BNL

March 2000

WBS 1.1.2

SCT Plan

- Testing to Minimize Risks
- Hybrids
- Module Construction
- Division of Effort: UCSC and LBL
- Schedule

Where were we a little over a year ago?

•Both frontend solutions had fatal problems, we were getting ready to submit the next iteration.

•Since then: Both solutions work, with still small, well identified, fixes required. Both extensively radiation tested: PS at CERN, 88-inch cyclotron at LBL, cobalt radiation, neutrons, beam test of performance.

•Have made the frontend choice close to our schedule goal of December 1999, set several years ago.

•The extensive work on frontends has however precluded focusing sufficiently on hybrid verification and optimization. This is a major goal for the next few months.

Testing Through End of Summer 2000

Now that the frontend chip has been chosen, change focus to next set of issues.

1. Low dose rate check over next 6 months - dedicated a UCSC postdoc to this. Typically have run at rates > 100x what we expect in experiment. Look at chip behavior for rates ~3x what we expect in the experiment.

2. Hybrid stability for a 12 chip production-like hybrid on a detector.

3. Summer system test: ~10 modules taking data together.

These needed to minimize risk for the full SCT.

Some Key Personnel

Alex Grillo is leading the entire SCT electronics effort. Facilitated UCSC-LBL role in pushing forward the work on frontends.

Ned Spencer has assumed the major responsibility in a number of SCT system areas, particularly grounding and shielding.

Carl Haber has been leading the US effort in the area of hybrids and module construction.

SCT Hybrid and Module Status

The Module is the basic readout unit of the Silicon Strip Tracker

The Module consists of:

•2 back to back pairs of silicon strip detectors

•1 baseboard assembly consisting of Pyrolytic Graphite heat spreader and 4 Beryllia facings to interface to support structure and hybrid

•1 Hybrid assembly consisting of 12 readout chips, thermally conductive substrate, electrical traces, discrete components, flex cable interface to external bus.

The US is responsible to deliver ~700 working modules for the SCT barrel.

Herein we review the status of the various components and procedures necessary to meet this goal.

SCT Hybrid Status

The Hybrid is the electronics package which reads out signals from the silicon strip detectors. It is the main electrical component of the Module.

Building on past experience from CDF and early ATLAS prototyping the US groups concentrated effort on the development of a hybrid using the well developed ***thick film*** gold conductor technology utilizing Beryllium Oxide substrates.

It was understood that this was the conservative approach and closest to commercially standard processing.

It appeared at the outset to be the most expensive approach and to have (marginally) the most material.

It was also the most reliably costed option due to commercial experience.

Progress with the Thick Film Hybrid

1st version for Café/CDP built in 1995 and used extensively in beam and bench tests.

2nd version for Café/ABC built in 1998 used in beam and bench tests. Excessive mechanical bow observed.

3rd version for Café/ABC built in 1999 used in bench tests. Bowing problem solved.

Parallel version 3 also fabricated in a mixed silver and gold technology with a second vendor in order to reduce cost and material. Vendor abandoned this as a business choice.

New smaller version of #3 designed in 1999. First vendor indicated desire to fabricate in the mixed silver and gold technology. Not yet submitted by us.

Extensive electrical tests and irradiations have been performed in order to study stability, performance, etc.

Other approaches which were pursued within SCT were:

Kapton: flexible copper printed circuit laminated to thermally conductive Carbon-Carbon substrate.

Thin Film: aluminum conductors deposited on higher thermal conductivity graphite substrate. Internal CERN "high-tech" development.

A hybrid technology choice was to be based upon consideration of electrical performance, manufacturability, reliability, material, and cost.

In order to advance the schedule and focus effort the SCT management has chosen the ***Kapton*** hybrid as the baseline. Many electrical issues for a module fully populated with 12 ASIC's remain to be resolved and important to focus effort. Work will continue on the ***Thin Film*** approach due to promised cost advantage (not yet substantiated) and fact that this solution has the least material. The ***Thick Film*** approach is abandoned since it is the most expensive.

Due to the advanced development of the ***Thick Film*** solution it can easily be re-activated if problems emerge with the baseline. Time to produce next prototype is 8-10 weeks.

Future US Role in Hybrids

The US should not "join" the technology development but rather ensure that quality and reliability standards are met in the chosen technology by participating in extensive testing.

The US has received one Kapton hybrid designed for the Café/ABC and is in the process of populating it. A module will be constructed using this hybrid. Detectors have been provided by the Japanese groups for this.

The US has received 1 Kapton hybrid module with ABCD chips for full bench evaluation.

The US has received 2 Thin Film hybrids (one for mechanical and one for electrical tests). These will be populated and built into modules. Detectors have been provided by the UK groups for this effort.

Production Issues

Assuming the Kapton baseline, the US would buy enough hybrids from Japan to build the ~700 modules required. These hybrids would have all discrete components mounted already. We would prefer to have chips mounted and bonded as well but this is not agreed. We can handle the chip attachment and bonding. Roughly half the hybrids would be tested at LBL and half at UCSC. Assembly would be at a commercial vendor.

