GEM TN-93-359

GEM Calorimeter Working Group Meeting - SSCL

March 16, 1993

Abstract:

Agenda and presentations of the GEM Calorimeter Working Group Meeting held at the SSC Laboratory on March 16, 1993.

From: SSCVX1::WOMERSLEY "John Womersley, SSCL-D0" 15-MAR-1993 16:53:25.93
To: @CALSIM
CC: WOMERSLEY
Subj: Calorimeter Simulation Working Group meeting

Calorimeter Simulation Working group meeting
Directorate 2 conference room (near the library), SSCL
3 - 5 PM on Tuesday March 16.

The start has been delayed to 3PM to allow those interested to attend the GEM Local Computing meeting on OOP methods in B125 conference room 2-3 pm.

The calorimeter simulation meeting will focus exlusively on what has been done and what else is needed to be done for the TDR.

Agenda:

Status of calorimeter in gemfast (pp.Skwarnicki)

Status of UAZMIX mixture-level simulations (Shupe)

Status of detailed simulations of EM (Ma, ?Seman, ?Leltchouk)

Status of detailed simulations of liquid HAD (Moore)

Status of detailed simulations of scintillating barrel and overall system resolution after weighting (Efremenko, Shmakov)

Pileup noise in GEM liquid ionization calorimeter (Vanyashin)

What other work is needed?
e.g. jet reconstruction studies? (Carey?)
(discussion)

The last item will be continued in the Physics Simulation meeting on Wednesday afternoon.

gem

γeμ

Presentation by:

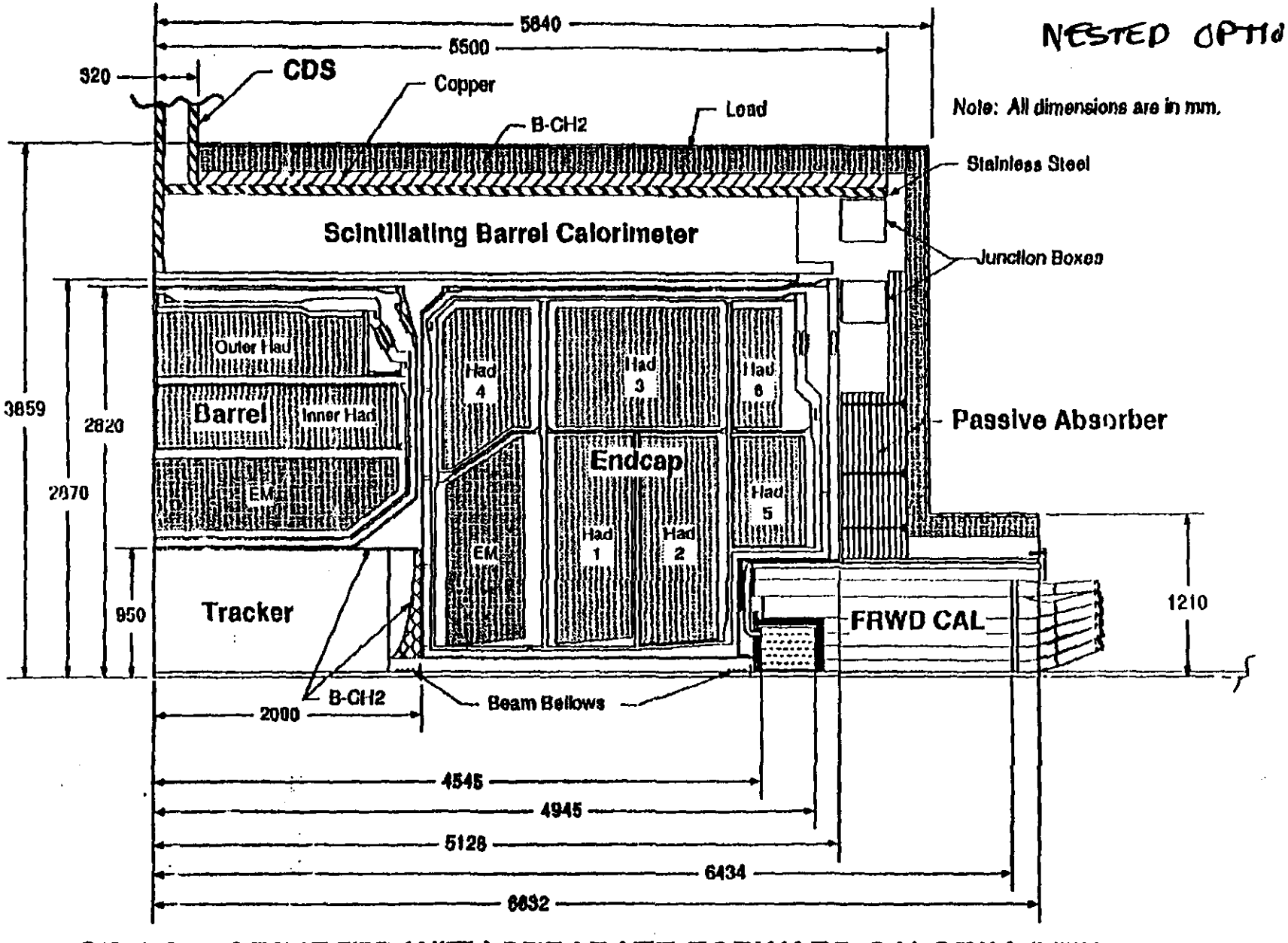
Michael Shupe

STATUS OF UAZMIX – GEM GEANT MIXTURE LEVEL SIMULATION

M. SHUPE
UNIV. OF ARIZONA
MARCH 16, 1993

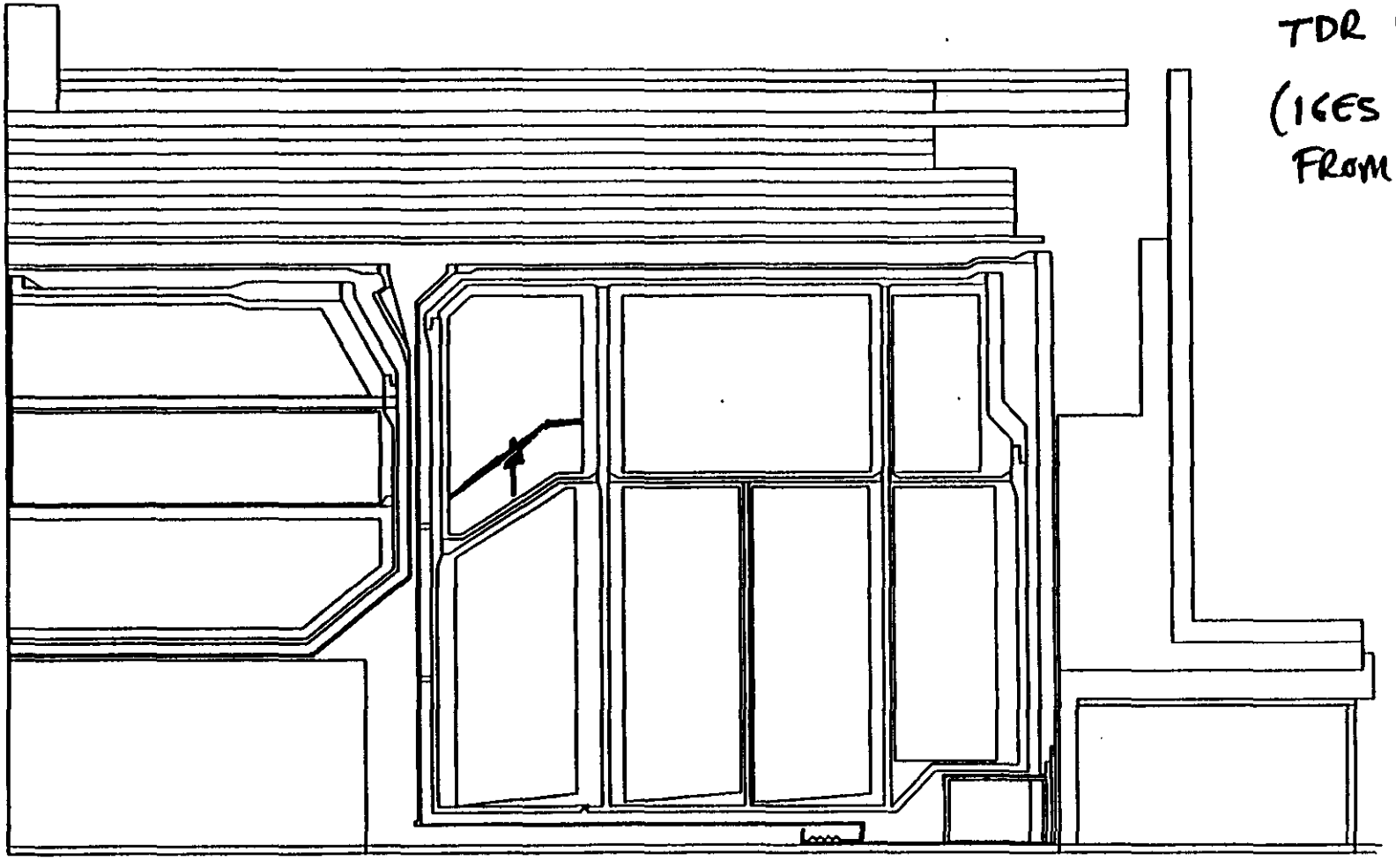
- GEM CALORIMETER DESIGNS AS OF LAST FRIDAY.
- FCAL PARAMETERS
- MARTIN-MARIETTA DESCRIPTION/TOOLS
- UAZMIX – SETTINGS + TECHNIQUES
- TODAYS GEOMETRIES IN UAZMIX
- SEGMENTATION
- JETFINDING, CONSTANT TERMS, WEIGHTING SCHEMES.
- PLANS FROM HERE

NESTED OPTION



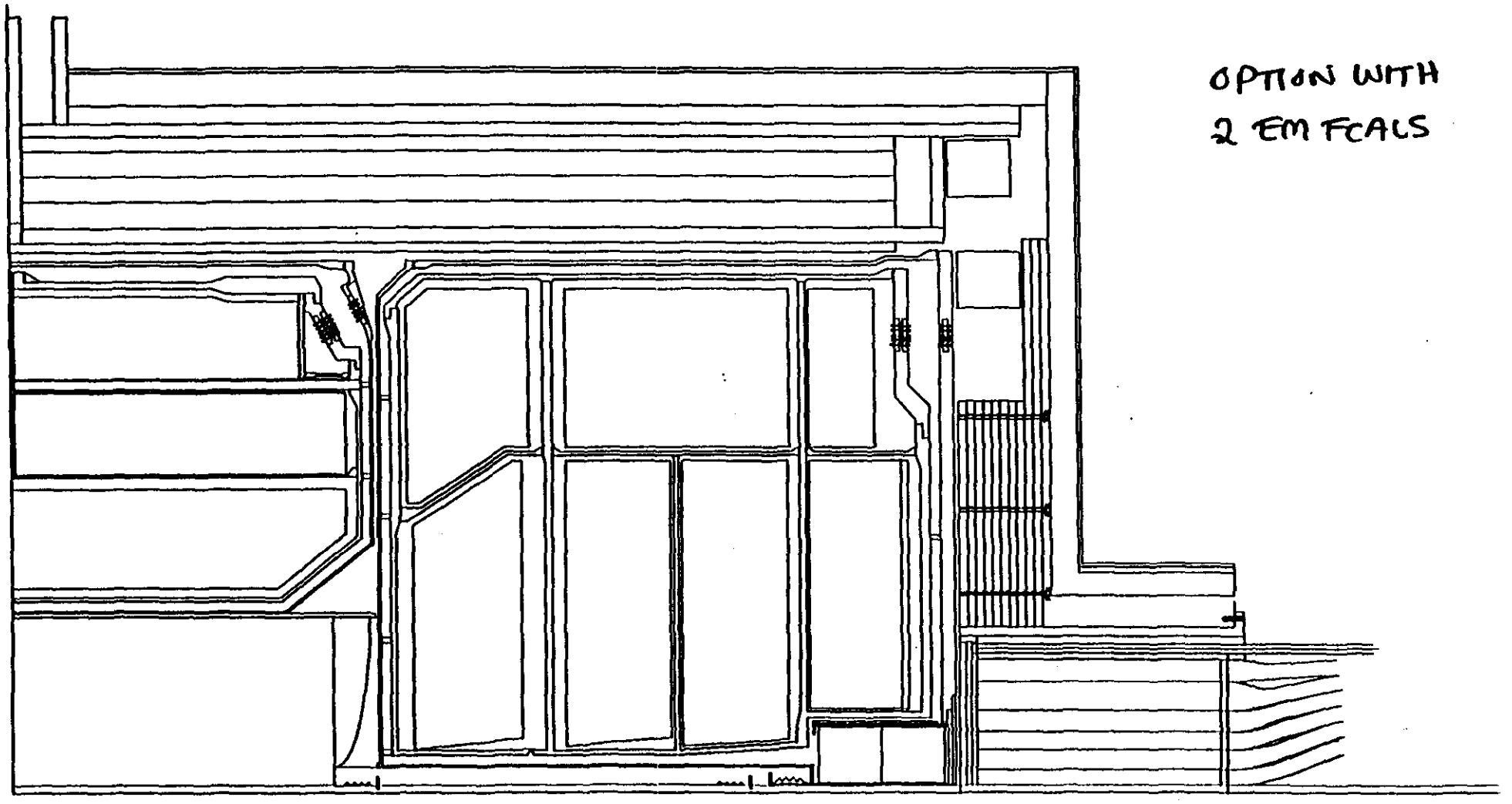
GEM CALORIMETER WITH SEPARATE FORWARD CALORIMETER

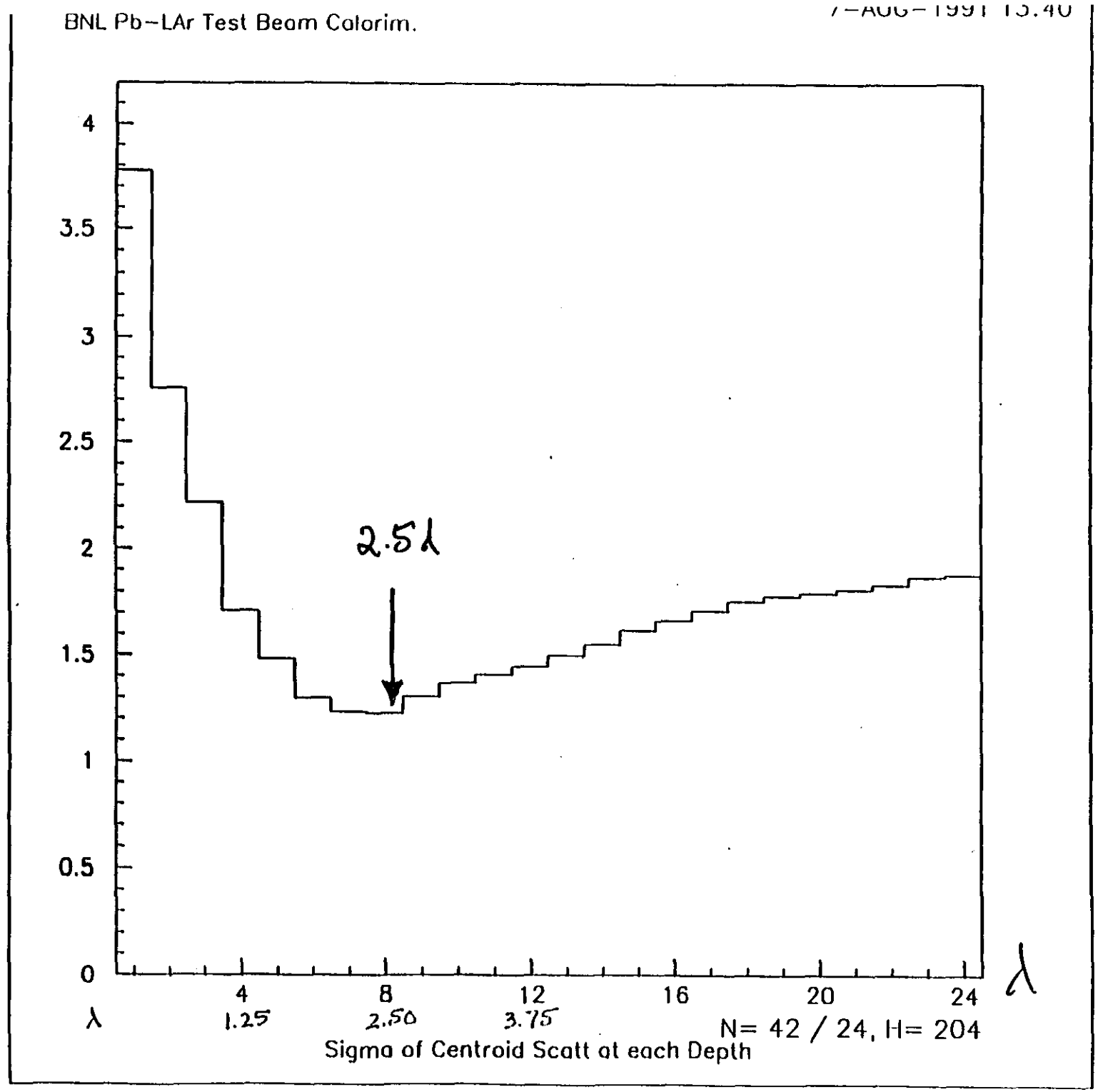
LLMarca Separate FEM Cal 930308



TDR BASELINE

(IGES FILE FROM M-M)


OPTION WITH
2 EM FCALS



σ_x (FOR $\frac{d\theta}{\theta}$)

ENERGY AND ANGLE REGIMES FOR FORWARD CALORIMETRY.

η	θ DEG	θ RAD	p WHEN $p_T = 10$ GeV
3	5.7	.099	100 GeV
4	2.1	.037	270
5	.77	.014	740
5.5	.47	.0082	1220
6	.28	.0050	2020

AND HIGHER FOR "HIGH" p_T !

SOURCES OF ERROR IN p_T DETERMINATION:

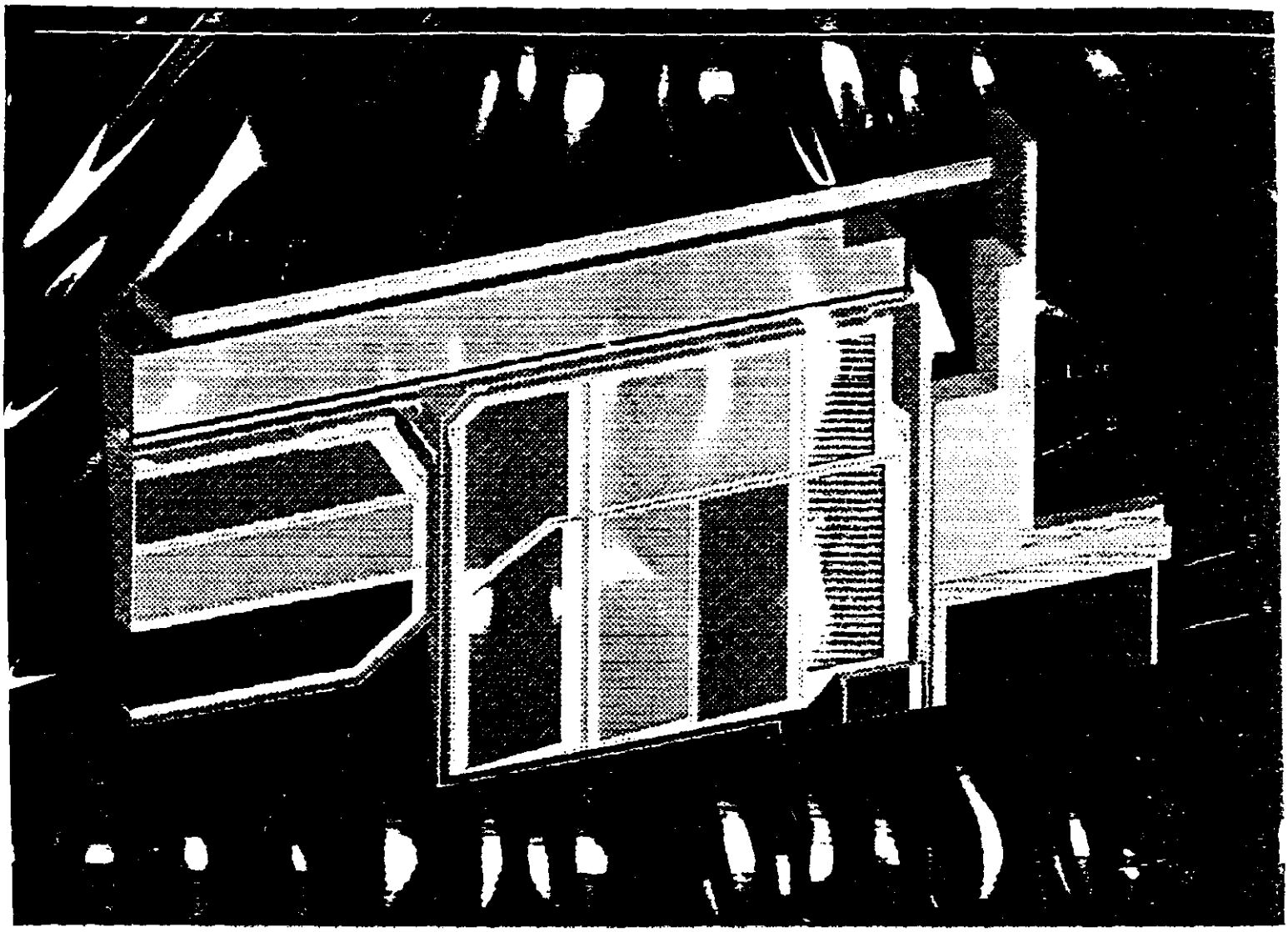
$$\frac{\delta p_T}{p_T} = \left[\left(\frac{\delta p}{p}\right)^2 + \frac{1}{\sin^2\theta}\,\delta\theta^2\right]^{1/2}$$

$$\approx \left[\left(\frac{\delta p}{p}\right)^2 + \left(\frac{\delta\theta}{\theta}\right)^2\right]^{1/2}$$

AND $\frac{\partial\eta}{\partial\theta} = \frac{1}{\sin\theta} \Rightarrow \delta\eta \approx \frac{\delta\theta}{\theta}$ IN FCAL.

WE SHOULD SEE THAT $\frac{\delta\theta}{\theta}$ TERM IS COMPARABLE TO $\frac{\delta p}{p}$ CONTRIBUTION FOR TYPICAL FCAL DESIGNS.

MARTIN-MARIETTA



LArEM1.4Pb

Material	Sensor	Cell Repeat	plate thickness	total thickness,mm	depth g/cm2	Absorption length	Radiation Length	E deposition
SS		2	0.15	0.3	0.238	1.3014E-03	1.72E-02	0.3518
G10		2	0.38	0.15	0.027	3.0155E-04	8.24E-04	0.0503
LEAD		1	1.4	1.4	1.589	8.1907E-03	2.49E-01	1.7958
Kapton		1	0.4	0.4	0.044	5.7888E-04	1.23E-03	0.0821
LAr	3	2	2	4	0.580	4.7782E-03	2.36E-02	0.3456
			Totals	6.26	2.46	0.0157	0.297	3.1128

7 rad len= 147.38
28 rad len= 589.54

Cell Depth (cm)	Density (g/cm3)	Effective cm/Abs length	Effective cm/Rad length	Sampling Fraction
0.826	3.927	39.999	2.105	27.08%

LArHad_27Cu

Material	Sensor	Cell Repeat	plate thickness	total thickness,mm	depth g/cm2	Absorption length	Radiation Length	E deposition
COPPER		1	27	27	24.192	1.7963E-01	1.98E+00	34.3385
LAr	5	4	2	8	1.120	9.5663E-03	5.73E-02	1.8912
COPPER		6	0.0762	0.4572	0.410	3.0367E-03	3.19E-02	0.5899
Kapton		3	0.0762	0.2286	0.025	3.3066E-04	7.03E-04	0.0469
G10		2	0.5	1	0.170	1.8847E-03	5.15E-03	0.3178
COPPER		1	27	27	24.192	1.7963E-01	1.98E+00	34.3385
LAr		4	2	8	1.120	9.5663E-03	5.73E-02	1.8912
COPPER		6	0.0762	0.4572	0.410	3.0367E-03	3.19E-02	0.5899
Kapton		3	0.0762	0.2286	0.025	3.3066E-04	7.03E-04	0.0469
			Totals	72.3716	61.66	0.3864	3.847	74.647

Cell Depth (cm)	Density (g/cm3)	Effective cm/Abs length	Effective cm/Rad length	Sampling Fraction
7.237	7.139	18.730	1.833	2.27%

LAr_EM_ISB

Material	Sensor	Cell Repeat	plate thickness	total thickness,mm	depth g/cm2	Absorption length	Radiation Length	E deposition
G10			10	10	1.700	1.8847E-02	5.15E-02	3.1790
StripLine			5	5	2.489	2.2142E-02	1.56E-01	3.5882
LAr			30	30	4.200	3.5336E-02	2.15E-01	9.3420
Backplate			14	14	0.140	1.4628E-03	4.69E-03	0.2552
G10			2.5	2.5	0.425	4.7118E-03	1.29E-02	0.7948
LAr			9.5	9.5	0.910	7.7846E-03	4.86E-02	1.3741
EM_Inn_Tab			20	20	4.041	4.1888E-02	1.90E-01	7.3029
			Totals	91	15.90	0.1327	0.646	23.037

Cell Depth (cm)	Density (g/cm3)	Effective cm/Abs length	Effective cm/Rad length	Sampling Fraction
9.100	1.529	68.500	14.080	

LAr_EM_OSB

Material	Sensor	Cell Repeat	plate thickness	total thickness,mm	depth g/cm2	Absorption length	Radiation Length	E deposition
EM_Out_Tab			20	20	5.881	4.7978E-02	4.88E-01	8.7435
LAr			9.5	9.5	0.910	7.7846E-03	4.86E-02	1.3741
G10			2.5	2.5	0.425	4.7118E-03	1.29E-02	0.7948
LAr			44	44	6.160	5.2560E-02	3.13E-01	9.3019
StripLine			5	5	2.489	2.2142E-02	1.56E-01	3.5882
G10			10	10	1.700	1.8847E-02	5.15E-02	3.1790
LAr			5	5	0.700	5.9727E-03	3.58E-02	1.0670
G10			5.5	5.5	0.935	1.0368E-02	2.83E-02	1.7485
SS			4	4	3.188	2.4018E-02	2.29E-01	4.5886
			Totals	108.5	22.14	0.1944	1.343	34.775

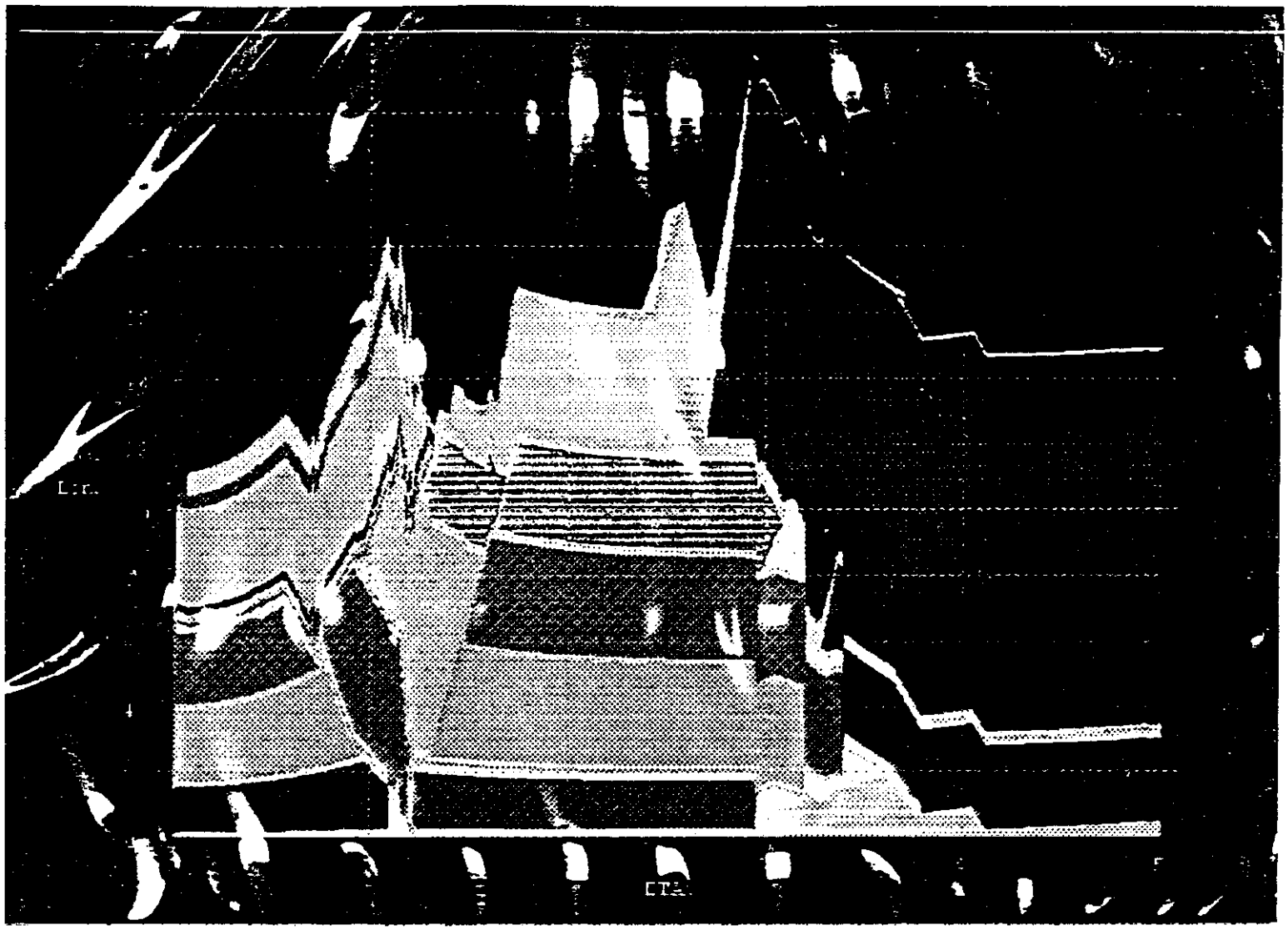
Cell Depth (cm)	Density (g/cm3)	Effective cm/Abs length	Effective cm/Rad length	Sampling Fraction
10.560	2.096	54.280	7.555	

LAr_Had_SB

Material	Sensor	Cell Repeat	plate thickness	total thickness,mm	depth g/cm2	Absorption length	Radiation Length	E deposition
ALUMINUM			12.7	12.7	3.429	3.2227E-02	1.43E-01	5.5550
LAr			6.5	6.5	0.910	7.7846E-03	4.86E-02	1.3741
G10			2.5	2.5	0.425	4.7118E-03	1.29E-02	0.7948
LAr			25.4	25.4	3.556	3.0341E-02	1.82E-01	5.3896
LAr			25	25	3.500	2.9857E-02	1.79E-01	5.2850
LAr			5	5	0.700	5.9727E-03	3.58E-02	1.0570
G10			5.5	5.5	0.935	1.0368E-02	2.83E-02	1.7485
SS			4	4	3.188	2.4018E-02	2.29E-01	4.5886
			Totals	96.6	16.62	0.1453	0.856	25.372

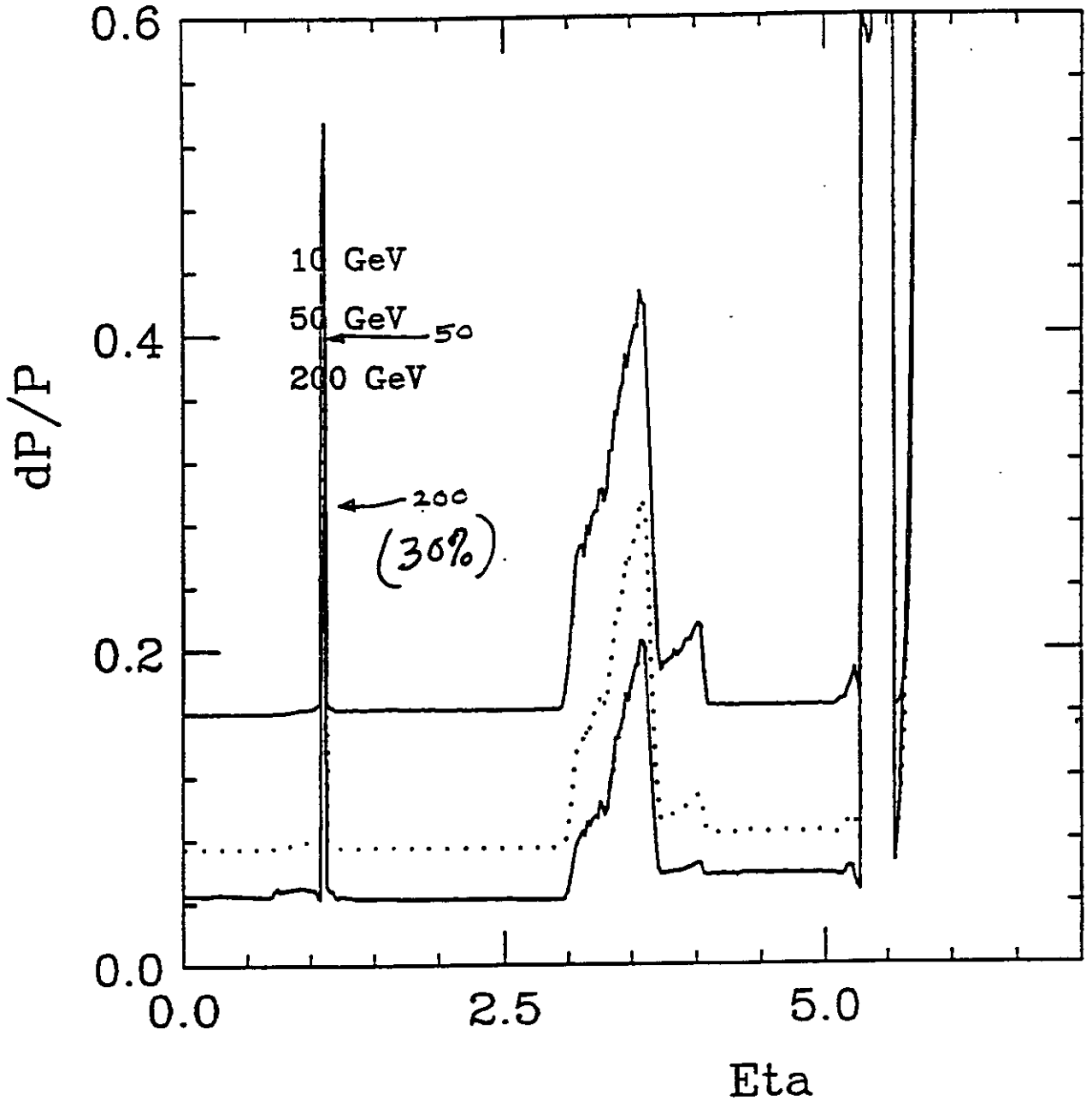
Cell Depth (cm)	Density (g/cm3)	Effective cm/Abs length	Effective cm/Rad length	Sampling Fraction
8.880	1.920	59.815	10.114	

S. W. Easom 3/10/93



VERTEX SMEARING STUDY

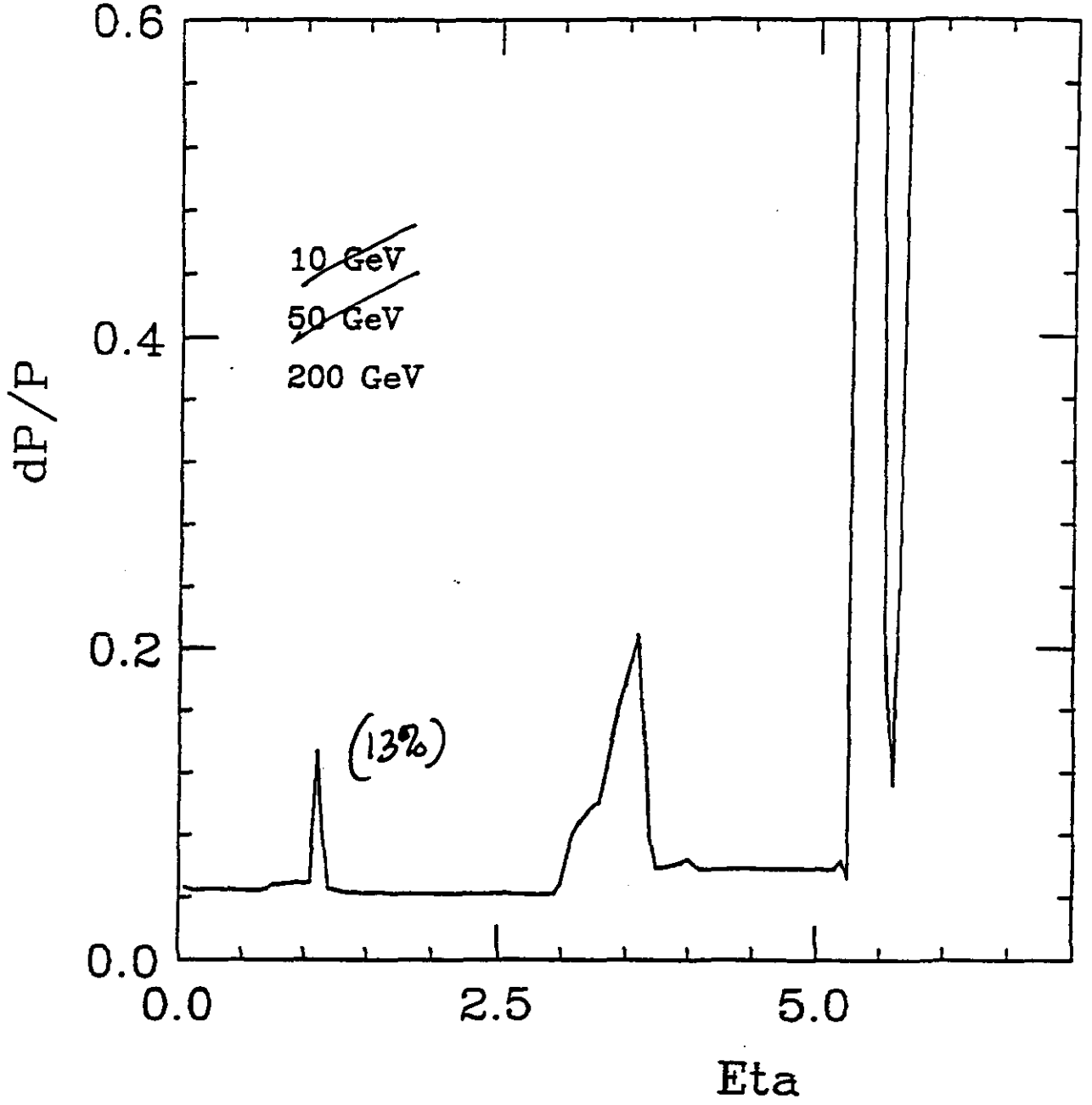
MM Resolution, No Vertex Smear – Pions



③

VERTEX SMEARING STUDY

MM Resolution, Z Vertex Smeared – Pions



GEANT SETTINGS FOR FCAL SIMULATION:

- VERSION ~~3.14~~ 3.15
- GHEISHA
- STANDARD CUTS

  EM 1.0 MeV
  HADRONIC 10. MeV
  } O.K. NO CUT DEPENDENCE.

