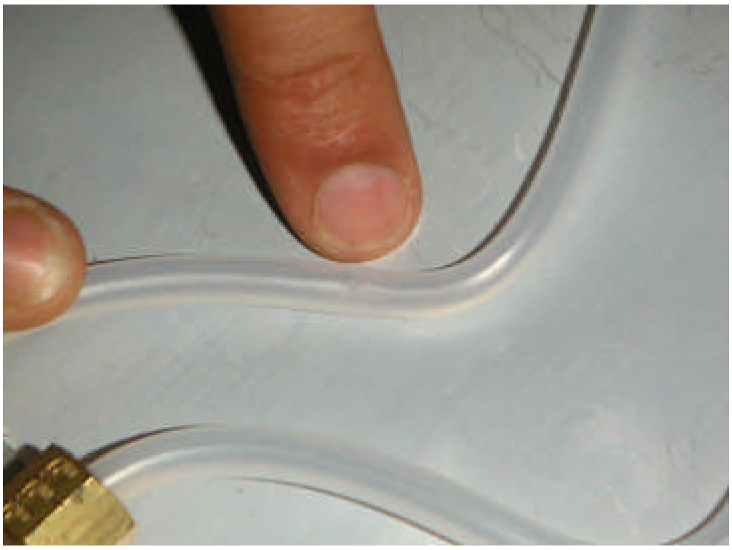
The routing and thermo forming of the gas pipes must be done so that the routing is facilitated. This is not such a good example. Numerous iterations will be needed to obtain a good repeatable result. Tooling is essential for each model of pipe.



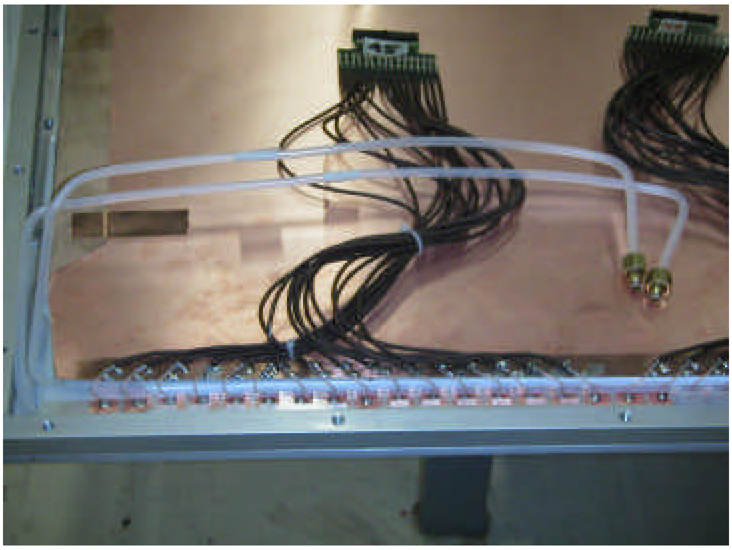
Coming back to cut outs, here the gas pipe can easily be kinked if the hole is too small as is the case in the picture below. (The HV cutout is a good example). Flow should not be obstructed. The kink will be unlikely to relax and alleviate the problem



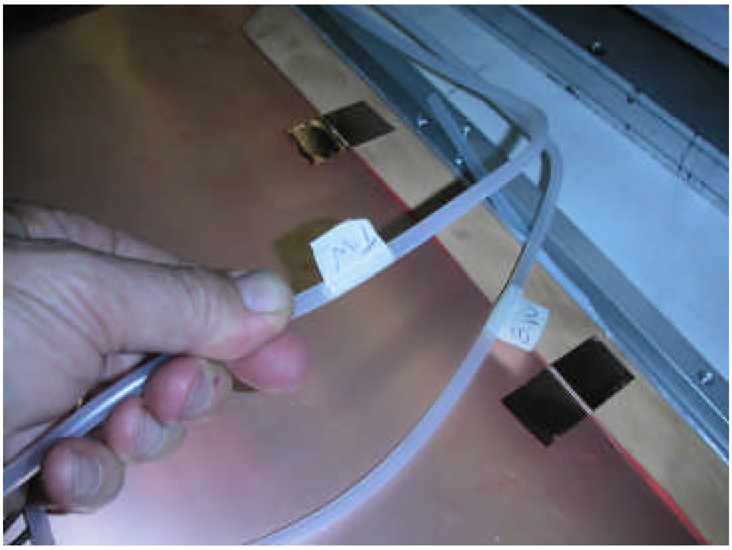
The pre-forming of the pipes must be done according to a pre-established method, using standard tooling (to guarantee the right temperature for the correct length of time). In the case illustrated, the pipe has melted and is damaged.



