GEM TN-93-456

GEM Test Beam Meeting - SSCL

Holiday Inn - Desoto

August 19, 1993

Abstract:

Agenda, attendees, and presentations of the GEM Test Beam Meeting held at Holiday Inn - Desoto on August 19, 1993.

Test Beam Meeting

August 19, 1993
Holiday Inn – DeSoto
9:00 AM – 4:00 PM

Agenda

Introductory Remarks	P. Slattery
Calorimeter Test Beam Plans	P. Slattery
Central Tracker Test Beam Plans	K. Morgan
Muon Tracker Test Beam Plans	G. Mitselmakher
Test Beam Data Acquisition	J. Dunlea
Computing & Data Storage	G. Word
Status Reports	
BNL Tracker Tests	H. Fenker
Muon Chamber Testing	V. Glebov
MWEST Preparations	G. Ginther
MWEST Transporter	F. Lobkowicz
MWEST Cryostat	W. Wisniewski

Test Beam Meeting

August 19, 1993
Holiday Inn – DeSoto
9:00 AM – 4:00 PM

List of Participants

Name	Institution	Email Address
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Christopher B. Lirakis	FERMILAB	FNAL :: LIRAKIS
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Test Beam Meeting

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List of Participants

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—OVER—

Name	Institution	E-Mail address
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Gena Mitselmakher	SSCL	MITSELMAKHER @ SSCVX1
Bill Wisniewski	SSCL	WJW @ SSCVX1

FERMI TEST BEAM CONCERNS

1. ALLOCATION OF ASSEMBLY SPACE FOR ALL SUBSYSTEMS

2. ACCESS TO BEAM LINE FOR ALL SUBSYSTEMS

3. CONTINGENCY FOR LATE ARRIVAL OF EQUIPMENT. (NO ASSEMBLY WORK FORESEEN IN BEAM LINE?)

4. MINIMUM COST OPTION

The GEM Test Beam Program at Fermilab

Overview

Phase I —

A *coordinated* test of the various GEM subsystems:

- Calorimeter (Barrel & End Cap)
- Central Tracker (IPC's & Silicon)
- Muon Tracker (CSC's)
- Electronics & Trigger Development
- Data Acquisition & Data Handling
- Software Development and Data Simulation

Phase II —

An *integrated* test of an 18° sector of the GEM detector.

Goals

I. Optimize the design of the GEM detector components before full scale production begins.

II. Modify assembled detector elements when test beam results demonstrate this to be necessary.

III. Understand in detail the technical characteristics of the final GEM detector.

IV. Integrate the various GEM subsystems into a unified detector before the start of SSC operations.

Slattery
8/19/93

MWest Overview

- Beam:
  - Primary Protons: 800 GeV/c
  - Secondary Beams: ±10 –> ±600 GeV/c
  - Momentum Tagging: ~0.2 % (2.4 or 4.8 mr)
  - Electron Tagging by Cherenkov & SRD (new)
  - Primarily Low Intensity : ~10 Hz –> 10 kHz
  - Possible "Pinged" Beam : ~10^9 Hz for ~1 ms
- Hall:
  - Floor Space: 200 × 63 ft^2
  - Crane: 25 tons & 30 ft hook height
  - Cryogenics:
    - Storage Tanks: LN_2 & LAr
    - Extensive Cryo-plumbing
    - Complete ODH System (incl. runoff pit)
  - Magnet:
    - Field ≤ 1.2 T
    - Aperture: H=50 in; W=36 in; L=60 in
  - Transverse Rails (400 t) across (3 ft deep) Trench
  - Internal & External Counting Areas
- Reusable Equipment:
  - Tracking Chambers (E706 & E672; E704)
  - PREP Electronics
  - Computers

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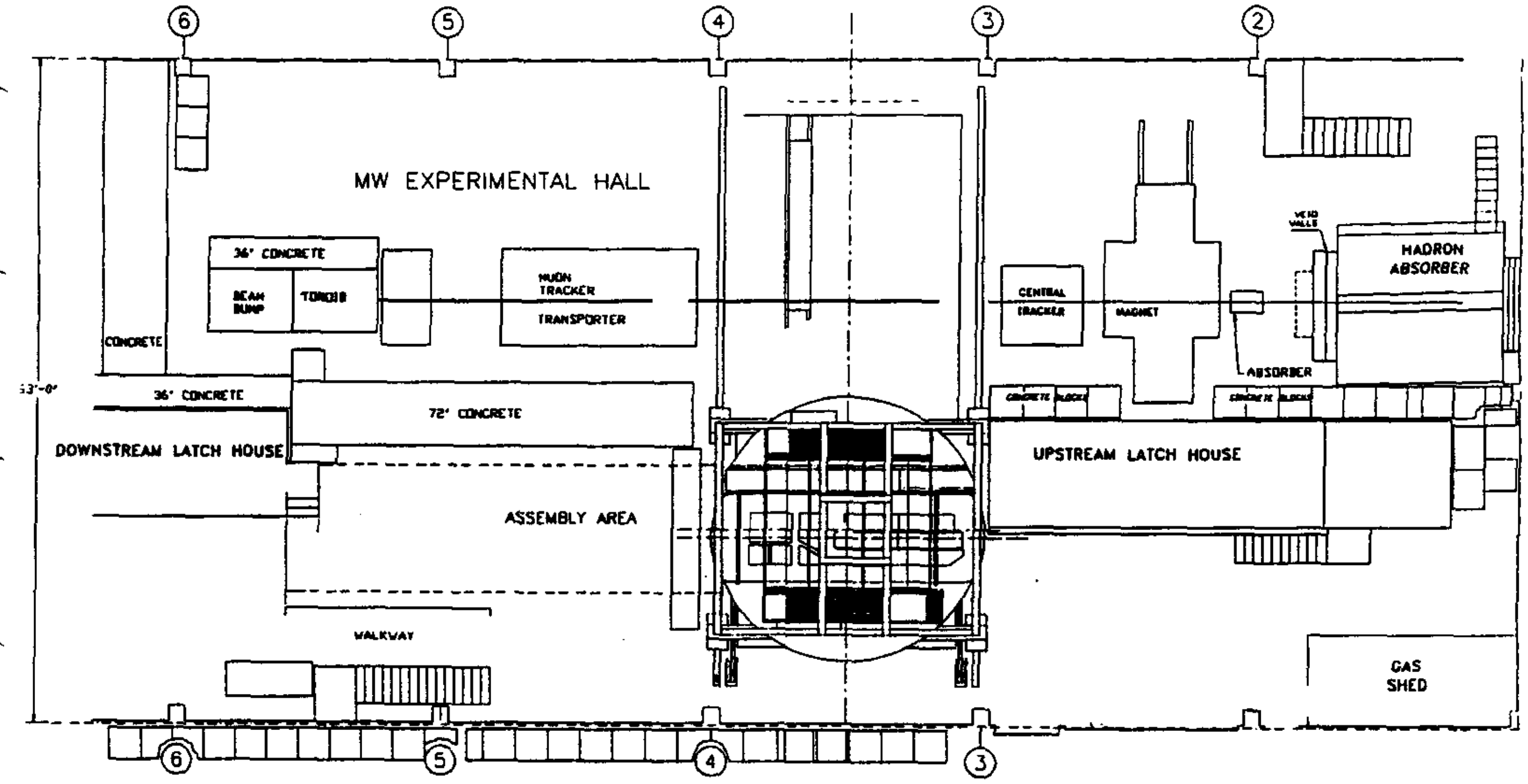
6/30/93

MWest Experimental Area

Fermi National Accelerator Laboratory

GEM Test Beam Configuration



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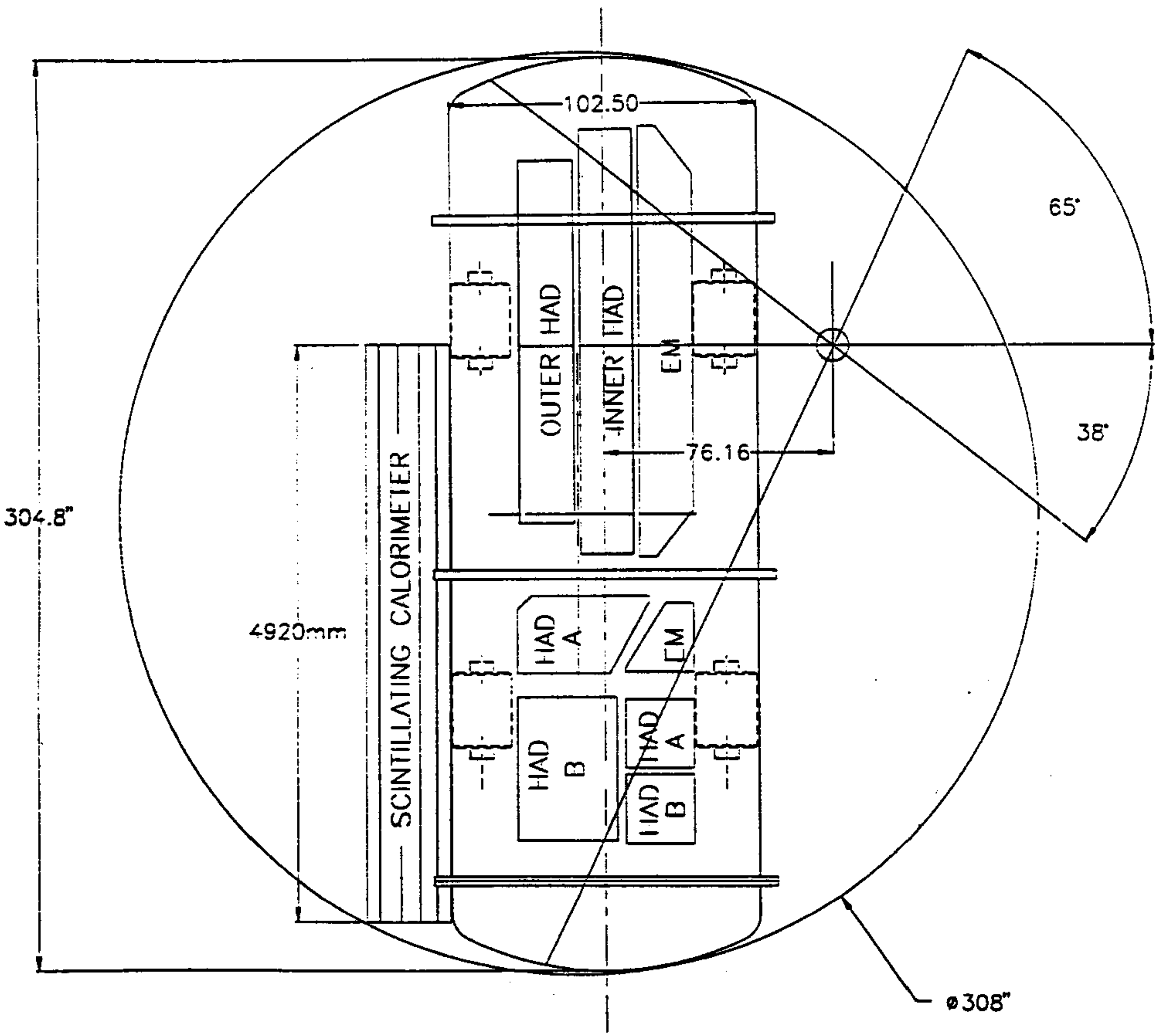
Calorimeter Testing and Calibration

- Perform full-scale engineering studies of all calorimeter subsystems: mechanical, electronic and cryogenic.
- Achieve full system integration of the electromagnetic and hadronic cryogenic calorimetry, and of the external scintillating calorimetry.
- Carry out a full system test of the calorimeter readout and calibration systems.
- Measure the response of the scintillating calorimetry, and determine the reproducibility of its performance from module to module.
- Study the calorimeter's energy and spatial resolution up to the highest available energies using both electrons and hadrons.
- Investigate the calorimeter's response to single particles in the vicinity of representative cracks.
- Study the calorimeter's response to single particles across the barrel to end cap transition region.
- Investigate the calorimeter's response to high energy muons.

The results of these studies will be used to pin down the Monte Carlo simulations that provide the critical link between the MWest test calorimetry and the operational GEM calorimeter.

GEM Test Cryostat Plus Modules



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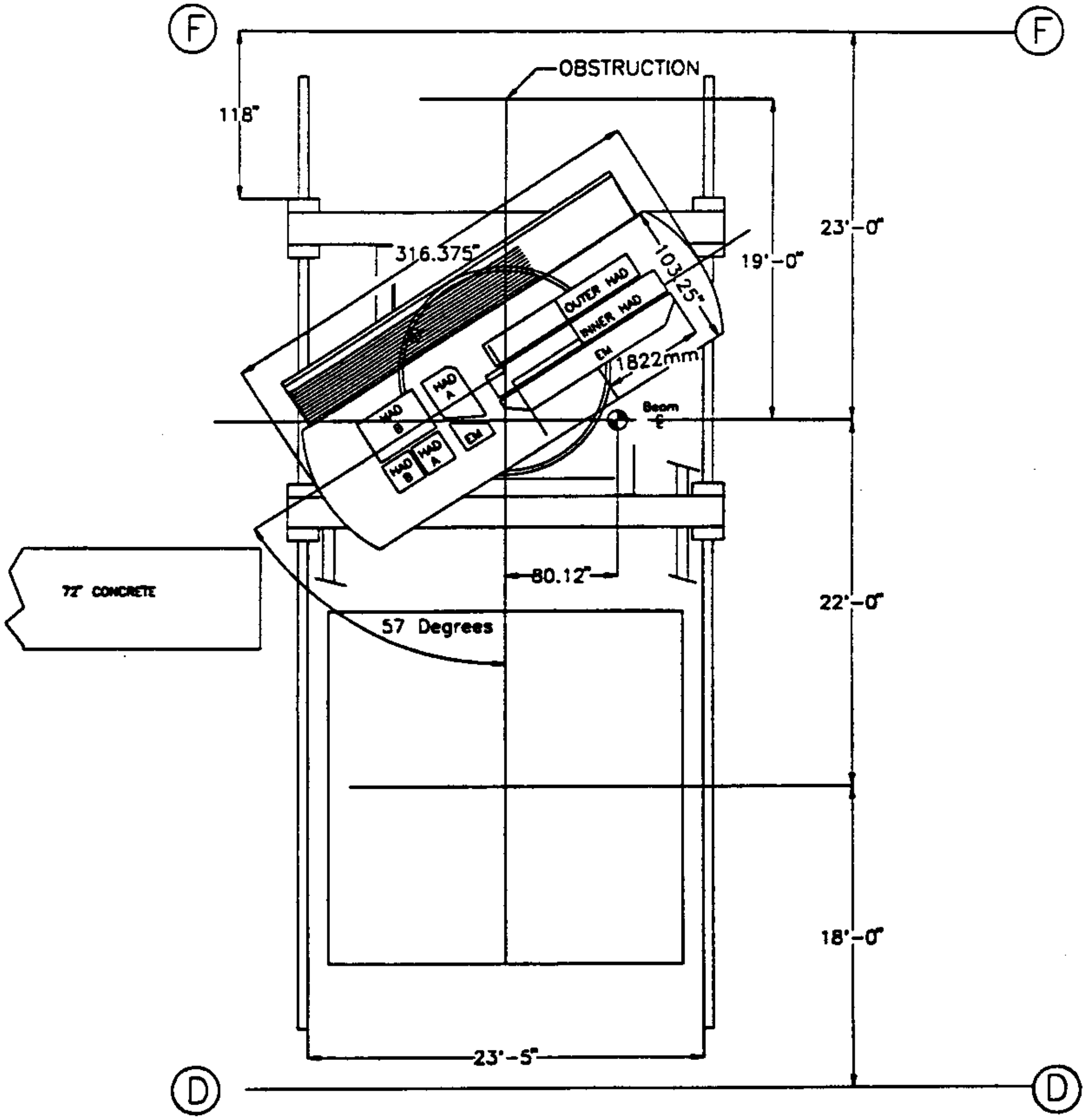
Calorimeter Testing



Investigation of Barrel to End Cap Transition

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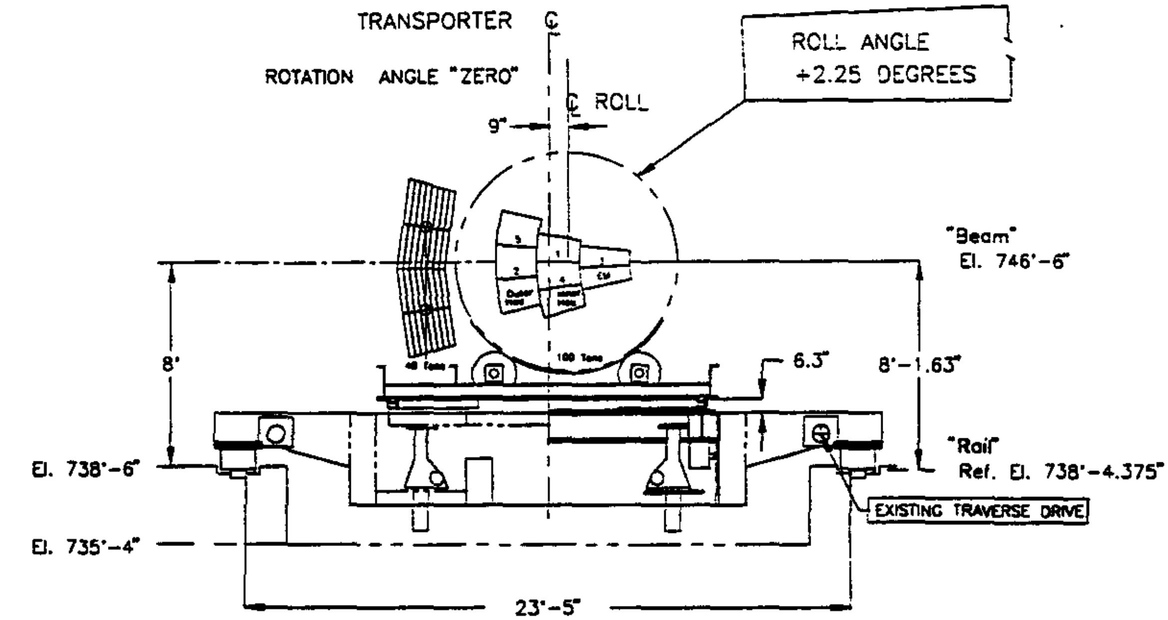
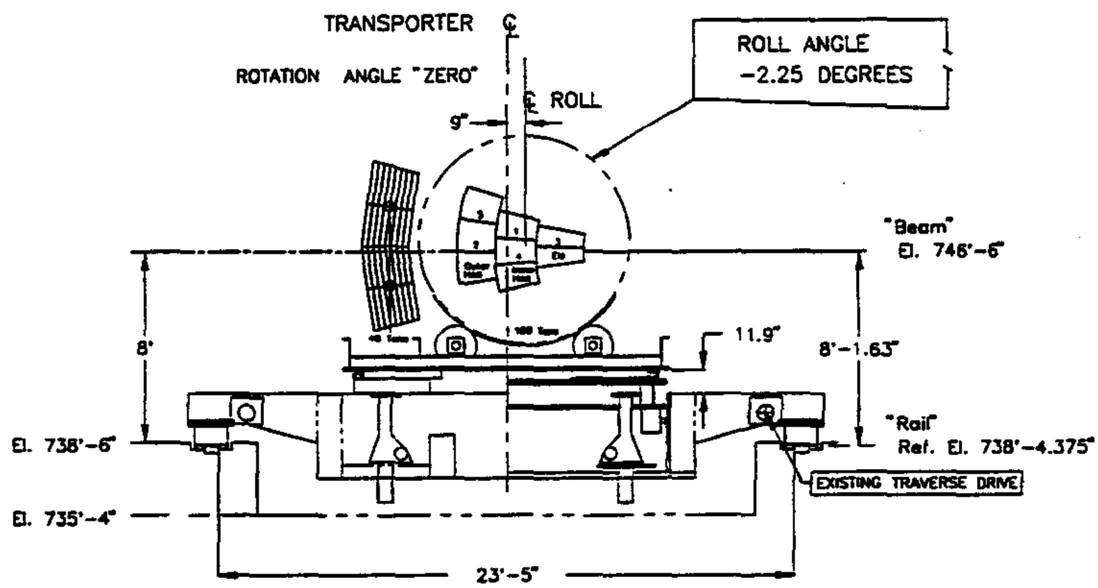
5/28/93

Calorimeter Testing



Beam Centered on Crack in First Hadronic Layer



Beam Centered on Crack in Second Hadronic Layer

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5/28/93

Preliminary Run Plan {HG, DL, HT} Calorimeter Testing

- Energy Resolution Studies
  - Take e^-, π^- & μ^- at ~10 energies from 20 – 600 GeV, plus protons at 800 GeV.
  - Accumulate ~10^5 events at ≥3 calorimeter positions for each particle type, implying ~10^7 total events.
- Electronics Testing
  - Employ two readout chains for one of the electron energy scans, implying ~10^6 additional events.
- Phi & Eta Scan
  - Accumulate ~10^5 events at ≥4 energies for each particle type at 20 ϕ & η points for a total of ~ $2.5\text{x}10^7$ events.
- Pointing Studies, Shower Shape Analysis & e/π Separation
  - Employ the same data samples used for the energy studies and the ϕ & η scan.
- "Jet" Studies
  - Approximate hadron jets by studying events from a tertiary target positioned at the simulated IP.
  - Accumulate ~10^7 events at several different energies and ϕ & η positions .

At 100 events/s and a ~23s/57s beam cycle, and assuming 25% efficiency during data taking, 5x10^7 events can be accumulated in 5x10^6s, or ~2 months.

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Central Tracker Testing
Preliminary {~ 6/30/93}

- Investigate the rate capability of full size barrel and end cap IPC's using final design electronics.
- Carry out full scale system tests of gas, cooling, and mechanical support systems.
- Continue IPC resolution and efficiency studies begun at BNL, incorporating new ideas and improved electronics.
- Investigate IPC performance in a 0.8 T magnetic field:
  - Study Lorentz angle effects.
  - Investigate two-track resolution.
- Mount and operate a complete 18° sector of the GEM central tracker (silicon plus IPC's).

In general terms, these studies are designed to extend and complement IPC testing to be carried out in 1993 and 1994 at BNL.

Slattery
8/19/93

Muon Tracker Testing
Preliminary {~ 6/30/93}

- Test several small (30x30 cm^2) CSC prototypes in a 0.8 T magnetic field:
  - Simulate muons by π^- at ~200 GeV/c.
  - Study Lorentz angle effects.
  - Investigate two-track resolution.
- Study the effect of the upstream calorimetry on the performance of CSC's operating in a magnetic field:
  - Install passive absorber directly upstream (and penetrating into) the MWest magnet.
  - Study hadron punch-thru (50 – 800 GeV/c).
  - Investigate muon radiation at high energies.
- Mount and operate a full size sector of the GEM barrel muon tracker:
  - Verify the precision and stability of a full scale, dynamically alignable (via software) sector fixture.

In general terms, these studies are designed to be complementary to CSC tests conducted at the TTR, and to bench tests using sources and UV-lasers.

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GEM Central Tracker Goals for FNAL Test Beam

IPC tests at FNAL-95

High rate performance

Performance in magnetic field

Systems tests
- cooling for electronics
- gas circulation system
- position stability (time, temp, humidity)

Silicon tests at FNAL-95

10 μm position stability
- stability of components
- stability between components
- optical measurement capability
- validate ladder construction technique
- cooling system design margin
- cabling and utilities routing

5. Test Beam Program

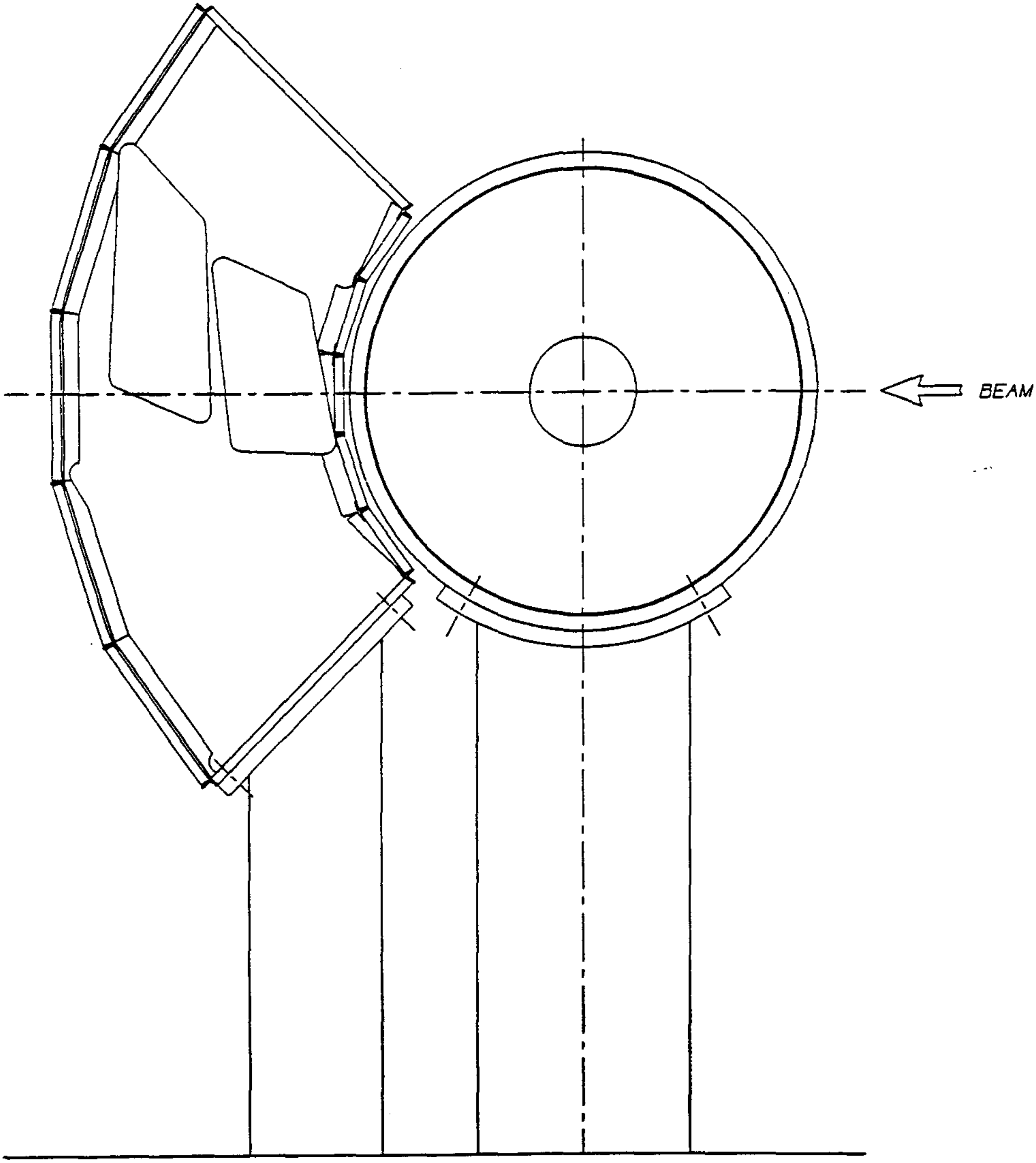
The test beam program for the Central Tracker has been developed to answer questions about the performance capabilities of the detectors in a logical and sequential fashion. This program began in the summer of 1992 using small IPC prototypes. The goals of these early tests were to find stable operating conditions under which the chambers would achieve the required resolution of 50 μm, to explore the Lorentz angles of different gas mixtures and to gain experience operating Interpolating Pad Chambers. In the absence of available test beams, those first tests were carried out with cosmic rays using a magnet at Indiana University.

Testing in beams from accelerators has begun with a beam test at Brookhaven in July 1993. This test is designed to measure the single particle resolution as a function of position on a full scale barrel IPC prototype. Approximately 70 channels of an early version of IPC electronics are available for this test. We are using an external Silicon telescope to define precise trajectories of the particles. The chambers can be scanned vertically and horizontally through the beam. We can also measure the resolution as a function of the variation in the phi angle of the incoming particles. In another test in parallel using smaller IPC prototypes we will begin to study the two track resolution. One of the major limitations of all our work at BNL is the limited rate available in the test beam there.

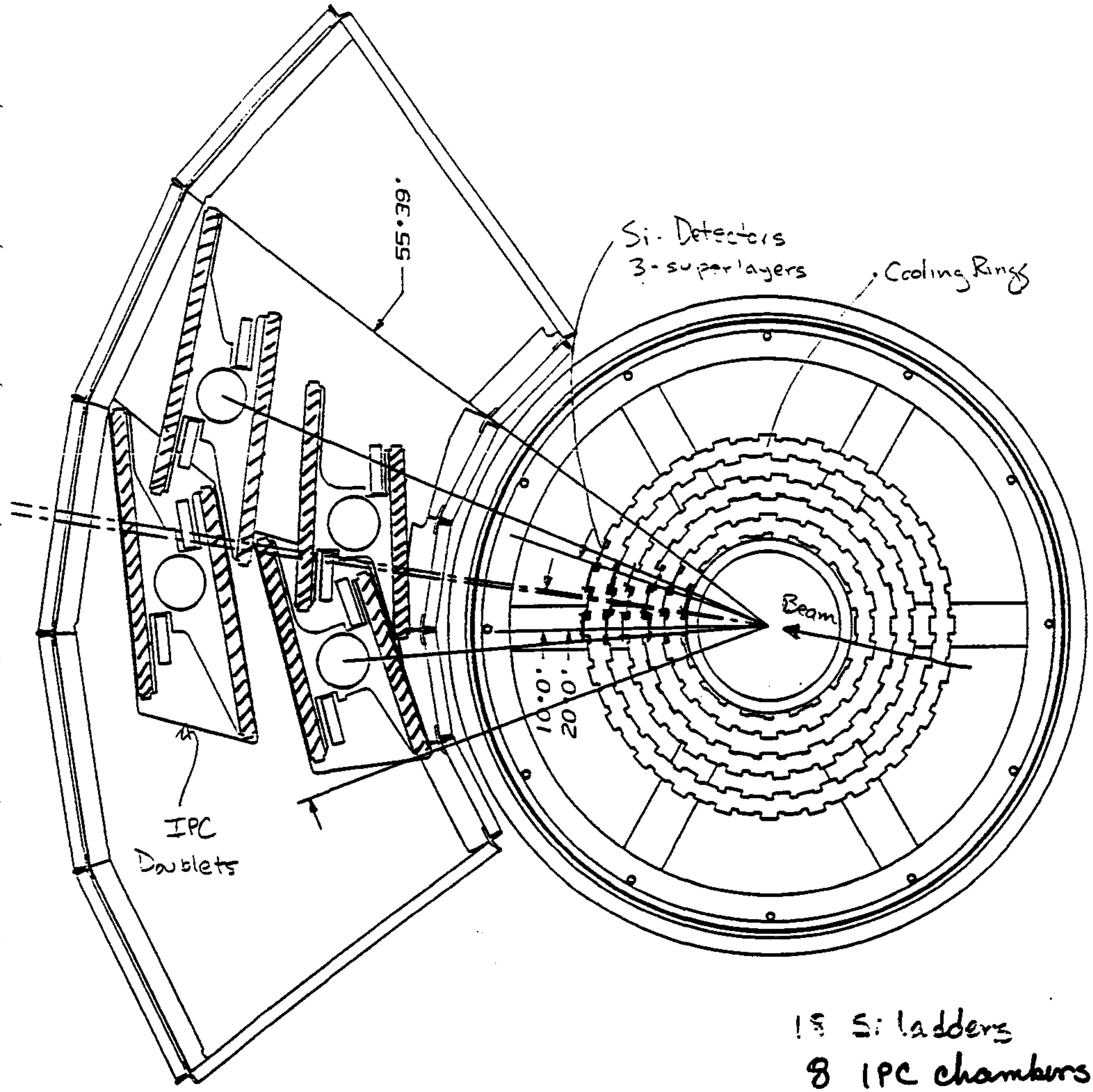
In Brookhaven in 1994 we plan to continue the two track resolution studies begun in 1993 and we plan to measure resolution as a function of variation in the theta angle of incoming particles. There will be a full scale End Cap IPC available for resolution studies and we will for the first time test GEM Silicon prototypes in conjunction with the IPC chambers. For this test we should have about 1000 channels of IPC electronics which are one stage closer to final design, with the ADC's integrated on the preamplifier chips. At the conclusion of this test there should be only a few unanswered questions about Central Tracker performance. These are 1) the high rate performance, 2) the IPC performance in a magnetic field and 3) the overall integrity of the final designs for the various systems: electronics, gas, mechanical support structures, and cooling for both the IPC and the Silicon components of the Central Tracker. These issues will be addressed at Fermilab in tests now scheduled to begin in 1995.

