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I. PROJECT MANAGER'S SUMMARY

The SDC resumed intensive technical work on all subsystems in November following the DOE Review at the end of October. The subsystem groups are now fully engaged in detailed engineering of the system elements, construction of prototypes for mechanical, electrical and beam or radiation tests and are also beginning to address detailed integration issues. Some conceptual work is still needed in the forward muon calorimeter systems as well as beamline shielding outside the detector. This work will be planned in December and carried out in the first quarter of 1993.

In the Silicon tracker system, a focus of work in November was the preparation in England, Italy, Japan and the U.S. for beam tests of an initial set of double-sided Silicon detectors with their proper electronics and mechanical support/cooling structures. In the process, a number of vendor associated problems were identified and corrective measures taken. This is a necessary process as suitable industrial partners are identified and qualified on prototype elements so they will be ready to undertake production runs later. Details are in the text. On balance, the barrel Silicon systems are progressing very well with no unpleasant surprises.

Straw tracker work is advancing in the areas of mechanical design including wire support elements, straw module enclosure boxes, the module attachment systems and the fabrication of support rings and cylinders. Exploration of a second straw tube vendor in England was carried out. Tests of electronic pulse shape were pursued at Colorado using Fe55 sources and cosmic rays. The results are comparable with desired behavior and the crosstalk is a the 1-3% level. Penn ASD electronics compares with Lecroy ASD performance. The mechanical support and survey-technique designs will be pursued in a test at SSCL in December. Duke pursued the task of transferring wire position information to fiducials on the outside frame. Duke also conducted tests of straw tube sensitivity to neutron fluxes as well as the mitigation of the flux by polyethylene absorber. These data will be combined with the neutron background studies underway in SDC. Computer simulation work for the February tracker technology decision was pursued at Indiana. Results are very encouraging.

The work on gas microstrips for the ITD concentrated during November on attempts to identify satisfactory methods for etching electrode strips on a conductive substrate. A test run in a beam at CERN was carried out by Carleton, Liverpool and RAL on GMD tiles with Al electrodes, Tedlar substrate and Ar-isobutane (90/10) gas. A trigger threshold of 6 electrons was seen using the RAL/UCL/Liverpool electronics, adequate for ASC purposes. It is clear, however, that the reliability of lithography and the suitability of substrates is still unproven and will require further intense development. Work is also proceeding at Montreal, Purdue and Texas A&M on GMD development using various metallization schemes and substrates. Optimum chamber gases are also under study. Backup studies for the substitution of a Silicon disk system for the GMD's is continuing at Texas Tech. In addition to these direct detector studies, useful work went ahead on mechanical deflection (FEA) studies for the tiles and support structures and useful integration work was carried out by Carleton, RAL and SSCL. Electronics evaluation work advanced at Carleton and Oxford and simulation activity commenced at Montreal. In general, it is likely to require several more months of intense R&D work before a definitive judgment can be arrived at on the suitability of the GMD technology for the SDC ITD. Present results look hopeful but are not definitive.

Design work for the SDC calorimetry advanced in all areas in November. The critical path barrel wedge prototype design is complete and engineering details are being finalized while fabrication of parts has begun. One hadron absorber is in fabrication in China’s Xinhe Shipyards and another will commence soon at Fermilab. The EM section is
in final design at ANL and WSTC. The scintillator tiles and fibers for the instrumented towers are being initiated by Tsukuba. The SMD components are being pursued at Saclay. The tile grooving and edge treatment (painting) have been finalized and combined with the chosen SCSN38 scintillator, meet the SDC light yield specification. Radiation hardness studies at IHEP Beijing continued and showed that multifiber tiles can withstand radiation doses beyond 20 Mrads, thus easing the endcap scintillator replacement scenario. Endcap design is advancing at LBL in preparation for a decision review at LBL in January. This review will address recently developed alternates to the wedge-based baseline. Other progress areas included conceptual design work on the test beam positioner structure and lifetime testing of source drivers for the barrel system conducted by Purdue. In general, progress is steady and satisfactory. Some concerns were identified in the area of scintillator plate supply stock to meet the barrel prototype schedule.

Advances in the forward calorimeter design included a test run with electrons, hadrons and muons at CERN utilizing a test module based on liquid scintillator in quartz tubes embedded in a mild steel matrix. Supporting R&D for both liquid scintillator and high pressure gas forward calorimeter technologies is proceeding vigorously. A decision on technology is expected in late summer 1993.

Muon Subsystem work proceeds in the barrel, intermediate and forward systems. Both magnet and detector systems are active. A high priority has been accorded to the fabrication of prototype barrel toroid blocks in Russia at Atommash. This effort moves ahead steadily and appears to be on schedule. Work on the drift tube system and the scintillator and RPC trigger devices also continues steadily at many SDC institutions. It is likely that an O-ring seal will be used to ensure leak-free tubes. Significant amounts of finite element analysis continues in both magnet and detector module systems. Gravitational and thermal deformation issues have been modeled at Washington. No serious problems have been uncovered. In the regime of alignment, conceptual design of the fencepost system continues at Draper Lab and FNAL as well as evaluation of specific devices and technologies to be used in the actual system. Details are in the text of this report. Manufacturing studies are continuing with the RAM at Martin Marietta. Simulation work for the muon detectors as it involves the trigger is underway at Colorado, SSCL, NIU and Washington. Results are consistent with SDC specifications and expectations. The forward muon system conceptual design is receiving particular emphasis as it lags the barrel and intermediate systems. A two week FMS workshop is to be held in January at SSCL to pull the concepts together as well as to address integration issues connected with accelerator devices, shielding, neutron/photon radiation and other issues of significant concern. Work on the barrel tower prototype and associated fabrication facilities at SSCL and UTA advanced well. Prototype scintillator counters made at IHEP Protovino were tested with the result that further development will be required to ensure adequate quality.

Good progress has been realized during November in the Superconducting Solenoid subsystem. The main focus of the work is on production of the R&D coil and cryostat. Both are proceeding well. The test coil winds were tested in Japan and found to have a shear strength in excess of 20 MPa, where the expected force in the SDC coil should not exceed 1MPa. The cryostat pieces fabricated from hexcell and those made of isogrid are both fully successful. An isogrid based cryostat will be shipped from Fermilab to Japan for the R&D coil test. Progress in analysis of the mechanical support of the cryostat from the calorimeter was achieved. A total of 16 supports are needed to ensure longitudinal deflections in the desired range of less than 2mm. The conceptual design for the refrigerator and its required capacity was verified by a new analysis at SSCL. Preliminary discussions with potential refrigerator suppliers took place. A draft paper for participants in the magnet and refrigerator design and construction was completed at SSCL.

The Electronics subsystem work is distributed over a large number of specific activities from front-end amplifier/discriminators and pulse-height ADC or timer TMC.
circuits to level 2 trigger physics signals studies. It is hard to summarize this work in a few words, but the general activities break down into chip design and test; data acquisition design and hardware realization with boards and bus/connector designers; data transmission designs based on 1.5GHz optical distribution; electronic behavior simulation using SPICE and other tools; and design of sophisticated test circuitry, both on-board and separate from the tested items. The front end chips now being tested in the Silicon straw and fiber systems are functionally successful, but exhibit yield problems typical of the initial versions of developmental designs. These yields are expected to be improved in the next production round. First high frequency (60MHz) tests of the flash ADC chip for the shower max digitizer were successful. Linearity vs rate and dynamic range issues are also being explored. In the muon front end, the TMC engineering test samples were received from Toshiba and successfully tested at KEK. Work on the other muon front end and DAQ/trigger boards is also progressing steadily. DAQ concepts and hardware realizations are underway at many institutions and Level 1 and Level 2 trigger studies are also reaching a high level of activity. The details are covered in the appropriate text sections of this report. In general, there is a great deal of activity and it will be a challenge just to characterize the status and ascertain whether the various elements are maintaining the desired overall schedule. No specific serious problems are presently in evidence.

SDC Computing Systems include their reports for the first time this month. The PASS system is progressing with the development of software tools and data modeling. Real CDF data is being used to help characterize the data modeling. Simulation of physics events along with trigger and pattern recognition is being pursued intensively at a number of SDC institutions. Support of the outer tracker technology decision meeting in February is a focus of this work. Organization of a software organization for SDC in Japan among groups of SDC collaborating institutions is in progress. A goal of this activity during November was the organization of a simulation workshop in December at KEK. The workshop will consolidate the use of SDCSIM and organize computerizing working relationships among the Japanese collaborators. A number of key physics processes were studied at Fermilab.
II. SDC SUBSYSTEM REPORTS

1.0 TRACKING SYSTEMS R&D SUMMARY

1.1 Silicon Tracker R&D

Subsystem Project Leader: A. Seiden
Subsystem Technical Manager: A. Grillo
Reported by A. Grillo

Summary of Activities

November was a very busy month. Activities at LANL on the mechanical development have been moving along quickly in all areas leading to our stability tests next year. The rest of the group has been occupied in preparations for our first beam test at KEK which is to take place in December. At month end we were still scrambling, but it looked possible that we would have three planes of detectors with electronics and a controller card and DAQ ready for the test.

1.1.1 Main Mechanical Assembly

Los Alamos National Laboratory

Technical Staff: Team Leader: W. O. Miller
Alignment/Assembly Work Station Development: R. Michaud, R. Ricketts, G. Jordan, H. Salazar, B. Wilds
Composite Structures: T. Thompson, C. Grastataro, G. Dransfield, D. Weinacht, E. Correa
Optical Alignment Development: J. Hanlon, W. Christensen, S. Schramm, D.C. Jones
Cooling System Development: K. Woloshun, M. Elder, J. Williams, L. Salazar
Reported by W.O. Miller

Alignment/Assembly Work Station Development

We have sent revised assembly drawings of the manipulator, rotary fixture tail stock, and optics mount to Anorad for final estimates of the stage alignment and assembly work. The revisions evolved from a recent meeting with Anorad in which they proposed some necessary modifications. In addition to the mechanical assembly drawings, we sent them several work station layouts which they require to determine cable lengths and cable carrier arrangements.

Kinematic Mount Development

Quotes for the fabrication of six prototype kinematic mounts, a shell test fixture, and one manipulator arm were received on November 23. Estimates ranged from $10.7K to $63.8K. Since the lowest bid was only 58% of the next lowest bid we asked the vendor to re-evaluate his estimate. The amended estimate was still quite low at $12.3K. In spite of our concern, we awarded them the contract based on their good past performance. This item is on the STS critical path, and we can not spare additional time to repeat the bid cycle. Based on their quoted delivery of 3 months after receipt of order, mount tests will probably not commence until late February or early March. We will endeavor to improve this delivery through close liaison with the vendor.
Silicon Shell Analysis

Finite element analysis of cooling rings and shell structures subjected to kinematic mount preloads, temperature changes, and gravity effects continued. Mechanical properties of the cooling ring material and information about cabling sizes, quantities, and placement are needed so that we can continue with the mount design. We expect composite data from cooling ring material tests in January that will allow us to update these study preliminary study results.

Composite Structures

We now have a supply of P75/954-3 120∞ arc segment cooling rings. These ring segments will be used to initiate construction of full, 360∞ cooling ring structures. Our thermal conductivity measurements of specimens extracted from these rings suggested that something was amiss with the consolidated composite material properties. Acid digest tests revealed that the prepreg material from which these ring segments were fabricated was actually only approximately 45% fiber by volume. Our specification called for 60% fiber by volume. Photomicrographic samples were also taken of the cooling rings specimens. The fiber's length was less than 100 microns in length. LANL had supplied ball-milled 400 micron fiber to ICI for prepregging with cyanate ester resin. We learned that ICI used a mechanical prepregging process that severely damaged the fibers. We have requested a new prepregging technique that should not alter the fiber geometry. ICI will correct their processing steps that contributed to the low fiber volume fraction.

We recently received replacement molding material. However, our first attempt at producing parts was not satisfactory. We discussed the problem with ICI, and they indicated that additional B-staging of the material was needed. Presently, the mold is out for periodic refurbishing of the Teflon coating, which ensures that the molded part will release. We will be in a position to resume production of the ring segments shortly.

We have fabricated cooling ring covers with the new cover mold. The mold worked extremely well and the parts produced had an excellent fit to the cooling ring's serrated pattern. For the time being, we are making the covers from the sub-standard molding compound mentioned above.

A finishing tool to aid the trimming and sanding of 120∞ arc segments has been designed and is being built. This will allow the arc segments to be spliced neatly to form a 360∞ cooling ring. We expect to produce full 360∞ cooling rings by the end of January from new 120∞ arc segments which meet our design goals.

A parallel cooling ring manufacturing process is underway at Programmed Composites. They proposed molding the cooling rings on a 360∞ monolithic graphite male mandrel (zero coefficient of expansion). The cured molded part would have a final machining operation to achieve our stringent tolerances. This method of fabrication seems very promising for making a complete 360∞ cooling ring. The process will be initially demonstrated with a 120∞ segment. This concept is being evaluated as a backup to the matched metal mold ring manufacturing concept.

Optical Alignment /Stability Development

The development of the software interface needed for the various instrument packages used in the semi-automated assembly station for constructing silicon shell structures is on schedule. We have been using the new LabVIEW software for "Windows", and are very happy with it. Interface packages for the electronic autocollimators, stepper motor drivers, detector centering system (for maintaining the assembly station on the line of sight), and the CCD camera centroid interface (for the
alignment microscopes) have been written. We are working on the driver interfaces for the Anorad servo motors.

The holographic testing lab is being renovated. We have disassembled the entire optical system, and are now in the process of reassembling it. We took the holographic system apart to move the optical tables into position for stability testing, and to get the hardware inside a temperature controlled space. The parts to build the temperature controlled space arrived at the end of last month. Its construction was just completed and its performance is currently being evaluated. This room is the prototype for the controlled environment that will enclose the semi-automated assembly station.

We have just acquired additional space that will be used for the assembly process. The building is being cleaned out, and we are preparing to move two large optical tables that we have just received into that space.

**Butane Cooling System**

A series of experiments using previously tested wick specimens was conducted with the liquid butane supplied from the top of the specimen, as opposed to from the bottom as was done in the past. Several observations were common to all of the most recent tests: 1) there was no bleeding from the wick specimen; 2) there was a continuous flow of liquid through the artery, requiring a liquid return system; 3) there was less temperature variation on the test piece but sometimes slightly higher temperature, presumably due to lack of wick bleeding. Calculations show that the liquid pressure inside the artery can be below the local vapor pressure, the result of which is no bleeding from the wick.

Feeding the cooling ring from the top allows for the relaxation of the requirements for small pore size. This is significant because larger pores have given lower temperature differences. The largest pore size wick produced to date can now be used. Larger pore sizes will be pursued in the coming weeks.

Testing has continued on a porous graphite product that has resulted in significantly lower temperature differences. The graphite has a solid fraction of 52% and a much higher thermal conductivity than the polystyrene foam. The enhanced effective wick/liquid matrix thermal conductivity is believed to be responsible for the lower temperature difference.

**Management/Integration**

On November 12, 1992, a meeting was held at the SSCL to discuss detector alignment. W. Miller presented a preliminary alignment tolerance specification for the central tracking system. The tolerances, as presented, are contained in Table 1. Miller's talk included a brief overview of how, in the case of the Silicon Tracker System central region, one might achieve the placement tolerance for $R_f$. The main recommendation coming out of Miller's presentation was a proposed study plan. The plan focused on the methodology of improving the knowledge base for these specific central tracker system requirements, with an ultimate goal of integrating the various subsystems.

1.1.2 Internal Electronics

**KEK**

*Barrel Silicon System*

Reported by T. Ohsugi and Y. Unno
**Si Sensor development**

The radiation damage test of the full-size double-sided sensor for the barrel detector is in progress. The gamma rays irradiation is being done at Hiroshima University. The parameters sensitive to the surface damage such as an interstrip isolation, capacitance and the discharge starting voltage at the strip edge were measured at the dose of 50k, 100k, 200k, 500k, 1M, 2M and 3M rad. The sensor is still survived and looks healthy.

Another sensor was irradiated by protons at LANL on the last September. The fluence was about $10^{14}$ protons/cm$^2$. This detector looks also healthy. No serious damages have been found so far. The leakage current increased and the full depletion voltage changed as expected. The biasing resistors and the channel isolation keep their function very well. The interstrip capacitance changed little bit but not serious. Detail measurement is still in progress.

**Fullsize prototype DSSD beamtest at KEK**

The beamtest of 1st full size prototype DSSD for the barrel section is being planned to be done at KEK on December. The first test is scheduled officially on Dec. 9 till Dec. 16 under the name, T279 (Spokesperson: Y.Unno). Digital readout section expected to be completed at the end of Nov. at UCSC. Mechanical translation-rotation stage is being developed at Univ. of New Mexico. DSSD mounting board is being designed at LBL. Light and electrical shielding box and associated items are under preparation at KEK. The proposed portable DAQ for SDC is being transformed to the Si DAQ system with the help of M. Nomachi, and other of KEK. We plan to go into the beamline area to set up the DAQ etc. from Nov. 30. On Nov. 24 a TV teleconference was held between KEK and LBL with the attendance of LBL, UCSC and KEK collaborators. The main goal was to exchange the last minute information of the beam test preparation. LBL showed the board, UCSC the DRC, and KEK the trigger logic and DAQ configuration. The teleconference was effective with the view of real stuffs.

**LBL**

*Prototype DSSD*

*Forward Silicon Disk System*

Reported by M. Strovink

No activity reported

*Front End Electronics System*

Technical Staff Involved: C. Corradi (LBL), J. DeWitt (UCSC), J. Iler (LBL), I. Kipnis (LBL), N. Spencer (UCSC), H. Spieler (LBL), K. Shankar (RAL),

Reported by H. Spieler

1. Module/Hybrid (Corradi, Iler, Engineering Solutions/Fujitsubo)

Although quite a few low-mass Al-Kapton cables have been fabricated, several problems still remain. The basic technology has been shown to be feasible, but yields must be improved before the process can be accepted for mass production. Etching uniformity tends to be good, but problems apparently occur in handling during the combined process of etching, applying the cover layers, and the electroless nickel-gold plating of the
connector contact surfaces. We have initiated a systematic yield study to isolate problems at individual fabrication steps. We utilize vendors suitable for eventual mass production. The goal is to establish a reliable recipe for fabrication and handling that allows us to assess the suitability of this technology for the final design. Cable fabrication is coordinated by Engineering Solutions and testing and fault analysis occurs at LBL.

Work on developing assembly techniques for prototype modules has proceeded, stimulated by rather detailed discussions during a visit to LANL. A fixture for gluing detectors has been designed and fabricated. Since tests with the currently used heat-cured epoxy have yielded inconsistent results, further tests with UV curing epoxy are planned.

Tests of wire-bonding to Kapton substrates have continued at Promex and at LBL, both with consistently acceptable results. Tests at Promex (coordinated by Engineering Solutions) included 2000 bonds (1000 wires), a large fraction of which was subjected to accelerated aging (15 h at 150 deg. C). All bonds remained acceptable.

2. Beam Test Electronics (Collins, Hutchinson, Kipnis, Merrick, Rowe, ?)

Boards for the December beam test electronics were designed, fabricated and tested. The PC boards were laid out and fabricated through LBL. Assembly and test were distributed between LBL and UCSC.

3. Analog IC (Collins, Kipnis, Spencer)

The AT&T ICs came out of fabrication. Preparations for the December beam test precluded extensive measurements, but spot checks of several ICs showed the circuit performs its basic functions. Probe cards for mass testing were received from the vendor and tested. An interface board that translates the low-level current outputs from the IC to standard test levels was designed, laid out and submitted for fabrication.

Test transistors for the AT&T CBIC-V and Westinghouse EKS processes irradiated at LAMPF to 1.2*10^{14} protons/cm^2 were measured and compared with pre-irradiation results. The devices were biased during irradiation. The samples comprised four each npn and pnp CBIC-V transistors and two each npn and pnp EKS devices. The results bring no surprises; both processes show adequate radiation resistance, with the current gain dropping to about 1/2 of the pre-irradiation value at the emitter current density used in our designs. The output curves are unchanged and the Gummel plots indicate no collector current leakage. A report summarizing the results has been prepared.

4. Digital IC (DeWitt, Kundu, Shankar)

A draft specification for the digital readout IC was prepared at Oxford and RAL and distributed for comments. The interim digital IC designed at UCSC was received from fabrication. These devices are needed for the detector test board used in testing the AT&T analog IC and for use in the March beam test at KEK. IC testing is to take place in December.

University of Oxford/RAL

Data Transmission, Liaison to Trigger & Data Acquisition

Technical Staff Involved: Mr. K. Shankar, Dr. N. Kundu, Mr. N. Martin,
Dr. B. Brooks, Mr. R. Wastie
Physicists: A. Fox-Murphy, R. J. Cashmore, R. Nickerson
Reported by R. Nickerson

Recent work on fibre-optics has revolved around the connection between fibre and LED/PIN. We have started a serious investigation of active alignment so that fibre stubs could be connected to the LEDs, making installation much simpler in the global system. This requires the use of connectors, so we have re-evaluated the available parts. In particular we are impressed by fusion splicing, which seems to offer a very attractive method for making joints.

We have measure the accuracy of location of the diode within the can and find it to be rather poor in the parts we have. This is an issue which we are taking up with the manufacturers. Honeywell have further indicated some reluctance to produce a non-magnetic can for us. This is apparently a political vibration within the Honeywell corporation and it remains to be resolved. There are clearly serious divisions within Honeywell over their interest in developing our package, so we have approached Fujikura, who have indicated considerable interest in examining our problem.

The receiver chip design has undergone considerable revision as a result of further conceptual design work this month. As the transmitted format changes, so does the receiver chip design.

The synchroniser chip was received back from ES2, and found to not hold voltage, a problem which has resulted from poor manufacture. It is being reprocessed now.

University of California - Santa Cruz

Component Testing and Characterization

Technical Staff: E. Barberis, N. Cartiglia, D. Dorfan, S. Friedman, D. Goldin, D. Hutchinson, E. Spencer, W. Rowe, H. Sadrozinski, A. Webster

Reported by H. Sadrozinski

Continuing testing of the Tektronix TEKZ chip on automatic probe station, set up test of UTMC DTSC chip with probe card. Start breakdown test of oxide in coupling capacitors on DSSD. Analyze capacitance of detectors from LAMPF proton irradiation. Analyze radiation damage on AT&T and Westinghouse test structures from LAMPF proton irradiation. Submit proposal for irradiation program at TRIUMF and LAMPF. Form collaboration in Italy to test bipolar chips and set up labs and plan irradiations. Prepare for KEK beam test to start December 10, 1992.

1.1.3 External Mechanical Systems

No activity this month:

1.1.5 Silicon Pixel Detectors (not part of current construction plan)

Collaborative (see staff below)

NO ACTIVITY REPORTED.

1.1.6 Assembly/Test/Special

No activity this month.

1.1.7 Project Management

UC Santa Cruz

Technical Staff: A. Grillo, A. Seiden
Reported by A. Grillo

According to my count there were two MOUs with FY93 Amendments completely signed off by month end and another two ready for signatures. That leaves 5 more for our domestic collaborators yet to finish. Mark Strovink has been having discussion with the institutions working on the Wedge Detectors to finish up their agreements.

We now have two target specifications for integrated circuits in draft form. A standard form with required topics is emerging. With some focused attention we should be able to get these two through review and signed off in December. The hope is that these two specs will serve as models for the many others which must be written by the various "responsible engineers" designing components of our sub-system.

Univ. New Mexico

Mechanical Integration with SDC

Technical Staff: J. Matthews (UNM)
Reported by J. Matthews

A mechanical integration meeting was held at SSCL November 12, 1992. Bob Hovde distributed a compilation of SDC measurement and alignment goals. There was substantial discussion on the topic of support for various detectors subsystems and the capabilities of those supports to provide alignment adjustments. The subsystems with an impact on the silicon tracking system include the outer tracking system and tracking system overall support/alignment structure, the coil, and the calorimeters. The ability to position the tracking system relative to the coil/calorimeter may be needed to achieve the tracking system alignment goal of 0.5mm centering with respect to the beam. Relative motion of the tracker with respect to the coil/calorimeter would need to be done without transferring loads to the tracking system via the large service plant (cables, pipes,..). Any adjustments must be confirmed by measurement of the actual motions of the tracking system.

The status was that the present plans for positioning of the calorimeter will not meet the tracking system goal for centering on the beam. One possibility is for the calorimeter support to provide the precision vertical positioning and the tracking system support to provide the precision horizontal positioning. In this scenario the tracking system services would have to be designed to allow for relative horizontal motion of the tracking system with respect to the coil/calorimeter without transferring loads to the tracking system. This
is less stringent than requiring the services to allow arbitrary motions of the tracking system.

The "fence post" position measuring system planned for the muon system should be extended to provide position measurements of suitable "fudicials" on the tracking system.

Technical Staff: J. Matthews
Reported by J. Matthews

Los Alamos National Laboratory

Technical Staff: H. Ziock (LANL)
Reported by H. Ziock

Electrical Integration with SDC

During November work was done to produce a more complete specification of the basic cabling system for the silicon subsystem. The transition point from the high mass copper cables to the low mass beryllium cables was moved to just outside the barrel calorimeter and the cables were resized. A review of the configuration of the cable system was begun. The people participating in this process include A. Grillo, K. Hess, W. Miller, R. Nickerson, H. Spieler, and H. Ziock.

Offline Software Liaison to SDC

Collaborative

Technical Staff: B. Hubbard, K.O'Shaughnessy (UCSC); D. Coupal (SSCL)
Reported by B. Hubbard

The last month much effort has been spent examining in close detail the reasons that the reconstruction code misses tracks. Higgs' events at design luminosity and 200 GeV pt b-jets were studied. Some changes to the fitting routines were made which substantially helped the efficiency in crowded regions. These solutions are now being installed into the official version of the code.

Dave Coupal has finished modifying the TS tracking algorithm, which has been used with the silicon/straw/gas microstrip system so that it can use fiber segments in place of straw segments, for comparison of the two outer tracker options. The aim is to evaluate the performance using QCD jet events at a range of transverse momenta. He has also been generating a sample of silicon + straw + ITD events for comparison.

Accelerator Interface

Collaborative

Technical Staff: D. Coupal, G. Chapman, M. Hechler, N. Mokhov, T. Pal (SSCL); A. Palounek (LANL)
Reported by T. Pal

No activity reported.
1.2 Barrel Tracker R&D

Subsystem Manager: Harold Ogren, Indiana University

For the Straw System we have progress reports from Colorado State University (Submitted by R. Wilson), Duke University (Submitted by A. Goshaw and S. Oh), Indiana University (Submitted by H. Ogren), University of Colorado (Submitted by W. Ford), Oak Ridge National Laboratory (Submitted by D. Davis), QRS (Submitted by B. Dunn), and Westinghouse Science and Technology Center (Submitted by D. Hackworth and R. Swensrud)

Summary:

During the month the Straw group worked on many aspects of our project with two goals in mind: the decision meeting in February and the beam test that is planned for the summer at BNL.

Preparation for the SDC December meeting and the decision process included completion of several neutron studies, as well as studies of electronics effect from large pulse height events. Several studies were begun on backgrounds, survivability, risk assessment. Simulation work in preparation for the decision was carried out at IU and Colorado.

We created two review committees that will begin preparation for a preliminary design review in the spring. The Module Assembly group met at IU and will meet after the SDC meeting at Duke. The other committee, on endplate design, will meet just before the SDC meeting in Dallas.

Work continued on module construction, tooling design, new straw production, completion of a bid package for trigger module shells, and interfacing of front-end electronics to the chambers at Duke and Indiana. The support frame contracts were completed for the test beam run.

The final changes to the MOU and amendments were signed, and the Statements Of Work were finalized for 1993.

Enclosed are the individual reports from members of the Straw group. They cover the following WBS items:

WBS 1.2.2 support
WBS 1.2.5 Tooling
WBS 1.2.6 Utilities
WBS 1.2.10 Facilities
WBS 1.2.11 Management
WBS 1.2.12 R&D activities

1.2.2 Support

1.2.2.1 Support Cylinders
WSTC

Engineers: W. Barkell, R. Swensrud

1) Completed the report of the combined selection and material property matrix, and FEA baseline deflection study (This report is on hold pending further FEA work on strut down sizing scheduled for second quarter FY 93).

2) Completed the draft report on humidity testing done to date (This report is also on hold pending further work on material testing scheduled for second quarter FY 93).