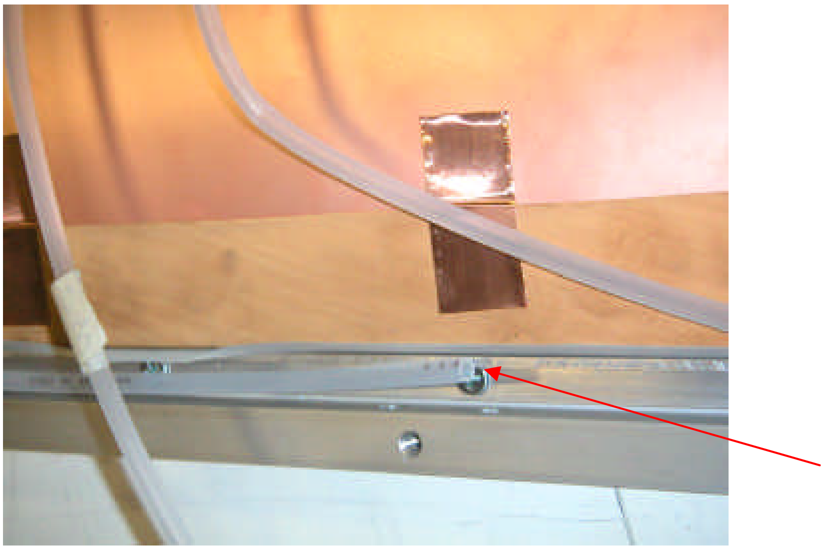
The routing has to be simplified, avoiding unnecessary crossovers



Labeling the pipes is good practice to prevent mistakes.



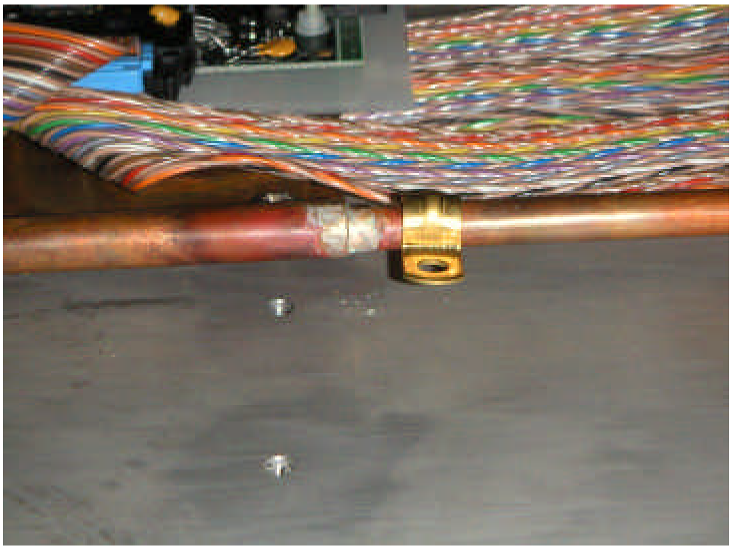
Leaving spare pipe in the chamber is not really useful.



- Copper Cooling Circuit.

Brazing the pipe to the cooling plate is unnecessary. ‘Soft’ Solder is sufficient (Pb & Sn)
The design of the FEB support plate to 8mm pipe can be simplified by a simple overlay. Sufficient strength will be achieved. The pipe between bulkheads must be a continuous piece to ensure a leak free system. The copper pipe should be hard, not annealed, for reasons of long term leak tightness at the union .