We expect to use two different test set ups at Fermilab. The first is used in a dedicated high rate performance test which will likely be conducted in a primary beam line independently of the general GEM test beam program at FNAL. Much of the test set up which is currently in use in the BNL beam tests will probably suffice for this measurement. For the FNAL Subsystems Tests we must construct a representative subset of final prototypes. This test is planned as a final check on all subsystems before construction of production modules begins. These measurements will be conducted in the MWest beam line. We will also be able to study the effect of the magnetic field on the chamber resolution using the magnet at MWest. This study will be conducted jointly with the muon group using a common mechanical manipulator inside the magnet. From the Central Tracker point of view, we expect to be able to explore the response of barrel IPC prototypes using devices similar to the small IPC prototypes now in the BNL test.

Our final test beam work will be conducted in conjunction with the GEM 18 degree sector test which should begin at FNAL in 1996. In addition to providing track information to the other GEM subsystems for use in determining their performance, this test will allow us to evaluate the effects of overlapping IPC chambers, the effects of the transition zone between end cap and barrel in both IPC's and Silicon, and the effects of the material in the tracker on the calorimeter response. For these tests we will use the same set up as that for the final systems evaluation tests.

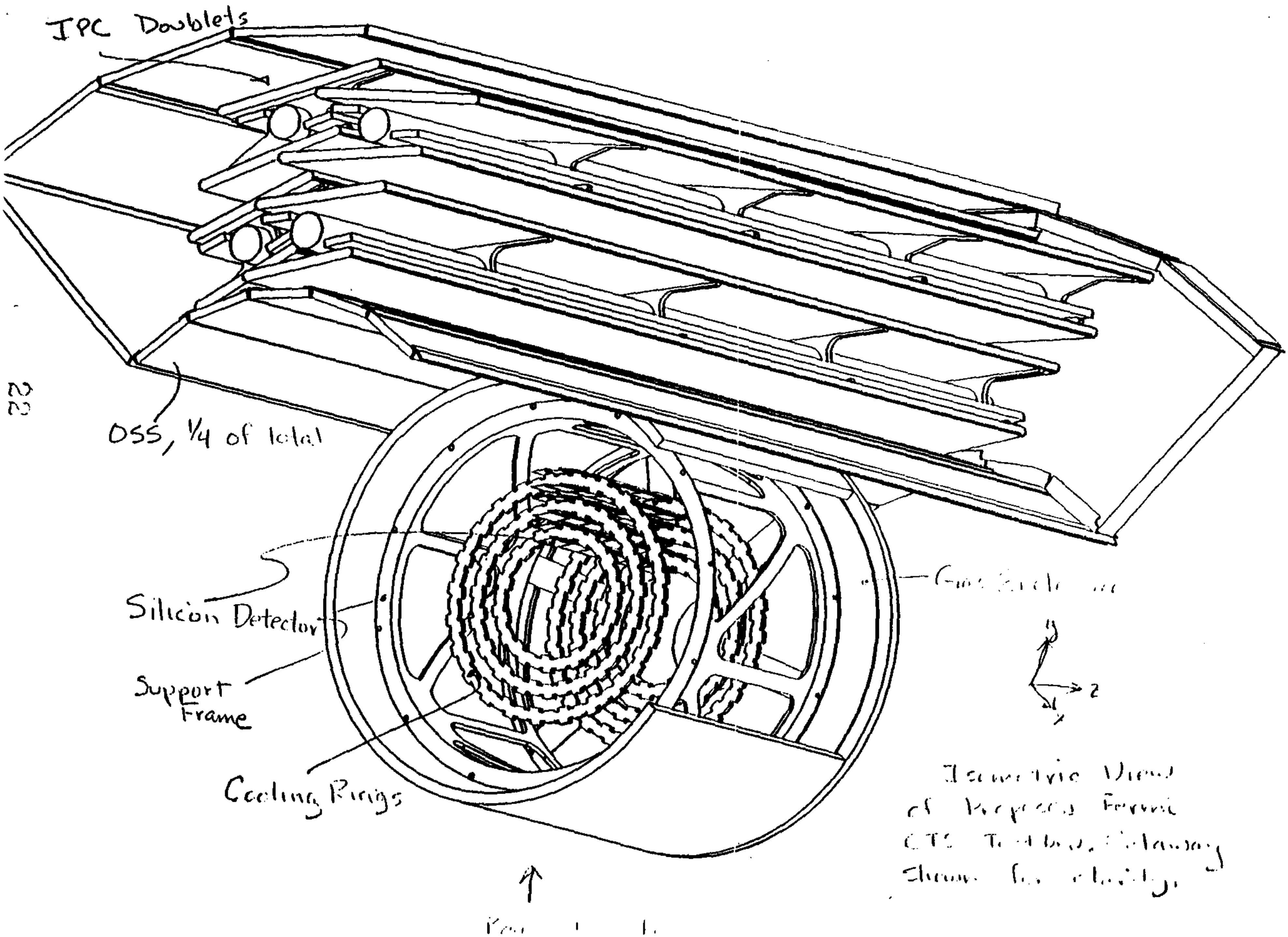


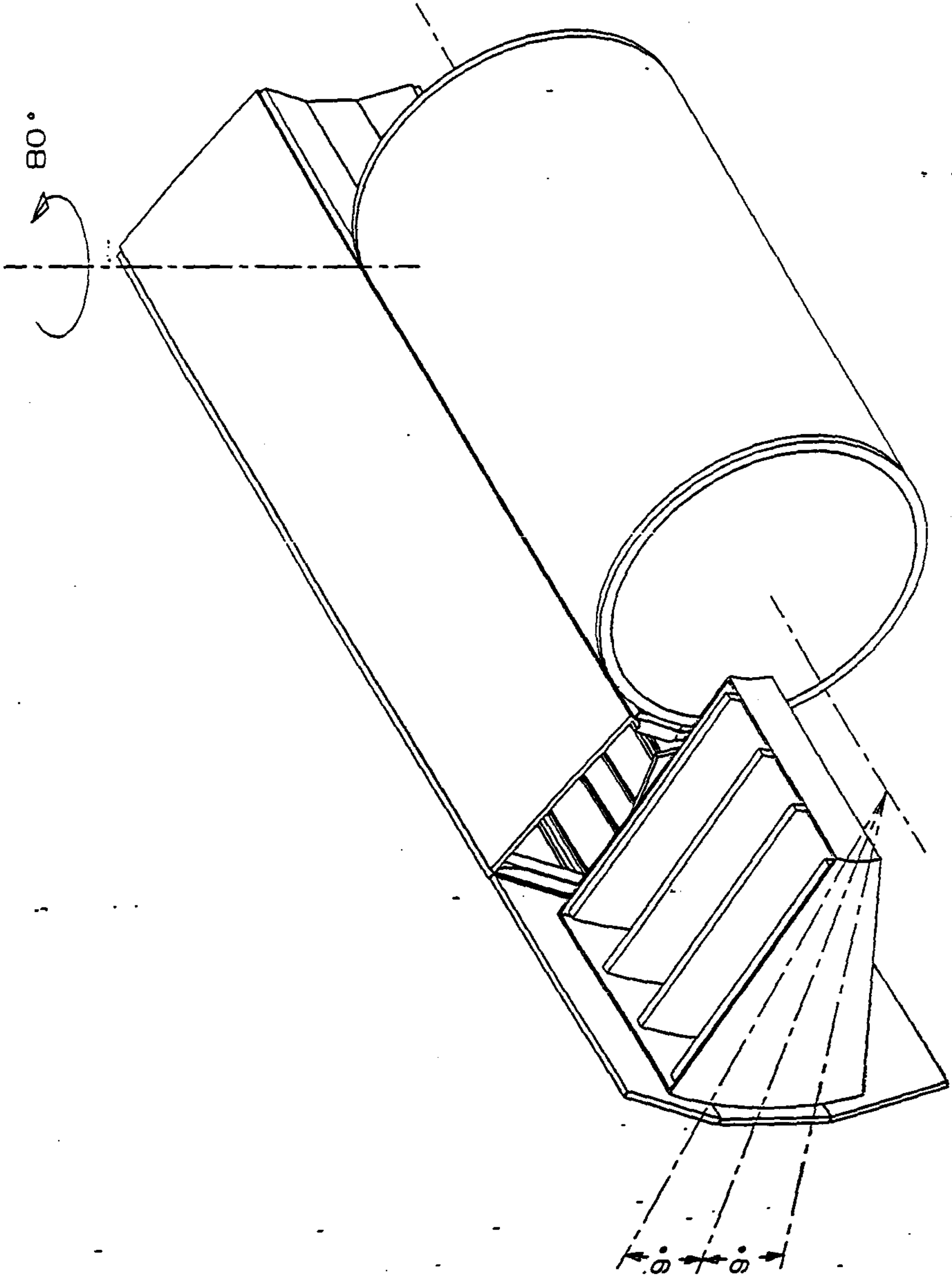
GEM-PROTO-ASSY.PRT

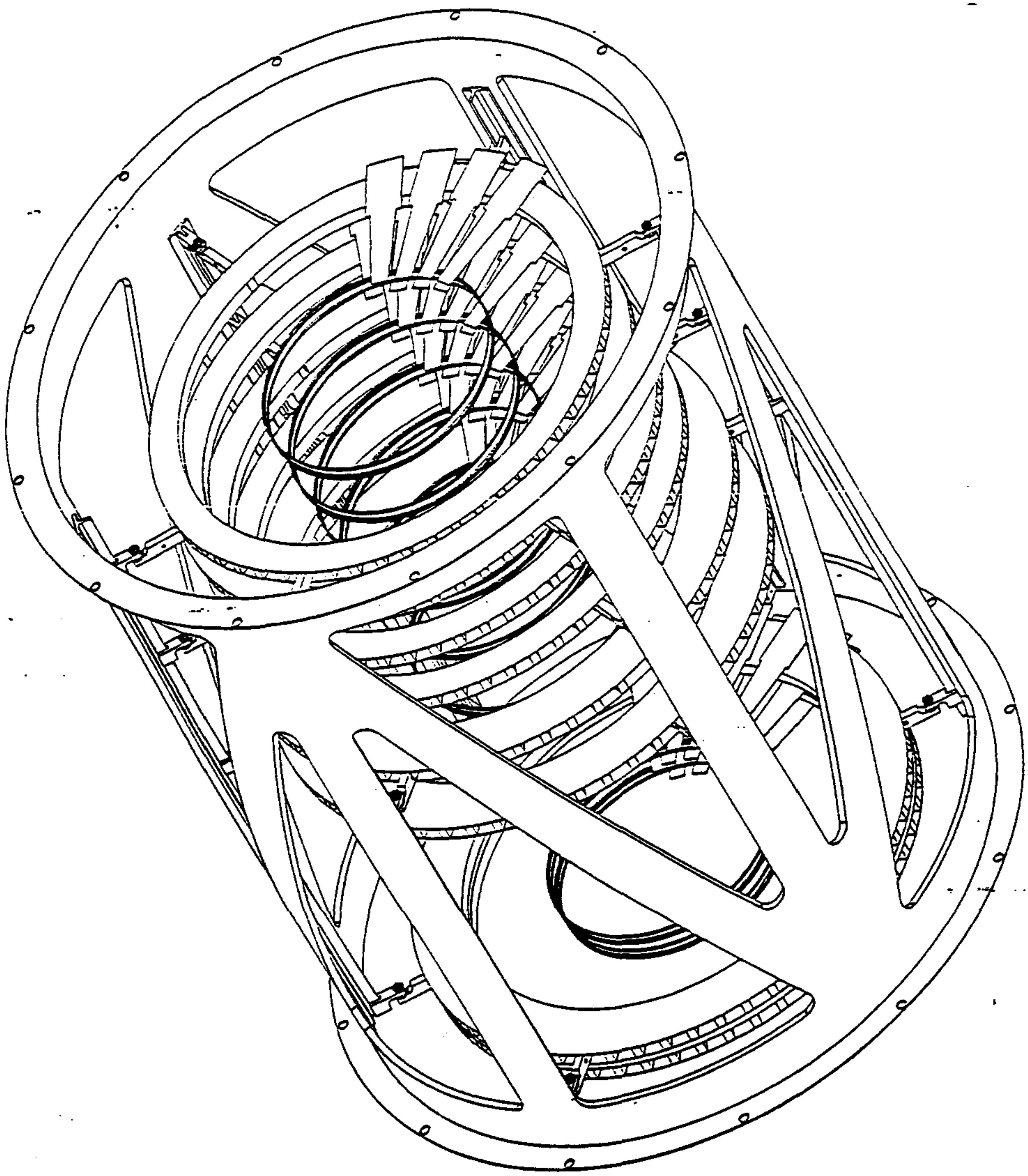


18 Si ladders
8 IPC chambers
(2 active planes per chamber)

End view showing the relative placement of the detector elements


IPC Doublets
OSS, 1/4 of total
Silicon Detector
Support Frame
Cooling Rings


80°



MUON SYSTEM TESTS:

Goals:

1. Test overall Muon System precision with tracks from a simulated focus

2. Time resolution of a large Muon System

3. Test compatibility of detectors, alignment, electronics and services

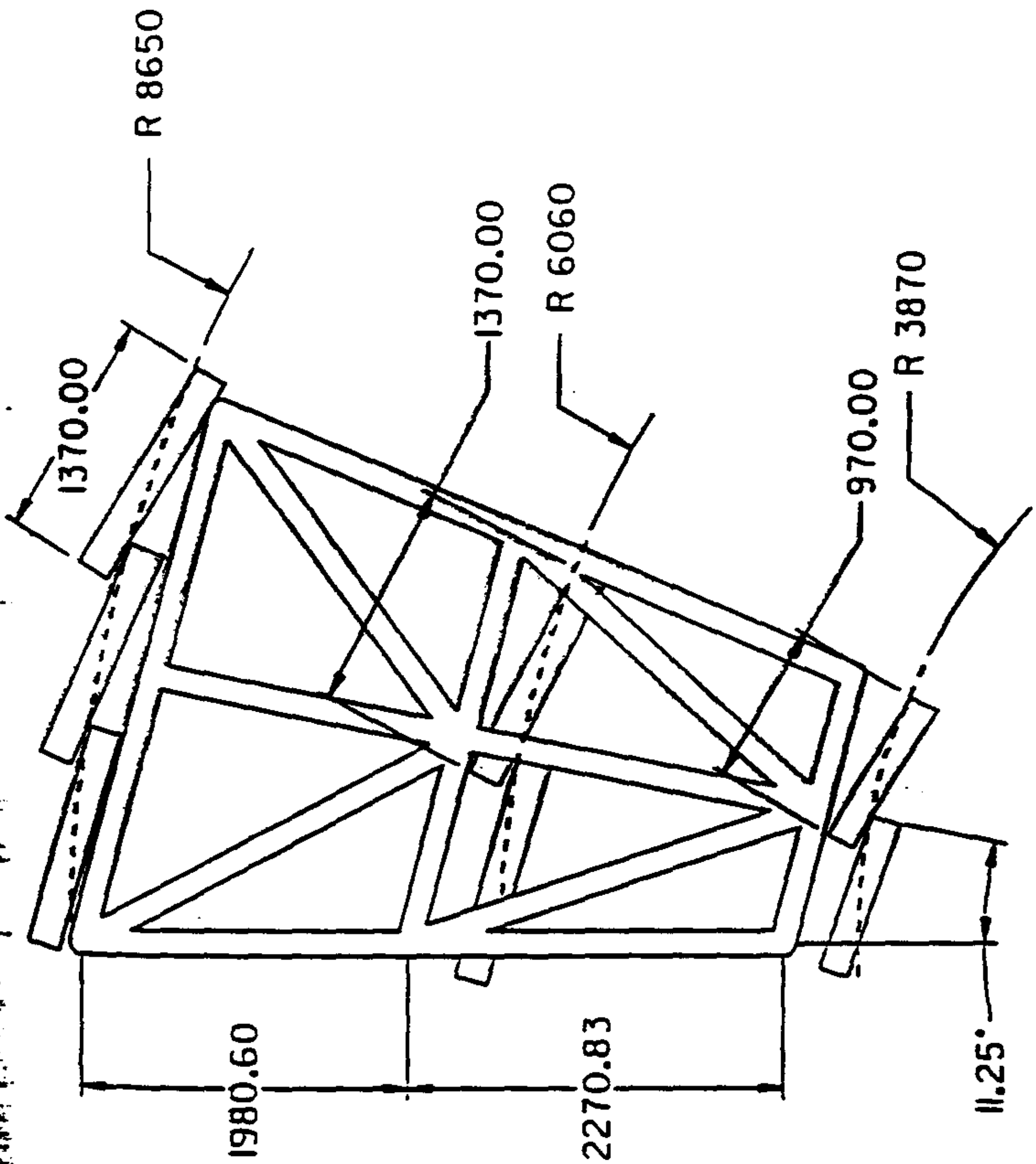
4. Investigate electronics issues and trigger prototypes

5. Test possibilities and precision of Muon System alignment with tracks (including chamber overlap region)

6. Test X-ray calibration system for global alignment

7. Muon System in integrated ("Sector") mode, test of compatibility with calorimeter and tracker, test of global alignment precision with muons.

8. Measure muon radiation and hadron punchthrough in 0.8 T field.


R 8650
1370.00
1370.00
R 6060
970.00
R 3870
1980.60
2270.83
11.25°

Equipment:

7 chambers (barrel)
(6 layers 3.5 x 1.2 m^2 active area)

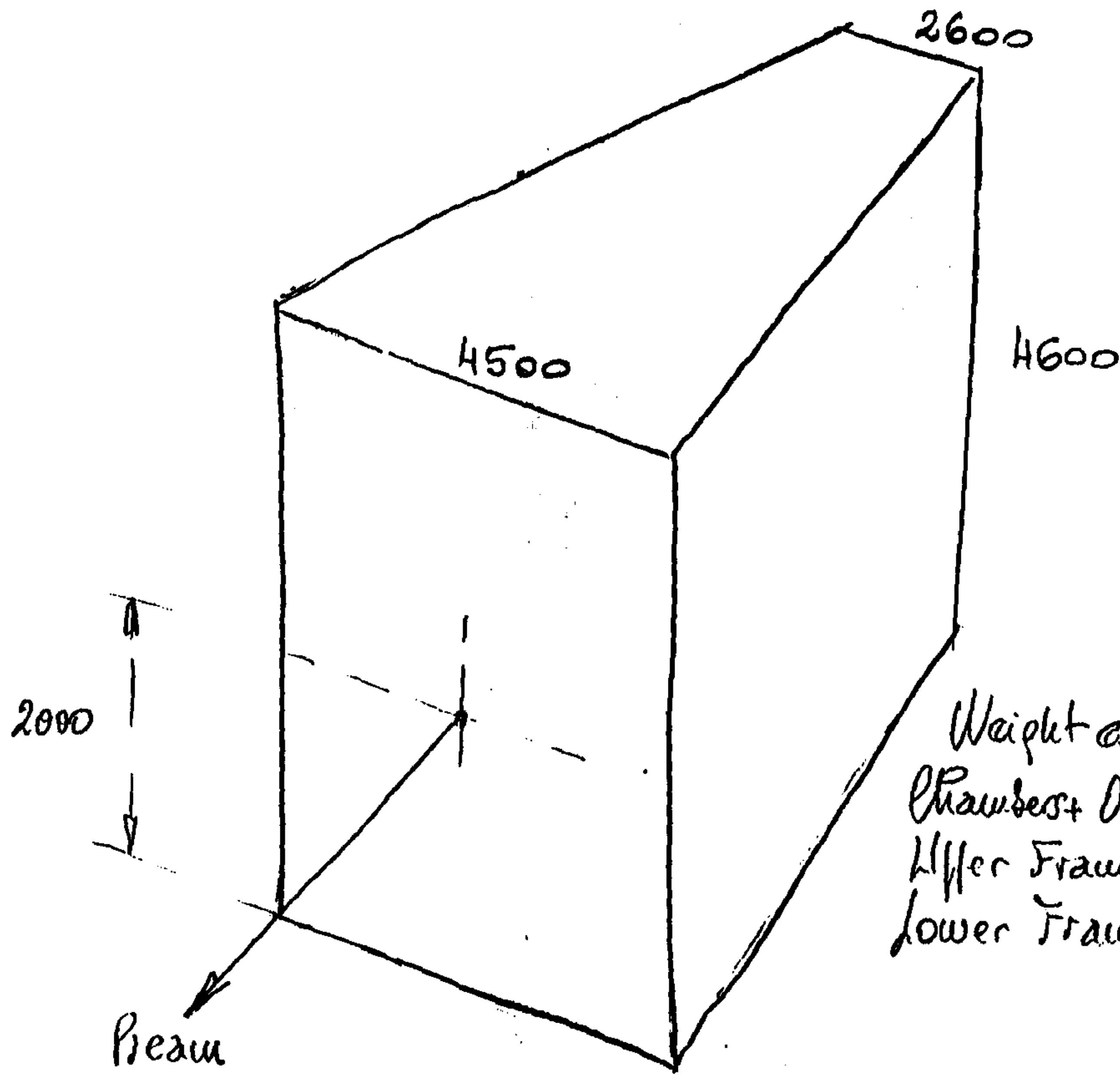
Alignment gadgets:
1. Optical monitors (LED-LENS-DETECTOR)
2. Stretched wires
Support frames, manipulators

~ 5000 channels of cathode electronics
anode electronics
trigger electronics

Tests in magnet(s).
1. Small „barrel type" chamber
2. Small „endcap type" chamber
Manipulators
Magnet(s) - different direction of magnetic field for barrel and endcap.

Electronics

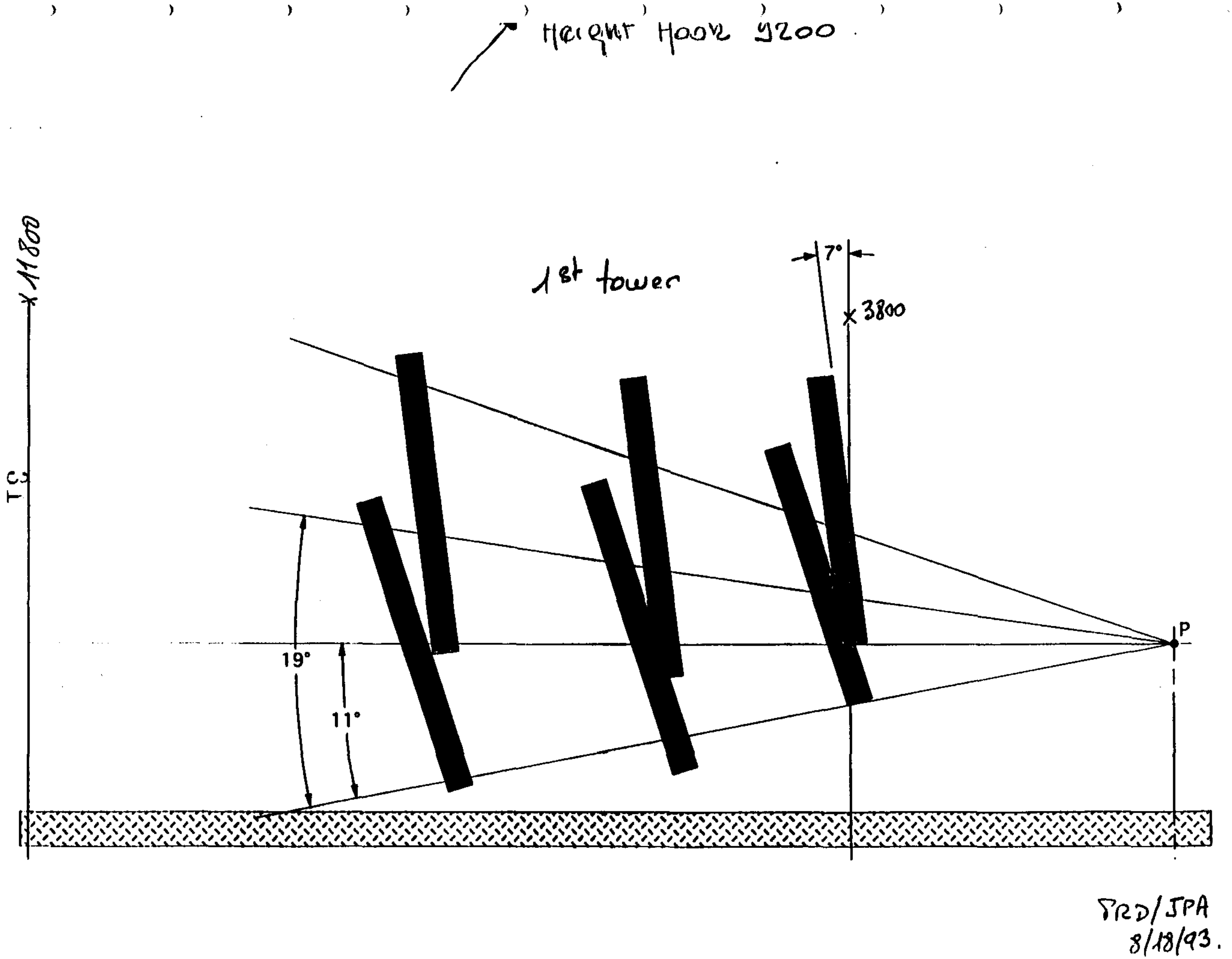
Chambers + Frames

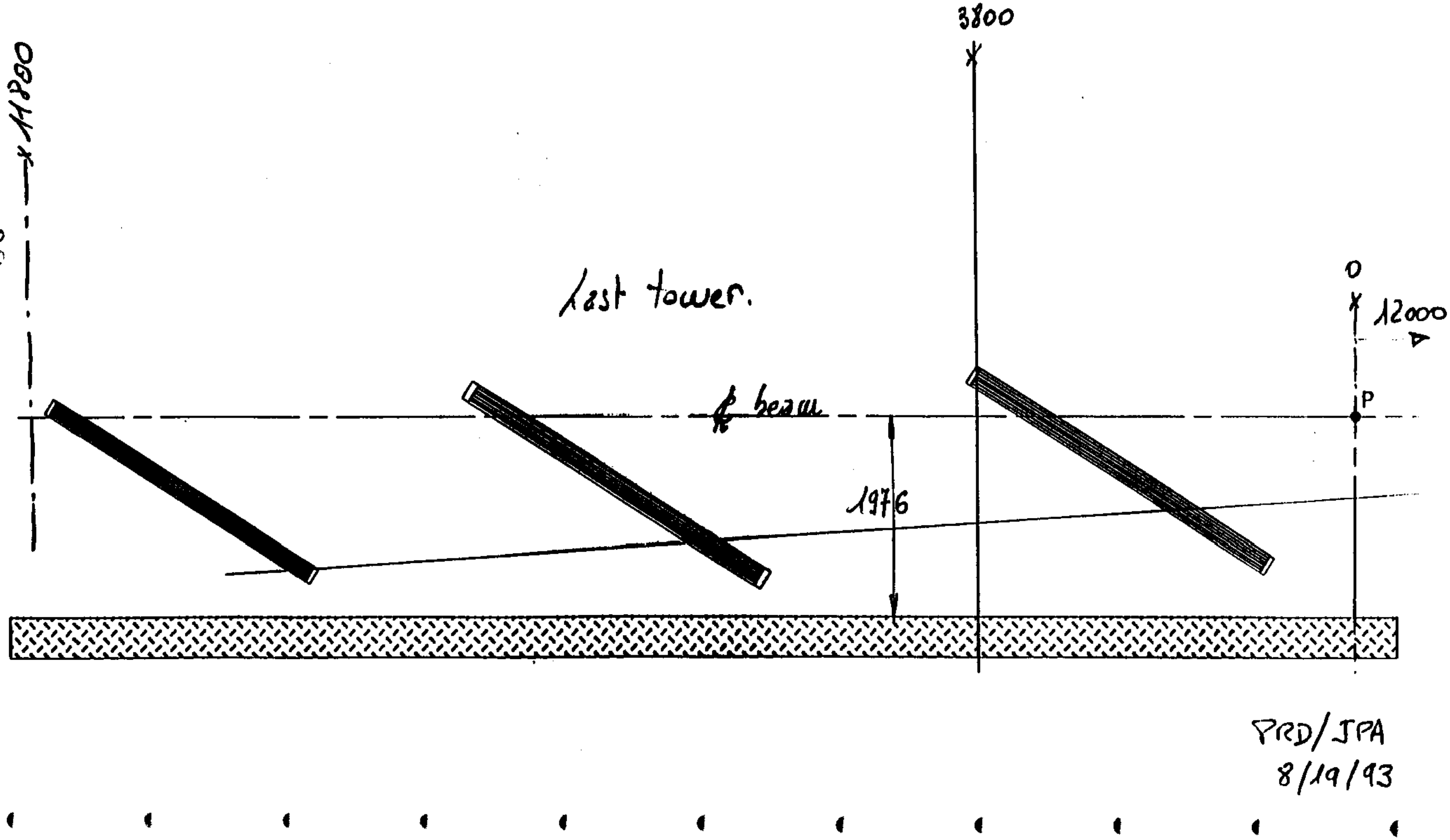


Weight estimation

Chambers + Umbilicals..	2500 kg.
Upper Frame (Steel)	5000 kg.
Lower Frame	8000
	15 500 kg.

PPD/JPA.
8/19/93.


Height floor 9200
1st tower
7°
× 3800
× 11800
P
19°
11°
TRD/JPA
8/18/93.


11800
3800
0
12000
P
last tower.
℄ beam
1976
PRD/JPA
8/19/93

(I) R&D Plan; cost, schedule, milestones for 6/95 target date.
(II) Run Plan; goals, beams, hrs, variables, time-share, calibration

I. R&D PLAN

A. INTRODUCTION

The status of the CSC muon detector design will be clarified as informaton is receivedback from the engineering studies of the first round (post-TDR) of chamber construction now in progress. The chambers built in this first round cannot be considered true prototypes as new materials and techniques which have not been tested are required for full scale production. The R&D plan presented below which leads to the arrival of 6 or 7 GEM CSC's to Fermilab in June 1995 will be adjusted later but even in this form will focus our attention on the critical path items.

B. SCHEDULE AND MILESTONES

November 1993: Construct a 6-layer full-scale CSC chamber.
Transport to the TTR and evaluate basic performance data.
Start redesigning of the Alignment Test Stand

January 1993. Start of design of the CSC chamber for Fermi tests

February 1994. Comissioning of the Alignment Test Stand.
Begin alignment hardware testing.

March 1994: Construct a 6-layer full-scale CSC with lastest design.
Transport to the TTR and evaluate basic performance data.
Finish " 0 " Generation design.
Setup chamber factory. Start building "0" generation prototype.

May 1994. Start tests of "0" generation prototype.
Finalize mechanical and alignment mounting hardware.

July 1994: Finalize design for Fermilab test CSC chambers.
Finalise design of the CSC electronics.
Finalize design for Fermilab sector framework.
Finalize design of sector transporter.

September 1994: Construct first production chamber.

Construct electronics for the first chamber.
Transport to SSC lab for testing.
Finalize design of small chamber manipulator.

December 1994: Complete Fermilab sector framework at SSC. Install available chambers and exercise system/services.

March 1995: Complete sector transporter at Fermilab. Deliver small chamber manipulator to Fermilab.

June 1995: Deliver 6 chambers, electronics, sector framework, alignment and mounting hardware, gas system to Fermilab.

COST ESTIMATE

Roughly 5% of final system cost or 6M$.

OPERATING BUDGET

150 - 200 k$ including gas and travel.

II. RUN PLAN

A. INTRODUCTION

The precision of the CSC muon system for GEM relies on its ability to accurately measure a track's sagitta. In particular a straight track (infinite momentum in a 0.8T magnetic field) should yield a sagitta of zero within errors. Any systematic point-to-point distortions in the sagitta measurement will result in a worsening of the momentum resolution. Unknown systematic distortions are to be held to less than 25 microns. Since the chambers are not rigid nor immobile an alignment system has been designed that has a primary sensitivity to movement which affects the sagitta measurement; absolute locations being a secondary concern. A sector test at Fermilab, although not in a magnetic field, will confirm that the combination of support framework, chamber mounting hardware, alignment hardware, electronics and chamber services are compatible with the precision requirements of GEM.In addition it will address the issues of practical limits of local and global alignment with muons themselves.

The chambers will be installed in a sector framework which closely approximates the barrel muon chamber support structure including all of the chamber mounting hardware, alignment hardware, and chamber services. The sector framework will be attached to a transporter which can rotate the sector framework both vertically (phi) and horizontally (theta) to project high momentum tracks through the chambers at the angles expected at the SSC.

A separate test in same beam of a small chamber in a 0.8T field will confirm previous resolution measurements (TTR, RD5, ITEP, BNL) and benchmark the effects of muon radiation and hadron punchthrough in the GEM chamber configuration. A remote manipulator will be constructed for these tests and for tests of the central tracking system.

B. GOALS

1. Test compatibility of detectors, supports, alignment and services.
2. Test track sagitta corrections with tracks from a simulated focus (test of overall muon sector precision)
3. Test X-ray calibration system for global alignment.
4. Test time resolution over a large area.
5. Test limits of muon system alignment with particles (including chamber overlap regions).
6. Investigate electronics issures and trigger prototypes.
7. Measure muon radiation and hadron punchthrough in 0.8T field.
8. Combined test with calorimeter and tracker. Test of compatibility. Test of limits of global alignment with muons.