1.2.2.3 Spaceframes

WSTC

Engineers: W. Barkell, R. Swensrud

Shim Rings

1) Issued the design report for the module attachment and actuating tool prototype.

Spaceframes

Engineers: W. Barkell, R. Swensrud

1) Completed the Revised Straw Outer Tracker Subsystem Geometry Definition Report.

1.2.5 Tooling Equipment

1.2.5.1 Module Tooling

Indiana

Engineer: T. Collins

1) Organized a review team to look at the module assembly.


2) Prepared the straw component assembly purchase request. It is now in final form and ready to go out for bids.

3) Design and in the process of procuring the Lid/Base attachment tooling.

4) Started preliminary design of straw handling and wire insertion tooling.
1.2.5.2.2 Support Alignment

WSTC

Engineers: W. Barkell, R. Swensrud

1) Assisted in further developing a detailed hardware specific subsystem program plan for the structure alignment work required during tracker component fabrication and final assembly.

1.2.5.4 Tracking Detector Alignment

QRS

Staff: M. van Haaren, W. Dunn, A. Yacout
Author: M. van Haaren

In November, we have been revising the measurement task list developed last month. We are planning to continue work on tasks related to final global position measurement of the straw modules and we are working on a complete alignment plan for the spaceframe production as well as shim ring machining processes.

We are planning to test our module fiducial measurement technique at the SSCL in December (at the SDC meeting DEC 10-12).

We are planning to build three fixtures to conduct this test using various sized balls and plates.

Duke University

Physicists: Al Goshaw, Tom Phillips and Bill Robertson

(Al Goshaw, Bill Robertson and Bao-tang Zou)

Some prototype fiducials for the straw tube modules have been made at Duke by Michael van Haaren of QRS. The survey equipment (Wild Themat 3000) has finally arrived at the SSCL and will be available in early December for tests of the survey procedure proposed for the straw tube modules. David Veal will conduct the survey at the SSCL with the help of Michael van Haaren.

If these results are satisfactory we will proceed to work with the group at ORNL on the design of plates or bands needed to mount the fiducials on the modules. Tooling for aligning the fiducials with respect to the precision surface on the module "foot" has to be developed. We have some fairly specific ideas about how to transfer the wire map measurements to the fiducial locations. A plate which would use two of the fiducials as part of a kinematic mount would provide a reference to external sense wires. These in turn would be measured as part of the scan of the sense wires internal to the module.

Bao-tang Zou is now working at Duke and is in the process of setting up SDCSIM on our local Vax cluster. This will eventually be used to study the effects of chamber misalignments on tracking measurements, and help to refine our placement and survey requirements.
1.2.6 Utilities for the Straw Tracker

**ORNL**

1.2.6.1.1 Straw Tracker Cooling Utilities
Engineer: R. Leitch

1.2.6.1.2 Drift Gas Utilities
Engineer: R. Leitch

1.2.6.1.3 Signal Electronics Utilities
Engineer: R. Leitch

1.2.6.1.4 Electrical Power Utilities
Engineer: R. Leitch

1.2.10 Facilities

1.2.10.1.1 Module Clean Room

**Duke**

As discussed in last month's report, we need to acquire one more large lab room for construction of straw tube modules. A 900 square foot room will be available to us starting in May of 1993. We expect to get a grant from Duke to carry out some physical modifications of the room for our SDC work.

**Colorado State University**

Physicist: R. Wilson

**Indiana University**

Engineer: T. Collins

Contacted a third vendor of clean rooms. He visited the site and is preparing a bid. We have bids from one vendor. Prices look reasonable.

1.2.11 Management

1.2.11.2 Scheduling and Reporting

**Westinghouse**

Engineers: F. Beninat, R. Swensrud

1) Presented to the sub system at a meeting at the SSCL during the week of October 26 the strategy to be used in the future to facilitate Cost/Schedule Control for Earned Value tracking.
2) Continued to setup the FY93 Engineering Budgets per the WBS with an overall institutional wide detailed schedule, well defined deliverables, and work task activities to facilitate Cost/Schedule Control System Criteria for Earned Value tracking.

3) Issued, on November 16, 1992 to all 7 Institutional Cost Account Managers, the first monthly update summary of the Outer Tracker Subsystem WBS 1.2 construction cost and schedule progress report. This report was for the period from October 1 to 31, 1992. The document contained an overview of each institutions FY93 work packages, the actual work tasks, a schedule, and a spreadsheet (plus a diskette) for next months update. This report will be issued monthly.

1.2.11.5 Management, Scheduling and Reporting

Westinghouse

Engineers: F. Beninati, R. Swensrud

1) Attended the SDC Collaboration DOE Stage II Approval Presentations at SSCL on October 26 to 30, 1992 and respond to straw tracker engineering, cost and schedule questions.

2) Responded to technical questions from the vendors with respect to the Hercules prototype cylinder and lamina tests and the Kaiser spaceframe testing program being procured by SSCL.

3) Attend and participate in the subsystem relationship alignment strategy meeting held at the SSCL on November the 12th.

4) Drafted a statement of work, tasks, deliverables, schedule, and detailed cost breakdown in response to a pending RFQ from the SSCL for the FY93 tracker design effort.

ORNL

Engineer: D. Davis

Program Management

Additional engineers are being brought onto the job to support mechanical efforts. Several experienced individuals have been interviewed and a selection is expected in early December. With these additions, David Vandergriff will be transitioning off SDC work over the next several months to assume a position with the Advanced Neutron Source program.

Indiana University

Physicist: G. Hanson, H. Ogren

Final changes in MOU amendment were made to reflect the costs of items that are going to be bid by SSC. The contract proposal to DOE was written, and negotiations with the university were begun on matching funds for the assembly areas. Two review teams
were set up to study the module assembly process and the endplate design. They will report to the Straw Technical Board in preparation for the preliminary design reviews in February.

The organization for the December meeting, the decision report on Straws or Fibers, and discussion with rapporteurs took up a major part of the month.

*University of Colorado*

Physicist: W. Ford

Made a presentation on the scope of the straw tracker at the DOE Review. Completed MOU and amendment. Held planning meeting with CSU on the Colorado assembly line, and attended a meeting at IU of the committee to design the assembly process.

1.2.12 R&D Prototypes

1.2.12.1 R&D on Modules

*ORNL*

Prototype Cylinder/Module Interface - David Vandergriff

Design of a prototype module attachment began this month. Current efforts are focusing on the method for attaching the module foot to the module shell in a manner that will allow knowledge of the straw location relative to the foot. In conjunction with the foot attachment, the placement and attachment of the fiducial relative to the foot is also being evaluated.

*Colorado State University*

Physicists: W. Toki, R. Wilson

*Duke University*

Physicist: S. Oh. Chiho Wang
Engineer: William Lee

*Straw Drift Tube Chamber Research and Construction*

(Seog Oh, Chiho Wang, William Lee)

During November, we have been working on the four projects.

1. Test of the electron scanner.
2. Study the chamber response to neutrons.
3. Test of the ORNL ASD module.
4. Design of an end-plate.

1. This month, we are continuing to test the scanner. We have moved the scanning location to several different places along the module. In one location, we have...
noted asymmetry in the average time distribution which for ~50% of wires (out of 48) we have not seen before. We do not understand the asymmetry. We are investigating the reason.

2. The neutron measurement study continues using different ASD electronics. The cross talk with Penn ASDs is quite similar with the results using Lecroy ASD card. The cross-talk is confined within the neighboring tubes. We also measured the output pulse width from ASD electronics for very large signal pulse (pulse from knocked out protons). The pulse width is about 100-200 NS for the signal about 100 times of the minimum ionizing track. On the request from Gil, we measured the shielding effect of polyethylene. We measured the counting rate due to neutrons as a function of polyethylene thickness.

3. E. Emery of ORNL came to Duke to test the first 159 channel ASD module. With some modification, we were able to fit the ASD module to the straw module. We were not able to extensive test because a good fraction of ASD chips were bad. However, we were able to study HV connection, noise pickup and grounding schemes.

   The minimum threshold we were able to operate was 1.5V (6 fC). ORNL is constructing another ASD module with better grounding and good chips. We will continue the test when the new ASD module is completed.

4. For the preparation of the module construction for the test beam, we are designing an end-plate based on the design of the existing module. A prototype is being constructed in order to test mechanical, electrical characteristics. This design is considerably reduced in material, and the end-plugs are integrated with the plate.

   Indiana University

   Staff: B. Martin, E. Wente, T. Collins, M. Hampton
   Physicists: G. Hanson, D. Rust, H. Ogren, F. Luehring

   R&D on Modules

   Module developments for the beam tests were worked on extensively this month. They included:

   1) Submission of a trigger module endplate to the machine shop for creation of several sets of endplates by mid-December. This will be the first module to have the gas returned to the same end as the supply.

   2) Inspection of the straw production at Stone industrial as they began the production of 2000 straws for the beam test modules.

   3) Placement of a straw order with Lumina in England for 1000 straws. They have had experience with making straws for CERN, and may be cheaper.

   4) Placement of an order to manufacture a test sample of resistive double V’s using the Colorado mold and Columbine Plastics. If these look OK, we will have them make a new mold that would be satisfactory for terminations.

   5) We constructed a model of the beam test structure to understand some of the constraints. This model or a copy may be sent to Japan for comments.

   6) We have been studying a new stereo module that was completed this month.
Several new measurements of crosstalk in the 12-inch prototype straw chamber/ASS-D8 system, with Fe55. Various approaches confirming about 1-3%. Measurements of the A-S-D8 output pulse width as function of input pulse charge. Preliminary findings are:

1) With Fe55 at a HV setting chosen to match output pulse height to what we'd get for minimum ionizing at the design gain of 20000, we measure 31 ns. The design value is 25 ns, for pulse shapes corresponding to minimum ionizing particles. (2) Raising the HV until we see 10* input charge the output pulse width increases to 45 ns. (3) With Fe55 at high gain (about 300,000) the largest output pulse width we see is 55 ns. This indicates the response of the front end to highly ionizing radiation. (4) For a few pulses captured with cosmic rays the width was about 35 ns, over a wide range of crossing angles.

Cinch Connector supplied a quote for a connector to bridge between wires at HV and the ASD, with the blocking connectors built into them (CIN::APSE technology). We are working with them to finalize the design for a prototype.

Produced a preliminary design for a HV supply board with recesses for HV guards to mate the Cinch connector/capacitor assembly. Consulted with a local vendor on the design (which presents some challenges); presently anticipating further input from them. Ordered several of a modified routing board for use with a high-density prototype FEB being built at Penn.

Completed a report (SDC 92-360) of a measurement of the radiation length of sample blocking capacitors. Confirms they contain high-Z material.

Prepared a specification for HV capacitors that includes a figure of merit for the radiation length contribution. Anticipating a response from KD Components.

We are conducting detailed discussions with several vendors on the next procurement of wire supports. One indicates a reasonable price for double V's in quantities needed for test beam prototypes. We are also seeking quotes on the twister design, made by machining, but also possibly by injection molding.

**Beam Test Components**

**Westinghouse Science and Technology Center**

Engineer: W. Barkell, R. Swensrud

1) Produced a detailed schedule, conceptual design, and a draft conceptual drawing package for the support structure for the FY93 R & D WBS 1.2.12.1 & 2 Beam Test Prototype Program.

2) Obtained estimates for long lead tooling items such as cylinder mandrels and shim ring machining tooling for the Beam Test Prototype structure.

3) Obtained estimates for sub component major fabrications such as cylinders, Spaceframes, and shim rings for the Beam Test Prototype structure.
1.2.12.2 Beam Test Assembly and Mount Prototype

**ORNL**

Motion System - David Vandergriff

Initial design requirements for the beam test motion system were received this month and are being evaluated. Discussions with Indiana University are underway and initial design concepts are being formulated. It is hoped that layout work can begin in December.

Prototype Utilities - Rob Leitch, Doug Sparks

A plan was developed to aid in the design process for the prototype utilities to be used in the beam test planned for June 1993. Conceptual drawings of the beam test article have been received from Westinghouse and the process of designing utilities and interfacing them with the test article has begun. Several design inputs are needed in order to complete this design. Among them are the electronics configuration, an accurate description of facility interfaces, and the available resources at the beam test facility.

*Westinghouse Science and Technology Center*

Engineer: W. Barkell, R. Swensrud

1) Develop a conceptual design plan for the concepted FY93 R & D WBS.

2) Obtain quotes for long lead material, component, and tooling items for the assembly.

*SIMULATION*

*Colorado*

Physicists: W. Ford

In the simulation effort, reconciled occupancy results with those measured by Indiana. Began a study of the flux of low-energy photons.

*Indiana*

Staff: E. Wente
Physicists: F. Luehring, G. Hanson

1) Code maintenance for RW track reconstruction program.

2) Improved segment fitting in RW reconstruction program.

3) Optimized track finding cuts.

4) Compared Silicon based track finding and track fitting (TS program) with global track finding and fitting (RW program). Found that the TS fitting worked better than the RW program because it accounts for multiple scattering. Found some bugs in the TS code as a result of this study.
5) Studied the track finding ability of the combined tracking system in the process $H \rightarrow uuee$ at design luminosity.

6) Studied the track finding ability of the system given a descoped or no silicon tracker. Found that you can still find the Higgs and Z peaks even with no silicon.

7) Help J Chapman's student run the straw tube trigger simulation.

1.2.20 Tests of Scintillating Fiber Tracking at BNL

_UCLA, UIChicago, Notre Dame, Penn State, Purdue, Rice_


_Cosmic Ray Test of 1K Fiber/VLPC Channels_

_UCLA, Fermilab, Notre Dame, Penn State, Purdue, SSC Laboratory, UT Dallas_


1.2.26.3 ASD Development

_Fermilab, Notre Dame, ORNL, Purdue, UT Dallas, Rockwell EOC, Rockwell SC_


1.3 Intermediate Tracker R&D

1.3.1 GMD (Gas Microstrip Detector) Tiles

_Carleton/CRPP_

Technical Staff: G. Findlay, P. Gravelle, E. Neuheimer, K. Miels, M. O'Niell, Y. Yu


Submitted by M. Dixit

In early November, preparations continued for the beam test at CERN. We found that the P10 gas mixture was not a good enough quencher to obtain good gains at reasonable operating voltages for the 200 micron pitch GMDs. Much better gains were obtained with the OPAL gas mixture (argon/methane/isobutane 90/8/2) and argon/isobutane 80/20. For the beam test, a 200 micron pitch Tedlar GMD with aluminum electrodes (with readouts for both individual anodes and groups of 8 anodes) was used.
with argon/isobutane 90/10. Because of the quality of metallization, there were many broken anode traces and parts of the GMD were inoperational. However, for the active anodes, the gain was above 3000 and we were able to record energy and timing information for about 20,000 beam events. The trigger threshold was about 6 electrons before gain (3 fC after gain) and the online timing resolution was about 18 ns (sigma) consistent with the rise-time, gain and the noise performance of the electronics used.

At Carleton a GMD using ion implanted Upilex from Spire Corp. has been successfully operated. This has 400 micron spacing gold anodes and is operated with "Opal" gas. The sample will hold cathode voltages of 830 giving gas gains of 1200 and is very stable. The Fe55 peak and the escape peak are well separated from the noise. The resolution of the main photopeak is about 20%.

Reported by M. O'Neill

A draft proposal for a collaboration with the National Research Council Materials Division on the development of the composite components for the ITD; tile backing, drift plane and support disks and support structure has been written.

Carbon fibre/Rohacell prototypes of the largest tile backplanes and drift planes have been made.

Tile deflections under different boundary conditions were studied using hand and FEA (ANSYS) calculations and a draft summary of this study prepared. The radiation length study has been updated to reflect new information obtained as a result of the FEA analysis.

An engineering working meeting was held at RAL, discussions included tile design, mounting, cooling, drift gap, stereo angle, LV and HV electronics.

Liverpool

Technical personal: A. Muir, C.D. King + Workshop
Physicists: S. F. Biagi, T. J. V. Bowcock, T. J. Jones, S. Kiourkos
Submitted by T. J. Jones

Masks:

Two new mask designs have been completed by CompuGraphics and one copy of each has been sent to Hughes Microelectronics for processing.

Substrates:

Hughes are producing 12 substrates of ion-implanted SiO2 (3 microns) deposited on a 4" si wafer.

There will be 6 of each mask design, processed using the wet etch technique.

Hughes have suggested the use of phosphorous-doped SiO2, with a surface resistivity of 10E11 Ohms/cm2 as a substrate material and will produce 2 of each mask design.

The doping of the SiO2 occurs during the CVD process.

If these substrates work, the need for expensive, large area ion-implantation would be eliminated.
**Electrostatics:**

A 2D simulation of the electrode geometry corresponding to the largest MSGC tile required for the ITD (Superlayer 3, ring 1) has been made.

The electric field at the anode centre was evaluated from the simulation of two geometries corresponding to the inner and outer extremities of the tile.

The back-plane and cathode voltages were set to -700 V whilst the drift plane was at -1000 V, giving a drift field of 2.15 kV/cm across a 2 mm drift gap.

The substrate was assumed to be a 300 micron thick piece of 'something' with a relative permittivity of 5.0.

Parameters such as the anode strip width and anode-cathode gap were varied.

It was found that with a constant width (10 micron) anode and a constant width gap (78.57 microns) that the field at the outer end (320.64 kV/cm) was 0.7% higher than that at the inner end (318.53 kV/cm).

The change in field can be further reduced by allowing a small change in the anode-cathode gap from 78.57 microns at the inner end to 80.79 microns at the outer.

A simulation of the existing 300 micron pitch parallel sided pattern mask, as used in the test-beam chambers (see below), has also been made in order to understand the operating conditions of these chambers.

**Test Beam:**

The full support system for the U.K. MSGC beam test (Nov 92) was shipped to RAL and, following a trial build-up, to CERN where it was installed in the T7 beamline of the PS.

In collaboration with other U.K. groups, 3 RAL-type chambers were mounted and surveyed into position.

The chambers, each equipped with 32 channels of hybrid front-end amplifiers were readout into a 96-channel DL300 100MHz FADC system (RAL/UCL) and, via a buffer-adder post-amp (RAL) into the Lecroy 9450/PC 2-channel 400Msa/s system (Liverpool).

The run went well, with data being collected on all 3 chambers using both the DL300 FADCs and the Lecroy 9450 'scope.

Some data were taken with one chamber mounted on the rotary table (Liverpool).

**Universte De Montreal**

Physicists: Louis-Andre Hamel, Jean-Pierre Martin, Pierre Savard, Paul Taras
Reported by Paul Taras

In spite of a rather poor lithography, we finally were successful in observing for the first time signals from our GMOs. Our GMOs consist of a 670 micron thick Si wafer on top of which we have deposited a 1.75 micron thick SiO2 layer covered with a 1 micron thick a-Si:H layer having a bulk resistivity of 10**9 ohm-cm. The electrodes were 0.4 micron thick Al strips with a pitch of 400 microns. After optimizing the voltages, we shall carry out long term tests. Meanwhile, we shall do a new lithography on some of our other
wafers. We believe that the reason for the present success is the thicker SiO2 layer, 1.75 microns compared to 0.6 microns in the past.

RAL

Technical Staff: J. F. Connolly, J. E. Bateman, R. Stephenson, A. Nichols
Physicists: M. Edwards
Submitted by M. Edwards

The three Gas Microstrip modules prepared last month were installed in the test beam at CERN. Several days of data have been collected. This is currently being analysed.

Work on the large area mask with keystone cathode pattern continues. The company we were expecting to produce this mask now informs us that they cannot make it. We have contacted several other companies who claim to be able to produce the mask, and are in detailed discussion with at least one of these. Sources of masks larger than 210x155 mm are still being pursued.

Testing of various semiconducting glass substrates continues. Preliminary results from one of these are encouraging in that; it shows no gain change with time after turn on; little or no gain change with rate up to 10KHz for up to 2.5 hours; while there is a small gain change at 45KHz rate.

(This is a higher rate than expected at the SSC at design luminosity.) Samples of thin, 0.3mm, sapphire substrate material are on order from ITEP Moscow.

A systematic study of the difference in performance of identical substrates produced by wet etch and dry plasma etch has been initiated.

Purdue

Technical Staff: I. Shipsey, P. Wang, T. Miao, M. Bishai, E. Gerndt, N. Menon
Submitted by I. Shipsey

We are attempting to manufacture a large GMD using excimer laser ablation. A purdue negative chrome on quartz mask using a Hoya blank was able to take 70 mJ/cm² without damage. This is adequate for exposure of photo-resists and also for laser ablation of photo-resists.

Four tempax glass samples were prepared at Purdue with two photo-resists. No attempt was made to optimize the photo-resists used, or their thickness. These samples were exposed at Resonetics Inc., using the Purdue-made quartz mask. For each sample five or six separate GMD's were imaged with differing laser fluences. The samples were subsequently shipped back to Purdue for metallization and lift-off.

We had previously practised lift-off using UV lithography and have successfully produced patterns with 10 micron linewidth using Al on Tempax glass using this technique. We are therefore confident that we can produce patterns in the laser processed substrates. The results of this experiment are presented below.

<table>
<thead>
<tr>
<th>SAMPLE</th>
<th>LASER ACTION</th>
<th>STATUS</th>
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We conclude that when this experiment is repeated with a photo-resist optimized for excimer lithography, such as CAMP-6, that there is a high chance a GMD can be successfully produced.

We are also currently preparing metallized substrates and a positive image quartz mask for direct etching.

We have continued to build working GMD's on Tempax at Purdue from Purdue masks.

We have built our first working detector on Fe-Vanadium glass and have an Upilex chamber under test.

We are beginning the design work for a Bellazzini style buried-layer thin SiO₂ GMD. All facilities for manufacture exist in-house at Purdue.

Naresh Menon presented a paper on our work at the Undergraduate Science Symposium at Argonne on 7 November 1992.

Texas A&M


Physicists: E.F. Barasch (now at Touro College, Dix Hill, NY), H.P. Demroff (full time), R.M. Gaedke (Trinity University, San Antonio, TX), P.M. McIntyre, H.-J. Trost, G. Vanstraelen (SSCL, Dallas, TX)

Reported by Hans-Jochen Trost

The ion-implanted Kapton chamber (manufactured by Spire Corporation using our mask) has been tested at A&M and then irradiated with a 60Co source at Spire with dose of 1 Mrad and 10 Mrad. After each irradiation, we measured unchanged performances, the gain is the same as before irradiation and the 55Fe peak width at 5.9 keV is still at 17%. Note that these irradiations were on the open patterned substrate for the 1 Mrad and under our test chamber cover but in air for the 10 Mrad, in either case therefore without operating gas and voltages. Thus we have tested strictly the substrate and gold metallizations alone.

A comparison of gain-cathode voltage curves at otherwise equal conditions of chambers with widely different surface resistivities indicates that with increasing
resistivities larger gains are obtained. This effect is canceled out though by less mobility of charges on the surface leading to reduced rate capacity.

We have begun to work more with Argon-Isobutane gas (75-25) in place of P-10.

We find more or less equal responses at equal voltages but can in Argon-Isobutane-thane move voltages higher to obtain gains up to 7000 on the implanted kapton. This is again not a hard limit.

For our as yet uncompleted coarse alternative design using Bellazzini type chambers, I have investigated the turn-on thresholds for bins of $\Delta \eta = 0.3$, from $\eta = 1.8$ upwards. For thresholds up to about $p_T = 20$ GeV/c and $\eta < 2.7$ they retain barely acceptable sharpness, for higher energies and/or pseudo-rapidities, they deteriorate appreciably. We will move to go through the manufacturing process of Bellazzini style chambers next, and continue to work on multiline read-out for our test chambers.

Texas Tech University

Reported by: A. Sill

Hardware for microstrip testing:

We have decided to initiate purchase of a second SRS/SDA system to be used at Texas Tech for readout of CDF-style silicon electronics preamplifier chips. This system will be identical to the one being produced now at LBL (in collaboration with Rochester) for use at Fermilab, and will allow testing to proceed in parallel at both locations. The lead time is 2 to 3 months for the receipt of these items.

Modeling of silicon backup option:

Using the parametric program reported earlier, we have continued modeling of various options for the use of an all-silicon back-up intermediate tracker. Previous work showed that such a system would be conceptually possible with the addition of less than 10 square meters of total area to the default silicon tracker, and would have parametric resolutions in $p_T$, $\phi$, and impact parameter close to those of the default baseline, but would have a reduced number of hits (which could lead to poorer pattern recognition) at high eta.

The new work has been focused on systems which would need less additional silicon in order to decrease cost. The results of these studies seem to indicate that at least 8 to 10 square meters would be needed, even after accounting for removal of some disks of the default silicon where the Si ITD would replace them, in order to achieve baseline performance. Thus an all-silicon system (inner tracker + Si-ITD) in the forward direction would cost more than the present system to achieve the same performance.

We studied also a "mixed" configuration of silicon and gas microstrips which would consist of a slight expansion of the disks at the end of the silicon tracker, followed by a simple non-projective ITD. It would consist of six layers of double-sided gas microstrips per end, arranged in groups of two layers per superlayer. The trigger would take place in three layers of silicon arranged projectively at the end of the silicon tracker in front of the ITD.

The value of adding inner disks (in the radius range between 9 and 15 cm from the beamline) to the silicon disk layout has also been made clear by these studies, in agreement with work being done within the silicon group. Such "small" disks improve the lever arm

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for reconstruction of forward-going tracks, and appear to give very good "bang for the buck" as an element in arranging a cost-effective final system.

**Triumf**

Physicist: R. Henderson M. Salomon  
Submitted by: M. Salomon

1.3.2 Front End Electronics

**Carleton/CRPP**

Technical staff: E. Neuheimer, G. Findlay  
Submitted by: J. Armitage

A set of three amplifier boards were constructed for the recent GMD beam tests. We experienced some oscillation problems when all three amplifier driver boards were assembled together in the Test Beam chamber holder. This was cured by shielding the driver stages with copper foil attached to the local amplifier ground. After that, noise levels obtained from the amplifier chain, including the receiver module, were typically 20mV peak to peak (this was measured in position at the test beam with all channels connected and using 15m of cable between the driver and receiver). The amplifier had a gain of 0.5mV/fC; the driver a gain of 20; and the receiver was unity gain leading to an overall figure of 10mV/fC. Thus the noise figure quoted here corresponds to 2 fC peak to peak. Converting this to r.m.s., using the square root of 12 as the conversion factor, gives a figure of 0.6 fC r.m.s. or 3,700 electrons. If a minimum signal to noise ratio of 5:1 is required, the minimum signal would then be 18,500 electrons and assuming a gas gain of 2000, means that with these electronics the chamber is sensitive to a signal size of 9 initial electrons with a 5:1 S:N ratio.

The cabling concerns for the final detector have been reviewed. A meeting was held with Ken Hess to go over the current estimates. Our estimates have to be updated due to the continually evolving design of the ITD. Additionally Ken was able to provide a more accurate measure of the final cable lengths. These are longer than anticipated and will result in a greater voltage drop for the low voltage supplies. It is likely that the cable diameters will have to be increased. Alternative solutions are being explored.

**Universite de Montreal**

Personnel: Louis-Andre Hamel, Jean-Pierre Martin, Pierre Savard, Paul Taras  
Reported by: P. Taras

**Oxford University/RAL**

Technical Staff: Mr. R. Wastie, Mr. N. Martin, Dr. A. Brooks, Dr. N. Kundu, Mr. K. Shankar, Mr. R. Wilkinson, Dr. P. Seller, Mr. M. French  
Physicists: R. Nickerson, A. Fox-Murphy, R.J. Cashmore, M. Edwards  
Report Author: R. Nickerson
The parts of the ITD front-end electronics worked on by Oxford and RAL are largely identical to the silicon. Work is currently focussed on the front-end digital chip and the detailed report can be found under silicon.

Some effort has been put into evaluating some ITD specific details of LED the hybrid layout.

1.3.3 Mechanical Engineering

Carlton/CRPP

Technical Staff: M. O'Neill, Y. Yu, K. Miels
Submitted by M. O'Neill

The material requirements at the disk/cone interface were examined using FEA. A draft summarizing the FEA work on the Support Structure has been written. The radiation length study has been updated to reflect new information obtained as a result of the FEA analysis.

Concepts for x, y', and z mounts and adjustments for the ITD support to central tracker support frame are still being developed. Discussions with suppliers and fabrications continues on costing, materials and fabrication issues. An engineering working meeting was held at RAL, discussions included support structure design and mounting issues.

