GEM TN-92-109

Central Tracker Meeting - SSCL

June 4, 1992

Abstract:

Agenda, attendees, and transparencies of the GEM Central Tracker Meeting held at the SSC Laboratory on June 4, 1992. Discussions of Budgets, Simulations in Taiwan, R&D on IPC's, Integration Issues and Silicon Optimization.

Central Tracker Meeting
June 4, 1992
SSCL

Abstract:
Discussions of Budgets, Simulations in Taiwan, R&D on IPC's, Integration Issues and Silicon Optimation

Tracker Meeting Agenda

June 4, 92

1. Budgets, etc. — C.B + all
2. Gallium Arsenide Detectors — Ching Wang
3. Activities in Taiwan — P.K. Teng
4. IPC R&D Progress — C. Bowers
5. Software Simulations — S. McKee
6. Alignement, Integration, Test Beams — K. Morgan
7. Silicon optimization — all

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γeμ

Presentation by:

C. Baltay

Budgets

CENTRAL TRACKER BUDGETS

Category	Feb 25 Budget	April 25 Budget	May 7 Budget
Tracker	27.4	26.5	27.0
Electronics			
Silicon	5.9	12.3	9.3
IPC's	12.3	23.6	12.4
Total Electr.	18.2	35.9	21.7
TOTAL SYSTEM	45.6	62.4	48.7

GEM Central Tracker R&D Budgets

	1992	1993	1994
Silicon			
Mechanical – LANL	270	1147	850
Electronics – LANL	270	303	1311
Electronics – Oregon	0	0	0
Wafers – Moscow State	10	20	20
TPC's			
Mechanical – Yale	0	173	250
– LANL	55	140	140
– Michigan	50	50	50
– Washington	0	0	0
– Indiana	0	40	60
Electronics – Indiana	110	110	140
BNL	175	175	175
Oak Ridge	140	225	225
SLAC	0	200	250
Test Beams – SSCL	42	150	200
	1122	3233	3671

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Presentation by:

P.K. Teng

Simulations in Taiwan

$Z'^0 \to ee$ and electron ID

- Signal : X'section & width of Z'^0
- Background :
  - $\gamma / Z^0 / Z'^0$ interference
  - jj QCD production
- Cuts : P_t, E_{em}/E_{total}, Rcut , Pad ch.
- Conclusion

- Signal generator:

  Pythia 5.5 (default coupling const.)

  $M_{ee} = 4$ TeV

  cross section $= 8$ fb $\left(\begin{array}{l} |\eta| < 2.5 \\ p_t > 500 \text{ GeV} \end{array} \right)$

  fig 1, 2

- Backgrounds:

  1. $\gamma / Z^0 / Z'^0$ interference fig 1'

     "small"

  2. QCD jet fig 4

     cross section $= 250$ pb

     $\left(\begin{array}{l} 3 \text{ TeV} < M_{jj} < 5 \text{ TeV} \\ p_t > 500 \text{ GeV} \\ |\eta| < 2.5 \end{array} \right)$

     e/jet Rejection shall be $\sim 3 \times 10^4$ and more

- Cuts:

  1. P_t for $Z' \to ee$ and jets

     Fig 3. 4.

     No P_t cut for the following analysis

2. E_{em}/E_{total} fig 5. 6.

$$\frac{E_{em}}{E^T} > .8 \Rightarrow \begin{cases} \text{Rejection} \approx 45 \\ \text{electron loss} \sim 10\% \end{cases}$$

$E^T \hookrightarrow E^T_{em} + E^T_{had}$

3. Rcut fig 7. 8

$$\Delta E = \sum E^T(R1) - 1.02 * \sum E^T(R2)$$

Rcut (GeV)	Reject. factor	e loss (%)
8	5	25
[illegible]	2.8	10
40	2	6

Rejection factor $\sim (2.8 * 45)^2 = 1.6 \times 10^4$

4. Pad Chamber Cut

Ionization responce of Pad Chambers

Fig. 9. 10

QCD-correlated BKG

Can restrict e/jet Rejection in calorimeter.

