GEM TN-93-299

GEM Neutron Task Force Meeting - SSCL

February 24, 1993

Abstract:

Agenda, attendees, and presentations of the GEM Neutron Task Force Meeting held at the SSC Laboratory on February 24, 1993.

This is an update to the Neutron task force agenda.

I could not get the GEM conference room for the afternoon, and therefore the meeting will be in Bldg 1 Upstairs in room 285I.

Enter Bldg 1 from the Beckleymeade Ave. entrance. Go Upstairs. Turn left. Go to end of hall. Turn right into suite 285. Go to the end of hall.

==========

Neutron Task Force Meeting

Wed. 24th February

Bldg. 1 Upstairs conference room 285 I

1300	Neutron and Gamma sensivity measurements at ITEP	V. Gavrilov
1340	Background from accelerator components	N. Mokhov
1410	Shielding studies	L. Waters
1440	FCAL leakage studies	B. Moore
1510	Muon chamber singles rates using GEANT and CALOR	I. Fissyak
1600	TDR chapter progress Discussion	Everyone

T. Pal
P. Dingus
J. Coyne
G. Stapleton
V. Gavrilov
I. Azhgirey
A. Uzunian
J. Lawler
M. Diwan
M. Marx
G. Chapman
K. Freeman
N. Mokhov
K. Morgan
I. Fisyak
A. Golutvin
L. Waters
L. Hansen
C. Wuest
R. Mcneil
J. Rutherfoord
Y. Kamyshkov
B. Moore.

Neutron Task Force

Feb. 24, 1993

Presentation by:

V. Gavrilov

Neutron and Gamma sensitivity of RDT

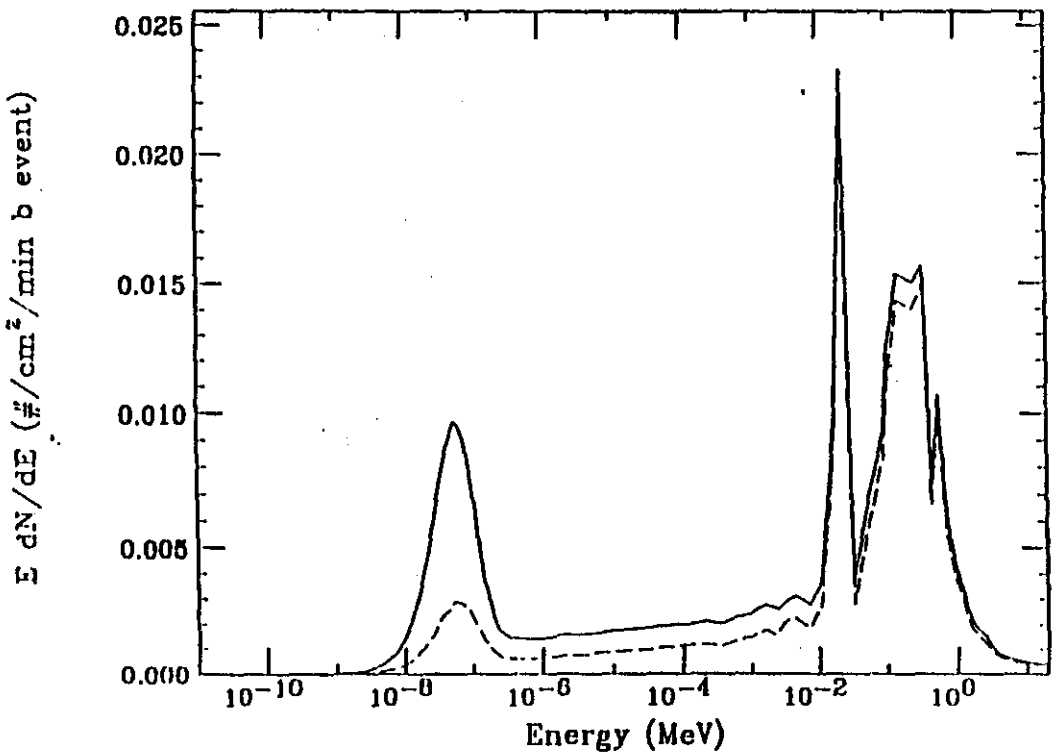
ITEP Data
(Jan.- Feb. 93)

Occupancy

$$\mathcal{L} \times S_{ch} \times \Delta\tau \times \sum_{n,\gamma} \int \frac{dn}{dE}\, \eta(E)\, dE$$

SOC-92-414

air within detector, w/ and w/o concrete



Previous results

LSDT GEM TN-92-122

2.2 cm 10% Ar + 90% iC_4H_{10}

"eff" = 4.3×10^{-3} ($1.95 \cdot 10^{-3}$/cm)

CSC GEM TN-92-199

0.5cm 50% CF_4 + 50% CO_2

"eff" = 4.7×10^{-3} ($9.4 \cdot 10^{-3}$/cm)

Questions

- Albedo ?
- Photon BG? (Pb shield)
- Amplitude distribution ?
- Energy dependence ?
- Sensitivity to photons ?

Features of neutron measurements

- Undefined trajectory
- Wide spectrum, undefined energy
- Poor n/γ separation in wire chamber

Isolation of albedo contribution (n & γ!)

Complimentay measurements:

- moderator
- absorbers (Pb, Cd)
- different distances

Flux measurements

Aims

- Developing methods
- Neutron sensitivity of RDT
  - at different energies
  - for various gases (and mixtures)
  - for various wall materials
- Amplitude distributions
- Gamma sensitivity of RDT
- Provide data for verification of neutron/gamma calculations

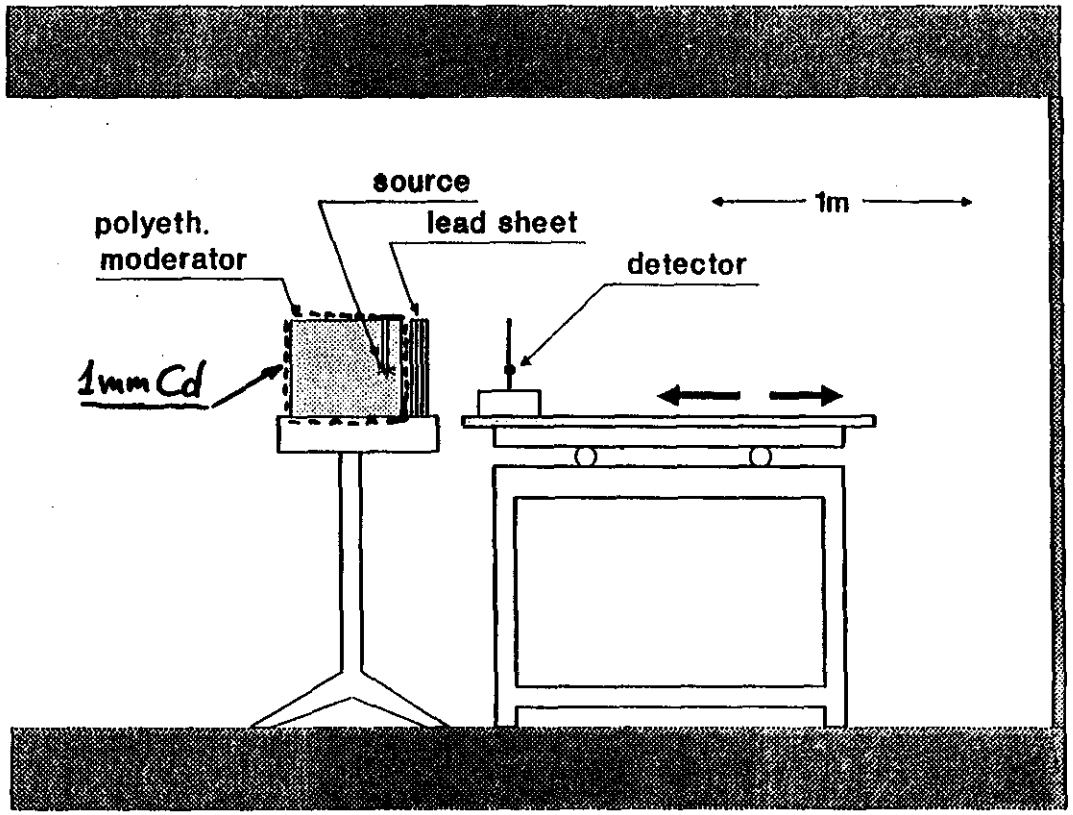
ITEP neutron group:

V. Gavrilov
L. Kondratiev
S. Kuleshov
V. Russinov

V. Stolin
I. Tikhomirov
V. Vassiliev
+ 2 students

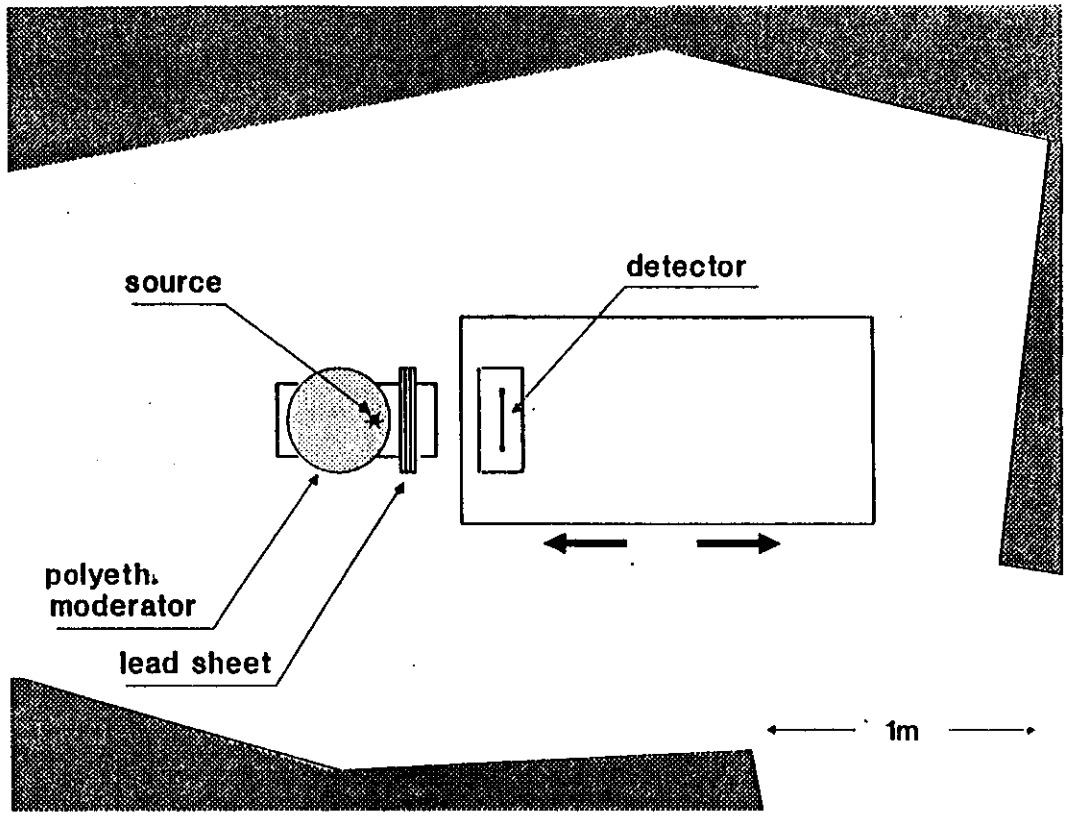
LAHET calculations:

V. Morgunov



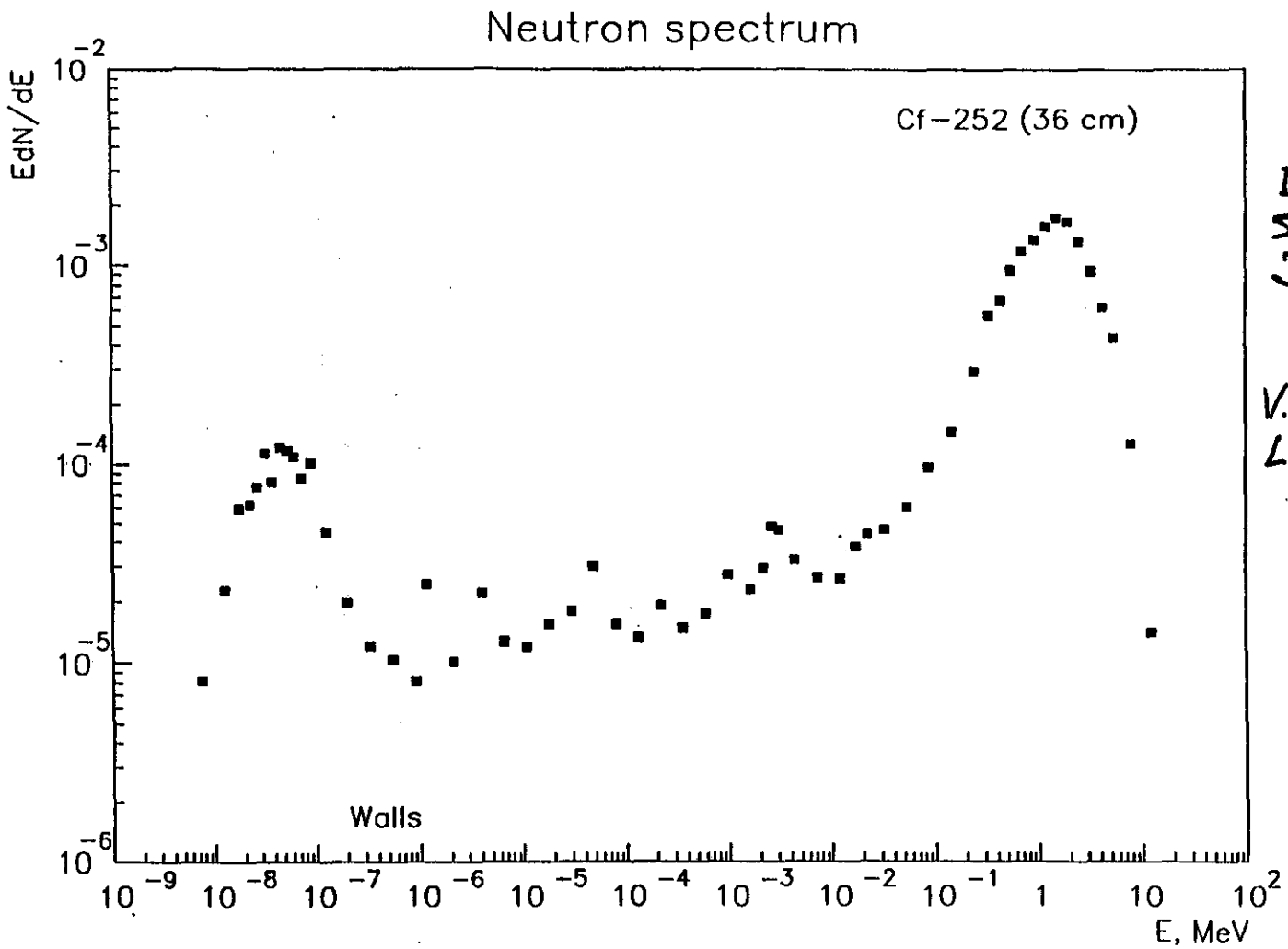
Jan. 93

ITEP neutron set-up



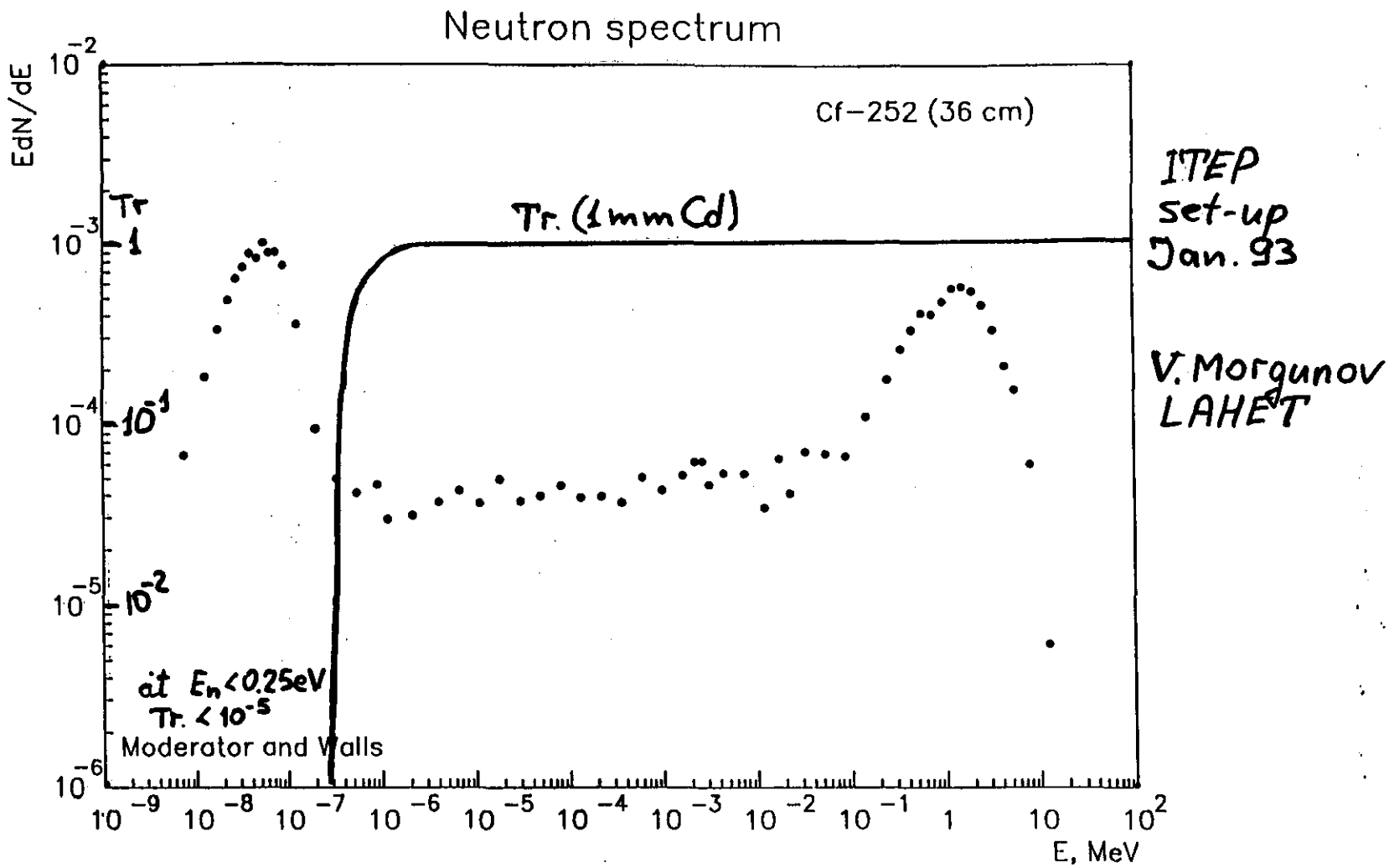
Jan. 93

ITEP neutron set-up



ITEP
set-up
Jan. 93

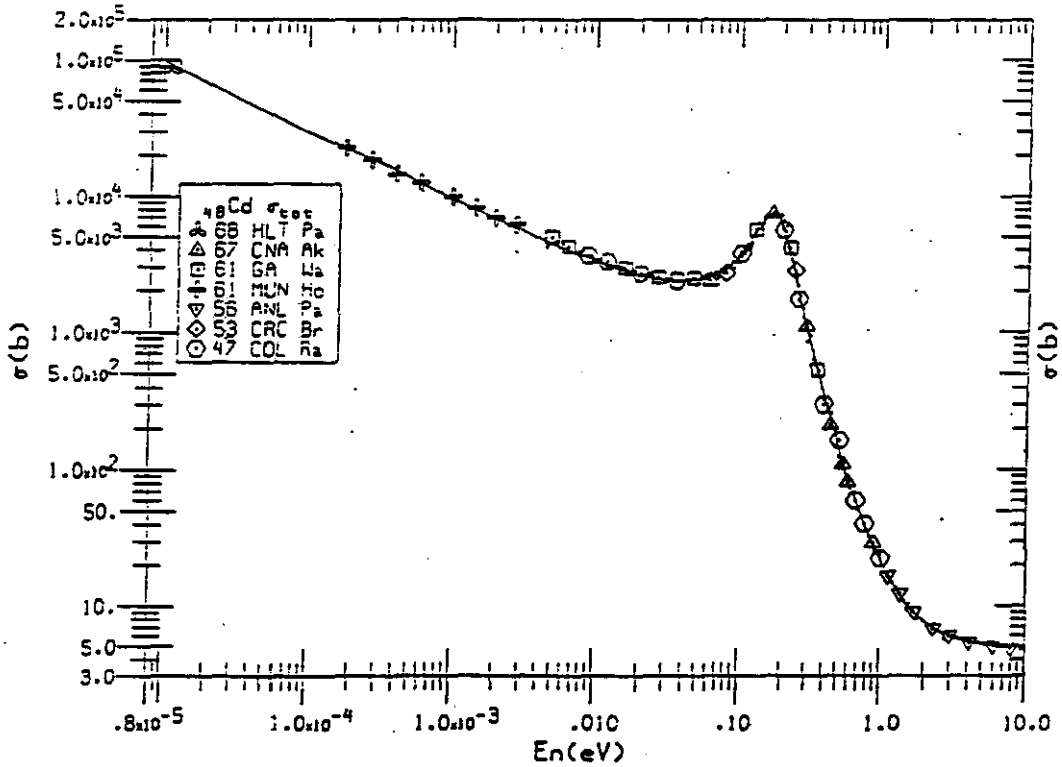
V. Morgunov
LAHET


Neutron spectrum
EdN/dE
Cf−252 (36 cm)
Tr. (1mm Cd)
Tr
1
10^{-1}
10^{-2}
at E_n<0.25eV
Tr. < 10^{-5}
Moderator and Walls
E, MeV
ITEP
set-up
Jan. 93
V. Morgunov
LAHET

$_{48}Cd$

σ_{tot}

[1281]



RDT parameters

	Tube I	Tube II
Wall material	Stainless steel	Aluminum
Wall thickness (mm)	1.0	0.7
Inner diameter (mm)	18.0	26.5
Length (mm)	142.	180.

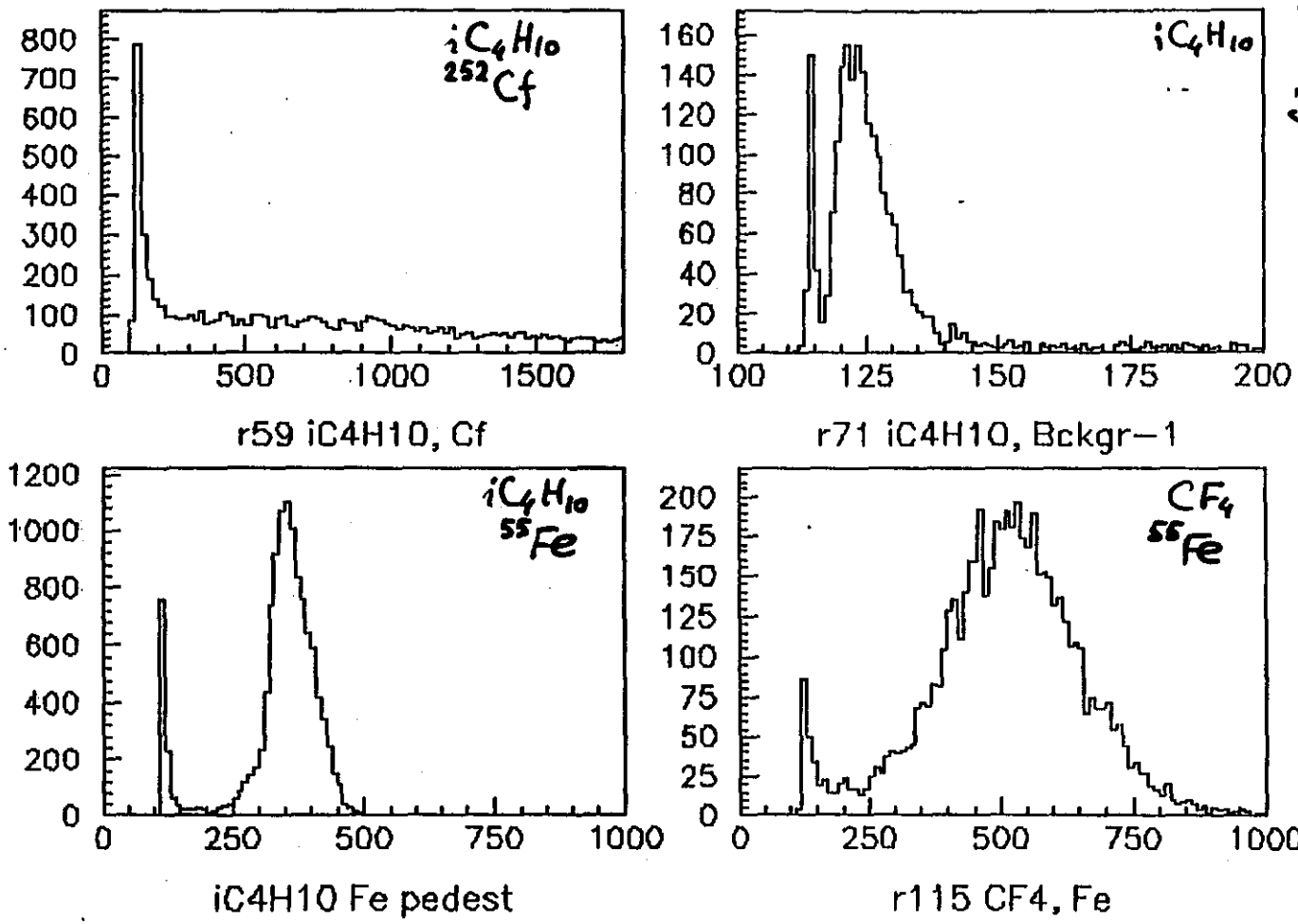
Wire ø	30 μm
$\Delta\tau$	1.4 μsec
Threshold	≃ 0.2 keV
Collected charge (^{55}Fe)	≃ 0.1 pC

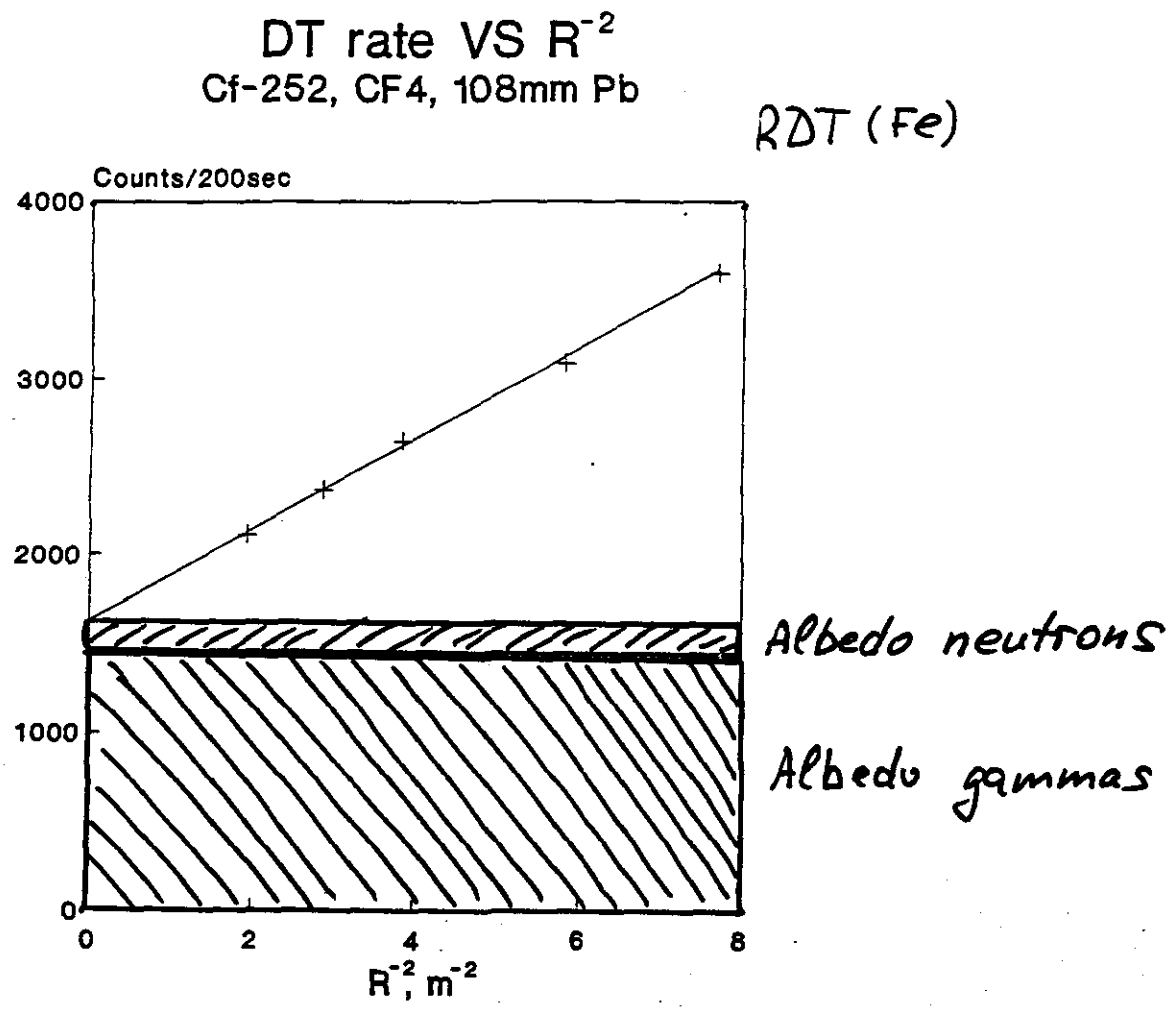
RDT (Fe)

Raw adc spectra

ITEP

Jan. 93





Gamma fraction ratio

V. Morgunov
LAHET
(E_γ ~ 0.5-5 MeV)

L, cm	Count rates		Fluxes
	exper.	calculations	
36	41%	50%	5.8%
72	70%	76%	16.1%

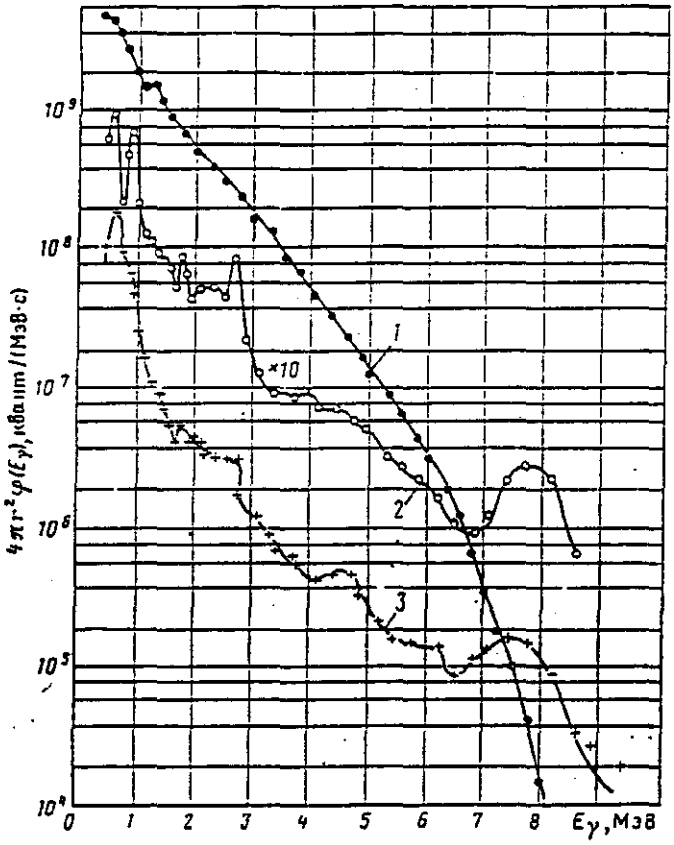
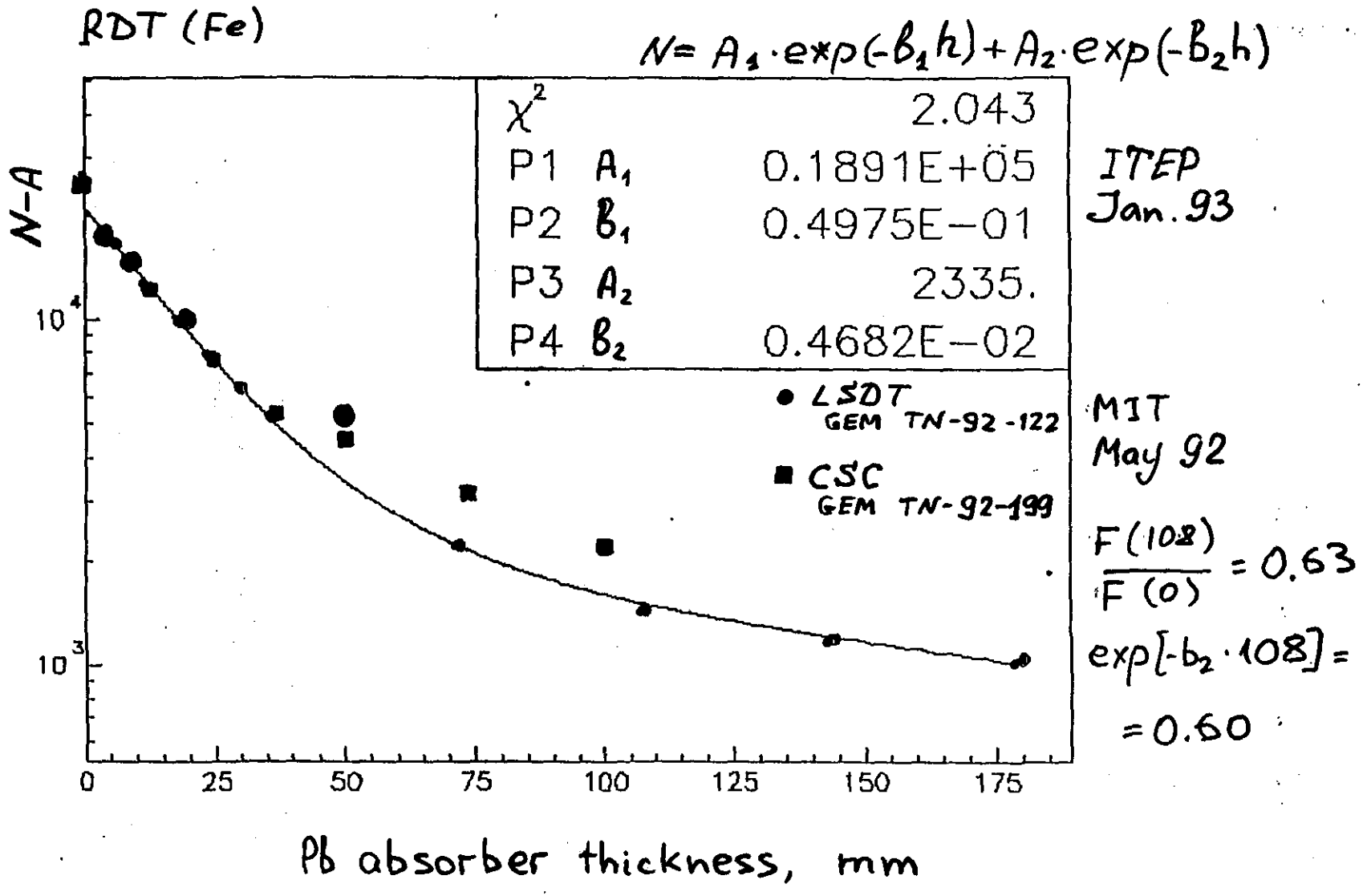


Рис. 3.39. Энергетические спектры γ-излучения, утекающего с поверхности шаров из Pb:

1 — первичный спектр из источника ^{252}Cf; *2* — шар диаметром 40 см со стальной оболочкой толщиной 2 мм (r=121 см); *3* — шар диаметром 60 см (r=60 см). Данные нормированы на источник нейтронов с выходом 10^6 нейтр./с


RDT (Fe)
$N = A_1 \cdot \exp(-b_1 h) + A_2 \cdot \exp(-b_2 h)$
χ^2 2.043
P1 A_1 0.1891E+05
P2 b_1 0.4975E−01
P3 A_2 2335.
P4 b_2 0.4682E−02
ITEP Jan. 93
LSDT GEM TN-92-122
CSC GEM TN-92-199
MIT May 92
$\frac{F(108)}{F(0)} = 0.63$
$\exp[-b_2 \cdot 108] = 0.60$
N−A
10^4
10^3
0
25
50
75
100
125
150
175
Pb absorber thickness, mm

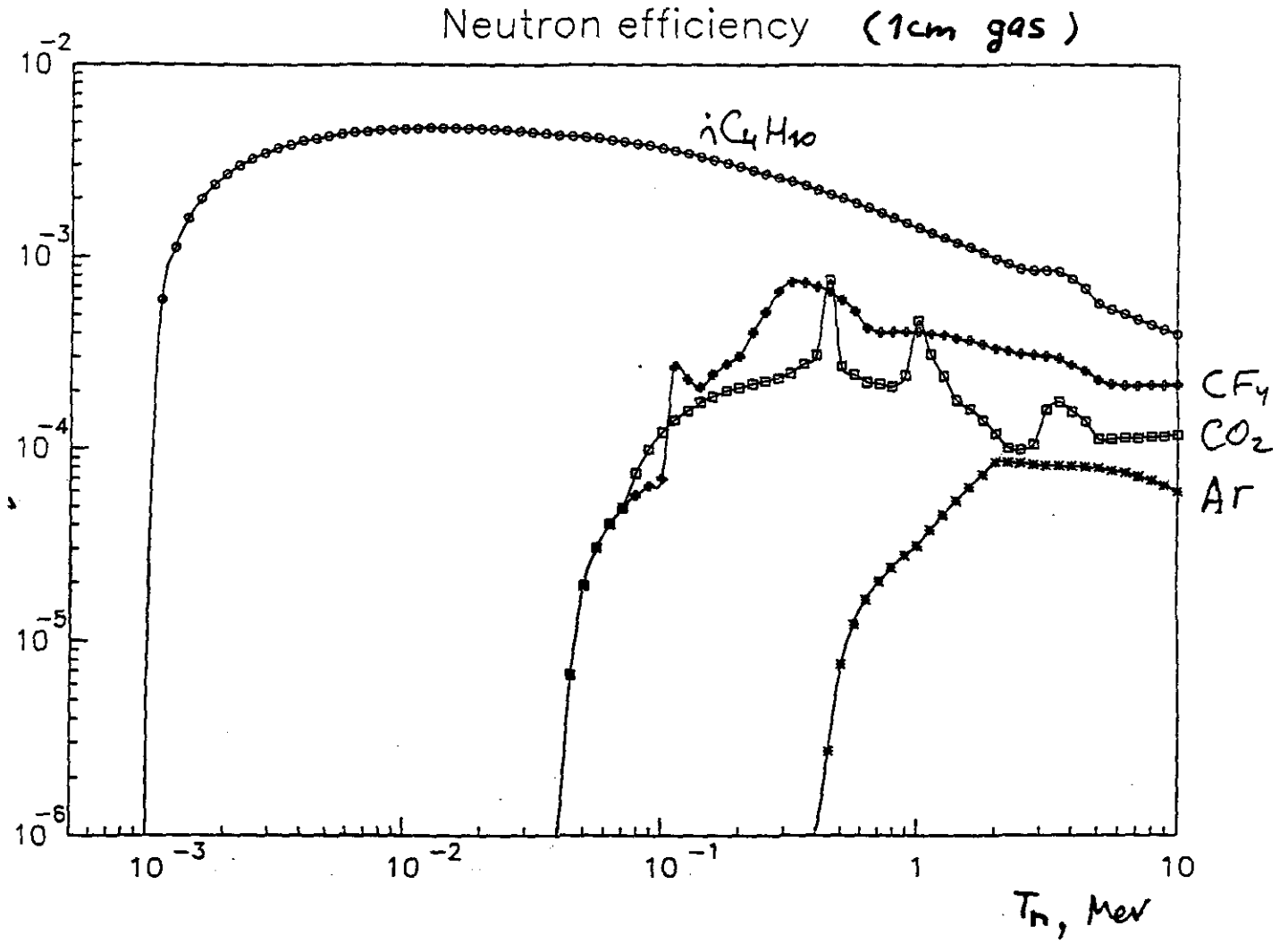
Preliminary

RDT sensitivity
to fast neutrons (in units of 10^{-3})

Tube #	Gas	eff.	eff./1cm	expect.
I (Fe)	CF_4	0.91	0.64	0.37
	iC_4H_{10}	2.36	1.63	1.31
II (Al)	CF_4	0.88	0.42	0.37
	iC_4H_{10}	2.30	1.11	1.31
LSDT	iC_4H_{10} + Ar 90% + 10%	4.3	1.95	1.2
CSC	CF_4 + CO_2 50% + 50%	4.7	9.4 ??	0.37

Pb house ⇒ Rate-albedo in 2.-2.4 times higher

$$T_e^{max} \simeq 4\, E_A \left(\frac{m_e}{m_A}\right) = 2\cdot 10^{-3}\,\frac{E_A}{A} \qquad E_A^{min} = A\cdot 1\,keV$$

