USA Atlas SCT Barrel Module Assembly

Status Report

March 2003

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.
- 29 series modules built or in process.
- Most modules with-in or close to spec mechanically
- Electrical performance regularly in spec
- Still in a process of addressing some mechanical qualification issues

Overview (2)

- At time of last SCT week (Dec 02) we proposed that some mechanical specifications be relaxed to advance schedule.
- Agreement was to continue building modules and reassess situation at next (this) SCT week or in PAR.
- Continued concern about leakage currents – inside spec but not always = sum of crystals
- Indirectly received some recommendations and comments from SQ committee 25-Feb-03.
- We submitted revised spec proposal 25-Feb-03.

Components and Fixtures

- Recently received large detector shipment.
- Baseboard inventory is fine.
- Hybrids- production requirement is 15/week. We usually get ~15/month, recently received 32 but had to return many due to fanout problems. Our assembly and test capacity remains very under-used here. UCSC line is in commissioning. process.
- Fixtures for module assembly
  - 3 assembly fixtures commissioned and in use.
  - 4 additional fixtures received and being commissioned.
  - 2 hybrid folding stations in use, 4 more in final assembly.
- Can now build ~2 module sides in one day.

Leakage Current & Channels (1)

- To address leakage concerns we adopted a no re-bond procedure beginning with module P6
- For modules P6-P16 – observed reasonable agreement with sum of crystals.
- Side effect is additional un-bonded channels due to fanout adhesion problems.
- With P17 start to re-bond once – leakage remains good.
- Initiated re-bonding where possible on P6-P16, ~50% of un-bonded channels were recovered.
- Results shown in table.
- Now re-bond as regular protocol.

module	? 4@500V	bonded 150C	unbonded	total bad	status and comments	fanout vintage
P1	500				on hold	
P2	480	1370	9	11		old
P3	510	441	1	2		old
P4	740	395	7	14		old
P5	560				on hold	old
P6	660**	1279	9	10	12 channels rebonded	old
P7	410	473	14	14	2 channels rebonded	old
P8	840**	1051	9	9	7 channels rebonded	old
P9	370	395	10	10	11 channels rebonded	old
P10	330	716	4	5	10 channels rebonded	old
P11	370	746	11	11	11 channels rebonded	old
P12	390	426	5	7	4 channels rebonded	old
P13	380	700	10	13	9 channels rebonded	old
P14	450	716	11	12	10 channels rebonded	old
P15	410	456	12	12	10 channels rebonded	old
P16	340	670	6	6		new
P17	380	334	4	7		new
P18	400	366	0	0		old
P19	380	366	0	0		new
P20	320	319	0	1		old
P21	330				on hold-stereo	
P22	350				on hold-damage	
P23	330	700	0		in electrical test	new
P24	420	760	0		in electrical test	old
P25	30000				on hold-1 det IV	
P26	350				on hold-sepf	
P27	340	370	0		in electrical test	new
P28	277		5		ready for IV	old
P29	380				in hybrid fold	old
P30					in glue	
P31					in glue	

Leakage Current & Channels (2)

- Clear trend seen on leakage towards lower currents after bonding
- All modules have <1% bad channels after re-bond
- Trend toward reduced bad channel count seen
- New re-bond procedure will be followed

Cleanliness and Handling Issues

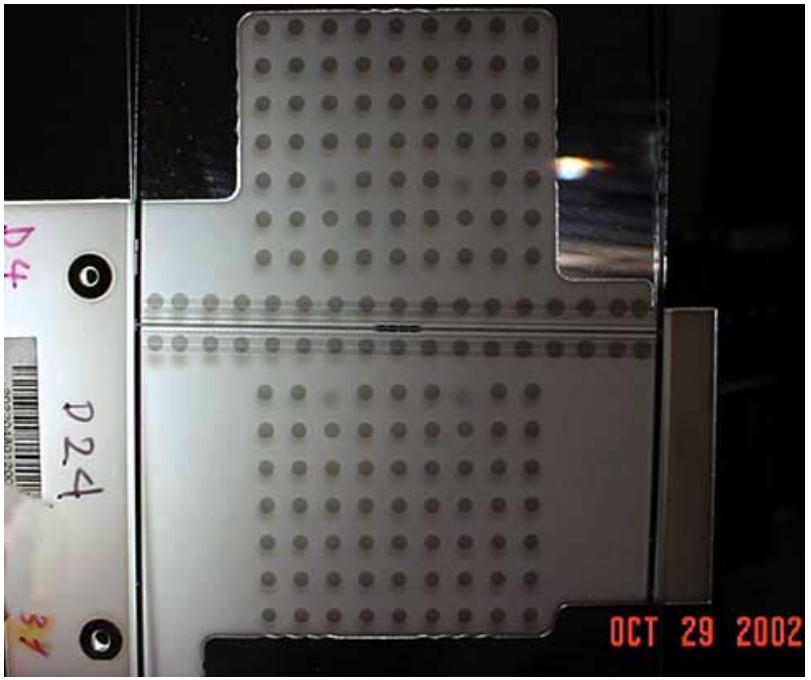
- Concerns expressed at time of original SQ process – dust, scratches
- Upgraded housekeeping and handling procedures
- Except for bona fide accidents modules are dust and scratch free
- Standard QMW module boxes in use