Liverpool

Technical Staff: C.D. King, A. Muir
Physicists: T.J. Jones, J.M. Morton
Reported by T. Jones

Design work on the MSGC tile and its mounting to the disc and connection and routing of services on the discs is progressing. WBS 1.3.8 Installation

RAL

Technical Personnel: G. Tappern, K. Goodchild, R. Malton
Reported by G. Tappern

The FEM of the support structure has continued and now includes skin thickness of the carbon fibre panels and construction details of the 90mm thick polymoderator disk.

Samples of the Hexcell carbon fibre holnetcomb has arrived in England and tests of coefficient of expansion and water absorption will start as soon as some prepreg is available.

The quarter section drawing of the support structure has been updated to the latest known information. This drawing has been successfully transferred electronically to Kurt Pennington at SSCL.

Conceptual design of the mechanism for transfer of the ITD from barrel to end cap for access continues.
1.3.8 Installation

Carleton/CRPP

Submitted by M. O'Neill

RAL

Submitted by G. Tappern

1.3.9 Project Management

Carleton/CRPP

Submitted by M. O'Neill

An engineering working meeting was held at RAL, discussions included plans for the next three months. A coop student has been hired for the period Jan - April 93 to work on tile cooling, design and mounting as well as continuing to update the radiation length study.

Simulation

Universite de Montreal

Reported by: P Taras

The SDCSIM package is now running on our Vax system. We intend to put some effort in understanding the intricacies of the program prior to installing it on a Unix machine.
Table 1: Central Tracking System Alignment Tolerances

<table>
<thead>
<tr>
<th>Placement</th>
<th>Calibration</th>
<th>Stability</th>
<th>Adjustment Tolerances</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;φ&lt;/sub&gt;</td>
<td>R</td>
<td>Z</td>
<td>R&lt;sub&gt;φ&lt;/sub&gt;</td>
</tr>
</tbody>
</table>

I. Local Subsystem Coordinate System (Internal)
- Pertains to individual superlayer alignment and stability between individual superlayers

<table>
<thead>
<tr>
<th></th>
<th>Silicon</th>
<th></th>
<th></th>
<th>Straws</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Gas</th>
<th></th>
<th></th>
<th></th>
<th>Microstrips</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;φ&lt;/sub&gt; (</td>
<td>25 μm</td>
<td>80 μm</td>
<td>250 μm</td>
<td>5 μm</td>
<td>80 μm</td>
<td>250 μm</td>
<td>5 μm</td>
<td>80 μm</td>
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<td>250 μm</td>
<td>250 μm</td>
<td>100 μm</td>
<td>250 μm</td>
<td>100 μm</td>
</tr>
<tr>
<td>R</td>
<td>140 μm</td>
<td>1200 μm</td>
<td>250 μm</td>
<td>35 μm</td>
<td>1200 μm</td>
<td>250 μm</td>
<td>35 μm</td>
<td>1200 μm</td>
<td>250 μm</td>
<td>250 μm</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Z</td>
<td>40 μm</td>
<td>1000 μm</td>
<td>1000 μm</td>
<td>40 μm</td>
<td>250 μm</td>
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<td>40 μm</td>
<td>250 μm</td>
<td>1000 μm</td>
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</tr>
</tbody>
</table>

II. Central Tracker Local Coordinate System
- Pertains to individual subsystem's centroidal axis alignment and stability relative to one another

<table>
<thead>
<tr>
<th></th>
<th>Silicon to</th>
<th></th>
<th></th>
<th>Straws</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Gas</th>
<th></th>
<th></th>
<th></th>
<th>Microstrips</th>
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</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;φ&lt;/sub&gt; (</td>
<td>135 μm</td>
<td>150 μm</td>
<td>250 μm</td>
<td>10E&lt;sup&gt;-5&lt;/sup&gt; rad</td>
<td>15 μm</td>
<td>250 μm</td>
<td>10E&lt;sup&gt;-5&lt;/sup&gt; rad</td>
<td>15 μm</td>
<td>250 μm</td>
<td>[3 mm]</td>
<td>[3 mm]</td>
<td></td>
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<td></td>
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<tr>
<td>R</td>
<td>10E&lt;sup&gt;-4&lt;/sup&gt; rad</td>
<td>1000 μm</td>
<td>250 μm</td>
<td>10E&lt;sup&gt;-5&lt;/sup&gt; rad</td>
<td>40 μm</td>
<td>250 μm</td>
<td>10E&lt;sup&gt;-5&lt;/sup&gt; rad</td>
<td>40 μm</td>
<td>250 μm</td>
<td>[3 mm]</td>
<td>[3 mm]</td>
<td></td>
<td></td>
<td></td>
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</table>

III. Detector Global Coordinate System
- Pertains to entire central region's alignment and stability relative to beamline

<table>
<thead>
<tr>
<th></th>
<th>Central Tracker to</th>
<th></th>
<th></th>
<th>Beamline</th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>R&lt;sub&gt;φ&lt;/sub&gt;</td>
<td>500 μm</td>
<td>250 μm</td>
<td></td>
<td>100 μm</td>
<td>250 μm</td>
<td></td>
<td>100 μm</td>
<td>250 μm</td>
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<td>[5 mm]</td>
<td>[5 mm]</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

References: SDC TDR, 4/1/92, #SDC-92-201; CDR Tracking Support System and Assembly, 1/30/92, by Westinghouse Electric Corp.
Fiber Lengths

Averaged over \( \beta \)

Radiation Lengths (%)

Pseudorapidity

\( 0.00 \) \( 0.20 \) \( 0.40 \) \( 0.60 \) \( 0.80 \) \( 1.00 \) \( 1.20 \) \( 1.40 \) \( 1.60 \) \( 1.80 \) \( 2.00 \) \( 2.20 \) \( 2.40 \) \( 2.60 \)
2.0 CALORIMETRY SYSTEMS R&D SUMMARY

Summary

Fabrication on the barrel prototype started in earnest in November. Steel plates were being machined for one of the hadronic absorber prototypes in the PRC. Materials were ordered in anticipation of building the second steel absorber prototype at Fermilab. Materials were also ordered for the prototype barrel EM sections for the two prototype wedges. Some details of the optics specification remain to be determined. Safety reviews are being organized to deal with prototype fabrication and eventual installation in the beam.

Important test results have been obtained for a forward calorimeter (FCAL) liquid scintillator test module placed in a beam at CERN. A decision between liquid scintillator and high pressure gas for FCAL will be made in late summer, 1993.

Plans were made for a conceptual design review of the endcap to be held on January 12-13 at LBL. The review committee will be asked to recommend the endcap configuration. The choice will be between the baseline shown in the Technical Design Report and the alternates for both the EM and hadronic sections.

2.1 Barrel Calorimeter R&D

ORNL

Technical Staff: T. A. Gabriel

2.1.1.1 Module Structure

Argonne National Laboratory

Technical Staff: V. Guarino

During the month of November, an iterative, or construction analysis was done on the Barrel Assembly to analyze the deflections and connecting forces of the structure while it is under construction, as well as to get a better handle on the actual final shape of the Barrel. The analysis is not yet complete, but data will be presented as soon as it is available. This analysis is intended to supplement analysis being done by FNAL, and will be used in conjunction with assembly of the Barrel Calorimeter.

Fermilab

Technical Staff: M. Banas, L. Bartoszek, I. Churin, R. Da Silva, B. Hahn, B. Wheeler

FNAL is producing weld samples to be tested for mechanical strength, as well as developing a test to study weld distortion and clamping issues. We are currently using a welding consultant to develop Weld Procedure Specifications which will qualify the geometry, process and individual welders. We should have test results from weld coupons in mid January.

The Chinese have received updated drawings allowing them to proceed with plate machining. A FNAL visit to China is being planned for late January or early February, 1993.
We have received the first shipping container from ANL; the second is in transit from Germany and is due in the next two weeks. Preparations are underway for installing brackets to hold two wedge halves from China. We have contracted with a shipping broker to coordinate the move from China.

FEM analysis continues on solenoid support and wedge to wedge connections. Looking at integrating the two requirements into a single design.

Following the December 11, 1992 SSCL review, work is continuing on documenting and completing the wedge engineering calculations to prepare for the FNAL safety review. An independent FNAL committee is being appointed to look at prototype safety issues.

2.1.1.2 Scintillator Assemblies

University of Tsukuba


Tile/Fiber design and fabrication

Design of prototype barrel EM tiles

Began design of tiles with half-key-hole grooves for 1 mm dia. fibers.

Design of prototype barrel HAD tiles

Began design of tiles with half-key-hole grooves for 1 mm dia. fibers.

Al sputtering of fiber ends

Hara and several students visited Ulvac Japan in Tsukuba.

Splicing of fibers

Optimized various parameters in the splice machine for 0.83 mm fibers at Nissei-Denki.

Number of photoelectrons

Measured the number of pe's from tile/fiber assemblies using double-clad WLS and clear fibers 0.83 mm in diameter. SCSN-81/Y11 yielded 4.2 pe's for $\eta = 0.6$ tiles. Investigating light yield dependence on pressure.

Availability of prototype SCSN-38 tiles and Y11 fibers

Discussed with Kuraray. The fibers will be available soon. The prospect of getting SCSN-38 tiles in a time schedule of our desire is gray.

Simulation

GEANT simulation of tile/fiber calorimeters

Doing simulation of EM calorimeters to evaluate effects of transverse non-uniformity and longitudinal non-uniformity.
According to the current plan of international responsibilities, some of the tiles, WLS and clear fibers, spliced fibers, PMTs, and CW bases will have to be shipped to China in the near future. We began investigating if any of them belong to controlled items of COCOM.

**Saclay**


**Shower Max Simulations**

**GEANT simulations:**

These simulations, using single particles, are continuing. The effect of the steps in Shower Max depth and the presence of the bulkheads is being studied.

Simulation of physics channels to determine trigger and reconstruction efficiencies are continuing:

\[ t \rightarrow W \rightarrow \tau \rightarrow \rho \rightarrow \pi^+ \pi^0 \rightarrow \pi^+ \gamma \gamma \]

\[ t \rightarrow W \rightarrow e \]

**Shower Maximum Detector**

Two engineers visited LBL and Fermilab to work on the design and schedule of the '93 pre-production prototypes.

The \((\eta = 0)\) shower max module was shipped back to Saclay and is being refurbished for a second iteration of fiber routing inside the module itself. The feasibility of the external fiber routing in the phi-cracks and its compatibility with the EMC fibers has already been demonstrated at \(\eta = 0\).

The design of the second module \((\Delta \eta \times \Delta \phi = 0.2 \times 0.2)\) is now complete. It will be installed in the high-eta region of the mockup barrel wedge at Fermilab \((\eta = 1.2-1.4)\). This module is made of individual strips of plastic, wrapped in TYVEK, and 3 meter long fibers of diameter 1 mm.

The goal is to test the assembly procedures of a SM module which is as close as possible to the final design, and in particular to make sure that the total thickness of the module \((\text{strips+fibers+wrapping+cover-plates})\) does not exceed the total allocated space of 20 mm. The second goal is to demonstrate the feasibility of the fiber routing in the high-eta region.

Fabrication of this module will start in December, and the installation at Fermilab will take place in January, 1993.

Procurement of scintillator and fibers for the '93 prototypes has been arranged with Tsukuba and Fermilab.
2.1.1.3 Photomultiplier Tube System

UCLA

Technical Staff: T. Muller, J. Hauser, K. Arisaka, D. Joyce, T. Tran, A. Mirzayan.

Reported by: D. Joyce

Crosstalk/Uniformity Tests of H4139

In early October we received a Hamamatsu H4139 MOD, 64 channel Multianode PMT, and began testing the level of crosstalk between channels as well as the tube's uniformity. This 'MOD' version, (like the H4140 MOD, a 256 channel PMT) has greatly improved crosstalk characteristics due to the use of ceramic spacers between the fine-mesh layers which isolate neighboring pixel/electron channels within the tube. This tube was mounted into our dark box equipped with an optical table/XYZ scanner system, which allows us to precisely position an optical fiber on a pixel of the tube. We use the stepper-motor, computer-controlled scanner to locate and establish the positions of the pixels with respect to the face of the tube.

Crosstalk tests consist of comparing the signal observed from a given channel when the fiber is directly on the given channel's pixel with that observed when the fiber is centered on the neighboring pixel. The fiber used is a 0.8mm wavelength-shifting fiber 2m in length. These comparisons are done for nearest-neighbor (NN), next-to-nearest-neighbor (NNN), nearest-diagonal-neighbor (NDN), etc. so that the crosstalk from pixels two units away including diagonally is measured (this involves the comparison of 24 signals to the signal from the pixel of interest, and represents six unique distances from that pixel). Our results show that the crosstalk to NN and NNN is 2.5% and 0.4% respectively, and that from NDN and NNDN is 1.1% and 0.1% respectively. (there is one more relevant neighboring pixel, two over and one down, having a crosstalk of 0.4%). In contrast, the 256 channel H4140 MOD tube has a NN crosstalk of 7.7% and for NDN it is 1.7%. The main reason for the lower crosstalk in the H4139 is that the pixels are 5.08mm apart, whereas for the H4140 they are only 2.56mm apart. An optical fiber of the type SDC will use produces a spot of light approximately 3- 4mm wide on the photocathode, and so we are shining some of the light on the neighboring pixel in the case of the 2.56mm pitch tube.

Uniformity test were also done for the H4139, consisting of a comparison of the pulse height from each channel for the same light intensity. The results for the H4139 indicate the pulse heights vary by a factor of 2-3 from minimum to maximum, whereas for the H4140 the pulse heights were within a factor of 2. These results were presented at a shower max technical meeting held at Rockefeller University on October 19-20.

Rate Tests

Using a Hamamatsu PLP-01 laser, we have done preliminary tests of output signal vs. pulse rate reaching up to 10MHz for the Hamamatsu H4139-MOD, a 64 channel Multianode PMT. The laser used is an infra-red diode type laser that has been outfitted with a frequency-doubling head with light output at 410nm, and is capable of 50 picosecond pulses at rates up to 10MHz. The light output is not large, and with the H4139 at high gain of $10^6$ the output pulse is 16pC (corresponding to 1.6 mA peak-current for the 10ns output pulse) which is only 10% of the pulse-height level at which the tube's signal should begin to drop off due to non-linearity. (Our current prototypes actually become significantly non-linear above the level of 5mA peak current, but according to the manufacturer this is due to a manufacturing defect of the read-out pad resistivity. This problem has been corrected and we expect to obtain tubes in January
allowing a peak-current three times larger.) Under such conditions, the output of the tube is stable up to a pulse repetition rate of 2MHz, after which it begins to fall linearly with log(f) reaching 12pC at 10 MHz. These tests will be extended to higher signal levels using a fast-pulsing LED circuit which should allow several or all pixels to be illuminated in order to fully test the rate-caused non-linearity under worst-case conditions.

**LabView installation**

In conformance with the SDC standard for small data acquisition systems, we have installed the LabVIEW data acquisition and analysis software package on a Macintosh computer system which has a Nubus to GPIB interface. This is connected to a CAMAC crate employing a GPIB controller.

It is envisioned that we may be able to test and calibrate a large number (800?) of MAPMT's fairly efficiently with this system should such devices be chosen by SDC for the shower maximum subsystem. Currently we have GPIB-based instruments including a digitizing scope usable for pulse-shape characterization, a high-voltage power supply and picoameter. Also in connection with this system, the construction of an electro-mechanical optical attenuator was completed. This will allow the automatic and calibrated setting of light intensity levels for PMT tests.

**University of Tsukuba**

Technical Staff: K. Takikawa, I. Nakano, K. Hara, H. Hirade

**PMT/bases**

**PMT test bench**

Doing design work.

**Bases**

Evaluated performances of CW bases made by Rin-ei seiki. There is high frequency noise associated with diode switching, which should not be so hard to remove by smoothing the voltage pattern.

**University of Texas at Arlington**

Technical Staff: P. Draper, L. Sawyer, G. Sickand, M. Sosebee, A. White

Reported by: P. Draper

**PMT Drift Monitoring**

2.1.15 Tile Calorimeter Calibration System

**Purdue**

Physicists: V. E. Barnes, A. T. Laasanen, J. Ross, M. Fahling

Reported by: V. E. Barnes

The wire in the PC-based long-term-wear test station at Purdue failed by fatigue fracture after 57,000 round trips in triple-bent tubes. The wire in the Fermilab PC-based test station passed 40,000 round trips and continues.
We are continuing to explore how to get 25-foot long (or longer) 22 gauge tubing in the fully hardened form needed to make the sources for the SDC barrel wedges. The K-tube corporation will attempt to straighten a 110-foot long sample of the continuous coil which does not meet our needs in its present state. They have tested the hardness of the unstraightened material and find it the same as the earlier good batch. The process records of the two batches are essentially identical, except for the straightening.

Fahling: One more source driver had its wiring and electrical components installed and was mechanically tuned up. These drivers incorporate a number of mechanical design improvements based on experience with heavy use of source drivers in the past year at testbeams at FNAL and BNL.

Ross, Fahling, Barnes: Explored the possibility of deducing both individual tile responses and individual source tube positions in the cast Lead EM calorimeter, by independently measuring with two different radioisotopes (with different sharing fractions) in all source tubes. The Monte-Carlo simulated mathematical system converges very slowly, and seems to converge tofalse minima having incorrect individual tile responses and incorrect source tube placements, but a relatively small RMS difference between the Cs-137 unfolded tile responses and the Co-60 unfolding.

A few lines of algebra with a "toy" model having four tiles and four source tubes, with no source response sharing except to adjacent tiles, shows that a set of uniform tiles and suitably mis-positioned source tubes gives exactly the same raw response as a set of alternately high- and low-response tiles with source tubes centered in the lead plates. This tradeoff between tile response and source tube position is reminiscent of the false minima seen in the realistic simulation.

Shen, Ross: A more direct method of measuring the individual tile responses, for QA, will be pursued. In particular, Longitudinal sourcing of the ANL cast Pb 1991 prototype will be done as soon as the module can be rotated and the skins removed. Results from a preliminary Longitudinal sourcing were presented at the recent collaboration meeting, and show promising levels of response from towers remote from the source. The hope is to be able to longitudinally source all towers from the edge of the calorimeter during production. The level of accuracy of this method remains to be determined.

2.1.2.1 Assemble Scintillator into Module Structure

Fermilab

Technical Staff: J. Carson, H. Fulton, A. Oleck, W. Foster, J. Freeman, B. Hahn, S. Gourlay, M. Banas

Project Description: Fiber routing studies using a wooden barrel wedge mock-up.

Work continues on fiber routing geometry and hold-down schemes. We should converge on an acceptable solution in the next few weeks. The work is expanding to include interface with the PMT's. An eclectic group of engineers, physicists, designers and techs has been formed to work on the layout of the wedge backbone. The wedge layout is quite complex, requiring integration of the PMT's, electronics, cabling, laser monitoring system, Shower Max PMT's and electronics, and calibration system.
Physicists continued efforts on specification of parameters for the SDC calorimeter system. This includes studies of (1) using E/p for calibration, (2) using the Z0 mass constraint for calibration, and (3) using shower max information to correct for effects on performance of radiation damage. No technical staff were involved in this activity.

We continued construction of a 20-tower test module for studying calibration accuracy and stability. We have begun production of the megatiles and absorber plates. We are putting together the trigger hodoscopes from Dubna. We are also working on doing the source calibrations under computer control.

University of Udine

Technical Staff: G. Pauletta

A test lab has been set up at FNAL. Test equipment includes:

- A pulsed Nitrogen Laser (LN203c)
- Safety box for the laser
- Light-tight boxes for Photomultipliers
- Fiber-optics and related equipment
- Assorted optical bench equipment
- Assorted Photodiodes.
- Electronics for data processing.
- Hardware and software for data acquisition (DA)

Similar equipment is being set up in Italy. This presently includes:

- Light-tight boxes
- Fiber-optics
- Optical bench equipment
- Data-processing electronics.

An LN300 pulsed Nitrogen Laser is on the way.

Recently, a number of tests have been performed with the aim of determining the best method of distributing light from the primary (laser) light-source to the PM's.

The test setup is as follows:

A LN203C pulsed nitrogen laser is optically coupled to a single 50-m strand of 0.7mm-diameter UV-grade fused silica ("quartz") fiber. Such a fiber might transmit the laser light from the laser, situated outside the enclosed area, to the distribution points near the calorimeter modules.

Transmission efficiency is estimated at 30%.

The U/V light transmitted by the fiber is then distributed to different calorimeter modules by means of a quartz-fiber bundle (our test "bundle" consisted of two 10m-long, 0.4mm- diameter quartz fibers). Each fiber in the bundle feeds a secondary distribution point, a so-called "cow" which uses the U/V pulse to generate and distribute scintillation pulses to each tube contained in the calorimeter module.
Our test "cow" consists of a reflective cavity into which wave-length-shifter (wls) fibers may be inserted to an adjustable degree. Each wls fiber is optically coupled to 1 m of clear plastic fiber which transmits the light absorbed by the wls fiber to its individual PM light-mixer.

The U/V light transmitted into the cavity by the quartz fiber can either excite a plastic scintillator or may be allowed to reflect directly from the cavity walls. In the first instance, a large proportion of the light emitted by the scintillator is collected by a PIN photodiode while a much smaller fraction excites the wls fibers. In the second, a small-aperture U/V- sensitive PIN diode samples a fraction of the light-emission cone from the fiber, while the rest is distributed by reflection and partly absorbed by the wls fibers.

In either case, the pulse that eventually reaches each PM has the same spectral distribution as those reaching it from the corresponding calorimeter tower and its time-dependent characteristics are those of the phosphor because the width of the U/V pulse is much smaller (600 picosecs). In either case, the +/- 3% to 5% fluctuations in primary laser intensity may be factored out of the PM/Diode ratio on a pulse-by-pulse basis. The light that is absorbed by each wls fiber may be adjusted by adjusting the length of wls fiber projecting into the reflecting chamber. One may want to perform a coarse calibration of the adjustable range in terms of energy in order to facilitate PM high voltage setting.

To date, we have conducted a series of tests with different cylindrical scintillators coupled to 20 mm**2 PIN-diodes, aimed at verifying that sufficient light is transmitted to;

a. obtain better than 1% resolution

b. allow a large range of adjustment in the pulse which eventually reaches the PM.

The fractional resolution Dr of the ratio

$$R = \frac{A_{pm}}{A_d}$$

where \(A_{pm}\) and \(A_d\) are the PM and diode signals respectively, is given by

$$(Dr)^2 = \frac{1}{N_{pm}} + \frac{1}{N_d}$$

where \(N_{pm}\) and \(N_d\) are the number of photoelectrons generated at the PM and PIN diode photocathodes, and since the PM gain is about 10**4 larger than that of the diode (gain=1), the diode contributes negligibly to Dr for comparable signals \(A_{pm}\) and \(A_d\). So, for .01 fractional resolution in Apm, we need the same fractional resolution in R which corresponds to \(N_{pm} = 10^{**4}\) photoelectrons generated at the PM photocathode. The laser generates 100 microJoules per pulse. We calculate that this intensity is reduced by \(F = 3 * 10^{**7}\) by the time it reaches the PM photocathode, where \(F\) is a factor which includes scintillator efficiency and other effects difficult to calculate. This leaves us with about \(F = 2.2 * 10^{**9}\) photons at the PM photocathode, where \(F\) must be larger than \(5*10^{**6}\).

Our tests with various scintillator and cavity configurations led to the following observations:

* for all configurations tested; \(5*10^{**-5} < F < 3*10^{**-4}\) Light to the PM's is therefore more than adequate for a better than 0.5% statistical contribution to monitoring accuracy.

* However, fractional variances in R were never better than 0.4% and did not track with \(N_{pm}\).
* the best configuration has a 1 cm - diameter cylinder of plastic scintillator coupled to a 20mm**2 PIN diode.

We conclude the following:

* The LN203c pulsed nitrogen laser and coupled single-fiber transmission system + primary distribution is more than adequate as a light source. This will allow us to relax some design restrictions such as cavity size in order to incorporate features like adjustable calibrated flasher signals to the PM's

* A lower limit of about 0.5% monitoring accuracy seems to be dictated by other than statistics. This needs to be investigated and understood.

* Other possible cow configurations such as the purely reflective cavity still need to be investigated

* Redundant monitoring, such as may be provided by "light pulsers should be considered in detail.

Development on these and other items is in progress.

2.1.4.5 Barrel Erection Tooling

Argonne National Laboratory

Technical Staff: N. Hill, J. Nasiatka

After reviewing the work done on the required crane lifting height for Calorimeter Assembly, a study was done based on ideas proposed by Tim Thurston. The overall height of the Calorimeter was reduced by removing the Picnic Table sized transport fixture, and setting the Hydraulic Jacks/Hillman Rollers directly on steel rails and a support bed to distribute the load into the concrete. (See Figure 1) Using this configuration, the Calorimeter would ride on these rails to the outside of the building where it would either be lifted by a crane, or the rails could be extended to the Top Of Hole. As a result of these modifications, the overall height of the Calorimeter was reduced to approximately 10.54 meters. (See Figure 2); however, it should be pointed out that this height does not accommodate the supports/tie-ins required to join the Hillman Rollers together into a framework that would stabilize the structure as it is moving. There will also have to be additional supports for strengthening the cradles so that they can accommodate a dynamic load.

The overall height of the crane hook was reduced by using a swivel shackle instead of a full hook, and a low-profile lifting block. (See Figure 3) To further increase the space available, we are proposing to make special lifting fixtures for the last modules in both Barrel and Endcap Calorimeters. (See Figures 4 & 5) These low profile lifting fixtures would require the removal of the electronics crate from one or more modules during installation, and would not allow for rotation of the module.

To facilitate installation we are proposing to reorient the assembly so that the last module is inserted vertically. (See Figure 6) If we are able to implement this and all of the above items, the space required for handling modules will be marginal at best.
2.1.6.2 Module Assembly Facility

Argonne National Laboratory

A proposal for upgrading the 35 ton crane in building 366 to 45 tons has been initiated. ANL Plant Facilities Services is scheduling engineering time to evaluate the building's structure to determine if it can withstand the loads without modification. Whiting Crane has been contacted to complete the crane analysis and possibly to do the upgrade if possible.

2.1.7 Surface Assembly

Argonne

Technical Staff: J. Nasiatka, N. Hill, L. Balka

2.1.8.4 Project Coordination

Fermilab

Preparations were made for a review of the calibration system and a follow-up review of the prototype absorber to be held during the December Collaboration meeting. Plans were also made for a design review of the endcap to be held at LBL on January 12 and 13. Details of the Memoranda of Understanding are still being worked out with the collaborating institutions.

Eric Larson has assumed the task of Fermilab engineering coordination for the SDC. Jim Hanlon will assist with cost and schedule tasks until a new cost and schedule manager can be recruited.

We are investigating software tools for cost, schedule, and component tracking of the central and endcap calorimeters, and are beginning to address the cross-task (and cross-subsystem) tasks associated with the alignment and calibration of the calorimeter. In particular, approaches to improve the transmittal of cost and schedule information to the SDC Planning and Tracking office are being investigated, as is the scope of the calorimeter alignment and calibration integration tasks.

2.1.8.5 System Engineering

Fermilab

Technical Staff: N. Bartlett, H. Fulton, J. Missig

The "control drawing system" is operating at FNAL with the procedures for operating the system in draft form. A preliminary SDC/CC document control charter is presently 50% complete. It is expected to be finished before January, 1993. Integration meetings are being held weekly with new integration drawings being reviewed as they become available.
2.1.8.7 Quality Assurance

Fermilab

Technical Staff: J. Missig, D. Tinsley

The SDC/CC Quality Assurance plan Section 7 specification 01 for the barrel hadron absorber is in draft form. This plan is our first for the project and we propose to use the same format for subsequent plans. The SQIP implementation plan is presently being drafted. We expect to complete that draft in December.

2.1.9 R&D / Prototype

2.1.9.1 R&D Tests

University of Beijing

FNAL: A.Byon and D.Green

Radiation hardness tests of tile/fiber calorimeter modules.

Two 3HF/02 modules, one a standard tile/fiber structure and the other had 9 fibers per scin. tile, were irradiating up to 10 Mrads with BEPC 1.3 Gev electron beam. The data analyses have been finished. The 3HF/02 appeared very good radiation hardness and the multi-fiber module structure increase the radiation hardness of the module more. The characteristic doses $D_0$ are 20 Mrad and 26 Mrad for the standard module and multi-fiber module respectively. The results will be reported in the Dec. meeting by D.Green.

