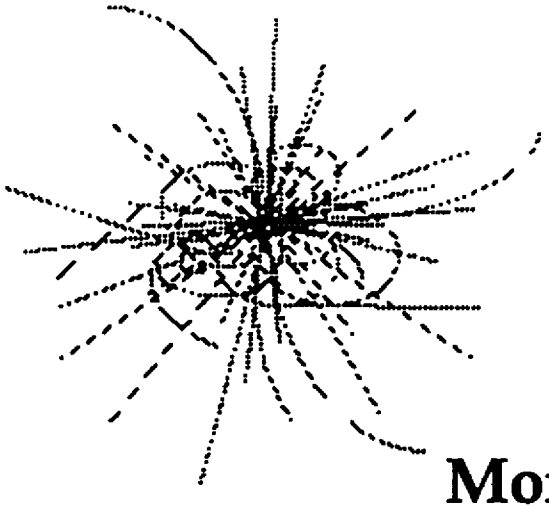
SDC-91-00053

SDC
SOLENOIDAL DETECTOR NOTES

MONTHLY REPORT OF THE SOLENOIDAL DETECTOR COLLABORATION

June 1991

SDC-91-00053



Monthly Report of the Solenoidal Detector Collaboration

June 1991

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MONTHLY REPORT
OF THE
SOLENOIDAL DETECTOR COLLABORATION

JUNE 1991

REPORT SUMMARY

1. OAK RIDGE NATIONAL LABORATORY (ORNL)

Efforts were directed at updating the cost estimate for the Scintillating Fiber Outer Tracker. The Magnet and Central Tracker Resource Requirements Report and the Interface Control Document were revised to reflect current designs.

2. PHYSICAL SCIENCES LABORATORY (PSL) - MUON

The muon chamber system cost estimates were reviewed and updated. A draft of the Muon barrel toroid conceptual design was completed.

3. PHYSICAL SCIENCES LABORATORY (PSL) - TRIGGER

The overall structure of the trigger system has been developed. Simulation efforts are continuing to evaluate front-end electronics options.

4. FERMI NATIONAL LABORATORY (FNAL)

Conceptual design efforts have continued on the superconducting solenoid. Construction methods for the inner and outer vacuum shells have been explored as well as options for the cold mass supports.

Design and cost optimization work progressed on the scintillation tiles, the all-iron hadron plate lead EM calorimeter, and the calorimeter support system.

5. ARGONNE NATIONAL LABORATORY (ANL)

The barrel and endcap calorimeter geometries were revised to reflect current cost/performance specs. Design options and finite element modeling of the barrel EM module is continuing. Plans are underway for evaluation in the FNAL test beam.

6. WESTINGHOUSE (WSTC)

This month efforts focused on developing cost and schedule information for the barrel calorimeter, the end-cap calorimeter and the straw tube tracker.

7. UNIVERSITY OF MICHIGAN

Work centered on triggering with super layers of straw tubes making use of application specific Integrated circuits. The effort includes chip fabrication and software simulation of the circuits as well as assembly of a cosmic ray test stand for system tests.

8. LOS ALAMOS NATIONAL LABORATORY (LANL)

Cost and Schedule activities associated with the silicon tracking system (R&D, design, construction, assembly and test) have been developed into an integrated program plan. The specific design issues under study are forward region structural interfaces, alignments, and power cabling concepts.

9. KAISER ENGINEERS (KE)

Efforts focused on developing an overall SDC construction schedule. Monthly assembly sequence drawings were started. Preliminary design and cost estimates of a calorimeter lowering frame were prepared.

10. LAWRENCE BERKELEY LABORATORY

A preliminary layout of mechanical utilities was created. New configurations of cables and electronic crates were developed. Both electrical and mechanical integration groups assisted in the overall cost estimating and provided the final roll-up and associated analysis.

Martin Marietta is working with the LAC group to provide Cryostat and Module cost estimates. The Silicon Tracking effort produced revised costs and schedules. The Computing Systems work is exploring new database technologies. Prototype systems will be built to explore the new ideas.

A. TECHNICAL PROGRESS

1. OAK RIDGE NATIONAL LABORATORY (ORNL)

Systems integration and subsystems meetings were attended in May at Duke University and at KEK. At the Duke meeting a draft of the Central Tracking Subsystem Task Force report was prepared. Drafts of the report were returned with comment to the subsystem group. At the KEK meeting presentations were made on design and integration activities which had been accomplished during the year at ORNL. On May 28-29, 1991, we attended a meeting at SSCL of the Magnet/Central Tracker Task Force of which T.L. Ryan is co-chair with W. Miller of LANL. A significant part of the effort for May was expended in preparing for the Magnet/Central Tracker Task Force Meeting.

In June, efforts to were focused on the update of the Cost Estimate for the Scintillating Fiber Outer Tracker and the update of the Magnet and Central Tracker Resource Requirements Report and Interface Control Document.

The update to the cost estimate was presented at the SSC Laboratory on June 19, 1991. The main work had been accomplished at the working meeting earlier in the month. The main changes included reflecting the current number of scintillating fibers and better definition of man hours against all tasks in the WBS. Additional refinement of the estimate is continuing and the next updated estimate will be available in July.

The main changes to the Interface Control Document were the addition of envelope drawings and line routings for the superconducting magnet and the silicon tracker. Interferences were identified in the proposed routing of the mechanical lines associated with the silicon tracker. This and other issues are continuing to be worked and revision of the document will be published in July The SDC Technical No. for the document is SDC-91-00026.

2. UNIVERSITY OF WISCONSIN PHYSICAL SCIENCES LABORATORY (PSL) - MUON SYSTEM

In May a detailed cost estimate of the muon chambers was prepared for the early June cost meeting at LBL. Design of the barrel muon chamber supermodule is progressing. With the extrusion being used in the prototype chamber, new weights were calculated and analysis is being done to determine support structure behavior under load. This analysis is done for all octants of the barrel. This analysis, along with the behavior of chambers under load, will result in numbers that will serve as starting points for the development of the alignment system. Preliminary work on the geometry of the intermediate system was done.

Extrusions for a 32 square coil prototype chamber were ordered and are expected early July. An assembly and gas sealing and routing scheme has been chosen. Design of the wire mounts has been chosen. Drawings for a prototype chamber assembly and test plans are being developed.

In June, the muon chamber system cost estimates were updated. A mechanism was developed to quickly estimate costs of various arrangements of layers in the muon chambers for the current design. Conceptual drawings of supermodules for the barrel, as well as detailed drawings of all the cells in the barrel are included, (Figs. 2-1 thru 2-5). More detailed calculations of the chamber mechanical behavior were done to arrive at a support system, and number of support points. This is shown schematically in the supermodule conceptual drawings.

The die for the double cell octagonal cell was fabricated in June by International Extrusions in Detroit, MI. First run samples are expected in July. After approval, the production run for the prototype will be completed in early July. A layout drawing for the prototype chamber is included, (Fig 2-6), Shop drawings for all the parts are made but will be released for fabrication after extrusions are inspected for dimensional accuracy to ensure proper fit of parts.

A draft copy of "SDC Muon Barrel Toroid Conceptual Design Report using Long and Short Bolted Blocks" was completed. The concept (Fig. 2-7) proposed uses thin long blocks, thin short blocks and thick short blocks as building blocks for the barrel. The report was discuss at the first meeting of the muon magnet subcommittee. There were some modifications made. The current steel design was presented at the integration meeting June 19th. The concept was submitted for approval to the technical board. There has also been some effort to understand the support concept proposed by the SSC and investigate alternatives to the horizontal hydraulically tension cables.

The coil parameters have been recalculated for the Russian steel, longer barrel, and new forward toroid dimensions. A computer spread sheet is being generated to allow quick calculation of different configurations in the future. Production line layout and conceptual tooling design has begun.

Much work has been done on the cost model for the steel, the coils, and chambers. UW-PSL is providing information for Martin Marietta and attended the cost meetings at both LBL and SSC. A detailed coil cost and schedule model has been partially completed at PSL using "Timeline". Since the collaboration meeting the cost work has concentrated on checking the numbers in the muon system cost model and developing cost estimates for various descoping alternatives.

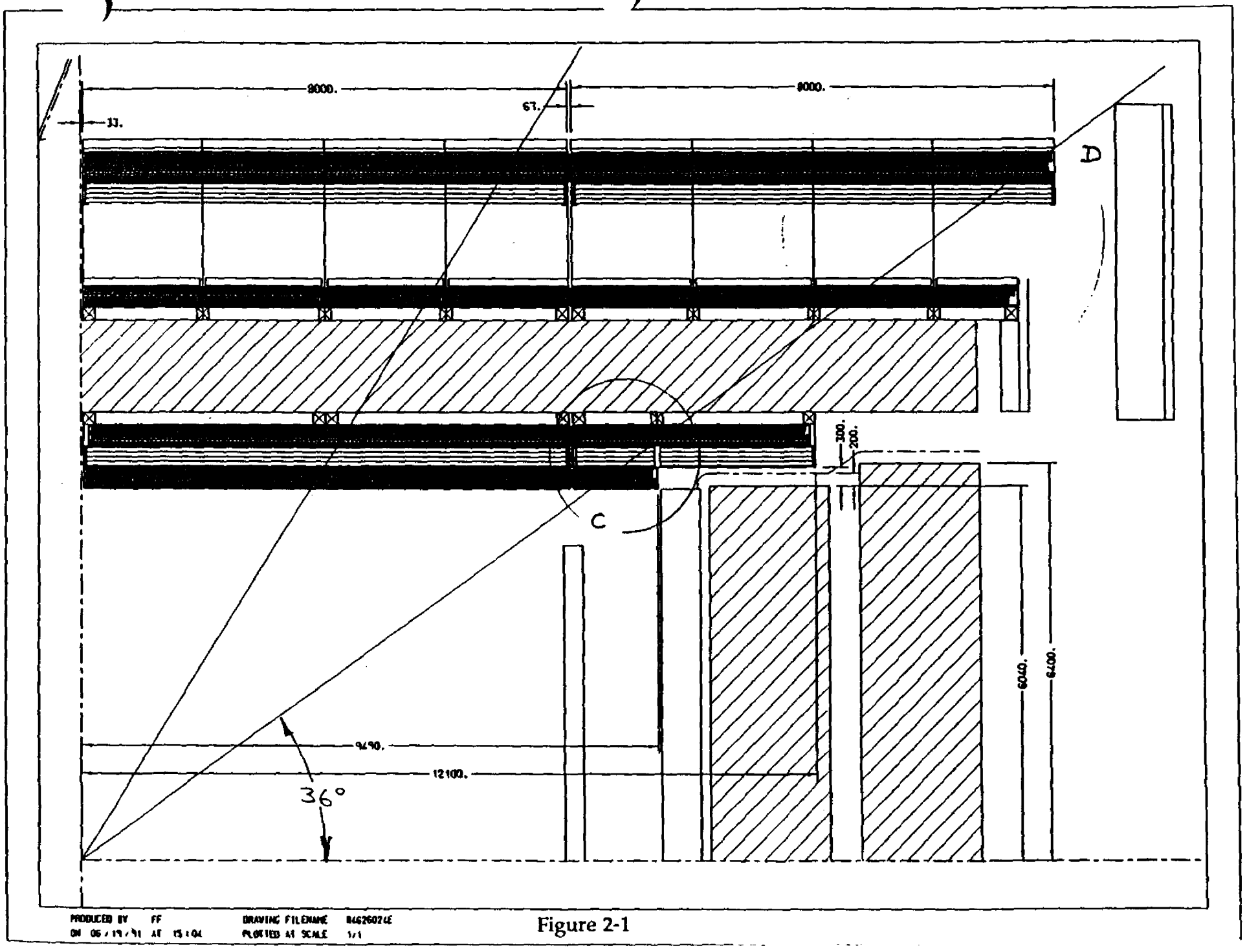
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Figure 2-1