Glue and Thickness

- USA glue dot pattern in regular use, appears to work well
- Shim calculator used to determine thickness module by module
- Except for (rare) mistakes in shim selection see no problems with module thickness, glue thickness, or asymmetry

Control of Glue Dots

- 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
- Continued on all production modules



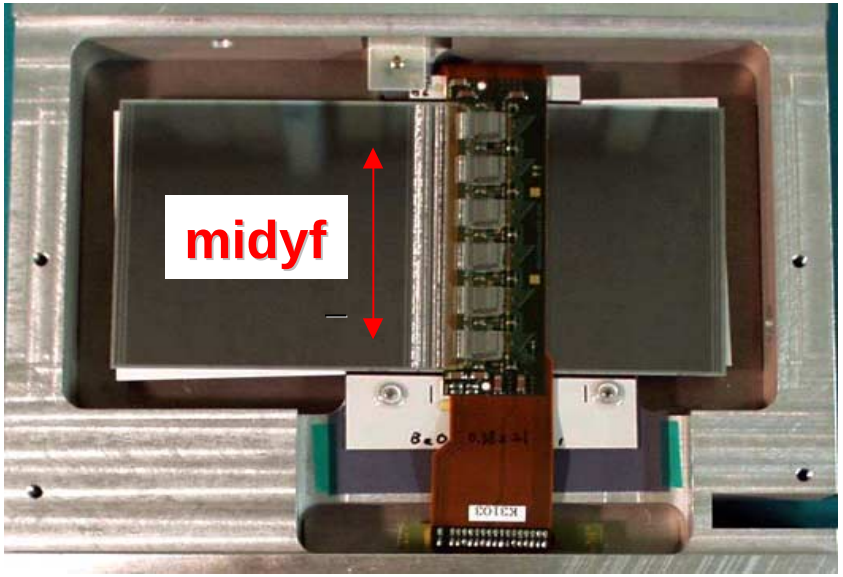
Mechanical Survey

- Some in plane parameters remain close to but still outside spec
- Trend analyses and adjustments continue and will improve these
- No differences seen after test and thermal cycle

