GEM 91-TN-00011

GEM Collaboration Council Meeting SSCL

September 5, 1991

Abstract:

Transparencies from the GEM Council Meeting at the SSCL on September 5, 1991 are presented

GEM
COLLABORATION COUNCIL MEETING
SEPTEMBER 5, 1991

Preliminary AGENDA

9 AM - General News and Status (Barish/Willis)
Document tracking and other issues (Yost)

9:45 - Working Group Reports
1) Hall and Facilities (Stefanski)
2) Magnet (Stroynowski)
3) Muons (Taylor/Ahlen)
4) Calorimeters (Brau/Adair)
5) Inner Tracking (Musser/Gordon)
6) Electronics/Triggering (Marlow/Shaevitz)
7) Computing (MacFarlane/Newman/Zhu)

Noon - Lunch

1 PM - Discussion Item
1) Forward Calorimetry - Virtues/Requirements (Rutherfc ·d)
2) High Field option for GEM (Olson)

2 - Defining GEM for LOI
1) Detector Decisions (Barish/Willis)
2) Parameters/Engineering/Costs (Sanders/Marx)
3) LOI Physics Questions (Lane/Paige)
4) R&D - Engineering FY92 Requests; Beam Tests (Baltay)
5) The Collaboration (Ferbel)
6) Management and Organization (Barish/Willis)

B. Barish

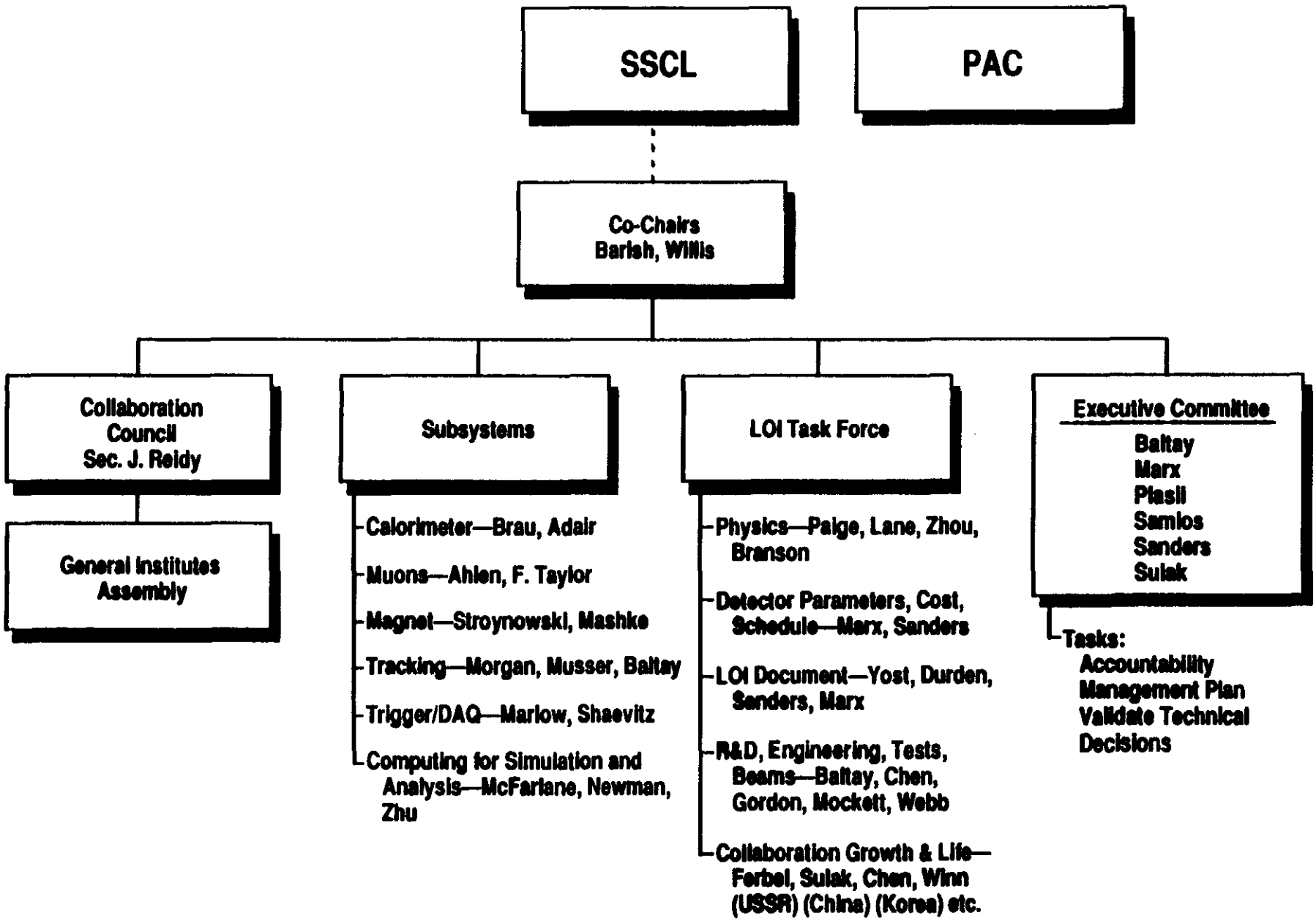
GEM

Collaboration Council Meeting

Sept 5, 1991

Status / News

- Agenda (Organization)
- Logo
- Logistics
  - Registration Fee ($50) - Council Mtg
  - SSC Organization
- Collaboration List / Contact Book
- Meetings, etc
  - USER Exec Committee
  - Corpus Christi (Oct 13-17)
- Internal Notes
  Bulletin Board, etc.


SSCL
PAC
Co-Chairs
Barish, Willis
Collaboration Council
Sec. J. Reidy
General Institutes Assembly
Subsystems
Calorimeter—Brau, Adair
Muons—Ahlen, F. Taylor
Magnet—Stroynowski, Mashke
Tracking—Morgan, Musser, Baltay
Trigger/DAQ—Marlow, Shaevitz
Computing for Simulation and Analysis—McFarlane, Newman, Zhu
LOI Task Force
Physics—Paige, Lane, Zhou, Branson
Detector Parameters, Cost, Schedule—Marx, Sanders
LOI Document—Yost, Durden, Sanders, Marx
R&D, Engineering, Tests, Beams—Baltay, Chen, Gordon, Mockett, Webb
Collaboration Growth & Life—Ferbel, Sulak, Chen, Winn (USSR) (China) (Korea) etc.
Executive Committee
Baltay
Marx
Piasil
Samios
Sanders
Sulak
Tasks:
Accountability
Management Plan
Validate Technical Decisions
hd/7-17-91

gem

gem

Tentative Agenda

The Project, The Progress, The Physics

1991 Symposium on the Superconducting Super Collider

October 13 - 17, 1991
Corpus Christi, Texas

Sunday, October 13

7:00 -9:00 PM	Registration/Reception

Monday, October 14 **SSC Project**

8:30 AM	Welcome - *Mary Rhodes, Mayor of Corpus Christi*
8:45	SSC Laboratory - *R. Schwitters, SSC Laboratory*
9:30	DOE
9:45	TNRLC
10:00	*Break*
10:30	Theory
11:30	Physics Research at SSCL - *F. Gilman, SSC Laboratory*
12:30 PM	*Lunch*
2:00	Texas Education - *H. Mark, Chancellor, University of Texas System*
	SSC Education - *T. Gadsden, SSC Laboratory*
3:00	Magnets - *T. Bush, SSC Laboratory*
3:30	*Break*
4:00	Accelerator - *D. Edwards, SSC Laboratory*
4:30	Computing - *K. Rich, SSC Laboratory*
5:00	Conventional Construction - *J. Ives, SSC Laboratory*
5:30	Adjourn

Free Evening

Tuesday, October 15 — SSC Detectors

8:00 AM	Continental Breakfast
8:20	Coalition Discussions
9:00	Theory - *F. Paige, Brookhaven National Laboratory*
10:00	GEM
11:00	*Break*
11:30	SDC - *T. Kondo, KEK*
12:30 PM	*Lunch*
2:00	B-Physics
2:45	Special Purpose Detectors - *R. Stefanski, SSC Laboratory*
3:30	*Break*
	Users' Meeting
4:00	Chairman's Report - *D. Cassel, Cornell University*
4:15	Site Development Plan - *J. Sanford, SSC Laboratory*
5:00	Sociology Round Table - *Moderator - R. Adair, Yale University*
6:00	Adjourn

Users Night at the Sheraton

Wednesday, October 16 — Detector Subsystem R&D at CERN and SSCL

8:30 AM	Calorimetry I - *J. Brau, University of Oregon*
	Calorimetry II - *W. R. Frisken, York University and LBL*
	Calorimetry III (CERN)
10:15	*Break*
10:45	Tracking I - *A. Goshaw, Duke University*
	Tracking II - *A. Seiden, University of California at Santa Cruz*
	Tracking III (CERN)
12:30 PM	*Lunch*
2:00	Electronics I - *J. Dorenbosch, SSC Laboratory*
	Electronics II - *H. H. Williams, University of Pennsylvania*
	Electronics III (CERN)
3:45	*Break*
4:15	Muons - *J. Bensinger, Brandeis University and SSC Laboratory*
4:45	Computing - *K. McFarlane, Temple University and SSC Laboratory*
5:30	Adjourn

Sunset Cruise on Corpus Christi Bay

Thursday, October 17	Physics
8:30 AM	Fermilab Collider Program- *J. Huth, Fermilab*
9:30	CERN LHC Program
10:30	*Break*
11:00	Status of the Project - *Paul Reardon, SSC Laboratory*
11:40	"What Lies Ahead?" - *J. Bjorken, SLAC*
12:15 PM	Closing Remarks
1:00	Adjourn

Please return no later than September 11, 1991

USERS ORGANIZATION OF THE SUPERCONDUCTING SUPER COLLIDER

BALLOT

Executive Committee

Candidates for Secretary-elect
(please select one)

☐ **Robert D. Kephart**
Fermilab

☐ **Paul M. Mockett**
University of Washington

Candidates for Member of the Executive Committee
(please select three)

☐ **Richard Hubbard**
CEN Saclay

☐ **Dennis J. Judd**
Prairie View A&M University

☐ **Kate Morgan**
SSC Laboratory

☐ **Pekka K. Sinervo**
University of Toronto

☐ **Nicolai Tyurin**
IHEP-Serpukhov

☐ **Yoshinobu Unno**
KEK

Milestones

Oct 3-4 PAC Review

Nov 30 LOI Due

- - - - - - -

'Defining' the Detector

Sept 5 - Reports from Subsystems Working Groups

Scheme: Joint - Exec Committee / Subsystem Leaders (Advisory Group)

Meetings - Sept 19-20 (Caltech)
Sept 26 (SSC Lab)

Oct 2 - Collab Council Meetings (PAC Presentation)

W. Willis

DETECTOR DECISIONS

IDEAL: REDUCE OPTIONS TO CONCENTRATE EFFORT

CALOR IMETER: ~ 5 ⇒ 1 OR 2

PRERADIATOR: ~ 4 ⇒ 0 OR 1 ?

MUON TRACKER ~ 4 ⇒ 1 OR 2

MUON TRIGGER ~ 3 ⇒ 0 OR 1

ELECTRON TRIGGER ~ 2 ⇒ 1 OR 2

TOTAL R&D EFFORTS = 3-8

HOW MANY CAN WE SUPPORT ?

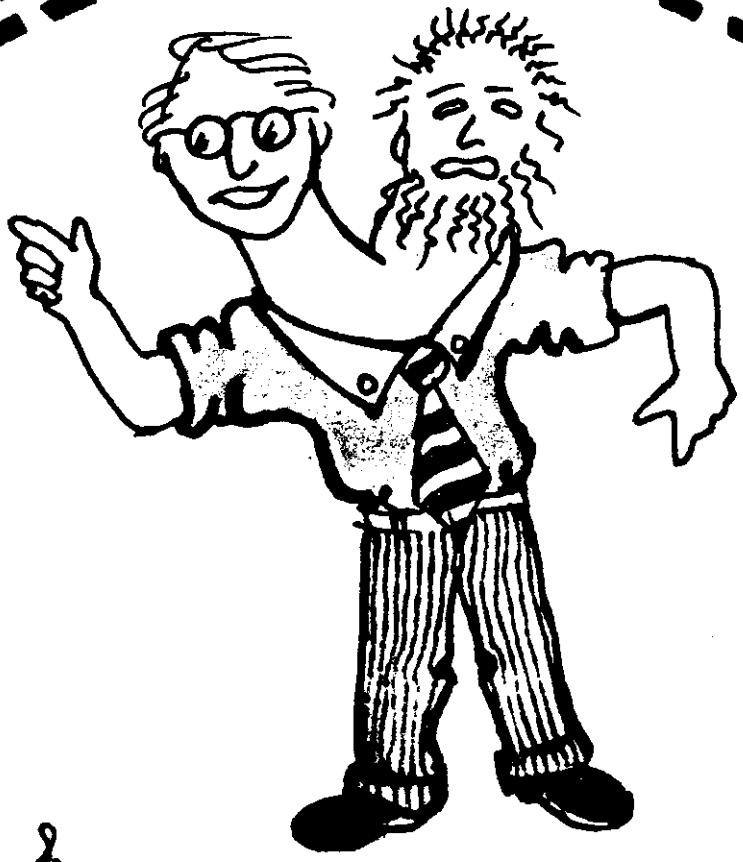
FY 92 PROBLEM

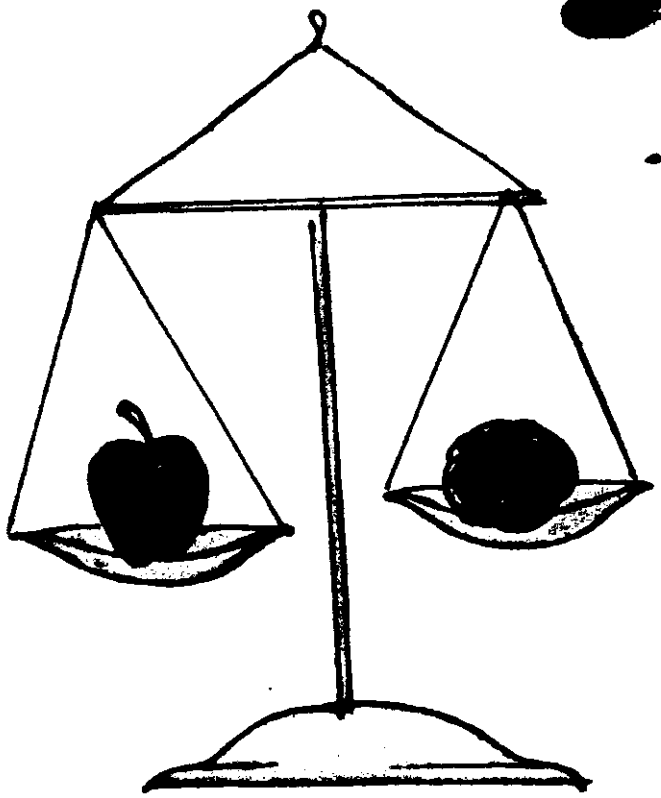
FY 92 R&D FUNDS

- WE **MUST** HAVE THE ENGINEERING FOR TECH PROPOSAL
  MOSTLY FY 92

- SYMMETRICAL SPLIT ?
  IF NO

THE CALORIMETER DECISION





THE CRITERIA ARE NOT HOMOGENEOUS

EG: σ_E vs σ_X

DECISION GROUP:

SPOKESPERSONS

+ EXEC COM

+ WORKIN GROUP CONVENORS

= 19 SOULS

MEET 19-9-1991

EVERY COLLABORATOR

URGED TO TALK TO BARRY, BILL, OTHERS ON THESE DECISION !!

U. YOST
910905

NUMEROUS ISSUES

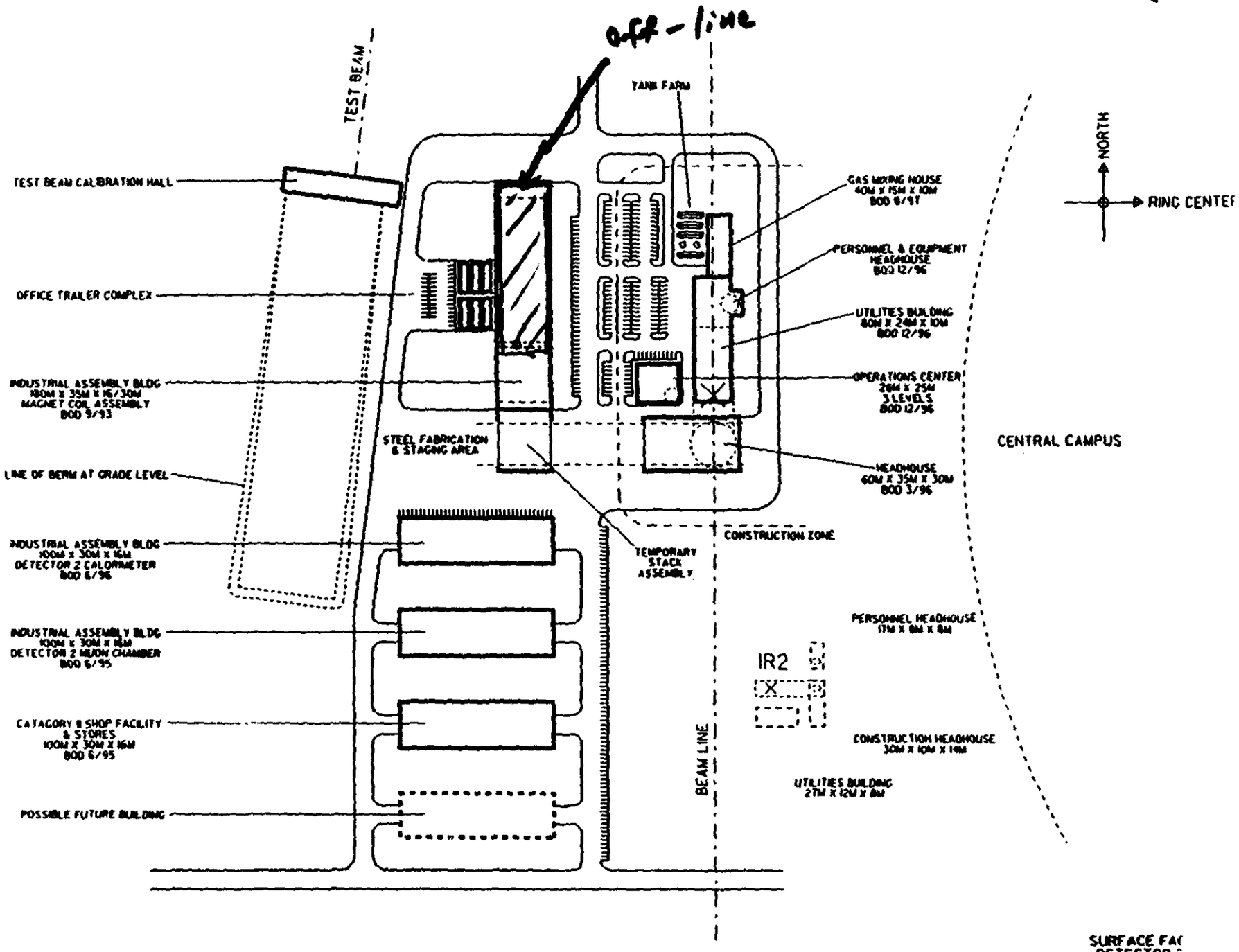
A) COMPUTER (& OTHER) SPACE AT THE I.R. & CAMPUS

NO REAL PLANNING SO FAR.

ONLY SPACE FOR ON-LINE -
NO PROVISION FOR OFF-LINE OR SIMULATION, ETC.
(EXCEPT 15,000 ft² AT THE CAMPUS - FOR US, SDC, ...)

IF WE NEED TO AFFECT PLANNING FOR THE I.R., NEED INPUT BY END OF THIS MONTH.

SAME FOR CAMPUS.



SURFACE FA
DETECTOR
06/25/
TVP/KH - R

B) COLLABORATION LIST, E-MAIL LIST, ETC.

USER'S OFFICE (PHYLLIS) IS COMPILING THIS. WE NEED MORE PEOPLE'S ADDRESSES, ESP. E-MAIL.

E-MAIL LIST IS ON

SSCVX1::USER3[NUDETECTOR]NEWBET.DIS

UPDATED AS OFTEN AS POSSIBLE, BUT STILL LOTS OF GAPS. NEED ALSO CONTACT PEOPLE (WE HAVE MOST BUT NOT ALL).

C) MEETING ARRANGEMENTS

I WILL BE SINGLE POINT OF CONTACT (214) 708-6028

SSCVX1::YOST

YOST@SSCVX1.SSC.GOV

PLEASE ARRANGE MEETING TIMES & ROOMS THROUGH ME.

D) MEETING TRANSPARENCIES

GIVE ME ENTIRE PACKETS FOR REPORT.

INCLUDE:

1) AGENDA
2) LIST OF ATTENDEES
3) SPEAKER'S NAME ON FIRST PAGE OF EACH PACKET
4) RUSH OR NON-RUSH (REALISTIC, PLEASE)

WE WILL PRINT, DISTRIBUTE TO ATTENDEES, CONTACT PEOPLE

(6) STANDARD GEM REPORT FORMAT

ORANGE COVERS, ROAD-RUNNER

DOCUMENT NUMBER

SEND MAIL TO

SSCVX1::GEMDCC

STANDARD NUMBERING

GEM TN-91-00007 TECH NOTES

PN PHYSICS NOTES

IN INTERNAL NOTES (NOT PUBLIC)

GCD-XXXXXX ENG. DRWG, CIVIL CONST.

GCT- " ENG. TXT, " "

GDD - " ENG. DRWG, DETECTOR

GDT - " ENG. TXT, "

GOD - " ENG. DRWG, OTHER

GOT - " ENG. TXT, "

NUMBERS SEQUENTIAL, DO NOT START OVER NEXT YEAR

F) THE LOI

- ALL DRAFTS & EDITS FROM SECTION CHIEFS ONLY - NOT DIRECT TO SSCL

- MICROSOFT WORD

- DOUBLE - COLUMN FORMAT

- DRAFTS TO US WEEK OF NOV 4.* INCLUDING FIGS (AS FINAL AS POSSIBLE)

- FINAL DRAFTS WEEK OF NOV 11.

- ASCII & WORD RTF FILES WILL BE KEPT IN SSCVX1::[GEMLIB] (USED TO BE NEWDETLIB)

- OUTLINE + RESPONSIBILITIES (FINAL) FIRST WEEK OF OCT

* PHYSICS SECTIONS (& OTHER WHERE POSSIBLE) EARLIER

1. List files for GEM account (DIRECTORY)
2. Display the contents of a file (TYPE/PAGE)
3. Invoke VMS Mail
4. View a file with EDT (READONLY)
5. Access Document Tracking System
6. Access GEM_NEWS Bulletin Board
7. Display GEM Calendar

LOI FILES

DTASS

BULLETIN BOARD

calendar

Enter number or press <RETURN> to LOGOUT:

GEMLIB ACCOUNT ON
SSCVX1
(NO PASSWORD)

PLUGS YOU INTO ACCOUNT WHERE LOI FILES WILL BE KEPT

PLUGS YOU INTO DOCUMENT TRACKING AND STORAGE SYSTEM

PLUGS YOU INTO GEM_NEWS BULLETIN BOARD (INCL. CALENDAR)

```
Enter number or press <RETURN> to LOGOUT: 6
Current Folder: GENERAL                                          GEM_News 2.6
*****************************************************************************
Folder          Status          Description
CALENDAR                        Collaboration Calendar
CALORIMETER                     Calorimter Folder
COMPUTING                       Computing Folder
ENGINEERING                     Engineering Folder
GENERAL         Notify          General information for the whole collaboration
MAGNET                          Magnet Folder
MUONS                           Muons Folder
PHYSICS                         Physics Folder
TRACKING                        Tracking Systems
TRIGGER_DAQ                     Trigger/DAQ Folder
GEM_NEWS> quit
Use EXIT or Ctrl-Z to tag every NEWS as seen.
```

Folders [+ collab. members + announcements]

BULLETIN BOARD

Olivier Callot of CERN - author
[Also used by D0, SDC, ...]

Can be installed on any VAX linked to SSCVX1.

Bulletins propagate automatically to all nodes.

Send items to SSCVX1::BALLARD
(include an expiration date)

Also - section chiefs with an SSCVX1 account.

From SSCVX1 account, can do
SETUP GEM_NEWS
GEM News

Works a lot like VAX mail

DOCUMENT TRACKING AND STORAGE SYSTEM (DTASS)

RUNS ON A SUN. WILL INCLUDE BIBLIO. DATA FOR GSFC DOCUMENTS. ALSO THE ACTUAL DOCUMENT IN SOME CASES - FORMAT IS AN OPEN QUESTION.

CAN SEARCH ON TITLE WORDS, KEYWORDS, OTHER ITEMS.

KELLY RATHBUN (SSCVX1::GSFCDCC) WILL ENTER DOCUMENTS.

→ AUTHORS MUST CONTRIBUTE KEYWORDS

```
SunOS Release 4.1 (GENERIC) #1: Wed Mar 7 10:59:35 PST 1990

     Attention: AFS client software has been installed on this machine.
                The installation created the directory /afs.  Do not attempt
                to remove this directory or write to it; however, read access
                to this directory is permitted.  If you have questions
                concerning AFS or how it affects sdcl, then contact
                Computer Operations at x5133, x6055, or x6021, or send
                e-mail to somogyi@sscvx1.

Please enter the terminal type:
<<< Valid terminal types include ----------------------->>>
<<< vt100, vt220, vt240, vt330, wyse-50, wy99gt, x11>>>
vt100
```

OTASS. CHOOSE YOUR TERMINAL TYPE. X11 IS MORE USER-FRIENDLY (ALLOWS MOUSE). IF YOU TELL IT "X11," YOU WILL NEXT HAVE TO TYPE IN YOUR IP #.

```
*************************************************************************
*                                                                       *
*  DOCUMENT TRACKING AND STORAGE SYSTEM LOGIN                        X  *
*                                                                       *
*                                                                       *
*                                                                       *
*                                                                       *
*    User name: gem_guest                                               *
*     Password:                                                         *
*                                                                       *
*                                                                       *
*                                                                       *
*************************************************************************
```

IN SDCI. FROM GEMLIB.
NO PASSWORD HERE

```
*****************************************************************************
*                                                                           *
*  DTASS MAIN MENU                                          ^       X       *
*                                                        <  +  >            *
*                                                           v       ?       *
*                                                                           *
*                    Physics Research Division                              *
*            Document Tracking and Storage System (DTASS)                   *
*                                                                           *
*                                                                           *
*                    Edit/Find Document                                     *
*                                                                           *
*                    Enter New Document  <- NOT ALLOWED                     *
*                                           FROM GEMLIB                     *
*                    Standard Reports                                       *
*                                                                           *
*                    Utilities                                              *
*                                                                           *
*                    Help                                                   *
*                                                  For Information:         *
*                    Quit                            Norm Wells             *
*                                                    (214) 708-6105         *
*                                                    wells@sscvx1.ssc.gov*
*****************************************************************************
```

TO ENTER A NEW DOC AND GET A DOC #, NEED AN SDCI ACCOUNT (SEE NORM WELLS).

DOC NUMBERING:

GEM TN-91-00007 TECH NOTES
GEM PN-91- " PHYSICS NOTES
GEM IN-91- " INTERNAL NOTES (NOT PUBLIC)

+ SAME ENGINEERING NOTES NUMBERS

BACK TO PREV. MENU

TO GET ON HERE, USE CONTROL-R + ARROWS.

```
**********************************************************************
*                                                                    *
*  DOCUMENT SEARCH                                     ^        (X)  *
*                                                    <  +  >         *
*  Clear!   DONE!                                       v       ?    *
*                                                                    *
*                                                                    *
*                                          Document Date (MM/DD/YY)  *
*            Org(^v) Document Number(^v)     On/Prior      After     *
*                                                                    *
*     Title:                                                         *
*  Doc.Type:                                                         *
*  Related Docs:                                                     *
*  Access Level(^v):          Owner(^v):                             *
*                   First          Middle          Last (^v)         *
*         Author:                                %                   *
* Corp/Inst (^v): %                                                  *
*  Keywords (^v):                                                    *
*                                                                    *
*                                                                    *
*        WBS_ref:                                                    *
*                        Everything OK? (y/n):                       *
*                                                                    *
```

HAVE TO ANSWER THIS

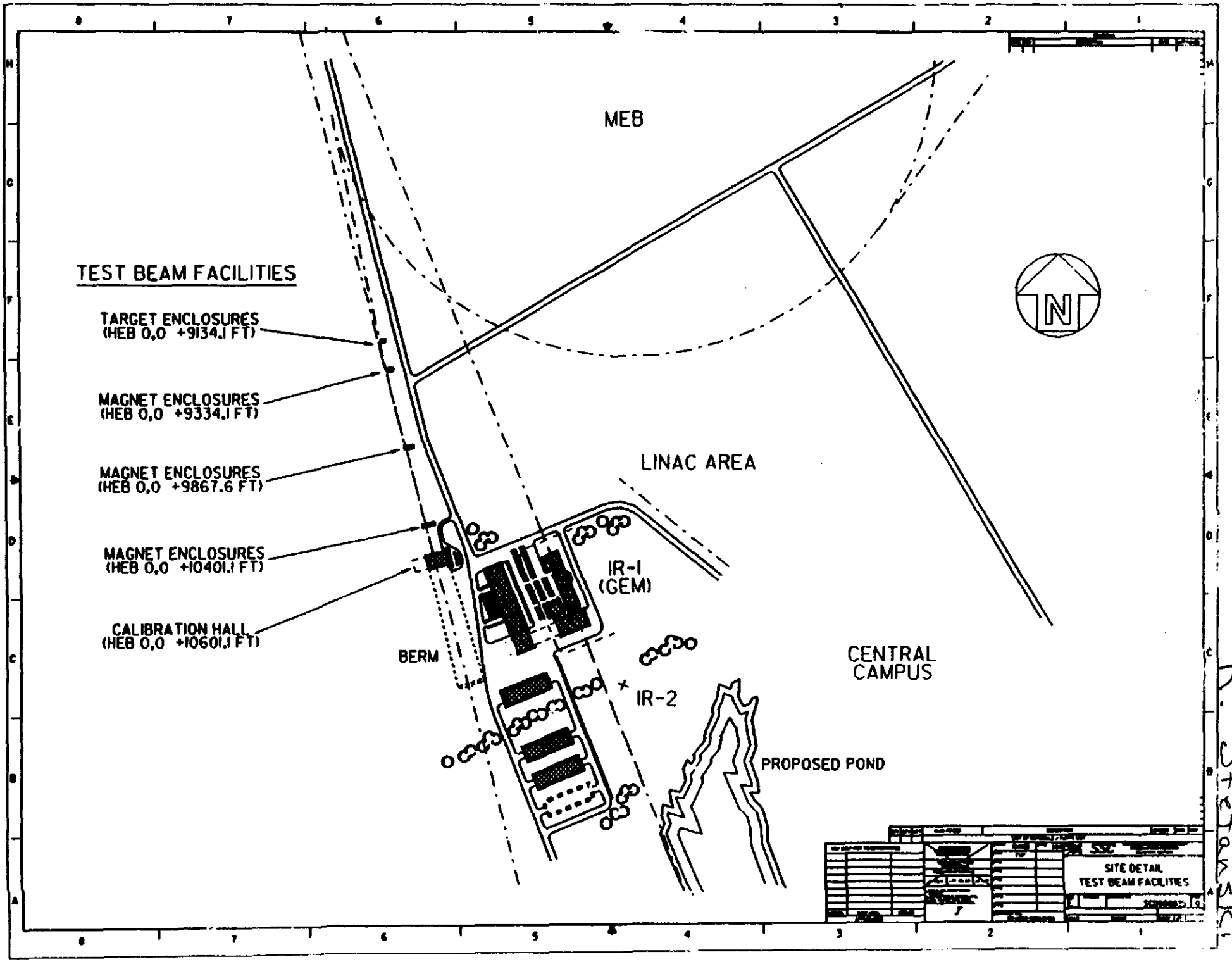
"FIND" SCREEN

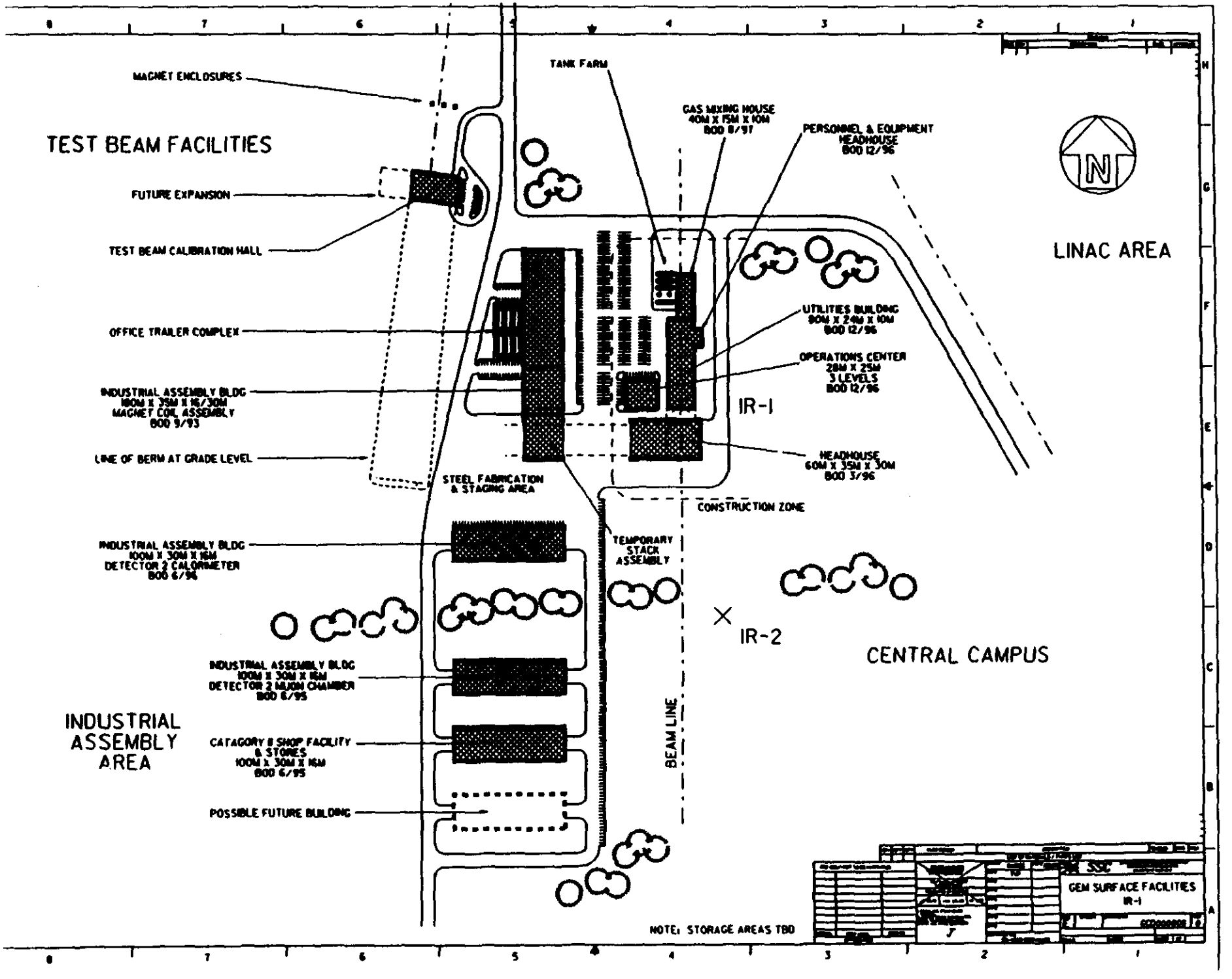
TAB OR MOUSE (X11 ONLY) TO GET AROUND.

```
**********************************G  ******************************************
*                                                                            *
*  SUMMARY SEARCH RESULTS                                   ^       X        *
*                                                         <  +  >            *
*  Detail Information!   DONE!                              v       ?        *
*                                                                            *
*  _        Title                Type          Date            Notes         *
*  _   test (hpgl -- ps      TECH NOTES     Aug 19 1991                      *
*  _ [9;on the fly)                                                          *
*                                                                            *
*      elec dwg:hall         DRAWING        Aug 14 1991    EXPERIMENTAL     *
*      utility bldg                                        FACILITIES       *
*      preliminary riser                                   ELECTRICAL DRAWING *
*      elec dwg:gem dc       DRAWING        Aug 14 1991    EXPERIMENTAL     *
*      magnet power riser                                  FACILITIES       *
*      diagram                                             ELECTRICAL DRAWING *
*      elec dwg:gem          DRAWING        Aug 14 1991    EXPERIMENTAL     *
*      alternate power                                     FACILITIES       *
*      source riser                                        ELECTRICAL DRAWING *
*      elec dwg:gem          DRAWING        Aug 14 1991    EXPERIMENTAL     *
*      operating center                                NTAFACILITIES        *
*      one line diagram                                    ELECTRICAL DRAWING *
*                                                                            *
******************************************************************************
```

FOR LOTS MORE INFO

EXAMPLE SEARCH RESULTS

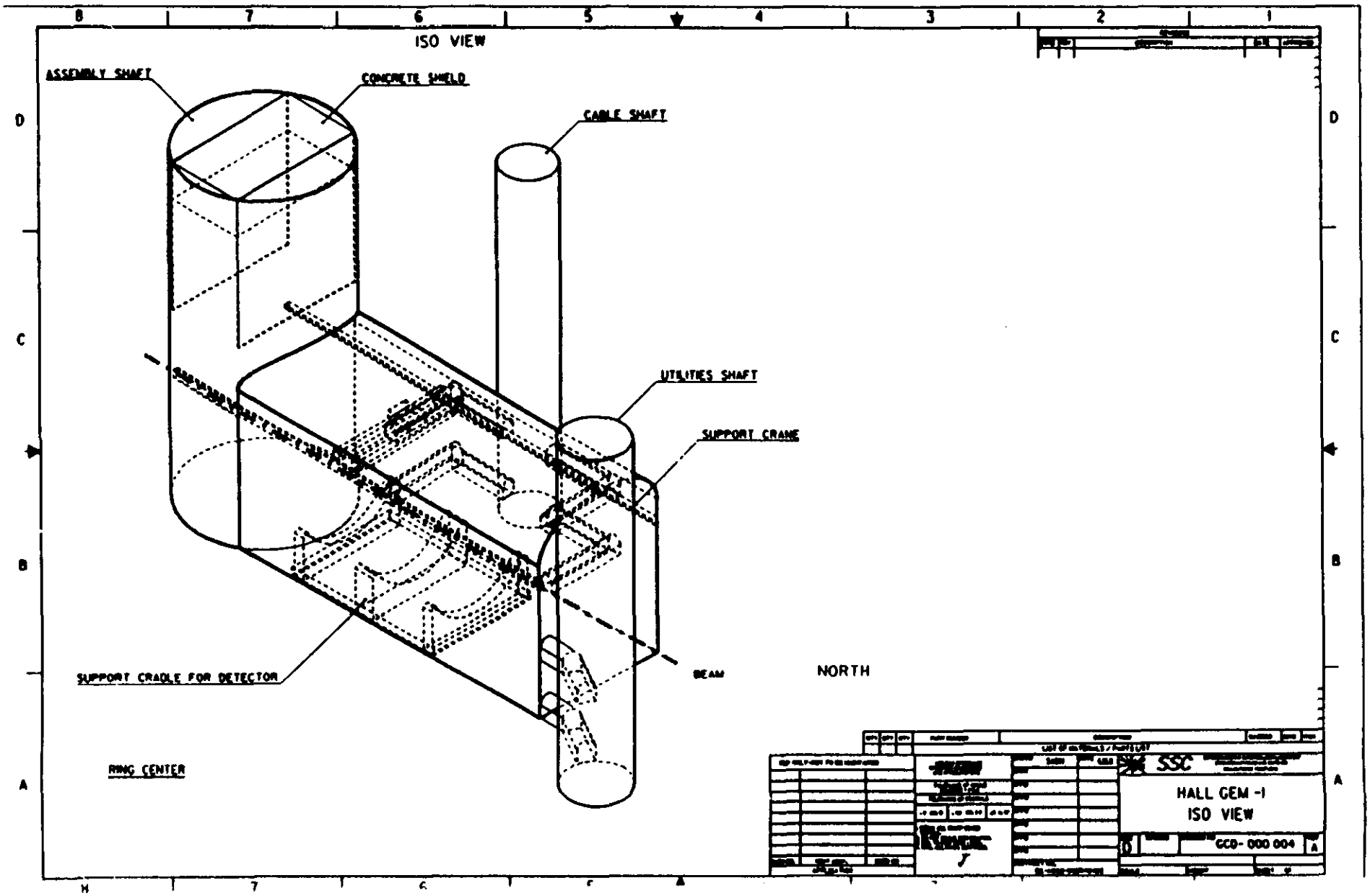

TEST BEAM FACILITIES
TARGET ENCLOSURES (HEB 0,0 +9134.1 FT)
MAGNET ENCLOSURES (HEB 0,0 +9334.1 FT)
MAGNET ENCLOSURES (HEB 0,0 +9867.6 FT)
MAGNET ENCLOSURES (HEB 0,0 +10401.1 FT)
CALIBRATION HALL (HEB 0,0 +10601.1 FT)
BERM
MEB
LINAC AREA
IR-1 (GEM)
IR-2
CENTRAL CAMPUS
PROPOSED POND
N
SITE DETAIL
TEST BEAM FACILITIES

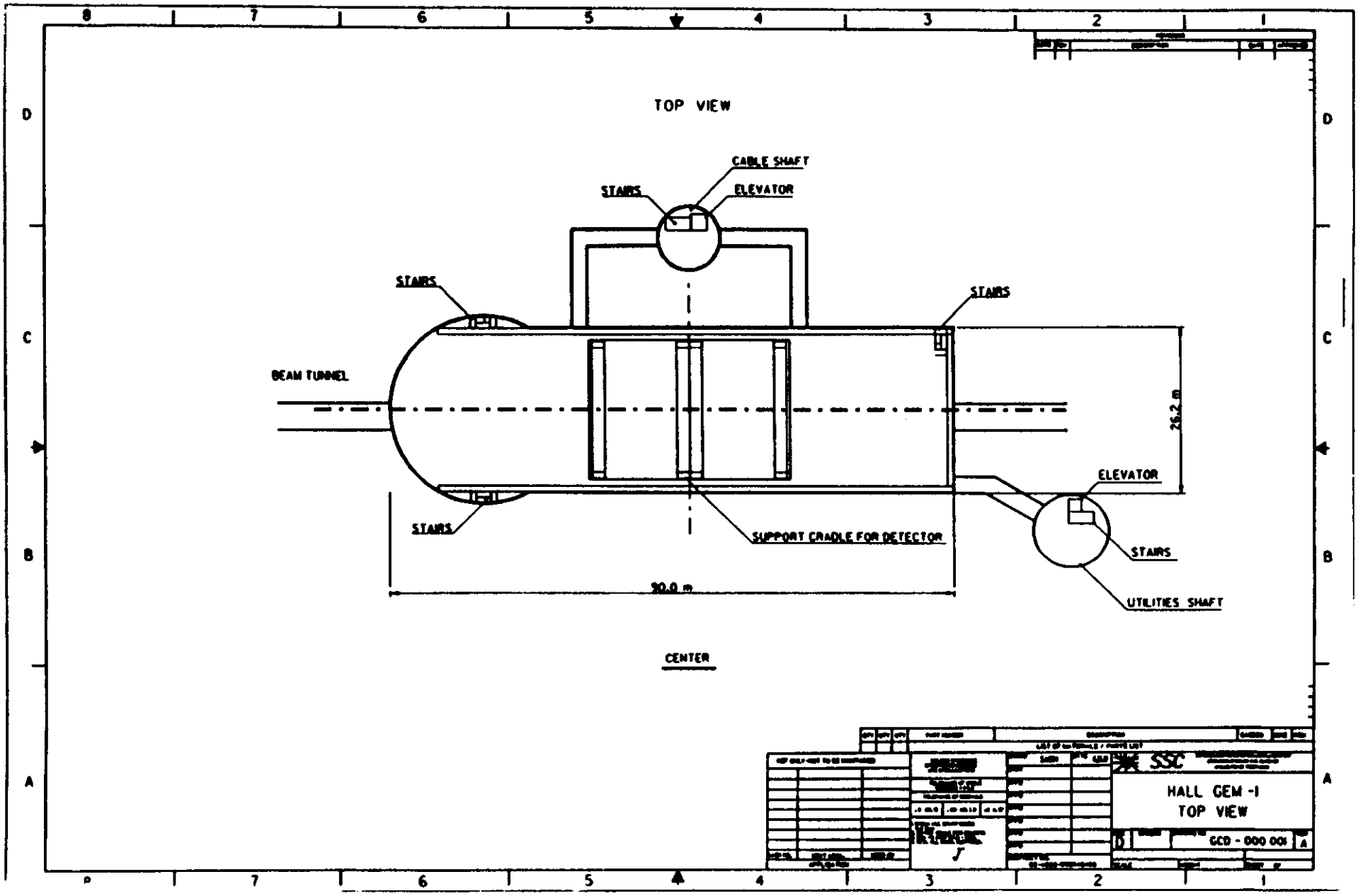

TEST BEAM FACILITIES
MAGNET ENCLOSURES
FUTURE EXPANSION
TEST BEAM CALIBRATION HALL
OFFICE TRAILER COMPLEX
INDUSTRIAL ASSEMBLY BLDG
180M X 35M X 16/30M
MAGNET COIL ASSEMBLY
BOD 9/93
LINE OF BERM AT GRADE LEVEL
INDUSTRIAL ASSEMBLY BLDG
100M X 30M X 16M
DETECTOR 2 CALORIMETER
BOD 6/96
INDUSTRIAL ASSEMBLY BLDG
100M X 30M X 16M
DETECTOR 2 MUON CHAMBER
BOD 6/95
CATAGORY II SHOP FACILITY
& STORES
100M X 30M X 16M
BOD 6/95
POSSIBLE FUTURE BUILDING
INDUSTRIAL
ASSEMBLY
AREA
STEEL FABRICATION
& STAGING AREA
TANK FARM
GAS MIXING HOUSE
40M X 15M X 10M
BOD 8/97
PERSONNEL & EQUIPMENT
HEADHOUSE
BOD 12/96
UTILITIES BUILDING
90M X 24M X 10M
BOD 12/96
OPERATIONS CENTER
28M X 25M
3 LEVELS
BOD 12/96
IR-1
HEADHOUSE
60M X 35M X 30M
BOD 3/96
CONSTRUCTION ZONE
TEMPORARY
STACK
ASSEMBLY
IR-2
CENTRAL CAMPUS
BEAM LINE
LINAC AREA
N
NOTE: STORAGE AREAS TBD
SSC
GEM SURFACE FACILITIES
IR-1

RD Surface Facility Summary of Requirements_June 1991

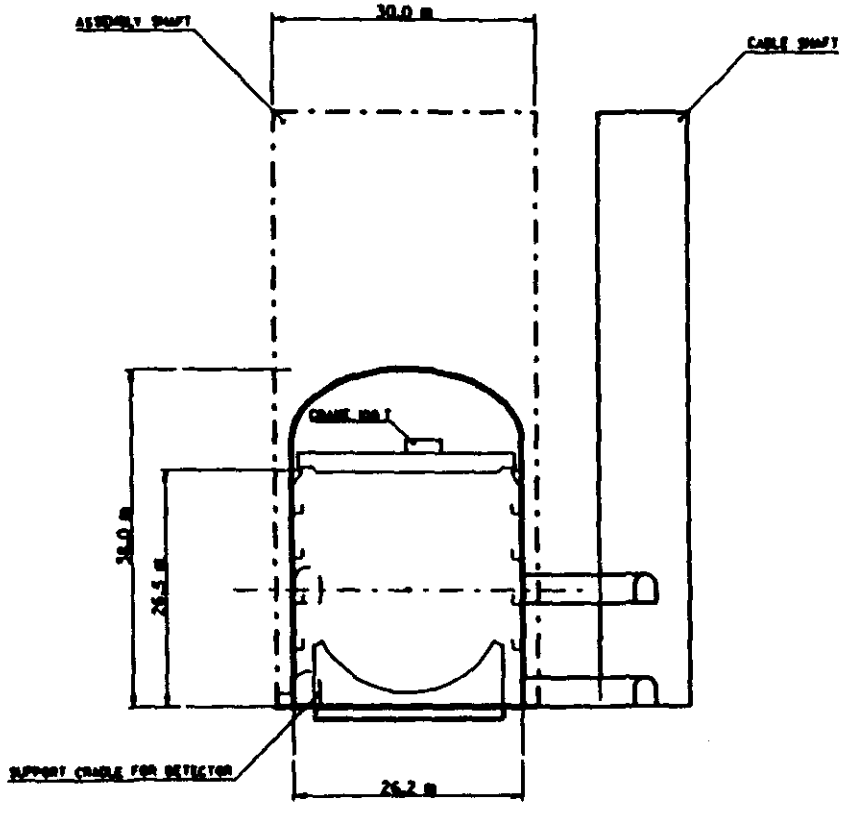
Locations	Area (m2)	Occupancy	Totals /Function Utility	Hdhse	Irnwks	Ind/Ass	Ad/Lab	CC Office
IR1								
Utility	2,520		2,520					
Headhouse	2,244			2,244				
Ironworks	n/a							
Industrial Assembly	6,300	40				6,300		
Admin/Lab (CR)	2,100	12					2,100	
IR4								
Utility	2,244		2,244					
Headhouse	3,672			3,672				
Ironworks	n/a							
Industrial Assembly	6,000	80				6,000		
Admin/Lab & CR	4,006	112					4,006	
IR5								
Utility	1,375		1,375					
Headhouse	360			360				
Ironworks	n/a							
Industrial Assembly	n/a							
Admin/Lab (CR)	670						670	
IR8								
Utility	1,375		1,375					
Headhouse	300			300				
Ironworks	n/a							
Industrial Assembly	n/a							
Admin/Lab (CR)	1,580						1,580	
West Campus								
Industrial Assembly	12,000	160				12,000		
East Campus								
Industrial Assembly	0							
Central Campus								
Office/Lab/Shops	14,775	796						14,775
Total_June 1991	61,521	1,200	7,514	6,576	0	24,300	8,356	14,775
Base Line Total_June 1990	46,617		5,989	7,029	2,888	9,000	16,673	3,888
Comparison	14,904		1,525	-453	-2,888	15,300	-8,317	10,887

(Increase or decrease per function)


ISO VIEW
ASSEMBLY SHAFT
CONCRETE SHIELD
CABLE SHAFT
UTILITIES SHAFT
SUPPORT CRANE
SUPPORT CRADLE FOR DETECTOR
BEAM
NORTH
RING CENTER
SSC
HALL GEM -I
ISO VIEW
GCD- 000 004


TOP VIEW
CABLE SHAFT
STAIRS
ELEVATOR
STAIRS
STAIRS
BEAM TUNNEL
26.2 m
ELEVATOR
STAIRS
SUPPORT CRADLE FOR DETECTOR
STAIRS
90.0 m
UTILITIES SHAFT
CENTER
SSC
HALL GEM -I
TOP VIEW
GCD - 000 001
A

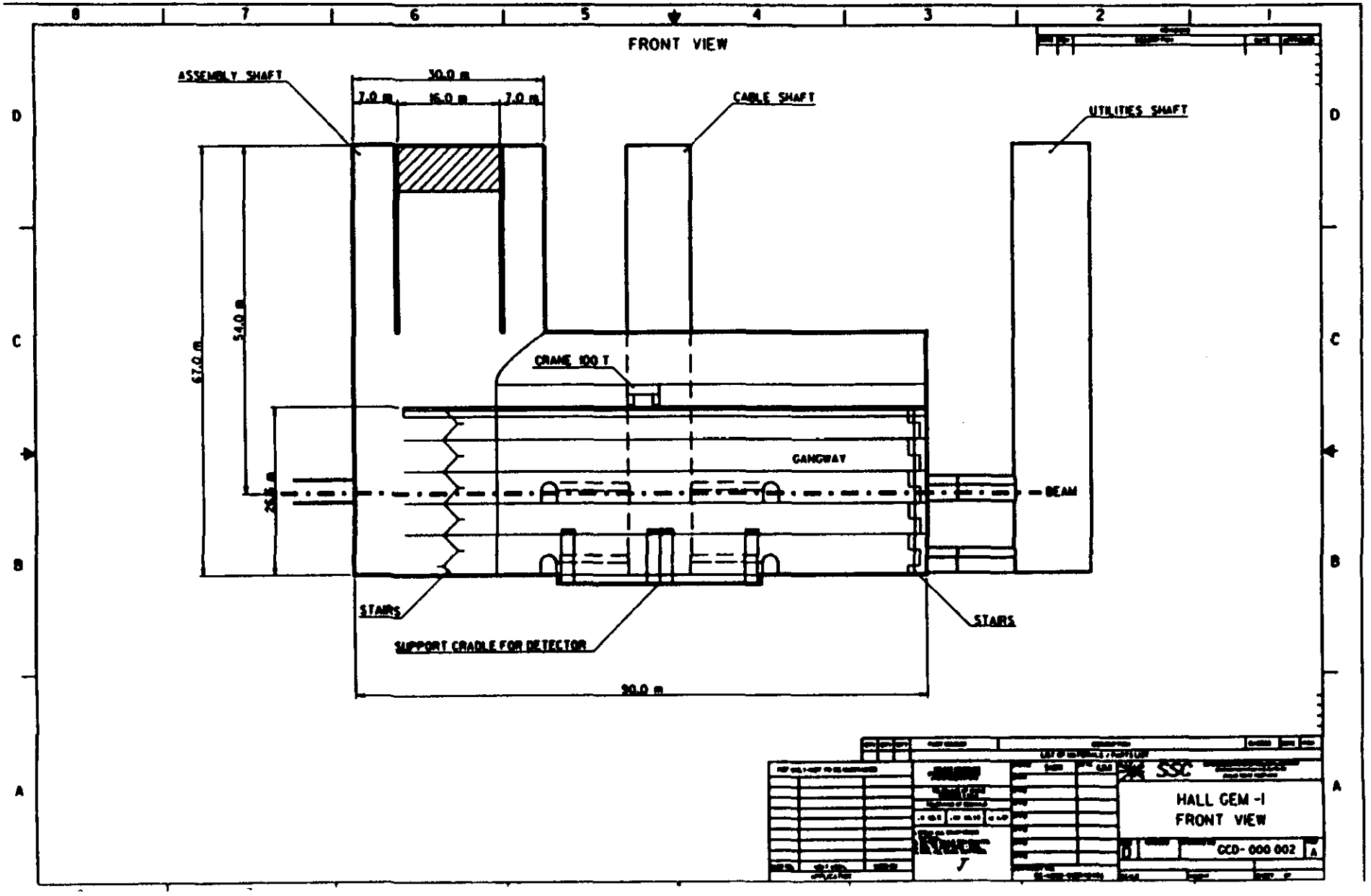
RIGHT VIEW



SSC

HALL GEM -I
RIGHT VIEW

GCD- 000 003

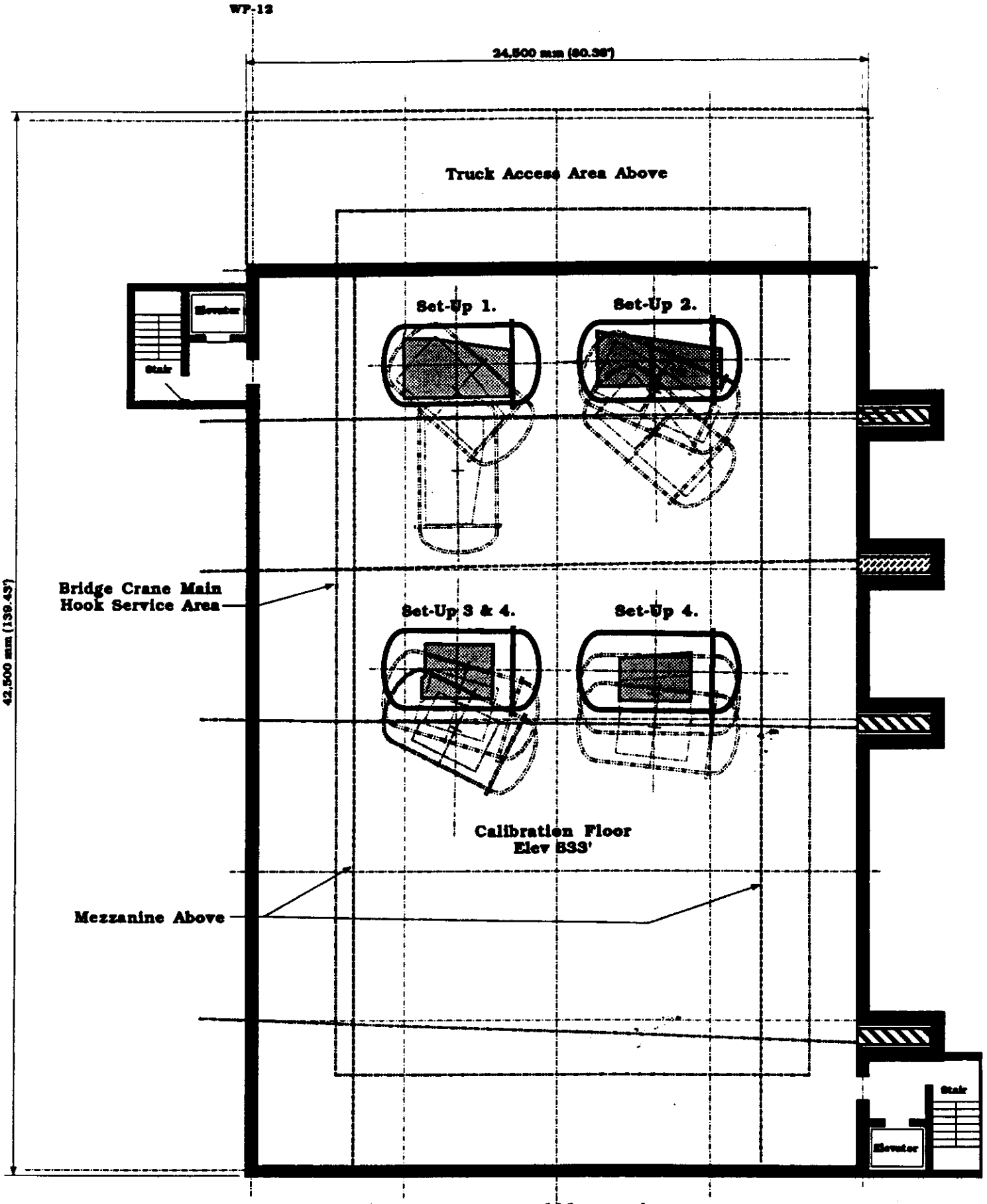

FRONT VIEW
ASSEMBLY SHAFT
30.0 m
7.0 m
16.0 m
7.0 m
CABLE SHAFT
UTILITIES SHAFT
67.0 m
54.0 m
CRANE 100 T
GANGWAY
BEAM
STAIRS
STAIRS
SUPPORT CRADLE FOR DETECTOR
90.0 m
SSC
HALL GEM -I
FRONT VIEW
CCD- 000 002

GEM Facilities:

- Accelerator Interface
  Stray fields vs accelerator components.
  Quad string is fixed; must work around.
  RF Beam stability issues.

- Test Beams (now and future requirements)
  Do we want 200 GeV beams at SSC in '97?
  Decision to proceed will be made in April '92.