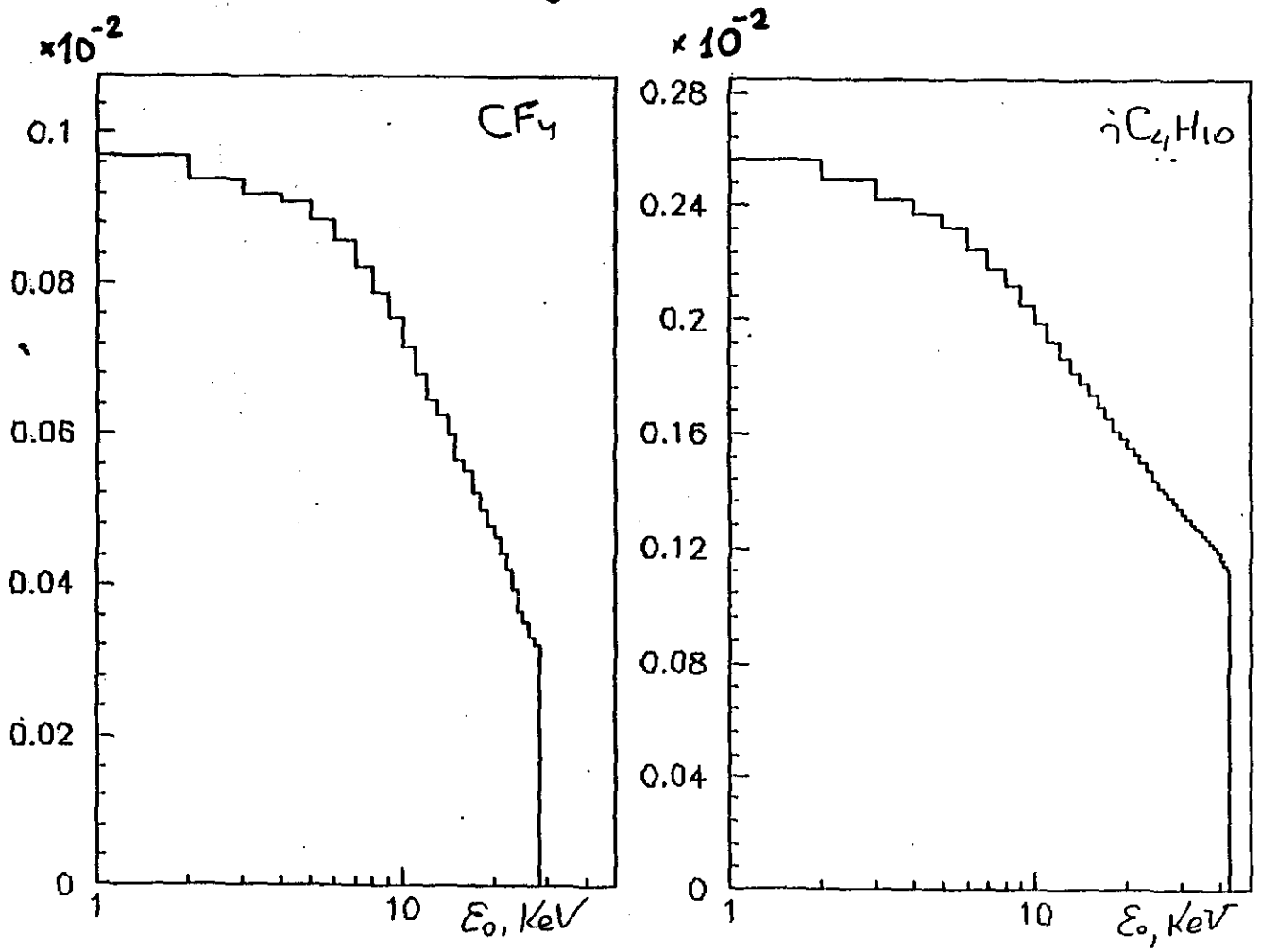


RDT (Fe)

Preliminary

Fast neutrons

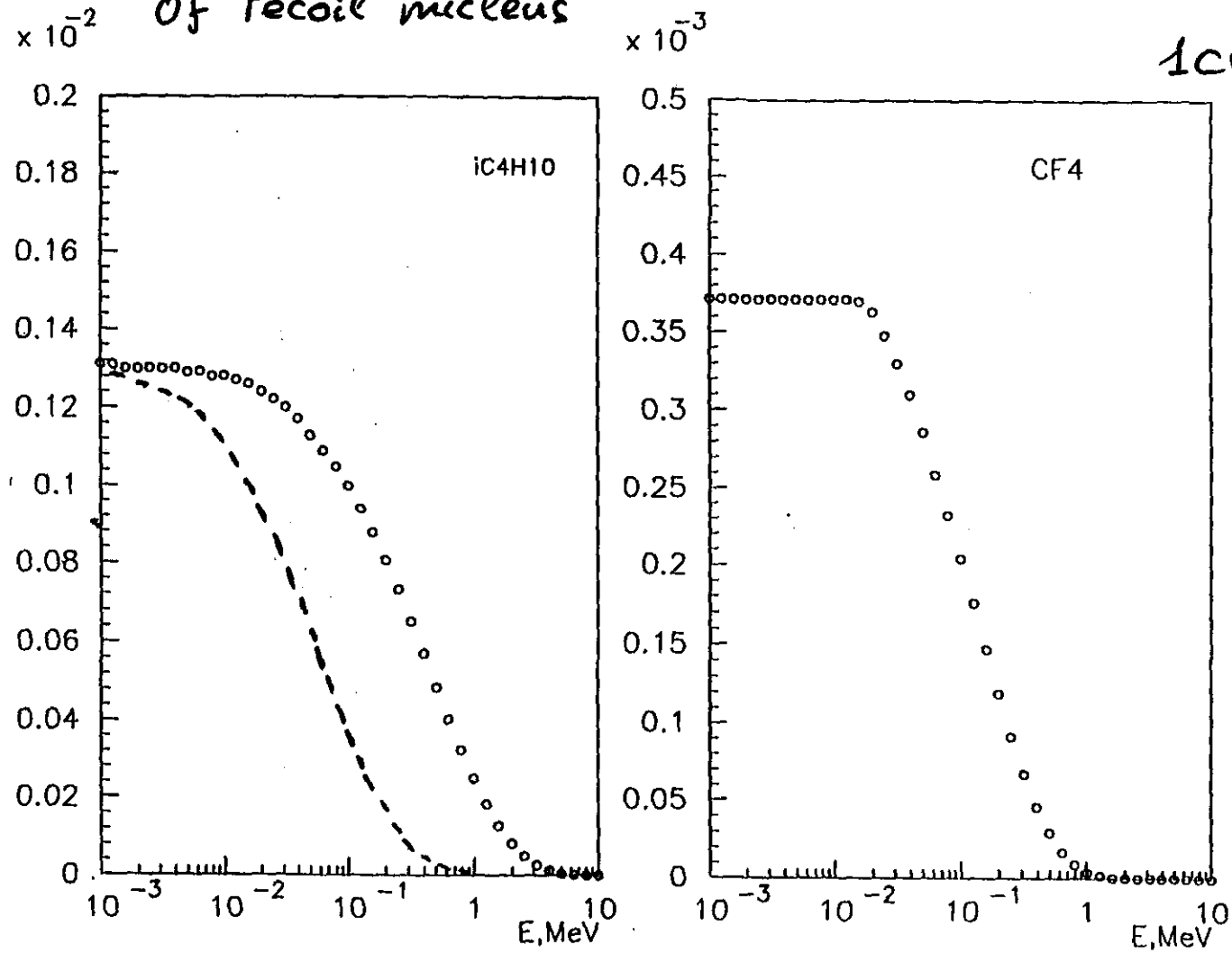
Neutron efficiency VS threshold



ITEP
Jan. 93

Neutron efficiency VS min. energy of recoil nucleus ^{252}Cf

1cm of gas



Preliminary

RDT sensitivity to thermal neutrons and gammas (^{60}Co source, $E_\gamma = 1.17, 1.33$ MeV) in units of 10^{-3}

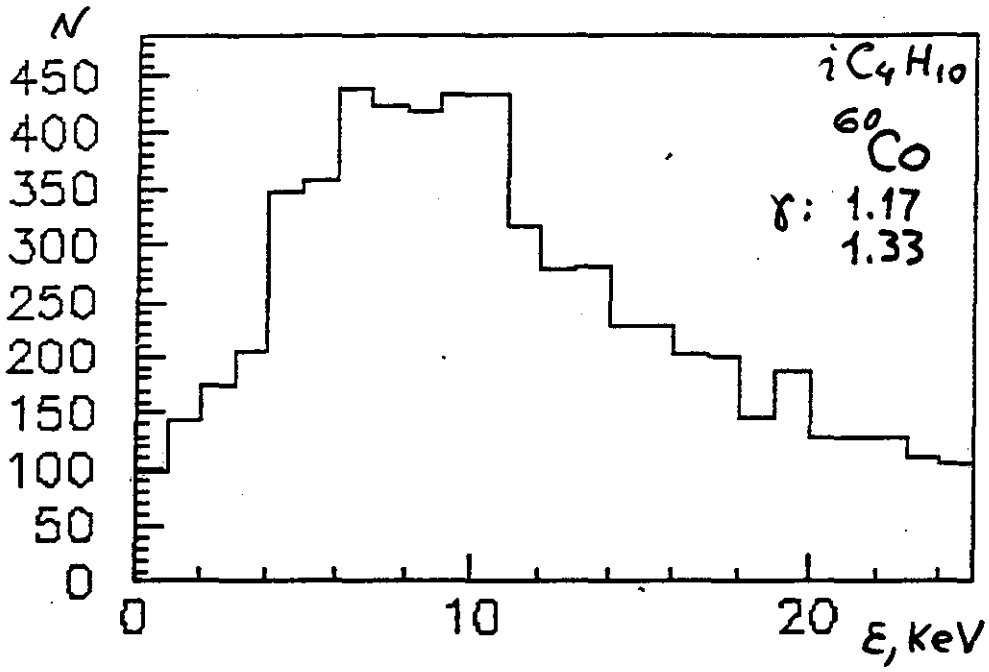
Tube #	Gas	eff. (n)	eff. (γ)
I (Fe)	CF_4	2.44	10.8
	iC_4H_{10}	2.54	9.1
II (Al)	CF_4	0.90	11.3
	iC_4H_{10}	0.68	8.3

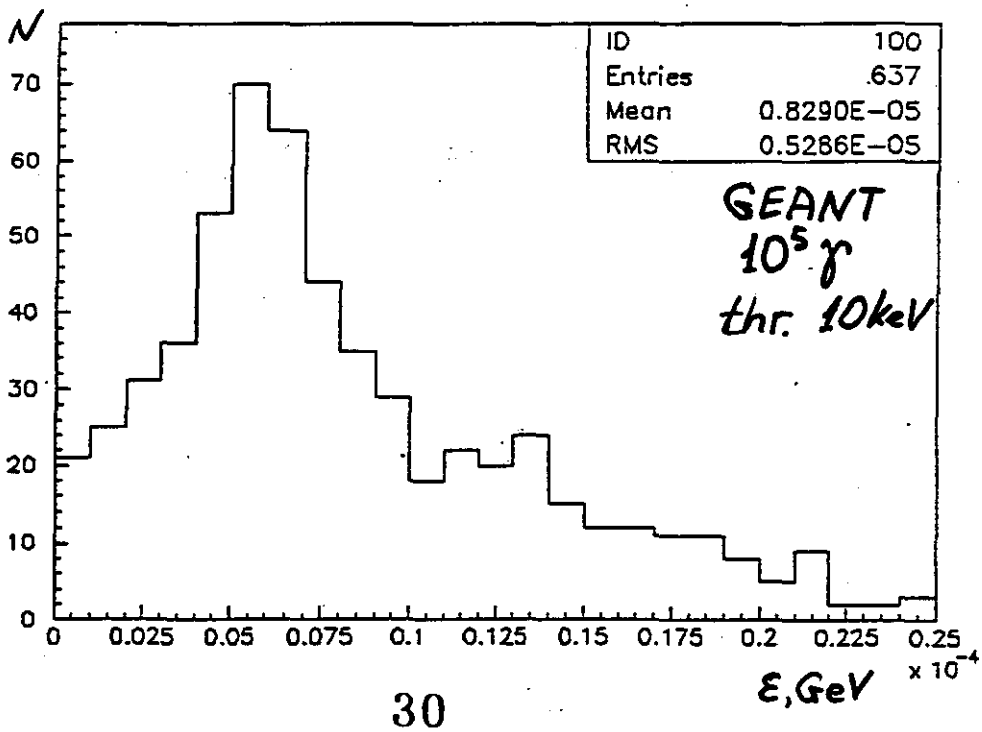
GEANT ($E_{MIN} = 10$ keV)

$\zeta_\gamma = (6.4 - 7.0) \times 10^{-3}$

RDT (Fe)

ITEP
Jan. 93





Completion RDT n/γ measurements:

- Neutron fluxmeter calibration
- Gamma fluxes/spectra measurements
- Data for different gas mixtures and pressure
- High statistical ADC spectra in the wide range of collected charge

Conclusions

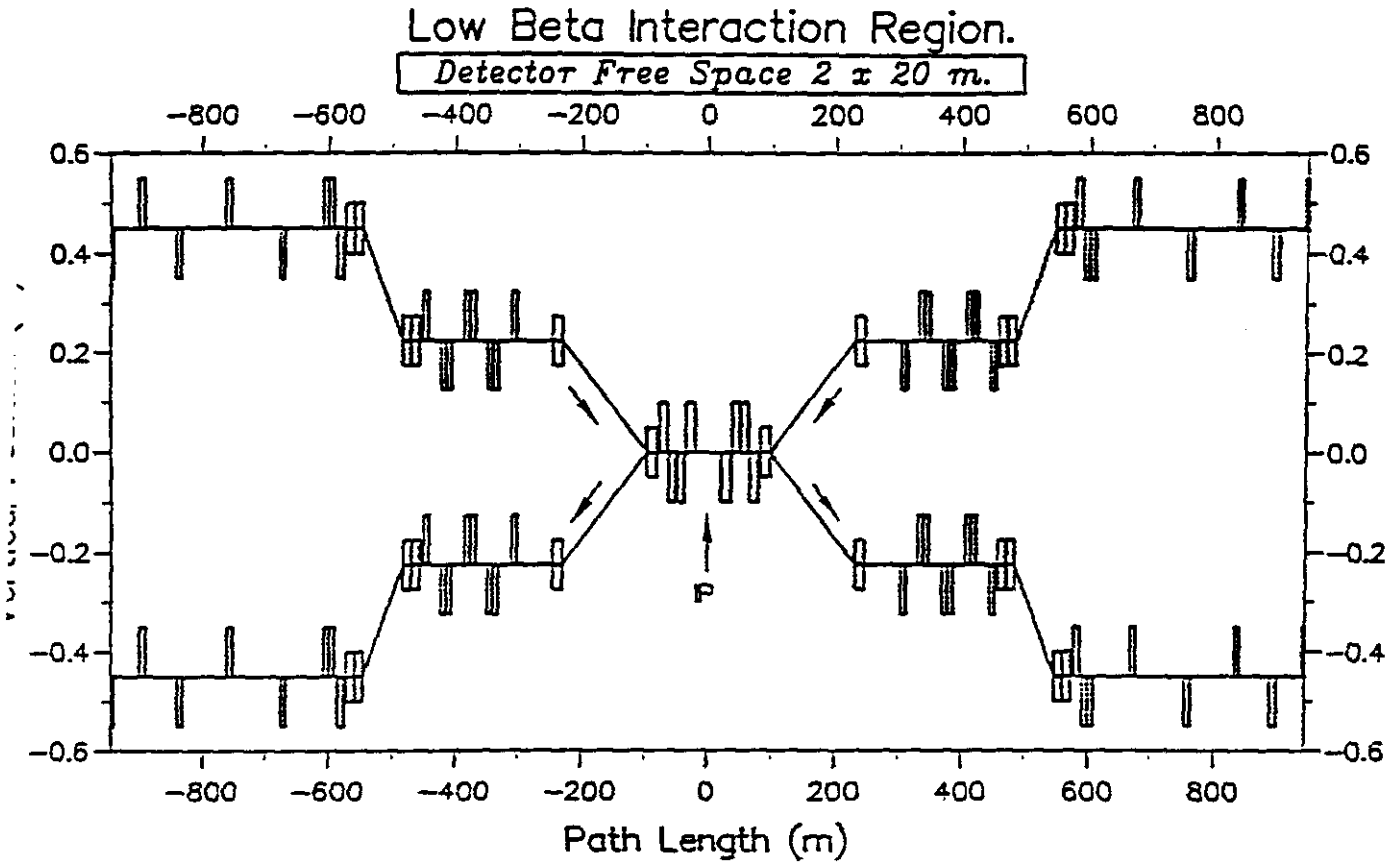
- Sensitivity to fast neutrons of wire chamber filled by CF_4, CO_2, Ar mixtures $\approx 0.5 \cdot 10^{-3}$/cm
- Sensitivity to thermal neutrons depends on chamber materials (Fe: $2.5 \cdot 10^{-3}$ Al: $0.8 \cdot 10^{-3}$)
- Sensitivity to 1 MeV gammas $\boxed{\sim 10^{-2}}$
- Good agreement between data and LAHET calculations
  - spectra shapes
  - albedo fraction
  - gamma fluxes (?)

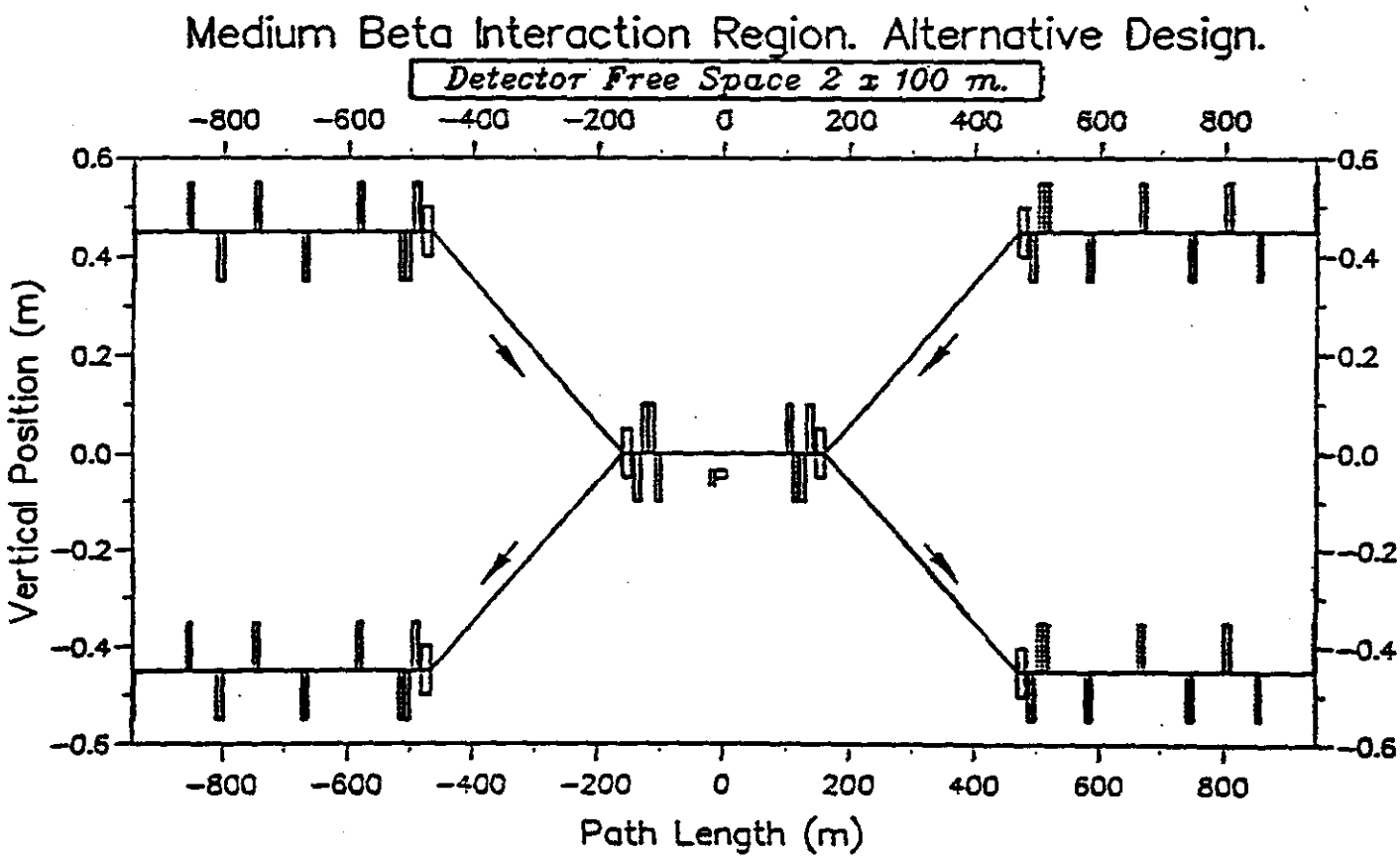
Required future measurements:

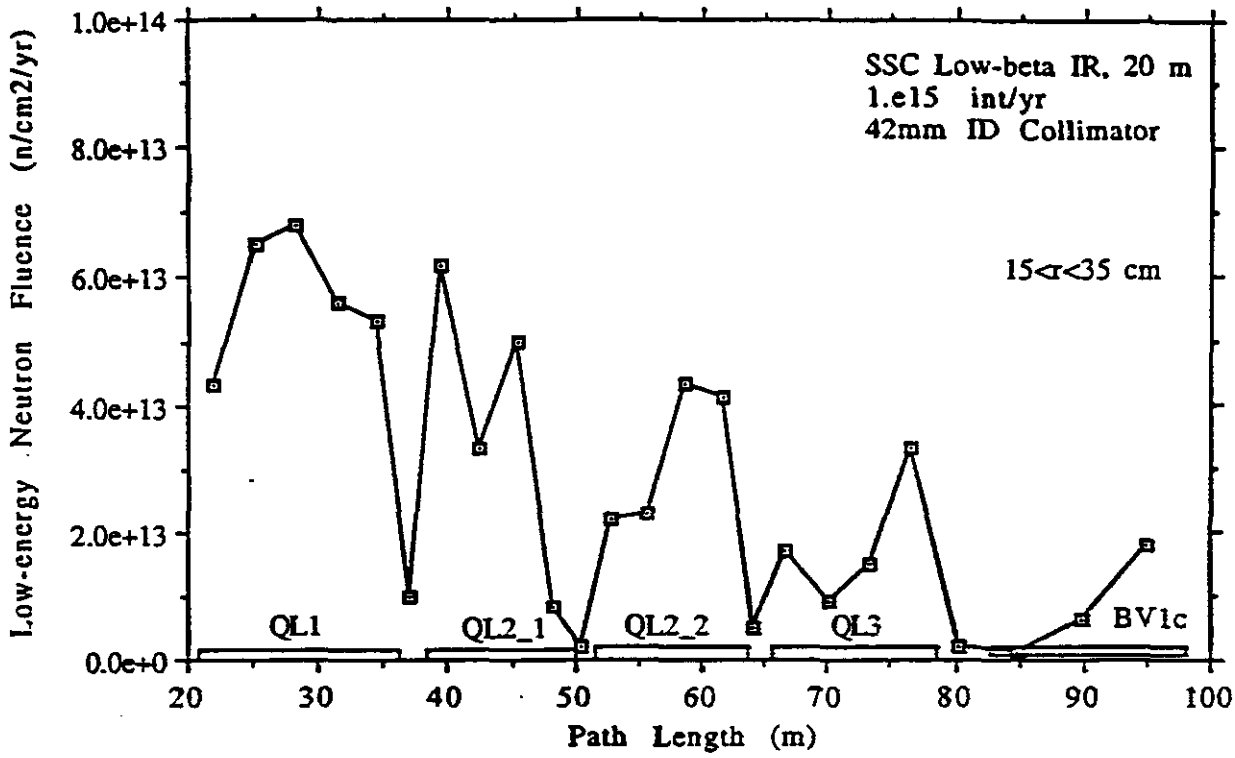
- Multylayer CSC prototype
- Study of γ/n albedo off various materials: Fe, Cu, Pb, Polyethylene(+B) etc.
- n/γ BG at hadron collider (DØ?) and comparision of the data with the calculations by codes using for GEM n/γ fluxes evaluations

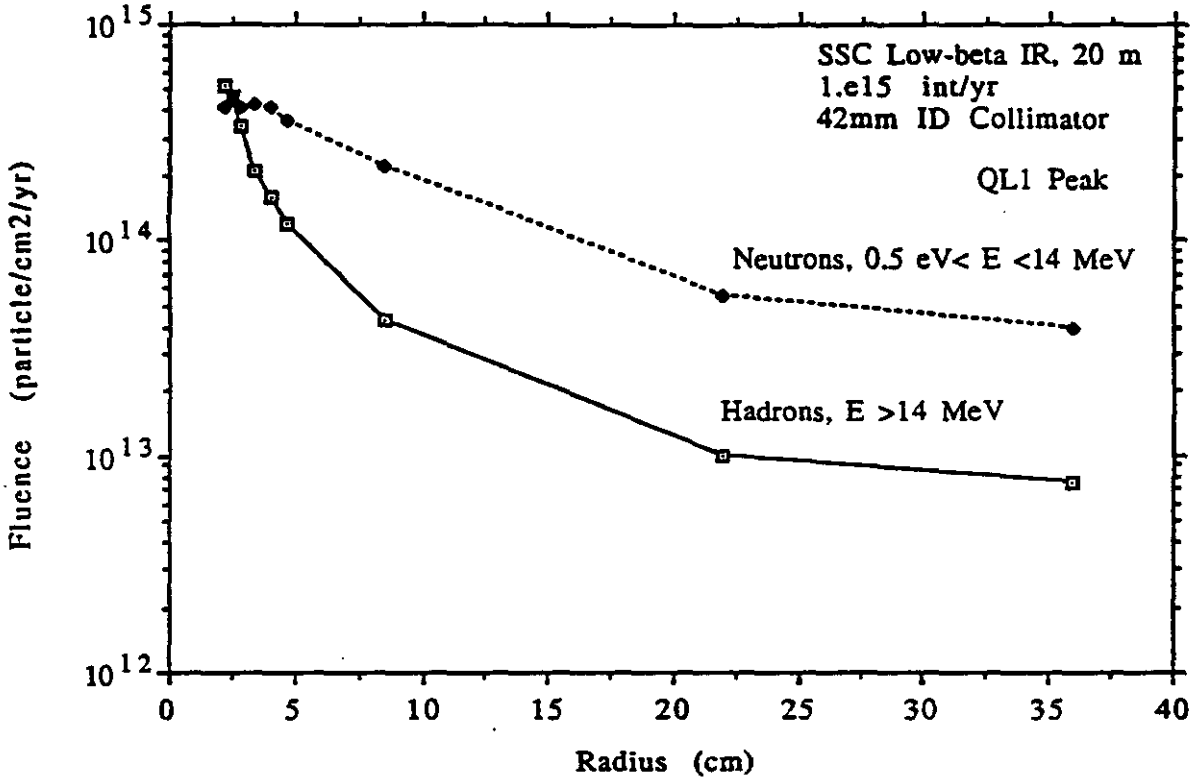
Presentation by:

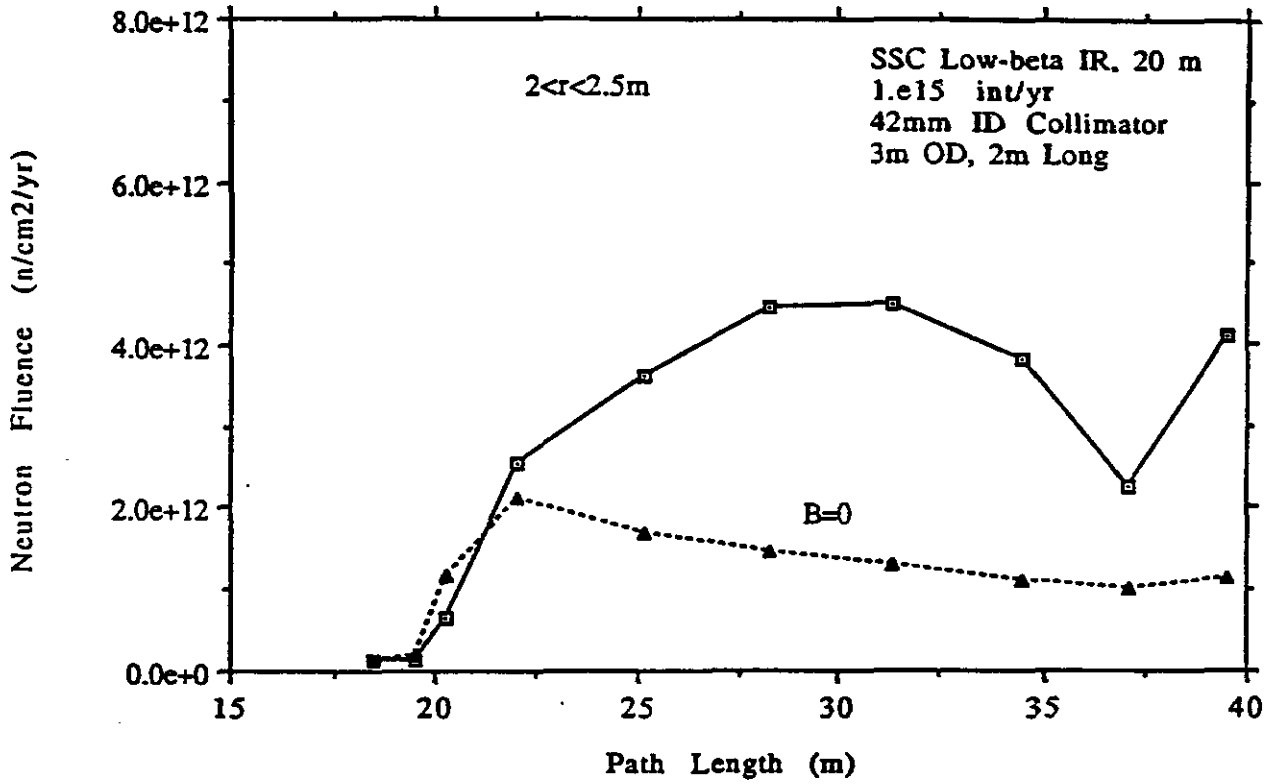
N. Mokhov

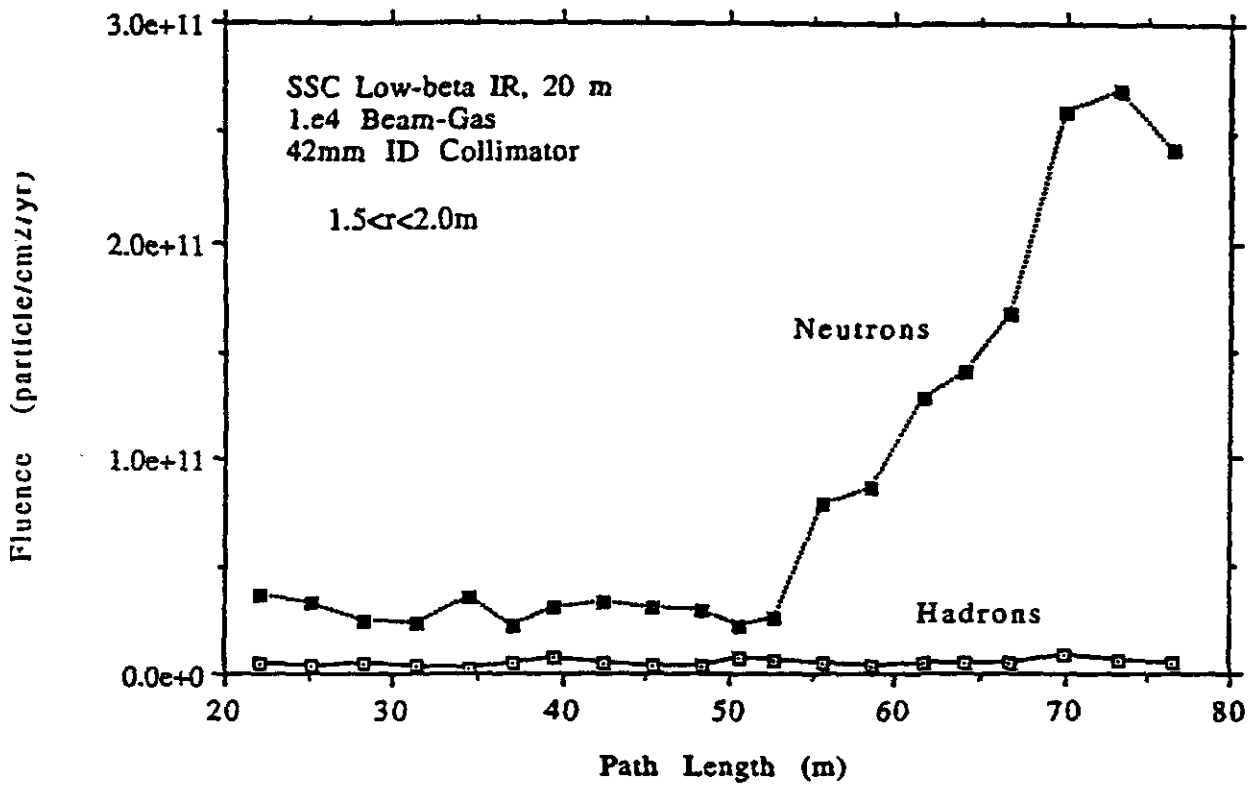

Low Beta Interaction Region.
Detector Free Space 2 x 20 m.
-800 -600 -400 -200 0 200 400 600 800
0.6 0.4 0.2 0.0 -0.2 -0.4 -0.6
IP
Path Length (m)

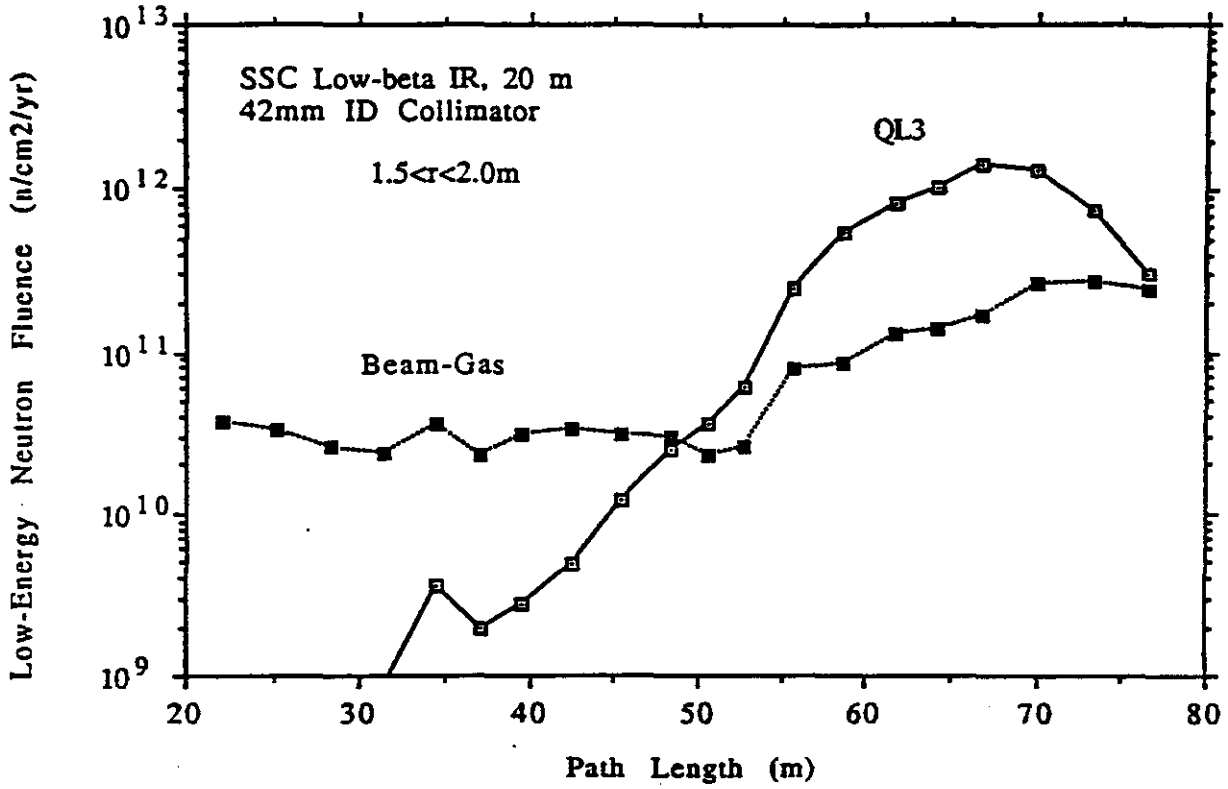

Medium Beta Interaction Region. Alternative Design.
Detector Free Space 2 x 100 m.
-800 -600 -400 -200 0 200 400 600 800
0.6 0.4 0.2 0.0 -0.2 -0.4 -0.6
Vertical Position (m)
IP
Path Length (m)


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


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


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.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
Path Length (m)
Fluence (particle/cm2/yr)


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

Collimator Aperture Effect

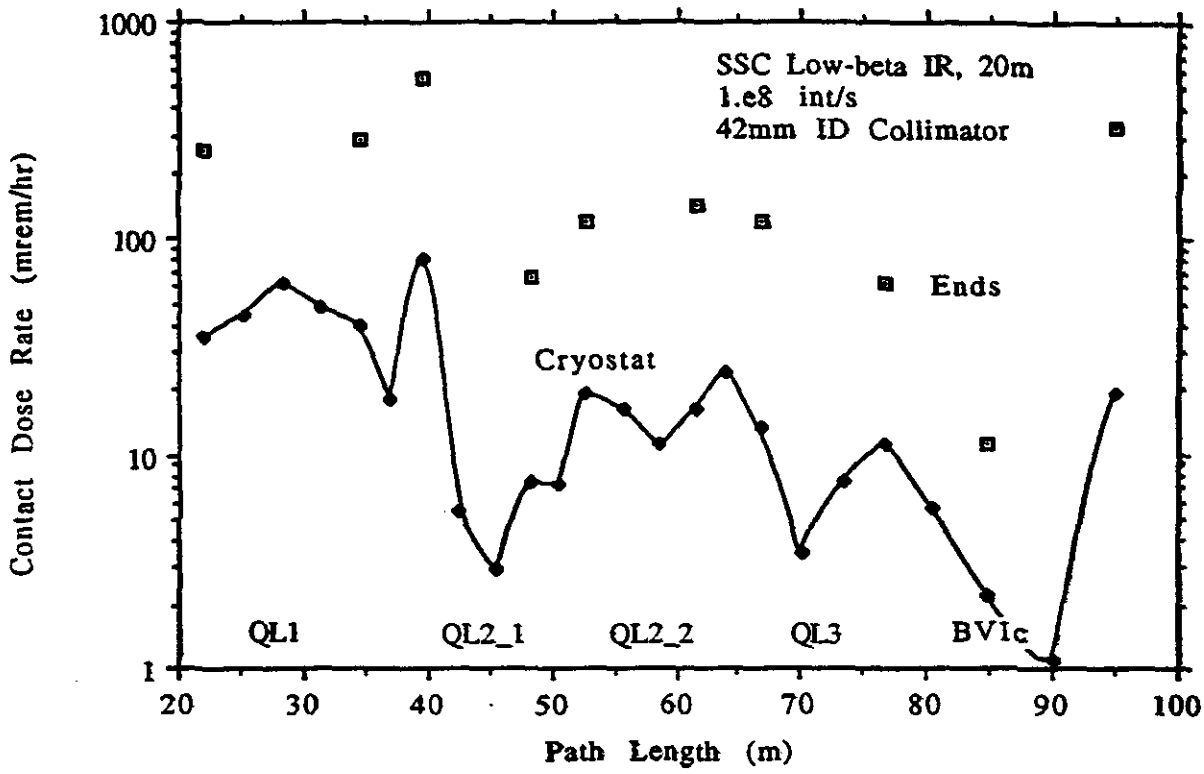
Collimator at 32-35 m
QL1 > 35.5 m
$\mathcal{L} \approx 10^{33}\ cm^{-2}\ s^{-1}$

