

Chamber Production in ISR

Flow plan

Gas Gap Preparation.

Prepare Traveler Sheet for the Gas gap Set.

After having removed the gaps from their packing note the numbers of the gaps in the Traveller . The gaps are ALWAYS handled in a vertical orientation. Use the Rotating table (RT) to place them horizontally and then slide onto the steel table.

Dimensional Accuracy

Measure the gap at 3 points and ensure they agree with the tolerances given in the document http://project-cms-rpc-endcap.web.cern.ch/project-cms-rpc-endcap/rpc/Chambers%20%26%20Integration/Integration/Global%20View/Geo_layout2002.doc.

Check that the gas pipe connexions are correctly oriented w.r.t the HV
Check the HV and 0V are in the correct positions with = 1m of cable.

Gas Pipe

Attach the pipe (PE) connexions and plugs to the bottom gap. Cut gaps must use both PE and silicon pipes as the interconnects are common to both gaps. See diagram: **Attach diag.**

Gap Test

On the Pressure Test Gas Rack check the safety bubbler is connected.
Check the pressure regulator on the Argon gas supply is set to 200mbar.

Gas leaks	(?)	
Gas Pressure		20 mbar
HV test	(?)	

HV/0V cables

Cut the HV and 0V cables to approx length of 800mm. Slide on the 20mm collar of heat shrink tube (scem [04.86.62.120.1](#))

Thread them through the braid shield (scem [04.01.31.006.7](#)) using the delrin dowl of Ø10mm. The cables have to taped to the faced off end. With the

rounded off end work it through the copper braid until you can pull the cables out of the far end. Remove the cables from the delrin dowl and remains of the tape used.

Stop the braid 60mm from the HV connexion. Shrink the collar all around using the heat gun taking care not to excessively heat and so damage the HV/OV cable pair.

Remove the Transparent protective 50µm film from the HV face of the gas gap.

Bottom Honeycomb Panel Preparation .

(See Preparation Appendix) do not loose the position and orientation of the 4 aluminium alloy bars.

Clean the assembly bench and the required tools .



Place the Bottom HCP on the marble inside face up .

Mount Non High Voltage Side (NHVS) 16x16mm Bar and Bottom Bar (not the High Voltage (HV) side and gas connexion bar) and the 3 NHVS “L” gap location brackets (standard) on the bottom HCP. There are 3 different types of “L” Location Brackets :-

Standard “L” Location Brackets without slot	SLB
Large cut gap “L” Location Brackets with slot	LGLB
Small cut gap “L” Location Brackets with slot	SGLB

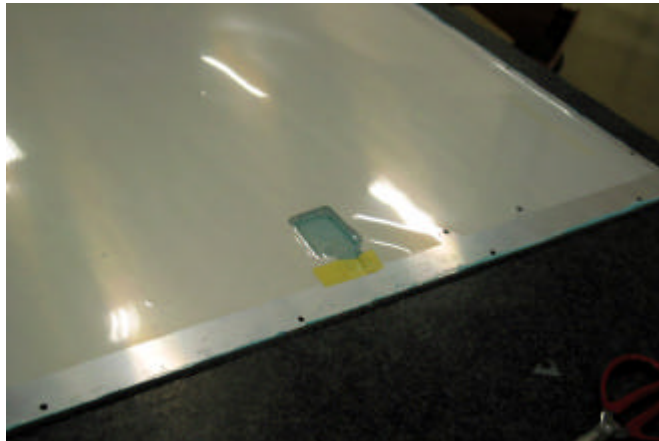
The "L" brackets are secured with 6 x M6 x 8mm allen key headed screws and flat washers. The HPL buffer of 250mm x 14mm is mounted correctly on the vertical side using 9mm wide double stick (scem [04.95.60.213.4](#)) and the aluminium is fully covered by the tape. Check before hand that:-

The poly protective sheet is removed on both faces of the HCP
The faces of the HCP are clean. All cutouts are done, cleaned and deburred.
The 35 counter sunk head M6 x 12 screws are available
The correct size No. 3 screw drivers are available and only these are used to tighten the screws to a torque of 8 Nm using the Torque wrench

