GEM TN-93-437

GEM Liquid Hadron Calorimeter Meeting at the University of Washington

P. Bosche, P. Mockett, S. Wasserbaech

June 21-22, 1993

Abstract;

Agenda, attendees, and presentations for the GEM Liquid Hadron Calorimeter Meeting in Seattle, WA on June 21-22, 1993.

Liquid Hadron Calorimeter Meeting
June 21st and 22nd

Agenda

TO: Hadron Group:

Attached is the preliminary agenda for the Washington GEM meeting. Please let me know about additions/ modificationsyou would like to make.

FR: David Lissauer

JUNE 21

8:30am I. FNAL Cryostat.

8:30 a) CalTest objective/ Schedule, **Veljko Radeka**

b) Compilation of specification for the Cryostat Design., **Fred Lobkowicz / Bill Wisniewski**

c) Cryostat Design Status, **Neil Hall / Bill Wisniewski**

11:30 d) Transporter Design and status, **Univ. of Rochester**

12:00 e) Feedthrough (For FNAL Test), **Paul Mockett**

1:30 f) How do we hold the modules inside, **Rich Hund**

g) Cryogenic Design - Liquid argon operation

l) Krypton operation, **M. Diwan / Dave Rahm**

2:30pm II. Feedthrough R&D.

2:30 Feedthrough Test Program for GEM. Paul Mockett/ Dave Rahm
For high voltage , Signal , Power etc.

a) Status of feedthrough design.

b) Plans for testing; Washington?/Rochester?/BNL?

c) Pre-Prototype construction.

d) Plans for FNAL construction.

JUNE 22ND

8.30am III. Barrel Hadronic Modules.

8:30 Including Design Update and Production Plans, **Fred Lobkowicz**
a) Design Update.
b) Prototype production plan.
Mechanical components.
Connections.
Preamp motherboards.
10:00 c) Box Design- stress analysis, **Rich Hund**
Mounting of Box in the cryostat.

11:00am IV. Endcap Hadronic Module.

11:30 a) Design Update, **Paul Mockett**
b) Prototype Production Plan.
Mechanical components.
Connections.
Preamp motherboards.
2:15 c) Box Design- stress analysis, **Rich Hund**
Mounting of Box in the cryostat.

3:00pm V. Barrel PDRR

VI. PREPARATION FOR THE PRELIMINARY DESIGN REVIEW.
Lyle Mason

LIST OF PARTICIPANTS,

GEM HADRONIC CALORIMETRY MEETING
June 21-22, 1993
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Hund, Rich	Martin Marietta	SSCVX1::Hund
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Presentation by:

V. Radeka

V. Radeka, 6/21/93

FNAL Liquid Calorimeter Test

Objectives:

1. Mapping of EM response and E-resolution
2. Shower Shape analysis; Pointing resolution
3. Hadron calorimeter E-resolution
   e/π, weighting,
   comparison with simulations
4. Mapping of barrel/endcap transition region
5. Readout electronics:
   - S/H + analog sums, (known electronics), waveform analysis
   - "Final" electronics
6. Liquid monitoring: T, P, α-response
7. - Calorimeter run (stand alone)
   - Common run with other dets. (μ-chambers)

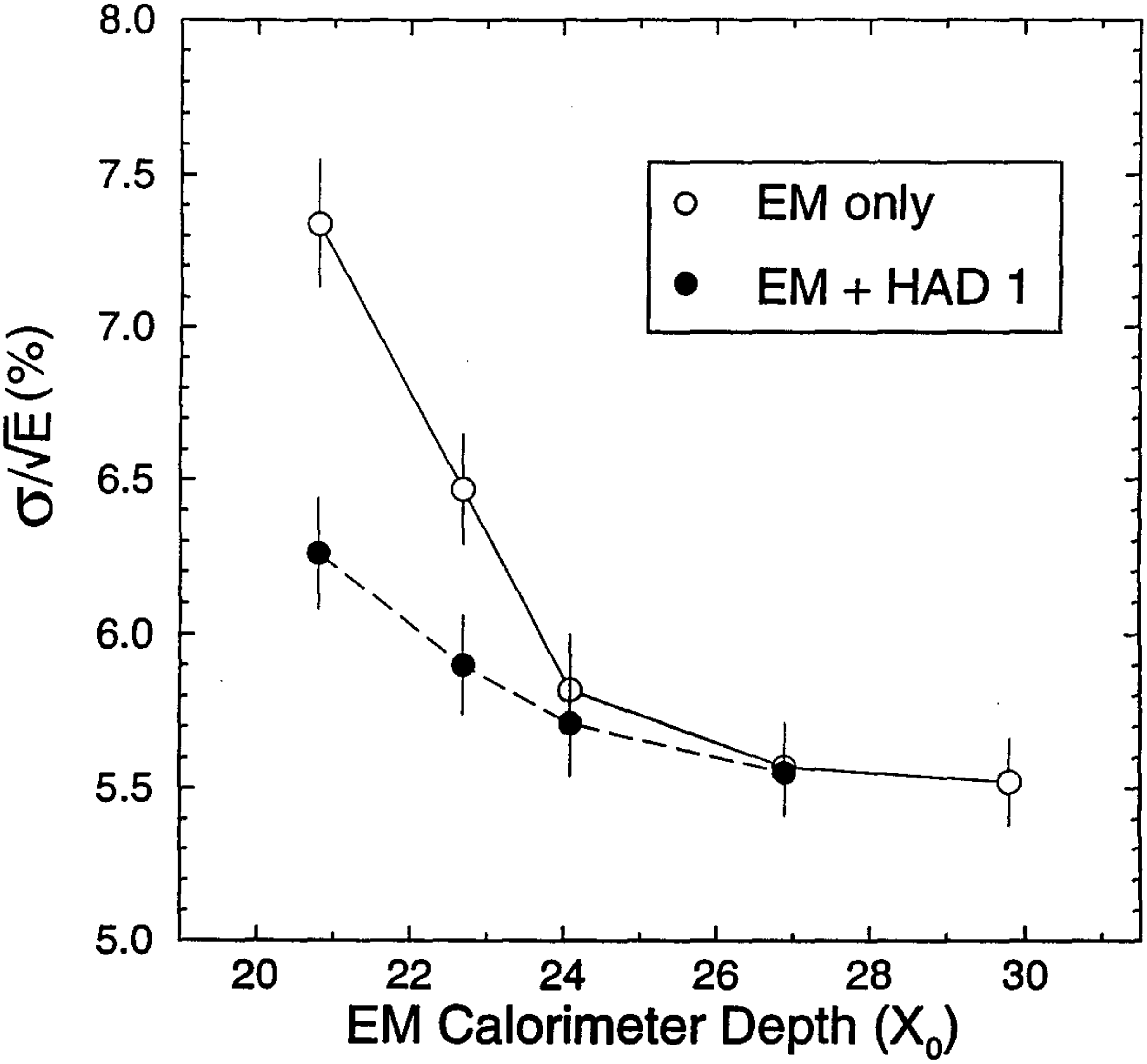
A Key Question:

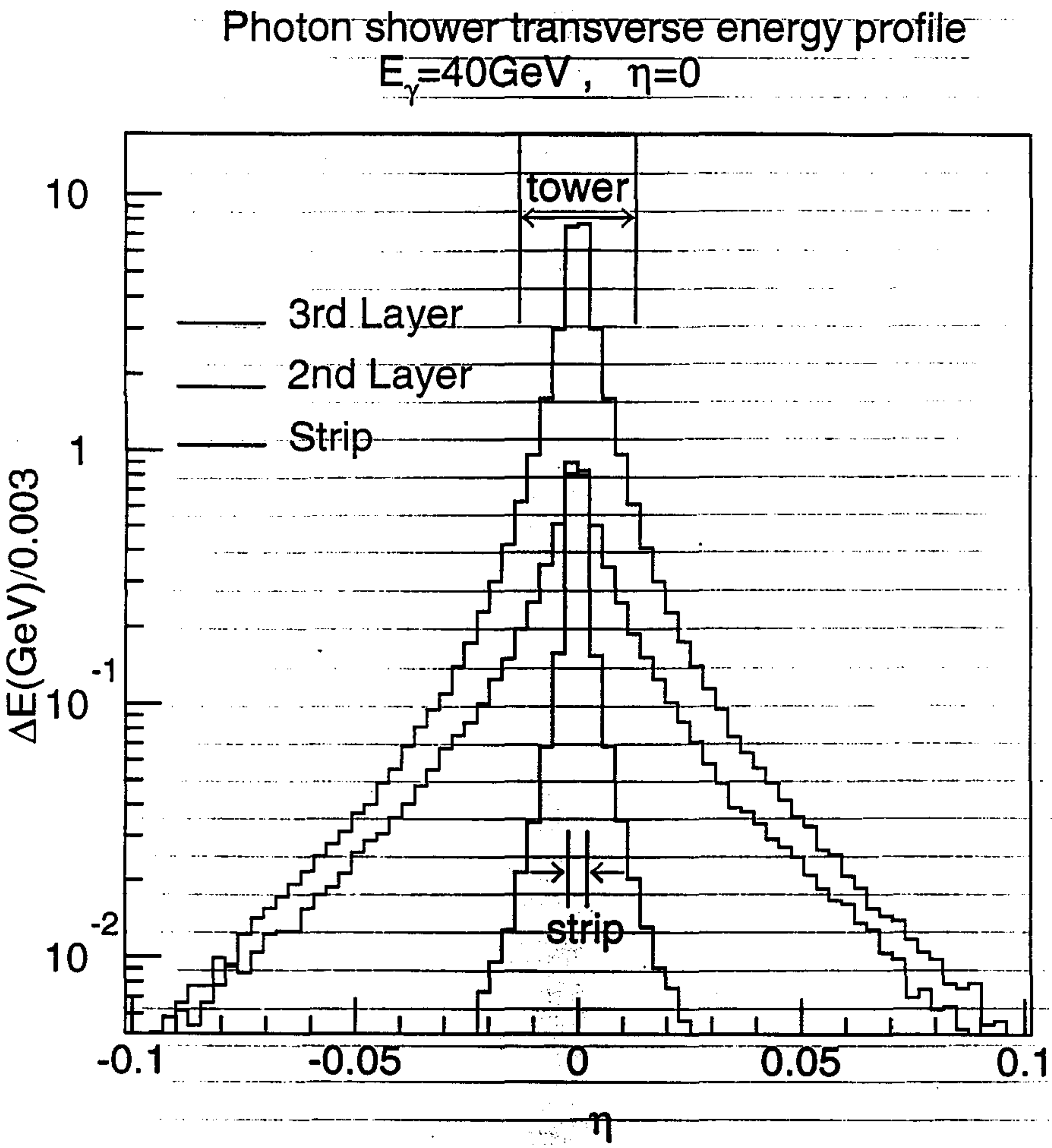
How to realize this test economically?
(Work on cost estimates)

EM Calorimeter - Barrel

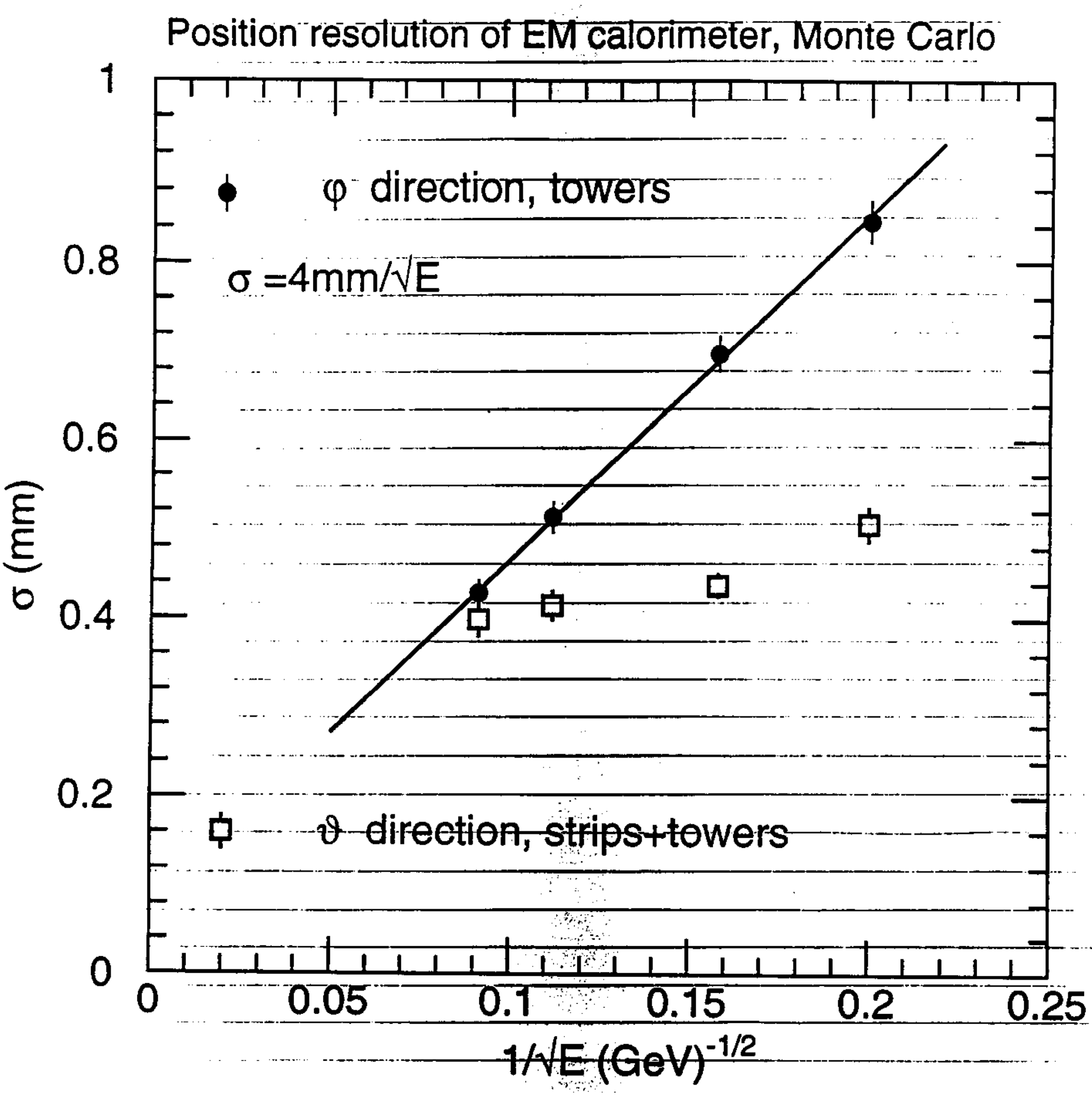
Energy Resolution vs calorimeter depth

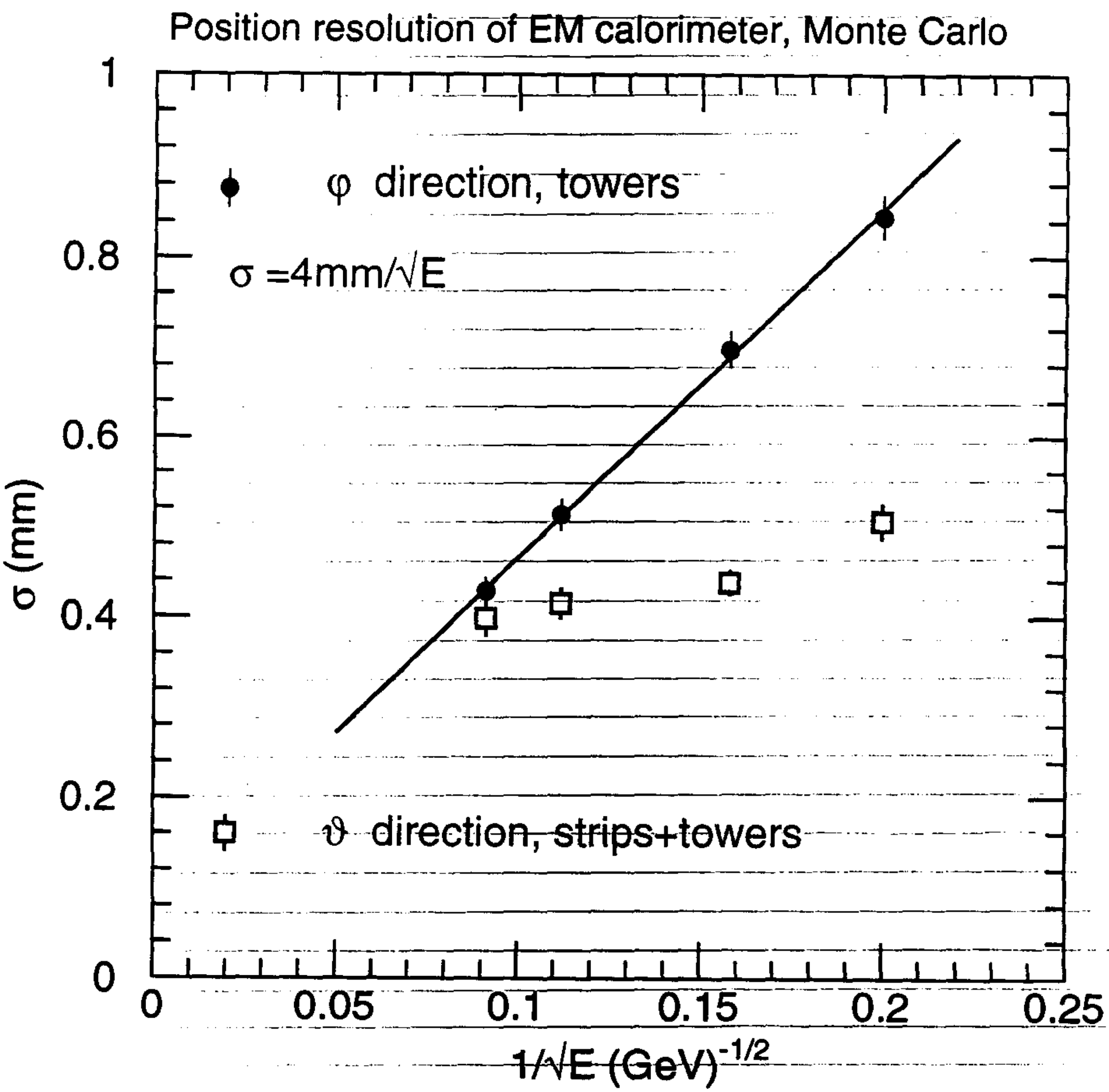
$E_\gamma = 80$ GeV





Photon shower transverse energy profile
E_{γ}=40GeV , η=0
tower
3rd Layer
2nd Layer
Strip
strip
ΔE(GeV)/0.003
10
1
10^{-1}
10^{-2}
-0.1
-0.05
0
0.05
0.1
η


Position resolution of EM calorimeter, Monte Carlo
φ direction, towers
σ =4mm/√E
ϑ direction, strips+towers
σ (mm)
1/√E (GeV)^-1/2
0
0.2
0.4
0.6
0.8
1
0.05
0.1
0.15
0.2
0.25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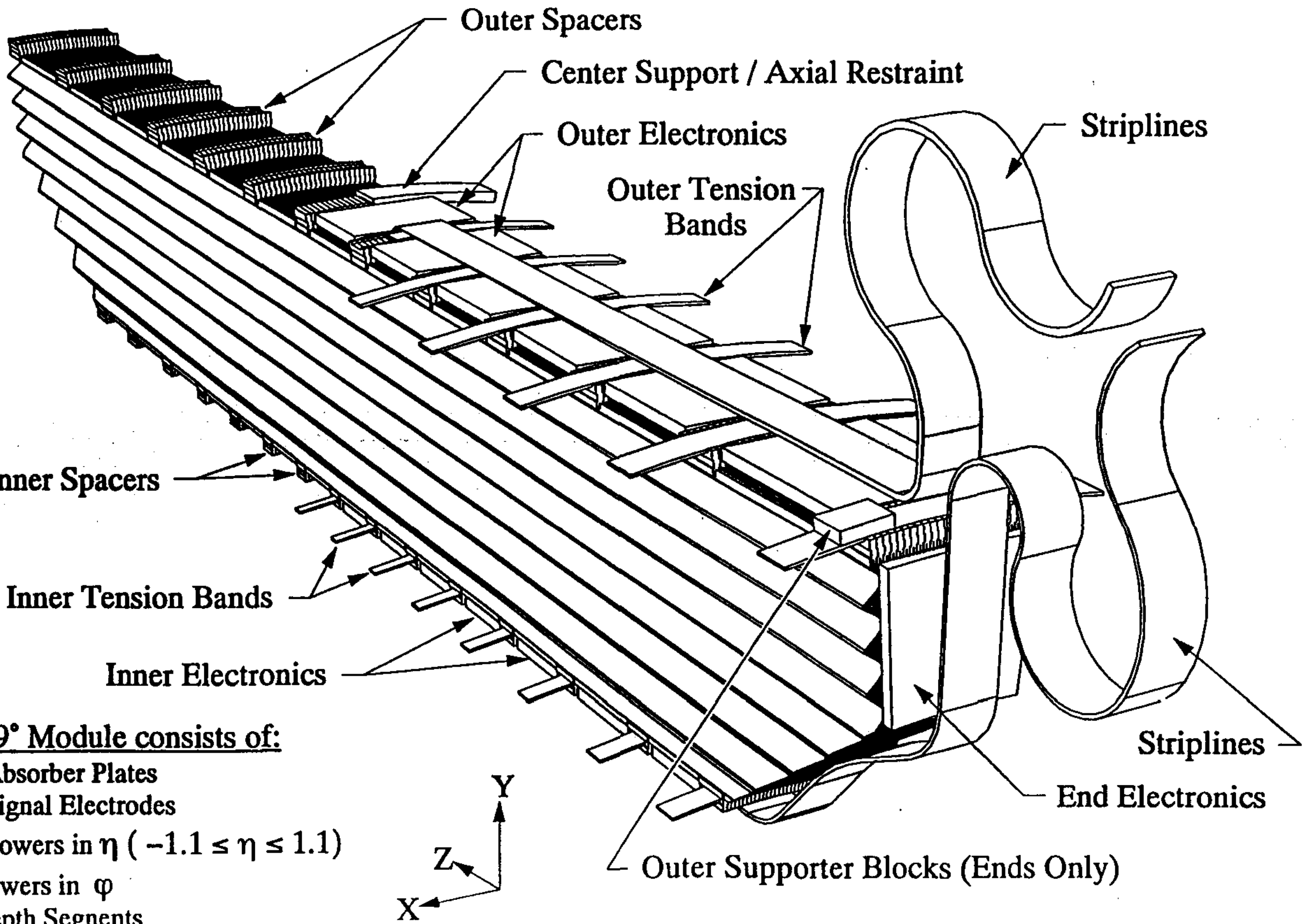
0
0.2
0.4
0.6
0.8
1
0
0.05
0.1
0.15
0.2
0.25

CONTRIBUTIONS TO THE CONSTANT TERM : Goal < 0.4%

	Local/Zonal	Magnitude or Time Scale	Corrective Action	
1. Absorber tolerancies	Z	50 μm crown – no effect	QA in production, 25 μm, sorting by mean value	< (0.
2. Liquid gap tolerancies	Z	≥ 3× absorber tolerancies	design & production	
3. Q_s time dependence (impurities)	Z	very long time scale	purification, α-cell monitoring, MIP response 5-10×α	< 0.1
4. Liquid density/temp.	Z	– ״ –,	design and control	~ 0.1%
5. Readout stability	L		calibration	~ 0.1%
6. Local inhomogenities – variation with φ – barrel, $e^{+/-}$ impact ∡ – endcap, z-vertex	L L	small and understood		< 0.2
7. Variations in the material in front of active region	L, Z		design	< 0.1%
8. HV variations	L, Z	$\frac{\Delta Q_s}{Q_s} / \frac{\Delta V}{V} \leq \frac{1}{5}$ (t 40 nsec)	design, control to < 10 V at 2 kV	< 0.1%

Barrel Electromagnetic Module



<u>Each 9° Module consists of:</u>

24 Absorber Plates
24 Signal Electrodes
84 Towers in η ($-1.1 \leq \eta \leq 1.1$)
6 Towers in φ
3 Depth Segnents

Presentation by:

F. Lobkowicz

Fred Lobkowicz

Subject: testbeam - latest specs
From: "F. LOBKOWICZ/ROCHESTER" <LOBK@URHEP.PAS.ROCHESTER.EDU>
To: mockett@phast.phys.washington.edu

This is the "preliminary final" version of the specifications for the testbeam calorimetry setup at FNAL. It gives specifications on the cryostat, transporter, electrical connections, and cryogenic demands. I would expect it to change from now on only in minor details. In some places in this document, however, we say only that specifications will be provided in the future.
As far as this writer (F. Lobkowicz) is concerned, further refinements to this document should be done by the new testbeam calorimetry coordinator whose appointment was suggested by the PAC review pannel. I will continue only for a few more days until such a person is officially appointed.

SPECIFICATIONS FOR FNAL TESTBEAM CRYOSTAT AND TRANSPORTER.
(This is Version 005, June 28, 93)

I. Time scale.

In order to be ready for taking beam in March 1995, all the necessary components should arrive at FNAL in the fall of 1994. The following schedule is specified:
Beneficial occupancy of MWEST by GEM March 1,94 /1/
Transporter arrives at Fermilab August 15, 94 /2/
Transporter is fully assembled for cryostat Sept 15, 94
Feedthrus ("Seattle version") are delivered to cryostat vendor by August 1 for welding in.
Cryostat arrives at Fermilab Oct 1, 94
All necessary cryostat plumbing is ready Oct 1, 94
All cryostat/transporter control components are at Fermilab oct 1
Assembly of modules into support structure begins Nov 1, 94
Junction boxes and outside cables are at FNAL on Nov 1,94
Partial delivery of shapers (enough for test) by Dec 1, 94
DAQ adequate to test system Dec 1,94
Modules inserted in cryostat, internal hookup begins, Jan 1, 95

******* Cryostat ready for cooldown Feb 15, 95. ***********

II. Cryostat and arrangement of modules

NOTE: The modules inside the cryostat are to simulate the real GEM detector arrangement as closely as possible. This implies that all particles hitting the calorimeter modules are to be imagined to come from the "interaction point (IP) - actually a thin axial line ca 15 cm long centered on the IP. See Figure 1 for the arrangement of the real GEM detector, and Figure 2 for its simulation in the test detector.
All specific distances mentioned in this document assume that the IP is 76" +/- 2" away from the axis of the cryostat, and that "crack # 1" = upper crack in inner hadronic barrel modules is at an angle of 2.25 degrees above the horizontal. Figures 3 and 4 give the definition of the IP in our setup

1) The cryostat is to accommodate: 2 Barrel EM modules,
4 Barrel inner hadronic modules /3/, 3 Barrel outer hadronic modules,
3 Endcap outer A and B hadronic modules, 2 Endcap inner hadronic A and B modules and at least a section of a simulated endcap EM. /4/

2) When looking downstream, with the beam (that is NORTH), the endcap modules are ON THE LEFT (West). /5/

3) Outer cryostat diameter is AT MOST 102.5". Neil Hall will attempt to make it

smaller. The cryostat length is AT MOST 308" /6/. Every effort should be made to make the cryostat shorter.

4) The inner cold cryostat vessel is to be designed for an operating overpressure of 50 psid as a ASME CODE VESSEL. The inner vessel is not required to hold -15 psid (vacuum), but positive pressure relief must be provided to that the inside pressure can never be less than outside pressure.
The warm vessel is to be designed for vacuum using the CGA code and FNAL safety codes. /7/

5) There are two stiffening rings of AT MOST 6" thickness between the cryostat and the rocking wheels on the transporter. The inside load of modules, bathtub, etc has to be transferred to these two stiffening rings.
The separation between these stiffening rings is 131.25" (Center to center) /8/

6) The cryostat (both cold and warm vessel) are to be flanged at the Endcap end. The recommended seals for the cold vessel are compression ring seals such as manufactured by

Helicoflex Seals
P.O. Box 9889
Columbia S.C. 29290
803-783-1880

Such seal rings are standard at CERN. There are other manufacturers of such seals. The warm vessel can be sealed by an ordinary O-ring.

7) The beam is to hit the detector (cryostat) always going through the IP region. The sensitive region is defined as a region rotating 65 degrees counterclockwise, 30 degrees clockwise around a vertical axis, and +/- 4 degrees rocking of the cryostat. In the sensitive region the total wall thickness (cold and warm vessel) should not exceed 0.25 radiation length AS REFERRED TO NORMAL INCIDENCE.
This can be accommodated either by a thin window or keeping the overall wall thickness below the limit. /9/

8) The baseline design of the cryostat is an aluminum vessel, both inside and outside. The vessel is to be a code vessel.

9) The cryostat with its internal support structure for the individual modules is to be designed by SSCL.

10) The assembled cryostat will be tested cold by vendor before shipping./10/

III. Cryostat and transporter.

1) The cryostat will sit on a transporter, to be designed by Rochester./11/

2)The cryostat on its transporter has to be movable /12/ /13/:
(i) East-west along the whole track in MWEST, with continuous motion of at least 10'.
(ii) Around a vertical axis at least 65 degrees clockwise (into the endcap) and 30 degrees anticlockwise.
For installing the modules on their support vehicles the cryostat has to rotate by 90 degrees with the endcap section pointing North (downstream).
(iii) The rolling motion (around the cryostat axis) is to be at least +/- 4 degrees with the cryostat bathtubs filled with liquid.
(iv) The vertical motion has to accommodate the rocking motion, keeping the calorimeter modules in the right orientation to the beamline. /14/

3) There will be a position measurement system accessible to the DAQ system which will locate all degrees of freedom to approx +/- 1 mm.

4) a section of the warm (scintillating) calorimeter will be sitting behind the cryostat; this will participate in the horizontal and

up/down motion as well as in the rotation about a vertical axis. the scintillator calorimeter will not participate, however, in the rocking motion of the cryostat.

5) A small X-Y set of drift chambers (with positional accuracy of 0.1 mm) will be mounted at the imaginary intersection point from where all particles must seem to emanate. The chamber should be mounted on an arm extending from the cryostat, thus participating in all of its motions. It should be sufficiently large that one can simulate the length of the interaction pencil in the real GEM experiment (7 cm r.m.s.). /15/

6) The transporter is to be designed for the following loads:
(i) The Hillman Rollers supporting the transporter will be rated at at least 200 tons each /16/
(ii) The elevation (up/down)motion will be designed to support 200 tons total. This implies four 100-ton jacks.
(iii) The cryostat and its inside load is not to exceed 120 tons.
(iv) The scintillation calorimeter (See III-3) is to consist of two pieces, each of less than 25 tons INCLUDING ANY LIFTING/SUPPORT MECHANISMS.

7) No part of the transporter, at a height of 60" or higher above floor level, can in any position and orientation protrude more than 154" south of the center between the rails. This condition has to be satisfied either by physical design of transporter or by positive lockouts of positions where this condition could be violated. /17/
Below the level of 60", about 3.5" more is available. /18/

8) The topmost table on the transporter (rotating around a vertical axis and carying the cryostat) will be equipped with an elevated platform which gives access to the top of the cryostat for cabling, cryo connections etc. The platform will be at a height slightly above the cryostat, and will cover most of the cryostat except where there are penetrations. /19/
The topmost transporter table and the platform together must accommodate the liquid purifying mechanism (approx 6'w x 4'd x 7' h), the gas purification mechanism (approx 4'w x 4'd x 7'h), a vacuum pump (approx 2' x 2' x 2'), all local control mechanisms (appros three 6' tall electronics racks) and has to leave clear space for the junction boxes mounted on the cryostat.
None of these structures can interfere with the beam entering the detector modules inside the cryostat, nor can they intrude outside of the 154" radius limit from the vertical axis of rotation. /20/

IV. Electrical connections.

GENERAL COMMENT: All power fed onto the transporter, and a fortiori all power fed into the cryostat, has to be "clean power". This means that insulation transformers have to be used for all AC lines which are active during data taking.
Ground loops are also to be eliminated wherever possible. This implies that the transporter is to be insulated from the Hillman rollers which support it, and that all cryogenic connections need to have an insulating section. Such sections have been designed for the D0 test beam area.

1) There will be approx 5000 signal and calibration connections from the calorimeter modules. The signals will come from internal preamplifiers.

2) There will be 100-200 HV connections into the cryostat - half for the barrel and half for the endcaps

There will be 100-200 DC power connections for the preamplifiers into the cryostat. Each will cary AAA amperes at +/- VVV Volts. The HV and power connections will use the same feedthru ports as the signal connections.

3) The cryostat is to have nine feedthru ports for accommodating the signals as well as the auxiliary connections (thermometry, pressure and level monitoring, heaters etc). Of these six will be above the separation region between barrel and endcap modules, while three will be near the cold flange. Each of these ports must be suitable for the Seattle type feedthrus; P.MOCKETT will provide more detailed specs by July 15, 93. Each of the feedthrus is capable of transmitting 860 signals, as well as the corresponding HV leads and the power to the preamplifiers. /21/ /22/

4) All control and power wiring into the cryostat has to be filtered and/or shielded to prevent coherent noise. This means that any signal of 100 kHz or higher frequency has to be attenuated by at least 60 dB.

5) From the feedthrus the signal cables will go to junction boxes (one per signal feedthru) which are mounted on the cryostat directly above the feedthru port. These junction boxes, together with the feedthru port, are to form a local Faraday cage. The Junction boxes have a depth (back to front - input cable to output cable) of 304 mm, and a width of 268.75 mm. The length depends on the number of driver cards in each bos. The barrel junction boxes have 17 cards and a length of 312 mm, the endcap junction boxes have 21 cards and a length of 384 mm. The power consumption is 0.2W/channel. The junction boxes are to be water cooled. The power supplies will be mounted next to the junction boxes. /23/ /24/

6) From the junction boxes, cables will go up to an arm which allows the cables to move while the cryostat is rotated, without interfering with the cryo lines. /25/
From there on cables of 40-45 meter length will lead to the shapers/ADC-s located in the upstream latchhouse.
The cable layout has to allow initial connections to be made while the cryostat is still open. These connections will then stay continuously closed while the cryostat is pumped down, the modules cooled, the cryostat brought into the beam, and during a whole run.

7) There will be heaters inside the cryostat:
(i) a heater of ca 1 kW max. in contact with the bottom of the cryostat (under the bathtubs, bot NOT in contact with them) will warm the cryostat wall to a temperature slightly above that inside the modules, thus preventing pooling of liquid at the bottom. This heater will be on at all times with the DC current being regulated by the temperature; the typical power consumption will be a few hundred Watt.
(ii) a heater of 10-20 kW is to be used for emptying the vessel - evaporating the liquid. Half of this heater should be attached to the underside of the barrel module support, and half below the endcap modules.

8) There will be many more thermometers in the testbeam vessel than in the real cryostat. We estimate at least 100-200 such thermometers, mostly of the 4-lead platinum type. Some of these should be next to the EM amplifiers.

9) There will be at least two (probably more) alpha - source purity monitoring cells inside the liquid. These will be read out using the same preamplifiers as are used in the detector. No beta sources will be used for monitoring. /26/

10) All AC power for power supplies of electronics on the transporter and inside the cryostat has to be filtered against SCR spikes from powersupplies on the whole FNAL site. The definition of "clean power"

is <10 mV at frequencies above 200 kHz between any two power leads or between AC power and ground. /29/

11) The total power required for motor control for the various motions will be specified later. Unless these lines can be disconnected during data taking, they will have to be "clean power". About 2-3 standard racks should be reserved for controls of motors, temperature monitoring, purity monitoring, etc.

V. Cryogenic specifications

1) The modules will be filled with either LAr or LKr. The maximum available amount of LKR during the first test (Phase 1)will be approx 3000 liters./27/ Both Argon and Krypton will be introduced as gas, and at the end expelled as gas. Every effort should be made to make the bathtubs as compact as possible, unused volume which cannot be eliminated can in principle be filled with Aluminum blocks, but this is not a cheap filler material.

2) There will be two separate "vehicles": one carrying the barrel modules, one the endcap modules. These have to be individually and separately movable. The separation between the two "vehicles" is to be as similar as possible to the actual separation between endcap and barrel. Each vehicle carries a bathtub which contains the liquid.

3) The bathtubs have to be connected by a pipe AFTER they are wheeled into place. There should be a helium actuated valve which can shut off this connection. /28/

4) Each bathtub is to contain as little extra liquid as possible. The bathtubs should be made very compact, and any free space left over filled with a filler (probably Aluminum).

5) There will be two LN2 cooling loops at the top of the cryostat, one above each bathtub. There will be either an inside set of Helium actuated valves allowing either of the two cooling loops to be activated, or there will be separate inlets and outlets for the two loops (so that the loops can be turned on/off externaly).

6) Each bathtub will have a small (1/8") pipe leaving it at the bottom. This pipe has to continue downwards at least to the inner vessel bottom. From then on it can go to a cryo port at the top./30/

7) Each bathtub needs a separate drain which is to be connected to an opening at the top of the cryostat. This drain consists of a tube reaching to the bottom of each bathtub, which becopmes double walled (cryo insulating) BEFORE it reaches the top of the cryostat. A liquid return which ends near the top of each bathtub is also required. These inlets and outlets will be connected to the liquid purifier. All need the possibility to be valved off. /31/

8) There will be at least one gas port on the cryostat, which will carry relief valves, pumpout connections, and connection to stored Krypton gas, connection too a gas purification system etc. etc. /32/

9) A large vacuum pump to evacuate the inside of the cryostat will be situated on the building floor. A diffusion pump with a forepump mounted on the cryostat will pump the insulating vacuum.

10) There may also be continuous gas purification of LKr. The purification in gas form will use the drain to flash liquid from the bottom of a bathtub.

11) The approx 4000 preamplifiers will not be separately cooled. Adequate thermometry must be provided to monitor the quality of the liquid near the preamplifiers.

VI. Insertion of modules.

1) The cryostat has to be filled from the downstream (North) side in the MWEST hall. Figure 5 shows the approx. arrangement during installion of modules. /33/

2)The region between the two bathtubs should closely simulate the transition between the real cryostats. This means that the "barrel bathtub" should end on the endcap side with a reasonable thin wall.
The bathtub should also incorporate a segment of the cylindrical stay at r = 1670 mm. The same consideration applies to the endcap bathtub: on the barrel side its endwall should be reasonably thin. /34/ It should also ioncorporate the various support stays which are part of the endcap cryostat. The hadron modules will be mounted in as much the same way as possible to the mounting in the real cryostat.

3) The barrel bathtub is to be reasonably thin at the entrance over the region of the EM modules./35/

In the back the bathtub should also be reasonably thin; the total thickness of bathtubs + inner cryostat + outer cryostat in the back should not exceed 5.8 cm (2.3") of Aluminum.

4) Both the barrel and the endcap bathtub should include the relevant segments of the reinforcing stays in the real endcaps.

5) The mounting details for the endcap modules will be provided by Mockett and LLMASON

6) The mounting details for the barrel module will be provided by Lobkowicz and LLMASON.

Figure captions: (Figures are sent out by FAX - one copy to each institution)

Figure 1: GEM Calorimeter dimensions according to the TDR.

Figure 2: Layout of the modules inside the testbeam cryostat. Also shown are the approx. locations for the electrical feedthrus.. Other ports (Cryo, gas, pumpdown, safety etc) are not shown.

Figure 3: Overview of the transporter and definition of the intersection point IP. The angular region which one can accommodate within the limits of motion is also given; the actual limit is the horizontal travel along the tracks (max 14 feet with existing screws).

Figure 4: Endview of the cryostat on the transporter, showing also the center of the "rocking" motion (around cryostat axis)

Figure 5: Overall view of building with the transporter and cryostat in the position where modules are loaded.

Comments and footnotes

/1/ This is a specification agreed upon by G. Ginther representing the FNAL side of the operation.

/2/ According to D. Spisiak this is reasonable assuming that PO can be sent out by Sept. 15, 93

/3/ Further MCarlo studies will be required to determine for certain whether 3 or 4 inner barrel hadronic modules are needed for full shower containment. The bathtub should be designed to hold 4 inner modules if at all possible.
Note also that the initial complement of hadronic modules covers only half of the region to be tested. In order to study the region around the washer, one needs a double complement (8 inner and 6 outer) of hadronic barrel modules.

/4/ Phase 1 (spring 95) of the test program assumes that no endcap EM accordion segment is available. A section of such a segment is to be available for phase 2 of the test - approx spring 96.

/5/ This specification is driven by the nearness of the East wall, and the end of the trough, when the calorimeter is in the beamline. Reversing the orientation leads to interference with the wall.

/6/ The "upstream latchhouse" is 154" away from the centerline between the rails. If any part of the transporter protgrudes more than 154" from its vertical axis of rotation, interlocks have to be provided to that the latchhouse is NEVER hit.

/7/ The leaktesting of the inner vessel (it has a flange!) will be cumbersome although possible (Overpressure of helium inside WITHOUT EVER PUMPING ON INSIDE). FNAL safety will have to sign off on this before design can be finalized. However, this spec is probably necessary if there are to be no windows.
Note also that at FNAL vacuum means collapse pressure of at least 30 psid.

/8/ This distance specifies the distance between the support rollers on the transporter.

/9/ The IP is about 25" +/-2" in front of the warm vessel. The range of -65/+30 degrees implies a window over 70" long in the warm vessel, and correspondignly longer in the cold vessel. It is likely that the most reasonable way to accomplish the "window" is to make the whole cryostat as thinwalled as possible between reinforcing hoops spaced approx 70" apart. This is the origin of the specification II-4. The individual calorimeter specialists should carefully consider whether such an extreme angular range is necessary.

/10/ This means that either the feedthrus have to be delivered to vendor for welding in before shipping, or vendor has to test with blank flanges and welding in of feedthrus requires separate cooldown. In the time schedule (part I) we assume that the feedthrus are delivered directly to the manufacturer.

/11/ See Figures 3 and 4 for an overview of the transporter. One should note that the building has a 25 ton crane; this limits the maximum weight of items to be handled inside the building.

/12/ All moving parts of the drives have to be covered to satisfy OSHA requirements.

/13/ There are two schools of thought on how to move the transporter during "scanning across modules". The first school envisages occasional motion of the transporter and cryostat, followed by electrically disconnecting the power to the controls and taking data. A second school envisages scanning "on the fly", moving the detector between beamspills by small amounts, and taking only approx one beamspill per position.
While the second school, if successful, would increase data collection speed, it is unclear whether this scheme is able to adequately suppress electronic noise and effects of liquid sloshing around inside the bathtubs.

At a minimum only "clean power" could be used for the motor drives and controls. See the section on electrical specifications.

/14/ The amount of vertical modion depends on the distance from the cryostat axis to the intersection point.

/15/ With the assumed locations of the modules, the chambers are about 25" in front of the warm cryostat vessel. The asembly should probably be rotatable (in fixed increments for accuracy) about a vertical axis so that the beam impinges always approx. normally to the chambers.

/16/ Existing rollers are rated at 300 tons each.

/17/ This is to prevent the "upstream latchhouse" to be hit.

/18/ The Hillman rollers, situated on the rails, exceed the 154" limit, but do not interfere with the latchhouse.

/19/ Attention must be paid that during the various rotations of the cryostat the platform does not interfere with the upstream latchhouse, concrete shielding or any other obstruction. Attention also must be paid that the rocking cryostat does not pinch any cabling or other connections between cryostat and platform.

/20/ The sum total of all these requirements will produce an arrangement which will be extremely unwieldy and probably impossible. The specialists should carefully consider whether their demands cannot be met by more modest space demands.

/21/ However, the assembly scheme is somewhat different from that in the real Gem detector.

/22/ Actually only seven of the ports will be used for the usual signal/HV/premp power connections similar to those in the real detector. One will be used for auxiliary connections (heaters, pressure monitoring, temperature monitoring etc), and one will be used for the test sources whjich monitor liquid purity. Figure 2 shows the desired location of the ports.

/23/ At present there is no detailed design of the junction boxes with the associated power supplies. Somebody better supply one before it is too late. The design should also incorporate stress reliefs for the cables into and out of the junction boxes.

/24/ At the Seattle meeting the electronics experts (VR) stated that one can violate the "equality to real detector" in considering cable length between feedthrus and junction boxes. In the real detector these are approx 3 meters for the barrel feedthrus, 0.4 meters for the endcaps.

/25/ Having the cables go up from the junction boxes rather than down was a decision made at the Seattle meeting. The detailed design of the cable layout has to be done simultaneously with the layout of the cryo lines. F.L. anticipates troubles and still counsels to have the cable snake initially down to the floor. In either case it is unlikely that 40 meters is enough to go to the counting room area.

/26/ The fast shaper experts stated that studying the shape of an alpha pulse allows to separately determine recombination, drift time and loss by attachment. Then there is no need for a beta source monitor.

/27/ This means that at least initially it will not be possible to fill both barrel and endcap modules with LKr. Once more Kr is available, a complete test should be made (probably in phase 2)

/28/The remote opening of the connection is necessary if one wants to fill both bathtubs with argon, and then empty and refill one bathtub with krypton without opening the vessel.

/29/ A common experience at FNAL is a slow drop of the 60 Hz AC power voltage by 5-10 Volt during a spill. The raw AC lines have spikes on them (in the few MHz range) of 100 Volts or more; these spikes are due to the switching power supplies for the main magnet ring.

/30/ The purpose of this pipe is to measure the liquid depth by measuring the pressure difference between the top and bottom of the bathtub. The pipe has to warm up BEFORE turning upwards to that no liquid can accumulate in it. As an alternate to leading the pipe all the way to the bottom one could install a small heater at the lowest point of the pipe.

/31/ The drain pipe forms part of the bathtub, and has to be connected to the line going through the cryo port after the bathtub is inserted. The same is true for the return line.
Since it is possible that later on we will have ennough LKr, both bathtubs should be able to to be connected to the purifier. We may even want to purify the LAr.

/32/ several such ports are obviously preferable.

/33/ There may not be enough space to insert individual modules from the "natural" side, that is from the East. The available space between the imaginary centerline through the cryostat and the concrete wall is about 105" = 2.67 m. If this is not enough to install the modules, the "assembly area" should be on wheels so that it can be moved further West.

/34/ By "reasonably thin" we mean thinner than the cold+ warm vessel thickness in that region. The idea is to be able to measure how much adding material will degrade the resolution. For this purpose one wants to start with "too little" and then add more wall material.

/35/ By reasonably thin we mean here that the total of cryostat wall and bathtub wall before a particle hits the EM detector should be no more than in the real GEM detector. This is best achieved by inserting a window where the bathtub is crossed by the beam, This window should not exceed 0.25" of aluminum, but can be somewhat curved. The region above and below in front can be
heavy, and can be used to reinforce the support plate. Provisions should be made for mounting additional pieces of aluminum to the front of the EM modules, so that one can study the effect of material in front of the detector.

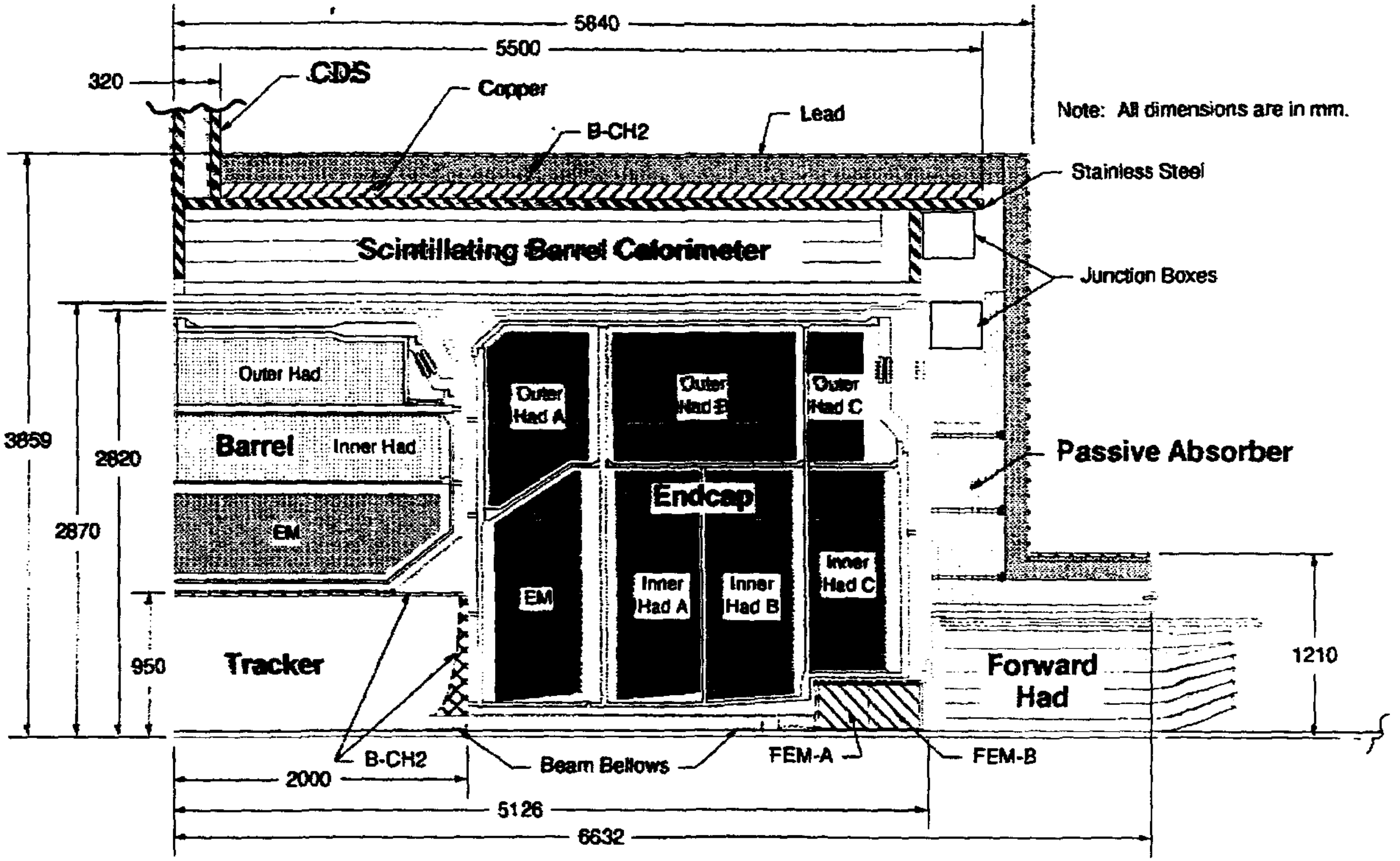

5840
5500
320
CDS
Copper
B-CH2
Lead
Note: All dimensions are in mm.
Stainless Steel
Scintillating Barrel Calorimeter
Junction Boxes
Outer Had
Barrel
Inner Had
EM
Outer Had A
Outer Had B
Outer Had C
Passive Absorber
Endcap
EM
Inner Had A
Inner Had B
Inner Had C
3859
2820
2870
950
Tracker
Forward Had
1210
B-CH2
Beam Bellows
FEM-A
FEM-B
2000
5126
6632

Figure 1

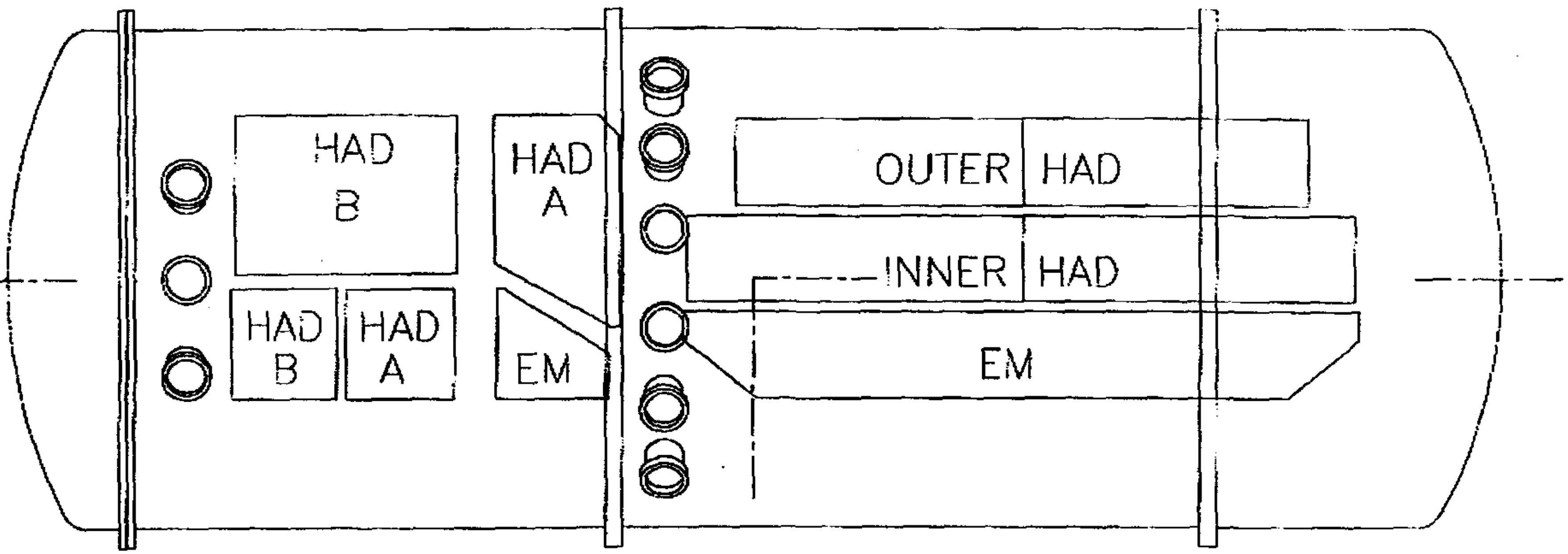


Figure 2.

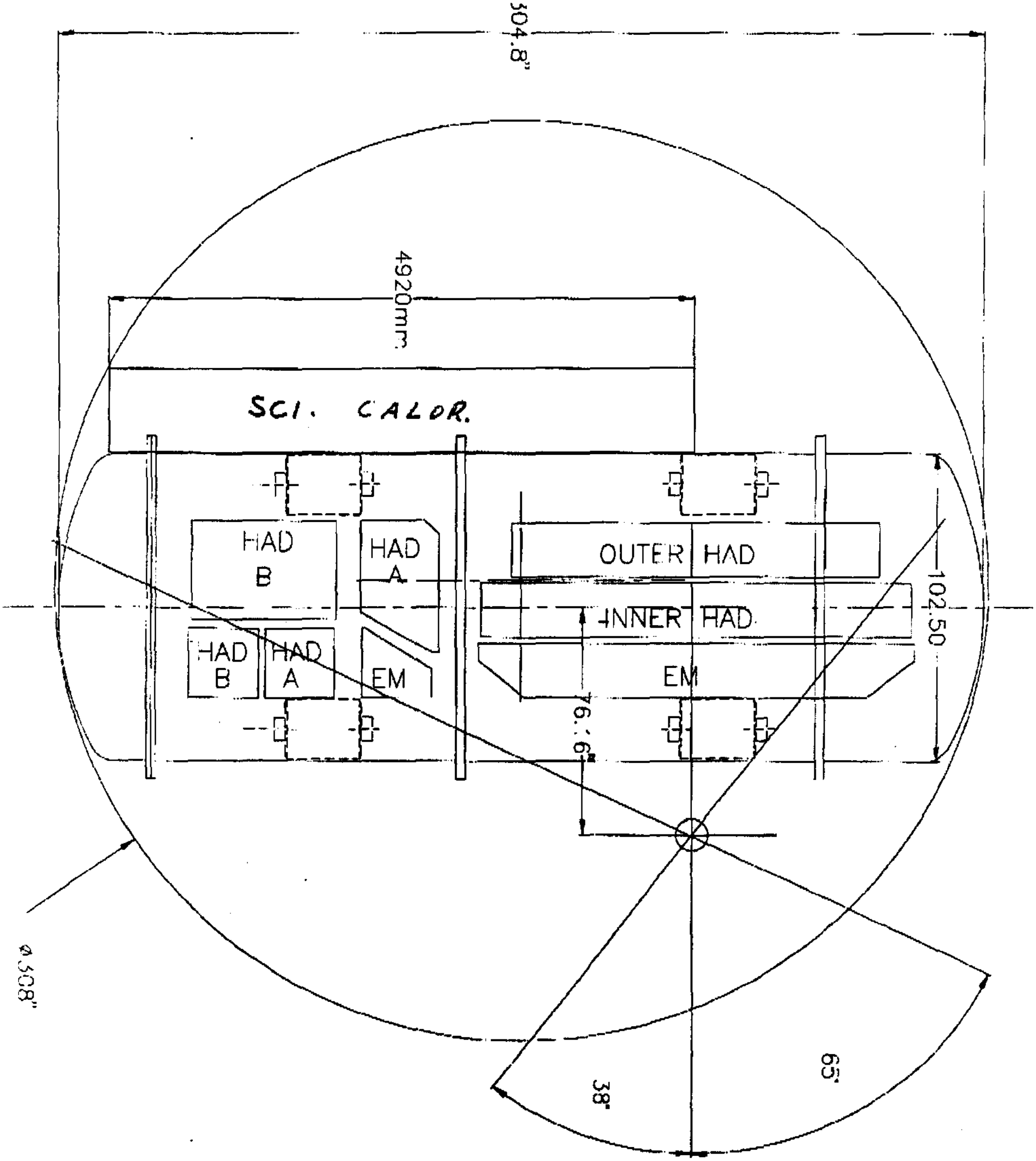
NO.	REVISIONS	BY	DATE

DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY

DWG. TITLE
PORT CONCEPT PLAN VIEW

DR. DAN SPISAK	DATE:	FOR LOBKOWICZ
CK'D	DATE:	

REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .XX ±.01 FRACTIONS ANGLES

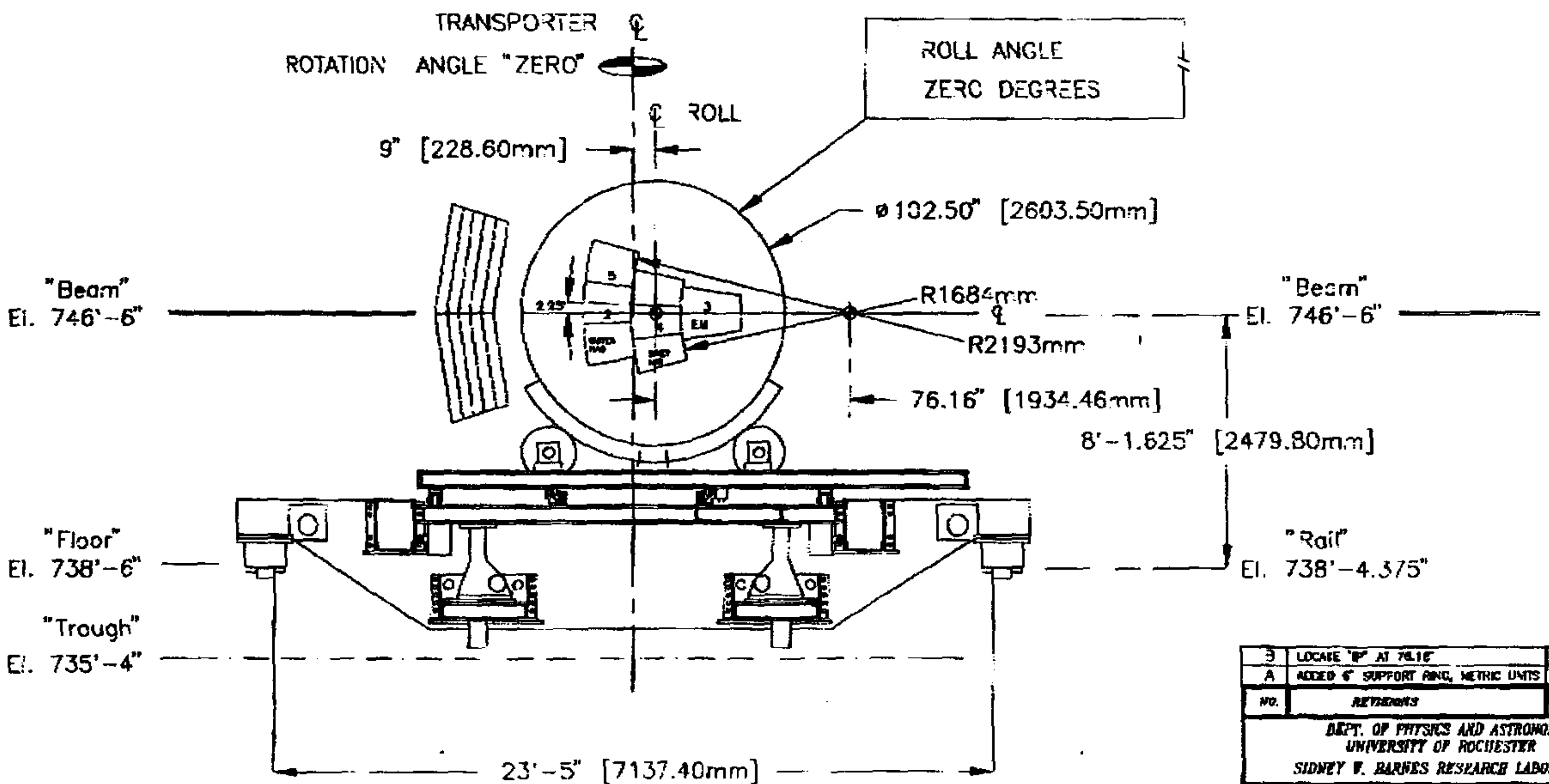


304.8"
4920mm
SCI. CALOR.
HAD
B
HAD
A
HAD
B
HAD
A
EM
OUTER HAD
INNER HAD
EM
102.50
76.16"
Ø.508"
38°
65°

Figure 3

; 7- 9-93 ; 12:25PM ; ROCHESTER PHYSICS- UW PHYSICS:# 5

SENT BY:L 01 R



NOTES

1. Building - Architectural Units
2. Transporter - Engineering Units
3. Modules - Metric Units

NO.	REVISIONS	BY	DATE
B	LOCATE "B" AT 76.16"	DRS	6/28/93
A	ADDED 6" SUPPORT RING, METRIC UNITS	DRS	6/17/93

DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY F. BARNES RESEARCH LABORATORY

DWG. TITLE CONCEPC3
REF. STARTING POINT ZERO ANGLE

DR. DAN SPISIAK DATE: 5-7-93 FOR LOBKOWICZ
CK'D DATE:

REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .XX ± .01 .XXX ± .005 FRACTIONS ±1/32 ANGLES ±30'

SCALE SHEET OF DWG. NO.