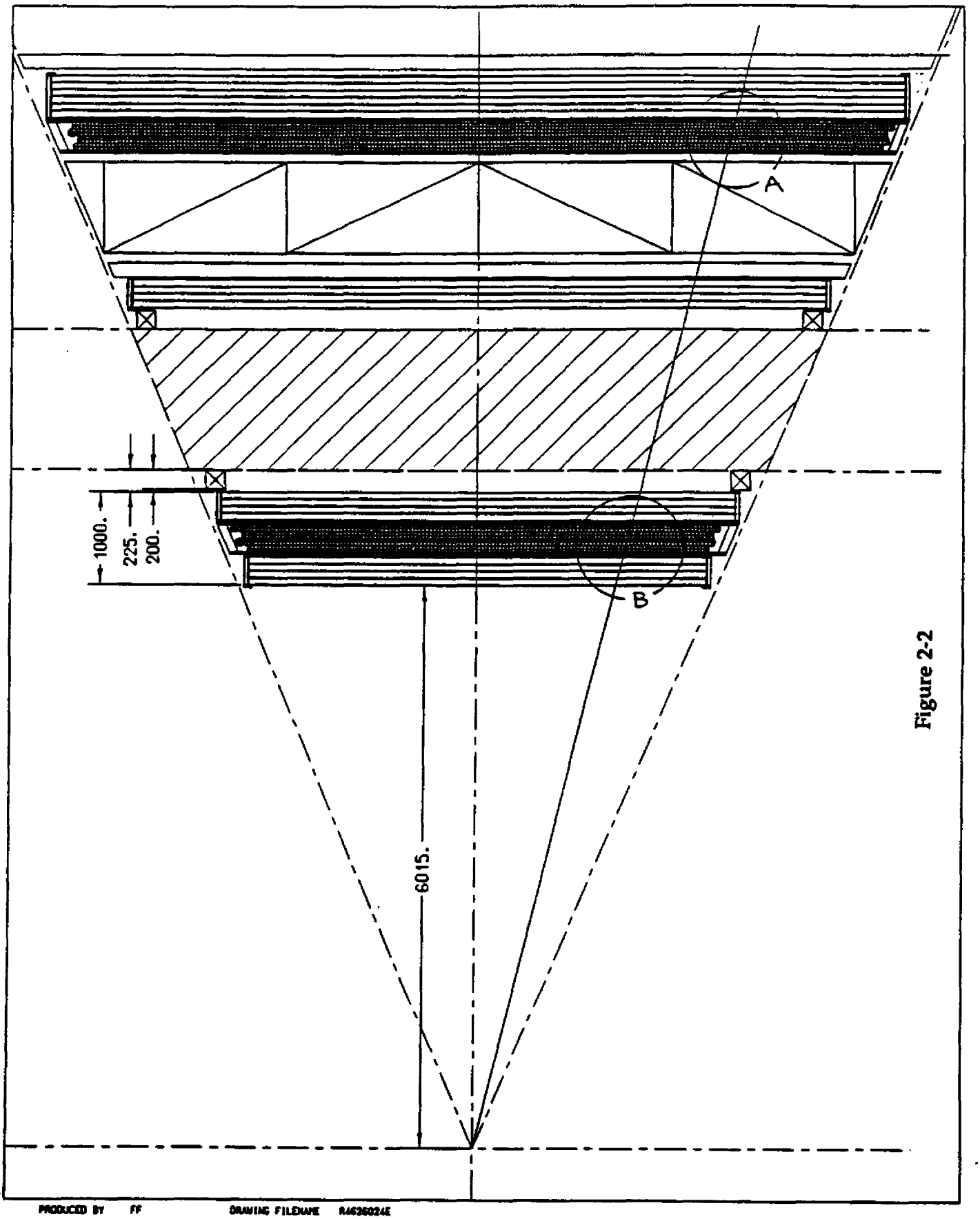

Figure 2-2

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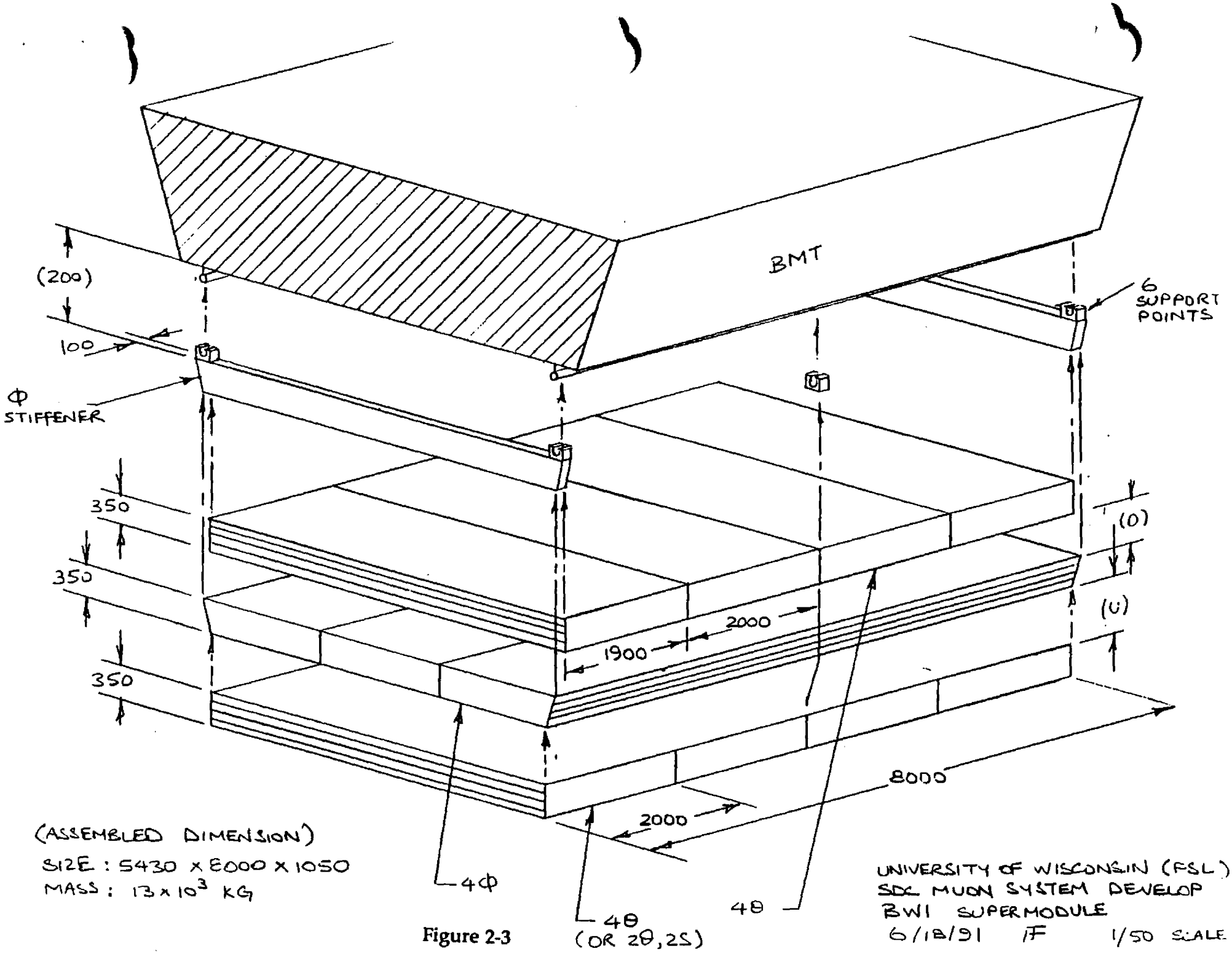
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100
Φ
STIFFENER
6
SUPPORT
POINTS
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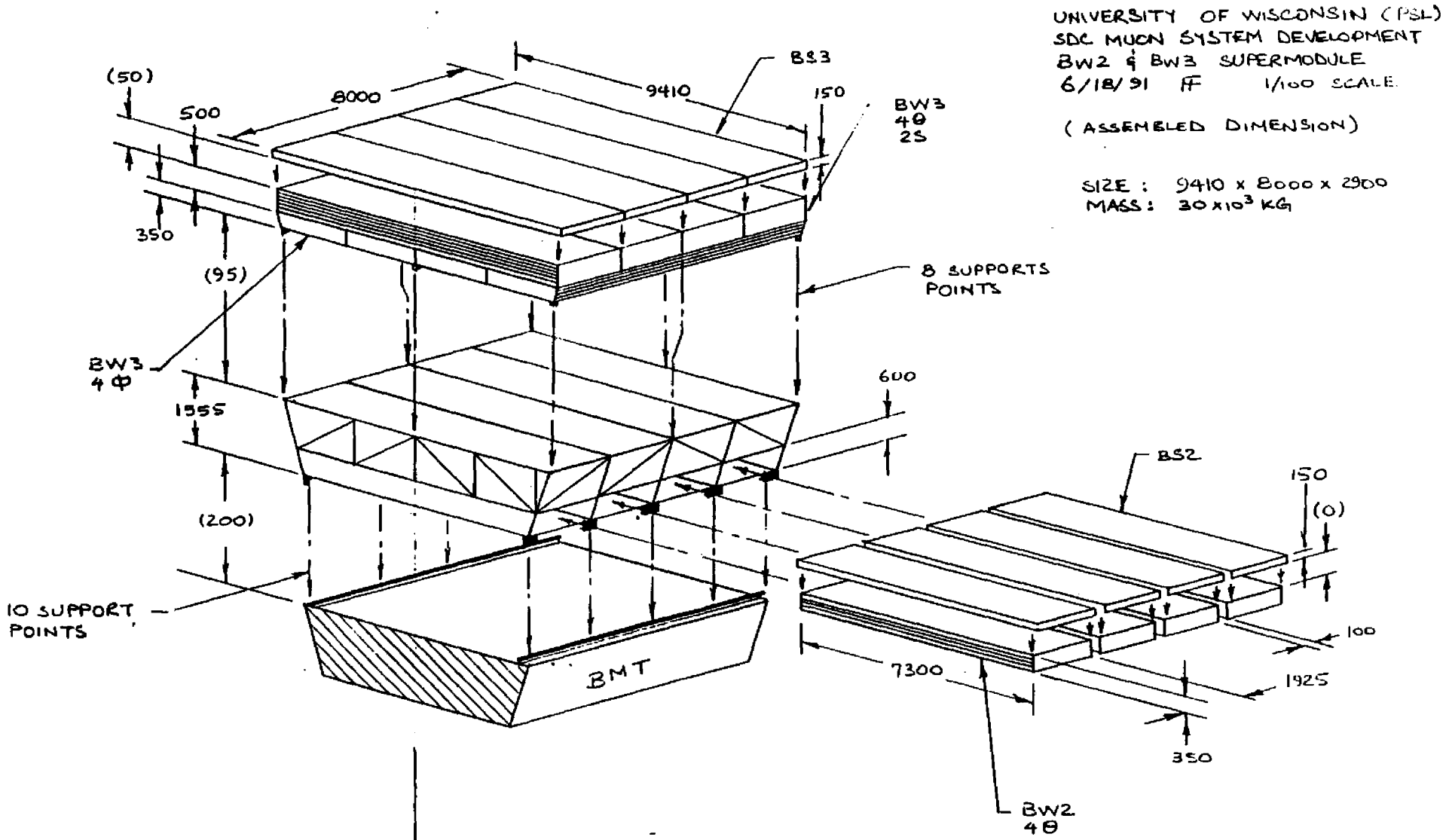
350
350
(0)
(U)
2000
1900
8000
2000
(ASSEMBLED DIMENSION)
SIZE : 5430 x 8000 x 1050
MASS : 13 x 10^3 KG
4Φ
4θ
(OR 2θ,2S)
4θ
UNIVERSITY OF WISCONSIN (FSL)
SDC MUON SYSTEM DEVELOP
BWI SUPERMODULE
6/18/91 JF
1/50 SCALE

Figure 2-3


UNIVERSITY OF WISCONSIN (PSL)
SDC MUON SYSTEM DEVELOPMENT
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6/18/91 FF 1/100 SCALE
(ASSEMBLED DIMENSION)
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MASS : 30 x 10³ KG
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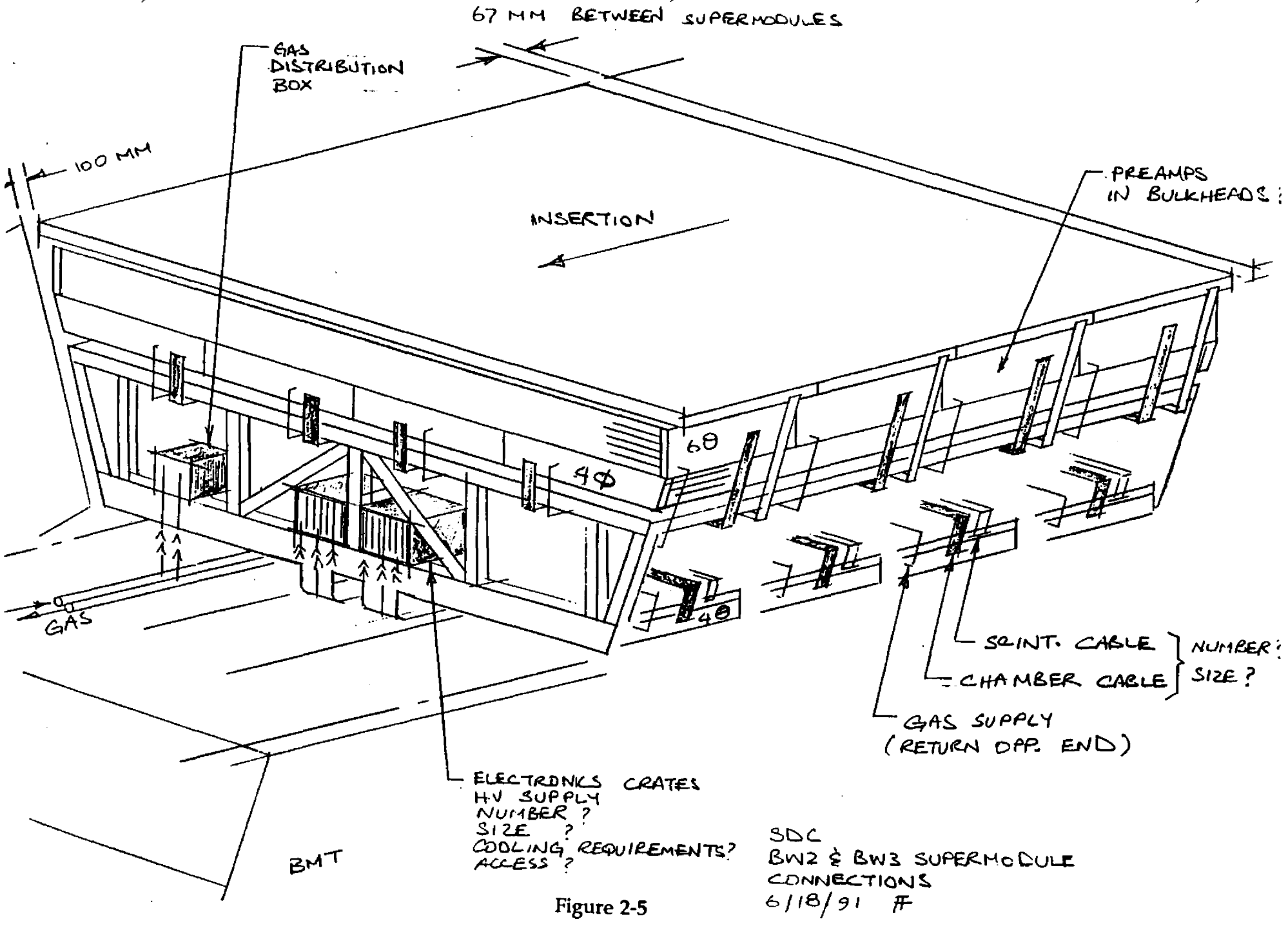
BW3
4θ
2S
(50)
500
8000
9410
150
350
(95)
8 SUPPORTS POINTS
BW3
4Φ
1555
600
BS2
150
(0)
(200)
10 SUPPORT POINTS
BMT
7300
100
1925
350
BW2
4θ

Figure 2-4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INSERTION
PREAMPS IN BULKHEADS
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40
40
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NUMBER ?
SIZE ?
GAS SUPPLY (RETURN OPP. END)
ELECTRONICS CRATES
HV SUPPLY
NUMBER ?
SIZE ?
COOLING REQUIREMENTS?
ACCESS ?
BMT
SDC
BW2 & BW3 SUPERMODULE CONNECTIONS
6/18/91 F

Figure 2-5

32 CELL PROTOTYPE
CHAMBER

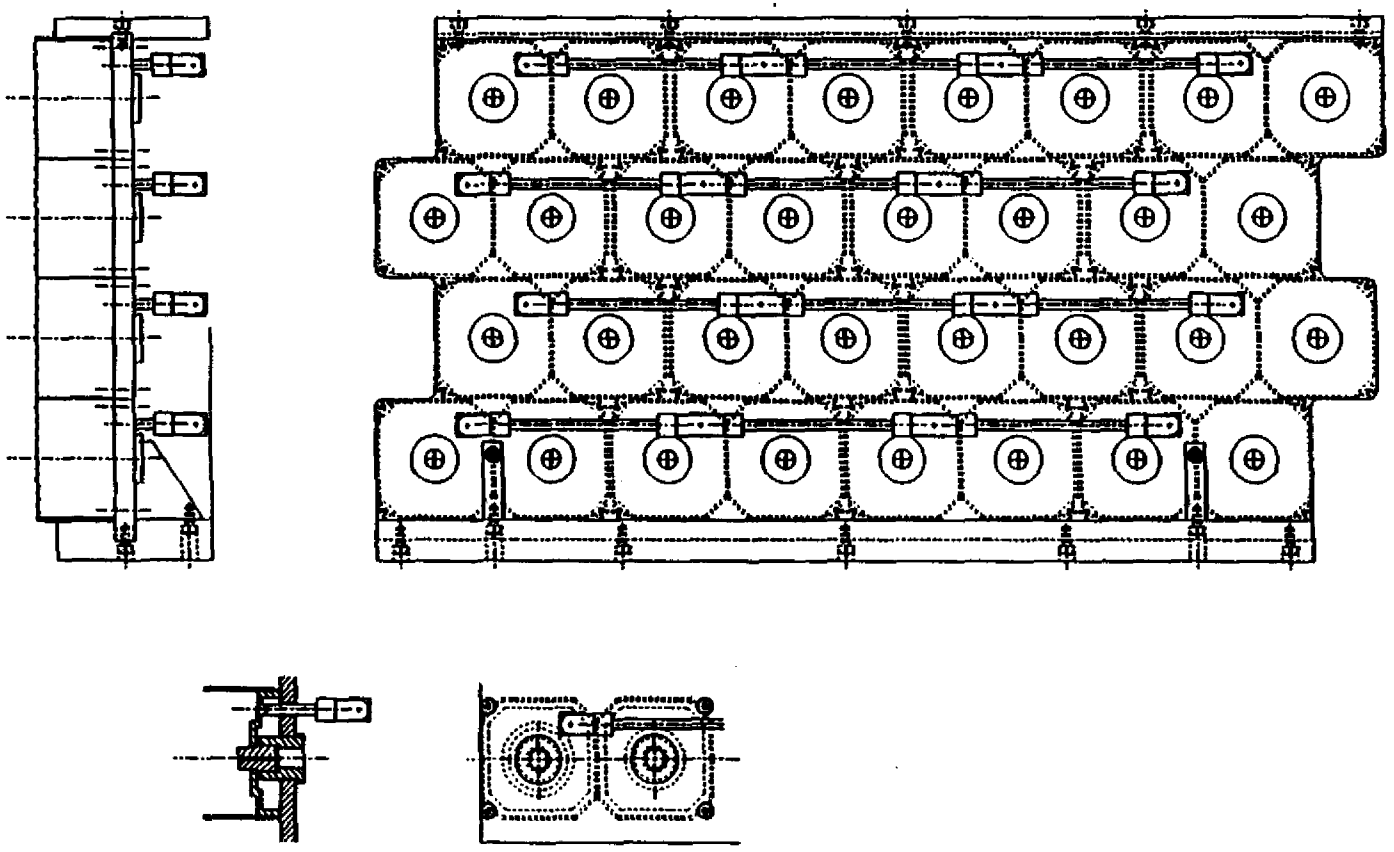

Figure 2-6

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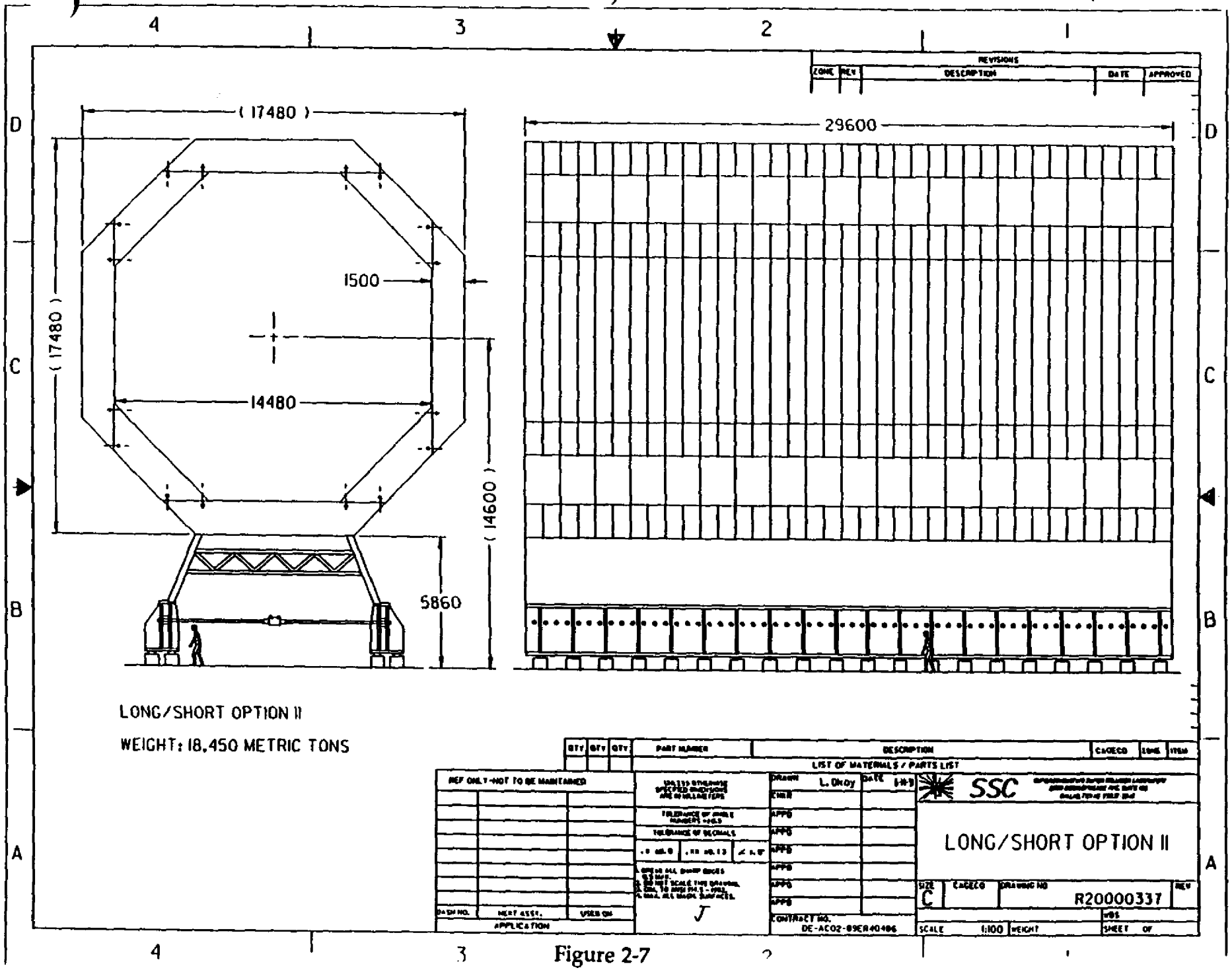
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5860
29600
LONG/SHORT OPTION II
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REVISIONS
ZONE
REV
DESCRIPTION
DATE
APPROVED
PART NUMBER
DESCRIPTION
LIST OF MATERIALS / PARTS LIST
REF ONLY - NOT TO BE MAINTAINED
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L. Okoy
DATE
SSC
LONG/SHORT OPTION II
SIZE
C
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CONTRACT NO.
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APPLICATION

Figure 2-7

3. UNIVERSITY OF WISCONSIN PHYSICAL SCIENCES LABORATORY (PSL) - TRIGGER SYSTEMS

The overall structure of the trigger system has been developed and there is progress on simulation and conceptual design. Much of this effort is in the context of different front end electronics options, necessitating alternative designs to address the different detector technologies. It is anticipated that the detector subsystem decisions will provide additional focussing of the R&D effort.