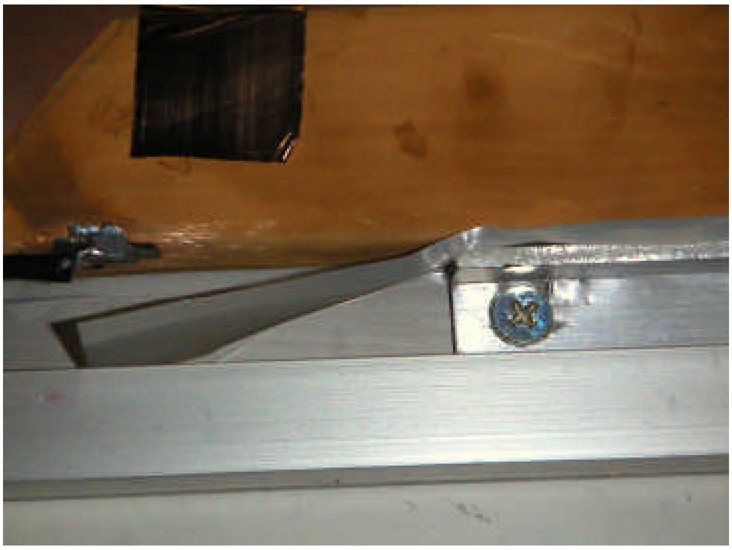
Two M5 inserts have been provided in the HCP for pipe mounting using the clamp shown and an additional one on the far side of the Cu cooling plate. In the RE1 case M6 nuts are used to increase clearance. There seems to be a design error in the RE2 case as one more hole should have been provided on the ‘far side’, giving a ‘3 point ‘ mounting scheme. If hard quality pipe is used, soldered to the cooling plate, the assembly may be rigid enough without modification.



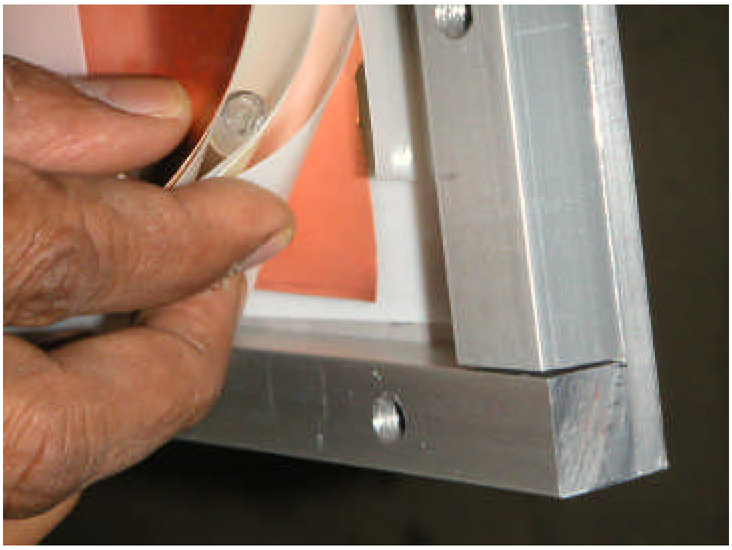
Structure

Mechanics

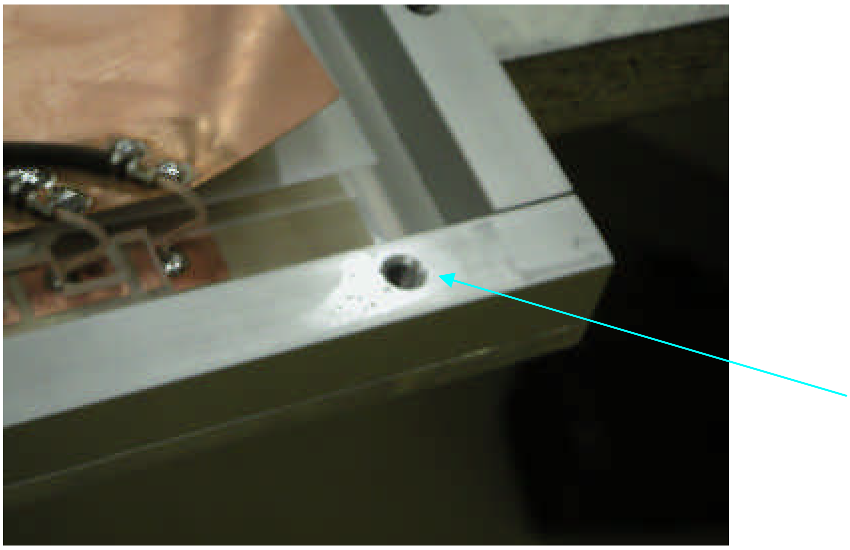
- Space is tight but it all fits ! Perhaps the insulating band on the gap locator could be incorporated into the bottom Mylar layer. In both RE1 and RE2, the gap insulation at the 'R' ends of the structure should be reviewed.