Figure 4

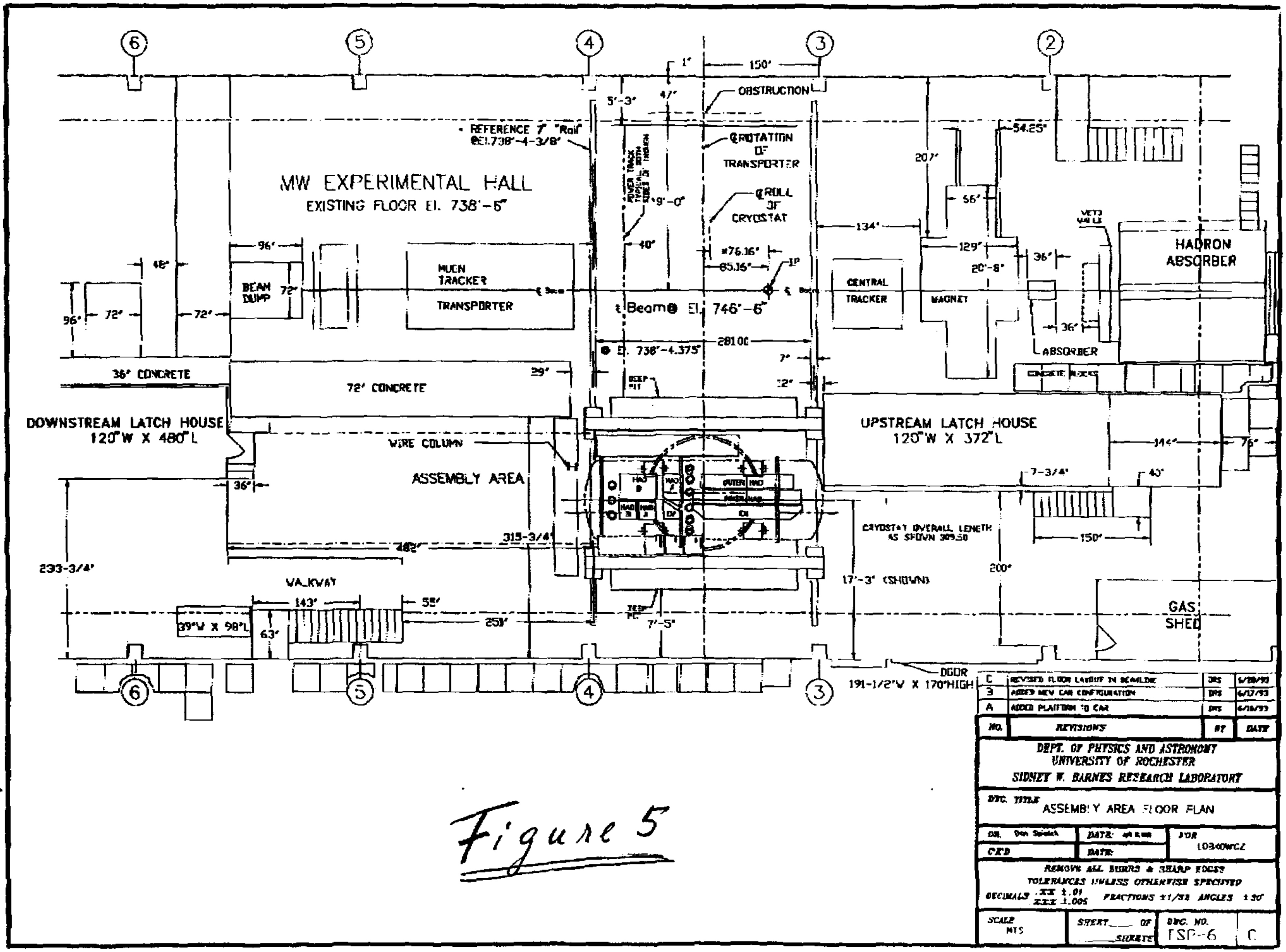

MW EXPERIMENTAL HALL
EXISTING FLOOR EL 738'-6"
REFERENCE 7" "Rail" @EL.738'-4-3/8"
OBSTRUCTION
℄ ROTATION OF TRANSPORTER
℄ ROLL OF CRYOSTAT
BEAM DUMP
MUON TRACKER
TRANSPORTER
℄ Beam @ El. 746'-6"
CENTRAL TRACKER
MAGNET
HADRON ABSORBER
ABSORBER
36" CONCRETE
72" CONCRETE
DOWNSTREAM LATCH HOUSE
120"W X 480"L
UPSTREAM LATCH HOUSE
120"W X 372"L
WIRE COLUMN
ASSEMBLY AREA
CRYOSTAT OVERALL LENGTH AS SHOWN 309.50
WALKWAY
39"W X 98"L
GAS SHED
DOOR
191-1/2"W X 170"HIGH
C REVISED FLOOR LAYOUT IN BEAMLINE
B ADDED NEW CAR CONFIGURATION
A ADDED PLATFORM TO CAR
NO. REVISIONS BY DATE
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY
DWG. TITLE ASSEMBLY AREA FLOOR PLAN
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
SCALE NTS
DWG. NO. TSP-6 C

Figure 5

From: URHEP::LOBK "F. LOBKOWICZ/ROCHESTER" 18-JUN-1993 16:39:29.84
To: MWEST::LOBK
CC: LOBK
Subj: testbeam

This is the fourth version of the document, and incorporates in some form all comments I received by afternoon on june 17. It has been strongly influenced by a long discussion at BNL with several people there, as well as by a visit to SSCL on june 14 and the testbeam meeting at FNAL on June 17. All of this has generated some answers, but also many new questions.

I am not repeating again all comments made in earlier versions. Hopefully the document will now converge towards a concise list of precise and correct specifications. Please remember that the final document is to be ready no later than June 22.

SPECIFICATIONS FOR FNAL TESTBEAM CRYOSTAT AND TRANSPORTER.
(This is Version 004; Vs 007 gives me the licence to kill)

I. Time scale.

In order to be ready for taking beam in March 1995, all the necessary components should arrive at FNAL in the fall of 1994. The following schedule is specified:

Beneficial occupancy of MWEST by GEM March 1,94 (As per G. GINTHER)
Transporter arrives at Fermilab August 15, 94 (12 mo after PO - D. SPISIAK)
Transporter is fully assembled for cryostat Sept 15, 94
Cryostat arrives at Fermilab Oct 1, 94
All necessary cryostat plumbing is ready Oct 1, 94
All cryostat/transporter control components arrive at Fermilab oct 1
Feedthrus ("Seattle version") are at Fermilab Oct 1. P.MOCKETT(??)
Assembly of modules into support structure begins Nov 1, 94
Junction boxes and outside cables are at FNAL on Nov 1,94
DAQ adequate to test system Dec 1,94
Modules inserted in cryostat, internal hookup begins, Jan 1, 95

Cryostat ready for cooldown Feb 15, 95.

II. Cryostat and arrangement of modules

NOTE: All specific distances mentioned in this document assume that the imaginary point which is the interaction point in the real calorimeter is 76" ~~71.12"~~ = ~~1806.5~~ mm away from the axis of the cryostat, and that "crack # 1" = upper crack in inner hadronic barrel modules is at an angle of2.25 degrees above the horizontal.

1) The cryostat is to accommodate: 2 Barrel EM modules, 4 Barrel inner hadronic modules, 3 Barrel outer hadronic modules, 3 Endcap outer A and B hadronic modules, 2 Endcap inner hadronic A and B modules and at least a section of a simulated endcap EM. Should a part of a real EM endcap be available, it should be used. See Figure 2 for some details.

2) When looking downstream, with the beam (that is NORTH), the endcap modules are ON THE LEFT (West).

Comment: This spec is driven by the nearness of the East wall, and the end of the trough, when the calorimeter is in the beamline. Reversing the orientation leads to interference with the wall.

---

3) Outer cryostat diameter is AT MOST 102.5". Neil Hall will attempt to make it smaller. The cryostat length is AT MOST ~~315"~~ 308". Every effort should be made to make the cryostat shorter.

4) The cold cryostat vessel is to be designed for an operating overpressure of 50 psi and underpresure of 15 psi (Vacuum). The warm vessel is to be designed for vacuum. Attention must be paid (by both pressure relief and/or adequate vessel design) to protect the outer warm vesel from rupture should the inner vesel fail (e.g. at the window)

5) There are two stiffening rings of AT MOST 6" thickness between the cryostat and the rocking wheels on the transporter. The inside load of modules, bathtub, etc has to be transferred to these two stiffening rings. The separation between these stiffening rings is 131.25" (Center to center)

6) The cryostat (both cold and warm vessel) are to be flanged at the Endcap end. The recommended seals are ASR rings such as manufacutred by

~~Le Joint Francais~~		Helicoflex Seals
~~84-116, rue S. Allende~~		P.O. Box 9889
~~95870 Bezons, France~~	OR	Columbia S.C. 29290
~~Tel 001-33-34-23-34-23~~		803-783-1880

Such seal rings are standard at CERN.

6) Unless the cost is prohibitive, the cryostat is to have a thin window presenting at most 0.15 radiation length. The window is to allow a rotation of 57 degrees anti clockwise, 25 degrees clockwise about a vertical axis and a rocking motion of 9 degrees. A beam size of apoprox 1 " width must be added to the minimal size.

NOTE 1: the exact size of the window is determined by the distance between the cryostat axis and the virtual intersection point. The present best value is 76". Assuming an outer vessel radius of 51." and inner vessel radius of 48", this implies a window of at least 52" width in the outer shell and 58" in the outer shell. The window height is then at least 5.5" in the outer vessel and 6" in the inner shell. If necessary, the window could be subdivided into two, as long as the region between them is no wider than 5".
NOTE 2: If one wants to enlarge the angular range to 65 degrees into the endcap, 30 degrees the other way, the window acquires a length of 70" or so, by which time it is ridiculous to discuss a window. Rather one should now consider stiffening rings some 70" apart along the whole cryostat, with the wall thickness now chosen as thin as possible consistent with this spacing. Note that this implies also stiffening rings on the inside - even the inside has to withstand a collapse under 1 atm overpressure.

---

7) The baseline design of the cryostat is an aluminum vessel, both inside and outside. The vessel is to be a code vessel.

8) The cryostat with its internal support structure for the individual modules is to be designed by SSCL.

9) The assembled cryostat will be tested cold by vendor before shipping.

NOTE: This means that either the feedthrus have to be delivered to vendor for welding in before shipping, or vendor has to test with blank flanges and welding in of feedthrus requires separate cooldown.

III. Cryostat and transporter.

1) The cryostat will sit on a transporter, to be designed by Rochester. See Figure 3 for an overview of the transporter. One should note that the building has a 25 ton crane; this limits the maximum weight of items to be handled inside the building.

2)The cryostat on its transporter has to be movable :
(i) East-west along the whole track in MWEST, with continuous motion of at least 10'.
(ii) Around a vertical axis at least 57 degrees clockwise (into the endcap) and 20 degrees anticlockwise. ***NOTE: these angles should probably be increased to 65/33. There is a negligible cost increase due to the rotational aspect alone.
For installing the modules on their support vehicles the cryostat has to rotate by 90 degrees with the endcap section pointing North (downstream).
(iii) The rolling motion (around the cryostat axis) is to be at least +/- 4 degrees. Anything more is so much gravy, but not in the baseline.
(iv) The vertical motion has to accommodate the rocking motion, keeping the calorimeter modules in the right orientation to the beamline.
NOTE: The amount of vertical modion depends on the distance from the cryostat axis to the intersection point.

There will be a position measurement system accessible to the DAQ system which will locate all degrees of freedom to approx +/- 1 mm.

All moving parts of the drives have to be covered to satisfy OSHA requirements

COMMENT: There are two schools of thought on how to move the transporter during "scanning across modules". The first school envisages occasional motion of the transporter and cryostat, followed by electrically disconnecting the power to the controls and taking data. A second school envisages scanning "on the fly", moving the detector between beamspills by small amounts, and taking only approx one beamspill per position.
While the second school, if successful, would increase data collection speed, it is unclear whether this scheme is able to adequately suppress electronic noise and effects of liquid sloshing around inside the bathtubs. At a minimum only "clean power" could be used for the motor drives and controls.

3) a section of the warm (scintillating) calorimeter will be sitting behind the cryostat; this will participate in the horizontal and up/down motion as well as in the rotation about a vertical axis. the scintillator calorimeter will not participate, however, in the rocking motion of the cryostat.

4) A small X-Y set of drift chambers (with positional accuracy of 0.1 mm) will be mounted at the imaginary intersection point from where all particles must seem to emanate. The chamber should be mounted on an arm extending from the cryostat, thus participating in all of its motions. It should be

sufficiently large that one can simulate the length of the interaction pencil in the real GEM experiment (15 cm total??).
****
NOTE: With the assumed locations of the modules, the chambers are about 25" in front of the warm cryostat vessel. The asembly should probably be rotatable (in fixed increments for accuracy) about a vertical axis so that the beam impinges always approx. normally to the chambers.
****

5) The transporter is to be designed for the following loads:
(i) The Hillman Rollers supporting the transporter will be rated at at least 200 tons each (Existing rollers are rated at 300 tons each)
(ii) The elevation (up/down)motion will be designed to support 200 tons total. This implies four 100-ton jacks.
(iii) The cryostat and its inside load is not to exceed 120 tons.
(iv) The scintillation calorimeter (See III-3) is to consist of two pieces, each of less than 25 tons INCLUDING ANY LIFTING/SUPPORT MECHANISMS.
NOTE that 25 tons = 55,000 lbs = 22,700 kg

6) The "upstream latchhouse" at present starts 154 +/- 1" south of the centerline betwee the two rails. Below a height of ca 65" there is 3.5" more available. This implies that NO PART OF the rotating table, including cryostat, platform on top, electronics etc should extend more than 153" from the center of rotation. If this is not possible, safety stops will have to be introduced which limit combined motion. As a third possibility, the latchhouse would have to be moved.

7) The topmost table on the transporter (rotating around a vertical axis and carying the cryostat) will be equipped with an elevated platform which gives access to the top of the cryostat for cabling, cryo connections etc. The platform will be at a height slightly above the cryostat, and will cover most of the cryostat except where there are penetrations. Attention must be paid that during the various rotations of the cryostat the platform does not interfere with the upstream latchhouse, concrete shielding or any other obstruction. Attention also must be paid that the rocking cryostat does not pinch any cabling or other connections between cryostat and platform. None of these structures can interfere with the beam entering the detector modules inside the cryostat. The topmost transporter table and the platform together must accommodate the purifying mechanism (approx 6'w x 2'd x 6' h) a vacuum pump (approx 2' x 2' x 2'), all local control mechanisms (appros 3 6' tall electronics racks) as well as the junction boxes (unless these are attached directly to the cryostat, in which case the platform cannot impede their motion).

--Figures below not yet in existence---
Figure 3a: Side view of cryostat on transporter with platform. The darkly shaded area has to stay clear so that beam can pass unhindered. The ligher shading is present clear volume
Figure 3b: End view of cryostat, showing where one could install the purification equipment and the junction boxes.
Figure 3c: View from top - again showing "stay clear" area.

NOTE 1: Details of these drawings depend on the exact location of the modules inside the cryostat.
NOTE 2: If the junction boxes are attached to the cryostat

rather than to the platform, there would be less likelihood that the cable connections strain the feedthroughs. If the junction boxes are attached to the platform, one needs a restraint for the cables which is attached to the cryostat and prevents the cables from pulling while the cryostat is rocking around its axis.

IV. Electrical connections.

GENERAL COMMENT: All power fed onto the transporter, and a fortiori all power fed into the cryostat, has to be clean power. This means that insulation transformers have to be used for all power.
Ground loops are also to be eliminated wherever possible. This implies that the transporter is to be insulated from the Hillman rollers which support it, and that all cryogenic connections need to have an insulating section. Such sections have been designed for the DO test beam area.

1) There will be approx 5000 signal and calibration connections from the calorimeter modules. The signals will come from internal preamplifiers.

2) There will be 100-200 HV connections into the cryostat - half for the barrel and half for the endcaps
There will be 100-200 DC power connections for the preamplifiers into the cryostat. Each will cary AAA amperes at +/- VVV Volts.
The HV and power connections will use the same feedthru ports as the signal connections.

3) The cryostat is to have nine feedthru ports for accommodating the signals as well as the auxiliary connections (thermometry, pressure and level monitoring, heaters etc). Of these six will be above the separation region between barrel and endcap modules, while three will be near the cold flange. Each of these ports must be suitable for the Seattle type feedthrus; however, the assembly scheme is somewhat different from the real Gem detector. P.MOCKETT will provide more detailed specs by July 15, 93. Each of the feedthrus is capable of transmitting 860 signals.
Actually only seven of the ports will be used for the usual signal/HV/premp power connections similar to those in the real detector. One will be used for auxiliary connections (heaters, pressure monitoring, temperature monitoring etc), and one will be used for the test sources whjich monitor liquid purity. Figure 2 shows the desired location of the ports.

NOTE: All control and power wiring into the cryostat has to be filtered and/or shielded to prevent coherent noise.

---

4) From the feedthrus the signal cables will go to junction boxes situated on the transporter,EITHER ATTACHED TO THE CRYOSTAT or on a platform near the top of the cryostat. If the junction boxes are attached to the platform,then the junction boxes participate in all cryostat motions except the rocking motion. In this case attention must be paid to prevent any cables putting a stress on the feedthrus. The junction boxes need two standard rack spaces of ca 30 " height, one each near the two port areas. It is likely that the power supplies for the junction boxes will be located directly underneath. The junction boxes will use XXX amperes at +/- YYY Volt.

5) From the junction boxes, cables will go downwards through an opening on the transporter towards the bottom of the trough. From there on cables of 50 meter length will lead to the DAQ system located in the MWEST counting room.
The cable layout has to allow initial connections to be made while the cryostat is still open. These connections will then stay continuously closed while the cryostat is pumped down, the modules cooled, the cryostat brought into the beam, and during a whole run.

NOTE: It seems doubtful that the originally specified length of 40 meters is sufficient to have the next stage be in the counting room. Before the specified length is shortened, one has to either allow the DAQ to be inside the hall (RADIATION!!!) or invent a scheme which allows the transporter to be set through its motions while the cables stretch into the counting room.

3) There will be heaters inside the cryostat:
(i) a heater of ca 1 kW max. in contact with the bottom of the cryostat (under the bathtubs, bot NOT in contact with them) will warm the cryostat wall to a temperature slightly above that inside the modules, thus preventing pooling of liquid at the bottom. This heater will be on at all times with the DC current being regulated by the temperature; the typical power consumption will be a few hundred Watt.
(ii) a heater of 10-20 kW is to be used for emptying the vessel - evaporating the liquid. Half of this heater should be attached to the underside of the barrel module support, and half below the endcap modules.

6) There will be many more thermometers in the testbeam vessel than in the real cryostat. We estimate about 100 such thermometers, mostly of the platinum type. Some of these should be next to the EM amplifiers.

7) There will be at least two (probably more) alpha - source purity monitoring cells inside the liquid. These can be read out on the same cables as the calorimeter modules. (??? There will also be several two-gap beta sources, where a pulse in the second gap triggers the first gap.???)

8) All AC power for power supplies of electronics on the transporter and inside the cryostat has to be filtered against SCR spikes from powersupplies on the whole FNAL site.

9) The total power required for motor control for the various motions will be specified later. Unless these lines can be disconnected during data taking, they will have to be "clean power".
About 2-3 standard racks should be reserved for controls of motors, temperature monitoring, purity monitoring, etc.

V. Inside the cryostat

1) The modules will be filled with either LAr or LKr. The maximum available amount of LKR will be approx 3000 liters. This means that it may not be possible to fill both barrel and endcap modules with LKr.Every effort should be made to make the bathtubs as compact as possible, unused volume which cannot be eliminated can in principle be filled with Aluminum blocks, but this is not a cheap filler material.

2) There will be two separate "vehicles": one carrying the barrel modules, one the endcap modules. These have to be individually and separately movable. The separation between the two "vehicles" is to be as similar as possible to the actual separation between endcap and barrel. Each vehicle carries a bathtub which contains the liquid.

3) The bathtubs have to be connected by a pipe AFTER they are wheeled into place. There should be a helium acuated valve which can shut off this connection.

COMMENT: Point 3 is necessary if one wants to fill both bathtubs with argon, and then empty and refill one bathtub with krypton without opening the vessel.

---

4) There will be two LN2 cooling loops at the top of the cryostat, one above each bathtub. There will be either an inside set of Helium actuated valves allowing eather of the two cooling loops to be activated, or there will be separate inlets and outlets for the two loops (so that the loops can be turned on/off externaly).

COMMENT: This assumes that only these two loops will be used for cooldown. No additional loops are envisaged.

QUESTION: We are right now assuming that all Ar/Kr fills will be by Gas. If not, we need another cryo connections to the inside.

---

5) Each bathtub needs a separate drain which is to be connected to an opening at the top of the cryostat. This drain consists of a tube reaching to the bottom of each bathtub, AFTER the bathtub is inside the cryostat the tube is connected to a vacuum insulated liquid feedthru at the top of the cryostat. A liquid return is also required above each bathtub. These connections are required for purification of the LKr in liquid form.

COMMENT: Since it is possible that later on we will have ennough LKr, both should be able to to be connected to the purifier. We may even want to purify the LAr.

---

6) There will be at least one gas port on the cryostat, which will carry relief valves, pumpout connections, and connection to stored Krypton gas, connection too a gas purification system etc. etc.

7) A large vacuum pump to evacuate the inside of the cryostat will be situated on the building floor. A small pump for (if necessary) continuously pumping on the insulating vacuum will have to be located on the transporter, preverably on the last rotating horizontal table.

6) There will be continuous purification of LKr. The purification in gas form will use the drain to flash liquid from the bottom of a bathtub. The gas purification station will fit into a volume of 2' x 2' x 2' situated on the uppermost table on the transporter. AS an option there will also be purification of Kr in liquid form. For this a volume of approx 2' x 6' x 6' has to be allocated on the top table on the transporter (under the platform). The liquid purification setup will require a leakfree (reactor type or similar) cryogenic liquid pump.

7) The approx 4000 preamplifiers will not be separately cooled.
NOTE: Can we live with these specs? The power is 400 Watt!!

VI. Insertion of modules.

1) The cryostat has to be filled from the downstream (North) side in the MWEST hall. Figure 4 shows the approx. arrangement during installion of modules.
There may not be enough space to insert individual modules from the "natural" side, that is from the East. The available space between the imaginary centerline through the cryostat and the concrete wall is about 105" = 2.67 m. If this is not enough to install the modules, the "assembly area" should be on wheels so that it can be moved further West.

2) The region between the two bathtubs should closely simulate the transition between the real cryostats. This means that the "barrel bathtub" should end on the endcap side with pieces simulating the cold + warm cryostat walls. The bathtub should also incorporate a segment of the cylindrical stay at r = 1670 mm. The same consideration applies to the endcap bathtub: on the barrel side it should simulate the real thing. It should also ioncorporate the various support stays which are part of the endcap cryostat. The hadron modules will be mounted in as much the same way as possible to the mounting in the real cryostat.
LLMASON et al. will provide a mounting scheme for the two barrel EM modules, which require special attention since in the real device they are just a part of a rigid cylinder and have no mechanical stability on their own.

3) The barrel bathtub is to have a thin window at the entrance over the region of the EM modules. This window is not to exceed 0.25" of aluminum, and can be somewhat curved. The region above and below in front can be heavy, and can be used to reinforce the support plate. Provisions should be made for mounting additional pieces of aluminum to the front of the EM modules, so that one can study the effect of material in front of the detector.

In the back the bathtub should be reasonably thin; the total thickness of bathtubs + inner cryostat + outer cryostat should not exceed 5.8 cm (2.3") of Aluminum.

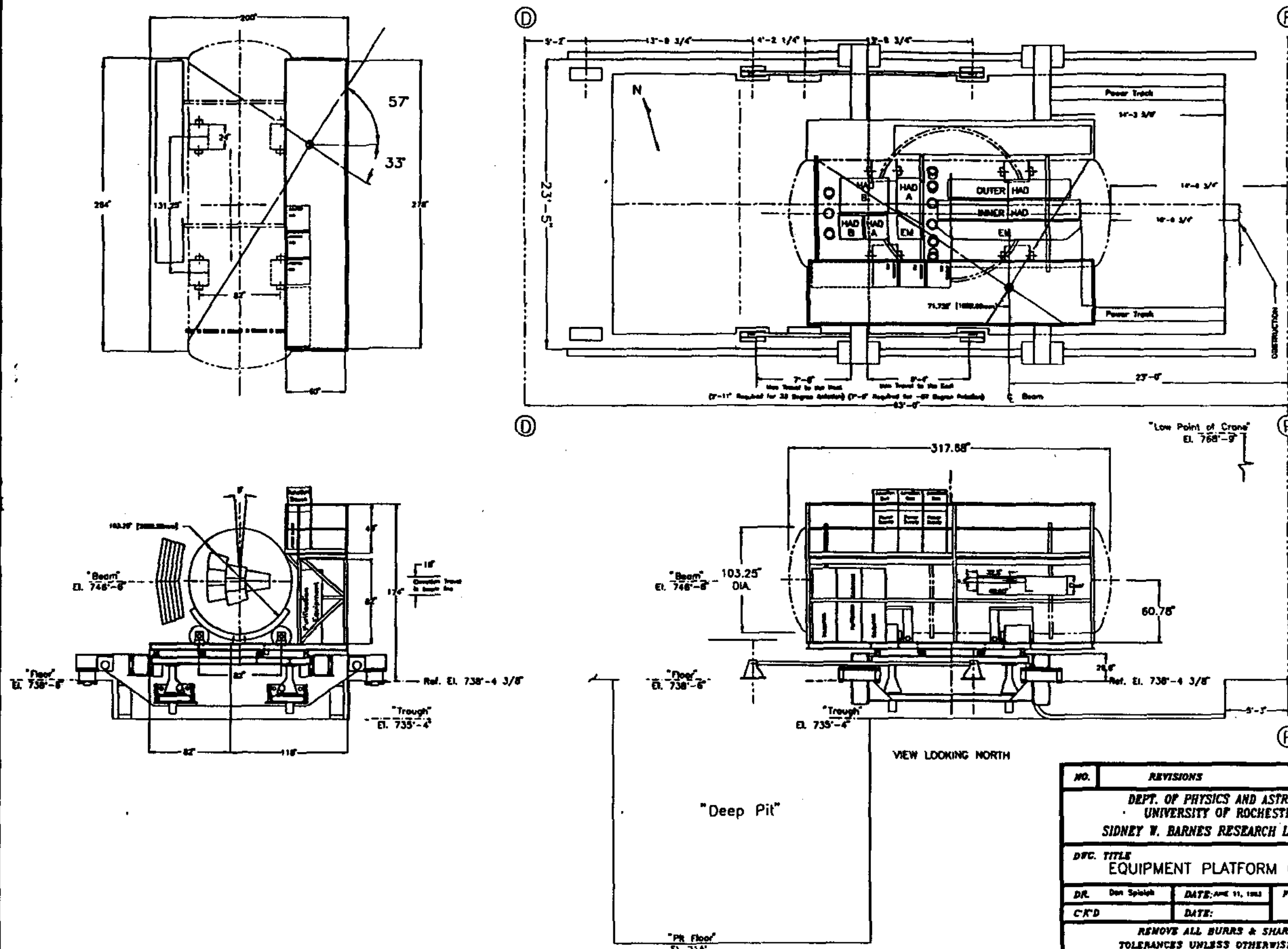
4) The endcap bathtub should have walls simulating the real cryostat walls between it and the barrel bathtub. The rest of the walls can be heavy.

5) Both the barrel and the endcap bathtub should include the relevant segments of the reinforcing stays in the real endcaps.

6) The mounting details for the endcap modules will be provided by Mockett and LLMASON

The mounting details for the barrel module will be provided by Lobkowicz and LLMASON.

Further comments, insults or wisecracks to be addressed to URHEP::LOBK or "LOBK@URHEP.PAS.ROCHESTER.EDU"



NO.	REVISIONS	BY	DATE

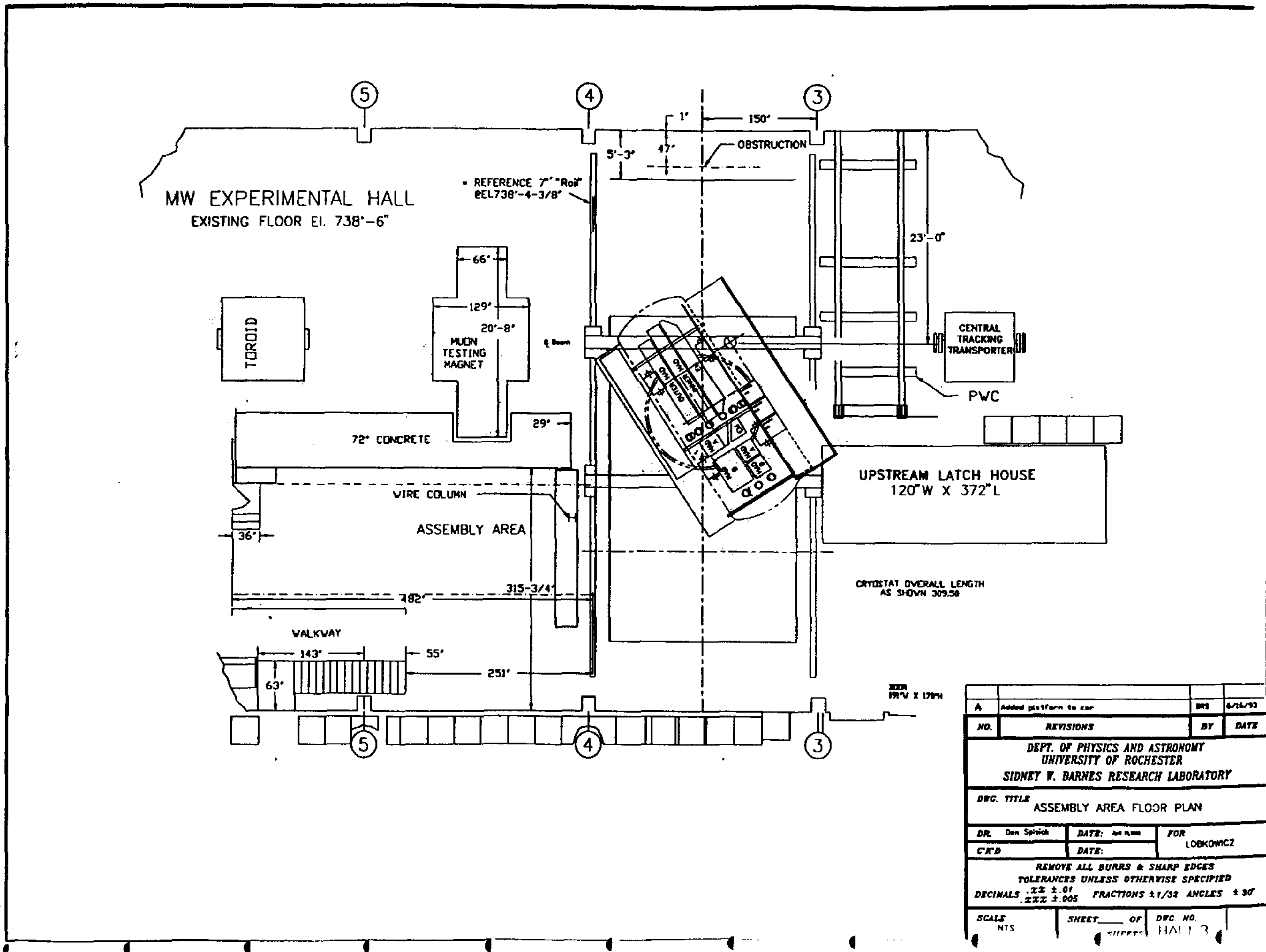
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY

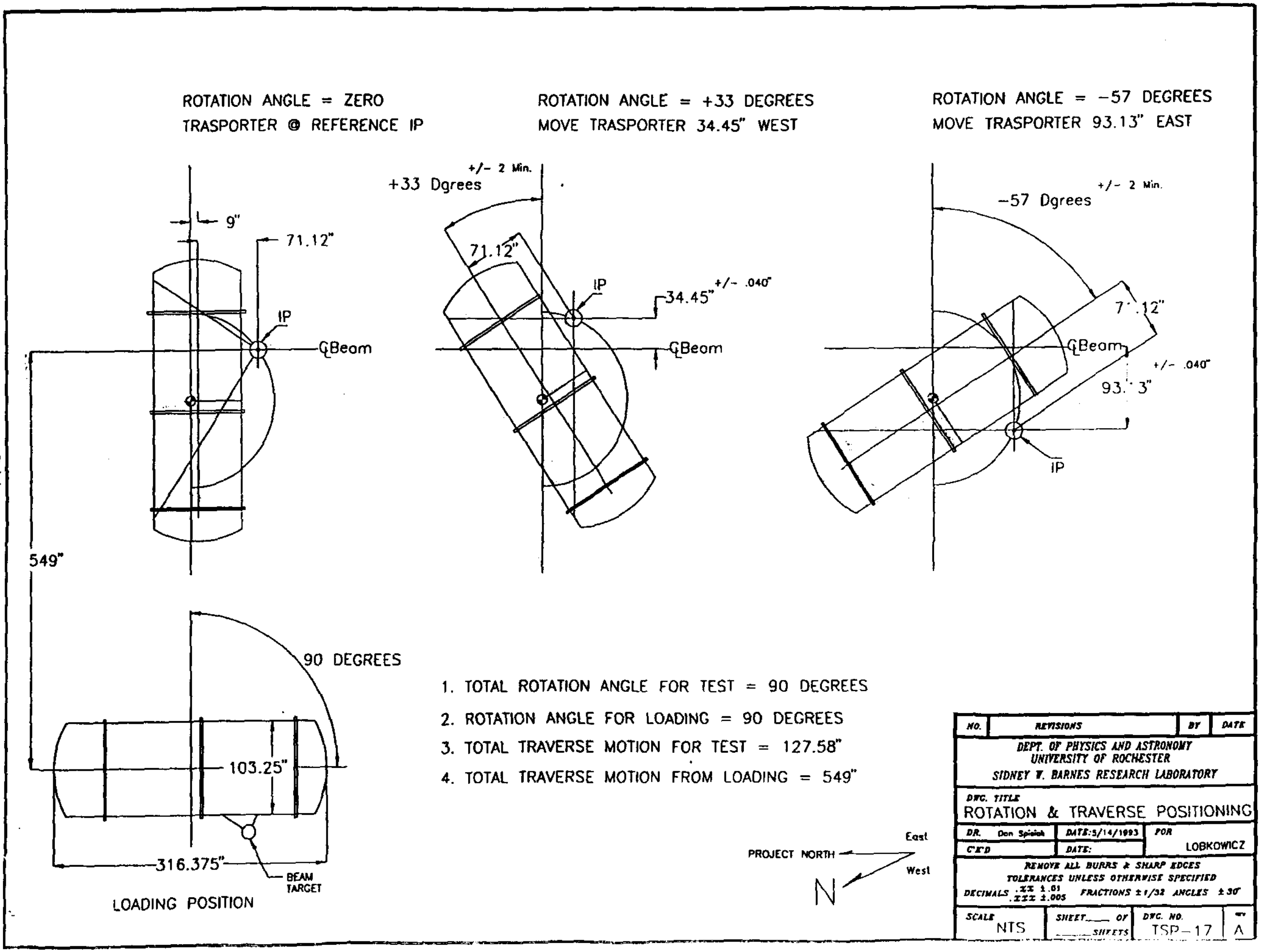
DWG. TITLE
EQUIPMENT PLATFORM CONCEPT

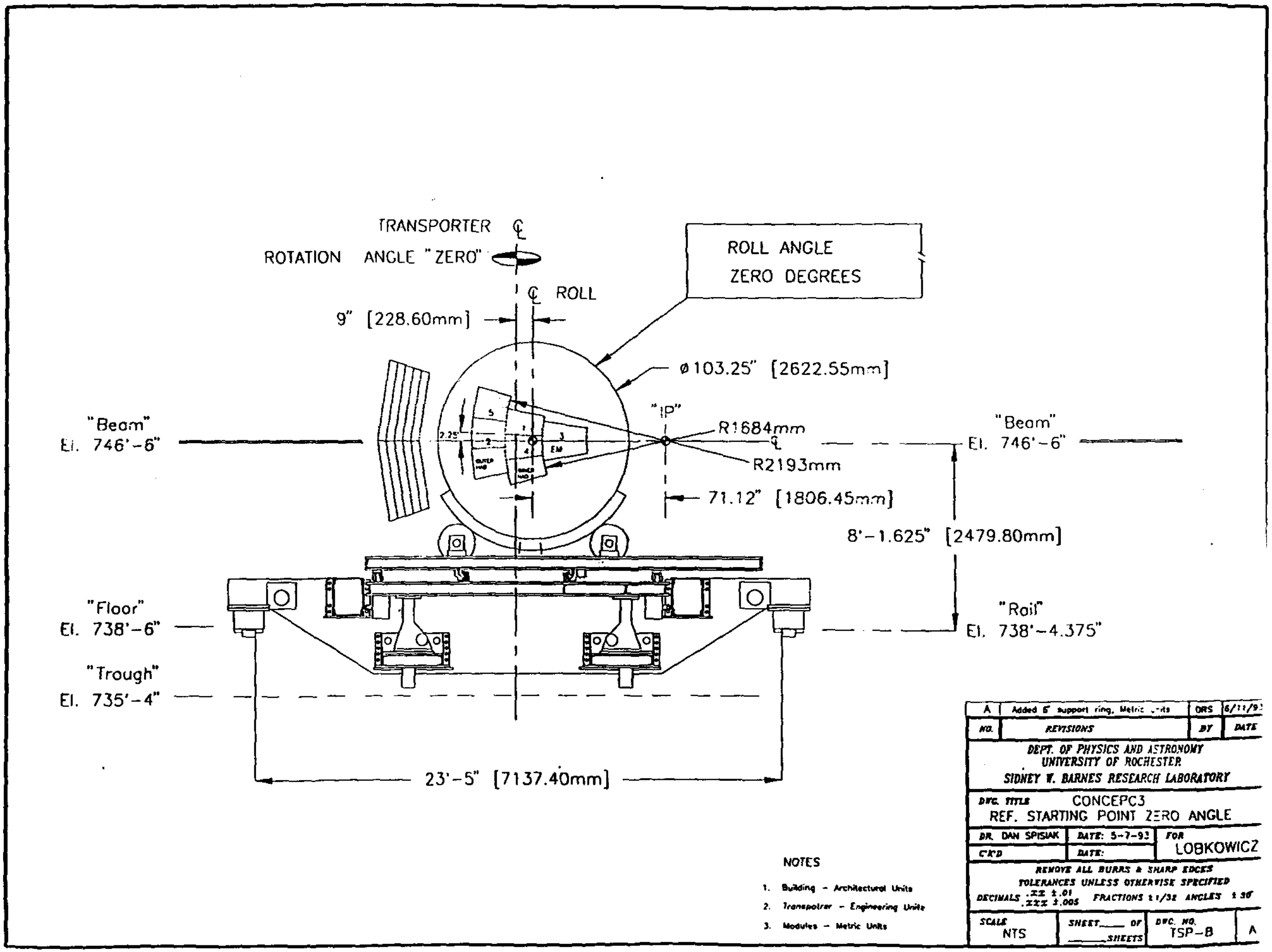
DR. Don Spiolch	DATE:	FOR LOBKOWICZ
CK'D	DATE:	

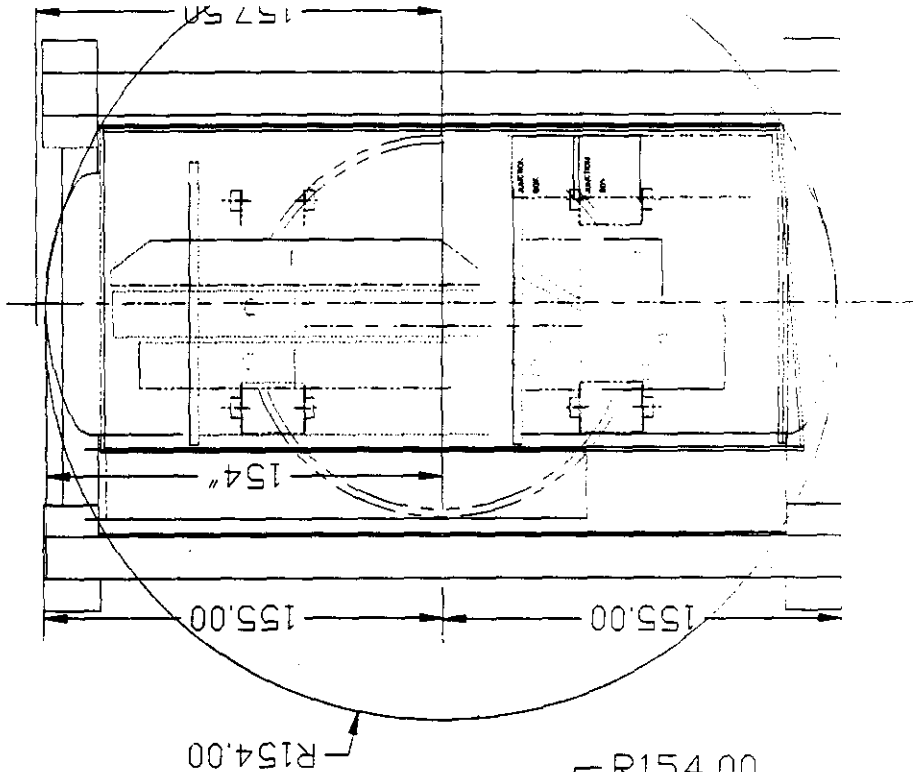
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .XX ±.01 .XXX ±.005 FRACTIONS ±1/32 ANGLES ±30'

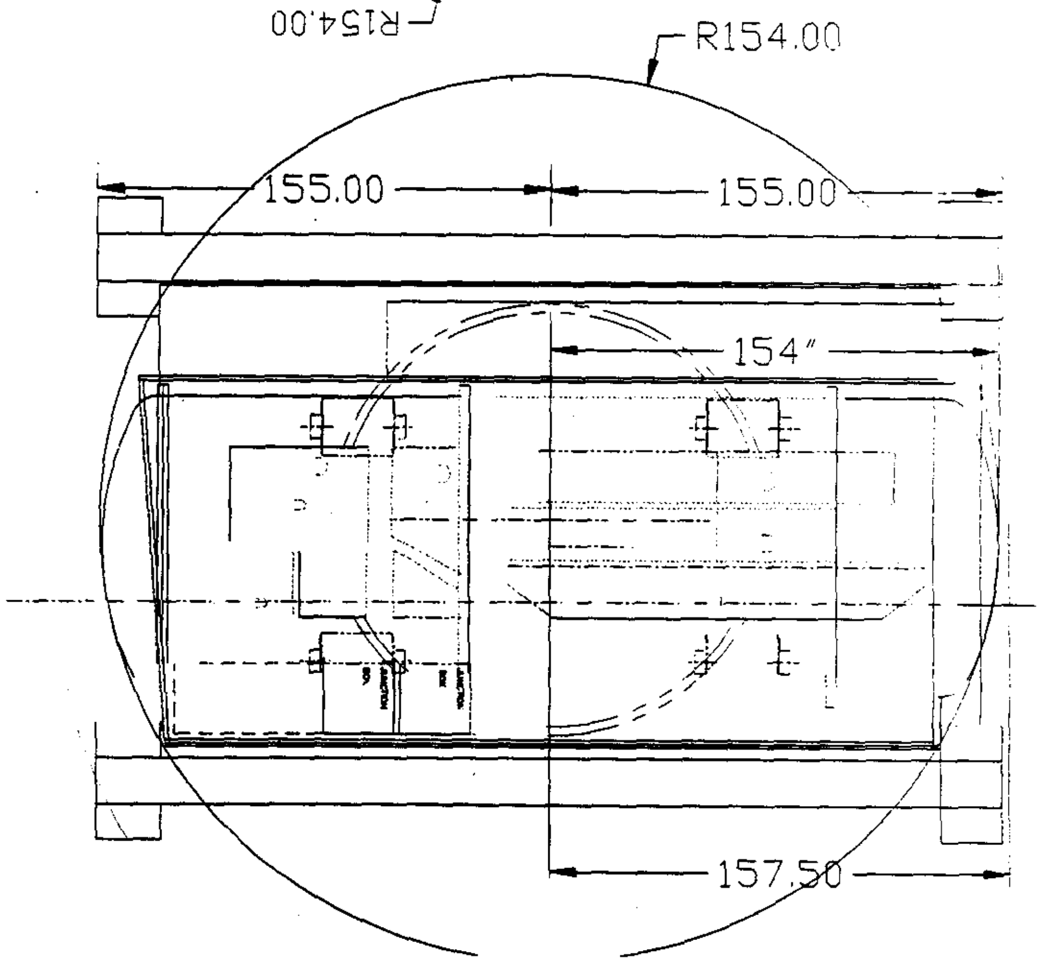
SCALE	SHEET ___ OF ___ SHEETS	DWG. NO. TSP – 27


MW EXPERIMENTAL HALL
EXISTING FLOOR El. 738'-6"
5
4
3
1'
150'
5'-3'
47'
OBSTRUCTION
REFERENCE 7" "Rod"
@EL.738'-4-3/8"
23'-0"
66'
129'
20'-8'
TOROID
MUON
TESTING
MAGNET
CENTRAL
TRACKING
TRANSPORTER
PWC
29'
72" CONCRETE
UPSTREAM LATCH HOUSE
120"W X 372"L
WIRE COLUMN
ASSEMBLY AREA
36'
CRYOSTAT OVERALL LENGTH
AS SHOWN 309.50
315-3/4'
482'
WALKWAY
143'
55'
63'
251'
A
NO.
REVISIONS
BY
DATE
6/16/93
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY
DWG. TITLE
ASSEMBLY AREA FLOOR PLAN
DR.
DATE:
FOR
LOBKOWICZ
CK'D
DATE:
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .xx ±.01 .xxx ±.005
FRACTIONS ±1/32
ANGLES ± 30'
SCALE
NTS
SHEET
OF
SHEETS
DWG. NO.


ROTATION ANGLE = ZERO
TRASPORTER @ REFERENCE IP
ROTATION ANGLE = +33 DEGREES
MOVE TRASPORTER 34.45" WEST
ROTATION ANGLE = −57 DEGREES
MOVE TRASPORTER 93.13" EAST
9"
71.12"
IP
℄Beam
+/− 2 Min.
+33 Dgrees
71.12"
IP
34.45" +/− .040"
℄Beam
−57 Dgrees +/− 2 Min.
℄Beam
+/− .040"
IP
549"
90 DEGREES
103.25"
316.375"
BEAM TARGET
LOADING POSITION
1. TOTAL ROTATION ANGLE FOR TEST = 90 DEGREES
2. ROTATION ANGLE FOR LOADING = 90 DEGREES
3. TOTAL TRAVERSE MOTION FOR TEST = 127.58"
4. TOTAL TRAVERSE MOTION FROM LOADING = 549"
PROJECT NORTH
East
West
N
NO.
REVISIONS
BY
DATE
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY
DWG. TITLE
ROTATION & TRAVERSE POSITIONING
DR. Don Spiciak
DATE: 5/14/1993
FOR
LOBKOWICZ
CK'D
DATE:
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .XX ±.01 .XXX ±.005 FRACTIONS ±1/32 ANGLES ±30'
SCALE
NTS
SHEET ___ OF ___ SHEETS
DWG. NO.
TSP−17
A


TRANSPORTER ℄
ROTATION ANGLE "ZERO"
ROLL ANGLE
ZERO DEGREES
℄ ROLL
9" [228.60mm]
ø103.25" [2622.55mm]
"IP"
R1684mm
R2193mm
"Beam"
El. 746'-6"
"Beam"
El. 746'-6"
71.12" [1806.45mm]
8'-1.625" [2479.80mm]
"Floor"
El. 738'-6"
"Rail"
El. 738'-4.375"
"Trough"
El. 735'-4"
23'-5" [7137.40mm]
NOTES
1. Building - Architectural Units
2. Transpoltrer - Engineering Units
3. Modules - Metric Units
A | Added 6" support ring, Metric units | DRS | 6/11/93
NO. | REVISIONS | BY | DATE
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY
DWG. TITLE CONCEPC3
REF. STARTING POINT ZERO ANGLE
DR. DAN SPISIAK | DATE: 5-7-93 | FOR LOBKOWICZ
CK'D | DATE:
REMOVE ALL BURRS & SHARP EDGES
TOLERANCES UNLESS OTHERWISE SPECIFIED
DECIMALS .XX ±.01 .XXX ±.005 FRACTIONS ±1/32 ANGLES ±30'
SCALE NTS | SHEET ___ OF ___ SHEETS | DWG. NO. TSP-B | A


157.50
154"
155.00
155.00
R154.00


R154.00
155.00
155.00
154"
157.50

Presentation by:

N. Hall

GEM TEST BEAM
CRYOSTAT STATUS

FNAL MEETING 6/17/93

Neil Hall - SSCL
(214) 708-6180

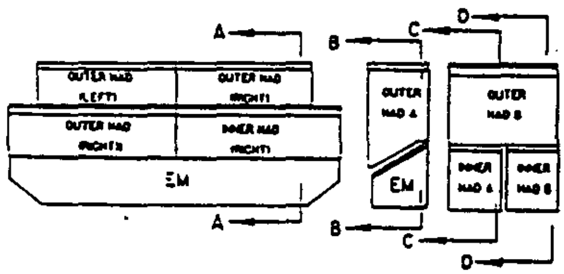
GEM TEST BEAM CRYOSTAT
MODULE CONFIGURATION

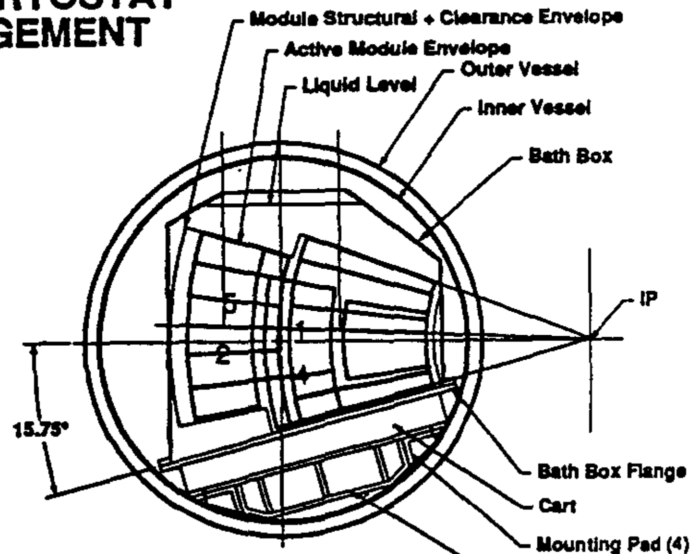
- CONFIGURATION CHANGED SINCE 4/22/93 FNAL MEETING
  - NUMBER OF BARREL INNER HADRON MODULES CHANGED FROM 8 TO 6
  - BARREL EM ROTATED 2.25° CCW
  - END CAP OUTER HAD's A & B HAVE SAME CLOCKING
  - END CAP INNER HAD's A & B HAVE SAME CLOCKING AND ARE CENTERED WITH CRACK 1
- REQUIREMENT IS TO PROVIDE ROLL OF ± 4.0°. THIS ALLOWS BEAM TO FAN 1.75° BEYOND CRACKS 1 & 2

Neil Hall, SSCL - (214)708-6180
June 16, 1993

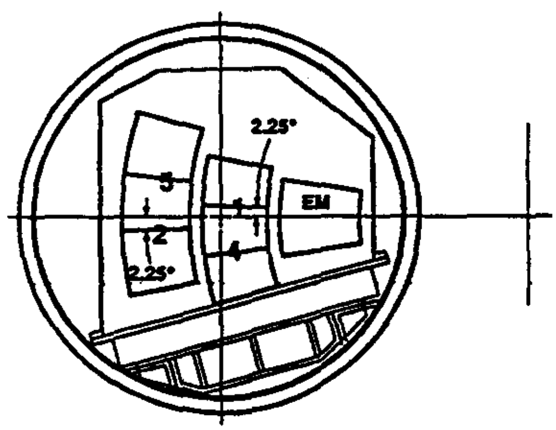
GEM TEST BEAM CRYOSTAT MODULE ARRANGEMENT

Rev: 6/11/93

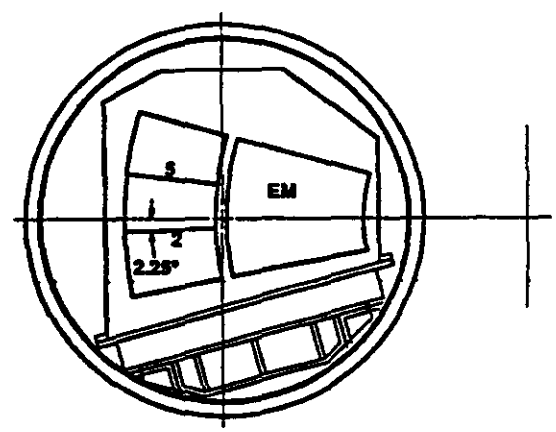




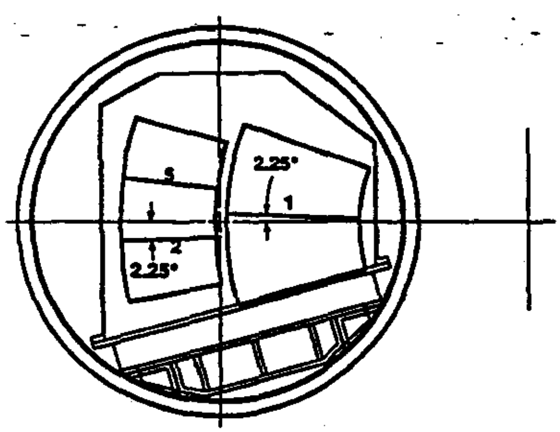
COMPOSITE VIEW
ROTATED 90°



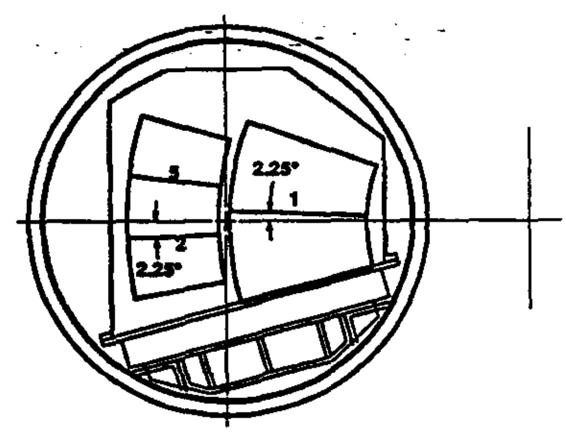
SECTION A-A (BARREL)
ROTATED 90°



SECTION B-B (ENDCAP)
ROTATED 90°

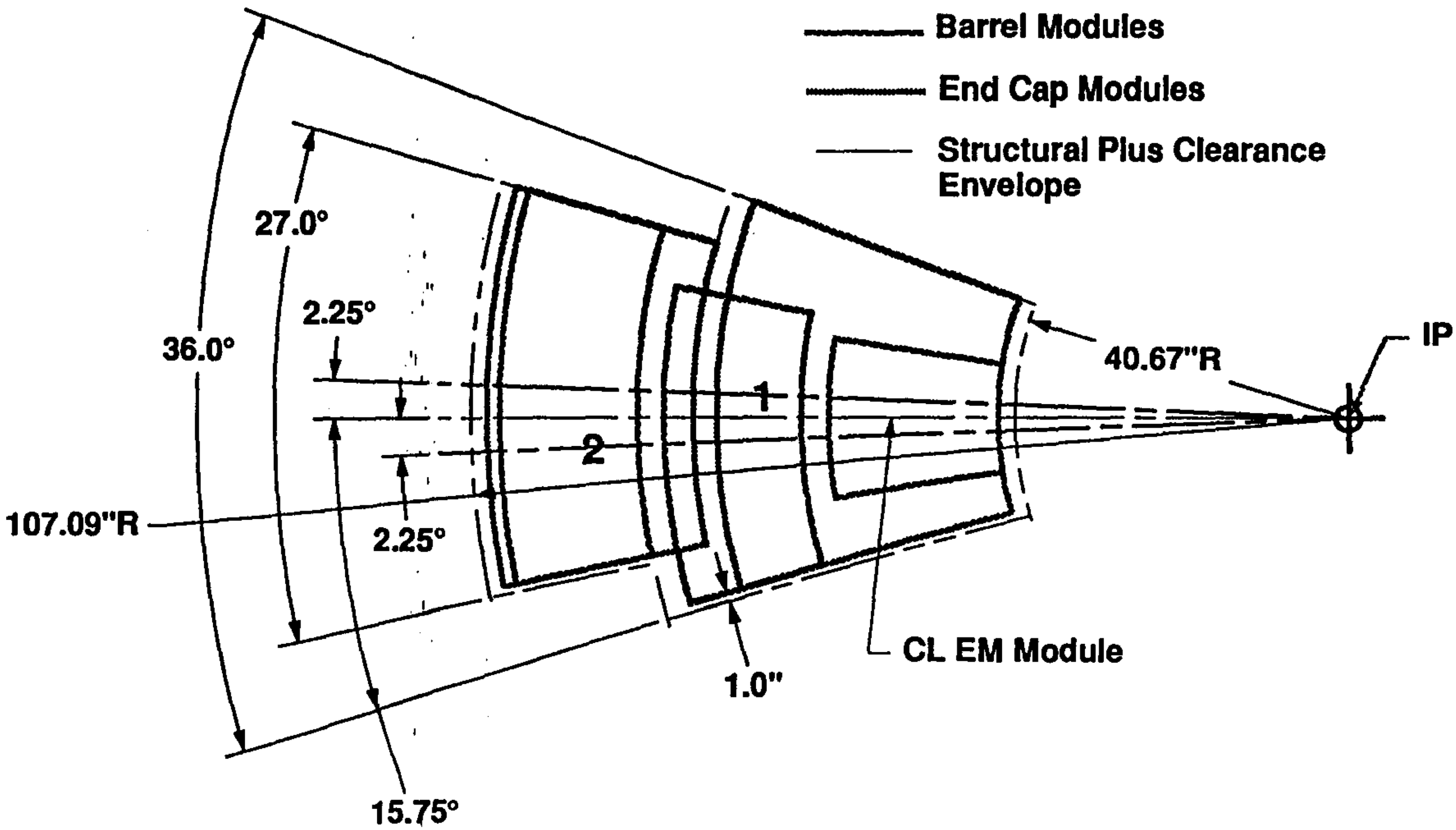


SECTION C-C (ENDCAP)
ROTATED 90°



SECTION D-D (ENDCAP)
ROTATED 90°

GEM Test Beam Cryostat
Module Configuration
Rev: 6/11/93



GEM TEST BEAM CRYOSTAT
VESSEL DESIGN STATUS

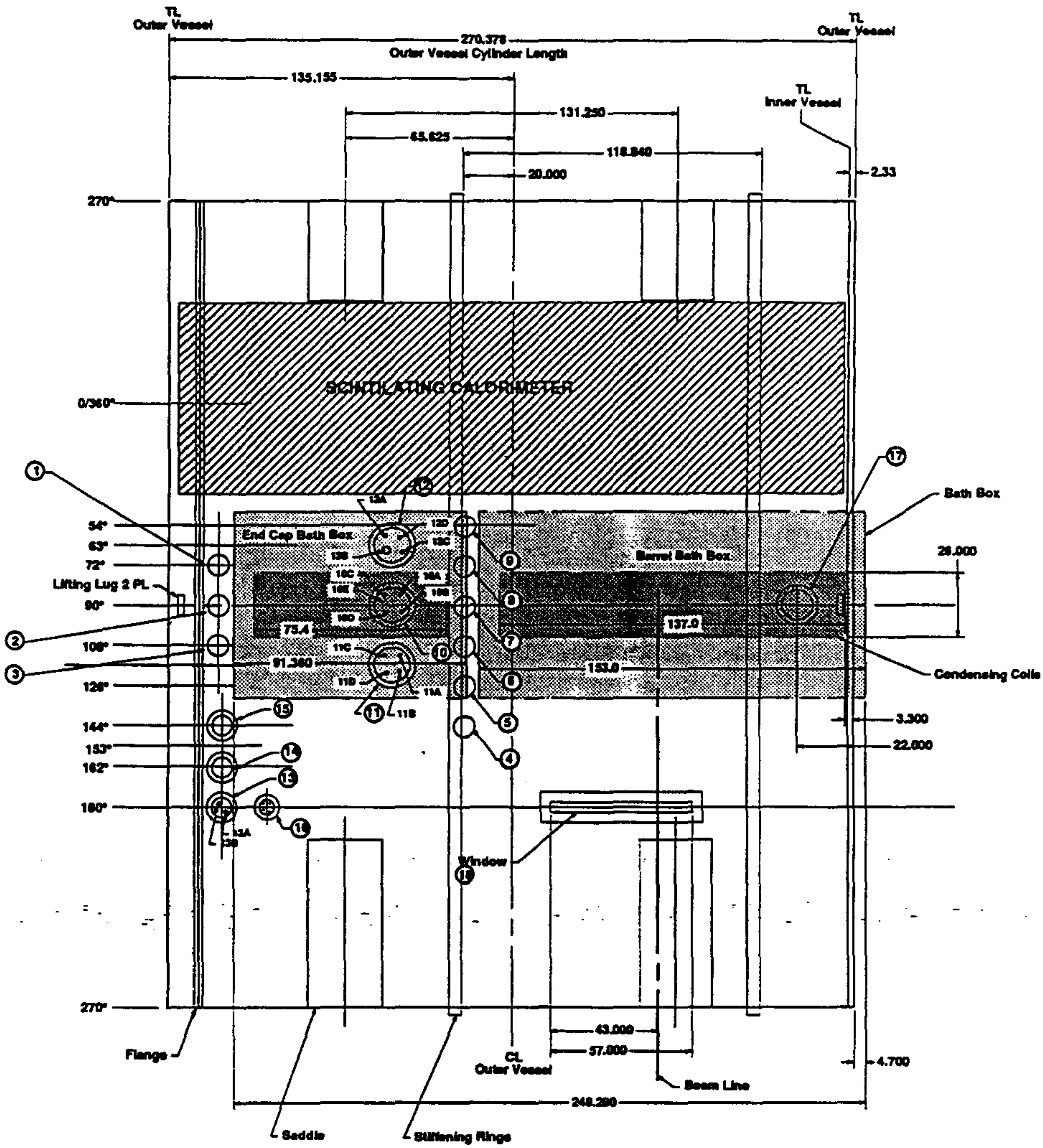
- BOLTED FLANGE WILL BE USED INSTEAD OF WELDED FLANGE
- WINDOW WILL BE ADDED ON BEAM SIDE OF CRYOSTAT
  - √ WINDOW THICKNESS WILL BE MINIMIZED
  - √ FRONT WALL OF BATH BOX WILL BE THINNED SO THAT SUM OF WINDOWS PLUS BATH BOX ARE EQUAL TO SUM OF GEM CRYOSTAT INNER AND OUTER VESSELS (i.e., 1.30 in)
- NO WINDOW AT REAR OF CRYOSTAT NOR WILL BATH BOX WALL BE THINNED
- CRYOSTAT WILL BE DESIGNED FOR .05 g's SEISMIC LOAD. DALLAS AND CHICAGO IN ZERO EARTHQUAKE ZONE
- FLAT PATTERN OF VESSEL PENETRATIONS HAS BEEN DEVELOPED
  - MAJORITY OF PENETRATIONS WILL REQUIRE ACCESS FOR HOOK-UP PRIOR TO VESSEL CLOSE-OUT.
- VESSEL DIAMETER CURRENTLY 102.5". EFFORT UNDERWAY TO REDUCE.
- VESSEL LENGTH CURRENTLY 310" T0 315".
  - √ DISTANCE BETWEEN SOUTH BLOCKHOUSE AND CONCRETE WALL IS 329". ALLOWS 7" CLEARANCE EACH END OF VESSEL.
  - √ VESSEL PROBABLY CANT BE MOVED THROUGH DOOR. ALTERNATIVES SHOULD BE INVESTIGATED.