- MIXTURE W/LAr (FOR EXAMPLE)

		f_{VOL}	f_{WT}	
$\rho =$ 18.24	TUNGSTEN	.841	.937	$\rho =$ 17.31
	NICKEL	.067	.034	$\lambda =$ 11 cm
	COPPER	.029	.015	
	STAINLESS	.021	.009	
	LIQ. ARGON	.042	.003	

- $\vec{B}$ FIELD .8 TESLA. (PURE SOLENOIDAL)

NOTE: $\lambda_{GEANT} = \lambda_{PDG} \pm 10\%$

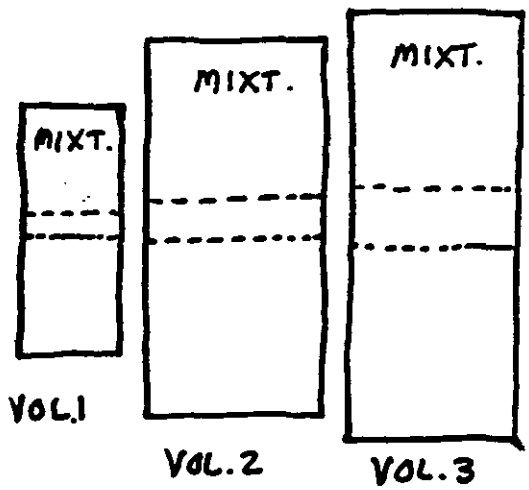
THIS NEEDS INVESTIGATION!

SOFTWARE CELLS "CAL TOWERS"

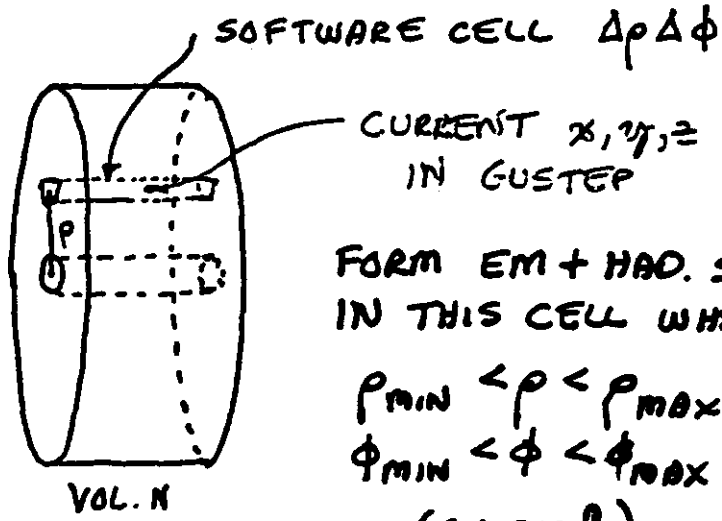
⇒ TO SPEED UP GEANT, REDUCE THE NUMBER OF VOLUMES.

⇒ USING MIXTURES ALLOWS VOLUMES TO FOLLOW ONLY "MAJOR" SEAMS AND CRACKS.

IN THE CURRENT FCAL SIMULATION:



+ BEAMPIPE
+ CRYOSTAT VOLUMES



FORM EM + HAD. SUMS IN THIS CELL WHEN

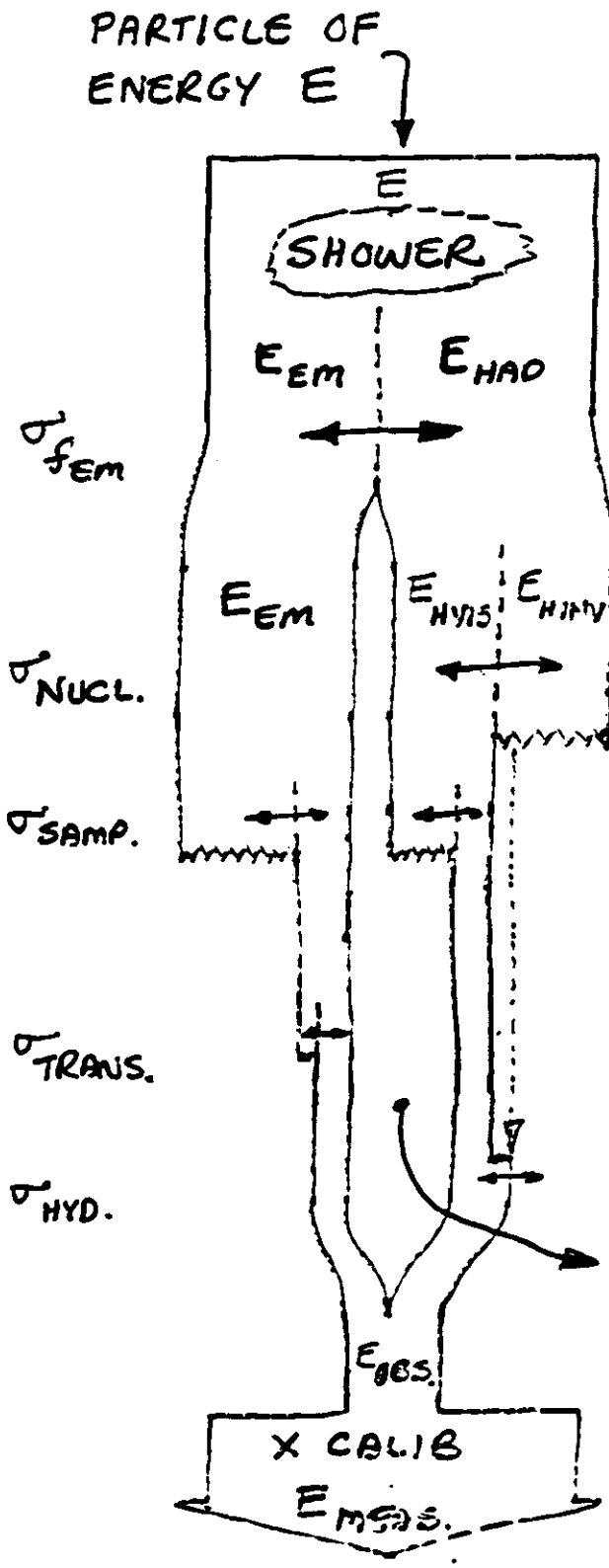
$\rho_{MIN} < \rho < \rho_{MAX}$

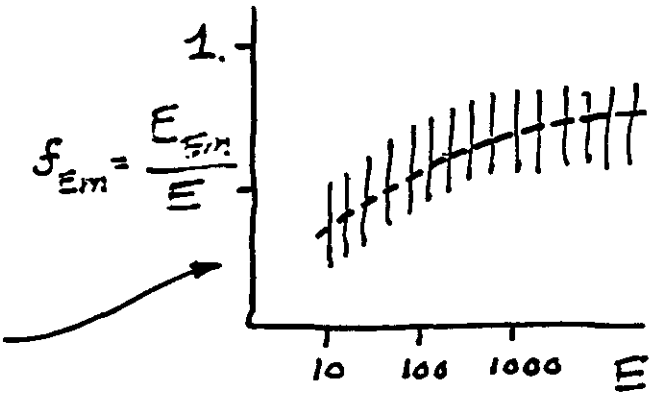
$\phi_{MIN} < \phi < \phi_{MAX}$

(QUICK!)

⇒ AVOIDS 100'S OF GEANT VOLUMES.

ENERGETICS OF SAMPLING CALORIMETERS





- NUCLEAR BINDING, EXCITATI
- ν's. $f_{HVIS} = \frac{E_{HVIS}}{E_{HAD}}$
- SAMPLING FRACTION, S. (dE/dx WEIGHTED)
- TRANSITION EFFECT e/MIP
- HYDROGENIC MATERIALS

IF HYDROGEN NEGLIGIBLE, COMPENSATION WHEN →

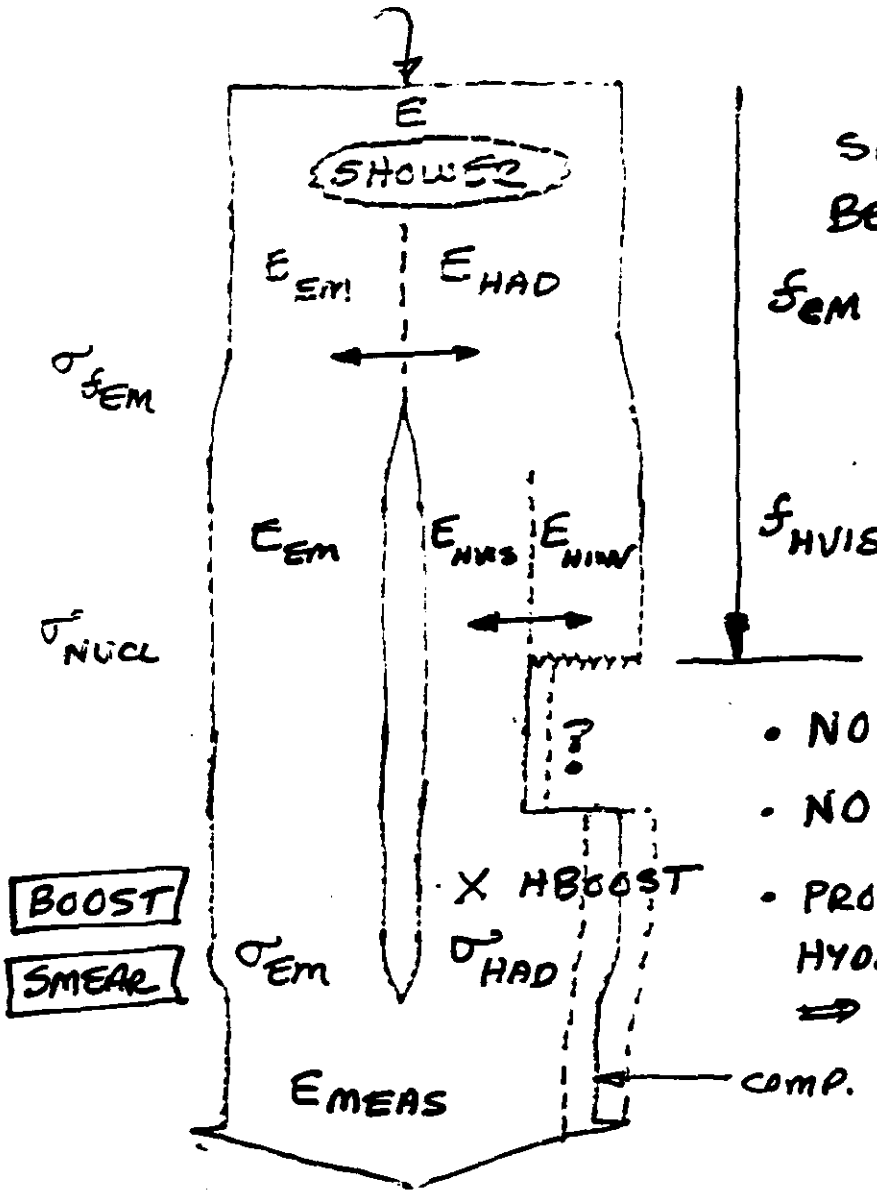
$$\boxed{e/MIP = f_{HVIS}}$$

FOR NONCOMPENSATION:

$$e/h = e/MIP \,/\, f_{HVIS} \quad (.8/.5 = 1.$$

ENERGETICS OF GEANT MIXTURES

UAZMIX TECHNIQUE.



SIMULATES REAL BEHAVIOR TO HERE.

- NO SAMPLING FRACTION, S
- NO TRANSITION EFFECT, e/mip
- PROPER SIM. OF HYDROGENIC MATERIALS ⇒ "CALOR89." (GCALOR)

① EM ENERGY REMAINS CALIBRATED.

② COMPENSATION ⇒ HBOOST = $1/f_{HVIS}$ (~2)

NON COMPENSATING ⇒ HBOOST = $(h/e)/f_{HVS}$ (EG. $\frac{2}{1.6}$)

③ σ_{EM} INCLUDES σ_{SAMP}, σ_{TRANS} ⇒ "TEST BEAM"

σ_{HAD} INCLUDES σ_{SAMP}, σ_{HYD} ⇒ "TESTBEAM ⊖ σ_{NUCL}"

MIXMAKER

```
***** MAKING MIXTURE FROM PROPORTIONS BY   VOLUME:  BRASS
 # OF COMPS:    3  DENSITY:    8.920  SAMP.FRAC:    0.000
 RAD.LEN.(CM):    1.400  ABS.LEN.(CM):   15.256 DEDX:    1.427
        COMPONENT          INPUT         FRAC BY WT        INDX
             COPPER        0.93000        0.93417          15
             ZINC          0.05000        0.04002          16
             LEAD          0.02000        0.02545          22

    ELEMENTS BY FRACTIONAL WEIGHT.  # =      3
         COPPER                     0.934506      15
         ZINC                       0.040037      16
         LEAD                       0.025458      22

***** MAKING MIXTURE FROM PROPORTIONS BY   ATOM  :  MYLAR
 # OF COMPS:    3  DENSITY:    1.390  SAMP.FRAC:    0.000
 RAD.LEN.(CM):   26.740  ABS.LEN.(CM):   61.660 DEDX:    2.066
        COMPONENT          INPUT         FRAC BY WT        INDX
           CARBON          5.00000        0.62493           6
           HYDROGEN        4.00000        0.04204           2
           OXYGEN          2.00000        0.33302           8

    ELEMENTS BY FRACTIONAL WEIGHT.  # =      3
         CARBON                     0.624935       6
         HYDROGEN                   0.042044       2
         OXYGEN                     0.333021       8
```

INPUT

OUTPUT

MIXMAKER

```
***** MAKING MIXTURE FROM PROPORTIONS BY   VOLUME:  LKREM_1.0PB$
 # OF COMPS:    5  DENSITY:    4.190  SAMP.FRAC:    0.394
 RAD.LEN.(CM):    2.064  ABS.LEN.(CM):   37.328 DEDX:    1.350
        COMPONENT          INPUT        FRAC BY WT       INDX
SS                          0.04000       0.12686         13
G10                         0.01600       0.01385        108
LEAD                        0.10000       0.45451         22
KAPTON                      0.04000       0.01778        107
LIQUID_KRYPTON              0.40000       0.38699         17

    ELEMENTS BY FRACTIONAL WEIGHT.  # =      7
         SS                         0.126863      13
         LEAD                       0.454511      22
         LIQUID_KRYPTON             0.386995      17
         CARBON                     0.019963       6
         HYDROGEN                   0.003358       2
         SILICON                    0.003885      10
         OXYGEN                     0.004426       8
  SIG-EM  SIG-HAD  CTERM   CNOISE   BOOST  ETOH:
 0.0600  0.6000  0.0040 25.0000  2.2200  1.8000

***** MAKING MIXTURE FROM PROPORTIONS BY   VOLUME:  LKRHAD_9CU$
 # OF COMPS:    4  DENSITY:    7.383  SAMP.FRAC:    0.051
 RAD.LEN.(CM):    1.744  ABS.LEN.(CM):   18.173 DEDX:    1.411
        COMPONENT          INPUT        FRAC BY WT       INDX
COPPER                      0.93400       0.15889         15
COPPER                      4.50000       0.76554         15
G10                         0.50000       0.02052        108
LIQUID_KRYPTON              1.20000       0.05505         17

    ELEMENTS BY FRACTIONAL WEIGHT.  # =      6
         COPPER                     0.924431      15
         LIQUID_KRYPTON             0.055046      17
         SILICON                    0.005756      10
         OXYGEN                     0.006558       8
         CARBON                     0.007027       6
         HYDROGEN                   0.001182       2
  SIG-EM  SIG-HAD  CTERM   CNOISE   BOOST  ETOH:
 0.1600  0.6000  0.0200120.0000  2.0100  1.6000
```

INPUT

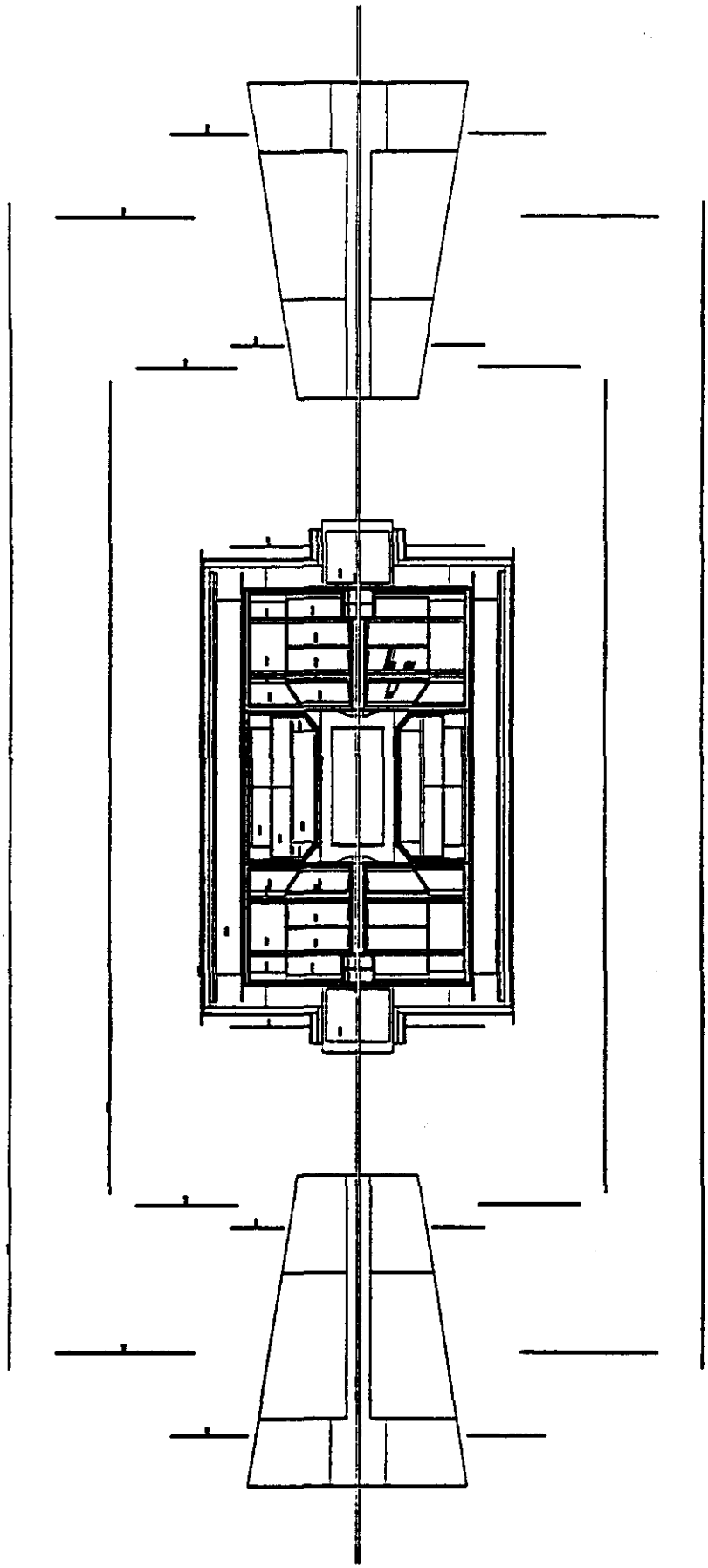
OUTPUT

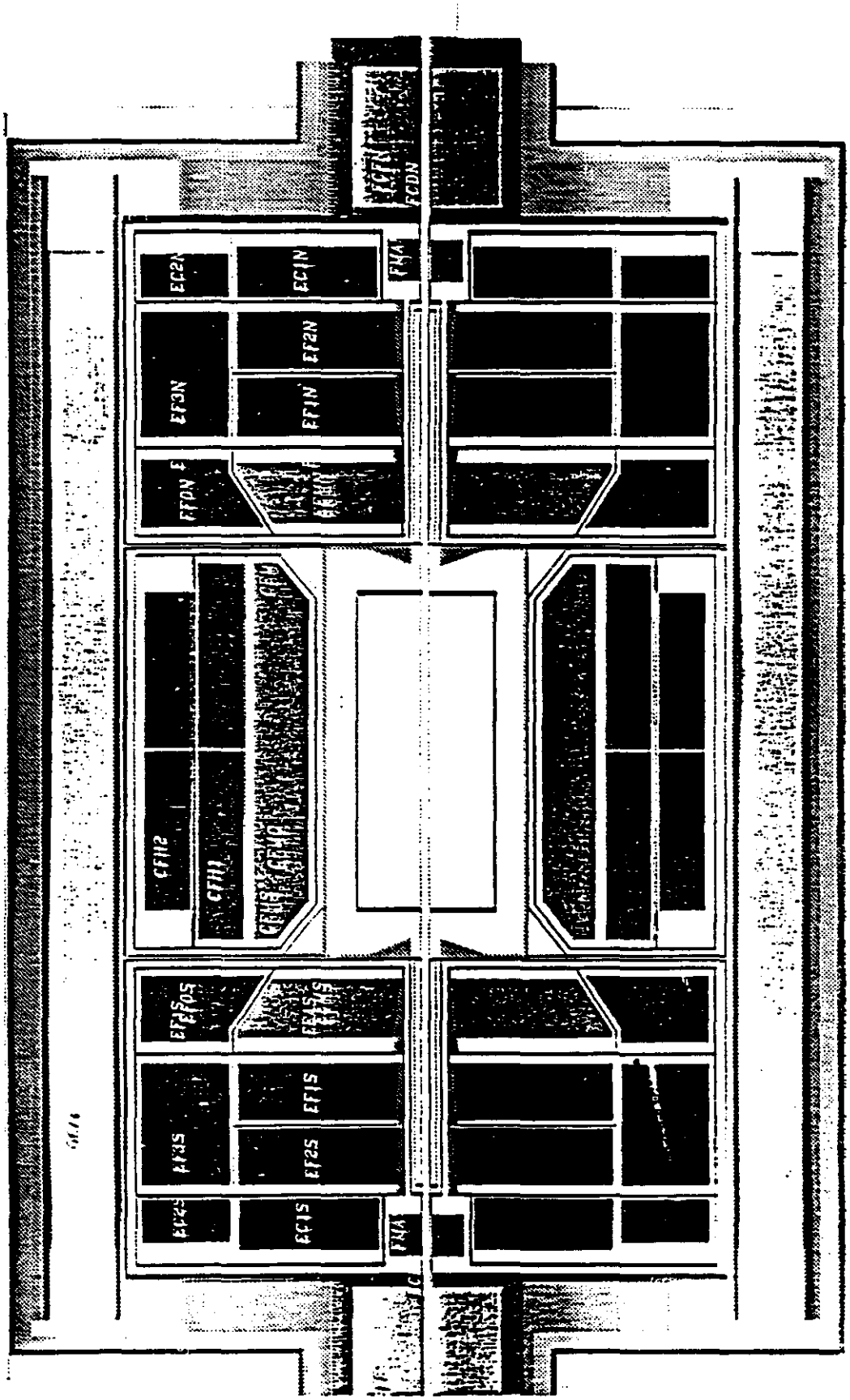
EXPLICIT HYDROGEN FOR NEUTRON STUDIES

PARAMETER VALUES IN CURRENT STUDY

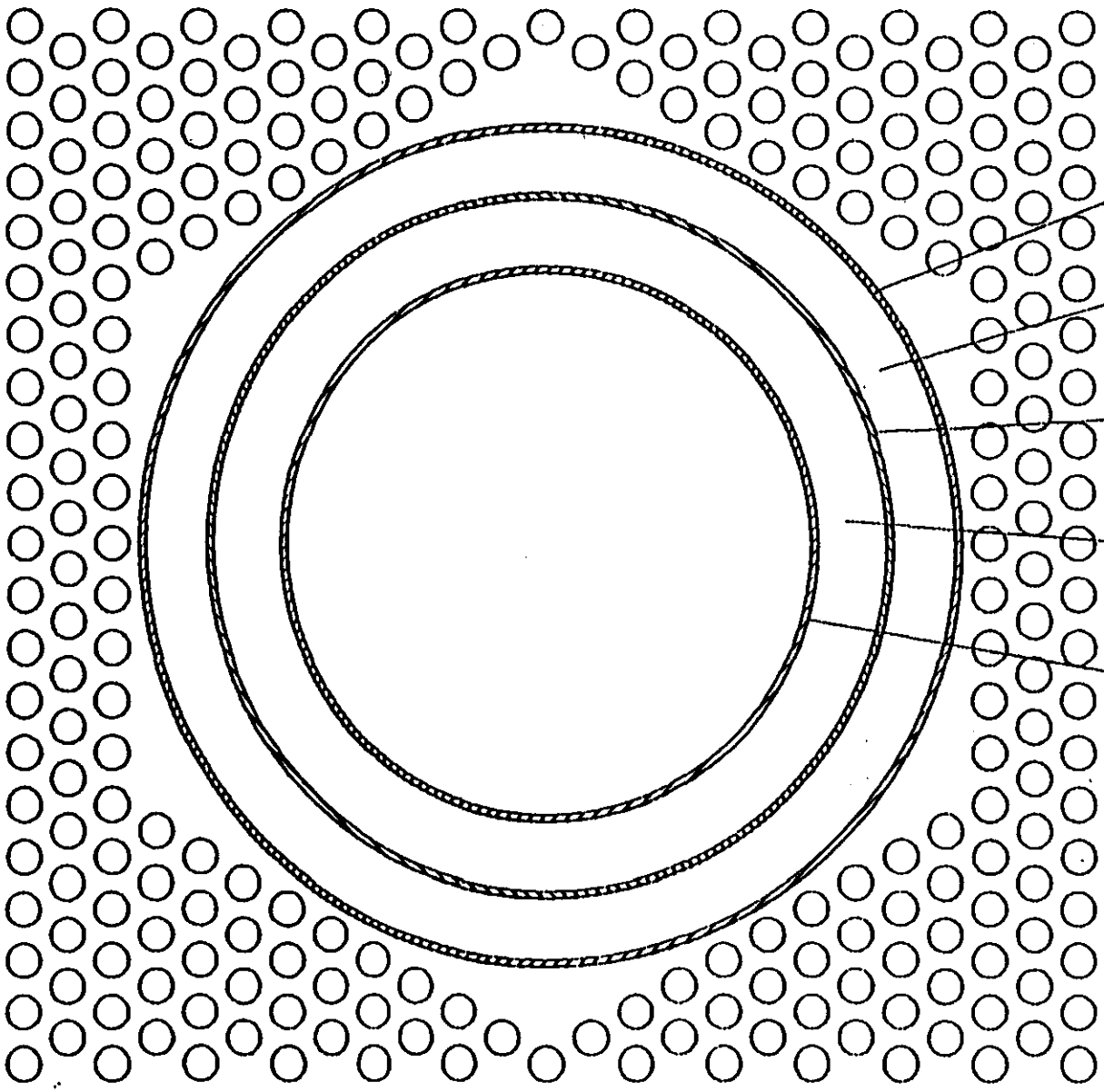
MIXTURE	$f_{HAD\ VIS}$ (GEMFAST)	(NEW)	e/h	e/h (WIMER)
EC				
ACC LKr Pb	.450	(.454)	1.8	
FH LKr Pb	.498	(.467)	1.6	(1.46)
EC				
ACC LAr Pb.	.500	(.472)	1.8	
FH LAr Cu	.500	(.465)	1.8	
FC				
FC LAr VV	.515	(.454) (PETER LOCH SIMULATION)	1.4	
FC HAD SCILIQ	—	(.420)		

GEM
UAZMIX



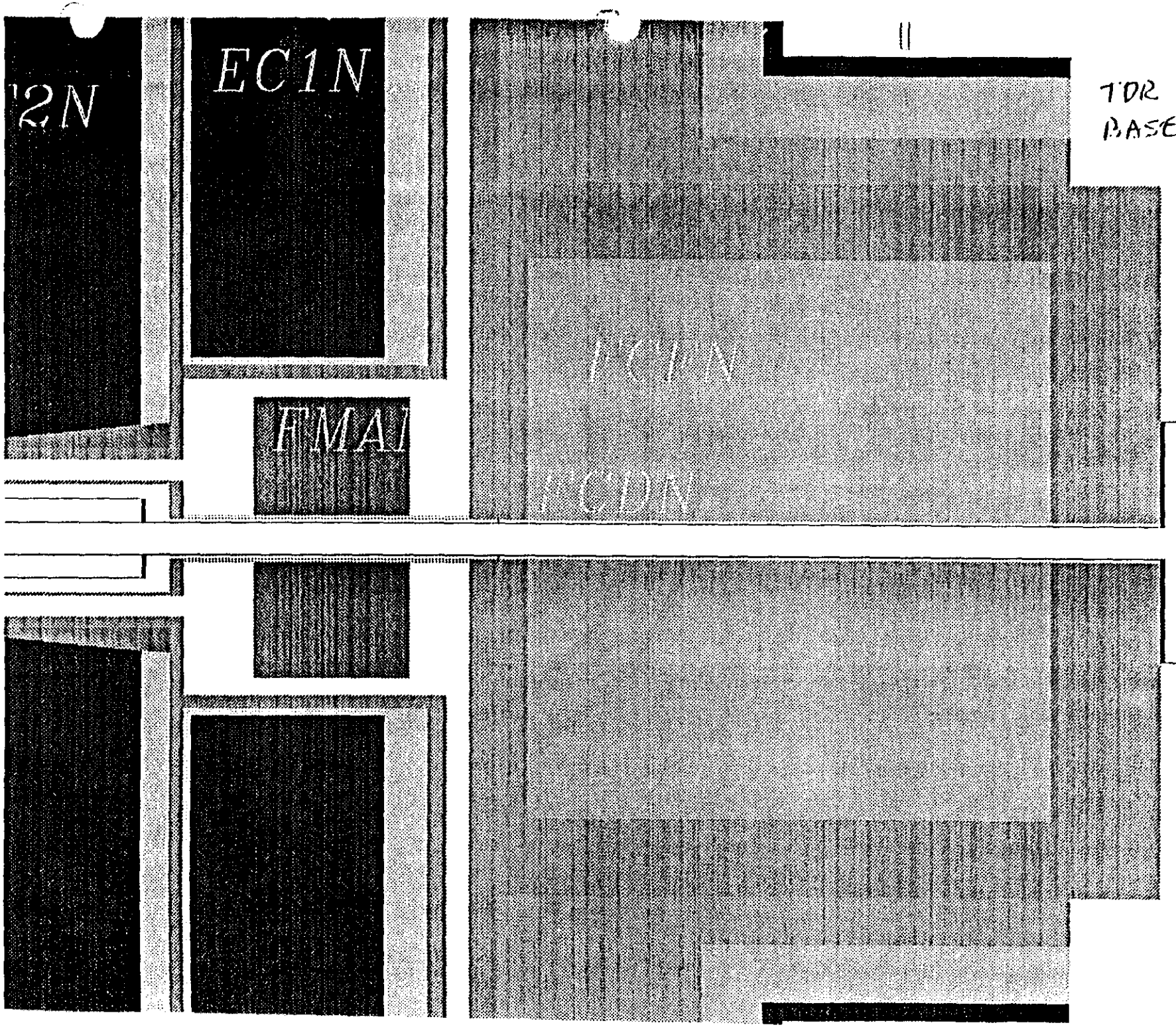

EC2N
EC1N
EF2N
EF3N
EF1N
CFH2
CFH1
EF1S
EF2S
EC1S

"STANDARD" BEAMPIPE



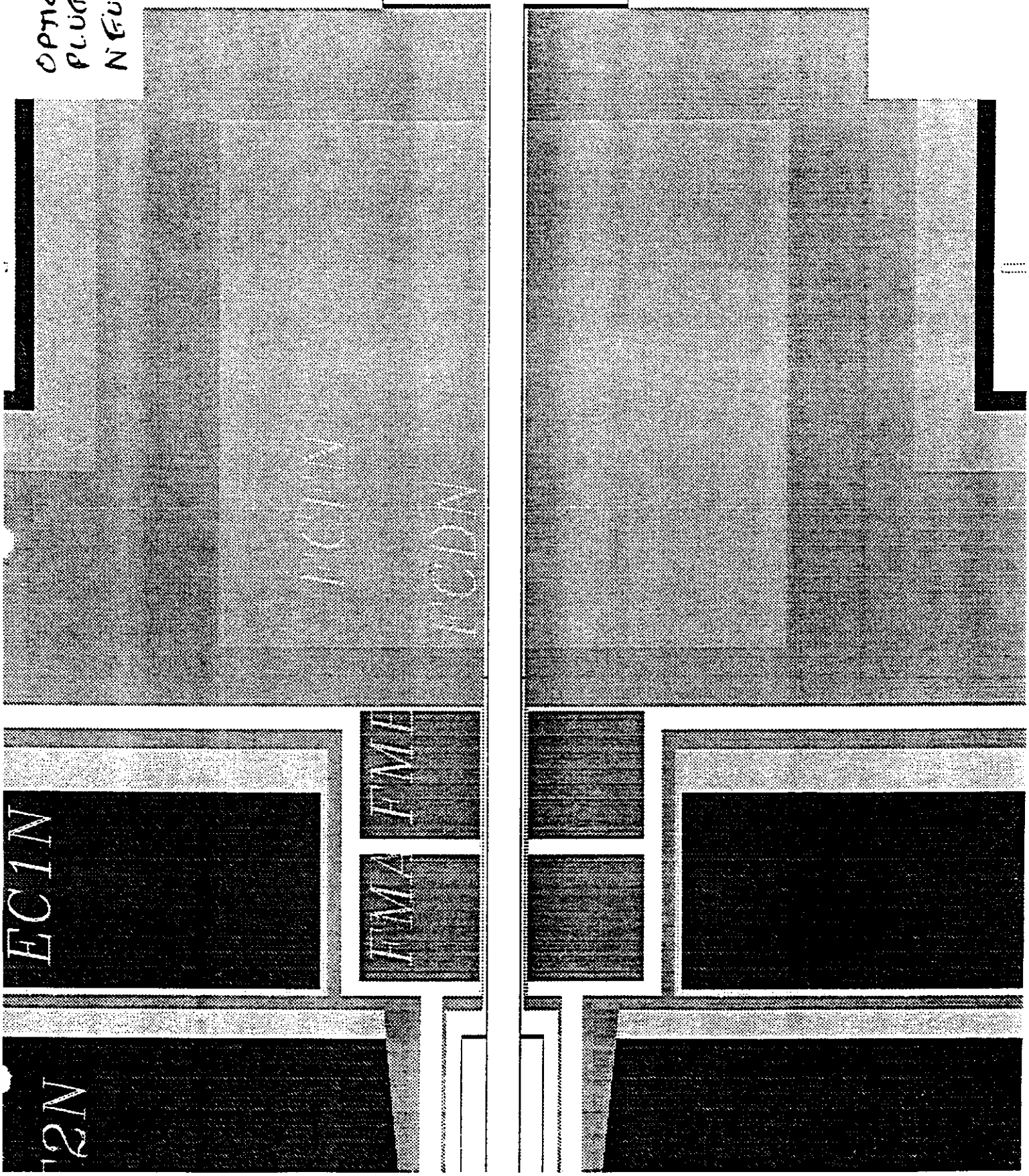
		SMALLER
~~122mm~~ 114 OD x 1mm thick cold wall		86 mm
~~9mm~~ 5mm gap for multi-layer insulation		5 mm
102mm OD x 1mm thick warm wall		72 mm
10mm air gap for alignment		2 mm
80mm OD x 1mm thick beam pipe		66 mm

NET GAIN 1.4 cm IN RADIUS



TDR
BASELINE:

OPTION TO
PLUG UP
NEUTRONS.



