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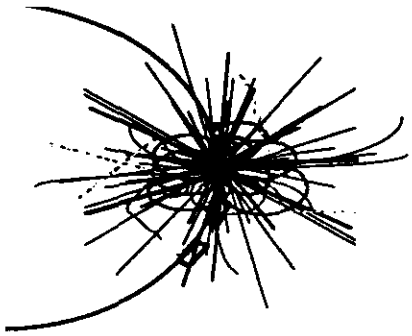

THE MONTHLY REPORT OF THE SOLENOIDAL DETECTOR COLLABORATION

FEBRUARY AND MARCH

1992

FEBRUARY AND MARCH 1992

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A. TECHNICAL PROGRESS

1. Oak Ridge National Laboratory (ORNL)

FEBRUARY

Summary

The majority of the work done at the Oak Ridge in February in support of the SDC program dealt with the completion of the Technical Design Report (TDR). Gary Alley, Mike Emery, Rob Leitch and David Vandergriff supported both the fiber tracking group and the modular straw tracking group in the preparation of this document. ORNL also provided input to the SDC management on funding for FY92 during this time frame.

Barrel Tracking

Support for the barrel tracking group focuses in three areas; the fiber tracker, the straw tracker, and tracking integration. Each of these is discussed below.

Tracking Integration

Integration of the barrel tracker into the overall SDC detector is being coordinated by the SSCL. ORNL is providing input to the integration group in the area of support facilities, assembly, services, and safety. The main focus during February was on safety.

ORNL is responsible for developing the safety requirements document input for the fiber tracker, the straw tracker and the microstrip tracker. Rob Leitch has prepared a preliminary safety document which lists the safety concerns and requirements for each of these areas. Several meetings have been attended to discuss and review the contents of the safety document.

Work on the support facilities, assembly requirements and service requirements will increase in the coming months as the detector enters the engineering phase. Preliminary requirements documents have been prepared by Oak Ridge for the service and interface requirements, and this will also be done for assembly and support facilities.

Fiber Tracking

Oak Ridge has worked very closely with the fiber tracking group (FTG) over the past several months to prepare a conceptual design report (CDR) and input to the TDR. During February, we assisted in the revision and compilation of the first revision. This revision was also used as the basis for the TDR input. Additional input supplied for the TDR includes cost and schedule data. These items were upgraded and revised in February.

ORNL also participated in a review of the conceptual design report for the VLPC at Rockwell International. The review demonstrated some areas of need for additional mechanical input as well as electrical. The Instrument and Controls (I&C) division of ORNL has prepared a proposal for supporting the FTG and Rockwell in the development of an amplifier/ shaper/ discriminator chip to work in conjunction with the VLPC's. This work task will continue to be defined in the coming weeks.

Straw Tracking Group

Support for the straw tracking group (STG) has involved input to the TDR in the form of utilities requirements. We are working to develop channels of information flow where the straw and fiber groups have similar requirements. This is progressing smoothly, and we hope to have additional task definition in the near future.

In the electrical arena, the I&C division continues to provide valuable input to the straw tracker. Recently, conceptual drawings were prepared and presented to the group that integrate the overall electronics package for the STG into a compact unit that will plug into the end of the straw module. This work continues to grow and is supported in the FY92 funding plan.

Future Directions

The coming months will be very active. In March, we will visit Hercules Aerospace in pursuit of producing several composite components that will be used to test the various tracking concepts. We will also participate in cost and schedule meetings that will provide final input to the SDC detector cost picture. Safety meetings will also be held to work toward a final draft on the safety requirements document. This area of study will grow as the actual design and fabrication of the detector nears.

During the late spring and summer, ORNL will be working to provide mechanical and electrical hardware to the straw and fiber tracking groups to assist them in their beam tests. These tests will ultimately be used to determine the overall makeup of the barrel tracker for the SDC.

2. University of Wisconsin
Physical Sciences Laboratory (PSL) - Muon System

FEBRUARY

Muon System

With the muon chamber decision behind us, some engineering issues received badly needed attention. Efforts at UW-PSL were concentrated on the issues of: intermediate/barrel interface, access space to inside SDC, access to barrel and intermediate muon system, cable routing for barrel and intermediate muon system, utility routing for barrel toroid, assembly sequence, and general integration issues. A plan was approved at the muon engineering meetings for further engineering studies.

It is assumed that IW3 will contain 4 theta and 4 phi layers. It should be noted that phi wires in the intermediate region have to be radial if a barrel style phi trigger is required. This necessitates 8 physical layers of tubes for phi to get at least one pair of projective wires. Therefore, total number of layers will be 14, which will make IW3 about 1.4 m thick. In the above plan access is provided through the gap between FW5 and IW3 owing to the increased Z location of FW5. This allows IW3/BW3 corner to be closed and avoids the overlap. As a result IW3 need not be as large and the increased thickness will be more than offset by the reduced size.

A conceptual design for the supertower alignment stand was also done and briefly discussed at the engineering meetings. The features of this concept are: minimal floor space requirements, flexibility for use with all types of barrel and intermediate supertowers, and ease of fabrication.

Preliminary Design (Iron and Coils)

The design of the Muon Barrel Toroid (MBT) has been refined in three ways this month. The press or shrink fit pin in the corner has been replaced with a tapered pin. Side plates have been adopted as the primary method of connection between the rings in Z. The shear step in the corners has been replaced by a three piece shear key. There is also a proposal to reduce the thickness of the plates that make up the blocks to nominally 75 mm. This change has not been accepted yet, but preliminary analysis of plate flattening indicates that thinner plates are a good idea. The full 3D model of the MBT and it's support has been completed as a joint project between the SSC and FNAL. The load cases run to date indicate that the expected loads on the corner bolts have a good safety margin. The deflections of the structure are less than 3 mm under self weight of the forward toroid (FT) loads with a slightly idealized floor model.

Preparations for the TDR consumed some effort this month for writing and drawing preparation. UW-PSL prepared sections on the MBT and the coils for the MBT and FTs. There has also been a considerable amount of work on scheduling and a little work on costing. Revision of safety documents for the muon system coils were also part of this months paper stream. Methods of MBT block handling and transportation were refined in preparation for the title one document on surface facilities.

Coil work continues to be a relatively low priority. UW-PSL received a bar of copper from the Institute of Nuclear Physics Uzbek Academy of Sciences. Chemical, mechanical, and electrical tests are under way to evaluate the possibility of using this copper for the muon system coils.

MARCH

Intermediate Chamber design and integration

A conceptual design for IW2-3 module was done. A support system was analyzed for a closed-corner IW3-BW3 interface. It appears possible to kinematically mount the IW module from the end of the Barrel Toroid, owing to the reduced weight of IW module. The mass of IW module will be between 11,000 kg and 15,000 kg depending upon IW3-BW3 interface. If BW3 overlaps IW3, then IW3 will be lighter but BW3 will have a 4,000 kg overhang. If IW3 overlaps BW3, the reverse is true. Both configurations are under analysis. Since the end of the barrel is an extremely crowded area, and since IW modules mount in this area, a detailed layout of this region was started. This layout includes routing of coil cooling, coil power, muon power, muon gas and muon cables, as well as coil locations on the barrel and bridge interface to barrel. The bridge, as configured now, interferes with IW module installation on octants 4 and 6. It also forces the coils on octant 5 closer together to approximately 2 meters on center. The utility routing to octant 5 will also be different than other octants.

Muon Tube production planning

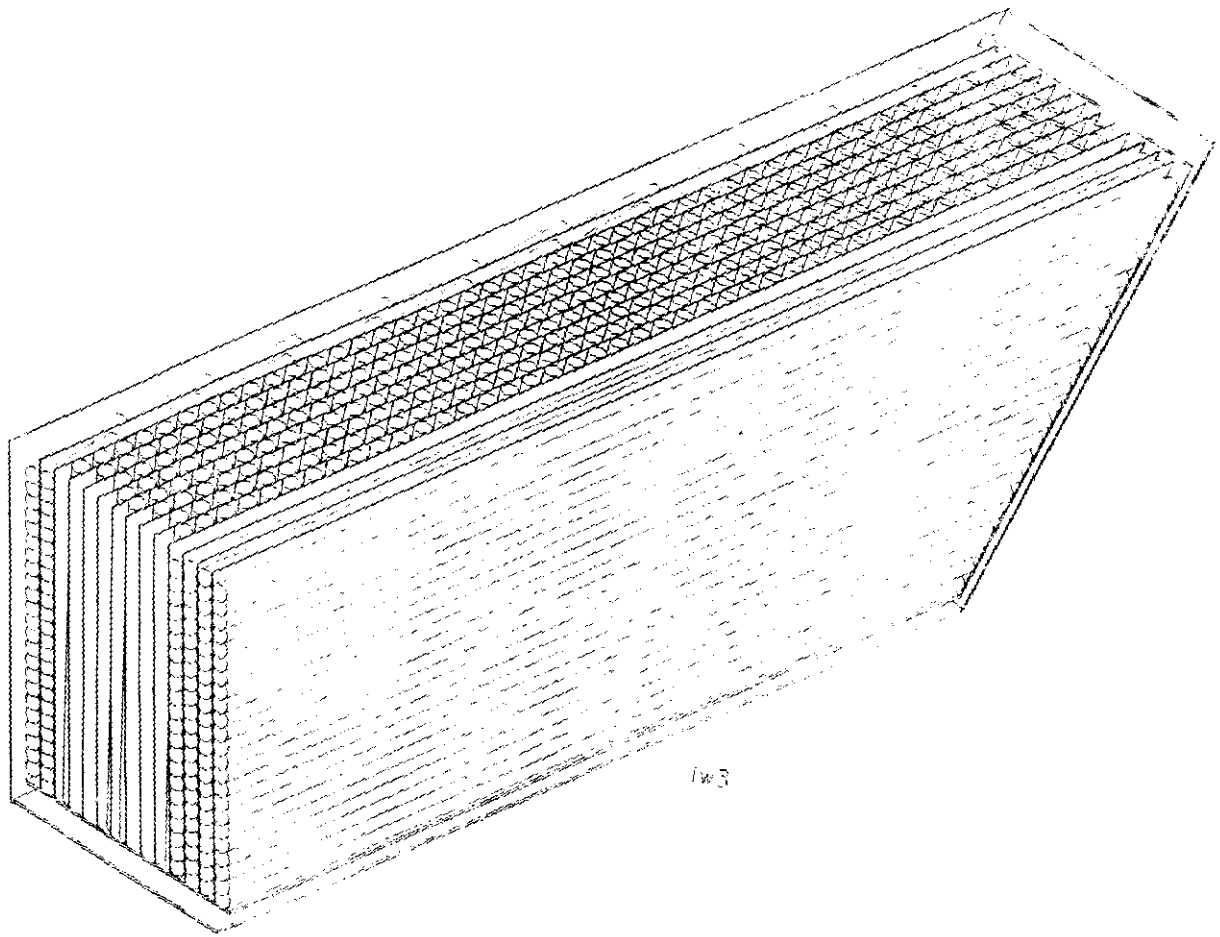
Efforts were concentrated on tooling requirements for tube production to stay consistent with cost estimates. A comprehensive table of all the tooling, their functions and the specifications for operation has been assembled. This table is still under development and details are being investigated. A supplier for tube boring and finishing was located and a visit was made. The tube finishing machines from this supplier can be adapted to our requirements as a special order. A conceptual design for the tube finishing station has been completed. A table of all tube sizes and counts is under development. The large number of different tube lengths will require a very carefully designed inventory control system. It is apparent that each tube needs to be marked and tracked individually until it is assembled in a module. Because of radial wires , which are of different lengths, this is even more necessary in the intermediate system.

SDC Preliminary Design (Iron and Coils)

Structural analysis and investigation of fabrication possibilities have been the focus of the work on the Muon Barrel Toroid (MBT). A study of plate thickness effects has been under way at Martin Marietta. Investigation of expected plate condition, commercial plate flattening methods, and the flattening capabilities of the block bolts has been completed. 150mm thick plates can be used for the blocks. Hydraulic plate flattening may need to be used to improve the flatness of some of the rolled plates, but this capability is available. Finite Element analysis at FNAL and SSCL have focused on the 3D model of the MBT and it's support. Cases have been run for the MBT load, Forward Toroid (FT) load, calorimeter load, a 10% load in Z, a 10% load in X, a 10mm bow in the floor, and failure of selected jacks. The corner joint moments, side plate shear loads, stresses in the support, and deflections look acceptable for each case. Combinations of these cases are now under investigation. The stack up of tolerance errors in the rings is also being studied at the SSC. Preliminary results show the maximum error between blocks in the ring is 12mm, but the error will be less than 5mm for the vast majority of cases. The loads required and moments produced when these gaps are closed are under studied. Some work was done on the availability of the large corner bolts and the design of this joint. Several sources for the bolts have been identified. A drawing of one ring of the MBT with all the changes was produced.

The testing of the copper sample from Uzbek Academy of Sciences showed that the copper was not usable as received. The oxygen content was high, the elongation was low, and the electrical resistivity was high in the sample received. A large part of these problems may be due to the fact that the sample was cast and not extruded. The Uzbek Academy of Sciences will now

provide an extruded sample for testing. Other work on the coils in March included the preparation of a coil safety report with the SSCL and work on the interconnects for power and water between the barrel coils.



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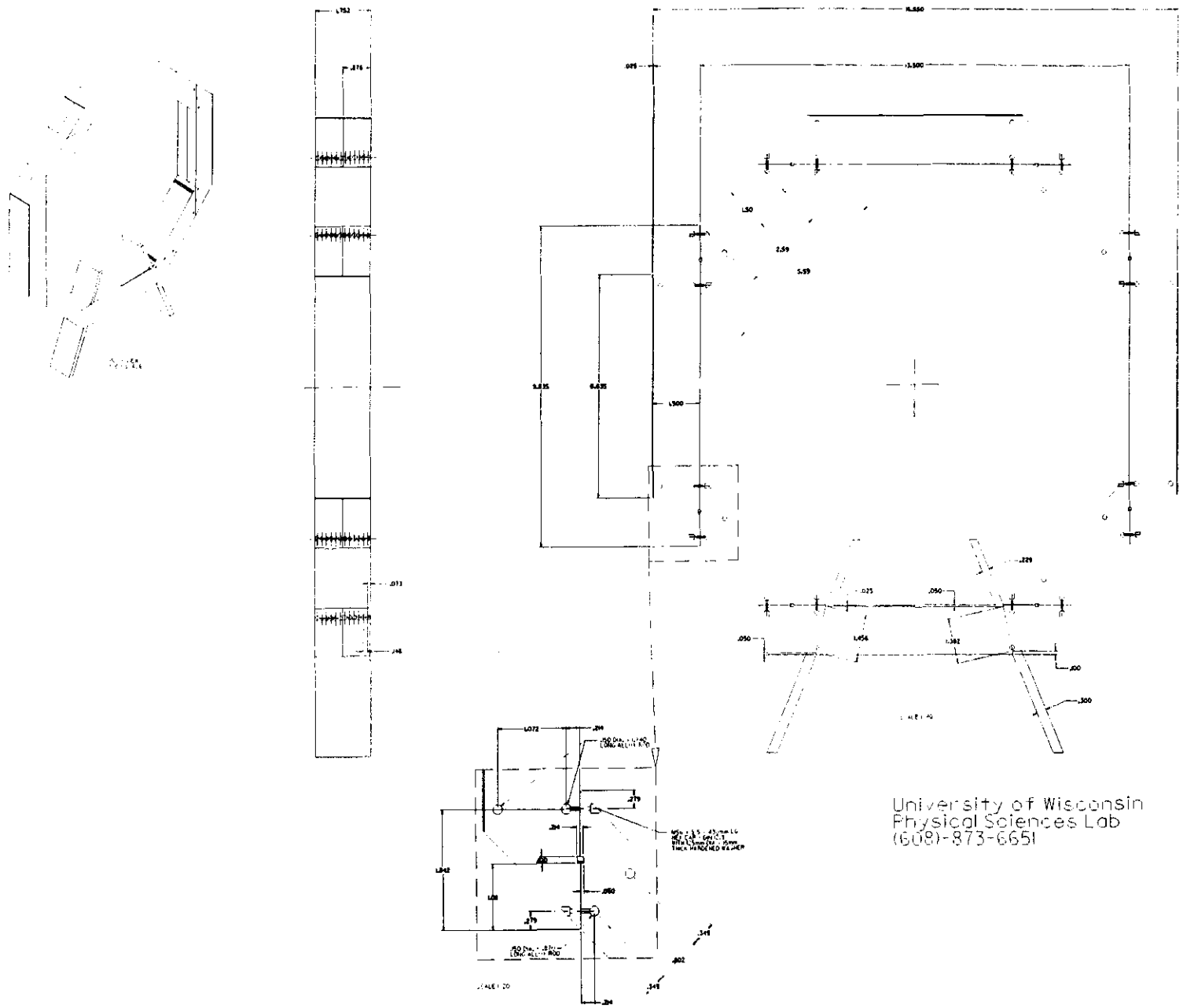

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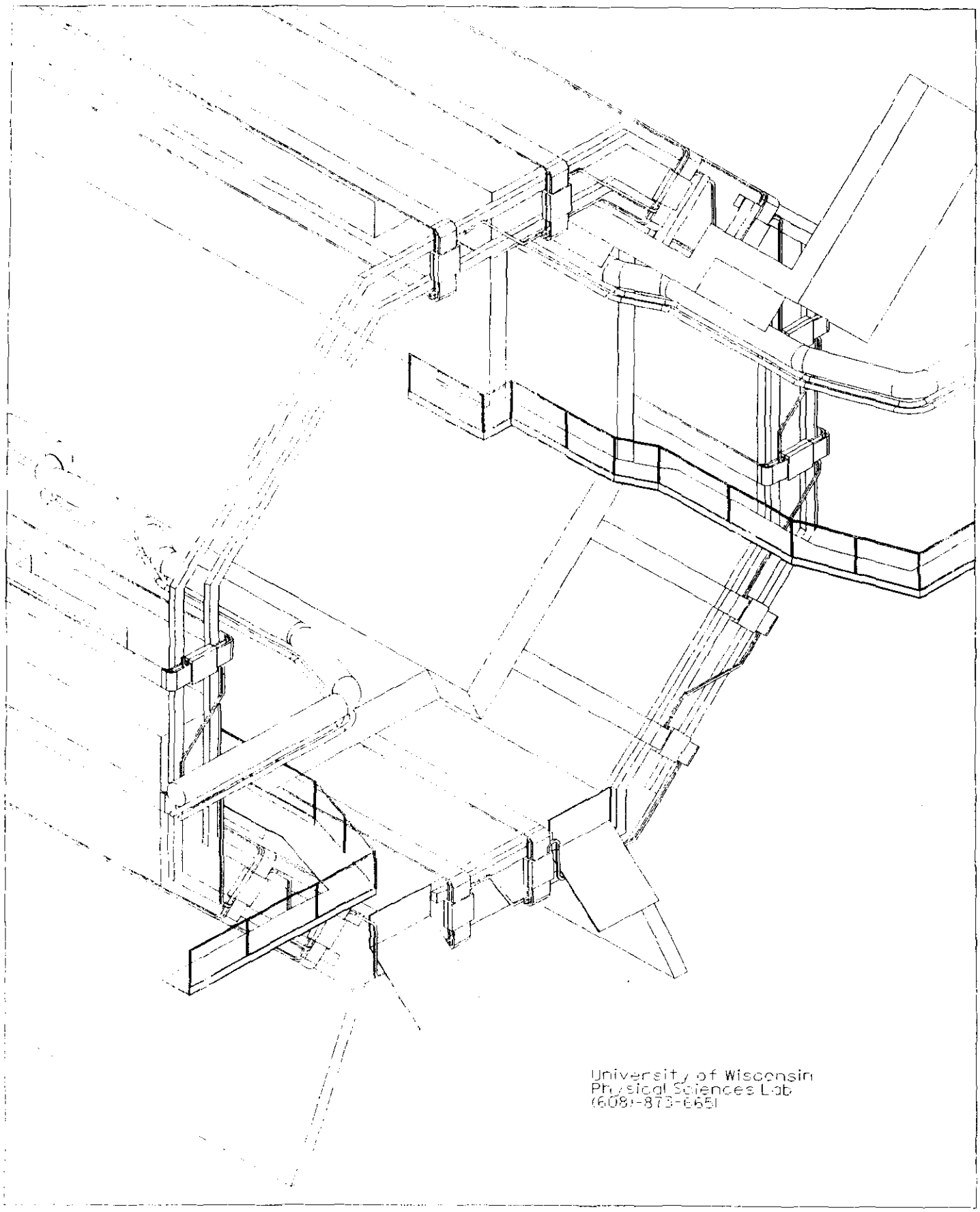
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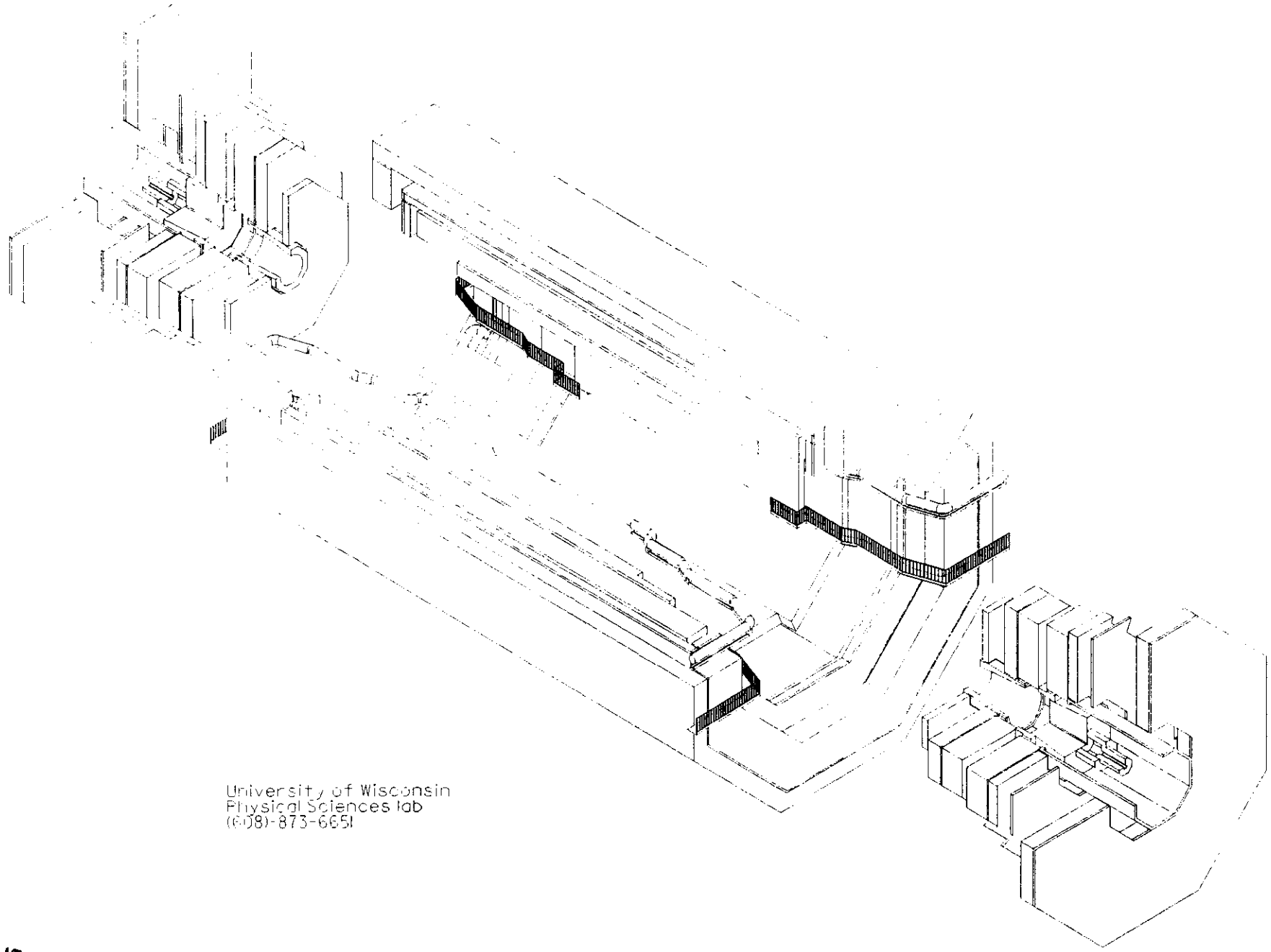
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3. University of Wisconsin Physical Sciences Laboratory (PSL) - Trigger

FEBRUARY AND MARCH

Calorimeter Level 1 Trigger

System Design

We have begun work on simulation of the performance of the revised calorimeter trigger system design which uses a reduced granularity of shower maximum and tracking information. The new design also looks at new techniques of making the jet trigger. A new cost estimate has been developed. This new design reduces the information arriving on optical fibers and still operates within the pipeline time constraints.

Preamplifier

We have designed, prototyped, and have produced preamplifiers for use with a trigger/readout system that employs switched capacitor array (SCA) storage of phototube pulseheight information. One of them is now under test at LBL and has been used in performance tests of the LBL SCA device.

Jet Trigger Studies

We have studied the revised design for a calorimeter level 1 jet trigger based on tower sums. We have used large samples of minbias and jet background events on tape to study pileup and luminosity dependence of the jet trigger up to 10^{34}. We have also investigated the tower sum size for optimal efficiency at low background rate. We find that the best performance is for overlapping grids of 1.6 x 1.6 or 3.2 x 3.2. We also find that an 8-bit nonlinear scale performance is not significantly worse than that of a full-resolution scale.

Trigger System Engineering

Cost & Schedule

We have continued development of the preliminary conceptual design of the SDC trigger system. The design has been revised recently to include reduced granularity of information from the tracking, muon, and shower max systems. A revision of the original cost analysis of the SDC trigger system based on this revised design has been produced.

System Design

We have begun detailed studies of the new system design of the Level 1 trigger. This includes a new version of the Level 1 Muon trigger that correlates the muon system with the outer tracker and quiet regions in the calorimeter with only 64 ϕ bins. We have verified the trigger timing. We have also begun the process of evaluating the feasibility of various hardware realizations of the design. As part of this we have designed, simulated and submitted for fabrication a 4 x 12-bit CMOS adder, which is a common component of several boards in the present circuit design.

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 designed a pipelined domino logic two-stage adder. The device has been simulated in CMOS technology and has achieved the design goal step time of less than 13 ns. We have submitted the ASIC to MOSIS for fabrication. We are now designing an evaluation board. The device takes as input 4 12-bit operands and as output a single 12-bit number. Carry in and out, reset, overflow, and diagnostic inputs and outputs are provided for.