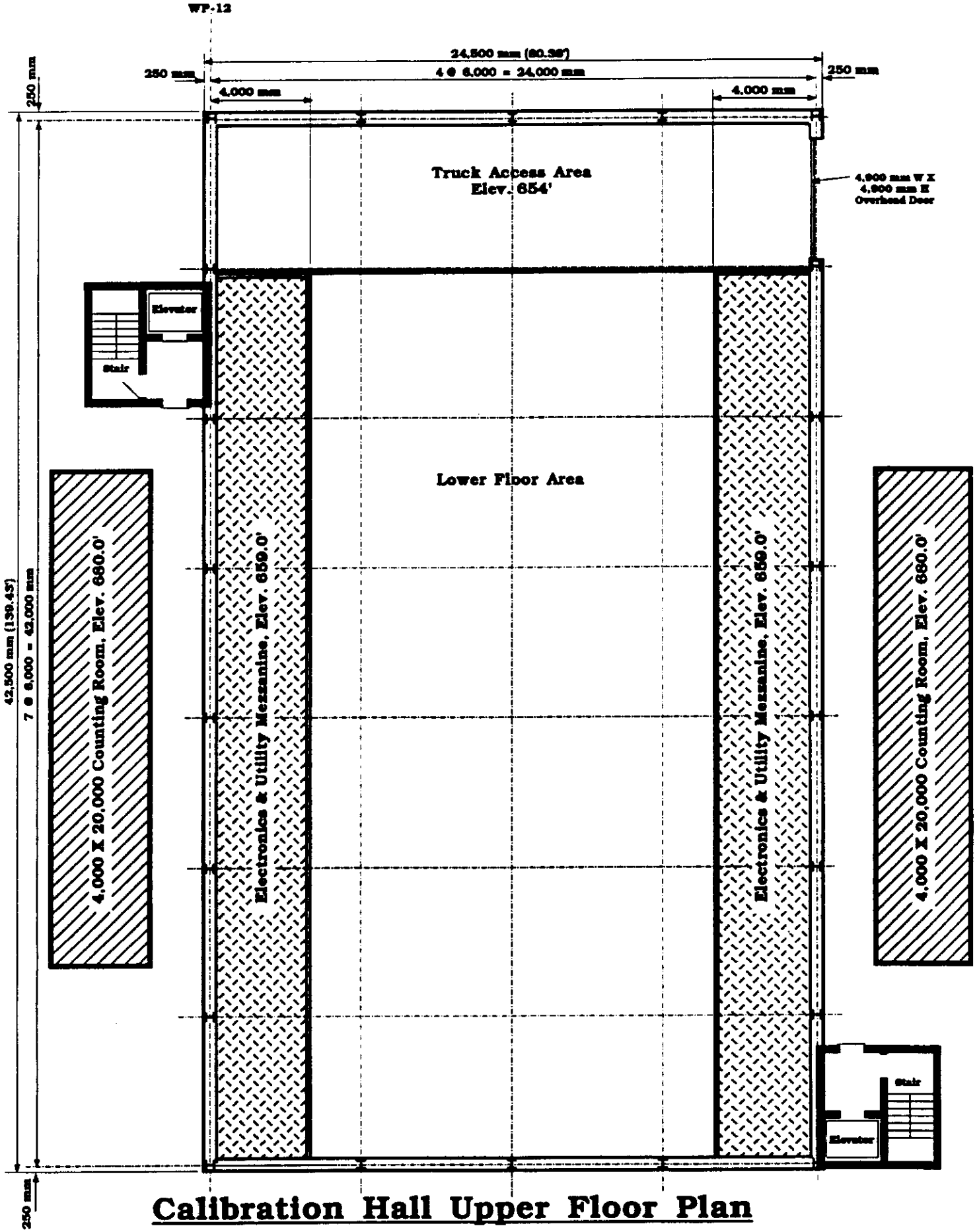
- GEM Experimental Facilities User Requirements (GEFUR)
  Version A will be available on Oct 28 th.



SDC LA Calorimeter Calibration Set-Ups

Scale 1:200

8-27-91



Calibration Hall Upper Floor Plan

Scale 1:200

8-27-91

GEM MAGNET

3/5/91
R. STROYNOWSKI/SMU

- CONTINUING ENGINEERING WORK ON BASE LINE MAGNET DESIGN

- DESIGN TEAM: MIT P. MARSTON et al.
  LIVERMORE T. CHARGIN, G. DEIS, C. JOHNSON et al
  NHMFL (FLORIDA) J. MILLER
  SSCL M. HARRIS, R. RICHARDSON et al.

- FUNDED JULY - SEPTEMBER $200K
- ENGINEERING MEETINGS 23 JULY, 29 AUGUST

GEM MAGNET TECHNICAL PANEL
DESIGN TEAM + OUTSIDE EXPERTS
CHARGE - ASSES THE FEASIBILITY OF DESIGN
- PROVIDE RECOMMENDATIONS AND CHOICES
i.e. INPUT TO DESIGN PROCESS

FIRST MEETING 4-6 SEPTEMBER

- PRESENT EFFORT: FOLLOW-UP OF 2 OPTIONS
  1. SINGLE COIL SUPERCONDUCTING SOLENOID
  2. DOUBLE COIL SUPERCONDUCTING SOLENOID

INITIAL EMPHASIS - SINGLE COIL OPTION
CENTRAL REGION

NO HIGH FIELD OPTION EFFORT

GEM Magnet System Tasks & Funding for 3 month period (K$) (July-September, 1991)		
	LLNL	MIT
Define Baseline & Options Identify Critical Issues Relevant Experience Adequacy and Availability of Technology	4	8
Complete Conceptual Design	25	5
Refine Baseline Design Cost & Costing Algorithms	18	2
Define Conductor & Development Program	4	5
Pole Design & Handling	2	5
Cryogenic System	4	1
Power, Instrumentation, Protection	3	1
Manufacturing Sequence & Flow/Fab. Analysis Experimental Hall Surface Facilities, Fabrication/Test Shield Options	40	2
Fringe Field Effects/Shielding Safety/Operational/Beam optics Experimental Hall/Access Shafts Surface, Counting Room/Environmental	8	15
Magnet/Muon Chambers/Central Detectors Integrated Design/Support/Alignment	35	2
Cost/Risk, FMEA, RAM, etc.	3	2
Schedule & Funding Profile	4	2
Totals (K$)	150	50

Superconducting solenoid with external iron

Relative cost, approximately 1.9 (dominated by the additional cost of a 30-kt iron shell).

Coaxial superconducting solenoids (shielding by annular flux return between coils)

Relative cost, approximately 1.5

Single superconducting solenoid (unshielded)

Relative cost, 1.0

GEM MAGNET TECHNICAL PANEL MEETING

First Session	September 4, 5 & 6
Second Session	September 25, 26 & 27
Third Session	October 10 & 11

LIST OF PARTICIPANTS

Peter Clee, Rutherford Appleton Laboratory (only second session)
Gary Deis, Lawrence Livermore National Laboratory
Mike Harris, SSC Laboratory
Alain Hervé, CERN (only third session)
Coleman Johnson, Lawrence Livermore National Laboratory
Robert Johnson, JBc Associates
E. Klimenko, Kurchatov IAE
Dennis Lieurance, General Dynamics Space Systems
Peter Marston, Massachusetts Institute of Technology
Nickolai Martovetsky, Kurchatov IAE
John Miller, Lawrence Livermore National Laboratory
Bruce Montgomery, Massachusetts Institute of Technology (Only first session)
Dr. Roberto Penco, Ensaldo Compontenti
Robert Richardson, SSC Laboratory
Dr. Gary Sanders, Los Alamos National Laboratory
Ray Stefanski, SSC Laboratory
Dr. Richard Stroynowski, Caltech High Energy Physics
Francois Wittgenstein, CERN (only second session)
Ronn Woolley, SSC Laboratory

BASE LINE DESIGN

GEM Magnet Subsystem

Single-coil Design

Major Parameters List
Rev. 2
8/28/91

	Parameter	Symbol	Unit	Value	Ref.	Note	Rev
1.	Central Induction	Bi	T	0.80	-	1	1
2.	Mean radius of windings	Rw	m	8.9	6	2	1
3.	Outer Radius of outer cryostat vessel	Rv,o	m	9.463	6	2	1
4.	Inner Radius of inner cryostat vessel	Rv,i	m	8.4	6	2	1
5.	Inner Radius, magnet subsystem		m	8.3	1	2	1
6.	Coil length, end-to-end	Li	m	28.5	1	2	1
7.	Pole-to-pole inside length	L	m	29.0	1	-	1
8.	Cryostat vessel length (end-to-end)	Lv	m	30.0	1	2	1
9.	Conductor Length	Lc	km	24	1	2	1
10.	Total mass of windings	Mw	t	440	1	2	1
11.	Total mass cold structure (per half)	Mcs	t	330	6	2	1
12.	Total mass cryostat vessel(each half)	Mv	t	555	6	2	1
13.	Total mass iron end poles (each pole)	Mp	t	2950	1	2	1
14.	Radial pressure on windings	Pr	kPa	255	1	2	1
15.	Operating current	I	kA	52.5	9	3	2
16.	Stored Energy	Es	GJ	1.84	1	2	1
17.	Inductance	H	H	1.47	1	2	1
18.	Number of turns	Nt	#	408	9	3	2
19.	Thickness, inner thermal shield		m	0.100	6	-	1
20.	Thickness, inner cryostat	tv,i	m	0.019	6	-	1
21.	Outer radius, inner cryostat vessel	Rvi,o	m	8.419	6	-	1
22.	Inner radius, inner LN shield		m	8.649	6	-	1
23.	Outer radius, inner LN shield		m	8.651	6	-	1
24.	Inner radius, conductor		m	8.850	6	-	1
25.	Mean radius, conductor		m	8.900	6	-	1
26.	Outer radius, conductor		m	8.950	6	-	1
27.	Inner radius, bobbin		m	8.950	6	-	1
28.	Outer radius, bobbin		m	9.000	6	-	1
29.	Inner radius, outer LN shield		m	9.199	6	-	1
30.	Outer radius, outer LN shield		m	9.201	6	-	1
31.	Thickness, outer cryostat vessel	tv,o	m	0.0635	6	-	1
32.	Inner radius, outer cryostat vessel	Rvo,i	m	9.400	6	-	1
33.	Overall outer radius (outside ribs)	Ro	m	9.4635	-	-	1
34.	Depth of outer ribs		m	0.000	-	-	1
35.	Number of coil/cryostat assemblies		#	2	-	-	1
36.	Number of ribs per coil assembly		#	0	-	-	1
37.	Thickness of cryostat vessel ends		m	0.010	6	-	1
38.	Actual axial winding length per assembly		m	14.25	6	-	1
39.	Central membrane maximum z		m	0.025	6	-	1
40.	Cryostat inner end minimum z		m	0.025	6	-	1
41.	Cryostat inner end maximum z		m	0.125	6	-	1

	Parameter	Symbol	Unit	Value	Ref.	Note	Rev
42.	LN shield minimum z		m	0.162	6	-	1
43.	Bobbin minimum z		m	0.200	6	-	1
44.	Winding minimum z		m	0.250	6	-	1
45.	Winding maximum z		m	14.500	6	-	1
46.	Bobbin maximum z		m	14.600	6	-	1
47.	LN shield maximum z		m	14.750	6	-	1
48.	Cryostat outer end minimum z		m	14.900	6	-	1
49.	Cryostat outer end maximum z		m	15.000	6	-	1
50.	Pole face minimum z		m	14.500	1	-	1
51.	Number of turns		#	?	-	-	1
52.	Axial force on poles		N	63.5e6	3	-	1
53.	Axial force on conductor		N	27.9e6	7	-	1
54.	Mass of one muon sector		t	11.4	5	-	1
55.	Number of central muon sectors per half		#	16	5	-	1
56.	Radius of CG of central muon sectors		m	6.22	5	-	1
57.	Z-location of CG of central muon sectors		m	3.89	5	-	1
57.	Magnet axis height above hall floor		m	13.0	8	-	2

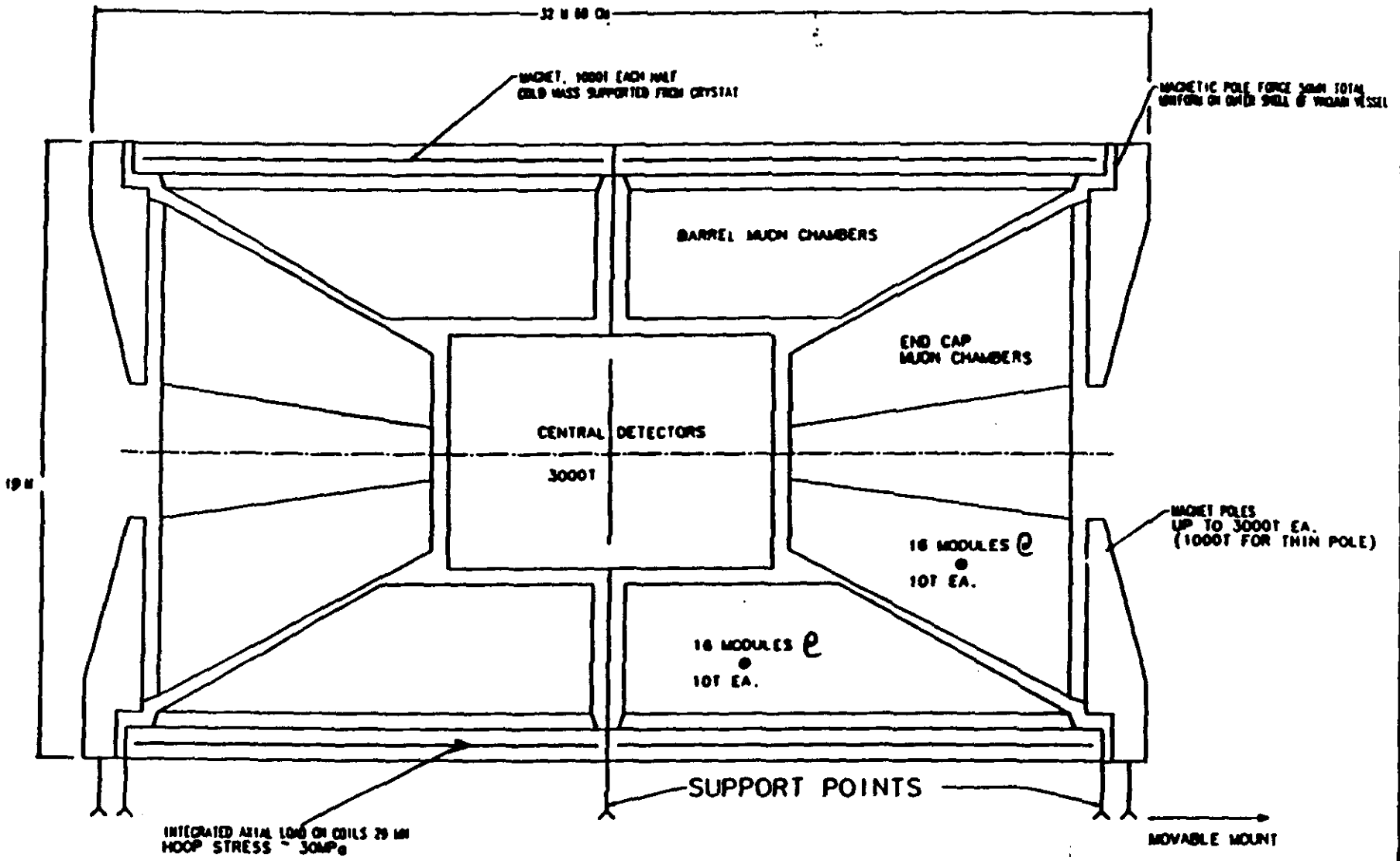
References

9. P Martson calculation 8/27/91
8. GCD - 000002 (7/25/91 version)
7. G. Deis notes, "Axial Force on Coil" 8/13/91
6. P Marston notes, 8/12/91
5. F. Nimblett estimates, 8/9/91
4. Obsolete
3. P. Marston calculation, per G. Deis
2. Obsolete
1. Second Detector EOI

Notes

3. 8/28/91 - Values revised from Ref1 values, based on more detailed design and calc's by P Martson.
2. 8/8/91 - Value revised from Ref1 value, based on more detailed design and calc's.
1. 8/8/91 - Ref 1 actually shows 0.823T, and historical number is 0.83T.

Time to charge it up ~ 1 h
Discharge time ~ 5÷10 min



GEM GLOBAL SUPPORT SCHEME

Magnet Subsystem Engineering Status

- Single-coil concept
  - "first pass" done on all major magnet elements
  - electromagnetic calculations done for baseline and options
  - first edition of magnet specifications sent out
  - calculations now in progress to refine and complete single-coil design: cold-mass supports, vessel support saddle, vessel stiffeners, etc
  - initial studies on shell fabrication have begun
  - assembly schedule is being examined separately
  - quench calculations complete for 2 conductor designs
  - performance vs eta calculations completed for 2 pole designs

- Double-coil concept
  - calculations in progress on magnetic shielding options
  - "first pass" design of two-coil concept in progress

SINGLE COIL FRINGE FIELD

R. P. Woolley report – NO SMOKING GUN

ENVIROMENTAL PROBLEM – 35 GAUSS AT THE SURFACE (54m).

- REGULATIONS REQUIRE CONTROLLED ACCESS TO ALL AREAS WITH > 5 GAUSS FIELD
- PACEMAKERS CAN BE AFFECTED AT 15-17 GAUSS
- NO OBVIOUS OTHER HEALTH HAZARDS

OPTIONS UNDER STUDY

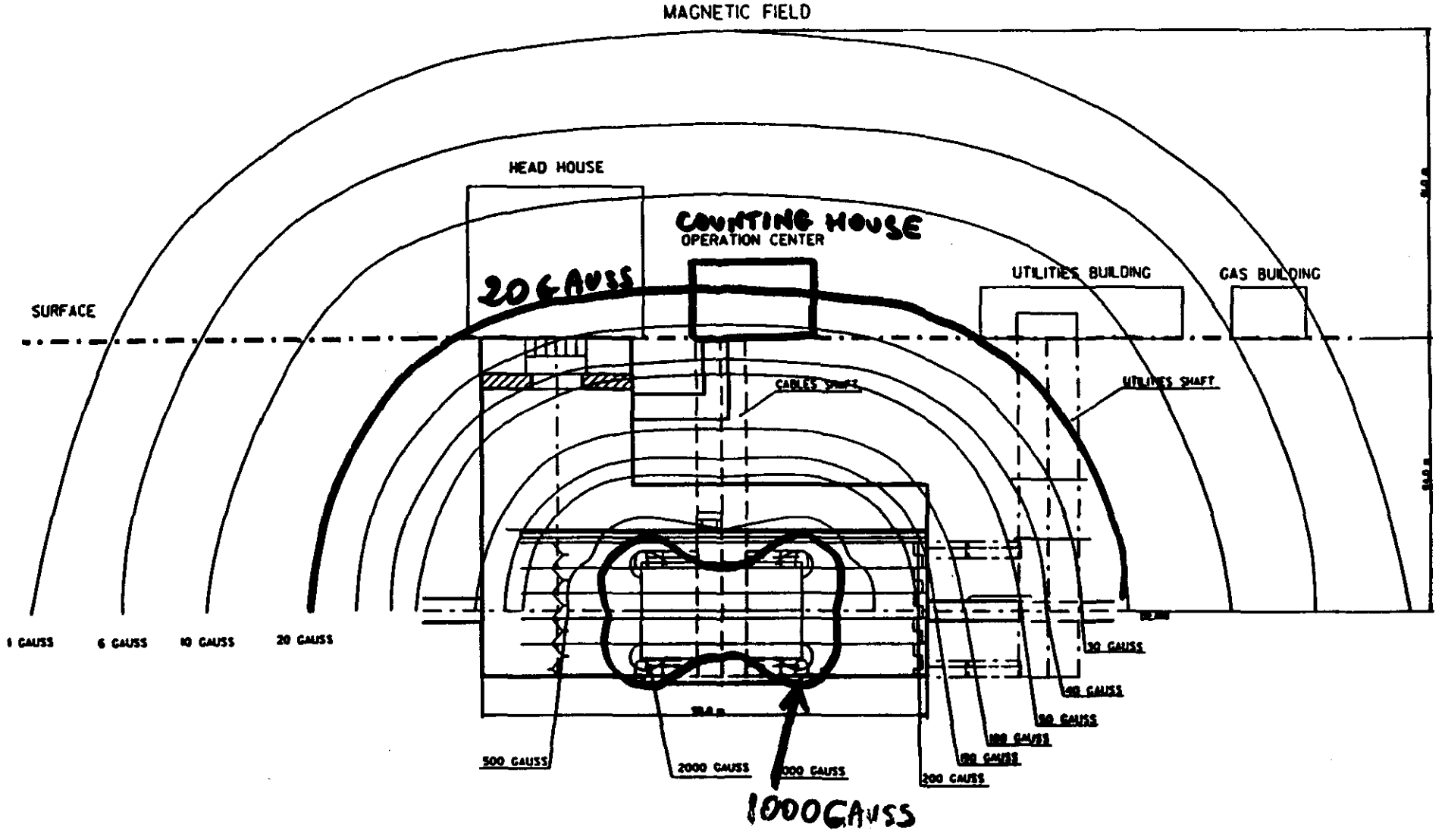
- SHIELD THE COUNTING HOUSE ~$150K
- FENCE AROUND THE 5 GAUSS PERIMETER
- RESTRICT ACCESS FOR PEOPLE WITH PACEMAKERS

- SHIELD SURFACE WITH IRON PLATE
  200 × 200 m 5 ÷ 15 cm thick plate ~$5M
- BUILD A HILL ~50 m high
- GO TO DOUBLE COIL

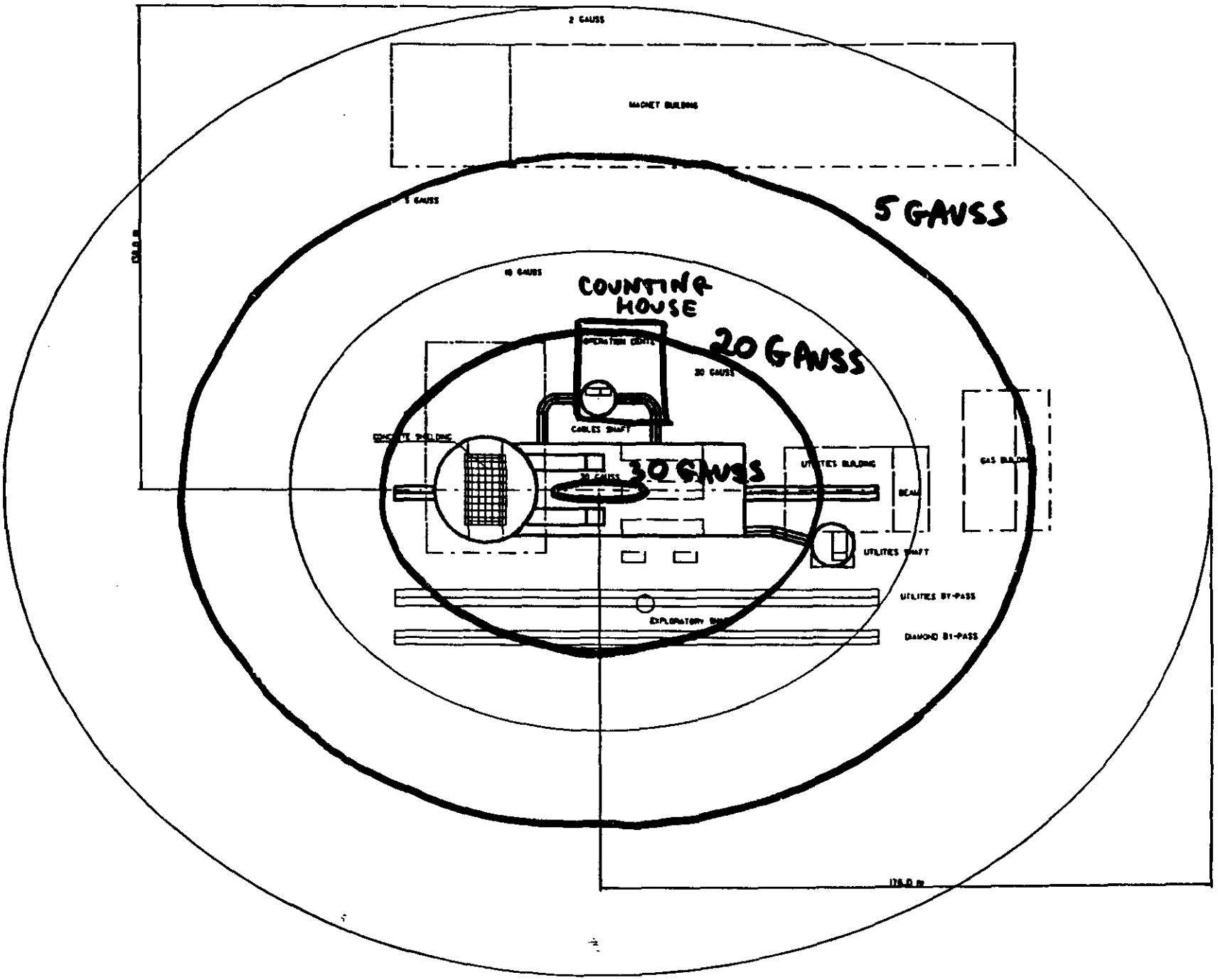
Woolley's report sent to F. Gilman and Roy Schnitters

- FRINGE FIELD IN EXPERIMENTAL HALL
  - LARGE 1-2 kG NEAR DETECTOR
  - TOOLS, GAS BOTTLES, FANS, PUMPS, MOTORS etc WILL BE AFFECTED
  - PERSONNEL PROTECTION SYSTEM UNDER DISCUSSION

MIT THICK POLE OPTION



MIT THICK POLE OPTION



SSC GEM Magnetic Field Safety & Health Effects

R.P.Woolley

Table 4. Sensitivity of Equipment and Component

	>5 G	>10 G	>100 G	>1000 G
Data Acquisition System				
Computer	x			
Monitors				
Black & white		x		
Color	x			
Instrumentation & Control				
Relay			x	
Solid-state device			x	
Magnetic solenoids, valves			x	
Safety device				x
Analog display			x	
Vacuum & Refrigerator				
Mechanical pump			x	
Turbo pump			x	
Electric motors			x	
Ferro-fluidic seals				x

x: shielding is needed

OTHER CRITICAL ISSUES

- POLE DESIGN
  - COUPLED TO MUON SYSTEM
  - PHYSICS ISSUE
    THIN POLE EASIER TO SUPPORT BUT
    WORSE $\int B dl$ for $\eta \sim 2.5$

- TIME

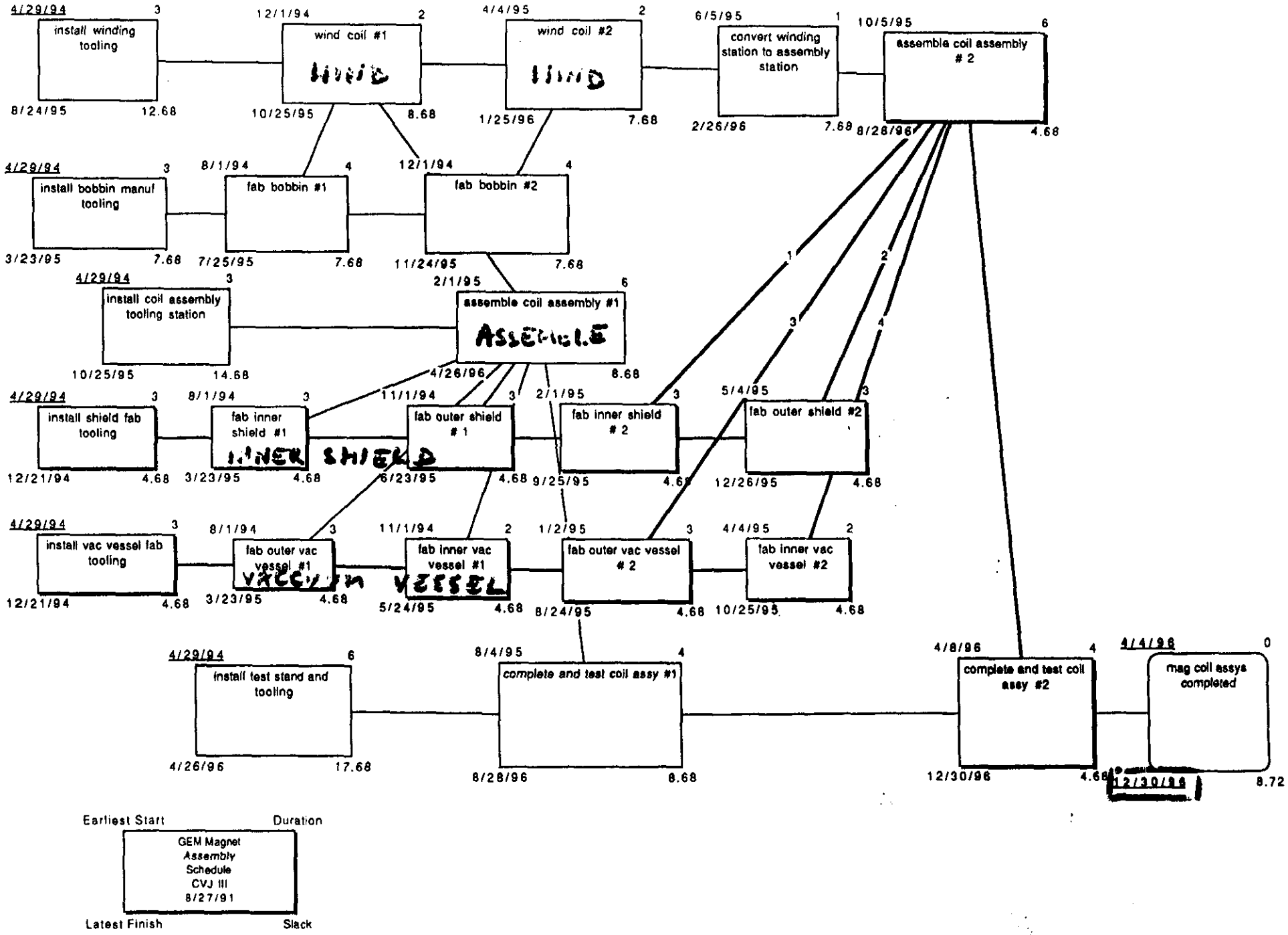
DETECTOR INSTALLATION SCHEDULE REQUIRES THAT MAGNET IS COMPLETED, TESTED AND MAPPED AT THE END OF 1996.

LLL ATTEMPT AT SCHEDULE TO FIT THIS REQUIREMENT MAY NOT BE REALISTIC!! REQUIRES START OF CONSTRUCTION OF MAGNET ASSEMBLY BUILDING AT THE END OF THIS YEAR

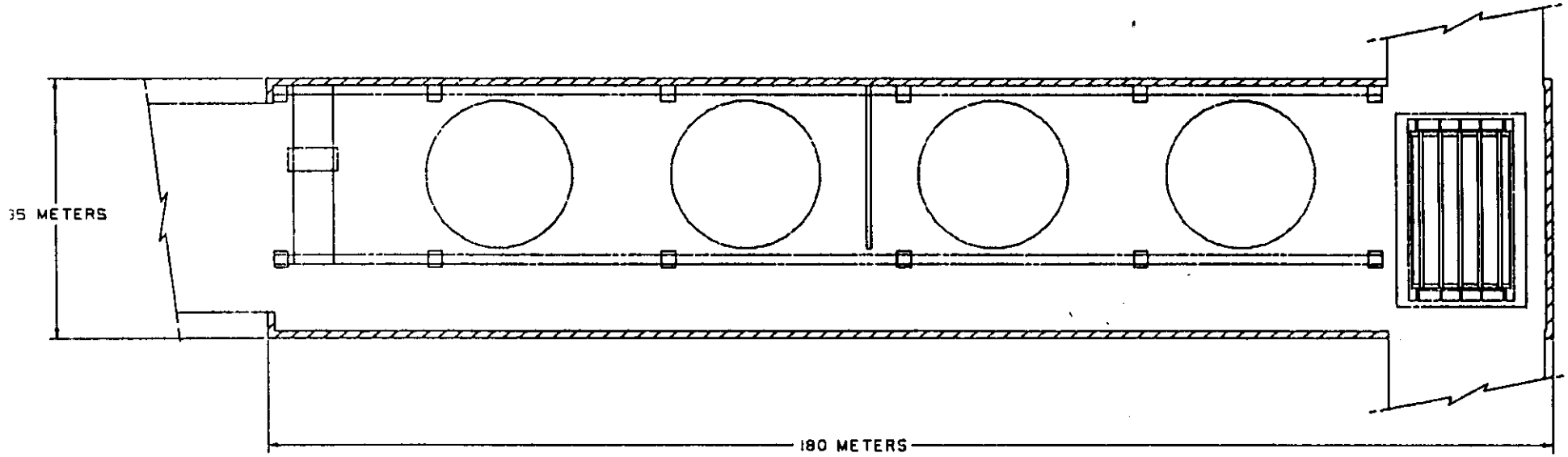
- SSCL ATTEMPT AT SCHEDULE SHOWS ~1 YEAR DELAY
- SERIOUS REVIEW BY MAGNET PANEL NOW
- MANY DESIGN DECISIONS NEEDED SOON

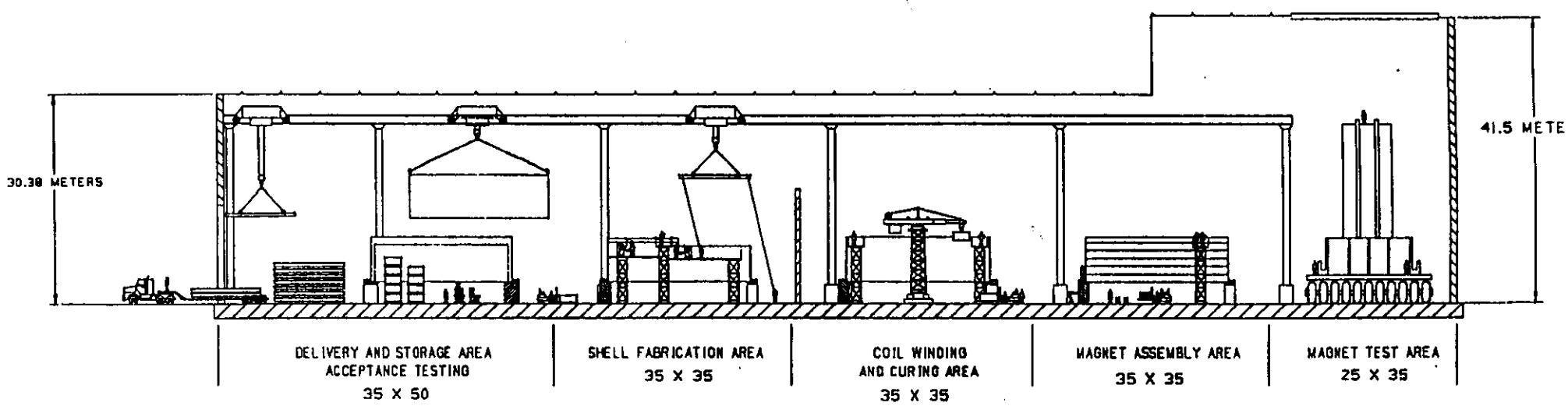
FUNDING PROFILE

- MOST OF DESIGN ENGINEERING FUNDS NEEDED NEXT YEAR
- COMMITMENT TO TOOLING AND PROCUREMENT IN NEXT 2 YEARS


install winding tooling
wind coil #1
wind coil #2
convert winding station to assembly station
assemble coil assembly # 2
install bobbin manuf tooling
fab bobbin #1
fab bobbin #2
install coil assembly tooling station
assemble coil assembly #1
install shield fab tooling
fab inner shield #1
fab outer shield # 1
fab inner shield # 2
fab outer shield #2
install vac vessel fab tooling
fab outer vac vessel #1
fab inner vac vessel #1
fab outer vac vessel # 2
fab inner vac vessel #2
install test stand and tooling
complete and test coil assy #1
complete and test coil assy #2
mag coil assys completed
Earliest Start
Duration
GEM Magnet Assembly Schedule CVJ III 8/27/91
Latest Finish
Slack

SSC DETECTOR 2 MAGNET FABRICATION FACILITY





REPORT FROM MUON GROUP

S. Ahlen

July 19 - Management Plan

July 24 - Discussed Engineering Plan with Sanders

Aug. 1 - Requested Muon Group Names (~130 people)

Aug. 4 - Scheduled Aug. 23 meeting

Aug. 7 - Sent out criteria list

Aug. 8 -
- Sent "standard form" to "advocates"
- Sent out 1st agenda for Aug. 23 meeting
- "CHARTER" from BB/WW: "by Oct. 3 focus on two technologies with detailed prototype + engineering plan"

Aug. 23 - Muon meeting in Boston

Aug. 23 Meeting

37 people from 15 institutions

Fackler (L3)	Zhou (SS tubes)
Miller (straws)	McNeil (High B)
Osborne (LST's)	Korytov (FNAL)
Pless (RPC's)	Sullivan (magnet)
Whitaker (Pads)	Nimblett (plan)
Weinstein (Iarocci Tubes)	Hanlon (alignment)

DECIDED TO:

By Aug. 30, answer 3 questions:

1) Favorite?
2) Why the best?
3) # 2 Choice

By Sept. 2, Taylor / Ahlen send out critiques

Sept. 6 – "no holds barred" discussion

About 2 weeks later decision will be announced.

ENGINEERING PLAN

2 { F. Nimblett (Draper) - coordinate mech. eng.
Todd Hamilton (") - WBS / costing
Bernie Antkowiack (") - structural analyst

1 { Jack Hanlon (LANL) - global alignment
Brian Smith (") - central membrane, etc.

Coleman Johnson (LLNL) - Overlap of <u>muon</u> and <u>magnet</u>

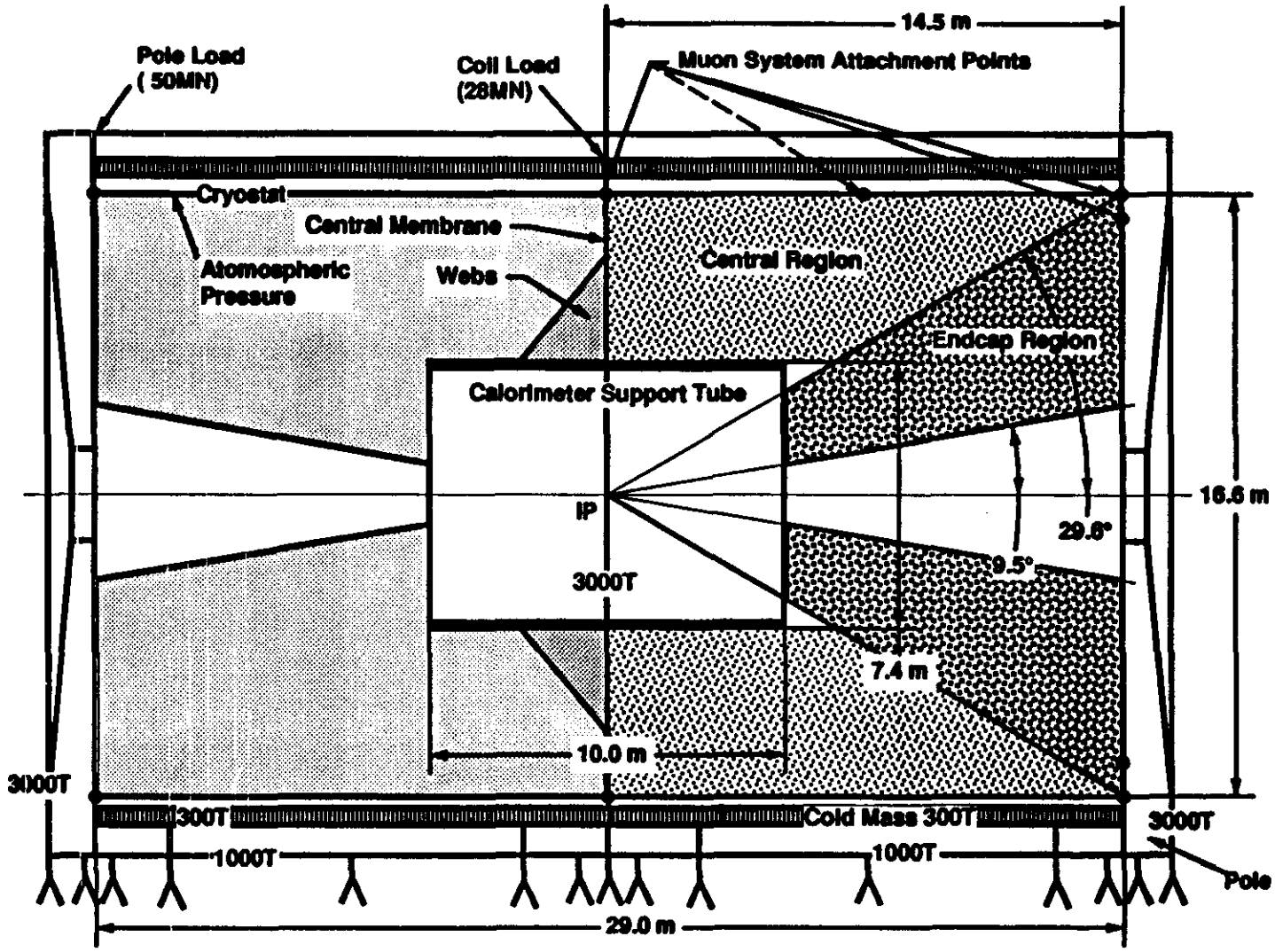
DETAIL CHAMBER WORK:

<u>DRAPER</u>: LST's + PADS

<u>LANL</u>: Pressurized Tubes

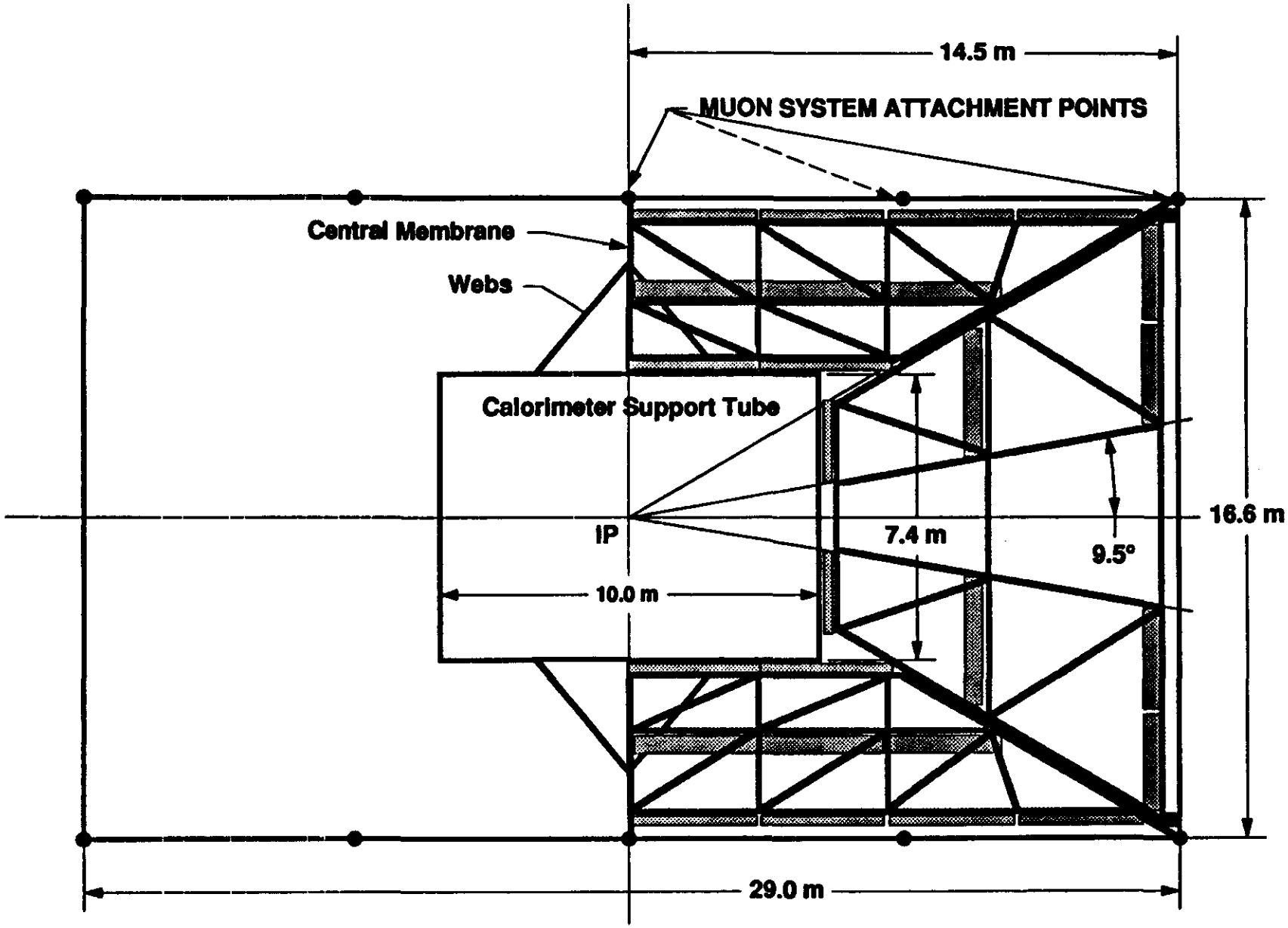
ELECTRONICS - Eric Hazen (BU)
- costing, liason with trigger/DAQ engineers

Jim Sullivan - momentum resolution calculations for various magnet designs



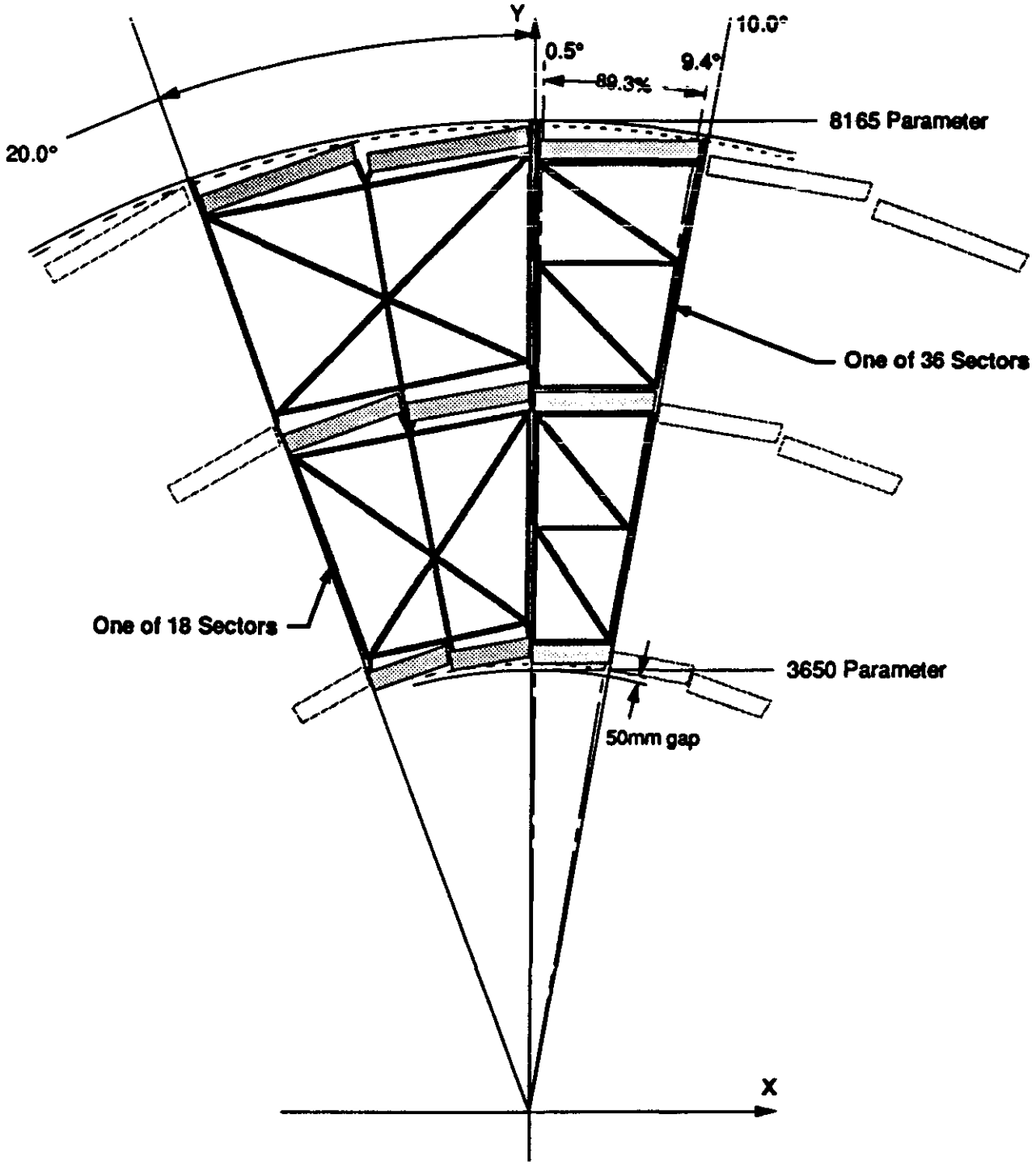
Elevation of GEM Magnet/ Muon System

F. Nimblett 8/21/91



ELEVATION OF PDT MUON SYSTEM

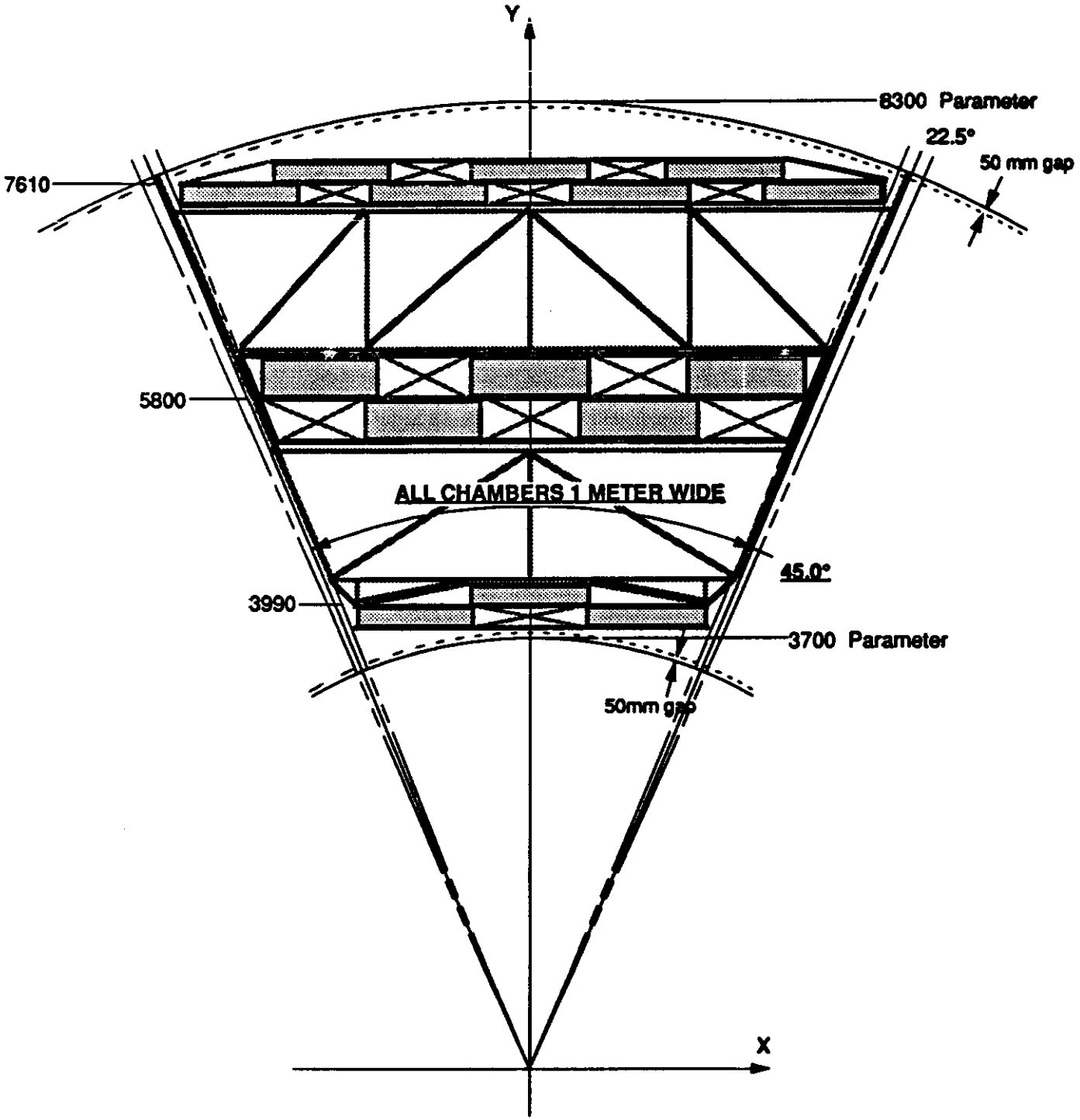
F. Nimblett
21 August 1991



Gas Pad Muon System

Central Region Section

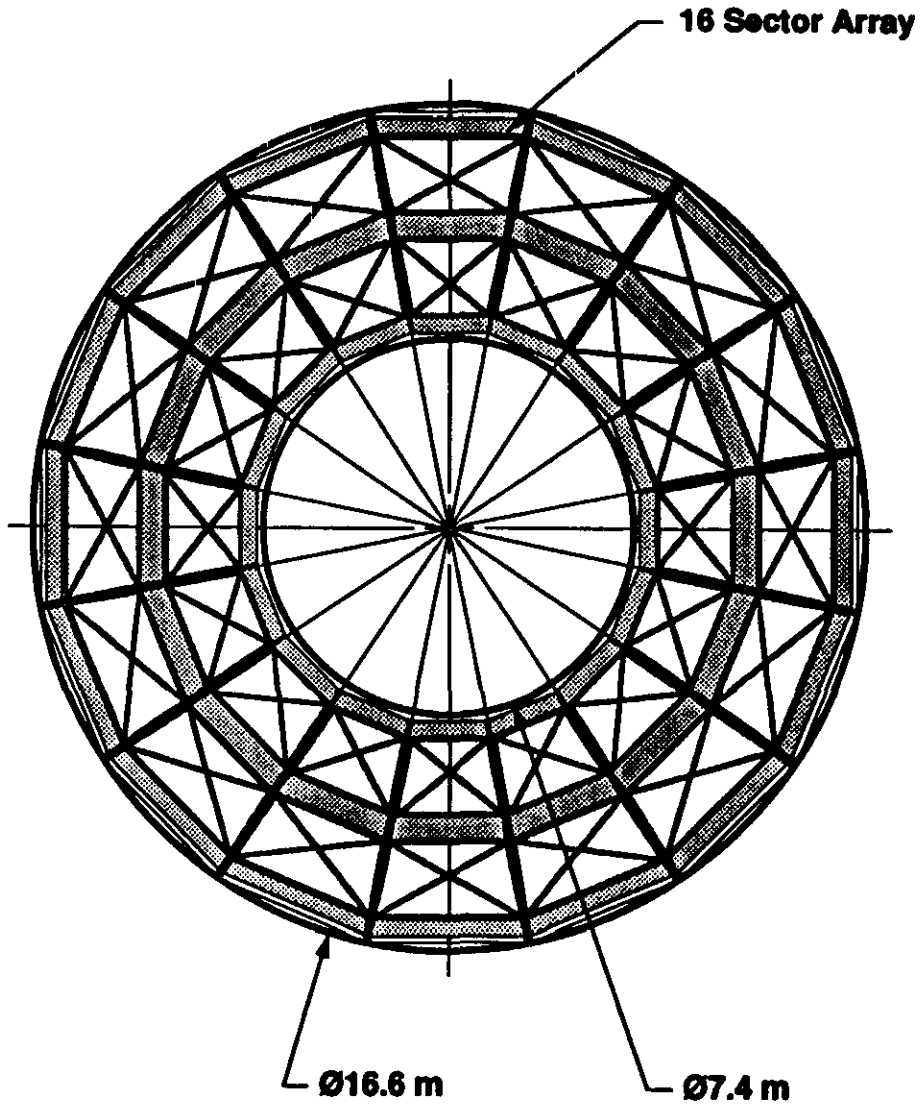
F. Nimblett- Study.2
21 August 1991
Scale 1:50



Limited Streamer Tube Muon System

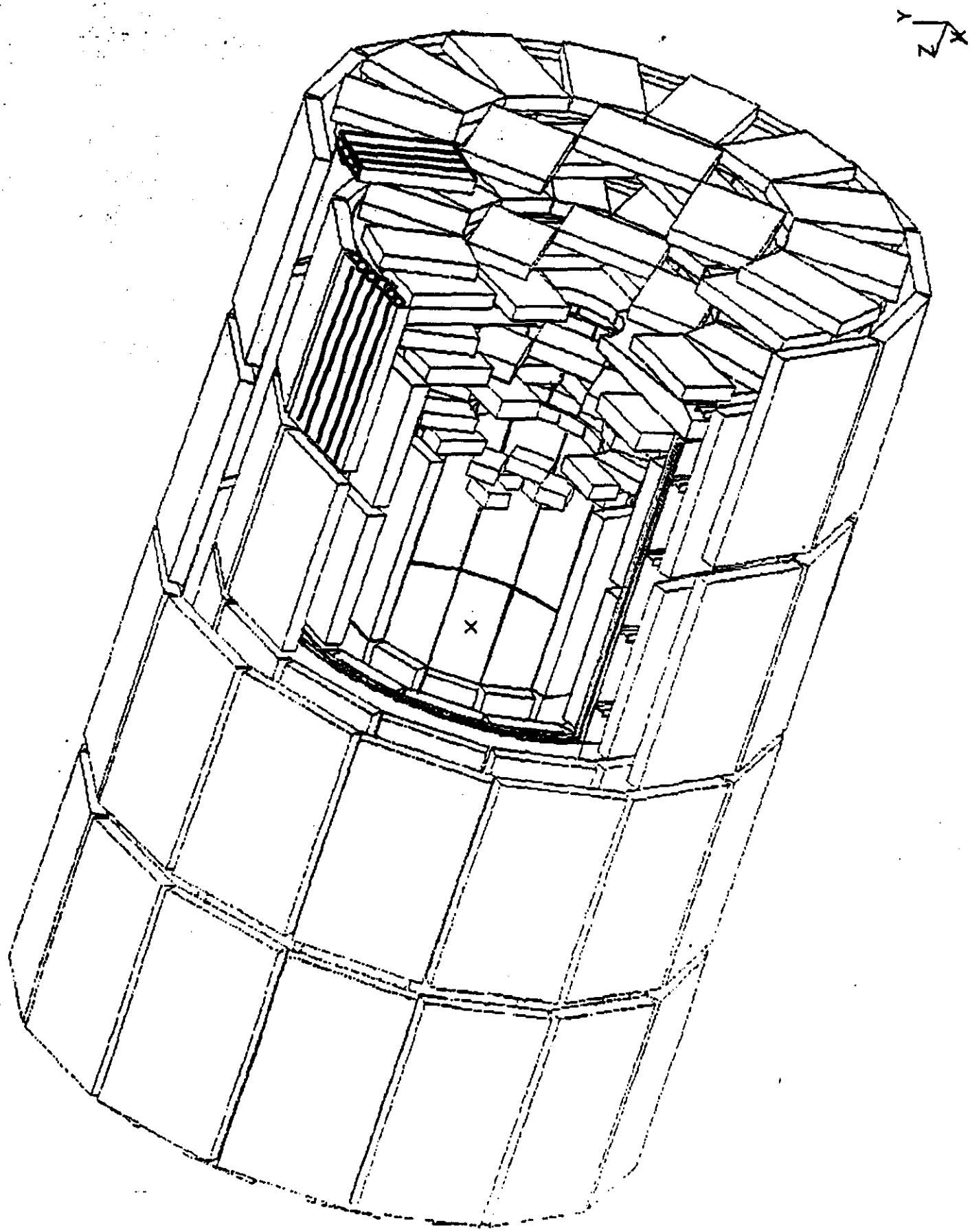
Central Region Section

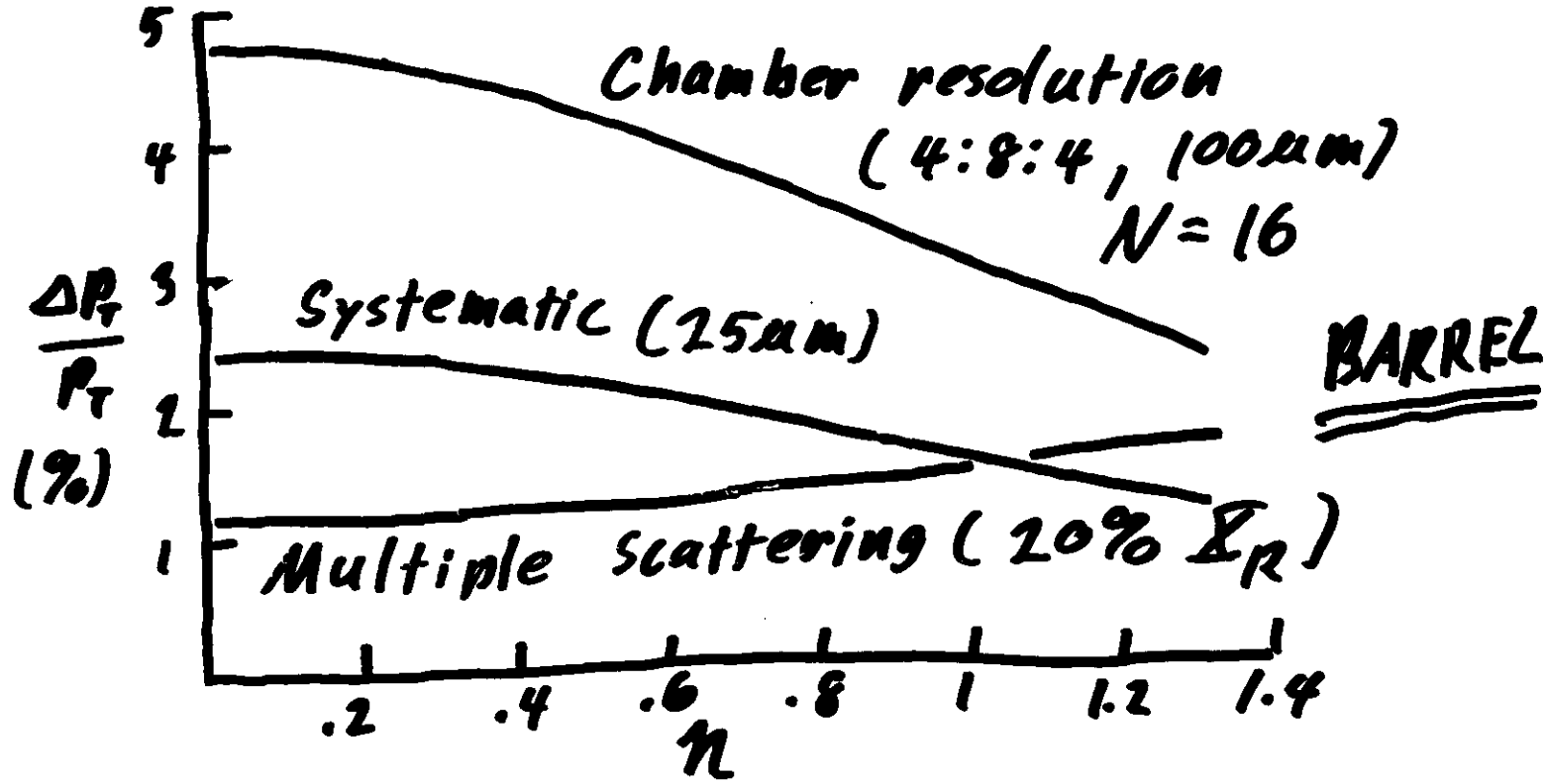
F. Nimblett - LST Study.2
19 Aug 91
Scale 1:50