C. BEAM REQUIREMENTS

The ideal beam for most of these tests is a 500 GeV muon beam with an intensity of at least 100 Hz. Since pion beams of 1 MHz (up to 10MHz) are standard for the MW-beam at 500 GeV, with a hadron filter upstream and momentum reselection a clean muon beam of sufficient intensity should be readily be available.

If for some reason the muon beam described above cannot be accomplished an alternative scheme would allow the pion beam to come into the experimental hall and there a combination of a beam dump and a muon tagging system downstream of the CSC test stand would be sufficient to clean up the muons for the sagitta tests.

In any event it seems prudent to plan on a muon tagging system behind the CSC test stand.

For some of the tests a 500 GeV pion beam could be used particularly in the early tuneup stages. Pion interactions in the chamber frames or in the active area would make the analysis of the data considerably more difficult but preliminary sagitta distortion measurements could be made to get a early picture of the system.

For that matter, with a large scintillation counter array as a trigger the muon system can tuneup with the muons from the primary target and dump which fill the experimental hall . These muons are of unknown momentum and therefore are not appropriate for precision measurements but provide a continuous source of particles whenever the primary target is being hit. This will provide ample opportunity to make use of the beam while other systems are using it. The large scintillation counter array can also provide a halo muon veto when tests with the secondary beam are of primary interest.

D. RUNNING SCHEDULE

More than likely the full compliment of chambers will not be ready at beam startup. Our program would, therefore, involve the following progression of tasks:

1. Test of a small chamber in magnetic field
2. Tests of a single large chamber in the sector framework/transporter.
3. Commissioning of muon sector of 6-7 chambers (possibly using beam halo).
4. Tests of muon system sector, to investigate alignment transfers and system
   precision
5. Tests of muon and calorimeter systems in close proximity.

Assuming 1-2 weeks of tuneup with halo muons before each of the above tasks that 1-2 weeks of running (or better 1-2 runs of 1 week each) for each task would be sufficient.

Points of Agreement

July 9th meeting

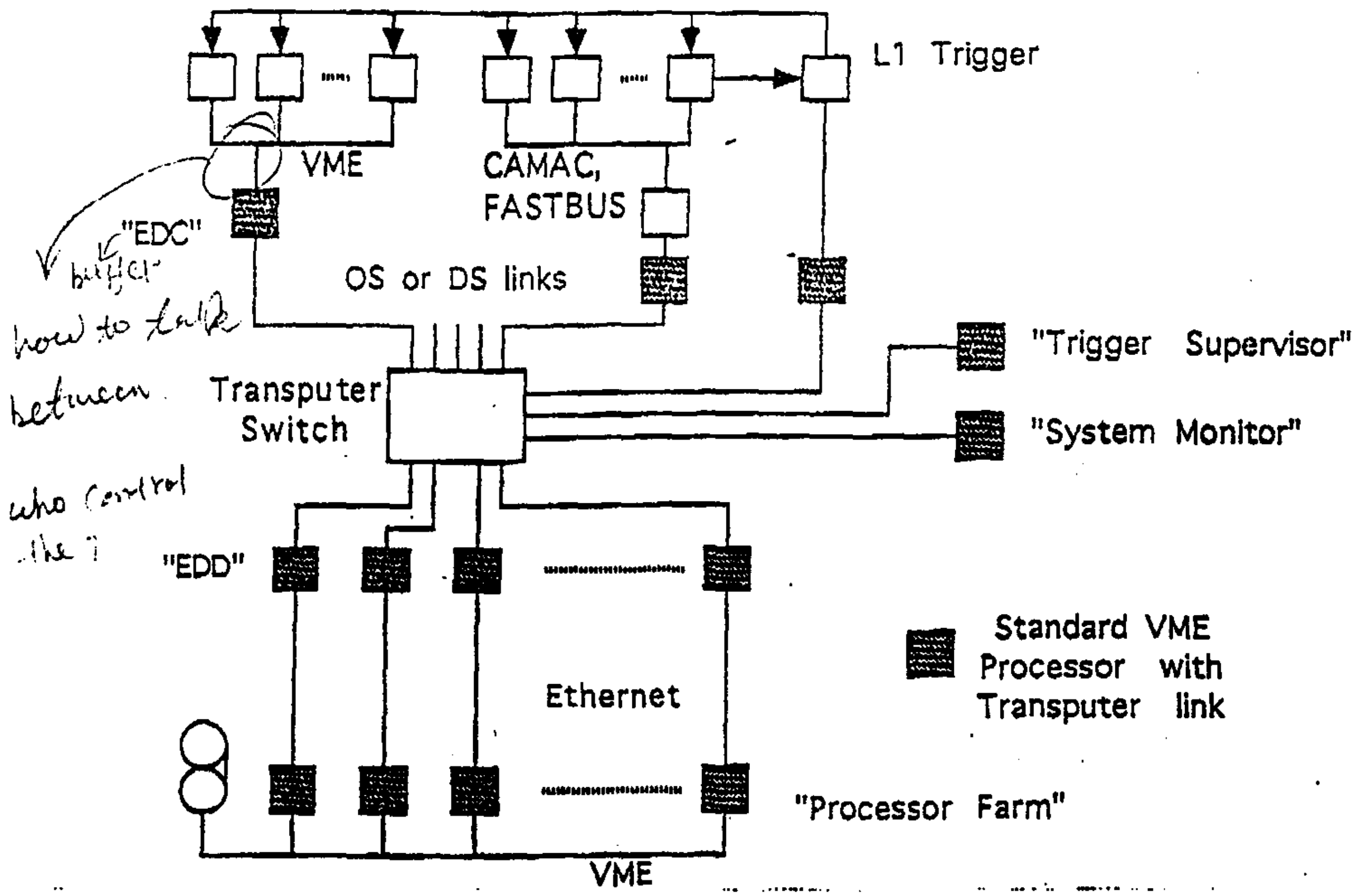
1) The Fermilab test beam DA will employ a two level architecture employing VME crates at both the subsystem and master levels.

2) The subsystem level crates will employ Motorola CPU's (MVME 162's or 167's), VME modules and VxWorks running the same software to read out the individual detector elements (Calorimeter, Central Tracker, ...). The subsystem level hardware must be capable of supporting both CAMAC and Fastbus input.

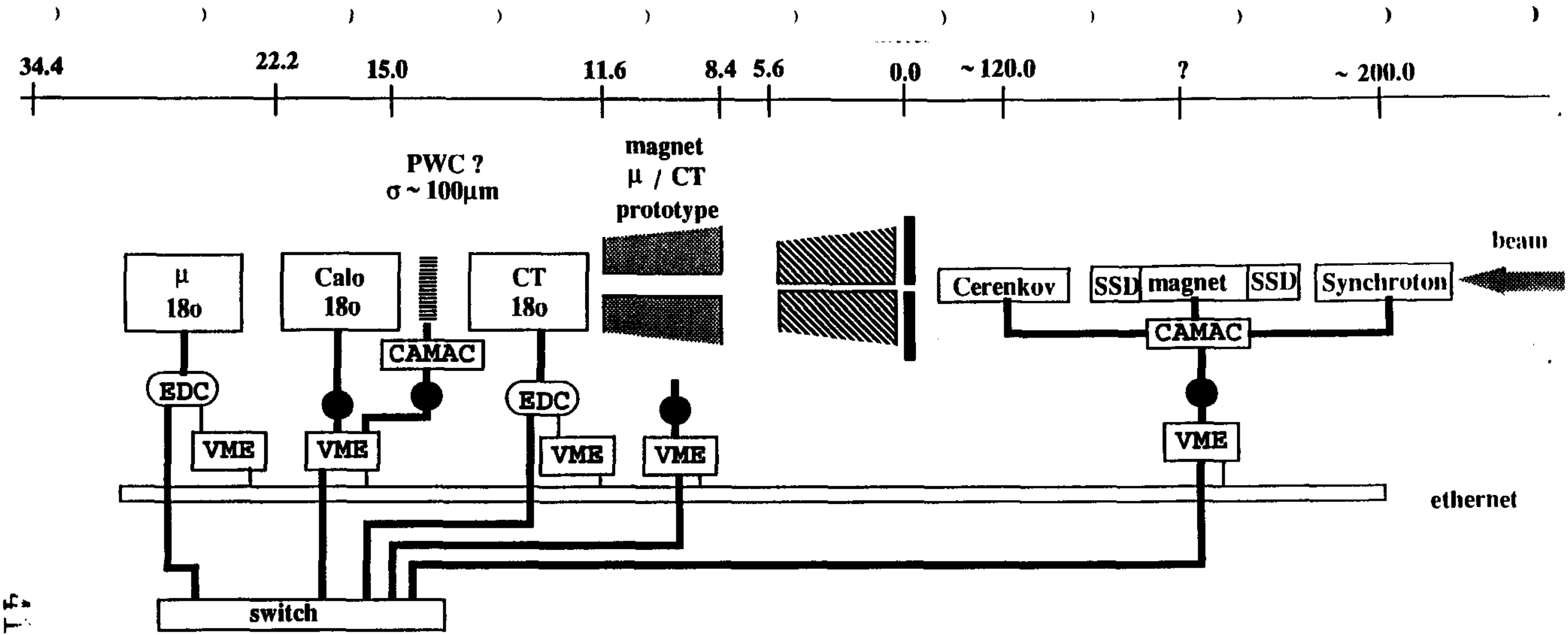
3) The master crate (data collector/event builder/data distributor) level will incorporate two options:

> BASELINE: Employ a hardware switch - T9000/INMOS Packet Switches (which may reside in VME modules).
>
> FALLBACK: Employ the same hardware used at the subsystem level and VxWorks running existing software - e.g., PRDAQ or a variant of the existing BNL system.

4) The choice between the baseline and the fallback position will be made early enough (12-18 months) to insure a working Test Beam DA prior to the start of the next fixed target run.



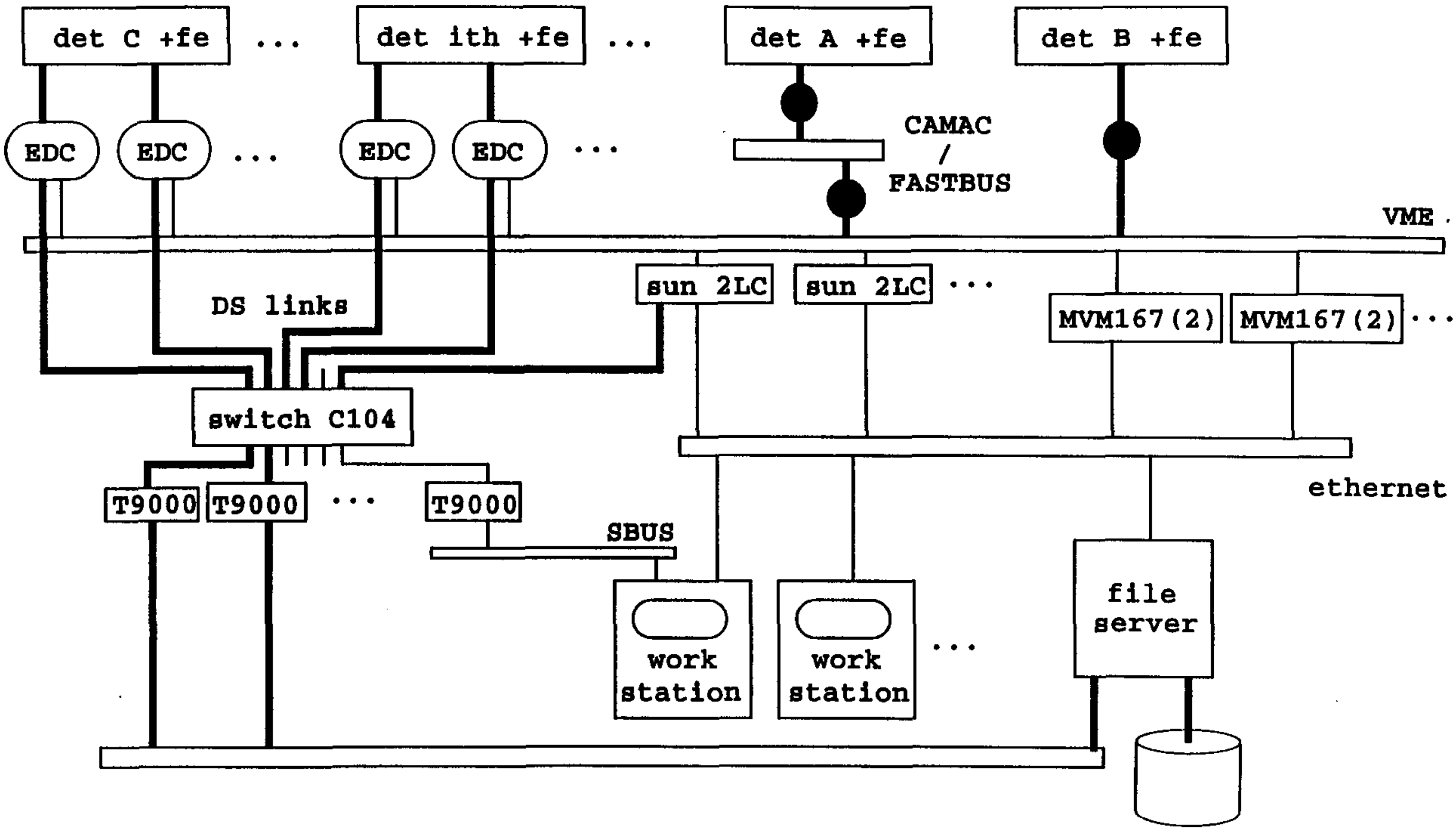
July 9 design



where those crates are going to be (cable distance)?

Dept. Phys. & Astr. U. of Roch. SWB-RL DWGNo TSP-(
Antonio Morleos 17 Aug 1993

Conceptual DAQ Architecture Design for GEM Test Beam at Fermilab



interface

data
flow

NO contact when line crosses device o bus

Antonio Morelos v001-06 18-Aug-1993

Tasks

Planning
- Write Test Beam DAQ chapter contribution
  - Goals
  - Time Scales
  - Costs
  - Requirements
- Architecture Specification
- Organization and decision making

EB Switch
- Design Requirements Review - 9/15/93
- Preliminary Test of Test-EB - 1/15/94
- Design/Test Review - 7/15/94
- Deliver Test-EB to Fermilab - 2/15/95
- Test Beam operation

Build MWEST hardware system and experience
- Need parts for test system
- Write code for test project (but useful)
- Bring up backup EB
- Bring up EB switch after delivery

General DA software development
- Need Interfaces for each device to Event Builder
- Interface to slow controls
- Interface to Analysis and Control System
- Interface to Configuration Manager
- Develop calibration mechanisms

Implementation
- Bring up stand alone systems
- Exercise simulated data
- Test rates
- Exercise full system with simulated data.

Chapter 6 - Electronics

Chapter 7 - DAQ / Computing

DAQ - Jim Dunlea

DAQ System Architecture
Hank Uijterwaal, Antonio Morelos et al.

Trigger and readout requirements
Sean McCorkle, Bill Cleland, Magel A., Peter Dingus, Hank U.

Computing - Gary Word

Control/Monitoring
T. Kozlowski, V. Glebov

Analysis and Code Development
John Womersley

Data Communications
PRCD/ Larry Cormell

Simulation
John Womersley

Storage
PRCD/ Larry Cormell

Both

DAQ/Computing R & D

Cost and Schedule

DAQ/Computing RDT Mtg.
18 Aug 93

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Vladimir Glebov	214-708-6321	GLEBOV@SSCVX1.SSC.G
MARK BOWDEN	-6233	BOWDEN@SSCVX1.SSC.
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Antonio Morelos	6209	Morelos @ sscvx1
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Ken McFarlane	6120	Mcfarlan@sscvx1

DAQ/Computing R&D Goals:

- Global Control System
  - Test of EPICS
  - Test GUI for run control
    (may not use EPICS for GUI)

- DAQ
  - Develop EDC protocol
  - " EDD "
  - Gain Switch experience
  - Test of production DAQ <u>concepts</u>

- Online
  - Develop event filter interface
  - Test interface to data storage
  - Develop efficient data re-formatting techniques
  - Provide Level 2/3 interfaces

- Data Storage
  - Test the "transparent tertiary storage" model
  - Test the "single-file system" model
  - Provide for long-term access to all data
- Analysis
  - Provide interface to data for common HEP analysis tools such as PAW
  - Test some newer tools
- Simulation
  - Compare with data
  - Correct deficiencies
- Calibration
  - Develop and test scheme for handling calibration data.

RDT sections & authors

- General DAQ reviewer/editor: J. Dunlea
- General Comp. " " : G. Word
  - DAQ R&D and System Architecture
    - H. Vijterwaal - lead author
    - M. Bowden, M. Botlo
    - P. Dingus - reviewer
  - Trigger & Readout Requirements
    - H. Vijterwaal • lead author → S. McCorkle
    - B. Cleland, M. Atiya
    - A. Morelos - reviewer
  - Control & Monitoring
    - Tasks
    - Architecture
    - Configuration Management
    - Calibration
      - T. Kozlowski - lead author
      - V. Glebov - reviewer

- Computing Architecture
  - G. Word - lead author
  - L. Cormell
  - K. McFarlane - reviewer
- online (event selection/monitoring/display)
  - G. Word - lead author
  - V. Glebov, L. Cormell
  - K. McFarlane - reviewer
- analysis and code development
  - J. Womersley - lead author
  - K. McFarlane, L. Cormell
  - G. Word - reviewer
- data communications facilities
  - L. Cormell - lead author (TBC)
  - G. Word - reviewer
- data storage facilities
  - K. McFarlane - lead author
  - L. Cormell
  - G. Word - reviewer
- simulation
  - J. Womersley - lead author
  - I. Fissiak
  - H. Vijterwaal - reviewer

Memo

To: L. Cormell
From: G. Word

Re: Response to June 2, 1993 memo on "GEM and SDC Test Beam Requirements"

Date: August 18, 1993
CC: (PRCD) J. Burton, S. Frederiksen
(GEM) K. McFarlane, P. Slattery, G. Yost, H. Newman
(SDC) A. Fry, I. Gaines, J. Siegrist

E-file: /afs/ssc.gov/home/w/word/notes/tb/comp.req.930818

In response to your memo of June 2, 1993, here are some of the expected requirements for the computing needs for the GEM Test Beam effort.

Scope of Requirements

The test beam runs are expected to commence around the fall of 1995. The run will probably last for one year. While ongoing test beam activities may continue for many years, possibly even after the GEM detector begins taking data at the SSC, in this memo, I restrict my attention to the computing requirements anticipated during the first year of running.

Data Rate Requirements

The expected event size will be on the order of 10 kilobytes, with an anticipated event rate on the order of 100 events/second during a 20 second spill of particles from the FNAL particle beam. Thus the data rate over a spill is 10 kB/event * 100 event/second = 1 MB/s (20 second spill average).

Each 20 second spill is separated by 40 seconds of time during which a new spill is being prepared and no events are taken. (While some calibration data may be taken during these 40 seconds, the calibration data is assumed to be small compared to the beam-generated data.) Averaged over a minute, the data rate is 1 MB/s * 20s/60s = 0.3 MB/s (minute average).

During the course of an hour of data taking, the detector will be moved to various locations. Allowing for one third of the time over the course of an hour to be devoted to moving the detectors, the average data rate per hour is expected to be 0.3 MB/s * (1 - 1/3) = 0.2 MB/s (hourly average).

Data Transfer Rates

The transfer rates should be sufficient to keep from losing beam data. This implies a data transfer rate somewhat greater than the hourly-averaged rate of 0.2 MB/s. As a rough estimate I add 50% to the average rate, yielding a transfer rate of 0.2 MB/s * 150% = 0.3 MB/s (hourly average).

File Size

The smallest natural unit for raw data is an event (roughly 10 kB). Each minute, one spill of data will be collected, so the next natural unit is 1 MB/s times 20s, or 20 MB. Since it is expected that files much larger than, say, 500 MB might be difficult to handle, files can be restricted to be less than some maximum size. Minimum file sizes may be desirable to make efficient use of the mass storage system. We expect that the files should at least be 20 MB in size.

Mass Storage

* Total Long Term Capacity

Allowing for one year of running, the mass storage requirements can be determined by taking the number of seconds in a year (pi * 10**7) multiplied by the (hourly averaged) data rate (0.2 MB/s) and multiplying by the typically machine efficiency factor of (1/pi), for an expected yearly collection of data on the order of 2 TB in size. This is in rough agreement with the data sample sizes that will be required to perform the anticipated physics measurements. (A forthcoming memo will describe in more detail the expected data sample sizes for each subdetector.)

It is expected that a modest increase in capacity on the order of 50% should be sufficient to handle data enrichment, so that the total capacity of the mass storage should be increased to about 3 TB by the end of the run. An acceptable scenario might be to have on the order of 0.5 TB of storage available and tested by turn on with about 0.2 TB of capacity added on average each month.

* Accessibility of Long Term Data at SSCL

It is desirable that all data be accessible at all times without human intervention. It is expected that large quantities of data will be available at the SSCL in a fast-cache with disk-like access times. The SSCL fast-cache should be capable of holding about 10% of the data, which implies a minimal fast-cache of about 0.3 TB.

* Raw-Data Disk Cache at FNAL

The size of the disk cache at FNAL that is required for data taking should be large enough to handle any reasonably expected non-scheduled outages of the remote mass storage system or links to it. An estimate of the raw-data disk cache may be made by requesting about a days worth of data, or (0.2 MB/s * 60 s/min * 60 min/hr * 24 hr) = 17 GB.

* Accessibility of Long Term Data at FNAL

It is expected that all data that is taken at FNAL will always be visible at FNAL, even after the data has migrated to SSCL. Visibility at FNAL means that the data file will appear to still be on disk by the use of the "ls" command, and that file sizes and time stamps will be available, so that the information that is returned by "ls -l" command will always be available. Some distributed file system, such as AFS, might satisfy this requirement, if the speed of caching can be demonstrated to be sufficient.

* Additional Analysis Disk Cache at FNAL

It is expected that data analysis will occur on cpu's both at FNAL and at SSCL, running on data which is transparently cached so that it is available locally to the analysis program. Thus, it is expected that additional disk cache at FNAL will be required to hold data that is being analyzed at FNAL, but which is not in the raw-data stream. An additional 2 days worth of data, or 34 GB, is an estimate of the size of this additional disk cache.

* Additional Copies of Data

It is expected that the SSCL will be the sole central repository of the raw data. Data samples which are to be transferred outside of SSCL are expected to be created by those who want the data. PRCD is not being asked to provide the manpower to create large data samples which would be taken elsewhere.

Note that it is anticipated, however, that one complete copy of the data will be made and stored in a different building, such as SSCL Central Facilities, for backup purposes and as a safeguard against local disasters.

CPU Requirements

The type of analyses that will be performed on the FNAL data will be much less demanding of CPU power than would be expected in a typical data analysis run. It is anticipated that the CPU requirements for data taking and data analysis at FNAL will be satisfied by on the order of ten workstations of the 50 to 100 MIPS variety. Later memos will be directed to making a detailed analysis of the CPU requirements, both at FNAL and at SSCL.

Analysis Mode

* Overview

To better understand the anticipated manner in which the data will be analyzed, it is worthwhile to explain a few details about the data taking. What will be of great interest in the data is the response of a particular part of the detector to different beam energies. Because it takes considerable time to tune a particle beam to a particular beam energy, the beam energy will be fixed at some energy while the detector is moved so that the beam will scan differing parts of the detector. After a full scan of the detector at a particular beam energy, the beam will be retuned to a different energy and the detector will be scanned again at this new energy. Thus, the events which are collected at a particular part of the detector for various energies will be taken at disparate times.

During data analysis, the analysis program will be interested in accessing events at a particular detector location, and will thus be asking for run and events that were taken at disparate times. It is expected that a database will be used to assist in creating the list of events that were taken at a particular detector location, or have some other common attribute. (Note that this requirement does NOT impact whether the raw data itself will be placed in a database.)

* Graphics Hardware

It is expected that minimal-color Motif displays will satisfy our graphics requirements and that we will not, in general, need high-end graphics workstations. Such a request being made at a future date, however, is not ruled out.

* Limiting Factors

It is expected that the limiting factors in an analysis will typically be access to disparate data samples, followed by i/o access. Due to the type of data being collected, it is not expected that the analyses will be cpu intensive. A later memo will provide a detailed analysis.

Summary

The first year of GEM Test Beam at FNAL data will be collected at a rate of about 0.2 MB/s onto about 17 GB of disk cache (a days worth), transparently transferred over a network with at least 0.3 MB/s capacity to about 0.3 TB of disk cache at SSCL where it will be transferred again into tertiary storage with an initial capacity of about 0.5 TB, growing at the rate of about 0.2 TB each month, for a year-end capacity of 3 TB. The data will be analyzed on cpus primarily at SSCL (cpu requirements not yet specified). Some analysis will occur at FNAL with about 1 GIPS of cpu power and about 34 GB (2 days worth) of additional disk capacity.

Ensuing memos should be directed at understanding the implementation issues of creating such a system, including installation, routine maintenance, systems administration, disaster-recovery procedures and integration into the existing FNAL network environment.

SSC EPICS System.

(Global control system prototype).

* The system arrived last week and has been installed next to the TTR.

* The system consists of a Sun Sparc IPX station, some hardware to control (power supply, stepper motor, ...), the EPICS software (and a demo package) and a pile of manuals.

* Those of you interested in working with EPICS should contact me for an account on ssc-epics, a demo and a copy of the *"introduction to Epics"* by Bill Kornke.

* Warnings:

1. **There are a few minor problems with the setup itself,** not everything in the intro. works as it should work. Bill Kornke and I are working on this.

2. **At present, everybody can overwrite almost everything.** I'm trying to fix that. In the meantime: do not save any modified files unless the text explicitly tells you to do so.

3. **No backups are being made**, the system is not yet connected to the network. Both problems will be solved soon.

* We had a hardware problem last week that made the screen look like a TV. with a bad antenna. It disappeared for no apparent reason. Should this problem ever occur while you are working on the system, call me immediately.

****** File: user9:[kozl.gcs]gem_rdt_gcs.tex ******

1 Global Control System

The Global Control System (GCS) for the GEM FNAL Test Beam effort provides "slow control" and monitoring for the detector subsystems, including data acquisition and online computing, and interfaces to external systems (beamline, acclerator, etc.). The EPICS system will be used to implement as much of the GCS as resources and capabilities permit. The GCS Test Beam effort, besides its necessity for carrying out the Test Beam program, also is an opportunity to gain experience applicable to and to prototype parts of the final GEM GCS. The scope of the GCS includes all hardware and software from user interfaces to and including hardware modules residing in the VME and Industrial IO crates that interface to actual sensors, motors and actuators, but not including actual sensors and actuators. They, including cabling to the modules in crates, are considered to be part of specific subsystems.

1.1 Major Tasks

The FNAL Test Beam GCS provides the following functions:

1. Central tracker control, monitoring and archiving, including transporters
2. Calorimeter control, monitoring and archiving, including cryogenics and transporter
3. Muon System control, monitoring and archiving, including alignment system and transporters
4. Electronics crates monitoring and archiving
5. Online computing control, monitoring and archiving
6. Control, monitoring and archiving of external systems, including beamline (requires interface to FNAL EPICURE control system), interfaces to accelerator, and interfaces to environmental and safety systems
7. Global user interface

Major tasks that must be carried out to implement the GCS are:

1. Specification of requirements for each GCS component
2. Prototyping and design for each GCS component

3. Hardware (crates, IO modules, workstations, microprocessors) acquisition for each GCS component
4. If EPICS is to provide support for control and monitoring of online computing systems (including event and other data processing), an EPICS interface to "channels" in UNIX tasks is required (EPICS at present only supports access to hardware "channels").
5. EPICS interface to FNAL EPICURE control system. Required if EPICURE monitoring data (magnet currents, etc.) is to be archived along with other EPICS data.
6. Specific software for each GCS component
7. Installation and testing at FNAL

1.2 Architecture

Functionally the Test Beam GCS matches the functionality of the GEM GCS, with the exception of the GEM Magnet Subsystem, and different interfaces to external systems. [cf. TDR for appropriate block diagrams]

```
FNAL Test Beam GCS R\&D
 (70% of GEM TB allocation for WBS 60.1.1.5)
Materials:                                      $ 8k
Labor:                                           53k
Contingency (15%):                                9k
TOTAL:                                           70k

FNAL Test Beam GCS Implementation
 (70% of GEM TB allocation for WBS 60.2.7)
Materials:                                     $100k
Labor:                                           80k
Contingency (18%):                               33k
TOTAL:                                          213k

Operations                                     [TBD]
```

2 Cost and Schedule

2.1 Budget Totals

Budget estimates are based on the alloations in the current "GEM Computing Detailed Cost Book" which breaks down costs in terms of the GEM WBS (Work Breakdown Structure). All costs, included EDIA and contingencies are included. Only those items in the GEM plan that relate directly to Test Beam activities are included.

2.2 R&D Budget and Schedule

The responsibilities for implementation of the FNAL Test Beam GCS are not yet established in detail. A working group will be formed to specifcally address GCS issues for the Test Beam work. At present the following persons have been identified, including contacts and resources for the various subsystems and GCS components:

1. T. Kozlowski (SSCL/LANL), coordination
2. C. Timmer (LANL/AT-8), implementation of EPICS applications (presently responsible for the calorimenter transporter controls)

3. TBD. silicon tracker contact
4. TBD. IPC contact
5. Spisiak (Rochester), calorimeter transporter contact
6. W. Wisniewski (SSCL) noble liquid calorimeter contact
7. J Voyles (SSCL) cryogenics contact
8. V. Glebov (SSCL) muon system contact
9. TBD [redacted] (SSCL) electronics monitoring contact
10. TBD. online computing contact
11. R. Dalesio (LANL/AT-8) EPICS contact (UNIX IOC)
12. Therese Watts (FNAL) EPICURE control system contact
13. TBD. FNAL beamline contact
14. TBD. FNAL accelerator systems contact
15. TBD. FNAL safety systems contact

TA preliminary budget and schedule for individual tasks follow. This is based on estimates of allocations of funding for Test Beam activities in the GEM cost plan. Further refinement is necessary.