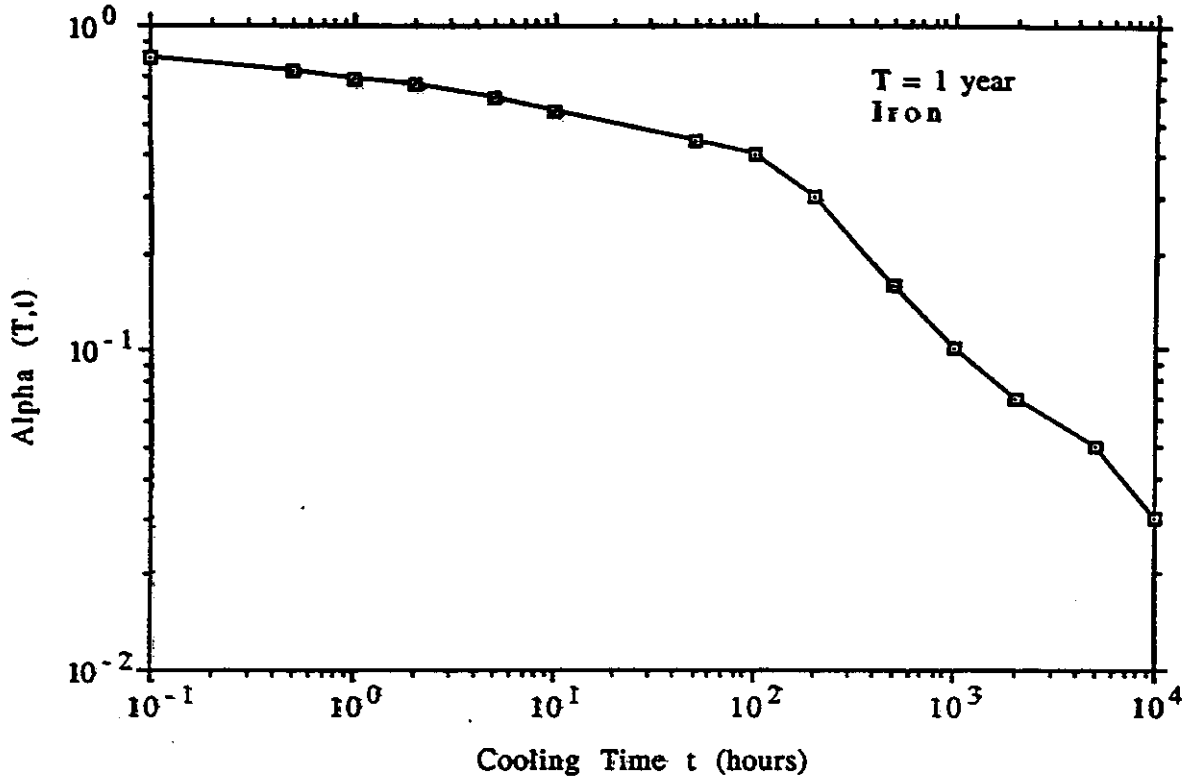
Aperture (mm)	25	42	∞	
QL1 (Watts)	21	40	85	(m.b. < 50)
Lifetime (yr)	7	5	1.5	
QL1 Neutron Leakage 10^{13} n/cm²/yr	2.6	3.8	4	
Albedo	2.5	1	1	

NEUTRON BACKGROUND

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)
- Local Beam Loss (Normal Operation): 1×10^{9} cm^{-2}
- Beam-Gas (cold+10^{-8} torr in warm): 5×10^{10} cm^{-2}
  around beam pipe: 3.5×10^{12} cm^{-2}


SSC Low-beta IR, 20m
1.e8 int/s
42mm ID Collimator
Ends
Cryostat
QL1
QL2_1
QL2_2
QL3
BVIc
Contact Dose Rate (mrem/hr)
Path Length (m)
1000
100
10
1
20
30
40
50
60
70
80
90
100


T = 1 year
Iron
Alpha (T,t)
Cooling Time t (hours)
10^0
10^{-1}
10^{-2}
10^{-1}
10^0
10^1
10^2
10^3
10^4

gem

γeμ

Presentation by:

L. Waters

LAHET / CINDER / MCNP ... PROGRESS

LAURIE WATERS
NEUTRON TASK FORCE - GEM
2-24-93

1) BASELINE 2
   A) GEOMETRY — NOSHIELD, QUADSHIELD
   B) DTUJET
   C) ~~*~~ DENSITY
   D) Neutron Currents
   E) Neutron Energy Spectra
      - KERMA FACTORS
      - SHIELDING INSITE
      - ACTIVATION
   F) (n, γ) photons
   g) REDUCTIONS

2) TDR GEOMETRY
   CALORIMETRY, TRACKER, CHAMBERS

3) DISCRETE ORDINATES

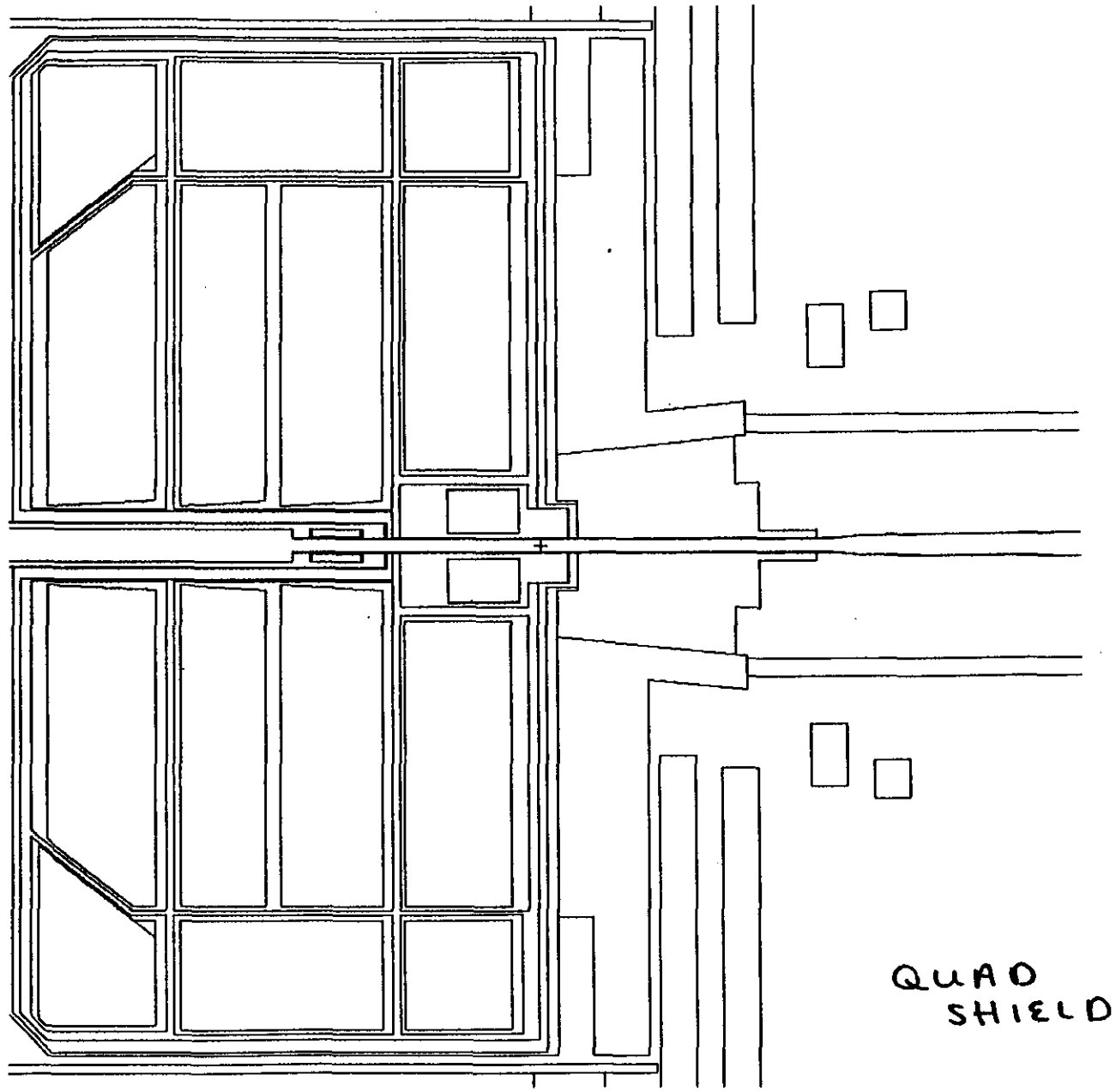
4) CHARGED DOSES
   1) HADRONS, EGS : BASELINE 2
   2) NEUTRONS - heating factors
      γ, e±, Q, n
      pp, pe, ...

5) ACTIVATION
   1) STAR DENSITIES
   2) CINDER - SDC γ tracking

6) Code IMPROVEMENTS

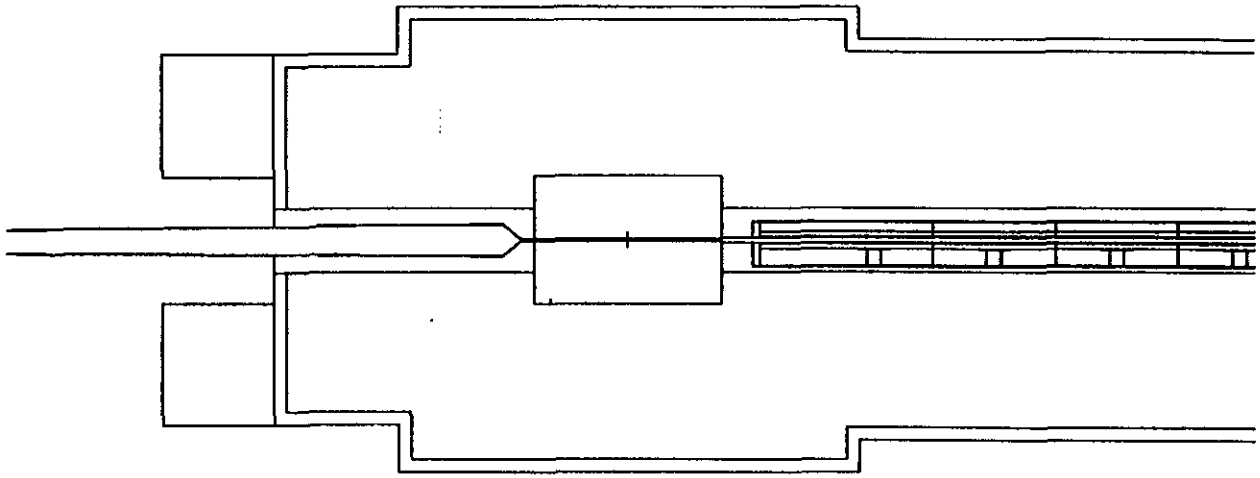
2/ 3/93 13 08 37
GEM SIMULATION FINE
SEGMENTATION

PROBID = 2/ 3/93 13 04 54
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 500.00)
EXTENT = (300.00, 300.00)

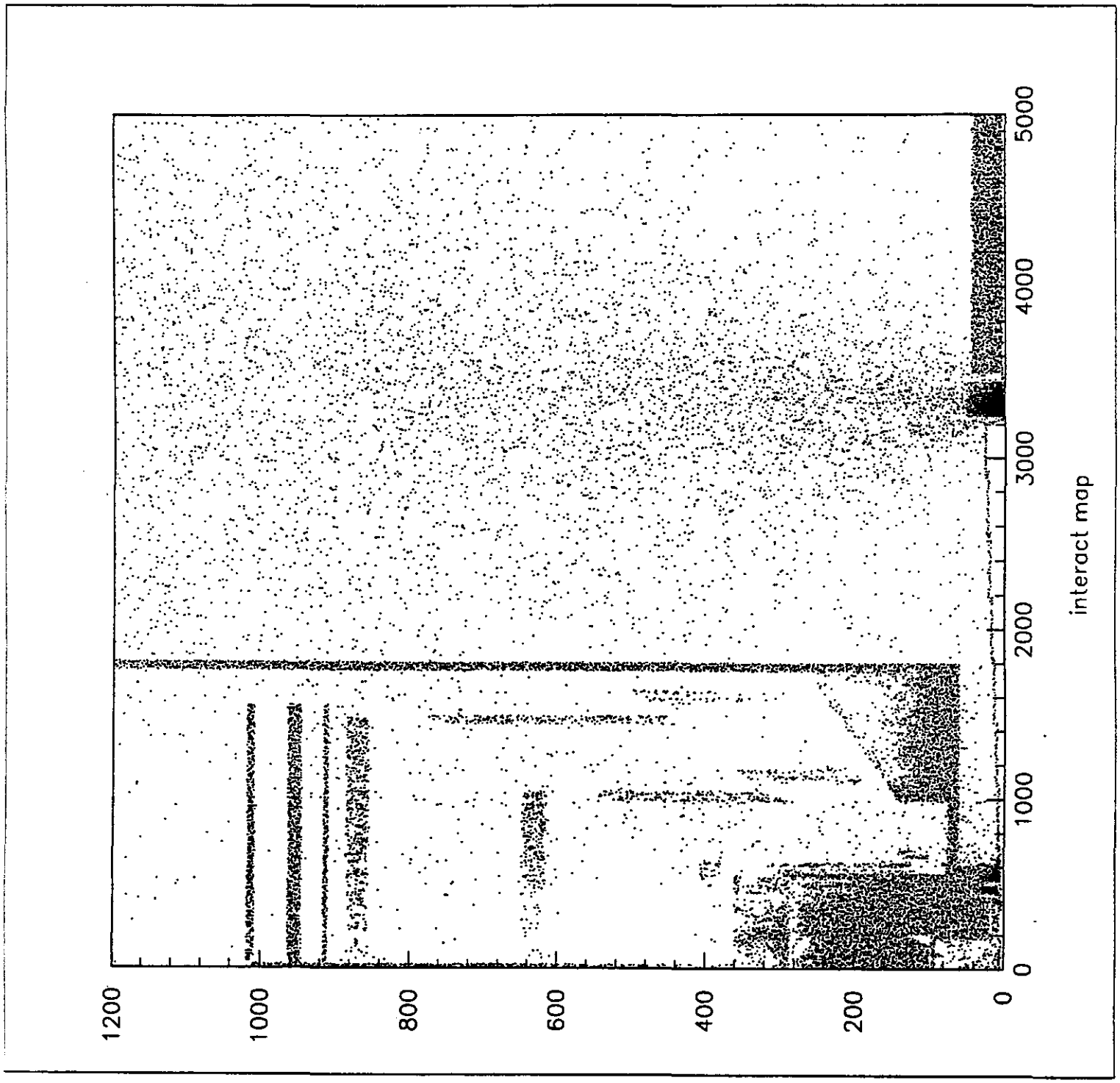


2/18/93 09 05 43
GEM SIMULATION 4-2B NEW
BEAMPIPE, SHIELDED QUAD

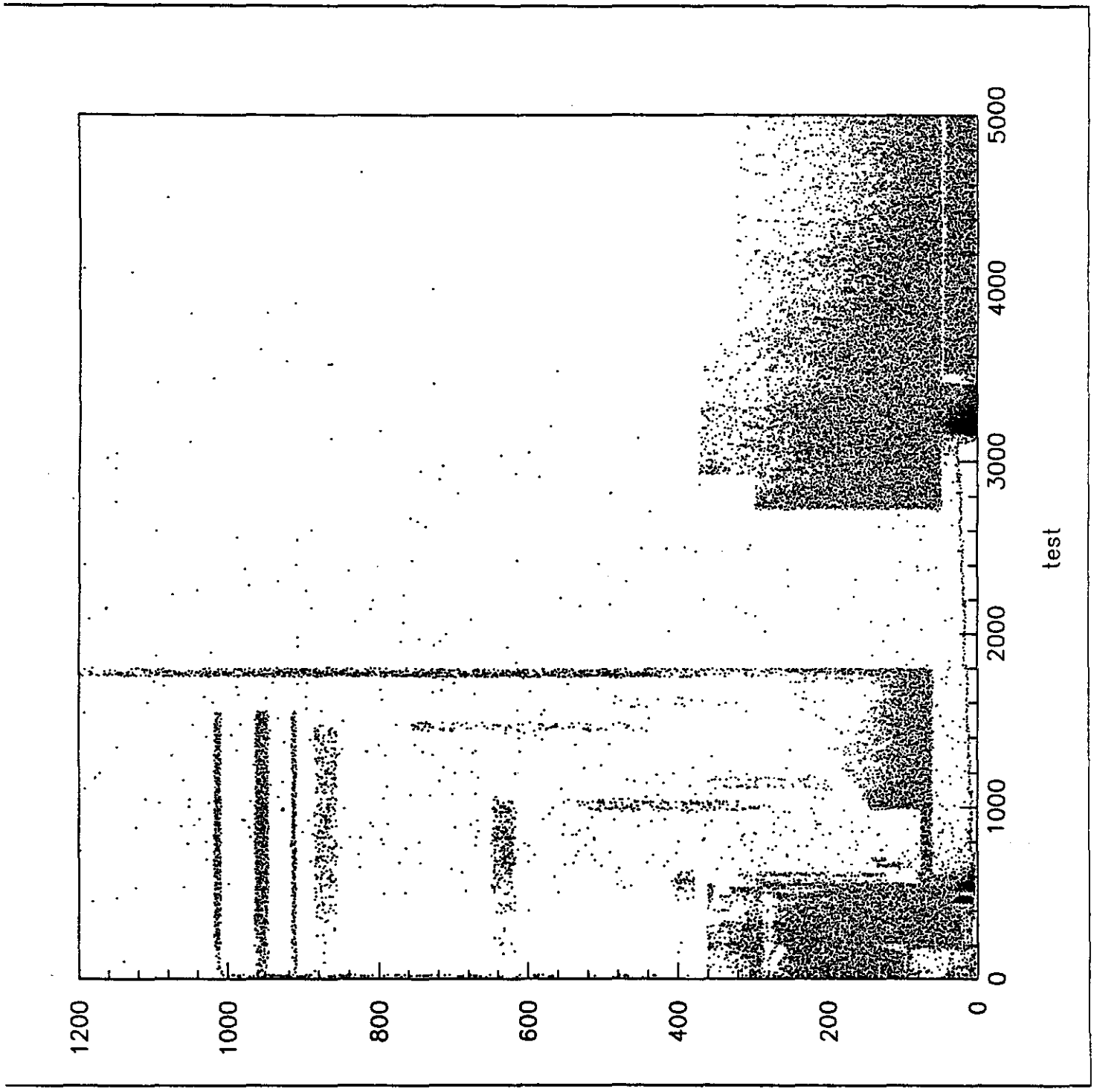
PROBID = 2/18/93 09 02 17
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 3300.00)
EXTENT = (1000.00, 1000.00)

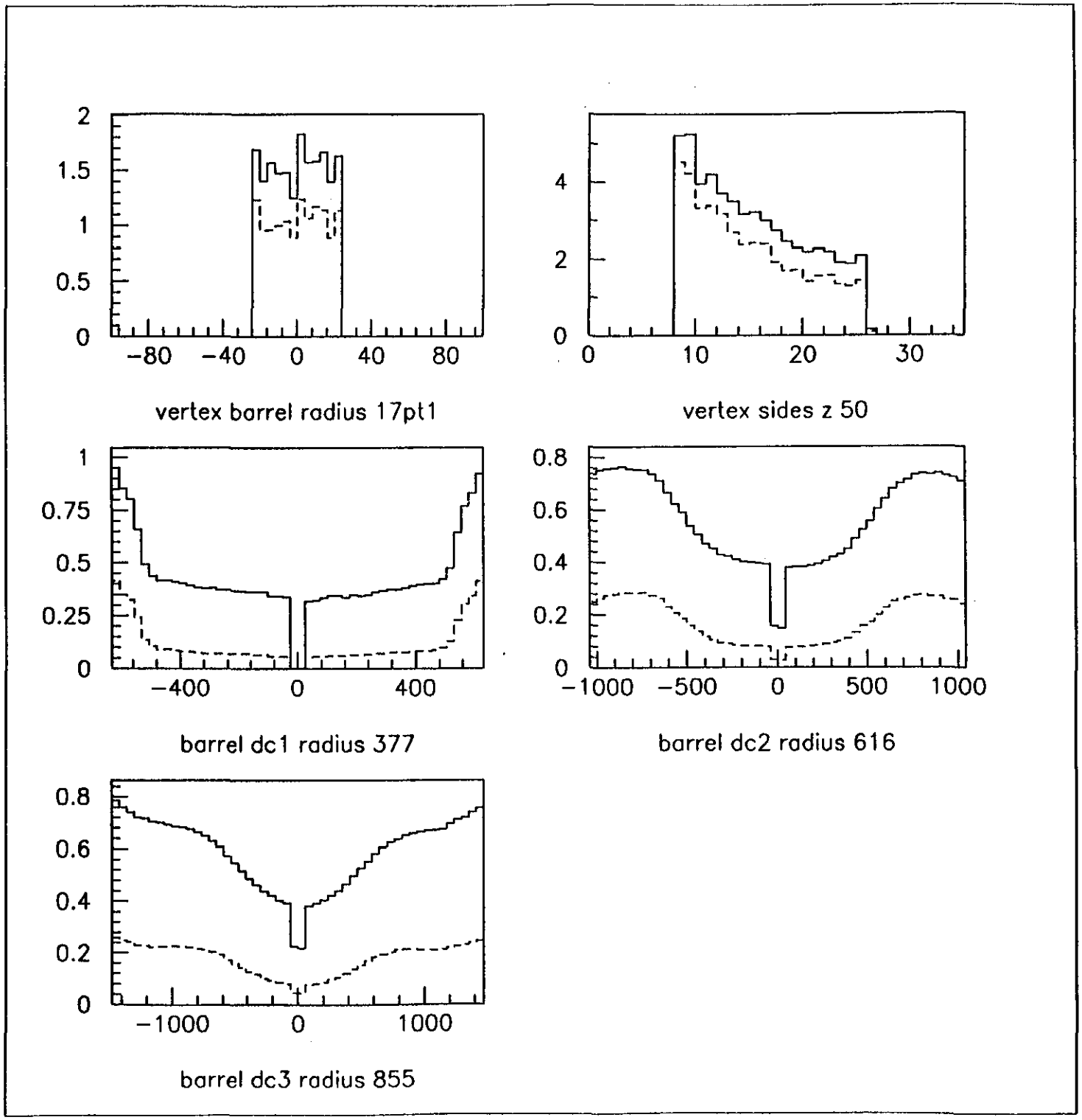


20 SHIELD 2

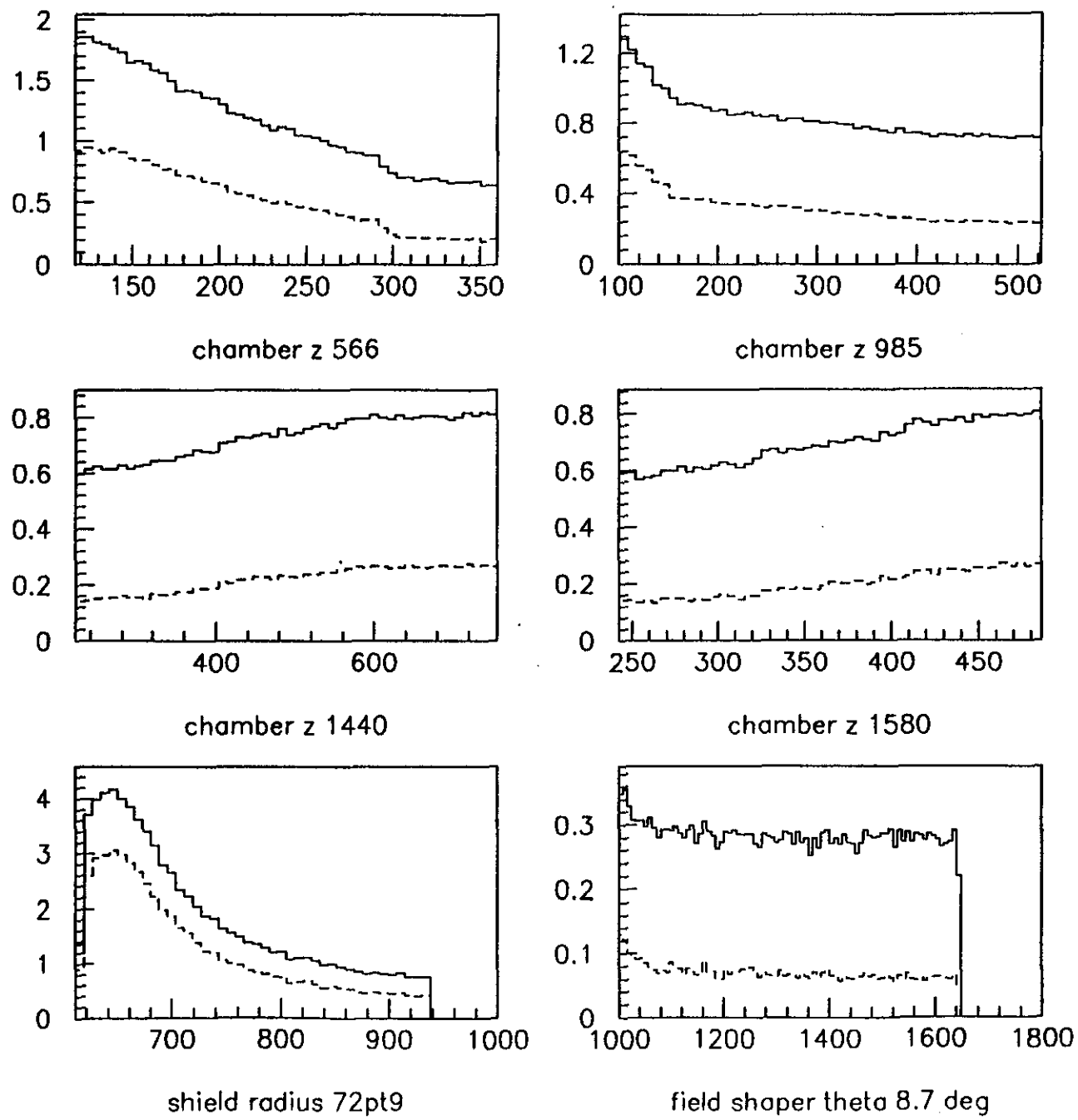

1200
1000
800
600
400
200
0
0
1000
2000
3000
4000
5000
interact map

QUAD SHIELD

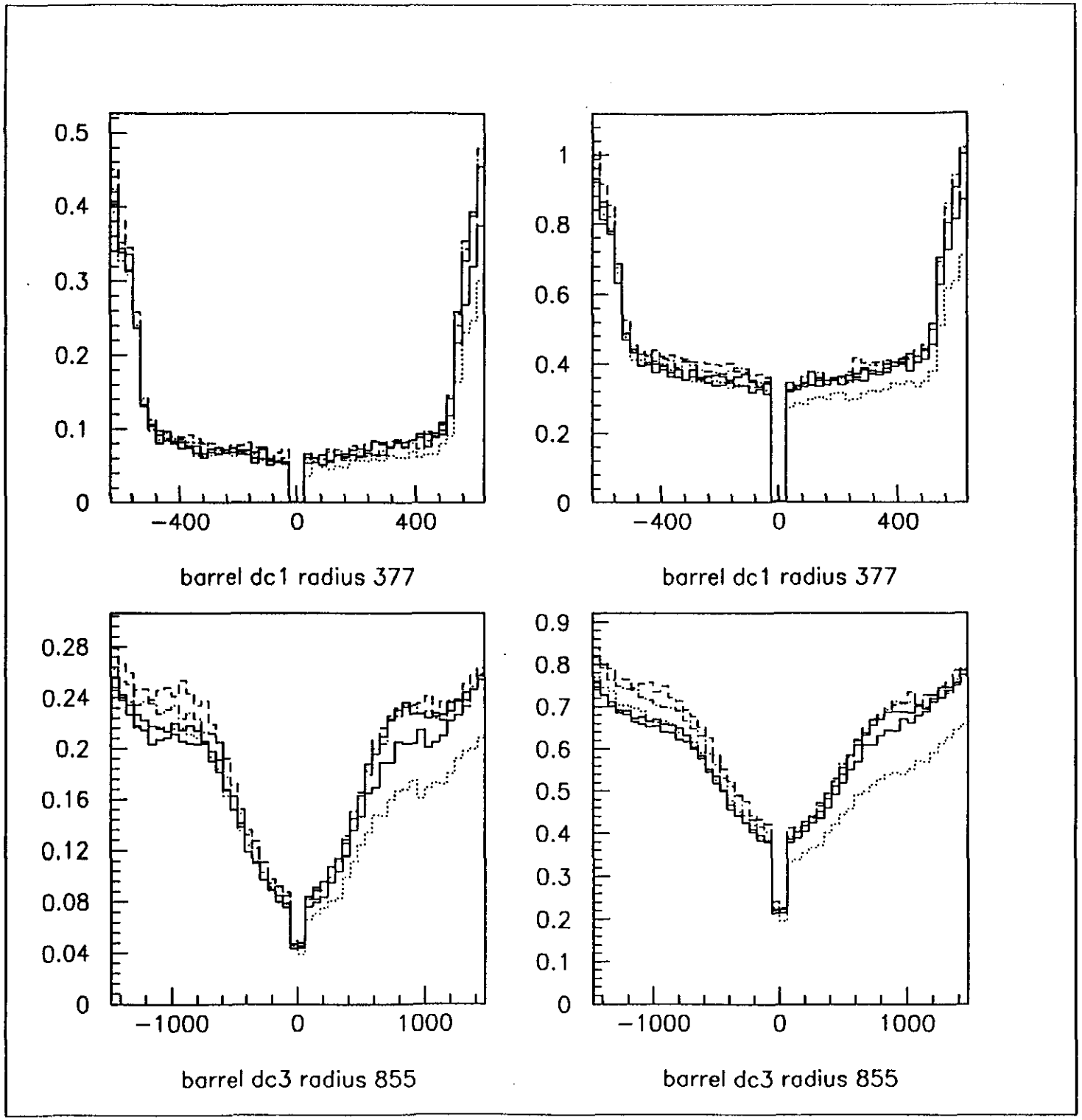



vertex barrel radius 17pt1
vertex sides z 50
barrel dc1 radius 377
barrel dc2 radius 616
barrel dc3 radius 855

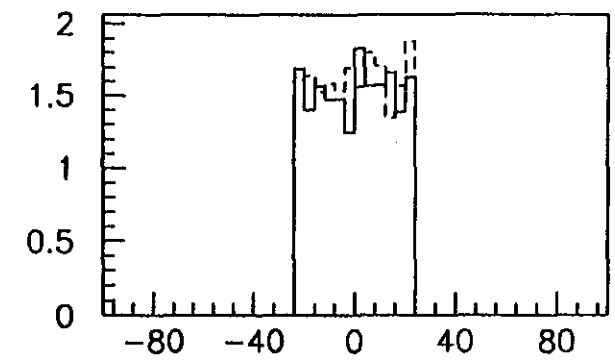
NOSHIELD2


chamber z 566
chamber z 985
chamber z 1440
chamber z 1580
shield radius 72pt9
field shaper theta 8.7 deg

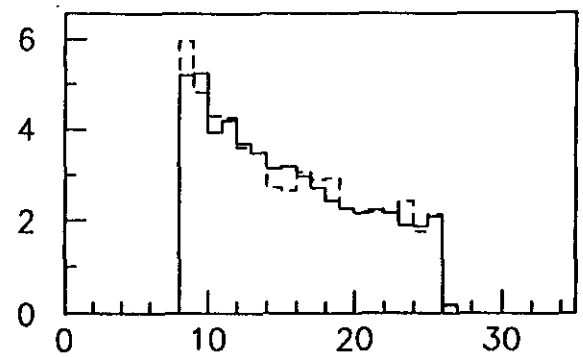
NOSHIELD2


0.5
0.4
0.3
0.2
0.1
0
−400
0
400
barrel dc1 radius 377
1
0.8
0.6
0.4
0.2
0
−400
0
400
barrel dc1 radius 377
0.28
0.24
0.2
0.16
0.12
0.08
0.04
0
−1000
0
1000
barrel dc3 radius 855
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
−1000
0
1000
barrel dc3 radius 855