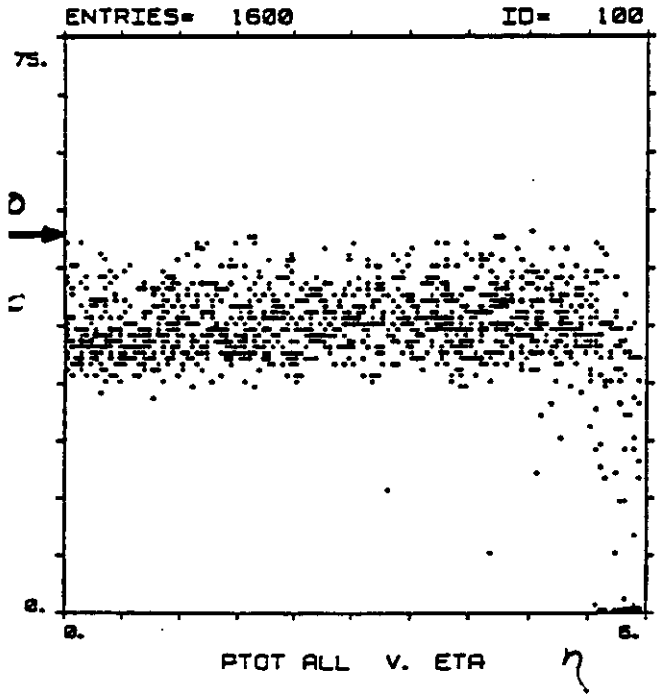
ANOTHER NEGATIVE OPTION.

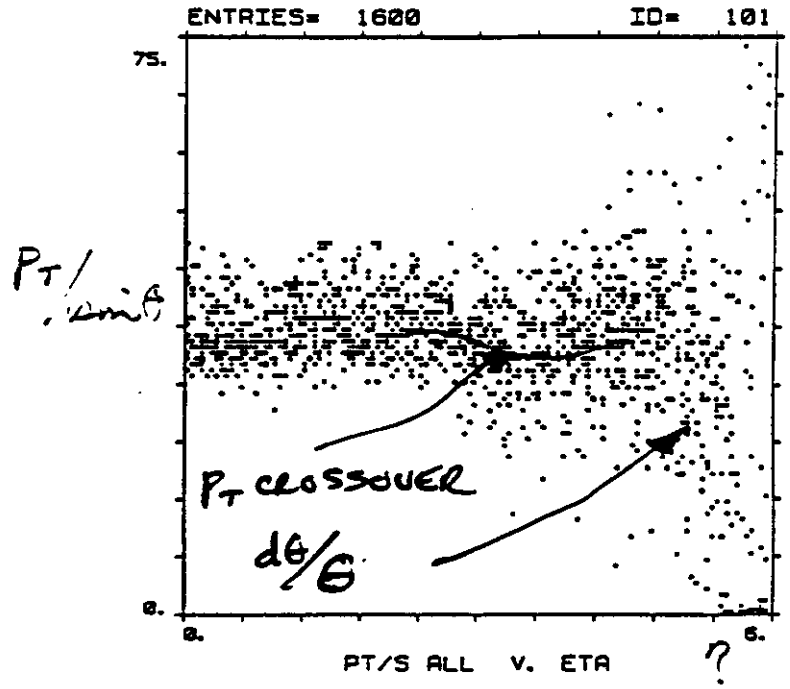
SHALLOW CHANNEL?

50 GeV PIONS

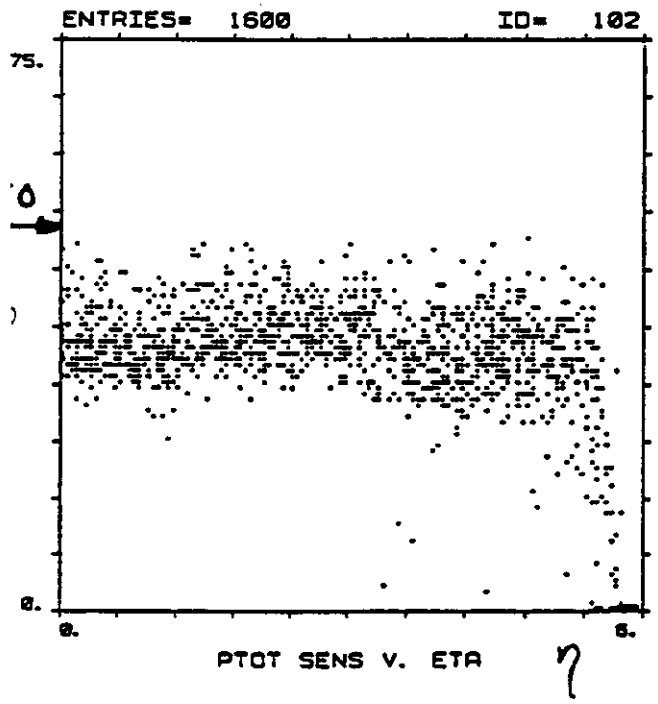
IN GEMFAST

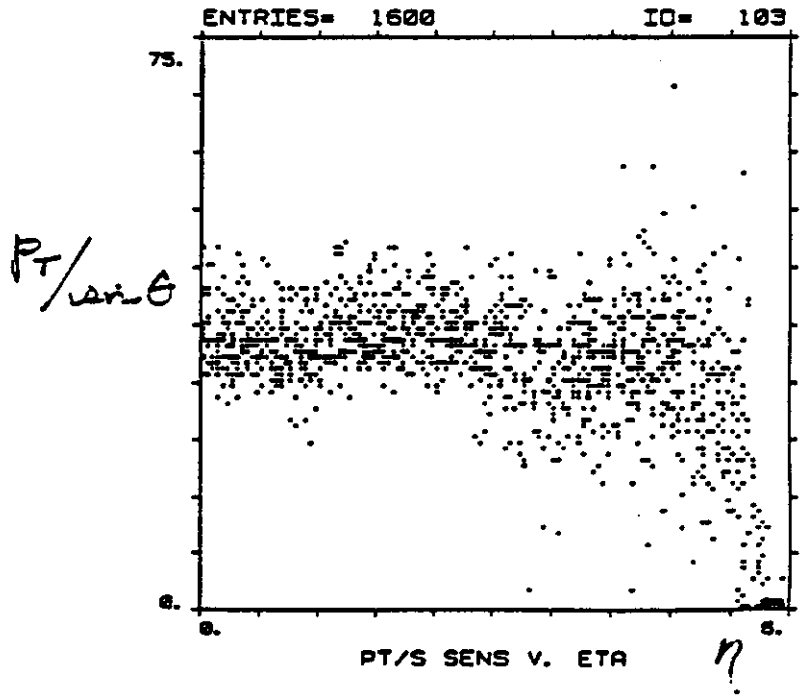
ALL VOLUMES





ACTIVE VOLUMES



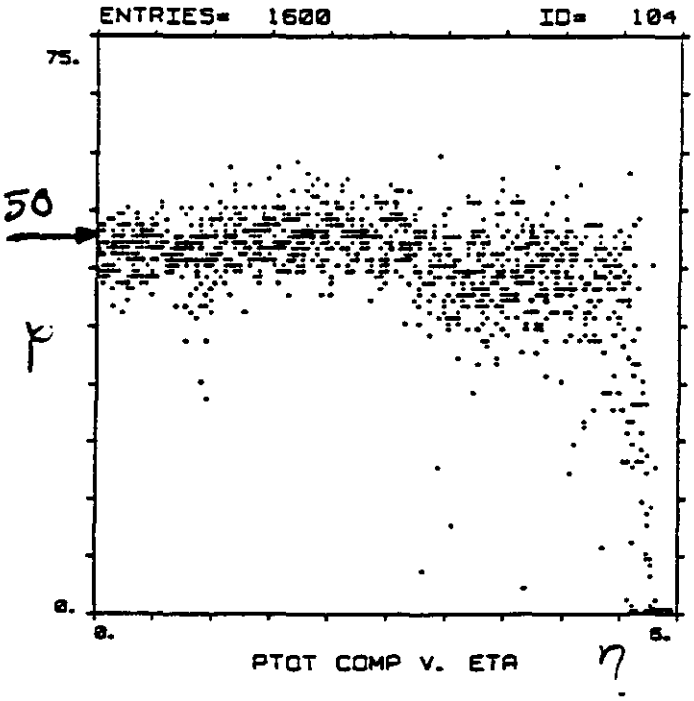


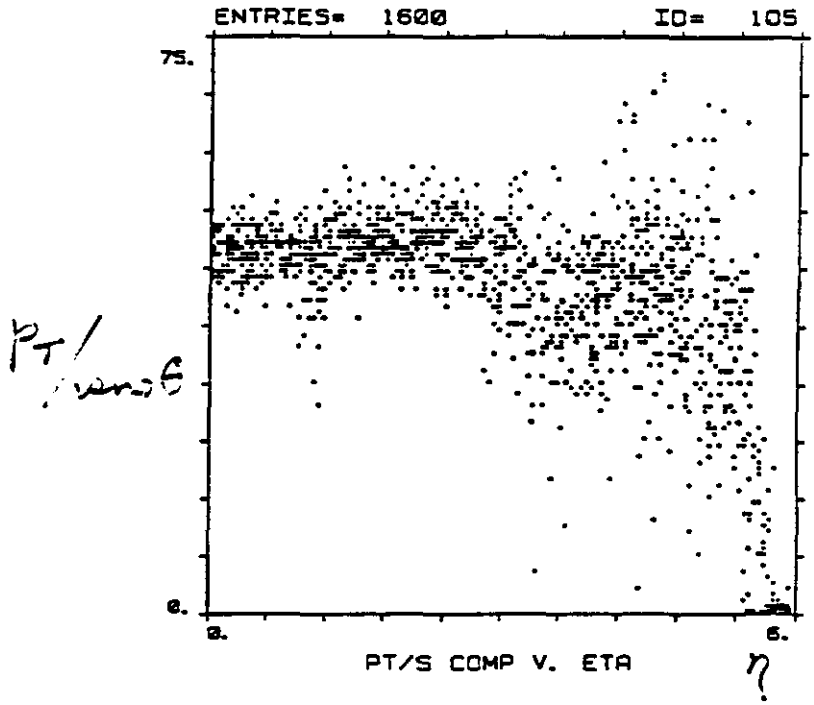
(NO SMEARING)

50 GeV PIONS

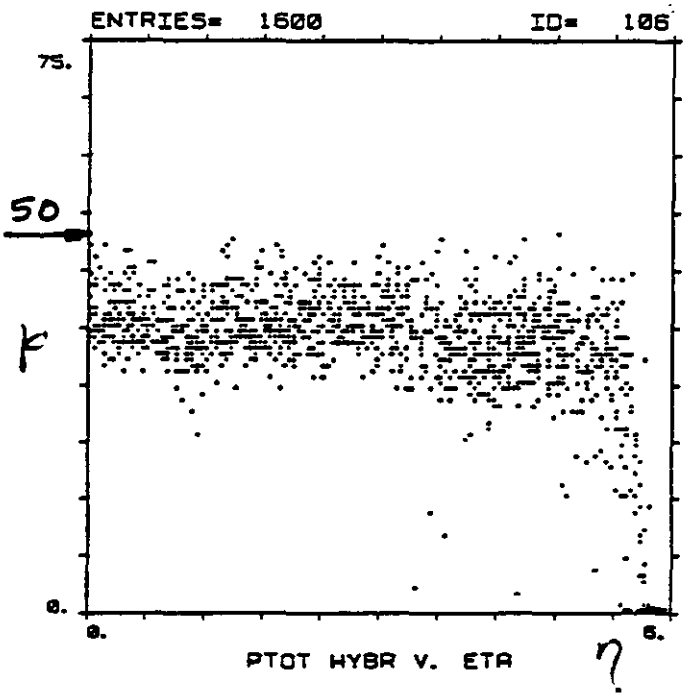
COMPENSATING CALORIMETER

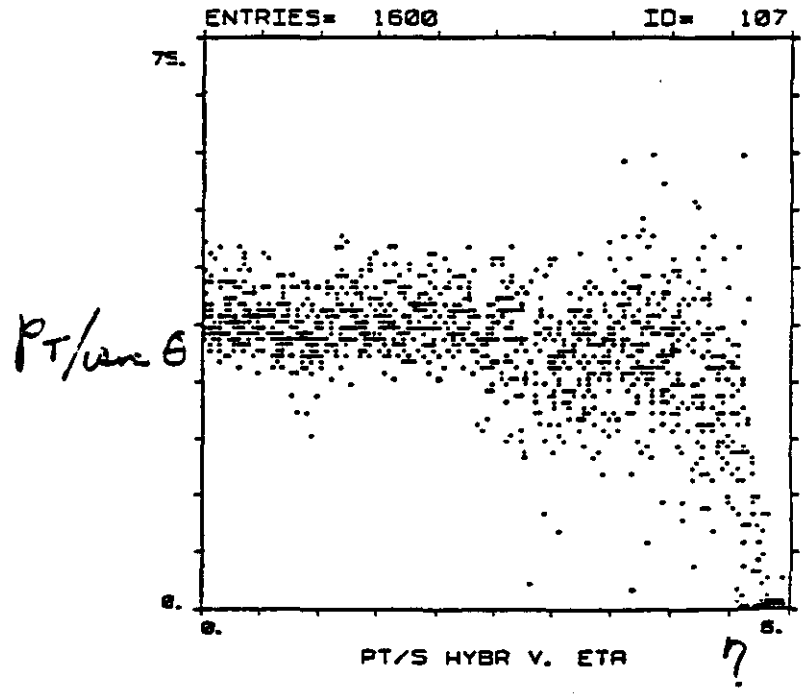
IN GEMFAS





BASELINE II



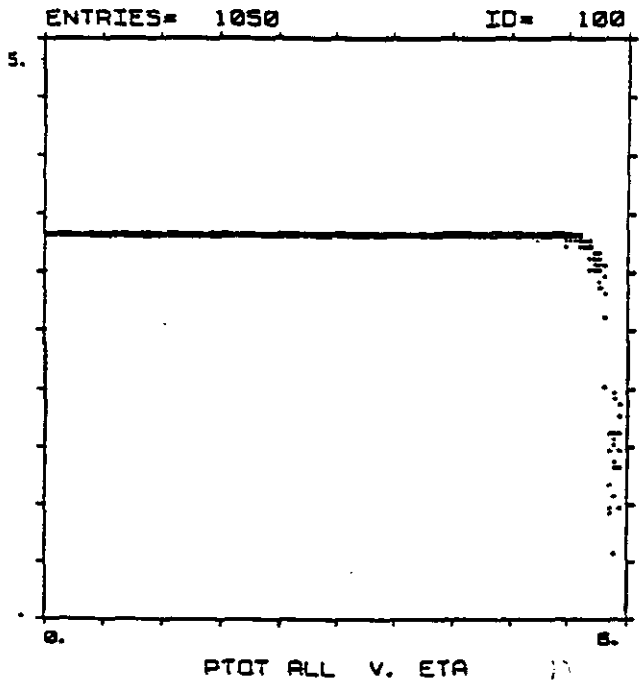


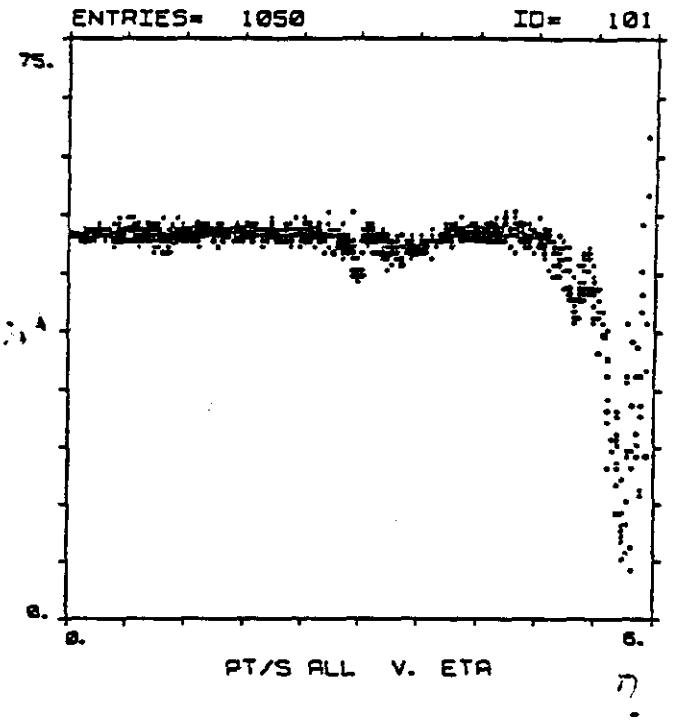
(NO SMEARING)

50 GeV ELECTRONS

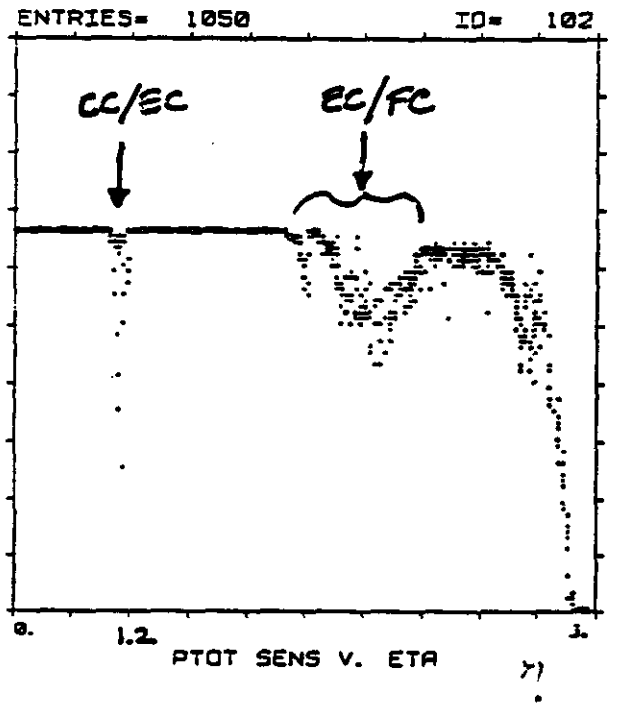
IN GEMFAST

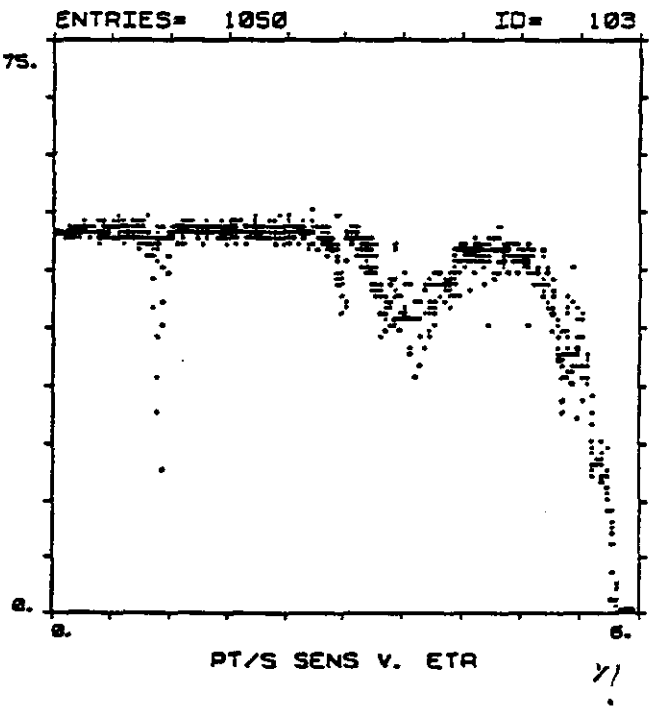
ALL VOLUMES





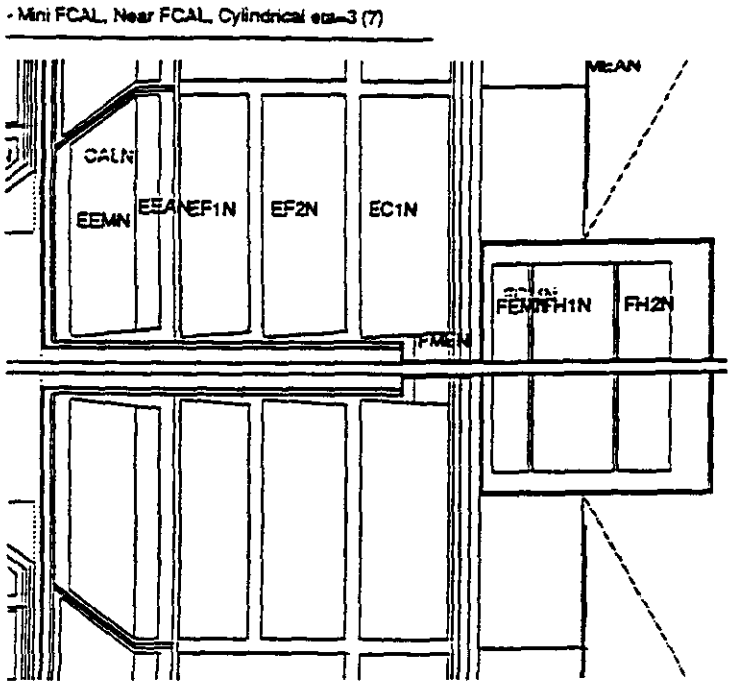
ACTIVE VOLUMES

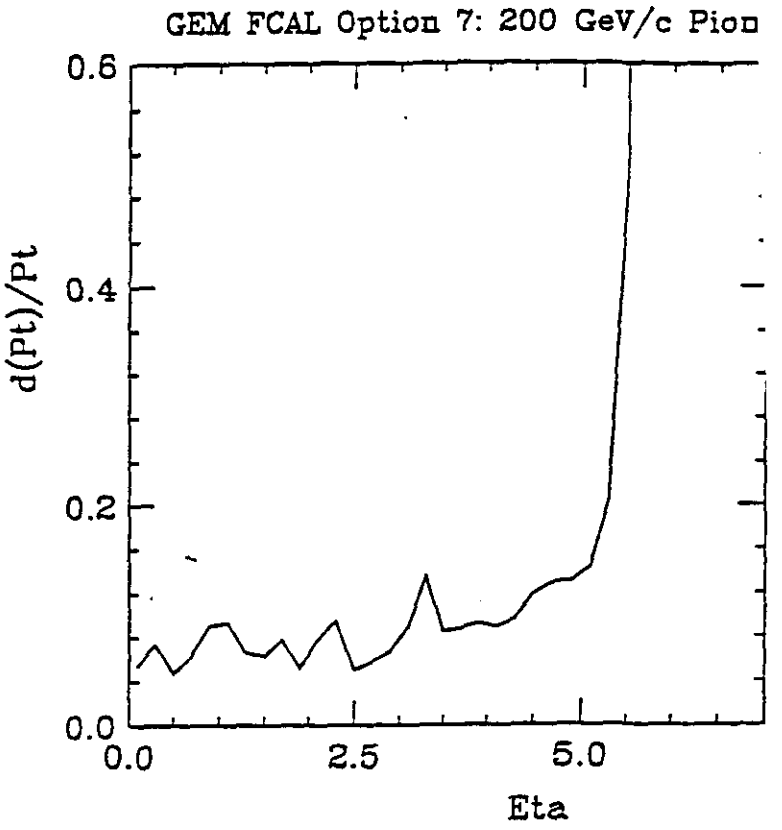


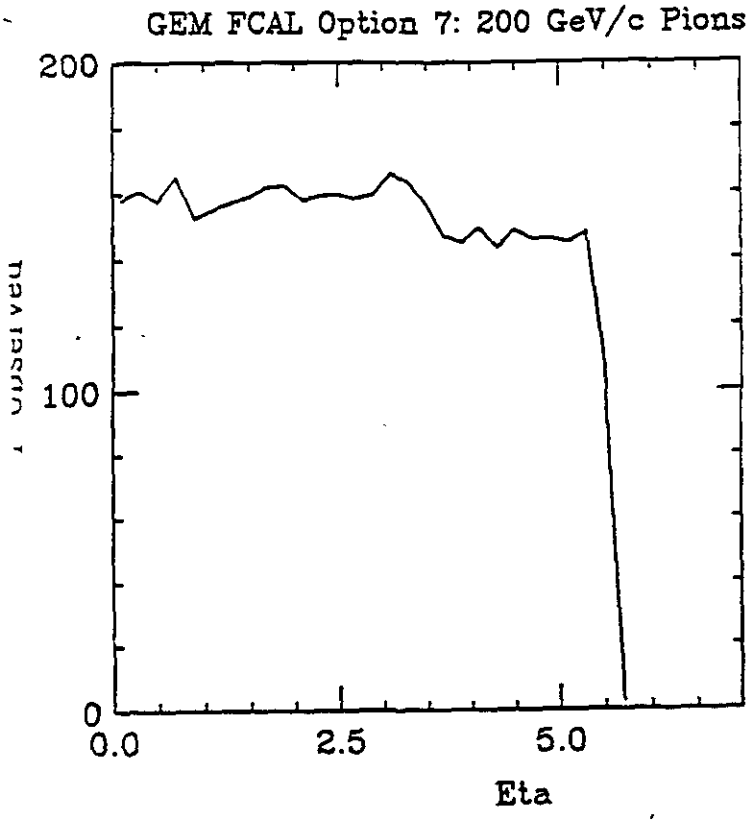


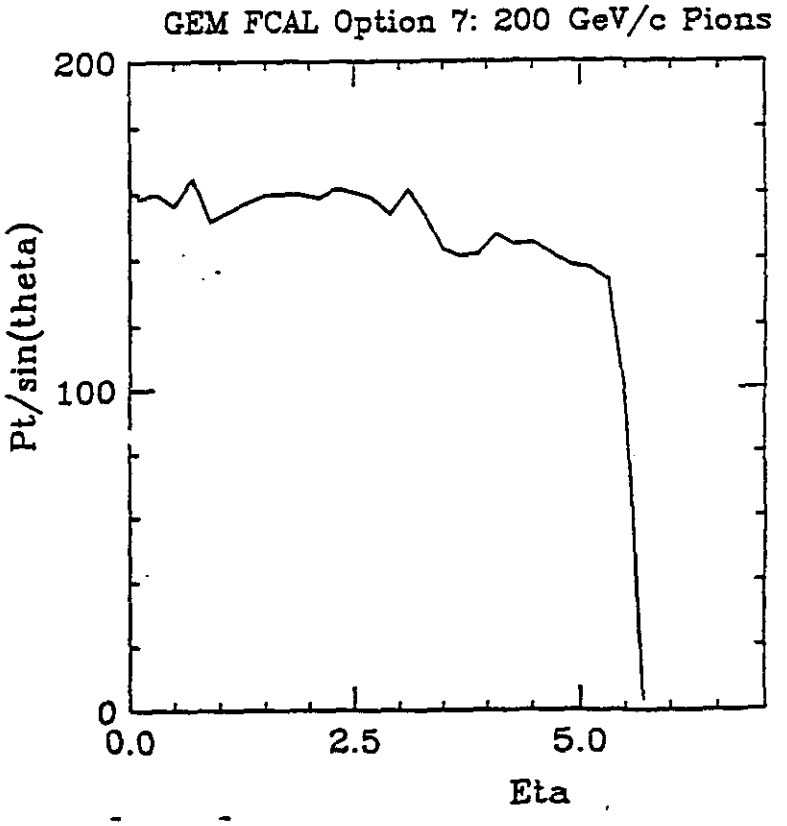
(NO SMEARING)

IN GEMFA


Mini FCAL, Near FCAL, Cylindrical eta=3 (7)
MCAN
CALN
EEMN
EEAN
EF1N
EF2N
EC1N
FEMN
FH1N
FH2N

