MEGHA MODULE - Assembly and Testing Manual

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The Charissa Collaboration

Preface

The "MEGHA MODULE - Assembly and Testing Manual" is intended to guide an individual through the complex process of building and testing a MEGHA module. It is hoped that the protocol out-lined in this manual will result in less time being spend on signal loss and leak chasing, by the use of tried and tested methods. This manual will be constantly updated, and hence the latest version of the manual should be used while assembling a module. Please follow the procedure out-lined, in the order that it appears in this manual.

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Contents

List of Figures

Chapter 1

Introduction

The MEGHA detection system makes use of multi-telescope modules. The five modules can hold up to forty four, three detector telescopes, and are therefore both sophisticated and complex. Special handling and assembly requirements has lead to the necessity of an “Assembly and Testing Protocol Manual”. The manual, as well as explaining how to build up a module, will also explain how to test it’s signal integrity, prior to installation in the MEGHA scattering chamber. By assembling correctly and testing prior to installation, it is possible to reduce the amount of time required to rectify signal loss and to leak chase.

While using this manual to built up a module, attention must be drawn to the existing “MEGHA MANUAL, by Steve Chappell et al.”. This manual is also an excellent source of information. A copy of both manuals are available at the, Department of Nuclear Physics (Australian National University) as well as the Daresbury document server. Both manuals have a section where notes and corrections may be entered by the person building up a module. Periodically these corrections will be made to the master copy on the Daresbury server, by the author. So please, if you see any mistakes or have something to add, use the notes section.

N.B. *Prior to working with any part of the module, it is important that each component is free from dust and grease. Any dirt attached to the components will be out-gassed, when installed in MEGHA, and hence will put a greater load on the pumps and limit the systems ability to attain high vacuums. It is therefore always a good idea to wear surgical gloves while handling MEGHA. This reduces the risk of the person assembling the module from transferring grease from their hands to the equipment. Any dirty components can be cleaned with dust free tissue paper and an alcohol based solvent. The modules are regularly ultrasonically cleaned, which does removes a large amount of grease.*

Chapter 2

Baseplate Assembly

2.1 The Baseplate

Ensure that the baseplate (see Figure 2.1) is clean and free from grease and other deposits. This can be achieved by cleaning with an alcohol based solvent as mentioned in the 'Introduction'.

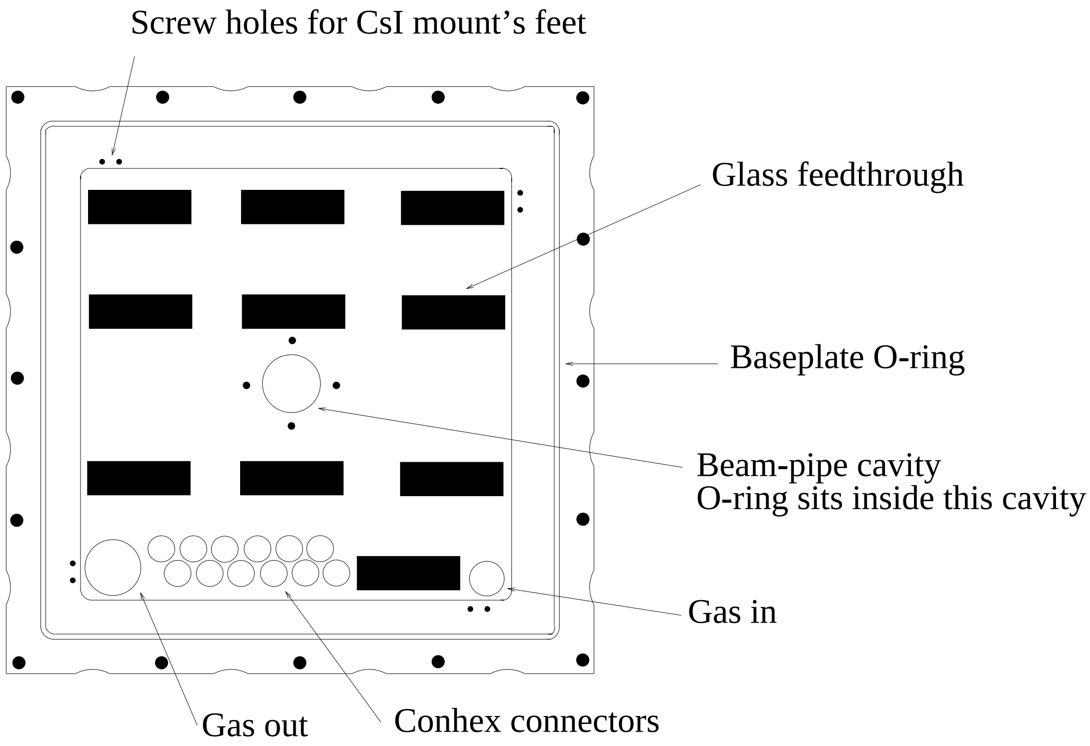

Figure 2.1: Module baseplate (front view).

Firstly ensure that the beam-pipe O-ring is in place, see Figure 2.2. A groove exists in the central cavity of the baseplate to accommodate the O-ring. Prior to placing the O-ring in the groove, ensure that there are no tears, or dust attached to it. Again clean it with alcohol if necessary. A tear on the O-ring (or dust) can compromise the high vacuum requirements when the chamber and modules are in operation. Therefore it is necessary to ensure the integrity and cleanliness of all O-rings prior to their use.

If the baseplate is to be used for other than a centre module, then after placement of the beam-pipe O-ring, a blanking plug may be fitted through the cavity at the centre of the module. See Figure 2.2. For the centre module, the blanking plug is replaced by the beam-pipe.

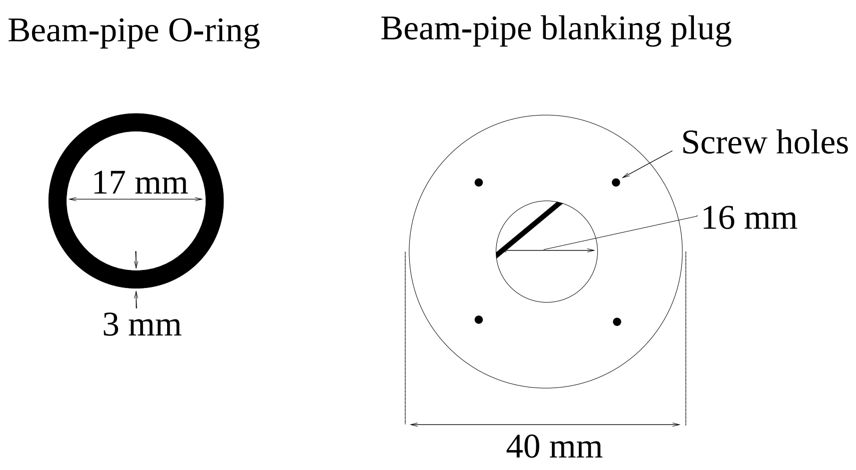

Figure 2.2: The beam-pipe O-ring and the beam-pipe blanking plug.

The fit between the O-ring and blanking plug is quite tight. A delicate turning motion of the plug will aid in it's placement. When placing the blanking plug ensure that the groove machined into the plug head (see Figure 2.2) lines up with the rectangular groove cut into the back of the baseplate. The rectangular grooves are there to accommodate the pre-amplifier cans, and hence correct alignment of the plug is necessary.

Four small counter sunk screws are required to fix the plug in place. These screws have had part of their thread planed off along their axis. See Figure 2.3. This is required to "vacuum relieve" screws which sit inside a vacuum. Please make sure that all screws which lie within the vacuum of the module, or chamber, are vacuum relieved.

Figure 2.3: Example of a vacuum relieved screw.

2.2 Sixteen Pin Glass Feedthrough

The baseplate accommodates ten, sixteen pin glass feedthroughs. See Figure 2.4. The feedthroughs are used to supply the detectors with bias and power. They also allow the extraction of the signals that the detectors produce as they are hit by ions. The sixteen pins sit in a fragile glass-like material and hence the vacuum integrity of the module is undermined if a fracture should occur in the glass. For this reason it is very important to handle the glass feedthroughs carefully. Before installing any feedthroughs into the baseplate, hold the glass feedthrough up to a light source and check for fractures. Do not use any feedthroughs which have cracks, and have not been repaired using an araldite based glue. Repaired feedthroughs will still have a visible crack, but will have been vacuum tested, and are safe to use.

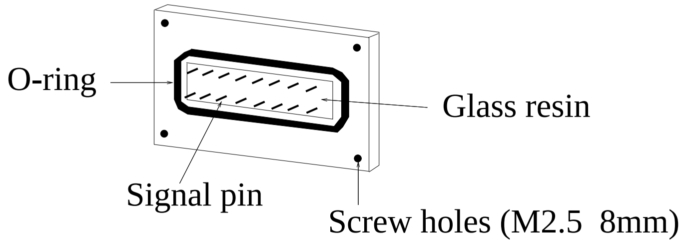

Figure 2.4: Sixteen pin glass feedthrough.

The body of the glass feedthrough has a rectangular groove machined into it. The groove is used to accommodate an O-ring. See Figure 2.5. The O-ring is circular when not in place, but can be compressed into the rectangular groove. As with all O-rings please ensure that the glass feedthrough O-ring is clean and has no faults. Four allen screws (M2.5 8mm) and washers are required to attach the feedthrough to the back of the baseplate. A series of screw holes can be located on the back of the baseplate. The screws do not require vacuum relieving and hence non-modified screws should be used.

To ensure that no fracturing of the glass takes place while screwing the feedthroughs down; hand tighten the four screws first. Tighten the screws diagonally not adjacently (i.e. opposite corners). Follow the same procedure with an allen key, after hand tightening. Turn the screws a quarter turn at a time. In this way it is ensured that the feedthrough is tightened evenly, and no excess pressure is put on any one corner.

This procedure must be performed for all ten glass feedthroughs. After placement of all ten, hold the baseplate up to a light source and check if any of the feedthroughs (other than repaired feedthroughs) have cracked while being placed. Replace any cracked feedthroughs. Also check that none of the sixteen pins have been bent during this process, as this will restrict the placement of the pre-amplifier packs and baseplate PCB's (printed circuit boards) later. If any are bent, delicately straighten them ensuring no cracks form in the resin.