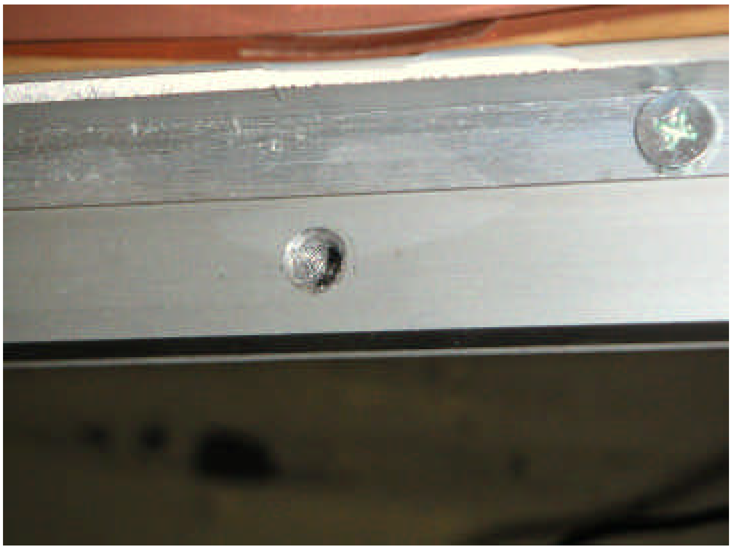
The bottom copper foil must be insulated from the chamber chassis. Since the chambers are vertical the copper film may shift, thus the edges should be insulated with tape. Tape used to retain pieces in place during assembly is insufficient. Some additional positive location is needed.



- Overall the structure of the chamber appeared fine but it would be preferable to remove traces of oil.



- More importantly any metallic swarf should be removed as it will tend to move under the influence of the 'E'(and or 'B') fields and finally end up giving a breakdown problem.



- The gaps had been well cleaned as no finger marks were visible.. The gap showed considerable curvature (>10mm).

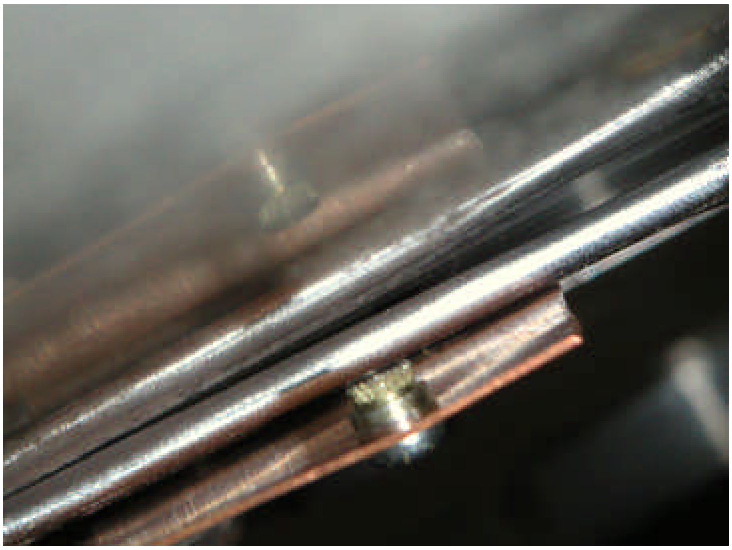
- The torque of the screws securing the HCPs to the alu. bars (structure) should be controlled and tight to ensure the two HCPs work together to form a rigid assembly. Torques of 2-4Nm were measured, where 7-9Nm were expected.

Mr Chai torquing up the frame screws. A torque wrench is required for this operation.

FEB

- The FEB should be mounted in a secure manner to the copper cooling system. It is electrically insulated from it.