1. R&D: Specification of requirements
   (a) budget: $ 30k
   (b) duration: 1 Aug 1993 - 1 Jan 1994
2. R&D: Prototyping and design
   (a) budget: $ 40k
   (b) completion: 1 Jan 1994 - 1 Jan 1995
3. Production: Hardware (crates, IO modules, workstations, microprocessors)
   (a) budget: $ 82k
   (b) completion: 1 Jan 1994 - 1 Aug 1995

4. EPICS interface to "channels" in UNIX tasks software
   (a) budget: $ 50k
   (b) completion: 1 Jul 1994 - 1 Jul 1994
5. EPICS interface to FNAL EPICURE control system
   (a) budget: $ 10k
   (b) completion: 1 Jul 1994 - 1 Jul 1994
6. Production: Software
   (a) budget: $ 30k
   (b) completion: 1 Jan 1995 - 1 Apr 1995
7. Installation and testing at FNAL
   (a) budget: $ 40k
   (b) completion: 1 Apr 1995 - 1 Aug 1995

2.3 Milestones

- 01 SEP 1993 - 1st draft of project plan document for TB GCS
- 01 SEP 1993 - 1st draft of requirements document for TB GCS
- 01 JAN 1994 - Completed specification of TB GCS
- 01 JAN 1995 - Completed final design of TB GCS
- 01 APR 1995 - Cryostat/Transporter controls ready at FNAL
- 01 AUG 1995 - Working TB GCS at FNAL
- 01 SEP 1995 - start of FNAL fixed target run
- 01 SEP 1996 - end of FNAL fixed target run

PRELIMINARY RESULTS FROM FIRST TEST OF FULL SIZE BARREL PROTOTYPE AT BNL AGS TEST BEAM

INDIANA

C. BOWER J. HUSSER

LOS ALAMOS

M. BROOKS D. LEE R. MARTIN G. MILLS
J. ROMERO

SSC LAB

H. FENKER K. MORGAN R. SHYPIT J. THOMAS

SUNY @ ALBANY

B. NEMATTI, J. O'NEILL, H. SEVERINI

YALE

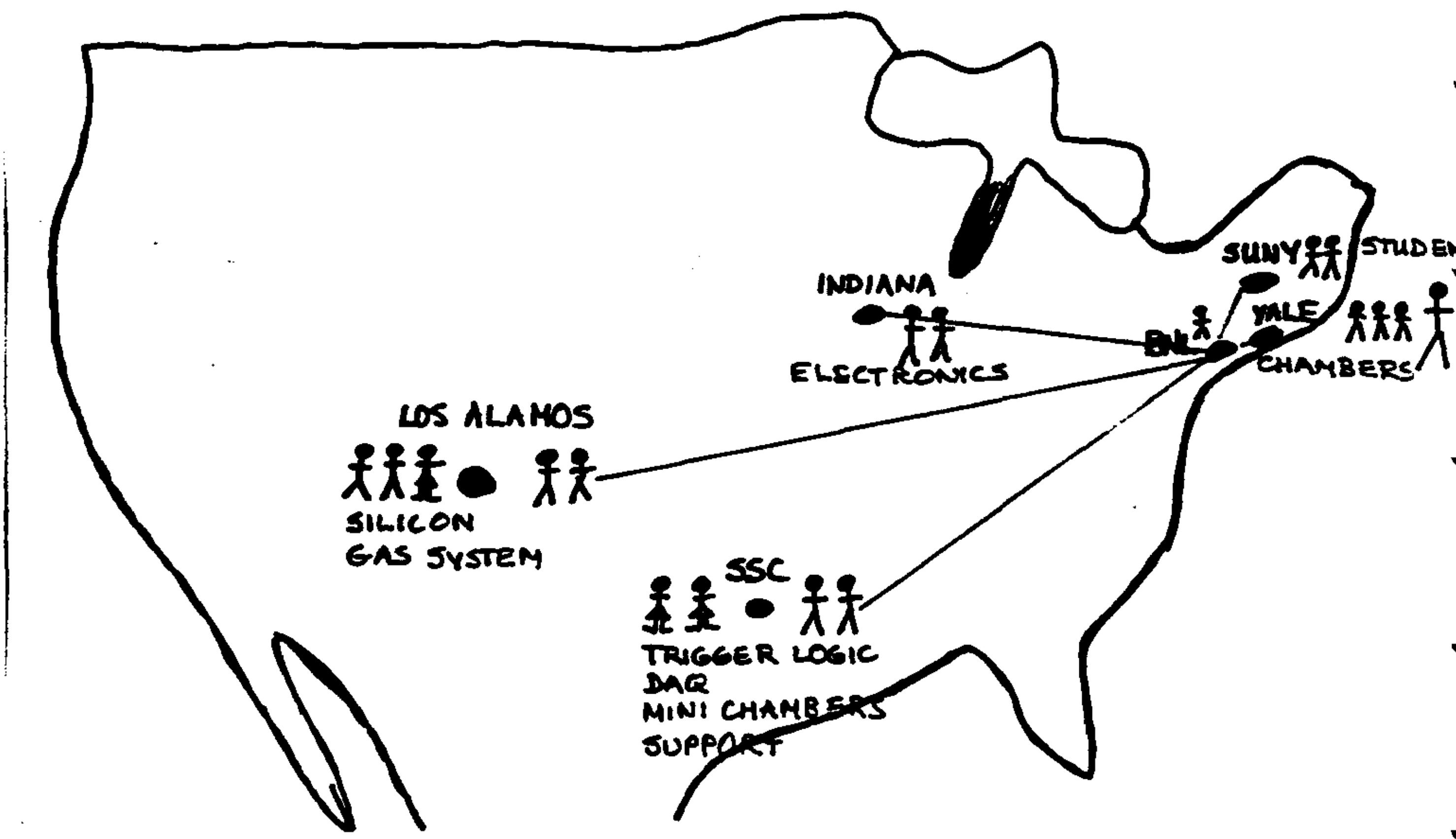
C. BALTAY B. BRRAKET E. WOLIN

BNL

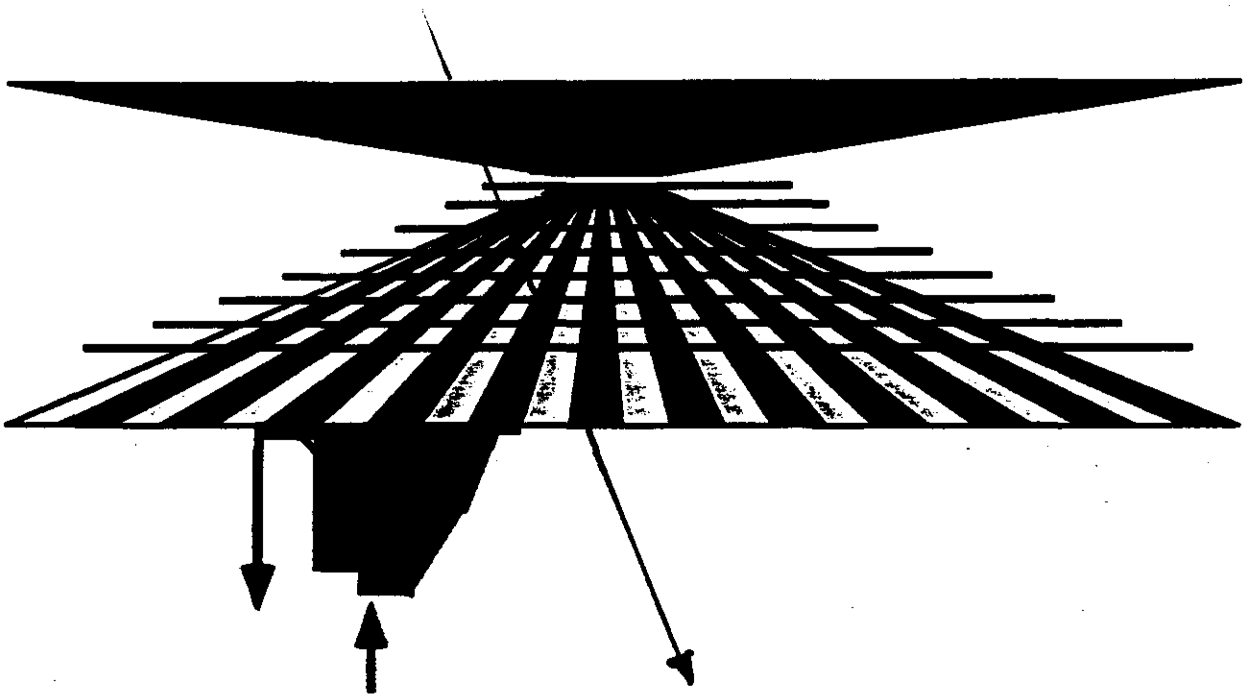
B. YU

THANKS TO H. GORDON, V. POLYCHRONAKIS

- FIRST OPPORTUNITY TO GET THE HARDWARE & PEOPLE TO WORK TOGETHER



- TOTAL OF 17 PEOPLE FROM 5 INSTITUTIONS



EQUIPMENT

- 2 IPC PROTOTYPES : 2m LONG
  20 CM WIDE
  (2.5 mm pads) TWO STEREO LAYERS ± 50 mR
- 4 SILICON WAFERS 1 y, 3 x
  AC COUPLED "OPAL" DETECTORS
  SVXD ELECTRONICS (FROM CDF)
  USE ANALOGE INTERPOLATION
- 72 CHANNELS OF BNL HYBRID BASED FAST PREAMP / SHAPER + 11 BIT ADC s
  (FUNCTIONALLY IDENTICAL TO FINAL DESIGN WITHOUT READOUT SAMPLING)
- DAQ – TTR BASED SYSTEM WITH 68040 μP
  + 2 SPARC WORKSTATIONS IN VME
- 6 MINI-CHAMBERS + ELECTRONICS FOR TWO-TRACK STUDY

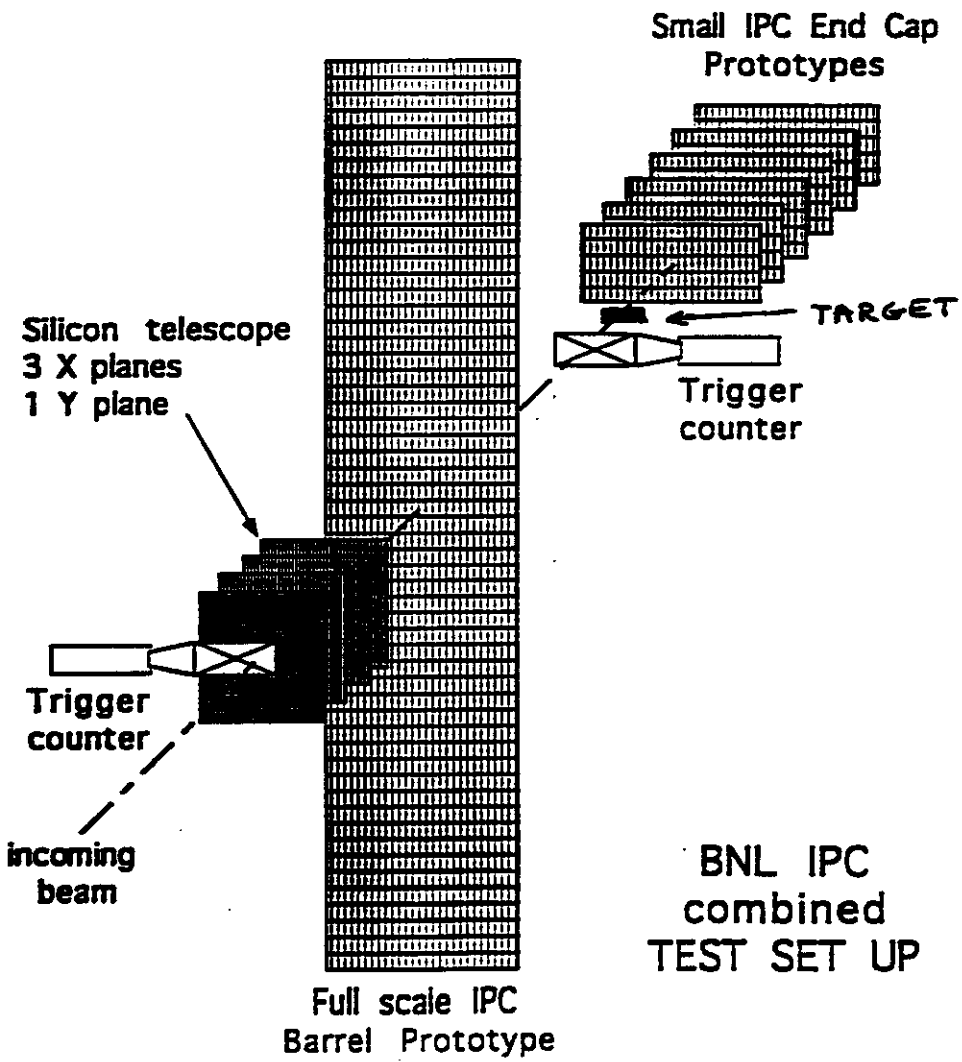
- 2 RACKS OF TRIGGER LOGIC + ASSORTED ELECTRONICS

- RECYCLABLE GAS SYSTEM TO CLEAN & REUSE CO_2 CF_4 GAS

INTRODUCTION

- PLAN WAS TO TEST FULL SIZE BARREL IPC PROTOTYPE & MEASURE RESOLUTION

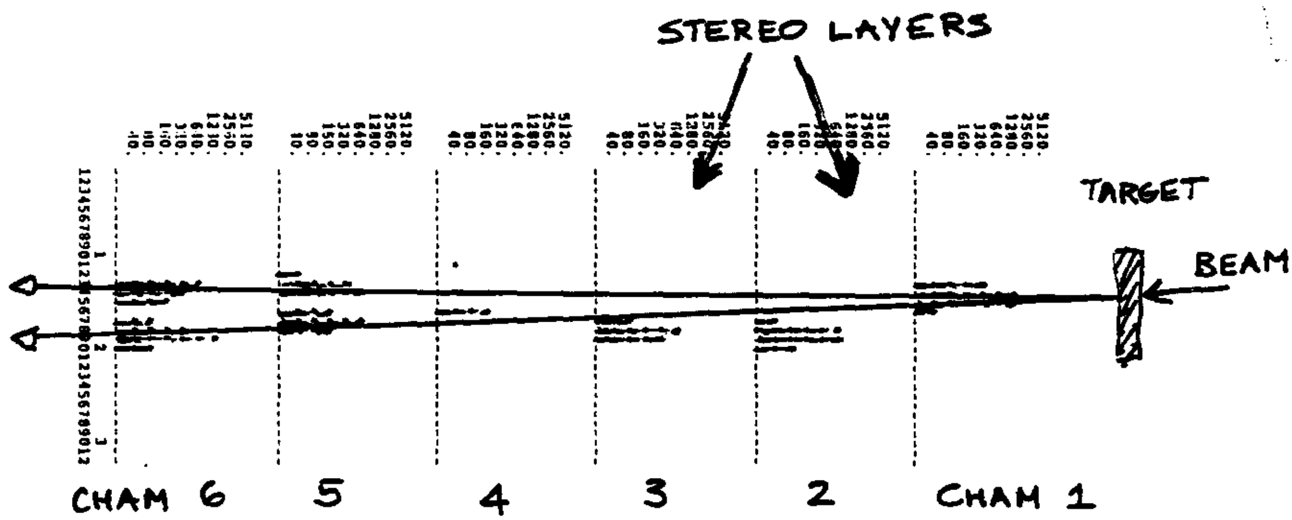
- SEPARATELY TO MEASURE TWO TRACK RESOLUTION USING MINI-CHAMBERS OF SIMILAR DESIGN

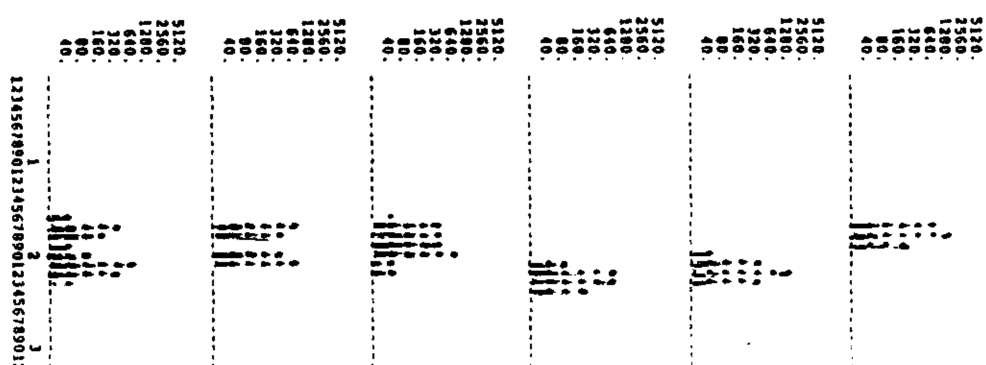


BNL IPC combined TEST SET UP

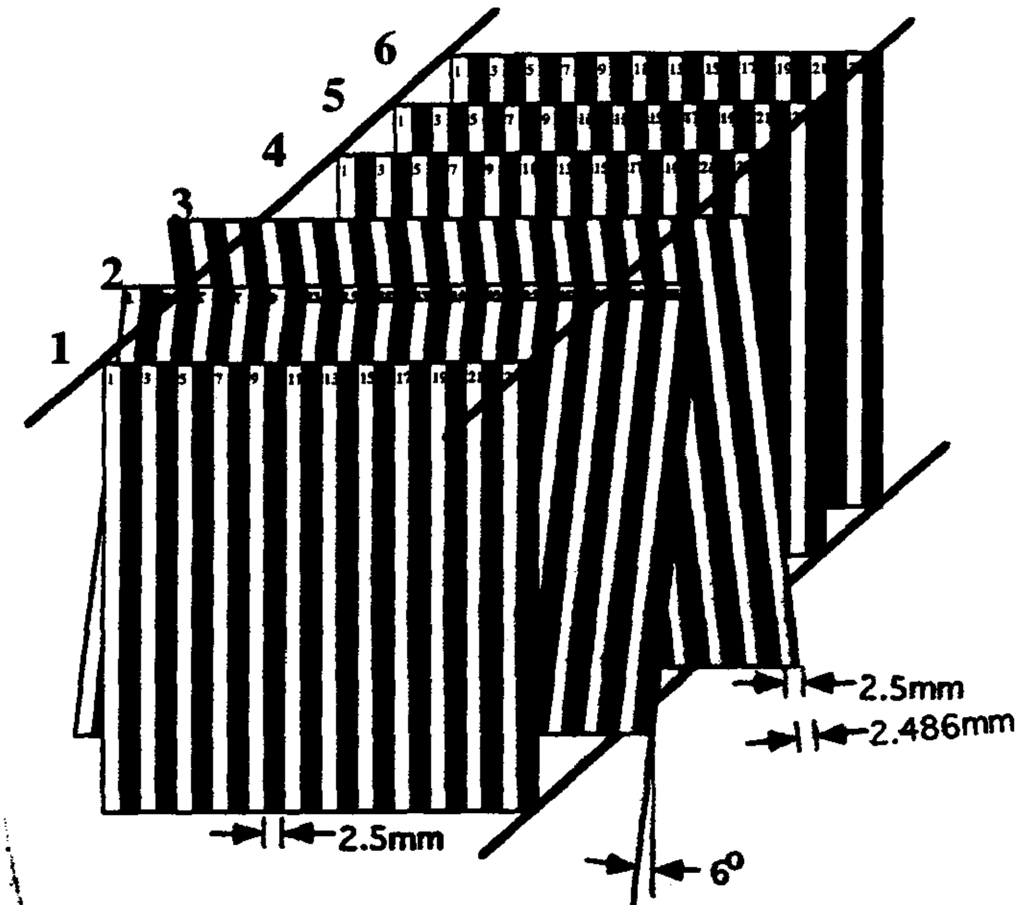
TWO TRACK STUDY

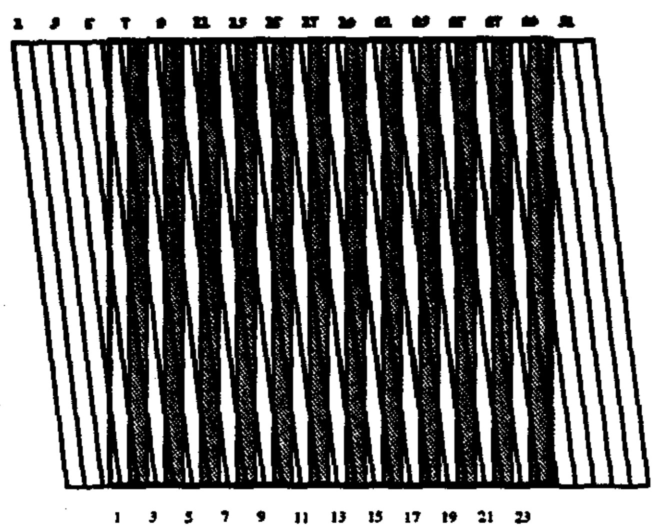
- 6 MINI-CHAMBERS + TARGET USED TO MAKE & FIND 2 TRACKS
- 2 CHAMBERS HAVE STEREO GEOMETRY
- IDEA: IDENTIFY TRACKS AT LAYER 6 WITH GOOD SEPARATION - EXTRAPOLATE BACK TO EXPLORE INTERESTING REGION

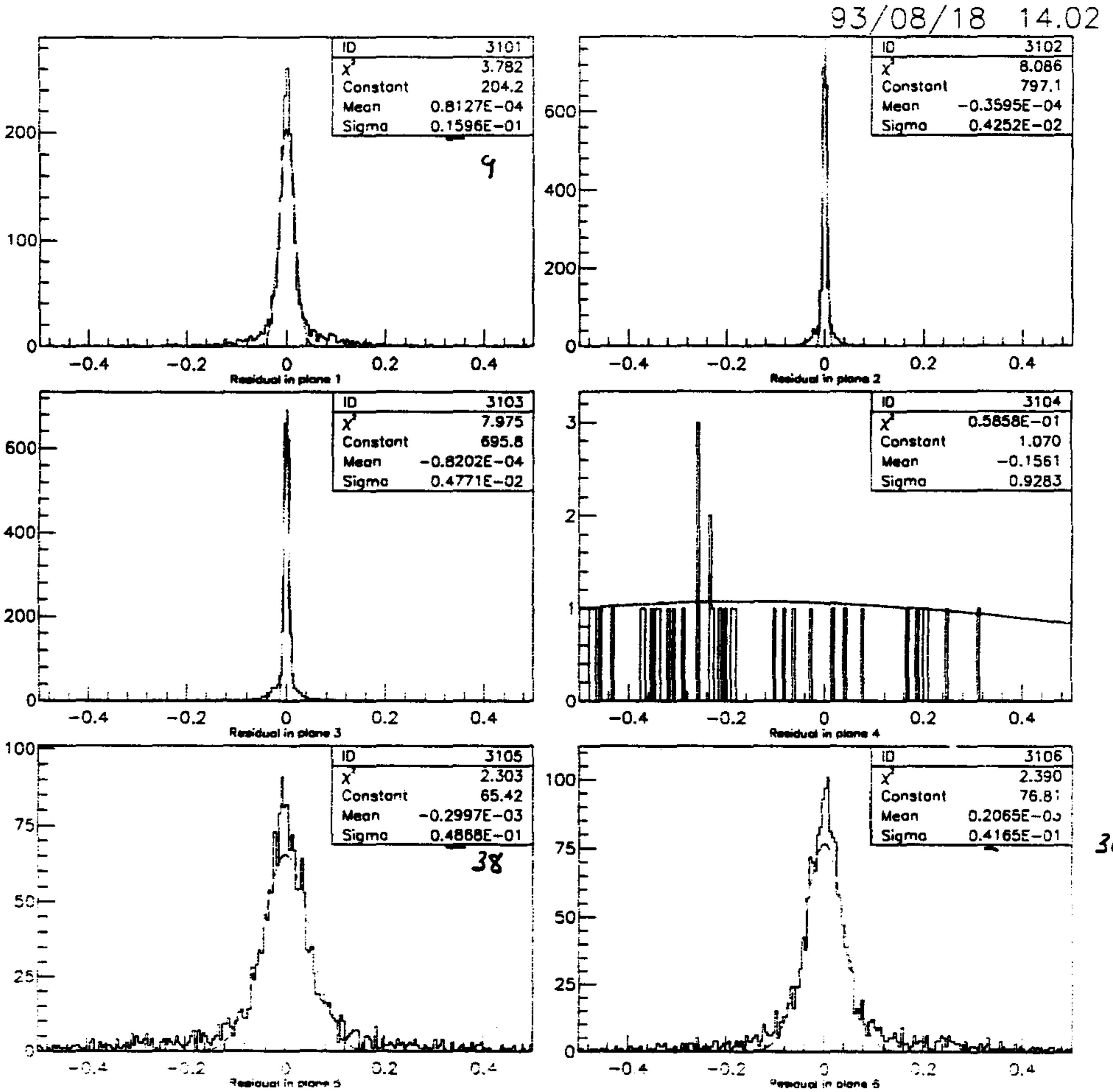


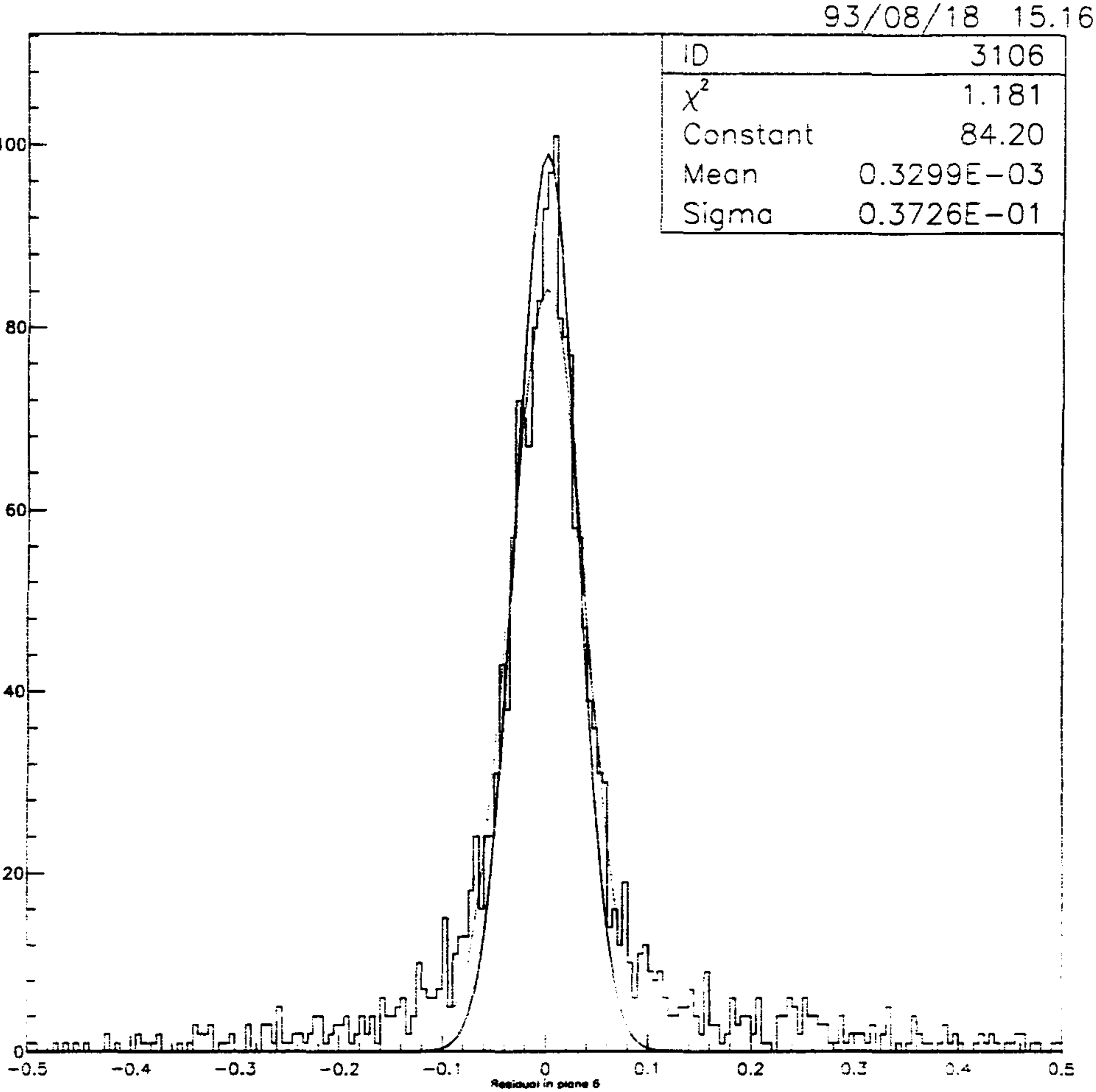


TYPICAL EVENT DISPLAYS.


1
2
3
4
5
6
2.5mm
2.486mm
2.5mm
6°


1 3 5 7 9 11 13 15 17 19 21 23


93/08/18 14.02
ID 3101
χ² 3.782
Constant 204.2
Mean 0.8127E-04
Sigma 0.1596E-01
9
Residual in plane 1
ID 3102
χ² 8.086
Constant 797.1
Mean -0.3595E-04
Sigma 0.4252E-02
Residual in plane 2
ID 3103
χ² 7.975
Constant 695.8
Mean -0.8202E-04
Sigma 0.4771E-02
Residual in plane 3
ID 3104
χ² 0.5858E-01
Constant 1.070
Mean -0.1561
Sigma 0.9283
Residual in plane 4
ID 3105
χ² 2.303
Constant 65.42
Mean -0.2997E-03
Sigma 0.4868E-01
38
Residual in plane 5
ID 3106
χ² 2.390
Constant 76.81
Sigma 0.4165E-01
30
Residual in plane 6

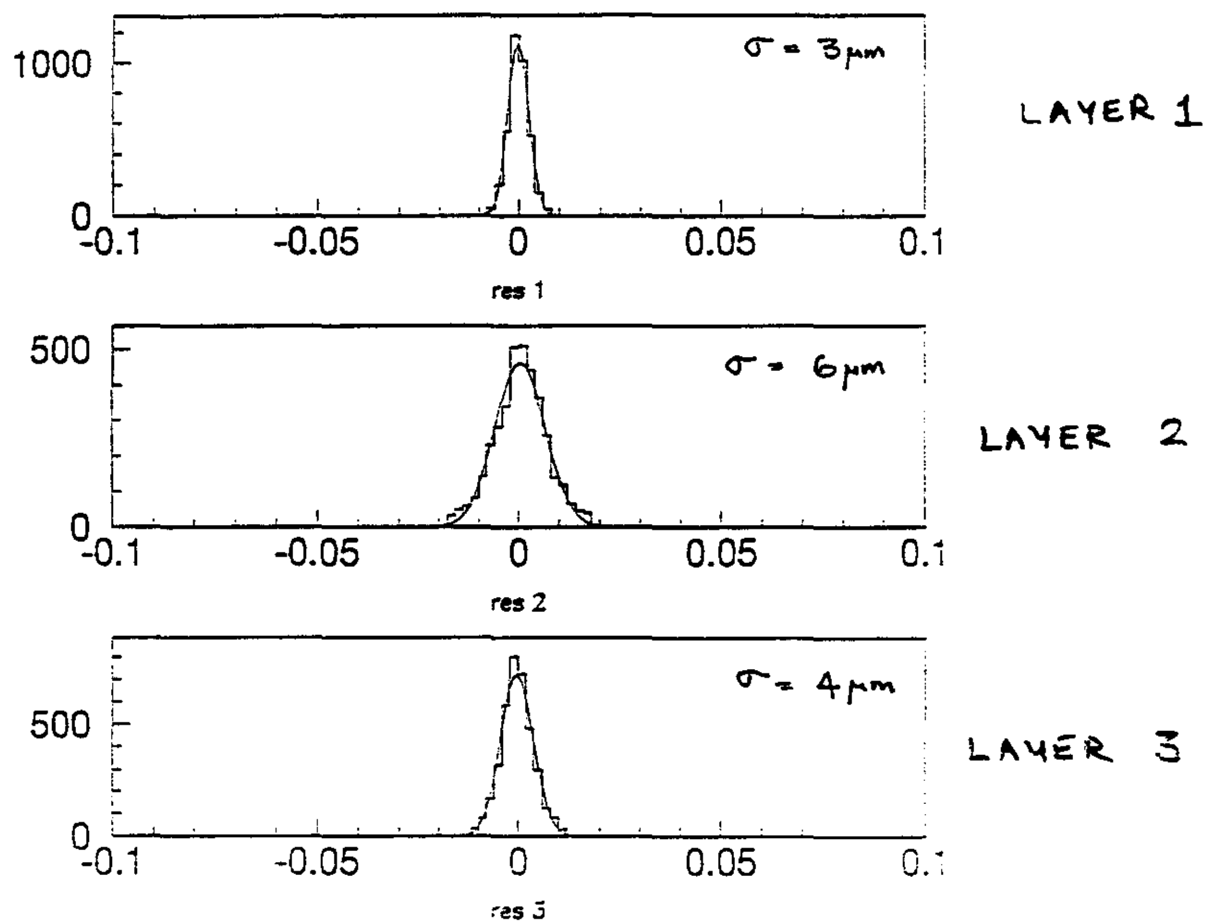

93/08/18 15.16
ID 3106
χ^2 1.181
Constant 84.20
Mean 0.3299E-03
Sigma 0.3726E-01
0
20
40
60
80
100
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
Residual in plane 6

- USE SILICON INFORMATION TO FIND A TRACK.

