GEM TN-91-42

GEM COLLABORATION COUNCIL MEETING

December 5, 1991

Abstract:

Agenda and transparencies contributed to the GEM Collaboration council Meeting held on December 5, 1991..

COLLABORATION COUNCIL MEETING

Thursday, December 5, 1991 - 9 A.M.

S S C L

Agenda

I	Update on Status of GEM	(Barish)
II	BaF2 'Expert' Panel	(Newman or Brau)
III	GEM R & D/Engineering Request for 1992	(Baltay)
IV	Report on Status of First Budget Roll-Up	(Sanders)
V	Report on Hall Design and GEM Assembly Considerations	(Marx)
VI	GEM Organizational Structure	(Samios)
VII	Reports on R & D Programs of Subsystems Groups	
	- Magnet (Stroynowski)	
	- Muons (Taylor/Ahlen)	
	- Calorimetry (Brau)	
	- Inner Tracking (Baltay/Musser/Morgan)	
	- Electronics (Shaevitz/Marlow)	
	- Computing (McFarlane)	
ADJOURN		3 PM

A Meeting of the 'New' GEM Executive Committee will follow the Collaboration Council Meeting, immediately (3 PM - 5 PM)

The PAC will meet to consider our LOI (copies will be available at the Collaboration Council Meeting) on December 15-17th. We will present our LOI in open session on the morning of December 16th. All are welcome to attend.

B. BARISH

GEM

Collaboration Council Meeting

Nov 6, 1991

UPDATE (SINCE Nov CC Mtg)

- LOI submitted Nov 30

THANKS → Subsystems Groups
Paige / Lane
Yost, MacFarlane, Durdon ...

		EOI	LOI
Countries		8	15
Institutions	US.	40	47
	nonUS	11	39
	TOTAL	51	86
Collaborators	US	244	323
	non-US	66	282
	TOTAL	310	605

- **GEM Collaboration R+D/Eng. Plan**

  (Baltay, Webb)

  Budgets \$19.9M → \$15.0M

  → (Baltay Report)

- **BaF_2 Expert Panel**

  1st Meeting Dec 4, 5

  → (Newman Report)

- **LOI COSTS - FIRST ROLL-UP**

  Not included in LOI

  → (Sanders Report)

- **Halls / Shafts / Assembly**

  → (MARX Report)

- Magnet Conductor Workshop

→ (Stroynowski)

- GEM Organization (Nominations)

→ (Sulak)

official before PAC Mtg.

PAC Presentations

Dec 16 Morning

1.5 hr + .5 hr

OPEN

Support Documents

1) Magnet Choice (Stroynowski)
2) GEM R&D/Engineering Plan
3) Occupancy + Pileup (Marlow)
4) Cost Studies of GEM/LOI Detector (Sanders)

Willis / Barish ⇒ { Taiwan
Beijing
Shanghai

Dec 6 - 15

NEW EXECUTIVE COMMITTEE MEET

3-5 PM TODAY

Topics - Organization
+
PAC Strategy

FUTURE MEETINGS

Jan	23	Collab. Council - SSCL
⇒ MARCH	8-11	GENERAL MTG TUCSON
April	~~28~~ 30	Collab Council - SSCL
June	4	Collab Council - SSCL

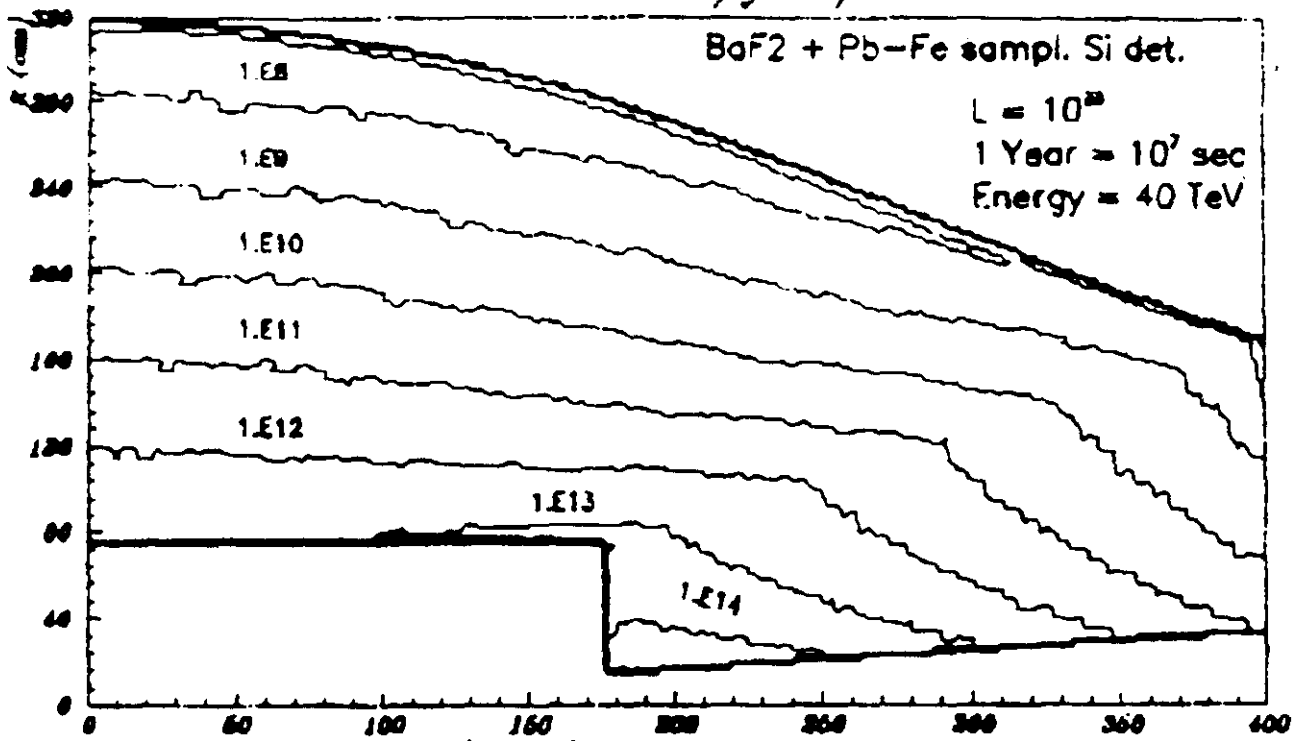
H. Newman

Barium Flouride Mtg. List

Name	Institution	Address	Country	Phone	FAX	Bitnet
David J. Nagel	Naval Research Lab	Code 4600 4555 Overlook Ave S.W. Washington, DC 20375	USA	202-767-2931 202-767-2885	202-767-3709	
Richard A. Craig	Battelle Memorial Inst. Pacific Northwest Lab.	K5-25 P.O. Box 999 Richland, WA. 99352	USA	509-375-6907	509-375-3614	
Gregory Belenky	Bell Labs	Room 2D-209 600 Mountain Ave. Murray Hill, N.J. 07974	USA	908-582-7668 908-789-8971	908-582-2043	
Paul LeCoq	CERN	EP Division 1211 Geneve 23	Switzerland			
Yok Chen	Oak Ridge National Lab	P.O. Box 2008 Bldg. 3025, MS 6024 Oak Ridge, TN 37831	USA	615-574-6284	615-574-4143	
Richard F. Wood	Oak Ridge National Lab	P.O. Box 2008 Bldg. 3025, MS 6032 Oak Ridge, TN 37831	USA	615-574-5781	615-574-4143	
Majewski, Stanley	Continuous Electron Beam Accelerator Fac	12000 Jefferson Avenue Newport News, VA 23606	USA	804-249-7448	804-249-7363	puphep::marlow
Steve King	Naval Research Lab	Code 4600, 4616 4555 Overlook Avenue S.W Washington, D.C. 20375	USA	202-767-5692	202-767-3709	
Jeffrey W. Griffin	Battelle Memorial Inst. Pacific Northwest Laboratory	K6-81 P.O. Box 999 Richland, WA 99352	USA	509-375-2081 509-735-3684	509-375-3614	
Craig Woody	Brookhaven National Lab	Physics Dept. 510A 20 Pennsylvania Street Upton, NY 11973	USA	516-282-2752		
Mordechai Rothschild	MIT Lincoln Laboratory	244 Wood St. Lexington, MA 02173-9108	USA	617-981-7816	617-981-4983	
Rob Sparrow	Optovac	North Brookfield, MA. 01535	USA	508-867-6444	508-867-8349	
Paul Schotanus	Quartz and Silice Holland B.V.	P.O. Box 168 3454 ZK de Meern	The Netherlands			schotanus@hotrnu51
Andrew Drukier		7986 Lakecrest Drive Greenbelt, MD 20770	USA	301-864-0816 301-982-9808	301-864-0816	drukier@umdhep
Steve Smith	Charles Evans and Associates	301 Chesapeake Dr. Redwood City, CA 94063	USA		415-369-7921	
Harvey Lynch	SLAC	2575 Sandhill Rd. Menlo Park, CA. 94025	USA			

Radiation Dose in BaF_2

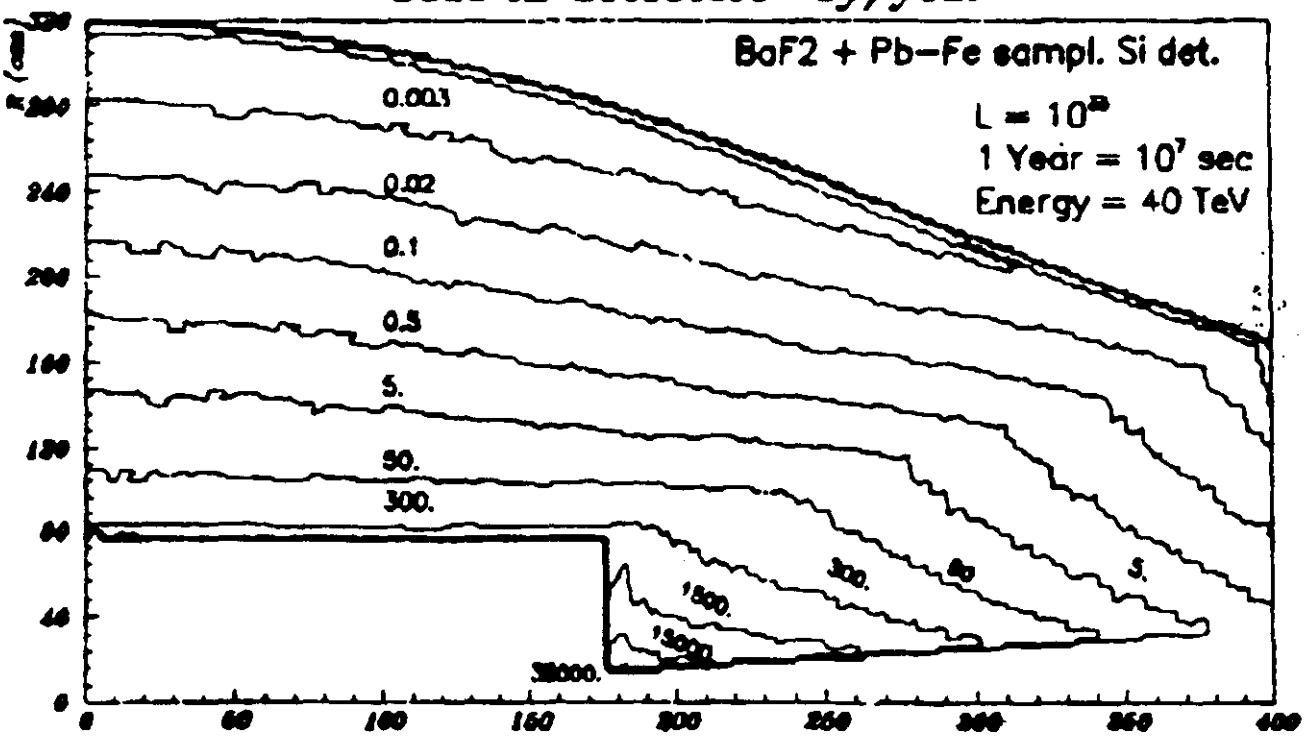
Neutron flux /year/cm2



$10^{12} - 10^{16}$ n/cm²/year

gray = 1 joule/kg
Gray = 100 rad
1 joule = 10^7 erg
rad = 100 ergs/gram

Doze in detectors Gy/year

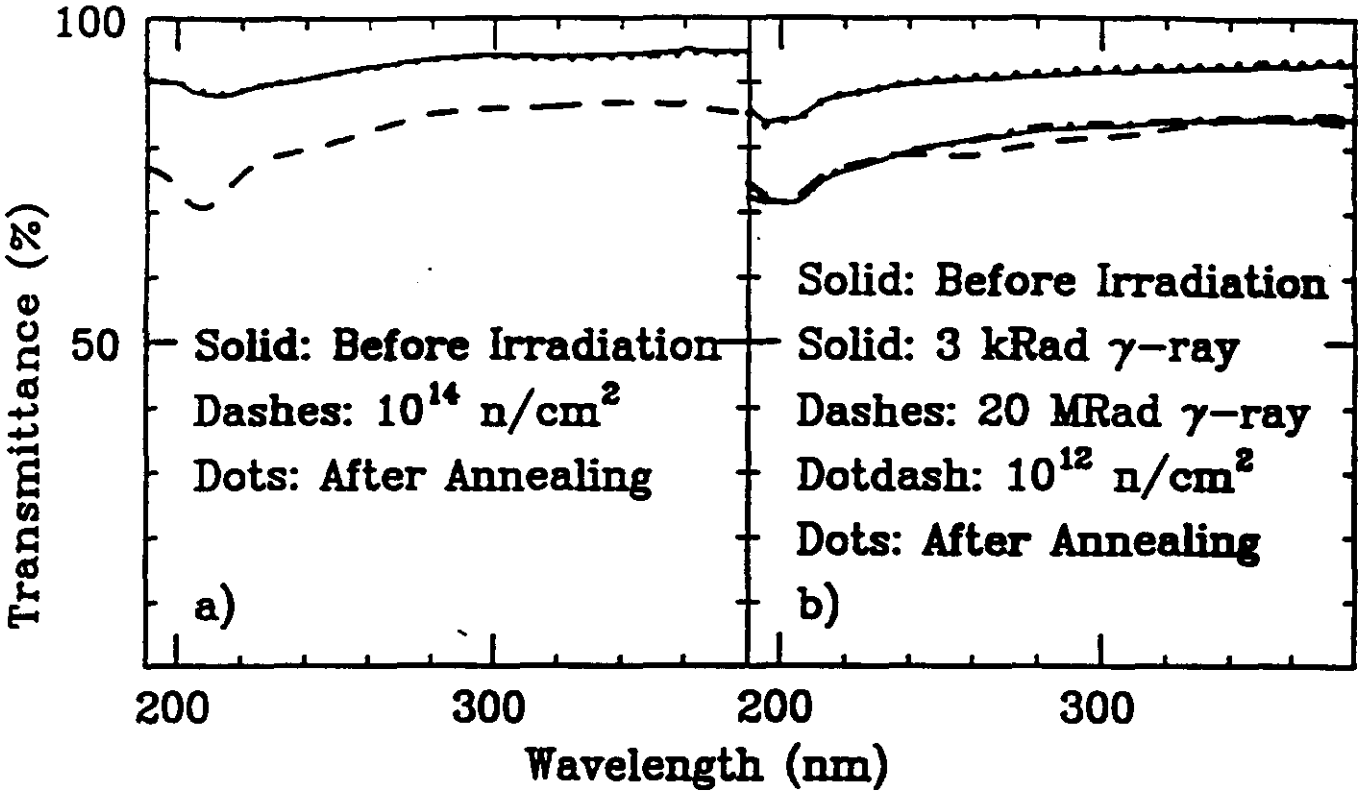


300 ~ 30K Gy or 30K ~ 3M Rads/year

- L3 extrapolated up to LH
use 3 times

BaF_2 Transmission Before and After Irradiation:

- (a) Recovery from Neutron Damage
- (b) Typical Saturation Effect :
  - Same for γ, NEUTRONS
  - NO ANNEALING at ROOM TEMPERATURE



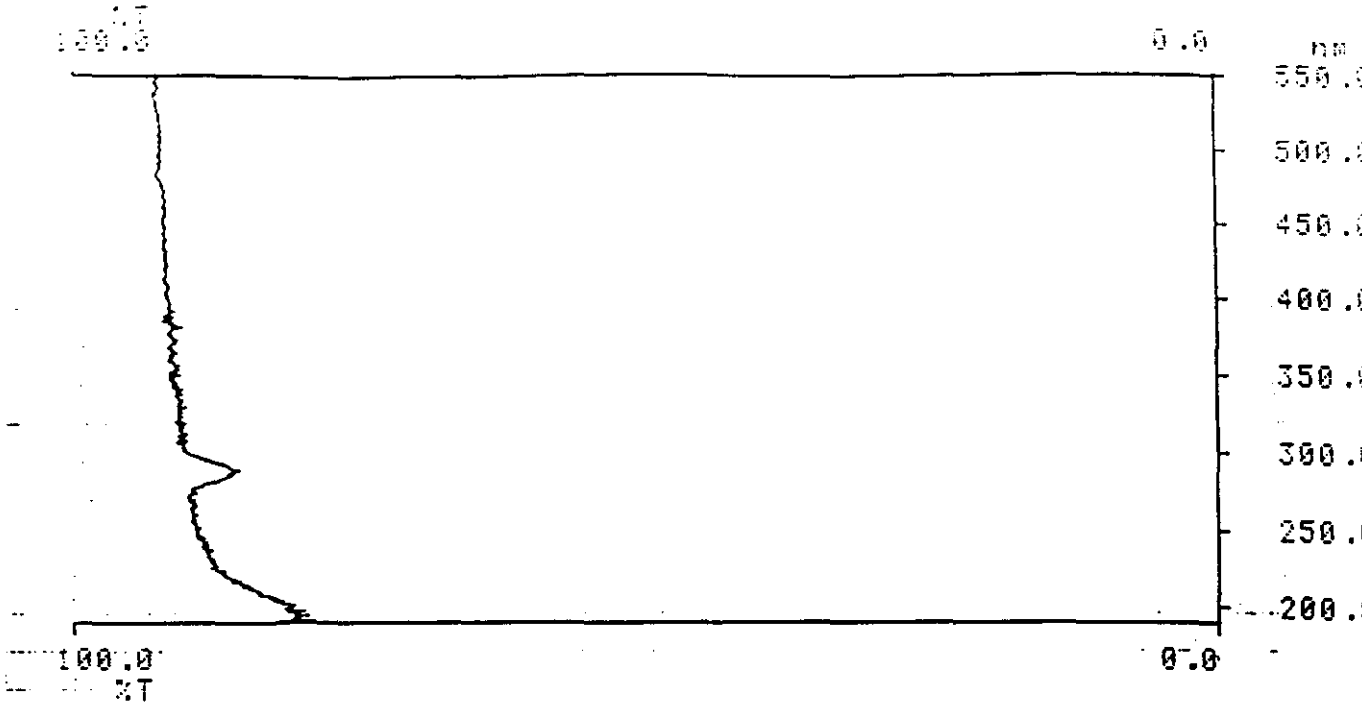
- UC IRVINE REACTOR : NEUTRONS , JPL : Co^{60} γ RAYS

- B. Studies of radiation damage in BaF_2 crystals indicate that the damage may be associated with an absorption peak at $288nm$. This peak is suspected to be caused by Cerium or O_2 in the crystals. SIC and BGRI will pursue a systematic series of studies to eliminate this absorption peak.

  - SIC and BGRI will therefore determine the source of Cerium as a trace element, and eliminate it from further crystal batches.

  - SIC and BGRI also will continue to pursue tests that will determine the effect of Oxygen(O_2) dissolved in the crystals. SIC, BGRI, Caltech, engineers from ORNL, and engineer M. LeBeau will work together to improve the growing conditions, so as to remove O_2 down to a level where it does not lead to significant absorption in the UV following irradiation. In order to achieve this, the vacuum systems of the ovens may be improved. A production oven with improved pumping, to achieve a vacuum in the 10^{-6} to 10^{-7} Torr range, will be set up with the assistance of Caltech and the engineers.

  - SIC and BGRI will investigate the use, and necessity of the use, of very pure raw materials in the crystal growth. This step is recognized to be useful only once effective methods of analysis down to a trace element level of $\leq 10^{-7}$ (molar fraction) have been established.



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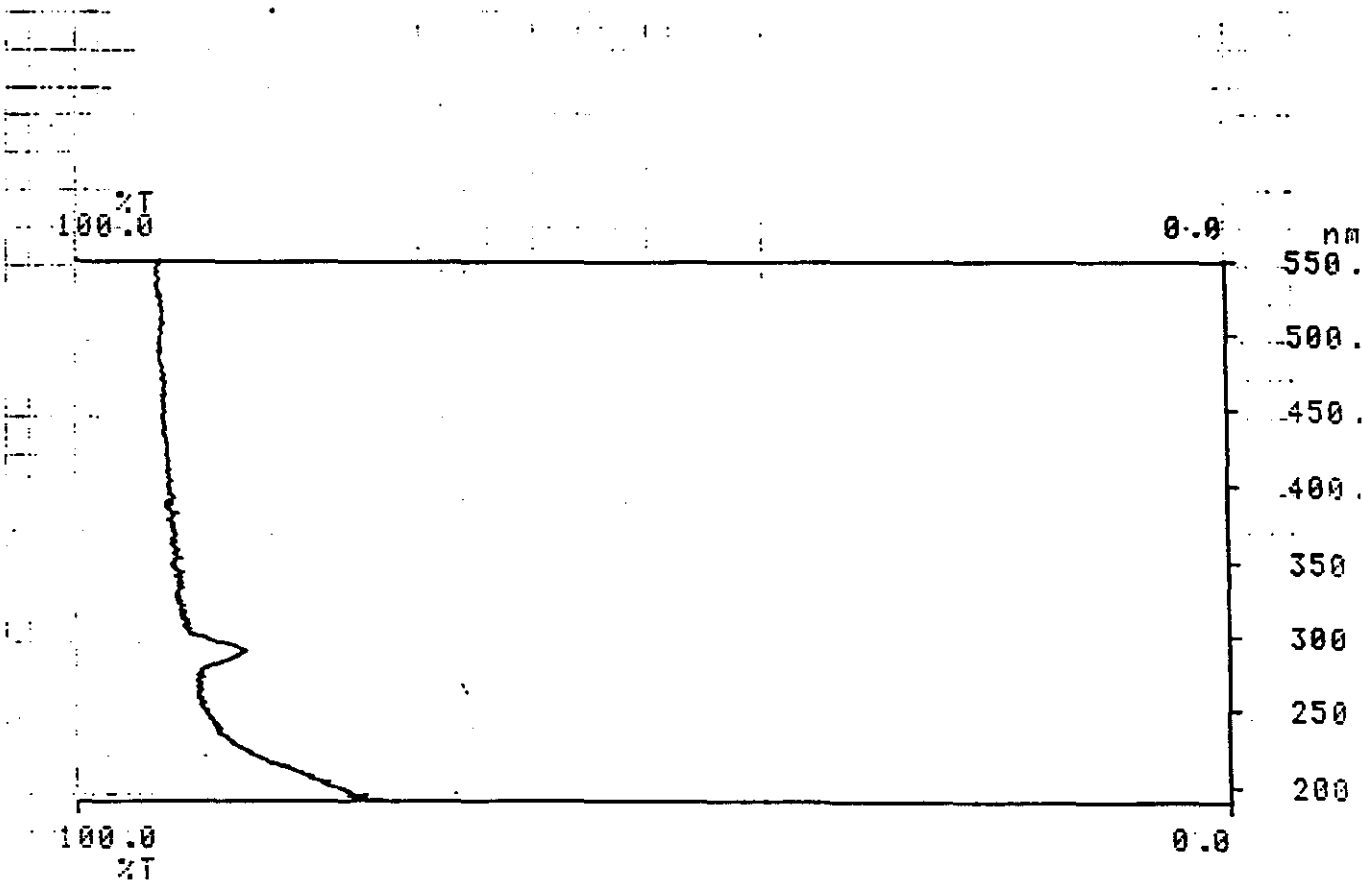
BANDPASS: 5.00nm



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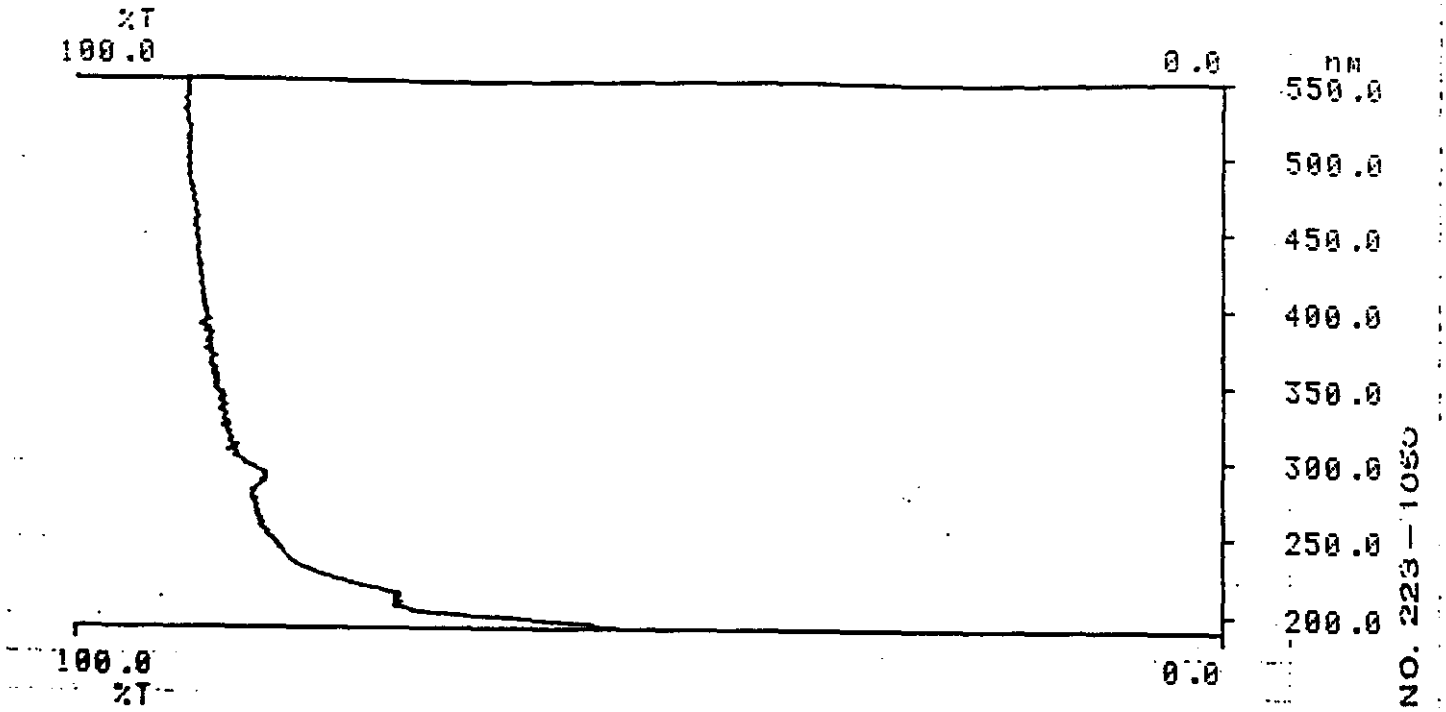
BANDPASS: 5.00nm

HITACHI NO. 228-1050



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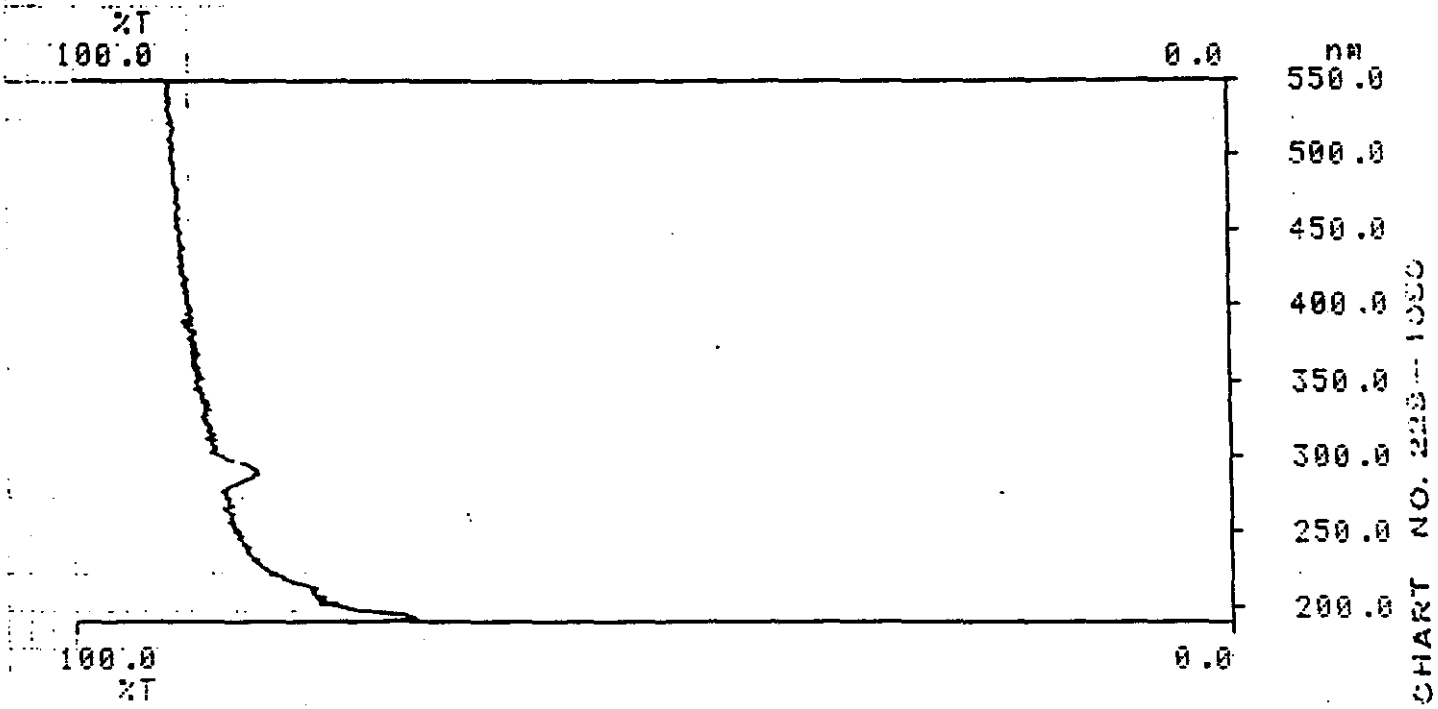
BANDPASS: 5.00nm

12: 2 PM 5/16/91
RESPONSE: MEDIUM



TITLE: S1B005.DT
SCAN SPEED: 60.0 nm/min
BANDPASS: 5.00nm

11:21 AM 5/16/91
RESPONSE: MEDIUM

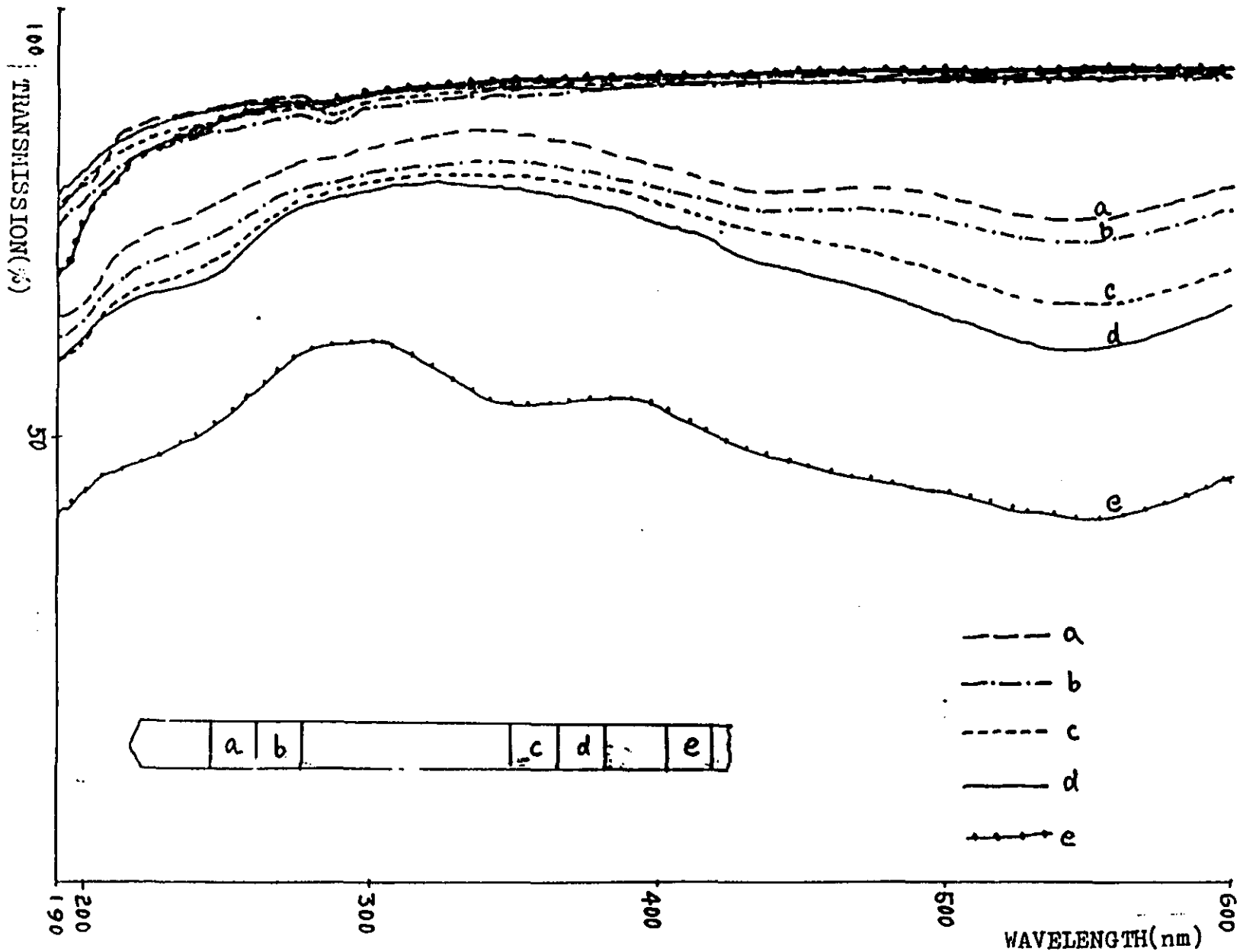


Fig.2 25 mm long crystal, r-ray irradiation: 1.6 MRad.
BaF₂ crystal cut from different sites of a 300 mm crystal

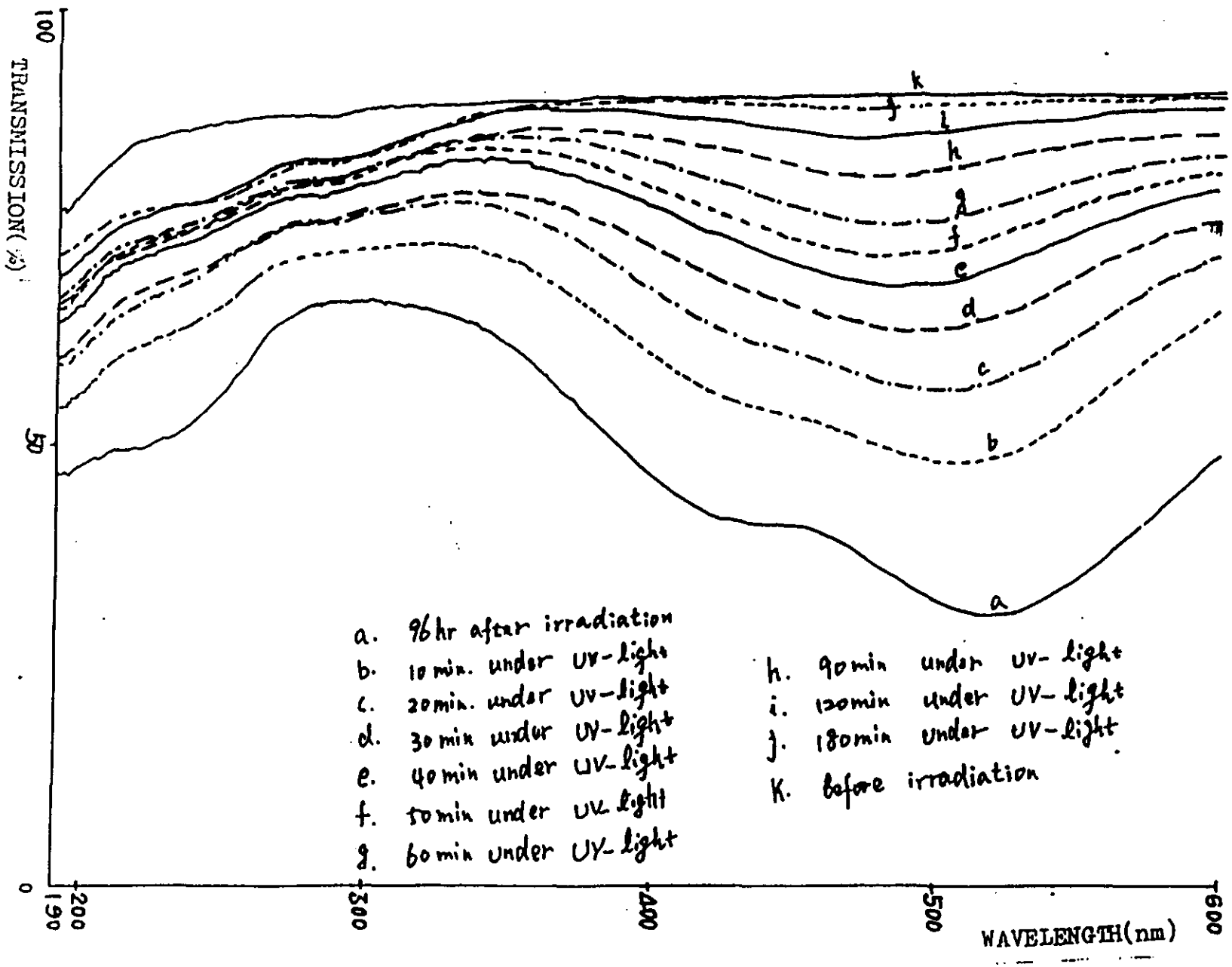


Fig.10 Bleaching effect of damaged BaF_2 crystal by UV light

* Oxygen containing fluorides can be considered as a mixed crystal of MF_2 and MO, for example, can consider oxygen containing SrF_2 crystal as a mixed crystal of SrF_2 and SrO. It was known that the UV absorption band of SrO is located at 215-217 nm[7], and it is 205-209 nm (about 6 e.V) for BaO. They are due to the transition from O_{2p} state to conduction band of Ba^{+2} or Sr^{+2} ions.

* When oxygen containing BaF_2 crystals were irradiated by γ-ray radiation, O^{-2}-F^{+} dipoles decomposed:

$$O^{-2}\text{-}F^{+} \longrightarrow O^{-2} + F^{+}$$

which will increase the concentration of lone O^{-2} ions and O^{-2} ion pairs so as to increase the absorption in the 190-250 nm region. F^{+} vacancies are easy to capture electrons to form F centers which are responsible to the absorption in the visible region. In the mean time, the hollow at 290 nm was reduced or disappeared due to the decomposition of O^{-2}-F^{+} dipoles.

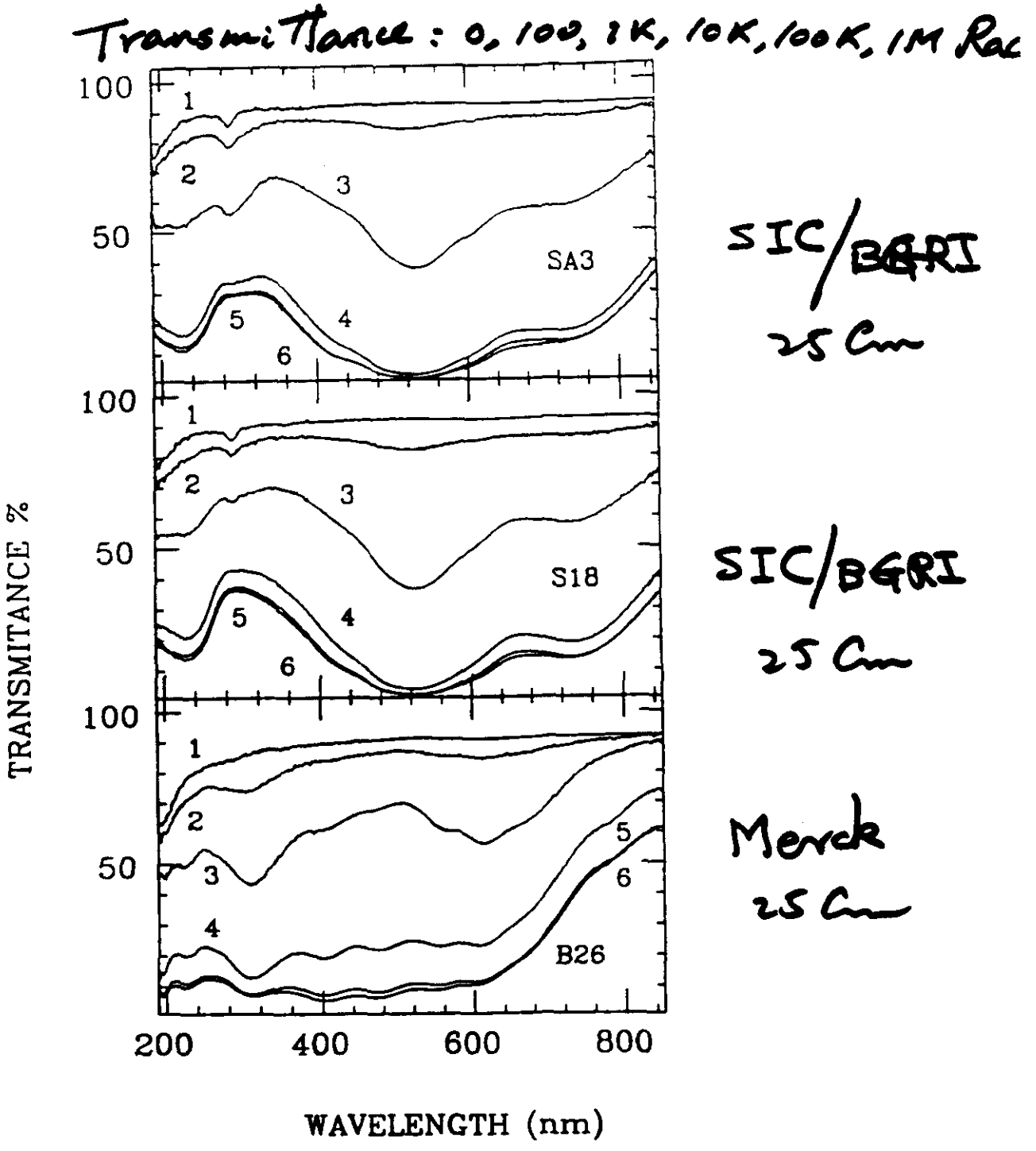
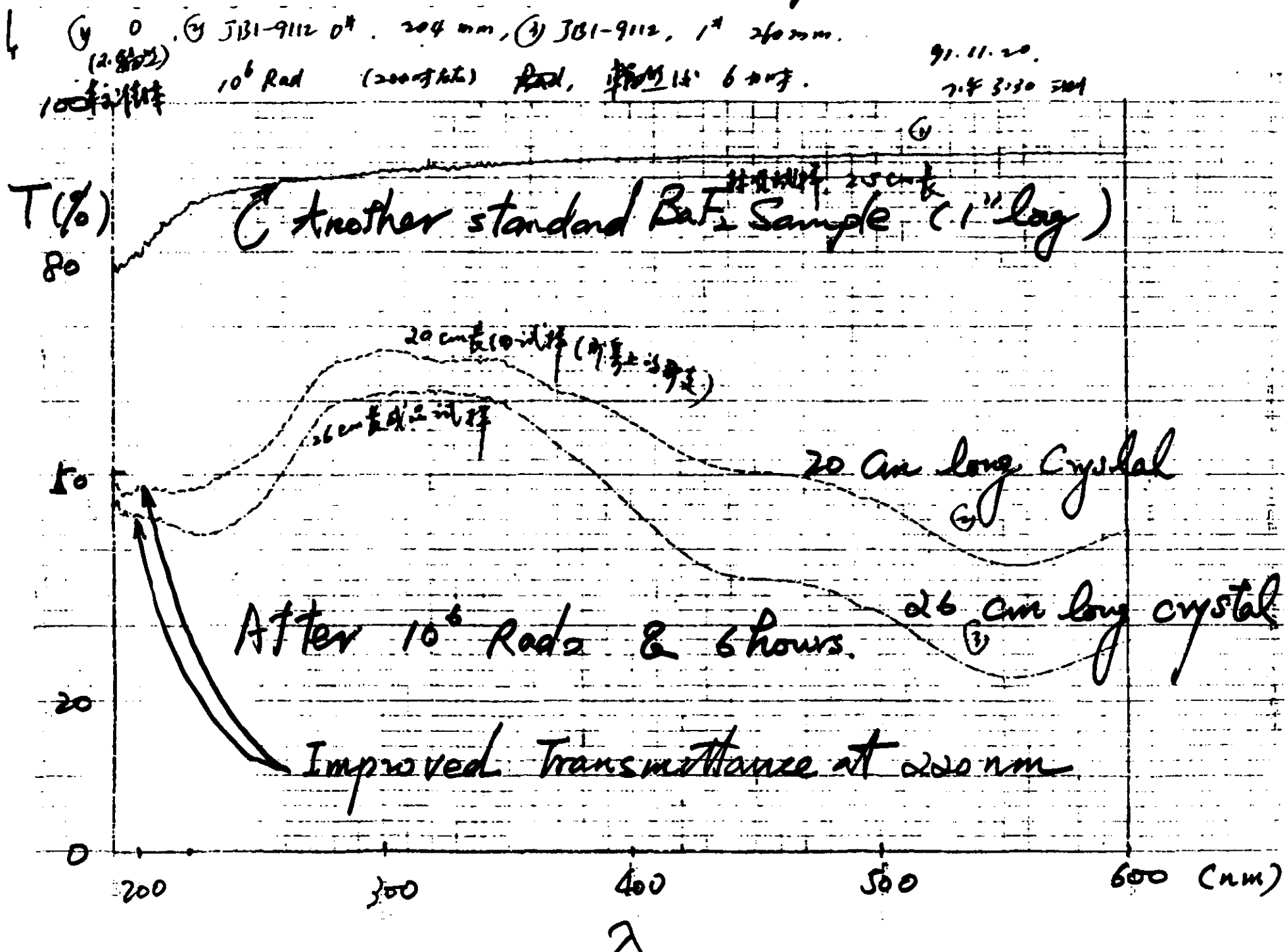


Figure 2. The transmission spectra of SA3, S18 and B26 before and after Co^{60} γ-ray irradiation. (1)unirradiated, (2)100, (3)1K, (4)10K. (5)100K and (6)1M rads.