Level 1 Clock & Control

System Design

We have studied the revised global clock and control system. We have evaluated the overall system timing and potential impact of the revised correlated muon trigger. We are now determining the design specifications for the functionality of a module designed to simulate the clock and control system for use in front end electronics tests and in test beams in 1993.

Level 1 Trigger Timing

We are studying the Level 1 Trigger timing which determines the overall level 1 pipeline length in an attempt to shorten it. We have recalculated the trigger timing in this system for the revisions mentioned above. The basic conclusions about pipeline length have not changed.

4. Fermilab (FNAL)

FEBRUARY

Muon Alignment and Monitoring R&D

The measurement and test results on two wire flux pickup transformer configurations was reviewed. Initial data is at FNAL and the long term stability looks promising. We would like to upgrade the readout circuitry by finding some commercial LVDT electronics. Based on the analysis of the two prototype designs we have tested, we are building a third transformer configuration for test.

We have set up a new SSCL readout system at FNAL. A new microprocessor and amplifier gain changes have been installed in the Migatron RPS8800 ultrasonic ranging system in an attempt to eliminate the random reference fluctuations. If these fluctuations were eliminated, the long term system resolution would be impressive. We are trying to obtain some long term stability data on a model IW2-FW2 optical relative transverse position monitoring system referenced in the TDR. We will reconfigure the inclinometer setup onto a more stable granite base and add transverse bubbles. This should help reduce real fluctuations. Expanded measurements on a set of capacitive proximity sensors will be initiated along with relative humidity monitoring.

There was a workshop of the SDC Muon Alignment committee at FNAL to work out a monitoring scheme for the outer tracking system. After reviewing the crack configuration in the calorimeters, the best design seemed to be an optical extension of the barrel fencepost system where we monitor the transverse position of retroreflectors on the tracking bulkheads. The final draft of the alignment section of the TDR was submitted.

Initial analysis of the large database of long term monitoring by the various sensors we are studying will be presented in New Orleans. A more detailed report of the work and the results, SDC-92-0195, is being prepared for release in March.

Solenoid Design

Technical Proposal

The content of the technical proposal was discussed in a meeting held at KEK on Feb 18, attended by R. Kephart and C. Grozis (Fermilab). Following this meeting, the second draft for the Technical Design Report (TDR) was sent by Akira Yamamoto to the LBL editor on Feb 21. We are working on revising and redrawing the figures for the solenoid chapter of the TDR.

Some effort in February was devoted to the CSAR (Conceptual Safety Analysis Report). Working with G. Leskens and R. Lavelle of the SSCL, we have written the textual portion of the solenoid chapter of the CSAR and have begun the individual hazard analysis sheets.

Project Liaison

R. Kephart and C. Grozis were in Japan from February 12 to 19. They visited several companies who are involved with the prototype magnet or the R&D program: (1) Furakawa Wire and Cable is providing the aluminum stabilized superconductor for the prototype magnet, (2) Toshiba is the prime contractor for the prototype and is providing the coil winding machine, (3) Sumitomo Light Metal Company is doing R&D on a honeycomb vacuum shell, and (4) IHI is doing R&D on the forming of honeycomb panels.

They also attended a meeting at KEK at which the progress on the design of the detector solenoid was presented. A number of substantive design issues were discussed.

Cryogenics

After further work by our consultant, we have decided to use a different alloy for the prototype isogrid vacuum shell. Our original design used 2219-T351, but this alloy is difficult to procure and is rather expensive. We have chosen 5083-H321 instead. Although the weight-effective thickness, in mm, is slightly greater for the 5083 shell, the thickness in radiation lengths is about the same. (X0 for 5083 is 89 mm,while for 2219 it is 79 mm.) We have ordered material (5083) to fabricate and form one additional test panel. The purchase order for the 5083 for the prototype shell has been sent to the purchasing department.

We began an investigation into the two primary design standards for vacuum shells--the ASME Pressure Vessel Code and the Compressed Gas Association Standard for over-the-road tankers--with the intent of comparing the design methodology and equations of each. We learned that both methods start from the same buckling collapse equation and that the CGA Standard requires a safety factor of two on this collapse, while the ASME Code requires a safety factor of three. We have written to the CGA asking for their rationale in choosing the smaller safety factor.

Magnetostatic and Other Calculations

We made several runs to verify the KEK calculations of the coil compressive force and the axial decentering force as a function of the coil-to-iron separation. The Bdl vs pseudorapidity curve and the flux plot contours was generated for the 47-cm coil-iron separation to be used in the TDR.

<u>Calorimeter, FADC</u>

Adder Chip

We began testing the current design of the ADDER chip during the week of 2/17/92. We were prepared for testing and it took little time to discover that the chip was functioning. After taking some time to understand the changes which had taken place in the design, patterns were selected which could be generated without the use of the pattern generator and the chip was found to be working as designed. Patterns were selected in the testing which could be simulated using IRSIM and we found each test to conform closely with the simulations.

The initial testing examined the clock-in to clock-out delays as well as the maximum adding speed The Clock-in to Clock-out undelayed total propagation delay is only 12ns on the actual chip. The difference between the Clockout undelayed and the Clockout delayed is 3.5ns. In clocked mode the chip appears to actually add at 200Mhz. when tested with patterns that changed at 50 MHz. and a clock running at 200 MHz. The second impressive finding is that in fall through mode the ADDER chip can easily add at 150 MHz. as seen by pulsing an input with a 50% duty cycle square wave 75 MHz. When using the HP pattern generator, we were able to verify that the Adder could run faster than 66Mhz. in fall through mode. The limit here is that the HP pattern generator cannot reliably work with patterns smaller than 16ns width. Discrepancies between testing the clocked mode and fall through mode center around the limits of our testing system. Plans are being made to improve our test system to accommodate testing at the 200Mhz speeds.

Some additional timing values were investigated. In fall-through mode the time from Data-in rising edge to the Mantissa-out data valid was between 37ns to 44ns. Many of the timing values

are limited by the rise time of the signals. Rise time of the Clock-out undelayed was 5.85ns and the Fall time was 5.2ns.

There was one design error found which related to the overflow bit and the Mantissas. This problem will be corrected in future designs.

Calorimeter Design

The calorimeter design group continued to collect requested budgetary data from the steel vendors. This effort is to refine the cost of the absorber steel for the calorimeter. We set up a system to absorb new data and add it to what we have, and we have come up with the most sensible scheme to date to scale steel cost numbers from the barrel to the end cap, which remains somewhat behind in design with respect to the barrel.

We also froze the design of the calorimeter support structure long enough to make a first cost estimate of our design. The current support structure design has a reasonable horizontal motion degree of freedom perpendicular to the beam line, but we are not satisfied with the design yet to claim that it can yaw the calorimeter.

We have continued our efforts to up-date the parameters list in the face of continuous change. One problem with this task is that we still have not achieved complete concensus with our Argonne colleagues as to exactly how many tiles there are in each tower.

We began the process of exchanging drawings with the shower max group in Saclay. We need to flush the lines of communication a little more to get the flow of information up to speed.

We are preparing to design an alternative barrel EM section for comparison to the baseline design. We feel there is a strong possibility that the new design will have cost reductions and performance increases over the baseline.

MARCH REPORT

Muon Alignment-Support

The initial long term results and conclusions on prototype remote alignment monitoring schemes for SDC Muon system supermodules was presented at the IISSC symposium in New Orleans. This included initial long term data on the current wire-leakage flux pickup transformer system.

A detailed report, Prototype SDC Muon Alignment-Position Monitoring Concepts (SDC-92-0195) was completed as a primary test reference for the TDR Muon alignment and monitoring text. This summarizes the results of our Alignment R&D program at FNAL since May of 1991.

The SDC Muon Alignment group met at FNAL, March 20 to consider a new concept of individual fencepost extension measurement outside the detector using laser distance survey system. This would decouple the fencepost system from a magnet shape model and eliminate the convolution of errors to define local reference positions.

We are now establishing a prototype setup of a physical fencepost and three stations of supermodule proximity sensors. Temperature sensors have been installed on the fenceposts which will allow us to create thermal gradients, etc., to study post shape stability and motions. Detailed comparison of sensor stability and their resolution at each station will be made.

The Intergraph CAD system is now operating and we are able to exchange files with the SSCL, PSL, etc. With some difficulty, we have now interfaced the system to a local plotter. We are now looking at fencepost locations through the steel block assembly of the barrel toroid and at liquid level sensor layouts for the detector base.

Fiber Tracking

The month of March was spent working on the Technical Design Report.

Calorimeter Design

March saw the focus of our group shift from a predominantly costing mode to more of a design focus. We wrote a summary document on our findings about the cost of steel absorber for the barrel as came back from our vendor quotes.

We also decided to change the way the end cap steel cost is scaled from the barrel. The barrel cost/pound is complicated by the question of whether the weight is calculated with or witnout the slot material removed. This becomes a very sticky issue when calculating the cost of the end cap in particular because less work has been done to solidify the exact weight of the end cap in either case. The change made was to do the scaling on the basis of the envelope volume of barrel and end cap wedges. The envelope volume for both is easy to calculate so there are no 20% possible errors just from methodology. The problem becomes one of defining the features of the barrel steel in enough detail that vendors can accurately estimate it. The result of the vendor's estimate is then the total cost to build the barrel, which is divided by the barrel envelope volume. This cost/unit volume is then applied to calculate the cost of the end cap steel. In the future, we intend to do a bottoms up cost estimate of the end cap, but this must wait until the exact configuration of the end cap is decided upon.

The primary focus of the design effort for March was on the stacked EM section. The stacked EM is a version of the electromagnetic calorimeter which is made up of individual plates of lead and scintillator stacked together and compressed by a tightening mechanism. The tightening mechanism must be able to put enough compression on the stack that it cannot slip no matter how it is supported from its back plate. There are many interesting design challenges to this version, such as designing fiber routing through the stack which does not allow compression to be carried on the fibers. We are currently looking at a scheme which routes fibers through an opaque piece of polystyrene above the scintillator tile which has grooves that match up with the fiber routing grooves in the tile below. The polystyrene plate then transmits the compression and the fiber feels none. As always, tolerances between the two plates determine whether the fiber actually passes through one and into the other.

The intent of the stacked design is to allow one to stack all the tiles and lead without any wave-shifter fibers in the tiles, and then be able to put them in after the absorber/tile stack has been fastened to the HAC1/2 wedge. This is so that the many fibers coming from the EM section will not have to be fixtured and potentially damaged while the EM section is being moved or mounted. To make this work, the tightening mechanism must allow the technician to remove a wire or band after the EM section is mounted, insert the fiber, then replace the band or wire. We are examining several possible mechanisms to accomplish this.

Another design challenge to be overcome is in designing an inner radius plate for the EM which is thin enough to avoid problems with excess material, yet able to transmit a uniform compression load into the stack to avoid damaging the first few layers of scintillator. The design we are pursuing involves bowing the inner plate away from the stack to turn it into a softening spring. By putting an optimized sheet of soft material between the spring and the stack, the first layers of scintillator don't suffer and the final compression in the stack is as close to uniform as we can make it. Analysis and prototyping of this design is under way.

The Shower Maximum detector also poses particularly sticky design problems here, as in every other version of the EM section. The chief difficulty here is to design the polystyrene plates to carry all of the shower max fibers out of the wedge and make them tangent to the outer surface for routing up the side of the wedge. The whole fiber routing scheme is complicated by the density of fibers coming from shower max, but again this is a constant feature of its design in every version.

The advantages hoped to be reaped from the stacked EM are no internal bulkheads or cracks, and it should be possible to make it more cheaply than the baseline design because of fewer pieces to handle. It is also easier to decrease the thickness of the lead in this design without changing the structural integrity of the EM wedge. We are trying to assemble a full scale mechanical mock-up of a 1/32 EM wedge for the June Collaboration meeting.

Solenoid Design

Technical Design Report

The final version of the text for the solenoid chapter of the TDR and the figures for that chapter were submitted early in March. The evolution of the Design Parameters Book continues; the intention is for the Parameters Book to be kept current after the TDR is published.

The text of the solenoid chapter of the CSAR was finalized as well as the preparation of the individual hazard analysis sheets, of which there are about 45.

Cryogenics

The engineering and design work associated with laying out the isogrid panels for the next test piece and for the prototype shell continued and is now essentially completed. The contract for the aluminum alloy, 5083-H321, was negotiated with Alcoa. Delivery of the three plates is expected in late June. We must have the machining and forming contracts in place by that time in order to stay on a schedule which calls for the vacuum vessel to be shipped to Japan in March, 1993.

5. Argonne National Laboratory (ANL)

Lead Scintillator Plate Calorimeter Design

FEBRUARY

Radiation Hard Scintillator Development (Bicron Corporation)

The material and sizes were selected for the final production test of this part of the program. Sizable areas of scintillator sheet of thickness 2.5 and 4 mm are to be produced. In addition, fibers of several diameters and doping concentrations are to be drawn for optical system tests. The first run (of 4 mm sheet) was initiated at the end of February. The plates are expected to be released from the mold in early March.

Barrel Calorimeter Conceptual Design (WSTC)

Additional funds were received to prepare an 18-slot mold for a Pb casting. The period of performance was extended to April 30, 1992. In February, the 18-slot mold and casting were redesigned to change the lead thickness to 4mm. The old mold and casting were melted apart and salvageable parts were cleaned. New parts were machined. A purchase order has been placed with Taracorp to make a casting with a .08% calcium, 0.5% tin, balance lead, alloy.

A further contract extension is in the process of negotiation to allow additional lead casting development work by Westinghouse during April.

Calorimeter Conceptual Design

A test mold has been designed and is presently being fabricated to provide a test bed for mechanically testing single cast lead absorber plates. These tests will be used to confirm calculated loads and stresses on both absorber plates and the connections to the structural frame components.

Castings will be made with alloyed lead and pure lead. Different end connections will be studied using this same test mold. A simple cross section of the mold is shown in Fig. 1.

Westinghouse has modified their 18-cell mold and Argonne/Westinghouse will make the first casting using alloyed lead in the near future.

Central Calorimeter Design

Prototype Program:

Work was completed on the modified 10-tower section that is more representative of the current design. This has modified endplates which are now 1/8" thick. The other major change was redesigned to reduce the absorber thicknesses to 4mm. With the reduced absorber thickness, new end connections have been designed. The cross section of the redesign is shown in Fig. 2.

A plan and schedule for the ANL prototype work for FY92 and extending into FY93 is shown in Figs. 3 and 4.

Central Calorimeter Analysis

Barrel EM

An optimization of the barrel EM calorimeter is shown in Figs. 5 and 6. As shown, the case numbers that will optimize the bulkheads are represented by Case 3 and 9.

Endcap

The endcap analysis models are being remeshed to represent the endcap with the removable EM wedge and the adaptation of the Monolithic Hadron Section Plug.

Papers Published This Month

Mechanical Design and Finite Element Analysis of the SDC Central Calorimeter", Presented at the Forth Annual International Industrial Symposium on the Super Collider (March 4-6, 1992), SDC-92-226.

Finite Element Analysis of the SDC Barrel and Endcap Calorimeters, SDC-92-222

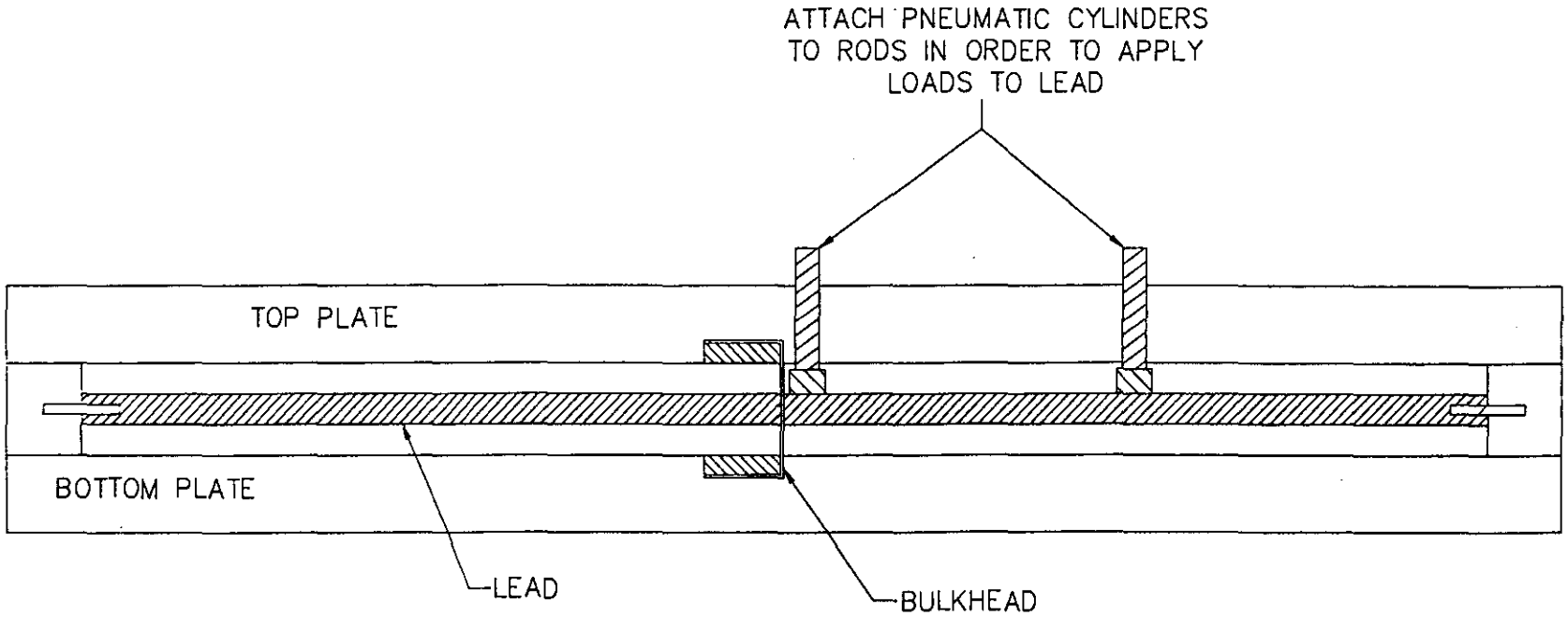

ATTACH PNEUMATIC CYLINDERS
TO RODS IN ORDER TO APPLY
LOADS TO LEAD
TOP PLATE
BOTTOM PLATE
LEAD
BULKHEAD

Figure 1

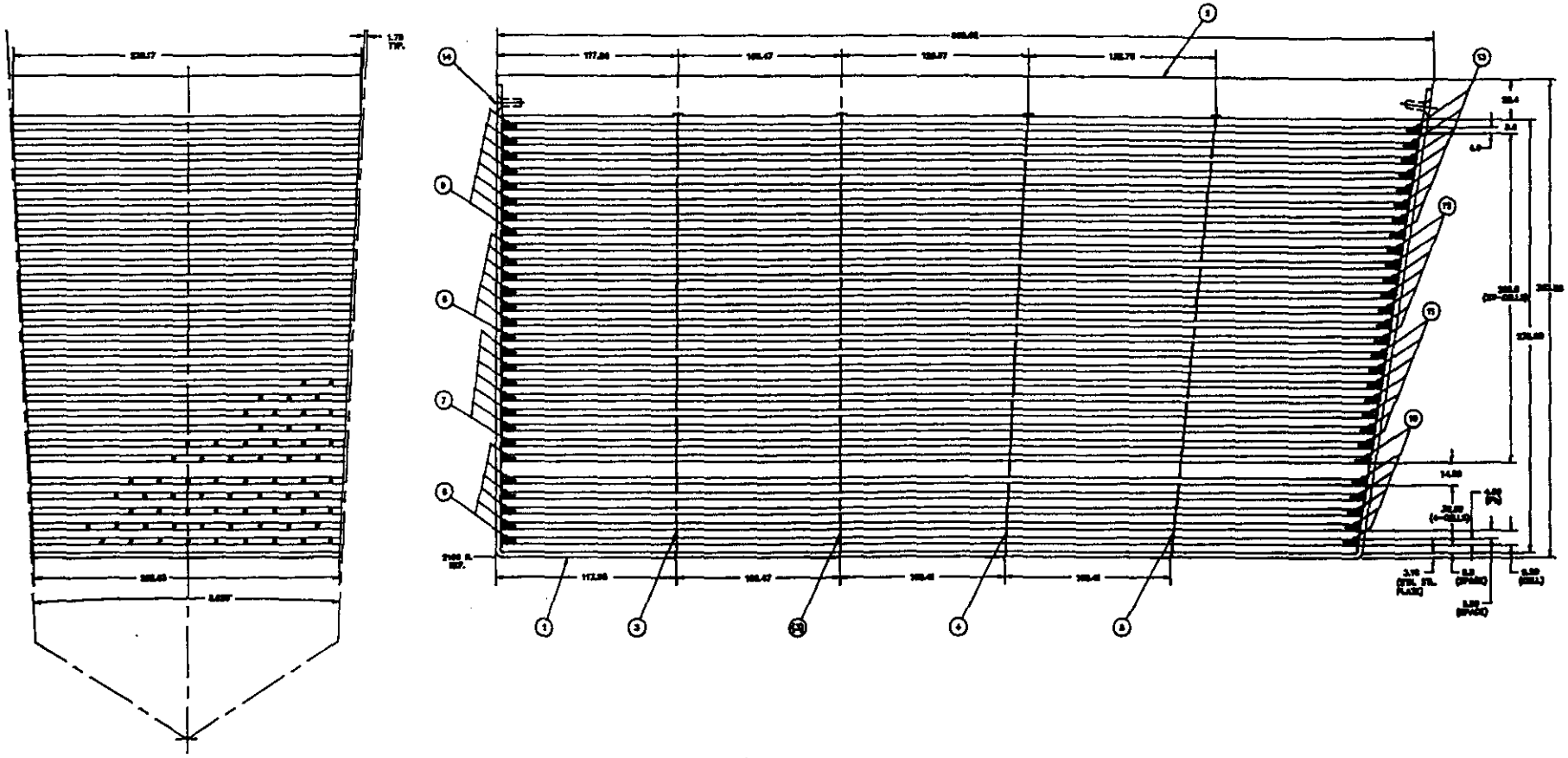


Figure 2

Argonne HEP Design Group Development Plan for Full Size Barrel EM Prototype

Tasks:

1. **18 cell test castings**
   - Mold rework
   - Casting with .5 Sn - .065 Ca alloy
   - Casting with 1.2 Sn - .065 Ca alloy

2. **Absorber Plate End & Bulkhead Connections**
   - Design Mold/Fixture
   - Fabricate Mold/Fixture
   - Castings
     Pure Lead
     .5 Sn - .065 Ca
     1.2 Sn - .065 Ca
     End Connection Options

3. **10 Tower Casting**
   - Mold Rework
   - Frame Fabrication
   - Casting with preferred alloy

4. **Mechanical Tests**
   - Design & Fabricate Test Fixture
   - Instrument Module
   - Test for Stress & Deflection at 12 o'clock & 3 o'clock positions

5. **Full Scale Barrel EM Prototype**
   - Final EM Module Design
   - Mold Design
   - Mold Fabrication
   - Support Frame Fabrication
   - Mold Testing
   - Casting Full Size EM Prototype

Figure 3

Argonne HEP Design Group Schedule for Full Size Barrel EM Prototype

	FY 1992												FY 1993		
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar
18 Cell Casting															
Mold Rework	////////	////////													
1st Casting			////////												
2nd Casting				////////											
Connections															
Fixture Design	////////	/////													
Fixture Fab		////	////////												
Castings				1234	5678	- - - -	- - - -	- - - -	- - - -						
Testing				1234	5678	- - - -	- - - -	- - - -	- - - -						
10 Tower Cast															
Mold Rework			////////	////////											
Frame Design	/////	////////													
Frame Fab			////////	////////											
Casting					////////										
Mechanical Test															
Test Fixture			////////	////////	////////										
Instrument						////////									
Tests							////////	////////							
Full Size Proto															
Final Design									////////						
Mold Design									////////	////////	////////				
Mold Fabrication												////////	////////		
Supp. Frame Fab										////////	////////	////////	////////		
Mold Testing														////////	
Cast 1st Full Prot.															////////

Figure 4

Load Case Parameters

Case #	Loading Position	Bulkhead Thickness	No. of Bulkheads	Restraints
1	12 o'clock	1.0 mm	13	none
2	12 o'clock	.5 mm	13	none
3	12 o'clock	.5 mm	13	@ z=0
4	12 o'clock	1.0 mm	13	@ z=0
5	12 o'clock	.5 mm	27	none
6	12 o'clock	.5 mm	27	@ z=0
7	3 o'clock	1.0 mm	13	none
8	3 o'clock	.5 mm	13	none
9	3 o'clock	.5 mm	13	@ z=0
10	3 o'clock	1.0 mm	13	@ z=0
11	3 o'clock	.5 mm	27	none
12	3 o'clock	.5 mm	27	@ z=0

Fig. 5

Maximum Component Stress

Case #	Max Left End Plate Stress (psi)	Max Front Plate Stress (psi)	Max Right End Plate Stress (psi)	Max Bulkhead Stress (psi)	Max Lead Stress (psi)
1	5,662	1,899	2,776	6,307	565.5
2	10,641	1,899	22,591	4,828	855.5
3	5,205	3,726	11,933	3,784	420.5
4	2,450	1,986	6,090	4,074	304.5
5	8,671	797	13,731	2,479	565.5
6	3,262	2,073	7,931	1,464	406.0
7	319	725	319	1,218	6.8
8	4,205	130	406	2,508	9.57
9	522	362	406	2,407	14.3
10	377	145	319	1,232	7.2
11	295	768	261	1,218	8.7
12	295	145	203	1,218	8.7

Figure 6

6. Westinghouse Science and Technology Center

FEBRUARY

The WSTC objective is to act as a "subsystem integrator" with the goal of producing the schedule, cost projections, and manufacturing plans for the scintillator calorimeter subsystem.

In February, the WBS was revised. These revisions included redistributing non-touch production support labor from the management section into the appropriate hardware sections of the WBS, and changing the End Plug WBS Number from 2.4 to 2.2.10, thus making it part of the End Cap. Costs, schedules, and contingencies were given a complete bottom-up revision, per the new WBS structure. This data was transferred to SSCL on February 24-26.

Some design work was performed in order to improve the quality of the cost estimate. The outer support structure for the end cap was designed, drawn, and sent out for quotes.

