UK-B Site Qualification Request

1. Overview

The following documents and information form the basis of the UK-B request to be approved for Series Barrel Module Production. They are provided below in the format from the Site Qualification Needs Document:

For the UK-B Barrel Module project

Cluster Responsible:	A Carter
Cluster Quality Control:	D Charlton

Qualified teams exist for module assembly and metrology (RAL), hybrid assembly (Birmingham) and electrical testing (all UK-B institutes):

RAL:	P Adkin, R Apsimon, P Booker, J Bizzell, V Davis, J Easton, C Fowler, S McMahon, O Morris, PW Phillips, M Tyndel, G Villani
Birmingham:	P Bell, D Charlton, B Gallop, P Jovanovic, S Pyatt, X Serghi, J Wilson
Cambridge:	J Carter, M Palmer, D Robinson, A Sabetfakhri, C Barham, B Fromant
Queen Mary, London:	G Beck, A Belymam, A Carter, J Morris, S Lloyd

Details of RAL work can be seen in this document (MS-Word format).

An overview of the UK-B module QA is given in the Outline of UK-B Module QA activities document (MS-Word format).

2. Steps to have been Completed

Production of 5 electrical modules, satisfying every aspect of the electrical and mechanical specifications listed in SCT-BM-FDR4 and SCT-BM-FDR7. For the summary, including yield, see:

- Summary of UK-B site qualification modules assembled (MS-Word format)

For the electrical and mechanical properties see:

- Summary of electrical performance of UK-B site qualification modules (MS-Word format)

- Summary of metrology results (MS-Word format)

3. Documentation

3(a). Manuals for Operator Use

Principal manuals:

- (Birmingham) Hybrid assembly: Operator's Guide (MS-Word format)
- Birmingham Hybrid bonding operation manual (MS-Word format)
- (RAL) Instructions for the Construction of an ATLAS Barrel Module (MS-Word format)
- (RAL) Simplified programming and operating procedures for the dispensing system (MS-Word format)
- (RAL) SCT Barrel Module: Hybrid mounting procedure (MS-Word format)
- (RAL) Smart-scope set-up (MS-Word format)
- (RAL) Metrology recording (MS-Word format)
- (RAL) Assembly of Hybrids and Wirebonding of ATLAS SCT Barrel Hybrids and Modules (covers only the wirebonding of barrel modules)
- (RAL) Final inspection checks (MS-Word format)
- UK-B Electrical tests operator's guide (MS-Word format).
- Main electrical test specification document

Additional supporting information:

- Precautions taken at RAL against damage to ATLAS barrel modules by electrostatic discharge (MS-Word format)
- RAL Clean room in R12 (MS-Word format)
- Birmingham electrical tests operator's guide (MS-Word format). This document is Birmingham-specific and also used for training.

3(b). Batch traveller procedure

- Overview document (MS-Word format)
- Birmingham Hybrid Assembly Check Sheet: These are available at http://www.ep.ph.bham.ac.uk/exp/ATLAS/sct/hybrids/assembly/ as "Whole" in the

"Check Sheet" column

- RAL module build sheet (MS-Word format): also contained in the appendix of the document Instructions for the Construction of an ATLAS Barrel Module, listed above

3(c). Procedure for Component Accountability and Yield Statistics

See:

- Overview document (MS-Word format)

3(d). Visibility of Results to All Barrel Sites

The results are available via:

- Hybrid assembly and testing results
- Module construction information, via Nobu-worksheets, is in preparation
- Metrology summaries (all in Excel format): X-Y metrology (also before thermal cycling); UK standard shape; Z metrology
- Metrology results for the different modules, measured after thermal cycling (all files in Excel format):
  - **20220170100042 (E1)** X-Y and Z
  - **20220170100034 (E3)** X-Y and Z
  - **20220170100038 (E4)** X-Y and Z
  - **20220170100053 (E5)** X-Y and Z
  - **20220170100056 (E6)** X-Y and Z
- Module electrical test results from RAL and from Cambridge

4. Required Facilities

The appropriate facilities are now in place at each of the 4 institutes, and include:

- inert gas storage for components and completed modules available at all UK-B cluster sites
- appropriate glue storage is implemented as required at RAL and Birmingham
- a clean room for module assembly equipped with all necessary wire bonding, module assembly station, glue dispensing, metrology station is in use at RAL; a clean room is also in use at Birmingham for hybrid assembly and bonding, and at Cambridge and QMUL for semiconductor testing.

- a jig set has been commissioned for all processes in module assembly and 5 further sets are in production
- database terminals and barcode readers are in use at all UK-B cluster sites
- hardware and software for module QA as listed in SCT-BM-FDR7 is in use
- appropriate insurance cover has been applied for by all institutes concerned. It is already in effect in the universities.

BARREL MODULE PRODUCTION

SITE QUALIFICATION: UK-BARREL

Barrel Module Assembly Site Qualification Procedures and Criteria

1. Named Personnel

(a) A Cluster Responsible Person
(b) A Cluster Quality Control Person
(c) A qualified team of assembly, metrology and electrical test staff

Site	Cluster Responsible	Cluster QC Responsible
UK BARREL	Tony Carter	Dave Charlton

2. Steps to have been completed

(a) Production of at least 5 electrical modules, satisfying every aspect of the electrical and mechanical specifications listed in SCT-BM-FDR4 and SCT-BM-FDR7, from a starting date to be agreed by the Module Co-ordinators for each site.
(b) Yield: no more than one failed module to have been part of the qualifying series.
(c) At least two modules to have been exchanged between pairs of sites to verify metrology and electrical measurements

3. Documentation

(a) Sufficient documentation and manuals for operator use in assembly and test
(b) Agreed batch-traveller procedure for module production and test
(c) Procedure in place for component accountability and yield statistics
(d) All results visible to all barrel sites (through the database?)

4. Required Facilities

(a) Inert gas storage for components and completed modules
(b) Appropriate glue storage
(c) Clean room for module assembly equipped with all necessary wire bonding, module assembly station, glue dispensing, metrology station
(d) Commissioned jigging for all processes in (c)
(e) Database terminal and barcode reader
(f) Hardware and software for module QA as listed in SCT-BM-FDR7
(g) Necessary insurance cover for components and modules

Responsibilities for Barrel Module Assembly at RAL.

At RAL there are two module construction teams. The team maintains ownership of the module throughout its construction to final inspection (including documentation). However, the module is handed to the Bonding-Facility for bonding, the module returned to the same team on completion. The final stages of the module construction (electrical tests and visual inspection) are handled by the test facility.

Primary RAL Contact People

- Steve McMahon & Richard Apsimon.

Clean room operation manager.

- Qualified persons are: Ozy Morris

The Construction Teams

- Team A. Leader Martin Gibson supported by Chantal Fowler.
- Team B. Leader Ozy Morris supported by Julia Easton.

The Bonding facility.

Leader: **Vicki Davis**, other qualified personnel are Paul Booker and Paul Adkin.

The Electrical and Inspection Facility.

Leader: **Peter Phillips**, other qualified personnel are Jeff Bizzell, Giulio Villani and Bruce Gallop. Jeff Bizzell is responsible for the final visual inspection of all modules.

Smart-Scope Operation.

Qualified operators are: Ozy Morris, Julia Easton, Vicki Davis and Chantal Fowler

Glue Dispensor Operation.

Qualified operators are: Julia Easton, Chantal Fowler

Alignment stage Operation.

Qualified operators are: Martin Gibson, Ozy Morris, Julia Easton and Chantal Fowler

Hybrid Mounting.

Qualified operators are: Paul Booker and Martin Gibson.

Analysis of Metrology Data.

Qualified persons are: Steve McMahon.

Shipping.

Qualified persons are: Martin Gibson

Training

There is a continuing program of training between the construction disciplines. What is presented above is the situation at the time of qualification.

S.J McMahon 24/05/02

Outline of UK-B Module QA activities

24 May 2002

Introduction

This document aims to clarify the locations and institute responsibilities for module QA activities in the UK barrel cluster.

Details of individual QA procedures are given in the Barrel Module FDR QA document SCT-BM-FDR-7. An update to that document is being prepared by Nobu Unno.

Institute contacts for barrel module QA related matters

Birmingham	Dave Charlton
Cambridge	Dave Robinson / Janet Carter
Oxford	Georg Viehhauser / Richard Nickerson
QMUL	Graham Beck / Tony Carter
RAL	Jeff Bizzell / Peter Phillips / Steve McMahon

QA of components

The QA of barrel module components is not discussed here. UK-B supplies of components are QA'ed by:

- passive-stuffed hybrids by KEK (contact Nobu Unno)
- baseboards at CERN by QMUL/Cambridge (contact Tony Carter)
- detectors by Cambridge (contact Dave Robinson)
- ASICs at RAL (contact Bill Murray)

QA tests during hybrid assembly

Hybrid assembly and QA of the ASIC-stuffed hybrids is the responsibility of Birmingham. The QA steps are as follows – assembly steps are included also for clarity:

1. Hybrids are received from KEK and unpacked
2. Visual inspection
3. Bond-pull tests
4. Assembly of ASICs onto hybrid, glue curing, wire bonding of chips to hybrid pads (but not yet to pitch adaptor)
5. Electrical characterisation sequence
6. Long-term test (initially 100h at 37C on hybrid temp sensors)
7. Wire-bonding of ASICs to pitch adaptor
8. Final electrical confirmation test
9. Packaging and shipping to RAL

All steps are on a 100% basis. All steps are done for pre-qualification modules, and all steps will be maintained for full production. The only change anticipated for full production is that the length, and temperature, of the long-term test may be reduced with experience across the SCT.

Hybrids failing steps 2 or 3 are returned to Japan. Hybrids failing tests 5, 6 and 8 are re-worked in Birmingham – chip replacement being the most that can be done.

QA tests of baseboard-detector sandwich

This is done at RAL. The steps are:

1. Visual inspection of baseboard
2. Visual inspection of detectors
3. Assembly of detectors onto baseboard
4. Visual check
5. I-V measurement up to 500V
6. Full metrology

QA tests during hybrid mounting

These are done at RAL:

1. Electrical confirmation test of received hybrid
2. Visual check of hybrid
3. Assembly of hybrid onto module (gluing but not yet wire-bonding)
4. I-V measurement up to 500V as a diagnostic step
5. Detector strip wire-bonding

We should aim to reduce/eliminate step 4 during production. A hybrid failing steps 1 or 2 would be returned to Birmingham for re-work where possible.

QA tests on completed module

This is split between RAL and the Universities. This document aims to define a QA sequence and responsibilities:

1. I-V measurement to 500V (ASICs off)
2. Electrical confirmation test
3. Full metrology
4. Thermal cycling
5. Full metrology
6. Electrical characterisation before shipping

7. Ship to Birmingham/Cambridge/QMUL
8. I-V scan (ASICs off)
9. Electrical characterisation test at room temperature
10. Long-term electrical and I-V stability test (aim to run these two concurrently, at 0C as measured by hybrid temperature sensors, in a controlled N_2 environment). Terminates with a characterisation test at 0C.
11. Optional source or laser tests

12. Pack and ship to Oxford
13. Confirmation test at Oxford while still in module box, before mounting onto barrels

Modules failing the I-V tests undergo further tests at the Universities, as agreed in the February 2002 SCT week module meeting (to be documented by Nobu Unno). Modules failing any other tests in the Universities are returned to RAL for re-work or storage.

Step 3 could also migrate to a sampling basis, dependent on experience.

Sampling QA

Irradiation and test-beam are SCT-wide activities.

Source and laser tests – will be done at Cambridge.

Sampling fractions are not yet defined, but will be small.

Summary of UK-B Site Qualification Modules Assembled

1. Overview of Qualification Modules

The UK-B site qualification modules are:

Module Number	Hybrid Type	ASIC Wafer	Baseboard Type	Hamamatsu Detector Type
20220170100042 (E1)	K4	CERN-Z36459A-W06	Prototype, old washers	Pre-series
20220170100034 (E3)	K4	CERN-Z36459A-W06	Site qualification, new washers	Pre-series
20220170100038 (E4)	K4	CERN-Z36459A-W05	Site qualification, new washers	Pre-series
20220170100053 (E5)	K5	RAL-Z37277A-W05	Site qualification, new washers	Pre-series
20220170100056 (E6)	K5	RAL-Z37277A-W05	Site qualification, new washers	Series

Further component details can be found in
http://www.ep.ph.bham.ac.uk/exp/ATLAS/sct/hybrids/assembly/
http://www.hep.phy.cam.ac.uk/si-bin/moduledetectors.pl
http://hepwww.rl.ac.uk/atlas-sct/qualification/Default.htm
http://www.ep.ph.bham.ac.uk/exp/ATLAS/sct/sq/ComponentTracking.pdf

The cold long-term tests for three of these modules will be completed during this week, as the final QA step. This is discussed in section 2.5 of the accompanying *Summary of electrical performance of UK-B site qualification modules*. Up to the point of their long term tests, all modules are within the full electrical and mechanical specifications, as shown in the documents accompanying this section. They have been made with final jigs proposed for the UK-B cluster at RAL. The ASICs were mounted on the hybrids at Birmingham, as for series production.

An additional module (E2) using prototype baseboard number 20220900200102 and pre-series detectors, was also started, see section 2 below. This was not taken beyond the stage of the detector-baseboard sandwich.

2. Non-Qualification Module E2

This is the module referred to in the email sent from Janet Carter to SCT module builders on 24th April 2002, an extract of which is reproduced below:

As module production gets underway, this mail is a reminder of the care needed to preserve the cleanliness of the edge and guard regions of the detectors. It is particularly prompted by a high voltage problem seen with a UK-B module, whose origin has been *diagnosed by Jeff Bizzell, and which has led to an alteration in detail of the UK-B module-making procedure.*

For Hamamatsu detectors, the passivation that should cover the vertical sides of the aluminium at the edge of a passivated metal region can be very thin in places. This has been seen by Jeff in an SEM picture, and is confirmed as possible by Hamamatsu. This can increase the danger of conducting paths being formed, through surface debris or contaminants, between the edge metal of the detector (at high volts), the floating guard and the bias rail. This occurred in the UK-B module when using clean-room paper that was slightly smaller than the detector area to protect the top surface of the detector during module assembly. For that particular module, a deposit was left round the edge of the paper, crossing the guard regions of the detectors. In a clean-room atmosphere there was sufficient absorbed moisture to cause breakdown at around 450V. In a nitrogen atmosphere there was no problem. The area of the clean-room paper has now been increased to match the detectors. Spit round the edge region of the detectors can also conduct sufficiently to induce breakdown, and precautions need to be taken against this (ie the use of face masks or guards).

The detector surfaces on this E2 module were cleaned, and it now holds 500V bias. However, UK-B preferred to keep it as a detector sandwich for assembly tests at Oxford rather than to proceed with hybrid mounting as a qualification module.

The clean room paper now used in UK-B module assembly at RAL covers the whole active area of the detectors, and since the change no further problem of this type has been observed.

Summary of Electrical Performance of UK-B Site Qualification Modules

1. Detailed Results

The full electrical test data of the completed modules can be found at

http://hepwww.rl.ac.uk/atlas-sct/qualification/Default.htm
and
http://www.hep.phy.cam.ac.uk/~silicon/moduleresults.html

All measurements satisfy the module electrical specifications.

The measurements are complete, apart from the long-term tests for modules E3 and E5. These are due to be finished during the week beginning 27th May, and will then be added to
http://www.hep.phy.cam.ac.uk/~silicon/moduleresults.html

An overview summary of the results is given in Table 1.

Module Number	Uncorrected Noise ENC (warm, from NO)	Noise-Occupancy at 1fC (uncorrected threshold)	Poor Quality Channels from electrical test (which is insensitive to oxide punchthroughs)	Leakage Current (warm) at 500V bias
20220170100042 (E1)	1377 - 1501	3.5e-006 – 1.1e-005	0	1.60 µA
20220170100034 (E3)	1171 - 1299	1.8e-007 – 9.2e-007	2	0.73 µA
20220170100038 (E4)	1330 - 1588	2.2e-006 – 3.3e-005	2	0.91 µA (rises with time)
20220170100053 (E5)	1186 - 1329	1.9e-007 – 3.0e-006	2	0.80 µA
20220170100056 (E6)	1233 - 1319	1.6e-007 – 2.5e-006	3	1.48 µA (falls with time)

Table 1: Superficial overview of electrical characteristics of modules. Results are from the most recent characterisation test (modules E1, E3, E5 at RAL, E4, E6 at Cambridge)

2. Points to Note

2.1 Noise and Noise-Occupancy

The results in presented have not been corrected for differing values of ASIC calibration capacitor. The correction values supplied for these ASICs are a factor of 1.13 for modules E1, E3, E4 and a factor of 1.12 for modules E5 and E6.

The large number of channel defects, classed as 'part bonded', seen in the cold LTT of E6 is because the uncorrected noise value for this module is low in comparison with the software cut.

Given the normal uncertainties, the noise and noise occupancy results seem satisfactory.

2.2 S-Curves

These can be found with the electrical results. They show the usual level of small scale structures apart from module E4, where stream 1 exhibits some larger effects. This is the only qualification module made with ASICs from that wafer; the hybrid is K4.

2.3 Bad Channels

The numbers of 'poor quality' channels given in Table 1 include those with slightly high noise. We are in the process of comparing these with known detector defects. There are in total just 3 channels that are definitely bad due to the assembly process:
Module E4: 1 unbonded channel (damaged when a short was removed between 2 nearby channels)
Module E6: 2 part-bonded channels caused by a bonding jig problem, which is now corrected.

A stuck pipeline cell developed on one channel (884) of module E4 during its long term cold test.

2.4 Leakage Currents

Modules E1, E4 and E6 have total leakage currents at 500V bias that are slightly larger than the sum of the 4 original detectors. The changes come at the bonding stage, and work is still ongoing to investigate the cause. Module E6 has been subjected to a long-term (72 hour) test at 22C under nitrogen at 350V bias:
(http://www.hep.phy.cam.ac.uk/~cleanrm/images/mod56istab.gif)
The current stabilises at a value of about 0.7-0.8 µA. (This module uses series detectors).

The leakage current of module E4 rises from its initial value during long-term test. The result of a 24 hour test at ~ 21C under nitrogen at 350V bias can be seen at:
http://www.hep.phy.cam.ac.uk/~cleanrm/images/mod38istab.gif
After the initial rise, the current varies during the test within about 1.3-1.6 µA.

Our assessment is that the room temperature leakage currents of the modules are acceptable to go forward for ATLAS, but we will continue to look for improvements in this area as we proceed with series production.

2.5 Long-Term Cold Electrical Tests

The long-term (24 hour) cold tests with the hybrid temperatures reading ~ 0C and a bias voltage of 200V have been completed for E1 and E6, and these modules showed good long-term stability.

The first cold long-term test of module E4 terminated after 16 hours with an apparent SCTHV trip, the current limit of 100 µA having seemingly been exceeded. It is now thought most probable that the SCTHV had not in fact tripped, but that the problem was due to a failure of communications between VME, the HV card master processor and the active channel processor. This is supported by the fact that the last measured noise values were normal, although the bias voltage appeared to be only 7.14V. Apart from this 'trip', E4 developed a stuck pipeline cell (see 2.3 above) during the test, and also the leakage current increased to a high (for the temperature) value of 0.6 µA from an initial 0.1 µA. We will repeat a long-term cold measurement of E4 to check its leakage current behaviour.

The cold long-term tests of E3 and E5 are now beginning, and the results will be posted on http://www.hep.phy.cam.ac.uk/~silicon/moduleresults.html as they become available.

3 Comparison of Results at Different Institutes

These qualification modules have not been exchanged for electrical measurement with clusters outside the UK. Within the UK, some of the modules have already been measured at Cambridge as well as RAL, with similar result. They will soon also be measured at Birmingham and QMUL.

RAL module electrical measurements are already well normalised within the SCT, and UK-B modules made in 2000 and 2001 have long been at CERN as part of the system test.

Summary of Metrology Results for the UK-B Site Qualification Modules

1. X-Y Results

A summary Excel sheet for the qualification modules can be found at

http://hepwww.rl.ac.uk/atlas-sct/ModuleProduction/XYHistory.xls

This gives, in the upper table, the results of the in-plane (X-Y) metrology recorded immediately after the thermal cycling but before wire bonding. Also shown (lower table and plots) are the differences from nominal of the in-plane parameters for the five qualification modules, ordered in construction order (abscissa label 2-6).

Also presented at

http://hepwww.rl.ac.uk/atlas-sct/ModuleProduction/XYHistory.PreTC.xls

for comparison are the results of the in-plane metrology immediately after the construction of the 4 wafer assembly.

All measurements satisfy the module metrology specifications.

2. Z Profile Results

Summary Excel sheets in the standard Z profile format are to be found at

http://hepwww.rl.ac.uk/atlas-sct/ModuleProduction/ZHistory.xls

The data were recorded after the hybrid was mounted and the bonding complete. Also presented are histograms of the time ordered parameters of interest. When comparing to a standard shape we have used the KEK shape presented as part of their qualification.

All measurements satisfy the module metrology specifications.

The construction of the standard UK-B shape from the qualification modules is presented in

http://hepwww.rl.ac.uk/atlas-sct/ModuleProduction/zCommonProfileUKB111.xls

In the same file we present comparisons of the KEK and UK-B shapes for 111 sensors.

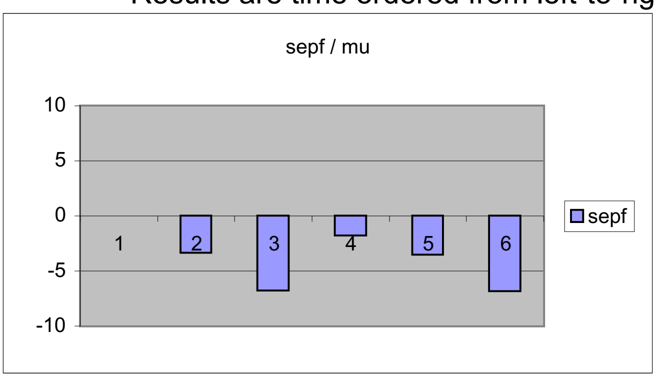
3. Comparisons

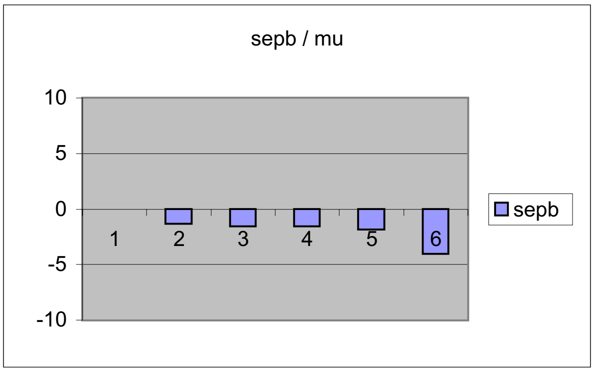
Cross-checks between UK-B and KEK carried out on an exchanged module show good agreement in both XY and Z between the two clusters. It is planned to send another UK-B module to KEK to compete this process.

