GEM TN-93-263

Neutron Task Force Meeting

January 6, 1993

Abstract:

Agenda, attendees and presentations of the GEM Neutron Task Force Meeting held at the SSC Laboratory on January 6, 1993.

Neutron Task Force

January 6, 1993

0900	Opening remarks Agenda changes	M. Marx M. Diwan
0915	Backgrounds from Machine Components	N. Mokhov
0930	Update on Lahet Simulations	L. Waters
1010	Shielding Strategies	V. Morgunov
1050	Beam pipe design	G. Chapman
	Short Break	
1115	Update on GEANT-COLOR89	I. Fissiak
1130	Update on LLNL work	C. Wuest
1145	Comments on FCAL	J. Rutherford
1200	Relevance of BNL measurements	M. Diwan
1215	Discussion Next meeting ?	
1300	Lunch	

M. Marx

M. Diwan

N. Mokhov

L. Waters

V. Morgunov

G. Chapman

I. Fissiak

C. Wuest

J. Rutherfoord

K. Morgan

G. Sanders

R. Mcneil

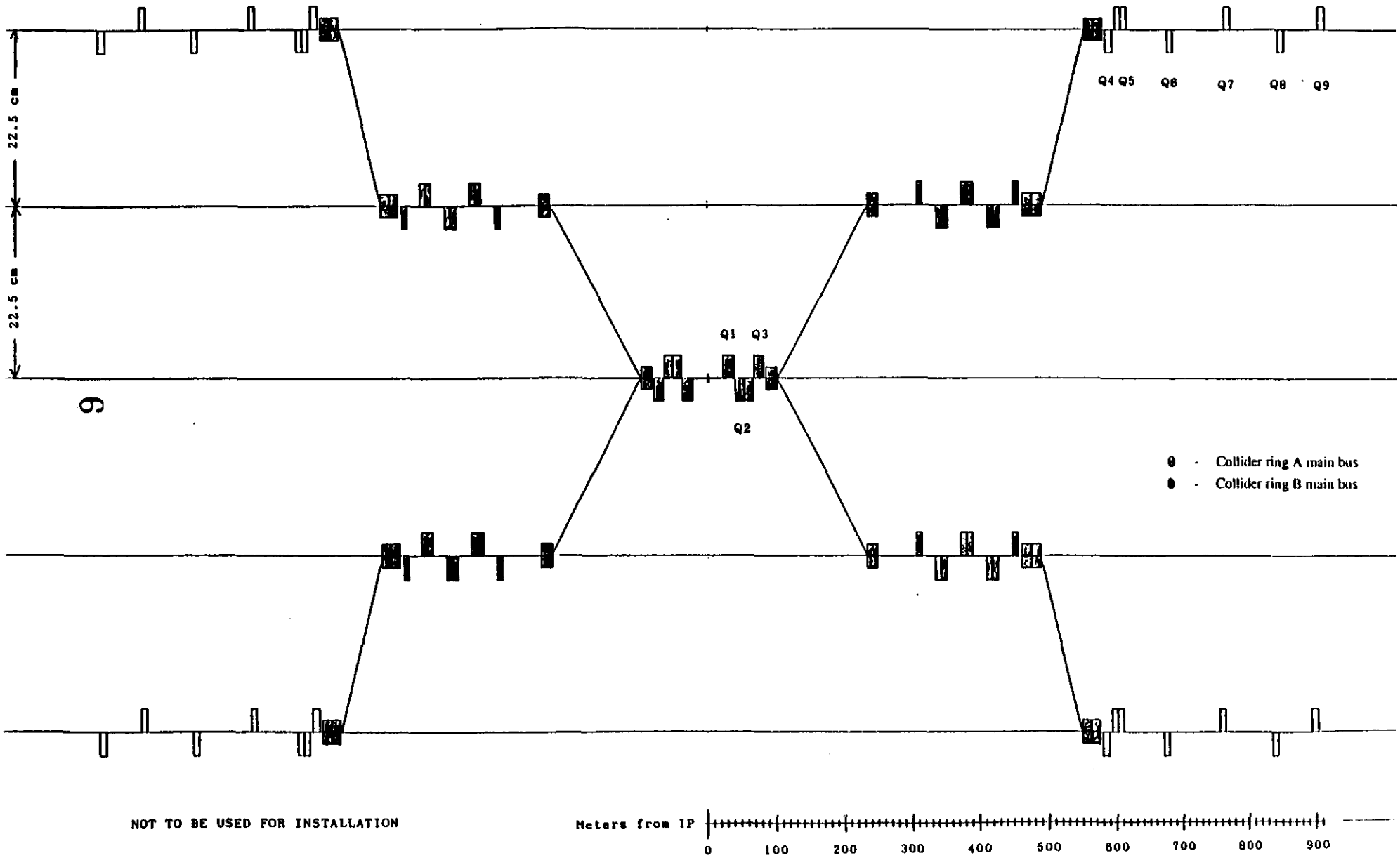
Backgrounds from Machine Components

N. Mokhov

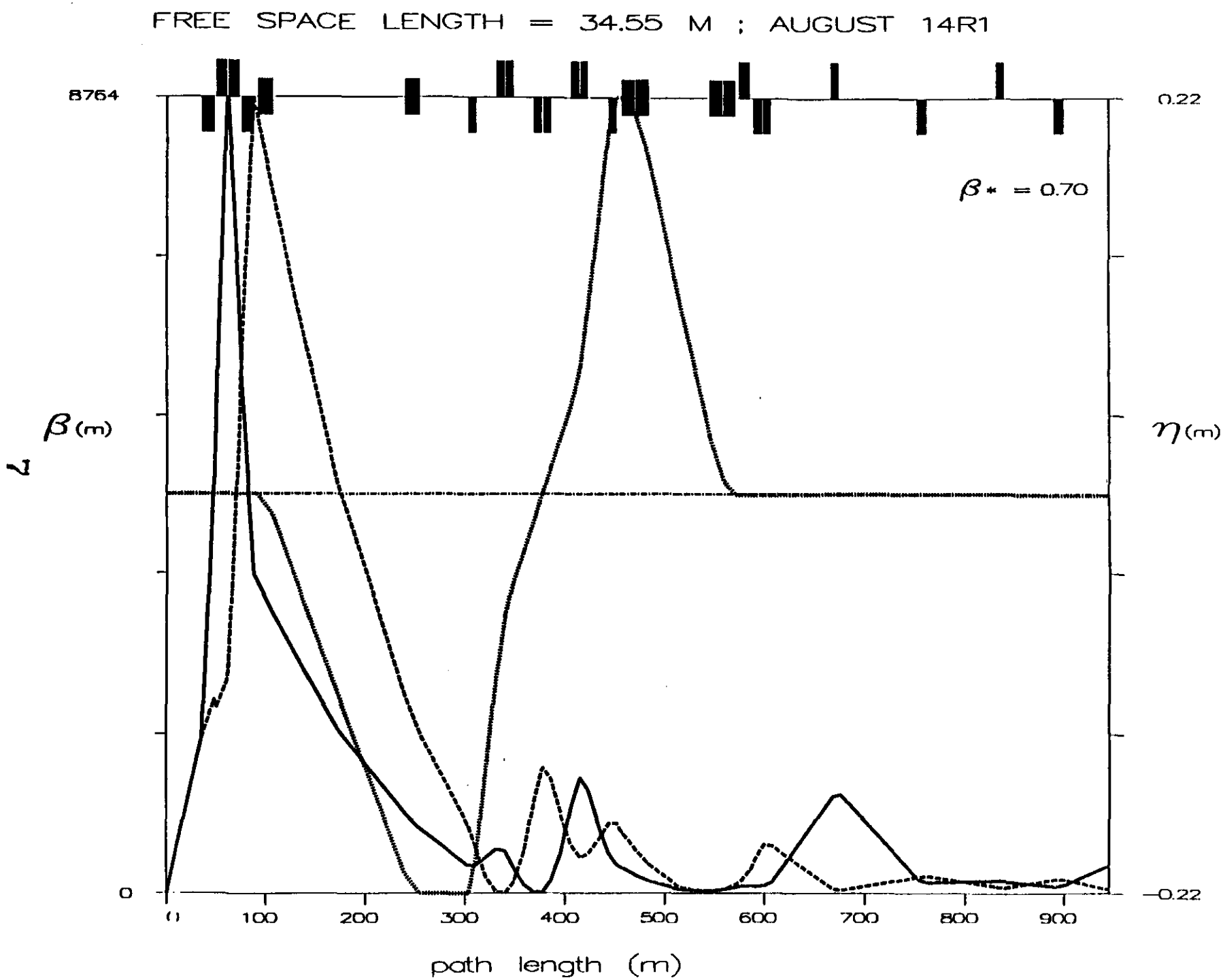
BACKGROUND FROM COLLIDER

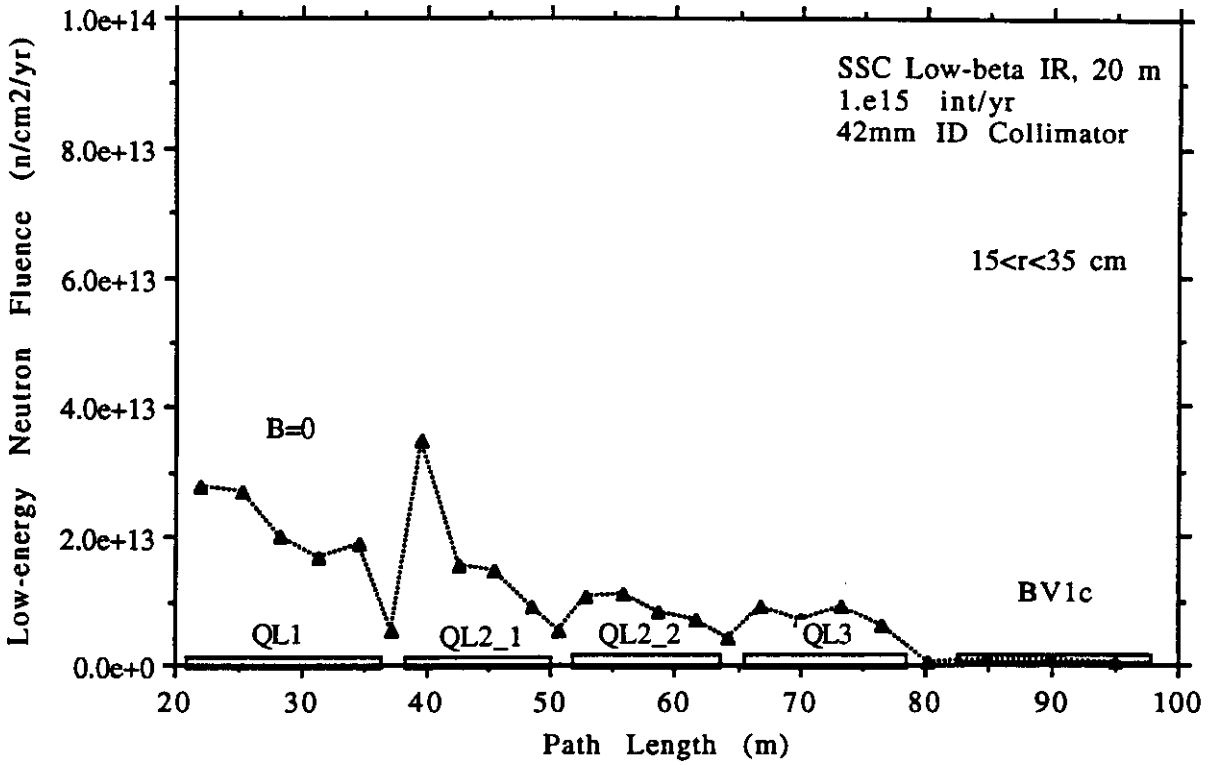
- SSC Low-beta IR
- Shielding and Magnetic Field Effects
- Beam-Gas
- Local Beam Loss in IR

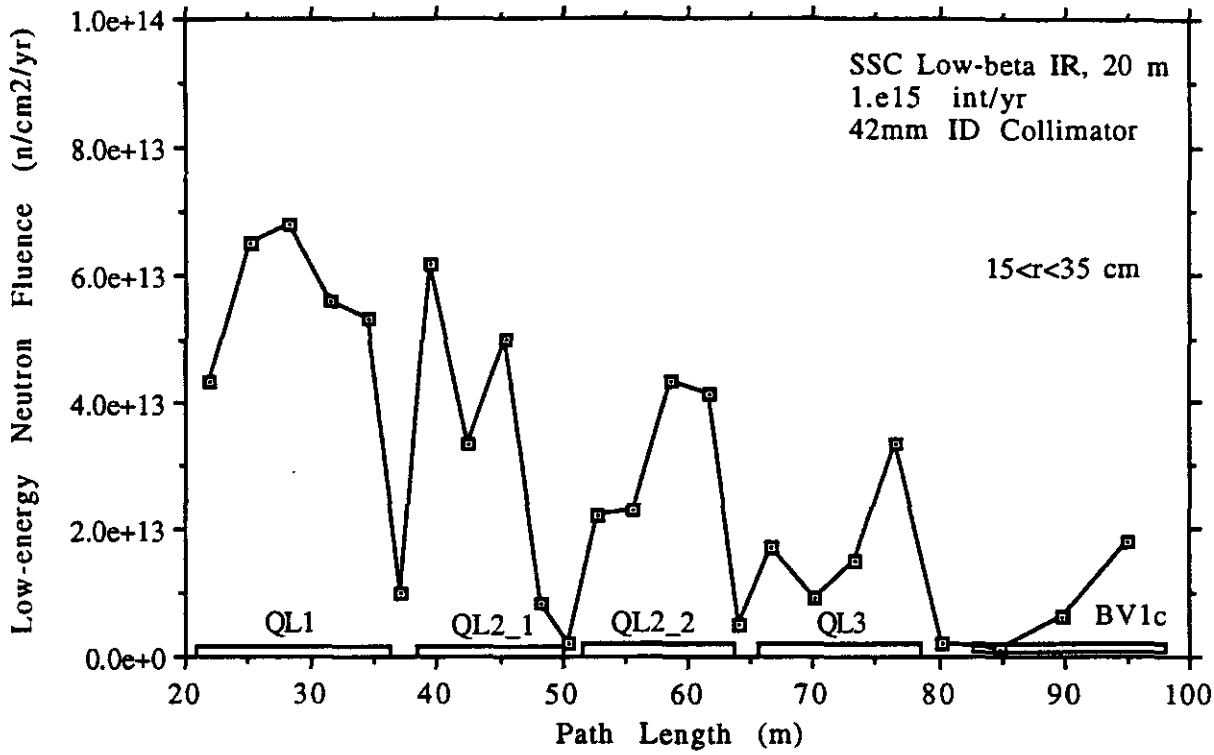
The Preferred Design, August 14 Rev 1

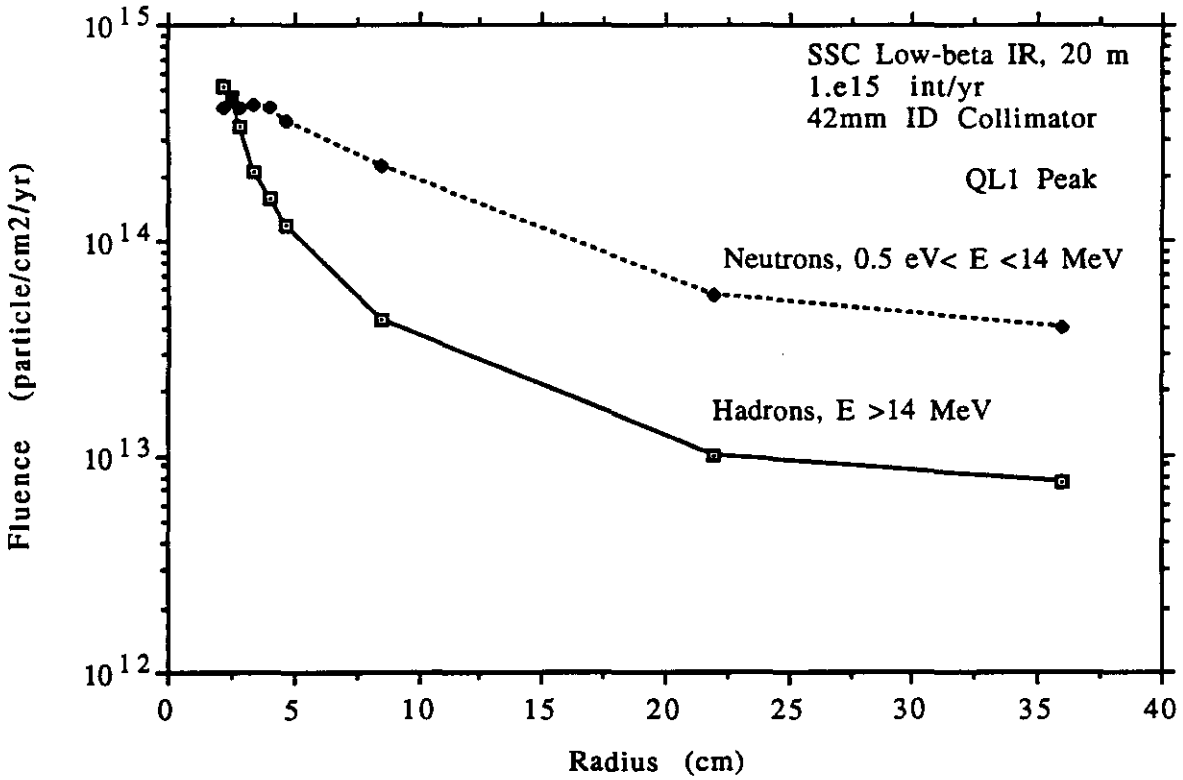


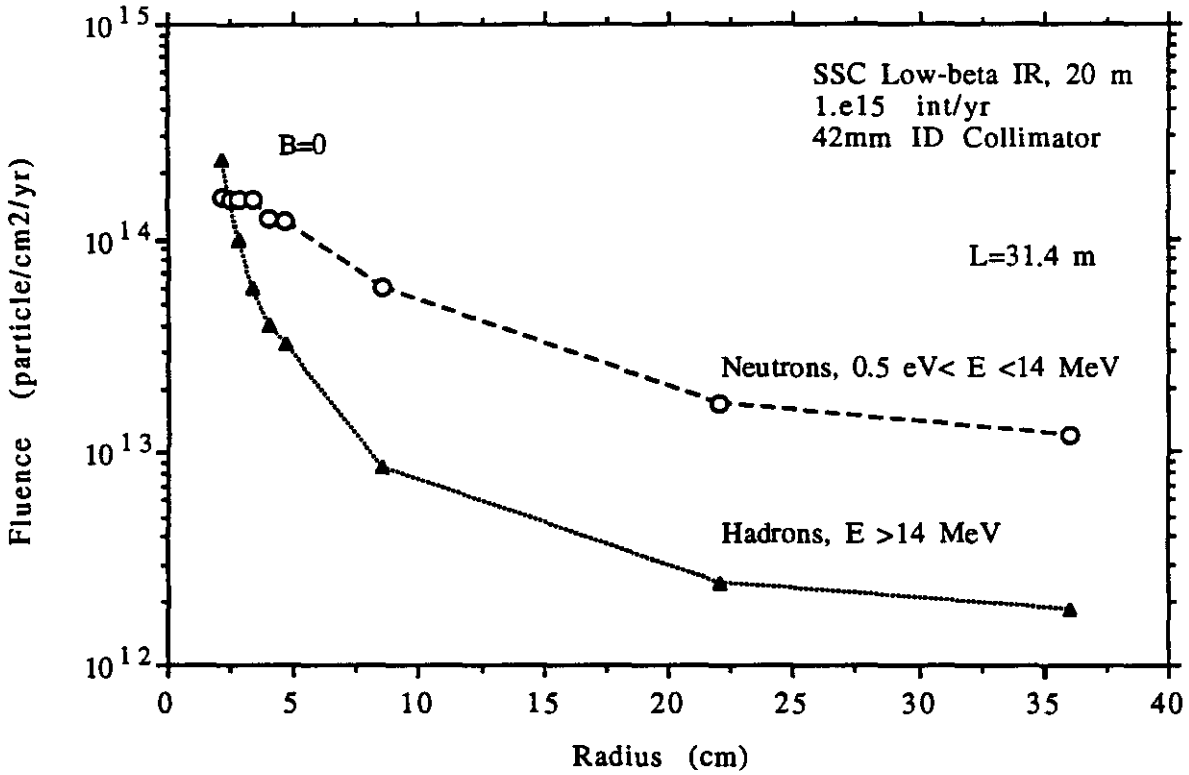
NOT TO BE USED FOR INSTALLATION

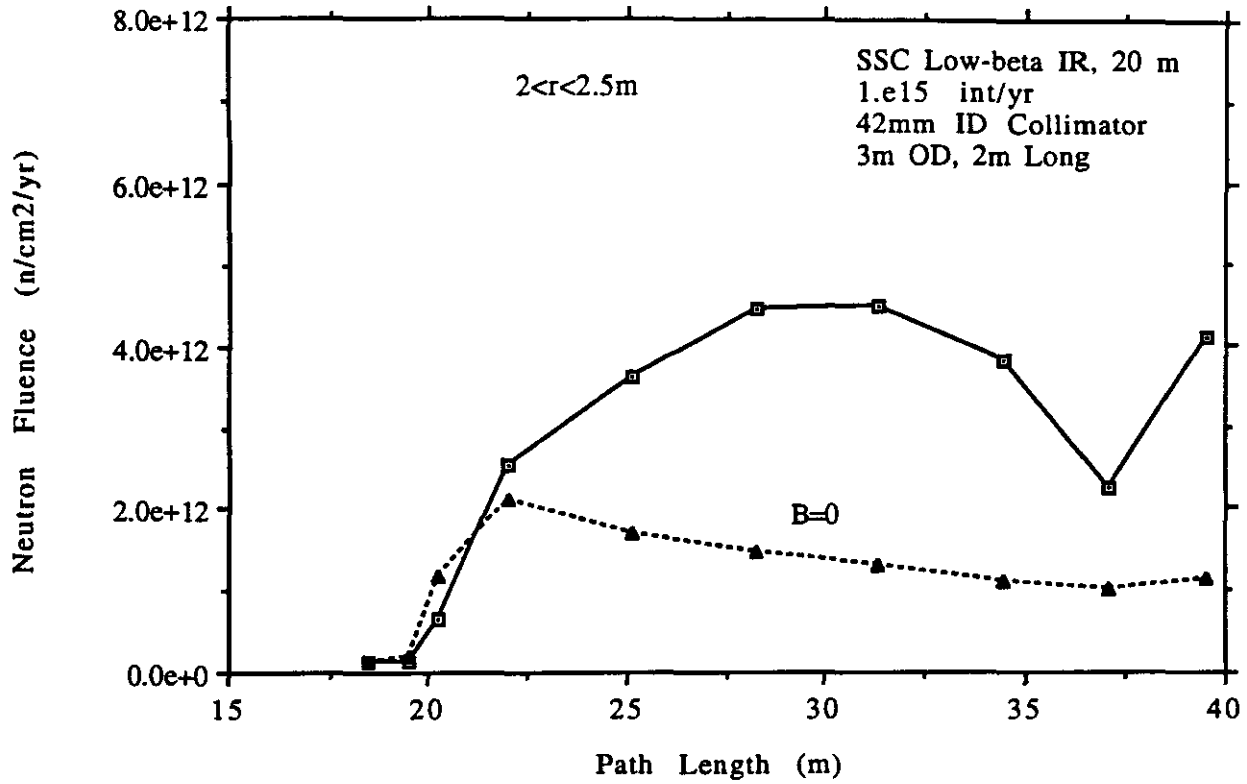

FREE SPACE LENGTH = 34.55 M ; AUGUST 14R1
8764
0.22
β* = 0.70
β (m)
η (m)
0
−0.22
0
100
200
300
400
500
600
700
800
900
path length (m)

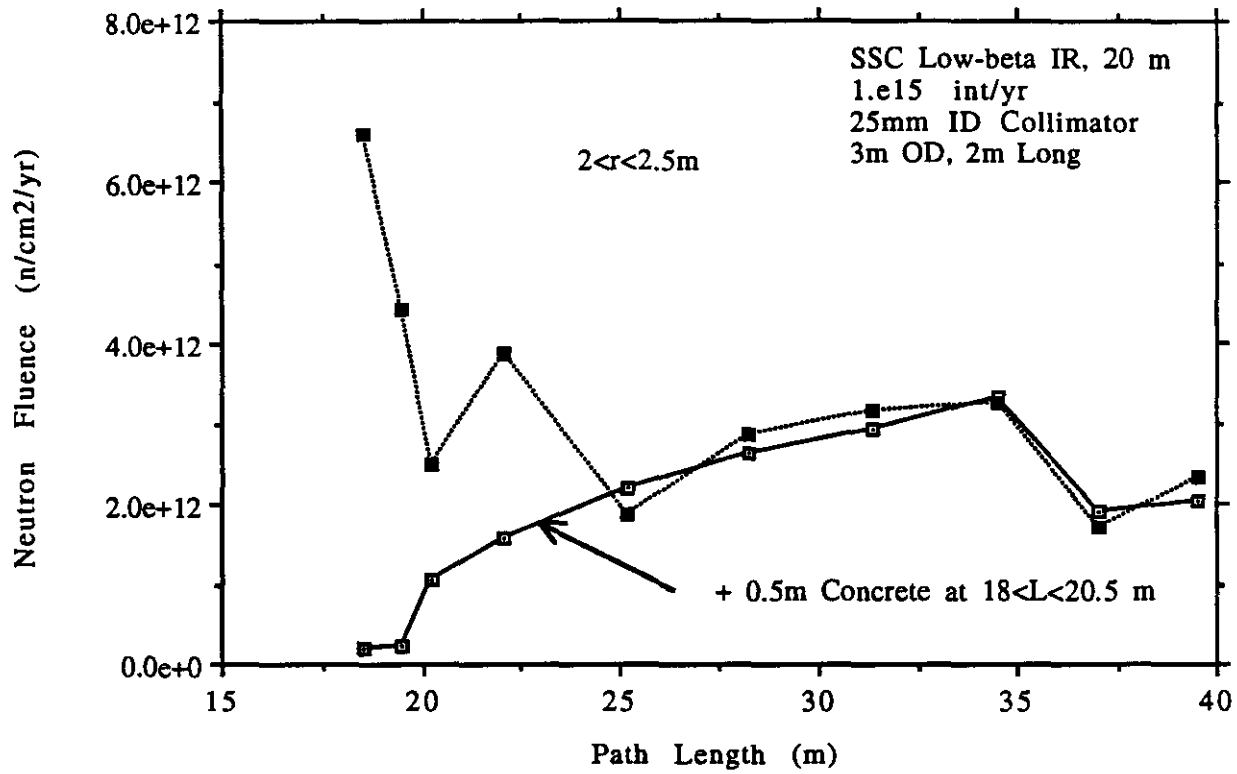

SSC Low-beta IR, 20 m
1.e15 int/yr
42mm ID Collimator
15<r<35 cm
B=0
QL1
QL2_1
QL2_2
QL3
BV1c
Low-energy Neutron Fluence (n/cm2/yr)
Path Length (m)
1.0e+14
8.0e+13
6.0e+13
4.0e+13
2.0e+13
0.0e+0
20
30
40
50
60
70
80
90
100

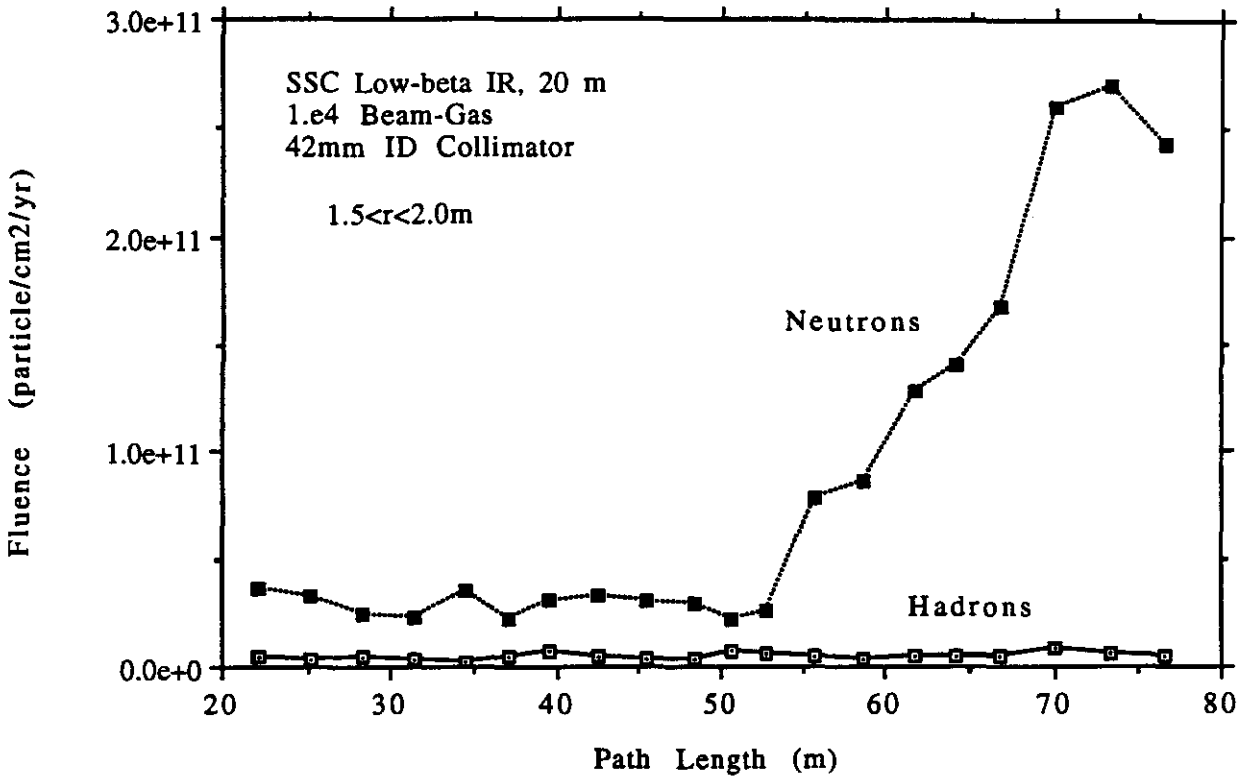

SSC Low-beta IR, 20 m
1.e15 int/yr
42mm ID Collimator
15<r<35 cm
QL1
QL2_1
QL2_2
QL3
BV1c
Low-energy Neutron Fluence (n/cm2/yr)
Path Length (m)
1.0e+14
8.0e+13
6.0e+13
4.0e+13
2.0e+13
0.0e+0
20
30
40
50
60
70
80
90
100

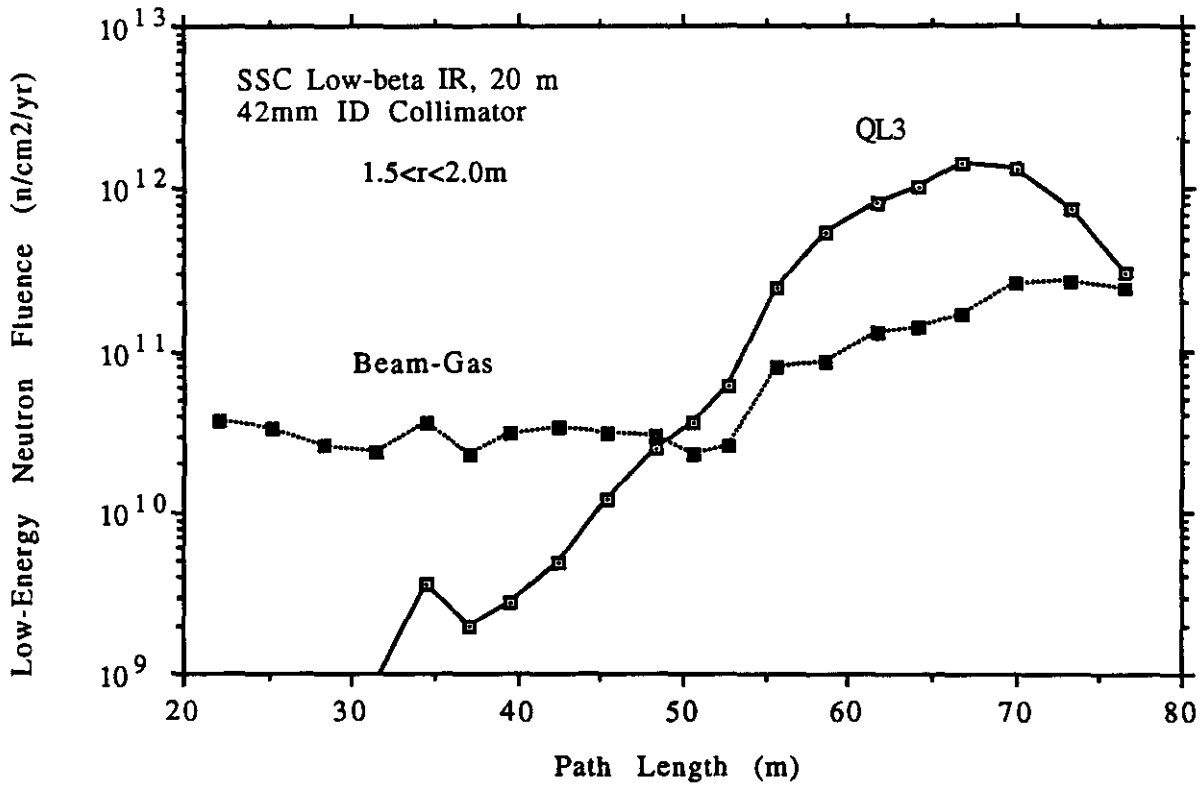

SSC Low-beta IR, 20 m
1.e15 int/yr
42mm ID Collimator
QL1 Peak
Neutrons, 0.5 eV< E <14 MeV
Hadrons, E >14 MeV
Fluence (particle/cm2/yr)
Radius (cm)
10^{15}
10^{14}
10^{13}
10^{12}
0
5
10
15
20
25
30
35
40


SSC Low-beta IR, 20 m
1.e15 int/yr
42mm ID Collimator
B=0
L=31.4 m
Neutrons, 0.5 eV< E <14 MeV
Hadrons, E >14 MeV
Fluence (particle/cm2/yr)
Radius (cm)
10^{15}
10^{14}
10^{13}
10^{12}
0
5
10
15
20
25
30
35
40


8.0e+12
6.0e+12
4.0e+12
2.0e+12
0.0e+0
Neutron Fluence (n/cm2/yr)
2<r<2.5m
SSC Low-beta IR, 20 m
1.e15 int/yr
42mm ID Collimator
3m OD, 2m Long
B=0
15
20
25
30
35
40
Path Length (m)


SSC Low-beta IR, 20 m
1.e15 int/yr
25mm ID Collimator
3m OD, 2m Long
2<r<2.5m
+ 0.5m Concrete at 18<L<20.5 m
Neutron Fluence (n/cm2/yr)
Path Length (m)
8.0e+12
6.0e+12
4.0e+12
2.0e+12
0.0e+0
15
20
25
30
35
40


SSC Low-beta IR, 20 m
1.e4 Beam-Gas
42mm ID Collimator
1.5<r<2.0m
Neutrons
Hadrons
3.0e+11
2.0e+11
1.0e+11
0.0e+0
20
30
40
50
60
70
80
Fluence (particle/cm2/yr)
Path Length (m)


SSC Low-beta IR, 20 m
42mm ID Collimator
1.5<r<2.0m
QL3
Beam-Gas
Low-Energy Neutron Fluence (n/cm2/yr)
Path Length (m)
10^13
10^12
10^11
10^10
10^9
20
30
40
50
60
70
80

BACKGROUND FROM COLLIDER

Neutron Fluence at L=20m and R=2m per the SSC year

- pp-collisions (10^{33} @ 20 m): 2×10^{12} cm^{-2}

  (can be significantly reduced @ 35 m)

- Beam-Gas (cold+10^{-8} torr in warm): 5×10^{10} cm^{-2} - (*)

  (cold+10^{-7} torr in warm): 5×10^{11} cm^{-2}

- Local Beam Loss (Normal Operation): 1×10^{9} cm^{-2}

  ("Wrong" Operation): 1×10^{12} cm^{-2}

(*) 3.5×10^{12} cm^{-2} around beam pipe

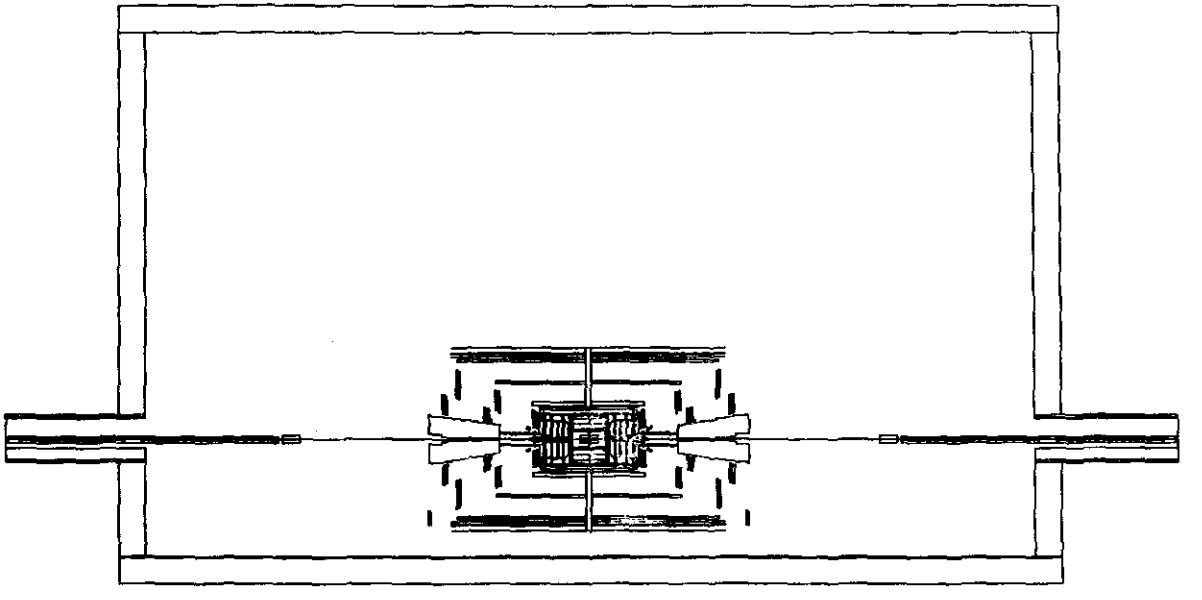
Update on Lahet Simulations

L. Waters

Laurie Waters
Neutron Task Force
1-6-92

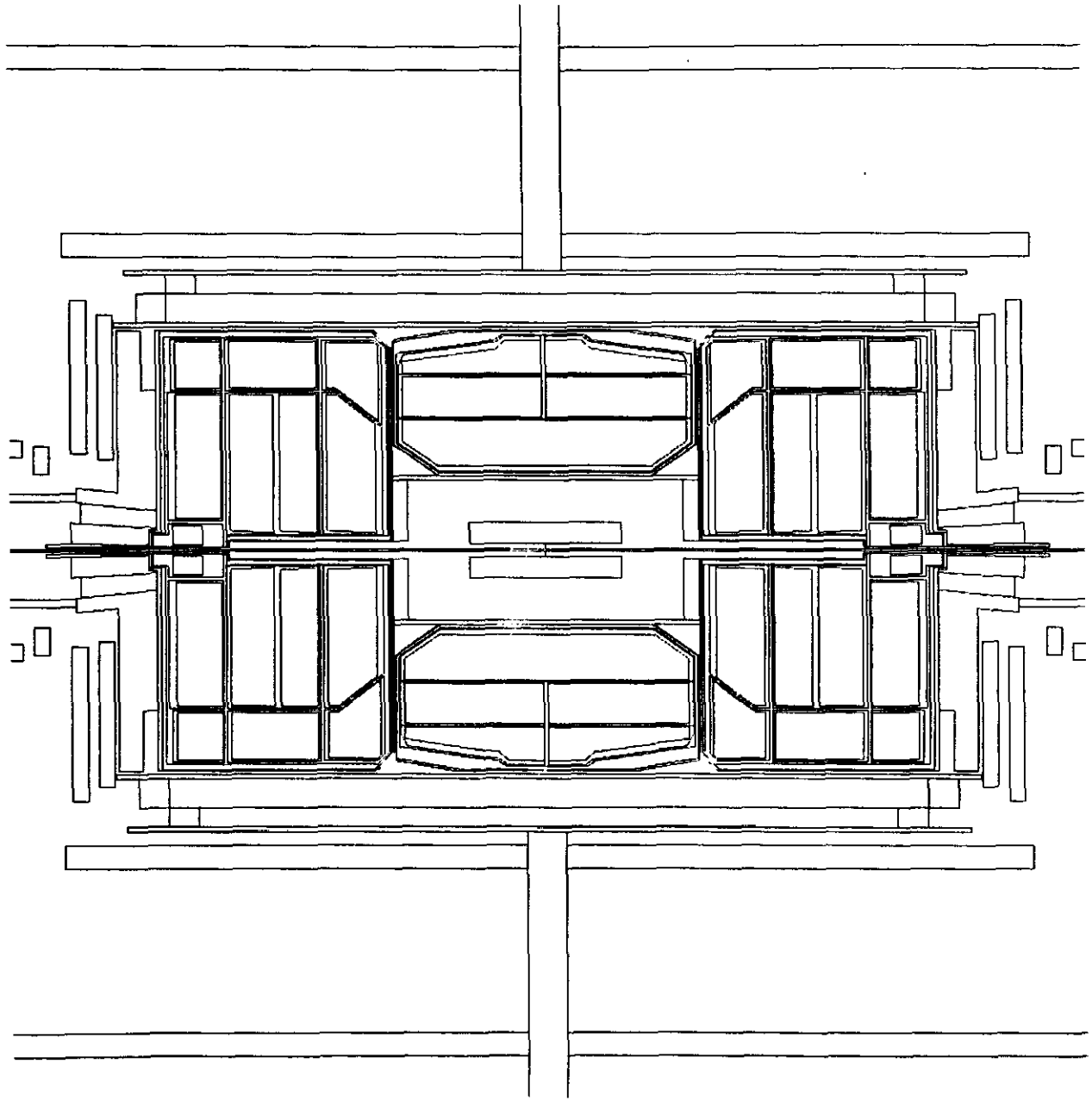
12/ 7/92 16 39 43
GEM SIMULATION FINE
SEGMENTATION