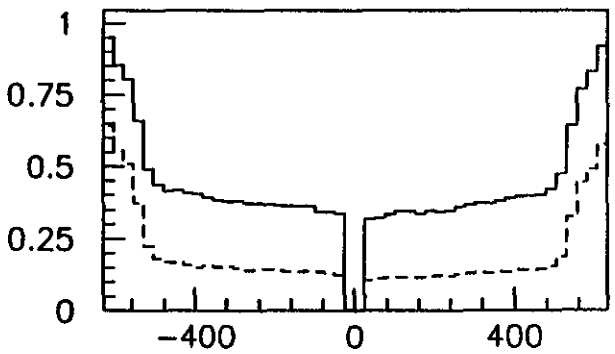
NOSHIELD2



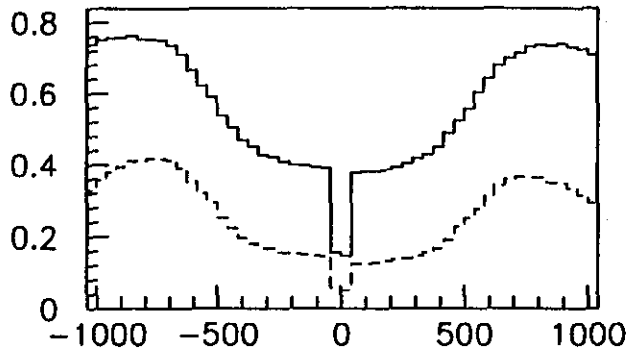
vertex barrel radius 17pt1



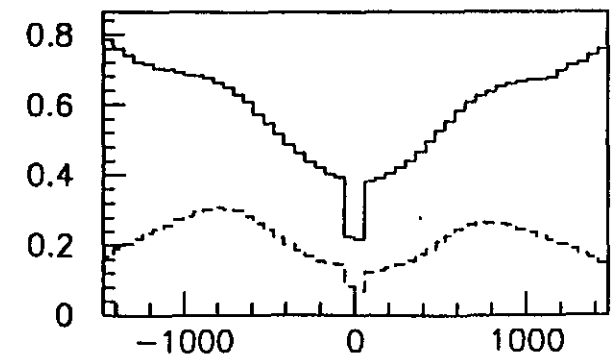
vertex sides z 50



barrel dc1 radius 377



barrel dc2 radius 616



barrel dc3 radius 855

compare all

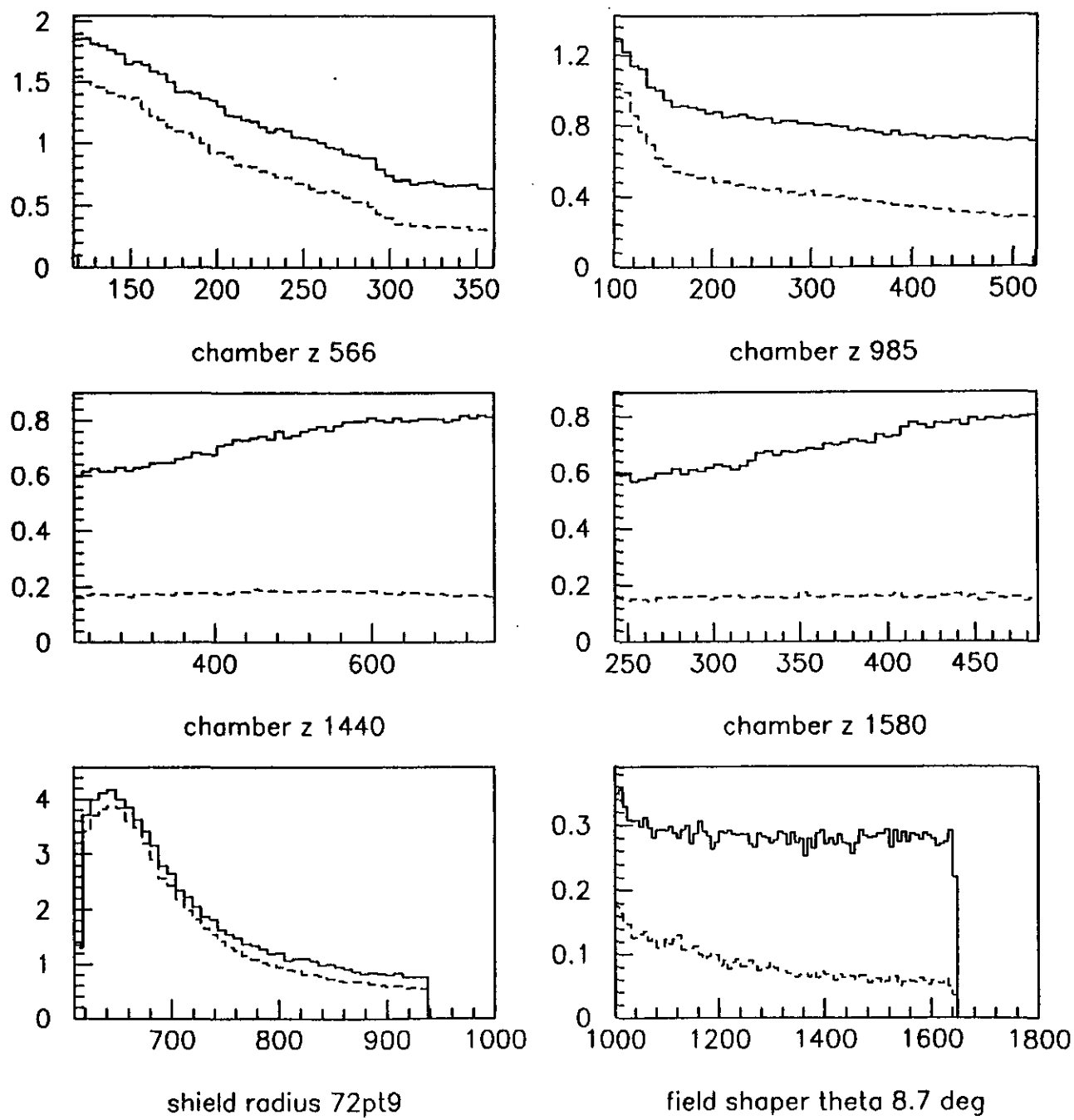
NOSHIELD2

QUADSHIELD

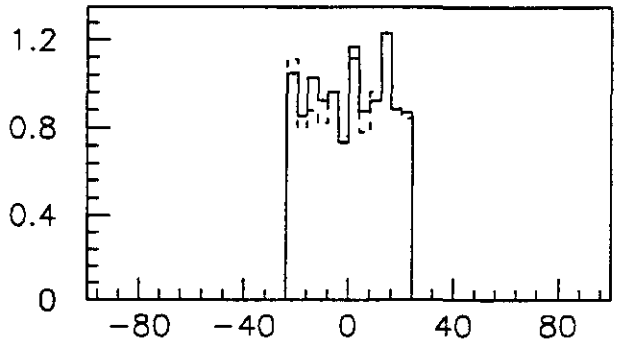
$L = 10^{33}$

$\#/cm^2$

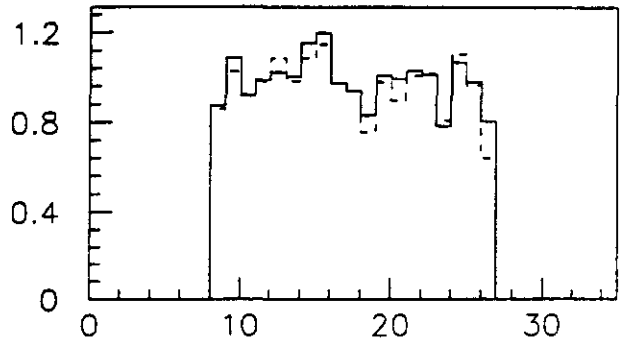
$/SSCYR \times 10^{17}$



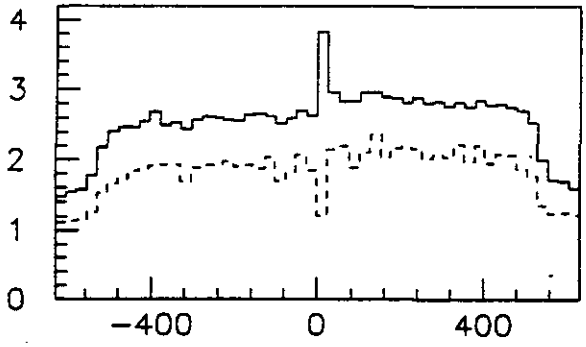
compare all
no shield ?
quad shield



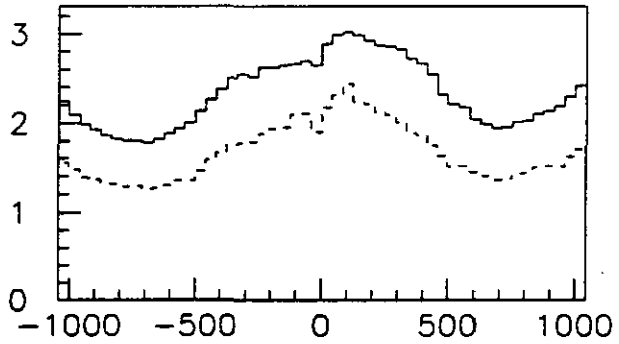
vertex barrel radius 17pt1



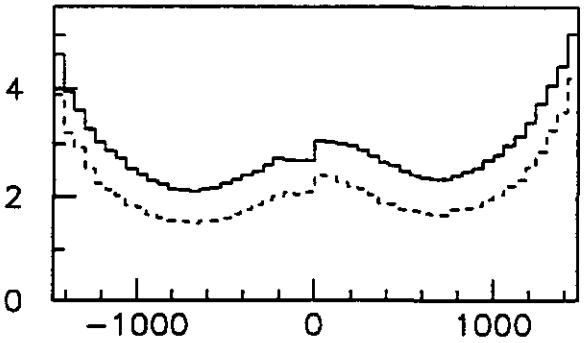
vertex sides z 50



barrel dc1 radius 377



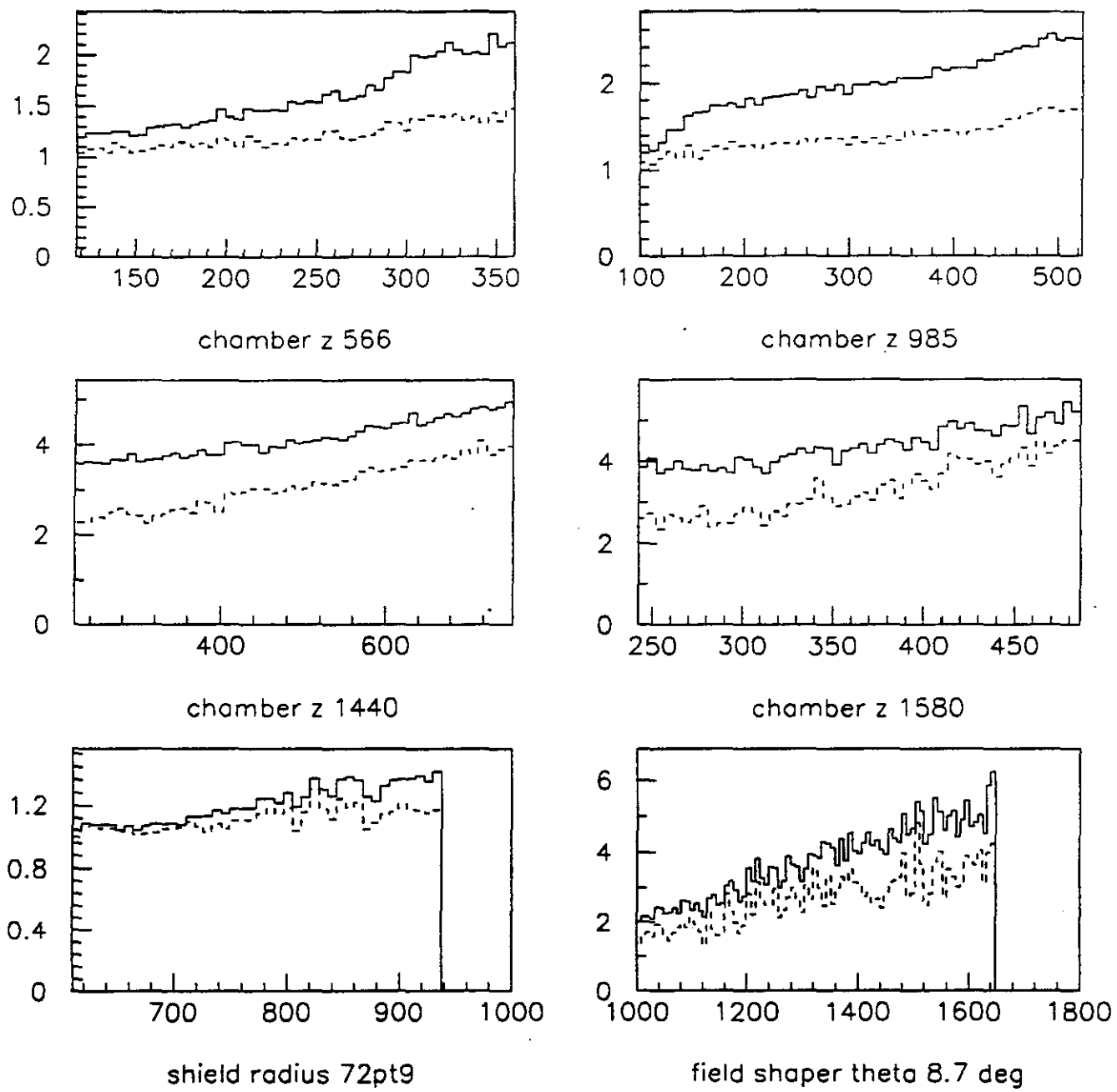
barrel dc2 radius 616

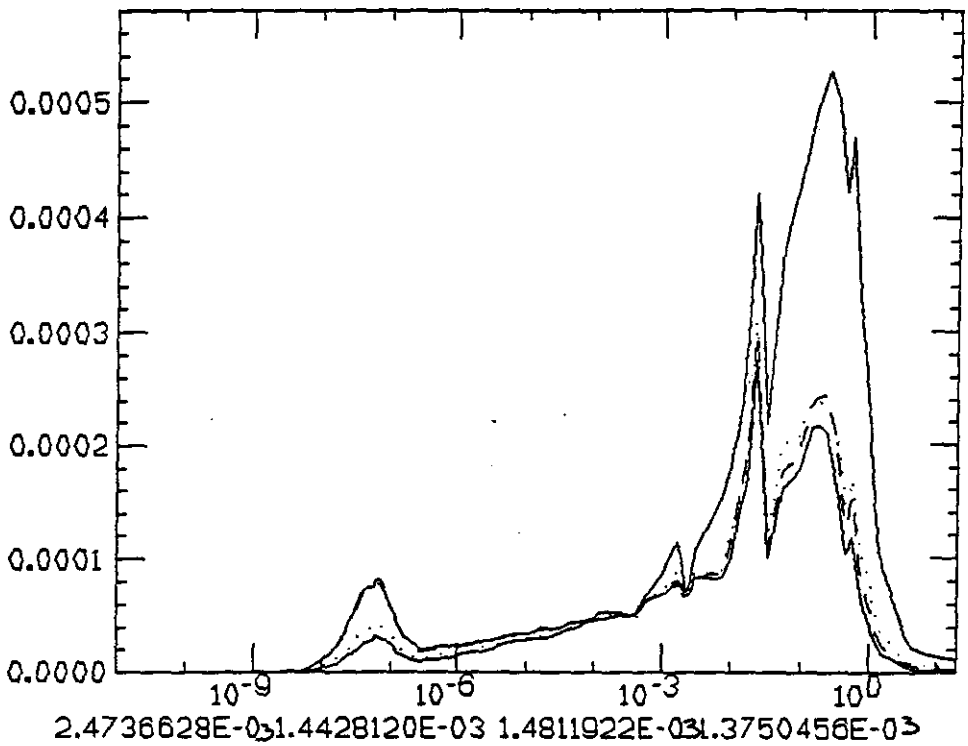


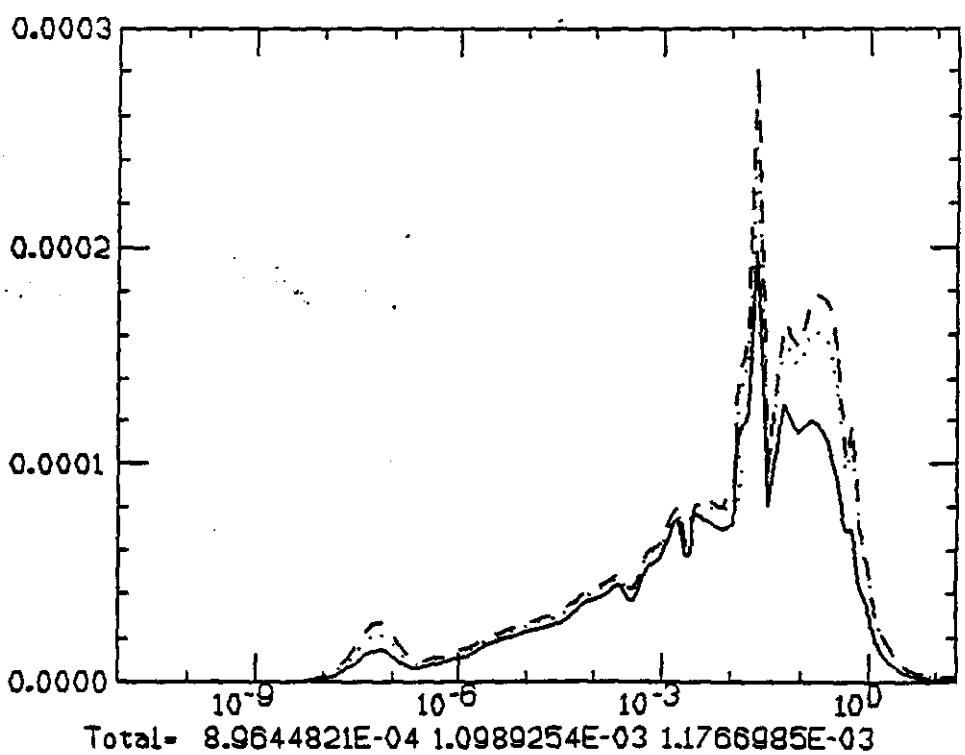
barrel dc3 radius 855

REDUCTION FACTORS

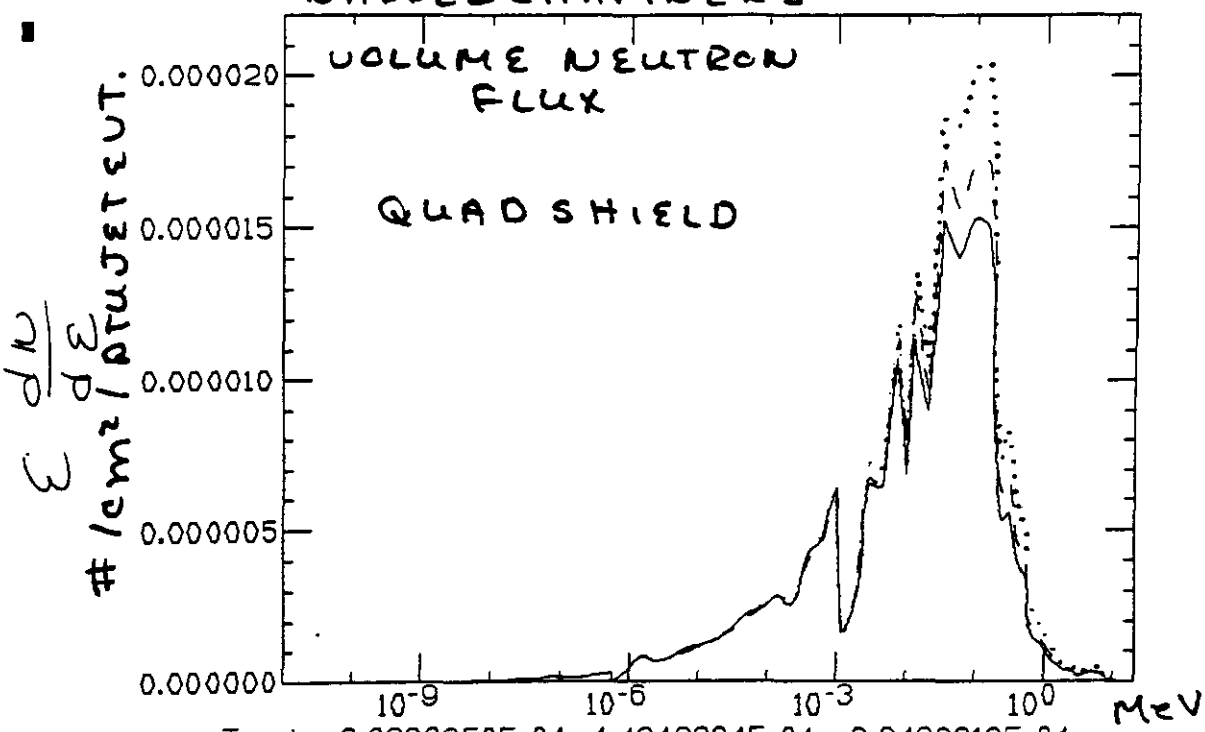
—— ALL - - - - >100 keV




0.0005
0.0004
0.0003
0.0002
0.0001
0.0000
10^{-9}
10^{-6}
10^{-3}
10^{0}
2.4736628E-03 1.4428120E-03 1.4811922E-03 1.3750456E-03


0.0003
0.0002
0.0001
0.0000
10^{-9}
10^{-6}
10^{-3}
10^{0}
Total= 8.9644821E-04 1.0989254E-03 1.1766985E-03

BARREL CHAMBERS

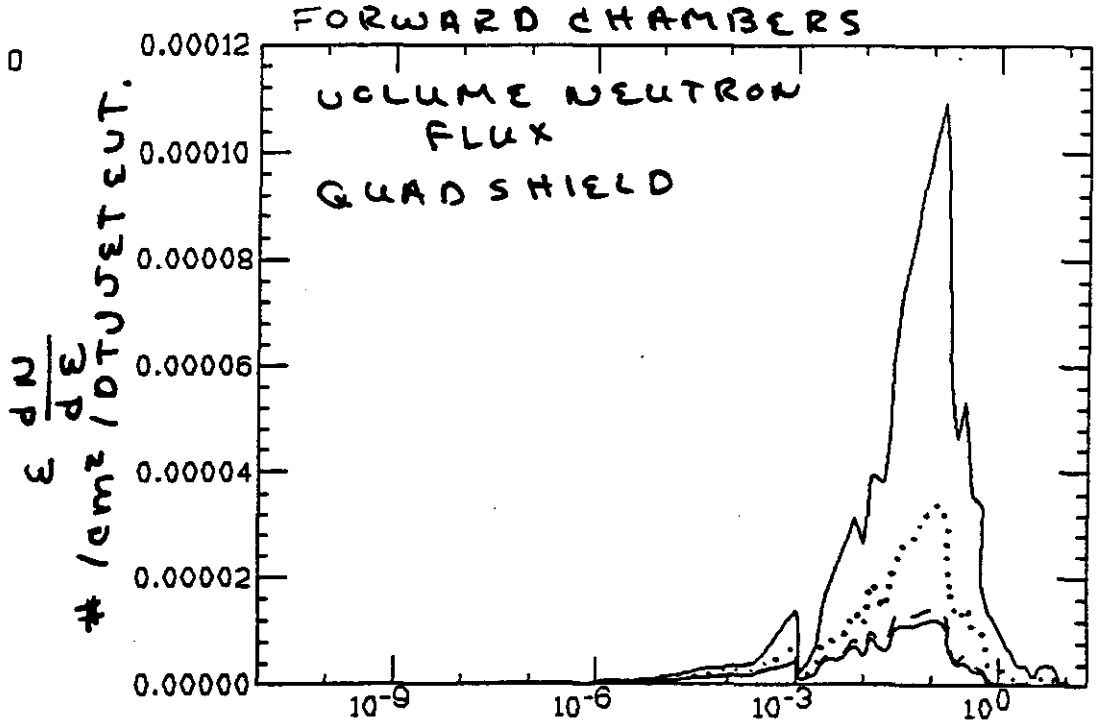


Total= 3.6236650E-04, 4.4343324E-04, 3.9463912E-04

BW1 — BW2 — BW3

2.5 — 2.47 — 2.98

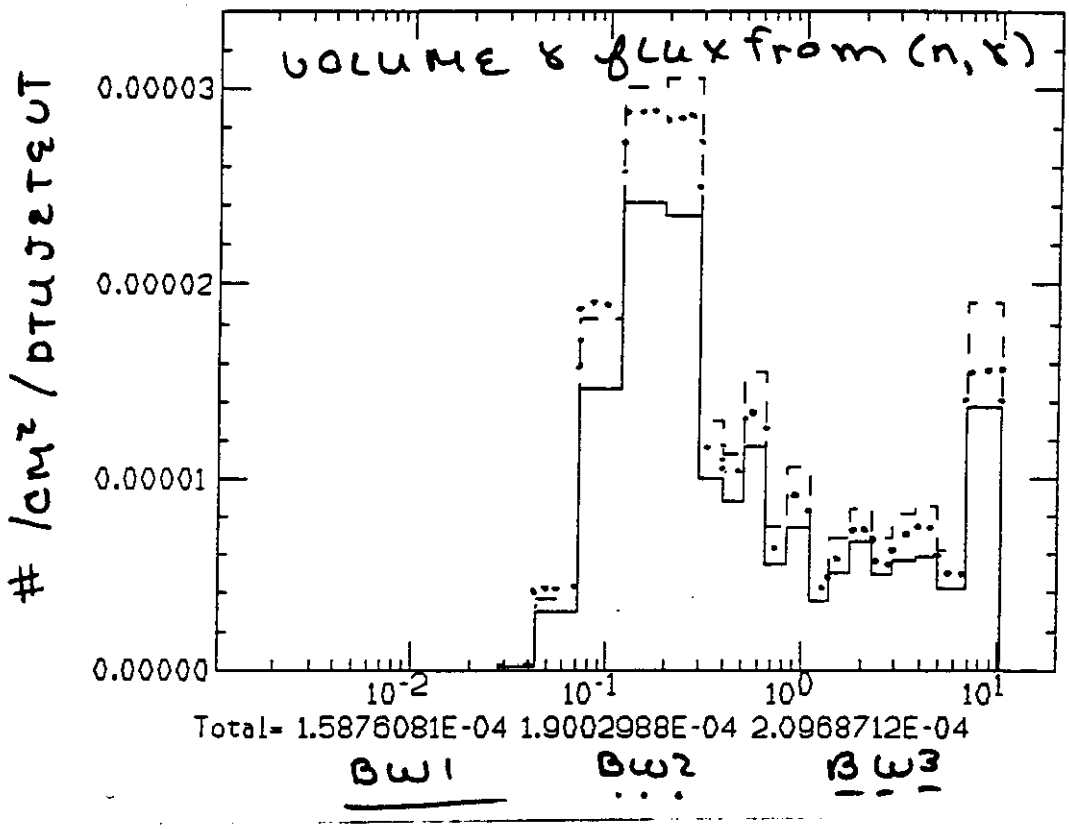
FORWARD CHAMBERS



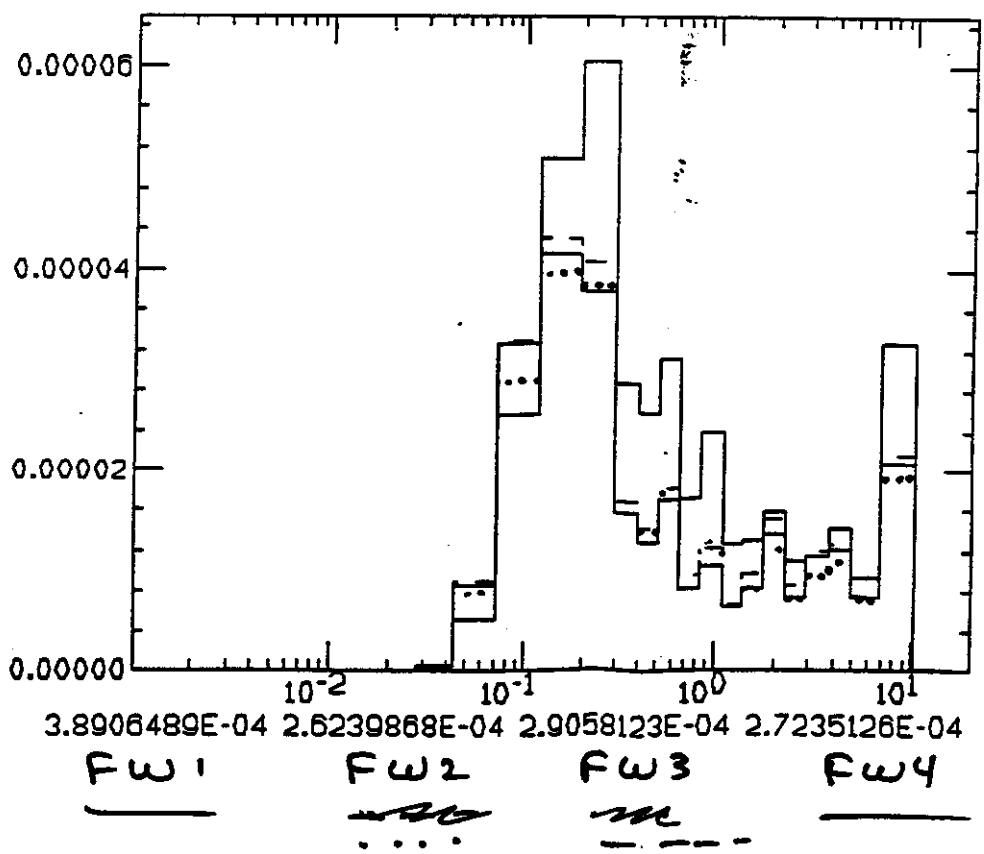
1.7789785E-03 6.3941162E-04 3.1647191E-04 2.7190172E-04

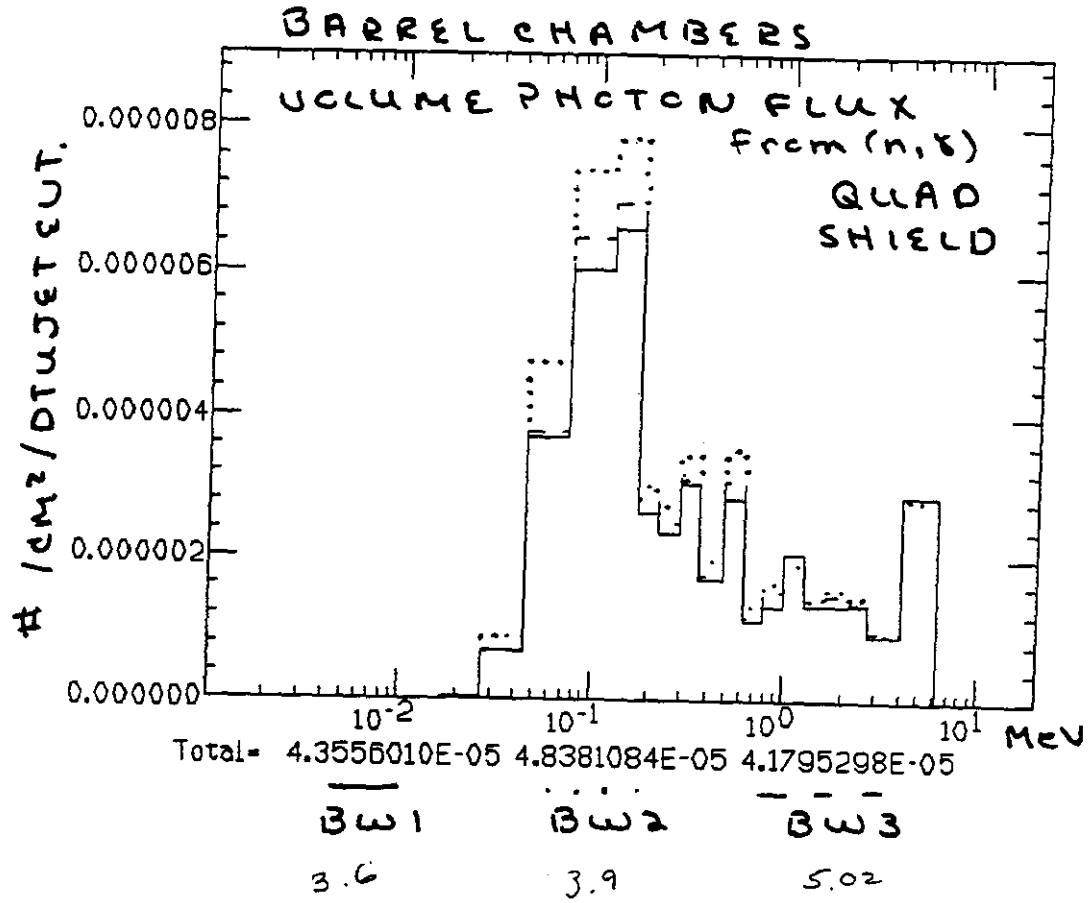
upper FW1 — FW2 — FW3 — lower FW4

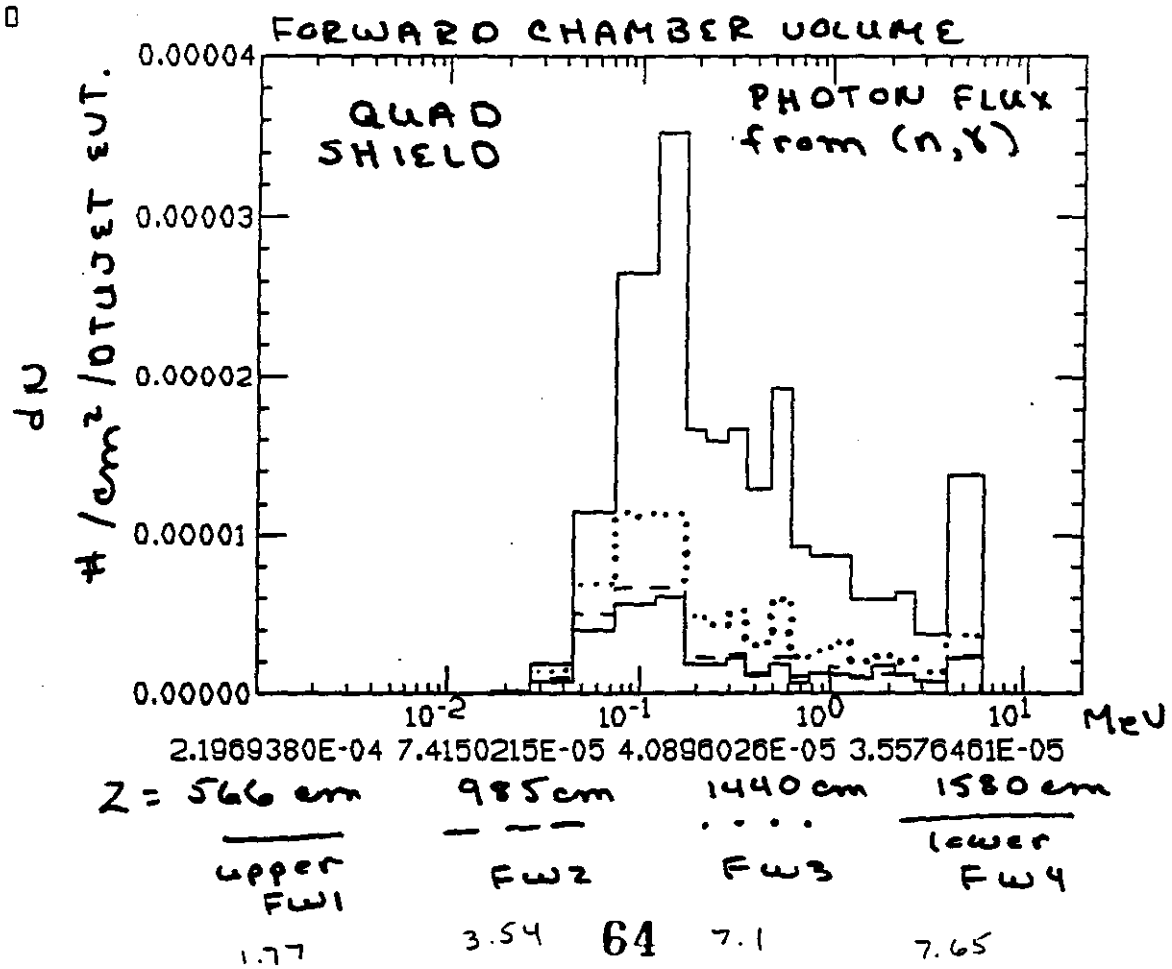
1.39 — 2.25 — 4.68 — 5.06

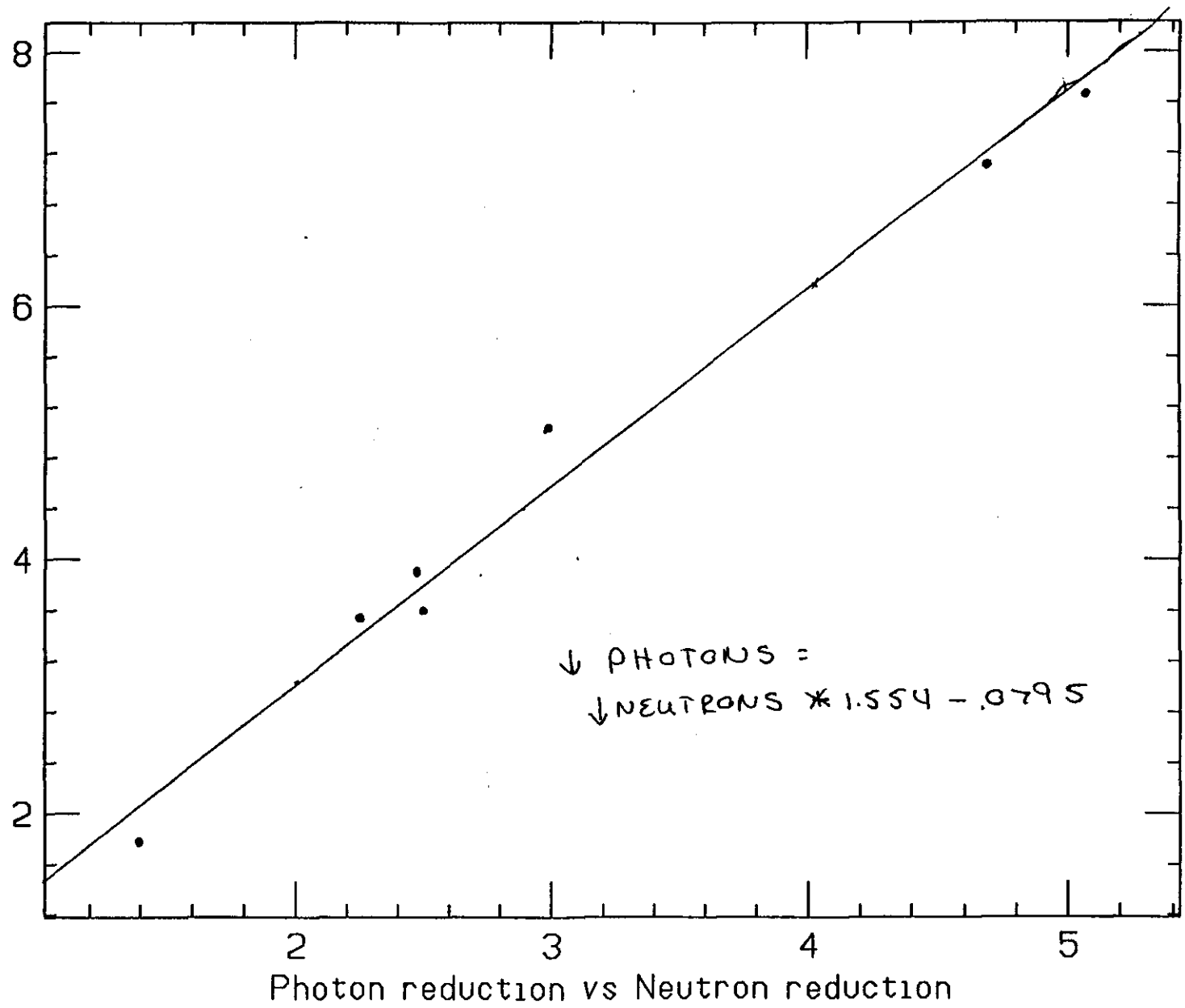

VOLUME γ flux from (n,γ)
/CM² /DTU JETEUT
0.00003
0.00002
0.00001
0.00000
10⁻²
10⁻¹
10⁰
10¹
Total= 1.5876081E-04 1.9002988E-04 2.0968712E-04
BW1
BW2
BW3

NO SHIELD

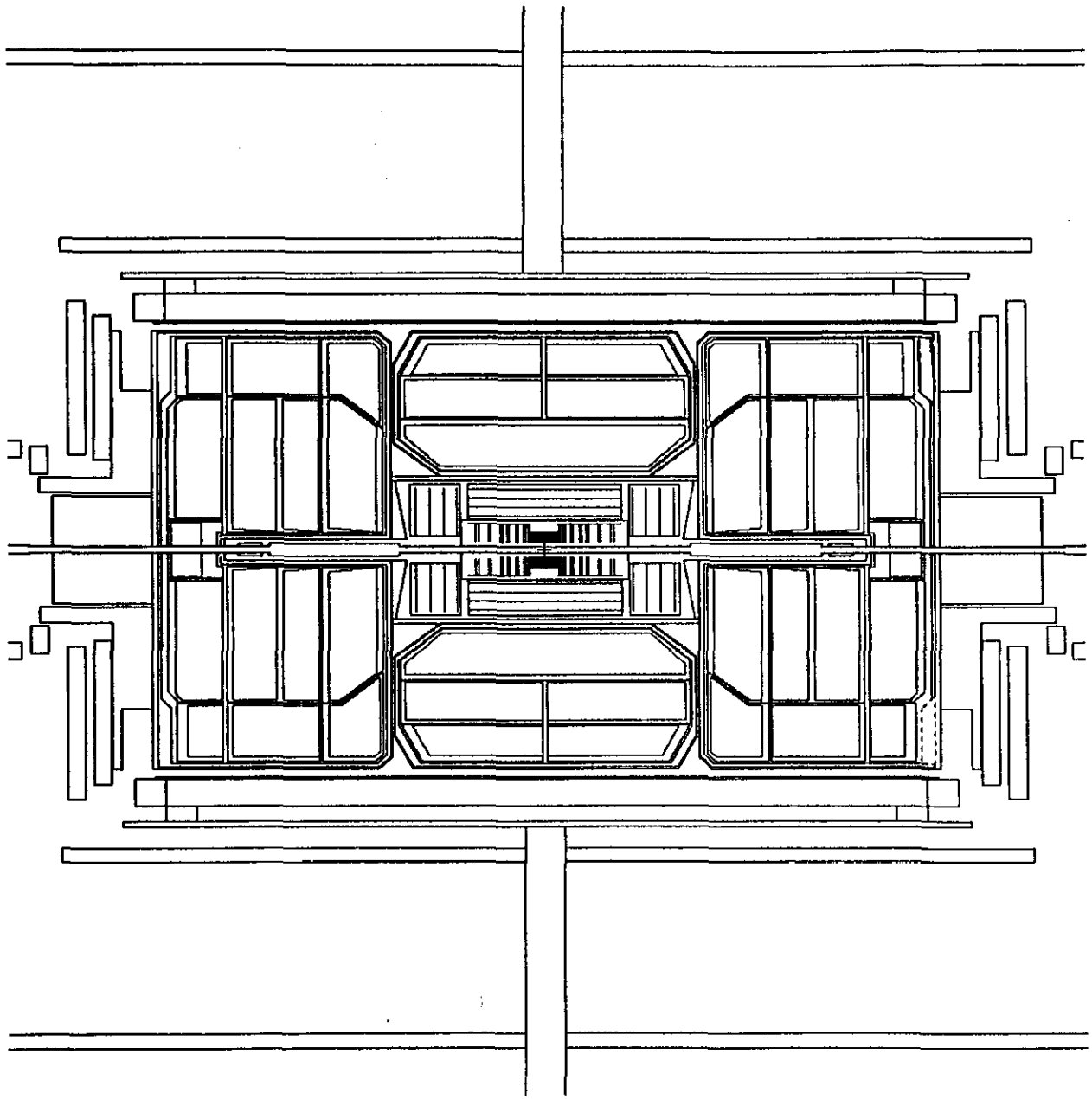

0.00006
0.00004
0.00002
0.00000
10⁻²
10⁻¹
10⁰
10¹
3.8906489E-04 2.6239868E-04 2.9058123E-04 2.7235126E-04
FW1
FW2
FW3
FW4


BARREL CHAMBERS
VOLUME PHOTON FLUX
from (n,γ)
QUAD
SHIELD
/cm²/DTUJET EVT.
0.000008
0.000006
0.000004
0.000002
0.000000
10⁻²
10⁻¹
10⁰
10¹
MeV
Total= 4.3556010E-05 4.8381084E-05 4.1795298E-05
BW1
BW2
BW3
3.6
3.9
5.02

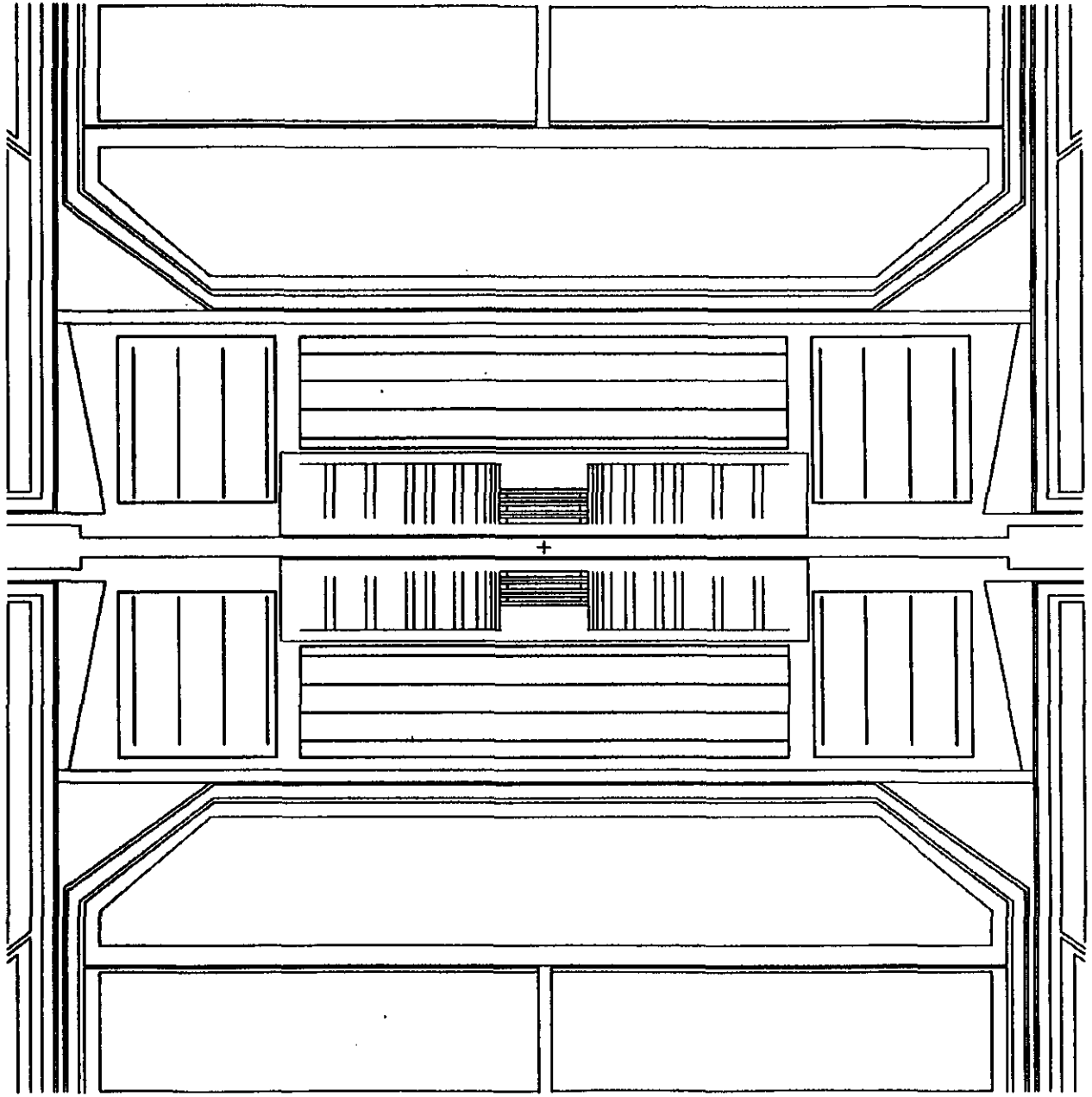

FORWARD CHAMBER VOLUME
QUAD
SHIELD
PHOTON FLUX
from (n,γ)
dN
/cm² /DTUJET EVT.
0.00004
0.00003
0.00002
0.00001
0.00000
10⁻²
10⁻¹
10⁰
10¹
MeV
2.1969380E-04 7.4150215E-05 4.0896026E-05 3.5576461E-05
Z = 566 cm
985 cm
1440 cm
1580 cm
upper
FW1
FW2
FW3
lower
FW4
1.77
3.54
7.1
7.65


8
6
4
2
2
3
4
5
↓ PHOTONS =
↓NEUTRONS * 1.554 - .0795
Photon reduction vs Neutron reduction

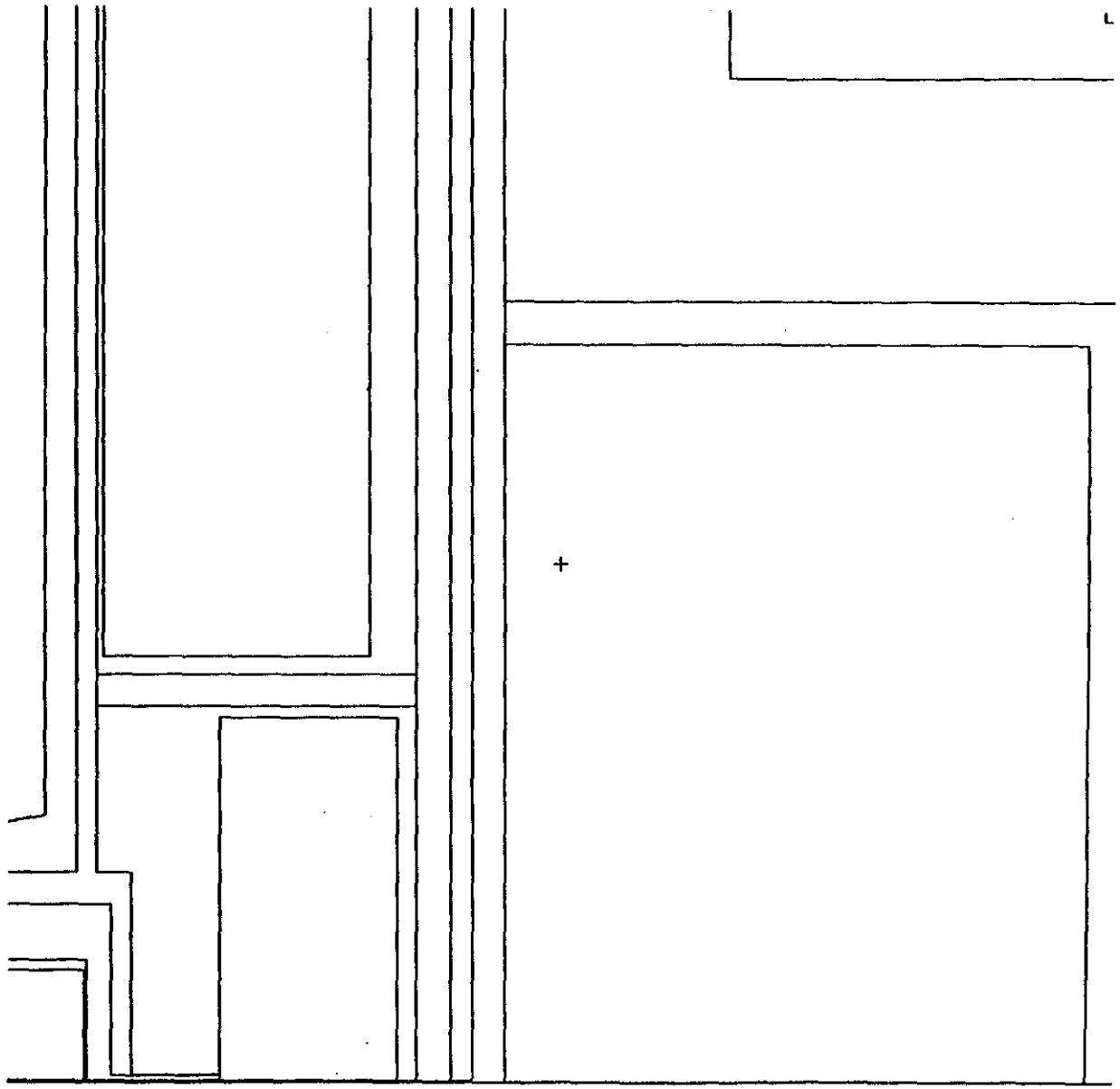
2/23/93 11 28 25
GEM SIMULATION 4 3B
UNSHIELDED QUAD UNSHIELDED
FCAL REAL BEAMPIPE
PROBID = 2/23/93 11 13 48
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (700.00, 700.00)
POSSIBLE CAUSES OF DOTTED LINES
ERRORS IN THE GEOMETRY.
COOKIE-CUTTER CELL IN THE SOURCE.
A PROBLEM PLANE COINCIDENT WITH
THE PLOT PLANE.