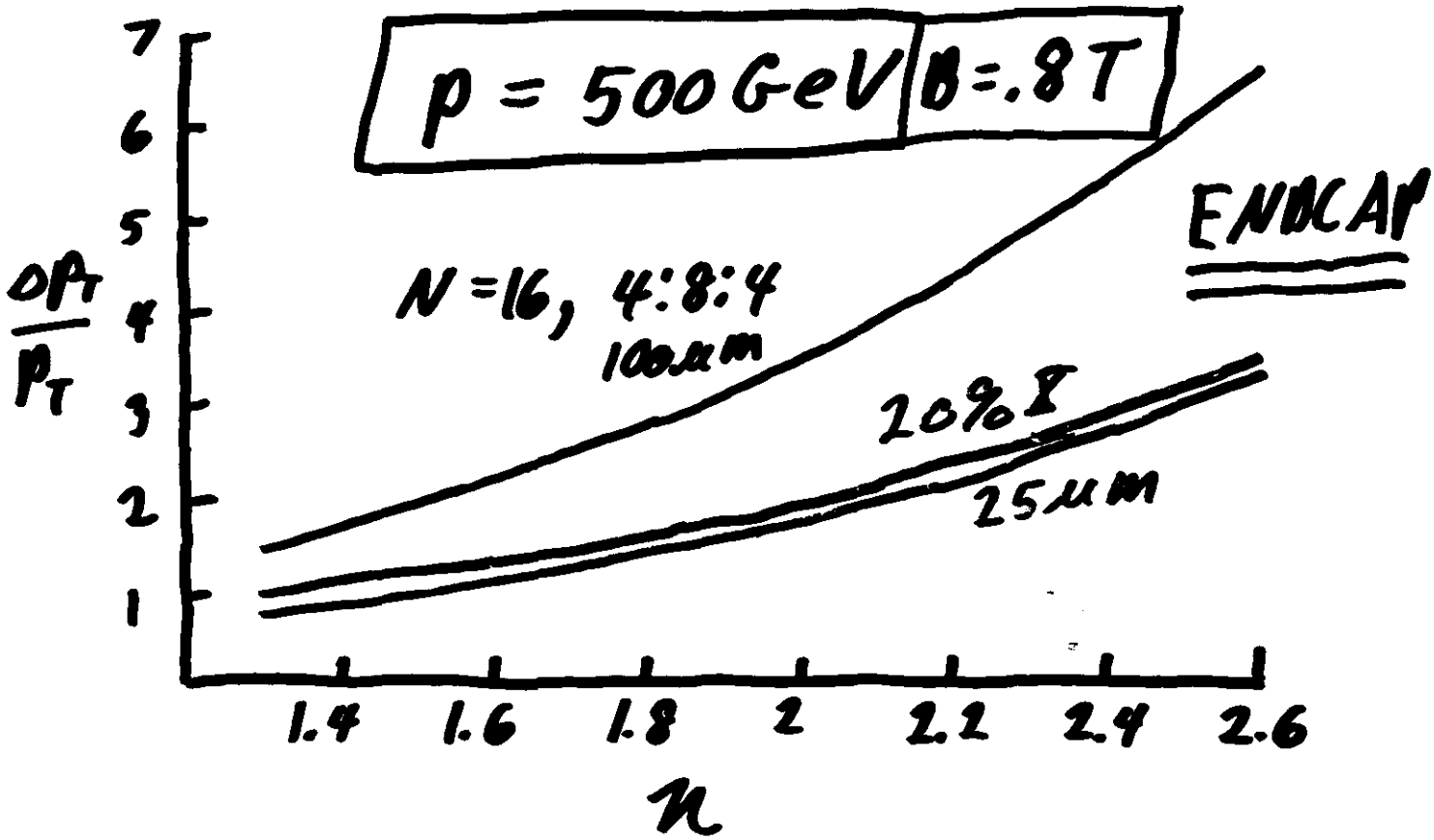


END VIEW PDT MUON SYSTEM
(Central Region shown with support structure)

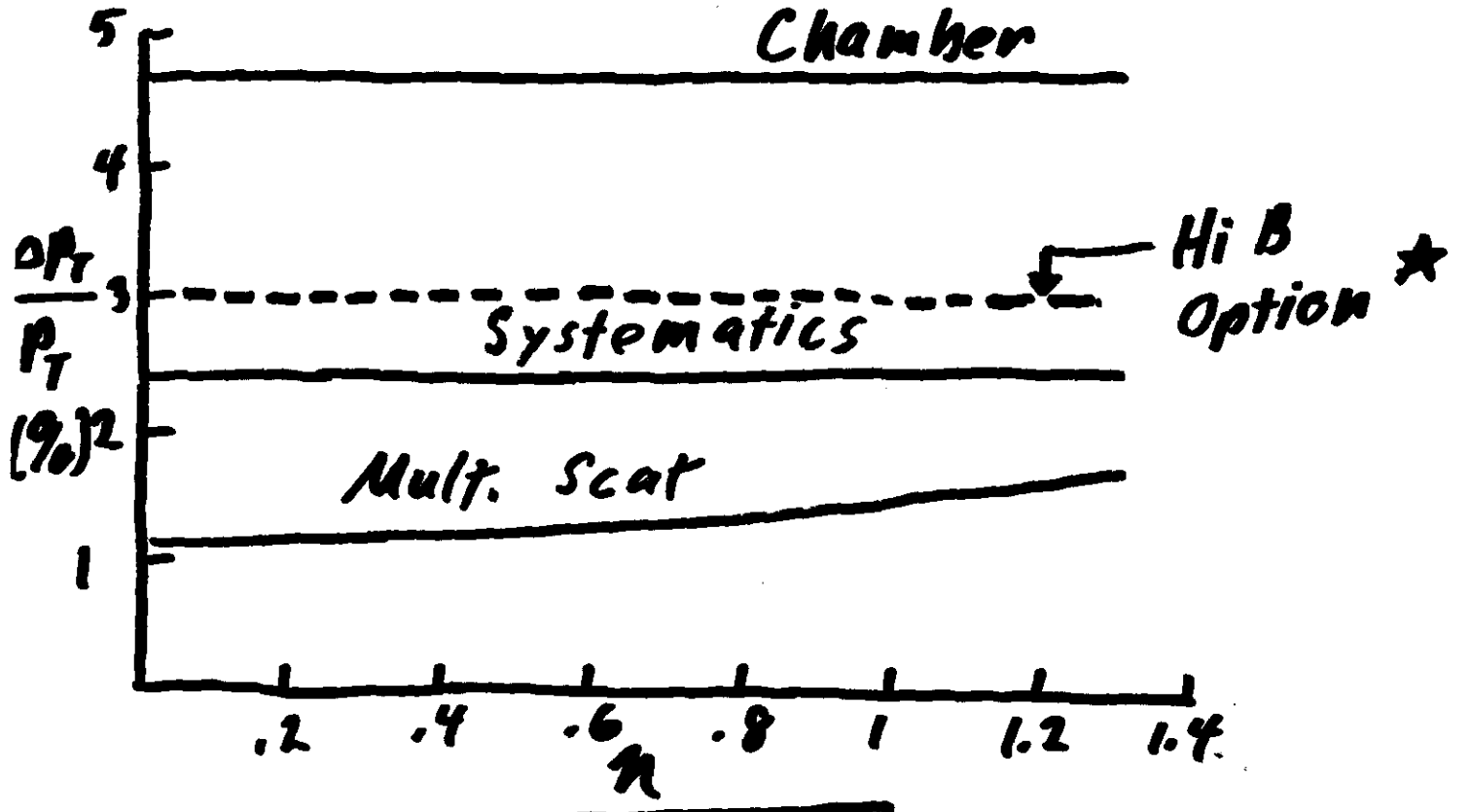
F. Nimblett
21 August 1991

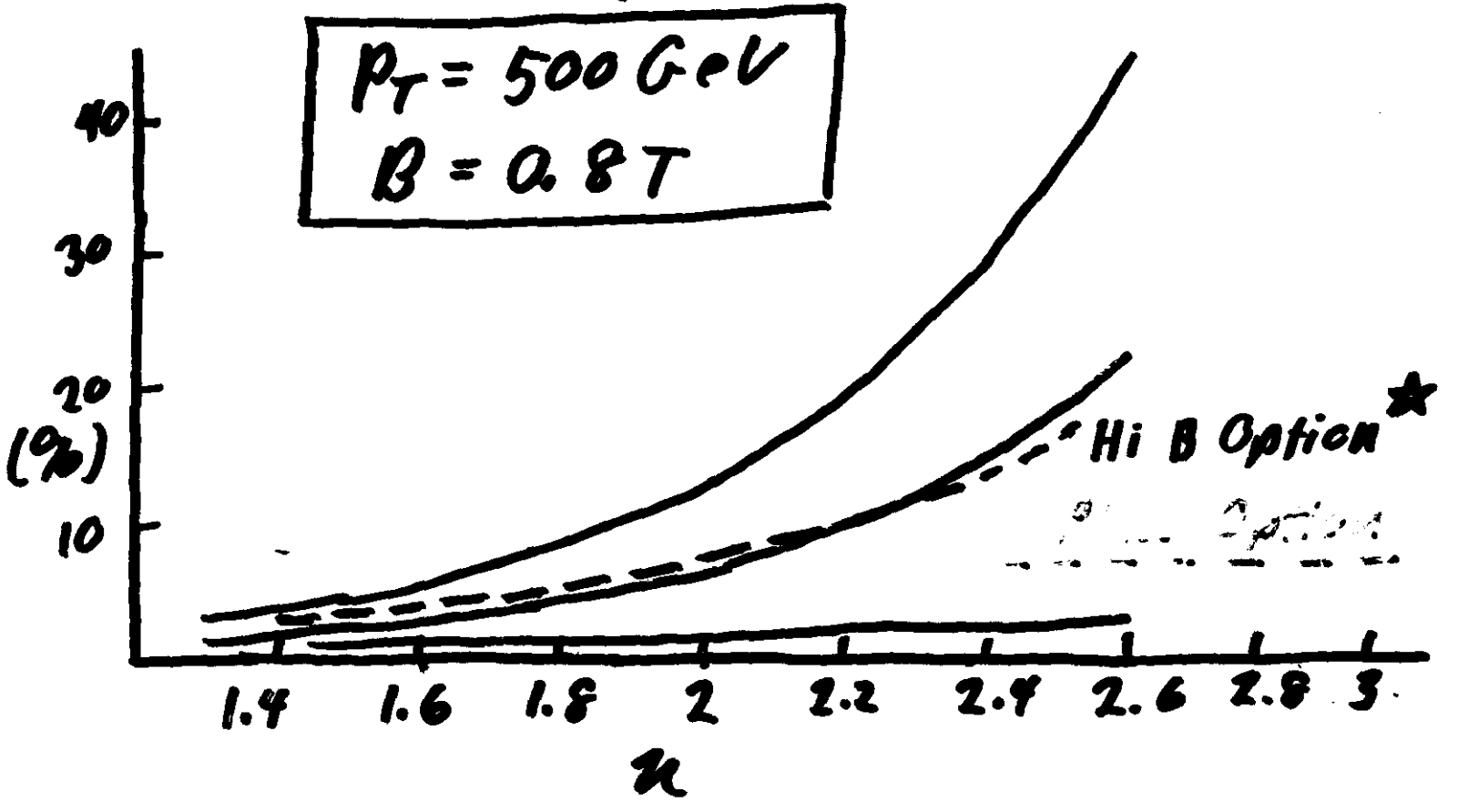

Y
X





$$CR, SYS \propto \frac{\sigma P}{B\sqrt{N}} \qquad MS \propto \frac{\sqrt{X}}{B}$$

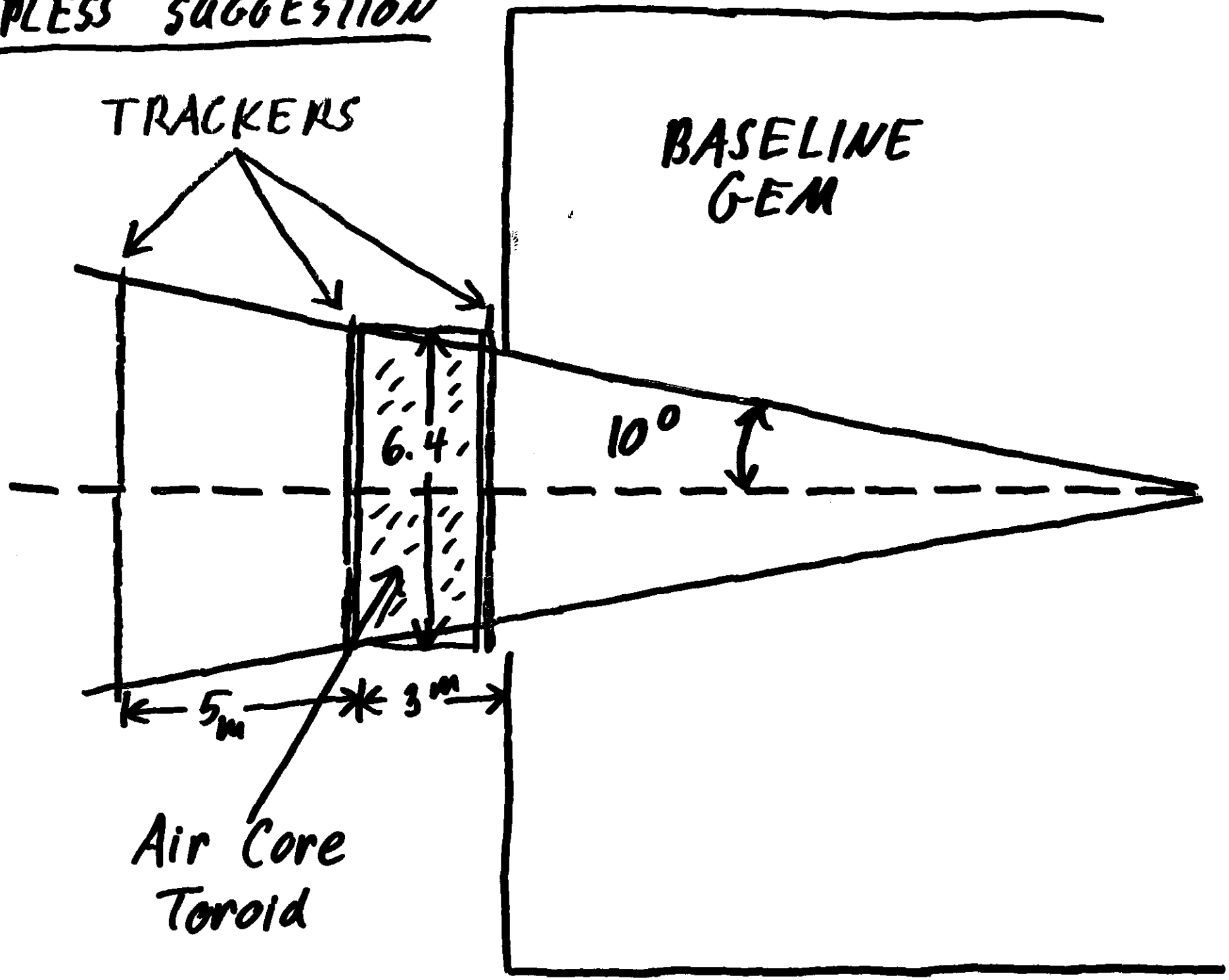


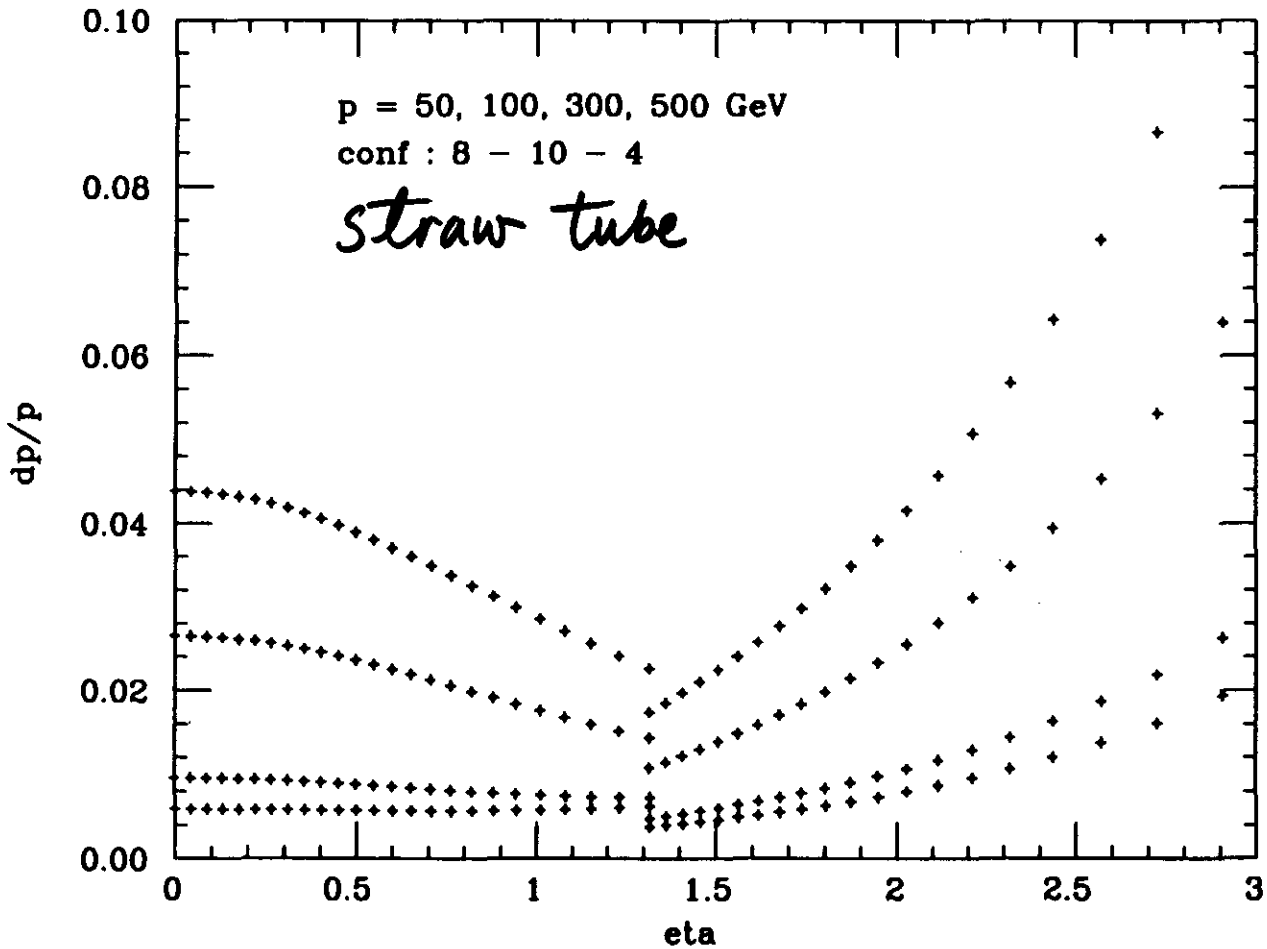


★ Move up by factor of 2 if no Central Tracker

If Pb calorimeter, move up by 1.6

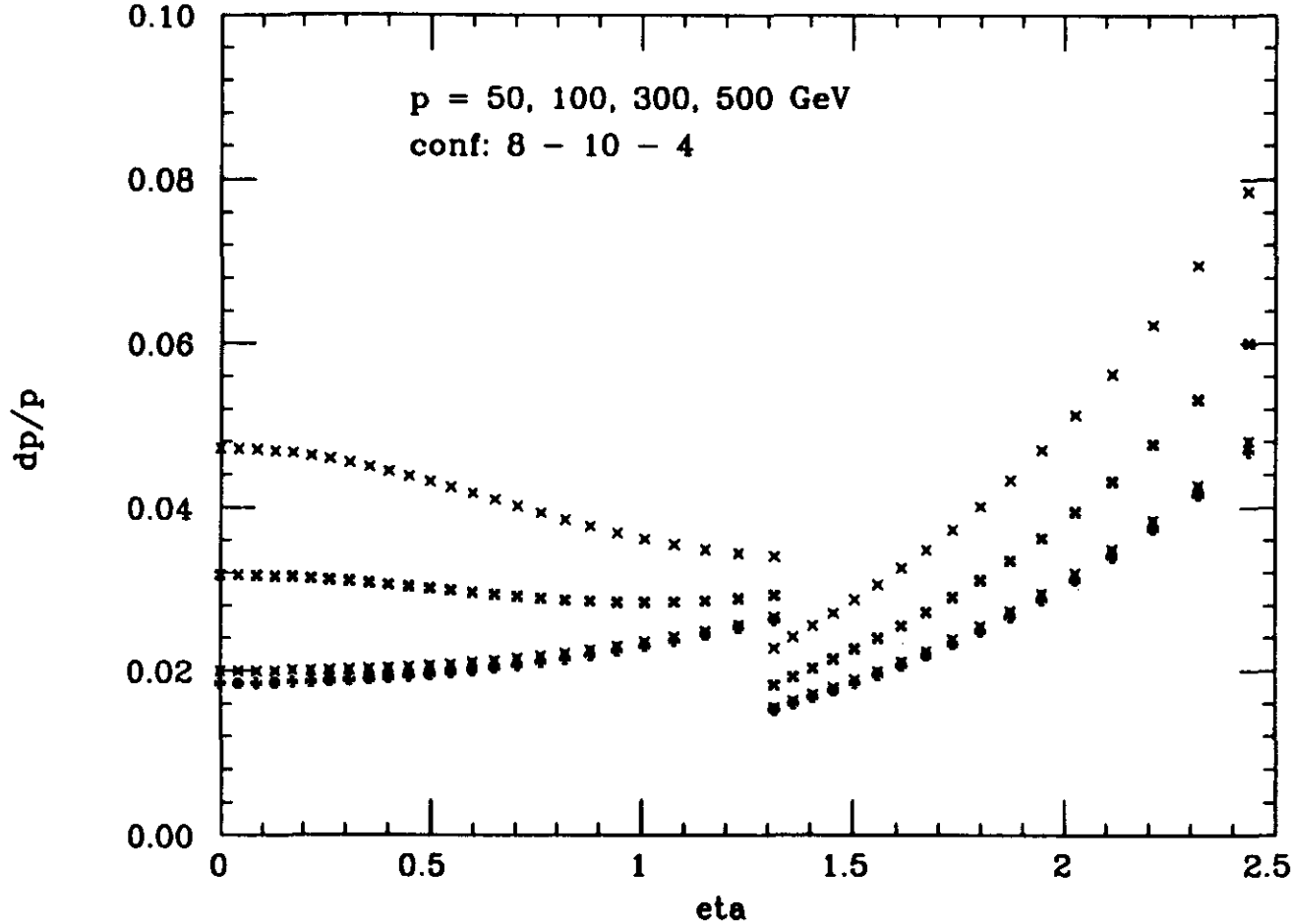
PLESS SUGGESTION




p = 50, 100, 300, 500 GeV
conf : 8 - 10 - 4
straw tube
dp/p
eta
0.10
0.08
0.06
0.04
0.02
0.00
0
0.5
1
1.5
2
2.5
3

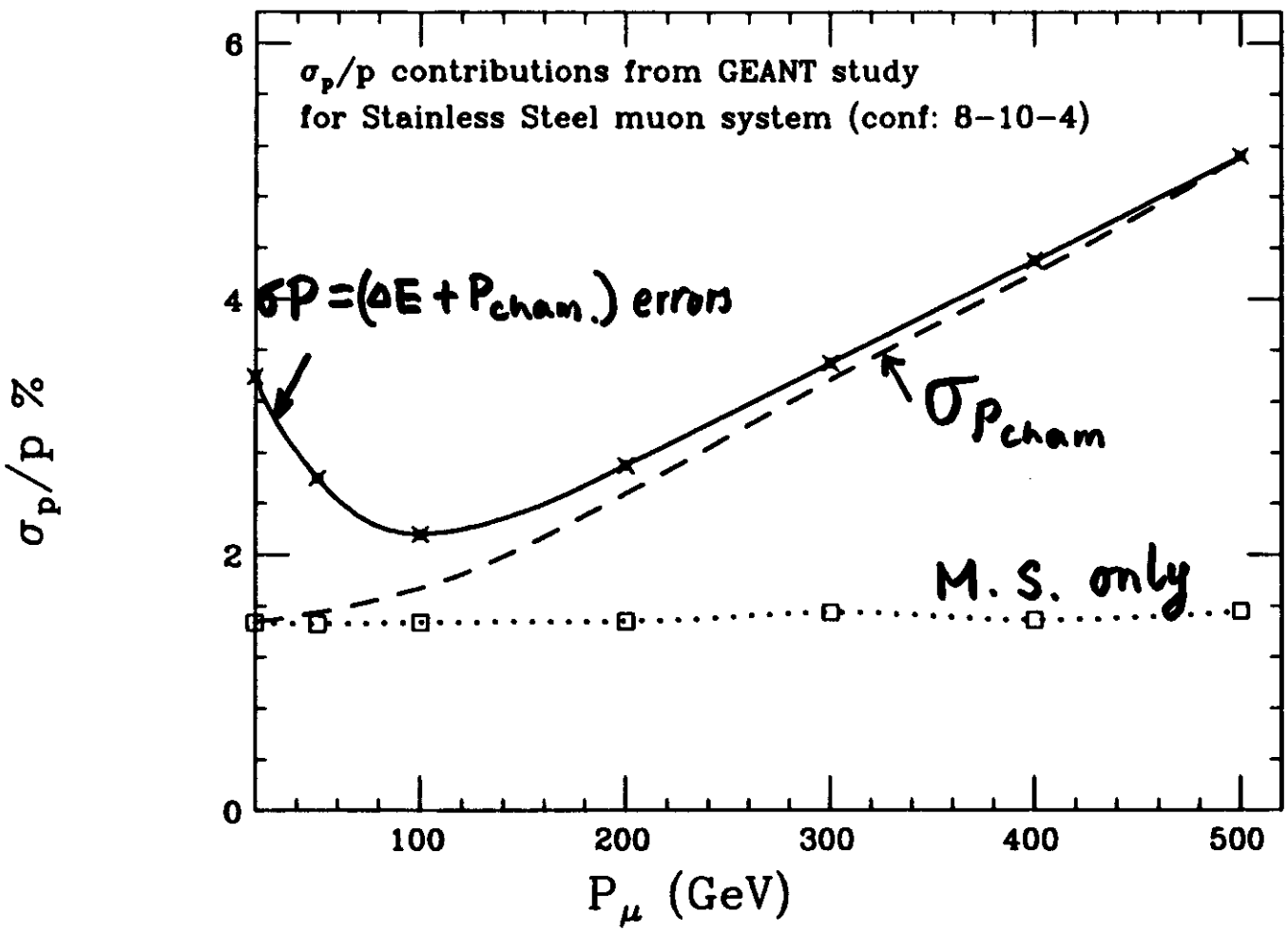
Concern about stainless steel tube

$\Delta p/p \sim 2\%$ (Limit)

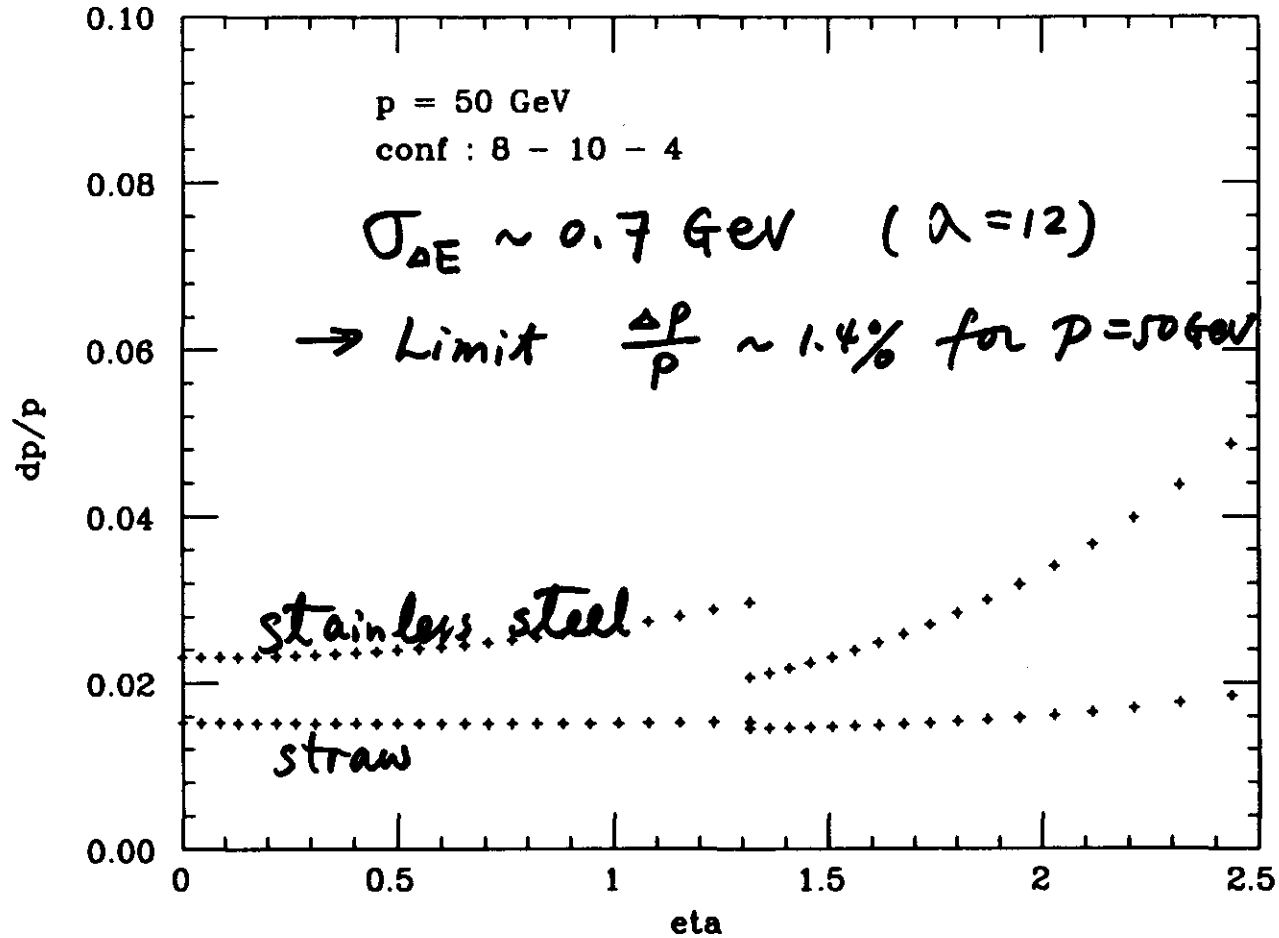


$P_\mu = \Delta E_{HC} + P_{cham}$

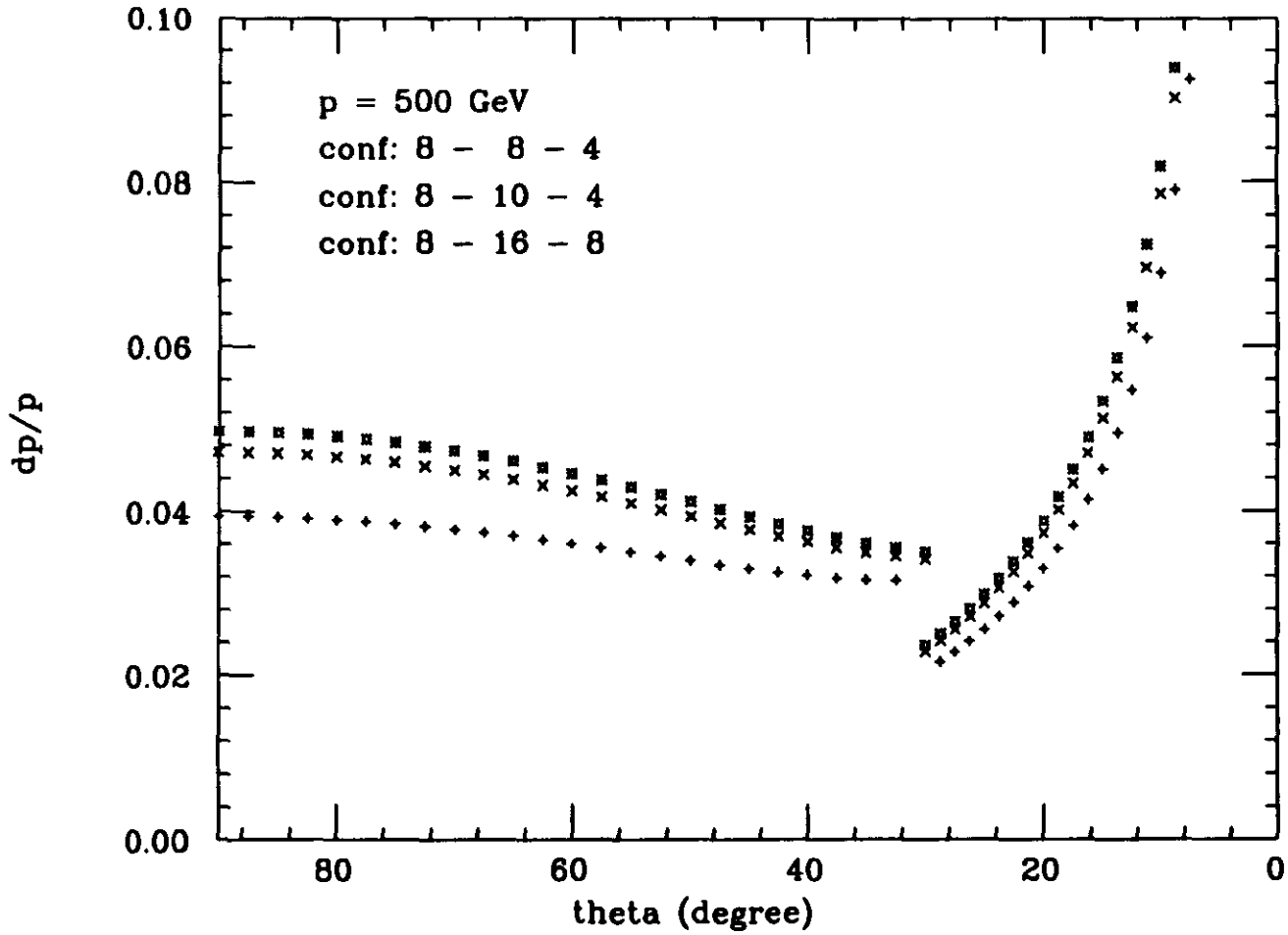
Total σ_{P_μ} come from : $\sigma_{\Delta E}$, $\sigma_{sagit(MS)}$, σ_{sys}, σ_{cham}.

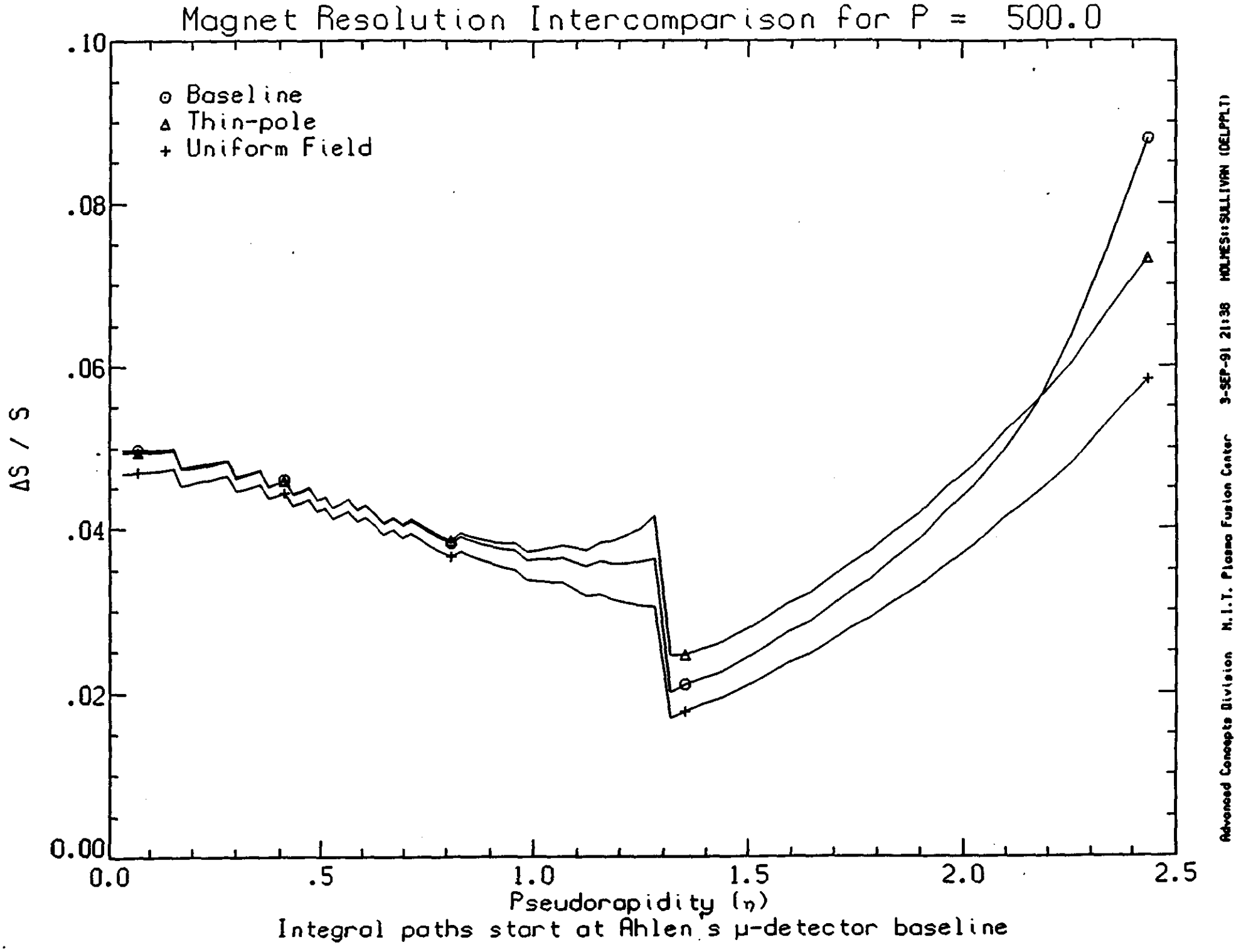


$$P_\mu = \Delta E + P_{chamber}$$



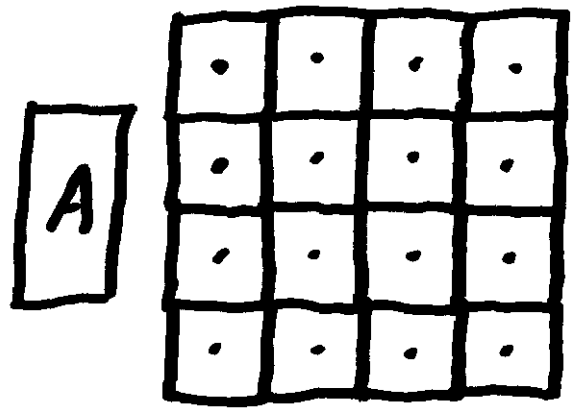
Configuration




Magnet Resolution Intercomparison for P = 500.0
Baseline
Thin-pole
Uniform Field
ΔS / S
.10
.08
.06
.04
.02
0.00
0.0
.5
1.0
1.5
2.0
2.5
Pseudorapidity (η)
Integral paths start at Ahlen's μ-detector baseline
Advanced Concepts Division N.I.T. Plasma Fusion Center 3-SEP-91 21:38 HOLMES::SULLIVAN (DELPPLT)

Korytov Talk

$\frac{1}{2}$ TeV μ →
(Fermilab)

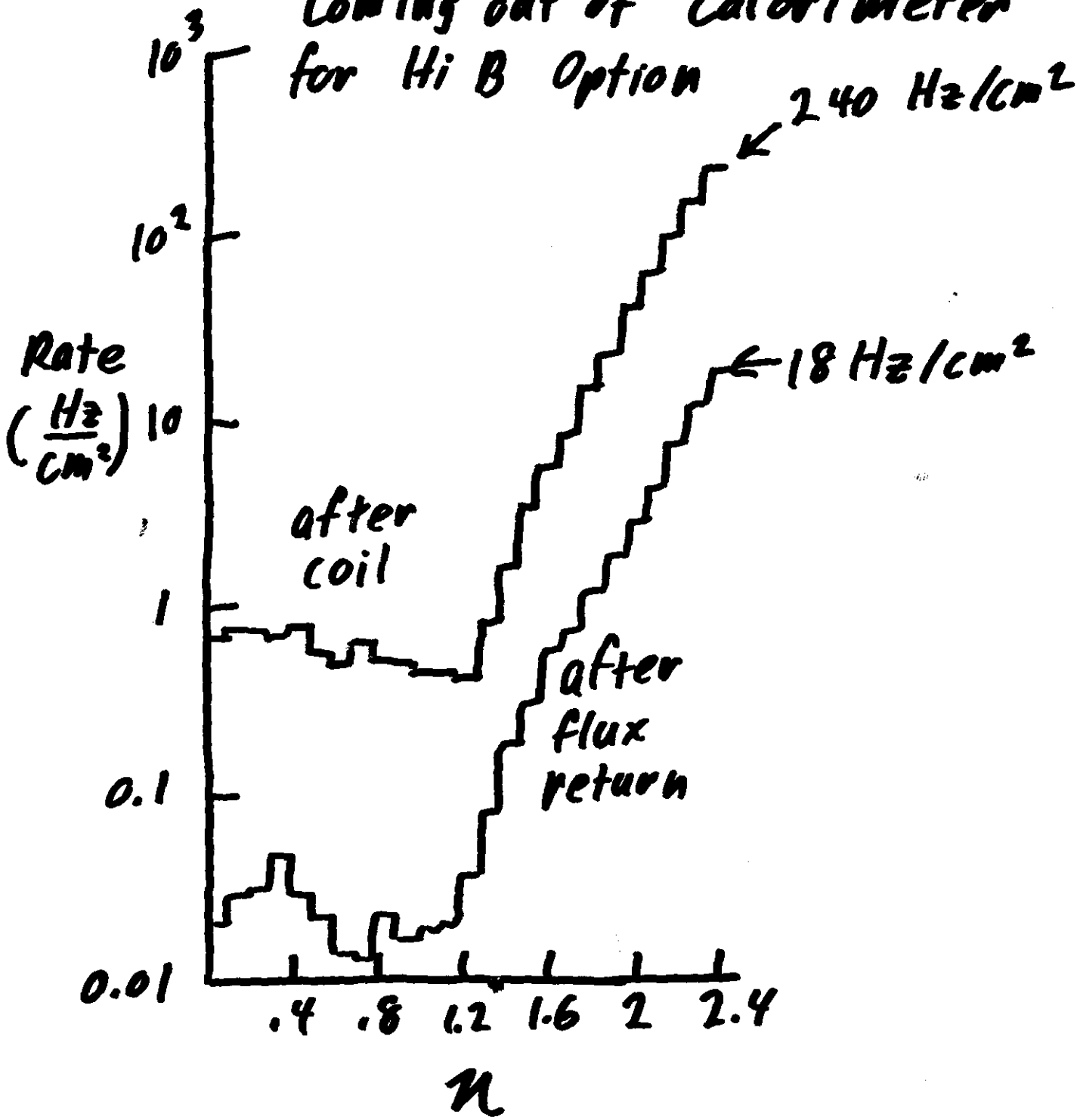


A =

	Nothing	10cm Fe	10cm Pb
4 cell events	75%	65%	61%
1 track	92.4	87.7	87.4
2 tracks	4.2	7.0	7.4
3 tracks	1.4	2.1	2.8
4 tracks	2.0	3.1	2.4
σ_{FIT}	57 μm		61 μm

McNeil's Talk

Isajet Simulation of Junk Coming out of Calorimeter for Hi B Option



TECHNOLOGY COMPARISONS

SSRT = stainless tube
ALSQT = aluminum LST
PLRT = plastic round tube

B = Barrel; E = End Cap

	PLRT	L3	SSRT	PAD	ALSQT
B CONFIG	8:20:12	32:64:32	4:8:4	4:4:3	4:8:4
EC CONFIG	8:16:8	32:64:32	8:16:8	4:4:3	(8:16:8)
AREA	43k-m²	136k-m²	19.7k	11.2k	(20k)
B WIRES/STRIPS	156k	190k	76k	844k	190k
EC " "	117k	145k	45k	231k	
TDC'S (ADC'S)	20k	91k	39k	1.1M	140k (B
COST/DC ASSUMED	100	190	60	20	60
MIDDLE X_R	4%	1%	20%	8%	11%
MODULE COST:					
B		36M	14M		4.7M
EC		24M	9M		
T	16.2M	60M	23M	11M (PC Boards)	(7.8M
ELEC. COST:					
B		17M	2M		8.4M
EC		13M	2M		
T	3.3M	30M	4M	20M	(14M)
TOTAL	19.5M	90M	27M	31M	(22M
TOTAL/LAYERS IN MIDDLE	1.2M	1.4M	3.4M	7.7M	2.7M

OTHER COSTS (L* LoI)

	Barrel	Endcap	Total
Support	11.1M	9.0M	20.1M
Assembly/Test	3.3M	4.0M	7.3M
Alignment/Cal.	3.3M	2.3M	5.6M
Gas/Other Sys.	1.5M	1.5M	3.0M
Testing at SSCL	1.1M	1.1M	2.2M
Installation	1.6M	1.7M	3.3M
Proj. Engineering	~~1.9M~~		1.9M
Inst. Support	~~9.2M~~		9.2M
			$\boxed{52.6M}$

PLUS 20% Contingency

PLUS THERIOT FACTOR (25%)

$$(34 + 52.6) \times 1.2 \times 1.25 = 130M$$

"SYSTEM" OPTIONS

"PURE" (same technology for ρ, z, trigger):

- PADS — BNL, BU, Draper
- EXTRUDED LIMITED STREAMER TUBES — MIT, Houston, Dubna, SSCL, Draper
- PRESSURIZED STRAWS — MSU, LANL

"HYBRID" (different technology for ρ, z, trigger)

- PRESSURIZED STAINLESS TUBES + RPC's (z, trigger) — BU, MIT, Dubna, Brown, Indiana, LANL, LLNL
- L3 type + "I-Beam" (z) + RPC's (trigger) — LLNL

MUON GROUP MEETING TOMORROW

Room 328 - Building 4 - 9AM

Morning - Technology Discussions
Afternoon - non-Baseline options

TAYLOR/AHLEN "CRITIQUE" FORMAT:

(1) Principle of Operation
(2) Description of Module Construction
(3) 2nd Coordinate Determination
(4) Number of Channels
(5) Electronics Requirements
(6) Single Layer Resolution
(7) Average Layer Thickness
(8) Cost of Construction
(9) Timing Characteristics
(10) Trigger Characteristics
(11) Advantages
(12) Disadvantages

J. Brau

Charge to the Calorimeter Group from Barry and Bill August 8, 1991

This group has the onerous task of sorting through the many options presented in 3.3-2 of the EOI and determining quickly which should be retained. We have promised to make a decision between pursuing the high precision (BaF or Liquid Xenon) electromagnetic or the precision sampling electromagnetic options. The Calorimeter group must pull together all relevant information to help in making this crucial decision. As part of the decision, we also expect to determine which technologies to pursue toward the final choices. In particular, we expect that we should only continue development on either two homogeneous e.m. choices and one hadronic or two sampling e-m + hadronic choices. Both decisions should be ready to defend at the Oct. 3 PAC review, though the details may not be ready. We would like to determine in detail what future work needs to be pursued in any option, what resources we have within the collaboration for that work, what additional support R&D or engineering will be required from SSCL, time scales, beam tests required, etc. Finally, in order to understand future options and flexibility, we would like to encourage study of the options where the space and other considerations are made such that the e-m calorimeter could be replaced at a future date. The purpose of this is to understand the 'penalty' in building such future upgrade flexibility into the detector as suggested by the PAC. We understand that this possibility might be reviewed at the Oct. PAC

Charge to the Calorimeter Group
from Barry and Bill
August 8, 1991

- sort through the many options and determine quickly which should be retained
- pull together all relevant information to help in making the crucial decision between:

  pursuing the high precision (BaF or Liquid Xenon) electromagnetic or -

  the precision sampling electromagnetic

  (we expect to continue development on either two homogeneous e.m. choices and one hadronic or two sampling e-m + hadronic choices)
- decisions should be ready to defend at the Oct. 3 PAC review, though the details may not be ready
- determine in detail:

  what future work needs to be pursued in any option,

  what resources we have within the collaboration for that work,

  what additional support R&D or engineering will be required from SSCL,

  time scales,

  beam tests required,

  etc.
- study options where the space and other considerations are made such that the e-m calorimeter could be replaced at a future date - understand the 'penalty' in building such future upgrade flexibility (as suggested by the PAC - this possibility might be reviewed at the Oct. PAC)

Thursday, August 8 (SSCL - room TBA)

9 am General discussion of objectives, goals, etc.
Plan for proceeding to the LoI and the Technical Proposal

10 am Discussion of physics requirements for the electromagnetic calorimetry (led by R. Zhu)

11 am Begin discussion of the EoI table of advantages and disadvantages of of specific technologies

Newman
Gordon

noon Lunch

1 pm cont. discussion of technologies

Friday, August ~~10~~ 9, 1991

8 am Electronics and signal processing issues
(eg. speed, noise, S/N, etc.) P. Denes et al

10 am Pre-radiator discussion (led by P. Cushman ??)

noon lunch

1 pm Plan program of studies, positions papers, response to criticism and issues, focussing on narrowing options for the LoI and defining plan to achieve technical proposal by late 92.

4 pm adjourn

August 6 — SCAT CAC

NAME	INSTITUTION	EMAIL ADDRESS
Jim Brau	U of Oregon	JIMBRAU @ SLACVM
Min Chen	MIT	MITLNS :: Chen
Paul M. Mockett	U. Washington	MOCKETT @ UWAPHAST
Howard Gordon	BNL	BNLCL6 :: GORDONH (GORDONH@BNLCL1)
Harvey Newman	Caltech	newman @ Cithex.Cithep.Caltech.edu
Ren-yuan Zhu	Caltech	newman @ cithex. bitnet ZHU @ CITHEX. BITNET ZHU@CITHEL.CITHEP CALTECH. EDU
Peter Denes	Princeton	DENES AT CERNVM or VXCERN :: DENES
HANS KOBRAK	UCSD	SDPHV1 :: KOBRAK FNAL :: KOBRAK
Craig Woody	BNL	WOODY @ BNLDAG
TED KYCIA	BNL	BNL787 :: KYCIA
Ken READ	ORNL/UTenn.	READ@ORPH01
HONG MA	BNL	BNLCL1 :: HMA
Martin Bauer	ORNL	MBB @ ORNLSTC
Yuri Kamyshkov	UTK/ORNL	VXCERN :: KAMYSHKOV
NICK DI GIACOMO	MARTIN MARIETTA	DiGiacomo@ COLORADO
Bill Worstell	Boston University	BUPHYC :: WORSTELL
Jim Reidy	U. Mississippi	REIDY@UMSPHY
Bill Bugg	U. Tenn	BUGG @ SLACVM
William Marciano	LANL	None
Geoffrey Forden	U of Arizona	UAZHEP :: Forden
MICHAEL SHUPE	U OF ARIZONA	UAZHEP :: SHUPE
LAWRENCE SULAK	BOSTON	BUPHYC :: SULAK ; SULAK @ BUPHY

CLIFF EBERLE	ORNL	ECC @ ORNLSTC
MARK REDWICK	ORNL	REN @ ORNLSTC
John Rutherford	Univ. of AZ	UAZHEP :: RUTHERFO

Bugg reformulation of charge
(as enunciated by Newman)

(1) Choose one EM calorimetry option

(2) Choose one technology that could function as a unified EM+ HCAL

(3) Choose one technology that would be well-matched to the homogeneous EM, but which could also serve as a unified EM + HCAL — perhaps with further development

Time Factor in Discovering an 80 GeV Higgs

As function of energy resolution (**a** and **b**)

a	1.0	2.0	3.0	5.0	7.5	10	15
b=0	0.33	0.48	0.68	1.1	1.6	2.2	3.3
b=.25	0.53	0.63	0.83	1.2	1.7	2.2	3.3
b=0.5	0.94	**1.0**	1.07	1.4	1.8	2.3	3.4
b=.75	1.3	1.4	1.5	1.7	2.1	2.6	3.6
b=1.0	1.8	1.8	1.9	2.1	2.4	2.9	3.7

- Note: Different detectors have different background rate. This table is for detectors with the same background rate.

EM / HADRONIC

Technique	Attributes	Disadvantages	R & I
Liquid Argon	Mature basic technology	Dewar walls, supports, etc.—affects hermeticity	Hadro oped
	Experience with large systems	Speed/noise tradeoff—affects isolation cuts	
	Uniform response	Shaping time $\geq$20ns; affects pileup	Fast sh
	10^6 dynamic range	Preamps inside dewar—reliability/maintenance/hardness?	
	Gain = 1	Cryogenic system	
	Simple calibration	Large sampling fraction e/h~1.5	1 mm l
		Accordion mechanics nontrivial for projective geometry	
EM only:	$7\%/\sqrt{E} \oplus 0.5\%$ resolution for plate geometry		Needs
	2 depth seg.		
Scintillating Fiber	σ_E and e/π in 16 ns trigger, 32 ns integration time shown at 80 GeV.	Rad. hard at endcap to be studied	O_2 infl
		No hadronic depth segmentation	Fiber r
	Test beam data		Constr
	Simple construction, modular	Calibration/monitoring	Detaile
	Inexpensive		
	Uniform response		~ 0.5%
EM only:	$6\%/\sqrt{E}$ demonstrated (JETSET)	Compensating 0.5 m m resolution for 50% fiber	Under
	(40% fibre)	Must tilt fibers at 3°	Rad. d
hline **Silicon Pads**	Fast (< 7 ns peaking time, 16 ns trigger integration time):Large signal (10^4 e's/100μm/mip); absolute gain for sampling medium; 10^5 dynamic range; linear response; room temperature, low voltage operation; Rad hard to ¿ 3 × 10^{14} neutrons/cm^2; insensitive to ionizing radiation damage; insensitive to magnetic field; extremely compact hermetic construction; compensation demonstrated	Current cost of detectors must be reduced by a factor of 5 to 10; tested in one hadron prototype (7.5λ at INFN); large capacitance per unit area requires preamplifiers at detector (also necessary for high speed)	Constr tion of fast ele ening t of silic manufa

HOMOGENEOUS ELECTROMAGNETIC

Technique	Attributes	Disadvantages	R & D Effo
BaF_2 Crystals	50 γ_e /MeV	Technology untested at high speed. Technology to be developed for high radiation	RFQ Calibra
	Experience from L3 BGO system: crystal manufacture and processing	High purity needed for radiation hardness	Refining mat age mechanis
	Fast component with sub-nsec decay time; slow component can be suppressed to avoid pileup		UV Selective RbTe) Under
		Medium density / Moliere radius = 3.4 cm (1.5 times BGO)	Fast preamps
	Dynamic range 10^5	More expensive than some lower resolution calorimeter s	Detailed engi full system a
	Uniform coverage with minimum dead spaces; based on the L3 BGO design		UV (220 nm) tubes
			Test beam w
Liquid Xe/Kr	Ultra-high resolution with $10^4\gamma_e$ /MeV Calibrat ion: 0.2% per α, cross calibrated with heavy ions.	Cryogenic dewar for Xe recovery	FADC or Lin Cross calibra
	Cryostat similar to LAr	Optical system untested	Light attenu (> 200 cm)
	Purification similiar to existing ionization detectors	170 nm VUV: reflective wall quality critical?	Wall reflectiv internal reflec
	Fast, radiation hard. Large dynamic range: non-saturating	50% of Air Liquide Co.'s new capacity in 8 yrs. $2.5/cm^3$ for LXe: endcap?	System radia
	e/π potentially to be ~ 1.	5x5 needed for 0.25%	
	UV diodes, fast amp. and shaper in production, linear to 10^{-3} from 1 to 70,000 MeV.		
	3 depth segments: off axis γ vertex and angular resolution , and helps 2 shower separation: minimum intercell walls.	Density/Moliere radius =3 g cm^{-3}/ 4.1 cm: causes overlap showers but does not degrade isol. cut, due to fine depth seg ments.	
	Basic LXe cell R&D completes in 92.		
	Option: γ/π^0 separation.		Drift diodes

HADRONIC

Technique	Attributes	Disadvantages	R & D
Liquid Scintillator — Wavelength Shifting Fiber readout	Fast, 2 ns peaking time, Easy to replace liquid if radiation damage occurs; Fine Segmentation; 10^5 dynamic range; Inexpensive technology; Simple Modul ar Construction	Leaks, Radiation resistance of fibers (>10 Mrad); New, unteste d light collection technology	Leak pr sistance types ar bility of
Scintillator Plates Wavelength — shifting fiber readout	Similar to liquid scintillator but not replaceable	10 Mrad sensitivity = 2 years @10^{34}@η = 3; Production technique not yet established; Untested light collection technology	Improve and sci types an

FORWARD CALORIMETRY

Technique	Attributes	Disadvantages	R & D I
Liquid Scintillator	Fast	Circulate and filter to avoid Capillaries 10 MRad dosage	Rad hardi
	Hermetic	Not proven in a large experiment	Liquid m
	Good resolution		
	Inexpensive	Leaks	Engineeri
	Uniform response	Readout dynamic range	Calibratic
	Compensating		
	Small Moliere radius in tungsten version		
	Safe		
Liquid Argon	See Liquid Argon entry above		
	Small Moliere radius in tungsten version		
	Rad hard		
High Pressure Gas	Faster than liquid Argon		Performa
	Rad Hard	Leaks	Engineeri
	Small Moliere radius	Not proven in a large experiment	
	Inexpensive	Safety	
	Robust	Long term gain stability	
Warm Liquid — TMS	Fast	Purity maintenance to parts per billion / materials compatibility	Test o f a
	Rad Hard	Calibration: Not proven in a large experiment	Electronic
	Large dynamic range	Expensive	Complete
	Small Moliere radius — uranium/tungsten	Electronics embedded in the detector — rad hard?	
	Compensated	Safety — flamability?	
		Radiolysis production of gas and long lived isotopes	R&D on

PRERADIATOR

Technique	Attributes	Disadvantages	R & D I
Scintillating Fibers	High spatial resolution ~0.3 mm — can veto *pi*°'s	Pad/strip structure- no ghosts or shadowing	Specialize bits/ch) n tor develo
	Projective in 2D	15k readout channels	
	Spatial resolution <- 0.5 mm	Two track resolution 3.0 mm (pi0 veto o nly below 90 GeV at 1 m)	Demonstr
	Two track resolution 3.0 mm Fast (single bunch response)		
Silicon Pads/Strips	Pad/strip structure, pixel device — no ghosts or sh adowing	Very expensive	Electronic testing
		Very high channel count — integratable into trigger?	Demonstr
	Projective in 2D	Large area devices — may be too slow, lesser spatial resol ution, may not veto π^0's?	
	Spatial resolution < 0.5 mm	Two track resolution 4.5 mm (π^0 veto for < 50 GeV at 1 m)	
	Fast (single bunch response)	Specialized readout (3-4 bits/ch) to be develop ed	
	Only 15k readout channels		

PROPOSAL FOR PROCESS
(TO BE DISCUSSED)

1. AUG 8-9

2. REMAINDER OF AUGUST

   CRITICS PREPARE WRITTEN NOTES TO ADAIR + BRAU (BY AUG 16 - ~~[illegible]~~

   ADAIR + BRAU SYNTHESIZE CRITICISM AND PREPARE QUESTIONS FOR PROPONENTS BY AUGUST 23

3. SEPTEMBER 4

   PROPONENTS BRING <u>WRITTEN</u> RESPONSES TO CRITICISM TO GEM-CAL MEETING AT SSCL

   GEM council meeting Sept 5

   Reconvene GEMCAL - Sep 6

To: GEM Calorimeteurs
From: Bob Adair and Jim Brau
Subject: Issues of concern

Dear Colleagues:

Attached you will find the concerns our colleagues have identified for the various calorimetry options. We have attached them without any reformulation. We note some of the comments in the file were a bit out of order, but we leave the understanding of this to each of you, only calling it to your attention.