A number of simulation efforts on calorimeter triggering and various triggering algorithms are under development and test. There are partially complete conceptual designs for isolated electron, jet and missing energy triggers. These are being evaluated. Studies show that calorimeter data separated by only two crossings can be distinguished for triggering purposes. A conceptual design of trigger primitive generation is partially complete. The appropriate tower size for summing is under study.

A preliminary outline of the Global Level 1 Trigger system has been produced and is under discussion. Protocols for the interface between the Trigger and DAQ and between the Trigger and Front End electronics have been developed. Methods of error handling, rate control, and deadtime monitoring are being evaluated. The clock and control sections are under study. Simulation studies are being preformed to determine the efficacy of correlation between subsystem trigger information. The overall role of the Level 1 and 2 trigger systems is being defined

4. FERMILAB (FNAL)

A. Superconducting Solenoid

Cryogenics

A design was developed for the vacuum jacketed, helium-nitrogen transfer line which will run from the control dewar on the detector to the cryogenic utility building on the surface. It has the liquid helium supply line inside the two-phase helium return line. Two liquid nitrogen supply lines cool a thermal shield around the return helium line. A cross section of the line is shown in Fig. 4-1.

Two vendors of helium refrigerators responded to our Request for Information (RFI), issued by the SSCL in May. The vendors provided cost and technical information for the SDC refrigeration system as described in the preliminary specification prepared at Fermilab.

A drawing of the chimney-to-cryostat joint area (Fig. 4-2.), shows a preliminary layout of the chimney, the expansion bellows and the instrumentation feed-throughs.

Inner Vacuum Shell

The baseline design of the inner vacuum shell is a rolled and welded solid 1/4" aluminum plate. Calculations showed that the stiffness of the 3.4-m diameter shell was so low without the constraint provided by the annular end bulkheads that considerable fixturing would be necessary for handling the shell during fabrication and sub-assembly. We investigated the use of isogrid to stiffen the shell and reduce the amount of fixturing required. We calculated that an isogrid shell with an effective thickness of 1/4" and a total thickness of 1/2" had a collapse pressure of 3.4 psid, compared to 1.35 psid for the solid 1/4" shell. The collapse pressure of a solid 3/8" shell is 3.7 psid; we propose to adopt this for the baseline design since is would be much cheaper than the isogrid shell and is only 0.035 radiation lengths thicker.

Outer vacuum shell

A follow-on contract has been negotiated with PS Associates for the final design of an aluminum isogrid outer vacuum shell. We fabricated, using conventional machining, a six-triangle hexagonal demonstration sample of the isogrid pattern resulting from the preliminary design. We also laid out this pattern on a 4 x 8 foot sheet. Our plan is to procure several 24" square sheets, made by NC machining, and to practice bending them to the 130" diameter required for the solenoid. We will then roll and weld several 4 x 8 foot plates into a short cylinder for testing. We have calculated the radiation thickness as a function of pseudorapidity for three values of polar angle. Figure 3 shows the effect of the bundle of copper cables which wraps around 90% of the circumference at the end and of the warm and cold end of the support system which occupy the remaining 10%.

Cold-mass Support System

Efforts continued on the design of the cold-mass supports, with the goal of minimizing the radiation thickness of the supports, the bearing rod-ends and the attachment blocks. Since the amount and location of the iron in the calorimeter is not yet known, the forces on the coil/cold-mass are likewise uncertain. For our design work on the supports, we have assumed a coil-iron geometry which gives de-centering forces of 66 metric tonnes in the axial direction and 60 tonnes radially. We have chosen truss rods made of filament wound carbon-epoxy composite. The threaded insert at both ends of the rod will be titanium (6 Al-4 V) to match the thermal contraction of the composite. We are studying a variety of materials for the rod-ends and attachment blocks to determine the optimum material in terms of radiation thickness, Inconel 718, Ti(6 Al-4V), Al(2219-T78) and Be-Cu(172). It may be necessary to anodize or plate the attachment blocks to prevent galvanic corrosion of the aluminum vacuum bulkhead to which they are attached.

Magnetostatics

We have been investigating the conditions under which an axial preload applied to the superconducting coil will reduce relative motion between the coil and the outer support cylinder, and the degree to which this motion can be eliminated. (This relative motion is a source of mechanical energy which can cause the coil to quench before reaching the operating current.) A sensitivity study showed that the relative motion is strongly affected by the axial distribution of the axial Lorentz force. If the axial force is uniformly distributed, the relative motion will be much larger than if it is concentrated at the ends of the coil. We also studied the influence of the coil modulus on the relative motion, the outer support cylinder being aluminum, and showed that the relative motion increases as the coil modulus decreases.

System Integration

We attended a meeting of the Magnet-Tracking Task Force on June 7th at Oak Ridge National Laboratory, the purpose of which was to prepare the final draft of the Magnet-Tracker Interface Control Document. Final envelopes for the baseline design were determineed as was the azimuthal locations of the supports for the solenoid cryostat, outer tracker, intermediate tracker and the silicon detector. As assembly scenario of these components was also developed. We also attended the SDC integration meeting at the SSCL on June 17th.

We were asked by the SSCL to review the equipment layout and space allocation in the cryogenic utility building. As a result we requested that the space allocated to the technician assembly area be increased by three meters in length, while keeping the outside dimensions of the building at 24 by 27 meters.

Costs and Schedules

Two cost-scheduling meetings were held in June, the first at LBL the second at the SSCL. We prepared the magnet and cryogenics portions of the work breakdown schedule (WBS), sections 4.1 and 4.2 respectively. We refined the cost and manpower estimates for the liquid nitrogen system (4.2.1.2), the cryogenic transfer line system

(4.2.2.1) and the gas piping system (4.2.2.2). The cost estimate for the refrigeration system RFI was incorporated into element 4.2.1.1. At the meeting at the SSCL, KEK provided an overall cost estimate for the superconducting solenoid, and we assisted in breaking this number down into WBS sub-elements.

REV.	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE

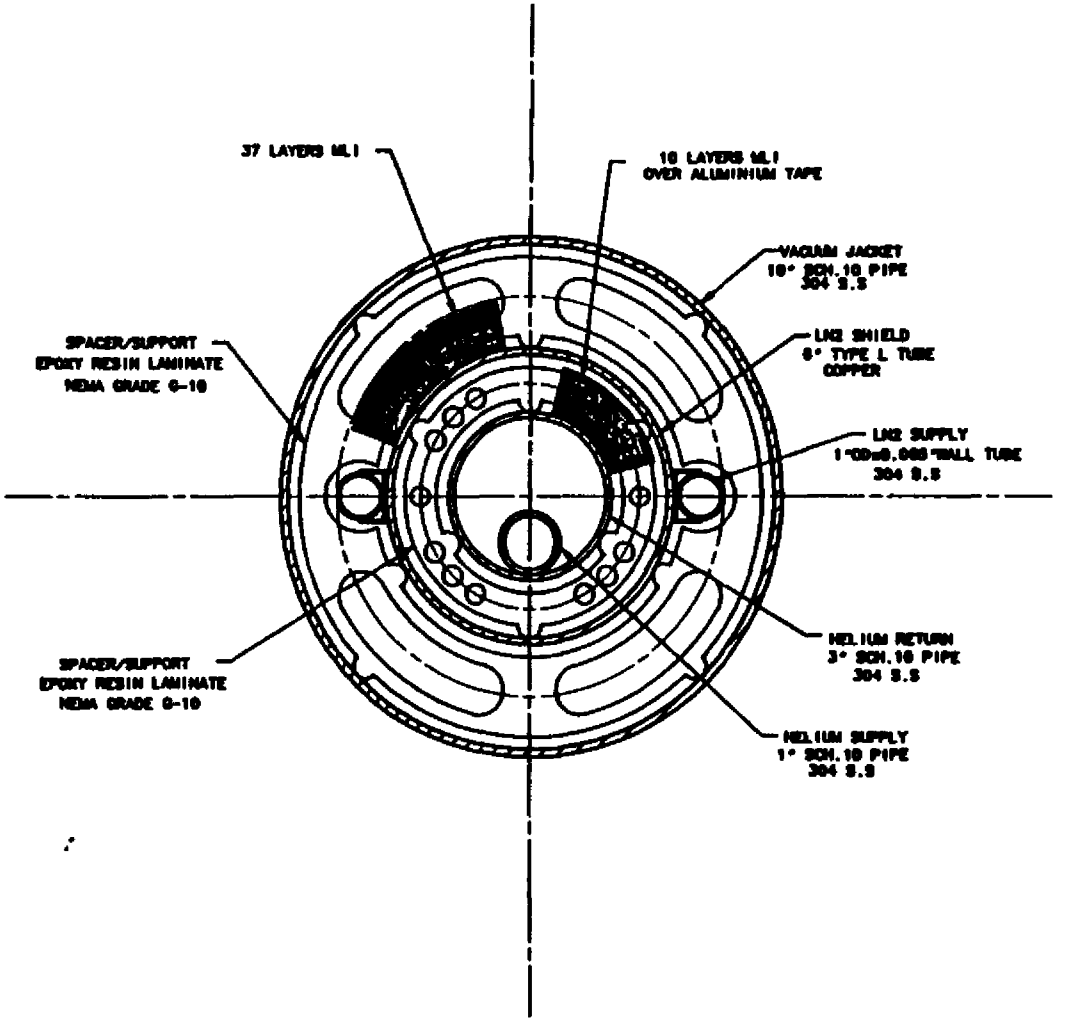

Figure 4-1

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	USED ON		
√ MAX. ALL MACHINED SURFACES	MATERIAL		C

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

SOLENOIDAL DETECTOR COLLABORATION
CRYOGENIC TRANSFER LINE, CROSS SECTION
SUPERCONDUCTING SOLENOID

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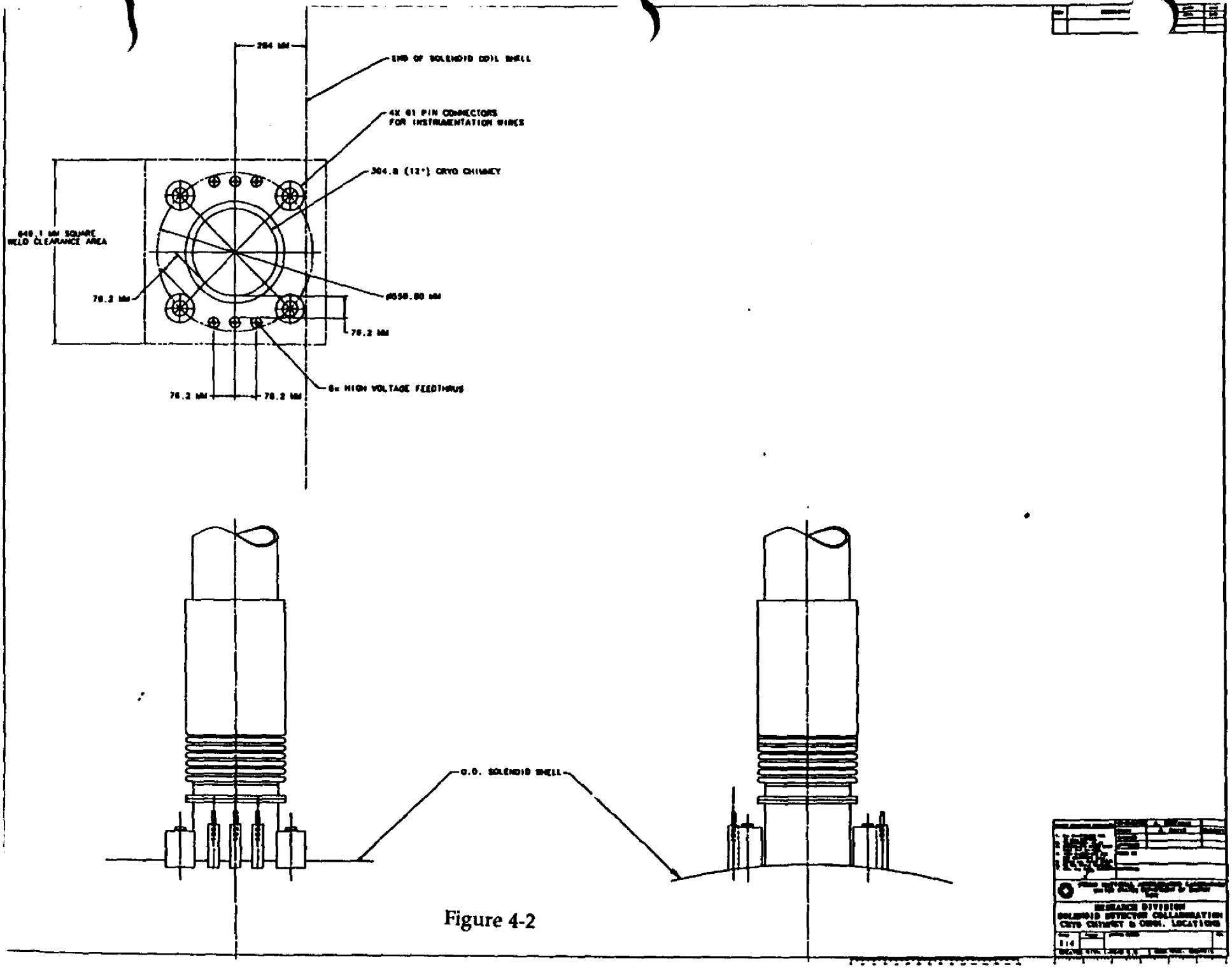
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WELD CLEARANCE AREA
76.2 MM
ø558.80 MM
76.2 MM
76.2 MM
76.2 MM
6x HIGH VOLTAGE FEEDTHRUS
O.D. SOLENOID SHELL
RESEARCH DIVISION
SOLENOID DETECTOR COLLABORATION
CRYO CHIMNEY & CONN. LOCATIONS

Figure 4-2

Radiation Length V.S. Psedorapidity

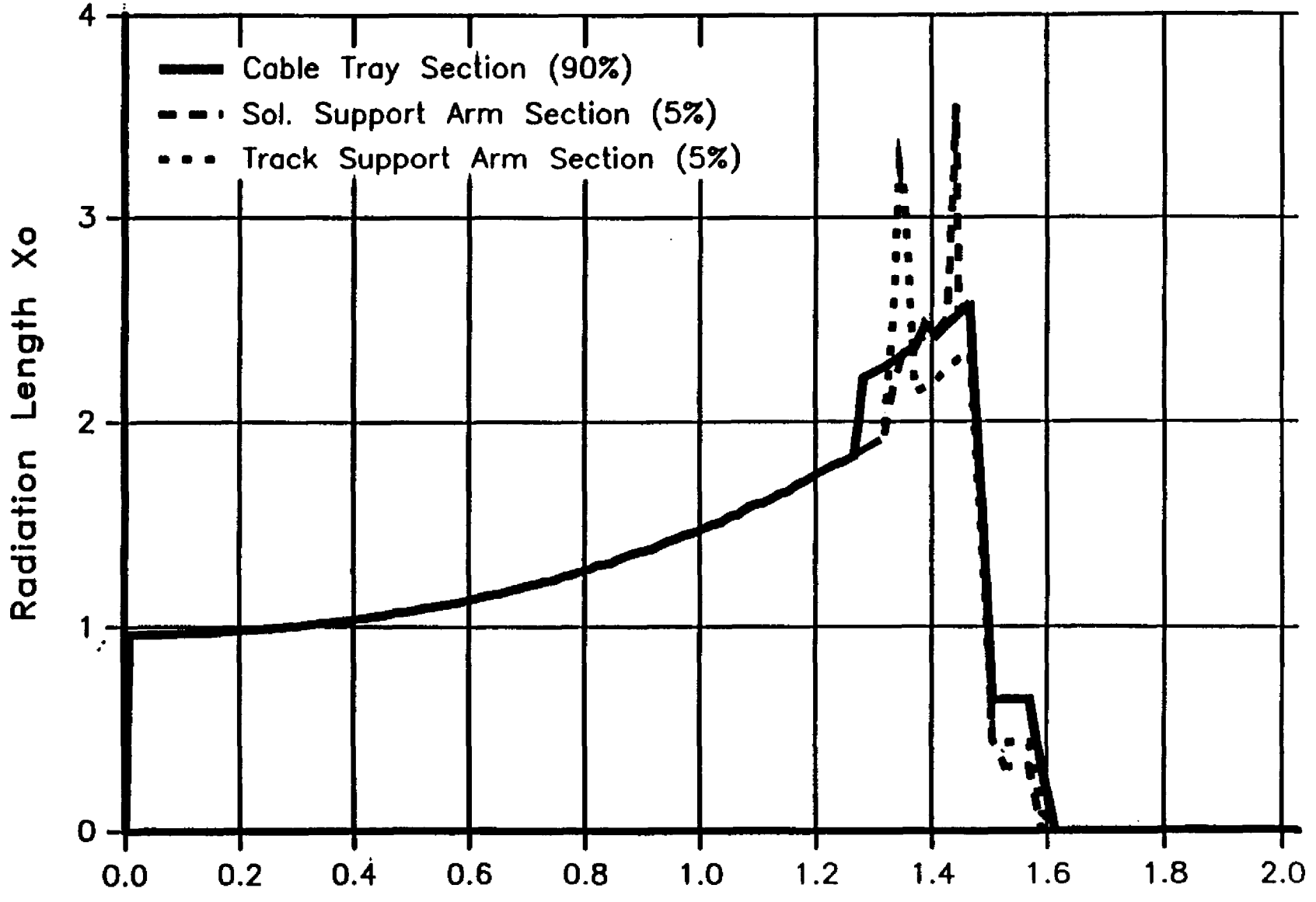


Figure 4-3

B. Calorimetry

Cost Estimating

Work continued to refine the model of the FNAL scintillating tile factory to better understand the partial derivatives of cost. We discovered that the cost of tiles and fibers is very tile quantity driven, and the effort is to understand how to scale back the cost of tiles for different baseline designs with different tile counts. The labor scales easily by tile count. The area we are trying to understand better is when tooling cut backs can be made as a function of tile quantity.