2/23/93 11 25 55
GEM SIMULATION 4 3B
UNSHIELDED QUAD UNSHIELDED
FCAL REAL BEAMPIPE
PROBID = 2/23/93 11 12 13
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (220.00, 220.00)



2/23/93 11 12 59
GEM SIMULATION 4 3B
UNSHIELDED QUAD UNSHIELDED
FCAL REAL BEAMPIPE
PROBID = 2/23/93 11 10 15
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 50.00, 525.00)
EXTENT = (125.00, 50.00)



er cryostat wall:
uminum 5083, density = 2.66 g/cc)
ius = 12.0 to 12.9 cm

221.4 cm to 230.0 cm	.3746 +/- .050	Megarads
230.0 cm to 240.0 cm	.4373 +/- .080	
240.0 cm to 250.0 cm	.4596 +/- .069	
250.0 cm to 260.0 cm	.4783 +/- .066	
260.0 cm to 270.0 cm	.4788 +/- .076	
270.0 cm to 280.0 cm	.4828 +/- .075	

es: I missed the region from z = 200.0 to 221.4 in this calculation, but will pick it up next time.
I now have the latest figures on the cryostat dimensions, the radius actually goes from 13.7 to 14.7 cm.

sullation:
H2, density = 1.032 g/cc)
dius = 12.9 cm to 18.8 cm

202.0 cm to 210.0 cm	.9164 +/- .137
210.0 cm to 220.0 cm	1.0943 +/- .257
220.0 cm to 230.0 cm	1.3339 +/- .274
230.0 cm to 240.0 cm	1.6627 +/- .267
240.0 cm to 250.0 cm	1.7289 +/- .3
250.0 cm to 260.0 cm	1.7007 +/- .253
260.0 cm to 270.0 cm	1.6808 +/- .249
270.0 cm to 280.0 cm	1.4432 +/- .355

tes: Latest radial figures are 14.7 cm to 19.7 cm. I am also informed by designers that this will be vacuum. The gal I got the figures from was very surprized that any insulation was contemplated for this area. Apparantly she has build such devices at CERN.

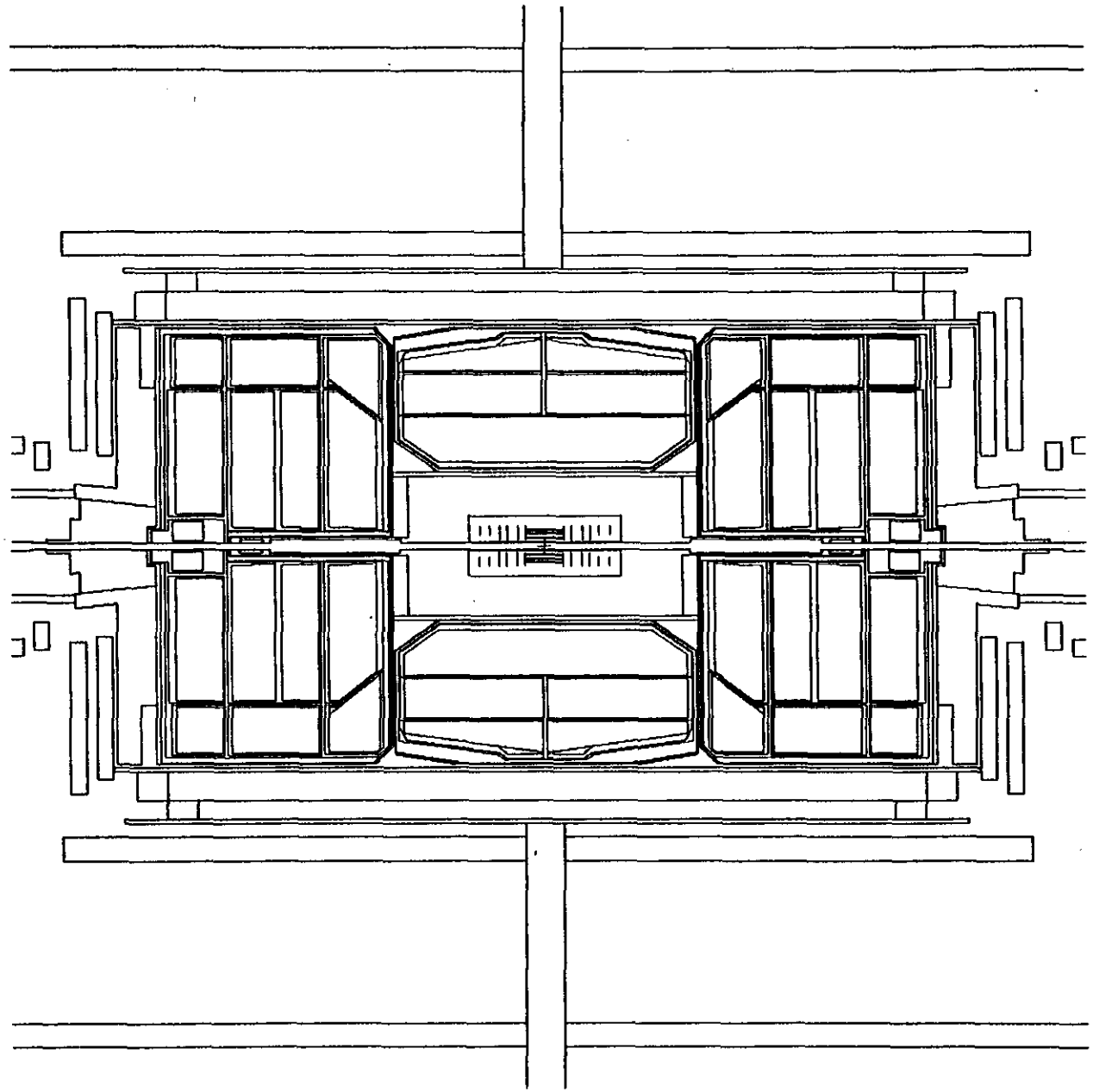
ner cryostat:
l 5083, density = 2.66 g/cc)
dius = 18.8 cm to 20.0 cm

206.0 cm to 210.0 cm	.2359 +/- .045
210.0 cm to 220.0 cm	.2788 +/- .045
220.0 cm to 230.0 cm	.3318 +/- .047
230.0 cm to 240.0 cm	.3823 +/- .069
240.0 cm to 250.0 cm	.3941 +/- .061
250.0 cm to 260.0 cm	.4056 +/- .065
260.0 cm to 270.0 cm	.3851 +/- .069
270.0 cm to 280.0 cm	.3877 +/- .078

tes: Latest radial figures are 19.7 cm to 22.5 cm.

2/ 3/93 13 21 34
GEM SIMULATION FINE
SEGMENTATION

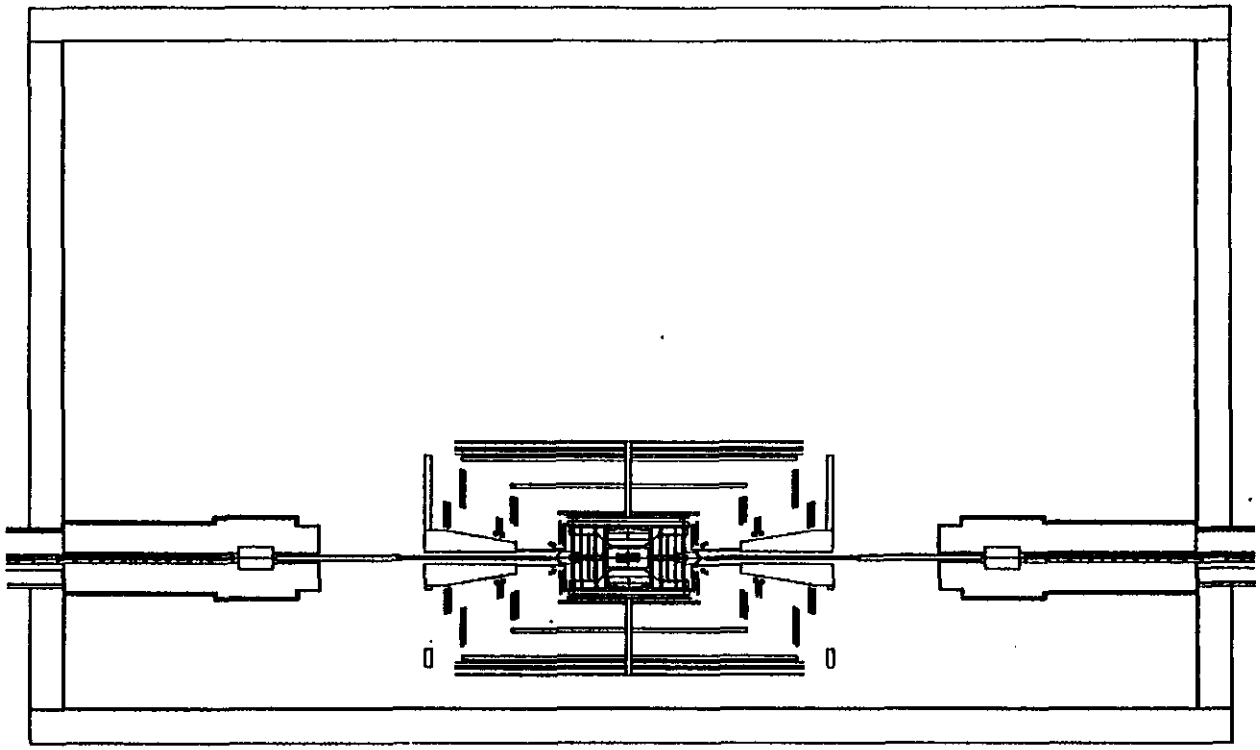
PROBID = 2/ 3/93 13 11 01
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (700.00, 700.00)



QUAD
SHIELD

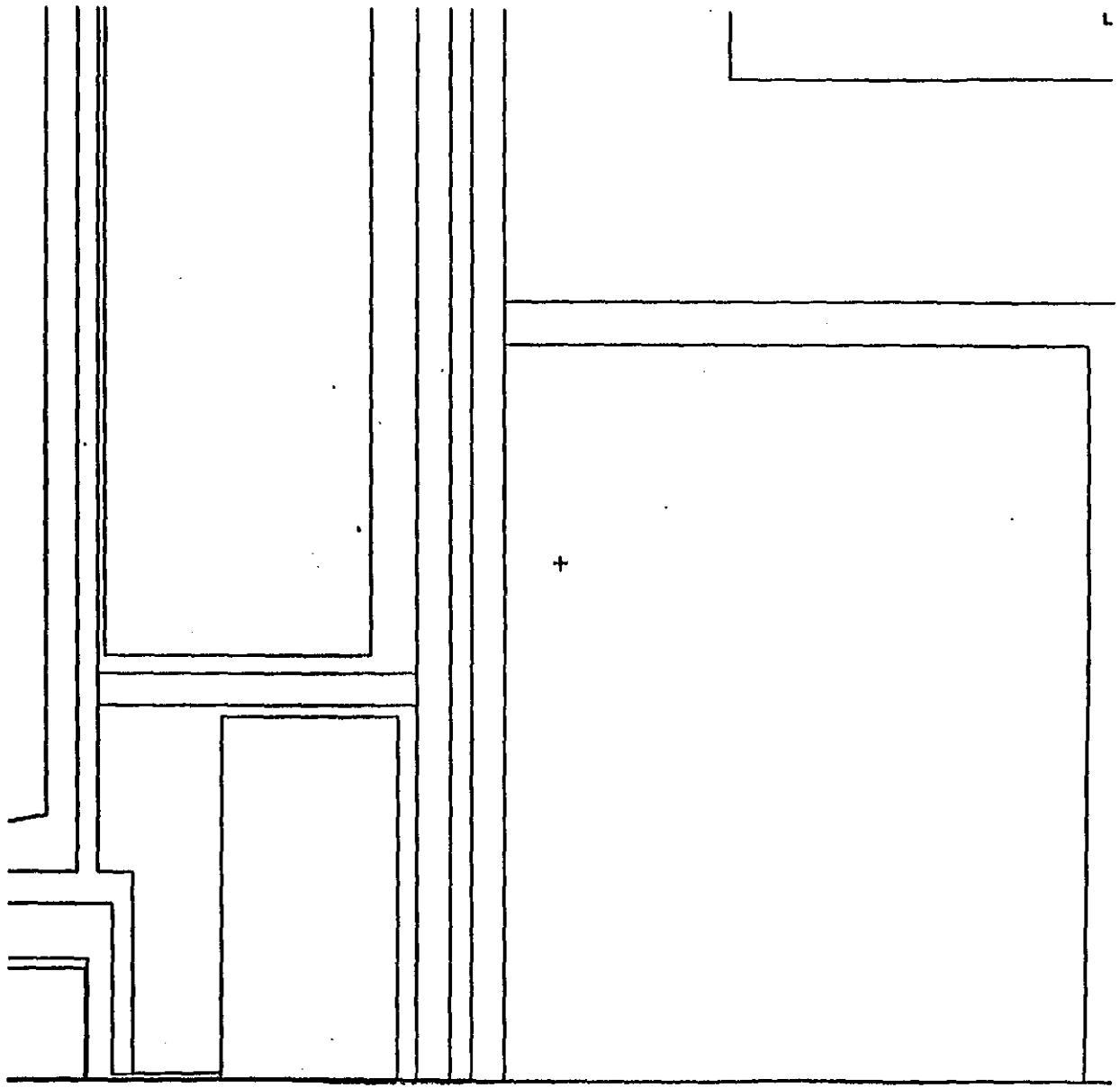
2/ 3/93 14 52 27
GEM SIMULATION FINE
SEGMENTATION

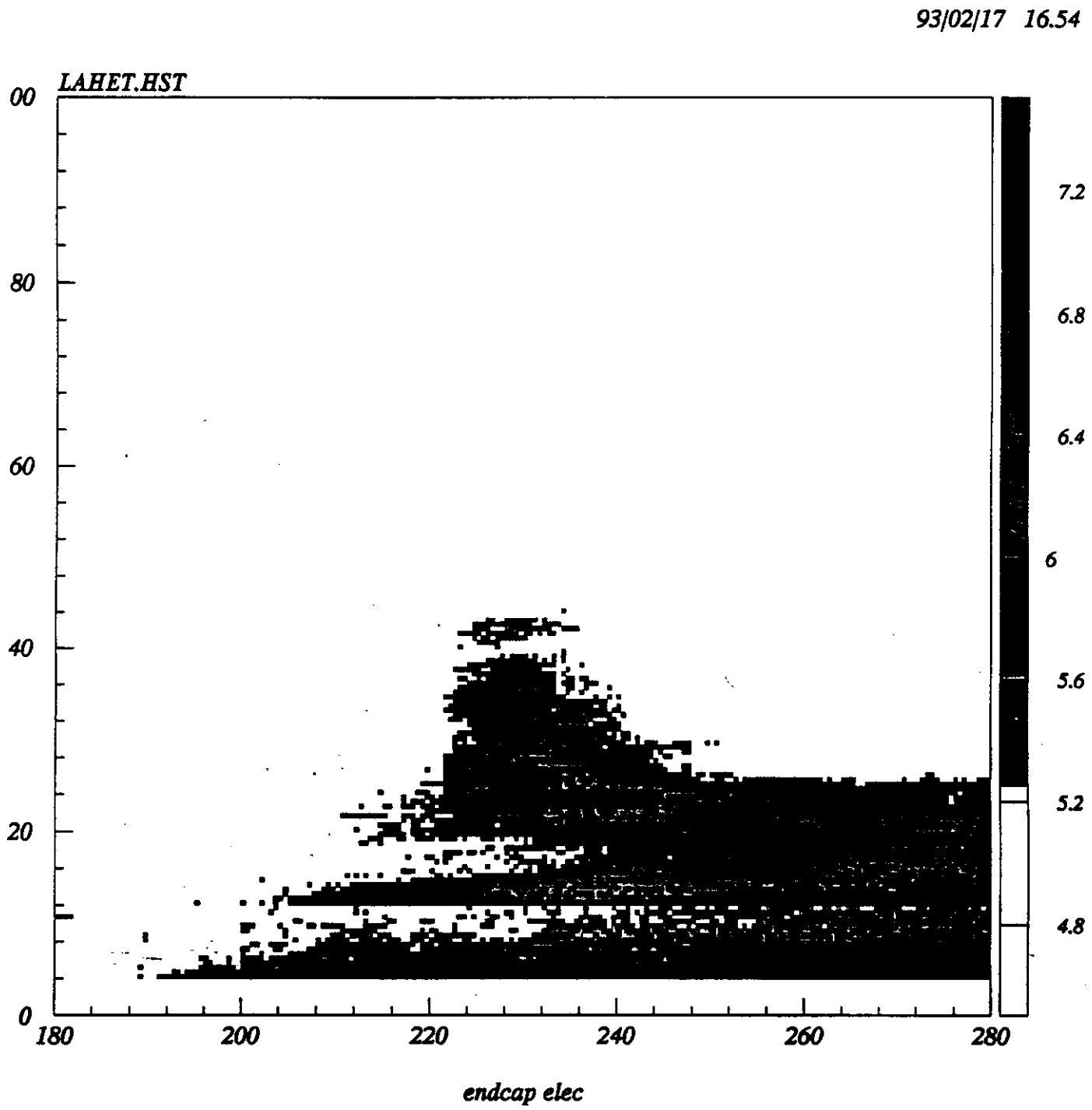
PROBID = 2/ 3/93 14 36 33
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 0.00)
EXTENT = (5500.00, 5500.00)

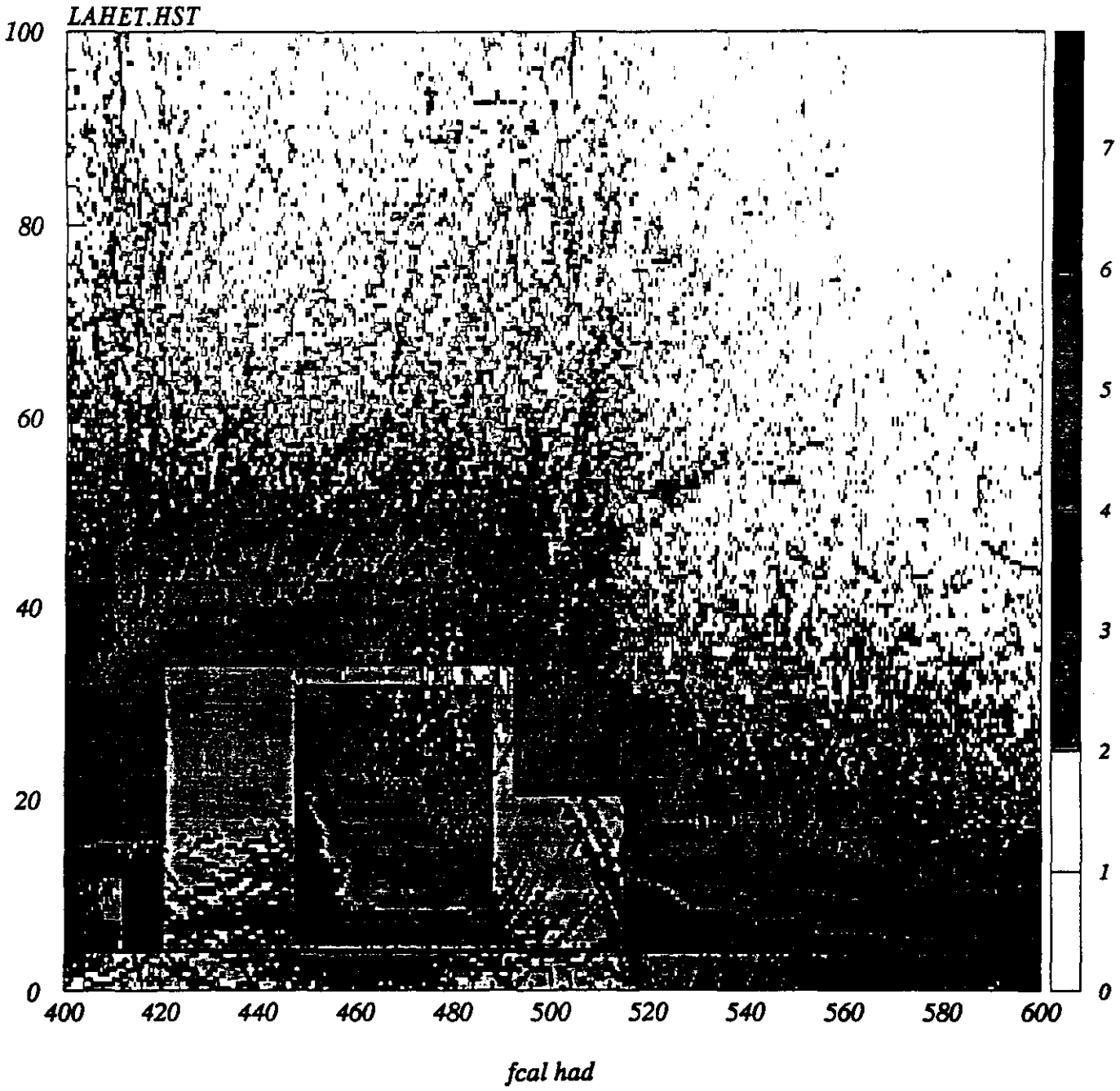


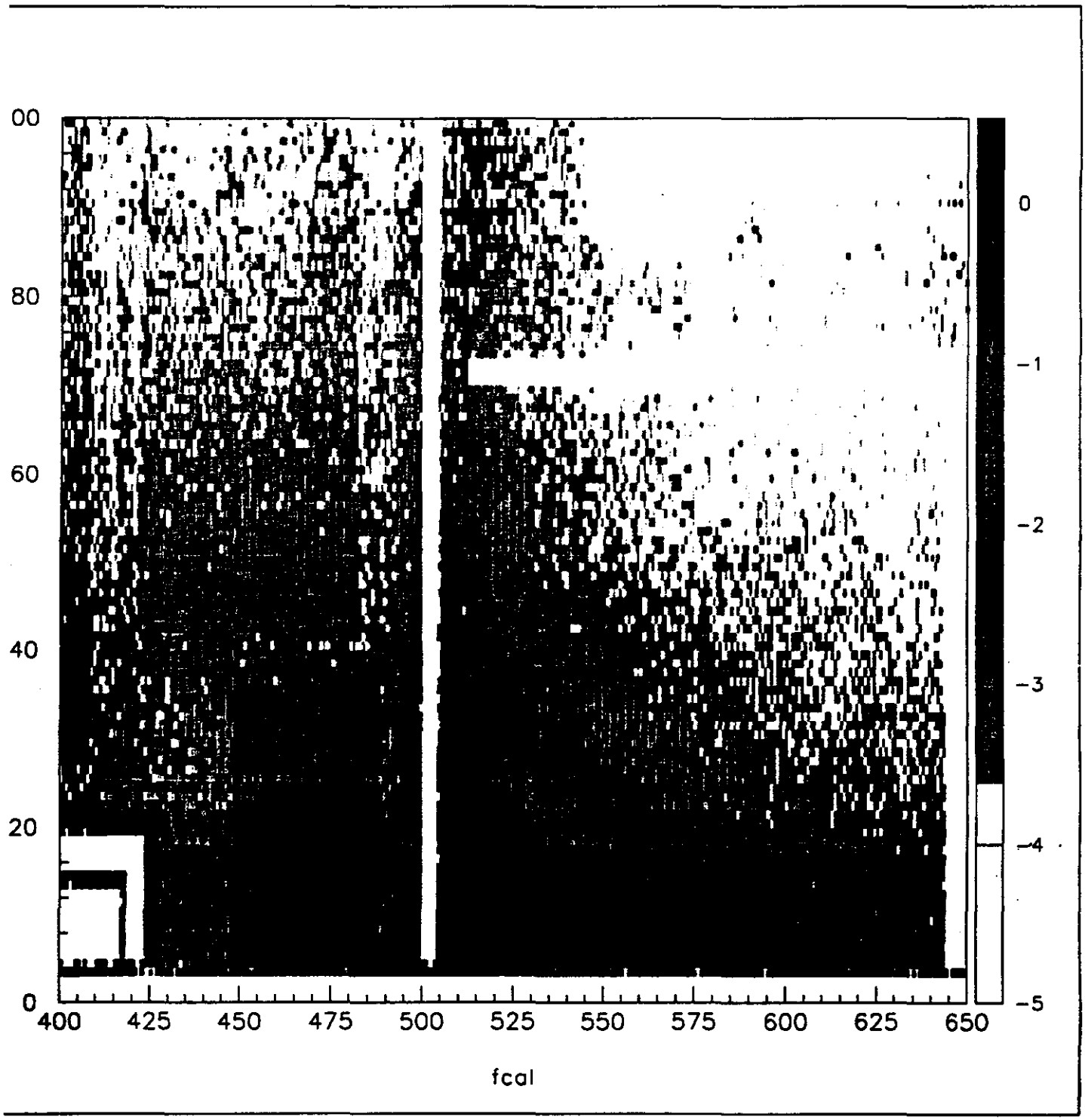
QUAD SHIELD

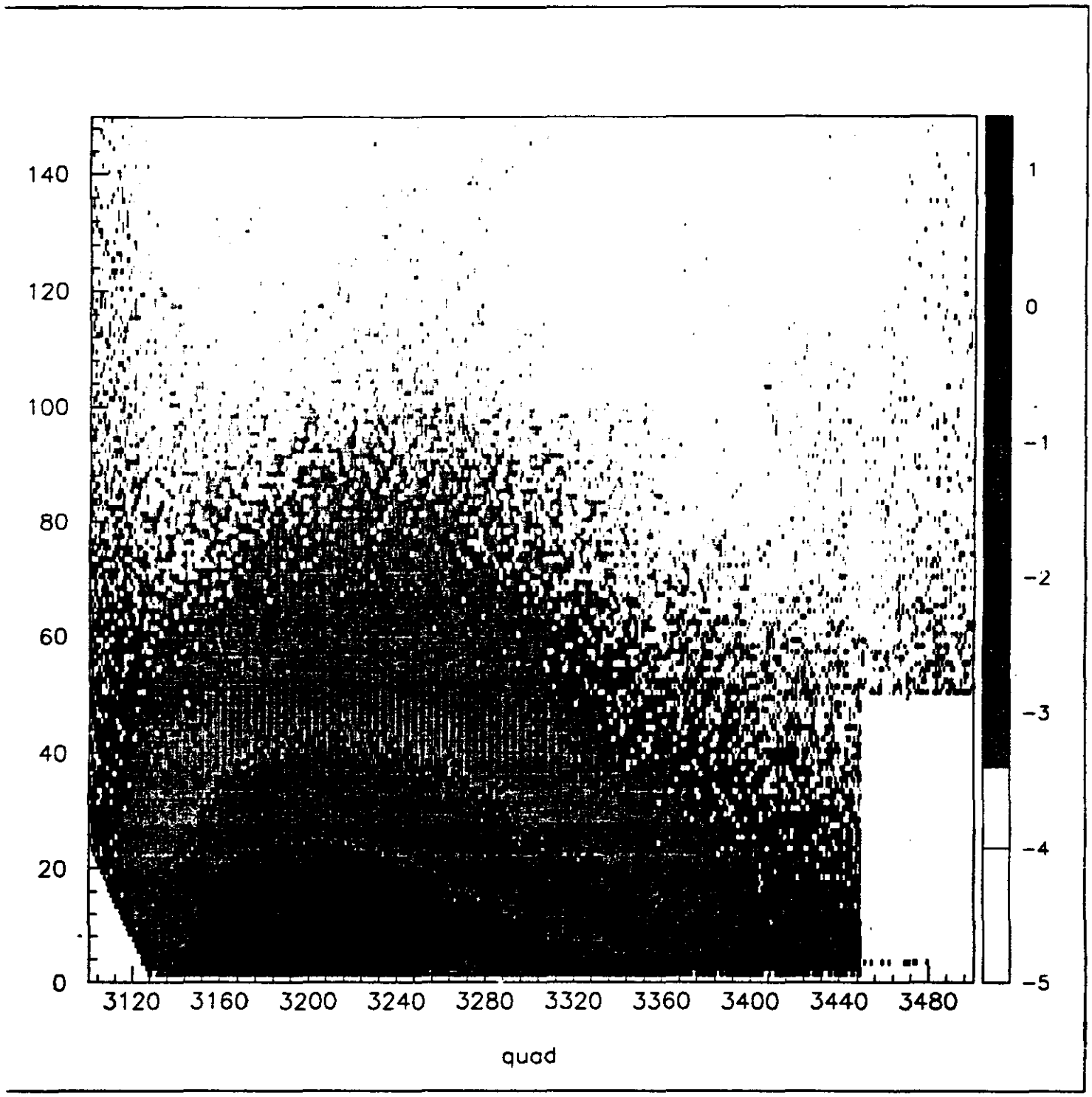
2/23/93 11 12 59
GEM SIMULATION 4 3B
UNSHIELDED QUAD UNSHIELDED
FCAL REAL BEAMPIPE
PROBID - 2/23/93 11 10 15
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 50.00, 825.00)
EXTENT = (125.00, 50.00)



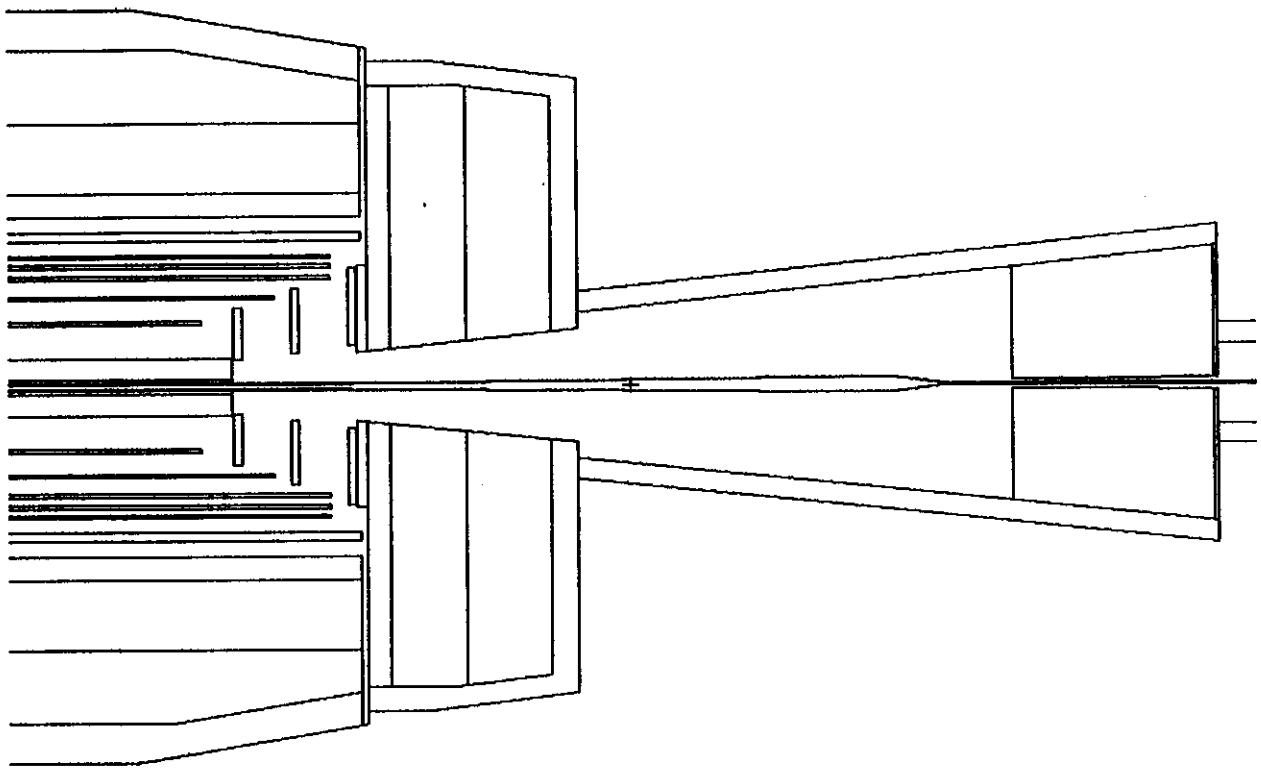

93/02/17 16.54
LAHET.HST
00
80
60
40
20
0
180
200
220
240
260
280
endcap elec
7.2
6.8
6.4
6
5.6
5.2
4.8


LAHET.HST
100
80
60
40
20
0
400
420
440
460
480
500
520
540
560
580
600
fcal had
7
6
5
4
3
2
1
0


00
80
60
40
20
0
400
425
450
475
500
525
550
575
600
625
650
fcal
0
−1
−2
−3
−4
−5

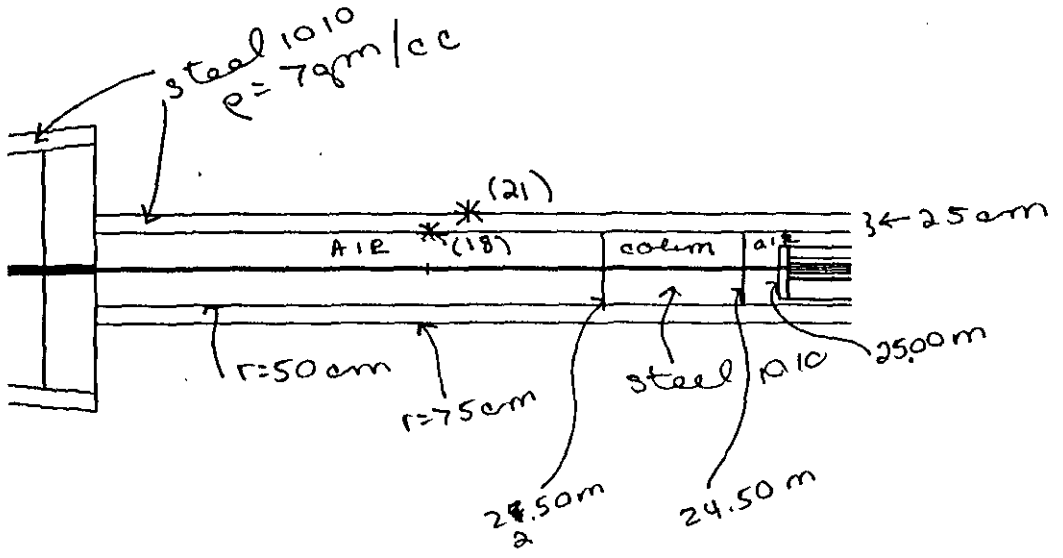

140
120
100
80
60
40
20
0
3120
3160
3200
3240
3280
3320
3360
3400
3440
3480
quad
1
0
−1
−2
−3
−4
−5

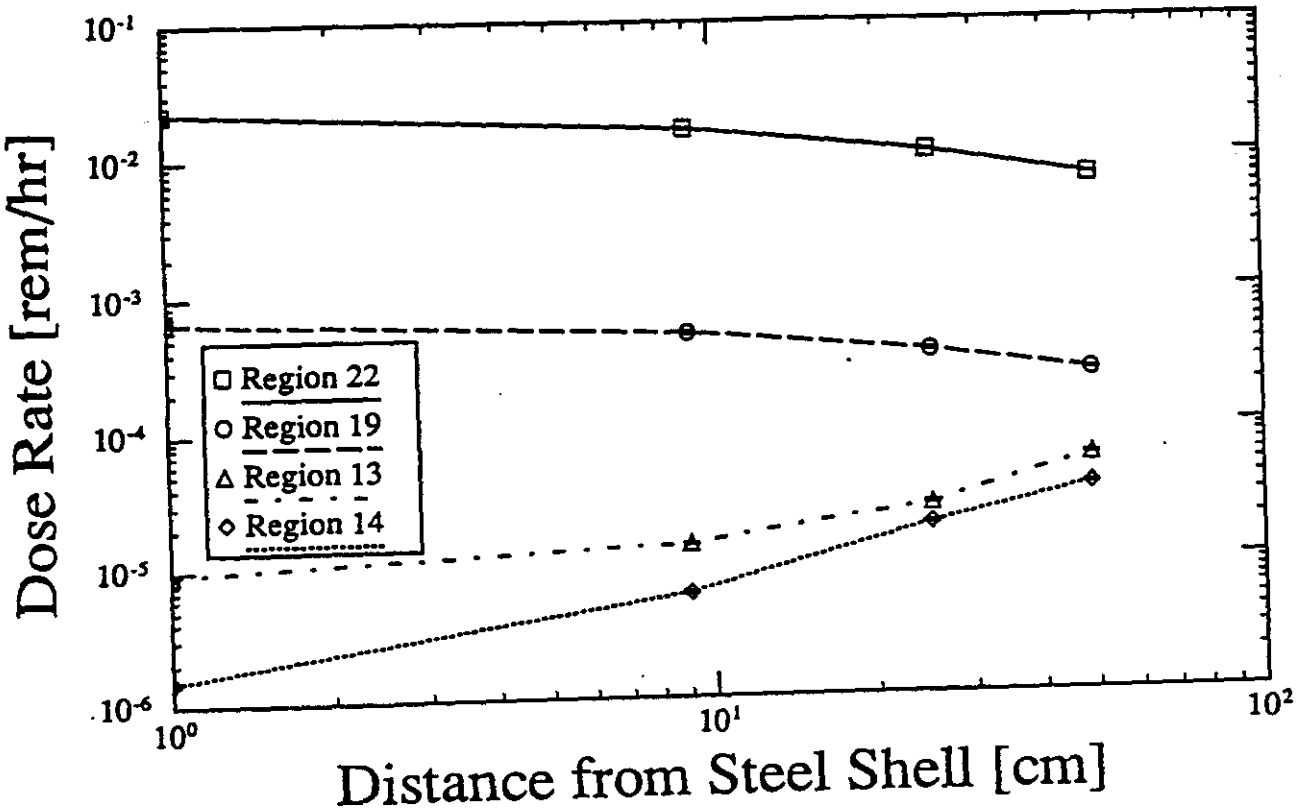
2/14/93 11 11 37
SDC SIMULATION TO GIVE TO
ORNL FOR DISCRETE ORDINATES
INPUT 2-7-93
PROBID = 2/14/93 11 10 55
BASIS
(0.000000, 0.000000, 1.000000)
(0.000000, 1.000000, 0.000000)
ORIGIN
(0.00, 0.00, 775.00)
EXTENT = (775.00, 775.00)