Florida State University

Physicists: Vasken Hagopian and Kurtis Johnson
Students: Elizabeth Bartosz, Daryl Davis, Chris Immer and Heather Whitaker
Engineers: Maurizio Bertoldi, Kerry Hu and James Thomaston

1. Completed investigation and an SDC note written on green extended phototubes, which now show that for light from BCF91A fiber (peak of spectrum at 495 nm), the green extended 10 stage Hamamatsu R580-17 has 40% ± 10% more quantum efficiency than ordinary bialkalai phototube, the Hamamatsu R329. Abstract from SDC Note paper:

The quantum efficiency of the green extended phototube R580-17 made by Hamamatsu Corporation is approximately 40% more efficient as compared to the bi-alkali R329 for light from the green fiber BCF91A made by Bicron Corporation.

2. Completed investigation and an SDC note written on the decay time of various fluors in scintillator tiles and wave-length-shifting (WLS) fibers. The K27 fluor of the WLS fiber BICRON BCF91A and Kuraray Y11 is slow (time constant 12 nsec) while the BICRON G2 WLS fiber is much faster, but more radiation soft. Abstract from SDC Note paper:

The decay times of several scintillator-fiber combinations have been measured. The decay times are dominated by the wave-length-
shifting (WLS) fibers. The scintillator tile - WLS fiber combined decay times varied from 13 nsec down to 4 nsec. The fastest combinations were the new BICRON BC499-52 together with BICRON's G1 or G2 WLS fibers.

3. Completed investigation and an SDC note written on white paints to be applied at the edges of scintillating tiles. Even though many paints were tested, the best is still BICRON 620. Two new methods of paint application were investigated and both can apply the paint very quickly and uniformly. Abstract from SDC Note paper:

The edges of the scintillating tiles for the SDC calorimeter will be painted white. The best paint is BICRON 620. The best method to apply this paint is by a compressed air sprayer for large areas and by dense foam poly brush for single edges. BICRON paint did not show any degradation by 2 Mrad of irradiation.

4. Interim report. The double clad Y11-250 WLS fiber from Kuraray (received the day before Thanksgiving on Nov. 25) is about 50% brighter as compared to single clad fiber. We will investigate the coupling to clear fiber to see if the brightness is maintained. Will also investigate radiation hardness of double clad fiber.

5. Interim report. For the uniformity test of small and large tile-fiber units, we received (Nov. 25) the 4 mm thick SCSN38 scintillators. These are being machined and grooved. To wrap these in TYVEK paper, samples were obtained from Dupont. There are at least 20 types of TYVEK paper. Each has its own reflectivity and to our great surprise, one even turned brown with radiation. We will continue the investigation to determine the best and order larger sheets, so we can perform the uniformity tests with both Ru106 source and cosmic muons.

**University of Tsukuba**

Technical Staff: K.Takikawa, S.Kim, I. Nakano, K. Yasuoka, K. Hara, M. Okabe, Y. Miyamoto,

*Radiation damage*

Preparing for tests of barrel EM and HAD "sigma" tiles.

*Endurance tests*

Fabricating a test stand to measure endurance of fiber bends, splice, mirrored fiber ends, and tile/fiber assemblies.

**Argonne**

Technical Staff: J. Nasiatka, D. Carbaugh, C. Keyser, L. Kocenko

**Fermilab**

Technical Staff: A Byon-Wagner, M. Davidson, G.W. Foster, D. Green, F. Markley (FNAL), R. Gustafson, M. Rivard (University of Michigan), H. Mao et al. (IHEP, Beijing)
Saclay

Technical staff: F. Rondeaux, G. Comby, A. Giganon, C. Jeanney, D. Pierrepont

The effect of gluing the fibers into the groove was measured. The light increase with glued fibers is 20% which is less than preliminary measurements had indicated. We will investigate this question further. Optical disconnects (8-channel) were made at Saclay and are being evaluated for light transmission and fiber-to-fiber spread. The behaviour under mechanical stress of spliced fibers is being studied; results will be reported at the SDC meeting in December.

2.1.9.2 Barrel Prototype

Argonne

Technical Staff: N. Hill, V. Guarino, J. Nasiatka, E. Petereit, T. Kicmal

Prototype Assembly Facilities

This month, preliminary talks with Argonne's ES&H division were conducted to determine what requirements had to be met for safe handling of the cast lead modules and the various solvents and chemicals involved in processing them. This examination revealed that the areas used to process modules would need to have ventilation/filtration for lead particulates, and for solvent fumes. In addition, particulate monitoring for lead would be required. ES&H also recommends that, until the particulate monitoring for the first module is complete, respirators should be used by any personnel in those areas.

The area in Bldg. 366 that was used for stacking of Zeus modules currently has fixtures that would facilitate the assembly/dis-assembly of molds and the cleaning of the completed casting, as well as adequate ventilation and particulate monitoring. This room will be modified for that purpose. An enclosure for preparing steel plates for PDK will be moved, and used for preparation of the molds for casting. This involves cleaning the molds, and spraying/coating the pieces with mold release. The use of chemicals will be confined to this room. This enclosure is scheduled to be moved when PDK module assembly is complete, a ventilation/filtration system will be added along with additional particulate monitoring, and a small rail system for moving the molds in and out of the enclosure.

EM Section Prototype Design

During the month of October, the following work was completed on the design and construction of the EM Section Prototype. All the changes that occurred from the Imm dimension increase (see October's report) have been completed, and the final assembly drawing is approximately 70% complete. The design and fabrication of the two welding and assembly fixtures required has been initiated.

A FORTRAN routine was created to generate the various scintillator gap sizes for the prototype, and has been passed on to Dave Freeman for use in cutting the scintillator tiles.

A series of tests were conducted to find the best solvent for both the silicone and graphite mold releases. To clean off the excess mold release, we evaluated 748 Cable Cleaner Solvent, 1677 Tech Spray, 3M Industrial Cleaner, and Om/Cycle. 1677 Tech Spray was selected for its quick removal of the graphite mold release, and Om/Cycle
Cleaner for removing the silicone mold release. The silicone mold release will be used on the high-eta test casting to evaluate it's performance, and a decision on which to use for the full prototypes will be made then. Handling of both types of release and their solvents are similar, and changing will not effect the module production facilities.

A small section of the 3mm front plate was bent at the high-eta end in preparation for the full front plate. The bends looked very good, and preparations for bending the full 14' long front plate are proceeding. Also, the design of the High Eta Test casting mold was completed, and construction is approximately 50% complete.

**EM Section Prototype Parts Procurement**

All the required materials are on order, the stainless steel plates for the HAD1 section is scheduled to arrive at ANL by December 14, and the brass tubing for covering the source tubes in the HAD1 section has arrived. The source tubes and perforated reinforcing tubes should be arriving at ANL before Christmas. Cost proposals have been received for perforating the reinforcement tubes. A contract will be awarded soon.

**University of Beijing**

Technical staff: Huishun Mao, Benwei Shen (100% absorber), Linsu Wang (100% absorber), Jiwei Xi and Weiguo Li.

The BEPC lab director S.X. Fang and the international affair officer T.Z. Xu also spent some time working on the absorber.

The IHEP and the shipyard engineers have studied FNAL drawings in detail and discussed them with Larry by fax and "E" mail many times. Most of the drawing are clear; however, the final and correct list (or drawing) of grooves and slots has not yet arrived from FNAL. The shipyard has stopped cutting while waiting for these drawings.

The manufacturing drawings were developed from FNAL design drawings. We had 9 mm steel plates and started to clean them with sand, then cut them. The thick steel plates (21mm, 24mm, 36mm) have been ordered and will be delivered to Xin_He at the end of this month. The Xin_He shipyard borrowed half million Chinese yen from the Chinese bank for materials, tooling and so on.

The absorber attachment of IHEP/SSC was discussed and modified many times. Tom said he would send it to IHEP for leader's signature after he came back from China (early of Nov.); however, IHEP have not yet received it. The sub-contract between IHEP and Xin_He is waiting for the attachment of IHEP/SSC.

IHEP engineers worked and will continue to work in the Xin_He shipyard on the technical problems and monitoring quality.

The shipyard will use the painting materials for the prototype absorber as follows:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>PRIMER</th>
<th>FINAL PAINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPOSITION</td>
<td>702 zinc rich epoxy primer</td>
<td>epoxy paint</td>
</tr>
<tr>
<td>DRY FILM THICKNESS</td>
<td>about 0.02 mm</td>
<td>about 0.1 mm</td>
</tr>
</tbody>
</table>
Fermilab


Project Description: Design and construction of two (2) barrel prototype

Hadron absorber material has been ordered. RFQ was sent out for plate machining. Quotes close on 12/11/92. Stacking assembly fixture design and construction were begun. We are still on schedule to start stacking and welding plates in early January. The FNAL engineering staff is in constant E-mail communication with the PRC engineers. They have some minor drawing details to work out and clarify. The PRC seems ready to begin to machine plates at any time. Fermilab has begun the process of establishing welding procedures. A group from FNAL plans a trip to the PRC in January to transfer this information. We have made preliminary steps in forming a safety review committee. Two shipping modules are required to ship the two steel absorber halves from the PRC. These are being obtained from ANL. One is now in the Industrial Center Building at FNAL and is being outfitted with the required fixturing. The second module will be shipped to FNAL from Hamburg. Both modules should arrive in the PRC by March in order for the wedges to arrive at FNAL in May.

Florida State University

Personnel during the past month who have contributed towards the project:

Physicists: Vasken Hagopian and Kurtis Johnson
Students: Elizabeth Bartosz, Daril Davis, Chris Immer and Heather Whitaker
Engineers: Maurizio Bertoldi, Kerry Hu and James Thomaston
Principal Investigator: Vasken Hagopian

Purdue

Technical Staff: V. E. Barnes, A. T. Laasanen, J. Ross, M. Fahling

Laasanen: Work continues on incorporating computer control of the source driver motors into the PC-based source current DAQ system which already uses the ANL 48/96 signal conditioner and multiplexer and reads the reel and indexer position counters.

Garfinkel: A connection was made between the PC and the VAX. The program MUX96 for controlling the ANL48/96 Analogue Multiplexer ADC has been transferred to the VAX for development.

Fahling, Barnes: Calculations and measurements of the source-height dependence of tile response indicate that this dependence is much worse when the source is in a groove in steel (~25% per mm) vs. when the source is in air (~6% per mm for a typical large hadron tile). Suitable modifications in the groove cutting for the Hadron prototype steel have been proposed at the recent collaboration meeting, and will be implemented.

It is worth noting that the source height dependence in air is larger for a small tile (11% per mm for a typical EM tile, ~10 x 10 cm**2) than for the HAD tiles.
2.2.1.1 Module Structure

Lawrence Berkeley Laboratory

Technical Staff:
Engineering: J. Carrieri, M. Hui, D. Hunt, A. Lim, Y. Minamihara, W. Thur

Monolithic Endcap EM

Budgetary Quotes on the key mechanical components have been received and analyzed. They are now being incorporated in the detailed cost estimate for the ECEM being prepared for the design review at LBL on January 12-13.

In a meeting with Saclay physicists and engineers at LBL, details of the ECEM Shower Max. assembly and the Preshower Detector layers were resolved.

Parts are being fabricated for a tabletop model of the ECEM perimeter structure to be displayed at the January design review.

Physical tests of the long-term creep resistance of our calcium-tin lead alloy continue. The critical geometries of bushing and spoke loads on the lead have been duplicated exactly, with creep displacements monitored by dial indicators. Preliminary results are encouraging - after two months, no measurable creep displacements have been recorded.

Physical tests of the strength and stability of the "ears" on our sheet aluminum "curtains" have been completed. As planned, the resulting elastic load limits and "spring constants" were then incorporated in a finite element model of the sheet metal curtains to determine the sharing of loads around the perimeter.

Plans are being made for a second round of beamline tests of the "4 x 4" ECEM calorimeter test station module. Optical system improvements will first be developed on a single tile/fiber basis, and the most successful variation(s) will be built into the 4 x 4, along with a Shower Max assembly from Saclay. We hope to conduct the beamline tests at BNL sometime next summer.

SDC Transporter Progress Report:

Complications have arisen related to spatial constraints at the likely Fermilab test hall (MP9) and the planned SSCL test hall. Both have serious space limitations, and they also seem to require mirror-image transporter designs. We hope to resolve these problems without unduly complicating the design.

2.2.10 End Plug Calorimeter

Lawrence Berkeley Laboratory

Technical Staff:
Replaceable Hadronic Plug:

Hadronic Plug Documentation--Much of the month has been spent upgrading the endplug’s documentation. This report is numbered, SDC-92-328 (5/22/92). The report is complete except for upgrades in the cost estimate section and artwork. We will mail copies of this note to endplug reviewers by Dec. 23, 1992. Sherbarth (WSTC) will be revising the endplug cost estimate with appropriately reduced contingencies and EDIA, and eliminating some older WBS categories which are not applicable to the existing design.

Flexible Source Wire--We have assembled two flexible source wires (one 2.44 mm O.D. and one 1.78 mm O.D.) and demonstrated their capability of elastically negotiating three, 45 mm radius, series 180 degree bends in 2.4 m of tubing with modest push/pull forces. The small wire was displayed to the calibration sub-group at the Dec. SDC meeting at SSCL. We will be building a similar wire to a size meeting barrel EM module requirements in early 1993.

We have performed initial FEA optimizations of the radial tie rod locations at the front HAC1 plate. We used the RASNA FEA code for this work. Our version of the potentially powerful, developing (but currently, linear elastic) RASNA code has too limited a set of design optimization objective function alternatives to make decisive rod location selections. Nevertheless, we are able to conclude that two boundary condition extremes have only a minor influence on plate stress optimized radial tie rod locations.

2.3.1 Design and Documentation

University of Toronto

Technical Staff: G.G. Stairs
Physicists: R. S. Orr
Reported by: R. S. Orr

The WBS and Scheduling information for 2.3 was not successfully transferred to the SDC costing book in time for the D.O.E. review. We regard this as being due to the incompatibility of the planning tools we have been using (MicroSoft EXCEL + MicroSoft Project). The acquisition of Open Plan is a high priority item; it has been ordered. In order to carry out 3-d modeling, the engineering workstation at Toronto has been upgraded, and AutoCAD installed.

2.3.2.1 Beam test of Liquid Scint Test Module.

University of Toronto

Reported by: R.S. Orr

The Beam Test referred to in last month’s report was carried out during the period 29th October until 8th November in the X.5 test beam in the CERN West Hall. After assembly and setting up subsequent to transportation we were scheduled a total of 12 shifts of beam. Since the test module is 50x20x20 cms only electron beam data is particularly
meaningful. Data was collected with the electron beam at 5, 10, 15, 20, 30, 50, 75, 100 GeV. Data was also collected with the electron beam impinging on the module at angles of 0, 50, 100, 160, and 220 mrad. Data was collected with and without 1 radiation length of lead in front of the device. Vertical scans were performed across the front face, and data with hadrons was collected at 5, 10, and 20 GeV. In addition to electron and hadron data, one shift was used to make a vertical and horizontal scan using 100 GeV muons. This latter data will be used in order to gain some understanding of the method of calibration using paraxial muons.

This is the first beam test of a course sampling liquid tube device (3mm internal diameter tubes). It is also the first test of a device using Isopropyl-biphenyl based scintillator, quartz tubes, and a mild steel absorber. These are essentially the baseline parameters of the Forward Calorimeter. The analysis of the data is going on at present, and will continue for the next month. At present we have shown that the device behaves as a calorimeter, having a linear energy response, see Fig.1. The energy resolution improves stochastically with energy. This device is not intended as a precision electro-magnetic calorimeter. In fact, the predicted hadron energy resolution is around 100%/sqrt(E); it is thus a crude em calorimeter by design. The stochastic behavior of the energy resolution is shown in Fig.2. This figure corresponds to 100 mrad beam angle, and a "pencil" electron beam. The stochastic term in the energy resolution is 58%/sqrt(E), which is in agreement with Monte Carlo simulations.

This data, in conjunction with the 1mm tube data collected by Texas A&M, will provide input for the selection of the spatial modularity of the hadronic test module. In particular, data collected with a broad electron beam will provide information on the effect of lateral geometry effects which are more or less common to both the high pressure gas and liquid scintillator approaches.

2.3.2.2 Design and Construction of the Hadronic Prototype

Rockefeller University

Technical Staff: Mike Morgan (Ability Engineering Technology, Inc.)
Physicists: Nikos Giokaris, David Khazins
Reported by: Nikos Giokaris

All the components, necessary for the assembly of the 16 hadronic prototype modules are in hand. High voltage feedthrough welding tests, hydraulic high pressure tests and electrical tests on a single tube assembly have been carried out. Feedthrough welding by an orbital welder seems to work. The High voltage on the rod of a tube assembly was raised to 4 KV (to be compared with the design operating high voltage of 2 KV) with no problem. The hydraulic pressure in a tube assembly was raised to 14,000 psi (this is to be compared with the design operating pressure of 1,500 psi) and no failure of the tube or the feedthrough was observed. Cleaning techniques of the tube assembly components have been exercised and they are almost finalized. Two papers on the "A Comparison of Argon and Xenon Gas Mixtures at High Pressure for Calorimetry" and "High - Pressure Gas - Ionization Tube Calorimeter for Forward Detectors" have been written and they will be submitted to Nuclear Instruments and Methods A.

2.3.2.3 Radiation Damage Tests

Rockefeller University

Technical Staff: Jerry Zimmerman
Physicists: Luc Demortier, Nikos Giokaris
The components for two more short tube assemblies for radiation damage studies were made.

**Texas A&M University**

Physicists: J.T. White, Mei Gui
Reported by: J.T. White

We continued liquid radiation damage studies. We looked at samples with 10, 50 and 100 MRads doses (mostly gammas). In all cases, the attenuation lengths drop, but with the 515 nm filter, the 10 Mrad dose sample still had an attenuation length over 2.6 meters. Also, the 50 and 100 Mrad doses seemed to be identical, suggesting some sort of saturation effect. The samples became yellowish with dose, which according to Bicron and other chemists, suggests oxidation with the oxygen dissolved in the liquid. We attempted to redo the experiment with the oxygen removed by bubbling dry nitrogen through the liquid, but were unsuccessful, and are trying again with a nitrogen filled "tent".

Another finding which is quite interesting, is that we attempted to filter out the yellow component using a silica filter (captures polar molecules). Indeed, much of the yellow is removed, but we did not have a large enough sample to measure the filtered sample. This suggests the possibility of greatly extending the lifetime of the scintillator. However, the filter likely takes out some of the wave shifters as well, so a recirculation system will have to replenish lost components. We have also built a small system designed to allow measurement of the light output while being irradiated, and to replace the liquid in situ. The measurements have not yet been made.

We have built a two-dimensional scanning device for light guide mapping. The device is run by stepping motor in the same way as our attenuation length measurement stand. We are preparing to develop a flat response light guide using optical fibers in combination with a filter pattern to flatten the response. The masking pattern will determined by an iterative procedure.

We are designing our next generation em prototype for both beam testing and radiation damage testing. This device will use a realistic plumbing system, fully understood liquid and properly engineered light guide to correct the weaknesses of our first prototypes.

**University of Toronto**

Technical Staff: A. Kiang
Physicists: J.D. Prentice
Reported by: R.S. Orr

The Toronto tube measuring machine has been complete for the past month. Production measurements have not been carried out due to the fact that the shielding of the 150 mCi source led to excessive scattered radiation. This was rectified during the past weeks.
2.3.7 Electronics

Rockefeller University and University of Rochester

Physicists: George Fanourakis, Nikos Giokaris, David Khazins, Fred Lobkowicz
Reported by: Nikos Giokaris

Work on the construction of the high voltage distribution boards and on laying out the preamplifier boards started.
Gaussian Fit - Energy Resolution

15 to 100 GeV/c

58%/sqrt(E)

100 mrad, no Pb
Pencil Beam
Gaussian Peak
100 mrad, no Pb
Pencil Beam
3.0 MUON SUBSYSTEM

The barrel toroid is made from 196 blocks, about 85 metric tons each. We have arranged to produce two prototype blocks, one long and one short. To do this we have completed a material and block specification and complete design of the blocks. An agreement between the SSCL and JINR to produce the blocks at the ATOMMASH facilities in Russia has been signed by both the SSCL and JINR. Delivery of the block to the SSC is expected next summer.

Work continued on the design of the barrel tower prototype, the intermediate system, the forward system, and the alignment system. In addition we have continued our planning efforts with Magnet installation studies and measurement system fabrication and installation modeling.

3.1 Magnet

3.1.1.1 Barrel Magnet

Fermilab

Technical Staff: Bob Wands, Zhijing Tang
Author: Bob Wands

Wands: The new welded strap design on the short blocks was modeled and the shear modulus calculated for use in the full 3-d model. Strap and weld stresses were calculated for the yz assembly tolerance load case and found to be acceptable.

A complete 3-d detailed model of a single bolted joint was generated to address the concerns of the preliminary design review committee about the application of simplified hand calculations to bolt and key stresses. The model has been checked for modeling accuracy, but no runs have been done to examine actual bolt load distributions as of this writing.

Another round of calculations were made to verify the cantilever load case from the test model. These included the effect of gravity, but still showed that the finite element model reproduces the correct final slope of the bolt load vs moment curve from the test, but consistently overestimates the bolt loads.

Tang: The magnetic forces on a circular toroid have been derived from a closed form solution for the stress distribution in such a system. This solution was then used to estimate the deflection in the actual octagonal geometry. This deflection can be very conservatively upper-bounded at 0.34 mm. A more realistic estimate is <.1 mm.

A study of the various scaling factors between the test model and actual toroid was carried out. The scaling is inconsistent, because the model and the actual toroid have the same mass density. Therefore, since their modulus is the same, the force scale for external loads is different than the force scale for self-weight.

University of Wisconsin

Technical Staff: Jeff Cherwinka, Glen Gregerson
Physics Staff: Don Reeder, Duncan Carlsmith, Dick Loveless
Author of Report: Jeff Cherwinka
A prototype upper long block and a prototype short block will be built at Atommash in Russia this winter under the supervision of our colleagues at JINR. The majority of work on the MBT in November focused on preparing the specifications and contracts for this effort. UW-PSL participated in producing the material specification, the prototype block specification, and the associated drawings. The thick machined plate (219 mm) option has been adopted to tailor the design to Atommash's production facilities.

The plates are now held together with welded straps. The corner bolt size is now M72-6. UW-PSL worked on these design changes and the corresponding analysis. The testing plan for the prototype blocks was also generated by UW-PSL. Other MBT tasks worked on in December by UW-PSL include communication with Bigge for the installation study, planning the upcoming trip to Russia, creating a work plan to prepare for the CDR and the production block contract, refinements to the MOU, and production of model coils. The permeability numbers for the steel indicate we will need 8 of the model coils. 6 have been built so far. 9 will be built so there is one spare. One coil and the power supply were tested and they both performed fine.

SSCL

Technical Staff: Jim Krebs, Laura Combs, Randy Gates, Mike Whitacre
Physics Staff: None
Reported by: Jim Krebs

The drawings for the prototype short block, the prototype long block, and associated weld straps, pins and corner bolts were completed mid month. The drawings were checked for form by Kurt Pennington of SDC and checked for fit and function by Jim Krebs of the Experimental Facilities Department. The release ticket was completed by Jeff Tseng. This is deemed as a temporary document release procedure in lieu of the "Document Release Procedures for Physics Research" which is still in the early stages of development.

3.1.1.2 Barrel Coils

University of Wisconsin

Technical Staff: Jeff Cherwinka, Glen Gregerson
Physics Staff: Don Reeder, Duncan Carlsmith, Dick Loveless
Author: Jeff Cherwinka

Grant Emmel, and electrical engineer at UW-PSL, has been added to the coil team. He will be working about half time on the coils. Information on coil ringing was gathered in November. The braze test samples were returned and tested. One of the samples was good, but the second braze was bad. It looks like the joint was overheated, but there may also have been a fit up problem. More testing needs to be done before the induction brazing method can be adopted. Coil fixture costs were reviewed.

3.1.1.3 Support System

SSCL

Technical Staff: Jim Krebs, Laura Combs, Randy Gates, Mike Whitacre
Physics Staff: None
Reported by: Jim Krebs
Conceptual design work has begun on defining the interface between the support and the barrel toroid. The design will incorporate an adjustable shoe that may be machined or shimmed during barrel installation to assure that the upper surface of the octant 5 iron is level. The shoe material will be 304 stainless steel in order to magnetically decouple the support from the barrel.

3.1.2.3 *Forward Toroid support System*

*Institute for High Energy Physics, Protvino, Russia*

Technical Staff: V.Pyatakov, A.Simonov, A.Surkov
Physics Staff: V.Kochetkov, I.Kotov
Author of Report: A.Surkov

A start has been made on the developing of the FC calculation program to determine the amount of the FMS loads on the supports.

It's working out the design solutions for the support-transport block allowing to solve the problem for the FMS side displacement correction under the movement into barrel toroid and from it.

It's carrying out the refining calculations on the transport block hydraulic system and rigidity calculations on the most loaded elements.

3.2 Muon Measurement System

3.2.1.1 *BW1 Module*

*University of Texas, Arlington*

Technical Staff D.Vanecek, M.Diver, R.Glenn, T.Lawley
Physicists A.White, P.Draper, L.Sawyer, E.Gonzales, J.Perkins
Author of Report A.White

Work has continued on the specification of the Swift Center building that will house the UTA muon module assembly facility. Soil borings have been made inside and outside the building to establish the nature of the supports required for the muon module assembly pad. It is expected that the pad will be similar in concept to the pad under construction at the SDC muon lab at SSCL, but that the depth of the piles and/or the thickness of the concrete pad will need customizing to the UTA environment.

The process flow model for the operation of the Swift Center facility has been updated to reflect the content of the draft assembly procedures document.

The video visualization of the assembly procedures has been further developed and has resulted in a more open plan layout for the central assembly area. This should result in a cost reduction in the building renovation and in greater simplicity in the movement of tubes from the receiving area through testing to the final assembly.

At the last muon engineering meeting we agreed to study the largest pad size that we could reasonably accommodate in the Swift Center, rather than building a pad directed towards only the BW1 modules. This study is driven by uncertainties in module assembly scheduling at SSCL and by the desire to have maximum flexibility in the UTA facility. The first goal still remains the assembly of the first BW1 module at UTA later next year.
We have submitted a proposal to TNRLC for continued support in the development of our muon assembly facility.

We have begun the process of UTA personnel working closely with SDC muon personnel at SSCL during the prototype phase. M.Diver of UTA will work two days a week at SSCL on items such as the design and implementation of the adhesive dispensing systems for module assembly.

3.2.1.2 BW2 Module

University and INFN Pavia

Physics Staff: S. Ratti, G. Boca, M. Cambiaghi,
G. Introzzi,
Author: G. Liguori, P. Torre.
G. Introzzi

3.2.1.4 BWT Tower

University of Washington

Technical Staff: C. Daly
Physicists: H. Lubatti
Author: C. Daly

Access ways to the space between BW2 and BW3 for scintillator maintenance are being designed. The access spaces between the modules and between the intermediate and barrel systems have been settled. Exact locations can be changed as the design is finalized with little impact on the tower design. Work is beginning on the design of various walkways and the mounts onto the inside of BW3. (C. Daly)

SSCL

Technical Staff: J. McIntosh, Gary Pennycuff, J. Thunborg
Physicists: D. Davisson, H. Lubatti, P. McBride, P. Schuler
Author: Patricia McBride

3.2.1.5 Barrel Region (shared items)

University of Washington

Technical Staff: C. Daly, P. Reinhall, W. Song, R. Storch
Physicists: H. Lubatti
Author: C. Daly, H. Lubatti

Structural Analysis of Detector Modules:

Bar code system development. A draft of the bar code system specification has been prepared and modified. Some of the bar code system software is being evaluated. Samples of bar codes have been printed out. A set of bar code system hardware has been selected and ordered. We also contacted the Forward Muon System group regarding the bar code system. Specifications including the needs of the Forward group are under development.

(W. Song, R. Storch)
Epoxy system development. Information about epoxy systems has been collected. A preliminary idea of how to develop the system has been established. (W. Song, R. Storch)

The displacement analysis of the detector modules with separated tubes was continued. Several different methods of joining the tubes were modeled in order to optimize the design. (P. Reinhall)

An analysis of the deflection of the detector due to temperature gradients was initiated. A two-dimensional ANSYS model of a 10-layer BW3 structure is used in this analysis. (P. Reinhall)

Possible mounting schemes for the BS2 scintillator panels have been designed. Collaboration with Curtis Weaverdyck continues with a view to fixing the design of the panels and the mounts -- at this time, the basic idea is agreed on. It is intended to use the mounting rails for the panels to add to the stiffness of the BW2 modules. (C. Daly).

