USA Atlas SCT Barrel Module Assembly

Status Report Dec 2002

ATLAS SCT Week Barrel Modules Dec 10, 2002

Overview (1)

- USA Cluster is to deliver 670 barrel modules.
 - LBL task: assemble, bond, and test
 - UCSC task: bond and test
- USA Cluster works closely with RAL in mechanics. Common fixtures, procedures, software. Weekly scheduled phone meetings.
- Qualification: May 02-July 02, complete
- Report issued August 4, 2002 "proceed to production but continue to monitor various aspects", 4 production modules built.

Overview (2)

- Second request for studies issued 10/02
 - Study midyf, leakage, USA glue pattern
 - Construct 5 glass modules, 3 silicon modules with reject sensors, metrology, monitor leakage current
- All requested studies complete, report issued 11/20/02
- Met with convenor(s) 11/25/02
 - Resume production, monitor and document results, OK to use USA glue pattern
- 2 production modules built since 11/25/02

Status (1)

- Situation is mixed
 - Many technical aspects are working well
 - Hybrid assembly and test is OK
 - Module electrical and mechanical performance reasonable
 - Concerns expressed in reports have been addressed
 - But ramp has been slow in an effort to check everything
 - Component deliveries
 - Full baseboard deliveries are now in place ~100 on hand
 - Hybrid pitch adapters redone, still not receiving production quantities. Hybrid assembly capacity not saturated.
 - Chips some with damage, little inventory on hand
 - Have 3 of 7 assembly fixtures in hand.

Status (2)

Technical concerns

- Very tight spec on front to back alignment (5 um): Now improved due to additional alignment checks (but time consuming)
- Leakage current increase after bonding: A series of 4 production modules bonded all show no increase now but some modules built with dummy silicon have high current after bonding.
- Size of glue dots & thickness of glue line: Series of 8 test modules in spec with improved shim criteria during build.
- USA proposed new glue pattern to improve bond reliability: All 8 test & 6 series modules show no glue leakage problems.

Alignment

- Tightest specs are on midyf and angles (stereo)
 - These were given highest weight in error budget calculations leading to spec.
- Angles are rarely outside spec.
- Midyf always inside 9 um, usually inside 5 um.
- Other parameters are OK
- To improve midyf apply UK final alignment check procedure
 - After detectors are placed in fixture we resurvey them with respect to new fiducials on the assembly fixture
 - Adjust set screws on linear bearing to compensate for shifts
 - 8 modules done -> usually need to correct, up to 10 microns
 - Under ideal conditions spend ~20 minutes per side, but often spend 45 minutes.

Front/Back Alignment





Last 8 modules built with new alignment procedure. Spec is 5 microns. One outlier was a calibration run on a different fixture

Note: alignment always within 9 microns

Alignment

- Use of UK alignment step definitely helps keep midyf inside 5 microns
- It is not a sure thing, drifts are seen.
- It is time consuming ~20 min/per side good case.
- Uses same SmartScope as used for metrology and hybrid mounting.
- In production have to process 6 sides per day.
 - 6 x 20 min = 2 hours THISIS
 EXCESSIVE AND WILL SLOW
 PRODUCTION DOWN

Comparison of parameters

- All 5 USA glass modules have been sent to other sites for comparison
- Data recv'd on 4
- Excellent agreement
- Avg diff, stdev
 - Midyf:1.4 um, 1.1 um
 - Midxf:1.9 um,0.9 um
 - Stereo:0.016 mr,0.009 mr
 - (based on 4 recv'd + 1 qual)

D22 Uppsala Su	irvey				
Parameter	Upps Deviatio	USA Deviatio	Tolerance	diff	diff/tol %
mhx [um]	1.854	1.4	30.000	0.454	1.5
mhy [um]	0.974	-0.7	30.000	1.674	5.6
msx [um]	23.449	18.5	100.000	4.949	4.9
msy [um]	(5.855)	2.6	30.000	8.455	28.2
sepf [um]	(7.611)	-6.4	10.000	1.211	12.1
sepb [um]	(0.027)	0.8	10.000	0.827	8.3
midxf [um]	1.265	-0.1	10.000	1.365	13.6
midyf [um]	6.932	6.7	5.000	0.232	4.6
a1 [mrad]	0.084	0.091	0.130	0.007	5.1
a2 [mrad]	0.141	0.105	0.130	0.036	27.4
a3 [mrad]	(0.014)	-0.023	0.130	0.009	6.9
a4 [mrad]	(0.106)	-0.074	0.130	0.032	24.5
stereo [mrad]	0.013	0.015	0.130	0.002	1.3

Leakage Currents

- Table shows currents in uA, before and after bonding on a series of production modules and dummy modules
- Dummy modules made with HPK rejects
- I mproved cleanliness and handling procedures used.
- I mproved bonding reliability with new glue pattern.