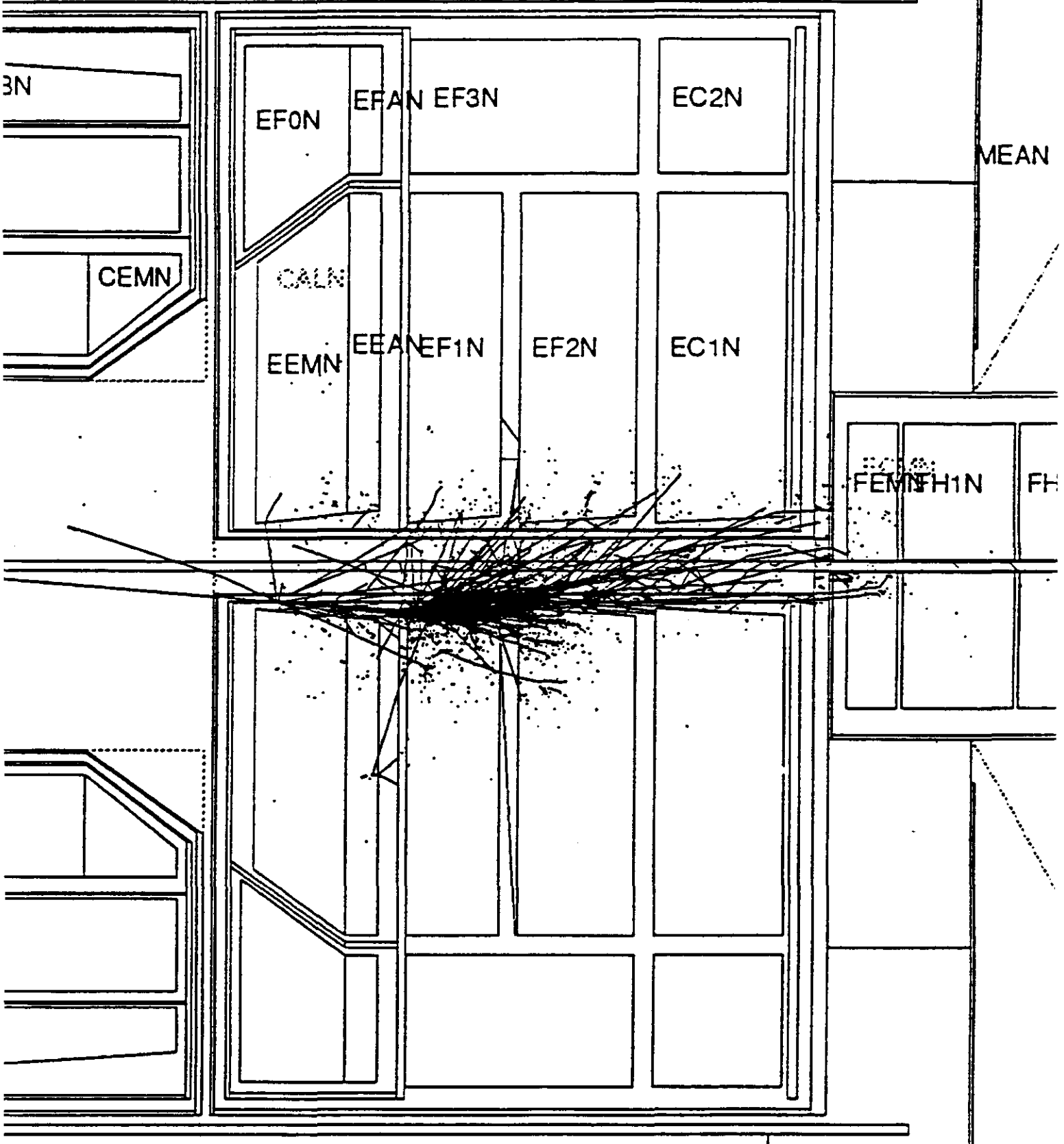

GEM FCAL Option 7: 200 GeV/c Pion
d(Pt)/Pt
0.6
0.4
0.2
0.0
0.0
2.5
5.0
Eta


GEM FCAL Option 7: 200 GeV/c Pions
200
100
0
0.0
2.5
5.0
Eta

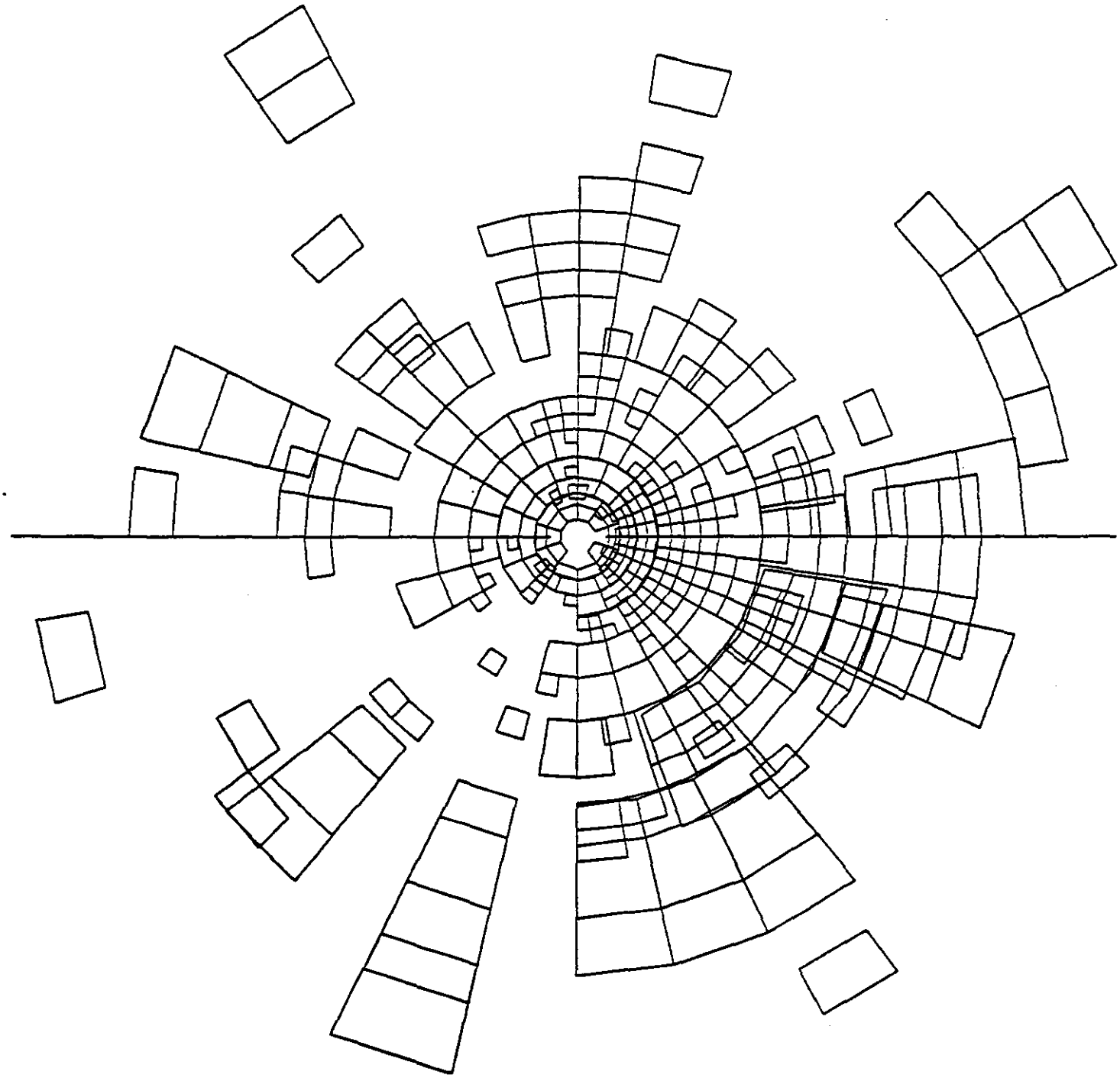

GEM FCAL Option 7: 200 GeV/c Pions
Pt/sin(theta)
200
100
0
0.0
2.5
5.0
Eta

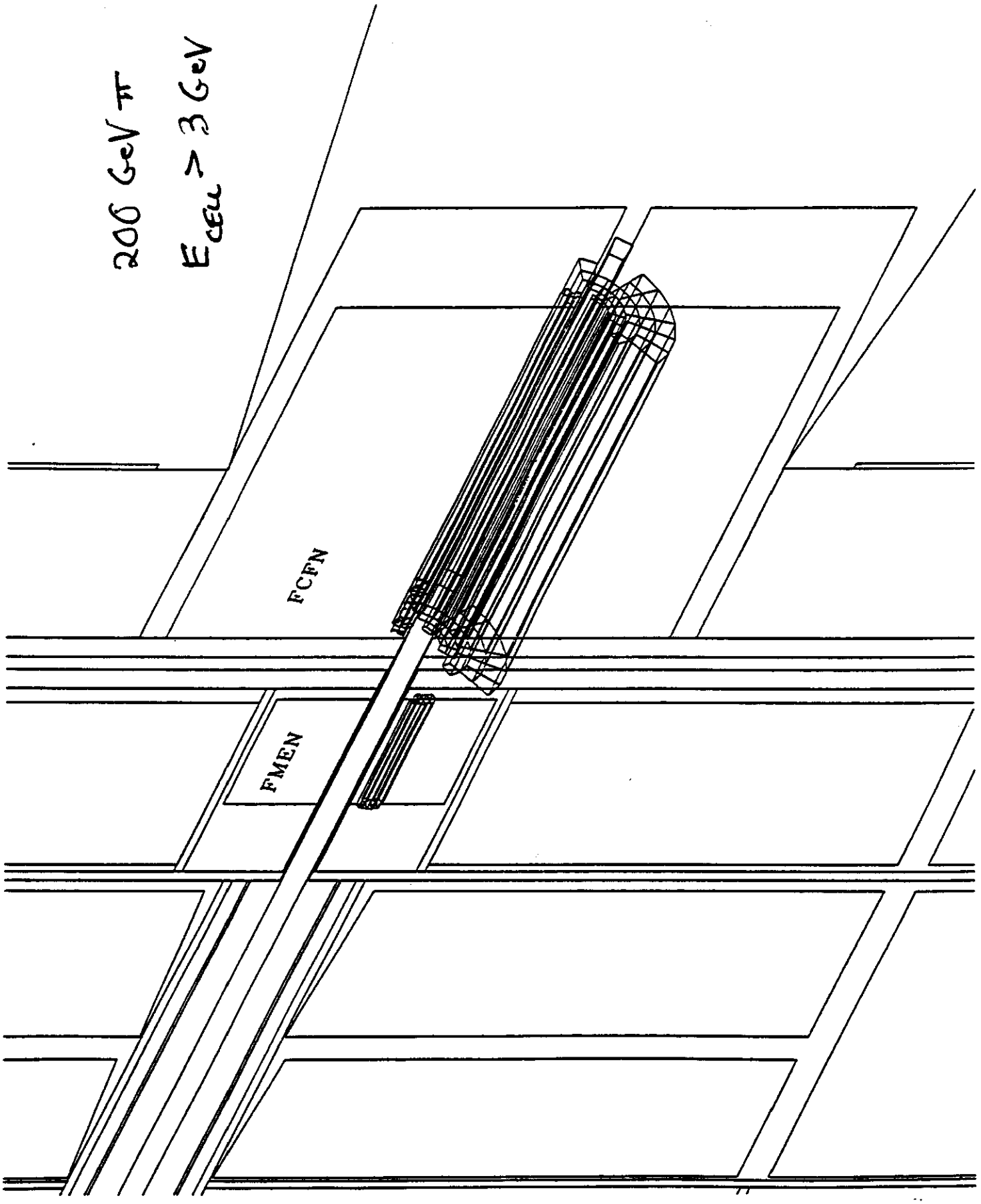
200 GeV PION

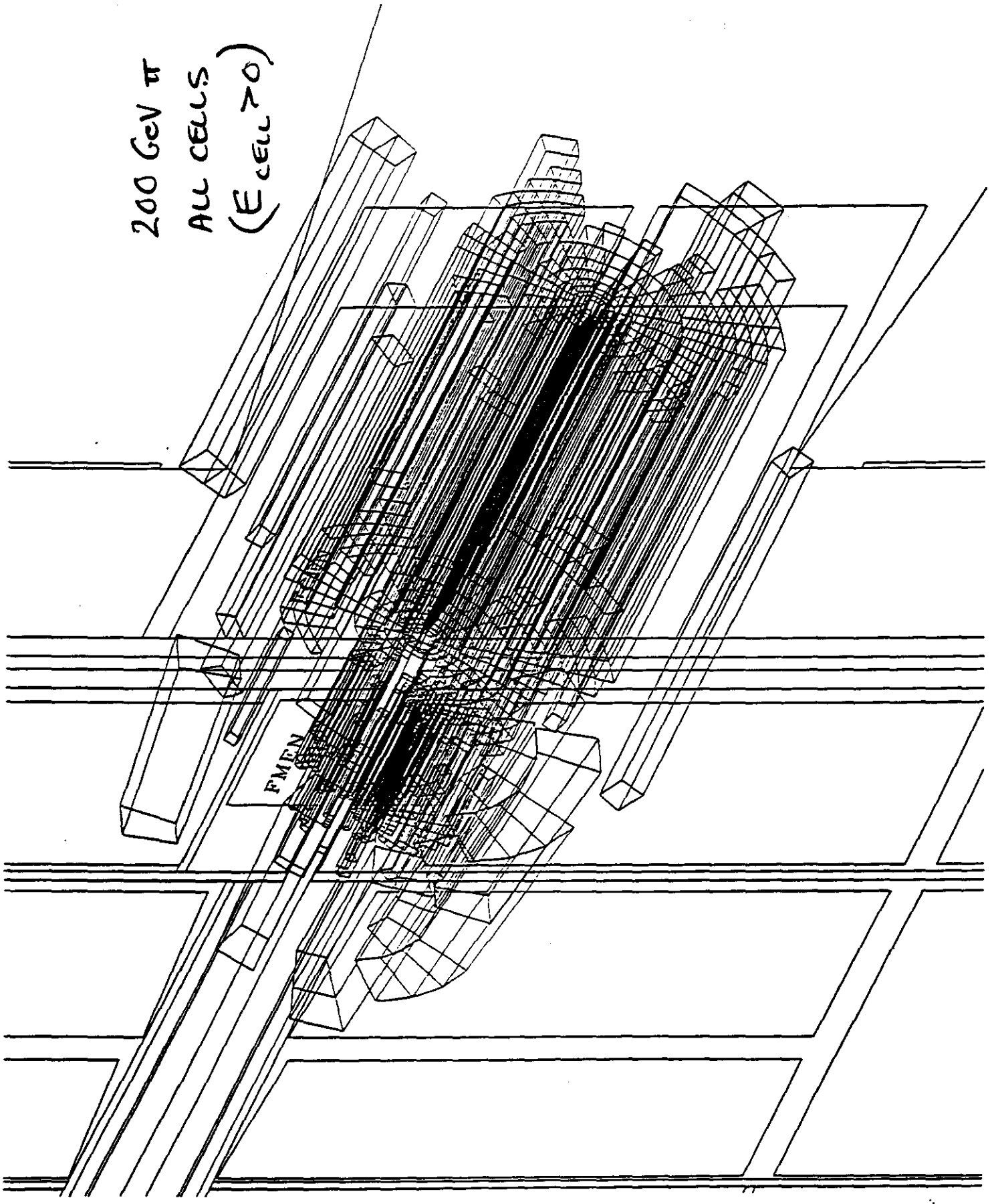
→ ILLUSTRATING "Pt CROSSOVER"

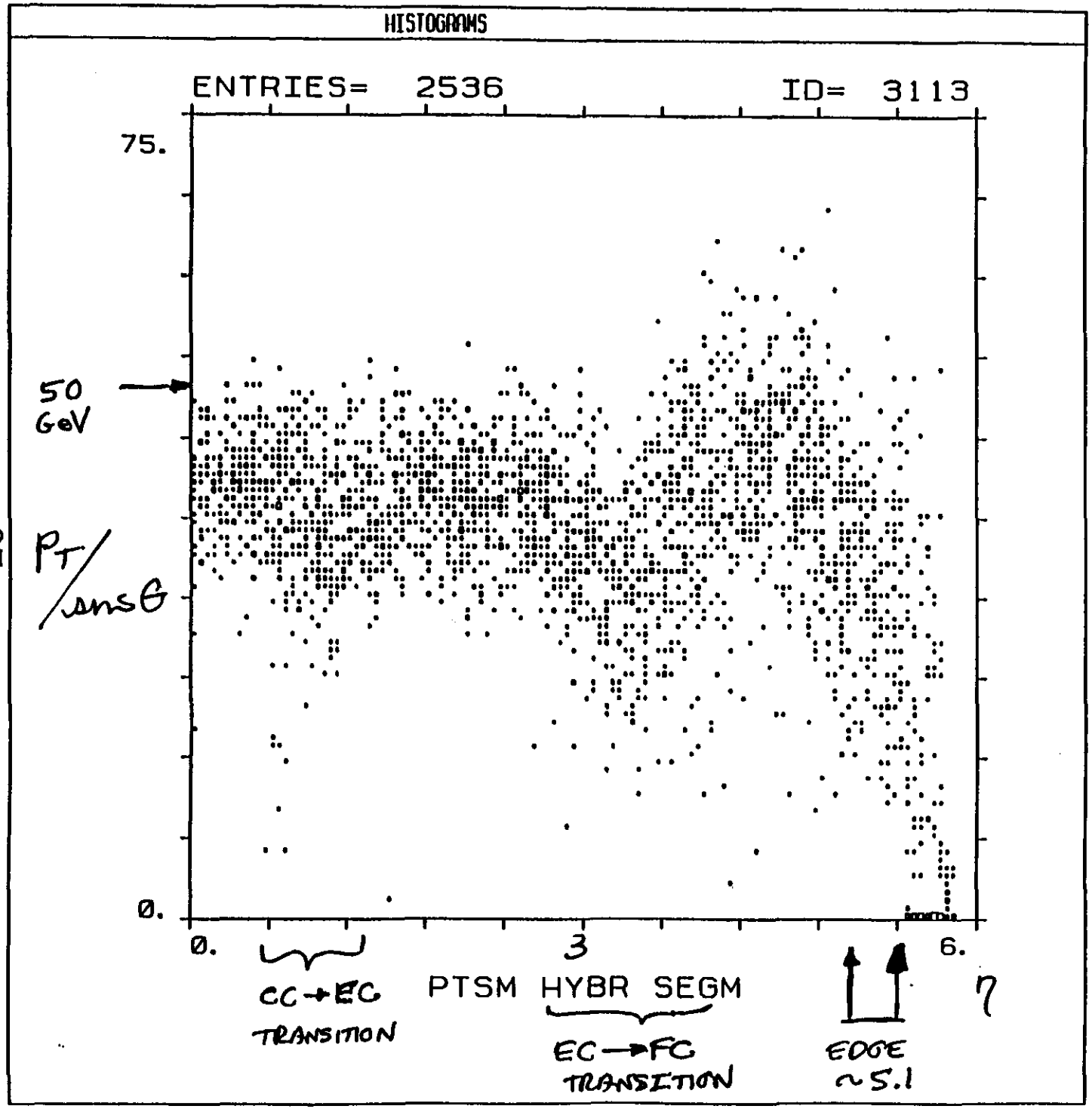


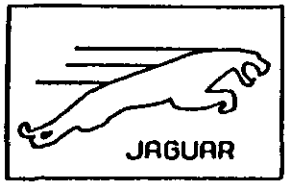
SEGMENTATION




200 GeV π
E_CEL > 3 GeV
FCFN
FMEN


200 GeV π
ALL CELLS
(E_{CELL} > 0)
FMEN

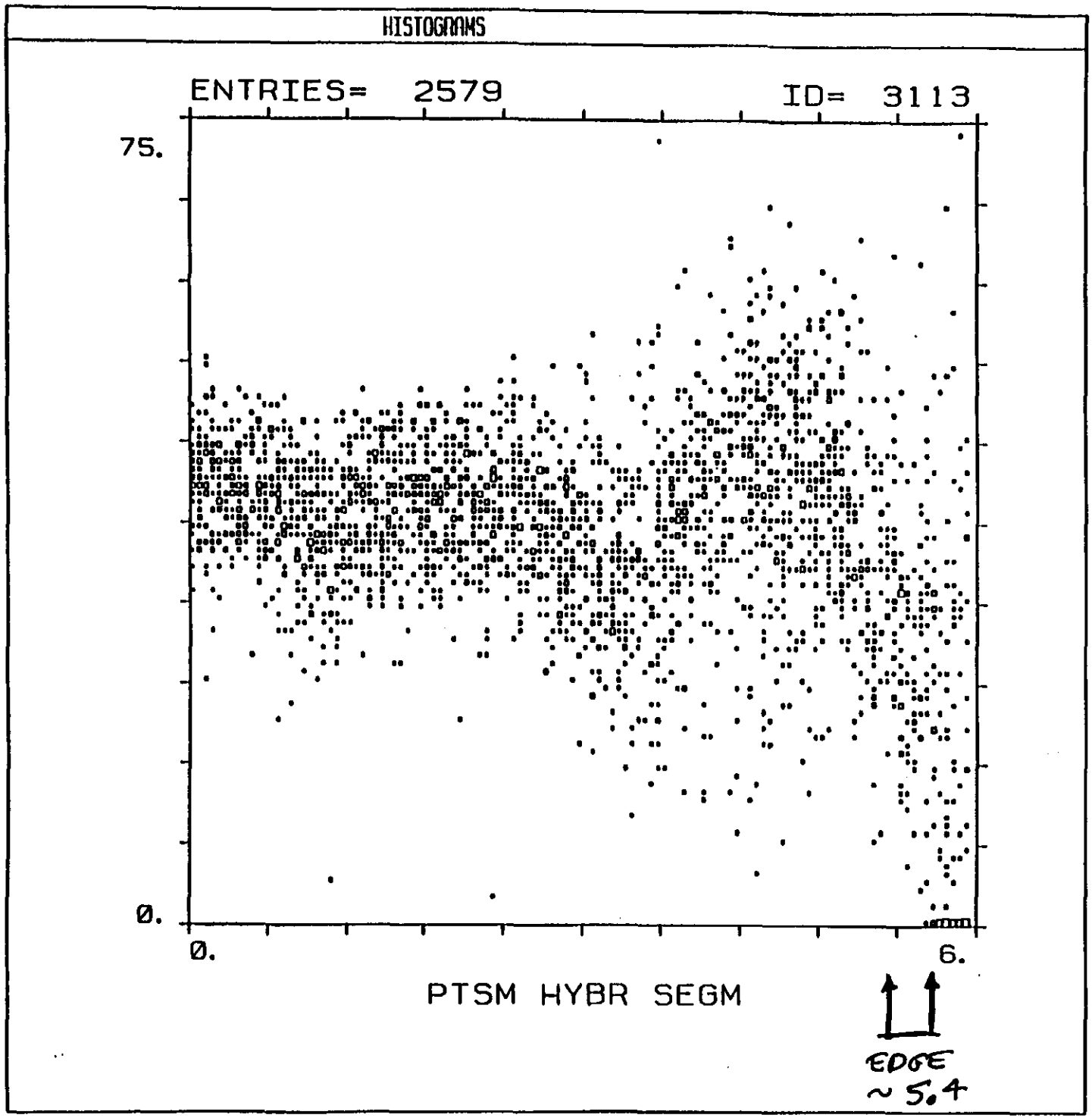




BASELINE
MAR 10, 1993

50 GeV π
CURRENT BASELINE

(2 DAYS OF STATISTICS)

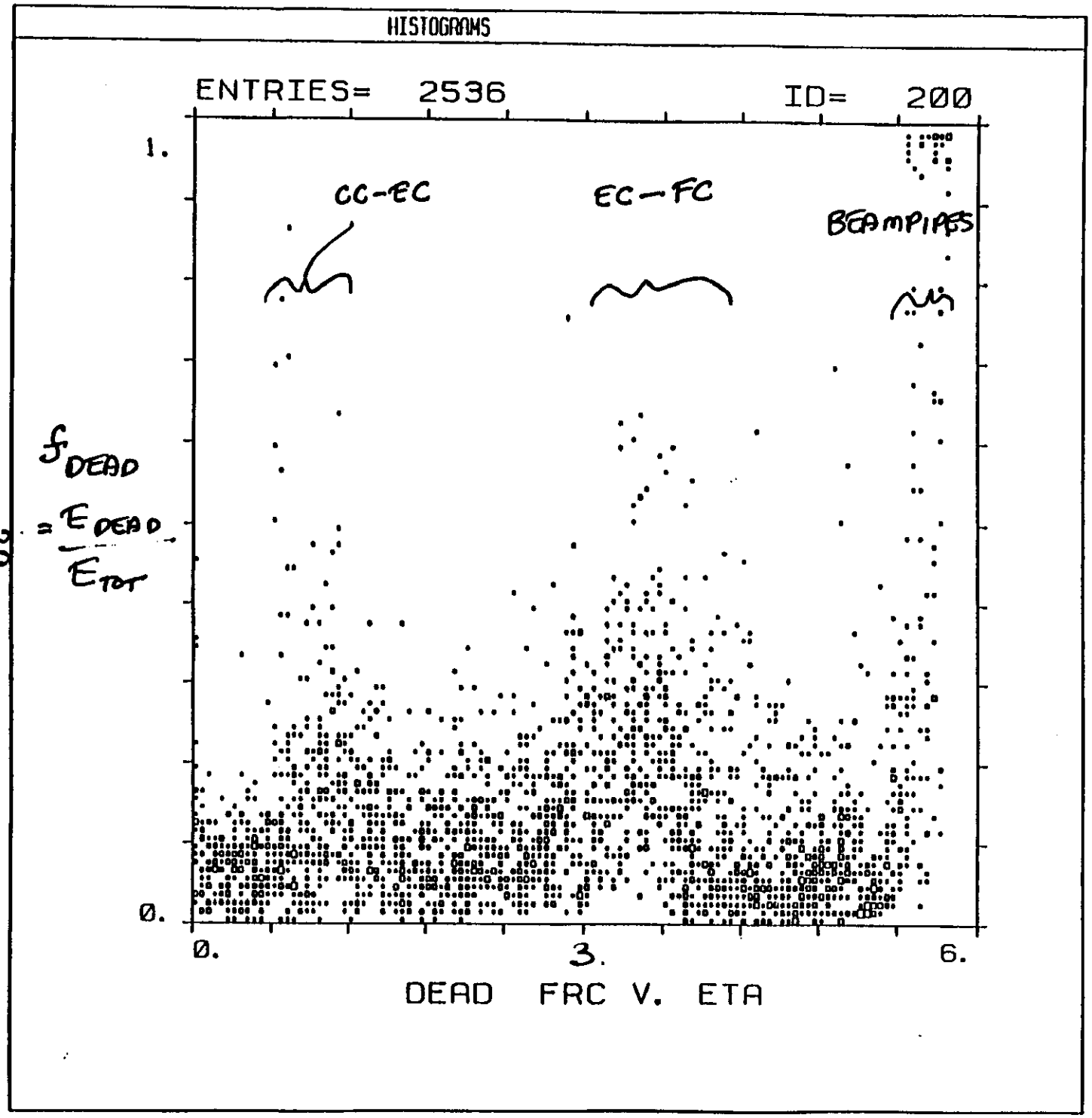


JAGUAR

SMALL PIPE

50 GeV π

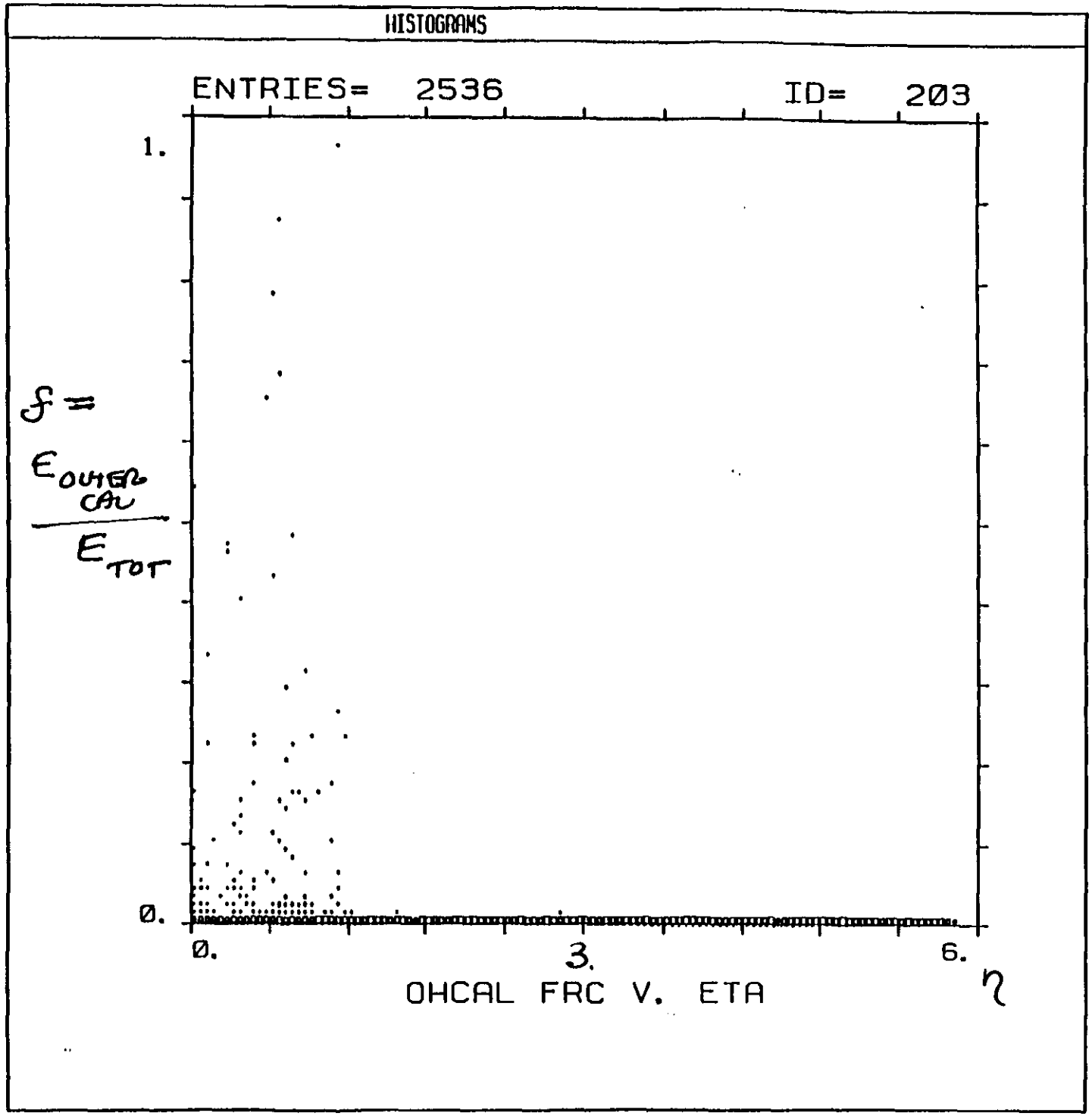
SMALLER BEAMPIPE



JAGUAR

BASELINE
50 GeV π's

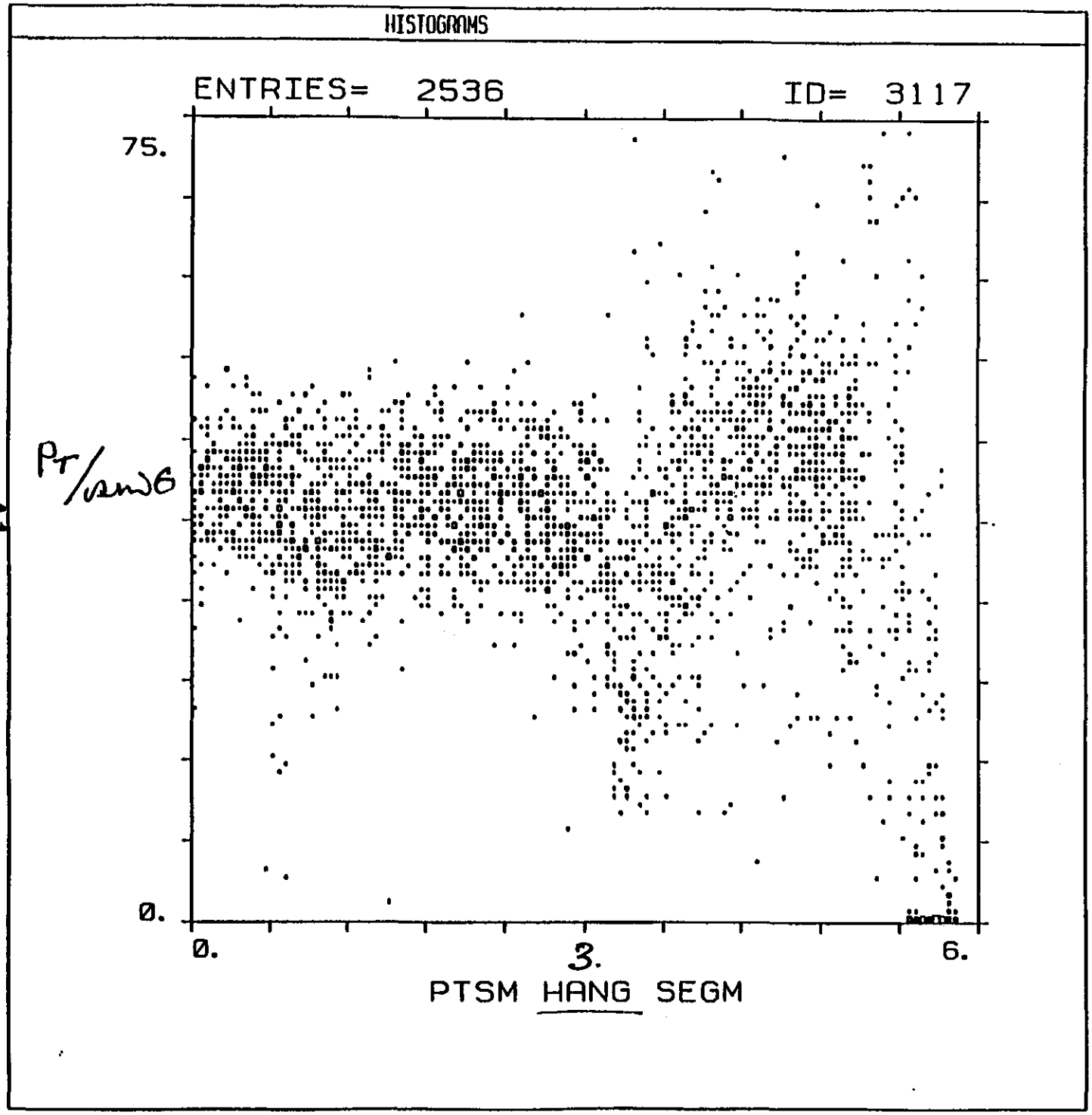
EFFECT OF
DEAD MATERIALS

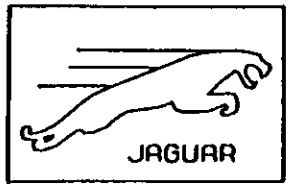


JAGUAR

BASELINE
50 GeV π^-

ENERGY IN OUTER CALORIMETER.



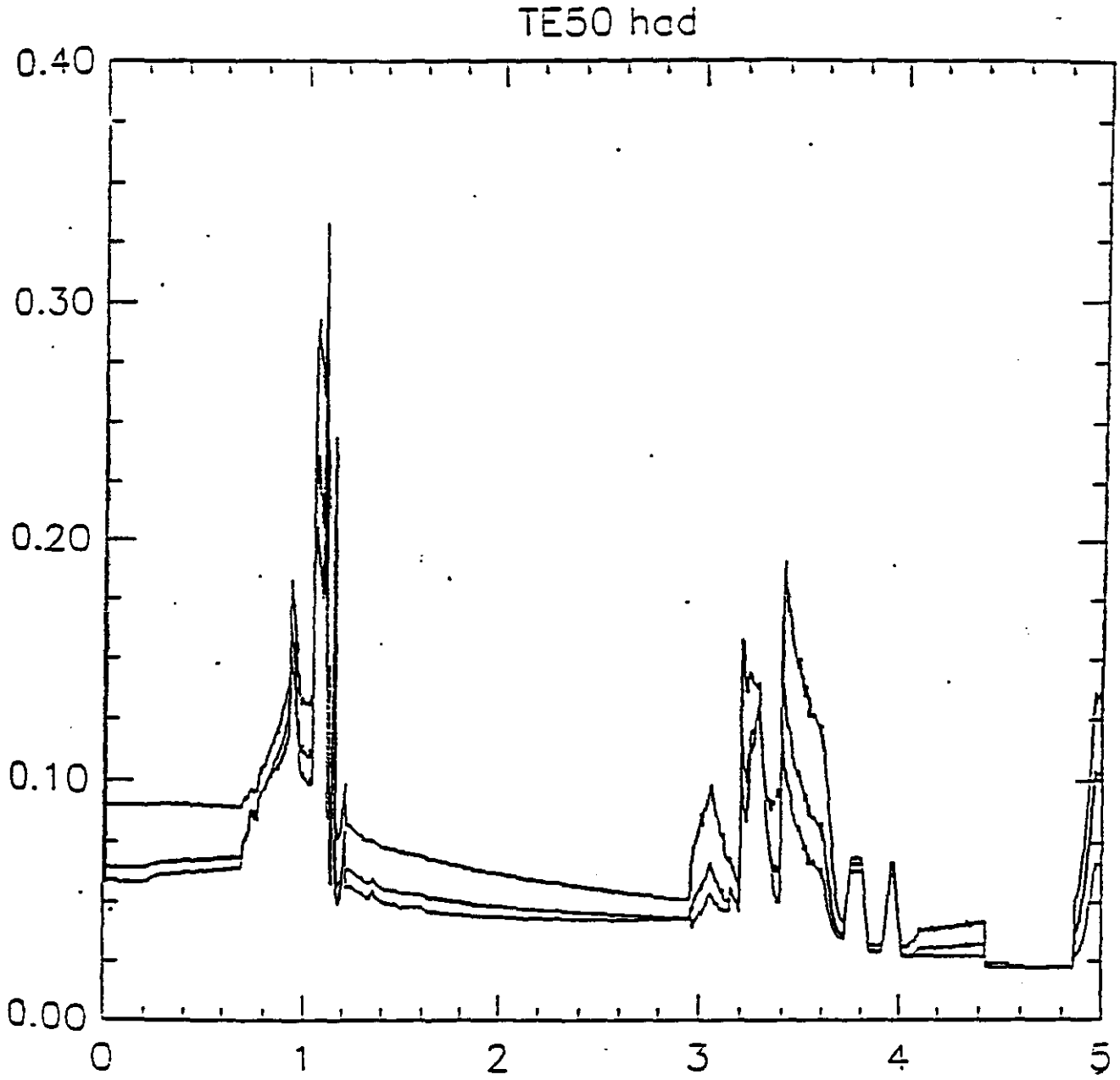


BASELINE

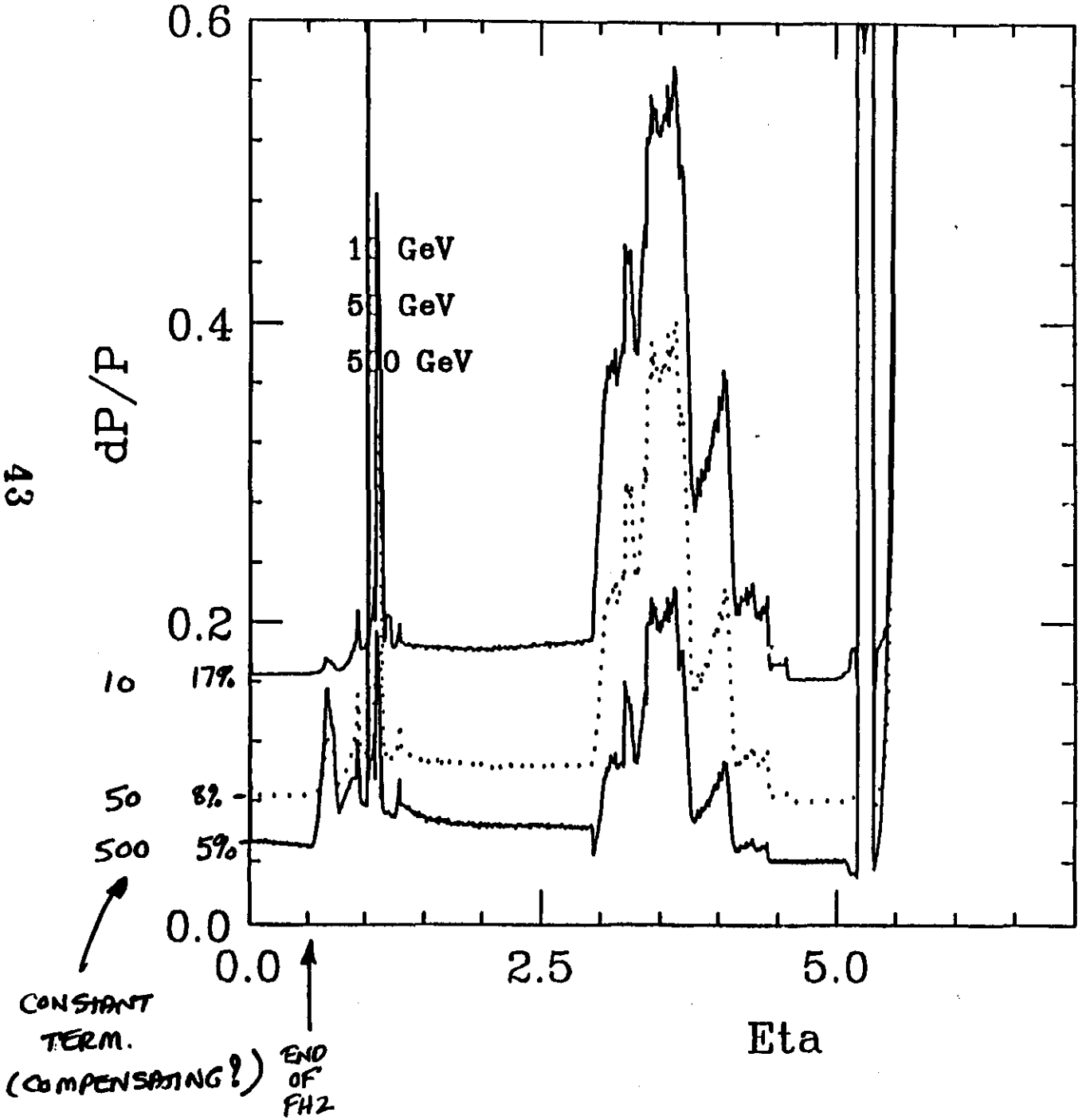
USING FRONT FCAL FOR θ DETERMINATION.