The exact method of implementing the sparse tube algorithm in a practical way is being finalized in collaboration with Gary Holden. (C. Daly)

SSCL

Technical Staff: K. Bramble, Gary Pennycuff, J. Thunborg
Physics Staff: Dick Davisson, Henry Lubatti, Patricia McBride, P. Schuler
Author: Patricia McBride

S. Day has continued working towards the December 31 deadline for the detail drawings for the prototype muon module bw2t4 and bw3t4. Preliminary drawings have been made on most of the individual module parts, but until final geometric requirements have been made geometric tolerancing cannot be placed, and the drawings cannot be finished. This problem along with the final locations for the theta, phi and stereo tubes will be discussed with Colin Daly during the December SDC meeting.

Tufts

Technical Staff: L. McMaster, D. Dupuis (Physics Dept. shop technicians).
Physicists: T. Kafka, W.A. Mann, R.H. Milburn
Author of Report: W. Anthony Mann

Testing continued to find the optimal method to ensure a tight gas seal when endcaps are heat-bonded onto extruded aluminum cylindrical drift tubes. It is found that, upon outfitting endcaps with an "o"-ring which resides in a groove around the cap inner diameter, an extremely tight gas seal is always obtained. Preparations were made to test "o"-rings of assorted diameters and materials. The "o"-rings required are not off-the-shelf items. Rather, custom-tailored molds need to be made for each of the trial "o"-rings, hence some expense and delay have been incurred. Tests during December are expected to establish the optimal "o"-ring dimensions. Discussions are underway with manufacturers to determine the minimal cost to be incurred per tube, if "o"-rings are used with every endcap in mass production of muon system drift tubes.

It has been presumed for some time that drift tubes which fail quality assurance testing would necessarily have to be rejected, since nondestructive disassembly is not possible. It was now been demonstrated in the Tufts shop that there are at least two procedures whereby endcaps can be removed from cylindrical extrusions without damage to the extrusion. It is plausible that the second procedure, which involves reheating an
extrusion end while the tube is overpressured to 15-20 psi, may leave intact the circuitry which is mounted within the endcap.

Acquisition continued through the month, of tooling items (stone cold saw, CNC readout, steel plates and tubing for assembly benches, etc.) in anticipation of fabrication needs of the Boston Consortium, as the startup date for the drift tube assembly lines approaches.

Harvard University

Technical Staff: Ed Sadowski, Frank Dalrymple, Rick Haggerty, Steve Sansone Physicists: Peter Hurst, Gary Feldman, George Brandenburg
Submitted by G.Brandenburg, E.Sadowski

We have begun design of wire transport and wire feed device. There are ongoing tests on end caps for gas tightness. We are investigating various sealing modes to obtain desired tightness, re: O-rings, epoxy grooves, different machine finishes etc. We are getting bids on the stamping of the end caps, for cost comparison, availability, and as second source information.

A rework of our clean room is in process for muon tube assembly.

IHEP, Protovino

Technical Staff: M.Chernetsov, S. Votvud, K.Kachnov, V.Polyakov.
Author of Report: V.Rykalin

Four scintillator counters were shipped from Moscow to Michigan on November 26. The test of these counters on cosmic rays is in progress.

C S Draper Laboratory

Technical Staff: F. Ayer, J. Govignon
Author of Report: J. Govignon

The Location of the on-module SLMs has been discussed at several meetings; the clear space needed for the optics is a tubular shape with a diameter approximately 50 mm at the largest point; therefore it seems that the best location is in between the end plate and the outer plate, at mid height of each module. Mechanical designers have to give their approval. Location of the proximity sensors for the Fencepost is being evaluated as the design of a Fencepost evolves.

3.2.1.5.6 B. R. Trigger Counters

University of Michigan

Technical Staff: E. Dodd, C. Weaverdyck Physicists: E. Gero, S. Hong, R. Thun
Author: R. Thun
We have constructed a full-scale model of the BW2-BW3 gap to investigate the requirements for servicing the BS2 muon counters.

3.2.1.5 Barrel Region

*University & INFN Pavia*


Author: G. Introzzi

Some new R&D data have been obtained by the GEM collaboration. At the DPF'92 meeting P. Haridas (MIT) reported a 90% efficiency testing a single chamber (50 \times 50) cm\(^2\) RPC module, using the following gas mixture:

- Argon 73%
- Carbon dioxide 16%
- Isobutane 8%
- Freon 3%

This result was obtained without a proper readout system, using instead standard LeCroy modules. The obvious extrapolation to a double chamber RPC with staggered spacers (the kind of modules suggested for SDC) indicates an efficiency close to 99%. This gas mixture could result NON flammable, as indicated by J. Elias: "The mixture that you reported from GEM should be sent out for testing to determine flammability. It is very difficult to put in all of the specific heat corrections - CO(2) is better than nitrogen while argon is worse - sometimes just measuring a candidate mixture is the best thing to do". As SDC group, we intend to carry out specific bench tests in Pavia, to find our "magic mixture", to be tested for flammability.

About freon, it could be possible to use some kind of freon that does not contain chlorine (very active in destroying the ozone layer). Instead of usual freon (R12 or R22), some alternate candidates such as R13B1 (CF3Br) or R14 (CF4) could be considered. We are in contact with SSC Lab safety experts to find out the present limits for releasing these gases on the atmosphere, and what is (or will likely be) the Lab policy about these gases. Finally, a preliminary test done by GEM indicates an upper limit of 1 mV for the pick-up noise of a standard RPC module installed in proximity of other muon chambers. Such a performance has been considered excellent by the people performing the test.

*SSCL*

Technical Staff: Kelly Bramble, Scott Day, Jim McIntosh, Gary Pennycuff, Jon Thunborg, Scott Wolfe

Physics Staff: R. Davisson, Henry Lubatti, Peter Schuler, Patricia McBride

Author: Patricia McBride

The muon laboratory at the Stoneridge site has been expanded and the assembly platform was constructed this month. The concrete for the pad was poured on November 20. H. Lubatti, J. Thunborg, and G. Pennycuff worked with the facilities group and with contractor to monitor development of the prototype tower assembly pad and modifications to muon lab. We are now working with D. Kruger to develop plans for the new office space that will become available after the first of the year.

With the completion of the concrete work for muon assembly foundations, the group is now coordinating with epoxy grout contractors so that we can find the best
H. Lubatti organized a Prototype Tower Workshop for December 12 and 13. The workshop will bring collaboration members together at the SSCL to focus on the tasks facing the group 1993.

One of the primary efforts this month has been on placing orders for the prototype and discussing with vendors to identify appropriate sources for material which we need. J. Thunborg researched types of plates available and initiated orders for cover plates and spacer sheets for muon prototype.

S. Wolfe joined the technical staff in late November. We are continuing interviews for an engineering position and developing a plan for the manpower support for the prototype tower fabrication.

Work intensified on the design of an epoxy distribution system. We currently have two concepts under consideration. Several meetings with suppliers of epoxy distribution equipment occurred. U.T. Arlington engineer Mike Diver began working with us two days a week contributing to the epoxy system design. K. Bramble worked on the design and prototype for the Automatic Adhesive Applicator.

J. McIntosh and S. Wolfe inspected various parts delivered to the lab, specifically, they inspected new tubes which were to be used in the fabrication of the detector. The tubes were found to be out of specifications according to drawings.

G. Pennycuff visited numerous local vendors to inspect possible manufacturers of parts for the muon detector. He and J. Thunborg evaluated potential metal stamping and injection molding facilities.

P. McBride and P. Schuler have been working with K. Hess, J. Oliver and J. Piles to go over cabling and cable routing. This issue must be resolved to avoid interference with the scaffolding in the region between BW2 and BW3. In addition, the placement of the regional crates will depend on the routing of the cables from BW2. A halogen-free shielded twist and flat cable can be obtained with a diameter of 9.1 mm, however the space between the modules is only 20 mm. Since the cables must be protected, it is not clear that there will be sufficient tolerance to allow efficient installation of the modules.

J. Thunborg and P. Schuler discussed methods to manufacture the muon chamber gas manifolds. For the gas manifolds on the modules, two different technologies based on stainless steel tubing and on Noryl plastic tubing are being evaluated. We have ordered and received 304 type stainless steel tubing of 1" and 1.5" OD, as well as solid rods of Noryl EN265, which have been machined at the lab into short sections of tubing. Small orders (100 ea.) of stainless steel and brass gas fittings have been placed and delivery has been promised for Dec. 9. These fittings have the same barbed design as those used on the injection molded tube end caps. They will be joined to the manifold tubing by welding or thermal insertion, depending on the materials.

3.2.1.5.6 B. R. Prototype

University of Michigan

Technical Staff: E. Dodd, C. Weaverdyck
Physicists: E. Gero, S. Hong, R. Thun
Author: R. Thun
We have constructed and tested a prototype muon trigger counter with two 180 degree light guides. We propose to use this design for the BS2 and IS2 layer of trigger counters. In collaboration with Vladimir Rykalin of IHEP Protvino, we have also constructed and tested a second such counter using Russian scintillator and phototubes.

3.2.1.6 Forward Region (Shared Items)

**IHEP, Protvino**

Technical Staff: L. Baliev, A. Levin, S. Nikitin, V. Starcev  
Author of Report: Yu. Antipov

**IHEP, Protvino**

Physics Staff: V. Kochetkov  
Author of Report: A. Surkov

3.2.2 Intermediate Region (summary)

3.2.2.2 Intermediate Region (shared items)

**University of Wisconsin**

Technical Staff: Farshid Feyzi, Alan Pitas  
Physics Staff: Don Reeder, Duncan Carlsmit, Dick Loveless  
Author of Report: Farshid Feyzi

First week of November was spent with the conceptual design of an access scheme for IS2. A set of walkways and ladders have been designed that allow good access to all parts of IS2 within the space between IS2 and BW3. There is also a walkway that connects to the access space to BS2 through the same space. A comparison of the choice between IS2 and IS3 was done as it relates to: weight, IWT distortions, installation and access. All results were reported on November 5, at SSCL. This activity continued through November in order to report at meeting on December 9.

All plates and rails drawings for IWT were updated. A set of drawings for the assembly sequence of an IWT was produced. A full length 16 cell IW2 prototype was initiated. The end plate drawings were produced. Unlike barrel modules, a vertical insertion of the tubes into intermediate modules is not feasible. A 45 degree insertion angle was decided upon after modeling on the CAD system. This scheme will be tested on the 16 cell prototype.

Author of Report: Alan Pitas

Two design options for tube placement tools were examined. The interaction of the tube/tool interface, overall tolerance budget, and the relative cost for each design was
examined. Alignment procedures for each design were developed based on commercially available alignment equipment. Neither approach has demonstrated a clear superiority.

SSC has provided us with the latest endcap hole pattern dimensions and tolerances from the barrel design. These tolerances were examined with reference to their applicability to the intermediate module construction. It was decided that the intermediate group will use the tolerances for the first round of small prototypes. If no difficulties arise, the dimensions and tolerances will be adopted for the full scale prototype.

The specifications on the hole locations for the boss and pin endplates was reviewed. The only data currently available on the specifications being used by the barrel group are those listed on drawings made last May. The specifications were found to be inappropriate for describing the placement of intermediate end plate features. Since several aspects of the end plate design have been changed in the last six months, the barrel drawings are being completely redrawn. It was decided that we should wait until the barrel design has been updated and then reexamine their solution to see if it can be adopted for the intermediate modules.

Two areas of fixturing were examined in detail. First, the design of the table was reopened with a view toward finding a less expensive solution. In particular, a design using air filled bladders to support most of the weight of a module was detailed. This approach has the possibility of providing a low cost platform. However, an extensive search did not reveal a vendor who could provide a top surface with sufficient flatness to meet our needs. At that point the idea was dropped.

Second, a conceptual design was developed for aligning fixturing. Based on the design, a specification for the alignment hardware is being developed. The search for laser alignment vendors was renewed. A list of vendors has been developed and a request for bids will go out in late December or early January.

The requirements for the mounts continue to be refined. A review of the tower placement requirements for first and second level triggers has lead to the conclusion that all towers should have two mounts that are adjustable in Z after the tower has been installed. This results in an increase in the number of kinds of mounts to five. The conceptual designs of the mounts are now being developed.

Design of a small 4 cell by 4 cell prototype was begun. Because of the desire to test a variety of assembly techniques, the endcap pin diameters were changed to accommodate English size removable dowel pins. We are not aware of supplier of metric removable pins. The machining of the encaps is almost complete.

**University of Minnesota**

*Technical Staff:* Dave Maxam  
*Physics Staff:* Nelson Christensen, Ken Heller  
*Author:* Nelson Christensen

1) Lightguides were designed and built for the new scintillator reflector design. Quality control tests are under way.

2) Data acquisition systems to be used for the muon system's scintillator test stand are being investigated.

3) Scintillator calibration work is under investigation. We are looking at an LED pulsed with 5 nanosecond pulses. These would be attached to every scintillator so that the system may be checked at any time.
4) Beginning work on an optical proximity sensor for alignment use in the intermediate region.

3.2.3 Forward Muon System (Measurement System)

University of Maryland

We had a three day meeting at Maryland with our Russian collaborators from Protvino. The minutes of the meeting have been posted on the bulletin board.

FE analysis work on the 3-point mounting scheme for the FMS station frames continued. The ball screw gear train scheme was revised for the vertical motion of the 3-point adjustment system. Design was begun on transverse (x and z) motion of the stations (Fw's).

Work was started on the drift tube endcaps using the Protvino spherical hinge mounting concept for the drift tubes. The FMS group has tentatively adopted this mounting scheme as the baseline for further investigation.

Analysis of the horizontal supermodule assembly scheme in the assembly building was begun. An FE analysis will have to be done on the loaded frame to examine the local distortions when the supermodule is supported only from the radial spokes when in the horizontal position.

One of our engineers (Frank Desrosier) attended a Muon system engineering meeting at the SSC on November 18 and 19.

Work continued on testing the 4.5cm baseline tubes using the Penn/Harvard amplifier with Argon/CO-2 and with Argon/Ethane.

3.2.3.1 FW1 Module

3.2.3.6 Forward Region (shared items)

University and INFN Pavia


Author: G. Introzzi

The ideas underlying the RPC project for the forward regions are now published in the SDC note "Resistive Plate Counters for the SDC Muon System", appeared on Nov. 3rd, 1992. We suggest the use of 2 cm wide readout strips, as long as an octant (see Fig. 14 in the Note). The required time resolution would be assured by mean timers, with a time resolution of +/- 1 ns. The gas mixture to be used would be the same as for the RPC's in the barrel region.

C S Draper Laboratory

Technical Staff: K. Dyer, J. Gorman
Author of Report: J. Gorman

During November, we formulated an ANSYS finite element model of the AB1/AB2/AB3/AB4/Support Sleeve assembly including weight contributions from all FW
supermodules, FS modules and the FCAL. This model was exercised in a gravity field for parameterically varied Hillman Roller support stiffnesses between AB1 and AB2. Results indicate that, in the likely roller design range, the FW deflections are insensitive to roller stiffness. The IHEP results reported for FW5 in SDC Report #000063 are shown to be somewhat conservative. We predict, for example, FW5 deflections of 1.5 mm versus the IHEP prediction of 1.9 mm. Draper further delivered during November a report outlining requirements and concepts for the FMS. Also during November we began reviewing and itemizing FMS hardware for the purposes of a US cost estimate.

\section*{Institute for High Energy Physics, Protvino, Russia}

Technical Staff: L.Baliev, S.Nikitin, A.Tuhtarov, A.Levine, V.Starcev

Author of Report: Yu.Antipov

Reports on IHEP activities in FMS design were made at U.of Maryland by L.Baliev and Yu.Antipov. Discussions at this meeting were very fruitful.

Bushnin’s group started design and production an electronics for this stand. About 25 percent of a work was made.

Baliev group started design of a stand for scintillator checking at IHEP. About 50 percent of a design work was made.

Baliev's group started a working design of tubes with ballhinge.

Technicians were trying to study US Noryl plastic for endcaps in IHEP workshop.

Physics Staff: V.Kochetkov
Author of Report: A.Surkov

In order to provide the access to all FMS system, the work on the design of the space metal structure on the basis of Al alloys are being continued.

There has been refining the traces for laying of the cable and gas utilities in the FMS frameworks.

Work has continued on the FMS integration project during November.

There has been refining and revising of the absorber design in accordance with the physical calculations proceeding at IHEP.

The technological work on the using of borated concrete and lead is being conducted.

The design has begun on the Cerenkov counter placed between FS4 and FW5. Its installation in given position may have a pronounced effect on the access issues to FS4 and FS5.
3.2.4 Global (summary)

3.2.4.1 Global Tube

University of Texas, Arlington

Technical Staff: W. Lutes
Physicists: A. White, P. Draper, L. Sawyer, E. Gonzales, J. Perkins
Author of Report: A. White

Our students have completed the first version of the detailed simulation, using GEANT, of the stack of four muon tubes to be built in our clean room. This simulation predicts the pulse shapes that should be observed from tracks crossing the tubes at various angles.

Brandeis University

Technical Staff: Pat Long, Matt McNeely, Glen Olsen
Physics Staff: H. F. Wellenstein, D. Kaplan, M. Styllar, D. Lorenzon
Author: H. F. Wellenstein

We are studying details of the manufacturing and testing methods for the production of muon drift tubes.

Securing End Caps: We continue to investigate the cheap, mechanically sound, and electrically secure method of installing end caps into the heat expanded muon drift tube. End caps with different surface finishes, were inserted using interferences of 0.006". It was found that the tubes had leaks of about 0.025 torr x liters/sec. regardless of the surface finish. Using "VacSeal" applied to the joint reduced the leak to zero (<0.0005 t.l/s). We ordered small 'O' rings (0.035") to seal the endcaps. -- the most promising approach as reported last month.

Wire Stretching: A PC controlled tungsten wire tensioning device using a "load cell" (strain gauge) and a stepping motor is being tested. This devise will also be used to record strain versus time, i.e. observe "creep".

Back Diffusion Studies: We have build a gas handling system and attached to a Residual Gas Analyzer to measure the back diffusion though a potential leak, i.e. the air leak into the tube against the out flowing argon. We expect data by Dec.3.

Leak Test: A leak test technique for the assembled tubes was constructed and found to detect leaks > 0.001 t.l/s in less than 15 sec.

Checking Wire Positions by X-rays: We have started construction of the single tube test station to accommodate tubes of 6.6 to 8.8 meters. The x-ray technique developed for the "Boston Tubes" has been adapted for the Washington Tubes.

University of Colorado

Technical Staff: Bruce Broomer, Eric Erdos, Gerhard Schultz,
Physics Staff: Mark Christoph, Quenten Van Egeren, J. Lee
Reported by: Mourad Daoudi, U. Nauenberg

Not much progress took place this month.
In Colorado we are working on three aspects:

1) We are beginning to build the assembly line for muon tubes. We are building frames for high quality table tops that we already have. The refurbished space has been completed and we will move into it. We expect to build a first order clean room during the next few weeks.

2) The tracking device is essentially complete. It is gas tight and we are applying high voltage. We expect to observe the drift signals soon.

3) We are starting the construction of the wire feeder and the wire tensioning device.

Ohio State University

Technical Staff: D. Fisher, R. Wells
Physics Staff: L.S. Durkin, T.Y. Ling,
Reported by: D. Fisher

On November 9th we received 25 full length (9 meter) aluminum extrusion tubes from R.D. WERNER. One tube was cut into 9 pieces and measurements were taken. The outside dimension was within 0.001" along the entire length, all other dimensions were within our specifications. Less than 1 degree of twist was recorded.

Six tubes were brought into our prototype lab and one has been endcapped and strung with 0.003" wire. So far it is holding 912 grams of tension. The wire tension was checked with an oscillator and inductive pickup device. We have also designed a new plunger for installing the field shape extrusions along the 9 meter length of the drift tube. Some modifications are needed, but the design appears to be functional.

We will soon be ready to flow gas and apply high voltage on a full length prototype drift tube.

University of Washington

Technical Staff: R. Davisson, Y. Chen, S. Han, J. Stephens
Physicists: H. Lubatti, T. Zhao
Author: H. Lubatti, T. Zhao

The design of the drift tube and chamber modules were reported at the 1992 DPF meeting at Fermilab. Results of the BNL beam test and the results of drift chamber gas studies were also reported. A paper has been submitted for publication in the proceedings of the meeting. (T. Zhao)

Preparation for the tube fabrication facility is continuing. The electrode installation tool has been tested using a full length tube. The two installed electrodes have been tested up to 9 kV overnight. The Noryl insulator appears to be extremely good. We are preparing a document describing the drift tube testing and quality control procedures used during the tube fabrication. (Y. Chen, T. Zhao)

Studying the thermal deformation on the prototype drift tube module which we built in Seattle is in progress. The top of the module is heated up to 20 degrees C uniformly. The shape of the module is monitored by using ten dial indicators at different locations. We plan to also heat up the module unevenly. (J. Stephens, T. Zhao)
The drift chamber gas study is continuing. The contamination of N2 and air to the Ar-CO2 88:12 mixture is being studied. Measuring the dependence of drift velocity on temperature is underway. (Y. Chen, S. Han, T. Zhao.)

Progress has been made in the design of jigs for manufacturing the drift tubes. (R. Davisson, H. Guldenmann)

The tool for finishing the tube ends has been completed and tested. Some minor design changes will be implemented in the next model. A cutting tool to trim the field shaping electrodes was designed, fabricated and tested (H. Guldenman).

A shipment of field shaping electrodes (30 foot lengths) has been received. Samples were sent to Harvard, SSCL and KEK. (H. Guldenman and T. Zhao)

Computer code has been written to study the trigger efficiency as a function of muon transverse momentum and the trigger rate. This study will make the Monte Carlo code written by T. Zhao and L. He more general. Eventually, the finished package will be incorporated into SDCSIM. (Z. Feng, T. Zhao)

SSCL

Technical Staff: K. Bramble, S. Day, J. McIntosh, Gary Pennycuff, J. Thunborg, S. Wolfe
Physics Staff: T. Fukui, H. Lubatti, P. McBride
Author: Patricia McBride

Ordering of parts for the prototype is proceeding. J. Thunborg placed orders for metal stamping for prototype end caps and initiated the order for the plastic injection molded pieces.

J. McIntosh and S. Wolfe continued work on the creep test with D. Davisson. They modified and added various sheet metal parts to the fixture in order to install a tungsten calibration rod, thus doubling the size of the fixture. The expanded size increased the capacity of the fixture to hold 10 more wires for a total of 18 wires.

K. Bramble has been working on an alternative angle bracket for use on circuit board in the signal end plug. The design will cover the transformer to screen out EF noise. He also redesigned the High Voltage connector plug to better facilitate potting compound flow around the electrical pin connectors and reduce potential source of arcing between the pins.

P. McBride and T. Fukui have been operating a test tube of the 9 mm design to check the design and operation of the end cap and end plug. They have found on HV problem with the end plug which has been corrected.

T. Fukui continued to measure the resolution of 75 mm, 9m long tube with the Portable SDC DAQ system (UNIX WS and VME) developed by KEK, SSCL, Univ. of Michigan etc. He also analyzed the data which were taken at BNL. Preliminary results of tube resolution about 220 micron without subtracting tracking error. Global tracking error of the Jet Chamber, which determines the track, is estimated to be about 120 micron. A. Wang is analysing the two track data taken at BNL.
3.2.4.2 Global Alignment & Monitoring

C S Draper Laboratory

Technical Staff: J. Govignon
Authors of Report: J. Govignon

The implications of the error model presented at the DOE Review have been explained and discussed at several meetings.

The Fencepost design has continued, and an optical alternative to the induction proximity sensors is being evaluated. Work is progressing in conjunction with Harvard and Fermi Lab. A comprehensive memo is being released: SDC-92-389.

Technical discussions with S. Behrends and P. Hurst regarding Alignment Requirements have continued, and progress has been presented at the various meetings.

Work on the reconstruction of the Detector geometry from the alignment measurements has been limited.

Harvard University

Tech. Staff: John Oliver, Kevan Hashemi, Sarah Harder, Howard Hill, Jack O'Kane
Physicists: Peter Hurst, Gary Feldman, George Brandenburg
Submitted by George Brandenburg, John Oliver

Straight line monitors. A VME/Macintosh DAQ was set up to measure performance of SLMs. Measurements were taken with quad photodiodes and lateral position sensitive detector photodiodes (PSDs). Measurements using PSDs indicate a short term resolution of order 3 microns and stability of under 6 microns over several days duration. The latter measurements show a periodicity of 1 day duration and probably indicate actual motion of our optical bench. The electronics is being redesigned for small size and lower power. This new electronics will cover both the SLM and the fencepost requirements.

Work on the laser rangefinder is somewhat longer term. A custom CMOS phase detector chip, which we hope will be the basis for this device, was received from Orbit Semiconductor. It was found to function but will require precision measurements to determine if it will give phase accuracy to the level required for 100 micron ranging accuracy. This testing will be carried out over the next several months.

Brandeis University

Technical Staff: None
Physicist: Steve Behrends
Author: Steve Behrends

The requirements placed on Supermodule alignment tolerances by the full offline muon momentum measurement system have been studied. Offline measurement of Pt was shown to consist, to a good approximation, of three independent measurements: (a) CTD tracking, (b) bend in the toroids as seen by the theta-chambers, and (c) matching in phi of the muon stub with the exit-point of the muon in the CTD. An analytic expression for the offline resolution vs. Pt was derived as the (weighted) average of these three techniques.
Using this expression, displacements of individual Supermodules (translational and rotational) can be translated into effects on momentum resolution. Tolerances per Supermodule were derived by demanding that misalignment contributes less than 10% to momentum resolution at 2 TeV.

Work has continued on establishing the requirements placed on Supermodule alignment tolerances by the full offline muon momentum measurement system. Our analytic expression for the offline resolution vs. Pt, composed of a weighted average of three SDC momentum-measuring techniques, was improved to account for translational multiple scattering errors in muon trajectories. A program package was also developed to assess the impact on resolution of various alignment scenarios, specifically those that result from the proposed baseline alignment system.

Work has continued on developing a program package for evaluating the impact on full/offline muon momentum resolution of proposed alignment scenarios. A geometric interface program was created to propagate the accuracies of sensor elements within the Barrel fenceposts into uncertainties on Barrel Supermodule alignment (i.e., limits on translational and rotational errors); a second package converts these errors into contributions to momentum resolution. We are presently awaiting a full rigid-body analysis of the alignment system from Draper Labs that will correlate the numerous RER and internal-fencepost measurements, which is predicted to improve the accuracy of Supermodule alignment knowledge beyond the accuracies of the single sensors composing the fenceposts.

Work has progressed towards implementing a program package for evaluating the impact on offline muon momentum resolution of various scenarios for the alignment system. A meeting with Draper Lab engineers has produced a protocol for acquiring tables of fencepost sensor-accuracies and interfacing these into our package for estimating momentum resolution of a "misaligned" Muon system.

SSCL

Technical Staff: D. Davisson, P. McBride, P. Schuler
Author: Patricia McBride

D. Davisson has continued to work on the conceptual design for the alignment system. He has developed a scheme to replace the inductive proximity sensors with mirrored lenses optical sensors similar to those used in the SLMs.

P. Schuler and P. McBride attended several meetings of the alignment group and have started working on global SDC alignment issues.

Fermilab

Technical Staff: J. Morrison (senior designer)
Physics Staff: D. Early
Author of Report: D. Early

Two mechanical designs for mounting and referencing proximity sensors to muon module precision bulkheads have been developed. The scheme of mounting individual sensors on a generic mount was reviewed at SSCL on Nov 18. This would require mountings inside the enclosed bulkheads. As an alternative, we have developed a design which mounts all three X, Y, Z sensors on a single external bracket which is referenced to the INSIDE machined side of the ONE precision bulkhead which extends to the outer...
plates. THIS REQUIRES AROUND THE CORNER REFERENCING OF HOLE LOCATIONS FROM THE MODULE

ASSEMBLY

We have been investigating the possibility of using graphite fiber-resin fencepost tube sections between optics/sensor station blocks. These would provide optimum mechanical deflections and near zero thermal expansions. End joint proposals are under study with Tilletson-Pierson and we shall see tube samples. However costs may prohibit doing this. Present test results with various shaped stainless steel fenceposts indicate that we can readily account for length changes with thermal fluctuations. Development of the prototype fencepost structure awaits the results of prototype optical island tests.