	I(T)	at T	at 20		
P3 after bonding	0.719	24	0.484		
P3 sum of crystals	0.48	24	0.323		
P4 after bonding	0.464	20	0.464		
P4 sum of crystals	0.48	20	0.480		
P5 after bonding	0.417	20	0.417		
P5 sum of crystals	0.558	20	0.558		
D26 after bonding	32	20	32.000		
D26 before bonding	0.415	20	0.415		
D27 after bonding	2.6	20	2.600		
D27 before bonding	0.39	20	0.390		
D28 after bonding	0.8	20	0.800		
D28 before bonding	0.445	20	0.445		
P6 after bonding	2.95	20	2.950		
P6 before bonding	0.415	20	0.415		
P7 after bonds (det only	0.78	20	0.780		
P7 before bonding	0.41	20	0.410		

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Leakage Currents (2)

- Total currents after bond
- P5 "good" unchanged
- D27 shows increase from 400 na (pre) to 2.6 uA
- No evidence for breakdown, would appear as noisy strips
- Curve is just "fatter", also leakage decreases with time at 500V in dry atmosphere
- Interaction of humidity with oxide surface effected by bonding, soft damage
- Should this be a real concern?



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Control of Glue Dots

- Dots now match 2mm spec
- No evidence of leakage with USA glue pattern
- Glue thickness within spec (~80 um per side)
- Demonstrated on 5 glass modules built in sequence
- These modules also show proper glue thickness and asymmetry



USA Summary

module	type	midyf	midxf	stereo	dots f/b	glue	assym	l sum	I bonded	comments
D21	glass	1.9	2.4	-0.058	3/3.4	135	16	Х	Х	
P2	series	3.3	-4.7	-0.057	Х	269	52	430	316	big error in shim calculation
P3	series	-3	-1.5	-0.12	Х	164	11	323	484	
P4	series	-5.9	-0.5	-0.136	Х	165	6	480	464	
P5	series	-0.6	-1.7	-0.173	Х	147	-9	558	417	
D22	glass	6.7	-0.1	0.015	2.6/2	142	38	Х	Х	
D23	glass	Х	Х	Х	2.3/2.3	177	31	Х	Х	used to calibrate A1 fixture
D24	glass	-2.8	-2.8	-0.016	2.5/2.5	124	4	Х	Х	
D25	glass	-2.8	-10.4	-0.04	2.2/2.2	116	13	Х	Х	
D26	HPK dum	-3.8	-0.3	0.028	Х	147	-9	415	32000	
D27	HPK dum	-2.5	0.9	0.012	Х	152	32	390	2700	
D28	HPK dum	-3.9	3	0.022	Х	159	-4	445	800	
D29	glass	8.7	-0.9	0.081	Х	160	6	Х	Х	used to calibrate A0 fixture
P6	series	-5.7	-1.9	0.03	Х	199	27	415	2900	
P7	series	-4.6	1.2	0.021	Х	176	20	410	780	

Components-hybrids

- Excess glue under pitch adapter interferes with chip placement tools.
- Appeared only in production batch
- So far KEK has pre-screened parts for the USA & supplied most parts with OK glue leakage -> <u>hope</u> <u>this will continue!</u>
- Alternative is for USA to develop new mounting process – time & cost issue
- Metallization on pitch adapter redone to improve bonding results on these parts are good so far.

Subjective Assessment

- Focus of SCT is still very much on technical details.
- Need to elevate schedule issues.
- Some technical specs are probably too aggressive. These can be met but at the expense of efficiency and production rate.
- Time to reconsider specs and now place schedule as primary driver.

USA Production

- Production Plan : Sep/02 Feb/04
 - Sep/02 Feb/03: ~8% 50 in ~110 days (~4/week max)
 - Mar/03 Jun /03: ~30% 200 in 75 days (~2.5/day)
 - Jul/03 Feb/04: ~62% 420 in 140 days (~3/day)
- Production relies on:
 - Multiple fixture sets in progress
 - Component deliveries probably OK....
 - Simple, robust assembly and measurement process ???!!!

