SCT Barrel Module Document

Appendix 3 to SCT-BM-FDR-6 Assembly Jigs & Procedures for the UK-B and US Clusters

Abstract

This document defines the procedures of the barrel module assembly and the jigs as developed for the UK-B and US Clusters

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Distribution List

Table of Contents

MODULE ASSEMBLY

JIGS AND THEIR USE

MODULE ASSEMBLY

1 Assembly Steps.

This document describes the steps and actions necessary for the alignment and fabrication of an ATLAS barrel module at RAL. The various steps are summarised below.

1) Detector alignment and transfer to the jig plates.
2) Fitting of the baseboard into the module assembly frame, and fitting the baseboard support plate.
3) Applying both the adhesives to side A of the baseboard.
4) Fitting one of the jig plates.
5) Transferring back into the adhesive dispenser for the second side application.
6) Fitting the second jig plate.
7) Removal of sub-assembly from the assembly frame.
8) Parameterisation of the IV characteristics of the detectors after construction of the sub-assembly.
9) Metrology of the sub-assembly.
10) Fitting of the hybrid.

1.1 Detector Alignment.

Figure 1 shows the general arrangement of the hardware. The necessary actions are listed below. The alignment of the detectors to each other and to a reference fiducial is automated and runs with custom LabView software.

1.1.1 The detector alignment chucks are positioned in their home positions and the four location blocks, two for each chuck, advanced to their minimum position.
1.1.2 A new piece of disposable pre-cut clean room paper is placed on each of the alignment chucks.
1.1.3 The detectors are placed, strip side up, in the correct orientation onto the chucks, the vacuum to each being turned on in turn. Vacuum warning lights indicate the quality of the vacuum.
1.1.4 The route card is completed.
1.1.5 The auto-alignment software now aligns the two detectors to each other and a to a reference fiducial on the wall.
1.1.6 When stage 2.1.5 is completed a new piece of double sized pre-cut clean room paper is laid on the strip side of the detectors.
1.1.7 The trolley (Figure 2) on which the jig plates are stored is connected to both the vacuum and power.
1.1.8 Because of manufacturing tolerances, each jig plate has its own software corrections, so it is important to place the appropriate jig plate into the linear bearings and lower into contact with the detectors.
1.1.9 Remove the vacuum from the alignment chucks and apply to the jig plate, checking that the warning lights are green.
1.1.10 Remove the jig plate and store on the trolley, detector side uppermost.
1.1.11 Repeat for the second pair of detectors.