We now ask each of the groups proposing a technology option for the calorimeter to write a statement addressing the issues identified in these notes, bring it to the September 4 meeting, and prepare an oral presentation. Please communicate to JIMBRAU at SLACVM who is working on each technology paper and who will present the oral version at the September 4 meeting.

We also attach the latest version of the table as it has been updated by Min Chen following the August meeting.

Date: Fri, 16 Aug 1991 18:25 EDT
Original_From: BNLCL6::GORDONH("HOWARD GORDON OR VIA BITNET 'gordonH@bnlcl1'")
Comments: This is gatewayed mail. Warning: Mail may not necessarily be returnable through this path.
From: General Delivery <POSTMASTER@BNLCL1>
Subject: Questions for calorimetry for GEM
To: jimbrau@slacvm
Original_To: YALPHY::ADAIR,BNLCL1::JNET%"jimbrau@slacvm"

Dear Jim and Bob,

The most up to date table probably contains plenty of questions for each technology, but I will list here what I think the most serious questions are(from a liquid argon bigot... I would like the questions you will ask me ASAP since I leave for Europe for a week on Aug. 24):

BaF2:

1. Radiation damage depends on knowing more about the effects of impurities. It is a very complex phenomonology. How long should we wait for the specifications to be met?

2. Describe the calibration system completely and indicate when each of the methods will be available to be tested - eg. fast RFQ, fast shaping electronics, trigger system for using minimum ionizing particles, etc.

3. Describe the justification of no depth segmentation which compromises the ability to get the photon direction, the photon/pi0 separation, and degrades the electron/pion separation.

Liquid Xe:

25 pages

Tentative agenda for the September 4/6 GEM Calorimetry Group meeting

Wednesday, September 4

(morning sessions in SSCL Cafetorium)

8 am - 9:45 Technology subgroups meet

9:45 am Begin General Meeting
Introduction - J. Brau

10:00 am Cost estimates/engineering -M. Rennich

10:45 am Liquid Scintillator: Answers to critics - Y. Kamyshkov

11:30 am Lunch

(afternoon sessions in the upstairs conference room)

1:00 pm Silicon: Answers to critics - B. Bugg

1:45 pm Scintillating Fibers: Answers to critics - ~~? ?~~ H. Paar

2:30 pm Liquid argon: Answers to critics - H. Gordon

3:15 pm Barium Fluoride: Answers to critics - H. Newman

4:00 pm Liquid xenon: Answers to critics - M. Chen

4:45 pm Scintillating plates: Answers to critics - ? ?

Friday, September 6, 1991

(all sessions in SSCL Cafetorium)

9 am Review and discussion of charge, process, direction

10 am Pre-radiator discussion
general, fibers -P. Cushman
silicon -M. Clemen

11:30 am Lunch

1:30 pm Forward calorimetry
The virutes of forward calorimetry - J. Rutherfoord
Liq. Scintillator - B. Webb
TMS - ??
Liq. argon - ??

3:00 pm Discussion of R/D plans, etc.

4:00 pm Adjourn

Brau	U. Oregon	JIMBRAU@SLACVM
Odian	Yale	ADAIR @ YALEHEP
Chen	M.I.T.	MITLNS :: CHEN
Shuvalov	IHEP	MITLNS :: Shuvalov
Bugg	U. Tennessee	BUGG @ SLACVM
Zhu	CALTECH	ZHU @ CITHEX.BITNET
KOBRAK	UCSD	FNAL:: KOBRAK
Branson	UCSD	BRANSON@UCSDHEP.UCSD.EDU
Newman	Caltech	Newman@CITHEX.BITNET
Shi	Caltech	XFS @ FNAL.BITNET
Bauer	ORNL	MBB @ ORNLSTC
Plasil	ORNL	FZP @ ORNLSTC
MASON	MARTIN MARIETTA	LLMASON@SIM.DELLNMC.COM
Shaker	SSC	Shaker@SSCHEP
Etherton	SSC-PRD	Etherton @ SSCVX1
West	LLNL	WWEST@LLNL.GOV
Savine	ORNL	VXCERN:: SAVIN
TARKOVSKY	ORNL	VXCERN:: TARKOVSKY
GORBEV	ORNL	VXCERN:: GORBEV
[illegible]	[illegible]	
Kamyshkov	ORNL	VXCERN:: KAMYSHKOV
Vaniachine	SSC	VANYASHN@BNLCL1
Cohn	ORNL	COHN@UTKVX
Rutherfoord	U. of Arizona	UABNLS:: RUTHERFO
Gordon	BNL	BNLCL6:: GORDONH
Radeka	BNL	RADEKA @ BNL CL1
Ma	BNL	HMA @ BNLCL1
Makowiecki	BNL	MAKOWIECKI @ BNLCL1

[illegible]	Carnegie Mellon Univ.	[illegible]
Eberle	ORNL	EBERLEEC@ORNL.GOV
Hackett	Univ. of Washington	Hackett@UWATH
Shinakov	ORNL	VXCERN:: SHINAKOV
Wigstell	Boston University	BUHYC:: WIGSTE
[illegible]	Univ. of Arizona	UABHEP:: [illegible]
Webb	Texas A&M	[illegible]
Ray Wlak	Boston	BUHYC:: SWAK
[illegible]	LANL	[illegible]
Parr	UCSD	27833:: HPA
Ayres	CSDL	fmayer @ [illegible]
Bromberg	MSU	MSUHEP:: BROMBERG
Rogers	MSU	[illegible]

The Final Report of the Calorimeter group will be made up of:

I. A brief (≤ 2 pages) summary - conclusion - recommendation by Brau and Adair.

II. One-page recommendations by other C-group participants. Everyone is invited to submit his own total plan and comments. We ask that these be limited to one single-spaced, typewritten page and include a total cost estimate in accord with our agreed unit costs. These should be signed - perhaps by several participants.

III. Appendices containing technical material submitted by proponents.

IV. Questions and Answers - edited - assembled by Brau and Adair.

recommendations next week

Final Report by Sept 20.

RESPONSES TO QUESTIONS PREPARED BY SUBGROUPS:

LIQUID SCINTILLATOR

SILICON

SCINTILLATING FIBERS

LIQUID ARGON

BARIUM FLUORIDE

LIQUID XENON

(AVAILABLE AT SSCL)

GEM CALORIMETER GROUP

SEPTEMBER 4, 1991

CONSENSUS DEVELOPED

WE SUPPORTED CONTINUED DEVELOPMENT OF THE FOLLOWING:

(1) A CONSERVATIVE APPROACH – LIQUID ARGON

(2) TWO PECISION EM SYSTEMS UNTIL THE END OF NEXT SUMMER
– BaF_2 and LIQ. XENON

(3) A HADRON CALORIMETER MATCHED TO PRECISION EM.
– SCINTILLATOR (FIBER OR LIQUID)

TOMORROW – CALORIMETER GP. CONT.
FWD CALOR.
PRE-RADIATOR
DISCUSS FIBER OR LIQUID (3)

Central Tracker Status

Gem Collab. Meeting

J. Musser

Sept. 5, 1991

Central Tracker Group

Kate Morgan
Charlie Baltay
Jim Musser
Geoff Mills
Barry Barish
Bill Willis
Paul Mockett
Jim Beatty
Andy Tomasch
Chuck Bower
Dick Heinz
Stu Mufson
Greg Tarle
Bob Binns
Vinnie Polychronakos
Pavel Rehak
Bing Zhou
Gary Sanders

Central Tracker Charge

- Determine role of central tracker
- Study appropriate technologies
- Decide which to pursue in detail

Key questions:

technologies ?

Space points / stereo ?

high luminosity ?

Design Parameters

In most cases could agree on <u>range</u> within which design parameters must live.

- Occupancy : 1% → (3% - 10%)
- $\frac{\Delta p}{p}$ (high mom): $a \times 10^{-3}\, p$(GeV/c) $a = 1-3$
- $\frac{\Delta p}{p}$ (low mom): $b \times 1\%$ $b = 2-4$ (mult. scattering)
- vertex resolution : 1-2 mm
- impact parameter res: 50-100 μ
- coverage $\eta \to 2.8$

Physics Goals of Tracker

Attempt to prioritize tracker features needed to accomplish GEM mission (γ, e, μ)

High Priority

- Event vertex
- e/γ separation
- e/μ isolation
- E-p comparison
- e sign determination

Secondary Priorities

- Secondary vertex finding
- Tracking at low momentum with good $\Delta P/P$
- Charge Multiplicity

We want to achieve secondary priorities if possible!

Tracker Technologies

1 Si Strip - LANL

2 Si Drift - BNL

3 Si Pixels - U.Wash

4 Fibers - SSC, Wash U, ...

5 Straws - I.U, Mich

6 Interpolating Pads - BNL, YALE

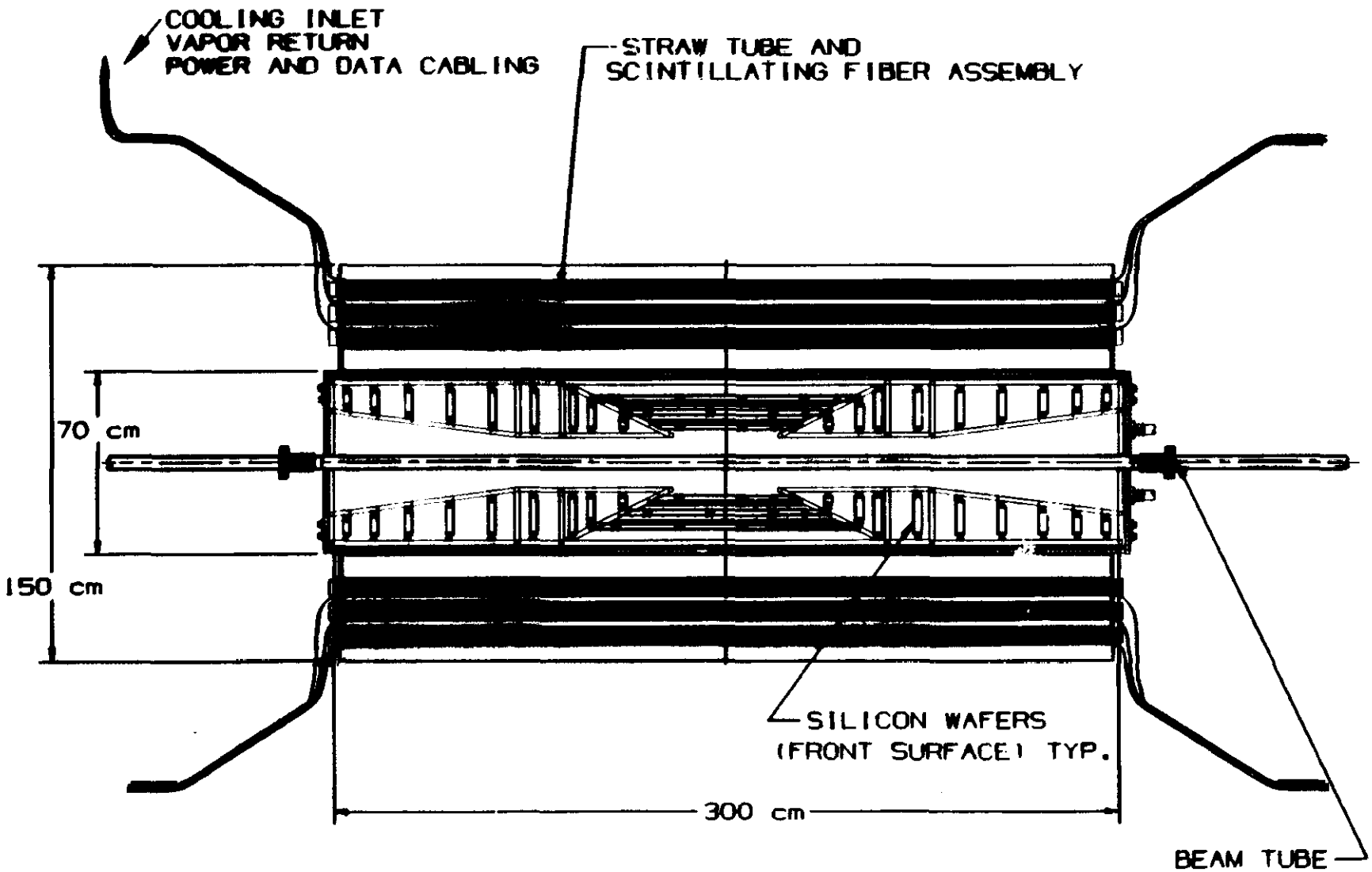
7 Gas Microstrips - IU

Configurations under Study

- Baseline - Si Strips
  Straws
  Fibers

- ~~All Si Strip~~

- Si Strip + Fibers
- Si Strip + Straws
- Interpolating Pads + Si Pixel
- Gas Microstrips +...

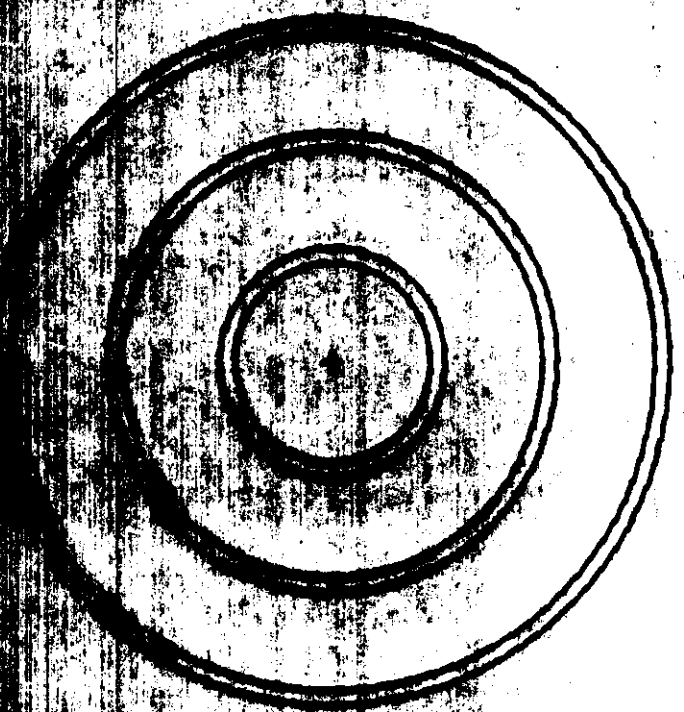

COOLING INLET
VAPOR RETURN
POWER AND DATA CABLING
STRAW TUBE AND
SCINTILLATING FIBER ASSEMBLY
70 cm
150 cm
SILICON WAFERS
(FRONT SURFACE) TYP.
300 cm
BEAM TUBE

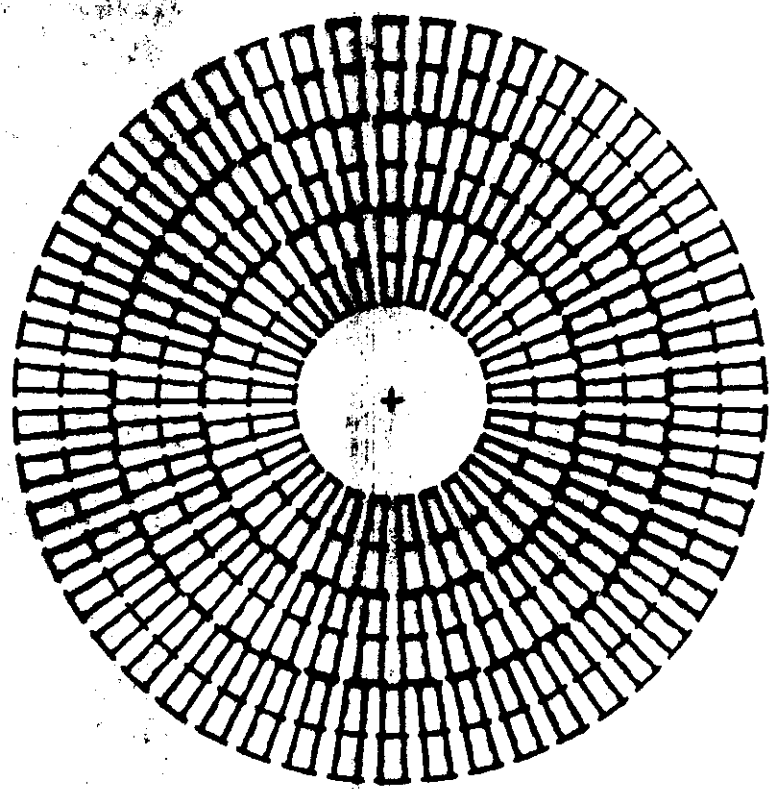
[redacted] Tracker

[redacted] (DB) 7336

[redacted] 40M$ + EDIA

[redacted]

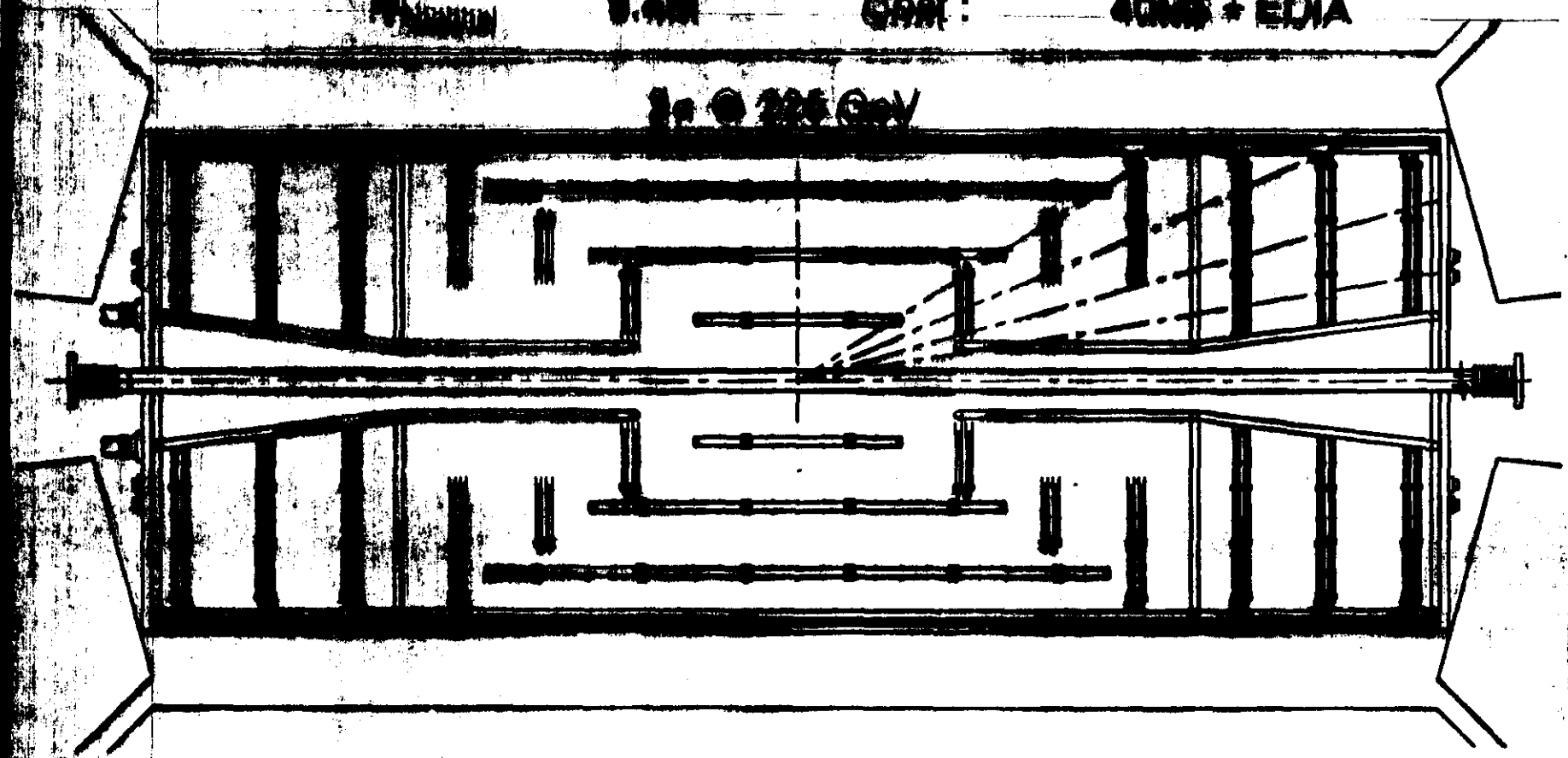




Silicon Strip Tracker

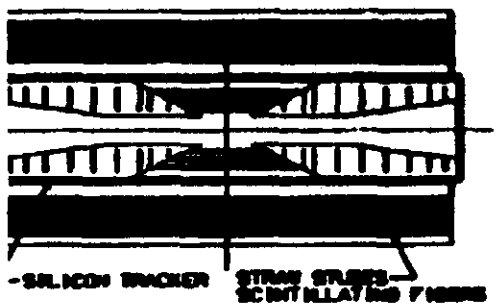
$A_{Silicon}$(DR) : [illegible] N_{layer}(DR) : 7936

$N_{channels}$: 9.4M Cost : [illegible] + EDIA

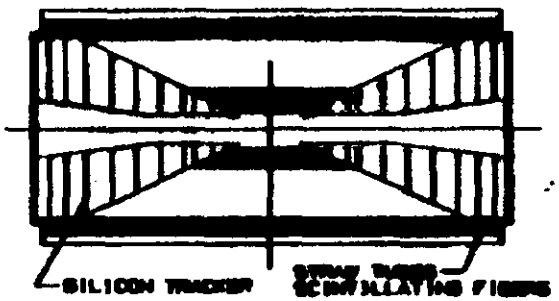


CENTRAL TRACKER OPTIONS

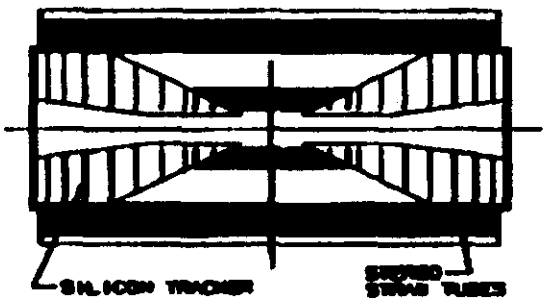
BASELINE DESIGN (GEM BOX)



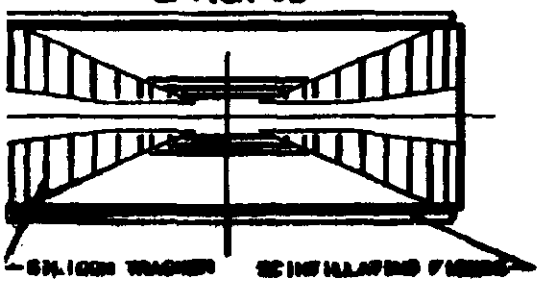
OPTION #1



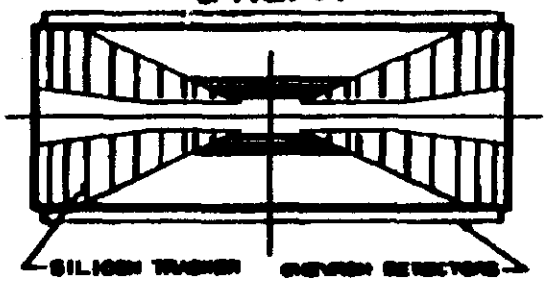
OPTION #2



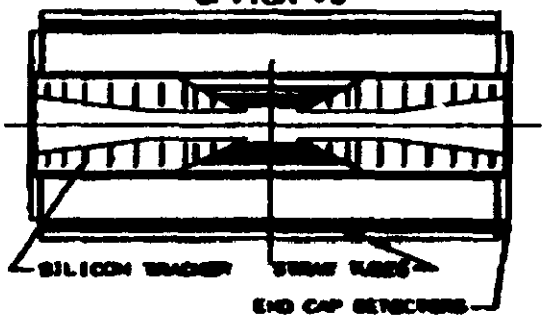
OPTION #3

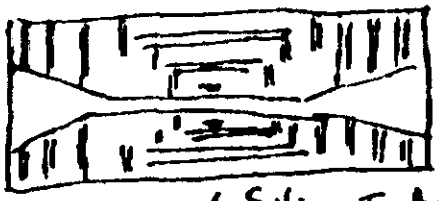


OPTION #4



OPTION #5





1.2 m ϕ Silicon Tracker

Tracking Technology Parameters

Technology / Parameter	Gas Microstrips	Si Pixels			
Space Resolution rφ	30μm	12μm			
z	150	100μm			
Occupancy @10^33	adjustable	10^-6			
@10^34		10^-5			
Pattern Recognition layers needed @ ~95%					
Efficiency	99%	~100%			
Radiation Lengths per layer	.4%	.5%			
Radiation Hardness Minimum Ionizing Rads / lifetime	OK?				
Neutron Dose n / cm2 / lifetime	OK				
Trigger?	< 2	2-maybe 1 NO			
Speed # of crossings	1	?			
Electronics digital / analog	analog	nasty digital			
Channel Count		4-5K cm^2			
Technology Maturity	3	3.5			
Cost	electronics dominated	$1K/cm^2			
Other					

Technology Maturity Scale

1. Proven in experiments
2. Working full scale prototype (or High Channel Count)
3. Table top prototype (or Low Channel Count)
4. Conceptual Design

Radiation Hardness

Numbers should be given for the highest lifetime dose at which the technology is still functioning correctly.

lm 9/4/91

Tracking Technology Parameters

Technology / Parameter	Si Strip	Si Drift	Straws	Fibers ϕ 830 μm	Interpolating Pads
Space Resolution rφ	10 μm	10 μm	70 μm	80 μm	50 μm
z	2-3 mm	10 μm	1-2 mm	~1 mm	~200 μm
Occupancy @ 20 cm @10^33	$4 \cdot 10^{-4}$	@10cm 0.3-0.6%	12%	3%	1%
@10^34	NO	@10cm 3-6%	60%	30%	capable of 1% ##
Pattern Recognition layers needed @ ~95%	≥12 single sided	8-16	~30	?	12
Efficiency	99.9%	99.9%	97%		97%
Radiation Length per layer	.3% (Si)	.3% Si	0.05%	support included 0.6%	?
Radiation Hardness Minimum ionizing Mrads / lifetime	3 MRad	Soon to be measured	0.5 MRad	to be measured >1 MRad	?
Neutron Dose n / cm2 / lifetime	$4.5 \cdot 10^{13}$	"	$>60 \cdot 10^{13}$		
Trigger?	yes L2	No	L2	L2	L2
Speed # of crossings	1 bunch X	1 ns	20 ns	1 X	1-2 X
Electronics digital / analog	digital	analog	analog	digital	analog
Channel Count	~5 million	480 K	30 K	100,000	200-400 K
Technology Maturity	1.5	1.9	2	2	1.5
Cost Do not believe	$160/cm² (2 layers)	$62.50/cm² *	$11 M **	$17 M **	$25 M
Other					

Technology Maturity Scale

1. Proven in experiments
2. Working full scale prototype (or High Channel Count)
3. Table top prototype (or Low Channel Count)
4. Conceptual Design

Radiation Hardness

Numbers should be given for the highest lifetime dose at which the technology is still functioning correctly.

* disregard

** includes EDIA and contingency
Los Alamos burdened engineering

kth 9/4/91

M. Shaevitz

Electronics / Triggering / DAQ Group

Time	Speaker	Topic
8:30	Shaevitz	Overview of Trigger Architecture etc.
9:00	Marlow	Front End Specifications, rack placement, etc.
9:30	Lowry	Update on Electro-optic modulators
10:00	Coffee	
10:20	Seman	TRD Muon Trigger
10:50	Pless	RPC Muon Trigger
11:20	Texas Instr.	High-Speed GaAs ADC's
12:00	Lunch	
1:00	Crosetto	A Programmable System for Missing E_T Triggers, Cluster Finding, and DAQ/Compaction
1:40	Botlo	DAQ Schemes

Next three talks to be held in joint session with Computing Group . . .

2:30	t.b.a	Intel Touchstone Level 2/Level 3 Processor Farm
3:00	Coffee	
3:20	Wang	Missing E_T Triggers (to be confirmed)
4:00	McFarlane	Status of GEM MC Package

Return to Trigger Group Only . . .

4:20	Discussion	Plans for LoI etc.

Work in Progress for Letter of Intent

- Outline of General Trigger/DAQ Architecture
- Generic Triggers and Rates — e, γ, μ, jets, $\not{E}_T$
- Level 1 / Level 2 Trigger Strategies/Rates
- Estimate of Level 1 Trigger time
- Estimate of Event Size
- Cost Estimate
- Data flow into Microfarm
  - → Show that $H \to \gamma\gamma$ OK
- Data flow in general
  - Inner Tracker into L2 Trigger (Electron ID)

Electronics Working Group Activity

- Members: Bauer, Denes (CERN), O'Connor, Paffrath, Radeka, Sippach, Sumner, Wadsworth (Marlow & Shaevitz *ex officio*)

- Activities

  — System Architecture

  — Strobe Timing Distribution

  — Analog Sampling

  — Calibration

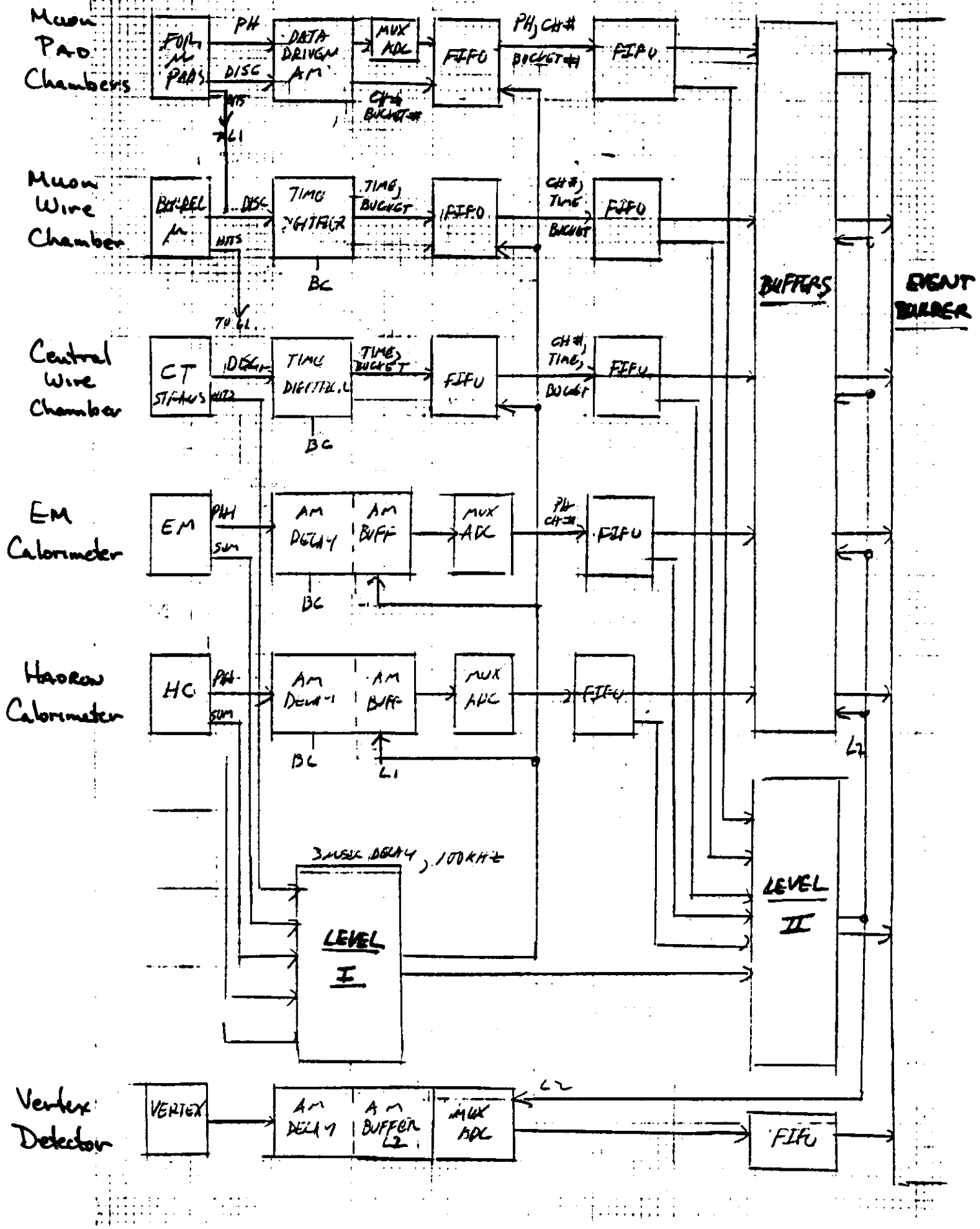
  — Rack Placement

Calorimeter Readout Performance Specifications

- 16 ns sample rate. $\sim$ 2-5 samples per hit
- Dynamic Range $\geq 2^{16}$
- Resolution $\geq$ 8 bits
- Total Conversion time $\leq$ 10 μs (for $\simeq$ 5 samples)
- Packaging
  - — $\sim$ 25 channels per FASTBUS-sized board
  - — $\Longrightarrow$ < 3 W/channel

B. Sippach

GEM TRIGGER, DATA ACQUISITION

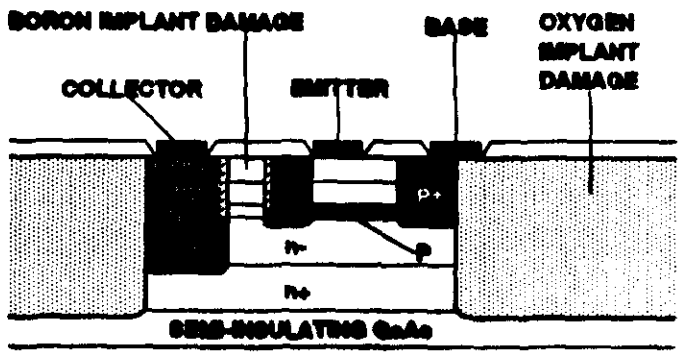


GaAs HETEROJUNCTION BIPOLAR ADC TECHNOLOGY

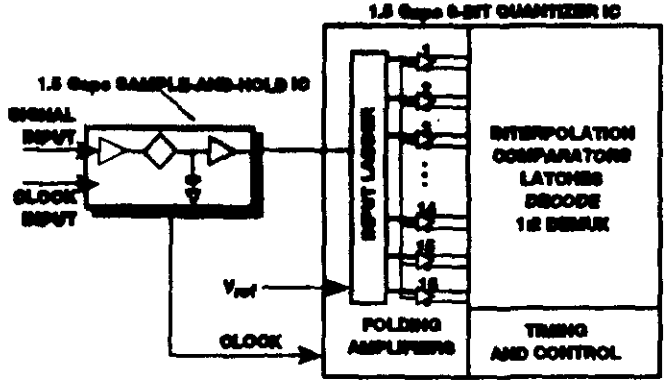
KEY PARAMETERS

f_T	25 GHz
FEATURE SIZE	5x5 µm EMITTER
METAL PITCH	5 µm
ΔV_{BE}	±1mV
V_A	>100V

NPN HBT CROSS SECTION



5 BIT, 1.2 Gsps FLASH ADC

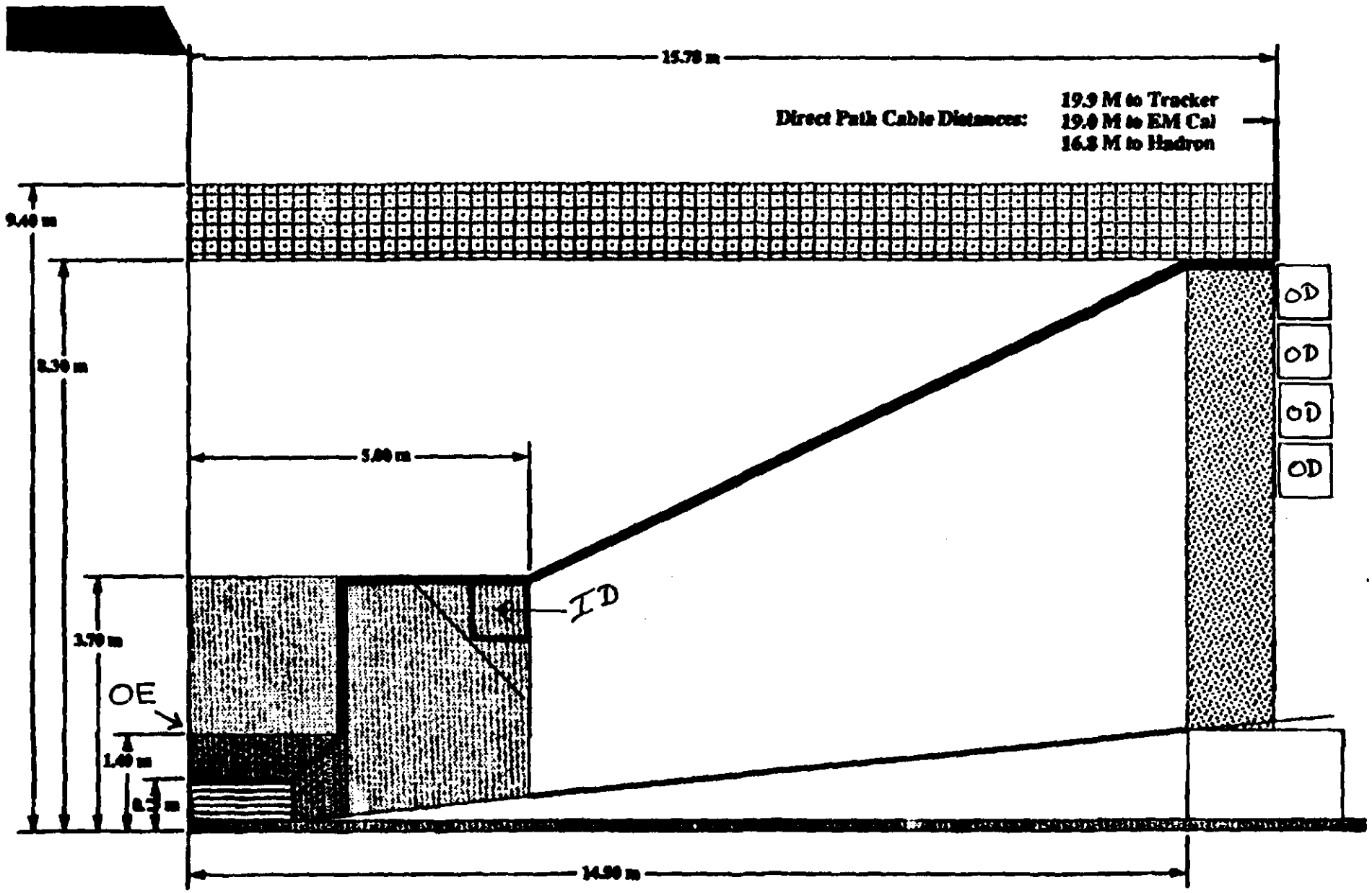


1.5 Gsps 8-BIT A-D CONVERTER

Placement Options

OE: On Element ⇔ No cable
ID: In Detector, e.g. in gap between EM and HCAL.
OD: On Detector, e.g. bolted to return yoke.
ND: Near Detector, e.g. lower counting room.
OS: On Surface, e.g. headhouse.

Location Summary				
		Cable Path	Radiation	
Loc.	Access Time	meters	Rad/Year	Comments
OE	Weeks	~ 0	500 – 150K	Access difficult
ID	Weeks	2 – 5	< 10	Limited Space
OD	Hours	20 – 30	—	Beam Off
ND	Minutes	60 – 80	—	Beam On
SD	Constant	100 – 130	—	



GEM DETECTOR CABLE ROUTING

OE = "On Element"
ID = "In Detector"
OD = "On Detector"

GEM.03.GN.00010

RENNICH

Lowry

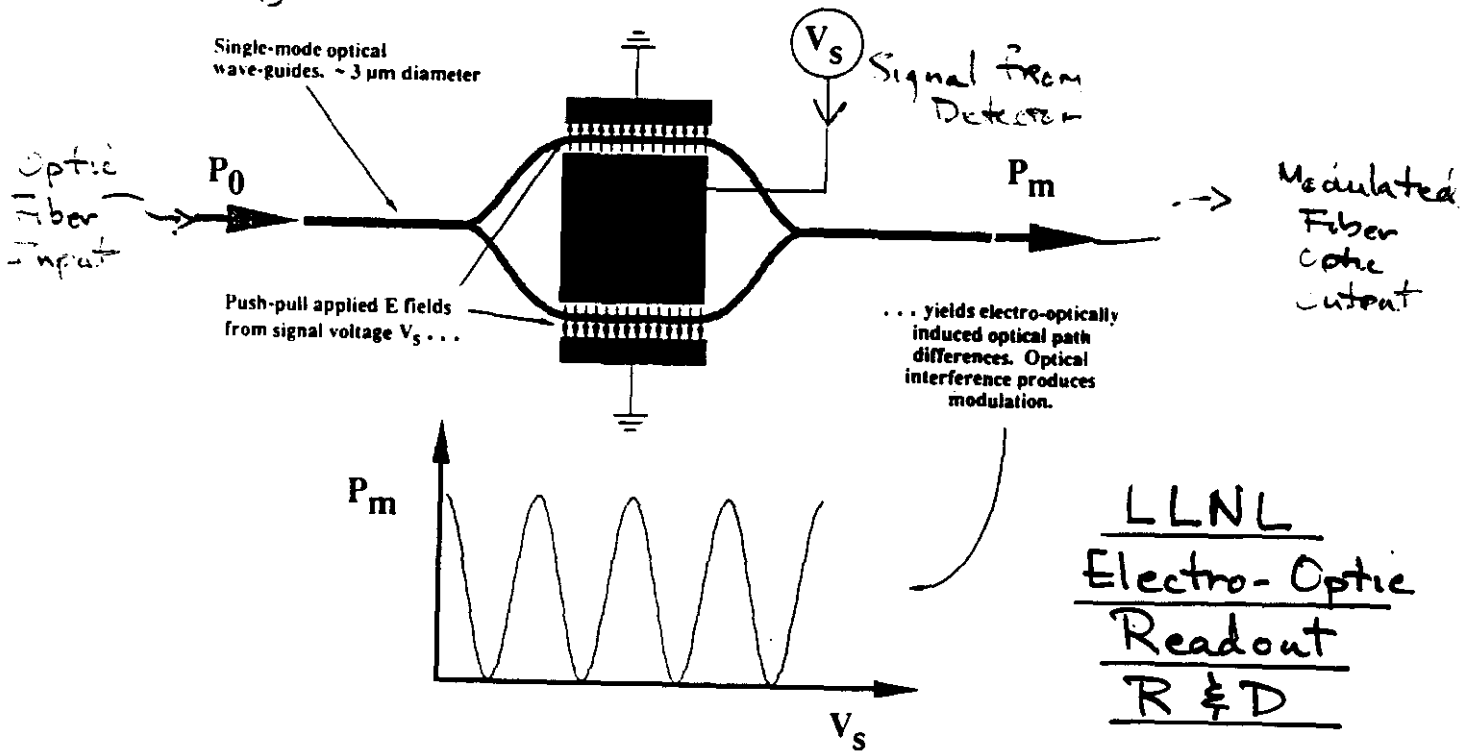


Figure 3. Simplified diagram of the operation of the Mach-Zehnder integrated optical modulator.

of the modulator response function. This setting is denoted as the half-power point. For the small signal levels typically read off the drift chamber sense wire, the modulator transfer curve was linear about the half-power operating point. If

tions of the Nd:YAG laser source. This resultant signal was sent to an oscilloscope for observation and recording. Figure 4 shows a picture of the output of the modulator/receiver system. The pulses are clearly discernable over the noise.

Our experimental demonstrations of LLNL E/O technology in the HEP environment have been very successful, and well received

.....concentrating on goals that would bolster credibility and quickly demonstrate institutional effectiveness.

- Sensitivity demonstration with 800 and 1300 nm systems
  dynamic range of 5 decades reasonable target, ref. 1
- First observation of muon chamber charge signals with E/O modulator without electronic
  ... achieved with LLNL muon chamber, ref. 2
- Collaboration with MIT (Ulrich Becker, et. al. from Ting's group)
  - -- demonstrated direct charge readout of drift tube--- no preamp !!
  - -- measured Fe 55 decay spectrum
  - -- demonstrated direct readout in B-field environment expected within the SSC detector
    ... at 0.8 Tesla no effect
  - -- measured muon track resolution with modulator readout system
  - -- familiarized key members of HEP community with technology
  - -- ref. 3
- Radiation hardness demonstrated in collaborative experiment at LAMPF
  - -- ref. 4

~ 10 SSC year dose → Only slight effects

-ROSETTE

Typical problems of Digital triggers & Data acquisition/compaction in Calorimetry of High Energy Physics.

For any number of channels:

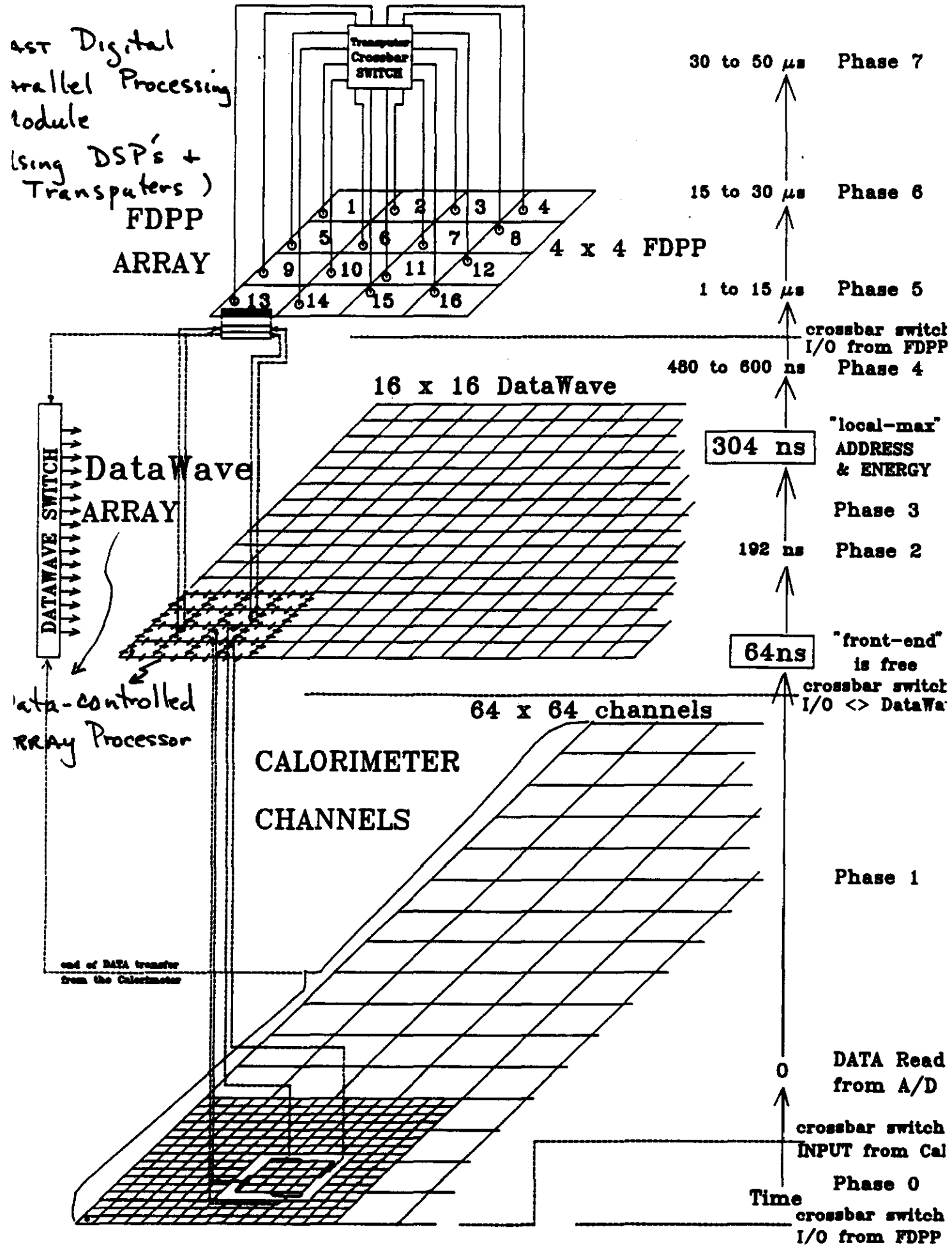
1. **Calculate the total energy and the transverse energy**

2. **Calculate the geographical address of clusters (local maxima).**

3. **Apply a threshold to the combined energy of a local maxima and of its neighbors.**

4. **Isolate from the empty calorimeter channels:**
   - the clusters found along with their regions of interest and
   - calculate their cluster shape-factors (e.g. to separate pions/electrons).

⇒ Programmable System for Calorimetry DAQ Using Commercial Components
(Example of Level 2 Architecture)


ast Digital
rallel Processing
odule
(sing DSP's +
Transputers)
FDPP
ARRAY
Transputer
Crossbar
SWITCH
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
4 x 4 FDPP
30 to 50 μs
Phase 7
15 to 30 μs
Phase 6
1 to 15 μs
Phase 5
crossbar switch
I/O from FDPP
480 to 600 ns
Phase 4
16 x 16 DataWave
304 ns
"local-max"
ADDRESS
& ENERGY
Phase 3
192 ns
Phase 2
DATAWAVE SWITCH
DataWave
ARRAY
64ns
"front-end"
is free
crossbar switch
I/O <> DataWa
ata-controlled
RRAY Processor
64 x 64 channels
CALORIMETER
CHANNELS
Phase 1
end of DATA transfer
from the Calorimeter
0
DATA Read
from A/D
crossbar switch
INPUT from Cal
Phase 0
Time
crossbar switch
I/O from FDPP

Rapid improvements in performance of commercially available

- Digital Signal Processors and of
- Data-driven Array Processors

} Integrate Commercial Units into System

are an invitation to make a serious effort

- to efficiently integrate these commercial components
-in a design that satisfies the requirements of the applications in HEP.

The decision of developing a new VLSI special digital processor

- should be weighted very carefully
- because of the difficulty of providing all necessary software development tools.

RPC

Table 1 - Characteristics of RPCs	
plate bulk resistivity	$10^{11\pm1}$ Ω cm
electric field	~40 kV/cm
pulse charge	10^2 pC
pulse rise time	~3 ns
pulse duration	~20 ns
efficiency	~97%
discharge area	0.1 cm^2
recovery time	10^{-2} s
time resolution	~1 ns

2. Resistive Plate Chambers

The Resistive Plate Chambers, developped in Rome ten years ago, work at a uniform electric field of ~ 40 kV/cm between parallel electrode plates of a plastic phenolic material (bakelite) with a resistivity $\rho \simeq 10^{11}$ Ω cm. The plates, 2 mm thick, are kept separated at a distance of 2 mm by spacers of polyvinyl chloride. Gas tightness is insured by a frame of the same material. The sensitive volume is filled with a gas mixture of argon/butane plus a small percentage of freon 13B1 at normal pressure. The generating field electrodes are layers of a graphite varnish coating the outer surface of the plates. They are isolated from the read-out electrodes by a 300 μm thick film. A section of the chamber is shown in Fig. 1.

Sketch of a Resistive Plate Chamber

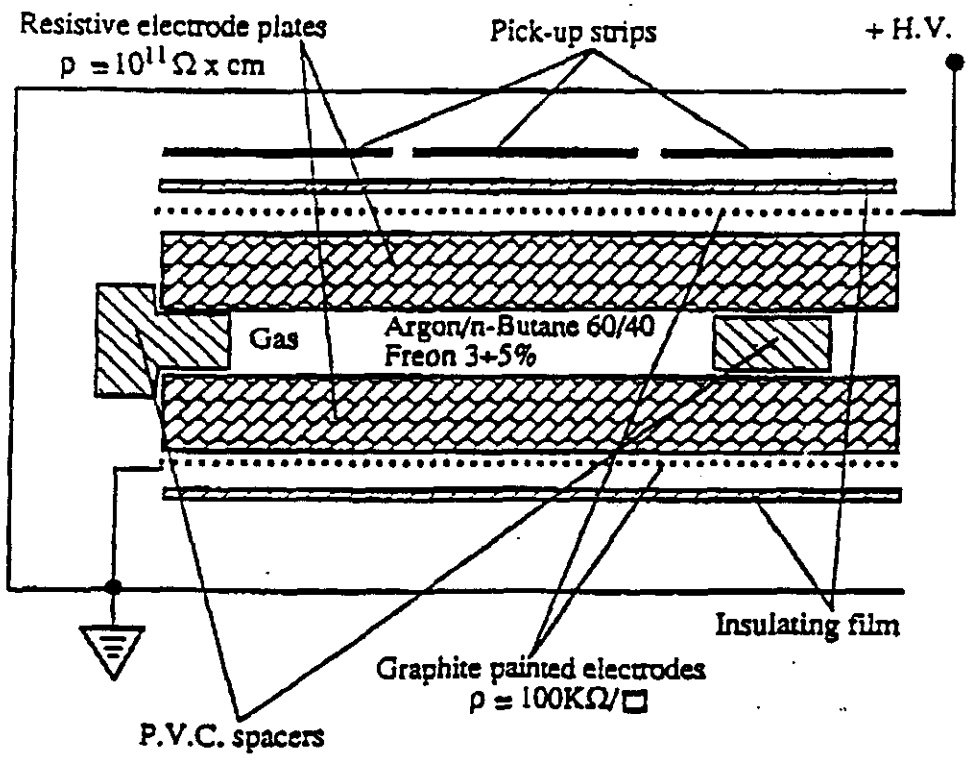


Fig. 1

Pless

CONCLUSIONS

1. USING RPCs ONE CAN GENERATE A P_t TRIGGER IN ABOUT 100 NANOSECONDS WITH A JITTER OF A FEW NANOSECONDS

2. TRIGGER LOGIC IS SIMPLE AND IS IN "REAL" TIME. THE INFORMATION FLOWS WITH THE PARTICLE

3. COSTS LOOK REASONABLE

4. THE Z COORDINATE AND THE RADIAL COORDINATE CAN BE MEASURED TO 1 MILLIMETER AND PROBABLY BE MEASURED TO 500 MICRONS

Resistive Plate Chamber R&D Collaborative Work

- Collaboration with Professor Irwin Pless's group at MIT.
  +BU + Brown + Indiana
- MIT will do the following:
  - Acquire an Italian bakelite RPC (1m x 2 m).
  - Set up a test stand to measure:
    - spatial resolution as a function of length along the readout strips,
    - time resolution
    - gas choice - non-flammable
    - noise
    - aging
    - high particle flux performance (< 100 Hz/cm^2 ?)
    - performance in high neutron flux (important for plastic based RPCs)
    - choice of readout electronics
    - choice of fast trigger electronics
  - Test facility with muon telescope, three component gas system, etc.
- LLNL will test glass-based counter on MIT test stand for comparison to the Italian RPC.

Resistive Plate Counter R&D at LLNL -

Craig Wuest, Elden Ables, Richard Bionta, Dan Makoweicki

- RPC R&D at LLNL is taking advantage of an extremely capable Chemistry and Materials Science Division.
  - We have expertise in coating a variety of dissimilar materials using a number of different technologies: e.g. sputtering of As on Pu.
  - We have identified a resistive soda-lime glass as a candidate for RPC plates (in place of the carbon-painted phenolic).
  - We will build a 25 x 25 cm^2 RPC in the first part of the program, based on the work of Cardarelli, et al., NIM A263 (1988).
  - Discussions with I. Pless of MIT have been initiated and a joint effort to develop RPC's is envisioned.
  - Larger 1 x 1 m^2 RPC's in the future.