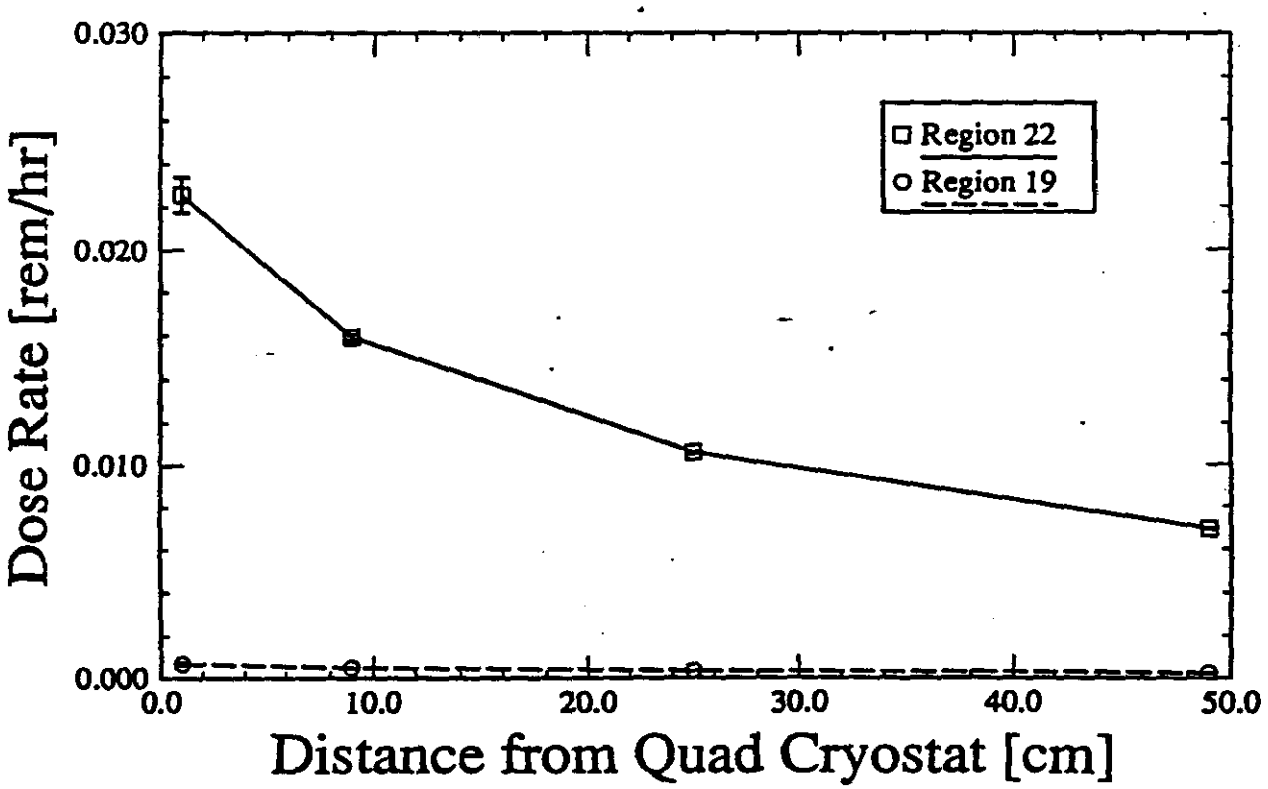


```
  2/ 8/93 12 57 17
SDC SIMULATION    TO GIVE TO
 ORNL FOR DISCRETE ORDINATES
 INPUT  2-7-93
PROB ID =    2/ 8/93 12 52 54
BASIS
( 0.000000, 0.000000, 1.000000)
( 0.000000, 1.000000, 0.000000)
ORIGIN
(      0.00,      0.00,   2000.00)
EXTENT = (    600.00,    600.00)
```

all particles stop when they reach this volume




Dose Rate [rem/hr]
Distance from Steel Shell [cm]
Region 22
Region 19
Region 13
Region 14


Dose Rate [rem/hr]
Distance from Quad Cryostat [cm]
Region 22
Region 19

gem

γeμ

Presentation by:

Y. Fisyak

February 24, 1993

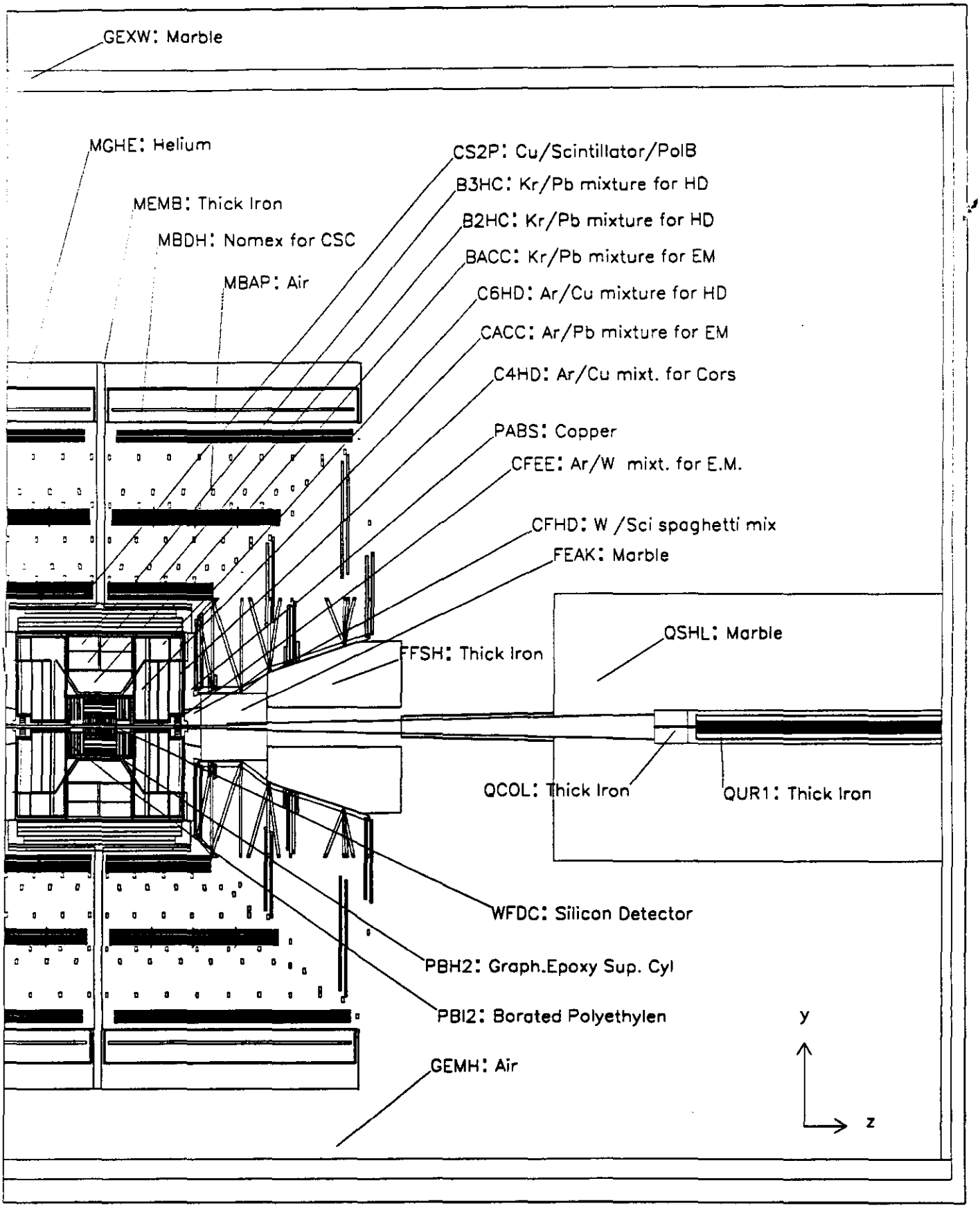
Y. Fisyak

Hit rates in GEM track systems

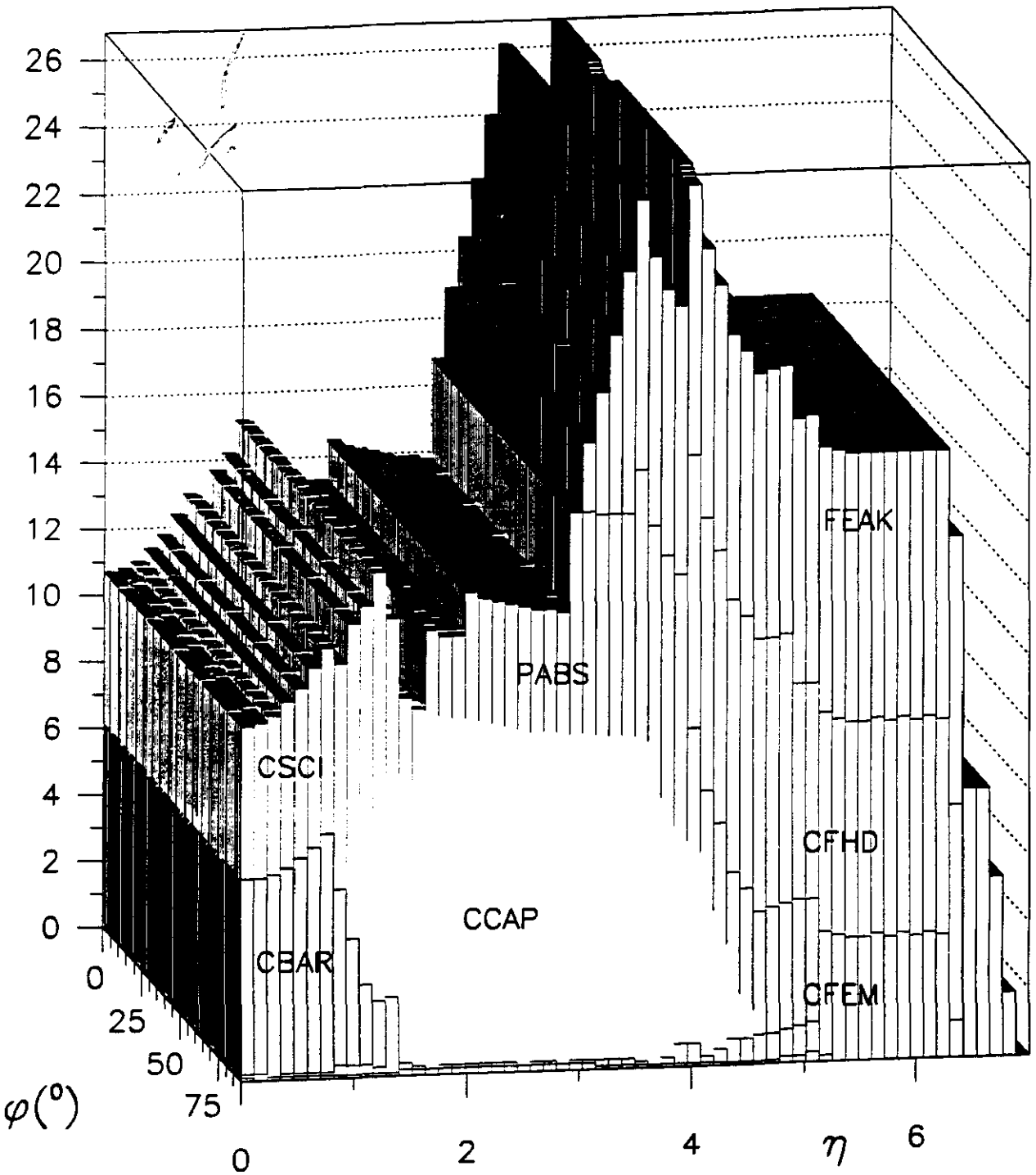
Simulation conditions

The presented results are based on the SIGEM calculations based on GEANT v3.15 + GCALOR v 0.93/06 930215 (C.Zeitnitz):

- Cutoff for neutrons: $E_{kin} = 10^{-11}$ GeV = 0.01 eV,
- Cutoff for γ's : 100 keV,
- Geometry : GEM base line 2 design (GEM-TN-92-231)
  - GEM experimental hall
  - No. of absorbtion lengths in the calorimeter system
  - Description of detector elements in Central track and Muon systems
- Statistics : 20 DTU events


GEXW: Marble
MGHE: Helium
MEMB: Thick Iron
MBDH: Nomex for CSC
MBAP: Air
CS2P: Cu/Scintillator/PolB
B3HC: Kr/Pb mixture for HD
B2HC: Kr/Pb mixture for HD
BACC: Kr/Pb mixture for EM
C6HD: Ar/Cu mixture for HD
CACC: Ar/Pb mixture for EM
C4HD: Ar/Cu mixt. for Cors
PABS: Copper
CFEE: Ar/W mixt. for E.M.
CFHD: W /Sci spaghetti mix
FEAK: Marble
QSHL: Marble
FFSH: Thick Iron
QCOL: Thick Iron
QUR1: Thick Iron
WFDC: Silicon Detector
PBH2: Graph.Epoxy Sup. Cyl
PBI2: Borated Polyethylen
GEMH: Air
y
z

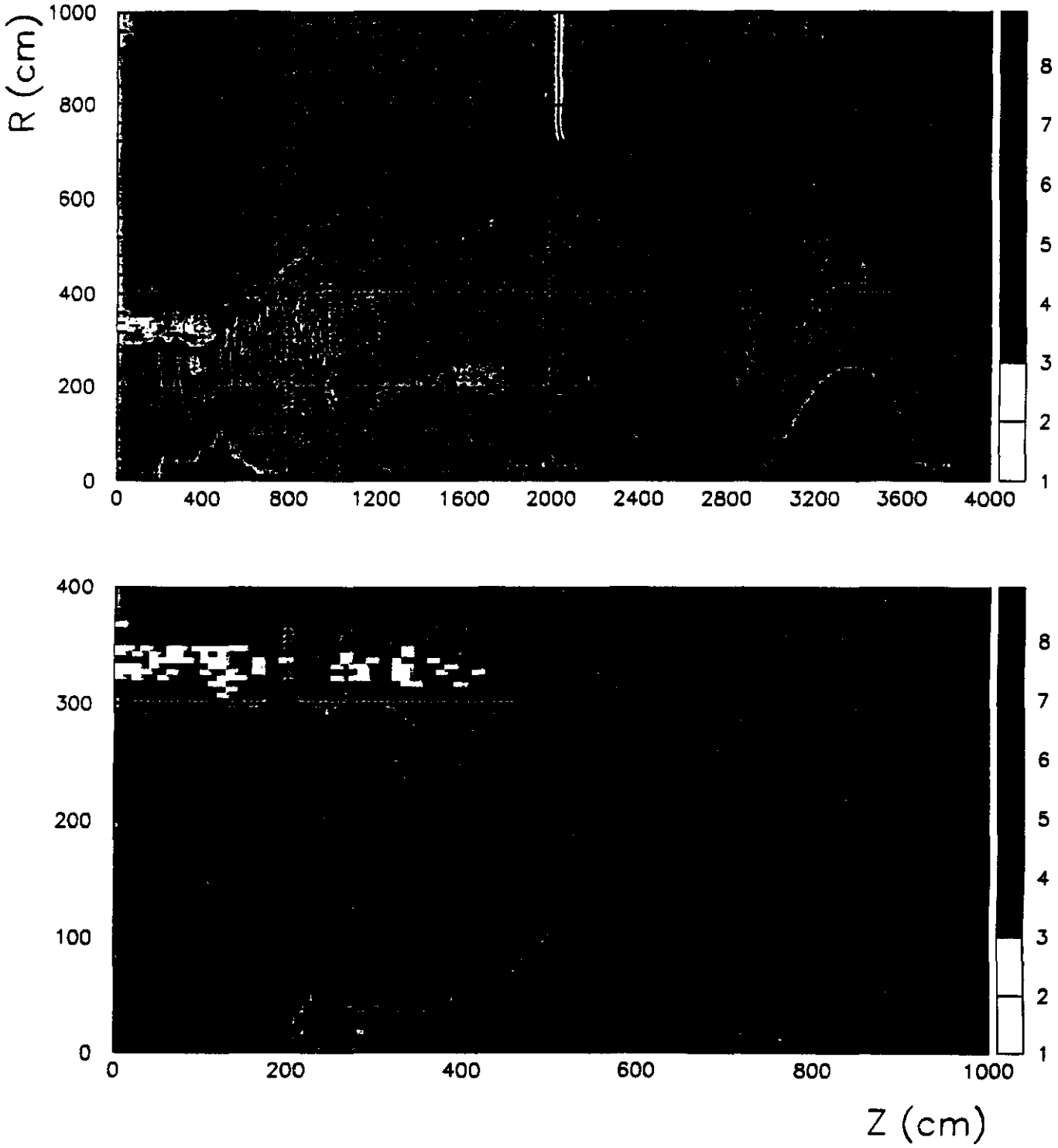
No. of absorbtion lengths in GEM calorimeter

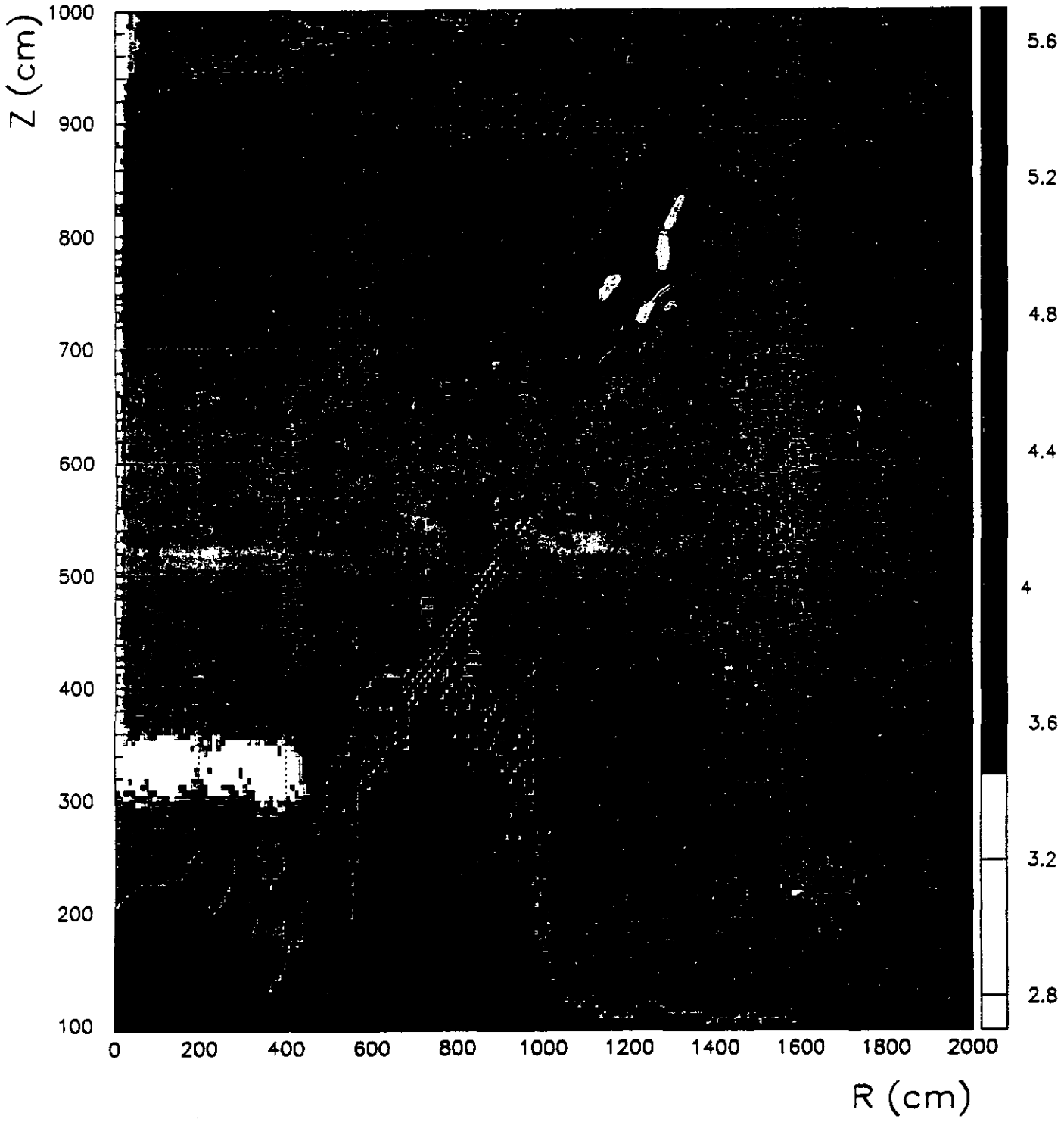


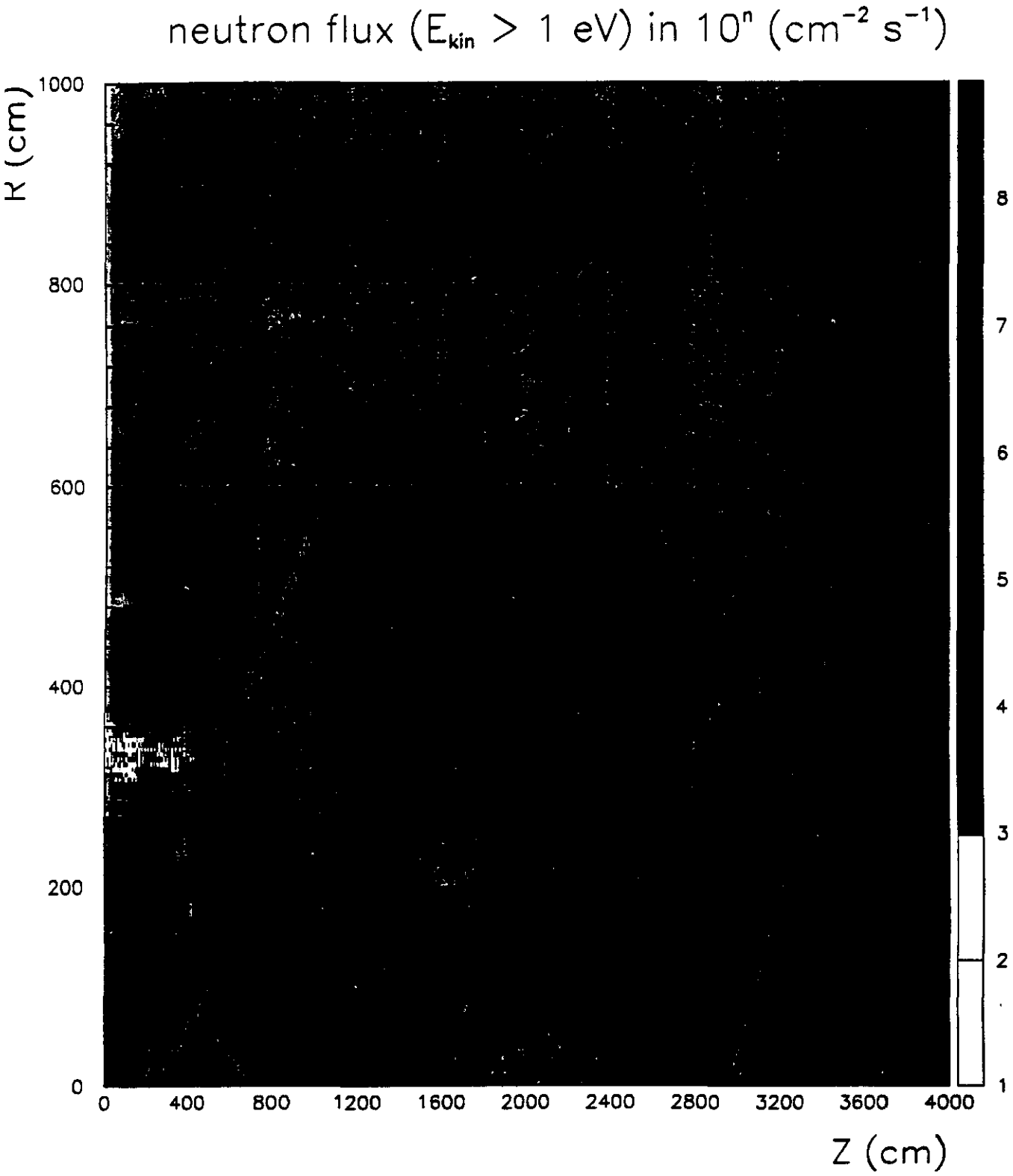
Neutron and γ fluxes

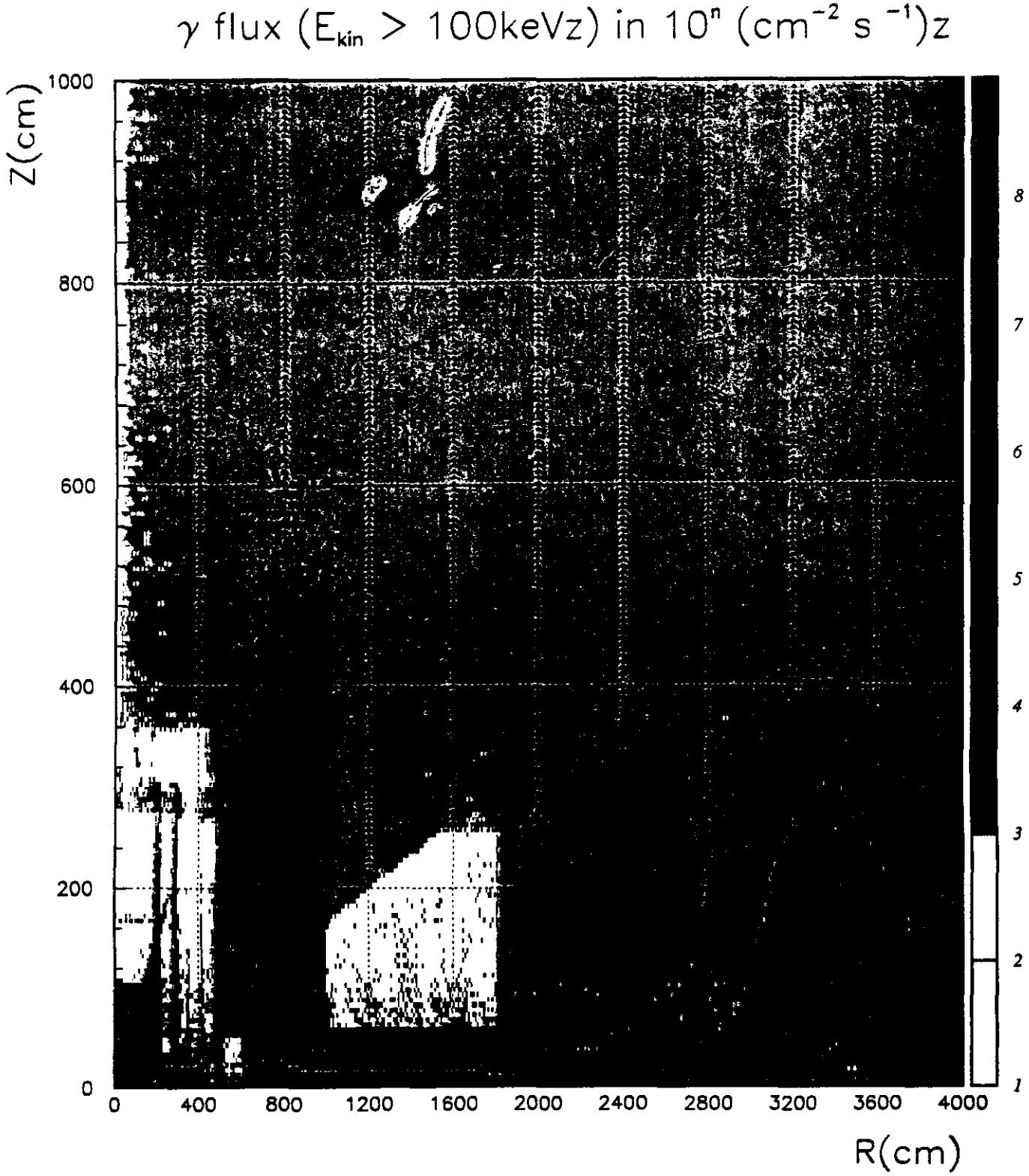
- Neutron fluxes in GEM experimental hall, Central tracker, Muon system
- γ flux in GEM
- γ to neutron flux ratio
- Neutron production region definition. Neutrons produced in the region are tagged together with all their "descendants "
- "Tagged" neutron fluxes
- γ fluxes from "tagged" neutrons
- Neutron energy distribution at each step.
  Thermal peak at 1-10 eV ?
- γ energy distribution.
  Cut at 100 keV?

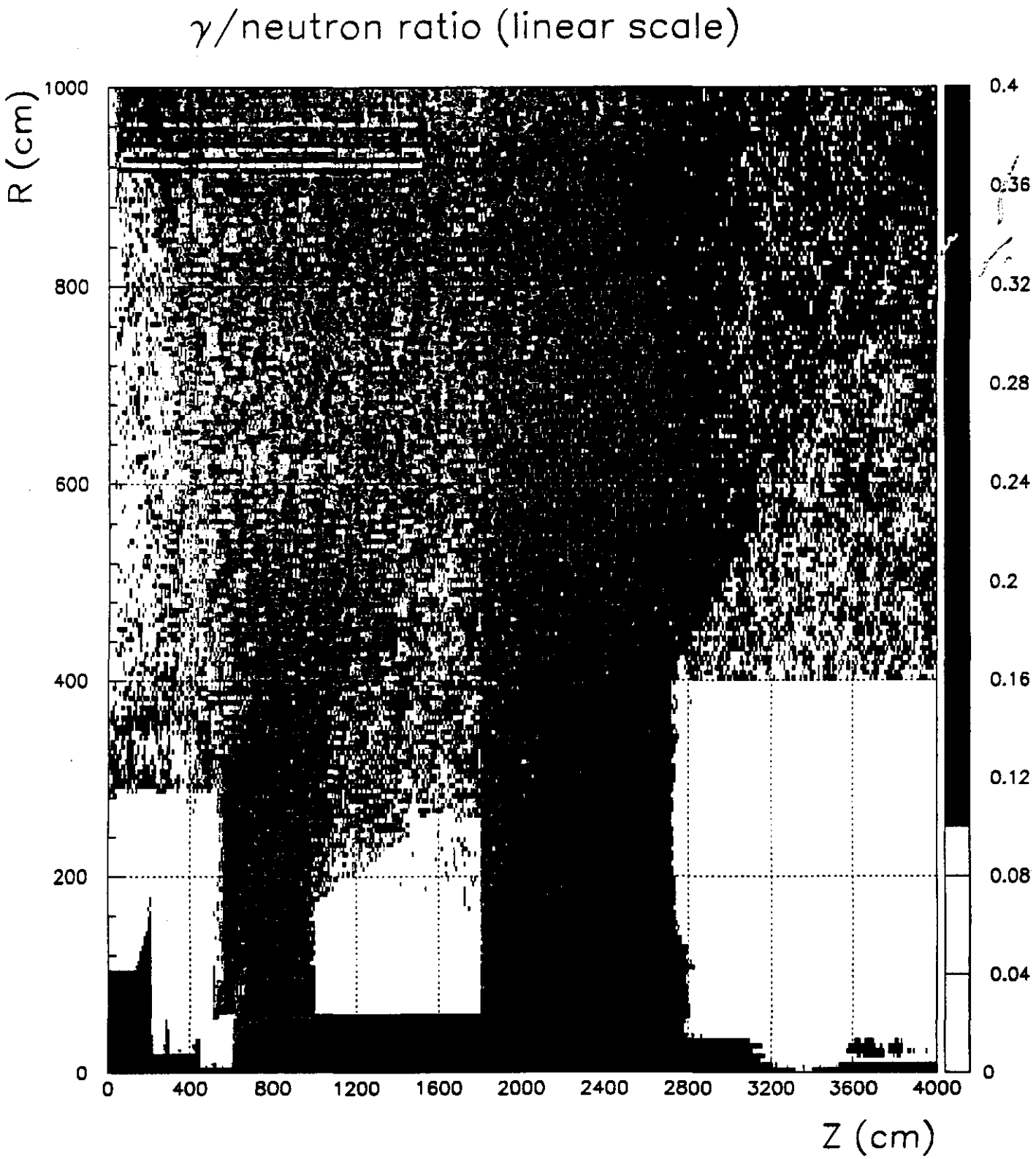
Flux of neutrons with E_{kin} > 1 eV in 10^n (cm^{-2} s^{-1})



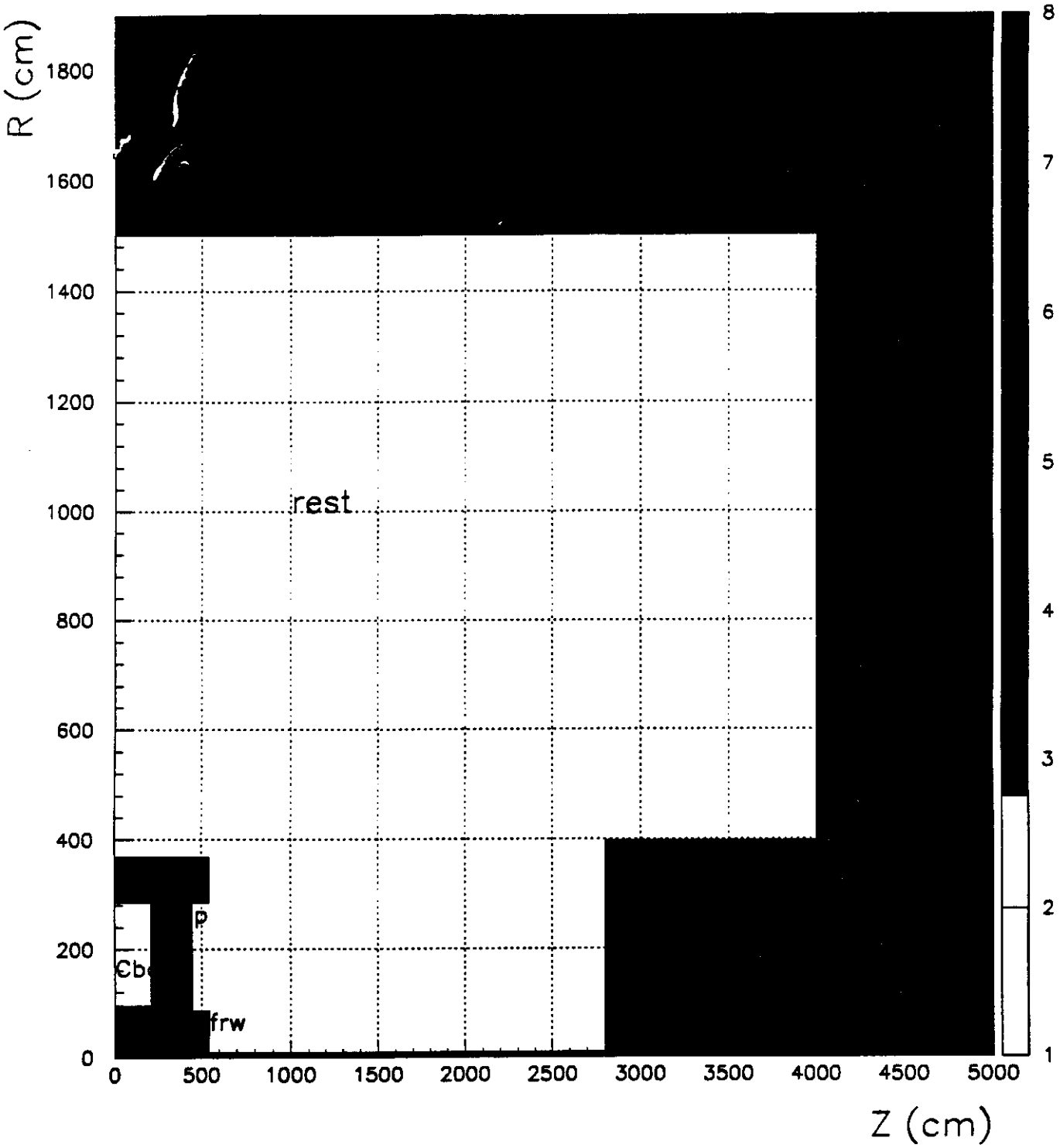

Z (cm)
1000
900
800
700
600
500
400
300
200
100
0
200
400
600
800
1000
1200
1400
1600
1800
2000
R (cm)
5.6
5.2
4.8
4.4
4
3.6
3.2
2.8

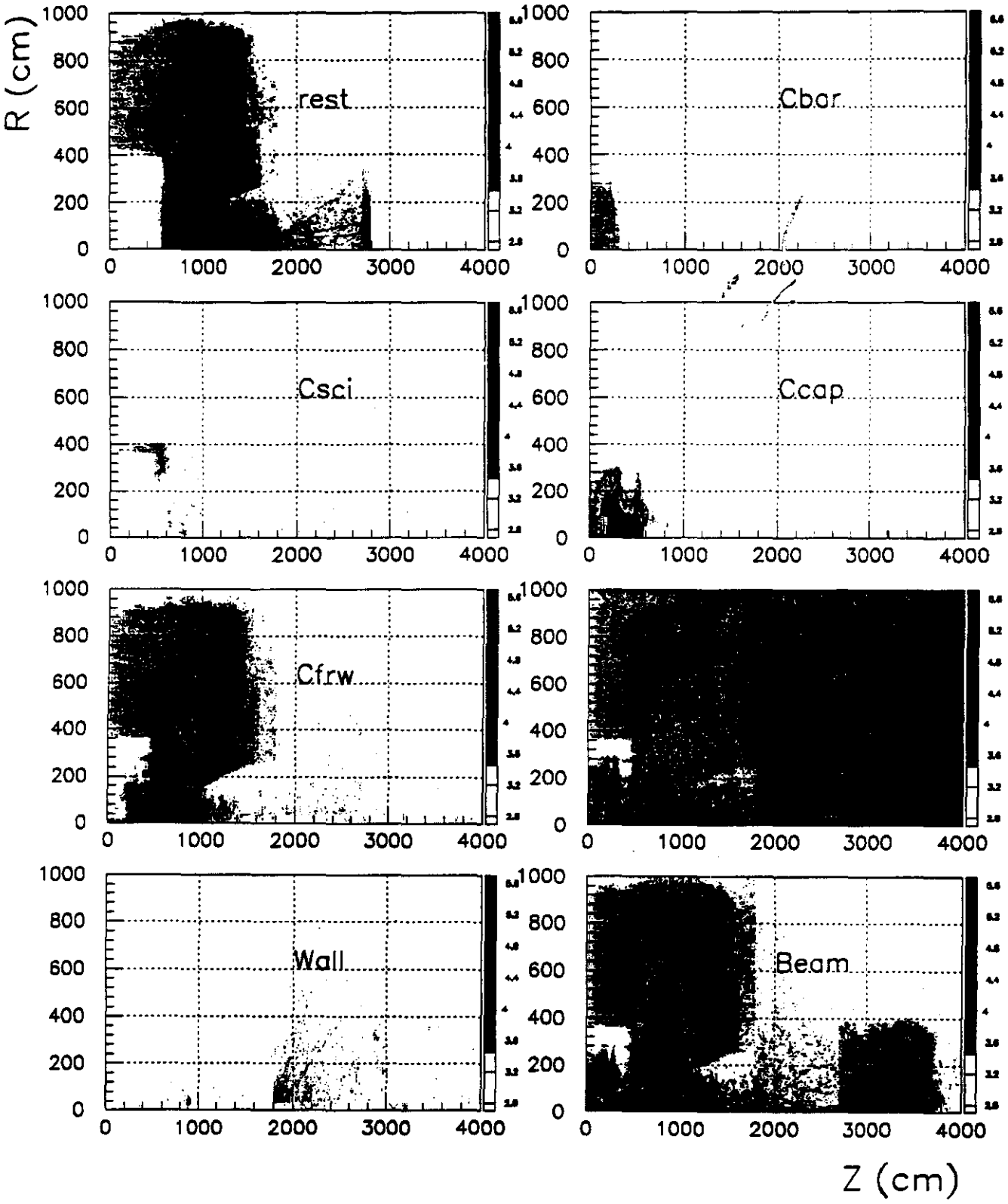

neutron flux (E_{kin} > 1 eV) in 10^n (cm^{-2} s^{-1})
R (cm)
1000
800
600
400
200
0
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
Z (cm)
8
7
6
5
4
3
2
1


γ flux (E_kin > 100keVz) in 10^n (cm^-2 s^-1)z
Z(cm)
1000
800
600
400
200
0
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
R(cm)
8
7
6
5
4
3
2
1