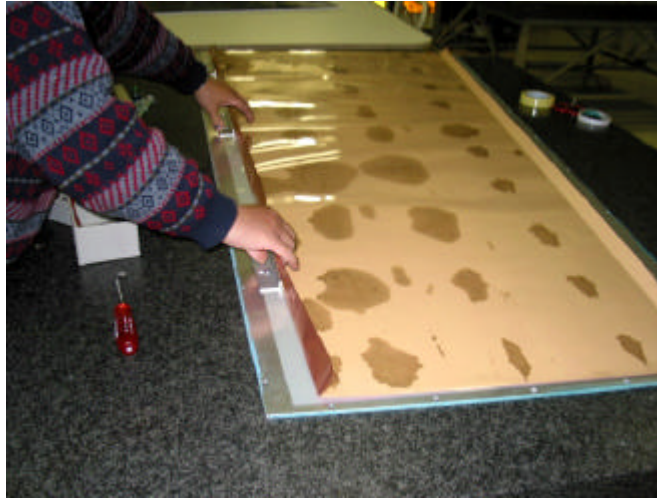
PET film.

The Film must have been cleaned with Antistatic cleaning liquid (Scem. [58.81.20.100.6](#)) and cleaning paper (Scem.....).
Mount the PET film on the bottom HCP (Honey comb Panel) using the polyester tape SCEM. [04.94.20.225.6](#). Use 6 pieces of 200mm along the 'R' sides of the trapezoid.

Cut out the area for HV cut-out on 2 sides and bend down. As shown.



The PET/Cu combined sheet must be creased along its long sides as shown.

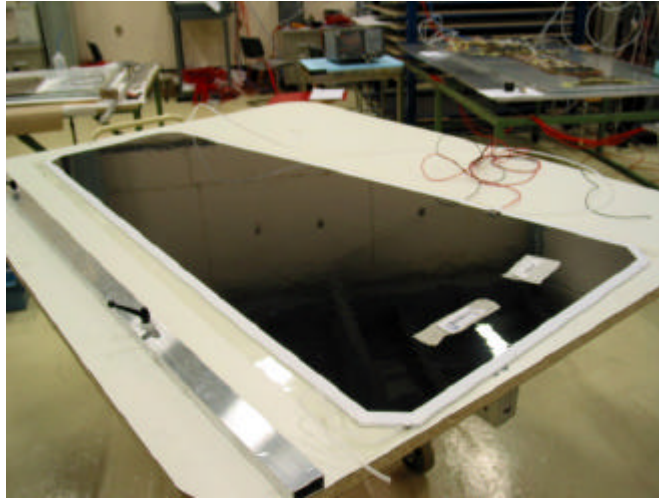


Mount the film on the bottom PET layer using double stick tape (**Scem.....**), taking care to centralize. Press down firmly using a screw driver handle. Check that the copper sheet is at least 20mm away from the top and bottom HCP edges. This is most important for the separation of the different 'grounds'. Cut out the areas of PET around the 6 "L" location brackets, they must sit directly on the aluminium of the HCP. Do not cut the Cu. foil at these locations. Present the 3 HVS "L" location brackets to identify the area to cut, using a pair of scissors. DO NOT use a knife as it will leave sharp edges in the HCP aluminium surface.

Gap / HCP mating

The gaps have been under gas and HV in the Gap Test Rig. (See Gas tests Appendix) **See photo.**

Ensuring the PET or foam protective layer is in place under the gap, slide the bottom gap onto the rotating table checking for correct orientation of the gap and table w.r.t to the marble. The HV side is still face up and approx 200mm away from the Aluminium Support Bar (ASB) on the Rotating Table (RT). See Photo.

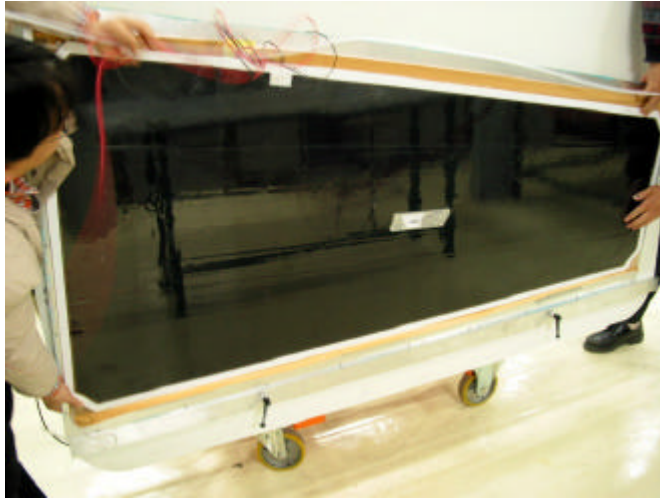


Ensure the ASB is secure to the RT surface using the 2 handles. Only a small force is required to be sure that these $\frac{1}{4}$ turn handles are doing their job.