Punchthru Rate Studies (Progress Report)

T. Bolton

Goals:

- Verify previous calculations for GEM
- Study feasibility of using Muon Layer 1
- Verify rates with proposed trigger strategies
- (• Physics req. for η coverage ie $Z \to \mu\mu$ 800 GeV)

Tools:

- GEANT GEM geometry + tracking (M. Seman)
- ISAJET FOR physics
- PCHTHR: Punchthru simulation from McNeil.
- Strategy:
  - Full tracking of all muons (primary, π/K decay)
  - Full tracking of punchthru products from back of calorimeter

T. BOLTON

Preliminary Results

(Twojet RATE Isajet $P_\perp \geq 2$ GeV = 35.0 MHz)

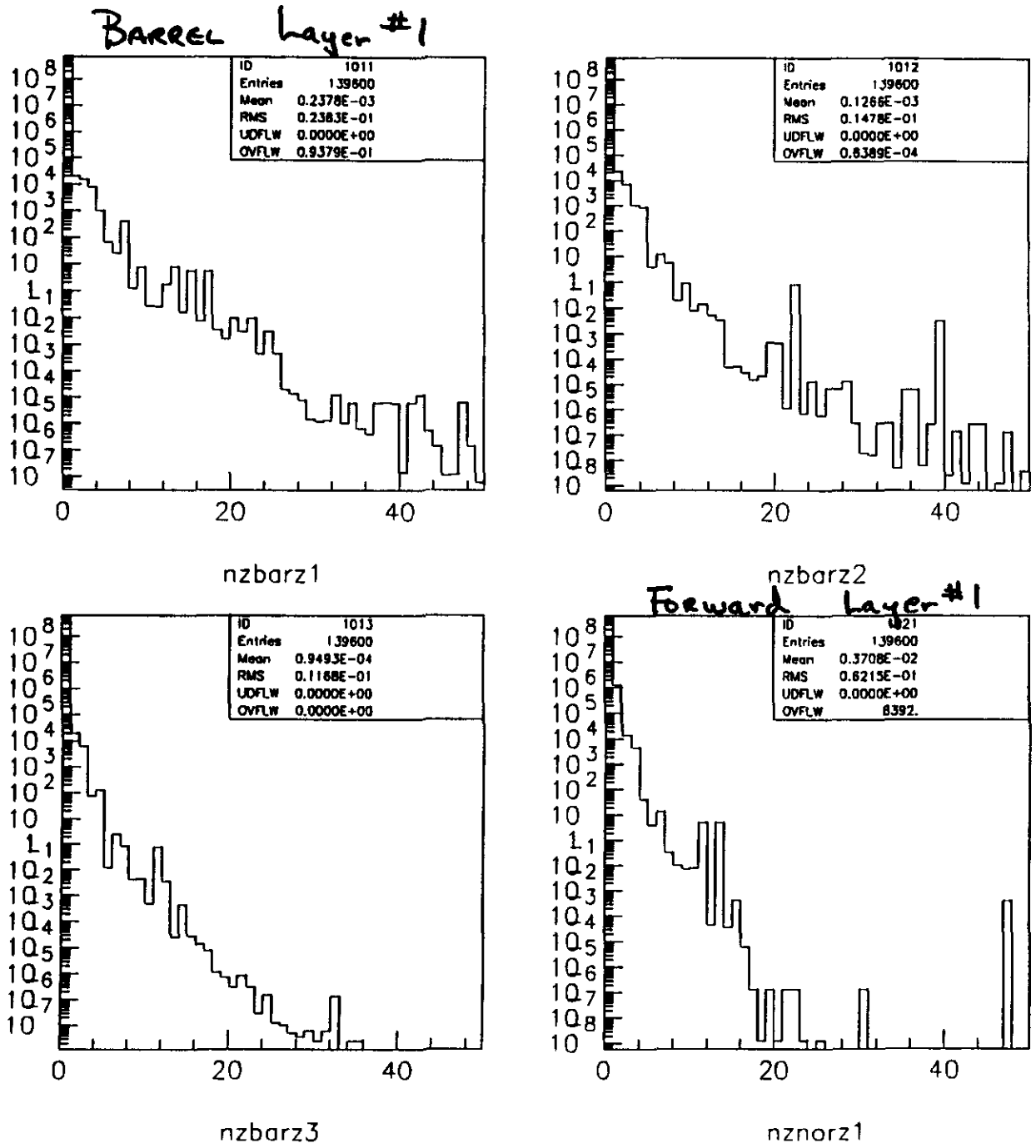
Mean Rate of Hits

BARREL	Layer 1	83	kHz
	Layer 2	44	"
	Layer 3	33	"
Forward	Layer 1	1.3	MHz
	" 2	1.0	"
	" 3	.8	"

Mean $\langle P_\perp \rangle$ of hits = 580 MeV

Mean Pnchthru Multiplicity = .0133/ev

03/09/91 11.34



Ordinate = Rates in Hz
assuming $\mathcal{L} = 10^{33}\ cm^{-2}s^{-1}$

~~abcis~~

Abcissa = # of hits

bar = barrel

nor = north end

sou = south end

TOTAL TWOJET rate

$P_T > 2$ GeV

$= 3.49 \times 10^8$

Fig. 1. Muon Trigger Strategies

M. Cerman

DPHI AND RAYS TRIGGERS

***

DPHI IS A VALID TRIGGER IF THERE IS A COINCIDENCE BETWEEN PADS PHI3(i) AND ONE OF PHI2(i +/- thr)

WHERE thr = 0,1,2,3,....

***

RAYS IS A VALID TRIGGER IF CALCULATED ANGLE BETWEEN RAY2 AND RAY3 IS SMALLER THAN A GIVEN THRESHOLD

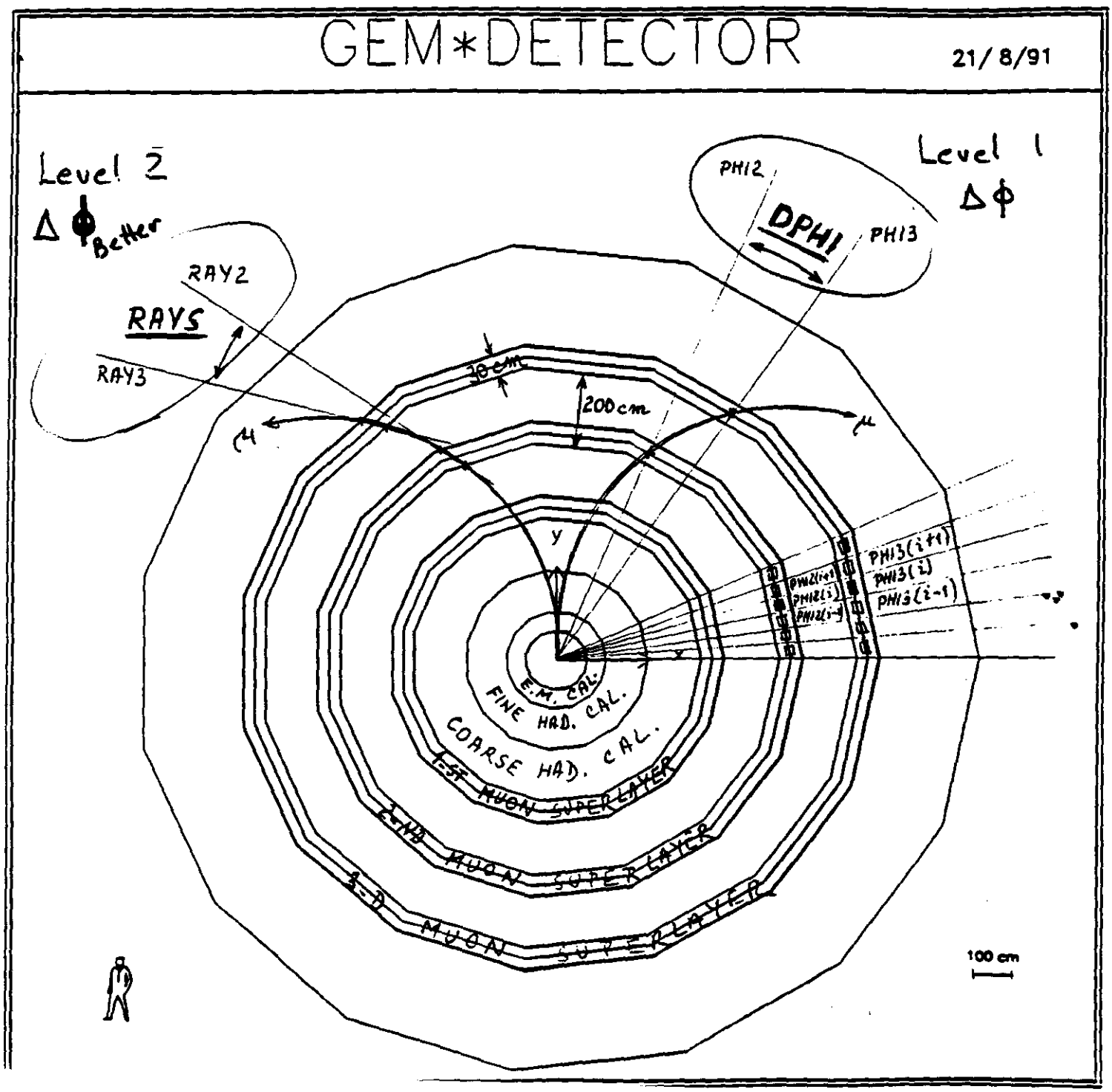
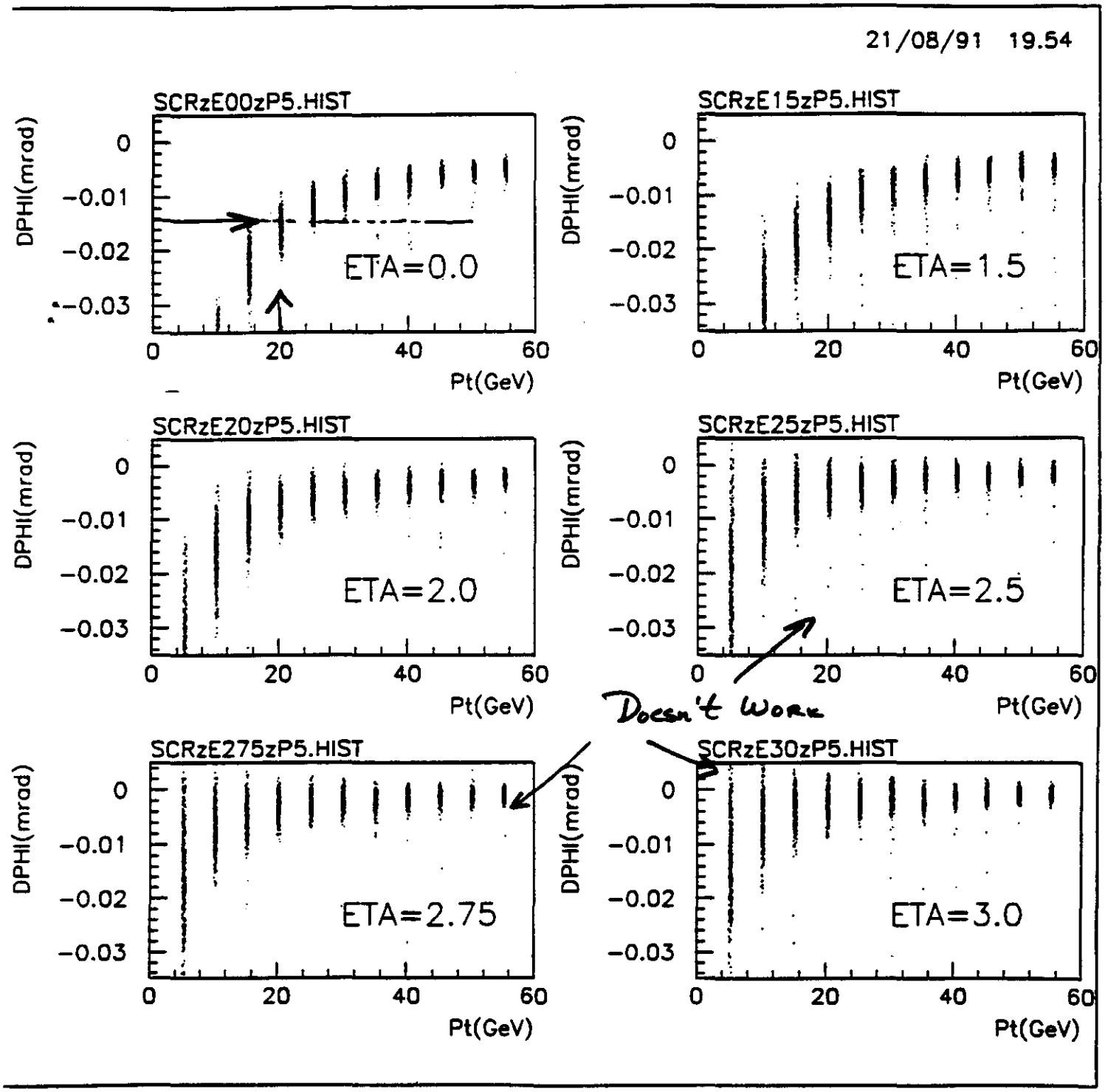


Fig. 2. Level 1 $\Delta\phi$ Trigger



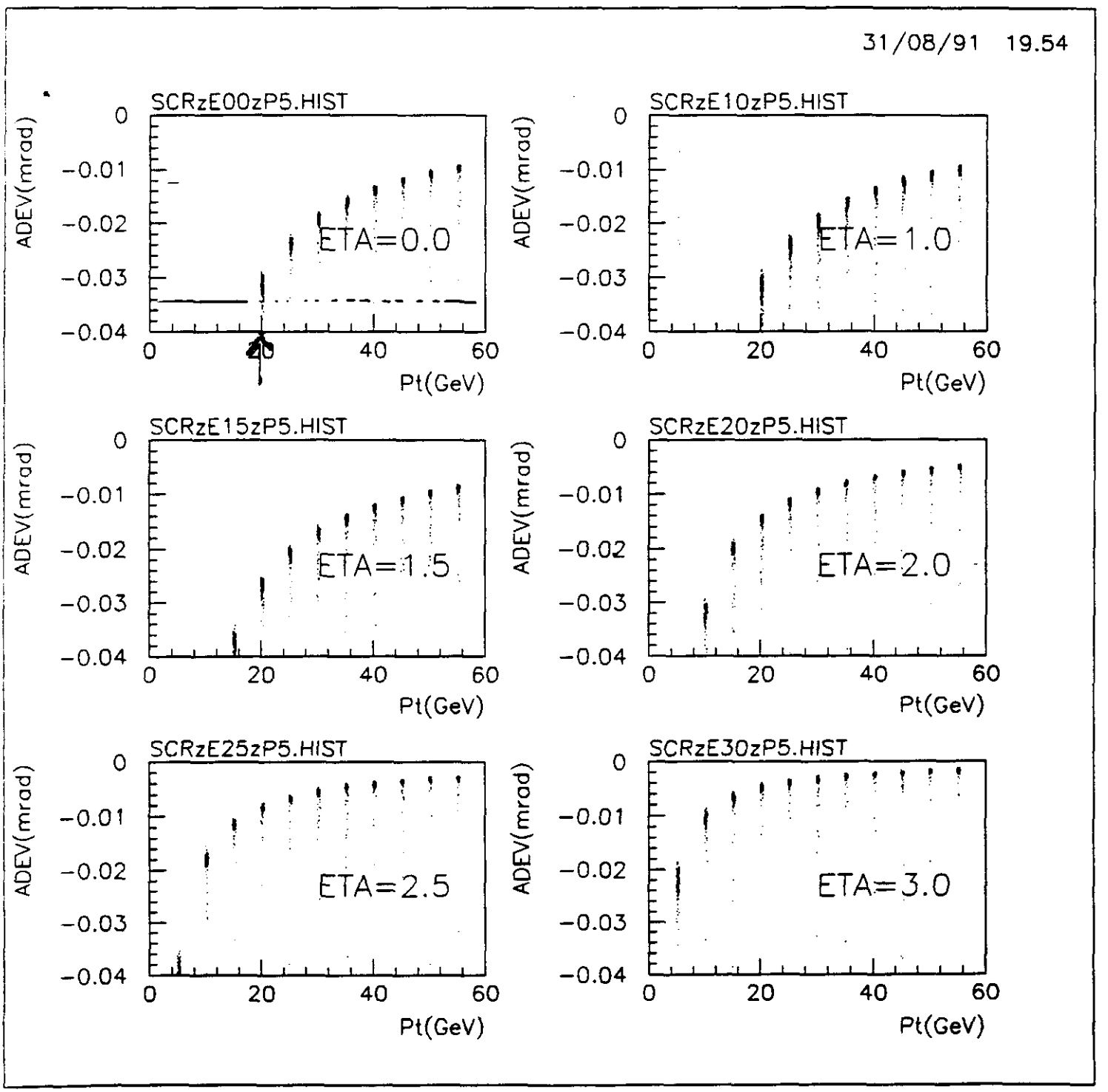
19.7.

D.REFOL = 0.1 cm

Level 2 "Ray Trigger"

$\Delta\phi$ Trigger

Better



R & D PLANS

- Continue General Architecture Development + Trigger Strategies

- Analog Pipeline Development
  - Longer Delay Units
  - Integrate MUX ADC system

  Augmented by SDC + LHC wor

- Digital Pipeline Development
  - FAST ADC's

- Electro-optic readouts
  - Improved charge sensitivity
  - Cost reduction

- RPC (Resistive Plate Chambers)
  - Test resolutions + electrical properties
  - Build 1m x 1m glass plate device

- TRD Development
  - Prototype unit to check efficiency and rejection.

- DATA FLOW Studies
  ⇒ Required rates + technologies

(1)

K. McFarlane

GEM Computing Meeting
SSCL

Sept. 4th 1991

Ahchurin, [illegible], Hand, Ma[illegible], Johnson,
McFarlane, Yost, Raja (FNAL/DD),
(Blanken, Fisher, IBM).

Computing for Simulation and Analysis

CHARGE

- Development of Computing Systems and Software for GEM
- Software Design Standards
- Development of simulation tools for general use
- Cooperation with Trigger/DAQ group on on-line (Level 3) system
- Assistance of Physics group on simulations

Near term Activities

- Preparation of LoI
  - simulations largely ad hoc ; approaches used do not commit collaboration
  - brief section on plans and needs, (for proposal preparation), organization
- Preparation of Proposal
  - computing done with eye to longer-term solutions
  - Detailed section on approaches to simulation, on- and off-line computing,
- Formation of working groups
- Central support group
- Working group meetings 7/19/91, 9/4/91 (agenda)

- Space requirements
  Yost, Cornell, McFarlane, Mount
- General Framework
  Johnson, Mount, McFarlane, ...
- 'GEM' software library at SSCL
  Lane, Zhou, McFarlane +
- 'GEM' detector description at SSCL
  L. Roberts

AGENDA

Computing for Simulation and Analysis Meeting

SSCL, Main Building (Bldg. 4) Room B110 (CCD conf.room)
(9:00 a.m. Sept. 4th)

The meeting will be informal, with talks and time for discussion of the topics raised. This agenda is a guide only. The issue of SSCL resources allocated to GEM computing next fiscal year and in the future needs to be discussed.

9:00 a.m. Status report -- K. McF
9:15 a.m. SSCL projections (and budgets) for GEM computing:
Space at Detector and Central Facility -- G. Yost
Facilities for offline simulation/analysis computing -- L. Cormell
9:45 a.m. Discussion of above issues and:
Projection of use of PDSF for FY92 (the planned expansion of thi
facility may be postponed or scaled back to direct funds elsewhere
Needs for space, manpower etc. in the detector area, and in the ce
facility.
10:15a.m. BREAK
10:30a.m. Approaches to computing at collider detectors:
L3 approaches to computing -- [redacted] R. Mount
11:30a.m. D0 approach -- R. Raja (FNAL)
12:30p.m. LUNCH
1:30 p.m. Joint with Trigger/DAQ on on-line farms. (bldg. 1, Rm 285??)
Parallel farms (Hypercube,Touchstone) L. Gladney/Lockyer (Penn)
2:30 p.m. SLD approach -- Tony Johnson
3:00 p.m. Discussion of:
Contribution to LoI.
Computing R&D programs (what's needed now?)
Contribution to Proposal -- plan for preparation
Computing model: Central vs. distributed
Code management, Languages, etc.
Unix code maintenance tools

From "PUPHEP::MARLOW"@SSCVX1.SSC.GOV Fri Aug 30 17:48:44 1991
Date: Fri, 30 Aug 1991 17:52:54 CDT
From: "PUPHEP::MARLOW"@SSCVX1.SSC.GOV (Daniel R. Marlow 609-258-4383)
Message-Id: <910830175254.20a0da04@SSCVX1.SSC.GOV>

(5)

Computing Needs -- Simulations

Use SSCUPs -- SSC Units of Processing power. 1 SSCUP = 0.9 VUP = 1 MVUP, on event generators.

- 10^5 parameterized events at 400 SSCUP-sec per event. One-day turnaround means 400 SSCUPs.
- 10^4 full simulation events at 20,000 SSCUP-sec per event (L3: 6 mins on VAX8650 x 10). One-day turnaround means 2,000 SSCUPs.
- 10^6 parameterized events at 400 SSCUP-sec per event. Three-day turnaround with 2,000 SSCUPs.

Workstations now are 20-30 SSCUPs.
SSCL has 1,000 SSCUPs in PDSF,
+ 3,000 by Jan. 1992

This does not include pileup, full shower for all events, overlap of events.....
Not all power available for one job.

7

3

Difficulty of projecting needs, costs:

Computing Projections [redacted]

- Much less definite than for apparatus *
  - [redacted]
- Need to make better estimate of costs and schedules and understand contingencies
- Areas of uncertainty
  - Simulation demands
  - Detector data rate
  - L3 farm requirements
  - Networking demands
  - Computer performance and cost evolution
- Research needed
  - Data storage and access
  - L3 farm
  - Networking
  - Software development
  - Parallel/distributed computing

Simulation Data Management

1) Parameterized 0.3 MB/event
2) Fully digitized 2.0 MB/event
3) Selected 0.1 MB/event

For 2,000 SSCUPs

1) 150 GB/day = 75 8mm tapes/day
   = 5 TB/yr
2) 20 GB/day

Some strategy may be needed in which events are summarized — 3).

Consider a robot facility 3m x 5m x 10m, 20% filled with 8mm tapes
= 5,000 TB

On-line

- Triggering and Data Acq.
  - Raw rate 10^8 Hz
  - L1, L2 out 10^{2-3} Hz out
  - L3 10^{2-3} Hz in ? Hz out 1-100Hz

    $10^2 - 10^3$ SSCU-sec : $10^4 - 10^5$ SSCUPS

    100-1000 SSCUPs/CPU = $10^2 - 10^3$ CPU's

    choose 10^6 SSCUPs/ ⇒ 2k CPU's
- Data Recording
  - 100Hz of 0.5 MB events to store 1,000 TB/SSC year
  - 1 stream of calibration data
- Performance Monitoring
- On line analysis
- Graphic Data displays
- Human interface
  - run control: fast, easy!
  - Alarms, Error logging
  - log of all 'events.'
  - Electronic notebook

Data Management

Physics data

- Storage of 10,000 TB of data
- Access

Calibration

- Data base
- Detector description

Software

- Code Management
- Version, capabilities management

Need an automatic system for connecting data, calibrations and software versions

Documents

Engineering data base

Off line Analysis

- Input 1,000 TB/SSC year
- Output 2,000 TB/SSC year
- fast Access to small sample
- Random access to event
  - by key
  - by characteristic
- CPU power needed 10^3 SSCUP-s/event
  $= 10^5$ SSCUPs
  for 'real time' first pass
- Second pass needs equal power
- At near term costs 2×10^5 SSCUPs costs \$20M. Expect reductions!
- At expected rates, data will be centralized.
- Software tools, help facility

Comment

Do not expect full utilization of (off-line) CPU power:

- Will be divided across many CPUs; no perfect scheduling!
- <u>Need</u> idle CPU power to be responsive
- Networking will be bottle-neck

See HN's fig 1.

Costs ; Budget

- Design to budget!

- SSCL off-line $75M construction
  split between equipment + operations
  - use of equipment fund split between
    SDC, GEM + other users
  - ≈ $ 15M for equipment used by GEM
    (assume ≈ SDC)
    60% CPU + memory + sys disk + interface
    16% Disk Storage
    10% Networking (increasing) 14% Tape storage (declining)
  - $10M for 'Basic box' inc. interfaces

-

• VLSI costs

	1983	1991	1999
SSCUPs	1	30	900
Basic box	\$40k	\$20k	\$10k
memory	2MB	32MB	512MB

$$\text{Power}/\$k = 1.5\, e^{0.492x} \qquad x = \text{yr} - 1991$$

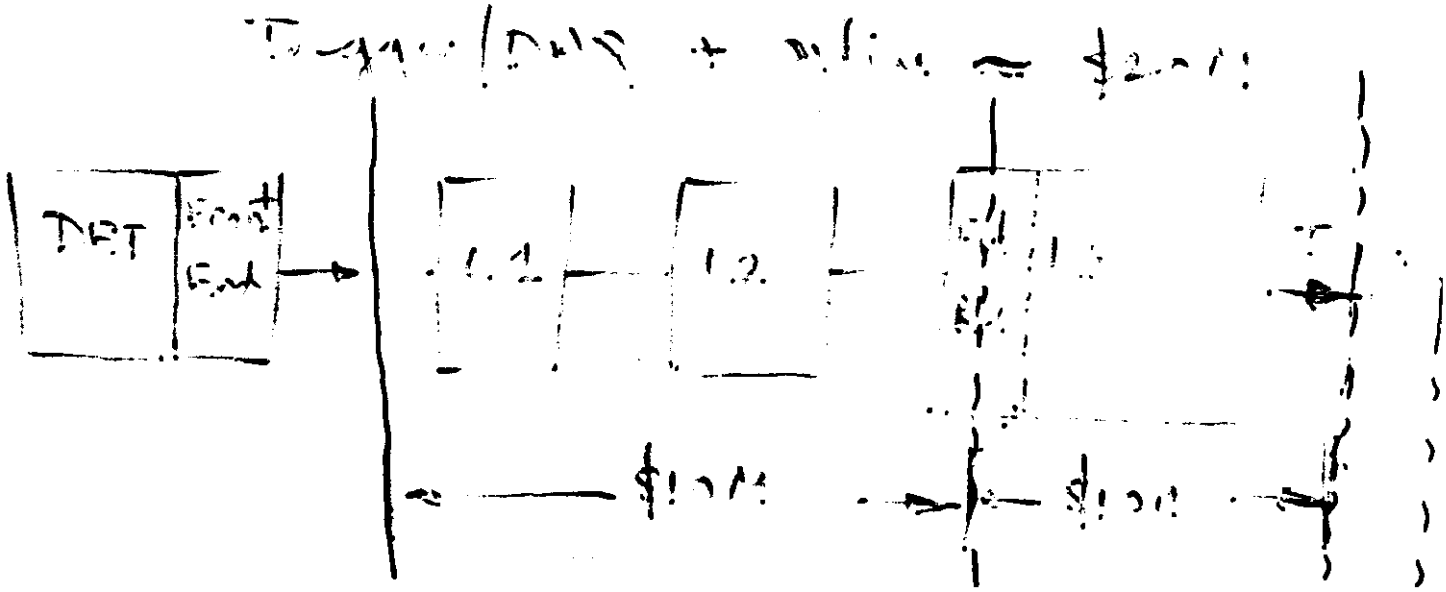
Spend \$2M each year; retire 5yr old equipment
\$10M spent from 91–99
$\approx 1.8 \times 10^5$ SSCUPs

All in 1999 : 7.68×10^5 SSCUPs

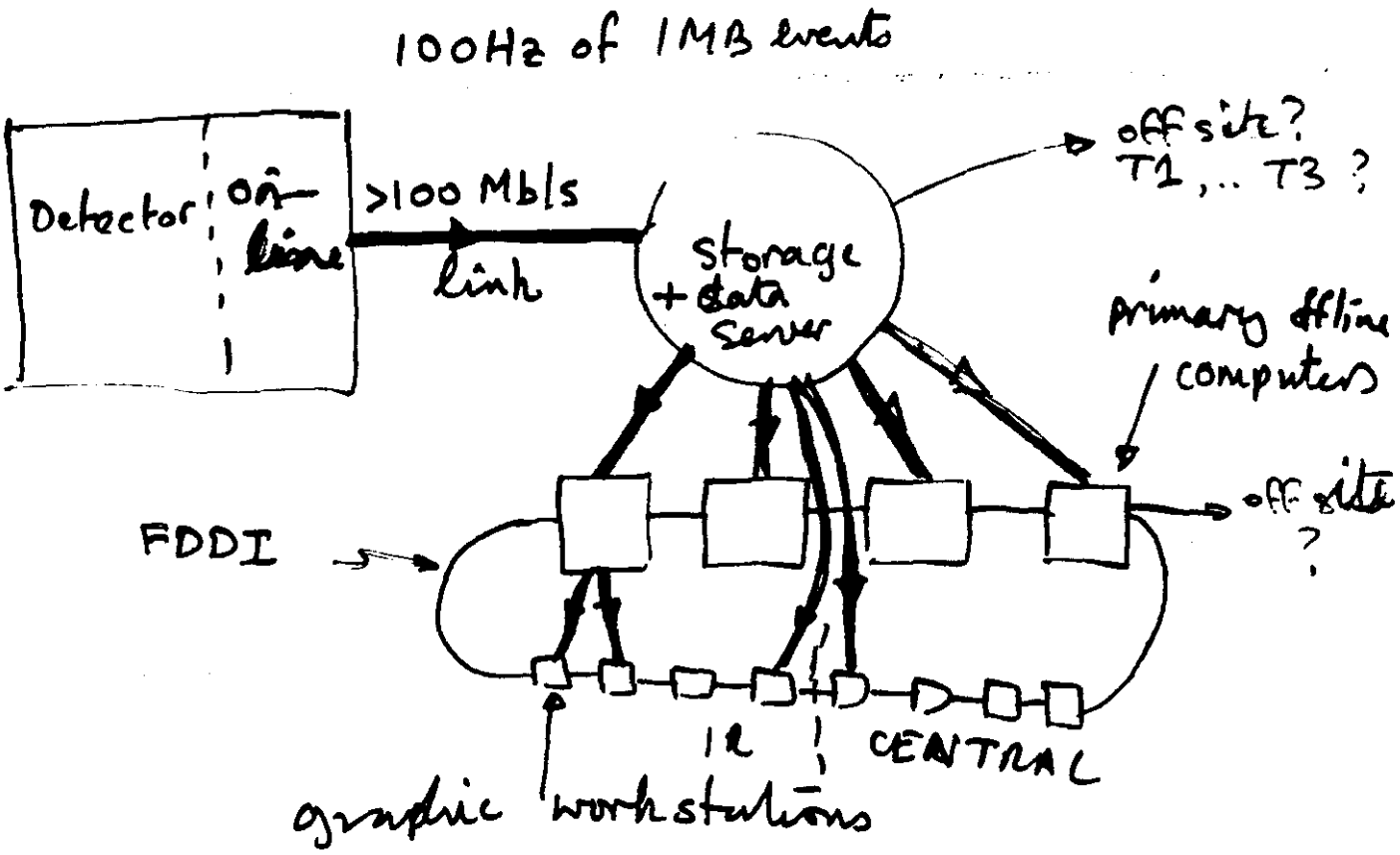
<u>L.R. Cornell projection</u>: different funding profile : $\approx$ ~~x~~ 4.4×10^5 MIPS

Expect shift from construction to operating
\$2M in ~~1999~~ 2000 buys $\approx 2.5 \times 10^5$ SSCUPs
($\sim 5 \times 10^5$ MIPS) for RISC

On-Detector Budget



Structure of System



No geographical restriction on location of data storage relative to detector (or offline computers?)

So

- No split data bases
- Data storage can be central or at IR. (13 PB – 13,000 TB for ≈ $1M) = B. Scientific

Rough space calculation

- 10^6 SSCUPs → 2,200 CPU's. (on + off)

  Stack 8 high → 280 stacks

  each stack 6' × 2' + equal for disks

  → 24 sq.ft./stack

  i.e. ≈ 7,000 sq.ft. for computers

- 50 people active. 80 sq ft/person

  Workstation, ~~document stor~~ disks, printers, coffee machine, copier...

  ≃ 4,000 sq ft for people + W.S.

- Bulk data

  25 ft × 25 ft for 13 PB system now

  allow 2,000 sq.ft. for "tape"

Operations Bldg – one floor for computing

25 m × 25 m = 6,000 sq ft

Need 7,000 sq ft additional!

M.A.B. 30 m × 125 m.

Schedule

Oct. 1999 — On-line, storage of $\gtrsim$ 2 PB
Off-line available

1998 – Purchase and installation of final increment of CPU.

1997 – CPU increment + storage system

1996 – Purchase and installation of basic on-line, off-line system + Software

1995 – Final specifications

1993 – Begin on 'real' software

1992 – Design of real software

Idea is to push final purchases to end.

HEAVY RELIANCE ON COMMERCIAL PRODUCTS.

The need to follow round of working with industry to ensure state-of-the-art product.

Programming Philosophy

Near Term (through Proposal)

Undecision:

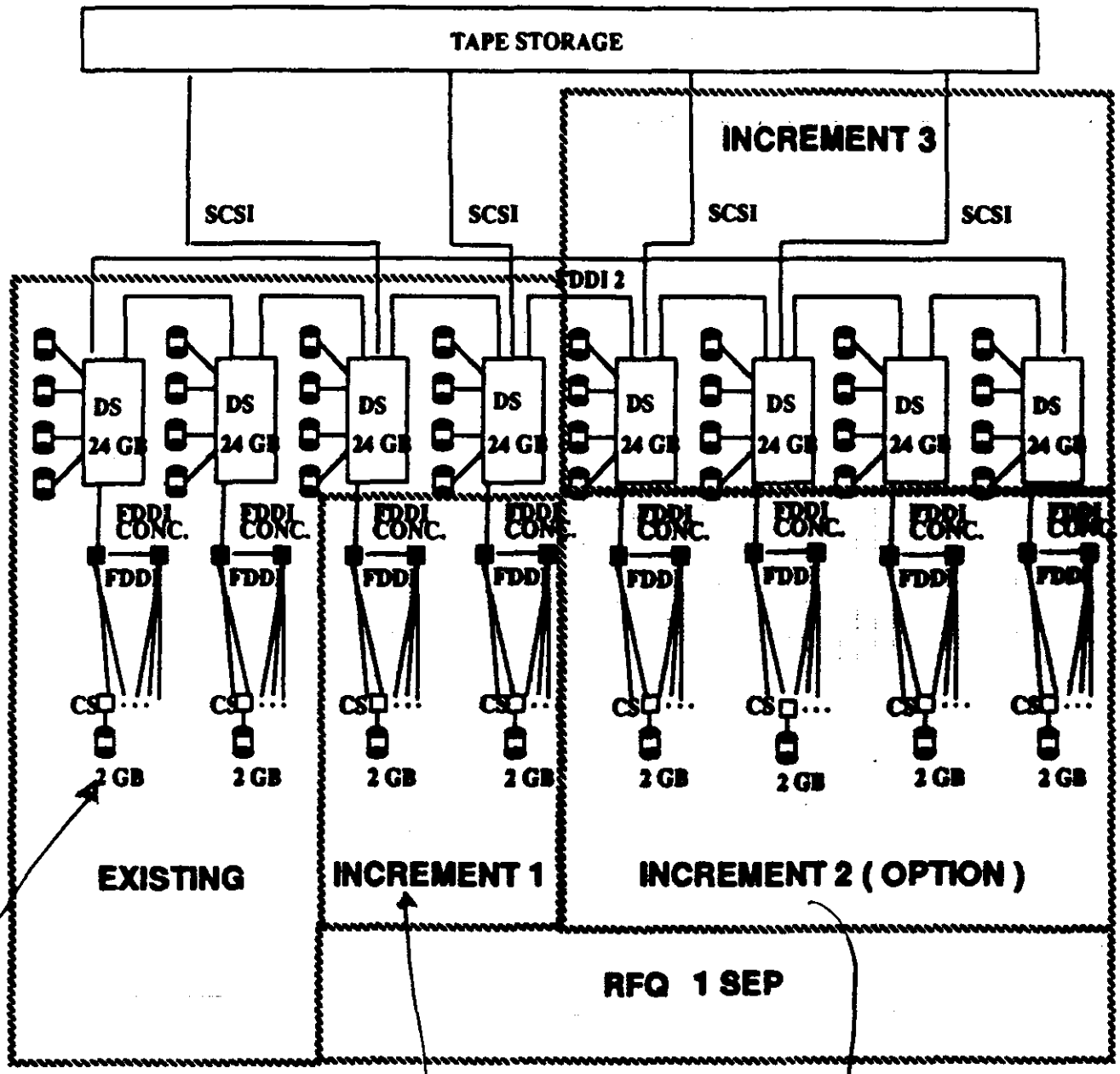
FORTRAN,
GEANT,
ZEBRA,
CERNLIB...

Longer Term

- Open philosophy – don't know what future systems will be.
- Communication within and between programs by defined data structures.
- Study use of other languages, but FORTRAN is current choice.

PDSF expansion

(20)



16 work stations

Jan '92

later in '92

Applying for accounts

SSCVX1 — VAX/VMS — MAIL

SSCULX1 - DEC/ultrix -

PDSF — simulation

1. Send E-mail request to MCFARLAN@SSCVX1

2. login to pdsf.ssc.gov as 'gem'
   copy newacct.txt, edit copy and
   mail to mcfarlan

3. check GEMNEWS for other instructions.

GEM software library

From: BUPHYC::LANE 3-SEP-1991 20:14:16.16
To: SSCVX1::MCFARLAN
CC: LANE
Subj: RE: GEM software 'library'

Dear Ken McF.

Thanks...I know enough unix that your instructions are perfectly clear.

Regarding "we have a way to go": After a conversation with Bing Zhou today, I think that people may be somewhat shy about contributing less-than-perfect programs. This could be counteracted by sending out a message saying that we are interested in ANY programs that are relevant and don't bomb...no matter how grundgy! For now, and for the purpose of addressing the PAC questions, my definition of a "relevant" program is that (a) it is directly applicable to one of the 1st four PAC questions or (b) the author MAY think it useful to question 5 --- complementarity to SDC. If the author thinks the program is useful by this definition, but not in the best of shape, (s)he could/should indicate that in introductory program comments. BUT, WE NEED THE PROGRAMS! ALL CONTRIBUTIONS WILL BE GRATEFULLY ACCEPTED! This is no time for foolish pride. You can consult with Bing and Frank (e.g.) who best to solicit for contributions.

Thanks again,

Ken L.

Username : gem

password : [redacted]

Sel GEM_NEWS

1) ftp to pdsf >ftp ws1.ssc.gov

2) login and ftp from pdsf

3) Create a directory in your name in public [illegible] identifier.

(2)

Forward Calorimetry
Do we need it?

John Rutherfoord
University of Arizona
GEM Collaboration Meeting
5 September 1991

$\not{E}_T$ Signals

$W^{\pm} \rightarrow \ell^{\pm}\nu$, $Z^0 \rightarrow \nu\bar{\nu}$

$\tau \rightarrow \ell\nu X$

$t \rightarrow W^{\pm}X \rightarrow \ell\nu X$

Weakly Interacting Particles (SUSY LSP)

"Fake" $\not{E}_T$ Signals

Jet "fragmentation" of neutrinos (primarily c and b quark semi-leptonic decays)

Calorimeter cracks, dead spaces, dead channels, etc

Calorimeter resolution (energy and angle)

Geometry effects, e.g.

$\eta = 3$ spray/cross-over

η coverage

Physics Requiring a Forward Calorimeter

Missing E_T

Higgs

$$H \rightarrow ZZ \rightarrow \ell^+\ell^-\nu\bar{\nu}$$
$$H \rightarrow ZZ \rightarrow \ell^+\ell^-\tau\bar{\tau}$$

New heavy quarks

SUSY

Technicolor

$$\rho_{TC}^{\pm} \rightarrow W^{\pm}Z^o \rightarrow \ell^{\pm}\nu\ell^+\ell^-$$
Leptoquarks $gg \rightarrow P_3P_3 \rightarrow b\tau\bar{b}\bar{\tau}$

New Gauge Bosons

$$W'^{\pm} \rightarrow \ell^{\pm}\nu$$

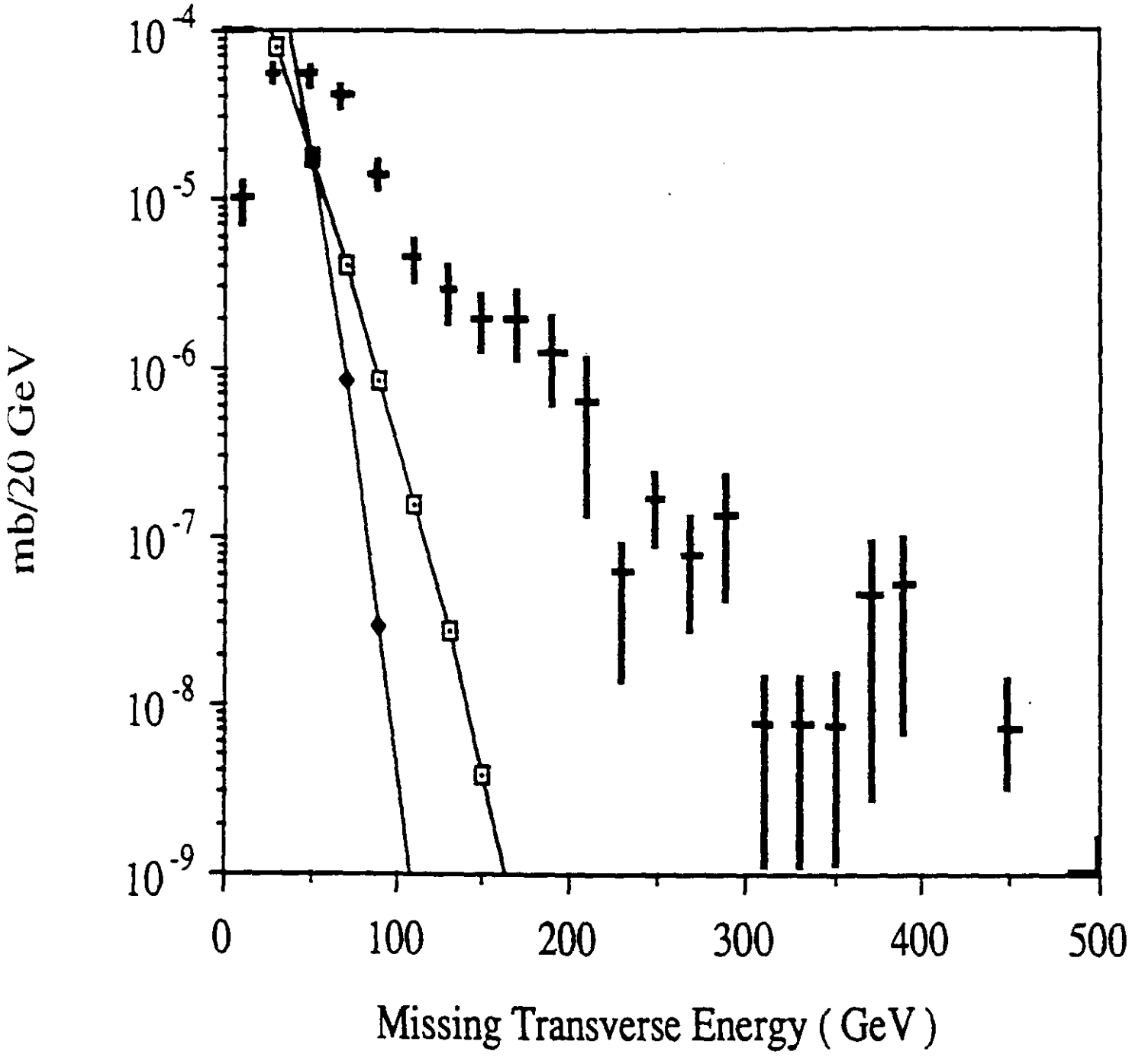
Other sources of boson pairs

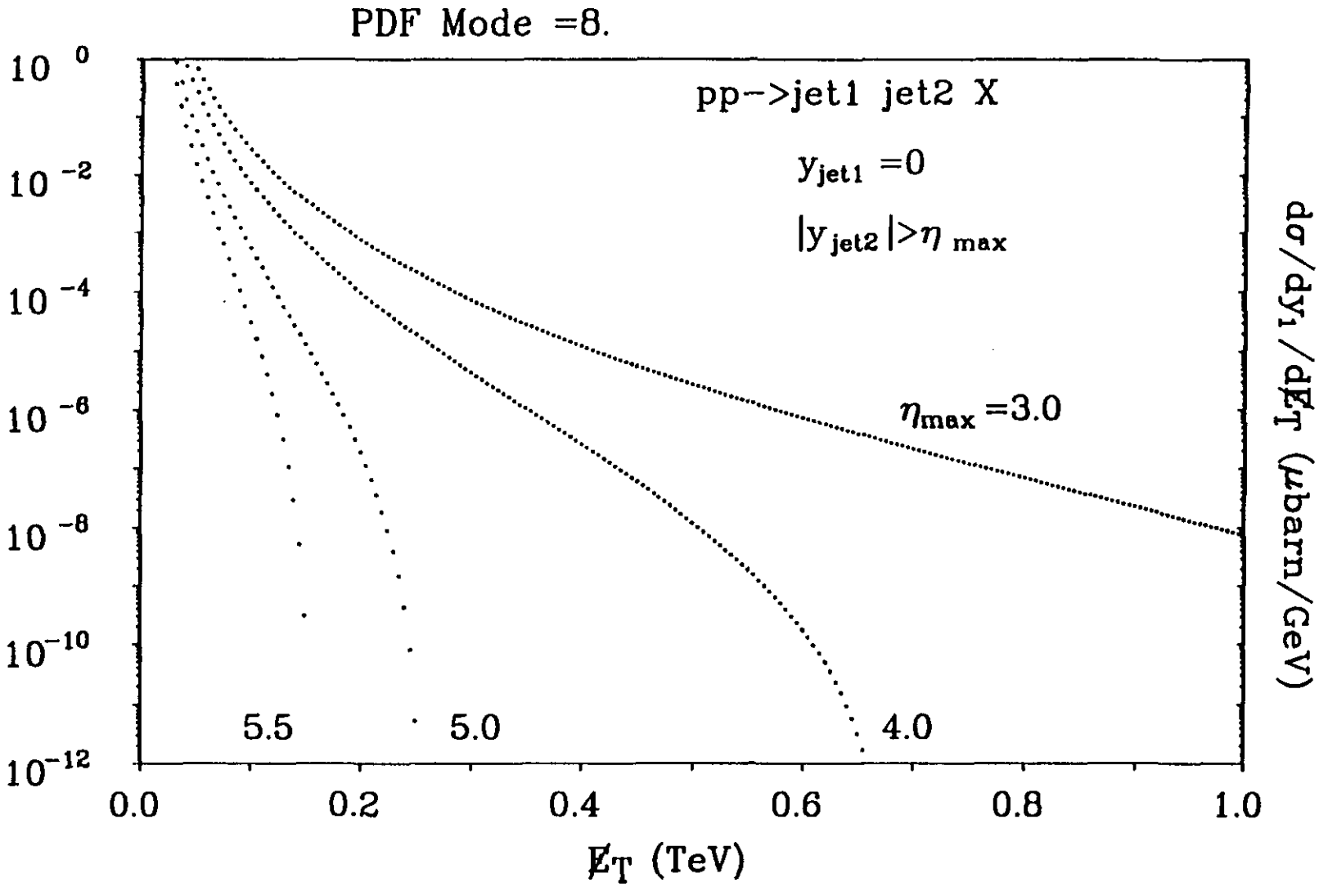
$$W^{\pm}Z^o \rightarrow \ell^{\pm}\nu\ell^+\ell^-$$
$$W^{\pm}W^{\pm} \rightarrow \ell^{\pm}\nu\ell^{\pm}\nu$$
$W^+W^- \rightarrow \ell^+\nu\ell^-\nu$ if separable from $t\bar{t}$

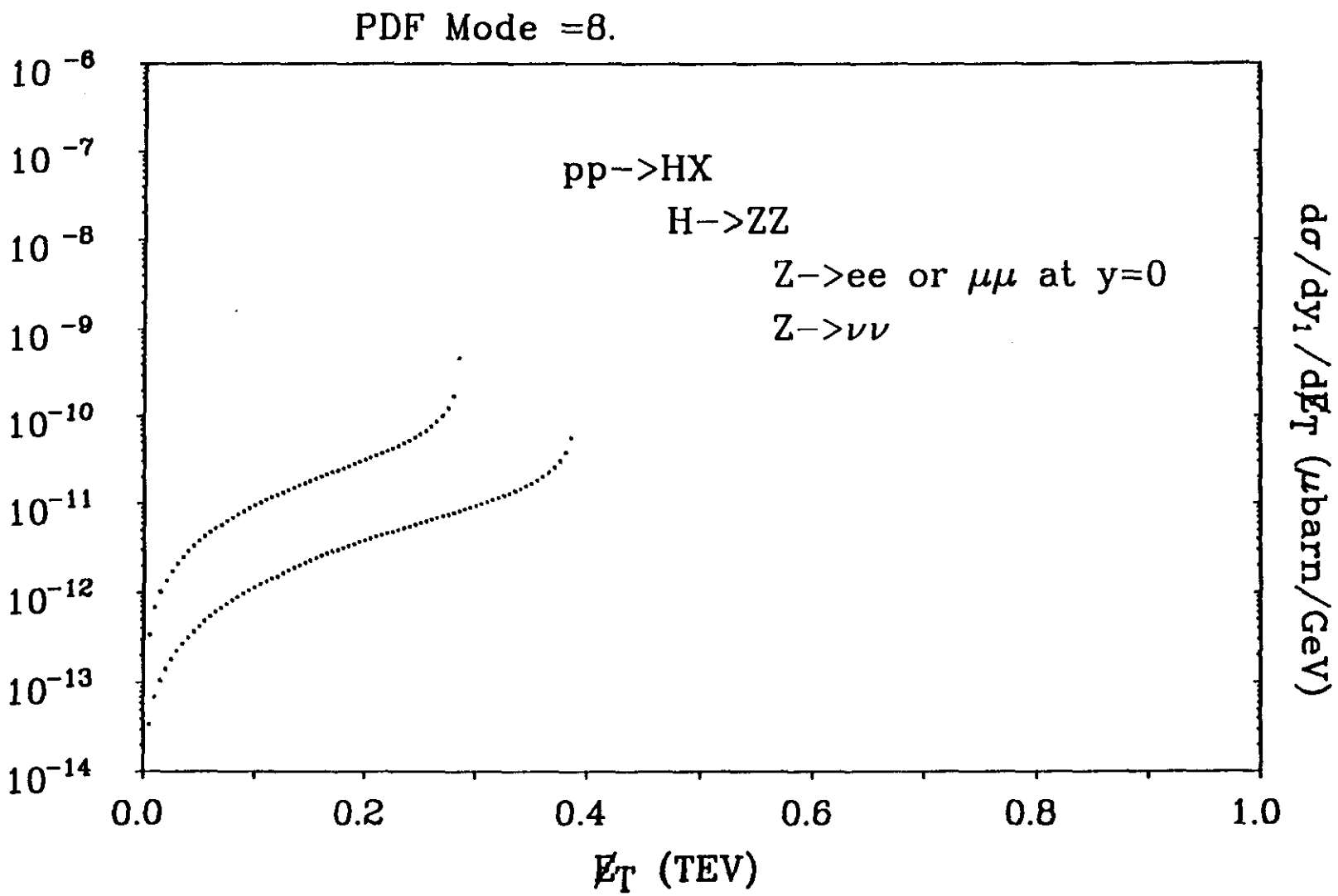
Forward Jets

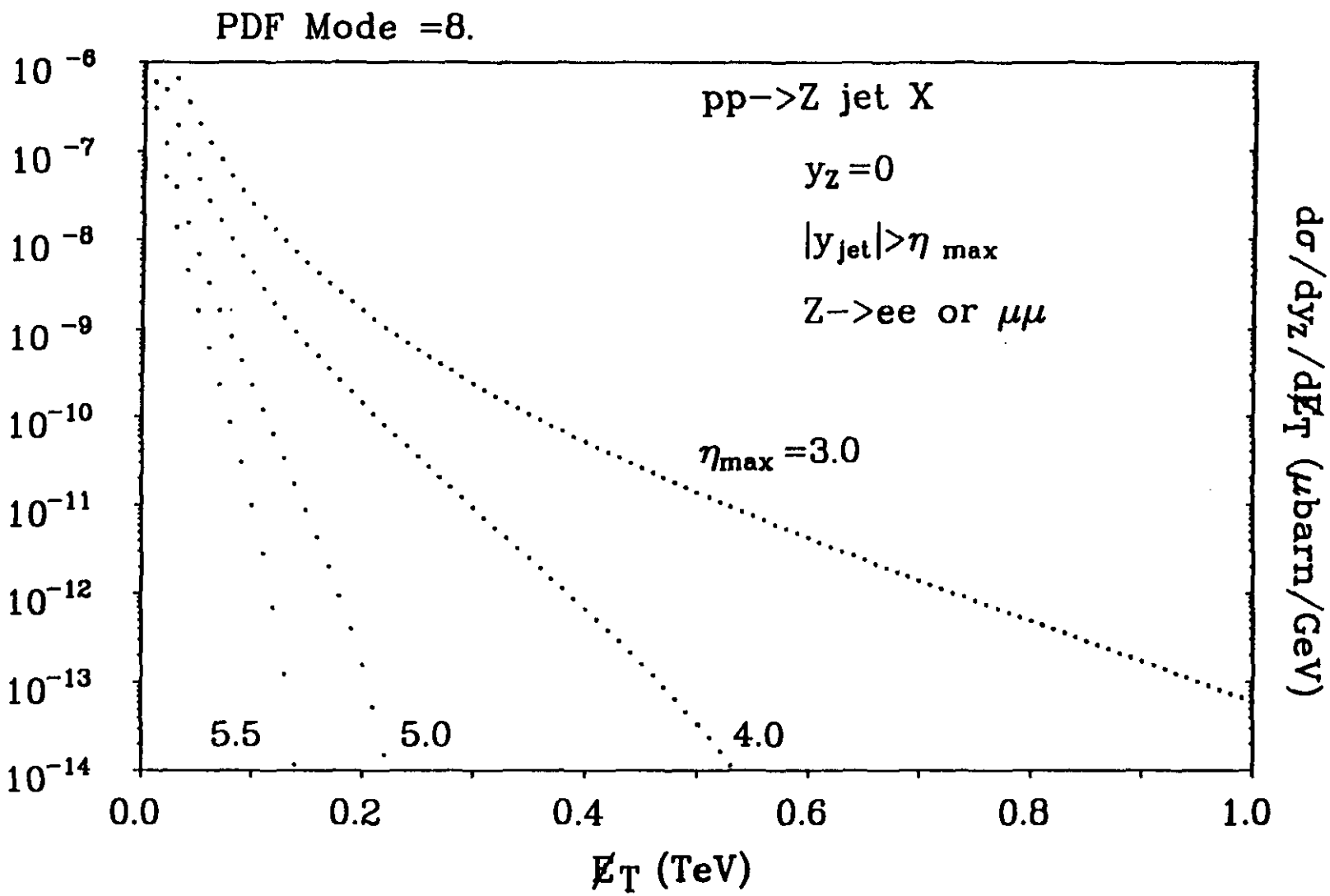
VV scattering with forward jet tagging

Low x physics via forward di-jets


10^{-4}
10^{-5}
10^{-6}
10^{-7}
10^{-8}
10^{-9}
mb/20 GeV
0
100
200
300
400
500
Missing Transverse Energy (GeV)

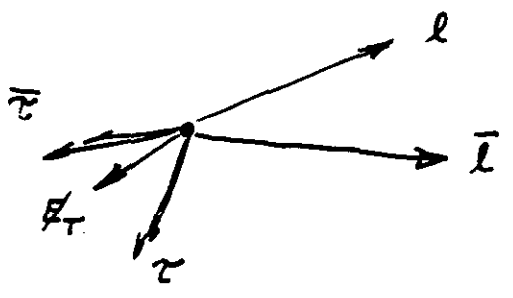

PDF Mode =8.
pp->jet1 jet2 X
y_{jet1} =0
$|y_{jet2}|>\eta_{max}$
η_{max} =3.0
5.5
5.0
4.0
10^{0}
10^{-2}
10^{-4}
10^{-6}
10^{-8}
10^{-10}
10^{-12}
0.0
0.2
0.4
0.6
0.8
1.0
$\not{E}_T$ (TeV)
$d\sigma/dy_1/d\not{E}_T$ (μbarn/GeV)


PDF Mode =8.
pp->HX
H->ZZ
Z->ee or μμ at y=0
Z->νν
10 -6
10 -7
10 -8
10 -9
10-10
10-11
10-12
10-13
10-14
0.0
0.2
0.4
0.6
0.8
1.0
E̸T (TEV)
dσ/dy1/dE̸T (μbarn/GeV)


PDF Mode =8.
pp->Z jet X
$y_Z = 0$
$|y_{jet}| > \eta_{max}$
Z->ee or $\mu\mu$
$\eta_{max} = 3.0$
5.5
5.0
4.0
10^{-6}
10^{-7}
10^{-8}
10^{-9}
10^{-10}
10^{-11}
10^{-12}
10^{-13}
10^{-14}
0.0
0.2
0.4
0.6
0.8
1.0
$\not{E}_T$ (TeV)
$d\sigma/dy_Z/d\not{E}_T$ (μbarn/GeV)

ZZ Final States

	ee $\mu\mu$	$\tau\tau$	$\nu\nu$
ee $\mu\mu$	1.0	0.5	3.0
$\tau\tau$	0.5	0.25	0.5
$\nu\nu$	3.0	1.5	9.0



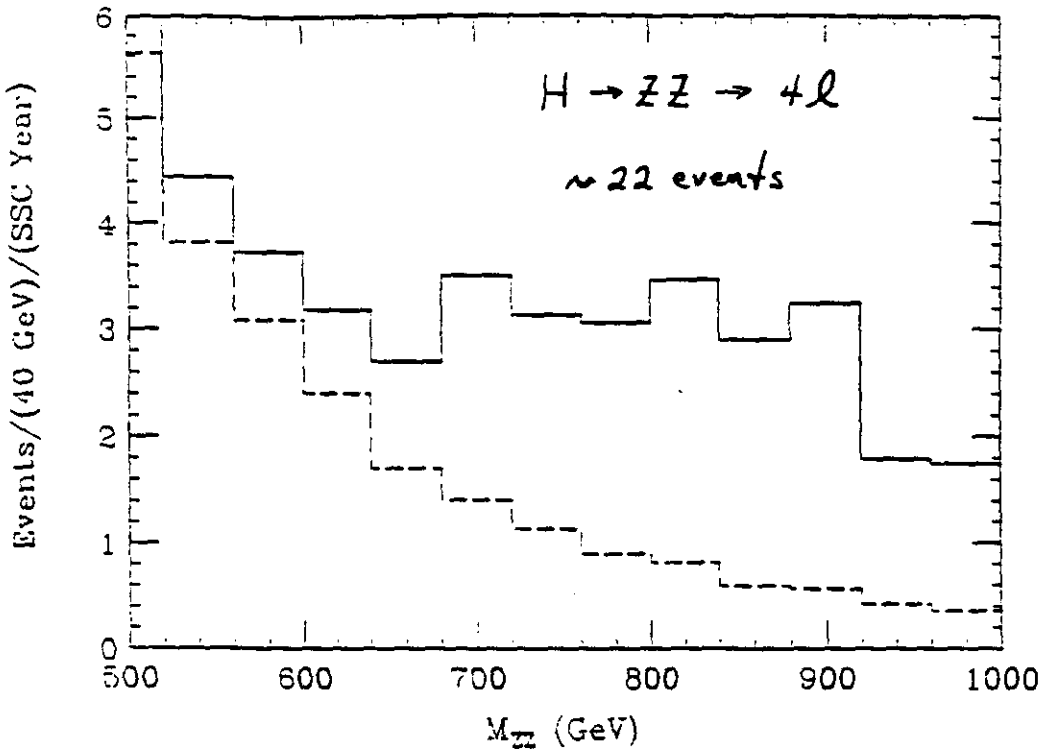


FIG. 3. As Fig. 1 except that the Higgs mass is 800 GeV.