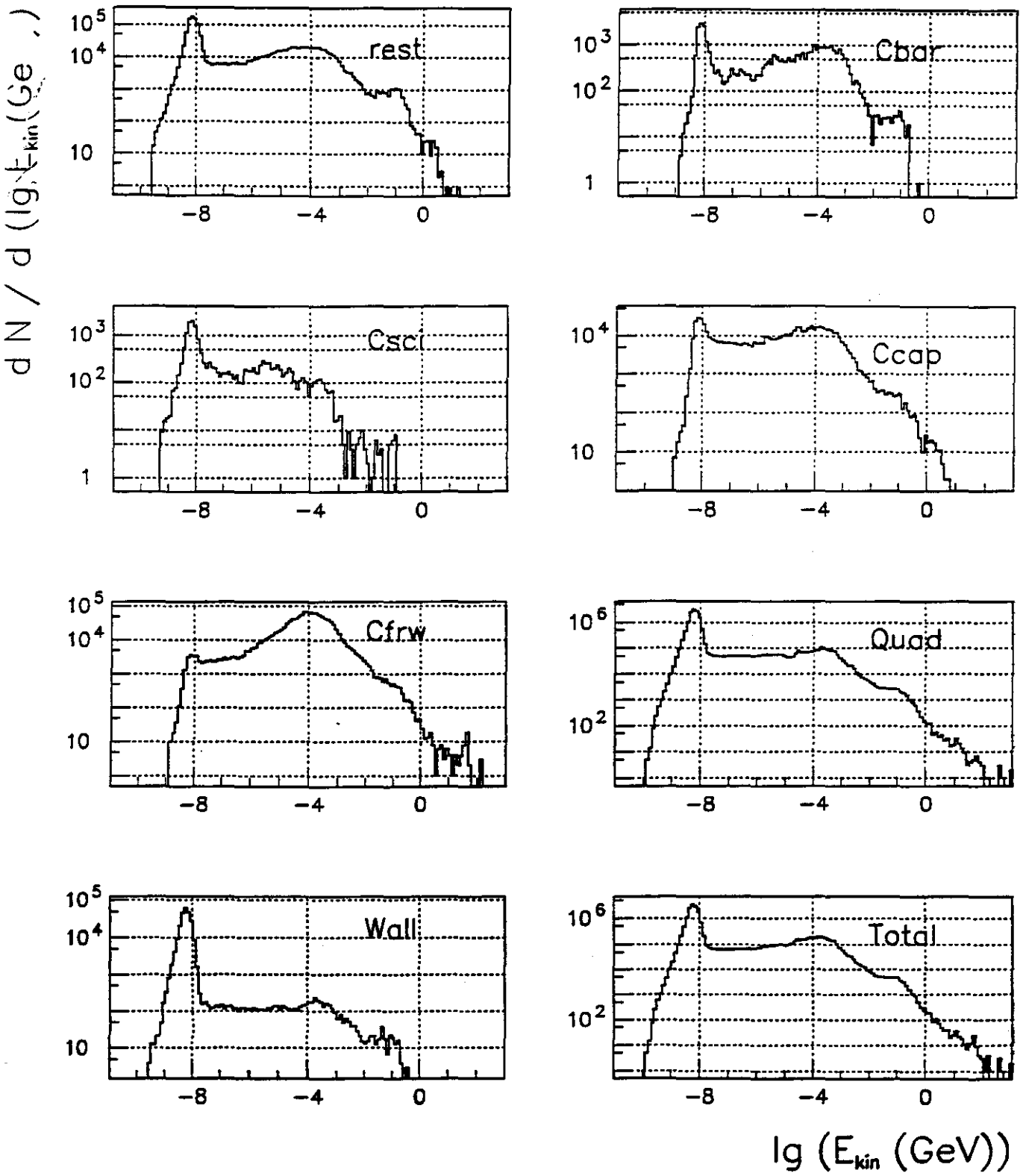

γ/neutron ratio (linear scale)
R (cm)
1000
800
600
400
200
0
0
400
800
1200
1600
2000
2400
2800
3200
3600
4000
Z (cm)
0.4
0.36
0.32
0.28
0.24
0.2
0.16
0.12
0.08
0.04
0

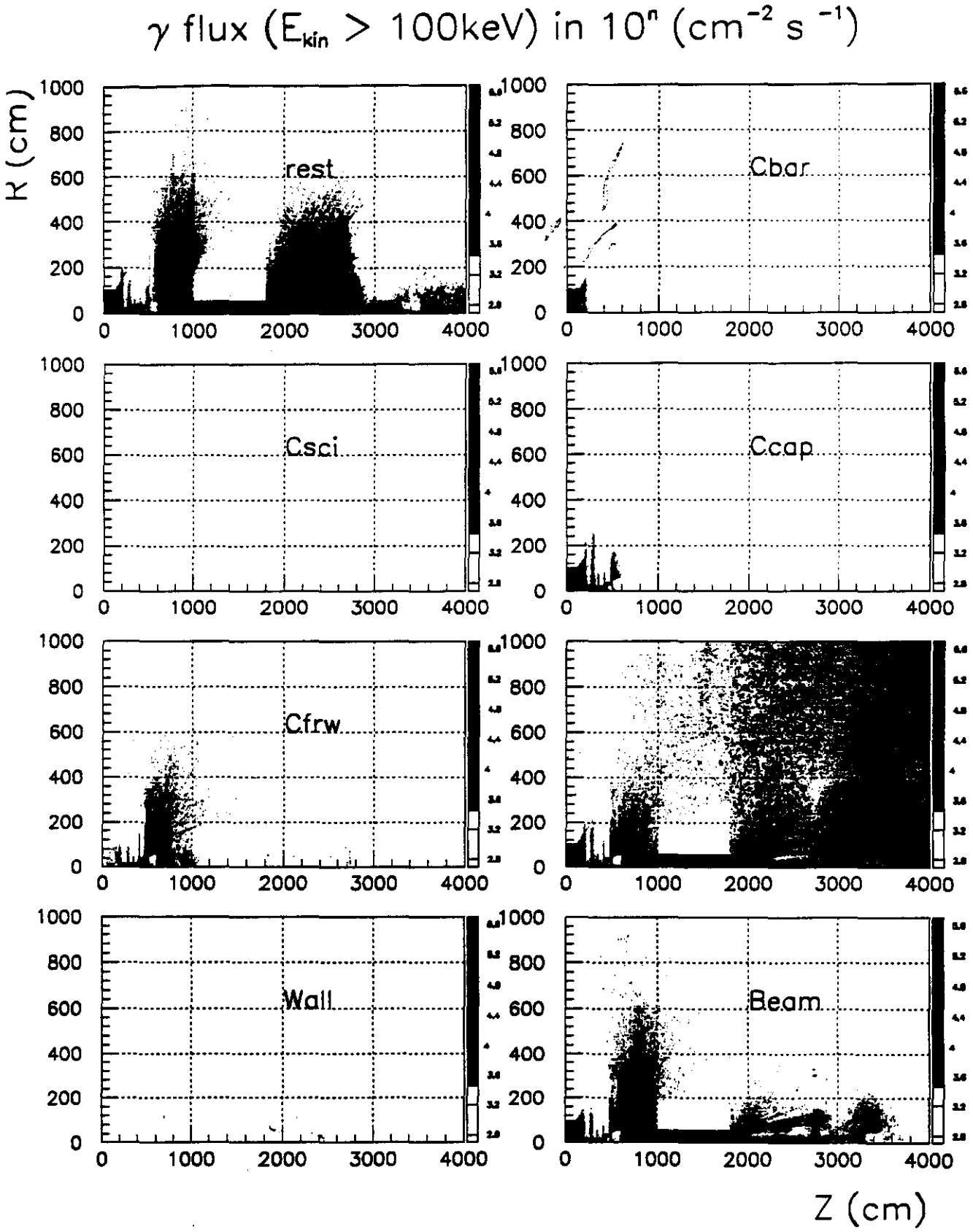
Region definition



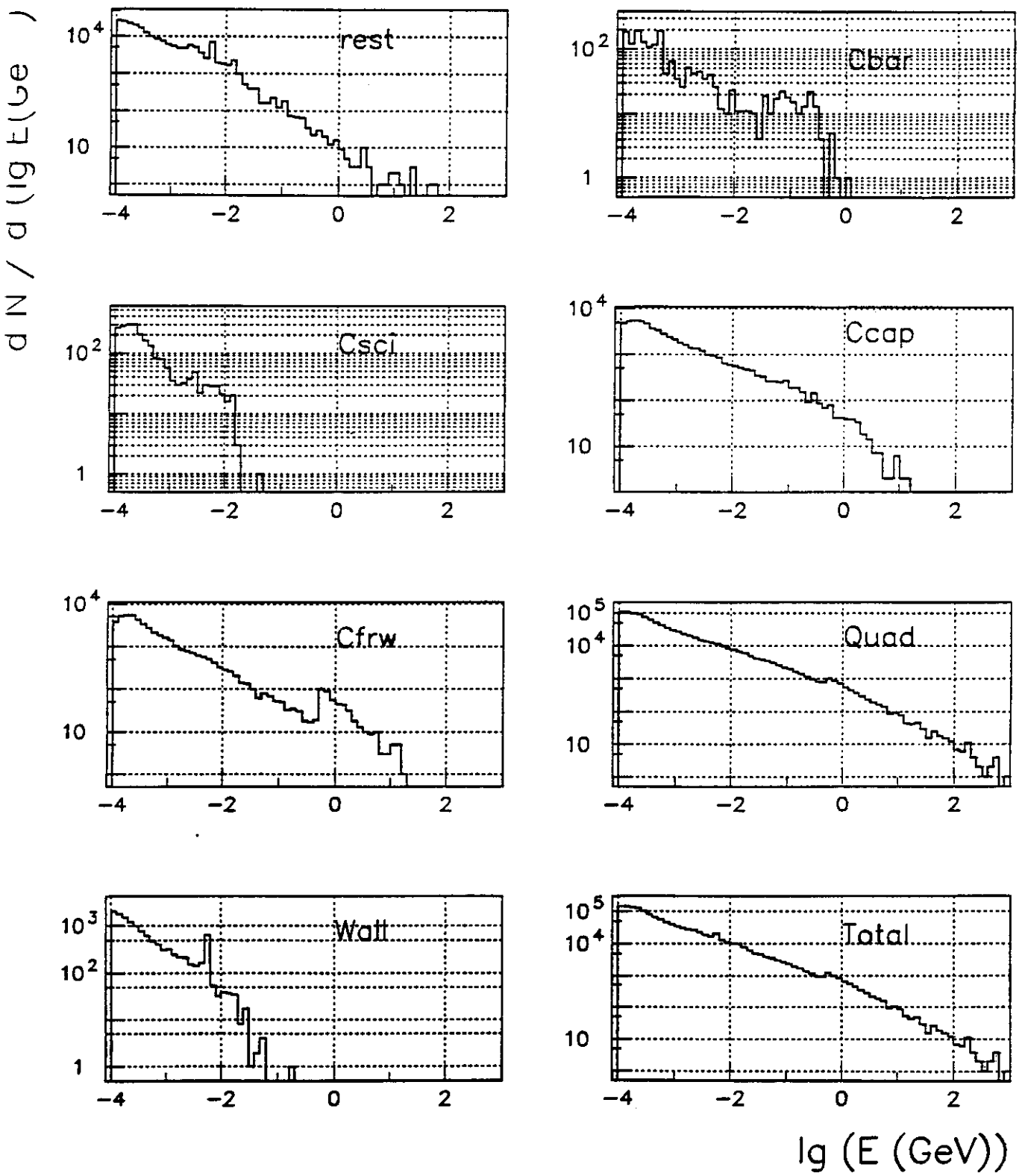

R (cm)
rest
Cbar
Csci
Ccap
Cfrw
Wall
Beam
Z (cm)

Neutron energy spectra

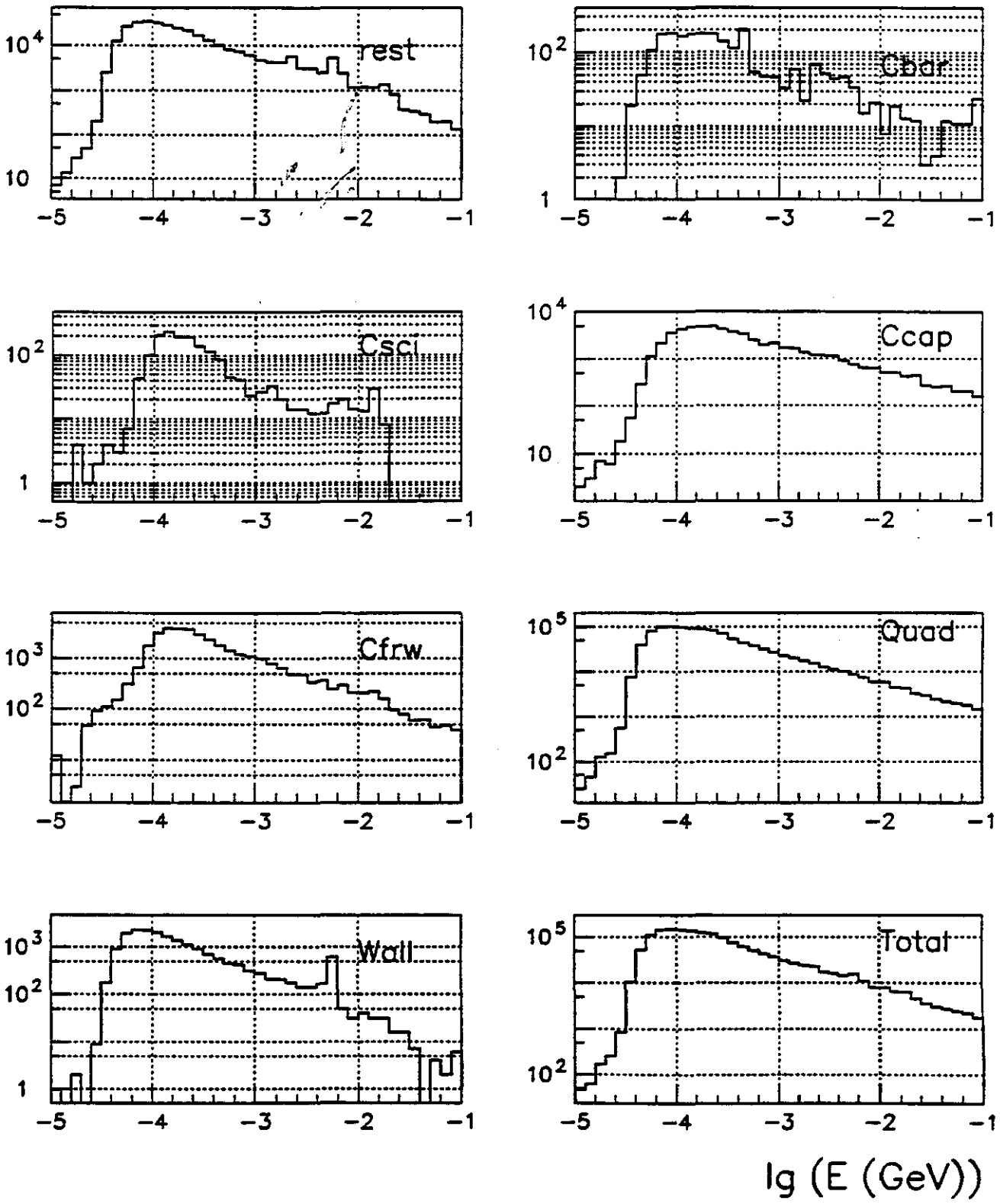



γ flux (E_kin > 100keV) in 10^n (cm^-2 s^-1)
R (cm)
Z (cm)
rest
Cbar
Csci
Ccap
Cfrw
Wall
Beam

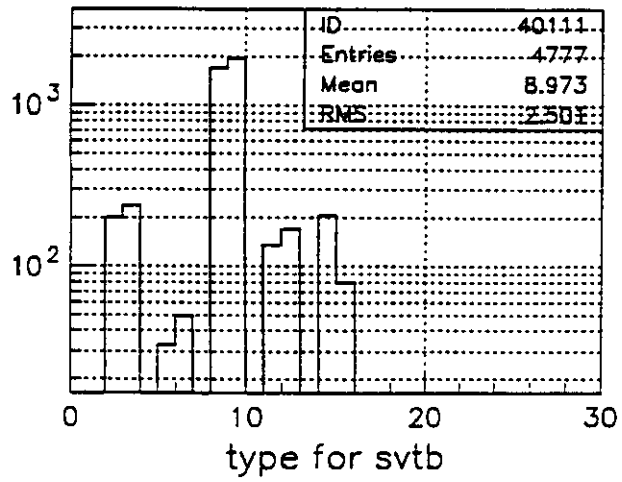
γ energy spectra

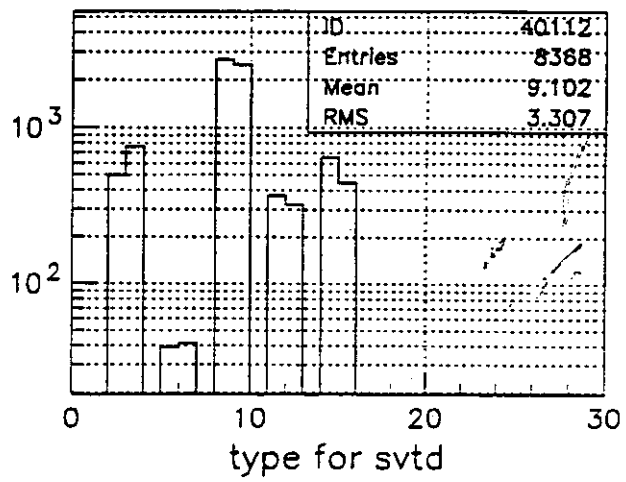


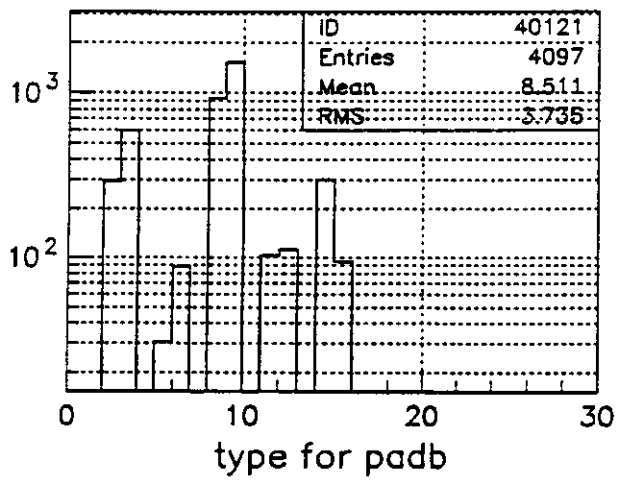
γ energy spectra cut 10 keV

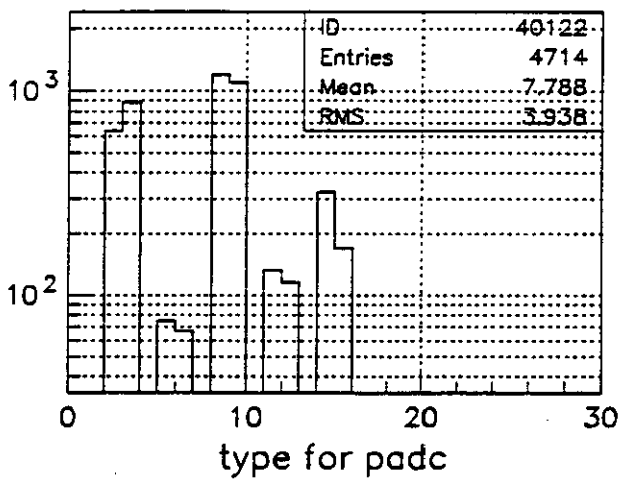


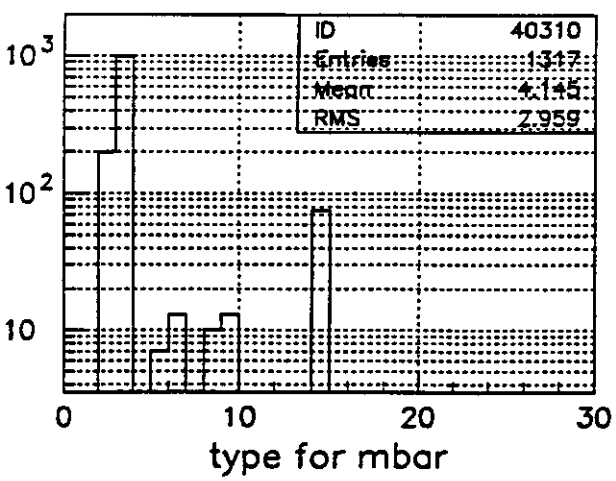
Hits from 20 minimum bias event

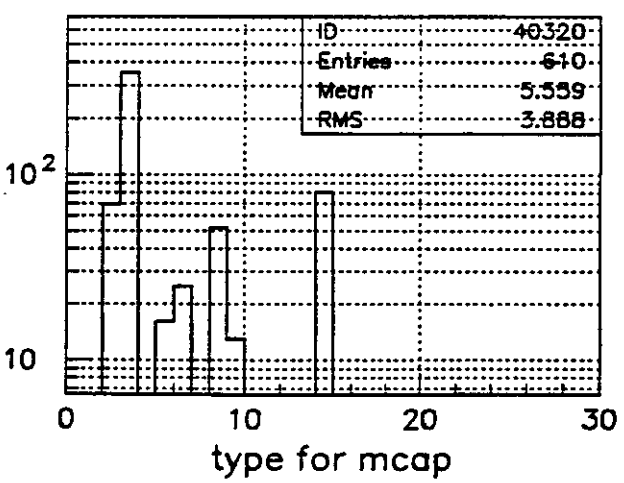












$\gamma - 1$, $e^+ - 2$, $e^- - 3$, $\mu^+ - 5$, $\mu^- - 6$

$\pi^+ - 8$, $\pi^- - 9$, $K^+ - 11$. $K^- - 12$, $p - 14$, $\bar{p} - 15$

Hit rates

Table 1: Hit rates

	SVTB	SVTD	PADB	PADC	MBAR	MBAR
Hit per 20 ev	4777	8368	4097	4714	1317	610
Hit rate (GHz)	23.8	41.8	20.5	23.6	6.6	3.
from e^+	5.7	5.8	7.6	13.1	15.6	11.8
from e^-	6.8	9.4	14.4	18.7	77.0	61.0
from $\pi^\pm$	72.9	63.7	59.8	49.2	1.5	8.6
from p	5.0	7.5	7.6	6.5	4.5	12.0

The sensitivity to neutron (for Muon barrel)can be estimated by the following way:

- The average flux of neutron in muon barrel: $4 \times 10^4 cm^{-2} s^{-1}$
- The total sensitive area : $1.2 \times 10^8 cm^2$
- Total number neutron crossing muon barrel chamber per bunch : $(1.2\times10^8 cm^2)\times(4\times10^4 cm^{-2}s^{-1})/(10^8 bunch/s) = 4.8\times10^4 neutron/bunch$
- Sensitivity :
  hit/neutron = 1317/20 / $(4.8 \times 10^4 neutron/bunch) = 1.4 \times 10^{-3}$

gem

γeμ

Presentation by:

B. Moore

NEUTRON STUDIES FOR GEM

BRENT R. MOORE

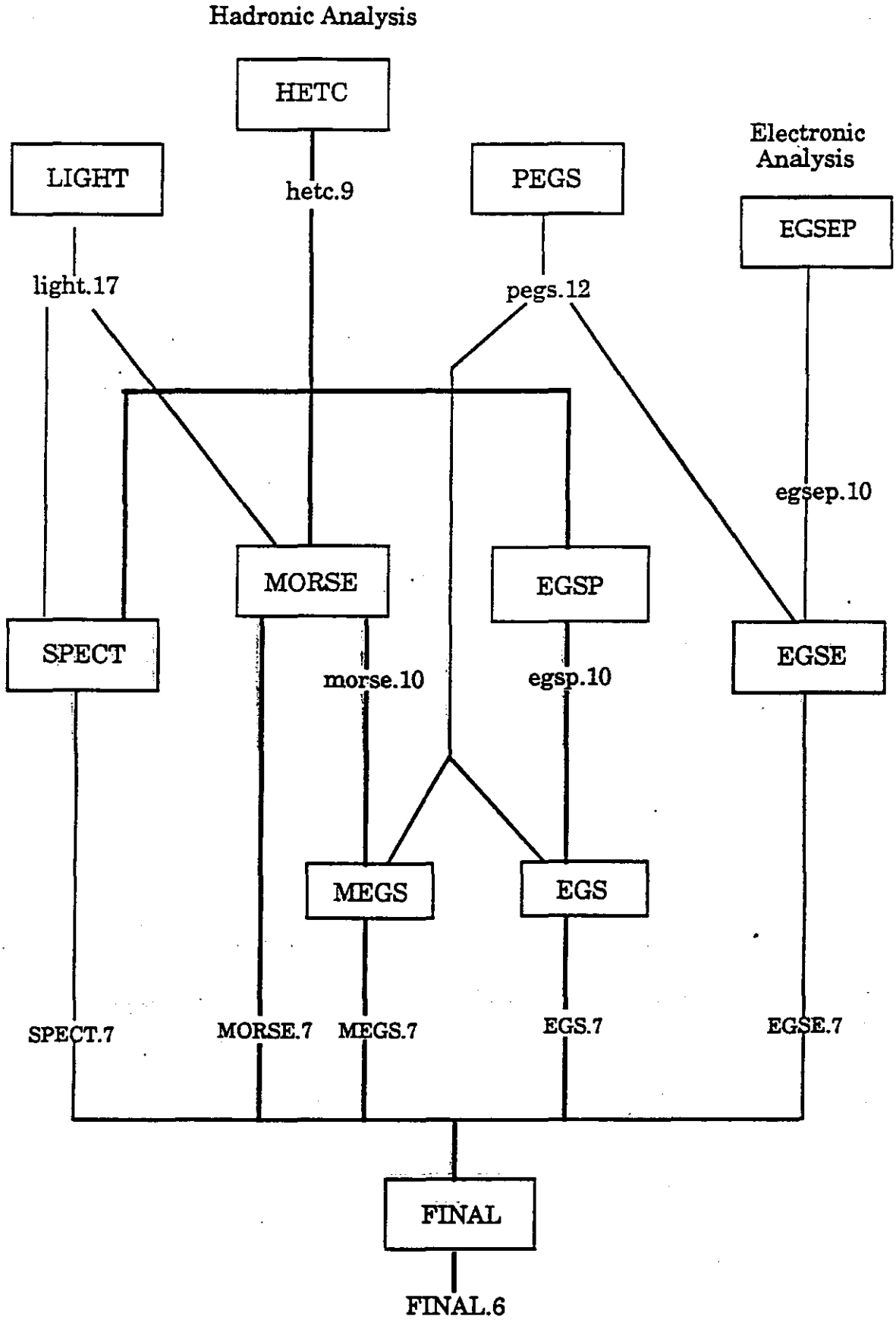
UNIV. OF MISSISSIPPI

MILIND DIWAN

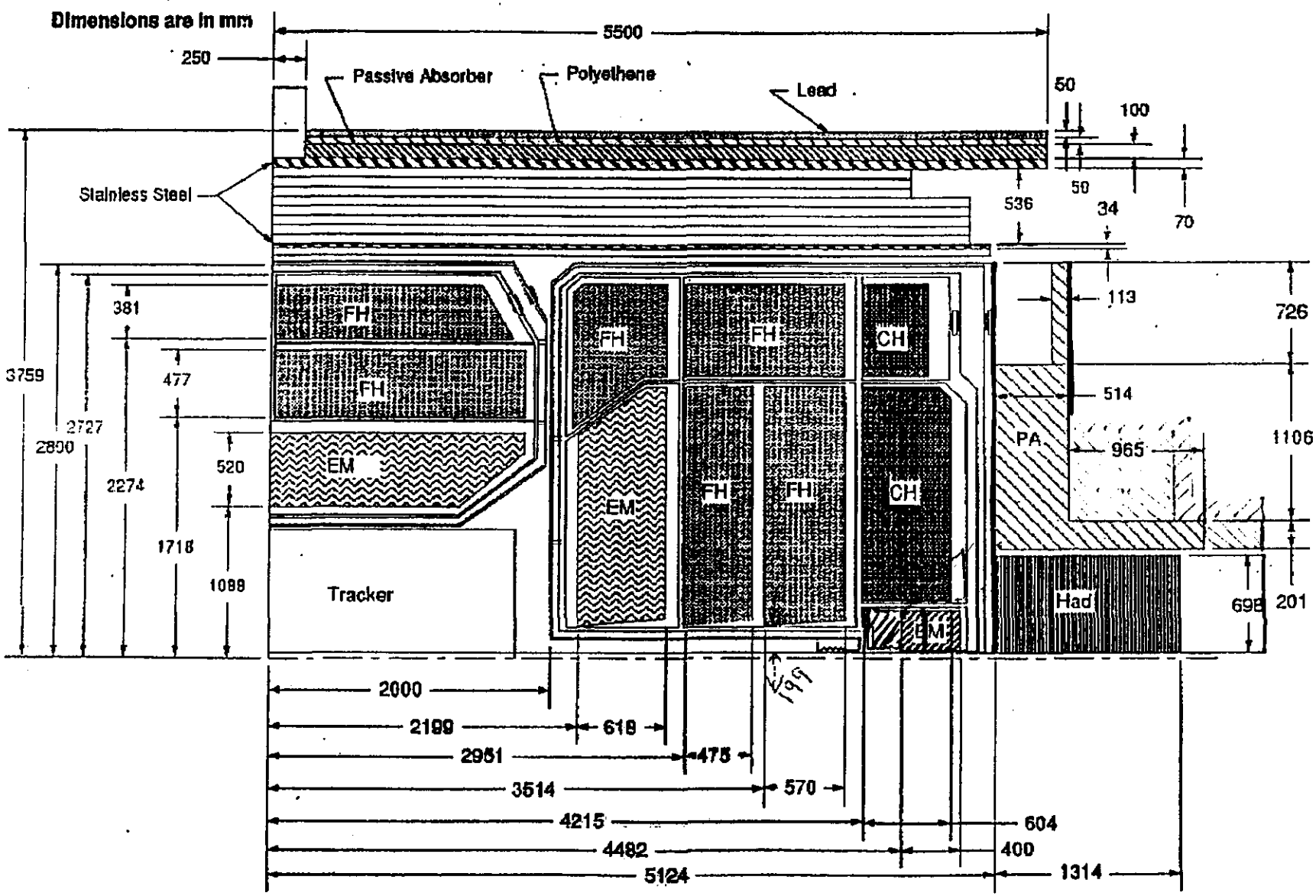
SSCL

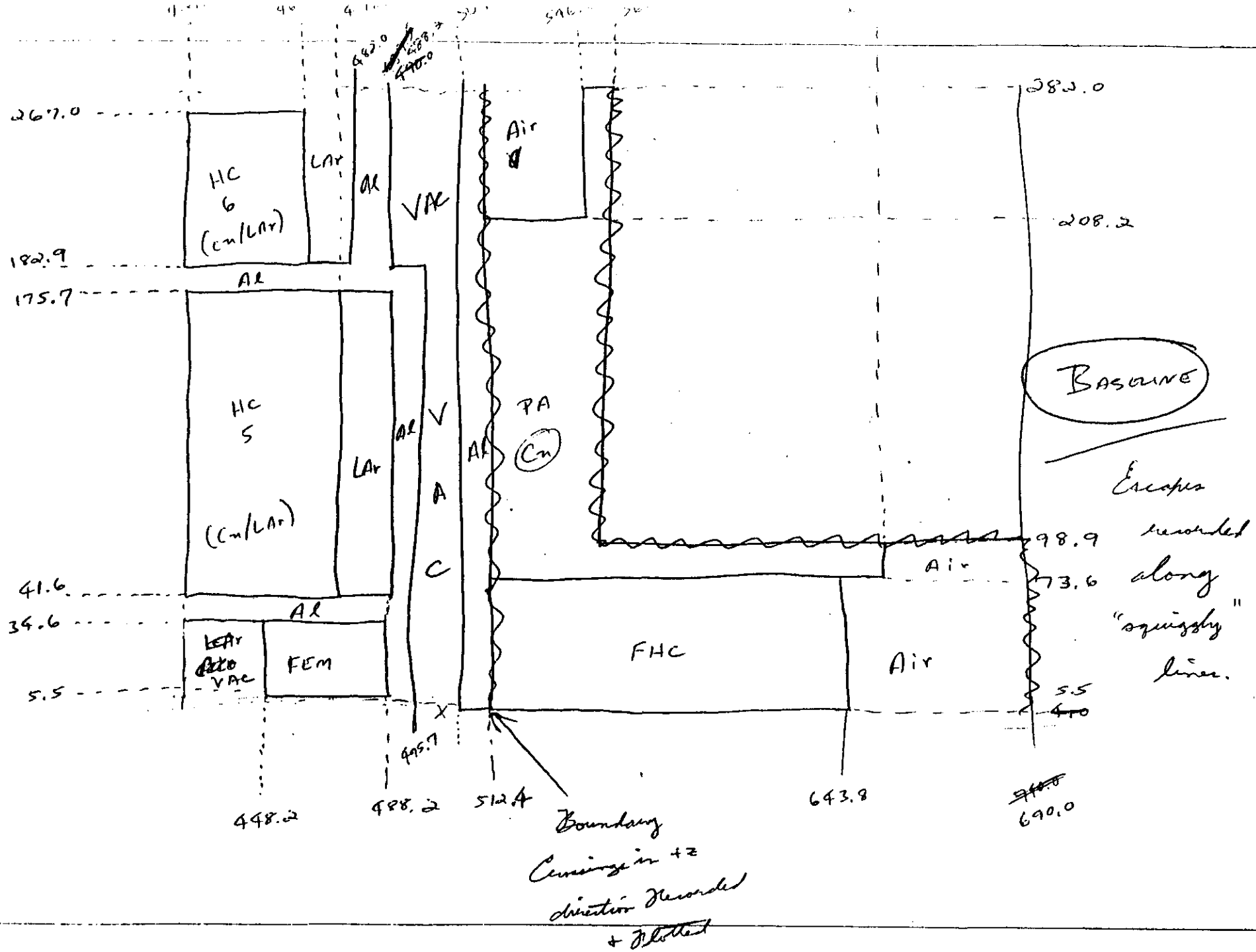
FEBRUARY 4, 1993

Overview of the CALOR89 - Unix Version 3 Package

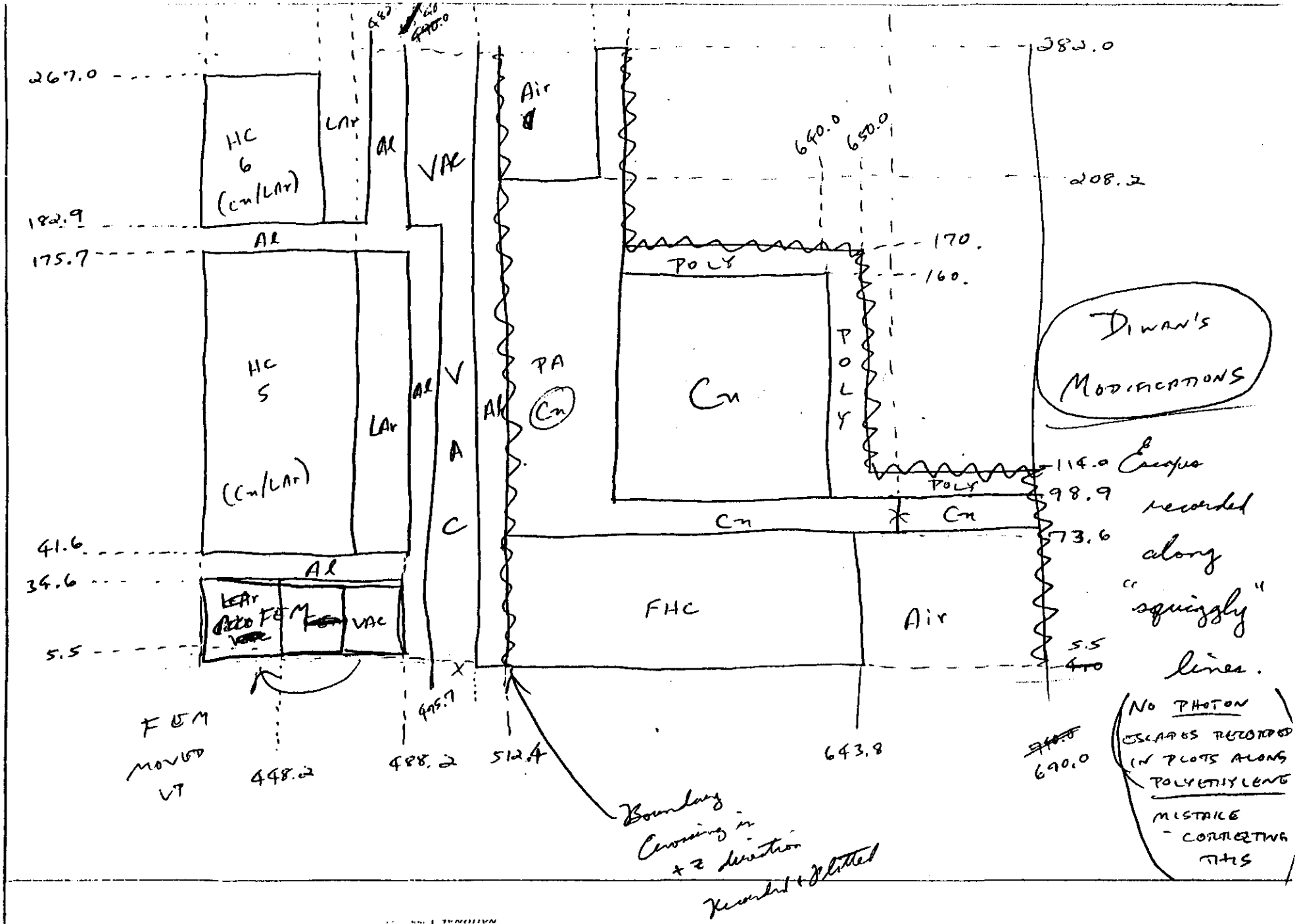


GEM Calorimeter - Dimensions





267.0
182.9
175.7
41.6
34.6
5.5
HC 6 (Cu/LAr)
LAr
Al
VAC
HC 5 (Cu/LAr)
LAr
Al
VAC
Al
FEM
Air
PA
Cu
Al
FHC
Air
Air
282.0
208.2
98.9
73.6
5.5
448.2
488.2
495.7
512.4
643.8
690.0
Boundary Crossings in +z direction Recorded + Plotted
Baseline
Escapes recorded along "squiggly" lines.