Figure 3. Relative change in light output tested by H4652 PMT for sample2, sample 4 and sample 5.

New Chinese BaF_2 Crystals (received 10/3/91)



C Baltay
Dec 5, 1991

GEM Engineering & R&D Plan

GEM Engineering & R&D Funds

R&D Committee: [illegible]

We are now half way into the FY92 process:

. We have received & compiled the Eng. and R&D requests from the GEM Subsystems

∴ R&D Committee + Bill + Barry + a few others will meet at 4:00 PM Thursday to discuss how to make 15 = 21

this will hopefully result in guidelines for allocations to the subsystems.

∴ Subsystems will prepare in the next two weeks their sections of the "Eng. and R&D Proposal" to be edited by the R&D Committee and submitted to SSCL.

4. Actual Funds will be dispensed based on MOU's between institutions, GEM, & SSCL

Expected Sources of Funding

Fred Gillman has requested the following funds for GEM R&D and Engineering

From SSC	10 M$
From TNRLC	5 M$
Total for GEM	15 M$

This is probably the maximum that we can expect.

There is an additional ~ 1+2 = 3 M$ of "Project Management" Funds for GEM administered by Mike Harris at SSCL

This presumably can be used for GEM system integration

R & D PLAN

SYSTEM	REQUEST	PLAN A
1. Integration	1.0	0
2. Magnet	6.2	5
3. Calorimetry	7.8	3.3 + 1.3 for BaF2
4. Muons	3.5	2.7
5. Tracking	1.3	1.1
6. Electrons	0.9	0.8
7. Computing	0.1	0.1
	20.8	
Reserve	1.0	0.7
	21.8	15.0

The GEM Collaboration's Engineering/R&D Plan for FY '92

The GEM Collaboration

26 November 1991

Contents

1. Introduction

2. Magnet

3. Calorimetry

4. Muon System

5. Central Tracking

6. Trigger and Data Aquisition

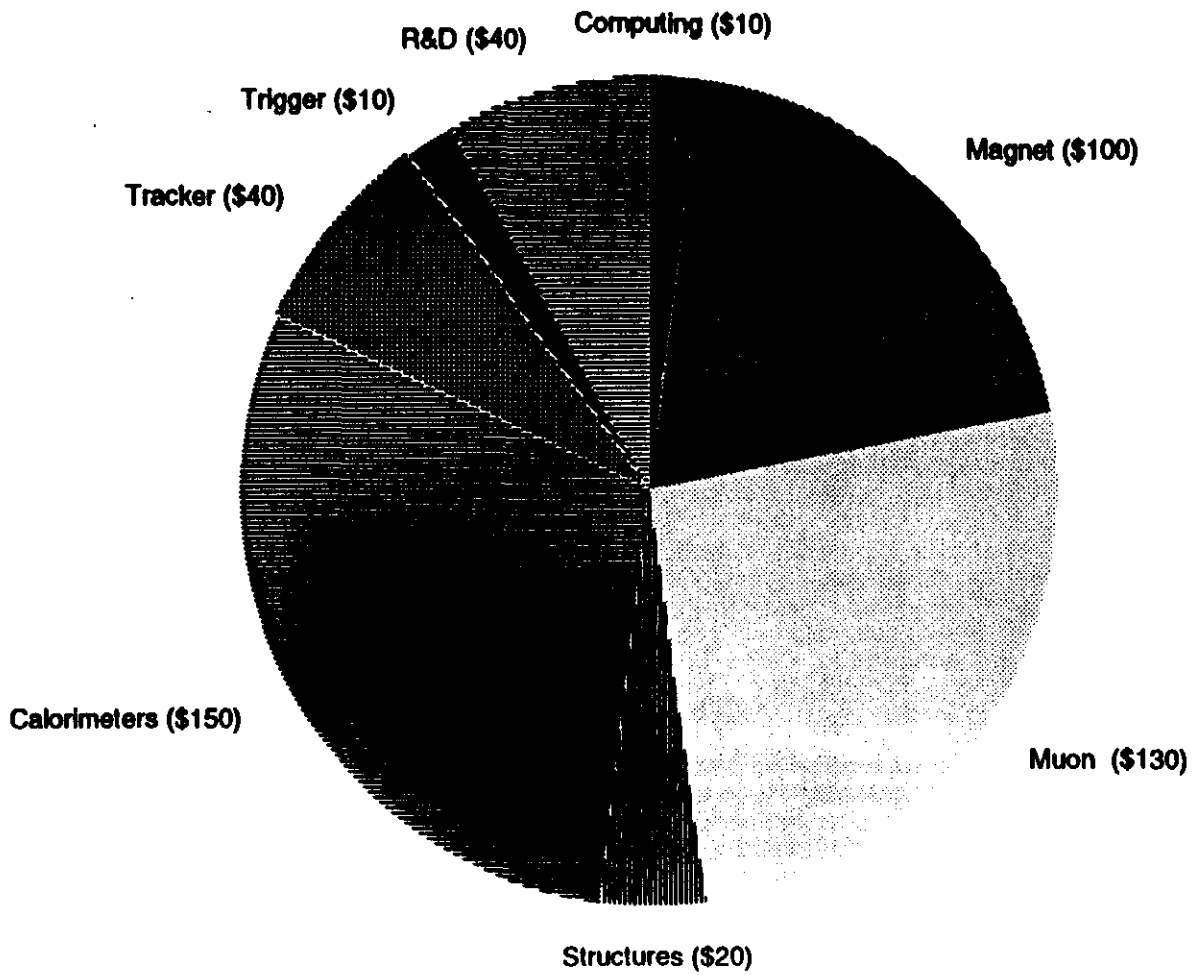
7. Computing

TABLE 1

1.	System Integration		0*
2.	Magnet		5,000
	Engineering design	2600	
	R&D on conductor etc.	2400	
3.	Calorimetry		4622
	Liquid Argon/Krypton	1170	
	Barium Fluoride	1209	
	Scintillating Fiber	610	
	Forward Calorimeters	75	
	Preradiators	140	
	System Engineering	1418	
4.	Muon System		2700
	Pressurized Drift Tubes	400	
	Limited Steamer Drift Tubes	480	
	Cathode Strip Chambers	500	
	Resistive Plate Chambers	300	
	System Engineering	700	
	TTR Facility	240	
	SCARF Test Facilities	80	
5.	Central Tracking		925
	Interpolating Pad Chambers	325	
	Silicon Microstrip Detectors	600	
6.	Trigger and Data Aquisition		975
	Calorimetry	385	
	Central Tracker	465	
	Trigger and DAQ	125	
7.	Computing		100
	Software Development Tools	40	
	Simulation Integration	15	
	System Architecture Studies	45	
8.	GEM R&D Reserve		678
	GEM total for FY92		15,000

* Funded by Project Management Funds at the SSC, which are not a part of this request.

GEM COST TARGETS (29 JULY 1991)
($ MILLIONS)



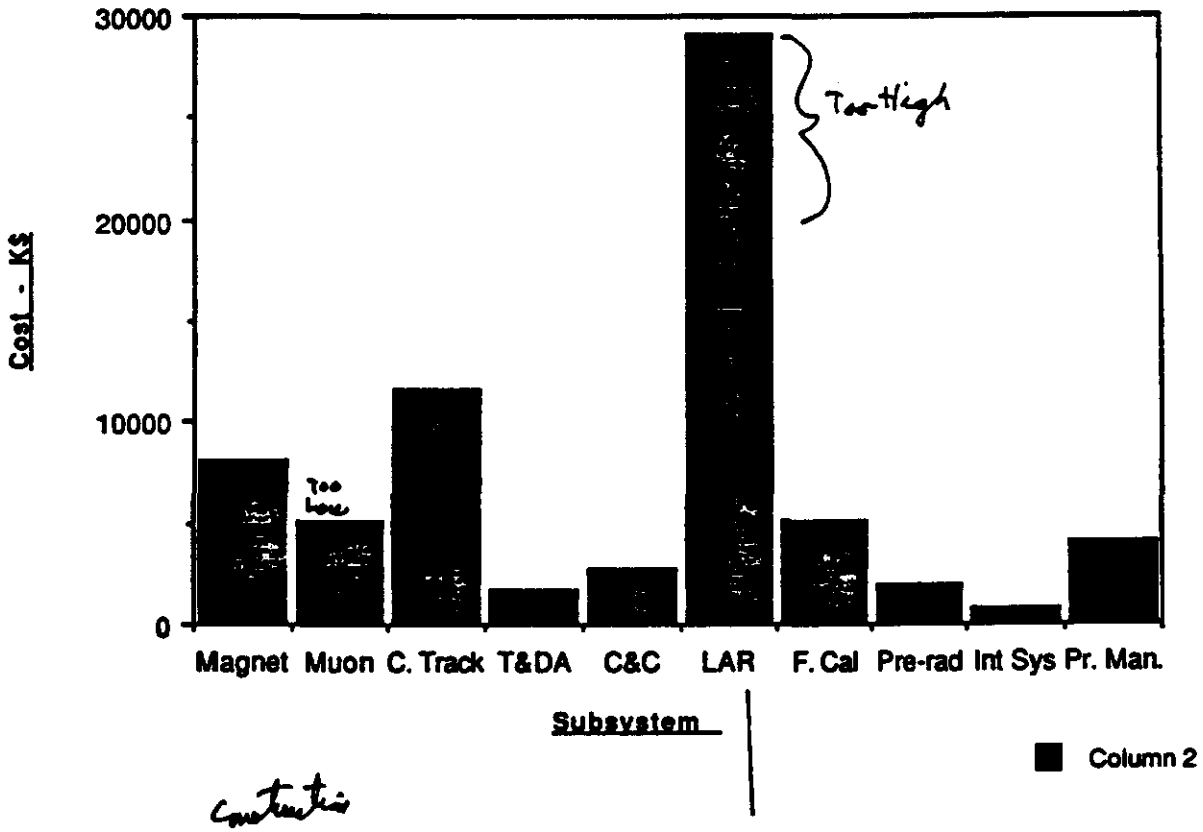
Sandrs

GEM COST ROLLUP 12/3/91

OPTION	DIRECT COSTS	CONTINGENCY	%	TOTAL
Liq. Argon/LSDT	$394,129	$128,804	33%	$524,689
SciFi,BaF/LSDT	$415,602	$132,729	32%	$548,540
Liq. Argon/PDT	$395,984	$129,917	33%	$527,657
SciFi,BaF/PDT	$417,457	$133,842	32%	$551,508
MAGNET	$86,319	$18,445	21%	$104,764
MUON (LSDT)	$71,381	$42,547	60%	$113,928
MUON (PDT)	$73,236	$43,660	60%	$116,896
SciFi HADRON CAL.	$66,283	$18,267	28%	$84,530
BaF EM CAL.	$67,387	$10,929	16%	$78,525
CENTRAL TRACKER	$43,630	$13,213	30%	$56,842
TRIGGER/DAQ	$11,300	$5,650	50%	$16,950
COMPUTERS	$12,813	$7,665	60%	$20,478
LIQ. ARGON CAL.	$112,177	$25,271	23%	$139,204
FORWARD CAL.	$20,167	$6,745	33%	$26,912
PRERADIATOR	$9,040	$4,520	50%	$13,560
INTERFACE SYSTEMS	$11,872	$3,205	27%	$15,077
PROJECT MAN.	$15,431	$1,543	10%	$16,974

VERY PRELIMINARY

GEM Engineering Costs (Includes R+D, C/Pdc

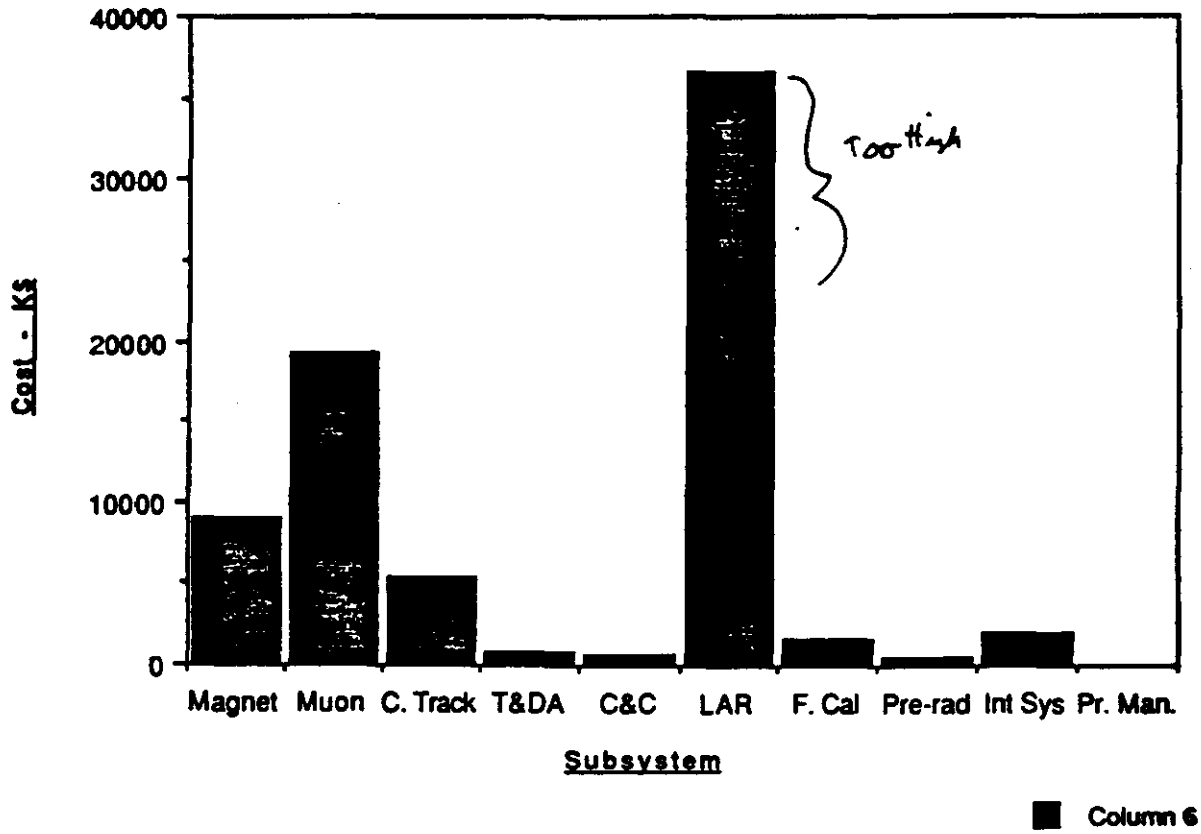


Engineering Construction Man years

Magnet = 29
Muon = 21 – too low
Sci. Fiber Cal = 113
BaF EM = 49
Central Tracker = 51
LAR = 121
Forward Cal = 23

BaF, SciFi = 28,000 MA (not 2 x C.T.)

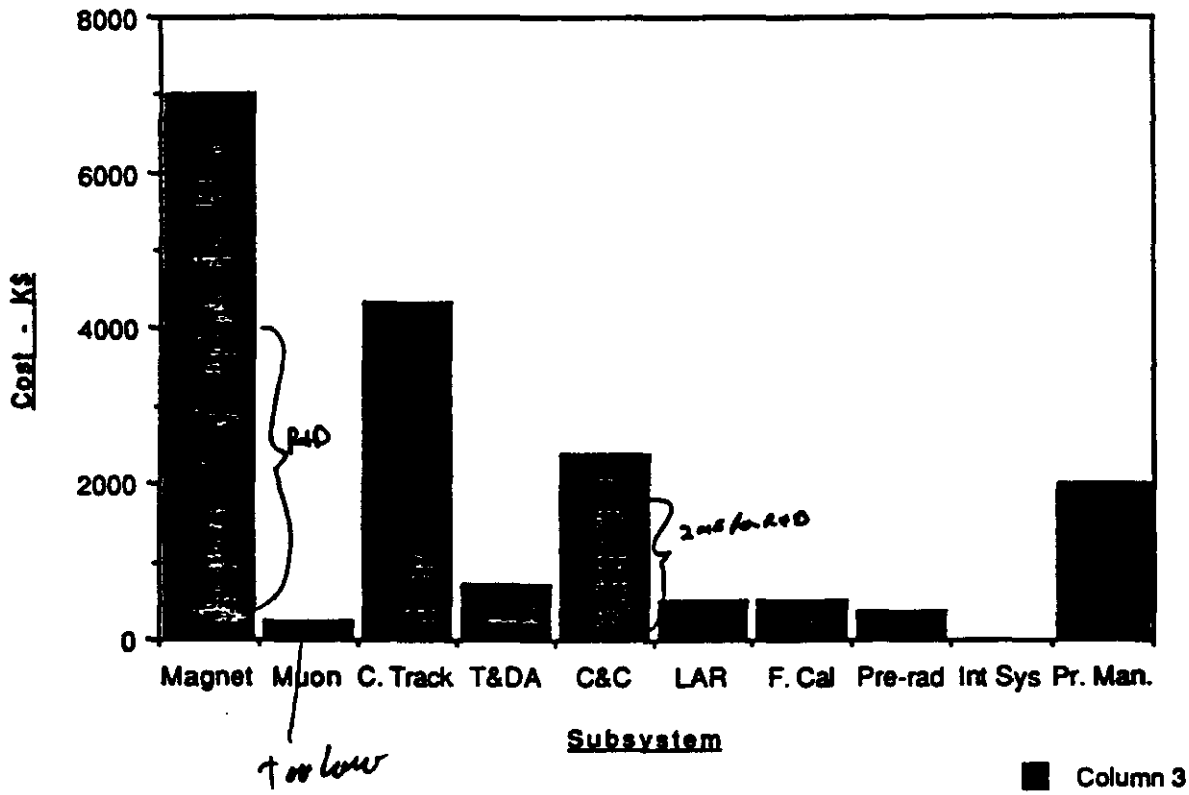
Installation and Assembly Cost



SciFi } 13414
BaF } 3949
17,363 K$ = ≈ ½ LAR

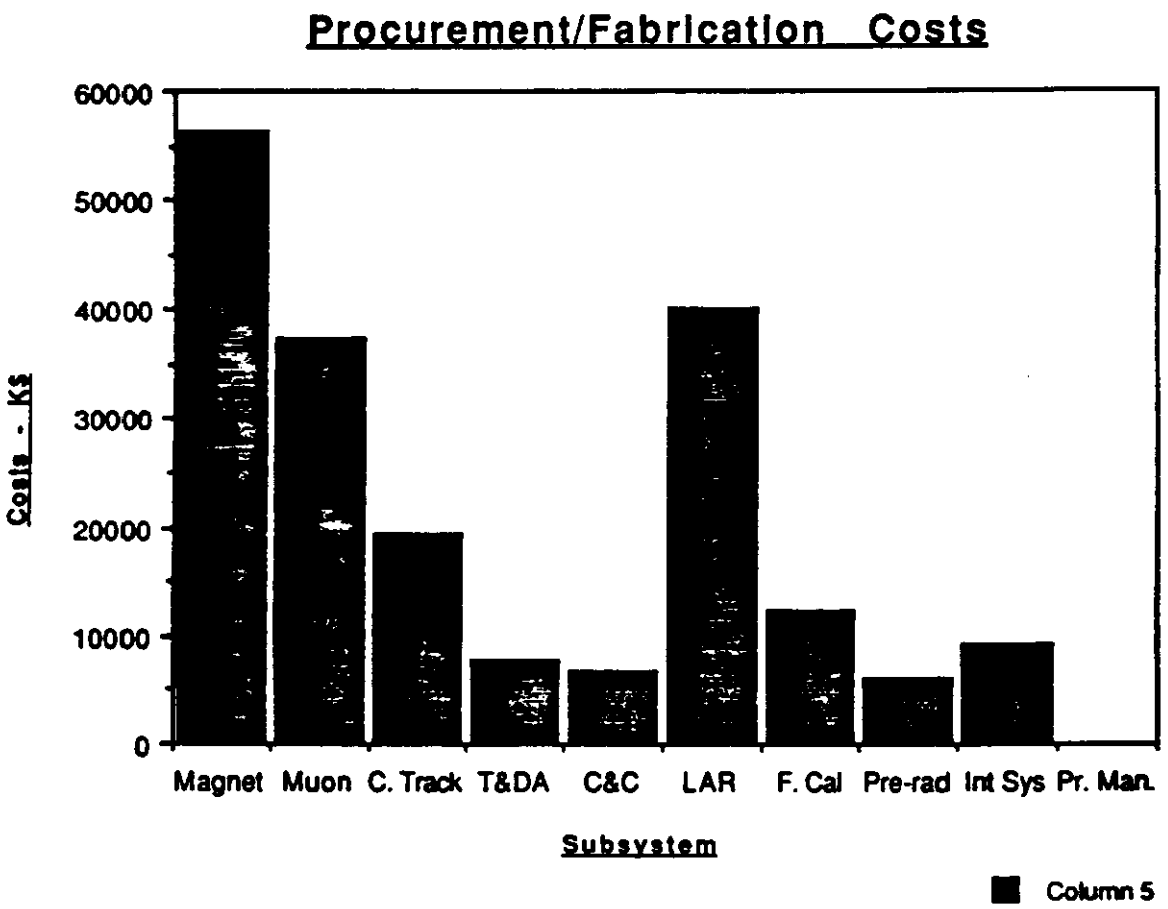
Do accordion section with 2 × I/A cost

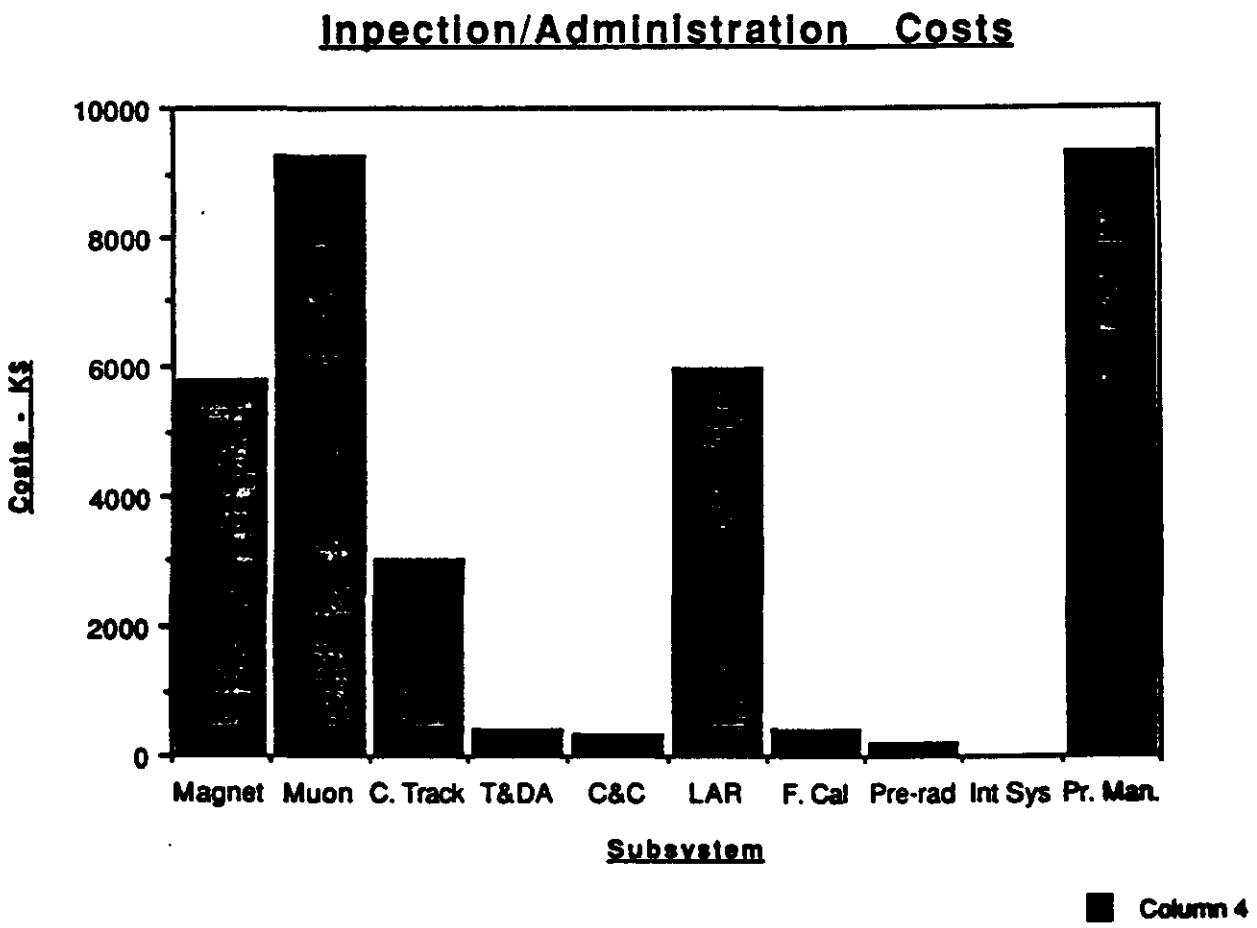
Material and Supply Costs



too low

should include material for R+D


Procurement/Fabrication Costs
60000
50000
40000
30000
20000
10000
0
Costs - K$
Magnet
Muon
C. Track
T&DA
C&C
LAR
F. Cal
Pre-rad
Int Sys
Pr. Man.
Subsystem
Column 5


Inpection/Administration Costs
10000
8000
6000
4000
2000
0
Costs - K$
Magnet
Muon
C. Track
T&DA
C&C
LAR
F. Cal
Pre-rad
Int Sys
Pr. Man.
Subsystem
Column 4

Proposed subsystem cost allocations - M$

Subsystem	Base target	Contingency	Total
Magnet	90	20	110
Muon	85	25	110
Central Tracker	38	12	50
Calorimetry	129	31	160
Comp. and Control	13	7	20
Trigger & Data Acq.	12	5	17
Interface Systems	12	3	15
Project Management	16	2	18
Total	395	105	500

GEM COST REVIEW

1. Scheduled December 10-11 at SSCL. or 11-12

2. Subsystem physicists required.

3. Lead design engineers required.

4. Integration team members invited.

5. Cost estimate engineers required.

6. Electronics and mechanical technologies required. Mechanical engineers and physicists should not present electronics cost estimates.

COST REVIEW FORMAT

1. Each subsystem to be reviewed.

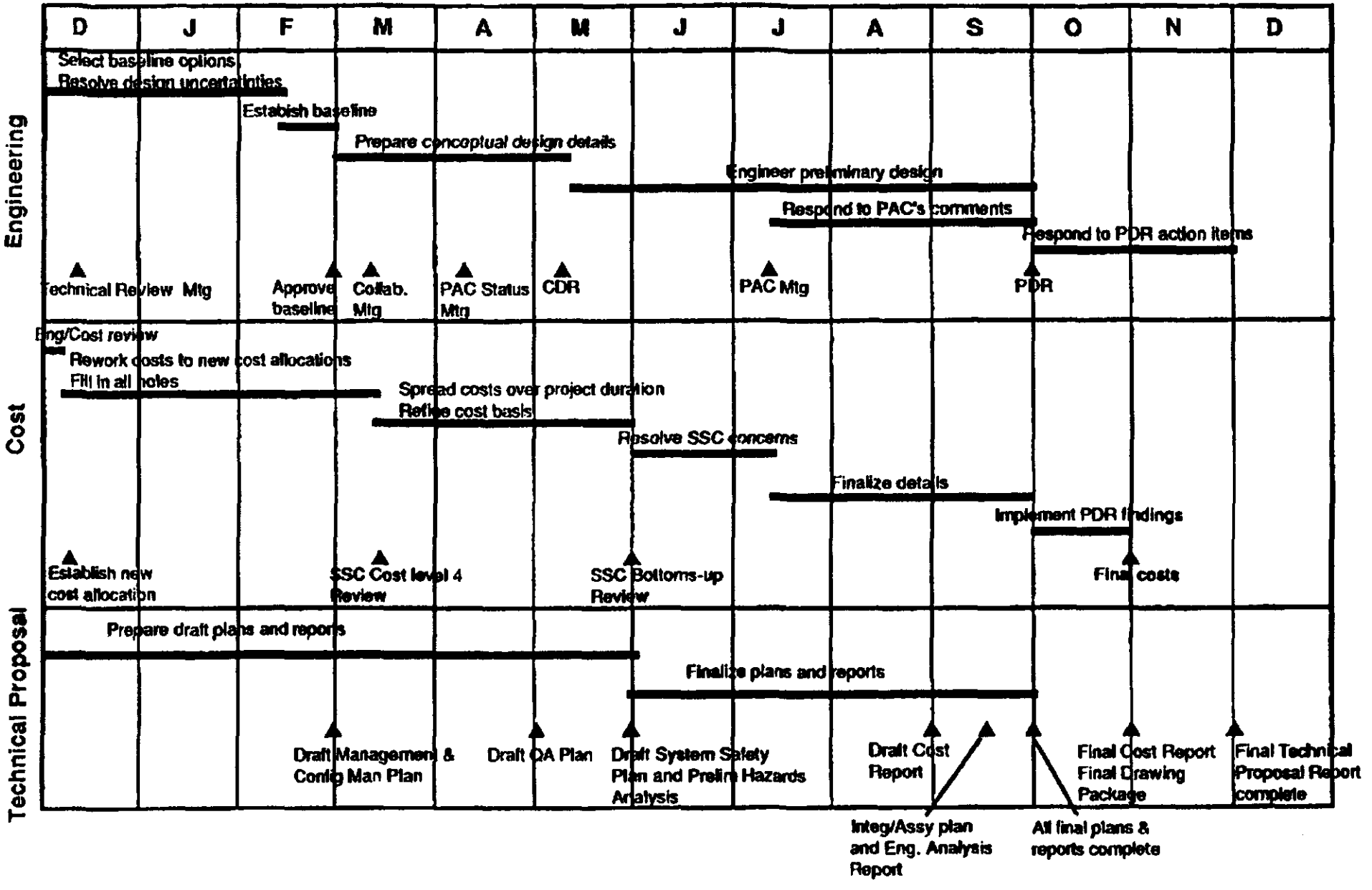
2. Liquid argon will be emphasized, but brief reviews of BaF/fiber system and preradiator and forward calorimeters will be covered.

3. LeCroy will make first presentation of electronics estimates. Other lead electronics engineers should be present.

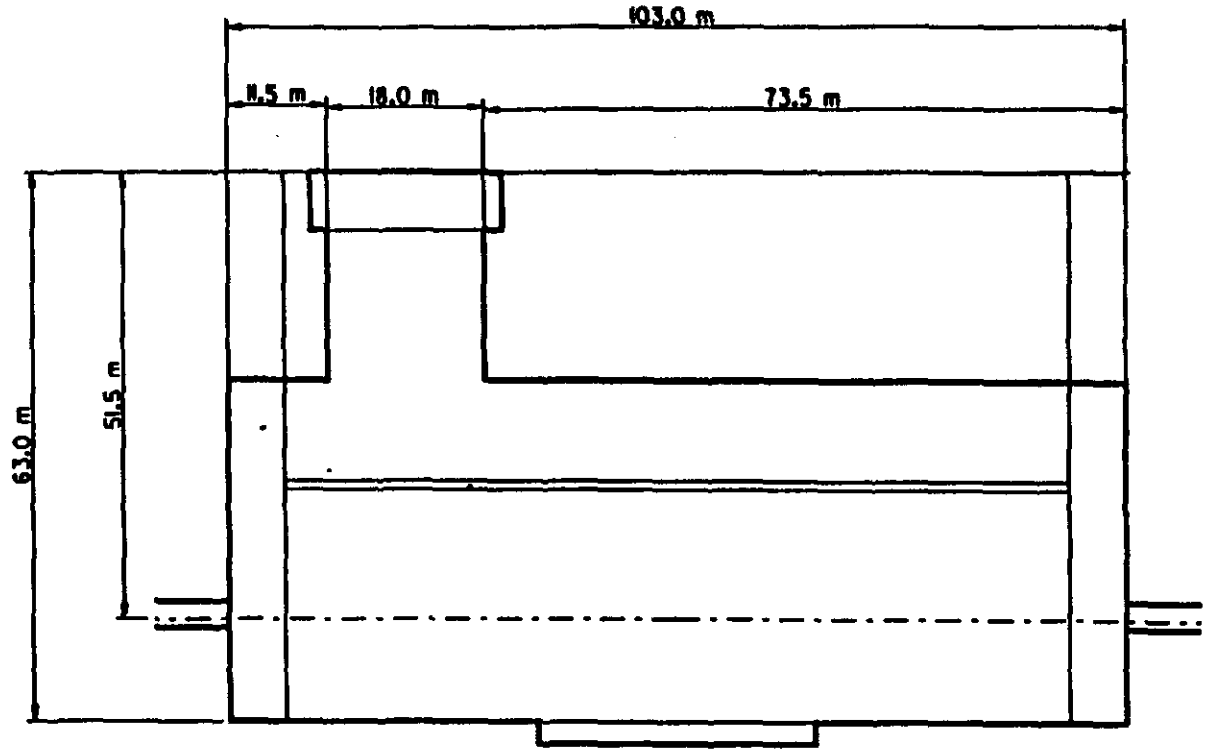
4. For each subsystem we will need efficient presentations of:

a. Physics performance parameters and requirements
b. Basic design parameters, dimensions, channel counts,...
c. Status of design.
d. Design team members and effort put into design to date.
e. Cost estimate with emphasis on basis, fraction of estimate with various bases.
f. Plan for next 2 months and descope options.

Proposed GEM CY 92 Engineering/Cost schedule



VERSION I



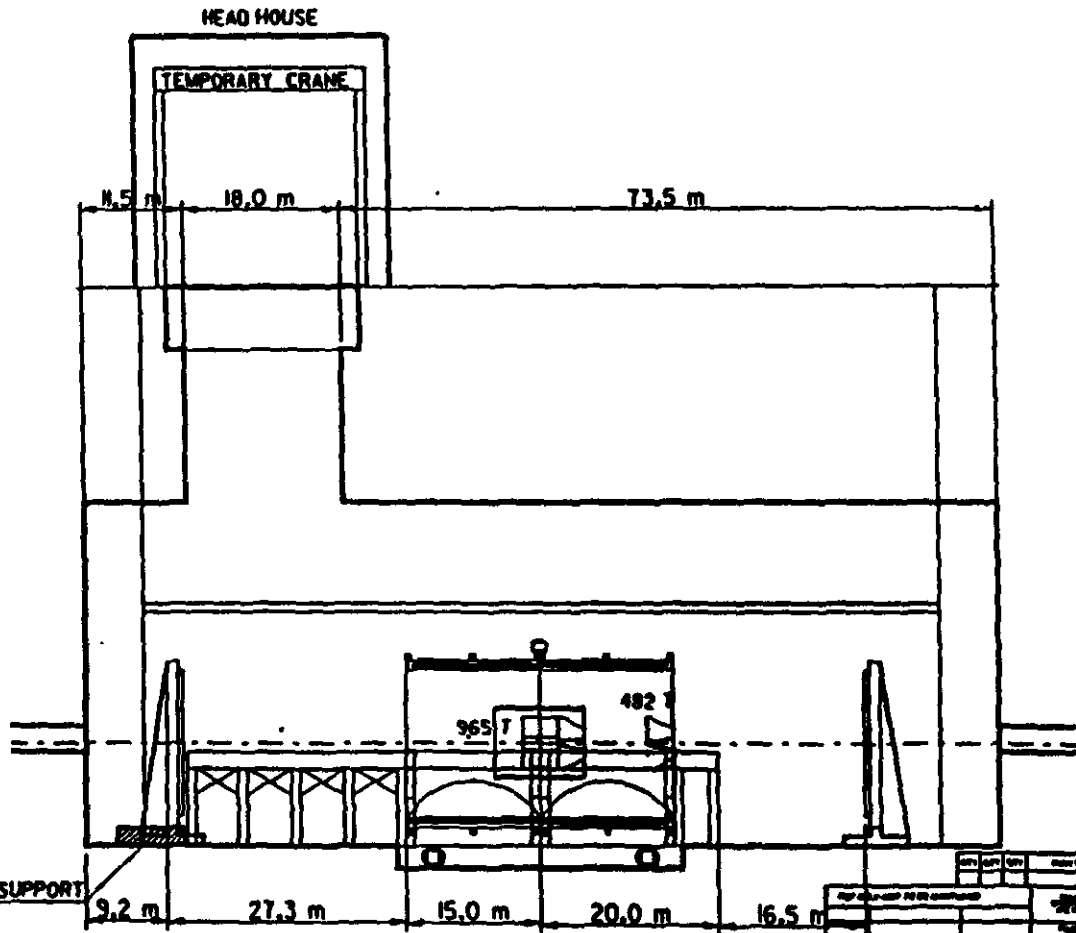
SSC

GEM HALL
VERSION I

GDD-000.010-A

VERSION I

ENDCAP CALORIMETER-BARREL CALORIMETER-TRACKER-



TASKS

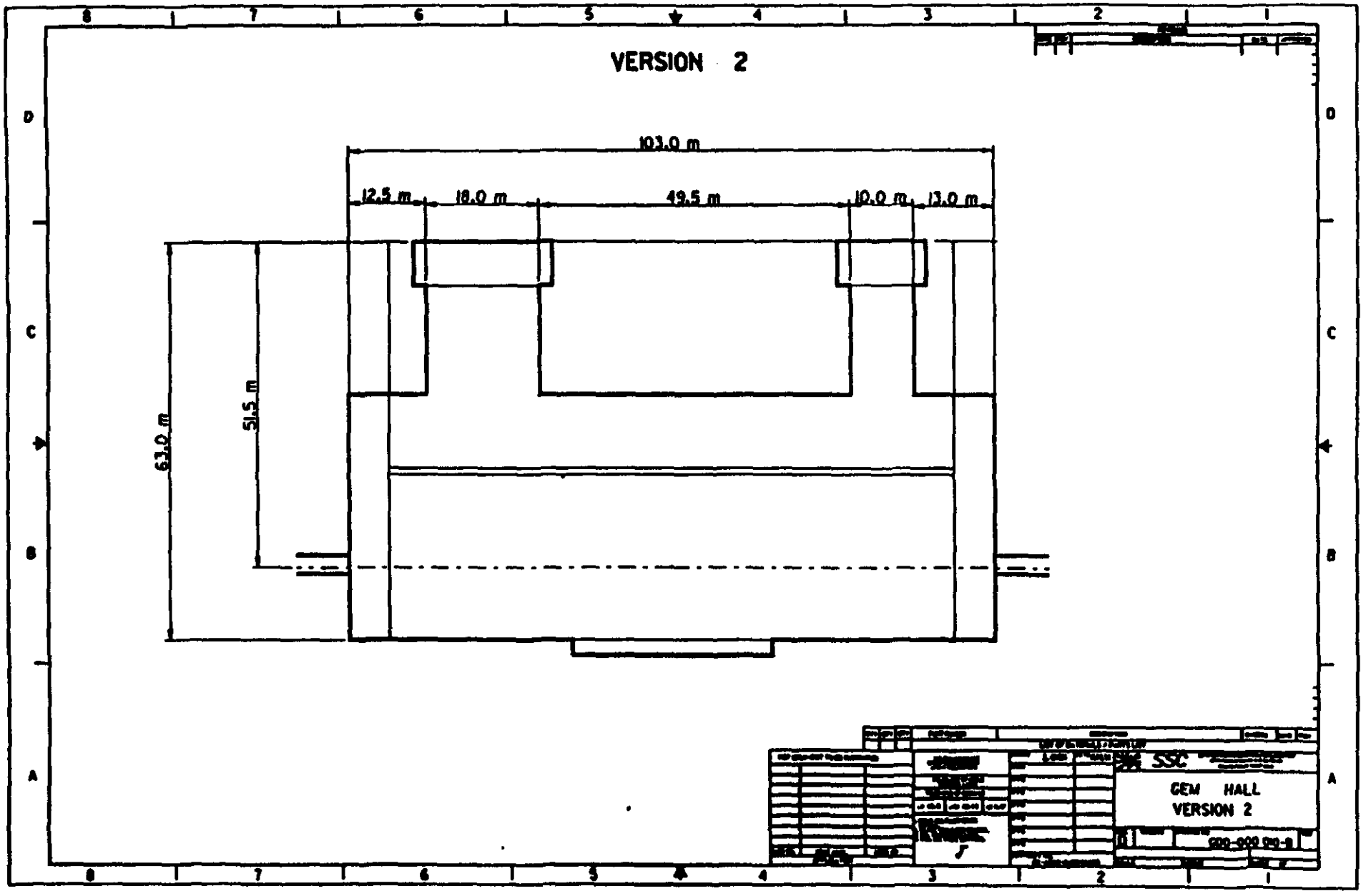
- LOWER FIXTURE + END CAP I
- MOVE THRU DETECTOR PARK
- LOWER FIXTURE + BARREL
- MOVE-INSTALL BARREL
- MOVE, INSTALL END CAP I
- REMOVE FIXTURE BARREL + END CAP
- LOWER FIXTURE + TRACKER
- MOVE, INSTALL TRACKER
- REMOVE FIXTURE TRACKER