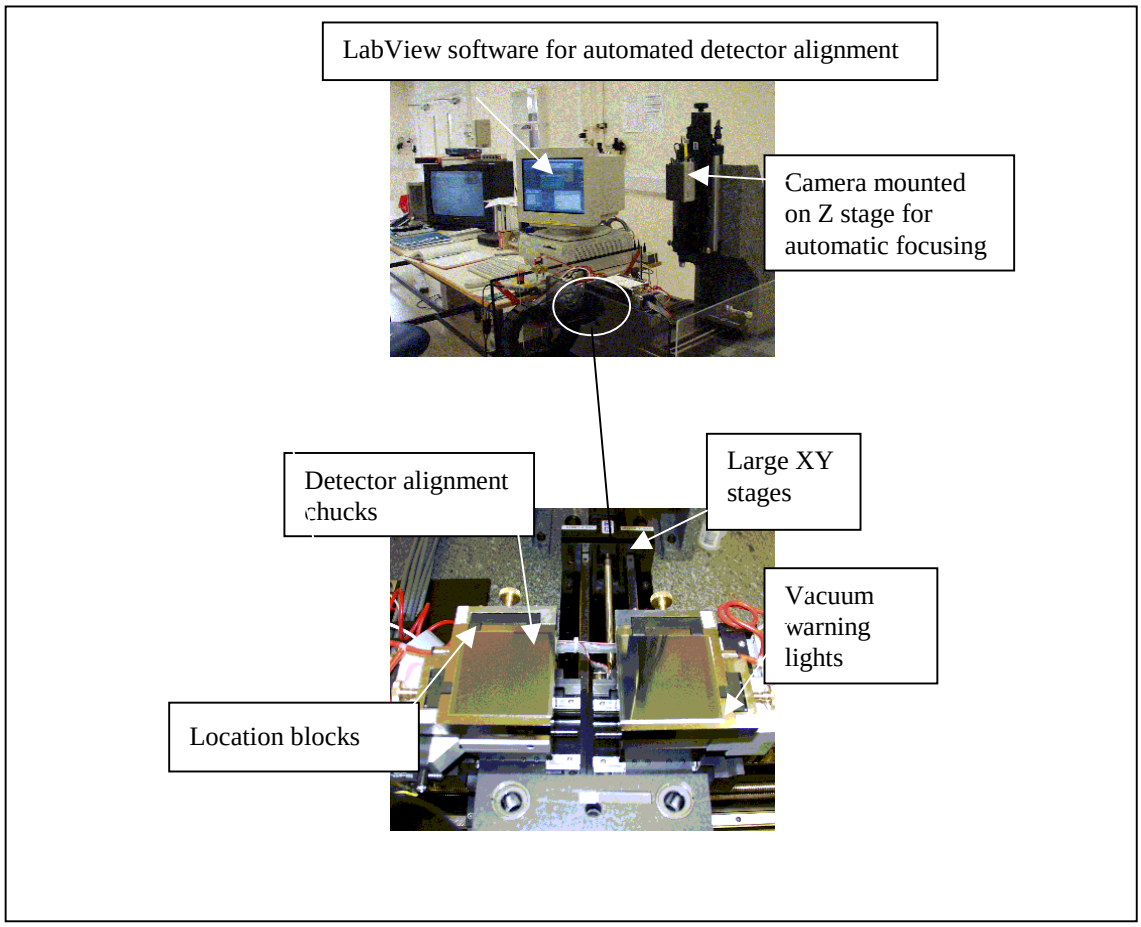


Figure 1

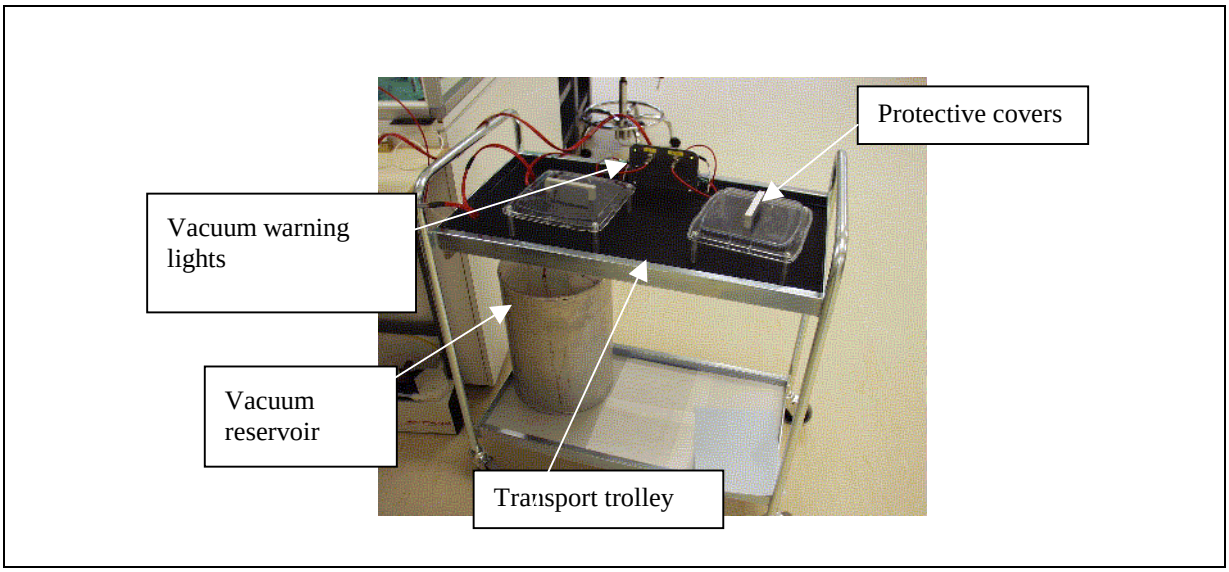


Figure 2

1.2 Baseboard to Assembly Frame.

Figures 3a and 3b shows an empty assembly frame with detailed close up of the baseboard kinematic supports.
A mounted but unsupported baseboard is shown in Figure 4a and a supported one ready for the adhesive to be applied in Figure 4b.

1.2.1 The thickness of the detectors and the baseboard are evaluated to ensure that the assembly jig spacers are of the correct value.
1.2.2 The two spring loaded custom screws are removed along with their springs.
1.2.3 The far end clamp is also removed.
1.2.4 The baseboard is laid onto the kinematic supports.
1.2.5 Each of the two spring loaded screws is refitted to restrain the baseboard.
1.2.6 The far side clamp is refitted.
1.2.7 The ATLAS serial number of the baseboard is recorded in the route card.
1.2.8 A new sheet of pre-cut clean room paper is fitted onto the baseboard support plate.
1.2.9 This is fitted into the jig and bolted in using the same holes as for the jig plate.
1.2.10 A visual check is now made to ensure that all components fit closely.
1.2.11 If necessary this jig may be adjusted in z independently of the assembly jig spacers.