(WILL REQUIRE ANALYSIS.)

EARLIER, FROM
MARTIN-MARIETTA



MM Resolution, No Vertex Smear – Pions



BASELINE, MAR 10, 1993

CONSTANT TERM DUE TO DEAD MATERIALS ~5% ?

UAZMIX CURRENT GEOMETRY.

$\eta = \phi$
NOT FCAL

ENERGY DEPENDENCE STUDIES

NOT CURRENT

WEIGHTING FOR GODOT?

TO LOOK AT THE EFFECTS OF NON-COMPENSATION, ENERGY SCANS AT $\eta = 0$ WERE MADE AT 10, 50, 200 AND 500 GeV WITH (1) PIONS AND (2) JETS.

THE RESULTS FOR PIONS:

	STOCHASTIC TERM	CONSTANT TERM
UNSMEARED		
FULLY COMPENSATING	.29 ± .01	* .021 ± .001
BASELINE II	.39 ± .01	.053 ± .002
COMP HADRONIC	.53 ± .02	.031 ± .002
SMEARED		
FULLY COMPENSATING	.71 ± .02	.011 ± .004
BASELINE II	.64 ± .02	** .058 ± .004
COMP HADRONIC	.74 ± .02	.023 ± .004

COMMENTS

* EXHIBITS SOME FIT INSTABILITY (TRADEOFF IN STOCH/CO

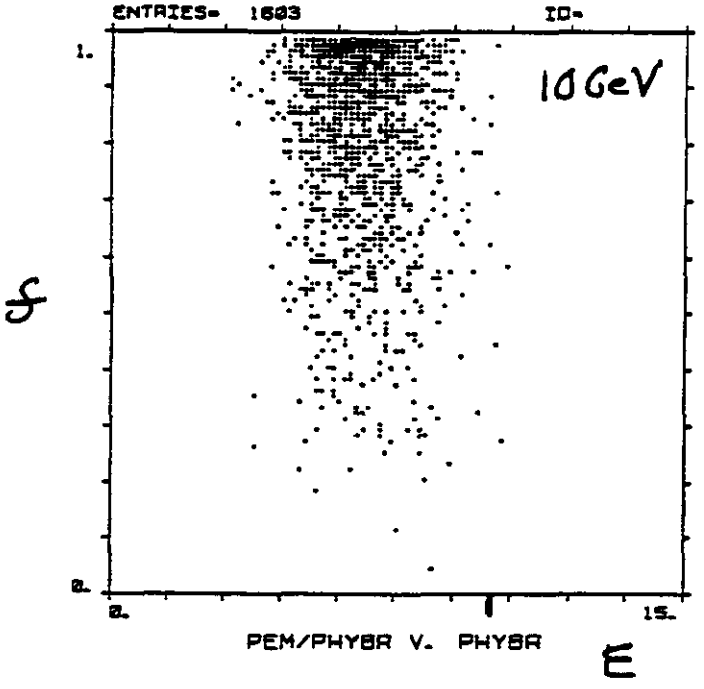
** 6% IS BIG! JET STUDY IS NOT COMPLETE, BUT CORRESPONDING POINT IS 4.5% (BETTER

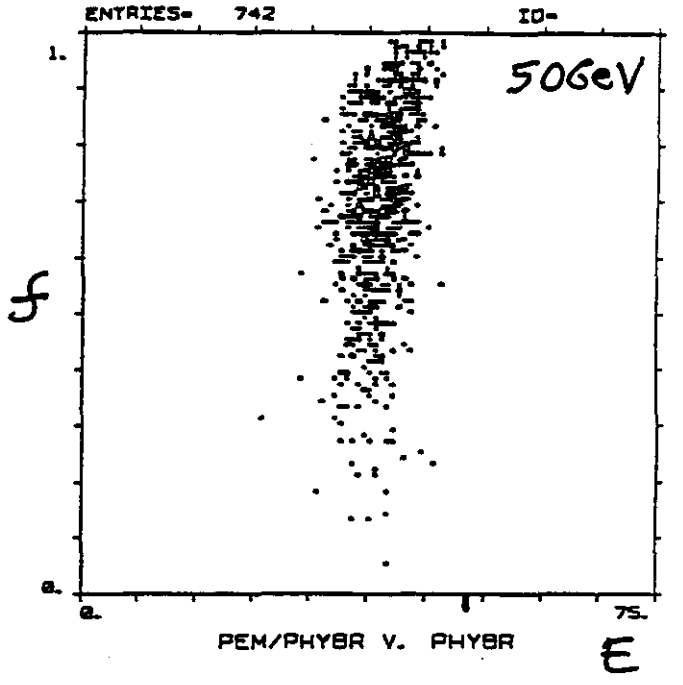
⇒ MAYBE WE WILL NEED TO RELY ON A WEIGHTING SCHEME! UGH.

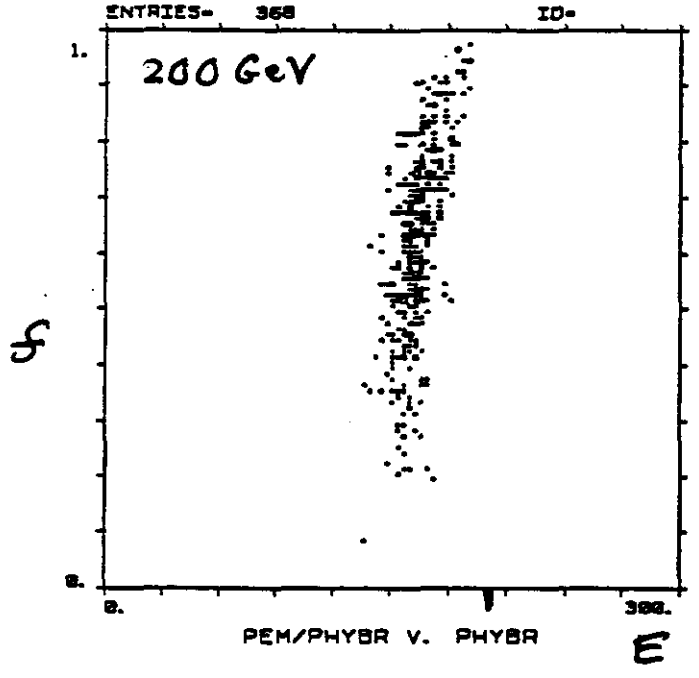
NOT CURRENT

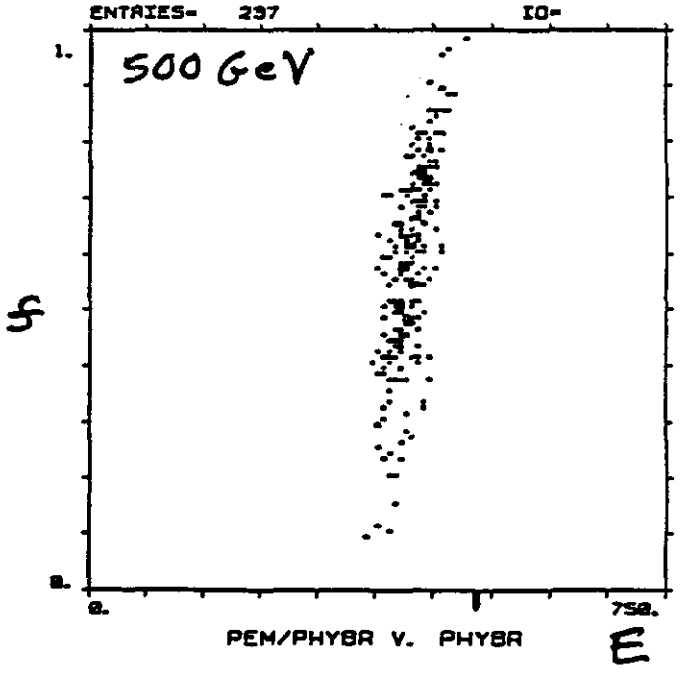
JET ENERGY SCAN AT $\eta = 0$ (JETSET)

BASELINE II HYBRID







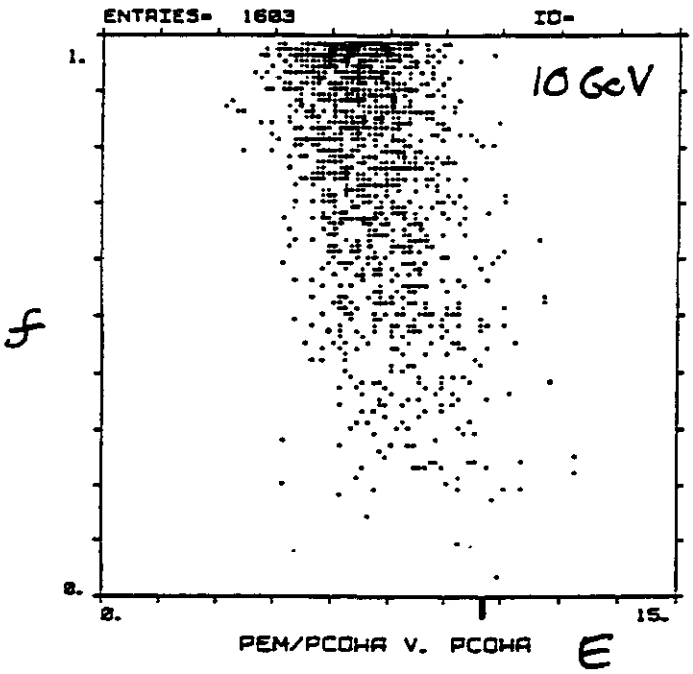


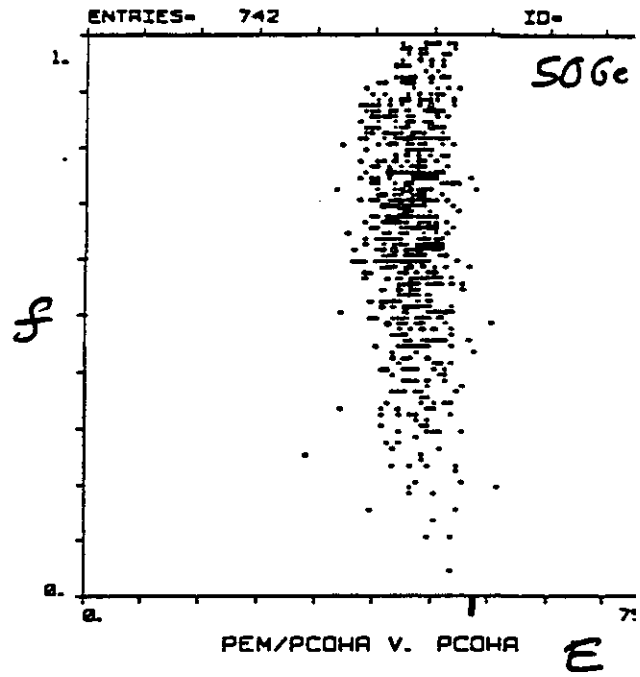
$$f = \frac{\text{ENERGY IN EM SECTION}}{\text{TOTAL ENERGY}}$$

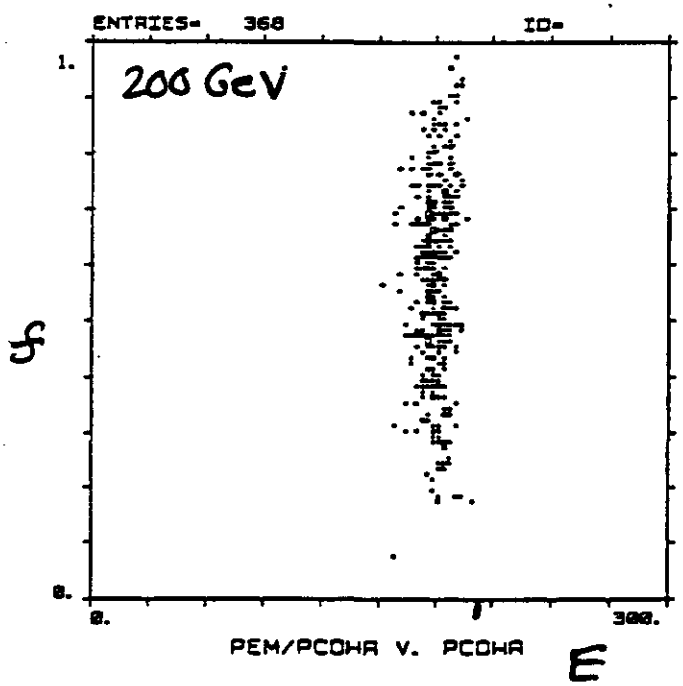
NOT CURRENT

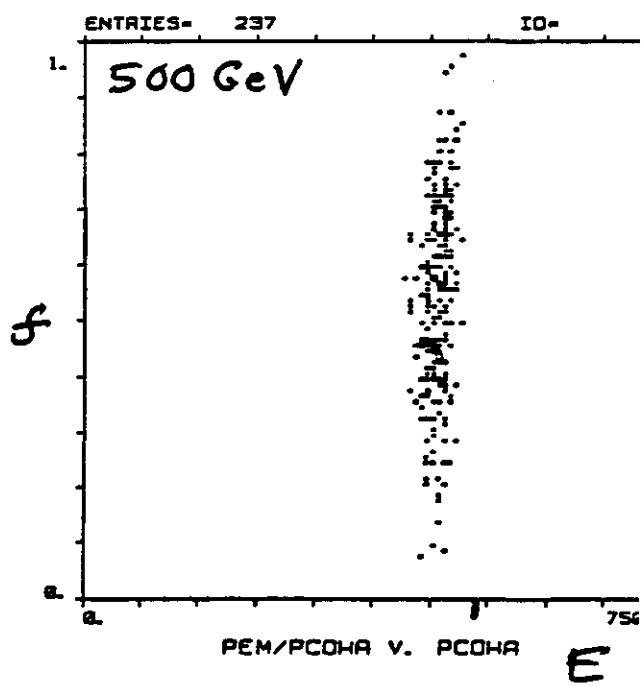
JET ENERGY SCAN AT $\eta = 0$ (JETSET)

ACCORDION EM, FOLLOWED BY COMPENSATING HAD.









WEIGHTING SCHEME CONCLUSIONS:

- OUR CHOICE TO DO PRECISION EM CALORIMETRY HAS GIVEN US AN EM SECTION WITH POOR e/h, AS IT MUST.

- THIS CHOICE, AS WELL AS DEAD MATERIAL FLUCTUATIONS (ETC), LEADS TO A SIZEABLE CONSTANT TERM IN JET RESOLUTION IF NO WEIGHTING SCHEME IS USED.

- TO REDUCE CONSTANT TERM (BY 1%, 2%?) WEIGHTING IS NEEDED WHETHER OR NOT HADRONIC SECTION IS COMPENSATING. (SEE GEM NOTE BY WIGMANS + PAAR)

- RESULTS MAY OR MAY NOT BE LINEAR! (SAME GEM NOTE).

NOTE: WEIGHTING SCHEMES ARE APPLICABLE ONLY TO ISOLATED SHOWERS OR JETS, NOT TO GLOBAL QUANTITIES SUCH AS $\not{E}_T$.
(MODULO FRANK PAIGE'S SCHEME "MINIJETS")

PLANS

1. MAP OUT CURRENT GECM + OPTIONS:
   - (A) π, e
   - (B) 2, 5, 20, 50, 200, 500 GeV
   - (C) $\frac{dp}{p}$, $\frac{dp_T}{p_T}$ etc

2. REDO ENERGY WEIGHTING STUDIES TO UNDERSTAND EFFECTS IN π'S AND JETS:
   - (A) DEAD MATERIALS
   - (B) NON-COMPENSATION
   - (C) HOW MUCH CAN BE REGAINED BY WEIGHTING SCHEMES.

3. JET RESOLUTIONS (SAMPLE?)

4. JET FINDING (f (PILEUP))

5. NEUTRON RUNS ON BASELINE + OPTIONS (GCALOR → CALOR89 IS WORKING IN UAZMIX)

   PYTHIA MINBIAS EVENTS (OTHER?)

gem

γeμ

Presentation by:

Hong Ma

HONG MA
3/16/93

EM Calorimeter Simulation

Pointing: Barrel $\frac{40\,\text{mrad}}{\sqrt{E}} + 0.5 \oplus \frac{40\,\text{mrad}}{E}$

Endcap: Horizontal strips

Average resolution $= \frac{52\,\text{mrad}}{\sqrt{E}} + ?$

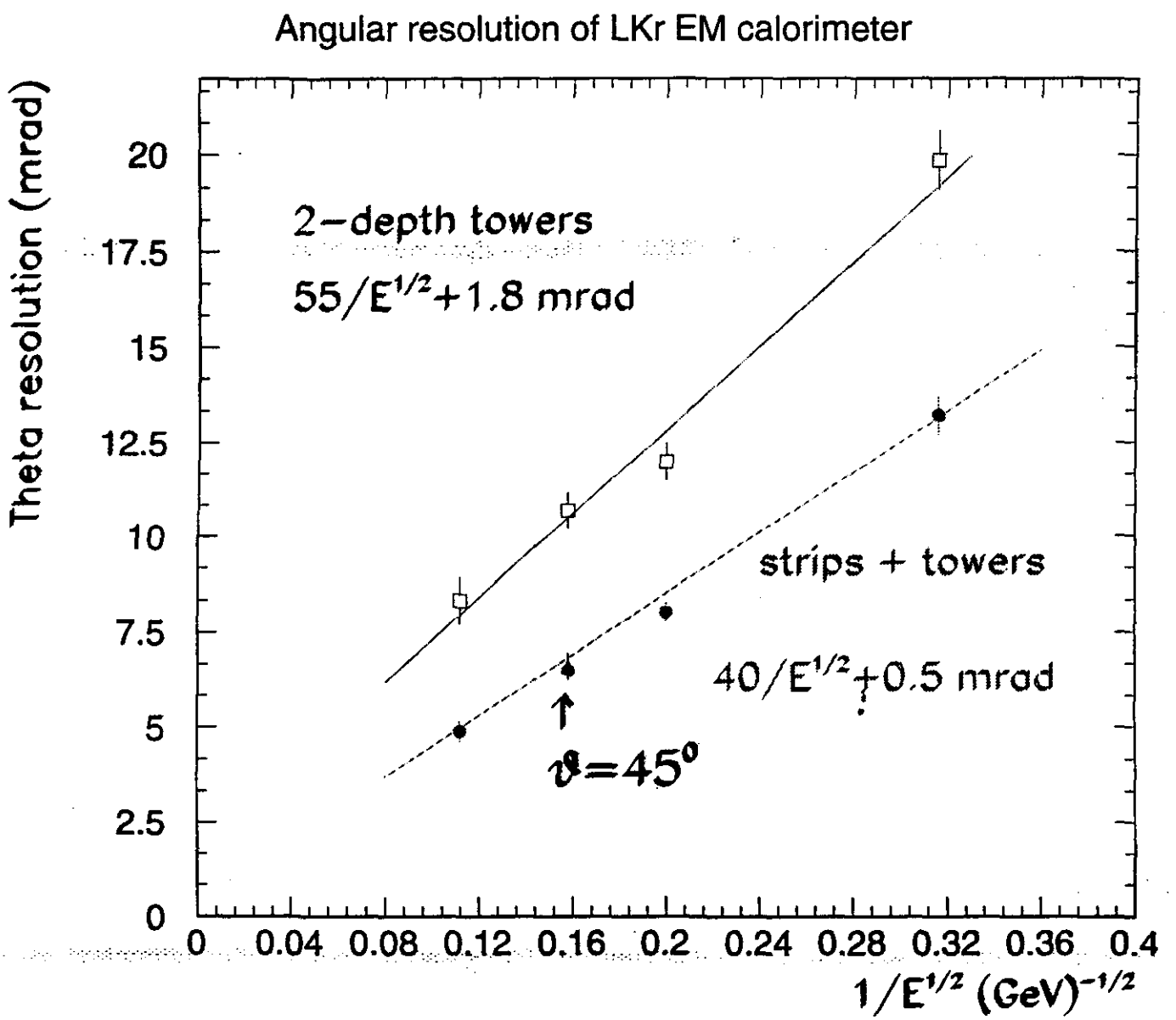
(needs full simulation)

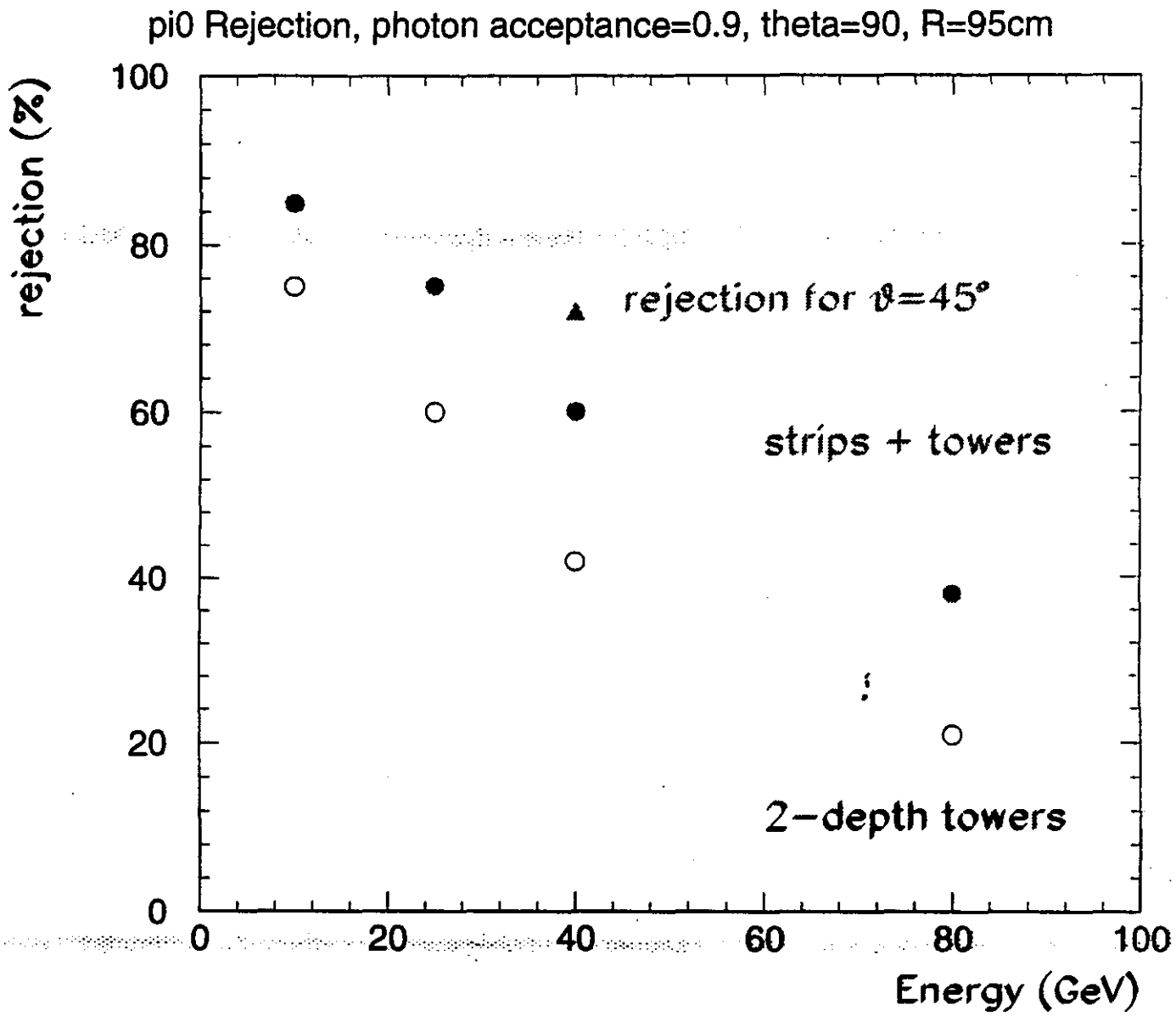
ulti-γ rejection: mphorej (E, η, mass)

mass = mass of the isolated photon candidate

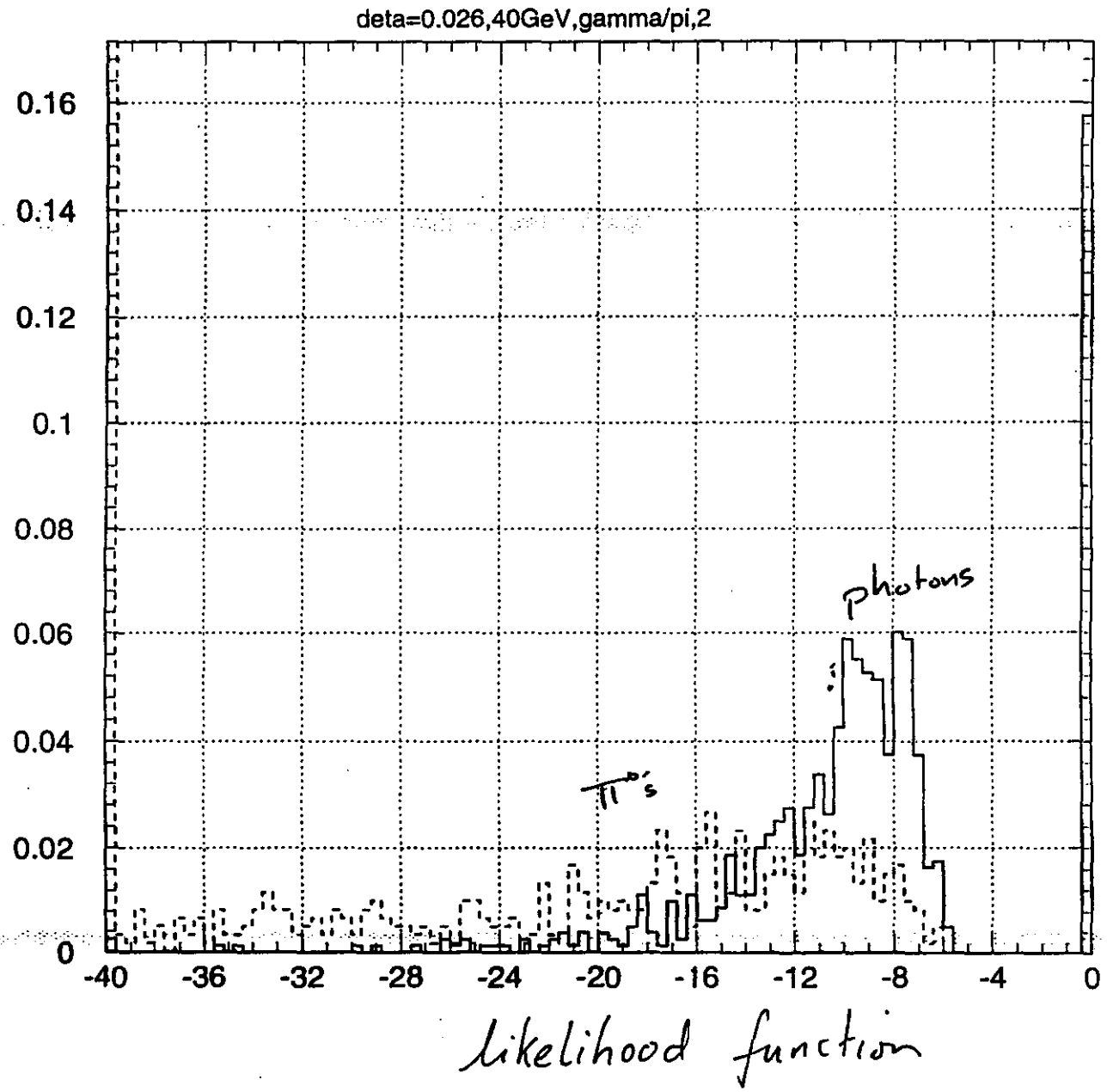
Parametrized rejection gives the same result as the full Geant simulation

A factor of 5 rejection for jet that survived the isolation cut.


Angular resolution of LKr EM calorimeter
Theta resolution (mrad)
20
17.5
15
12.5
10
7.5
5
2.5
0
2−depth towers
55/E^1/2+1.8 mrad
strips + towers
40/E^1/2+0.5 mrad
ϑ=45°
0
0.04
0.08
0.12
0.16
0.2
0.24
0.28
0.32
0.36
0.4
1/E^1/2 (GeV)^−1/2

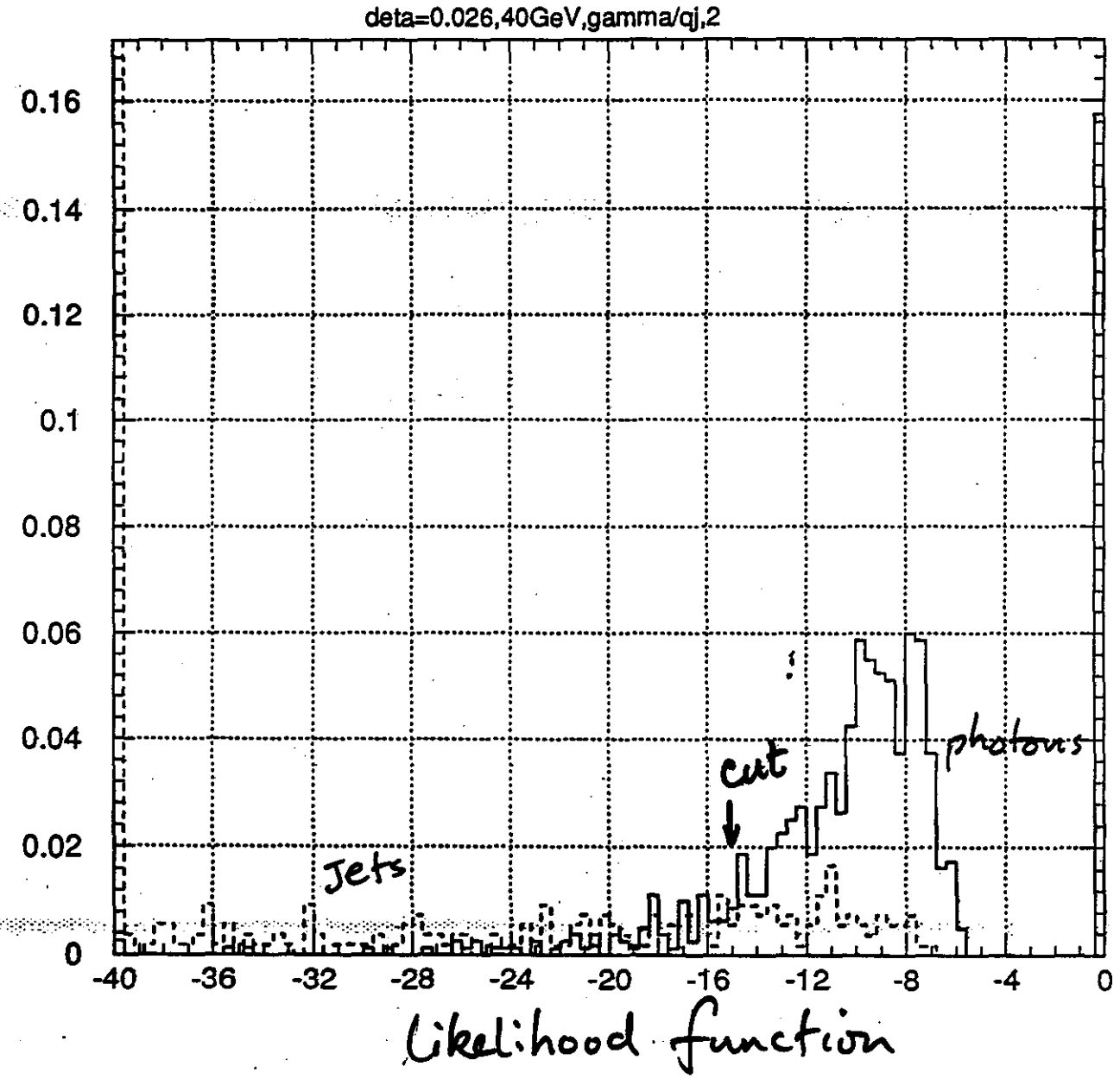

pi0 Rejection, photon acceptance=0.9, theta=90, R=95cm
rejection (%)
100
80
60
40
20
0
0
20
40
60
80
100
Energy (GeV)
rejection for ϑ=45°
strips + towers
2−depth towers

93/03/09 13.42

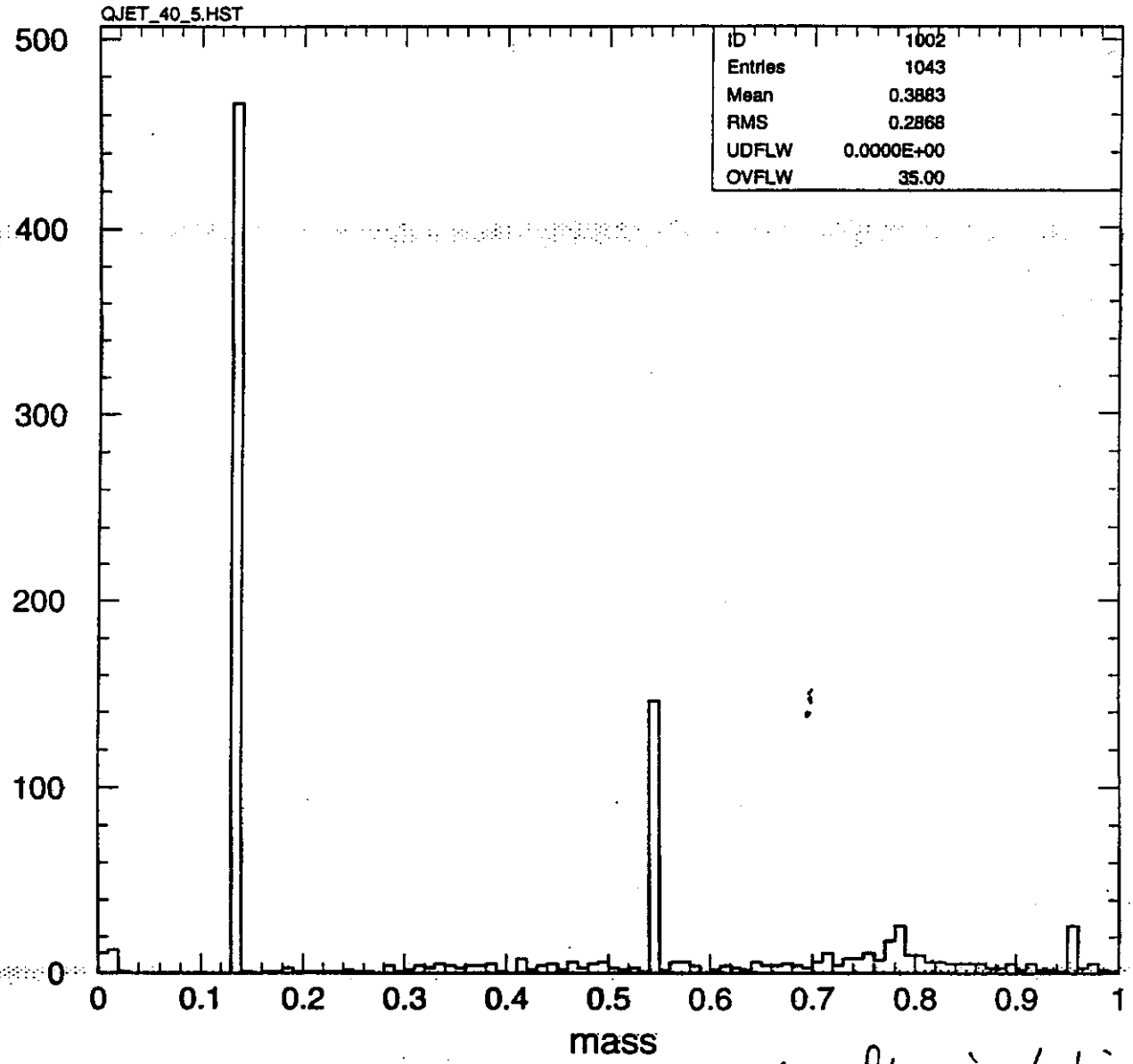

deta=0.026,40GeV,gamma/pi,2
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
-40
-36
-32
-28
-24
-20
-16
-12
-8
-4
0
photons
π⁰'s
likelihood function