PROBID = 12/ 7/92 16 13 08
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (7000.00, 7000.00)



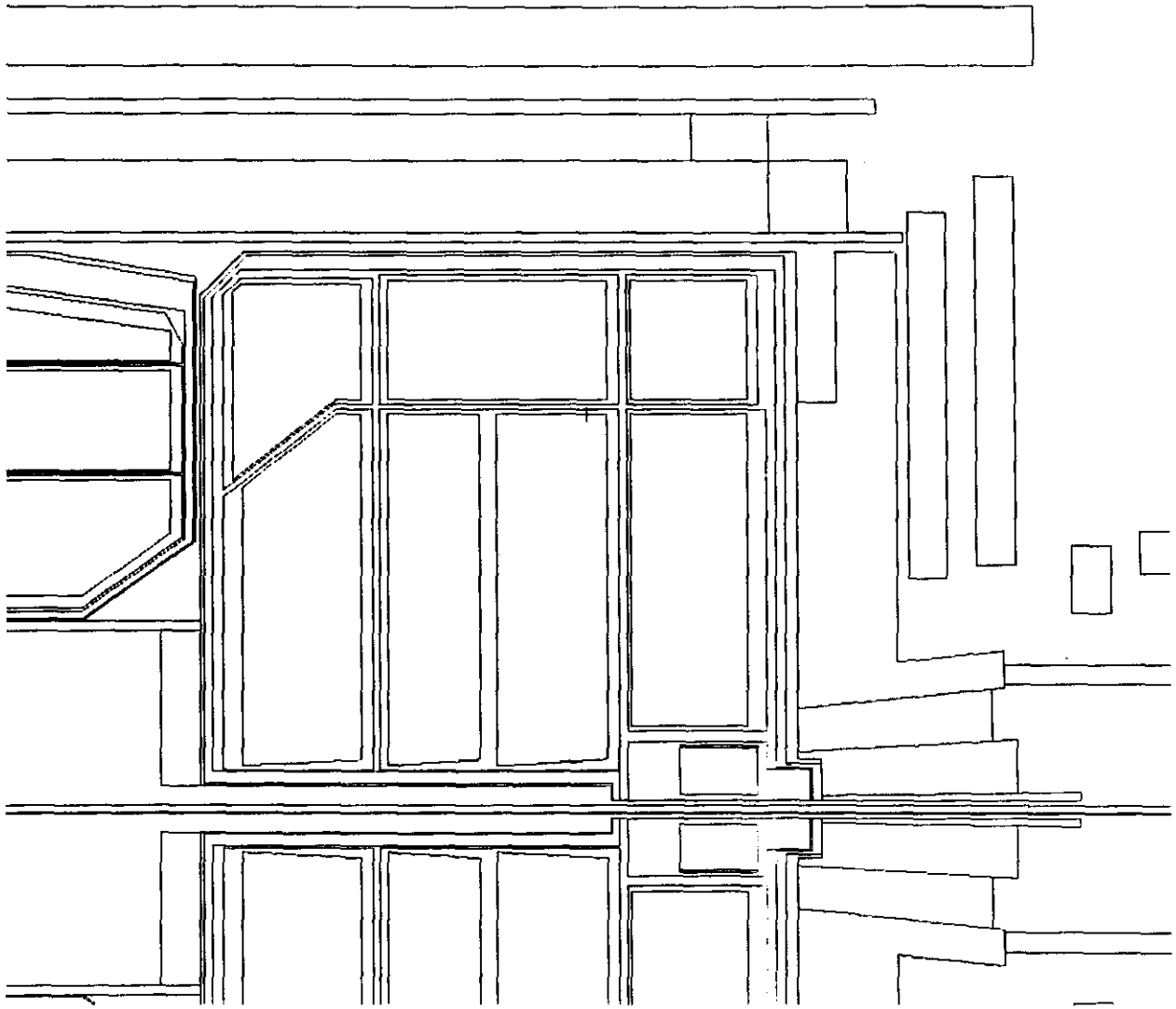
12/ 7/92 15 58 04
GEM SIMULATION FINE
SEGMENTATION

PROBID = 12/ 7/92 15 44 42
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (700.00, 700.00)



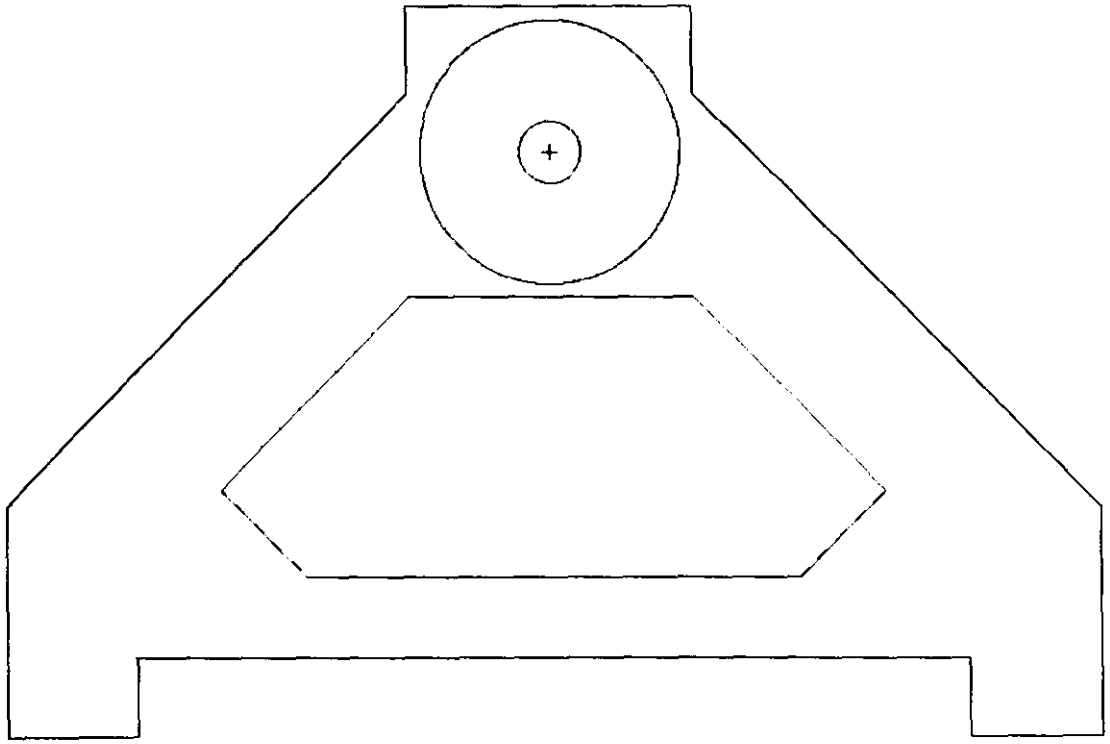
12/ 7/92 15 37 56
GEM SIMULATION FINE
SEGMENTATION

PROBID = 12/ 7/92 15 32 50
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 200.00, 400.00)
EXTENT = (300.00, 300.00)



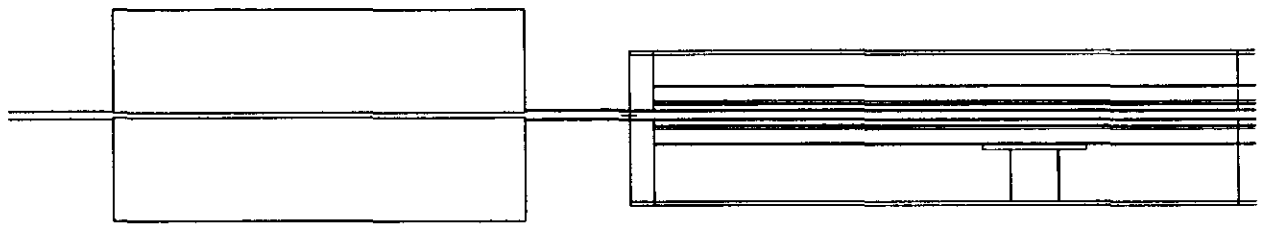
12/ 7/92 16 11 31
GEM SIMULATION FINE
SEGMENTATION

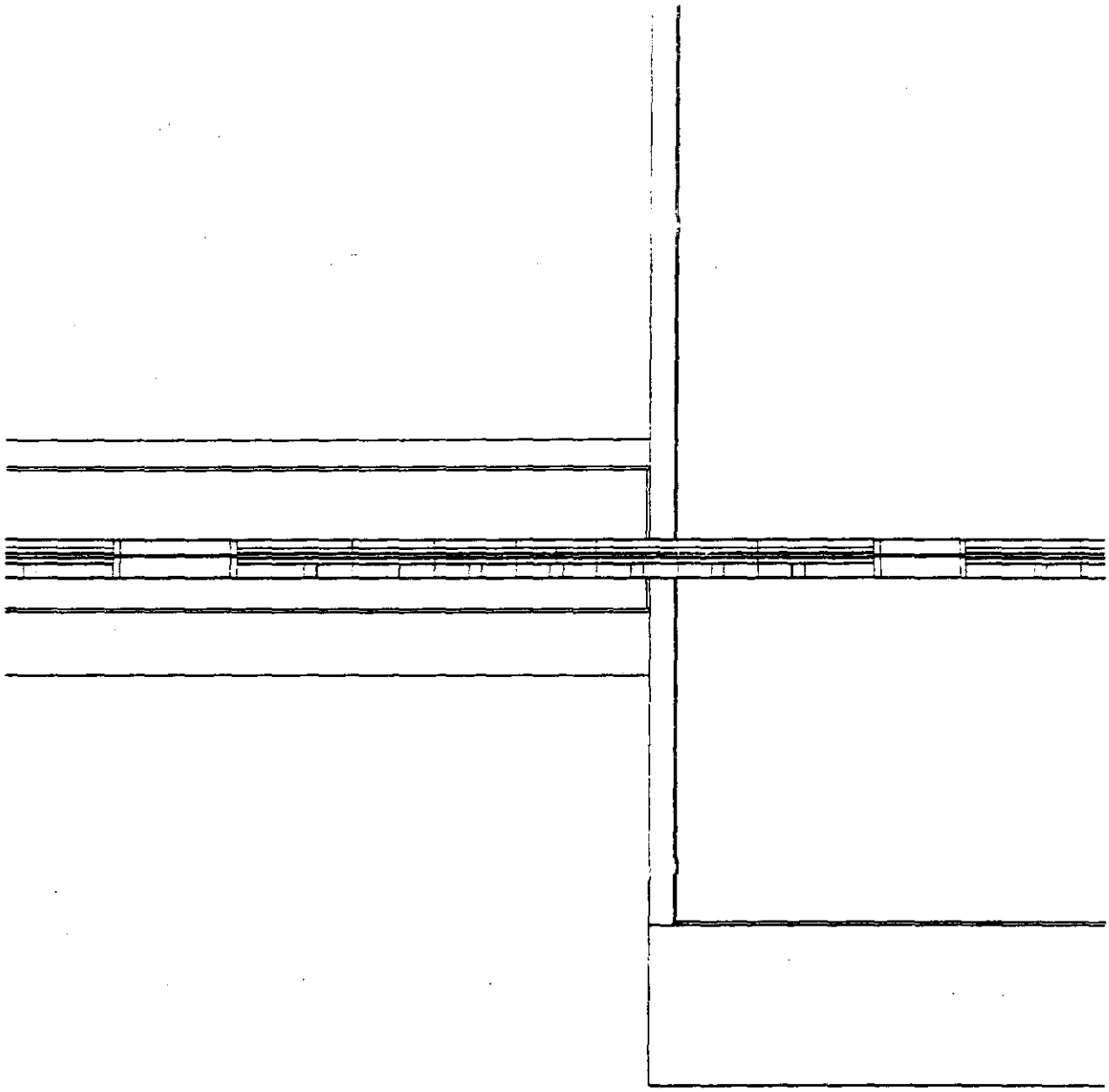
PROBID = 12/ 7/92 16 07 33
BASIS
(1.000000, 0.000000, 0.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 1799.00)
EXTENT = (1200.00, 1200.00)

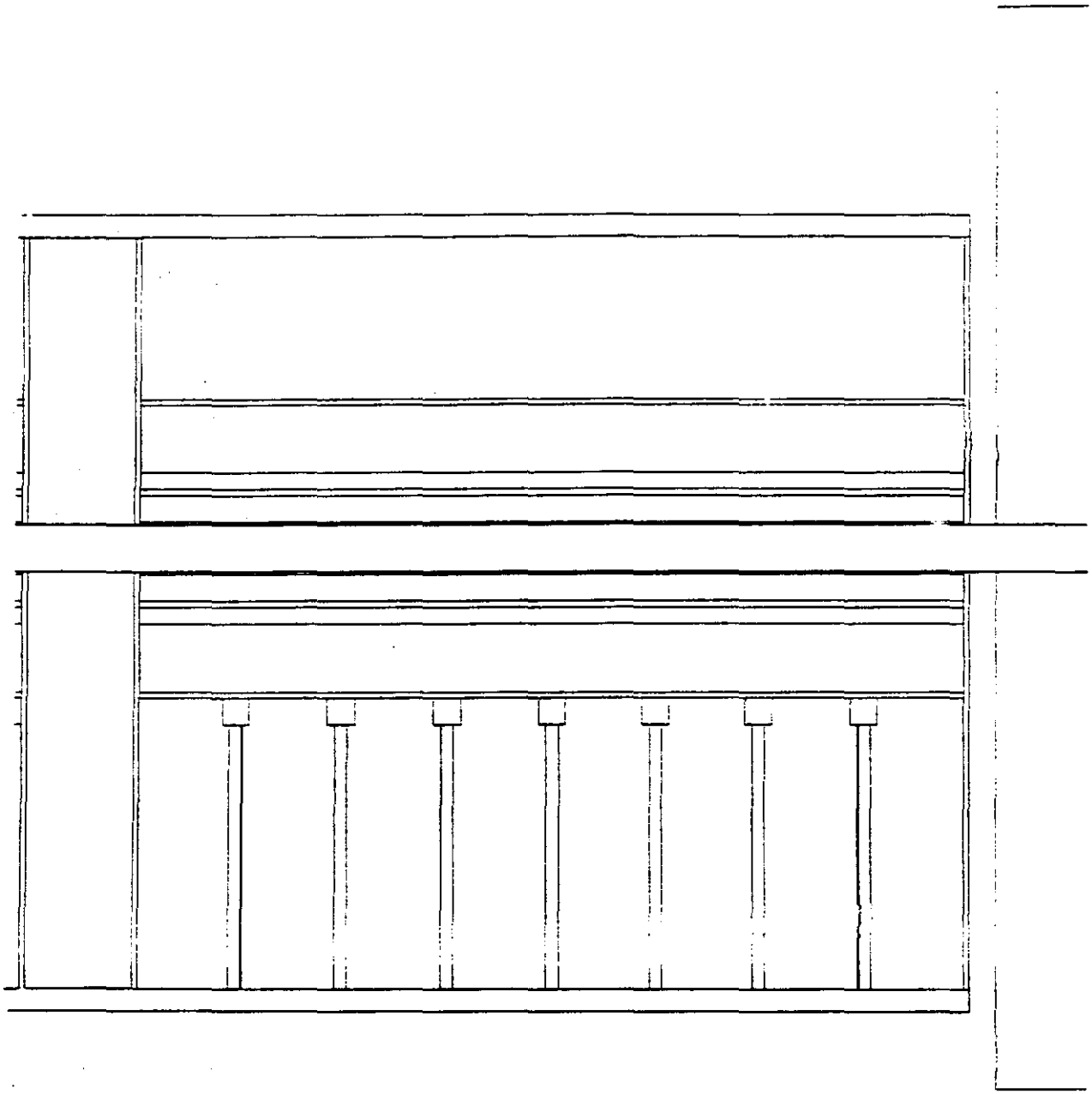


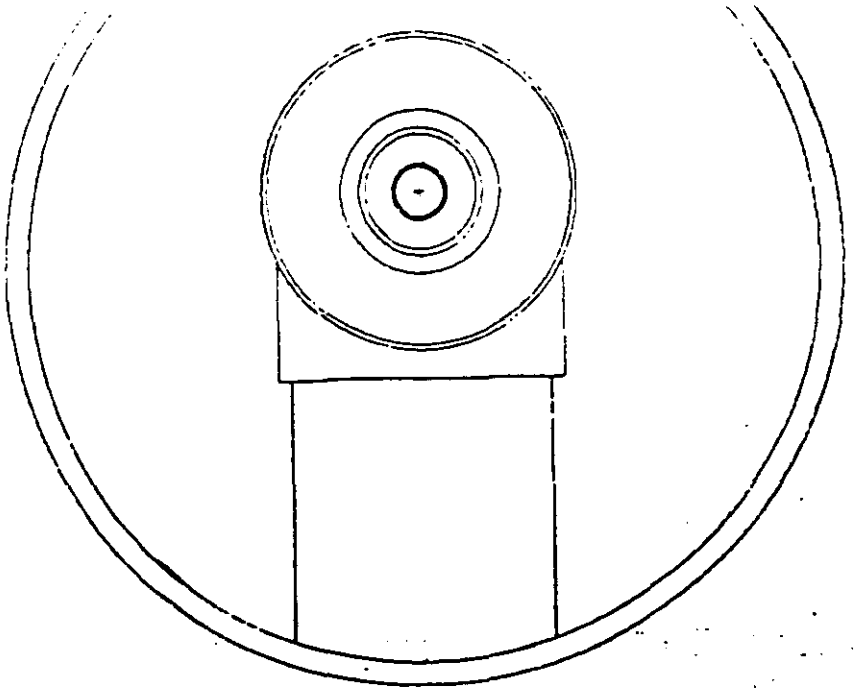
```
  12/ 7/92 15 31 25
GEM SIMULATION  FINE
 SEGMENTATION

PROBID =   12/ 7/92 15 28 48
BASIS
( 0.000000, 0.000000, 1.000000)
( 0.000000, 1.000000, 0.000000)
ORIGIN
(      0.00,      0.00,  3500.00)
EXTENT = (   300.00,   300.00)
```







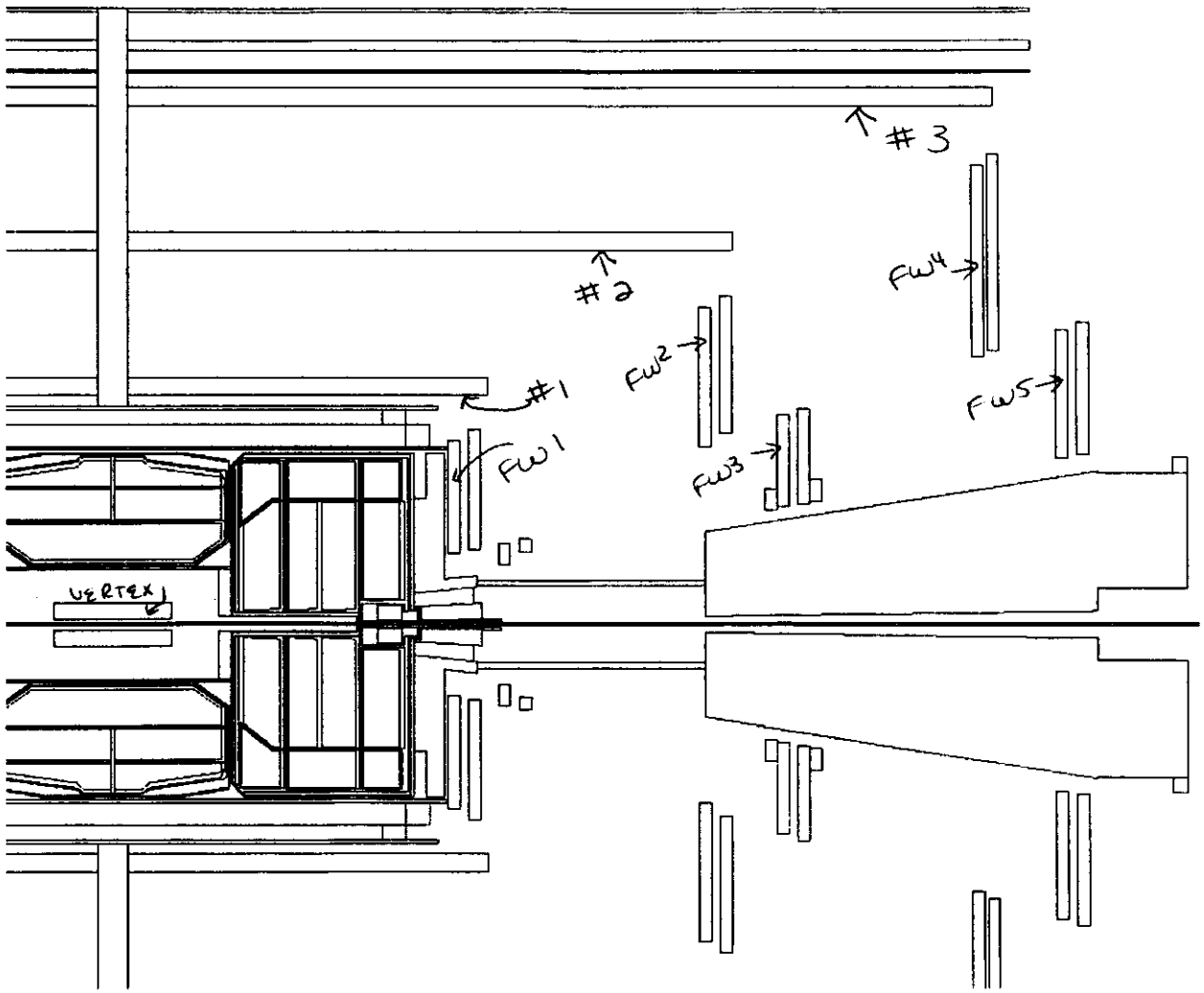


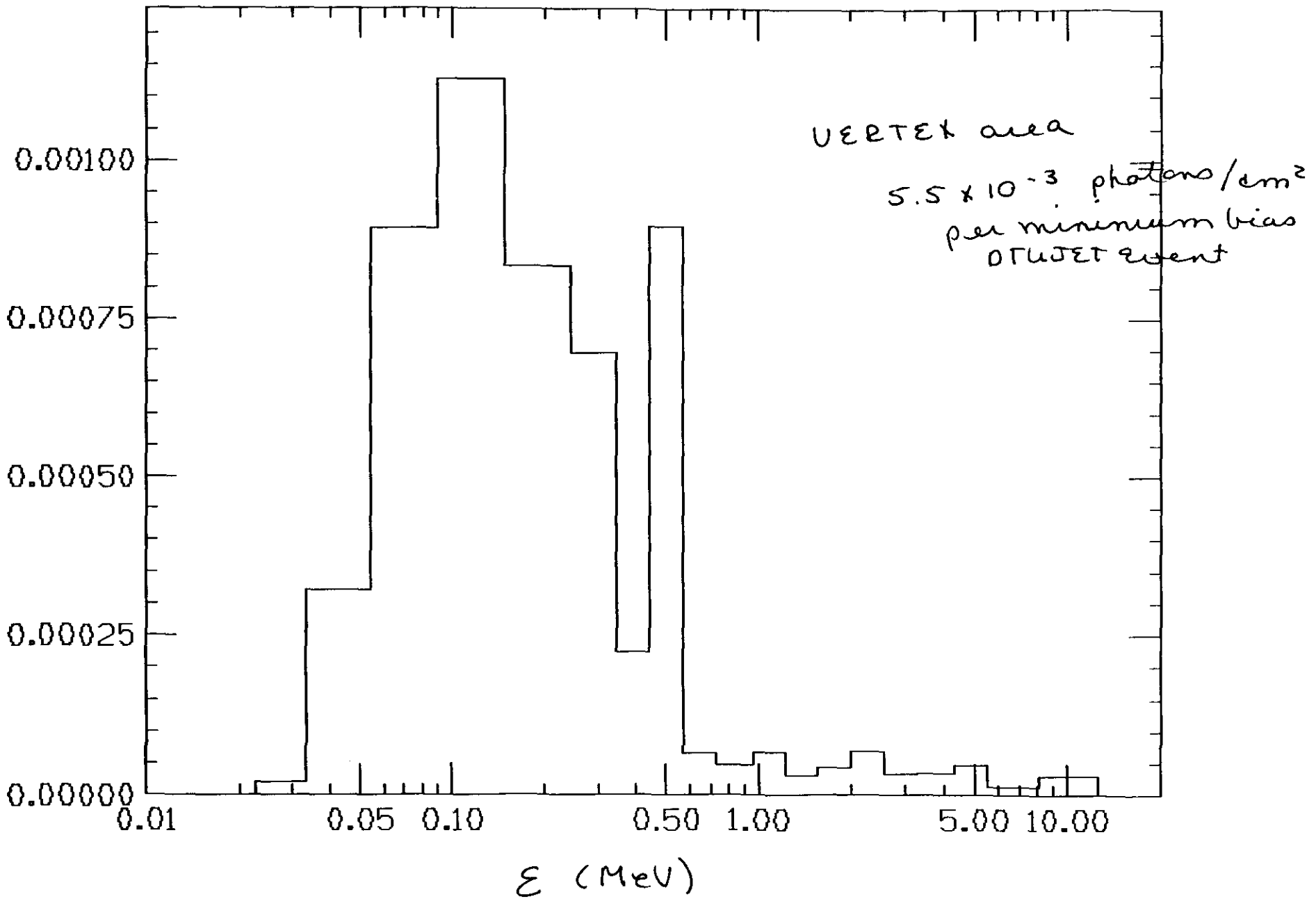
beampipe	r=2.1055 - 2.2305cm	SS304LN
liq. He	r=2.2305 - 2.485cm	liquid He^4
coil	r=2.485 - 4.936cm	24.25% Nitronic 40 .75% liquid He^4 40.6% copper 34.4% TiNb
spacer	r=4.936-5.493cm	Cartridge Brass
collar	r=5.493-7.020cm	99% Nitronic 40 1% He^4
yoke	r=7.020-13.335 cm	~ iron
shell	r=13.335-13.812 cm	SS304LN
insulation	r=13.812-34.83 cm	2.5% N_2He^4
		10.0% mylar 5.0% Aluminum 18% SS316
post	radius=12.5cm wall thickness 1.6cm	Aluminum
cradle	50 cm long	SS316
cryostat	34.83 - 36.83	SS316

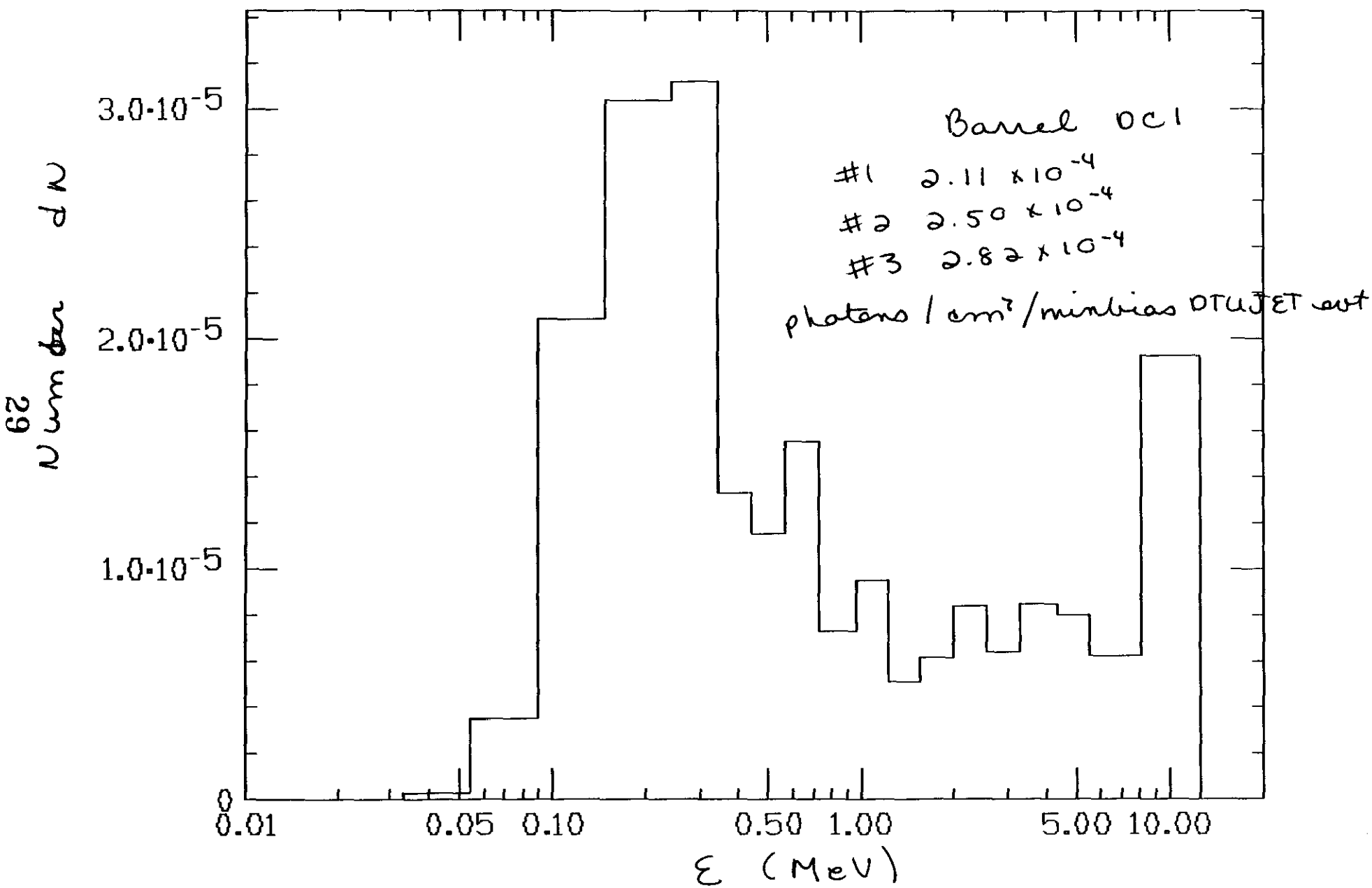
Table 1: Note the cold mass sits 6 cm above the center of the cryostat wall. All percents are by volume.

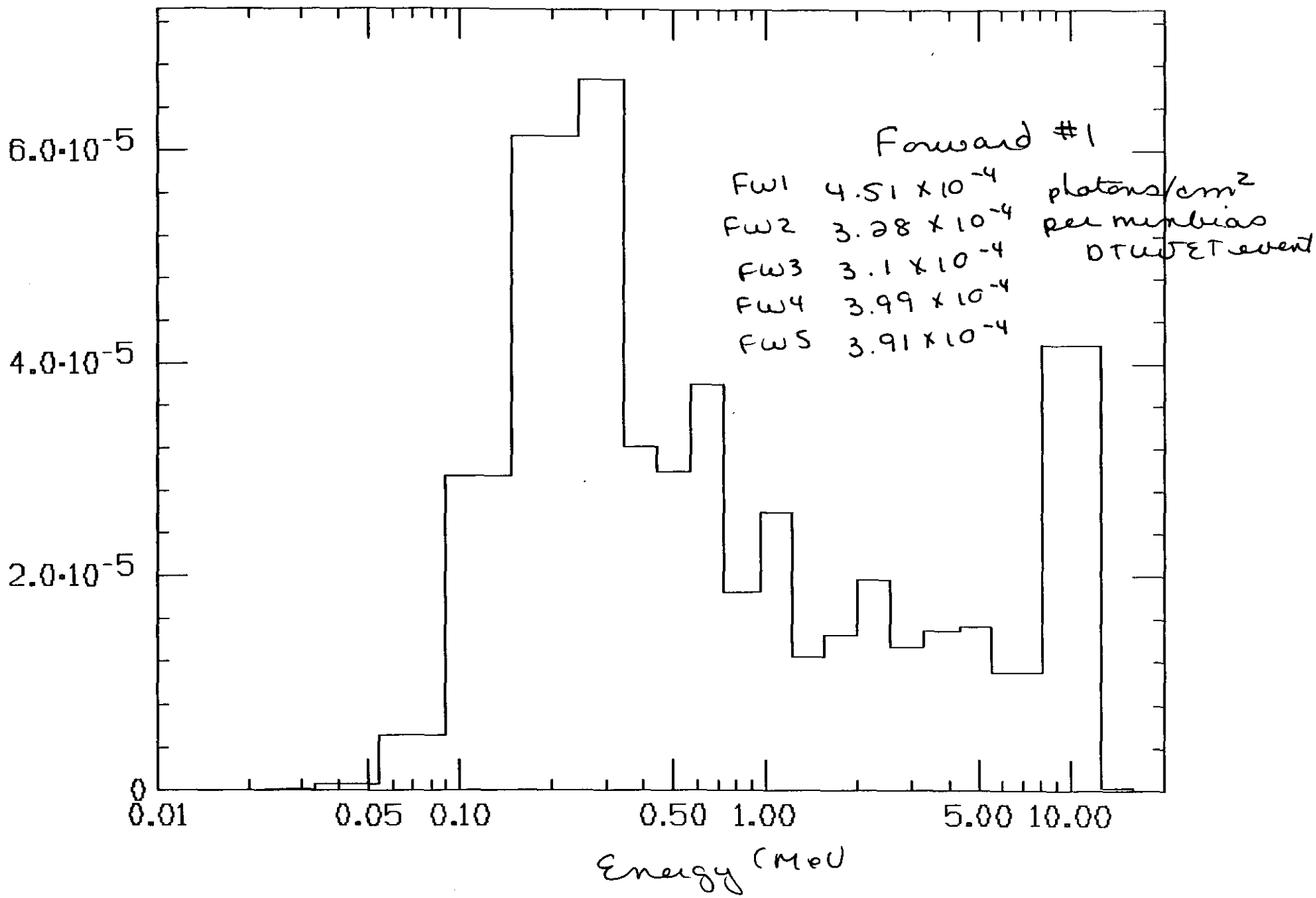
12/ 7/92 15 25 16
GEM SIMULATION FINE
SEGMENTATION

PROBID = 12/ 7/92 15 12 33
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 400.00, 820.00)
EXTENT = (1000.00, 1000.00)




VERTEX area
5.5 x 10^-3 photons/cm^2
per minimum bias
DTUJET event
0.00100
0.00075
0.00050
0.00025
0.00000
0.01
0.05
0.10
0.50
1.00
5.00
10.00
ε (MeV)


Barrel OC1
#1 2.11 x10^-4
#2 2.50 x10^-4
#3 2.82 x10^-4
photons / cm² / minbias DTUJET evt
3.0·10^-5
2.0·10^-5
1.0·10^-5
0
0.01
0.05
0.10
0.50
1.00
5.00
10.00
ε (MeV)
dN/dε

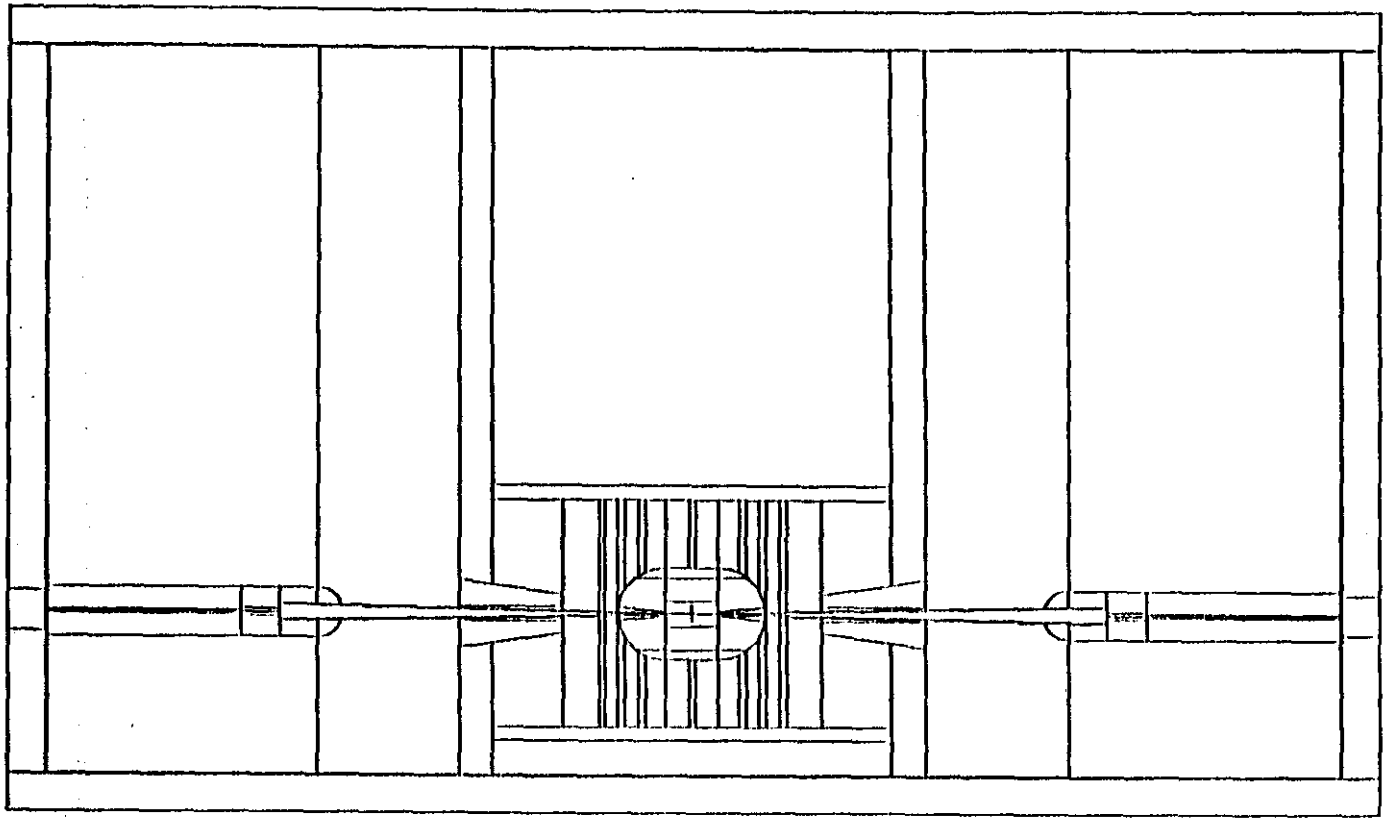

Forward #1
FW1 4.51 x 10^-4
FW2 3.28 x 10^-4
FW3 3.1 x 10^-4
FW4 3.99 x 10^-4
FW5 3.91 x 10^-4
photons/cm^2 per minbias DTWJET event
6.0·10^-5
4.0·10^-5
2.0·10^-5
0
0.01
0.05
0.10
0.50
1.00
5.00
10.00
Energy (MeV)