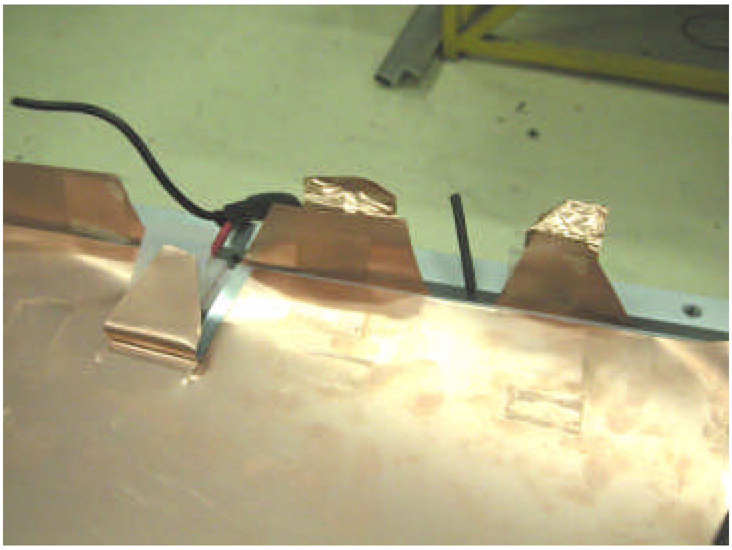
The spacer necessary should be kept to a minimum so as to keep overall thickness of the chamber to a minimum. This one can be reduced to the thickness of 2 flat cables.



The rigidity of the assembly could be improved .

The very small plastic scews used in attaching the FEB to the cooling plate are fine but insufficient in number (2) and tightness. There must be 3. The holes have to align somewhat better. Mounting the male part to the Cu sheet is a good idea and ensures an easier assembly than in RE1.

The use of double stick is not sufficient to ensure electrical conductivity in building a Faraday cage but of course it does ensure a close proximity of the two Cu sheets which is also a pre-requite of same. The tape was tested to be nonconductive.

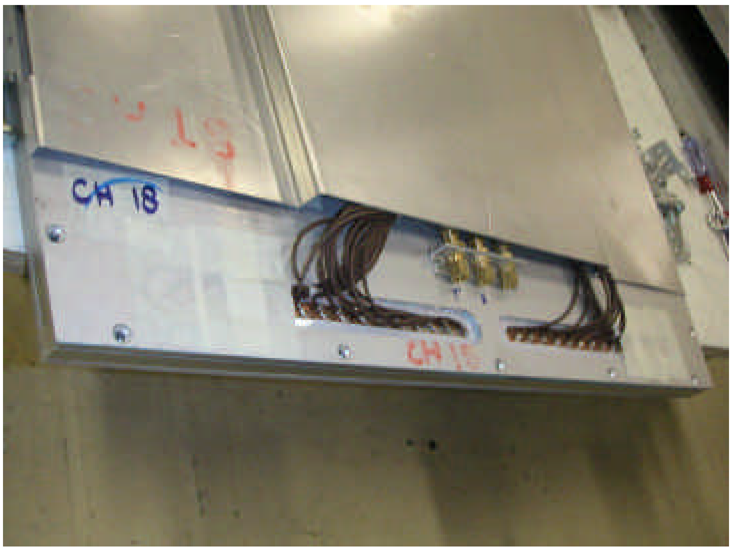


Soldering of small points along the edge are a good addition to ensure good long term conductivity, once thinner copper sheet is available.

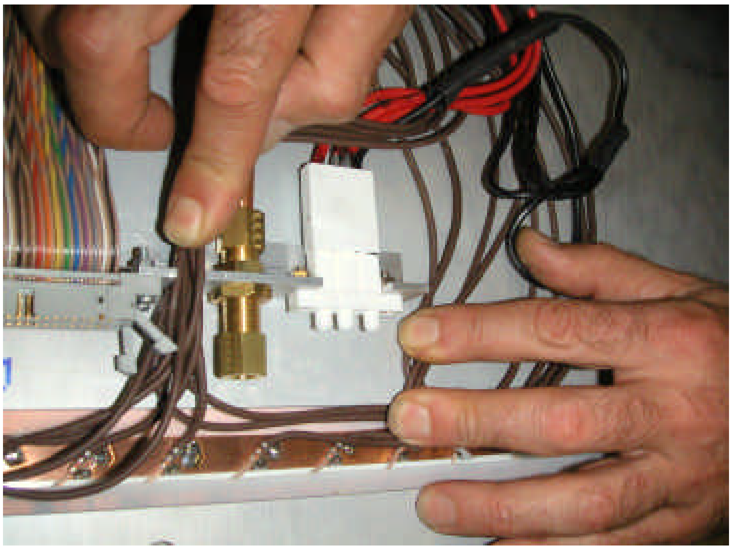
- Patch Panel

At the low ‘R side the patch panel is relatively simple. This could be extended to reduce noise. Javed has suggested an intermediate panel covering/joining the shield covers of RE2/2 and RE2/3 which would be a good solution. For the inner edge of RE2/2, an alternative, temporary solution is needed pending the arrival of RE2/1. Small aluminum panels 0.5mm think, self tapped to the HCP might suffice to cover the channel areas outside the existing shield cover.