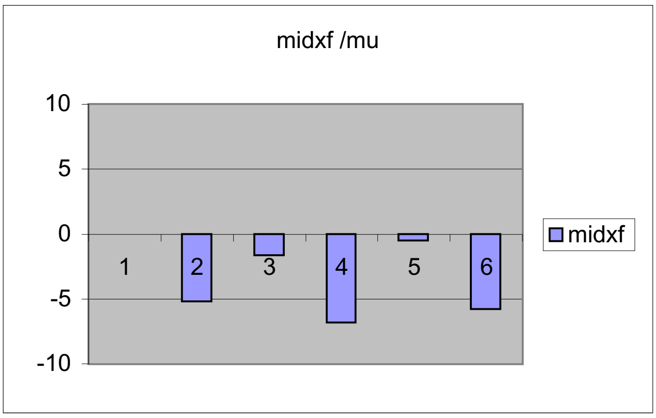
	Baseboard	...124	P90	P79	P68	P56
	Module	...42	...34	...38	...53	...56
Parameter	Nominal					
mhx	-6500	-6488.1	-6508.45	-6501.5	-6504	-6506
mhy	-37000	-37008.1	-36995.48	-37005	-36998	-37006
msx	38500	38498.7	38471.3	38490.3	38451	38576.4
msy	-37000	-37012.4	-37005.89	-37016	-37004	-36999.8
sepf	64090	64086.7	64083.25	64088.3	64086.5	64083.2
sepb	64090	64088.7	64088.5	64088.5	64088.2	64086
midxf	0	-5.15	-1.61	-6.79	-0.47	-5.75
midyf	0	-0.04	2.69	4.05	-0.31	1.58
stereo/mr	-20	-20	-19.99	-20.02	-19.93	-19.98
a1/mr	0	-0.02	-0.04	-0.01	0.02	-0.03
a2/mr	0	-0.01	-0.05	-0.06	0	-0.06
a3/mr	0	0.02	0	0.04	-0.03	0
a4/mr	0	0.07	0.06	0.04	-0.01	0.04

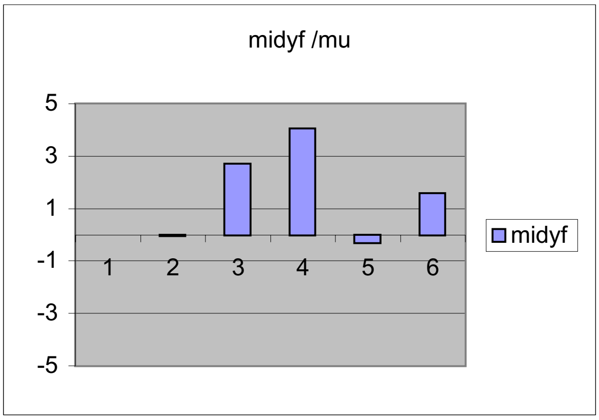
mhx	11.9	-8.45	-1.48	-4	-6
mhy	-8.1	4.52	-4.82	2	-6
msx	-1.3	-28.7	-9.69	-49	76.4
msy	-12.4	-5.89	-15.76	-4	0.2
sepf	-3.3	-6.75	-1.75	-3.5	-6.8
sepb	-1.3	-1.5	-1.5	-1.8	-4
midxf	-5.15	-1.61	-6.79	-0.47	-5.75
midyf	-0.04	2.69	4.05	-0.31	1.58
stereo/mr	0	0.01	-0.02	0.07	0.02
a1/mr	-0.02	-0.04	-0.01	0.02	-0.03
a2/mr	-0.01	-0.05	-0.06	0	-0.06
a3/mr	0.02	0	0.04	-0.03	0
a4/mr	0.07	0.06	0.04	-0.01	0.04

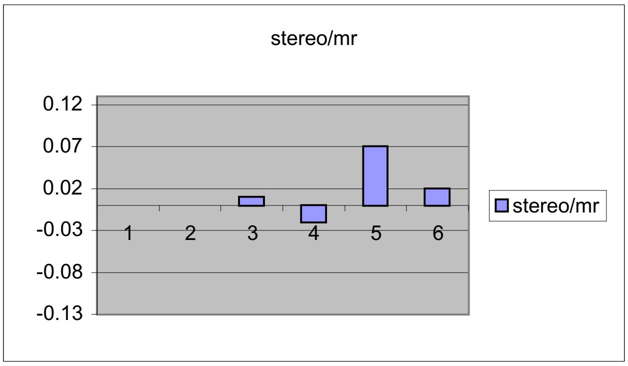
Differences from Nominal Values for 5 RAL Modules
Results are time ordered from left-to-right

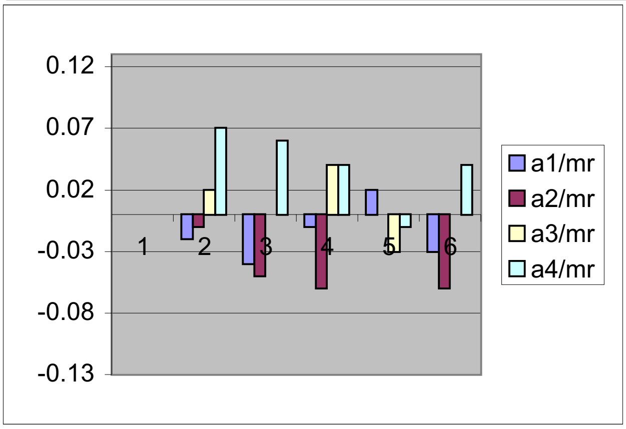


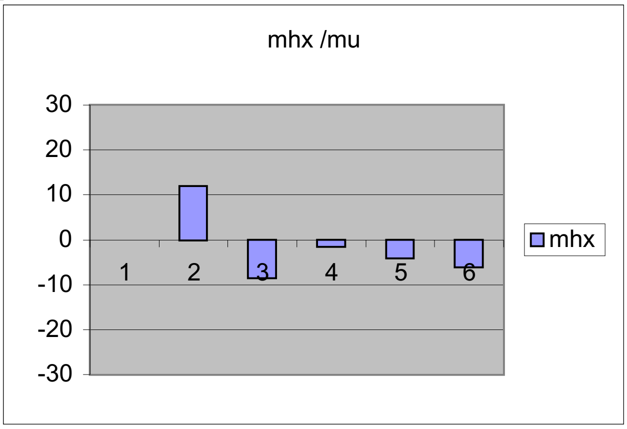


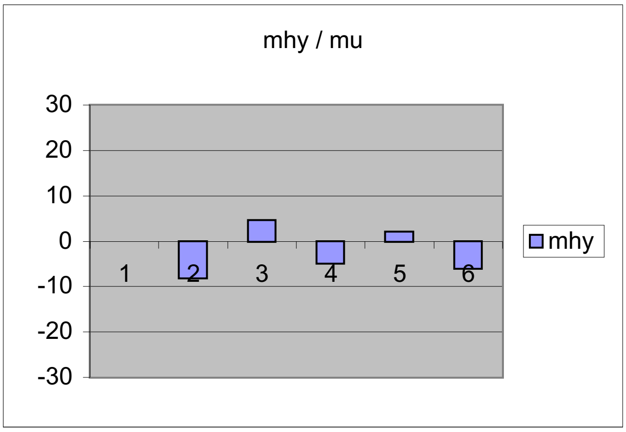


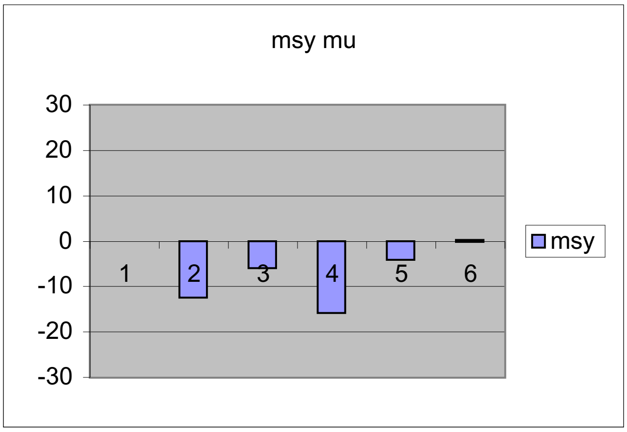



stereo/mr
0.12
0.07
0.02
-0.03
-0.08
-0.13
1
2
3
4
5
6
stereo/mr


0.12
0.07
0.02
-0.03
-0.08
-0.13
1
2
3
4
5
6
a1/mr
a2/mr
a3/mr
a4/mr


mhx /mu
30
20
10
0
-10
-20
-30
1
2
3
4
5
6
mhx


mhy / mu
30
20
10
0
-10
-20
-30
1
2
3
4
5
6
mhy

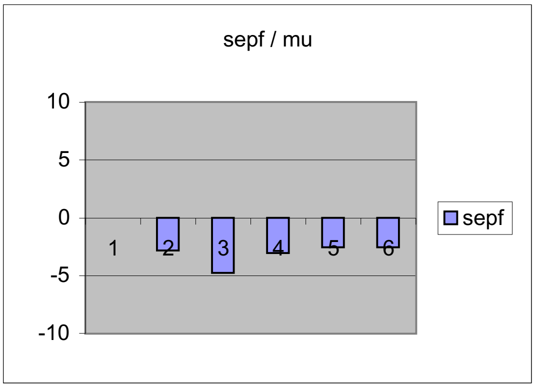

msy mu
30
20
10
0
-10
-20
-30
1
2
3
4
5
6
msy

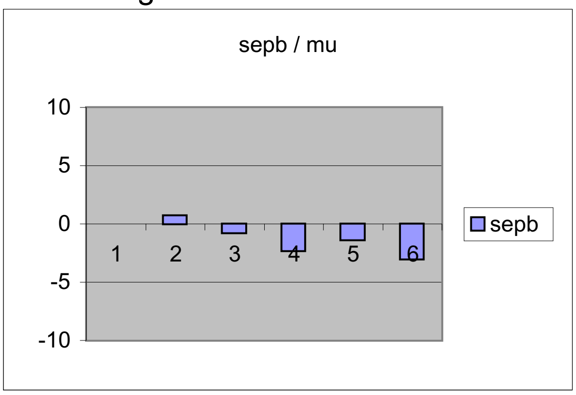
Max Tweak to X and Y prior to 585 and "mini-tweek in midyf " Prior to P68

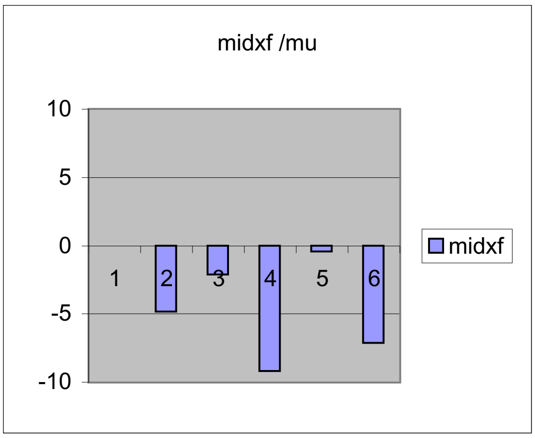
	Baseboard	...124	P90	P79	P68	P56
	Module	...42	...34	...38	...53	...56
Parameter	Nominal					
mhx	-6500	-6489	-6510.2	-6505.5	-6503.5	-6511
mhy	-37000	-37010.2	-36995.9	-37006.3	-36998.1	-37005
msx	38500	38516.9	38452.6	38471.27	38482.3	38556.7
msy	-37000	-37011.3	-37004	-37018.8	-37005	-37004
sepf	64090	64087.2	64085.25	64087	64087.5	64087.5
sepb	64090	64090.7	64089.25	64087.7	64088.6	64087
midxf	0	-4.8	-2.1	-9.18	-0.42	-7.08
midyf	0	-0.53	4.64	2.65	-0.28	2.15
stereo/mr	-20	-20	-19.98	-20.06	-19.99	-19.98
a1/mr	0	-0.02	-0.02	-0.02	0.02	-0.03
a2/mr	0	-0.01	-0.04	-0.06	0.1	-0.08
a3/mr	0	0.02	0	0.06	-0.02	0.02
a4/mr	0	0.06	0.06	0.06	-0.01	0.05

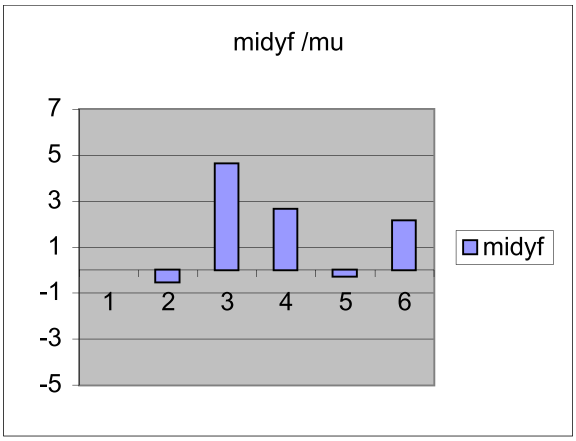
mhx	11	-10.2	-5.5	-3.5	-11
mhy	-10.2	4.12	-6.3	1.9	-5
msx	16.9	-47.4	-28.73	-17.7	56.7
msy	-11.3	-3.95	-18.8	-5	-4
sepf	-2.8	-4.75	-3	-2.5	-2.5
sepb	0.7	-0.75	-2.3	-1.4	-3
midxf	-4.8	-2.1	-9.18	-0.42	-7.08
midyf	-0.53	4.64	2.65	-0.28	2.15
stereo/mr	0	0.02	-0.06	0.01	0.02
a1/mr	-0.02	-0.02	-0.02	0.02	-0.03
a2/mr	-0.01	-0.04	-0.06	0.1	-0.08
a3/mr	0.02	0	0.06	-0.02	0.02
a4/mr	0.06	0.06	0.06	-0.01	0.05

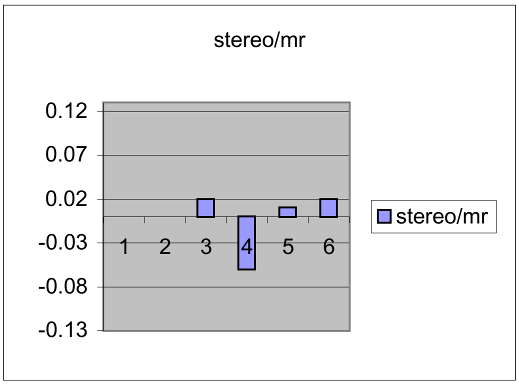
Differences from Nominal Values for last 5 RAL Modules
Results are time ordered from left-to-right

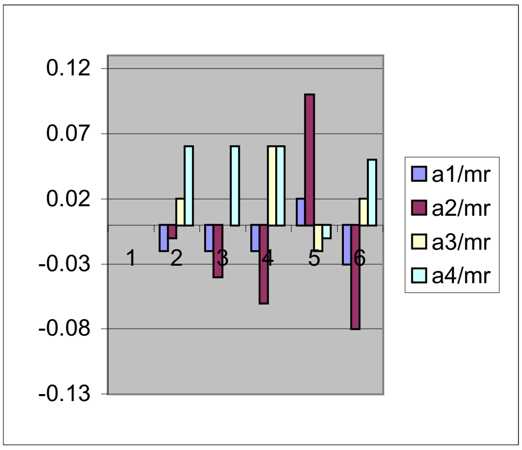


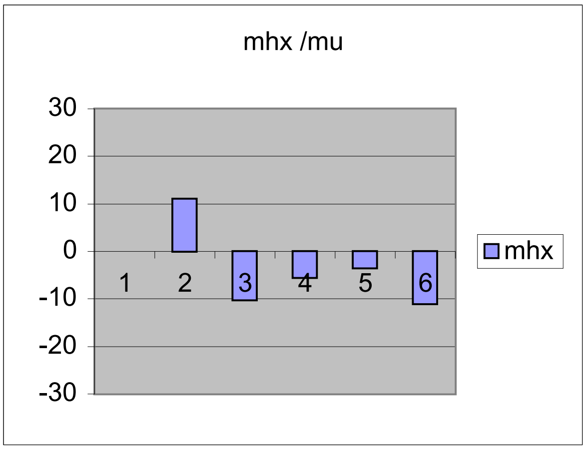


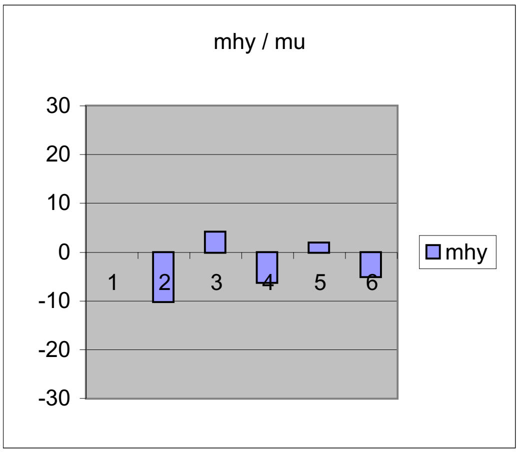


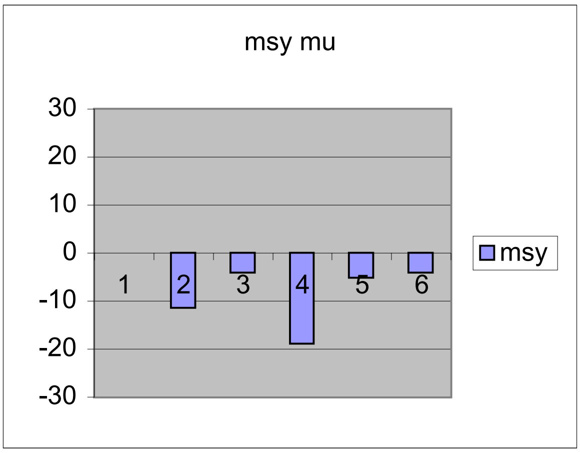



stereo/mr
0.12
0.07
0.02
-0.03
-0.08
-0.13
1 2 3 4 5 6
stereo/mr


0.12
0.07
0.02
-0.03
-0.08
-0.13
1 2 3 4 5 6
a1/mr
a2/mr
a3/mr
a4/mr

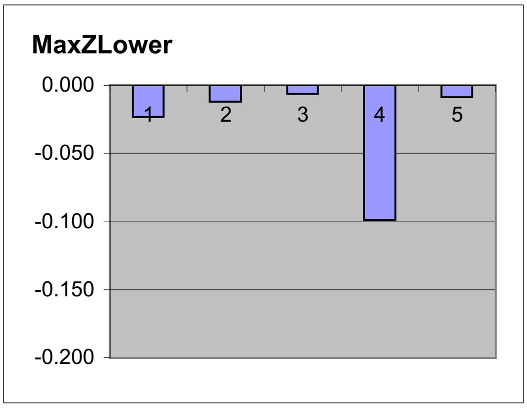

mhx /mu
30
20
10
0
-10
-20
-30
1 2 3 4 5 6
mhx

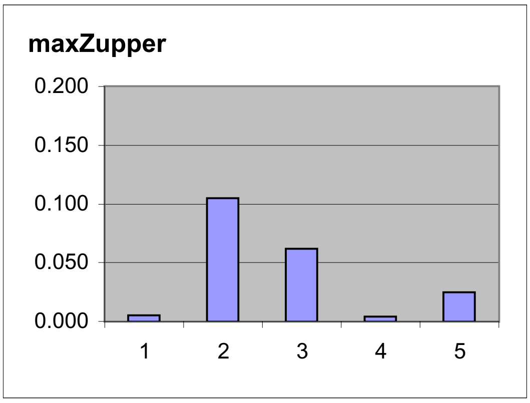

mhy / mu
30
20
10
0
-10
-20
-30
1 2 3 4 5 6
mhy

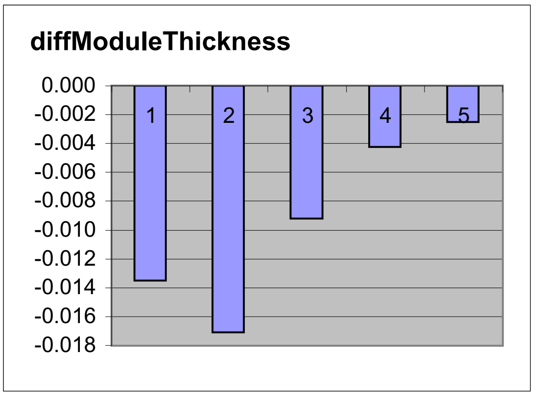

msy mu
30
20
10
0
-10
-20
-30
1 2 3 4 5 6
msy

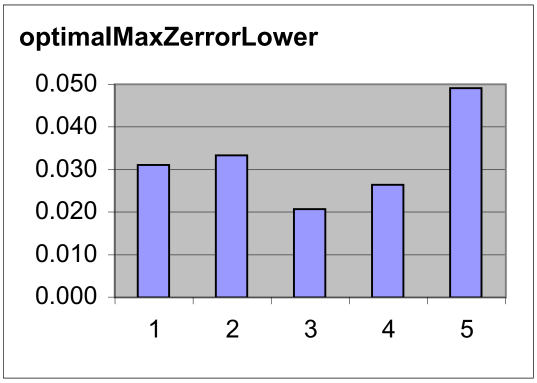
ZHistory.xls

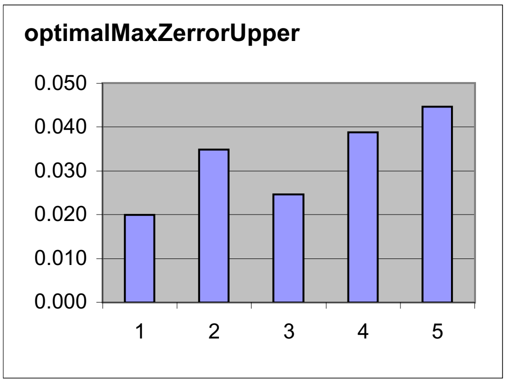
		...124	P90	P79	P68	P56
		...42	...34	...38	...53	...56
Parameter	Tolerance					
maxZlower [mm]	-0.2	-0.023	-0.012	-0.006	-0.099	-0.008
maxZupper [mm]	0.2	0.005	0.105	0.062	0.004	0.024
diffModuleThickness [mm]	0.1	-0.013	-0.017	-0.009	-0.004	-0.002
optimalMaxZerrorLower [mm]	-0.05	0.031	0.033	0.021	0.026	0.049
optimalMaxZerrorUpper [mm]	0.05	0.020	0.035	0.025	0.039	0.045
optimalRMSZerrorLower [mm]	0.025	0.011	0.014	0.009	0.010	0.017
optimalRMSZerrorUpper [mm]	0.025	0.009	0.015	0.008	0.009	0.016

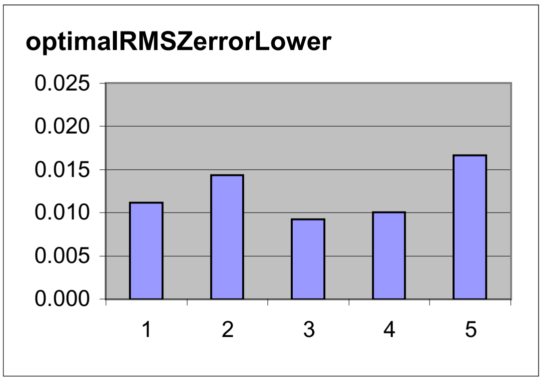


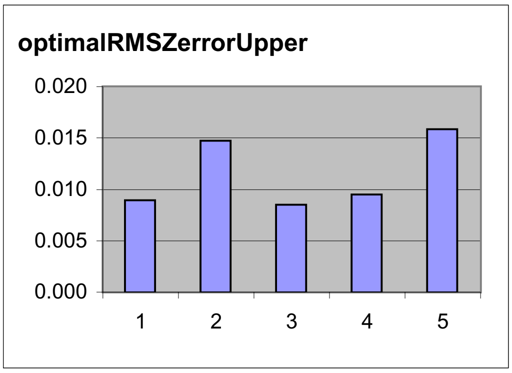












Hybrid Assembly: Operator's Guide

Version 0.2, Birmingham, May 2002

Unpopulated hybrids are stored in the "beer fridge" N_2 storage cabinet. The following steps must be performed for each hybrid. All steps must be logged using the clean room PC web interface.

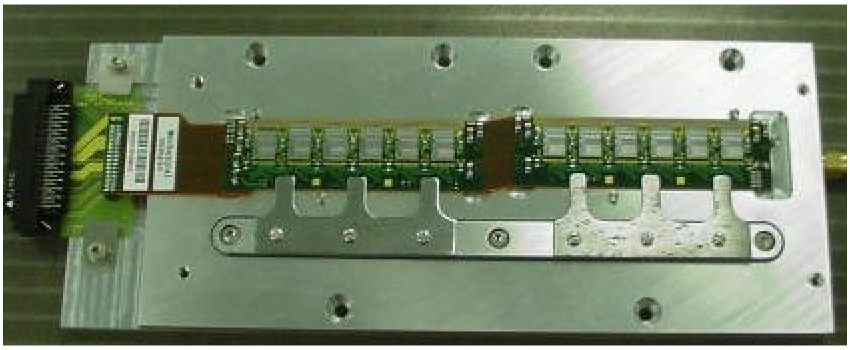
1. Note hybrid has entered production on the clean room PC web interface.
2. Visual inspection of hybrid. Use stereo microscope. Consult web interface or check sheet for items to check. Note all unusual features in comment boxes.
3. Place and secure hybrid onto production jig (see Appendix). Hybrid stays on this jig for all remaining steps until final packing.
4. Wire bond pull test. Absolute minimum of one bond on each of the four pull test pads on the hybrid. Check pull test QA criteria satisfied.
5. Ensure ASIC selection has been done.
6. Ensure glue is mixed. Mixture ratio 50:1 by weight. Mix glue well. Prepare small quantity on a slide for curing check.
7. Apply glue to all twelve hybrid positions.
8. Mount appropriate gel-pak onto manual die bonder.
9. Mount hybrid (in jig) onto manual die bonder.
10. Place all twelve ASICs onto locations on hybrid. Only use die bonder default force (10g) at this time. Check pickup tool cleanliness before lifting ASICs.
11. Push gently on hybrids with suction pen tip. Check tip clean before doing. Watch carefully for glue fillet to appear on all sides of ASIC. Approximately 100g force should be needed. Check ASIC positioning.
12. Cure hybrid(s) in oven at 50C for at least two hours. Include slide with glue which can be checked for correct curing.
13. Wire-bond ABCDs to hybrids and hybrid HV connections to pitch adaptor, following bonding operating manual.
14. Electrical characterisation and long-term tests. See electrical test operator's manual. Upper cover must be in place on jigs before performing these tests.
15. Wire bond ABCDs to pitch adaptor, following bonding operating manual.