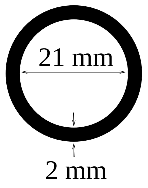

Figure 2.5: Glass feedthrough O-ring.

2.3 Swagelok Gas Fittings

The baseplate has two tapped circular holes, a large and small one, either side of twelve conhex connectors. The small hole is for 'gas in' and the large hole is for 'gas out'. A small and large SwageloK fitting, screws into the holes respectively. See Figure 2.6. Both fittings require O-rings to maintain the vacuum in the modules. These O-rings should already be in place.

SwageloK fittings must be tightened to a specific amount. A manual on all SwageloK equipment is available at the A.N.U. The designs of the large and small fittings are the same. These should be screwed into the tapped holes available, at the back of the baseplate, by hand until tight. Tighten further, using a spanner, for half a turn.

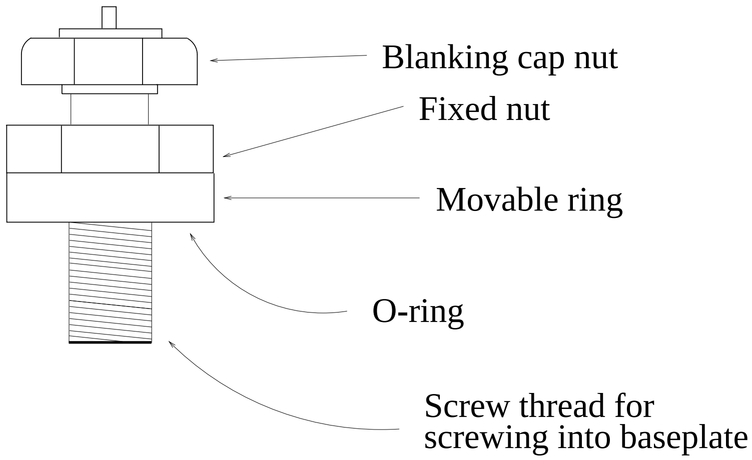

Figure 2.6: SwageloK fitting.

2.4 Conhex Connectors

The baseplate has twelve holes to accommodate *vacuum feedthrough* conhex connectors. See Figure 2.7. The conhex connector requires a small O-ring (which sits in a groove on the connector) a washer and a nut.

Ensure the the signal pin (which can be seen at both ends of the connector) is not bent. The fixed body of the connector and O-ring sit against the front of the baseplate body. The part of the connector which protrudes through the hole at the back of the baseplate requires the washer and nut, to fix the connector in place. The twelve conhex connectors must be tightened down securely so as to ensure the vacuum integrity of the module. Bias is supplied to the gas anode grid through one of these connectors, the others are redundant.

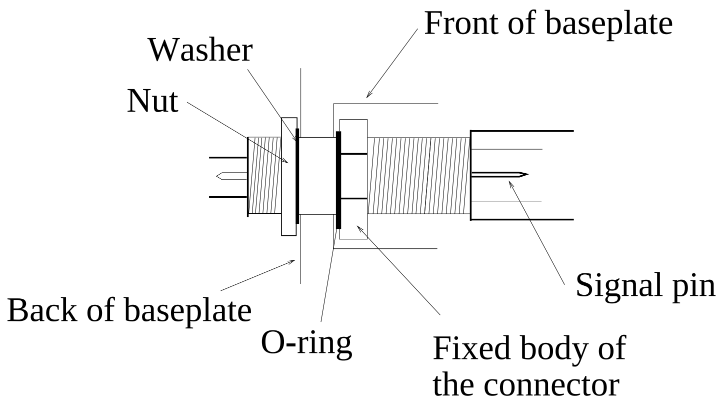

Figure 2.7: Vacuum feedthrough conhex connector.

2.5 Baseplate Legs

The back of the baseplate has a screw hole at each corner. Baseplate support legs can be screwed into these. Attach the legs (see Figure 2.8) to the back of the baseplate using M4 24mm allen head screws. These screws do not require vacuum relieving.

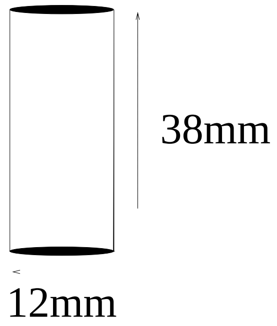

Figure 2.8: Baseplate support leg.

2.6 Baseplate O-Ring

Around the perimeter of the front of the baseplate is a square groove 210mm x 210mm. This groove is used to accommodate the baseplate O-ring. The O-ring is large, and is made out of one piece of rubber joined together at each end. Ensure that this joining has no faults before installing it into the baseplate. If the O-ring becomes out of shape, boiling it in water for 30 minutes will re-shape it.

2.7 Baseplate PCB's

Prior to installing the CsI scintillators, the baseplate PCB's must be put in place. Three separate PCB's attach to the front of the baseplate (see Figure 2.9). Each PCB has three sixteen pin (female) sockets, which attach to the glass feedthroughs already in place.

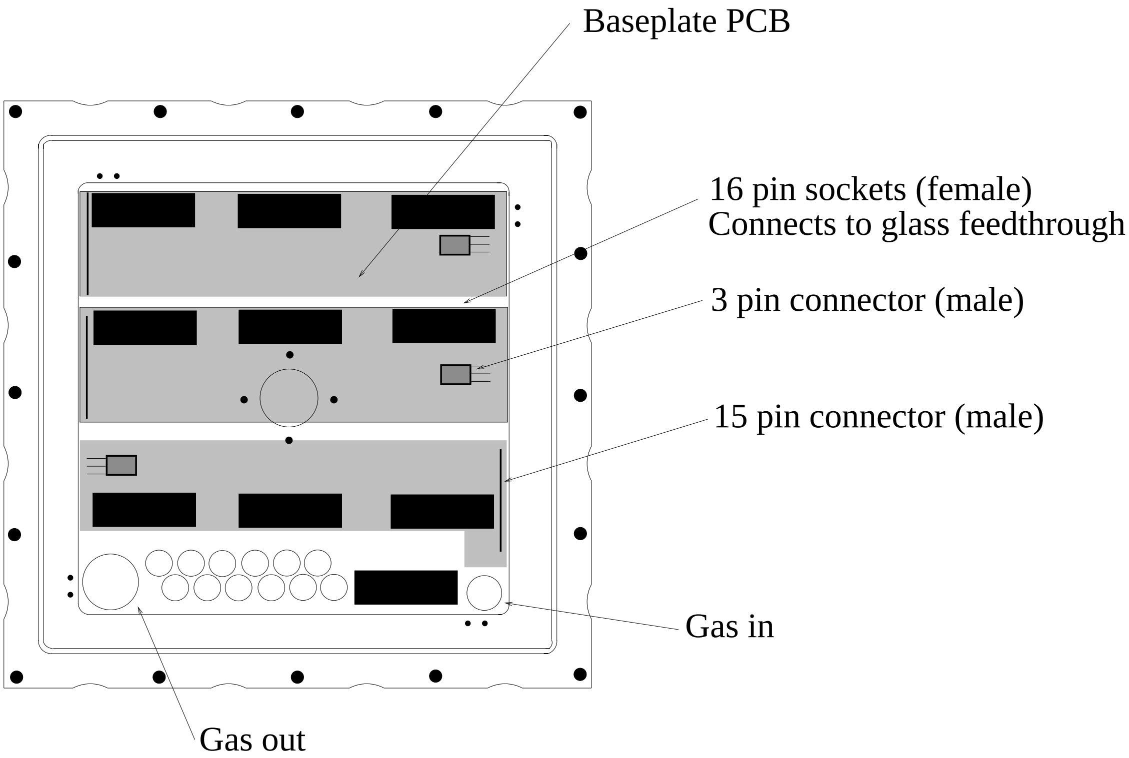

Figure 2.9: Module baseplate, showing the three baseplate PCB's.

The PCB's must be placed onto the baseplate in a particular arrangement. This arrangement is shown in Figure 2.9. For the centre module the middle PCB has a notch cut out of it to allow for the beam-pipe.

Each PCB also has a row of fifteen (male) pins at one end. These pins attach to the Position Sensitive Detector (PSD) PCB via a ribbon cable. Each board also has a three pin (male) connector. This takes the gas energy signal, from the gas anode grid, out to the pre-amplifiers.

N.B. *Care must be taken when installing the baseplate PCB's. The PCB connectors attach to the delicate glass feedthroughs.*

A female socket with three wires connected to it, attaches to the three pin connector on the baseplate PCB. The three wires attach to the three pin connector via a common socket. The wires are of different lengths and colour. Pink is 130mm , purple is 230mm, and yellow is 150mm.

After connection there should be nine wires in all for an outer module, and eight for a centre module. These wires relay the signal from the gas anode grid to the back of the baseplate. Once the wires are in place, check the continuity between the gold end of the wire and the corresponding output pin on the glass feedthrough, at the back of the baseplate. To find which pin on the feedthrough corresponds to which wire, follow the tracks on the baseplate PCB, from the three pin connector to the sixteen pin connector on the back of the PCB.

At this stage it is also a good idea to attach the gas bias lead. The gas bias lead has a conhex connector on one end and a gold connector on the other. Screw the conhex connector onto the conhex fitting (of which there are twelve on the baseplate) nearest the 'gas in' socket. Check the continuity between the gold pin and the conhex connector which protrudes from the back of the baseplate. The lead runs along the inside of the CsI mounts feet, and pushes into a connector on the gas anode grid. The position of this gas bias connector is shown on page seventeen (Figure 2.6) of "The MEGHA Manual", as well as figure 4.4 of this manual.

The baseplate assembly is now complete.

If there is enough time, and a leak checker is available. It is advisable to check the vacuum integrity of the baseplate. This can be done by following the procedure in section 4.3, to built up the module vessel, with a blanking plate. Screw the vessel onto the baseplate. Cap the small SwageloK fitting 'gas in', and evacuate the module via the large SwageloK fitting 'gas out'. A helium leak checker will register any leaks in the baseplate or module vessel.