All Iron Design Work

Work continued in the development of the design and cost estimate for the Fermi all-iron hadron, plate lead EM calorimeter. There are now two different steel designs for the hadronic compartment. One design uses punched 1/8" thick steel laminations stacked and fastened together in between thicker machined side plates. The other design uses thicker steel plates stacked perpendicular to the stacking direction in the punched steel design. Argonne and Westinghouse are using the thicker plate approach for their HAC2 section, but they create the tile slots using many individual pieces which must be welded or bolted together. The design we are pursuing would have the slots milled into the long thick plates so that the total piece count is much less as is the amount of fastening necessary. We are working to understand the cost trade-offs in the several versions.

Vendors were located who would estimate the side plates for the punched lamination version. This has been a problem because no one seemed interested in taking on the job of fabricating these pieces. Unfortunately, as mentioned below in Test Beam Work, our experience with machine laminations seems to indicate that it would not be practical to attempt to build the punched plate design without the thicker side plates. While the laminations themselves are cheap, the side plates are fabricated by more expensive machining techniques. The hope in this design is that the combination of a larger volume of cheap parts with a small volume of expensive parts would balance out to a reasonably priced steel section.

We have had trouble locating a vendor who can punch 72" wide sheet steel. We will probably modify the lamination design to use a narrower sheet and recipe stack them. This may avoid some tolerance stack up problems in the punched plate design.

Calorimeter support is also being re-examined because the FNAL calorimeter is more than 1000 tons less than the Argonne/WSTC base-line model. This weight loss will be useful in increasing access space under the calorimeter for electronics and phototubes.

We have a very good assembly scheme and fastening scheme to attach wedges to each other in final assembly. Our approach uses very minimal hardware.

Alternative EM Designs:

Work has proceeded on the Zeuss-style EM calorimeter design for SDC. We have produced some test drawings of lead sheets which may be stacked and used for the beam test at MP. Calculations are in progress to determine the amount of wire tension necessary to hold this design together.

Test Beam Work

The punched steel hadron blocks are currently being machined in the Village Machine shop to flatten their surfaces and put fiber routing grooves in. The work has not gone well, and the current feeling is that it is impossible to cut fiber grooves through several laminations on the face of the block without the laminations falling apart. This is the motivation for the side plates in the punched plate design. The side plates would cover the laminations and any post assembly machining would be done on the thick side plates where no trouble is expected.

The hanging file test has been assembled in the MT beam test area. Work should be completed shortly.

C. Data Acquisition System

The Data Acquisition Electronics Department is currently responsible for three SDC activities. Data Acquisition System Baseline DAQ costing, the DAQ section of the SDC Technical Proposal, and the Scintillating Tile Calorimetry - Scintillating Fiber Tracking test beam project.

Considerable time was spent in June costing the DAQ system in preparation of the SDC Collaboration meeting in June at Dallas. After the meeting, the major effort has been descoping the DAQ system.

For the Scintillating Tile Calorimetry - Scintillating Fiber Tracking Test Beam Project, most of the designs and PC artwork for an energy adder module, a data storage (SIRO) module, a test transmitter module and a track finder module were completed.

D. Muon Support Alignment Systems

A first concept detail design for Muon gas systems and distribution manifolding has been completed. Most of our effort has been devoted to cost estimating the support and alignment systems and developing an installation schedule. We are analyzing the proposed support rail system to define mounting hole and alignment hole configurations in the Barrel Iron.

We have begun studying prototype remote chamber alignment monitoring systems. This will attempt to monitor the distances between chamber layers and relative rotations and shifts of the layers in the planes of the layers. Various prototype system components have been identified and are in procurement. The first of these is a prototype high precision (1/4 mm) ultrasonic distance measuring system. This system

will be delivered early August. In the meantime, we have studied a commerically available selectron detector to understand sidewall beam reflection limitations on structure around the detector, resolution limits, temperature effects, air current effects, and stability. Preliminary results indicate that these can work between truss structures and through 3" holes in the magnet iron.

Alternatively, we are studying a system using proximity sensing of targets on a fixed tension stretched wire. We have established the computer logging and readout of linear output sensors. At present, we are using microswitch sensors but will extend our studies to other similar types. First we measured the sensing range for different metals (A1, SS, Mild Steel) as sensing targets. This study included both detector and target size effects. It also included some target shape studies as well. We have also looked at the effect of vibrations, air currents, and temperature variation. Preliminary results indicate short term resolution and stability of measurement to 0.025 mm (25 micron). More work will be done when the final setup is fabricated and long term stability will be measured.

5. ARGONNE NATIONAL LABORATORY (ANL)

Barrel and Endcap Calorimeter

The barrel and endcap geometry was revised to reflect the most current cost and performance specifications, as shown in Fig 5-1. The correct absorption thicknesses and calorimeter depths were incorporated into the latest drawings. The most current cross section is shown in Fig. 5-2

The details of the individual segments are shown in Sections A-H.

A. Barrel EM lead (Pb) cast cell and structure.

B. Barrel HAC1 lead (Pb) cast cell structure.

C. Barrel HAC2 lead (Pb) steel plate cell and spacers.

D. Endcap EM calorimeter support (proposed).

E, F, G Endcap, EM, HAC1, and HAC2 cell structure.

H. Barrel/Endcap calorimeter transition region.

EM Test Section for Test Beam

The mechanical design of the support and translation devices for the Fermilab test beam was completed. A current cross section view is shown in Fig. 5-3.

Barrel Calorimeter FEA Analysis

Engineering design and finite element modeling of a full length barrel EM module is continuing. Analysis of the base design with 1 mm bulkheads spaced on tower boundaries has been completed. This work has shown that the stress of the lead plates induced by deflections of the steel frame is the critical component in the design. Figures 5-4 and 5-5 show lead stress as a function of cell number is Tower 3 (near 900) and Tower 28 (the last barrel tower). Analysis of this design to optimize thickness, location, and number of bulkheads is now in progress.

Barrel Design

a) HAC1 3D Analysis: The model construction was completed for the HAC1 module, hanging from 12 o'clock. The first case was performed, with the center bulkhead at Z = 0 unconstrained. The magnified deflection plot is attached. The next case to be performed, which is currently in progress, will have the center bulkhead constrained as it would be in the assembled calorimeter.

b) Full Barrel 2D Model: The model was modified by removing the outer support steel beyond the bottom support cradle. This outer layer of solid steel was approximately 28 cm. thick in the previous model. Preliminary results with this

model show that stresses and deflections are comparable to those found in the earlier cases with the outer support steel. The next step is to tabulate the fastening forces between modules at the HAC2 inner diameter, and perform a preliminary design of fastening system.

Management and Meetings

A meeting was held at Westinghouse STC on June 12. A strategy was discussed and agreed upon for the production of the second EM test module casting. Westinghouse and Argonne also exchanged the latest results of their respective analyses efforts.

EMC Test Module

A detailed plan was formulated for the production of the second EMC test casting. The mold will be modified to increase the overpour from .5 to 1.25 in. The change should eliminate the top surface porosity found in the first casting. The casting process will be modified where possible to lessen thermal gradients and stresses in order to improve tolerances and reduce lead flash clean-up requirements. The following mold drawings were made.

1D33635, 36, 37, 38, 39, All Rev. 2.	Aluminum Inserts
1D33643, Rev. 3	Notched Steel Bar
1D33596, Rev. 1	Weldment Modification
1D33596, Rev. 1	Mold Lip
1D33645, Rev. 1	Small Outer Plates, Front
1D33651, Rev. 1	Small Outer Plates, Back
D.412.L0.June 17	Assy. of new mold

The major long lead item is the machining of the 145 aluminum inserts. Westinghouse has placed this order.

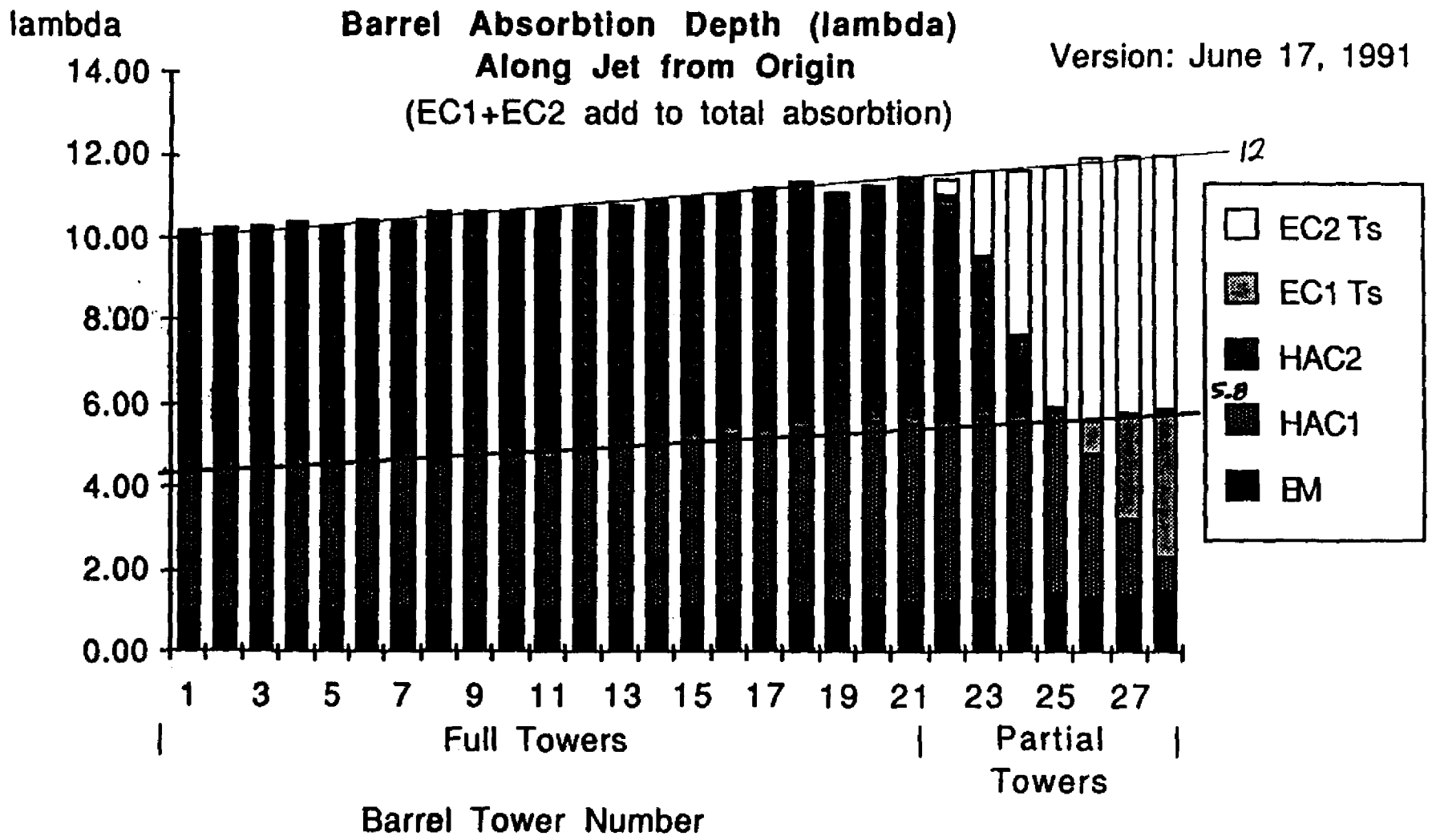

lambda
Barrel Absorbtion Depth (lambda)
Along Jet from Origin
(EC1+EC2 add to total absorbtion)
Version: June 17, 1991
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
12
5.8
EC2 Ts
EC1 Ts
HAC2
HAC1
BM
1 3 5 7 9 11 13 15 17 19 21 23 25 27
Full Towers
Partial Towers
Barrel Tower Number

Figure 5-1

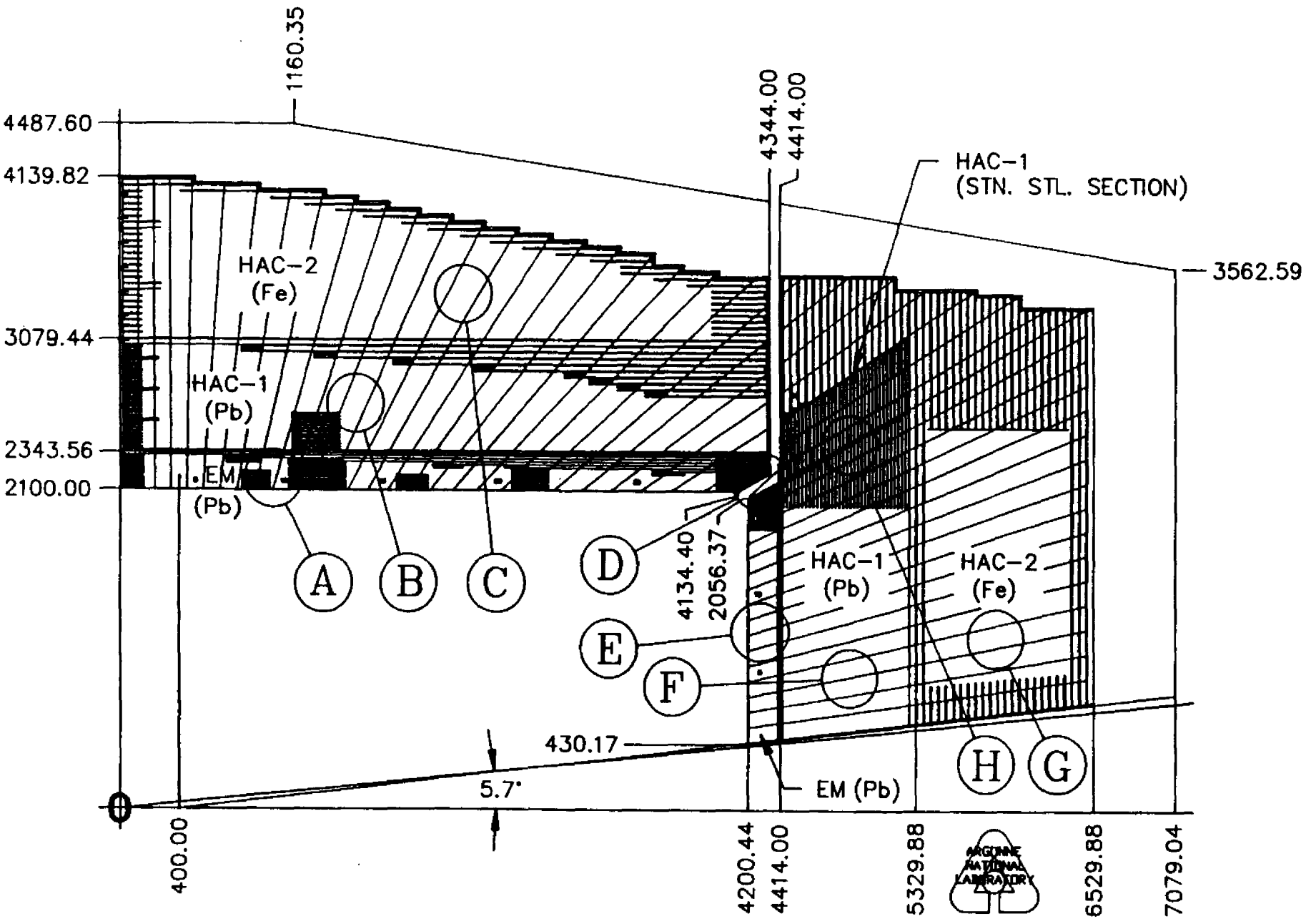

1160.35
4487.60
4139.82
3079.44
2343.56
2100.00
4344.00
4414.00
HAC–1
(STN. STL. SECTION)
3562.59
HAC–2
(Fe)
HAC–1
(Pb)
EM
(Pb)
A
B
C
D
E
F
G
H
4134.40
2056.37
HAC–1
(Pb)
HAC–2
(Fe)
430.17
5.7°
EM (Pb)
0
400.00
4200.44
4414.00
5329.88
6529.88
7079.04