16. Final electrical test. Characterisation for initial production. See electrical test operator’s manual.

17. Remove hybrid from production jig and transfer to hybrid box. Place in N_2 storage to await shipment to RAL.

Appendix: Hybrid assembly jig

The hybrid assembly jig is shown in the photograph below. The jig is used for all construction steps, and also for testing steps with the protective cover in place.



Hybrid assembly jig

Before mounting a hybrid onto the jig, the PCB retaining screws should be loosened (on the extreme left on the photo above). The retaining bar (with attached flexible fingers) should be loosened or removed via the hex screws. Do not adjust the small slotted screws. Place the hybrid onto the jig in the orientation shown, with feet in the slots. Connect the hybrid connector to the PCB, adjusting the PCB position as needed. Position hybrid against the locating pins to the top and right of it. Fasten PCB into position with hex screws. These screws should hold the PCB securely in position. Finally tighten hex screws on retaining bar.

The jig is attached to other holding pieces for the gluing, wire-bonding and testing steps, as described elsewhere.

Birmingham Hybrid bonding operation manual

Simon Pyatt, May 2002

This is a brief guide for use by people familiar with ultrasonic bonder operation.

0. Bonder pre-test.

It's good practice before fitting the hybrid jig to test the bonder operation quality. Bond on a test card, set the parameters to (Page 1) Bond height 30, Z-Presign 45. Mode 11 Ultrasonic power 50, distance between first and second bond should be 600units. Observe Bond Process Control, offset alignment of bonds, bond pull strength and Standard deviation.

1. Jig set-up.

Mode 11 check

Mode 11 is the single wire bond mode, which will be used later. However the tool position may not currently be in a safe position for this mode when the hybrid jig is fitted. Set the focus height as vertically high as possible.

ESC, MODE 11 (Enter)

Using cursor keys move cursor to focus. Using track-ball move bond head to a safe height. STORE TRACE

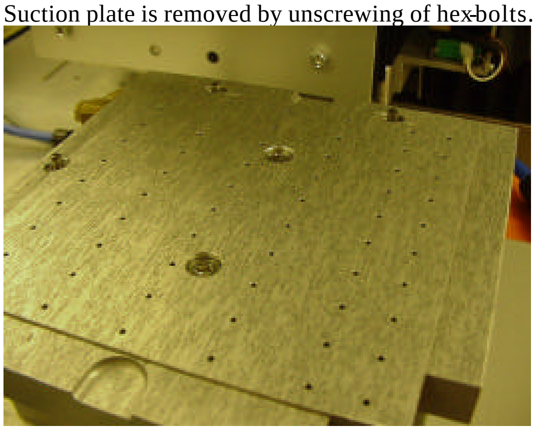
Mounting Hybrid in jig

Refer to the Hybrid assembly operators guide for mounting hybrid in jig.

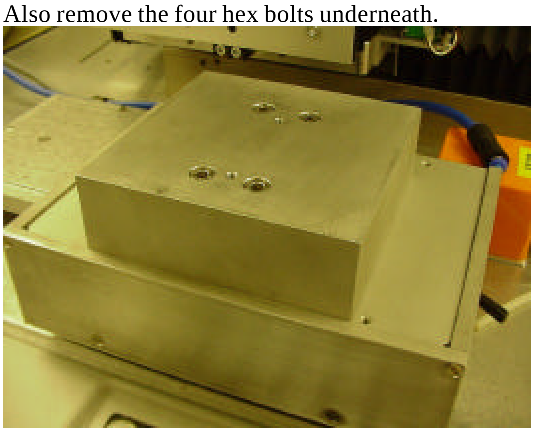
Setting up jig plate

If suction plate is fitted, this needs to be removed and replaced with jig plate.

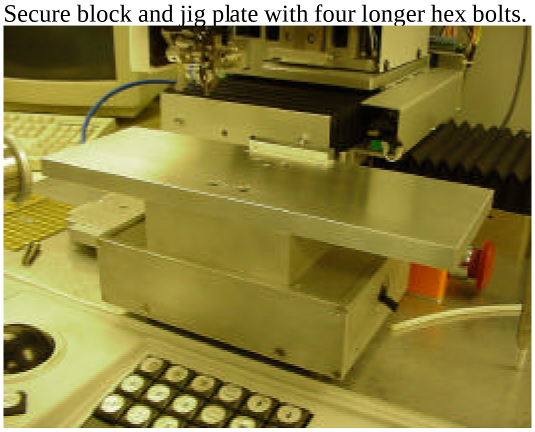
Suction plate is removed by unscrewing of hex-bolts.



Also remove the four hex bolts underneath.



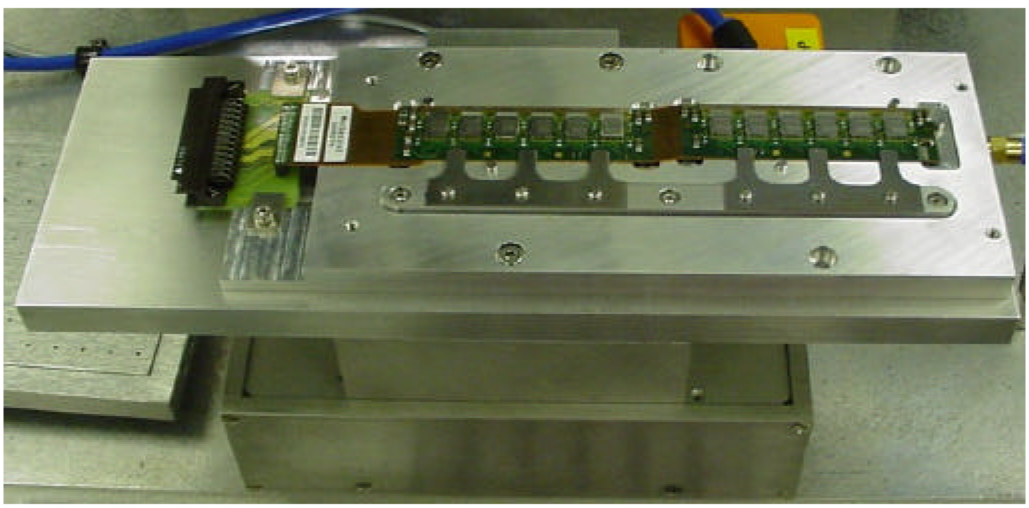
Place jig holding plate on metal block.
Secure block and jig plate with four longer hex bolts.



Fitting jig onto jig plate

The two halves of the hybrid are usually named top and bottom. For bonding purposes top will be called left and bottom will be called right.

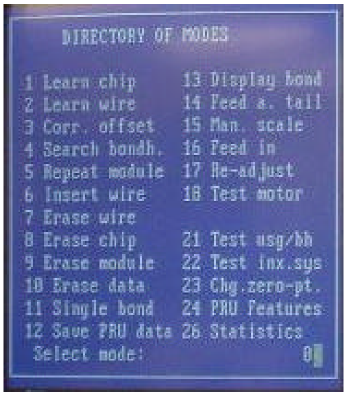
Hybrid is bonded one half at a time. Left hand side first, jig is held down central on the jig plate using three bolts. Use alignment bar at back to ensure jig is square before tightening the three bolts.



Jig set-up for left hand side of hybrid.

2. Loading program.

When using the bonder different modes are required to perform tasks. To get to the directory of modes press ESC key, then the MODE key. Menu will be as follows:



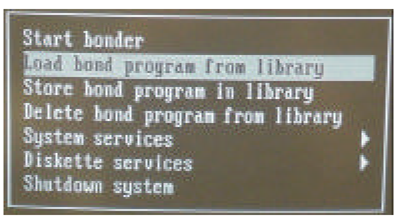
Directory of modes

First step is to erase RAM to remove any previous parameters, this is done using mode 10, while in the directory of modes type 10 then ENTER key.

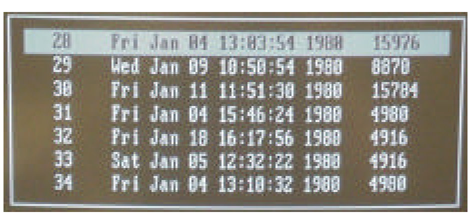
On next screen press ENTER key to erase RAM.

Next load the correct bonding program. For the left hand side program 28 is used, for right hand side 30. For the pitch adapter use program 29. 29 can be used for both sides.

Press STOP key, the menu will appear:



Use cursor keys to select Load Program.
ENTER



Use cursor keys to select program
ENTER
Select Start Bonder
The machine will ask if y ou want to transfer the COGNEX images, simply press ENTER
The correct bonding program will now be in memory.

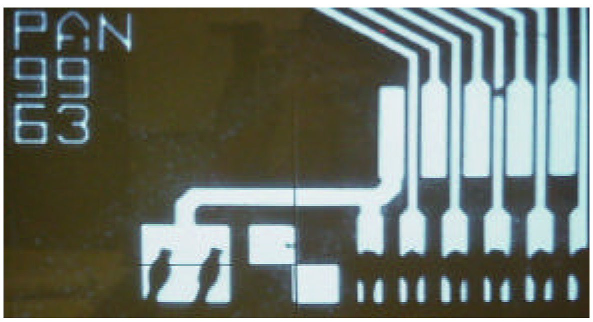
IMPORTANT: For the pitch adapter a manual change to the parameters is needed. Select MODE 25, press 1 7 9 3 to access the set-up pages then select page 5. Check REVERSH is 39 and REV FCT is 7. The two parameters are at the bottom of the screen.

3. Pattern recognition points

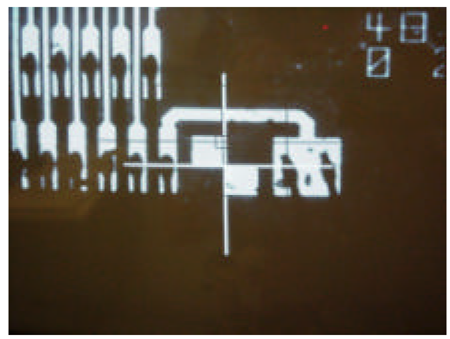
The Delvotek 6319 features automatic pattern recognition to enable fast and precise finding of fiducial points. However it still needs help to find the first point. This is done using Mode 23.

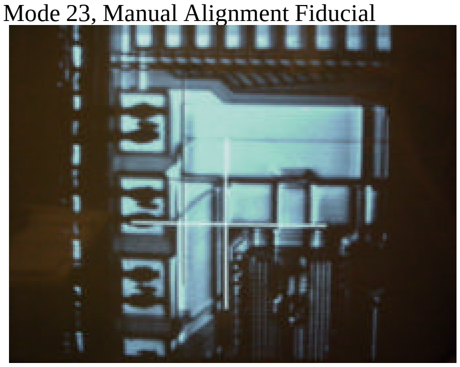
Press ESC then MODE to get back to Directory of Modes, select MODE 23.
Using the track ball, align to the Pitch Adapter far left fiducial point, so the two squares fill the top left and bottom right of the crosshairs. Alignment only has to be approximate.
Press ENTER.

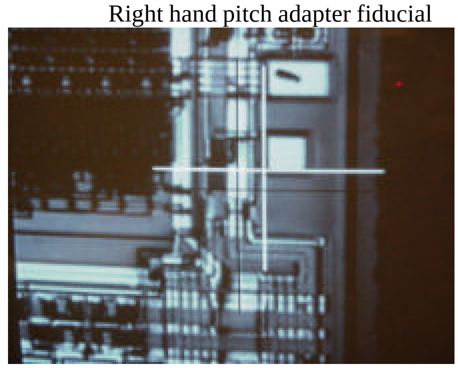
Turn on the Automatic Pattern Recognition system so the other Fiducials can be found automatically. Pressing the AUTO ADJUST key does this. The lighting of a red light on the key will indicate APR is on.
Next press the ADJUST key, pattern recognition will start. The bond head will move fairly quickly from one point to the next. After the last Fiducial has been found press STEP before the bond head moves to the first bond position. Press ESC.
If the PR fails to find any of the points, the machine will sound a “Beep” and stop. Manual alignment can be used, move the trackball so the crosshairs are aligned to the Fiducial and press ADJUST. If the problem persists then adjusting the lighting will help. The PR system prefers a grayish image.

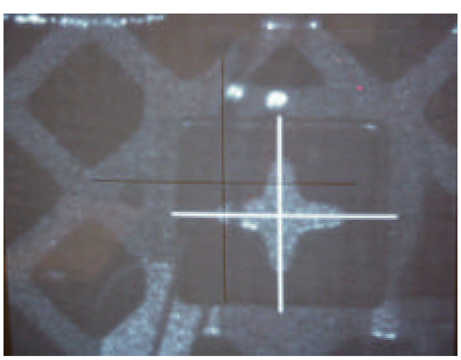


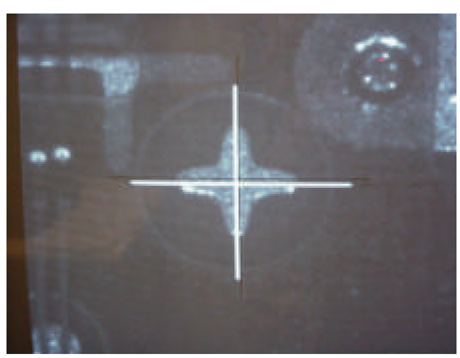
Mode 23, Manual Alignment Fiducial


Right hand pitch adapter fiducial


Top left chip fiducial


Bottom right chip fiducial


Top left substrate fiducial


Bottom right substrate fiducial

4. Checking bond pad position

The quickest and simplest way of checking the pad position is to use the re-bond mode.
Press REBOND, select chip one and wire one. The bond pads with be shown on the BW monitor, use PAGE FORWARD to cycle through the pads, check the crosshairs are centered in the middle of each pad. Using the left and right cursor keys it is possible to change between the source and destination bond pads.

Tip: The source pads for the pitch adapter and chips are the odd numbers and the substrate is the even numbered destination pads. So by starting at chip 1 wire 1 you can see all the source pads, then starting at Chip 2, wire 1 you can view the destination pads.

If any pads are misaligned then re-running the pattern recognition (AUTO ADJUST) helps. Also manually aligning pads using Mode 17 can be used.

IMPORTANT: Once alignment is correct, turn OFF the pattern recognition. If this is not done, once the height is measured the bonding will start automatically. Press AUTO ADJUST, so the light on the key is off.

5. Height measurement

The bonding machine needs to measure the height of the pads before the bonding starts. This is done using Mode 4. Select chip 1 as the start point. Height measurement takes a few minutes.

6. Creating a tail

Bond height measurement damages the wire in the bonding tool, so a few bonds on the test pads is needed to correct the fault for bonding. Use MODE 11 for single bonds.

Firstly the focus will need to be adjusted, move the cursor to FOCUS. Using the trackball, adjust until the image is in focus, press STORE TRACE.
Use the cursor keys to select BOND X D for destination bond, bond at top of pad. Then BOND X S for source bond at bottom of pad. STORE TRACE is used to set the positions.
For bond height measurement select BHEIGHT D, then press STORE TRACE, height will be measured. Press BOND, to move along for a new position press PAGE FORWARD. Bond about 3 or 4 times. Don't forget to remove the wires. The tail on the wire is now ready for bonding.

7. First few bonds

This procedure should be done with the aid of the microscope to observe the bonding.
Its best to start to take things slowly, if any problems are to occur this is when it will happen. Use the REBOND mode, select CHIP 1, WIRE 1. The first bond positions will be shown, if you press REBOND the connection bond wire is bonded onto the pads. You can also press STEP as soon as you press REBOND, then keep pressing STEP, to slowly cycle through the bonding process. After each bond press PAGE FORWARD to move to the next bond. If the bonding is successful the rest of the bonding can be done.

8. Bonding Hybrid.

Make sure the bond positions are on the last bond you have done NOT the next un-bonded pads. If you are happy that the first few bonds look good, press BOND. The machine will now bond fully automatically. Follow the bonding with the microscope, if any problems occur press STEP or STOP.

Observe bond process control, watch to make sure that all the deformations are consistent.

9. Changing bonding sides

Change from the left hand side to the right hand side. Unbolt the hybrid jig, slide across plate so the right hand side is in the bonding area, bolt jig. Go back to step 2 for bonding right hand side.

To remove jig simply unbolt and remove.

10. Post-inspection.

Visual inspection is done through microscope.
Check the bonding schedule, make sure all the correct wires have been bonded.
Check the loops shapes are correct and not touching anything.
Check the bonds are centered correctly on the pads.
Check for similar bond deformation on Bond Process Control.

M.Gibson 3/05/02
Version 2

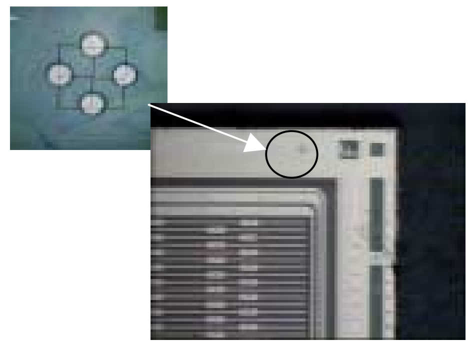
Instructions for the Construction of an ATLAS Barrel Module.

The aim of this document is to provide a working step-by-step guide for the production of a 4 detector sub-assembly. Other stages in the construction have their own specific instructions. An additional module-by-module build sheet is used, a copy of which is attached for reference.

Overview.

A general view of the hardware is shown opposite. It consists of a dedicated Mac running custom LabView software, a Z stage, two large linear stages for positioning of the detectors under the optics and two packs of XY and R stages to perform the alignment process.

Each detector is equipped with 4 fidicial situated in the 4 corners as indicated opposite. These are used for alignment purposes by the automatic system. 2 additional crosses are used for later checking of the validity of the alignment process when the dots are no longer visible.



The major components of the assembly jigs as shown opposite.
It consists of a window frame with 4 linear bearings. Two pickup jigs and a baseboard support plate (not shown). Each of the assemblies are uniquely identifiable.

Step by step guide.

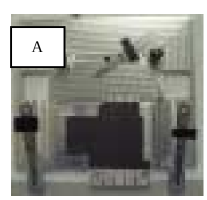
1) At lest 1 hour before starting assembly turn on the following items.
    a) Camera, (switches on camera and at rear of granite table).
    b) Lights (switches at rear of table).
    c) Stages (switches at rear of table but also on the controller).
    d) Monitor.
    e) Target generator.

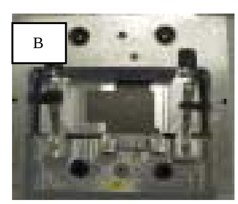
2) Ensure that you have to hand.
    a) A new module build sheet.
    b) 4 detectors (with known thicknesses).
    c) A baseboard.
    Instructions for the allocation of baseboards and their metrology is described elsewhere.

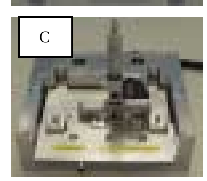
3) Checking the electrical continuity of the baseboard.
    a) Place the baseboard on a sheet of tissue washers uppermost.
    b) Set the small pencil DMM to ohms.
    c) Check between the gold pad on the two facings. Resistance should be ohms.
    d) Check between the large gold pad on the cooled facing to EACH of the 4 holes in the VHTPG. Do not press hard, just brush the surface. Resistance should be ohms.
    e) Invert the baseboard and check from one of the holes in the VHTPG baseboard to each of the other 3. Again the resistance should be ohms.

4) Checking the baseboard thickness.
    a) Using a digital micrometer measure the thickness of the baseboard at the 6 points indicated on the module build sheet. (The reason for this is that it is much easier to spot possible errors in the build cycle).

5) Setting the gap for the adhesive on the top (front) side.
    a) Place the baseboard onto the pins of the baseboard support plate. Do not force it on. (A)
    b) Connect to the vacuum supply, and ensure that it is well seated down.
    c) Fit the baseboard support plate to the appropriate window frame, and fix with the 3 bolts.
    d) Invert the frame.(B)
    e) Fit the relevant top (front) pickup jig and fix with the 3 bolts.
    f) Using the module build sheet as a guide, calculate the spacer thickness.(C)







6) Starting the system from an unknown condition.
    a) Run the control box.VI and 'home' all the stages in the order stated at the top of the screen.
    b) Using 'control box' drive the A and B stages to the reference fiducial position stated on the keyboard.
    c) With the power to the Z stage turned off at its controller, focus the stage.

d) Turn on the power back on.
e) Re-home the A and B stages only

7) Loading the detectors onto the alignment jigs.
   a) Remove and discard any remaining paper.
   b) Wipe the each of the two jig surface with a DRY tissue.
   c) Check for any damage.
   d) Screw in the 4 stops (two on each jig).
   e) Fit two new sheets of paper.
   f) Working over the trolley, take the first of the detector packages and carefully open it.
   g) Retain the correct inner surface for the inner card packing.
   h) Examine the back of the detector for anything unusual. Find expert if necessary.
   i) With detector strip side up, orientate with the identification pads at the bottom RH corner.
   j) Replace the top packing.
   k) Move to the LHS alignment jig remove the top packing.
   l) Pick up the vacuum pencil and look at the cup. Check the metal tube does not protrude and that the cup looks clean. DO NOT BREATH ON IT! Wipe it with a tissue if you must.
   m) Transfer the detector from the packing to the alignment jig ensuring that it is butted up to the stops.
   n) Turn on the vacuum for the alignment jigs and then release the vacuum pencil.
      The detector is now safe.
   o) Store the packaging adjacent to the detector so that if it is necessary to replace it then you know which one it came from
   p) Repeat for 2nd detector.
   q) Retract the 4 stops.

8) Running the alignment programme.
   a) Load the 'Build.vi ' program.
   b) Ensure that you have selected the correct jig and side.
   c) Run the programme.
   d) Check on the MONITOR that all is progressing as expected.
   e) A list of the more usual errors and the solutions is given in appendix 2.
   f) When the programme has successfully run , exit it.

9) Running the checking routine.
   This is a self-contained routine to ensure that the alignment was successful and the subsequent action of picking up the detector pair has been successfully achieved.
   a) Load the routine 'Finalcheck.vi'.
   b) Run the programme.
   c) Assuming that the initial alignment was OK then place a new piece of paper over the two detectors, aligning it by eye to the lower edge and the right hand edge.
   d) Place the appropriate pickup jig on the wall.
   e) Continue with the checking routine.
   f) If successful remove the jig and store on the trolley covering with the antistatic shield.
   g) If unsuccessful then you will have to repeat the whole operation again.

10) The detectors and baseboard are now ready to move to the adhesive dispenser where both the structural and electrically conductive adhesive is added and which has its own instructions. Subsequently it will move onto the Smart Scope for checking prior to allow the adhesive to cure When the first side has cured the construction may continue.

11) Removing the baseboard support plate.
    a) With the baseboard support plate uppermost in the window frame turn off the vacuum for *the baseboard only* and wait for 10 to 15 minutes.
    b) Remove the 3 retaining bolts.
    c) Carefully remove the baseboard support plate and store.

12) Setting the gap for the back (bottom) pickup jig.
    a) Using the module build sheet as a guide calculate the spacer thickness.

13) Repeat task (7) for the bottom.

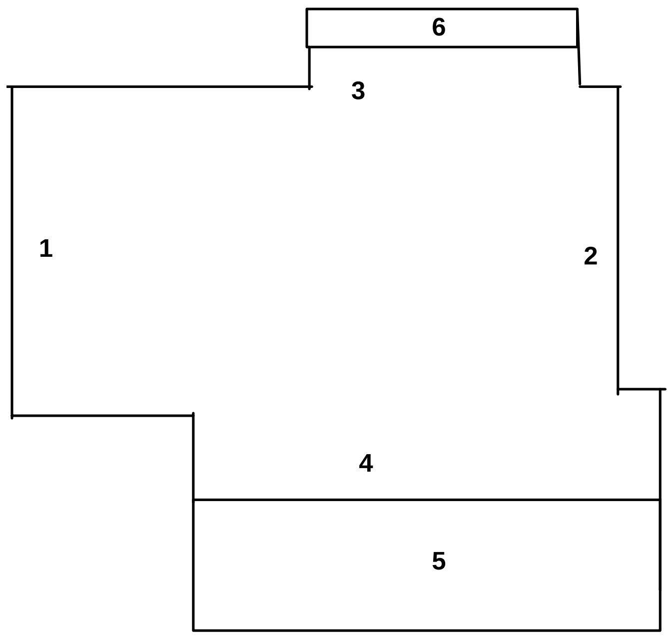
14) Removing the completed sub assembly.
    a) Turn the vacuum off to the top (front) pickup jig only.
    b) Remove the 3 bolts.
    c) Remove the top pickup jig.
    d) Invert the window frame.
    e) LEAVE THE VACUUM ON!
    f) Remove the 3 bolts and remove the bottom pickup jig with the sub-assembly held onto it by vacuum.
    g) Place the pickup jig on the trolley and turn off the vacuum.
    h) Remove and fit to relevant frame.