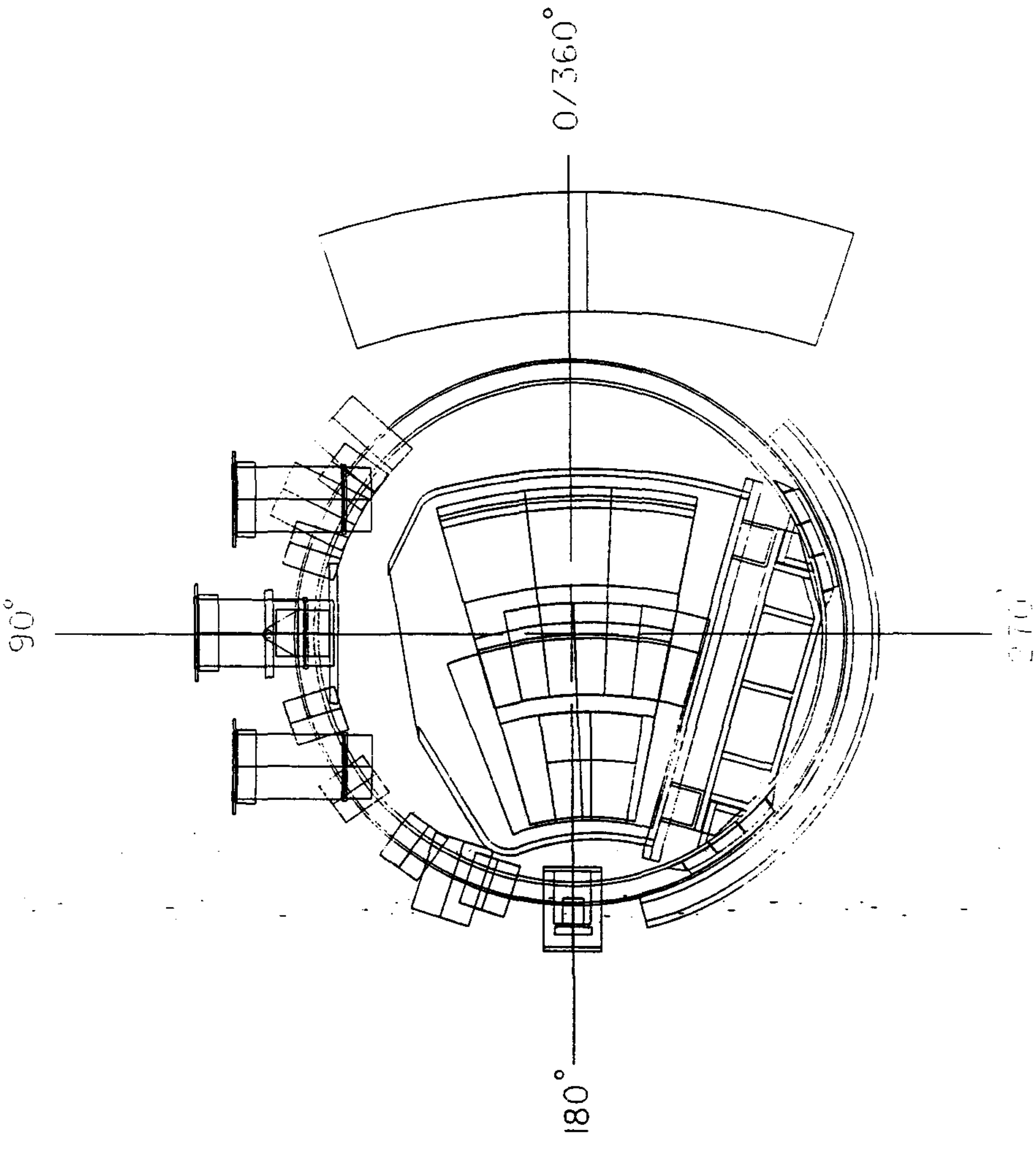
Neil Hall, SSCL - (214)708-6180
June 16, 1993

47

Cryostat Outer Vessel Flat Pattern (Heads Not Shown)

Rev: 6/15/93





0/360°
90°
270°
180°

Individual Penetration Definition
Rev 6/15/93

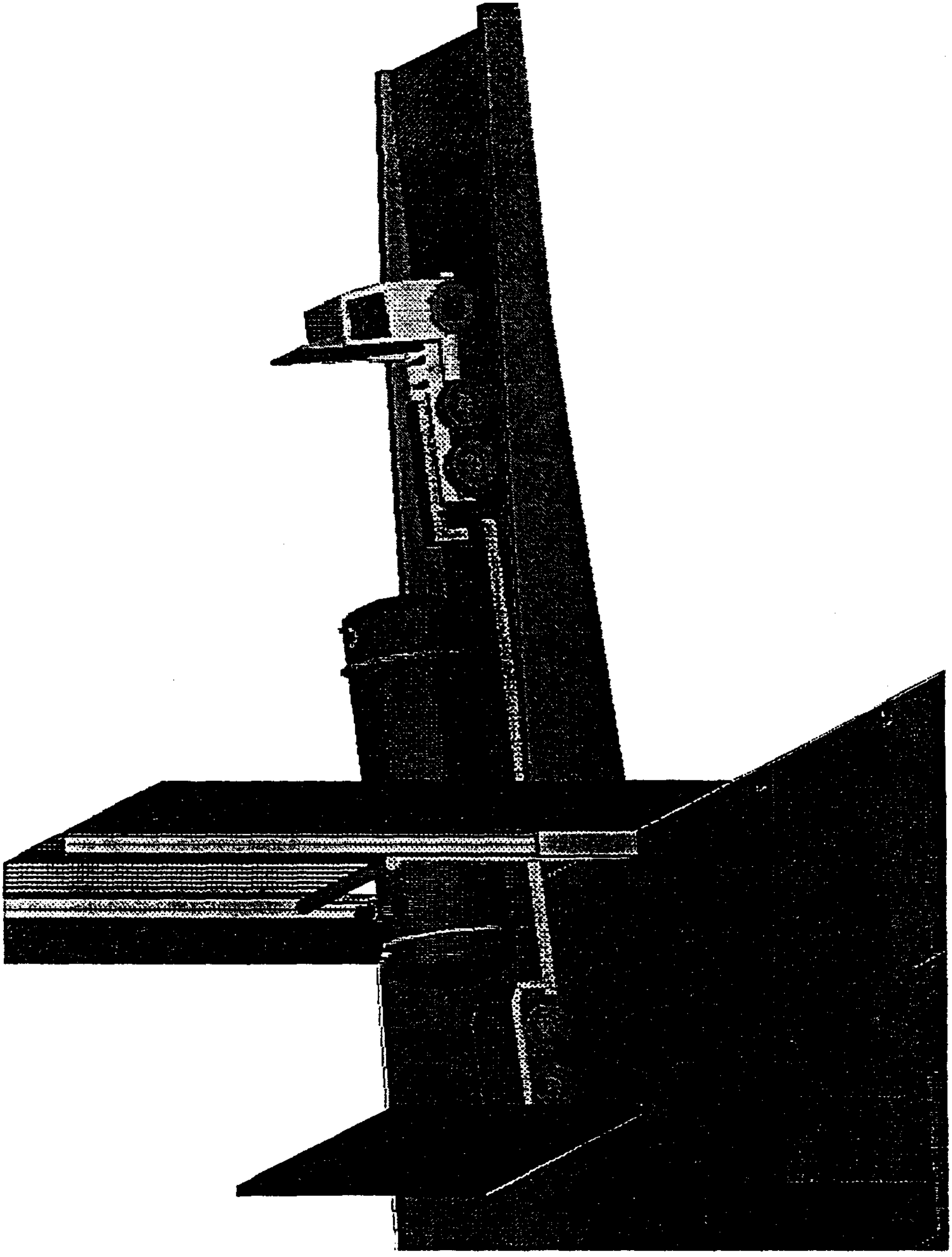
Description	Qty	IPS or Size, in	Penetration No.	Route Thru Penetration No.	Hook-up Required Upon Vessel Close-out?	Penetrate Thru both Vessels?	Bayonet Required?	Other
End Cap Module feedthrus for: a. Signal Cables b. Power Cables (4 conductor, 460 Volt, TBD amps) c. High Voltage Cables	3	8.5	1-3	1-3	Yes	Yes	No	Double block type, 12 connectors per block, 32 pins per connector (ea feedthru=768 channels) 1 27° EC EM seg @ TBD channels 10 EC Hads @ TBD channels
Barrel Module feedthrus for: a. Signal Cables b. Power Cables (4 conductor, 460 Volt, TBD amps) c. High Voltage Cables	6	8.5	4-9	4-9	Yes	Yes	No	Double block type, 12 connectors per block, 32 pins per connector (ea feedthru=768 channels) 2 Barrel EMs @ TBD channels 12 Barrel Hads @ TBD Channels
LN2 inlet to condensing coils - Barrel	1	1.5	10A	10	No	Yes	Yes	
LN2 outlet to condensing coils - Barrel	1	1.5	10B	10	No	Yes	Yes	
LN2 inlet to condensing coils - End Cap	1	1.5	10C	10	No	Yes	Yes	
LN2 outlet for condensing coils - End Cap	1	1.5	10D	10	No	Yes	Yes	
Ar/Kr Pressure Tap	1	0.25	10E	10	No	Yes	No	
LAr/LKr Drain Line/Liquid Sample	1	1.5	11A	11	Yes	Yes	Yes	Route to bottom of Barrel Box. For Tracking Purity/quick drain
LAr/LKr fill line	1	1.5	11B	11	Yes	Yes	Yes	Stub above Barrel Box
LAr inlet for internal module cooling	1	1.5	11C	11	Yes	Yes	Yes	
LAr inlet for internal module cooling	1	1.5	11D	11	Yes	Yes	Yes	

N. Nalli - SSCL
Rev: June 16, 1993

Individual Penetration Definition (Cont.)

Description	Qty	Size, in	Penetration No.	Route Thru Penetration No.	Hook-up Required Upon Vessel Close-out?	Penetrate Thru both Vessels?	Bayonet Required?	
Auxiliary Cryo 1	1	1.0	12A	12	Yes	Yes	No	
Auxiliary Cryo 2	1	3.0	12B	12	Yes	Yes	No	
GAr/GKr Vapor Inlet/Return	1	3.0	12C	12	No	Yes	Yes	Stub to inside of vessel
Liquid level indicator	1	.50	12D	12	Yes	Yes	No	Group of 4 or 5 wires feed through .50 pass-thru
LN2 inlet to heat intercepts	1	1.5	13A	13	No	Yes	Yes	Bayonets are in horizontal position. Would be better if they were vertical
LN2 outlet to heat intercepts	1	1.5	13B	13	No	Yes	Yes	Bayonets are in horizontal position. Would be better if they were vertical
Vacuum Pump out - Inner vessel -	1	8.0	14A	14	No	Yes	No	Vacuum pump-out and Relief line tee off of same penetration
Inner vessel pressure relief line	1	6.0	14B	14	No	Yes	No	Vacuum pump-out and Relief line tee off of same penetration
Vacuum Pump out - annular cavity	1	8.0	15A	15	No	No	No	
Inner Vessel flange vacuum pump out port	1	0.25	15B	15	No	No	No	
High Voltage Feedthru for Strip Heater at 4 sides and bottom of bath box, 1/8" dia wire, 460 volt	5	.50	16	16	Yes	Yes	No	No bellows here, so penetration can be located towards rear of vessel if necessary but will need extension cord.
Outer Vessel Pressure relief Valve	1	12.0	17	17	No	No	No	
Window			18	18	No	Yes	No	

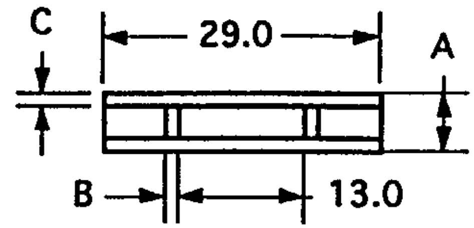
N. Nalli - SSCL
Rev: June 16, 1993



GEM TEST BEAM CRYOSTAT
SADDLE ANALYSIS

- **SIMPLIFIED ANALYSIS COMPLETED**

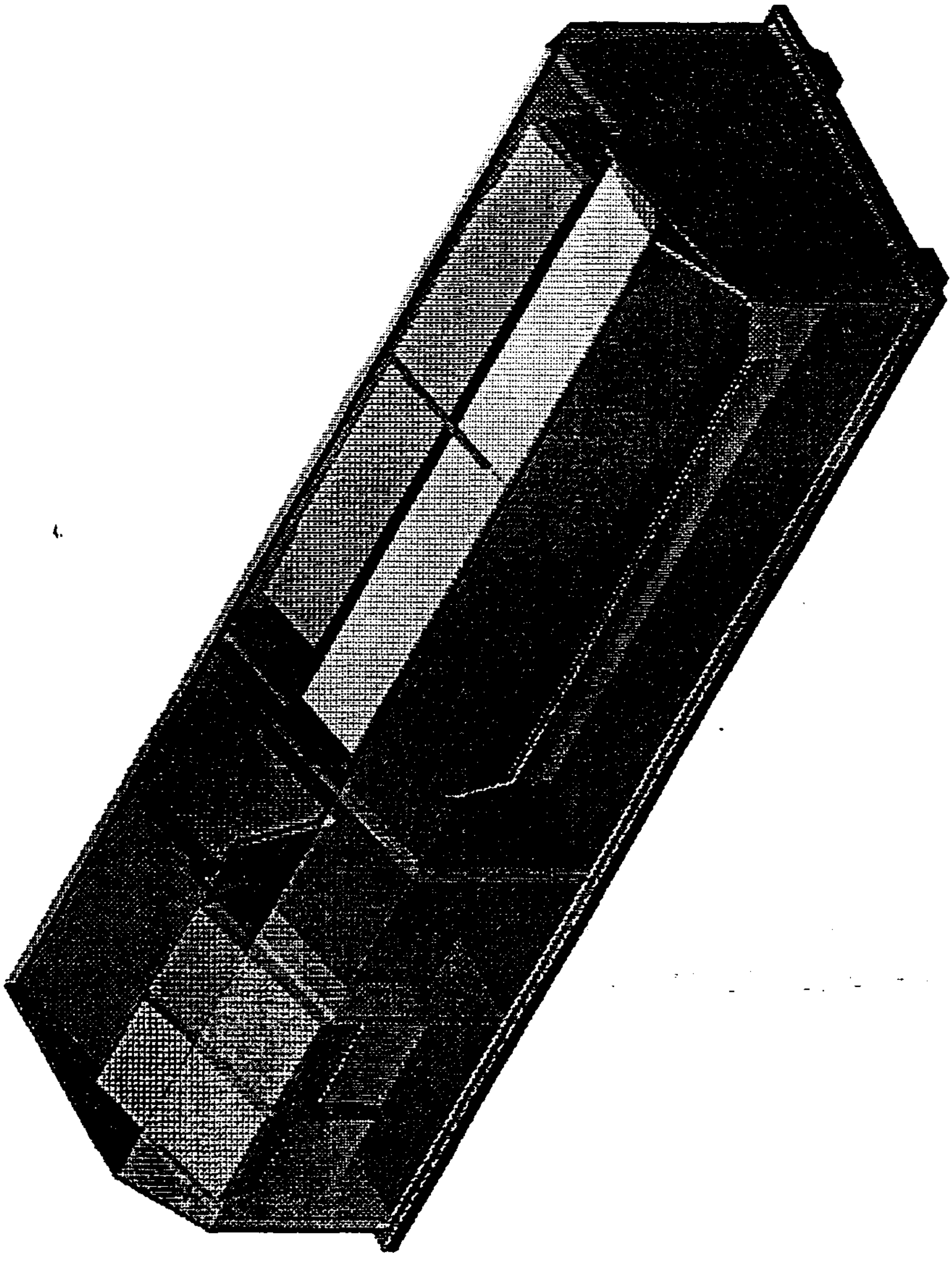
Dimension	Case 1	Case 2	Case 3
A , in	6	5	4
B , in	0.875	1	N.A.
C , in	0.875	1	N.A.
Inertia, in^4	400	303	220
Stress, psi	7400	8000	9000

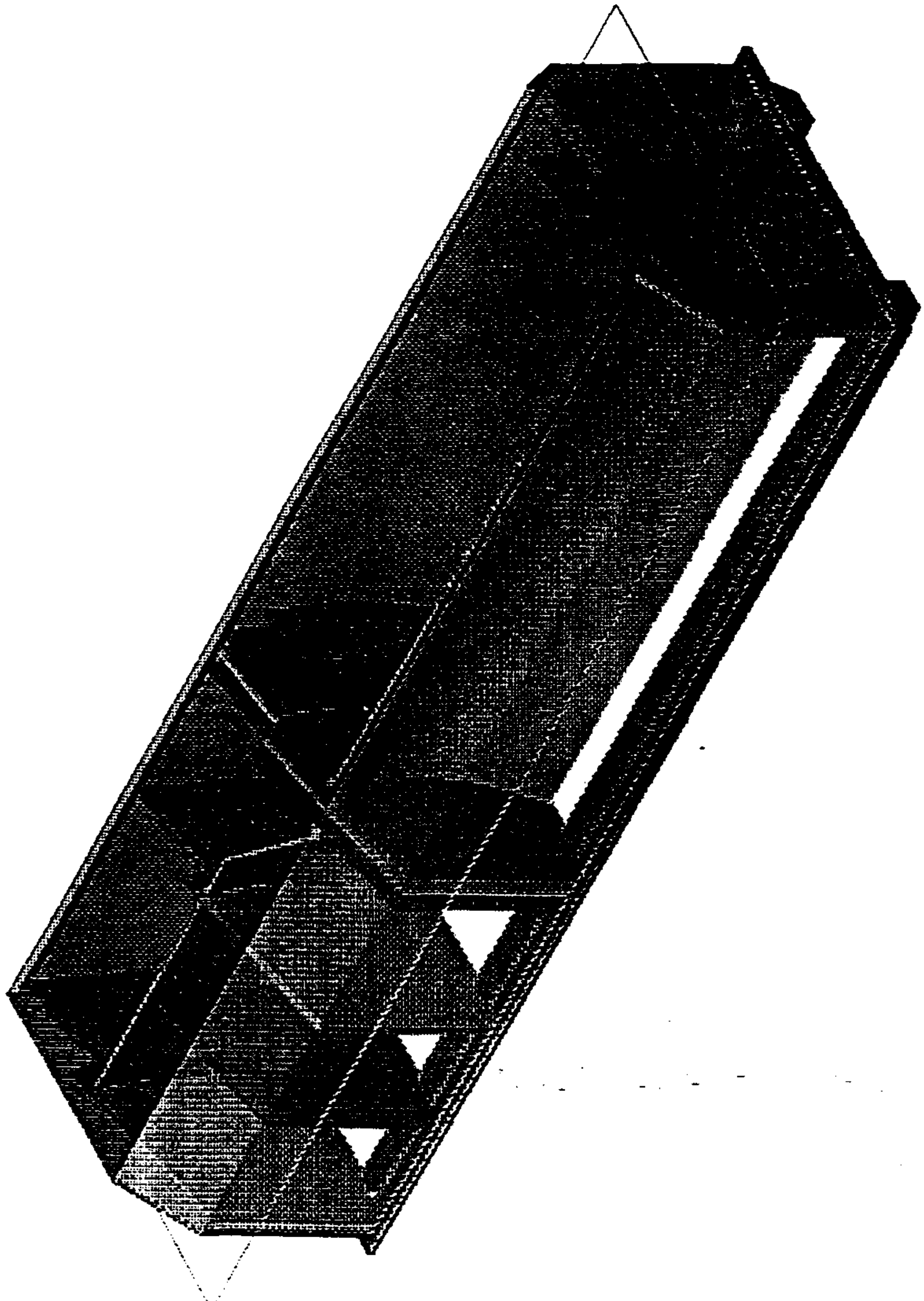


Beam X-section

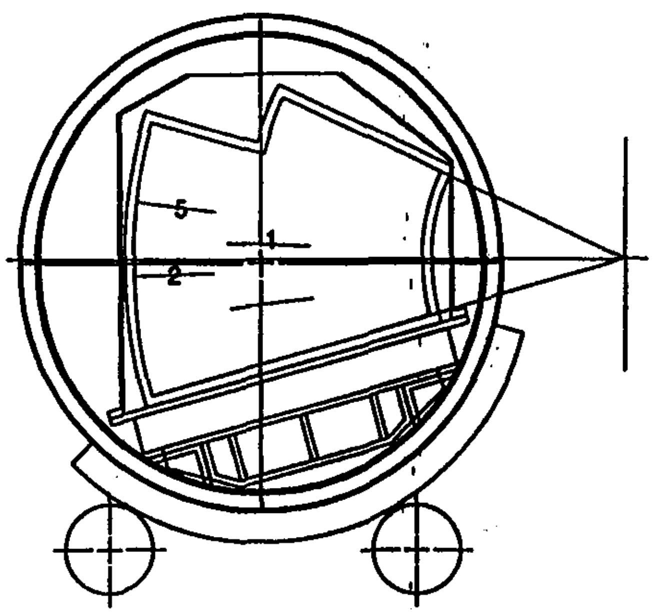
- **SADDLE MATERIAL IS ALUMINUM 5083-O – ALLOWABLE STRESS 10 KSI**
- **FACTORS NOT CONSIDERED IN ANALYSIS:**
  - **LOCAL DEFORMATION OF BEAM AT ROLLERS**
  - **EFFECT OF DEFORMATION OF ROLLERS ON REACTION FORCES**
  - **INNER VESSEL AND SUPPORT STRUCTURE CONSIDERED RIGID**

Neil Hall, SSCL - (214)708-6180
June 16, 1993

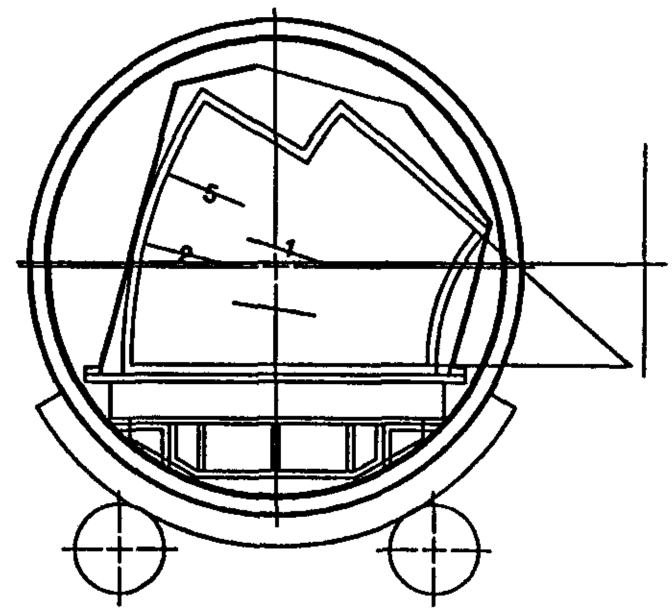




Bath Box Concept

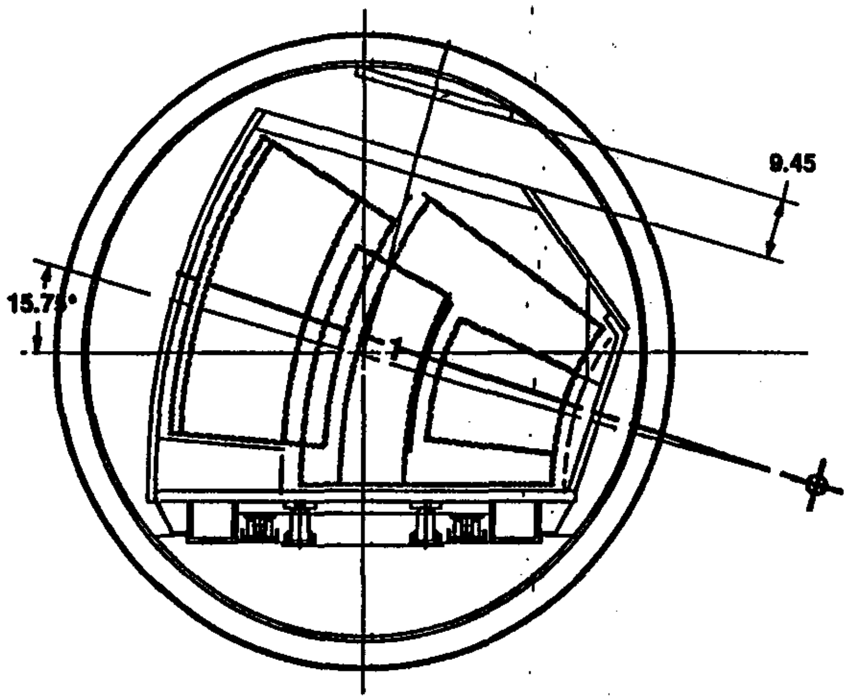


Operating Position

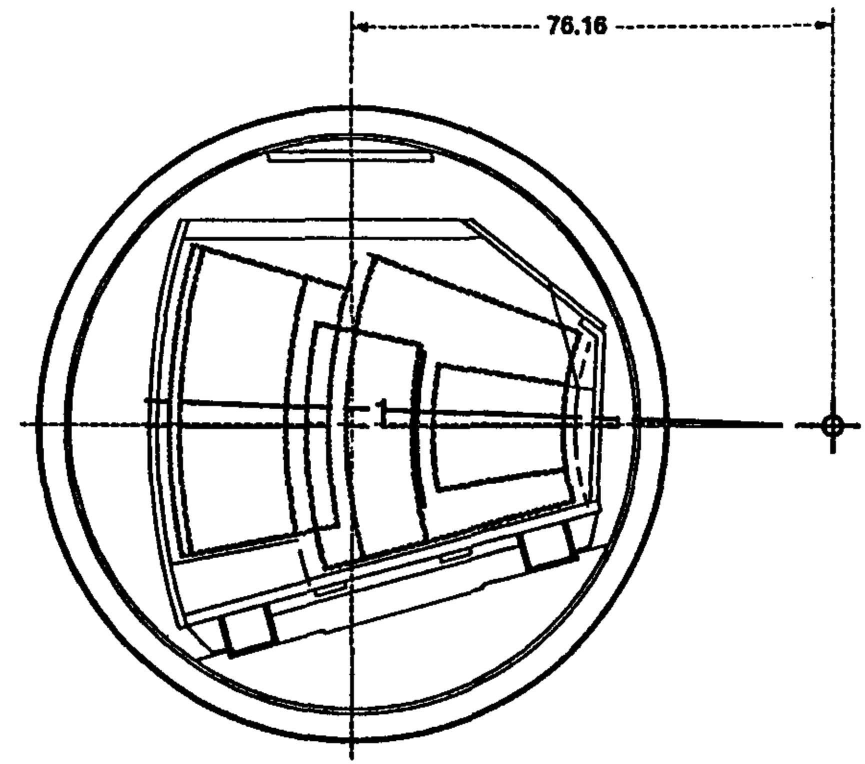


Loading Position

BATH BOX CONCEPT



LOADING POSITION



OPERATING POSITION

GEM TEST BEAM CRYOSTAT
LOADING STAND/INSERTION OF MODULES

- PRELIMINARY SIZE IS 12' WD X 30' LG X 8' HT
- ELEVATES BATH BOX TO LEVEL OF CRYOSTAT
- PROVIDES 3 FOOT WIDE WALKWAY AROUND BATH BOX
- WILL BE FIXED TO FLOOR – NOT ON RAILS
- SIX FOOT LONG REMOVABLE BRIDGE TO BE INSTALLED BETWEEN LOADING STAND AND VESSEL
  - NECESSARY TO SPAN OVER CABLE TRAY
- ROLLER/JACK ASSEMBLY USED TO TRANSFER BATH BOX FROM LOADING STAND TO SUPPORT STRUCTURE ON INSIDE OF VESSEL

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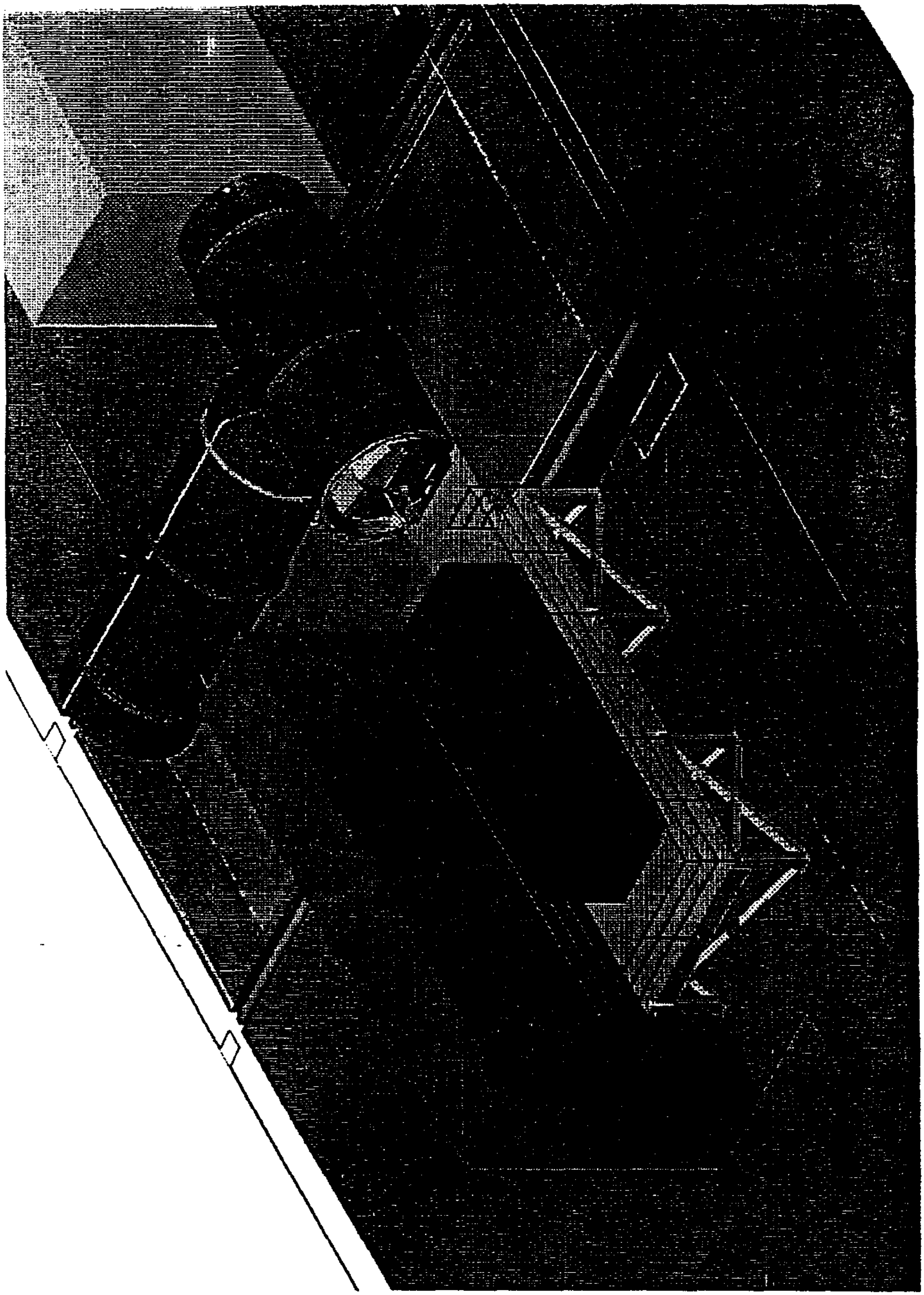
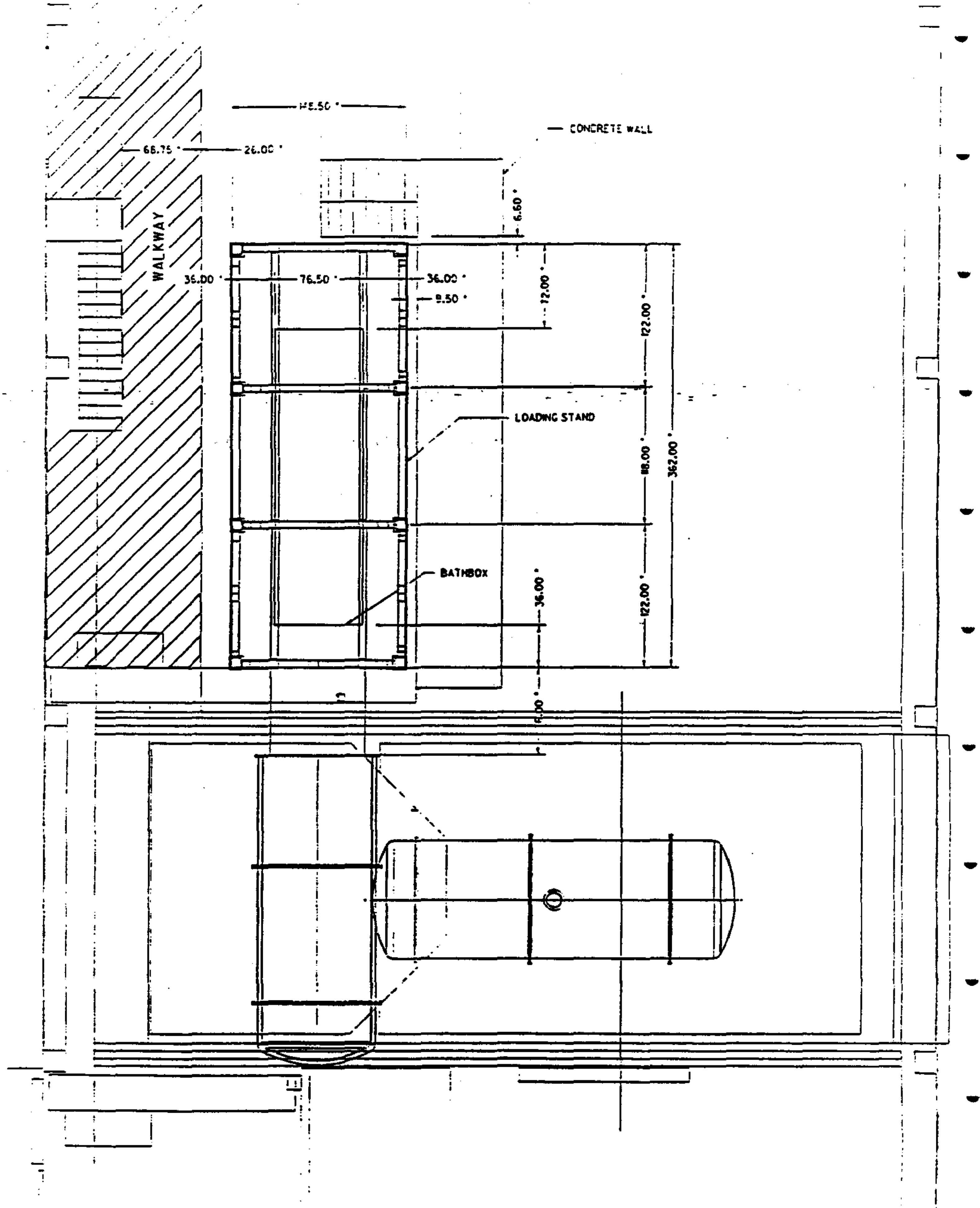
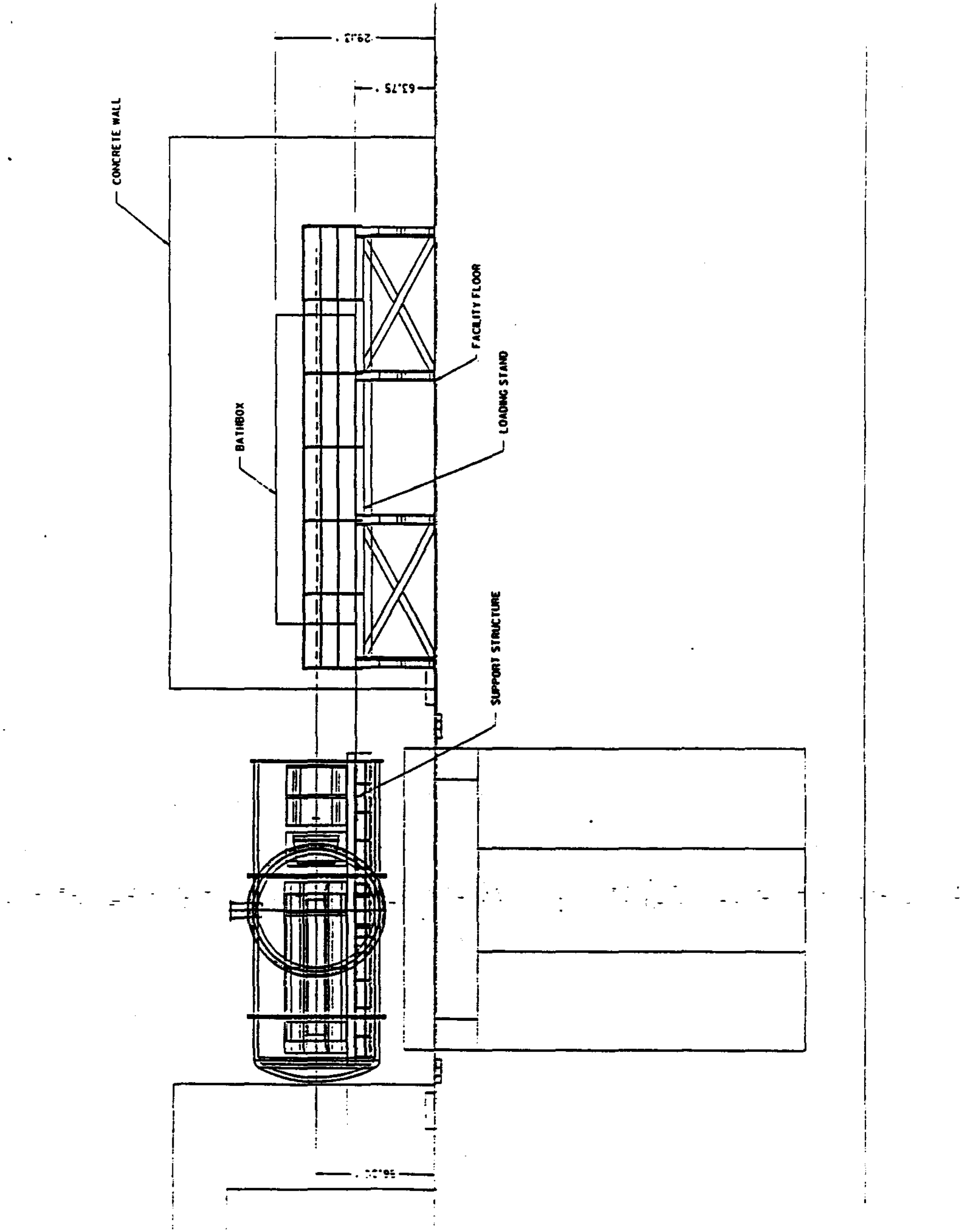
June 16, 1993





145.50"
CONCRETE WALL
66.75"
26.00"
6.60"
WALKWAY
36.00"
76.50"
36.00"
9.50"
72.00"
122.00"
LOADING STAND
118.00"
362.00"
BATHBOX
36.00"
122.00"
6.00"



CONCRETE WALL
BATHBOX
FACILITY FLOOR
LOADING STAND
SUPPORT STRUCTURE

GEM TEST BEAM CRYOSTAT
OPEN ITEMS/ITEMS OF CONCERN

- HOW WILL VESSEL BE MOVED INTO BUILDING?
- IS THERE ADEQUATE ROOM TO INSTALL MODULES FROM CONCRETE WALL SIDE OF BATH BOX?
- HOW WILL SIGNAL CABLES BE ROUTED IN BATH BOX? IS THERE ENOUGH ROOM FOR THEM TO CHANGE DIRECTION WITHOUT KINKING?
  - ROUTING SCHEME MAY REQUIRE ADDITIONAL CABLE WIRE. IS CABLE LENGTH A CRITICAL FACTOR.? HOW LONG CAN CABLES BE FOR EACH OF THE MODULES?
- ROUTING AND HOOK-UP OF ALL LINES INTERNAL TO VESSEL SHOULD BE EVALUATED IN DETAIL TO ENSURE THERE WILL BE NO SPIDER WEBBING OF LINES
- NEED TO ESTABLISH REQUIREMENT FOR MODULE LOCATION WITH RESPECT TO POINT ON OUTER VESSEL
  - TOLERANCE REQUIREMENT
  - POINT AT WHICH EACH BATH BOX MUST BE FIXED TO INNER VESSEL

Neil Hall, SSCL - (214)708-6180

Presentation by:

R. Hund

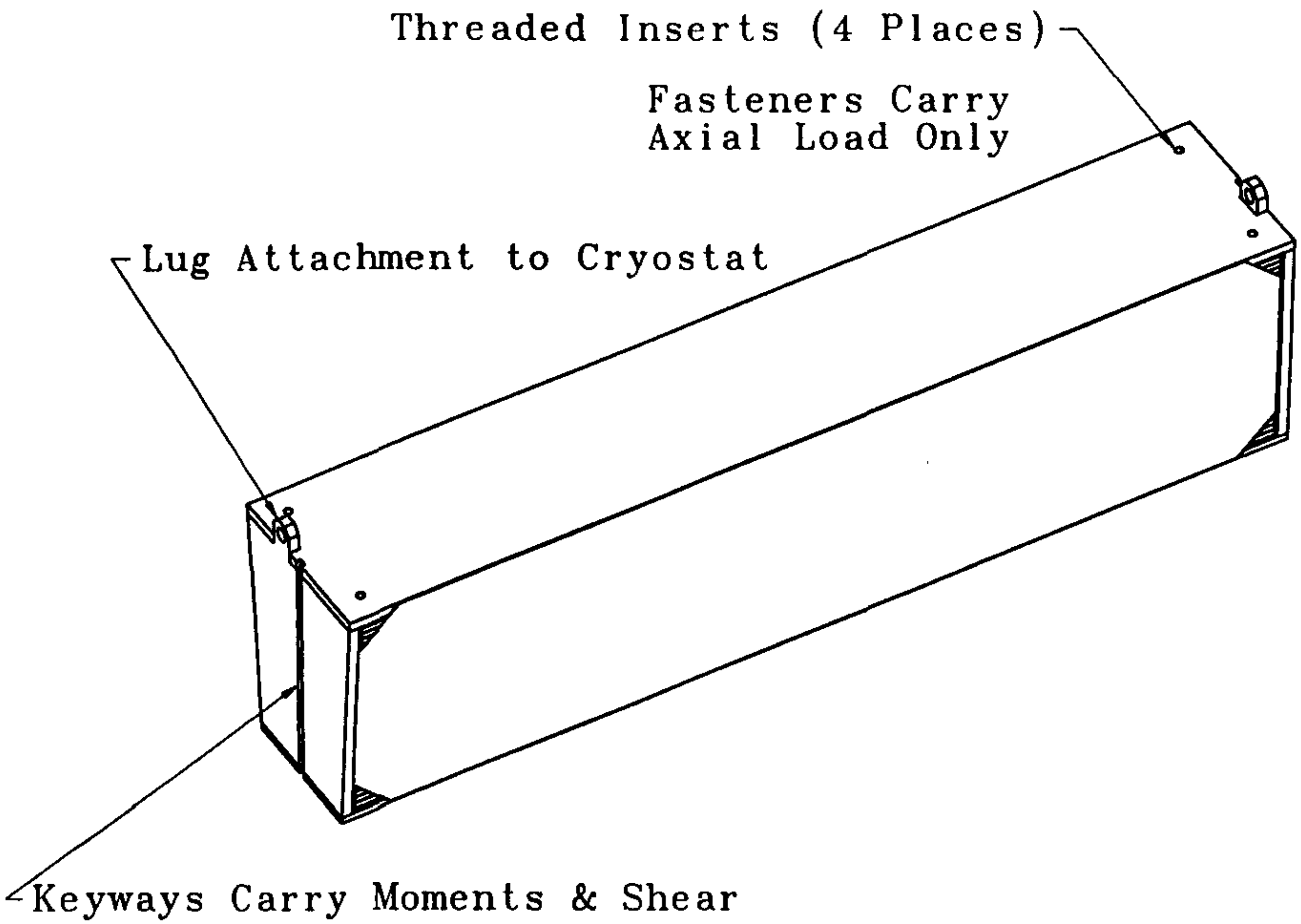
Hadronic Module Interface to FNAL Cryostat

June 21, 1993

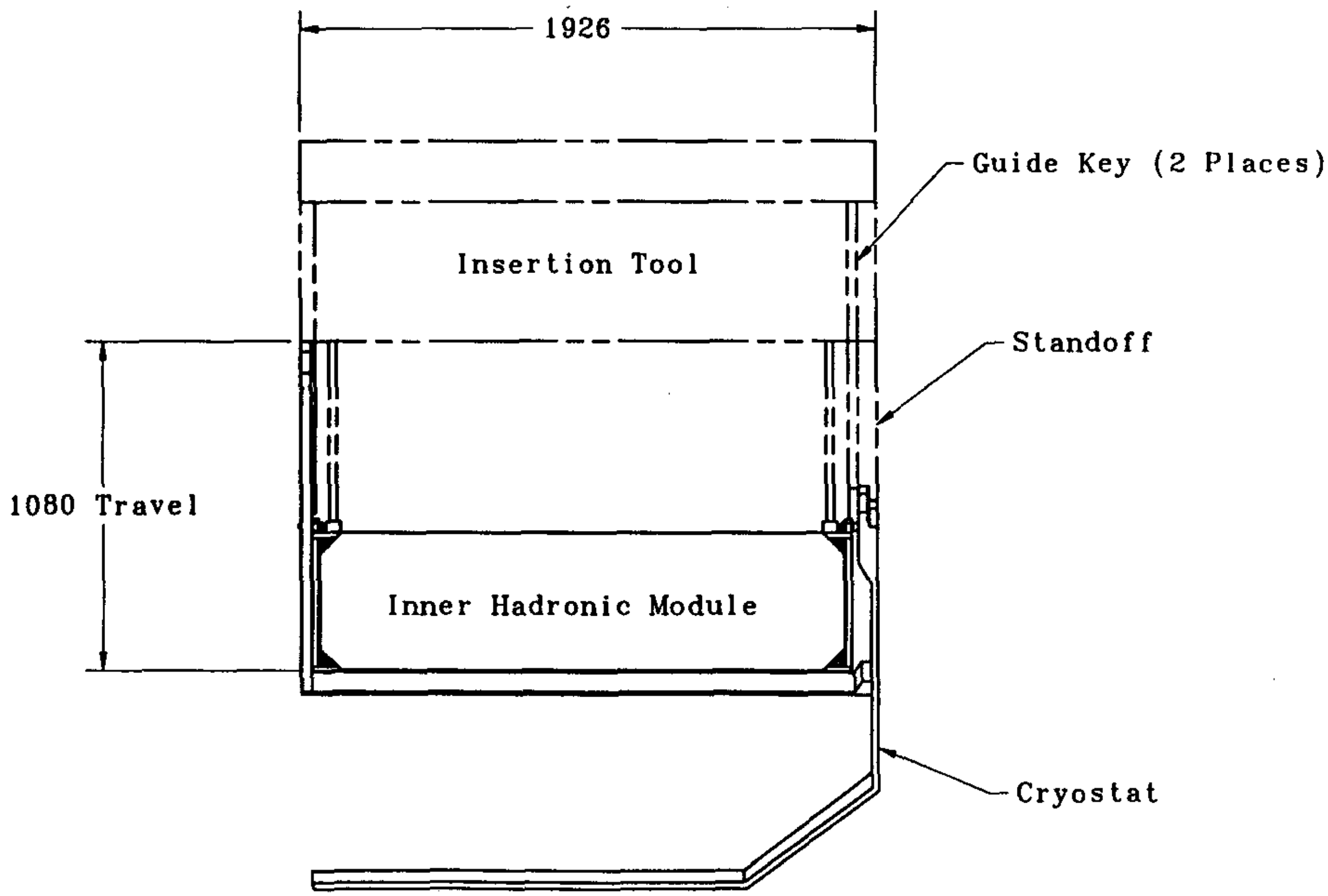
R. Hund
Martin Marietta Astronautics
Science Systems

65

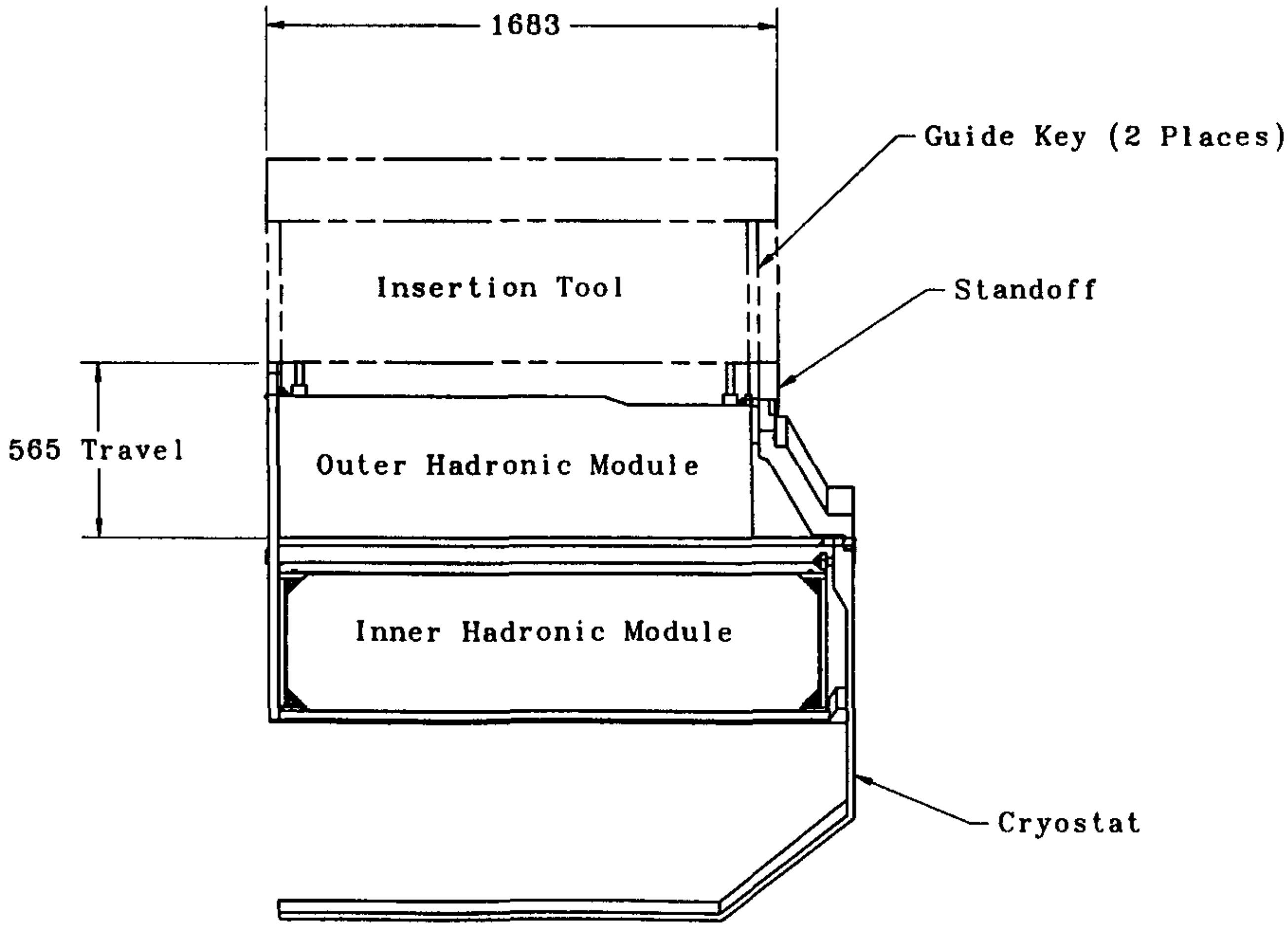
Hadron Module - Insertion Tool Interface



Inner Barrel Hadronic - Insertion Tool Requirements



Outer Barrel Hadronic - Insertion Tool Requirements



Insertion Tool - Future Activity

- Determine Requirements For Endcap Module Installation

  -Can Same Insertion Tool be Used

- Investigate SLD Insertion Tool

  -Can It be Used in Our Application

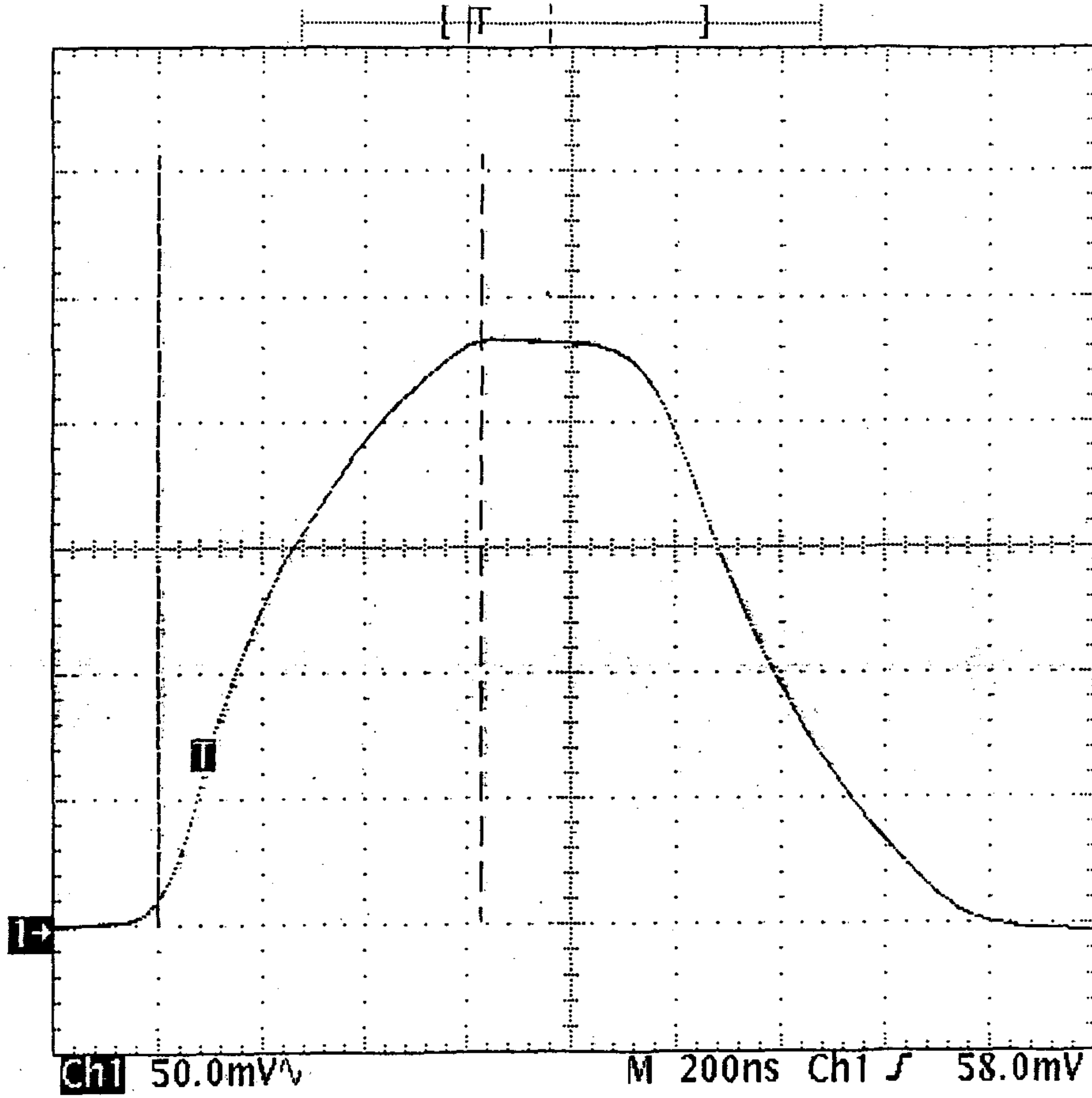
  -If Not, Is Concept Valid

- Verify Good Access to Attach Points (Installed Module)