Figure 5-2

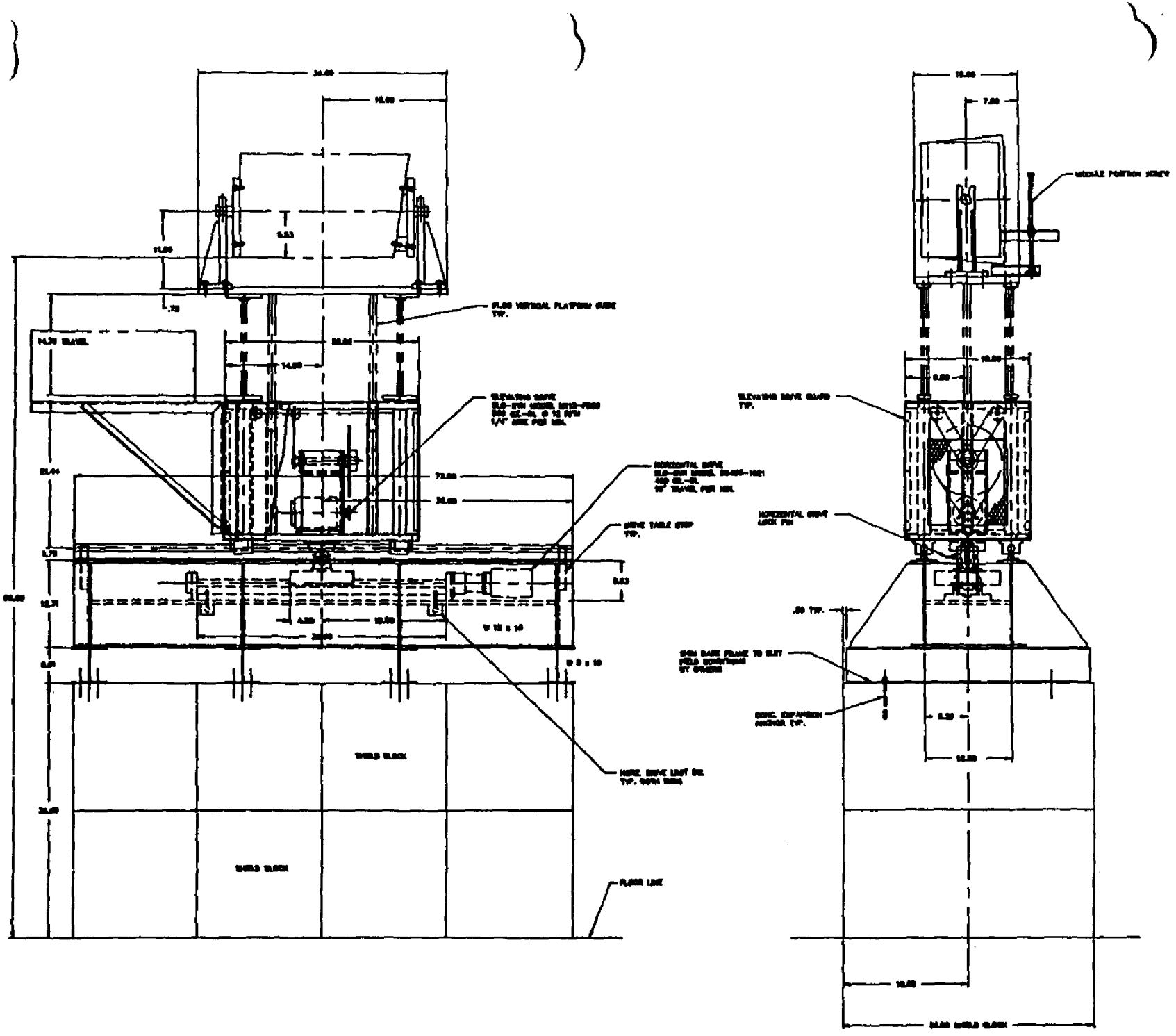


Figure 5-3

LEAD STRESS vs. CELL NUMBER

TOWER 28 – 12 O'CLOCK POSITION

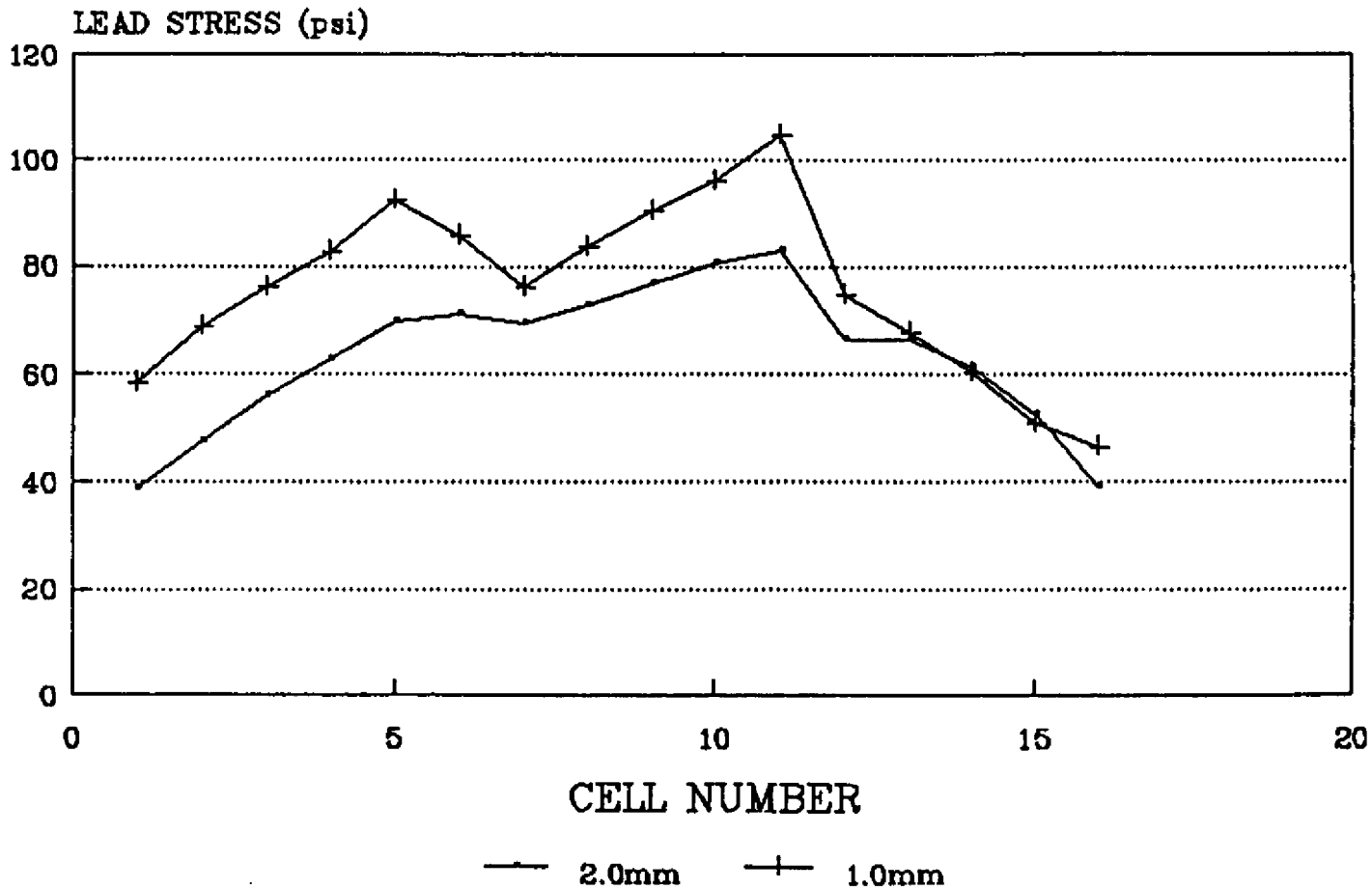


Figure 5-4

LEAD STRESS vs. CELL NUMBER

TOWER 3 – 12 O'CLOCK POSITION

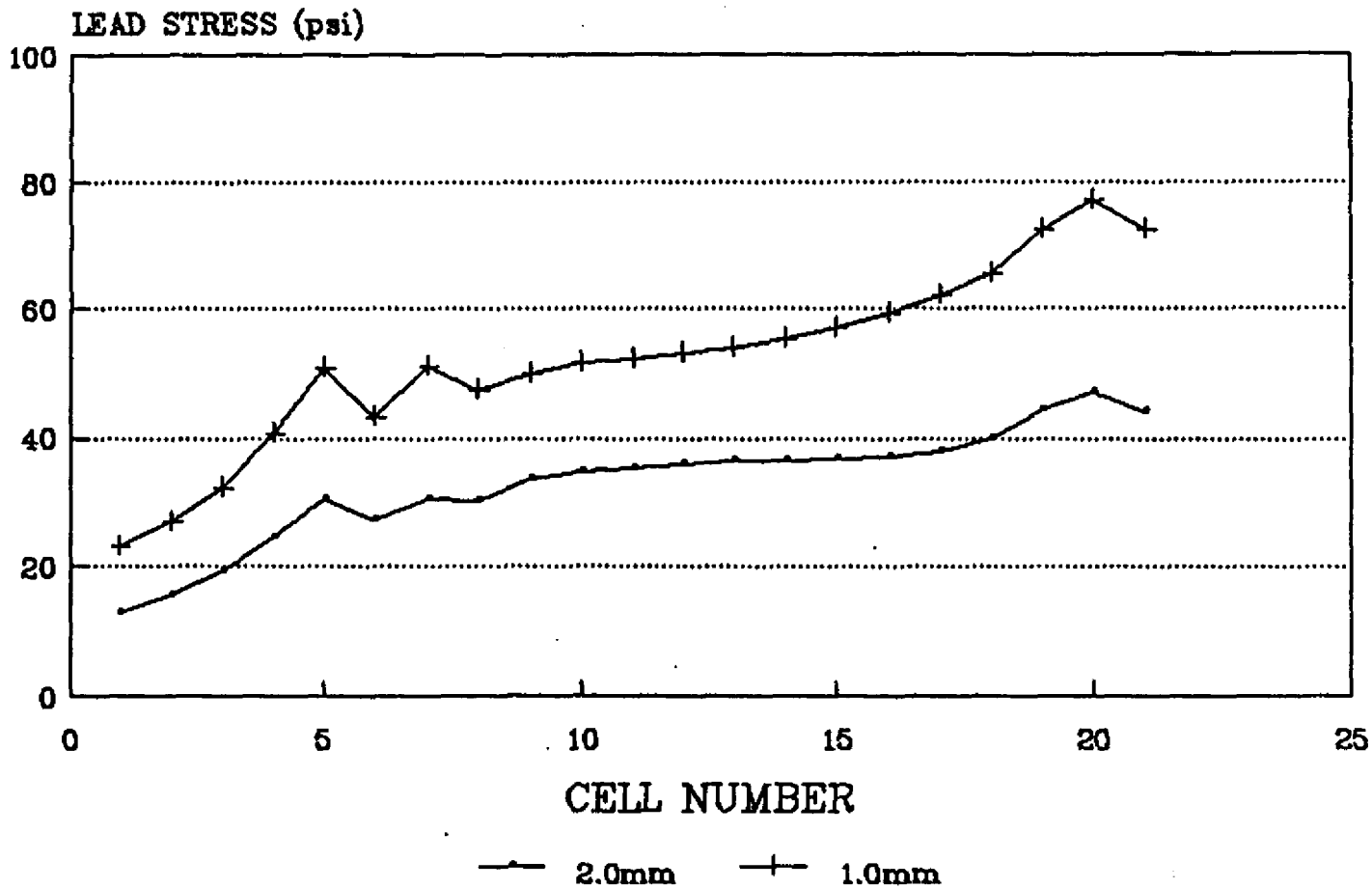


Figure 5-5

6. WESTINGHOUSE SCIENCE AND TECHNOLOGY CENTER (WSTC)

The effort over the past month has been in the areas associated with costing and scheduling of the barrel calorimeter, end cap calorimeter and central straw tube tracker.

The Work Breakdown Structure (WBS) for the three main areas has been revised with comment from all participating organizations. Dictionaries for these items are complete and will be transmitted to the SDC the first week of July. The straw tube tracker dictionary is not at the same level as the calorimeter and will be revised in July.

Initial cost roll-ups on the lead scintillator calorimeter and straw tube tracker were provided for the collaboration meeting of June 20-22. Those were the first roll-up numbers resulting in minor changes/corrections. Detail breakdown of these costs based on resource loading and materials will also be provided the first week of July. Information is being provided both in hard copy and computer disc for insertion into the overall detector costing.

Schedule information is in very good shape on the calorimeter with the straw tube tracker in acceptable condition. Schedule information on tasks and activities as well as critical path for the subsystem is available.

7. UNIVERSITY OF MICHIGAN

Summary

Efforts have continued on triggering with superlayers of straw tubes making use of Application Specific Integrated Circuits (ASICs) to implement a stiff track sensor composed of several circuits designated "synchronizers". The digital implementation has been selected and a first prototype synchronizer has been designed and is in fabrication. Delivery is anticipated in Mid-July. Our efforts are on three fronts: the chip fabrication mentioned above, on a software simulation of the performance of the circuit and of other possible arrangements of the same basic circuit elements, and on the assembly of a cosmic ray test stand to exercise the chips with real tubes. Progress is being made on all three.

Chip Development

The circuit that is in fabrication is a single stage synchronizer based on 2ns delay elements. It has a 15 delay elements in the momentum selection portion of the circuit and 30 delay elements in the total drift time section. This gives it a range of up to 30ns in the timing difference of radial wires and up to 60ns of maximum drift time. Values less than these extremes are programmable within the chip. The locking of the delay element timing to an external clock is provided as well as numerous diagnostic points. We expect to be able to learn enough about the delay cell to parameterize it well. With this parameterization we will be able the characterize the unit for use in other trigger algorithms. We will test the chip on our Tektronix LV511 IC tester initially and then with straw tubes in the cosmic-ray test stand described below.

Trigger Algorithm Simulation

We have continued to work on trigger simulation in the framework of GEANT and are presently inserting the Michigan trigger simulation into the GEANT code developed by Indiana for straw tube tracking. This new version contains the silicon system definition (as far as material present in the particle path) as well as an updated version of the straw tube tracker.

With this version we will be better able to assess the effect of material on the trigger. The elaborated version runs quite slow, however, and is a problem as a consequence of its slowness. To bypass this painfully slow code for trigger algorithm optimization, we have developed a faster simulation. To insure that this faster simulation is realistic, we have optimized the parameters of the fast simulation for the one case where we have initial full GEANT results. With this tuning in hand we have turned our attention to other trigger patterns. In particular, we have considered a pattern based on 8 tubes in a single trigger layer. This is in contrast to the 9 tube layer considered in the original design. A trigger based on 8 tubes has been devised that maintains the efficiency of the 9 tube system with a sharper turn-on threshold and very similar false triggering rate. We are very encouraged about this option.

Cosmic-ray Test Stand

The cosmic-ray test stand is mechanically complete with scintillator trigger counters, straw tube layer, amplifier-discriminators, and cabling. We plan to connect this stand to A LeCroy 1879 Fastbus TDC in the near future and begin testing the straw tube pattern. Our plan for testing trigger chips is to use the auxiliary card connection of the LeCroy TDC for pickoff of the straw outputs, form the trigger with one of several options, and reconnect the trigger results back into unused channels of the 1879. We will first exercise the chips that arrive in July. Later versions will also be tested. The auxiliary cards that we plan to use are already in hand.

Muon Trigger

Development of the muon trigger has a hardware and software component. A simple trigger systems based on fast signals from layers of scintillators and protective wires is being studied in simulations. The first of these simulations indicated that the choice was effective. This simulation continues to be elaborated with more precise multiple scattering emulation and with the addition of parameterized punchthrough.

Circuits to accomplish the muon trigger are being designed on the CAD system at Michigan using the same delay elements and registers used in the straw tube development but with 4ns delay stages rather than the 2ns used for the straws. If the trigger algorithm for muons continues to look promising, trigger chips that implement the design will be fabricated. We anticipate that such a chip submission is likely in September 1991.

8. LOS ALAMOS NATIONAL LABORATORY (LANL)

Cost and Schedule Activities

The task activities associated with the silicon tracing system R&D, design, construction, assembly and test have been developed into an integrated program plan (>400 activities). Task resources have also been estimated in a similar detailed manner. LANL's program effort was integrated with LBL program activities, which define tasks associated with electronics and detector procurements, and related data acquisition elements. For the present, the program costs are summed using a spread sheet format. We hope by the next report period to have the resource files integrated with the WBS using OPLAN software. In accordance with LANL's proposed statement of work, an overall program plan has been completed and submitted by the July 1, 1991 deadline. LANL's future activities related to this commitment will be to further refine and update the documentation throughout the detector cost and schedule effort.