Fig. 13. 11. 12

jet events with/without calorimeter cut

To jet event looks like electron event

Can Use Pad Chamber to improve e/jet rejection, eliminating jet events without charged tracks in the cone.

Criteria for Pad Chamber Cut :

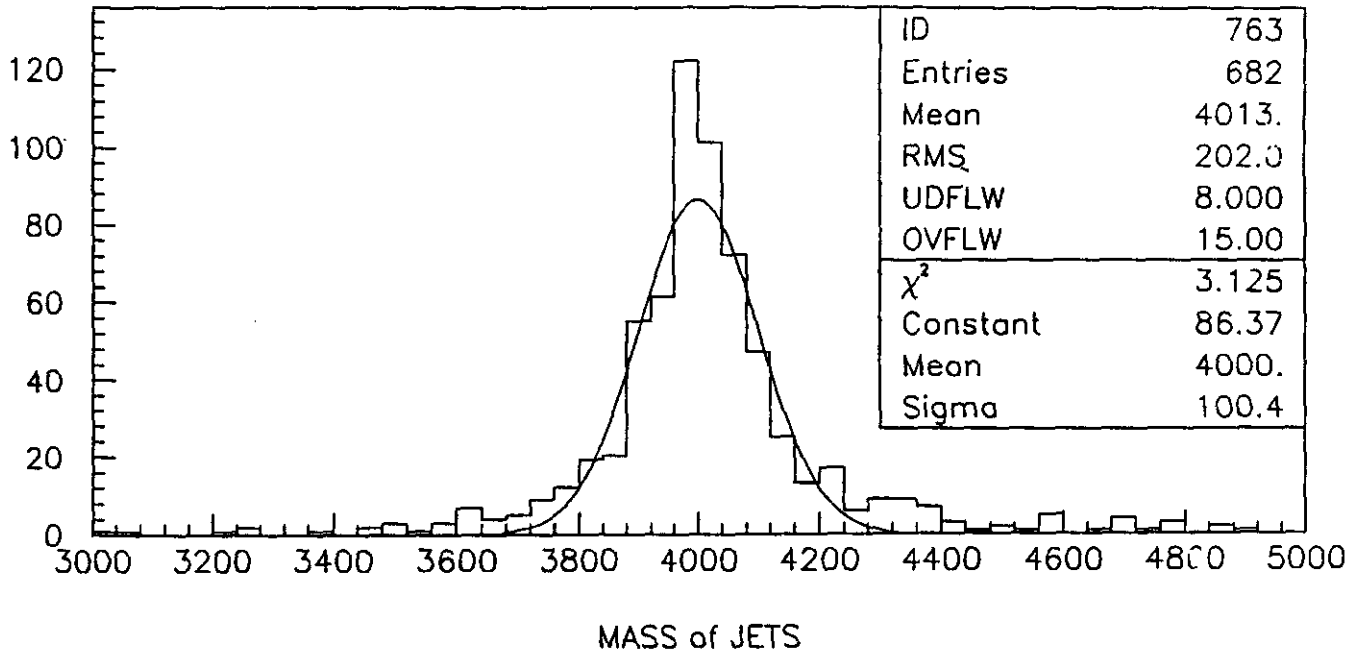
1. 1 or 2 tracks in 3 pads
2. 1 track in 3 pad
   with $|\Delta\eta| \leq 0.009$
   $|\Delta\phi| \leq 0.003$
3. 2 track in 3 pad
   with $|\Delta\eta| \leq 0.009$