8. Los Alamos National Laboratory

FEBRUARY 1992

Spaceframe Studies

The space frame provides structural support for the cylindrical arrays of the central region and the flat, planar arrays of the forward regions, as shown in Figure 1. The dimensional stability requirements motivated the use of metal matrix composites (MMC) construction materials. Their ultrahigh elastic modulus is supplemented by their immunity to moisture-induced distortions and by the ability to tailor the longitudinal coefficient of thermal expansion (CTE) to approach zero. The selection of these materials also facilitates the use of adhesives in the demountable joints as a design option. The frame features an inner hexagonal geometry rotated about its longitudinal axis to avoid aligning with the outer hexagonally arranged members. This design diminishes the radiation length experienced by any particle. Finally, the MMC space frame readily satisfies the requirement for butane compatibility in a high-radiation environment.

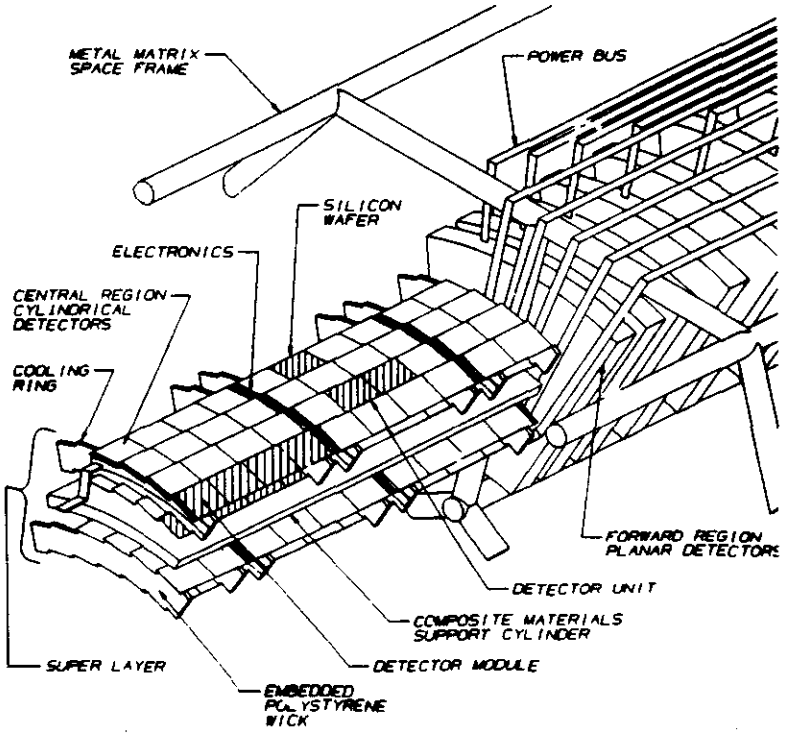


Figure 1. STS cutaway view.

Materials Science Studies

The materials selection for the STS is motivated by three primary factors: (1) 5-μm stability in $r\,\phi$, (2) 3% radiation length restriction, and (3) radiation resistance in the presence of hydrocarbon fluids. The large scale of the detector dictates that linear expansion effects must be minimized, whether from thermal or moisture effects. During the conceptual design effort, materials choices were narrowed to MMCs, whose CTEs can be tailored to be approximately zero, and to hydrophobic cyanate-ester resin systems for the G/C-E composite candidate. Although the cyanate-ester resins have low moisture saturation levels, typically 1% (producing an overall laminate coefficient of moisture expansion (CME) that is 1/50 that of a G/E laminate), uncertainties still exist in overall stability in a radiation and butane environment. The CTEs of G/C-E composites are tailorable and have long radiation lengths. Experimental verification of the CTE and CME of the G/C-E system is in progress; Table 1 lists the experimental results fo the mechanical properties verification of this materials system.

Table 1. Mechanical test results of G/C-E materials system P75/954-3.

Test	Neat Resin	Longitudinal	Transverse	Quasi-isotropic
Tensile Modulus	3.8 Gpa	323.8 GPa	6.4 GPa	96.5 GPa
Tensile Strength	58.6 MPa	1 GPa	23.4 MPa	293.8 MPa
Poisson Ratio	0.39	0.32	0.0063 0.33	
Comp. Modulus	3.4 GPa	268.7 GPa	6.2 GPa	77.2 GPa
Comp. Strength	6.9 MPa	337 MPa	41.3 MPa	131 MPa
Shear Modulus	0.96 GPa	4 GPa	1.6 GPa	—
Shear Strength	27.6 MPa	40 MPa	19.3 MPa	—

Radiation Length Studies

Throughout the design process, the need for ultralightweight, low-Z, radiation resistant materials will be stressed. Structures are configured to have minimum material thicknesses along the particle trajectories. The design requirement is expressed in terms of the number of equivalent radiation lengths. The design is restricted to using no more than 3% of a radiation length at normal incidence for all materials exclusive of the silicon detectors. Figure 2 illustrates the radiation length associated with silicon and the silicon detector support material, detector electronics, cabling, cooling, etc., expressed as a function of rapidity. It is clear that the baseline design nominally meets the requirement at zero rapidity (<3%), but as expected, its contribution increases slightly with increasing rapidity. This is an area of concern, and the preliminary design effort must address how further reductions in support materials may be attained.

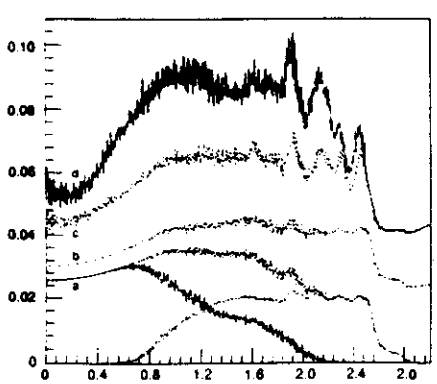


Figure 2. Average fraction of a radiation length in the silicon detector expressed as a function of pseudorapidity (η-ln(tanθ/2), where θ is the angle with respect to the beam axis). a) Silicon detectors alone (central and forward regions shown separately below, and both combined). b) including the gas inside enclosure vessel. c) including the beam pipe, d) including the outer enclosure vessel wall, cooling rings and wicks, support cylinders, and the space frame averaged over ϕ, and e) including the electronics packages, cabling and inner enclosure vessel wall.

Compression Molding Studies

A 30° cooling ring arc segment mold was fabricated to produce partial cooling ring prototype components for compression molding evaluation. Small components present similar technology issues as their larger counterparts. When an epoxy-based molding compound proved unsuccessful, MX4925, a phenolic-based compound, was used because of its ease of fabrication. Both compounds were composed of approximately 63% graphite fibers and 37% resin. The cooling ring wall thickness of 0.4 mm is substantially thinner than typical compression molded components and proved troublesome. Poor material flow, quick curing, and difficult uniform charge deposition complicate fabrication. Ultimately, molding success was achieved using MX 4925 molding compound, and the desire to use an epoxy resin was replaced by plans to use an advanced hydrophobic resin system.

Cooling rings composed of a very high elastic modulus graphite fiber and hydrophobic cyanate-ester resin are the ultimate objective of this program. Hence, a molding compound composed was produced of P75 graphite fibers that were ball-milled to approximately 100-μm lengths and mixed with 954-3 resin. These were significantly shorter than the 2.5-mm-long fibers used with the phenolic resin. The mold was again used to produce 30° arc segments from this compound. This resin system exhibited much more flow than the phenolic but failed to evenly distribute the fibers. The parts also tended to adhere tenaciously to the mold. These problems were overcome by carefully shaping the partially cured, or advanced, charge in the mold that had been Teflon coated. Uniform arc segments with well-filled walls were produced.

A larger mold, spanning 120° of arc, was fabricated to further this compression molding evaluation. Problems have been encountered because the larger mold possesses subtle geometric complications and it requires more time for filling, hence allowing resin hardening during charge deposition. Resin flow and fiber uniformity issues are difficult to control using this new mold. High quality components are being produced with the mold but the rejection rate must be minimized. Once this is accomplished, material qualification and thermal conductivity enhancement will be undertaken using this mold. Figure 3 is a photograph of high-quality 30° and 120° arcs produced. Ultimately, a 360° cooling ring mold will be fabricated, and rings will be produced for prototype testing, manufacturing optimization, and deployment into the STS.

Figure 3. 30° and 120° partial cooling ring arc segments.

Thermal Conductivity Enhancement

Chopped fiber/resin compression molded products are theoretically quasi-isotropic. The fibers, however, tend to align with the mold wall, yielding much higher in-plane physical properties than those transverse to the wall. More specifically, both mechanical and thermal properties are higher in the wall plane. Figure 4 depicts an ultrasonic image of the distribution of fibers in the plane of a compression molded arc segment. Material physical properties transverse to the wall are fixed, largely by the matrix physical properties. Because the resin and the transverse fiber thermal conductivity are low, the transverse wall thermal conductivity is typically quite low. This situation is of significant concern for the STS. It is important to minimize the thermal gradient from the electronic readout chips to the cooling system's evaporative wick structure. If it is not minimized, the silicon strip detectors will operate above the 0°C base temperature chosen to maximize performance amid a radiation environment. Enhancement of the transverse thermal conductivity is in progress, while emphasis is concurrently placed on obtaining uniform cooling ring properties.

Figure 4. One-mm-wide ultrasonic image of graphite fiber distribution in a compression molded component.

The thermal gradient through the cooling ring was investigated for conditions simulating the polystyrene wick. Finite element (FE) solutions were obtained as a function of transverse thermal conductivity (k_t) for a constant heat flux. This solution isolated the fin effect of the cooling ring sidewall. For low k_t, e.g., 0.5 W/m°C, characteristic of the MX 4952 carbon/phenolic system, heat flows down the sidewall, as well as through the top surface of the ring. The peak temperature gradient is ameliorated by this effect. For higher assumed k_t values, the gradient

directly across the ring top surface diminishes significantly. Because the temperature gradient is reduced noticeably, the sidewall fin effect diminishes similarly. In short, as the transverse wall thermal conductivity of the molded ring is improved, a significant reduction in the temperature gradient through the wall is achieved. The temperature gradient in the cooling ring sidewall becomes insignificant as the fin effect diminishes to zero. The results of this study clearly identified the benefit of achieving a k_t of roughly 4 W/m°C. For this case, the temperature gradient becomes the temperature drop across the wick, 2.5°C for the effective wick convective film coefficient chosen.

Numerous ring segments and material specimens have been fabricated and their thermal conductivities measured during the initial phase of this investigation. We studied the effects of high-conductivity additives in the resin and the potential benefit of using shorter fiber lengths. A seven-fold increase in k_t, up to 3.6 W/m°C, has been achieved. Although the results of this program are quite encouraging, they are preliminary. Noticeable improvements to this particular aspect of the ring design have been achieved, and a factor of 10 increase over the earlier development ring models is ultimately expected. The final results of this investigation will be reported in the coming STS research and development report.

Thermal Stability Studies

An analytical assessment of the ability of the silicon substructures to resist thermally induced distortions is in progress. Precise measurement of the charged-particle momentum requires an ultrastable platform. It is important to note that the STS cooling system under development is intended to maintain a high degree of thermal stability. The evaporative cooling system should preclude any significant thermal gradient within the support structures. An understanding of the structure's sensitivity to thermally induced distortions, will alleviate concerns regarding structural stability. An FE model of the central region silicon shell module has been developed and will aid in the design and construction of a prototype to be used in stability tests. As the STS design progresses, this analytical effort will be expanded.

An FE model of a typical central region structure was developed that represents a structure with outer and inner diameters of 420 mm and 360 mm, respectively, and a length of 240 mm. Thirty-six silicon strip detector modules are attached to each diameter. The cooling ring cross-section is 8 mm wide by 30 mm high, with a wall thickness of 0.40 mm. The cooling ring will ultimately be a compression molded G/C-E resin composite component, possessing approximately 60% fiber by volume. The analysis was performed assuming mechanical properties characteristic of IM7 graphite fibers embedded in an epoxy matrix. This combination yields an elastic modulus of approximately 80 GPa. Verification of the final compression molded cooling ring properties will be undertaken. A larger modulus of elasticity is anticipated for the final product than is used in this analysis. Boundary conditions applied to the model simulate kinematic restraints at three equally spaced locations on each end. Figure 5 depicts the distortion that occurs when the temperature of the outer layer of silicon is allowed to rise uniformly. For small temperature changes, the distortion of the structure is linear with temperature.

For the size module studied, a 6°C to 8°C temperature difference between the upper and lower silicon layers composing a silicon superlayer could be tolerated because of the small, 2.5-μm radial and 0.94-μm axial, displacements that are induced.. The larger silicon shell modules will be more flexible and are likely to exhibit more distortion under this temperature variation.

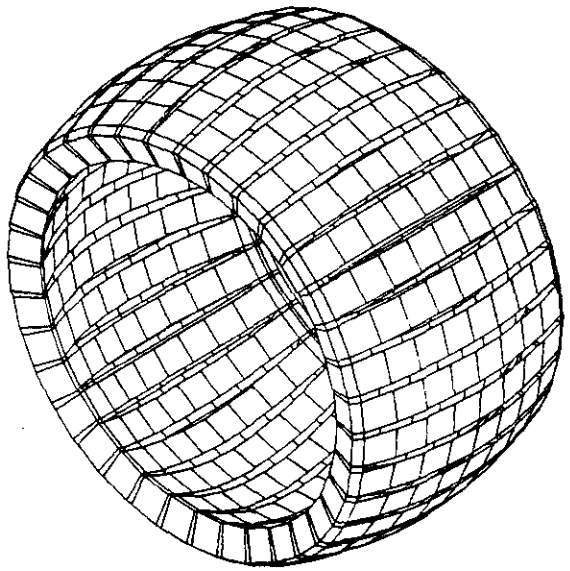


Figure 5. FE model of a typical central regionstructure, deformed configuration.

Evaporative Cooling System Wick Development

The dimensional stability requirements of the SSC silicon detector array dictate precise thermal control of the entire array to a nominal operating temperature with minimal thermal gradient within the array. The cooling system developed to achieve this thermal stability is by the free-surface evaporation of a cooling liquid in near-equilibrium with its vapor. Thus, the entire detector containment vessel is filled with the coolant vapor and liquid is distributed to the cooling rings by a combination of hydrostatic and capillary forces. Based on the desire to maintain a nominal pressure of 1 atm while operating near 0°C, butane was chosen as the coolant.

The critical research and development component of this system is the distribution wick. The wick must have sufficient capillary pumping capability to overcome its flow impedance. The gravity contribution dictates a maximum pore size of 5.4 μm. The flow impedance is minimized by providing a low-impedance artery circumferentially around the cooling ring. However, even a short flow path through the wick can contribute a substantial pressure drop if the wick permeability is low. The actual pressure drop contribution caused by flow impedance is a function of wick thickness, which must be minimized; proximity of the heated surfaces to the circumferential artery; and wick permeability, which is coupled to the pore size.

Based on these requirements, the wick development approach has been to examine candidate wick structures that have a maximum pore size of 4 μm or less, with a high enough permeability to keep the wick thickness to an acceptable value, that can contain a distribution artery and, that can be integrated into the complex geometry of the cooling rings in the central region.

The baseline wick material is a polystyrene foam that can be molded to the desired shape and can incorporate the distribution artery in the molded form. The foam is produced by mixing water with a monomer with a ratio of 90/10. An emulsifying liquid and an initiator is added to the mixture. The emulsion is polymerized at 60°C and then dried. The resulting foam has densities of less than 0.1 g/cm^3 and a porosity of 95%. A scanning electron micrograph of a typical foam wick cross section is shown in Figure 6. The structure consists of a honeycomb pattern of large pores connected by smaller pores that govern the effective capillary pore size. This structure has the potential of offering a relatively high permeability for a given capillary pore size.

The desired pore size has not yet been achieved, but it has been bounded. A 30-μm effective pore radius sample has been machined from bulk material. Micrographs of this material show pores sizes less than 10 μm, which suggests that the effective large pore size is a result of damage to that structure due to machining. Geometrically simple molded wick samples are currently being produced that have a capillary pore size of less than 1 μm. The permeability of these molded samples is unacceptably low. Development efforts are focusing on tailoring the pore size and increasing the permeability by altering the foam mixing process.

Temperature drop was measured as a function of power density at the cooling ring surface, across a cooling ring/wick assembly. The test apparatus was a 30° arc segment on a 40-cm radius, with electronic resistive heaters on each of six flats. The measured temperature drop for 1 W/cm^2 is approximately 4.5°C.

Further experiments were conducted to estimate the effective thermal conductance across the wick only. A resistance heater is mounted on a thin aluminum plate. The wick is attached to the opposite side of that aluminum plate. The measured temperature drop is from the center of the aluminum plate to the wick-vapor interface. Wick thicknesses of 0.25, 0.50, and 1.25 mm were tested. An effective conductance of about 0.3 W/cm^2 °C was calculated from the temperature measurements. This conductance was independent of wick thickness and power density in the range of 0.4 W/cm^2 to 1.3 W/cm^2.

These results, together with the assumption that wick pore size can be tailored to the desired value, indicate that the polystyrene wicks will meet the system design requirements. These wicks will be molded to the cooling ring shape in machined delrin molds thereafter bonded in place. Delrin has good machinability for cost-effective mold production, and the good wettability, which assures foam pore configurations at the foam-mold interface are essentially the same as in the bulk material.

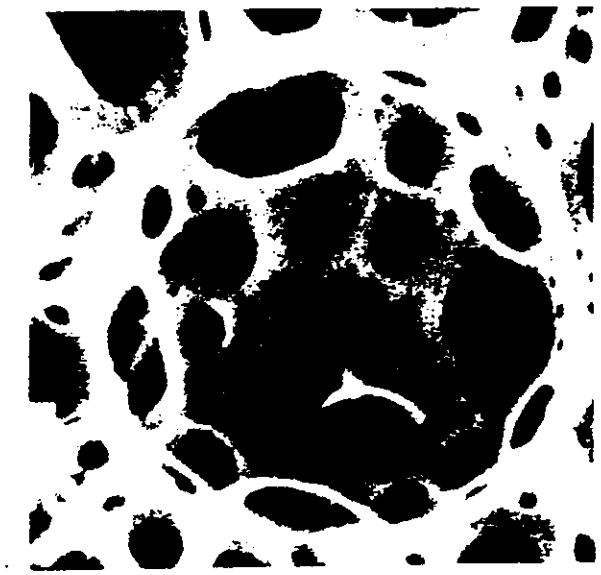


Figure 6. Electron micrograph of the poly-styrene wick structure demonstrating pores of 6–10 μm diam.

Alignment and Assembly Studies

The overall alignment and assembly concept must be integrated with the mechanical structure in many important ways. The concept must provide a method for positioning silicon ladders to micron accuracies while they are being attached to the cooling rings and must provide a method for integrating the structural shells and forward region planar arrays onto the detector space frame. The concept must also include alignment considerations for the completed detector, including alignment shifts in shipping, reassembling, and positioning the detector onto the SSC beam line; *in situ* alignment; verification; calibration; and knowledge of alignment changes over the detector operating life. These alignment and assembly tasks are necessary in addition to component and subassembly testing, structural verification, and correlation of test data with FE models, which are also important components of the overall alignment and assembly process.

One of the most important and challenging alignment tasks is to develop a time-saving alignment maintenance system for the calibrated detector. With a recently developed fiber optic system, it will be possible to continuously monitor the relative three-dimensional position of one subassembly relative to another and the position of the detector to the outside world using a compact, nonintrusive fiber-optic motion sensor that functions by observing variations in light intensity. For this to be possible, the integrity and stability of the subassemblies must be assured so that the subassemblies can be treated as rigid bodies. This is another important reason for careful subassembly testing.

Detector Stability

The stability of silicon ladders, barrel, and planar subsystems will be tested using TV holography which provides quantitative and qualitative information about object shape changes in the presence of heat or mechanical forces. The results will be used to optimize subassembly designs, aid in the choice of appropriate adhesives, benchmark FE models, and provide experimentally tested analytical models for predicting many other detector mechanical performance features or structural performance characteristics under unusual operating conditions. TV holography offers submicron shape-change resolution and hundreds of microns of dynamic range over a 1-m field of view using 30 mw He-Ne lasers. The system operates like an optical interferometer for objects, which are not of interferometric quality, by comparing the shape of the object under load with its unloaded shape. Fringe patterns provide the information about shape change. Recent TV holography advances provide a way to interpret the fringe patterns and obtain quantitative information about the test object. As an example of the technique, a silicon ladder glue joint was tested using TV holography. Two silicon pieces, each 30 mm × 60 mm × 0.3 mm, were glued together along the 30 mm × 0.3 mm sides with Epoxy Technology H70S adhesive. The assembly was secured and loaded by deflecting its free end. The arrow in Figure 7 marks the position of the butt joint, while continuity of the fringes across the joint indicate that the bonding is mechanically equivalent to a single piece of silicon.

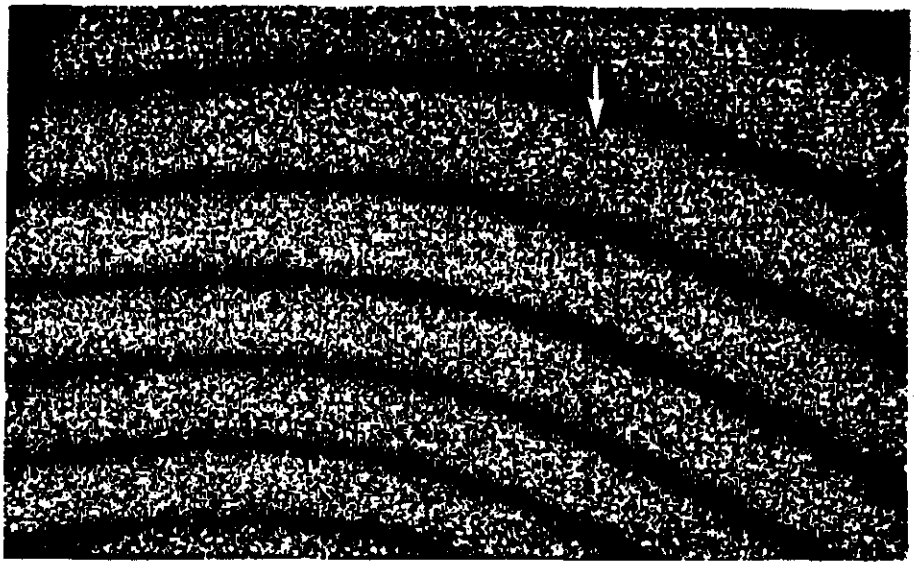


Figure 7. Continuous fringe pattern across silicon detector butt joint.

9. ICF - Kaiser Engineers (KE)

FEBRUARY

Detector Installation Planning and Scheduling

3d modeling for the descoped version of the SDC detector was continued this month. Several perspective drawings depicting construction status of the detector at different stages were produced, delivered and discussed. These drawings will be included in the installation chapter of the SDC Technical Design Report..

Figure 1 is the latest detector installation schedule, which has been worked out and coordinated through SSC personnel.

Figure 2 shows the installation of the muon barrel steel supports.

Figure 4 shows muon steel being erected and the system of supports necessary for holding the building blocks until they are aligned and fastened.

Figure 5 shows the installation of the coils and muon chamber rails on the muon steel barrel.

Figure 6 shows a forward steel toroid being built. Note that coils have to be threaded into position as the different blocks are assembled.

Figure 7 shows the installation of the barrel calorimeter. The first half has been installed and the second half is being lowered from above.

Figure 8 shows muon chambers trusses BW2 and BW3 being installed on the barrel rails.

Forward Toroids

One the preliminary design of the forward toroids steel, progress to date includes the completion of weight, center of gravity and load distribution calculations of all components of the forward toroids assembly. This includes FT1, FT2, FW1 through FW5, future Cerenkov counter, Forward Calorimeter, Absorbers, Support Sleeve and trusswork, all to be carried on a single transport system located under FT1 and FT2.

Computer runs indicate that to maintain stability and a reasonably uniform load distribution to the eight rollers of the transport system, a very stiff transport frame and shear transfer ties between FT1 and FT2 are needed.

The space for the transport frame and the rollers and hydraulic jacks under the FT steel is very limited. The space between the barrel steel and FT2 at octants 3 and 7 is also limited, so that the tie plates may have to be recessed into the FT steel.

Five drawings and a brief description of the FT assembly and support system have been prepared.

Proposals made by NIIEFA and IHEP for the forward toroid muon steel fabrication and construction have been reviewed and commented on.

Details of a push-pull hydraulic jacking system connected to the forward toroid transport frame via two pipe struts are being finalized.

Forward Toroids Transfer Bridge

Finite element analysis of a transfer bridge has been completed. Two copies of the computer model showing spring supports (to simulate stiffness of the barrel) are attached. Preliminary runs indicate that a 1500mm box girder (using the roller track plate for top flange) will meet deflection and stress requirements. To maintain the critical lateral and vertical alignment between the bridge and the barrel, the box girder will be pinned to the last plate of the barrel. The end of the box girder is tapered to reduce the area to be kept clear of piping and cables, at the barrel steel faces.

Drawing No. 0012-s, showing the cross section of the box girder and the access platform, has been prepared. Other drawings of the support bridge are in progress.

Installation procedures of the Transfer Bridge and its support frames are being developed.

Detector Basement

Interface details and loadings on the detector basement and on the operating floor are being established.