Test results on a102mm diameter round stainless steel fencepost indicate that stability thermal motions (+-6 deg F) in Y (gravity direction) are the largest, but are less than 50mm at MBW3. A local heating thermal cycle test in excess of 60 degrees F indicates primary motions are in the gravity direction (Y). A test report is being prepared.

The modified electronics in the Capacitec liquid level sensor cluster indicates individual sensor long term resolutions of 6 to 19mm standard deviation. This is a factor of 2 improvement. Thermal tracking is improved, and simple thermal corrections can reduce raw data fluctuation by another factor of two. The Mechanical Technology, Inc sensor system output is very linear with gap, and the stability is better in dry gap monitoring but worse in wet pot tests. The Lion Precision system is very linear, has the least thermal fluctuation, but has some unsatisfactory slow drift. A detailed test result report is being prepared.

We have modified the liquid level pot system design to provide better tilt and height adjustment and measurement.

WBS 3.2.4.3 Global Trigger Counters

*University of Michigan*

Technical Staff: E. Dodd, C. Weaverdyck
Physicists: E. Gero, S. Hong, R. Thun
Author: R. Thun

We have completed three of six tracking planes for the muon counter test facility, comprising 288 out of the required 360 proportional tubes.

3.2.4.4 Global Surface Facilities

*University of Washington*

Technical Staff: C. Daly, W. Song, R. Storch
Physicists: H. Lubatti, R. Davisson
Author: H. Lubatti

Discussions on assembly procedures continued. (All)

Fermilab

Technical Staff: J. Morrison (senior designer)
As the RAM model with detailed module assembly flow charts indicated a fabrication schedule problem for the defined Phase I muon installation, we have created a new model and startup schedule which meets the installation requirements and does not violate storage limitations. It is being evaluated in the RAM. Another RAM version with a second shift on MBW3 production is being done.

3.2.4.6 System Engineering

SSCL

Technical Staff: Matt Piazza, Payson Willard  
Physics Staff: none  
Reported by: Matt Piazza

Developing Muon Subsystem Procedures for procurement, schedule development, and monthly cost/schedule statusing. Placed order for 2 magnet toroid blocks from JINR, processed "missing" $8K request for payment of prototype counters, and ordered some computer hardware for shipment to Russia. Researched serious issue regarding import duties. This issue represents a potential 35% budget buster for some imports.

Proposed acceptance of common practice for subcontractor reporting costs with a one month lag. This practice reduces administrative burdens without a significant reduction in management information. The practice supports one reporting cycle per month instead of two cycles each month, one for technical information and one for financial information.


Progressed in developing a Magnet working schedule consistent with the WBS. Expect completion by January 15th. Also, working on 1st cut status reports showing cost and schedule information. Expect completion by December 15th.

Placed equipment requests with Sandra for three positions, Business Office Manager, Cost Analyst, and Scheduler.

December plans include 1st cut status reports; EAC and FY93 budget loaded into COBRA, completion of Muon Subsystem Procedures, 1st analysis of Muon Measurement working schedule with RAM information, 1st pass at negotiating the Draper and Martin Marietta contracts, completion of paperwork for the 3 Business Office positions.

C S Draper Laboratory

Technical Staff: G. Holden, J. Gorman, C. Grinnell  
Authors of Report: G. Holden, J. Gorman, C. Grinnell

Engineering Coordination, Planning and Tracking

C. Grinnell

The development of the working schedule for the design phase of the project were completed to an appropriate level of detail and the resources from the cost estimate were loaded. The schedule durations were adjusted to meet the design review milestones from
the last version of the Project Schedule. The resource profiles which were produced demonstrate the clear need to reallocate funds appropriately.

A meeting was held at Martin Marietta to make a first pass at integrating the fabrication phase of the project into the working schedule. A roll-up of the activities and resources in the RAM to the appropriate level of detail for the working schedule was performed and the file transfers made successfully. Gaps in the planning between the design and fabrication phases to do things like procurement and facilities preparation must be worked on. It is not clear at this time how to interface this planning with that of the detector installation.

An SDC muon group engineering meeting was organized and held on the 19th and 20th to review status of all subsystems and the management of the group.

Integration tasks for services, facilities, the forward system and alignment needs were not covered adequately due to limited resources.

*System Design, System Engineering*

G. Holden

Work continued on the tube placement and analysis for the SDC muon system. Arrays describing the tube positions were exchanged between Washington (C. Daly) and Harvard, and analysis was performed on these. Discrepancies between the two groups have been defined and are in the process of being resolved. A consensus on the tube positions for the barrel region should be reached in the near future. Once this is accomplished, the Intermediate and Forward region tube placements can be nailed down as well. The Muon system model configuration tracking has been expanded to include tube placements as well.

Progress on a pilot archiving/library system for the muon group was presented at the SDC Engineering meeting in Dallas on Nov. 19-20. The top level structure has been implemented, and access for the muon system community has been realized. Files can now be easily exchanged between Intergraph workstations located in Washington, Maryland, Wisconsin, FNAL, SSCL, and Harvard.

Work was also carried out in support of the alignment system task being performed at Draper. This involves the development of model to evaluate the errors based on a set of reference points and measurements.

*Martin Marietta*

Technical Staff Involved: J. Bakken, J. Brogan, R. Hund
Reported by: J. Bakken, J. Brogan, R. Hund

*Muon RAM Modeling*

The RAM now generates output that can be directly read by Grinnell's scheduling overview program (MacProject PRO) and by Montgomery's WBS program (Microsoft Excel). This output is still evolving and will change as necessary. The scheduling overview files represent a "management" level overview of the entire RAM output. Approximately 30,000 RAM operations have been condensed into about 50 overview operations. There is enough detail in this overview for one to grasp the big picture and suggest overall changes to the production and installation sequences. The overview files contain the overview activities, the logic that connects the activities, the labor hours, broken out according the SSCL rules, that are required to complete the activities, and the resource
first-use costs needed to build the pieces in the activities. (We were instructed that individual resources need not be listed individually in this overview – only the costs had to be tabulated. In any case, the list can be added.) The overview logic is entirely connected; that is, there is only one place that one has to enter a start date and then all other tasks feed off of that. The WBS files generated by the RAM contain a detailed listing of the labor hours necessary to complete the various muon modules, again broken out according to SSCL rules. These files will allow the WBS and the RAM to be in complete agreement and avoid discrepancies that have surfaced in the past.

New production build sequences and module installation sequences, suggested by Eartly and Brogan, have been input into the RAM. The “blockout” dates for muon module installation have been input into the RAM. Only the resources that are specifically unavailable during these blockout periods are excluded, other muon work may continue as usual. Because of the large time difference in building a bw3 and bw2 module and due to the fact that the bw3 module has to mate to a bw2 module before the bw2 module is completed, a second shift was added for the bw3 production. This balances the bw3 and bw2 productions quite adequately.

Muon System Safety

Work was completed this month on the draft muon safety outline and plan. A preliminary version of this document was reviewed by Bob Lavelle and his comments incorporated. The document was also submitted to the SSCL on December 4 to fulfill contractual requirements.

A safety presentation was given at the November muon engineering meeting. The major items of discussion were the muon safety plan, major safety analysis milestones, responsibilities, and general discussion about PSARs.

Information was prepared for the second Trigger Counter Placement Task Force meeting. Included in this information is emergency rescue, normal and emergency lighting requirements, ODB monitors and ventilation, and communication requirements.

Simulation

SSCL

Technical Staff: J. Thunborg
Physics Staff: T. Fukui, N. Khalatyan, P. McBride, A. Wang
Author: Patricia McBride

T. Fukui, P. McBride, D. Davisson and J. Thunborg developed concepts for a cosmic ray test for the 90 mm tubes - the main function of which would be to evaluate the front-end electronics developed by J. Oliver. The concept includes five 90 mm tubes correctly aligned by an aluminum structure and that provide, as nearly as possible, the electrical isolation which the full scale module provides. The tubes and end plates for the test stand will be constructed at Seattle.

University of Colorado

Technical Staff: Mark Christoph, Mourad Daoudi, Quenten Van Egeren, Uriel Nauenberg, Victor Slonim.
Physics Staff: Uriel Nauenberg.
Reported by: Uriel Nauenberg.
We are continuing our effort in simulation. We have and are continuing our effort in pattern recognition. Most of it is done and improvements are taking place now.

We have written a program that will add the off time events from reactions coming from different beam buckets (16 nsec offset). Work to test it is now proceeding.

Students are comparing various particle production packages. They will now start to study the detector performance with the backgrounds added.

Northern Illinois

Physics Staff: Suzanne Willis, Vladimir Sirotenko
Author: Suzanne Willis

Work on developing the muon reconstruction program in the barrel chambers (package MI) continued. During this month the pattern recognition algorithm has been rewritten and other modifications have been made to

1) increase the track reconstruction efficiency,
2) decrease the CPU time per event and
3) test the program in the environment with muons and electromagnetic debris accompanying them.

At the present time the status of the program is the following:

- SDCSIM Geant has been used to simulate the test events.
- The program has been tested on the sample with events (each event contains 5 muons of momentum 500 GeV, with associated electromagnetic showers). There were 2500 such events processed. The muon reconstruction efficiency is about 90% for tracks with the minimum number of theta and phi projections in the regions before and after toroid equal to 2, and with at least 1 stereo projection. The efficiency is about 98% for tracks whose minimum number of such projections equals 3.
- The momentum resolution for 500 GeV muons is about 70% (sigma).
- The program is now being tested on a sample of 50 GeV muons.
- The speed of the program has been increased drastically and for the moment is acceptable for the off-line reconstruction.

Work remaining includes adjusting the MI package, testing it in different conditions, including the intermediate chambers, interference with forward muon reconstruction and so on. But the most important result is that the first working version of the barrel muon reconstruction is ready and will be released to SDCSIM users soon.

University of Washington

The mini-tower test at KEK is being prepared. This test is mainly intended for testing trigger electronics. The drift tube resolution will also be studied. The University of Washington group is responsible for building a trigger logic board to process signals from the Michigan board and also another board which will be able to make a complete test for
the baseline design of the muon trigger. The board processes 16 pairs of signals from the
drift tubes in the KEK mini-tower, generates trigger primitives and outputs trigger flags
according to the desired trigger algorithm. Our design, which is based on Xilinx
programmable gate array, is very flexible. The trigger threshold will be programmable.
Different delta T determination circuits and different trigger algorithms will be tested. The
design of logic circuits for this board has been completed and tested by using a prototype
board. (Y. Chen and T. Zhao)
4.0 SOLENOID MAGNET SYSTEMS SUMMARY

4.1 Superconducting Solenoid

**KEK**

Technical Staff: Akira Yamamoto, Yasuhiro Makida, Ken-ichi Tanaka, Takahiko Kondo, Hiroshi Yamaoka

Author of Report: Akira Yamamoto

**Prototype coil winding:**

Coil winding practice by using the newly developed coil winding machine has been completed. The schematic picture of the winding machine as well as photographic pictures of the winding process and the cut-out view of the coil-winding were shown in the October report.

The thickness of ground insulation was measured to be 0.5 mm as expected. The epoxy bonding shear strength was also measured to be $> 20$ MPa at LN2 temperature. It is strong enough against an expected shear stress of $< 1$ MPa. The coil winding machine is ready for the prototype coil winding starting in early December.

**Prototype Cryostat Component design:**

Design study of the prototype cryostat components is being carried out.

The support scheme has been fixed and the chimney design is being fixed. The support base made of high strength aluminum alloy has been tested successfully and it will not be necessary to worry about bumps in transparency around the axial support in the detector magnet. The design will be fixed soon and the components will be fabricated.

**Honeycomb Vacuum Vessel R&D:**

The honeycomb vacuum vessel has been completed. Vacuum leak-tight test has been carried out successfully. No buckling has happened during evacuation inside. A serious evaluation of this R&D honeycomb vacuum vessel against buckling is planned to be done in December.

**Fermi National Accelerator Laboratory**


Author of Report: Ron Fast

**Vacuum vessel for prototype solenoid:**

All three isogrid panels for the outer vacuum shell have been machined by the Camarillo Dynamics Company. The panels have been completely inspected; all dimensions conform to the drawing specifications. The Amro Company has formed all three panels to the 2004-mm radius. The minor deformation that occurred from over-forming the first panel has been repaired to our satisfaction. The fixture to be used to assemble and weld the panels into a shell should be completed in the first week of December.
The fixture for the inner vessel has been completed and has been inserted into the inside of the shell. This fixture will remain in the inner vessel during the final machining operations and shipment to Japan. The inner vessel has been sent to the Square Tool Company where the machining to length and the tapping of the holes is scheduled to start in the first week of December.

The material for the annular bulkheads has been received and sent to a local vendor to be saw-cut into segments for welding into rings. The final machining is expected to start in mid-December.

A meeting was held with Helium Leak Testing, Inc., to discuss the requirements for the vacuum leak checking of the weld channels and the complete vessel. This company will have a vacuum technician present to help with the installation of all O-rings. A written procedure for the leak checking will be written by Fermilab and HLT, Inc.

The latest schedule from Amro shows that the vessel will be completed, including the leak testing and other inspection, and ready for shipping to Japan on February 26, 1993.

Since this vacuum vessel was procured with SSCL funds, it is the property of the SSCL. We have asked the Property Office at the SSCL for a determination as to whether the vessel is considered a piece of capital equipment. If so, the SSCL will prepare a loan agreement with KEK. We have also asked the SSCL Shipping and Receiving Office if they want Fermilab to arrange for shipping the vessel to Japan.

System for Attaching Cryostat to the Calorimeter:

We performed an analysis of the cantilevered cryostat support, including the functional relationships between the support taper, length, modulus, cross-section area, and the deflection under load. Using the current calorimeter and cryostat dimensions, we showed that a support can be designed to have a stiffness 20 greater than the magnetic force constant. This support has these parameters: length, 17.5 in; modulus, 10 Msi; width at calorimeter, 12 in; width at cryostat, 4.8 in; number of supports, 16.

The deflection of this 16-element support system under a 40-tonne axial load is 1.1 mm. The deflection of an 8-element system is unacceptably large.

The length of 17.5 inches assumes that the load path from the cold-mass axial supports passes through the bulkhead radially outward to the outer radius of the cryostat vacuum shell. The bulkhead should be analyzed to check the validity of this assumption.

The deflection of the calorimeter module at the attachment point should be considered since it will increase the overall deflection and, therefore, the force.

4.2 Cryogenic Systems

KEK, National Laboratory for High Energy Physics

Technical Staff: Akira Yamamoto, Yasuhiro Makida, Yoshikuni Doi, Takahiko Kondo
Author of Report: Akira Yamamoto

Conceptual design study of the SDC solenoid cryogenics has been continued. Thermal heat load including transfer lines, valves and others into the system has been re-estimated, to verify the system sizing. The refrigerator system with a capacity range of
1,000 - 1,200 W has been verified to be required to recover the system to steady state condition within 24 hours after a quench. Our study is consistent with the study done by SSCL.

**Superconducting Super Collider Laboratory**

Technical Staff: Charles Collins, Jim Krebs, Matthew Wilson, Warren Kampmeier, Gerry Chapman, Ray Fox  
Author of Report: Matthew Wilson

A draft of the Preliminary Design Requirements document for the cryogenics systems was prepared and released to the Technical Board for review. Final approval of the document should take place at the December meeting of the Solenoid Magnet working group in Japan.

During the DOE review, the method used to size the helium refrigerator was challenged. A paper was written to explain the method used to size the helium refrigerator for the SDC solenoid. The conclusions drawn in the paper show that a refrigerator of 1000-1200 watts at 4.2K is required to meet the operational requirements of the solenoid. This confirms the previously selected capacity range.

Separate meetings were held with Lotepro (the American version of Linde/Sulzer), Process Systems International (formerly Koch), and CCI Cryogenics as a part of a series of meetings to introduce the helium refrigerator. CVI was also invited to meet, but did not respond. A meeting will be held in Japan with Hitachi for the same purpose.

Several cryogenic valve and bayonet designs have been evaluated to use in the SDC systems. The options will be discussed during the Japan meeting for final selection. It is hoped that SSCL can standardize on common designs.

Detailed layouts of the piping and VJ transfer lines has progressed, and a 3D solid model illustration will be presented at the Japan meeting. Concern about interface with other hall systems is driving the effort.

A draft Agreement of Scope for WBS 4.0 has been prepared for discussion at the meeting in Japan. It is an attempt to clarify roles and responsibilities in the interim until an official Memoranda of Understanding can be prepared.
5.0 ELECTRONICS SYSTEMS SUMMARY

Effort continued on four WBS items:

5.1 Front-End Electronics  
5.2 Data Acquisition System  
5.3 Trigger System  
5.4 Ancillary Control Systems

Work in general focused on continued development of system designs and of critical components and preparation of electronics for detector prototypes. Progress is detailed below.

5.1 Front End R&D

Reports for four WBS items follow:

5.1.1 Scintillating Fiber Tracker Front-End Electronics  
5.1.2 Straw Tracker Front-End Electronics  
5.1.3 Calorimeter/Shower Max Front-End Electronics  
5.1.4 Muon System Front-End Electronics

5.1.1 Scintillating Fiber Tracker Front-End Electronics

Fermilab

Technical Staff Involved: A. Baumbaugh, A. Romero, K. Knickerbocker  
Reported by: A. Baumbaugh

Additional Fiber Storage/Trigger/Readout Boards, which were used in the test beam effort, are being built and tested. The design is also being looked at in terms of modifications which will bring it more in line with the final system boards, and in preparation for a several thousand channel test. These efforts continue.

We also continue the task of putting together test stands for use with tracking boards as well as boards used by the calorimeter. We are procuring IBM clones and interfaces from the PC to VXI so that we can set up simple DAQ and control functions from the PC into the VXI crate. These test stands should be fairly sophisticated and will include high speed pattern generators and have interfaces to logic analyzers, ADCs and DACs.

We continue working with the Fiber Tracking Group and Rockwell to set the specifications for the VLPCs and cassettes.

5.1.2 Straw Tracker Front-End Electronics

University of Pennsylvania

Technical Staff: N. Dressnandt, T. Eckenberg, J. Cook, R. Pearce  
Physicists: R. Van Berg, H. H. Williams, F.M. Newcomer  
Reported by: R. Van Berg
**Preliminary Design Document**

A number of greatly expanded and revised documents have been produced (see above for ASD paper and University of Toronto section for the various papers on the DCC definition) and must be interwoven into the revised PDD, actual revision has proceeded slowly.

**Amplifier/Shaper/Discriminator Design and Production Models**

ASD chips - currently two types of 68-pin packages are in use. A ceramic PLCC package with 50mil lead spacing for ASD T4 possibly other prototyping boards, and an EPIC package with 25mil contact spacing.

PLCC chips - A test board has been used to check more than 170 chips to date. The most recent set of 40 chips has had a much lower yield (We expect 80%), 15 chips had a short between analog ground and the preamp power. This may indicate that one of the wafers is significantly different than the first two. It does not appear that bonding was the problem.

EPIC chips - Due to the tight lead spacing, testing is quite difficult. Based on the excellent yield for chips bonded in the PLCC's and the delays involved with waiting for a reliable test jig for the EPIC's, we decided to attach the EPICS without testing initially. Most (I think all) channels of the first few EPIC packages checked, worked. We then told Promex to bond 40 more packages. Mike Emery (ORNL) reported a high failure rate on these parts. Our subsequent investigation showed that there was a serious problem with the bonding. Promex has identified the problem and agreed to re-work the affected parts. It should be pointed out that the next batch of 30 EPICs which were bonded before Mike detected the problem show a much higher, nearly normal yield, based on DC tests of packages. An order has been placed with an alternate vendor for bonding 50 more EPIC packages. This vendor offers room temperature bonding with gold bond wires, which should help to minimize yield loss due to bonding.

EPIC testers - we have managed to fabricate a test fixture for these packages using an elastomeric areal connector manufactured by AT&T which seems to work better in this application than the ShinFlex material - it seems less sensitive to deformation. We have also nearly finished a tester using 0.025" centerline Pogo Pins - we hope to have that tester available for use in early December.

ASD design/measurement - A paper covering the design, fabrication and testing of the ASD has been submitted to IEEE and is available to anyone interested.

Neutrons - Chiho Wang at Duke observed an unpredictable behavior of the ASD discriminator lasting up to several microseconds after a neutron conversion in the straw tube. Using scope pictures provided by him and SPICE, we have identified the behavior as being due to the combination of limited dynamic range in the shaper and the long signal tail in the straw. The ASD works well with signals of up to about 0.3pC,~2E6 electrons, beyond that saturation sets in and tail compensation begins to fail, resulting in a DC offset that effectively lowers the discriminator threshold. The dynamic range of the tail cancellation network may be extended by about an order of magnitude by placing it at the output of the preamp with limited costs in Signal-to-Noise and some cost in power. Other options, for even larger signals, include adjusting the threshold when large depositions are sensed. Since power and dynamic range are rather directly related for a given response time, it would be good to know more about the kinds of depositions we expect. How often? How large?
ASD/HV Assembly Production Model - Revised AZTEC and Folded Layout

BOARD LAYOUT: Design of the PC board for the Colorado (Folded) front end design (159 straws) is near completion. The board will be submitted in the first week of December.

The experimental AZTEC board is due back from the fabricator in the first week of December.

Production Model L2I

The four-channel version of L2I has been received back from the foundry. Six die have been bonded in a 68-pin LCC to be tested for functionality.

The effort to design a four-channel version of the TCC/AMU with the level 2 buffering and read-out multiplexing has started. All major blocks except the read-out multiplexor have been laid out, and a floor-plan for the entire chip has been established. Verilog simulations (which will verify logical operation and gross timing violations) have been run successfully with a netlist extracted from the schematics of the chip. These simulation runs have increased our confidence in the logical design of the circuit. They can also be used in a higher level simulation aiming at modelling the behavior of several TCC/AMU's together with the DCC. A model of the L2I (TMC version) has also been developed in Verilog.

Project Management - Project Planning

The Straw Electronics Cost and Schedule plan presented before the DOE review panel at the end of October was apparently well received by the committee - the preliminary report seems quite favorable both on the technical and planning progress made to date.

5.1.2.2 Straw Tracker Electronics Design & Production Models

University of Colorado

Technical Staff: B. Broomer, E. Erdos, C. Zuelchner
Physicists: D. Craig, W. Ford, S. V. Greene, D. Johnson, P. Rankin
Reported by: W. Ford

Completed loading of components for 20 A-S-D8/T4 front-end boards and delivered to Penn for testing.

Cinch Connector supplied a quote for a connector to bridge between wires at HV and the ASD, with the blocking connectors built into them (CIN::APSE technology). We are working with them to finalize the design for a prototype.

Produced a preliminary design for a HV supply board with recesses for HV guards to mate the Cinch connector/capacitor assembly. Consulted with a local vendor on the design (which presents some challenges); presently anticipating further input from them.

Ordered several of a modified routing board for use with a high-density prototype FEB being built at Penn.

University of Toronto / McGill University

Technical Staff: G. Stairs
A preliminary description of the dataflow from the Level 2 Buffer to the DCC, DCC to CIC and CIC to DAQ was completed by G. Stairs and circulated to the other members of the straw electronics group. This included a detailed description of the protocols between the different devices and a proposed architecture for the Crate Interface Card. A meeting was held at the University of Pennsylvania between the Penn, McGill and Toronto groups to discuss this and other issues related to the development and testing of the prototype DCC system.

The first set of ASIC’s designed at Toronto were fabricated and received by the group in the middle of November. This first IC consisted of a set of low-level differential receivers and drivers that were designed in the Northern Telecom 1.2 micron CMOS process. A total of 5 parts were received, and a test bench was assembled to test this IC. By the end of the month, tests of this device were underway.

FETX

Design of a prototype combined FMUX and FETX was completed and submitted to the Canadian Microelectronics Corporation for fabrication in the NT 1.2 micron CMOS process. This chip will read out two TMC chips using the Level 2 Interface ASIC (L2I) currently under development by the University of Pennsylvania group. Data from each L2I is buffered in a 24-bit fifo with 8 storage locations. The FIFO’s are readout with a multiplexor that appends a chip ID and transmits the data off-chip using a serial, on-chip differential driver. The serial protocol uses group-encoding to effectively communicate 4 bits using a 5-bit format.

The next prototype version of this ASIC will contain the necessary logic to properly drive the output so that a number of FMUX/FETX chips can share the same differential output path and be read out in the correct order. The next version will also have the appropriate logic to recognize the End of Data (EOD) word that is generated by each Level 2 Buffer chip. CMC has approved the inclusion of this design in the January submission.

Trigger Interface Circuitry

A part of the SDC Trigger meeting at Fermilab on November 18 was allocated to a discussion of the organization of the readout of the straw tracking data for the L1 and L2 triggers. Both P. Sinervo and A. Lankford (UCI) discussed similar proposals for how this readout was to take place. The primary difference between the two designs was that the UCI proposal segmented the L1 tracking trigger information spatially into a format compatible with the L1 calorimeter trigger segmentation, whereas this was not considered in the competing design. Both systems had similar readout schemes for the L2 trigger data.

The implications of this readout scheme on the architecture of the Crate Interface Card is currently being assessed and a straw-man design for the CIC will provide for this functionality.

Data Buffer

The preliminary description of the data flow through the data collection system (UOFT-DCC-08) also included a description of the dataflow through the Crate Interface Card. Comments are currently being solicited from other members of the group on this design. A detailed proposal for the data packet format was also proposed. Estimates were
made of the computational and memory requirements imposed on the CIC by the straw data volume and these were found to be technically achievable with the current generation of microprocessors.

**DAQ and Trigger Interface**

The group continued to discuss with members of the SDC DAQ group at SSCL to set up an SDC portable DAQ system at McGill.

**KEK**

Technical Staff: M. Ikeno
Author of report: T. K. Ohska

To reduce the board area occupied by HV resistors, a test is under way to use printed resistors in the inner layers of a multilayer PC board. This is the same technique used in thick film resistors, except that it never was used on inside layers of multilayer PCBs and was never used for HV applications. A test board was produced and is under various tests.

**Straw Tracker Electronics Design and Production Models: Cables - ASD to TTA**

In parallel with the Penn effort, KEK is searching for adequate cables for the straw electronics. A vendor, Jyunko-sha, is now producing a prototype cable with a shielding material called ETFE which is known to have radiation resistance up to $10^7$ rads. We will be receiving them soon for tests.

Conductor size is chosen to be AWG 30 for a particular connector choice. It is very compact so that we expect radiation length to be within an acceptable range.

**Straw Tracker Electronics Design & Production Models System Level Tests**

An additional 4 CAMAC TMC modules were fabricated and tested for various straw/muon tests.

**Oak Ridge National Lab**

Technical Staff: G. T. Alley, M. S. Emery, R. Maples
Physicists: Tony A. Gabriel
Reported by: Michael S. Emery

An ORNL "Aztec" front-end module was fully populated and assembled. This assembly includes all three boards with Penn EPIC-packaged ASD chips. Unfortunately, bench testing showed a very low percentage about 40% - of functional channels. Penn traced this problem to a wire bonding problem with the packaging vendor.

Of the working channels, some oscillation was observed. This was eliminated by better grounding and proper threshold settings. Lab bench sensitivity was a little less than 4 fC. If the threshold was much below that, oscillations would occur. The assembly was tested at high voltage up to 2200 volts with no arcing or observed corona. A conformal coating of Dow Corning 3140 RTV (Electronics Grade) was applied over the high voltage sections prior to testing.
After mapping out the good and bad channels, the assembly was taken to Duke University. Different schemes for connecting to the straw module were tried. The Shin-Flex elastomer connector did not perform adequately for this module due to uneven straw ends. The Shin-Flex will require a very flat end if it is to work. Pogo sticks showed the best connection in this case.

With a straw module attached, noise was a little worse. This caused the threshold voltage to need a higher setting, about 5.5 - 6 fC.

This is the first fully assembled "Aztec" module to actually be used with a straw module. Areas for improvement were identified which can be incorporated in future efforts. The next step is to obtain an adequate supply of tested and functional EPIC-ASD chips in order to get an assembly with a high percentage working channels.