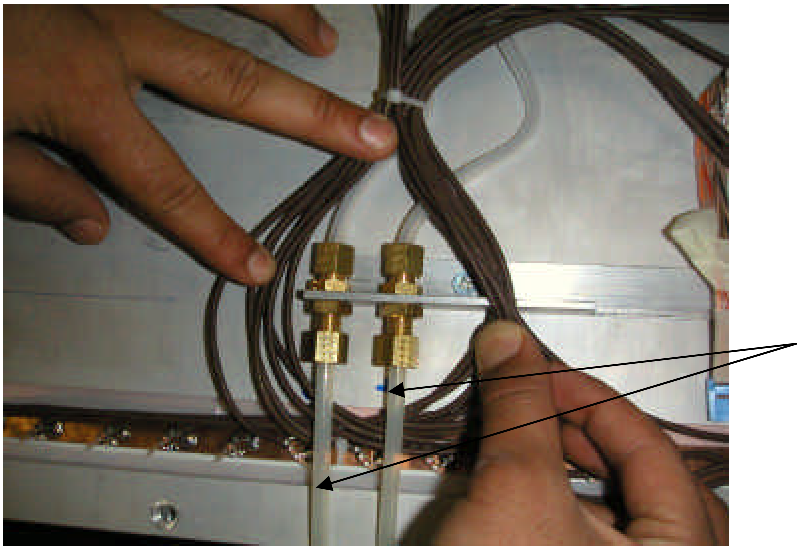
Can the bottom patch panel be reversed so that the cooling and gas pipe do not crossover each other?



However at the outer ‘R’ end the situation is more complex. Here the obstruction/hindrance of connectors appears to be a problem. The solution may be to redirect more coaxial cables through the slot already milled next to the cooling union., as shown.

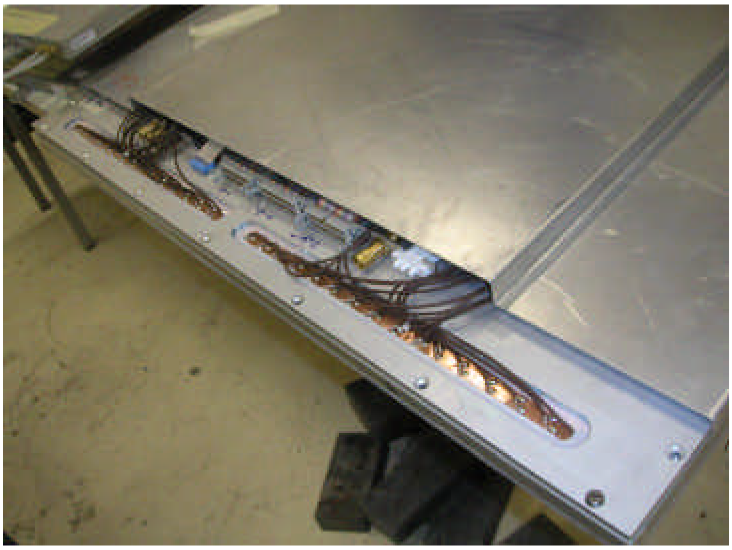


A similar argument can apply to the other side. Note the external gas pipes.



All unions and their respective lock nuts must be tight, otherwise twisted gas pipes and leaks can result.

Clearly at this high 'R' side we must face the patch panel termination on RE2/3.