Shielding Strategies

V. Morgunov

12/ 8/92 13 45 45
GEM SIMPLEST VERSION SECOND
EXAMPLE

PROBID = 12/ 8/92 13 44 21
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (5500.00, 5500.00)



```
 12/ 8/92 13 44 48
 GEM SIMPLEST VERSION SECOND
 EXAMPLE

PROBID =   12/ 8/92 13 44 21
BASIS
( 0.000000, 0.000000, 1.000000)
( 0.000000, 1.000000, 0.000000)
ORIGIN
(     0.00,      0.00,      0.00)
EXTENT = (  2000.00,   2000.00)

.

COMMAND INPUT IS NOW BEING SWITCHED FROM FILE C.C
   TO YOUR TERMINAL.
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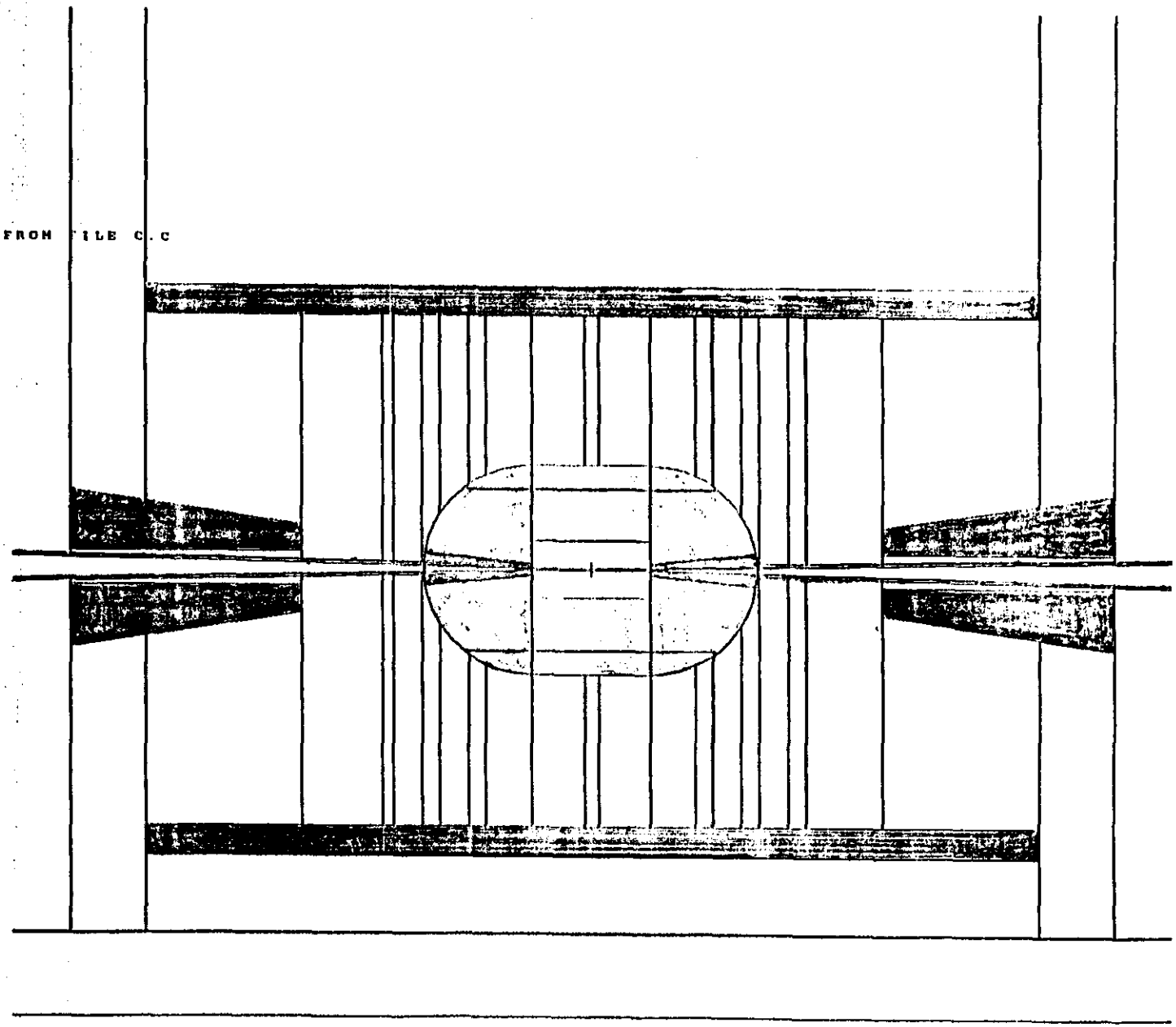
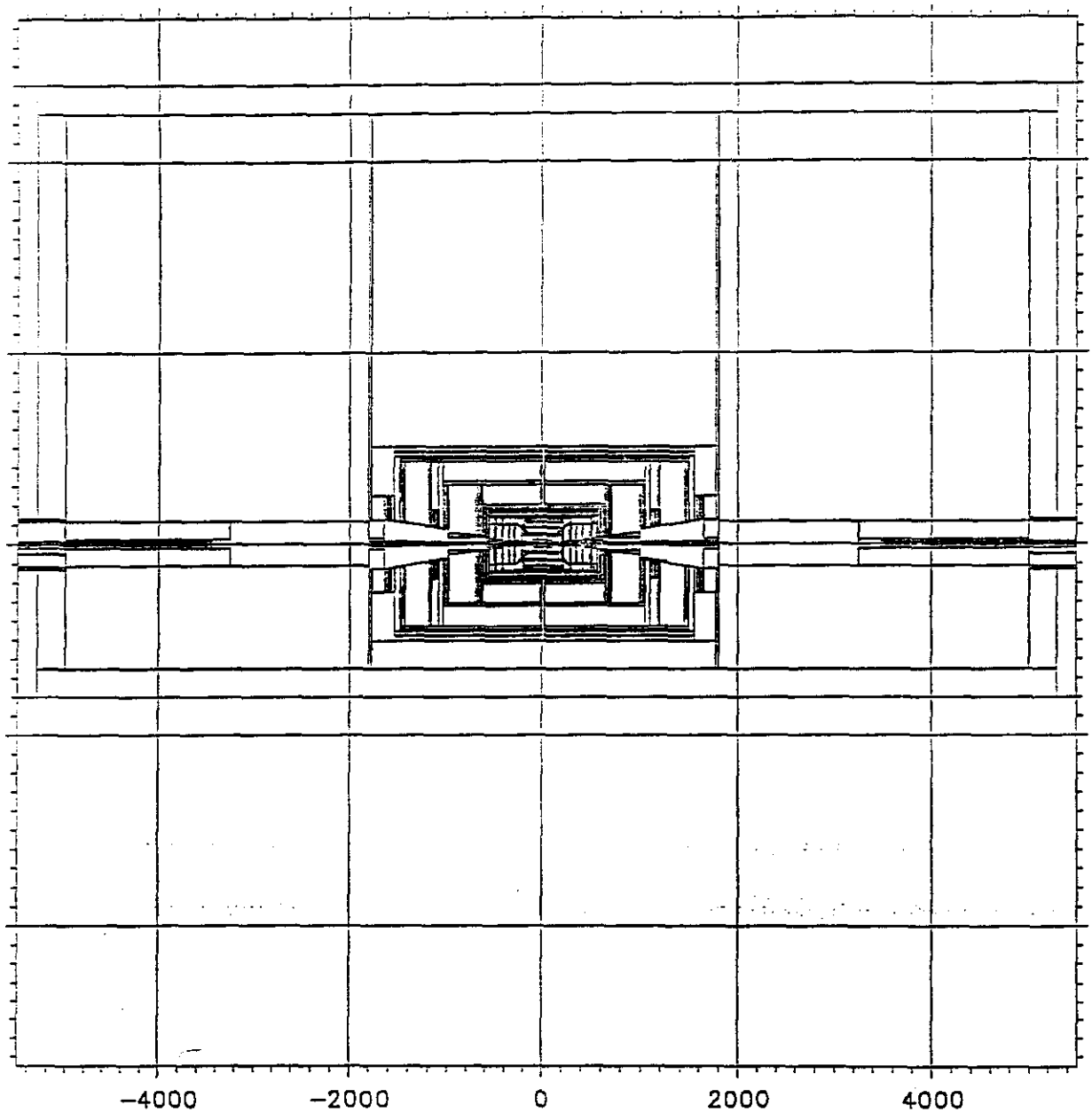
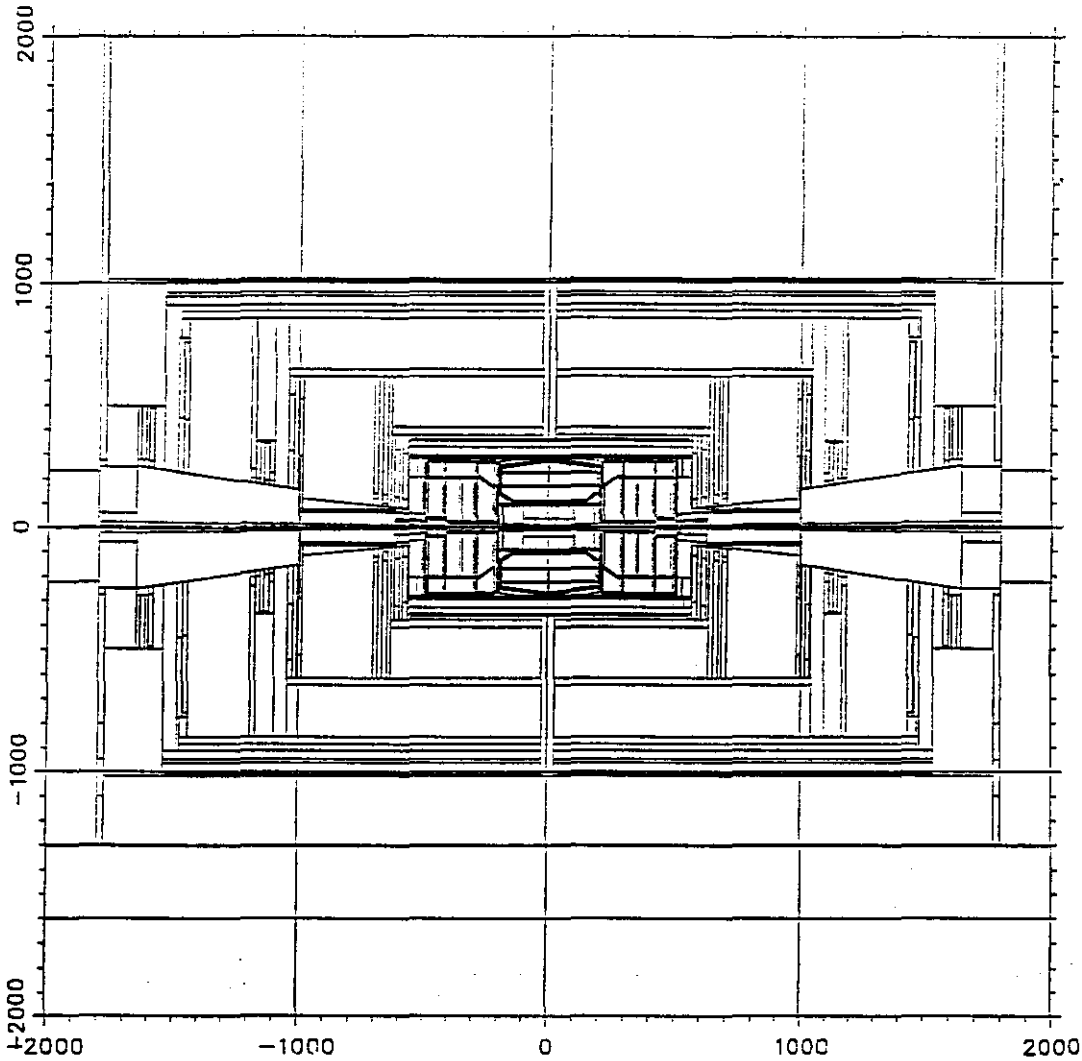



-4000
-2000
0
2000
4000

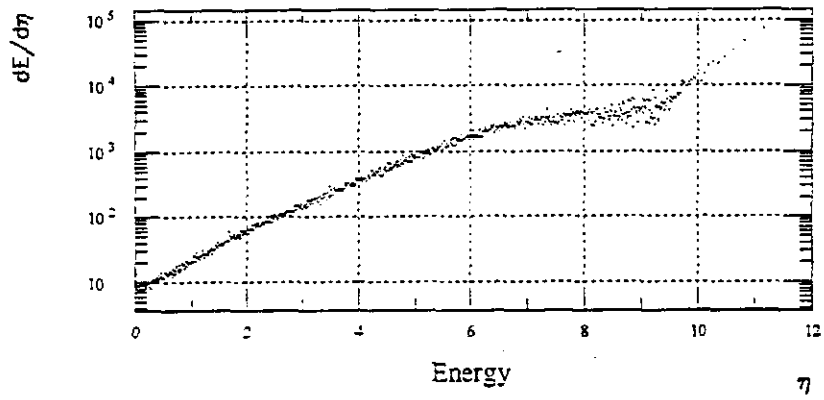
12/10/92 20 12 47
DEA SIMULATION FINE
SEGMENTATION

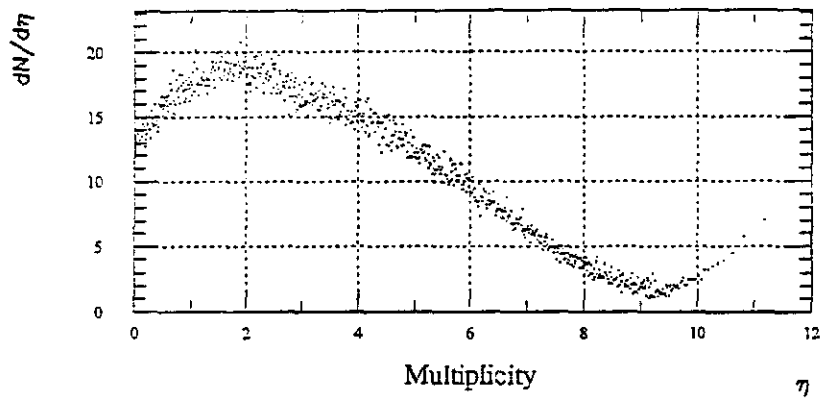
PROB_D = 12/10/92 20 05 17
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (2000.00, 2000.00)

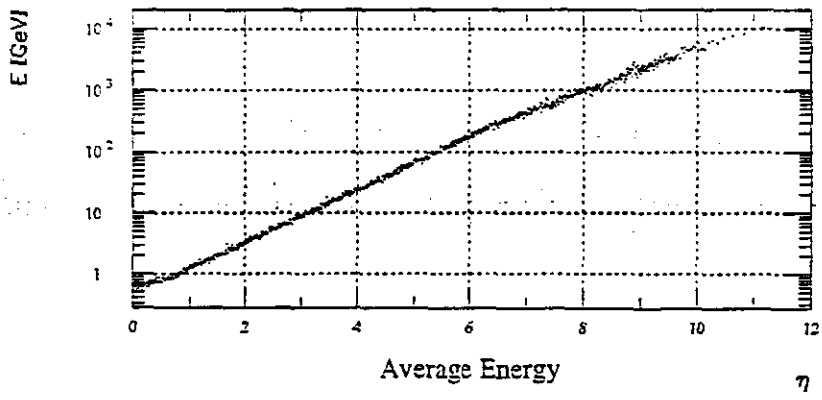


93/01/02 16.29

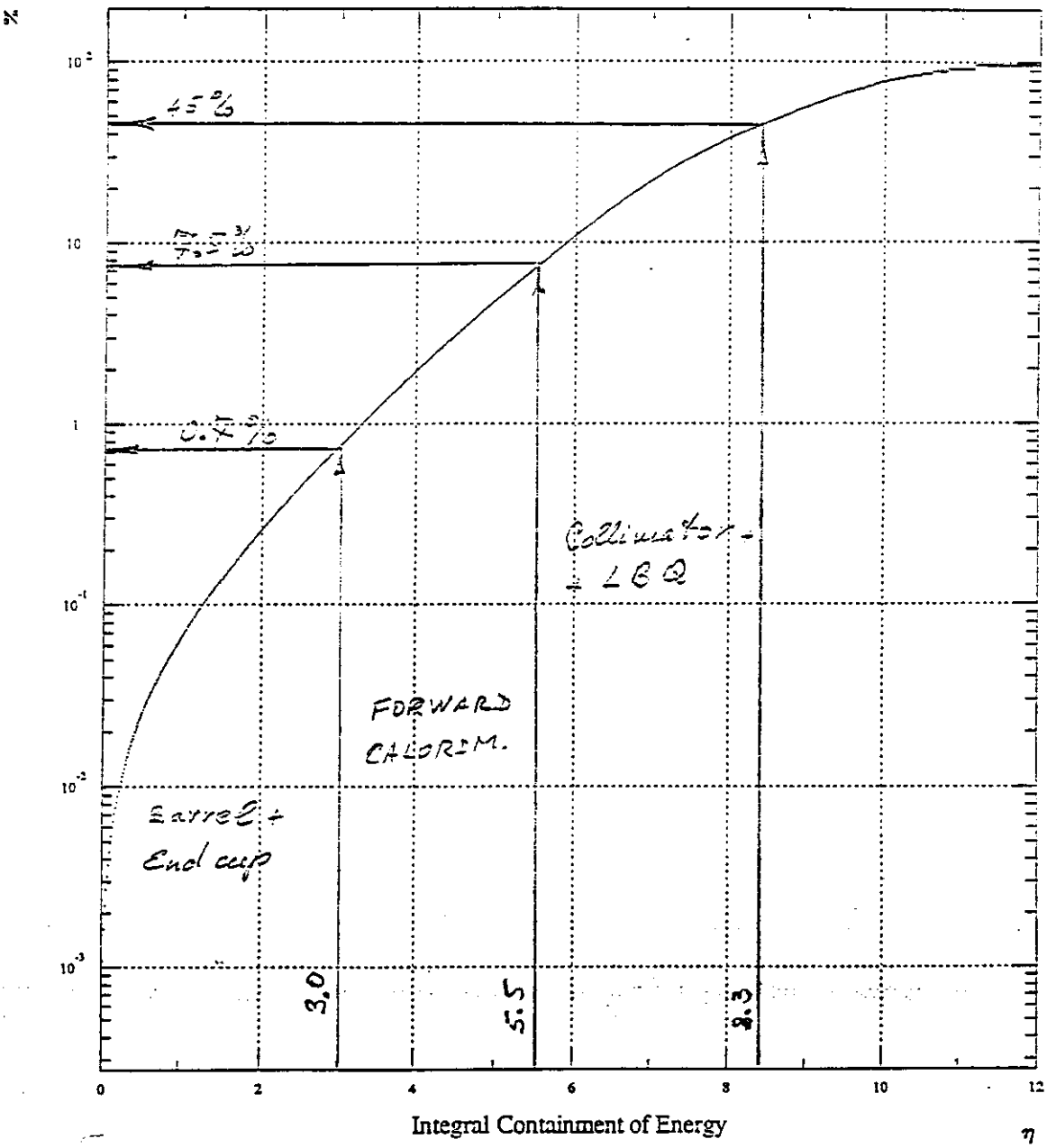
DTUJET Minibias Event

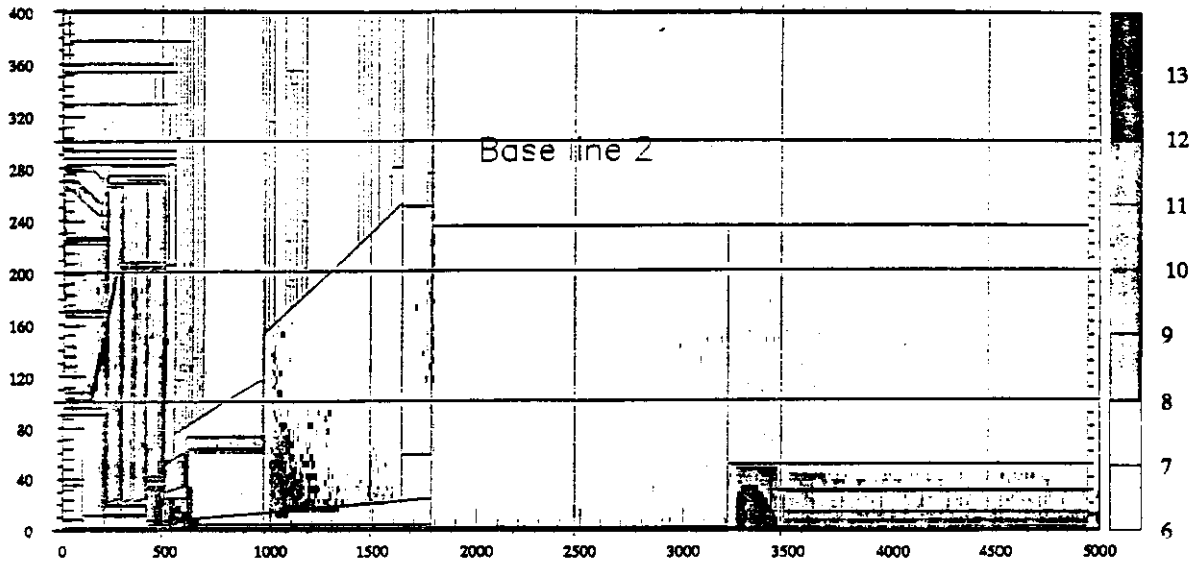




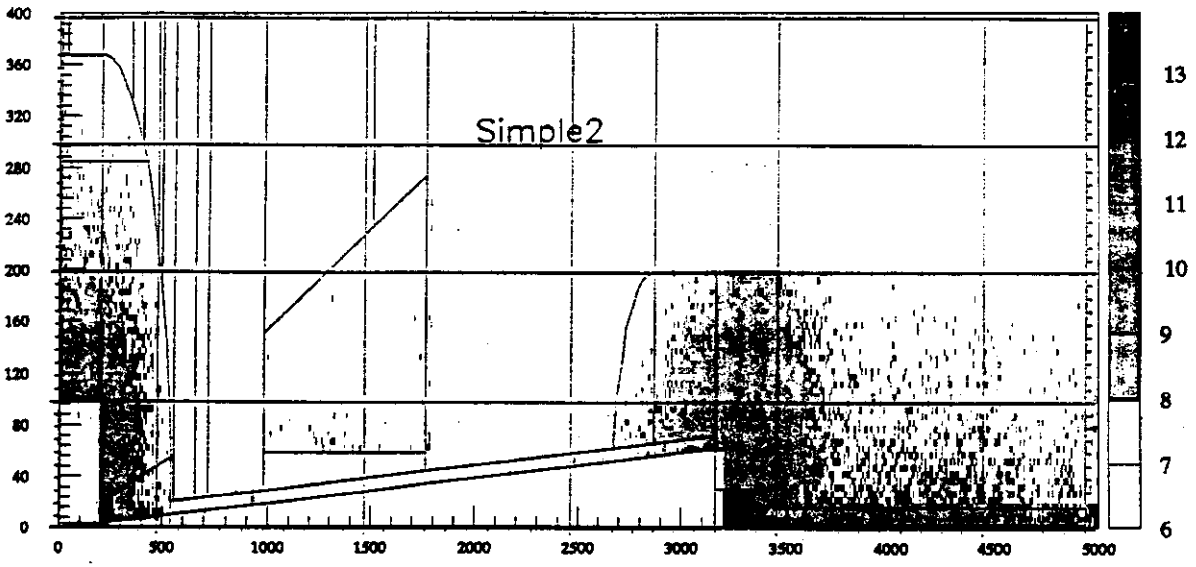


DTUJET Minibias Event

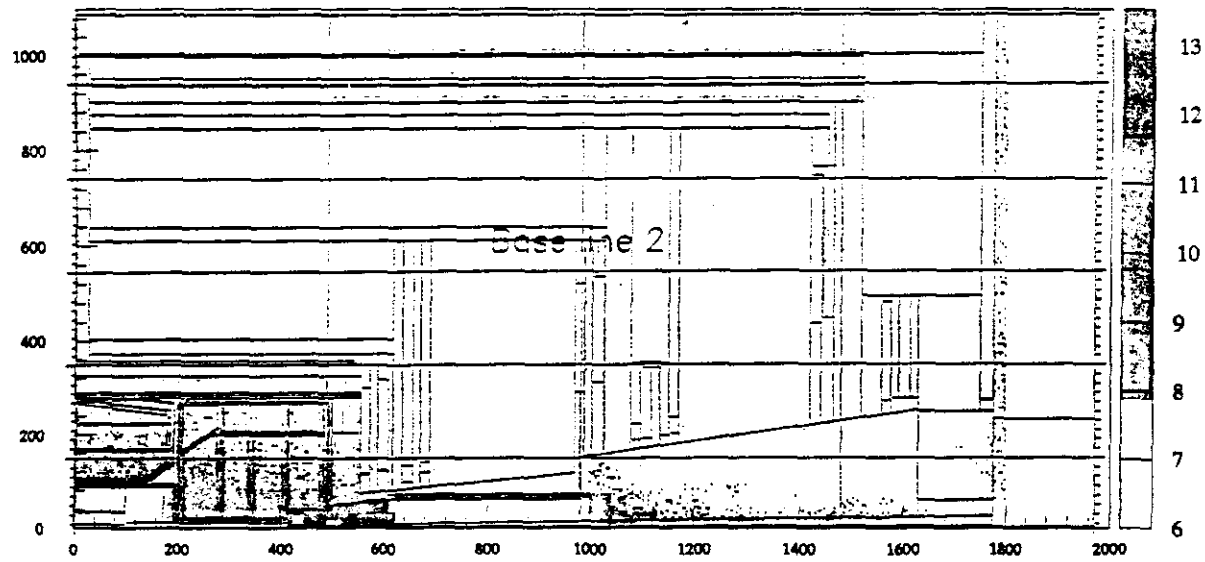




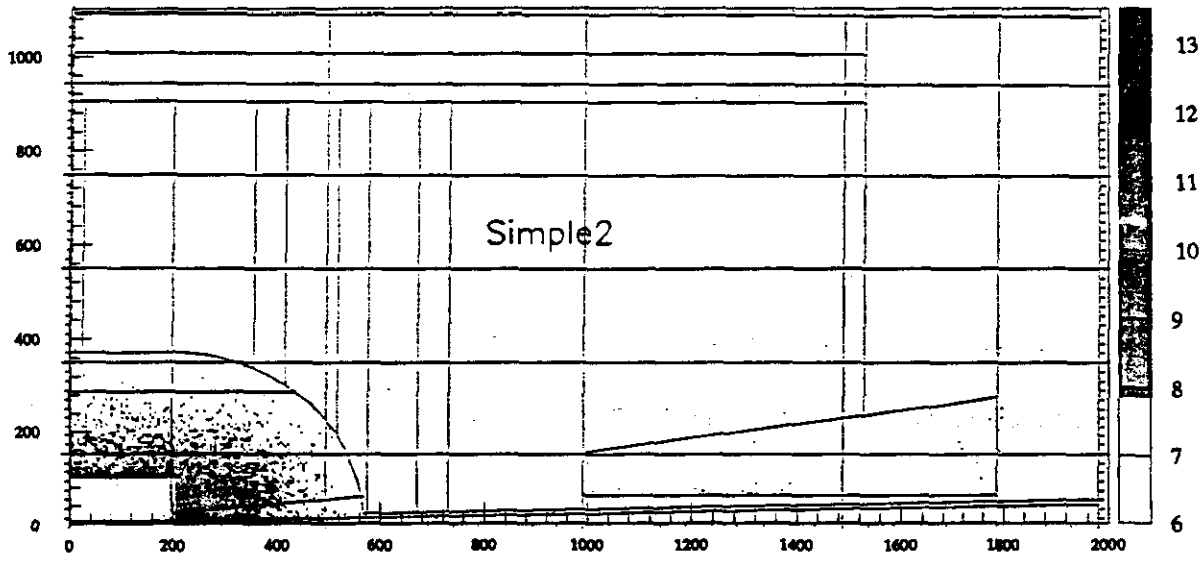
NEUTRON ORIGINS DISTRIBUTION



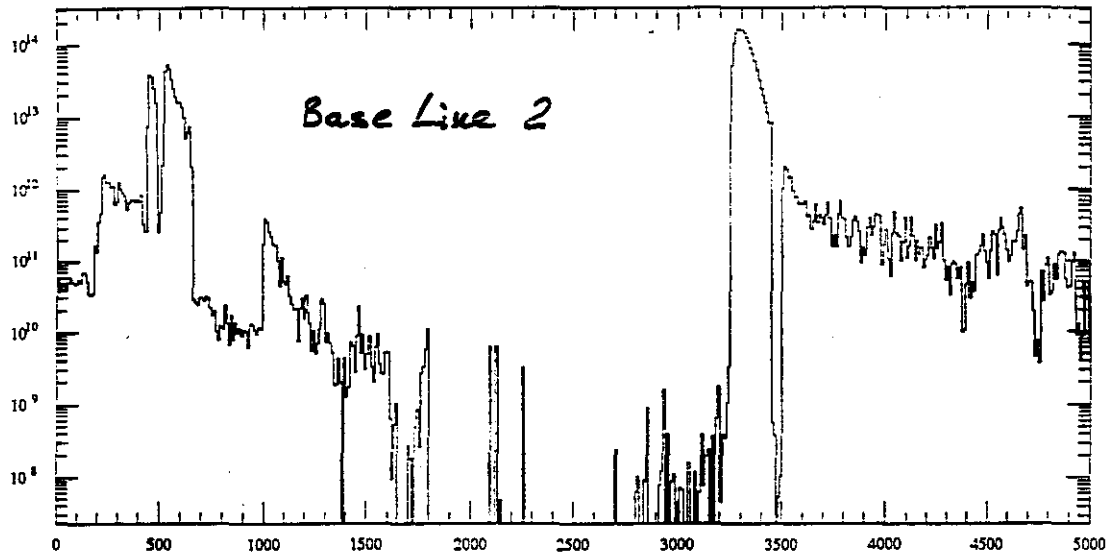
NEUTRON ORIGINS DISTRIBUTION



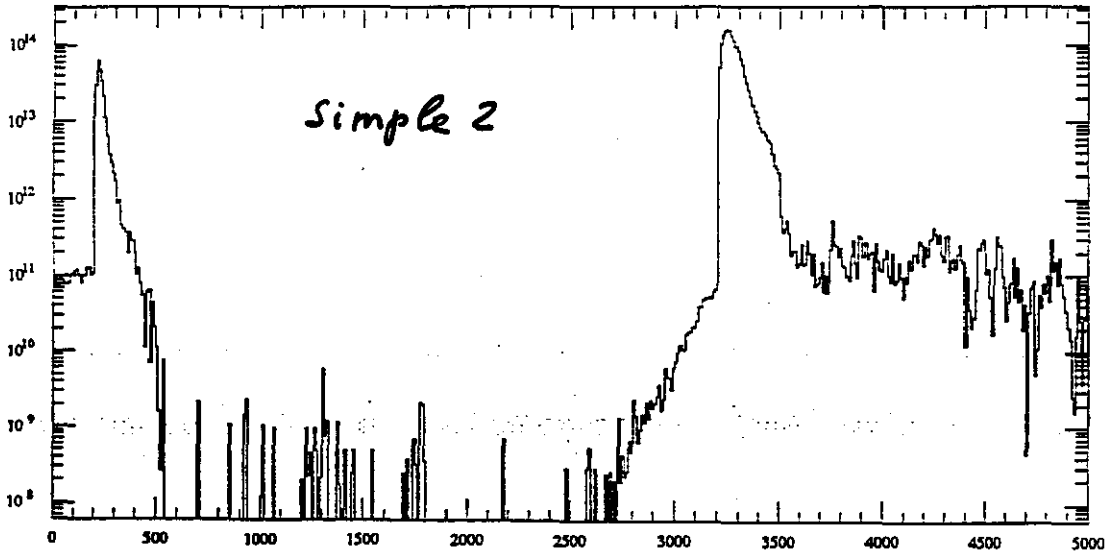
NEUTRON ORIGINS DISTRIBUTION



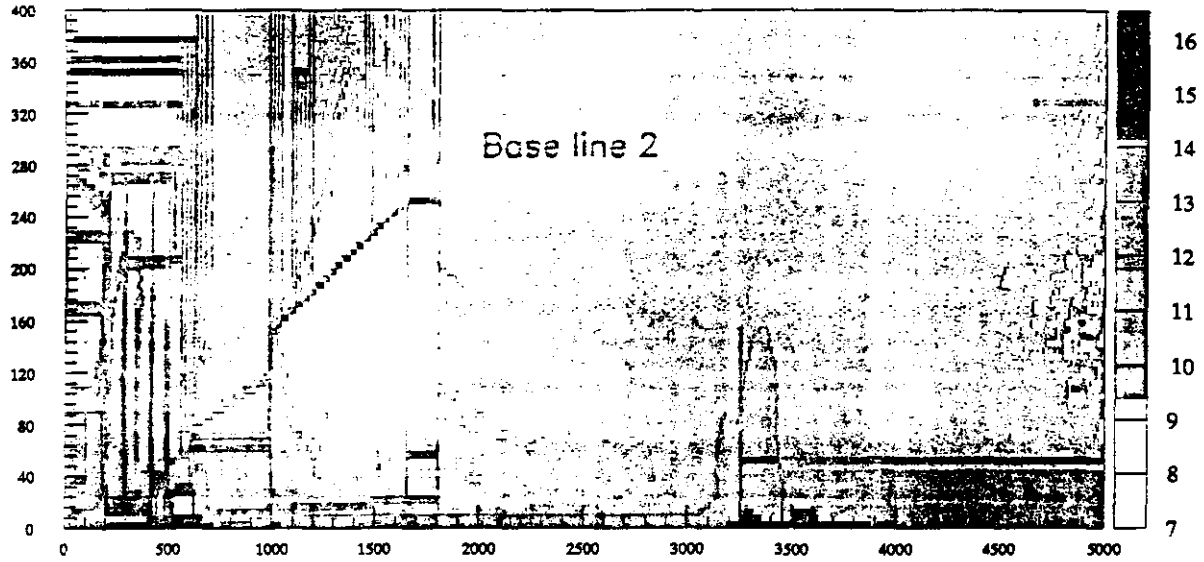
NEUTRON ORIGINS DISTRIBUTION



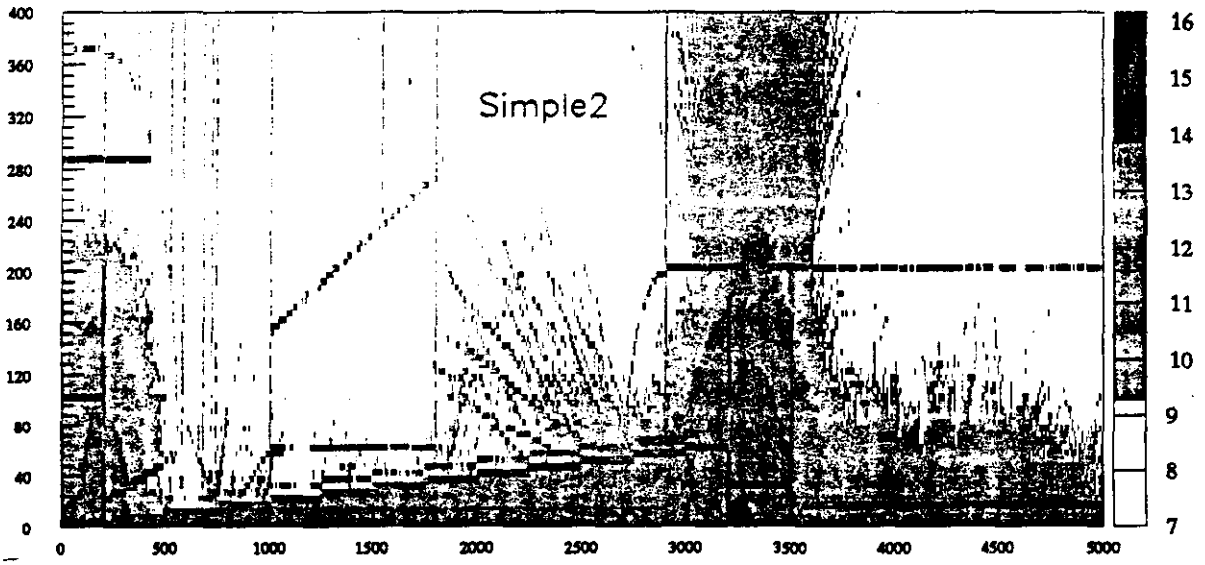
Linear neutron origins density



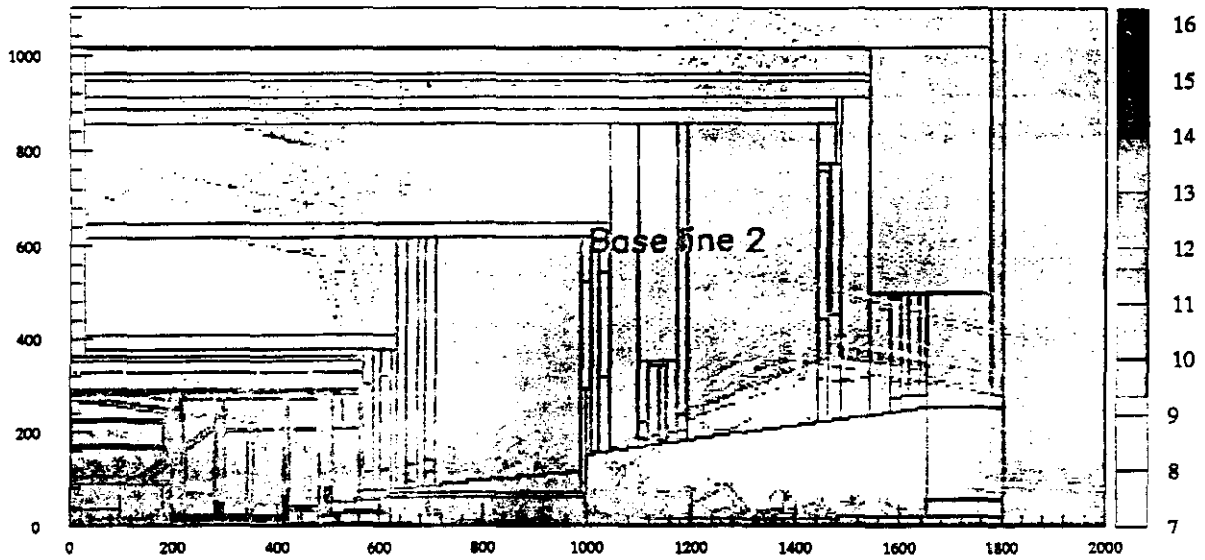
Linear neutron origins density



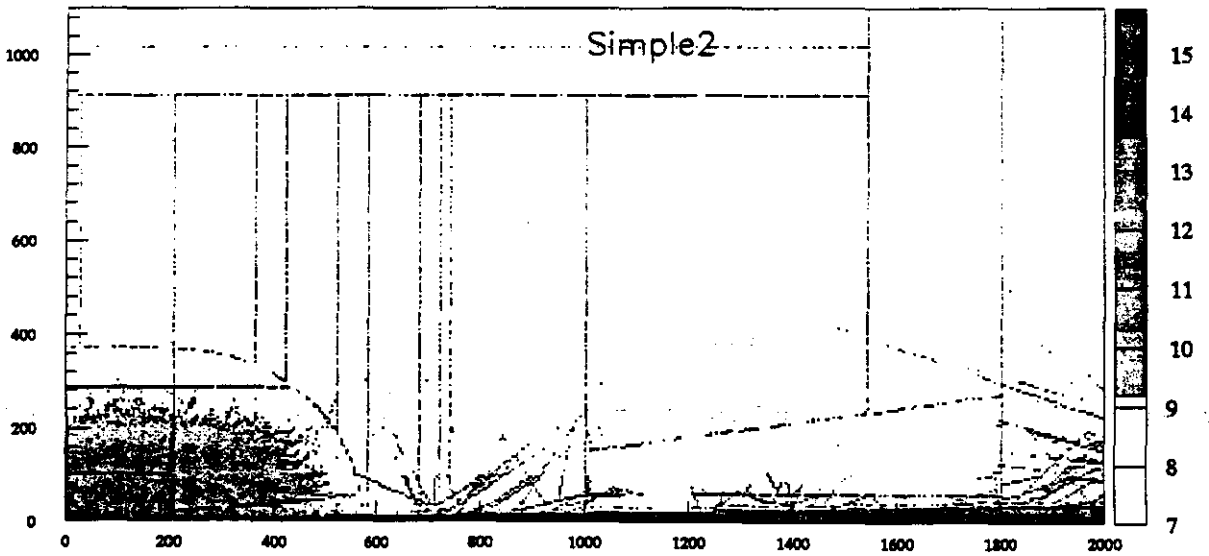
Neutron flux density



NEUTRON FLUX DENSITY

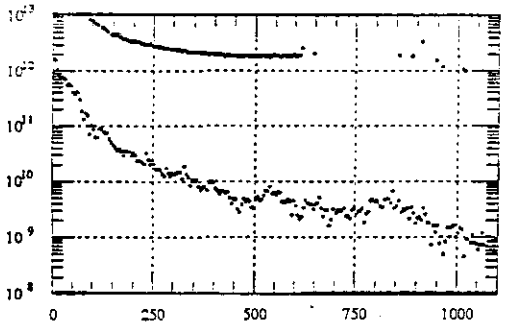


Neutron flux density

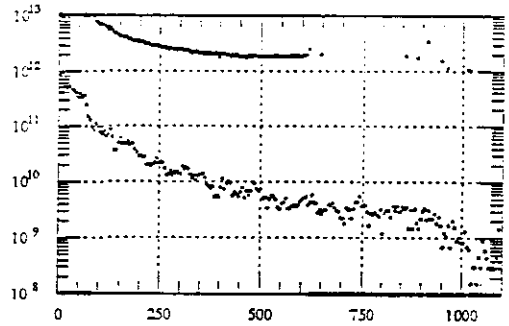


NEUTRON FLUX DENSITY

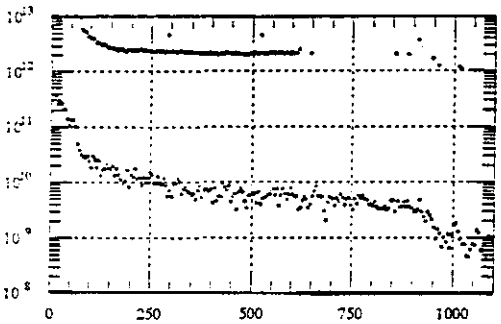
Neutron Flux Density Baseline2



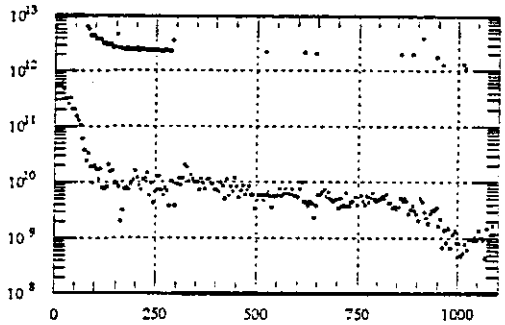
z=685cm



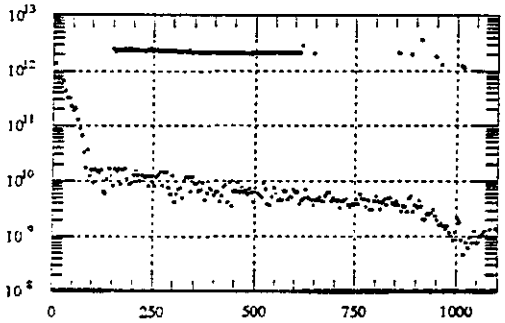
z=705cm



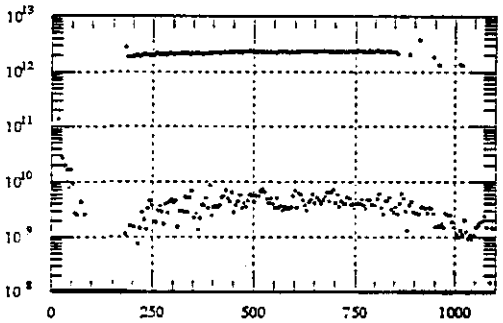
z=985cm



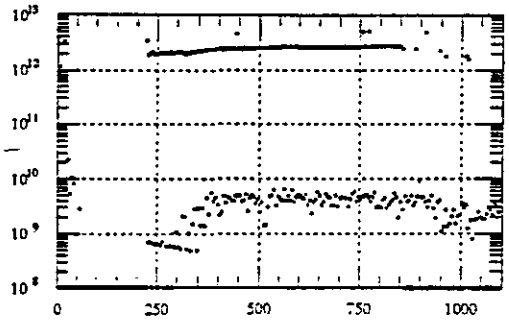
z=996cm



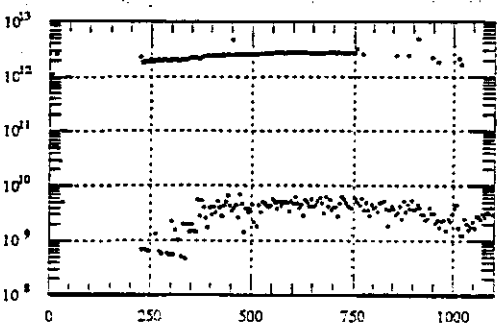
z=1005cm



z=1190cm

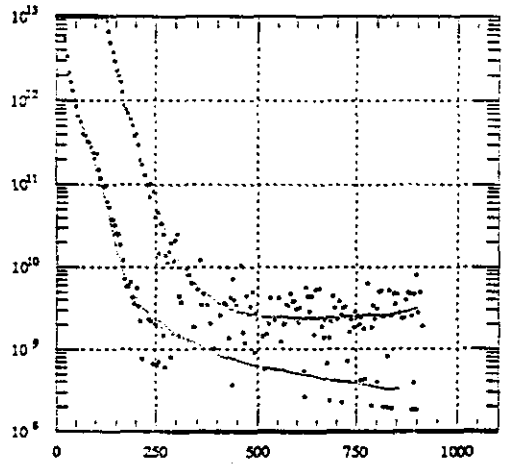


z=1440cm

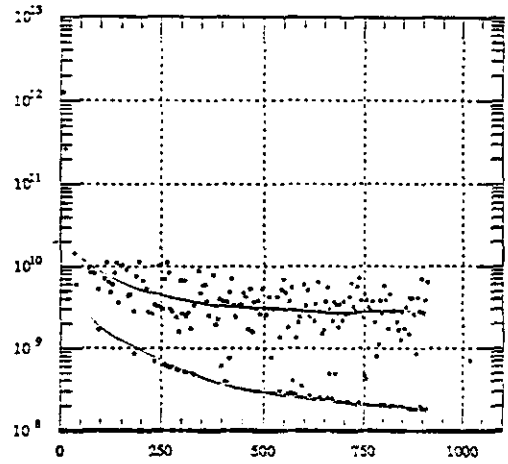


z=1460cm

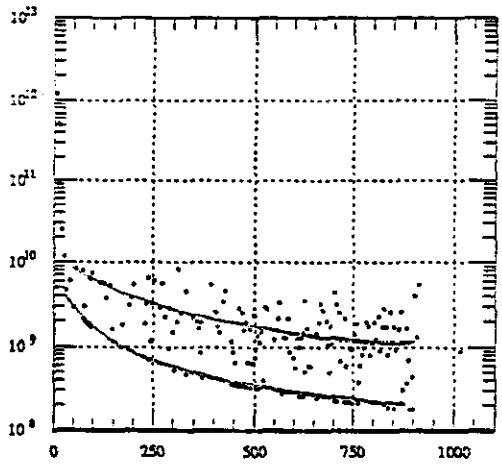
Neutron Flux Density Simple 2



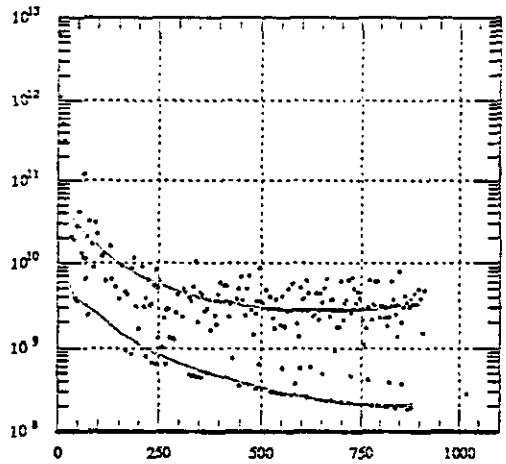
z=205cm



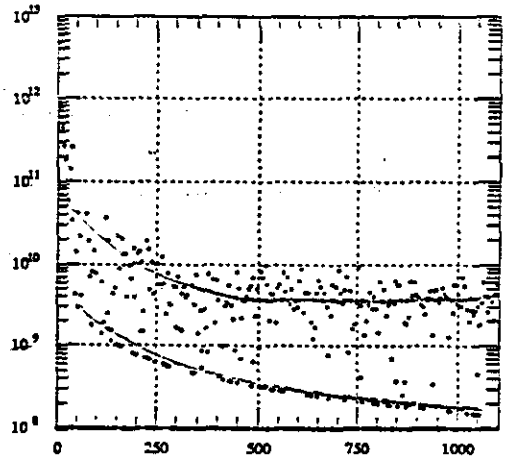
z=580cm



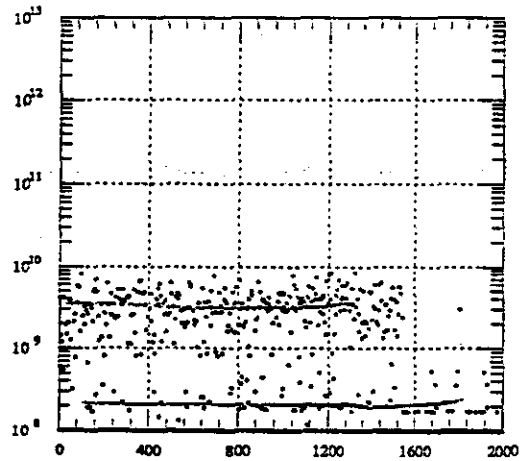
z=740cm



z=1000cm

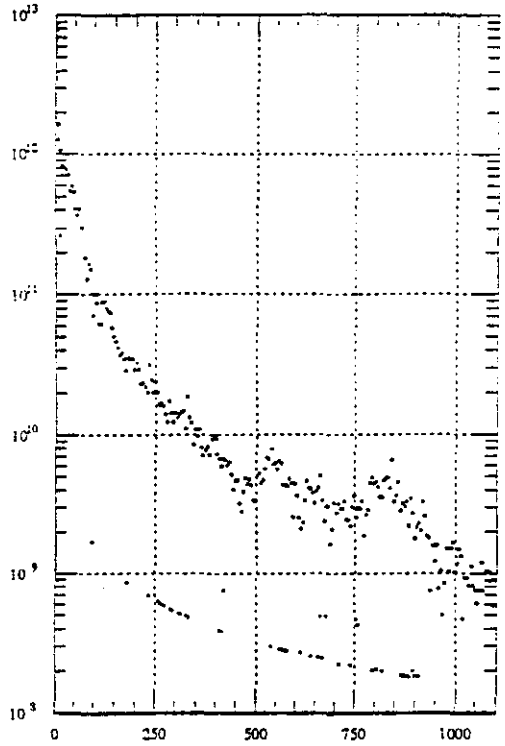


z=1800cm

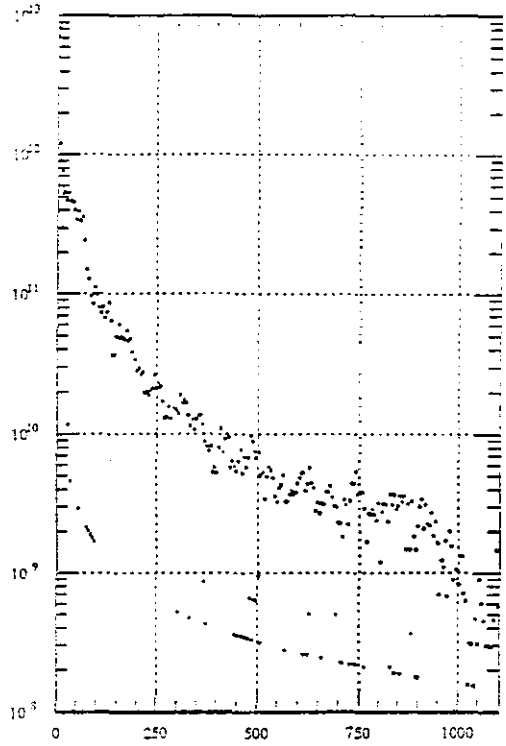


r=910cm

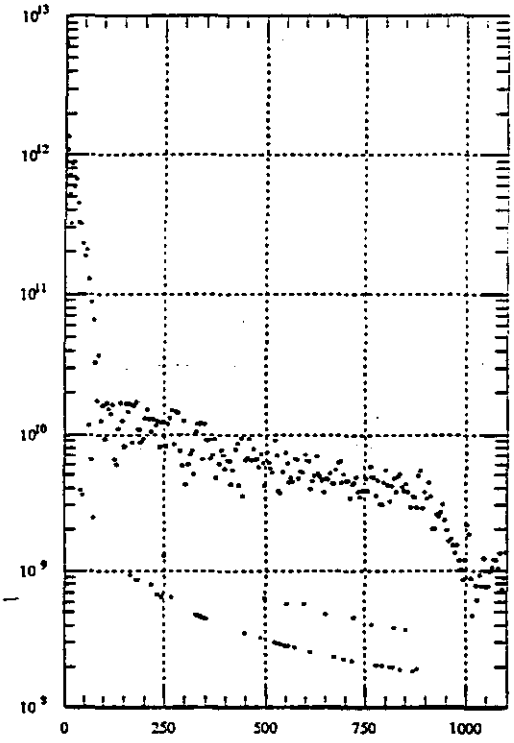
High energy neutrons



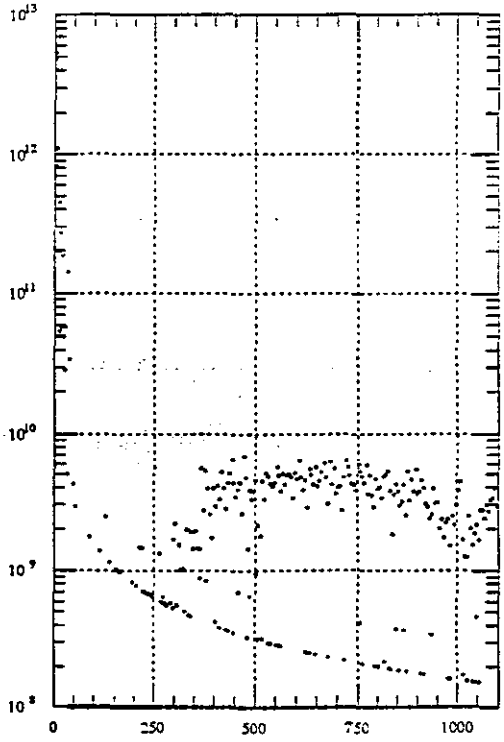
z=685cm



z=705cm

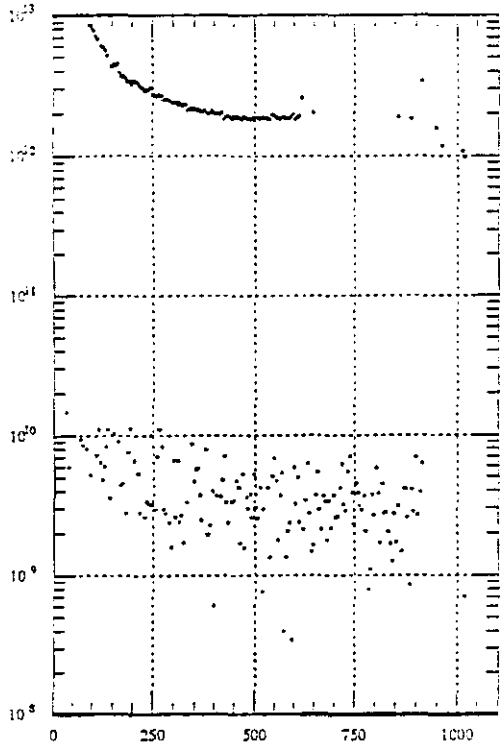


z=1005cm

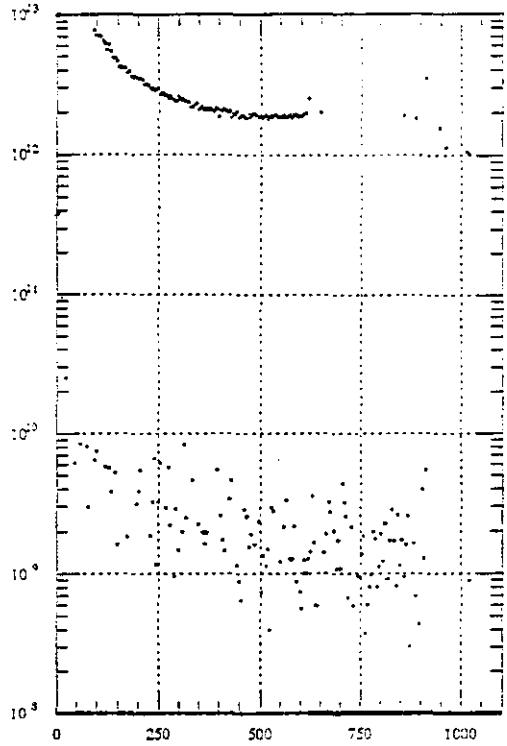


z=1460cm

Low energy neutrons



z=685cm



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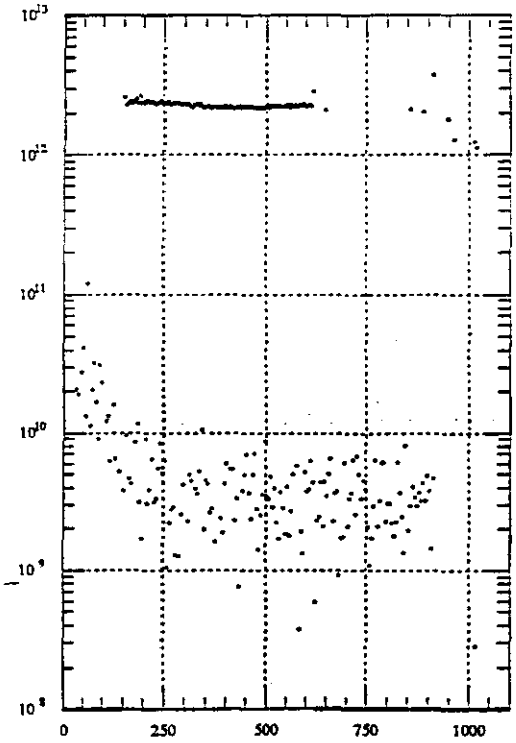

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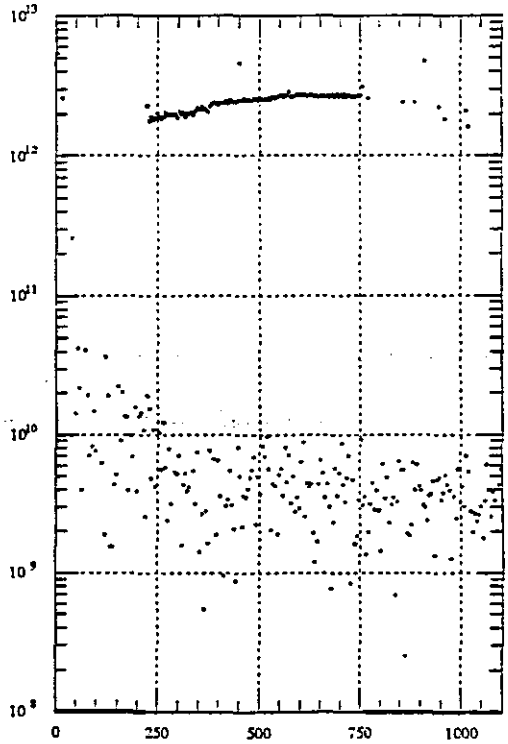