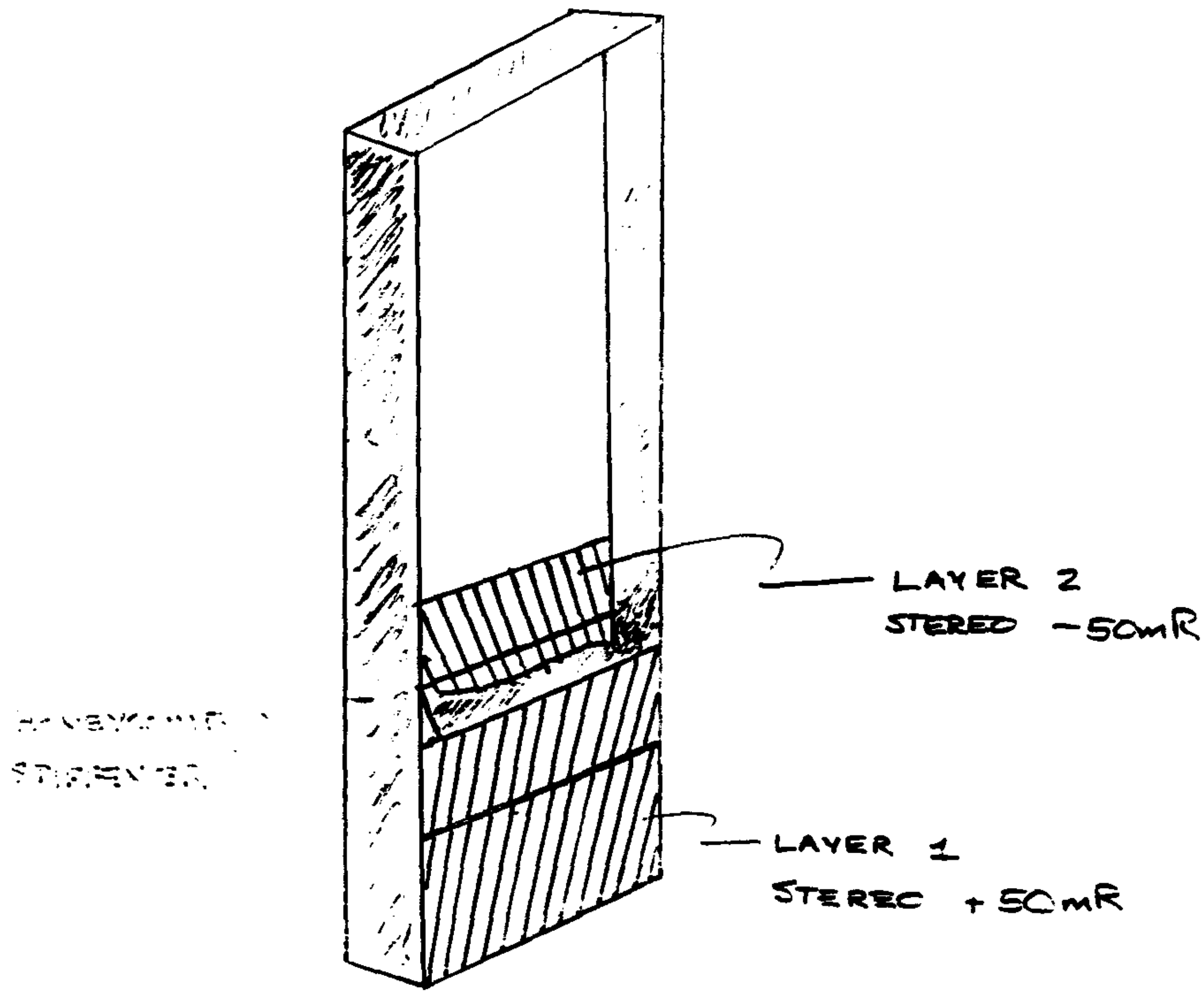
- ONE MEASUREMENT IN Y & 3 IN x

- PROJECT TRACK IN SILICON INTO IPC s

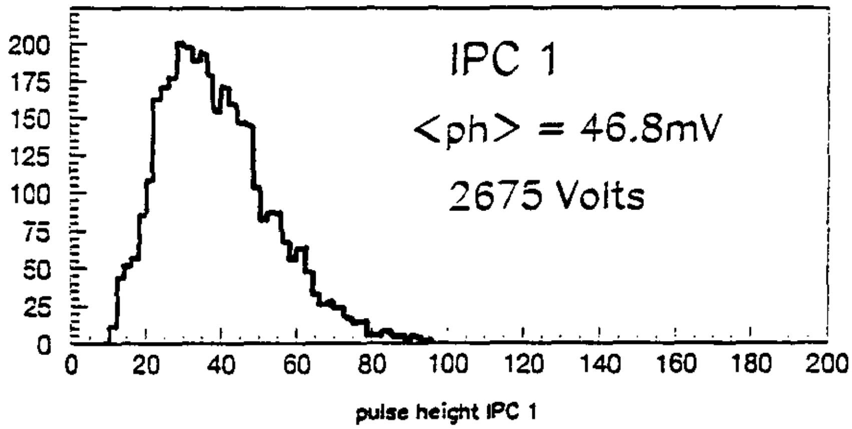
FIT RESIDUALS

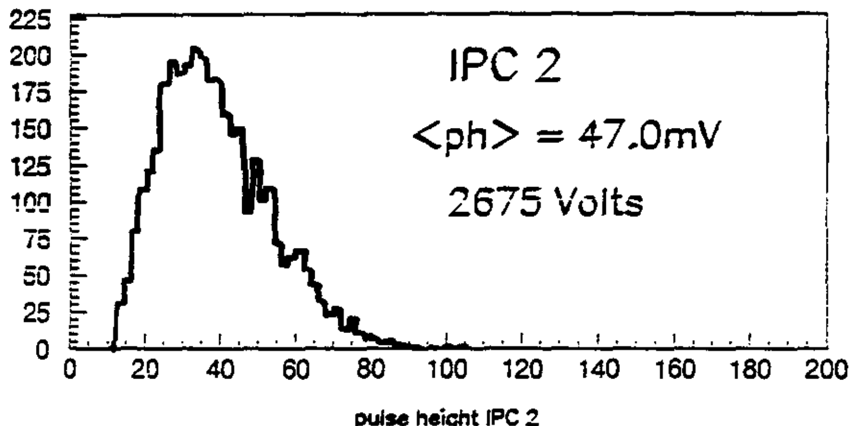


IPC SCHEMATIC.



IPC RESULTS

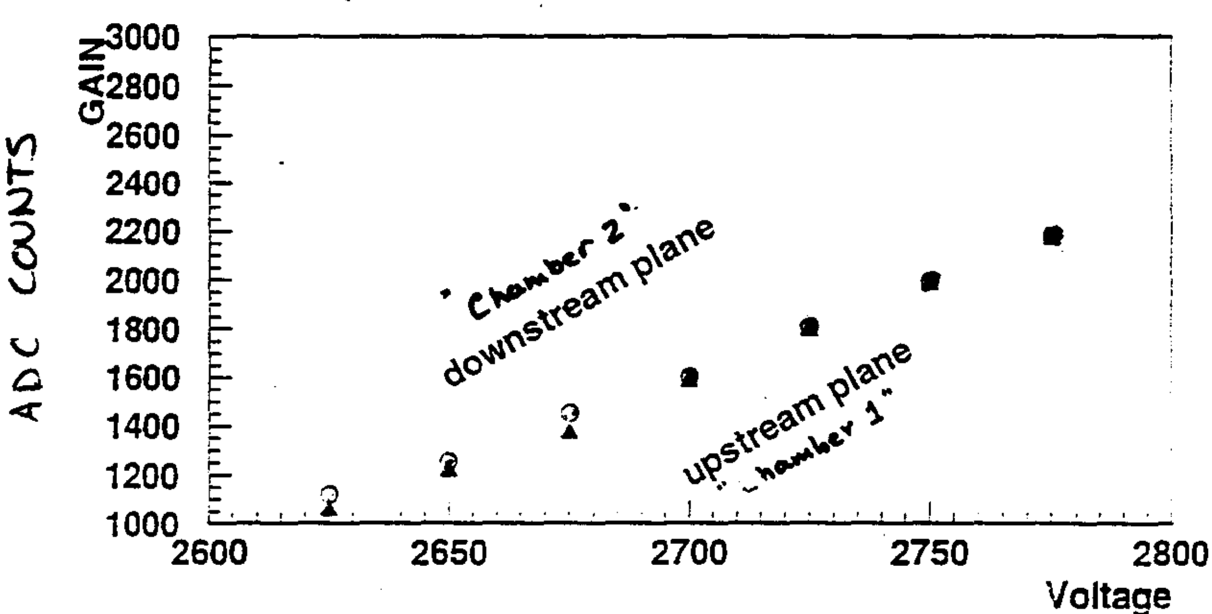




$\langle PED \rangle \simeq 10 - 20$ ADC / 2000

$\sigma_{E.N.} \simeq 4 - 5$ ADC

IPC Gain vs Voltage



- SEVERAL SOURCES OF UNCERTAINTY IN THE PROJECTED POSITION OF TRACK

  → 2mR BEAM DIVERGENCE IN Y

  ≃ 20 μm

  → MULTIPLE SCATTERING AT LAST LAYER OF SILICON

  ≃ 10μm

  → VIBRATION OF IPC IN STRUCTURE

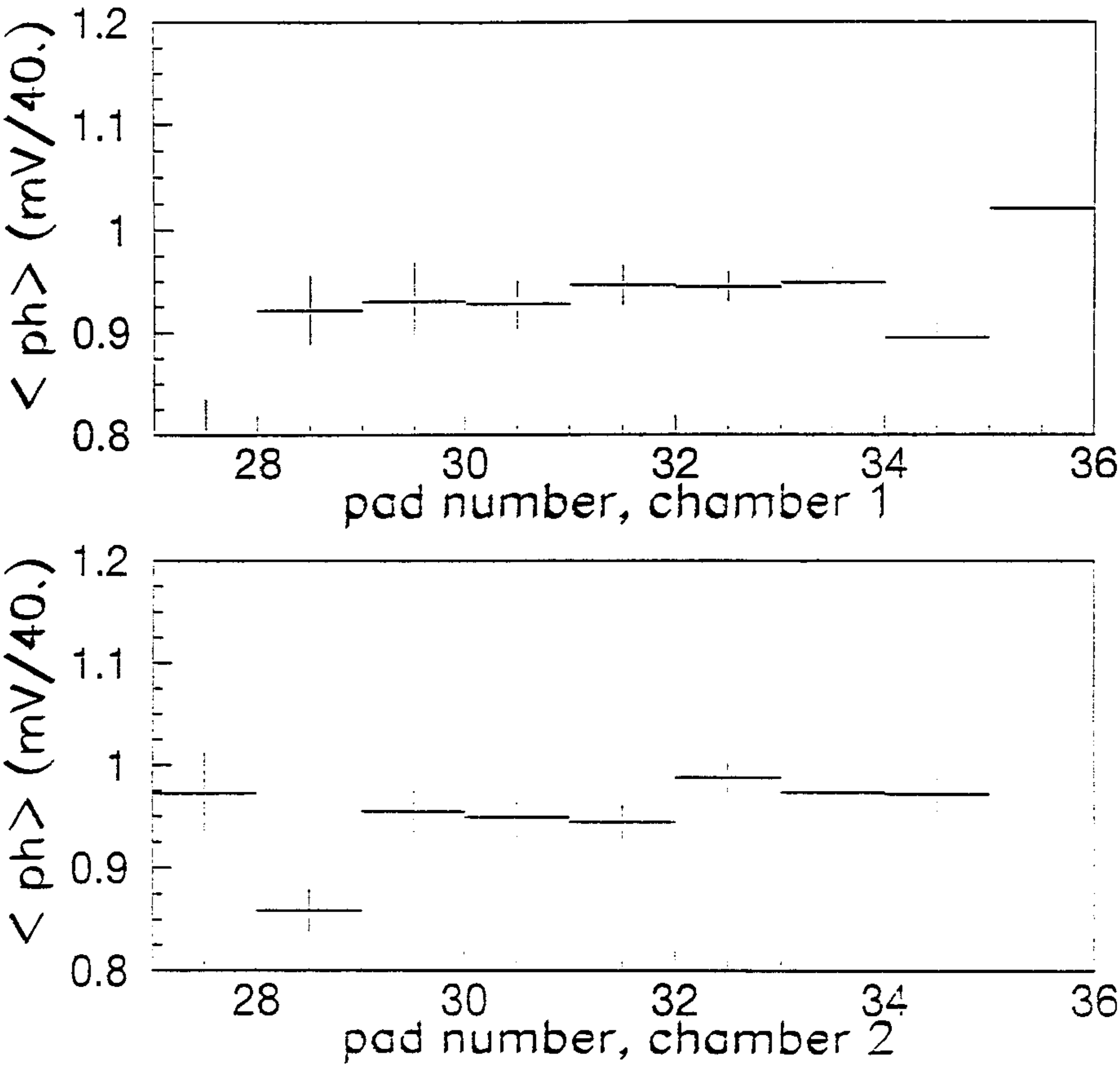
  ≙ 25 - 50μm (?)

- COLLECTED ~ 200K EVENTS TOTAL

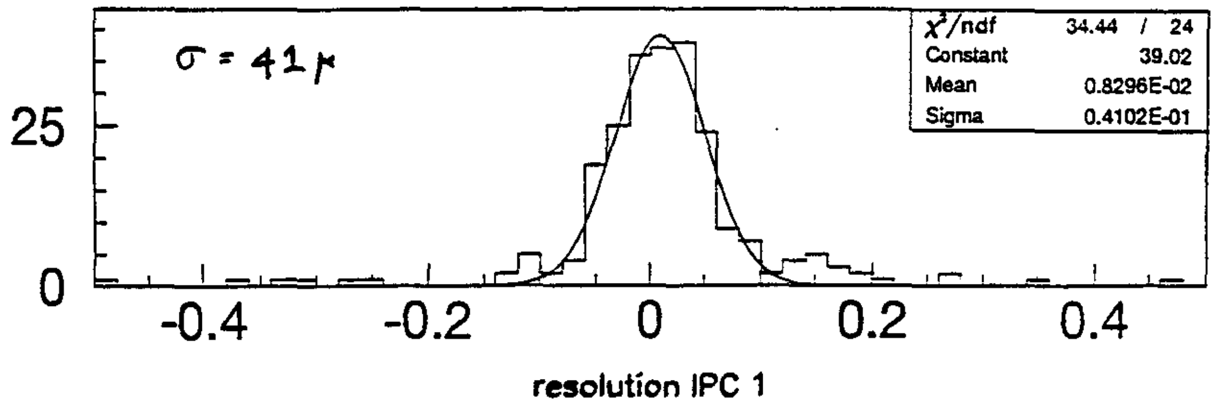
  20% PASS CUTS

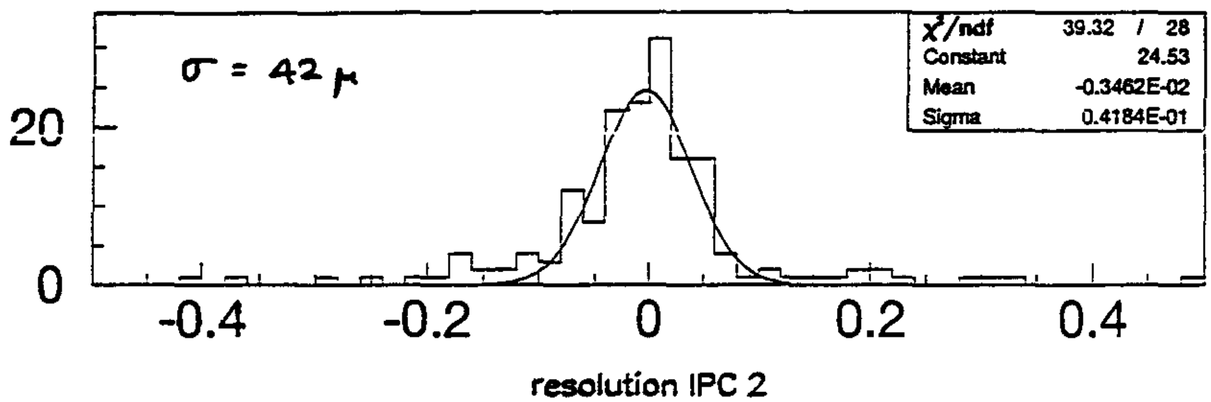
  → HITS IN ALL 4 SILICON (=1 IN Y)

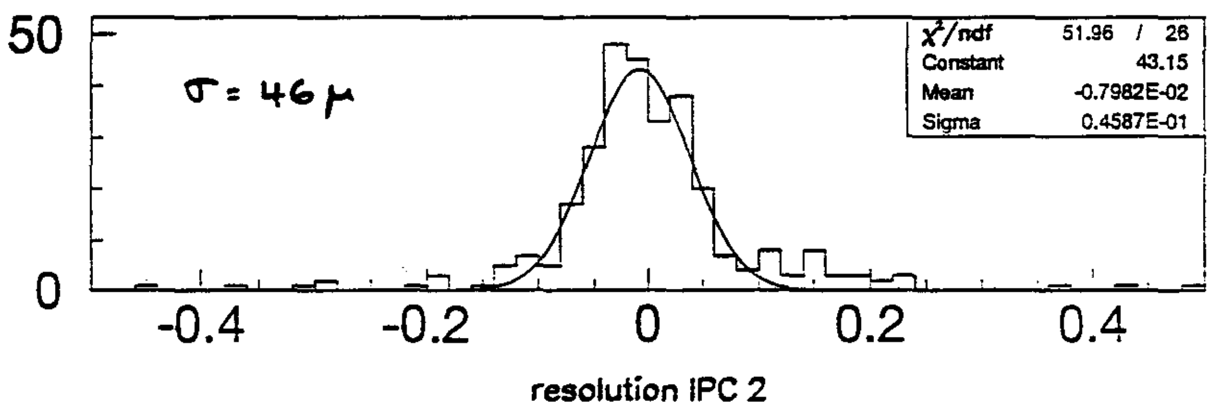
  → NON SATURATED HIT IN 1 IPC

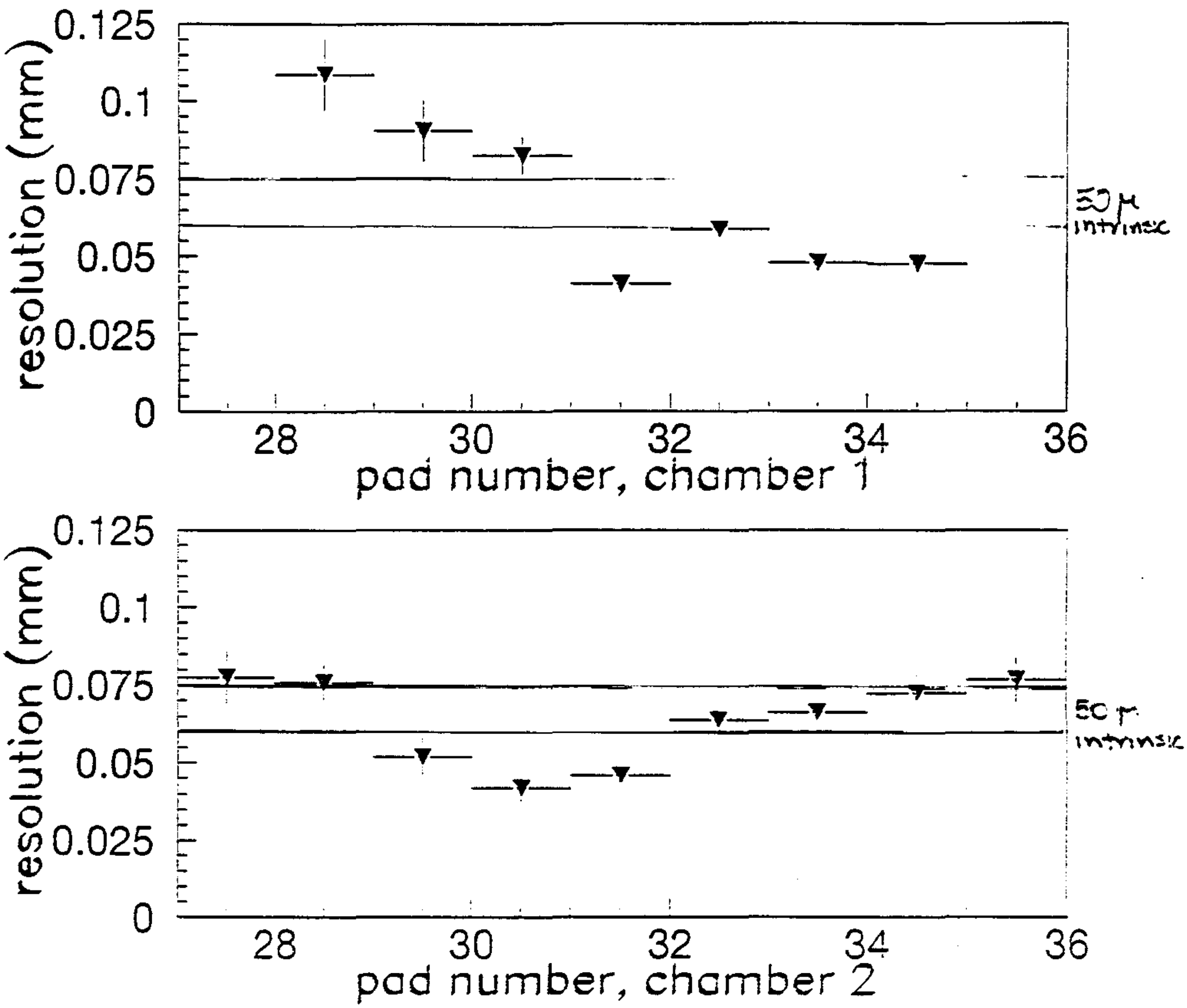


< ph > (mV/40.)
1.2
1.1
1
0.9
0.8
28
30
32
34
36
pad number, chamber 1
< ph > (mV/40.)
1.2
1.1
1
0.9
0.8
28
30
32
34
36
pad number, chamber 2


σ = 41μ
χ²/ndf 34.44 / 24
Constant 39.02
Mean 0.8296E-02
Sigma 0.4102E-01
25
0
-0.4
-0.2
0
0.2
0.4
resolution IPC 1


σ = 42μ
χ²/ndf 39.32 / 28
Constant 24.53
Mean -0.3462E-02
Sigma 0.4184E-01
20
0
-0.4
-0.2
0
0.2
0.4
resolution IPC 2


σ = 46μ
χ²/ndf 51.96 / 26
Constant 43.15
Mean -0.7982E-02
Sigma 0.4587E-01
50
0
-0.4
-0.2
0
0.2
0.4
resolution IPC 2

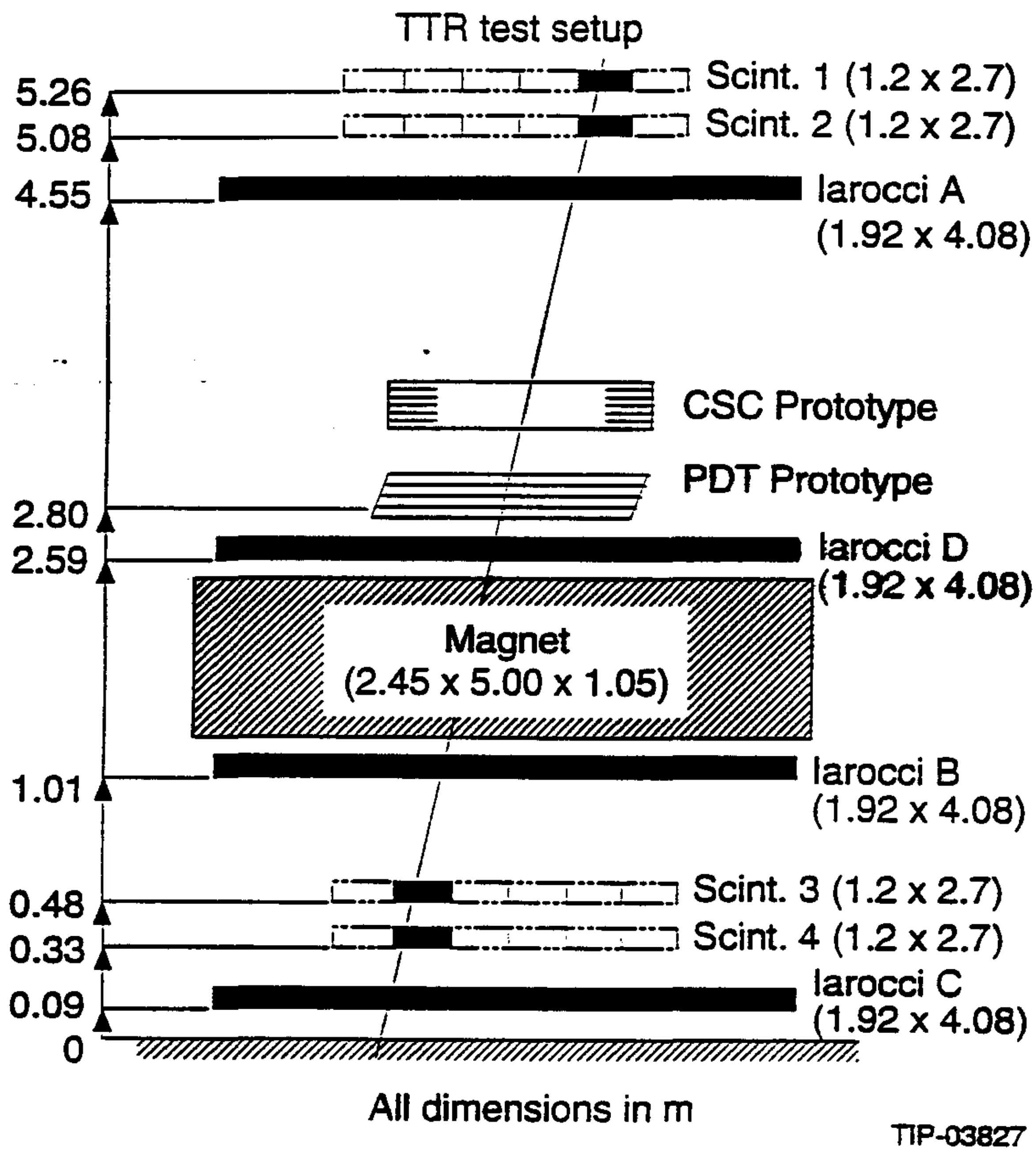

0.125
0.1
0.075
0.05
0.025
0
resolution (mm)
28
30
32
34
36
pad number, chamber 1
intrinsic
0.125
0.1
0.075
0.05
0.025
0
resolution (mm)
28
30
32
34
36
pad number, chamber 2
50 μ
intrinsic

CONCLUSIONS

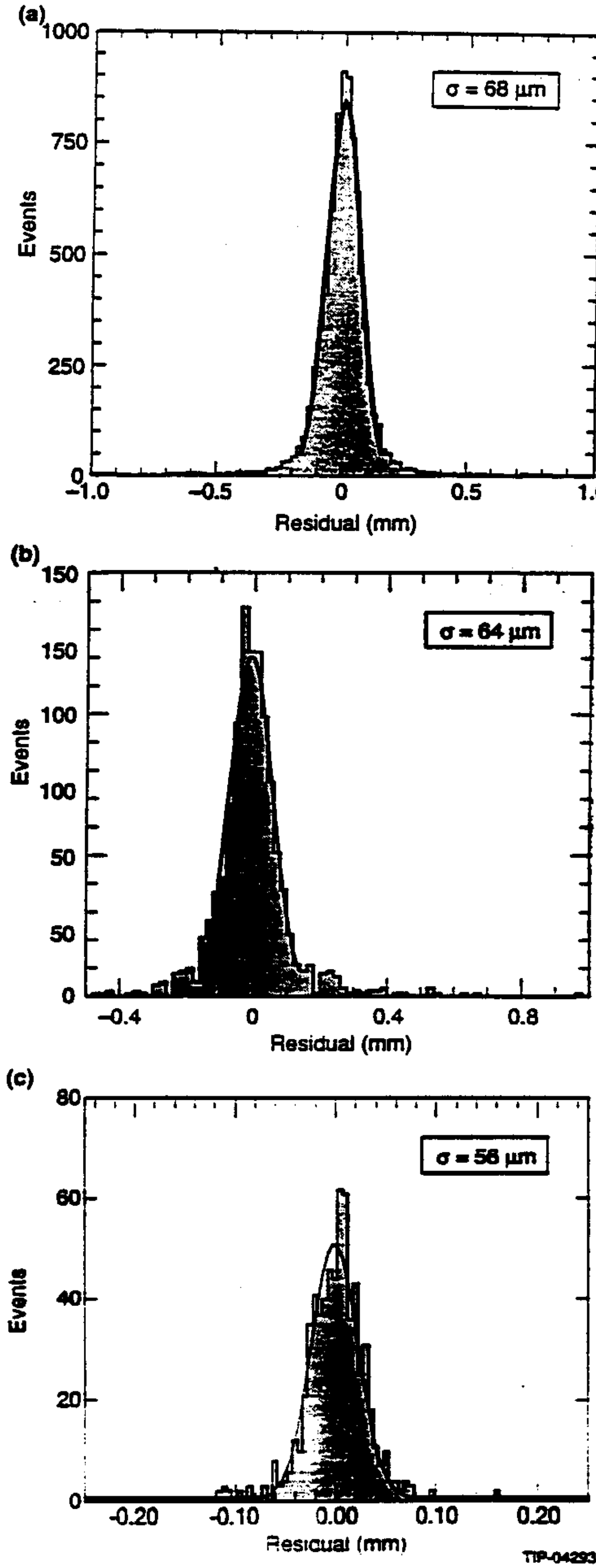
- FIRST LOOK AT RESULTS SHOWS 50 μm RESOLUTION ACHIEVABLE

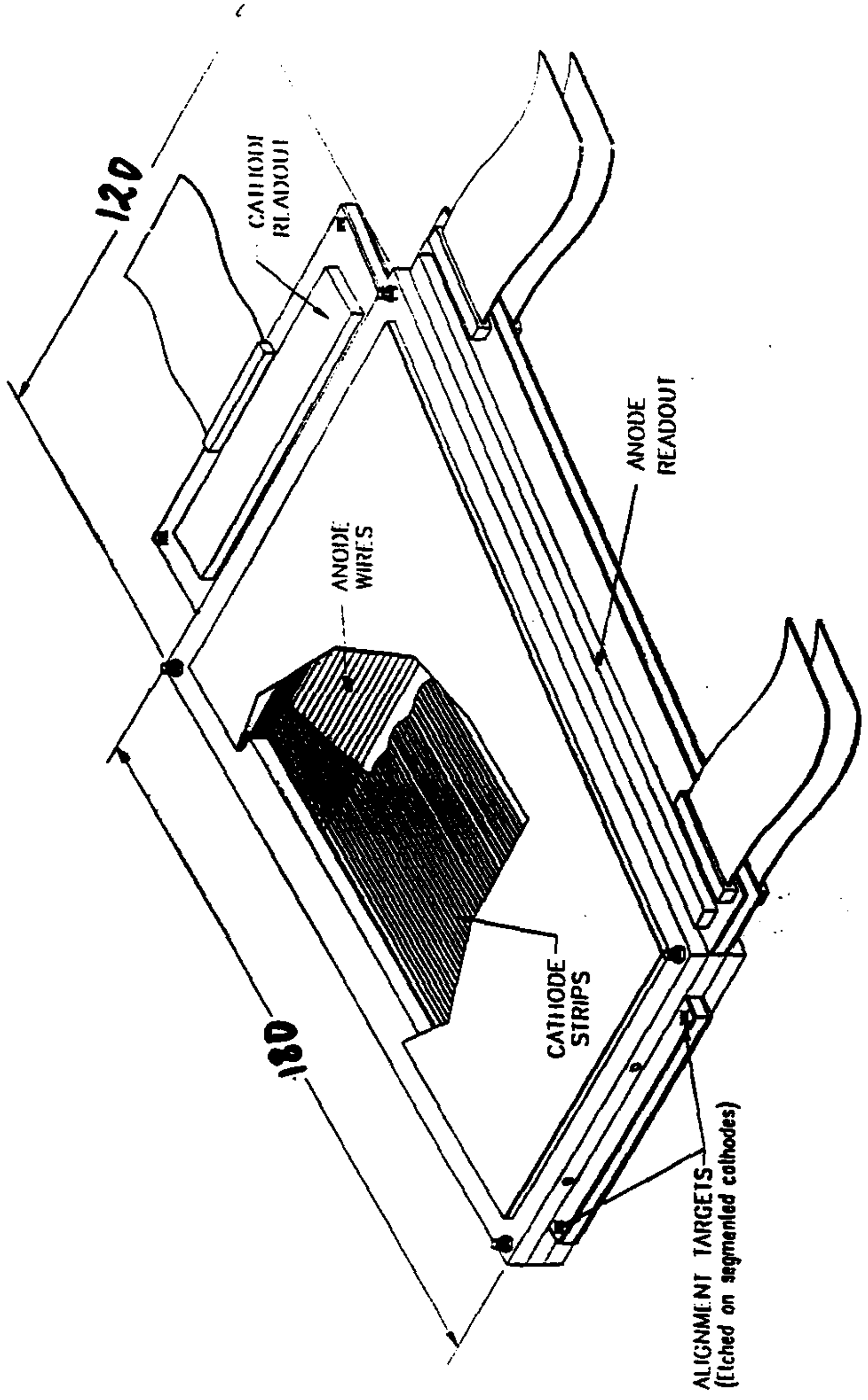
- MORE WORK NEEDED TO UNDERSTAND CALIBRATION

- THOROUGH UNDERSTANDING OF TWO TRACK RESOLUTION IS UNDERWAY (~ 10 - 20K USEFUL EVENTS)