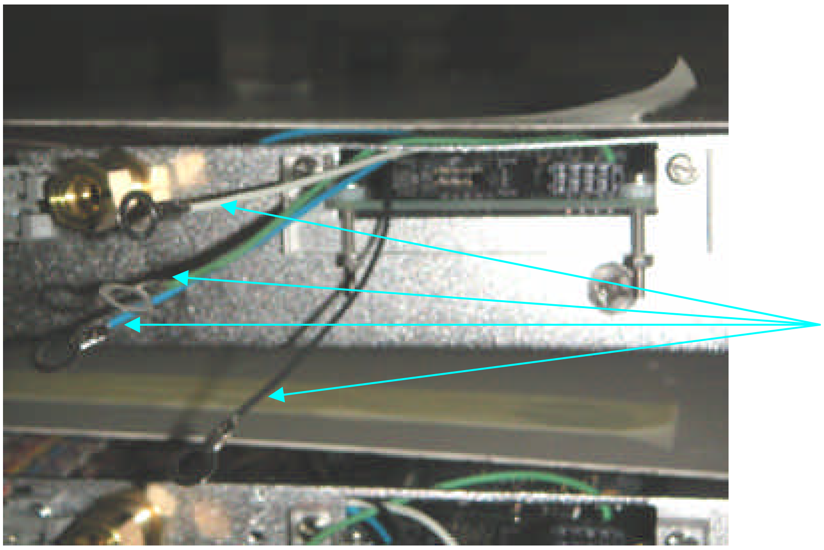


Remembering that the peripheral 'Z' stops are close by so the patch panel must remain behind the front/outer face.   This should not stop us screwing on a final cover plate to mask off the sensitive areas.

Introduced this year, separate leads from the following must be taken out to the patch panel;

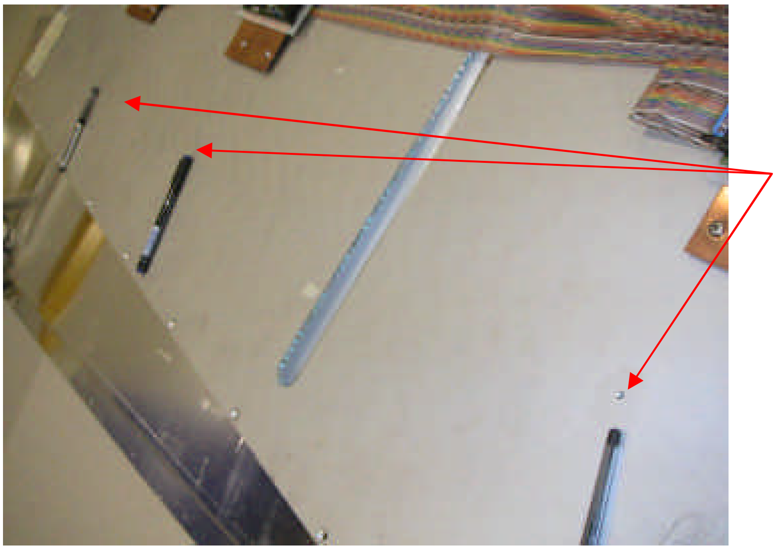
1	Farady cage/sig ref	Blue
2	0V (-ve) of LV	Green
3	HV 0V	Black
4	HV shield	white

The final connection of these will be determined by trial and error as a function of ground loops generating noise, although today in the Cosmic stand all of them are connected, including the lab ground.



- Shield Cover

The shield cover had been intended to be mounted on the 6 x M5 threaded inserts indicted in the photo below. The use of a full span shield cover has some advantages , such as immediate full access, but will inevitably increase the occupation in ‘Z’ due o the flexibility of itself. Primarily ,however, the access to the electronics/chamber of the on yoke chambers requires the 2 adjacent chambers to be removed beforehand. This mistake has been made by the CSCs , we should not limit our access, especially since the decision to have the CSCs on one yoke and the RPCs on the opposite was made in part for this reason



Note the 3 pens indicating the positions of the mounting inserts.

The shield cover was designed to be attached at six points along ‘R’ each side of the FEB’s. Taking the cover to the outside edges increase the occupation in ‘Z”.The cover is 25 mm deep and should be decreased to ~20mm as is achieved in RE1/2. & 3. The total chamber thickness is between 56.4 and 55.4mm.