Make sure the baseplate is leak tested before continuing.

Chapter 3

CsI Scintillators

3.1 CsI Scintillator Mount

N.B. *Most components have an identification number stamped on them.*

Take the CsI scintillator mount (AO-32/8045). See Figure 3.1. The top of the mount has the number AO-32/8045 engraved upon it. Screw on four legs, see Figure 3.2.

The screw holes for the legs can be located on the side of the mount (two screws per leg). The legs are identified by A2-32/8052. The feet of the leg should point outwards (see Figure 3.2). Eight screws (M2 6mm) will be needed for the attachment, in this case vacuum relieved screws are necessary as the screws do not go all the way through the CsI scintillator mount.

Four 60mm threaded rods are used to separate the different grids and PSD's used in the module. These rods screw into the four holes, that reside at the four corners of the central mount point (see Figure 3.1). Screw them through such that 5mm of rod shows through the back of the mount. Lock these rods into place using a small nut screwed tightly onto the 5mm of thread showing.

3.2 CsI Scintillators

Eight CsI scintillators will be required for the centre module and nine for the outer modules. Ensure that each scintillator has an insulator ring attached. At either side of the insulator ring are two spring mounts. Attach the round end of the spring to these (see Figure 3.3). The hooked end of the spring is used to attach the CsI scintillator to the scintillator mount. At this point particular attention must be payed to the orientation of the CsI scintillators within the mount. The orientation of the scintillator is defined by the number on the back of the photo-diode PCB and pin 1 of the ribbon cable socket which sits on the PCB. See Figure 3.4.

Hence prior to fitting the insulator ring, make sure that the ring is fitted such that the correct orientation of scintillators is met according to Figure 3.5.

N.B. *The spring hooks attach into the holes provided on the CsI scintillator mount (see Figure 3.1) such that the front mylar face of the scintillator sits level with the front face of the mount. In this way when the mount is stood on its feet*

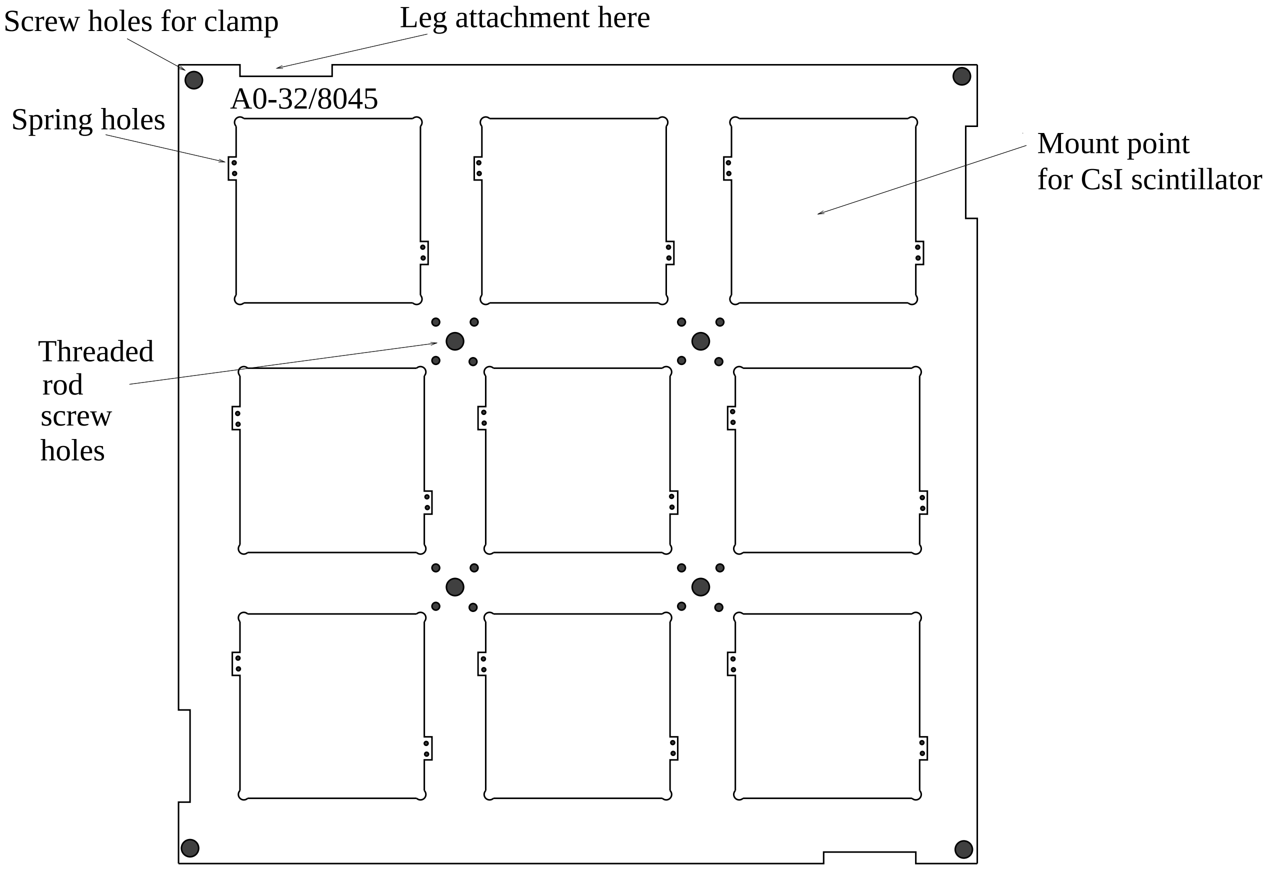

Figure 3.1: CsI scintillator mount (A0-32/8045).

the spring takes the load and the mylar faces of the scintillators point upwards. If a centre module is being constructed, then the central CsI scintillator will be missing.

At this stage the CsI scintillator clamp (AO-32/8046) can be screwed in place. This requires four screws at each corner of the clamp, screwed into the CsI scintillator mount (see Figure 3.1). In this case the screws do not require vacuum relieving.

The CsI scintillator ribbon cable can now be attached as shown in Figure 3.5. By flipping the top of the socket attached to the ribbon cable, it is possible to expose the pins which attach to the socket on the scintillator photo-diode PCB. Check the continuity between the pins of the last socket on the ribbon cable and the sixteen pin female connector at the other end of the ribbon cable. In this way we can make sure that there are no discontinuities in the signal lines of the ribbon cable.

Figure 3.4 shows the labeling used for the scintillator signals. It is important to understand that pin 14 of the socket on the back of the photo-diode PCB, corresponds to line 1 of the ribbon cable (i.e. the red line).

When placing the ribbon cable into the socket on the back of the scintillators, care must be taken not to bend any of the pins. At this point check that each scintillator has a pre-amplifier board attached to the eight pin connector on the

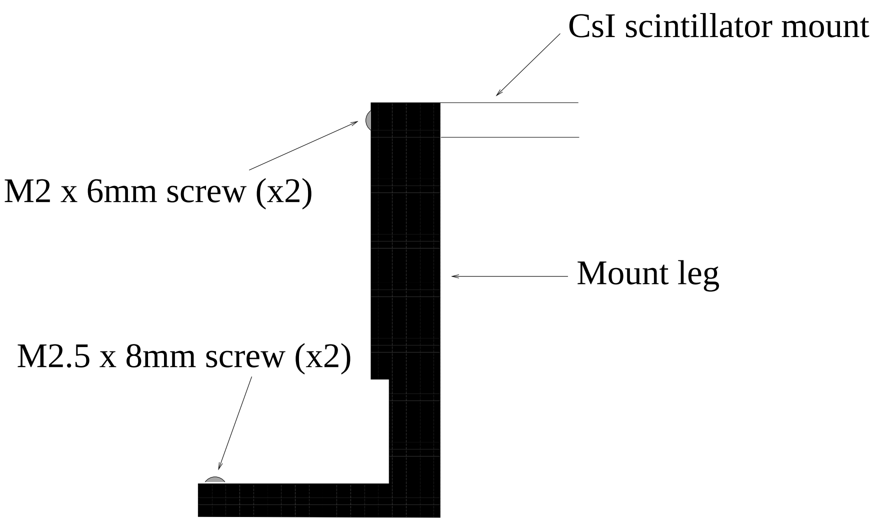

Figure 3.2: CsI scintillator mount support leg.

PCB.

The scintillator mount can now be screwed onto the baseplate, ensuring that the sixteen pin female connector at the end of the ribbon cable can be fitted into the glass feedthrough next to the 'gas in' SwageloK fitting. Eight vacuum relieved screws (M2.5 8mm) are required at this point. Screw these through the feet of the mount into the eight holes on the base plate (see Figure 2.1)

Figure 3.5 also shows the way in which we number the telescopes. The telescope which is next to the sixteen pin female connector (attached to the ribbon cable) is defined as telescope one.

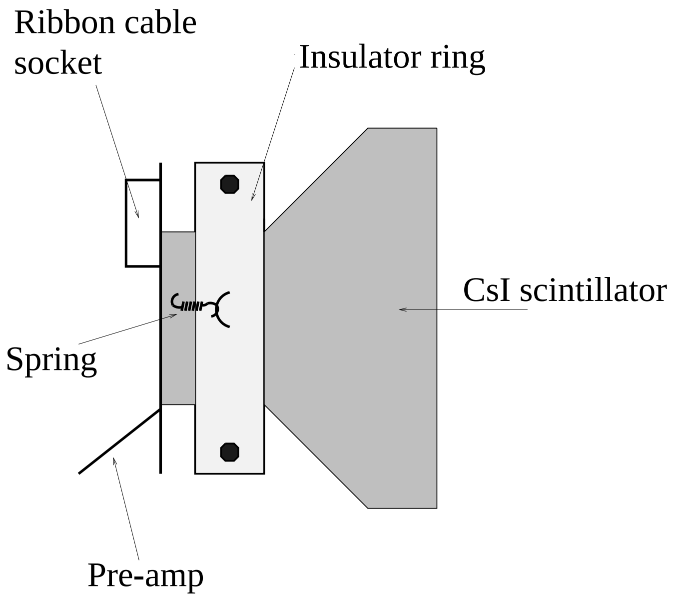

Figure 3.3: CsI scintillator (side view).