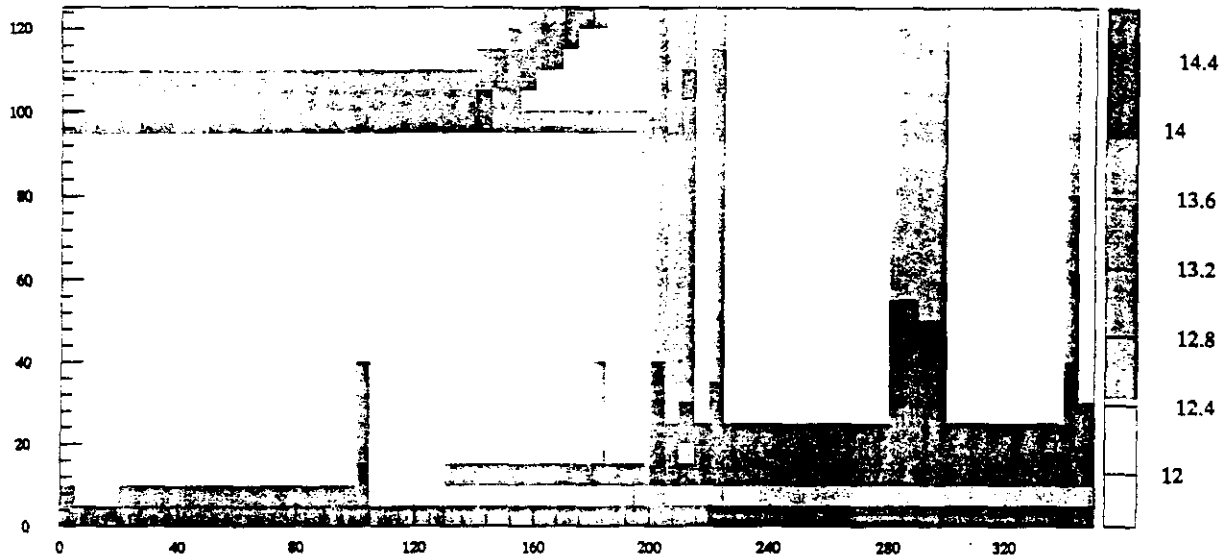


z=1460cm

93/01/05 13.39

Tracker region

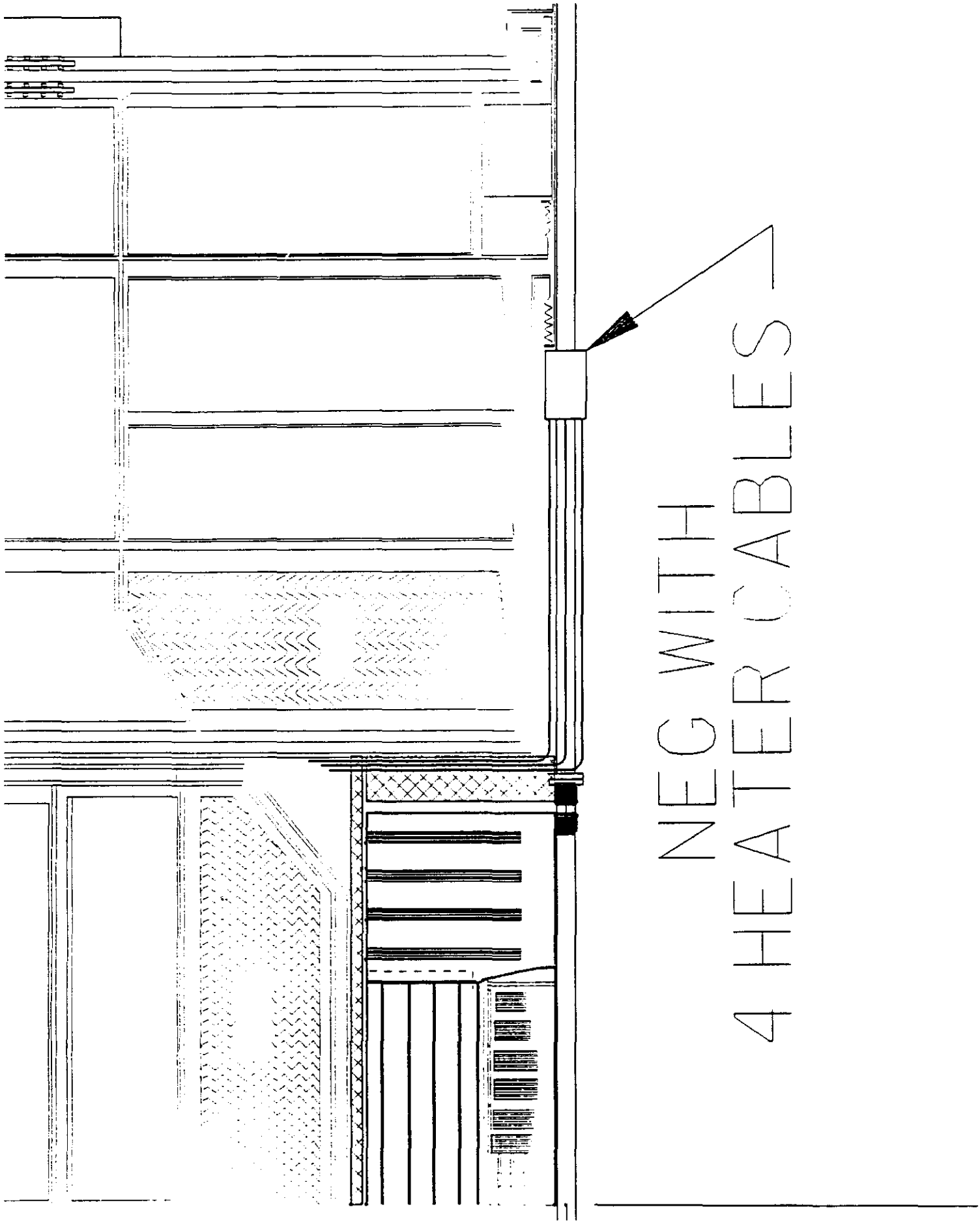


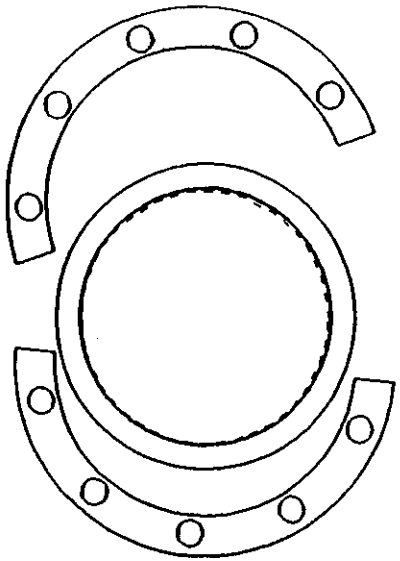
Neutron flux density

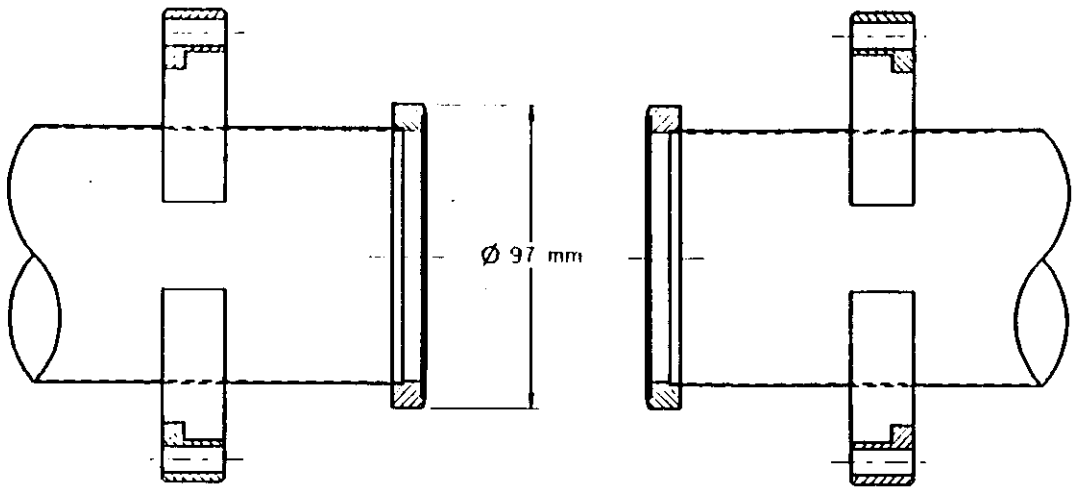
NEUTRON FLUX DENSITY

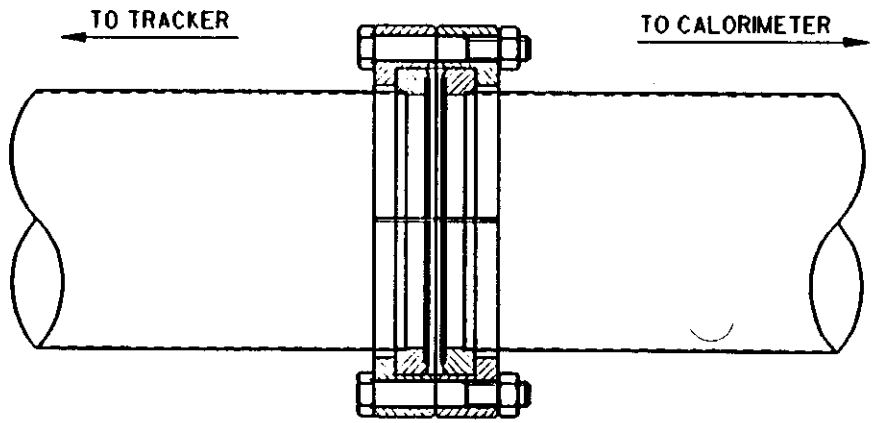
Beam Pipe Design

G. Chapman

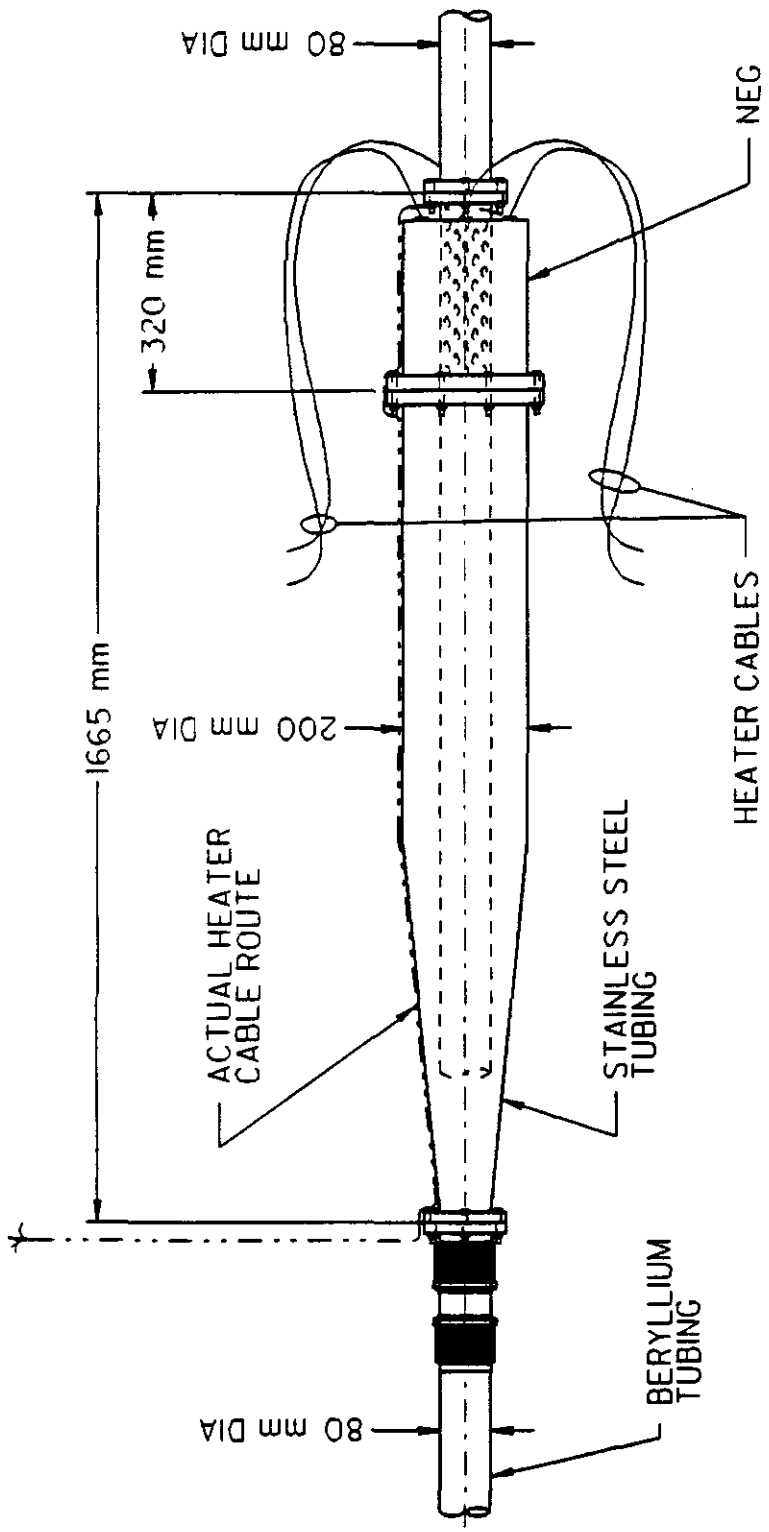

4 HEATER CABLES
NEG WITH

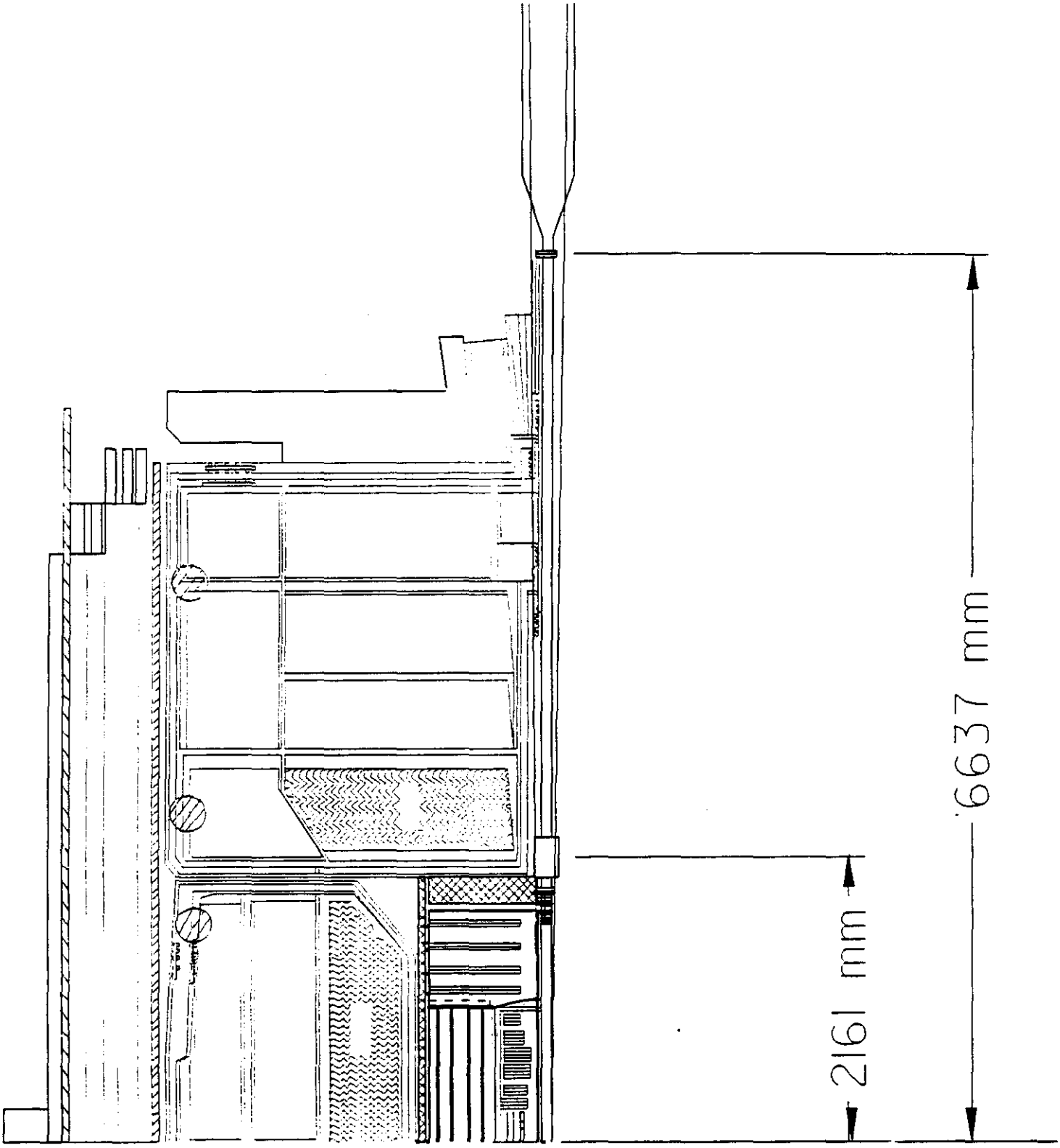




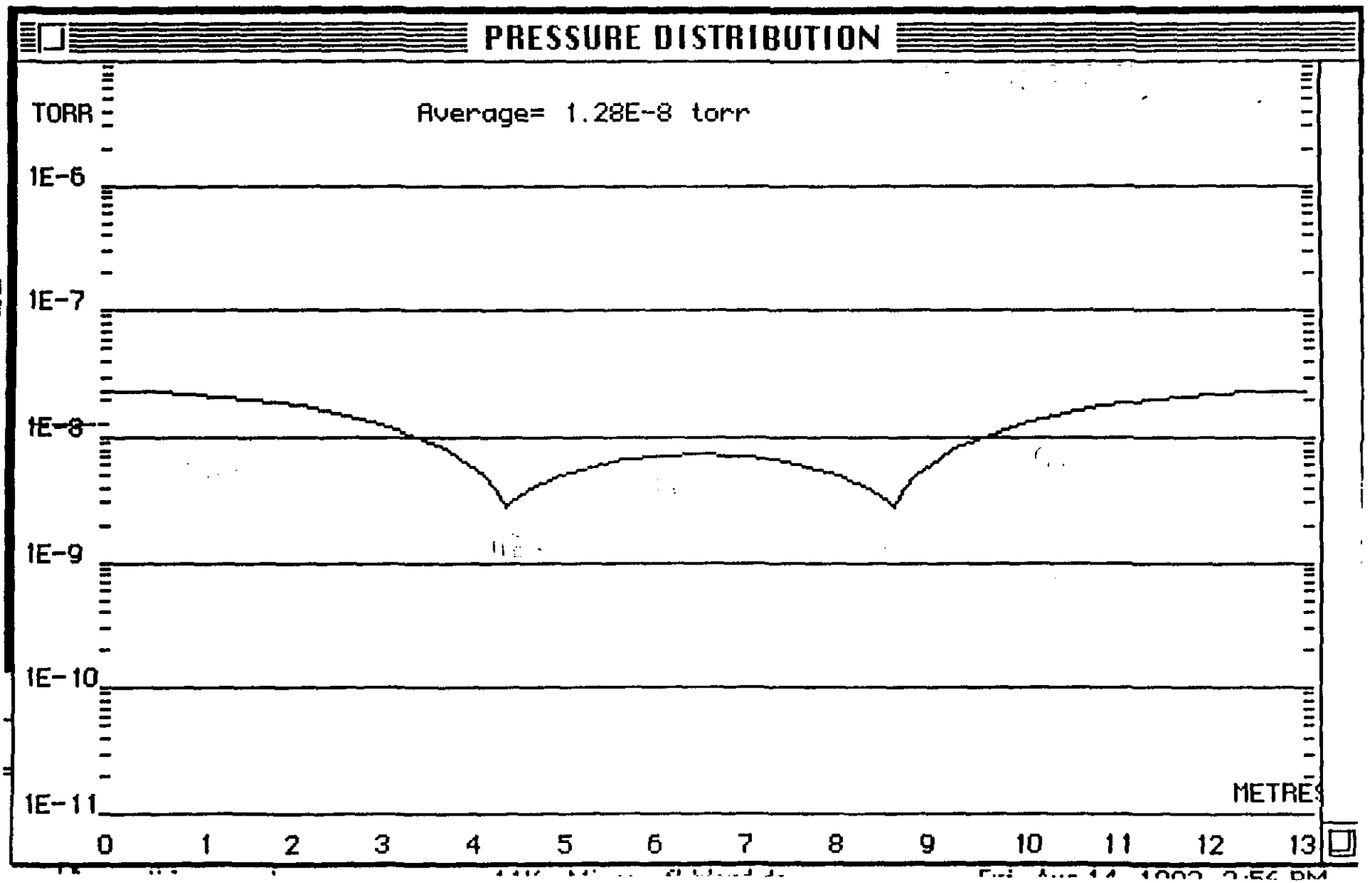


SPLIT RING FLANGE INSTALLATION

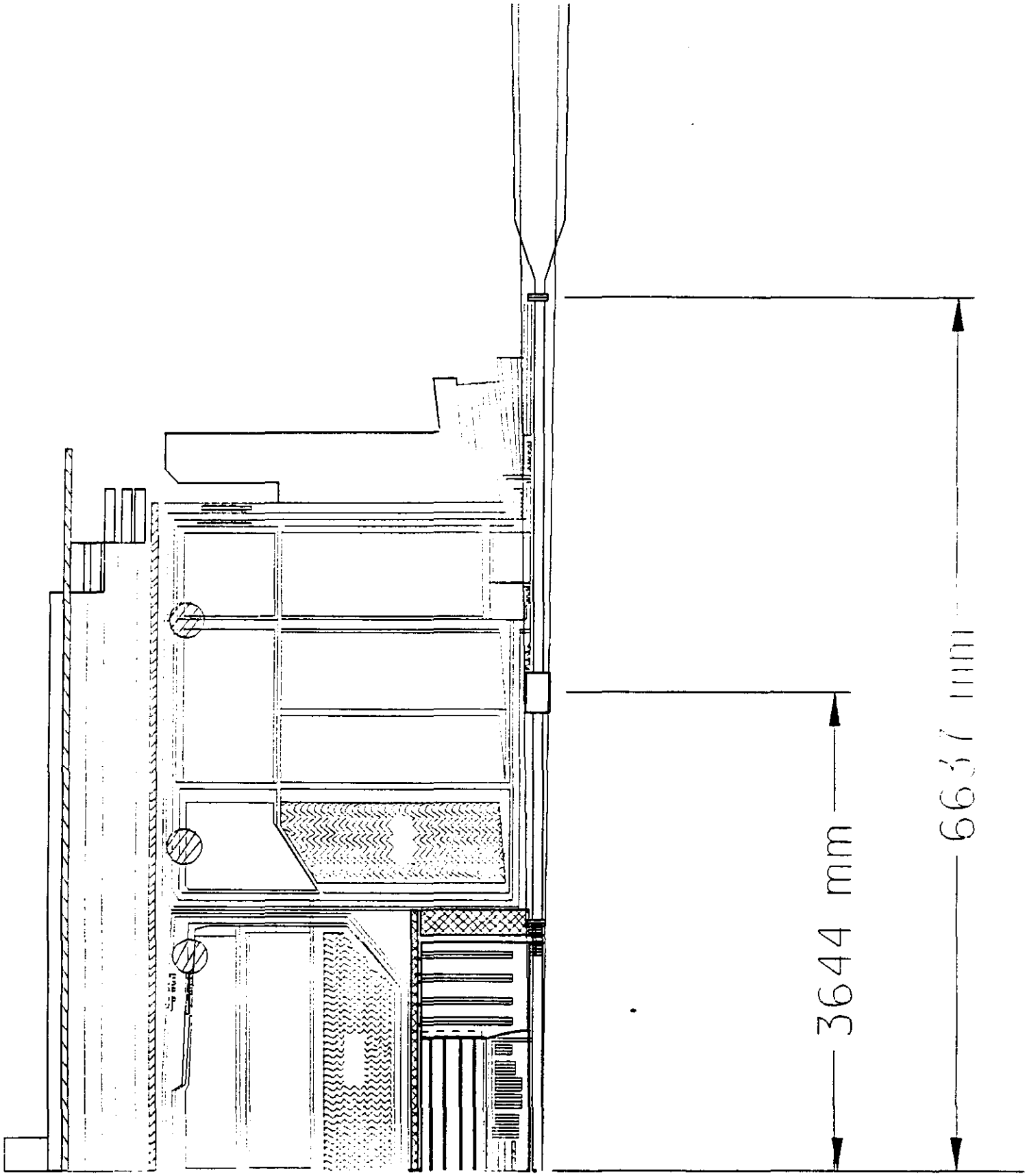

80 mm DIA
320 mm
1665 mm
200 mm DIA
80 mm DIA
NEG
HEATER CABLES
ACTUAL HEATER CABLE ROUTE
STAINLESS STEEL TUBING
BERYLLIUM TUBING


6637 mm
2161 mm

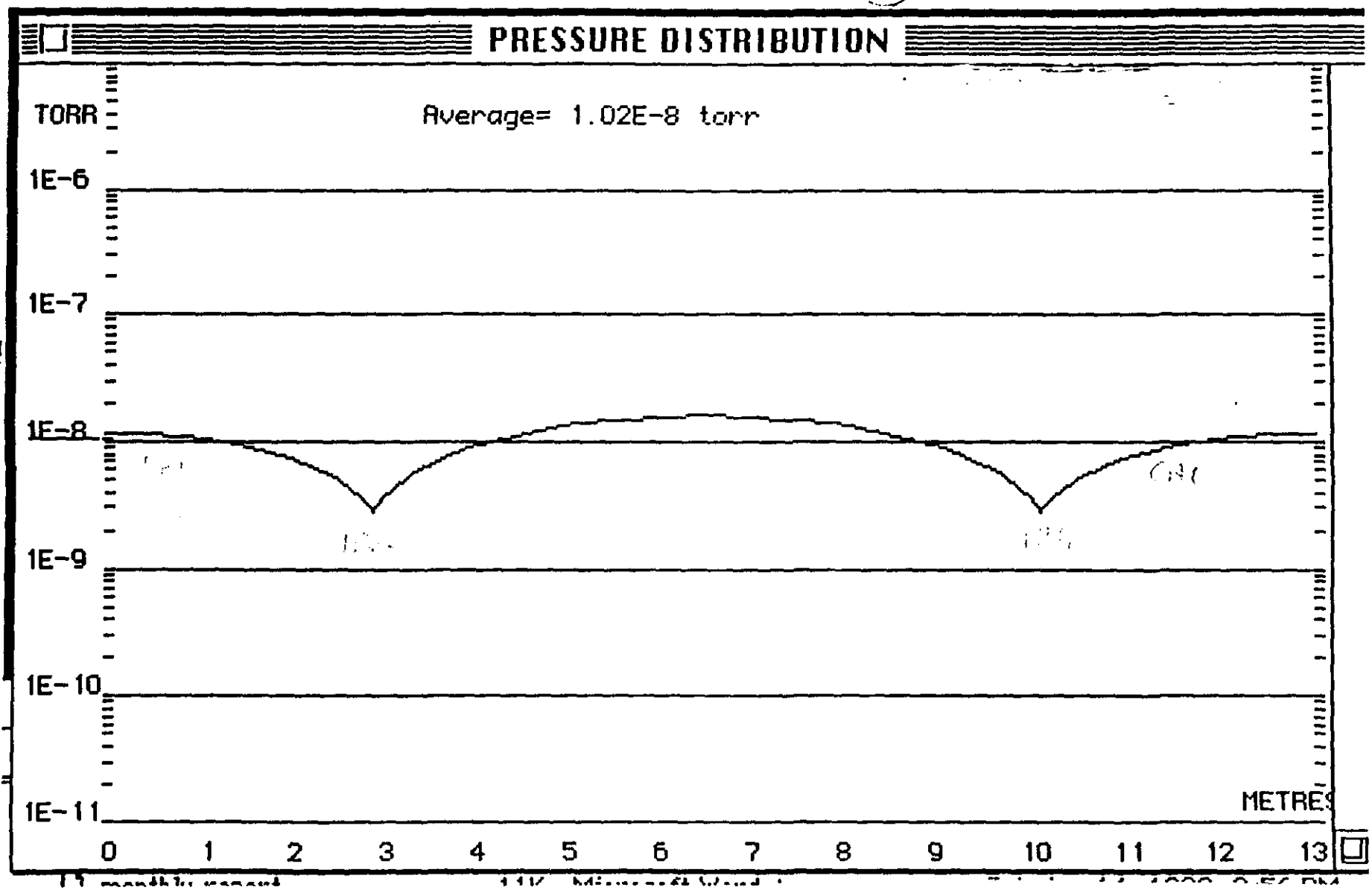
1

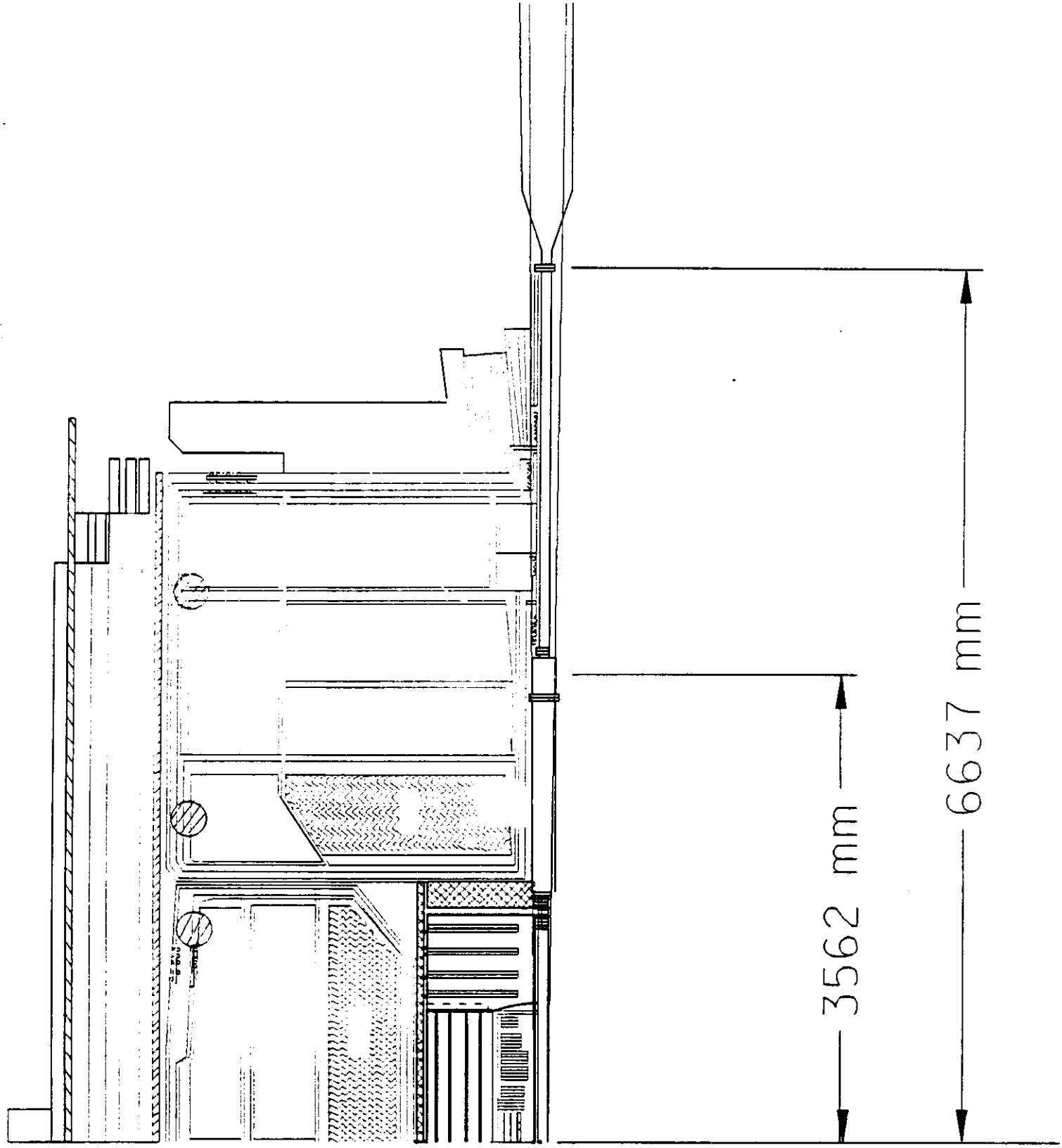

PRESSURE DISTRIBUTION
Average= 1.28E-8 torr
TORR
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
METRES
0
1
2
3
4
5
6
7
8
9
10
11
12
13

55

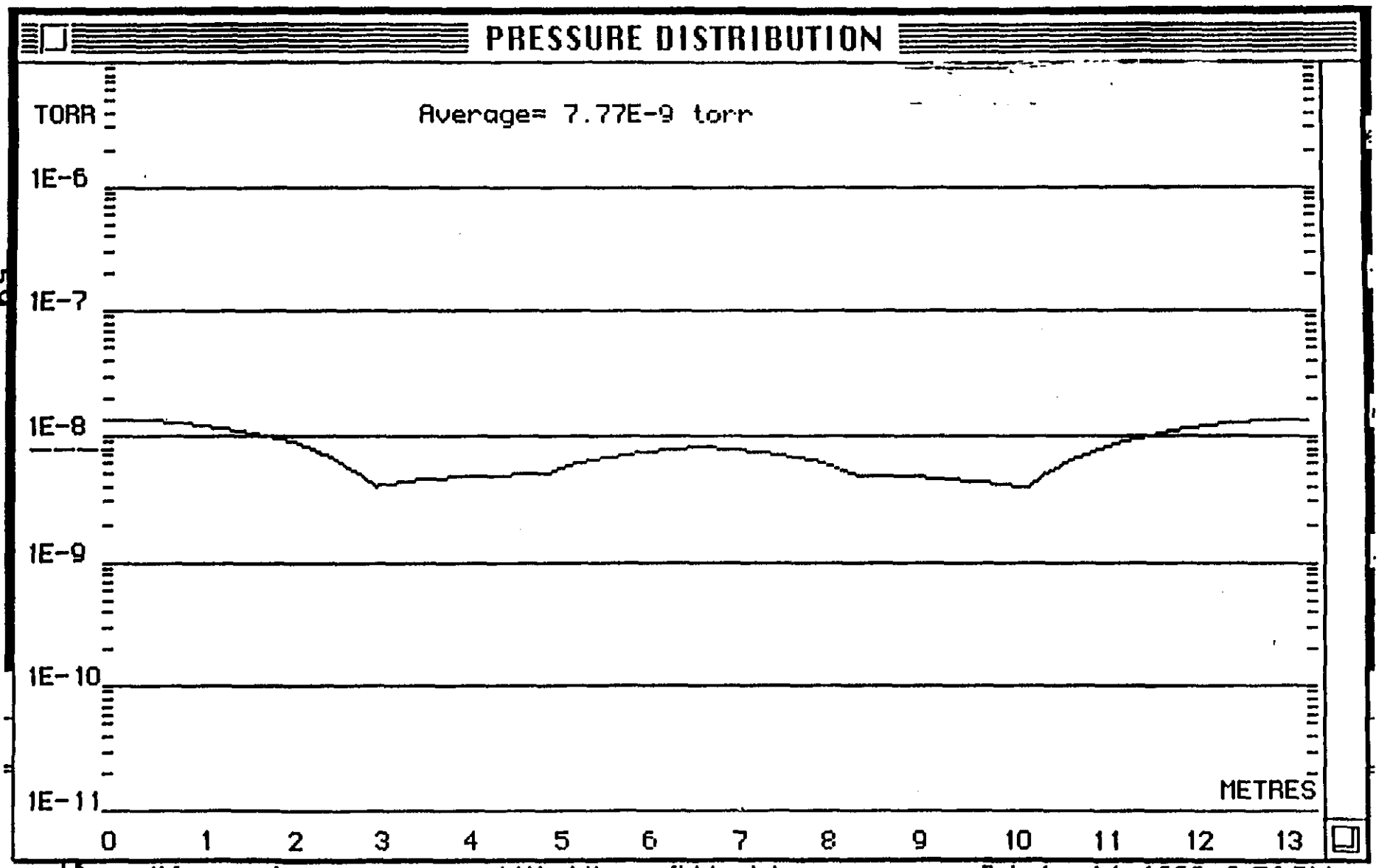

3644 mm
6637 mm

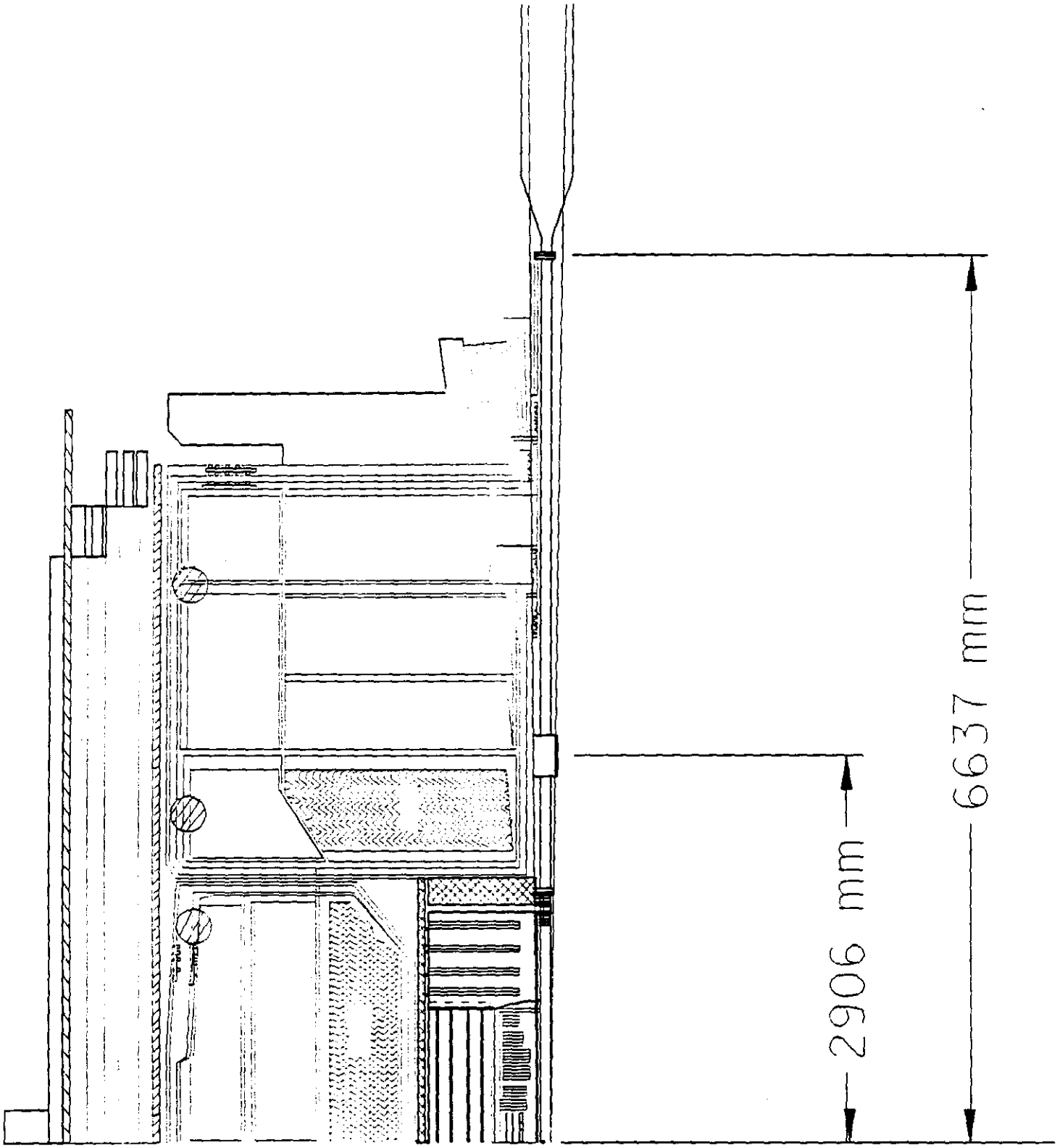
(2)


PRESSURE DISTRIBUTION
Average= 1.02E-8 torr
TORR
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
METRES
0
1
2
3
4
5
6
7
8
9
10
11
12
13

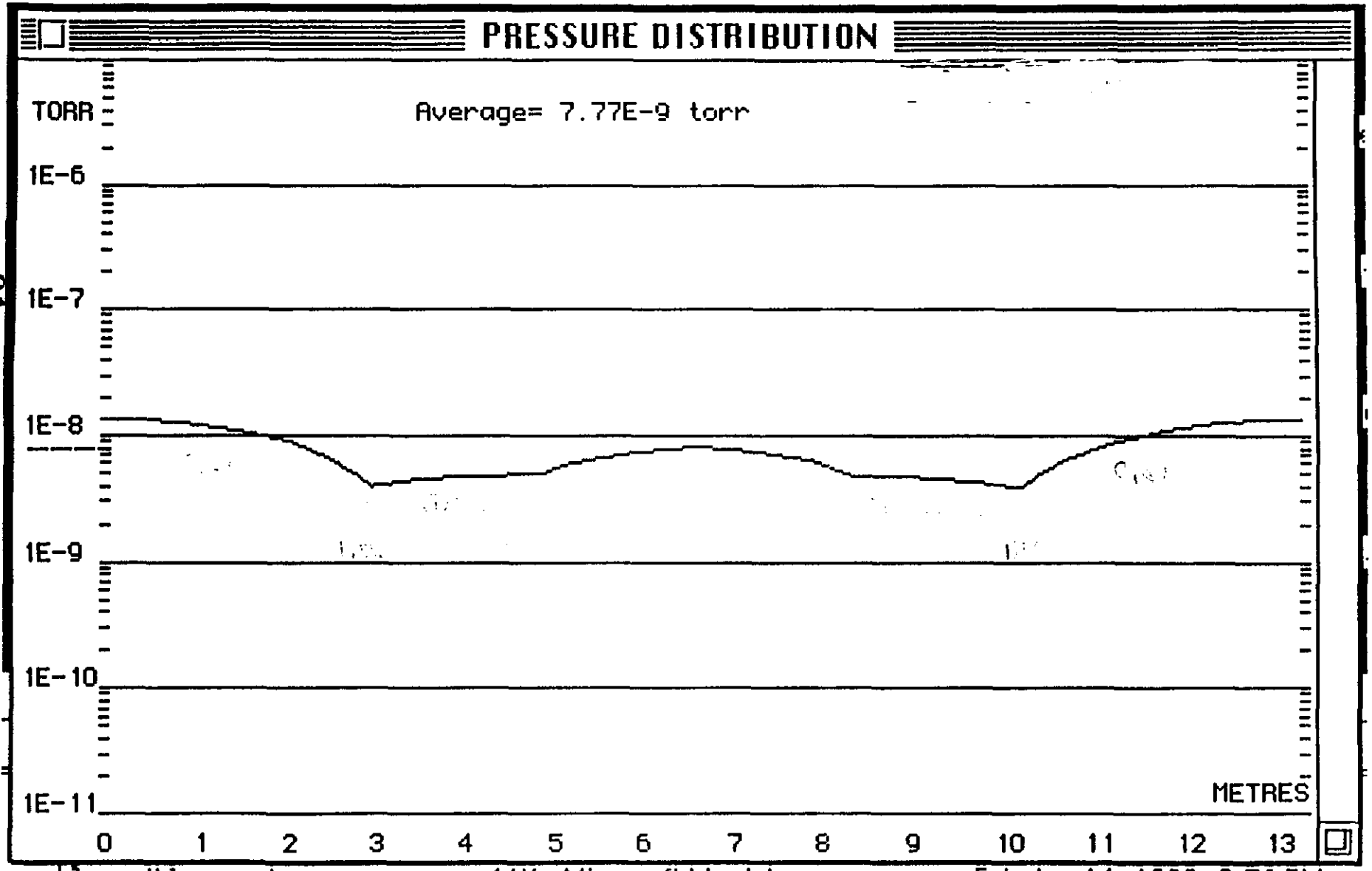

3562 mm
6637 mm

3


PRESSURE DISTRIBUTION
Average= 7.77E-9 torr
TORR
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
METRES
0
1
2
3
4
5
6
7
8
9
10
11
12
13

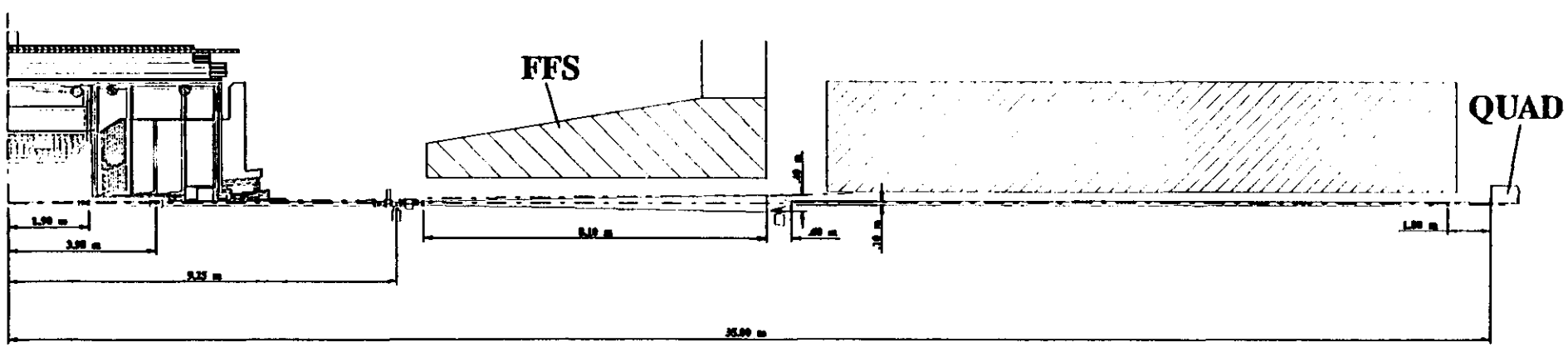

2906 mm
6637 mm

3


PRESSURE DISTRIBUTION
TORR
Average= 7.77E-9 torr
1E-6
1E-7
1E-8
1E-9
1E-10
1E-11
METRES
0
1
2
3
4
5
6
7
8
9
10
11
12
13

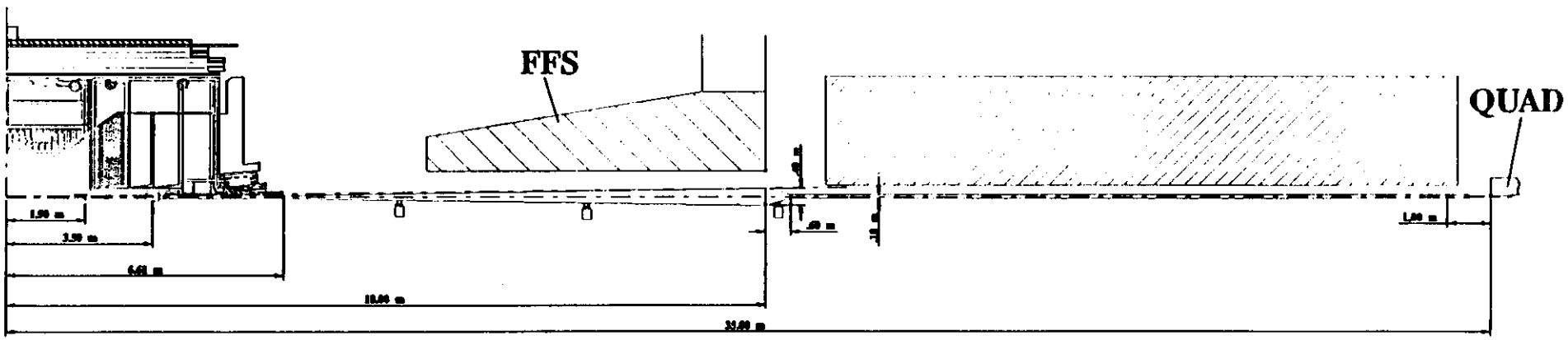
BEAMLINE LAYOUT

OPTION 1



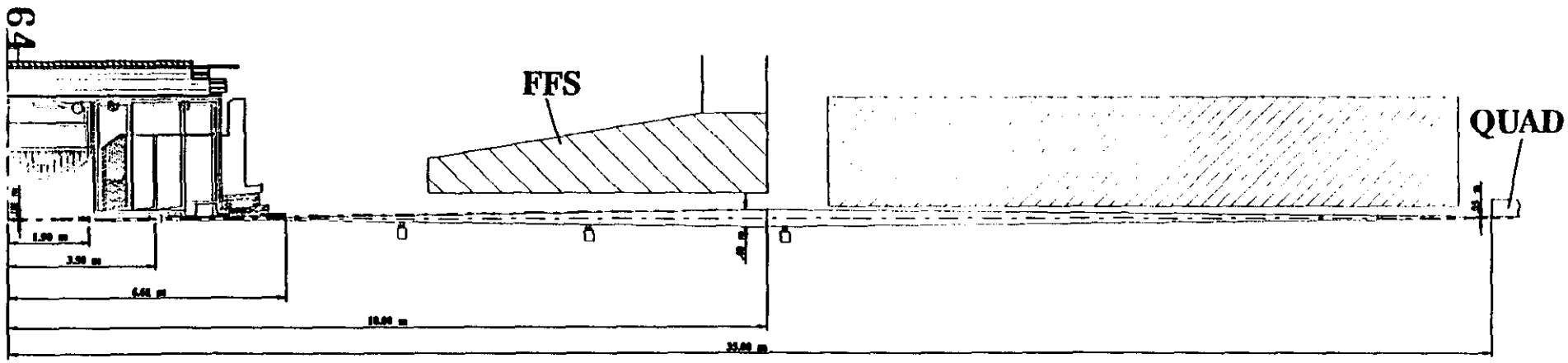
BEAMLINE LAYOUT

OPTION 2



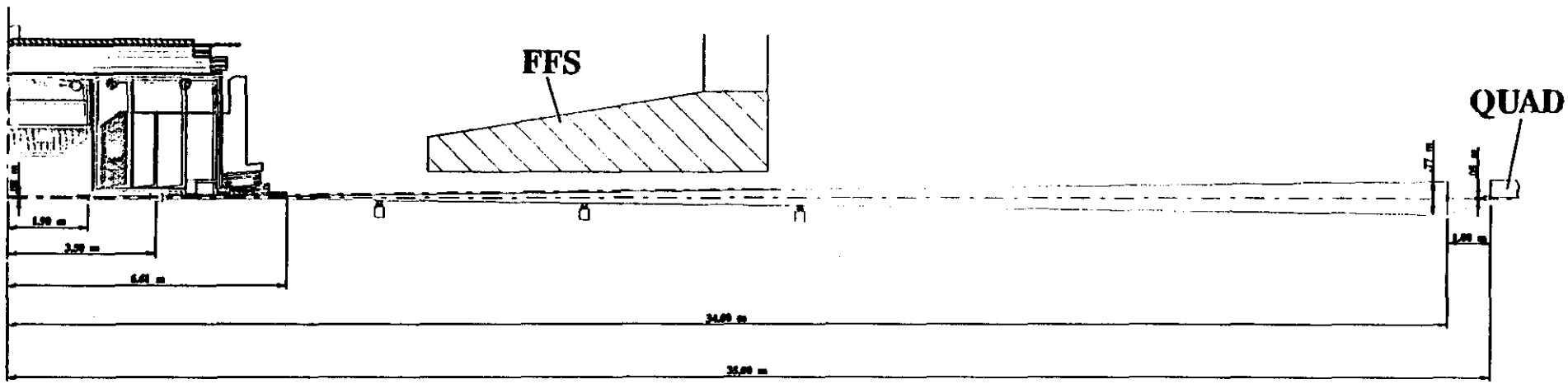
BEAMLINE LAYOUT

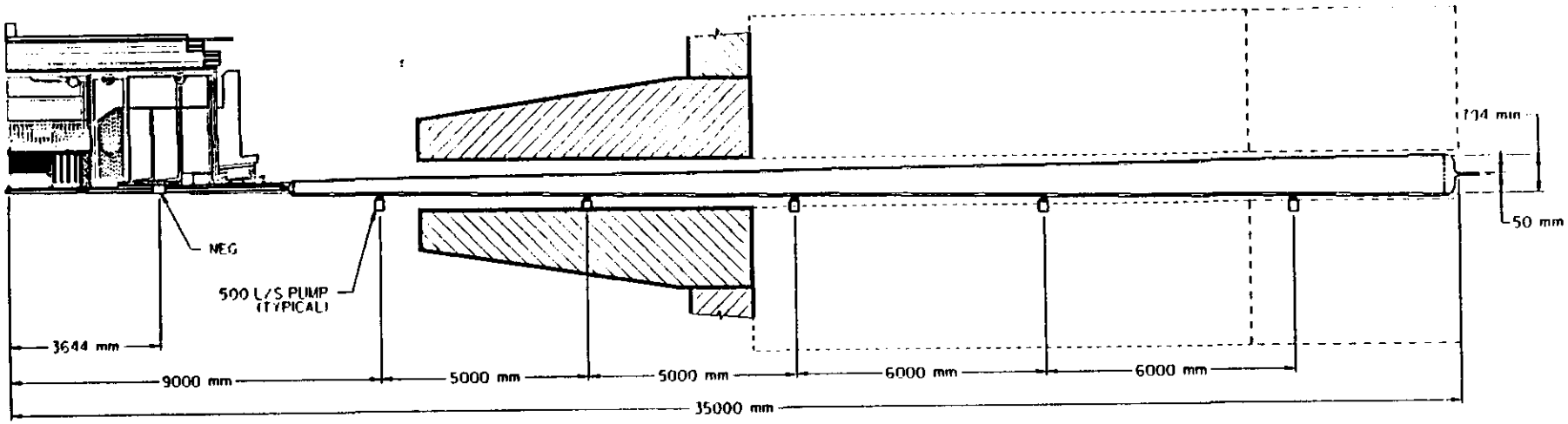
OPTION 3



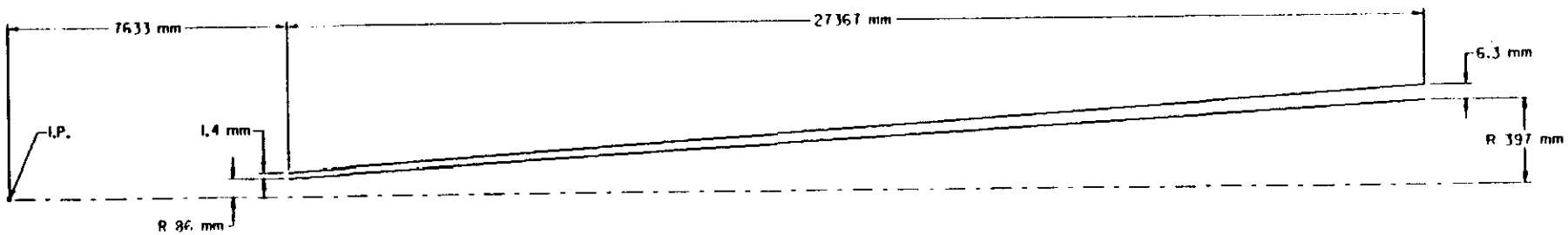
BEAMLINE LAYOUT

OPTION 4





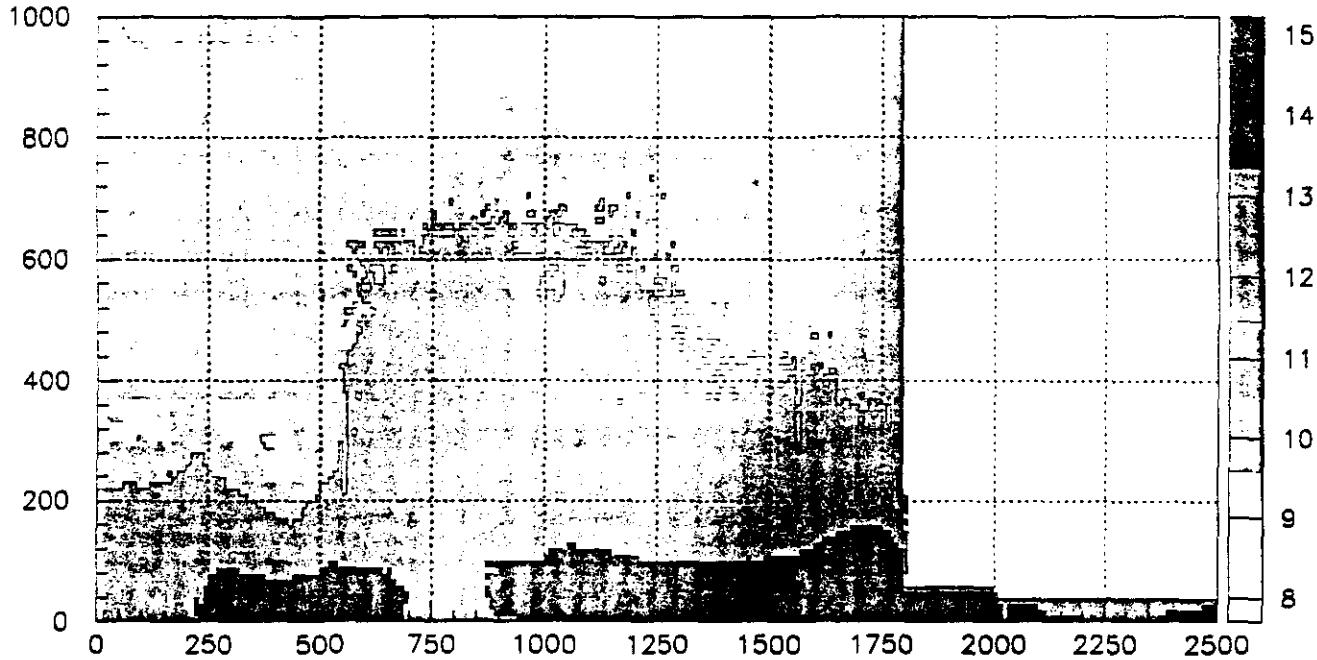
OPTION 4



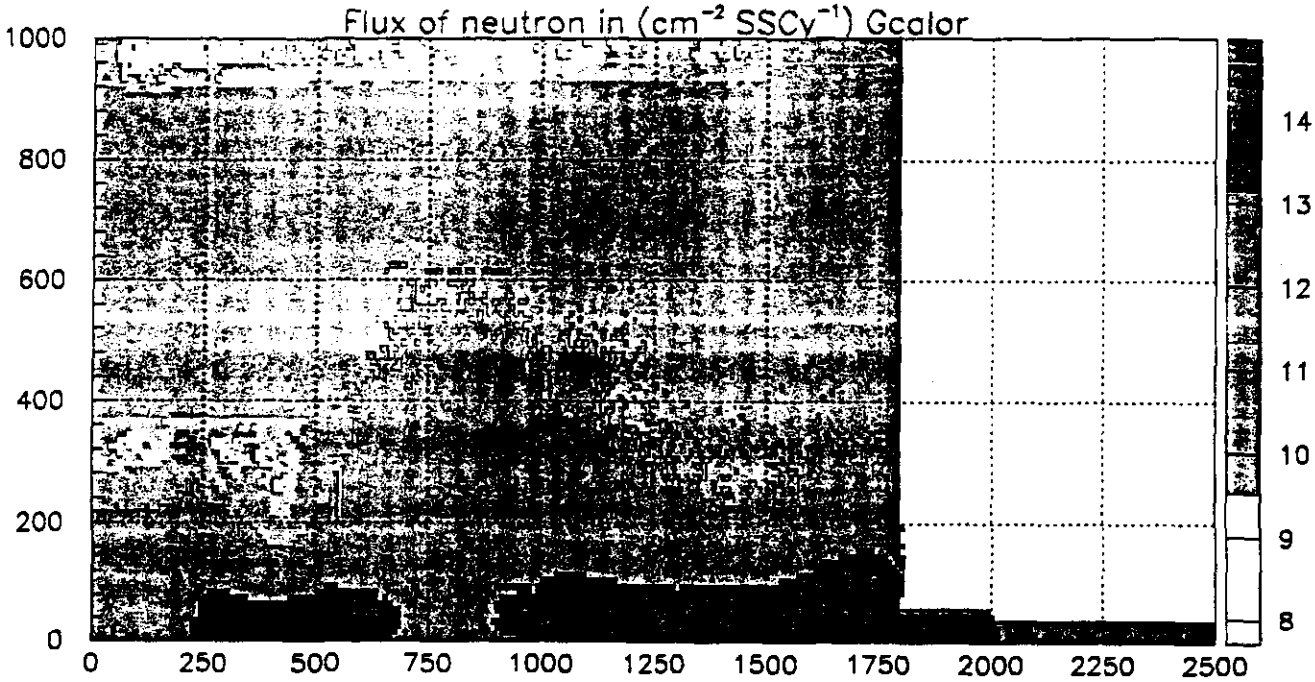
CONICAL SECTION
WALL THICKNESS
SAFETY FACTOR 2

Update on GEANT-COLOR

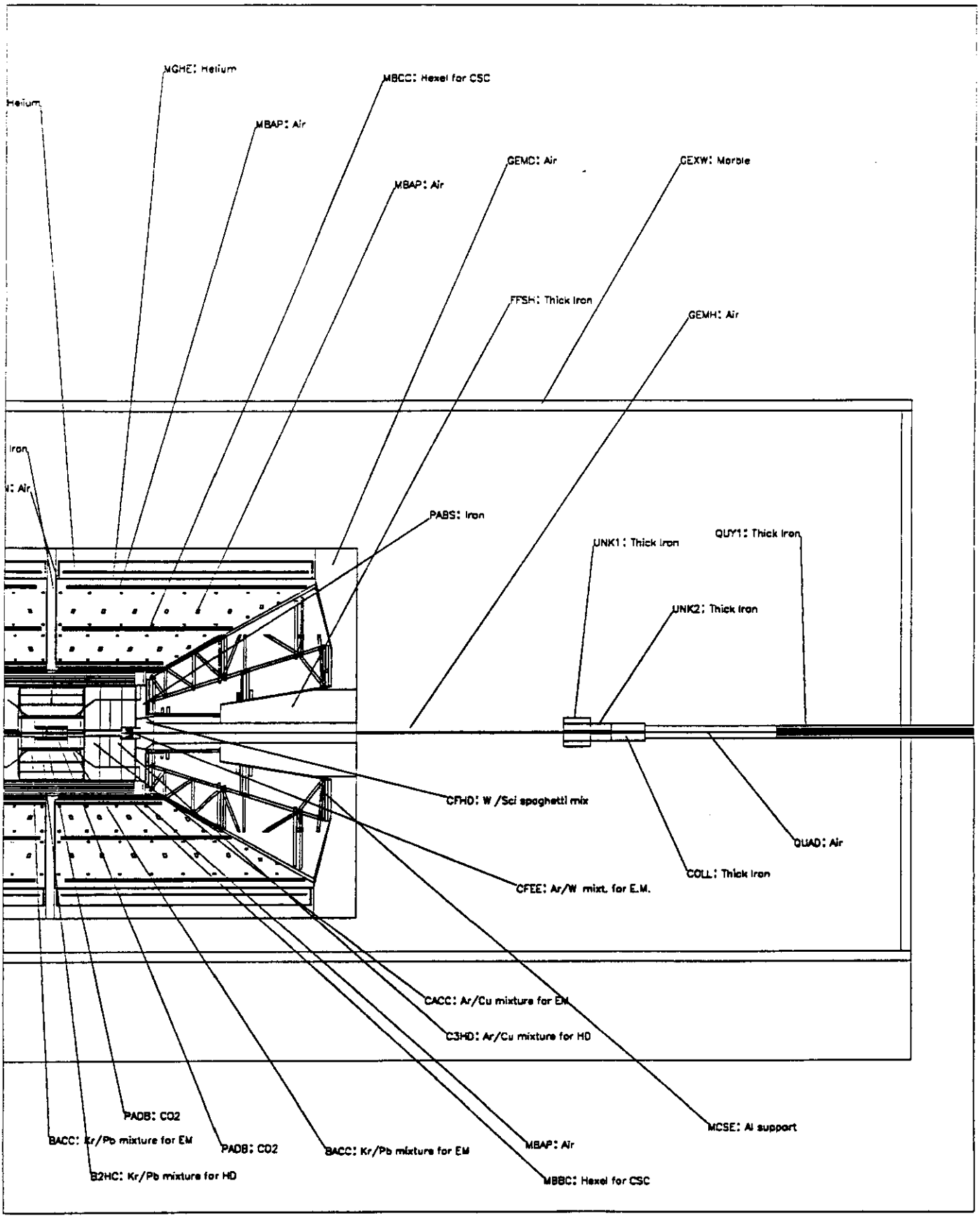
I. Fissiak

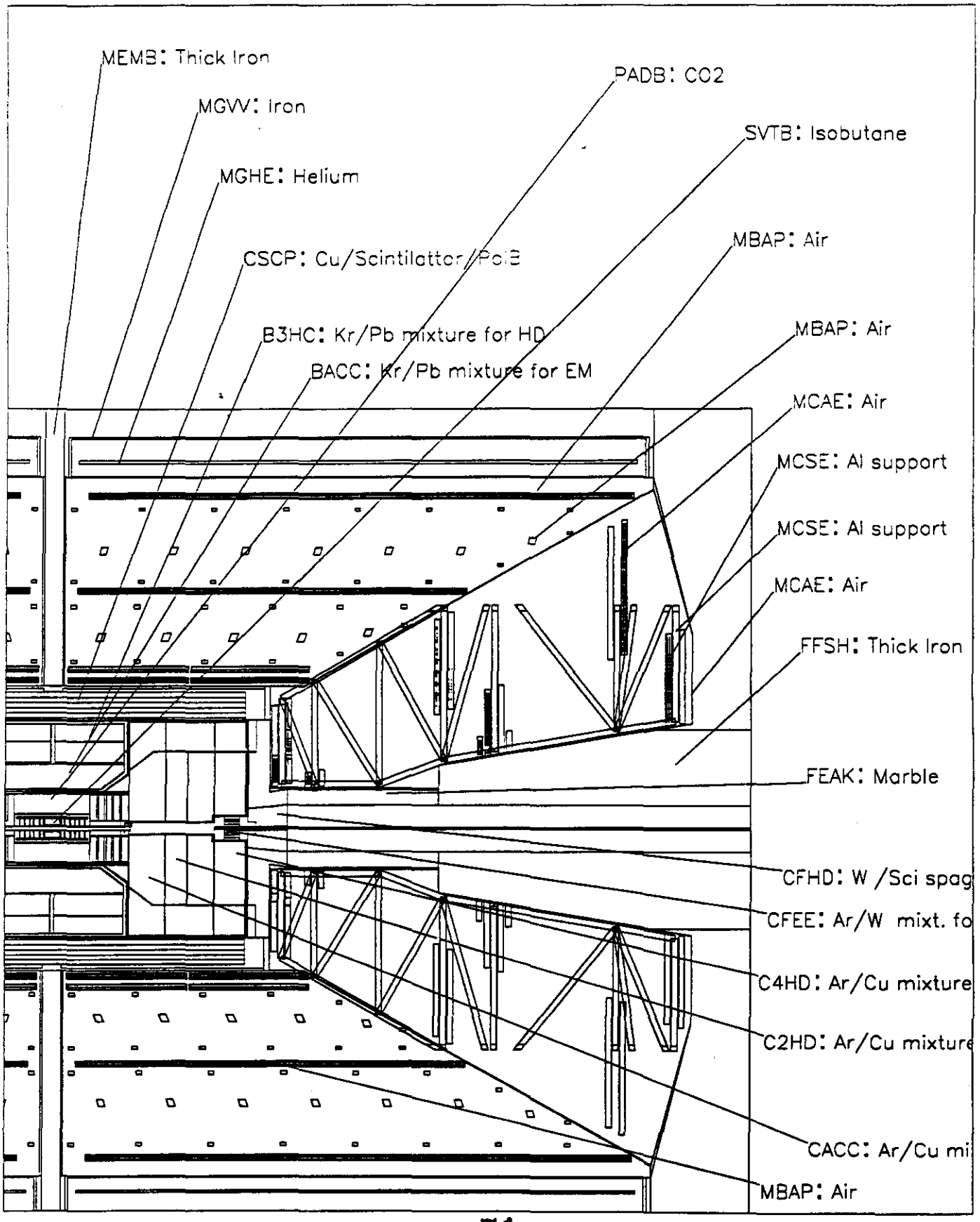


Flux of neutron in (cm^{-2} $SSCy^{-1}$) Gcalor



Flux of neutron in (cm^{-2} $SSCy^{-1}$) Geant


MGHE: Helium
MBCC: Hexel for CSC
Helium
MBAP: Air
GEMC: Air
GEXW: Marble
MBAP: Air
FFSH: Thick Iron
GEMH: Air
Iron
: Air
PABS: Iron
UNK1 : Thick Iron
QUY1 : Thick Iron
UNK2: Thick Iron
CFHD: W /Sci spaghetti mix
QUAD: Air
COLL: Thick Iron
CFEE: Ar/W mixt. for E.M.
CACC: Ar/Cu mixture for EM
C3HD: Ar/Cu mixture for HD
PADB: CO2
MCSE: Al support
BACC: Kr/Pb mixture for EM
PADB: CO2
BACC: Kr/Pb mixture for EM
MBAP: Air
B2HC: Kr/Pb mixture for HD
MBBC: Hexel for CSC


MEMB: Thick Iron
MGVV: Iron
MGHE: Helium
CSCP: Cu/Scintillator/PolE
B3HC: Kr/Pb mixture for HD
BACC: Kr/Pb mixture for EM
PADB: CO2
SVTB: Isobutane
MBAP: Air
MBAP: Air
MCAE: Air
MCSE: Al support
MCSE: Al support
MCAE: Air
FFSH: Thick Iron
FEAK: Marble
CFHD: W /Sci spag
CFEE: Ar/W mixt. fo
C4HD: Ar/Cu mixture
C2HD: Ar/Cu mixture
CACC: Ar/Cu mi
MBAP: Air

Update on LLNL Work

C. Wuest