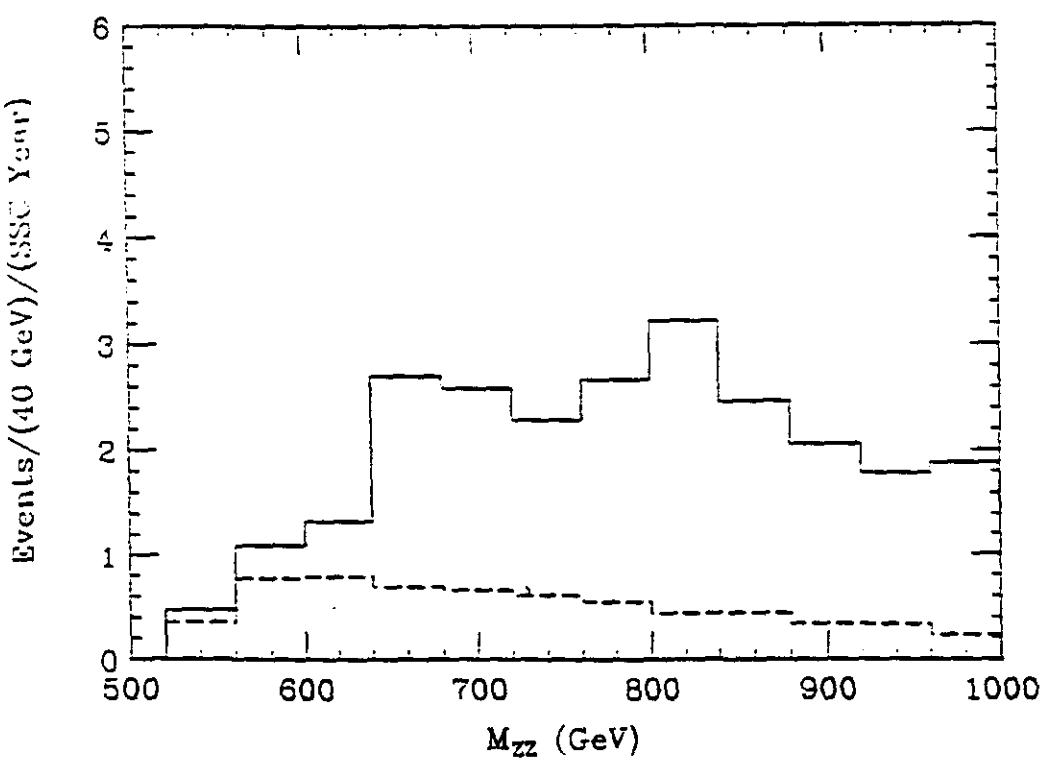


FIG. 4. As Fig. 3 except that we have rrequired that at least one of the Z's has p_t >250 GeV/c.

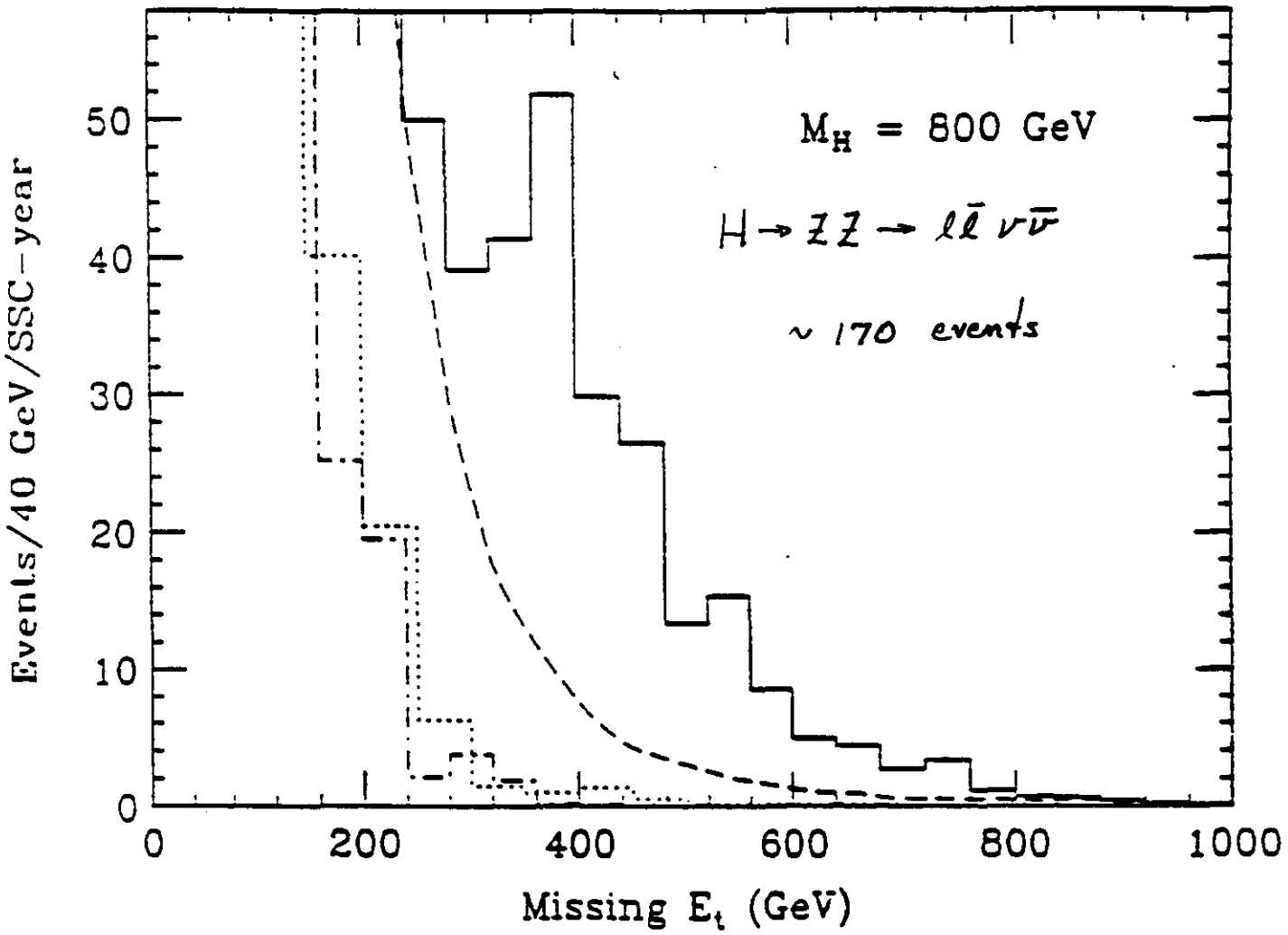


FIG. 5. The distribution (solid histogram) in missing-E_t for the final state $Z(\to \mu^+\mu^-, e^+e^-)$+ missing-$E_t$ including the effect of a Higgs boson of mass 800 GeV, where $H \to ZZ \to \ell^+\ell^-\nu\bar{\nu}$. The reconstructed Z is required to have $p_t > 250$ GeV/c and the charged leptons to have $|\eta| < 2.5$. The background shown as a dashed curve arises from $q\bar{q} \to ZZ$ (multiplied by 1.5). The dot-dashed background histogram arises from the final state $Z + jets$ where the missing-E_t is generated by calorimeter resolution and by energy loss out of the end of the detector ($|\eta| > 5$). The dotted background histogram arises from the final state $t\bar{t}$ where there is an e^+e^- (or $\mu^+\mu^-$ pair of mass $M_Z \pm 20$ GeV and the missing-E_t is due to neutrinos. The events are rejected they contain a jet with $E_t > 300$ GeV. Backgrounds from other final states such as $Zt\bar{t}$ negligible.

$\tilde{g}\tilde{g}$

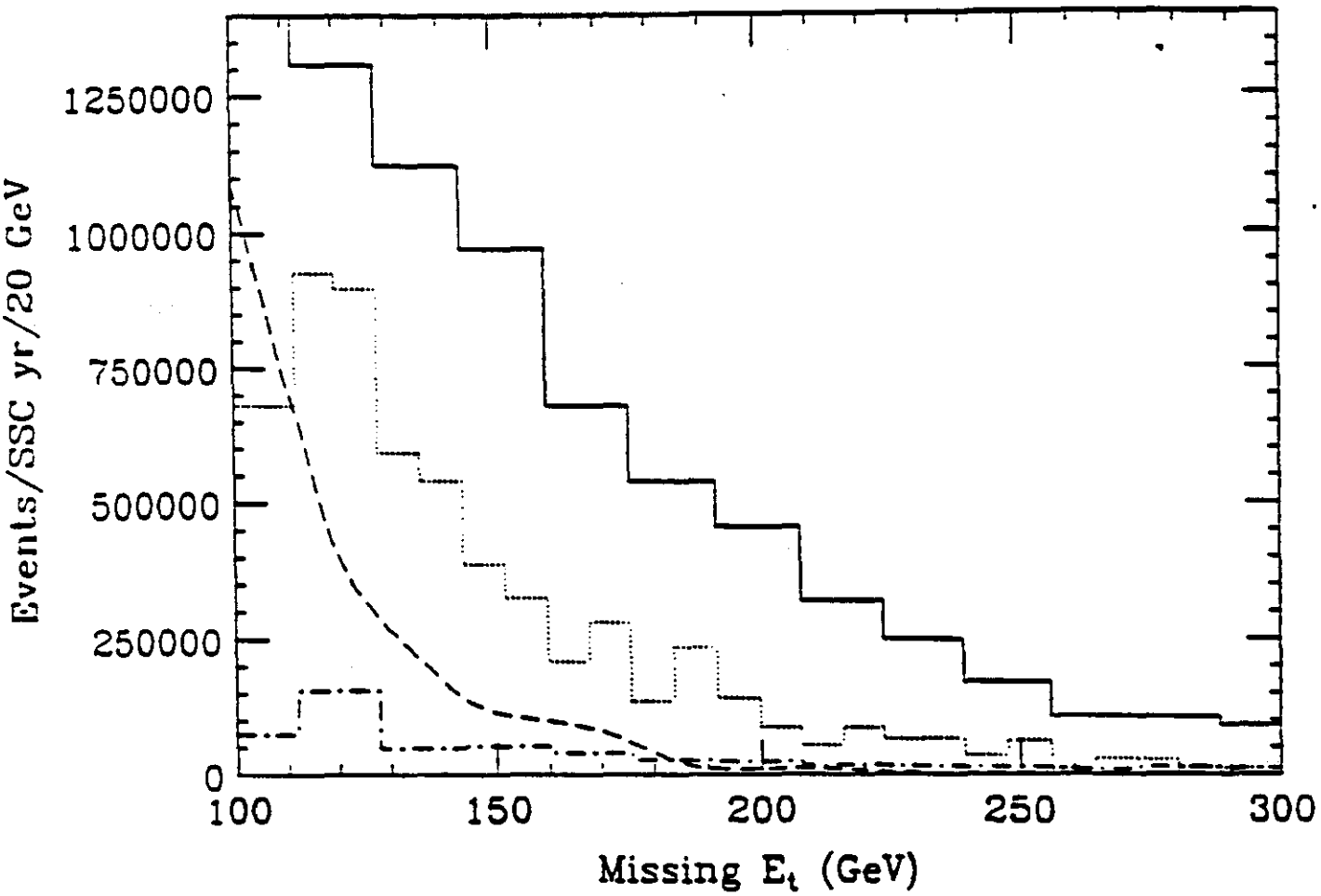
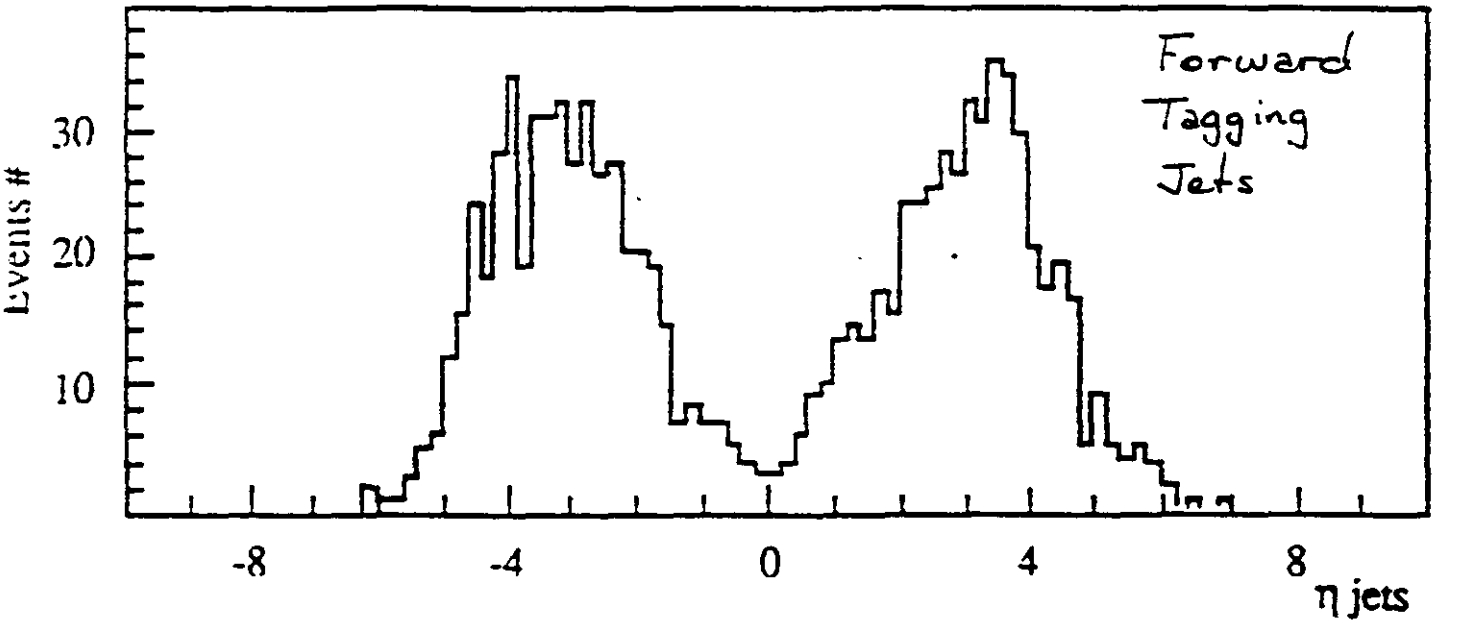
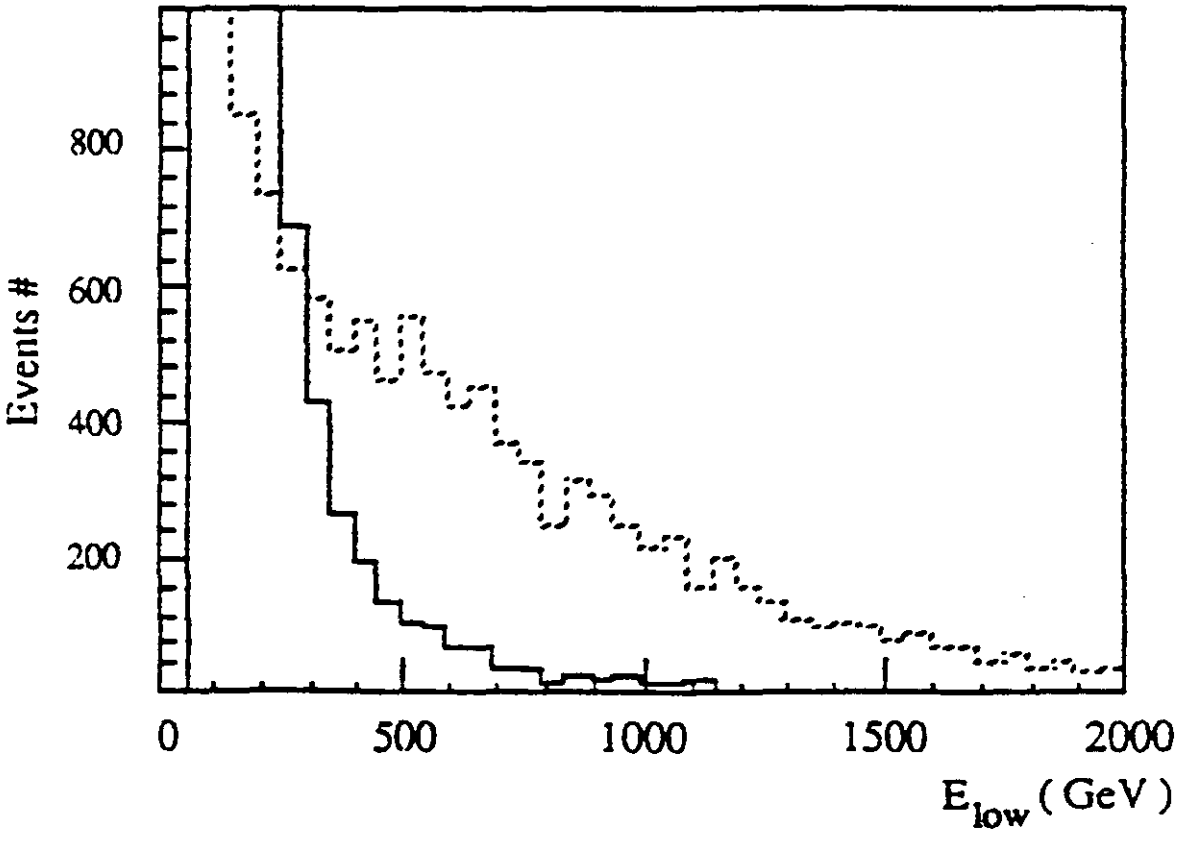


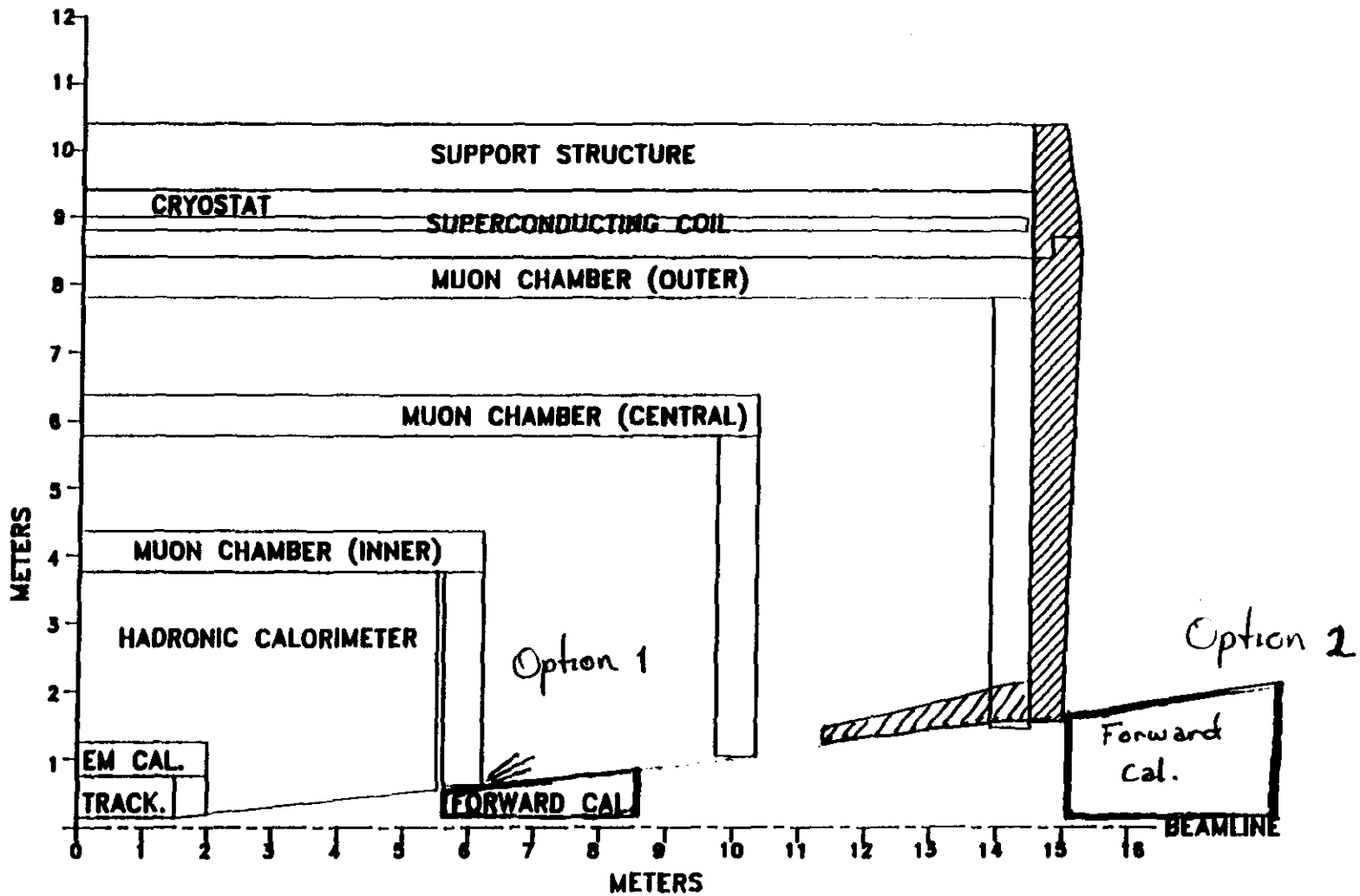
FIG. 19. Search for evidence of gluino pair production in the distribution of missing-E_t for the final state of three or more jets each with $E_t > 70$ GeV separated by ΔR of 0.7. The jets are required to have $|\eta| < 5$. Events are rejected if they contain a jet with $E_t > 70$ GeV within an azimuthal angle of 20 degrees of the missing-E_t or if they have circularity (defined in the text) < 0.2. The solid histogram is for pair production of 300 GeV gluinos decaying as described in the text. The detector-dependent background due to multi-jet events with missing-E_t generated by calorimeter resolution or by energy loss out of the end of the detector ($|\eta| > 5$) is shown as a dashed curve. The dotted background arises from the final states $t\bar{t}$ and $b\bar{b}$, where the missing-E_t is due to neutrinos. The dash-dotted background is due to Z + *multi-jet* events.

WW fusion

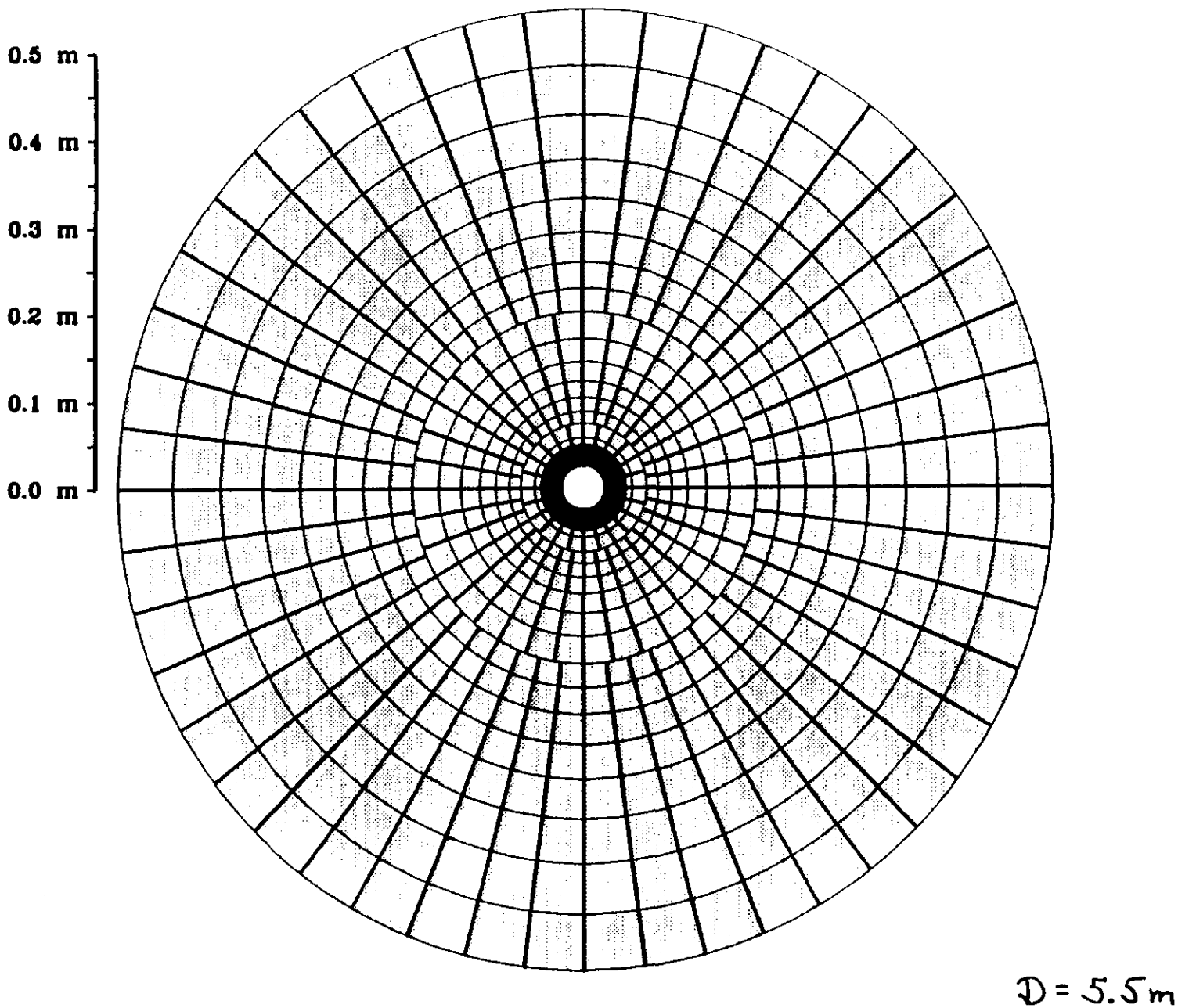




: Rapidity distribution of the "tagging" jets and energy distribution of the lower energy jet for the WW fusion process pp -> qqH. Dashed line is the signal and the full line is the QCD background.



QUADRANT VIEW OF THE DETECTOR CONCEPT


0.5 m
0.4 m
0.3 m
0.2 m
0.1 m
0.0 m
D = 5.5m

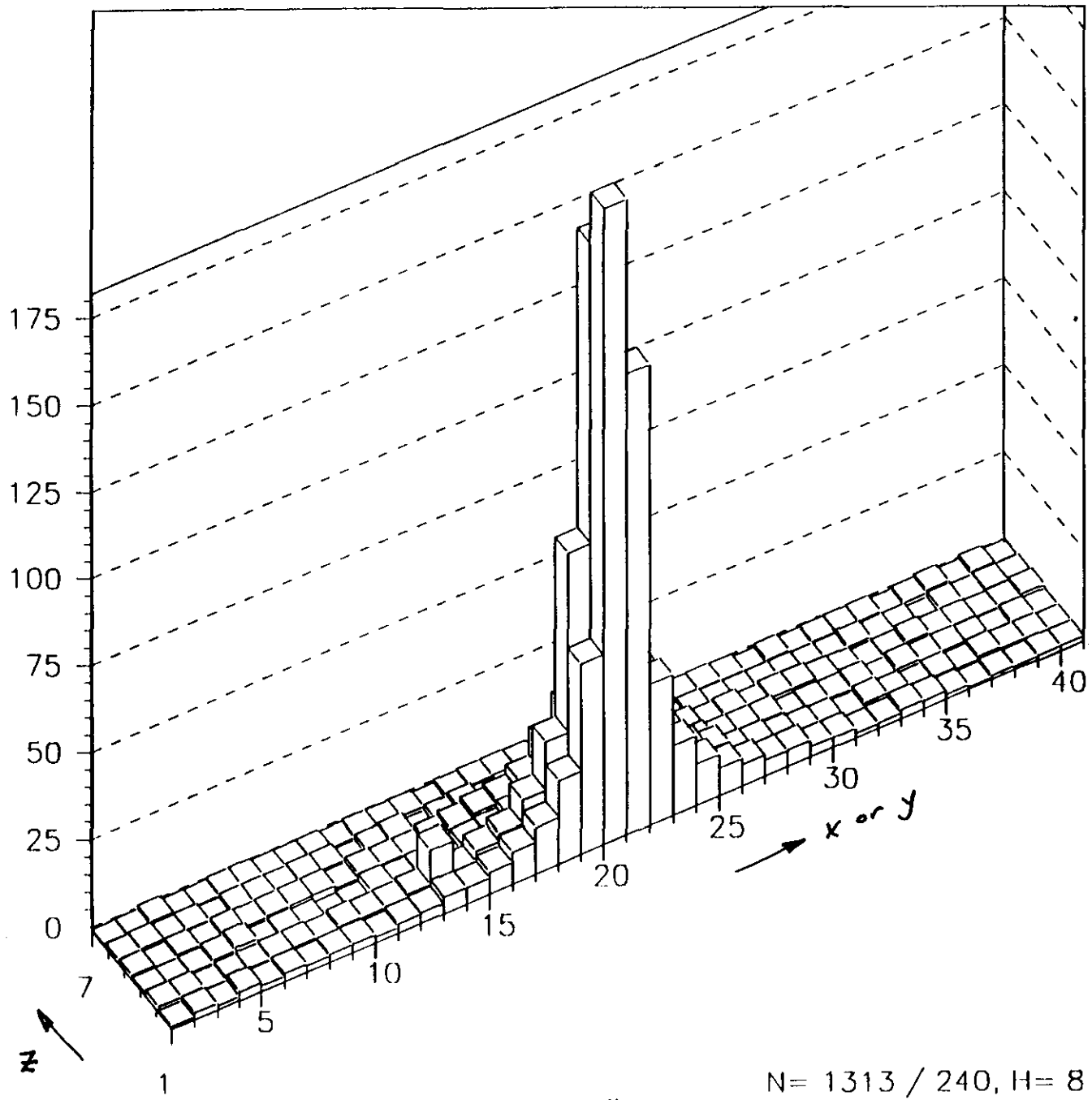
Hadronic Shower Containment

Showers have narrow cores and long tails
(GFLASH not at all useful)

Tails are

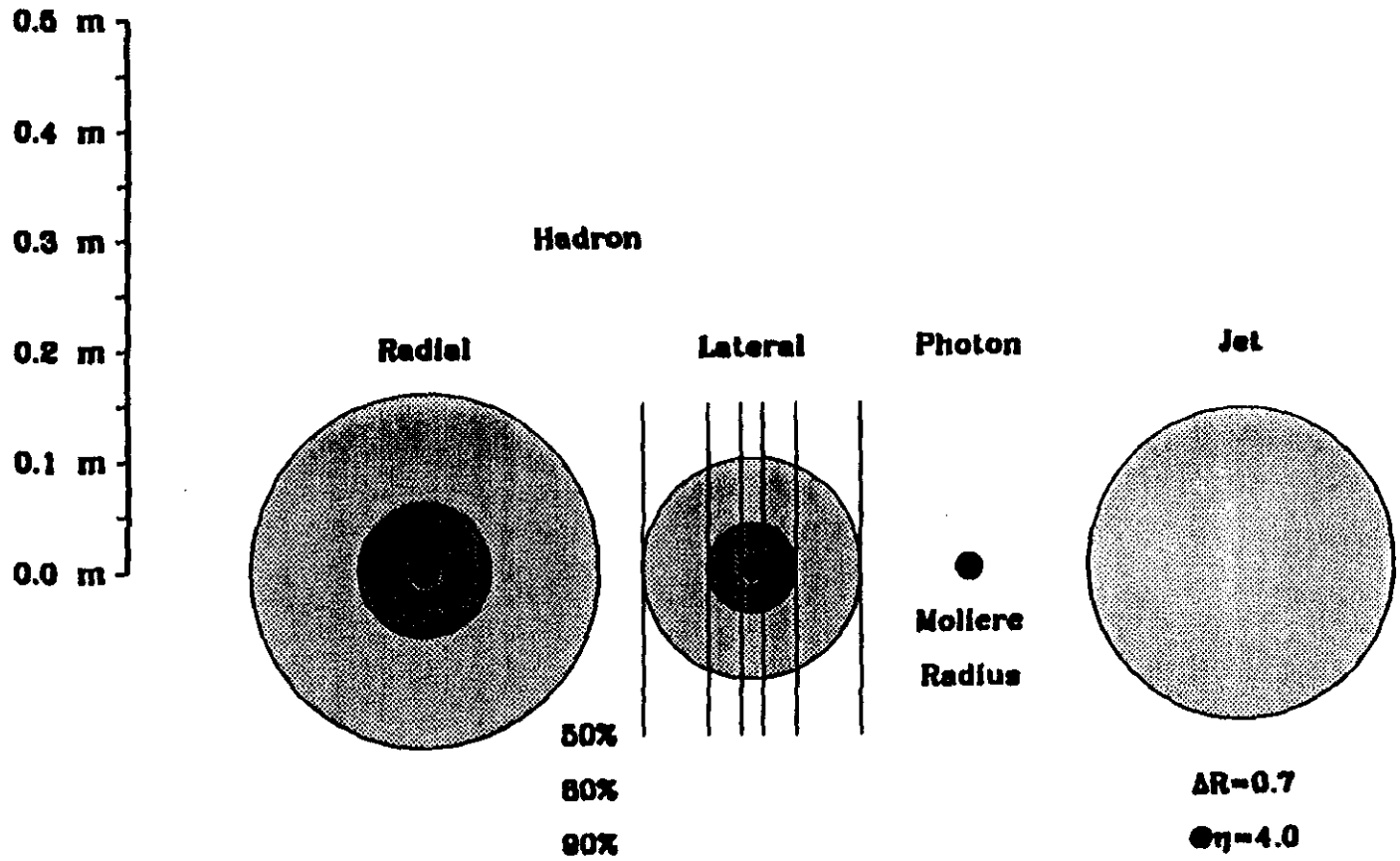
- technology dependent
- gating time dependent

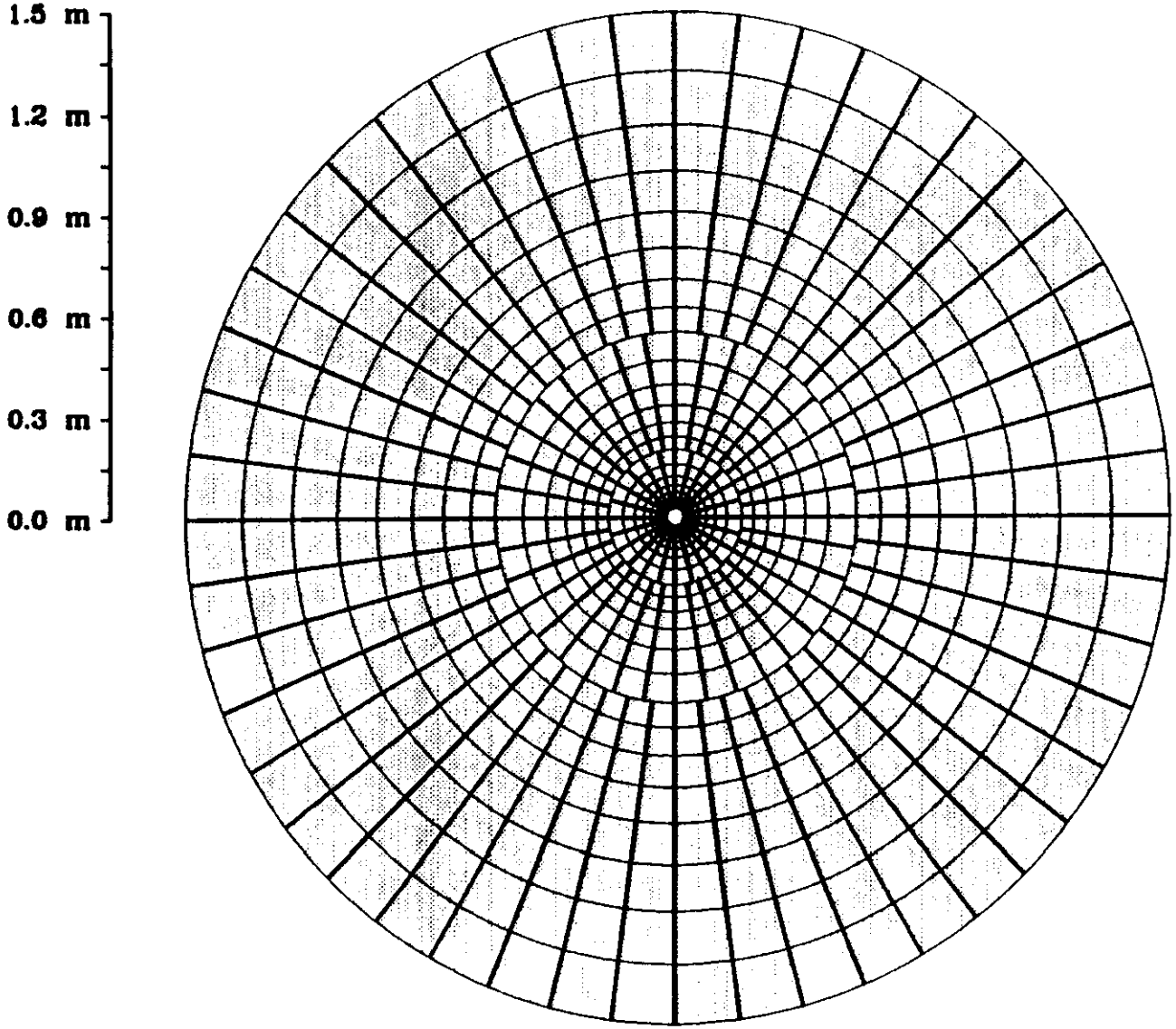
BNL Test Beam LAC 10 GeV π^- energy profile



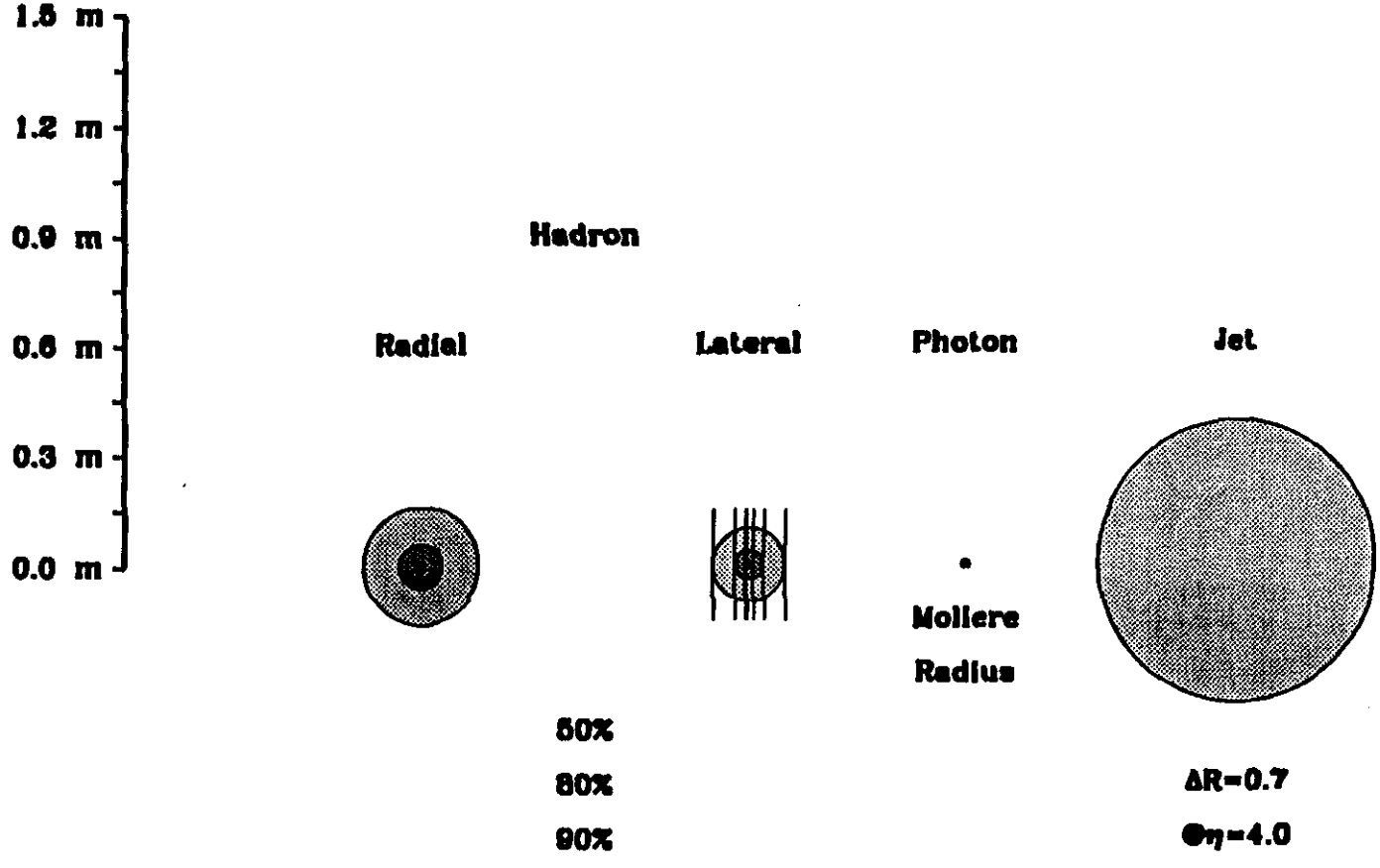
N= 1313 / 240, H= 8

2-D Profiles


0.5 m
0.4 m
0.3 m
0.2 m
0.1 m
0.0 m
Hadron
Radial
Lateral
Photon
Jet
Moliere
Radius
50%
80%
90%
ΔR=0.7
Δη=4.0



D = 15m


1.5 m
1.2 m
0.9 m
0.6 m
0.3 m
0.0 m
Hadron
Radial
Lateral
Photon
Jet
Moliere
Radius
50%
80%
90%
ΔR=0.7
Δη=4.0

Albedo Neutrons
in GEM

Albedo neutron flux in tracking volume

Due to barrel and endcaps $6 \times 10^{12}\ cm^{-2}\ yr^{-1}$

Due to forward calorimeter

@ 5.5 m $6 \times 10^{12}\ cm^{-2}\ yr^{-1}$

@ 15 m $3 \times 10^{12}\ cm^{-2}\ yr^{-1}$

Notes:

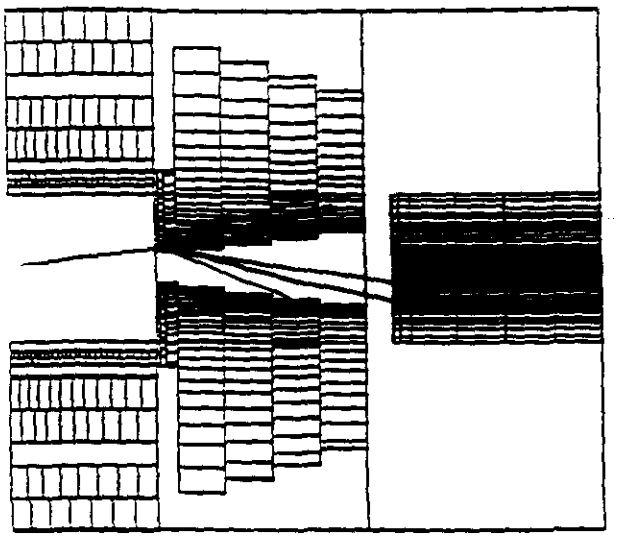
Assumes U/Scint calorimetry everywhere

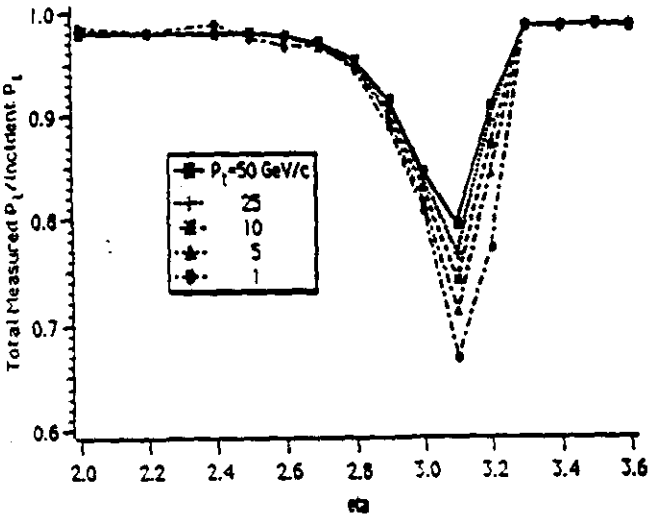
If Pb-LAC multiply by 1.67

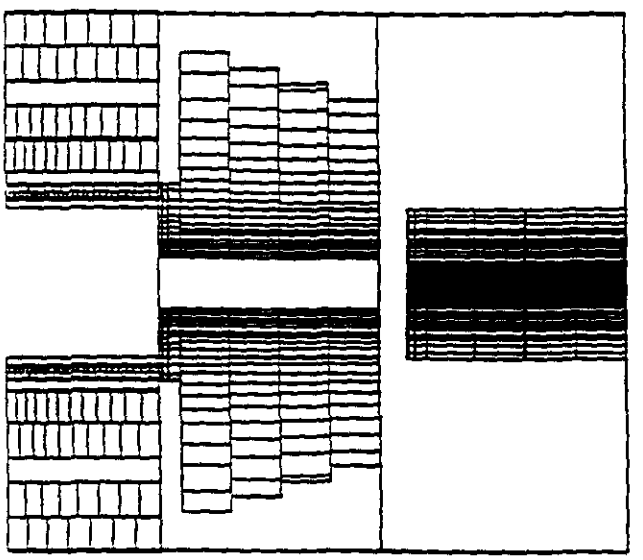
If U-LAC multiply by 3.3

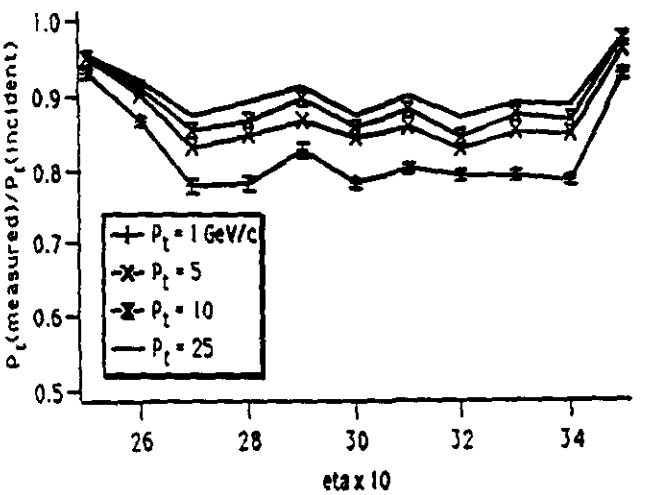
If Pb/Scint multiply by 0.5

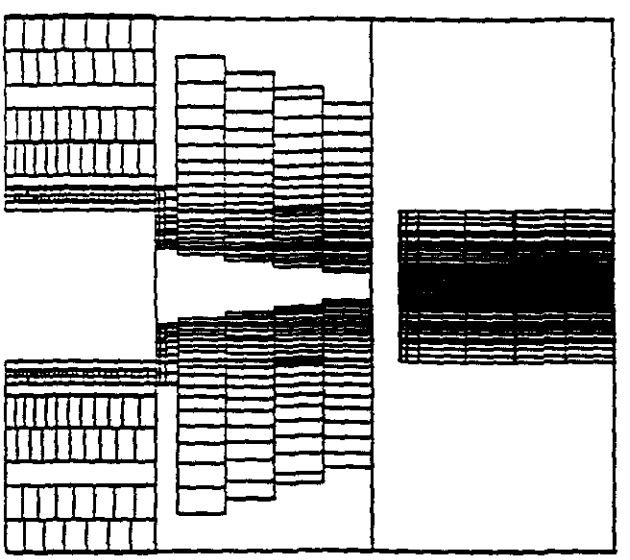
If 10 cm polyethylene multiply by 0.1 ?

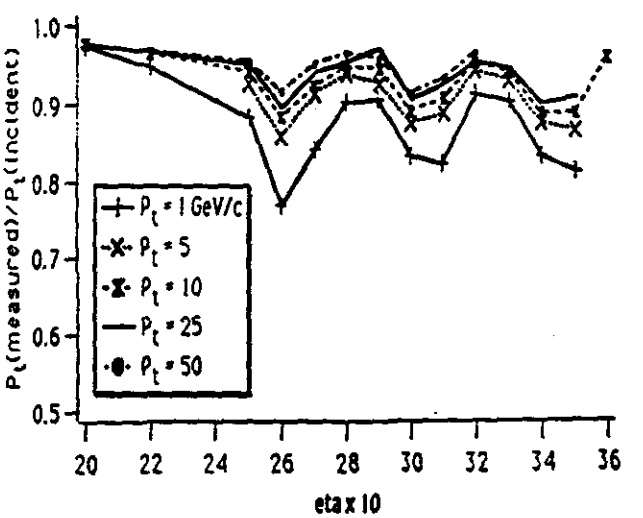



Total Measured P_t / Incident P_t
1.0
0.9
0.8
0.7
0.6
P_t=50 GeV/c
25
10
5
1
2.0
2.2
2.4
2.6
2.8
3.0
3.2
3.4
3.6
eta




P_t(measured)/P_t(incident)
1.0
0.9
0.8
0.7
0.6
0.5
P_t = 1 GeV/c
P_t = 5
P_t = 10
P_t = 25
26
28
30
32
34
eta x 10




P_t(measured)/P_t(incident)
1.0
0.9
0.8
0.7
0.6
0.5
P_t = 1 GeV/c
P_t = 5
P_t = 10
P_t = 25
P_t = 50
20
22
24
26
28
30
32
34
36
eta x 10

Simulation

Assume only <u>jets</u> are important in determining p_T of event, not underlying hadrons.

Assume $r = 6\,m$ for forward calorimeter

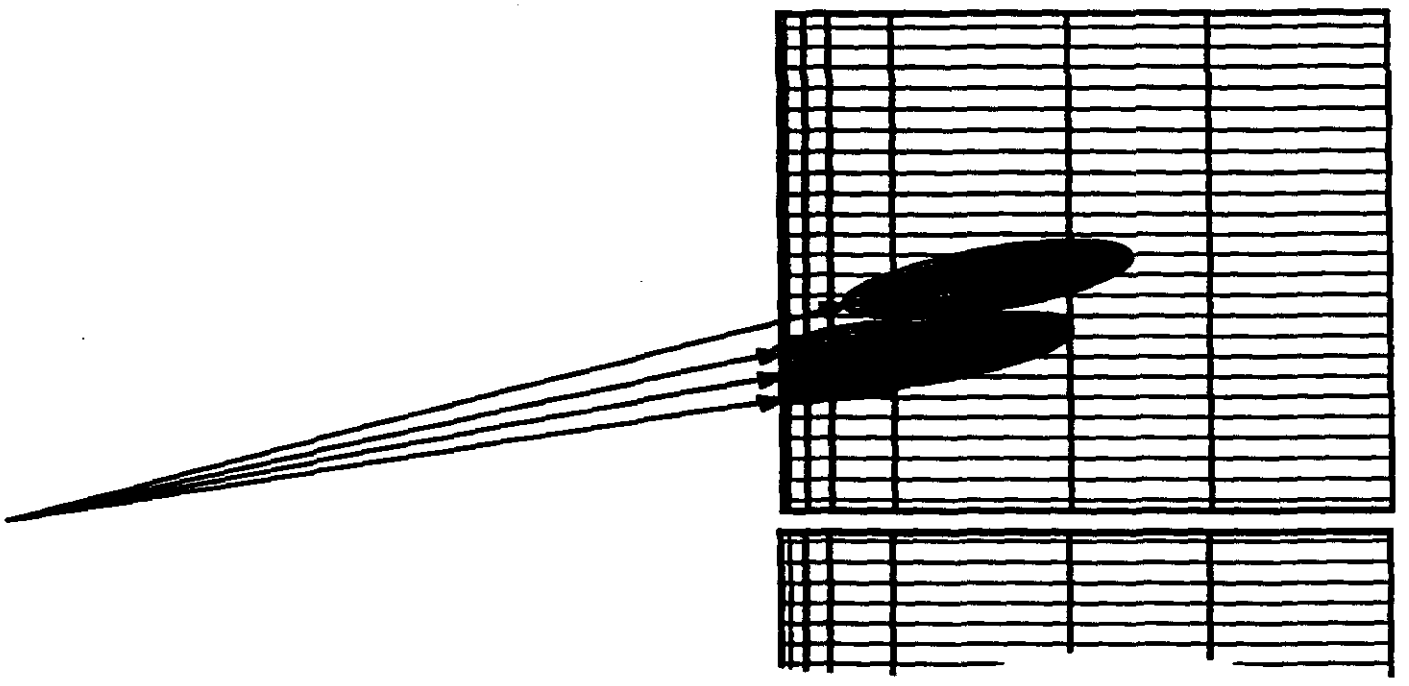
$$\Delta\eta \times \Delta\phi = 0.1 \times 0.1$$

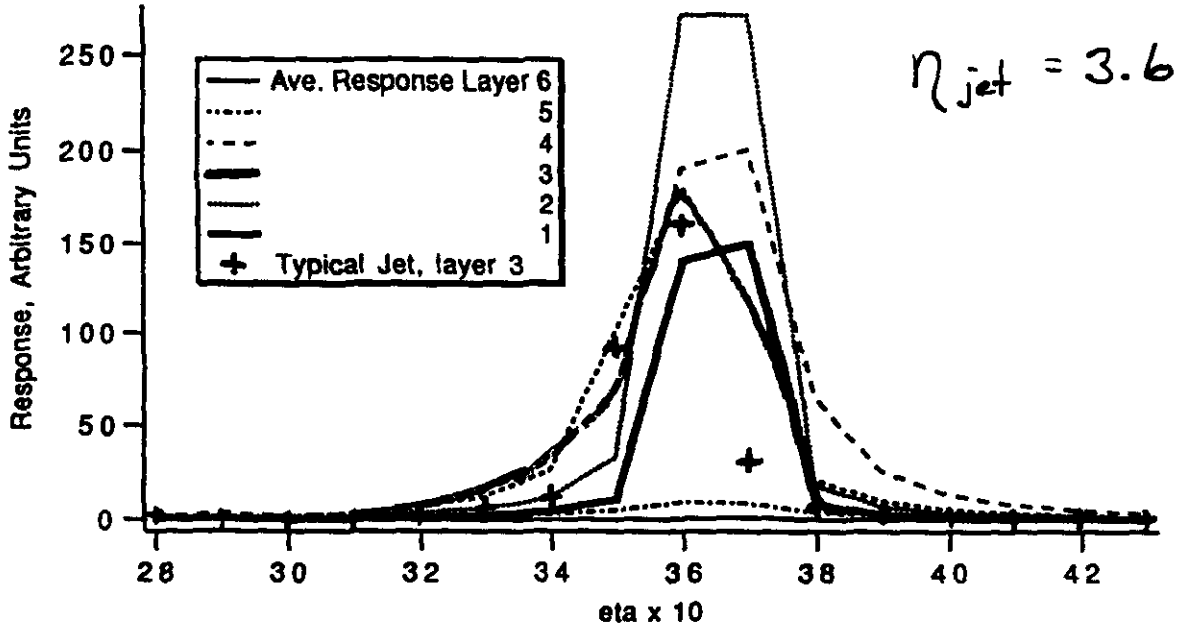
Spray Pythia jet at set values of η

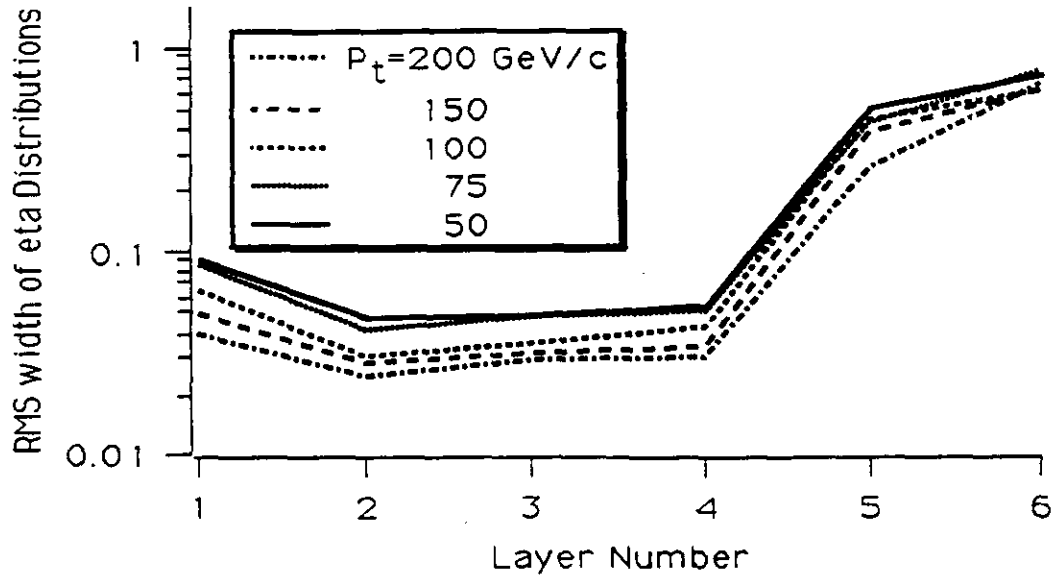
Preliminary results

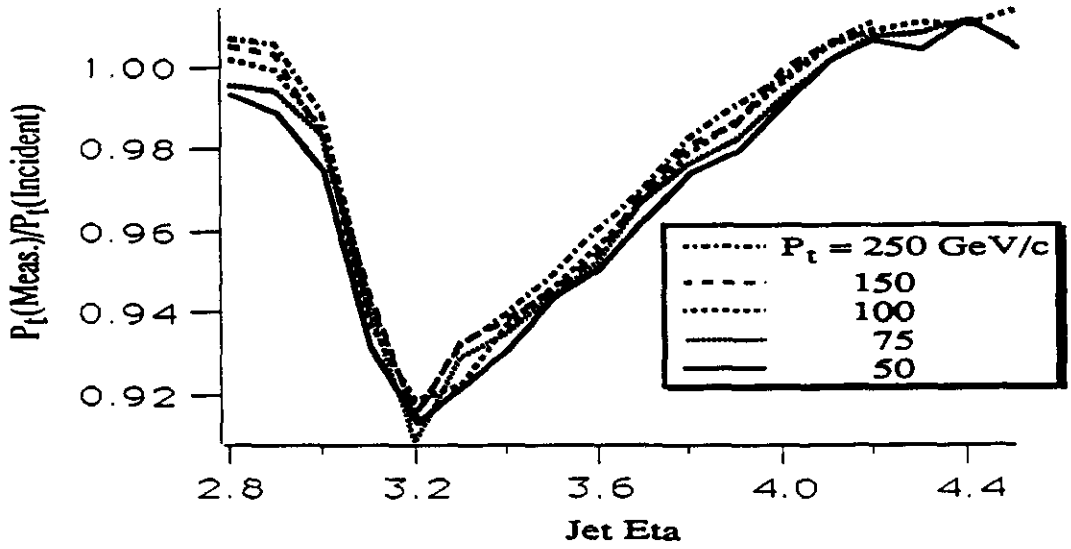
More to come

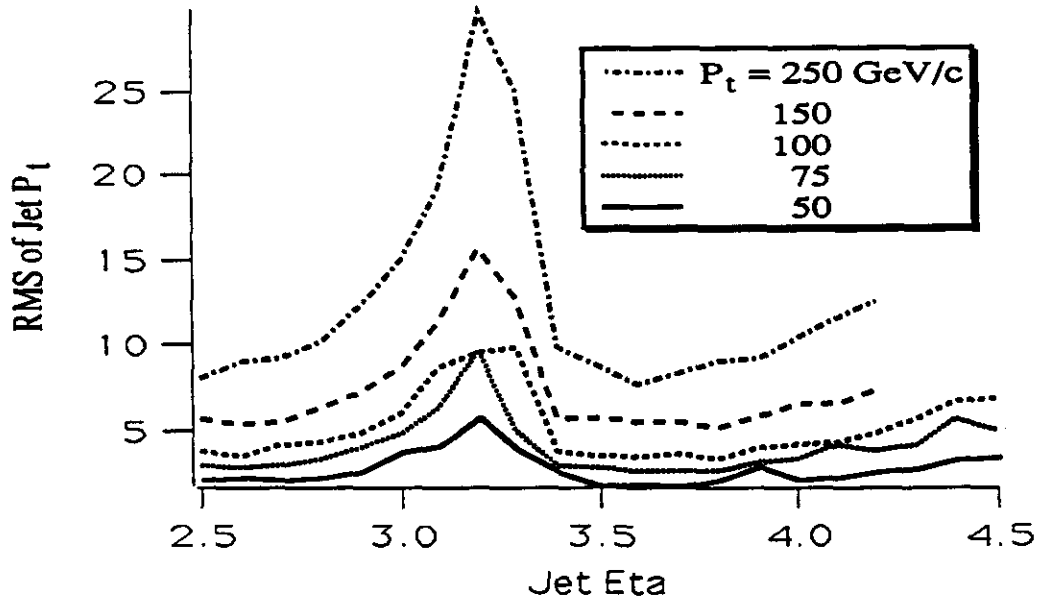
Transverse Segmentation
– Jet Centroid Determination






RMS width of eta Distributions
1
0.1
0.01
P_t=200 GeV/c
150
100
75
50
1
2
3
4
5
6
Layer Number


P_t(Meas.)/P_t(Incident)
1.00
0.98
0.96
0.94
0.92
P_t = 250 GeV/c
150
100
75
50
2.8
3.2
3.6
4.0
4.4
Jet Eta


RMS of Jet P_t
25
20
15
10
5
P_t = 250 GeV/c
150
100
75
50
2.5
3.0
3.5
4.0
4.5
Jet Eta

Technology Choices

Liquid Scintillator $28 M

Warm Liquids

High Pressure Gas

Liquid Argon

The High-Field approach for Gammas Electrons ~~Muons~~

mostly ~~muons~~

Interested Parties:

BNL: ATIYA, KYCIA, TANNENBAUM

UC(Davis): Ko, Lander, Yager, Smith

Stony Brook: Mohammadi

Rochester: Ferbel, Olsen, Fanourakis, Ueno, Zielinski

VPI: Abashian, Piilonen, Morgan

So.Car: Rosenfeld, Robbins

LSU: McNeil

Texas: Ritchie, Yameshita

OSU: Kagan

San Diego: Vernon

MSU: Abolins, Bromberg

Yale: Cushman

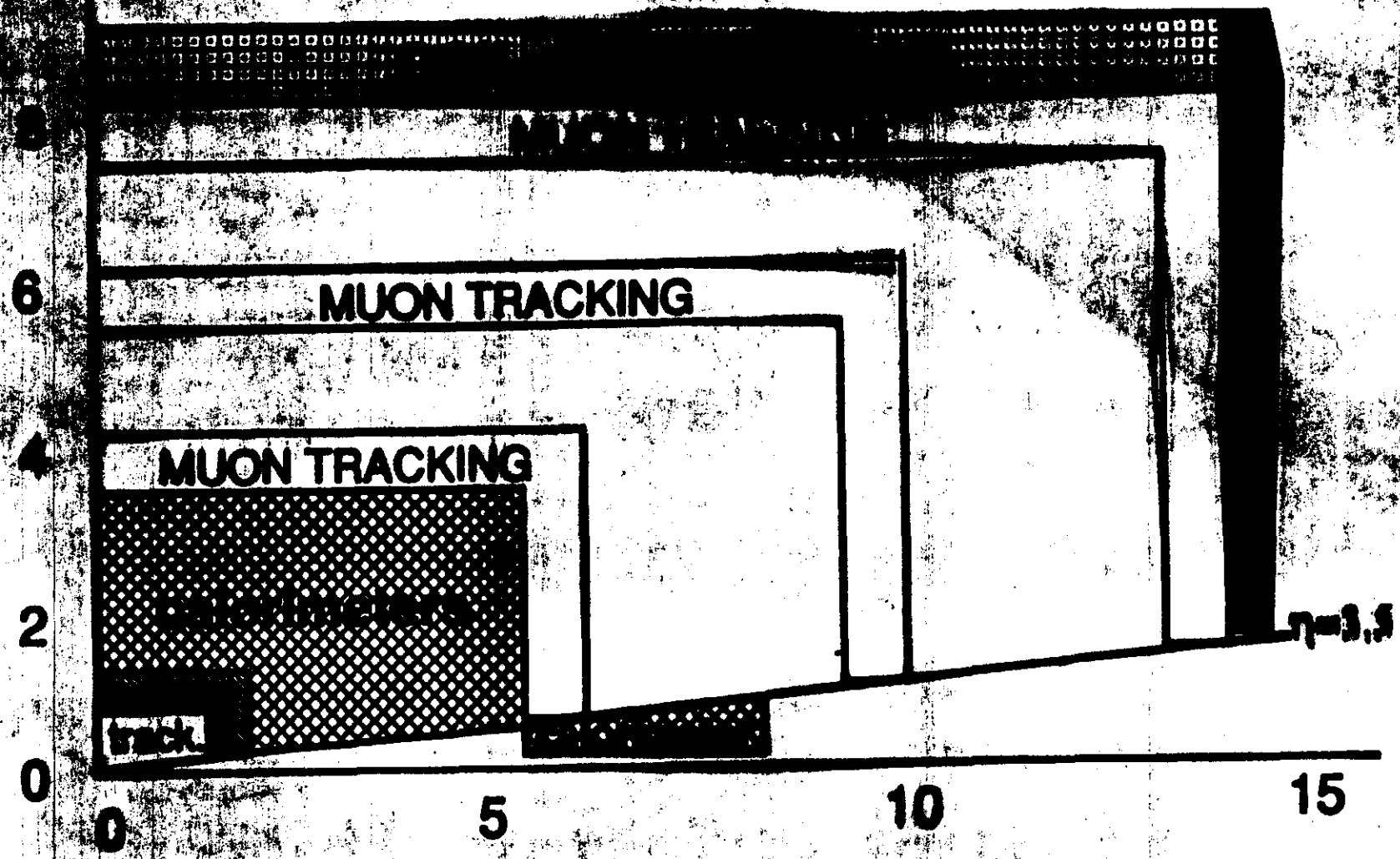
MIT: Chen

Rockefeller: Rusack

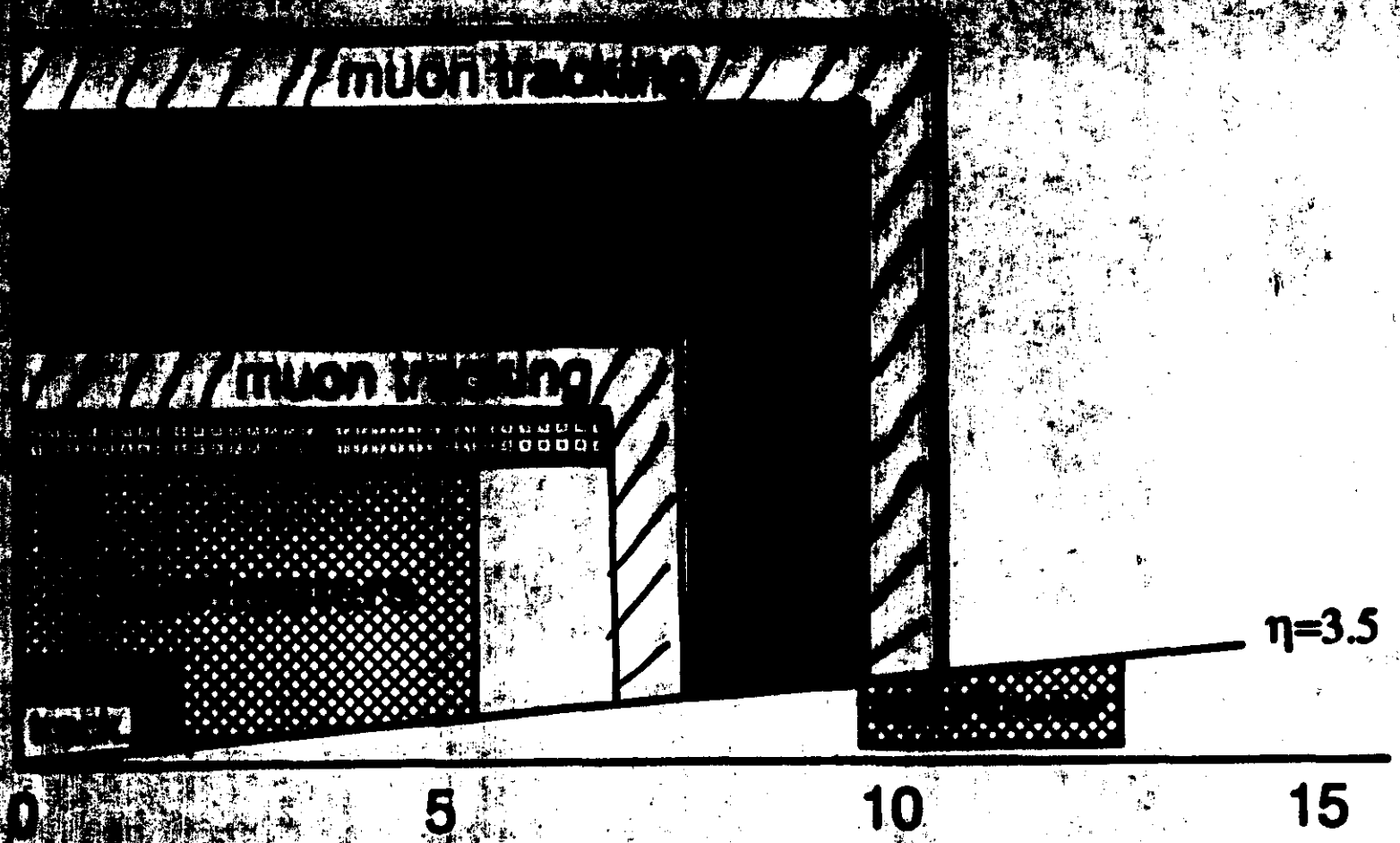
Steve Olsen

Why?