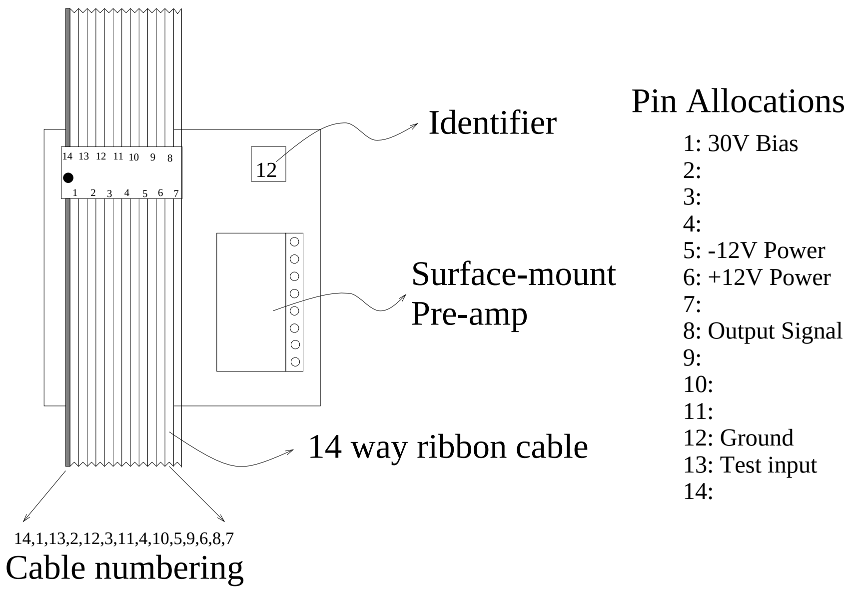

Figure 3.4: CsI scintillator (back view).

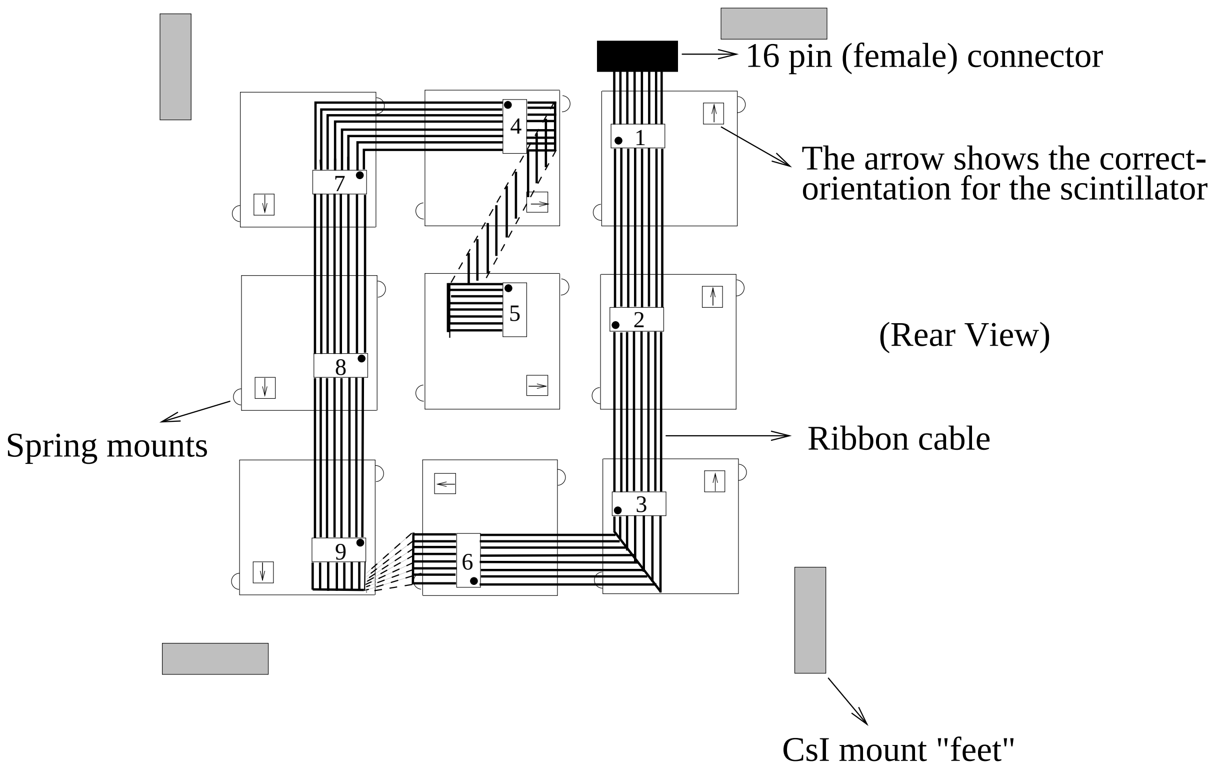

Figure 3.5: CsI scintillator configuration.

Chapter 4

Silicon and Gas Detectors

4.1 PSD Printed Circuit Board

The PSD PCB allows for the mounting of eight silicon detectors for the centre module and nine for the outer modules (see Figure 4.1). All signals produced by the PSD's are routed to the pre-amplifiers via three fifteen line ribbon cables. The ribbon cables are soldered to the sides of the PSD PCB. The ribbon cables push onto the vertical fifteen pin (male) connectors on the baseplate PCB (see Figure 2.9).

The PSD PCB is suspended from the top of the CsI scintillator mount by four 4mm insulators, which sit on the four threaded rods already in place (see Figure 4.2). The orientation of the PSD PCB with respect to the baseplate is governed by the baseplate PCB's. Hence there is only one correct orientation. The top of the PCB has a series of soldered connectors (female). The six pins on the back of the PSD fit into these connectors, hence securing the PSD in place. These connectors also relay signals produced by the PSD to the ribbon cables and hence to the baseplate and pre-amplifiers.

Before installing the PSD's it is good practice to check the continuity between the soldered connectors on the PSD PCB and the continuation of the channel to the back of the baseplate via the glass feedthrough. Each connector on the PCB will have continuity with one glass feedthrough pin at the back of the baseplate.

N.B. *The PSD's are very delicate and gloves should be worn when handling them.*

The PSD's should be placed such that their six pins (on the back surface of the PSD) line up with the six connectors on the PSD PCB. Apply even pressure to the corners of the PSD until it is securely in place.

N.B. *Care must be taken not to touch the delicate corner bonds of the PSD while placing it onto the PCB. A similar bond also exists at the back of the PSD. Do not touch these bonds.*

The actual position sensitive detector can be mounted onto the PSD PCB incorrectly. Only one of the middle pins on the PSD (the one bonded to the back face) actually carry the back face energy signal. This pin must be mounted onto the middle connector of the PSD PCB which has a soldered track. The other middle

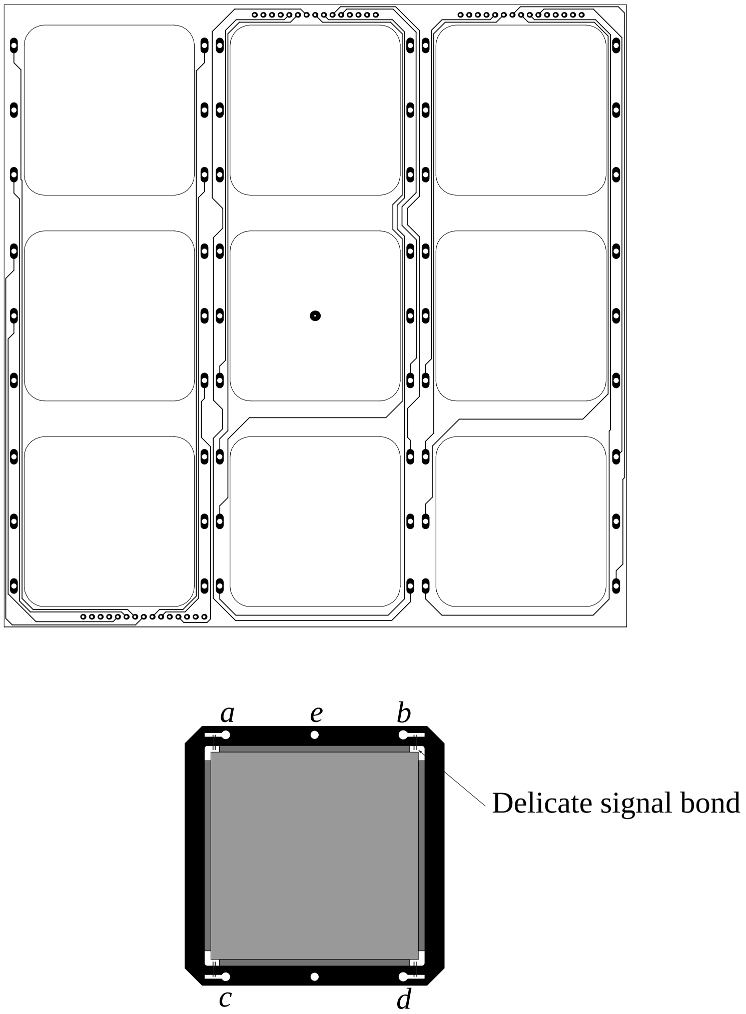

Figure 4.1: PSD PCB (top). PSD (bottom).

connector on the PCB will have no track. Figure 4.1 only shows the front view of the PSD PCB. The soldered tracks are easily seen in this figure. It is also evident that some of the PSD mounting points do not have a soldered track running to either of the middle pins. This is because both the back and front of the PCB has soldered tracks. And so to align the PSD correctly, the front of the PCB as well as the back must be viewed.

4.2 Anode and Cathode Grid

Both the anode and cathode grid have extremely fine wire ($\sim 20\mu$m) soldered across their faces, at a pitch of 1mm.