Appendix 1

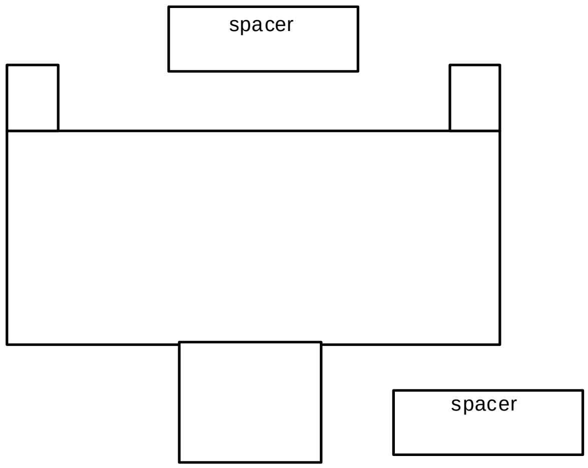
Module build sheet check list v3

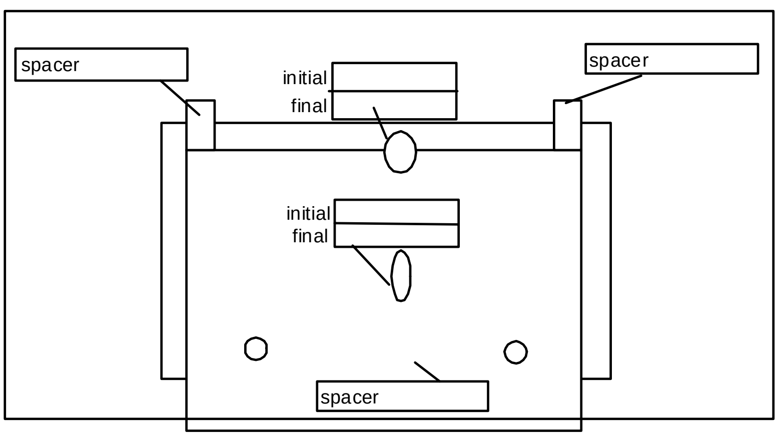
Baseboard serial number					
Hybrid serial number					
Baseboard metrology done? ………		date		inits	
Electrical check done ? …………..		date		inits	
Baseboard thickness measured ?….		date		inits	
4 detectors chosen, collected and baseboard allocated………………		date		inits	
Top side spacers calculated…………		date		inits	
Top side aligned and checks ok…….		date		inits	
Glue dispencer z set up done……….		date		inits	
Top side stuck………………………		date		inits	
Bottom side spacers calculated……..		date		inits	
Bottom side aligned and checks ok…		date		inits	
Glue dispencer z set up done……….		date		inits	
Bottom side stuck……………………		date		inits	
Metrology done……………………		date		inits	
Metrology analysised……………		date		inits .	
IV's done………………………….		date		inits	
Uploaded? ………………………..		date		inits	
Post cure done?…………………..		date		inits	
Hybrid side 1 stuck.?……………..		date		inits	
Hybrid side 2 stuck?……………		date		inits	
Wire Bonding done ………………		date		inits	
Metrology done?………………….		date		inits	
Pictures taken?……………………		date		inits	

Baseboard thickness



Spacer calculation





TOP

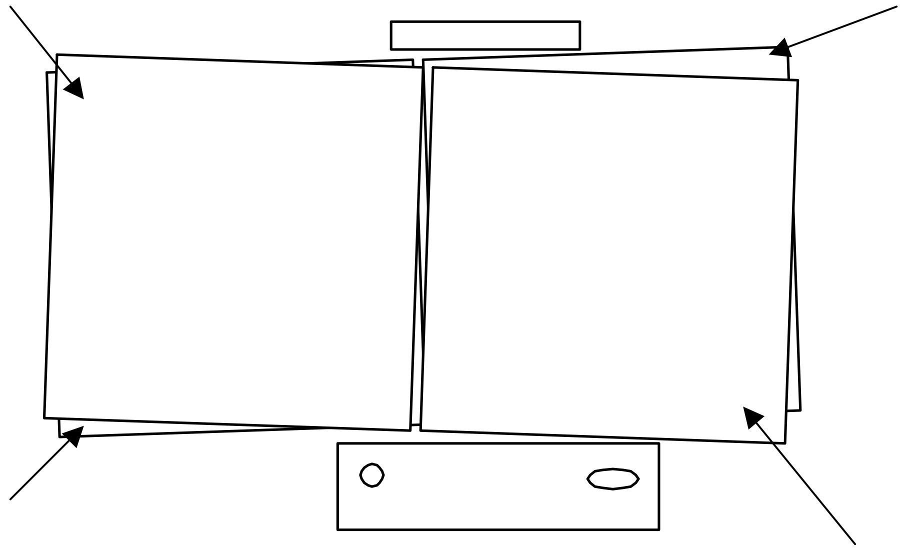
initial

1) plate	
2) detector	
3) paper	
initial-1-2-3 = gap	
spacer	

final

1) plate	
2) detector	
3) paper	
initial-1-2-3 = gap	
spacer	

Detector positions



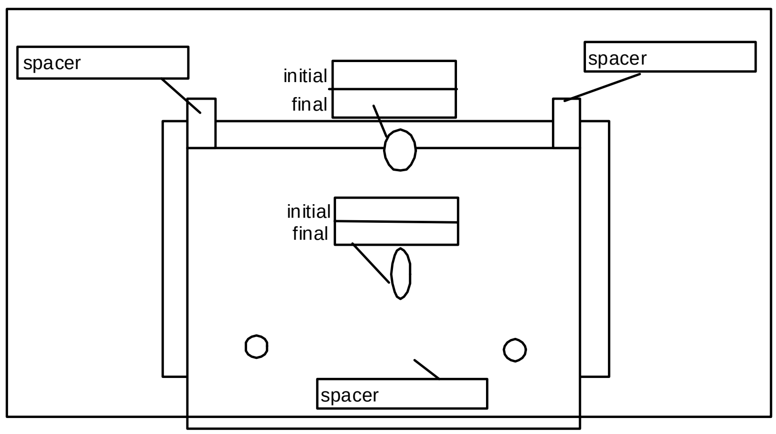
Top Position Check Jig Number …

Date……………………………………………..
Assembly log number………………………….

Errors After alignment			
F6		A	B
F3		A	B
F7		A	B
F2		A	B

After alignment		
Mid F-Ref (A)	**71.896 to 71.894**	
Mid F-Ref (B)	**34.475 to 34.471**	

Vacuum transfer			
Mid J - Ref	**A**	**5.570 to 5.564**	
Mid J - Ref	**B**	**32.265 32.263**	
Mid C-Mid J	**A**	**34.757to 34.756**	
Mid C-Mid J	**B**	**2.214 to 2.211**	



BOTTOM

initial

1) plate	
2) detector	
3) paper	
initial-1-2-3 = gap	
spacer	

final

1) plate	
2) detector	
3) paper	
initial-1-2-3 = gap	
spacer	

Bottom Position Check Jig Number ……

Date……………………………………………..
Assembly log number………………………….

Errors After alignment			
F6		A	B
F3		A	B
F7		A	B
F2		A	B

After alignment		
Mid F-Ref (A)	**71.912 to 71.908**	
Mid F-Ref (B)	**34.466to 34.462**	

Vacuum transfer			
Mid J - Ref	**A**	**4.742 to 4.740**	
Mid J - Ref	**B**	**29.839 to 29.836**	
Mid C-Mid J	**A**	**35. 606 to 35.602**	
Mid C-Mid J	**B**	**4.602 to 4.598**	

IV test summery

I @ 150V…

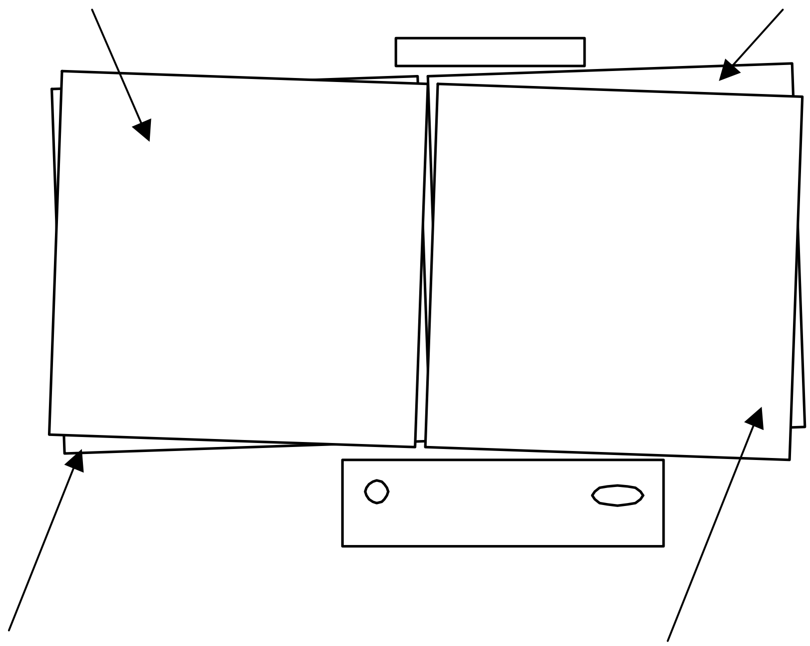
I @ 350V..

I @ 500V…

I @ 150V….

I @ 350V..

I @ 500V……



I @ 150V…

I @ 350V..

I @ 500V…

I @ 150V….

I @ 350V..

I @ 500V……

Comments

Possible errors and their solutions…

1) Nothing happens when you try and run the 'build.vi' program.
    a) Have you got the Z stage switched on?
    b) Has the Mac crashed?
    c) Does the control 'box VI' work the XY stages?

2) No picture on the monitor.
    a) Have you got the monitor switched on ?
    b) Have you selected E1 with the remote control?
    c) Is the camera powered? (There should be a green LED on the top).
    d) Is the camera connected to the monitor with the BNC (Coax) cable?
    e) Is there anything to look at?
    f) Is the lamp at the bottom of the optics that produces the light working? (you should be able to see it at the objective with a piece of paper.)

3) No image on the Mac screen when the reference fiducial is under the camera.
    a) Is there an image on the monitor?
    b) Is the camera connected the digitizing board in the Mac via the mulitway connector?
    c) Has the Mac crashed?

4) Program runs but unable to focus on the reference fiducial.
    a) The 'zero' position for the Z stage is the reference fiducial when its in focus. Turn of the Z stage refocus by hand and turn on again.
    b) Reference fiducial not under the optics.

5) Reference fiducial found but unable to find other fiducials.
    a) Are the detectors properly centered on the vacuum jigs using the stops?

6) Unable to find 4 dots.
    a) Error 1…only found 1 dot. maybe there is only one dot visible?
    b) Error 999.. load of dots more than 5. get expert or choose another detector.
    c) Error 3….only found 3 dots. Its OK click on continue.
    d) Any other problems…Ask yourself, can I see 4 clean dots?

7) After running the 'Finalcheck.VI' you are unable to get the expected values.
    a) I am afraid that you will have to run the whole alignment program again, But before you do, check that the detector are approximately the same thickness, by looking at the database again there might have been an error.

Version 2 15 February 2002

Chantal FOWLER

Simplified Programming and Operating Procedures for the dispensing system

1)**Programming**

The purpose is to teach the machine patterns as shown on picture 1 to be dispensed automatically (programme and register the displacements of the needle).

Step	Procedure	Machine response
1.	Ensure that the machine is turned off Connect the teaching pendant while pressing the eject button. Take an A card from the holder. Remove the protection cap and replace it on the other end of the card. Insert the A card into the memory card slot.	
2.	Installation of the block needle with a test gel product in the barrel. a) Put a pair of gloves on b) Ensure that the machine and compressed air are turned off. c) Ensure that the valve from the controller is disconnected by switching off the two compressed air supply switches. d) Install the JIG properly on the table (picture 4) Ensure that the jig is properly installed with the required model of the glue pattern (usually a paper model covered with a glass held by vacuum) (example in picture 1) e) Installation of the needle Place a new dispense tube inside the needle block (Picture 3 and 5). Cut the extra length with a scalpel. Install a new needle ensuring the tube is as straight as possible, Fix the needle fix in line with two screws. (Picture 3 and 6). Fix the needle block on the Z unit by screwing the two nuts with an Allen key (Picture 7 and 8).	

	the two nuts with an Allen key (Picture 7 and 8). f) Installation of the barrel: Load the barrel with adhesive (or gel for programming or trial testing). Screw the barrel on the top of the needle block (Picture 8), and place its yellow cap securely. g) Turn on the compressed air supply (max. 7 bar). h) Turn on the regulated compressed air supply to the barrel at 4-5 bar for dispensing adhesive, or 1 bar for dispensing test material (gel) i) Switch on the two compressed air supply switches, re-connecting the valve to the controller. j) Shut the door	After several minutes the adhesive or gel will appear at the end of the needle (picture 8). An excessive hissing means incorrect fitting of the barrel cap. Clean the needle with a tissue. The dispense tube will be pinched preventing further adhesive leakage.
3.	Turn the machine on and if required the camera on to help to place the needle.	The start indicator flashes swiftly.
4.	To enter in a teaching mode Set the programme switch to 00 (picture 2) and then press the HOME key on the teach pendant. The teach pendant switches in mode POINT automatically.	The start indicator will turn on and home return starts. When the home return is completed the start indicator will turn off.
5.	Select the Application programme and Work Programme numbers on the programme switch (Picture 8). The Application Programme number is the left-	

	hand digit and the Work programme number is the right hand digit. Ex: the Application programme is 3 for a line/point dispensing mode. The Work programme is between 0 and 4 for Atlas work. Consult and update the register in annexe 2 to avoid overwriting a programme that is still required.	
6.	Set programme parameters. Press the Mode key until the parameter indicator is illuminated. With the numeric 100 +/- key select the parameter you want to check Ex A1 with a setting value of 11 The parameters used in the programmes are recorded in annexe 1, and usually remain the same for all programmes. Press the numeric 10 +/- and 1 +/- key to specify the setting value if you want to modify it (page 3-7 of the operation manual) Press Enter A to register a new value of the parameter selected if necessary.	A and 1 flashes alternatively. The ZR indicator on the teaching pendant flashes once to register each parameter.
7.	Return to POINT Mode by pressing the Mode key until the POINT indicator is illuminated.	
8.	Register the WORK Points in POINT mode. An example of pattern with all the work points is presented in picture 9. Use the numeric +/- keys to indicate the	

	required point number Ex : 001 Use the arrow keys to move the X/Y table to the required position. You can move swiftly by pressing the shift key at the same time. Press the ZR key (Z indicator lights) and than the appropriate arrow keys to move in Z. When the needle is in the required position, press SHIFT enter A/C to register the point. Repeat the procedure for each point required.	The X/Y table moves. The Z height is moving The 'ZR' indicator on the teach pendant flashes once to register each point
9.	Verifying the registered points in POINT mode. In POINT mode set the point number using the numeric +/- keys Ex 005 Press the GO key. If the needles doesn't move to the required position return to step 8 to modify it.	The needle moves to the programmed position.
10.	Copy a block of points Select the programme number with the programme switch into which you want to start copy the master block. An example of a master block is shown on the pattern of picture 10. *In EDIT Mode register the master block : Use the numeric +/- keys to indicate the first point of the master block and press COPY : CC1 appears illuminated. Use the numeric +/- keys to indicate the last point of the master block and press COPY : CC2 appears illuminated. If it is not the same programme number into which you want to start copying the master block, select the new programme with the switch (See Step 5)	

	switch. (See Step 5). In POINT mode register the starting point where you want to copy the master block (see step 8) if he doesn't exist already. In EDIT mode use the numeric +/- keys to set the point where you want to copy the block and press SHIFT COPY.	ZR flashes when the programme is copied.
11.	Register the END Point In POINT mode use the numeric +/- Keys to set the End point Number. This will be the last Work point Number + 1. Press Home key. *Ex: set 153 for programme 30.* When the starts indicator is turned off press Enter A to register the end position. The machine doesn't recognise the end point as a physical point within the programme.	The start indicator will turn on and home return starts. When the home return is completed the start indicator will turn off. The ZR indicator flashes three times and the programme is now completed.
12.	Register a reference Point where the offset procedure will be done (see step 11 of the operating procedure) In POINT mode use the numeric +/- Keys to set the reference point number. It is often the first point of the programme *Ex: set 001 for programme 33.* In SPEED mode press SHIFT EnterB/D to register the reference position	
13.	Delete a work point: In EDIT mode select the point that you want to delete by pressing the numeric +/- keys. If you want to delete more that one point, it is less confusing to begin by the biggest point number, as deleting a point will result in all setting numbers of the points being reduced by one digit.	

	Press SHIFT and ZR / Enter E keys An example is shown in picture 9 and 10.	The ZR indicator flashes three times indicating that the point is deleted.
14.	INSERT a new work point: In EDIT mode set the desired point number with the numeric change keys and press Enter A. An example is shown in picture 11. In POINT mode use the numeric +/- keys to set this point again. Teach the work point using the arrows keys and press SHIFT Enter A/C All point with higher numbers than the inserted point will have their point number increased by 1. Verify the position of the new point by setting the point number with the +/- keys and pressing GO key (as step 9).	The ZR indicator flashes three times indicating that a space has been created. The ZR indicator flashes once indicating that the point has been registered. The needle moves to the new point position.
15.	END the teaching session by pressing the start button	The start indicator flashes and the machine enters in the stand-by-state to run.
16.	Remove the teaching pendant from the machine while pressing the eject button.	

2) Operating Procedure for ATLAS module Assembly adhesive dispensing.

	Procedure	Machine response
1.	Put a pair of gloves on	
2.	Ensure that the machine and compressed air are turned off.	
3.	Ensure that the valve from the controller is disconnected by switching off the two compressed air supply switches.	
4.	Install the JIG properly on the table (picture 1).	
5.	Installation of the needle Place a new dispense tube inside the needle block (Picture 3). Cut the extra length with a scalpel. Install a new needle ensuring the tube is as straight as possible, and fix the needle in line with two screws. (Picture 4). Fix the needle block on the Z unit by screwing the two nuts with an Allen key (Picture 5).	
6.	Installation of the barrel Load the barrel with adhesive (or gel for programming or trial testing). Screw the barrel on the top of the needle block (Picture 6), and place its yellow cap securely.	
7.	Turn on the compressed air supply (max. 7 bar).	
8.	Turn on the regulated compressed air supply to the barrel at 4-5 bar for dispensing adhesive, or	After several minutes the adhesive or gel will appear

	1 bar for dispensing test material (gel)	at the end of the needle. An excessive hissing means incorrect fitting of the barrel caps.
9.	Switch on the two compressed air supply switches, re-connecting the valve to the controller.	Clean the needle with a tissue. The dispense tube will be pinched preventing further adhesive leakage.
10.	Take an A card from the holder drawer. Remove the protection cap and replace it on the other end of the card. Insert the A card into the memory card slot.	
11.	**Registering an OFFSET.** **An OFFSET correction must be programmed or verified each time the machine is turned on, An OFFSET must be registered for each new needle because of the variation of their length.** a) Connect the teaching pendant. b) Turn the machine on. c) Set the programme switch to 00 and then press the home key on teaching pendant. d) Select the programme number required on the programme switch. (See**. Register of programme numbers**) *Ex : set programme 33* e) In POINT mode use the + / - keys to set a reference point and press GO key. *Ex in programme 33 the reference point is 001.* If necessary register the reference point as shown in step 12 of the programming procedure.	The start indicator (green light) flashes quickly. The machine comes back to its origin and is in teaching mode. The machine goes to the reference point position.

	f) In POINT mode: Put a glass detector blank under the needle as a gauge. Move Z until the needle touches the glass by pressing ZR key and using arrow keys with the ZR indicator light on. The glass detector must slide easily. g) In SPEED Mode register the OFFSET point by pressing SHIFT Enter A / C. Then put away the glass detector. h) You can check the registered OFFSET point by pressing COPY in SPEED Mode.	The machine goes to the OFFSET point position.
12.	Disable the teaching pendant by pressing the START button during removal.	The start indicator lights continuously and the machine returns to 'home' position. When this is complete the start indicator flashes slowly. The machine is now ready for use.
13	Press START to begin the dispensing operation.	**The dispensing operation will be carrying out each time the start button is pressed.**
14.	Entering Missed Points Points can be entered individually should they be missed due to an air bubble in the glue. To carry out this operation the teaching pendant must be connected. The eject button must be pressed during connection. a) When dispensing has finished and the machine has returned to 'home'. Change the programme switches to 00 and press the HOME key. b) Put the programme switches back to the selected pattern programme. e.g. *programme 33*	The machine is in teaching mode.

	Check that the OFFSET is always good with the glass gauge. If not apply again step 11. c) Press the mode key in POINT mode. d) Use the numeric +/- keys to set the number of the missed point. (Use the grid of position numbers in the ATLAS programmes by the machine). e) Press 'GO' on the teach pendant. f) Press the foot switch to dispense a dot of adhesive. g) Repeat steps (d) to (f) for additional points. h) Press home when all points have been dispensed. i) After the machine has returned to home, press the start indicator on the machine to switch back to machine control.	The machine will move to the correct position and to dispense height. Adhesive will be dispensed. The machine will return to the home position.
15.	When dispensing is complete, turn the Sony CAST-PRO off.	Machine is off.
16.	Remove the A card and replace the protective cap. Return the card to the drawer.	
17.	Disconnect barrel compressed air supply at the push connector by the machine. Remove barrel.	
18.	Remove the two Allen nuts on the front of the dispense valve.	
19.	Remove the face plate assembly.	
20.	Loosen the thumb screw on the top of the face plate.	
21.	Loosen the two screws that hold the needle block in place and turn the needle block one quarter-turn to facilitate removal.	
22.	Remove the needle block.	

23.	Slide out the dispense tube from the top of the face plate and remove the tube by pulling it.	
24.	Return the face plate assembly to the drawer without a needle and tube.	

Annexe 1 : Record of the value of the parameters used in Programmes

Parameters for 'ATLAS 1' Programme Numbers 31, 32,33,34 and 'ATLAS 2' Programme Numbers 30 (see chapter 3-5 page 3- 7 of the operation manual)

A0	01
A1	11
A2	01
A3	03
A4	01
A5	00
A6	00
A7	00
A8	00
A9	00
Ad	02
AE	00
AF	00
	0.5
C1	00
C2	00
C3	00
C4	00

C5	03 This parameter is 01 for programmes 30, 31 and32 on Atlas 1 and 2.
C6	05
C7	00
C8	00
C9	00

Annexe 2 Register of Programme Numbers

Owing to the number of points in an ATLAS glue pattern, each dispensing card is set up to contain up to 5 programmes with a maximum of 250 points each.

Programme Number	**ATLAS 1** Description of Programme	**ATLAS 2** Description of Programme
30	Glue pattern for ATLAS module assembly for use with acceptance test jigs. Program of the pattern on the new table.	Glue pattern for ATLAS module assembly for use with acceptance test jigs.
31	Last glue pattern for ATLAS module assembly, for use with assembly jig. N.B. This programme of 152 points has 4 extra points onto the side of the jig at the start.	Last glue pattern for ATLAS module assembly, for use with assembly jig. N.B This programme has 4 extra points onto the side of the jig at the start
32	**4 points at start on jig only**	**4 points at start on JIG only**
33	As 32	As 32
34	**1 points at start on jig only**	**1 points at start on jig only**

SCT Barrel module: hybrid mounting procedure

Introduction

This document describes the fitting of a hybrid p.c.b. to a sub assembly of 4 detectors on a base board, using the hybrid mounting tool station situated in R12 clean-room. The process entails gluing one side of the hybrid to the top of the sub-assembly, allowing it to cure overnight, then wrapping the hybrid round the sub-assembly and gluing the other side, again with an overnight cure.