Two people carry the bottom HCP to the tested gap and turn it upside down onto the gap taking great care not to damage the edges of the gap nor the HV connexion by ensuring it locates into the centre of the cutout in the HCP. DO NOT allow the HCP "L" brackets and the gas bulkhead bar to but up against the gap. A third person must be on his or her knees to verify this. Slide the assembly by pushing on the gap (NOT the HCP) using the Gap slider (GS)

Gap/HCP Rotation

Proceed by rotating the assembly to the (approximate) vertical position using the RT. Push the safety pin into its lodging on the side of the scissor table that makes up the RT. Check to see that there is ample space around the RT. Three people are required to lift the assembly. Be VERY sure both the gap and HCP stay clamped together. The cables and gas pipes must be kept off the floor. Rotate the 2 pieces around their vertical axis and replace on the RT that is still vertical. Rotate the RT panel into its horizontal position. Remove the PET or foam protective film.



Adjust the height of the RT to some few mm higher than the marble .Slide the HCP and gap onto the assembly table. The HV connexion is no longer apparent !

Put the RT into its vertical position and move it away from your assembly area.

Loosely mount the 3 remaining “L” location brackets on the HV Side positions. Use one each of SLB, SGLB and LGLB

Ensuring that :

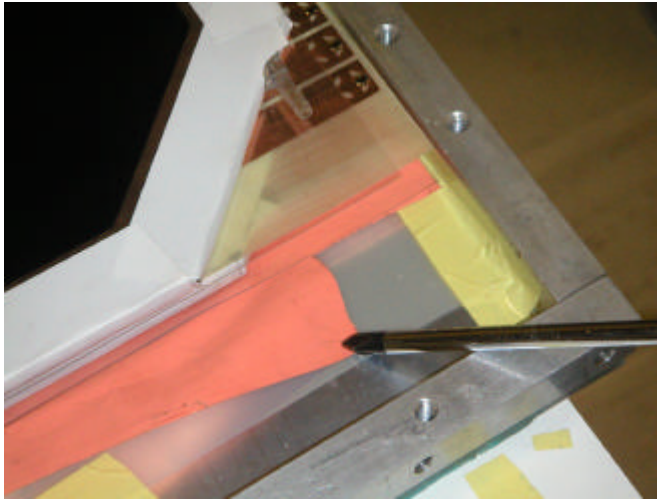
- The (x6) M6 x 8 allen key headed screws and flat washers. Washers are mounted under each head.
- Each Bracket has its HPL (scem.....) buffer secured in place and that the top aluminium edges are insulated with tape. (scem.....)
- Retract the brackets to their outer limit.
- Centalise the gap by careful measurement.

Approach each bracket to a “close touch” with no excessive pressure . Be sure they are parallel to the gas gap edge. Using the correct No. 3 red handled screw driver tighten the 12 screws while holding the ‘L’ brackets in place to avoid twisting them. Finally on the NHVS fully tighten to the specified torque of 6Nm using the N0.3 driver end and the torque wrench adjusted to 6Nm.

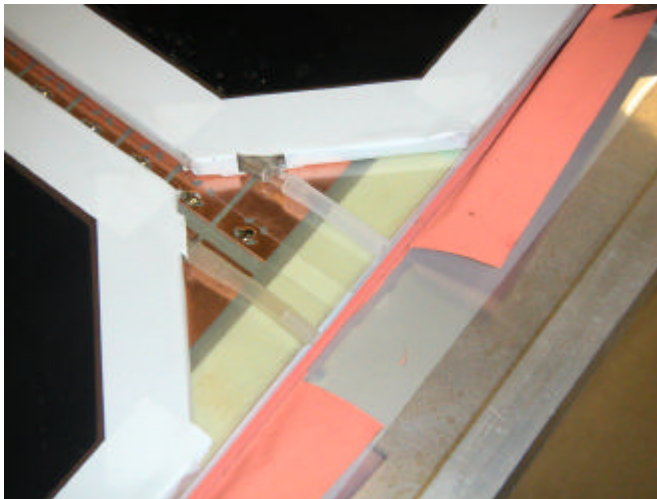
Inspect and clean this gap surface. You haven’t seen this face before, Korea was the last group to see it some months ago !