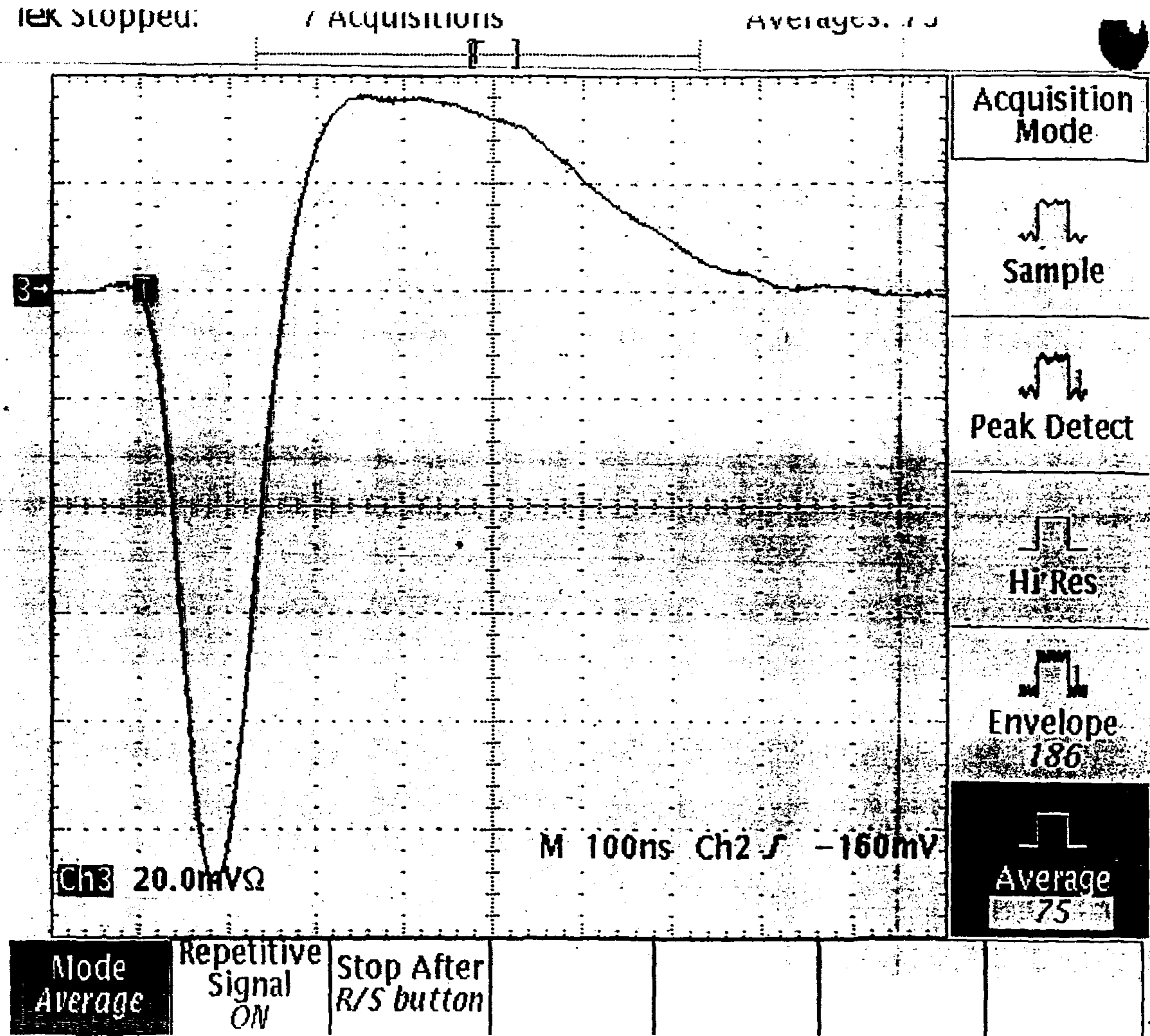
- Determine if Interface between Tool and Barrel / Endcap modules can be Standardized

Presentation by:

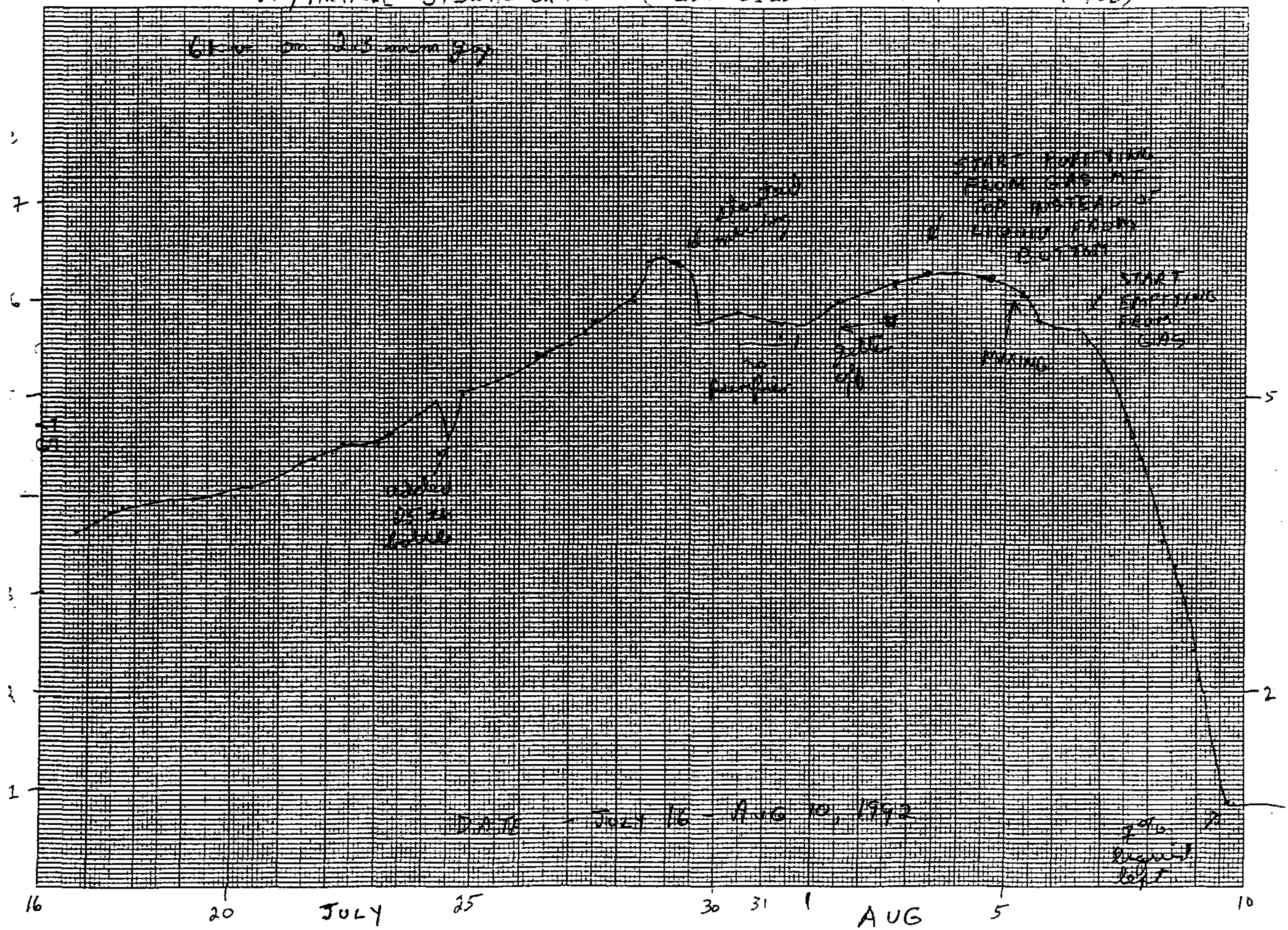
D. Rahm



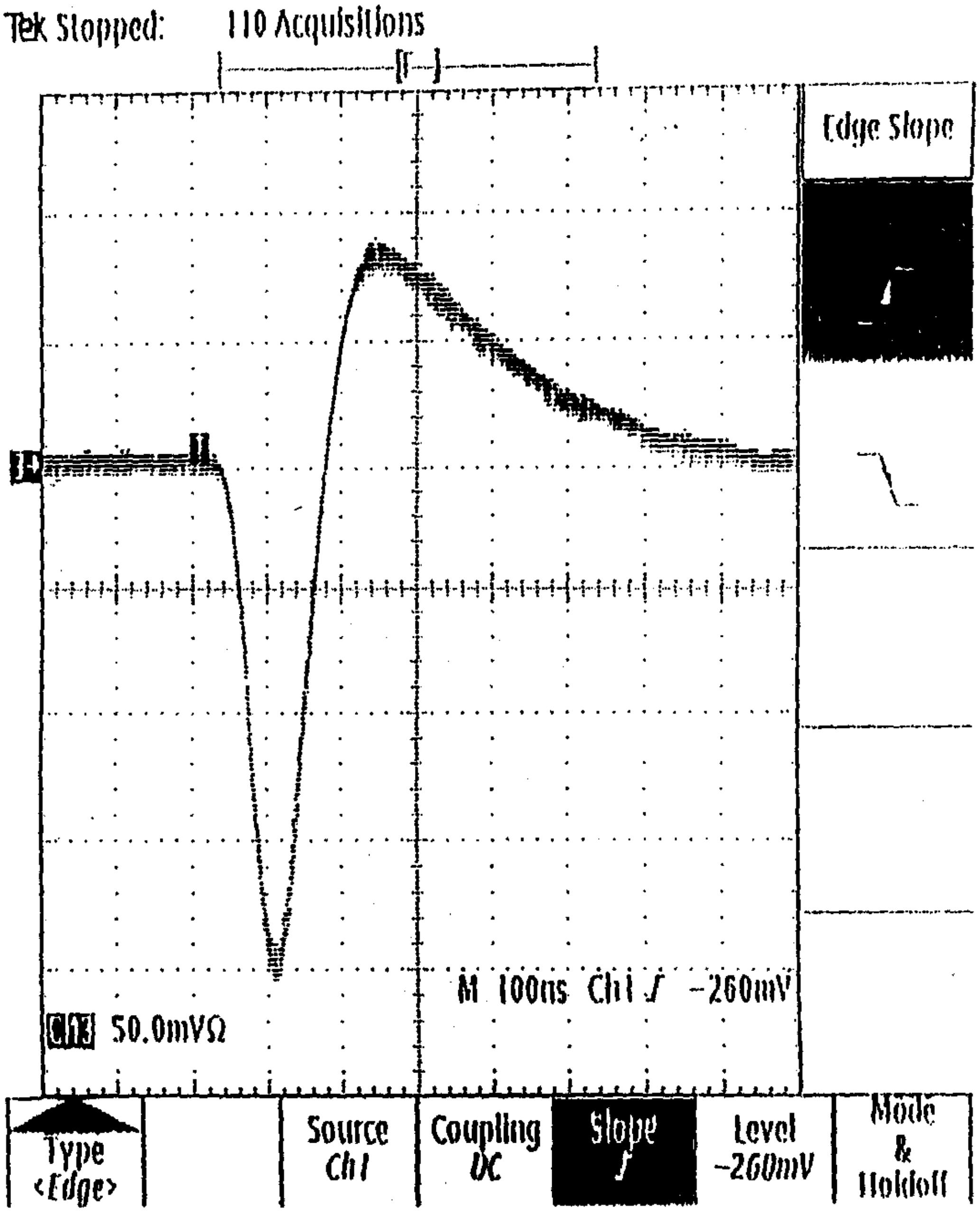
23 kV
(1kV/mm)
REF 2
(term on 50 Ω
on HP scope)
Saved in
REF 2
Aug 7, 92


Acquisition Mode
Sample
Peak Detect
Hi Res
Envelope 186
Average 75
Ch3 20.0mVΩ
M 100ns Ch2 ∫ −160mV
Mode Average
Repetitive Signal ON
Stop After R/S button

α-PARTICLE SIGNAL in Kr (TEST CELL IN BOTTOM OF BATH TUB)



7/22/92



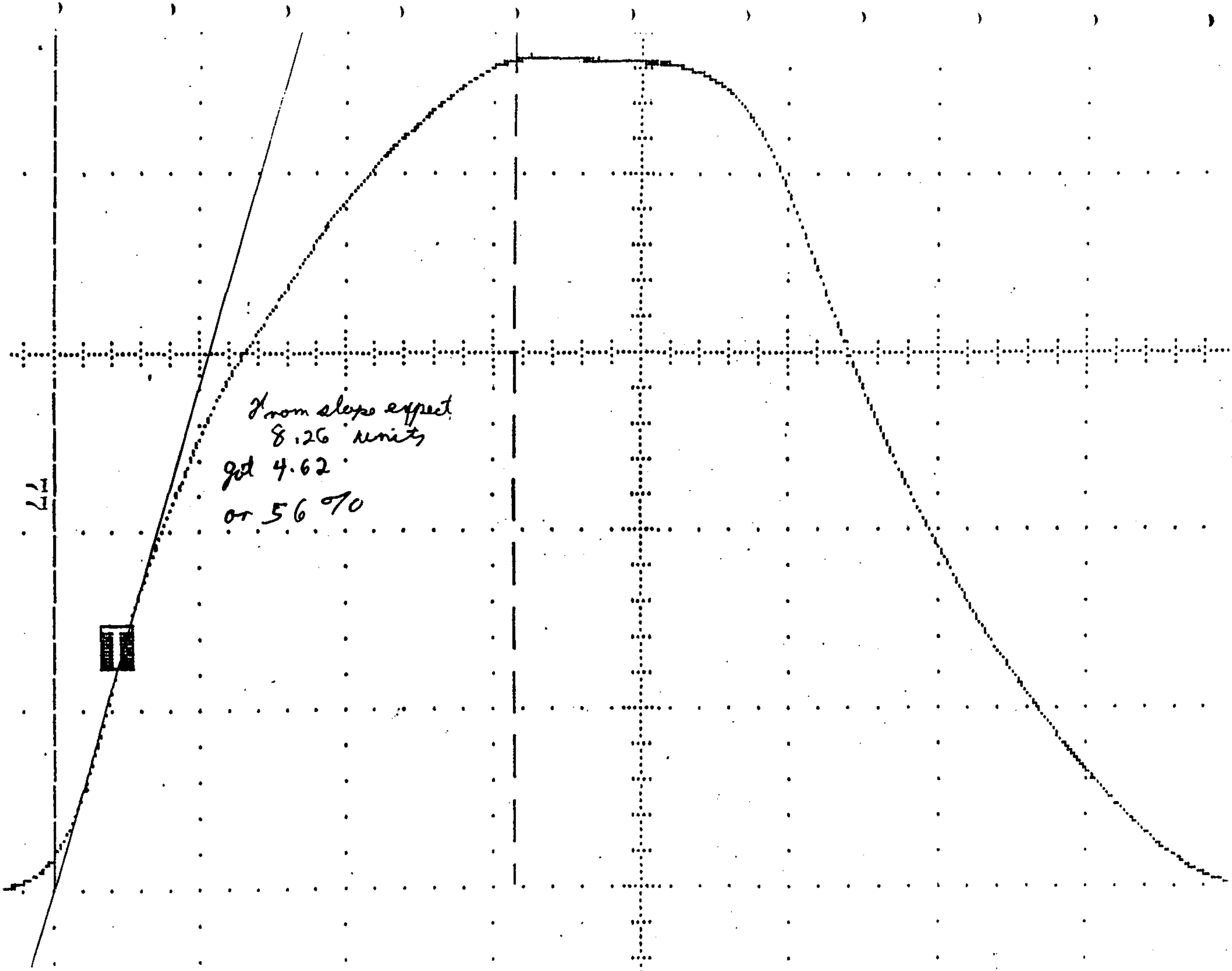
LKr, 2 mm stack, 1.5 kV

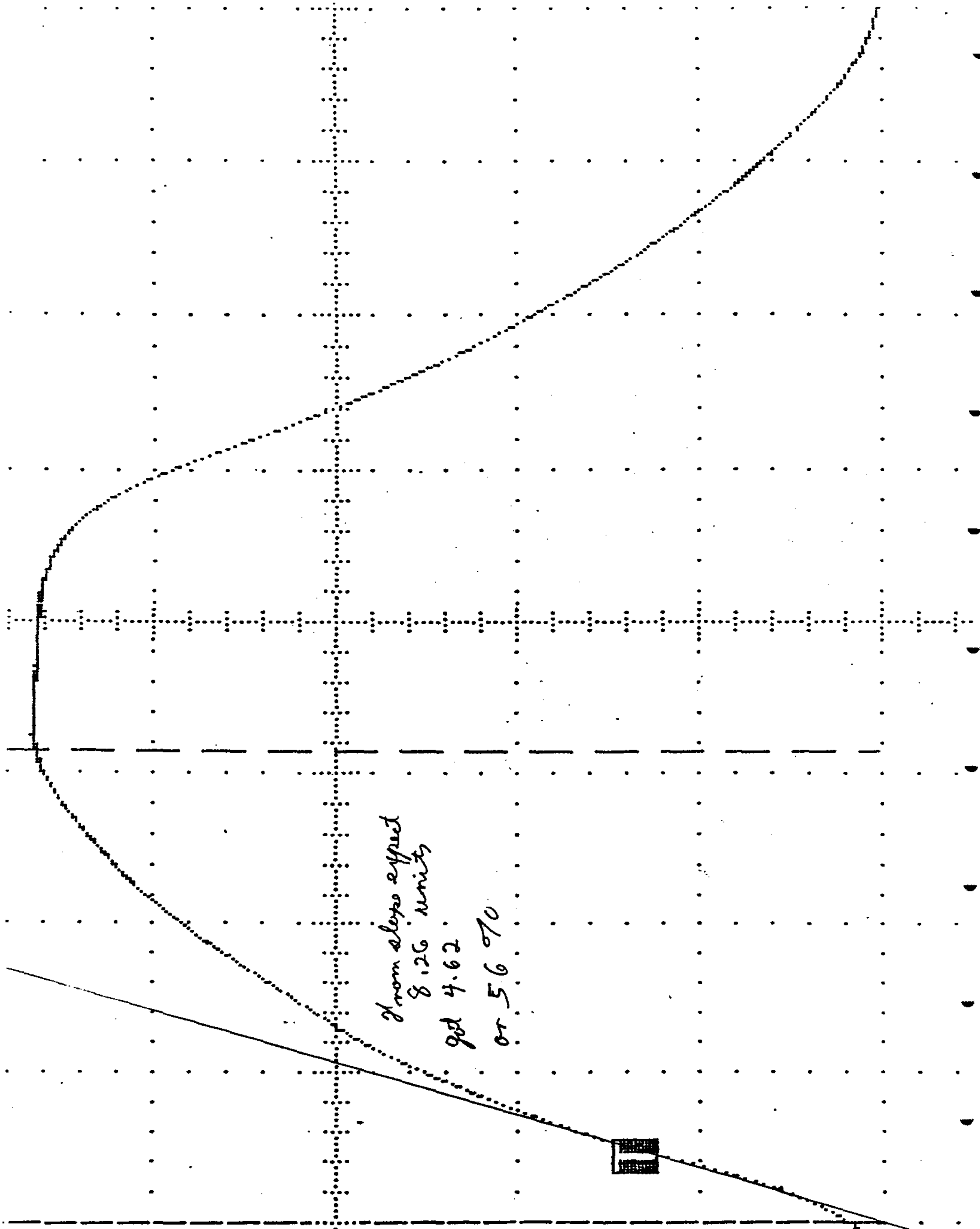
20GeV

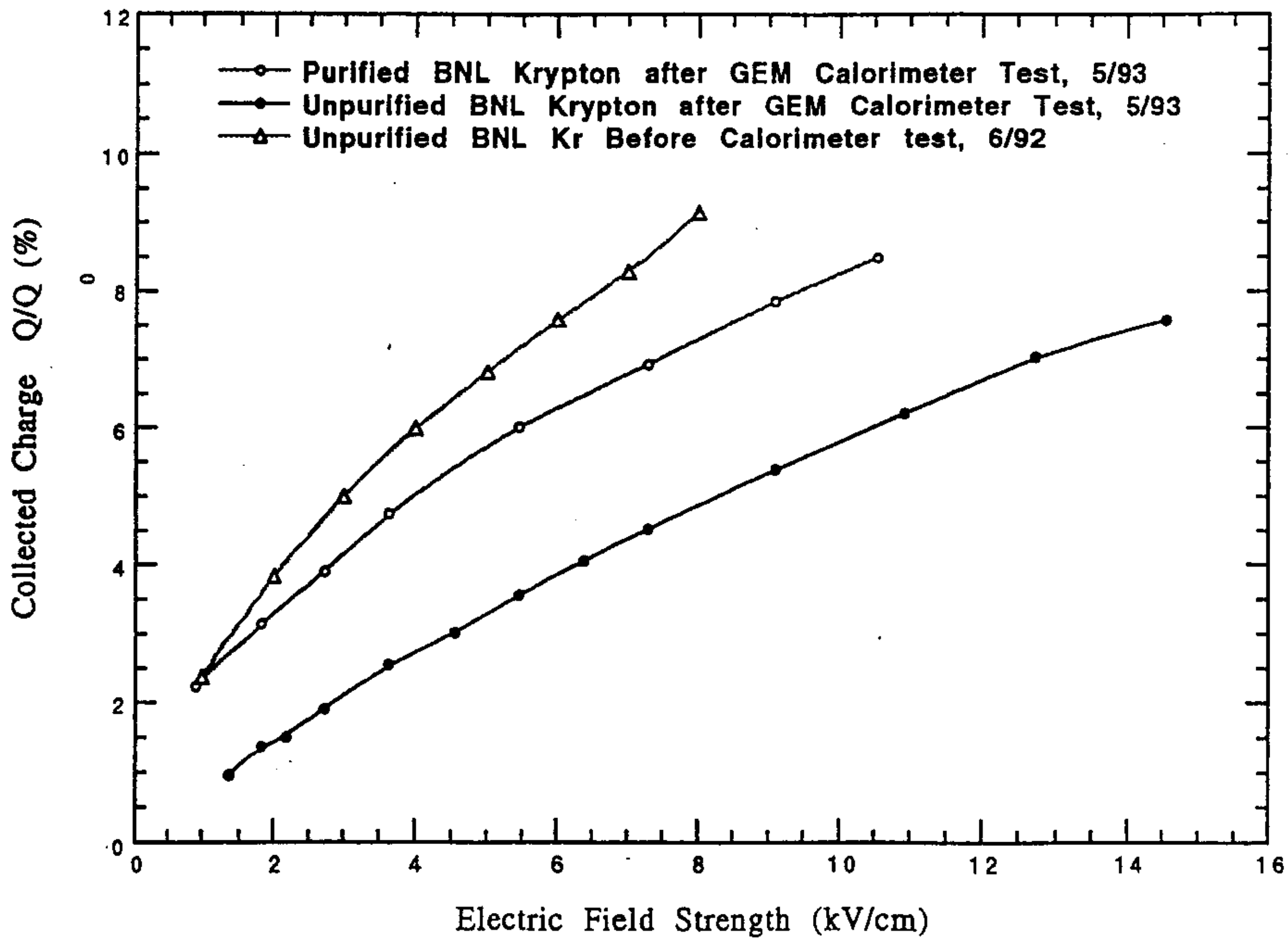
Sum of ~150 channels

Multiple trace - variable persistence

Beam size: 2.5 x 5 cm^2


from slope expect
8.26 units
got 4.62
or 56 %

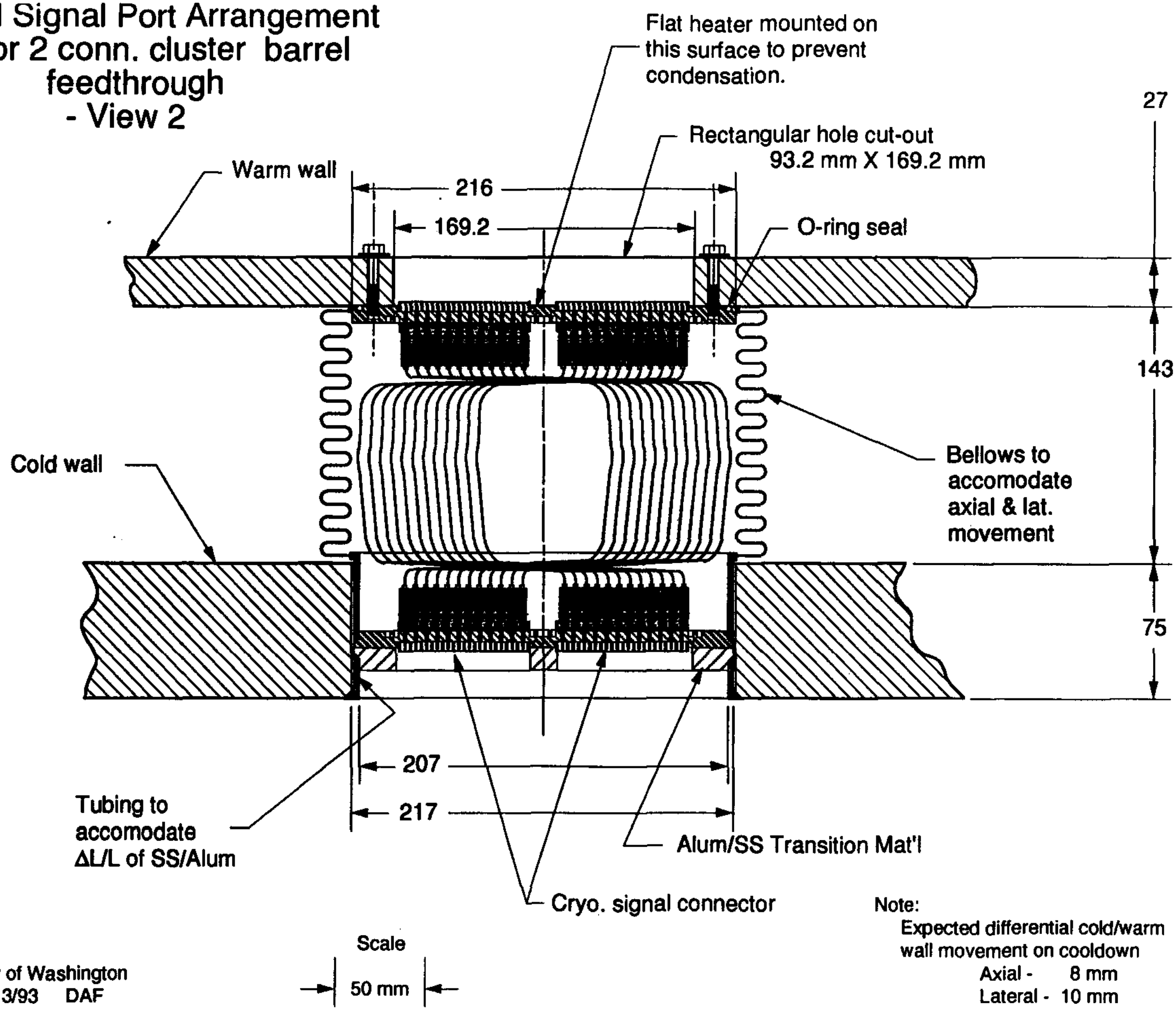

From slope expect
8.26 units
got 4.62
or 56 %


Purified BNL Krypton after GEM Calorimeter Test, 5/93
Unpurified BNL Krypton after GEM Calorimeter Test, 5/93
Unpurified BNL Kr Before Calorimeter test, 6/92
Collected Charge Q/Q (%)
0
Electric Field Strength (kV/cm)
0
2
4
6
8
10
12
14
16
0
2
4
6
8
10
12

Presentation by:

P. Mockett

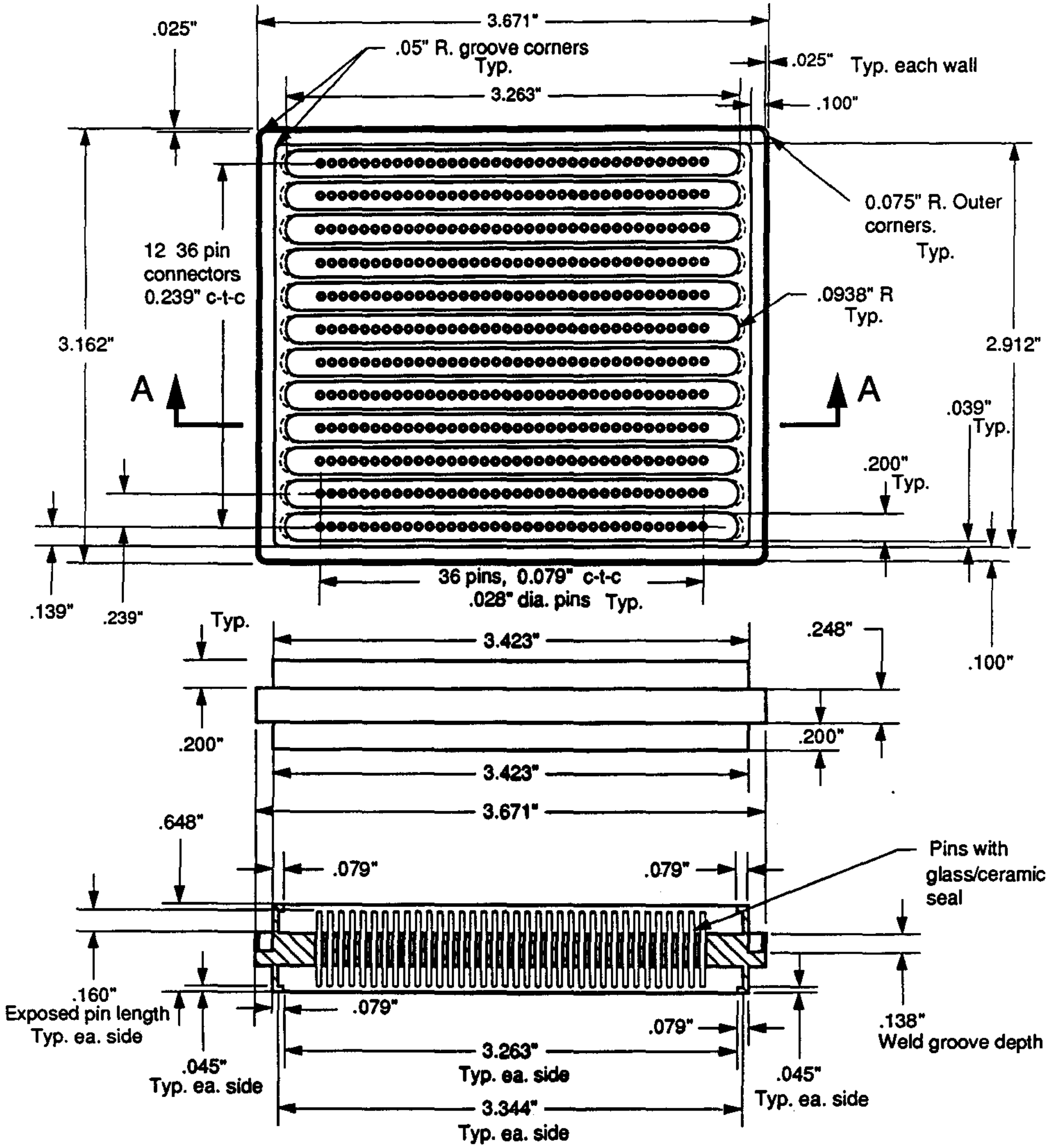
Typical Signal Port Arrangement for 2 conn. cluster barrel feedthrough - View 2



Note:
Expected differential cold/warm wall movement on cooldown
Axial - 8 mm
Lateral - 10 mm
All dimensions in mm

University of Washington
5/13/93 DAF

GEM Calorimeter Cryo. 36 Pin Signal Connector



Material

Body and Pins
-Inconel "X750"

University of Washington
5/2/93 DAF

May 4, 1993

Paul M. Mockett
UNIV. OF WASHINGTON
DEPT. OF PHYSICS, FM-15
SEATTLE WA. 98195

Dear Paul:

Attached please find quotations to support summary of GEM Calorimeter Cryogenic 12 X 36Pin Feedthru as listed below.

ELECPAC Cary, Ind.	$1052.08 / Feedthru $1825 setup charge	320 pcs.
PACIFIC COAST TECHN. Roseburg, Oregon	$1928.92 / pc. $1445.79 / pc. $1343.07 / pc. $1239.38 / pc.	10 pcs. 250 pcs. 350 pcs. 450 pcs.
MICROMODE PRODUCTS	$1000 - $1200 / Feedthru $2000 (NRE) $5000 / pc. (Development qty.)	325 pcs.
NORTHEAST ELECTRONICS Milford, Conn.	$1573 / Feedthru	320 pcs.

Conversation with Bob Morley regarding use of ceramic/glass to seal pins in INCONEL X750 feedthrus indicates that the ceramic seal is the much better way to seal effectively in environment being subjected to cryogenic fluids. Also talked with Bob Wright of PACIFIC COAST TECHN. who said the same thing and therefore quoted using ceramic seals.

Thank you,

JAMES FRANKLIN

GEM REPORT

6/10/93

TDR (Technical Design Report) submitted April 30th

TDR presented to PAC(Program Advisory Committee) May 24-28

UW Responsibilities

ENDCAP HADRON MODULES
- FNAL Beam Tests January of 1995
- 3 Outer Hadron A
- 3 Outer Hadron B
- 2 Inner Hadron A (partial)
- 2 Inner Hadron B (partial)
- 1 EM Substitute (possibly)

FEEDTHROUGHS
- 10 Two connector assemblies (9 plus 1 spare)

MILESTONES Through 1993

Module Materials Ordered	July 30, 1993
Complete Outer A and B design	**August 27, 1993**
Module construction facility prepared	September 17, 1993
Tile press	
Clean room for assembly	
Kapton etching facility	
Test area	
Construction of Outer Hadron B begins	September 24, 1993
Feedthrough component RFP's	**October 8, 1993**
Feedthrough component contracts	November 12, 1993
1st Outer Hadron B Completed	November 26, 1993
Finalize Feedthrough Design	**December 3, 1993**
Feedthrough production begins	December 13, 1993
Complete Inner A and B design	**January 7, 1994**
First feedthrough assembly complete	January 28, 1994

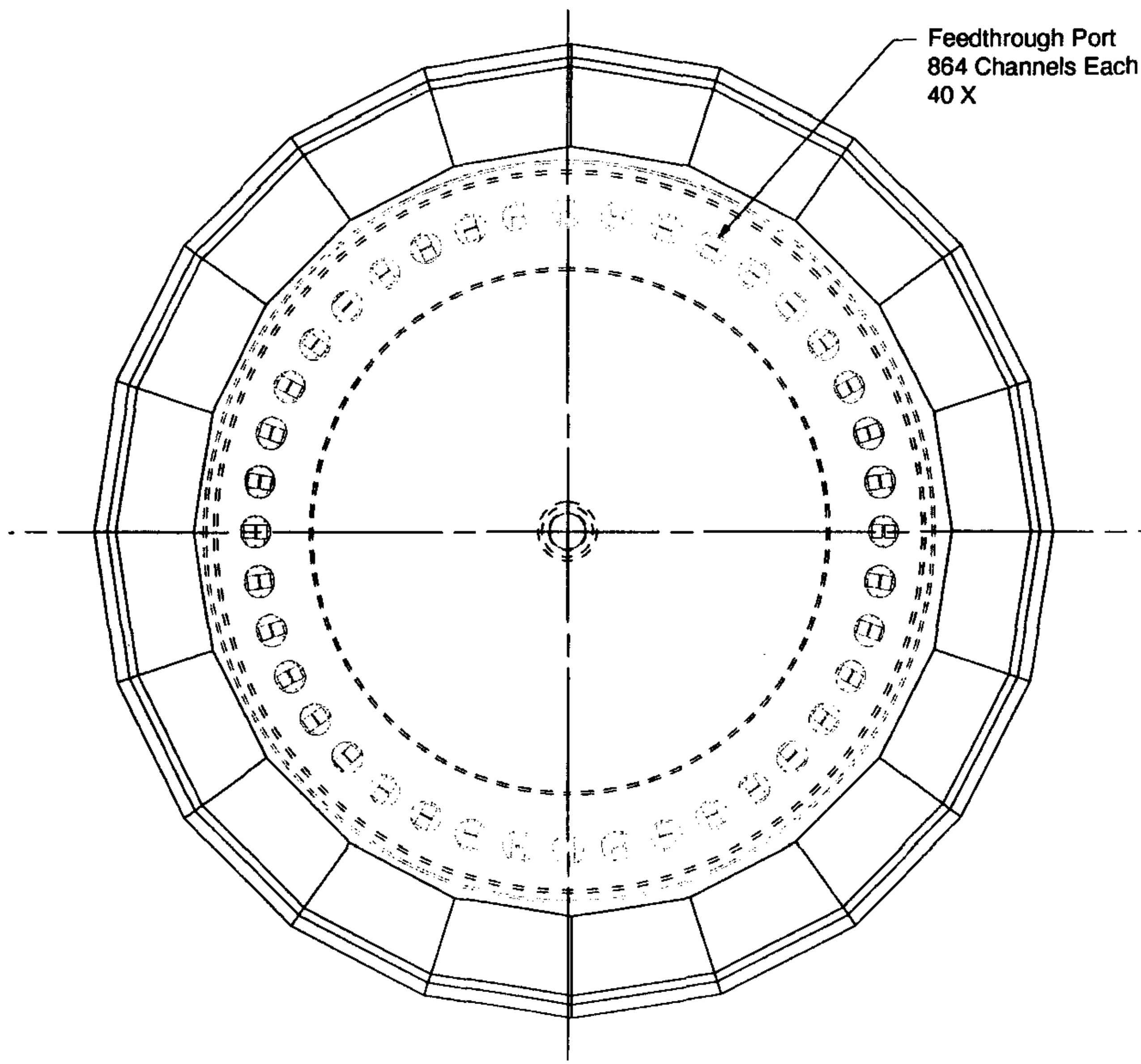
gem

γeμ

Presentation by:

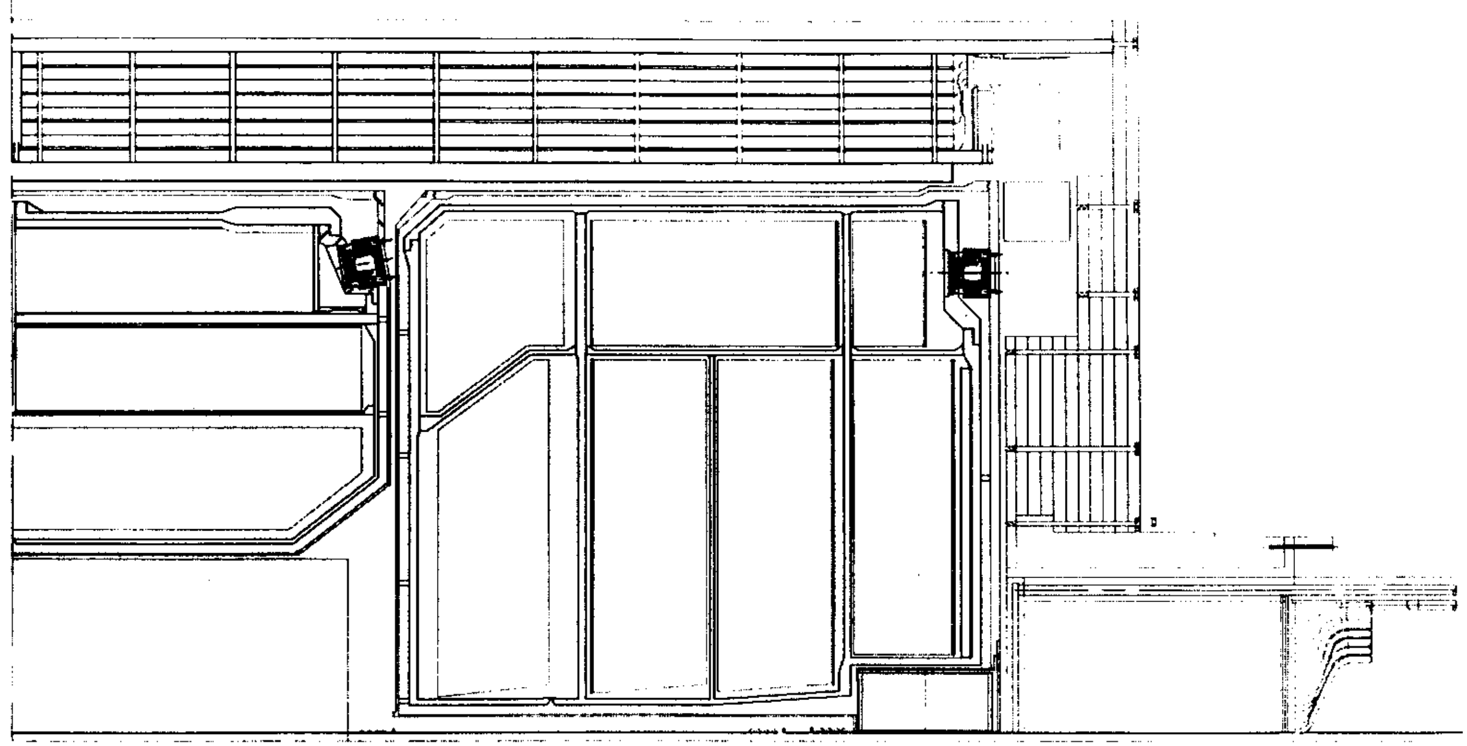
D. Forbush

Endcap Calorimeter Feedthroughs



Barnstable: Endcap Feedthrus930520

GEM Calorimeter with Commercial Feed-thrus in Bellows



Ovrvw.Blwsf/t

432 ch. × 2 = $\boxed{864 \text{ ch}}$

~~65,65~~ in^2

Inconel - higher Nickel 45%
Cobalt 30%

than St.-St.

Ult. 120,000 psi.
Yield 60,000 psi.

St. St. 304 Ni. 10%
Co. trace.

Ult. 85,000 psi.
Yield 35,000 psi.

Heat leak bellows.

~ 1.5 watts.

½ oz Cu. < 9 mW/ch. < 12 mW./ch. 864 ch.
¼ oz Cu. < 5 mW/ch. total ≈ 10½ watts./unit.

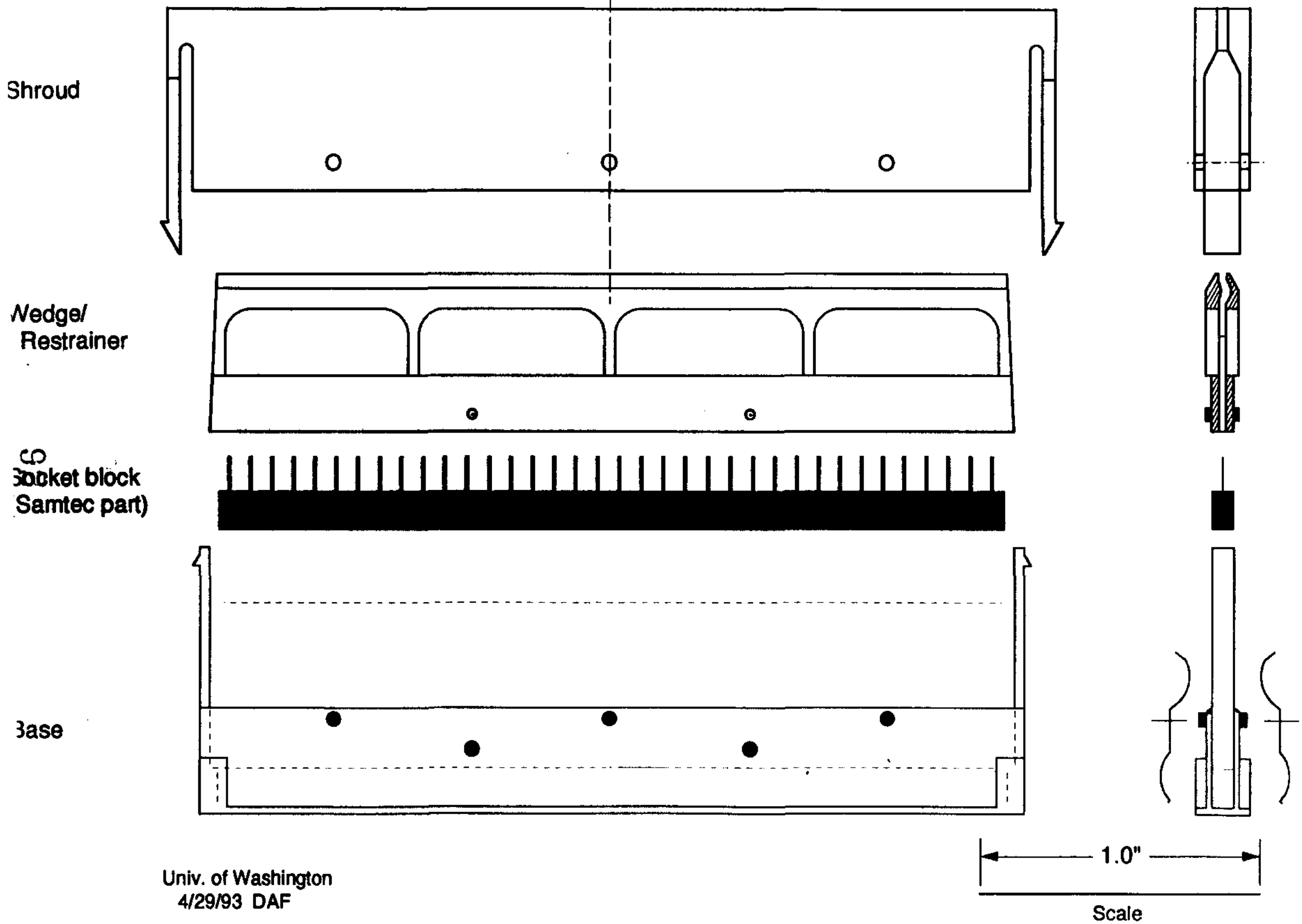
Glueing vectra for test.

Newport epoxy B-stage.

Θ, theta, z-direction

Φ, phi, - x, y.

Connector in pieces



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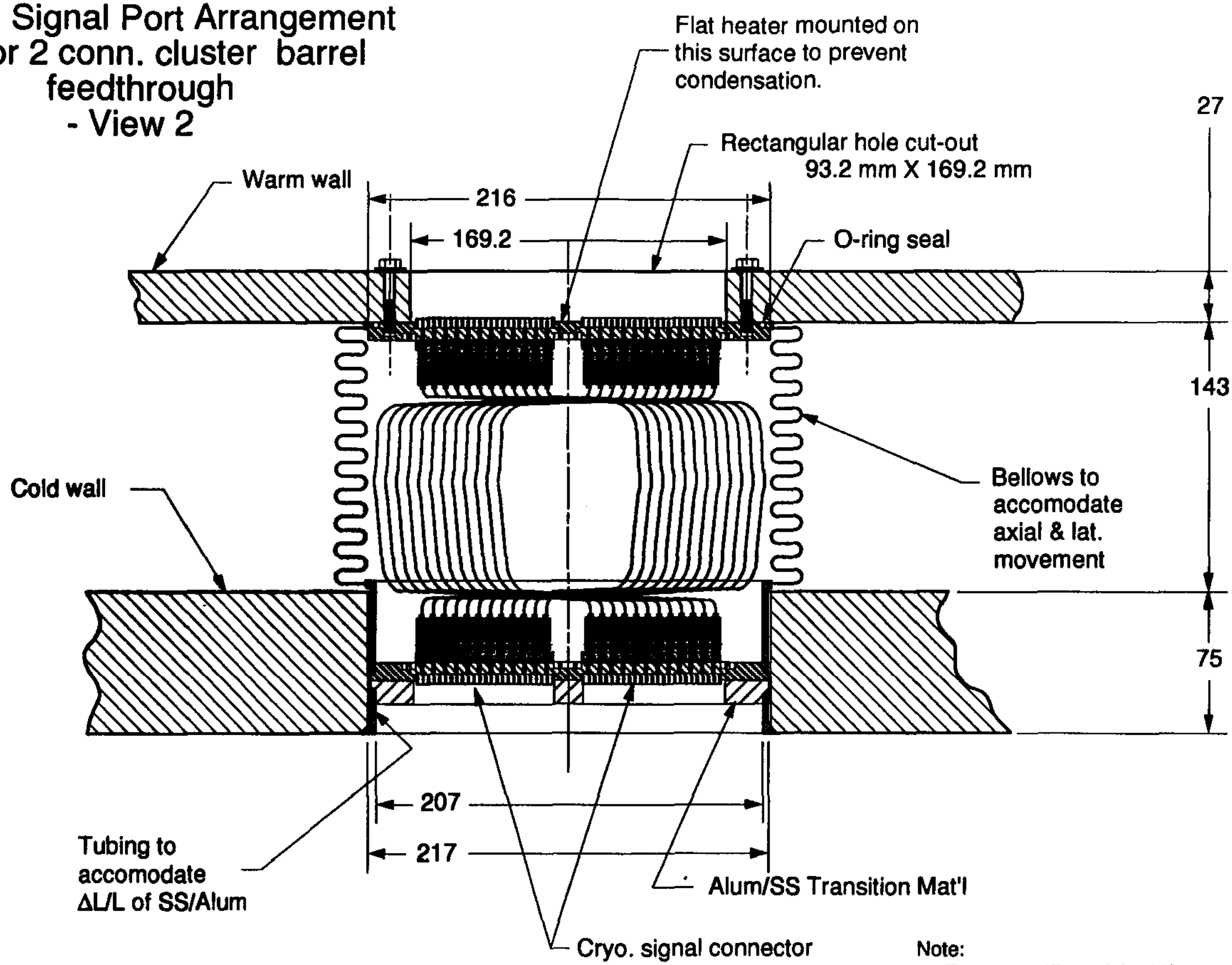
4/29/93 DAF

Typical Signal Port Arrangement for 2 conn. cluster barrel feedthrough - View 2



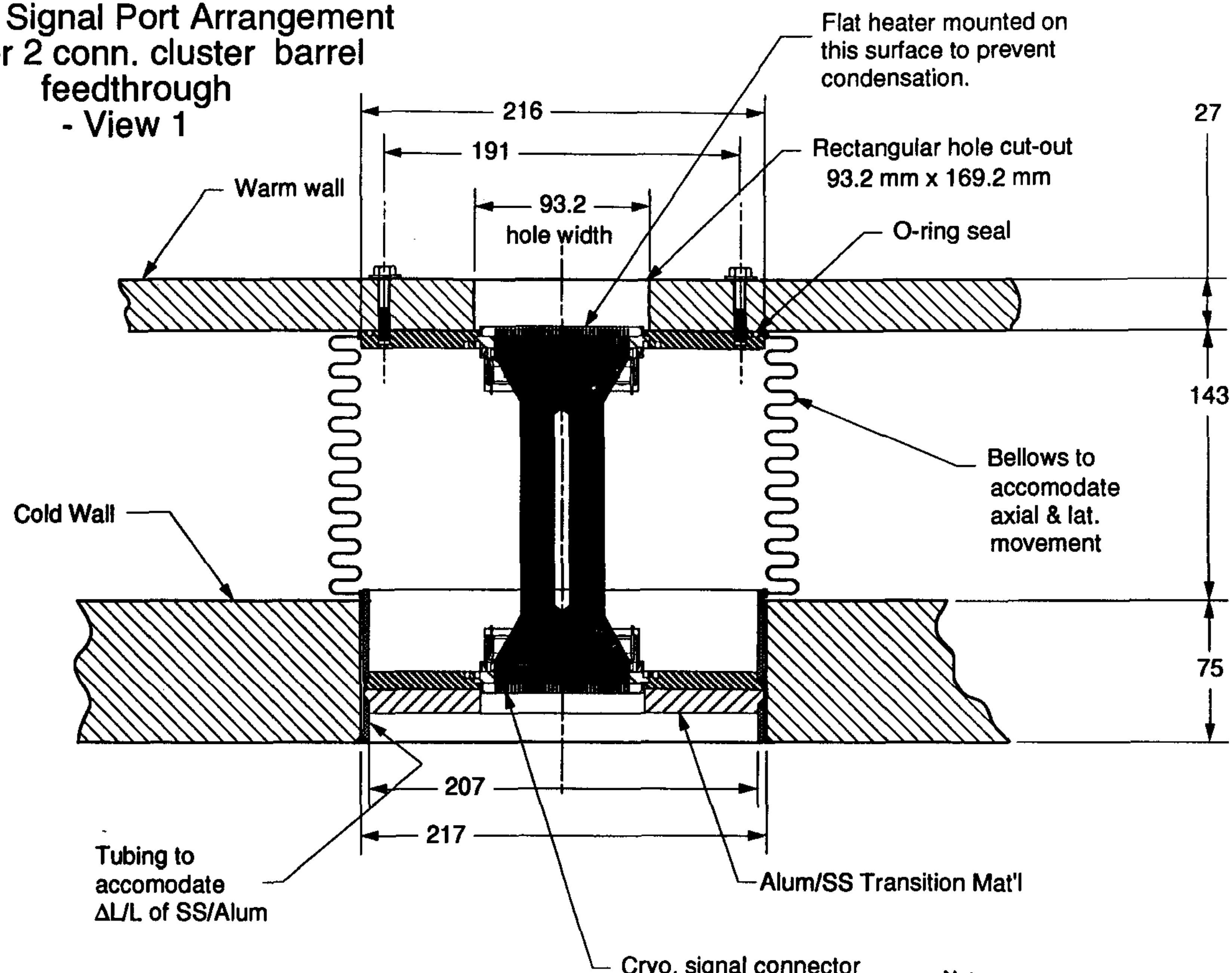
Scale

50 mm

University of Washington
5/13/93 DAF

Note:
Expected differential cold/warm wall movement on cooldown
Axial - 8 mm
Lateral - 10 mm
All dimensions in mm

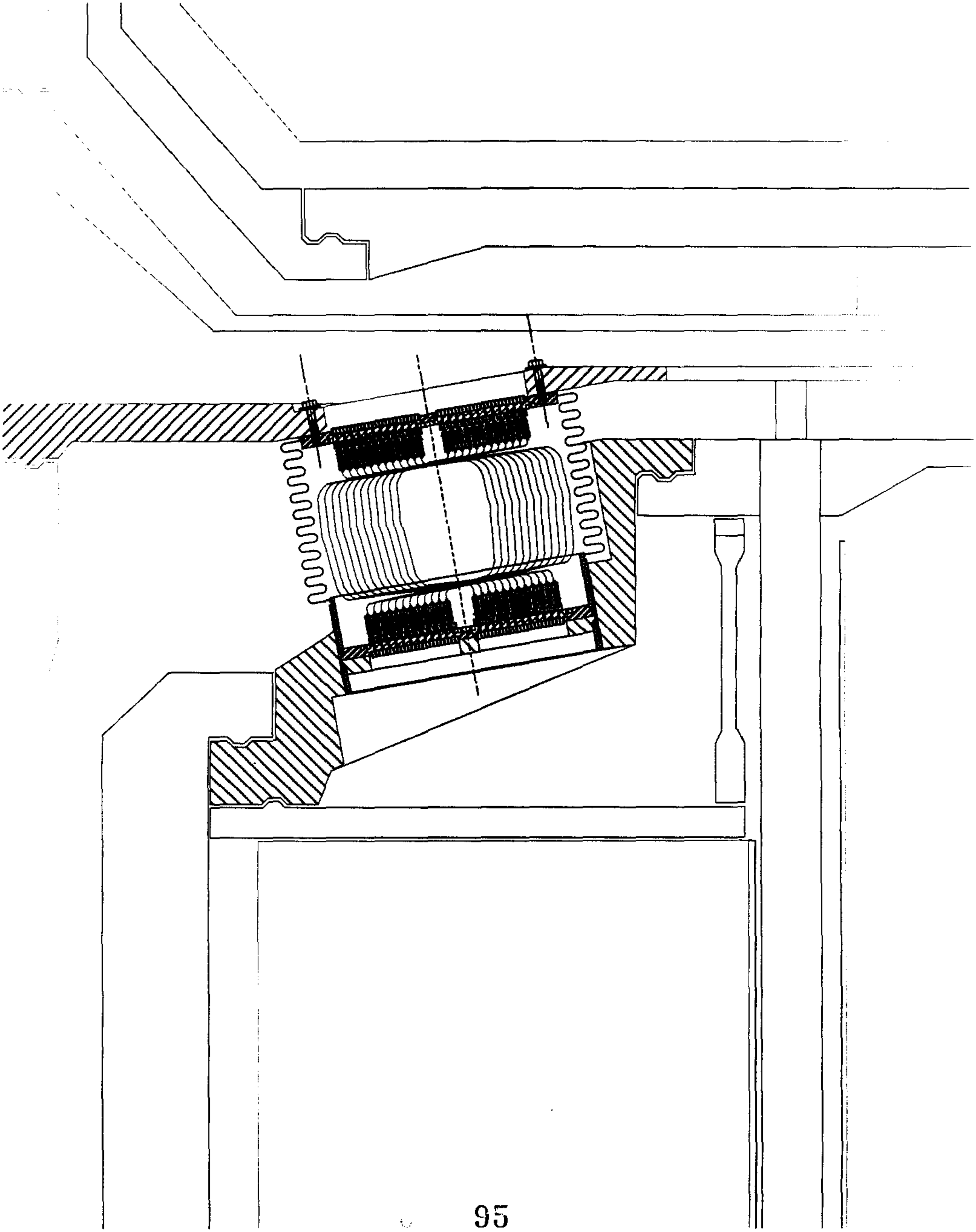
Typical Signal Port Arrangement for 2 conn. cluster barrel feedthrough - View 1



University of Washington
5/13/93 DAF

Scale
50 mm

Note:
Expected differential cold/warm wall movement on cooldown
Axial - 8 mm
Lateral - 10 mm
All dimensions in mm



6/18/93

Block connector cost, each, 36 pin, gold plated pins, 432 ch./ block	$1000 - 1500/ block

Rectangular connector -

Mold cost (3 molds)	$18000
Injected part (based on 20K sets)	.90/3 pc set
Connector springs	1.00 ea. , 2 req'd. per set
Samtec block	1.00 per 36 ch.