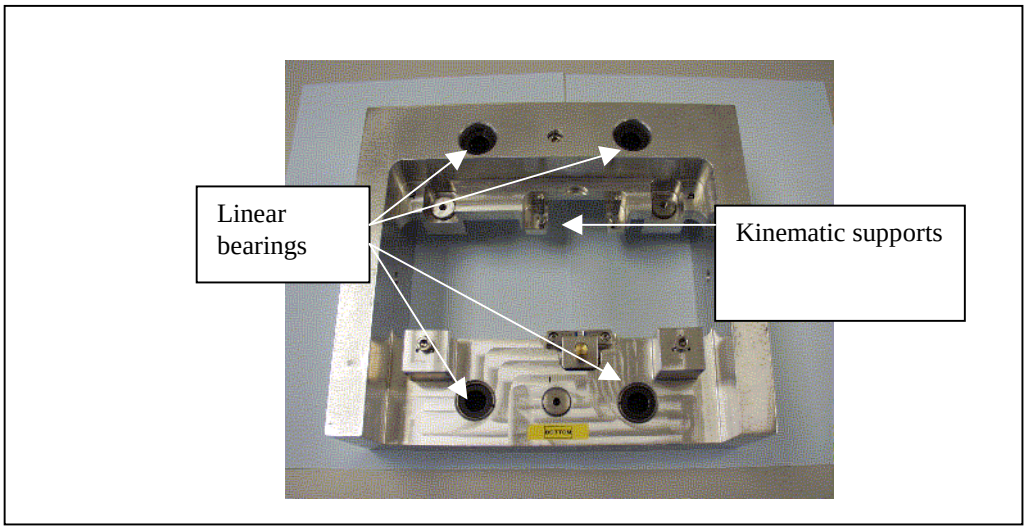


Figure 3a

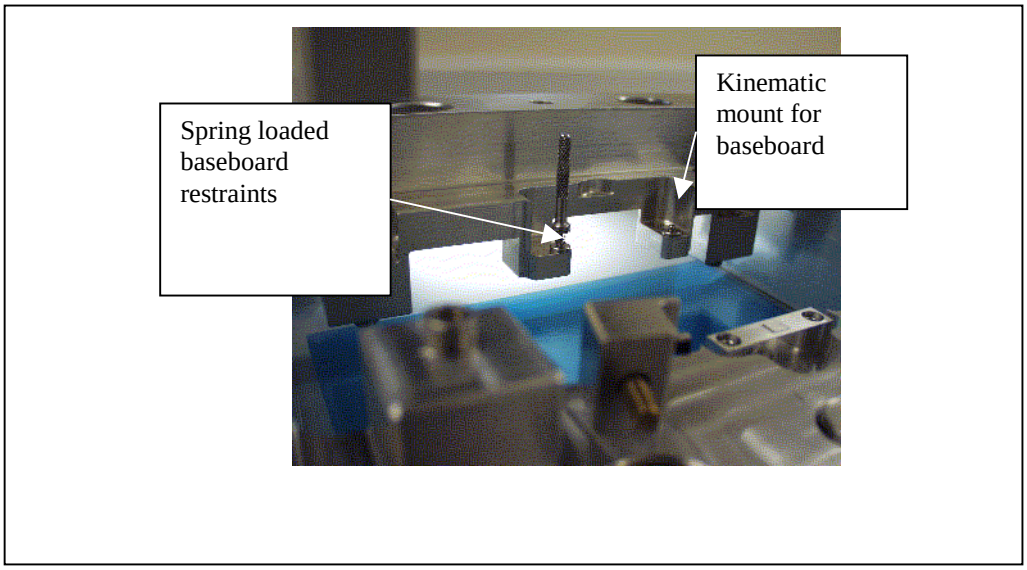


Figure 3b

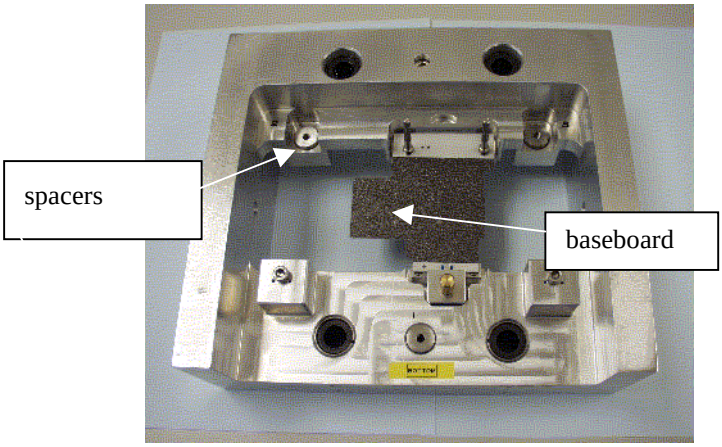


Figure 4a

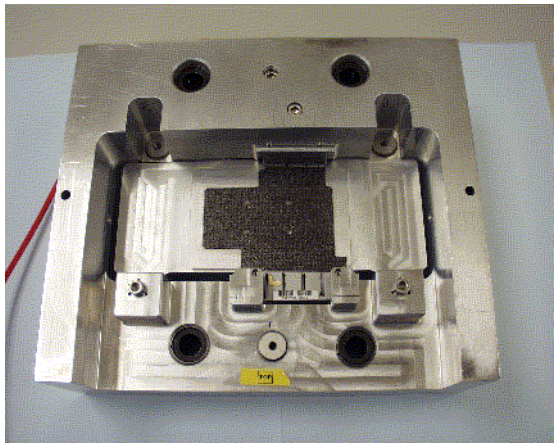


Figure 4b

1.3 Adhesive Application.

Figure 5 shows the 3 axis high precision dispensing workstation used for adhesive application in barrel module assembly. The stand-alone unit uses a standard Sony tabletop robot with 0.02mm X, Y, Z position resolution. The Y axis stage is modified to accommodate the barrel module assembly jig directly. The dispense system is mounted onto the 'X, Z' axis and consists of a Dispensit Model 802-30 Positive Displacement Pinch Tube Valve using an EFD controller. The dispensing workstation is also fitted with a camera and monitor to assist in programming the position of adhesive spots. This system is used to dispense the high viscosity adhesive mix of Ciba-Geigy AW106/HV953V(2011) and Boron Nitride Grade PT140S filler. The mix by weight being 2.5g resin, 2g hardener, 2g filler. The adhesive pattern dispensed Consists of 154 dots arranged as shown if figure 6. The time to complete the dispensing operation including loading the Adhesive into the dispenser and purging adhesive through the dispense system is less than 10 minutes.
The silver loaded conducting epoxy is applied manually after the assembly jigs are removed from the dispensing workstation.

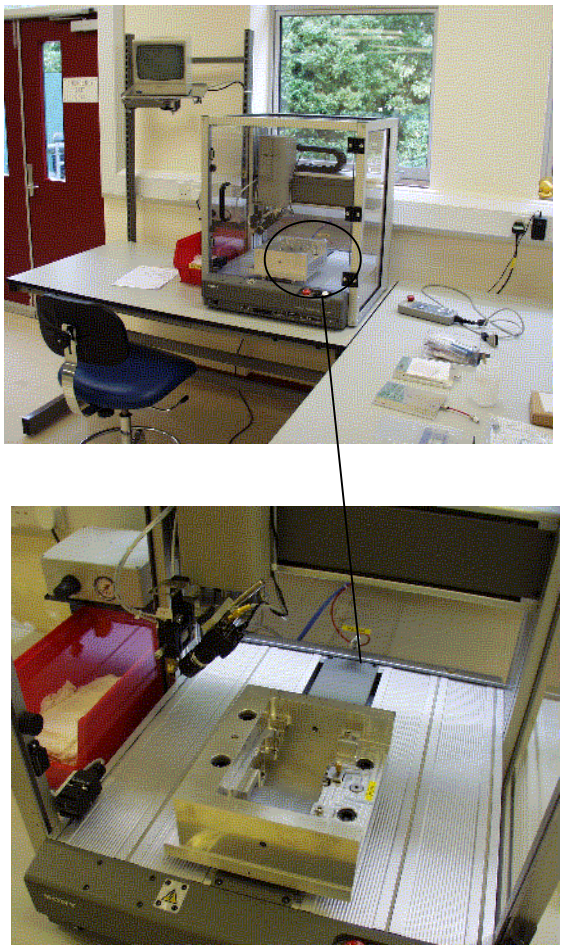


Figure 5

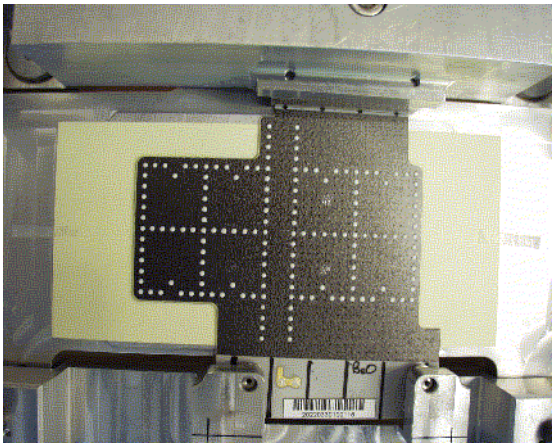


Figure 6

1.4 Fitting The Top Jig Plate.

The previously aligned detectors are held under vacuum on the two jig plates. The dowel pins in the top plate simply Slide into the linear bearings of the main jig as seen in figure 4b. It is retained by 3 screws. This assembly is then placed to one side to cure.

1.5 Transferring Back into The Adhesive Dispenser.

The vacuum is turned off and the baseboard support plate is removed. The whole assembly consisting of the main frame and the top jig plate is returned to the adhesive dispenser and the glue for the second (bottom) side dispensed.

1.6 Fitting The Bottom Jig Plate.

This operation is simply a repeat of step 1.4.

1.7 Removal of the Completed Sub-Assembly

The completed sub-assembly is removed from the assembly jig by removing all the baseboard retaining fixings and lifting it out on the top jig plate, leaving free access to the top of the module so that the universal handling tool (fig 7) may be fitted.

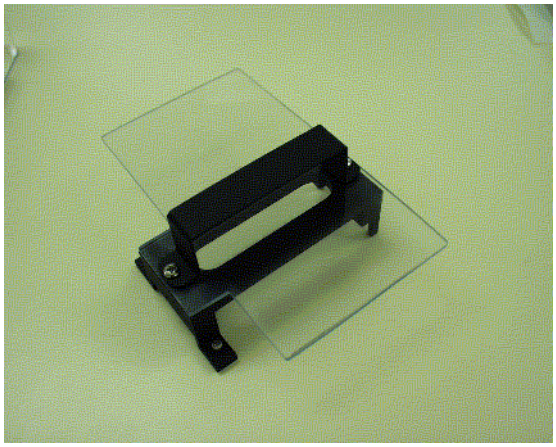


Figure 7

1.8 Parameterisation of The IV Characteristics of The Detectors After Construction of The Sub-Assembly.

The prototype system is described below and in figure 8. The main differences between this and the production version are that the module frame that at present is unique to this process will be replaced by a frame that is also used for sub-assembly testing, hybrid mounting and wire bonding.

1.8.1 The 4-detector sub-assembly is placed in the frame.

1.8.2 A check is made for electrical continuity between the far top bias and the spring loaded bias connection on the cooled upper facing.

1.8.3 This assembly is then fitted onto the custom support.

1.8.4 This is now positioned underneath the optics and locked in position.

1.8.5 The manual prober is now used to position a probe needle onto the relevant bias pad.

1.8.6 All internal lights are turned off and the door shut to isolate the detectors.

1.8.7 Custom software is then used which checks the ATLAS database for detector compatibility, biases the detectors and produces the IV characterisation curves which have pass/fail parameters.

1.8.8 After successfully testing the top two detectors the frame is removed, inverted and reinstalled for testing the second side.