B.O.D
12.6.95

SSC

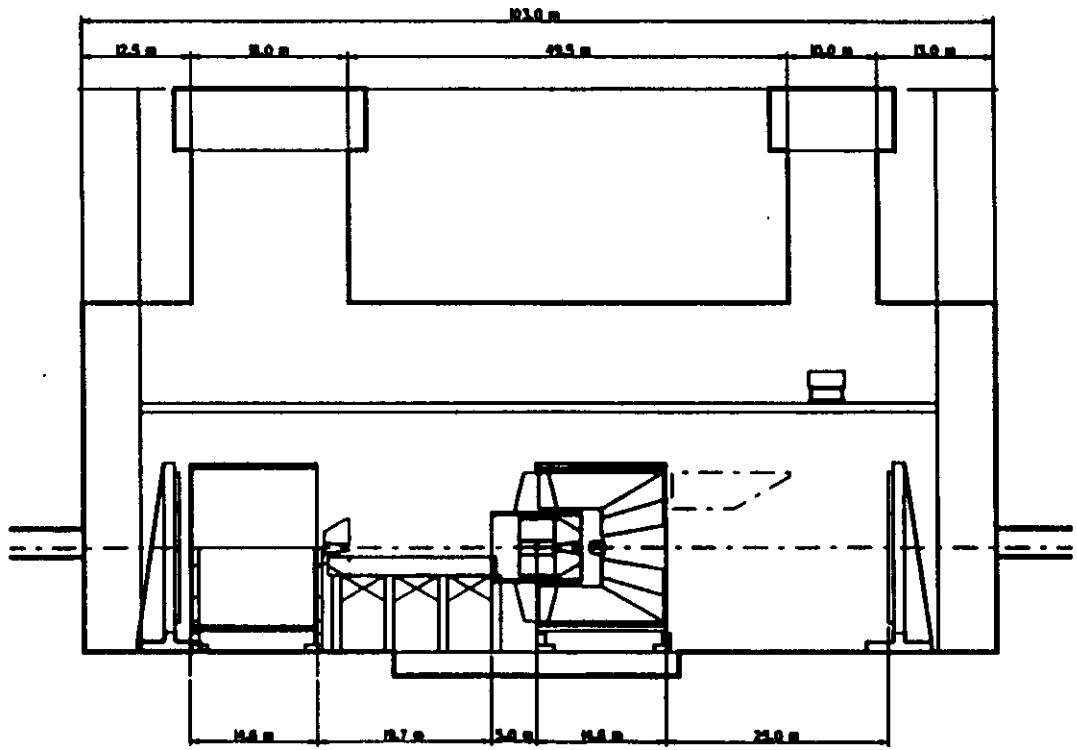
GEM DETECTOR
INSTALLATION SEQUENCE
PHASE 8

COD-000 010-D


VERSION 2
103.0 m
12.5 m
18.0 m
49.5 m
10.0 m
13.0 m
63.0 m
51.5 m
SSC
GEM HALL
VERSION 2

VERSION 2

1 SHAFT 23 m x 18 m + 1 SHAFT 16 m x10 m

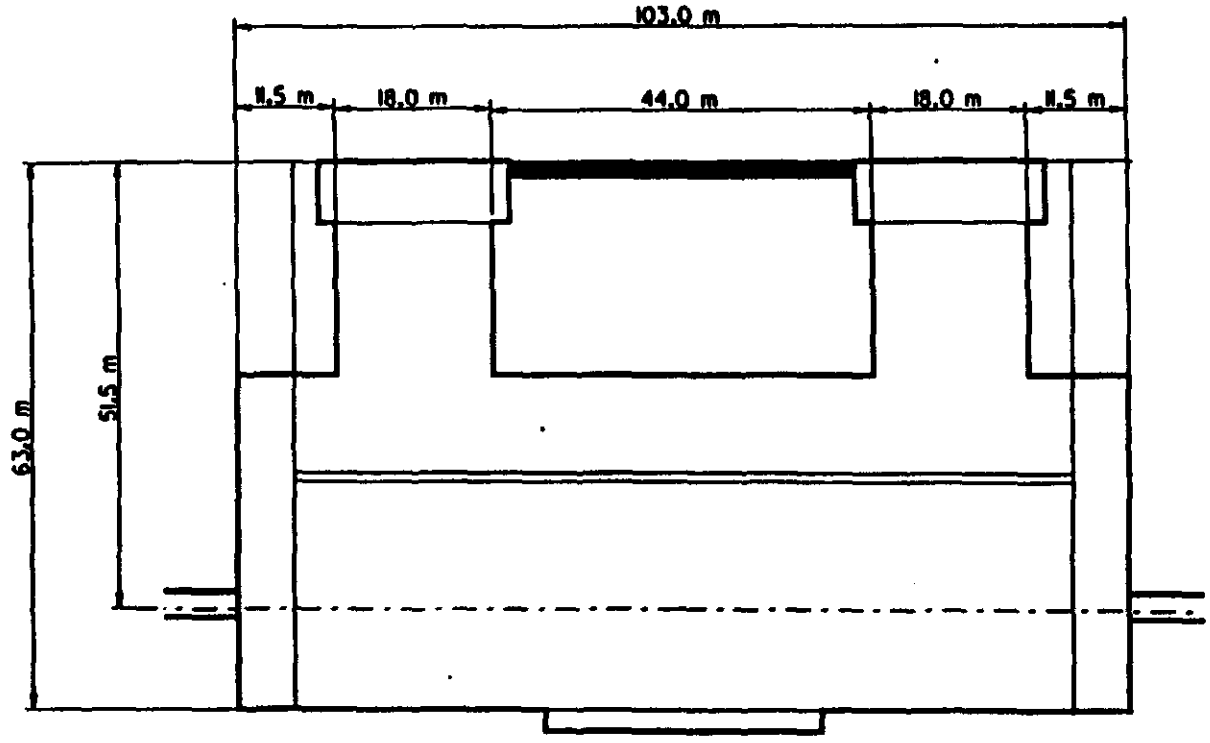


SSC

GEM DETECTOR
INSTALLATION SEQUENCE
PHASE 10

CQD-000 010-C

VERSION 3

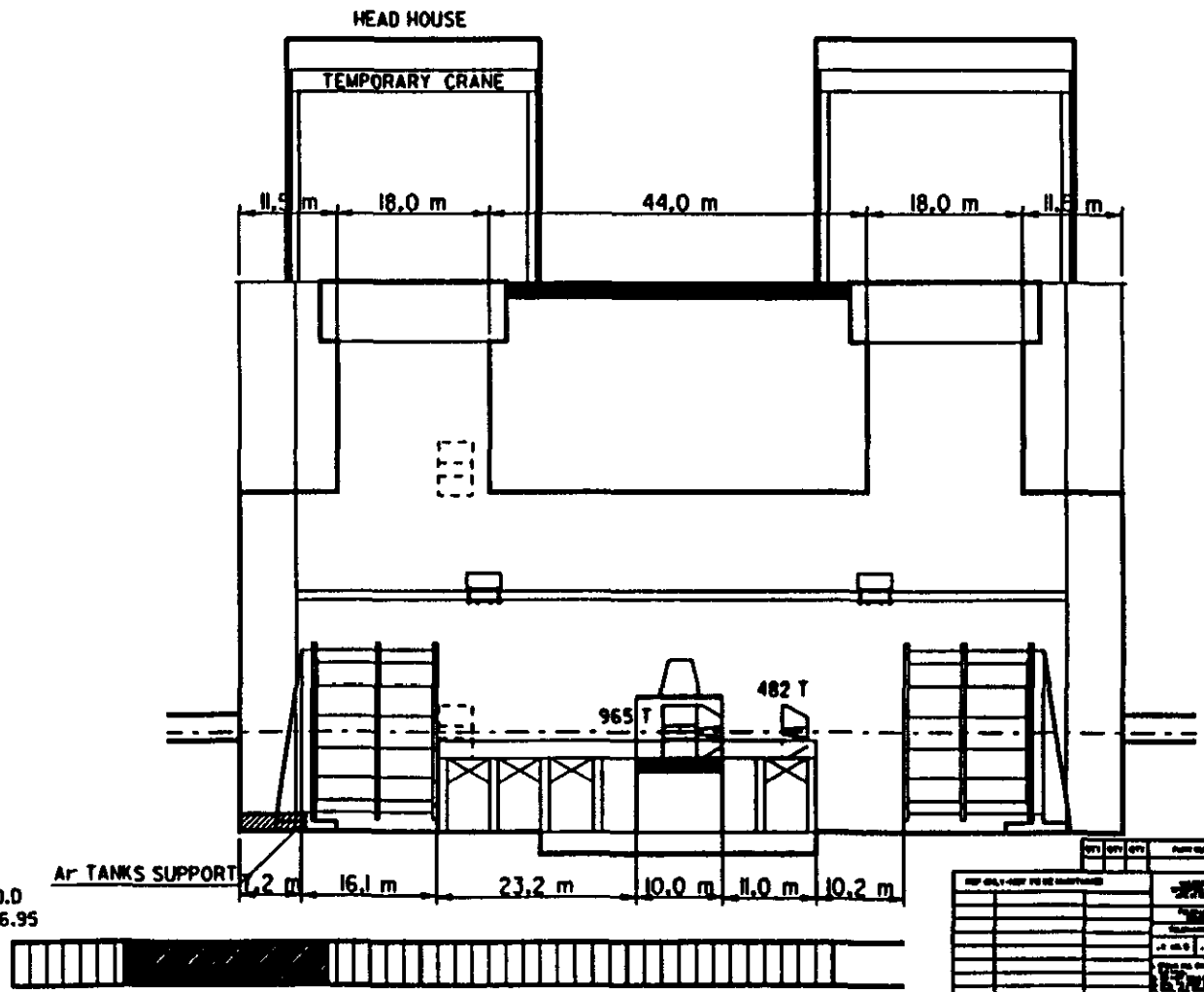


GEM HALL
VERSION 3

GDD-000 010-C

VERSION 3 PHASE 5

ENDCAP CALORIMETER-BARREL CALORIMETER



TASKS

LOWER FIXTURE + END CAP I

MOVE THRU DETECTOR PARK

LOWER FIXTURE + BARREL

MOVE-INSTALL BARREL

MOVE ,INSTALL END CAP I

REMOVE FIXTURE BARREL + END CAP

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B.O.D
12.6.95

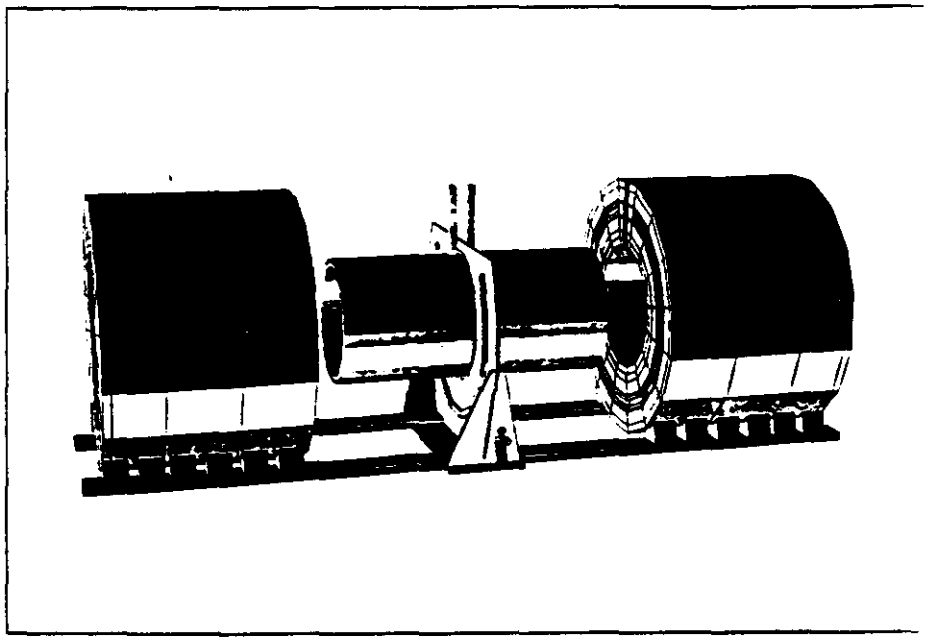
SSC

GEM DETECTOR
INSTALLATION SEQUENCE
PHASE 5

D

GDO-000 010-A

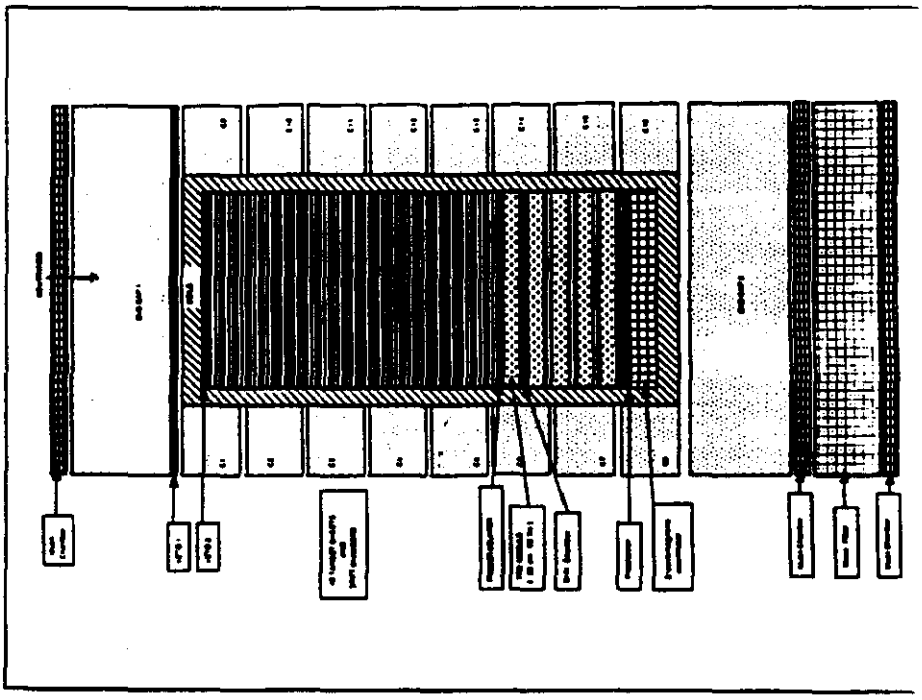
tectors (October, page 25), while a magnet study group coordinates the designs for the big magnets at the heart of new detector schemes.



A possible superconducting solenoid design for an experiment at CERN's proposed LHC proton collider. For giving an idea of the scale, some people have suggested that the 'standard man' could be usefully replaced by a 'standard dinosaur'.

Around the Laboratories

Schematic of the planned WA96 ('NOMAD') neutrino experiment at CERN.

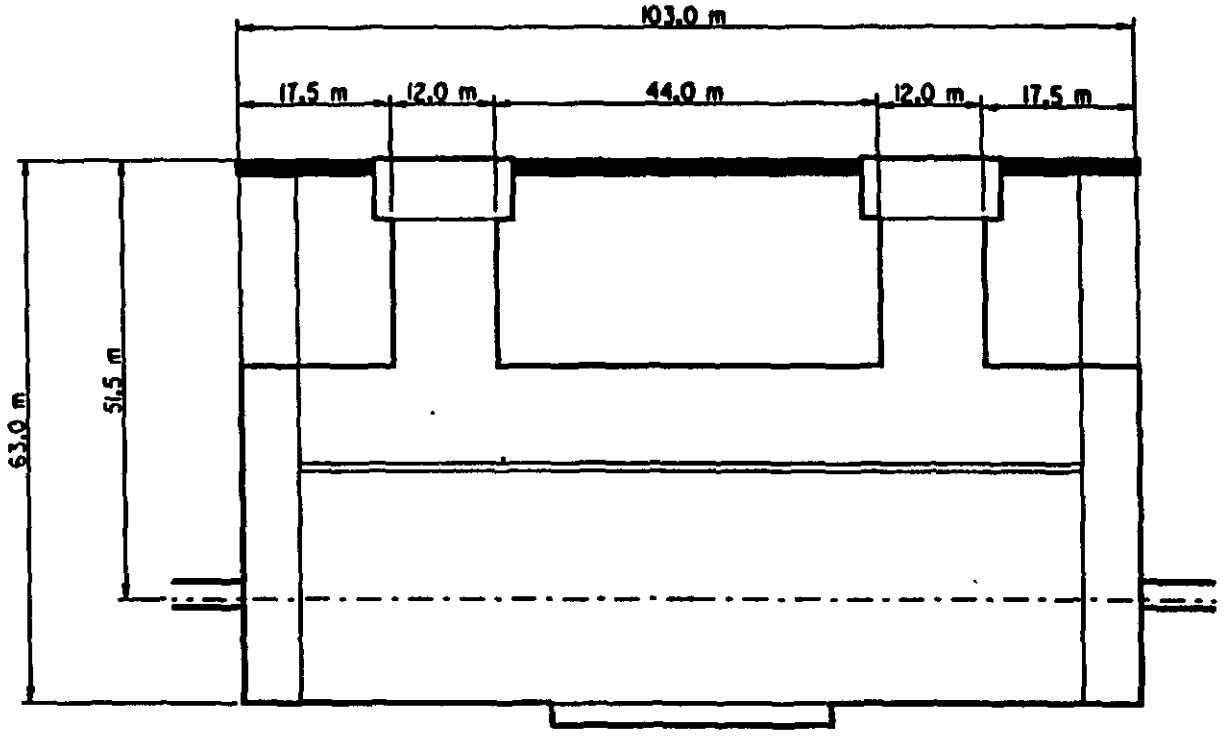


CERN
Neutrino facelift

With the termination this summer of the CHARM II neutrino experiment at the SPS proton synchrotron (October, page 5), CERN's 30-year tradition of neutrino physics came to a temporary halt. However with these enigmatic particles playing a vital role in today's Standard Model but continually reluctant to give up all their secrets, neutrino physics will continue to be in the forefront of this research.

Thus after 15 years of continually being battered by the intense proton beams which create the neutrinos' parent particles, the ageing neutrino facilities at the SPS will be refurbished to service two major

VERSION 4



SSC

GEM HALL
VERSION 4

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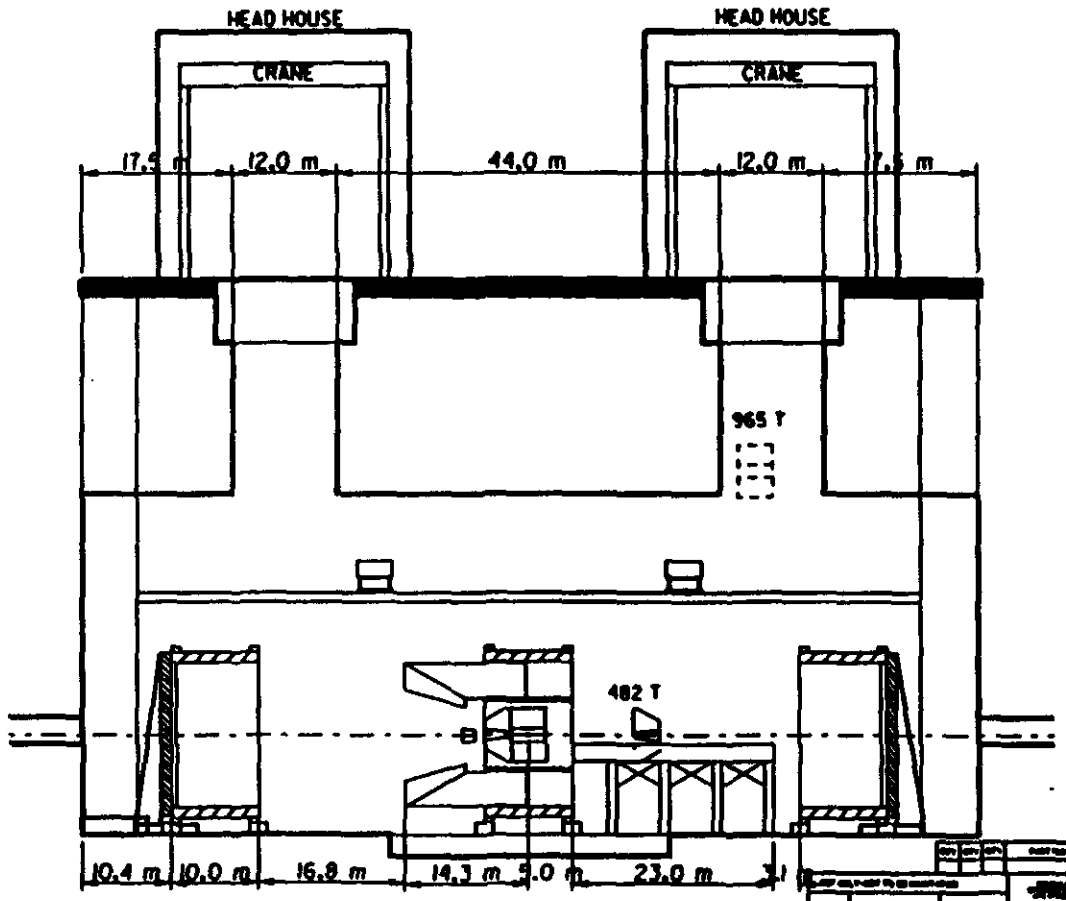
VERSION 4 PHASE 4

ENDCAP CALORIMETER SIDE 2 -BARREL CALORIMETER

END CAP MUON SIDE 1 - 2 + BARREL MUON SIDE 2



TASKS

LOWER FIXTURE + END CAP 1

MOVE THRU DETECTOR PARK

LOWER FIXTURE + BARREL

MOVE-INSTALL BARREL

MOVE ,INSTALL END CAP 2

LOWER- INSTALL BARREL MUON SIDE 2

LOWER- INSTALL END CAP MUON SIDE 2

FORWARD SIDE 2

SSC

GEM DETECTOR

INSTALLATION SEQUENCE

PHASE 4

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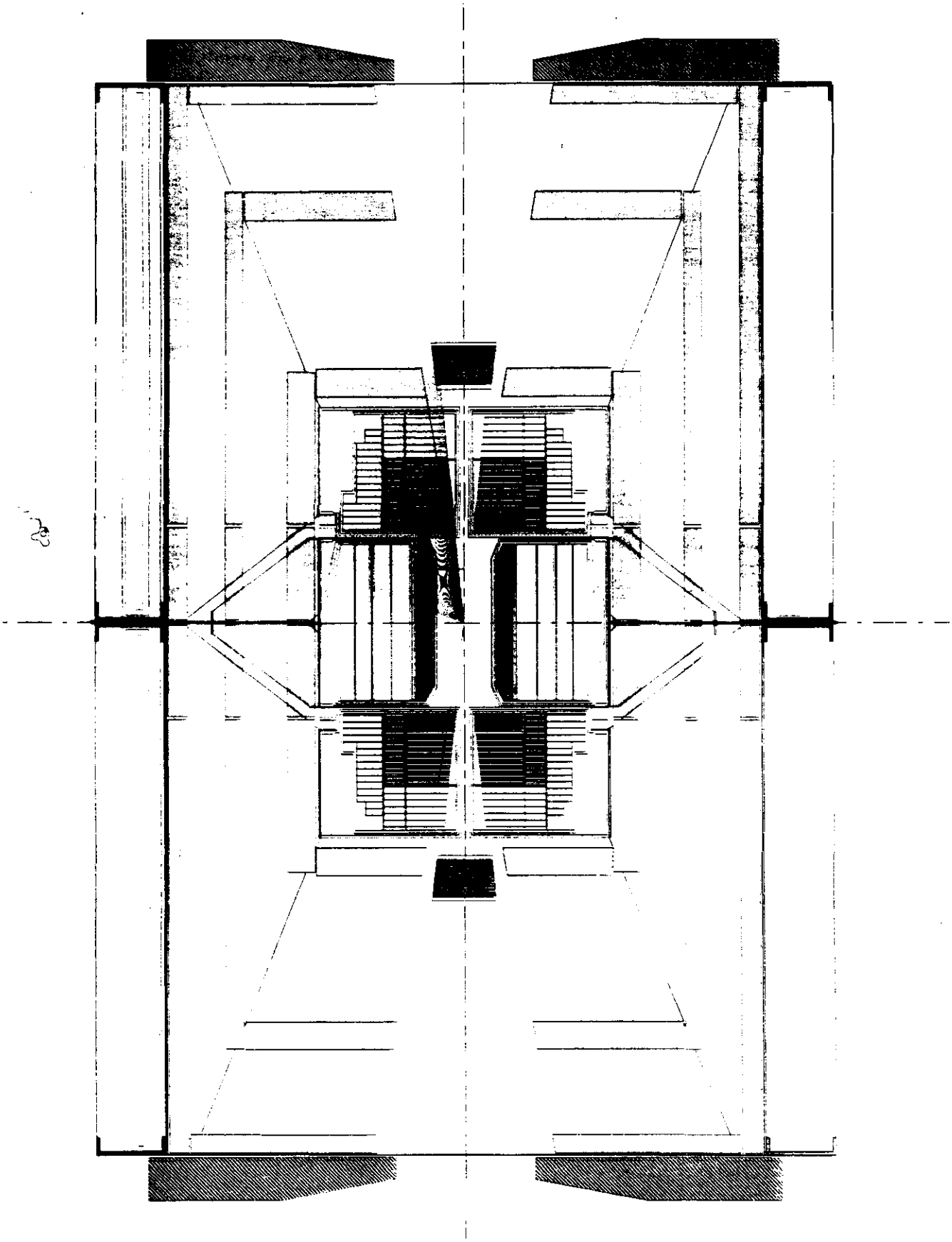
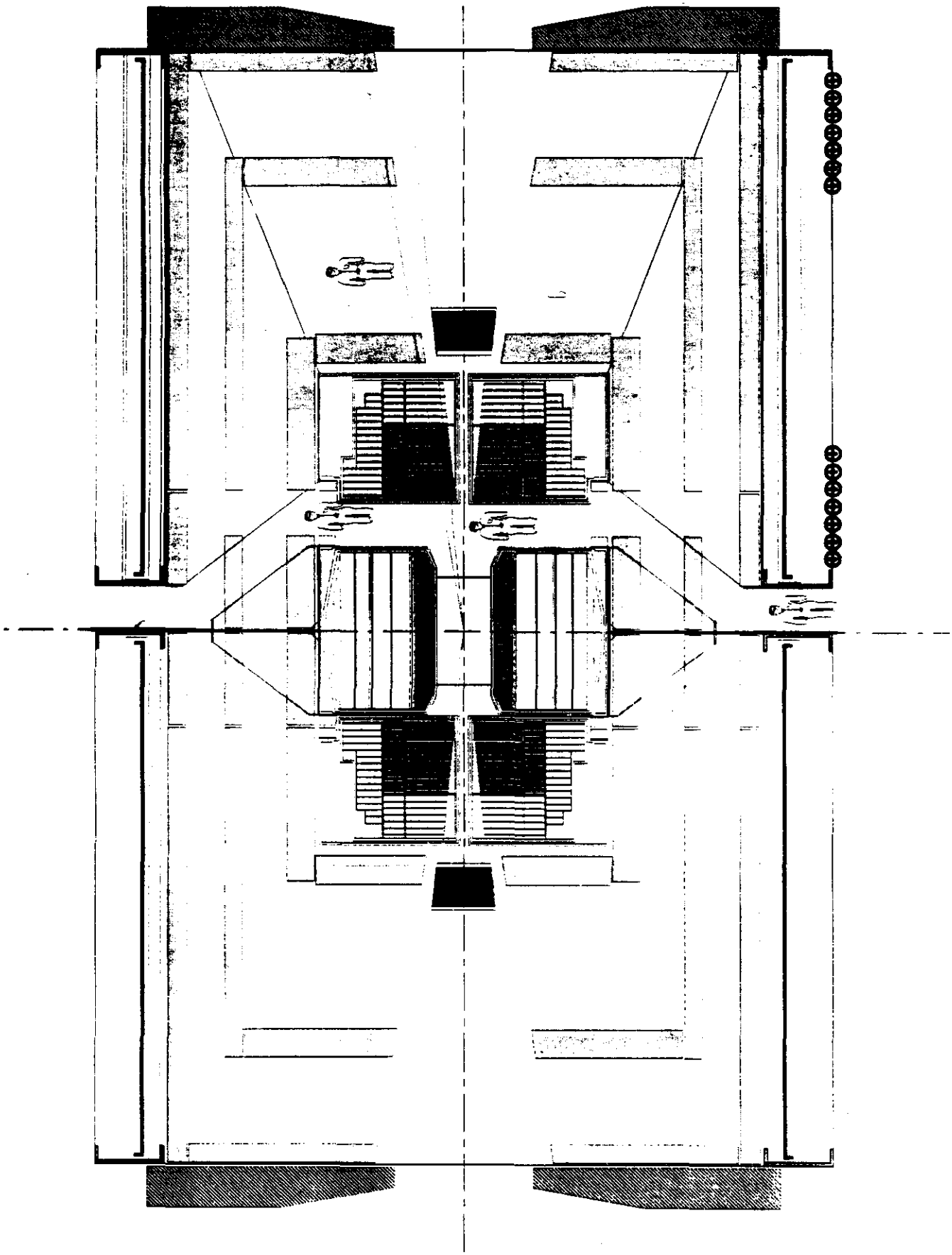
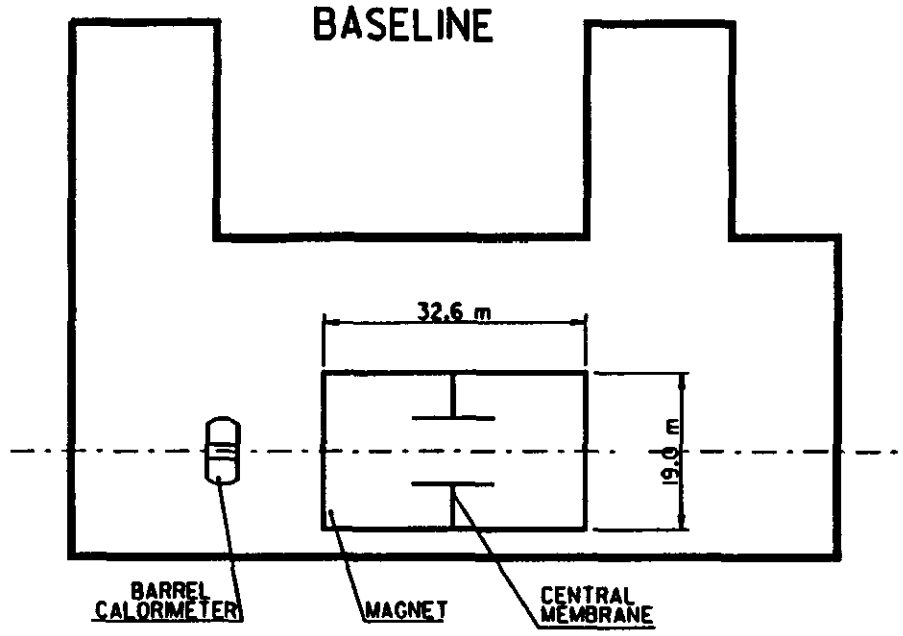
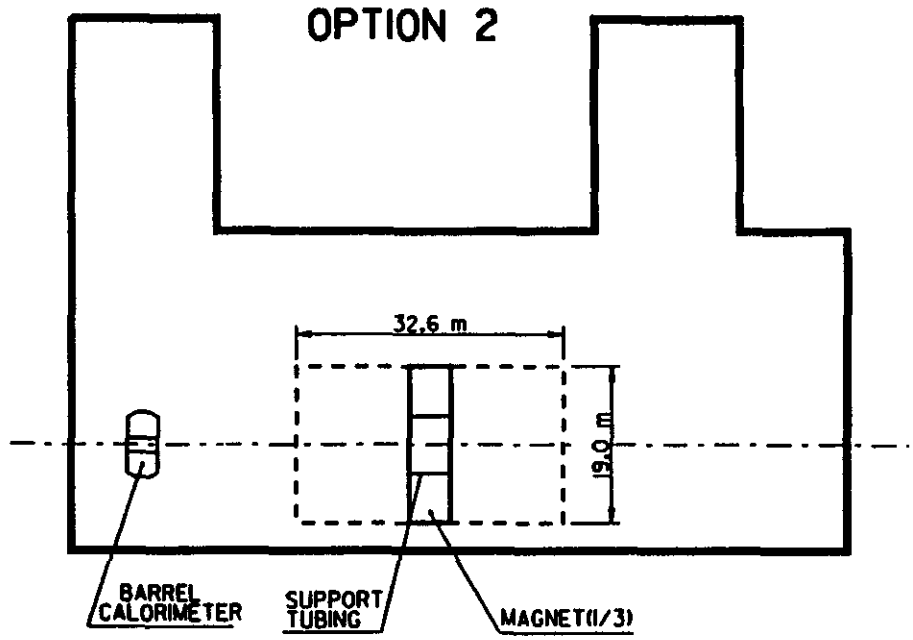
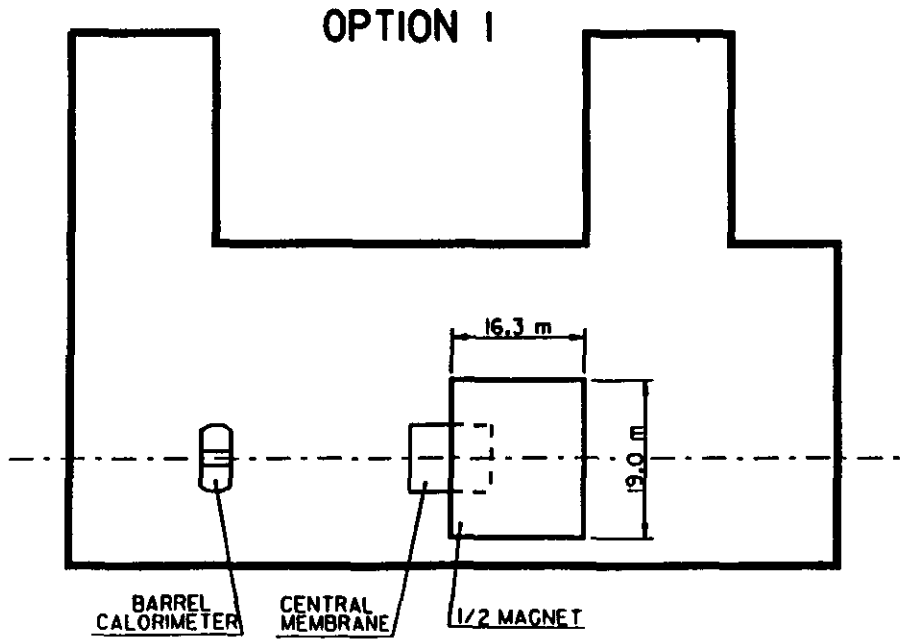




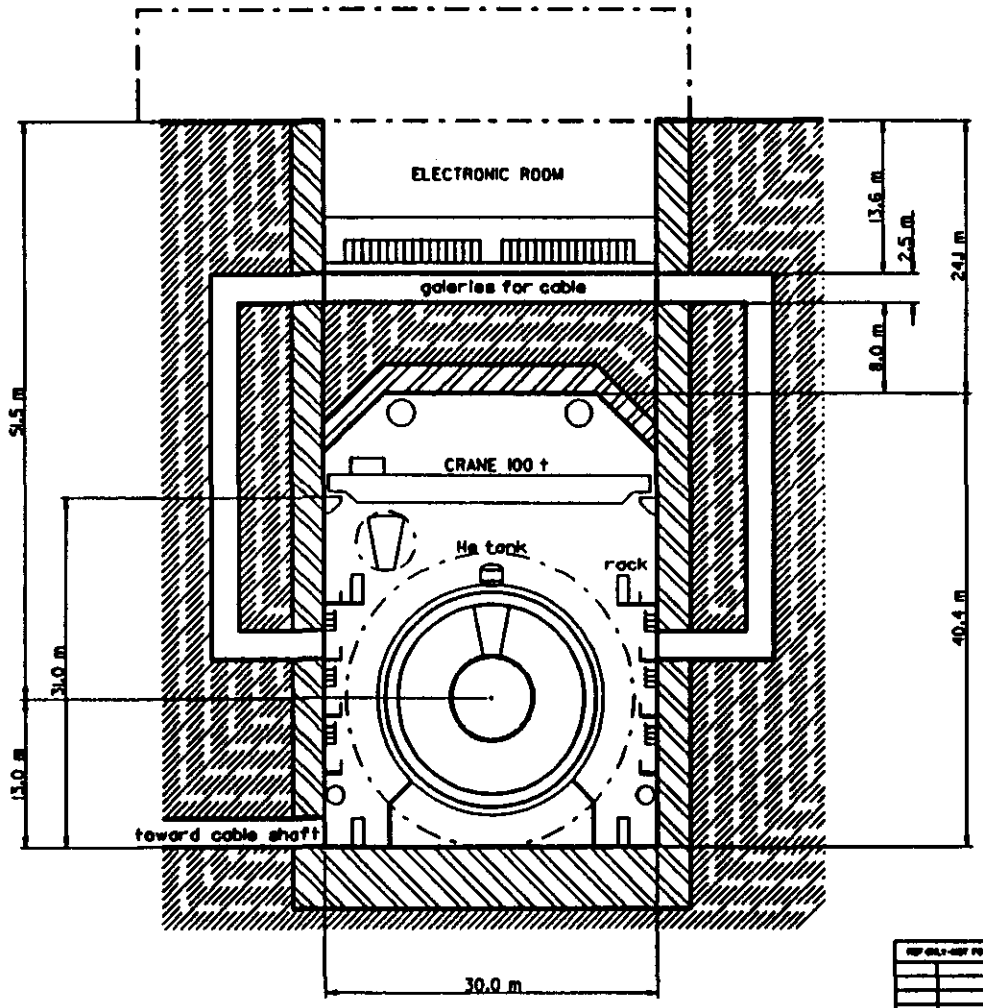






GEM CALORIMETER INSTALLATION

CROSS SECTION



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CROSS SECTION
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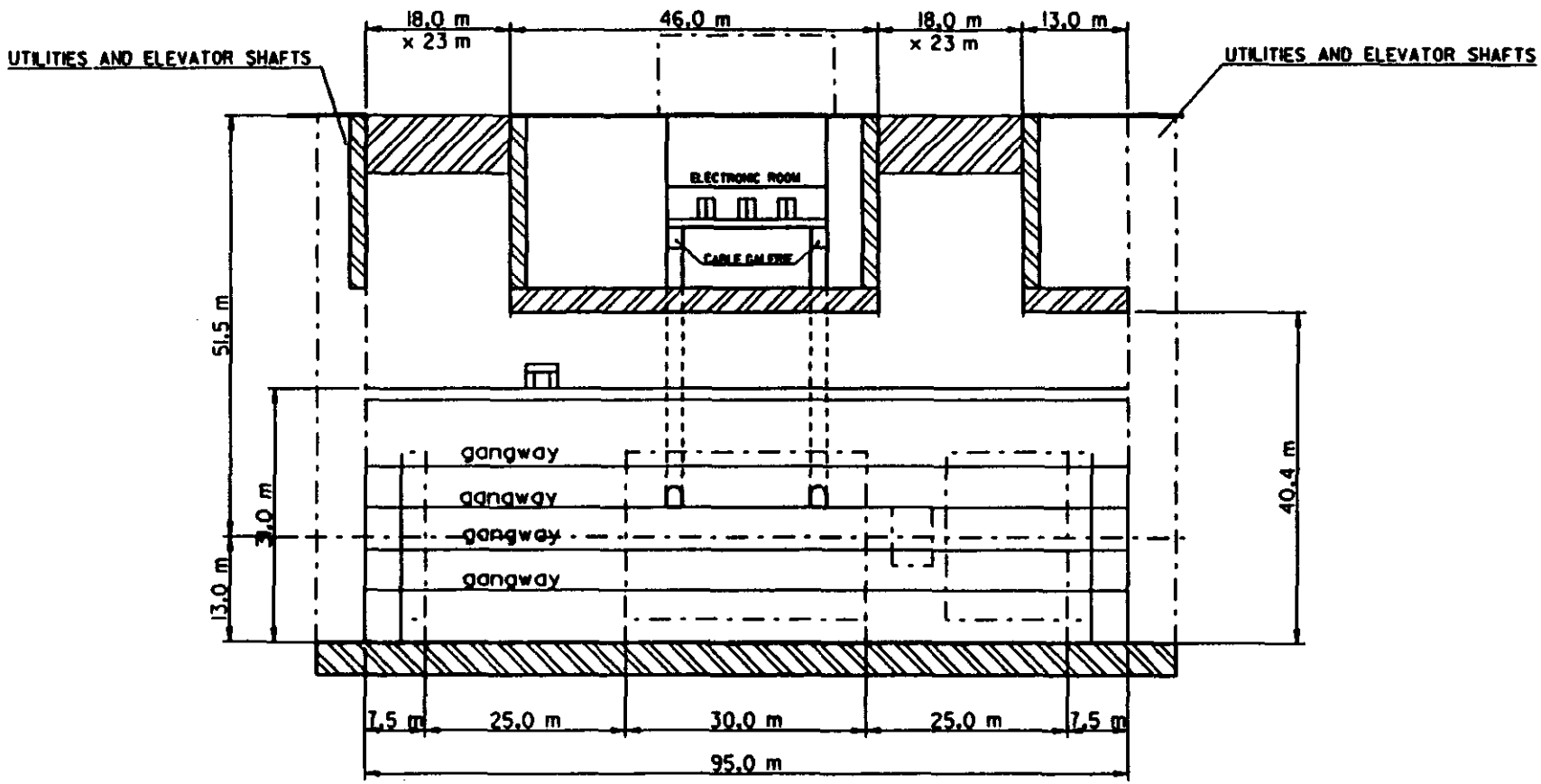


GEM' SURFACE ONLY

SSC

GEM'S HALL
FRONT VIEW

D GCD -000 043-B

(SAMIOS)

GEM ORGANIZATION

EOI → LOI

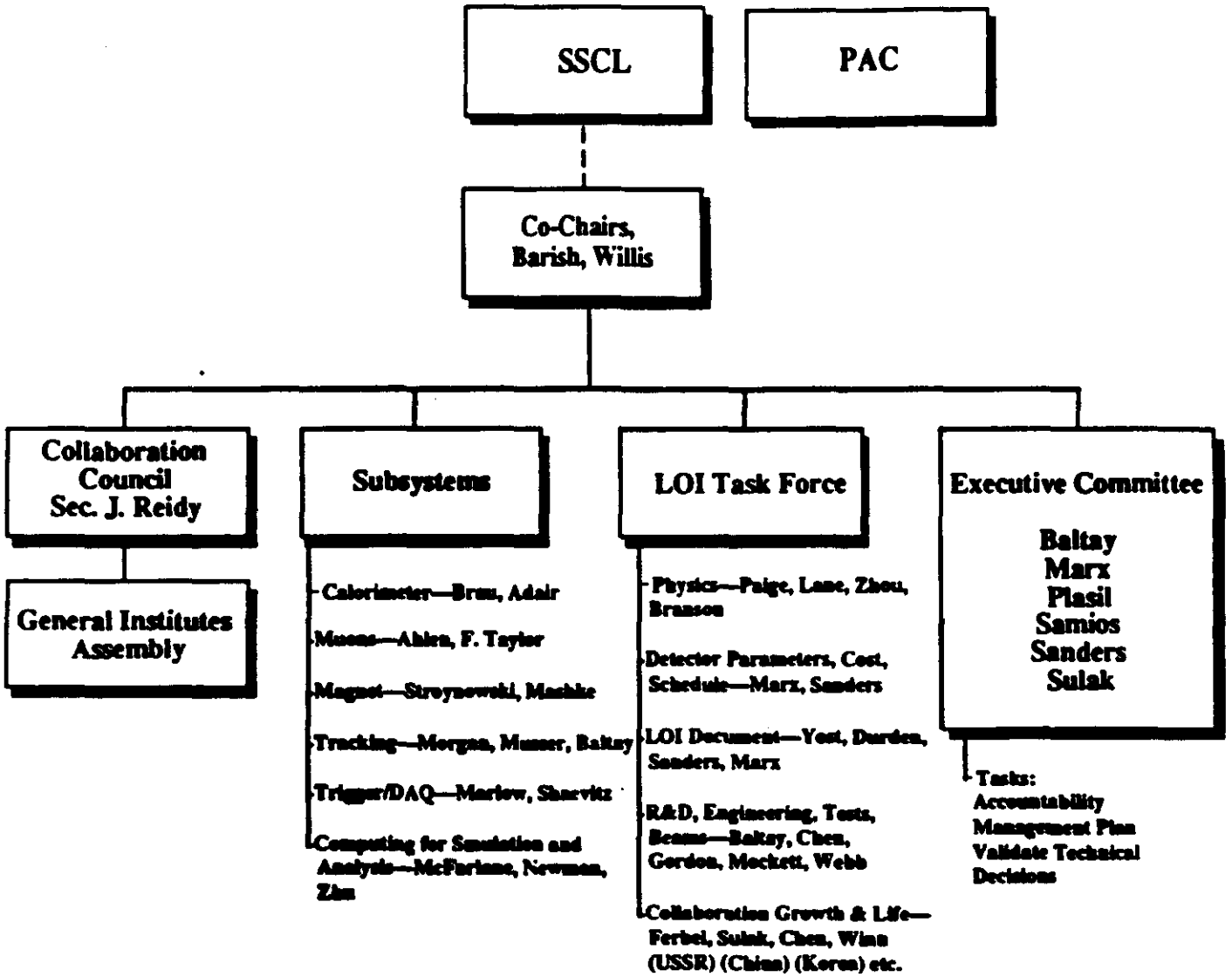


Figure 5.0-1 GEM Collaboration Organization

Nominations
GEM Organization
December 5, 1991

Co-Spokesmen: B. Barish (Exec. Hd); W. Willis (Tech. Hd.)