N.B. *The grids must be handled with great care, and in such a way that the hands do not come in contact with the wires at all.*

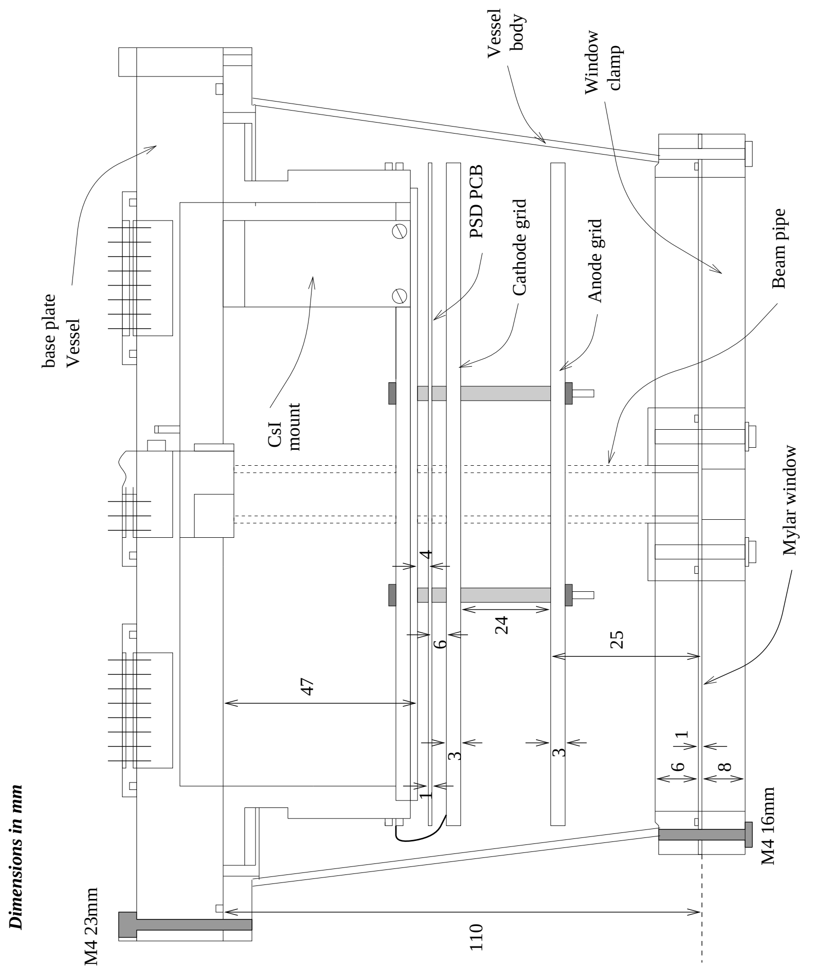

Figure 4.2: Side view of a MEGHA module.

Four 6mm spacing insulators separates the PSD PCB from the cathode grid (see Figure 4.2). The cathode grid sits on top of these insulators, and is mounted such that the grid wires are at the top. The anode grid is separated from the cathode grid by 24mm insulators (as shown in Figure 4.2).

The cathode grid (Figure 4.3) unlike the anode grid (Figure 4.3) does not require resistors or connectors, and hence is easily distinguishable from the anode grid. The cathode grid does however have an ear-thing wire. This wire should be screwed onto a scintillator mount leg.

The anode and cathode grid must be orientated with respect to the baseplate such that the grid wires for both grids lie parallel, and that the gas bias pin on the anode grid is orientated with respect to the 'gas in' and 'gas out' sockets as shown in Figure 4.4.

Connect the gas bias cable (from the conhex connector) to the bias connector on the anode grid (see Figure 4.4). Making sure that the bias lead travels around the inside of the CsI scintillator mount legs. Also connect the nine coloured wires (eight for the inner module) from the baseplate PCB's to the anode grid connectors

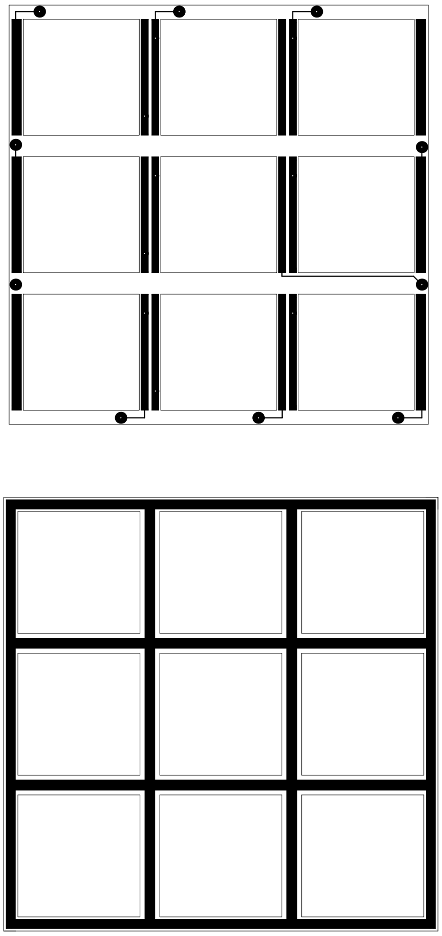

Figure 4.3: Anode grid (top). Cathode grid (bottom).

shown in Figure 4.4. Page seventeen (Figure 2.6) of "The MEGHA Manual by Steve Chappell et al.", shows the correct way of attaching these wires to the gas anode grid.

Check the continuity of the signals from the anode grid to the back of the baseplate.

4.3 Module Vessel

At this stage we must turn our attention to the module vessel. The vessel sits on top of the baseplate, and covers the detectors. The flange of the vessel sits against the baseplate, whereas the other end of the vessel accommodates the mylar window. At this latter end of the vessel a groove has been machined to accommodate the vessel O-ring. The groove is 174mm x 174mm, and the O-ring, like the baseplate O-ring, is made out of one length of rubber. Please ensure the integrity of this O-ring prior to placement in the vessel. Due to the necessity of testing the detector signals prior to placing the module into the scattering chamber, it is safer to attach a blanking plate to the top of the vessel. The blanking plate is just a sheet of metal with screw holes drilled around its perimeter. To attach the blanking plate, first introduce the O-ring into the groove. Using sixteen M4 16mm allen head screws (vacuum relieved). Bolt the blanking plate to the vessel. When fixing the blanking plate down, use a similar method as was adopted for the glass feedthroughs, i.e. opposite corners. This will ensure correct seating of the O-ring.

At this stage the vessel can be lowered onto the baseplate and detectors. While lowering it into the vessel, make sure that no wires become trapped between the baseplate and vessel flange. Sixteen M4 23mm, (non-modified), screws are required to bolt the vessel and baseplate together.

N.B. *The length of the screw used is critical as longer screws will protrude through the vessel and damage the aluminum end flange.*

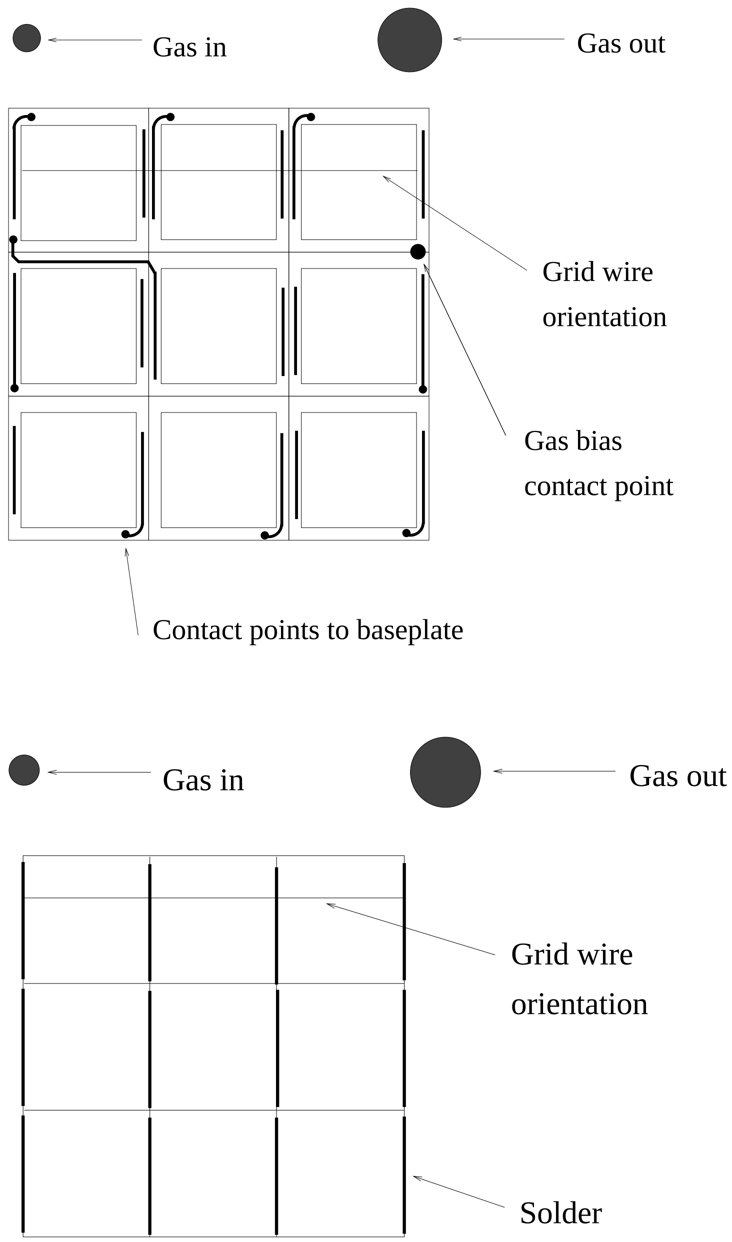

Figure 4.4: Anode grid (top). Cathode grid (bottom).

Chapter 5

Module Testing

Now that the baseplate and components have been lowered into the module vessel, it is now useful to test the integrity of the detector signals. This must be done prior to the module being installed into the scattering chamber.

First the pre-amplifier packs must be attached to the back of the baseplate. See Figure 5.1.