Station

The mounting tool comprises a Vision scope positioned over a slide, onto which a platen carrier is mounted. The carrier travels under the scope and may be “parked” on either side of it.
There are a total of six platen assemblies, each permanently attached to a N_2 storage box, and stored three to each side of the slide. The boxes are in turn permanently connected to vacuum and N_2 supplies, which may be monitored on the wall-panel behind the slide. The vacuum supply is used to hold hybrids to each platen assembly, while positioning and bonding. Thus, up to six sub-assemblies may be maintained over extended periods at either stage of hybrid mounting, i.e. side A or side B bonding.

Preparation

Work area and jigs should be clean, and unnecessary items removed.

- Calibration jig
- Glass scale
- Hybrid with carrier
- Positioning block
- Sub-assembly (4 detectors on baseboard) in c-frame (initially with both covers fitted)
- Vacuum source
- Adhesive components
- Tracking document

Calibration

Optics position is calibrated for this procedure. This should be regularly checked, requiring a glass scale and a calibration jig, both sited locally.
The jig is placed on the platen and observed through the scope to establish that the scope is mounted perpendicular to the platen.
It comprises 2 flat surfaces at different heights with a corresponding mark on each, consistent in “x”. When changing focus between surfaces, the marks should align consistently with the scope’s vertical graticule.
The glass scale is placed on the platen and observed through the scope. When in focus, the scale should show a spacing of 4.68 mm between the scope’s horizontal graticule lines.

Procedure

The procedure describes:

1/ mounting components onto mounting tool
2/ adjustments
3/ adhesive preparation
4/ bonding the front hybrid section
5/ the wrap-around
6/ aligning and bonding the back hybrid section
7/ removal from the jig

1/ Mounting components onto tool.

The hybrid carrier is placed on the positioning block, under the tool platen.

The priority here is to ensure the correct position for the posts on the tool carrier destined to sit over the holes on the hybrid (currently 0.6mm). The posts are cut away to help the siting. Once positioned, vacuum is applied to retain the hybrid (switches for left and right side), and the vacuum integrity checked to be better than 200mbar. The z-adjustment is used to lift the hybrid to its maximum height over the platen. Carrier and positioning block should be carefully removed.

Note that here, unusually, vacuum is working against gravity, and great care must be exercised.

The platen is rotated through 180 degrees.

The module in its c-frame is secured to the underside of the platen, in position B, to remove the A-side c-frame cover, then secured in position A.

The platen is righted again for a preliminary alignment check.

The illustrations show the various tool positions.

Hybrid held on tool,

…and inverted.

C-frame in position A,

…and position B.

2/ Adjustments

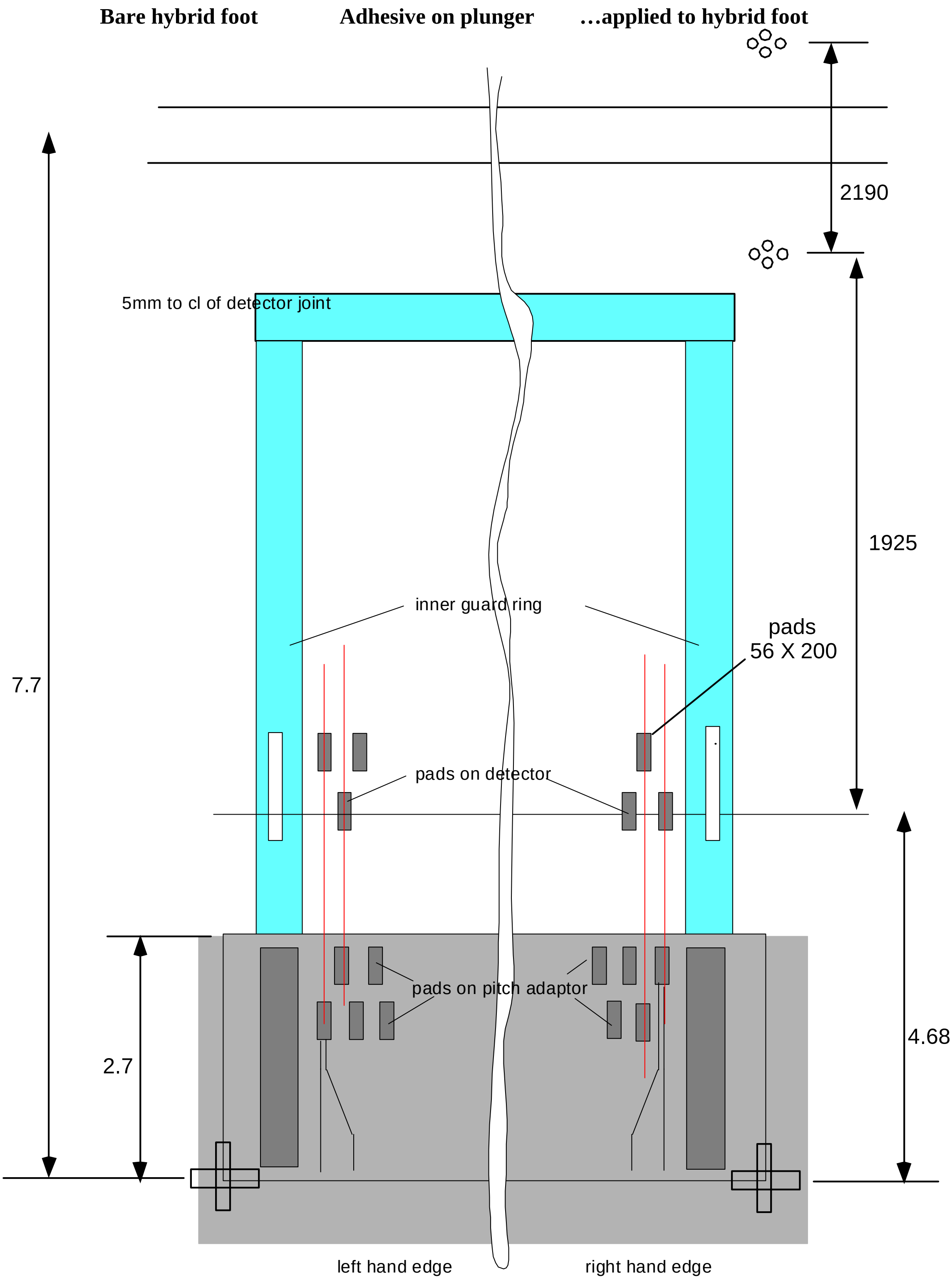
1. Lower the hybrid to within 0.5 mm of the sub-assembly.
2. View the left/right ends of the hybrid by eye and approximately centre the hybrid (left/right, or x) with respect to the detector.
3. Transfer the platen to the optics.
4. Check the “y” distance from the detector pad’s centre to hybrid ”+” is 4.68mm, as shown by Figure 1, using the alignment marks on the optics (graticule). There is an adjuster to move the whole platen in y to aid this alignment.
5. Any difference in this distance between left and right ends of the hybrid is eliminated using the angle adjustment.
6. Confirm that the hybrid is centred, by checking the alignment of the first pad on the hybrid fan-in, with the corresponding pad on the detector.

Once alignment is assured, the hybrid z-axis is raised to its maximum height, and the module c-frame is turned over to position B.

3/ Adhesive preparation

The adhesive, hardener, and thermal component are weighed and mixed thoroughly, and applied to the two end pads on the front section of the hybrid, using the plunger from a 0.5cc syringe (illustrated).

Araldite 2011 resin	2.5g
Araldite 2011 hardener	2.0g
Boron nitride filler	2.0g



Bare hybrid foot
Adhesive on plunger
…applied to hybrid foot
2190
5mm to cl of detector joint
1925
7.7
inner guard ring
pads
56 X 200
pads on detector
pads on pitch adaptor
2.7
4.68
left hand edge
right hand edge

Figure 1

4/ Bonding the front hybrid section

The module carrier is returned to position A, and the hybrid lowered into position. A visual check of the big picture is valuable at this point, since the optics will not expose planar misalignment.
A long ‘pot’ life allows ample time for repositioning, though this should not be necessary at this stage. The slight flow of adhesive from under the feet is reassuring, if even.
Once positioned, the area should be secured for the duration of the cure. Currently, it is proposed that the platen is removed to N_2 storage.
Cure period is 16 hours minimum. Note that adhesive will also flow through the holes in the hybrid, and come into contact with the positioning posts of the tool. To date, the posts have rejected the adhesive successfully, but should be monitored as time progresses, and observed carefully when the posts are lifted after the cure.

5/ The wrap-around

The hybrid has a flexible joint, which wraps around the detector assembly. Note the use of the word ‘flexible’! This operation is ‘once only’, so adhesive should be applied beforehand. Previous attempts to ‘unwrap’ have resulted in shearing of the hybrid from its vacuum cups. The flexure is also rigid enough to transmit any positional errors of the front hybrid bonding through to the back, y-adjustment of the back section being especially difficult, more so in the presence of a planar error. It is therefore not as easy to find the “ideal position” for the B-side, but neither is it as critical. The main objective is to ease the wire-bonding task, so the alignment in x is the priority.
After curing, the platen is returned to the tool, and the vacuum is switched off side A. The z-axis is raised slightly to remove any pressure applied (also so there will be 0.5mm clearance after turning over). The platen is rotated 180 degrees, and the B-side cover removed. Adhesive is applied to the B side feet. The c-frame is turned over carefully, with the free end of the hybrid restrained gently by hand, and secured. The A-side cover is replaced securely.

6/ Aligning and bonding the back hybrid section

The “y” position of the hybrid can be adjusted slightly towards the optimum 4.68mm, but only with consideration to its “fixed” end.
The “x” position can be checked as on side A, and the hybrid lowered into position, again with the check for planarity and a measure of displaced adhesive. The platen is removed to N_2 storage.

7/ Removal from the tool

After curing, the platen is returned from storage to the tool. The vacuum is switched off and the z-axis raised to its full height. Then the platen can be inverted.
The c-frame is moved to position A, and the B side cover fitted.
The c-frame is removed from the jig.
The module remains in its c-frame in N_2 storage before the wire-bonding procedure.

SCT Barrel module

Hybrid mounting procedure

Module in C-frame (B-side)

Author: Paul Booker
30th April, 2002

ASSEMBLY ALIGNMENT CHECK

There are two programmes for the assembly alignment check :

wf_top_pujig.RTN This is for the module top side (front).

wf_bot_pujig.RTN This is for the module bottom side (back)

PROCEDURE

For module top (front).

Open programme wf_top_pujig.RTN

With the baseboard held under vacuum on the support jig and a pair of detectors held under vacuum to the top pick-up jig, all mounted in the assembly jig, procede with the ‘soft alignment’ as follows :

ORIGIN

1. On the left hand pillar of the assembly jig locate the single spot fiducial numbered 620, perform an automatic focus and centre the spot in the circle target. Zero x,y and z.

AXIS

1. On the right hand pillar of the assembly jig locate the single spot fiducial numbered 730 and centre this in the circle target. Click on the alignment button.

The programme is now ready to run.

Click the run button and the programme takes approximately 15 seconds to check the alignment. Compare the results with the expected figures and adjust the top plate if necessary. Re-run the programme and check the results.

For module bottom (back).

Open programme wf_bot_pujig.RTN

With the first pair of detectors and the baseboard held under vacuum to the top pick-up jig and the second pair of detectors held under vacuum on the bottom pick-up jig, all mounted in the assembly jig, procede with the ‘soft alignment’ as follows :

ORIGIN

1. On the left hand pillar of the assembly jig locate the single spot fiducial numbered 190 perform an automatic focus and centre the spot in the circle target. Zero x,y and z.

AXIS

1. On the right hand pillar of the assembly jig locate the single spot fiducial numbered 110 and centre this in the circle target. Click on the alignment button.

The programme is now ready to run.

Click the run button and the programme takes approximately 15 seconds to check the alignment. Compare the results with the expected figures and adjust the top plate if necessary. Re-run the programme and check the results.

<u>SOFT ALIGNMENTS</u>

<u>Module Profile Top.</u>- Metrology Jig 2

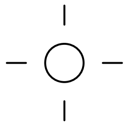
NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Open Programme - Module_top_profileV1

In icon box click “RUN” icon – yellow box appears on right hand side of screen.

<u>ORIGIN</u>

Left hand detector – bottom left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

<u>AXIS</u>

Right hand detector – bottom right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

<u>Module Profile Bottom.</u>- Metrology Jig 2

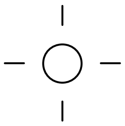
NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Open Programme - Module_bot_profileV1

In icon box click “RUN” icon – yellow box appears on right hand side of screen.

<u>ORIGIN</u>

Left hand detector – top left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

<u>AXIS</u>

Right hand detector – top right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

Module x,y Position Top - Metrology Jig 2

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Where the pinhole fiducials on the metrology jig are used for the origin and axis.

Open Programme – x,y pos top_pinholeV4

In icon box click “RUN” icon – yellow box appears on right hand side of screen.

ORIGIN

Locate bottom left hand pinhole (1 on fig.2).

Using backlight focus on edge of the pinhole.

Zero ‘z’.

Using circle target – centre the pinhole in the target area.

Zero ‘x’ and ‘y’.

AXIS

Locate the bottom right hand pinhole (2 on fig.2).

Using circle target – centre the pinhole in the target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

Module x,y Position Bottom – Metrology Jig 2

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Where the pinhole fiducials on the metrology jig are used for the origin and axis.

Open Programme – x,y pos bot_pinholeV4

In icon box click “RUN” icon – yellow box appears on right hand side of screen.

ORIGIN

Locate top left hand pinhole (1 on fig.3).

Using backlight focus on edge of the pinhole.

Zero ‘z’.

Using circle target – centre the pinhole in the target area.

Zero ‘x’ and ‘y’.

AXIS

Locate the top right hand pinhole (2 on fig.3).

Using circle target – centre the pinhole in the target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

<u>Module x,y Position Top</u> – Metrology Jig 2

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

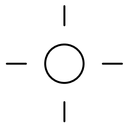
Where round hole in washer and slotted hole in washer are used for the origin and axis.

Open Programme – x,y,pos top_pinholeV5

In icon box click "RUN" icon – yellow box appears on right hand side of screen.

<u>ORIGIN</u>

Left hand detector – bottom left single fiducial.



Focus – zero 'z'.

Using circle target – centre the fiducial in target area.

Zero 'x' and 'y'.

<u>AXIS</u>

Right hand detector – bottom right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

Module x,y,Position Bottom – Metrology Jig 2

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

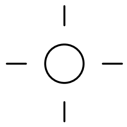
Where round hole in washer and slotted hole in washer are used for the origin and axis

Open Programme – x,y pos bot_pinholeV5

In icon box click “RUN” icon – yellow box appears on right hand side of screen.

ORIGIN

Left hand detector – top left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

AXIS

Right hand detector – top right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Programme is now ready to run.

<u>Writing a Programme for Measuring a Module Profile</u>

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

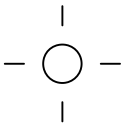
Metrology Jig 2

Programme to be written at maximum magnification.

Module ProfileTop – Do Soft Alignment as follows.

<u>ORIGIN</u>

Left hand detector – bottom left single fiducial.



Focus – zero 'z'.

Using circle target – centre the fiducial in target area.

Zero 'x' and 'y'.

<u>AXIS</u>

Right hand detector – bottom right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

<u>Programme</u>

On left hand detector locate bottom left single fiducial.

<u>Step 1.</u> Measure point.

<u>Step 2.</u> Construct 'z' origin using the point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

<u>Step 3.</u> Measure the circular fiducial.

<u>Step 4.</u> Construct 'x', 'y' origin using the circle measured in step 3.

On right hand detector locate bottom right single fiducial.

<u>Step 5.</u> Measure point.

<u>Step 6.</u> Construct 'z' origin using Step 5.

<u>Step 7.</u> Measure the circular fiducial.

Step 8. Construct the 'axis' using the circle measured in Step 7.

In the next 3 steps each point is measured next to a lug marked A in figure 2 (in approx. position ▪).

Step 9. Measure point.

Step 10. Measure point.

Step 11. Measure point.

Step 12. Construct a plane using Steps 9,10 and 11. (click reference plane box).

On left hand detector locate bottom left single fiducial. ('x' and 'y' should both read 0).

Move 'x' to + 3.00 and 'y' to + 0.7.

Step 13. Measure point.

In 'EDIT' drop down menu click on 'COPY'. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes:

Step number – 13

Number of times – 8

X/R Offset – 7.2

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 14 through 21.

Are you saving your input regularly?

Move to right hand detector and locate the bottom left hand single fiducial.

Using the 'circle' target place the fiducial in the centre of the target.

Note the 'X' reading.

Move the table to 'X' reading + 3.00 and 'Y' to + 0.7.

Step 22. Measure point.

In 'EDIT' drop down menu click on 'COPY'. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes.

Step number – 22

Number of times – 8

X/R Offset – 7.2

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 23 through 30.

In ‘EDIT’ drop down menu click on ‘COPY’. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes.

Step number – 13

To – 30

Number of times – 8

Y/A Offset – 7.7

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 31 through 174.

SAVE.

This programme is now complete and ready to run.

Writing a Programme for Measuring a Module Profile

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

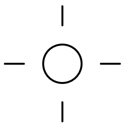
Metrology Jig 2

Programme to be written at maximum magnification.

Module Profile Bottom – Do Soft Alignment as follows.

ORIGIN

Left hand detector – top left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

AXIS

Right hand detector – top right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

On left hand detector locate top left single fiducial.

Step 1. Measure point.

Step 2. Construct ‘z’ origin using the point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure the circular fiducial.

Step 4. Construct ‘x’, ‘y’ origin using the circle measured in Step 3.

On right hand detector locate top right single fiducial.

Step 5. Measure point.

Step 6. Construct ‘z’ origin using Step 5.

Step 7. Measure the circular fiducial.

Step 8. Construct the 'axis' using the circle measured in Step 7.

In the next 3 steps each point is measured on a lug marked A in figure 3 (in approx. position ▪).

Step 9. Measure point.

Step 10. Measure point.

Step 11. Measure point.

Step 12. Construct a plane using Steps 9,10 and 11. (click reference plane box).

On left hand detector locate top left single fiducial. ('x' and 'y' should both read 0).

Move 'x' to + 3.00 and 'y' to - 0.7.

Step 13. Measure point.

In 'EDIT' drop down menu click on 'COPY'. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes:

Step number – 13

Number of times – 8

X/R Offset – 7.2

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 14 through 21.

Are you saving your input regularly?

Move to right hand detector and locate the top left hand single fiducial.

Using the 'circle' target place the fiducial in the centre of the target.

Note the 'X' reading.

Move the table to 'X' reading + 3.00 and 'Y' to - 0.7.

Step 22. Measure point.

In 'EDIT' drop down menu click on 'COPY'. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes.

Step number – 22

Number of times – 8

X/R Offset – 7.2

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 23 through 30.

In ‘EDIT’ drop down menu click on ‘COPY’. Prompt box opens on right hand side of screen.

Insert the following in the relevant boxes.

Step number – 13

To – 30

Number of times – 8

Y/A Offset – -7.7

Click OK – Prompt appears on screen – Click yes (only if satisfied that input is correct).

This gives you Steps 31 through 174.

SAVE.

This programme is now complete and ready to run.

Writing a Programme for Measuring a Module ‘x’, ‘y’ Position

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the ‘ORIGIN’ and the ‘AXIS’ are to be set.

They will either be set on the round hole and slot on the baseboard, or the ‘PINHOLE FIDUCIALS’ on the metrology jig.

Metrology jig 2

Programme to be written at maximum magnification.

Where ‘Pinhole Fiducials’ are used for the ‘ORIGIN’ and ‘AXIS’.

Module ‘x’,’y’ Position Top – Do soft alignment as follows.

ORIGIN

Locate bottom left hand pinhole (1 on fig.2).

Using backlight focus on edge of the pinhole.

Zero ‘z’.

Using circle target – centre the pinhole in the target area.

Zero ‘x’ and ‘y’.

AXIS

Locate the bottom right hand pinhole (2 on fig.2).

Using circle target – centre the pinhole in the target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

Locate bottom left hand pinhole (1 on fig.2).

Using ‘backlight’.

Step 1. Measure point on edge of hole.

Step 2. Construct ‘z’ origin using point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure pinhole.

Step 4. Construct ‘x’ ‘y’ origin using Step 3.

Locate bottom right pinhole (2 on fig.2).

Step 5. Measure point on edge of hole.

Step 6. Construct ‘z’ origin using point measured in Step 5.

Step 7. Measure pinhole.

Step 8. Construct the axis using Step 7.

Step 9. Re-measure the pinhole.

Locate the top right pinhole (3 on fig.2).

Step 10. Measure point on edge of hole.

Step 11. Construct ‘z’ origin using Step 10.

Step 12. Measure pinhole.

Locate top left pinhole (4 on fig.2).

Step 13. Measure point on edge of hole.

Step 14. Construct ‘z’ origin using Step 13.

Step 15. Measure pinhole.

Locate round hole in washer/baseboard.

Step 16. Measure point on edge of hole.

Step 17. Construct ‘z’ origin using Step 16.

Step 18. Measure an arc on edge of round hole.

Step 19. Measure a second arc on edge of round hole.

Step 20. Measure a third arc on edge of round hole.

Step 21. Construct a circle using Steps 18,19 and 20.

Locate slotted hole.

Step 22. Measure point on edge of hole.

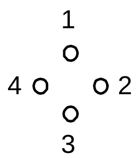
Step 23. Construct ‘z’ origin using Step 22.

Step 24. Measure a line on one edge of slot.

Step 25. Measure a line on second edge of slot.

Step 26. Construct width using Steps 24 and 25.

On the left hand detector locate bottom left 4 spot fiducial (Pos.1 on fig 2).



Step 27. Measure point at this fiducial.

Step 28. Construct ‘z’ origin using Step 27.

Step 29. Measure circular spot 1.

Step 30. Measure circular spot 2.

Step 31. Measure circular spot 3.

Step 32. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 33. Construct a line from spot 1 to spot 3 using Steps 29 and 31.

Step 34. Construct a line from spot 2 to spot 4 using Steps 30 and 32.

Step 35. Construct an intersection using Steps 33 and 34.

Repeat Steps 27 to 35 for the remaining seven sets of 4 spot fiducials at the positions shown and in this order – 2, 3, 4, 5, 6, 7 and 8.

This gives you Steps 36 to 98.

Save.

This programme is now complete and is ready to run.

Writing a Programme for Measuring a Module ‘x’, ‘y’ Position

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the ‘ORIGIN’ and the ‘AXIS’ are to be set.

They will either be set on the round hole and slot on the baseboard, or the ‘PINHOLE FIDUCIALS’ on the metrology jig.

Metrology jig 2

Programme to be written at maximum magnification.

Where ‘Pinhole Fiducials’ are used for the ‘ORIGIN’ and ‘AXIS’.

Module ‘x’,’y’ Position Bottom – Do soft alignment as follows.

ORIGIN

Locate top left hand pinhole (1 on fig.3).

Using backlight focus on edge of the pinhole.

Zero ‘z’.

Using circle target – centre the pinhole in the target area.

Zero ‘x’ and ‘y’.

AXIS

Locate the top right hand pinhole (2 on fig.3).

Using circle target – centre the pinhole in the target area

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

Locate top left hand pinhole (1 on fig.3).

Using backlight.

Step 1. Measure point on edge of hole.

Step 2. Construct ‘z’ origin using the point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure pinhole.

Step 4. Construct ‘x’,‘y’ origin using step 3.

Locate the top right hand pinhole (2 on fig.3).

Step.5. Measure point on edge of hole.

Step 6. Construct 'z' origin using step 5.

Step 7. Measure pinhole.

Step 8. Construct the axis using Step 7.

Step 9. Re-measure the pinhole.

Locate the bottom right pinhole (3 on fig.3).

Step 10. Measure point on edge of hole.

Step 11. Construct 'z' origin using Step 10.

Step 12. Measure pinhole.

Locate bottom left pinhole (4 on fig.3).

Step 13. Measure point on edge of hole.

Step 14. Construct 'z' origin using Step 13.

Step 15. Measure pinhole.

Locate round hole in washer/baseboard.

Step 16. Measure point on edge of hole.

Step 17. Construct 'z' origin using Step 16.

Step 18. Measure an arc on edge of round hole.

Step 19. Measure a second arc on edge of round hole.

Step 20. Measure a third arc on edge of round hole.

Step 21. Construct a circle using Steps 18,19 and 20.

Locate slotted hole.

Step 22. Measure point on edge of hole.

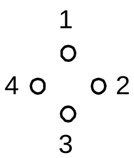
Step 23. Construct 'z' origin using Step 22.

Step 24. Measure a line on one edge of slot.

Step 25. Measure a line on second edge of slot.

Step 26. Construct width using Steps 24 and 25.

On the left hand detector locate top left 4 spot fiducial (Pos.1 on fig 3)



Step 27. Measure point at this fiducial.

Step 28. Construct ‘z’ origin using Step 27.