Place the x3 Thermal Heat Shields (THS) across the gap after having run your fingers along both edges to see they are not sharp.

Cut off the 4 corners of the Cu /PET film as shown. Use scissors being careful not to damage the gap. Do not use a knife, it will produce sharp edges in the HCP surface. The bottom PET film is not touched.



Cut out the Copper and top PET film around the inter gap gas connexions. Leave the bottom intact as shown.



Strip panel

Check to see that both sides of the strip panel are clean. Be sure all 96 solder points have been made.

Two people carry the strip panel by its longest edge place it on top of the bottom gap and centralize it w.r.t the gap.

Tape it in place ensuring that the top PET films are secured by polyester tape (scem [04.94.20.225.6](#)) and are not covering the solder points. Do not trap the thermal shields or “L” location brackets while performing this task.

Remove the HV Side “L” brackets.

Top Gaps.

Check the gaps have been tested. Consult the electronic log book . Slide the gaps from the HV rig with their respective protective PET film or foam onto the RT .Note the Kodel bar codes on to the chamber traveler. Make a last visual inspection.

*NOTA the bottom of these top gaps have not been inspected. Position the RT along side the marbel on the HV side.

Slide the top gaps , one by one into position on the strip panel *Are we sure this is correct, sliding that is ??*

Take care with the gas pipes , not to kink them and keep both pipes and cables off the floor. DO NOT allow the pipes to become trapped allowing a tractive force to be transmitted to the gas inlets. Remove the blocked flexible pipes used during the leak and pressure test.

Place the 6 holed PC inter-gap spacers (HIGS) into their respective positions, over their solder points noting the pitch differences in ‘R’. There are 3 different models per chamber and 2 per ‘eta’ slot with their outer most drilling sitting over the outer strip solder point. Check to see that NO solder points interferes with the access holes of the HIGS

Remount the 3 “L” brackets on the HV side. Approach them to a gentle touch.

Take the clearances out of the PET/copper foil.

Tighten by hand using the red handled No. 3 screw driver and then tighten down using the torque wrench to 6Nm. Be sure the brackets do not twist during this operation.

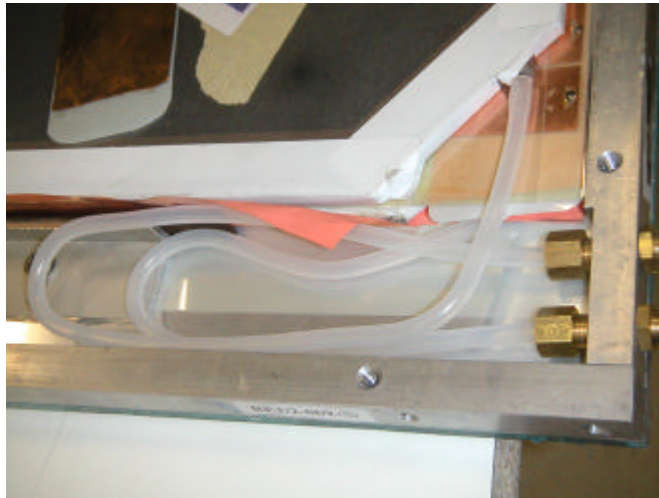
Connecting Chamber services.

Top gas bar (16 x 16mm).

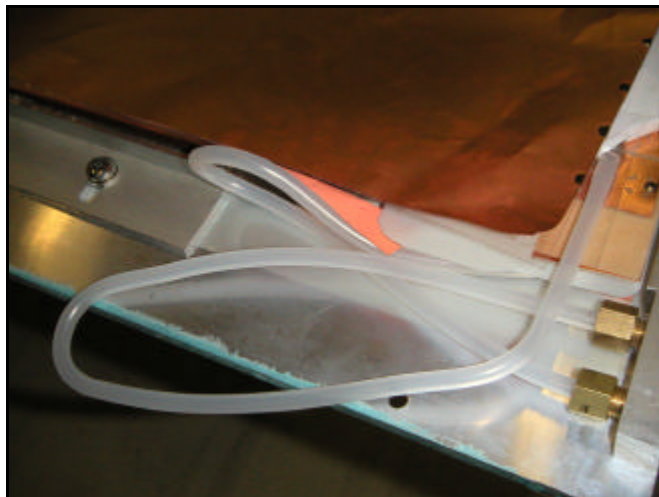
Be sure the gas (Legris Ø6mm scem [41.34.06.510.0](#)) unions are fitted, tight and flush without the locknut. They are screwed in from the outside using 4 drops of Loctit 245. Then mount the bar onto the bottom HCP using the 5 countersunk headed M6 x 8 screws and the red handled No.3 scw driver. Check that the ends are parallel to the HCP as there are 2 possible orientations