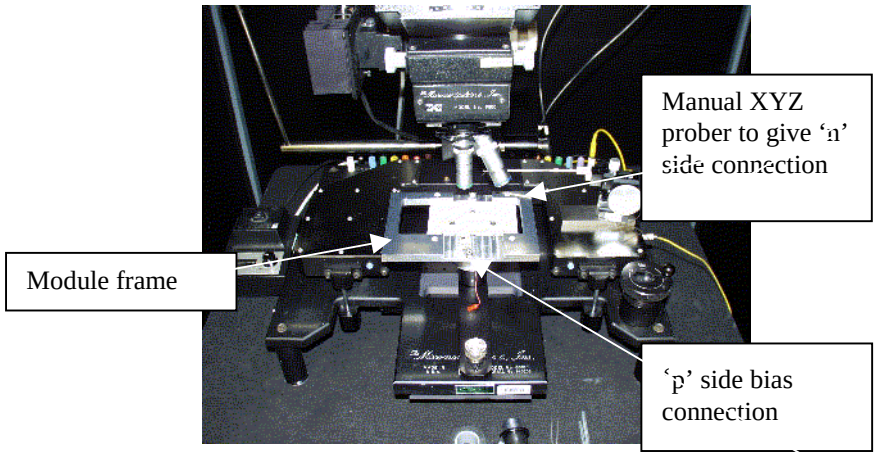


Figure 8

1.9 Metrology of The 4 Detector Sub-Assembly.

Metrology of the module in XY and Z planes with data from both the top and bottom detectors requires a technique of registration between the two sets of data. This is achieved by equipping the module frame with 4 thin pinholes to obtain the XY reference and 3 surfaces to obtain the Z plane datum. Figure 9 shows the completed item.

1.9.1 The module is fitted into the module frame by using the universal-handling tool.

1.9.2 The handling tool is removed.

1.9.3 The sub-assembly is restrained within the frame by the module restraining clips.

1.9.4 Metrology of the top is completed.

1.9.5 The module frame is inverted and replaced on the support plate that is fitted with kinematic supports.

1.9.6 Metrology of the bottom is then completed.

1.9.7 The module is removed and transferred to a storage box or the hybrid-mounting frame.

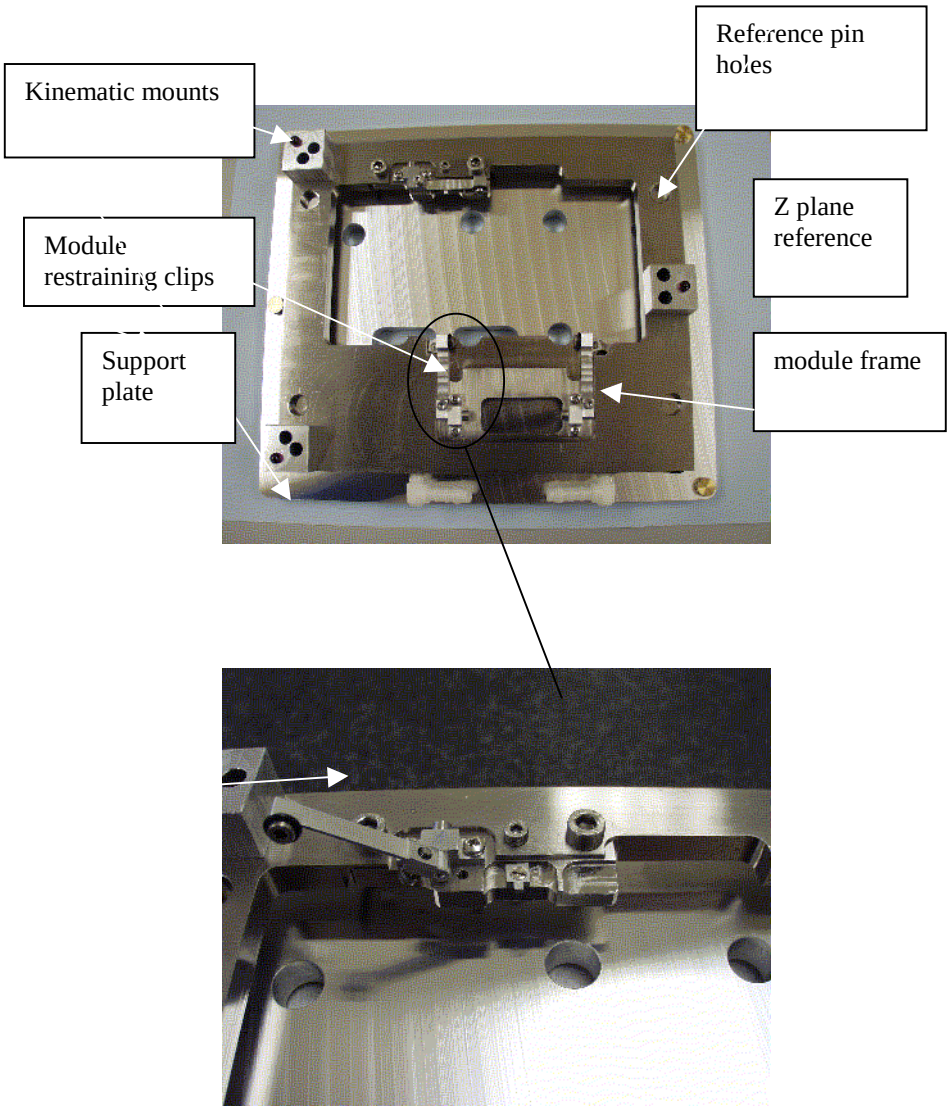


Figure 9

1.10 Hybrid Mounting Procedure.

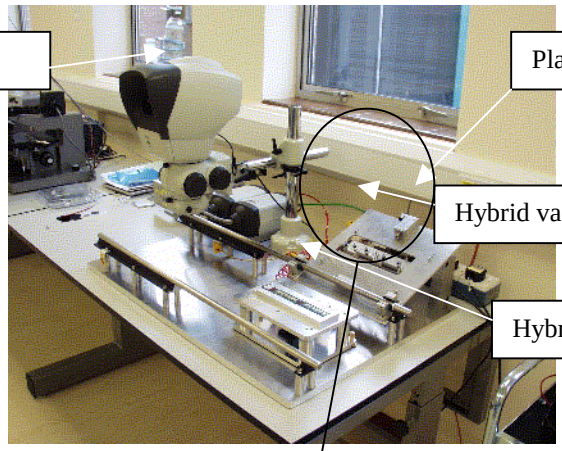
The procedure describes the necessary steps for aligning and mounting hybrids. Dedicated optics with an integrated custom graticiule allows viewing of both features on the hybrid and the detectors at the same time to ensure correct positioning. Figure 10 illustrates the hardware involved.

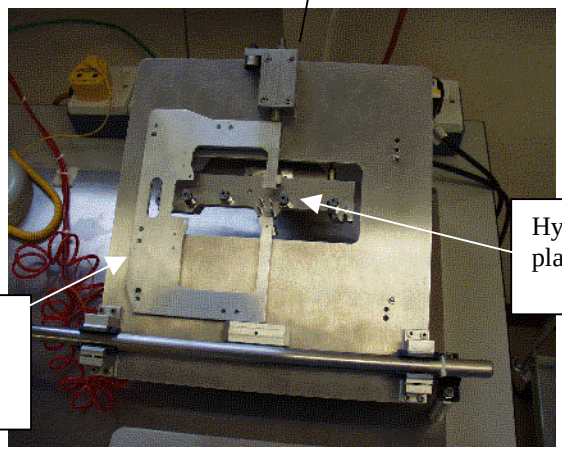
1.10.1 Mounting the upper hybrid.