Silicon Tracking System Configuration Studies

System integration tasks will be reported in two broad categories: system design issues internal to the silicon tracking system and external interface issues. Internal detector specific design questions that are under investigation are:

- forward region silicon planar array structural interfaces
- alignment, and
- power cabling concepts

Forward Region Studies

Finite element structural solutions for a typical flat planar array were performed. Structural loads associated with gravity and thermal effects were evaluated. The loading conditions tested the ability of a compliant silicon support concept to achieve strain free conditions. The displacement results for the stipulated load conditions were in the out of plan dimension in the submicron range. A structural support arrangement has been conceived that supports the wedged shaped detector array, provides for circumferential overlap of individual detectors, and incorporates means for containing the embedded heat pipe cooling system. Two layers of silicon are supported by each individual structure. LANL's system studies focused on the structural aspects of the support frame behavior to insure a viable design solution existed that was compatible with the general silicon tracking system design arrangement. Future analysis will center on the deflection behavior of the individual wedged shaped detectors, as well as the structural dynamic response of the flat planar array.

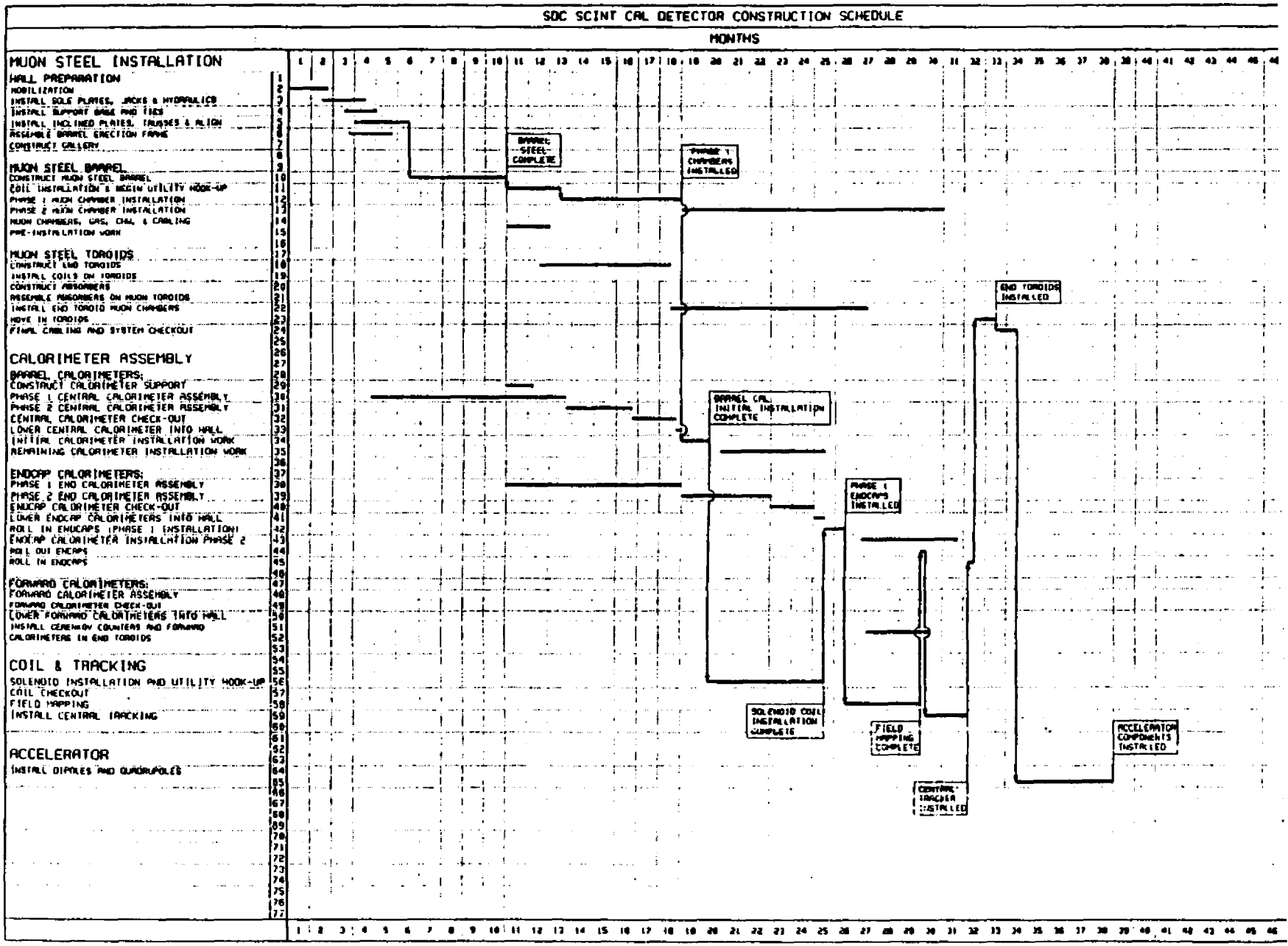

SDC SCINT CAL DETECTOR CONSTRUCTION SCHEDULE
MONTHS
MUON STEEL INSTALLATION
HALL PREPARATION
MOBILIZATION
INSTALL SOLE PLATES, JACKS & HYDRAULICS
INSTALL SUPPORT BASE AND TIES
INSTALL INCLINED PLATES, TRUSSES & RAIL
ASSEMBLE BARREL ERECTION FRAME
CONSTRUCT GALLERY
MUON STEEL BARREL
CONSTRUCT MUON STEEL BARREL
COIL INSTALLATION & BEGIN UTILITY HOOK-UP
PHASE 1 MUON CHAMBER INSTALLATION
PHASE 2 MUON CHAMBER INSTALLATION
MUON CHAMBERS, GAS, CHW, & CABLING
PRE-INSTALLATION WORK
MUON STEEL TOROIDS
CONSTRUCT END TOROIDS
INSTALL COILS ON TOROIDS
CONSTRUCT ABSORBERS
ASSEMBLE ABSORBERS ON MUON TOROIDS
INSTALL END TOROID MUON CHAMBERS
MOVE IN TOROIDS
FINAL CABLING AND SYSTEM CHECKOUT
CALORIMETER ASSEMBLY
BARREL CALORIMETERS:
CONSTRUCT CALORIMETER SUPPORT
PHASE 1 CENTRAL CALORIMETER ASSEMBLY
PHASE 2 CENTRAL CALORIMETER ASSEMBLY
CENTRAL CALORIMETER CHECK-OUT
LOWER CENTRAL CALORIMETER INTO HALL
INITIAL CALORIMETER INSTALLATION WORK
REMAINING CALORIMETER INSTALLATION WORK
ENDCAP CALORIMETERS:
PHASE 1 END CALORIMETER ASSEMBLY
PHASE 2 END CALORIMETER ASSEMBLY
ENDCAP CALORIMETER CHECK-OUT
LOWER ENDCAP CALORIMETERS INTO HALL
ROLL IN ENDCAPS (PHASE 1 INSTALLATION)
ENDCAP CALORIMETER INSTALLATION PHASE 2
ROLL OUT ENCAPS
ROLL IN ENDCAPS
FORWARD CALORIMETERS:
FORWARD CALORIMETER ASSEMBLY
FORWARD CALORIMETER CHECK-OUT
LOWER FORWARD CALORIMETERS INTO HALL
INSTALL CERENKOV COUNTERS AND FORWARD
CALORIMETERS IN END TOROIDS
COIL & TRACKING
SOLENOID INSTALLATION AND UTILITY HOOK-UP
COIL CHECKOUT
FIELD MAPPING
INSTALL CENTRAL TRACKING
ACCELERATOR
INSTALL DIPOLES AND QUADRUPOLES
BARREL STEEL COMPLETE
PHASE 1 CHAMBERS INSTALLED
END TOROIDS INSTALLED
BARREL CAL INITIAL INSTALLATION COMPLETE
PHASE 1 ENDCAPS INSTALLED
SOLENOID COIL INSTALLATION COMPLETE
FIELD MAPPING COMPLETE
CENTRAL TRACKER INSTALLED
ACCELERATOR COMPONENTS INSTALLED

Figure 9-1

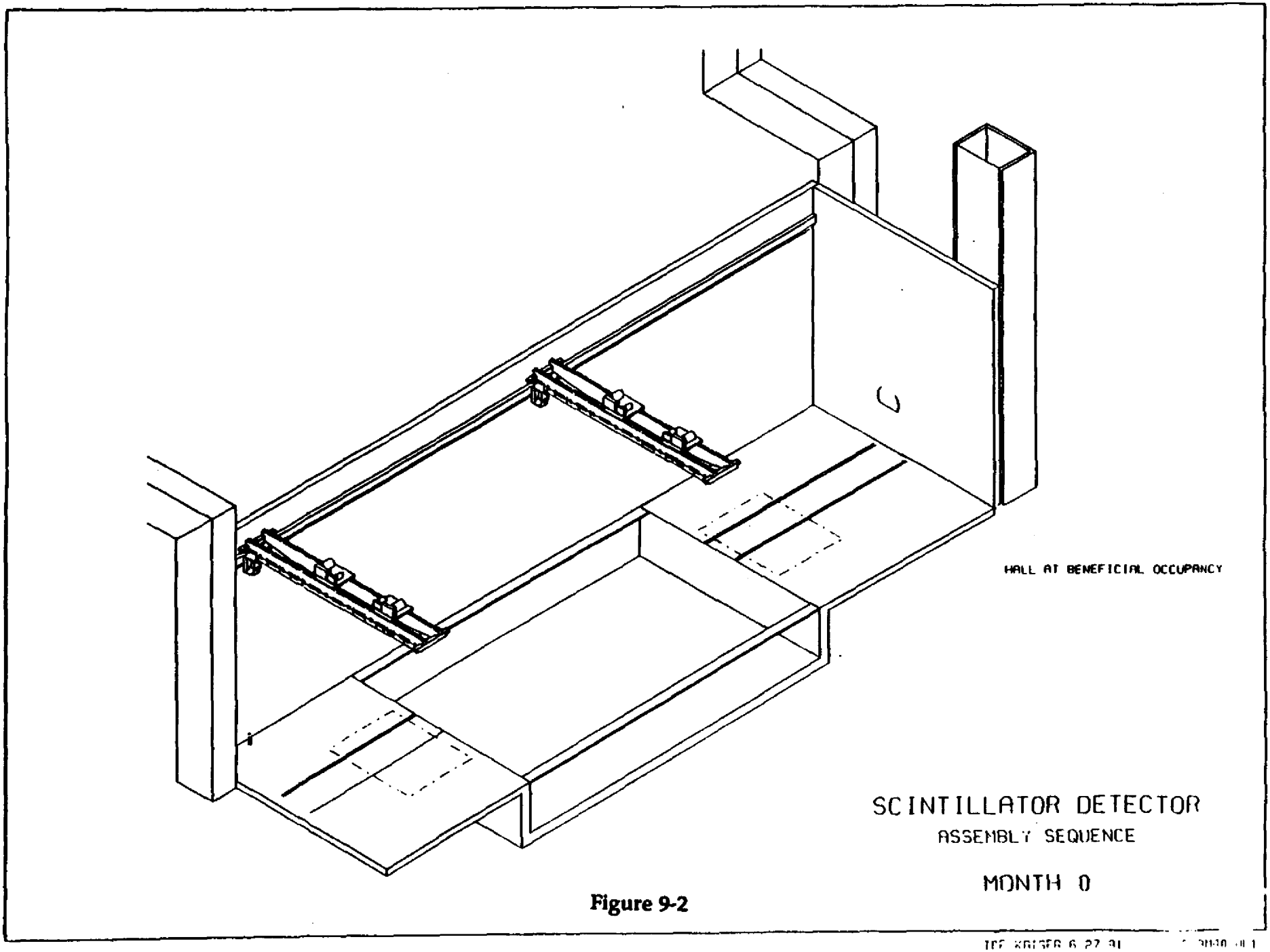
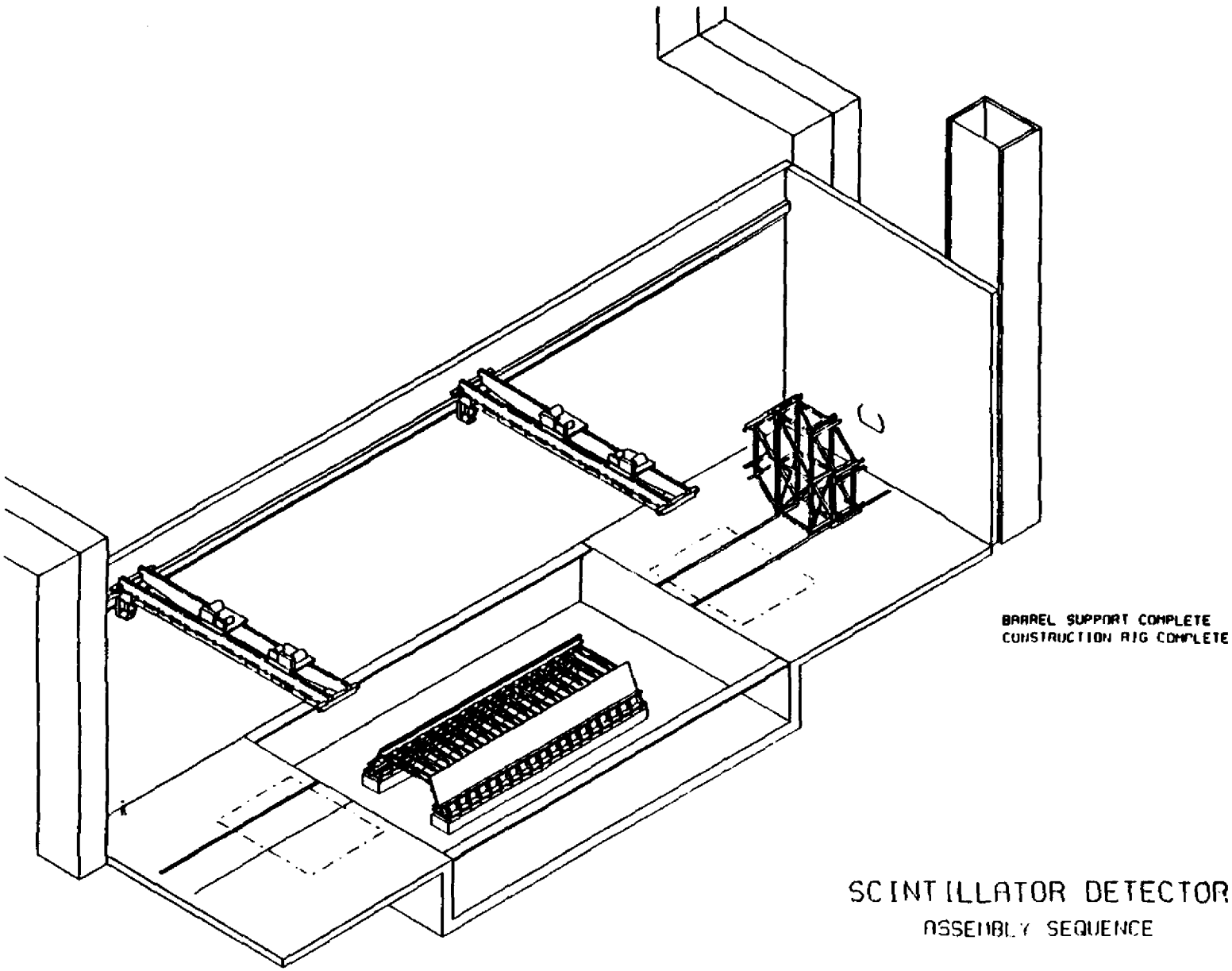