Connect the gas pipes to the external unions using Ø4mm brass inserts (**scem.....**). The gas pipes for the bottom gap go to the outer gas unions While the gas pipes for the top gaps go to the inner gas unions . They must be cut to length so that they reach 5mm over the edge of the union (with the nut removed)

Be sure to use the brass inserts in each pipe/union connexion (**scem.....**) Ensure the pipes are not twisted during this operation. The pipe must be pre-twisted in the opposite direction of rotation during tightening. Once tight , release 2 turns and retighten . Tighten to **25 Nm** using the modified spanner that gives easy access to the union nuts.



Be sure that the pipes are not twisted as shown below !



Cut to length the inter gap gas links and push onto their gas gap connexions by pre heating the PE pipe using the hot air gun adjusted to #5, not hotter, patience.



Secure the two longest gas pipes in place using tape, to ensure that they are not tapped during the top HCP mounting. Perform a visual inspection of all pipe connections to be sure non have been left out and that each gap layer has its own circuit.

Tape the bottom PET foil to the Gas Connexion Bar using the polyester tape. Stop the trapped up against the unions where the Cu. foil also ends. This is MOST important as the Cu foil and chamber body must have separate earths.

Bottom bar.

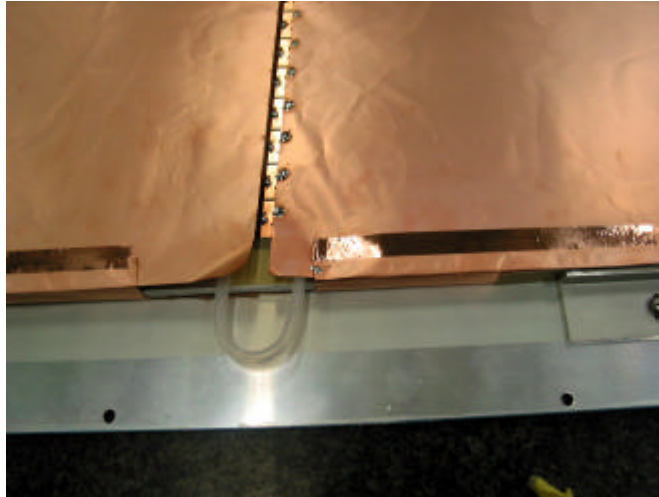
Mount this bar and tighten to 10Nm using the same method used previously by sliding the chamber to the edge of the marble. Do not let the tool sip off the head of the screw in this difficult position. The specification for the tightness must be rigorously adhered to.

Place the two PET/Cu foils onto the gaps Cu side up. Slid the x3 Thermal Heat Shields (THS) across the gap , under the Cu/PET foils , after having run your fingers along both edges to see they are not sharp!

Bend the bottom PET/Cu foil over the top one and secure with 6 pieces of 200mm long Cu tape (**Scem.....**). Improve the electrical conductivity and longevity by soldering the top and bottom Cu foils together ONLY over the corners where the gap is absent. Be sure the THS are in position for this action.

When soldering ensure the gas pipes are not damaged by the heat. CARE !

Do not solder the top and bottom copper foils together over the gap edges. You have no thermal heat shield available and the total thickness of the chamber will go beyond the 16mm available.