The hybrid is placed onto the positioning lift, under the hybrid vacuum platen at position A. Once positioned, the platen is lowered and vacuum is applied to retain the hybrid. The z-adjustment is used to lift the hybrid away from its carrier, to the end of its travel. The positioning lift is carefully removed. The 4-detector sub assembly is secured to the underside of the platen, under the upper hybrid and the whole assembly slid to position B, for a preliminary alignment check. Once alignment is assured, the platen is moved to position B. The adhesive is mixed, and applied to the two feet of the upper hybrid. The module carrier is returned to position B and the hybrid lowered into position and alignment rechecked. The long 'pot' life of the adhesive allows ample time for repositioning.

1.10.2 Mounting the lower hybrid.

The hybrid has a flexible joint situated between the upper and lower sections, which wraps around the detector assembly. This operation is 'once only', so adhesive is applied beforehand. The platen is moved to position A, the adhesive is applied and the 4 detector sub- assembly is flipped about its non-cooled edge, taking with it the previous mounted upper hybrid. The Platen is slid to position B for the alignment to be checked


Optics
Platen
Hybrid vacuum platen
Hybrid


Hybrid vacuum platen
4 detector sub-assembly carrier

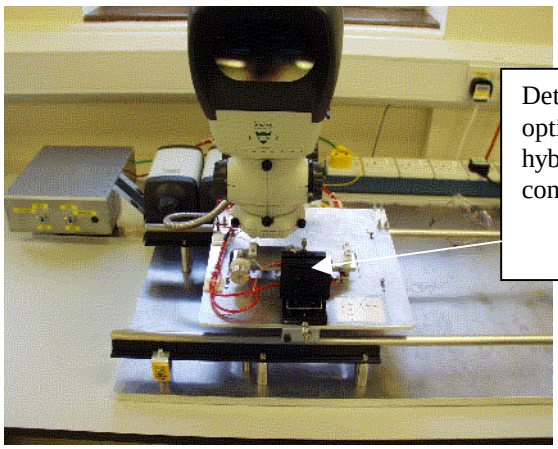

Detail of platen under optics in position B with hybrid XYZ and rotate control

Figure 10

Jigs and their Use

This section of the document describes all the jigs, fixtures and fittings used at the Rutherford Appleton Laboratory for the fabrication of ATLAS Barrel modules in their order of use.

1) Washer mounting jig.

Currently baseboards are supplied to RAL from CERN without either mounting washers or bushes. These are fitted by hand using the jig and fixtures shown in figure 1 and described by the drawings listed in table 1.

Table 1

Drawing number	Description	Drawing number	Description
A0-TB-0059-440-01	GA	A3-TB-0059-448-00	Spacer block
A3-TB-0059-440-02	Location jig datum washers & handling points	A3-TB-0059-449-00	Datum pin
A1-TB-0059-441-00	Base plate	A3-TB-0059-450-00	Obround pin
A3-TB-0059-442-00	Sealing plate	A3-TB-0059-451-00	Tooling ball holder
A3-TB-0059-443-00	Guide block large	A3-TB-0059-452-00	Spacer washer
A3-TB-0059-444-00	Adjustable stop large	A3-TB-0059-453-00	Tooling ball
A3-TB-0059-446-00	Adjustable stop small	A2-TB-0059-454-00	Clamp plate
A2-TB-0059-447-00	Top plate	A3-TB-0059-455-00	Location screw

Description of use

The washer mounting jig allow one baseboard per day to be equipped with both the handling bushes and the alignment washers. The position of the handling bushes on any baseboard is not a critical parameter while that of the alignment of the washers is. In order to accelerate the fabrication of these assemblies the handling bushes are temporarily fixed with superglue to the baseboard using the clamp plate. The two custom alignment washers are fitted over the two accurately machined pins that pass through the baseboard and are constrained in the Z plane by spring loaded plungers mounted on the top plate. Epoxy (Araldite 2011) is applied around the circumference of the washers and handling bushes.

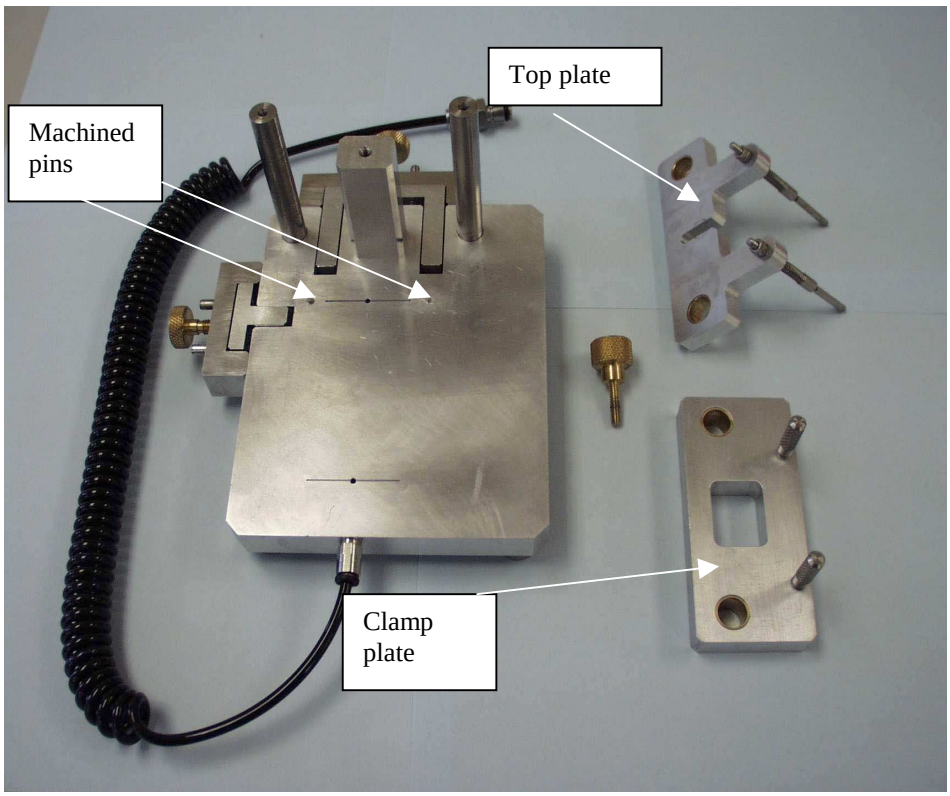


figure 1

2) Module assembly jigs

The following text describes the various jigs and fixtures required to construct an ATLAS barrel 4 detector sub-assembly as described in drawing TB-0059-601-02.

The jigs and fixtures are shown in figure 2, and described by the drawings listed in table 2.

Table 2

Drawing number	Description	Drawing number	Description
A0-TB-0059-400-00	Detector support chuck.	A0-TB-0059-422-00	Body drilling
A0-TB-0059-401-00	Base Right Hand Side	A0-TB-0059-423-00	Jig plate assembly
A0-TB-0059-402-00	Bridge piece large	A0-TB-0059-424-00	Jig plate machining
A0-TB-0059-403-00	Bridge piece small	A0-TB-0059-425-00	Location screw
A0-TB-0059-404-00	Double location block	A0-TB-0059-426-00	Clamp
A0-TB-0059-405-00	Single location block	A0-TB-0059-427-00	Location ball
A0-TB-0059-406-00	Protective film	A0-TB-0059-428-00	Captivated screw
A0-TB-0059-407-00	Adjusting screw modified	A0-TB-0059-429-00	Location spacer
A0-TB-0059-410-00	Detector support chuck left hand side	A0-TB-0059-430-00	Location spacer block
A0-TB-0059-411-00	Base left hand side	A0-TB-0059-431-00	Location bush
A0-TB-0059-420-00	Module assembly jig	A0-TB-0059-432-00	Location spacer
A0-TB-0059-421-00	Body final machining	A0-TB-0059-433-00	Protective film

Description of use

The module assembly jig is equipped with 4 linear bearings, which are positioned to provide the +-20 milliradians of rotation for the two sets of detectors relative to the baseboard. Small positional errors in manufacturing being corrected with the automatic alignment system. Accurate positioning of the baseboard is provided by kinematic supports. A pair of aligned detectors are held under vacuum on each of the two jig plates (each of which is equipped with 2 dowel pins). These jig plates slide onto the module assembly jig using the linear bearings. Additional temporary support for the baseboard while the first side is fitted it is provided by the baseboard support plate.