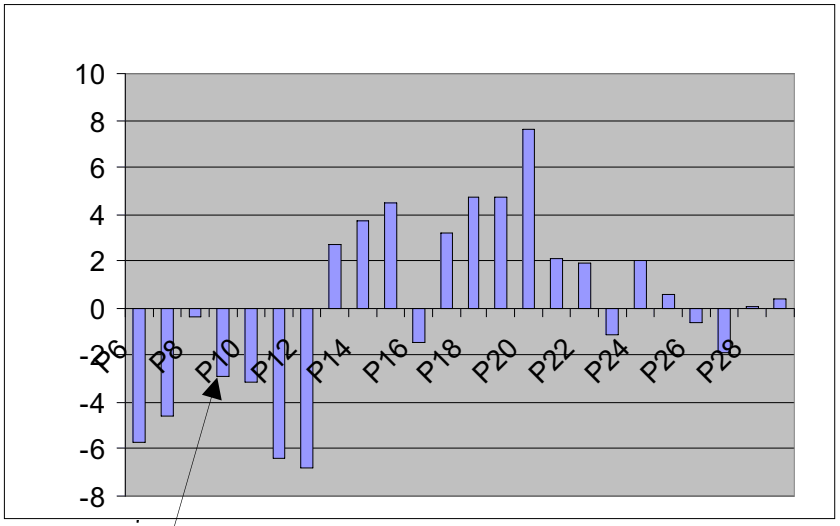
Mechanical Summary

module	midyf	midxf	stereo	glue	assym	sepf	sepb	fixture	comments, other issues
P1	**-52.8**	-5.6	**0.396**	226	-10	-5.9	-2.7	A1	wrong DIMS file loaded
P2	3.3	-4.7	-0.057	269	52	-4.5	-2	A1	**error in shim calc, too thick +14um**
P3	-3	-1.5	-0.12	164	11	-4.2	-6.5	A1	b/b b=3.2, spec is 3 (not assy issue)
P4	**-5.9**	-0.5	**-0.136**	165	6	-7	-3	A1	
P5	-0.6	-1.7	**-0.173**	147	-9	-7	-6.5	A1	
P6	**-5.7**	-1.9	0.03	199	27	-7.6	-5.8	A1	
P7	-4.6	1.2	0.021	176	20	-3.4	-1	A1	
P8	-1.1	7	0.01	165	7	-0.5	-4	A1	
P9	-2.9	0.5	0.018	175	13	-2.3	-3	A1	
P10	-3.7	0	0.029	157	3	-0.3	0.7	A1	
P11	**-6.4**	1.8	0.014	191	-21	-3.3	-2.3	A1	
P12	**-6.8**	7	0.017	213	50	-2.4	-3.8	A1	
P13	2.7	0.7	0.011	160	37	-3.7	-7.9	A1	
P14	3.7	3.6	-0.005	164	23	-6.4	-8.1	A1	hybrid height too high
P15	4.5	0	0.032	102	43	-7.1	-4.8	A1	
P16	-1.5	9.3	0.094	230	54	-3.8	-3	A0	**error in shim calc**
P17	3.2	1.3	0.034	148	25	-5.1	-3.3	A1	
P18	4.7	1.7	0.011	146	24	-3	-9	A0	
P19	4.7	8	0.117	122	17	-6	-3.1	A1	
P20	**7.6**	0.8	0.026	149	12	-8	-10	A1	
P21	2.1	2.5	**0.165**	130	6	-2.4	0.4	A0	
P22	1.9	-0.5	0.009	158	7	-10	-2.5	A2	
P23	-1.1	4.4	0.024	160	25	-2.8	**-15.1**	A1	
P24	2	5.5	-0.054	135	6	-6.9	-1.3	A0	
P25	0.6	1.3	-0.007	174	17	**-10.7**	-6.7	A2	
P26	-0.6	3	-0.01	147	23	**-23.1**	-5.7	A1	
P27	-1.9	7.8	0.026	159	31	4.1	1.7	A1	
P28	0.1	4.7	0.023	149	24	1.6	2.3	A1	
P29	0.4	1.9	0.041	161	25	3.5	3.4	A1	

Front/Back Alignment



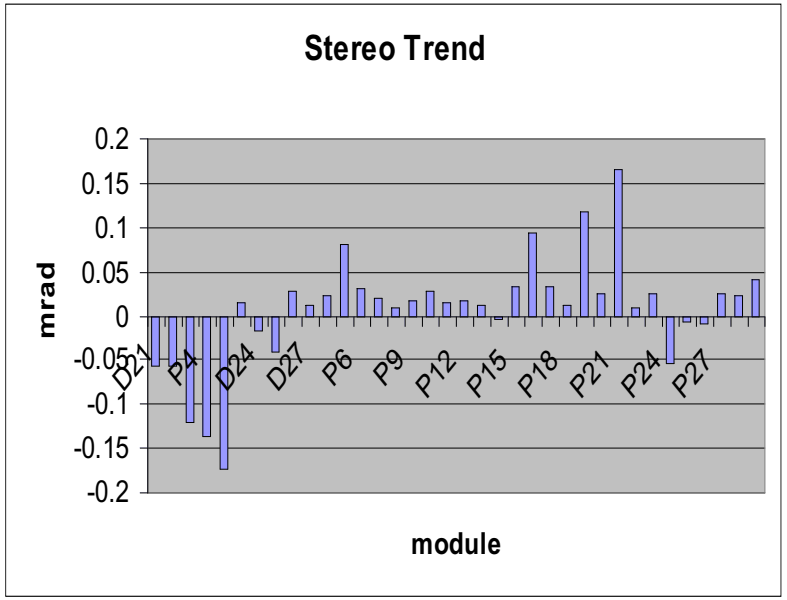
Modules Built since Dec 02



With RAL adjustment procedure P10 and after.