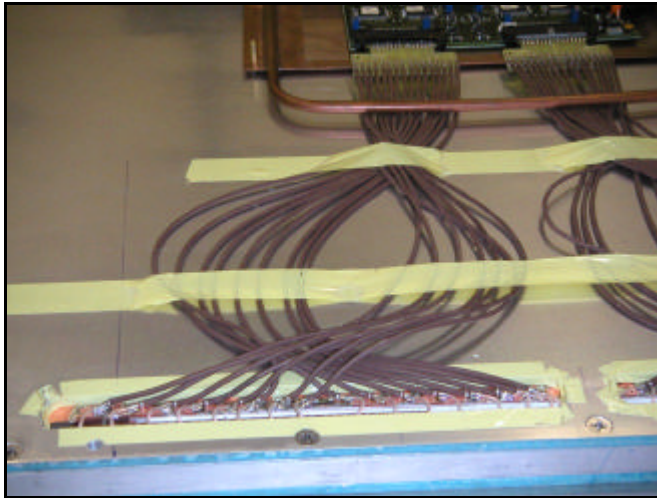
Solder on the signal reference cable that has been identified as such, using letters (**Scem.....**) . Use cable 'x' mm² (**Scem.....**)

Signal Cables

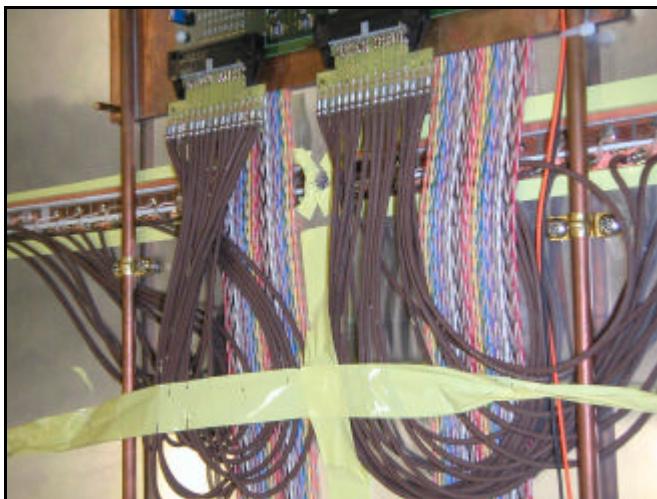
Place the Dummy FEB Jig (DFJ) in position and attach to the Top Gas Bar .
Attach the 6 Adapter Boards (AB) and their cables to the dummy FEBs.
RE1/2 uses one length of cable (420mm).

Place all the cables into their respective positions and order . Take great care with the orientation of the cables. **See photo**

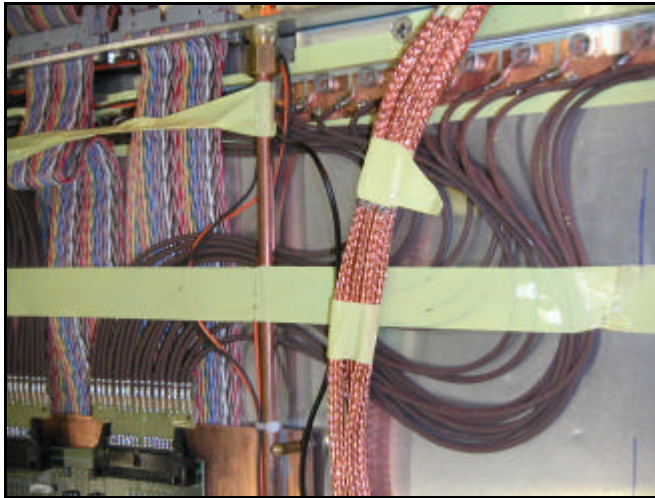
High Eta position



Mid Eta Position

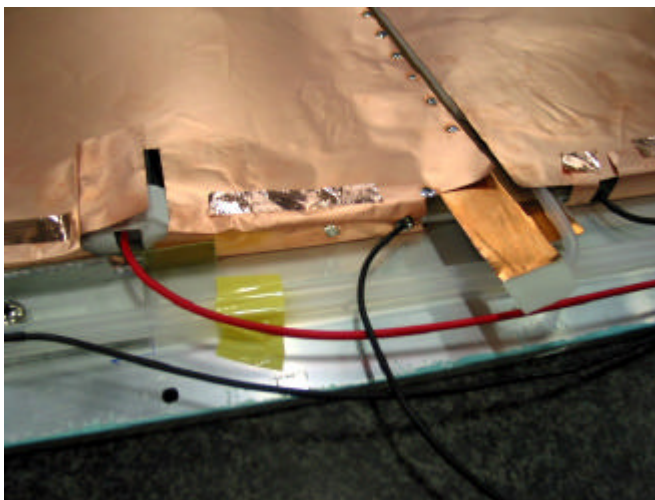


Low Eta Position (Gas connexion end)



Start soldering at the LHS if you are right handed or inversely. Orientate the cable so that the ferrule legs are almost horizontal and facing you. Solder on the signal cable to the pick-up strip taking care not to heat damage the HIGS. Rotate the ferrule over onto its side so that the legs contact the PCB and solder the front leg down using the residual solde already on the iron. Apply solder containing 2% Ag (**Scem.....**) to the rear leg and then return to the front one and apply solder . **See Photo**

Solder on the 96 (3 x 2 x 16) signal cables to the PCB/Cu sheet (the PCB 0.1mm has already been installed)and the pick-up strips. Ensure the THS are well placed to protect the gap.