Executive Committee: S. Ahlen, C. Baltay, J. Brau, D. Marlow, K. McFarlane, F. Paige, F. Plasil, N. Samios, R. Stroynowski, M. Shaevitz, F. Taylor, A. Vorobyov
(Spokesmen, Project Management Office, Ex-officio)

International Committee: T. Ferbel, J. Friedman, N. Samios, L. Sulak, V. Siderov, Chinese, . . .

Project Management: Acting Project Manager: G. Sanders
Project Engineer: M. Harris
Integration Coordinator: M. Marx

Subsystems Organization:

- Magnet Steering Committee
  Chairman - R. Stroynowski
  Deputy Chairman - (to be appointed)
  Members - A. Mashke, W. Busza

- Muon Steering Committee
  Co-Chairmen - S. Ahlen, F. Taylor
  Members - M. Atiya, L. Osborne, Wuest, Polychronakos, Mitselmakher, McNeil, Nimblett

- Calorimeter Steering Committee
  Acting Chairman - W. Willis
  Deputy Chairman - Yu Kamyshkov
  Members - J. Brau, J. Rutherfoord, H. Gordon, L. Sulak, H. Newman, M. Rennich

- Inner Tracking Steering Committee
  Chairman - C. Baltay
  Members - C. Baltay, D. Lee, K. Morgan, J. Musser

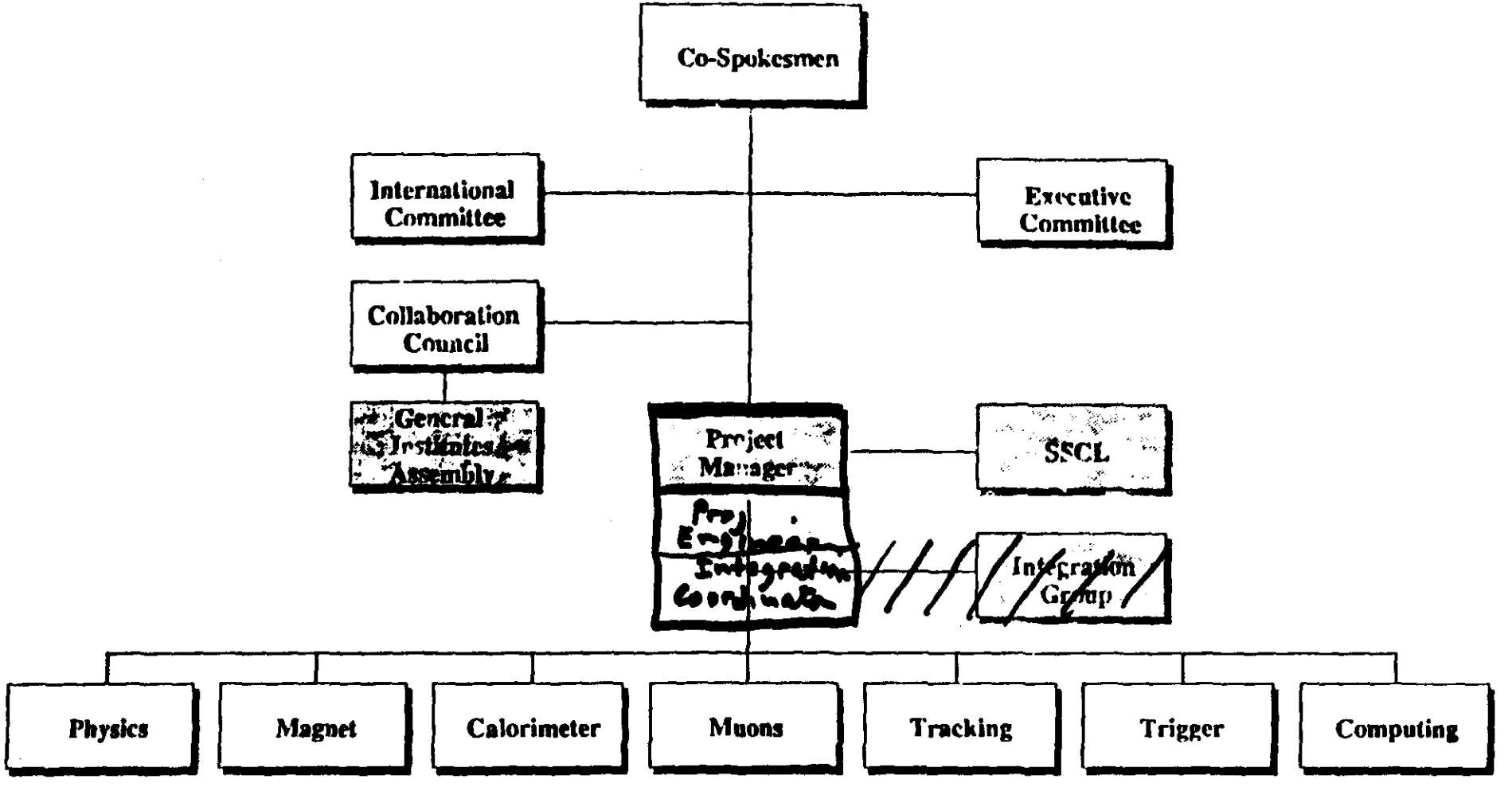
- Electronics Steering Committee
  Co-chairmen - D. Marlow, M. Shaevitz,
  Members - G. Mills, J. Musser, J. Parsons, V. Polychronakos, P. Denes, V. Radeka, D. Sumner, M. Atiya, W. Cleland, J. Ritchie

- Computing Steering Committee
  Chairman - K. McFarlane
  Members - H. Newman, G. Yost, . . .

- Physics Steering Committee
  Co-chairmen - F. Paige, K. Lane
  Members - B. Zhou, R. Zhu, . . .

GEM ORGANIZATION

12/5/91



MAGNET

R. STROYNOWSKI
SMU
12/5/91

WORK SINCE LAST MEETING

1. LETER OF INTENT
2. MAGNET SECTION OR GEM R&D PROPOSAL
3. "WHITE PAPER"

LOI - MAGNET SECTION BASED ON THE "THICK POLE" CONCEPT.
REASON - ONLY CONSISTENT SET OF CALCULATIONS OF FIELD, SHIELDING REQUIREMENTS, TECHNICAL DRAWINGS AND COST ESTIMATES

R&D - ORIGINAL REQUEST FOR $6.2 M REDUCED TO $5.0 M.
INCLUDES $2.6 M FOR ENGINEERING NEEDED FOR TECHNICAL REPORT (~20 PEOPLE)
$2.4 M FOR CONDUCTOR AND WINDING R&D

WHITEPAPER - AN ATTEMPT AT SUMMARY OF PRESENT STATUS OF DESIGN, ISSUES RELATED TO THE CHOICE OF BASE LINE MAGNET AND DIRECTION OF FUTURE WORK
- FEEDBACK NEEDED

ENGINEERING ISSUES

SHORT TERM (2-3 MONTH) CONCEPTUAL DESIGN

1. OPTIMIZATION OF MAGNET SIZE VS COST VS FIELD
2. MODIFICATION OF THE FIELD IN FORWARD DIRECTION ($\eta > 1$)
   EG: BENT POLE WILL INTRODUCE RADIAL COMPONENT OF THE FIELD
   - IS IT ACCEPTABLE FOR MUON SYSTEM TECHNOLOGIE
   - WILL THE FORWARD CALORIMETER FIT IN ?
3. HOW THE MAGNET IS PUT TOGETHER AND WHAT MUST BE MOVED TO ACCESS e.g. CENTRAL TRACKER.
4. SHIELDING. CALCULATIONS OF SURFACE SHIELDING PLATE EXIST BUT NOW IR WILL BE "CUT AND COVER". CAN SHIELDING PLATE BE INCORPORATED INTO THE ROOF? CAN WE GET AWAY WITHOUT SURFACE SHIELDING ?

- LONG TERM (~6 MONTH)

1. COMPLETION OF CONCEPTUAL DESIGN DRAWINGS AND COSTING FOR TECHNICAL REPORT
2. SAFETY AND RELIABILITY ANALYSIS
3. PRELIMINARY DESIGN OF CRYOGENIC SYSTEMS
4. PRELIMINARY DESIGN OF POWER SUPPLIES / PROTECTION SYSTEM
5. PRELIMINARY DESIGN OF MONITORING AND CONTROL SYSTEM

R & D ISSUES

1. CONDUCTOR – TOO MANY OPTIONS

SSC LABORATORY SPONSORED A CONDUCTOR WORKSHOP STARTED ON MONDAY DEC. 2, WILL CONTINUE FOR ~2 MONTH

PARTICIPANTS: EXPERTS AND PROPONENTS OF SPECIFIC DESIGNS + CRITICS + OBSERVERS + MODERATORS. JOHN MILLER (NHMFL), PETER CLEE (RUTHERFORD), PETER MARSTON (MIT PFC), GARY DEIS (LLNL) MARTOVIECKY (KURCHATOV)

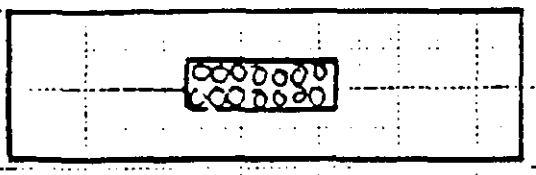
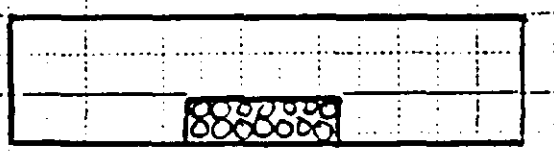
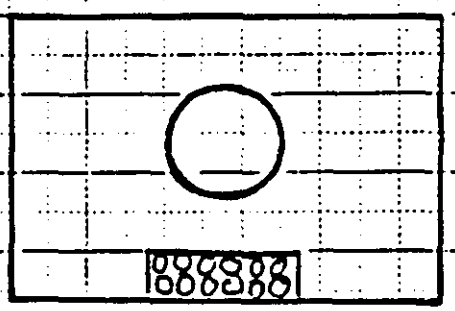
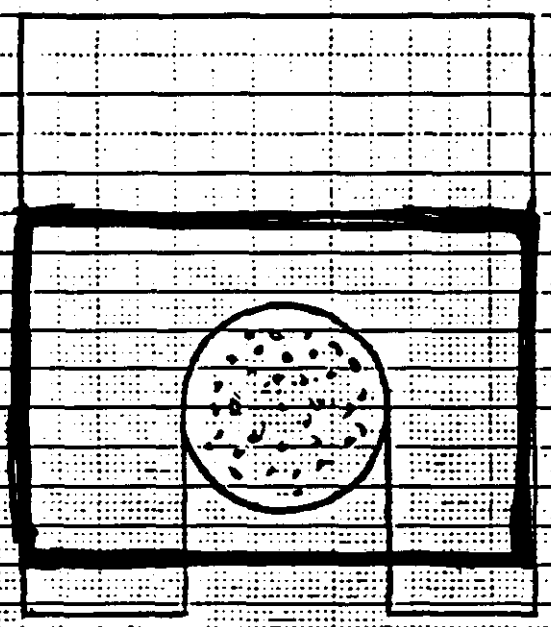
OBJECT: COMPARE VARIOUS DESIGNS ON COMMON BASIS AND SELECT ONE FOR FURTHER DEVELOPMENT. PROVIDE A BENCHMARK FOR ANY OTHER FUTURE PROPOSALS.

2. CONDUCTOR DEVELOPMENT – INVOLVES INDUSTRY
   a) PRODUCE SAMPLES OF NiTi STRANDS, CONDUIT, STABILIZER
   b) TEST TECHNIQUE OF PUTTING THEM TOGETHER
   c) VERIFY PERFORMANCE
   d) DEVELOP QUALITY CONTROL TESTS FOR PRODUCTION OF 24 Km.

3. JOINT DEVELOPMENT – DEVELOP TECHNIQUE FOR SPLICING THE CONDUCTOR AND DEVELOP QUALITY CONTROL TESTS

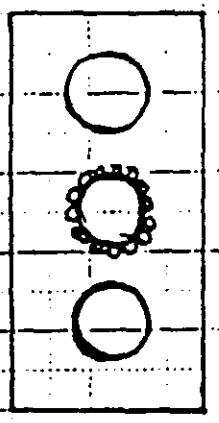
4. WINDING TOOLING AND DEVELOPMENT AND TESTS

GEM SOLENOID CONDUCTOR OPTIONS

	AREA mm^2	WEIGHT TONNES	LENGTH km
AL 99·999 	1216	73·7	22·4
Cu 	1053	195·1	22·4
Cu 	1980	348	22·4
AL 	4724	287	22·4

OPERATING CURRENT 50,000 A.

GEM SOLENOID CONDUCTOR OPTIONS.

		AREA mm^2	WEIGHT TONNES	LENGTH Km
AL		986	162	55.0

OPERATING CURRENT 20,000 A.

Nº TURNS 985.

$$J^2 = \frac{I_0 \; V_Q \; C(T_m)}{E}$$

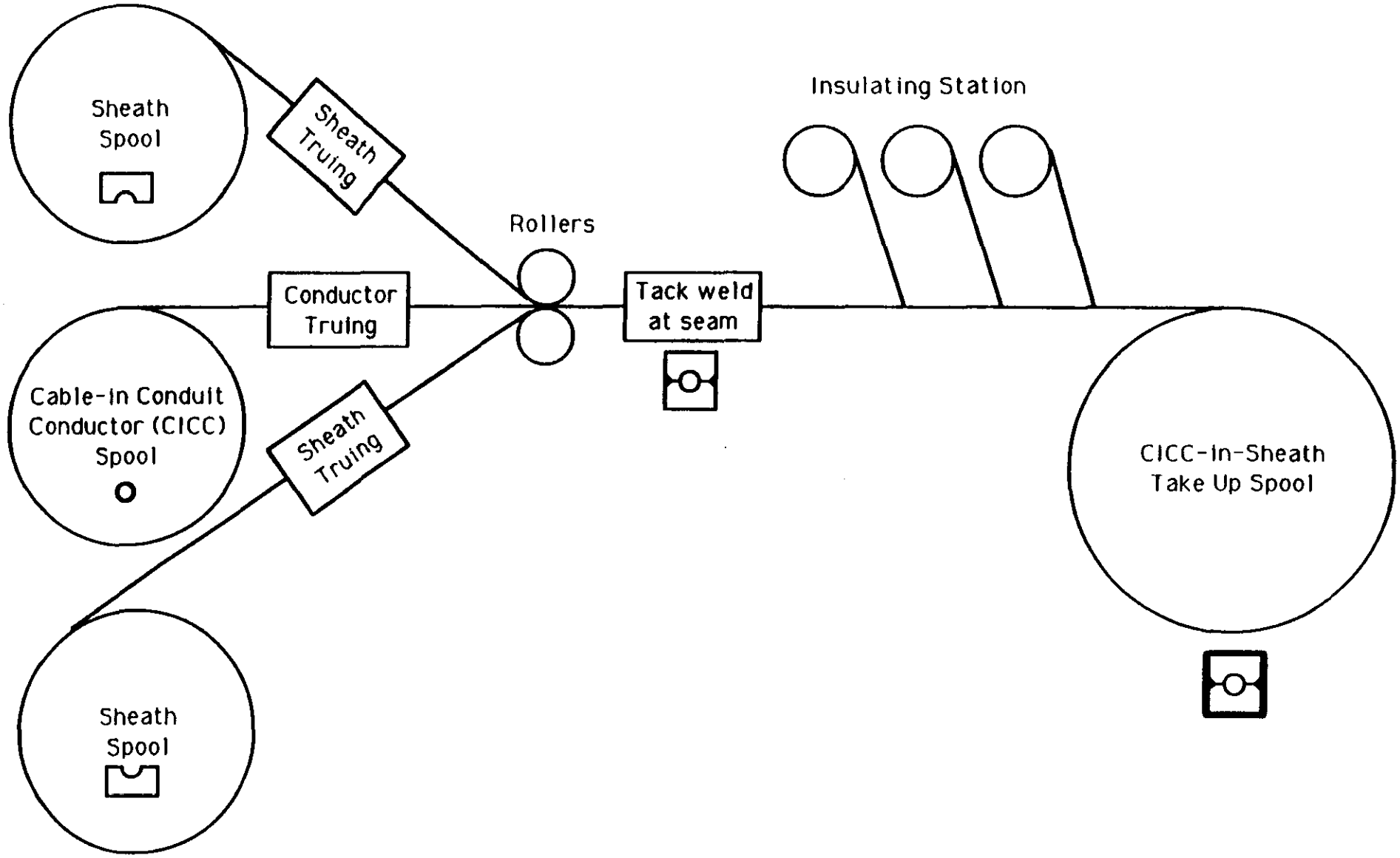


Figure 3 Schematic of Spooling and Insulating of CICC-in-Sheath (Factory Pre-assembled)

Cond-in-Stab|Rev 1

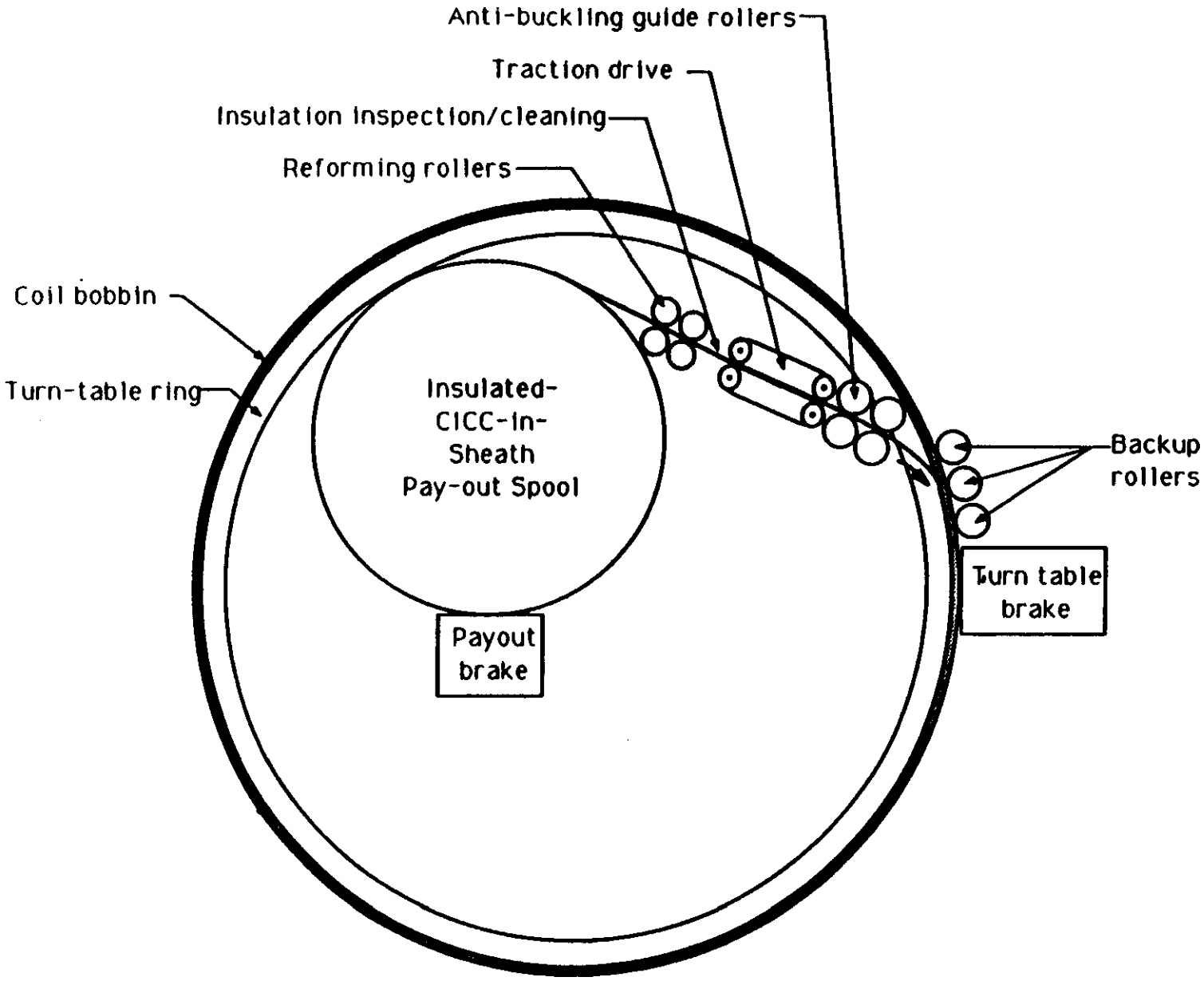


Figure 4 Schematic of On-site Coil Module Winding Concept

Magnet Winding-Brake

The R&D subcontracts.

1.1.1.2.1 Conductor Development and Testing ($600k)

Item	Sample Vendors	Amount ($k)
Strand purchase	IGC, Supercon	50
Cabling purchase	New England Cable and Wire	35
Conduit	Oxford-Airco, Okonite	25
Al extrusion	Arizona Aluminium New Jersey Aluminium	15
Strand verification	IGC, Supercon	75
Cable verification	New England Cable and Wire	70
Conduit verification	Oxford-Airco, Okonite	30
Al extrusion verification	Arizona Aluminium New Jersey Aluminium	25
Model coil	Everson Electric	275

1.1.1.2.2 Joint Development and Testing ($300k)

Item	Sample Vendors	Amount ($k)
Test joint parts	misc fab vendors	120
Joint verification	Koch Engineering	180

1.1.1.2.3 Conductor Tooling Development ($500k)

Item	Sample Vendors	Amount ($k)
Cabling tooling devices	New England Cable and Wire	250
Cond. sheathing tooling	Oxford-Airco, Okonite	200
Misc. small proc.	misc	50

1.1.1.2.4 Winding Tooling Development ($500k)

Item	Sample Vendors	Amount ($k)
Traction drive system	misc	275
Anti-buckling guides	misc	
Straightening sys	misc	100
Misc small proc.	misc	75
R&D Subcontracts:		50

WHY ALL THESE QUESTIONS ARE IMPORTANT ?

1. <u>TECHNICAL PROBLEM</u> - WINDING DONE AT ROOM TEMPERATURE. AT 4°K MAGNET BOBBIN WILL SHRINK ~ 13 cm, RADIUS WILL CHANGE TOO, ALSO CONDUCTOR LENGTH. THE CONDUCTOR HAS TO BE BONDED TO THE BOBBIN. ANY MOVEMENT OF THE CONDUCTOR (WHEN POWERED) WITH RESPECT TO THE BOBBIN OR OTHER WINDINGS MAY GENERATE ENOUGH HEAT TO INDUCE QUENCH.

2. <u>SCHEDULING PROBLEM</u> - THE CHOICE AND DESIGN OF CONDUCTOR AND WINDING HAVE TO BE MADE BEFORE END OF SUMMER OF 1992 IN ORDER TO BE ABLE TO INITIATE PROCUREMENT

OTHER IMPORTANT ISSUES

- 1. FIELD MAPPING – DO WE NEED IT ? HOW EXTENSIVE ?
  IN MUON REGION ONLY OR IN CENTRAL TUBE ALSO ?
  – IMPACTS DETECTOR ASSEMBLY PLAN

(IN GENERAL A SET OF CRITERIA FOR FIELD UNIFORMITY AND HOW WELL DO WE NEED TO KNOW IT ARE NEEDED FOR ALL DETECTOR COMPONENTS INSIDE THE MAGNET
i.e. MAXIMUM $\frac{\Delta B_z}{B_z}$, $\frac{\Delta B_r}{B_r}$ and $\Delta\left(\frac{\Delta B_z}{B_z}\right)$, $\Delta\left(\frac{\Delta B_r}{B_r}\right)$)

- PROCUREMENT PLAN – HOW DO WE BUILD THIS MAGNET ?
  - SCHEDULE REQUIRES PLAN IN PLACE BY SUMMER 1992
  - SEVERAL OPTIONS PROPOSED SO FAR
    1) GEM MAGNET GROUP PROVIDES THE LEAD AND WRITES OUT SUBCONTRACTS TO INDUSTRY FOR INDIVIDUAL COMPONENTS. PROCESS CAN BE CENTRALIZED AROUND e.g. SSCL, LLNL or MIT
       - ADVANTAGES : LARGER CONTROL OF THE PROCESS
       - DISADVANTAGES : LARGER HEADACHES, COSTS (?)
    2) COMPETITIVE BID TO INDUSTRY TO SELECT ONE COMPANY WHICH WILL COMPLETE DESIGN AND BUILD THE MAGNET. THIS COMPANY WOULD DO ALL SUBCONTRACTING
       ADVANTAGES : LOWER COST (?) AND FASTER SCHEDULE (?) WHICH AVOIDS DUPLICATED EFFORT
       DISADVANTAGES : NO CONTROL, SHADOW TEAM REQUIRED

3) COMPETITIVE BID TO INDUSTRY TO SELECT 2 TEAMS FOR MAKING COMPLETE MANUFACTURING DESIGN. THE TWO PROPOSALS EVALUATED AND ONE FINAL TEAM IS SELECTED

ADVANTAGES: COMPETITION IS GOOD FOR THE CONSUMER

DISADVANTAGES: NO CONTROL OF MANUFACTURING
SHADOW TEAM REQUIRED

4) FOREIGN MANUFACTURER (eg. EFREMOV IN ST. PETERSBURG)

CAN BE MAJOR MANUFACTURER OF MOST COMPONENTS EXCEPT CRYOGENICS AND CONTROL AND DIAGNOSTICS SYSTEMS

ADVATAGES: MAY BE LESS EXPENSIVE (?)

DISADVANTAGES: NO CONTROL,
INTEGRATION PROBLEMS
QUALITY AND TIMING
STABILITY OF RUSSIAN INDUSTRY DURING NEXT 5 YEARS.

Taylor

FET: 12/5/91

Status of GEM Muon System:

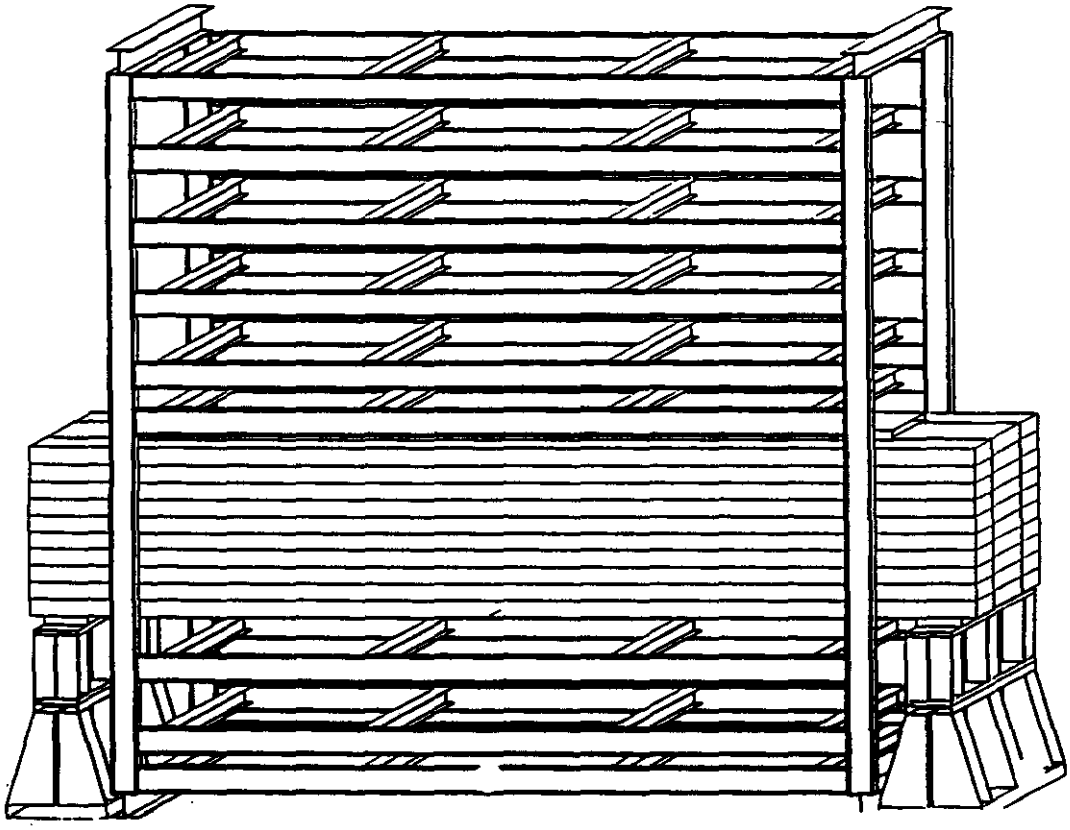
- LoI writing
- R&D Proposal
- Definition of TTR
- R&D Efforts
- Engineering
- Simulation of performance

GEM Muon Group R&D

SUBGROUP	DESCRIPTION	
CSC	Cathode Strip Chamber Subgroup; coordinated by V. Polychronakos, Brookhaven National Lab.	$500k
LSDT	Limited Streamer Drift Tube Subgroup; coordinated bu L. Osborne, MIT	$480k
PDT	Pressurized Drift Tube Subgroup; coordinated by S. Ahlen, Boston Univ.	$400k
RPC	Resistive Plate Chamber Subgroup; coordinated by I. Pless, MIT, and C. Wuest, Lawrence Livermore National Lab.	$300k
ENG	Engineering Subgroup; coordinated by F. Nimblett, Draper Lab.	$700k
TTR	Texas Test Rig Subgroup; coordinated by G. Mitselmakher, SSC Lab.	$240k
SCARF	Streamer Chamber Assembly and Research Facility Subgroup; coordinated by R. Weinstein, Univ. of Houston	$80k
		$2,700k

132 people
21 Institutions
4 countries

Texas Test Rig (Mitselmakher et al.)



Questions:

1) how large a chamber to test?
2) how much iron?
3) need a B-field?
4) setup - electronics, gas, DAQ, etc.

Short Term Efforts:

(1) TTR:
- engineering design of absorber iron and frame
- specification of what's needed to test chambers

(2) RPC:
- getting a chamber from Italy for evaluation
- studying glass prototype chambers

(3) CSC:
- measured the Lorentz angle for different conditions
- developing mechanical design

(4) PDT:
- developing mechanical design
- considering different gas mixtures

(5) LSDT:
- constructing 0.5 m x 6 m chamber
- setting up for Lorentz angle measurements
- seeking ways to reduce material in chamber

(6) Engineering:
- collecting material for cost review
- support structure support and interface hardware
- integration of muon system with GEM

(7) Simulation:
- how thick the calorimeter (punch-through)
- number of layers vs pattern recognition (δ-rays)
- B field uniformity
- trigger design and performance

Simulation: Roger McNeil

1) δ-rays from μ: 8-8-4 layers

1 TeV/c μ at 90°, 0.8T field

a) 2% δ μ's lost

b) SL_1: - 8 layers produce 8 good hits 78% of time.

- Increased to 85% after air gap

- to have ≥ 4 hits ≥ 95% of time need 7 layers

c) Out of 20 layers have > 18 hits 92% of time.

⇒ Air gap after calorimeter & more layers

2) How thick the Calorimeter?

Criterion:

Rate of hadron punch through << rate of prompt μ and π/K decay in tracking region.

Considerations:

pattern recognition & fake triggers

J. Brau
12/5/91

CALORIMETRY MEETING

Wednesday, December 4, 1991

(Location to be posted at the User's Office)

Revised Tentative Agenda (12/3/91)

8:30	Meeting opens, General Business	(Brau)
9:00	Progress Report on Noble Liquids	(Gordon)
9:30	The Parallel Plate Liquid Argon Option	(Mockett)
10:00	Progress Report on Forward Calorimetry	(Rutherford)
10:30	Progress Report on Silicon Strip Pre-Radiator	(Brau)
11:00	Pre-Radiator and Isolation Studies	(Zhu or Yamamoto)
11:30	Electronics	(Marlow?)
12:00	LUNCH	
1:00	Progress Report on Barium Fluoride, Panel	(Newman)
1:30	Progress Report on Scintillating Fiber	(Worstell)
2:00	Effective Compensation	(Paar)
2:30	Progress Report on Engineering	(Rennich)
3:00	Adjourn (SubGroups may meet separately)	

Table 1: Calorimetry Budget Summary

	R & D (k$)	Engineering (k$)
Liquid Argon/Kr	1 170	798
BaF_2	1 209	
Scin. Fiber	610	250
Forward	75	10
Sil. St. Prerad	140	10
Post decision		350
Totals	3 204	1 418

Engineering Split being reviewed

Table 2: Liquid Argon/krypton R&D

	k$
2 mm Pb Accordian (RD3) BNL	150
Improve EM accordian (2 mm Kr + 1 mm Ar)	520
Hadronic module EST	50
Parallel plate EM + preradiator (UW)	205
Test beam support (Arizona)	20
Precision calibration	75
Operation of test beam	50
Cryogenics, purification, for test beam	100
Liquid Argon/krypton total	1 170

Table 3: BaF_2 R&D

	k$
UV Performance Monitoring	47
Analog and Digital Readout Testing	50
Radiation Damage Tests	310
Prototype Electronics Readout	117
Rad Hard Electronics Readout	30
Beam and Cosmic Ray Tests	241
BaF_2 Crystal Matrix Assembly	414
BaF_2 total	1 209

Table 4: Scintillating fiber hadron R&D

	k$
Engineering and design	140
Shop time	20
M & S Hardware	200
Tooling	50
SPACAL work	150
Test Beam support	50
Scintillating fiber total	610

Table 5: Forward calorimetry R&D

	k$
Liquid scintillator	50
High pressure gas tubes	25
Forward calorimetry total	75

Table 6: Silicon strip preradiator R&D

	k$
Electronics development	80
Beamtest hardware and support	60
Silicon strip prerad total	140

I. Cryogenic

II. a) 1.3 mm Pb stock

b) Chevron Design.

c) 1mm Pb electrod readout.

III. Bending Machine —

IV. Electronic Read out.

V. Cal. Design

D. Lissauer
BNL.

I. Cryogenic.

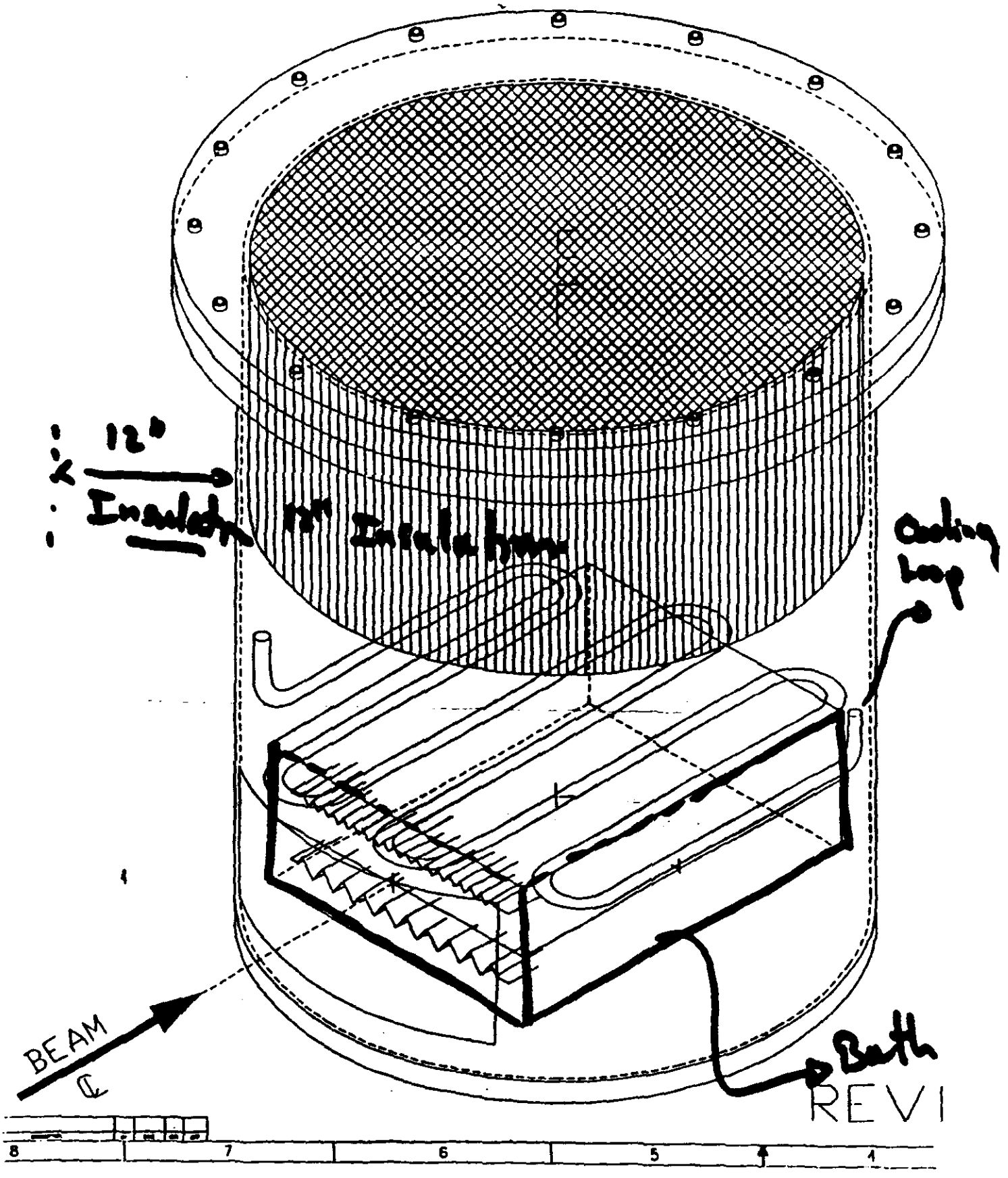
Vessel: Design is under way.

- New Vessel
  - Single Wall + Insulation.
  - Stainless Steel. ($\sim 1/8\ X_0$)
  - 1 meter Diameter
  - enough Space for 3-mini strels.
  - Cooling loop inside for Liq Argon
  - bathtub arrangement
  - Feedthrough (NA 34 Design.

Krypton –

- purification System. (NA 48)

design under way (MIT, Columbia, BNL)


12"
Insulation
Cooling loop
Bath
BEAM
℄
REVI
8
7
6
5
4

1.3 mm Pb

Cell structure:

	1.3 mm Pb .2 mm steel .05 mm Prepreg	Absorber
	2 mm Liq. Argon / Liq. Krypton.	
Readout ←	H.V. Cu + Res Kapton Cu. Kapton H.V. Cu + Res.	Readout Electrode.

Design of stack – 2 weeks.

Pb, steel, Prepreg – Ordered.

Bending tests – Start this week

Read out Board – Send out to P.C. Shop ~3 weeks.

[

Chevron Readout: (Under Study)

1. Improve position Resolution.

2. M.C. studies optimal π^0, γ separation from shower slope.

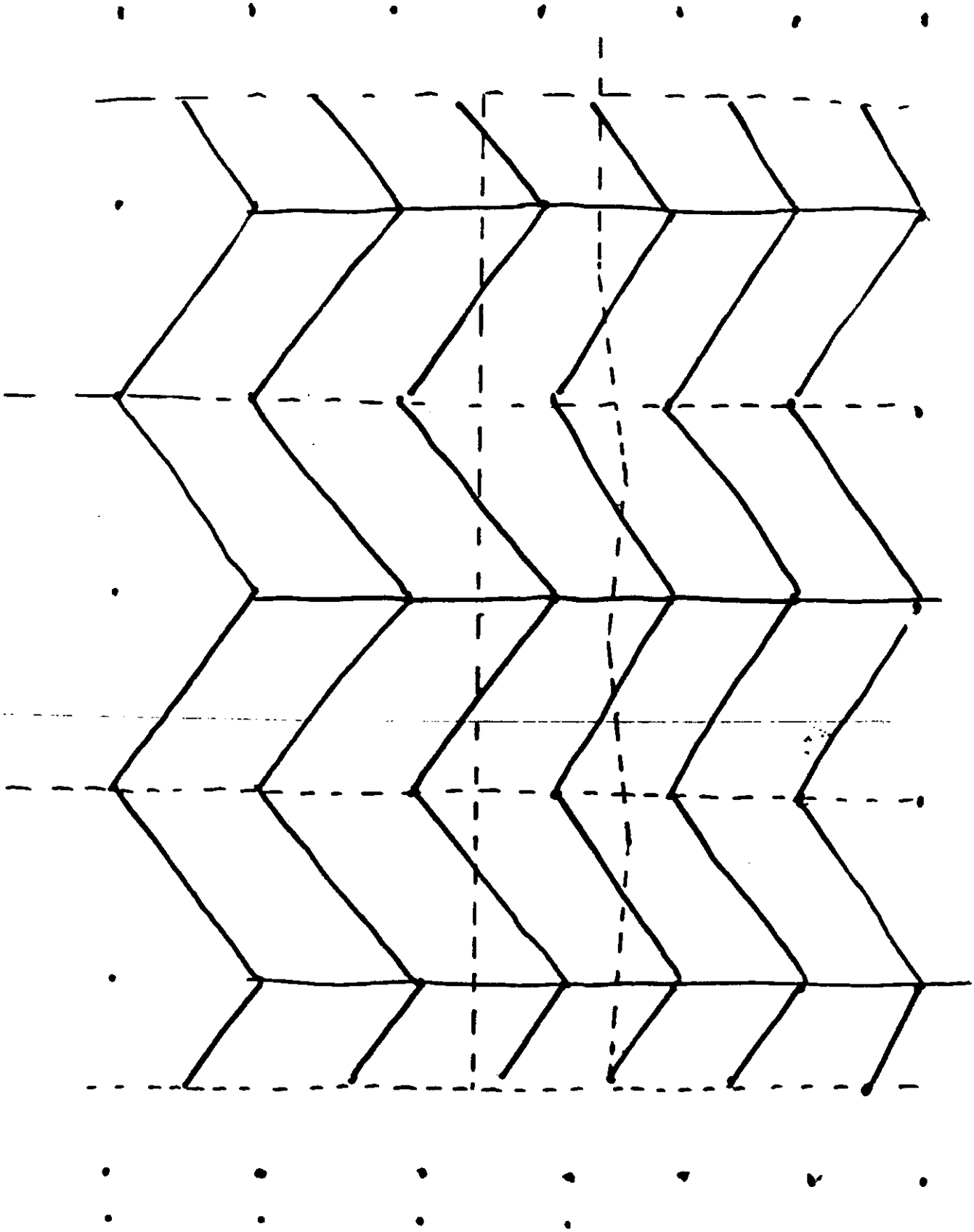
- What is a chevron Readout?

(Fig.)

M.C. Studies:

- frequency of chevron.
- Relation to Accordion frequency.