Stereo Angle Trend

- Data include 3 fixtures in use
- Adjustment procedure in use
- Large steps are DIMS file changes or new fixtures

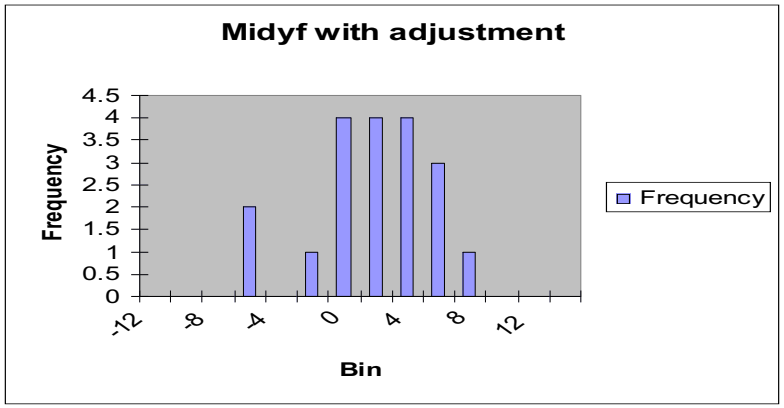


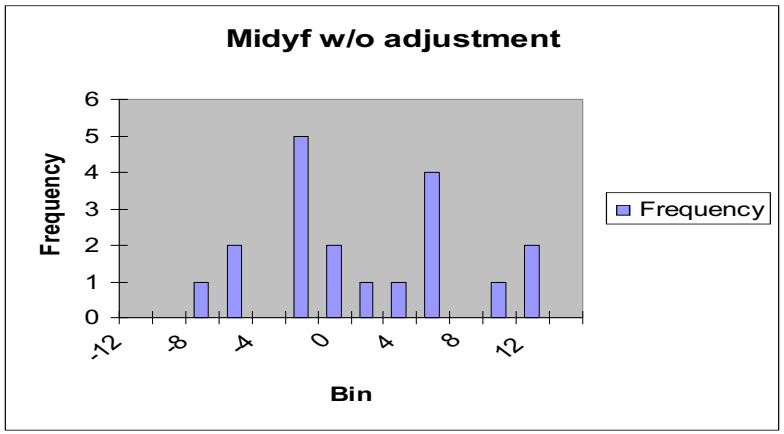
Assembly Procedure

- At present we use adjustment procedure similar to RAL.
- After sandwich but before cure, certain fiducials on crystals and fixtures are compared to nominals.
- If differ adjust by rotation of set screws on linear bearings.
- Record positions before and after adjustment.
- Process is non-linear and relies partly on unique stress and strain on fixture. Shifts are also seen over cure time.
- Adjust until deviation is less than ~2 microns from nominal. Try to upgrade this to ~1 micron for next series of modules.
- This process can effect only Midyf and Stereo.
- This process is very time consuming, average 45-60 minutes per side, and uses metrology system resources.
- Check also before cure for sepf and sepb errors

Midyf: effect of adjustments

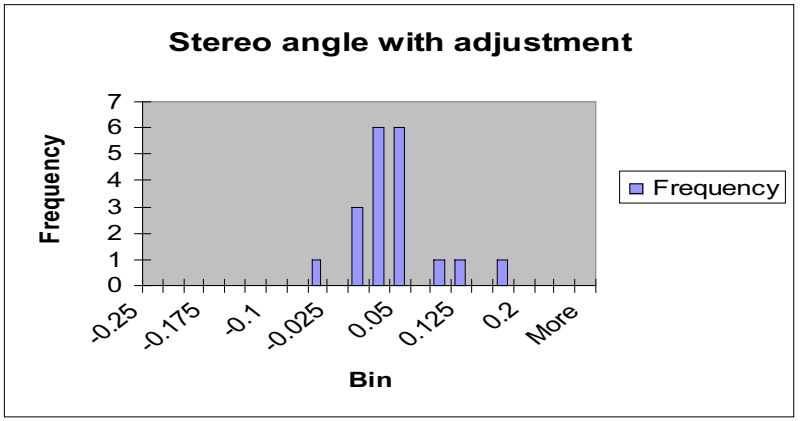
- With adjustment
  - Average=0.83
  - RMS=3.8
  - 3xRMS=11.4
- W/O adjustment
  - Average=1.20
  - RMS=6.0
  - 3xRMS=18