Remove the Dummy FEB Jig (DFJ).

Remove the thermal shields from under the strip panel.

Mount the two side bars (16 x 16mm), noting their orientation and parity. Use the M6 x 8 stainless Countersunk head screws.

Secure the PET/Cu assembly using polyester tape (scem [04.94.20.225.6](#))

Top Honeycomb Panel.

Prepare the top panel by removing the protective poly film. Ensure no metal shims or swarf are present.

The poly protective sheet is removed on both faces of the HCP

Be sure both faces are clean.

The 35 counter sunk head M6 x 12 screws are available

The correct size No. 3 screw drivers are available and only these are used to tighten the screws to a torque of 10 Nm.

The cut out are clean, swarf free and milled in the correct position.

The signal cable slots and HV slot are protected using the

...?...tape...

Position the top HCP vertically on HVS of the chamber. Slowly rotate the panel about this edge. Start by passing the 3 HV and signal reference cable through their respective slots.



Continue to descend the panel passing each AB through their slots as they come within reach. Do not allow the cables to snag during this operation. Take care not to twist and pull on them as they pass through the slots.

HV & 0V (x3 pairs) return line in the shield (scem [04.01.31.006.7](#))

Signal reference (x1)

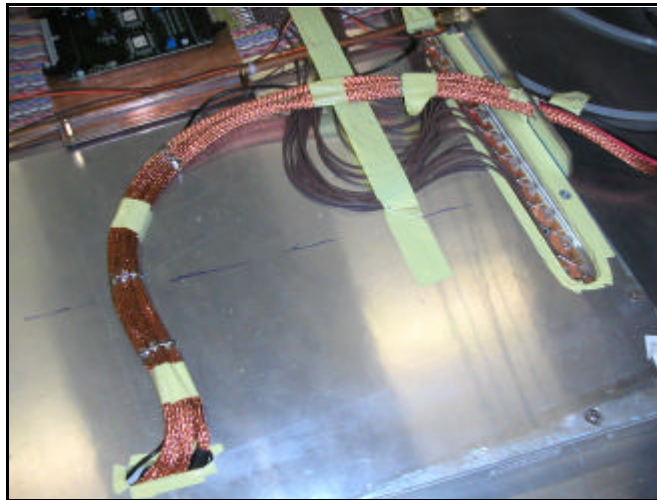
Signal (x96)

Take GREAT care lowering the top HCP. Check on all sides that no cables or pipes are trapped under the top panel.

Screw down Top HCP to a torque of 10Nm using the torque wrench (.....?.....) Be sure to use the correct bit (No. 3) in the torque wrench.

Using the Strip Tester connected to the 6 AB check for inter strip insulation, continuity, Ground and reference plane insulation > 5MO

Tape the HV/0V/signal reference cables in place, after having arranged them parallel and flat on the top panel, using the 50mm wide aluminium tape (scem [04.95.20.250.9](#) on the top panel. See Photo



Mount the 4 corner mounting Brackets to the chamber corners . Note their orientation. Tighten the 8 M6 x ? screws to 8Nm. See Photo

Top layer Services

Patch Panel

See Preparation Appendix

Screw on the Patch panel that has previously been equipped with the flat signal cables and the LV cables . Use the 5 stainless screws. Layout the flat cables down the length of the chamber.

HV Connector

This mounted after the Cosmic ray stand Test See the procedure relating to this task.

Ground Connections

Connect the reference plane cable (it is marked) to the patch panel with the 'spade connector ([Scem.....](#))

The Cooling Circuit

The copper plates must be fitted with the x12 20mm stand-offs secured using 12 M3 x 10 screws tightened to [.?...Nm](#).