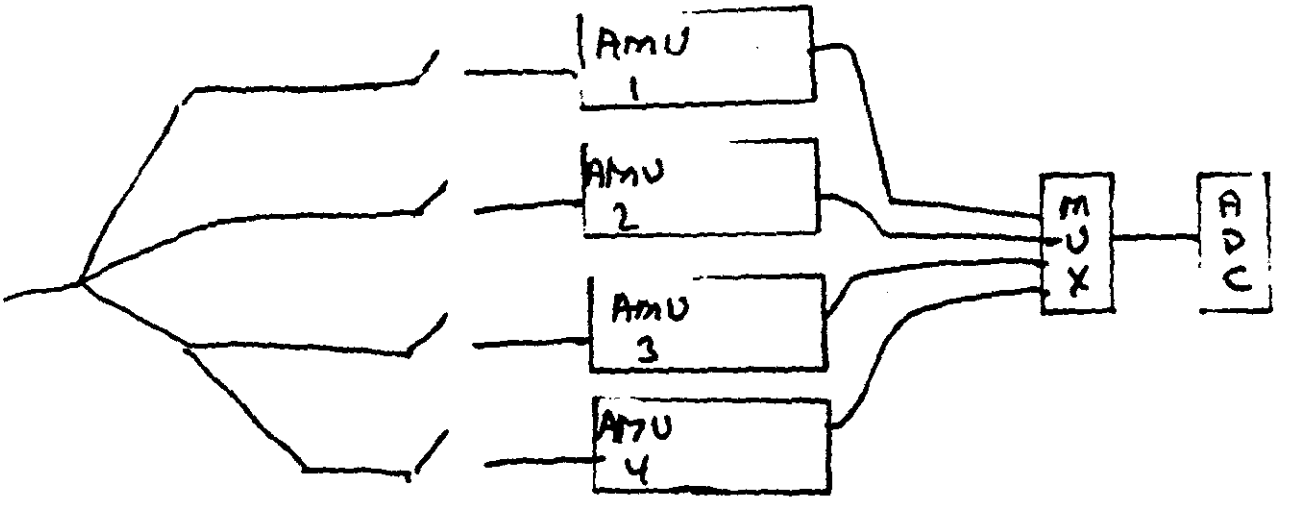
(Corr.).



fast movement
wheel to tighten chain
chain
big force
(slow) drive
rail for
upper bars
chains
upper
bars
lower
bars
alignment
rails for
lower bars
screw drive
structure
support beam

pre-amp : cold pre Amp.s.

Shaper : 40 n-sec.



ZEUS" AMU 58 buckets.

Design for 96 n-sec. clock (HERA)

Multiplex input into 4 diff AMU.

18 n-sec.

Tested last year at FNAL

J. PARSONE et Al. (NEVIS)

SUPPORT TUBE
ELECTRONICS BOXES
COARSE HADRON
FINE HADRON
ACCORDION EM
TRACKER
BARREL CYLINDRICAL
ENDCAP CYLINDRICAL
4000
6000
Dimensions in millimetres

Review

P. Hackett

Calorimeter Group Goal for Resolution

$\leq 7.5\% \sqrt{E}$ stochastic

$\leq .5\% E$ constant

Both clearly has potentially the best stochastic term

Much experience with LAr calorimeters

Accordion has demonstrated fast operation

$\tau_p \sim 20ns$ but $\sigma \sim 10\% \sqrt{E}$

NA31 demonstrated $\sigma = 7.5\% \sqrt{E}$

but slow

Can the NA31 design (parallel plates) be made Fast & retain $\sigma \leq 7.5\% \sqrt{E}$

?

PARALLEL PLATE OPTION
(PPEMCAL)

Meeting @ MIT Oct 23-24
UA MIT & UW

Stripline Design Review
a) 1.5 mm Pb plates with Cu cladding
$< 7\%/\sqrt{E}$ in LAr

b) <1% of area non uniform

c) $v = c/\sqrt{K(1+\eta)}$: Fast loaded stripline Readout

Discussion of Speed

Loaded Stripline

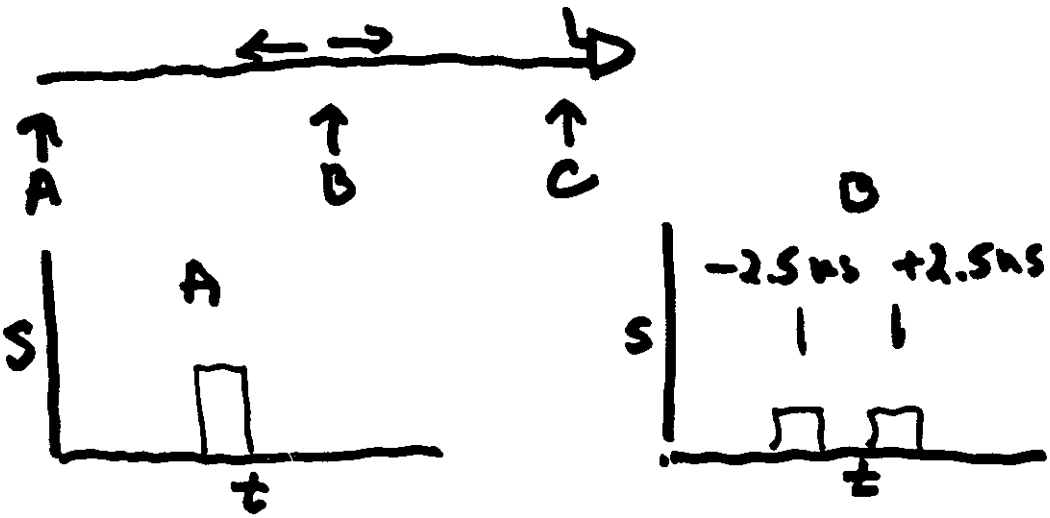
$$v = \frac{c}{\sqrt{K(1+\eta)}} \quad \text{where } \eta = C_l/C_s$$

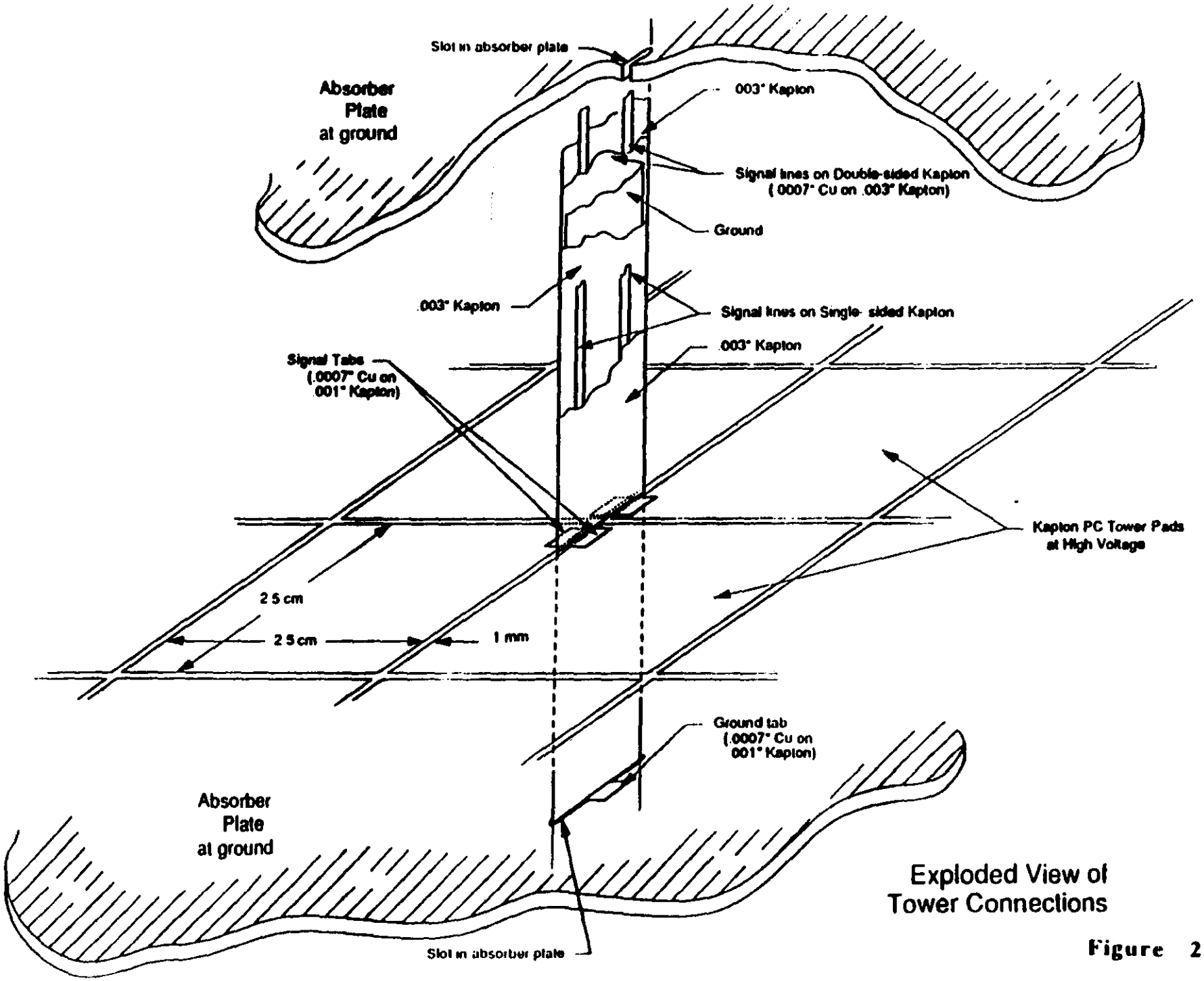
for $K = 3.5$ (Kapton) & $\eta = 3$

$$v = c/\sqrt{3.5 \times 4}$$

Accordion $v = c/\sqrt{3.5 \times 2}$

so Accordion $\times 2$ faster





Exploded View of Tower Connections

Figure 2.

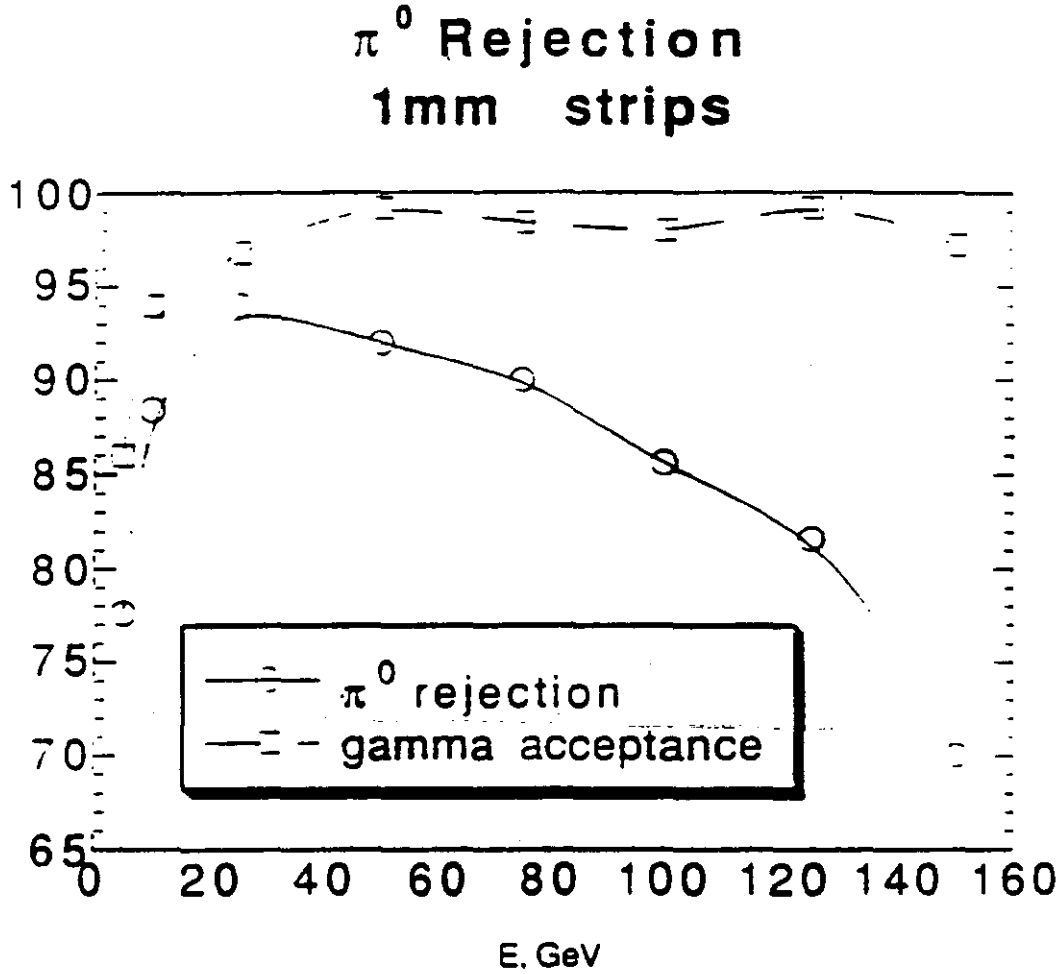

π⁰ Rejection
1mm strips
100
95
90
85
80
75
70
65
0
20
40
60
80
100
120
140
160
E, GeV
π⁰ rejection
gamma acceptance

Figure 2.

Progress on GEM Scintillating Fiber Hadron Calorimeter

Bill Worstell

GEM Calorimeter
Working Group Meeting

December 4, 1991

SSCL

Collaboration & Mission

1) We have made progress in coordinating and synthesizing the capabilities and efforts of the former scintillating fiber and liquid scintillator groups.

2) We have expanded our research program to more directly address several key issues which were raised by the GEM calorimetry working group during our recent technology decision meeting:

   a) Longitudinal Segmentation
   b) Long-term Stability + Radiation Damage
   c) Calibration Systems
   d) Photomultiplier + Readout Systems

3) Our R & D Budget request has been modified to reflect the increase in scope of our mission and the strengthening of our team.

Status of 4-Ton Prototype

We are constructing a total of 6 1-Ton supertowers:

(4 physics towers each, each tower would be 0.05 eta x 0.05 phi at eta=0)

a) One cast tower with splice joints for fiber bundle readout is complete, machined and under bench test.

b) Four towers are under construction, a subset of which will be tested at FNAL subject to beam schedule (December 23 - January 8)

Characteristics:

No splice joints (scifi bundle readout)
89% eutectic/ 11% 2mm fibers

First ready to cast, second being threaded, fibers cut for third

Four towers at FNAL by Xmas.

Key Questions to Resolve for 16-Ton Prototype

1) Supertower dimensions/segmentation:

   2.5-Ton Supertowers 0.16 eta x 0.16 phi may be optimal in long-term but may not be feasible short-term

   16 1-Ton 0.10 eta x 0.10 phi supertowers takes advantage of existing infrastructure

2) Degree of fidelity to long-term design which is feasible for short-term construction (August 1992 CERN Beamtest)

   a) Spherical vs. true GEM geometry
   b) Mesh dynode PMT readout ($)
   c) Specification of sheaths and mechanical support structure

3) Longitudinal Segmentation:

   a) Specifications for physical segmentation
   b) Off-shelf vs. dedicated electronic segmentation

Schedule & Deadlines

1) 4-Ton prototype:

   a) To FNAL by Xmas
   b) Lead shot supertower in January
   c) Fiber splice readout tested by January
   d) BNL spring run?

2) 16-Ton prototype

   a) Request for Quotations to Fiber Vendors
      Division of inside/outside preform preparation is key question

      Purchase order placed before Feb. 1

   b) Photomultipliers selected and ordered before Feb. 1

   c) Special order for splice/spacer plates by Feb. 1

3) We expect to begin construction of first new supertowers in March/April 1992.

Jet-Energy Measurement with a Non-Compensating Cal'r

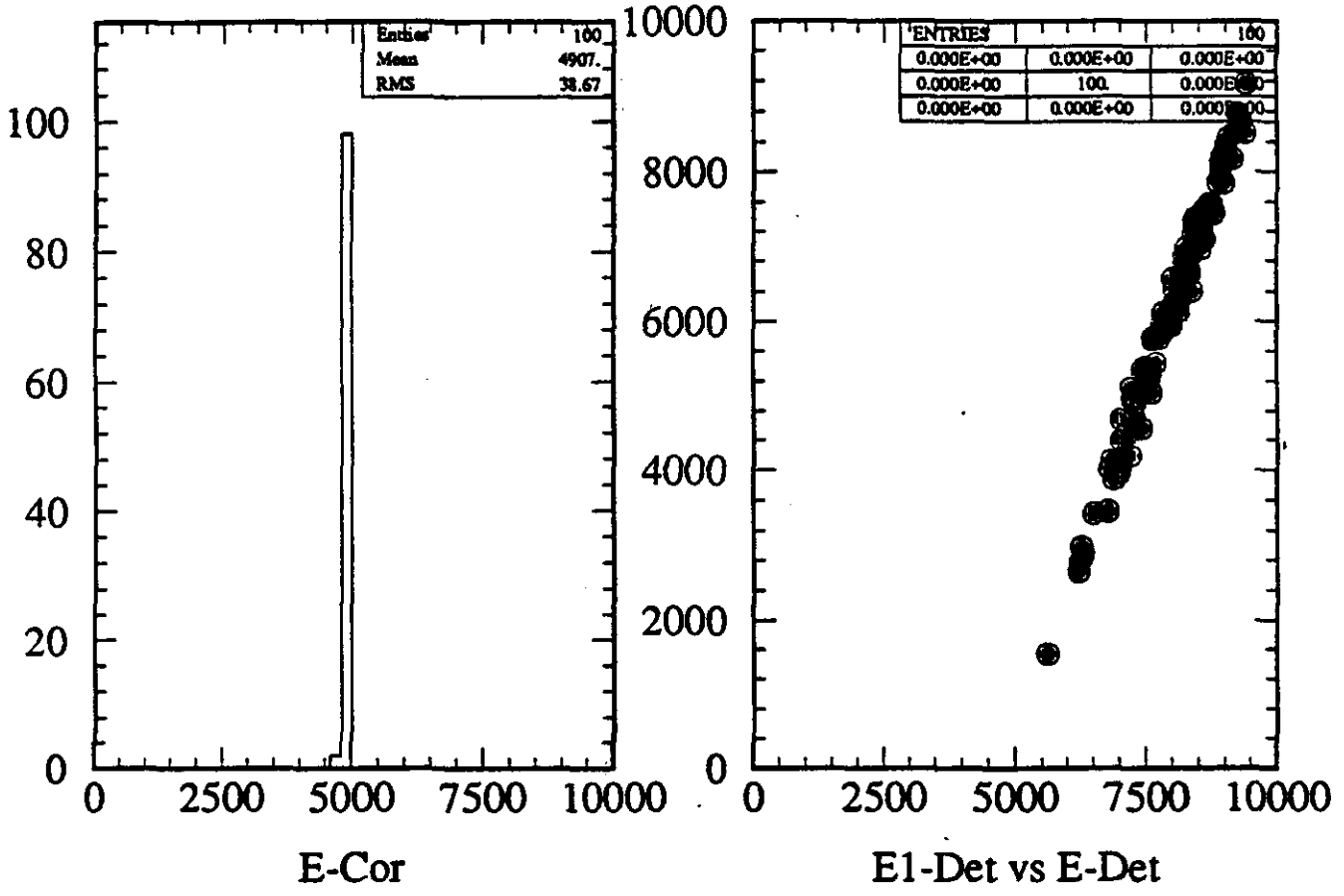
Hans Paar, Richard Wigmans

1. Goals
2. Method
3. Some general results
4. Corrected Jet-energy
   - Resolution
   - Linearity
5. Conclusions

Acknowledge discussions with
Jim Branson, Yuri Kamyshkov

BaF/Sc
$\alpha = 3$

5000 GeV



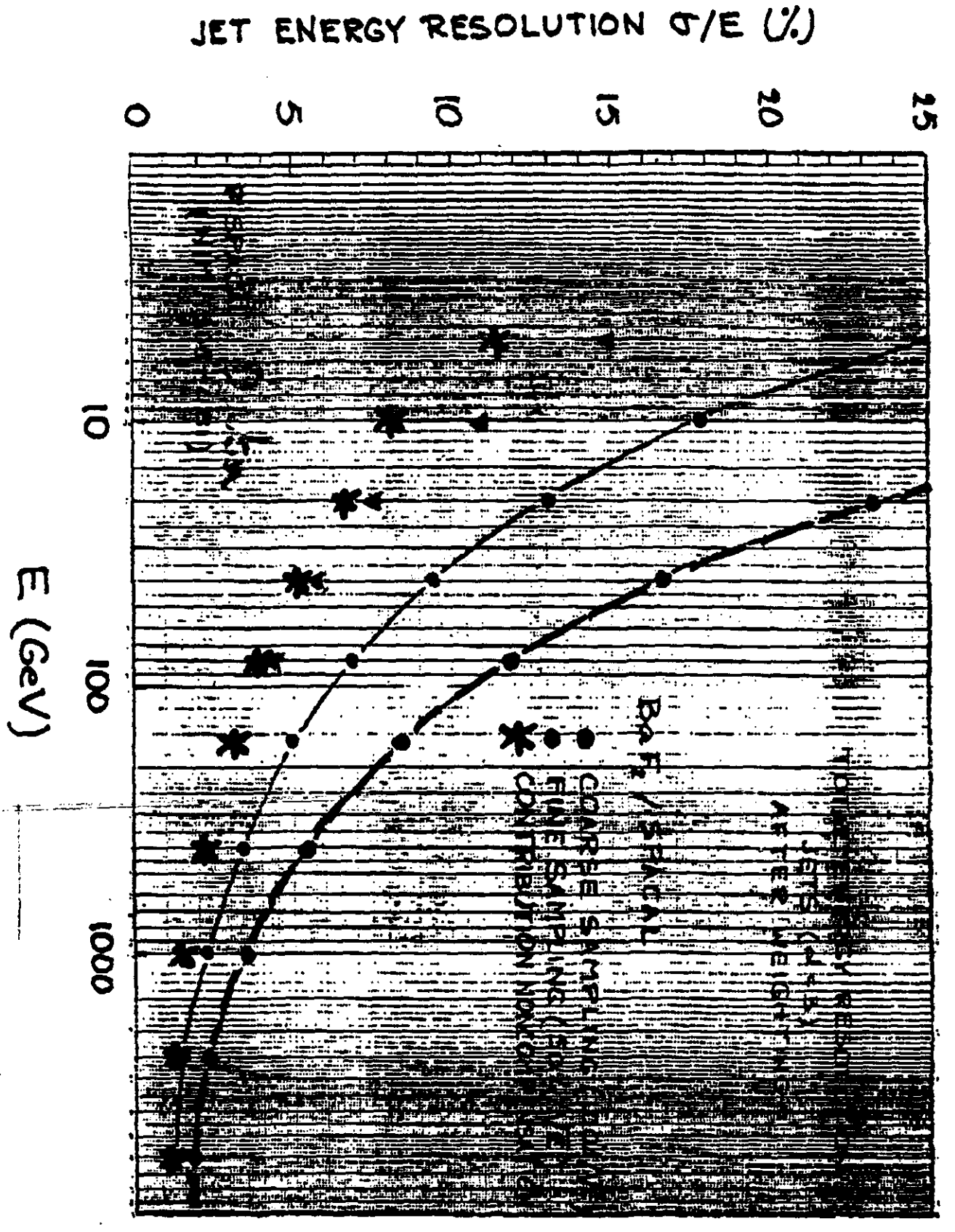

JET ENERGY RESOLUTION σ/E (%)
0
5
10
15
20
25
E (GeV)
10
100
1000
BaF2 / SPACAL
COARSE SAMPLING
FINE SAMPLING
CONTRIBUTION NOV

fig. 4

Conclusions

- Can get good E_{jet} above 100 GeV if had. cal. is compensating
- Input data for method is measurable with prototypes in testbeams (e, π, multi-part.)
- No need for "black-box" MC, fragmentation, hadron shower dev.
- Non-comp. hadron calorimeter introduces model dependence (ex. $\langle f_{\pi^0} \rangle$)
- Problem at low E_{jet}?
  Missing E_T but linearity and resolution not so important?

12/4/91
J. Rutherford
SSC Lab

GEM Forward Calorimetry

Physics Goals:

- Hermetic measurement of global $\vec{p}_T$
- Forward tagging jets

Critical Parameters

- Mean density of calorimeter
- Diameter of beam hole

Tucson ForCal Mtg: Monday Nov. 18th Summary

- Three proposed technologies
  - High Pressure Gas
  - Liquid scintillator capillaries
  - Liquid Argon
- General simulation
- Integration issues

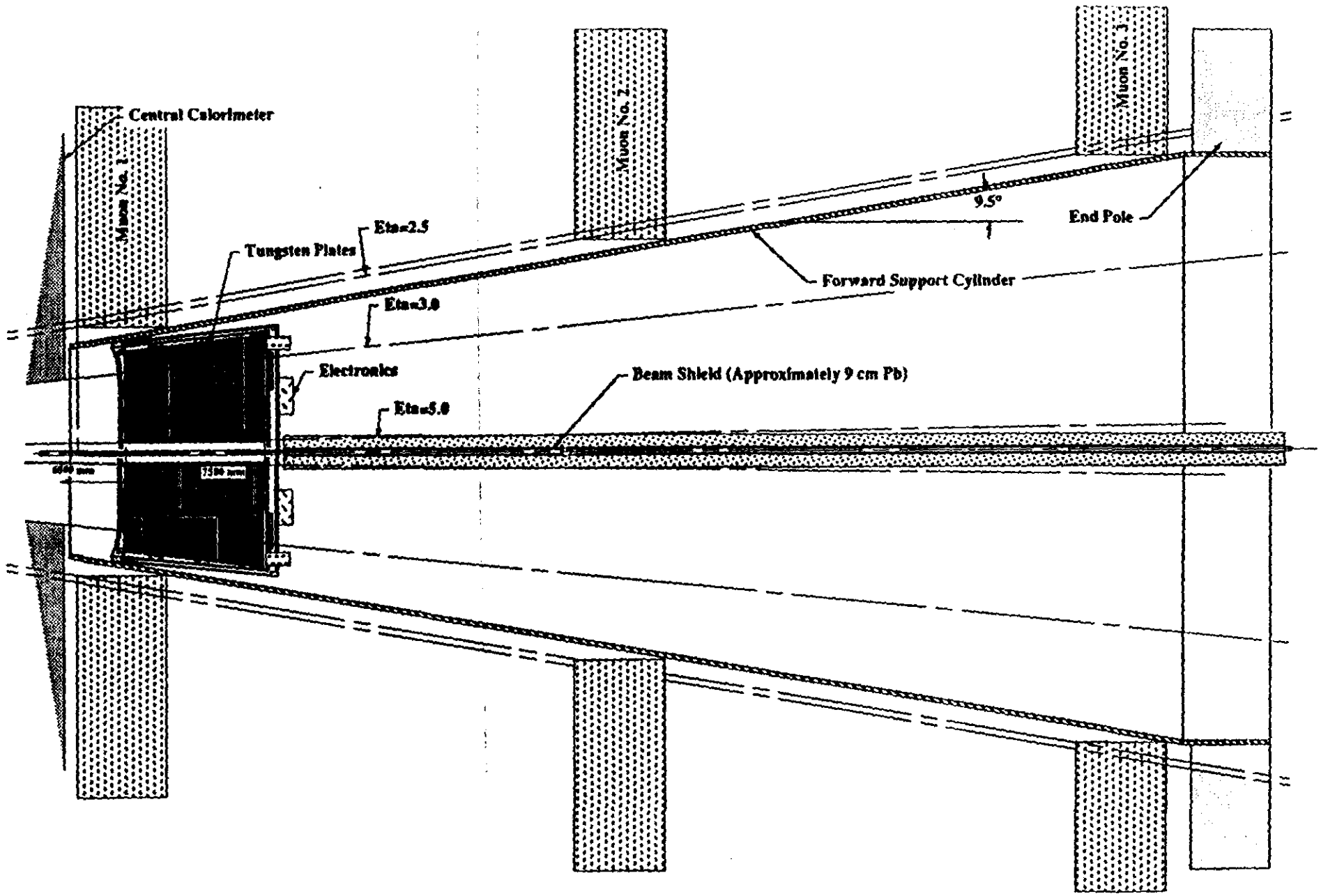
Preliminary Cost Estimates

GEM FCal Simulation Parameters

	Photons	Hadrons
Energy Resolution $\frac{\Delta E}{E}$	$\frac{40\%}{\sqrt{E}} + 2\%$	$\frac{100\%}{\sqrt{E}} + 2\%$
Position Resolution $\frac{\Delta\theta}{\theta}$	$\leq \frac{0.17}{\sqrt{12}}$	$\leq \frac{0.17}{\sqrt{12}}$
Coverage w/ full containment	$3 < \eta < 5.8$	$3 < \eta < 5.2$

GEM FCal Parameters (Each of 2)

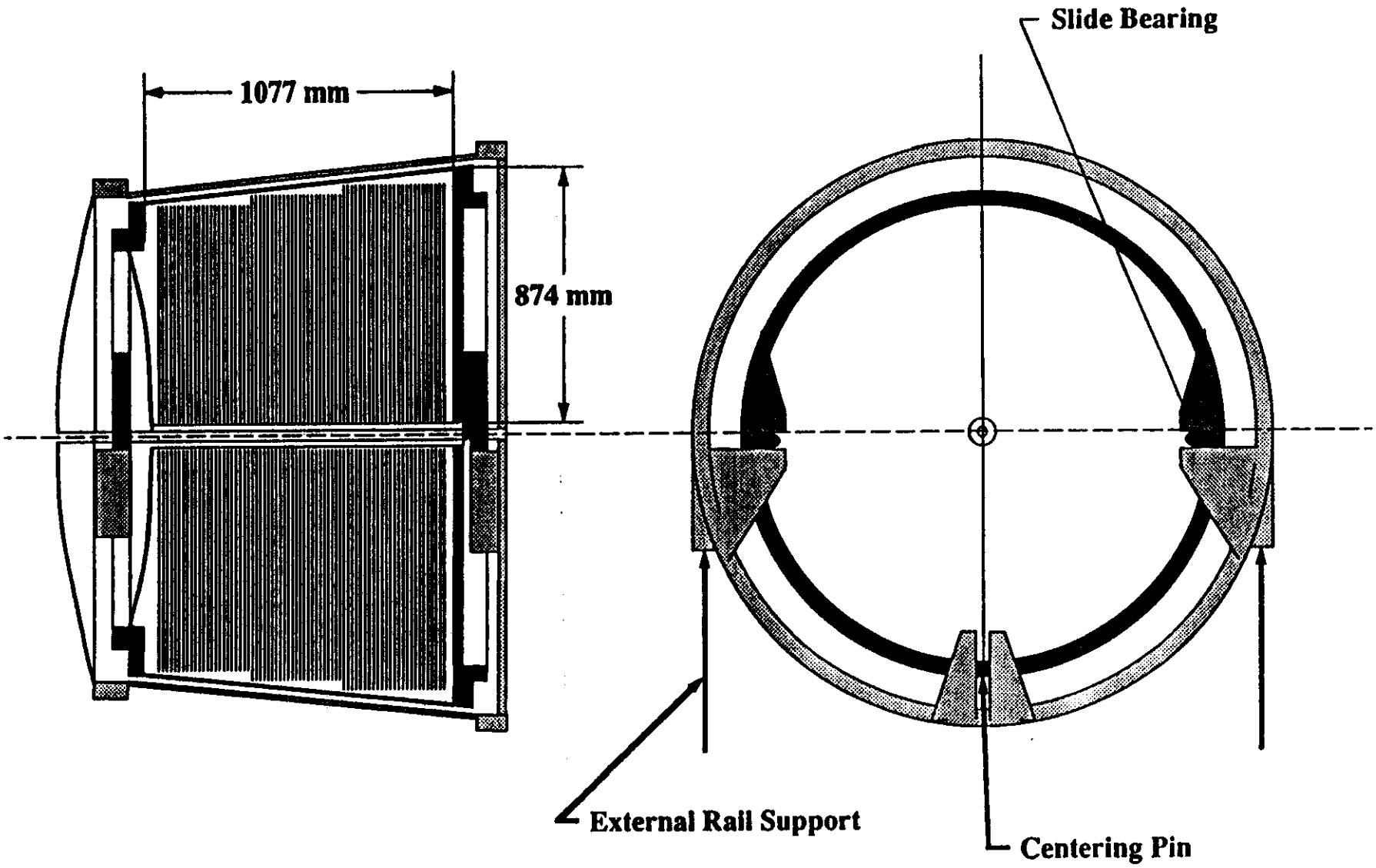
Distance from IP to front face	6.5 m
Mean outer radius	80 cm
Weight	40 T
Unit cell	
Heavymet plate	1.3125 cm
G10 sheet w/Cu pads	0.019 cm
Liquid Argon gap	0.10 cm
Electronic read-out channels	
At 1st depth segment	698
2nd	186
3rd	186
Total	1070 channels



GEM
Forward Calorimeter
Liquid Argon

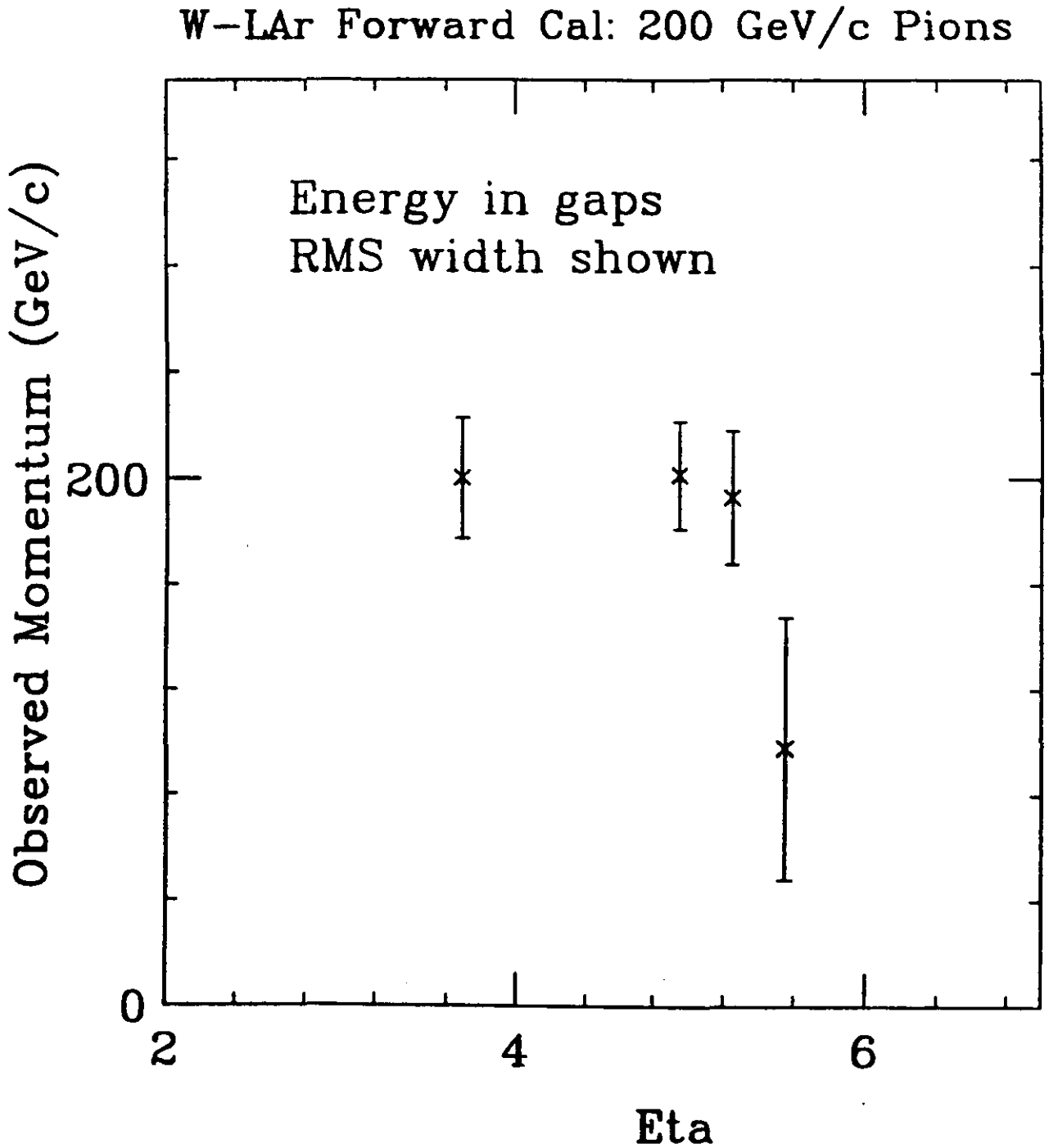
G.03.FD.00015

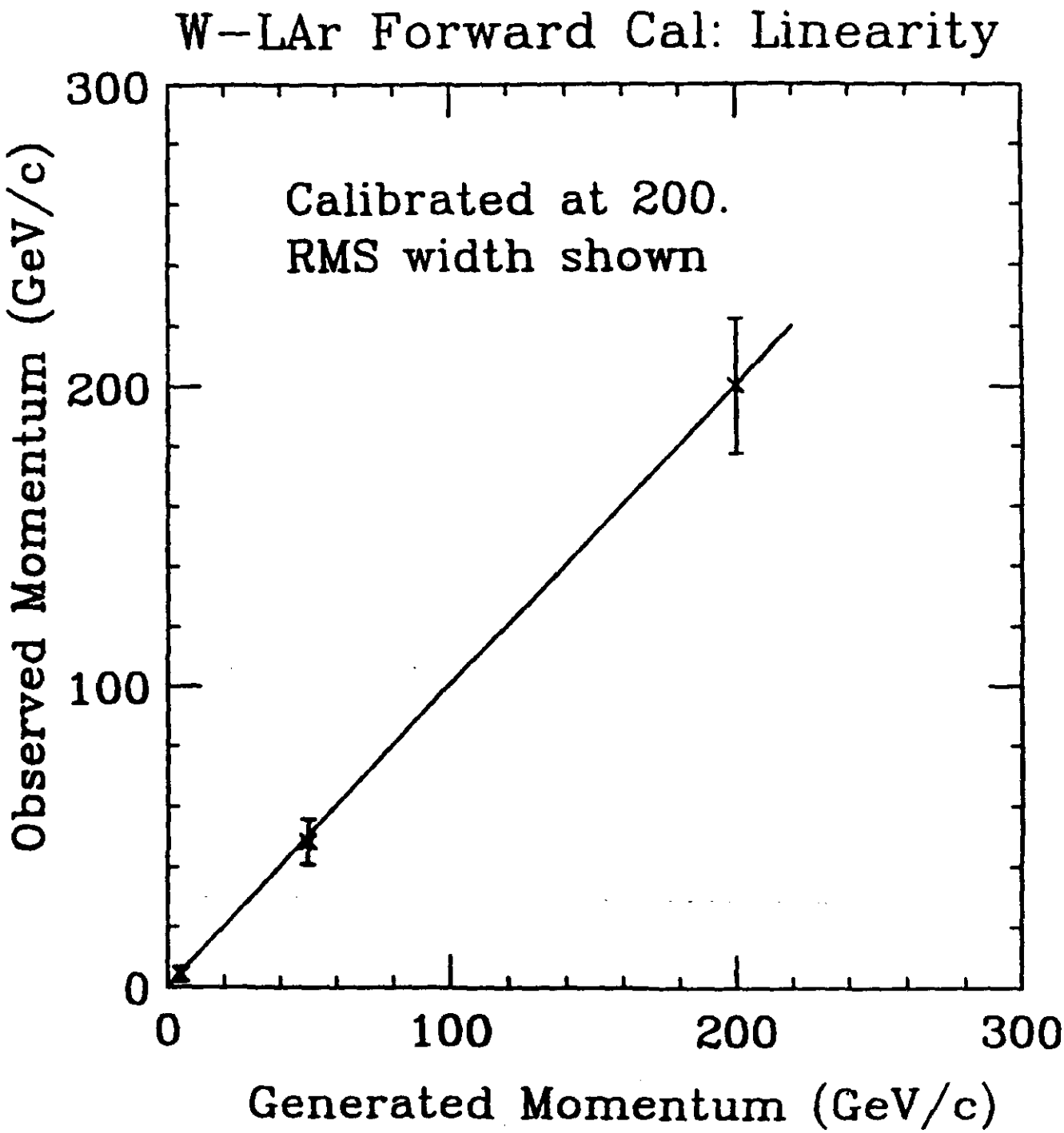
Rennich

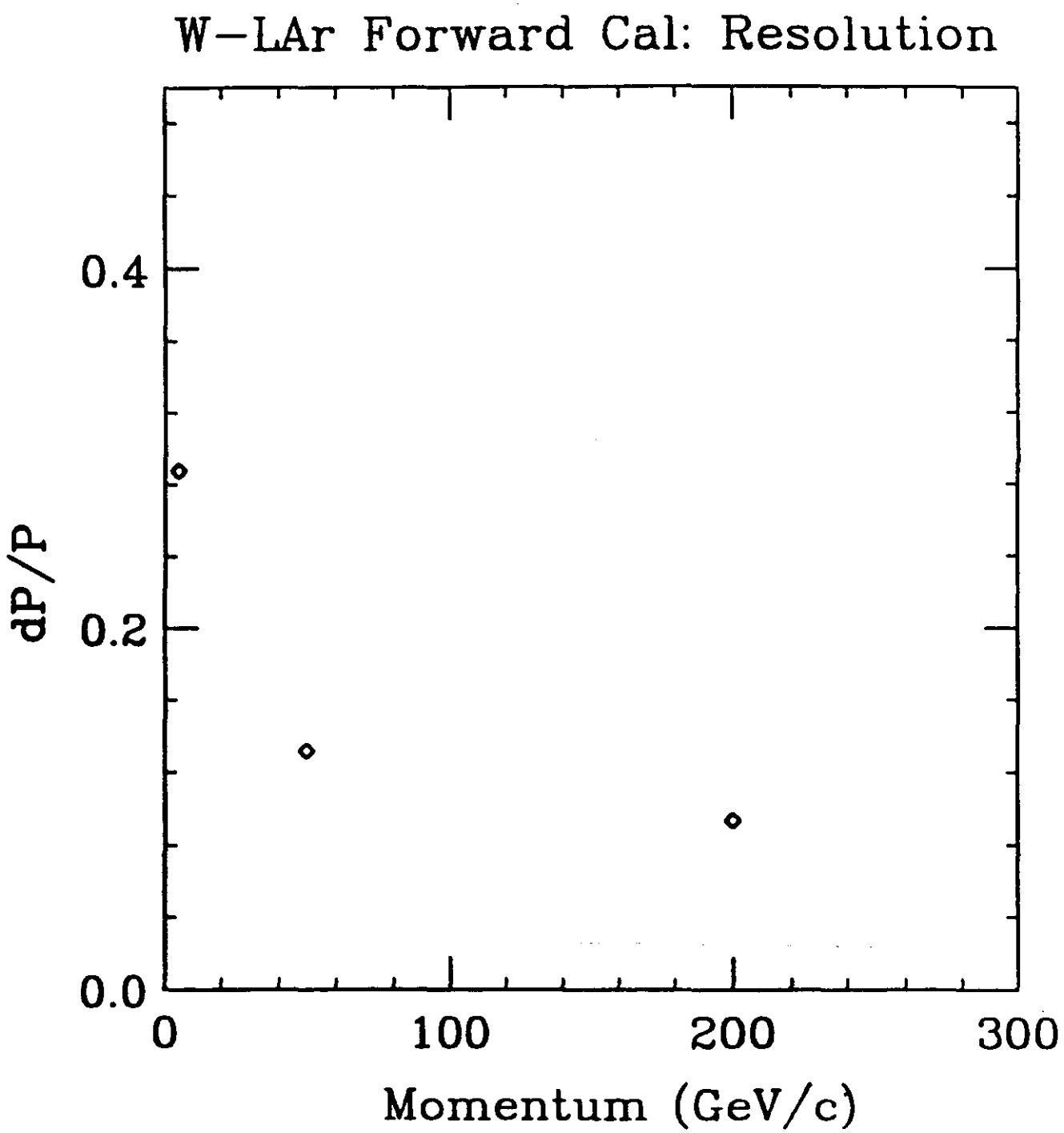


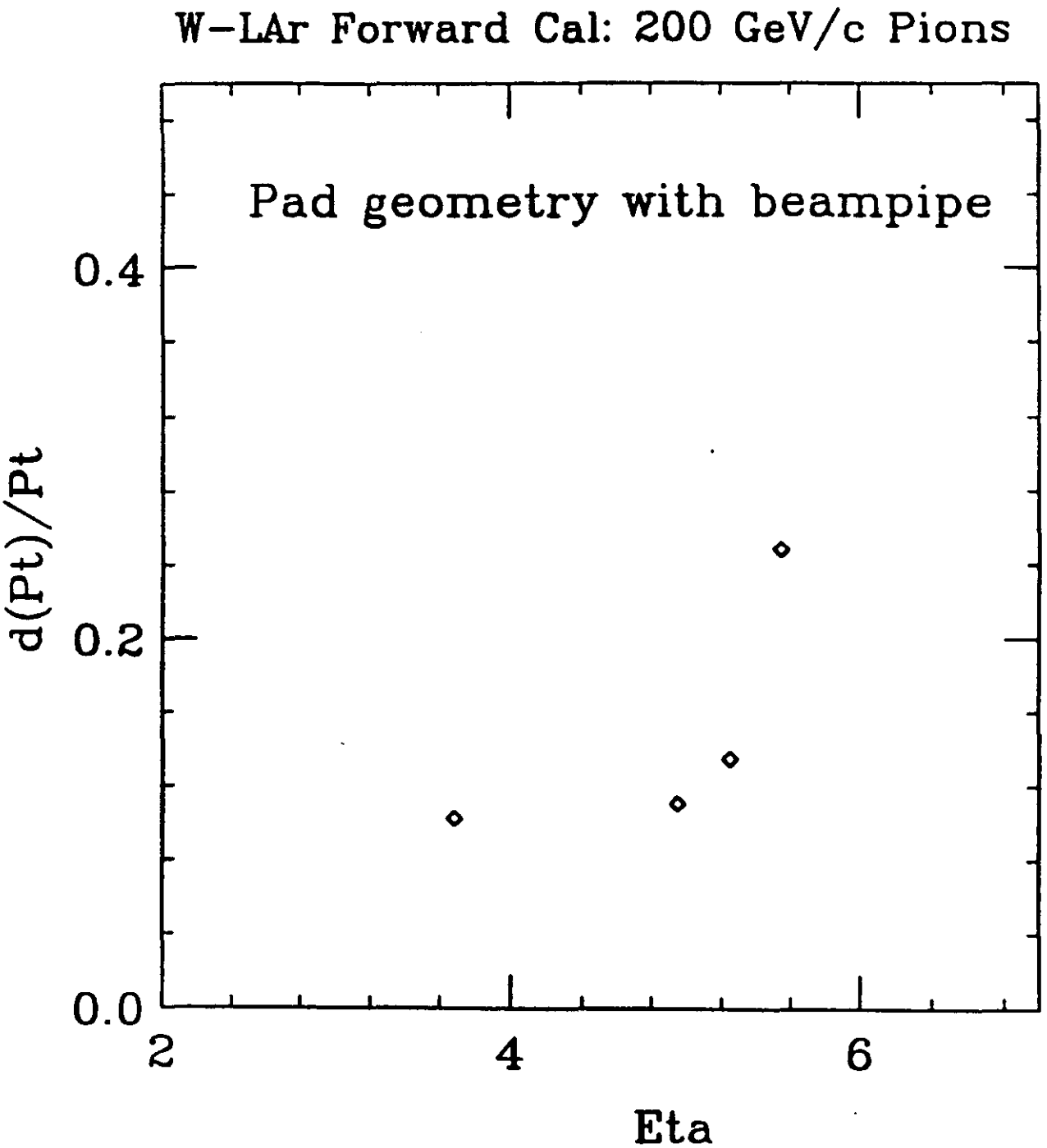
Liquid Argon Forward Calorimeter
Argon Vessel Support System