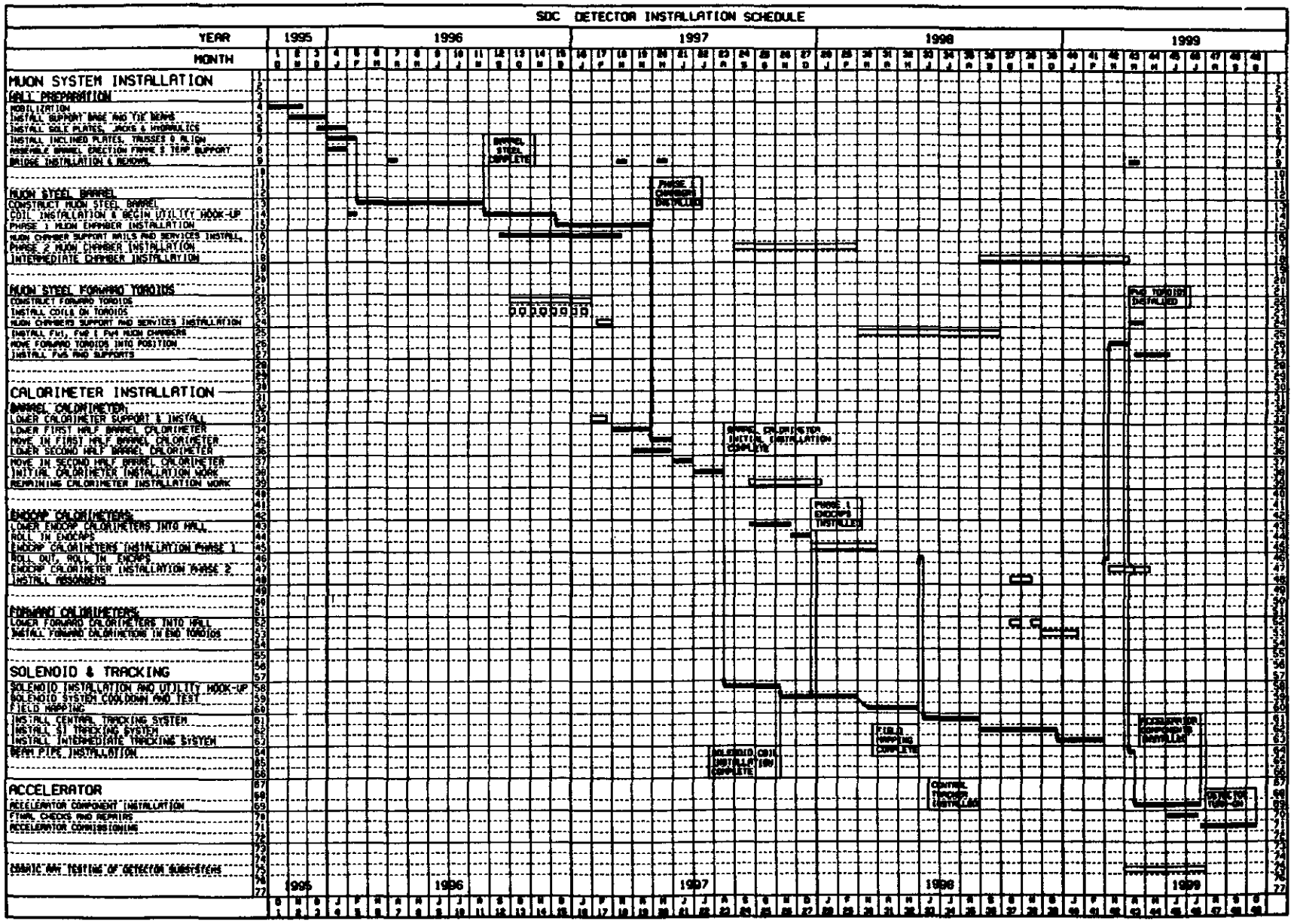

SDC DETECTOR INSTALLATION SCHEDULE
YEAR
MONTH
1995
1996
1997
1998
1999
MUON SYSTEM INSTALLATION
HALL PREPARATION
MOBILIZATION
INSTALL SUPPORT BASE AND TIE BEAMS
INSTALL SOLE PLATES, JACKS & HYDRAULICS
INSTALL INCLINED PLATES, TRUSSES & ALIGN
ASSEMBLE BARREL ERECTION FRAME & TEMP SUPPORT
BRIDGE INSTALLATION & REMOVAL
MUON STEEL BARREL
CONSTRUCT MUON STEEL BARREL
COIL INSTALLATION & BEGIN UTILITY HOOK-UP
PHASE 1 MUON CHAMBER INSTALLATION
MUON CHAMBER SUPPORT RAILS AND SERVICES INSTALL
PHASE 2 MUON CHAMBER INSTALLATION
INTERMEDIATE CHAMBER INSTALLATION
MUON STEEL FORWARD TOROIDS
CONSTRUCT FORWARD TOROIDS
INSTALL COILS ON TOROIDS
MUON CHAMBERS SUPPORT AND SERVICES INSTALLATION
INSTALL FW1, FW2 & FW3 MUON CHAMBERS
MOVE FORWARD TOROIDS INTO POSITION
INSTALL FW5 AND SUPPORTS
CALORIMETER INSTALLATION
BARREL CALORIMETER
LOWER CALORIMETER SUPPORT & INSTALL
LOWER FIRST HALF BARREL CALORIMETER
MOVE IN FIRST HALF BARREL CALORIMETER
LOWER SECOND HALF BARREL CALORIMETER
MOVE IN SECOND HALF BARREL CALORIMETER
INITIAL CALORIMETER INSTALLATION WORK
REMAINING CALORIMETER INSTALLATION WORK
ENDCAP CALORIMETERS
LOWER ENDCAP CALORIMETERS INTO HALL
ROLL IN ENDCAPS
ENDCAP CALORIMETERS INSTALLATION PHASE 1
ROLL OUT, ROLL IN ENDCAPS
ENDCAP CALORIMETER INSTALLATION PHASE 2
INSTALL ABSORBERS
FORWARD CALORIMETERS
LOWER FORWARD CALORIMETERS INTO HALL
INSTALL FORWARD CALORIMETERS IN END TOROIDS
SOLENOID & TRACKING
SOLENOID INSTALLATION AND UTILITY HOOK-UP
SOLENOID SYSTEM COOLDOWN AND TEST
FIELD MAPPING
INSTALL CENTRAL TRACKING SYSTEM
INSTALL SI TRACKING SYSTEM
INSTALL INTERMEDIATE TRACKING SYSTEM
BEAM PIPE INSTALLATION
ACCELERATOR
ACCELERATOR COMPONENT INSTALLATION
FINAL CHECKS AND REPAIRS
ACCELERATOR COMMISSIONING
BASIC AND TESTING OF DETECTOR SUBSYSTEMS
BARREL STEEL COMPLETE
PHASE 1 CHAMBERS INSTALLED
BARREL CALORIMETER INITIAL INSTALLATION COMPLETE
PHASE 1 ENDCAPS INSTALLED
SOLENOID COIL INSTALLATION COMPLETE
FIELD MAPPING COMPLETE
CENTRAL TRACKER INSTALLED
FWD TOROIDS INSTALLED
ACCELERATOR COMPONENTS INSTALLED
DETECTOR TURN ON