The cooling circuit can now be coupled to the Patch panel with the Ø8mm Legris unions (Scem ... [41.34.06.513.7](#)) fitted from the outside and tightened to a torque of [32Nm](#). It is mounted on the panel surface at 3 points using 3 brass tube clamps (scem 41.90.30.008.0 or 41.90.30.208.4.. Use 6 M5 x 6mm screws and washers (Scem). Tighten to 8Nm. Be sure that the screws do not go through the entire thickness of the HCP, so causing damage to the gaps and their insulation.

Coolant Circuit Leak Test (@ 20 bar)

This done using Argon at 20 bar. The acceptable leak rate should be less than 10 mbar/min. DO NOT use bubble spray to detect leaks. If the leak is too high then the unions can be retightened to the torque of 20Nm . If the leak persists then the unions and copper cooling circuit must be removed for inspection and possible rejection.

FEB

The insulating panels are 230mm x 110mm made from PET (scem)
Attach the above 3 panels using 2 lengths of 150mm double stick tape for each (scem [04.95.60.219.8](#))

Connect Mount the FEB to the cooling plates of the circuit with the 4 nylon screws M3 x ? ([Scem.....](#)) and the 3mm standoffs . Use the torque wrench set to 2 Nm.

Distribution Board

The insulating The DB is mounted with its two connectors facing out through the Patch Panel. Use the screws **M ? x ?** an dthe stand off to attach the board. Link the DB to the 3 FEB using the ready prepared 24 conductor flat cable and connectors.

Shield box

The Shield box should be mounted after all the tests have been completed in the Cosmic Ray Test Stand . Use the 8 M6 x 5 screws tightened to 6 Nm. Complete the assembly using 50mm Aluminium tape (Scem)

Go round and check all the M6 x 12 Countersunk headed screws for tightness with the No. 3 screw driver bit and Torque wrench set to 8Nm.

Remove the Completed chamber from the Assembly table

Place the Chamber on the RT checking all the screws UNDER the chamber for tightness as indicated for the top of the chamber.

TESTS

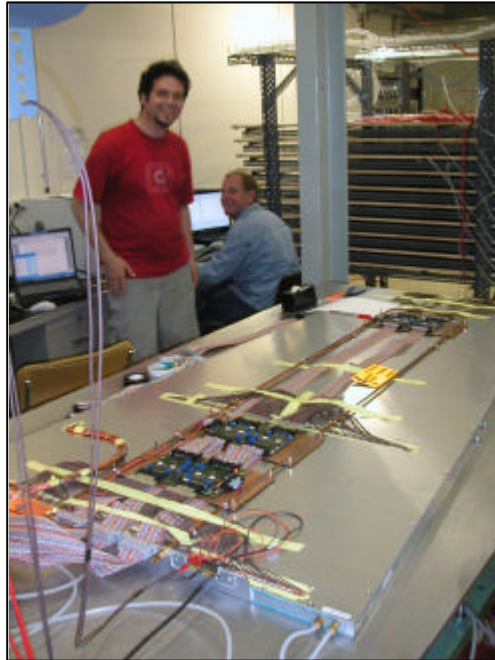
Gas leaks take the chamber to the Pressure Test Gas Rack and test for

- 1) circuit bubbling
- 2) pressure test for leaks

HV Take to the Cosmic ray stand and follow the procedure

Cosmic Make a through test of chambers after a minium of 40 volume changes , including efficiency, current, cluster size and noise.

A successful test gives a happy Cosmic Test Crew



HV Connector

Mount the HV Connector as indicated in the HV connector procedure. Test for currents

Glossary

NHVS	Non High Voltage side.
HVS	High Voltage side.
HIGS	Holed Inter gap spacer (There are 3 different versions made Transparent from PC)
HCP	Honey Comb Panel (made from 0.5mm alu. skins and alu. Core)
RT	Rotating Table (See Photo)
HV	High Voltage
0V	Zero Volt (refers to the return line of the high voltage supply. Both float wrt the chamber)

GS	Gap Slider (large bar made from PVC to push the gap/HCP over to the ASB)
ASB	Aluminium Support Bar
SLB	Standard Location Bracket
SGLB	Small gap Location Bracket
LGLB	Large Gap Location Bracket
DB	Distribution Board (Controls LV)
THS	Thermal Shield (Made from PET and copper foil taped together on their edges)
DFJ	Dummy FEB Jig (See photo)
AB	Adaptor Board

Photographic Material
Text

Andrew, Yung Ban, Ian
Ian
4 July 2004