Rennich/Chae


W-LAr Forward Cal: 200 GeV/c Pions
Energy in gaps
RMS width shown
Observed Momentum (GeV/c)
200
0
2
4
6
Eta


W−LAr Forward Cal: Linearity
Calibrated at 200.
RMS width shown
Observed Momentum (GeV/c)
Generated Momentum (GeV/c)
0
100
200
300
0
100
200
300


W−LAr Forward Cal: Resolution
0.4
0.2
0.0
dP/P
0
100
200
300
Momentum (GeV/c)


W-LAr Forward Cal: 200 GeV/c Pions
Pad geometry with beampipe
0.4
0.2
0.0
d(Pt)/Pt
2
4
6
Eta

FCal Cost Estimates
(Preliminary)

Liquid scintillator capillaries

$27 M → $14 M Mark Rennich Oak Ridge
Bob Webb Texas A&M

Liquid Argon

$20 M Steve Chae Oak Ridge
Jody Coulon Martin Marietta

GEM Silicon Strip Preradiator

Simulation

π^0 rejection

Energy correction

GEM skis

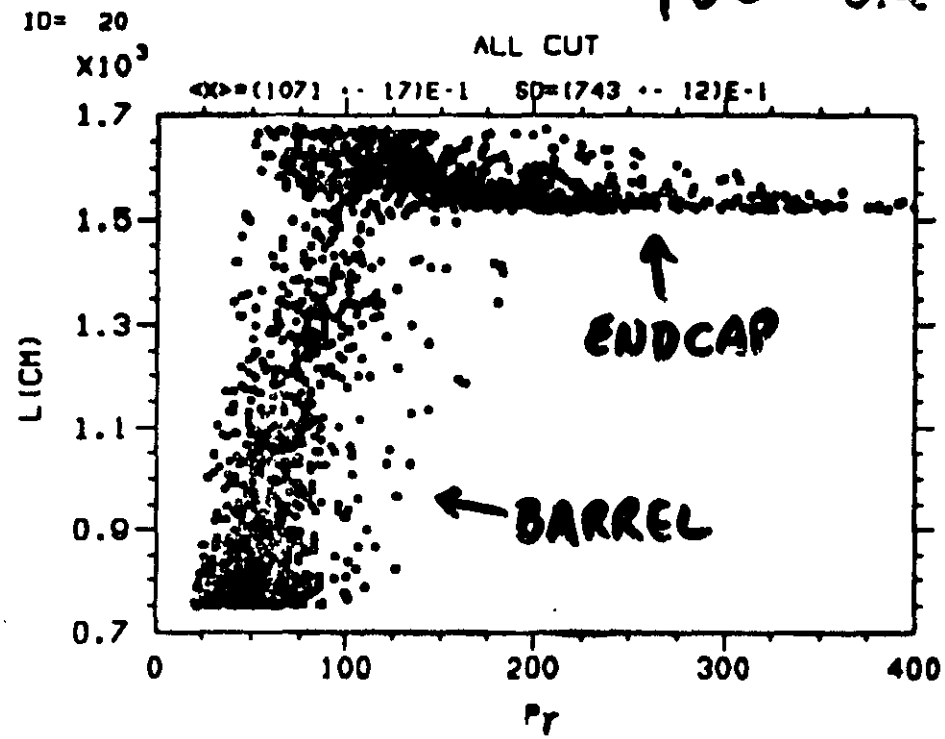
Russian industrial interest

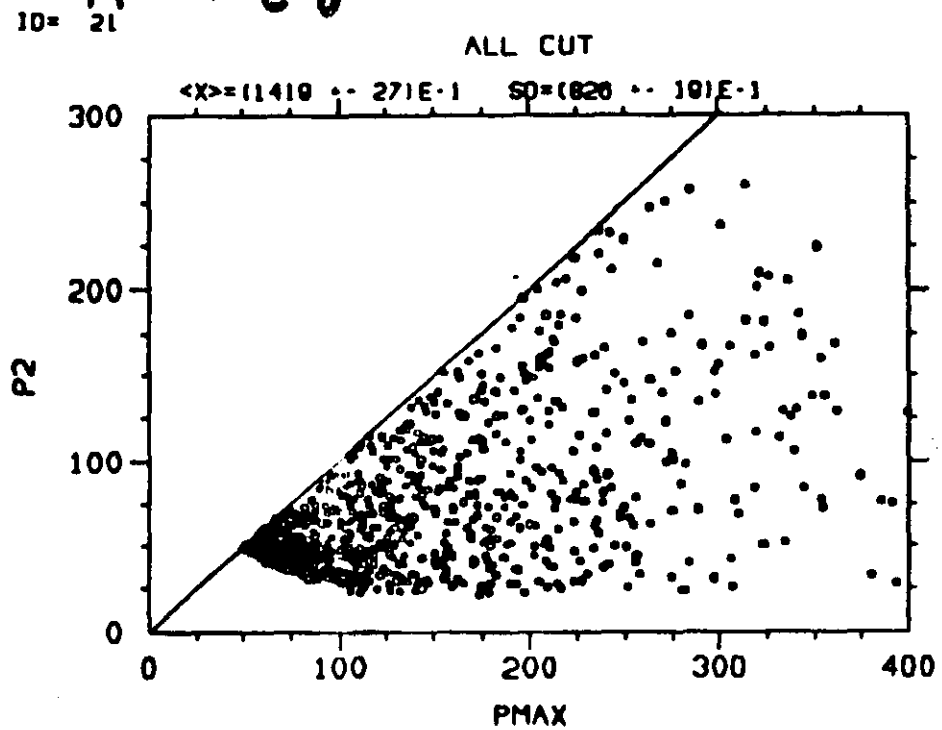
Prototype

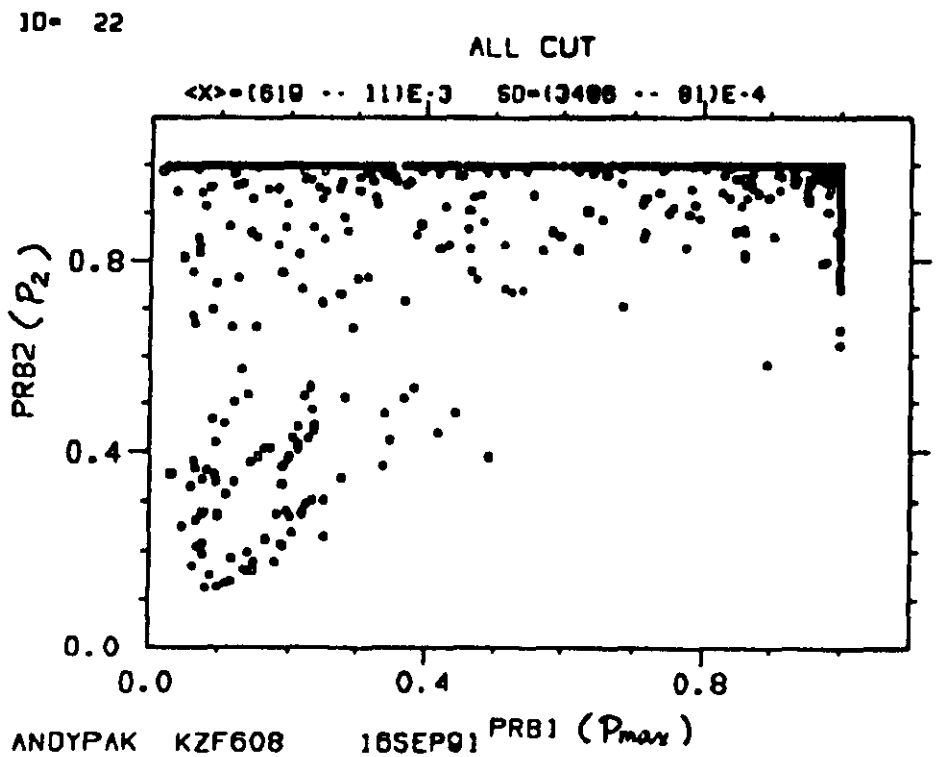
Final system electronics — VERY little progress

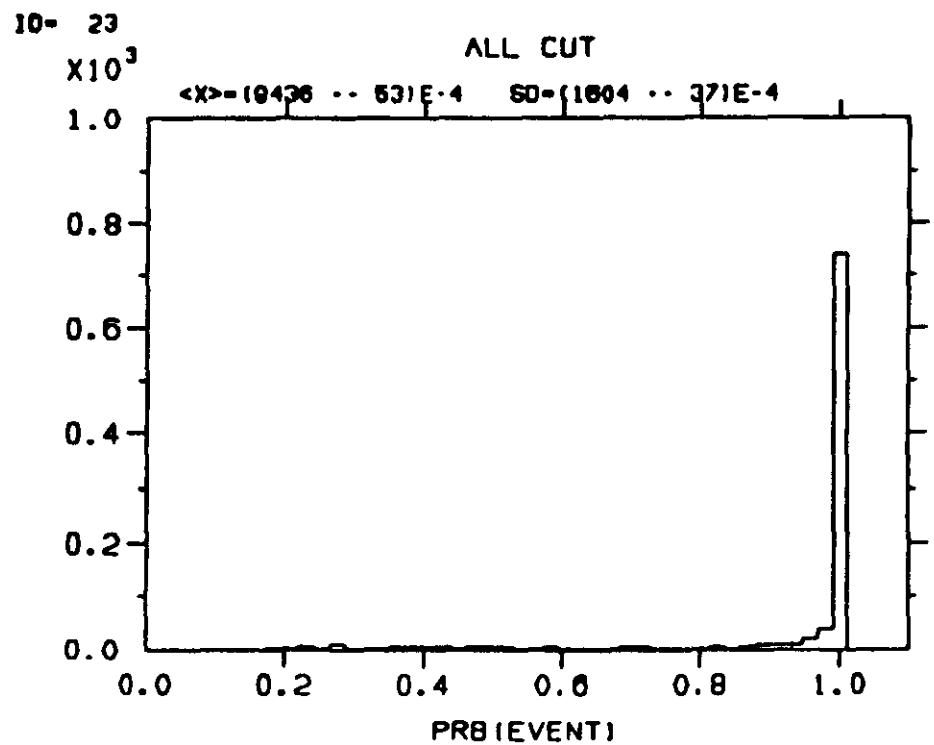
12/4/91
J. Brau

100 GEV IT 700









ANDYPAK KZF608 16SEP91

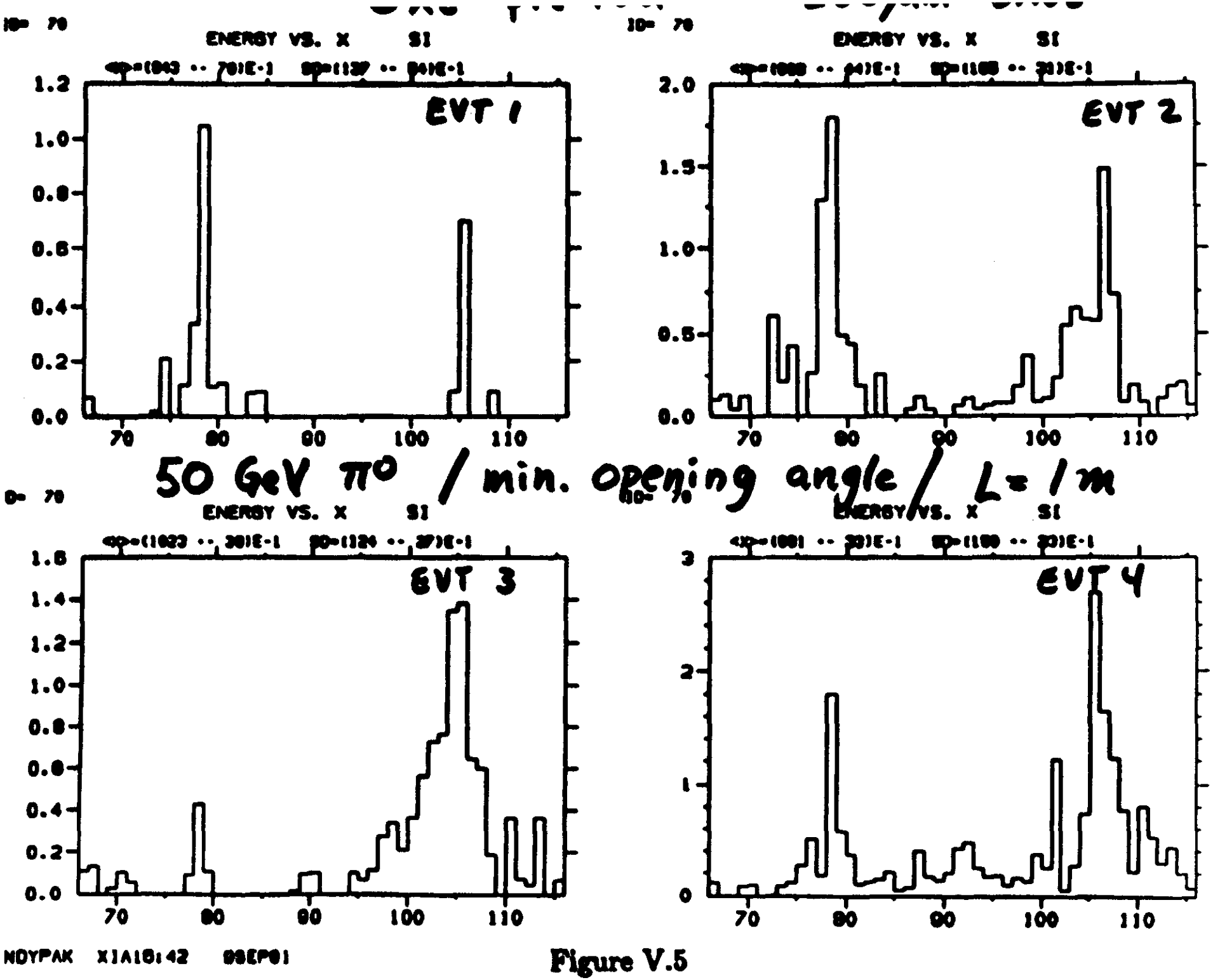
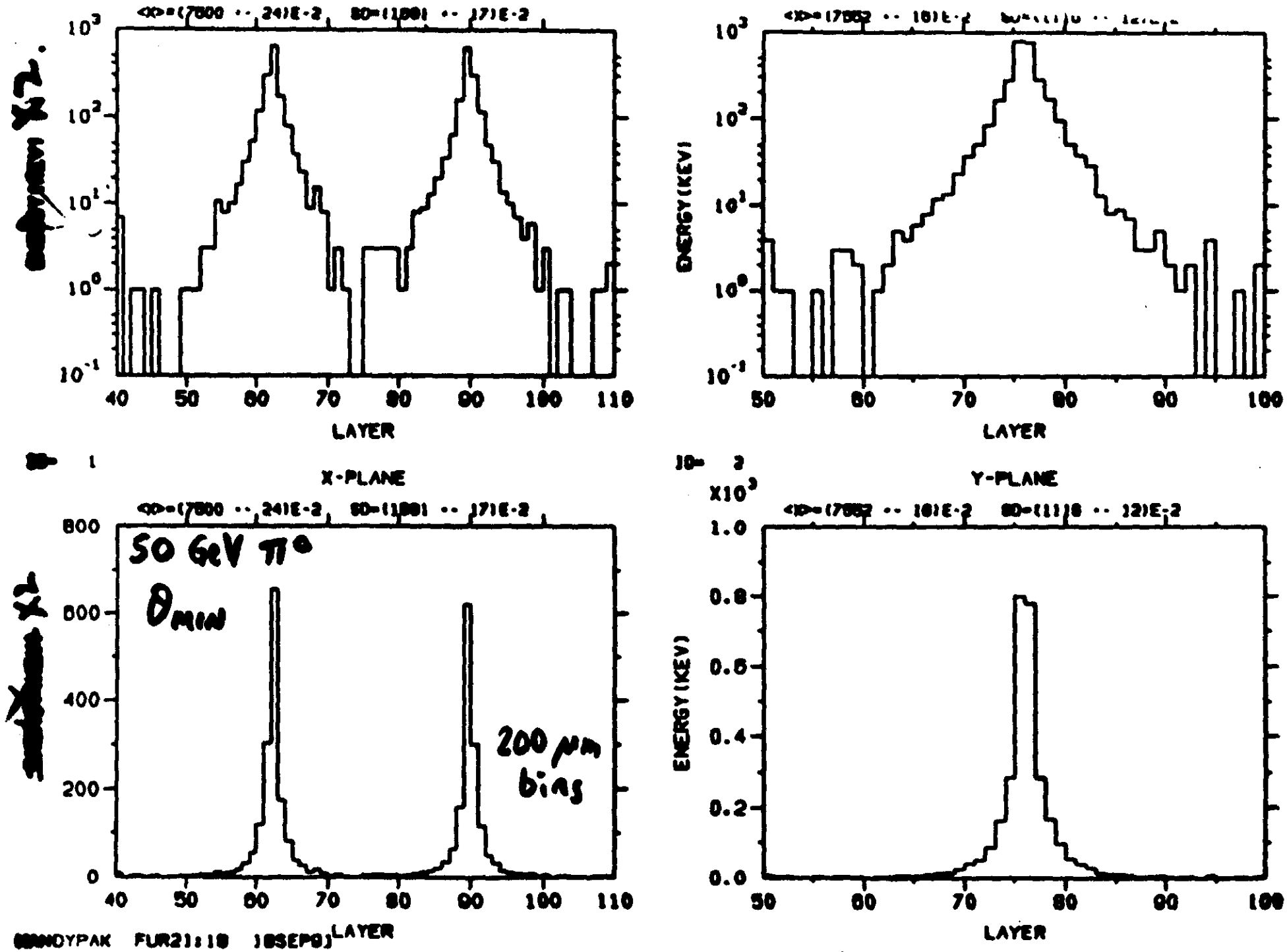

ID= 70
ENERGY VS. X SI
EVT 1
EVT 2
50 GeV π⁰ / min. opening angle / L = 1 m
EVT 3
EVT 4
NDYPAK X1A16:42 09EP91

Figure V.5



K. Furuno / X. Yang

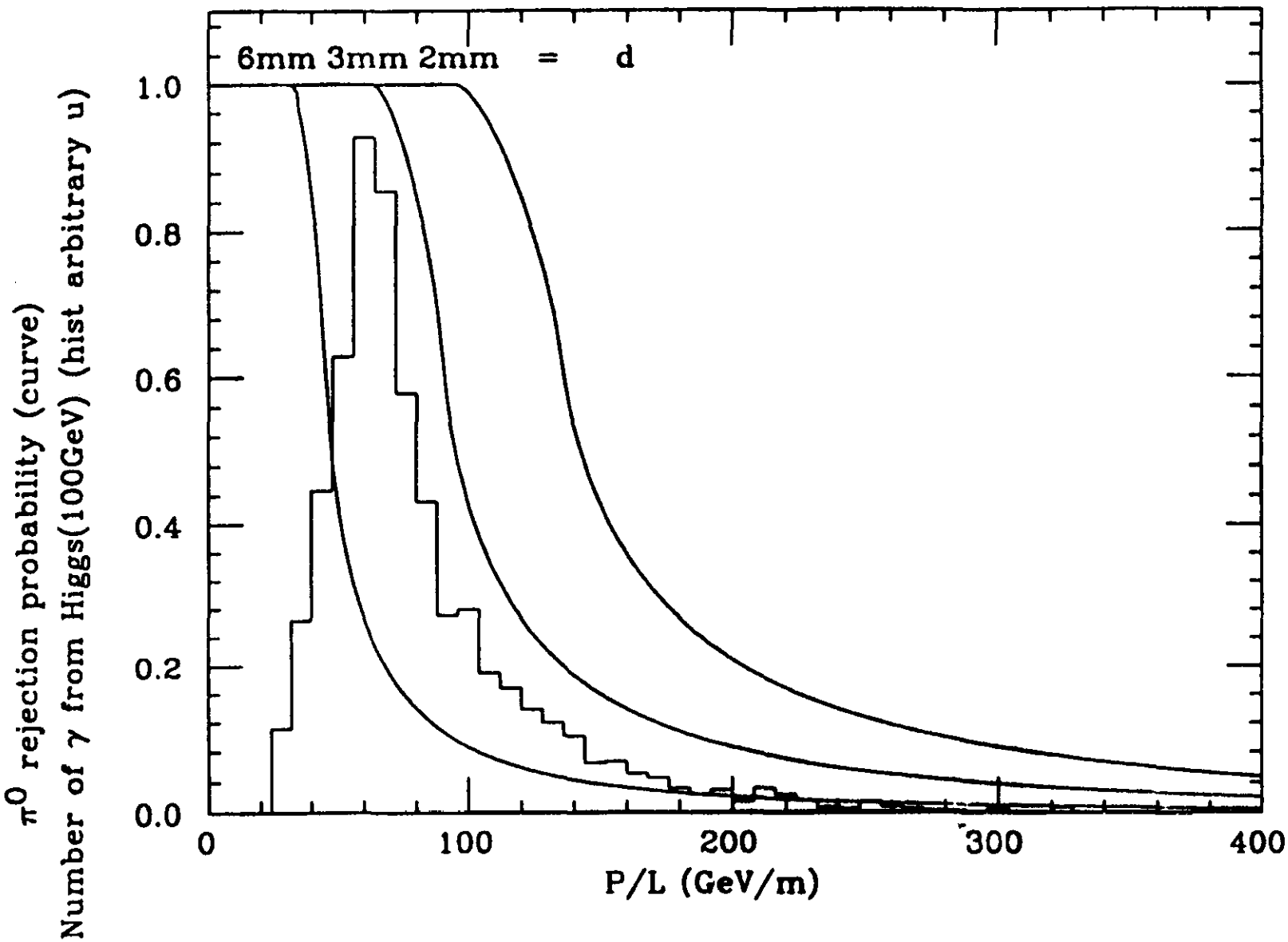
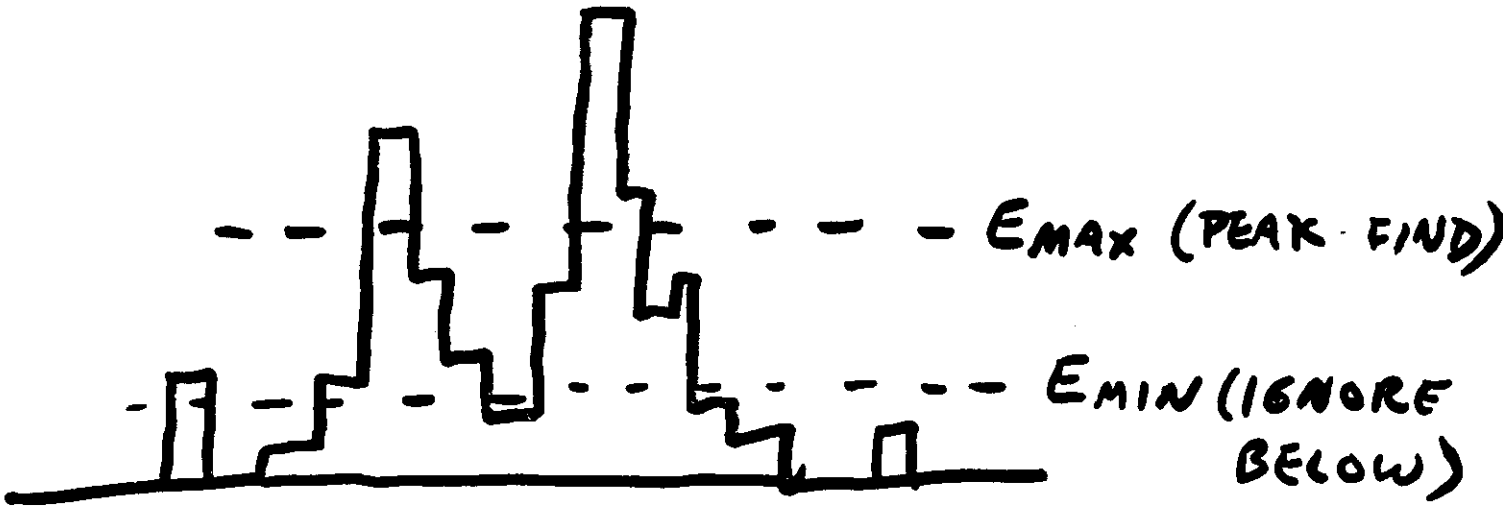

6mm 3mm 2mm = d
1.0
0.8
0.6
0.4
0.2
0.0
0
100
200
300
400
P/L (GeV/m)
π^0 rejection probability (curve)
Number of γ from Higgs(100GeV) (hist arbitrary u)

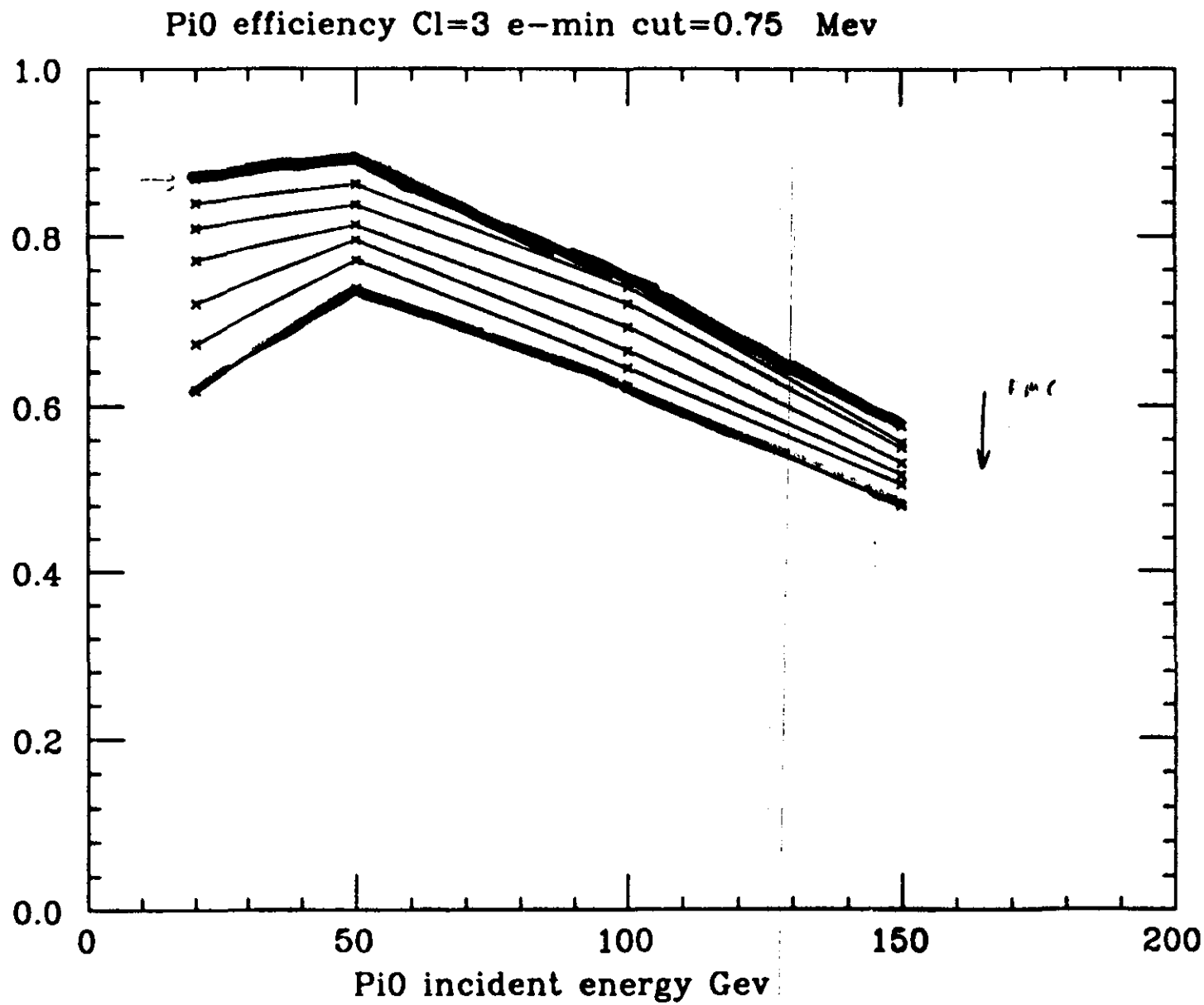
Figure V.2

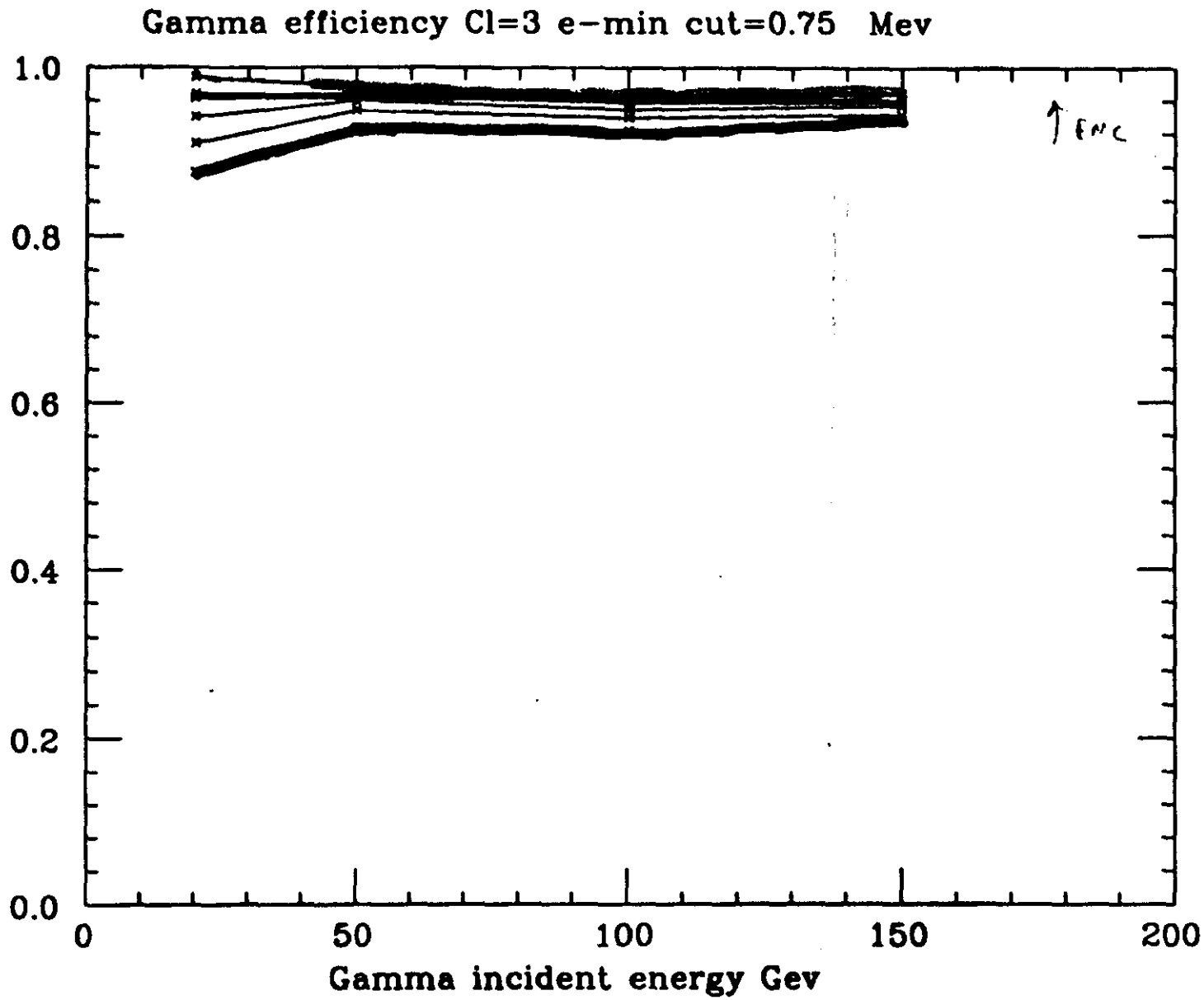

EMAX (PEAK FIND)
EMIN (IGNORE BELOW)

Search for all peaks (higher than neighbor)
applying E_{min}, E_{max}

Require $E^{2nd\ pk} / E^{Highest\ pk} > .4$

$|\langle x \rangle_{pr} - \langle x \rangle_{col}| < 1.5\ mm$

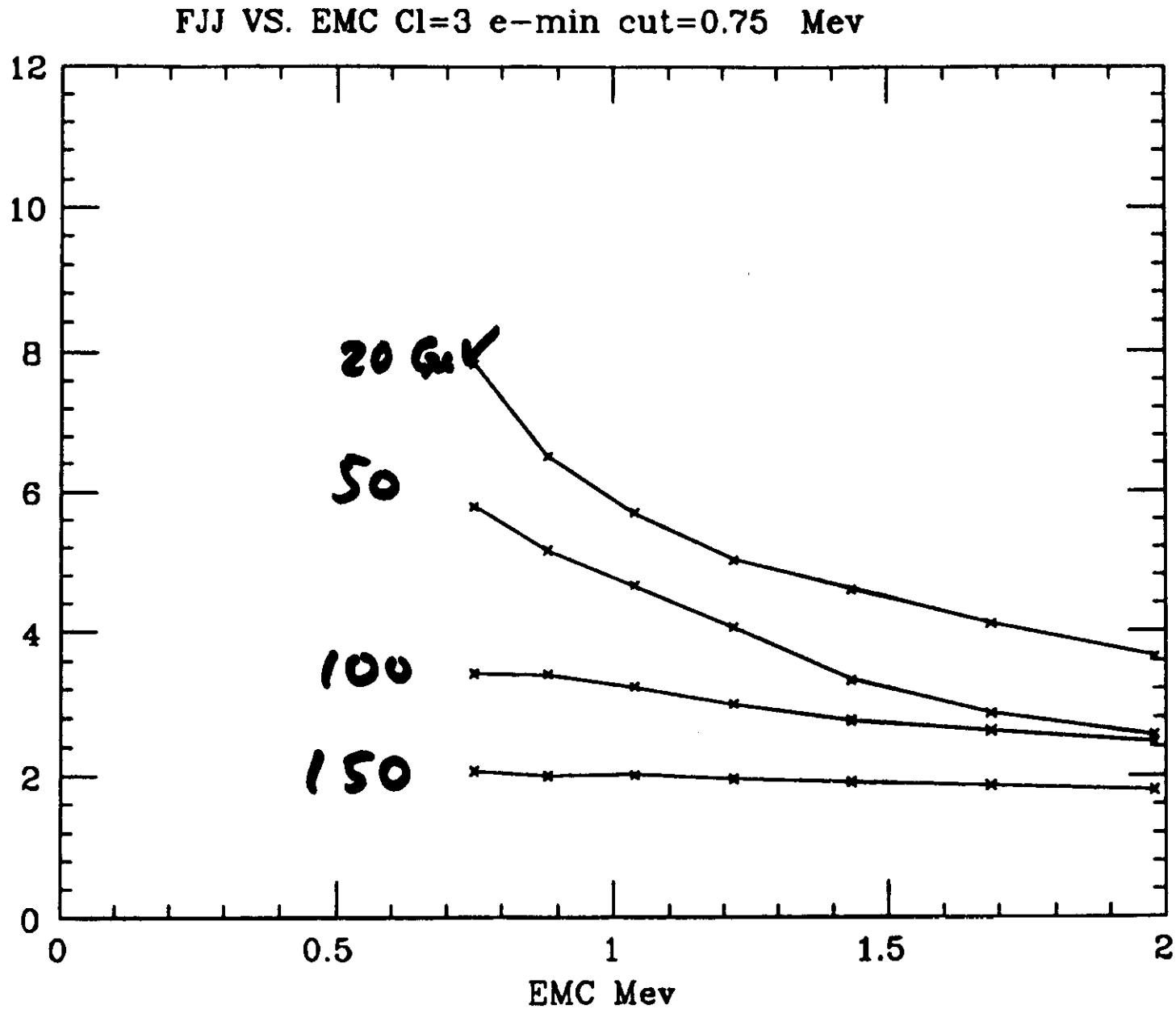

Pi0 efficiency Cl=3 e-min cut=0.75 Mev
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
Pi0 incident energy Gev


Gamma efficiency Cl=3 e-min cut=0.75 Mev
1.0
0.8
0.6
0.4
0.2
0.0
0
50
100
150
200
Gamma incident energy Gev
ENC

$$F_{xx} = \frac{\epsilon_x^2}{1-\epsilon_x^2}$$

$$F_{xy} = \frac{\epsilon_x^2}{\sqrt{\epsilon_x(1-\epsilon_x)}}$$

$$F_{yy} = \epsilon_x$$


FJJ VS. EMC Cl=3 e-min cut=0.75 Mev
12
10
8
6
4
2
0
0
0.5
1
1.5
2
EMC Mev
20 GeV
50
100
150

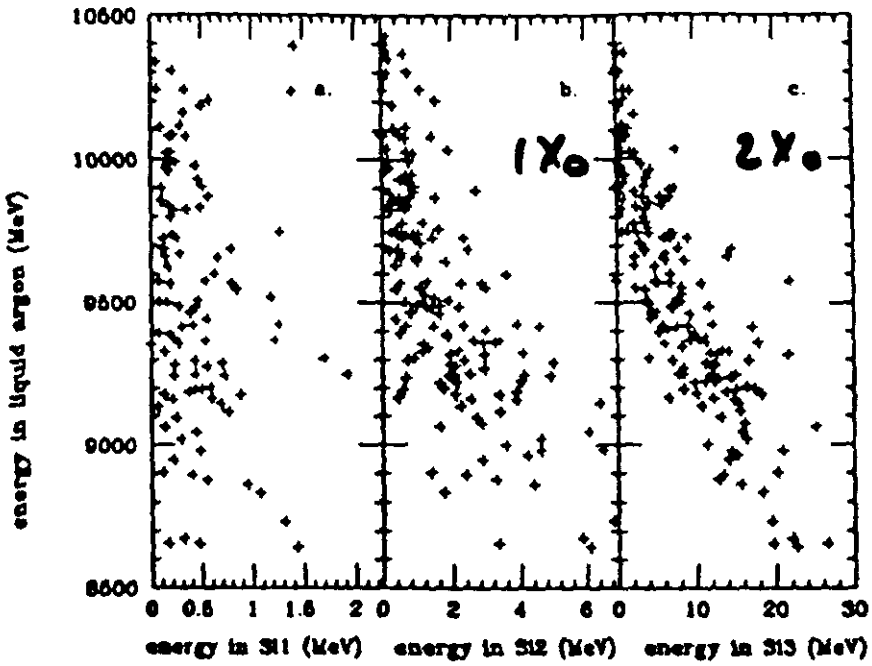
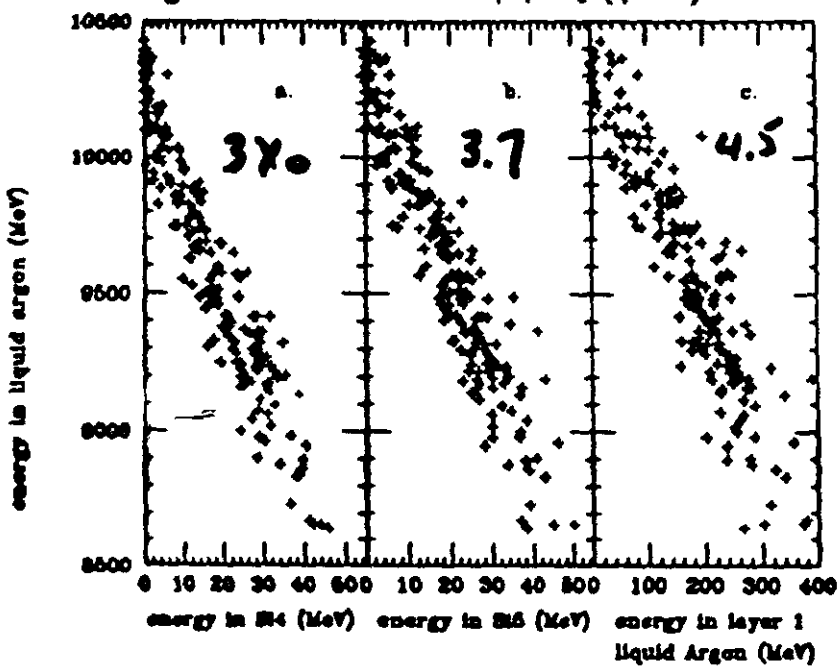


Figure 3. Preshower: $0, 1, 2X_0$ ($\eta = 1$)



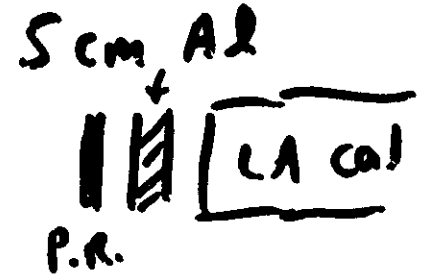
$\theta = 40°$

Figure 4. Preshower: $3, 3.7, 4.5X_0$ ($\eta = 1$)