Production time - 1 mo. for molds
- 2 wks. for 20,000 sets

Est. total cost/ feedthrough 2 conn. version (4 block connectors req'd. per unit), with 96 rect. connectors (4 rect. connectors req'd. per 36 channels)	$7000./feedthru

Cost estimate for materials excluding connectors: 6/18/93

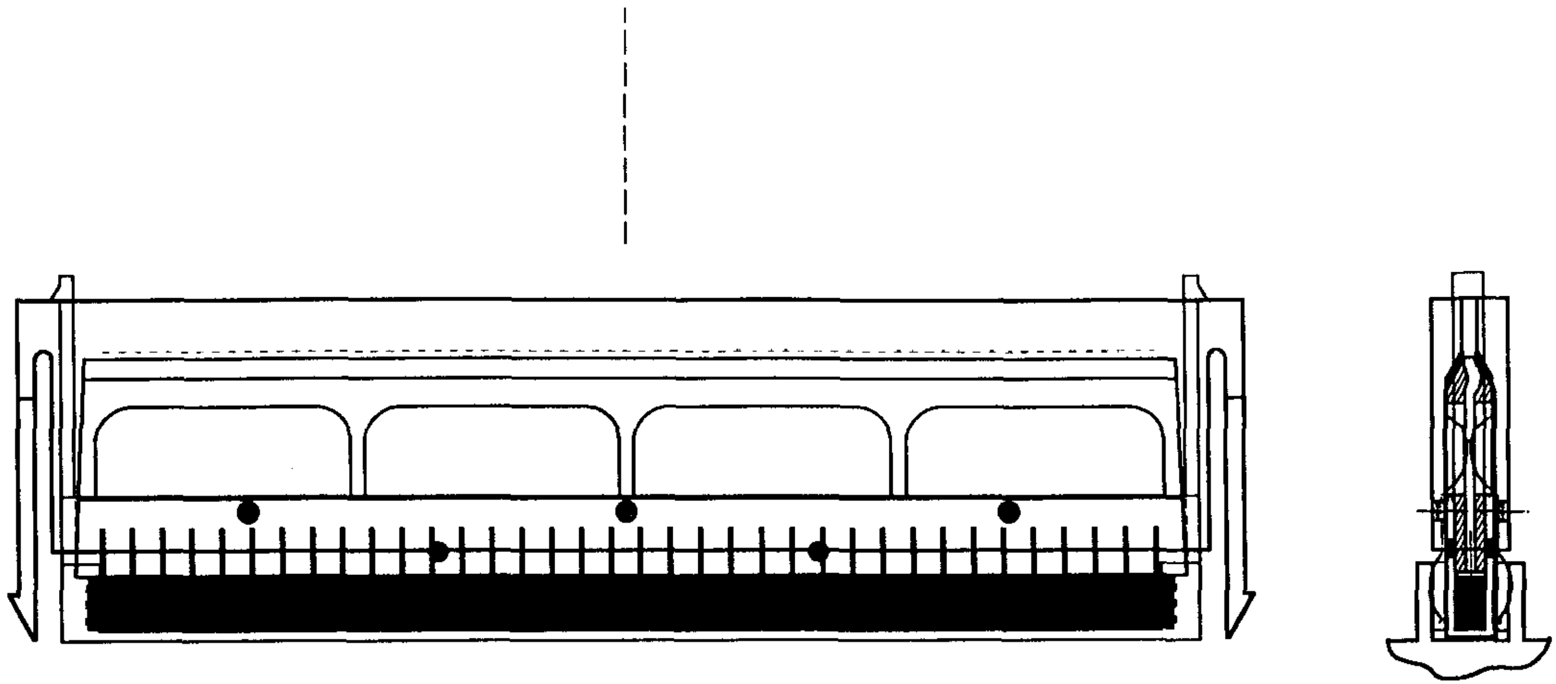
2 connector version - each unit

Tubing - 8 IPS, schedule 40, seamless 8.625" O.D. x 0.322" wall x 3" long ($136./ft., 20 ft. length)		$34.
Transition material -	9" dia. (63.6 in^2) ($ 3.50/ in^2)	223.
Bellows -	8.5" I.D., 9.75" O.D.	248.
SS Plate-	3/4" thick, 9" dia ($1.25/#)	24.
	Total	$529.

4 connector version - each unit

Tubing - 10 IPS, schedule 40, seamless 10.75" O.D. x 0.365" wall x 3"long ($154./ft., 20 ft. length)		$39.
Transition material -	9" dia. (95in^2) ($ 3.50/ in^2)	333.
Bellows -	11" I.D., 13" O.D.	270.
SS Plate-	3/4" thick, 11" dia.	24.
	Total	$666.

Est. mfg. time 2.5 days/unit (single unit)
6 hrs./ unit (20+ units)



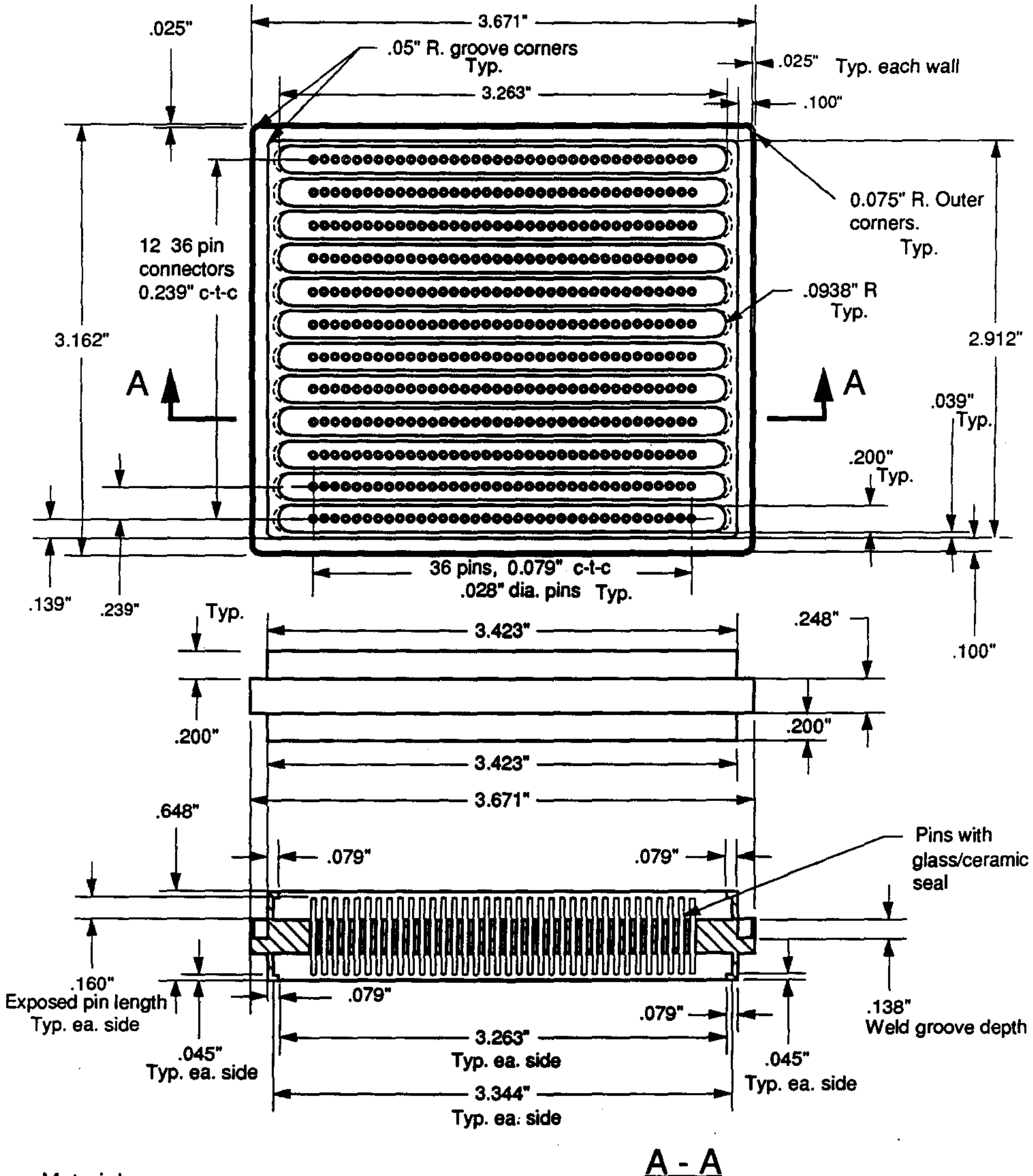
Univ. of Washington
4/29/93 DAF

1.0"

Scale

Connector in pieces

GEM Calorimeter Cryo. 36 Pin Signal Connector

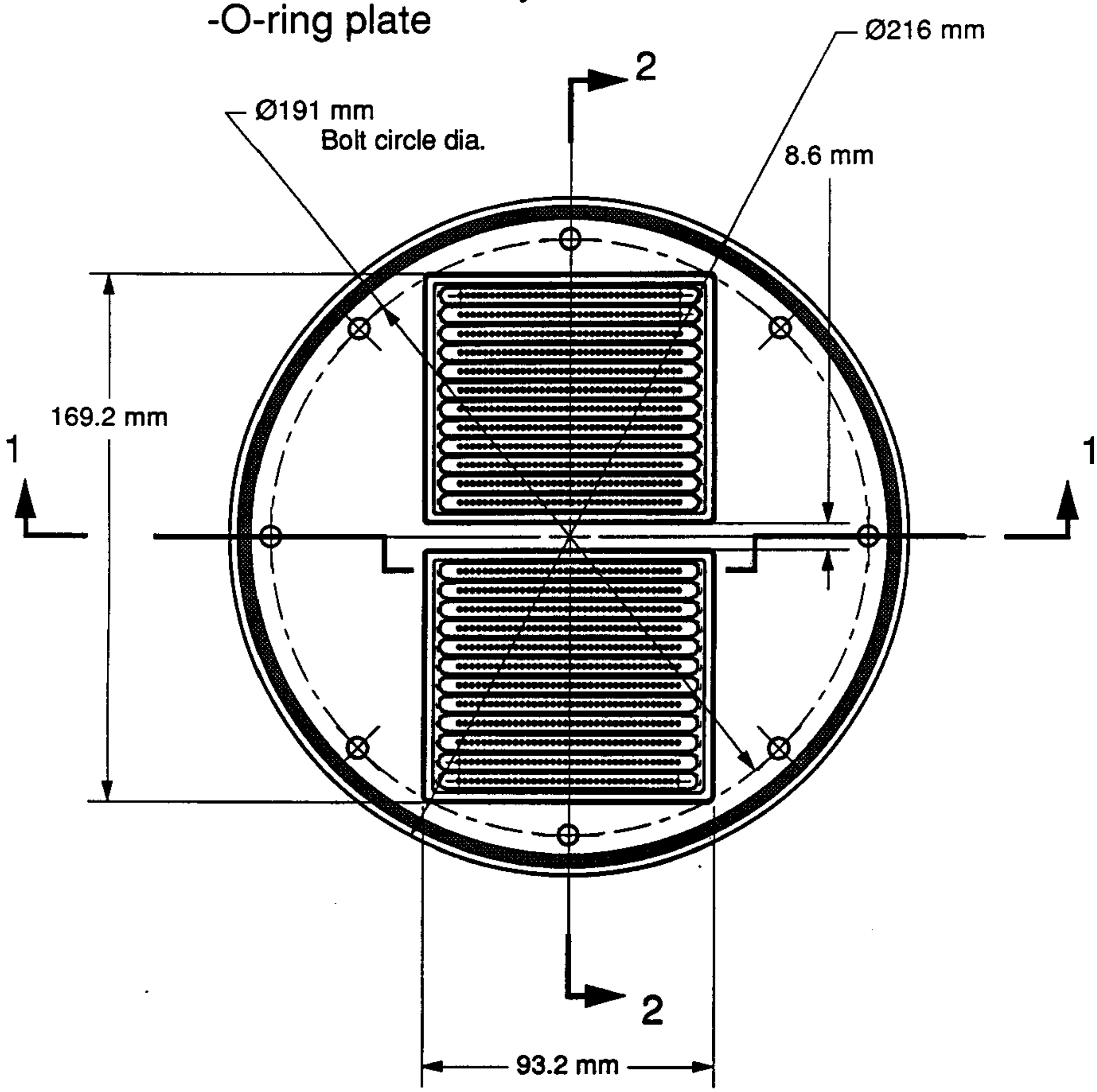


Material

Body and Pins
-Inconel "X750"

University of Washington
5/2/93 DAF

Signal Feedthrough showing
2 connector cluster array.
-O-ring plate



Note:
This sizing requires a rectangular hole cut-out in vessel wall 93.2 mm x 169.2 mm in size.
Plate dia. would need to be increased from 216 mm dia. to 245 mm dia. if a circular vessel wall cut-out is used. The cut-out dia. in this case would be 195 mm. dia.

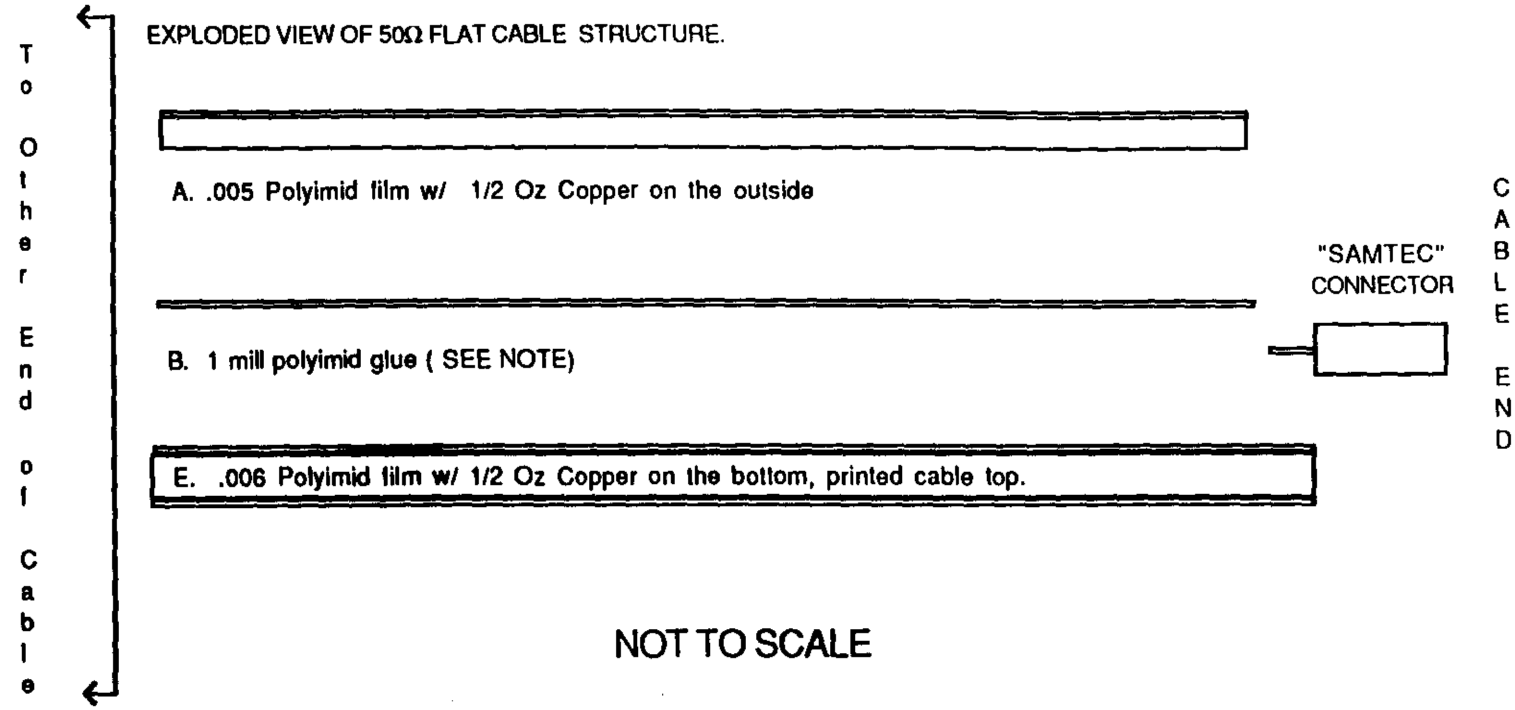
University of Washington
5/12/93 DAF

Presentation by:

F. Toevs

CABLE DESIGN REQUIRMENTS

1. $Z = 50\,\Omega$
2. HEAT LOSS < 5 mw/ch ($\Delta T \approx 210^\circ C$)
3. Shielding > 60 db @ 15 MHz
4. EASE of Assembly



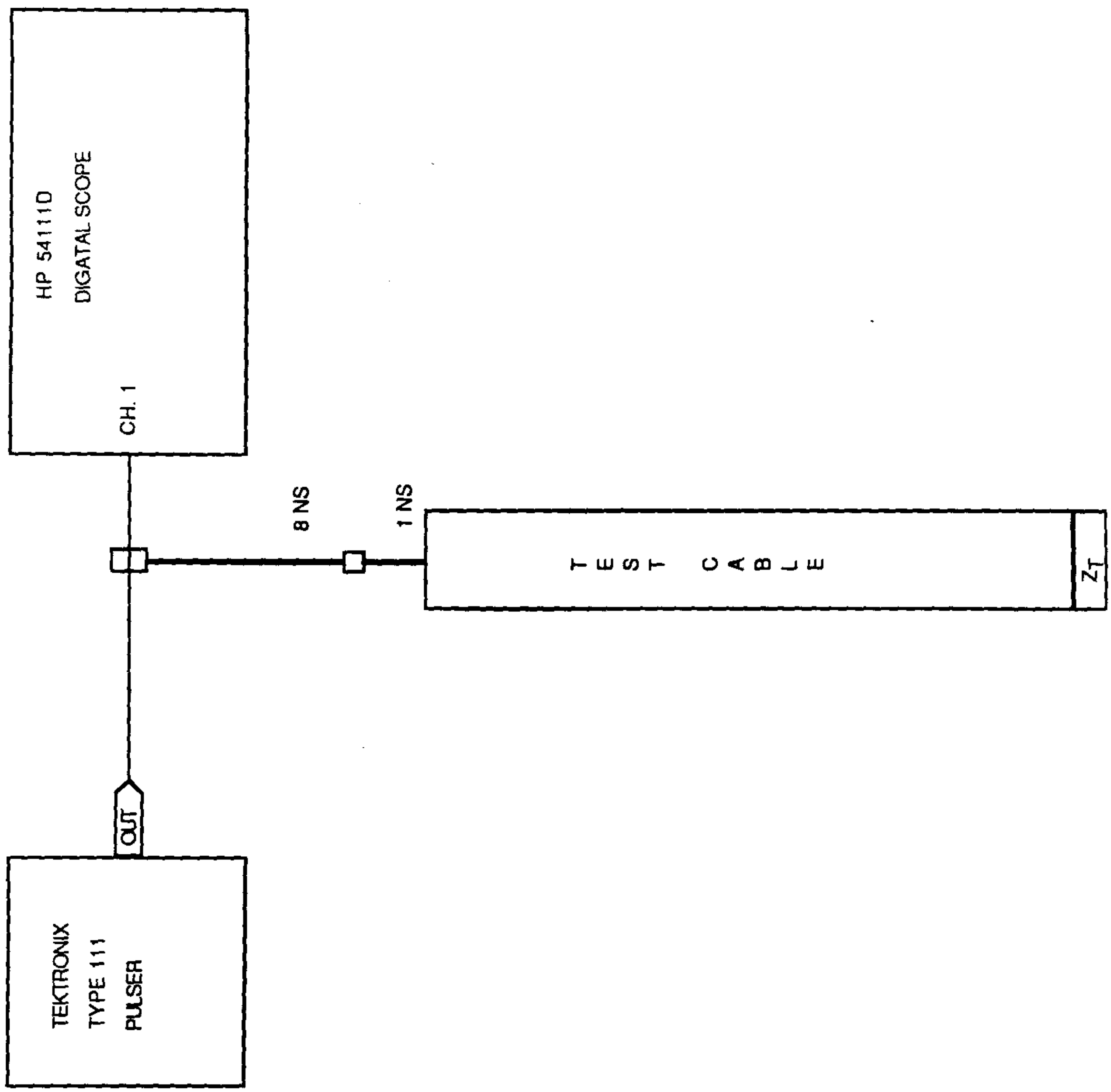
N.B. Both ends of cable are identical.

Film thickness to be determined by 50 Ω Z of cable

Polyimid glue..

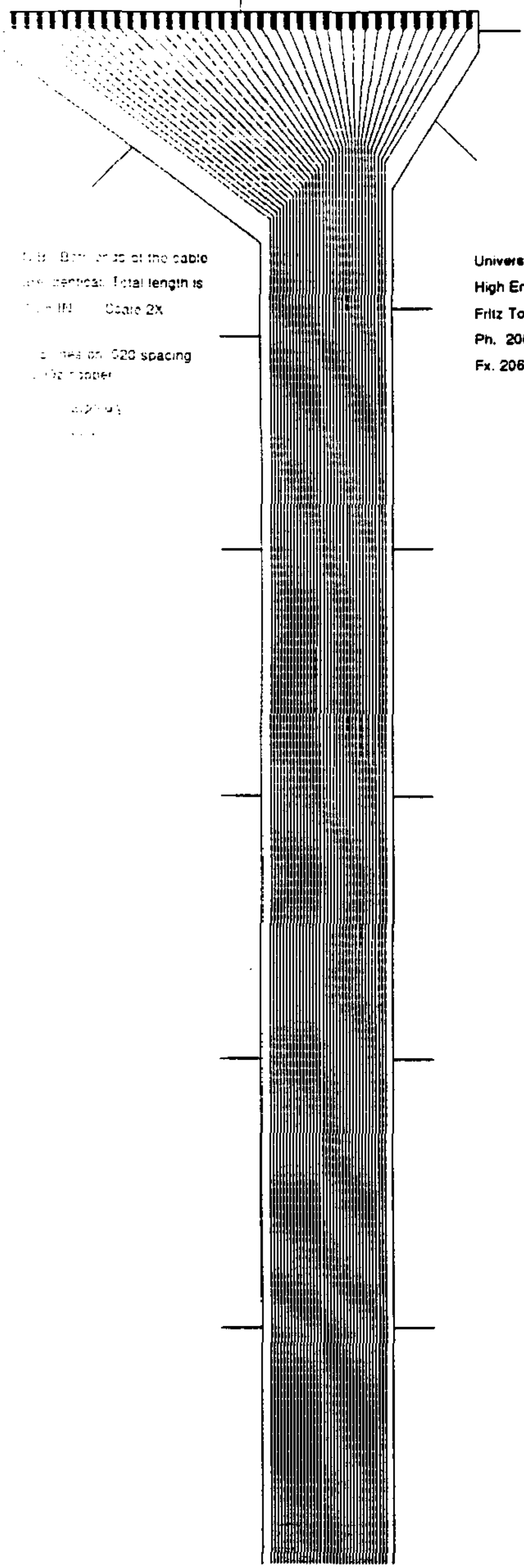
UNIVERSITY OF WASHINGTON
HIGH ENERGY PHYSICS
4-20-93 F.C.T.

Fritz Toevs
Ph. 206 543 8777
Fx. 206 685 0635


HP 54111D
DIGATAL SCOPE
CH. 1
8 NS
1 NS
TEST CABLE
Z_T
OUT
TEKTRONIX
TYPE 111
PULSER

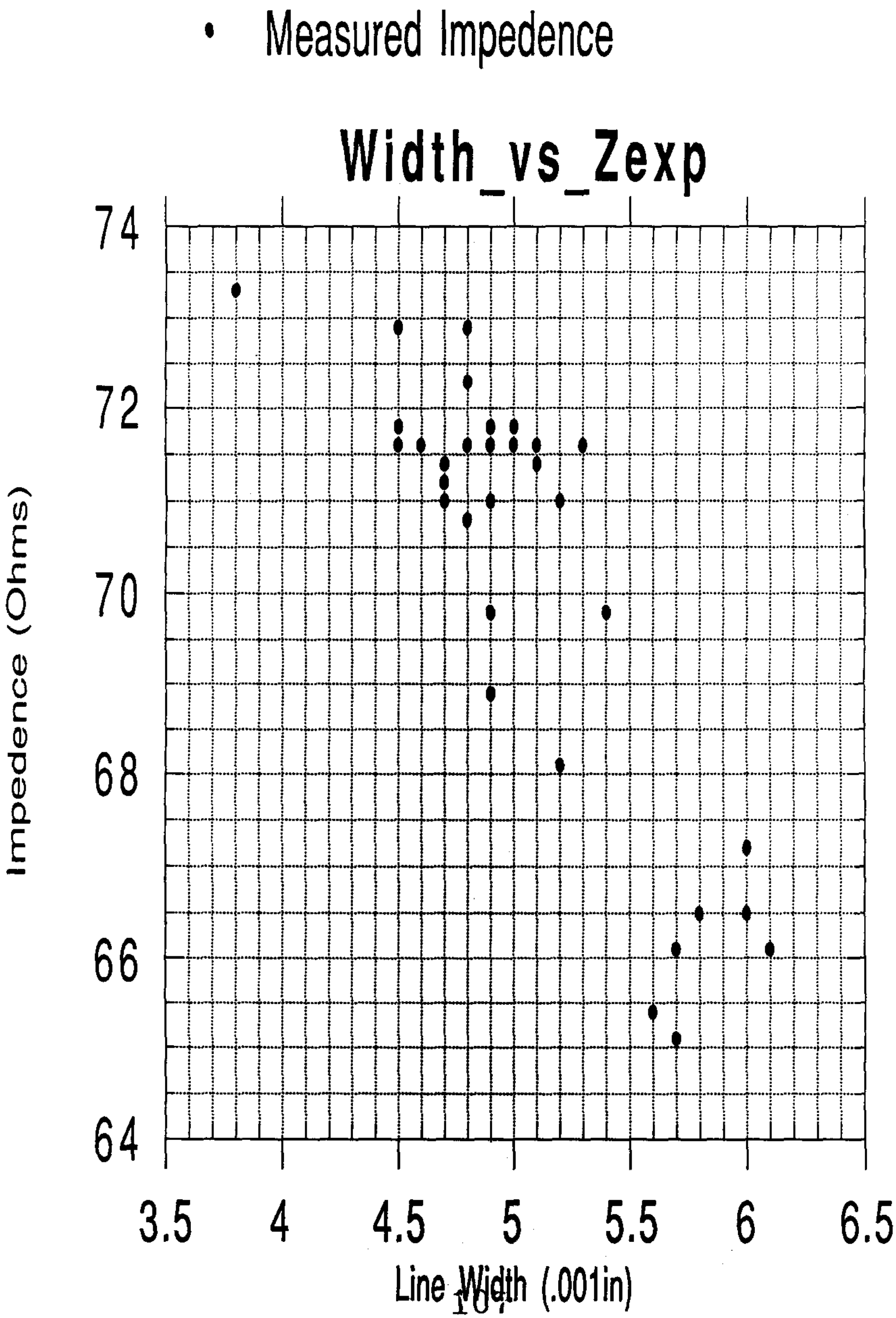
end of 50 Ω Impedence cable ("L" layer of Exploded view)

.079 spacing



University of washington
High Energy Physics
Fritz Toeve
Ph. 206 543 8777
Fx. 206 685 0635

μ stripline Test Results



Presentation by:

J. Franklin

The High Energy Physics group at the UNIVERSITY OF WASHINGTON would like to issue a Request For Quotation on the following item;

GEM Calorimeter Cryo. 36 Pin Signal Connector

1. Body - Rectangular,432pin (12 rows of 36 pins/row), TIG weld mountable, feedthrough machined from Inconel X750.
2. Pins - .028 inch diameter X .568 inch length Inconel X750 (pin ends to be Gold plated to 10 microinch thickness after attachment to feedthrough body)
3. Sealing Material (pins to body) - Ceramic

The general requirements/specifications for manufacturing these items is stated below;

A. Preproduction quantities should be manufactured using the same and/or similar tooling as the production requirements.
B. To be mountable using TIG welding.
C. Meet Helium leak rate of 1x10-9 cc std atm/sec.
D. Operate at 90K (liquid Argon temperature) and pressure of 500PSI.
E. Gold plated pins only (10 microinch)
F. Thermal Shock: 77K to 300K/hour

Feedthrough use/environment:

In operation, two feedthroughs will be TIG welded to a stainless steel flange which will be welded to a s/s bellows which will in turn be welded to a stainless steel/aluminum transition flange containing two feedthroughs. The purpose of double feedthroughs is for reliability of vacuum integrity reasons. The outer flange will separate atmospheric conditions from high vacuum while the inner flange will separate the high vacuum area from a 90K and high pressure (75PSI) environment

Presentation by:

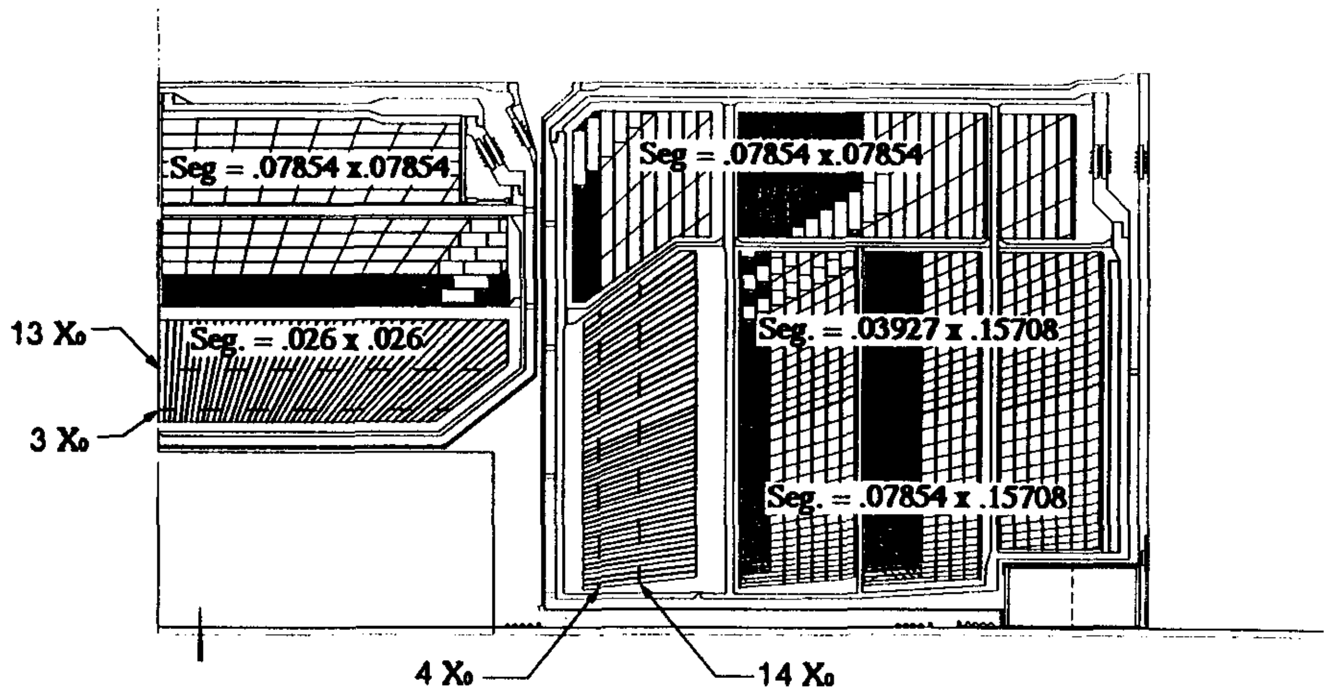
F. Lobkowicz

Barrel Hadronic Calorimetry

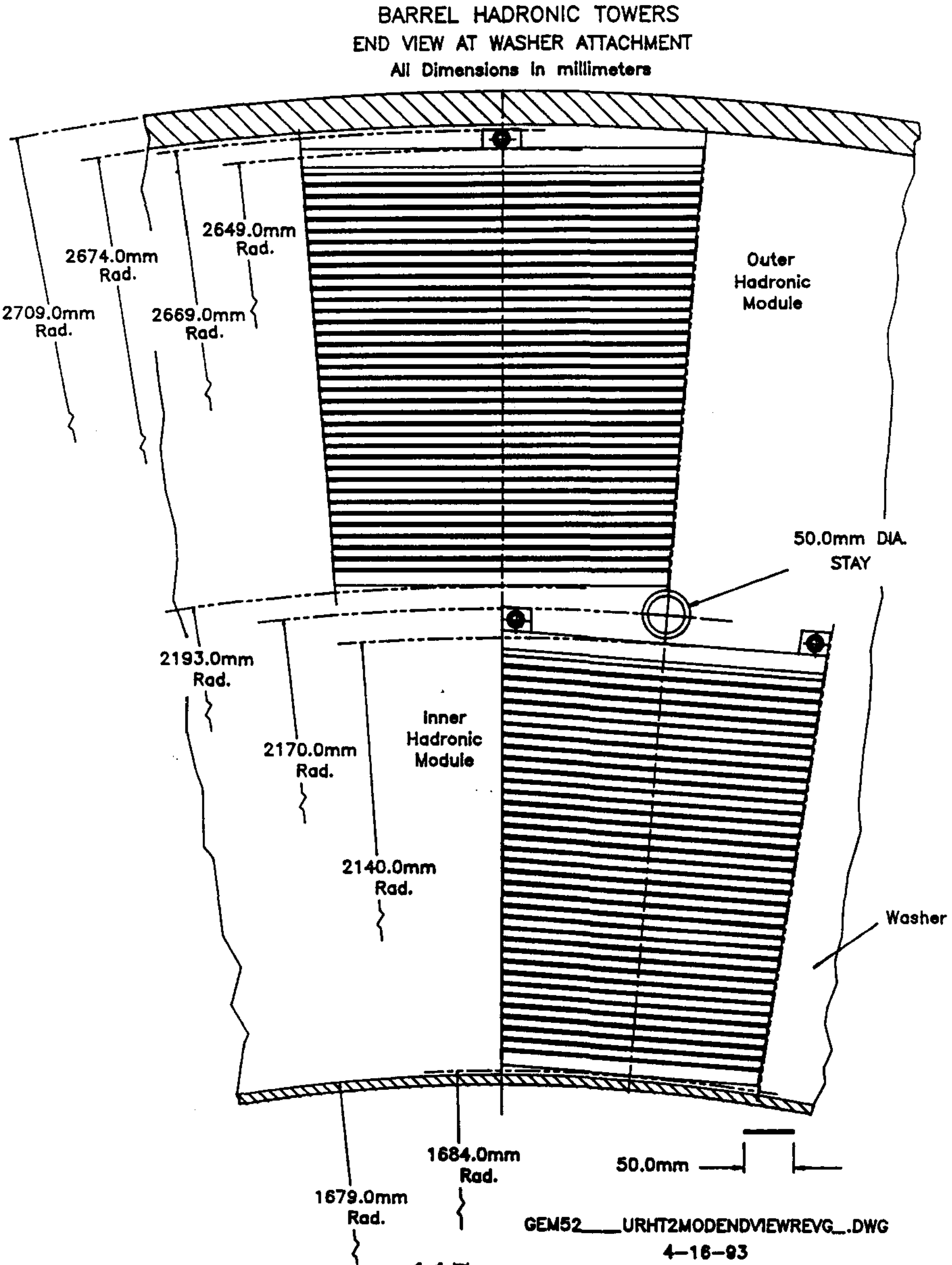
Segmentation	$\Delta\eta \times \Delta\phi = 0.0785 \times 0.0785$ $(\pi/40)$
Module layers	2 in depth (inner/outer)
Each module covers	$\Delta\eta \times \Delta\phi = 0.9(\text{typ}) \times 0.157$
Total # of modules	160 (40×2 sides $\times 2$ layers)
Transformer ratio	3 : 1, electrostatic
Unit cell:	6 gaps (3 in series, 2 sets in parallel)
Number of module layers	2 (inner/outer)
Absorber material	9 mm Lead
Active material	LKr, 2 mm gap
Number of cells/layer	6
Active absorber/ cell	0.346 Abs. lengths
Total absorber	4.56 Abs. lengths

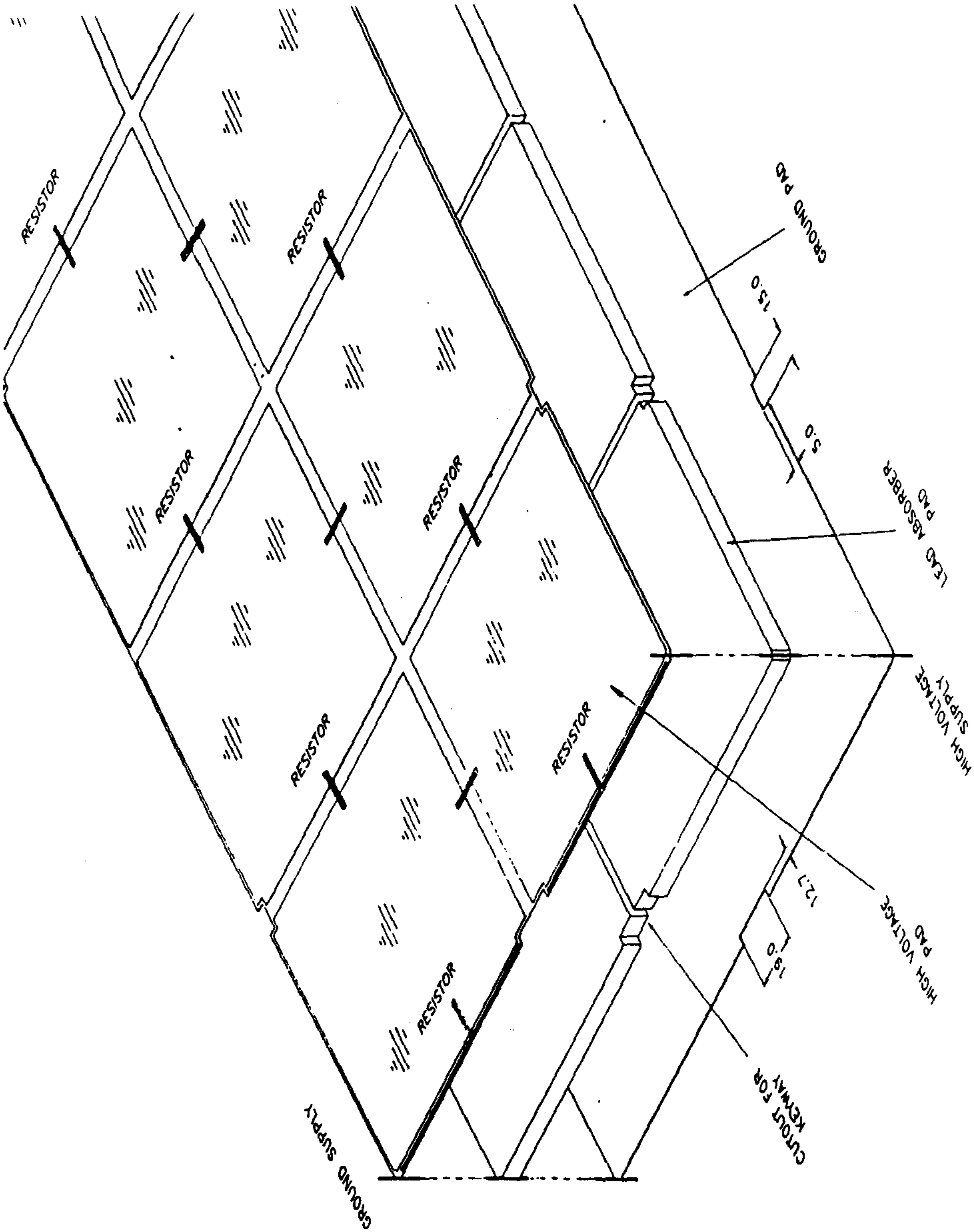
Cell Orientation in Modules

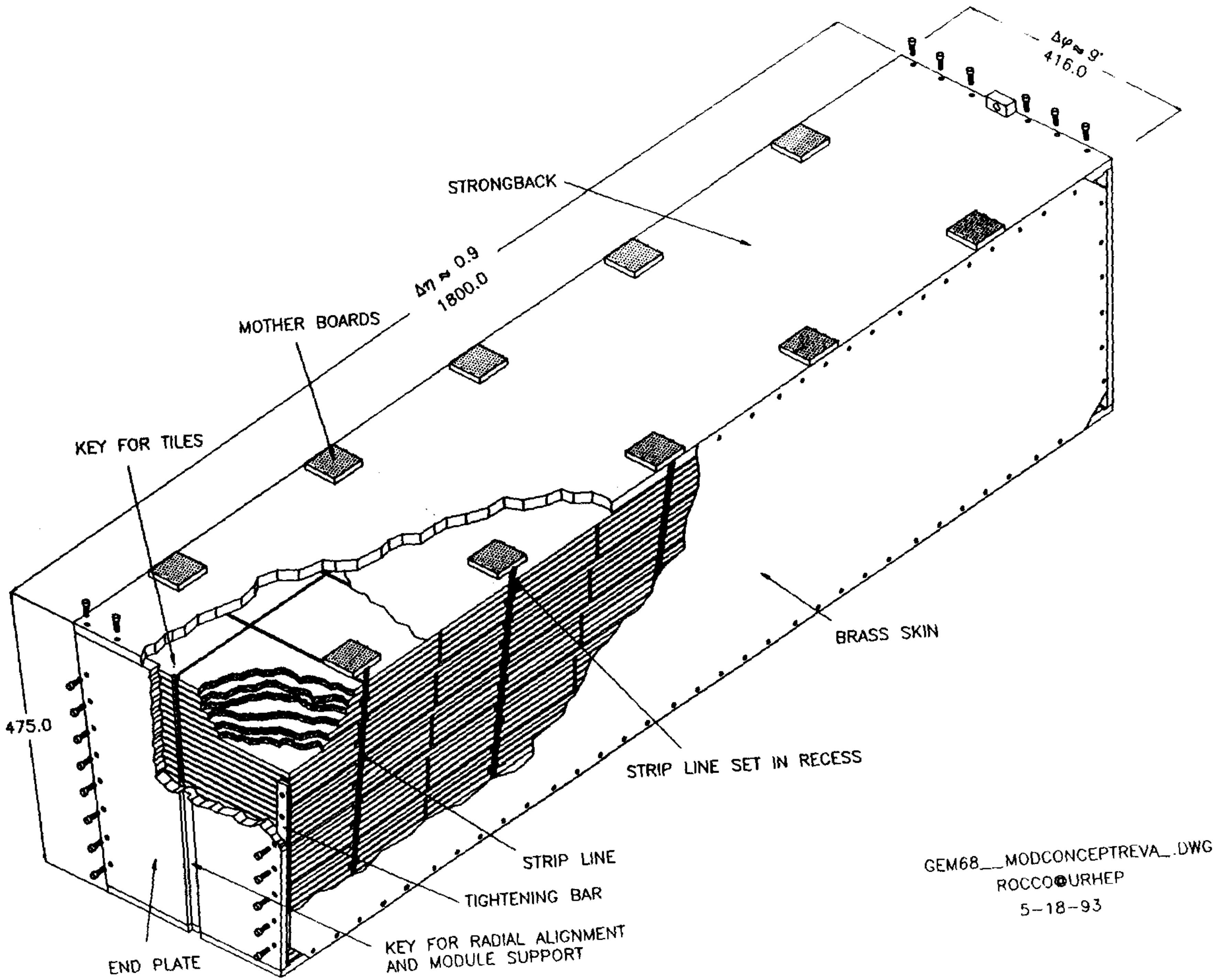
Segmentation (Eta x Phi)



Harnstable Segmentation 930517

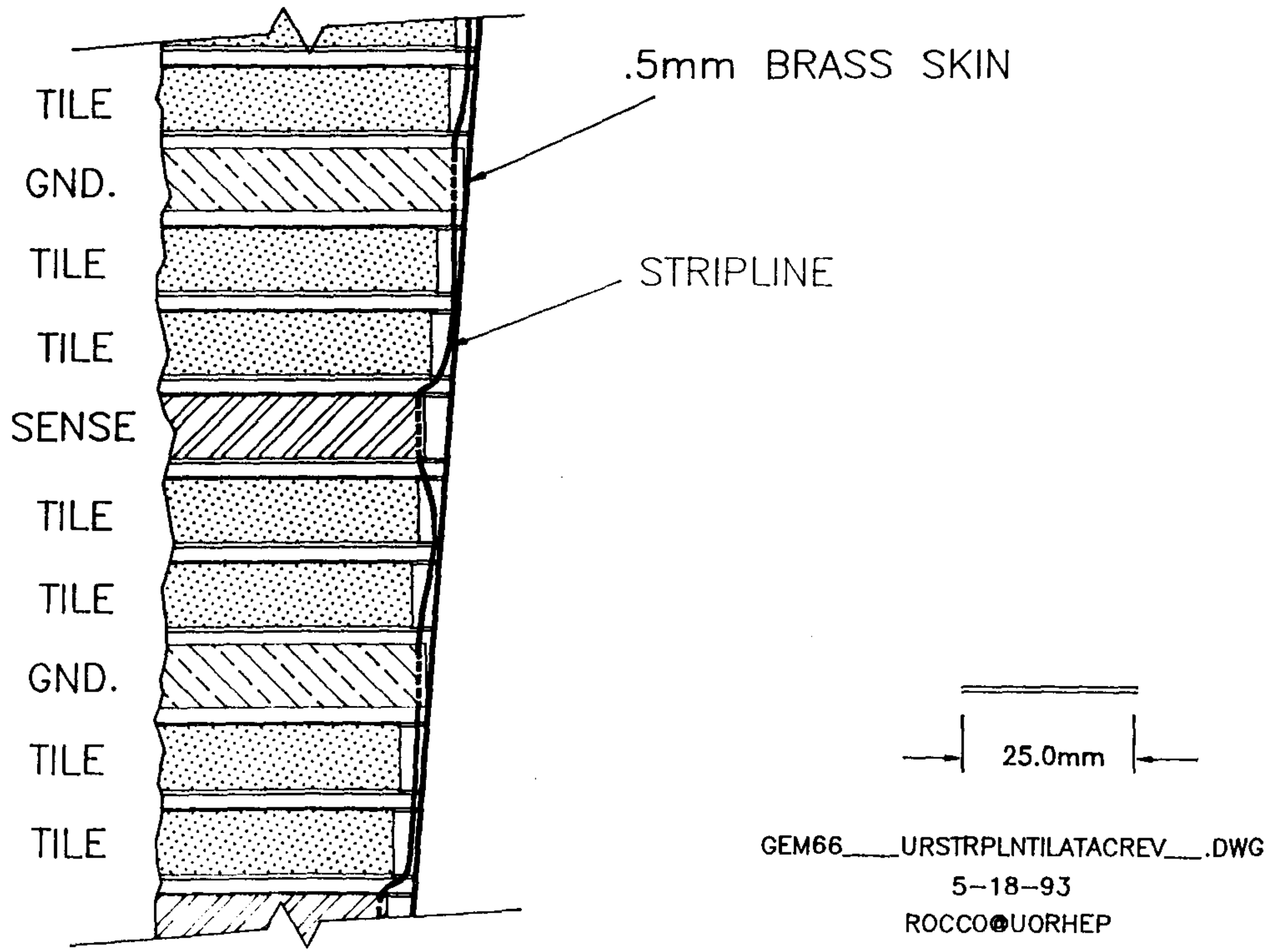

BARREL HADRONIC TOWERS
END VIEW AT WASHER ATTACHMENT
All Dimensions in millimeters
2649.0mm Rad.
2674.0mm Rad.
2709.0mm Rad.
2669.0mm Rad.
Outer Hadronic Module
50.0mm DIA. STAY
2193.0mm Rad.
2170.0mm Rad.
Inner Hadronic Module
2140.0mm Rad.
Washer
1684.0mm Rad.
1679.0mm Rad.
50.0mm
GEM52____URHT2MODENDVIEWREVG__.DWG
4-16-93
ROCCO@UORHEP


RESISTOR
RESISTOR
RESISTOR
RESISTOR
RESISTOR
RESISTOR
RESISTOR
GROUND PAD
13.0
5.0
LEAD ABSORBER PAD
HIGH VOLTAGE SUPPLY
12.7
19.0
HIGH VOLTAGE PAD
CUTOUT FOR KEYWAY
GROUND SUPPLY

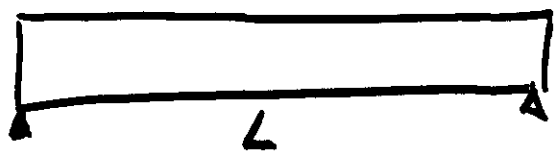

Δφ ≈ 9°
416.0
STRONGBACK
Δη ≈ 0.9
1800.0
MOTHER BOARDS
KEY FOR TILES
BRASS SKIN
475.0
STRIP LINE SET IN RECESS
STRIP LINE
TIGHTENING BAR
KEY FOR RADIAL ALIGNMENT
AND MODULE SUPPORT
END PLATE
GEM68__MODCONCEPTREVA_.DWG
ROCCO@URHEP
5-18-93

STRIPLINE/TILE ATTACHMENT

All Dimensions in Millimeters



Scaling – Models



$$\text{Area} \sim L^2$$

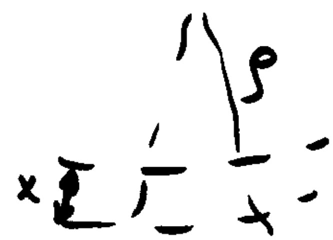
$$\text{Weight} \sim L^2$$

$$\text{Torque} \sim W.L \sim L^3$$

$$\text{Force} \sim \frac{T}{L} \sim L^2$$

$$\text{Stress} = \frac{\text{Force}}{\text{Area}} \sim 1$$

radius $$\frac{1}{\rho} \sim \underbrace{\frac{\delta l}{l}}_{\sigma \approx 1} \cdot \frac{1}{x} \sim \frac{1}{L}$$

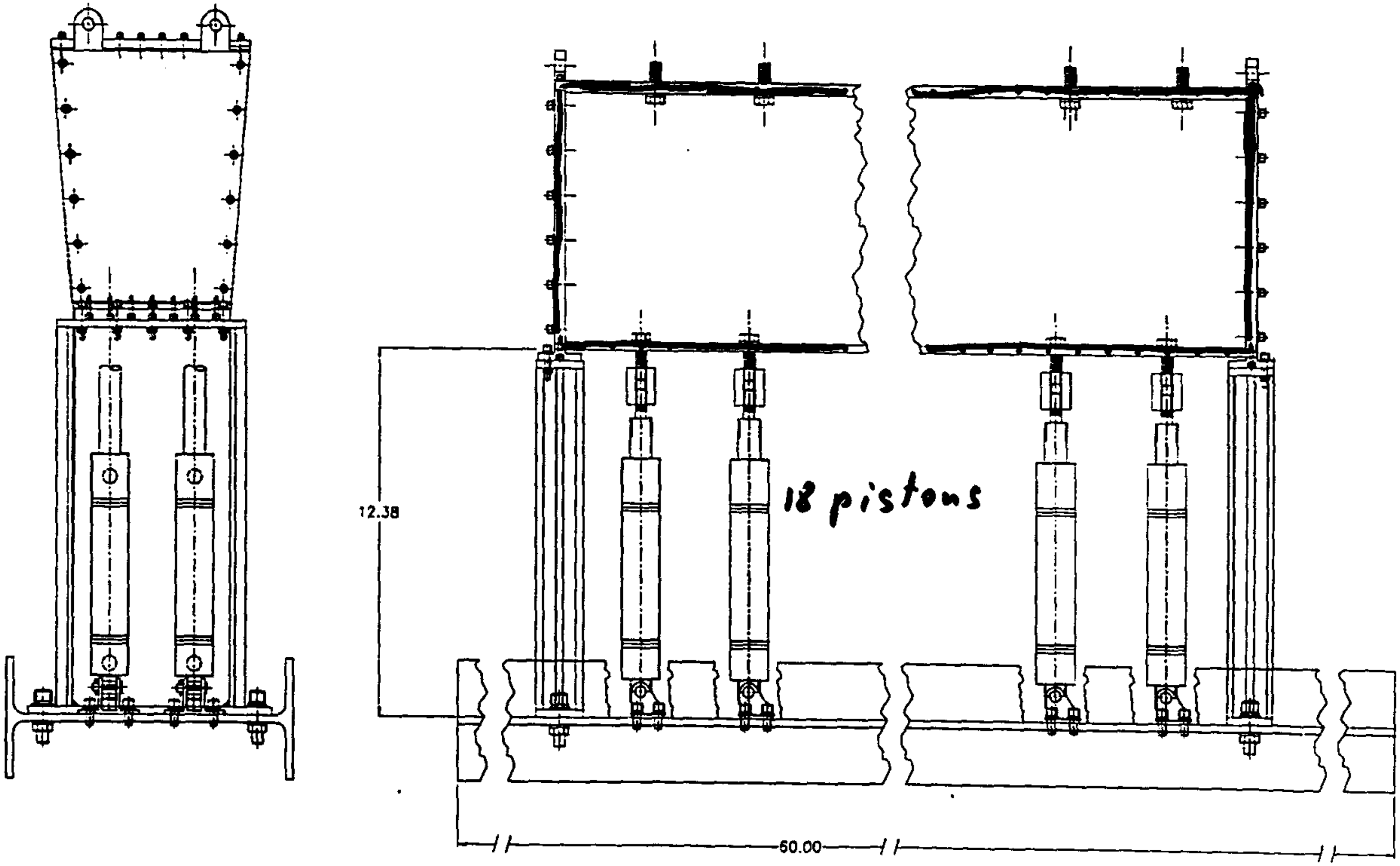


deflection: $$\propto \frac{L^2}{\rho} \sim L$$

1 Weight Full scale $\leq$ 5000 lbs

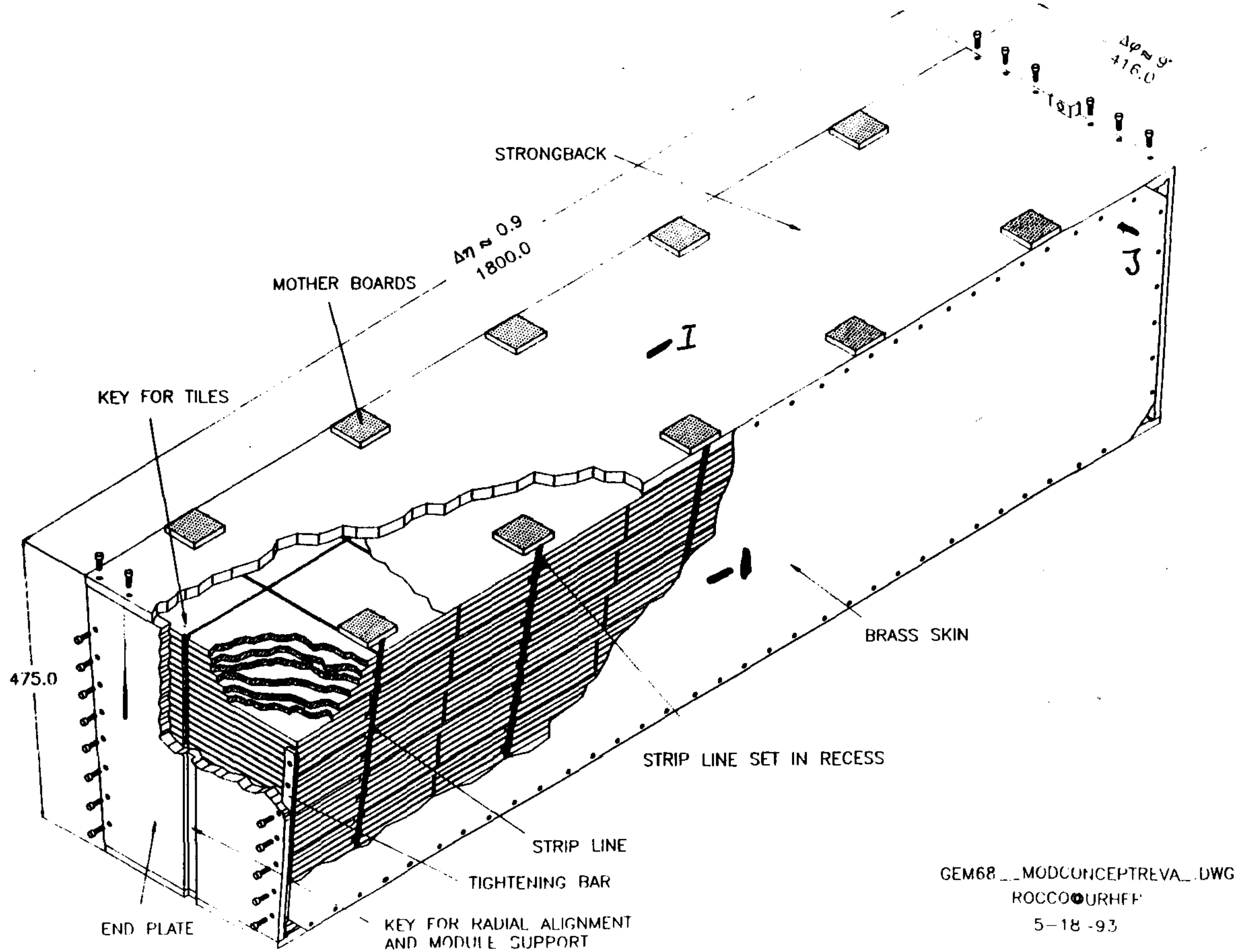
→ „1 Weight half scale" $\leq$ 1250 lbs

DEFORMATION TEST SETUP



$\frac{1}{2}$ scale

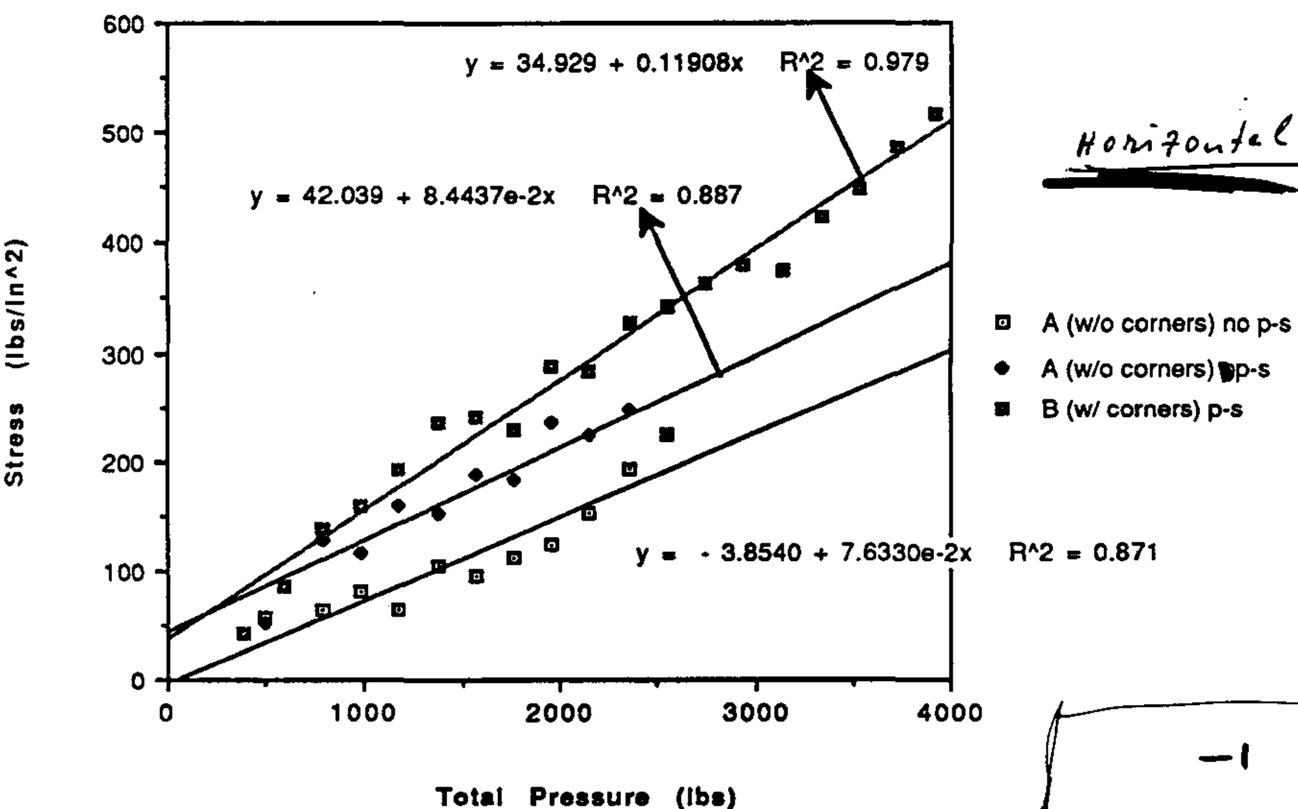
GEM63___URMODTESTFIXTURREV___.DWG
ROCCO@URHEP
4-28-93


STRONGBACK
$\Delta\varphi \approx 9°$
416.0
MOTHER BOARDS
$\Delta\eta \approx 0.9$
1800.0
KEY FOR TILES
I
J
475.0
BRASS SKIN
STRIP LINE SET IN RECESS
STRIP LINE
TIGHTENING BAR
END PLATE
KEY FOR RADIAL ALIGNMENT
AND MODULE SUPPORT
GEM68__MODCONCEPTREVA_.DWG
ROCCO@URHEP
5-18-93

June 1?, 1??