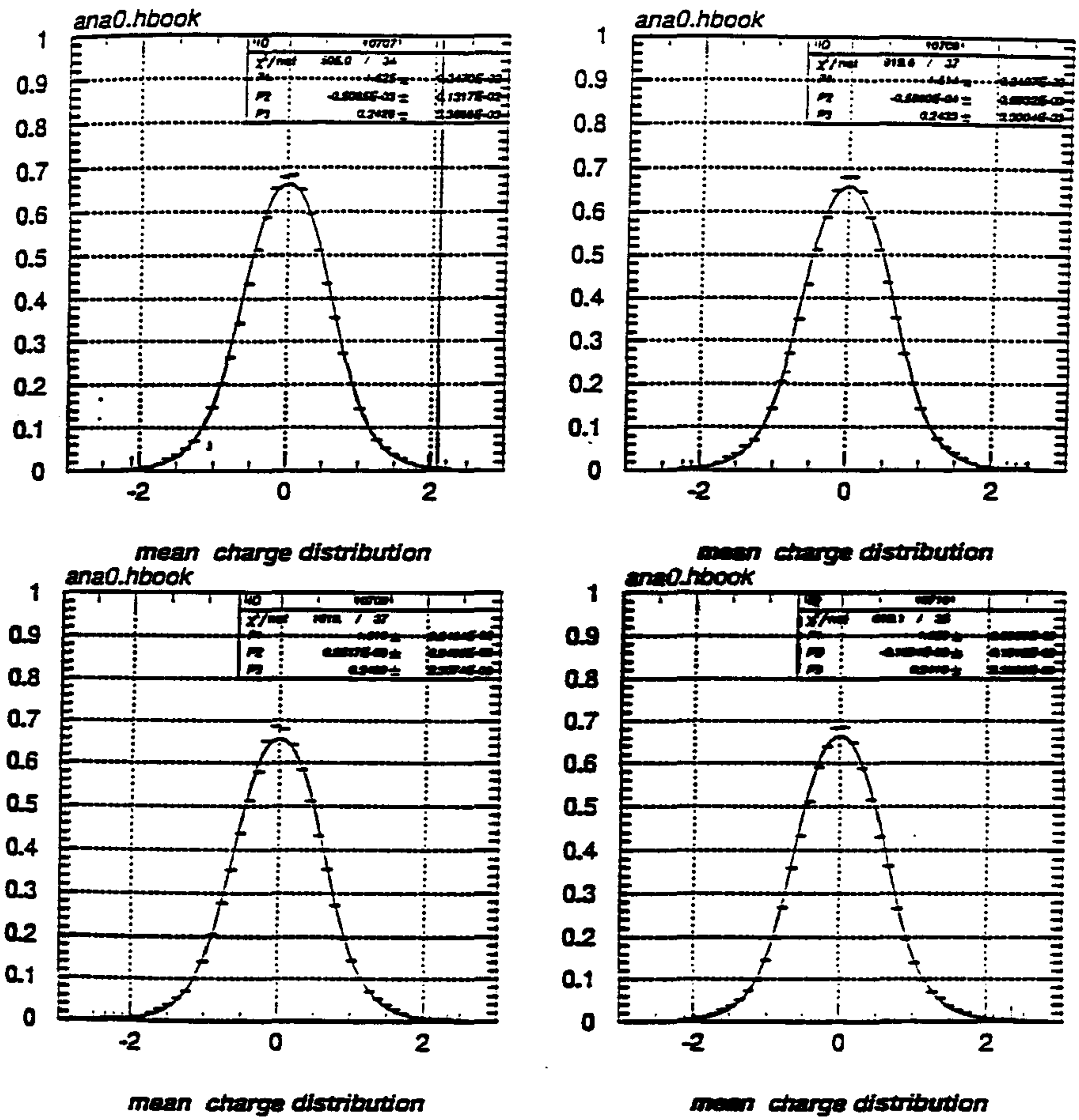
TTR test setup
5.26
5.08
4.55
Scint. 1 (1.2 x 2.7)
Scint. 2 (1.2 x 2.7)
Iarocci A
(1.92 x 4.08)
CSC Prototype
PDT Prototype
2.80
2.59
Iarocci D
(1.92 x 4.08)
Magnet
(2.45 x 5.00 x 1.05)
1.01
Iarocci B
(1.92 x 4.08)
0.48
0.33
0.09
0
Scint. 3 (1.2 x 2.7)
Scint. 4 (1.2 x 2.7)
Iarocci C
(1.92 x 4.08)
All dimensions in m
TIP-03827

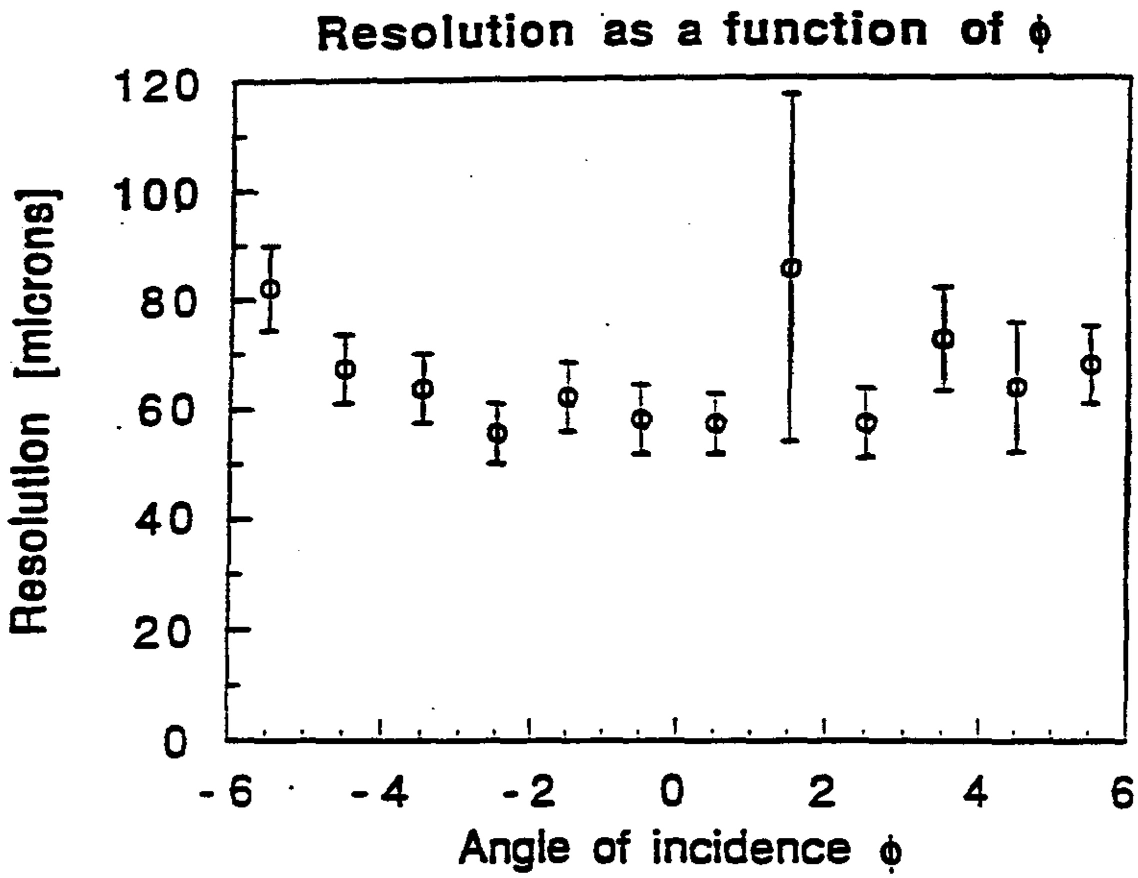

(a)
σ = 68 µm
Events
Residual (mm)
(b)
σ = 64 µm
Events
Residual (mm)
(c)
σ = 56 µm
Events
Residual (mm)
TIP-04293


120
CATHODE READOUT
ANODE READOUT
ANODE WIRES
CATHODE STRIPS
180
ALIGNMENT TARGETS
(Etched on segmented cathodes)

93/06/25 00.48

Gatti fit of charge distribution





Resolution as a function of φ
120
100
80
60
40
20
0
Resolution [microns]
-6
-4
-2
0
2
4
6
Angle of incidence φ

DUBNA

- 0.3m × 3.0m 4 GAP PROTOTYPE

- 0.5m × 0.5m 4 GAP PROTOTYPE

- 1.1m × 3.0m 6 GAP PROTOTYPE

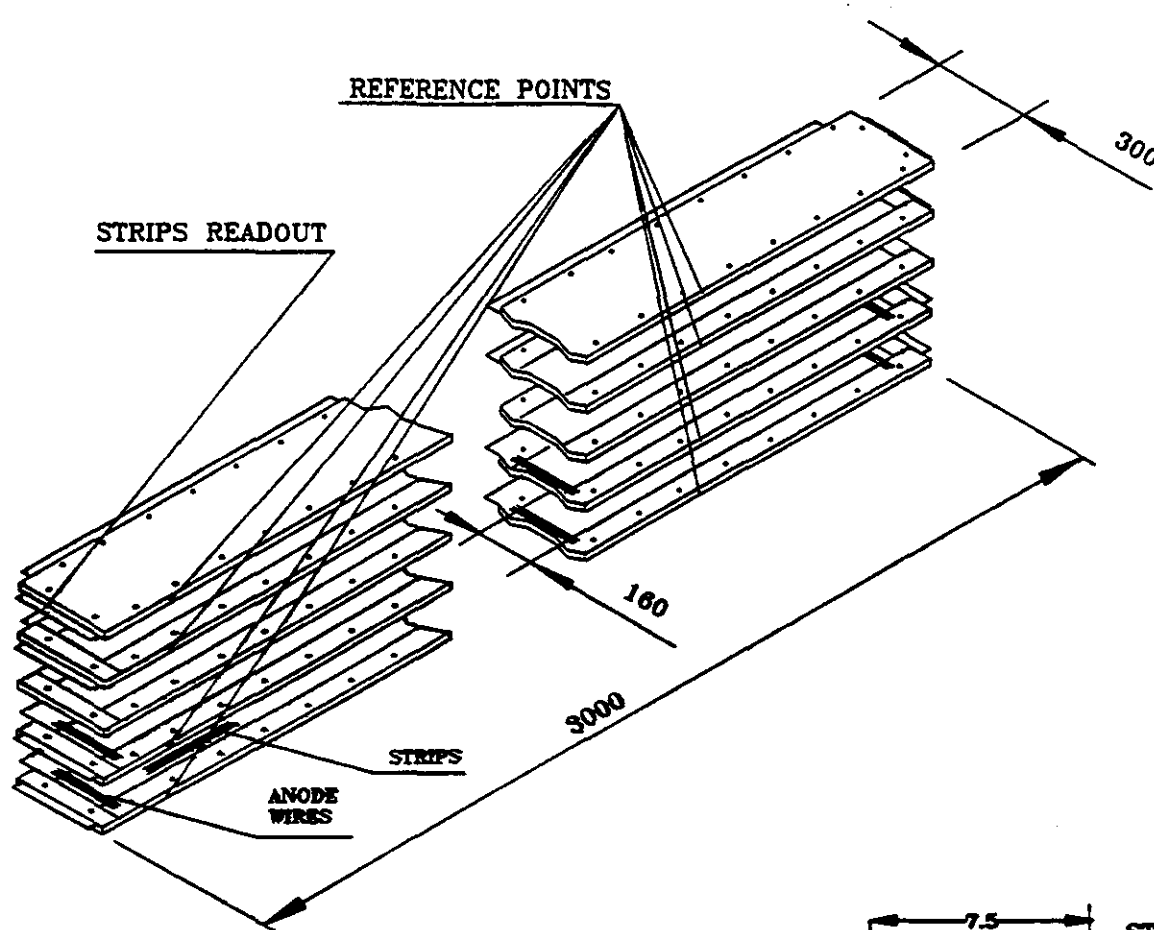
① 0,3 M × 3.0 M 4 GAP PROTOTYPE

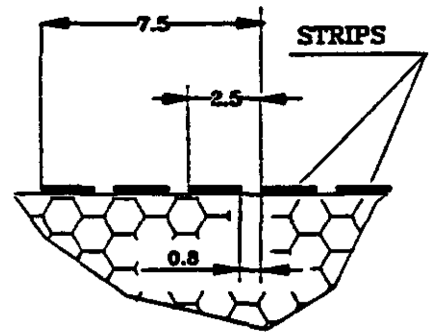
- CONSTRUCTION WAS COMPLETED (END OF MAY)

- TECHNOLOGICAL ISSUES HAVE BEEN AGRESSIVELY STUDIED

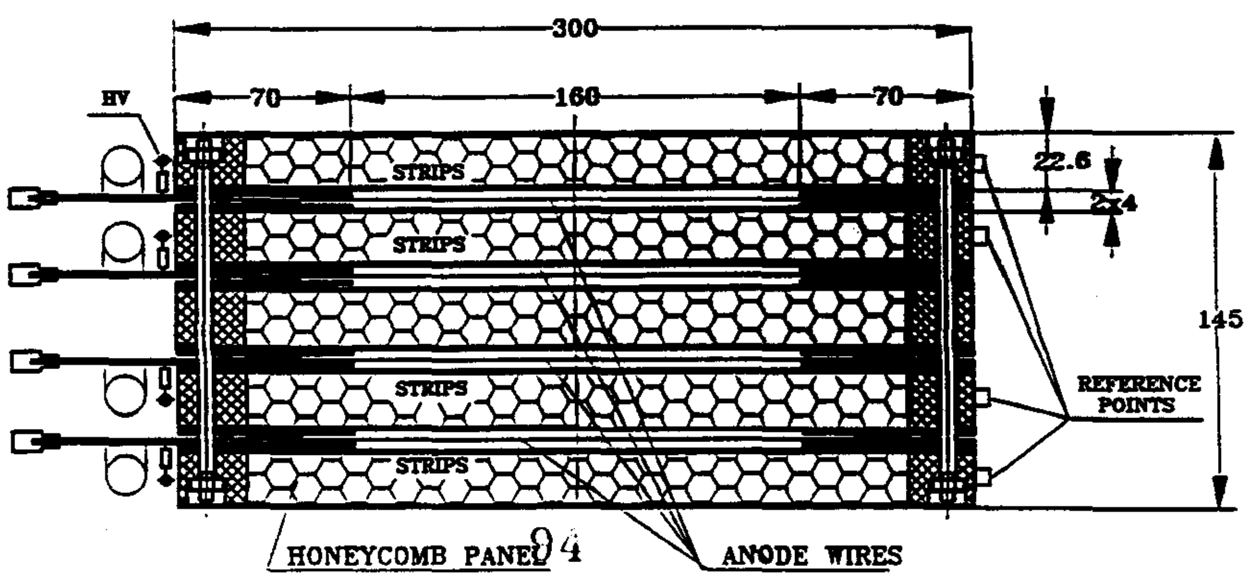
- NOW THIS PROTOTYPE IS BEING TESTED AT DUBNA WITH COSMIC RAYS

CSC 3m x 0.3m





CROSS SECTION ALONG THE WIRE



THE MAIN RESULTS OF TECHNOLOGY DEVELOPMENT:

- EXPERIENCE WITH 3M LONG CSC PRODUCTION;
- GAP IS CONTROLLED WITH A PRECISION ± 50 μm
- WIRE TENSION IS CONTROLLED WITH A PRECISION ± 1%.
- INTERSTRIP CAPACITANCES ARE CONTROLLED WITH A PRECISION ± 3%
- CHECK OF STRIPS
- HV TEST PROCEDURE
- WIRE CLEANING TECHNOLOGY
- ASSEMBLING THE CHAMBER WITH THE ELECTRODE TO ELECTRODE ALIGNMENT BETTER THEN ± 25 μm

AS A RESULT OF THIS TECHNOLOGY R&D
- STABLE CSS OPERATION AT $(1 \div 2) 10^5$
- NO ADDITIONAL NOISE DUE TO DEFECTS
- ALIGNMENT ± 25 μm

EXPERIENCE WITH BNL ELECTRONICS:

AMPLEX:

- CROSSTALK ± 5% ;
- NONLINEARITY;
- EXTRA NOISE IN THE 1ST AND THE LAST CHANNELS;

PAMPL:

- LEAKAGE THROUGH THE INPUT CAPACITOR;
- POOR PROTECTION OF THE MAIN TRANSISTOR

PCB:

- CROSSTALK ON TEST STRIPS

② 0,5M × 0,5M 4GAP PROTOTYPE.

- UNDER CONSTRUCTION
- WILL BE READY BY AUGUST 15 shiped to RDS

MAJOR GOALS:

(*) TECHNOLOGY R&D

(**) TEST OF ALTERNATIVE CONCEPTS OF READOUT ELECTRONICS

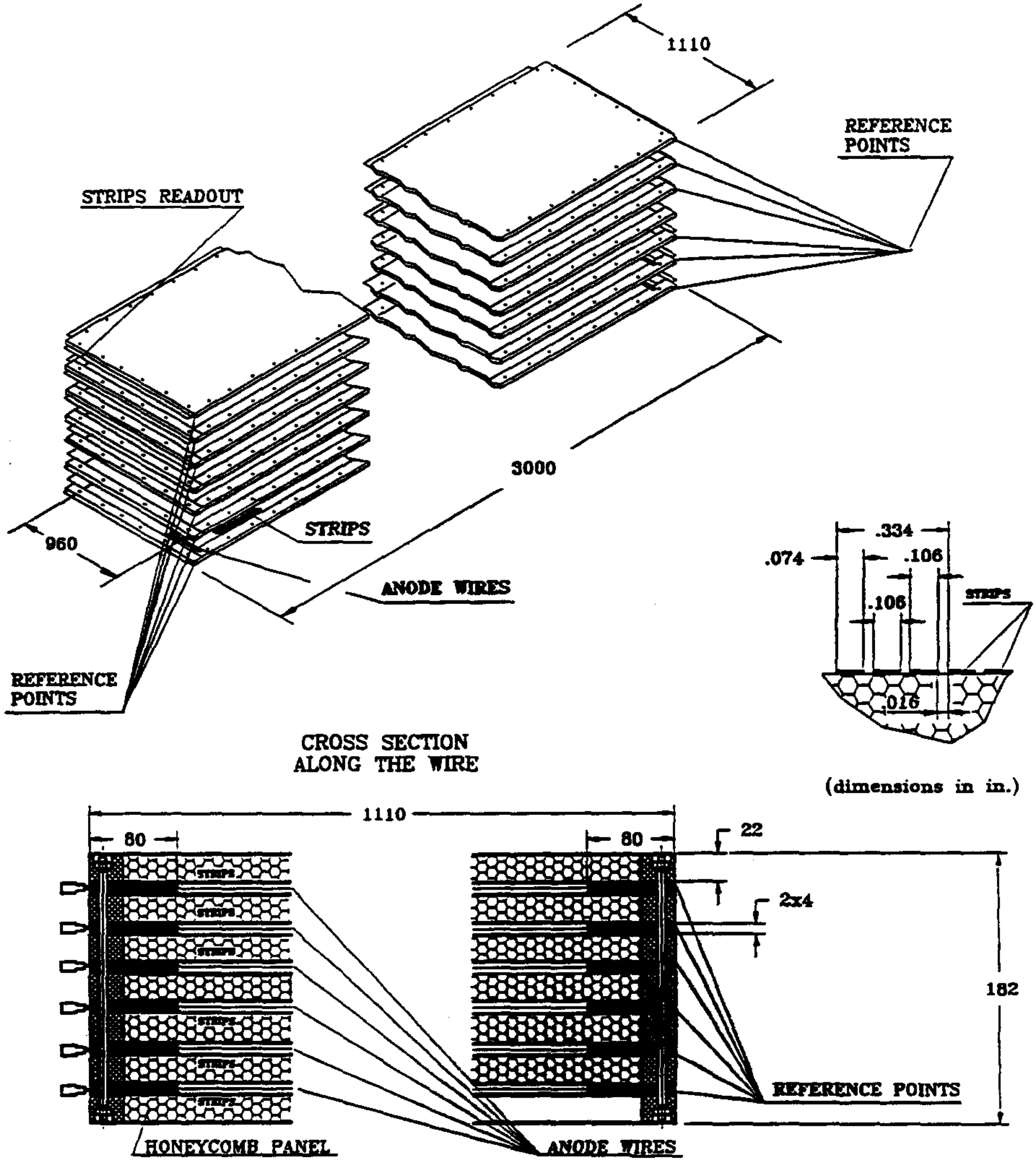
(***) PERFORMANCE STUDY

- THIS PROTOTYPE IS MADE OF 100% RUSSIAN MATERIALS
- STRIPED ELECTRODES ARE MADE AT DUBNA

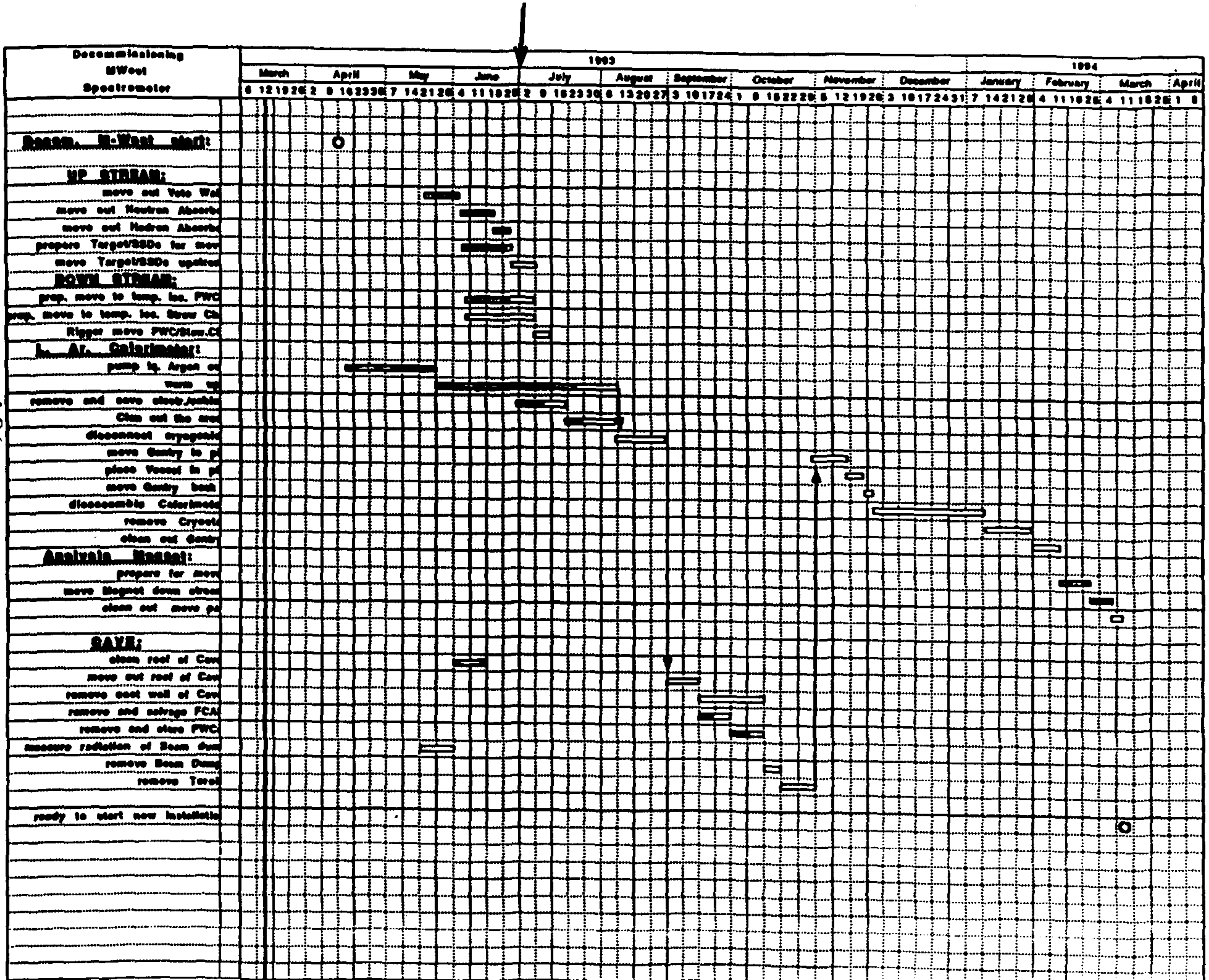
③ 1.1m × 3.0m 6 GAP PROTOTYPE.

GOAL: THE 1ST FULL SCALE GEM MUON SYSTEM PROTOTYPE

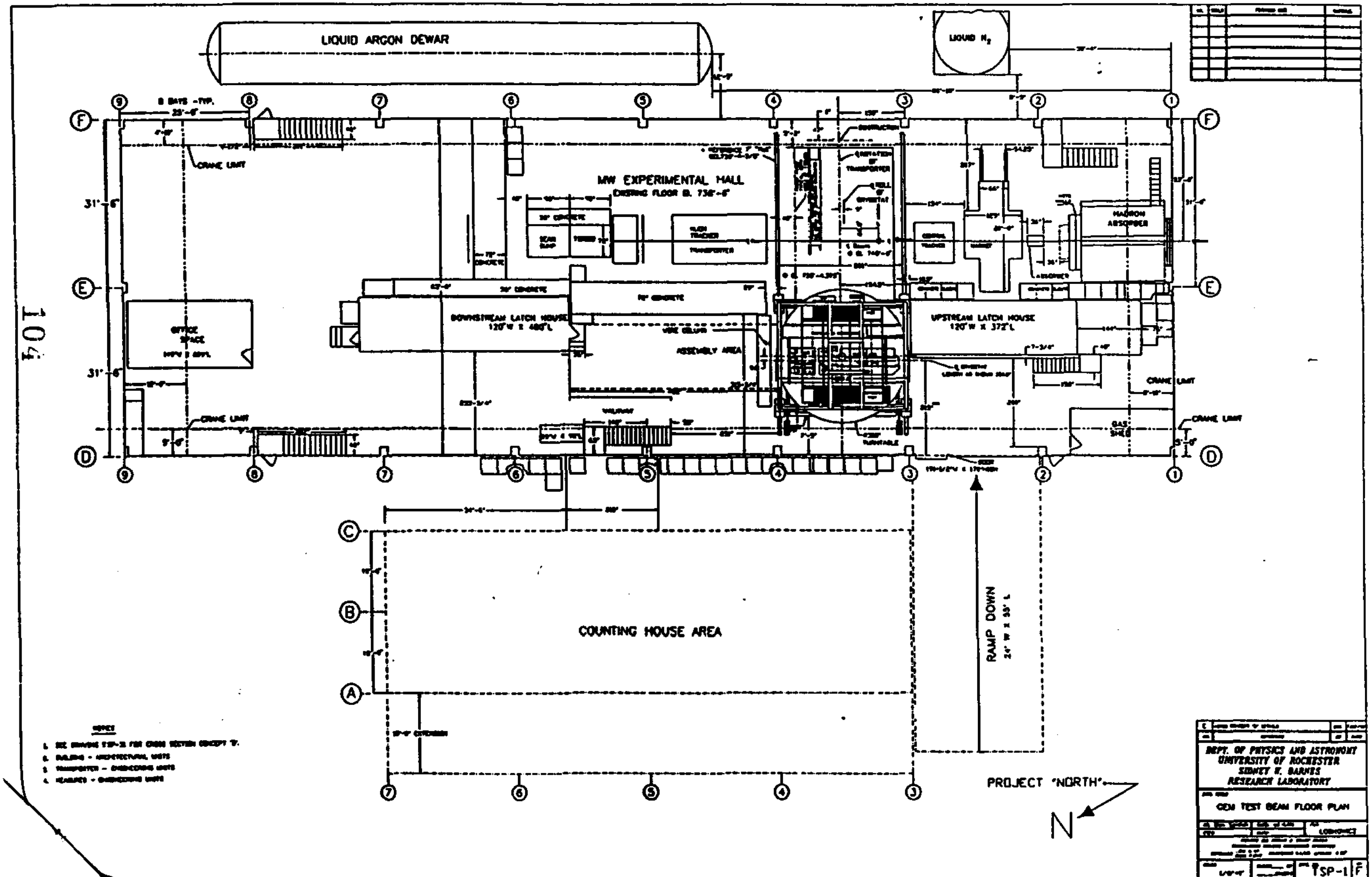
CSC 3m x 1.1m



(dimensions in mm)



Decommissioning
MWest
Spectrometer
1993
1994
March
April
May
June
July
August
September
October
November
December
January
February
March
April
Decom. M-West start:
UP STREAM:
move out Veto Wa
move out Neutron Absorb
move out Hadron Absorb
prepare Target/SSDs for mov
move Target/SSDs upstrea
DOWN STREAM:
prep. move to temp. loc. PWC
prep. move to temp. loc. Straw Ch
Rigger move PWC/Straw.C
L. Ar. Calorimeter:
pump lq. Argon ou
warm up
remove and save elect.Jumble
Clean out the are
disconnect cryogenic
move Gantry to p
place Vessel in p
move Gantry back
disassemble Calorimete
remove Cryost
clean out Gantr
Analysis Magnet:
prepare for mov
move Magnet down strea
clean out move p
CAVE:
clean roof of Cav
move out roof of Cav
remove east wall of Cav
remove and salvage FCA
remove and store PWC
measure radiation of Beam dum
remove Beam Dum
remove Targ
ready to start new installatio


LIQUID ARGON DEWAR
LIQUID N2
MW EXPERIMENTAL HALL
8 BAYS -TYP.
25'-6"
31'-6"
31'-6"
CRANE LIMIT
OFFICE SPACE
DOWNSTREAM LATCH HOUSE
120"W X 480"L
UPSTREAM LATCH HOUSE
120"W X 372"L
ASSEMBLY AREA
HADRON ABSORBER
GAS SHED
TURNTABLE
COUNTING HOUSE AREA
RAMP DOWN
24' W X 55' L
PROJECT "NORTH"
N
NOTES
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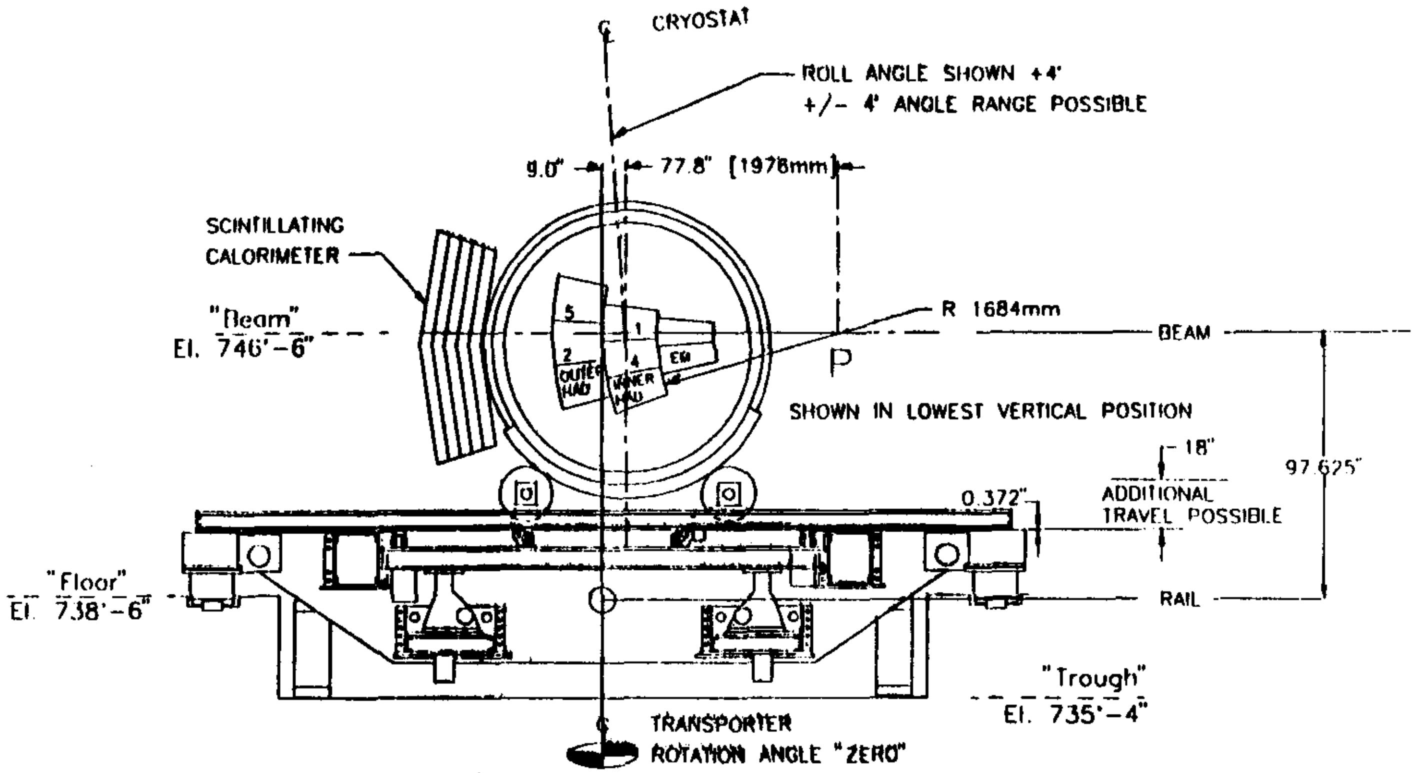
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES
RESEARCH LABORATORY
GEM TEST BEAM FLOOR PLAN
SP-1
F