3.7 is behind 1st Dewar wall

4.5 is in LA cal

ENERGY CORRECTION



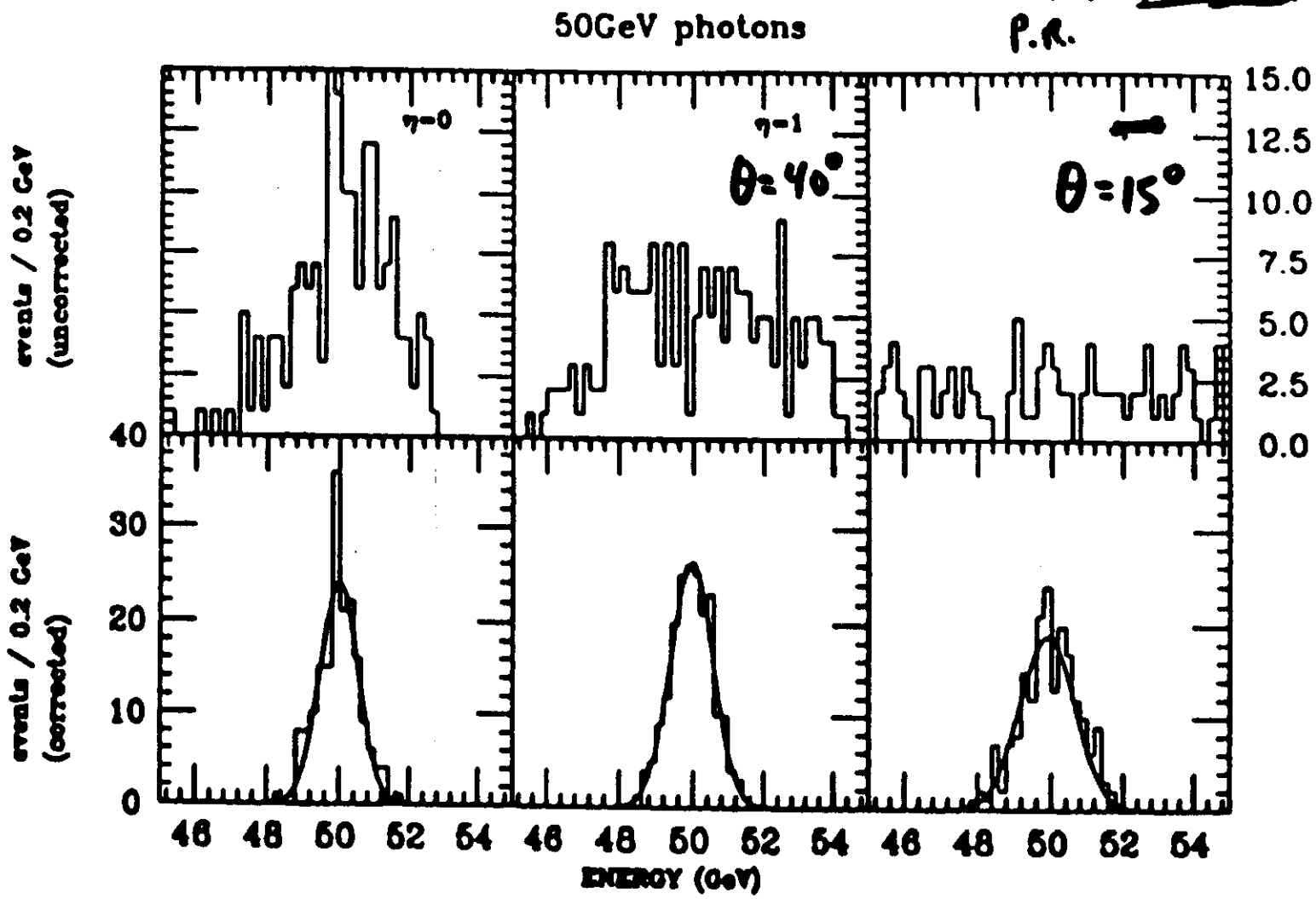
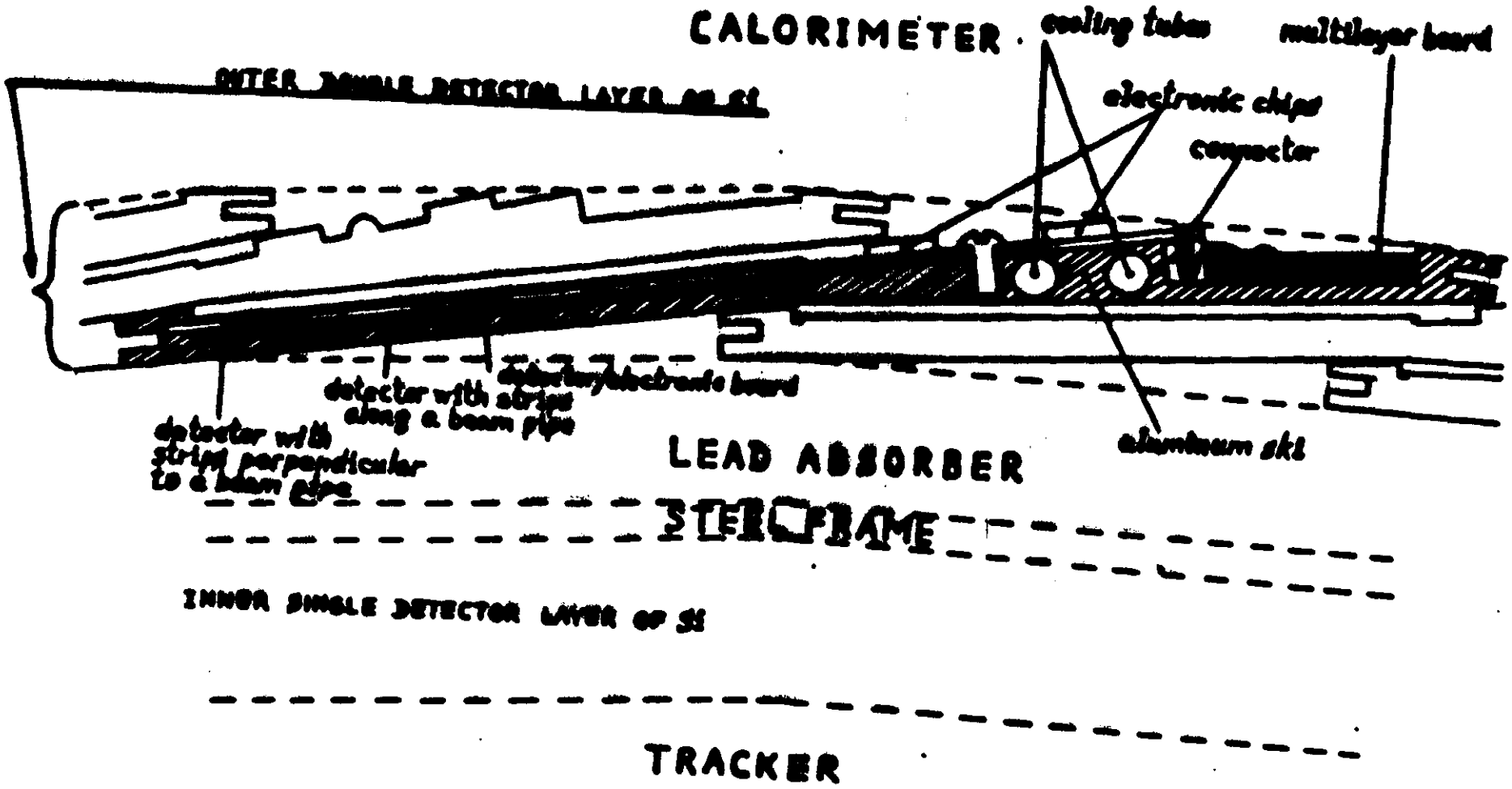


Figure 5. Uncorrected and corrected energy

PRERAD DRAWING 1



SCIENTIFIC - INDUSTRIAL ASSOTIATION
E L M A
103460 Moscow Russia
Telephone: (7)(095)531-7651, Fax: (7)(095)531-0976

Prof. P.F.Ermolov
Dr. G.L.Bashindzhagyan
Moscow State University

According to your request we have investigated and calculated a cost estimation for a possible strip detector production at ELMA for GEM detector at SSC.

Size	64 x 64 mm^2
Thickness	0.4 mm
Pitch	1 mm
Leakage current for 95% of strips	5 - 15 nA/strip
Leakage current	up to 200 nA is acceptable for 5% of strips
Bias voltage	less than 100 V

A cost estimation for a lot of 10,000 detector production is $ 400,000. 400 kg float zone n-type silicon ingots with resistivity 5-10 kOhm*cm and 100 mm diameter have to be supplied by customer.

General Director

L.A.Ivaniutin

ALSO

S.A. Levochkin Scientific-Industrial Union
ski structure
Microteah, USSR
multilayer card + assembly

Preradiator Prototype

Version 1 – Si pads + ORNL preamps/shapers

will be completed this month

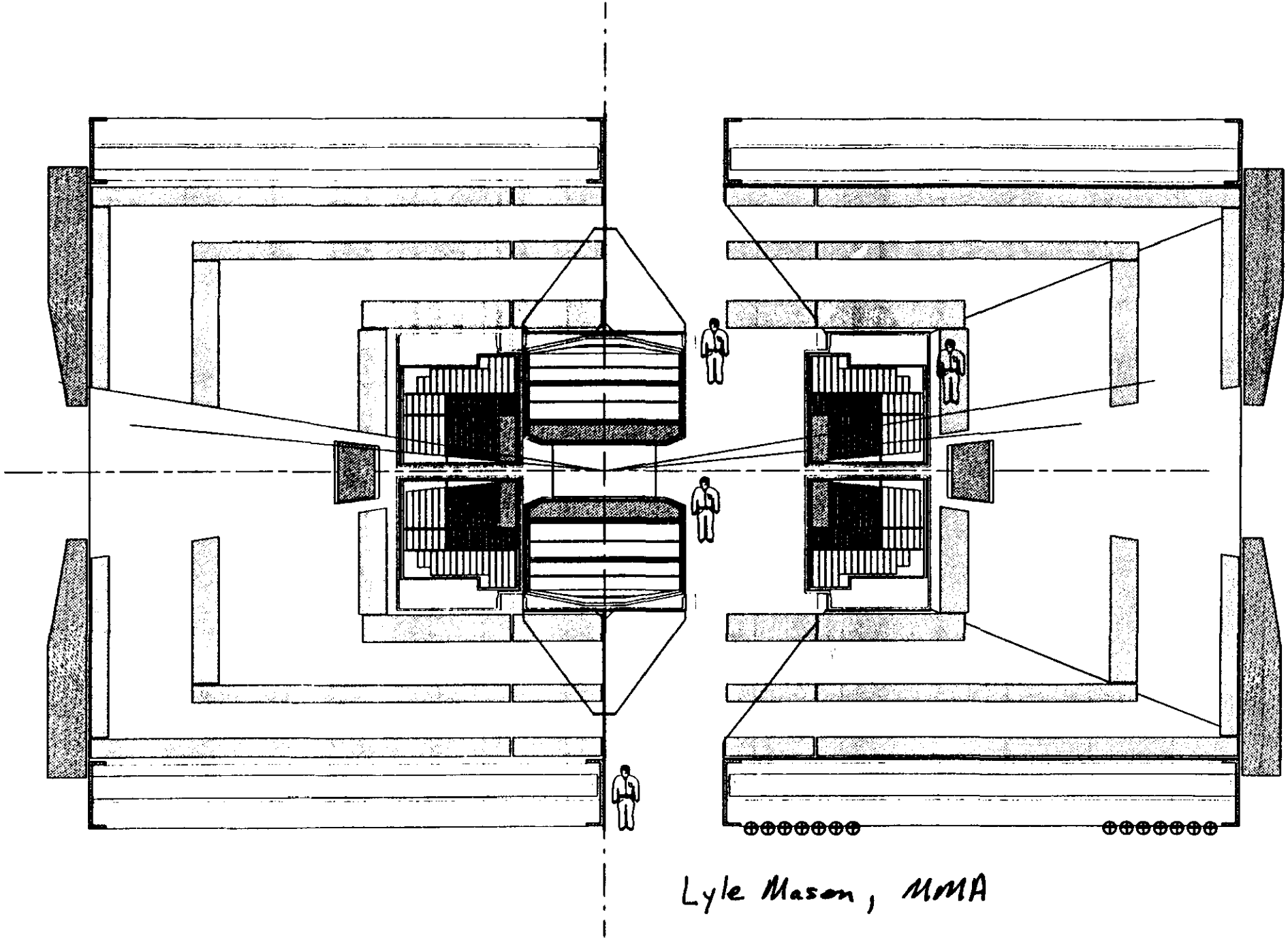
plan to test at FNAL w/

BaF_2 killed by Dec 23 shutdown

test in '92 @ BNL? CERN?

Version 2 – 1mm Si strips

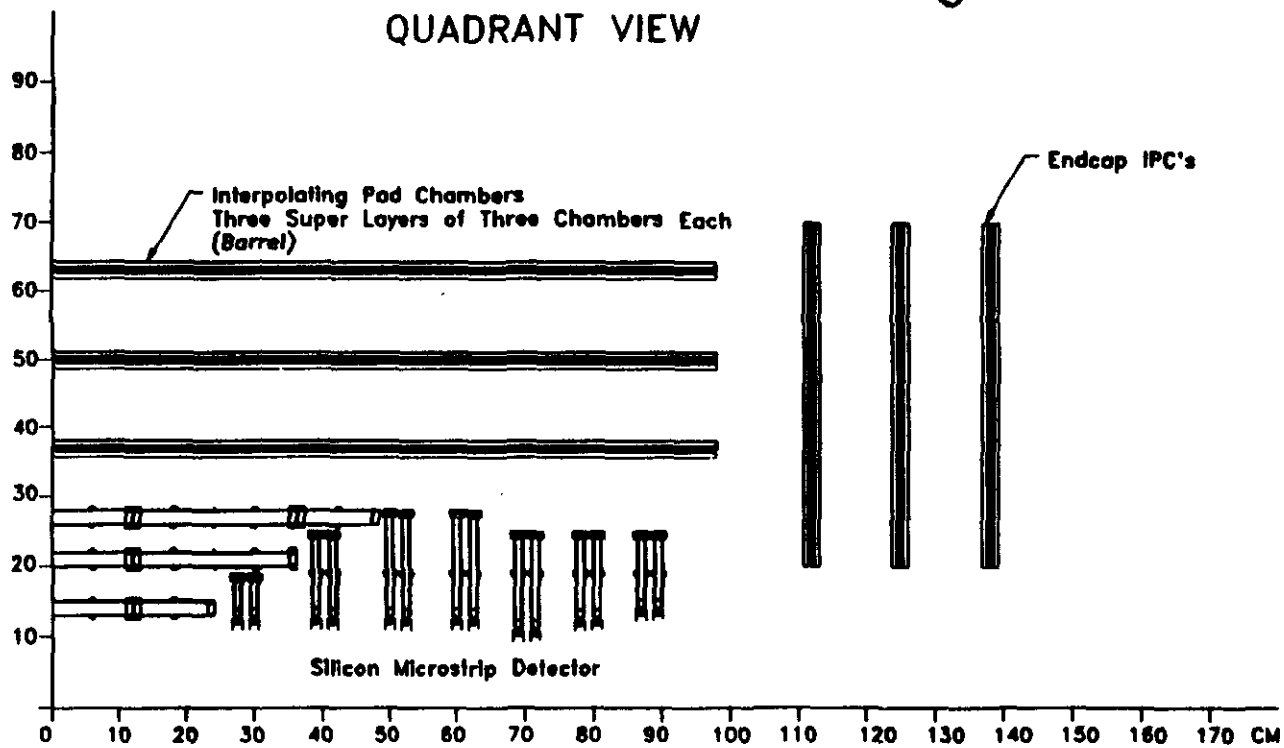
under construction



Lyle Mason, MMA

GEM Central Tracking

QUADRANT VIEW



Battay / Musser / Morgan

R/D Plans

IPC's, Si Microstrip supported

(no Straws, Si Fibers)

Si Strip - $600k

IPC's - $325k

$925k

Si R/D - FY92

Electronics

- Define frontend electronics archetecture
- Work to Proof-of-Principle hardware by last quarter FY-92

Sahgkoo Hahn (LANL)

1.5 FTE total	$225k
M&S	$75k
	$300k

- Test radiation effect on critical transistors

Si R+D

Mechanical - target items not covered in SDC

R+D

- bonding of single sided wafers
- structural analysis of bonded wafer
- structural analysis of ring supports

  (similar to SDC but must support more weight / wafer)

- in-situ alignment system

  maintaining ~~[illegible]~~ tolerances requires active alignment system.

  with select prefered method - build + test prototype

1.5FTE ME	$225k
M+S	$75k
	$300k

Interpolating Pads

R+D Mechanical

- Develop design which minimizes material (Yale, U.M.)
- Design support/alignment system (Yale, Los Alamos)
- Determine radiation resistance/aging (I.U.)

Mechanical Prototype constructed @ Yale

Yale	$0k
LanL (OSFTE)	70k
UM (OSFTE +M&S)	50k
	$120k

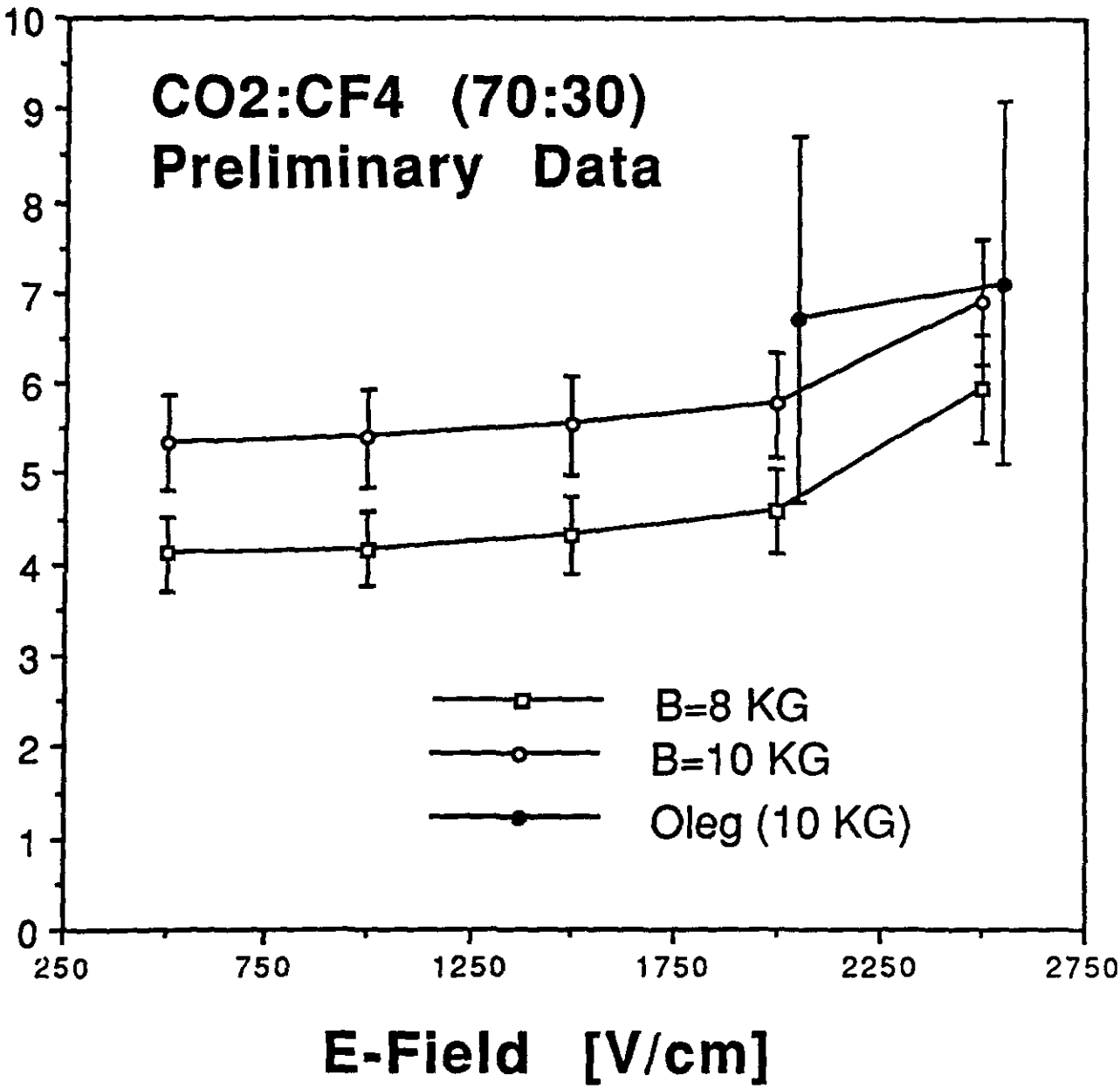
Intepolating Pads

Electronics

- select chamber gas (IU)
- high rate test of resolution (IU)
- determine resolution using short shaping time front end (IU)
- develop power, signal distribution scheme (WashU)
- develop front end design (IU, Brookhaven)

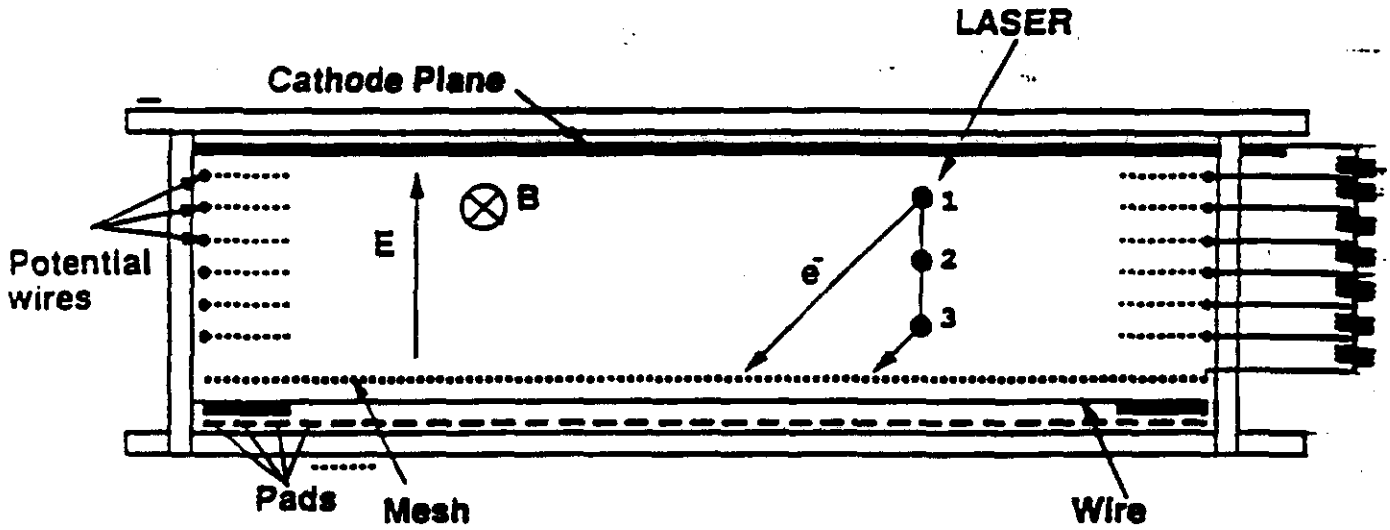
IU (1 FTE EE + engineer)	$120k
Wash U	$45k
	$165k

Beam Tests (SSCL) $40k


CO2:CF4 (70:30)
Preliminary Data
B=8 KG
B=10 KG
Oleg (10 KG)
0
1
2
3
4
5
6
7
8
9
10
250
750
1250
1750
2250
2750
E-Field [V/cm]

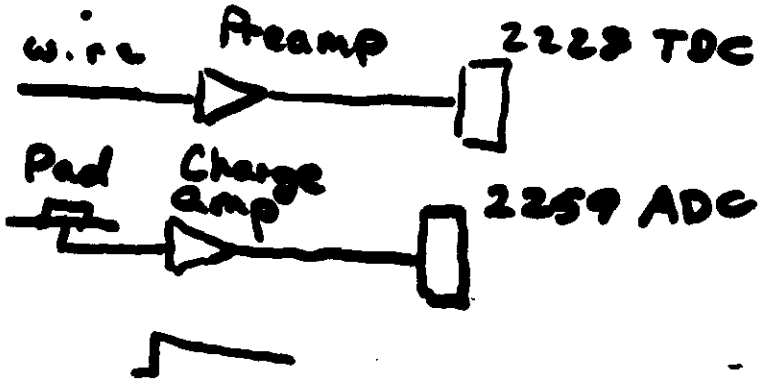
INDIANA UNIV.
DRIFT GAS STUDIES
IUCF

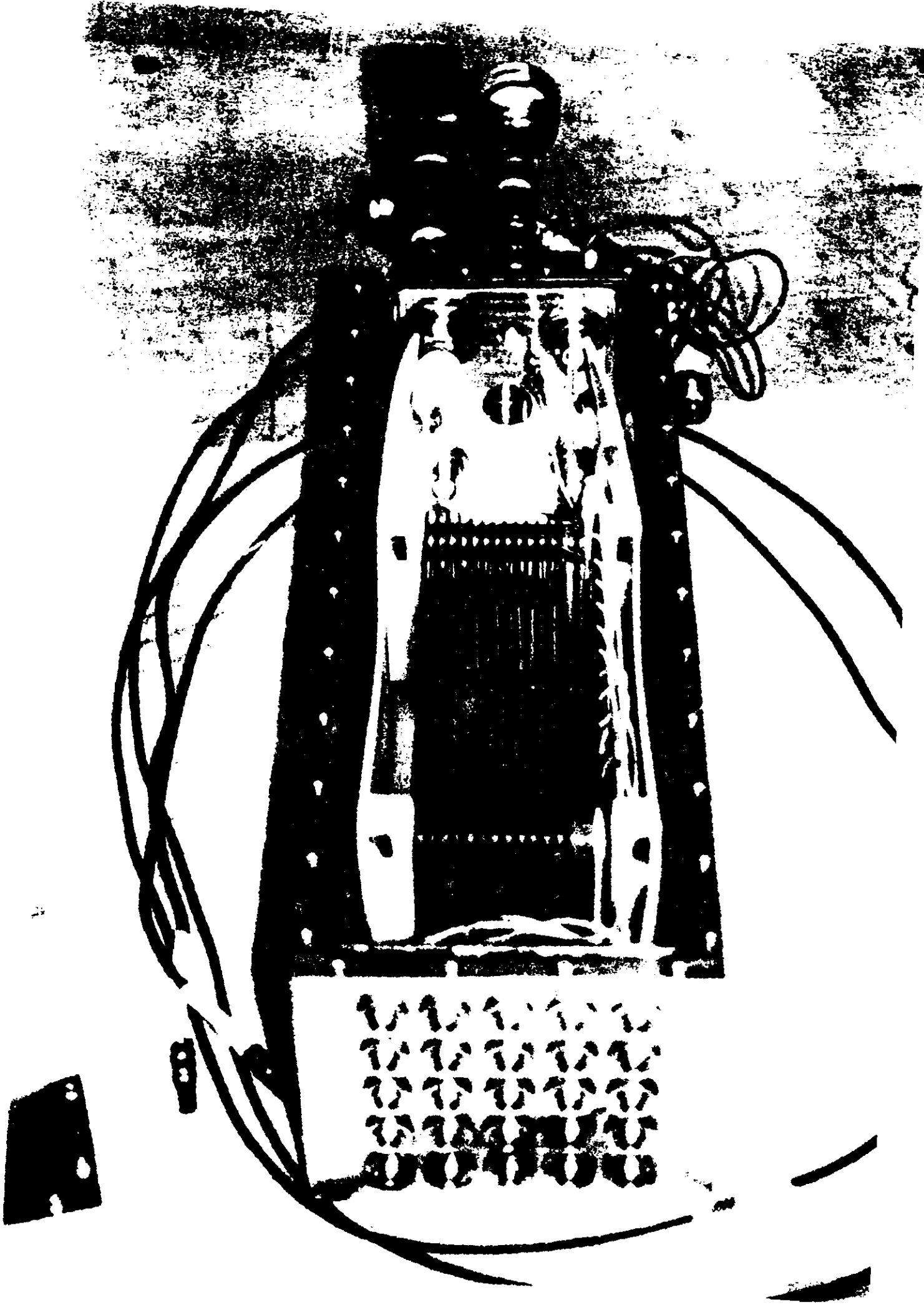
Kate Morgan

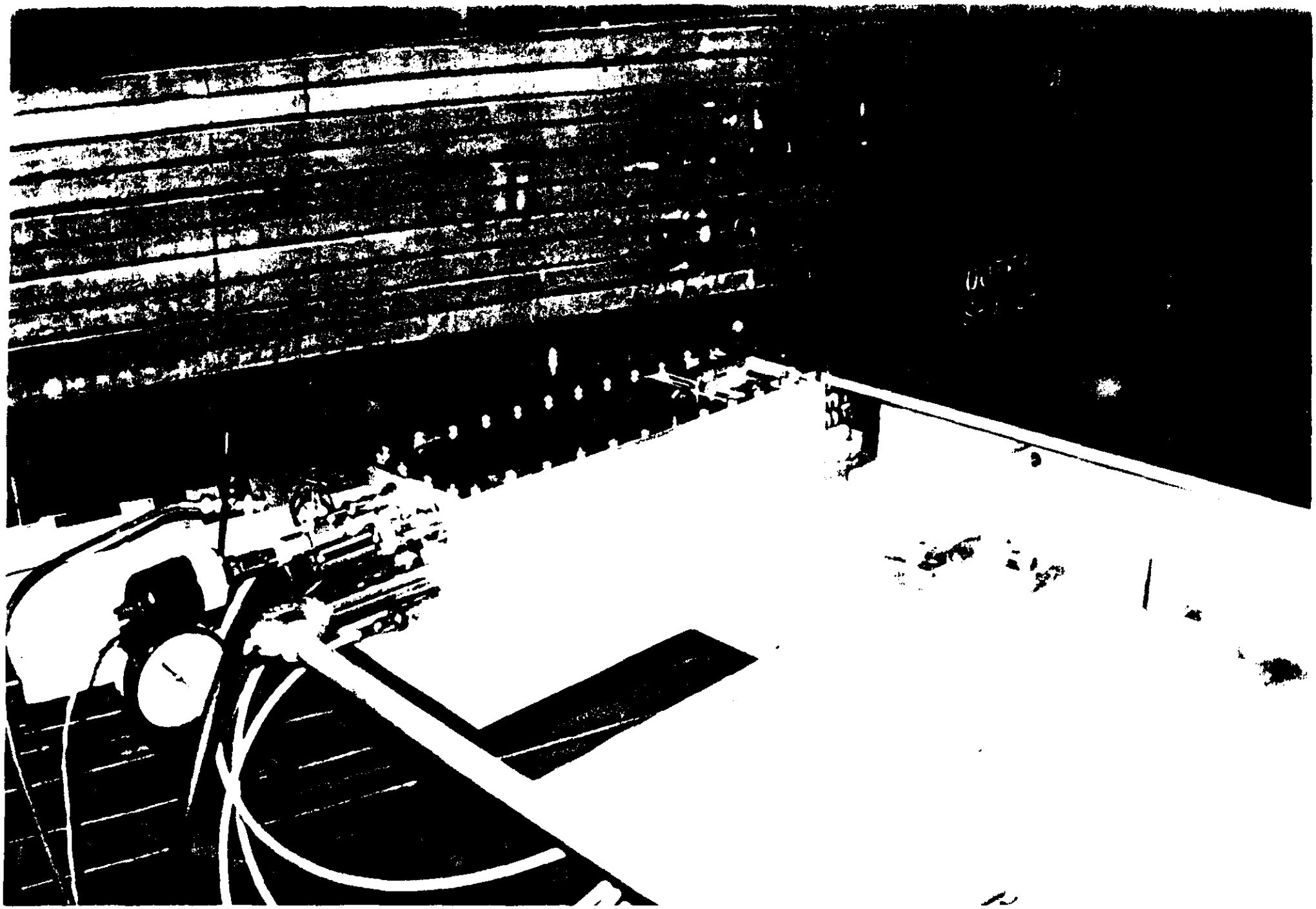


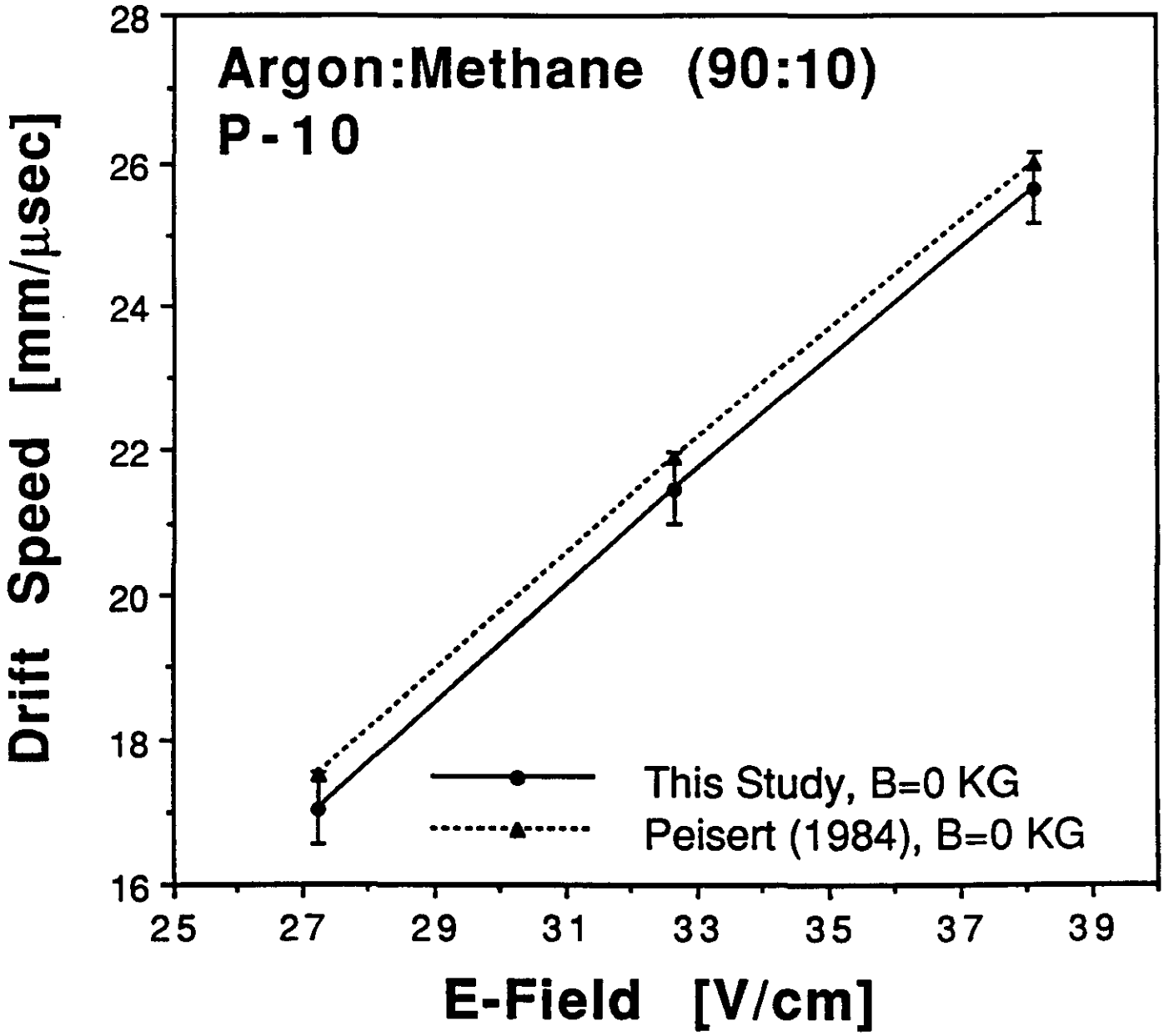
CHUCK BOWER
JIM PITTS

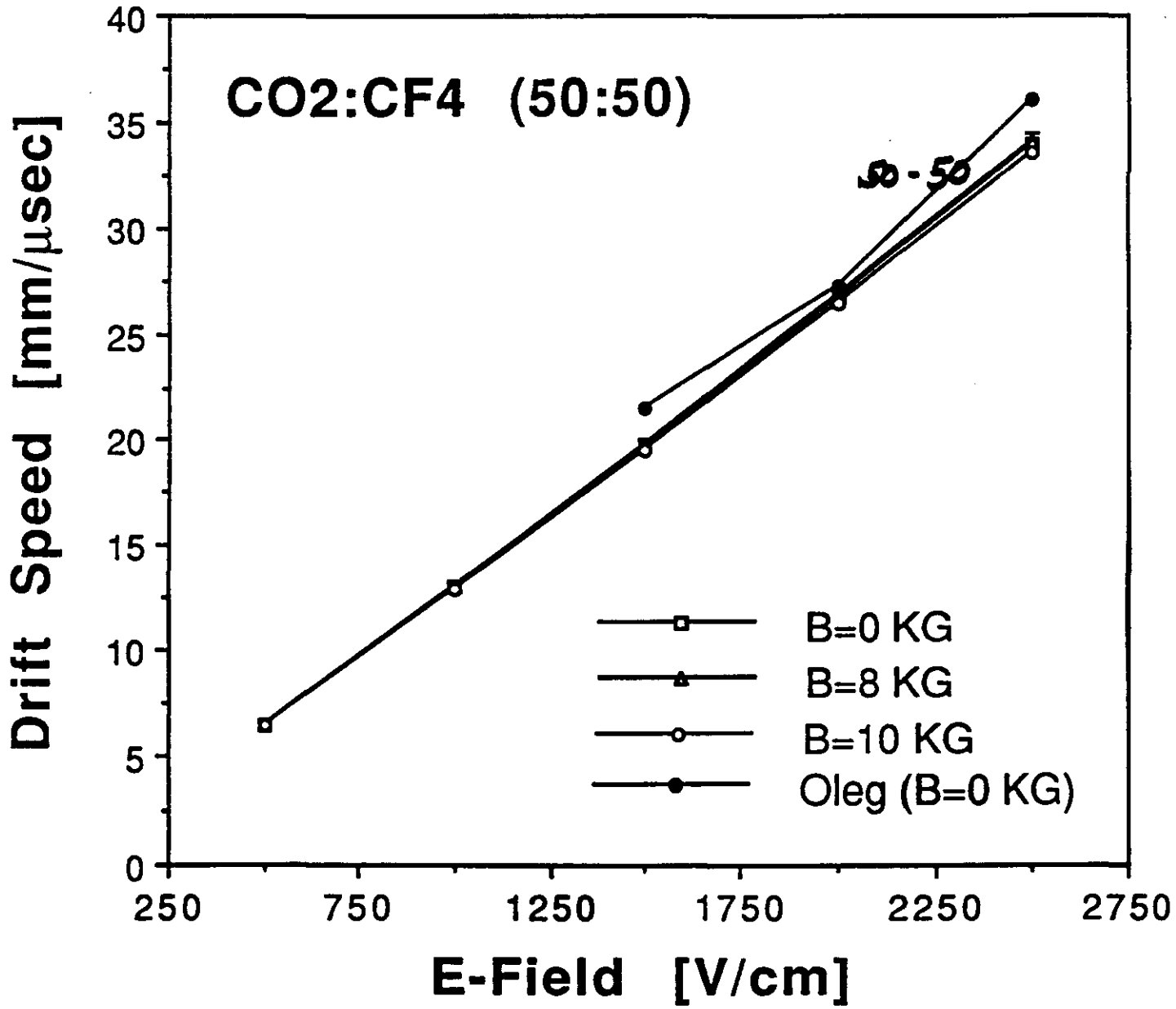
J. MUSSER } IU
R. HEINZ }
S. AHLEN } BU
B. ZHOU }