Reactor Experiments, Inc. R/X 1275 HAMMERWOOD AVE., SUNNYVALE, CA 94089-2231
(408) 745-6770 • FAX: (408) 745-7013 • TELEX: 34 5505

Bulletin S-87N
June, 1991

TECHNICAL DATA SHEET
POLYETHYLENE-BASE SHIELDING

Polyethylene is an excellent base material for neutron shielding materials because of its exceptionally high hydrogen content. Of all practical materials, it contains more hydrogen atoms in a given volume than any other substance, is chemically inert, and has excellent machining and fabricating characteristics.

This bulletin presents selected tests and data on the different available types of shielding that use polyethylene as a base material for a variety of additives.

Cat. No.	Description	Typical Applications
201	5% Boron-Polyethylene	Research, training and power reactors.
202	1% Boron, 80% Lead-Polyethylene	Where it is necessary to shield against combined thermal neutrons, fast neutrons and gamma rays.
206	76.5% Lead-Polyethylene	LIGHT-LEAD® gamma shielding for radioisotope and nuclear medicine fabrications.
207	Self-Extinguishing Borated Polyethylene	Power reactors or where flame-resistant material is important.
210	30% Boron-Polyethylene	Reduction of very high thermal neutron flux levels.
213	Pure Polyethylene	Moderator for neutrons.
215	7.5% Lithium-Polyethylene	Shielding gamma sensitive detectors or experiments against neutrons without producing capture-gamma rays.

MISCELLANEOUS DATA

Catalog No. 201

Effect of Heating: 9 days @ 200°F: Material lost 2.5% of its original hydrogen.

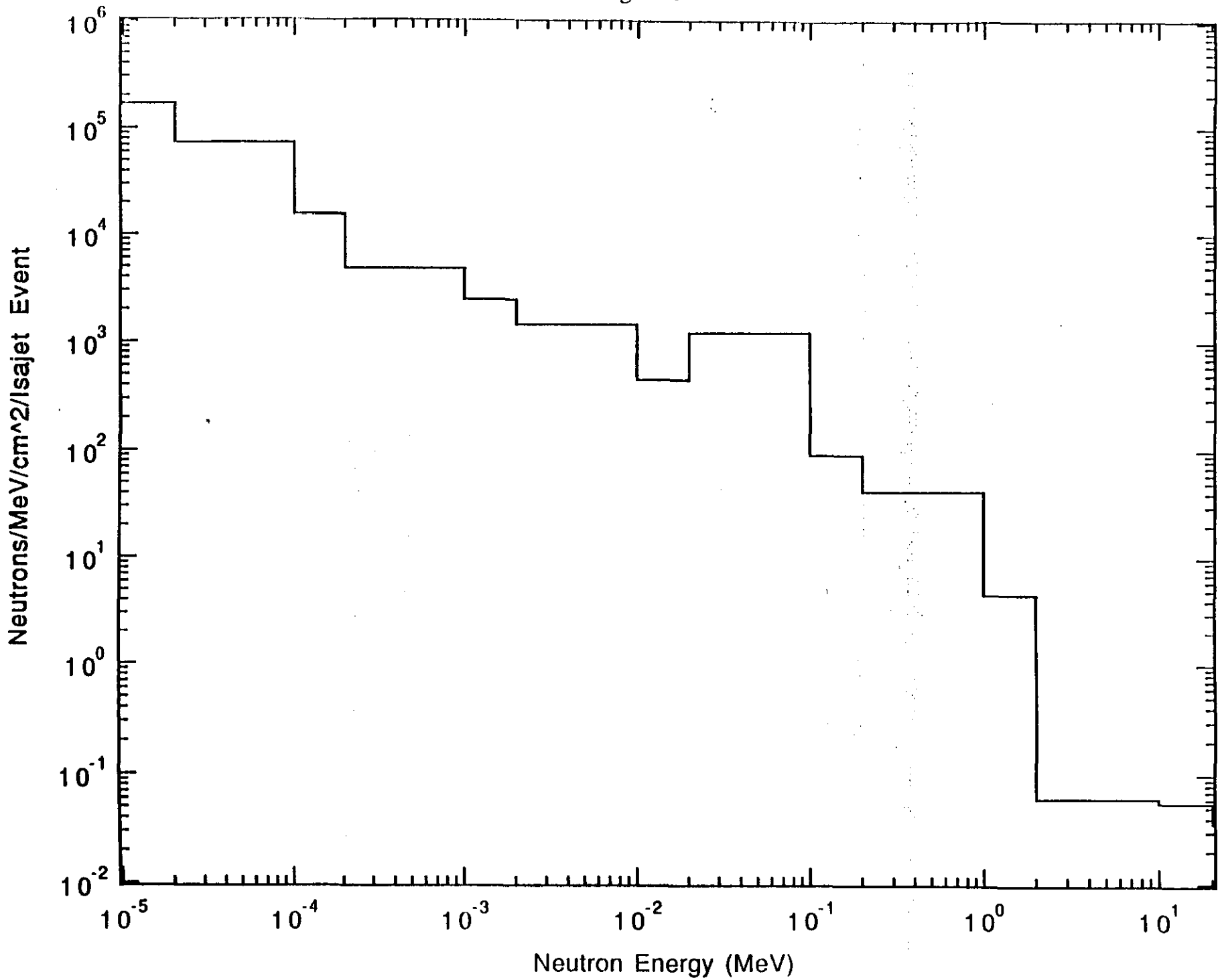
Calculated Heat of Combustion: 15,300 BTU/lb - 8425 cal/g.

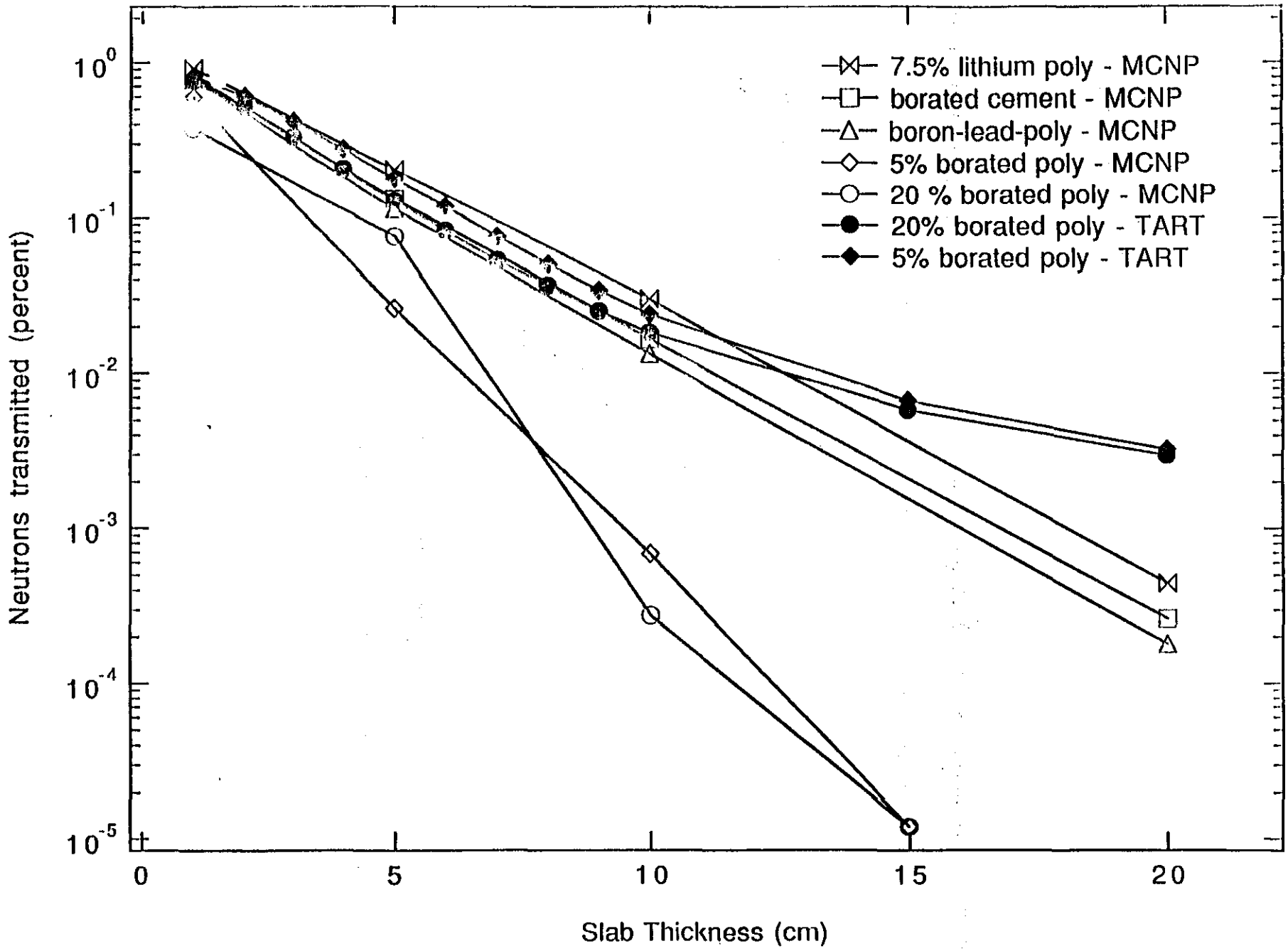
Exposure to 100% Relative Humidity for 3 Years: No effect.

Catalog No. 207

ASTM Test D-635 (Flammability of Self-Supporting Plastics) shows Catalog No. 207 to be completely self-extinguishing. No flame results after removal of a torch held to the material for 30 seconds. ASTM Test D-2863 gives a Limiting Oxygen Index of 30.2.

Figure 1


Neutrons/MeV/cm^2/Isajet Event
10^{6}
10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^{0}
10^{1}
Neutron Energy (MeV)



Total neutron flux a function of shielding material and thickness for a cylindrical slab (MCNP)

Figure 5

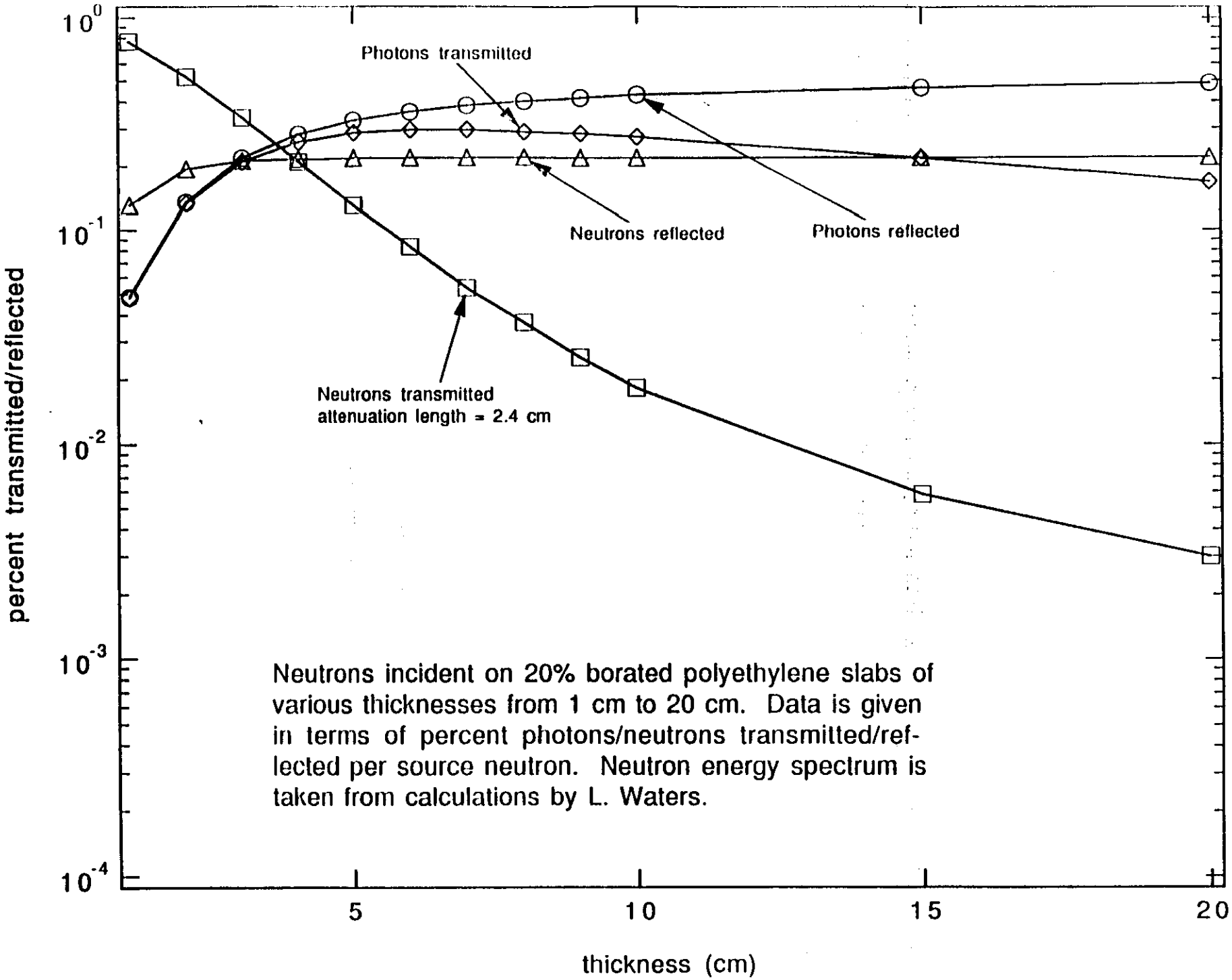

Photons transmitted
Neutrons reflected
Photons reflected
Neutrons transmitted
attenuation length = 2.4 cm
Neutrons incident on 20% borated polyethylene slabs of various thicknesses from 1 cm to 20 cm. Data is given in terms of percent photons/neutrons transmitted/reflected per source neutron. Neutron energy spectrum is taken from calculations by L. Waters.
percent transmitted/reflected
thickness (cm)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
5
10
15
20

Figure 2

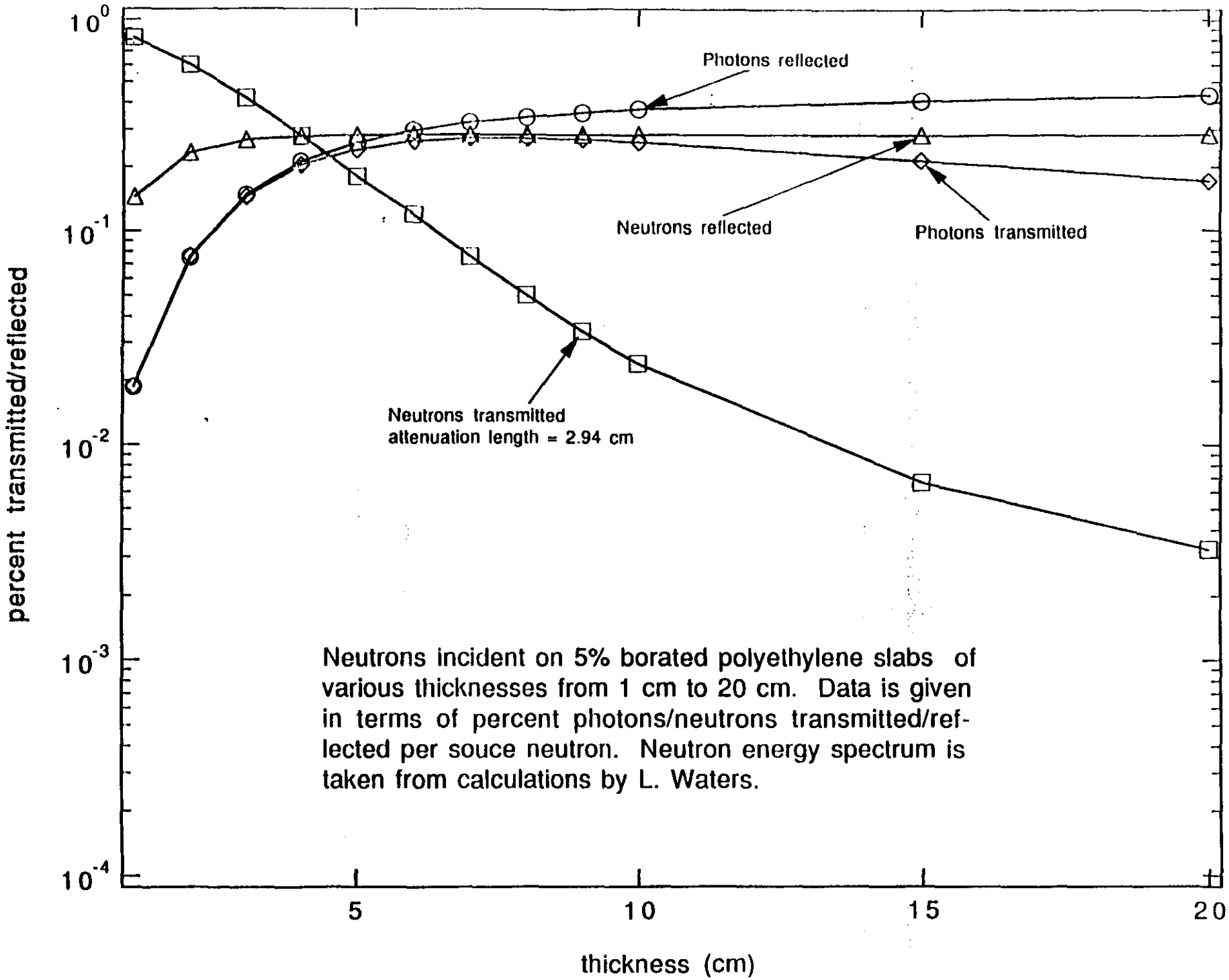

Photons reflected
Neutrons reflected
Photons transmitted
Neutrons transmitted
attenuation length = 2.94 cm
Neutrons incident on 5% borated polyethylene slabs of various thicknesses from 1 cm to 20 cm. Data is given in terms of percent photons/neutrons transmitted/reflected per souce neutron. Neutron energy spectrum is taken from calculations by L. Waters.