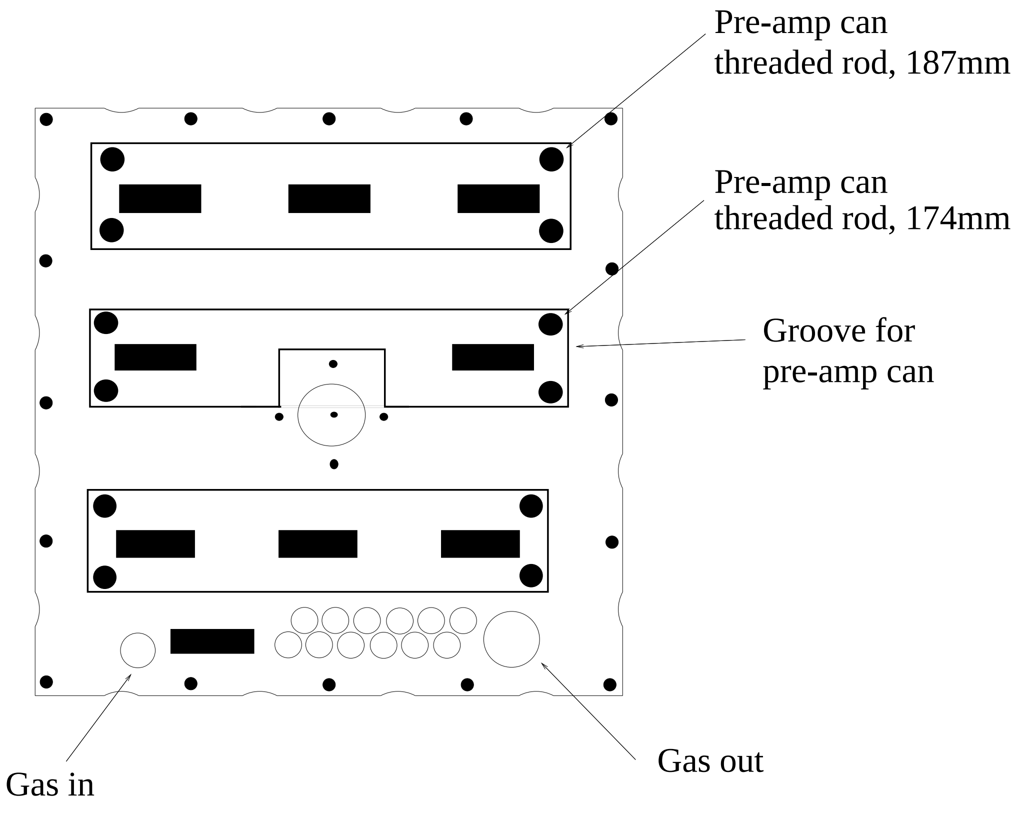

Figure 5.1: Module baseplate (back view).

The pre-amplifier cans each require four long threaded rods to fix them in place. The rods are of two sizes, 174mm and 187 mm. The shorter rods are used for the central pre-amplifier can, and the longer rods are used for the outer pre-amplifier cans. These screw into the holes provided on the back of the baseplate. The pre-amplifier can is lowered over the four threaded rods such that they run along the inside of the pre-amplifier can cover, and protrude through the holes in the lid of the pre-amplifier. The orientation of the pre-amplifier packs is shown in "The MEGHA manual", page 18, figure 2.7. The pre-amplifier pack has three black female connectors at the bottom. These should be lowered carefully onto the glass feedthrough pins at the back of the baseplate. Once this is done the lid of the can may be secured down using nuts and washers. The rods for the outer pre-amplifier cans are longer than those for the inner one so as to accommodate handles. The handles are made out of cast iron and have four holes tapped into them. The handles sit over the two outer threaded rods, and are fastened down with nuts and washers. Now that the module has been assembled, we can test it to see if all the signals from the detectors are present.

5.1 Pulser Testing of the Pre-amplifier Pack

N.B. *Bias must not be applied to the detectors while pumping the module. Bias applied to the detectors while pumping (or venting) could result in spark discharge, severely damaging them.*

Place the module on a sterile surface such that the top of the pre-amplifier cans are facing upwards. The power rails of the pre-amplifier packs each require ± 12 volts. First connect up the power to the pre-amplifier. At this stage the module does not need evacuating and bias should not be applied to the detectors. Each pre-amplifier pack is associated with three telescopes. Which are labeled on the back of the packs, A, B and C.

N.B. *"The MEGHA manual", defines the different connections on the back of the pre-amplifier pack. See page 18, figure 2.7 of that manual.*

Each pre-amplifier pack has three inputs devoted to test signals, these are, E_T, P_T and G_T. These inputs allow a pulser to be driven into the pre-amplifier pack, and to be looked at after pre-amplification. Any distortion of the pulser signal after pre-amplification draws our attention to a possible problem with the pre-amplifier pack in question. The pulser enters the pre-amplifier via these test inputs and travels around the internal pre-amplifiers and PCB's as a normal signal from an experiment would. The pulser is output to one of the corresponding signal output points, i.e. G, E, a, b, c, d. For example, by placing a pulser into E_T, of one pre-amplifier pack, we expect the same pulser to be seen at the output E for all three telescopes, A,B and C. In this way we test that the E channel of the pre-amplifier is amplifying correctly.

N.B. *The central pre-amplifier pack for the centre module, only represents two telescopes, as the central telescope does not exist due to the beam-line.*

The same tests can be performed for, P_T, G_T. Figure 5.2 shows the experimental setup required.

N.B. *a,b,c,d correspond to P_T. E corresponds to E_T. G corresponds to G_T.*

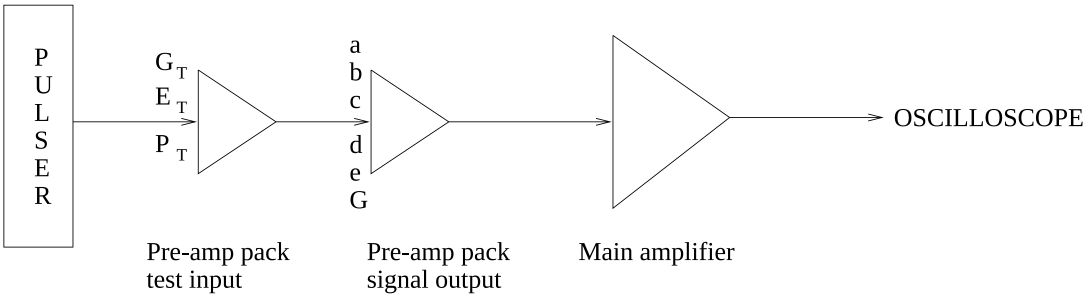

Figure 5.2: Experimental setup for pre-amplifier pack pulser testing.

Hence using a pulse generator, put a pulse successively into E_T, P_T and G_T, for each pre-amplifier pack. Make sure that the pulser can be seen in every corresponding output channel respectively. The reproduced pulser signal should be very clean with little noise.

N.B. *If a signal is missing, it may be necessary to replace the entire pre-amplifier pack if the reason cannot be diagnosed. Also due to the high gain of the gas signal pre-amplifier, feedthrough of the gas signal onto the position and energy outputs is common. This however is not a problem and should be ignored.*

The energy signal and position signal use the same gain pre-amplifier, and hence the pulser output for both will be the same. The gas signal however uses a gain five pre-amplifier and hence the pulser amplitude will be greater. After testing all the pulser channels, for all three pre-amplifier packs, remove the power from the pre-amplifier packs, as well as the pulsers.

5.2 CsI Scintillator Testing, using a Pulser

It is possible to apply a pulser to all the scintillators, to make sure that the pre-amplifier of each is working correctly. The CsI scintillators have a separate power rail and bias line to the other detectors (see Figure 5.3) and are hence totally separate to the pre-amplifier packs. The pulser is applied to the scintillators via pin 13 (see Figure 5.3). This supplies all the scintillators with a pulser signal, via the ribbon cable discussed earlier. A female connector (attached to twelve cables) seats on the CsI feedthrough. The ± 12 volts power is applied through these cables to pins 4 and 5 on the feedthrough (see Figure 5.3). The bias at this point is not required. After application of the power and pulser, the pre-amplified pulser signal from each scintillator can be reproduced using the setup in Figure 5.4. Each scintillator should have a reproduced pulser signal. Any that do not may have a faulty pre-amplifier and hence need replacing. After testing remove the pulser and power from the scintillators.

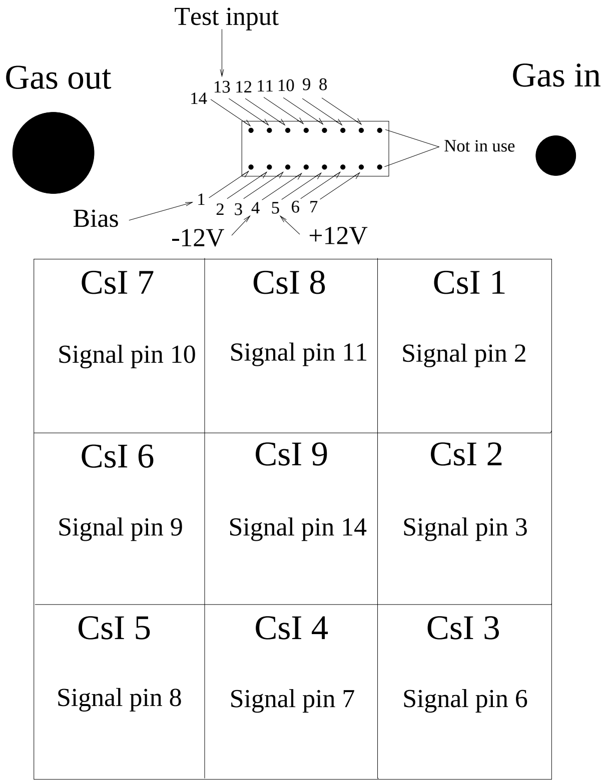

Figure 5.3: CsI scintillator pin allocation.

5.3 α-Source Testing

Using an α-source it is possible to test the signal integrity of the PSD's and CsI scintillators. To do this place the source underneath the telescope that is to be tested. This is done by removing the module vessel from the baseplate, and placing the source on the inside of the vessel, against the blanking plate. Carefully lower the detectors into the vessel, (making sure that the α-source is not disturbed, and that the O-ring around the perimeter of the baseplate stays in place), such that the pre-amplifier pack are facing upwards. At this stage you should now have an α-source directly beneath one of the telescopes. The source used is preferably mixed, so that a quick test of the energy resolution of the PSD can be made. The E signal from the PSD should be able to resolve all the α peaks in the source.