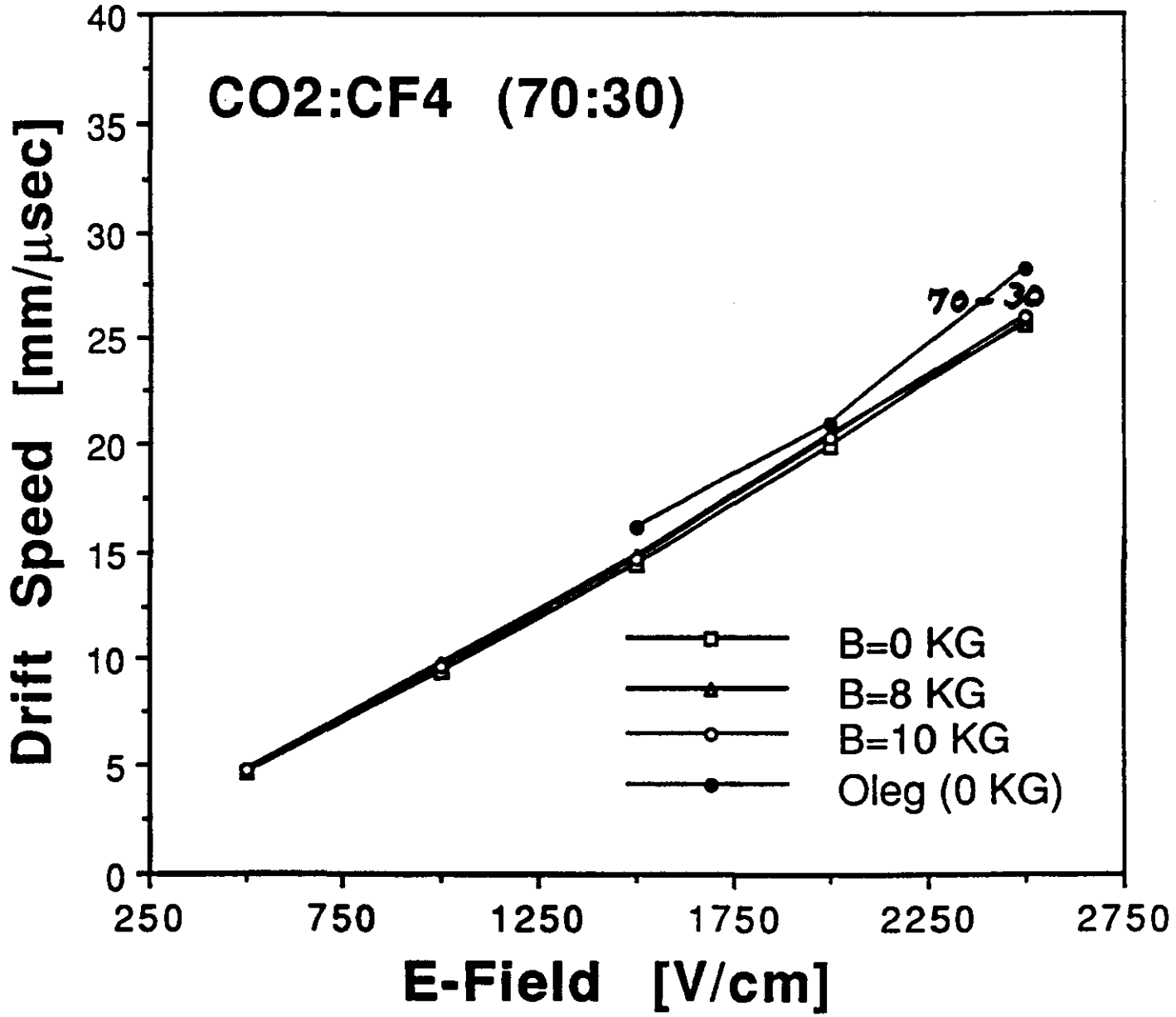


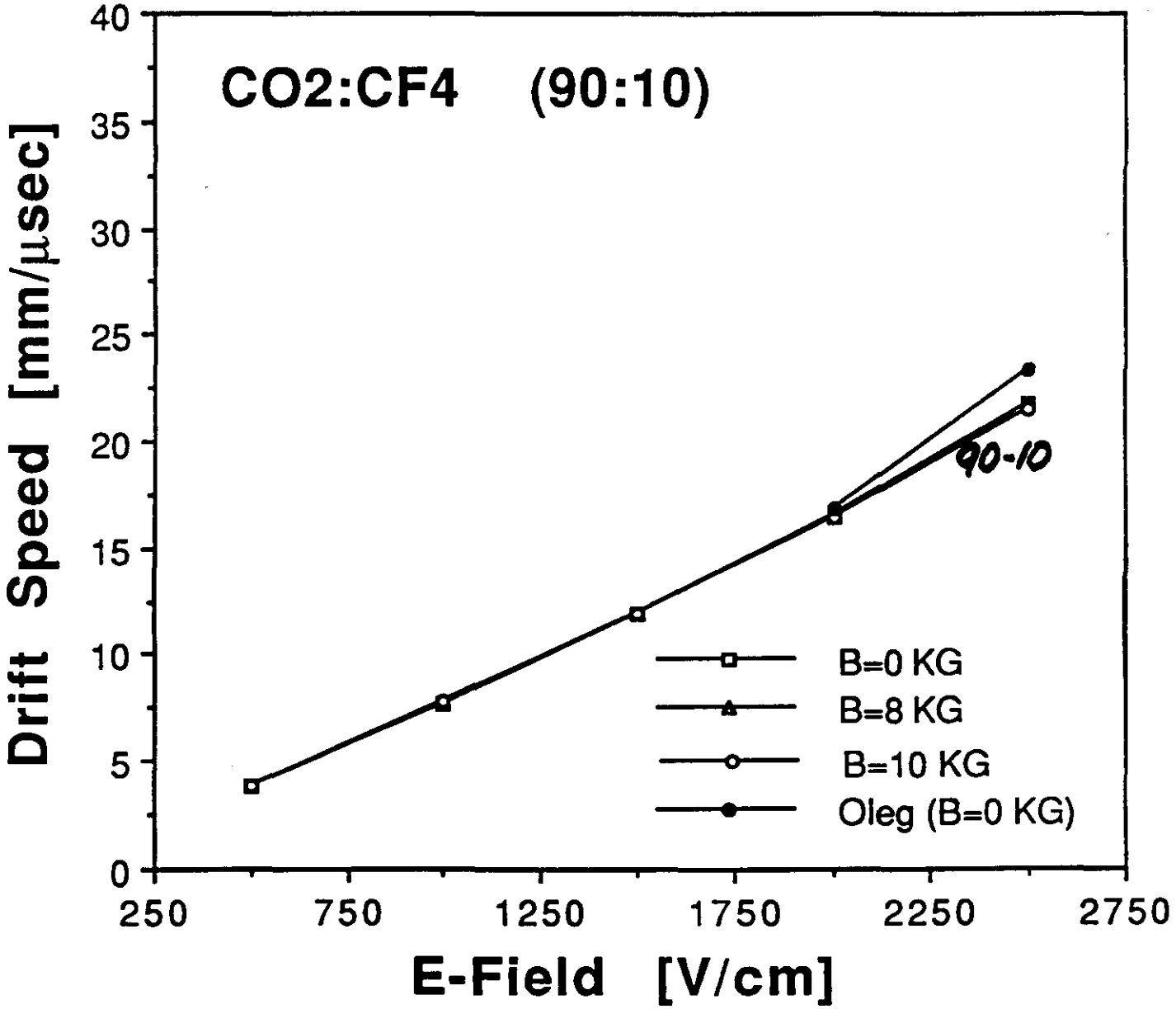


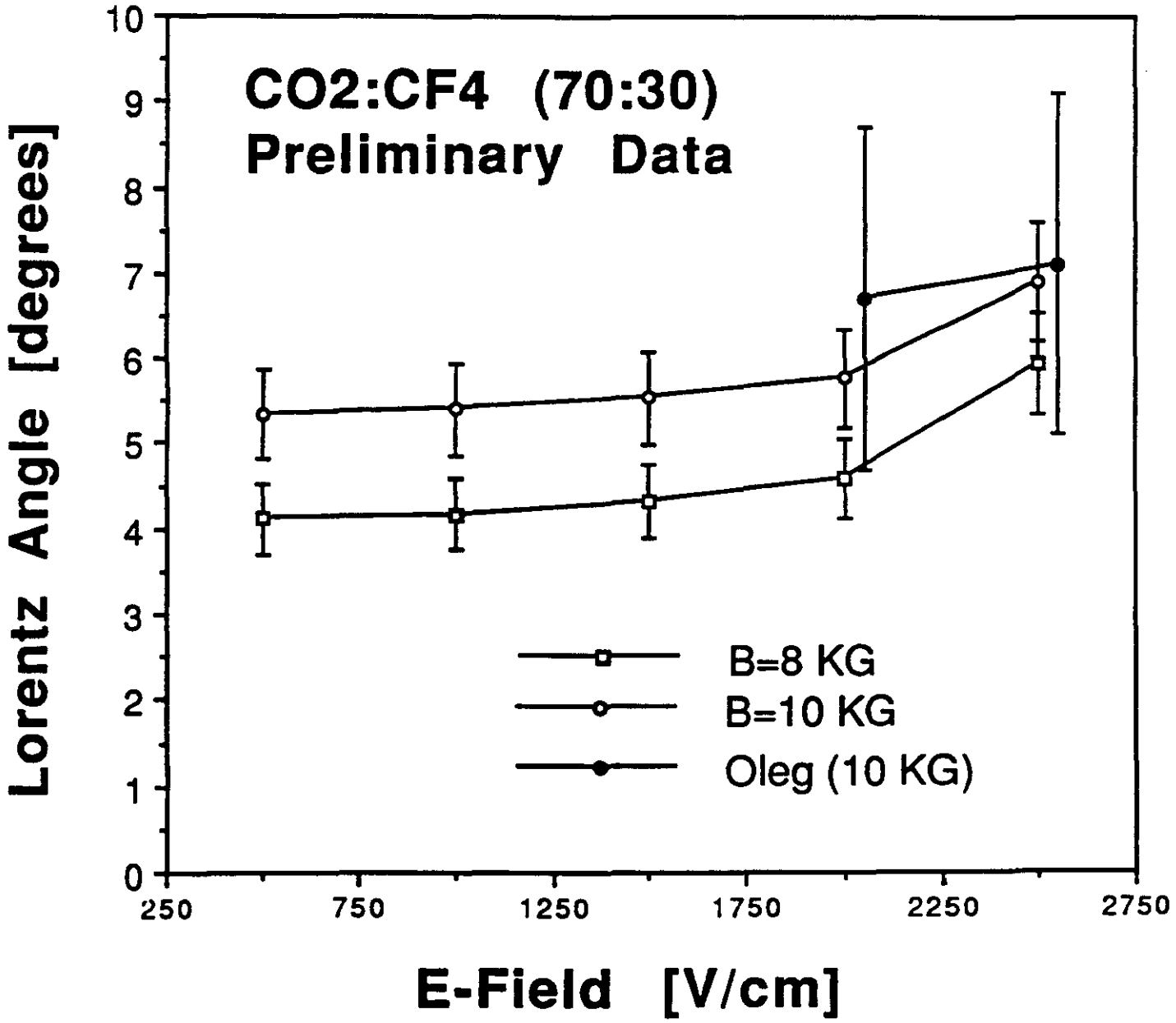



Argon:Methane (90:10)
P-10
Drift Speed [mm/μsec]
E-Field [V/cm]
This Study, B=0 KG
Peisert (1984), B=0 KG
28
26
24
22
20
18
16
25
27
29
31
33
35
37
39


CO2:CF4 (50:50)
50 - 50
B=0 KG
B=8 KG
B=10 KG
Oleg (B=0 KG)
Drift Speed [mm/μsec]
E-Field [V/cm]
0
5
10
15
20
25
30
35
40
250
750
1250
1750
2250
2750


CO2:CF4 (70:30)
Drift Speed [mm/µsec]
E-Field [V/cm]
0
5
10
15
20
25
30
35
40
250
750
1250
1750
2250
2750
70-30
B=0 KG
B=8 KG
B=10 KG
Oleg (0 KG)


CO2:CF4 (90:10)
Drift Speed [mm/µsec]
E-Field [V/cm]
0
5
10
15
20
25
30
35
40
250
750
1250
1750
2250
2750
B=0 KG
B=8 KG
B=10 KG
Oleg (B=0 KG)
90-10


CO2:CF4 (70:30)
Preliminary Data
Lorentz Angle [degrees]
E-Field [V/cm]
B=8 KG
B=10 KG
Oleg (10 KG)
0
1
2
3
4
5
6
7
8
9
10
250
750
1250
1750
2250
2750

Electronics Trigger / DAQ
Marlow

Electronics Group Meeting (Dec. 6th at SSCL)

9-9:30 am Discussion of Submitted R&D Plan, White Paper, Organization,etc.

Electro-Optics Review

9:30-10 am Review of BNL Work (T.Tsang)

10-10:30 am Review of NRL Work (M.Seman)

10:30-11 am Possibilities for Chinese Involvement (W.Willis)

11-11:20 am Progress at LLNL (M. Lowry)

11:20-11:50 am Overview of Possible GEM Applications and Needed R&D (V.Radeka)

11:50-12:30 pm General Discussion of R&D Plans and Efforts

12:30-1:30 pm Lunch

1:30-2:15 pm Review of Muon Pad System Readout (V.Polychronakos)

2:15-2:45 pm Rad-hard First Level Processors for Large Detectors (Robert Wixted, Q-Dot Inc,)

2:45-3:45 pm Other Working Group Reports

Electronics R&D Plans

Central Tracker

Coordinators: J.Musser, P.O'Connor

- Silicon Microstrips (LANL: G. Mills, S. Hahn) ($325K)
- Pad Chambers
  - Rad. Hard Front-end and Analog Pipeline (BNL, ORNL) $315K
  - Electro-optic Modulator Readout (BNL, LLNL, Columbia, Indiana) $150K (plus Subsystem R&D Funds)

Calorimetry

Coordinators: J. Parsons, B. Sippach, P. Denes

- Analog Pipeline and ADC Development (Columbia) $200K
- High Speed ADC and Digital Pipeline (Princeton) $ 50K
- Level 1 Triggering (Pittsburgh, BNL, Princeton) $135K

Muon Chamber System

Coordinators: V. Polychronakos, ?

- AMPLEX Chip Modifications and Additions (BNL, ORNL) ($150K)
- Microcircuit Development for Drift Time Readout (MIT, BU) ($ 30K)

Level 2 Triggering and DAQ

Coordinators: M. Atiya, D. Lissauer, J.Ritchie

- Level 2 and DAQ Studies (BNL, UofT, Yale) $ 75K
- Level 2 Trigger Hardware Development (SSCL) $ 50K

(Funding in parentheses is included in given subsytems request)

Occupancy Whitepaper

Contributors:

Cleland, Denes, Lissauer, Marlow, Mills,
Musser, Radeka, Shaevitz, Whitaker

From PAC's October report:

"For the optimization of the detector, the collaboration should include a detailed study of occupancy and pileup effects in all detector components, taking into account integration and dead times. "

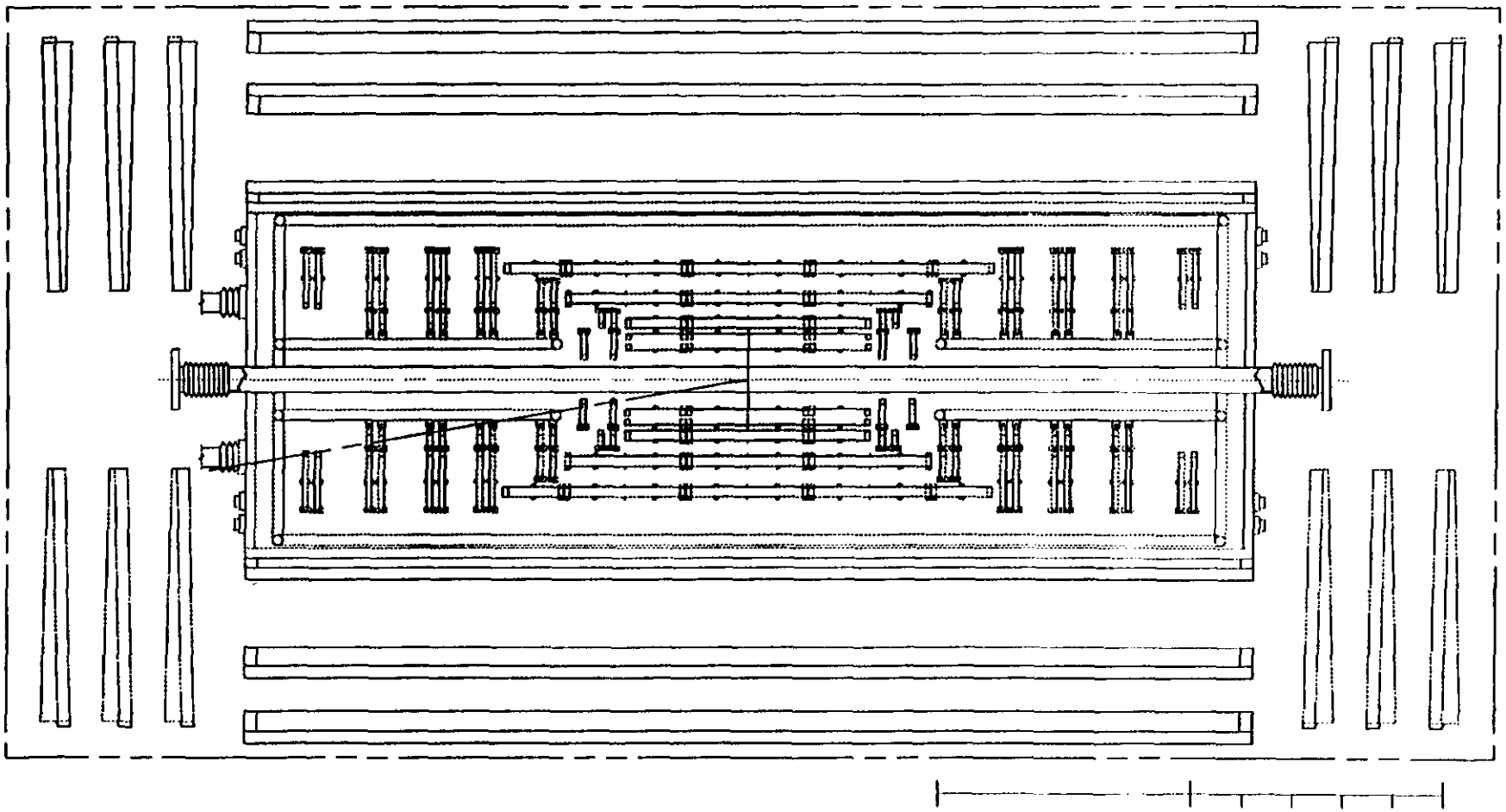


Table I: Standard assumptions for occupancy and rate calculations.

Parameter	Value
Luminosity	10^{33} cm^{-2} s^{-1}
Bunch Frequency	62.5 MHz
$\sigma_{\text{min. bias}}$	100 mb
$d^2N/d\eta d\phi$ for min. bias event	1.2

1.1 Silicon Strip Occupancies:

$$
\begin{aligned}
\mathrm{Occ} &= N_{BX} \times N_{\text{min bias}} \times \left(\Delta\eta \times \Delta\phi \frac{d^2N}{d\phi d\eta} \right) \times f_{\text{sec}} \\
&= 1 \times 1.6 \times (\Delta\eta \times \Delta\phi) \times 1.2 \times 2 \\
&= 3.8 \times (\Delta\eta \times \Delta\phi)
\end{aligned}
$$

where

$$
\begin{aligned}
N_{BX} &= \text{number of bunch crossings} \\
N_{\text{min.bias}} &= \text{number of minimum bias events} \\
f_{\text{sec}} &= \text{factor for secondaries}
\end{aligned}
$$

Table II Silicon-strip vertex detector occupancies in the barrel region. Occupancies are given for strips at $\eta = 0$.

	Radius	Occupancy	
Layer	(mm)	Raw (%)	Space-Point (%)
1	140	.11	1.27
2	200	.055	.65
3	260	.033	.38

Add in background from physics event:

$$\frac{d^2N}{d\eta d\phi})_{\mathbf{Physics}} = 1.8$$

Thus at $\mathcal{L} = 10^{33}$ cm^{-2} s^{-1} the effective occupancy per strip for physics events will be higher by

$$\frac{\mathrm{Occ}_{\mathbf{physics}}}{\mathrm{Occ}_{\mathbf{min.\ bias}}} = \frac{(1.6 \times 1.2) + 1.8}{1.6 \times 1.2} = 1.9$$

Table III Silicon-strip vertex detector occupancies for the forward disks.

z Position		Radius		Occupancy	
(mm)	Type	Inner (mm)	Outer (mm)	Raw (%)	Space-Point (%)
± 300	Inner	120	180	.038	.23
± 400	Inner	120	240	.050	.60
± 500	Inner	120	240	.053	.62
± 500	Outer	240	300	.012	.07
± 600	Inner	120	240	.053	.65
± 600	Outer	240	300	.012	.10
± 700	Inner	100	240	.067	.96
± 800	Inner	120	240	.055	.65
± 900	Inner	130	240	.048	.53

Table IV Pad dimensions for IPC barrel layers.

Layer	R (mm)	$\Delta\phi$ (mR)	η_{max}	$\Delta\eta$	Δz_{min} (mm)	Δz_{max} (mm)
1	380	13.2	1.7	.076	29	79
2	520	9.6	1.4	.104	54	112
3	660	7.6	1.2	.132	87	150

Table V Pad dimensions for the IPC forward/backward layers.

Layer	z (mm)	η_{min}	η_{max}	ΔR_{min} (mm)	ΔR_{max} (mm)
1	1100	1.27	2.69	4.6	94
2	1300	1.42	2.86	4.6	85
3	1500	1.55	3.00	4.6	80

$$\text{Occ.} = N_{BX} \times N_{\text{min. bias}} \times \left(\Delta\eta \times \Delta\phi \frac{d^2N}{d\phi d\eta}\right) \times N_{\text{image}} \times f_{\text{sec}}$$
$$= 2 \times 1.6 \times .0012 \times 2 \times 2 = 1.5\%$$

where

$$N_{\text{image}} = \text{number of illuminated pads per hit}$$

For $\mathcal{L} = 10^{33}$ cm^{-2} s^{-1} the occupancies will be larger for physics triggers

$$\frac{\text{Occ}_{\text{physics}}}{\text{Occ}_{\text{min. bias}}} = \frac{(3.2 \times 1.2) + 1.8}{3.2 \times 1.2} = 1.5$$

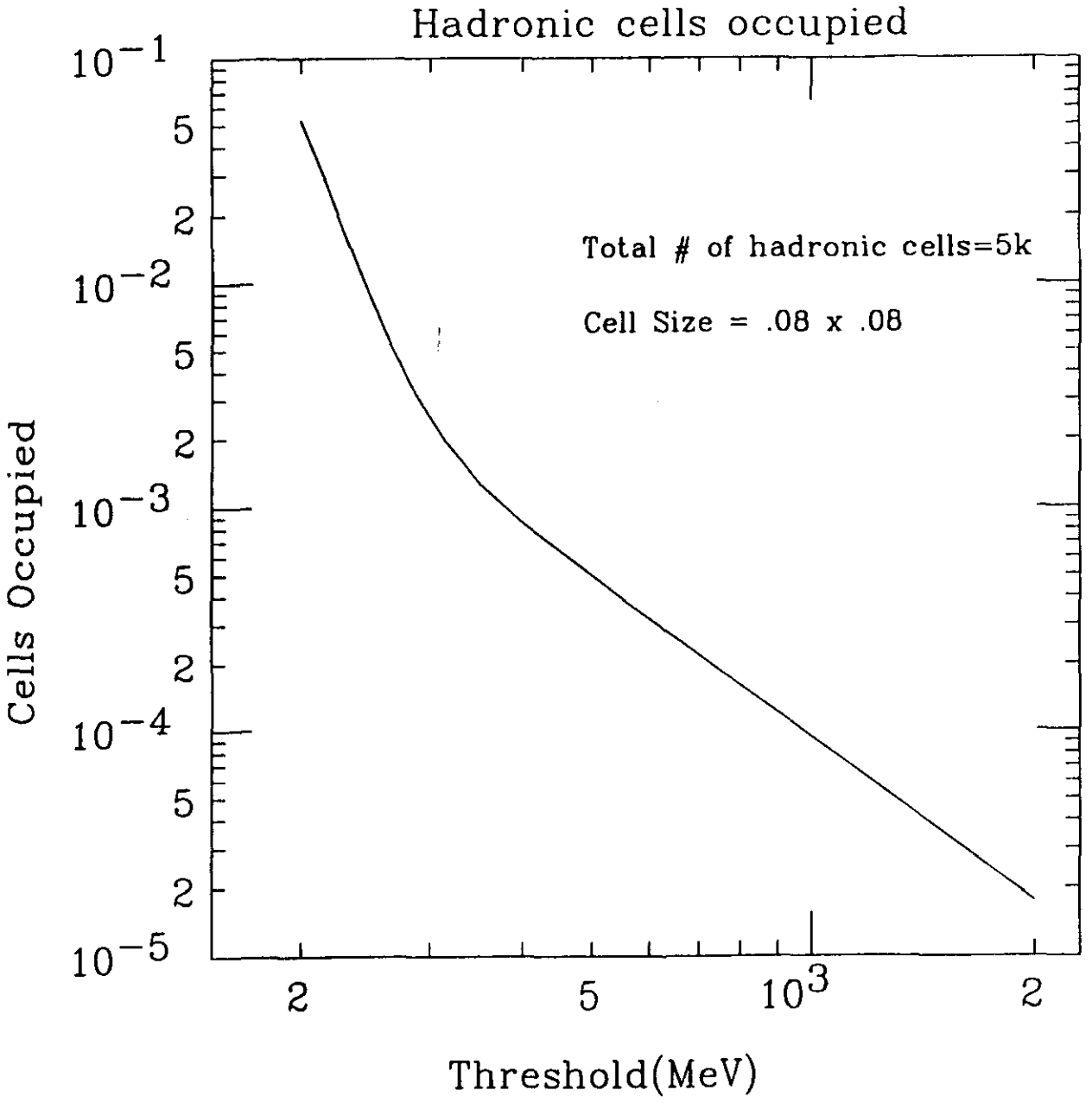
3.1 LAr Calorimeter

The regions of interest are:

1) the size of the individual tower—i.e. $\Delta\eta \times \Delta\phi = .04 \times .04$
2) a size which is useful for the definition of clusters (3×3 cells in the EM part and 4×4 in the hadronic part)
3) an area typical of that required for jet energy reconstruction or for application of isolation cuts—$\Delta R \equiv \sqrt{\Delta\eta^2 + \Delta\phi^2} = .45$

Table VI Thermal and pileup noise in the liquid-argon calorimeter.

Electromagnetic Section				
τ (ns)	Cell Size	σ_{thermal} (MeV)	σ_{pileup} (MeV)	σ_{total} (MeV)
	$.04 \times .04$	40 (20)	24 (30)	47 (37)
25 (40)	$.12 \times .12$	120 (60)	120 (150)	170 (162)
	$\Delta R = .45$	820 (410)	1640 (2070)	1840 (2110)
Hadronic Section				
	$.08 \times .08$	240 (150)	120 (145)	268 (208)
70 (100)	$.32 \times .32$	960 (600)	880 (1060)	1302 (1218)
	$\Delta R = 0.45$	2360 (1470)	3310 (3980)	4065 (4242)


Hadronic cells occupied
Total # of hadronic cells=5k
Cell Size = .08 x .08
Cells Occupied
Threshold(MeV)
10^{-1}
5
2
10^{-2}
5
2
10^{-3}
5
2
10^{-4}
5
2
10^{-5}
2
5
10^{3}
2

3.2 BaF_2 Option

For purposes of comparison with LAr, one can compute the "pileup sum"

$$S = \sum_{k=0}^{\infty} a^2(t_k)$$

where

$$a(t_k) = \text{normalized normalized pulse response}$$

and

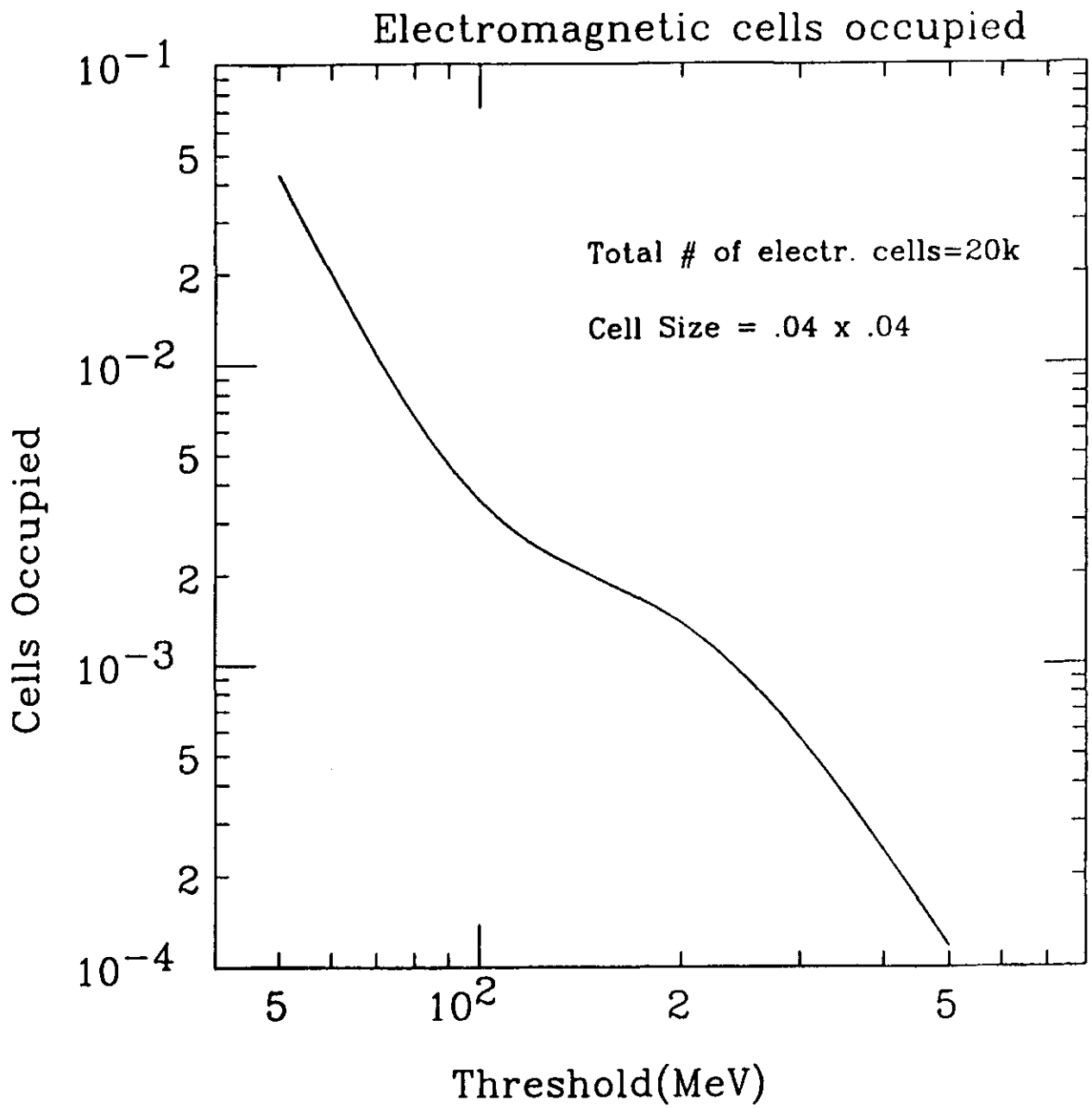
$$t_k = \text{time after pulse (multiple of 16 ns)}$$

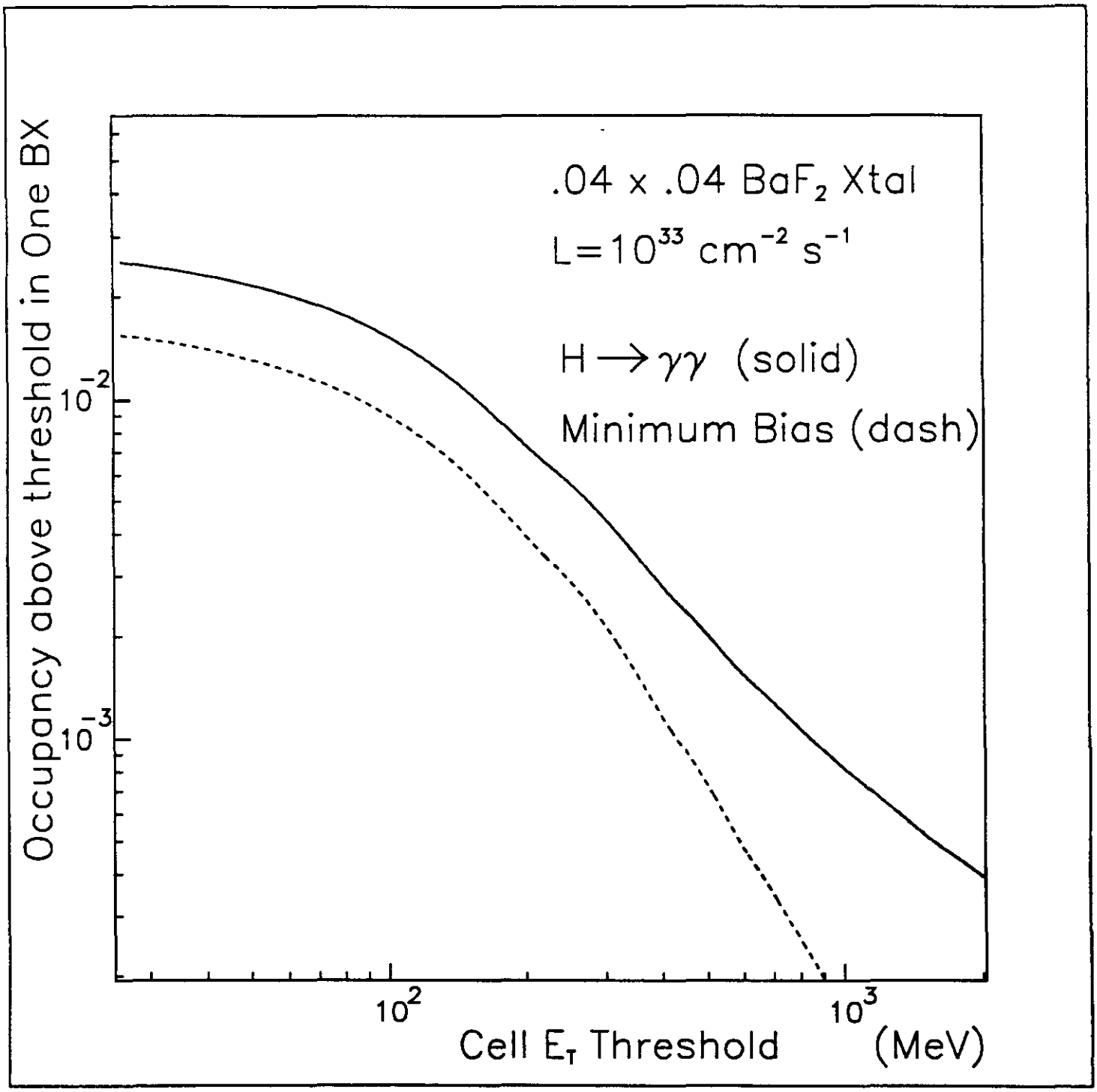
For BaF_2

$$a(t_k) = \delta_{k0} \quad \text{and} \quad S_{\mathrm{BaF_2}} = 1$$

For LAr with a 25 (40) ns shaping time $S = 2.8(4.1)$ hence

$$\sigma_{\mathrm{pileup}}(\mathrm{LAr}) \simeq 1.7(2.0)\sigma_{\mathrm{pileup}}(\mathrm{BaF_2})$$


Electromagnetic cells occupied
Total # of electr. cells=20k
Cell Size = .04 x .04
Cells Occupied
Threshold(MeV)
10^-1
5
2
10^-2
5
2
10^-3
5
2
10^-4
5
10^2
2
5


.04 x .04 BaF2 Xtal
L=10^33 cm^-2 s^-1
H → γγ (solid)
Minimum Bias (dash)
Occupancy above threshold in One BX
10^-2
10^-3
10^2
10^3
Cell E_T Threshold (MeV)

4. Muon System

Barrel Region Drift Wires ($|\eta| < 1.3$):

$$\begin{aligned}
\mathrm{Occ} &= \frac{dN}{dA}\, A\, t_{\mathrm{drift}} \\
&= 10^{-1}\mathrm{Hz\ cm^{-2}\ s^{-1}} \times 1200\ \mathrm{cm^2} \times 300\ \mathrm{ns} \\
&= 3.6 \times 10^{-5}
\end{aligned}$$

where

$$\begin{aligned}
\frac{dN}{dA} &= \text{rate per unit area} \\
t_{\mathrm{drift}} &= \text{is the maximum drift time} \\
A &= \text{area of } 4-\mathrm{m}-\text{long } 3-\mathrm{cm}-\text{dia tube}
\end{aligned}$$

Muon Forward/Backward Region (CSC's):

Table VIII: Summary of CSC strip dimensions for forward/backward muon system. All strips are 5 mm in width.

Superlayer	z (cm)	Strip Lengths Min. (cm)	Max. (cm)	Strips/ Plane	No.# Planes
1	± 600	23	176	7600	4
2	± 1000	70	202	10000	4
3	± 1400	149	220	14900	3

For the $\sim$ worst case (at $\mathcal{L} = 10^{33}$ cm^{-2} s^{-1}) of a 150 cm strip

$$\begin{aligned} \text{Occ} &= \frac{dN}{dA}\, A_{\text{strip}}\, N_{\text{image}}\, t_{\text{integ.}} \\ &= 10\text{Hz cm}^{-2}\ \text{s}^{-1} \times 75\ \text{cm}^2 \times 2 \times 3\ \mu\text{s} \\ &= .005 \end{aligned}$$

Although this is acceptable, a considerable additional margin can be be gained by recording the times digital control channels with time precision of one bunch crossing or better.

Number of Minimum Bias Events in Bunch Crossings Containing Rare Events

The probability that a process i having cross section $\sigma_i \ll \sigma_{\text{total}}$ will occur in a bunch crossing with m interactions is

$$P(m) = \frac{\sigma_i}{\sigma_{\text{total}}} m\, p(m) \quad \text{where} p(m) = \frac{\mu^m e^{-\mu}}{m!}$$

where

$$\mu = 1.6 = \#\text{interactions per crossing}$$

$$\begin{aligned}
< m > &= \left(\sum_{m=0}^{\infty} P(m) \right)^{-1} \times \left(\sum_{m=0}^{\infty} mP(m) \right) \\
&= \frac{1}{\mu} \sum_{m=0}^{\infty} \frac{m^2 \mu^m e^{-\mu}}{m!} \\
&= \frac{e^{-\mu}}{\mu} \sum_{m=1}^{\infty} \frac{m\mu^m}{(m-1)!} = \frac{e^{-\mu}}{\mu} \sum_{n=0}^{\infty} \frac{(n+1)\mu^{n+1}}{n!} \\
&= e^{-\mu} \left(\sum_{n=0}^{\infty} \frac{\mu^n}{n!} + \sum_{n=0}^{\infty} \frac{n\mu^n}{n!} \right) = 1 + \mu
\end{aligned}$$

K. McFarlane

GEM Computing Group Meeting Dec 6-7th

Tentative Agenda

STRATEGY ROOM (nr. Project Management #2)

Dec 6th 9:00 a.m. Simulation Integration

Intro – K. McF

Magnet – Jim Sullivan

Muons – Roger McNeil

~10:00 a.m. Calorimetry – D. Lissauer, H. Ma, H Newman / R. Zhu

Central Tracker – S. McKee

Trigger/DAQ – D Marlow

Physics – Lane, Paige

~11:00 a.m. Discussion of approach, issues, specific plans

Bldg 4, 311 (Physics Conf. Room)

1:00 pm General Issues

R&D program – K. McF

PDSF Upgrade Plans — Brian Scipioni

Set Agenda and date for extended Jan. 92 Workshop in prep. for Technical Proposal.

Bldg 4, 311 – Physics Conf. Room

Dec 7th ?? a.m. Working group – L. Roberts

Computing R&D

- Cooperate with / benefit from SDC work
- Develop independent expertise
- Study GEM-specific problems

- SDC/SSC Database project — 0 $
- E-Systems Architecture Study — 45 k$
- UT Arlington S.D. Methodology — 40 k$
- U. Miss Specific simulation CALOR-GEANT — 15 k$
- UT Arlington Slow Control software/system — deferred

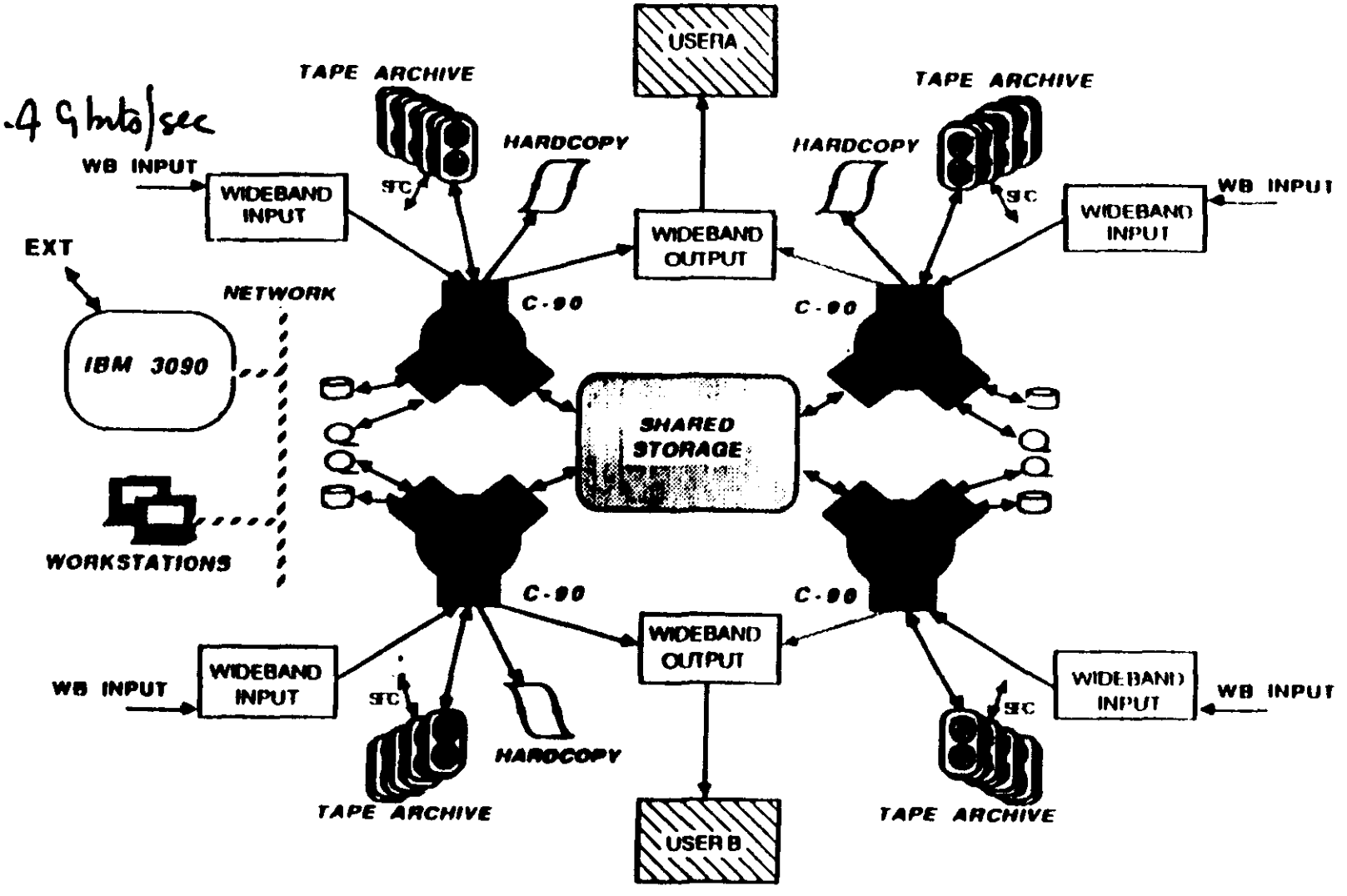
Other projects needed (e.g. fast I/O solutions in cooperation with vendors) ...

Physicists are needed to work on these efforts.

Current E-system project

SYSTEM BLOCK DIAGRAM (MORGAN PROJECT)

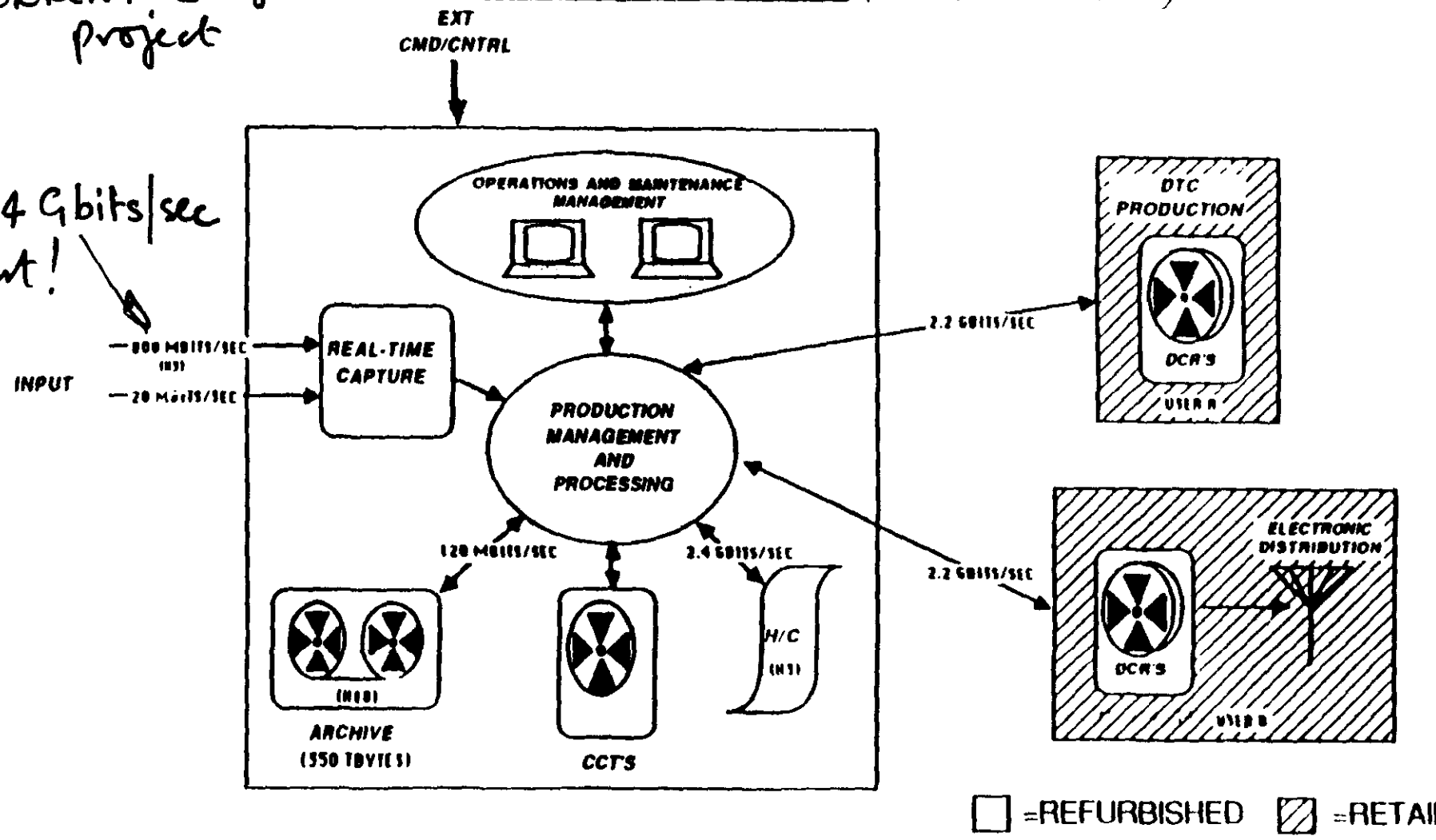
2.4 Gbits/sec



PROPRIETARY

11/11/90

CURRENT E-System project

REQUIREMENTS MODEL (MORGAN PROJECT)

2.4 Gbits/sec input!