FIG 1

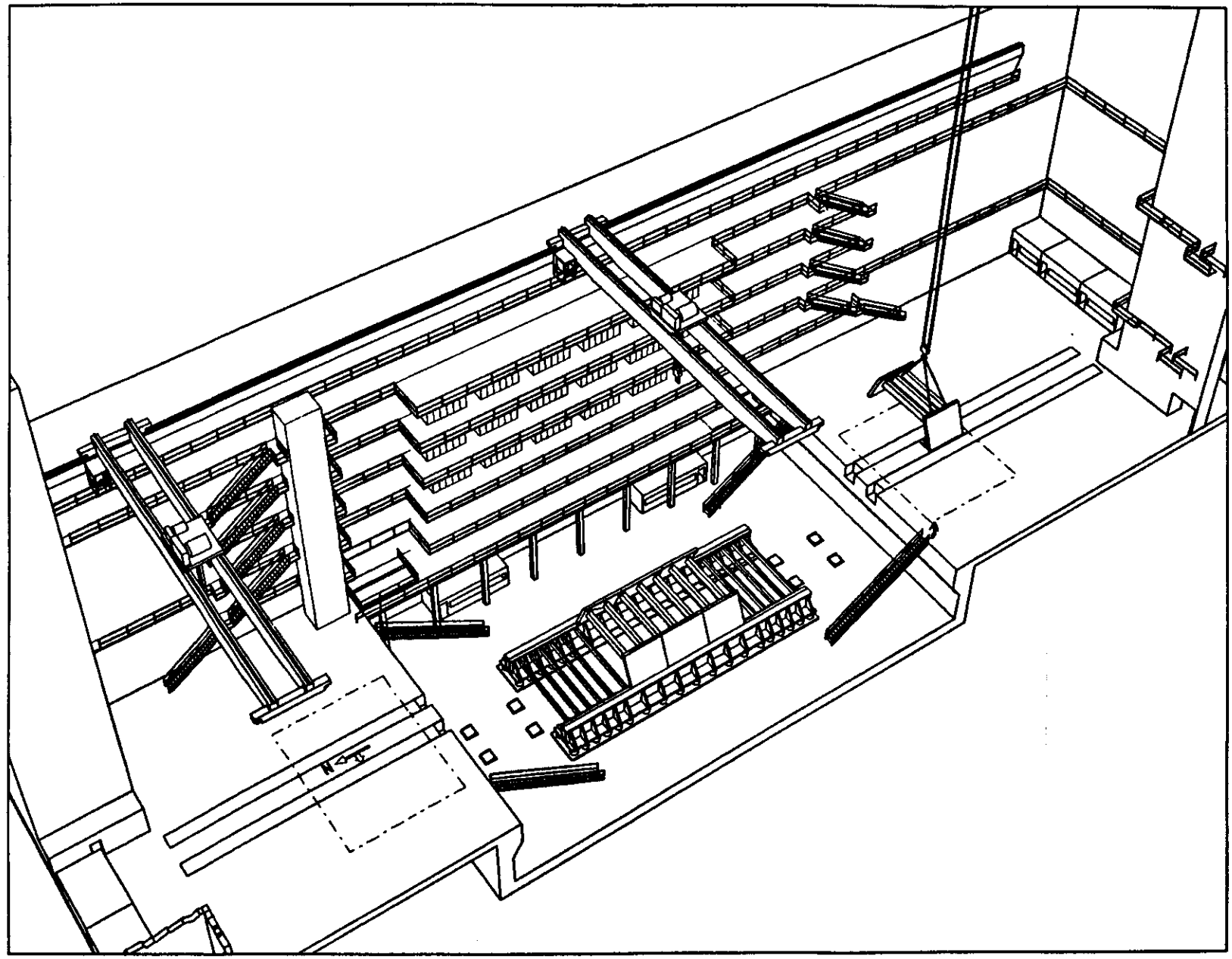


FIG 2

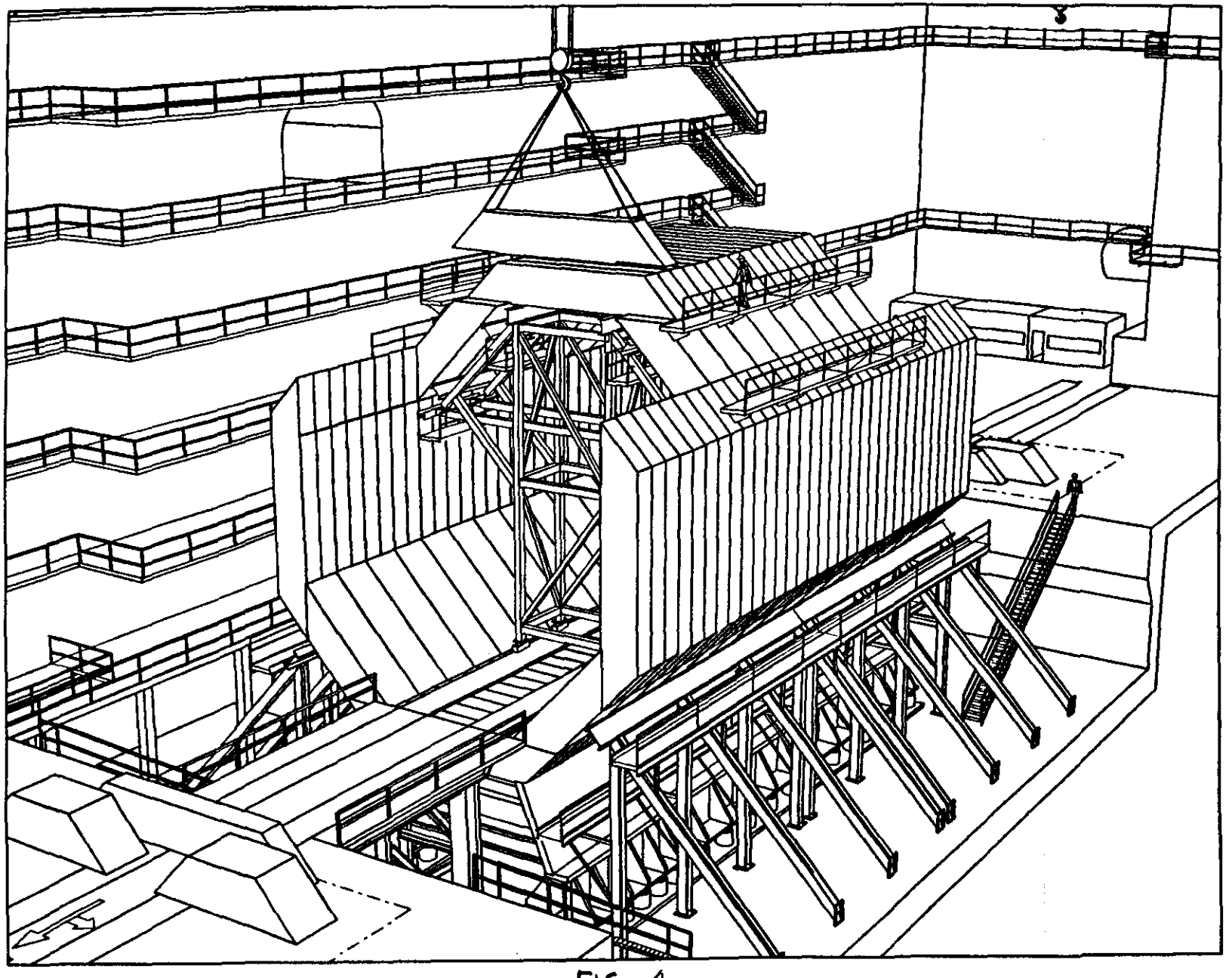


FIG 4

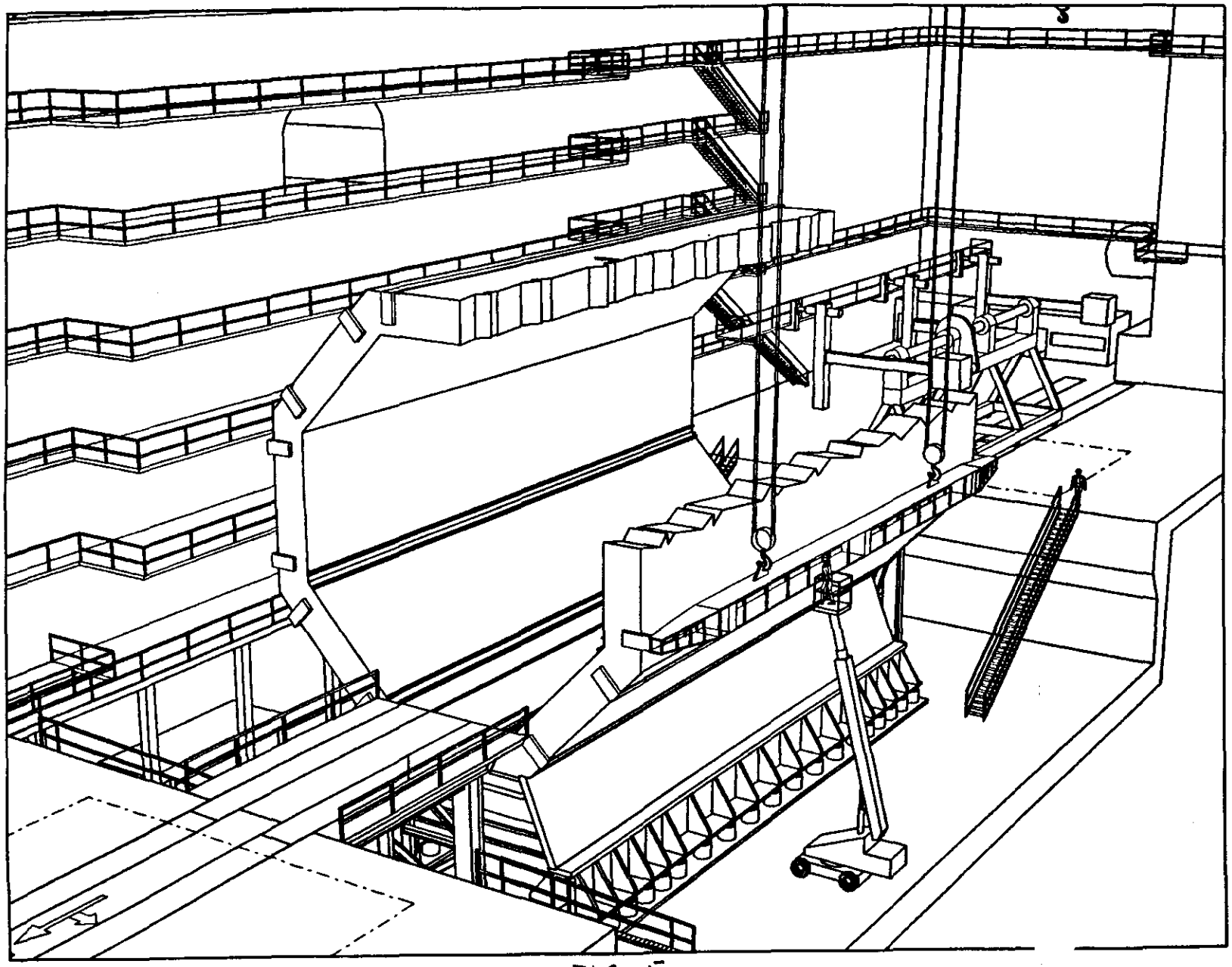


FIG 5

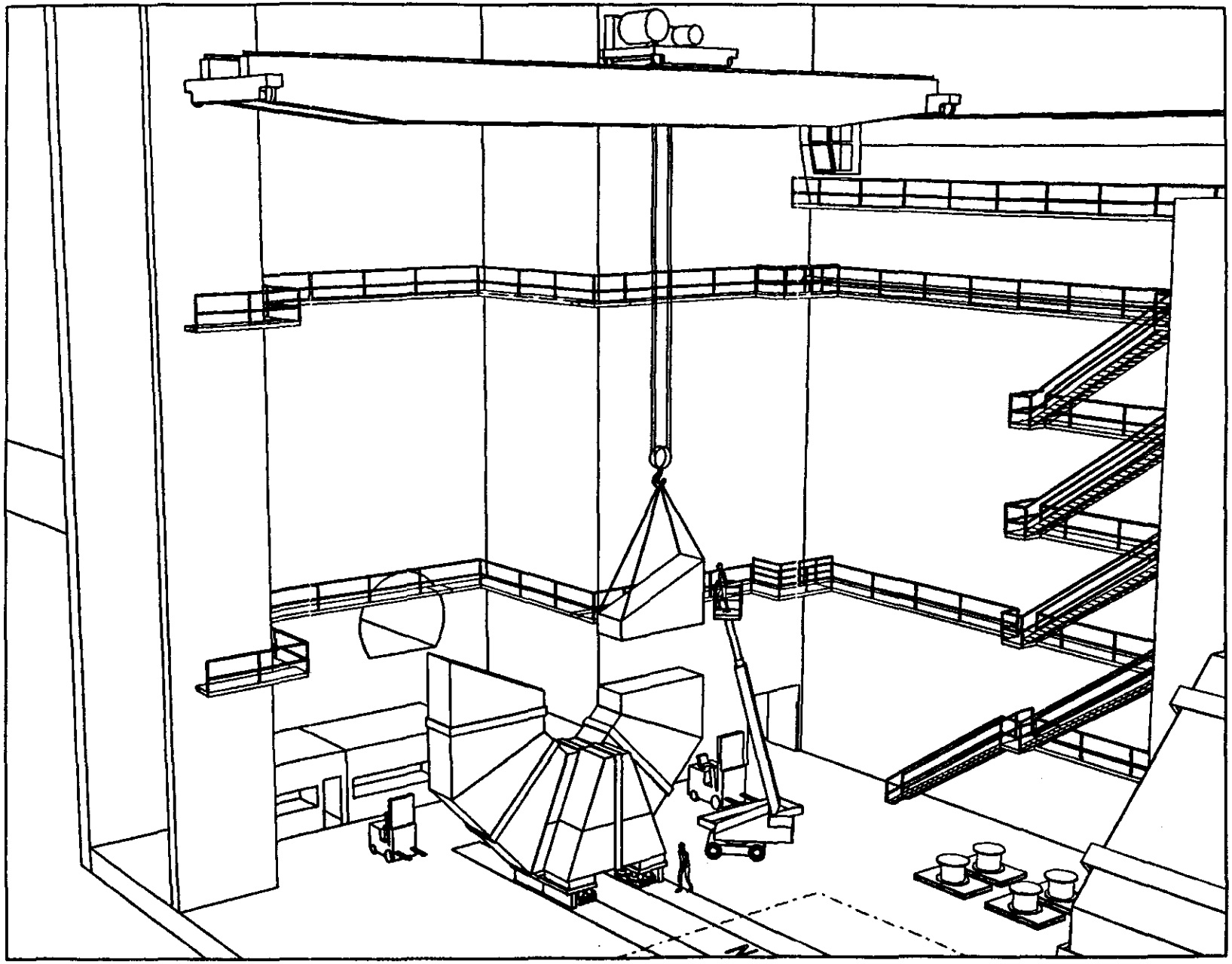


FIG 6

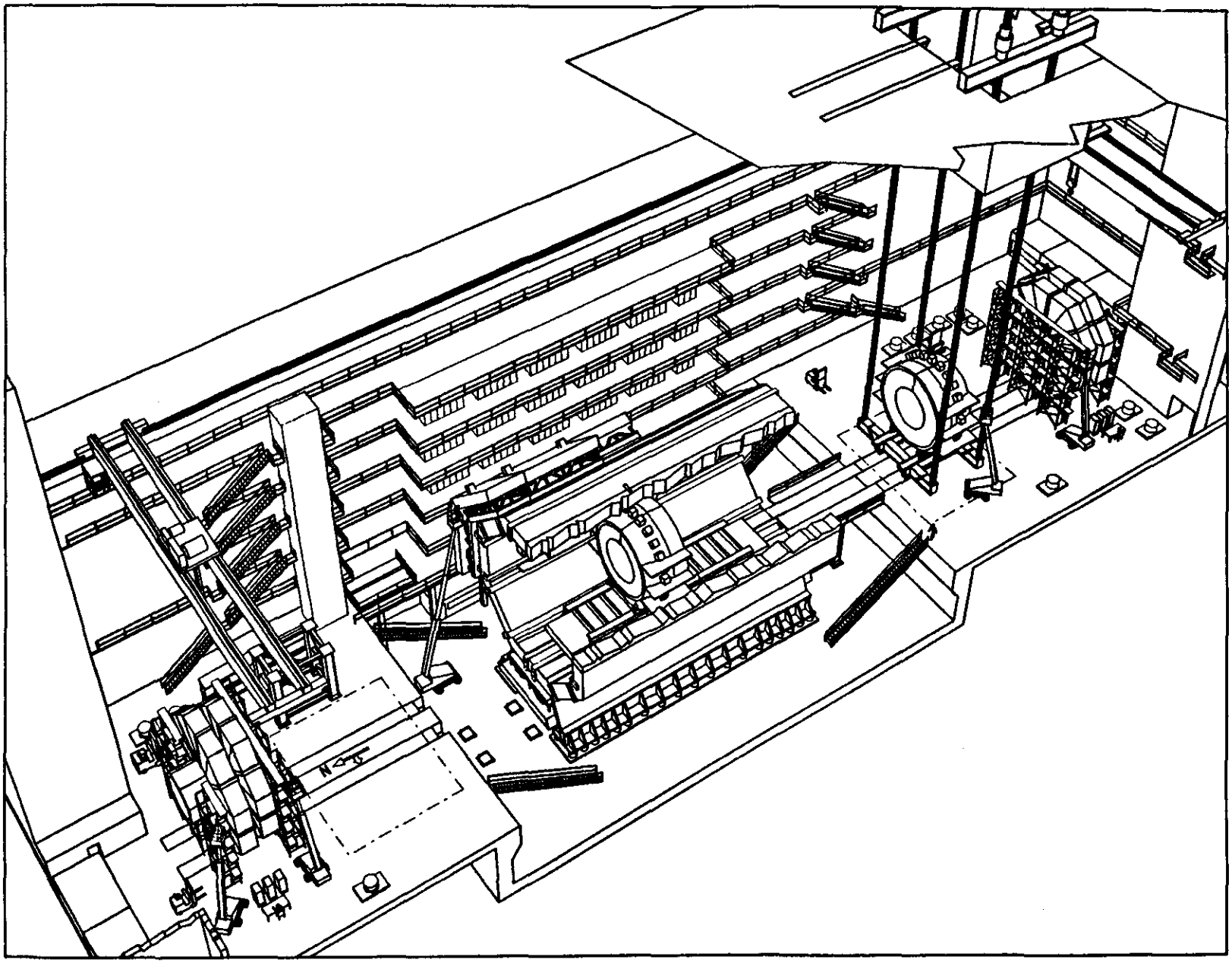


FIG 7

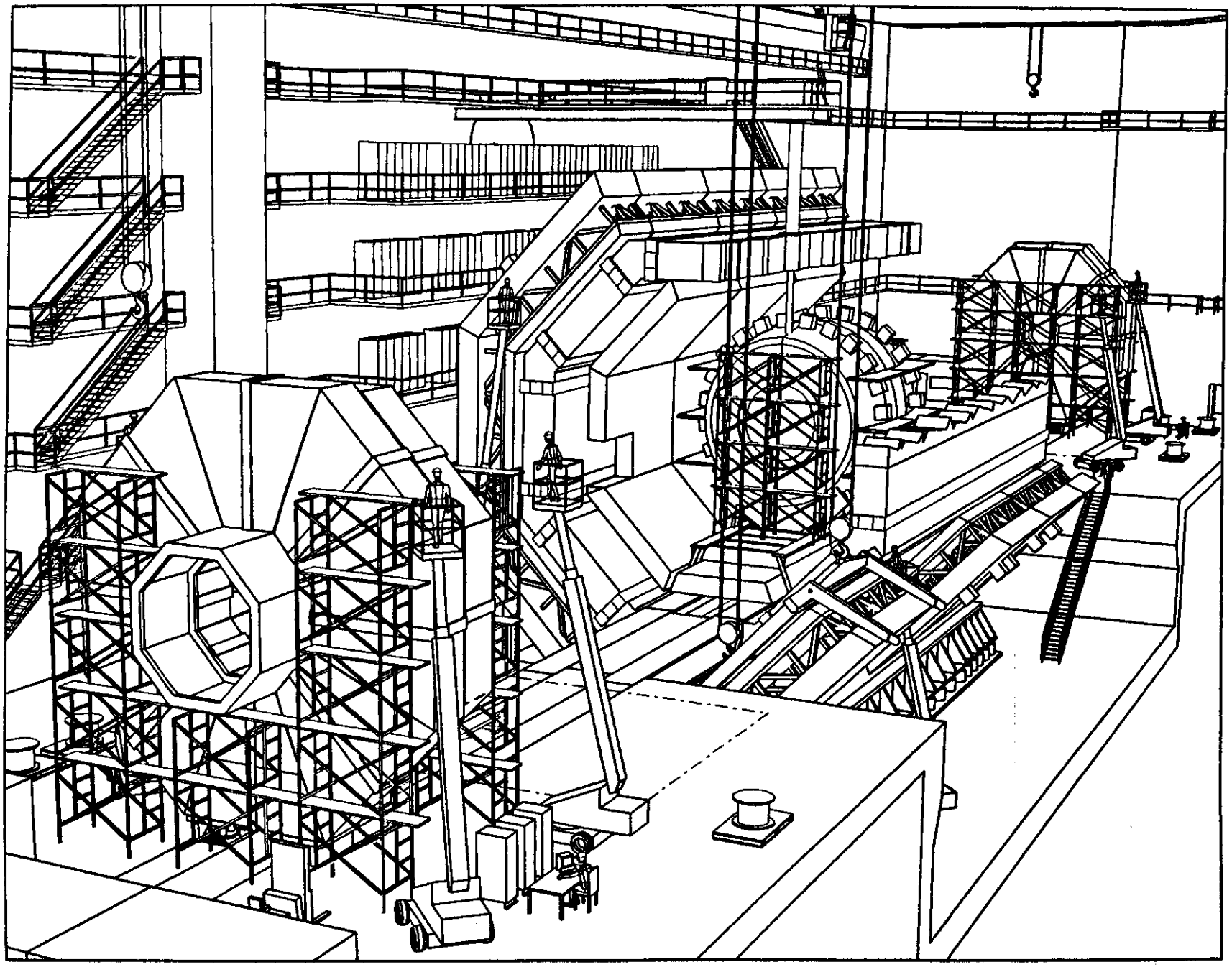
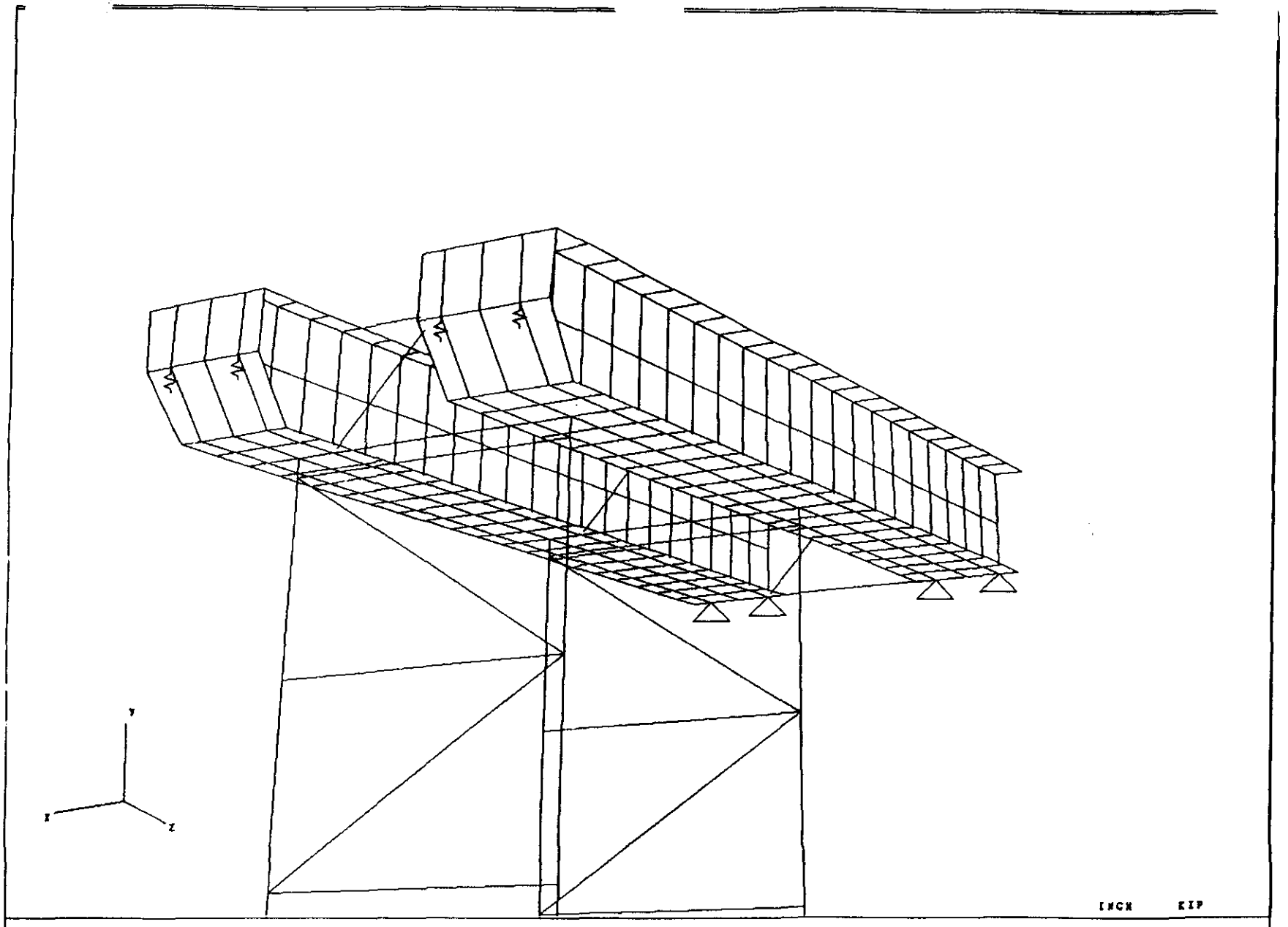


FIG 8



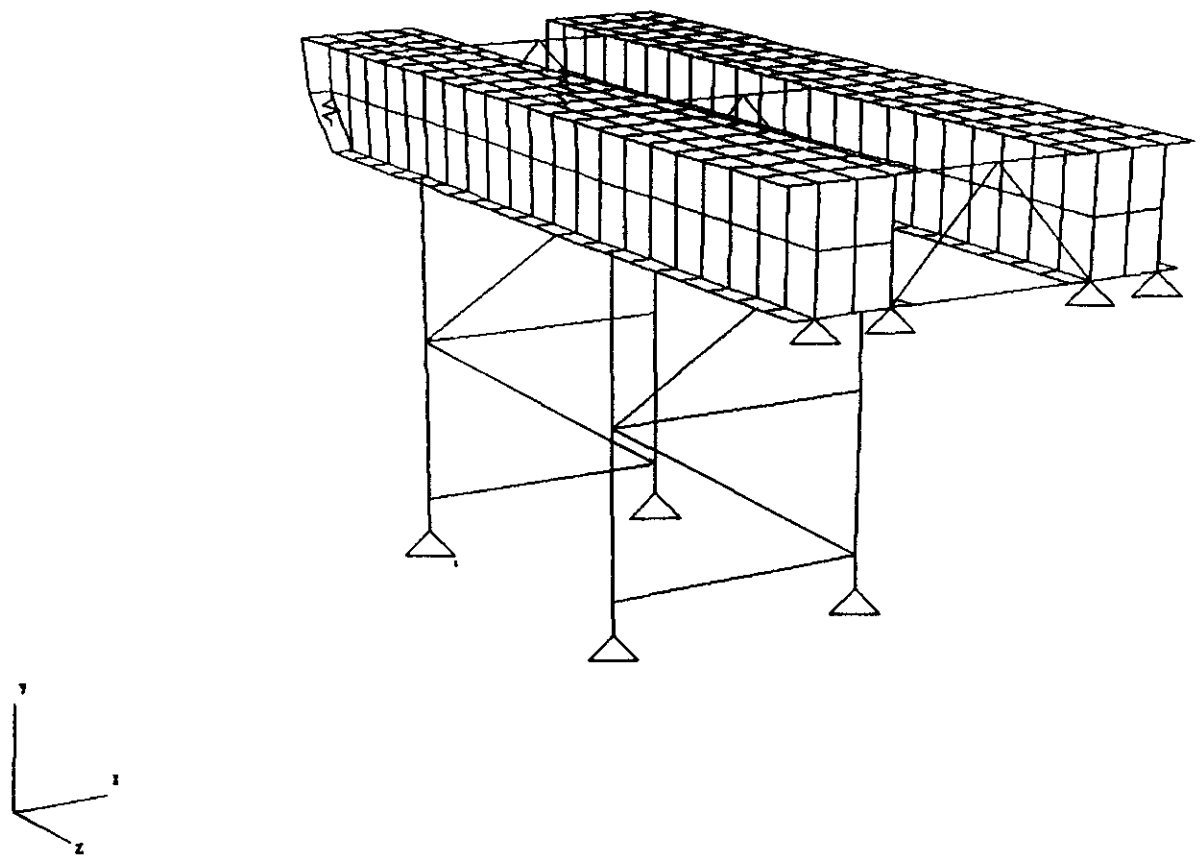
S T A A D P L - P L O T (REVISION 14.1)

COMPANY: ICF

DATE: FEB 19, 1992

TITLE: SUPERCOLLIDER - BRIDGE ANALYSIS WITH SPR

STRUCTURE DATA NJ= 548, NR= 41, NE= 577



INCH KIP

S T A A D P L - P L O T (REVISION 14.1)

COMPANY: ICF

DATE: FEB 19, 1992

TITLE: SUPERCOLLIDER - BRIDGE ANALYSIS WITH SPR

STRUCTURE DATA NJ= 548, NR= 41, NE= 577

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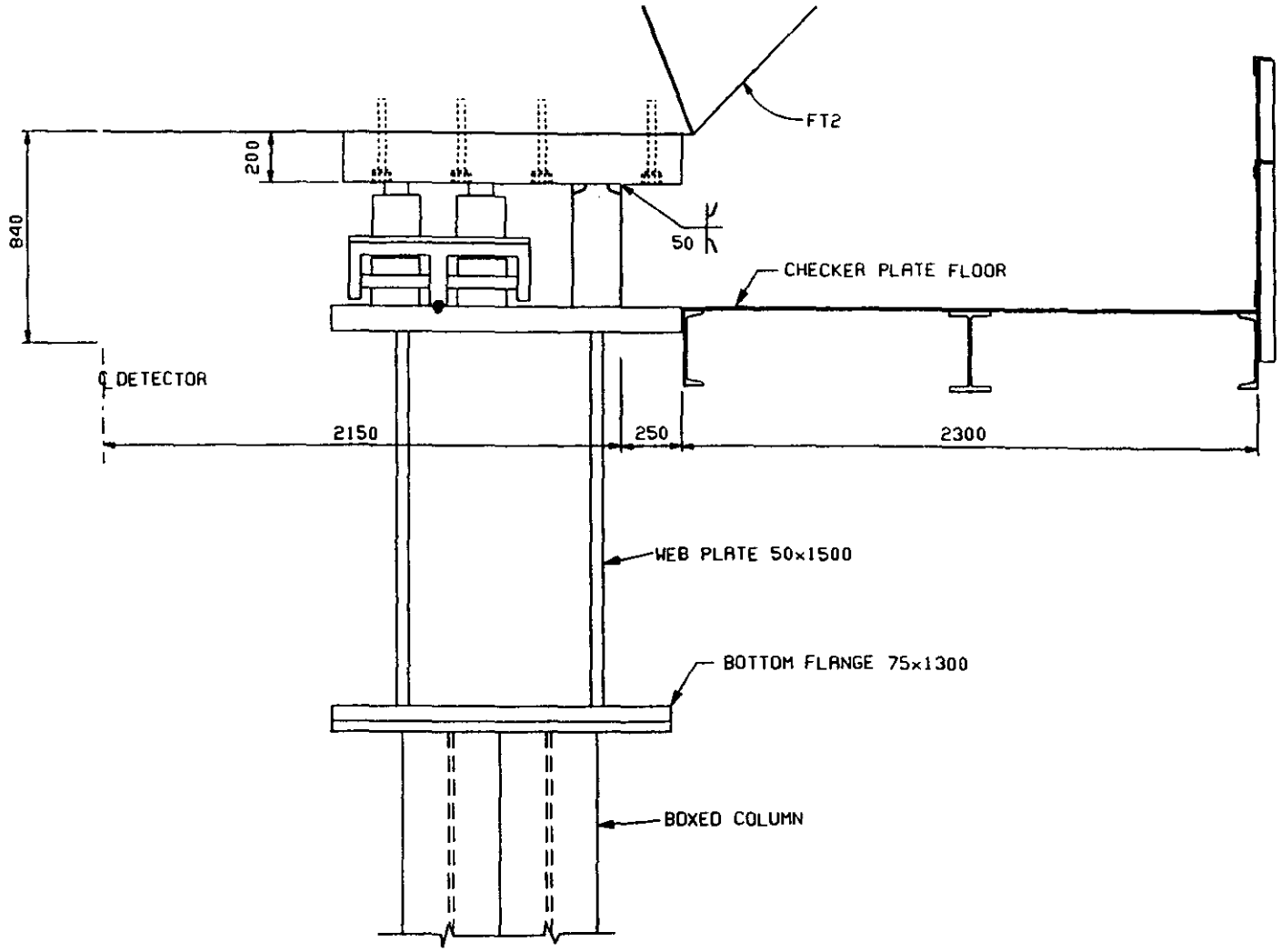


DETAIL 2 / 001-S

1:20

NO.	DATE	REVISION	BY	CHK.	APP.	APP	NOTES

APPROVAL	DATE	SCALE: AS SHOWN	DATE
		DESIGNED L. BITTERT	1/7/92
		DRAWN S. FLEMETIS	1/8/92
		CHECKED	
		REVIEWED	
		APPROVED	

ICF KAISER ENGINEERS

SDC DETECTOR

FORWARD TOROID
TRANSFER BRIDGE DETAIL SHEET 1

JOB NO. 92150-001 | DWG NO. 0012-S | REVISION A-0

MARCH

Detector Planning and Scheduling

3D modeling for the descoped version of the SDC detector was completed this month. These drawings (attached) will form part of the assembly chapter for the SDC Technical Design Report.

The first drawing shows a cutaway view of the assembled detector. Please note the disassembled bridges stored on the floor of the hall.

The second drawing shows the detector open for repairs and in the process of extracting the outer tracker. The drawing shows the quadrupoles, the muon chambers, the forward toroids and the endcaps all stored on the floor, however, depending on the amount of repair, it may be required to raise some of these components to the surface.

The picture for month 3 shows the muon steel support being erected.

Month 9 shows the steel blocks that form the magnet being bolted together.

Month 13 shows the overhead cranes holding a strongback used to hold a segment of the muon steel coil. A worker on a hydraulic lift is ready to crawl into the strongback to fasten the coil segment into position. The device shown at the end of the hall is used to install the interior coil segments, the interior muon chamber rails, the piping and electrical conduit.

Month 14 shows a forward toroid being assembled on top of Hillman rollers.

Month 20 shows the forward toroid steel erection completed and scaffolding for the installation of support devices for the muon chambers and for the installation of piping, conduit and wiring. The drawing also shows the phase 1 installation.

Month 24 shows the solenoid being installed and continuation of the installation of the barrel muon chambers.

Month 25 shows the endcaps being lowered to the hall floor.

Month 27 shows the installation of muon chambers on octant 4.

Month 34 shows the endcaps in temporary storage and the outer tracker being installed.

Month 35 shows the installation of muon chambers on the forward toroids.

On month 39, the forward calorimeters will be lowered. The drawing shows the installation of the barrel muon chambers completed and the intermediate chambers in the process of being installed.

The drawing for month 48 shows the detector complete.

Forward Toroids (See Figs. 1-4)

Load distribution analysis to extablish maximum roller loadings for the various options of assembly scenarios have been completed. Calculations indicate that stability of the FT Assembly during movement out of the barrel is not a problem, however, when FT1 is separated form FT2 (tie plates removed) for the installation of FW3 or for other reasons, FT2 becomes nearly unstable for overturning. This means that before the two toroids are separated a temporary support cradle must be installed under the support sleeve.

FE analysis of the toroids to determine bolt and shear key sizes for holding the blocks together continued. It appears that all shear keys can be made of the same materials as the blocks. This would result in minimum change of the flux distribution around lthe shear keys.

configuration of the support system have been finalized. The hydraulic jacks above the rollers will be vlaved together so that the four rollers of the support system may move over small depressions or hills withouit overstressing the rollers. This may also permit the use of the FT Transfer Bridge as a shallow ramp to make up small differences in elevations between the Operating Floor and the Barrel. This would eleiminate the need to distrub the alignment of the barrel for the purpose of moving the toroid out of the barrel and onto the Operating Floor.

The means of adjusting the elevation, tilt, and side-to-side position of the FT Assembly in the Barrel have been also determined. These adjustments will be performed by installing flat and/or tapered shims under the FT support frame, and by rolling the Assembly side-to-side.

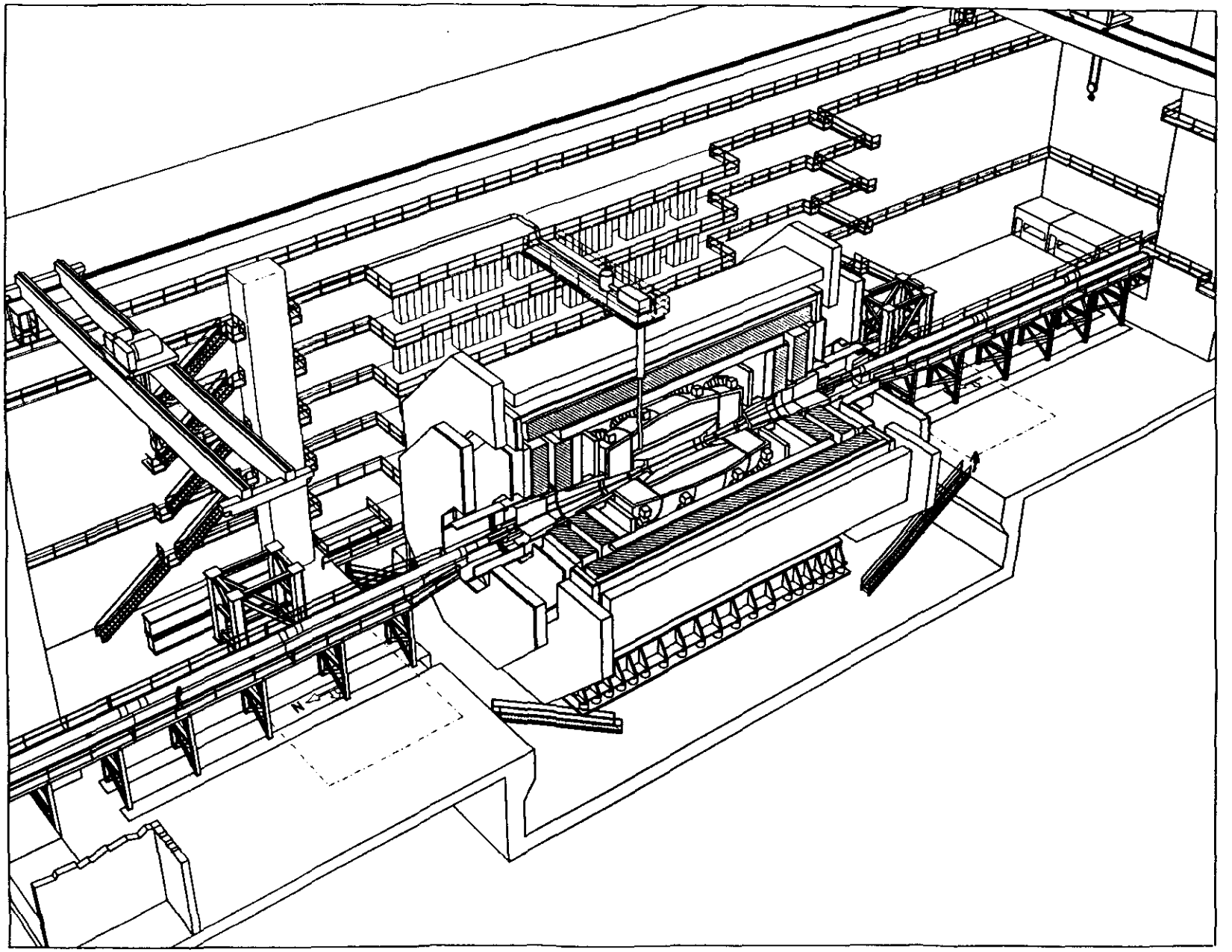
FT Transfer Bridge (See Fig. 5)

Drawings of the support bridge are in progress. Installation procedures of the Transfer Bridge and it's support frames have been developed. The number of muon chamber panels to be removed before the bridge can be installed and the FT ASsembly moved onto the Operating Floor can be minimized by adjusting the size and the split of the chamber modules. We note that, for instance, if all segments have to be removed and stored on the Operating Floor space in the hall for other operations will be extremely limited.

Details of a push-pull hydraulic jacking and electronic control system connected to the FT transport frame via two pipe struts have been finalized.

Interface Details

Interface details and loadings on the detector basement, on the Operating Floor, and on the end of the barrel have been established. Drawings to show these details are being prepared.



HK KAISER ENGINEERS

SDC DETECTOR CUTAWAY VIEW

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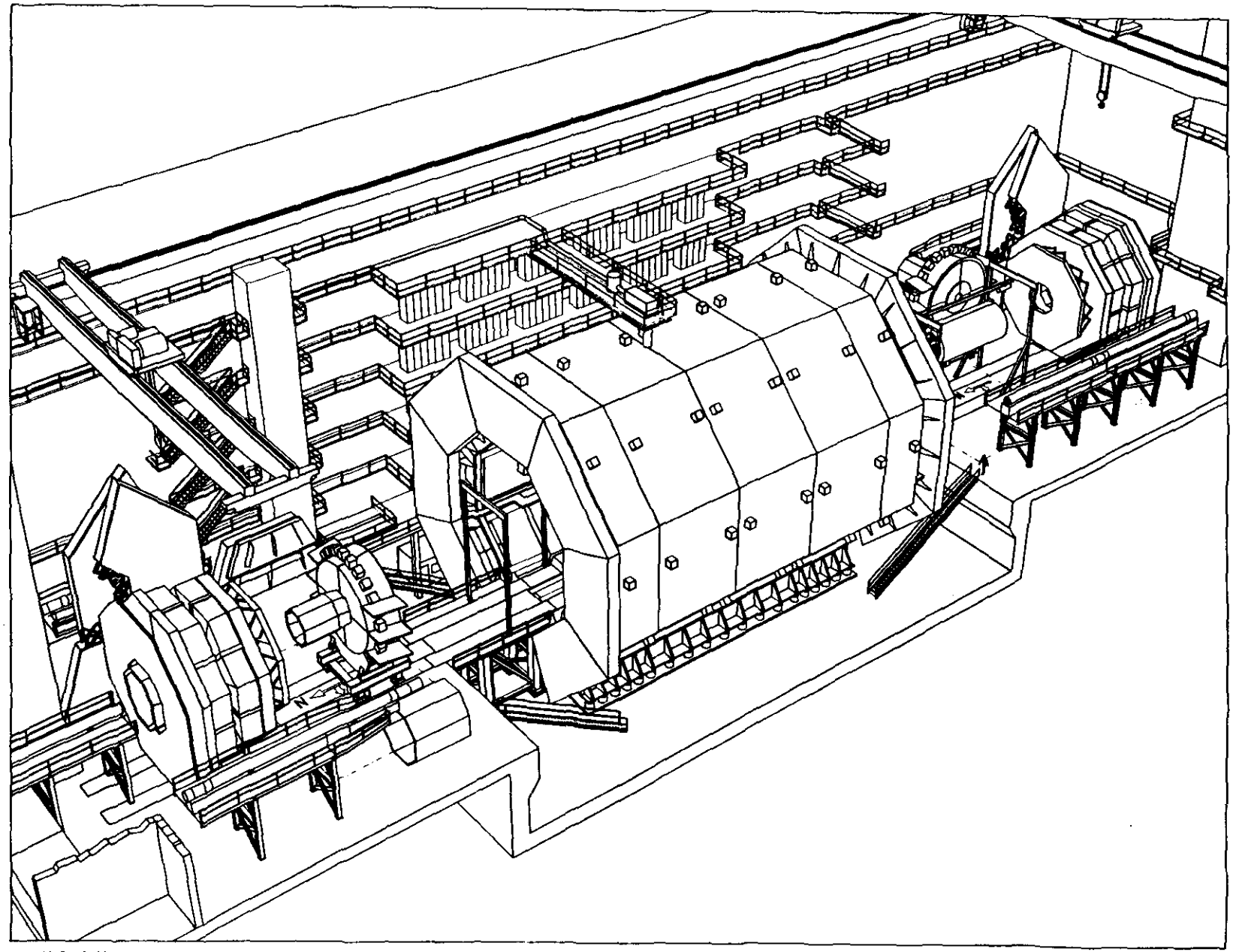