Step 29. Measure circular spot 1.

Step 30. Measure circular spot 2.

Step 31. Measure circular spot 3.

Step 32. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 33. Construct a line from spot 1 to spot 3 using Steps 29 and 31.

Step 34. Construct a line from spot 2 to spot 4 using Steps 30 and 32.

Step 35. Construct an intersection using Steps 33 and 34.

Repeat Steps 27 to 35 for the remaining seven sets of 4 spot fiducials at the positions shown and in this order – 2, 3, 4, 5, 6, 7 and 8.

This gives you Steps 36 to 98.

Save.

This programme is now complete and is ready to run.

<u>Writing a Programme for Measuring a Module ‘x’, ‘y’ Position</u>

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the ‘ORIGIN’ and the ‘AXIS’ are to be set.

They will either be set on the round hole and slot on the baseboard, or the ‘PINHOLE FIDUCIALS’ on the metrology jig.

Metrology jig 2

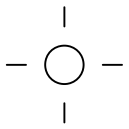
Programme to be written at maximum magnification.

Where round hole and slot in washers are used for the ‘ORIGIN’ and the ‘AXIS’.

Module ‘x’,’y’ Position Top – Do soft alignment as follows.

<u>ORIGIN</u>

Left hand detector – bottom left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

<u>AXIS</u>

Right hand detector – bottom right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

<u>Programme</u>

Locate round hole in washer.

Using backlight.

<u>Step 1.</u> Measure point at edge of hole.

<u>Step 2.</u> Construct ‘z’ origin using point measured in step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

<u>Step 3.</u> Measure an arc on the edge of round hole.

Step 4. Measure a second arc on edge of round hole.

Step 5. Measure a third arc on edge of round hole.

Step 6. Construct a circle using steps 3,4 and 5.

Step 7. Construct ‘x’,’y’ origin using step 6.

Locate slot.

Step 8. Measure point on straight edge of slot.

Step 9. Construct ‘z’ origin using step 8.

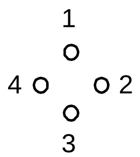
Step 10. Measure line on one straight edge of slot.

Step 11. Measure line on second straight edge of slot.

Step 12. Construct width using steps 10 and 11.

Step 13. Construct axis using step 12.

On the left hand detector locate bottom left 4 spot fiducial (Pos.1 on fig 2)



Step 14. Measure point at this fiducial.

Step 15. Construct ‘z’ origin using step 14.

Step 16. Measure circular spot 1.

Step 17. Measure circular spot 2.

Step 18. Measure circular spot 3.

Step 19. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 20. Construct a line from spot 1 to spot 3 using Steps 16 and 18.

Step 21. Construct a line from spot 2 to spot 4 using Steps 17 and 19.

Step 22. Construct an intersection using Steps 20 and 21.

Repeat Steps 14 to 22 for the remaining seven sets of 4 spot fiducials at the positions shown and in this order – 2, 3, 4, 5, 6, 7 and 8 on fig.2.

This gives you steps 23 to 85.

Locate bottom left hand pinhole fiducial (1 on fig.2).

Step 86. Measure point on edge of pinhole.

Step 87. Construct ‘z’ origin using step 86.

Step 88. Measure pinhole.

Repeat steps 86 to 88 for remaining three pinholes (2, 3 and 4 on fig.2) in this order.

This will give you steps 89 to 97.

SAVE.

This programme is now complete and ready to run.

Writing a Programme for Measuring a Module 'x', 'y' Position

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the 'ORIGIN' and the 'AXIS' are to be set.

They will either be set on the round hole and slot on the baseboard, or the 'PINHOLE FIDUCIALS' on the metrology jig.

Metrology jig 2

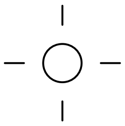
Programme to be written at maximum magnification.

Where round hole and slot in washers are used for the 'ORIGIN and the 'AXIS'.

Module 'x','y' Position Bottom – Do soft alignment as follows.

ORIGIN

Left hand detector – top left single fiducial.



Focus – zero 'z'.

Using circle target – centre the fiducial in target area.

Zero 'x' and 'y'.

AXIS

Right hand detector – top right single fiducial.

Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

Locate round hole in washer.

Using backlight.

Step 1. Measure point at edge of hole.

Step 2. Construct 'z' origin using point measured in step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure an arc on the edge of round hole.

Step 4. Measure a second arc on edge of round hole.

Step 5. Measure a third arc on edge of round hole.

Step 6. Construct a circle using steps 3,4 and 5.

Step 7. Construct ‘x’,’y’ origin using step 6.

Locate slot.

Step 8. Measure point on straight edge of slot.

Step 9. Construct ‘z’ origin using step 8.

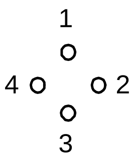
Step 10. Measure line on one straight edge of slot.

Step 11. Measure line on second straight edge of slot.

Step 12. Construct width using steps 10 and 11.

Step 13. Construct axis using step 12.

On the left hand detector locate top left 4 spot fiducial (Pos.1 on fig 3).



Step 14. Measure point at this fiducial.

Step 15. Construct ‘z’ origin using step 14.

Step 16. Measure circular spot 1.

Step 17. Measure circular spot 2.

Step 18. Measure circular spot 3.

Step 19. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 20. Construct a line from spot 1 to spot 3 using Steps 16 and 18.

Step 21. Construct a line from spot 2 to spot 4 using Steps 17 and 19.

Step 22. Construct an intersection using Steps 20 and 21.

Repeat Steps 14 to 22 for the remaining seven sets of 4 spot fiducials at the positions shown and in this order – 2, 3, 4, 5, 6, 7 and 8 on fig.3.

This gives you steps 23 to 85.

Locate top left hand pinhole fiducial (1 on fig.3).

Step 86. Measure point on edge of pinhole.

Step 87. Construct ‘z’ origin using step 86.

Step 88. Measure pinhole diameter.

Repeat steps 86 to 88 for remaining three pinholes (2, 3 and 4 on fig.3) in this order

This will give you steps 89 to 97.

SAVE.

This programme is now complete and ready to run.

Writing a Programme for Measuring a Module ‘x’, ‘y’ Position

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the ‘ORIGIN’ and the ‘AXIS’ are to be set.

Metrology jig 2

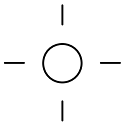
Programme to be written at maximum magnification.

Where 4 spot fiducials are used for the ‘ORIGIN’ and the ‘AXIS’.

Module ‘x’,’y’ Position Top – Do soft alignment as follows.

ORIGIN

Left hand detector – bottom left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

AXIS

Right hand detector – bottom right single fiducial.

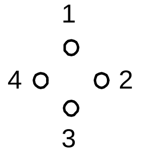
Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

On the left hand detector locate bottom left 4 spot fiducial (Pos.1 on figure 2)



Step 1. Measure point at this fiducial.

Step 2. Construct ’z’ origin using point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure circular spot 1.

Step 4. Measure circular spot 2.

Step 5. Measure circular spot 3.

Step 6. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 7. Construct a line from spot 1 to spot 3 using steps 3 and 5.

Step 8. Construct a line from spot 2 to spot 4 using steps 4 and 6.

Step 9. Construct an intersection using steps 7 and 8.

Step 10. Construct 'x','y' origin using step 9.

On left hand detector locate bottom right 4 spot fiducial. (Pos.2 on figure 2)

Repeat steps 1 to 9.

This will give you steps 11 to 19.

Step 20. Construct 'x' axis using step 19.

Step 21. Construct an intersection using steps 17 and 18.

Repeat steps 1 to 9 for the remaining six sets of 4 spot fiducials at the positions shown and in this order – 3, 4, 5, 6, 7 and 8 on figure 2.

This gives you steps 22 to 75.

Locate round hole in washer.

Step 76. Measure a point at the edge of hole.

Step 77. Construct 'z' origin using point measured in step 76.

Step 78. Measure an arc on the edge of the round hole.

Step 79. Measure a second arc on the edge of the round hole.

Step 80. Measure a third arc on the edge of the round hole.

Step 81. Construct a circle using steps 78, 79, and 80.

Locate slot.

Step 82. Measure a point on straight edge of slot.

Step 83. Construct 'z' origin using step 82.

Step 84. Measure a line on straight edge of slot.

Step 85. Measure a line on second straight edge of slot.

Step 86. Construct width using steps 84 and 85.

Locate bottom left hand pinhole fiducial. (1 on figure 2)

Step 87. Measure point on edge of pinhole.

Step 88. Construct ‘z’ origin using step 87.

Step 89. Measure pinhole diameter.

Repeat steps 87 to 89 for remaining three pinholes. (pos. 2, 3, and 4 on figure 2) in this order.

This will give you steps 90 to 98.

SAVE.

This programme is now ready to run.

Writing a Programme for Measuring a Module ‘x’, ‘y’ Position

NOTE – When reference is made to fiducial positions in the following instructions, bottom refers to the edge that is nearest the front of the Smartscope (where the operator stands), top refers to the back of the Smartscope (where the support column is).

Determine where the ‘ORIGIN’ and the ‘AXIS’ are to be set.

Metrology jig 2

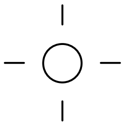
Programme to be written at maximum magnification.

Where 4 spot fiducials are used for the ‘ORIGIN’ and the ‘AXIS’.

Module ‘x’,’y’ Position Bottom – Do soft alignment as follows.

ORIGIN

Left hand detector – top left single fiducial.



Focus – zero ‘z’.

Using circle target – centre the fiducial in target area.

Zero ‘x’ and ‘y’.

AXIS

Right hand detector – top right single fiducial.

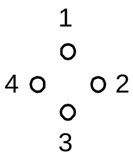
Using circle target – centre the fiducial in target area.

Click ANG box. (a number other than zero should appear).

Soft alignment is now done.

Programme

On the left hand detector locate top left 4 spot fiducial (Pos.1 on figure 3)



Step 1. Measure point at this fiducial.

Step 2. Construct ’z’ origin using point measured in Step 1.

If you save this now you will be prompted to give the programme a name, it is important to save regularly from now on.

Step 3. Measure circular spot 1.

Step 4. Measure circular spot 2.

Step 5. Measure circular spot 3.

Step 6. Measure circular spot 4.

Note – Spots are always measured in this order.

Step 7. Construct a line from spot 1 to spot 3 using steps 3 and 5.

Step 8. Construct a line from spot 2 to spot 4 using steps 4 and 6.

Step 9. Construct an intersection using steps 7 and 8.

Step 10. Construct 'x','y' origin using step 9.

On left hand detector locate top right 4 spot fiducial. (Pos.2 on figure 3)

Repeat steps 1 to 9.

This will give you steps 11 to 19.

Step 20. Construct 'x' axis using step 19.

Step 21. Construct an intersection using steps 17 and 18.

Repeat steps 1 to 9 for the remaining six sets of 4 spot fiducials at the positions shown and in this order – 3, 4, 5, 6, 7 and 8 on figure 3.

This gives you steps 22 to 75.

Locate round hole in washer.

Step 76. Measure a point at the edge of hole.

Step 77. Construct 'z' origin using point measured in step 76.

Step 78. Measure an arc on the edge of the round hole.

Step 79. Measure a second arc on the edge of the round hole.

Step 80. Measure a third arc on the edge of the round hole.

Step 81. Construct a circle using steps 78, 79, and 80.

Locate slot.

Step 82. Measure a point on straight edge of slot.

Step 83. Construct 'z' origin using step 82.

Step 84. Measure a line on straight edge of slot.

Step 85. Measure a line on second straight edge of slot.

Step 86. Construct width using steps 84 and 85.

Locate top left hand pinhole fiducial. (1 on figure 3)

Step 87. Measure point on edge of pinhole.

Step 88. Construct ‘z’ origin using step 87.

Step 89. Measure pinhole diameter.

Repeat steps 87 to 89 for remaining three pinholes. (pos. 2, 3, and 4 on figure 3) in this order.

This will give you steps 90 to 98.

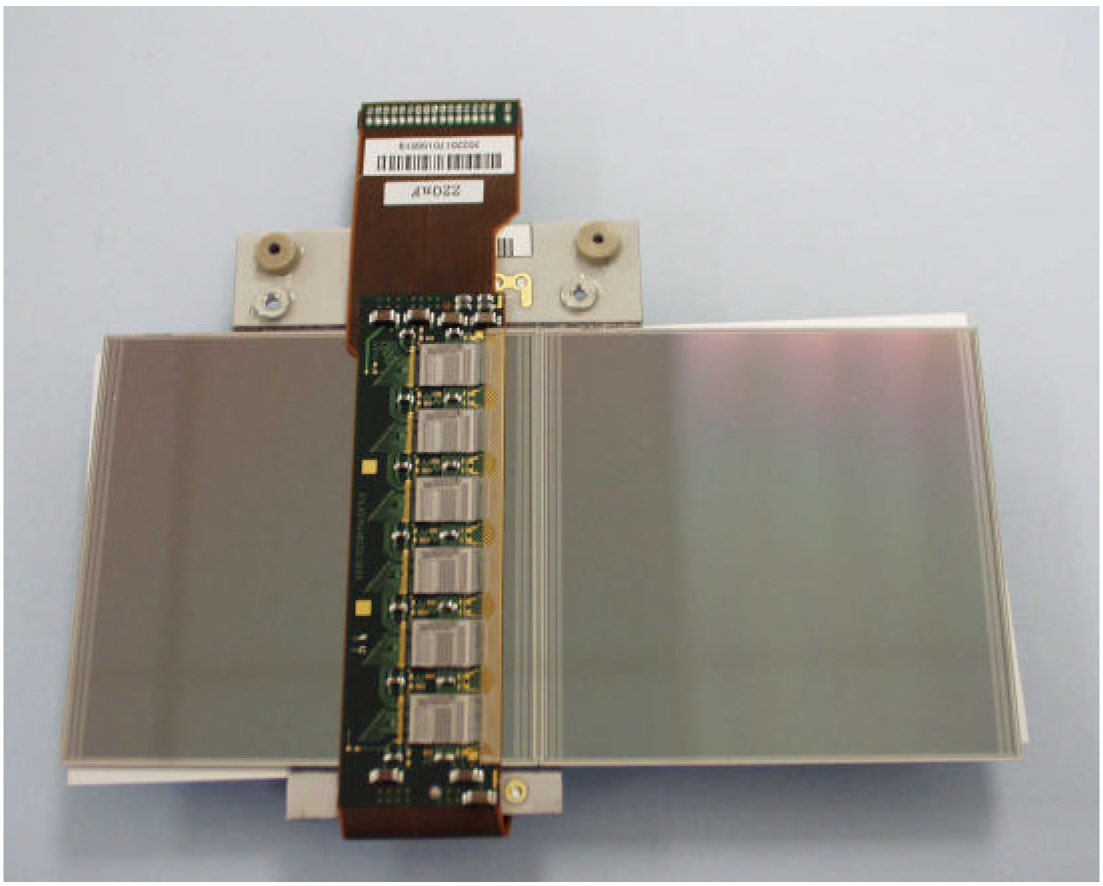
SAVE.

This programme is now ready to run.

INSTRUMENTATION
Department

ATLAS SCT
The ATLAS Semiconductor Tracker
RAL PPD

ASSEMBLY OF HYBRIDS AND WIREBONDING OF ATLAS SCT BARREL HYBRIDS AND MODULES



<u>ESD PROTECTION INSTRUCTIONS.</u>

WEAR WRIST-STRAP CONNECTED TO GROUND-GUARD.

ENSURE GROUND GUARD SHOWS GREEN LED ILLUMINATED.

UNPACK DEVICES ON DISSIPATIVE SURFACE.

ENSURE "VISITORS" OBSERVE THE SAME INSTRUCTIONS.

GENERAL OVERVIEW

STAGE 1: Solder the surface mount components onto the bare hybrid and attach the ABCD3T die at the appropriate locations.

STAGE 2: Wirebond the control and power wires between the hybrid pads and the ABCD3T pads.

STAGE 3: Wirebond the inputs of the twelve ABCD3T ASICs to the fanin (1536 channels).

STAGE 4: QA Requirements.

STAGE 5: Wirebond.

- 5.1 Ht and Bias from hybrid fanin to detector.
- 5.2 The 768 top face channels from the fanin to the detector.
- 5.3 The 768 top face detector to detector channels.
- 5.4 The 768 bottom face channels from fanin to detector.
- 5.5 The 768 bottom face detector to detector channels.

STAGE 6: Dispatch.

STAGE 1: *Solder the surface mount components onto the bare hybrid and attach the ABCD3T die at the appropriate locations.*

This is now the responsibility of the hybrid manufacture controlled by KEK, Japan.

STAGE 2: *Wirebond the control and power wires between the hybrid pads and the ABCD3T pads.*

This is now the responsibility of the University of Birmingham, UK.

STAGE 3: *Wirebond the inputs of the twelve ABCD3T chips to the fanin (1536 channels)*

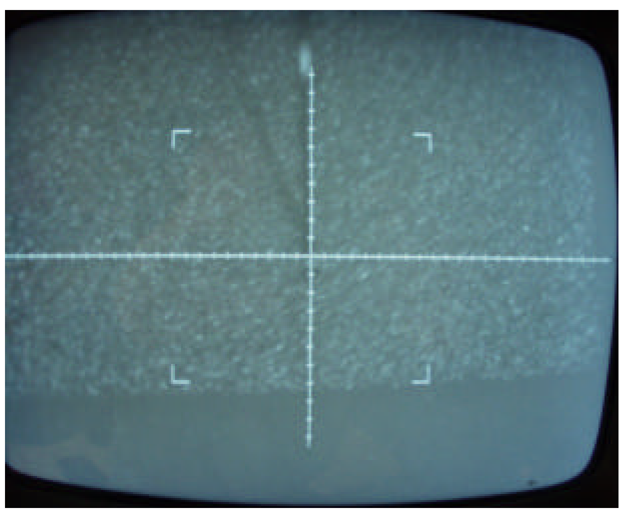
This is now the responsibility of the University of Birmingham, UK.

STAGE 4: *Module acceptance and QA requirements prior to and during wirebonding.*

The documentation for the identification of the correct module, also recording wire bonding parameters and detector channel errors must be adhered to.

STAGE 5: *Wirebonding of module.*

This is the responsibility of RAL and the following operating procedure is written assuming a K&S 1470 wire bonding machine is to be used. The calibration of the bonder is assumed to be such that the crosshairs are at the bondfoot. Any deviation from this should be taken into consideration when aligning the reference points.



STAGE 6: *Packaging and delivery for test after wirebonding.*

Stage 4 QA Requirements.

4.1 Module identification.

1. Documentation relating to module construction (i.e. which hybrid on which baseboard and individual detector relative position) is the responsibility of the module assembly team.

2. Ensure that the module is the correct one to be wire bonded by checking the barcode on the hybrid.

3. Download from [*dir.filename*] the information relating to the module.

4. Using the agreed relative detector layout plan identify and record on the wire bonding route card the channels which are not to be bonded.

5. Record all other relavent information on the route card and tick off sections as completed. Note the mean and standard deviations of bond quality obtained from the machine statistics via the keypad.

ATLAS BARREL MODULE WIRE BONDING

FRONT

FANIN TO DETECTOR

Power: 1st bond: ______ **2nd bond:** ______

Bond left HT (4 wires) ☐

Bond right HT (4 wires) ☐

Power: 1st bond: ______ **2nd bond:** ______

Bond left bias (2 wires) ☐

Bond right bias (2 wires) ☐

Channels not bonded: ____________________

____

DETECTOR TO DETECTOR

Power: 1st bond: ______ **2nd bond:** ______

Bond left bias (2 wires) ☐

Bond right bias (2 wires) ☐

Channels not bonded: ____________________

____

Channel numbering 1st row=

$$\frac{n+1}{2} \text{ where } n = \text{wire number taken from the wire bonder display}$$

Channel numbering 2nd row=

$$\frac{n}{2} \text{ where } n = \text{wire number taken from the wire bonder display}$$

Bond Quality:	**Ref. 1**	**Ref. 2**	**Bond Quality:**	**Ref. 1**	**Ref. 2**
Mean			**Mean**		
Standard deviation			**Standard deviation**		
Comments:			**Comments:**		

Completed by: ____________________ **Completed by:** ____________________

Date: ______________ **Date:** ______________

ATLAS BARREL MODULE WIRE BONDING

BACK

FANIN TO DETECTOR

Power: 1st bond: ______ **2nd bond:** ______

Bond left bias (2 wires) ☐

Bond right bias (2 wires) ☐

Channels not bonded: ____________________

____

DETECTOR TO DETECTOR

Power: 1st bond: ______ **2nd bond:** ______

Bond left bias (2 wires) ☐

Bond right bias (2 wires) ☐

Channels not bonded: ____________________

____

***Channel numbering 1st row*=**

$$\frac{n+1}{2} \text{ where } n = \text{wire number taken from the wire bonder display}$$

***Channel numbering 2nd row*=**

$$\frac{n}{2} \text{ where } n = \text{wire number taken from the wire bonder display}$$

Bond quality	**Ref. 1**	**Ref. 2**	**Bond Quality**	**Ref. 1**	**Ref. 2**
Mean			**Mean**		
Standard deviation			**Standard deviation**		
Comments:			**Comments:**		

Completed by: ____________________ **Completed by:** ____________________

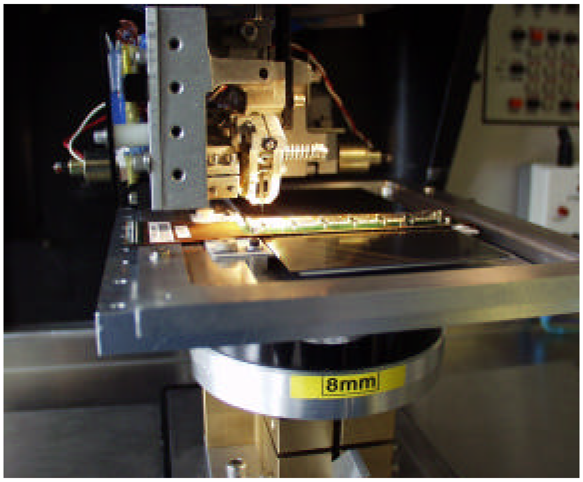
Date: ______________ **Date:** ______________

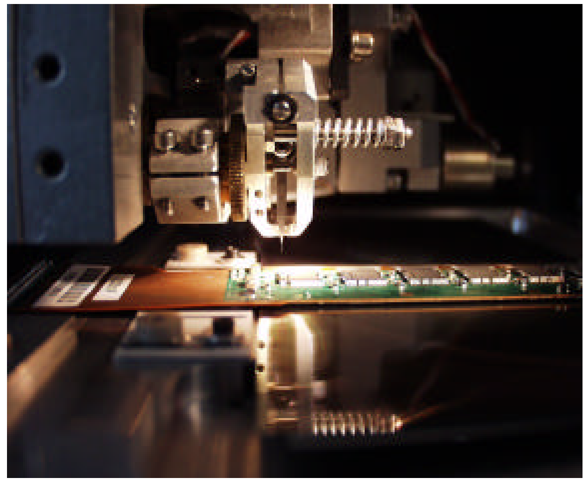
Stage 5 Wire Bonding.

5.1 Wirebond Ht and Bias from hybrid fanin to detector.

1. Mount the module on the bonding jig (top face up) and fix to the 1470 stage using the fixture plate, rotational stage and 8mm spacer.

2. In MAN Mode set loop height to 120 in LHT mode, CVL1 and CVL2 to 8.

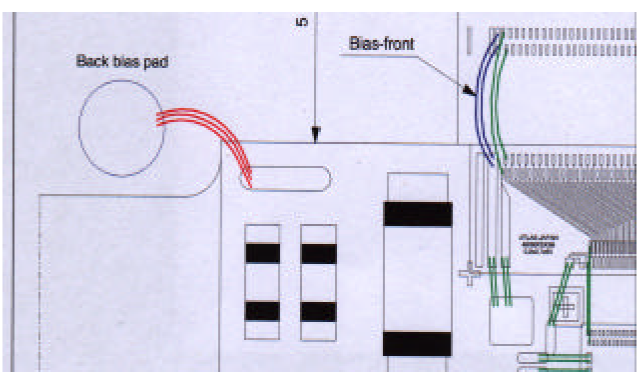


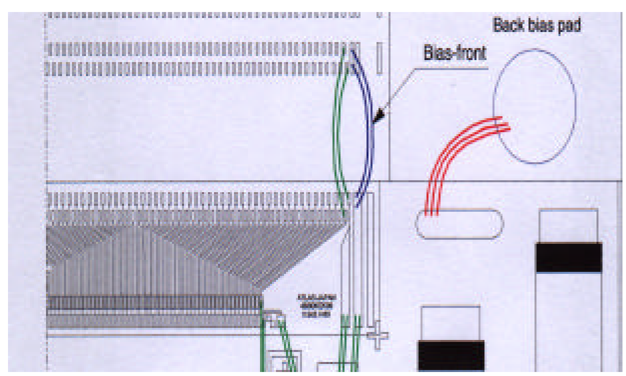


3. Set 1 on the presettable focus depth. Position the fanin under the wedge and, using the Theta/Z option, put the Z drive to 230 counts. Raise the workholder so that the fanin makes contact at this focus and Z height. This should ensure the focal planes for the fanin and detector are 1 and 6 respectively.