Production Discussion USA view

- To meet the SCT schedule production has to complete in early 2004
- There is no way to do this unless we achieve 3 modules per day or create additional assembly sites
- No site has yet demonstrated this rate
- Funding for module assembly only covers ~the next year

What effects the rate?

- Fixtures, machines, manpower
 - In the USA we will have sufficient fixtures
 - Assumptions were made about the time used by machines and people to complete the various tasks early in the project
 - After 6+months of work on qualification and early production it appears that assumptions were too optimistic if we are to meet all specs
 - We are locked into our staffing and major equipment allocations

How to get there

- As we see it the only hope is to simplify the process
- Are any of the specs too aggressive?
- Issues of concern
 - Leakage on bonded module = sum of 4
 - Midyf, stereo
 - Hybrid positions

Component Delivery Scenario

WBS 1.1.2 SCT Modules													
Line Of Balance Data													
All numbers are CUM complete numbers as c							f 1st of mon	th					
Version of Sept 2002 - Assuming best compon							ent deliverv s	cenario					
	FE	Silicon	Thermal	Kapton	Assembled	Tested	Assembled	Tested	Shipped	per month	per month	per month	per month
	ICs	Detectors	B-Boards	Hybrids	Hybrids	Hybrids	Modules	Modules	Modules	B-Boards	Modules	Hybrids	Detectors
Jun-02	0	0											
Jul-02	0	0	0		0	0				0	0		0
Aug-02	63	0	0	5	0	0	0			0	0	20	13
Sep-02	315	13	4	25	5	5	0	0		4	3	60	35
Oct-02	1071	49	44	85	25	24	3	0	0	40	8	60	71
Nov-02	1827	120	104	145	85	83	11	3	0	60	16	60	142
Dec-02	2583	262	164	205	145	141	27	11	3	60	32	60	266
Jan-03	3340	527	224	265	205	199	59	26	11	60	60	60	266
Feb-03	4096	793	284	325	265	258	119	58	26	60	60	60	266
Mar-03	4852	1059	344	385	325	316	179	117	57	60	60	60	266
Apr-03	5608	1325	404	445	385	374	239	175	116	60	60	60	266
May-03	6364	1591	464	505	445	433	299	234	174	60	60	60	266
Jun-03	7120	1857	524	565	505	491	359	293	232	60	60	60	266
Jul-03	7877	2123	584	625	565	549	419	352	290	60	60	60	266
Aug-03		2389	644	685	625	608	479	411	349	60	60	60	266
Sep-03		2655	694	745	685	666	539	469	407	50	60		105
Oct-03		2760			745	724	599	528	465		60		
Nov-03							659	587	523		31		
Dec-03							690	646	582				
Jan-04								676	640	694	690	740	2760
Feb-04									670				

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Leakage Current Discussion

- USA sees a range of behavior
 - Some modules have same current after bond
 - Some have larger but still inside 4x spec
 - Some have larger than spec but meets spec after time on HV, dry air
 - Some exceed spec by a few uA
 - Never see breakdown, just fatter IV
 - Never see new noisy channels
 - No strong correlation with bonding
- Cannot expect any major change in bonding equipment
- Does this matter? How much time and effort do we spend trying to control this?

Leakage currents

- Recall spec: current of bonded module can be 4 x sum of sensors
- This allows 1.6 uA at 20 C
- This implies we are willing to accept soft bonding damage/humidity effect at some (arbitrary!!) level

In plane parameters

- Midyf is measured wrt precision frame fiducials
- Also calculate midyf from data wrt to hole& slot
- Good correlation seen
- This is basis for deriving offset constants used in alignment for each set of fixtures (DIMS files)
- But these quantities drift over time!
- Process of constant tuning



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In plane parameters

- To keep inside tight spec for midyf we have to apply UK alignment checks (adjust bearings) and continually monitor and adjust DIMS offsets in software
- Every time we change DIMS we have to recalibrate the UK reference fiducial distances
- This is all very time consuming

Why the spec?

- Spec on midyf and stereo were set assuming we could then ignore them with no effect on performance of module in phi
- Other software corrections will exist such as module pos'n on barrel
- Why not loosen midyf and correct offline?
- Cross checks presented show midyf can be accurately measured.
- Spec on midyf assumed equal pain to set stereo. Seems stereo is easier to meet.
- If relax spec on stereo then midyf -> 7 um

Hybrid Position

- Attach top side first. Errors here propogate to backside.
- In practice top has to be better than spec if back is to be inside spec.
- If less concerned about back hybrid position can speed up process.
- What drives spec on back hybrid position?
- If bonding then can certainly relax it.