ICF KAISER ENGINEERS

SDC DETECTOR - OPEN FOR REPAIRS

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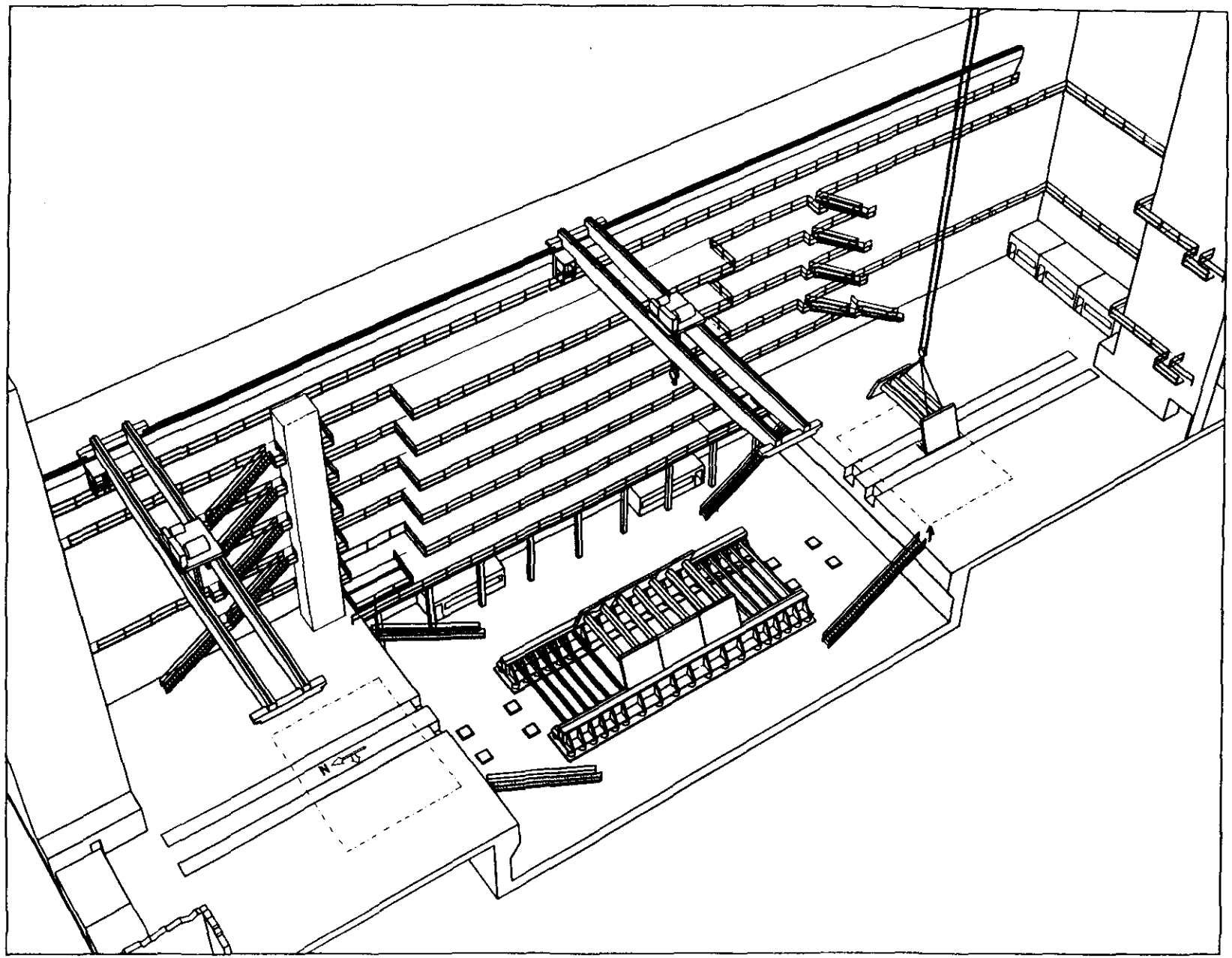

SDC DETECTOR - C RUCTION PROGRESS

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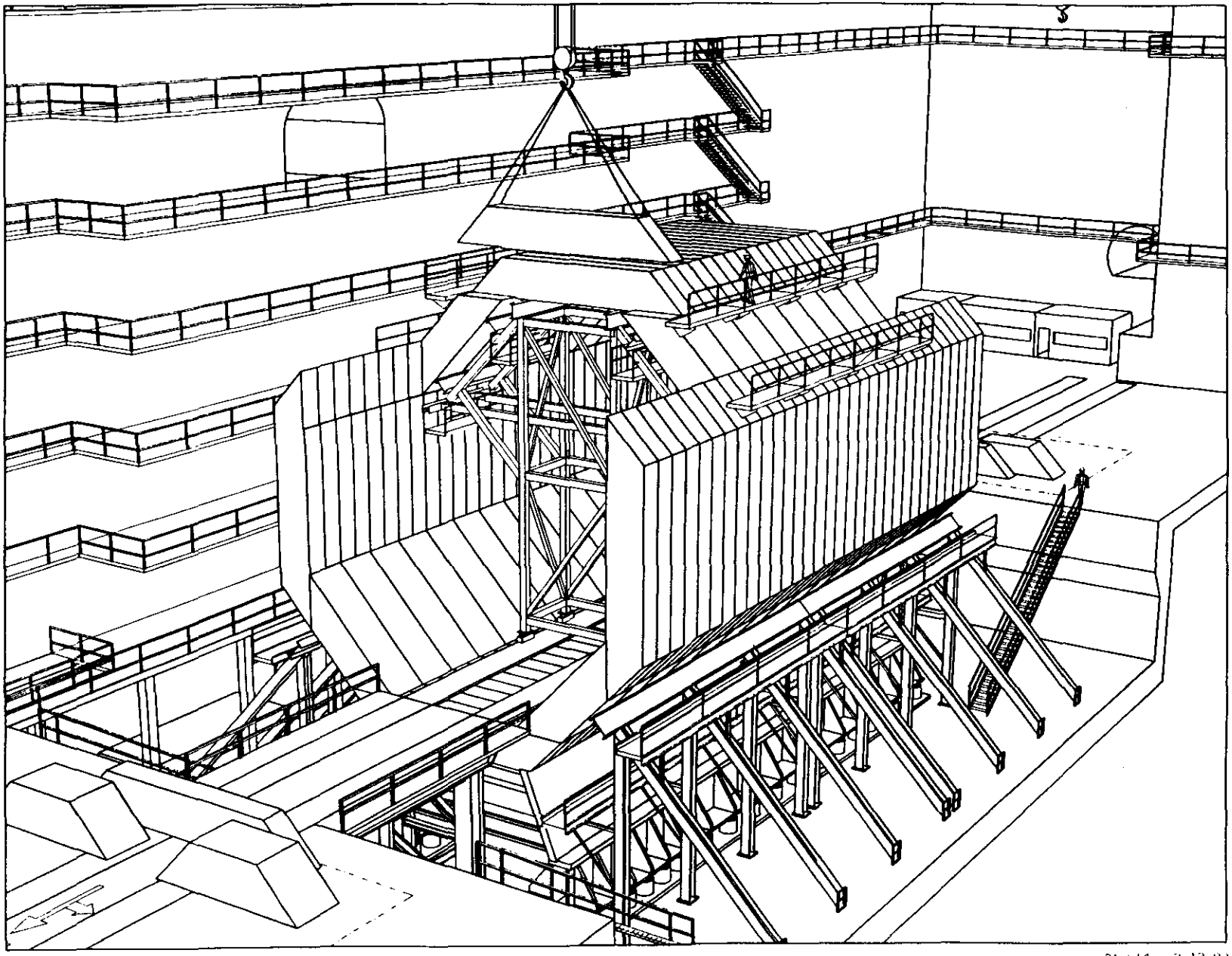

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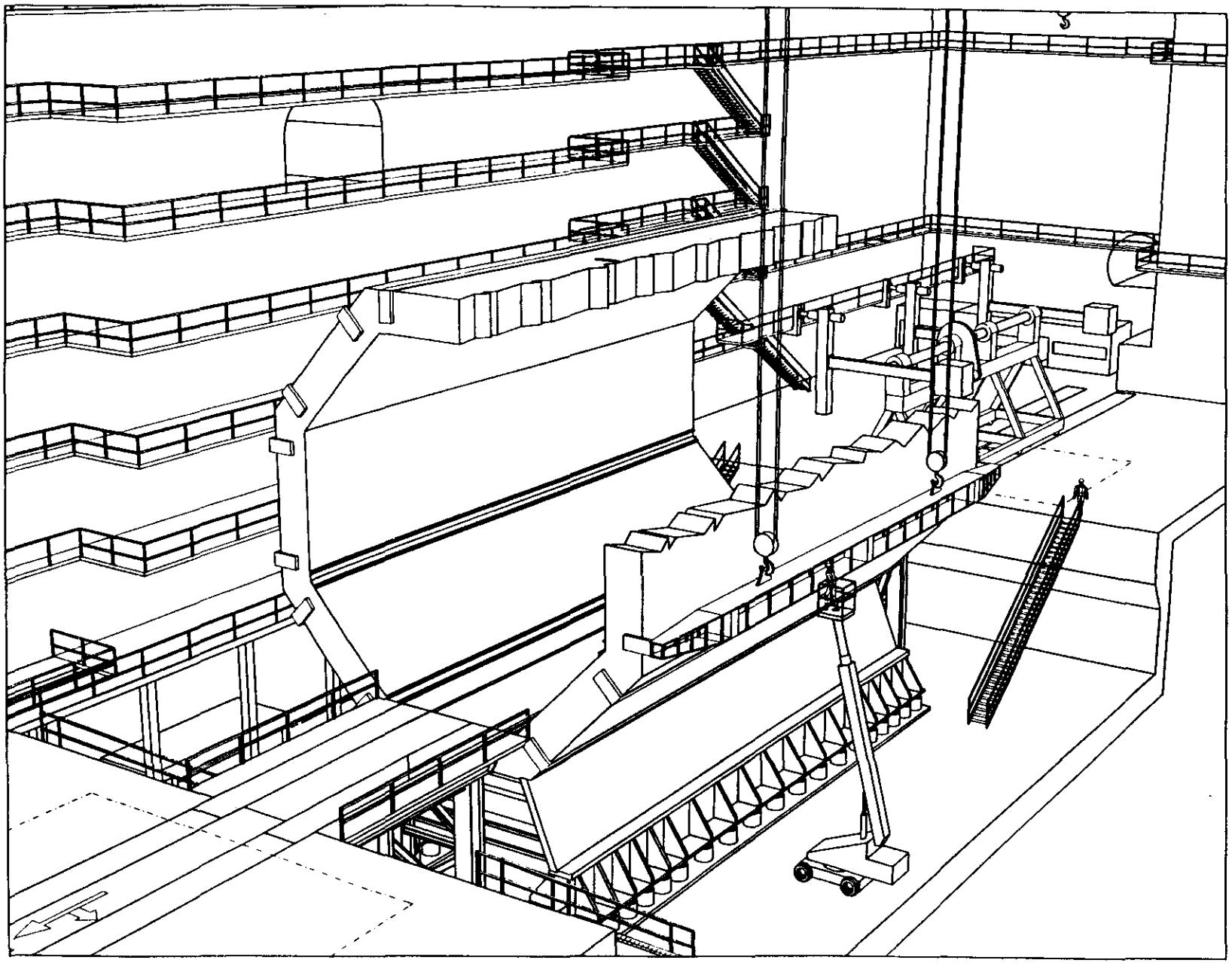
SDC DETECTOR - CONSTRUCTION PROGRESS

MONTH 9



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SDC DETECTOR - CO UCTION PROGRESS

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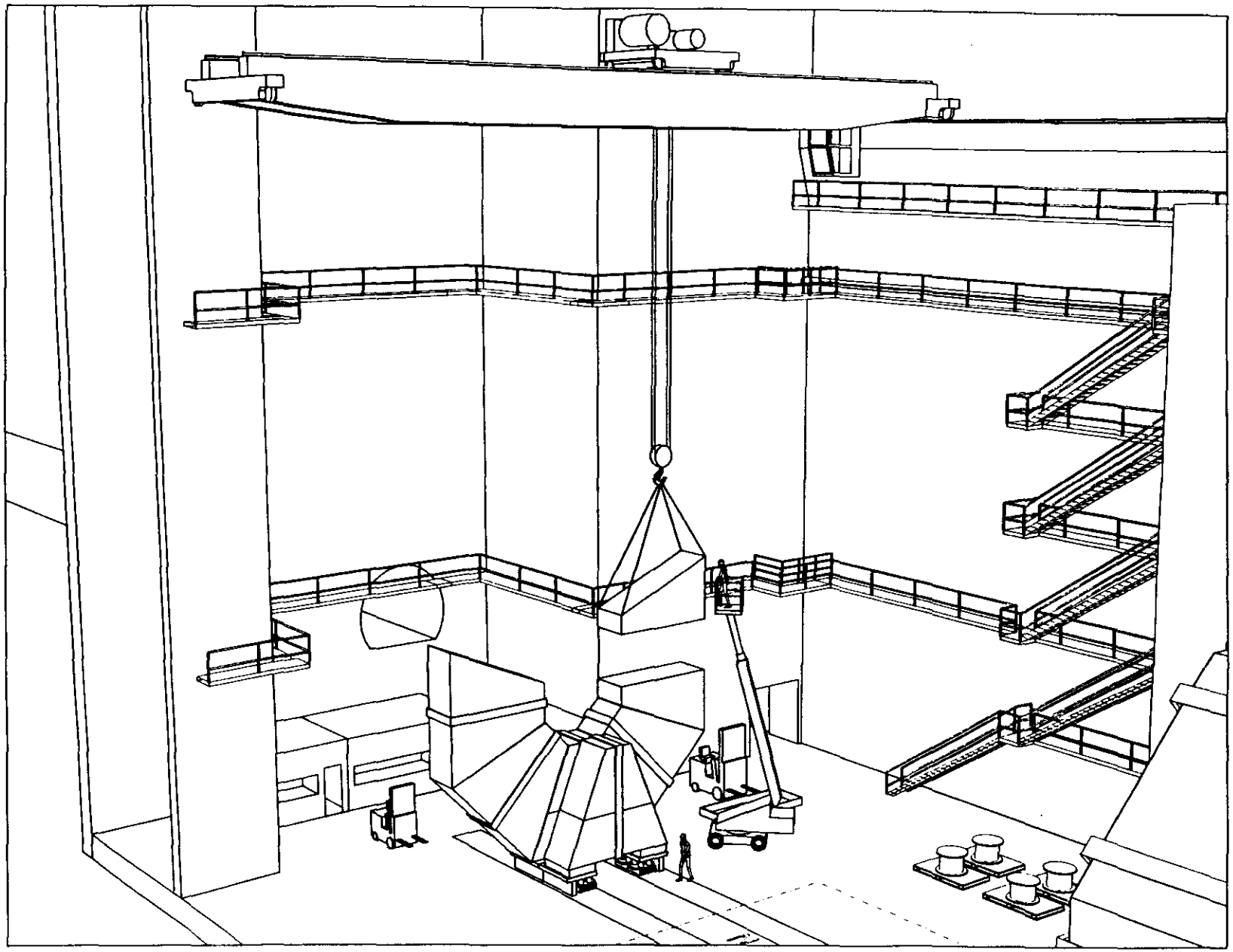

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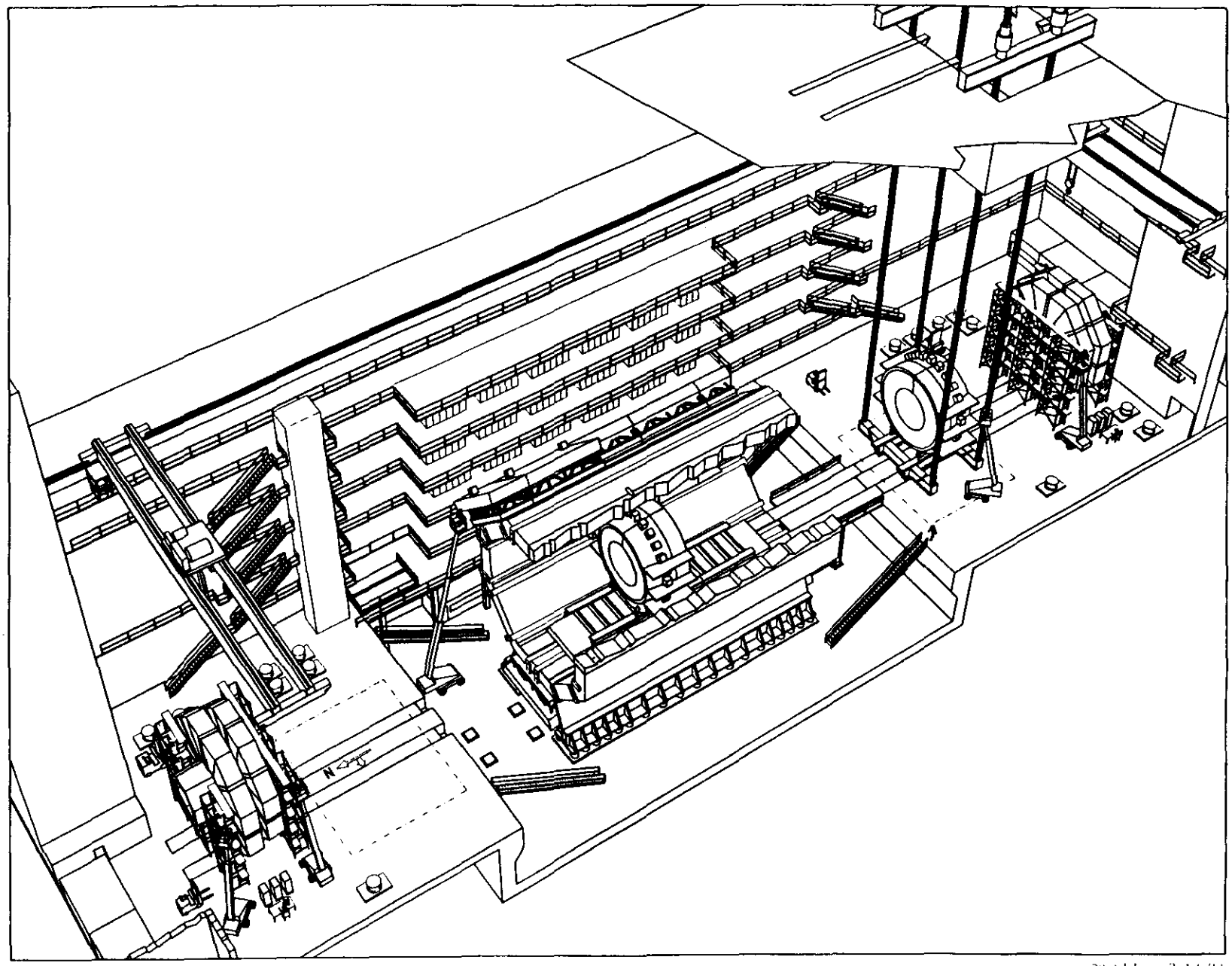
MONTH 14



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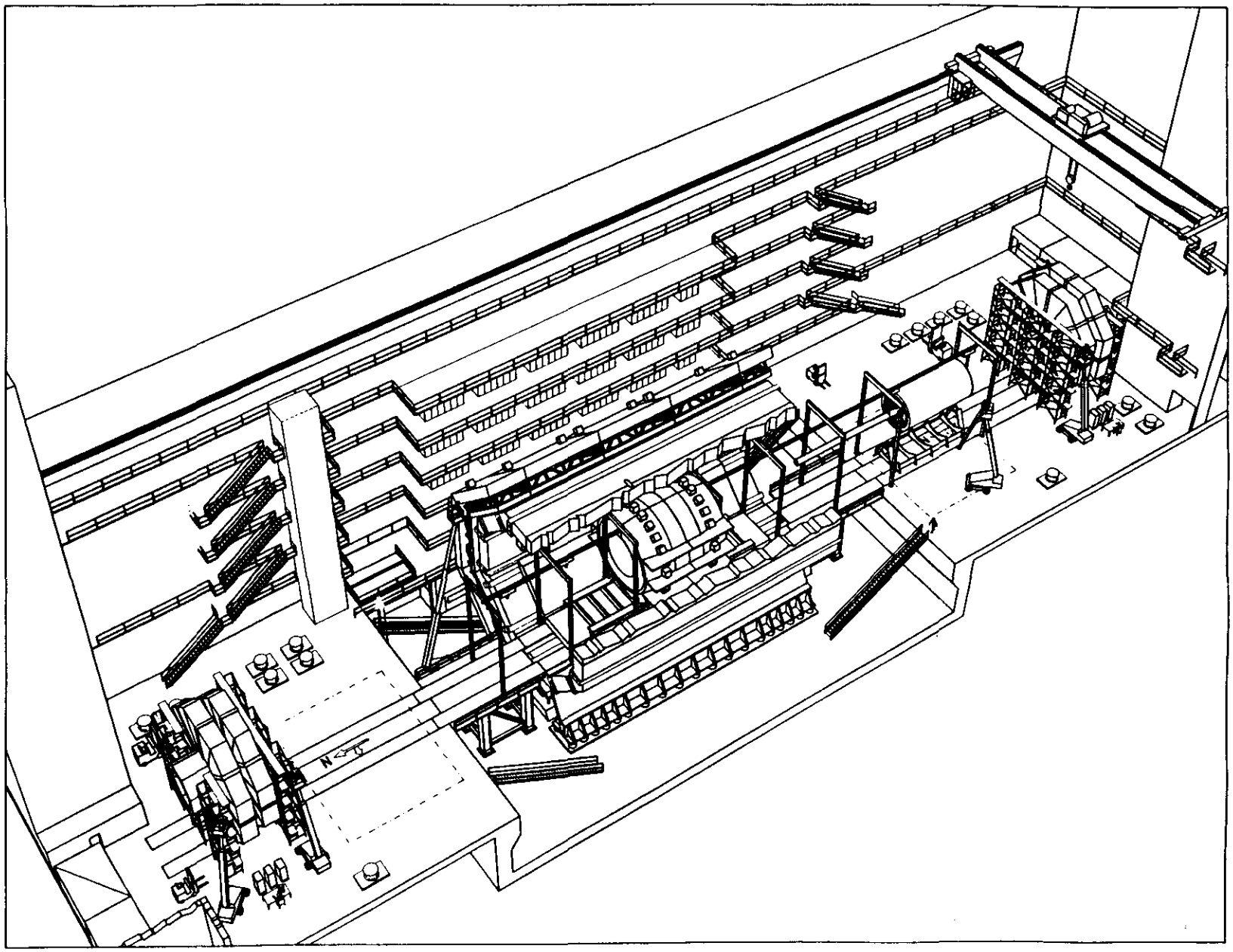

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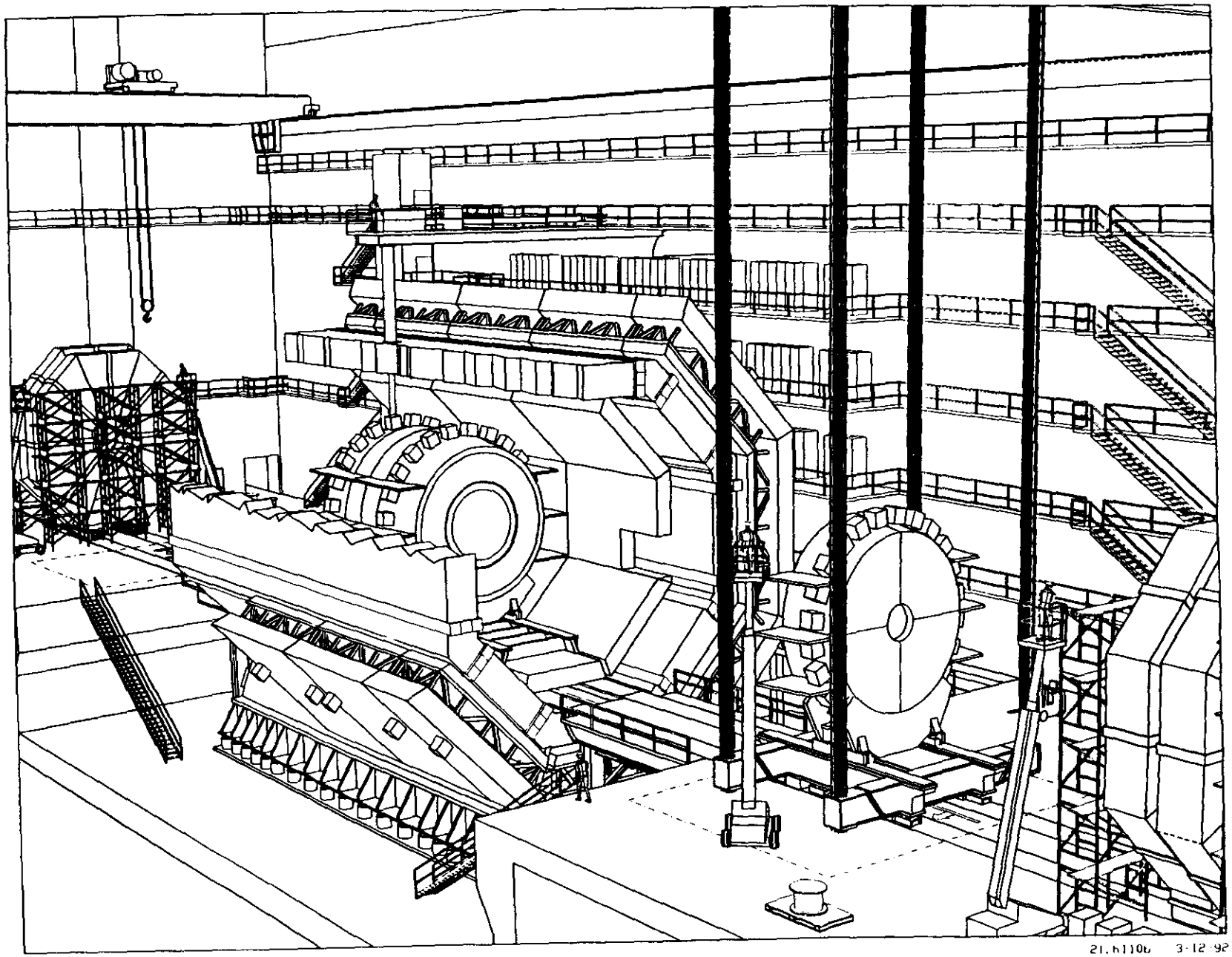
SDC DETECTOR - CONSTRUCTION PROGRESS