4. Set 1st bond and 2nd bond power to 2.8

5. Wirebond three wires from the HT pad on the hybrid to the BACK BIAS pad on the baseboard at both the left and right edges of the module.





6. Still in MANUAL Mode, leave loop height and CVL settings.

7. Change 1st bond power to 2.4 and 2nd bond power to 2.1.

8. Wirebond two wires from the FRONT BIAS rail on the fanin to the BIAS rail on the detector again at both the left and right edges of the module.

5.2 Bond 768 top face channels from the fanin to the detector.

1. Load program ATLAS 20.

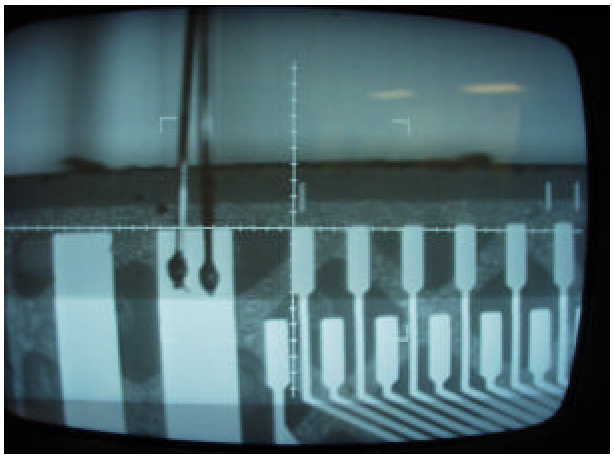
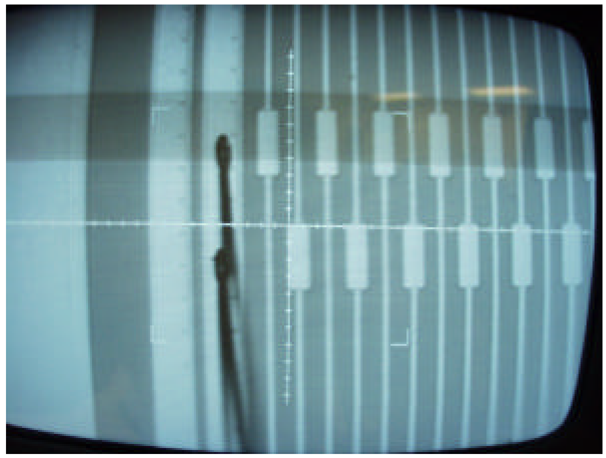
2. Check detector information for channels to be missed.

3. Set 1st bond power to 2.4 and 2nd bond power at 2.1.

4. In MAN mode set XY0.

5. Select SEMI-AUTO mode.

6. Set XY0 and align crosshairs to reference points as per the following images.

7. Set LOOP Ht to 120, 1st bond power to 2.4 and 2nd bond power to 2.1.

5. Commence bonding, checking on placement of bond foot and clearance of wire over front edge of the hybrid.

6. When satisfied AUTO bond the full fanin to detector array.

7. Record SIGMA and STD DEV for 1st and 2nd bonds.

8. Record intentionally and unintentionally missed bonds.

9. When 1st row is finished return to XY0 and align for the 2nd row bonding.

10. Set XY0 and align crosshairs to reference points as above but aligning to the second row.

11. Set LOOP Ht to 150, 1st bond power to 2.4 and 2nd bond power to 2.1.

12. Commence bonding, checking on placement of bond foot and clearance of wire over 1st row bonding.

13. When satisfied AUTO bond the full fanin to detector array.

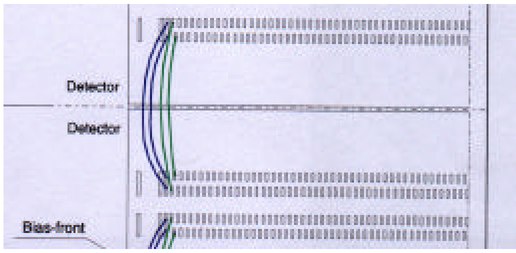
14. Record SIGMA and STD DEV for 1st and 2nd bonds.

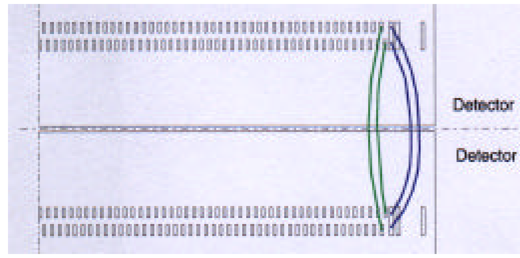
15. Record intentionally and unintentionally missed bonds.

5.3 Bond 768 top face channels from detector to detector.

1. Move the 1470 stage such that the detector/detector joint is positioned below the wedge

2. Do not adjust the height of the workholder but change the programmable focus point to focus the image on the monitor.





3. Load program ATLAS 21.

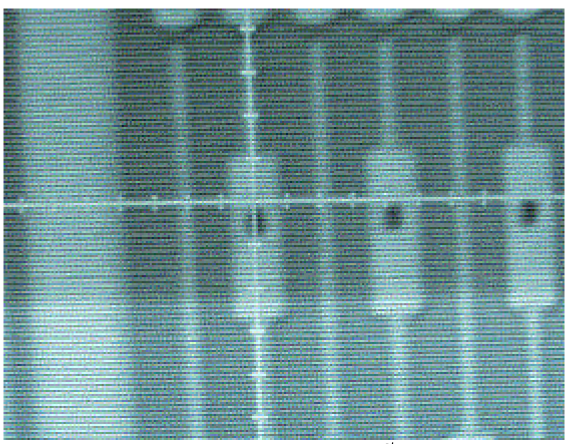
4. Check detector information for channels to be missed.

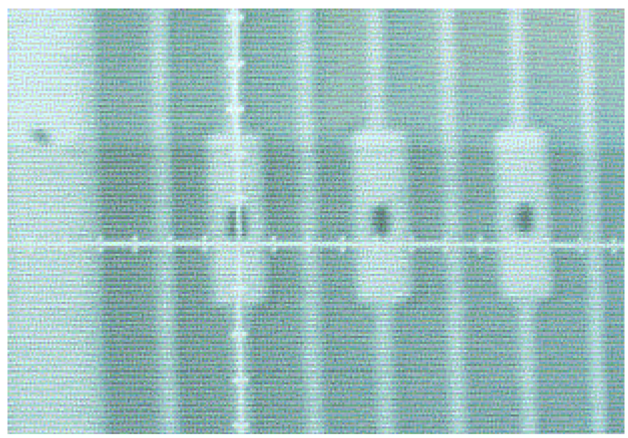
5. Set 1st bond power to 2.1 and 2nd bond power at 2.1.

6. In MAN mode and loop at 60 LHT mode bond BIAS between the two detectors at both edges of the detector. The pad is a window in line with the channel bonding pads.

8. Select SEMI-AUTO mode.

9. Set XY0 and align crosshairs to reference points as per the following images.





7. Set LOOP Ht to 60, 1st bond power to 2.1 and 2nd bond power to 2.1.

8. Commence bonding, checking on placement of bond foot.

9. When satisfied AUTO bond the full detector to detector array.

10. Record SIGMA and STD DEV for 1st and 2nd bonds.

11. Record intentionally and unintentionally missed bonds.

12. When 1st row is finished return to XY0 and align for the 2nd row bonding.

13. In MAN mode and loop at 80 LHT mode bond BIAS between the two detectors at both edges of the detector. The pad is a window in line with the channel bonding pads.

14. Set XY0 and align crosshairs to reference points as above but for the second row.

15. Set LOOP Ht to 80, 1st bond power to 2.1 and 2nd bond power to 2.1.

16. Commence bonding, checking on placement of bond foot and clearance of wire over 1st row bonding.

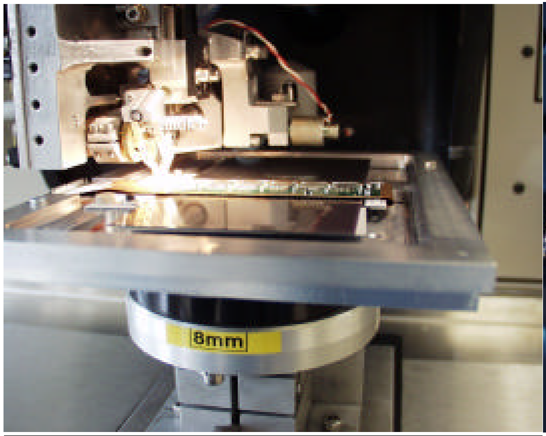
16. When satisfied AUTO bond the full fanin to detector array.

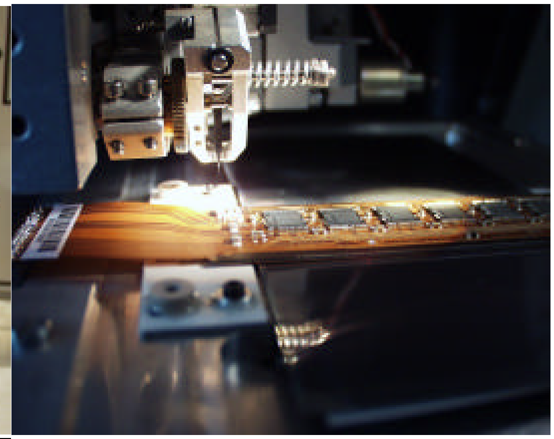
17. Record SIGMA and STD DEV for 1st and 2nd bonds.

18. Record intentionally and unintentionally missed bonds.

5.4 Bond 768 bottom face channels from the fanin to the detector.

1. Mount the module on the bonding jig (bottom face up) and fix to the 1470 stage using the fixture plate, rotational stage but no spacer.





2. There are no Ht connections between hybrid and detector on the bottom face.

3. Load program ATLAS 20.

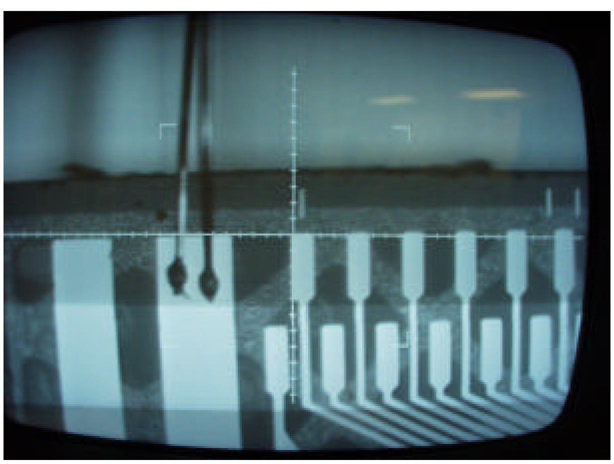
4. Check detector information for channels to be missed.

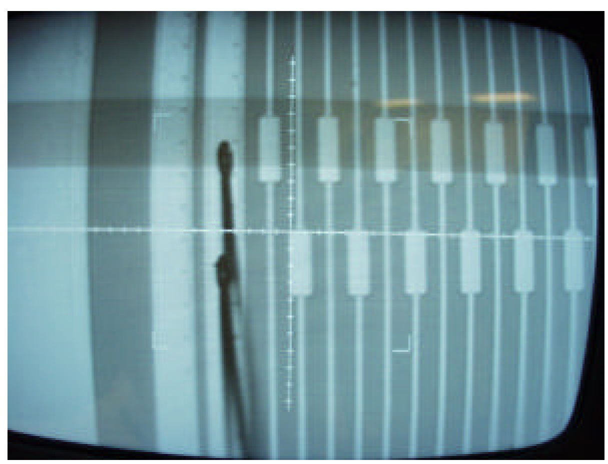
5. Set 1st bond power to 2.4 and 2nd bond power at 2.1.

6. In MAN mode set XY0.

7. Select SEMI-AUTO mode.

8. Set XY0 and align crosshairs to reference points as per the following images.





9. Set LOOP Ht to 120, 1st bond power to 2.4 and 2nd bond power to 2.1.

10. Commence bonding, checking on placement of bond foot and clearance of wire over front edge of the hybrid.

11. When satisfied AUTO bond the fullfanin to detector array.

12. Record SIGMA and STD DEV for 1st and 2nd bonds.

13. Record intentionally and unintentionally missed bonds.

14. When 1st row is finished return to XY0 and align for the 2nd row bonding.

15. Set XY0 and align crosshairs to reference points as above but aligning to the second row.

16. Set LOOP Ht to 150, 1st bond power to 2.4 and 2nd bond power to 2.1.

17. Commence bonding, checking on placement of bond foot and clearance of wire over 1st row bonding.

18. When satisfied AUTO bond the fullfanin to detector array.

19. Record SIGMA and STD DEV for 1st and 2nd bonds.

20. Record intentionally and unintentionally missed bonds.

5.5 Bond 768 bottom face detector to detector channels.

1. Move the 1470 stage such that the detector/detector joint is positioned below the wedge.

2. Do not adjust the height of the workholder but change the programmable focus point to focus the image on the monitor.

3. Load program ATLAS 21.

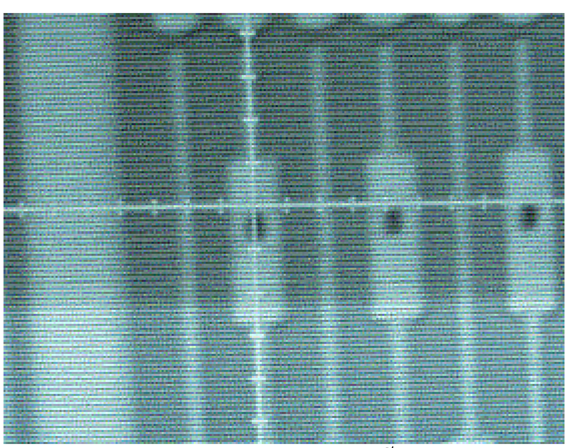
4. Check detector information for channels to be missed.

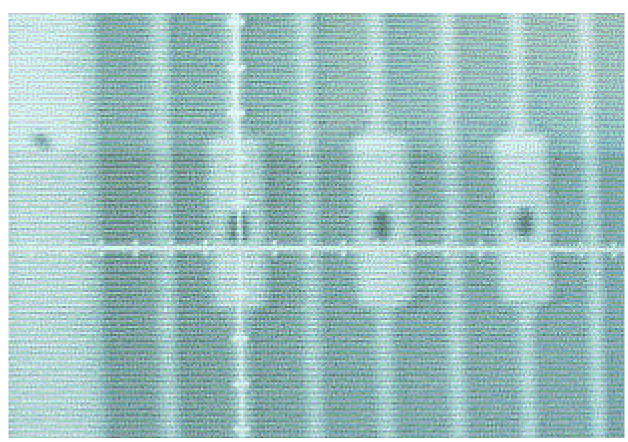
5. Set 1st bond power to 2.1 and 2nd bond power at 2.1.

6. In MAN mode and loop at 60 LHT mode bond BIAS between the two detectors at both edges of the detector. The pad is a window in line with the channel bonding pads.

10. Select SEMI-AUTO mode.

11. Set XY0 and align crosshairs to reference points as per the following images.





7. Set LOOP Ht to 60, 1st bond power to 2.1 and 2nd bond power to 2.1.

8. Commence bonding, checking on placement of bond foot.

9. When satisfied AUTO bond the full detector to detector array.

10. Record SIGMA and STD DEV for 1st and 2nd bonds.

11. Record intentionally and unintentionally missed bonds.

12. When 1st row is finished return to XY0 and align for the 2nd row bonding.

13. In MAN mode and loop at 80 LHT mode bond BIAS between the two detectors at both edges of the detector. The pad is a window in line with the channel bonding pads.

14. Set XY0 and align crosshairs to reference points as above but for the second row.

15. Set LOOP Ht to 80, 1st bond power to 2.1 and 2nd bond power to 2.1.

16. Commence bonding, checking on placement of bond foot and clearance of wire over 1st row bonding.

19. When satisfied AUTO bond the fullfanin to detector array.

20. Record SIGMA and STD DEV for 1st and 2nd bonds.

21. Record intentionally and unintentionally missed bonds.

Stage 6. Dispatch.

6.1 Record storage of module.

1. On completion of wirebonding transfer the module to the storage box and record [*dir:filename*] the storage location so that the correct module can be identified by the test team.

1. *Inspection of Hybrids and Modules.*

1.1 *Hybrid Reception.*

Correct packaging.

1.2 *Optical Inspection.*

Lynx Dynoscope Zoom with X80 maximum magnification combined with Nikon Coolpix 995 Digital Camera.

In the following "Inspect" refers to observations at X60 to X80 magnification.
"Check" refers to observations at X10 to X20 magnification.

1.2.1 *Hybrid.*

1. **Check component placement.**
2. **Check ASIC attach adhesive footprint.**
3. **Inspect front edge of hybrid.**
4. **Check ASIC peripheral wirebonds and any hybrid link bonds.**
5. **Check ASIC input wirebonds to fan-in.**

1.2.2 *Completed Module.*

This inspection is done after completion of all assembly/test and after any additional work performed before dispatch from RAL.

1. **Inspect high voltage wirebonds and glue vias.**
2. **Check ASIC wirebonds and any hybrid link bonds.**
3. **Check ASIC to fan-in wirebonds.**
4. **Inspect condition of fan-in.**
5. **Inspect fan-in to detector wirebonds.**
6. **Inspect detector to detector wirebonds.**
7. **Inspect outer guard to guard region around periphery of detectors where possible.**
8. **Check surface of detectors where possible.**
9. **Repeat from 2. for other side of the Module.**

Operating Manual for UK-B Electrical Tests

Dave Charlton
Version 0.4
24 May 2002

The main reference document for SCT electrical tests is *Electrical Tests of SCT Hybrids and Modules*, by Peter Phillips and Lars Eklund, available from http://hepwww.rl.ac.uk/atlas-sct/documents/Electrical_Tests.htm. This should be consulted for details of the test sequences, and the acceptance/defect criteria.

Hybrid and Module tests

As discussed in the UK-B site qualification document *Outline of UK-B Module QA Activities*, electrical tests of ASIC-stuffed hybrids are performed primarily in Birmingham with an acceptance test at RAL, whereas tests of modules are performed at the three university test sites, Birmingham, Cambridge and QMUL. Two types of tests are performed on both hybrids and modules – room temperature tests and long-term tests (LTTs). The long-term tests of hybrids and modules differ in two significant respects: the hybrid long-term test lasts (at least in the first part of production) for 100h and is run at elevated temperature, whereas the module long-term test is run for 24h cold.

The standard Mustard test system set-up should be used for all these tests, including a CLOAC to provide 100kHz triggers for the noise-occupancy tests if possible. It is recommended that test VME systems be left powered on during production, or at least only powered on or off with no hybrids/modules attached.

Hybrid Set-up

Hybrids are tested electrically in Birmingham on their production jigs. These are attached to water-cooled cooling blocks. Hybrid jigs must have the upper cover in place before testing commences. Support cards are attached to the patch card affixed to the hybrid jigs. The VME crate should be switched on, but the LV and HV power should be off, before connecting the support cards/cables to the hybrids.

The hybrid test set-up is identical for room temperature and long-term tests.

Module Set-up

Modules in old-style QMW module boxes can be connected directly to cooling water and N_2 if running a room temperature test. For the long-term test, N_2 should be flowed through the module box for some time before cooling down, and during the cooling procedure, and throughout the test and subsequent warm-up.

Modules in the new QMUL module box must be attached to a cooling plate before testing. N_2 should be flowed through the box as for the old-style boxes.

Test sequence names

Names have been devised to describe the standard test sequences for hybrids and modules, which are used in indexing the results for later analysis/storage/web display. The sequences defined are:

- Hybrid_Initial: the first test of a hybrid after ASIC attach (Birmingham)
- Hybrid_Longterm: hybrid long term test (Birmingham)
- Hybrid_Completion: the first test after the pitch adaptor is bonded (Birmingham)
- Hybrid_Reception: post-shipping hybrid acceptance test (RAL)
- Module_Initial: the first test after the hybrid is bonded (RAL)
- Module_Completed: completed module test (RAL)
- Module_Reception: post-shipping test (universities)
- Module_Longterm: module long term test (universities)
- Subsequent retests after any of these tests are denoted as Hybrid_Initial_Retest1, Hybrid_Initial_Retest2, Module_Longterm_Retest1 etc.

These sequence names are needed only when storing the results of the tests, and follow a UK-B convention. New sequence names may be defined in future.

Running the tests on hybrids or modules

1. Install devices to be tested as described above.

2. For a module room temperature test, start the N_2 flowing gently.

3. Turn on cooling.

   - For room temperature tests the chiller temperature should be set so as to obtain a hybrid thermistor sensed temperature within 3C of 25C.
   - For the hybrid long-term test (warm) it should be set to obtain a hybrid temperature of 37C. Care must be taken to avoid condensation on cooling pipes or blocks.
   - For the module long-term test (cold), the test is run in a cold environment (freezer or environmental chamber). Before cooling, dry the module box cooling channel. N_2 should be flowed through the module box before and during cooling at a reasonably high rate. The environment temperature is set to give a hybrid thermistor temperature of 0C. The next steps can be performed as the module is cooling, as far as step 8. Wait for the hybrid thermistors to reach 0C before starting the long-term test.

4. Check the `st_system_config.dat` defines the correct modules / hybrids.

5. In the same directory, check that the .det files exist, or that there is a default.det file, for the hybrids/modules in question. Check that .trim and .mask files do not exist, unless they are specifically required.

6. Start sctdaq.

7. Check that the hybrid power has come on. If it has not, try “LV recovery” from the main menu (can be repeated if it does not work first time, but only up to ten times).

8. Check the hybrid temperature and currents via DCSQuery.

9. If you have installed new cables, run the “Set Stream Delay” scan. This produces two integer values per hybrid/module (one per link), given as “optimum” in the printout. These values are loaded after the test, but may also be recorded for future use by changing the d0 and d1 values in the system config file.

10. For a module test, switch off the LV power to the hybrid, and wait for the hybrid thermistor temperatures to stabilise at around 20C (this may require the cooling water temperature to be raised, or for the cooling water to be temporarily stopped). Then do an I-V Curve. This will leave the HV on after the test. Switch the LV on.

11. Start the appropriate test sequence. For a characterisation test use a scope to do the hard-reset test.

12. The other tests in the sequence run on without intervention. For hybrids the typical length of a characterisation sequence from here on is about 60 minutes per hybrid, slightly longer for modules. This can vary (upwards!) quite a lot if there are noisy channels on the device, so be patient. For a six hybrid or module test, a characterisation can therefore take most of the day. The long-term test currently takes 100h(hybrids)/24h(modules), although this should be reduced with experience.

13. Keep an eye on the test while it is running, for program crashes.

14. When the test sequence has completed, shut down sctdaq via the “Exit” menu button. Confirm in the Rint window: type y (usually it gives you an error the first time: click on Exit again and type y again, and the system will shut down). Do **not** stop root using “.q” as this does **not** turn off the LV or HV power.

15. When sctdaq has exited, check that the LV and HV power lights are all off. If they are not, restart sctdaq and immediately “Exit”. This should turn the power off cleanly.

16. Switch off the cooling. For the module long-term test care must be taken to keep the module in a N_2 environment until it reaches room temperature, to avoid any danger of condensation.

17. Disconnect devices under test.

18. Test sequence results may be analysed using perl scripts. The test sequence name (see above) is needed for these. Test results and root files should be archived and backed up, respectively.

DRAFT

Precautions taken at R.A.L. against damage to ATLAS barrel modules by electrostatic discharge.

M.Gibson

General overview.

In this document I describe the electrostatic discharge (ESD) precautions that are undertaken at RAL as part of the production of ATLAS Barrel modules.

27 July 2001

Basic ethos for the protection against possible damage to ATLAS barrel modules by electrostatic discharge.

The aim is to produce a safe workable environment that effectively removes the possibility of damage to the electrical components of the ATLAS barrel module by ESD. It is assumed that all sites supplying components to RAL or that are involved in post fabrication work are taking similar precautions. We have taken great care to ensure that items that are not themselves static-sensitive but which may be used in the construction process have suitable intimate and proximity packaging and so can be allowed into the RAL construction area.