percent transmitted/reflected
thickness (cm)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
5
10
15
20

Figure 7

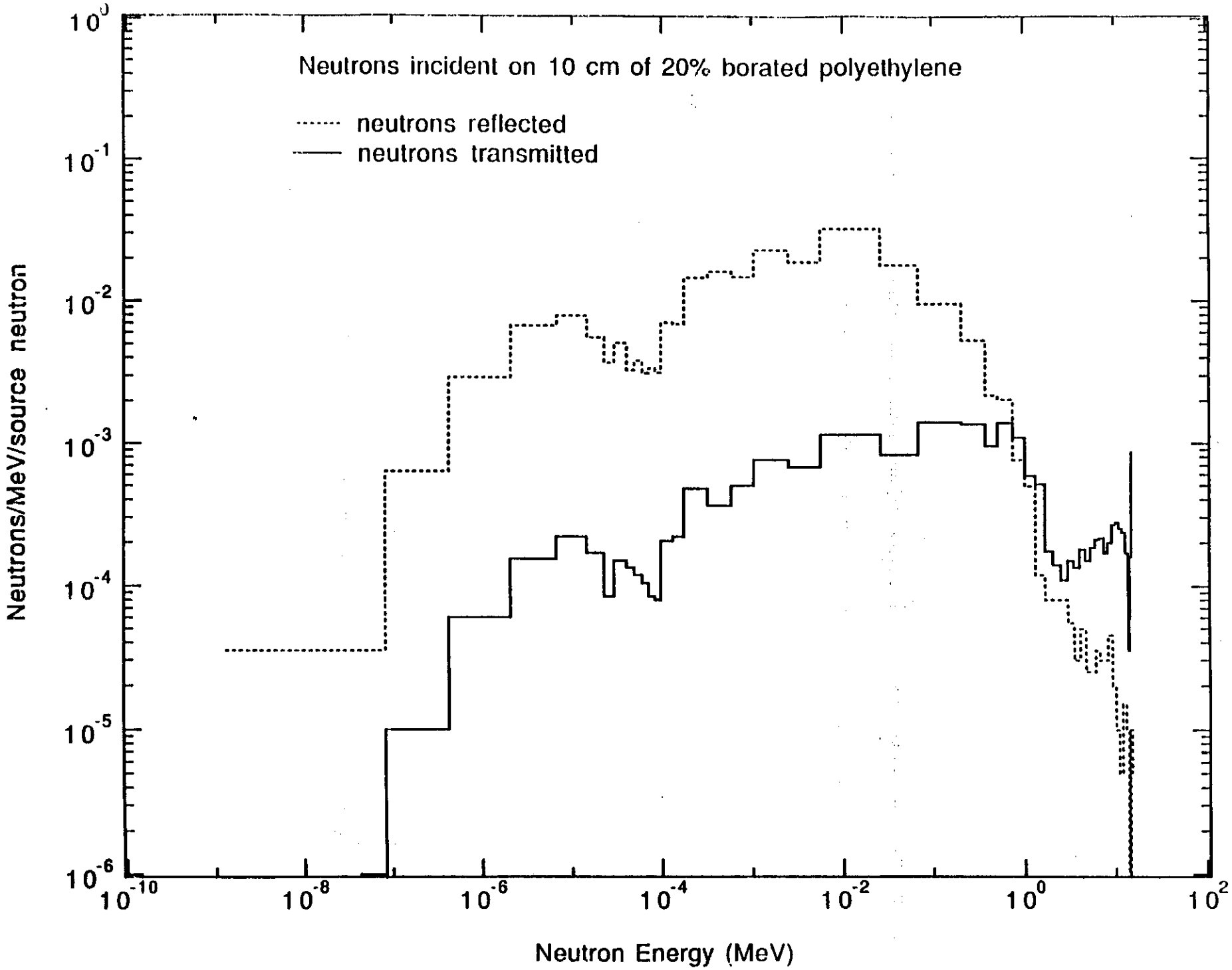

Neutrons incident on 10 cm of 20% borated polyethylene
neutrons reflected
neutrons transmitted
Neutrons/MeV/source neutron
Neutron Energy (MeV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
10^{0}
10^{2}

Figure 4

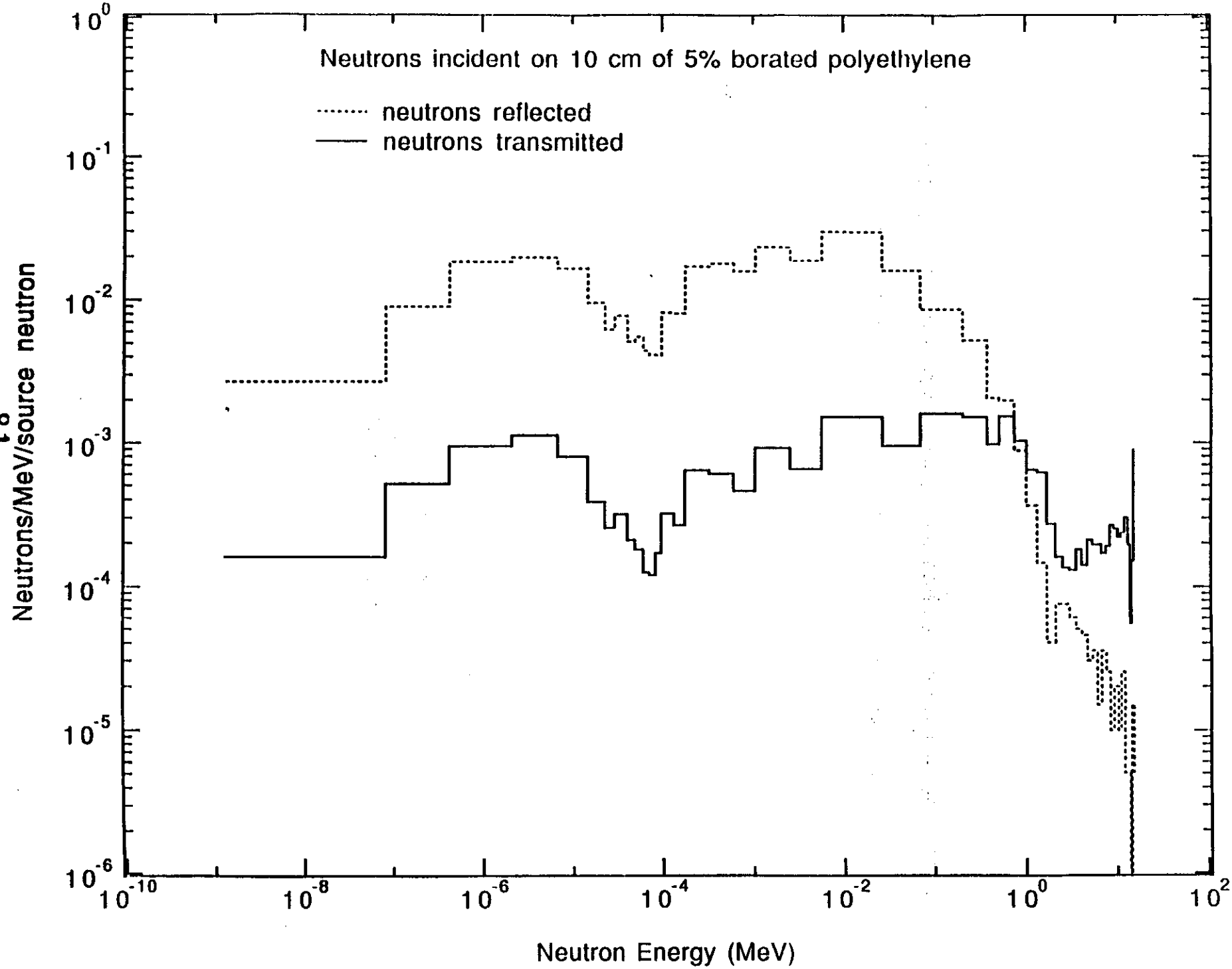

Neutrons incident on 10 cm of 5% borated polyethylene
neutrons reflected
neutrons transmitted
Neutrons/MeV/source neutron
Neutron Energy (MeV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-10}
10^{-8}
10^{-6}
10^{-4}
10^{-2}
10^{0}
10^{2}

Figure 3

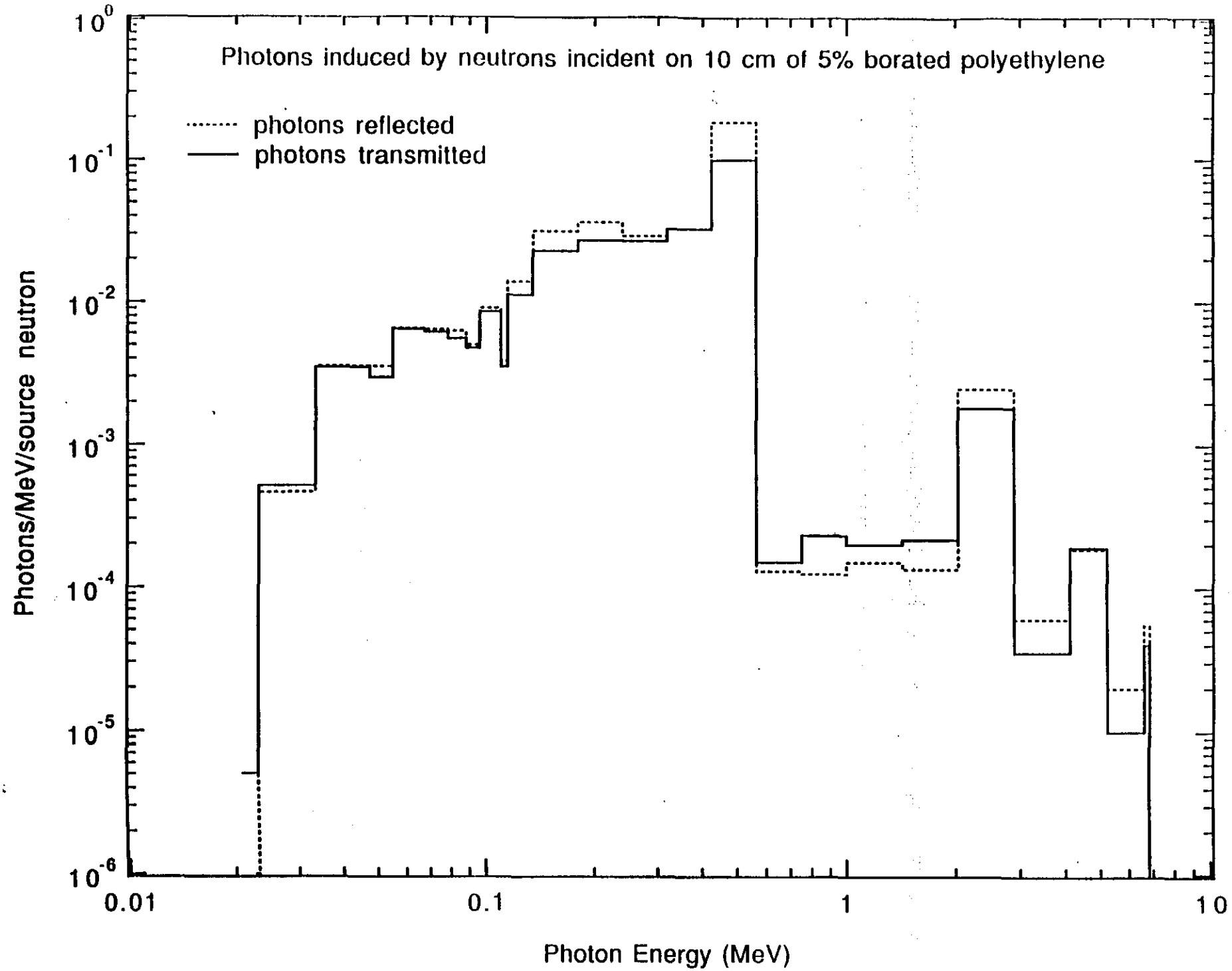
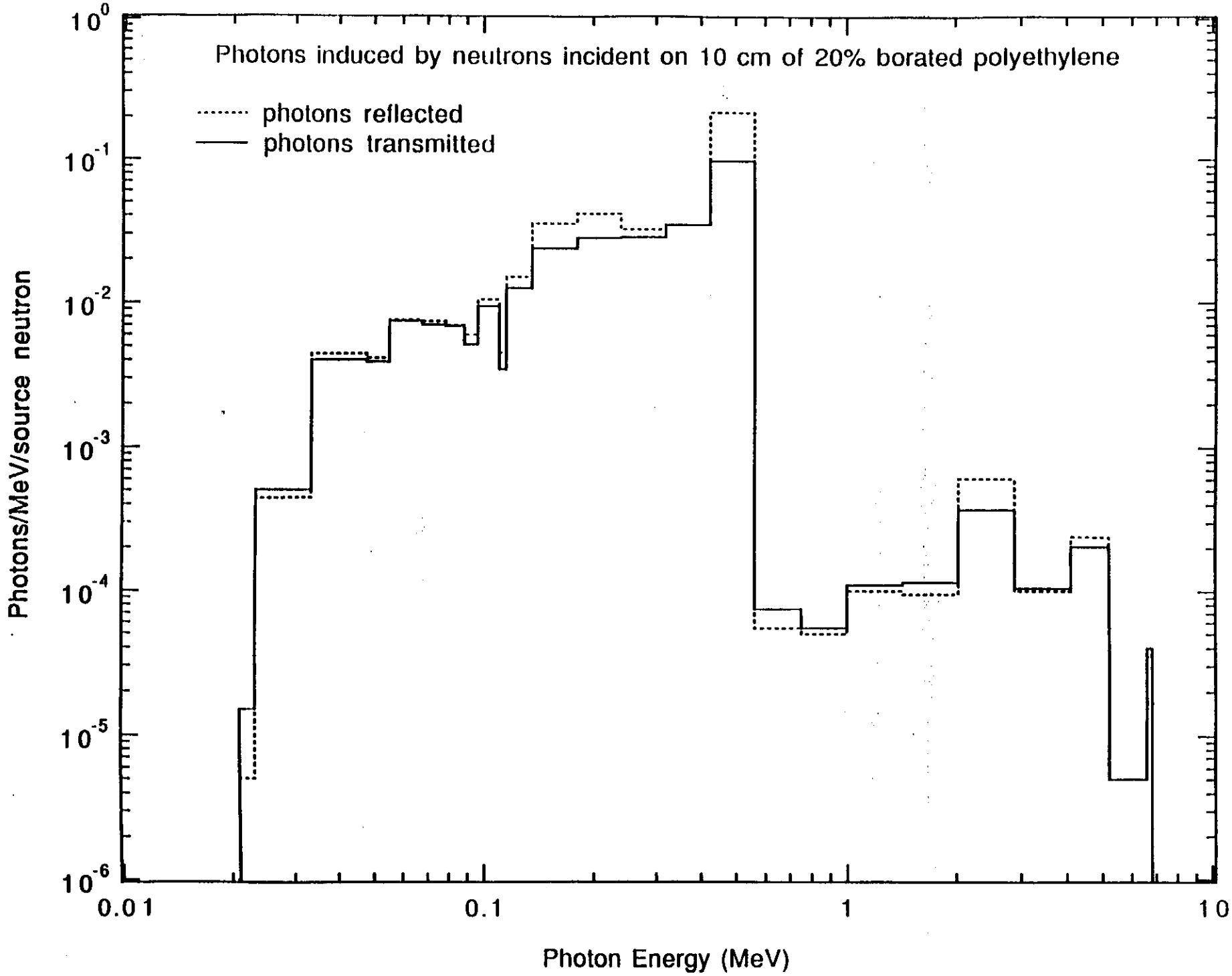

Photons induced by neutrons incident on 10 cm of 5% borated polyethylene
photons reflected
photons transmitted
Photons/MeV/source neutron
Photon Energy (MeV)
10^0
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0.01
0.1
1
10

Figure 6


Photons induced by neutrons incident on 10 cm of 20% borated polyethylene
photons reflected
photons transmitted
Photons/MeV/source neutron
Photon Energy (MeV)
10^{0}
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
0.01
0.1
1
10

Issues for Forward Calorimeter

J. Rutherfoord

Neutron Tube Geometry

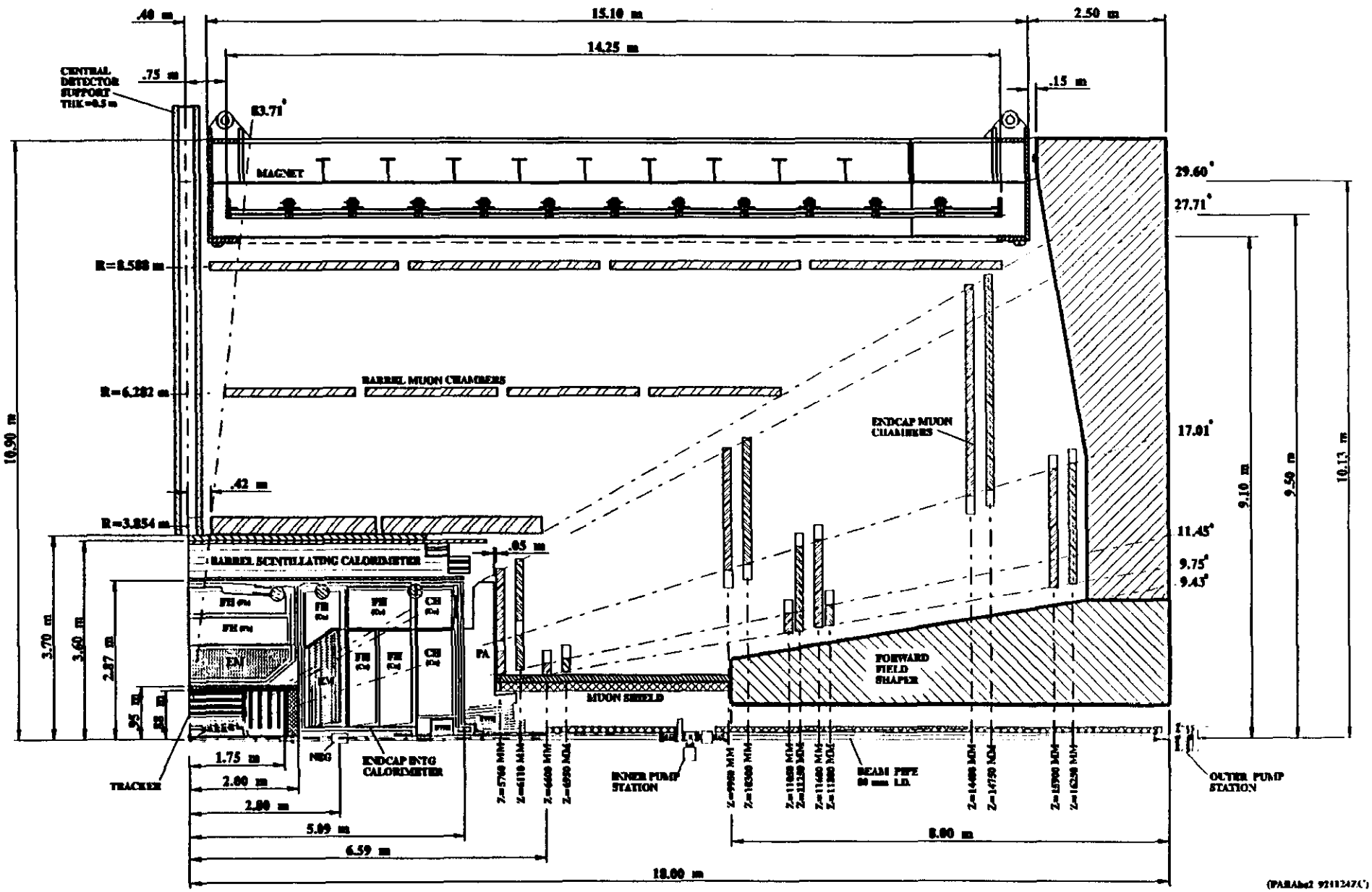
1/6/92

J. Rutherfoord

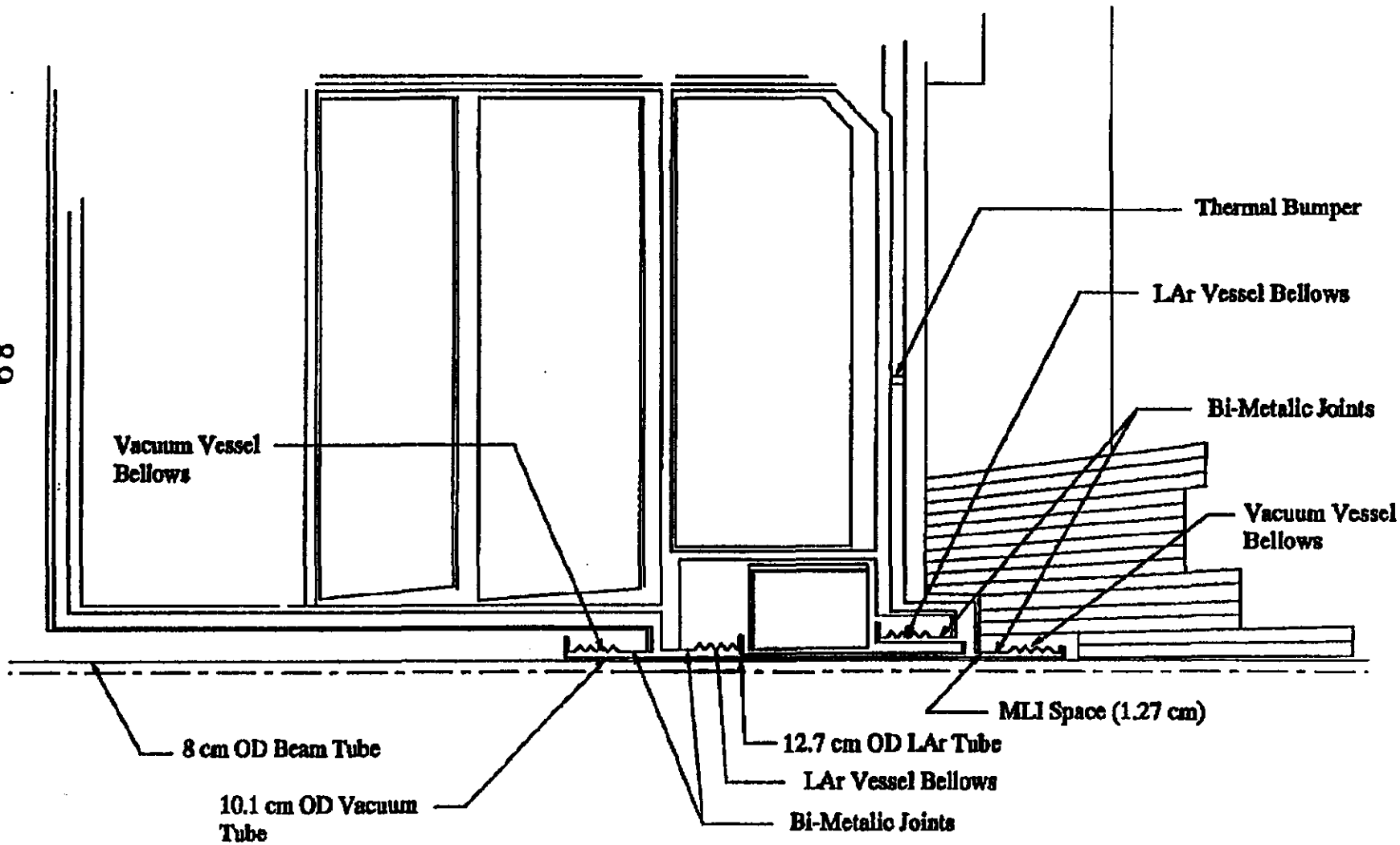
Issues for Forward Calorimetry

1. Sources of Neutrons
   Longitudinal segmentation of FCal
   "Lips" at downstream end of FCal
   Shower leakage thru FCal
2. Interaction with beam pipe
   "Ideal" geometry

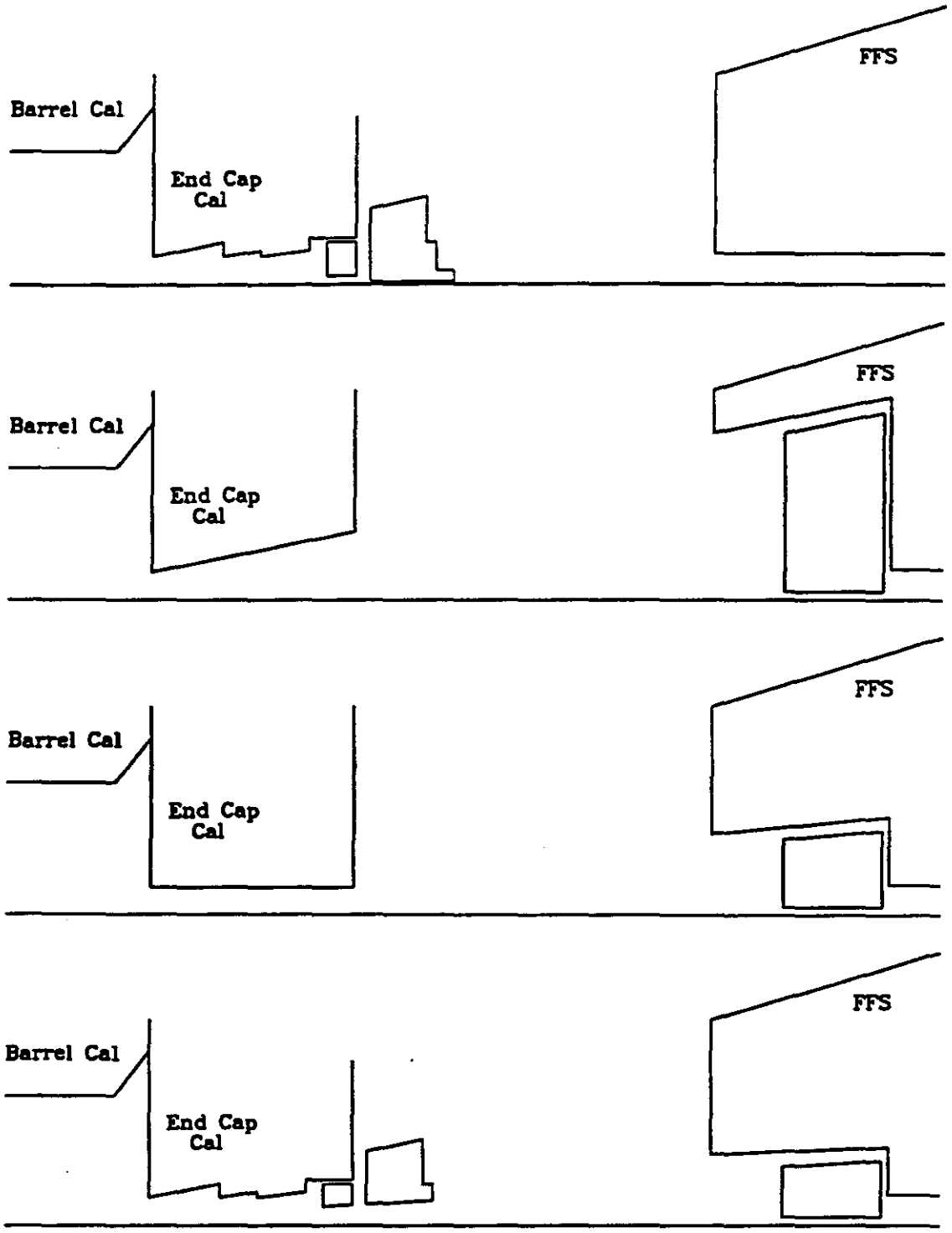
GEM DETECTOR PARAMETERS
BASELINE 2



GEM Forward Calorimeter - 11/16/92



TOTAL P.02



GEM FCal Options

J.Rutherfoord
11/20/92

GEM BEAM PIPE ISSUES

1) Vacuum requirements
   Beam-Gas events << Beam-Beam min bias events
      Minimize physics pileup
      Avoid confused triggers
      Maximize beam life-time
   Beam-Gas events outside calorimeter cavity
      Contribute to neutron fluence in muon chambers
   Beam-Gas events near FFQ will heat these quads

2) Beam Tube diameter and beam tube material selected to
   Maximize pumping efficiency
   Minimize secondary interactions in beam pipe walls
      Flaired beam pipe?
      FCal acts as collimator to clean debris from IP?
   Not act as a critical aperture in the accelerator!
   Reliably hold high vacuum

3) Vacuum and vacuum pump failure scenarios
   NEG's in regions with long access times

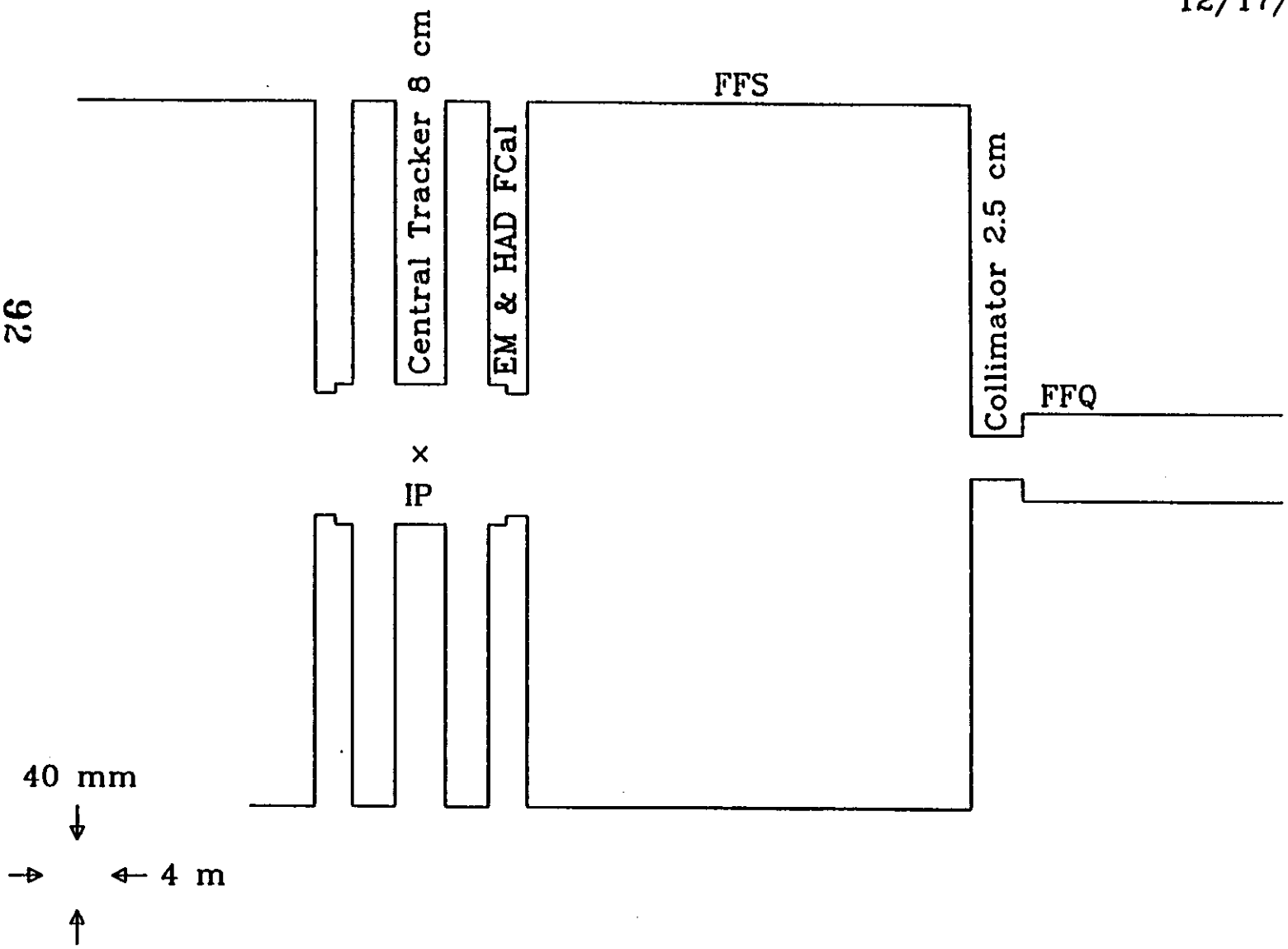
4) Surveyors' requirements on beam pipe diameter
   > 5cm diameter for sighting thru.
   Clearance to accommodate
      Assembly and disassembly for maintenance
      Rising and/or sinking of the hall floor

5) Physics coverage of FCal
   Beam pipe diameter > (8 cm plus clearance) inconsistent
      with FCal at z ~ 5 m.

6) Temperature requirements on beam pipe
   Is there sufficient thermal insulation between beam pipe
      and cryogenic calorimeters, particularly through FCal?

Elevation of Beam Pipe in GEM IR

J.Rutherfoord
12/17/92



Relevance of BNL Measurements