$q \to N\gamma$

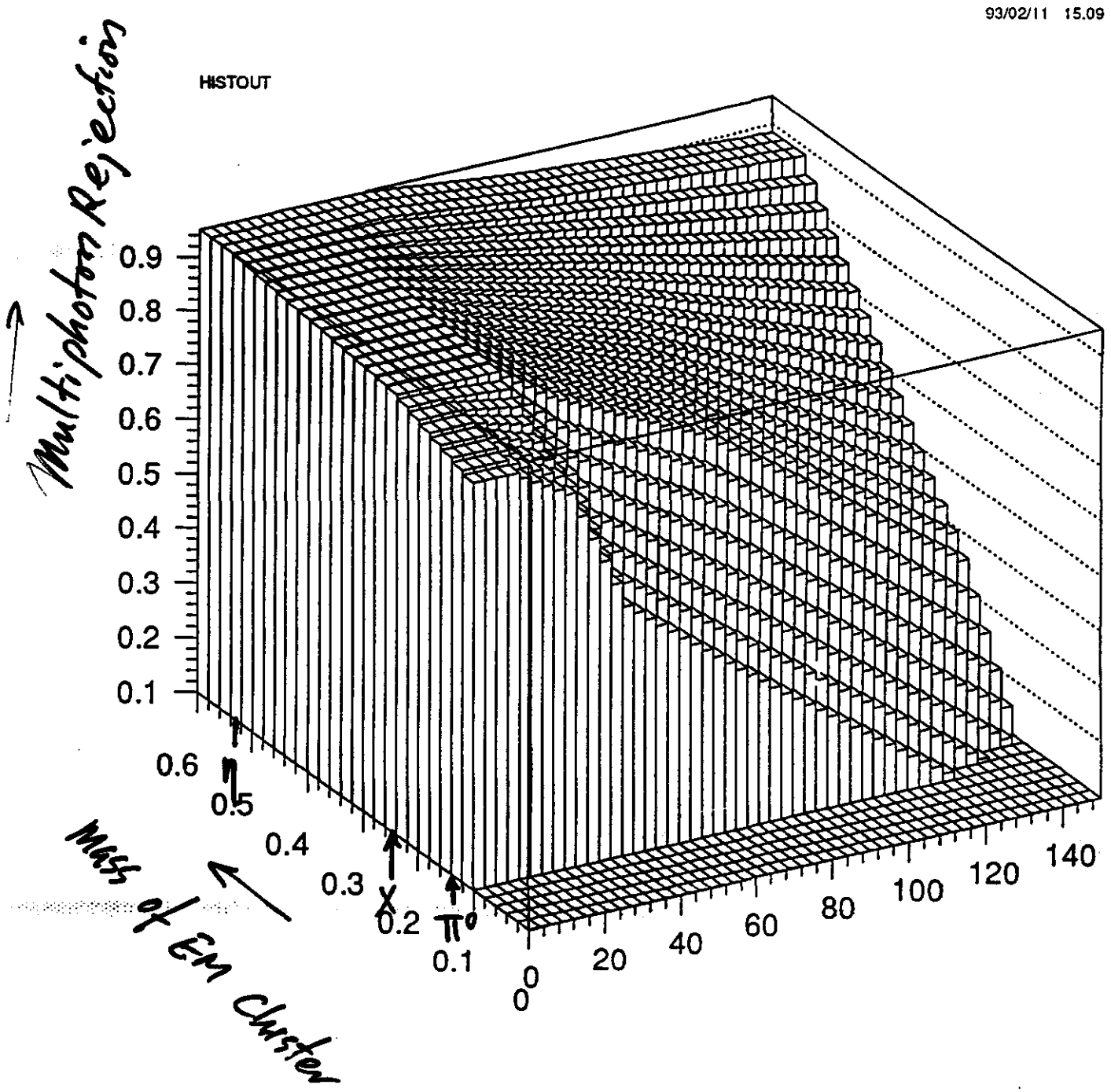
93/02/22 13.24



93/03/09 13.48



jet background after isolation cu



$\pi^0 \to \gamma\gamma$

$X \to \gamma\gamma\gamma$

$\eta \to \gamma\gamma$ (55%)

$\pi^0\pi^0\pi^0$ (45%

pile-up noise

1. changing tower size in Endcaps

optimization : 3x3 sum

faster shaping (20 ns)

Example : $H \to \gamma\gamma$ mass resolution :

Constant noise in E_T	600 MeV
GEMFAST 5x5 Sum	710 MeV
optimized (?)	650 MeV

2. Isolation

$\sigma_{tot} = 3.5$ GeV in $R = 0.45$ cone

with threshold on towers = 0.5 GeV

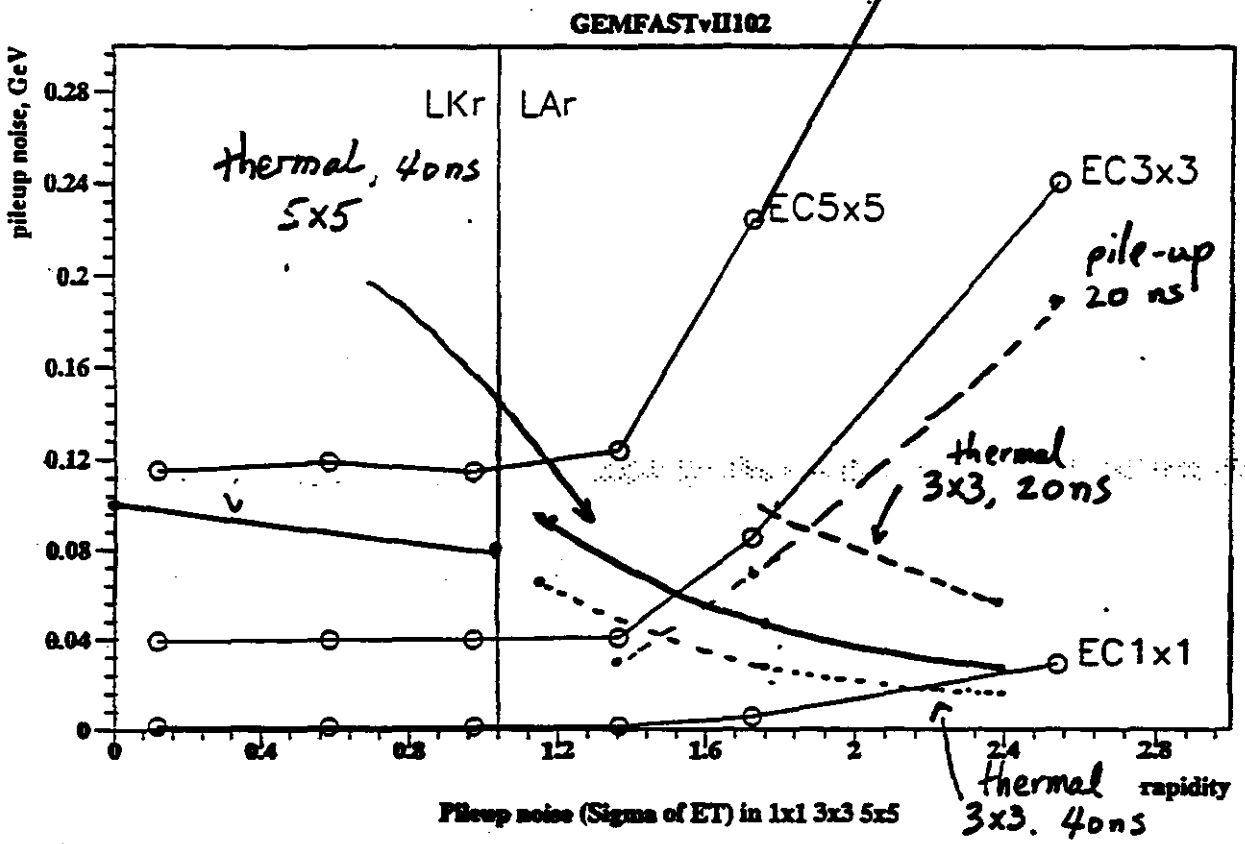
$\sigma_{tot} = 2.2$ GeV

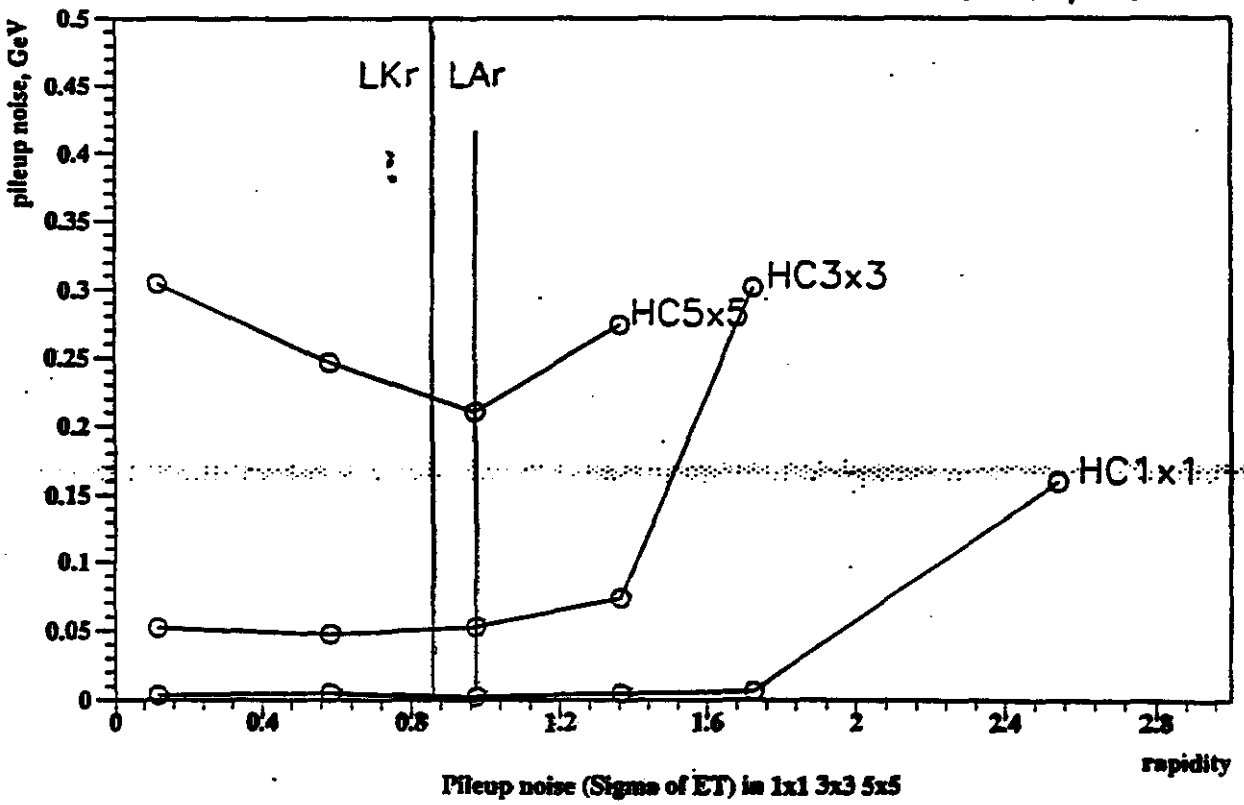
isolation cut = 5 GeV

high Photon Efficiency (95%) may rely on

good timing measurement of clusters.

(Simulations ??)


GEMFASTvII102
pileup noise, GeV
LKr
LAr
thermal, 40ns
5x5
EC5x5
EC3x3
pile-up
20 ns
thermal
3x3, 20ns
EC1x1
thermal
3x3, 40ns
rapidity
Pileup noise (Sigma of ET) in 1x1 3x3 5x5


pileup noise, GeV
LKr
LAr
HC3x3
HC5x5
HC1x1
rapidity
Pileup noise (Sigma of ET) in 1x1 3x3 5x5

Mar 14, 1990.

The Higgs mass resolution at 80 GeV is re-evaluated, taking into ac the tower size change in the endcap and more realistic pile-up noise. The resolution is calculated using GEMFAST, as well as parametrization of t resolution and noise. The parametrizations, in addition to what are used in GEMFAST, includes the following items:

1) The pile-up noise in 5x5 towers parameterized as
120+366*(eta-.14) MeV
and for 3x3 towers
40+181.8*(eta-.14) MeV
based on Sasha's study.

2) shaping time of 20 ns for towers above eta=1.8 is considered. The therm noise is increased by a factor of 2.83, and the pile-up noise is decreased b a factor of 0.8, compared to 40 ns shaping time.

3) Resolution of 3x3 tower is assumed to be 15% worse than that of 5x5 tower

Mass resolution (MeV)	tool	eta cut	other assumptions
550	GEMFAST	2.5	two photon only, no noise
715	GEMFAST	2.5	with all noises, 5x5 towers
615	GEMFAST	1.0	"
654	GEMFAST	1.5	"
674	GEMFAST	2.0	"
540	PARAM	2.5	two photons only, no noise
713	PARAM	2.5	all noises, 5x5 tower
619	PARAM	1.0	"
641	PARAM	1.5	"
669	PARAM	2.0	"

From the above table, it is clear that by taking into account the proper pile-up noise, parameterization gives identically the same resolution as GEMFAST. The mass resolution given by GEMFAST simulation is fully understood. Since GEMFAST lacks a reliable 3x3 tower resolution, I have to use the parameterization for the further optimization, as shown in t following table.

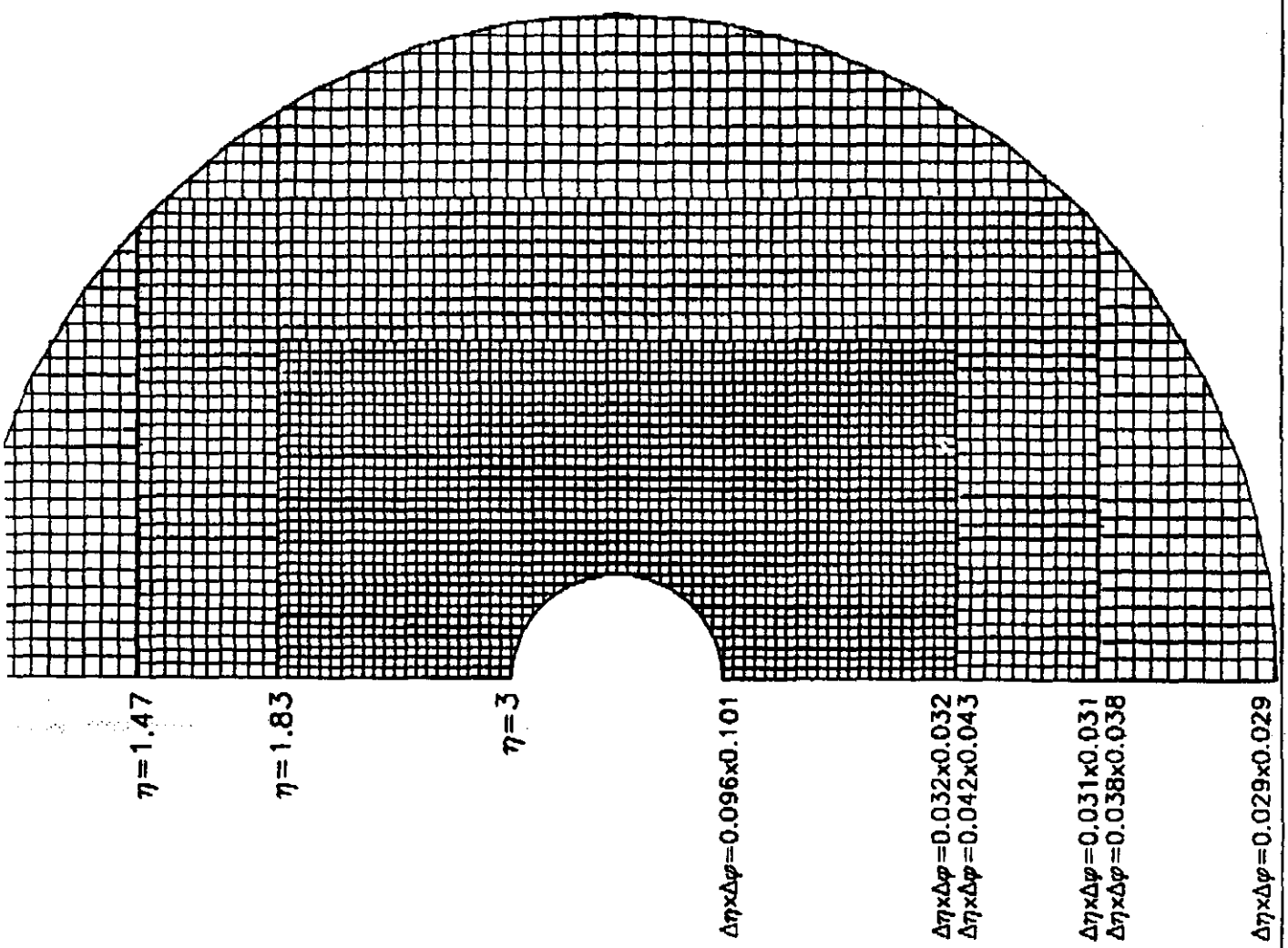
(eta_3x3 is defined as the eta above which 3x3 towers are used, tp is the shaping time above eta=1.8)

Mass resolution	tool	eta_3x3	tp (ns)	other assumption
713	PARAM	2.5	40	
688	PARAM	1.1	40	
677	PARAM	1.7	40	
666	PARAM	1.7	20	
657	PARAM	1.7	20	E-reso in endcap =8.0%/s and 0.4% const
647	PARAM	1.7	20	E-reso in endcap =7.5%/s and 0.4% const

noise contribution : $\sqrt{666^2 - 540^2} = 390$ MeV

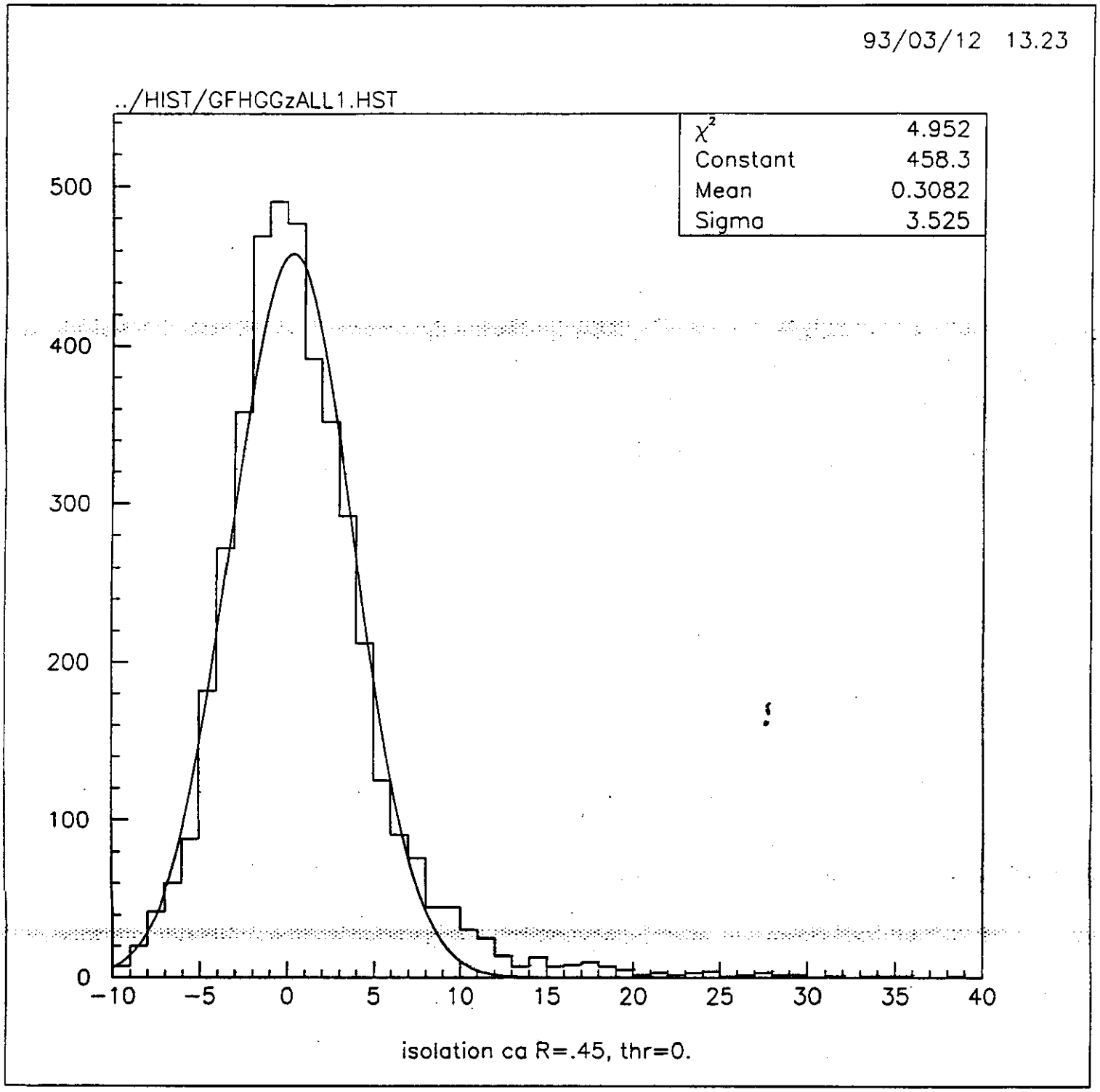
VER. 8.

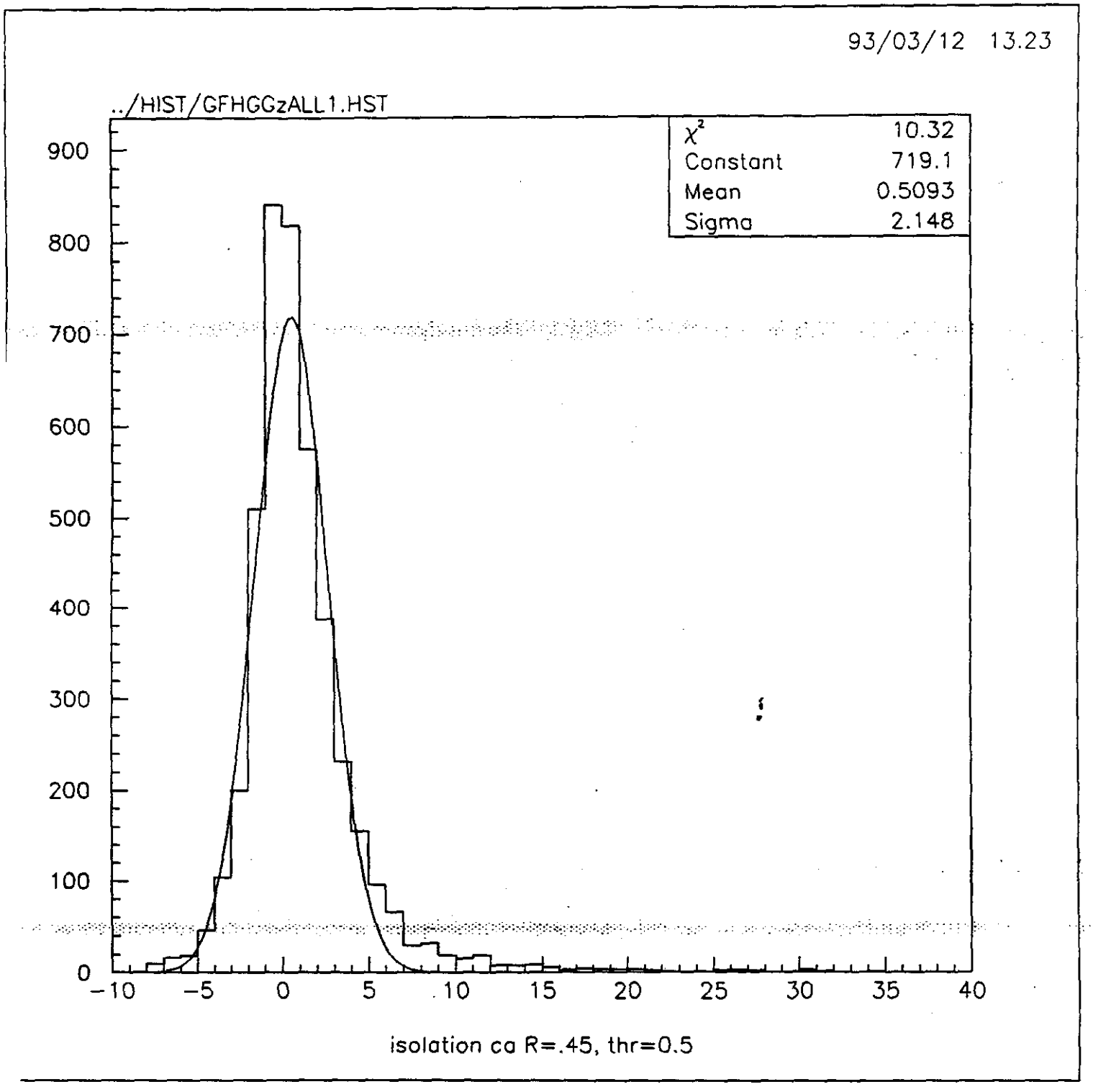
TOWERS IN GEM EM ENDCAP

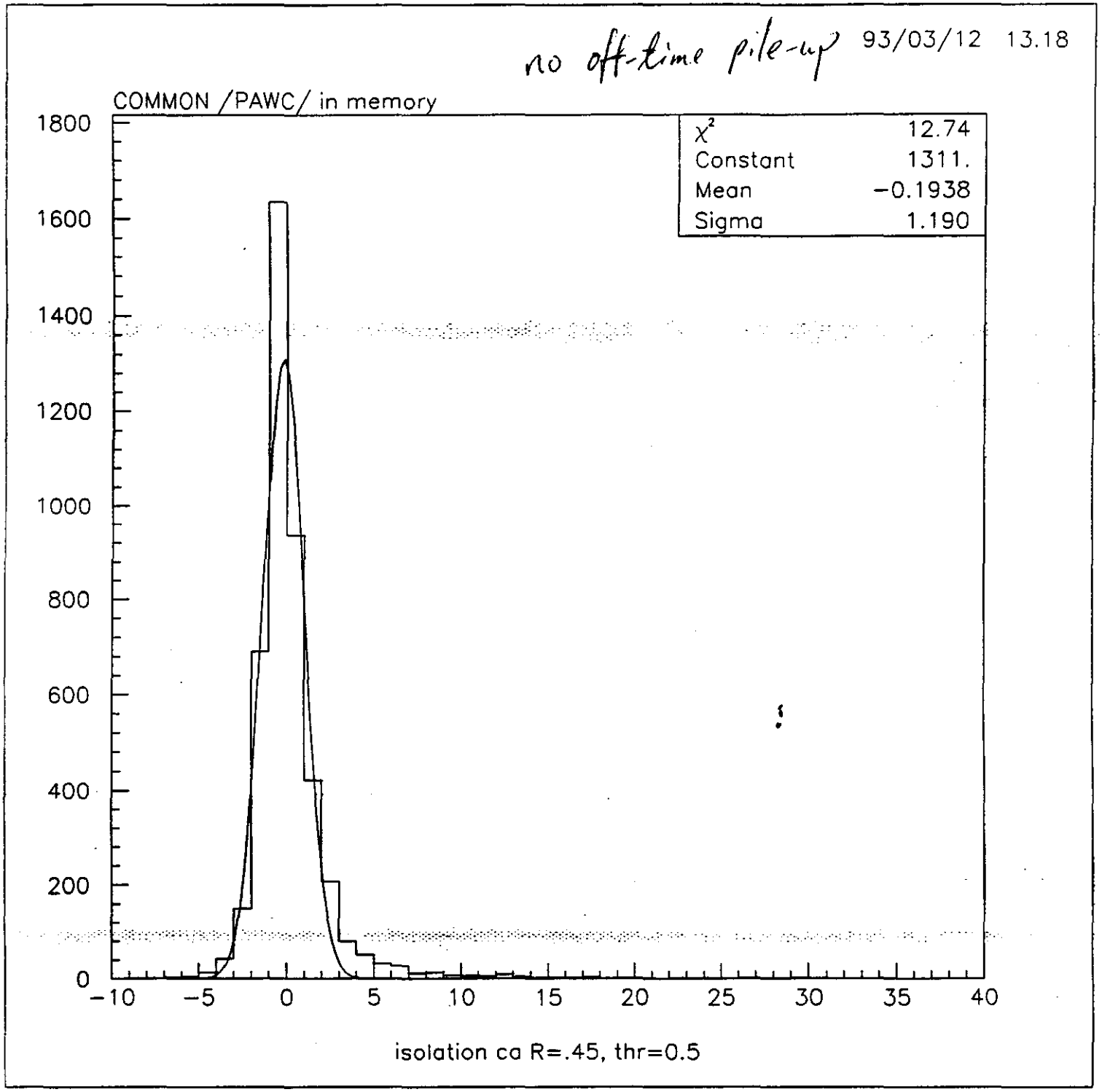


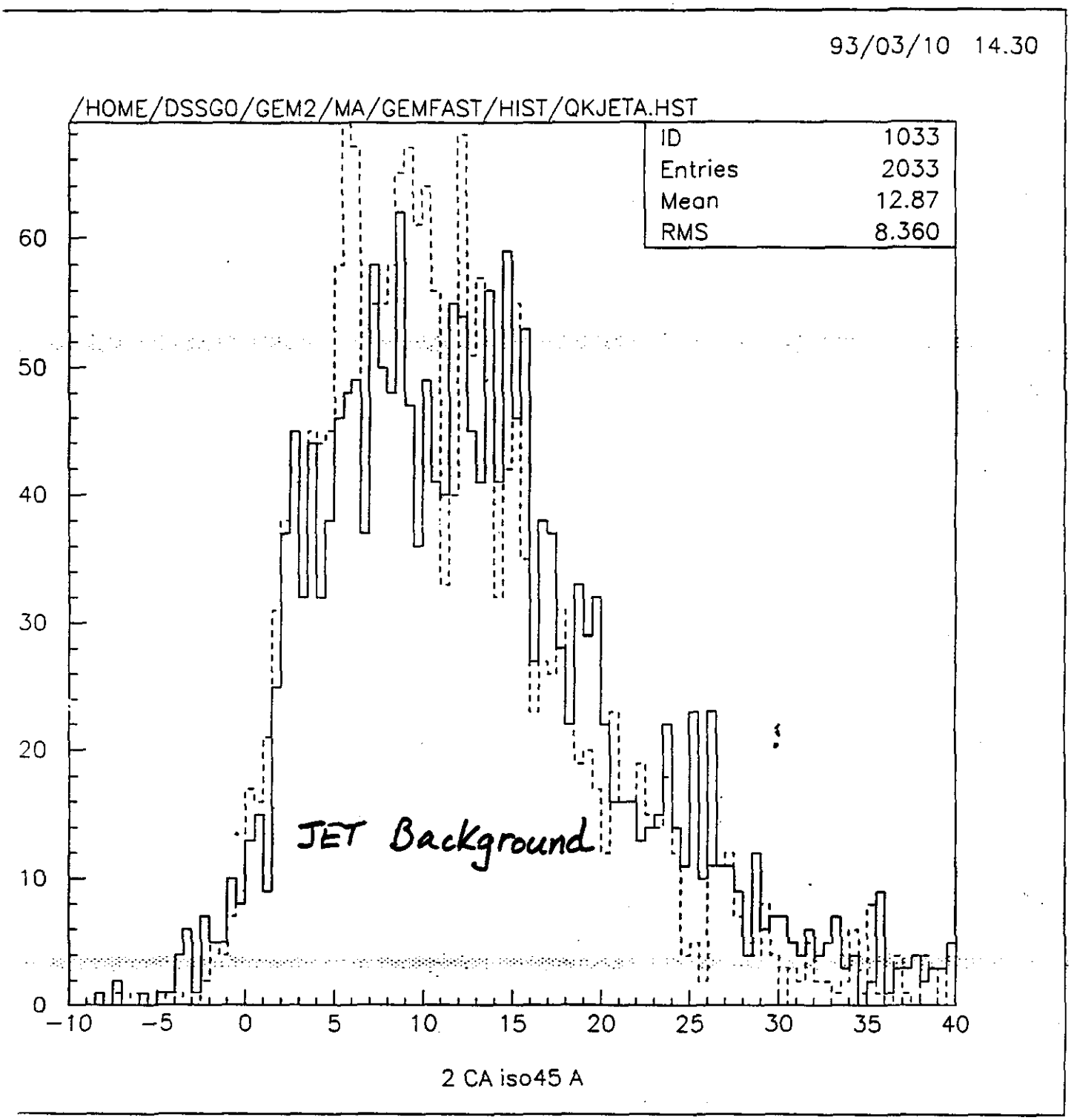
Number complete towers = 44160
Number of incomplete towers = 1128
XIMAL NUMBER OF CHANNELS = 45288
oth endcaps with 3 long. div.)

3 cells/tower
4 cells/tower
5 cells/tower


93/03/12 13.23
../HIST/GFHGGzALL1.HST
χ² 4.952
Constant 458.3
Mean 0.3082
Sigma 3.525
500
400
300
200
100
0
−10
−5
0
5
10
15
20
25
30
35
40
isolation ca R=.45, thr=0.