267.0
HC
6
(Cn/LAr)
LAr
Al
VAC
Air
280.0
640.0
650.0
208.2
182.9
175.7
Al
170.
160.
POLY
HC
5
(Cn/LAr)
LAr
Al
V
A
C
PA
(Cn)
Al
Cn
POLY
114.0
98.9
POLY
Cn
Cn
73.6
41.6
34.6
Al
LAr
FEM
VAC
FHC
Air
5.5
5.5
FEM
MOVED
UP
448.2
488.2
512.4
643.8
690.0
Boundary
Crossing in
+z direction
recorded + plotted
DIWAN'S
MODIFICATIONS
Escape
recorded
along
"squiggly"
lines.
NO PHOTON
ESCAPES RECORDED
IN PLOTS ALONG
POLYETHYLENE
MISTAKE
- CORRECTING
THIS

BOUNDARY CROSSINGS LEAVING CRYOSTAT

BASELINE		DIWAN	
CHARGED -	1,449	CHARGED -	1,246
NEUTRONS -	123,588	NEUTRONS -	90,620
PHOTONS -	0	PHOTONS -	0

1,246
90,507
~~0~~

ESCAPES OUT END

BASELINE		DIWAN		
CHARGED -	2.6	CHARGED -	5.7	5.7
NEUTRONS -	56.1	NEUTRONS -	190.5	225.9
PHOTONS -	2.9	PHOTONS -	6.1	11.4

ESCAPES IN MUON REGION

BASELINE

FACE 2

CHARGED -	0
NEUTRONS -	176.8
PHOTONS -	4.5

FACE 3

CHARGED -	0.1
NEUTRONS -	233.3
PHOTONS -	27.7

TOTAL

CHARGED -	0.1
NEUTRONS -	410.1
PHOTONS -	32.2

DIWAN

SURFACE 2

CHARGED -	0	0
NEUTRONS -	2.7	1.0
PHOTONS -	x	0.7

SURFACE 3

CHARGED -	0	0
NEUTRONS -	2.9	1.0
PHOTONS -	x	0

SURFACE 4

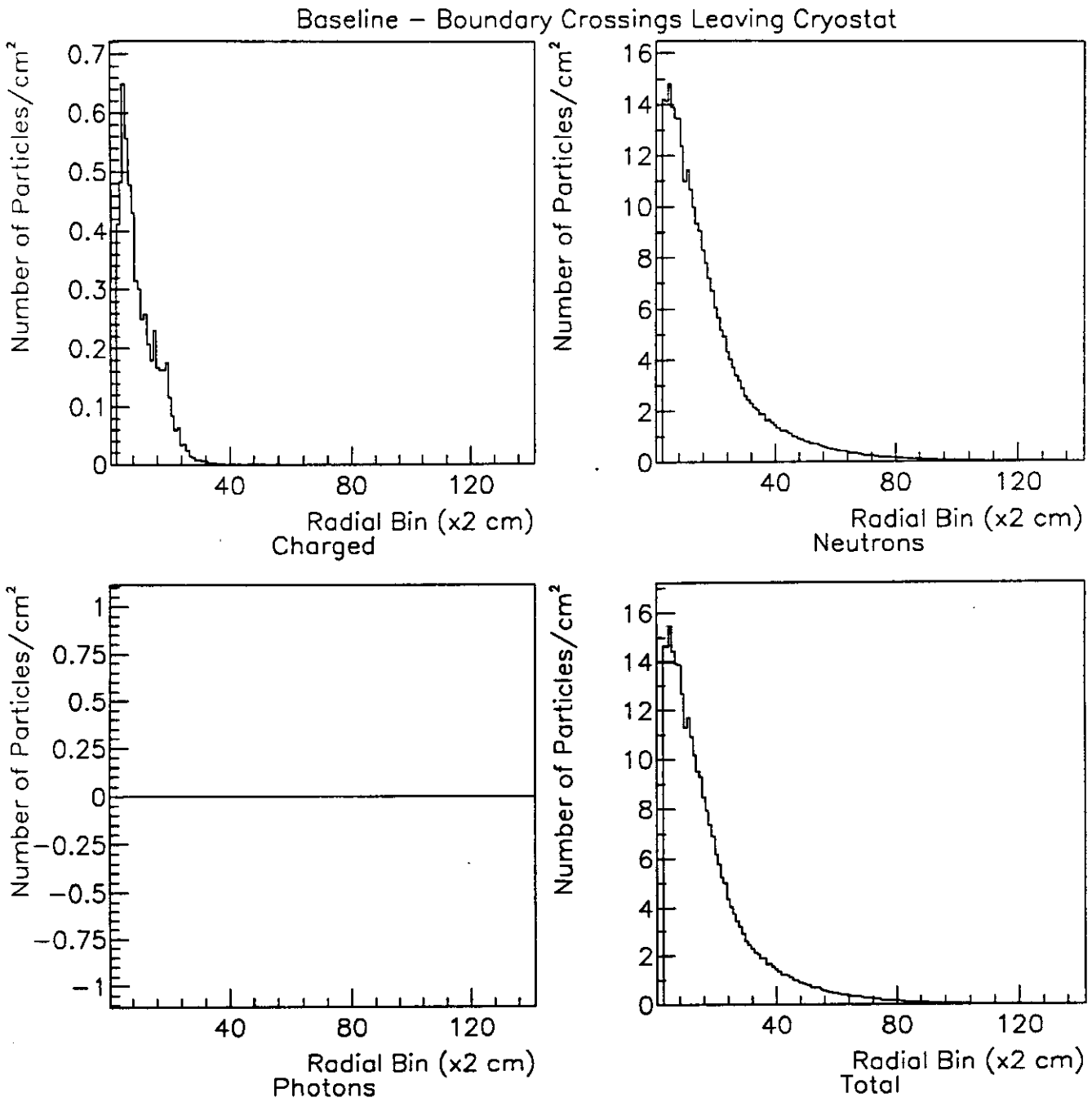
CHARGED -	0	0
NEUTRONS -	14.5	12.2
PHOTONS -	x	3.9

SURFACE 5

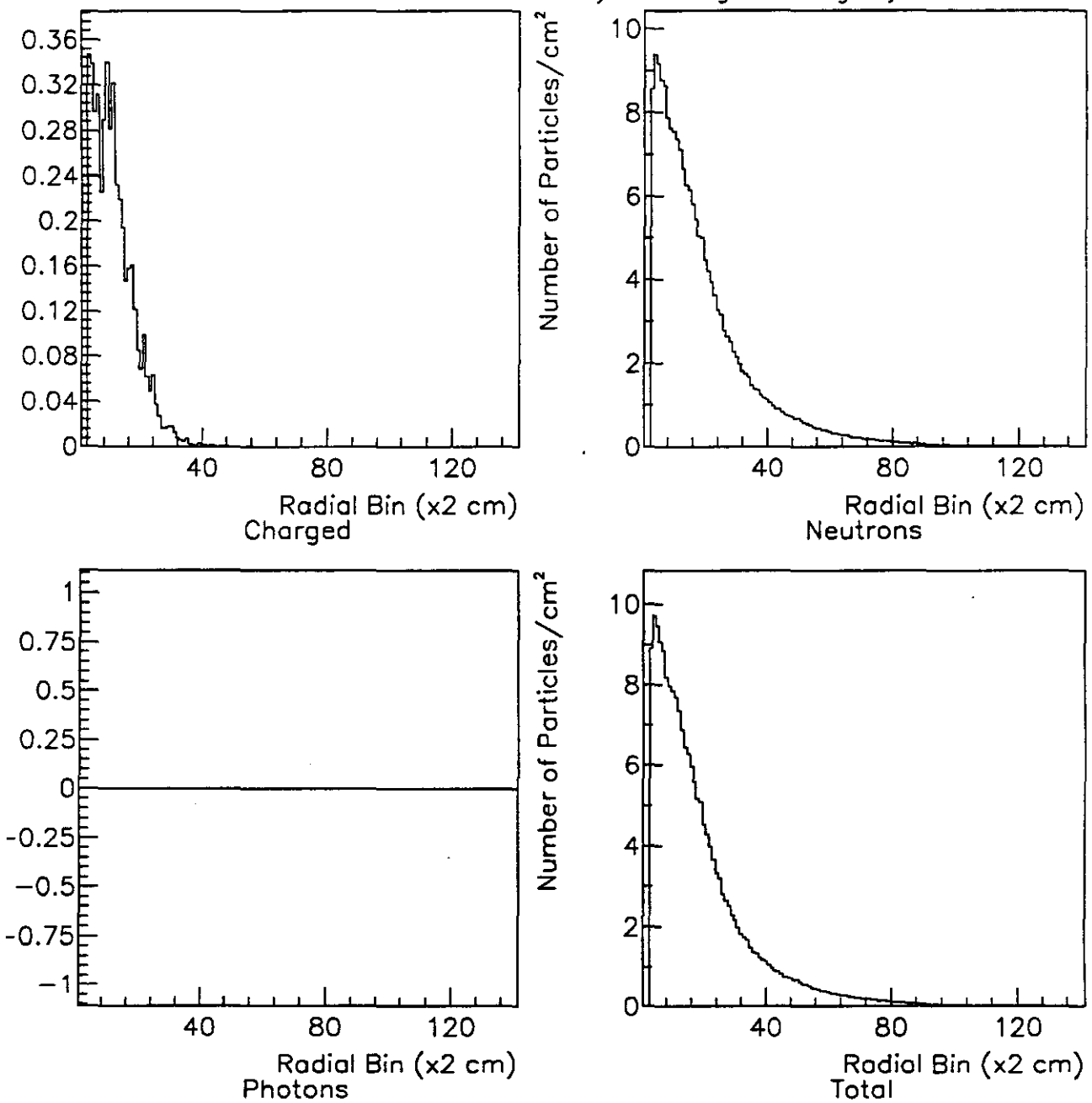
CHARGED -	0	0
NEUTRONS -	47.4	53.3
PHOTONS -	6.9	2.8

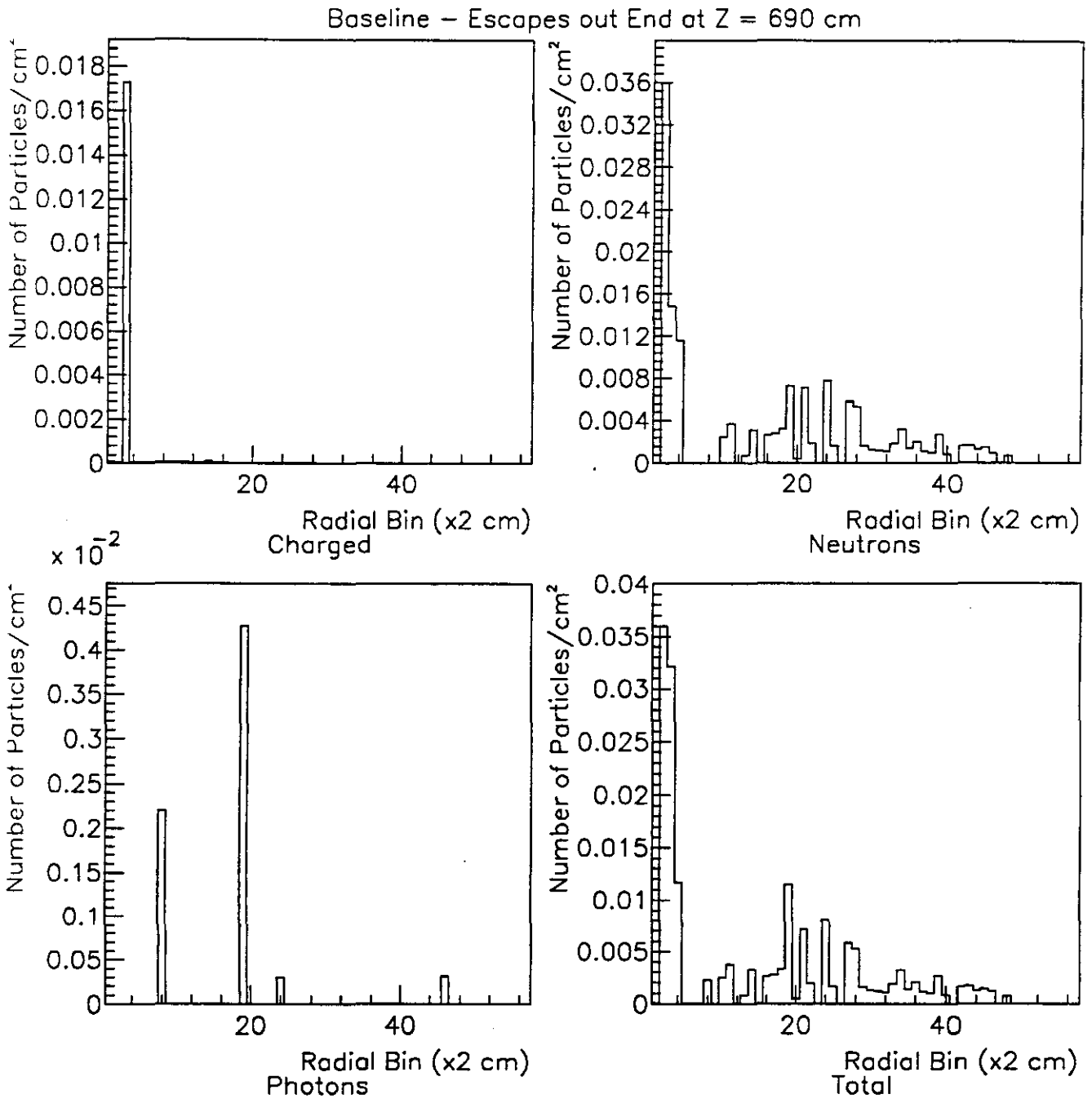
TOTAL

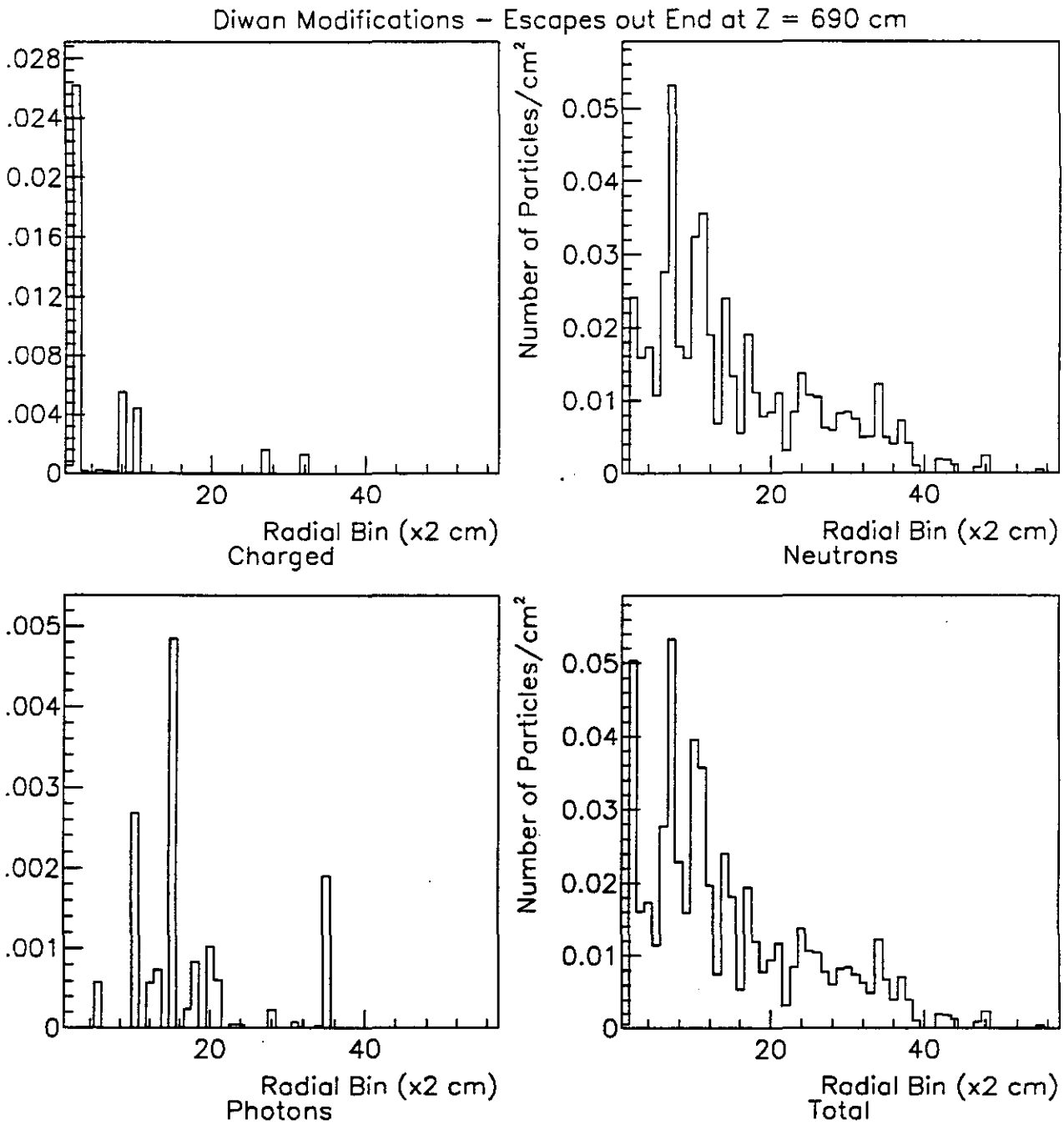
CHARGED -	0	0
NEUTRONS -	67.5	67.5
PHOTONS -	>6.9	7.4

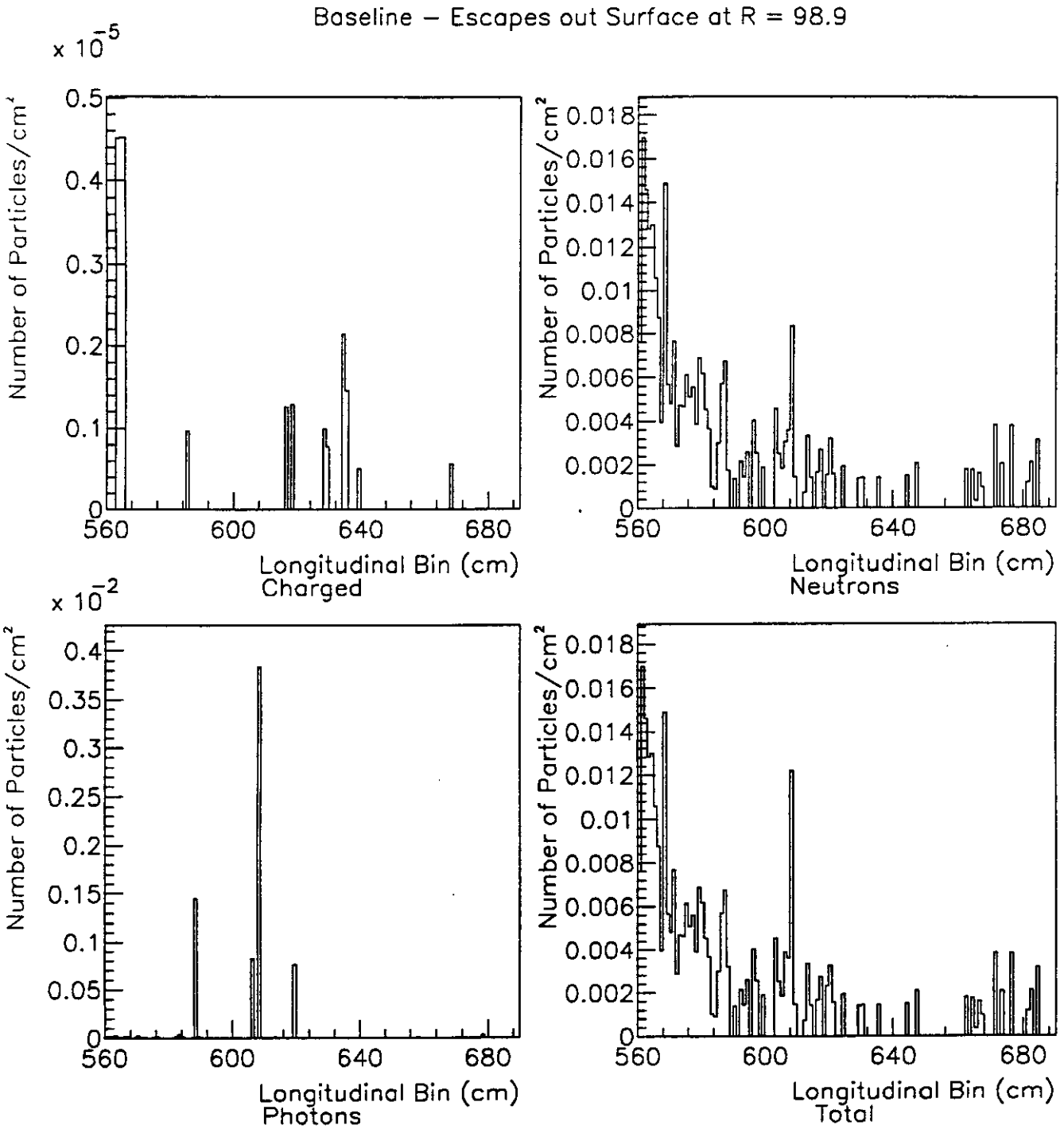

Baseline – Boundary Crossings Leaving Cryostat
Number of Particles/cm²
Radial Bin (x2 cm)
Charged
Neutrons
Photons
Total

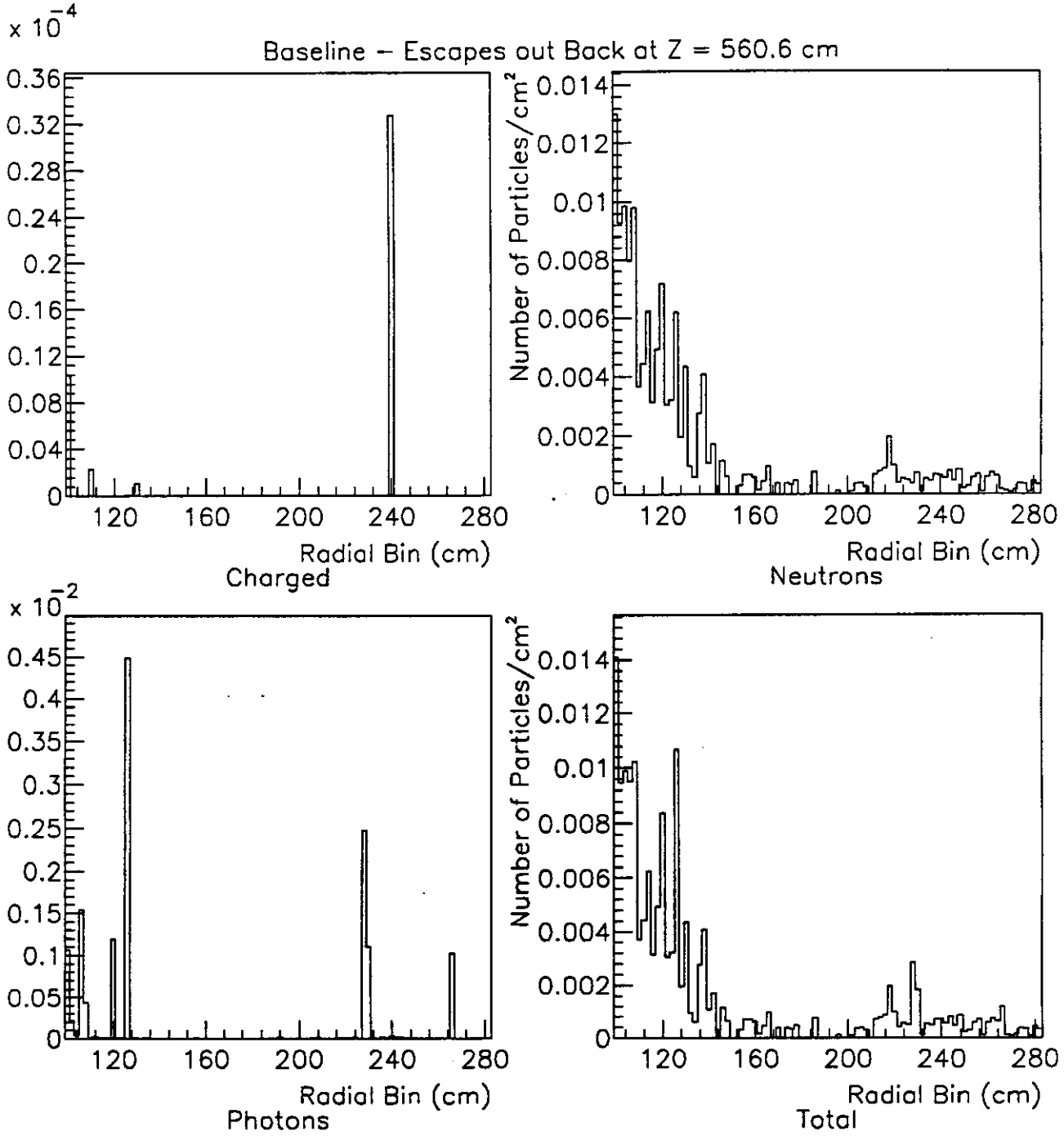
Diwan Modifications – Boundary Crossings Leaving Cryostat




Baseline – Escapes out End at Z = 690 cm
Number of Particles/cm²
Radial Bin (x2 cm)
Charged
Neutrons
x 10⁻²
Photons
Total


Diwan Modifications – Escapes out End at Z = 690 cm
Number of Particles/cm²
Radial Bin (x2 cm)
Charged
Neutrons
Photons
Total


Baseline – Escapes out Surface at R = 98.9
x 10^-5
Number of Particles/cm²
Longitudinal Bin (cm)
Charged
Neutrons
x 10^-2
Photons
Total


Baseline – Escapes out Back at Z = 560.6 cm
x 10^-4
Number of Particles/cm^2
Radial Bin (cm)
Charged
Neutrons
x 10^-2
Photons
Total

ROUGH CALCULATION

NEUTRON 'FLUX' IN CORNER IS ABOUT $0.008\ cm^{-2}$

$200\ \pi^-$ EVTS $\times$ 100 GeV = 20 TeV

EACH SECOND AT SSC: 8×10^7 TeV/s

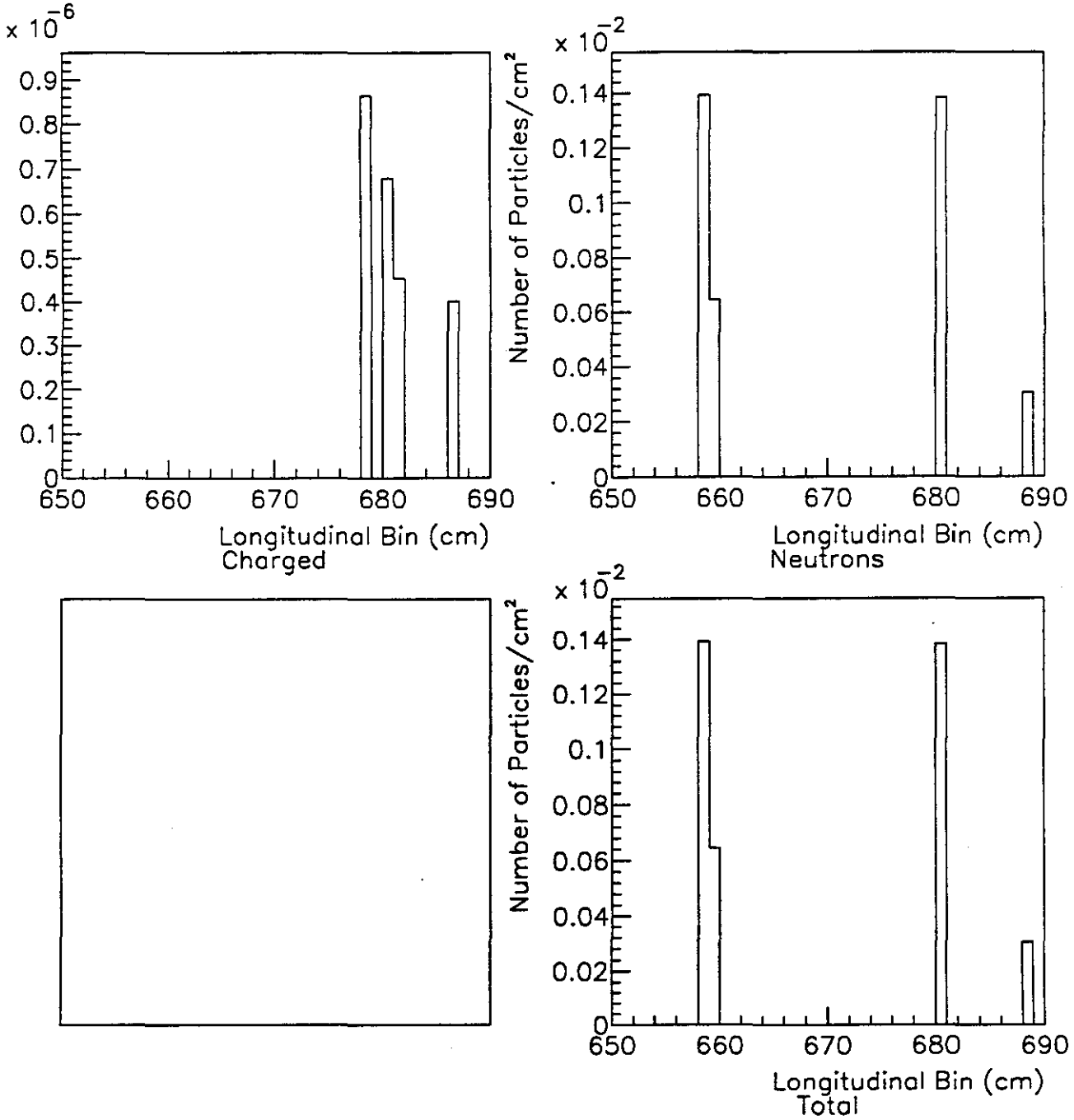
CALOR GIVES

$$\frac{8 \times 10^7 \frac{TeV}{s}}{20\ TeV} \times 0.008 \frac{n}{cm^2} = 4 \times 10^6\ s^{-1} \cdot 8 \times 10^{-3} \frac{n}{cm^2}$$

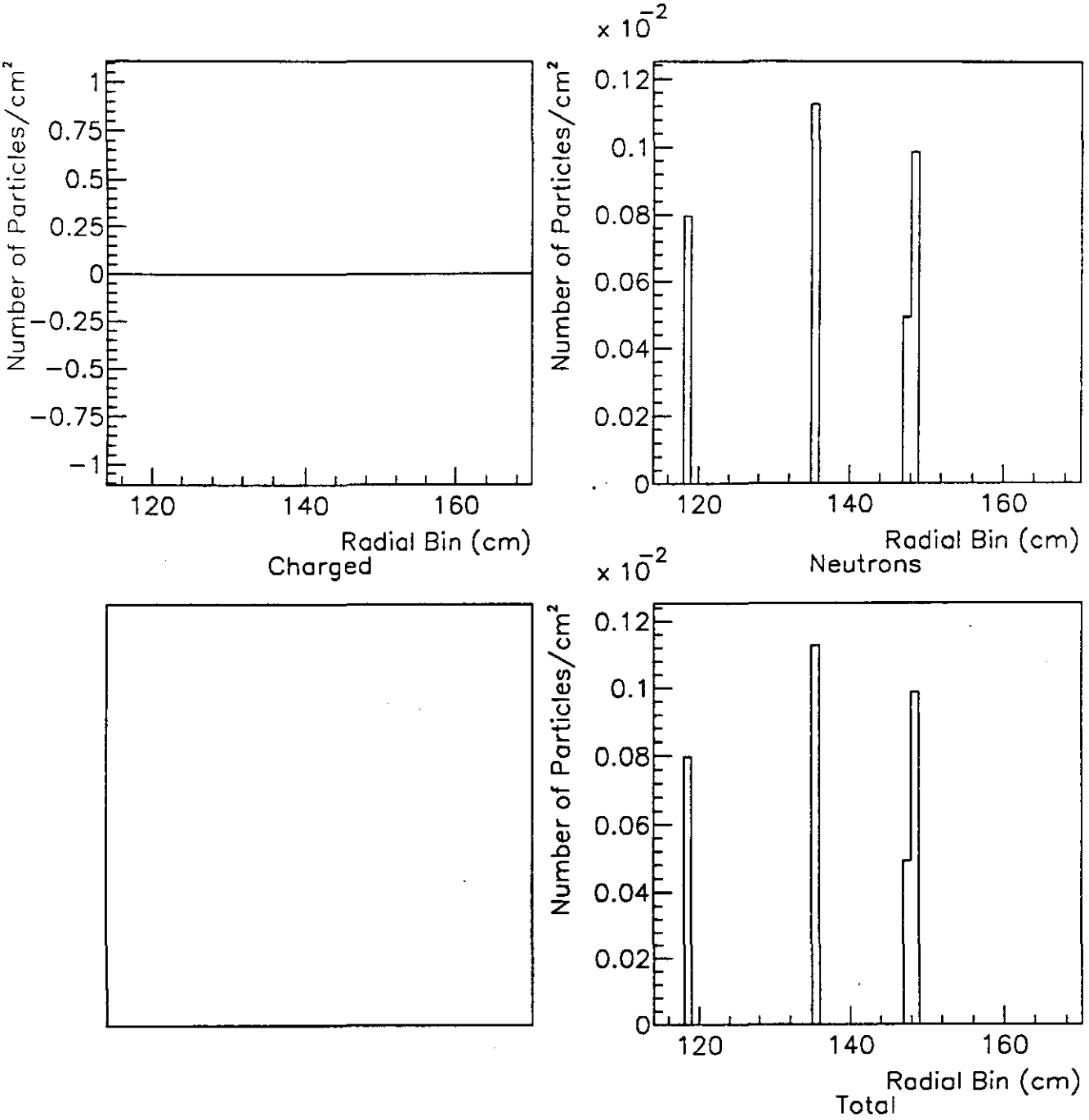
$$= 32 \times 10^3 \frac{\frac{n}{cm^2}}{s} \times \frac{10^7 s}{1\ yr} = 32 \times 10^{10} \frac{\frac{n}{cm^2}}{yr}$$

$$\approx \boxed{3 \times 10^{11} \frac{\frac{n}{cm^2}}{yr}}$$

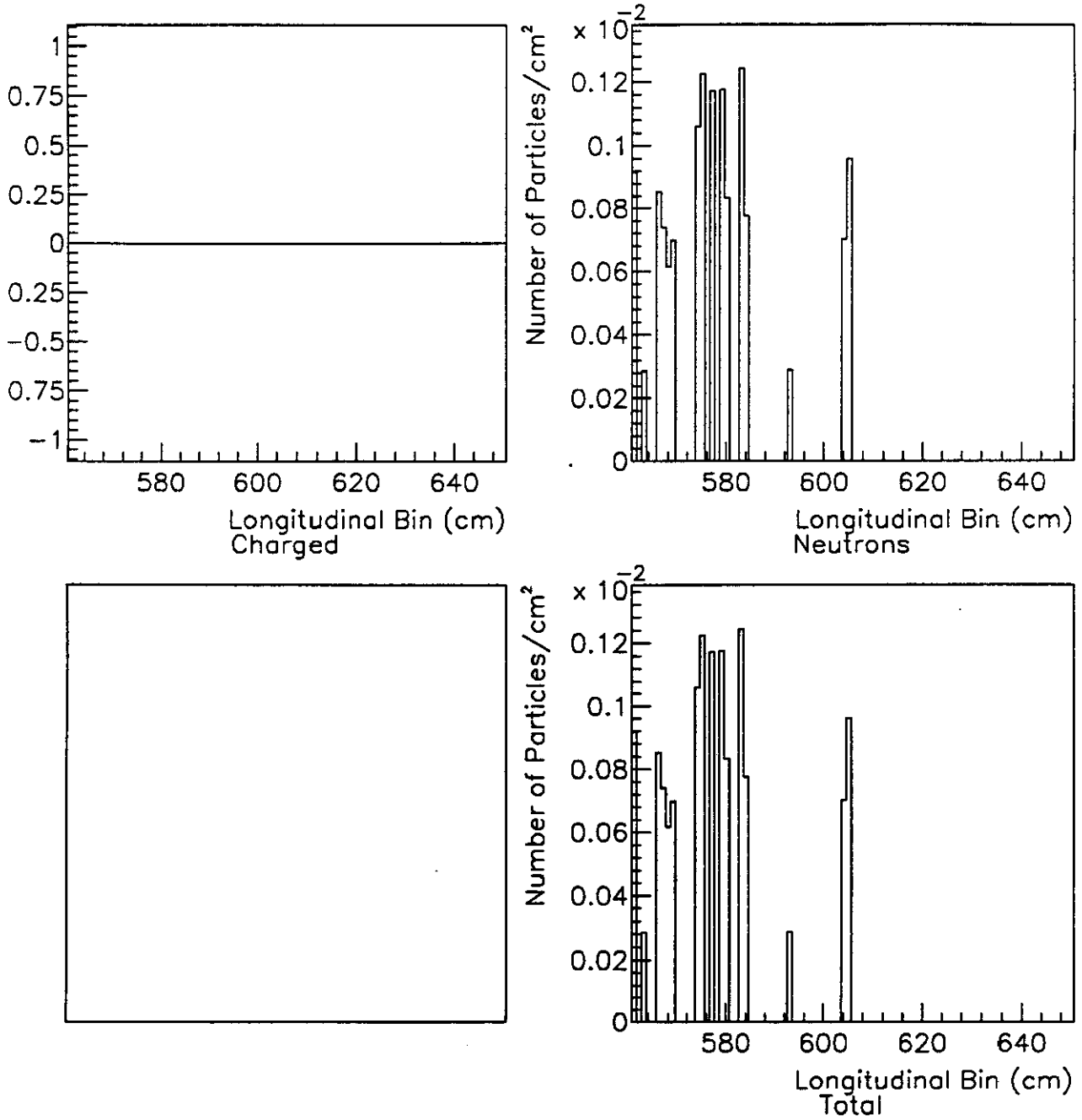
Diwan Modifications – Escapes out Surface at R = 114.0



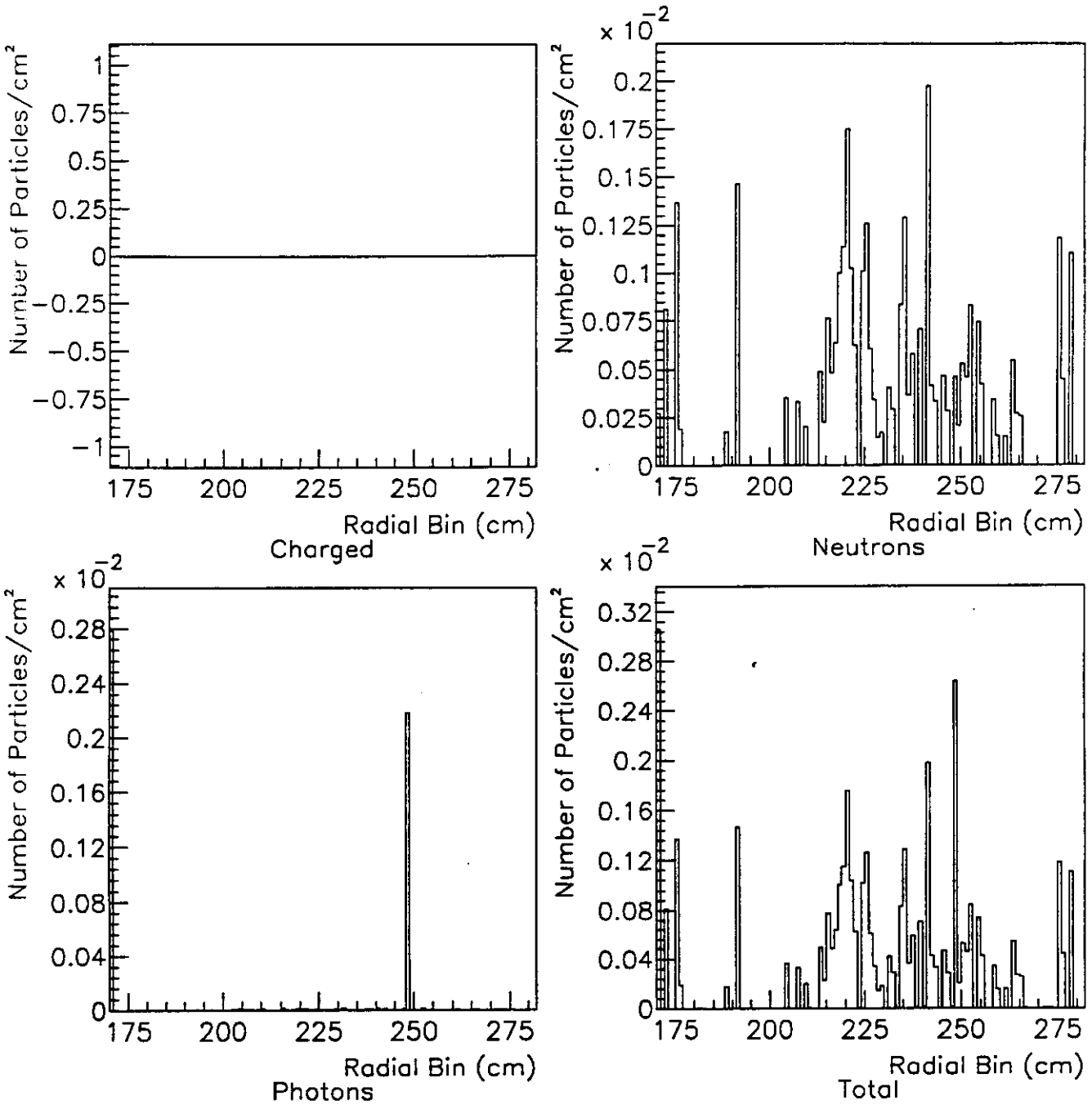
Diwan Modifications – Escapes out Back at Z = 650.0 cm



Diwan Modifications – Escapes out Surface at R = 170.0



Diwan Modifications – Escapes out Back at Z = 560.6 cm



gem

γeμ

Presentation by:

M. Diwan

13. GEM RADIATION ENVIRONMENT

Table of Contents

3. GEM RADIATION ENVIRONMENT
13.1 INTRODUCTION 1
13.2 COMPUTATIONAL METHODS 1
13.3 NEUTRON FLUENCE AND DEPOSITED ENERGY 1
13.3.1 Contribution from Protons Lost from the Beam 2
13.3.2 Contribution from Residual Gas in Vacuum 2
13.3.3 Contribution from Collisions at the Interaction Point 3
13.4 SHIELDING CONFIGURATIONS 4
13.3.1 Location and Aperture of the Collimators 5
13.3.2 Shielding for the Collimators 6
13.3.3 Forward Calorimeter Shielding 8
13.3.6 Implications for the Beampipe 11
13.5 CENTRAL TRACKER 12
13.6 TOTAL RADIATION DOSE 13
13.7 ACTIVATION 14
13.7.1 CINDER90 Monte Carlo Calculation 15
13.7.2 Estimates of Dose Rates with Star Densities 16
13.8 SUMMARY 17

13. GEM RADIATION ENVIRONMENT

3.1 INTRODUCTION

We have performed in depth simulation studies of the neutron, photon and harged particle fluxes in GEM, and the resultant doses and radioactivation of 11 major subsystems and neighboring accelerator components, as an integral art of the detector design process. As a result of these studies, we have been ble to develop a shielding and collimator configuration, and an overall layout f the experiment that will ensure that the detector will be able to operate ith its design performance, over a period of not less than 10 years of running t the standard luminosity of 10^33 cm^-2 sec^-1 (see Sections 5.x.y, 6.a.b, nd 7.v.w). This configuration also will allow the detector to function fficiently, according to its specifications, for several years at high uminosity (10^34 cm^-2 sec^-1), with the exception of the inner Silicon racker (see Section 6.c.d).

The main concerns which have been addressed by these studies are:

- The charged particle, neutron and photon fluxes, and the hit rates generated in the inner tracker and the muon spectrometer. The singles rates, trigger rates and data flow have been kept within the design limits of the data acquisition system (Section 7.e.f). The occupancy in the inner tracker and in the muon spectrometer is below the limit where the pattern recognition efficiency, particle ID efficiency, or track reconstruction precision would be substantially degraded.

- The particle fluences, and the doses delivered, especially to the inner tracker layers, the endcap and forward calorimeter components and electronics, the forward field shaper, and the beam line components within and adjacent to the experiment. The integrated fluences and doses over the lifecycle of the experiment have been kept at levels that allow for long term component survival. Examples of the survival limits which have dictated design choices in GEM are: 10^14 n/cm^2 for Silicon detectors, 10^X Rads for the forward calorimeter readout, 10^Y Rads for standard cables; 10^Z Rads and 10^W Joules of thermal energy dissipated in the nearest minibeta quadrupole.

- Radioactivation of the inner and forward parts of the detector,

Organizational opportunities

- Person power vs. tasks
- Computer power
- Entire detector Monte Carlos but not enough effort into optimizing pieces
- No single M.C. with all 3 Beam loss, Beam gas, Collisions
- Different MC's no single Scenario

Specific opportunities

Beam loss contribution in real detetor including all effects

Beam gas contribution in real detector including all effects

Heat load on quads vs. intercepted energy. $10^{34}\ cm^{-2}\ sec^{-1}$ Luminosity ?

collimator shield design

a) minimize cost, material

b) understand activation

c) understand interface to assembly

FCAL shield design

Same a), b), c) points

Barrel shielding

Magnet aperture

List of plots for the TDR.