MONTH 24



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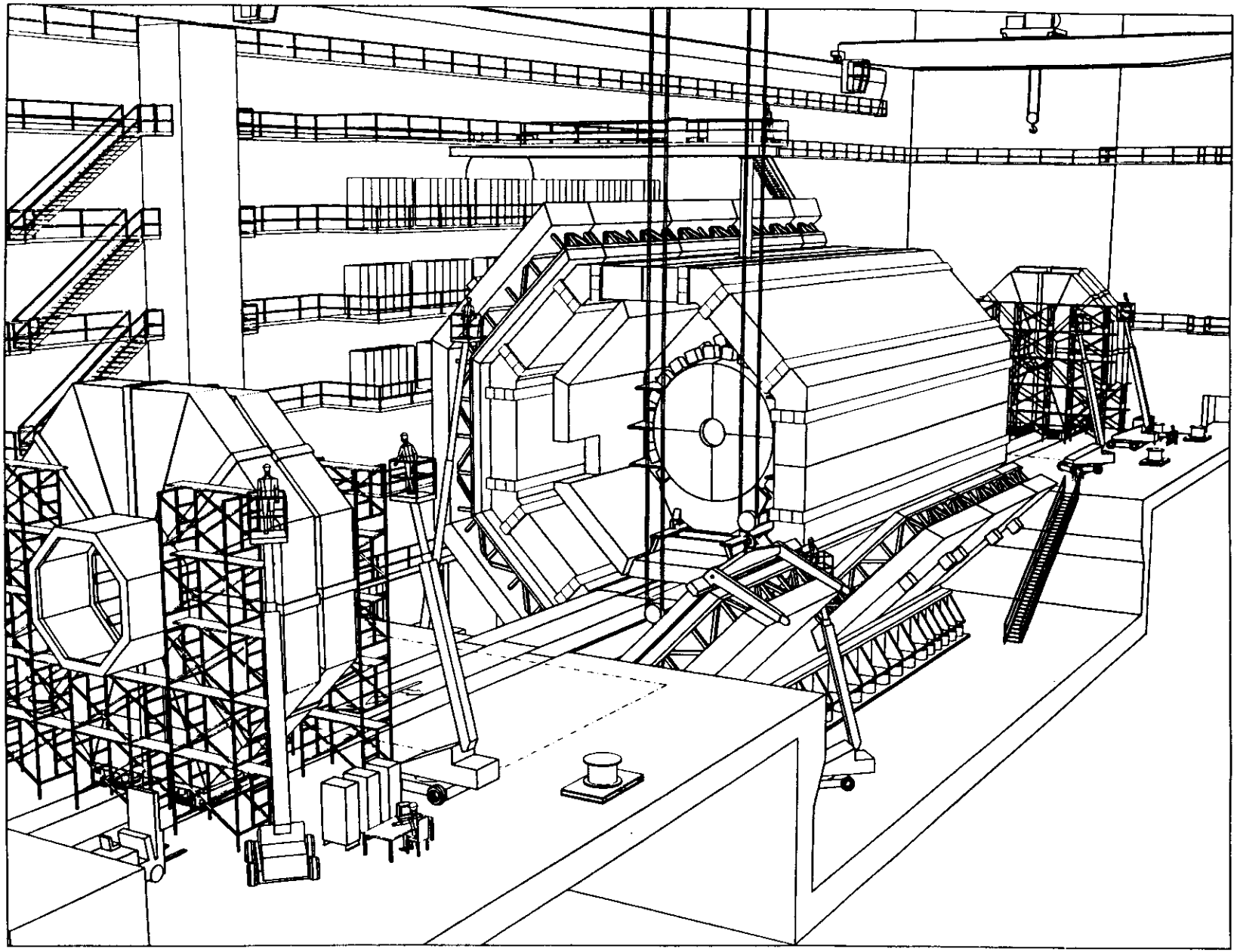
SDC DETECTOR - CONSTRUCTION PROGRESS

MON 25



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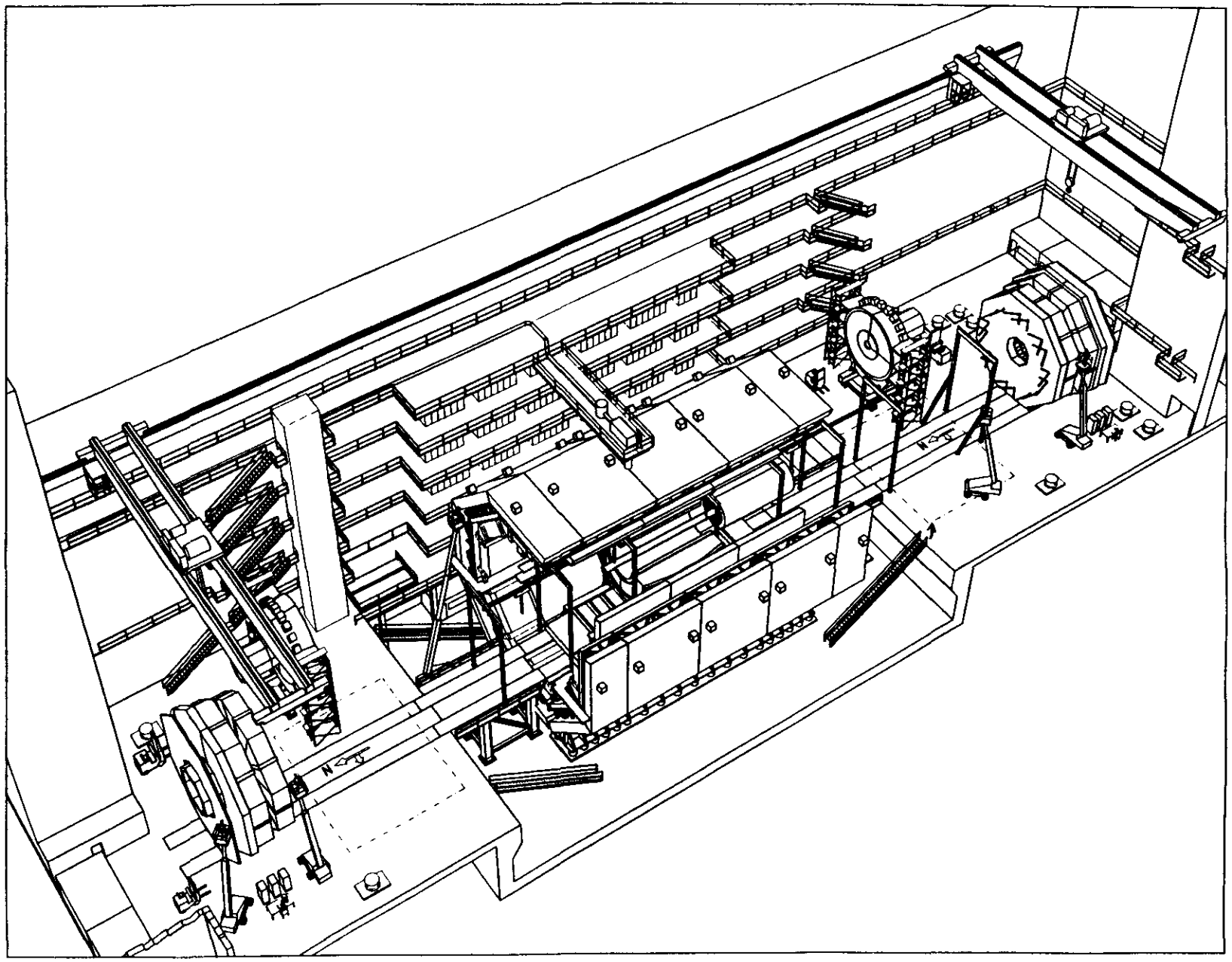
SDC DETECTOR - CONSTRUCTION PROGRESS

MONTH 27



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SDC DETECTOR - C RUCTION PROGRESS
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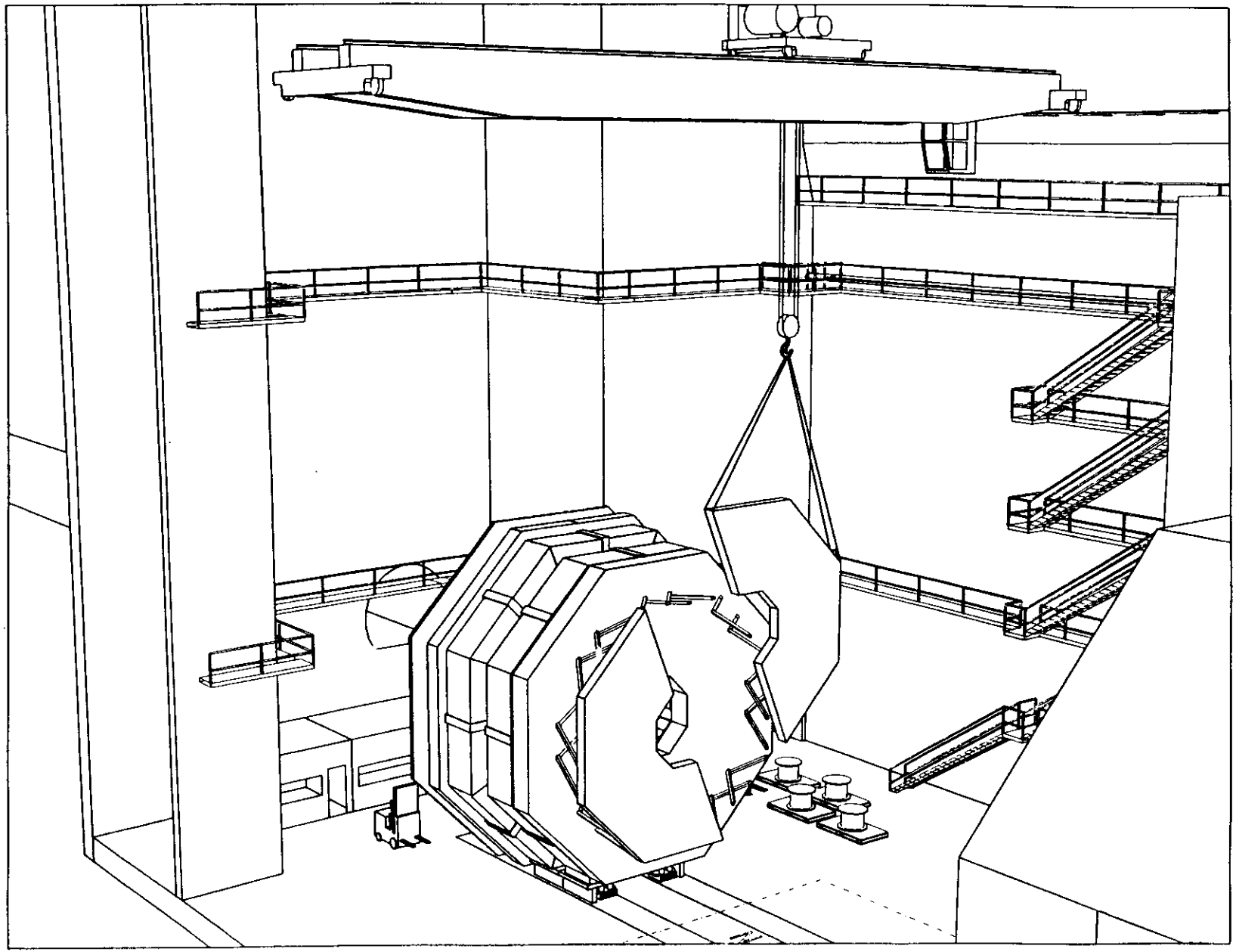

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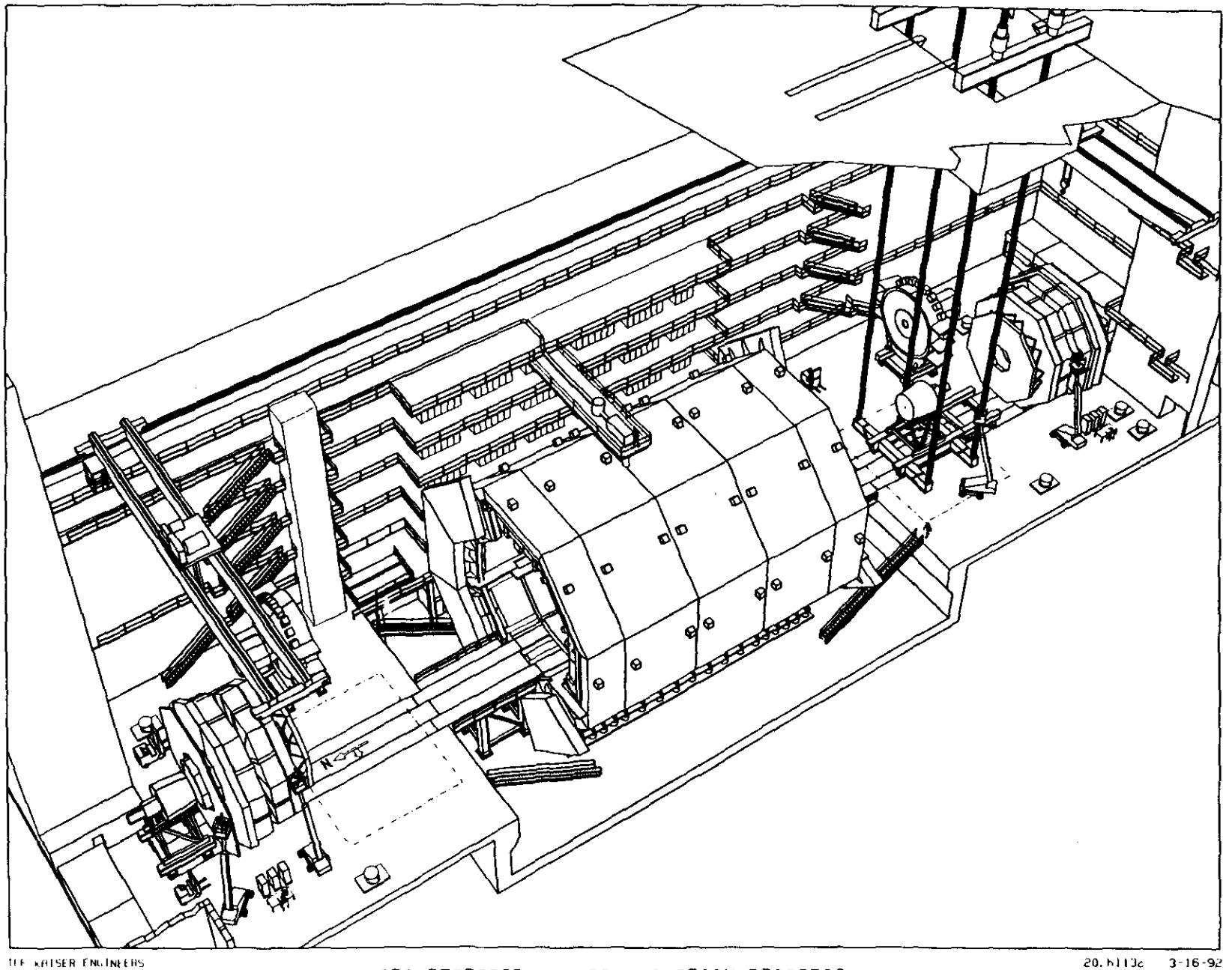
SDC DETECTOR - CONSTRUCTION PROGRESS

MONTH 35



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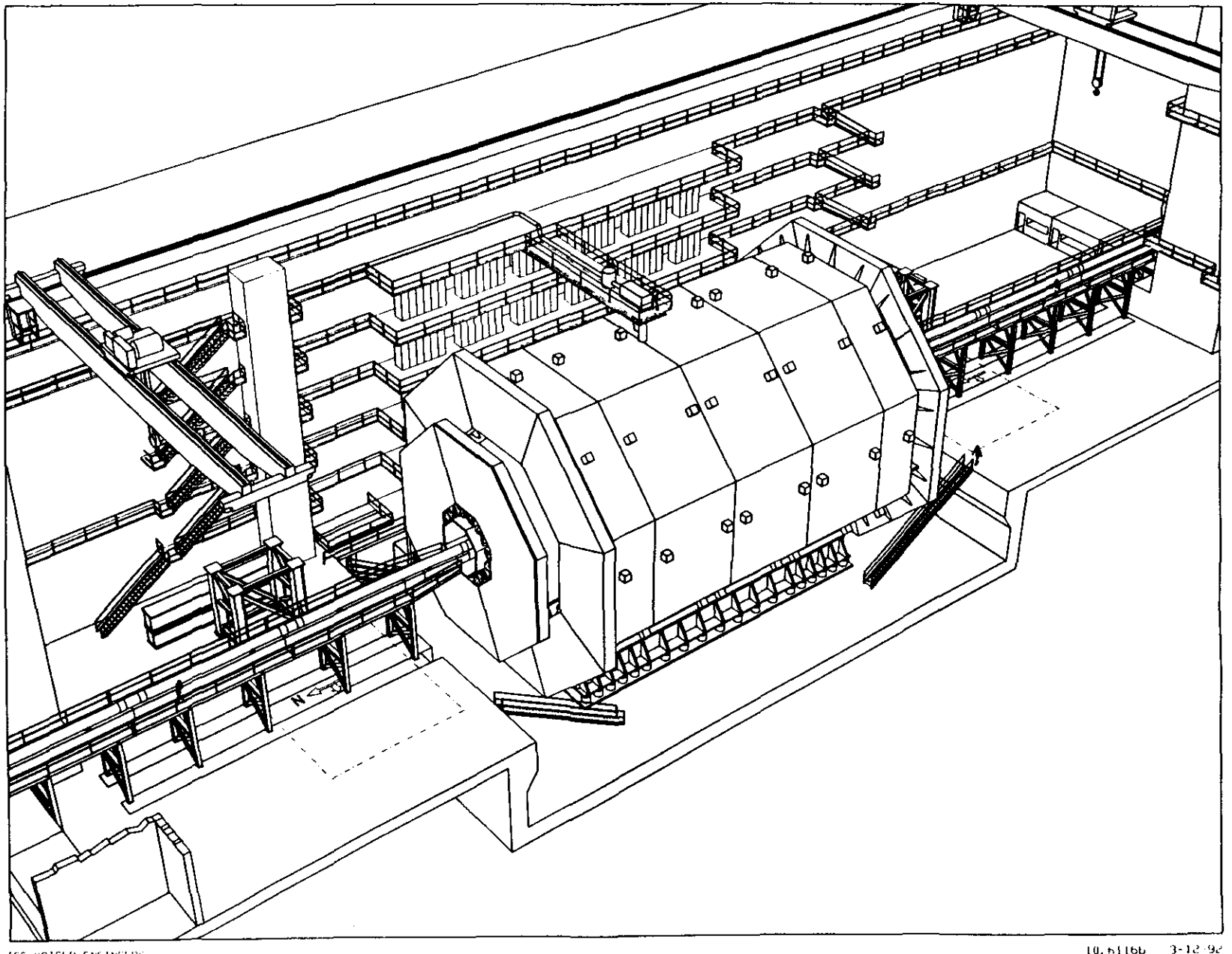

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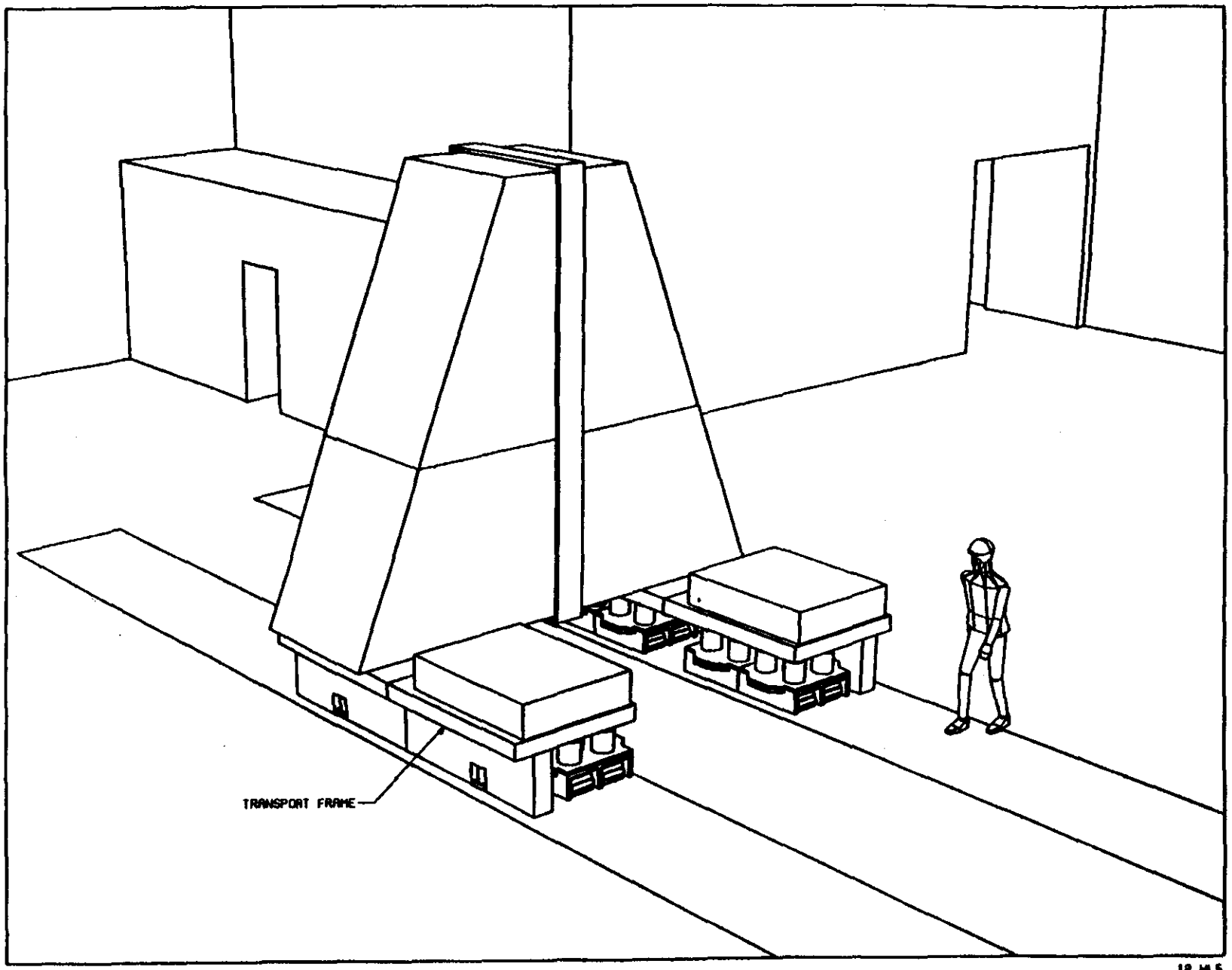
SDC DETECTOR - CONSTRUCTION PROGRESS

MONTH 48



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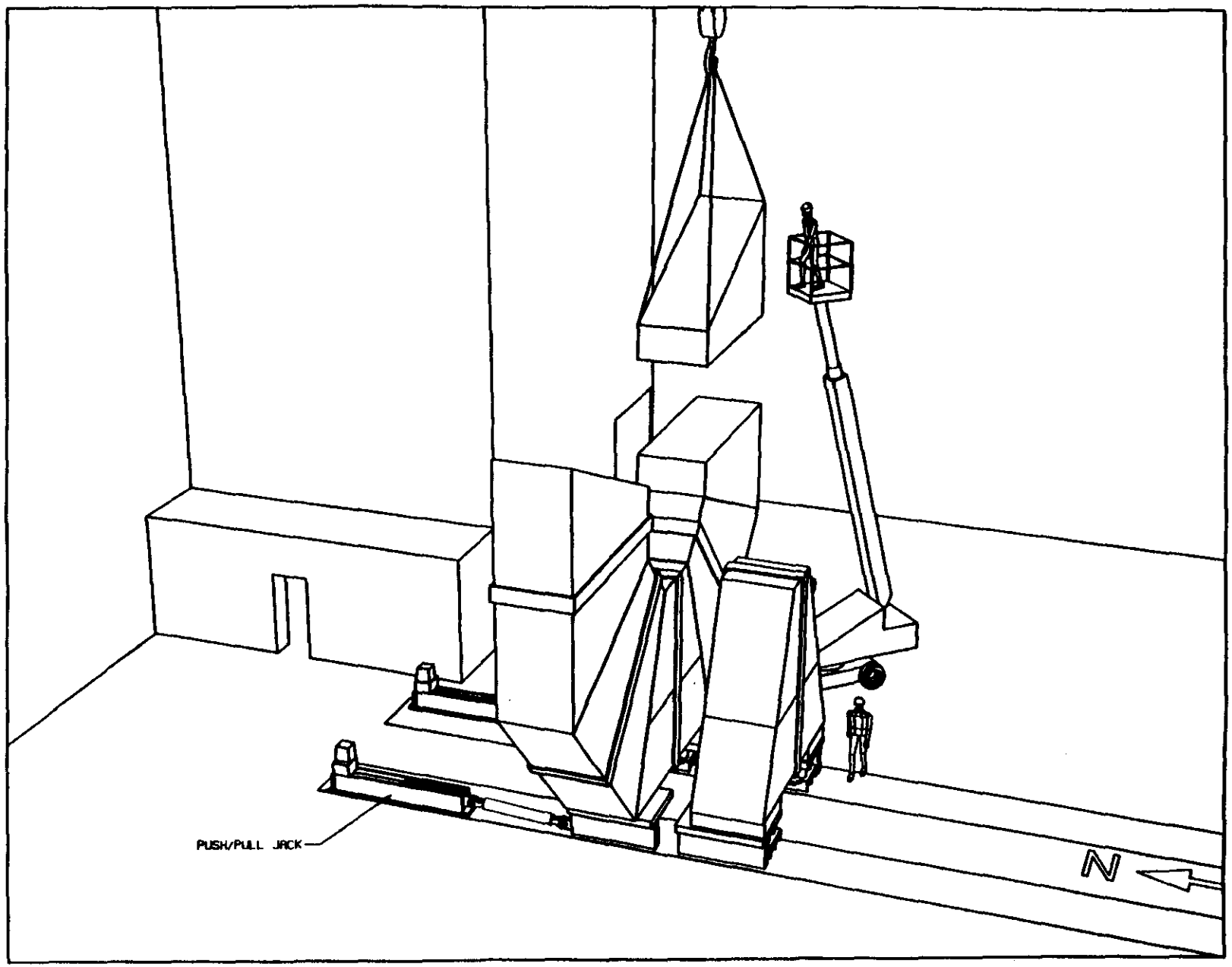
SDC DETECTOR - FORWARD TOROID CONSTRUCTION
FIGURE 1