As far as is reasonably practicable all electrostatic discharge sensitive devices (ESDs) will be stored and handled in accordance with British Standard **BS IEC 61340-5-1:1998** and **PD IEC 61340-5-2:1999**.

Temperature and relative humidity are logged continually to monitor the suitability of environmental conditions.

General technical information about the RAL clean-room.

1) The room is equipped with a static dissipitive floor.
   The external clothing worn by the operators is anti-static. An approved supplier cleans lab coats once a week.
2) The operators either wears a wrist strap connected to a single line earth monitor box with audible alarm or he/she is connected to the floor via their clean room anti-static shoes.
3) All the stations are equipped with earth bonding points.
4) All the free use plastic bags are ether static dissipative or anti-static. All custom containers have ESD intimate and proximity packaging.
5) All the plastic A4 folders are static dissipative.
6) All the table surfaces are ether manufactured in static dissipative materials or are covered with static dissipative mats. Both are connected to earth via high resistance paths. All surfaces being regularly cleaned with an appropriate ESD cleaner.
7) The RAL module storage boxes are constructed from aluminium. Commercially available plastic containers fabricated from anti-static materials or commercially available custom anti-static boxes.
8) The hybrid boxes that are used for transport between Birmingham and RAL provide both intimate and proximity packaging are fabricated from anti-static materials.
9) At the time of writing we have no information about either the baseboard transport boxes and internal packaging or the module test boxes.

Hardware

10) *The alignment system.*
    A) The small vacuum chucks are connected directly to ground.
    B) The front of the granite table is fitted with a static dissipative mat, which is connected to ground via a high resistance lead.
    C) The trolleys on which the module assembly hardware is mounted are of galvanised metal construction with no paint and connected to the floor via trailing links.
    D) Each trolley has all exposed surfaces covered in static dissipative mats which are in turn connected to the trolley and hence to the floor.
    E) The pickup jigs, which are of metal construction, are stored on the top surface of the trolleys.

11) *The Adhesive Dispensing System*.
    A) The adhesive applicator being of metal construction is all connected to ground.

12) *The sub-assembly probe station*.
    A) The test station is connected to ground and the entire table surface is covered with static dissipative matting.
    B) When testing a 4 detector sub-assembly the module and its surrounding frame which is 100% metallic are both at negative potential defined by the source measure unit, which is not a floating supply.

13) *Hybrid mounting equipment*.

A) The hybrid mounting station is connected to ground via a high resistance to form a static dissipative connection.

14) *The metrology hardware*.

A) The metrology frame is placed on a 3 point carrier which is electrically connected to the SmartScope via a high resistance cable to an earth bonding point.

B) The metal outer frame of the SmartScope is at ground potential.

15) *Wire bonding*.

A) Both the operator and all the relevant frames are connected to ground via high impedance paths.

16) *Electrical testing of the module*.

A) This electrical testing area is still under construction.

17) Storage.

A) Storage containers used for electrostatic discharge sensitive devices such as components or completed modules are mounted in ESD safe boxes may be ether of the following.

1. Commercially available freezers with metal inner surfaces bonded to ground and internal support frames with electrically conducting surfaces.
2. Commercially available plastic storage boxes with metal shelves that are bonded to ground via high resistive leads.

Both these options are supplied with Nitrogen. Because the freezers tops are at bench height they have additional static dissipative matting fitted
to their lids.

B) Standard metal cupboards (which are floor mounted) are used for the storage of non-critical items, such as gloves, adhesive mixing pots, syringes for adhesive dispensing etc.

Chantal FOWLER
16/05/2002

RAL Clean room in R12

This document describes the clean room and associated infrastructure that is used for the manufacturing and testing of ATLAS barrel modules.

The Person responsible of the clean room is F.S. (Ozy) Morris tel 5811/6451.

The clean rooms are a purpose built facility providing a safe working environment for the production and initial evaluation of ATLAS barrel modules. Topics described in this document are: access, air-conditioning, mains supply, nitrogen system, vacuum, compressed air, antistatic precautions, and safety.

- **Access of the clean room** is limited to people with a validated door swipe-card or visitors escorted with an authorised personnel. In the changing room there is a panel indicating and identifying the presence of persons in the facility.

- **The air-conditioning system** provides a low number of particles in the atmosphere, a controlled temperature of 22 ºC and a relative humidity of 40 %.

  The emergency contacts in working hours for problems with the air-conditioning system contact are: Andy Inchley 6869 and Mrs Holding 5613.

  1. Temperature and relative humidity are logged continually.
  2. A class 10000 in Federal standard 209D (or ISO 7 in ISO 14644-1) is expected at all times in all rooms. A particle counting survey is carried out bimonthly.

- **The main electrical supply to the clean room are:**

  1. Some 13A sockets are fitted with Residual Current Devices sockets (RCDs), with manual reset in the case of catastrophic failure of the supply.
  2. Wire bonding machines are supplied via uninterruptible power supplies.
  3. The detector alignment station is supplied via surge arresters.

- **Nitrogen supply:**

  Nitrogen is supplied to each of the rooms by the natural boil off from a single 240 l liquid nitrogen tank mounted externally to the building. Delivery is by external supplier and occurs every week or when necessary.

- **Vacuum supply:**

  The vacuum system currently comprises a single Edwards XDS10 dry vacuum scroll pump serving three areas of the clean-room complex:

  - Wire bounding room
  - Module assembly room
  - The future barrel assembly room.

  The first two areas have their own reservoir (100 litres) and emergency isolation circuit. The third is connected directly to the pump. The total system volume is about 300 litres.

  Each down-pipe is terminated with an isolation valve and a spring-loaded connector.

  In case of vacuum problems please contact Paul Booker tel 5236.

- **<u>Compressed air:</u>**

This is a laboratory wide system, which is supplied to three rooms of the complex: module assembly room, wire bounding room, future barrel assembly room.

- **<u>The basic precautions for the protection against possible damage to ATLAS barrel modules by electrostatic discharge are:</u>**
    1. The room is equipped with a static dissipative floor.
    2. The regular clean room users <u>must wear</u> the supplied blue ESD coats and ESD shoes at all times. These are available in the changing room. The coats are cleaned once a week.
    3. Visitors must <u>also</u> wear the supplied ESD coats and disposable plastic overshoes with an ESD heel grounder as described on the picture in the changing room.
    4. An ESD foot testing station and wrist strap testing station are supplied to allow users to check his/her ESD property.
    5. All the stations are equipped with earth bonding points.
    6. All the folders containing documents are ESD compatible.
    7. Special clean room paper (blue) and ESD pens must be used for writing notes.
    8. All the plastics bags used for proximity packaging are ESD.
    9. All table surfaces are either constructed from ESD materials or covered with ESD mats connected to ground.
    10. Storage containers used for electrostatic sensitive devices such as electrical components or modules are, where possible, ESD compatible.
    11. Custom bulk storage is provided in ether ESD compatible freezers or plastic boxes. Both are supplied with Nitrogen.

- **<u>Others precautions:</u>**

    Powder free nitrile disposable gloves, face masks and safety goggles are provided as appropriate.

- **<u>Safety</u>**:
    1. Because there is no water supply to this complex, emergency eyewash bottles are provided and stored on the solvent cupboard.
    2. A number of first aid boxes are provided.
    3. COSHH and Risk Assessment documents are filed together and stored on the top of the solvent cupboard.

<u>ESD: Electro static dissipative</u>

Operating Manual for Electrical Tests in Birmingham

Version 0.3
Dave Charlton – 1 May 2002

Currently we have two electrical test systems in Birmingham. Both live in the hybrid/module testing room **PB8G**. There are two controlling PCs, **epat2** and **epat3**, and the two VME crates to which they are connected are placed in the same rack.

System epat3 (closest to the door) is connected to the upper VME crate in the rack, and is primarily used for module testing, and includes an SCTHV unit. System epat2 (in the corner opposite the door) is the main hybrid test system. The two systems run consistent versions of the electrical test software (root and sctdaq). Each can run up to six hybrids at once. They do *not* share filesystems.

Each hybrid is installed into the electrical test system on its production jig, and attached to a cooling block.

Cooling block configuration

Cooling blocks (currently we have two) are installed on the table next to the rack, and may be used individually or in chains: note that the cooling blocks *only* have in and out cooling water connections. The in and out connections are interchangeable.

The main cooling device for hybrid production testing is the **chiller** placed just outside the door of the test room. The chiller cooling water temperature may be set by the rotary dial on the chiller front panel. Do not run the chiller below about 15C set temperature to avoid condensation problems. If at any time condensation is observed on cooling blocks or hybrid jigs, switch off immediately and raise the chiller temperature.

Alternative chilling is provided by the "**gurgley tom**" home-made chiller. Only use the "gurgley tom" if the main chiller is not available (either because it is already in use, or is being maintained/repaired). The gurgley tom does not have a settable temperature, and so may only be used for room temperature tests (*i.e.* not the long-term test). Since it blows humid air out of the top, it is best not to run it for extended periods. It also must be topped up with water periodically: check the side beaker.

The normal cooling block configuration is that the two blocks are connected in a chain to the chiller.

In any case where the configuration (chaining) of the cooling blocks is changed, you should run the cooling first without hybrid(s) installed to check that there are no water leaks.

Hybrid installation

Hybrid production jigs are attached to the cooling blocks by up to six allen-keyed screws. The use of three screws at the corners of the hybrids is recommended, more if you wish. Hybrid jigs must have the upper cover in place before testing commences.

Next attach the support cards to the hybrids. The hybrid jig-support card connection is robust enough to allow the support cards to sit unsupported. Two cables run from each support card to the VME crate – one is connected to the appropriate SCTLV channel, the other to the "patch panel card" connectors. If the cables to the VME crate are not already attached to the support card, attach them to the support card before plugging the support card into the hybrid jig connector. **Make sure the VME crate is OFF before connecting the support card to the hybrid**.

Running a characterisation or long-term test on hybrids

1. Install hybrids as described above.

2. Disconnect LV cable(s) (one per hybrid) at the SCTLV end, but leave other cables connected.

3. Check PC is **not** running root/sctdaq

4. Turn on VME crate.

5. Turn on cooling. For room temperature tests the chiller temperature should be set at 16C. For the hybrid long-term test it should be set at 30C. For room temperature tests the gurgley tom may be used.

6. Connect LV cable to VME crate. This **must** be done before the sctdaq software is started, as the LV channel must be off (double-check that the LV channel-on light is not lit before connecting cable).

The "sctvar" directory lives on different disks on the two pc's. It is d:\sctvar on epat2, c:\sctvar on epat3. Use the appropriate one in the following instructions.

7. Check \sctvar\config\st_system_config.dat defines the correct hybrids.

8. In the same directory, check that the .det files exist for the hybrids in question. Check that .trim and .mask files do not, unless they are specifically wanted (special purpose).

9. *(Only for epat3)* Run resman (the VME-interface Resource Manager, available on the desktop). You need to click on "Close" when resman has run.

10. Start sctdaq: Type your initials at the prompt, and "01" when asked to verify (or 00 if you typed them incorrectly!). Click "Close" after the Resource Manager has run.

11. Sctdaq will now start. Two more windows appear, to make three in total:

    - Rint, a text message/command window. You mainly use this for answering questions (you already typed your initials in this window).
    - Burst Display window (showing event hit-pattern histograms). The window title also contains the current run number. Note it!

- "Root interface to Win32" menu. The standard tests are all run using the menu system. This first menu is referred to as the "main menu".

12. Check that the hybrid power (one SCTLV light for each hybrid, just above the connector) has come on. If it has not, try "LV recovery" from the main menu (can be repeated if it does not work first time, but only up to ten times).

13. Check the hybrid temperature and currents. Run "DCSQuery" on the main menu. The printout (in the Rint window) has four blocks: the top block is a table showing various voltages SET and MONitored, and corresponding currents SET (meaning the limit set on them) and MONitored. The second block shows some temperature/humidity monitoring, the third information about trips and the fourth can be ignored.

    The main items to check are vcc and vdd, which should be 3.5 and 4 V respectively; icc and idd, which should be around 950 and 500 mA, respectively, and t1 and t2 which should be 22-23C for a room temperature test (35-37C for a long-term test). Don't worry if icc is slightly above 1A. If the temperature or currents (or voltages) are anomalous, you have a problem.

    (Note that all temperature monitoring is now done through the SCTLV(3). This may change when the third test system is in place)

14. The menu you will need for the production tests is brought up by clicking on "ABCD tests" about half-way down the startup menu. This menu is referred to below as the "ABCD tests menu".

15. If you have installed new cables, you should run the "Set Stream Delay" scan by clicking on the ABCD test menu button. This corrects for small differences in cable lengths. It produces two integer values per hybrid (one per link), given as "optimum" in the printout. These values are loaded after the test, but can also be recorded for future use (if the cables will not be changed again immediately!) by changing the d0 and d1 values in the system config file.

16. Before starting the sequence of tests, **make a note** of what the run number and "first scan" of the sequence will be: the run number is given in the title of the Burst Display window. The first scan is 1 if you just started sctdaq and did not run the stream delay scan. If you did run the stream delay scan, the first scan of the characterisation sequence will be 2. (If you have run other tests the scan number will be one higher than the last scan so far).

17. Now start the appropriate test from the ABCD tests menu. For a characterisation test, clicking on "Characterisation Sequence". In this case the first test is the "hard reset" test: this requires you to do some work, so don't leave! For the long-term test, use the "Hybrid LTT" menu button – you will not get a hard reset test at the start in this case.

18. Hard reset test: this is an interactive test that requires you use the scope. Use the High quality Agilent scope in the testing room. This is normally set up with a LEMO cable on channel 2: this needs to be plugged into the appropriate

"monitor" socket of the Mustard card in the VME crate. The hard reset test software advises you which socket to use (MA, MB or MC). Note that the signals out of these sockets are multiplexed four ways. The multiplex setting can be read off the two yellow LEDs on the Mustard front panel marked "M" and "L" (most and least significant bits). Follow the instructions and check that the signals appear and disappear on all relevant channels as instructed. The answer to all the questions should be "01" (*i.e.* 1=OK). Make sure to check, however! You should be asked six times per hybrid under test.

19. After the hard reset tests, switch off the scope.

20. The other tests in the sequence run on without intervention. For hybrids the typical length of a characterisation sequence from here on is about 60 minutes per hybrid. This can vary (upwards!) quite a lot if there are noisy channels on the hybrid, so be patient. For a six hybrid test, a characterisation can therefore take most of the day. The long-term test currently takes 100h, although this should be reduced with experience.

21. Keep an eye on the test while it is running. It may stop with an error, or root may crash. If that happens, you need to start again, by stopping sctdaq and restarting ideally (if root crashes be aware that the LV channels are often left on). It is particularly important to keep a watch on the long-term test.

The characterisation sequence is nicely documented in Peter and Lars' document "Electrical Tests of SCT Hybrids and Modules". Read it, if you need to keep occupied while waiting for the tests to run.

22. When the test sequence has completed, you may shut down sctdaq by using the "Exit" button on the main sctdaq menu. You are asked to confirm in the Rint window: type y (usually it gives you an error the first time: click on Exit again and type y again, and the system will shut down). Do **not** stop root using ".q" as this does **not** turn off the hybrid LV power.

23. When sctdaq has exited, check that the LV power lights are all off. If they are not, restart sctdaq and immediately "Exit". This should turn the power off cleanly.

24. Only when the power is off on the SCTLVs (and SCTHVs in the event you are actually testing a module) should you switch off the VME.

25. Now switch off the cooling.

Processing and analysis of test results

Now you may analyse the results of the test sequence. There are some perl scripts installed on the test systems, in directory c: \PerlScripts, to help with this.

1. Get a command prompt by Start->Programs->Command Prompt.

2. In the command prompt window, type “cd perlscripts”.

3. Work out which “named test sequence” you have been running. The name of the test sequence follows according to a convention defined in the UK-B community:

   - for the first test of a hybrid after ASIC attach this is “Hybrid_Initial”
   - for the hybrid long term test it is “Hybrid_Longterm”
   - for the first test after the pitch adaptor is bonded it is “Hybrid_Completion”.
   - Subsequent retests after any of these tests are denoted as Hybrid_Initial_Retest1, Hybrid_Initial_Retest2, etc.

   Make sure you do not use a test sequence name that has already been used for that hybrid, as you may overwrite the previous results. Do this by looking for directories d:\sctvar_archive\<hybrid>\<test> (c: on epat3), where <hybrid> is the hybrid serial number as given in the rightmost column of the st_system_config file, and <test> is a test sequence name, as above. If the <test> directory exists for the test you think you are running, **do not re-use** that name, instead use a _RetestN name, incrementing N by one if such tests have already been done.

4. Now run the command

   ```
   perl StoreTestResults.pl <hybrid> <test> <run> <scan>
   ```

   where you need to replace <hybrid> by the serial number of your hybrid (as indicated in the system config file), <test> by the name of the test sequence, and <run> and <scan> by the run number and start scan number you noted above.

5. Check the \sctvar_archive\<hybrid>\<test> directory after running the script: you should see the directory is created and that files have been copied into it.

6. If StoreTestResults seems to have worked, analyse the results by running the second perl script

   ```
   perl MakeWebIndex.pl <hybrid> <test>
   ```

   This makes an `index.html` file in the \sctvar_archive\<hybrid>\<test> directory. Double-click on this file in NT Explorer to look at it. You will see two tables, one of DCS quantities and one of test results, with links to the postscript files for tests which make them, and an overall result file for all the tests at the bottom.

7. Check the DCS table that the temperatures were within the specified range: from 22-28C for the room temperature tests, 35-38C for the long-term test. Check that the other DCS ranges look reasonable too (Vdd goes down to 3.5V in the FullBypassTest, so only worry if the minimum is not 3.5V).

8. Next check that all tests have status “PASS”. Also check for defects: a perfect hybrid will have no defects on all tests except the TrimRangeScan test – this

often produces a small number (up to about 20) of unimportant defects. Check in the results file (at the bottom of the page) if there are other defects. Look also at the "Comments" column in the web page table: strobe delays should be in a narrow band; gains are usually between 50 and 65 mV/fC; noises from "ThreePointGain" and "ResponseCurve" should be between about 550 and 650 ENC (absolutely not above 750 ENC); "Estimated ENC" from the NO (NoiseOccupancy) test should be in the same range, and the noise occupancies at 1fC should all be zero for hybrids; timewalk values should be at least 5ns and no more than 16 ns. You should also look at all the plots. Note that the long-term test just runs a long sequence of confirmation tests, so there may be no occurrences of the tests which are only done in a characterisation sequence.

Running a module characterisation test

Currently modules tested have been in the old-style QMW box. For a room temperature test, this must be connected to cooling water via the two cooling channel connectors. N_2 should also be flowed into the gas channel on the box.

Steps 2-14 as listed above for hybrid tests are then performed. Once sctdaq is running, turn off the hybrid power (main menu, item "LV off"). Then run an I-V curve test (ABCD tests menu, option 3 if test to be run to 500V). When this is complete, the HV will be left on at 200V. Turn on the LV power (main menu, LV on) and proceed with characterisation test exactly as above for a hybrid, steps 15-21.

The module characterisation test results can be analysed exactly as for the hybrid. The I-V test results will appear on the web page.

Running a long-term module test

The exact details of this test procedure are still in development, since no qualification modules have yet been tested cold.

The module long-term test proceeds as above, except that the module is placed in the environmental chamber for testing, so has no water flow connected. Before installing the module, carefully blow any water out of the cooling channel using N_2. Make sure the chamber is well sealed to avoid any condensation. The black plastic screen should be attached across the chamber window, and taped all around with black tape to stop any light leaks into the chamber.

When the modules are installed and connected up in the chamber, turn on the chamber at 23C. The N_2 purge light should come on: follow the instructions taped to the chamber if not. Check that N_2 is flowing. Flow 800 l/h for one hour prior to commencing cooling.

After 1h at 800l/n, reduce the N_2 flow to 200 l/h. Ramp the environmental chamber temperature down in approximately 10C steps, every half-hour, to –16.5C. After the first temperature ramp-down (to around 13C), turn on the VME crate (disconnecting the LV/HV cable before doing so), and then turn on the hybrid power (LV). Also turn on the N_2 mini-pump at this time. When the chamber temperature reaches –16.5C, check the hybrid thermistors via DCS query. When they approach OC (less than 2C) turn on the module HV and start the long-term test. Do not run an I-V curve cold, as you will learn nothing and turning off the LV will cool the module quickly down to –15C or so, from where it can be difficult to switch back on.

The module LTT runs for 24h. Check repeatedly during the test that the N_2 continues to flow (keep an eye on the pressure gauge close to the door of the basement lab area, and change the bottle if the gas will run out *eg* overnight). At the end of the test, maintain the N_2 flow during warm-up. Turn off the module HV before warm-up, but keep the LV on to ensure the module is warmer than its surroundings, just in case any condensation does form. Warm up in 10C steps every half hour, checking before each ramp of the chamber that the hybrid thermistor is already warmer than the new target temperature.

When the chamber temperature reaches 23C the hybrid can be turned off. Wait until the (unpowered) hybrid temperature reaches 18C before turning off the gas and chamber, and opening up.

UK-B Module Production: "Batch Traveller" Procedure

24 May 2002

Hybrid ASIC-stuffing, testing and shipping

A web-based hybrid check sheet [1] is used in Birmingham to keep track of assembly and QA information. The sheets are freely available to other sites. The completed sheet is printed out and sent along with each ASIC-stuffed hybrid to RAL. In addition the module Excel ASIC_HYBRID worksheet is created and made available on the web. Electrical test information is made available also on the web [1].

Detectors

Detectors are supplied and tracked by Cambridge, with a fully computerised system (see the UK-B site qualification document *Procedure for Component Accountability and Yield Statistics: UK-B Module Assembly* for more details).

Baseboards

Baseboards are delivered as simple components with an ATLAS serial number.

Module Assembly

A paper-based module build sheet [2] is used internally at RAL to keep track of assembly information. The module build sheet is structured around a baseboard to which detectors and hybrid are added.

Metrology and electrical test information are computerised for internal processing.

Information about every assembled module is made available [3] via the module Excel worksheets from Nobu Unno. These can be viewed at the module QA sites and at Oxford, where the modules will be consumed.

References

[1] See http://www.ep.ph.bham.ac.uk/exp/ATLAS/sct/hybrids/assembly/

[2] Module build sheet: see *Instructions for the Construction of an ATLAS Barrel Module*, http://hepwww.rl.ac.uk/Atlas-sct/ModuleProduction/Documents/Qualification/ModuleCOnstruction.doc

[3] Web location of assembled module DB worksheets: implementation is currently in progress

Procedure for Component Accountability and Yield Statistics: UK-B Module Assembly

Version 0.5
27 May 2002

All UK-B module assembly data are recorded electronically either immediately on construction or soon afterwards. Construction and QA data will be uploaded to a central storage repository at RAL. All components are traceable via ATLAS serial numbers or ASIC-numbers (site-lot-wafer-position format). Further consideration is given below to the procedure for detectors, ASICs and passive-stuffed hybrids.

Detectors

Tracking of detectors is managed entirely by the SCT database. After fabrication and quality checks, the manufacturer registers the detectors in the database, together with all test data, and registers their shipment to Cambridge. Quality control test data of the detectors at Cambridge are uploaded directly to the SCT database. Compatibility with the database is rigorously enforced by interaction between the test software and the database. Comprehensive reports of detector shipments, and all detector test data from the manufacturer and from ATLAS institutes, are available via a java graphical user interface to the database.

A second database, located at Cambridge and accessed via a web interface, supplies detector-specific information relevant to module production at RAL, such as the exact location of all detectors while in storage, and the management of detectors to baseboards. The allocation of detectors to baseboards/modules, and the detector characteristics, are available at

http://www.hep.phy.cam.ac.uk/si-bin/moduledetectors.pl

ASICs

An overview of all wafers tested at RAL, and where die have been distributed, can be found at

http://www.te.rl.ac.uk/ess/atlas_abcd3t/

This URL contains an Excel spreadsheet for each lot probed.

When ASICs are shipped to Birmingham from the testing facility at RAL, a data file is sent alongside (by email), one for each gel-pak. In addition the chip testing information will be made available on the web at RAL for the ASICs sent to Birmingham. The gel-pak data file details the ASICs in the appropriate gel-pak. A local database of ASICs in Birmingham is used to keep track of the usage of all ASICs on hybrids or otherwise. This database will be used to keep statistics of successful usage rates etc, as well as keeping track of all UK-B-allocated ASICs.

Passive-Stuffed Hybrids

A database in Birmingham records the serial numbers of all hybrids received in Birmingham from KEK, and the state of usage of them. An example summary sheet produced from this database is available at

http://www.ep.ph.bham.ac.uk/exp/ATLAS/sct/hybrids/assembly/