- Better Muon System
  - resolution at high p_T
  - robust
  - η coverage
  - operation at 10^{34}
- High Field in inner tracker
- No Magnetic Pollution
- Cheaper
- Magnet easier to build?



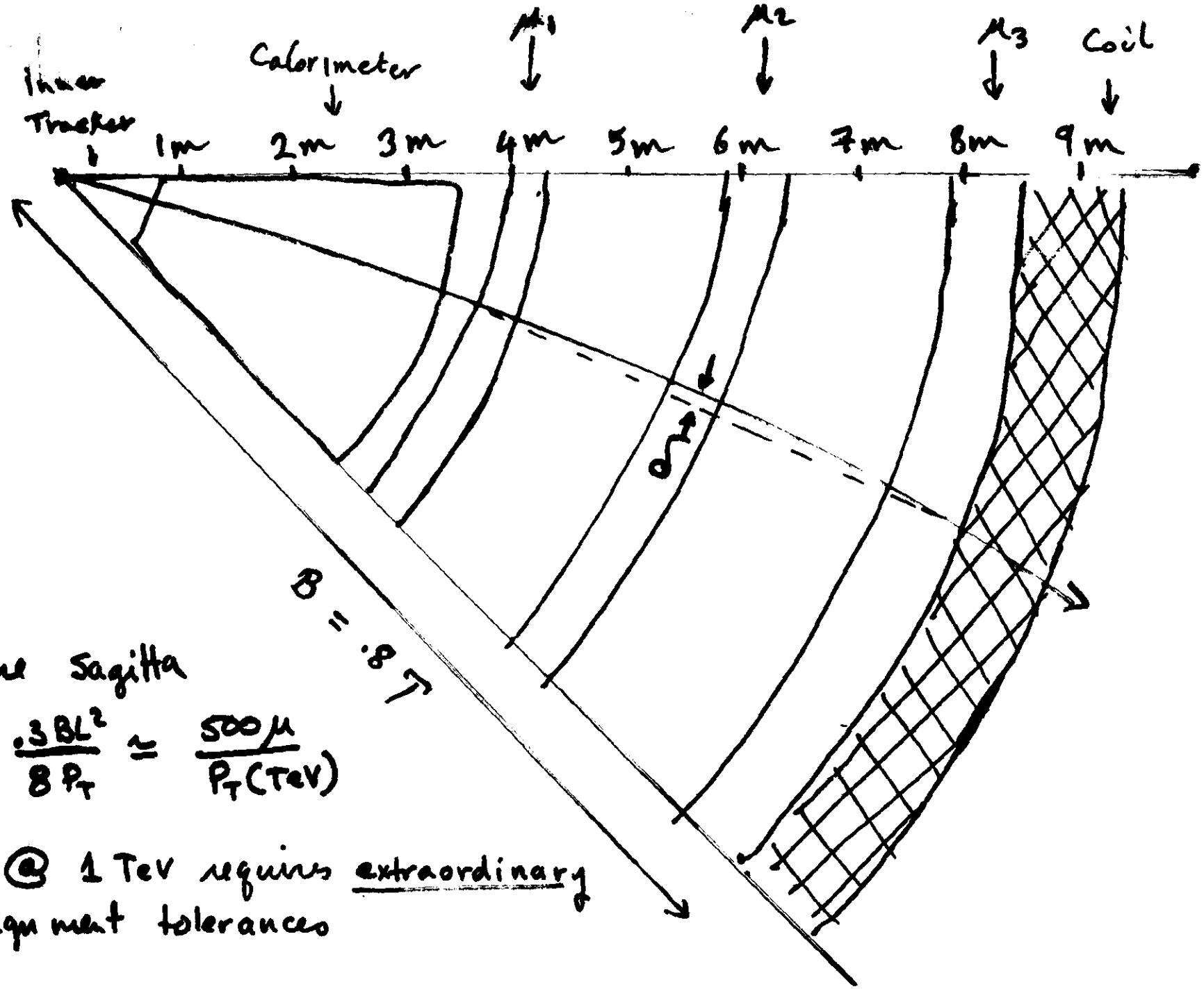
Baseline Design of GEM



High Field Design for GEM

- Inner Detector Geometry unchanged
- Inner Tracker now at B = 5T

Baseline

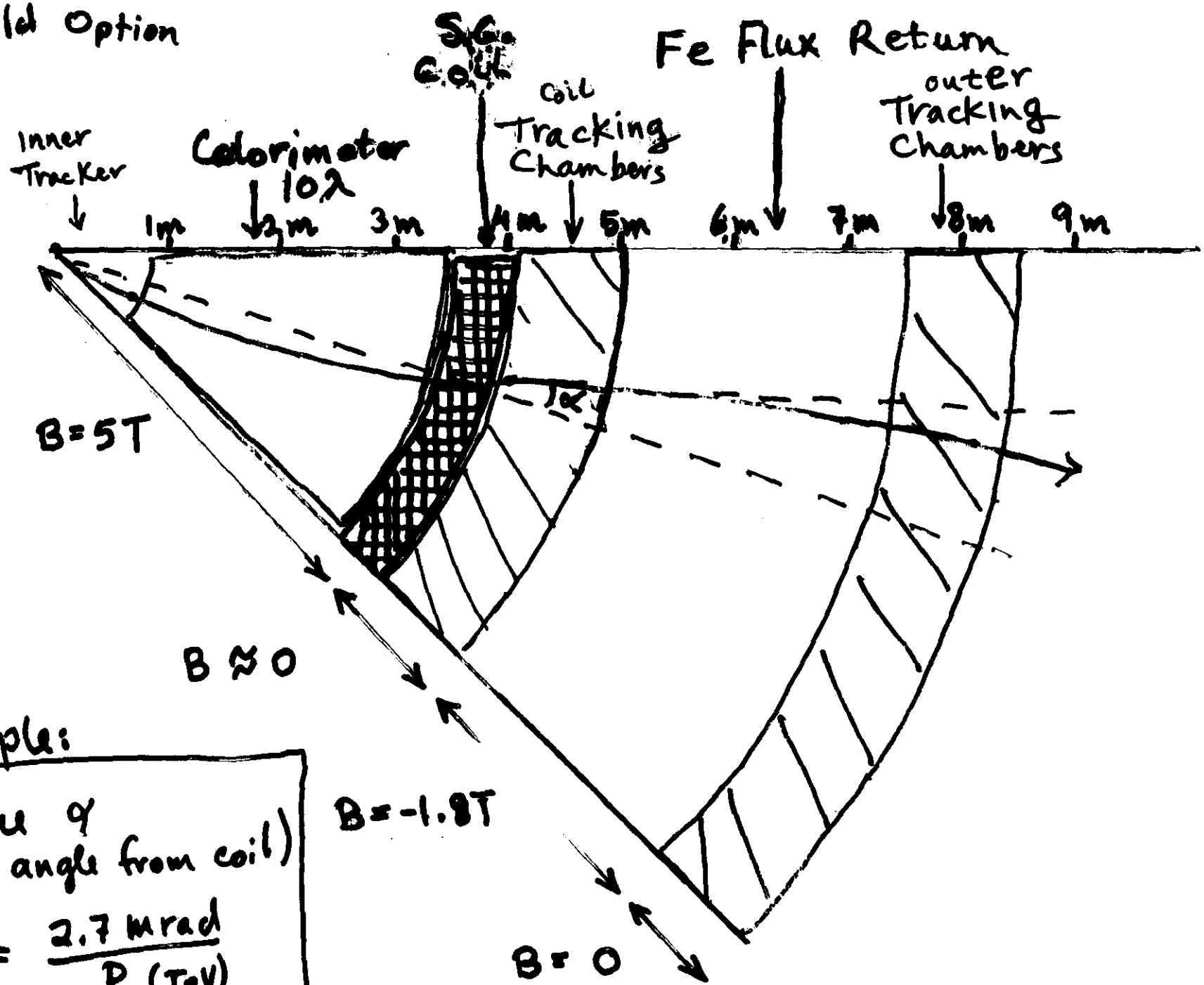


Measure Sagitta

$$\delta = \frac{.3BL^2}{8P_T} \simeq \frac{500\mu}{P_T(\text{TeV})}$$

→ 10% @ 1 TeV requires <u>extraordinary</u> alignment tolerances

High-Field Option



Principle:

Measure α
(exit angle from coil)

$$\alpha = \frac{2.7 \text{ mrad}}{P_T \text{ (TeV)}}$$

II. Momentum Measurement - Resolution

Point (vertex) - Slope (α) Measurement

$$\alpha = \frac{2.7\,\text{mrad}}{P_T\,(\text{TeV}/c)}$$

$$\theta_{ms} = \frac{0.014}{P_T\,(\text{GeV}/c)} \sqrt{\frac{X}{X_0}}$$ where X is # radiation length

《 Want low-Z Calorimeter 》

Recommend Hadronic Calorimeter with Stainless Steel Radiator

Then,

$$X \simeq \underset{\text{EM}}{30X_0} + \underset{\text{Had}}{\sim 80X_0} + \underset{\text{Coil}}{\lesssim 20X_0} = 130X_0$$

or

$$\theta_{ms} \simeq \frac{0.16\,\text{mrad}}{P_T\,(\text{TeV}/c)}$$

need to measure α to $\sim .1$ mrad @ 1 TeV

need to measure exit position to better than $\sim 300\,\mu m$.

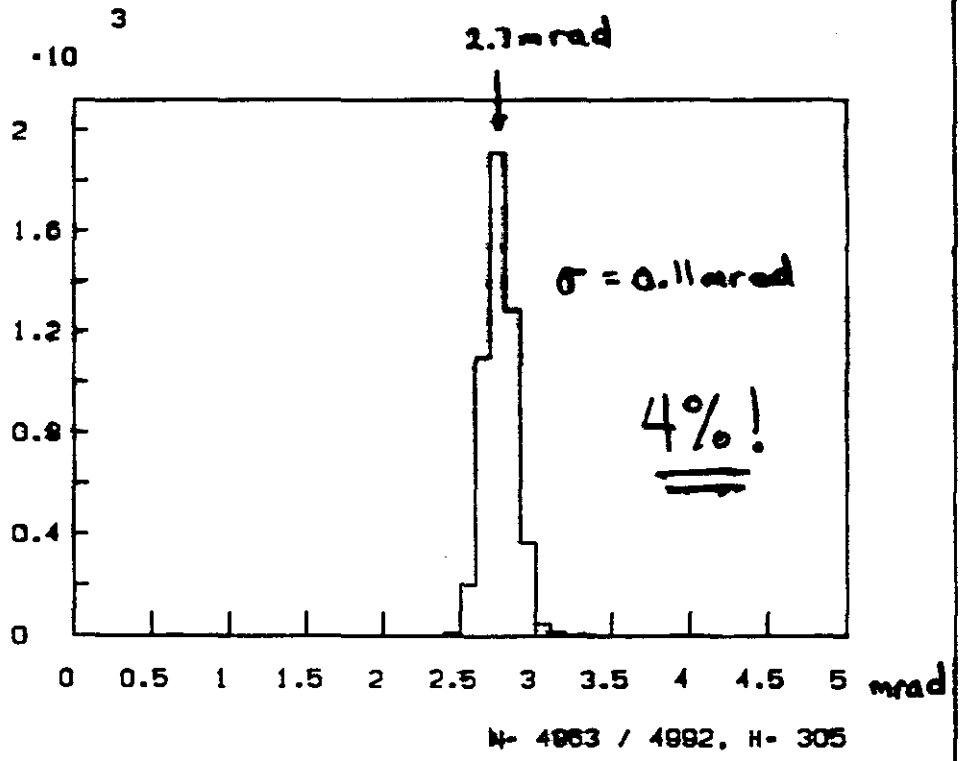
《 Modest μ system requirements 》

Then limiting resolution given by

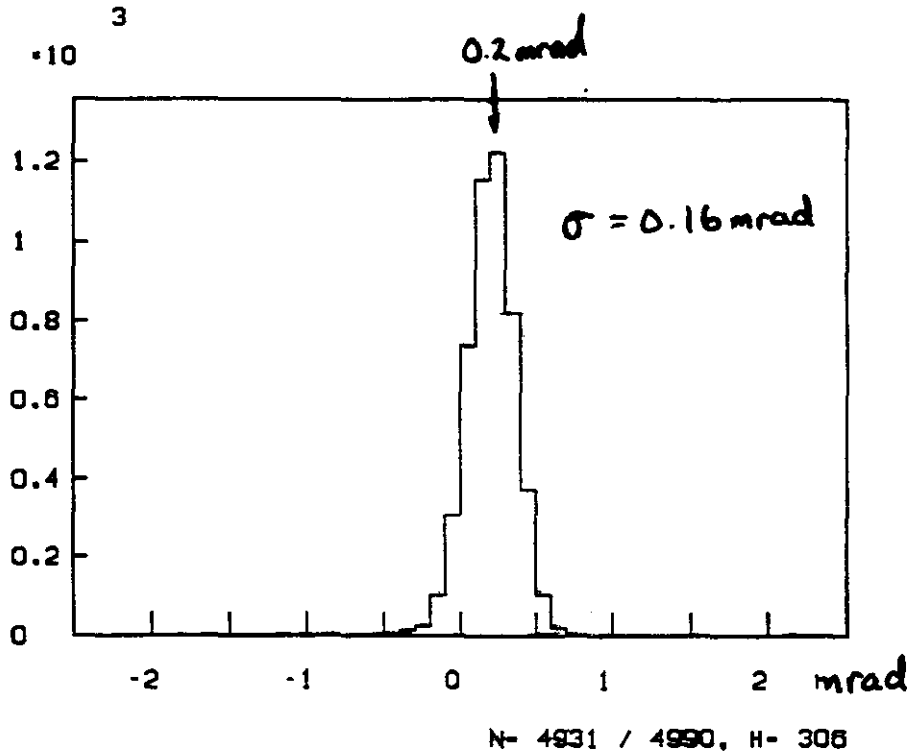
$$\frac{\Delta P_T}{P_T} = \frac{\theta_{ms}}{\alpha} \simeq 6\%$$

Independent of P_T! Without inner tracker!

1TeV/c Muons at 90degrees (GEANT Simulation)



Alpha (mrad)



Angle exiting from iron (mrad)
from radial

Hand Calculation

$$\alpha = \frac{.3BR}{2P_T}$$

$$= \frac{.3 \times 3T \times 3.7m}{2 \times 1000 GeV}$$

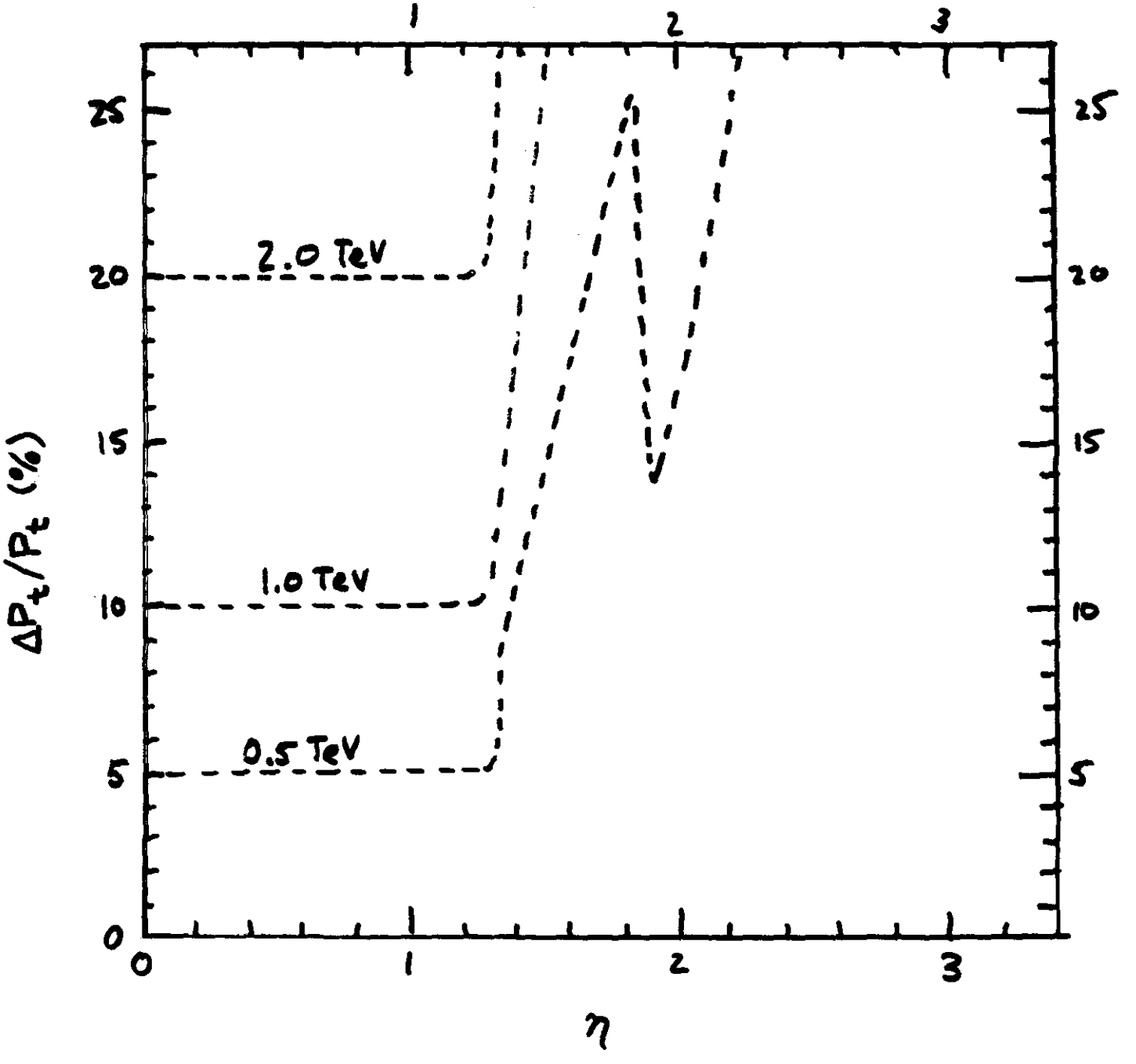
$$= 2.78 \text{ mrad}$$

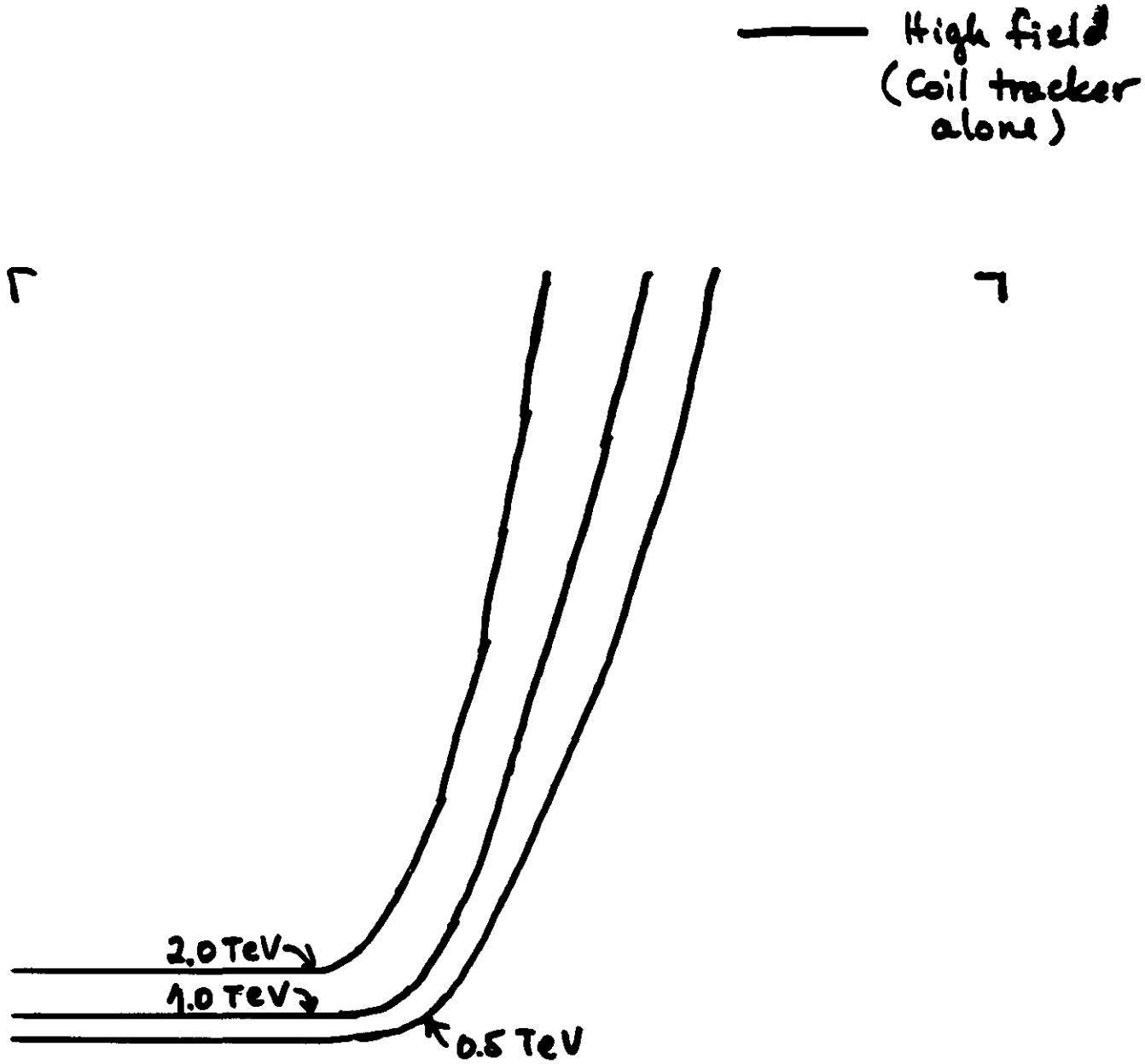
$$\theta_{ms} = \frac{0.019\sqrt{130}}{1000}$$

$$= .16 \text{ mrad}$$

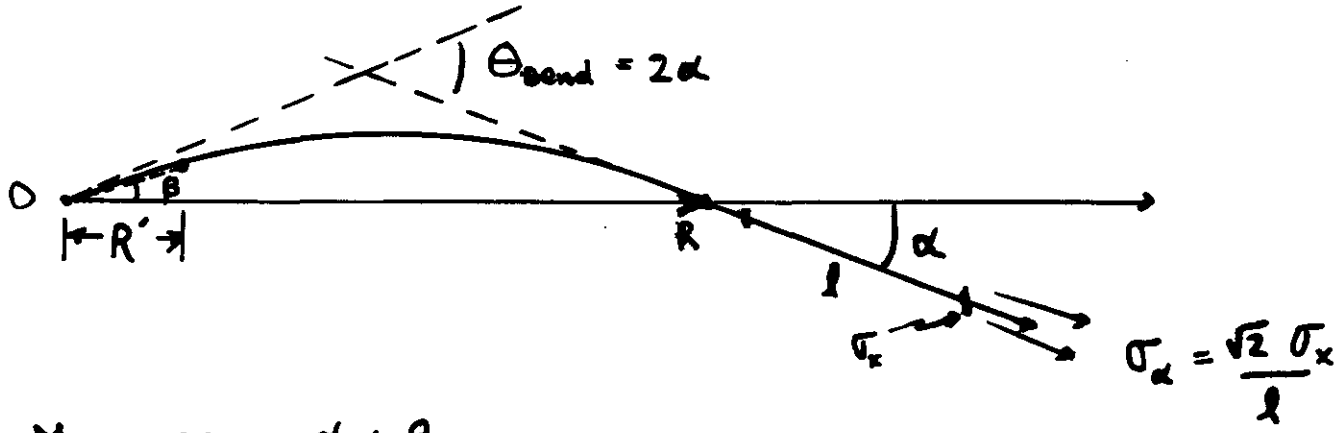
---- baseline (EDI)

Muon Momentum Resolution




High field
(Coil tracker
alone)
2.0 TeV
1.0 TeV
0.5 TeV

The momentum measurement can be improved by using a single position measurement from inner tracker



Measure $\alpha + \beta$

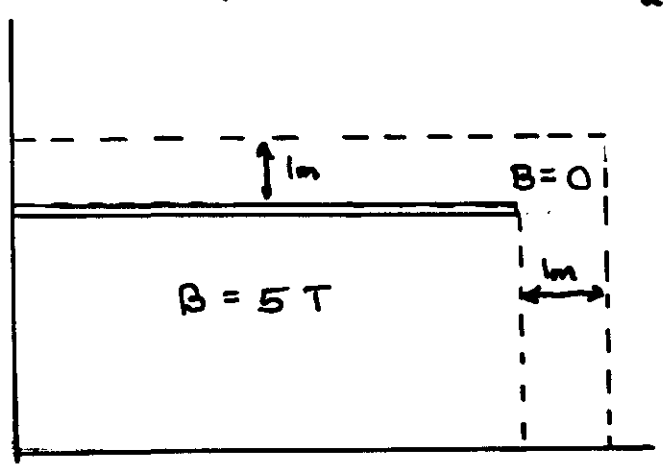
Then
$$\frac{\Delta P_T}{P_T} = \left[\left(\frac{\theta_{ms}}{\alpha+\beta} \right)^2 + \left(\frac{\sqrt{\sigma_\alpha^2 + \sigma_\beta^2}}{\alpha+\beta} \right)^2 \right]^{1/2}$$

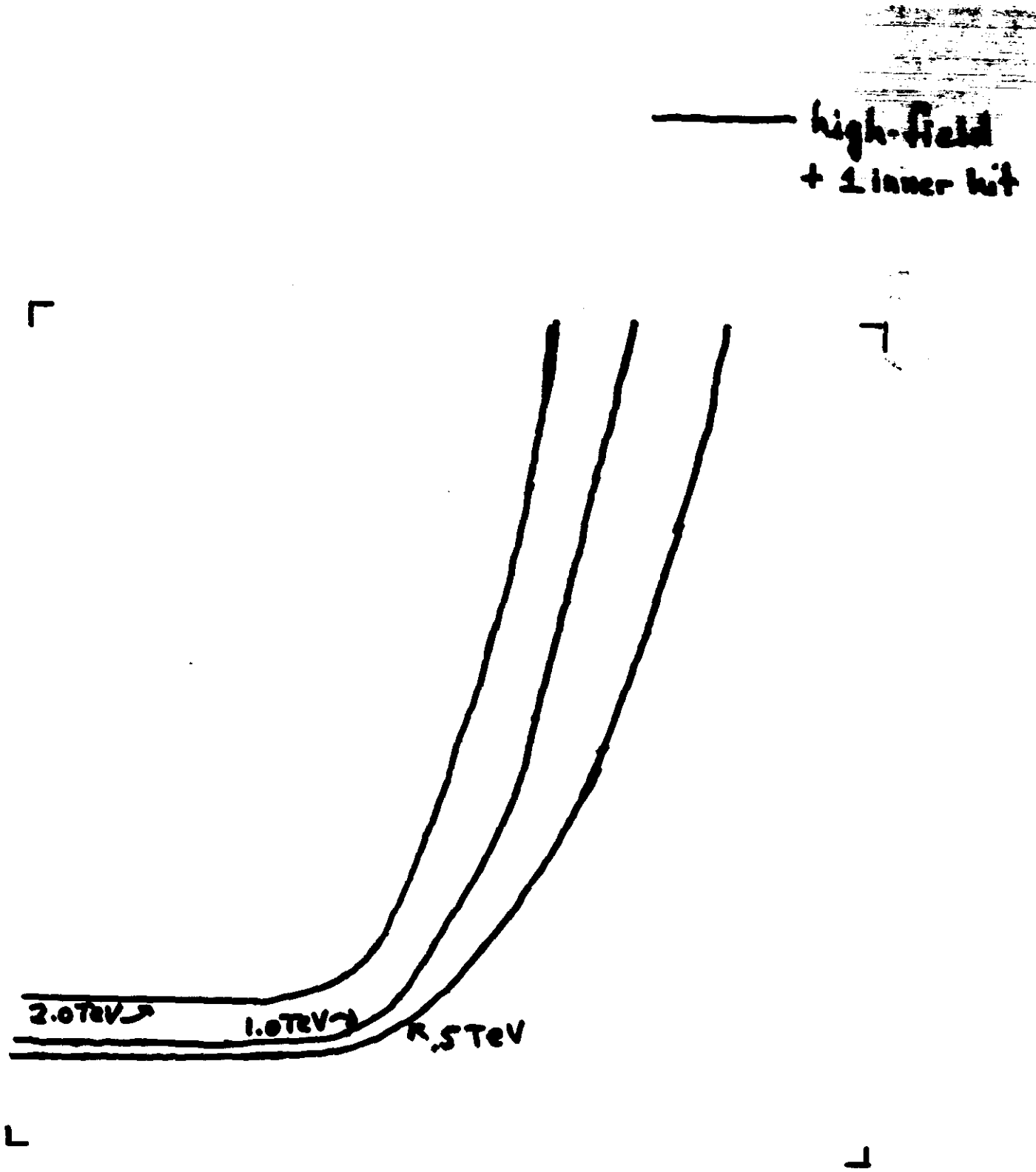
independent of P_T — depends on P_T

Parameters used: (R. Lander)

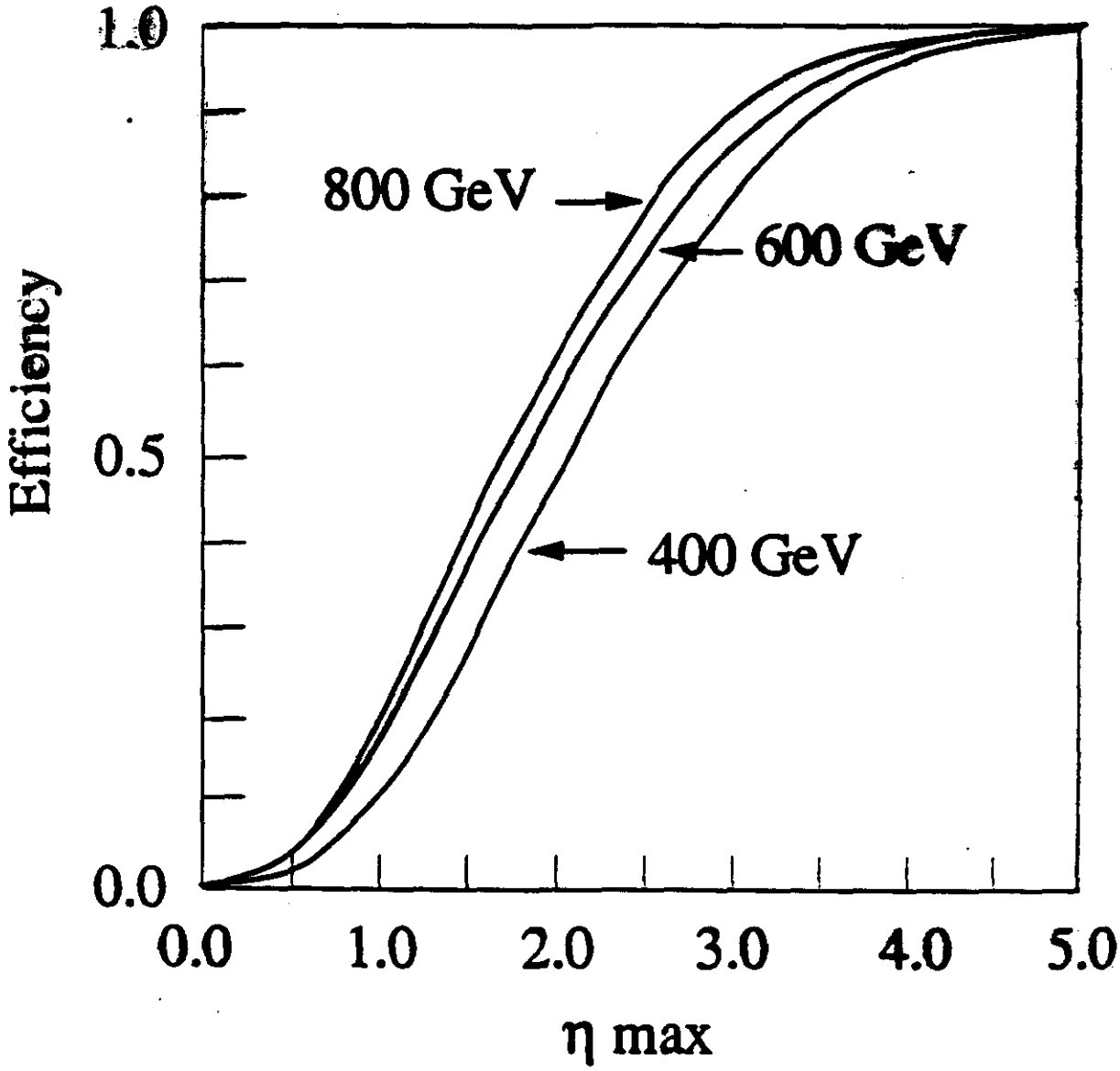
$R' = 0.75\,m$, $R = 3.7\,m$ $\ell = 1\,m$ $\sigma_x = 50\,\mu m$

$X = 110\,X_0$ $\sigma_\alpha \underset{\text{assume}}{=} \sigma_\beta = 0.07\,mrad$



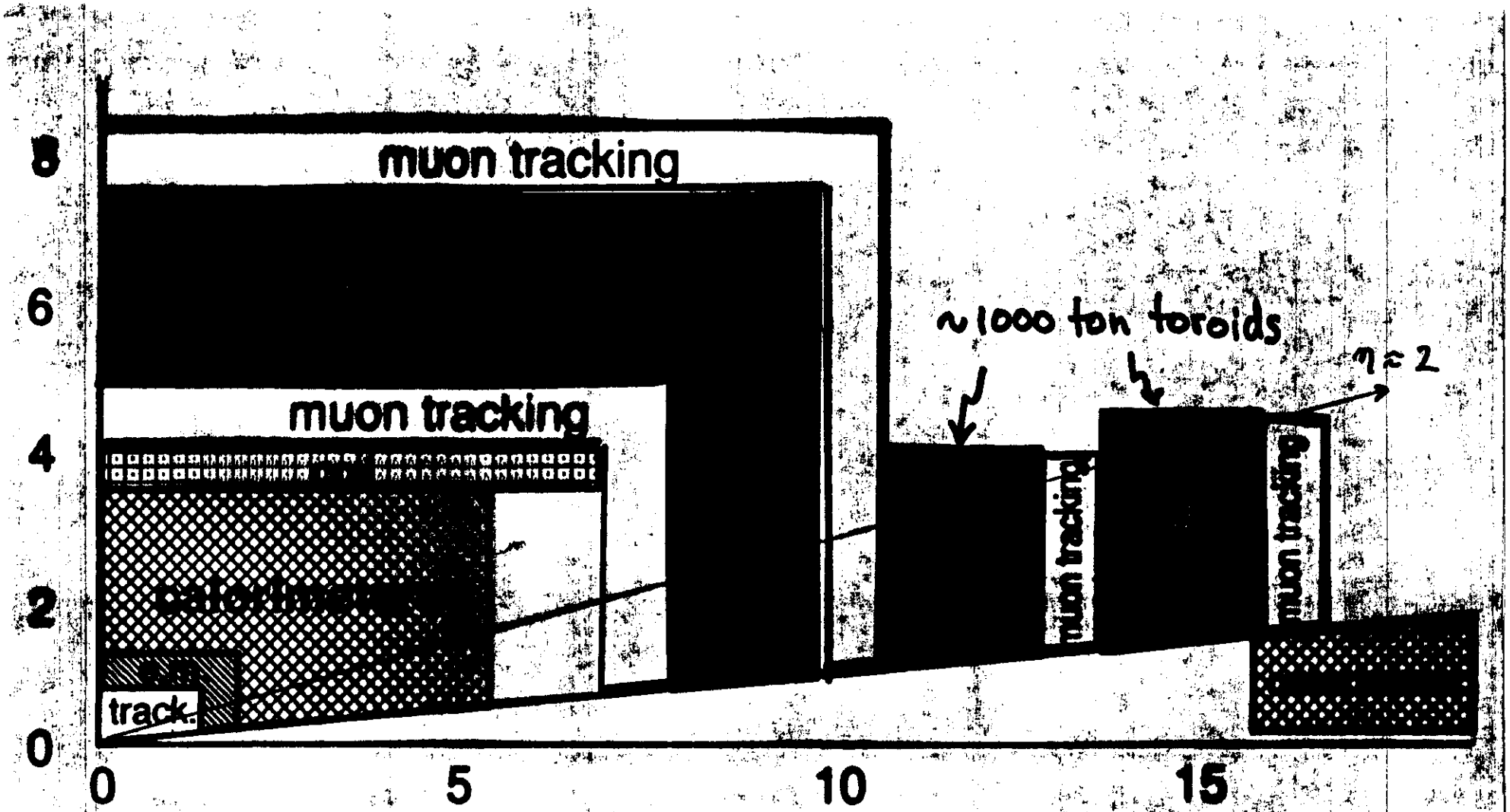

high-field
+ 1 inner hit
2.0TeV
1.0TeV
.5TeV

$H^0 \to Z Z$, $Z \to ll$, $Z \to ll$ Efficiency vs acceptance

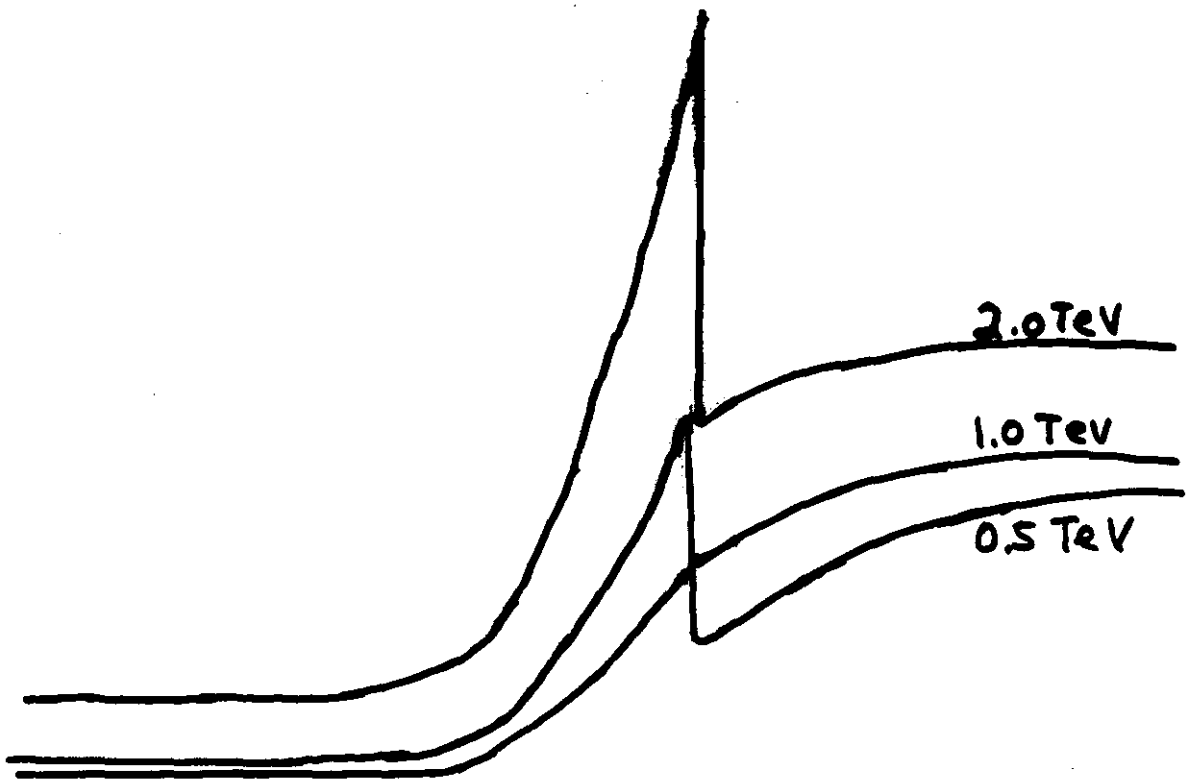


Need η coverage out to

$\eta = 3 \sim 3.5$



High Field Design for GEM with Forward Toroids


2.0 TeV
1.0 TeV
0.5 TeV

What about "Robustness"?

1. Constraints:

Track segment in the coil tracker predicts:

- exit position from iron $\pm \frac{270\mu}{P(\mathrm{TeV})}$
- exit angle from iron $\pm \frac{.16 \text{ mrad}}{P(\mathrm{TeV})}$
- position of hits in inner trkr $\pm \frac{250\mu}{P(\mathrm{TeV})}$

2. Trigger

- Coil tracker angle (α) < 270 mrad ($P_T < 10\mathrm{GeV}$)

  $\Rightarrow$ 10^3 Hz @ 10^{33} Level 1

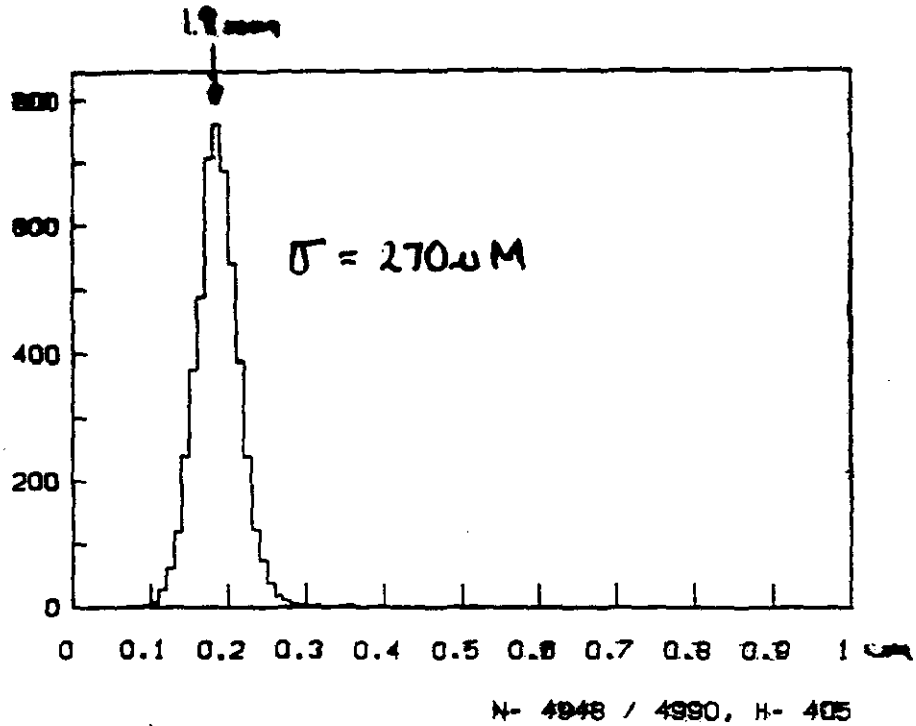
- match to position in outer tracker (behind 25 λ !) makes precision P_T selector

  $\Rightarrow$ P_T Level 2

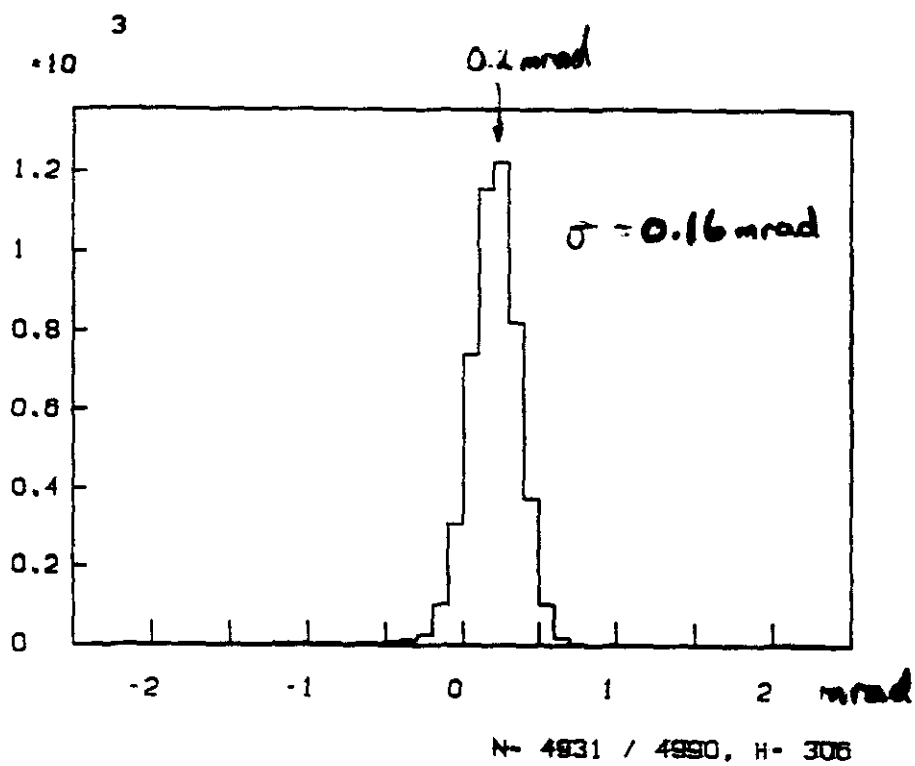
3. High Luminosity

- Works independently of inner det.
  - 6% $\Delta P_T / P_T$
  - Level 1 trigger = 10^4 Hz @ 10^{34}

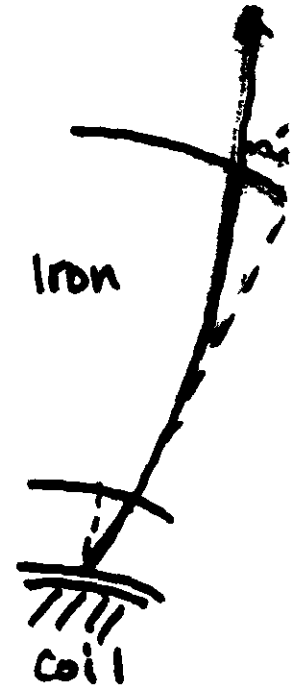
1TeV/c Muons at 90degrees (GEANT Simulation)



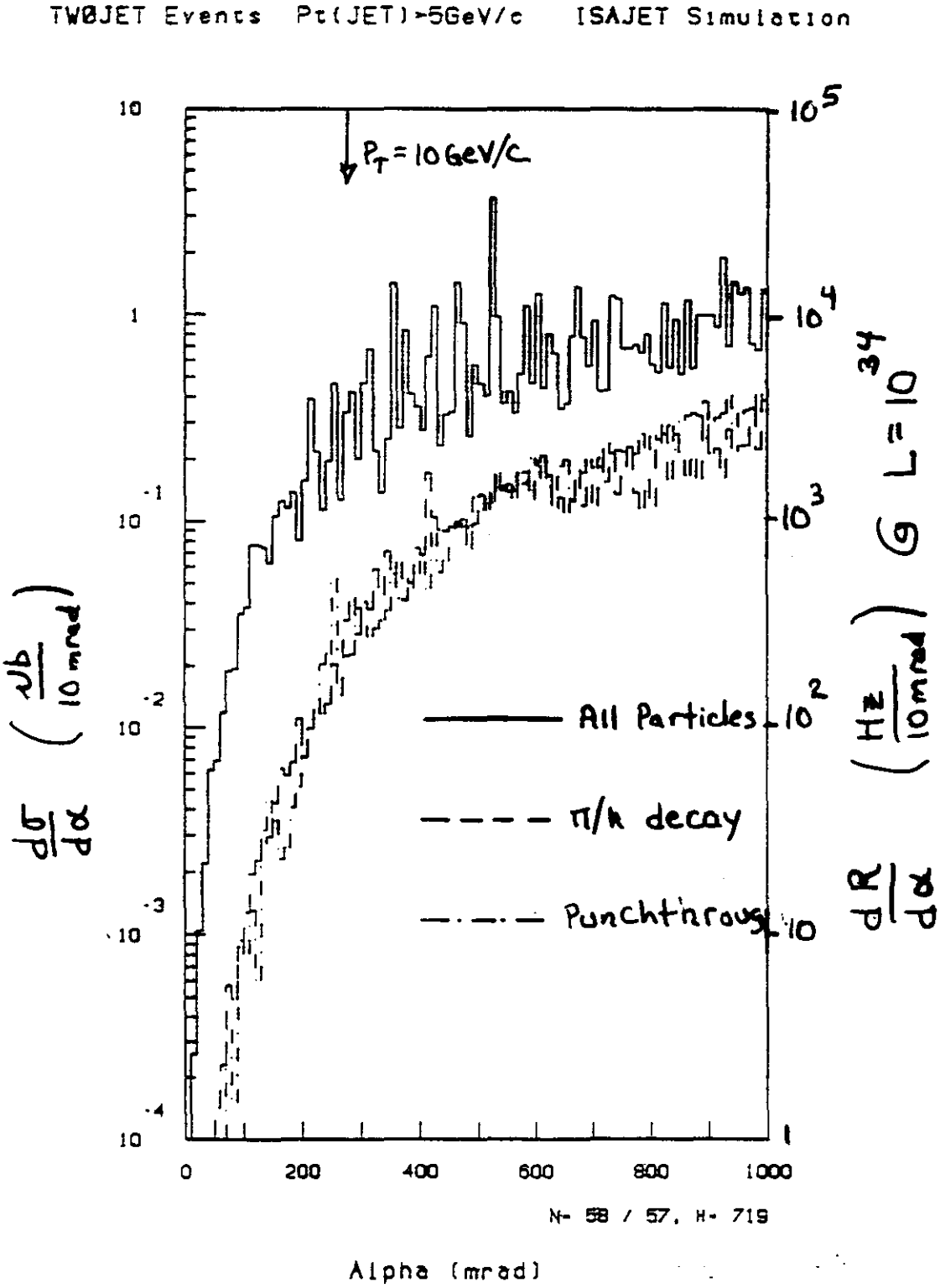
X pos after iron - projection from track after coil.