At this stage power, $\pm$12 volts, should be supplied to both the pre-amplifier packs and to the CsI scintillators. Pulsers to the pre-amplifier packs and scintillators should be removed. Due to using an α-source, the module will need evacuating. Assuming that a pump is available, attach the pump to the large SwageloK fitting on the back of the baseplate, (ensuring that the small Swagelok fitting has a cap nut screwed onto it), and begin to pump the module down. Due to pumping, the module vessel and baseplate should form an air tight seal, without the need of bolting the two together. Once the vessel is at a suitable pressure, the bias may be applied to

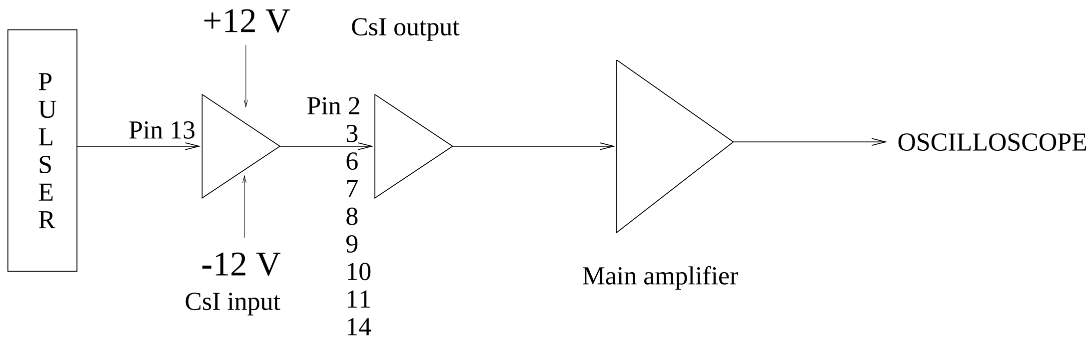

Figure 5.4: Experimental setup for CsI scintillator pulser testing.

the scintillators (typically 30V) and to the PSD's (typically 60V). The bias is applied to the scintillators via pin 1 of the scintillator glass feedthrough (see Figure 5.3). On the back of each pre-amplifier pack there are three SHV connectors labeled A,B and C. These correspond to the three telescopes also labeled A,B and C. Apply bias to the PSD under which the α-source was placed via the appropriate SHV connector. Using the setup shown in Figure 5.5, a bipolar signal produced by the α particles incident on the scintillators and PSD's may be viewed. Only one signal is produced by each scintillator, and these are carried out via pins 2,3,6,7,8,9,10,11 and 14 of the scintillator feedthrough. Each PSD however produces five signals, a,b,c,d and e. So each PSD should be tested to make sure that all five signals are there. It will be noticed that the PSD energy signal is stronger than the four corner signals. Each scintillator and PSD must have all their signals present. If a signal is missing then either the pre-amplifier is faulty or the detector. Pre-amplifier faults will be evident during pulser testing however.

Each of the telescopes should be tested in this way. After testing one telescope remove the bias and bring the module back up to air. Then move the α-source to a new telescope and repeat the procedure out-lined above.

N.B. *Remember to remove bias before evacuating or bringing the module up to air.*

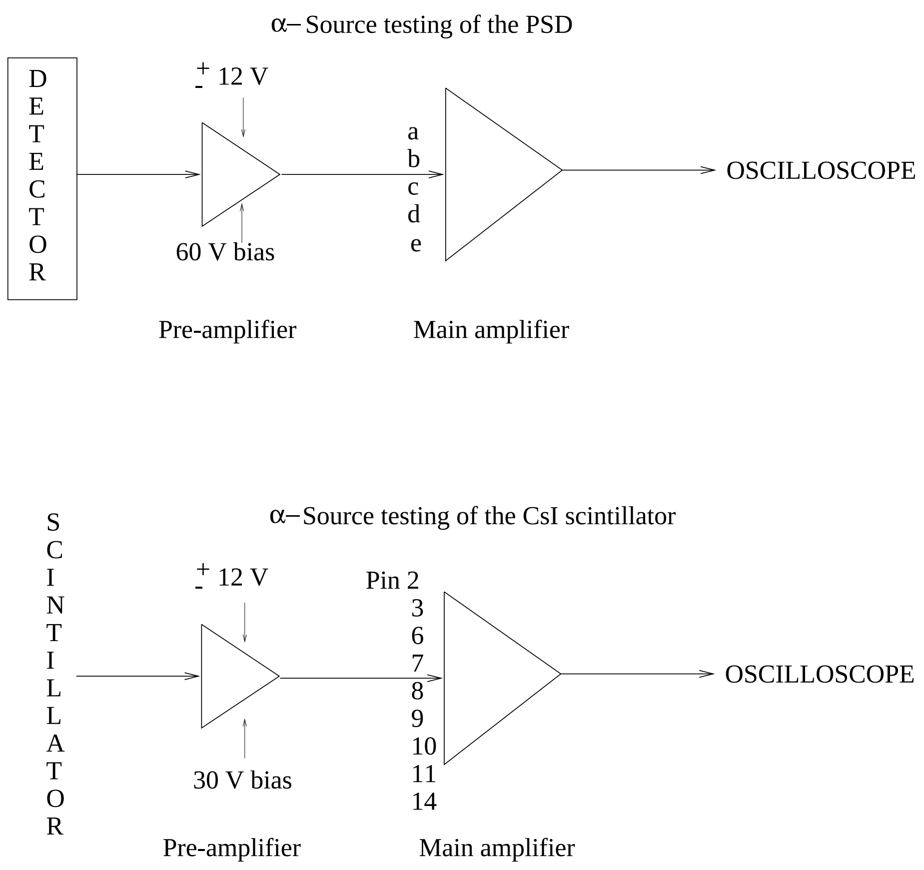

Figure 5.5: Experimental setup for α-source testing.

Chapter 6

Concluding the Module Assembly

At this stage the module is almost ready to be installed into the MEGHA scattering chamber. After testing, the only job that remains is to replace the blanking plate on the module vessel, with a mylar window and calibration grid. Remove all bias, power and pulsers from the pre-amplifier packs and CsI scintillators.

During testing a blanking plate was screwed onto the front of the module vessel. This will now be replaced with a mylar window and clamp (see Figure 6.1). The mylar window is placed against the vessel O-ring, such that the aluminum frame (of the window) is facing away from the vessel. In this way the mylar forms the vacuum seal against the vessel O-ring. The window is secured in place by the window clamp. The window clamp sits on top of the mylar frame and is secured down using sixteen M4 16mm allen head screws. These screws should be vacuum relieved. To guarantee correct seating of the vessel O-ring follow the same procedure of tightening the screws as was adopted for the glass feedthroughs (i.e. opposite corners). The clamp must be put onto the vessel such that the two protruding dowels (which allow correct seating of the calibration grid) face outwards.

N.B. *The mylar windows are fragile, and should be handled carefully. A technique to test the vacuum integrity of the mylar windows (prior to use in MEGHA), is being designed, and will be outlined in this manual once completed.*

To protect the mylar window while installing the module into the scattering chamber, the calibration grid is screwed onto the front of the window clamp. Using four M2.5 8mm vaccum relieved screws

The centre module has a specially adapted mylar window and window clamp, to allow for the beam-pipe, which passes through the centre module. See Figure 6.2.

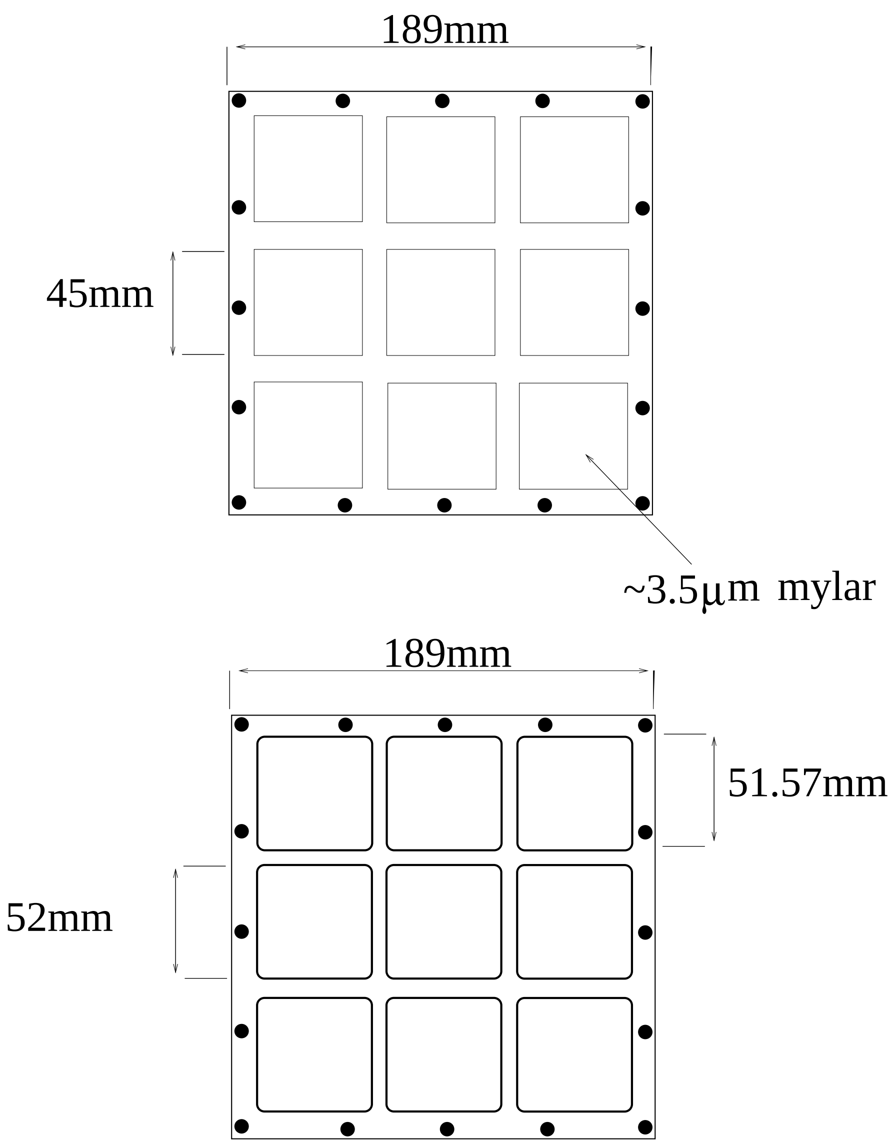

Figure 6.1: MEGHA mylar window (top). MEGHA window clamp (bottom).