Tokyo Metropolitan University

Physicists: T. Hirose, R. Hamatsu, M. Chiba, K. Kondo, K. Yamauhi

- Design and Production Models: Time and Trigger Assembly

System Level Tests

The 1-foot long Indiana straw chamber was operated at TMU with 80% CF4 and 20% Isobutane. The new 16ch ASD board was installed and is in operation without much problem.

Trigger Synchronizer

We found a problem in the Geant straw simulation program. Looper tracks are not properly reproduced. This is under study with the University of Michigan. We started bi-weekly TV conferences for straw trigger work.

KEK and Tokyo University of Agriculture and Technology

Physicists: T. Emura, F. Sudo, Y. Arai, M. Ikeno
Author: Y. Arai

Straw Tracker Electronics Design & Production Models - Time & Trigger Assembly

The first stage of TMC design transfer to Toshiba from NTT was accomplished. First stage work on the L2B was also included in the same chip. We have done preliminary tests on these circuits.

Engineering samples of the TMC test chip arrived at KEK on November 18. Originally, this was scheduled at the end of October, but was delayed due to a paperwork problem inside Toshiba (The chip fabrication was completed on schedule). There are 20 ceramic-packaged chips. Another 200 plastic packaged chips will arrive at the end of December.

Main features of this chip are:

* Toshiba 1 um CMOS process with Sea-of-Gate array.
* 0.5 mm pitch, 144 pin package.
* 54 k gate master, 22.6 k gate used (41.33%)
Die size = 9 mm x 9 mm.
* 2 kinds of TMC circuit (4 usec buffer)
* 2 kinds of PLL circuits.
* Fast FIFO (8 bit x 8 word).
* Differential Input buffer.
* etc.

Test of this chip is being done by attaching a sub-board (also KEK design/production) to the previous TMC-CAMAC module. Read/write operation to registers was successfully completed, and timing characteristics and stability of the PLL circuits are now being investigated. The FIFO circuit which is the basis for the L2B was also working.

University of Michigan

Technical Staff: J. Mann, J. Geld
Physicists: J. Chapman, S. Vejcik, B. Ball, C. Miao
Author of Report: J. Chapman

Straw Tracker Trigger Synchronizer - Tests

A program for evaluating the straw trigger on actual straw data is underway. For this study a trigger module has been designed and is currently in fabrication. This module carries 8 rad-hard UTMC straw trigger chips which are configured so that many different trigger configurations can be tested. Each trigger chip contains a triple mean-timer pattern with four inputs and a single output. The purpose of the trigger chip is to identify hits that are consistent with being due to a single high momentum track. In this context such a track has a small angle with respect to the normal to the straw superlayer. The 8 trigger chips represent 8 x 4 or 32 inputs and 8 outputs. We have connected the 32 inputs to the outputs of a 32 channel precision pulser built at Michigan. We can with this flexible unit inject signals in any time relationship. Our plan is to acquire data from all of the straw test fixtures operated by members of the SDC collaboration, play the data through the trigger circuits, and digitize the results in a LeCroy TDC. In this way we can accumulate adequate statistics on the actual straw data with its characteristic timing. The digitized outputs can be processed in various coincidence relationships within the computer to simulate numerous possible configurations. The pulser we are using has very precise timing (1/4ns least count) and the data taken on straw setups has 1ns digitizations. Evaluation of this data will, hopefully, be available in January.

Straw Tracker Trigger Synchronizer

The straw trigger simulation has been extended to include both straw triggering and muon detector signal simulation. This combination has been pursued in order that we may study the level 2 trigger algorithms needed to improve the muon triggering with the addition of central tracker information. The program is functioning and data is being accumulated. We are meeting via Teleconferencing with physicists from KEK and Tokyo Metropolitan University in early December to begin the process of transferring the simulation work to TMU since the primary responsibility for the front-end electronics including the generation of trigger primitives rest with the Japanese.

5.1.3 Calorimeter/Shower Max Front-End Electronics

Summary: Work continued on prototype preparation and testing for the Calorimeter PMT readout and system design for the shower Maximum system.
Work on improving the dynamic accuracy of the Orbit Semiconductor version of the Current Splitter continues. The main line of effort is directed towards means of cancelling the effects due to parasitics (chiefly the collector resistance and capacitance) of the Orbit NPN transistor. These effects are much smaller in a higher-performance process. It is hoped to be able to bring these effects below 1% in our next round of Splitter/Integrator prototypes using the Orbit process, with the expectation that they will be negligible in the final (Texas Instruments or Harris) design.

An improved version of the Cockroft-Walton base PMT base design was developed. Measurements were made on the PMT capacitances (anode to D6,D5...) of various PMTs. A full Spice model of the capacitive crosstalk was made to determine the ripple specification and the effectiveness of various filter and noise-cancelling schemes. After prototype tests, a circuit board layout based on the "Stacked Disc & Washer" approach was made. A second circuit board based on a single, flat card will be laid out next.

More testing was performed on the Splitter/Integrator test chip which included a temperature-compensated output buffer. The dynamic response of the buffer was adequate and the temperature drift of the whole system was ~300uv/deg C or 1 FADC count for ~13 deg C. This is better than a Phototube's temperature stability.

Different scenarios of pulse clipping and shaping for the calorimeter signals are being looked into. These are based on single-photon timing measurements of the optical pulsewidth of tile/fiber assemblies with different WLS fluors. These measurements are roughly consistent with BNL test beam data taken with the digital readout earlier this year. The goal is to clip the EM pulseheight back to baseline in 16ns. If this can be achieved, a number of good things happen including simplification of the calibration and an immunity to small-amplitude clock jitter. Candidate shaping schemes include single and multiple pole-zero filters, and lumped and continuous delay-line clipping. The best results seem achievable with delay-line clipping. Using a 4ns clipline the baseline can be restored within 1-2% in 16ns, with only 15-20% charge loss for a fast (G2) fluor and 30-40% charge loss for the standard (K-27) fluor.

Both FADC test chips came back from fabrication. The first (1.2u CMOS) is a 5-bit design suitable for the Shower-Max FADC. A test board was made, the chip was powered up and works at 60 MHz. Testing will continue to characterize the comparator offsets, analog settling time, etc. The second (BiCMOS) design is a candidate for a high-resolution integrated FADC for the main PMT readout.

In order to satisfy numerous requests from our collaborators for single-channel test systems, a CAMAC pipelined readout board was designed, laid out, and sent out for fabrication. It can be used in conjunction with a Splitter/Integrator test board to form a complete readout system. Additional Splitter/Integrator/FADC test boards are also being prepared and tested. A first copy was sent to Saclay in November.
The layout of a L1/L2 digital storage test chip was completed. This is to be combined with the FADC for the shower-max readout. Several design options were considered including shift registers, FIFOs, and RAM structures of various word widths and decoder types. We settled on a serial access RAM structure operating at 1/4 of the 60MHz clock frequency (with a word width of 4x the external data path width) since this provided the densest and lowest-power design.

Lawrence Berkeley Lab

Technical Staff:
T. Collins  I. Kipnis  R. Minor  E. Theil
S. Dow  S. Kleinfeldler  L. Pope  S. Wunduke
J. Franck  L. Luo  P. Salz  J. Zelver
G. Gabor  O. Milgrome  D. Santos  K. Shimada
R. Jared  T. Merrick  T. Shimizo

Physicists:  M. Levi, P. LeDu, M. Wong
Reported by:  R. Jared

The effort in this period was associated with five main areas: shower max current splitter, calorimeter readout, calorimeter ADC, shower max system design, and management of new and on-going efforts. A brief synopsis of the work in these areas is listed below:

Shower Max Current Splitter:

The main effort on the front end was directed at the CMOS current splitter for Shower Max. The current splitter and sample and hold are being modeled using the ORBIT 1.2 micron Level 2 SPICE parameters. Two approaches have been tried. One is to use current mirrors to perform the splitting and storage. This approach may be viable but suffers from linearity problems. The other approach is to use a conventional common base splitting followed by active storage switches composed of fed-back common gate stages. This approach is promising showing good linearity and speed. These designs have been modeled using 6V supply rails. The design effort will continue to see if this can be reduced to 5V. Effort spent was 1.4 man months. (Dow, Jared, Levi)

Calorimeter Readout:

Work continued on a floating point adder and VME interface used in the Calorimeter readout. The VHDL description of the 12-bit floating point adder has been completed. The simulated devices have been synthesized and two technologies targeted. In the first technology, a fusible logic family from CrossPoint, a floating point addition occurs in two pipelined clock cycles. There have been problems with the EDIF netlist conversion utility from Mentor Graphics that have prevented us from burning a part. The problem has been identified and will be corrected in the January software release. We have also received the technology file for the Mitsubishi 0.8 micron standard cell library. The Autologic synthesis into this technology has shown that the floating point adder performs an addition in under 9 nanoseconds. Effort has been started to develop a VHDL model for a VME slave interface. Effort spent was 0.8 man months. (Wunduke)

There was a small amount of close out work on the bipolar preamplifier. Effort spent was 0.5 man months (Kipness).

Calorimeter ADC:

Documentation of the common ramp ADC design was performed in this period. The effort spent was 0.1 man months. (Milgrome)
Shower Max System Design:

A system level design for shower max has been refined along with a cost estimate. The system design partitions the analog and digital functions of the front-end components into two major IC's mounted on a common hybrid substrate. Communication with the front-end cards takes place over a bi-directional 8 bit bus. This bus has both readout and slow-control functions. These results will need to be reviewed in the coming month. Effort spent was 0.4 man months. (Jared, Levi, Minor, Wunduke).

Management:

Management consisted of direction of on-going activities and attending meetings. Work was started on SDC system engineering. Effort spent was 0.4 man months. (Jared, Minor)

University of California, Irvine

Technical Staff: R. Atmur, C. Stratton
Physicists: A. Lankford, M. Schernau, B. Schmid, R. Schwarz, E. Van Drunen
Author of Report: B. Schmid

5.1.3.2 Shower Max Front-End Electronics

CEN - SACLAY (FRANCE)

Technical staff: Ph. Baron, A. Joudon, F. Lugiez, M. Rouger
Physicists: R. Hubbard, P. Le Du
Author of Report: P. Le Du

Electronics for shower max detector tests:

The 1993 Shower max test module at BNL will use the LBL ECEM monolithic prototype. The purpose of this test is to understand every requirement in a realistic environment using a complete chain from the light yield to the photodetector coupling to the read out. This part will include a 64-channel prototype of the mechanical motherboard arrangement for the coupling between the photodetector and the front-end electronics. The read-out will be organized around available front-end electronics.

Shower max digital front-end read-out:

The main goal of work on the shower max front-end readout currently is to develop a CMOS digitizer ASIC. Chip architecture and functionalities simulation are underway.

5.1.4 Muon System Front-End Electronics

University of Michigan

Technical Staff: K. Hashim, C. Murphy
Physicists: J. Chapman, S. Hong
Author of Report: J. Chapman
5.1.4.1  *Muon System Wire chamber electronics*

**Harvard University**

Technical Staff:  J. Oliver, H. Hill, S. Harder, J. O’Kane  
Physicists:  G. Feldman, P. Hurst  
Reported by:  J. Oliver

Twenty muon ASD boards intended for the muon supertower prototype went out for fabrication. These will be received and tested in late December or early January. Several additional boards were hand assembled and tested to satisfy requests by other institutions for testing their prototype tube production.

**Univ. Tsukuba, Institute of Applied Physics**

Physicists:  Y. Asano, M. Abe, K. Mituhashi  
Author of Report:  Y. Asano

*Muon System Front-End Electronics - Wire Chamber Electronics: Prototype ASD Card*

The printed circuit boards for the hybrid preamplifier circuits will be ready in two days. The transistors are expected to be available in 3 days. The first hybrid circuits are expected to be ready by 15 December, and measurement will follow. In parallel efforts, the mother board design will be completed in 3 days, and the artwork will follow. A SPARCstation was installed for use in monolithic IC design; however, the memory and disk space are still not enough for the job. They have been ordered for purchase. The Tektronix design tool is expected to be available soon. We expect to start learning to use the tool within this calender year.

**University of Colorado**

Technical Staff:  Bruce Broomer, Eric Erdos  
Physicists:  Uriel Nauenberg  
Reported by:  Uriel Nauenberg

*Muon System Electronics - Scintillation Counter Electronics: Prototype ASD Base*

We have designed a new Cockroft Walton phototube base that has a faster charging time and hence will be more stable in high rate situations. In addition we have designed an amplifier discriminator card to be used in association with this base. There was no new activity to report for this month. Hopefully we will begin construction of this base and amplifier discriminator card during the next few months.

**University of Michigan**

Technical Staff:  K. Hashim, C. Murphy  
Physicists:  J. Chapman, S. Hong  
Author of Report:  J. Chapman
This work is reported under WBS 5.1.4.4.2.2 Muon System Front-End Electronics - Regional F.E. Electronics: Prototype Custom Scintillator Trigger ASIC.

5.1.4.4  

University of Michigan

Technical Staff: K. Hashim, C. Murphy
Physicists: J. Chapman, S. Hong
Author of Report: J. Chapman

The plans for the mini-tower test are finalized and a 9U VME card is under design. The card will contain the Revision B muon scintillator trigger chips and the Revision B muon wire trigger chips. The card will contain one scintillator chip and five wire chips that instrument the central 10 tubes of the test setup and a single scintillator slab equipped with two phototubes. Output from the trigger card will be to a KEK supplied TMC module. Timing for the test configuration will make use of a MIDIS programmable clock module designed at Michigan for a previous experiment. The test configuration and schedule have been the subject of two Televideo conferences between Michigan and KEK. Evaluation of the KEK test results will guide us in the selection of electronics for the super-tower test to be conducted at the SSCL. A research team composed of J. Chapman, S. Hong, and C. Murphy will accompany the electronics to KEK for the test period in February and March 1993. As a preliminary to the actual test, Michigan and KEK will exchange modules for evaluation prior to the test. Michigan will receive a TMC digitizer and KEK will receive a MIDIS programmable clock.

KEK and TA&T

Physicists: Y. Arai (KEK), T. Emura (TA&I), F. Sudo (TA&I)
Author of Report: Y. Arai

Engineering samples of the TMC test chip arrived at KEK on November 18. Originally, arrival was scheduled at the end of October but was delayed due to a paperwork problem within Toshiba (The chip fabrication was completed on schedule). There are 20 ceramic-packaged chips. Another 200 plastic-packaged chips will arrive at the end of November.

Main features of this chip are:

- Toshiba 1 um CMOS process with Sea-of-Gate array.
- 0.5 mm pitch, 144 pin package.
- 54 k gate master, 22.6 k gate used (41.33%)
- Die size = 9 mm x 9 mm.
- 2 kinds of TMC circuit (4 usec buffer)
- 2 kinds of PLL circuits.
- Fast FIFO (8 bit x 8 word).
- Differential Input buffer.
- etc.
Testing of this chip is being done by attaching a sub-board to the previous TMC-CAMAC module. Read/write operation to registers has been successfully confirmed, and timing characteristics and stability of PLL circuits are now being investigated.

5.1.4.5  Muon System Front-End Electronics - Project Management

University of Michigan

Technical Staff:  C. Murphy
Physicist:  J. Chapman
Author of Report:  J. Chapman

The WBS entries for 5.1.4 continue to be reviewed and updated as the design is further formalized and specific quotations are received. This process will continue through the detailed design phase and eventually shift to cost monitoring as the actual fabrication begins. The project will continue to be evaluated within the context of our in house management software and results transmitted to the SDC central cost and schedule team.

In addition, a management team has been assembled and responsibilities defined for the muon system. Since the two major institutions participating in the muon electronics are KEK and Michigan, the task leaders were selected from these institutions.

SSCL

Physics Staff:  P. Schuler
Author:  Patricia McBride

5.1.4.6  Muon System Front End Electronics Project Management

University of Michigan

Technical Staff:  C. Murphy
Physicists:  J. Chapman
Author of Report:  J. Chapman

5.2  Data Acquisition R&D

Work focused on organizing the DAQ group to accomplish the FY93 goals, and on the portable DAQ system.

University of Illinois

Technical Staff:  T. Brandys, M. Haney, E. Hughes
Reported by:  J. Thaler
5.2.1 DAQ Project Management

Fermilab

Technical Staff: E. Barsotti
Physicists: I. Gaines
Reported by: I. Gaines

Work this month centered on plans for starting up a series of SDC DAQ working groups to do the detailed design work on the various components of the DAQ system. The first such group will be the Integrated Systems Engineering Working Group, which will commence work in December. A memo outlining the task forces was delivered to subsystem management.

5.2.2 Data Acquisition System - System Design Document

Lawrence Berkeley Laboratory

Technical Staff: W. Greiman
Author of Report: W. Greiman

Two basic designs for event data flow were studied. Both should be scalable from 1 GB/sec to 10 GB/sec. Cost, performance and complexity trade offs for these designs have been investigated. Work was done on a design for "Event Data Flow Control" and "Data Balancing/Input Queuing" that requires no special hardware.

5.2.8 Data Acquisition System - Event Builder Subsystem

KEK

Physicists: H. Fujii, O. Sasaki, Y. Watase, M. Nomachi
Author of Report: M. Nomachi

An Opto-Electric/Electro-Optical converter module, which works up to 1.5Gbs with 850-nm wave length, is being designed as a collaboration between KEK and Fermilab. It will be used for switching Fiber Channel optical signals with KEK's electrical switch.

We received a user's manual for ANCOR's Fiber Channel Interface on VME. The possibility of sending data without higher layer network protocol is being studied. It will be tested by end of January at Fermilab. It is very important to investigate the native speed of Fiber Channel without additional overhead.

Lawrence Berkeley Laboratory

Technical Staff: W. Greiman
Author of Report: W. Greiman

A sixteen port Fibre Channel switch was received from Ancor Communications. Work to assemble a test bed with four VME systems controlled by a SUN workstation was started. This test bed should be completed in December.
5.2.13 DAQ Online Computing Interface - Portable DAQ

CEN Saclay

Technical Staff: M. Gros, M. Huet
Physicists: P. LeDu
Author of Report: P. LeDu

DAQ for the 1993 ECEM-Showermax test at BNL:

A simplified version of the Portable DAQ is currently working at Saclay (MANIX) and will be installed as soon as possible at LBL. Replacement of the Ethernet connection by the SVIC is underway. Software for the CAMAC VCC controller is under development as well. A few technical problems of "transportability" of the graphical user interface have been found and fixed.

KEK, Hiroshima, LBL, UCSC

Physicists: M.Nomachi (KEK), Y.Yasu (KEK), Akagi (KEK), Ohyama (U. Hiroshima), G.Abrams (LBL), B.Hubbard (UCSC)
Author of Report: M. Nomachi

Portable DAQ activity in Japan:

The Portable DAQ system has been ported to a DEC station at KEK PS experimental area. We set up the system for the silicon beam test. Some simple examples for the silicon beam test were added by online group. Silicon subgroup members have developed experiment-specific readout codes and experiment-specific analysis codes. This work was done by silicon sub-group members Abrams (LBL), Hubbard(UCSC), Akagi (KEK) and Ohyama (U. Hiroshima). The DAQ system works very well for detector tests and calibrations.

SSCL, KEK, U. Michigan, LBL

Author of Report: M. Nomachi

Lawrence Berkeley Lab

Technical Staff: W. Greiman, D. Hall
Physicists: G. Abrams, A. Ciocio, P. LeDu, S. Loken
Author of Report: G. Abrams

Portable DAQ:

We have worked on the front end and user analysis code for the December silicon beam test at KEK. This test is the first field trial of the Portable DAQ.

University of Michigan

Technical Staff: R. Ball, B. Roe, C. Timmermans
Physicists: R. Ball
Author of Report: R. Ball
Portable DAQ:

g++ version 2.2 was installed on the KEK DECstations so that the Portable Data Acquisition Software would successfully compile. Preparations continued for the Si tests at KEK in early December. Using the models specialized processes were added to correspond to the hardware to be used. The operator interface was modified to add configurable buttons for specialized functions. Documentation of the system continues.

5.3 Trigger R&D

Progress occurred in four general areas: physics simulation of parts of the level 1 and level 2 trigger; design studies and development of specifications and prototypes for trigger 'foundation' components (crates, racks, fiber links, timing and control modules, etc.); design and specification of specific detector-related level 1 and level 2 triggers, including work on several prototype modules; and work on cost, scheduling, and management issues. A meeting was held at Fermilab which focussed on the status of the muon and tracking trigger systems.

University of Chicago

Technical Staff: Northrop, H. Sanders
Physicists: H. Frisch, G. Sullivan, M. Miller
Reported by G. Sullivan

5.3.1 First Level Trigger: Conceptual Design

University of California, Irvine

Physicists: A. Lankford, A. Lipniacka, R. Schwarz, B. Schmid, D. Stoker, E. Van Drunen
Author of Report: D. Stoker and A. Lipniacka

Conceptual Design:

Improvements are being made to the simulation of the level 1 trigger. The effect of track-shower matching on electron identification is being studied as a function of calorimeter trigger tower size. Studies of the effect of including calorimeter signal time structure indicate an increase of about 30% in the level 1 trigger rate.

University of Chicago

Technical Staff: Harold Sanders
Physicists: Henry Frisch, Greg Sullivan, Marshall Miller
Author of Report: Greg Sullivan

Trigger Room Crate and Rack Engineering:

Continuing work on standard crate and rack for SDC trigger electronics. We have begun assembly of the blower, heat exchanger and rack components, placed orders for the crates, and started specification and design of rack mounted power supply units.

Continuing work on Level 1 design issues of crate counts and connector/fiber density into level 1 crates. Specifically, a detailed engineering of bringing the fibers into the back of the trigger crates was begun.
Fiber Optics and Calorimeter Trigger:

With the selection of a front-end readout technology we have assumed that either a 10-bit or 12-bit floating point number would be transmitted from the calorimeter front-end, instead of a logarithmic number. We have now completed a VHDL description of a 12-bit floating point adder. This design can easily be reduced to a 10-bit fp adder or even an 8-bit fp adder. We have targeted the 12-bit design into a Mitsubishi 0.8 micron technology and have achieved 8.4 nsec typical simulated propagation delay. A 10-bit floating point number can be transmitted on a 1.5 Gbit fiber. With the transmission of an 8-bit floating point number the transmitted accuracy mimics the behavior of the original logarithmic design.

Work continues to proceed on our understanding of the Hewlett-Packard G-link chipset which we have running in our lab. This chipset operates up to 1.6 Gbit/sec. If this can be made to operate reliably at 1.5 G-bit/sec we would be able to transmit a 10-bit floating point number. The baseline assumes that we will be transmitting an 8-bit floating point number.

The output of the G-link chipset is an asynchronous data stream that must be resync-ed to the SDC clock. This can be performed in a straight-forward manner by use of a FIFO. Also variations in fiber run can be eliminated in this manner as well. The G-link will also require a state-machine to bring up the link and to look for and report parity errors. We have started to define the requirements for this function. The intention is to write a VHDL description that could be targeted into the Mitsubishi library which has imbeded RAM's and FIFO's.

5.3.1.1 First Level Straw Trigger - Tracking System

Fermilab

Technical Staff: A. Baumbaugh, A. Romero, K. Knickerbocker
Reported by: A. Baumbaugh

Relevant work for the first level fiber tracker trigger is reported under WBS 5.1.1 Scintillating Fiber Tracker Front-End Electronics.

Oxford University

Technical Staff: B. Hawes, N. Martin, A. Brooks
Reported by: R. Nickerson

ITD Level 1 Trigger System:

Work is in progress on the ITD external L-1 trigger chip. This is moving slowly and is still in the paper design phase and we anticipate at least another month before it starts to move into any kind of layout phase, primarily because most emphasis in the last months has been oriented towards verifying that the L-1 trigger can be implemented with the silicon
back-up ITD. Considerable simulation effort has been expended checking the viability of the back-up option.

**ITD Front End Transmission:**

No significant update.

**ITD Fibre Optics:**

Reported elsewhere

5.3.1.2 *Calorimeter Level 1 Trigger - Electron Trigger Studies*

**University of Wisconsin**

Technical Staff: T. Gorski, J. Lackey, W. Temple
Reported by: S. Dasu, W. Smith

Electron Trigger Studies:

We have completed a note (SDC-92-345) on high statistics results from simulations of electron triggers in SDC. From these studies we concluded that transverse isolation criteria, at level 1, is useful in achieving the best thresholds, with high efficiency for triggering on electrons from W, Z and top decays. We also concluded that transverse isolation is essential, if the electron trigger is based on information from calorimeter alone or if the SSC luminosity is increased to $10^{34}$/s$. This study was based on the our conceptual design of the electron pattern logic. It has been suggested that a simpler logic for transverse isolation is desirable. So, we have now embarked on comparative study of various algorithms to perform transverse isolation.

We have started efforts on making a public distribution of the fast Monte Carlo program that we have been using to study trigger rates and efficiencies. We are setting up a code management system to develop the program along with collaborators from Irvine and Chicago.

**Calorimeter Preamp:**

We presented a paper at the IEEE NSS on the previous SDC R&D work on the Calorimeter preamplifier: D. Panescu, J. Lackey, P. Robl, W. H. Smith "A Fast Low Noise PMT Preamplifier". The preamplifier is able to process PMT output signals of 16 ns duration within 94 dB dynamic range (input current range: from 300 nA to 15 mA). To achieve this performance we use both a high and a low gain path, with gains in a ratio of 32:1. The PMT output current is conditioned by 2 current amplifiers and then integrated by two fast and low noise integrators. The signal baseline is restored in order to avoid any loss of information when a high energy crossing is immediately followed by a very low energy one. The outputs are connected to switched capacitors arrays. Tests we performed show that we achieved:

1. droop of 0.5 % within 4 ns after the integration was completed;
2. 0.23-mV rms noise figure at the circuit output;
3. input impedance of 50 ohms;
4. fast baseline restoration;
5. output impedance of 100 ohms for twisted pair cables, or 50 ohms for coax cables.
5.3.1.5 Global Level 1 Trigger System

University of Michigan

Technical Staff: J. Srage, C. Murphy
Physicists: J. Chapman
Author of Report: J. Chapman

Level 1 Trigger Data Phasing Chip:

The specifications of the data phasing chip have been distributed and agreement on the general approach has been obtained. The design is being evaluated in terms of process options. Currently the work is in 1.2 micron CMOS. We plan to combine this design with our first use of the JTAG boundary scan technology in order to optimize our efforts. We await a general collaboration decision regarding JTAG before submission of the data phasing chip with JTAG I/O. It is highly likely that JTAG will be chosen as the downloading and testing standard for SDC.

University of Wisconsin

Technical Staff: T. Gorski, J. Lackey, D. Panescu
Physicists: S. Dasu, W. Smith, M. Thompson
Reported by: S. Dasu & W. Smith

System Design

We have been studying the transmission of trigger data via fiber optics and are working on the development of specification and performance requirements for the front end electronics and trigger interfaces to the fiber optics system. We have continued studies of the new system design of the Level 1 trigger. We have also evaluating the feasibility of various hardware realizations of the design. As part of this we have designed, simulated, fabricated and tested a 4 x 12-bit CMOS adder, which is a common component of several boards in the present circuit design. As part of the development of the interface between trigger and front end electronics and trigger and data acquisition, we are building the Trigger Emulation Module described below.

CMOS 4 x 12-bit Adder:

A common component found in several places in the present trigger system design is an Application Specific Integrated Circuit (ASIC) that adds 4 12-bit numbers and can operate in the clocked 16-ns trigger structure. As a result, we have fabricated a pipelined domino logic two-stage adder. The device has been fabricated in 1.2um CMOS technology. We have built a tester for the ASIC that contains a VME interface, 4 blocks of memory for the operands, 1 block of memory for the result and a controller. The tests of this ASIC reveal that the best case throughput is 16.5 ns and the worst case is 18 ns. The power dissipation is 0.75 W and the yield of chips is ~80% (out of 50 chips we received back from MOSIS 44 operated in agreement with our design and 6 had internal defects which did not follow any specific pattern, and are probably due to intrinsic errors which appear in all IC manufacturing processes). We have presented a paper to the IEEE on this subject: D. Panescu, T. Gorski, Y. H. Hu, J. Lackey, P. Robl, W. H. Smith "A Pipelined 4 by 12-bit Domino Logic VLSI Adder". We have a full-length paper in preparation, on this topic, for submission to NIM-A. We started performing SPICE.
simulations to assess the improvements in speed which would be given by the fabrication of this design in an 0.8 um process.