SCT Baseboards Status

The SCT baseboards are a laminate of pyrolytic graphite and BeO. The graphite surface is then encapsulated in polyimide or epoxy and windows are opened for electrical contact.

The baseboard fabrication is a proprietary development of CERN and QMW in the UK. We do not have access to this technology. We expect to buy the required number of assembled baseboards from the production group to construct our modules.

The US has received 4 baseboard assemblies for use in the various modules under construction here and will provide feedback to the development team.

SCT Module Construction

The US group is responsible for the construction and delivery of ~700 working barrel modules to the UK assembly site.

Beginning in 1996 we helped define an SCT wide module construction effort working particularly with the group at RAL.

We organized two well attended Module Assembly workshops.

In spite of this, no consensus has formed in the SCT community on a common set of tools and procedures for the precision assembly of modules. A common approach will be replaced by a common specification and common standard for metrology after assembly.

Another workshop will be held in April 2000 to further define this situation.

The US groups will work in absolute commonality with the RAL group. Identical fixtures will be used and identical procedures will be followed.

At LBL we have established a full module assembly system consisting of:

•granite table

•computer controlled precision stages

•image capture and analysis for location of fiducials and control

•custom tooling for assembly

•experience with adhesives and other materials

•automatic wirebonding (also at UCSC)

•upgraded “Smart Scope” for metrology

A number of modules, both mechanical and electrical, have been assembled there.

We are in the process of upgrading the custom tools to the latest release of drawings and software.

A new clean room facility is complete and the assembly, bonding, and measuring systems are being moved there.

All US module assembly will take place at LBL. Testing and rework efforts will be split between UCSC and LBL. Both sites have automatic wire bonders. Effort to be divided as appropriate during production. We won’t be sensitive to single point failure.

Key Dates

Decision on Frontend Electronics Vendor: **2/28/00**

Hybrid Choice Decision: **2/28/00**

Done: ABCD chip chosen. Kapton hybrid chosen.

Comment: Very limited experience with Kapton hybrid (provided by KEK in Japan).

Preproduction order: **5/1/00**, first chips available **10/16/00**.

Main production order: **3/5/01**

Comment: Approx. 5 months to work with chips.

Hybrid design review: **5/13/00**

Hybrid PRR: **2/15/01**

Comment: Approx. 1 year from now to be fully confident in hybrid choice and performance.

Module PRR: **3/6/01**

Comment: About same time scale as for hybrids to be ready.

Module production ends: **4/11/03**

Comment: 2 years for production. Expect to make 2 modules/day when in full operation.

Dates: Some Key Activities

Production Chip Testing:	7/5/01 - 7/5/02
Testing to be done:	8/19/02
Hybrid Work:	5/10/01 - 9/11/02
Testing to be done:	11/21/02
Module Work:	5/30/01 First Module Complete
	3/25/03 Complete Testing

Chip Testing in the U.S.: will test 1/2 of chips for full SCT

•*Tester has been designed, many aspects tested, but needs to be completed by the end of this summer. Physicist in charge has recently decided to leave, working on plan of how to complete tester.*

Hybrid and Module Work: U.S. is responsible for 700.

•*Tooling and technique for module construction is well advanced.*

Everything needs to be smoothly working summer of 2001.

Division of Labor:

- Chip testing will be at UCSC.
- Hybrid construction and testing shared. Some of the work done in Japan, particularly testing of Kapton with surface mount components. Chip attachment and bonding at a vendor.
- Module construction at LBL. Testing and rework will be split between UCSC and LBL.
- Both groups will be able to do all types of wire-bonding work so work can be transferred in the event of a bonder failure.

Budget Plan

WBS Number	Description	FY 00 (k$)	FY 01 (k$)	FY 02 (k$)	FY 03 (k$)	Total (k$)
1.1.2	Silicon Strip System	1101	2537	985	228	4824
1.1.2.1	IC Electronics	626	1759	174	125	2684
1.1.2.1.1	Design	250	131	131	125	636
1.1.2.1.2	Development and Prototypes	106	0	0	0	106
1.1.2.1.3	Production	270	1628	44	0	1943
1.1.2.1.3	Production			988		Management Contingency

Budget Plan

WBS Number	Description	FY 00 (k$)	FY 01 (k$)	FY 02 (k$)	FY 03 (k$)	Total (k$)
1.1.2.2	Hybrids/Cables/Fanouts	177	380	383	33	973
1.1.2.2.1	Design	0	0	0	0	0
1.1.2.2.2	Development and Prototypes	32	0	0	0	32
1.1.2.1.2	Production	145	380	383	33	941
1.1.2.3	Module Assembly and Test	298	398	401	70	1167
1.1.2.3.1	Design and Assembly and Test	127	0	0	0	127
1.1.2.3.2	Development and Prototypes	57	0	0	0	57
1.1.2.3.3	Production	114	398	401	70	983

Conclusions

1. Rest of this Fiscal Year: very important to establish that the technical design of the SCT detector is sound through building and simultaneous operation of a number of modules.

2. The first 9 months of Fiscal Year 01 will focus on pre-production to establish and quantify our ability to do testing and construction.

3. Starting summer 2001 go into full production.