93/03/12 13.23
../HIST/GFHGGzALL1.HST
χ² 10.32
Constant 719.1
Mean 0.5093
Sigma 2.148
900
800
700
600
500
400
300
200
100
0
−10
−5
0
5
10
15
20
25
30
35
40
isolation ca R=.45, thr=0.5


no off-time pile-up
93/03/12 13.18
COMMON /PAWC/ in memory
χ^2 12.74
Constant 1311.
Mean −0.1938
Sigma 1.190
1800
1600
1400
1200
1000
800
600
400
200
0
−10
−5
0
5
10
15
20
25
30
35
40
isolation ca R=.45, thr=0.5


93/03/10 14.30
/HOME/DSSGO/GEM2/MA/GEMFAST/HIST/QKJETA.HST
ID 1033
Entries 2033
Mean 12.87
RMS 8.360
JET Background
2 CA iso45 A

From: NEVIS6::LELTCHOUK 16-MAR-1993 09:45:56.71
To: SSCVX1::WOMERSLEY
CC:
Subj: Nevis status

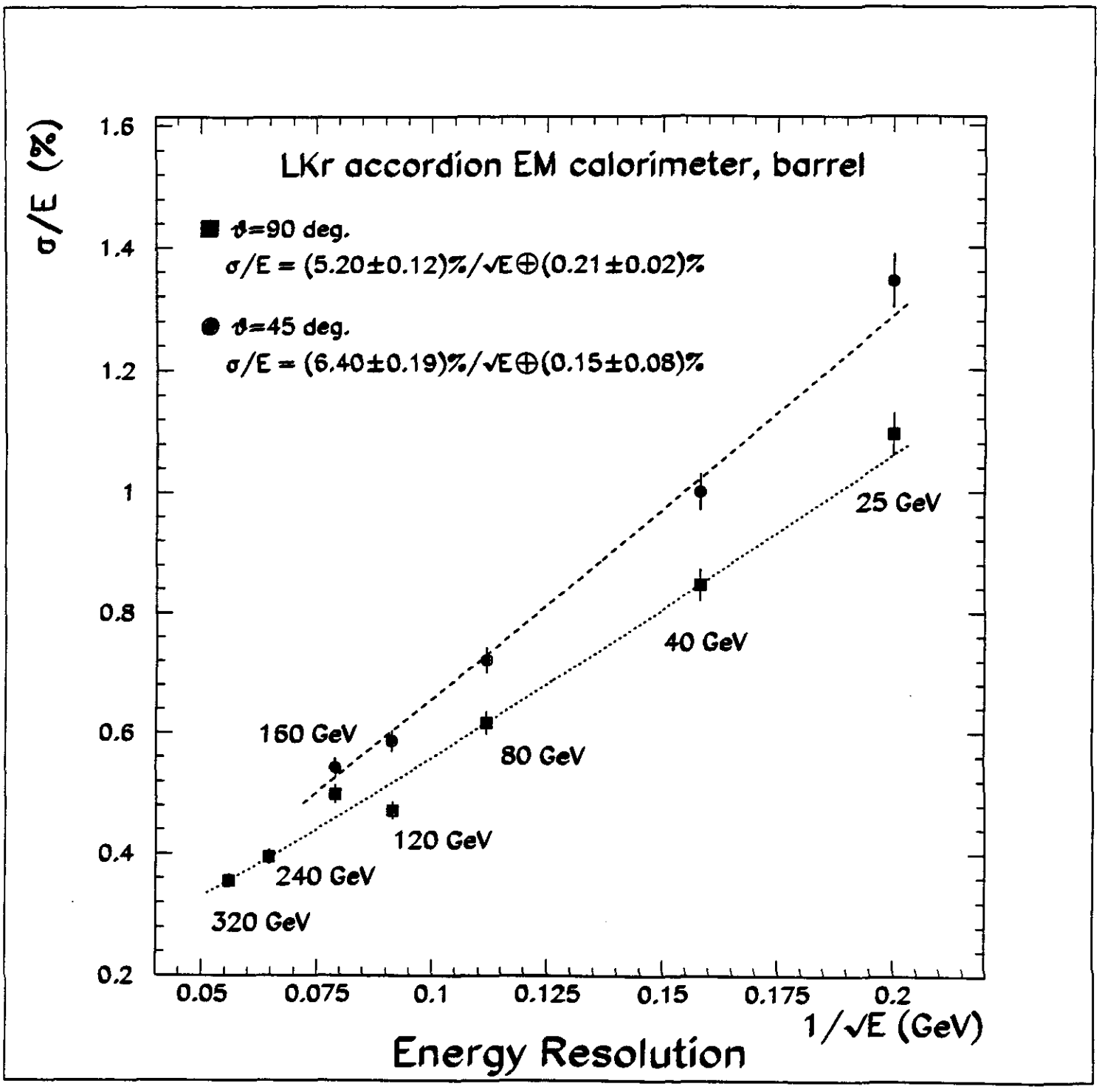
Dear John,
These are a few words to summarize the status of our recent work at Nevis (Columbia University).
M.Seman and I are working on detailed simulations and design of EM calorimeter.

1) I'll send you in next message a postscript file (paw.metafile) with our results on energy resolution in the barrel. Here we used energy, deposited in first section of fine hadronic LKr calorimeter, for leakage corrections at 160, 240, 320 GeV.

2) We discussed with Hong Ma my last results on pi0-rejection. He'll present our combined results.

3) M.Seman has a lot of progress in the endcap design.

Best regards, Mikhail



Energy Resolution

From: ORPH01::SHMAKOV 15-MAR-1993 21:11:22.51
To: SSCVX1::WOMERSLEY
CC: SHMAKOV
Subj: Tuesday meeting

Dear John,

I would rather go Dallas for this simulation meeting, but unfortunatelly I got a cold and can't go (we used to drive).

Simulation of the energy resolution of Scintillator barrel calorimeter and overall system was originally done by Sasha Savin. He used q-jets (with normalized energy) at 90deg and weighting procedure to minimize resolution (rms) of the overall calorimeter response and to keep linearity. (Though after minimization resolution is from sigma, not rms). This results was published in Boston's january meeting GEM note.
Now as I know he is doing at different angles, not only 90deg.
Missing Et study was done by me (published as GEM note in February) and now I am trying to check the resolution by tuning GEANT to different experimental data - BNL 91 Pb/LAr test, H1 test (very similar to us!) with gas chambers tailcatcher. As you know GEANT is usually not predicting e/pi good enough. Sasha Savin was using default GHEISHA. After justification (may be tuning) what GEANT is doing well with existing experimental data I am going to repeat Sasha's procedure for GEM resolution.

All this have to be finished before TDR (probabelly mid. of April) and published as GEM note (the number is reserved already).

Sincerely Yours
Kostya

From: ORPH01::SAVIN 10-MAR-1993 15:29:56.34
To: KAMYSHKOV,SSCVX1::WOMERSLEY
CC:
Subj:

Dear John!

Unfortunately, status of detailed simulation of OVERALL system resolution is on the same place where it was in the beginning of Febriary. As you know, i got my results as argument for TailCatcher instrumentation & optimization. Those results were reported, and GEM TN should be written.

If to speak about OVERALL system, one need some completed design with wall thicknesses, walls location, realistic estimation of dead material and so on. Now i have quite fresh numbers for wall thicknesses, but i don't know exact positions walls in crack region . I asked Hong Ma about it, and he send me one drawing, but it again has no NUMBERS for crack and walls in it.

As you mentioned in your mail about Calorimeter Status, this region is most 'interesting' to understand. I confirm, but for this understanding it is necessary to know all details of design. In opposit case any simulation should be shallow and results will have no 'weight' after any change in design. Optimization of design is so large job (not only in man power, but in CPU time & Disk Space too) that it is possible to do in 5-6 months, hardly less.

Now i try to write some 'flexible' geometry which may be easely changed using few 'key' sizes. This is the only reasonable way now, but requare more time than operation with fixed design.

Moreover, i was completely busy last 2 months by final optimization of Tail Catcher, preperation results for TDR and intensive study of Forward Calorimeter options (here i try now to reconstruct jet Pt in axial fibers system).

I don't plan to visit this meeting. We try to send to meetings now as small groop as possible because we soon may be out of money. K.Shmakov, Yu.Efremenko and Yu.Kamyshkov will be there, and some questions you can discuss with them.

Best Regards. Sasha

gem

γeμ

Presentation by:

A. Vanyashin

A. Vanyashin
March 16, 19[illegible]

pileup noise in GEM
liquid ionization Calorimeter

1. B. Cleland estimates
2. GEMFAST / GFLASH results
3. effect of 40 ns → 20 ns in the endcap.
4. optimization of HC shaping time

Corpus Christy Conf.

W. E. Cleland and E. G. Stern

PILEUP NOISE

The number of events of type i per crossing (in time $T_c = 16$ ns) is:

$$\overline{n_i} = \mathcal{L} T \sigma_i$$

These give rise to a transverse energy deposition in a calorimeter cell, whose variance is:

$$\rho_p^2 = \frac{\sum_i E_i^2}{n} - \frac{(\sum_i E_i)^2}{n^2},$$

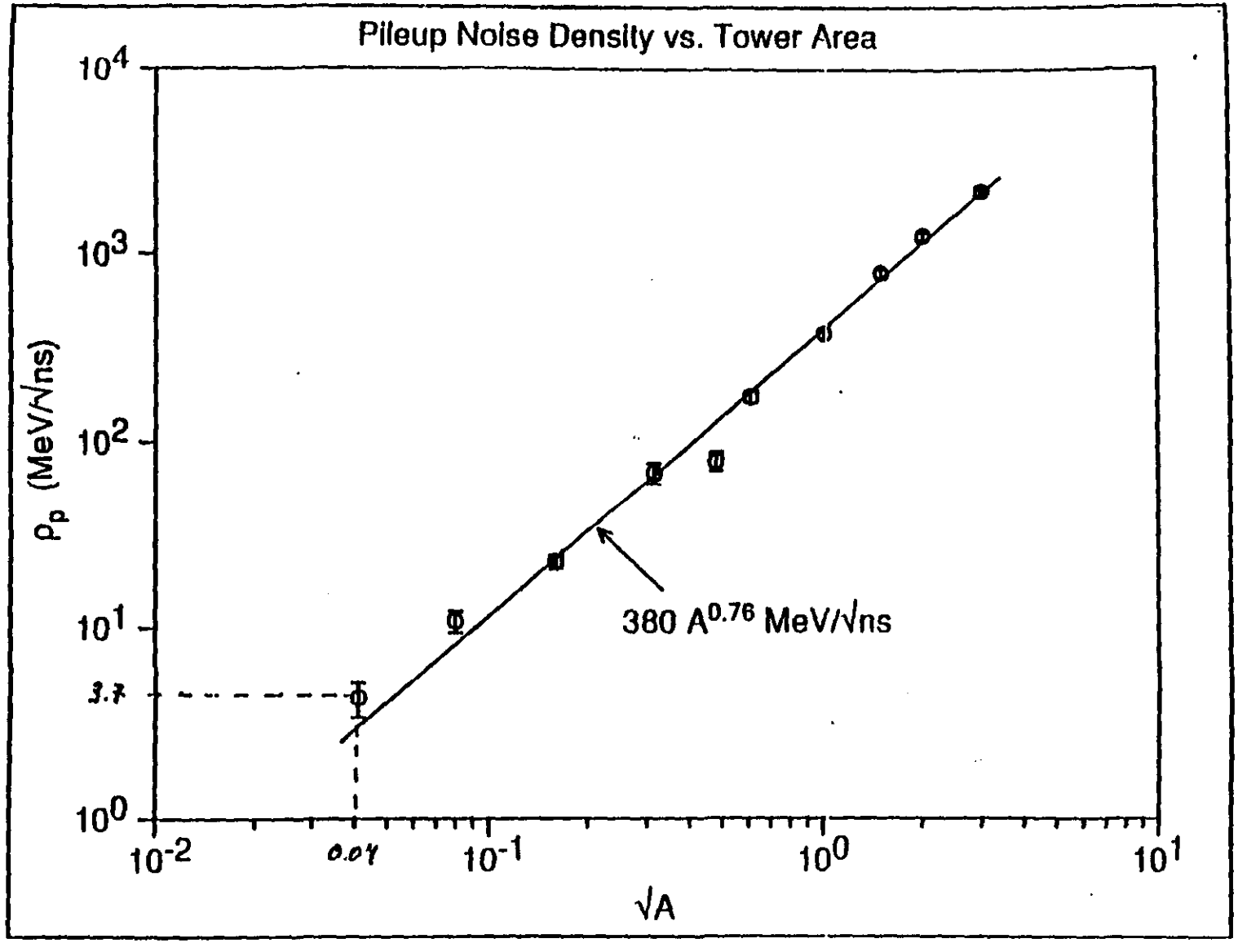
The "pileup noise density" ρ_p is defined by:

$$\sigma_p^2 = \rho_p^2 T_c \sum_{i=-\infty}^{\infty} g^2(t_i) = \rho_p^2 S_p$$

We have evaluated ρ_p for minimum bias and two-jet events using QFL/ISAJET in a spherical calorimeter:

$$\boxed{\rho_p = 380(\Delta\eta\Delta\phi)^{0.76}\sqrt{\frac{\mathcal{L}}{\mathcal{L}_0}}\,\mathrm{MeV}/\sqrt{\mathrm{ns}}}$$

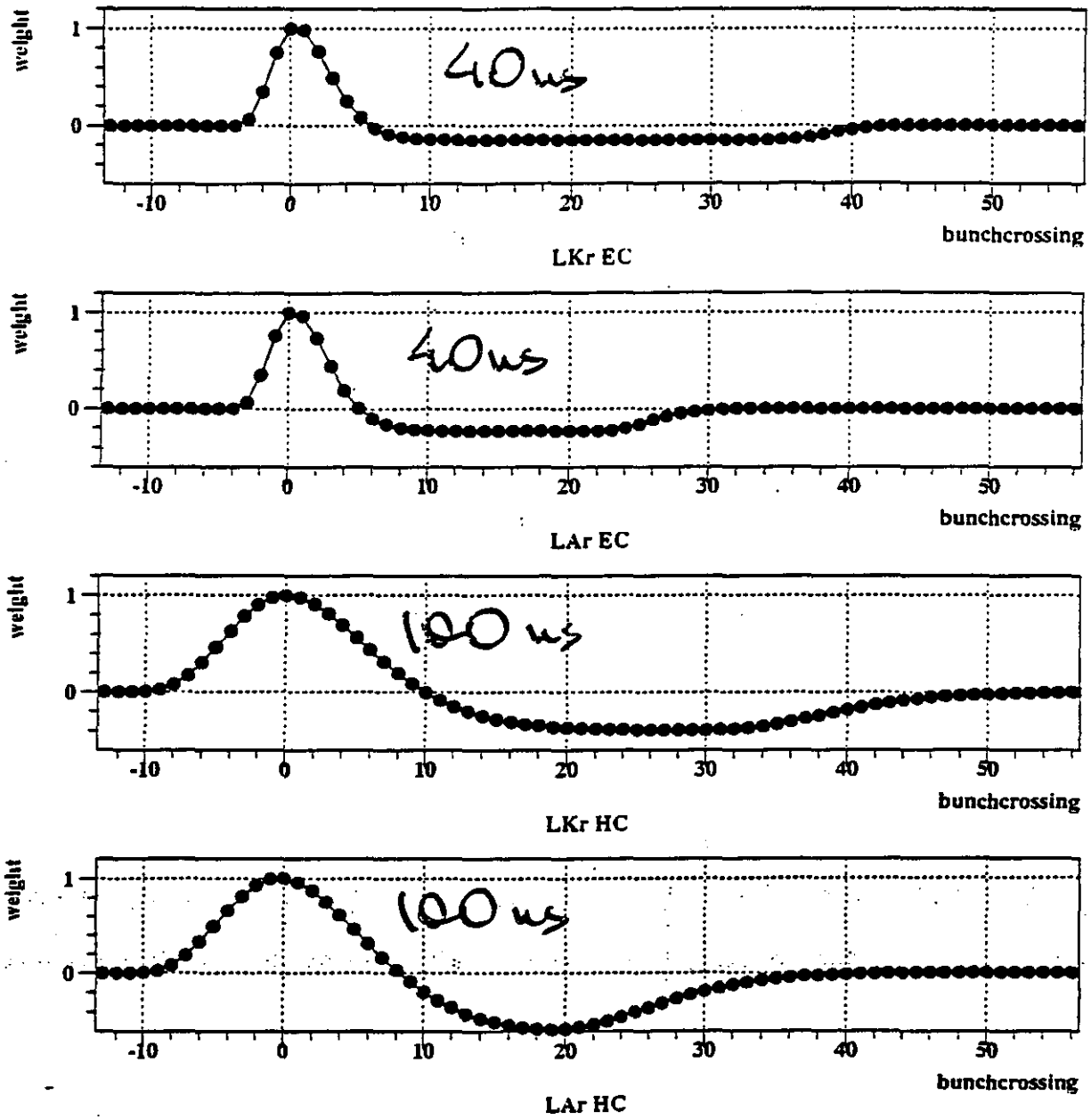
Luminosity dependence →


Pileup Noise Density vs. Tower Area
10^4
10^3
10^2
10^1
3.7
10^0
ρ_p (MeV/√ns)
10^{-2}
0.04
10^{-1}
10^0
10^1
√A
380 $A^{0.76}$ MeV/√ns

measurement time :

CD2 - RC6

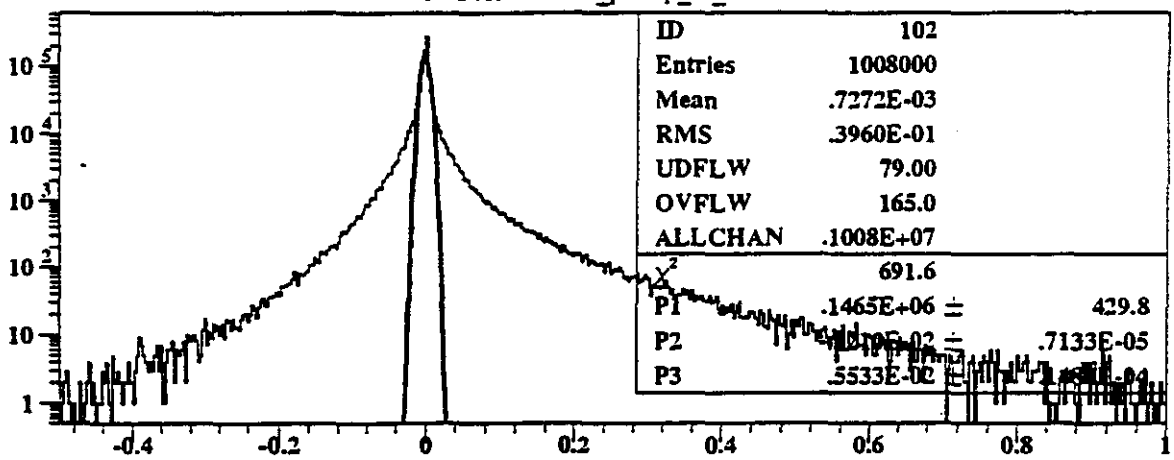
93/01/20 11.00



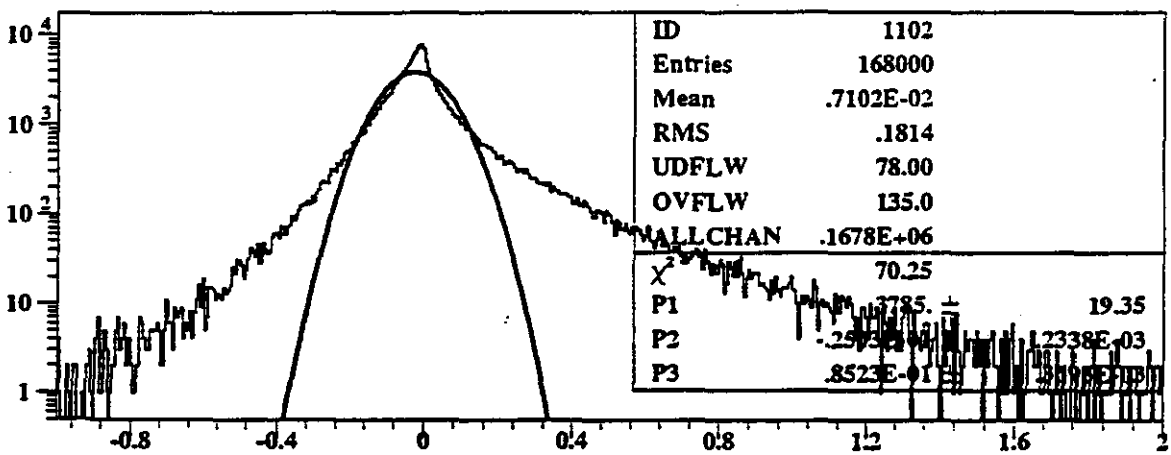
Pileup noise is non-gaussian

93/03/08 12.52

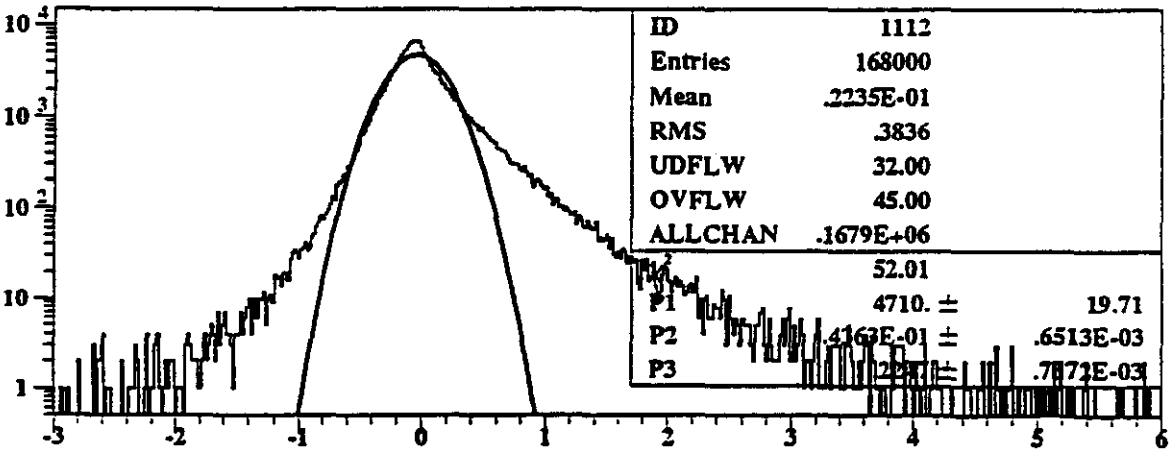
GEMFASTvII102_pileup_at_Y=1.7265



EC Cell



EC 9

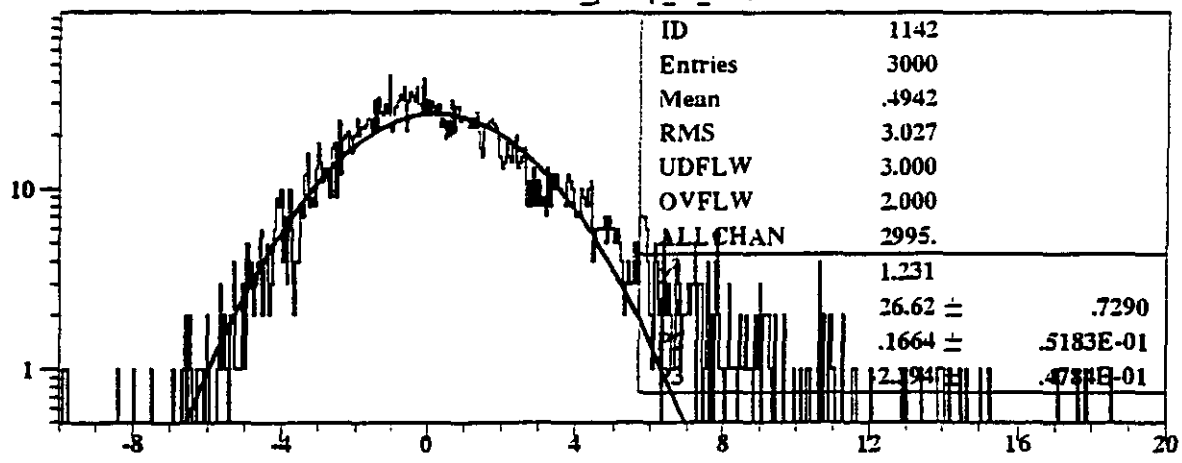


EC 25

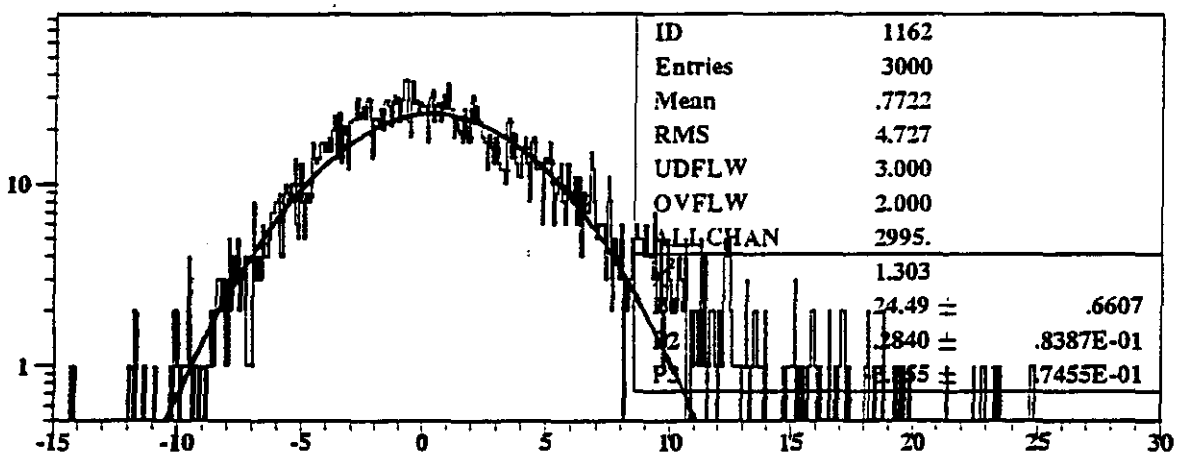
Pileup noise became more gaussian in large cones

93/03/08 13.12

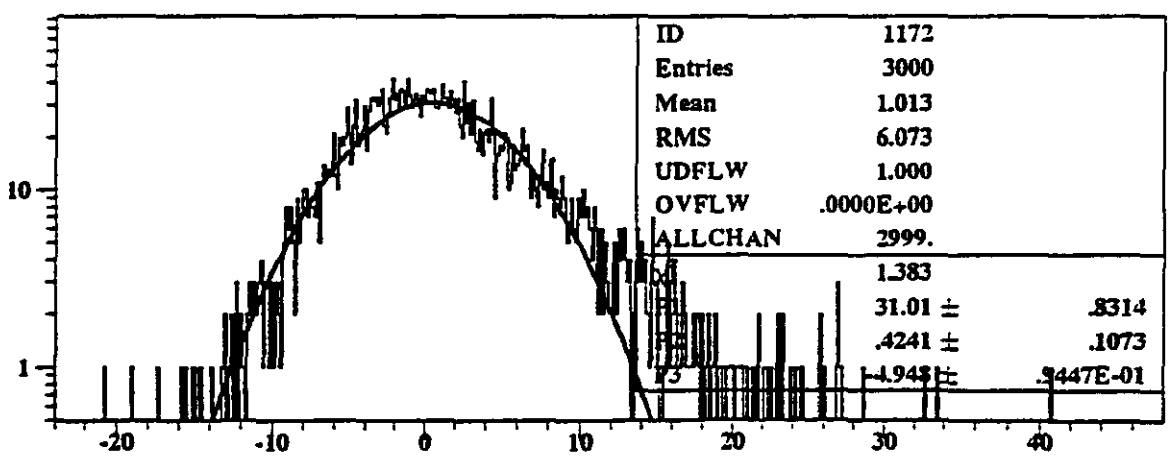
GEMFASTvII_pileup_at_Y=1.7265



EC 0.45



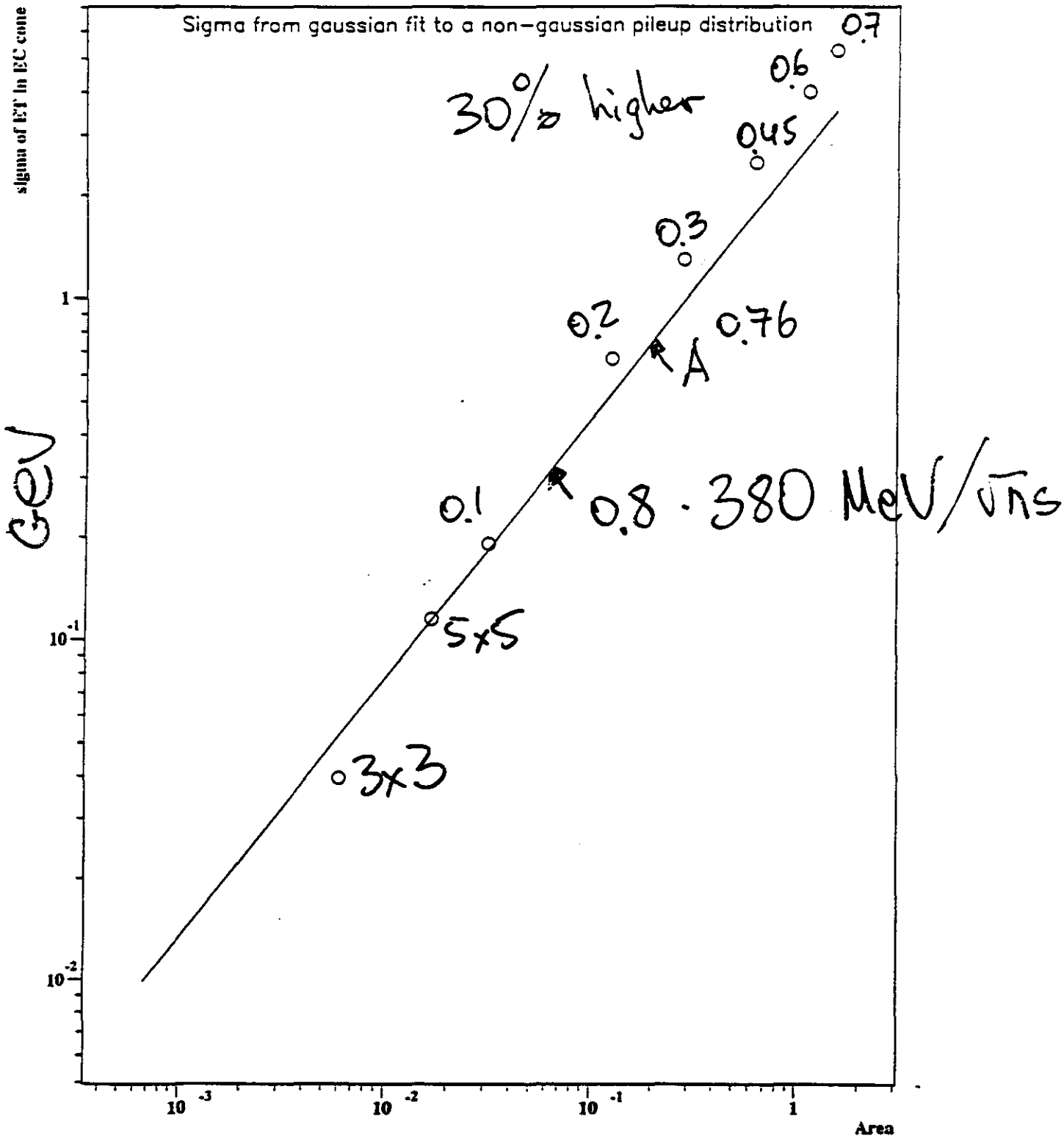
EC 0.6



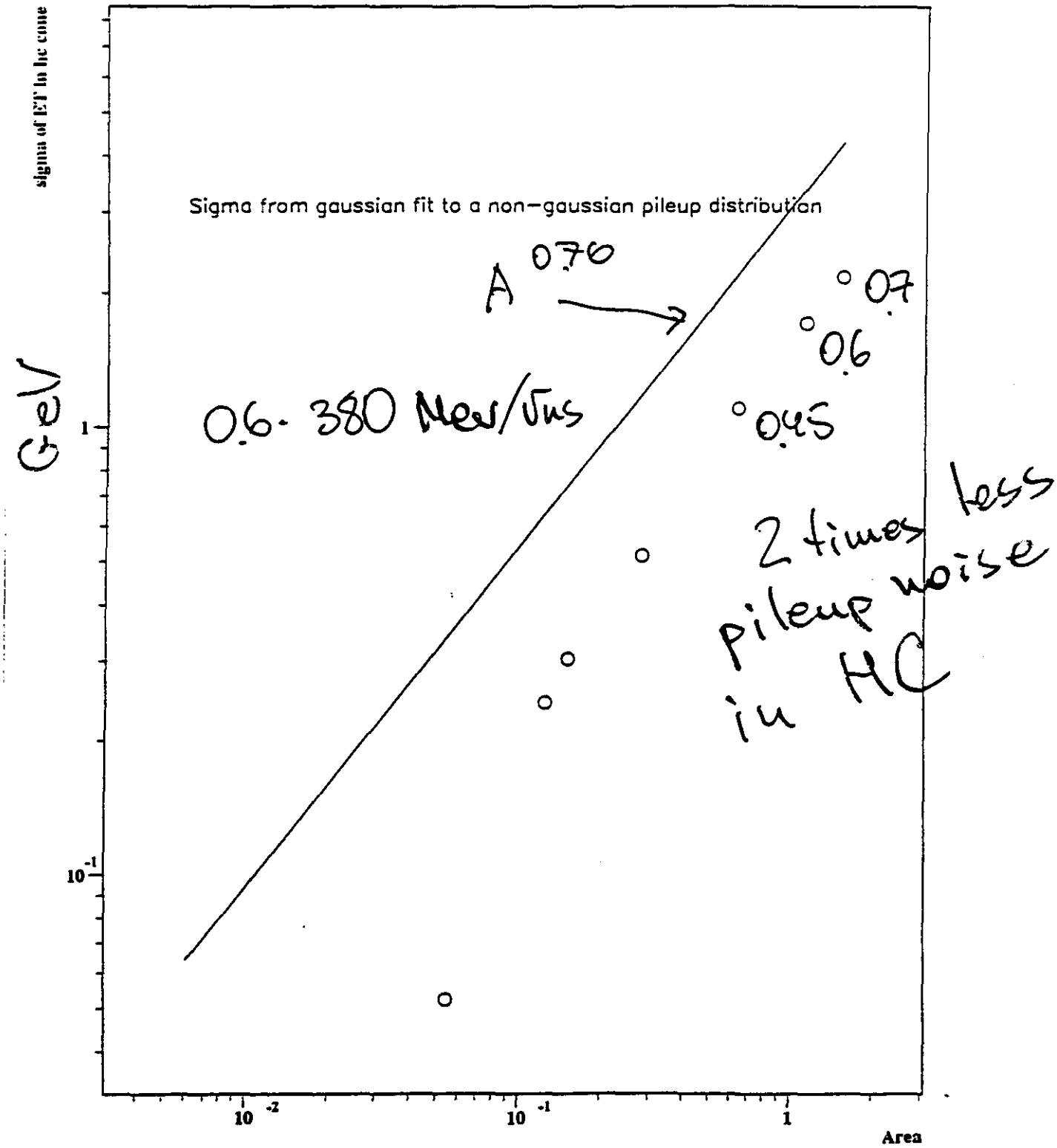
EC 0.7

93/03/16 15.14

GEMFASTvII

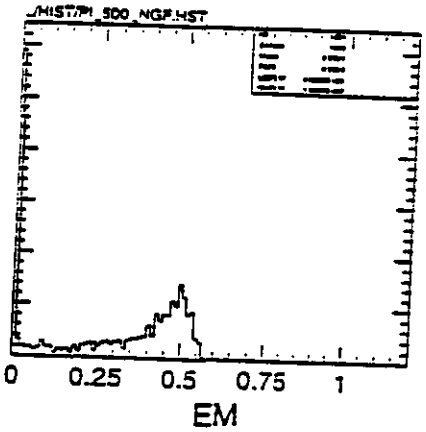


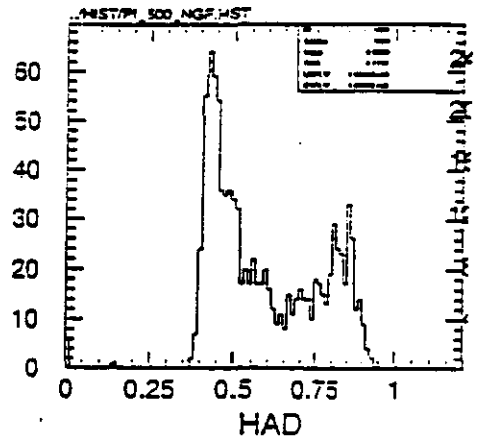
GEMFASTvII


sigma of ET in hc cone
Sigma from gaussian fit to a non-gaussian pileup distribution
A 0.76
0.7
0.6
0.45
0.6 · 380 MeV/√ns
GeV
1
10^-1
10^-2
10^-1
1
Area
2 times less pileup noise in HC