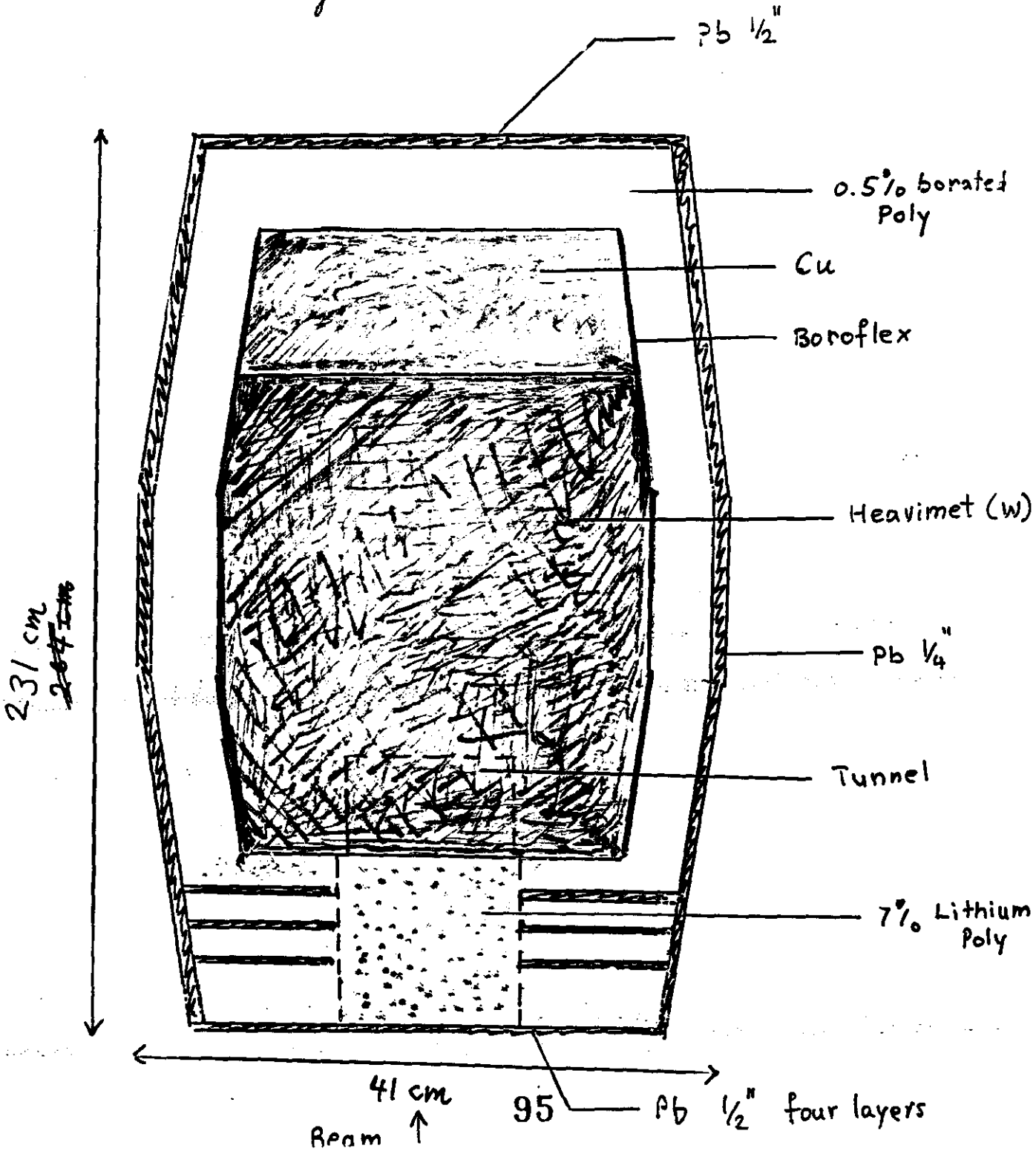
M. Diwan

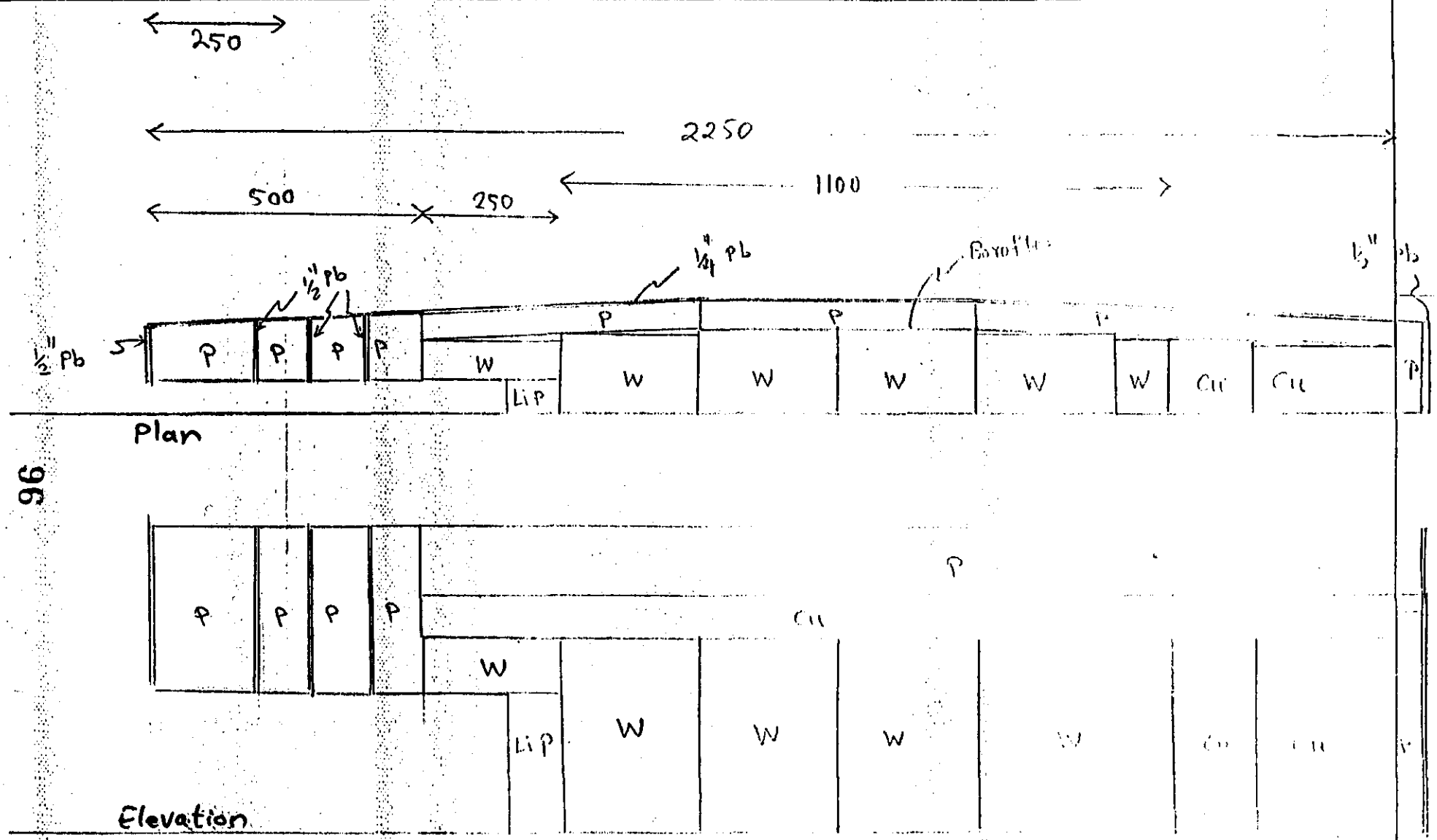
UCI, STANFORD, TEMPLE, UT-AUSTIN, WILLIAM & MARY

Beam Plug - plan view

Aspect ratio 1 transverse - 4 longitudinal

Height 112 cm

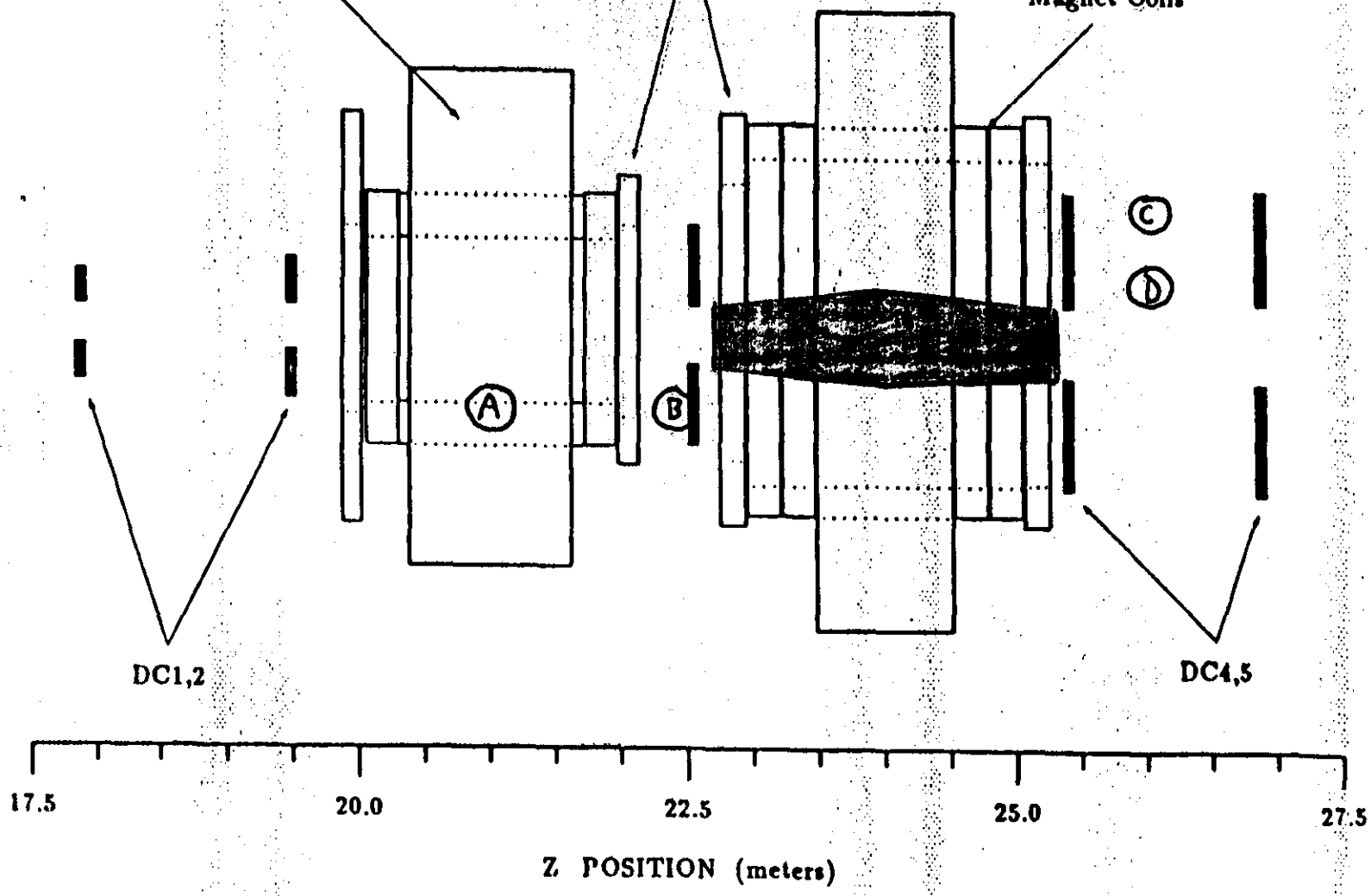




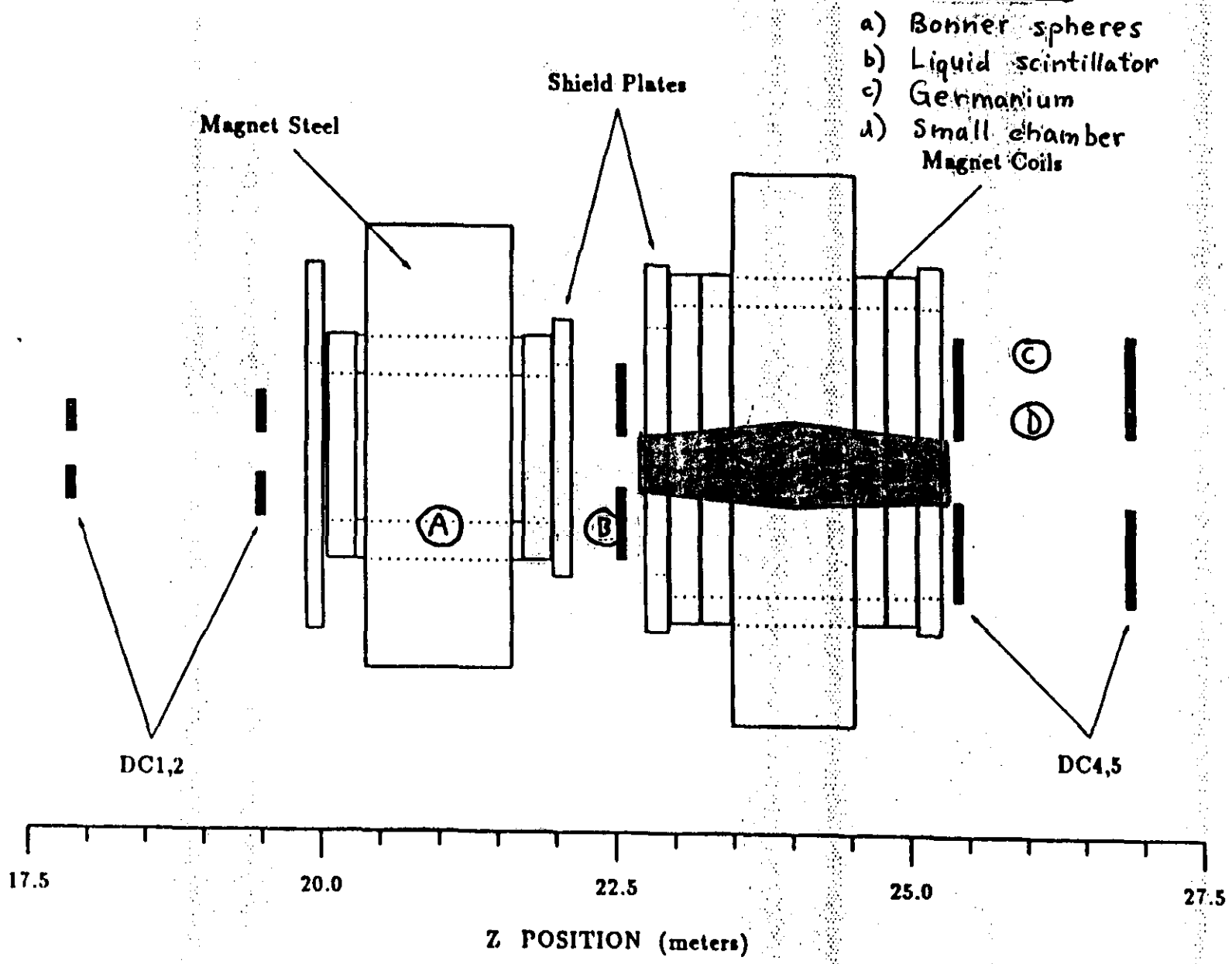
Boroflex = 30% Boron loaded poly
P = 0.5% Borated poly
LiP = 7% Lithium poly

Positions of neutron (γ) detectors

a) Bonner spheres
b) Liquid scintillator
c) Germanium
d) Small chamber



Positions of neutron (γ) detectors



Measurements

- 88 plug configurations
- Two sets of measurements as the plug was built up
  - A. Drift chamber, scintillator, etc.
  - B. Special purpose detector counts
    - n - Bonner sphere
      Liq. Scint.
      ^{3}He Counter
      Germanium
    - γ - Liq. Scint.
      Germanium
    - C - Liq. Scint.
      coincidence w. plastic scint.
- Normalization
  - No absolute normalization
  - Relative normalization between plug configurations at ~10% using beam telescopes and reconstructed V's.
- Goal

  spectra and absolute rates at diff. locations and diff. detectors.

* 88 plug configurations
* Two sets of measurements as the plug was built up
  - A. Drift chamber, Scintillator rates
  - B. Special purpose detector counts
    - n - Bonner spheres
      Liquid scint.
      ^{3}He counters
      Germanium
    - γ - Liquid Scint.
      Germanium
    - C - Liquid Scint.
      coincidence with plastic scint.
* Normalization
  - No absolute normalization
  - Normalization between plug configurations achieved ~~≈3~~ ~10%, using beam telescopes or ~~and~~ reconstructed V's.

*

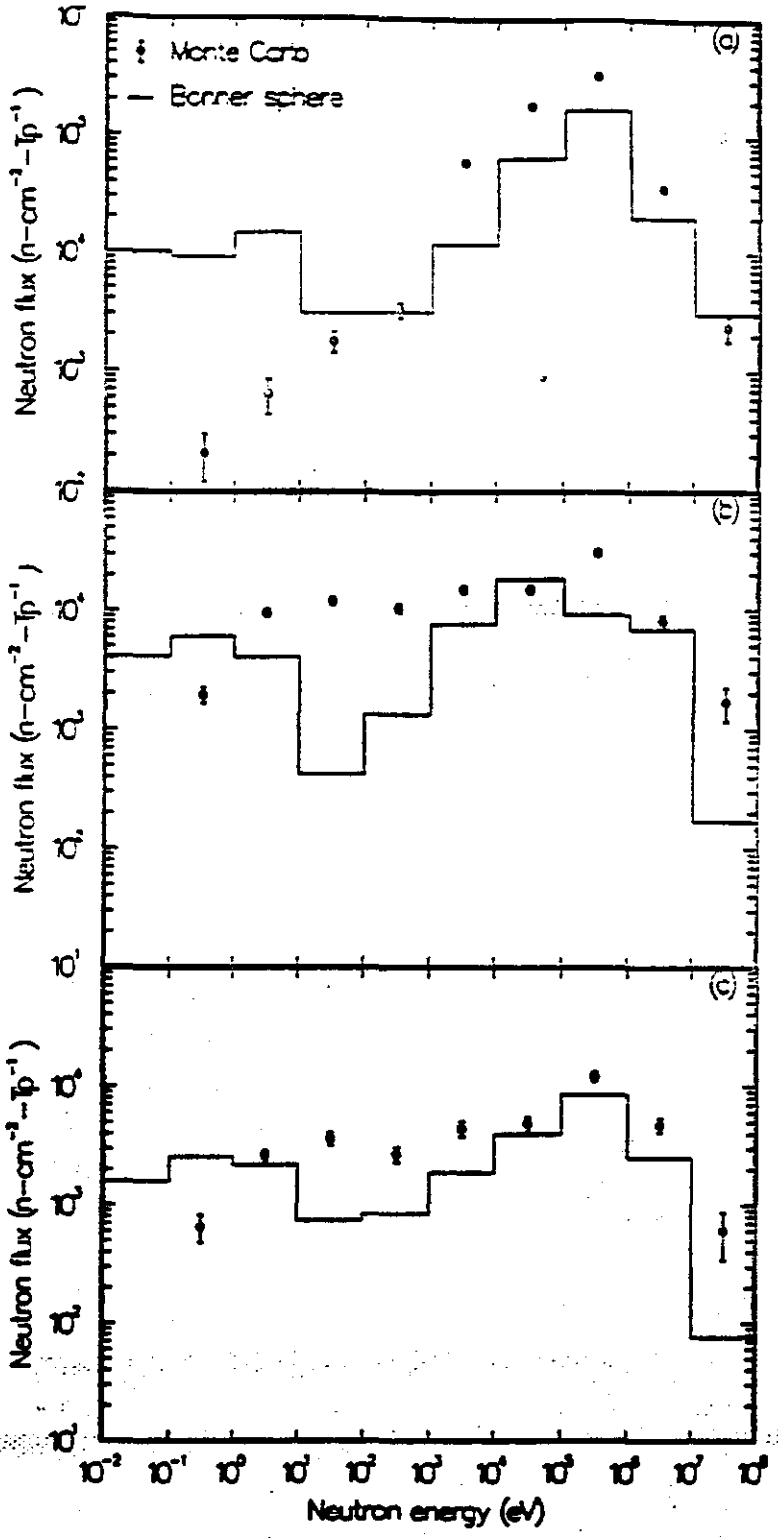


Figure 7: Comparison of Monte Carlo predicted neutron spectrum and measurements using Bonner spheres at the position of the upstream drift chamber for (a) metal only plug, (b) shielded plug, and (c) plug with an extra inch of tungsten and polyethylene.

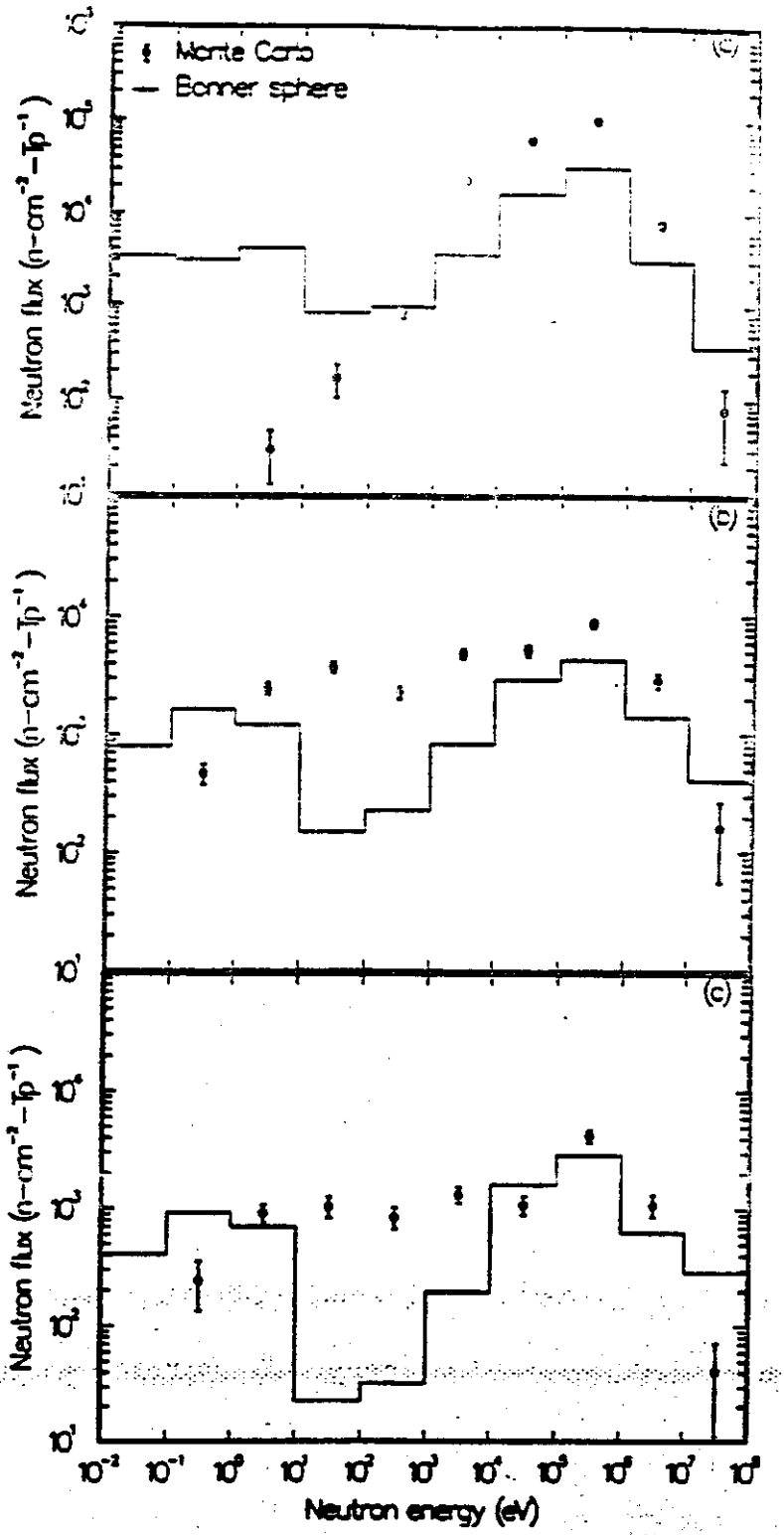
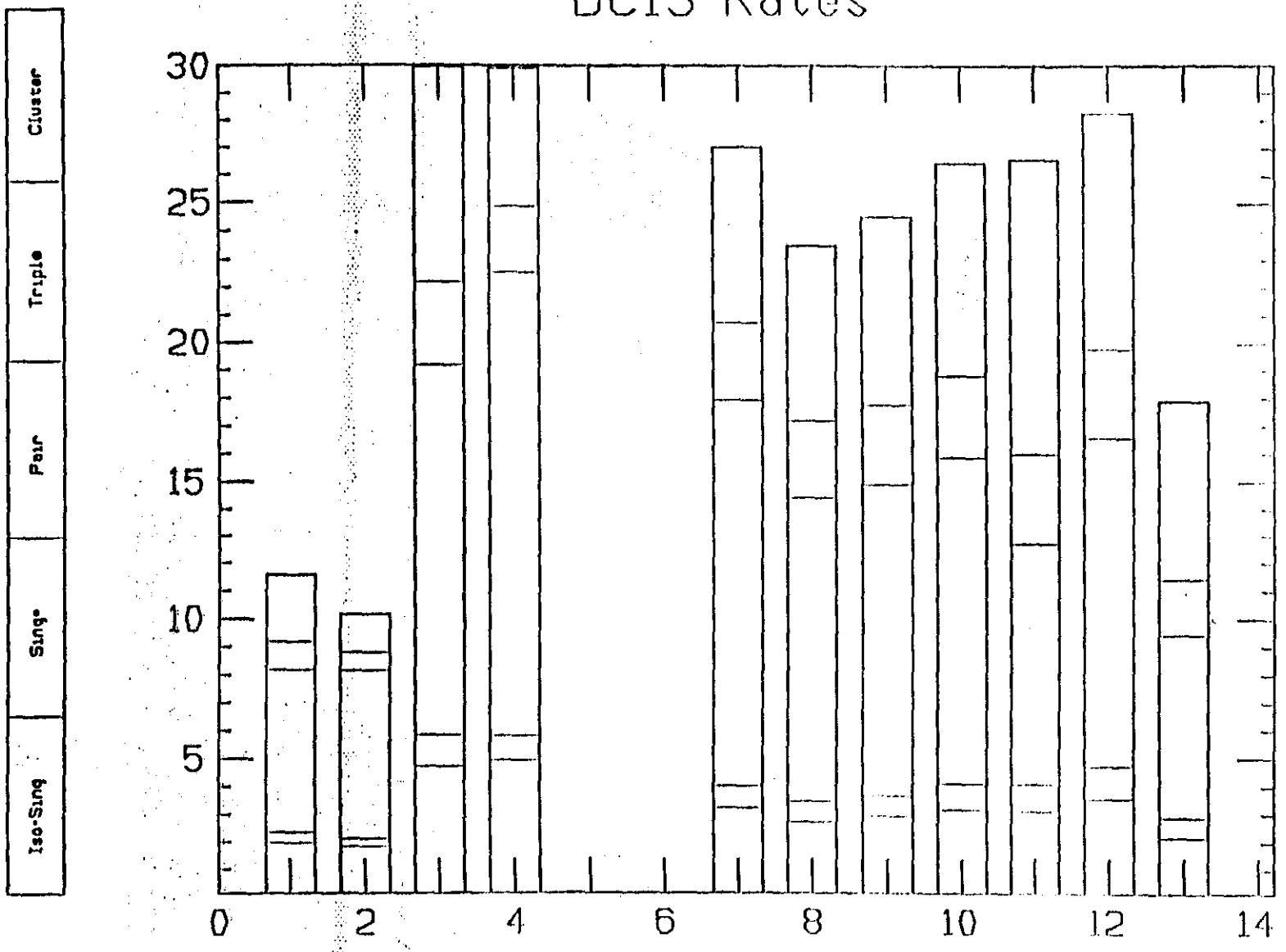
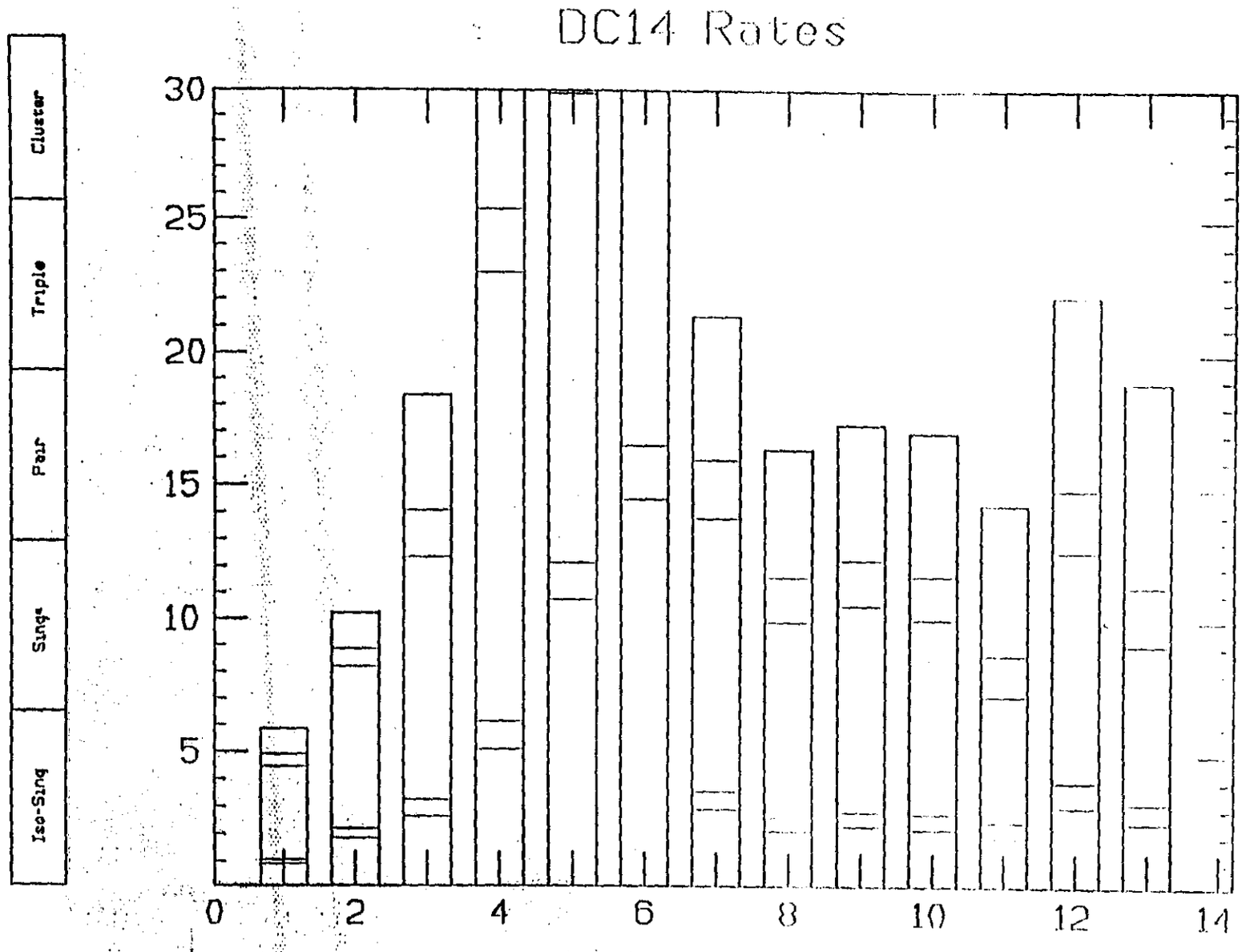
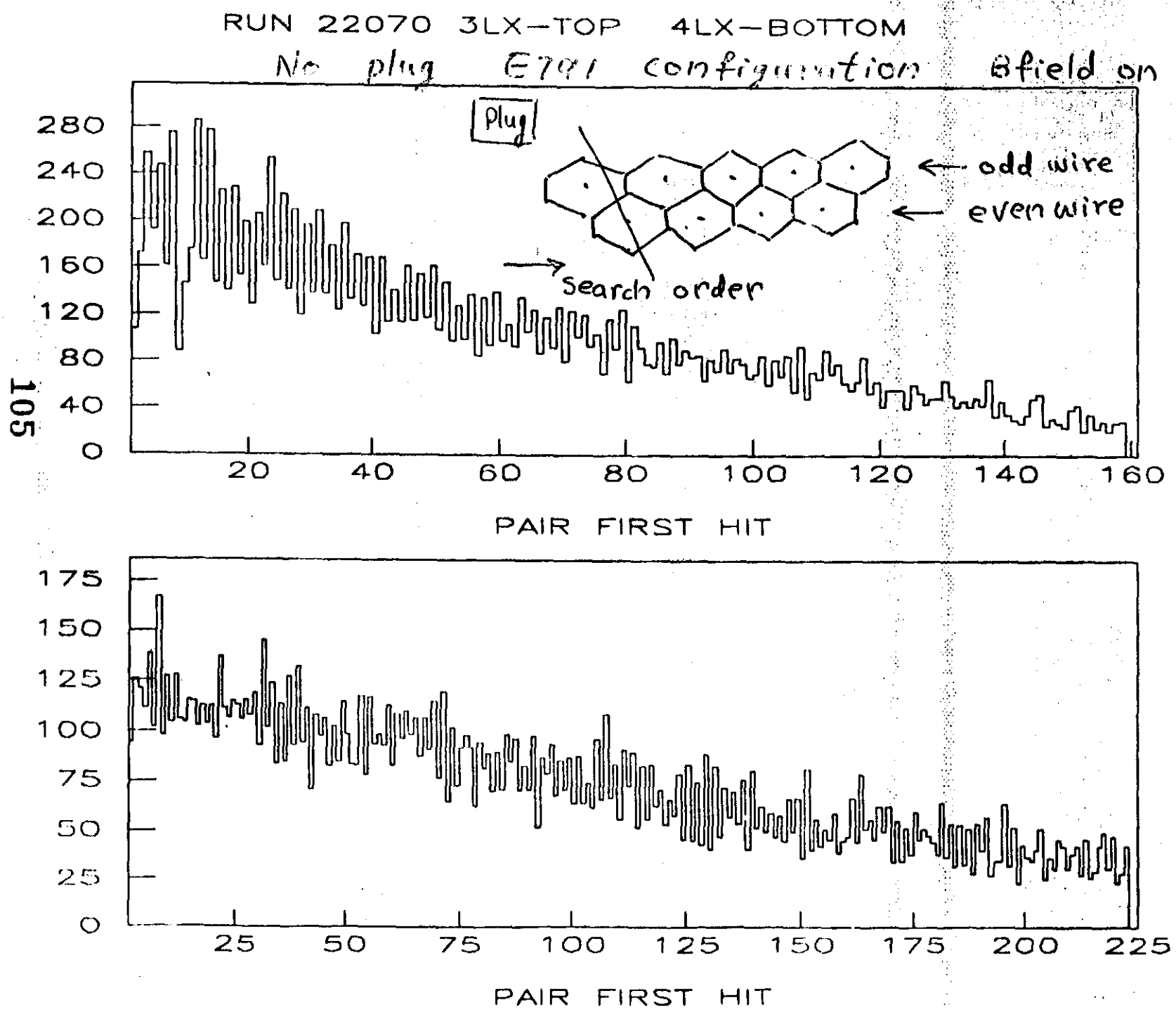
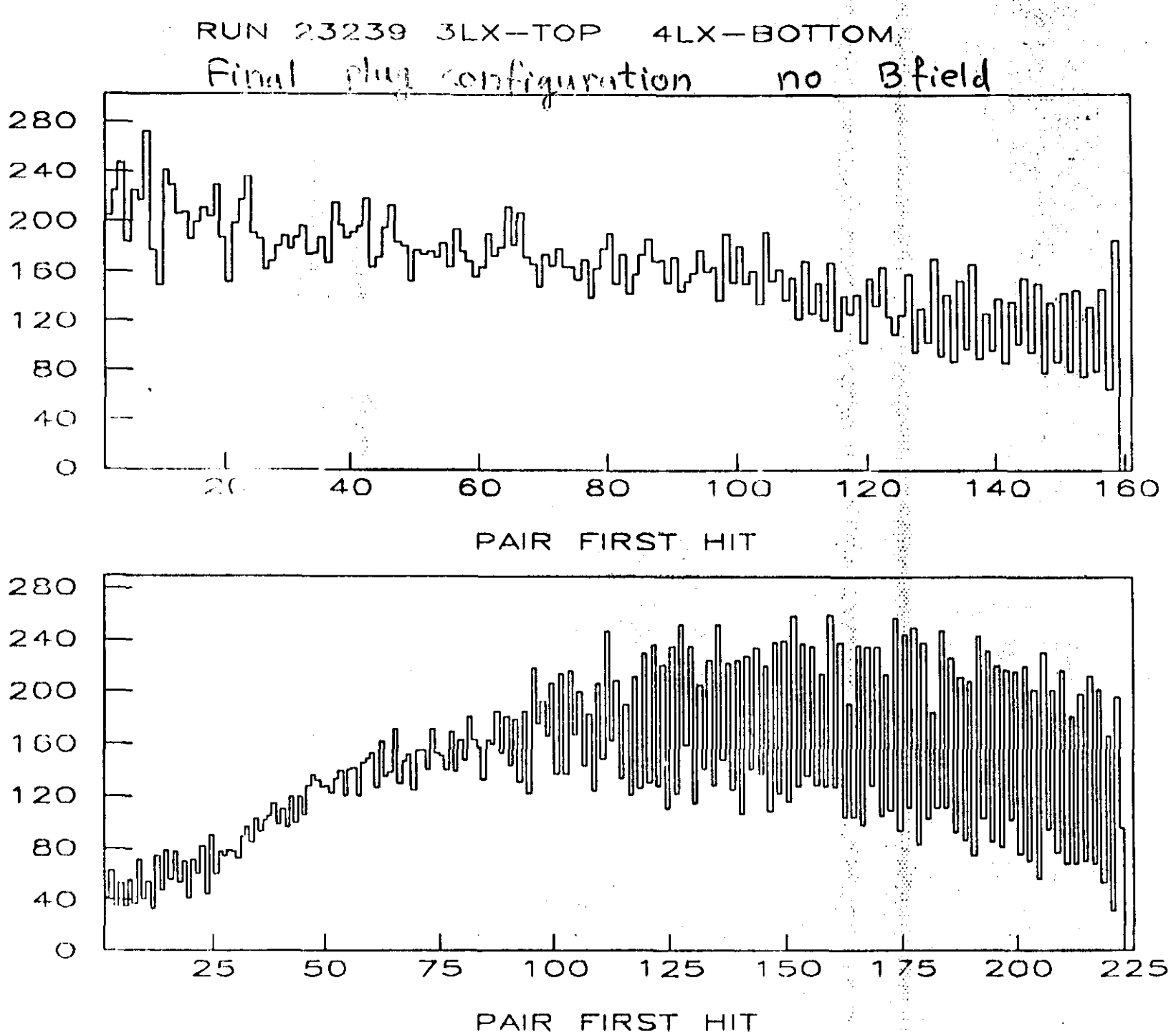


Figure 8: Comparison of Monte Carlo predicted neutron spectrum and measurements using Bonner spheres at the position of the downstream drift chamber for (a) metal only plug, (b) shielded plug, and (c) plug with an extra inch of tungsten and polyethylene.


DC13 Rates
Iso-Sing
Sing-
Pair
Triple
Cluster
30
25
20
15
10
5
0
2
4
6
8
10
12
14

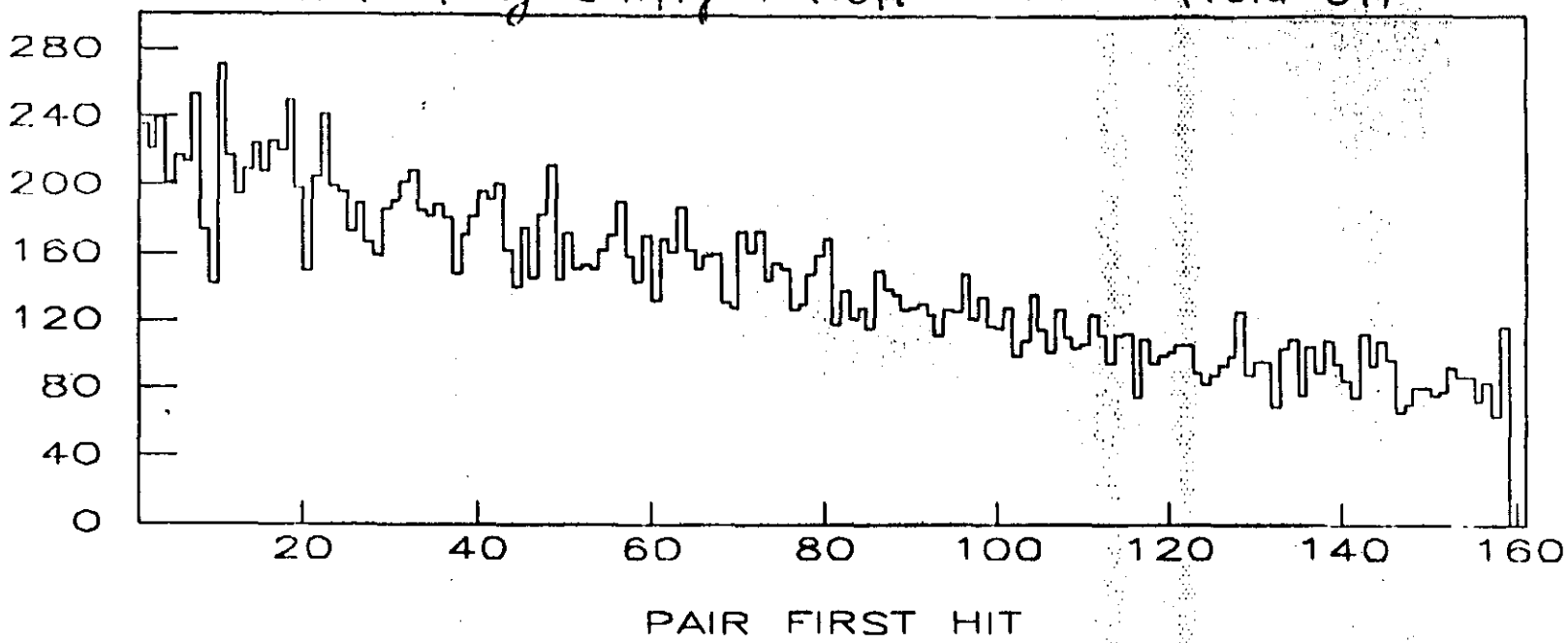

DC14 Rates
Cluster
Triple
Pair
Single
Iso-Sing
30
25
20
15
10
5
0
2
4
6
8
10
12
14

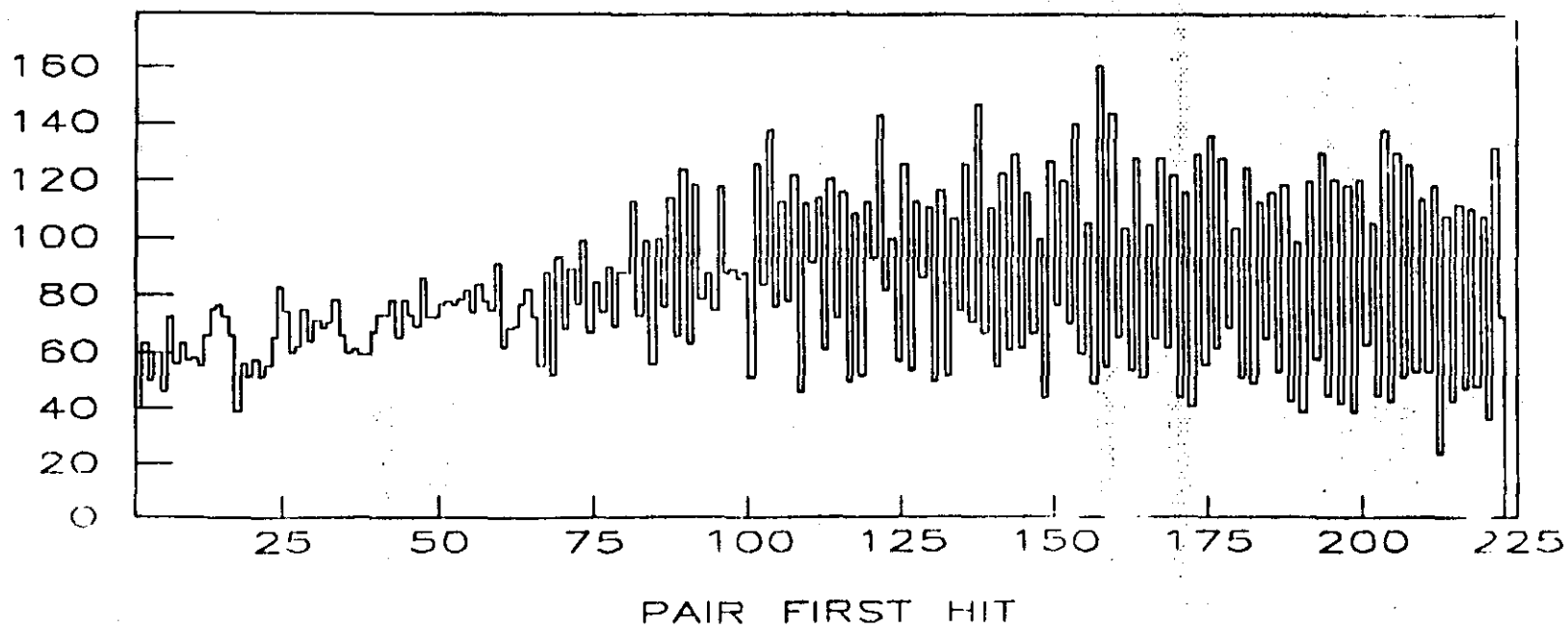

RUN 22070 3LX—TOP 4LX—BOTTOM
No plug E791 configuration Bfield on
Plug
odd wire
even wire
search order
280
240
200
160
120
80
40
0
20
40
60
80
100
120
140
160
PAIR FIRST HIT
175
150
125
100
75
50
25
0
25
50
75
100
125
150
175
200
225
PAIR FIRST HIT


RUN 23239 3LX—TOP 4LX—BOTTOM
Final plug configuration no B field
280
240
200
160
120
80
40
0
20
40
60
80
100
120
140
160
PAIR FIRST HIT
280
240
200
160
120
80
40
0
25
50
75
100
125
150
175
200
225
PAIR FIRST HIT

RUN 23241 3LX—TOP 4LX--BOTTOM