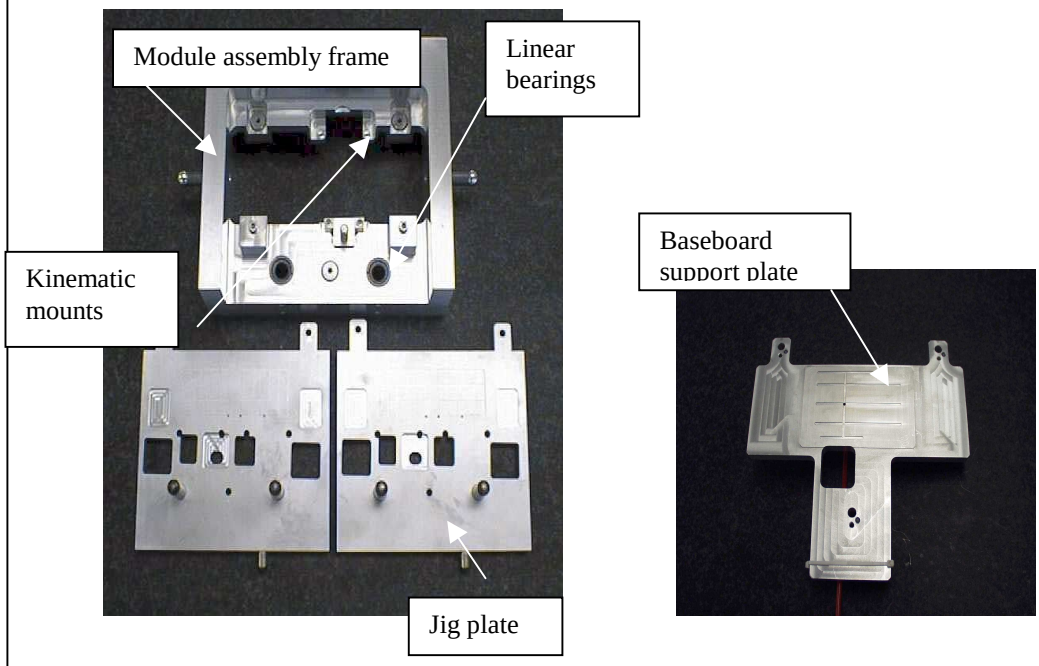


figure 2

3) Sub assembly tester.

The following text describes the jig and fixtures required to bias and parameterise the IV characteristics of the 4 individual detectors after mounting onto the baseboard but before fitting the hybrid. This allows a comparison between the values previously recorded for the separate items. A prototype item exists and is shown in figure 3.

Description of use.

This jig provides support for 4 detector sub-assembly with temporary electrical connection to the metal bias pad on the top facing. The second electrical connection is via a probe needle manually positioned by the XYZ prober. The jig also provides the ability to invert the sub-assembly and repeat for the second side. This removes any requirement for temporary wire bonding.

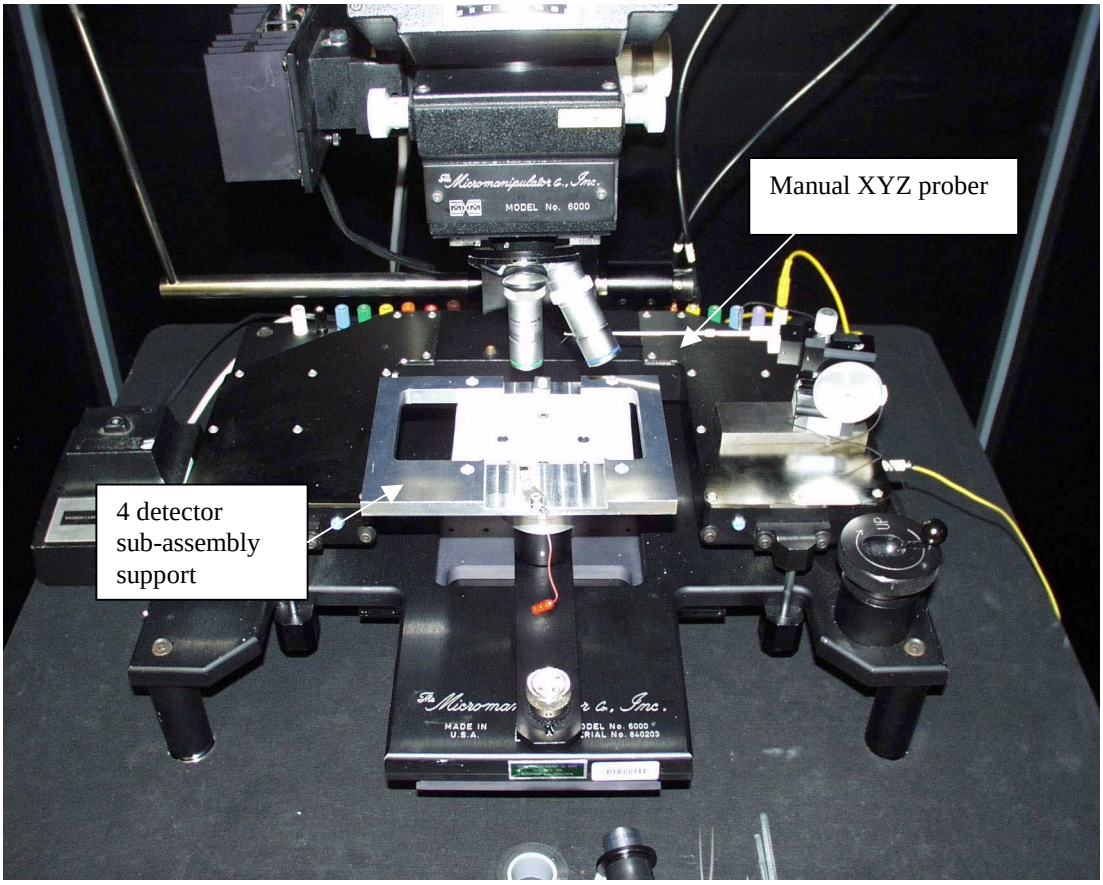


figure 3

4) Metrology.

The following text describes the jig required to support an ATLAS barrel 4 detector sub-assembly for metrology. The prototype is shown in figure 4, and described by the drawings listed in table 3.

Table 3

Drawing number	Description	Drawing number	Description
A1-TD-1009-100-03	Mounting Plate	A3-TD-1009-105-01	Spring Clip Support
A2-TD-1009-101-02	Edge Piece	A3-TD-1009-106-01	M2 Shoulder Screw
A3-TD-1009-103-01	M3 Shoulder Screw	A3-TD-1009-107-01	O Ring Screw
A3-TD-1009-104-01	Spring Clip	A3-TD-1009-109-01	M2.5 Shoulder Screw

Description of use.