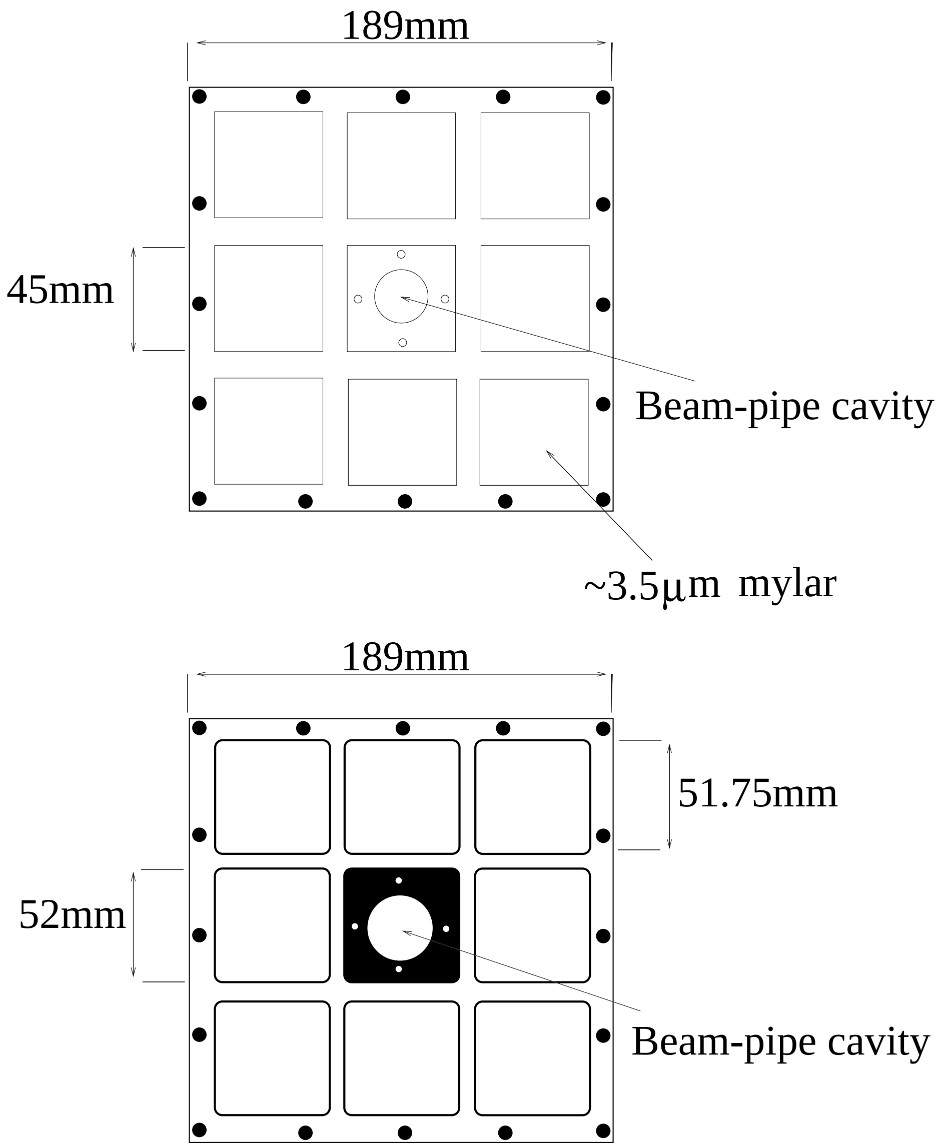

Figure 6.2: Centre module mylar window (top). Centre module window clamp (bottom).

Appendix A

Module Assembly

A.1 Chapter 2

• Make sure that you have all components on the check list (see Appendix B).
• Make sure you are wearing gloves.
• Make sure that all components are clean.
• Check integrity of all O-rings.
• Introduce beam-pipe O-ring into baseplate cavity.
• Place the blanking plug into the central cavity (for outer modules only).
• Install the ten sixteen pin glass feedthroughs, making sure that each has an O-ring.
• Install the 'gas in' and 'gas out' SwageloK fitting (ensuring that each has an O-ring).
• Install twelve vacuum feedthrough conhex connectors.
• Install the four baseplate legs.
• Install the baseplate O-ring (ensuring it's integrity before doing so).
• *Gently* install the three baseplate PCB's.
• Attach the three bundles of coloured gas signal wires to the 3 pin (male) connectors on the baseplate PCB's.
• Check the continuity of these wires from the gold connector (at the head of the wire) to the feedthroughs at the back of the baseplate.
• Attach the gas anode bias lead to the conhex connector nearest the 'gas in' socket. And check its continuity.
• Leak check the baseplate after it's assembly is completed.

A.2 Chapter 3

• Screw four legs (A2-32/8052) onto the CsI scintillator mount (A0-32/8045).
• Attach four 60mm threaded rods to the CsI scintillator mount.
• Make sure all CsI scintillators have an insulating ring, and a pre-amplifier board attached.
• Place the CsI scintillators into mount, making sure that the load of each scintillator is taken by the two springs.
• Screw CsI scintillator clamp into place (A0-32/8046).
• Attach CsI scintillator ribbon cable. And check the continuity of each line on the ribbon cable.

• Screw the scintillators and mount onto the baseplate.

A.3 Chapter 4

• Place four 4mm insulators onto the four threaded rods, which are attached to the CsI scintillator mount.
• Place PSD PCB onto the four threaded rods.
• Push the three fifteen line ribbon cables onto the three vertical fifteen pin (male) connectors which are fixed to the baseplate PCB's.
• Check the continuity between the PSD PCB and the feedthroughs at the back of the baseplate.
• Carefully place the PSD's onto the PSD PCB. Making sure that the middle energy pin on the PSD is attached to the middle connector on the PCB, which has a soldered track.
• Place four 6mm insulators onto the four threaded rods, which are attached to the CsI scintillator mount.
• Place the cathode grid onto the four 6mm insulators. Attach the earthing lead to one of the CsI mount legs.
• Place four 24mm insulators onto the four threaded rods, which are attached to the CsI scintillator mount.
• Place the anode grid onto the four 24mm insulators.
• Screw four nuts onto the four 60mm threaded rods. This secures the grids and PSD PCB in place.
• Connect the gas bias lead to the connector on the anode grid
• Connect the coloured wires from the three pin connector on the baseplate PCB to the anode grid.
• Check the continuity of the signals from the anode grid to the back of the baseplate.
• Place module vessel O-ring into the groove at the top of the vessel (ensuring it's integrity before doing so).
• Bolt the blanking plate to the top of the module vessel using M4 16mm (vacuum relieved) screws.
• Lower the module vessel onto the baseplate, and secure in place using M4 23mm (non-modified) screws.

A.4 Chapter 5

• Screw the 174mm and 187mm threaded screw rods into the back of the baseplate.
• Lower the three pre-amplifier cans onto these rods. Making sure that the three black female connectors at the bottom of each can seat correctly onto the glass feedthroughs.
• Attach the handles to the outer 187mm threaded rods. And fix the pre-amplifier cans down with nuts and washers.

A.5 Chapter 6

• Remove blanking plate from module vessel.
• Replace with mylar window and window clamp.

- Screw calibration grid onto window clamp.

Appendix B

Inventory of module parts

B.1 Baseplate

- Baseplate
  - 10 x sixteen pin glass feedthroughs, plus O-rings
  - 40 x M2.5 8mm allen head screws, plus washers
  - Blanking plug for beam-pipe exit
  - Beam-pipe cavity O-ring
  - Four small counter sunk screws (vacuum relieved)
  - A 'gas in' and 'gas out' SwageloK fitting
  - 12 x vacuum feedthrough conhex connectors
  - 4 x baseplate support legs
  - 4 x M4 24mm allen head screws
  - Baseplate O-ring
  - 3 x baseplate PCB's
  - 3 x bundle of three coloured wires. Pink is 130mm, purple is 230mm and yellow is 150mm
  - 1 x gas bias lead
  - 8 x 187mm threaded rods
  - 4 x 174mm threaded rods
  - 8 x nuts and washers
  - 2 x handles

B.2 CsI scintillators

- CsI detectors (per detector)
  - 2 x brackets
  - 2 x springs
  - 2 x allan cap screws 47mm

  - 2 x nuts/washers

- Legs x 4 [A2-32/8052]
  - 8 x M2.5 allan screws 8mm, vac. relieved
  - 8 x M2 screws 6mm, vac. relieved
- CsI scintillator mount [A0-32/8045]
- Clamp [A0-32/8046]
- 4 x screws for corners
- 4 x 60mm threaded rods
- 4 x nuts
- 9 port CsI ribbon cable (8 for central module)

B.3 PSD and Gas Detectors

- Spacers
  - 4 x 4mm spacers
  - 4 x 6mm spacers
  - 4 x 24mm spacers
- PSD printed circuit board
- Gas section
  - Cathode grid
  - Anode grid

B.4 Vessel

- Mylar window glued to frame
- Beam pipe (for central module)
- Vessel O-ring
- 16 x M4 16mm screws
- 16 x M4 23mm screws
- Vessel blanking plate - aluminium
- Window clamp

B.5 Detectors

- 8/9 PSD's
- 8/9 CsI scintillators with pre-amplifiers

B.6 Miscellaneous

- 3 x Pre-amp packs
- Multi-meter
- Oscilloscope
- CHARISSA amplifiers
- CsI scintillator signal cable
- Calibration grid

Appendix C

Additional Notes and Revisions

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