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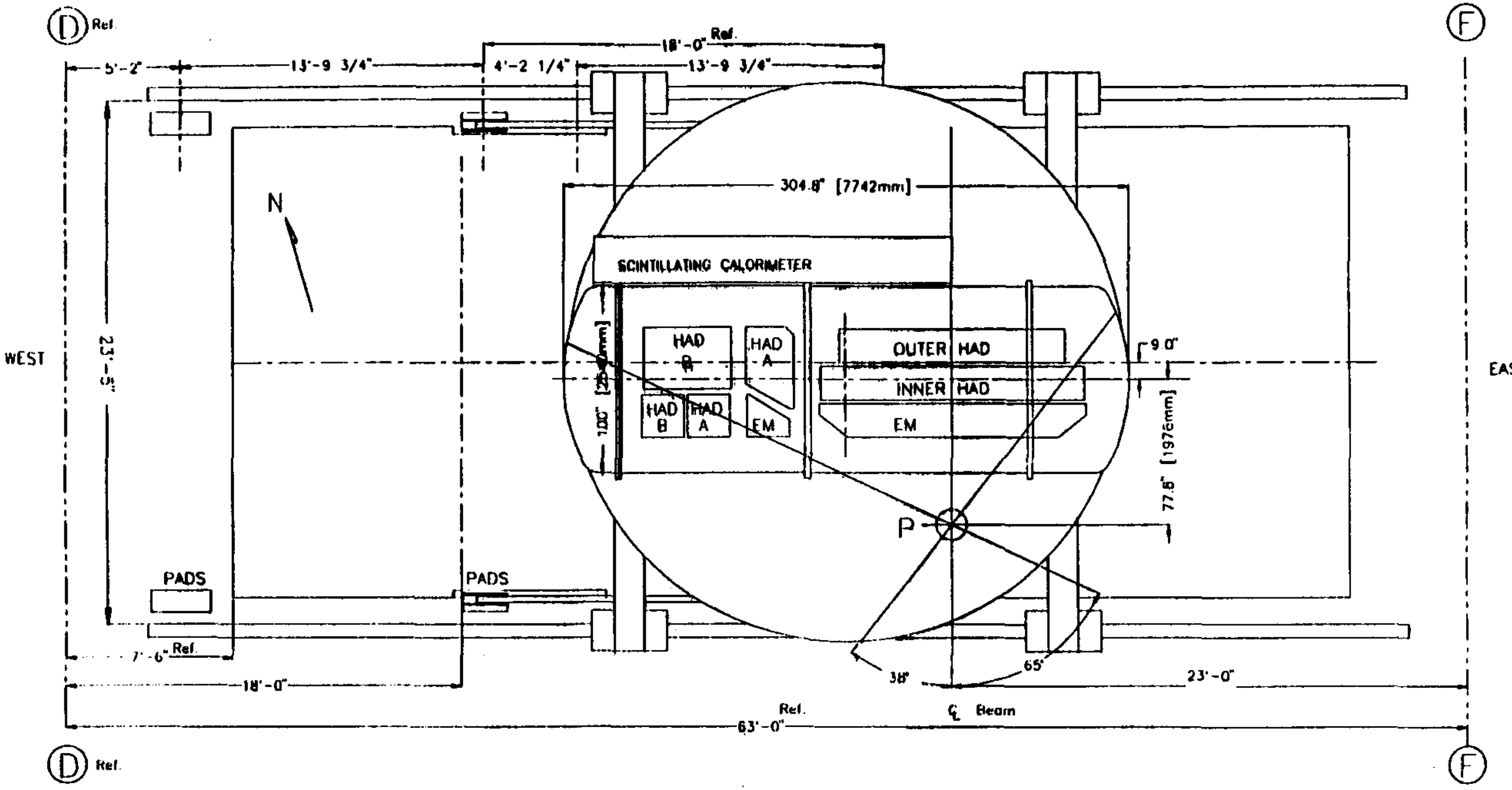
DWG. TITLE TRANSPORTER CROSS SECTION +4° ROLL		
DR. Dan Spisiak	DATE AUGUST 4, 93	FOR LOBKOWICZ
SCALE NTS	SHEET 1 OF 1 SHEETS	DWG. NO. 1SP-37



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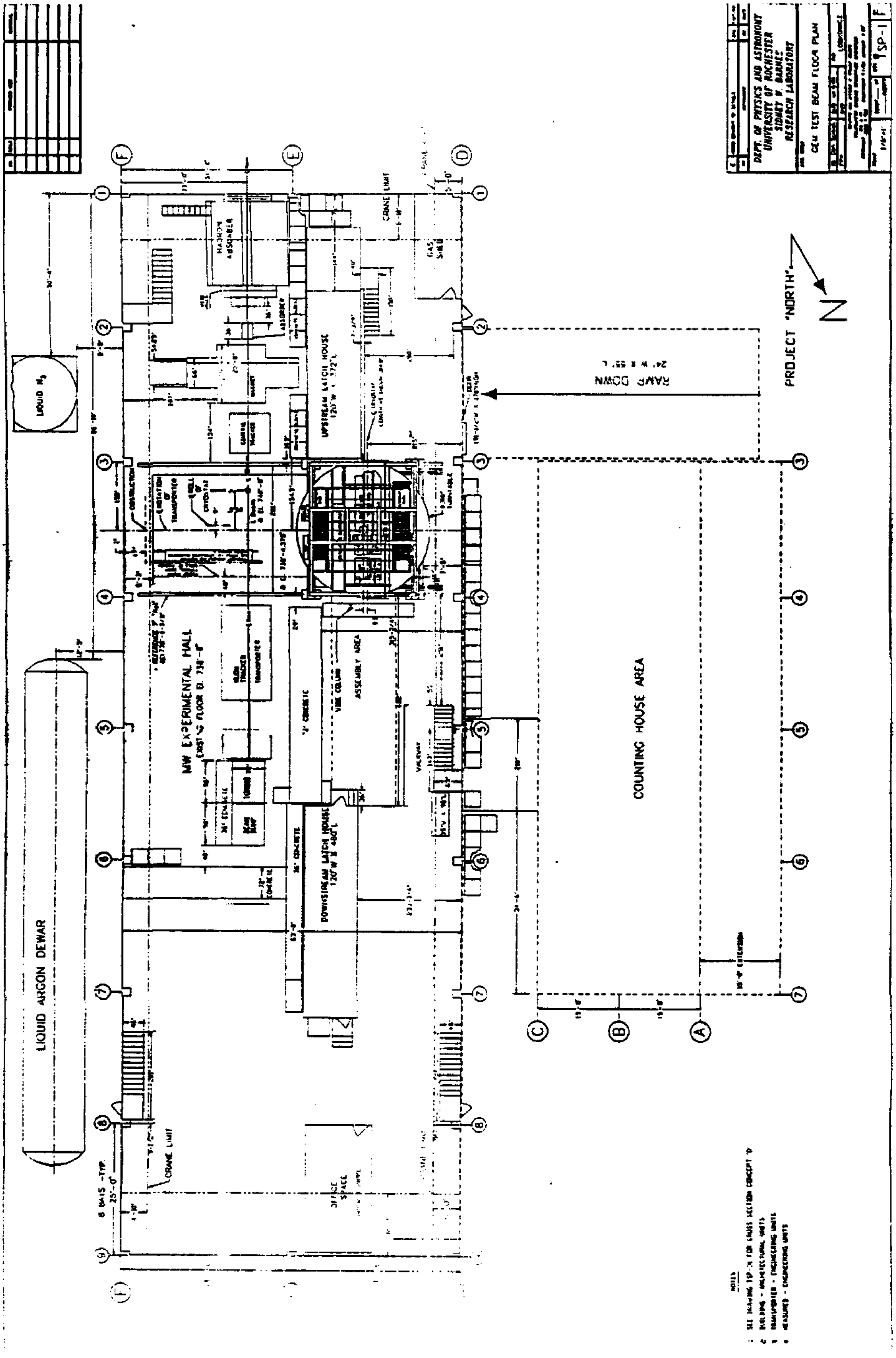
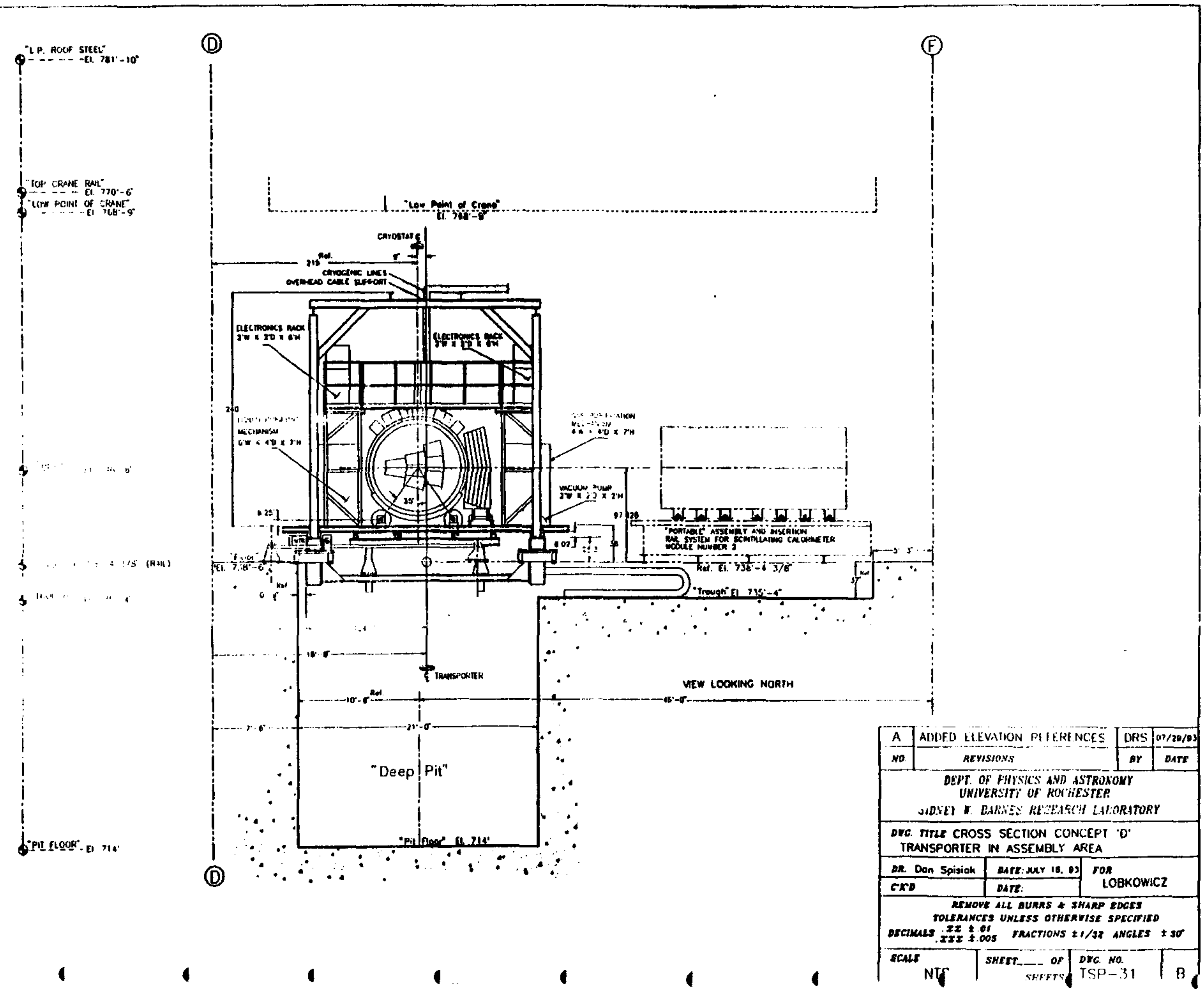
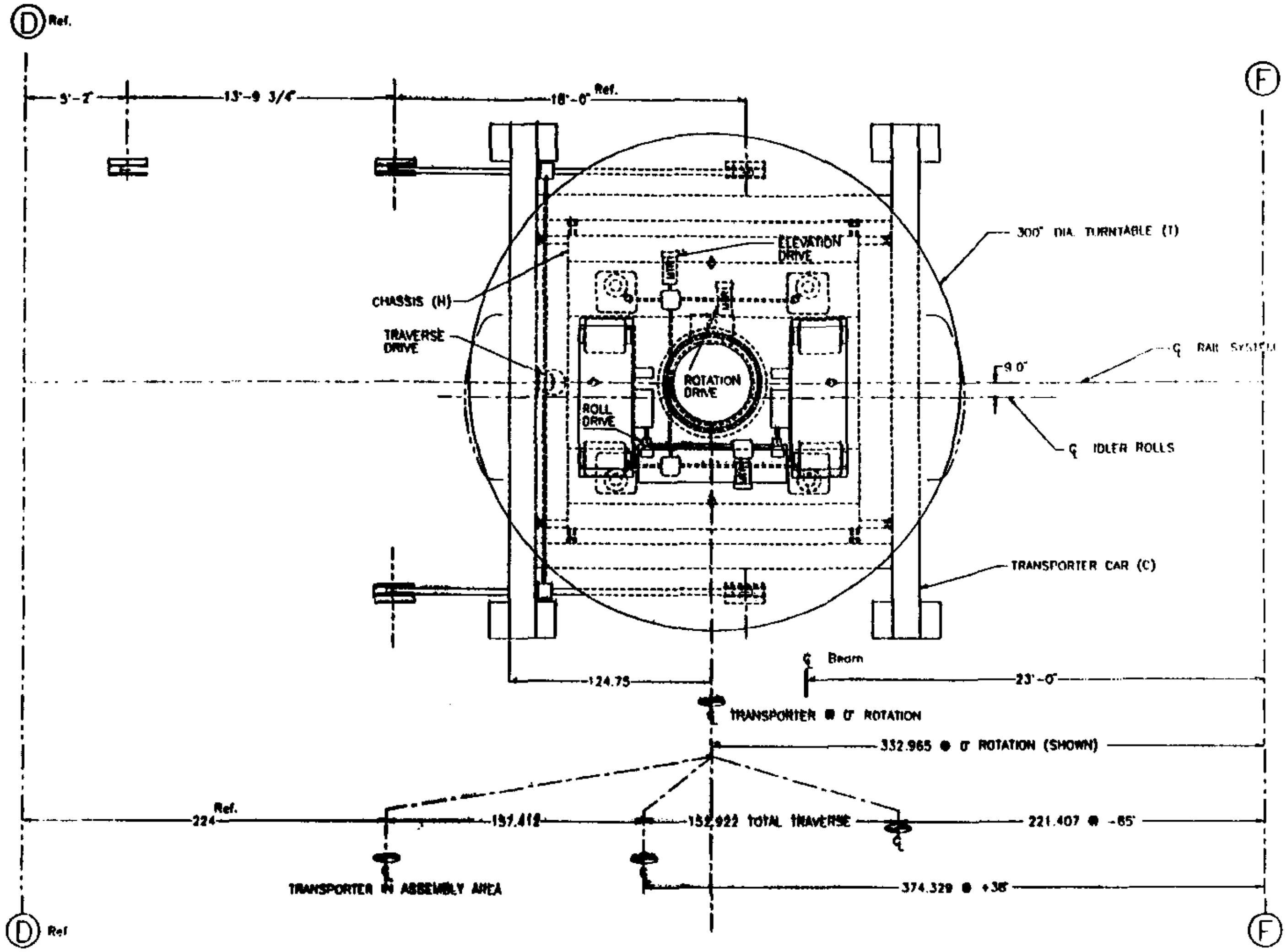
DWG. TITLE CRYOSTAT IN BEAM AREA			
DR Dan Spisiak	*DATE:* Aug 3, 93	*FOR* LOBKOWICZ	
SCALE NTS	*SHEET____ OF ______SHEETS*	*DWG NO.* TSP-36	



LIQUID ARGON DEWAR
LIQUID N2
NW EXPERIMENTAL HALL
HADRON ABSORBER
UPSTREAM LATCH HOUSE
DOWNSTREAM LATCH HOUSE
ASSEMBLY AREA
COUNTING HOUSE AREA
RAMP DOWN
PROJECT "NORTH"
N
CRANE LIMIT
OFFICE SPACE
GAS SHED
8 BAYS - TYP. 25'-0"


"I.P. ROOF STEEL" EL. 781'-10"
"TOP CRANE RAIL" EL. 770'-6"
"LOW POINT OF CRANE" EL. 768'-9"
"PIT FLOOR" EL. 714'
"Low Point of Crane" EL. 768'-9"
CRYOSTAT ℄
CRYOGENIC LINES
OVERHEAD CABLE SUPPORT
ELECTRONICS RACK 2'W X 2'D X 6'H
ELECTRONICS RACK 2'W X 2'D X 6'H
MECHANISM 6'W X 4'D X 7'H
VACUUM PUMP 2'W X 2'D X 2'H
"PORTABLE" ASSEMBLY AND INSERTION RAIL SYSTEM FOR SCINTILLATING CALORIMETER MODULE NUMBER 2
Ref. EL. 738'-4 3/8"
"Trough" EL. 735'-4"
℄ TRANSPORTER
VIEW LOOKING NORTH
10'-0" Ref.
45'-0"
21'-0"
"Deep Pit"
"Pit Floor" EL. 714'
A | ADDED ELEVATION REFERENCES | DRS | 07/29/93
NO. | REVISIONS | BY | DATE
DEPT. OF PHYSICS AND ASTRONOMY
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY
DWG. TITLE CROSS SECTION CONCEPT 'D' TRANSPORTER IN ASSEMBLY AREA
DR. Don Spisiak | DATE: JULY 16, 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-31 | B



NOTES

1. SEE DRAWING TSP-31 FOR CROSS SECTION OF CONCEPT 'D'.
2. BUILDING – ARCHITECTURAL UNITS
3. TRANSPORTER – ENGINEERING UNITS
4. MEASURED – ENGINEERING UNITS
5. SEE FINAL DRAWING B-1-4BC G-1 FOR BUILDING DIMENSIONS.
6. (T) TURNTABLE
7. (H) CHASSIS
8. (C) CAR

NO.	REVISIONS	BY	DATE

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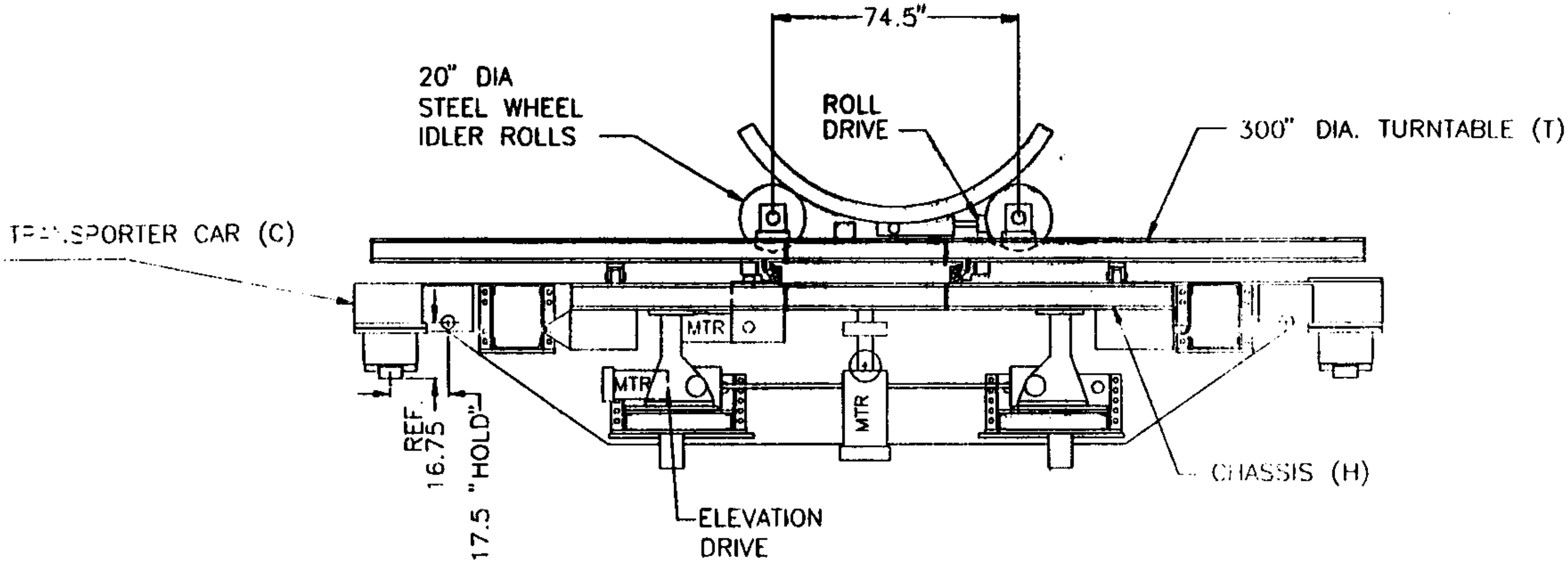
UNIVERSITY OF ROCHESTER
SIDNEY W. BARNES RESEARCH LABORATORY

DWG. TITLE GEN'L ARRANGEMENT MWEST TRANSPORTER

DR. Dan Solaido	DATE: AUG 18, 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-38



NOTES

1. SEE DRAWING TSP-31 FOR CROSS SECTION OF CONCEPT 'D'.
2. BUILDING - ARCHITECTURAL UNITS
3. TRANSPORTER - ENGINEERING UNITS
4. MEASURED - ENGINEERING UNITS
5. SEE FNAL DRAWING 8-1-48C G-1 FOR BUILDING DIMENSIONS.
6. (T) TURNTABLE
7. (H) CHASSIS
8. (C) CAR

NO.	REVISIONS	BY	DATE

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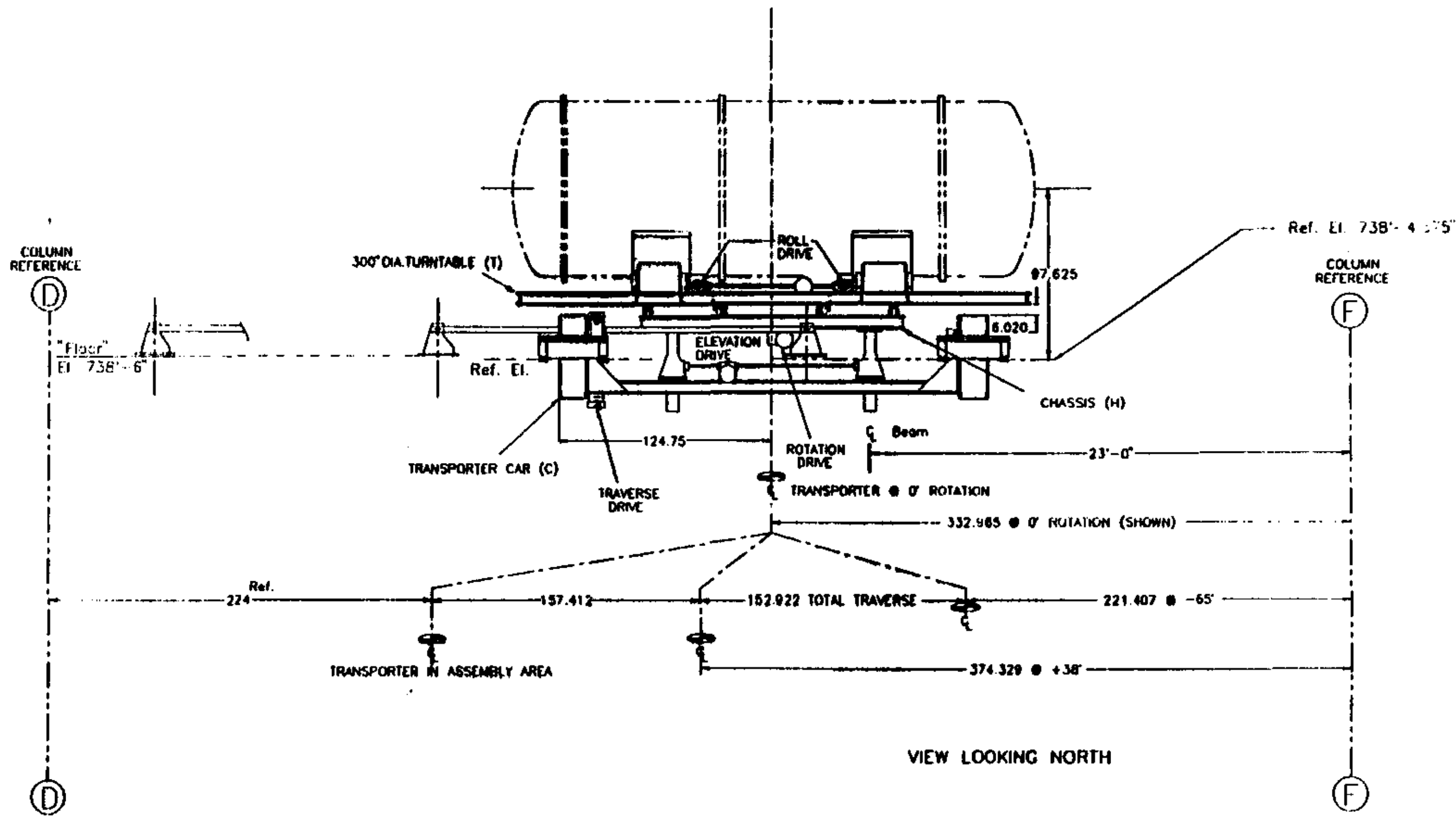
DWG. TITLE SECTION B-B
MWEST TRANSPORTER

DR. Dan Spisiak DATE: [illegible] 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-40



NOTES

1. SEE DRAWING TSP-31 FOR CROSS SECTION OF CONCEPT 'D'.
2. BUILDING – ARCHITECTURAL UNITS
3. TRANSPORTER – ENGINEERING UNITS
4. MEASURED – ENGINEERING UNITS
5. SEE FINAL DRAWING B-1-48C C-1 FOR BUILDING DIMENSIONS.
6. (T) TURNTABLE
7. (H) CHASSIS
8. (C) CAR

NO.	REVISIONS	BY	DATE

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DWG. TITLE: SECTION A-A MWEST TRANSPORTER

DR. Dan Spiolek	DATE: AUG. 12.93	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 N.T.S.	SHEET ___ OF ___ SHEETS	DWG. NO. TSP-39

Test Beam Cryostat

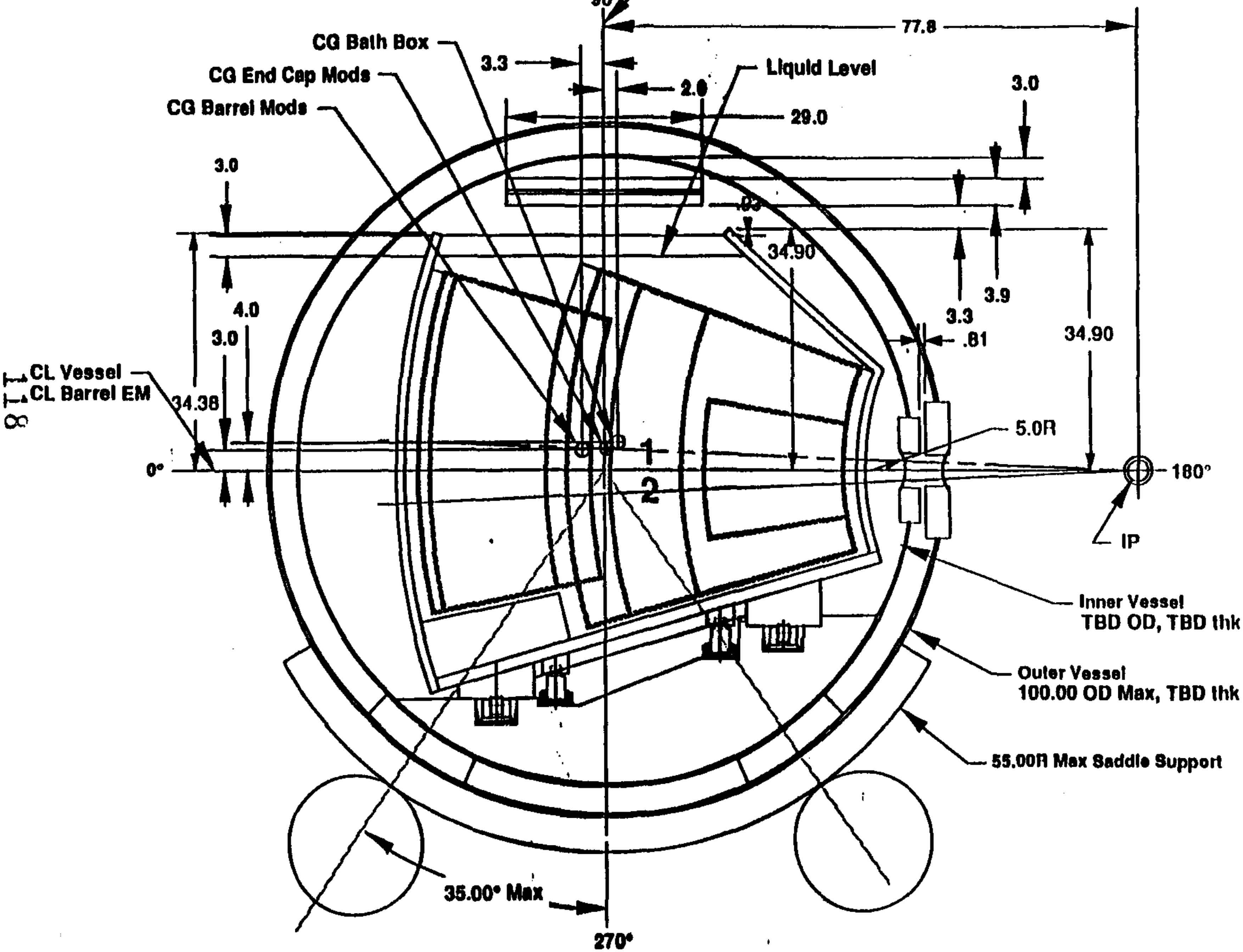
Engineering Team:

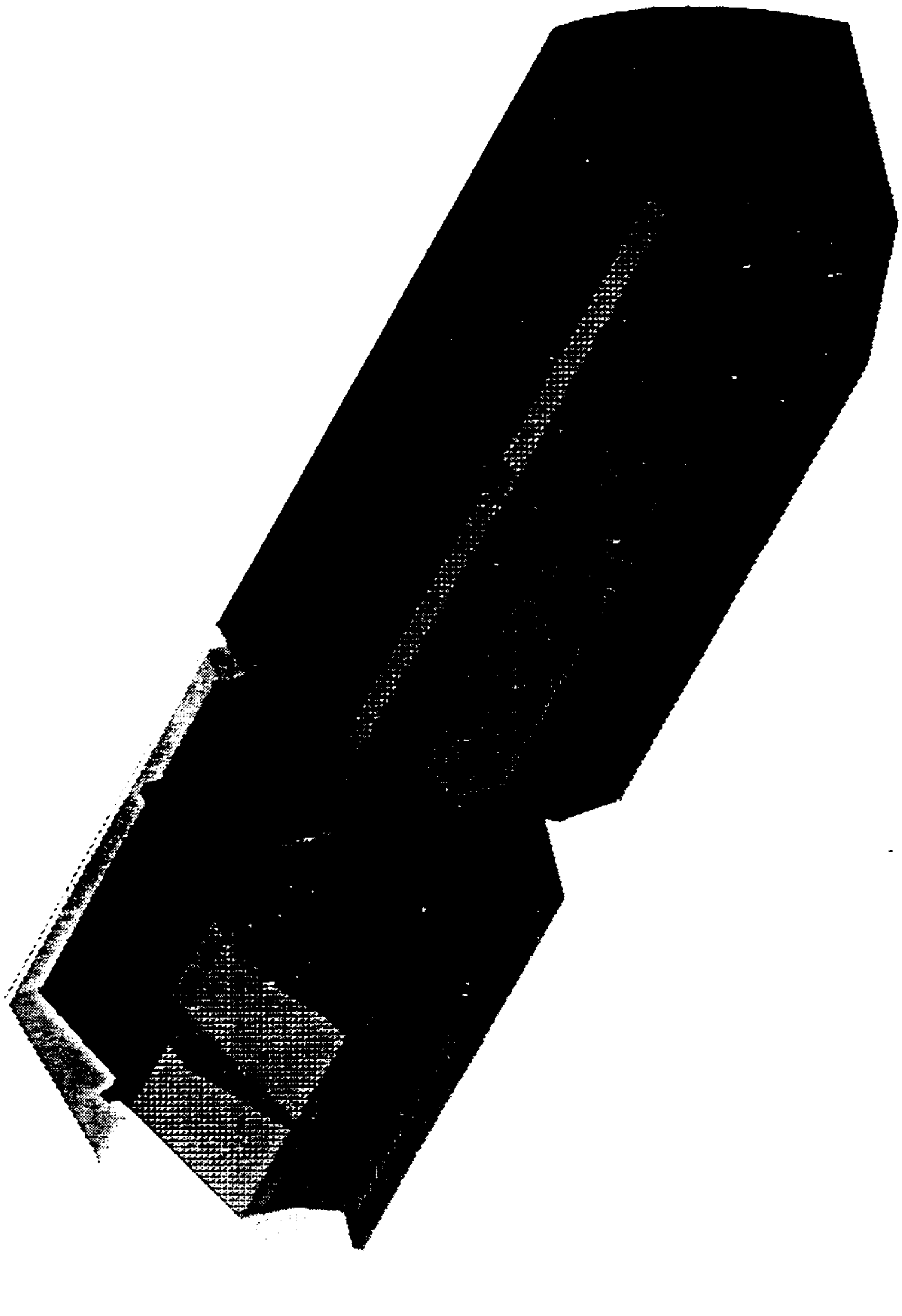
mechanical design: Neil Hall, Jim Krebs, Suneel D'Souza
David Russell & Laura Combs
flanges & some cryo work: Rich Smith
cryogenics: John Krupczak, Don Richied, Ahmed Sidi-Yekhlef
L.J. Wei, Matt Wilson, Cullen Shipp, Ray Fox
windows: Mike Gamble, Jacques Pier-Amory
vacuum: Gerry Chapman
module manipulator: Greg Velasquez
module support schemes (EM): Lyle Mason
controls: Jimmy Voyles
safety: Ronn Woolley, Kent Swartz
grounding, etc: Ken Freeman
Schedule: Ewald Zimm-Nixdorf
⋮