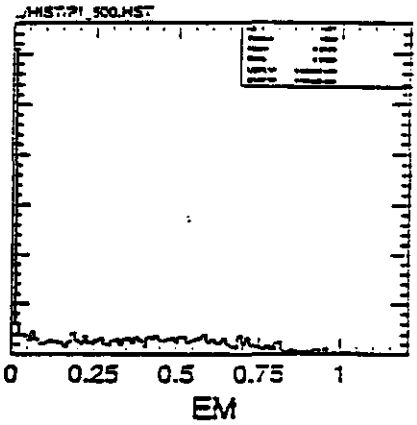
H. Ma GEM TN-93-267 p. 36-3

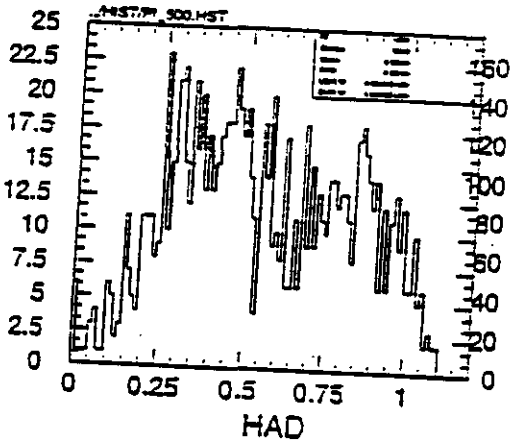
Bock



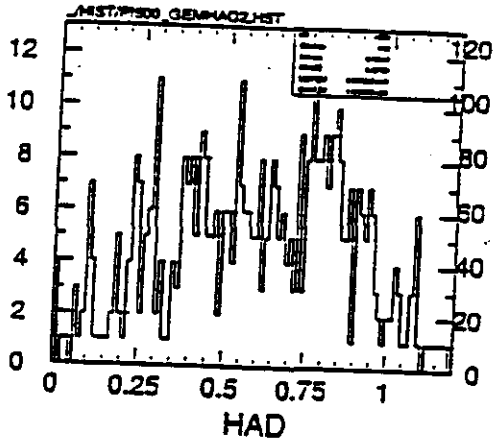


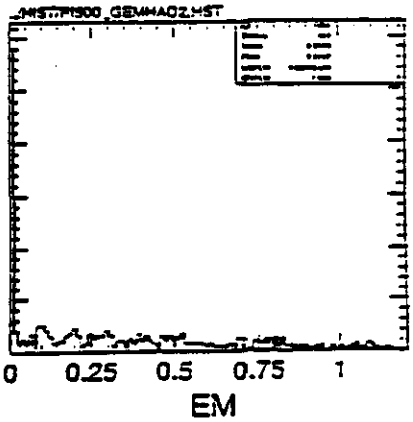
GFLASH





GEANT

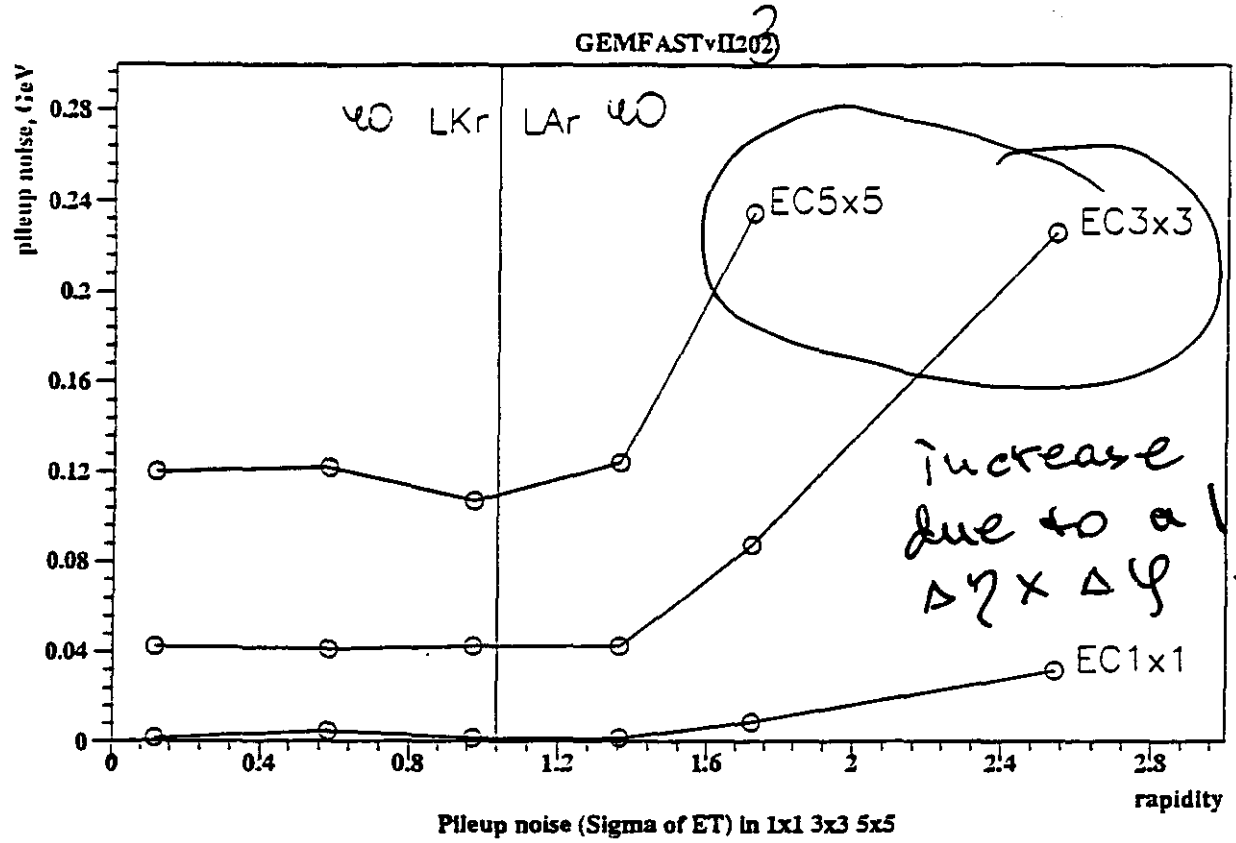




effect of π^0 fluctuations in hadronic shower

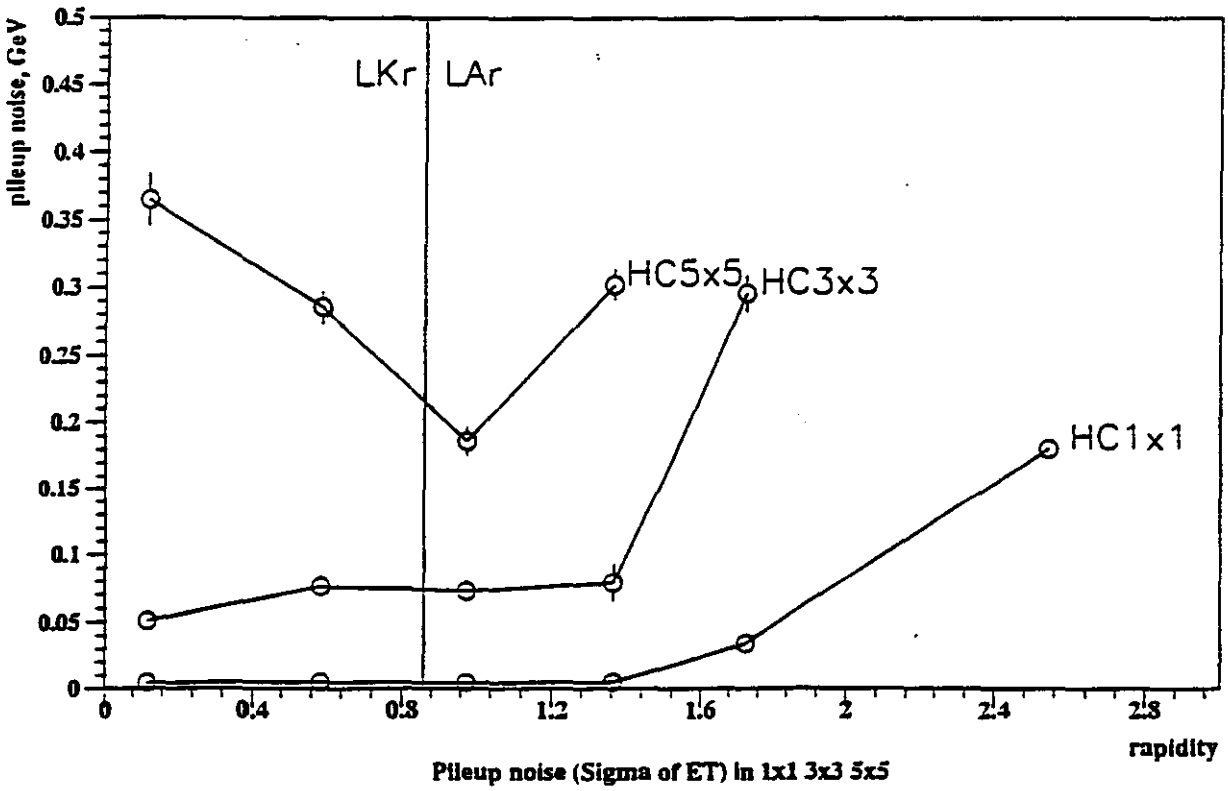
no difference from v11202

93/03/16 11.37



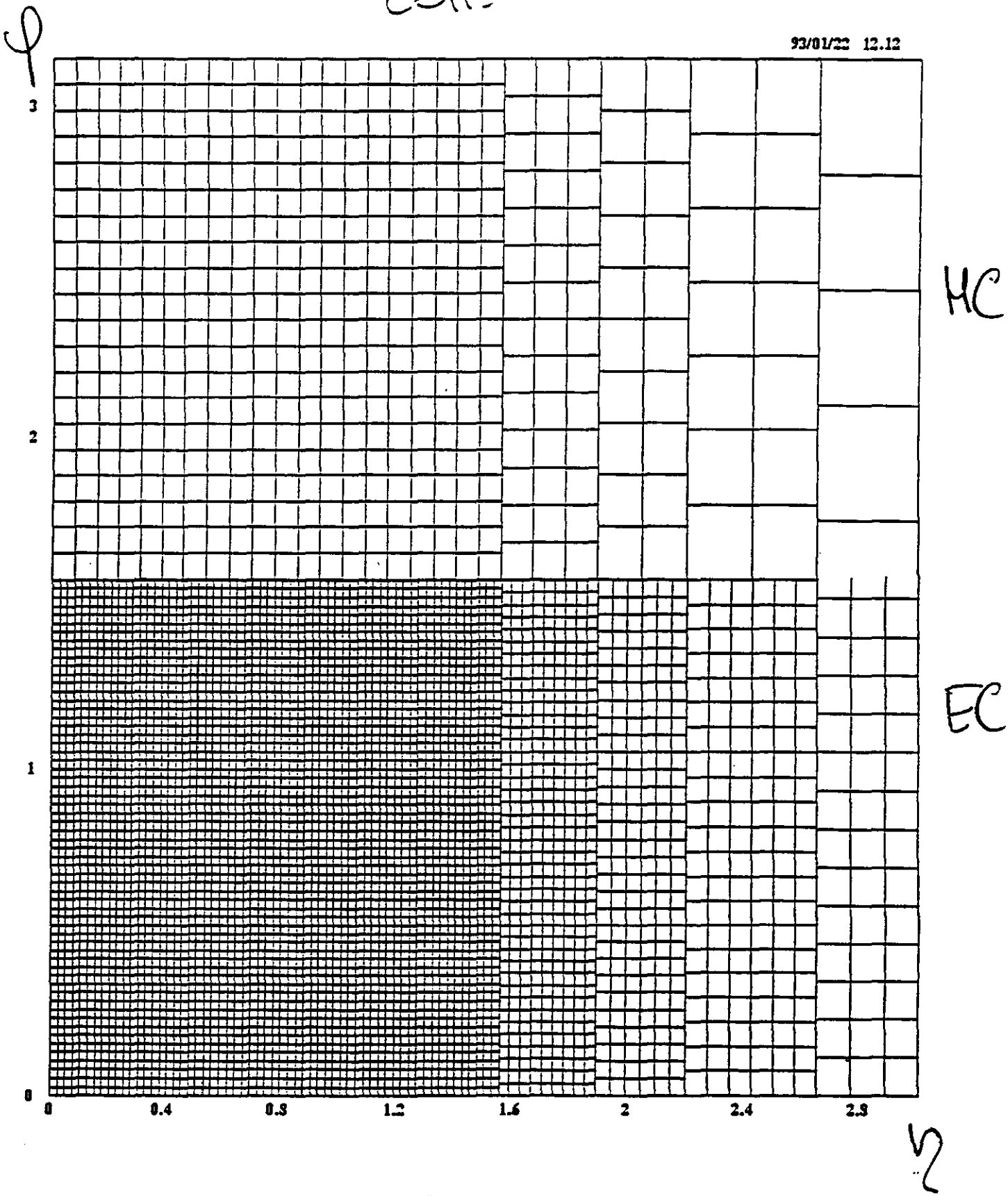
problem for $H \to \gamma\gamma$

increase entirely due to a larger $\Delta\eta \times \Delta\varphi$ for 5x5



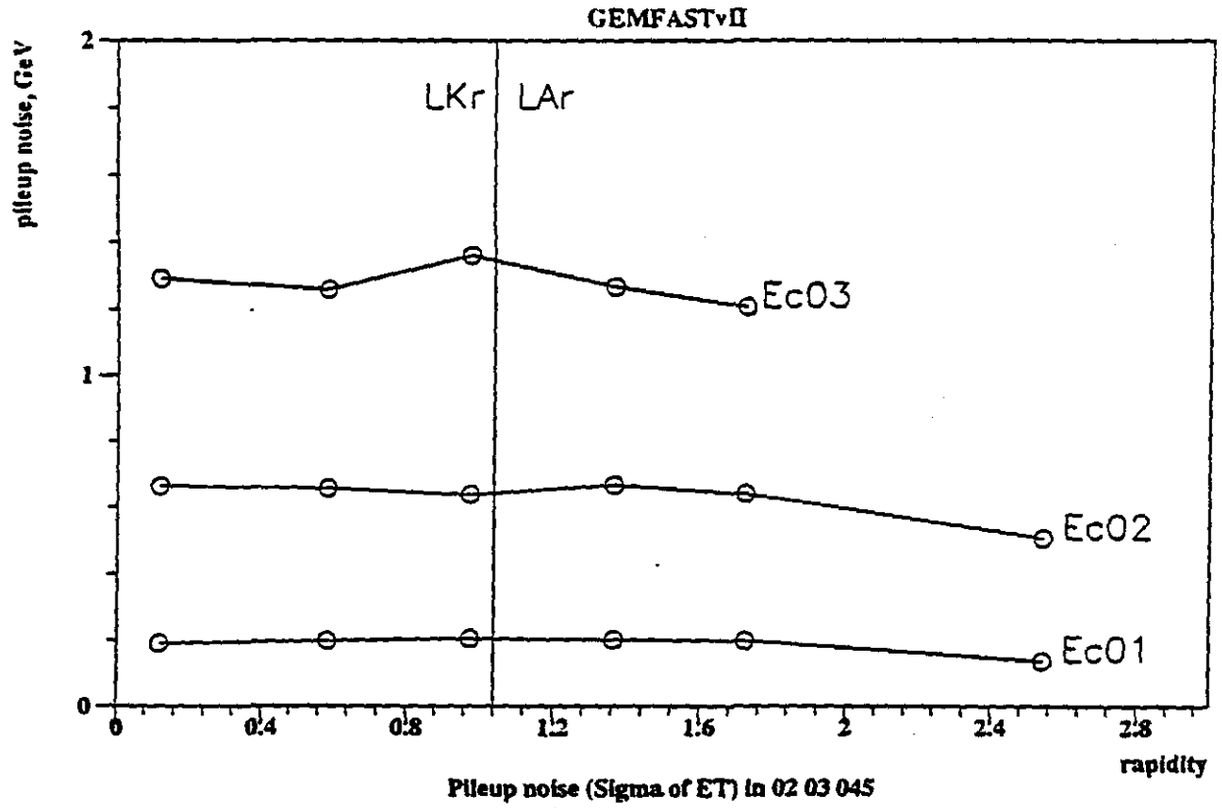
GCMFAST II

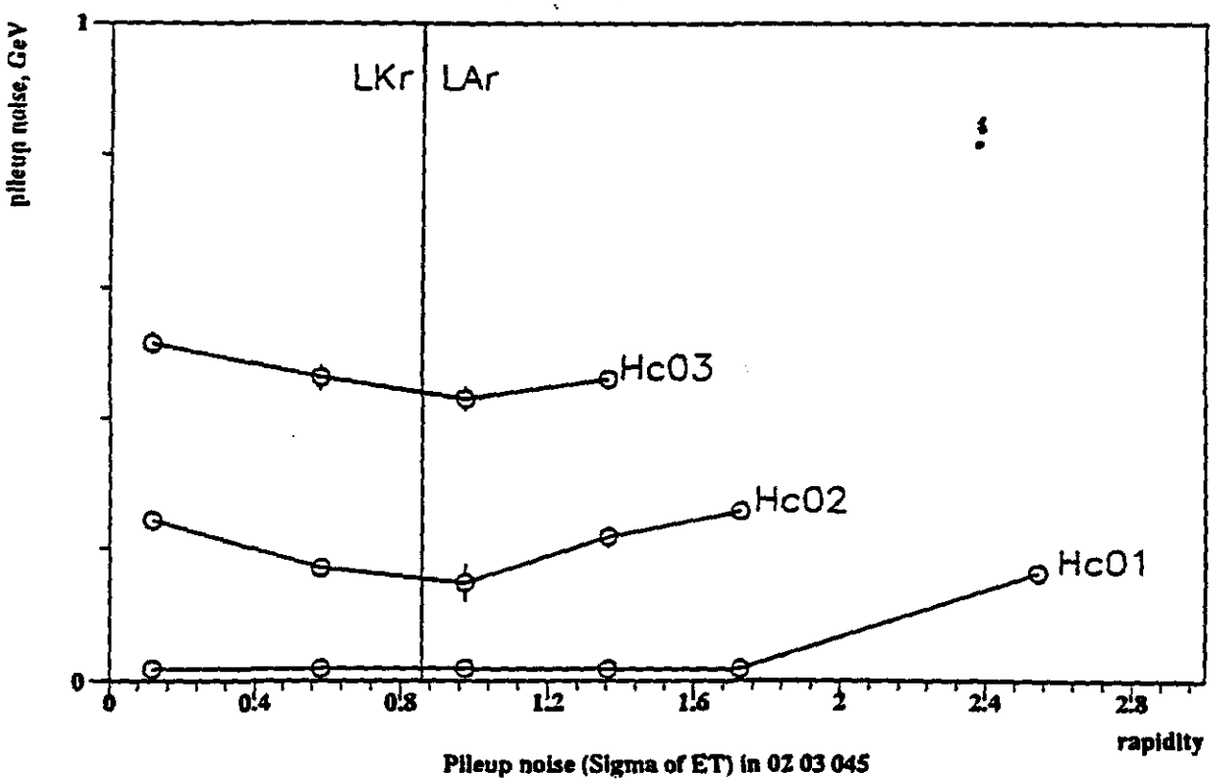
cells



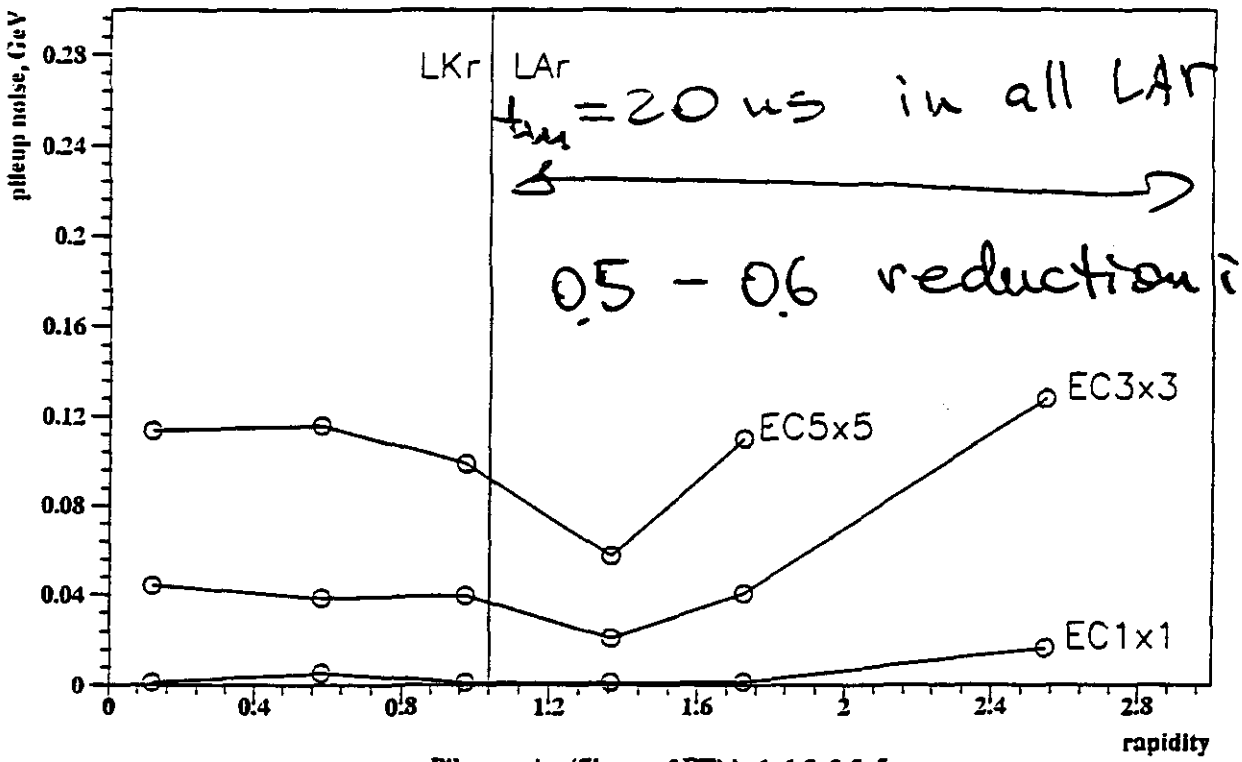
for a fixed area no pileup noise dependence on η

93/03/08 13.03





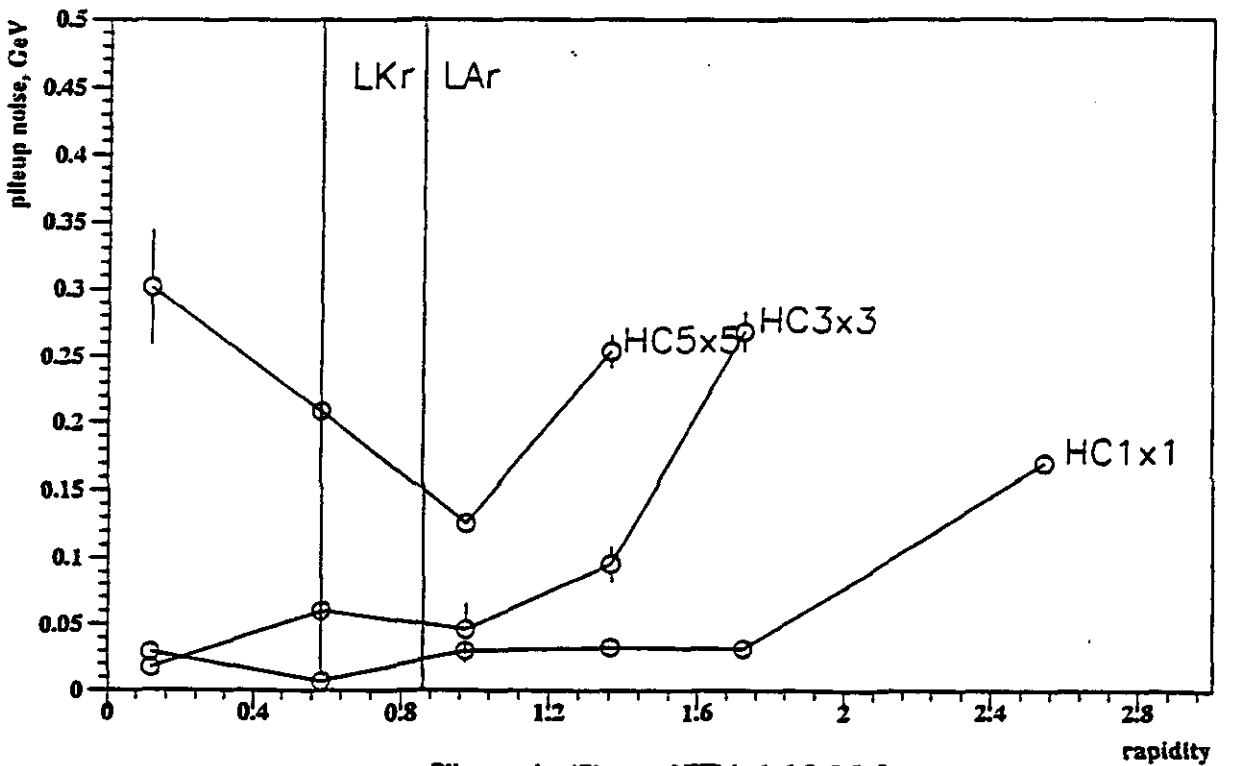
GEMFASTvII202



t_{sm} = 20 ns in all LAr EM

0.5 - 0.6 reduction in pileup noise

Pileup noise (Sigma of ET) in 1x1 3x3 5x5



Pileup noise (Sigma of ET) in 1x1 3x3 5x5

no large gain from 40 ns → 20 ns

5×5: @ Y=1.7

	40 ns	20 ns
thermal noise	100 MeV	280 MeV (H. Ma)
pileup noise	230 MeV	110 MeV
Total noise	250 MeV	300 MeV

Less nongaussian

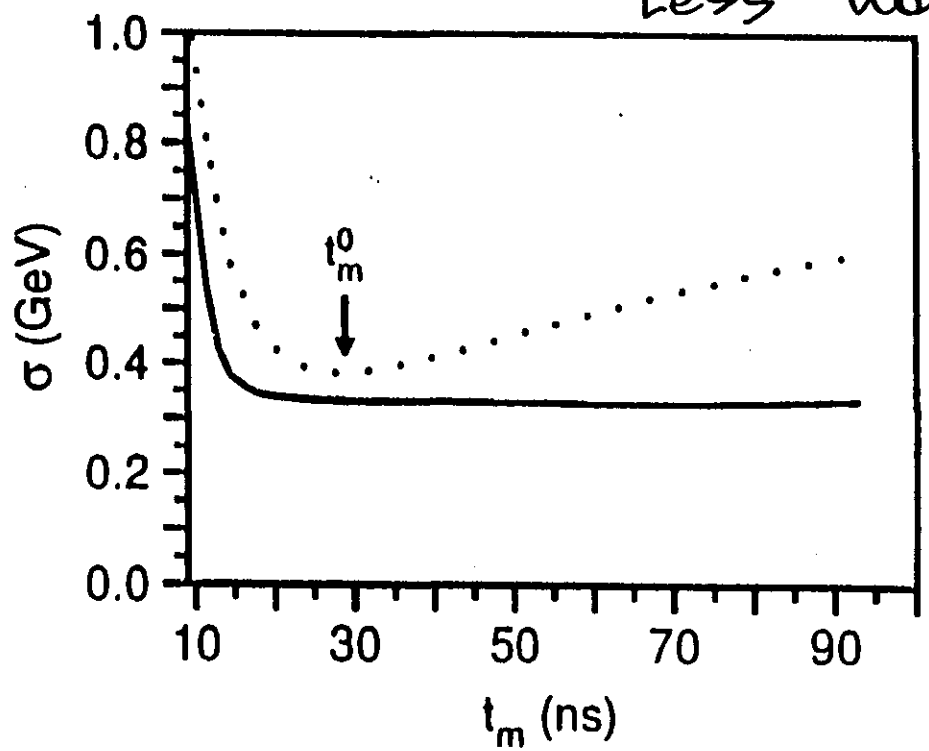
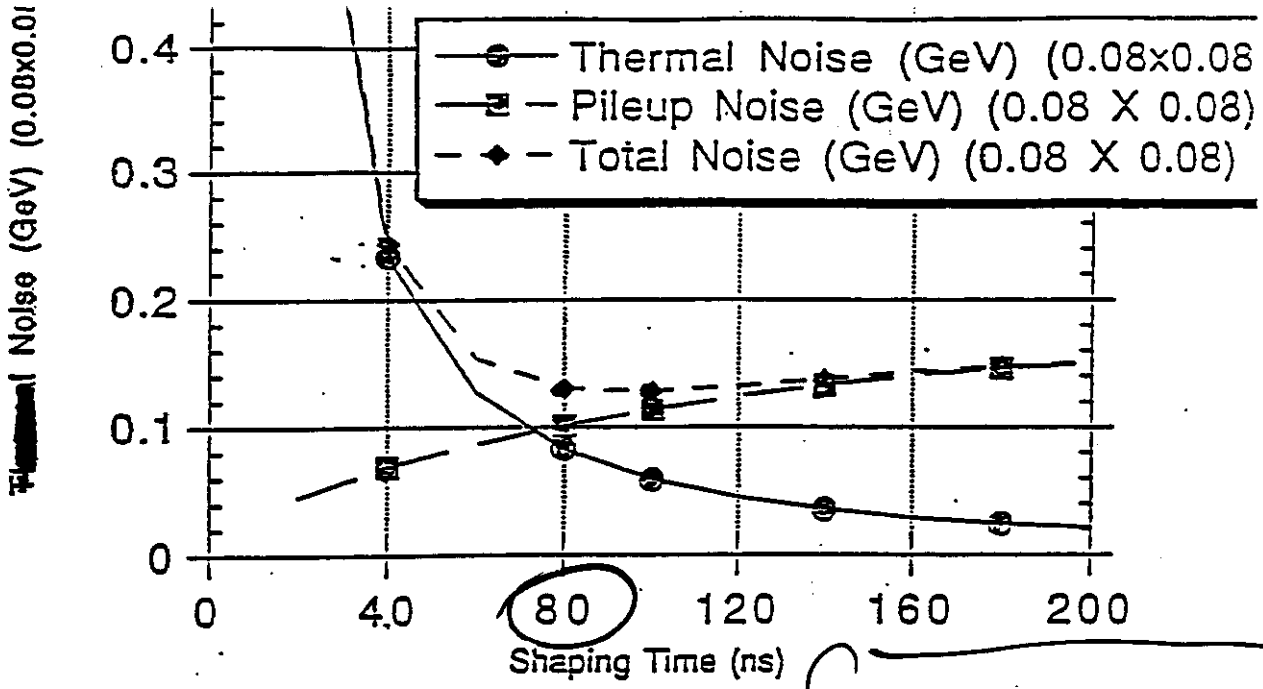


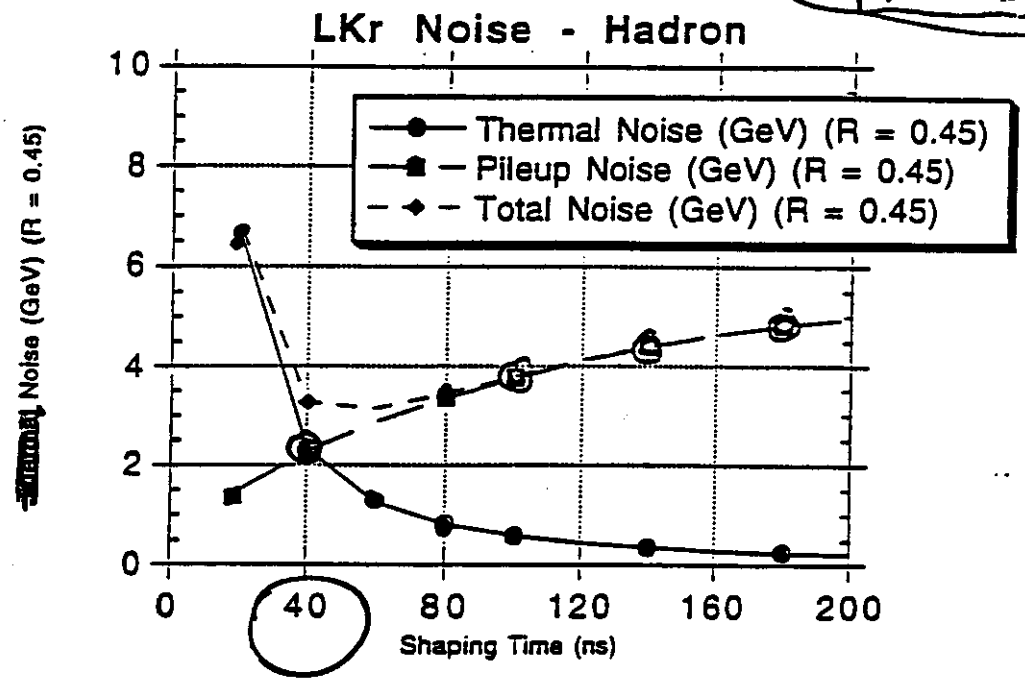
Figure 4.1: Noise value σ_s (dotted curve) for a 5×5 sum of 0.04 ×0.04 EM cells operating at standard conditions, compared with the values of σ_A (solid curve) obtained from optimal filtering for sampling of the full waveform each 16 ns. Use of a smaller number of samples produces a curve intermediate between these two.



Baseline I

Amplitude resolution was optimized

$\boxed{A \text{ and } A \cdot \tau}$



Hadron C. shaping time may be optimized for timing of 1 hadron (for isolation).

Best

Conclusions

(1). π^0 fluctuations in hadronic showe

a) increase pileup noise in EM by 3

b) decrease pileup noise in HC by 2

(2) non-gaussian nature of pileup nois still needs to be understood. uncerta — factor 1.5 in ρ_p estimates

(3) Little gain from 40 ns → 20 ns in the endcup

(4) increase in pileup noise in the endcup 5x5 sum is completely du to an $\Delta\eta \times \Delta\varphi$ area increase. optimal cell size can be detemined by that. → more channels in endcup (less channels in the barrel) → Baseline 3.

(5.) Hadron calorimeter shaping time should be optimized for best out-of-time sing hadron rejection (needed for isolation)

From: BUPHYC::CAREY "Isabel and Andrew's Father" 14-MAR-1993 20:56:58.40
To: SSCVX1::WOMERSLEY
CC:
Subj: RE: calorimeter simulation meeting

Dear John,

There is very little that I've done which would be of much interest to you. Most of my studies were really of GEMFAST and its clustering algorithm. However, your group may be of some help to me. As you know, one of the most significant shortcomings of the compositeness analysis is the fact that e/h is set to 1 in all calorimeters. Thus, the non-linearities which arise from lack of compensation never appear. Now it is certainly possible to put non-linearities into the response, if after-the-fact. However, I don't have a good idea how big those non-linearities ought to be for the mighty central jets that I consider, and even more important, how well we might be able to correct them.

That's my own selfish interest. Another, perhaps even more important issue to address is the question that you raised not a week ago; that is how to calibrate jets in general, in a range of etas and pts, particularly those of several hundred GeV which go into some of the leptons + jets studies. I don't think that there is time to introduce a more realistic model of the the detector and then try to unfold the various new effects that we might put in, but there is a clear need for someone who knows the hardware intimately (ooh that's cold) to write down a persuasive plan of calibration.

I don't think I will be down until Wednesday, if I'm down at all. But if I am, I will try to look for you.

Rob