5.3.1.6 Level 1 Clock & Control

University of Wisconsin

Technical Staff: T. Gorski, J. Lackey, D. Grimm, A. Penpek
Reported by: S. Dasu & W. Smith

System Design:

We have begun the study of the transmission and receiving of the clock and control signals via a fiber optic system. We are working on the requirements and specifications of interfaces to front end electronics and trigger systems. We are continuing to study the revised global clock and control system in light of our experience in designing the Trigger Emulation Module (see below) and our interactions with other subsystems as part of this process.

Trigger Emulation Module:

We have completed the checkout of the two prototype Trigger Emulator Module (TEM) cards. The TEM is designed to emulate much of the clock and control functionality anticipated for the final SDC Global Trigger System. Its purpose is to aid in the test bench debugging of subsystem DAQ and trigger circuits, and to serve the basic functions of a trigger module for test beam experiments. The TEM is designed to operate as part of a bench test of front-end electronics, where it provides patterns of level 1 and 2 trigger and clock signals that can be fed in from either pulsers, an external pattern generation module or a DAQ processor. The TEM is also designed to operate in a test beam, where the clock is externally provided by the accelerator RF signal and the triggers are produced by beam hodoscopes.

The results of the checkout were quite positive, showing the prototype TEM cards to be in compliance with the prototype performance specification in essentially all respects. We have initiated the activity for the production run of these modules. We have also distributed a note (SDC-92-348) that details the performance of the TEM.

We have set up a VME crate, with Motorola processor (MVME147), running OS9 operating system, to debug the Trigger Emulator Module (TEM). We have preliminary versions of debugging programs working. We are in the process of developing detailed suites of test programs. In addition, we are also working on a simple but generic VME diagnostics language to write quick tests involving memory pokes and dumps, including some looping and macros.

5.3.2 Second Level Trigger

University of California, Irvine

Physicists: E. Altshuler, G. Griffin, A. Lankford, A. Lipniacka, D. Stoker, J. Tarazi
Author of Report: D. Stoker and A. Lipniacka
**Conceptual Design:**

Simulation studies of electron identification at Level 2 continued. Rejection of charged and neutral pion overlaps in minimum bias events continued to be investigated for various shower max algorithms. Studies of algorithms to reject conversion electrons continued. Work continued on simulating electromagnetic showers in the EM calorimeter and shower max detector using EGS4.

**University of Chicago**

Technical Staff: Harold Sanders  
Physicists: Henry Frisch, Greg Sullivan, Marshall Miller  
Author of Report: Greg Sullivan

**Conceptual Design:**

Continuing work on Level 2 design and on the SDC note (in collaboration with Patrick LeDu from Saclay) giving the conceptual design of the level 2 trigger system.

**CEN Saclay**

Technical staff: J.C. Brisson, F. Bugeon, O. Gachelin, B. Thooris  
Physicists: J. Bystricky, J.F. Glicenstein, R. Hubbard, P. Le Du  
Author of Report: P. LeDu

**Conceptual Design:**

Work is progressing in 4 parallel paths

1) Physics simulation is in progress: First results of Monte Carlo on top → b → e and taus physics will be presented at the next December trigger meeting at Dallas.

2) Algorithm simulations are continuing using a SIMD parallel processor 1024 elementary processor simulator (ASPA).

3) Investigation to understand and define the rules common to each subdetector to extract the level 2 information. A common path for Level 2 and DAQ has been investigated for the shower max and calorimeter detector. Presentation for discussion inside the trigger group of such common DAQ/L2 Data collection scheme will be done at the next SDC trigger meeting.

4) A SDC report on the "level 2 trigger" is now achieved and will be available at the next trigger meeting at Dallas.

**5.3.2.1 Second Level Trigger - Tracking Systems: Silicon Tracker**

**Bristol University**

Physicists: H.F. Fawcett, B. Foster, G.P. Heath, S. George, N. Dyce  
Reported by: B. Foster

Progress with the conceptual design has continued. Simulation work using SDCSIM is investigating details of the coarse trigger algorithm. Work on the logical
subdivision of the processing and the number and layout of processing boards is being
restarted. Estimates of the feasibility of using DSPs for the fine triggering processing have
begun. If they continue to look promising a trial algorithm will be written for a particular
DSP and timed on Monte Carlo events.

Oxford University

Technical Staff Involved:

R. Wastie

Reported by: R. Nickerson

Work in this area is reported under WBS 5.3.2.4 Second Level Trigger - Silicon Tracker.

5.3.2.2 Second Level Trigger - Calorimeter Systems

Ohio State University

Technical Staff: C.J. Rush, J. Hoftiezer
Physicists: B. Bylsma, L.S.Durkin, T.Y. Ling
Author of Report: T.Y. Ling

The OSU electronics group acquired ViewLogic's Workview CAE tool for design
development during the summer of '92. In Oct. and Nov. several of our staff attended the
training school for this CAE package. One of our goals using this software is a hardware
based cluster-finder for SDC level 2 calorimeter trigger.

The current design of the level 2 calorimeter trigger uses an extension of the cluster
finding algorithm developed by this group for the Zeus fast-clear cluster-finder.

Experience with that device has lead to new approaches to the problem of locating
clusters. The design is being done in a hierarchical fashion, such that functional blocks
within the design are identified and can be tested independently. This structure was entered
during the month into Workview. Substitution of these blocks allows various specific
hardware implementations to be compared and refined. Over the course of the month, two
internal mask generators of the cluster-finder were simulated at a logic level. The
simulations have given a much clearer picture of the limitations of the two ideas.

We are also using Workview to incorporate VHDL models of some of the
functional blocks into our design. Such models allow the design to progress without the
specific hardware implementations of each block being completely determined. Models for
the memories were written and debugged.

The on going effort includes additional testing of the existing module blocks, the
expansion of the design to a completed cluster-finder and inclusion of the cluster-finder into
a more general second level trigger system.

5.3.2.4 Second Level Trigger - Silicon Tracker

Oxford University

Technical Staff Involved: R. Wastie
Reported by: R. Nickerson
The only detailed design effort related to the L-2 trigger system for silicon currently under way at Oxford is the line-receiver chip. This contains the buffer for L-1 trigger data, which is physically located on the L-2 trigger boards. This is currently under revision as the data format for transmission is changed.

5.3.2.5 Regional Interface of Global Level 2 Trigger

Ohio State University

Technical Staff: C.J. Rush, J. Hoftiezer
Physicists: B. Bylsma, L.S.Durkin, T.Y. Ling
Author of Report: T.Y. Ling

At the SDC trigger meeting in Denver we have proposed a global correlator as a part of the global second level trigger to identify physics objects by spatially matching the physics fragments generated from the detector subsystems. During this reporting period we have:

1. Sent for databooks and literature on digital signal processors and microprocessor chips.

2. Consulted with an expert on neural networks to explore their application to both the both the correlator and the calorimeter cluster processor.

3. Studied various connection topologies for the processors in the correlator array.

A report of these activities will be presented at the December 10 trigger meeting.

5.3.3 Trigger Project Management

Fermilab

Technical Staff: E. Barsotti
Physicists: J.N. Butler
Author of Report: J.N. Butler

We worked on the Trigger System Management Plan with Wesley Smith of University of Wisconsin and created a prototype documents library for eventual use by the trigger group.

University of Wisconsin

Technical Staff Involved: R. Craven, T. Gorski, J. Lackey
Reported by: W. Smith

Trigger Cost & Schedule:

We have been working on the SDC Trigger Memoranda of Understanding and Amendments to establish consistency. We have been further developing the trigger Research and Development Schedule in line with SDC Project management, and have proposed a series of milestones and deliverables. We have also been working on the SDC Trigger System management plan.
5.4 Ancillary Systems Control

Lawrence Livermore National Laboratory

Technical Staff: Thomas L. Moore, Eugene Oberst
Author of Report: Eugene Oberst

During October we finalized and submitted to the SDC Project Management Office the ASC information which was to be included in the SDC integrated cost and schedule documents. We also finalized and presented material for the DOE review which was held on October 27-29. There were no ASC activities conducted during the month of November.

University of Michigan

Technical Staff: D. Brooks
Physicists: B. Roe, R. Ball, C. Timmermans
Author of Report: B. Roe

An estimate of rack space required for muon slow control systems was prepared for Ken Hess. Work was initiated looking into noise problems for temperature sensors, strain gauges, etc. with long cables into the Harvard SADC.
6.0 COMPUTING SUMMARY

[This is Irwin Gaines report on Offline Computing, which has not WBS numbers.]

Argonne National Laboratory

Reported by: Ed May

Activities this month on the PASS collaboration included:

1. Two conference papers were completed and submitted to IEEE Mass Storage Systems, April 1993.

"Requirements for a System to Analyze HEP Events Using Database Computing", E. May etal, ANL-HEP-CP-92-101


2. The Mark 0 ObjectStore benchmarks were completed for standard comparison with those done earlier for YBOS, Sybase and PTool. All Mark 0 work is now complete.

3. Work continues on VTool. A prototype Persistent Volume Server and Volume Mover was developed and tested with PTool using hierarchical environment of memory-disk-8mmTape.

4. Two meetings were held on the design of Mark 3 (1Pbyte) database.

5. An Object-oriented data model (using the GE OMT tool package) was prepared for the CDF (Mark 0) data to compare with the Extended Entity-Relationship model (using the LBL erdraw/sdt toolset).

University of Colorado

Technical Staff: Mark Christoph, Mourad Daoudi, Quenten Van Egeren, Uriel Nauenberg, Victor Slonim.

Physics Staff: Reported by: Uriel Nauenberg

We are doing simulation in collaboration with Shuichi Kunori from U. of Maryland, Walter Toki of Colorado State U.

Sue Willis and Vladimir Sirotenko of Illinois, Steve Ball of U. of Kansas, and Jon Bakken of Martin Marietta Science Systems.

The people in Colorado are Mourad Daoudi, Victor Slonim and myself. We have been joined by two undergraduates Mark Christoph and Quenten Van Egeren who developed expertise in UNIX and our analysis packages during the summer workshops.

Our program is to work on the track fitting, track matching and pattern recognition. We will also work on the barrel trigger algorithms. All this work is proceeding satisfactorily.
We are continuing our effort in simulation. We have and are continuing our effort in pattern recognition. Most of it is done and improvements are taking place now.

We have written a program that will add the off time events from reactions coming from different beam buckets (16 nsec offset). Work to test it is now proceeding.

Students are comparing various particle production packages. They will now start to study the detector performance with the backgrounds added.

Lawrence Berkeley Laboratory

Technical Staff: Werner Koellner, et. al.
Physicists: George Trilling, et. al.
Report Author: Werner Koellner

Description: Feasability Study and Testing of CVS/RCVS - a Source Code Management and Control System for UNIX Platforms CVS (Concurrent Version System) and RCVS (Remote CVS) were installed on the SUN platforms at LBL and on the PDSF cluster at the SSC Lab. The SDCSHELL (SDCSIM) software package V03 was placed into the CVS Repository and subsequent exercises consisted of doing upgrade releases of V04 and remote fetch/replace operations under CVS control.

(1)KEK,
(2)Tohoku Univ.,
(3)Tokyo Metropolitan Univ.,
(4)Fukui Univ.,
(5)Naruto Univ. of Education,
(6)Hiroshima Univ. of Technology,
(7)Wakayama Medical College,
(8)International Christian Univ.,
(9)Kyoto Univ.

Staff: F. Abe(1), Y. Watase(1), Y. Morita(1), H. Fujii(1), M. Nomachi(1),
Y. Yasu(1), A. Manabe(1), H. Sakamoto(1), J. Kanzaki(1),
T. Tsuboyama(1), S. Kabe(1), Y. Takaiva(1), K. Amako(1), K. Abe(2),
K. Hasegawa(2), T. Hirose(3), R. Hamatsu(3), S. Kitamura(3),
M. Chiba(3), M. Kawaguti(4), H. Yoshida(5), M. Asai(6), M. Daigo(7),
T. Yamagata(8), R. Kikuchi(9)

Author: K. Amako (KEK)

We are trying to organize a local SDC simulation workshop at KEK on December 10 - 12. The purposes of the workshop are:

1) GEANT, 'sdcsim' and related computing environment will be introduced in order to initiate serious simulation works for those who need to do SDC detector design and performance studies in Japan,

2) An organization will be formed in Japan for communication among users of 'sdcsim' and other computing environment of SDC to help to get better understanding by exchanging experiences and information.

We are expecting about 20 participants mainly from universities.
Fermilab SDC Simulation group

Technical staff (none)
Physicists; A. Beretvas, J. Butler, D. Green, J. Marraffino, and W. Wu
Author: Andy Beretvas

"Study of the process $H(800) \rightarrow Z_1 Z_2, Z_1 \rightarrow q\bar{q}, Z_2 \rightarrow \tau_1 \tau_2 \rightarrow \rho \gamma$ for the SDC Calorimeter" W. Wu, A. Beretvas, D. Green, and J. Marraffino has been submitted to the Fermilab publication's office (FN 598).

John Marraffino has generated high energy electromagnetic showers using EGS4 on a silicon graphics computer so that we can study the issues of radiation damage.

Tables (stochastic and constant terms) have now be prepared for incident electron energies of 150 GeV and 250 GeV.

Weimin Wu has continued to study $Higgs \rightarrow \gamma + \gamma$. Weimin has also written a second draft of a paper on the complete work done by the SDC simulation group.

Joel Butler attended the SDC meeting on trigger simulations (Muon and Tracking Trigger R&D) at Fermilab.

I have put some hanging file data (pion data at 102, 162, and 241 GeV/c and some electron data at 102 GeV/c) into a convenient format for data analysis (Radiation Damage).
III. SDC SUPPORT AND MANAGEMENT SUMMARY

7.0 CONVENTIONAL SYSTEMS SUMMARY

7.1 Mechanical Systems

Superconducting Super Collider Laboratory

Technical Staff:       Henry Santos, Marvin Hecht
Author of Report:    Marvin Hecht

7.2 Electrical Utilities

Superconducting Super Conducting Laboratory

Technical Staff:       Warren Kampmeier, Kathy Stringfellow, Larry Schneider
Author of Report :    Warren Kampmeier / Larry Schneider

7.3 Personnel Access Safety System

Superconducting Super Conducting Laboratory

Technical Staff:       Larry Schneider
Author of Report :    Larry Schneider

7.4 Structural Support and Detector Access Systems

Superconducting Super Conducting Laboratory

Technical Staff:       Jim Krebs, Gary Tulk, Randy Gates
Author of Report:     Jim Krebs

7.5 Accelerator Related Systems

Superconducting Super Conducting Laboratory

Technical Staff:       Gerry Chapman
Author of Report :    Gerry Chapman
8.0 INSTALLATION AND TEST SUMMARY

8.1 Test Beam R&D

Reported by Jim Siegrist

For WBS 8, test beam, there is no activity to report for October.

8.1.1 Fixturing

8.1.2 DAQ

8.1.3 Labor

8.2 Installation and Assembly
9.0 PROJECT MANAGEMENT SUMMARY

9.1 Project Planning

Prepared by Dave Etherton

Cost Estimating and Scheduling

This month's activities included recovering from the October DOE Review and preparing the plan for completing the Integrated Project Schedule.

The Integrated Project Schedule now consists of 22 subsystem networks that have been translated into Open Plan at the SSCL. The networks are resource-loaded with the U.S. cost estimate and include major milestones. Refinement of the schedules is needed to work out remaining translation problems and to correct logic, resource-loading, or other scheduling problems. The schedules aren't integrated into a master network but the delivery dates generally meet the installation requirements as documented in the installation plan.

Work at SSCL and at Martin Marietta is ongoing to assess the schedules and scheduling methods and to provide guidelines for schedule refinement and schedule integration that will be pursued through workshops during the winter. By Spring we should have a fully integrated resource-loaded Integrated Project Schedule that can be used at all levels of management.

A master schedule for SDC has been developed to give upper-level management visibility as to the major subsystem milestones and SDC critical path. The summary schedule is provided as an attachment. Further development of detailed subsystem critical paths that supports this summary schedule is going on and a critical path analysis report will be available by the end of December.

The cost estimating efforts include gaining an understanding of the recommendations of the DOE Review team for project estimating and documentation. We are preparing guidelines for performing Value Engineering at the subsystem level. We have also performed pareto cost analysis to indicate the cost drivers that may be most susceptible to cost reductions. This information will be added to the cost and schedule guidelines document and released to the subsystem groups.

Other cost estimating work includes detail estimation of the Calibration system for the Calorimeter and preparation for developing a comparative cost evaluation for the Barrel Tracker technology decision to be made in February.

We are also supporting detailed scheduling within the Front-End Electronics area and the Off-Line Computing area.

Cost/Schedule Tracking and Reporting

Activities in tracking and reporting include preparation of a seven-year staffing profile for SDC, preparation for doing an Estimate at Completion that adjusts the Performance Measurement Baseline to meet FY93 budget targets, and development of guidelines for subsystem and institution cost and schedule reporting that meets SDC management and SSCL requirements. All of these efforts are in-process and are expected to complete in January. The cost/schedule reporting guidelines will be drafted and then communicated with the subsystem groups and major institutions before being finalized. This will then form the basis for cost and schedule reporting for the monthly report.
The EAC and FY93 budget will replace the PMB for SDC and will be the basis for cost reporting at the SSC Project level.

The actuals for SDC expenditures during October were not available for this report. Numerous problems with Oracle implementation have delayed any ability to see internal SSCL or external expenditures. This may be fixed in time for the December monthly report.

**Procurement Activities**

Work is underway to fund the SDC collaborative institutions with the first increment of FY93 monies. Procurement actions in November included the accomplishment of initial funding for Los Alamos, Draper Lab, and Martin Marietta. We also resolved some FY92 close-out procurements to Rockwell for Tracker work and Westinghouse for Tracker and Calorimeter work.

We developed an update to the Statement of Work for Collaborative Institutions and have adopted the funding approach that implements the new SSCL charging system and also implements budgeting and tracking to the SDC Work Breakdown Structure.

December goals are to release the remaining first increment of funding to institutions and to initiate SSCL contracted material and component procurements for muon work and tracker work.

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SDC Planning/Tracking Group

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Monday, December 21, 1993
9.2 Project Tracking

SSCL

Reported by
Mechanical
Electrical
Tracking

9.3 Document Control

SSCL

Reported by Norm Wells

Specification/Document Status

Prepared summary of changes to the SDC Experimental Facilities User Requirements spec and obtained coordination and approval signatures. A new Revision F is being published that will incorporate previous changes as well as some changes currently being presented to the CCP.

Wrote a draft SDC Practice for specification formats and sent it out for comments. Will also write practices describing the requirements for procurement packages, statements of work, and engineering drawing releases.

Released a specification and associated drawings defining our requirements for the prototype Muon Barrel Toroid.

Interface Status

Hosted the Detector-Collider Interface Working Group on 4 Nov. Announced that the official SDC position is that the low beta quad magnets should be at 20 meters from the interaction point. The Collider representatives stated that they planned to install a collimator in the 18 to 20 meter region. This makes the interface to the SDC beampipe at 18 meters, with other components interfacing out to 20 meters. Shielding, probably made of concrete blocks, is expected to be required at the end of the tunnel. Since the tunnel is a Collider responsibility, the shielding location and support will be that organization's responsibility.

Researched the issue of which contract builds the collider tunnel adjacent to the hall. Current plans are that the contract to build the hall shell will also include building a short section of the tunnel. The tunnel will be finished prior to joint occupancy in the hall which will facilitate an accurate survey for the detector foundation.

Attended Collider-Detector Interface Working Group meeting. Presented results of research into current status of planned down time. The baseline in specifications is that the beam will be scheduled to be down three months a year. A new planning document indicates a one month per year scheduled down time. However, this planning document does not supersede the Level 2 specifications and can be changed. SDC, GEM and collider representatives agreed that they needed to determine their maintenance scheme, especially the components that break and how long they take to repair. The goal is to develop the ability for each organization to take advantage of down time required by another
organization. Wrote a draft procedure for the operations of the working group and how Interface Control Documents would be developed and changed.

Prepared the SDC position on the Collider request to pay for the alignment and survey support for the detector. This policy issue has been forwarded to Fred Gilman for resolution. SDC had not planned to pay for this support and has no funds available for activities that were assumed to be provided by PMO.

Studies and Analyses

Alignment Working Group met on November 12. The primary objective was to get the various sub-system alignment and support structure designers together to work on the adjustment interfaces. Proposed that the tracker and calorimeter groups establish a formal Interface Control Document and a working group to refine the document as designs progress. Prepared and distributed a strawman ICD to the group as a starting point.

Formally distributed the Measurement and Alignment Goals paper for comment. The final addition to the paper was a description of the alignment baseline. Even though a Level 3B specification does not exist, a draft Level 4 spec which incorporates the alignment goals in the paper was attached to the paper for comment.

Attended a calorimeter system measurement and alignment demonstration at Fermilab. A theodolyte triangulation system for measuring the shape of the 12 calorimeter surfaces was demonstrated. It was decided that a survey system similar to the one demonstrated (BETS) could perform the measurements required to accurately describe the shape of the calorimeter. A special working group was formed to meet the day before the Alignment Working Group meeting, for the purpose of deciding the locations and types of fiducial references needed for the calorimeter components.

Chaired a one-day workshop for calorimeter alignment issues. Developed a specification of fiducial locations on calorimeter wedges for steel manufacturing and inspection, wedge assembly, calorimeter assembly, and final alignment. Also agreed on a coordinate nomenclature system similar to the muon groups' system.

Technical Design Reviews

Published the Muon Barrel PDR Committee Report. Prepared a draft of the action items from the report. The SDC Project Manager has asked for a written response to the report.

Test Program Status

No action yet.

Configuration Management

Prepared the SDC response for the review of the PRD Configuration Control Policy. Over four pages of comments were provided to PRD. Will participate in the discussion of the proposed changes.

Attended meeting to work out the details of how SDC will release and control drawings. The SSCL procedures will be followed. Will write an SDC procedure that describes the process and defines responsibilities.
Management Information Systems

Started developing a database to track accomplishment of action items.

Prepared form that will be used to update the SDC name and address data to include collaborators at SSCL. Will provide the data to the User's Office who will then provide us an updated listing that will go into our database. At that time, the system will be tested again and then be put into production.

Attended meeting to determine the requirements for an SSCL name and address database. This is being lead by the PRD but will try to meet other organization's needs.

Attended meeting to discuss the requirements for an SSCL database to track foreign participation. This is to be coordinated with the name and address database effort being led by PRD.

Quality Assurance

Prepared draft list of systems engineering tasks and deliverables for the next year. Concentrated on the deliverables that define the detector and its interfaces. Also, added those items necessary to comply with QA objectives.

Wrote up the review of the SSCL Mechanical Workmanship Standards Manual. Our engineers found that the manual addressed part of the standards covered by national standards but was not complete enough to be a stand-alone document that we could have our collaborators use. Determined that forcing the collaboration to use the SSCL manual in place of the national standards that they already use would be confusing and counterproductive.

9.4 Quality Assurance

9.5 ES&H

9.6 Detector Integration

9.6.1 Mechanical Integration

SSC Laboratory

Technical Staff: Jon Piles, Ken Hess, Mike Hechler, Tom Winch, Kurt Pennington, Lori Okay, Tim Stephens, Lewis Lemoine, Daniel Scott

Author: Jon Piles

The mechanical integration group worked on many items during the month of November. These items included assembly building crane height, air activation, prototype steel block drawing package release, modeling the tracker systems for radiation lengths calculations and developing a C program to work with CADD files for radiation length calculations.

a. assembly building crane height-coordinated the effort in trying to obtain additional crane bridge clearance for the calorimeter assembly area in the assembly building. Two feet was added to the clearance by using a low profile crane. Additional effort is continuing on the transportation of the sections to the TOH.
b. air activation- Through the radiation working group, a plan was developed for the HVAC system for the underground hall to handle any activation that might occur during beam operation.

c. prototype steel block drawing package release- The drawing package for the prototype blocks were reviewed for lab standards. Additional work was performed in getting the package altogether for release.

d. modeling the tracker systems-details of all tracking systems were asked for. These details will be used to enter in complete 3D and as much detail as possible the entire tracking system for radiation length calculations. The fiber tracker was the first to be received and ran detailed for the runs. The rest of the tracking systems are lacking sufficient detail to layout the structures.

e. developed a C program to work with CADD files for radiation length calculations- with great assistance from Bronke Grzegorek of the SSCL LTSPDS group a program was developed for taking any CAD model in the Intergraph I/EMS system and run rays through to calculate material lengths that are encountered. The program will allow phi to be varied and step through any increments in eta. The first complete run was completed on the fiber tracker which is attached.

9.6.2 Electrical Integration

SSC Laboratory

Technical Staff: Jon Piles, Ken Hess, Mike Hechler, Tom Winch, Kurt Pennington, Lori Okay, Tim Stephens, Lewie Lemoine, Daniel Scott

Author: Jon Piles

The electrical integration groups' work beyond what has already been discussed above was as follows: layout for microcrates on outside of calorimeter, fiber tracker crate layout, travel to Carleton University and LANL for electronic integration.

a. layout for microcrates on outside of calorimeter- responding to the straw tracker request for moving the microcrates to the exterior of the tracker. Layouts were performed showing the area and volume taken up by these crates. There are 370+ of these small crates approximately 10 cm x 12 cm x 6 cm.

b. fiber tracker crate layout- Using the latest proposed volumetric dimensions of the calorimeter a new layout was did to see the impact it would have on the fiber tracking crate layouts. With the additional space that might occur from the calorimeter the fiber crates are looking a little more realistic as far as access and replacement.

c. travel- A trip was made with stops at Carleton University and LANL for meetings with the individual electronic engineers to discuss and confirm cable quantities and sizes. This information was fed into the cabling layouts being done at the SSCL.
9.6.3 Installation and Assembly

SSC Laboratory

Technical Staff: Jon Piles, Ken Hess, Mike Hechler, Tom Winch, 
Kurt Pennington, Lori Okay, Tim Stephens, Lewis Lemoine, 
Daniel Scott

Author: Jon Piles

1) Much time was spent on the Muon Barrel Toroid Steel. The following items were included in this work:

a) Developed the shipping scenario for the Muon Barrel Toroid Steel from the Atom Mash plant in Volgodonsk, Russia to IR 8.

b) Obtained prices (quotes) for the shipping, hauling, and handling of the steel blocks. This was done for the two prototype blocks and the full 196 block shipment.

c) Some questions to be answered in the near future are: Can this number of loads (196) be shipped by heavy haul trucks or must we use rail? Must we use U.S. flag ships to haul 1/2 the shipment?

d) Reviewed the assembly details produced by Bigge.

2) IR 8 Assembly Building: Checked construction drawings against our SEFUR. Problems with crane height assembling the Barrel Calorimeter. Insured that the wall between the high bay area and the shop is replaced in the design of the building.

3) IR 8 Hall: Gathered information on heat loads. Determined temperature requirements for operation of the detector. Set temperature in the Assembly Building the same as that in the Hall.

All of the designer's time was spent in generating the month by month installation pictures for the SDC detector. The months that were completed during November are on the following pages.
0 FIRST HALF OF CALORIMETER LOWERED INTO HALL
0 MUON CHAMBERS INSTALLATION CONTINUES
FIRST HALF OF CALORIMETER MOVED INTO PLACE
SECOND HALF OF CALORIMETER LOWERED INTO HALL
NIMON CHAMBERS INSTALLATION CONTINUES

SDC DETECTOR
CONSTRUCTION PROGRESS
MONTH 20
SDC DETECTOR
CONSTRUCTION PROGRESS
MONTH 21

1. CENTRAL CALORIMETER INSTALLATION CONTINUES
2. MUSH CHAMBERS INSTALLATION CONTINUES
SDC DETECTOR
CONSTRUCTION PROGRESS
MONTH 22

1. INITIAL CALORIMETER INSTALLATION WORK
2. MUON CHAMBERS INSTALLATION CONTINUES
SDC DETECTOR
CONSTRUCTION PROGRESS
MON 23
SDC DETECTOR
CONSTRUCTION PROGRESS
MONTH 24

1. CALORIMETER INSTALLATION WORK IN PROGRESS
2. SOLIDAR INSTALLATION AND UTILITY HOOK-UP
3. TOWING END CAP CALORIMETERS INTO HALL
4. MUCTON CHAMBERS INSTALLATION CONTINUES

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The numbers in this table are incomplete and in some cases, not all the numbers provided by institutions are included because of the transition from 92 to 93 budgeting. The December report will include tabeling for both those in 92 budgets and those in 93.