+input from countless physicists & engineers —

CRYOSTAT END VIEW

REV: 8/19/93

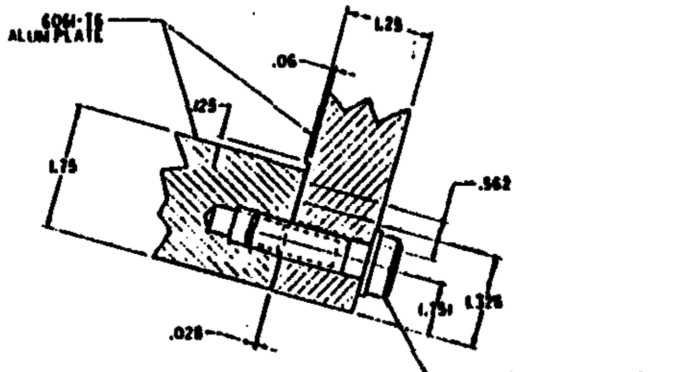




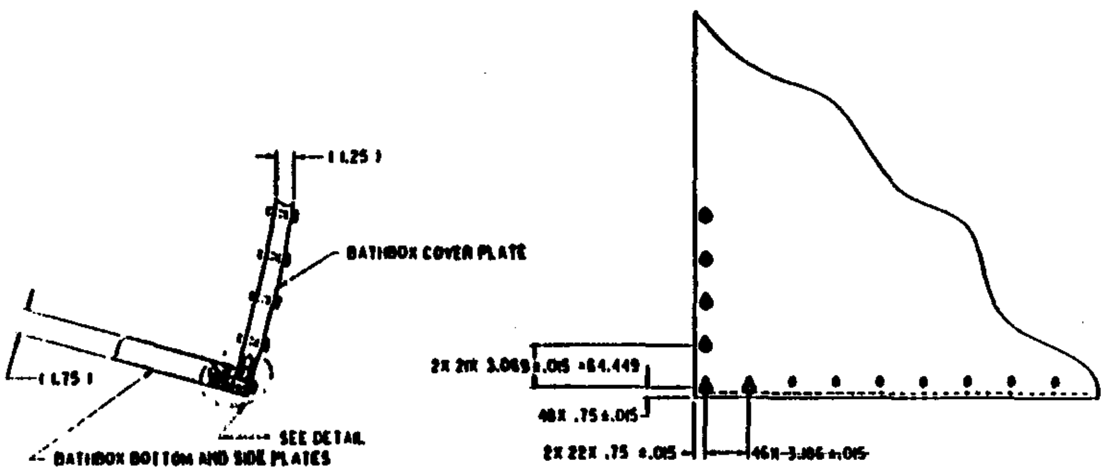
GEM TEST BEAM CRYOSTAT DESIGN STATUS
BATH BOX

- TWO SEPARATE BATH BOXES — ONE FOR BARREL MODULES, ONE FOR END CAP MODULES
- EACH BOX INDIVIDUALLY INSERTABLE
- BATH BOX TO INNER VESSEL PIN DOWN POINT AT FRONT END OF EACH BATH BOX
- WALL THICKNESS OF BATH BOX IS 1.25" WITH LOCAL THINNING AS NECESSARY IN AREA OF BEAM
- LIQUID EXCLUDERS WILL BE PROVIDED WITH BOTH BOXES TO MINIMIZE LKr REQ'MTS
- BATH BOX DESIGN MUST CONSIDER MODULE INSTALLATION
  - All Hadron Modules Are Mounted on Radial Keyways
    - √ Requires Installation From Horizontal direction
    - √ Small End Of Module Must Lead During Insertion
  - Barrel and End Cap EM Modules to be Inserted From Horizontal Direction
- REAR WALL OF BATH BOX WILL BE REMOVABLE (BOLTED) — ALL OTHER WALLS WILL BE WELDED.
- TOP OF BATH BOXES WILL BE OPEN TO RECEIVE CONDENSED CRYOGEN
- DESIGN IN INITIAL STAGES — NEED BETTER DEFINITION OF MODULE ATTACHMENT/INSERTION TOOL

Neil Hall, SSCL - (214)708 6180
July 15, 1993



DETAIL



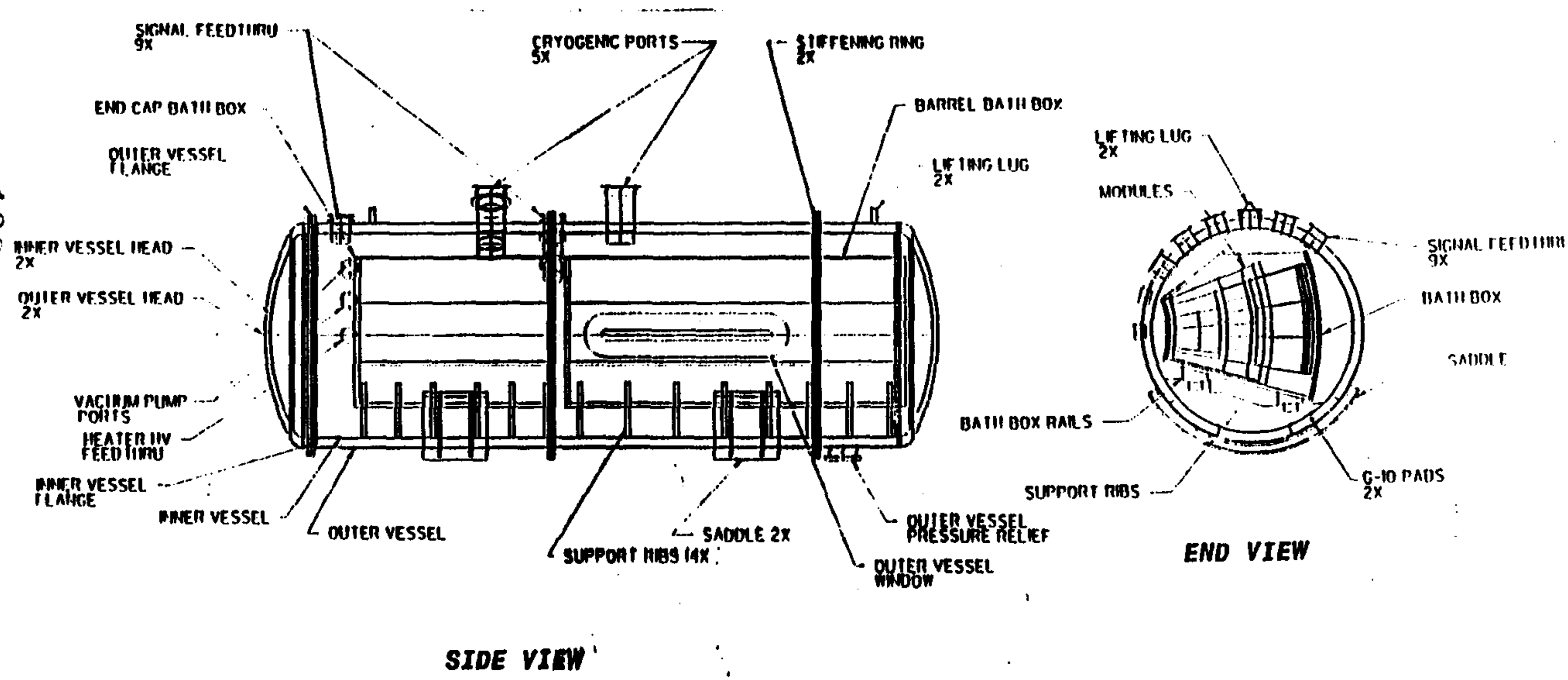
BARREL BATHBOX

GEM TEST BEAM CRYOSTAT DESIGN STATUS
VESSEL PENETRATIONS/PORTS

- APPROXIMATELY 19 MAJOR PENETRATIONS IN CRYOSTAT
  - 15 Penetrate Through Both Vessels — Require Bellows
  - 3 Penetrate Through Outer Vessel Only (Press Relief, Vacuum Pump-out, Window)
  - 1 Penetrates Through Inner Vessel Only (Window)
- MODULE SIGNAL, DC, AND HV FEEDTHRUS
  - Nine Total 11.75 Dia — Six for Barrel, Three for End Cap
  - GEM Feedthru Adapted to Test Cryostat
  - Ports Require Separate Vacuum Pump-out
  - Preliminary Design Complete
- CRYOGENIC PORTS
  - Five Allocated — 18.0 Dia
  - Design in process — Cryogenics Group Responsible
- VACUUM PUMP-OUT PORTS
  - Two Total — One for Annular Vacuum, One for Internal Vessel Vacuum
  - Vacuum Group Currently Defining Tube/Flange Sizes
- OTHER
  - HV feedthru For Strip Heaters — No Design Effort Yet
  - Outer Vessel Window 4.5" Ht X 76.25" Lg; Frame 3.5" Thk X 7.5" Wd
  - Inner Vessel Window 5.0" Ht X 88.38" Lg; Frame 3.0" Thk X 5.0" Wd

Neil Hall, SSCL - (214)708 6180
July 15, 1993

GEM TEST BEAM CRYOSTAT DESIGN STATUS
CRYOSTAT ARRANGEMENT



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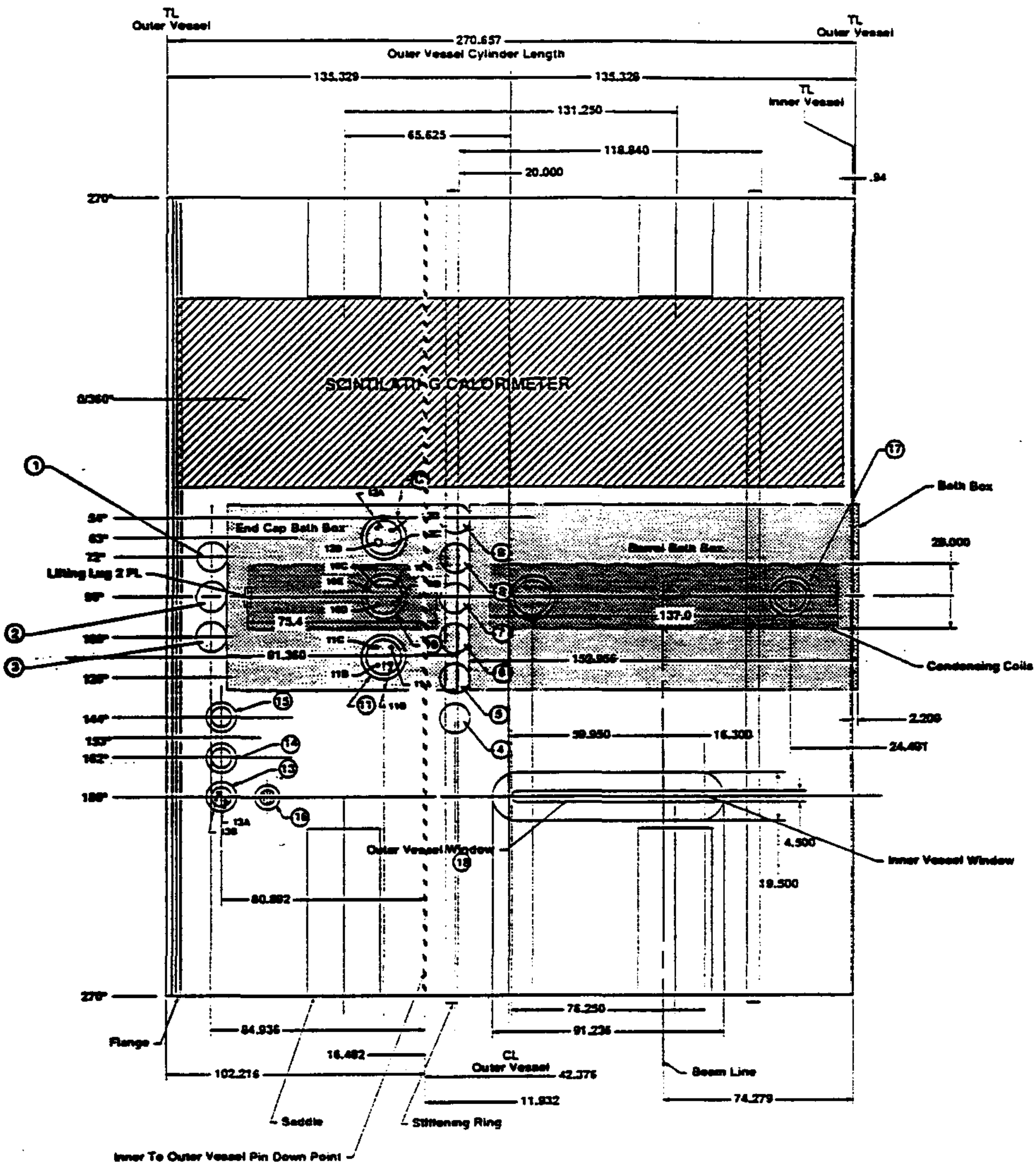
Neil Hall, SSCL - (214)708-6180
July 15, 1993

Cryostat Outer Vessel Unwrapped View
(Heads Not Shown; Head Depth = 17.17")

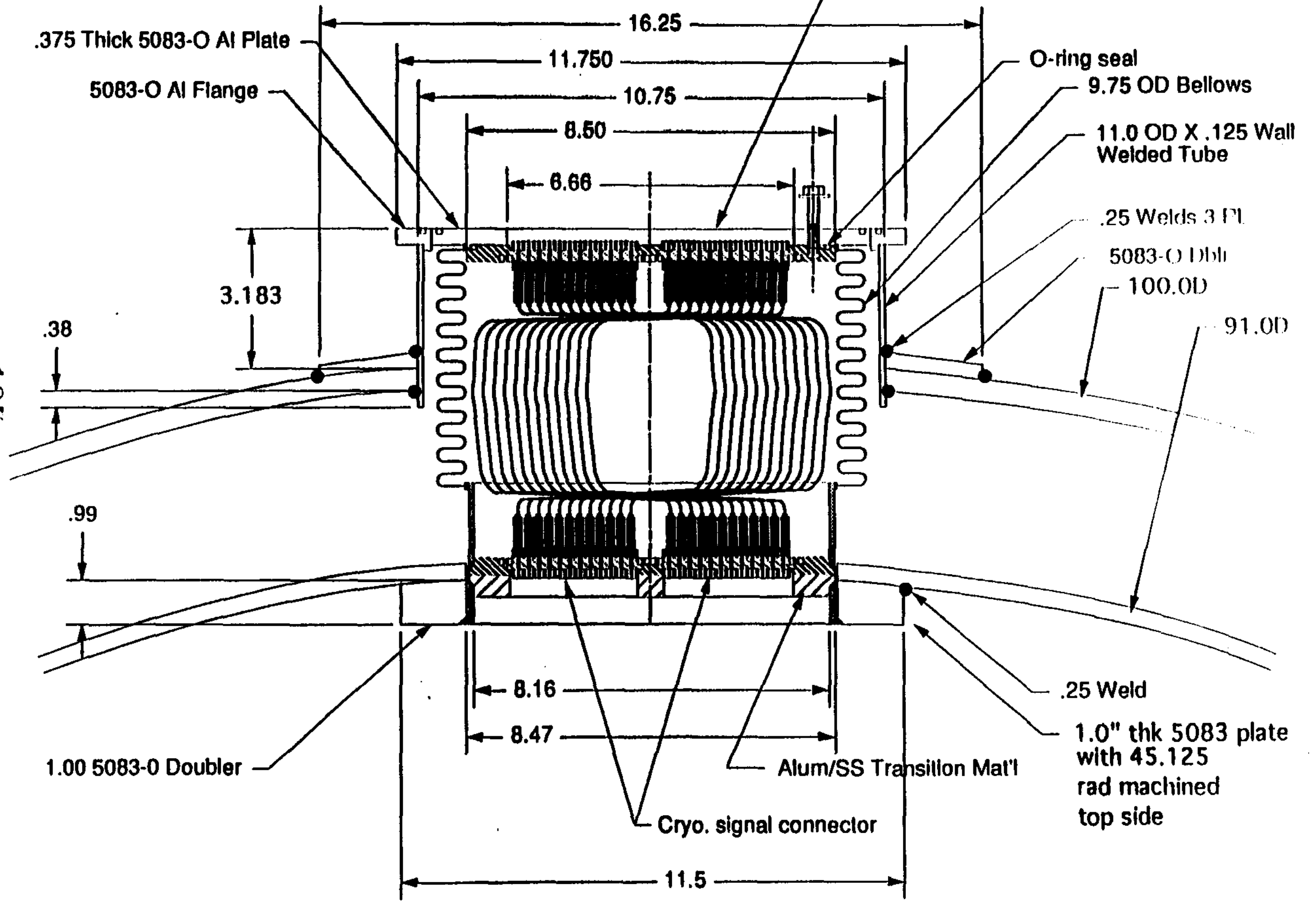
Rev: 7/8/93



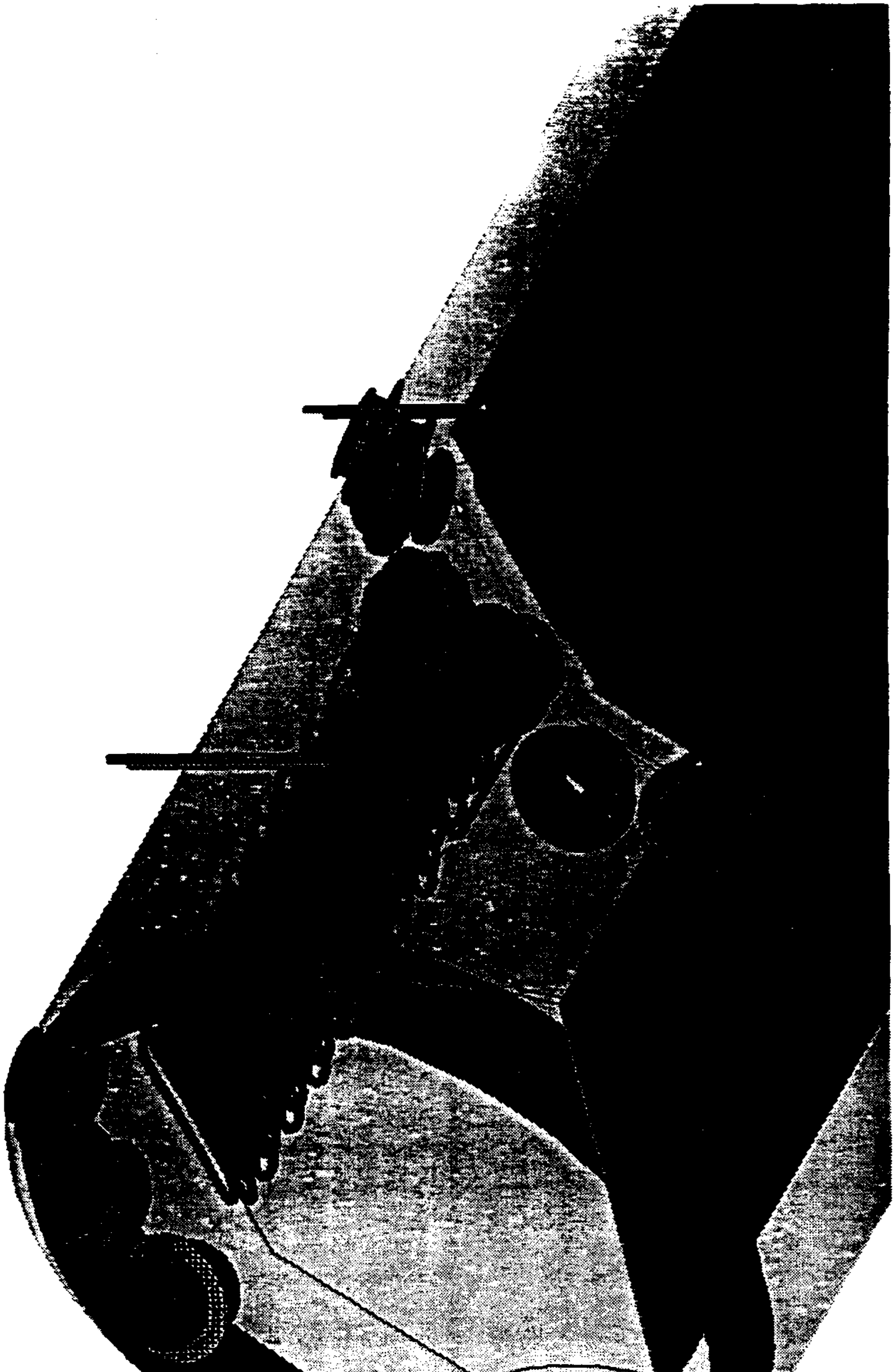
Problems:
1. Stiffening Ring interferes with center ports
2. Signal feedthru ports are now 12.0" dia and old spacing (shown) probably will not work.

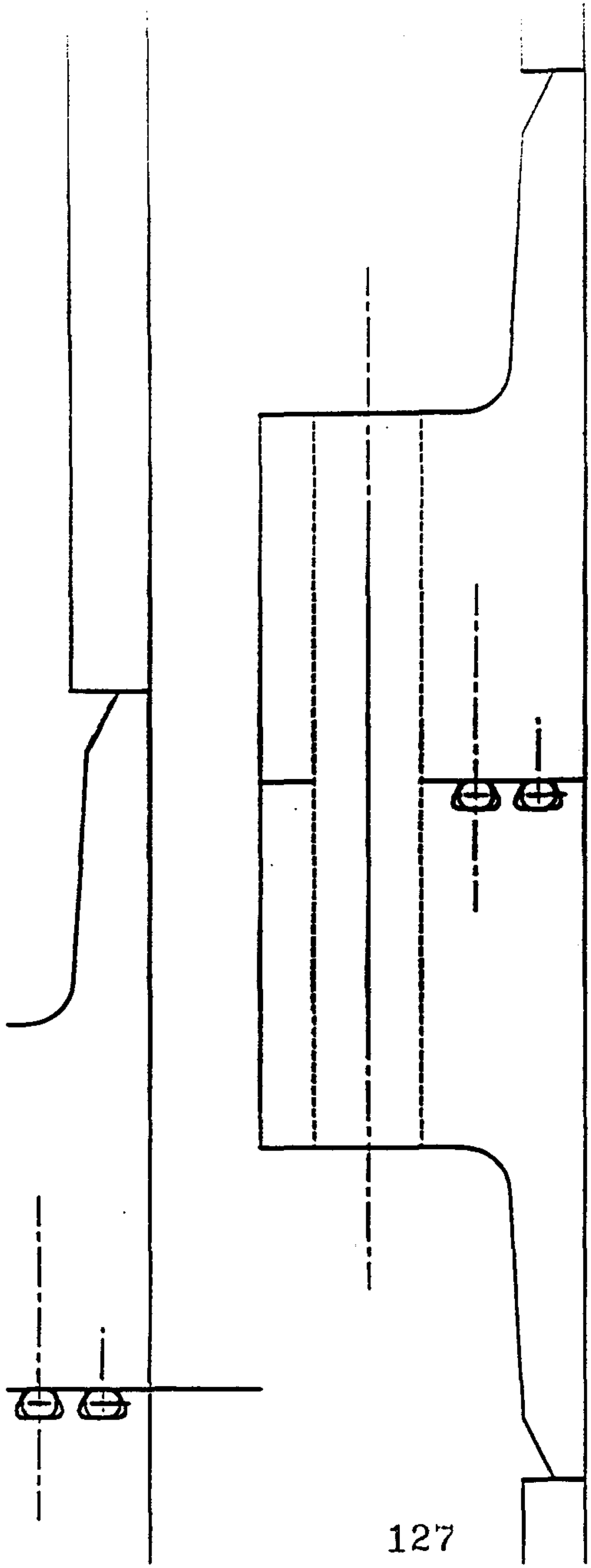
Notes
1. Axial thermal shrinkage at any point on inner vessel can be calculated by multipling length from pin point by -.00454.
2. Inner vessel radial shrinkage is .41".

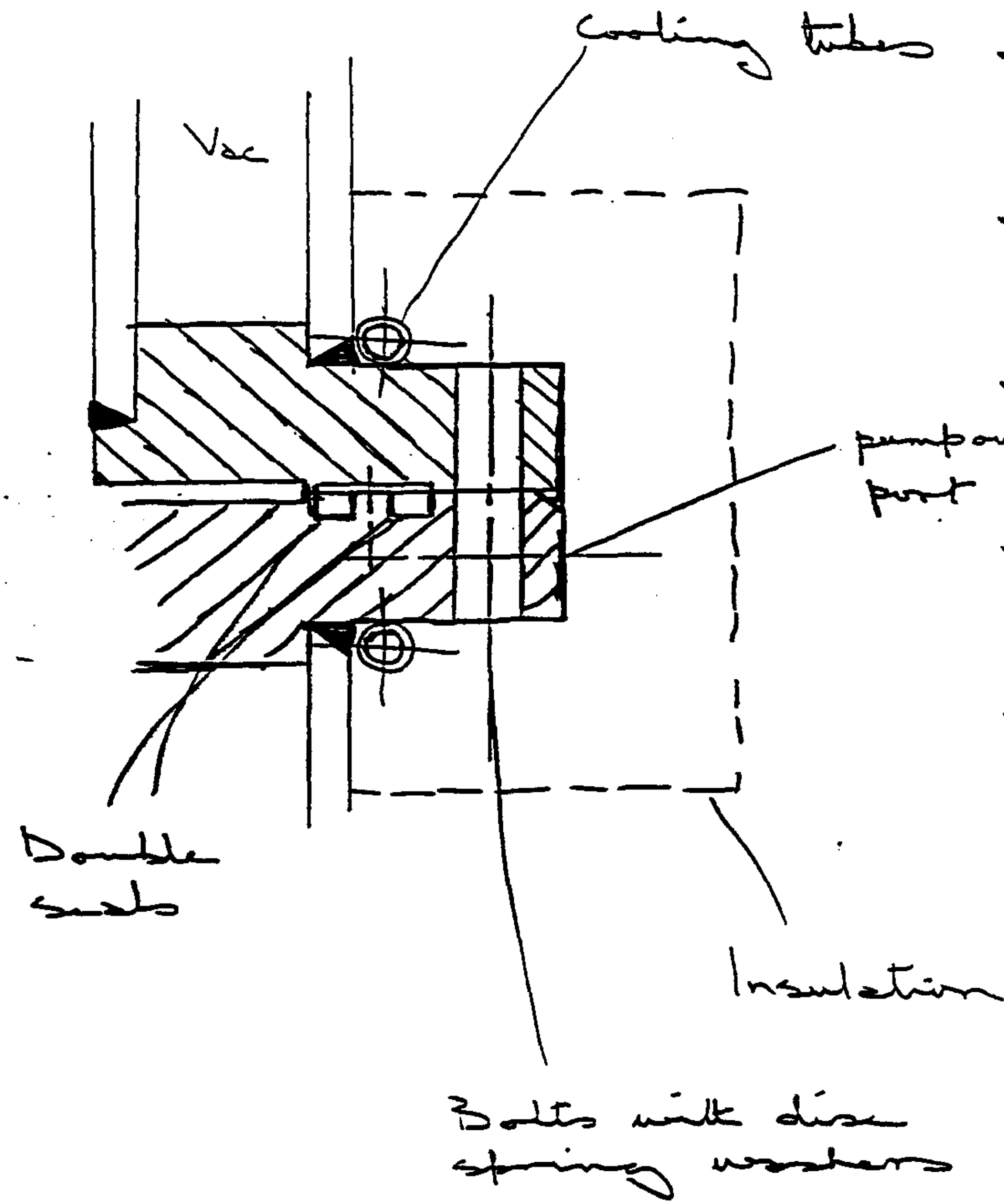
GEM Signal feedthru
Adapted forTest Beam Cryostate



N.Hall 7/14/93







Cooling tubes
Vac
pump out port
Double seals
Insulation
Bolts with disc spring washers

WELDED AND TWO PART "PICTURE FRAME" DESIGNS

- Serviceable Cryogenic Design
- Minimal Interfacial Thermoelastic Stress
- Low Cost

WINDOW MATERIALS CONSIDERATIONS

- Cryogenic Application Compatibility
- High Strength
- Long Radiation Length
- Ease of Fabricability
- Thermal Expansivity
- Cost

WINDOW MATERIALS UNDER INVESTIGATION

- Unreinforced Mylar
- Kevlar Reinforced Mylar
- Beryllium
- Aluminum

VACUUM SEAL CONSIDERATIONS

- Cryogenic Application Compatibility
- Weldability
- Low Flange Sealing Force
- Flange Surface Finish Requirements
- Inservice Leakage Expectations

VACUUM SEAL MATERIALS UNDER INVESTIGATION

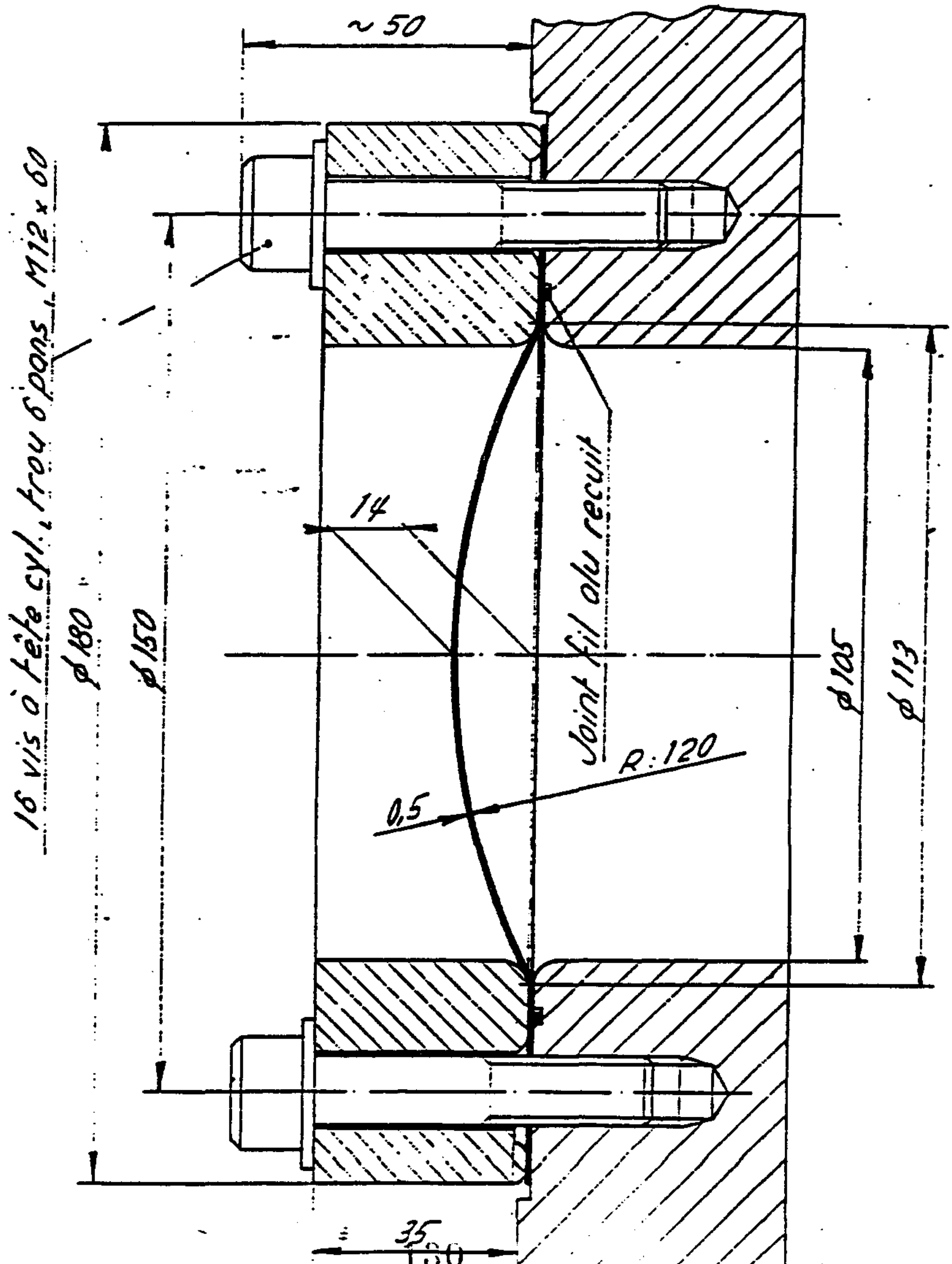
- Weld Material
- Indium
- Silver
- Copper

APPLICABLE DESIGN DOCUMENTS AND INFORMATION SOURCES

- ASME Pressure Vessel Design Code
- Mechanical Safety Subcommittee Guideline for Design of Thin Windows for Vacuum Vessels
- Cryogenic Materials Data Handbook
- Design of Large Aperture, Low Mass Vacuum Windows
- Specification Concerning the Construction of a Cryogenic Tank and Auxiliary Equipment for an Impactometer

M. Gamble, 2 August 1993

MONTAGE D'UNE MEMBRANE EN FORME EN ALUMINIUM ALLIE AVEC BRIDE RIGIDE



TEST CRYOSTAT WINDOW CONCEPT OPTION 2

Rev: 7/29/93
N. Hall x-6180