Angle exiting from iron (mrad) from radial

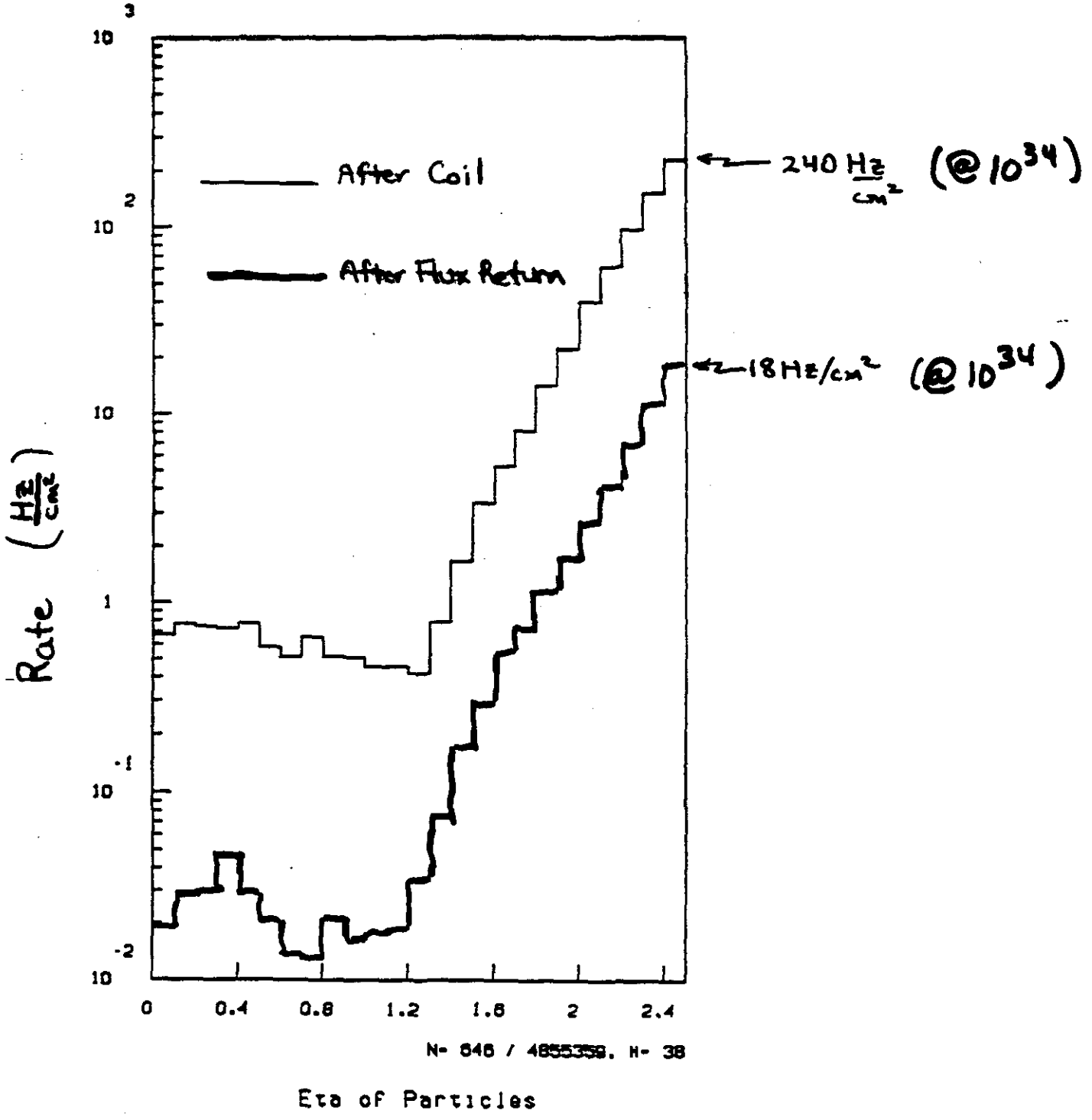


Rates as function of α for particles which Penetrate Flux return iron

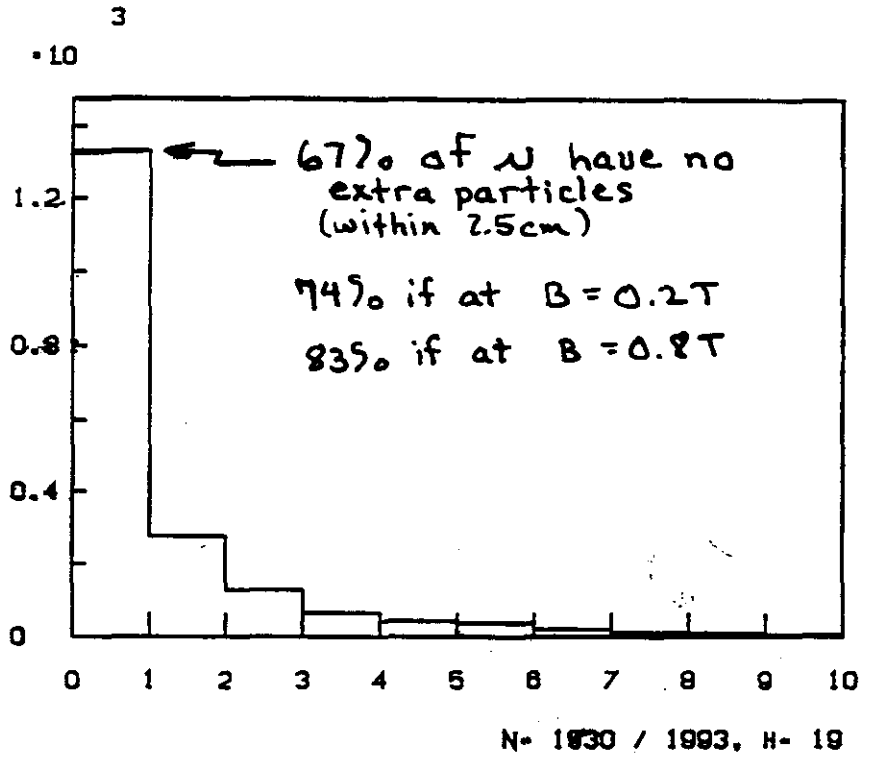


@ 10^{34} ⇒ TRIGGER Rate ~ 10^4 Hz for $P_T > 10$ GeV ($\alpha < 270$ mrad)

TWBJET EVENTS Pt(JET)>5GeV/c ISAJET Simulation

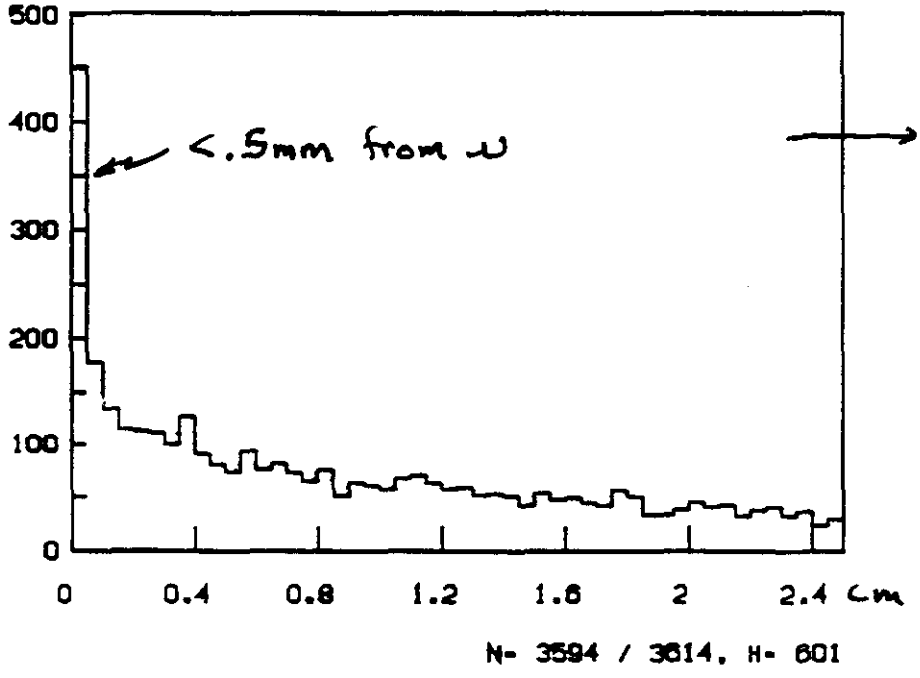


1TeV/c Muons at 90degrees GEANT Simulation



Multiplicity of extra particles (within 2.5cm of μ in bend-plane)

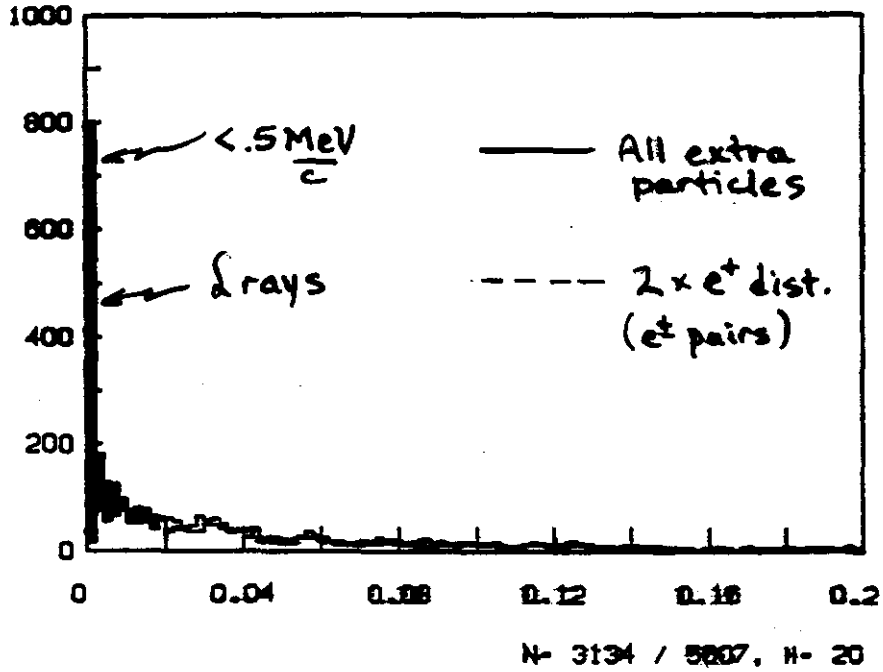
Some of extra particles further from wire that μ.



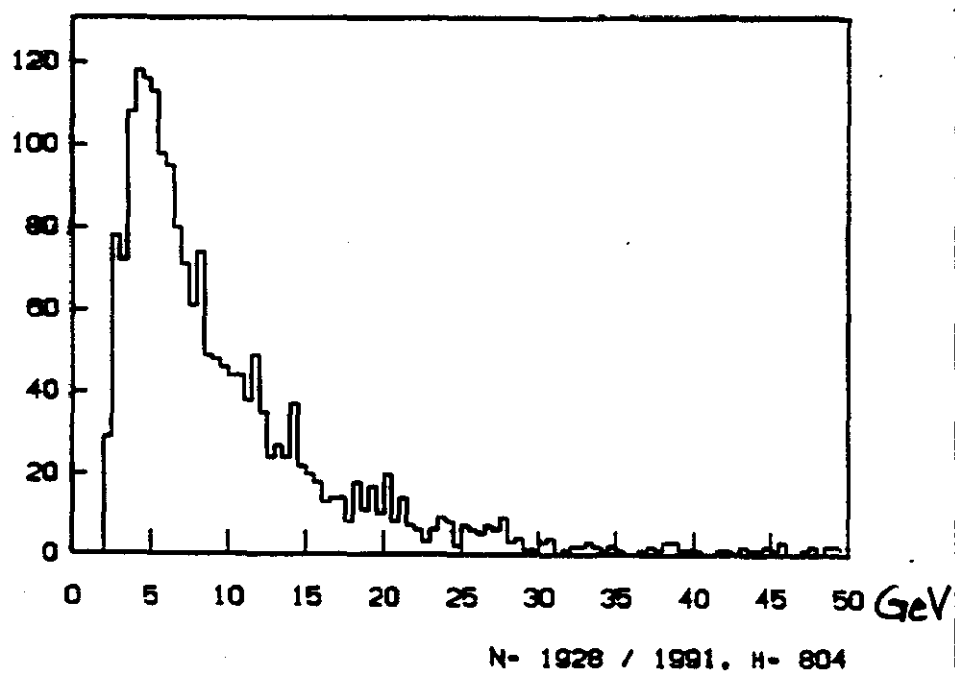
Sep Mu-elec in Bend-plane (cm)
(At initial location in gas)
First chamber after coil
2mm Al wall

Now need to extrapolate and see if μ measurement compromised

1 GeV/c Muons at 90degrees GEANT Simulation



Momentum of extra particles (GeV/c)



Energy loss by Muon in material (Fe cal)

First chamber after coil

Background From Muon-induced showers

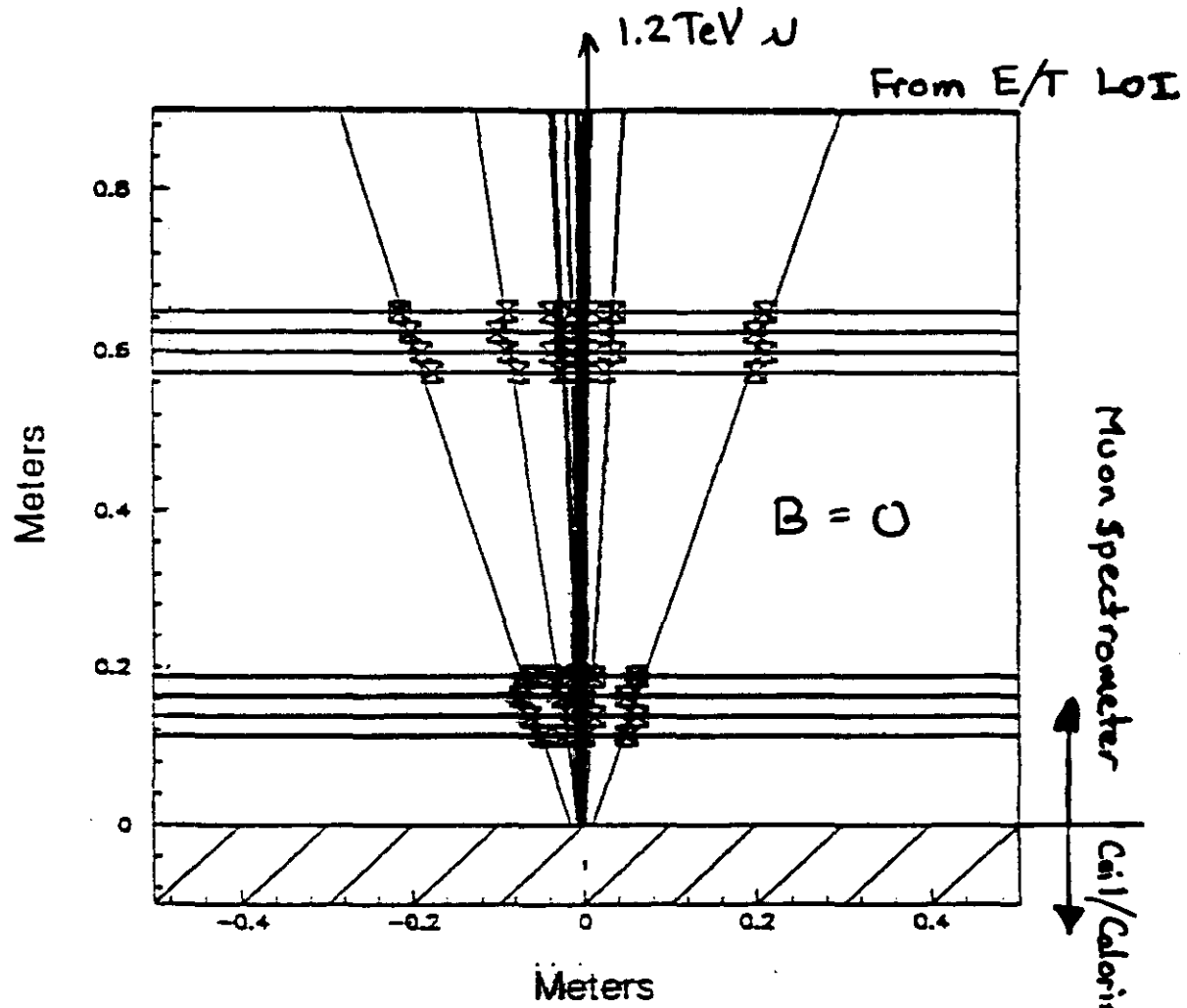


Figure 3-24 Muon track (vertical at 0) coming out of the calorimeter accompanied by the secondary particles resulting from muon radiation in a 4 TeV Z′ event. (Atypical)

Results of E/T Study: Good hit ≡ no other tracks in cell

Cell Size		All 8 good hits	4 good hits (1 good S.L.)
2.5 cm	4 TeV Z′	75.5 %	85.0 %
	high P_T t	87.6 %	94.0 %
1 cm	4 TeV Z′	82.0 %	92.0 %
	high P_T t	91.7 %	96.8 %

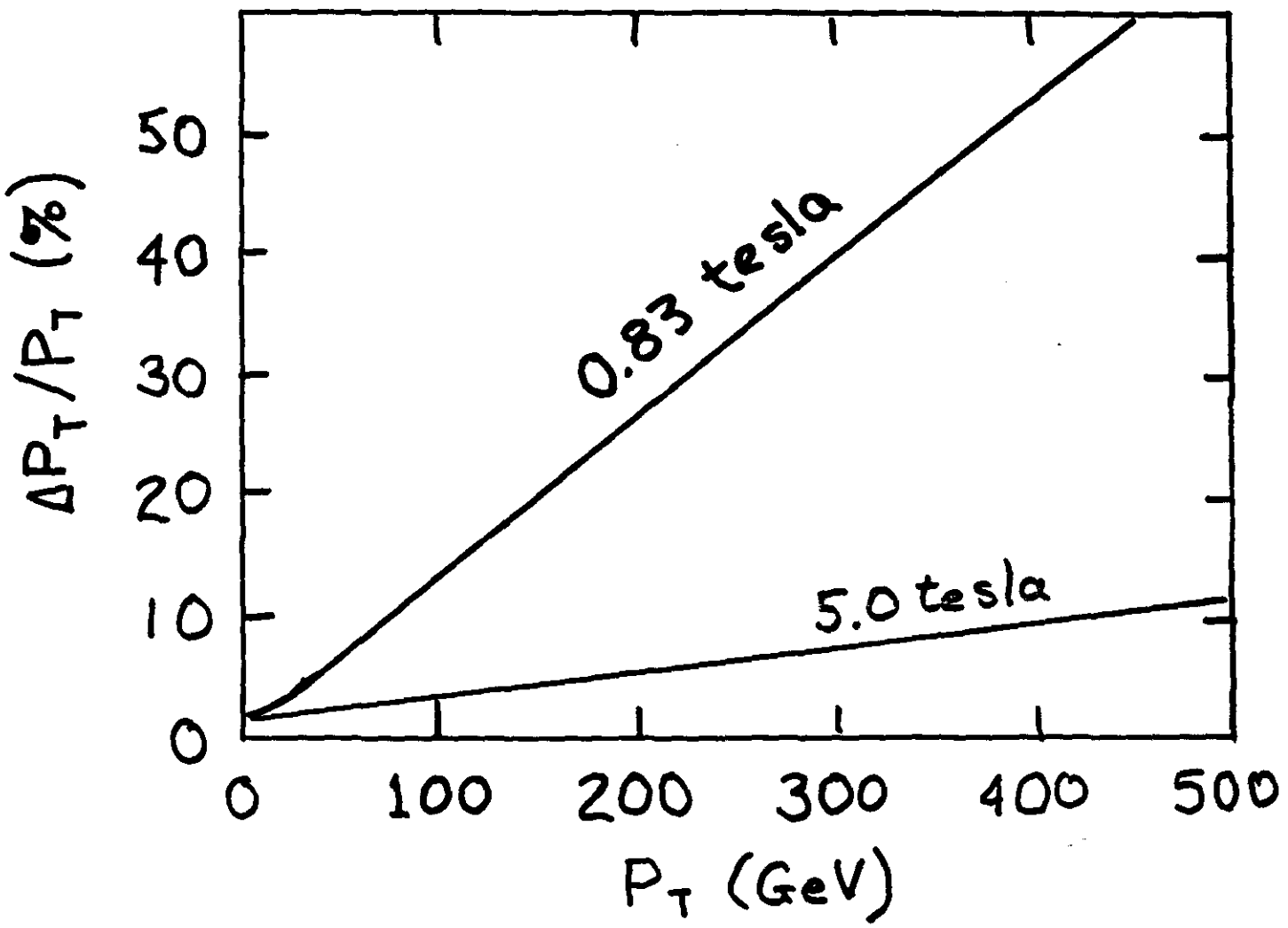
- Effects on the rest of the detector

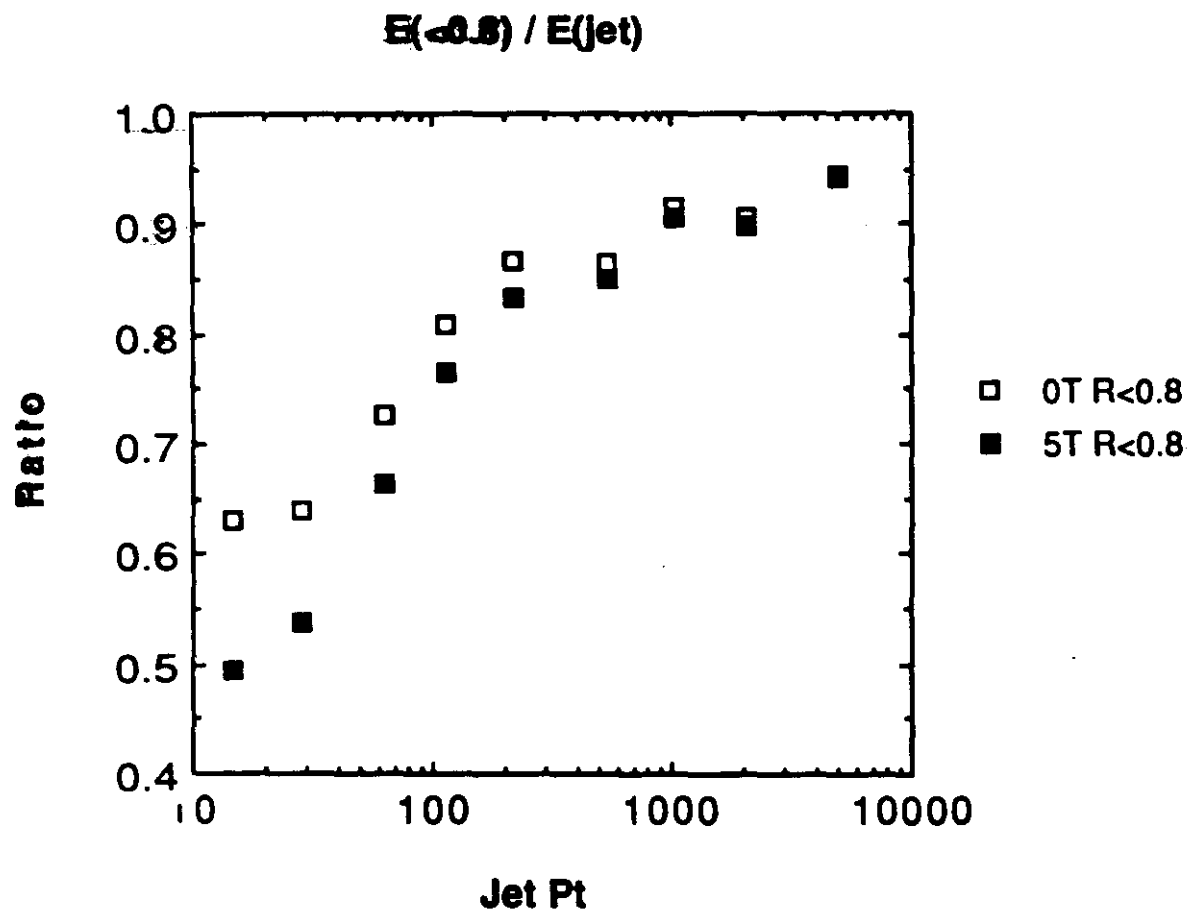
Physics:

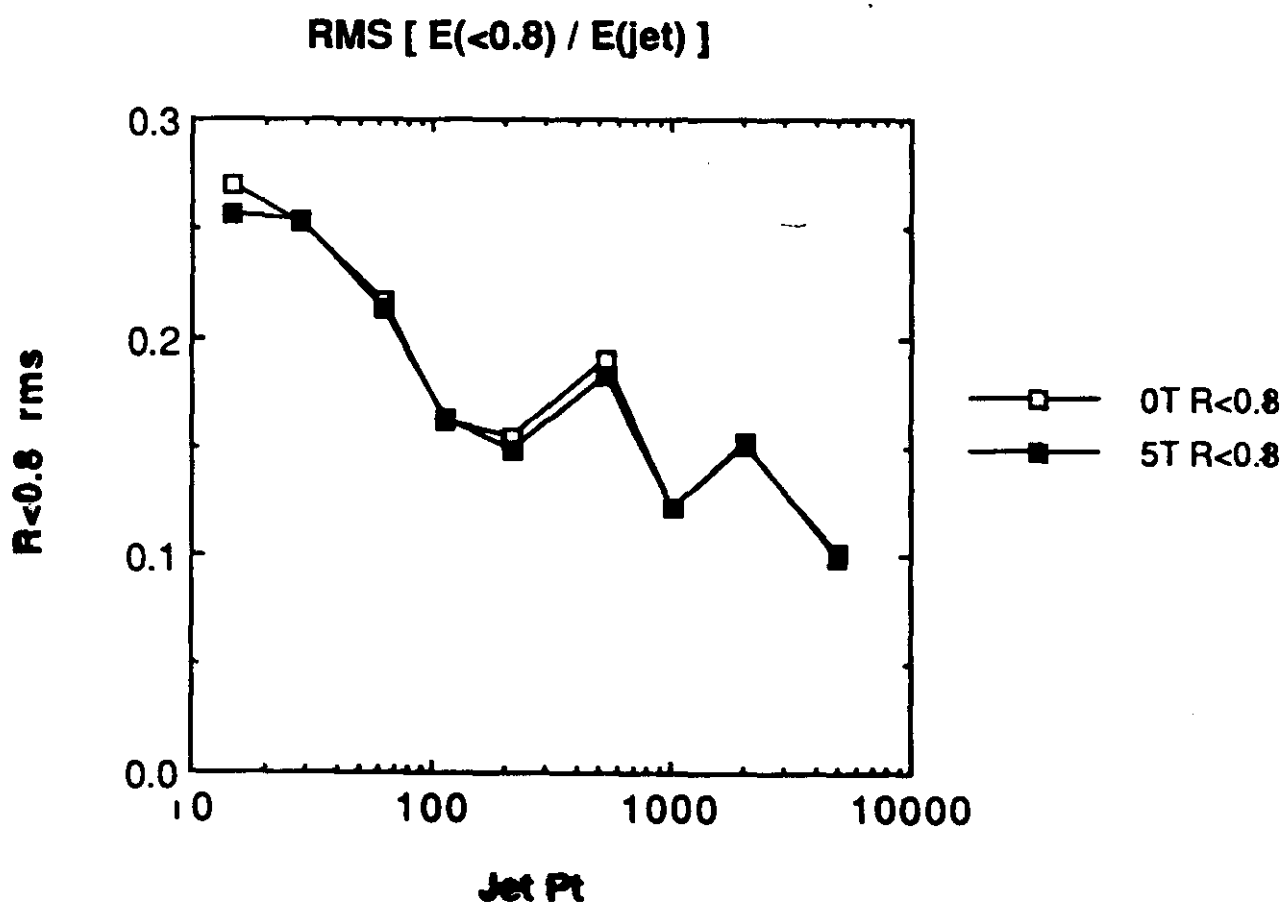
- $B \cdot L^2$ (inner tracker) increases by 6X
- jets 'unaffected'

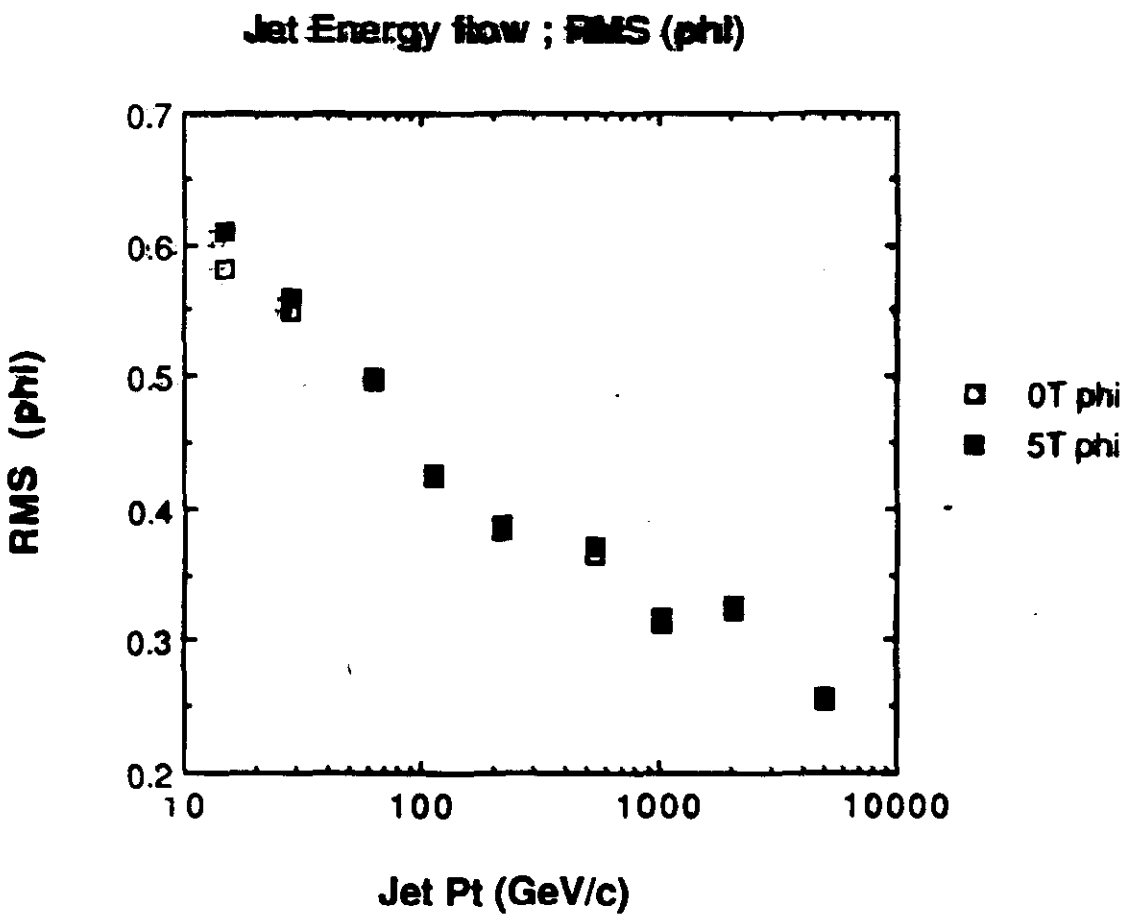
Technology:

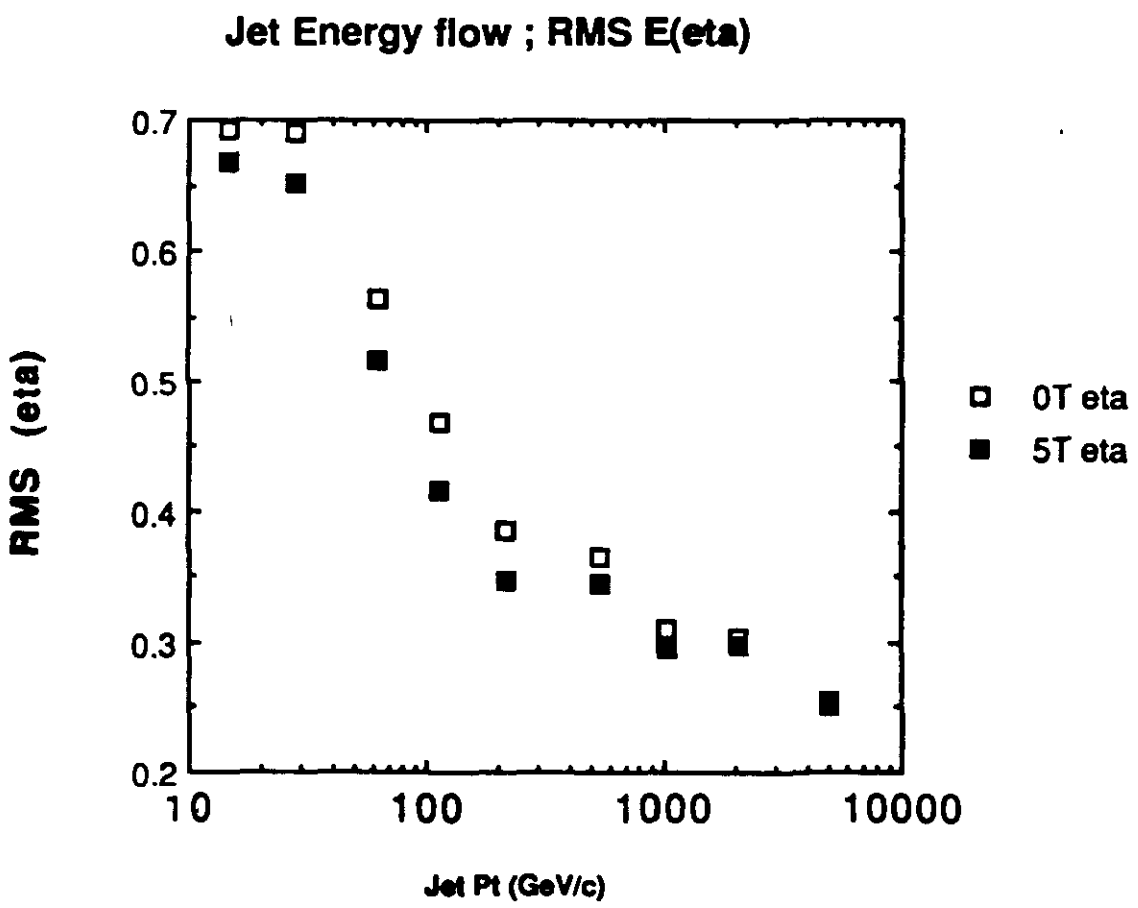
	OK	Problems ?
Tracking:	Silicon Strip Gas μ-strip Sci Fi	Straws Silicon drift
Calorimeter read out	Liquid ionization s.s. photo diodes	Vacuum photodiod


0.83 tesla
5.0 tesla
$\Delta P_T / P_T$ (%)
0
10
20
30
40
50
0
100
200
300
400
500
P_T (GeV)


E(<0.8) / E(jet)
1.0
0.9
0.8
0.7
0.6
0.5
0.4
Ratio
10
100
1000
10000
Jet Pt
0T R<0.8
5T R<0.8


RMS [E(<0.8) / E(jet)]
0.3
0.2
0.1
0.0
R<0.8 rms
10
100
1000
10000
Jet Pt
0T R<0.8
5T R<0.8


Jet Energy flow ; RMS (phi)
RMS (phi)
0.7
0.6
0.5
0.4
0.3
0.2
10
100
1000
10000
Jet Pt (GeV/c)
0T phi
5T phi


Jet Energy flow ; RMS E(eta)
RMS (eta)
0.7
0.6
0.5
0.4
0.3
0.2
10
100
1000
10000
Jet Pt (GeV/c)
0T eta
5T eta

IV. Cost Estimate

- Magnet - Extrapolate from CMS $100M

  Proper Costing in Progress

- Muon Detectors

  Channel counts assuming 2.5cm cells

  Barrel:
  - 24 layers between coil & iron × 2Z segments - 54K
  - 12 layers outside iron × 2Z segments - 48K
  - 24 layers before iron each end - 15K
  - 24 layers outside iron each end × 2 segments - 61K

  178K

  From EMPACT Costing 178K × $174/chan - Chambers $31M

  Gas & Alignment (Scaled from E/T) $10M

  Total Detectors $41M

- Fe Return 18kton × $2K/Ton $36M

System Total : $177M

- End Cap Toroids (only needed for $\eta > 2$)

  2 Toroids each end R = 5m t = 2m

  Fe 4 × 1.25kton = 5kton × $2k/ton $10M

  Chambers 24 - 10m × 10m layers (×2 split) behind each toroid

  = 8 × 24 × 1000cm/2.5cm = 77k × $174/ch $13M

End Cap Toroid System + Gas & Alignment $23M

Total $200M

Comparison with Base line

EOI μ+ magnet = \$226 M

- no fwd system
- no flux return

Differences:

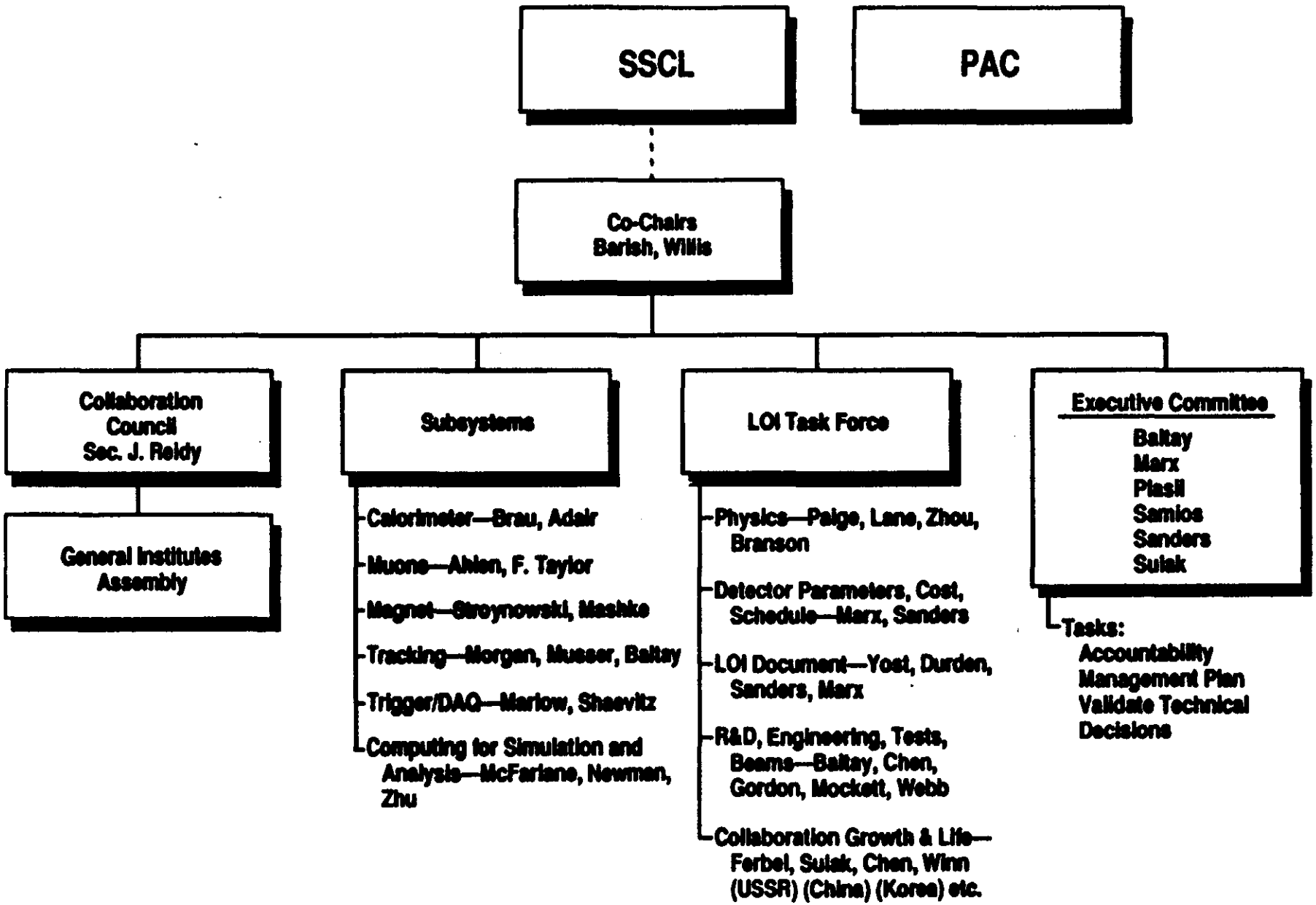
Alignment tolerances 10x relaxed.

Fewer channels

V. Summary and Future Work

Summary of Attributes

- No magnetic Pollution
- Momentum Resolution - Better than GEM baseline for $P_T \gtrsim 300$ GeV/c
  Deteriorates slowly for high P_T
  < 9% @ 0.5TeV out to $\eta = 2$
- Better η coverage
- Alignment - Tolerance relaxed from GEM baseline
  Modest requirements ~ 200 μM global allign.
- Robustness - Resolution ~ 6% even without inner tracking
  - Track outside can be linked to track inside. flux return for redundant measurement of track parameters and rejection of backgrounds
- Simple μ trigger - behind 25λ
- GEM Inner Tracking now at B = 5T
- No Additional Constraints on calorimeter geometry
  《 Want to have low Z radiator 》
  CAL @ 5 Tesla
- Rates/backgrounds - manageable
  - leak field in tracking region will help sweep out low-P δ-rays
  - High Field in Calorimeter reduces hadron bkg
- Costs - < GEM Baseline
  (but now includes fwd toroids + Field return
- Need a design study + cost estimate for magnet


SSCL
PAC
Co-Chairs
Barish, Willis
Collaboration Council
Sec. J. Reidy
General Institutes Assembly
Subsystems
Calorimeter—Brau, Adair
Muons—Ahlen, F. Taylor
Magnet—Stroynowski, Meshke
Tracking—Morgan, Musser, Baltay
Trigger/DAQ—Marlow, Shaevitz
Computing for Simulation and Analysis—McFarlane, Newman, Zhu
LOI Task Force
Physics—Paige, Lane, Zhou, Branson
Detector Parameters, Cost, Schedule—Marx, Sanders
LOI Document—Yost, Durden, Sanders, Marx
R&D, Engineering, Tests, Beams—Baltay, Chen, Gordon, Mockett, Webb
Collaboration Growth & Life—Ferbel, Sulak, Chen, Winn (USSR) (China) (Korea) etc.
Executive Committee
Baltay
Marx
Piasil
Samios
Sanders
Sulak
Tasks:
Accountability
Management Plan
Validate Technical Decisions
hd/7-17-91

G. Sanders

INITIAL ENGINEERING TEAM (JULY 29 - SEPT. 30, 1991)

Magnet - LLNL (Johnson (coord. group), Deis, Miller, ...), MIT (Marston, Hale, ...)

Muon - Draper (Nimblett, ...), LANL (Hanlon, Smith (coord. group)), Boston (Hazen (electronics)), LLNL (Johnson (coord. group)), SSCL (Grinnell)

Calorimeter - ORNL (Rennich, Richards,..., Eberly (coord. group)), Draper (Ayer, ...)

Tracker - LANL (Barber, Smith (coord. group), Boissevain (electronics))

Structures - (Smith (coord. group), Nimblett, Johnson (coord. group),...)

Coordination - LLNL (Johnson), LANL (Smith), ORNL (Eberly)

Layout - SSCL (Sabin, Okay)

ORDERED PRIORITIES UNTIL OCTOBER 1, 1991

1. SUPERCONDUCTING MAGNET DESIGN

2. SELECTION OF CALORIMETER OPTION - CONCEPTUAL DESIGNS, COST AND SCHEDULE IMPACTS, INTEGRATION ISSUES (SUPPORT THE PHYSICS TEAM)

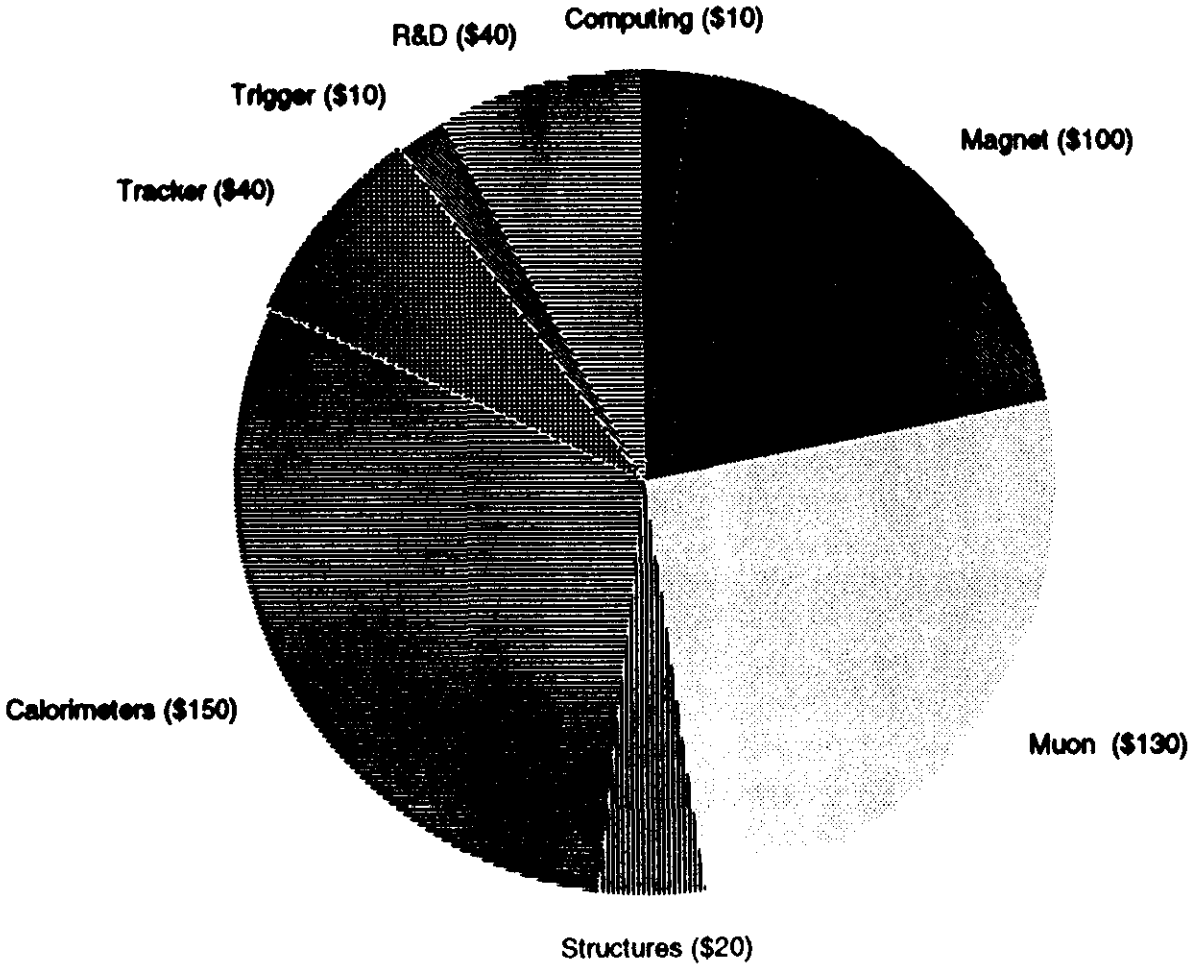
3. DEVELOP COST BOOK AND SCHEDULE

4. MUON SYSTEM - CONCEPTUAL DESIGN, COST AND SCHEDULE IMPACT, INTEGRATION ISSUES

5. TRACKER CONCEPTUAL DESIGN, OPTION SELECTION

6. DEVELOP INTEGRATION TEAM AND METHODOLOGY

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



GEM
ENGINEERING MEETING
MONDAY, JULY 29, 1991

9:00am - 4:00pm

I. Proposed Work Breakdown Structure and Cost Book Organization. Discussion of National Laboratory Labor Rates, Vendor Rates — Dave Etherton

II. Review of Schedule - Collaboration/Dave Etherton/ Mike Harris

III. Facility Requirements - Chris Laughton/ Ray Stefanski

IV. Organization of GEM Engineering

V. Requirements for Letter of Intent (LOI)

VI. Safety Issues - Liquid Argon/TMS/Butane/Stray Field/... — Ronn Woolley

VII. Schedule of Future Engineering Meetings

GEM ENGINEERING MEETING 2
THURSDAY, AUGUST 29, 1991
9:00
BUILDING 3, LG. CONF. RM.

Underground Facilities and Surface Facilities Update	9:00 - 10:30
Magnet Safety Report Ronn Woolley	10:30 - 11:00
Magnet Design Review and Progress	11:00 - 12:00
LUNCH	12:00 - 1:00
WBS and Cost Book Format Report	1:00 - 1:30
Informal Report on Muon System Status Frank Nimblett, Brian Smith, Coleman Johnson	1:30 - 2:00
Informal Report on Calorimeter Engineering Studies Mark Rennich, Ayer	2:00 - 3:00
Informal Report on Tracker Engineering Studies Ron Barber	3:00 - 3:30
Informal Electronics Group Report Marlow	3:30 - 4:00
Discussion of Future Integration Organization Coleman Johnson, Brian Smith, Cliff Eberle, Mike Harris	4:00 - 4:30

M. Marx

GEM SPECIFICATIONS

1) Set Physics Priorities
   SDC Complementarity } EoI

2) Performance Goals

Baseline Detector

Tracker R < .75m L = 3.0m

[illegible]eter R < 3.7m L = 10.0m

[illegible]on R < 8.4m L = 39m

Independent of Technology Cho[illegible]

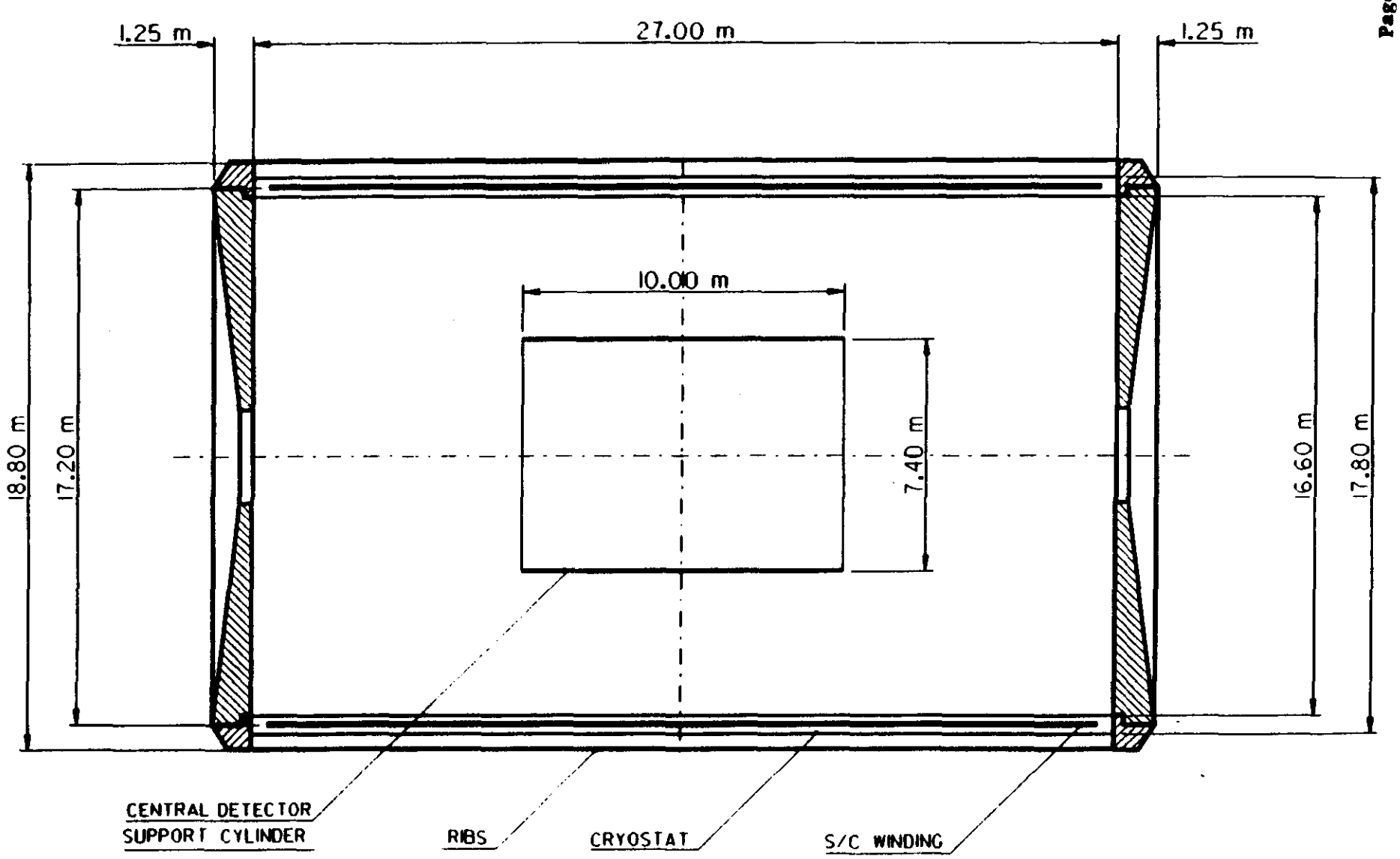
[illegible] Electrons $|\eta| < 2.5$

Muon $|\eta| < 2.5$

Central Hadrons $|\eta| < 3.0$

Forward Hadrons $|\eta| < 5.0$

Supports, Services, Transitions → Iterate


1.25 m
27.00 m
1.25 m
10.00 m
18.80 m
17.20 m
7.40 m
16.60 m
17.80 m
CENTRAL DETECTOR
SUPPORT CYLINDER
RIBS
CRYOSTAT
S/C WINDING

SIMULATION PARAMETERS NEEDED
Physics Simulation Group

In preparing the GEM LoI we need to answer the same four physics questions that were asked of L* and E/T. Briefly, these questions are

(1) Higgs search, 80 < m < 800 GeV;
(2) Top search, m = 250 GeV, and t -> H+ b search;
(3) Missing ET for gluino, m = 300 GeV, and for t', m = 400 GeV;
(4) Jet resolution for Z -> q qbar and Z' -> q qbar.

To start working on these questions, we need to have physics performance parameters for the various systems AS SOON AS POSSIBLE. We can deal with a few options, e.g. 2%/sqrt(E) and 7%/sqrt(E) electromagnetic resolutions, but we cannot simulate all possible detectors.

We list below the main parameters which we will need; we can do useful work without those in square brackets. Information on changes for L = 10^34 would be very helpful. We hope to have at most two options for each system.

MAGNET

Field in central region

MUON SYSTEM

Delta(pt)/pt vs eta.
eta coverage
[geometric and reconstruction efficiency]
[track time determination]
[readout time (for triggering)]
[two track resolution]
[punchthrough backgrounds]

HADRON CALORIMETRY

Delta(E)/E = a/sqrt(E) + b
Delta(E) from pileup and noise
Delta(eta), Delta(phi) vs. eta
[time determination]
[longitudinal segmentation]
[cracks, dead material]

EM CALORIMETRY

All of the above
Shower centroid determination
Shower pointing to vertex

FORWARD CALORIMETRY

Missing ET resolution
Maximum eta and (usable) eta, phi segmentation

TRACKING

Delta(pt)/pt
eta coverage
Vertex determination
Thickness in radiation lengths
[efficiency]
[two track resolution]
[time determination]
[readout time]
[multiplicity measurement]

F. Paige

GEM SIMULATION

Meeting at BU with K. Lane, B. Zhou. Simulation effort has at least three tasks:

- Answer PAC generic questions.
- Help to define GEM advantages.
- Help to make detector choices.

Many generic studies. Need to start specific work for GEM.

Can only deal with limited number of options. Need definition of detector NOW.

Must answer same EoI questions already considered by EMPACT, L*, SDC, and TEXAS:

1. Search for Higgs, $80 < m_H < 800\,\mathrm{GeV}$.
2. Search for standard t, $m_t = 250\,\mathrm{GeV}$ and for $t \to H^+ b$, $m_H = 150\,\mathrm{GeV}$.
3. Exhibit $\not{E}_T$ performance for gluino, $m_{\tilde{g}} = 300\,\mathrm{GeV}$, and $t' \to W^+ b$, $m_{t'} = 400\,\mathrm{GeV}$.
4. Exhibit jet resolution for $Z \to jj$ and $Z' \to jj$, $m_{Z'} = 1\,\mathrm{TeV}$.

Crucial parameters:

Muon

$\Delta p_T / p_T$ vs η, η coverage.

Hadron Calorimeter

$\Delta E/E = a/\sqrt{E} \oplus b$.

ΔE from pileup and noise.

$\Delta\eta$, $\Delta\phi$ vs η.

EM Calorimetry

All of the above.

Shower centroid determination.

Shower pointing to vertex, if any.

Forward Calorimetry

$\not{E}_T$ resolution, or equivalent.

Central Tracking

$\Delta p_T/p_T$ vs η, η coverage.

Δz for vertex.

Radiation length vs η.

Central B field.

Need 1–2 choices for each system.

Have identified some workers:

$H \to \gamma\gamma$	R-Y Zhu, Cal Tech
	H Ma, BNL
	M Chen, MIT
	S Manley, Yale
$H \to ZZ^*,\ ZZ$	B Zhou, BU
$Z \to ee$	K Furuno, Oregon
$H \to ZZ*,\ ZZ$	M Mohammadi, SUSB
$Z \to \mu\mu$	J Branson, UCSB
	B Zhou, BU
$H \to \ell\ell\nu\nu$	G Forden, Arizona
$H \to \ell\ell jj$	H Ma, BNL

$t \to W^+ b$	J Shank, BU
$t \to H^+ b$	S Protopopescu, BNL
$\tilde{g} \to \not{E}_T$	M Murtagh, BNL
$\tilde{g} \to \ell^\pm \ell^\pm$	F Paige, BNL
	S Kahn, BNL
$t' \to W^+ b$	A Vanyashin, SSC
$\not{E}_T$ resolution	G Forden, Arizona
	J Rutherfoord, Arizona
$Z \to jj$, $Z' \to jj$	R Frey, Oregon
	I Stumer, BNL

PAC asks us to define complementarity of GEM to SDC. Baseline design offers:

- Better EM resolution.
- More robust μ measurement outside calorimeter with comparable resolution.
- Higher luminosity capability.

Other potential advantages:

- ☐ Better γ/jet separation, either from speed or from preshower detector.
- ☐ Better jet and/or $\not{E}_T$ resolution — more compact calorimeter can be better.
- ☐ Better μ resolution at high p_T with high B option.

Particular processes which benefit:

EM Calorimetry:

$H \to \gamma\gamma$, both $\gamma\gamma$ and jet backgrounds.

$H \to ZZ^* \to e^+e^-e^+e^-$ resolution.

$Z' \to e^+e^-$ width (typically 1%).

Higgs in other models?

Muons:

More robust.

Measure μ in jet well. Useful for many possible processes:

$gg \to t\bar{t}$;

$gg \to \eta_T \to t\bar{t}$;

$gg \to P_3\bar{P}_3 \to b\mu\bar{b}\bar{\tau}$;

Also measure heavy flavor backgrounds.

$Z' \to \mu\mu$ and $q\bar{q} \to \mu\mu$.

High Luminosity:

Usable and important for many processes:

$Z' \to \ell^+\ell^-$, $W' \to \ell\nu$.

Compositeness in $q\bar{q} \to \ell^+\ell^-$, $q\bar{q} \to \ell\nu$.

$q\bar{q} \to \mu^+\mu^-$ asymmetry.

$\rho_T \to WZ$, $\omega_T \to Z\gamma$ and other strong WW interactions at TeV scale.

$H \to \ell^+\ell^-\ell^+\ell^-$.

$\tilde{g}\tilde{g} \to \ell^\pm\ell^\pm$ for very high masses.

$\tau^+\tau^-$ pairs from Z', compositeness?

C. Baltay

GEM Committee on R&D, Engineering and Test Beams

Min Chen

Howard Gordon

Paul Mockett

Bob Webb

C.B.

Engineering

Bridge funds for engineering

a) 675 K$ used in past 3 months

b) Similar amount available in next 3 mos.

c) Beyond that engineering has to be funded from GEM R&D funds

Test Beams

Test beams are available at BNL, Fermilab, and CERN at various times.

We need to develop a plan of our test beam needs to negotiate a coherent GEM program [illegible]

GEM R&D – Possible Sequence of Events

1. Sept 15 1991 due date for FY 1991 Progress Reports. Due date for FY92 R&D proposals for large detectors delayed until R&D plans prepared.

2. The GEM Collaboration should submit a single coherent R&D proposal by the delayed due date
   a) GEM to make decisions narrowing down the technologies to be supported for each subsystem to a few by Oct 3,4
   b) PAC to (hopefully) bless the GEM decisions on Oct 3,4 meeting
   c) GEM Subsystems to generate plan for the engineering and R&D needed to support the technologies of choice
   d) GEM management to provide subsystems with guidelines for engineering and R&D funds available to each subsystem

e) Subsystems to write their section of the R&D Proposal

i) Motivation and importance of work
ii) Technical Description
iii) Timetable
iv) Budget
v) Institutions involved (approx)

f) GEM R&D Committee to assemble proposal and submit to the SSC Lab.

3. The SSC R&D Panel (Big Williams etal) will review the proposal for technical correctness and hopefully recommend approval

4. Overlaps and possible collaboration with SDC on common R&D problems to be worked out

5. GEM Subsystems should generate a more detailed plan for the R&D

a) Institutions involved, with the scientists and engineers named, specifying fraction of time spent on this work

b) Detailed role and responsibility of each institution

c) Timetable for work at each institution

d) Budget at each institution, specifying support from all sources

- GEM R&D funds
- TNRLC funds
- Operating funds and manpower at that institution
- Other ?

6. Based on the above detailed plan, MOU's to be written between each institution, GEM, and the SSC Lab.

7. Members of the GEM Collaboration may wish to submit to the SSC Lab proposals to complete R&D work on technologies not selected to be supported by GEM. these proposals should be negotiated with the SSC Lab independently of the above frame work for GEM R&D. These proposals are still due Sept 15!