This item provides the reference frame for metrology of the 4 detector sub-assembly before fitting of a tested hybrid. The module is clamped into the frame with 3 flexible clips allowing unobstructed viewing of the two mounting washers. 4 reference pinholes provide the back and front positional correlation.

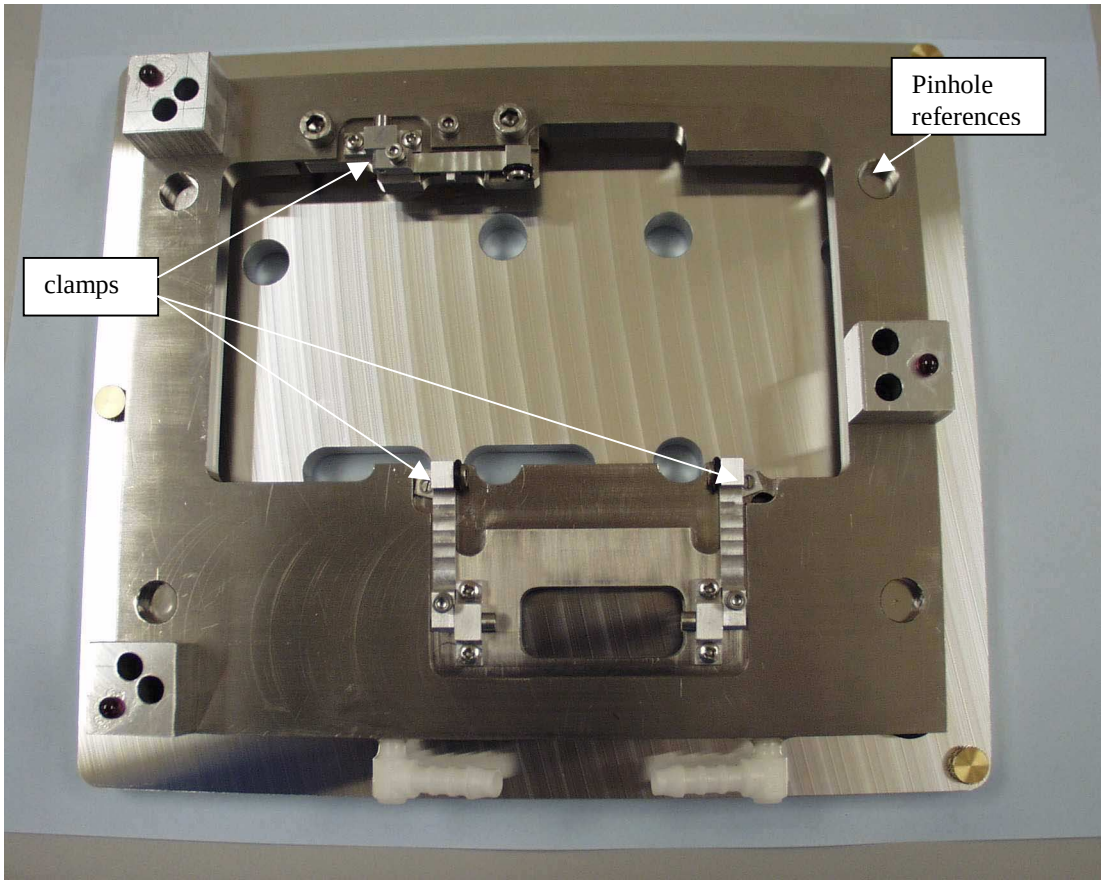


figure 4

5)Hybrid mounting jigs

The following text describes the various jigs and fixtures required to optically align and fit a hybrid onto a previously constructed 4 detector sub-assembly. A prototype item exists and is shown in figures 5 to 7 and described in the drawings listed in table 4.

Drawing number	Description	Drawing number	Description
TD-1009-303	G.A.	TD-1009-320	Module plate
TD-1009-318	GA for carrier assembly	TD-1009-326	Left hand clamp
TD-1009-390	Vacuum plate	TD-1009-329	Lower clamp
TD-1009-393	standoffs	TD-1009-331	Upper clamp
TD-1009-392	Cup fitting	TD-1009-327	Location pin
TD-1009-385	Angle bracket	TD-1009-316	Cover A
TD-1009-335	Module carrier	TD-1009-317	Cover B

Description of use.

This assembly kit provides all the actions necessary align and fit the hybrid relative to the detector Readout strips on each side of the sub-assembly using the detector strips and the pitch adapter on The hybrid. This is retrained within the hybrid vacuum pick up tool with a mixture of vacuum suction cups and pins, while the module is fitted into the support frame.