HALL AT BENEFICIAL OCCUPANCY
SCINTILLATOR DETECTOR
ASSEMBLY SEQUENCE
MONTH 0

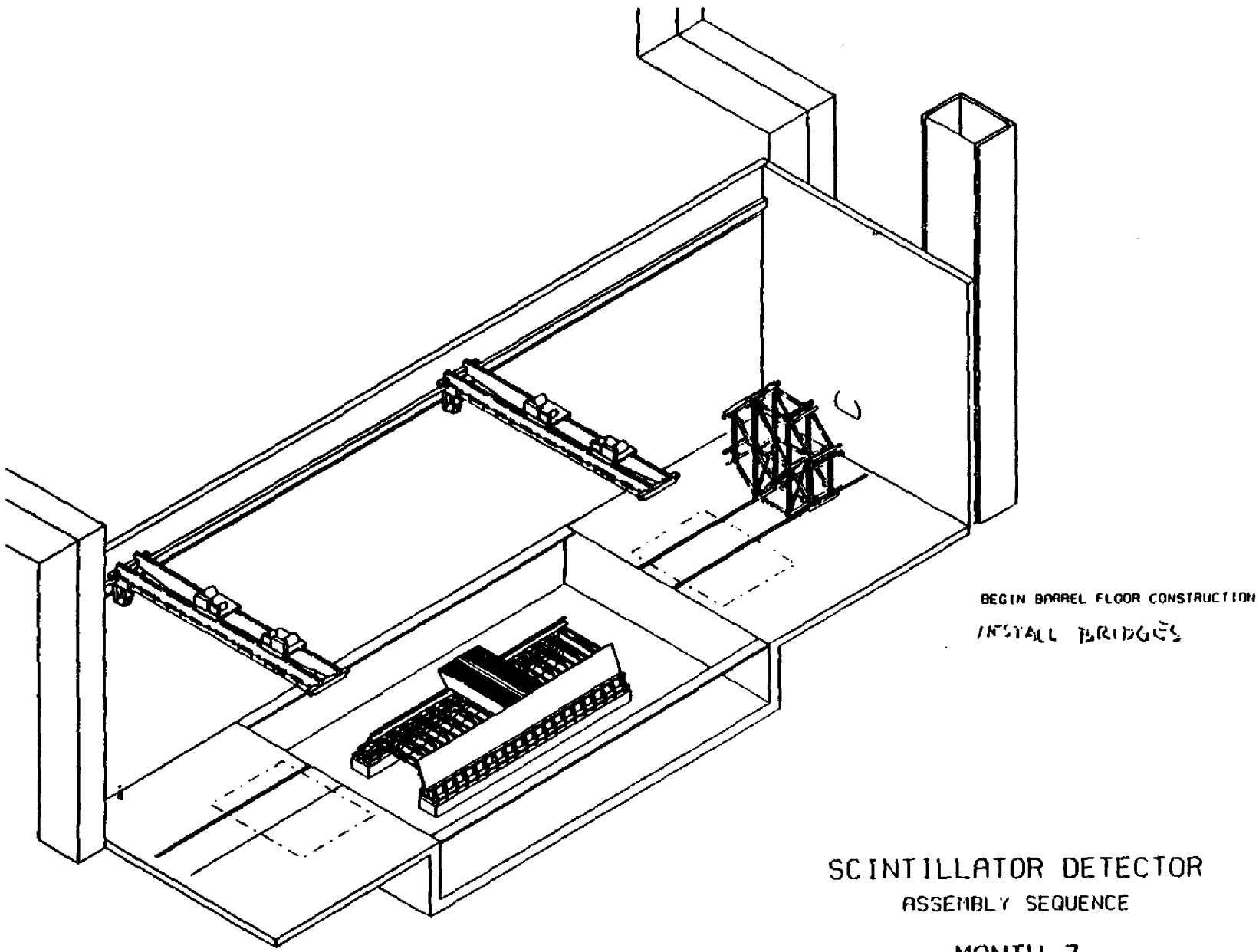
Figure 9-2



SCINTILLATOR DETECTOR
ASSEMBLY SEQUENCE

MONTH 6

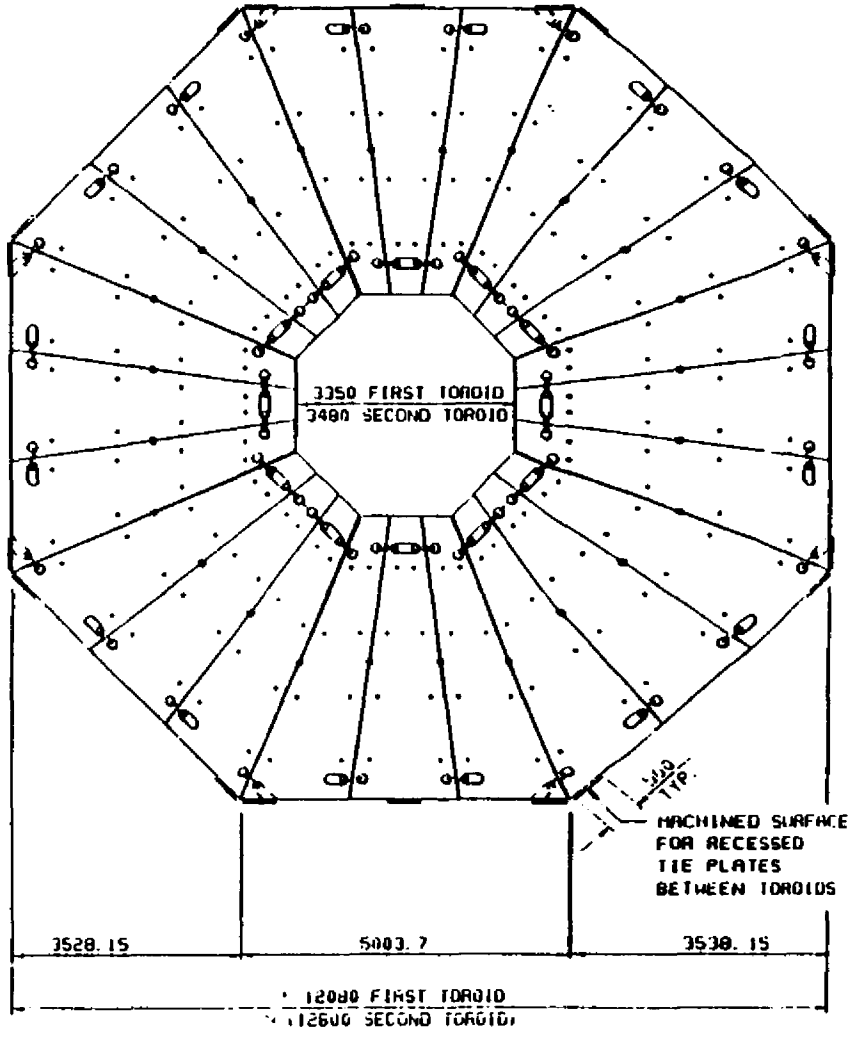
Figure 9-3

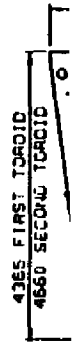


SCINTILLATOR DETECTOR
ASSEMBLY SEQUENCE

MONTH 7

Figure 9-4





BLOCK A

BARREL NUT IN HO

DETAIL

SDC DETECTOR

[illegible] STEEL END TOROID CONSTRUCTION

Figure 9-9

10. LAWRENCE BERKELEY LABORATORY (LBL)

Mechanical Integration

A preliminary layout of mechanical utilities (WBS section 7.1) was created to serve the 5/31/91 baseline detector in a 31 x 105 meter experimental hall. During the WBS and Costing meeting at LBL, an estimate of the cost and effort for this task was completed.

The mechanical utilities layout and cost estimate was presented to the SDC collaboration meeting at SSCL as well as a layout of the 5/31/91 baseline detector-to-hall interface, and details of the internal access and services. In concert with others, we developed additional details regarding these layouts and services including providing space in the utilities shafts for a general purpose vent line from the hall to the surface. This line will service all nonflammable vents.

The group participated in a LAC cryogenic system design meeting at SLAC during which the impact of the new hall dimensions and access requirements were considered. A third, and last, cryogenic safety meeting has been scheduled for July 8 at SSCL.

2D layout drawings of the interior of the 5/31/91 baseline detector were prepared showing the installation of 258 electronic crates and VLPC cryostats mounted, in 10 rings, around the central calorimeter. During the progress of these studies a revised concept of cable routing was developed which envisions sending part of the cables out via a cable tray in octant 7 rather than octant 6 and routing some services out beside the cryostack in octant 1. The rerouting of the cables was made possible by the decision of the electronics integration group that thousands of RG58 H.V. cables from the gallery to the calorimeter-mounted photomultiplier tubes could be deleted. Even with these changes, access to the internal electronics appears to be inadequate. Technical note LBL SDC 0026 was revised to reflect the reduced cross sectional area requirements. Technical note LBL SDC 0032 was generated to tabulate the lengths of trigger cables originating at extreme locations on the tracker and muon chambers.

A descoped detector (Option 1, 6/29/91) has been evaluated in a new layout drawing. Additional space for access to the interior of the detector would be provided by reducing the calorimeter support shell thickness by 20 cm. The thickness of the BW1 muon chamber was reduced from 100 to 50 cm, BW3 thickness was reduced from 100 to 80 cm and muon chamber FW1 was moved approximately 50 cm closer to the calorimeter. All of the muon steel toroids have been reduced in thickness by one-half meter. These changes allowed the detector to be reduced in "radius" by 1.2 meters and in length by 3 meters. Scintillating fibers have been deleted from the central tracker and this will reduce the internal congestion by eliminating the need for 64 of the VLPC cryostats and electronics crates. A revised electronics crate layout is being prepared for this option. Technical note LBL SDC 0033 provides a plot of the steel intercept length vs. divergence angle for this option.

The recreated 3D CAD baseline model with global dimensioning is working well and multilevel assemblies can be processed more efficiently. Simplified electronics crates, cable trays and walkways have been added to the baseline model. A new file has been created for the Descoped Detector, version 1, 6/29/91. Support was provided to LANL and other sites in obtaining access to the Telnet 2D CAD file for LBL Drwg. 23D0135, "May 31, 1991 baseline quarter section of the detector". We believe the other sites have successfully accessed this file and will now have ready access to LBL files in this format. A translator to make such drawing available in Postcript format is being developed. We are also working on a process whereby annotations (text, headers, etc.) can be added to a shaded 3D color image.

The SDC Integration Database was accessed via Telnet (at SSCL) and information was entered about LBL drawing files which will allow users to search for, and retrieve, LBL drawings. The entered data was subsequently retrieved, to confirm its availability. A memo suggesting software modifications, to improve security and facilitate use of the database, is being prepared.

Electrical Systems Integration (ESIG)

This month primarily was spent helping individual subsystem groups prepare for the cost and schedule meeting held 17-19 June,1991. Coordinating with subsystems representatives ESIG facilitated the development of a Work Breakdown Structure (WBS) that appropriately reflects the technological partitioning of the electronics used by the subsystems. An example of this is the inclusion of Shower Max detector electronics in the Calorimeter electronics WBS. It was felt that the two systems were closely aligned in applied technologies and could be combined in one WBS.

With input from subsystem coordinators, a self-consistent WBS was prepared and a cost estimate derived from information developed in the straw tracker electronics. Cost Coordinators were assisted in the following:

- preparing a self-consistent work breakdown structure for fiber tracker and straw tube structure complete with costing and contingency analysis.
- deriving cost and schedule information from MacProject source files.
- Translating cost information into appropriate form for integration into the project cost database.

Costs were developed for Cerenkov counters, Forward Calorimeter and Shower Max detector electronics from Calorimeter electronics estimates. The ESIG participated in the cost/schedule meetings held at SSCL 17-19 June and the subsequent collaboration meetings dealing with electronics systems cost scaling laws and scope reduction meetings. While in Dallas, ESIG coordinated a first-cut electronics installation scenario. The impact of this scenario on surface buildings was relayed to the PRD facilities representative. In order to maintain the detector schedule of 11/99 operation, early occupancy of the surface facilities i.e.,. counting room and control room is necessary. Actual schedule details are still being quantified.

In addition to the above, ESIG maintained and documented the system changes and choices being made by the technical systems coordinators, relating the new information to the mechanical integration group for inclusion in the latest detector configuration.

ESIG worked with the facilities planning people to further define the requirements for various utilities servicing the electronics systems, both in the detector and elsewhere in the hall and surface facilities.

Cost and Schedule

From June 5-7th, a cost meeting was held at LBL. This meeting was attended by C/S coordinators from FNAL, Westinghouse, ORNL, Univ. of Wisconsin, PSL, Brandise Univ., LANL, SSCL, Martin Marietta, LBL, and other institutions representing nearly all SDC subsystems. During the meeting, milestones and costing procedures were reviewed, status reports were given by each subsystem coordinator, and a detector installation schedule was discussed. The meeting ended with significant progress in many areas. On June 17th, another three day costing meeting was held at SSCL. The product of this meeting was a preliminary roll-up of the complete SDC detector cost (SSC WBS 5.2.1). During this meeting, "final" preliminary cost information was completed and gathered so that the SDC "Baseline" detector cost could be gathered and presented to the Collaboration.

Since the collaboration meeting, we have been analyzing the cost data, debugging it, filling in some of the holes, and trying to complete an automated roll-up. We are progressing, and should have a cost roll-up on the "baseline" SDC Detector, a preliminary construction schedule, and all C/S machinery in well oiled form by the end of July.

On July 1 and 2 we will meet with SSCL Physics Division staff to discuss the installation schedule and coordination of future cost and schedule activities as responsibilities are shifted from LBL to SSCL.

Liquid Argon Calorimetry (LAC)

The LAC group met at SSCL to discuss LAC cryogenics decisions and the status of the Calorimetry Report. The Cryogenic Safety meeting was cancelled--to be re-scheduled for early July.

Regarding the return Iron thickness, the Design of this structure, it's support to the Muon steel and their cost estimates are being studied at SSCL.

The Martin Marietta Astronautics (MMA) subcontract, Tasks 1 & 2 -- Cryostat & Module Cost Estimates will be provided to SDC management as follows:

Deliverable	Completion Date
a) WBS	June 17, 1991
b) First Cost & Schedule	July 1, 1991

c) Schedule & Resources July 31

d) Final Report Aug. 15, 1991

Details of the calorimeter module design concept for cast Pb Barrel modules (LBL SD # 0030) have progressed slightly, and MMA has been asked to compare the cost of this approach (with appropriate contingencies in their Task 2 work above) with conventional plate/bushing module construction.

Silicon Tracking

Several C/S related tasks were accomplished this month in addition to attending the two costing meetings. Specific logic tie points were selected from the LANL master construction schedule and inserted into each of the subproject's schedule. New subproject schedules based upon these tie point dates were made and used to separate the design and manufacturing phases. The resource and material costs were transferred to the SDC spreadsheet format and incorporated into the master cost roll-up.

The radiation length code has been modified to provide more input flexibility and increased ease of output data checking and manipulation. Several schemes have been considered to reduce the effort to prepare drawings for input into this code. So far, no easy solution has been found. Algorithms to increase the calculation speed may not exist due to the requirement to work in ME10. More detailed drawings of the three detector configurations (6, 12, and 18 cm detectors) have been completed and are ready to be used for the next round of calculations. The process for making the code usable by other laboratories has been initiated. Contact has been made with LANL and plans are being made to test the code on a PC prior to transferring it to them.

A preliminary finite element analysis of the intermediate length strip design (6 to 8 cm) predicted deflections within tolerance limits. The model used 8-cm length detectors with no added stiffeners. Two of these are glued end to end and then attached to support/cooling rings spaced 16 cm apart. Also completed was an ANSYS deflection analysis of the pixel L-design carrier described below. The predicted 54 micron radial deflection is well within acceptable limits.

A meeting was held with Bill Fujitsubo of Engineering Solutions to discuss final FY91 plans and FY92 activities. During the discussion, a module/cable configuration was conceived that appears to have many desirable features. As shown by Figure S1, it has a hybrid flex cable that uses a beryllium plate as both an electrical shield and as a stiffening plate. The hybrid cable would have 5 128-channel readout chips attached to it, possibly using flip chip technology. The top and bottom transition cables can go to one connector.

A method of maintaining the features of de-mountable test connections with final robust low mass connections was discussed. One plan is to use mechanical clips during initial and assembly testing. This allows rapid module replacement by simply removing the clip and yet does not require the bus connections to have their own stiff plates. After module assembly onto support/cooling rings, heaters in the clip can be activated and the bump connections soldered. This provides a final robust

connection. The same mechanical clip can be used to de-solder the joint if necessary. The final conceived module assembly is shown by Figure S2.

A sketch of a possible pixel readout/detector assembly is shown on Figure S3. Due to some of the features of the layout and the requirement for 100% coverage, the wingback design had to be abandoned. An L shaped design, shown by Figure S4, is now the baseline choice. This design increases the material inventory over that of the wingback concept, but the increase is small. No specific cable design has been determined, but the technology being developed for other parts of the tracker should be usable in the pixel assembly also.

Silicon pieces without metal lines have been received. These will be used to develop procedures for attaching detectors to the composite carriers. In addition, several detectors have been received. These will be carried to a vendor for determining if one of their X-Y measuring machines would be useful for tracker assembly work.

Computing Systems

The current focus is in the development of a design for SDC data analysis based on database technology. The perceived benefits would be, among other thins, much reduced I/O traffic, easier and faster access to the data, and use of industrial quality software. However such an approach has not used in HEP before, there are several competing database technologies available and the scale of SDC data is well beyond anything attempted in databases to date. To evaluate the potential for database ideas, several prototypes of increasing size using CDF data will be built. Activities this month have been oriented primarily toward building the first of these prototypes.

ObjectStore from ObjectDesign, Inc. was evaluated regarding its suitability for building a prototype object-oriented database for SDC data analysis. The result of the evaluation was favorable, so an order for ObjectStore was initiated. An extremely simple ObjectStore test database was built using data from CDF muon data and the ObjectStore system at the University of Illinois at Chicago. Design of a more complex database using CDF dilepton data selected for y's is underway.

Hardware requirements to support Object Store prototyping at LBL were evaluated. As a result of the evaluation an 8mm tape drive and a 1 Gigabyte hard disk were purchased and installed on the SPARCstation at LBL.

Since SDC code will need to be highly portable and interoperable, compliance with recognized standards is a must. To this end, template files were developed for headers and source modules emphasizing, and ensuring where possible, compliance with IEEE 1003.1 (POSIX.1) and ANSI C (Standard C). These templates also break out other industry standards, such as X11 and Motif, vendor products, such as ObjectStore, enterprise standards which may be developed by SDC and any application interfaces required. Similar templates for C++, used for many ObjectStore programs, will be developed as well.

In pursuance of establishing a standards-based development system, build procedures were converted to utilize the POSIX compliant interfaces available in SunOS. Also obtained and installed Sun C1.1 the (almost) ANSI C compliant compiler. (There are

a few discrepancies between the semantics specified in the ANSI standard and the behavior of the Sun library routines. These are supposed to be fixed upon the release of Sun's System V Release 4 compliant operating system. Until then, discrepancies will be flagged in the code as they are discovered with the intent to move to complete compliance as soon as possible).