Final Plug configuration Bfield on





n - 206 E < 50 keV 4.4/√E(MeV) b E > 50 keV
γ - 0.002/√E(MeV) ← Dominated probability 1.35 cm × 8.10^19 hydrogen/cm^3 in 30 g/cm^2 of material included 10 cm of air

	Metal only plug	Shielded plug	Extra 1" W and poly
DC3 rate – pre-plug	3015	772	545
Monte Carlo			
from charged particles	987	339	242
from neutrons	1125	247	70
from photons	235	137	94
Sum	2347	783	406
Liquid scintillator and Bonner spheres minus pre-plug			
charged particles	401	158	195
neutrons	432	99	31
photons	205	100	53
Sum	1038	357	279

Table 4: Comparison of drift chamber DC3 rates (in clusters/B5T1) from charged particles, neutrons, and photons as predicted by the Monte Carlo simulations and the liquid scintillator and Bonner sphere measurements.

	Metal only plug	Shielded plug	Extra 1" W and poly
DC4 rate – pre-plug/2	**2542**	**654**	**624**
Monte Carlo			
from charged particles	215	202	114
from neutrons	1025	195	55
from photons	187	110	59
Sum	**1427**	**507**	**228**
Liquid scintillator and Bonner spheres minus pre-plug/2			
charged particles	409	504	263
neutrons	263	48	21
photons	240	78	38
Sum	**912**	**630**	**322**

Table 5: Comparison of drift chamber DC4 rates (in clusters/B5T1) from charged particles, neutrons, and photons as predicted by the Monte Carlo simulations and the liquid scintillator and Bonner sphere measurements.

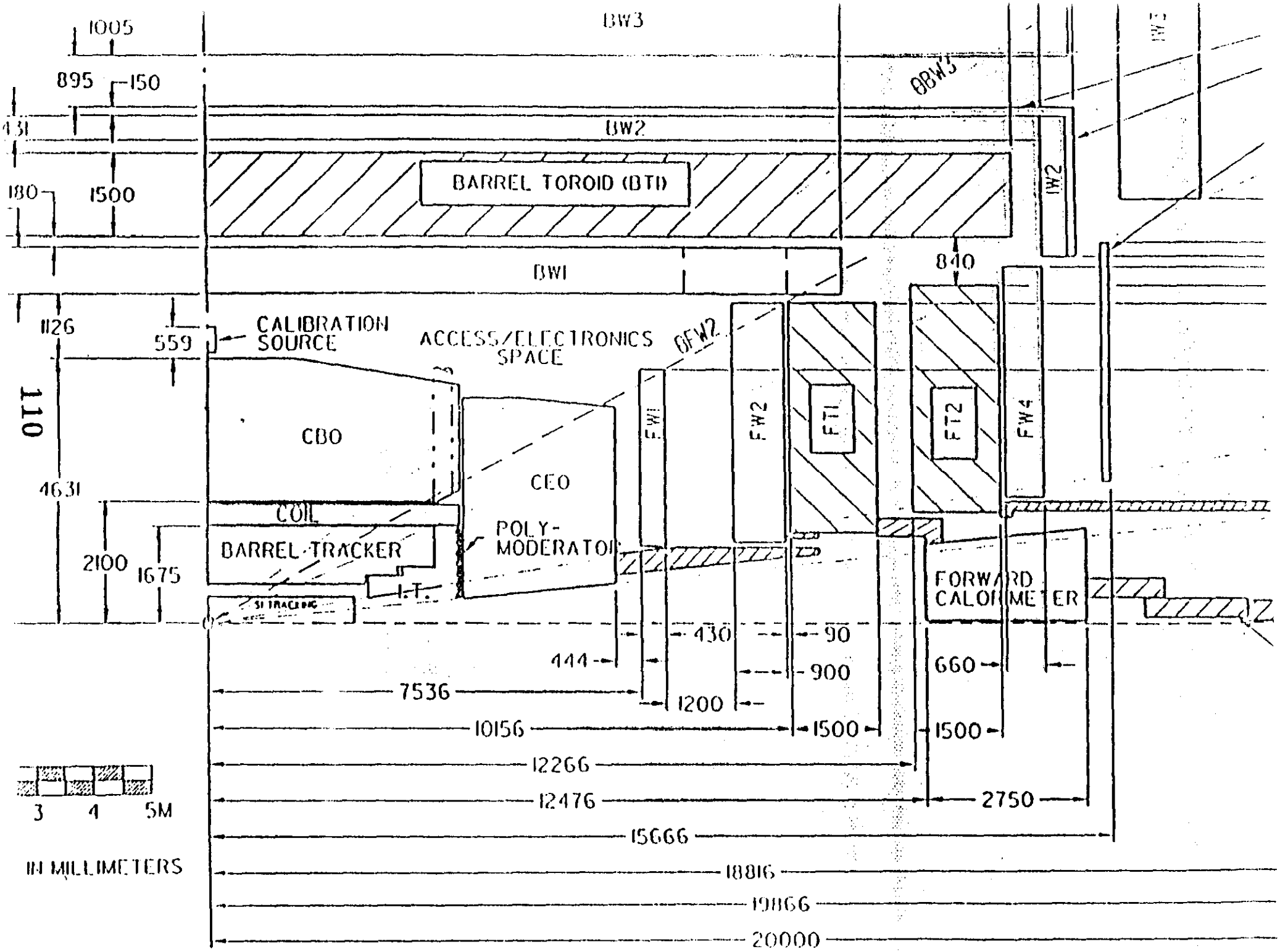
Key Results from Plug test

Detector [illegible]

1) Dou[illegible]
2) [illegible]
3) [illegible] increased by a factor of 2
4) [illegible] isotropic [illegible] increase of [illegible]

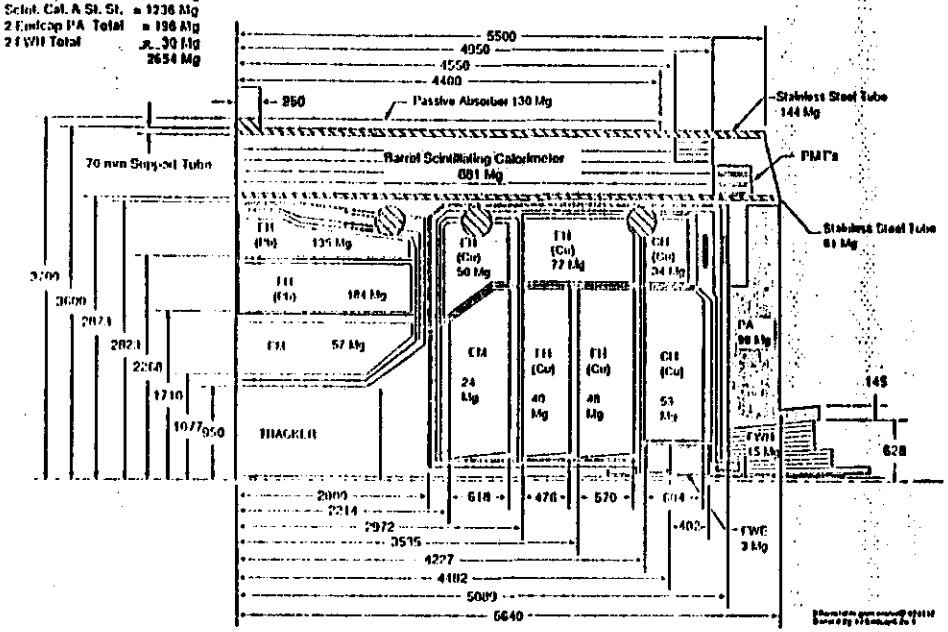
Fundamental understanding

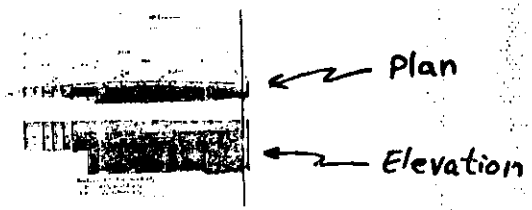
1) Low energy neutron rates very low after addition of polyethelene
2) photon flux could not be measured well below 200 KeV
3) Indirect measurements of low momentum charged flux. May be the main source of rates near plug. Use heavier material with same hydrogen content as poly.
4) Monte Carlo good tool, but lacks the "dynamic range" for this exercise


BW3
BW2
BW1
BARREL TOROID (BTI)
CALIBRATION SOURCE
ACCESS/ELECTRONICS SPACE
CBO
CEO
COIL
BARREL TRACKER
POLY-MODERATOR
FW1
FW2
FT1
FT2
FW4
FORWARD CALORIMETER
1005
895
150
431
180
1500
840
1126
559
110
4631
2100
1675
444
430
90
900
660
7536
1200
10156
1500
1500
12266
12476
2750
15666
18816
19866
20000
3
4
5M
IN MILLIMETERS

GEM Calorimeter

	Weight	Volume
Barrel Calorimeter	= 431 Mg	23135 L. I Kr
2 Endcap Total	= 752 Mg	38175 L. I Ar
Scint. Cal. & St. St.	= 1236 Mg	
2 Endcap PA Total	= 196 Mg	
2 I WI Total	30 Mg	
	2654 Mg	




Plan
Elevation

GEM UNDERSTANDING
ACTION ITEMS

- Muon system -

  [illegible] - [illegible]
  in [illegible]

  [illegible] - [illegible]
  [illegible]

  Beam pipe - [illegible]
  [illegible] beam pipe in detail.

- Central tracker

  FCAL - put shielding behind ([illegible])
  move FCAL back poly in front
  ([illegible])
  Calorimeter Cracks (probably not [illegible])

  CAN μuon and c.c be decoupled ?

- Detector response

  * need to calculate γ rates
  * Some models of detectors / electronics
  * Experimentation / no substitutes.