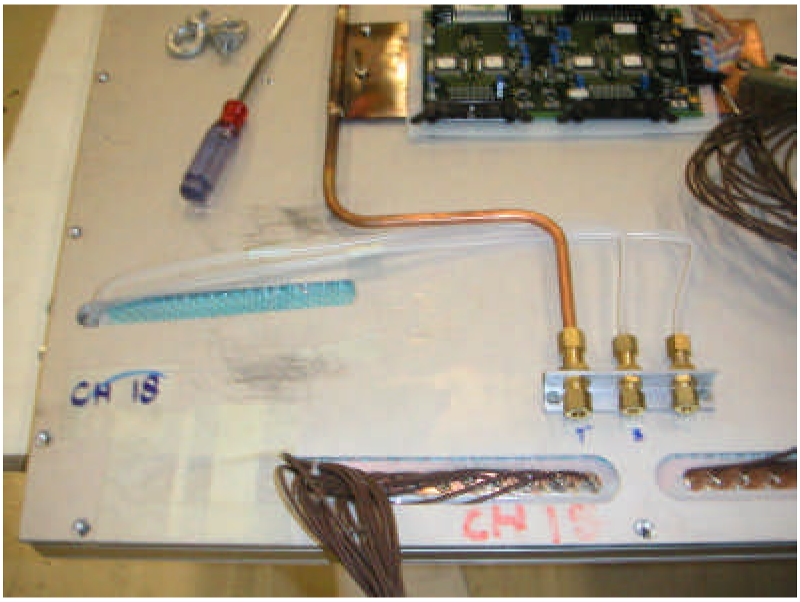
	RE1	RE2	
	2x 29=58	2 x 31.5 = 63	Chamber structure
	20	25	Shield cover
	5	5	Mounting bracket
	2	2	Clearance to yoke
	2	2	Clearance ch. & brackets
TOTAL	=87mm	= 97mm	

Given the proximity of the CSC alignment sensor at 94.5mm and the fact that these two elements (RPC and CSC alignment) are mounted on different yokes each of many hundreds of tons, some 7mm has to come off the total/final assembly in ‘Z’. The aim is to be less than 90mm.

In the case of RE1 the areas of coaxial cabling out side the shield box have been covered with 0.5mm alu sheet. Secured by self tapping screws 2.9 x 4.5

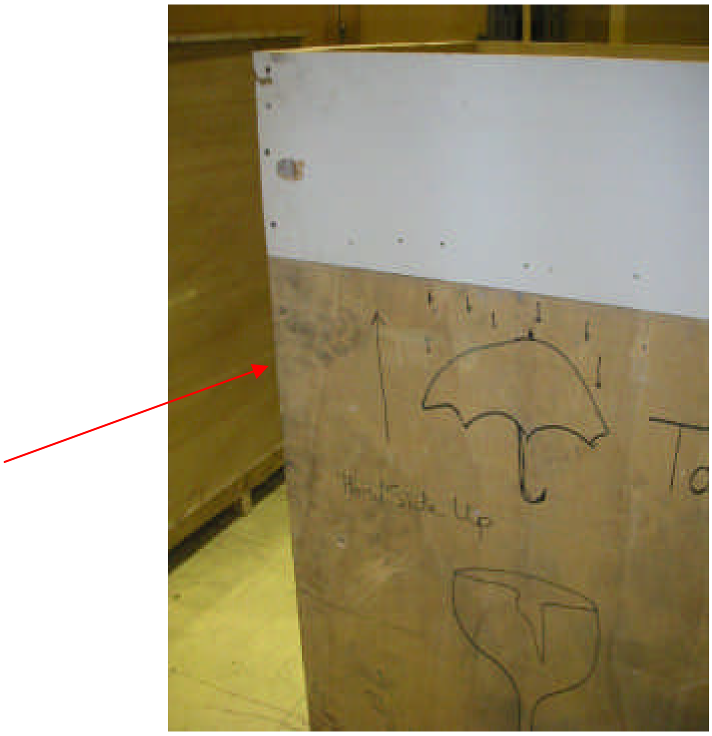
- Service (Pipe) cross-over

Crossing of services introduces unnecessary increase in, the thickness. Here the gas pipes are crossed and both cross with the cooling pipe.



- Packaging

The ever present problem of damage that may occur during transport has occured yet again. Note the ‘heavy’ foot prints on only one side of the now upright box, indicating that the box, and its contents, spent at least some time horizontal. With packing for more chambers this will be less likely to occur as the base of the box will increase in width so imparting greater stability and thus a lesser likelihood of tilting over. The box naturally ended up in its most stable condition that is with its largest surface on the ground!



‘This side up’ could be interpreted as meaning the side it is written on not where the arrow points.

The steel frame is a good feature which provides rugged support for the chambers and in particular the space left around the structure gives some protection against fork lift perforation. This space could well be increased to >10cm.

Ian Crotty
200605