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SDC DETECTOR - FORWARD TOROID CONSTRUCTION

FIGURE 2

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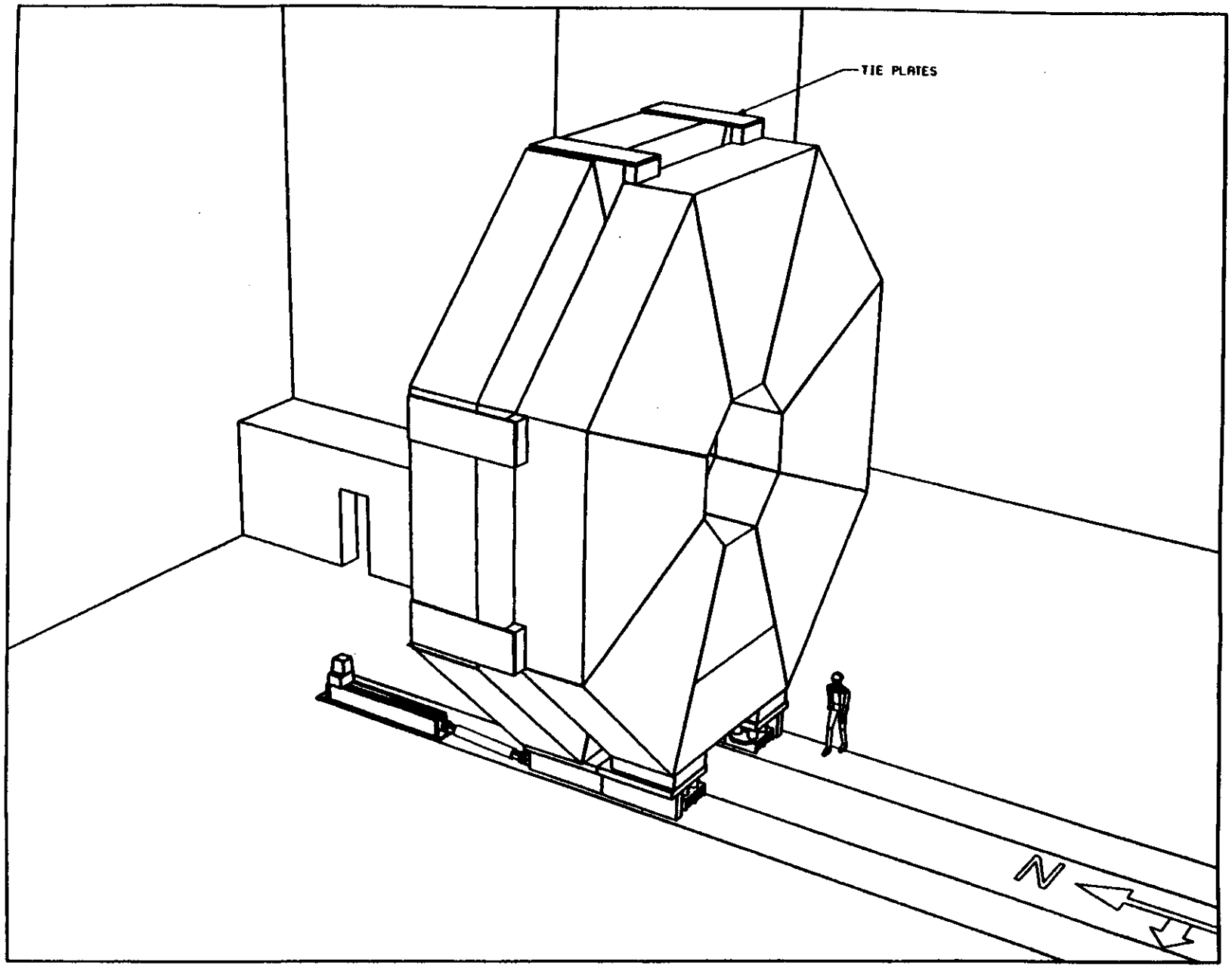
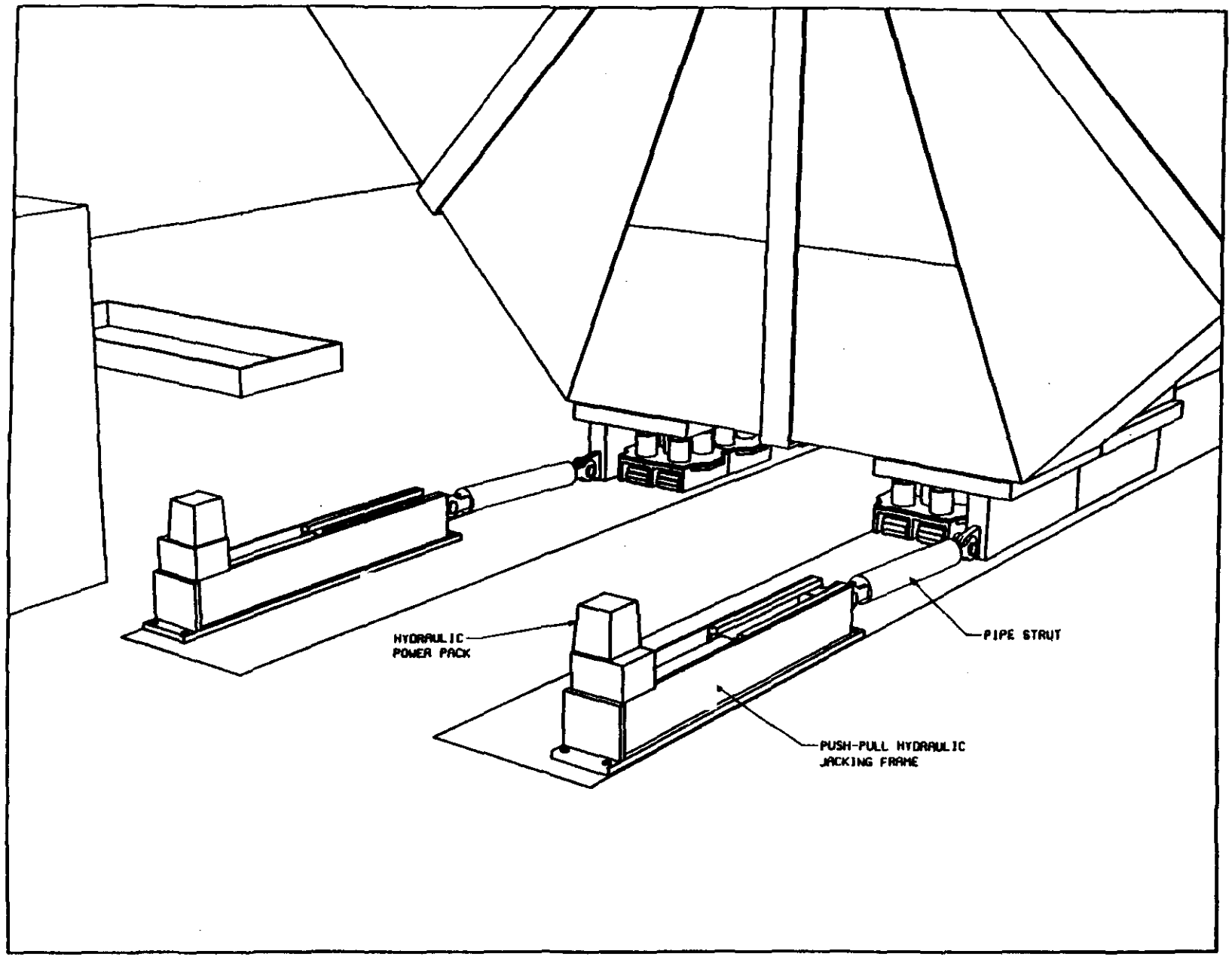


SDC DETECTOR - FORWARD TOROID CONSTRUCTION

FIGURE 3



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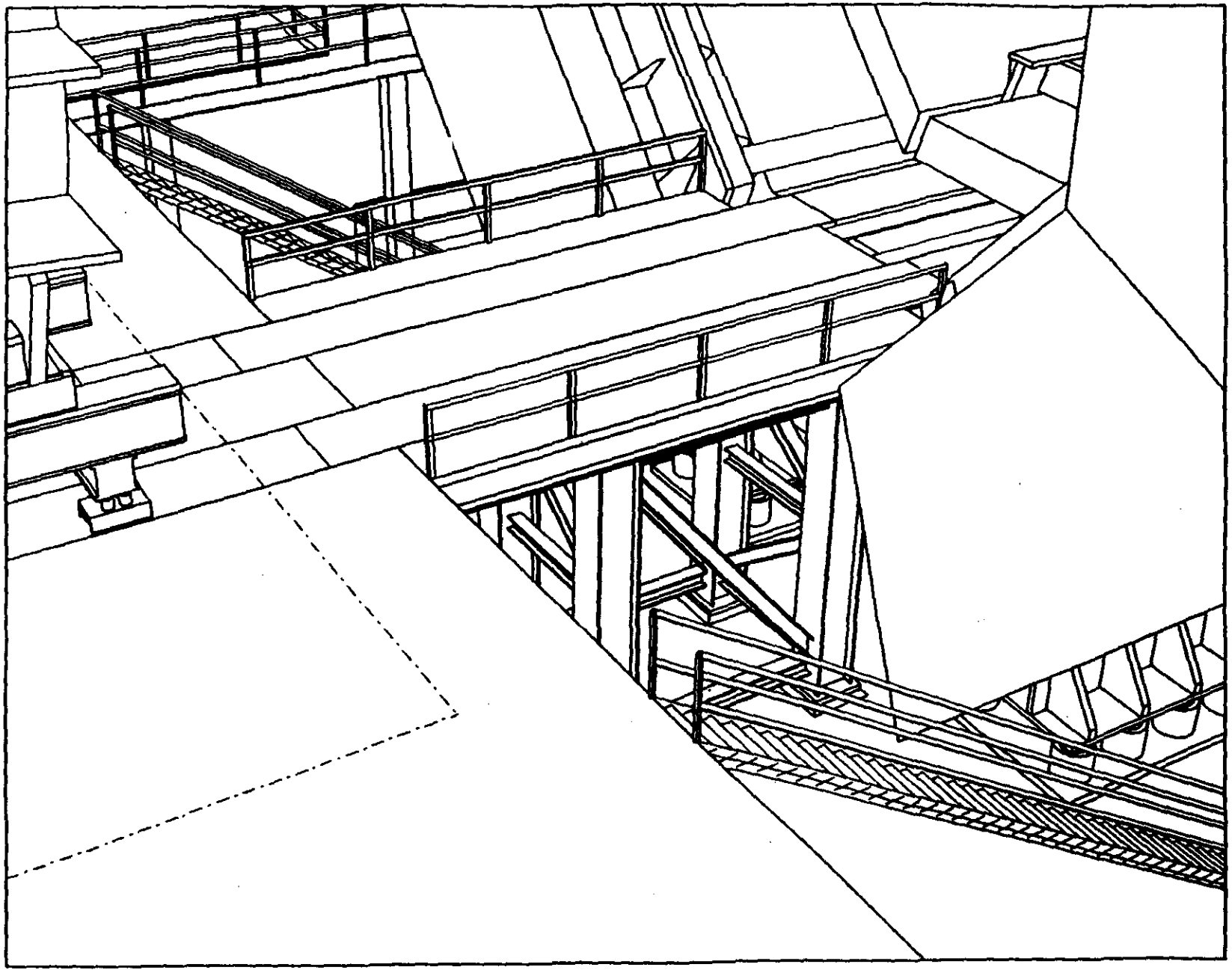
SDC DETECTOR - FORWARD TOROID CONSTRUCTION
FIGURE 4



SDC DETECTOR BRIDGE
PERSPECTIVE VIEW
Fig 5

10. Lawrence Berkeley Laboratory (LBL)

FEBRUARY

Cost and Schedule

The LBL C/S coordination effort was directed towards on-site assistance to the SSCL for cost roll up efforts of the two current SDC configuration options. We continued scheduling training for Dallas subsystem C/S coordinators.

Cost, contingency and schedules were completed for WBS 7 (Conventional Systems), WBS 9 (Project Management). We assisted with integration of the Silicon Tracker component schedules into a subsystem schedule. We continued assembling of the SDC Summary Cost & Schedule Book for inclusion in the Technical Design Report. Cost Rollup procedures were demonstrated to provide on-site capability at the SSCL.

Scintillating Tile Calorimeter Design

Replaceable Hadronic Plug:

Formal drawings of typical Plug had1 and had2 absorber plates are in preparation to obtain fabrication cost quotes from West Coast vendors. Work continued on a plan to remove the plug and the EC/EM (wedges or a monolith) to replace radiation damaged tiles.

Monolithic Endcap EM:

Materials have been ordered for the "4 × 4" full depth test assembly. This 4 × 4 module is designed for use with a particle beam or with cosmic rays; it will also function as a testbed for various tile, fiber, and optics/electronics R&D studies including measurement of light yield. Demonstrated uniformity of response across tiles and across cracks will be a goal. Routing of realistic length silica and plastic fibers and mounting of PMTs within a dark box enclosure is included in the design. In this fast track effort, detailing of individual parts will stay just ahead of the fabrication effort in March.

The design concept for the EC/EM now includes a simplified perimeter support structure and a workable inner core separation scheme for use in off-line replacement of radiation damaged tiles in the eta = 2 to 3 zone. We are currently working to find a way to reduce scintillating tile edge gaps as much as possible.

Computing Systems

Meetings were held with the IBM FSD people and with Ed MacNair from Watson Research Center. Preliminary simulations were prepared of the proposed SDC offline computing systems using RESQme, the RESource Queing Modeling Environment software which is on loan to us from IBM. Ed MacNair is one of the principle authors of the system. A copy of RESQme has been obtained for use on the LBL RS/6000.

While in Houston, we investigated IBM's WorkBench software, their implementation of HP's SoftBench. This product is designed as in interactive, graphical framework for incorporating software development tools; the tools themselves generally do not need to be modified to be incorporated into the framework. WorkBench conforms to the Europcan Portable Common Tools Environment Model. As such, it has potential for becoming a standard. It is also, in its HP

incarnation, similar to the proposed Object Request Broker of the Object Management Group. Overall, the product is well worth tracking both as a standard framework for the SDC code development environment and as the interactive analysis framework.

In the second week for February, we installed RESQme at LBL and worked more on the Technical Design Report. A database computing collaboration meeting was held in Dallas. This is the collaboration of LBL, ANL, SSCL, U of Ill at Chicago, and U of Maryland funded partially by SSCL and partially by the High Performance Computing and Communication Initiative. The latest results and analysis of outstanding problems in the ObjectStore effort were presented.

In the fourth week fo February we obtained copies of the RESQme models from Houston and got them to run on the LBL RS/6000. In Dallas we helped Kenneth Liao, from IBM, with the presentation on the RESQme modeling work and reformulated the models to respond to the critiques from other members of the SDC Computing Working Group (whose overall reaction was very favorable). Also made final changes in content to the Technical Design Report in response to review by the Working Group.

MARCH

Cost/Schedule Coordination

The LBL C/S coordination effort was directed towards on-site assistance to the SSCL for the final cost roll up efforts of the two current SDC configuration options. We continued scheduling training of the subsystem C/S coordinators. Cost, contingency and schedules were refined for WBS 7 (Conventional Systems), WBS 9 (Project Management).

We continued on-site assistance in developing the data needed for the SDC Summary Cost & Schedule Book for inclusion in the Technical Design Report and conducted quality checks and minor revisions to the cost rollup software. New scheduling and cost review capabilities in Open Plan were developed to make it more efficient.

Scintillating Tile Calorimeter Design

Replaceable Hadronic Plug:

The cost of the Plug's absorber structure is a strong function of the size and number of tie-rods (welded between absorber plates) to resist applied loads. Load cases, including assembly, handling, shipping, operation and removal have been defined. A requirements document is in work to prepare a cost-effective, parametric, 3D FEA half-model of the Plug. The FEA model, which will be detailed elsewhere and only "simulate" magnetic loads. The model will be used to determine minimum tie-rod diameters for given Plug configuration and rod distribution sets consistent with the load cases.

Results form the FEA model will be used in an existing absorber structure cost simulator to determine the "optimum" design.

Work continued on formal, generic absorber plate drawings to obtain vendor quotes.

Monolithic Endcap EM:

During the month of March, the LBL monolithic ECEM design was revised and developed to a more detailed level. The mechanical structure at the perimeter has been simplified, and now uses conventional 6061-T6 aluminum in easily fabricated forms. No projective elements are used, and preliminary stress calculations indicate modest section thicknesses. The internal "curtain" structure now includes a simple screw fastener joint at eta + 2.0. This feature allows for easier off-line rebuilding of the radiation damaged inner region without disturbing the much larger undamaged volume. A specific fiber routing design using a custom mass-terminated connector at the perimeter is now included, with a more developmental connectorless, spliceless option based on stranded silica fibers. The design can also benefit form the "magatile" scintillator saw slitting techniques currently being explored. "Magatiles" may reduce cost and allow even narrower tile edge gabs than those dictated by individual tile assembly tolerances.

All parts of the 4×4 beam test assembly have been detailed, and most of them have been fabricated or procured. An "interior exit" fiber groove pattern for the scintillator tiles and a low cost PMT housing design both look especially promising. Initial assembly is underway.

Computing Systems

Most of March was spend working with RESQme on models of the proposed SDC offline systems. The preliminary models built the previous month in Houston were corrected and generalized. There is one model to handle a fully centralized system where all data is concentrated at SSCL, and another regional model with subsets of the data maintained at one to five regional computing centers. A large number of parameters are available to tailor the models to specific situations. Only a very limited range of these parameters has been explored so far. In particular, caching ratios have been varied, where caching ratios are, e.g., the probability that a requested dataset is on local disk rather than on tape or that the dataset is only at the SSCL. The models and analysis are still too preliminary to have confidence in the numerical results, but one effect seems clear -- the network bandwidths assumed make "remote" access nearly as effective as local access. Note that the bandwidths assumed by the Technical Design Report are at least as great as that currently available to directly attached local discs. This is quite different from current experience and requires an adjustment in thinking.

The output form RESQme is rather awkward for direct analysis. A couple of simple text reformatting programs were also developed in March to convert RESQme output into a form acceptable to most Macintosh or PC based spreadsheets and graphics programs. Plotting is now done primarily on the Macintosh.

Attended a one-day workshop in Oakland, CA., on the installation and features of the latest release of the AIX operating system for the RS/6000. Of particular interest are its use of X11R4 and Motif 1.1 and its compliance with the programming interface of the OSF/1 operating system. Both features will allow better tests of the reality of portable code. The upgrade has been ordered.

Pursuing the ideas generated by last months demonstration of IMB's WorkBench software (a licensed form of HP's SoftBench), we obtained from NIST their Special Publication, "Reference Model for Frameworks fo Software Engineering Environments", which is jointly published by the European Computer Manufacturers Association. This document should help resolve some of the confusing in SDC as to what an integrated Computer Aided Software Engineering system should include. Since physics analysis involves software development in the contest of a fairly stylized analysis process, the NIST model should be extendible to encompass the SDC analysis framework or core software. If it does nothing but clear up just what is meant by "framework", "core" and "kernel" software, it will have been immensely useful.

16. Martin Marietta

FEBRUARY

Muon System Costing and Scheduling Phase II

Task Accomplishments:

1. Incorporated the final barrel toroid design specifications in the SDC Muon System Cost Model. The estimate was based on the specification dated 21 January 1992, the final baseline configuration for the cost estimates to be submitted in the TDR.

2. Incorporated the forward toroid design specifications into the SDC Muon System Cost Model. The estimate was based on the presentation at the Russian Magnet Meeting dated 23 January 1992, the final baseline configuration for the cost estimates to be submitted in the TDR.

3. Further developed the tooling lists for magnet system and muon chamber alignment. Tooling lists and costs were developed for transporting the coils, handling and fabrication of the steel, and alignment stands.

4. Cost estimates for the drift tubes were updated for the 95 mm diameter tube configuration adopted at the muon system committee meetings of 30-31 January. The original estimates were based on 75 mm diameter tubes. Muon chamber cost sensitivities to drift tube diameter were developed to support cost-reduction trade studies. Approximately $10 million was saved by going to 95 mm diameter tubes. The cost effects of these changes were incorporated into the SDC Muon System Cost Model for the TDR.

5. Contacted each of the muon subsystem lead engineers to obtain final comments and design configurations for use as the cost estimate baseline in the technical proposal.

6. Dave Etherton and Dennis Cox, from the SSCL, visited Martin Marietta Denver on 13-14 February to discuss the new muon chamber drift tube concepts and plan future SDC tasks.

7. Developed the muon system cost estimates for the technical proposal. A package was delivered to the SSCL for a scheduled 24 February cost roll-up. Summary charts were also generated and presented to project management.

8. Met with the Forward System muon chamber proponents at the SSCL on 26-27 February to develop a baseline configuration which could be cost-estimated and included in the TDR.

9. Delivered the final muon system cost estimate to be presented at the collaboration meeting of 26-28 February.

10. Began development of the WBS dictionary for the muon system.

11. Continued to refine the Open Plan database to include incorporation of the Washington muon chamber concept. Updated activities and resource data in support of the 24 February cost/schedule roll-up.

12. Attended and supported the following meetings:

• Cost, schedule, and engineering task review, Martin Marietta, 13-14 February

• SDC collaboration meeting, SSCL, 26-27 February

Deliverables Submitted to the SSCL:

1. Electronic media containing updated Open Plan muon system resource profile histograms, time-phased logic network, activity, resource, and predecessor/successor reports incorporating data for the Washington chamber concept

2. Cost sensitivities of muon chamber costs versus drift tube diameter

3. SDC muon system cost roll-up and summary tables for the TDR

Engineering Services to Support SDC Detector Development

Task Accomplishments:

1. Attended a muon toroid and support structure analysis review at FNAL on 13 February. Presented preliminary analysis results for magnet blocks, block joints, and support structure stability.

2. Performed the following muon toroid and support structure analysis tasks:

• Completed analysis, using effective material properties, of toroid iron blocks comprised of six inch thick plates connected by two shear pins and bolts.

• Completed plate flatness requirements analysis for long and short blocks.

• Completed stability analyses of the primary elements of the detector support structure: the inclined plates, trusses, and tie bars.

• Initiated analysis of effective material properties using 3-inch thick plates rather than 6-inch thick plates for the blocks.

3. Presented assembly facility analysis results and muon system services analysis results at the 24-25 February muon system engineering meeting at the SSCL.

4. Developed muon system cost summary tables for the SDC Cost/Schedule Summary Book. Costs were broken down by WBS elements, detector region, downsizing/technology options, and detector parameters.

5. Attended muon system engineering meetings at the SSCL to plan future engineering tasks. Topics included the selected drift tube configuration, alignment issues, configuration control, organization, and schedules.

6. Participated in a scheduling workshop on 28 February at the SSCL. Presented the muon subsystem (WBS 3.0) summary schedule in preparation for the cost/schedule volume of the TDR.

7. Developed engineering concepts for the module/supermodule alignment tool, cell shipping containers, and cell storage racks for the Washington chamber concept. Refined the chamber assembly tool design. Prepared two alternative on-site assembly facility floor plans based

on these concepts. This data will be used to update the assembly process RAM and to further refine the floor plan.

8. Developed a toroid coil shipping container concept and cost estimate.

7. Attended and supported the following meetings:

• Muon barrel toroid structural analysis meeting, FNAL, 13 February

• Cost, schedule, and engineering task review, Martin Marietta, 13-14 February

• Muon system engineering meeting, SSCL, 18-19 February

• SDC collaboration meeting, SSCL, 26-27 February

Deliverables Submitted to the SSCL:

1. Muon system updated cost summary tables for the SDC Cost/Schedule Book and supporting analyses.

2. SDC Muon Chamber Facility Analysis final report , dated 13 February submitted to the SSCL for publication as an SDC report.

MARCH

Muon System Cost & Scheduling, Phase II

Task Accomplishments:

1. Completed the muon system cost analysis to be submitted with the technical design report.

2. Developed the Muon System WBS Dictionary, a detailed description of each WBS element (over 500 items) including definition of the elements, parameters, materials, and labor costing methods.

3. Prepared 20 viewgraphs with facing-page text summarizing and detailing the muon system costs in tabular and graphical form.

4. Completed the final program planning inputs and updates to the muon system Open Plan time-phased logic network for the final SSCL SDC cost and schedule report. Incorporated resource data from the cost analysis study (item 1.above) and revised the schedules, using data from meetings with the muon subsystem group.

5. Published the "SDC Muon System Costs and Schedules" draft report (SSC-91-Z-11114). This 411-page report contains the cost estimates developed for the SDC Muon System. From the design information developed for the technical design report (TDR) and associated subsystem conceptual design reports, a detailed Work Breakdown Structure (WBS) was developed to facilitate the coordination of costs.

The WBS contains material and labor costs for each muon system element in spreadsheet format so the cost effects of design modifications can be quickly determined. The spreadsheets follow the established SDC format for totaling SDC detector costs described in the SDC Costing and Scheduling Procedures for Technical Proposal Notebook. Section 2 includes ground rules and assumptions used for estimating costs. Section 3 is a comprehensive review of costs broken down in many ways to facilitate cost-benefit trades. The format is viewgraphs with facing-page text that describes the chart or graph and presents conclusions. Section 4 is a comprehensive 133 page WBS dictionary. For each WBS element a definition including technical content and interfaces, physical parameters, and methods for estimating material and labor are provided.

Over the past six months the muon system evolved from a $150 million system to the current $116 million system. During this time subsystem redesigns, technology selections, downsizing, cost optimizations, and better estimating techniques have lead to a more robust muon system at lower cost. Section 5 describes evolution of the design and costs. Cost estimates for potential upgrades are summarized in Section 6.0 for possible future use. The main body of the report ends with a summary of the muon system project schedule outlined in the same WBS format used for the cost estimates. The appendices include the cost estimates by WBS element in the SDC format (Appendix A), the contingency analysis (Appendix B), and the backup spreadsheets and design concepts used to develop the muon subsystem cost estimates (Appendixes C-Q). Each appendix or subsystem spreadsheet is linked to the muon system WBS in Appendix A. This limits the spreadsheets to a manageable size and provides flexibility to work with one subsystem at a time.

Deliverables Submitted to the SSCL:

1. "SDC Muon System Costs and Schedules", 31 March 1992 draft report, submitted to Dave Etherton on 26 March 1992.

Deliverables for contract SSC-91-Z-11114. At the request of Dave Etherton, release of a final report is delayed to incorporate changes that meet a new cost target. The updated report will be delivered to the SSCL by 20 April.

Engineering Services to Support SDC Detector Development

Task Accomplishments:

1. Developed and presented final muon system costs for SSCL incorporation in the Cost/Schedule Summary book, a supporting document for the SDC 1 April TechnicalDesign Report.

2. Developed final summary level schedule and milestone listing for the muon subsystem, WBS 3.0, to be included in the SDC Cost/Schedule Summary book.

3. Initiated studies of alternative SSCL/SDC site facility layouts to accommodate both the barrel chamber assembly and forward muon chamber assembly process.

4. Reviewed muon chamber design and manufacturing issues with Henry Lubatti, Dick Davidson and Colin Daly in a 9-10 March meeting at the University of Washington.

5. Attended a forward muon system meeting at the University of Maryland. Reviewed manufacturing and engineering plans for the forward muon system, ranging from drift cell production methods to installation of the forward system in the hall and obtained the information to initiate a RAM analysis of the assembly process.

6. Updating the SSCL/SDC site facility layout to include current concepts for the assembly and test of the forward muon chambers and super module structure for Phase C RAM studies.

7. Developed tool concepts for the forward chamber assembly, super module structure assembly, for the RAM

8. Created manufacturing flows for the assembly of the forward muon octant chambers, resource lists, time span estimates, and resource loading for the first RAM cycle.

9. Attended and supported the following meetings:

- Muon chamber/supermodule design and manufacturing meeting, University of Washington,9-10 March
- Cost and schedule workshop, SSCL,10-13 March
- Muon barrel toroid structural analysis meeting, FNAL, 18-19 March
- Forward muon system meting, University of Maryland, 25-26 March