All at centers

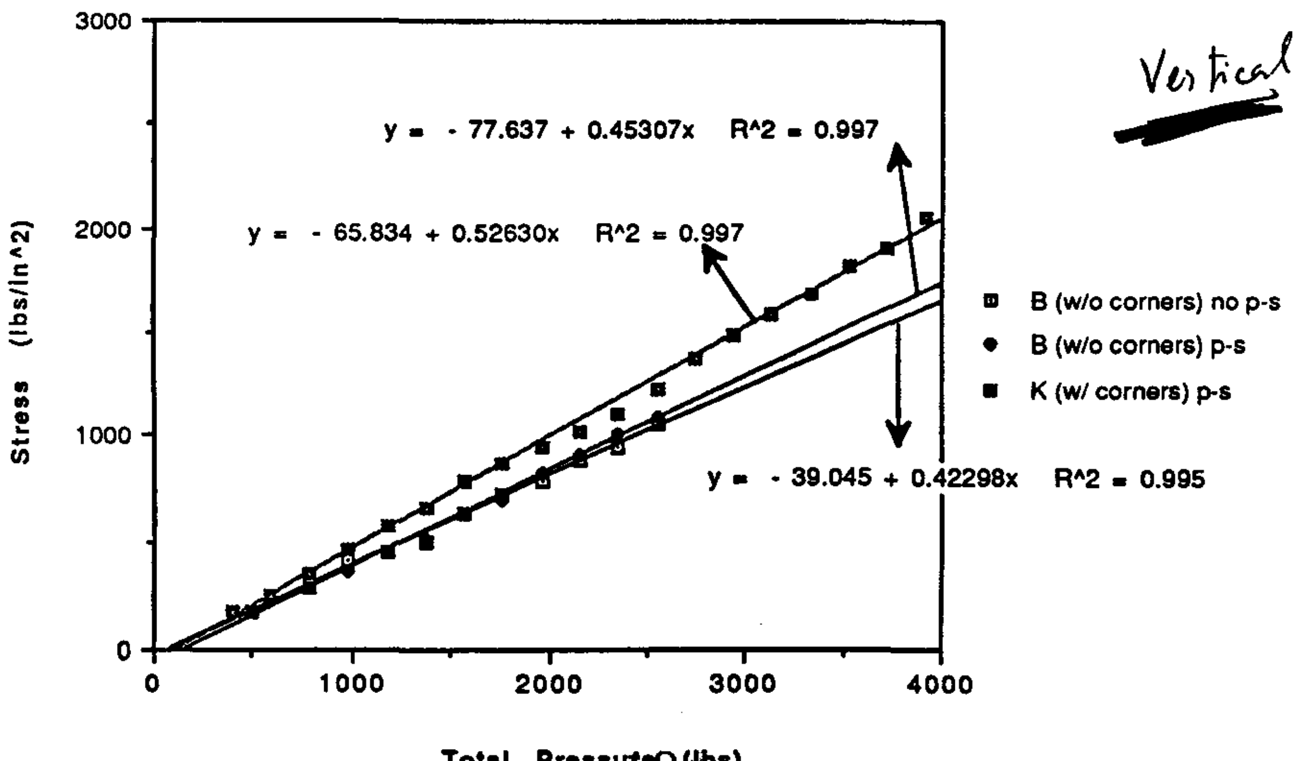
Data from Strain Gage A



Horizontal

-1

Data from Strain Gage B

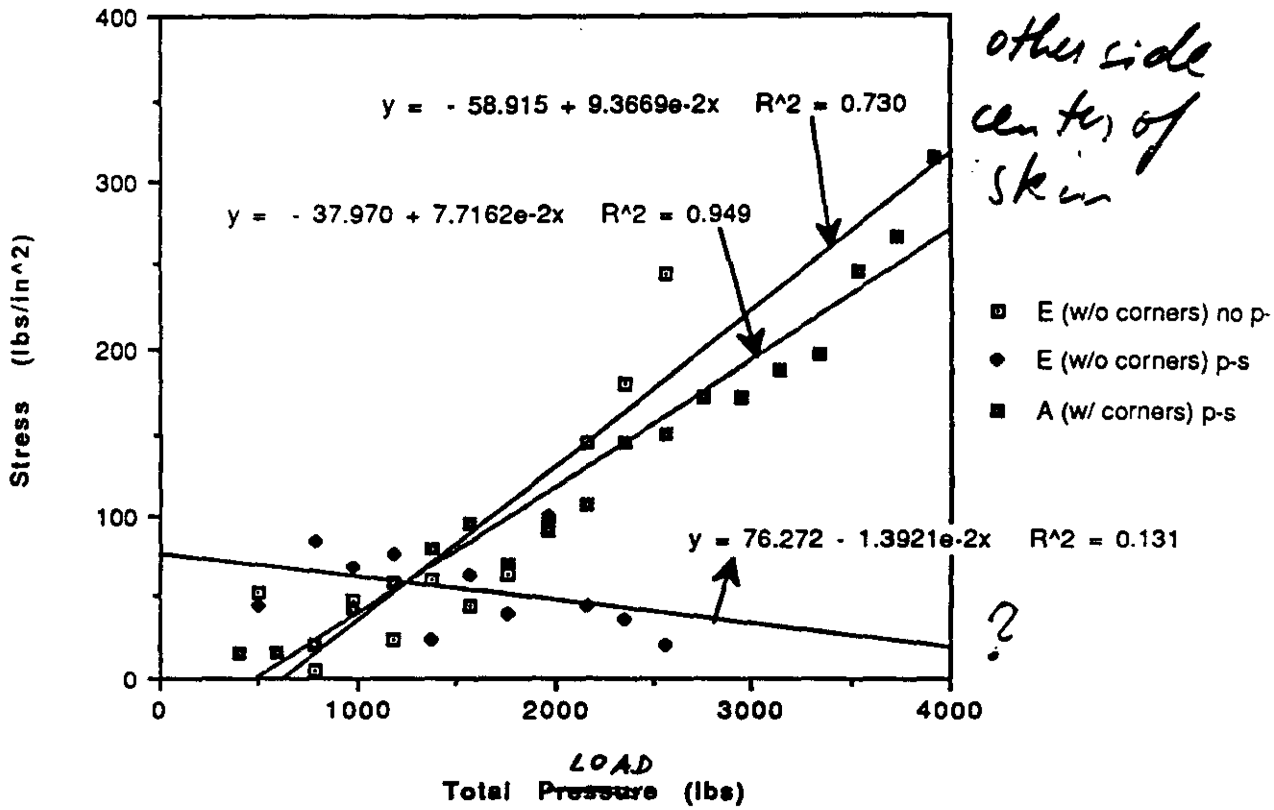


Vertical

Data from Strain Gage E

Horizontal

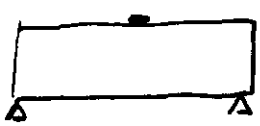
other side center of skin

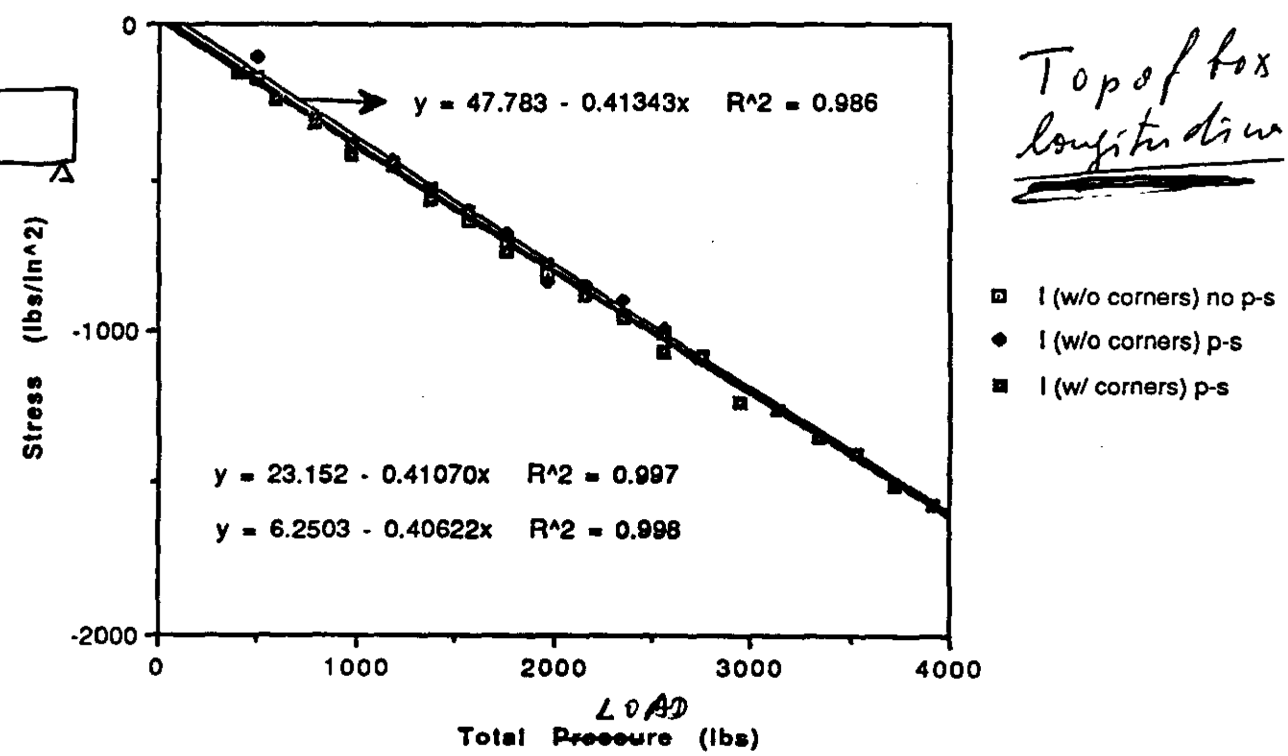


?

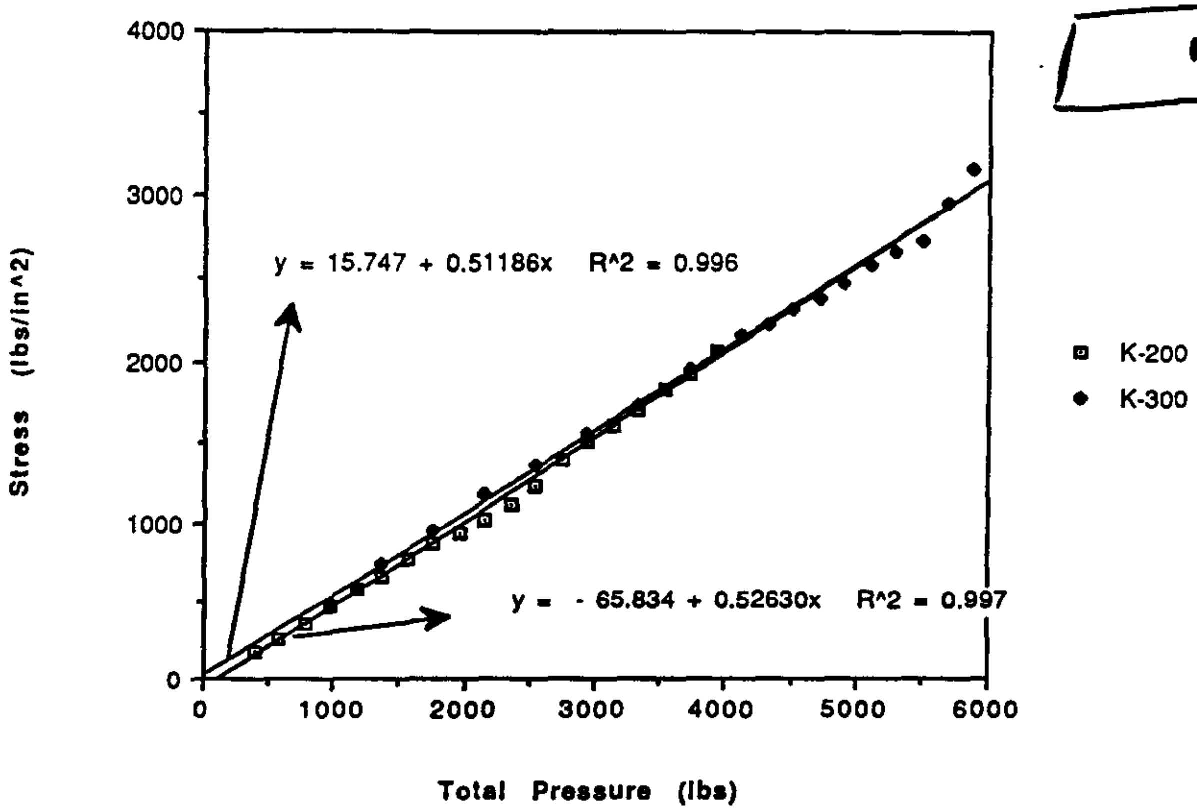
Data from Strain Gage I

Top of box longitudinal





Comparison 200 PSI Run and 300 PSI Run
For Gage K

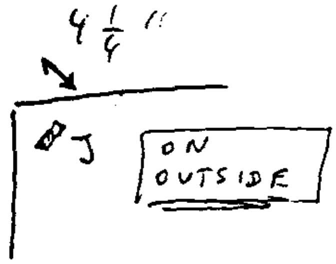


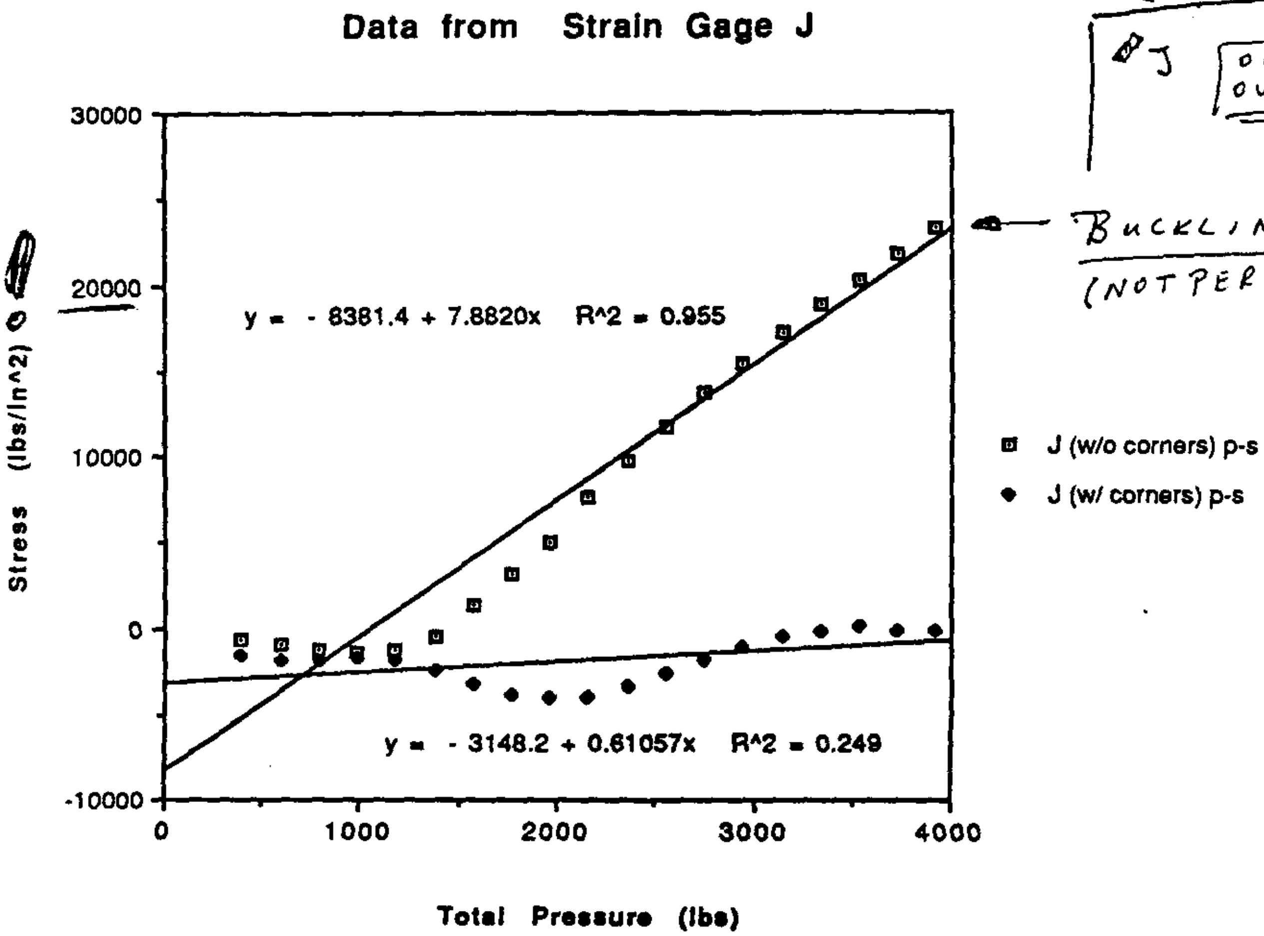
Vertical at center

The same style comparison graphs were do[ne for] the top and bottom gages. The followi[ng] data and graphs are from these gages.

June 14, 1993

Corner of module





BUCKLING
(NOT PERMANENT)

W/O corners: ~ 1" cut off

For J there were only two test. J ~~was~~ was added after the 1st set of runs (the w/o corners, no p-s)

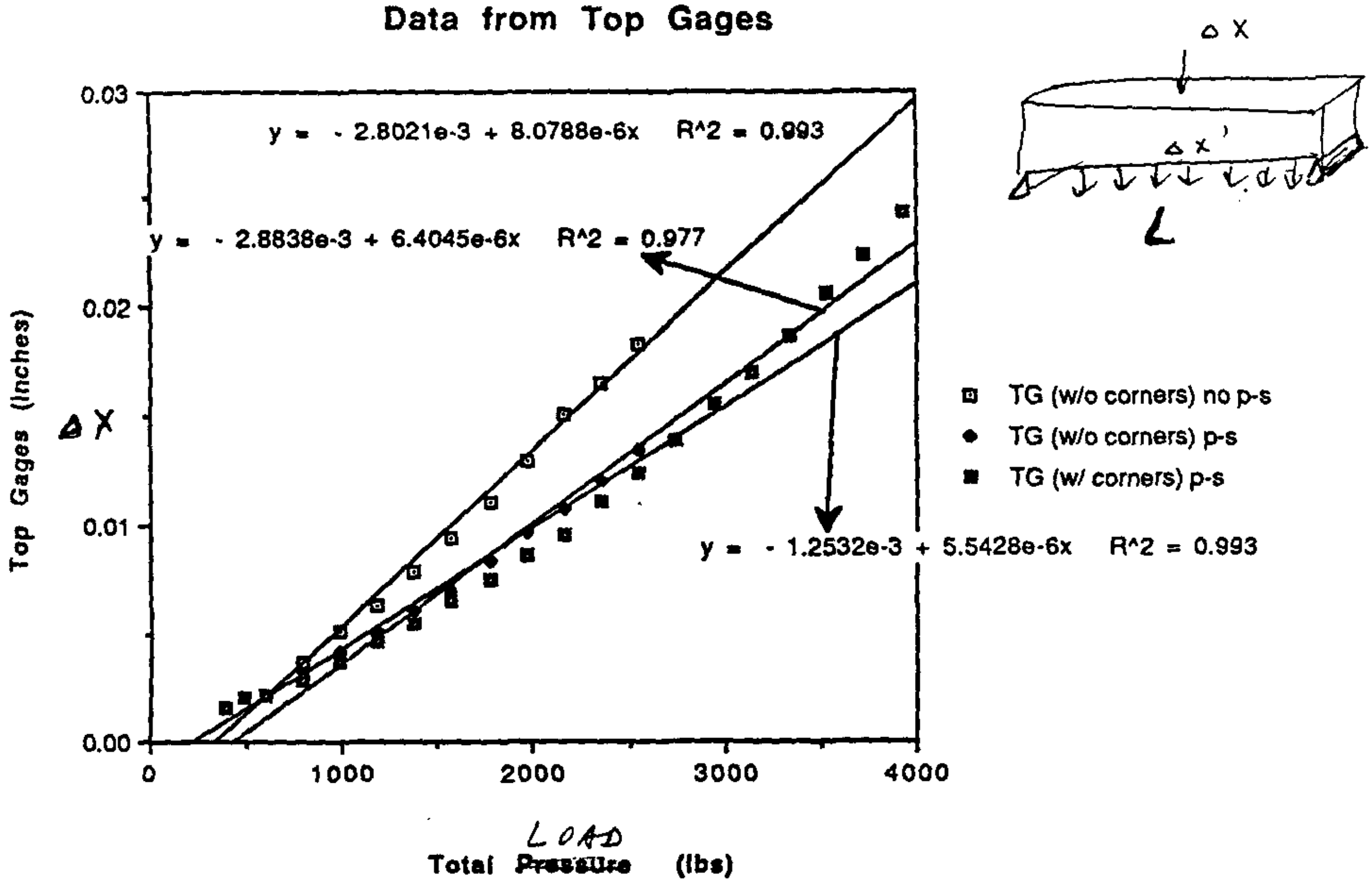
Difference in some strain gage letters are due to differences in labeling between the different sets of measurements

w/o corners no p-s } Setup on pgs 6, 16, 42.
w/o corners p-s }
w/ corners p-s } Setup on pg 58.

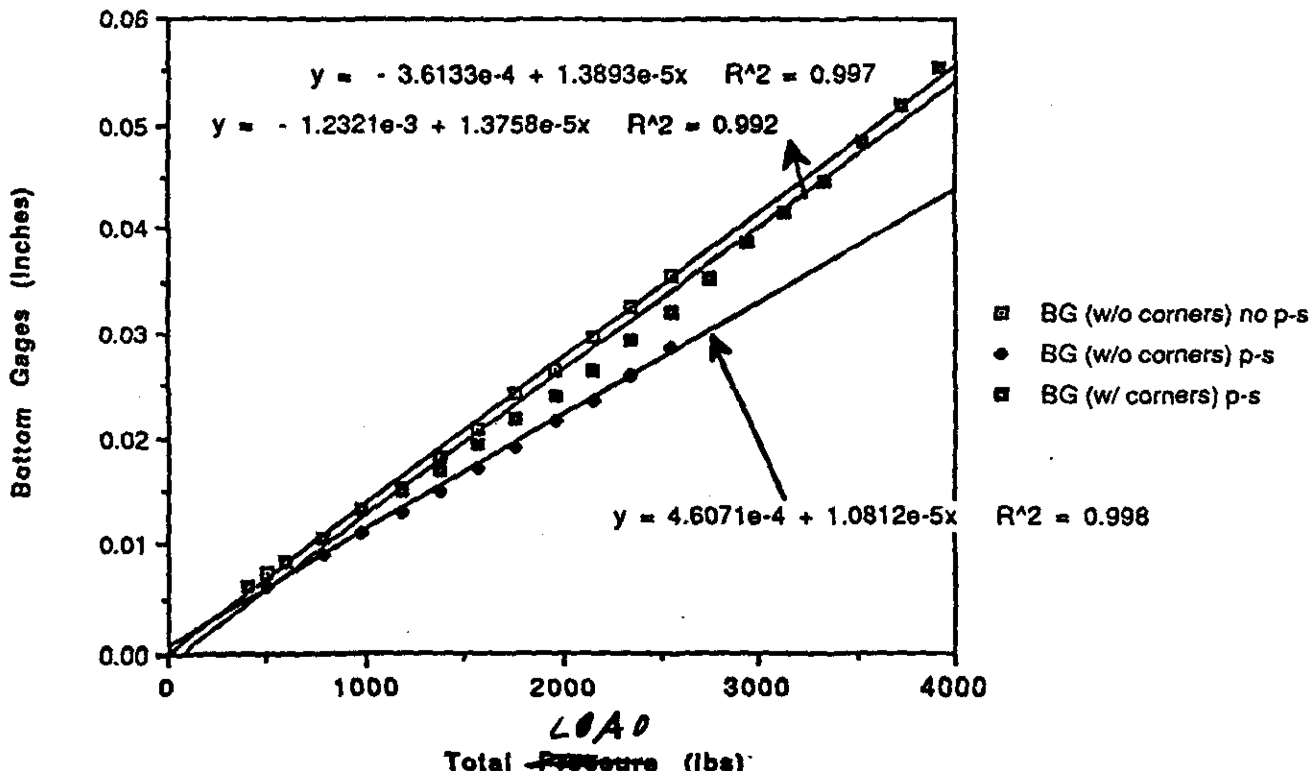
une 14, 1993

DEFLECTIONS

Data from Top Gages



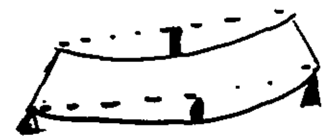
Data from Bottom Gages ΔX'

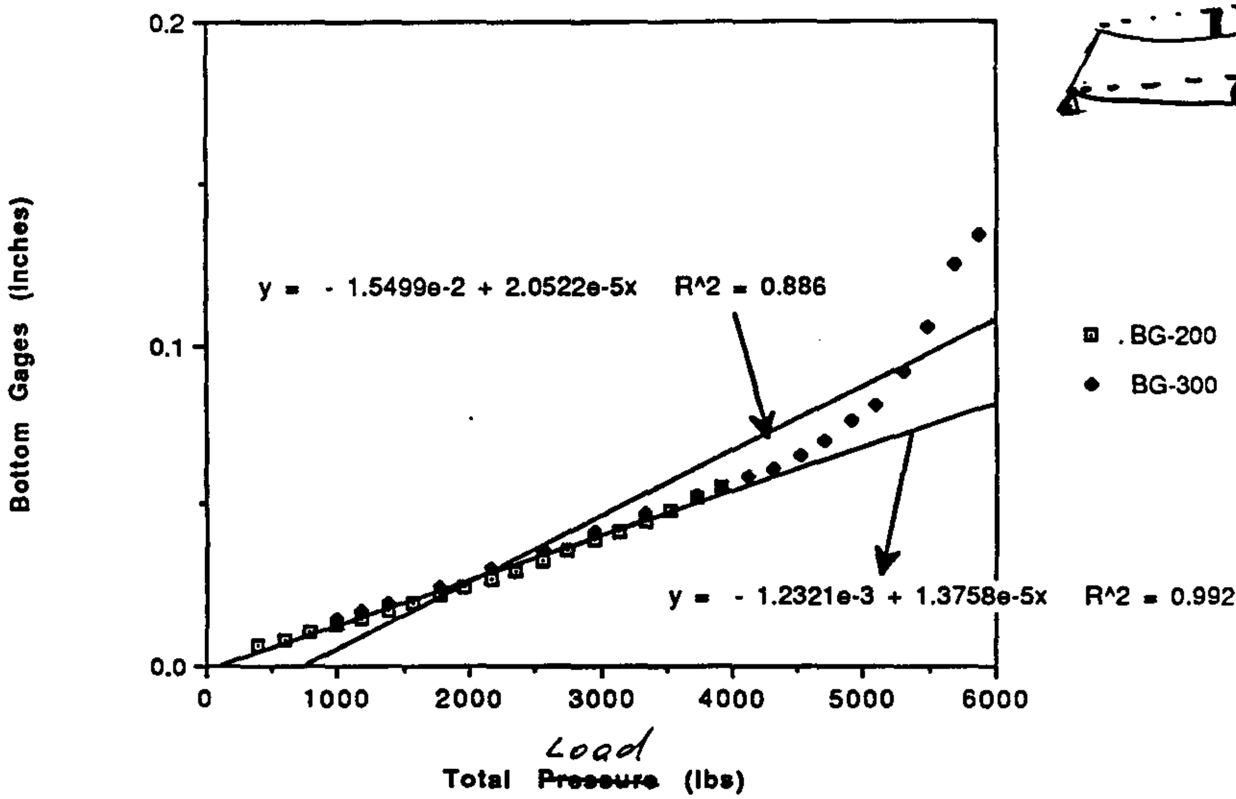


 June 14, 1993 DEFLECTIONS

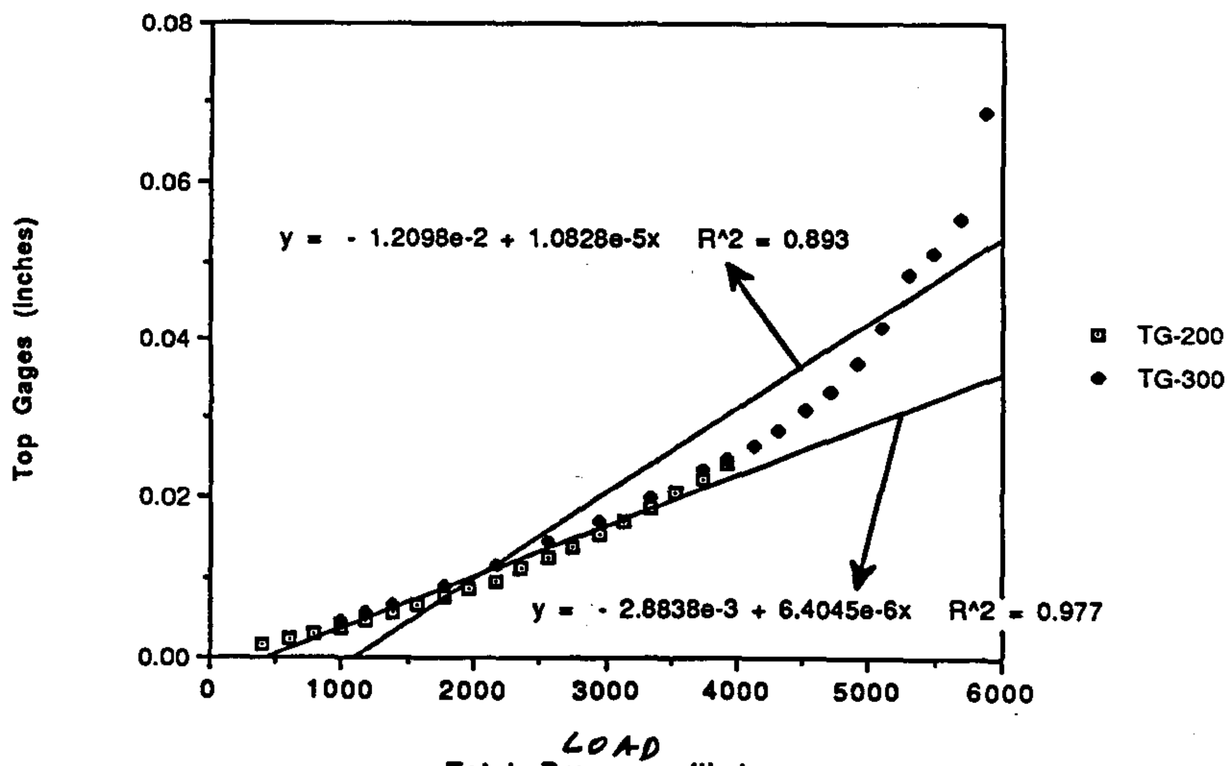
= 4000 lbs = 6000 lbs total

Comparison 200 PSI Run and 300 PSI Run
For Bottom Gage





Comparison 200 PSI Run and 300 PSI Run
For Top Gage

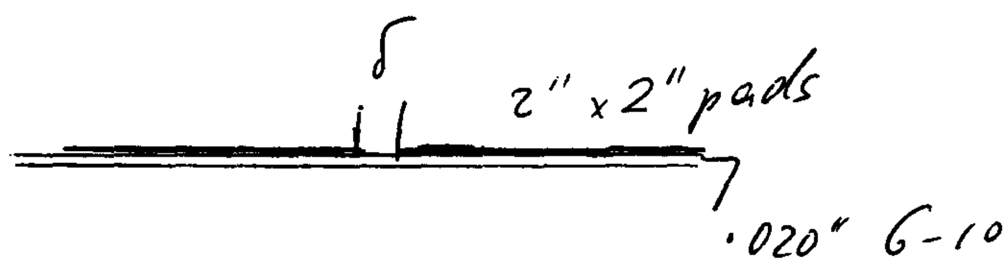


High Voltage breakdown tests

G-10 - along the surface

gap between pads	0.020	0.040	0.080	inches
First current range	2.2-3.2	2.7-4.6	4.0-5.8	kV
(average)	3.02	4.32	5.31	kV
Breakdown	2.7-3.2	4.3-4.9	5.7-6.1	kV

7 independent measurements each



Differential shrinkage between materials

From 293 K to 77 K.

MATERIAL	delx/x	
6061 Alu - 2024 Alu	1.0 E-4	+/- 30%
6061 Alu - (70-30 Brass)	3.2 E-4	+/- 20%
2024 Alu - (70-30 Brass)	2.8 E-4	+/- 20%
70-30 Brass - Copper	4.2 E-4	+/- 20%

Material on the left shrinks more

Presentation by:

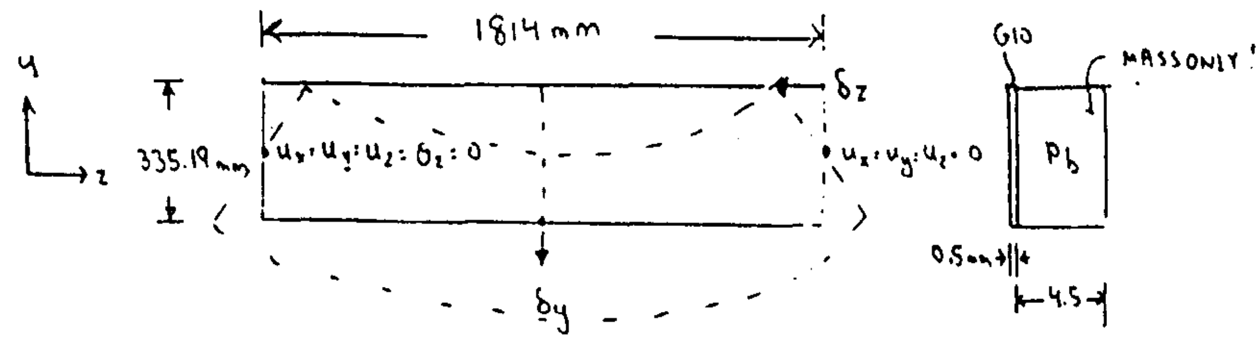
R. Hund

Barrel Hadronic Module Analysis and Mounting Update

June 22, 1993

R. Hund
Martin Marietta Astronautics
Science Systems

Barrel Inner Hadronic Module Individual Plate Analysis



Material	Density (g/cc)	Modulus (10^6 psi)	Poisson's Ratio
G10	1.70	4.4	0.30
Pb	11.30	2	0.44 ← NON STRUCTURAL $\rho_{eff} = 11.3\left(\frac{4.5}{.5}\right) = 101.7$ g/cc

CASE I: APPLY 1.0 G - y dir [$F_T = 303$ N (68.2 lbs)]

δ_y: 0.52 mm δ_z: 0.14 mm

σ_{von} = 49.7 MPa (7.2 ksi)   membrane σ_z: ±1044 PSI

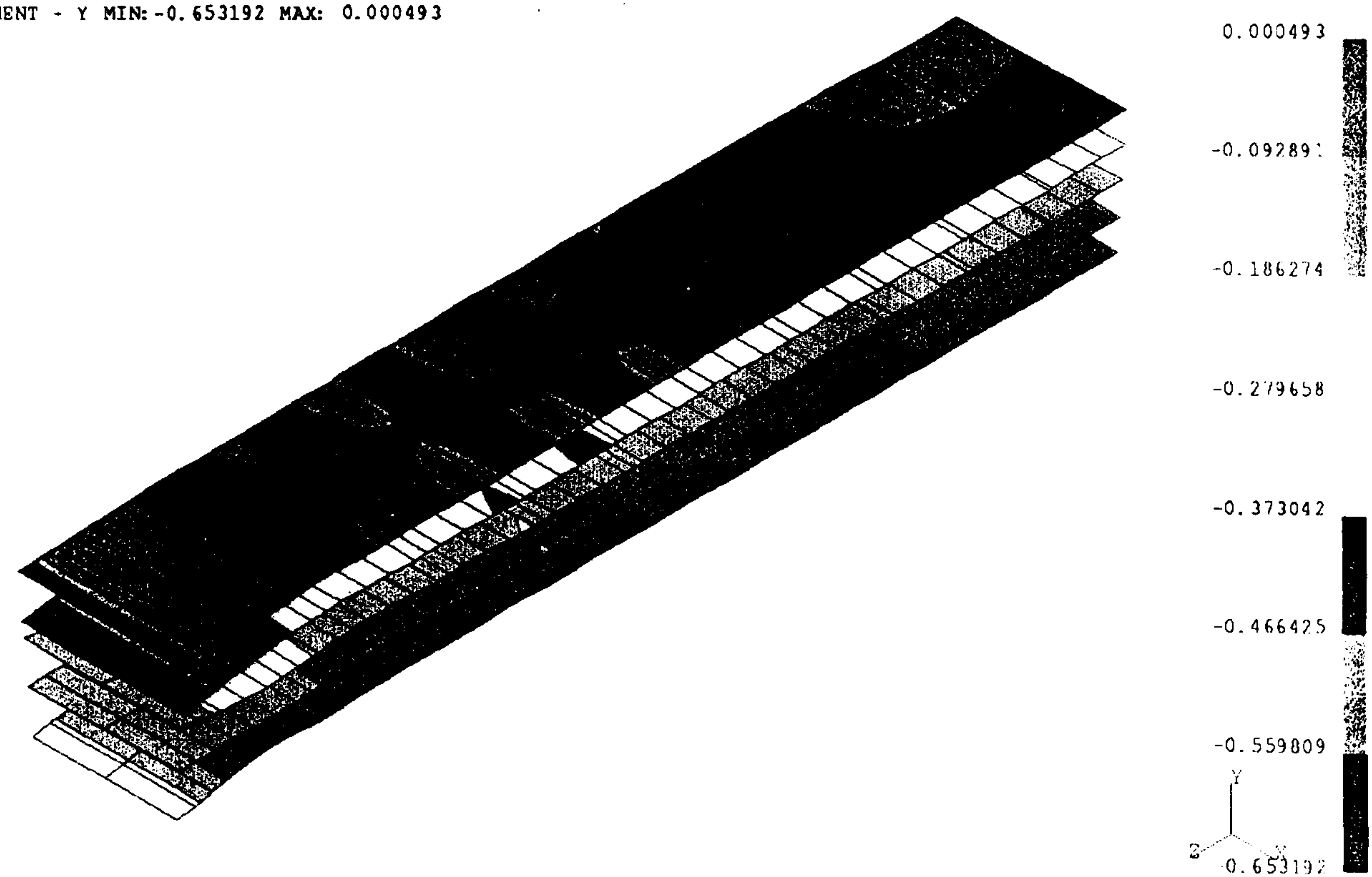
SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 23-MAY-93 18:48:49

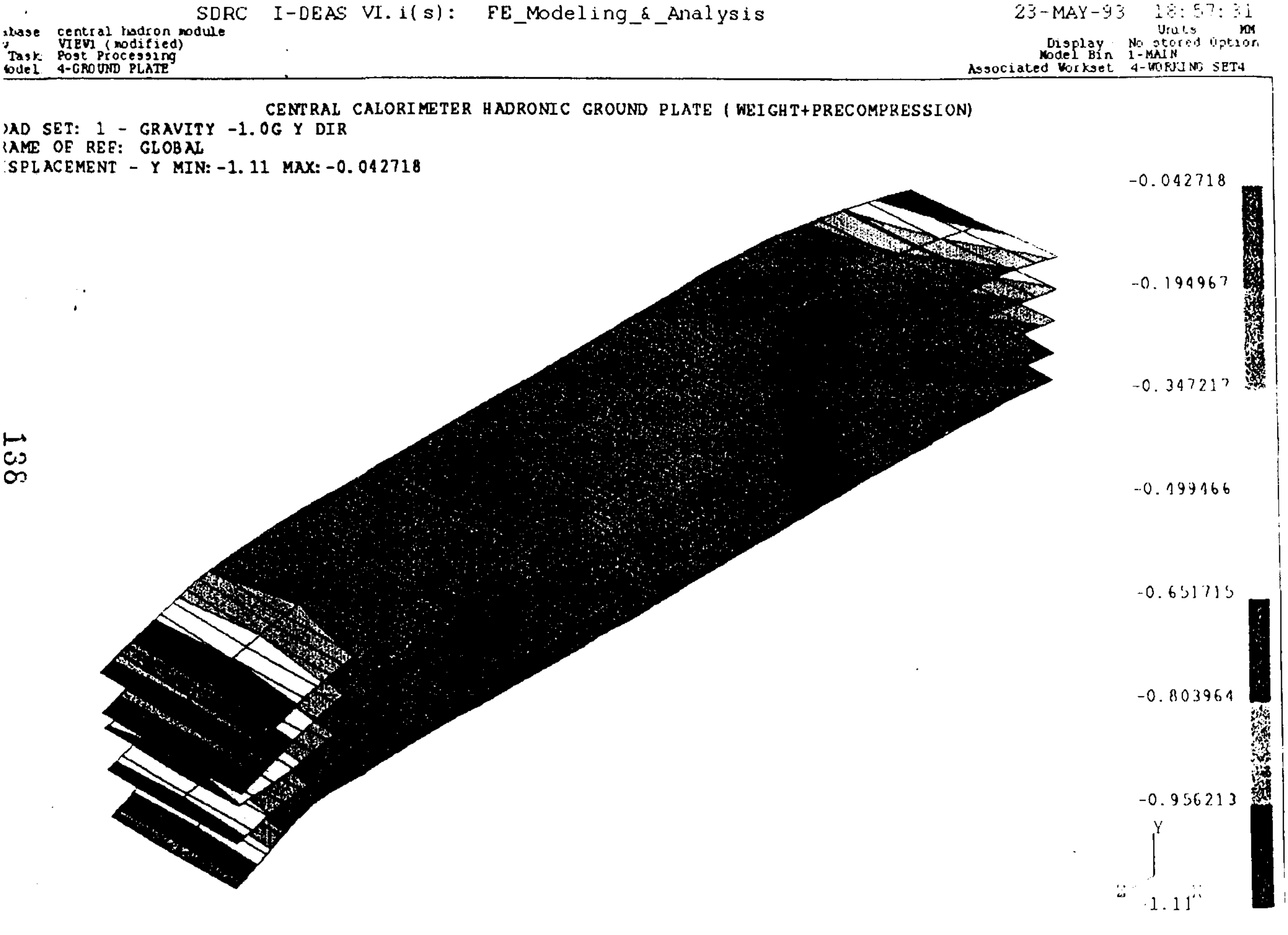
Base central hadron module
VIEW1 (modified)
Task Post Processing
del 4-GROUND PLATE

Units MM
Display No stored Option
Model Bin 1-MAIN
Associated Workset 4-WORKING SET4

CENTRAL CALORIMETER HADRONIC GROUND PLATES (PRECOMPRESSION - MODULE WEIGHT)

AD SET: 0 -
AME OF REF: GLOBAL
SPLACEMENT - Y MIN: -0.653192 MAX: 0.000493




SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis
23-MAY-93 18:57:31
abase central hadron module
VIEW1 (modified)
Task Post Processing
Model 4-GROUND PLATE
Units MM
Display No stored Option
Model Bin 1-MAIN
Associated Workset 4-WORKING SET4
CENTRAL CALORIMETER HADRONIC GROUND PLATE (WEIGHT+PRECOMPRESSION)
OAD SET: 1 - GRAVITY -1.0G Y DIR
RAME OF REF: GLOBAL
SPLACEMENT - Y MIN: -1.11 MAX: -0.042718
-0.042718
-0.194967
-0.347217
-0.499466
-0.651715
-0.803964
-0.956213
-1.11
Y

SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 23-MAY-9

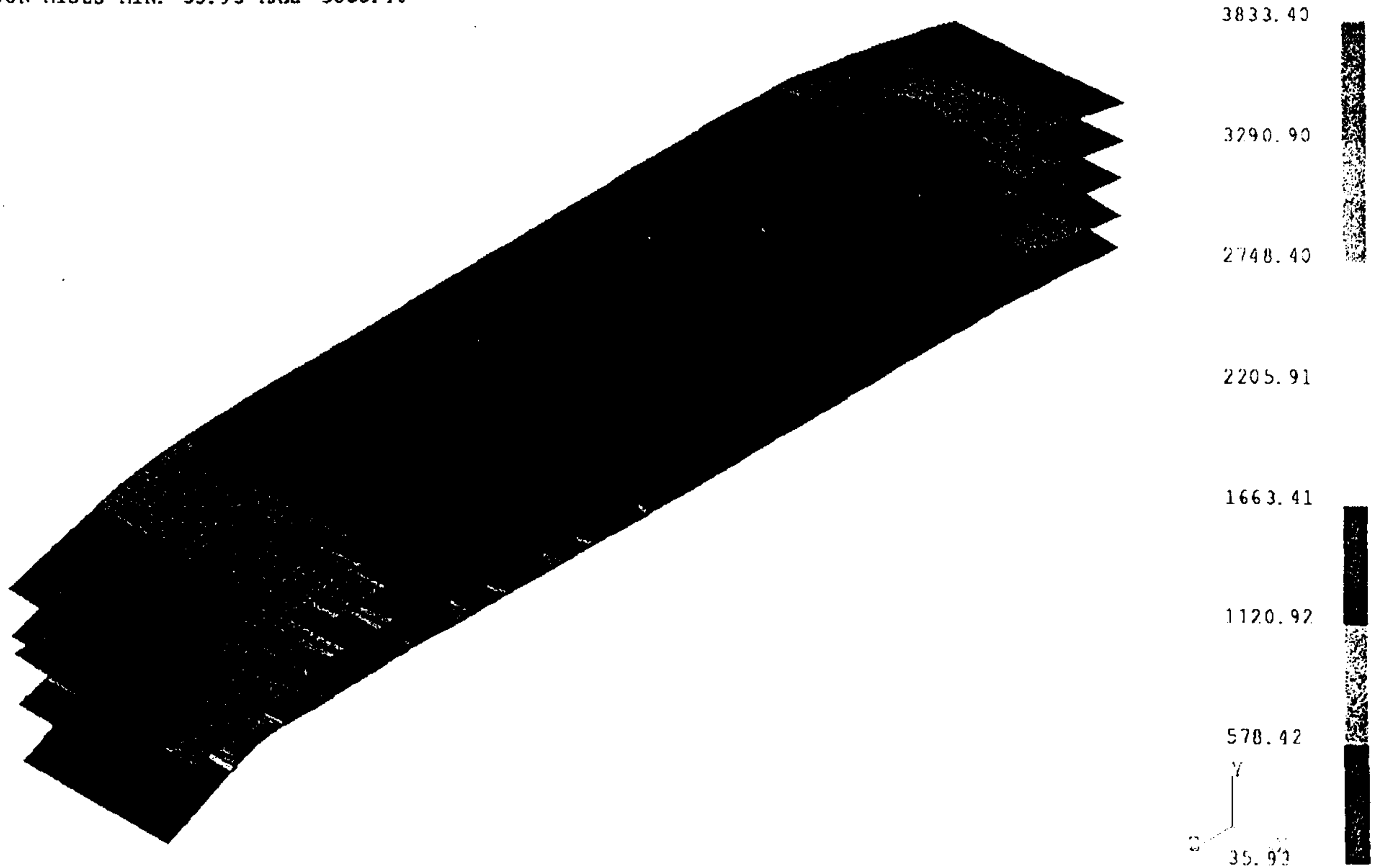
ase central hadron module
VIEW1 (modified)
ask Post Processing
del 4-GROUND PLATE

Display No stored Option
Model Bin 1-MAIN
Associated Workset 4-WORKING SETS

CENTRAL CALORIMETER HADRONIC GROUND PLATE (WEIGHT + PRECOMPRESSION)

AD SET: 1 - GRAVITY -1.0G Y DIR
AME OF REF: GLOBAL
RESS - VON MISES MIN: 35.93 MAX: 3833.40

SHELL SURFACE: TOP



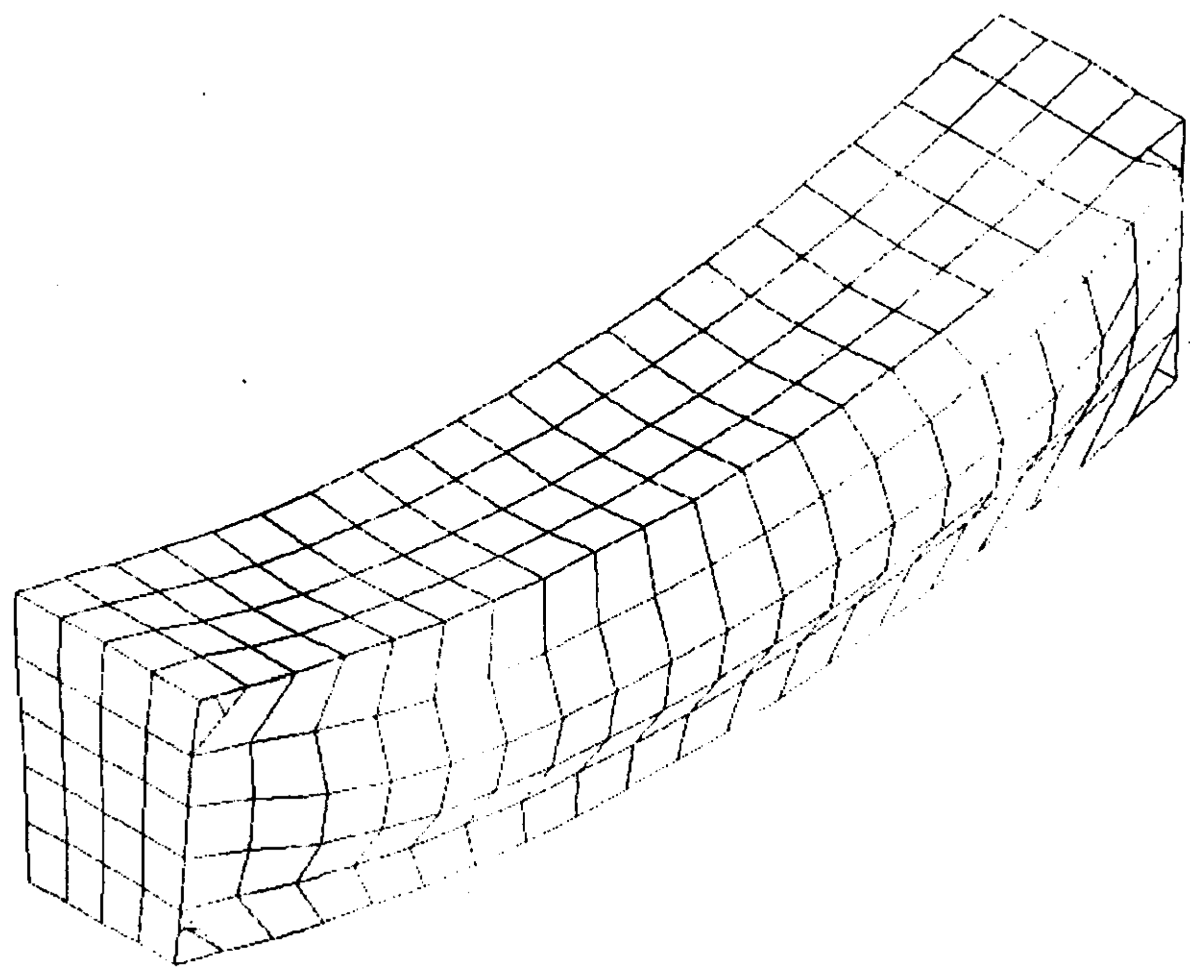
SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 14-MAY-93 15:1

Database: central hadron module
View : No stored View
Task: Post Processing
Model: 2-HADRON MODULE

Units
Display : No store
Model Bin: 1-MAIN
Associated Workset: 2-WORK

central hadron module

LOAD SET: 2 - GRAVITY -Y DIR
DISPLACEMENT - NORMAL MIN: 0.00 MAX: 0.347293



Barrel Inner Hadronic Module Box Structure Analysis (BOX STRESSES)

CASE 1, ~~LOAD~~: APPLY 1.0 G - Y DIR ($\frac{1}{2}$ WEIGHT TOP & BOT)

MEMBER	δ_y (mm)	$\sigma_{x,y}$ (PSI)	MEMBRANE σ_z (PSI)	$\tau_{xy,yz}$ (PSI)	TOTAL σ_{von} (PSI)
TOP	0.33	180	249	56	648
BOT	0.35	80	448	77	862
SIDE	0.30	685/-659	641/-464	$\boxed{\pm 2910}$	5044
SIDE	δ_x: 0.15	σ_x	σ_y		
FRONT/BACK	0.009	335	926	145	1452

CASE 2, ~~LOAD~~: APPLY 1.0G - Y DIR (WEIGHT OF MODULE AT BOT)

MEMBER	δ_y (mm)	$\sigma_{x,y}$ (PSI)	MEMBRANE σ_z (PSI)	$\tau_{xy,yz}$ (PSI)	TOTAL σ_{von} (PSI)
TOP	0.3	189	257	59	702
BOT	0.41	69	434	73	1545
SIDE	0.3	1403	875/-223	$\boxed{\pm 2919}$	5063
SIDE	δ_x: 0.11	σ_x	σ_y		
FRONT/BACK		351	951	149	1330

Barrel Inner Hadronic Module - Fastener Spacing

SHEAR CRITICAL $> 4d < 8d$

FASTENER SIZE (mm)	SHEAR AREA (mm^2)	SPACING BETWEEN (mm)	NUMBER OF FASTENERS	FACTOR OF SAFETY
3.0	4.51	12.1	20	1.92
4.0	7.81	16.93	14	2.33

BEARING CRITICAL

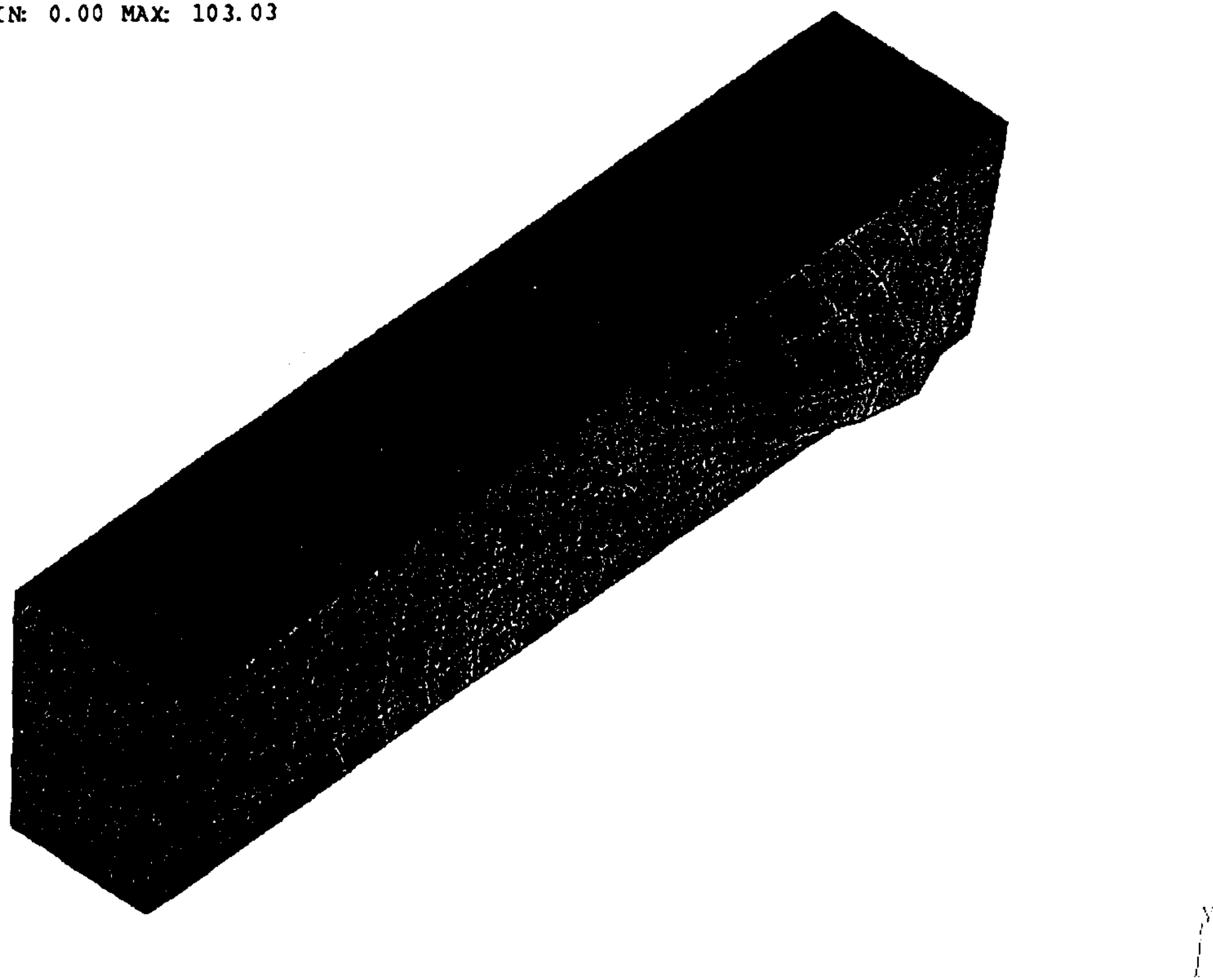
FASTENER SIZE (mm)	THICKNESS (mm)	SPACING BETWEEN (mm)	NUMBER OF FASTENERS	FACTOR OF SAFETY
3.0	0.50	12.1	20	1.59
3.0	1.55	12.8	20	4.94
4.0	0.50	16.93	16	1.49
4.0	1.55	16.93	16	4.67

SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 23-MAY-9

base central hadron module
VIEW1 (modified)
Task Post Processing
Model 2-HADRON MODULE

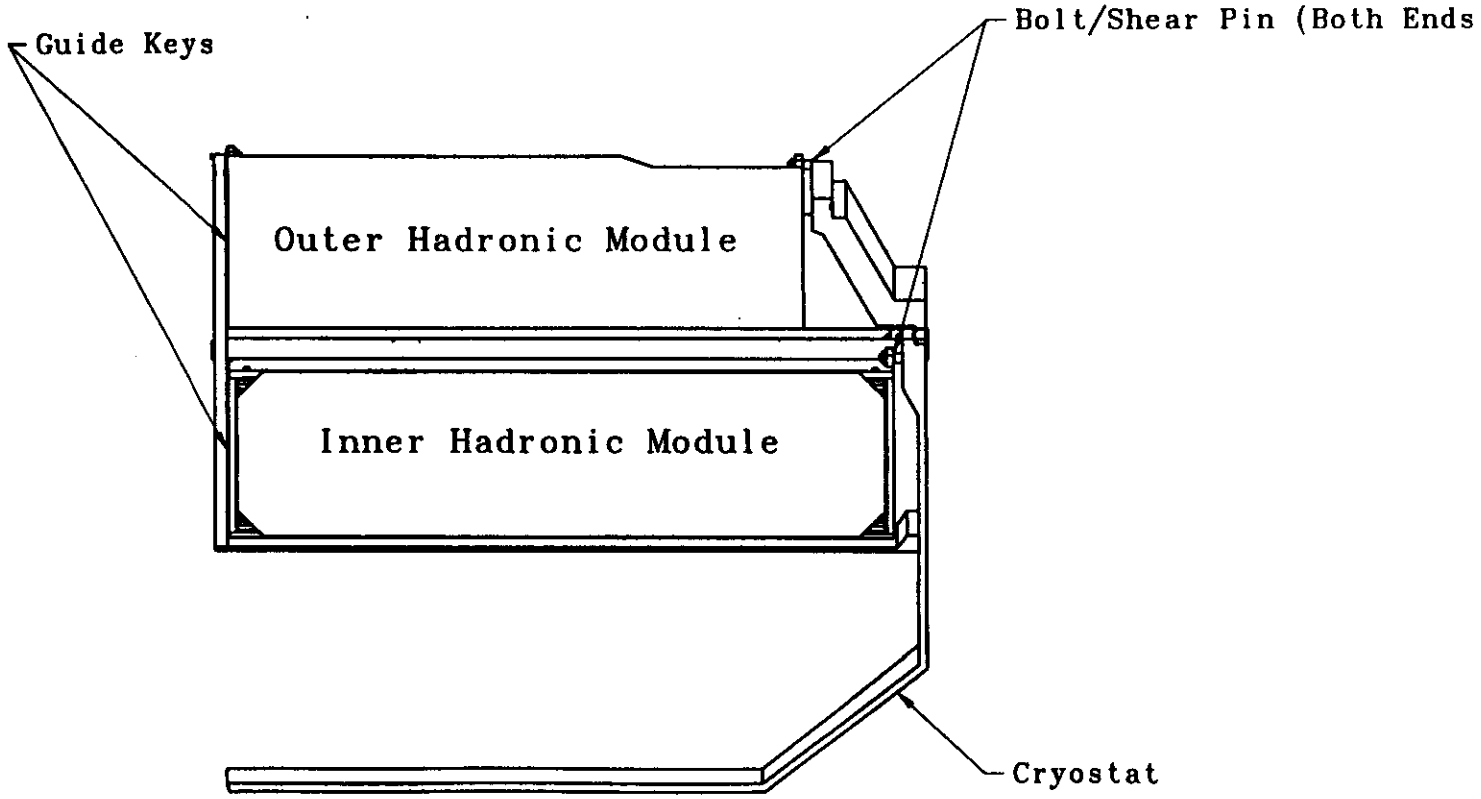
Display
Model Bin 1-MAIN
Associated Workset 2-WORKING SET

CENTRAL CALORIMETER HADRONIC MODULE 1.0G -Y DIRECTION
DE: 1 BUCKLING LOAD FACTOR: -0.10489514
SPLACEMENT - NORMAL MIN: 0.00 MAX: 103.03