A presentation and workshop with Sybase, Inc. in Chicago was attended to evaluate the use of Sybase for building a relational database prototype for SDC data. The relational prototype will use the same data as the object-oriented prototype to allow comparisons of the two database technologies. The relational database development will be done primarily at ANL.

We attended a workshop in Houston with the IBM Federal Systems Division people (Tony Elam, et.al.) to help in the abstract modeling of the data to be used in the two database prototypes. There was also a non-disclosure meeting in Dallas with DEC people. Future hardware and software directions were discussed.

A three day course was attended in San Jose on OSF/1 internals. OSF/1 is the operating system offering from the Open Software Foundation. It holds out the promise of being broadly based on industry standards and homogeneously available on a heterogeneous array of hardware. If successful in the market place, such a system could drastically ease the task of meeting SDC's portability and interoperability requirements.

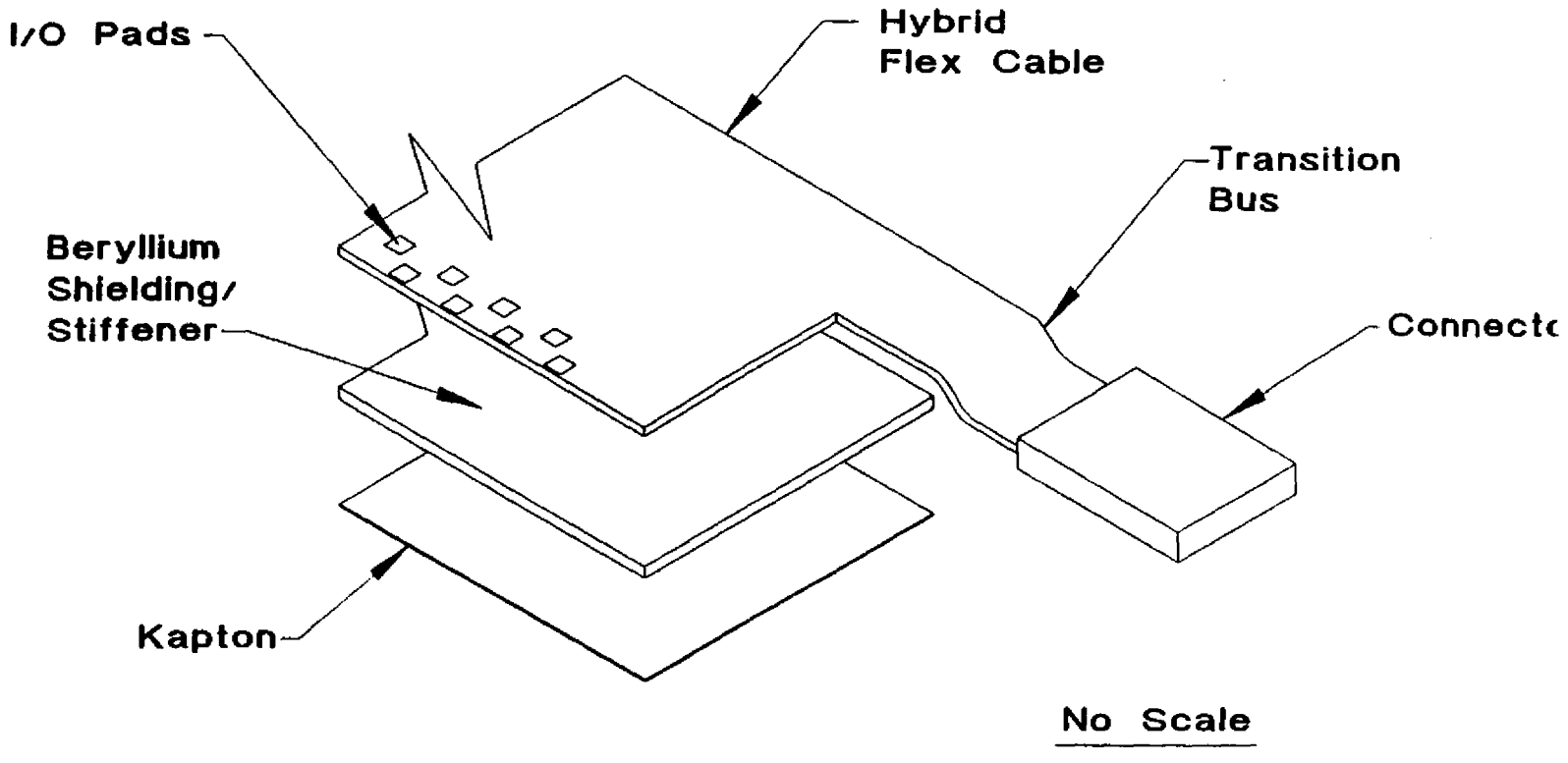


Figure S1. Hybrid Electronic/Bus Assembly (HEB)

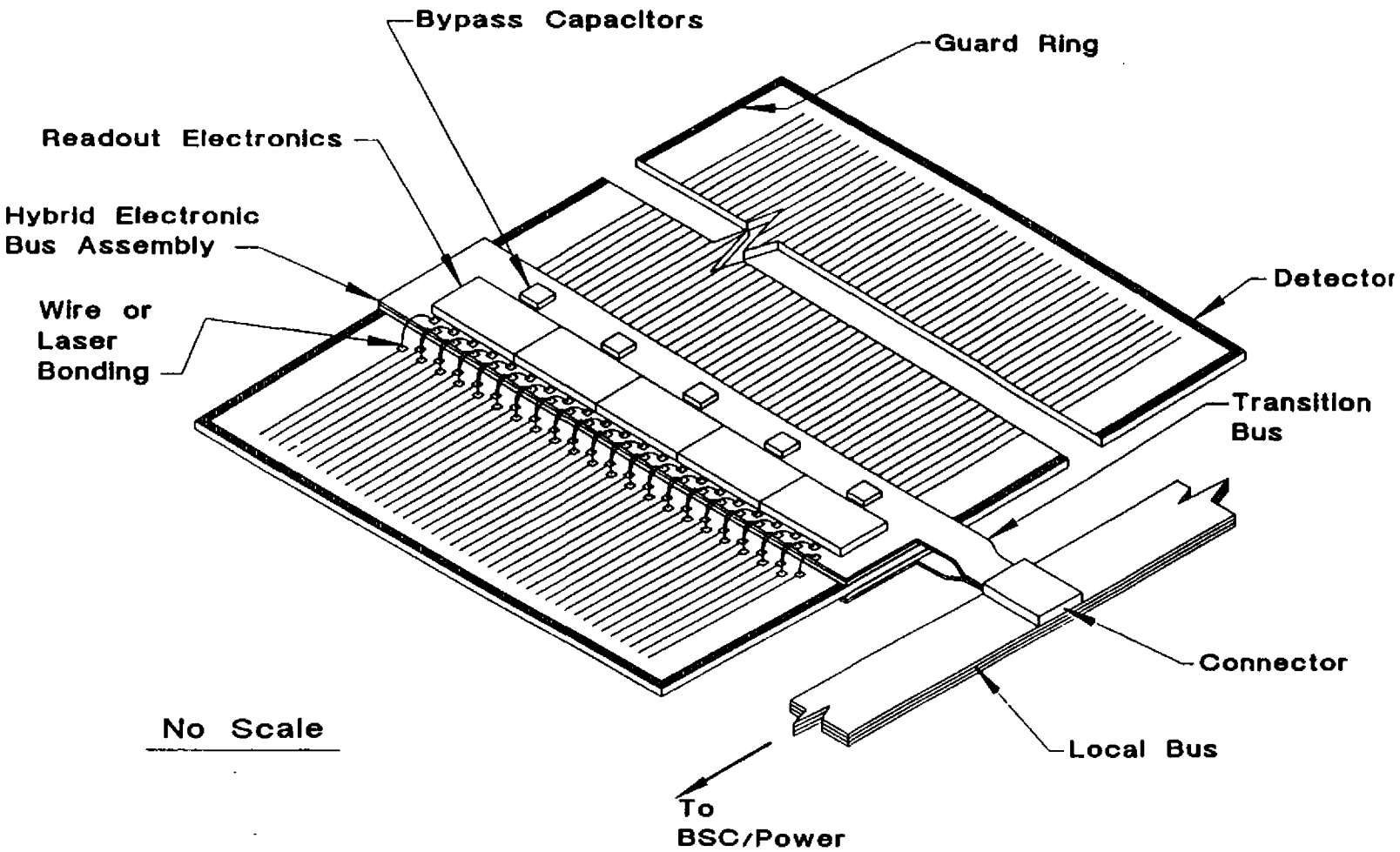


Figure S2. Silicon tracker detector/readout module assembly.

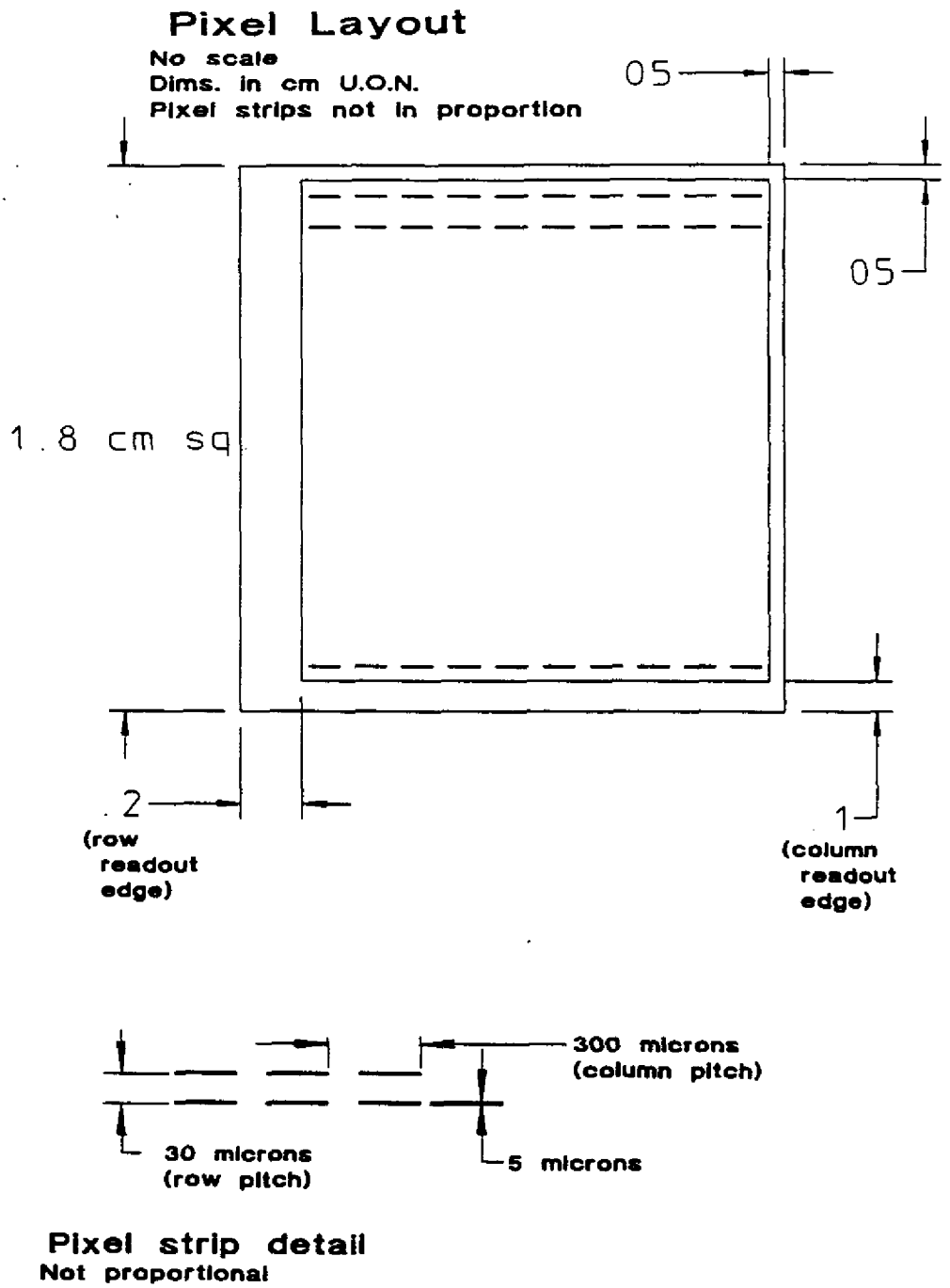


Figure S3. Pixel layout. I/O pads in row readout area.

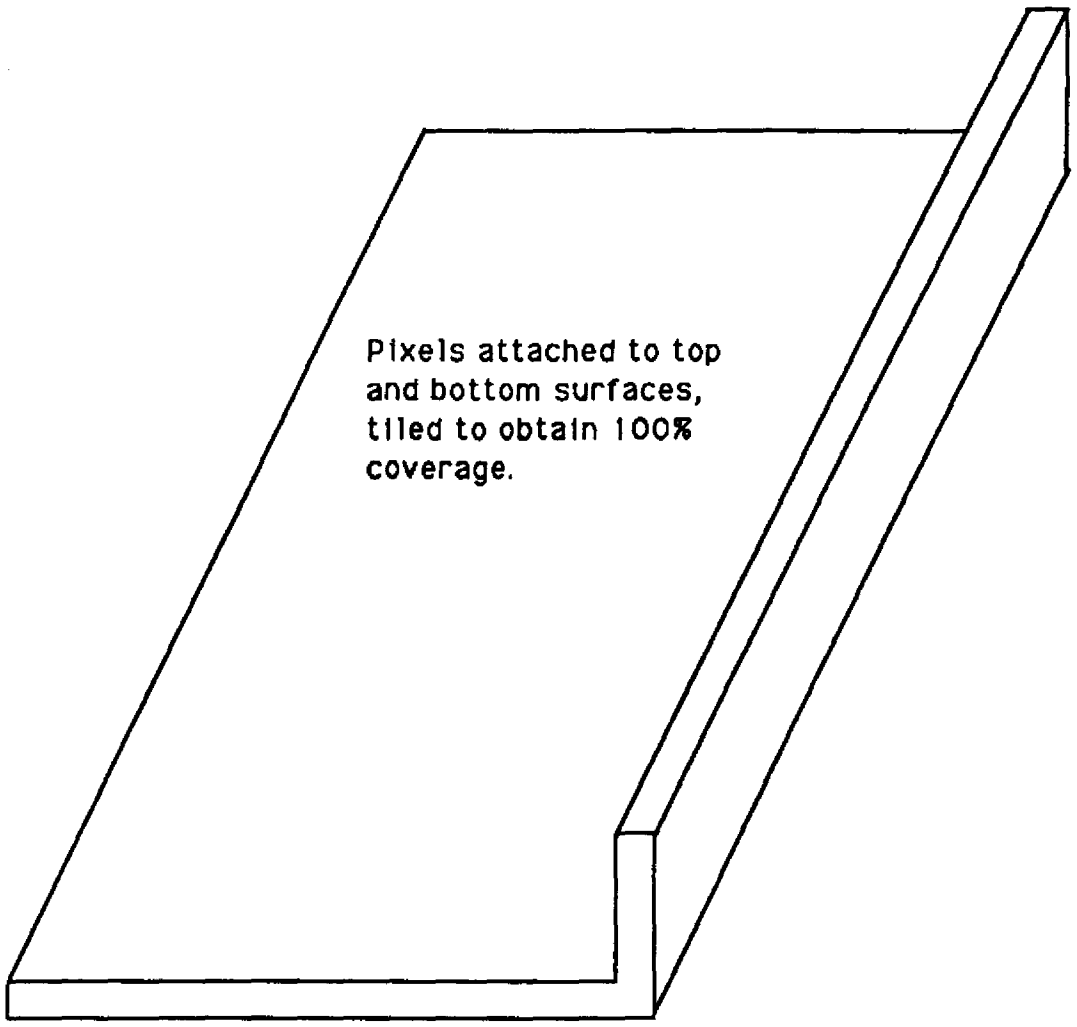


Figure S4. Pixel L carrier design.

B. PROGRAM COSTS

The budgets indicated below are for post-LoI funds allocated April 1991 and (hopefully) July 1991. Due to this change in funding definition and the new reporting format below, cost information is not available from all institutions this month.

Institution	Budget (Allocated & Projected)	June Cost (Actual or Estimated)	Prior Months (actual cost)	Total Cost
1. ORNL	210	—	—	—
2. PSL - Muon	80			
3. PSL-Trigger	75			
4. FNAL				
A. SC Solenoid	390		103.0	
B. Calorimetry	190		67.4	
C. Data Acq. Sys.	50		—	
D. Muon	70		—	
E. Fiber Tracker Read-out	100		—	
5. ANL	230	19.7	59.2	78.9
6. WSTC	110	55.0	45.0	100
7. U. MICHIGAN	85			
8. LANL	150	35.0	—	35.0
9. KE	210	16.0	41.3	57.3
10. LBL				
A. Integration & Mgmt.	630	115.2	377.6	492.8
b. Liq. A Calorimetry	201	34.7	139.1	173.8
C. Silicon Tracker	67	1.0	—	1.0
D. Computing Systems	107	18.2	47.1	65.3
E. Calorimetry Electronics	22	—	10.4	10.4
F. Contract Costs	128	—	128.0	128.0
11. IBM	35	—	—	—
12. U. CHICAGO	50	—	—	—
13. HARVARD	50	—	—	—
14. U. PENNSYLVANIA	75	—	—	—
15. SANDIA	50	—	—	—