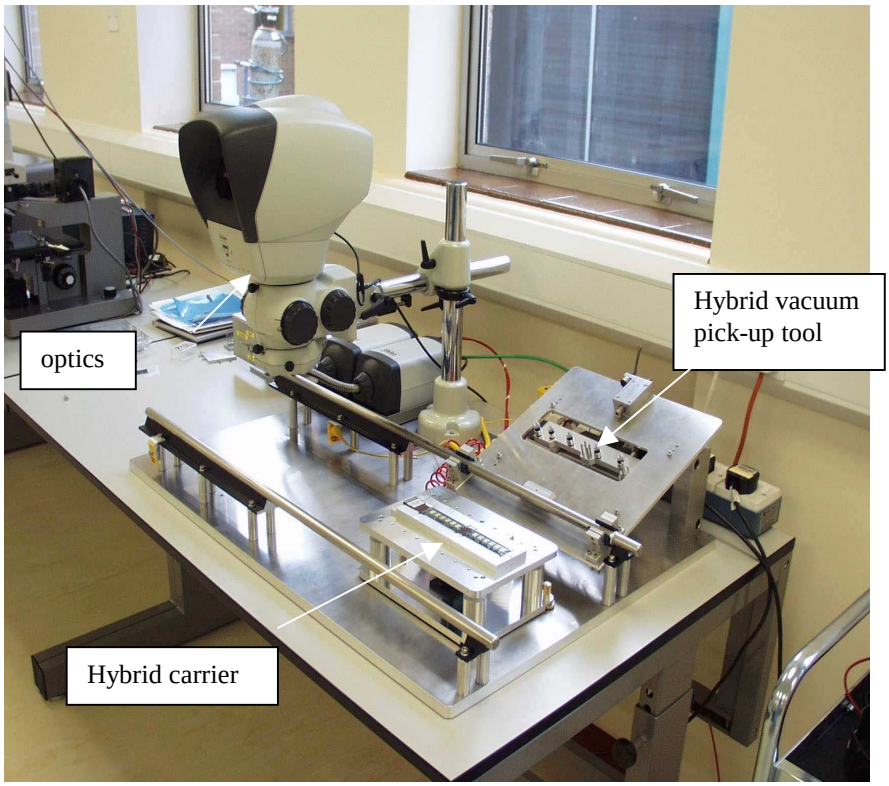


figure 5

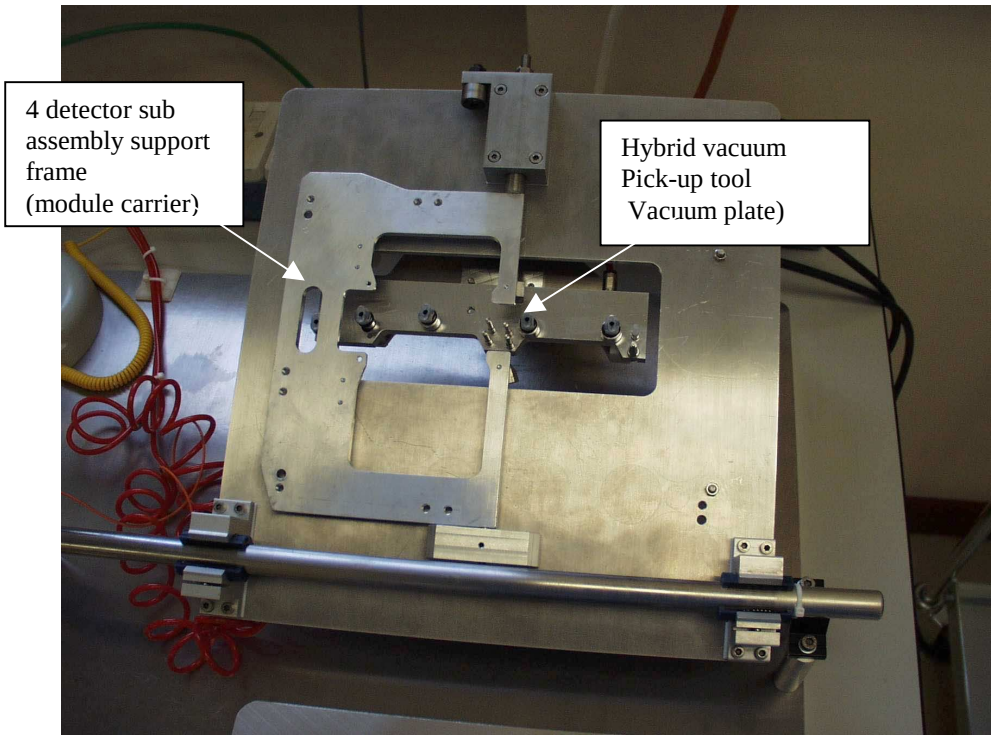


figure 6

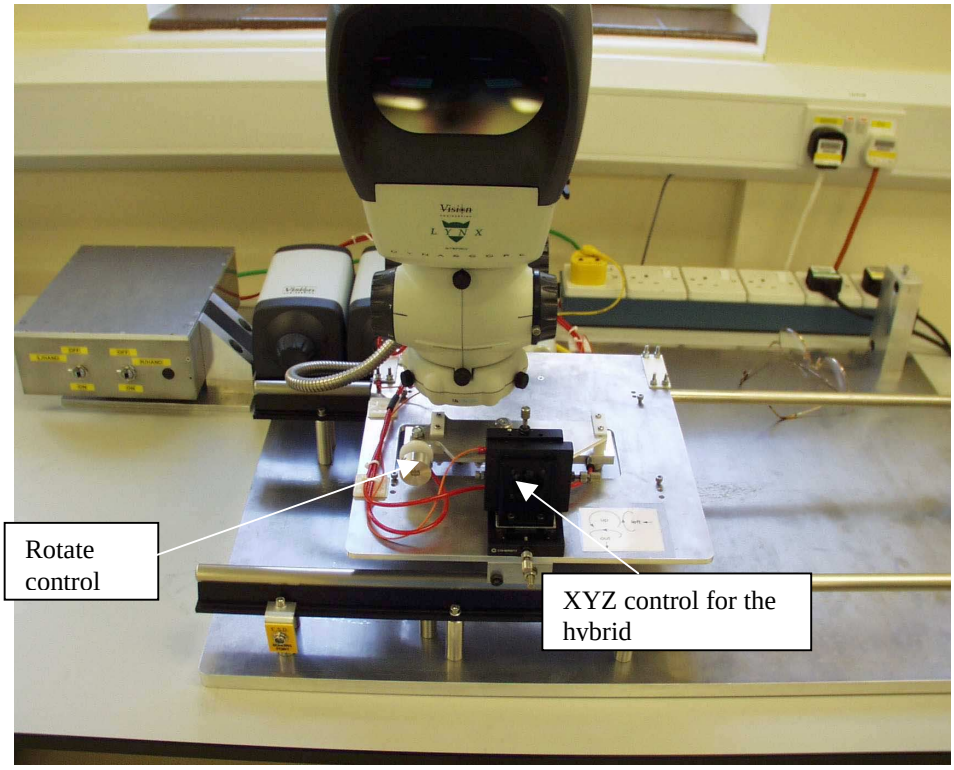


figure 7

5) Universal module handling tool.

At various points in the construction sequence the sub-assembly may have to be moved between the various jigs or stored awaiting testing or delivery of components. The handling tool below (figure 8) allows movement between all of the above jigs and current storage boxes (figure 9).

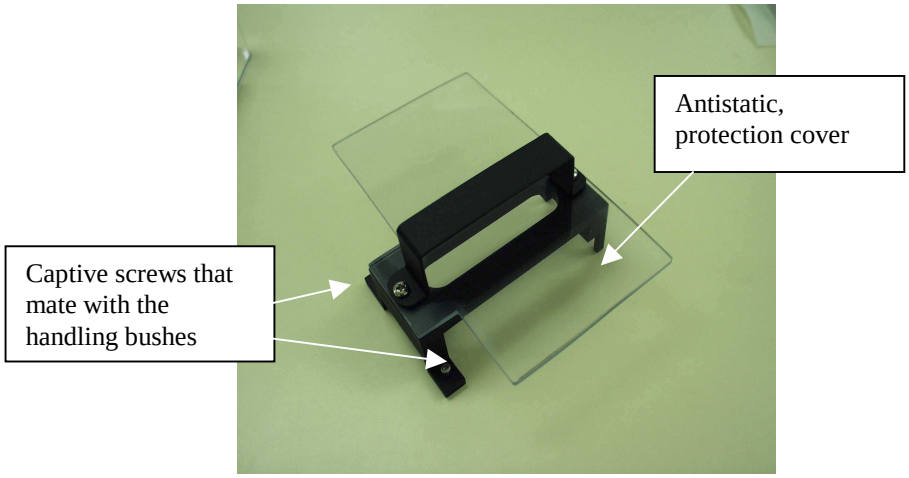


figure 8

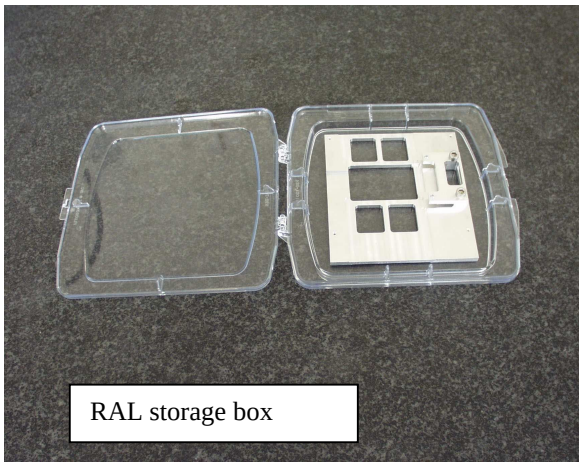


figure 9