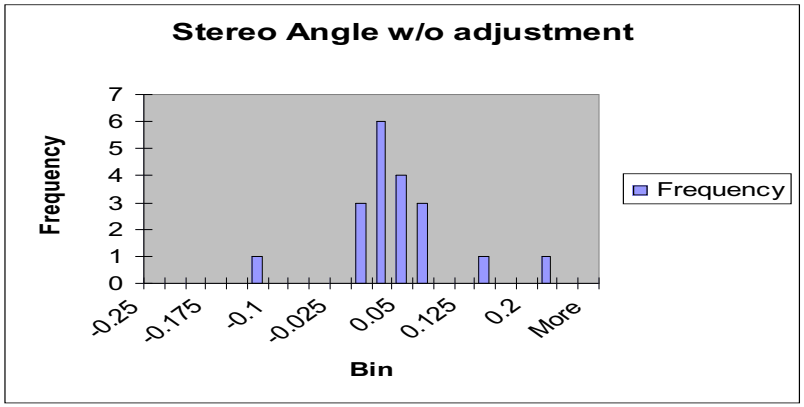




Stereo: effect of adjustments

- With adjustments
  - Average=0.03
  - RMS=0.049
  - 3xRMS=0.146
- W/0 adjustments
  - Average=0.029
  - RMS=0.070
  - 3xRMS=0.210





Adjustments

- 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 ~45-60 min/per side
- Uses same SmartScope as used for metrology and hybrid mounting.
- In production have to process 6 sides per day.
  - 6 x 45-60 min = 4.5-6 hours THIS IS EXCESSIVE AND WILL SLOW PRODUCTION DOWN SIGNIFICANTLY

New Specs Proposal

- Effect of Midyf and Stereo are easily corrected for in database during analysis (see note of S.Snow for example).
- Request specs be loosened and we drop adjustment steps.

New Specs Proposal

- **Study distributions of data on P10-P28, also RAL data.**
- **Compensate for effects of adjustments.**
- **New spec is based upon model of data as ~Gaussian distributed**
- **Propose 3*sigma cuts on all 13 parameters such that cummulative yield is >96%.**
- **Acceptable data should be ~Gaussian distributed with sigma equal to new tolerance divided by three.**
- **Software corrections should be implemented for analysis.**

parameter	Current tolerance	RMS value from data	Proposed tolerance
Mhx	30	8	30
Mhy	30	9	30
Msx	100	35	120
Msy	30	13	40
Sepf	10	4	12
Sepb	10	4	12
Midxf	10	4	12
Midyf	5	6	18
Stereo	0.130	.070	0.210
a1	0.130	0.030	0.130
a2	0.130	0.030	0.130
a3	0.130	0.030	0.130
a4	0.130	0.040	0.130

RMS value from data assumes no adjustments are made

Comparison of parameters

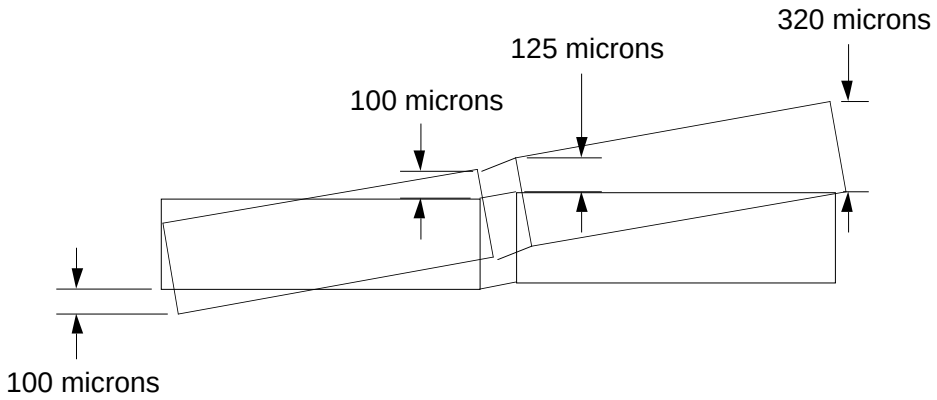
- Validity of approach relies on midyf etc being well measured.
- All 5 USA glass modules have been sent to other sites for comparison
- Data recv'd on 4
- Excellent agreement
- Avg diff, stdev
  - Midyf:1.4 um, 1.1 um
  - Midxf:1.9 um,0.9 um
  - Stereo:0.016 mr,0.009 mr
  - (based on 4 recv'd + 1 qual)

D22 Uppsala Survey					
Parameter	Upps Deviation	USA Deviation	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

Hybrid Position

- Attach top side first. Errors here propagate 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.

Proposed Modification to Hybrid Position Spec



- Retain 100 um spec on top side hybrid
- Assume worst case rotation of top hybrid
- Calculate shift at back side hybrid
- hymxb -> 125 & 320 microns far & near

Conclusions

- Hybrid delivery rate does not match our capacity
- Leakage current, channels counts in spec and good trend
- Handling, glue etc OK
- Mechanics – close to spec but still outside, inconsistent with required production rate, – requested modification submitted
- Hybrid placement – new spec proposed