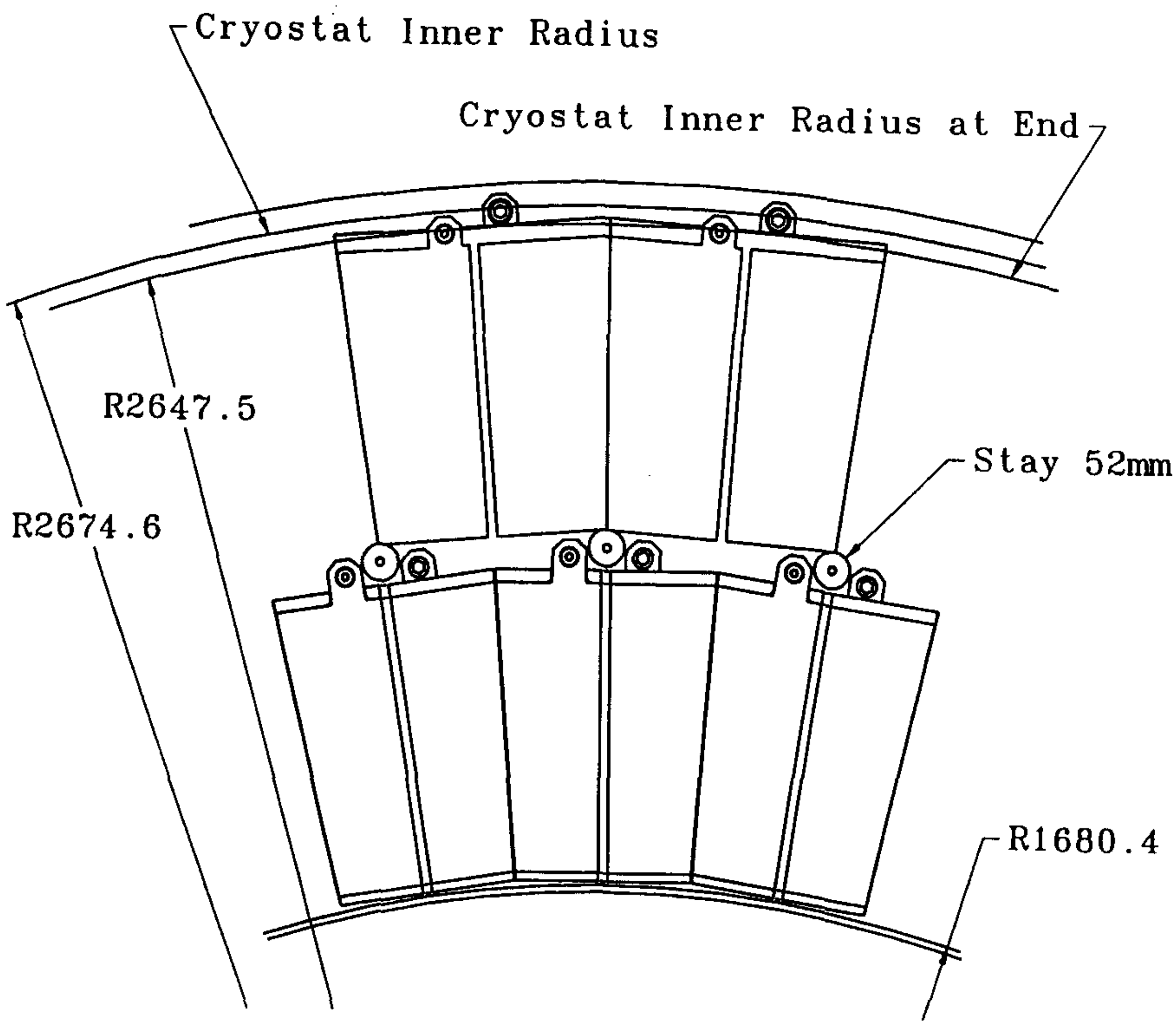


140

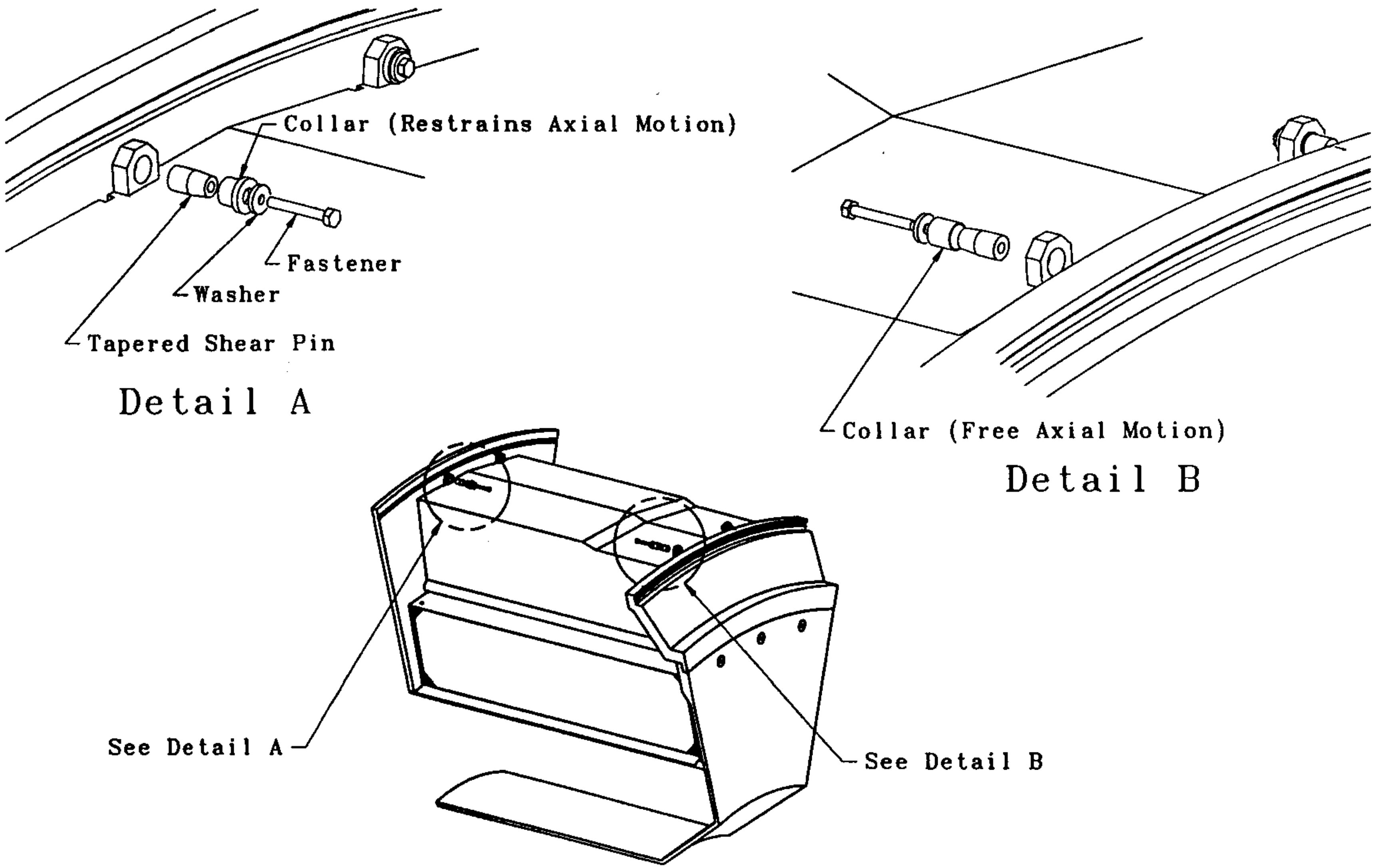
Barrel Hadronic Modules - Cryostat Interfaces



Barrel Hadronic Modules - Envelopes

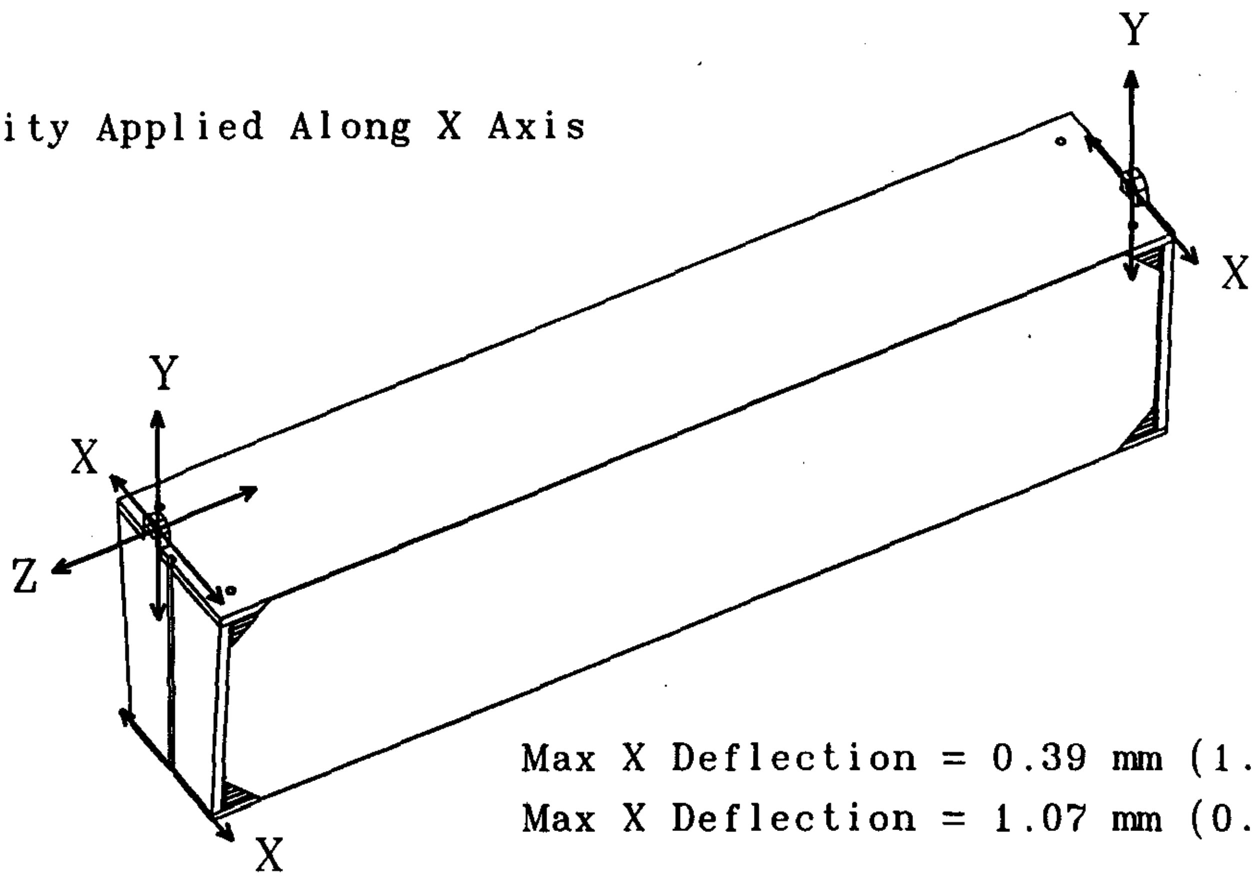


Barrel Hadronic Modules - Attachment to Cryostat



Barrel Hadronic Module - Three Point Attachment

Gravity Applied Along X Axis



Max X Deflection = 0.39 mm (1.5 mm Skin)

Max X Deflection = 1.07 mm (0.5 mm Skin)

Barrel Hadron Modules - Conclusions

- Individual Plates and Internal Plate Structure Has Acceptable Stresses and Deflections
  (Creep in Lead Due to Weight and Module Compression Not Looked At)

- Module As a Box Structure Has Acceptable Stresses and Deflections

- Module with .020 Inch Thick Side Sheets and No Sheet Pretension Buckles (Side Sheets) due to Shear Stresses

  -Increasing Sheet Thickness to .062 Inches Eliminates Buckling Problem

  -Pretension of Sheets Can Potentially Eliminate Buckling Problem but Pretensioning Technique and Consistency of Pretension Must Be Proven with Testing and Analysis

- Side Plate Fasteners (3 mm) and Fastener Spacing (12 mm) is Acceptable

- Interfaces with Cryostat and Potential Interferences need to be Worked

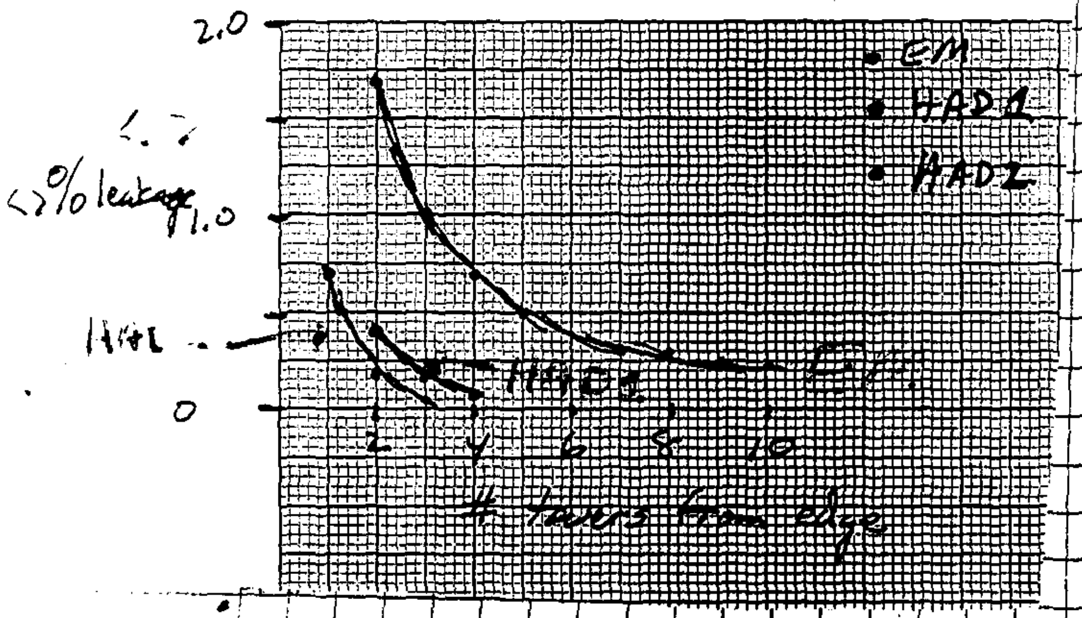
- Three Point Attachment Requires Further Evaluation

Presentation by:

H. Gordon

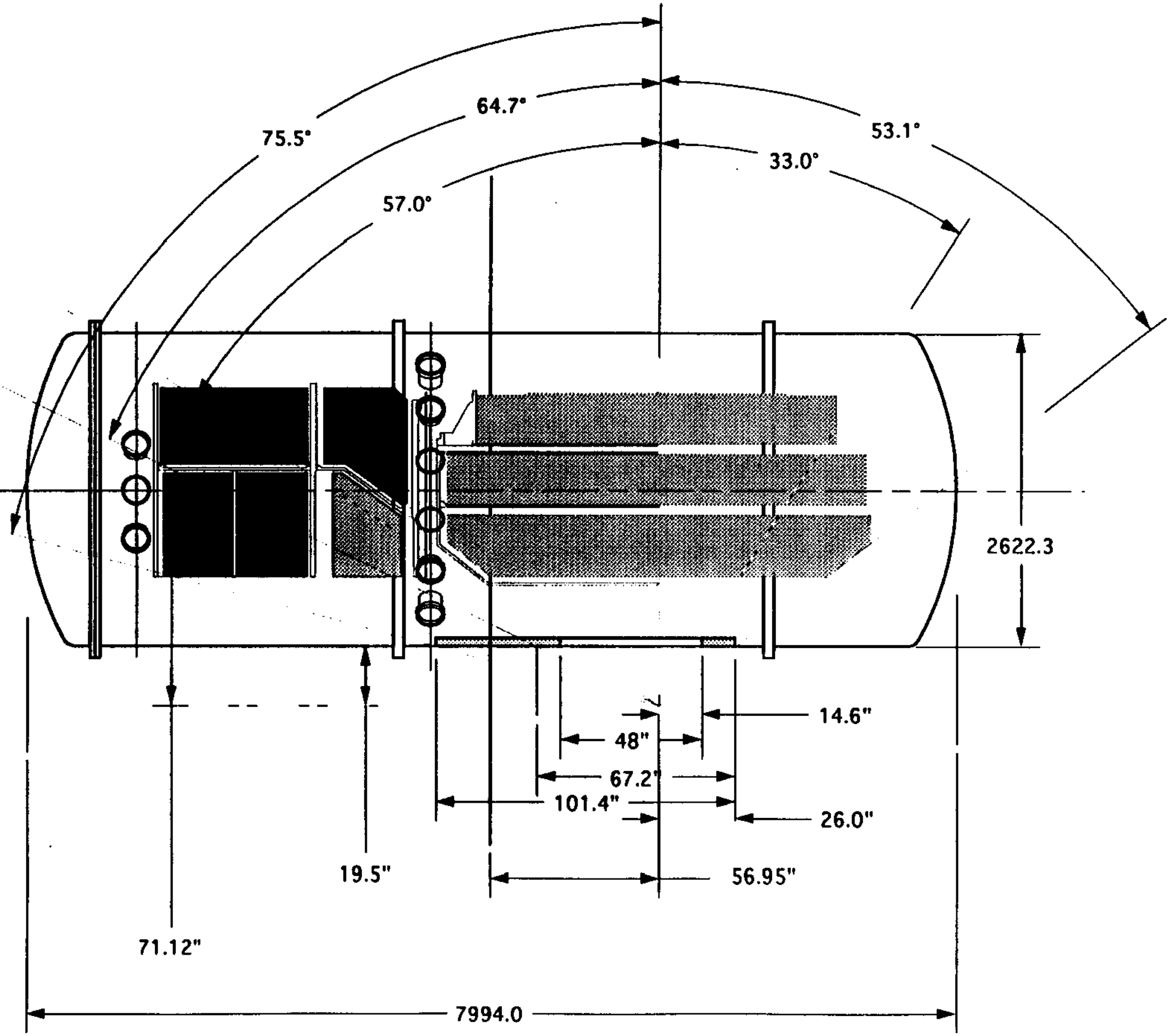
Page No.__

6/11/93 From Mike Shupe's simulations of 500 GeV JET



Presentation by:

P. Mockett



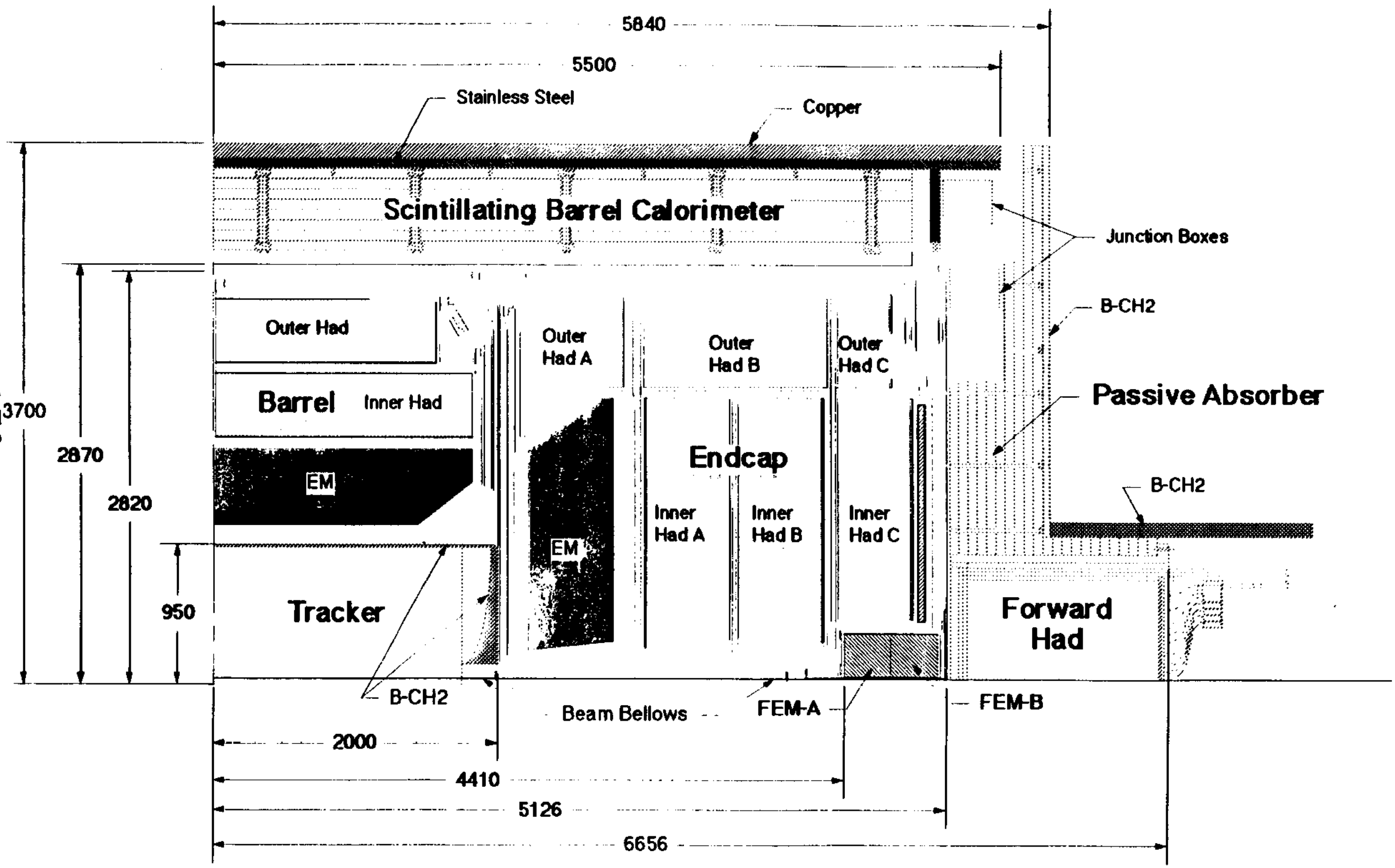
GEM Test Dewar with barrel and endcap calorimeter modules
-Plan view

6/14/93
Univ. of Washington
DAF

All dimensions in millimeters unless otherwise noted

Noble Liquid Calorimeter Overview

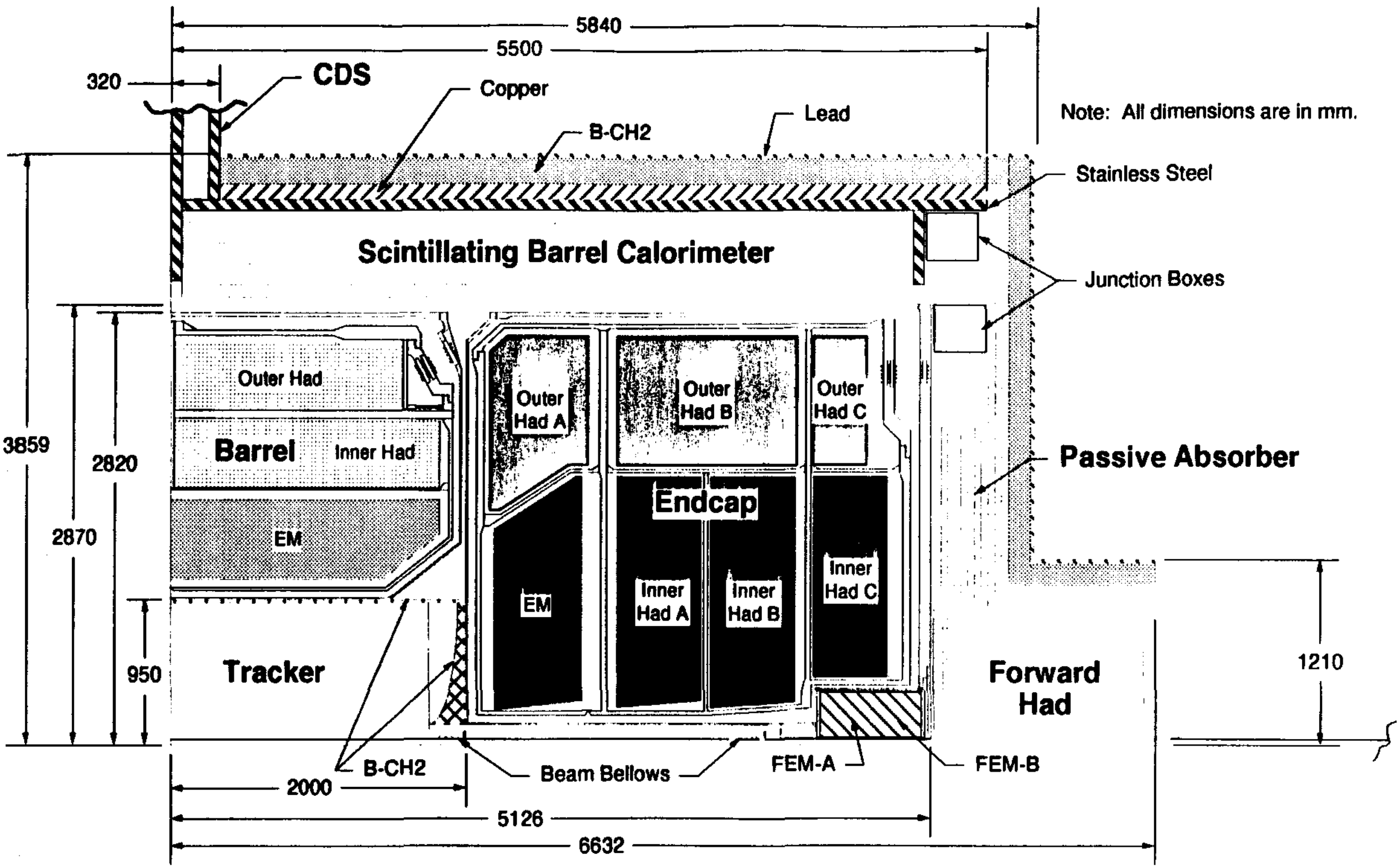
All dimensions are in mm.



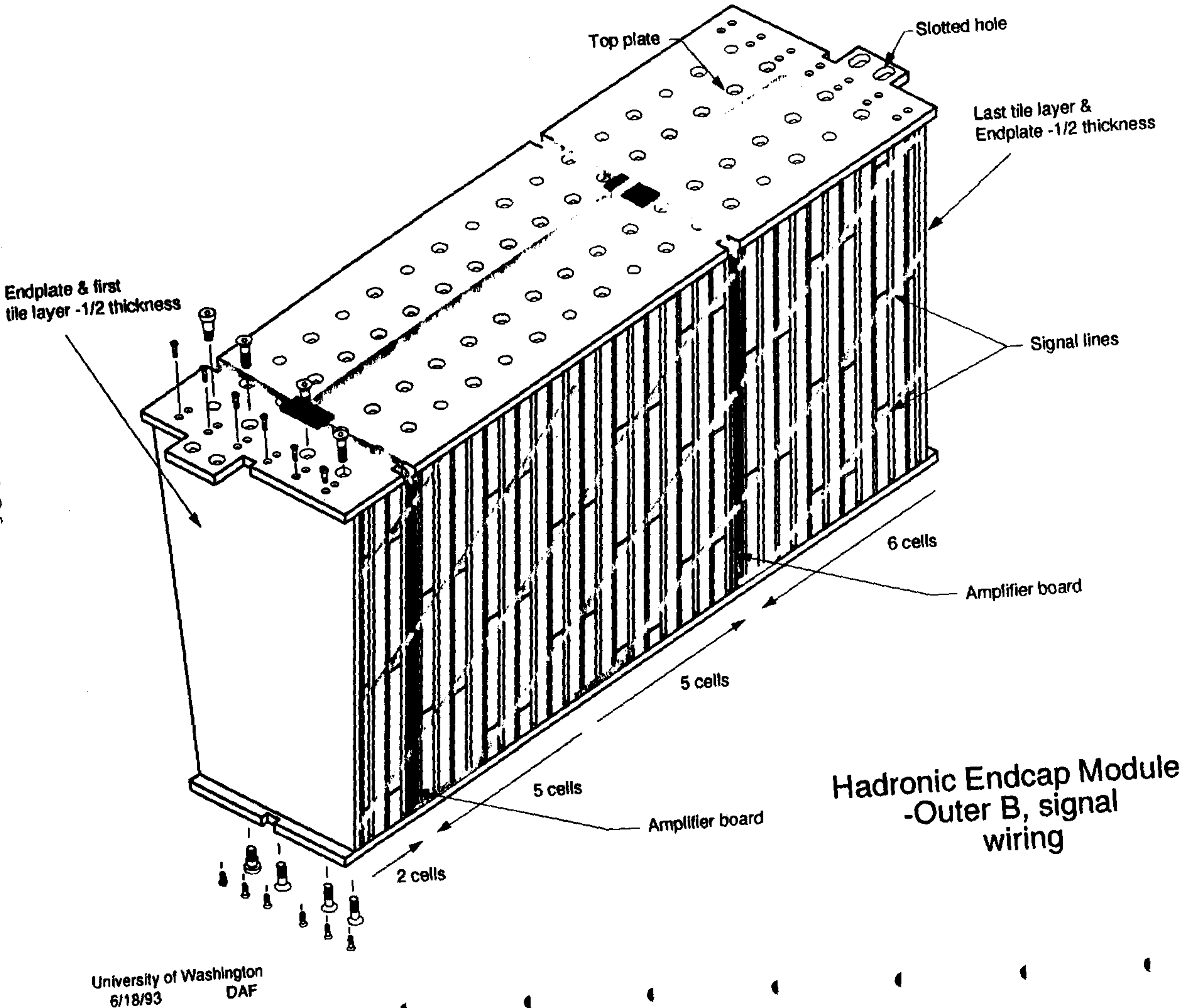
Barnstable: Overview 930426
3/15/93BarStk.Cold.Cu/Warm.Cu
3/15/93NdcpStk.Cold

Presentation by:

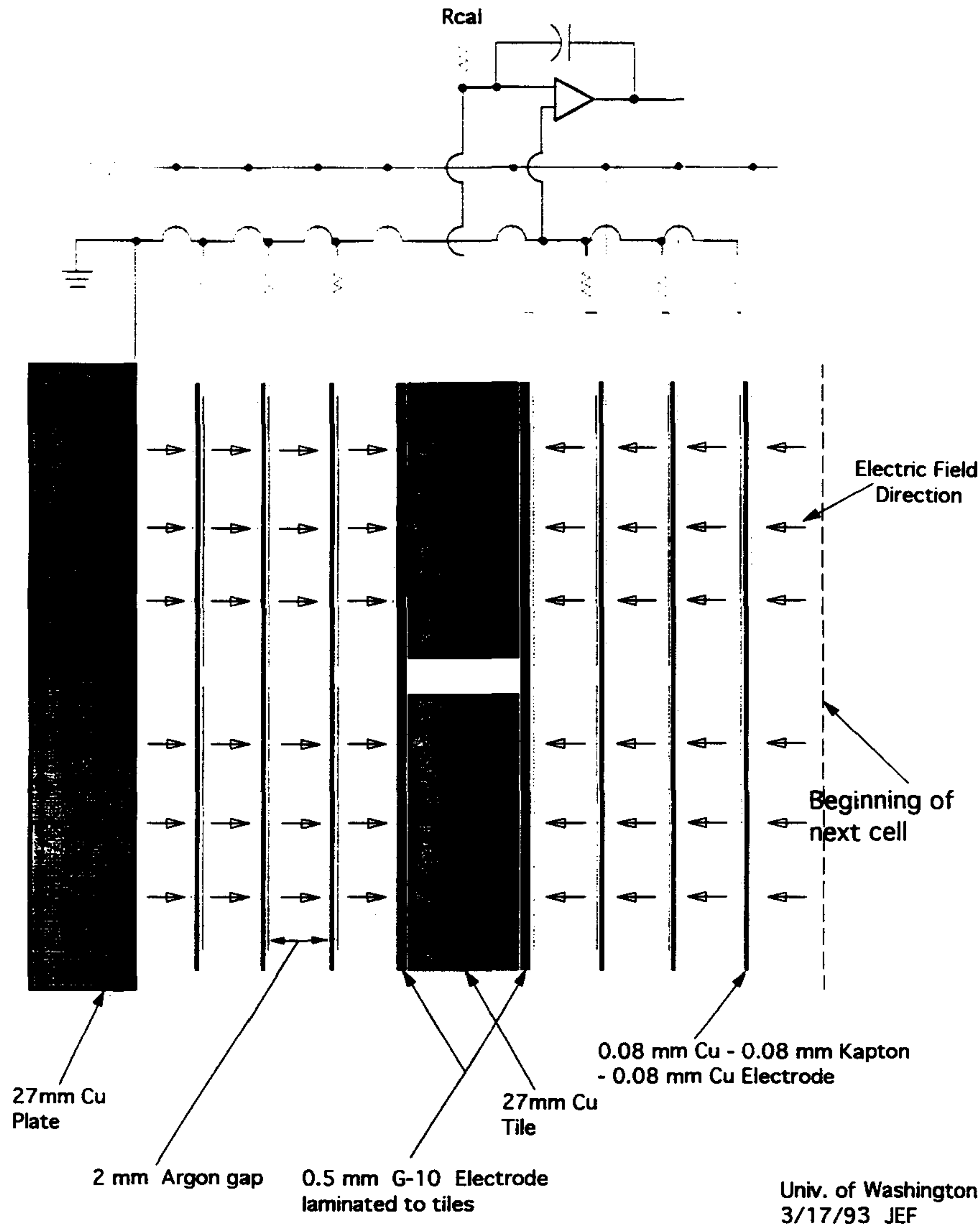
D. Forbush



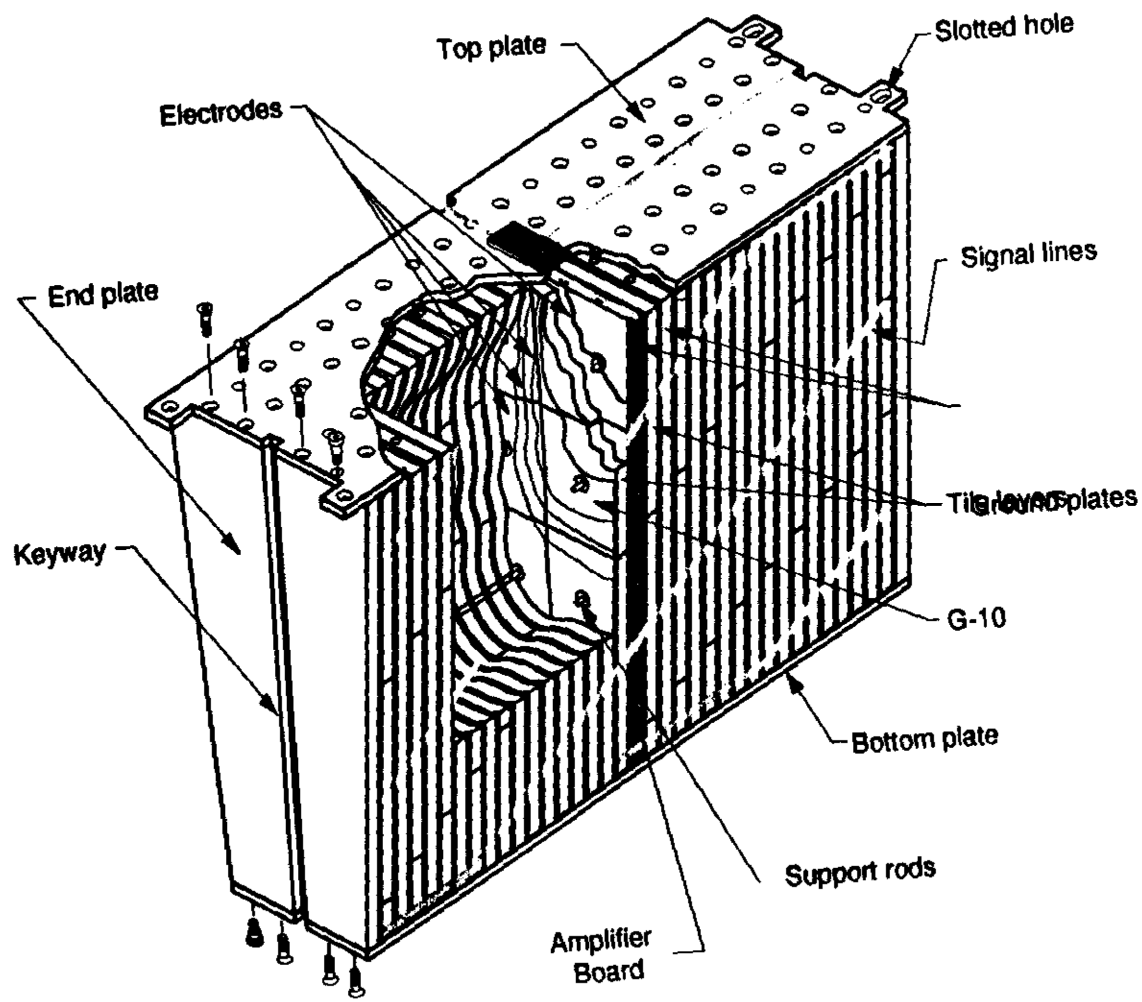
Barnstable: TDR Overview:930302
TDRBarrel Cold/Warm TDRNdcp.stckCld

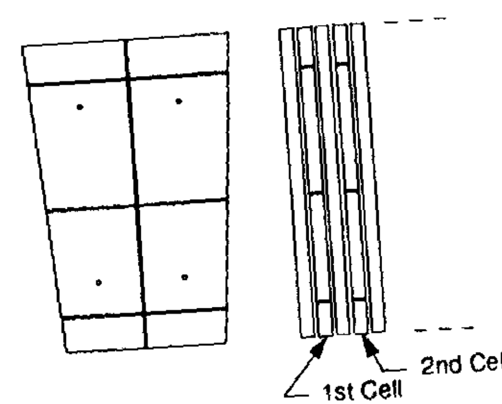

Top plate
Slotted hole
Last tile layer &
Endplate -1/2 thickness
Endplate & first
tile layer -1/2 thickness
Signal lines
6 cells
Amplifier board
5 cells
5 cells
Amplifier board
2 cells
Hadronic Endcap Module
-Outer B, signal
wiring
University of Washington
6/18/93
DAF

ELECTROSTATIC TRANSFORMER CONFIGURATION

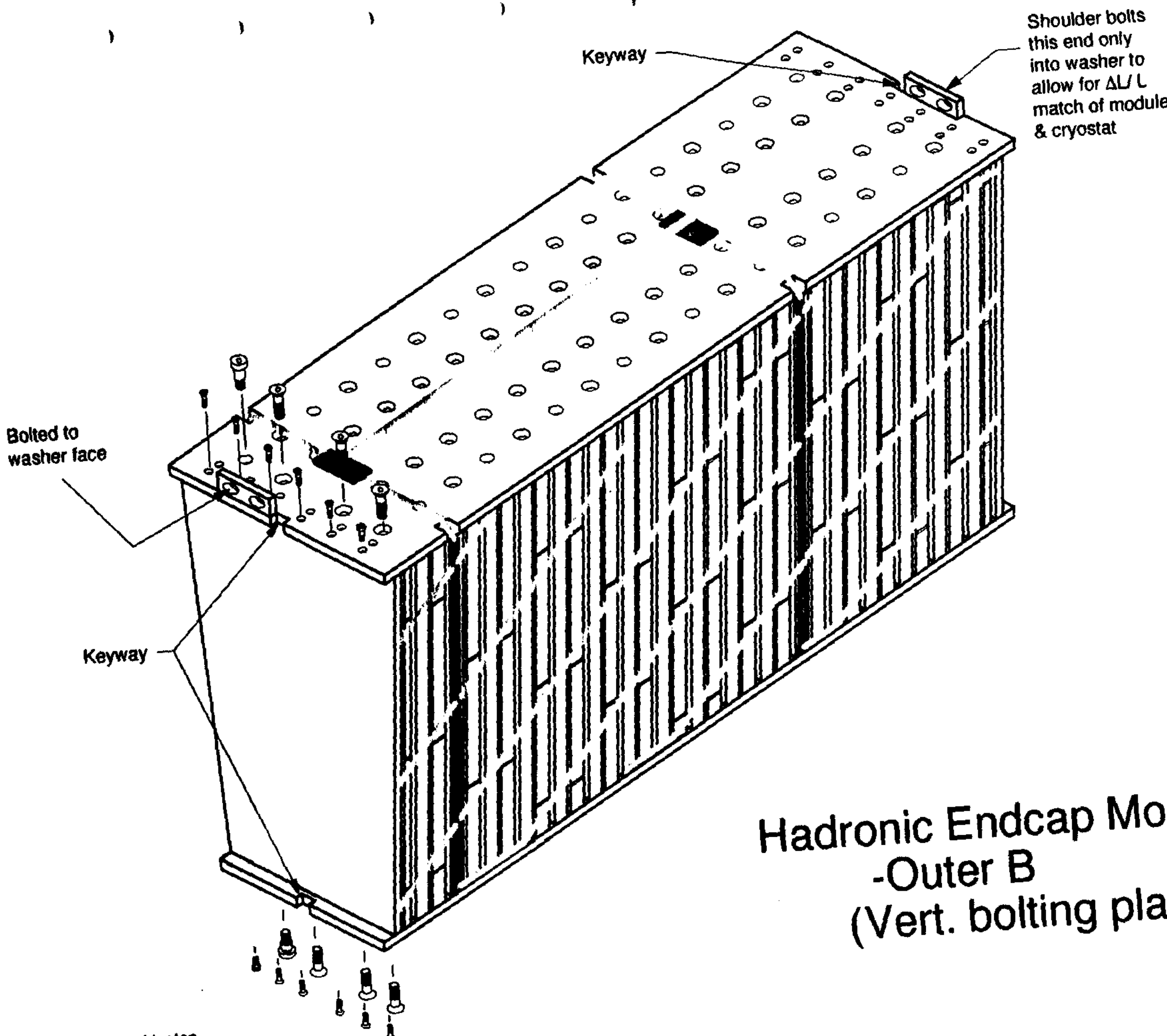


Hadronic Endcap Module





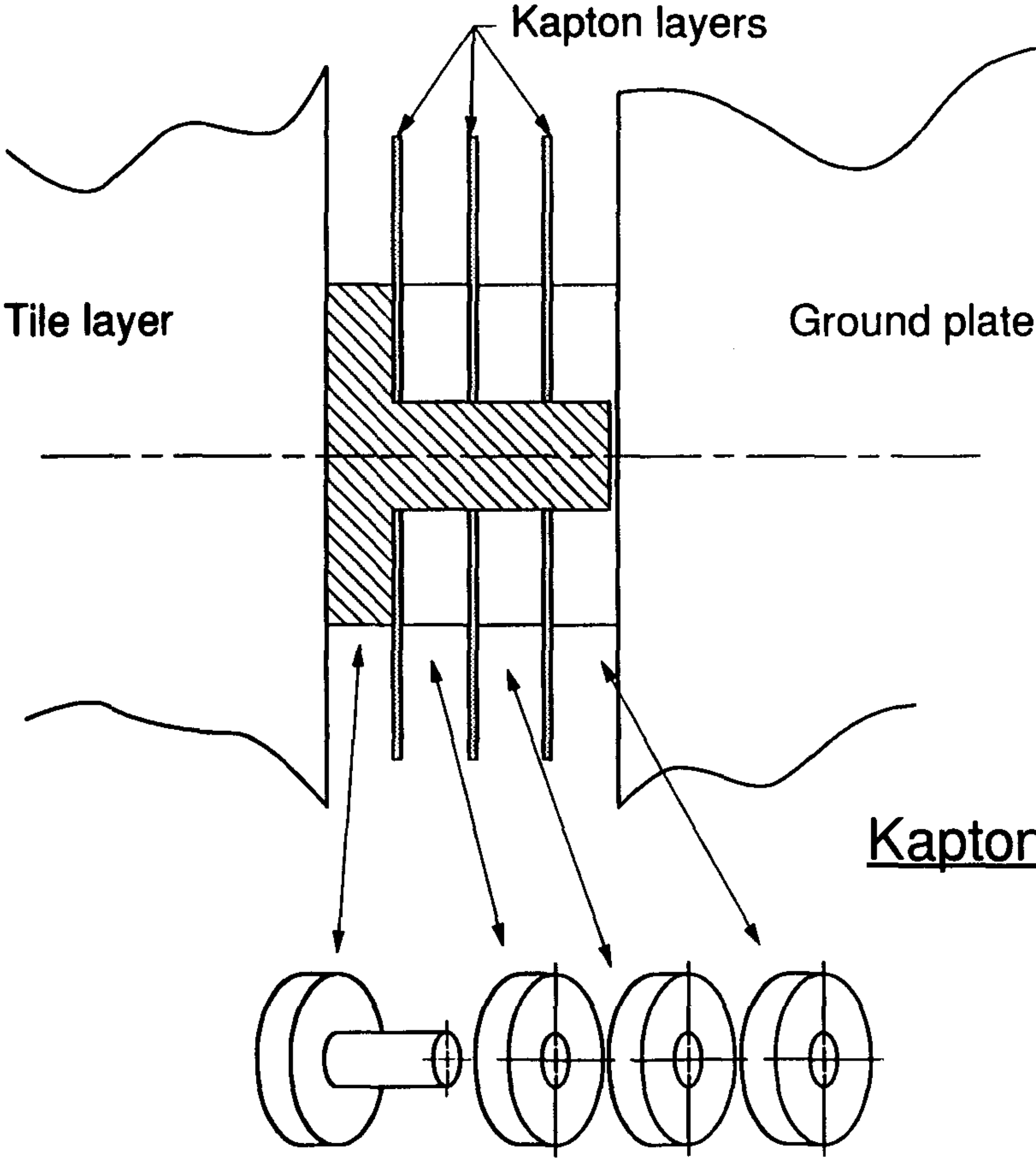
University of Washington
5/6/93 DAF



Hadronic Endcap Module
-Outer B
(Vert. bolting plates)

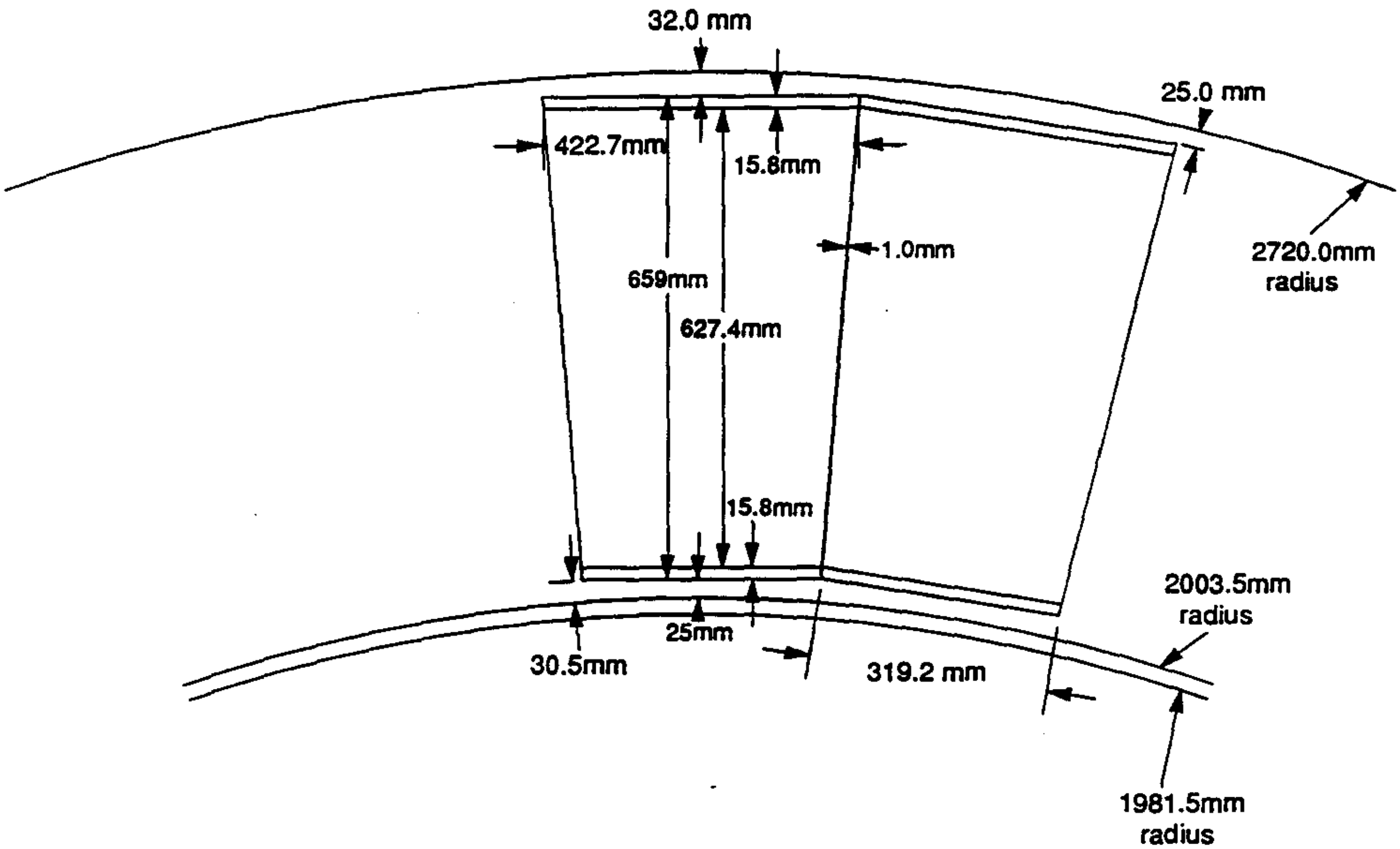
University of Washington
6/18/93 DAF

Kapton Layer Spacers



University of Washington
5/6/93 DAF

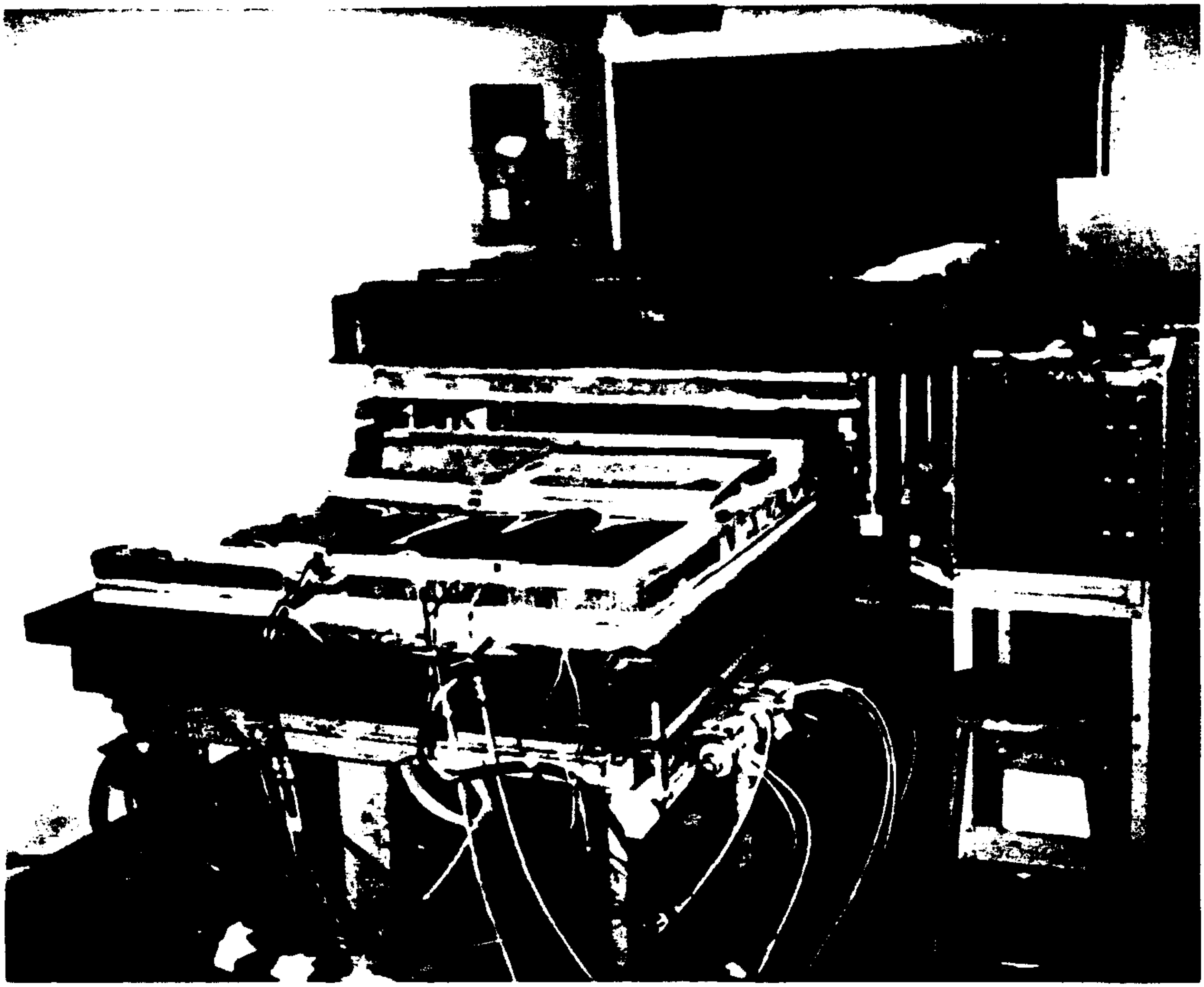
Frontal view of Outer Hadron B

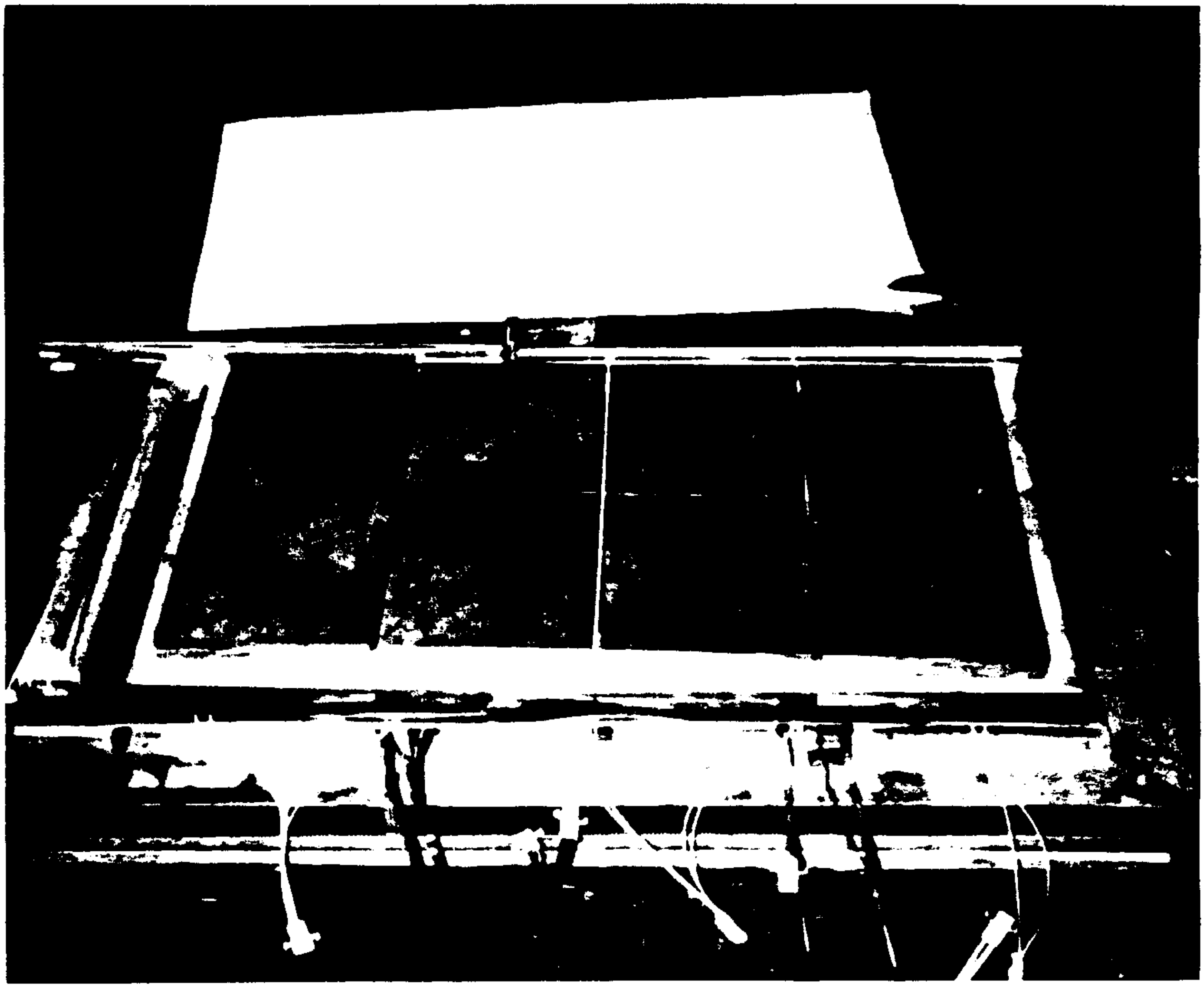


JEF
6/1//93

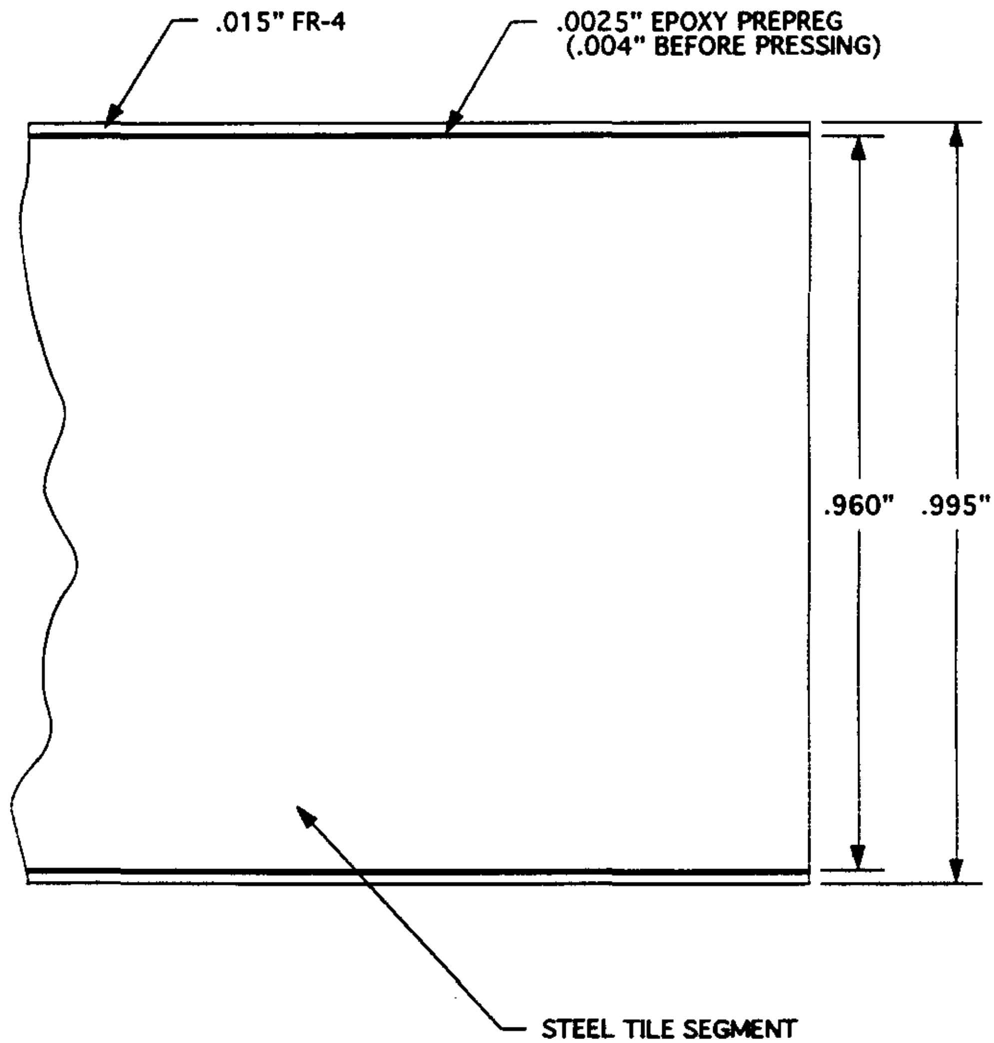
Presentation by:

P. Allison

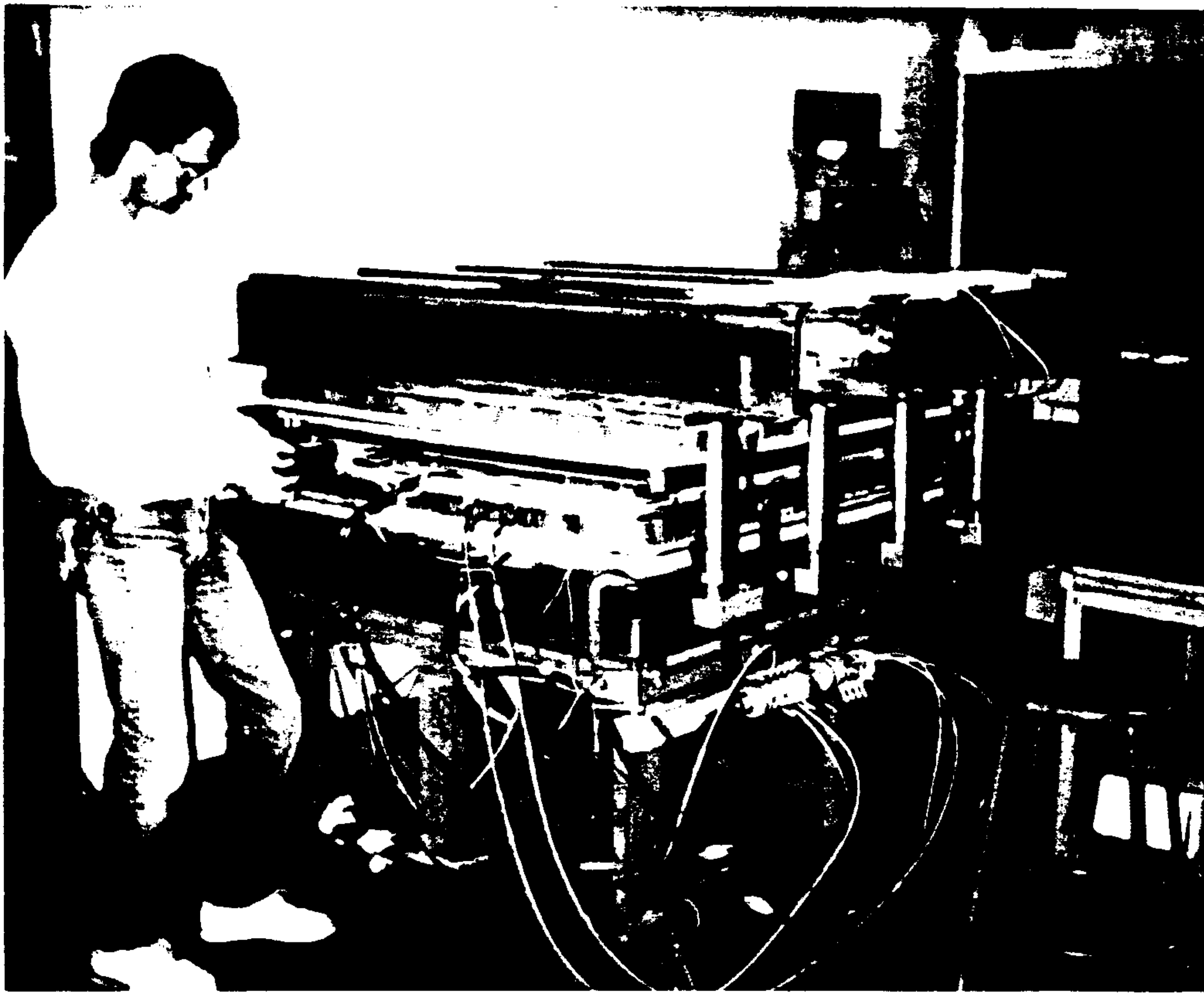


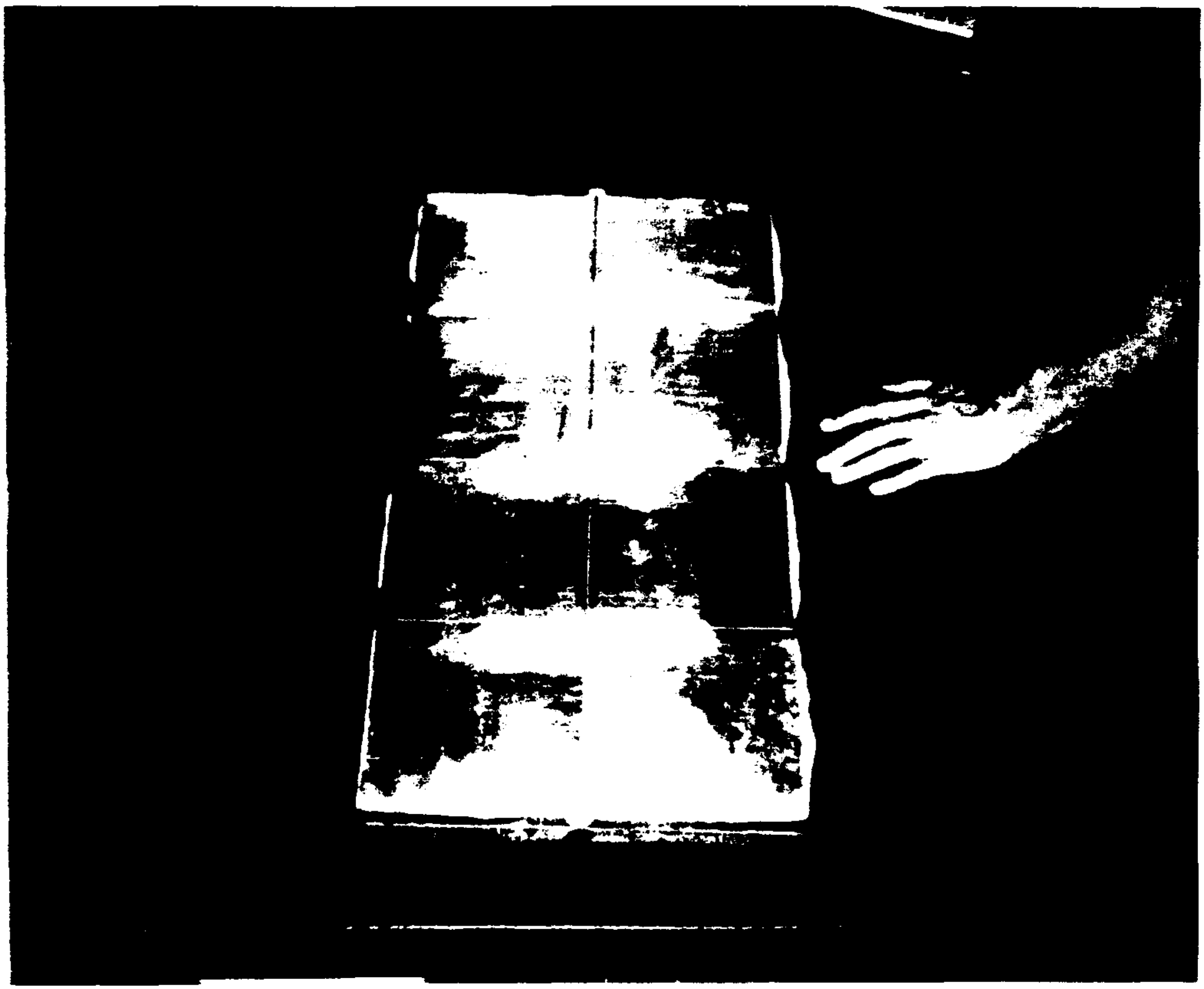


TILE SEGMENT - SIDE VIEW

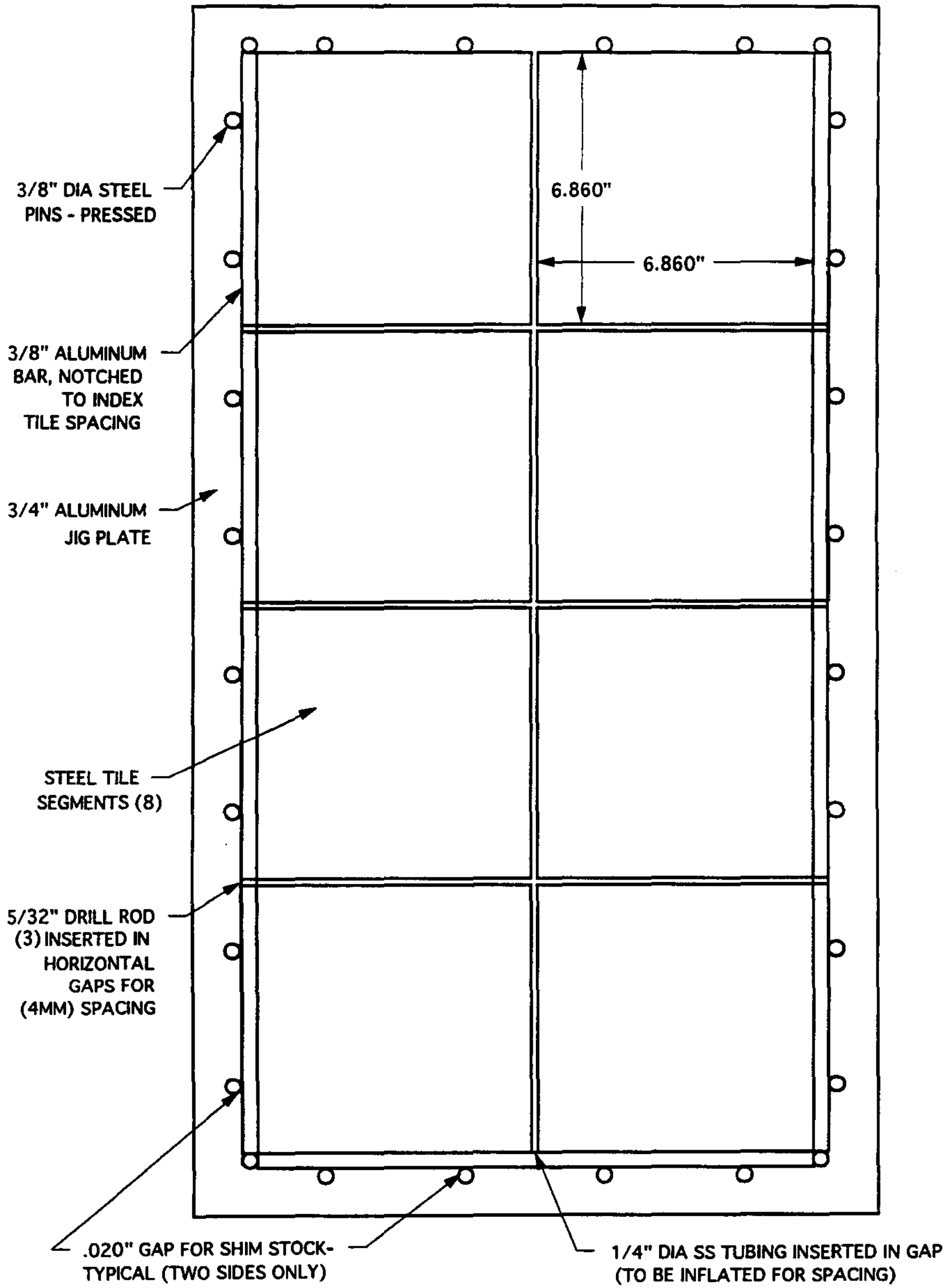


PEA
6/15/93



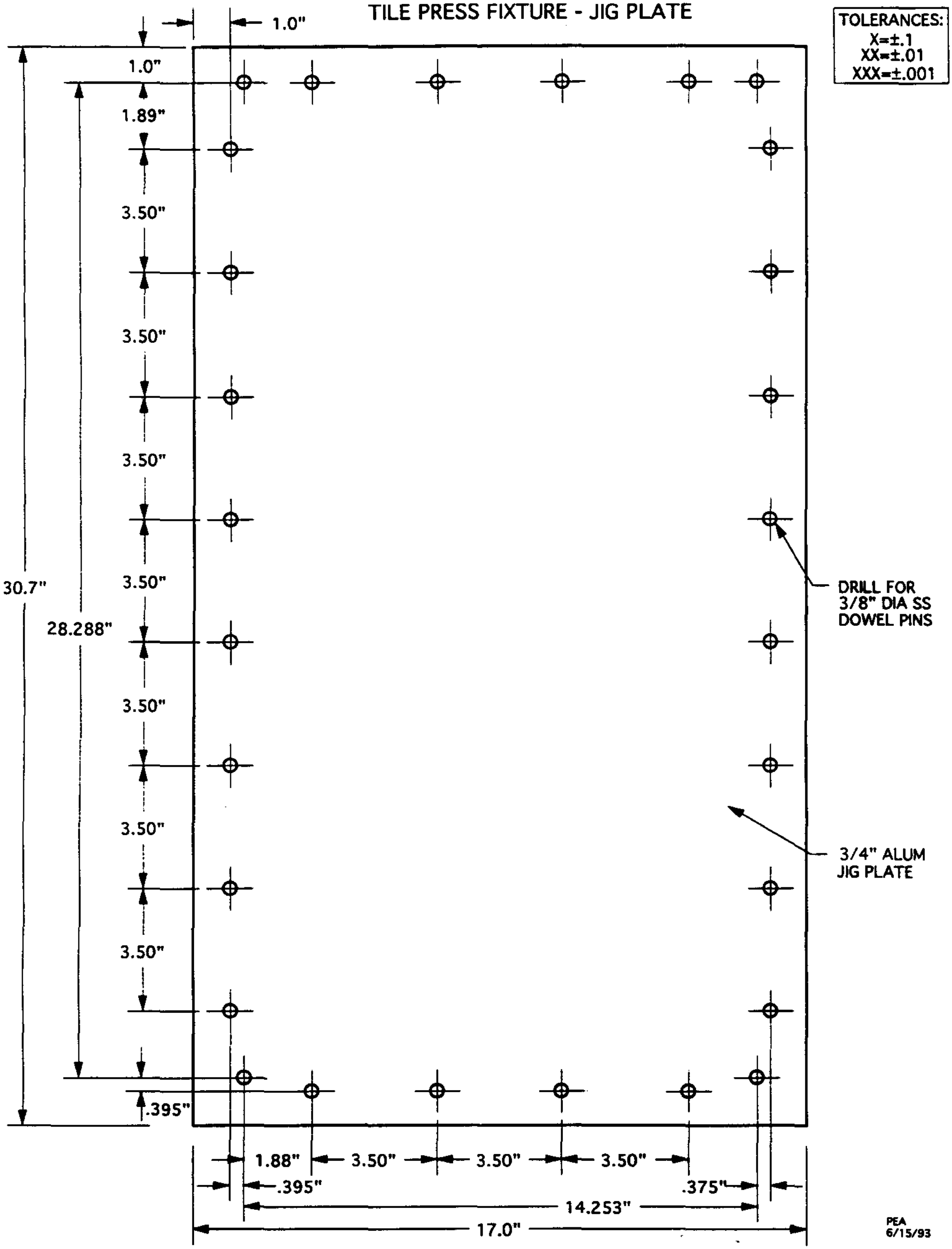


TILE PRESS FIXTURE - ASSEMBLY (TOP PLATE AND FR-4 NOT SHOWN)

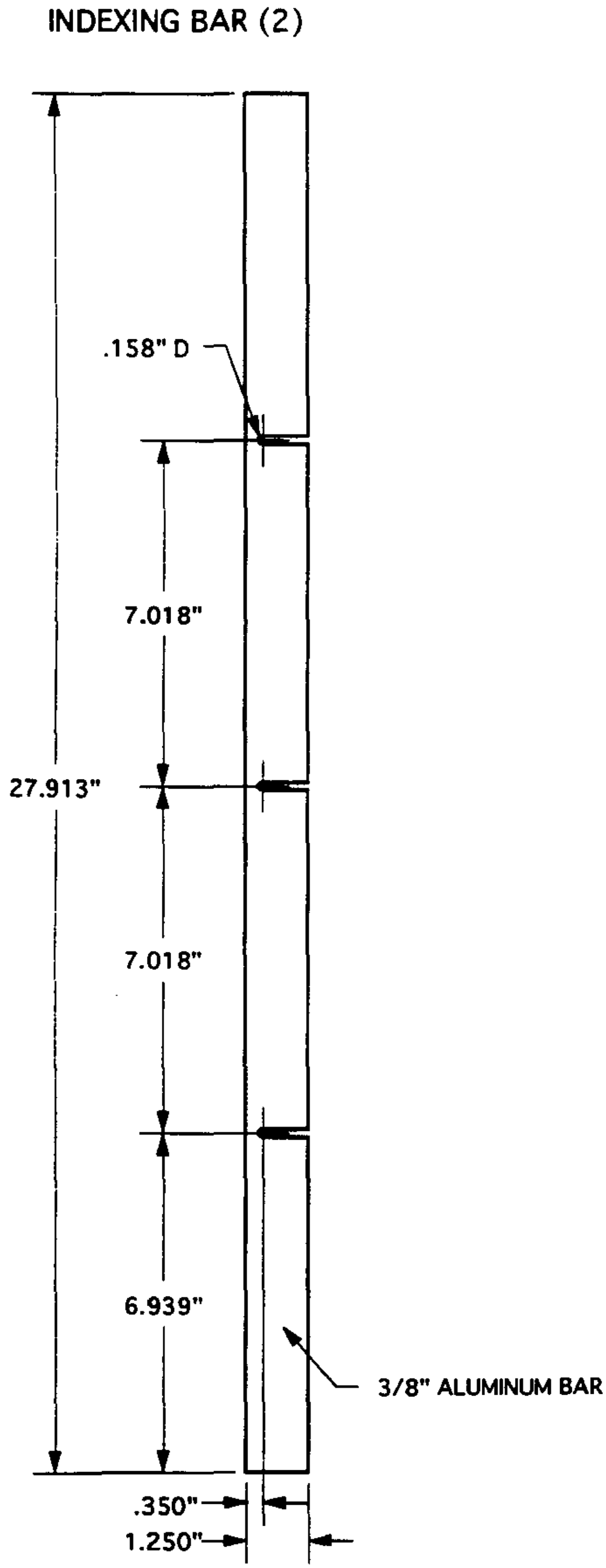


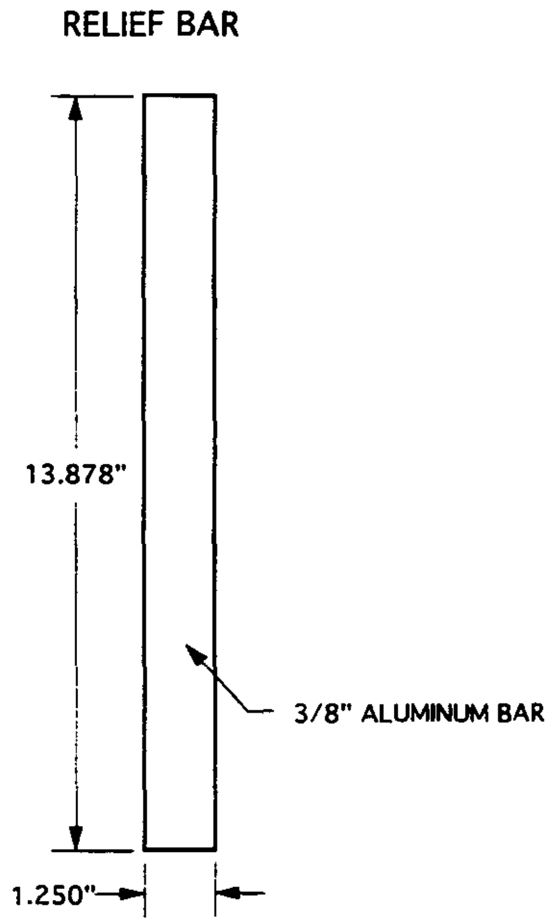
PEA
6/15/93

TILE PRESS FIXTURE - JIG PLATE



TILE PRESS FIXTURE - SIDE BARS



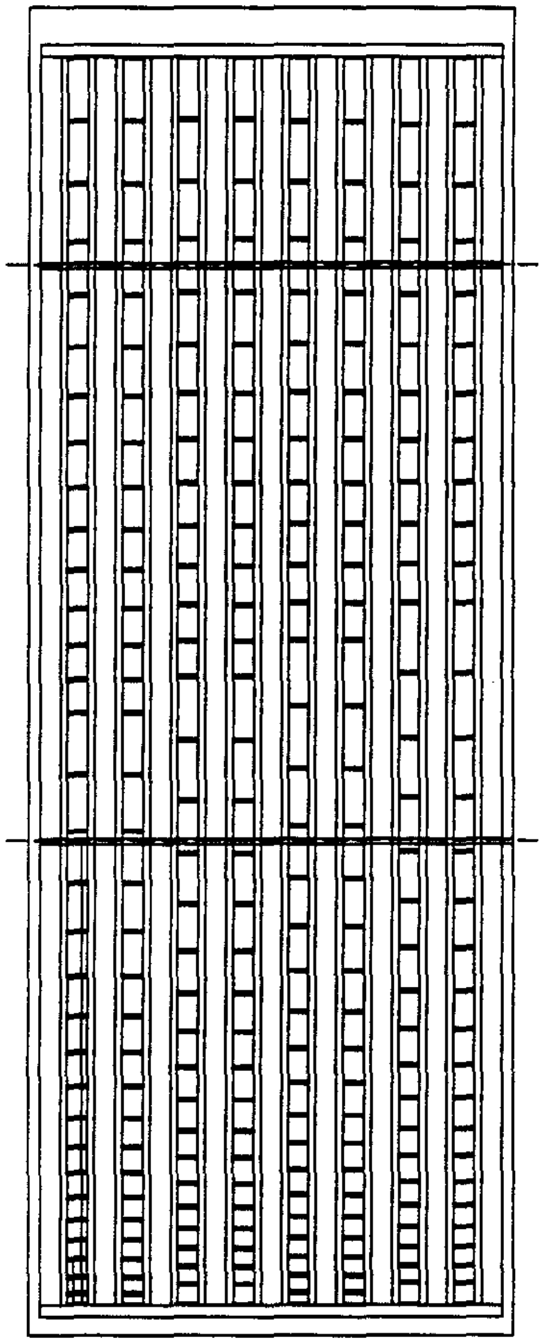


PEA
6/15/93

Presentation by:

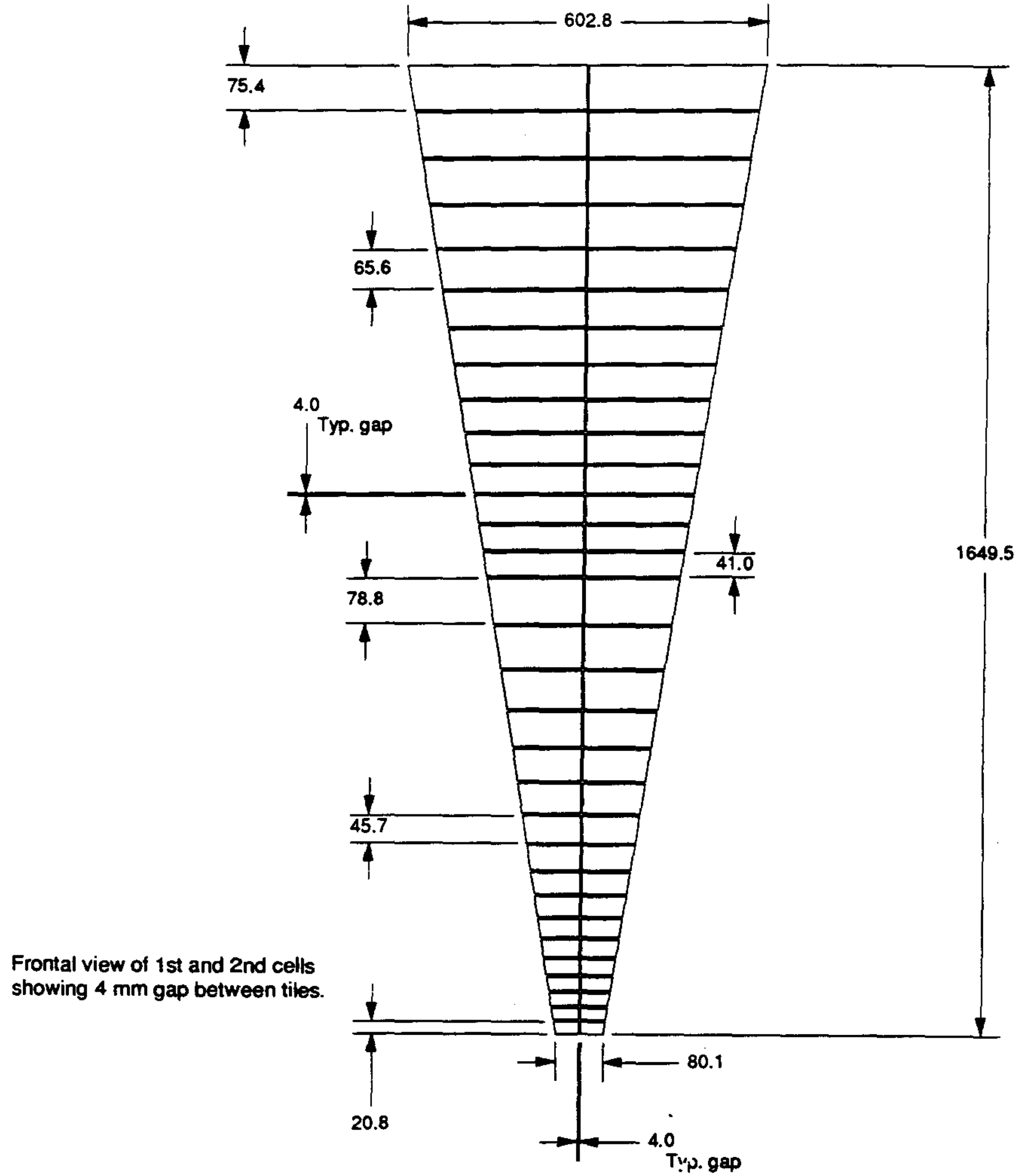
J. Franklin

Side view of Inner Hadron A
(Proposed double tile configuration)



JEF
6/4/93

Tile Segments - Inner Hadron A

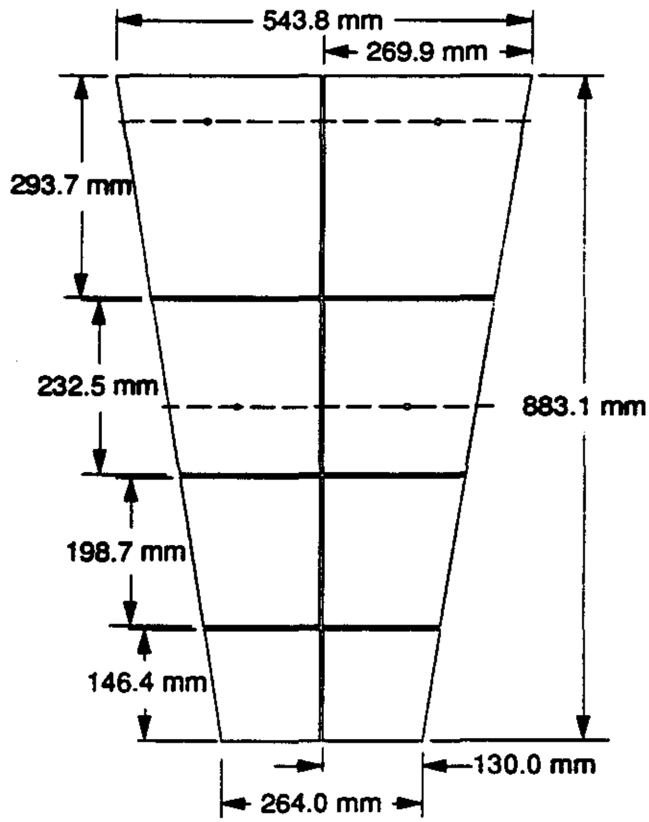


All dimensions in mm.

DAF
5/21/93

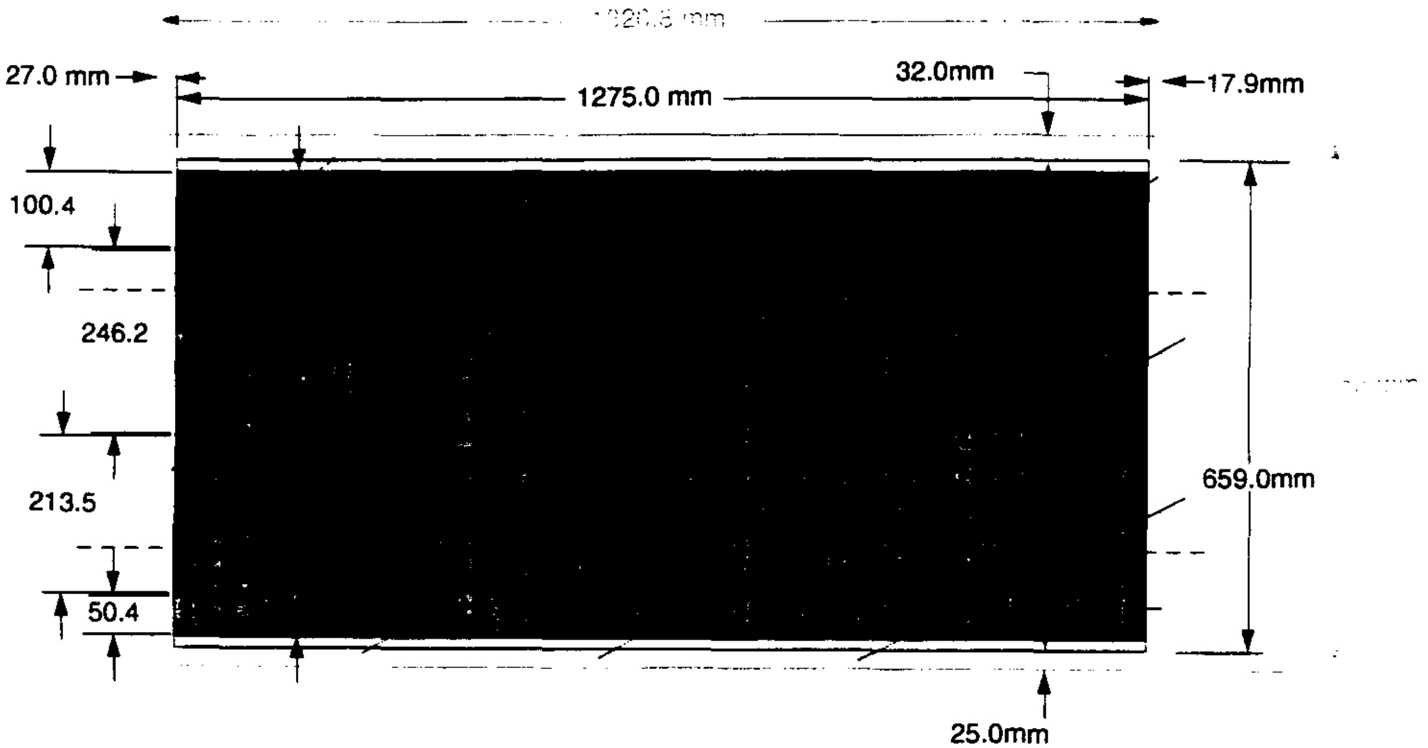
Frontal view of 1st. and 2nd. "cell" Tiles showing 4mm.gap between Tile segments of Outer Hadron A Module

All Dimensions in Millimeters



JEF
6/8/93

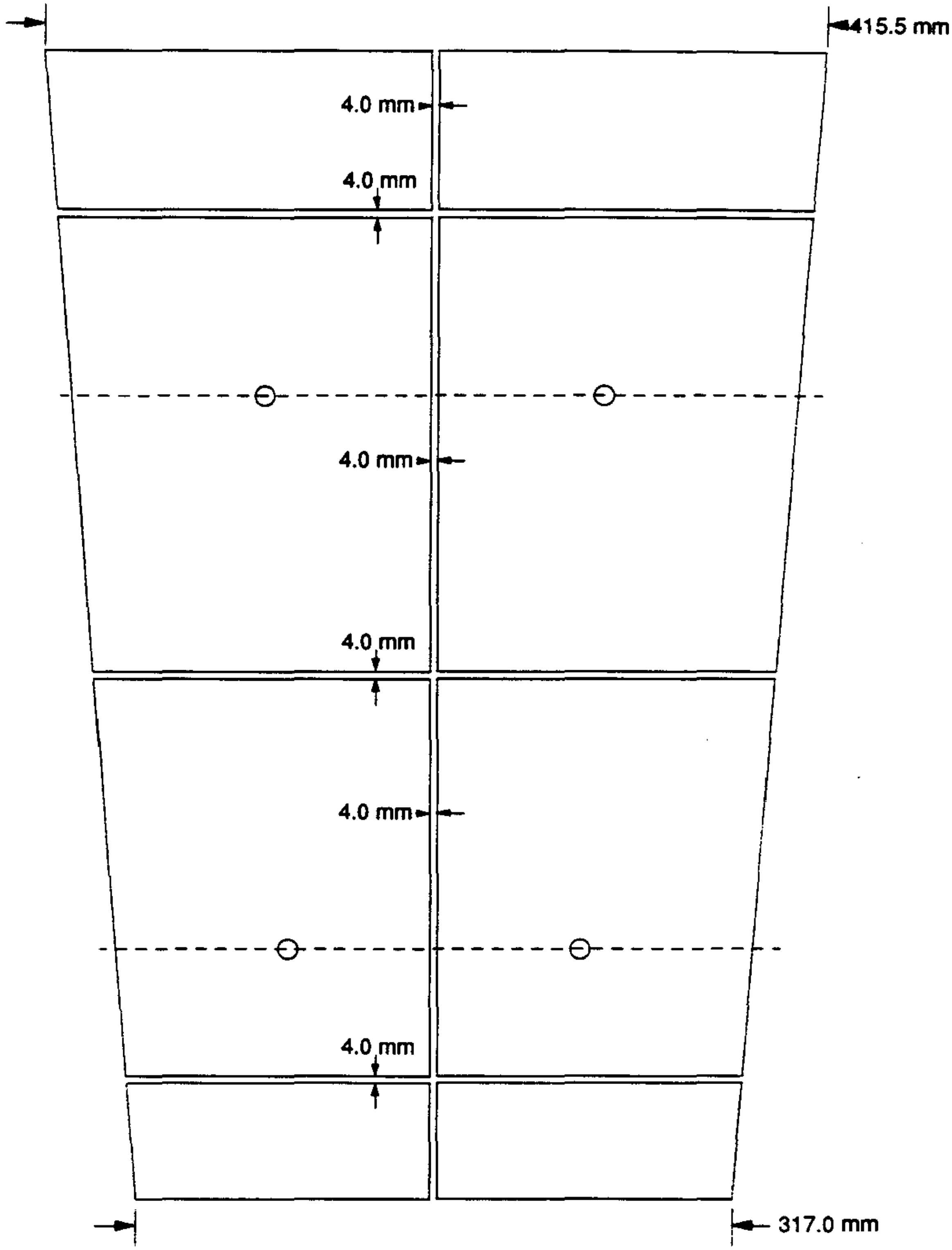
Side view of Outer Hadron B
(Proposed double tile
Configuration)



JEF
6/18/93

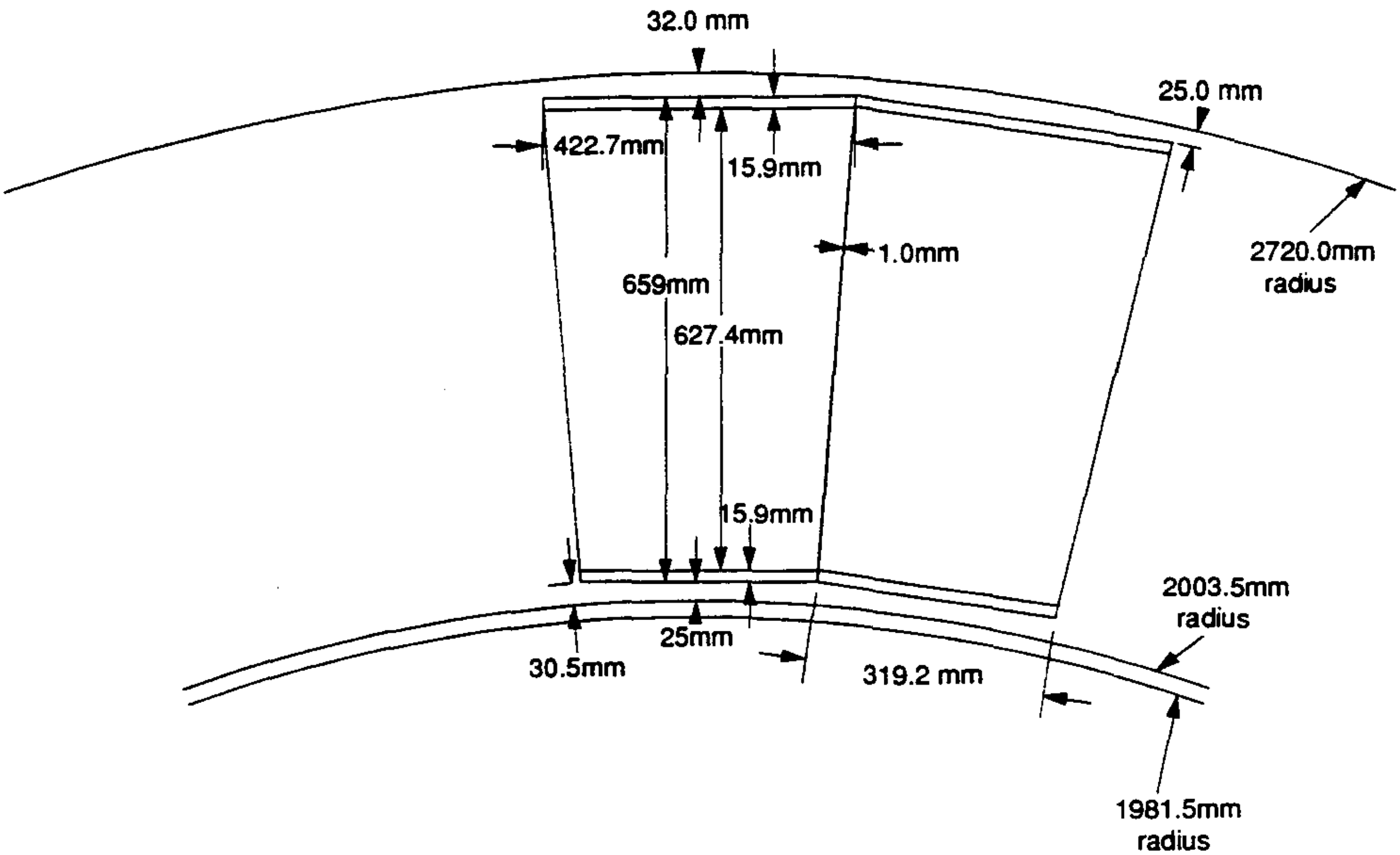
Frontal View of 1st. and 2nd. "cell" Tiles showing 4mm. gap between Tile segments in Outer B Hadron

Drawn 3mm / 10mm Scale



JEF
6/2/93

Frontal view of Outer Hadron C



JEF
6/16/93

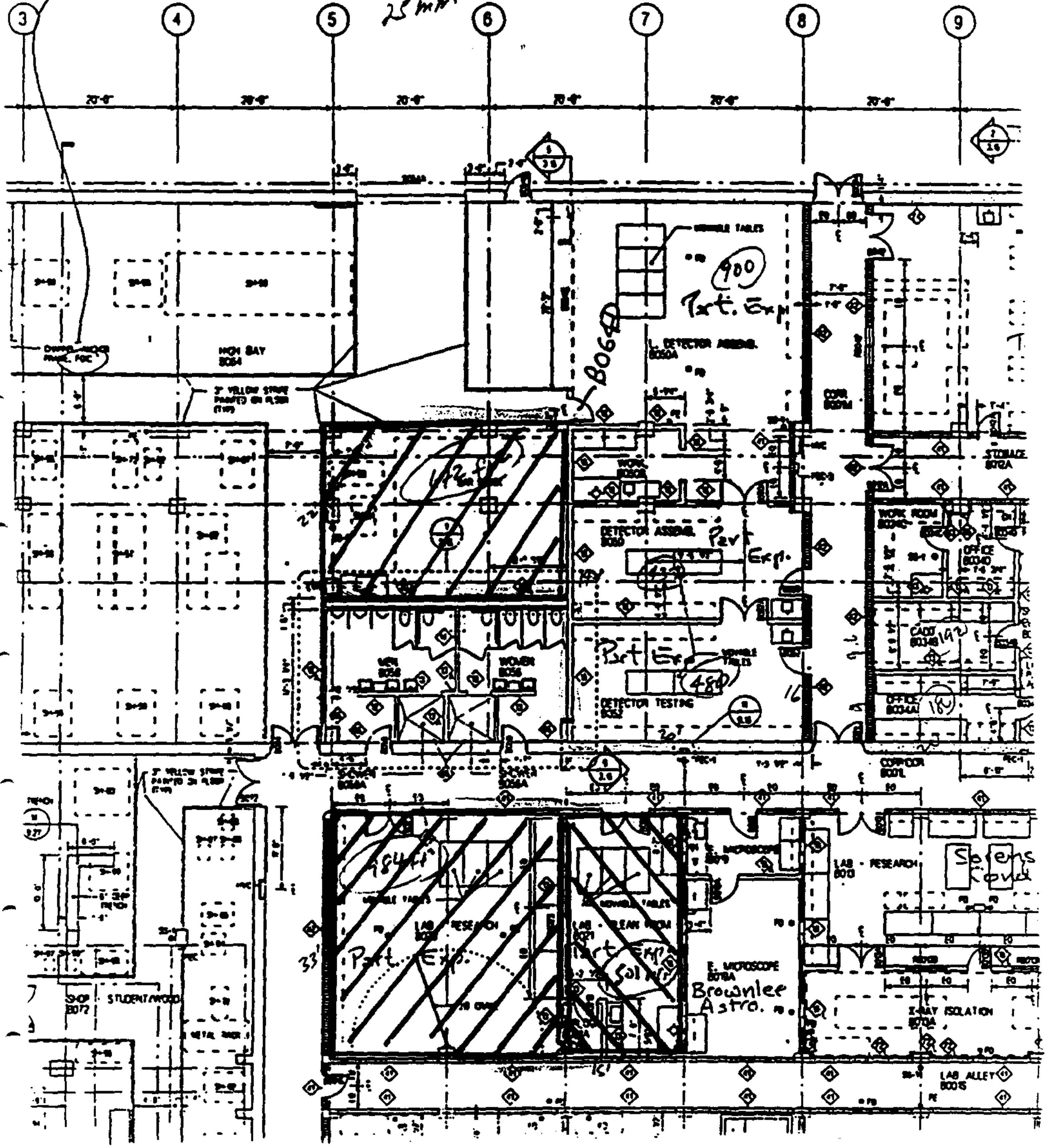
gem γeμ

Presentation by:

P. Mockett

Furnished by owner
installed by contractor

25 mm



Proposal I for HEP lab space
27 April/93

room	area (SF)	specialize	proposed	Lubatti	Mockett	Burnett-Y	Wilkes	For-Toevs
B021	501	clean rm	GEM_Mockett		501			
B023	984	crane_bm	GEM_Mockett		984			
B052	480	general	SDC_Lubatti	480				
B050	430	general	SDC_Lubatti	430				
B050A	900	big crane	SDC_Lubatti	900				
B050A ext	300	big crane	SDC_Lubatti	300				
B050B	300	noxious fu	SDEC_Lubatti	300				
B-barstock	672	no wall	GEM_Mockett		672			
B034A	180	office	Toevs +					180
B034B	192	CADD	Forbush+					192
B210	650	Dark room	CR_Wilkes				650	
B208	540	general	Dumand_SuperK_Young ,BES_Burnett			540		
B208B	143	general	Dumand_SuperK_Young ,BES_Burnett			143		
	6272		subtotals	2410	2157	683	650	372
			fraction of total lab space	0.384247	0.343909	0.108897	0.103635	0.059311
RA offices								
B317	164	3						
B225	164	3						
B227		2						
B219		2						
B210E	190	4	Could be lab					
B208A	182	4	Could be lab					
		18						

GEM REPORT

6/10/93

TDR (Technical Design Report) submitted April 30th

TDR presented to PAC(Program Advisory Committee) May 24-28

UW Responsibilities

ENDCAP HADRON MODULES
- FNAL Beam Tests January of 1995
- 3 Outer Hadron A
- 3 Outer Hadron B
- 2 Inner Hadron A (partial)
- 2 Inner Hadron B (partial)
- 1 EM Substitute (possibly)

FEEDTHROUGHS
- 10 Two connector assemblies (9 plus 1 spare)

MILESTONES Through 1993

Module Materials Ordered	July 30, 1993
Complete Outer A and B design	**August 27, 1993**
Module construction facility prepared	September 17, 1993
Tile press	
Clean room for assembly	
Kapton etching facility	
Test area	
Construction of Outer Hadron B begins	September 24, 1993
Feedthrough component RFP's	**October 8, 1993**
Feedthrough component contracts	November 12, 1993
1st Outer Hadron B Completed	November 26, 1993
Finalize Feedthrough Design	**December 3, 1993**
Feedthrough production begins	December 13, 1993
Complete Inner A and B design	**January 7, 1994**
First feedthrough assembly complete	January 28, 1994

gem

γeμ

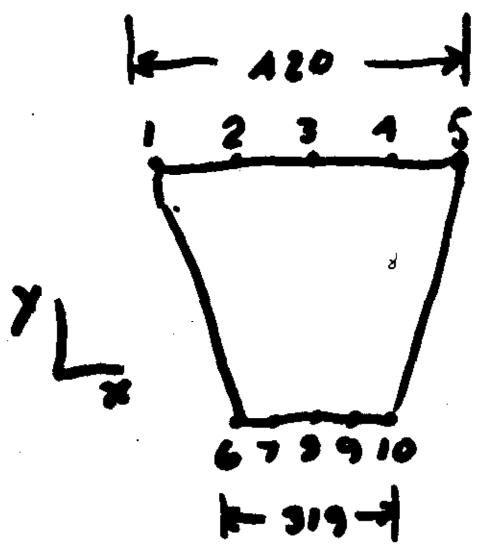
Presentation by:

R. Hund

ENDCAP HADRONIC MODULE - THINGS TO DO

- EXTRACT STRESSES/LOADS FROM INSIDE PLATES TO DETERMINE FASTENER SIZES AND NUMBERS.
- WORK CRYOSTAT INTERFACES AND INCORPORATE INTO ANALYSIS
- TEST THREADED JOINT IN ANNEALED COPPER
  - ARE HELICOILS NECESSARY TO PREVENT GALLING OR THREAD PULLOUT
  - EDGE DISTANCE ON "THIN" PLATES
- ANALYZE OTHER ENDCAP MODULES

ENDPLATE FASTENERS



σ_{max} (psi)

1	2	3	4	5
1157	1273	2098	1273	1157
6	7	8	9	10
1520	1643	1659	1643	1520

$\delta_{y\,max} = 0.70$ mm

- FORCE AT TOP (CONSERVATIVE) $2098\left(\frac{12.7}{25.4}\right)\left(\frac{420}{25.4}\right) = 17.35$ KIPS
- ASSUME MIN 1d EDGE DISTANCE $\longrightarrow$ 6mm FASTENER
- NUMBER OF FASTENERS $n = \frac{F_T}{.9\,S_y A_T} = \frac{17.35}{.9(30)(.03)} = 21.4$ use 22
- FASTENER SPACING $\frac{l-3d}{n-1} = \frac{420-18}{21} = 19.1$ mm

Endcap Hadronic Module Analysis Update

June 22, 1993

R. Hund
Martin Marietta Astronautics
Science Systems

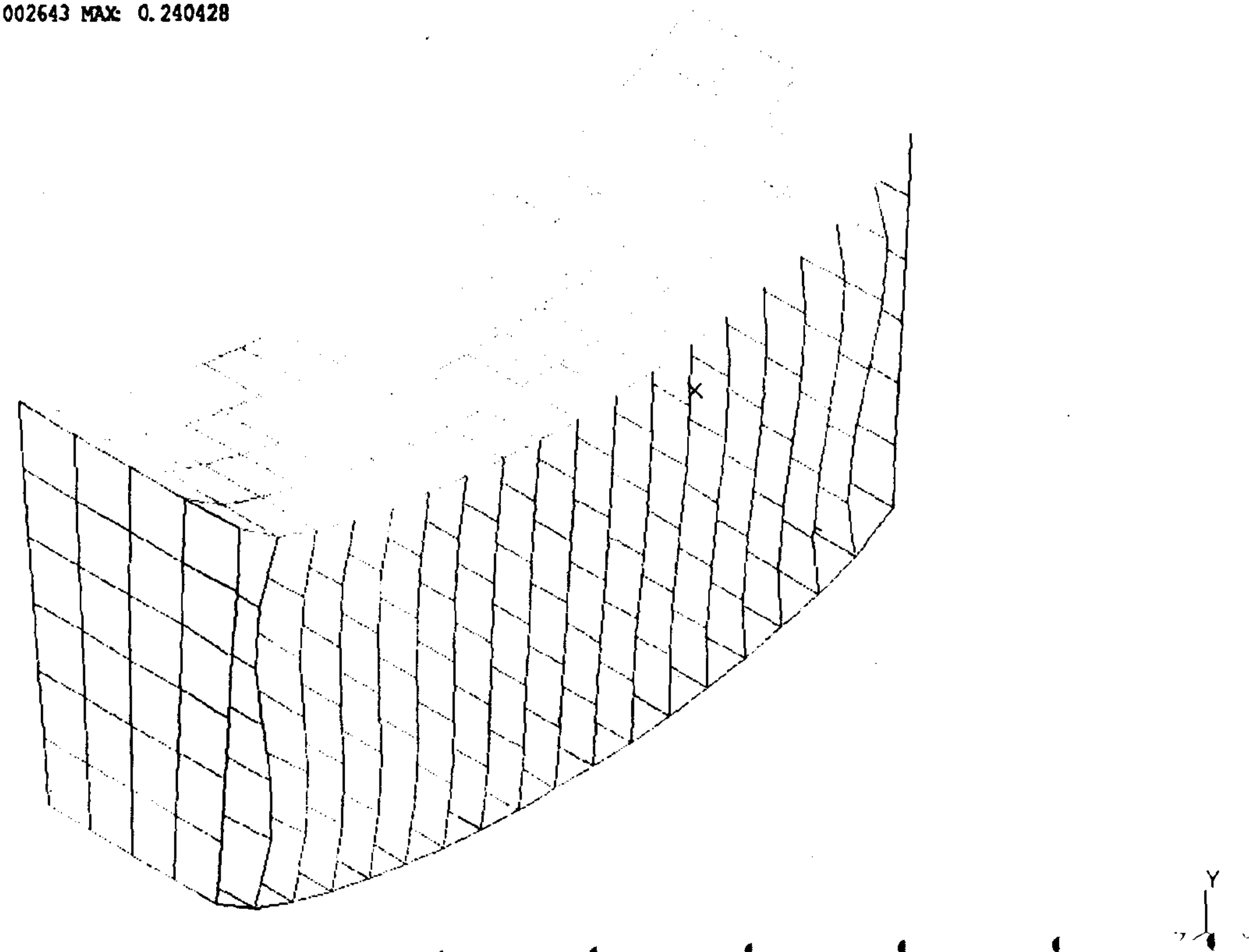
SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 14-MAY-93 14:38:

Database: endcap hadronic
View : No stored View
Task: Post Processing
Model: 1-ENDCAP HADRON

Units :
Display : No stored
Model Bin: 1-MAIN
Associated Workset: 1-WORKIN

endcap hadronic

LOAD SET: 1 - GRAVITY 1.0G -Y DIR
DISPLACEMENT - NORMAL MIN: 0.002643 MAX: 0.240428



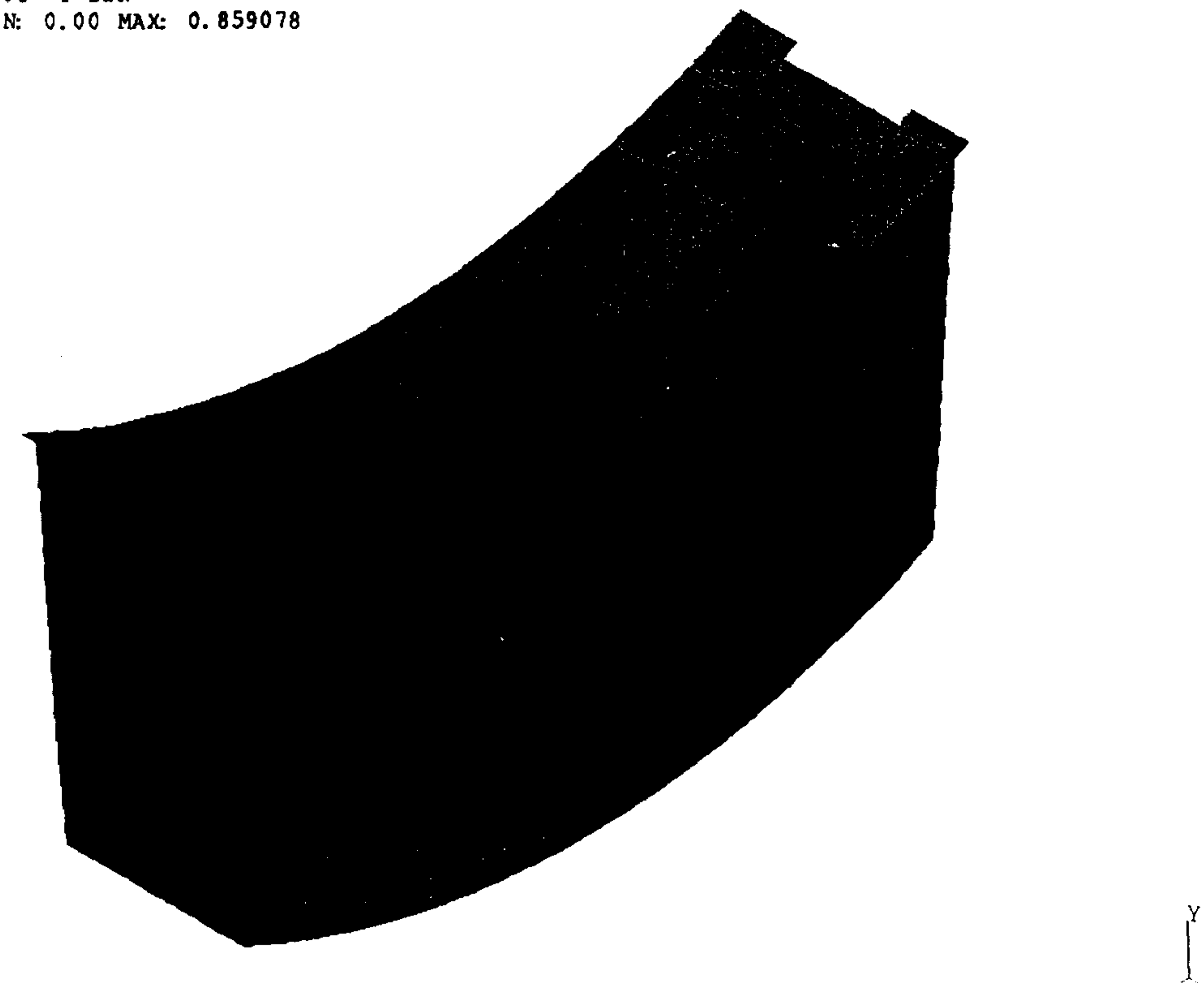
SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis 18-JUN-93 16:34:1

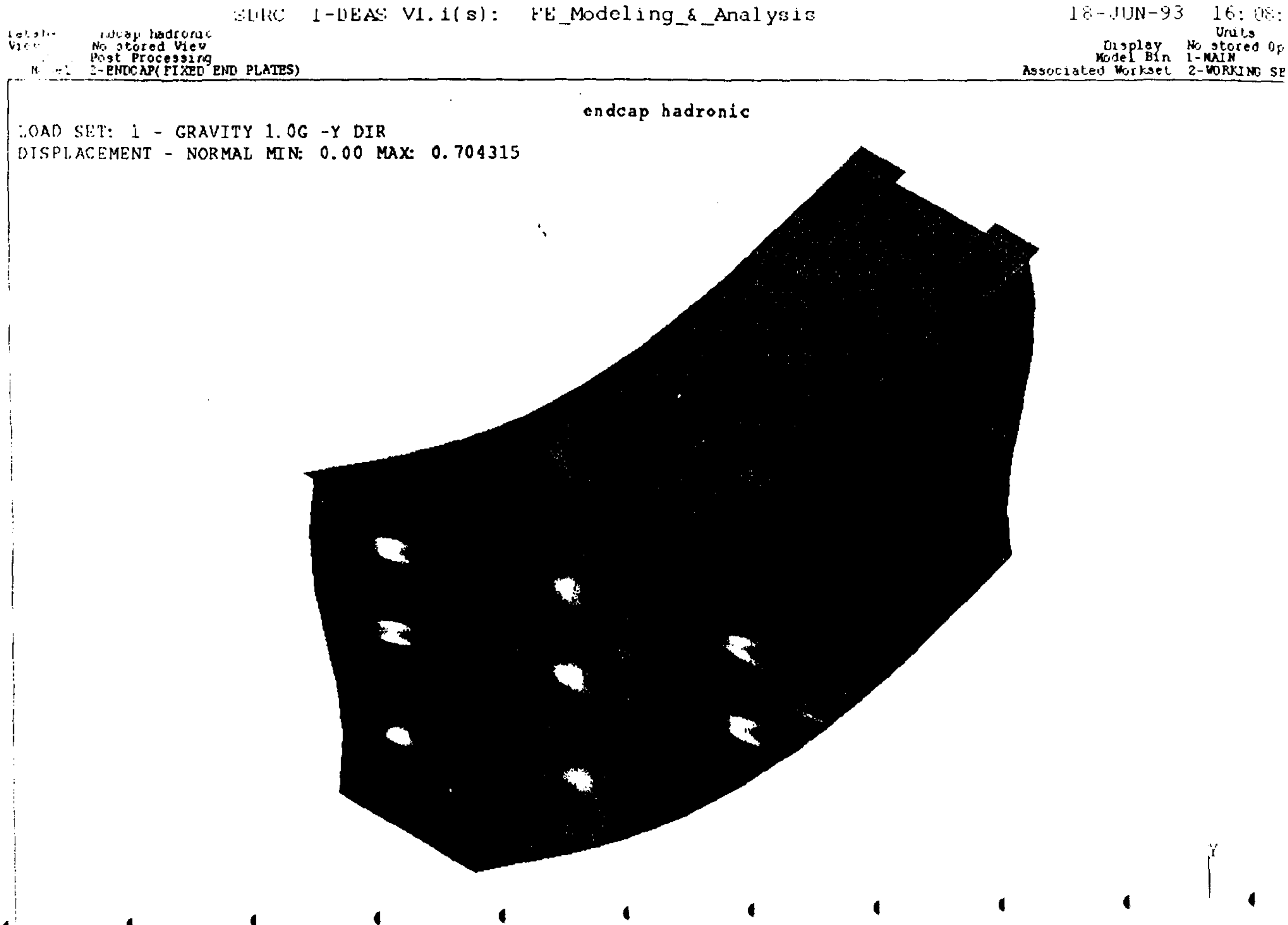
Database: ...ap hadronic
View: ...tored View
Task: ...st Processing
Model: ...-ENDCAP HADRON

Units ...
Display: No stored Opti
Model Bin: 1-MAIN
Associated Workset: 1-WORKING SET1

endcap hadronic

LOAD SET: 1 - GRAVITY 1.0G -Y DIR
DISPLACEMENT - NORMAL MIN: 0.00 MAX: 0.859078




SDRC I-DEAS VI.i(s): FE_Modeling_&_Analysis
18-JUN-93 16:08:
No stored View
Post Processing
2-ENDCAP(FIXED END PLATES)
Units
Display No stored Op
Model Bin 1-MAIN
Associated Workset 2-WORKING SE
endcap hadronic
LOAD SET: 1 - GRAVITY 1.0G -Y DIR
DISPLACEMENT - NORMAL MIN: 0.00 MAX: 0.704315
Y

gem

γeμ

Presentation by:

L. Mason

PREPARATION FOR PRELIMINARY DESIGN REVIEW

TDR — PARAMETER LIST - CONFG

SPECIFICATION

DETECTOR

CALORIMETER

NOBLE LIQUID

INTERFACE DOCUMENTS

SPECIFICATION

WBS

COST

SCHEDULE

SOW of SPEC.