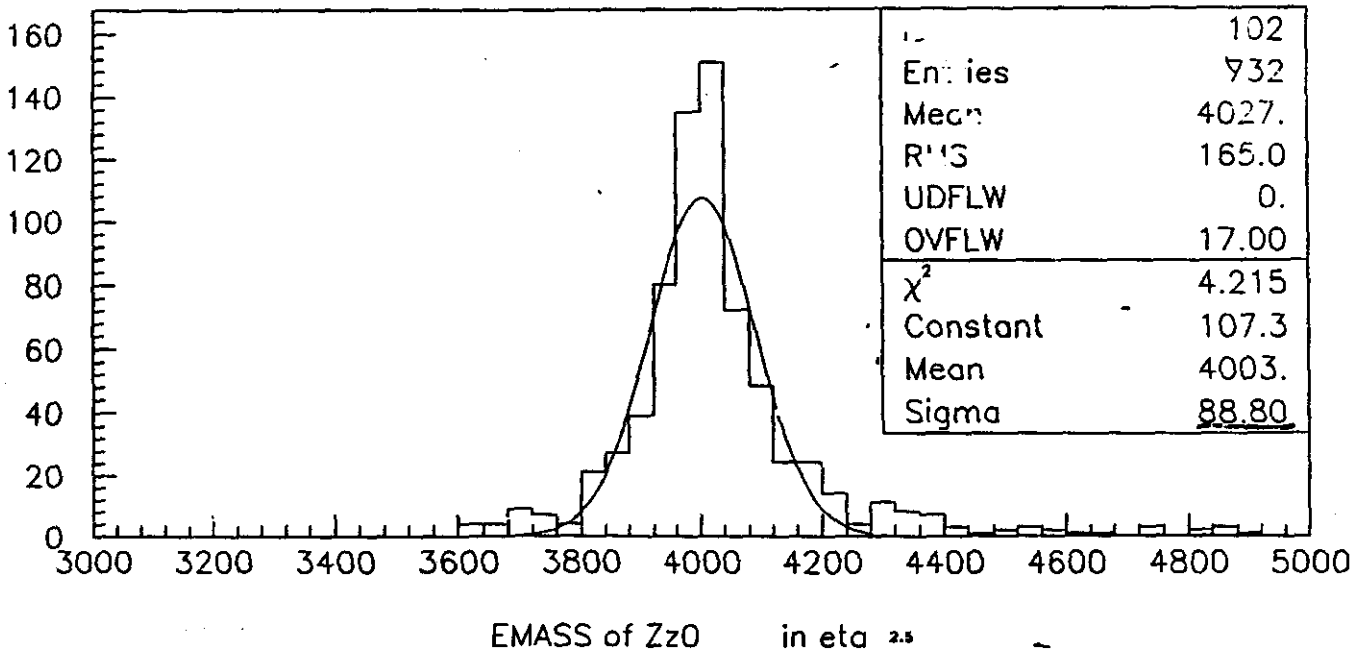
Rejection ≈ 20 electron loss $\sim 3\%$

Rejection factor	X'section for jet	Cut.
	250 pb	
	↓	
2000	125 fb	E_{em}/E_{total}
	↓	
x		
25	5 fb	R cut
x	↓	
10	.5 fb	Pad Chamber cut.

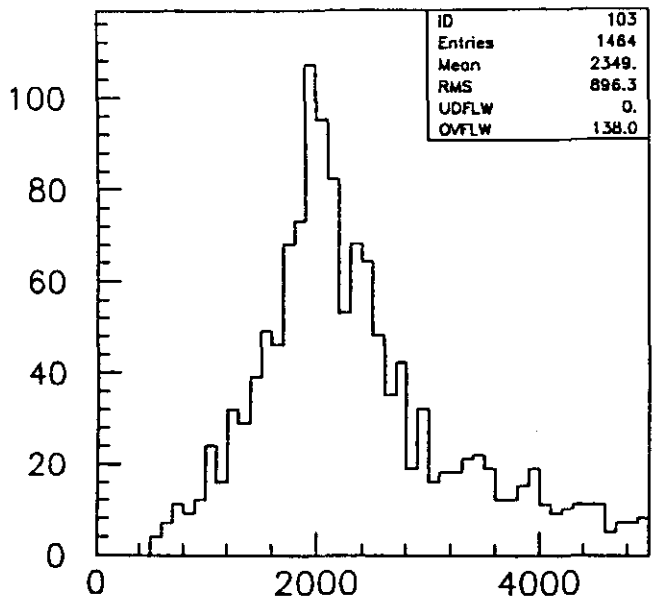
$M_{Z'} = 4$ TeV

8 fl

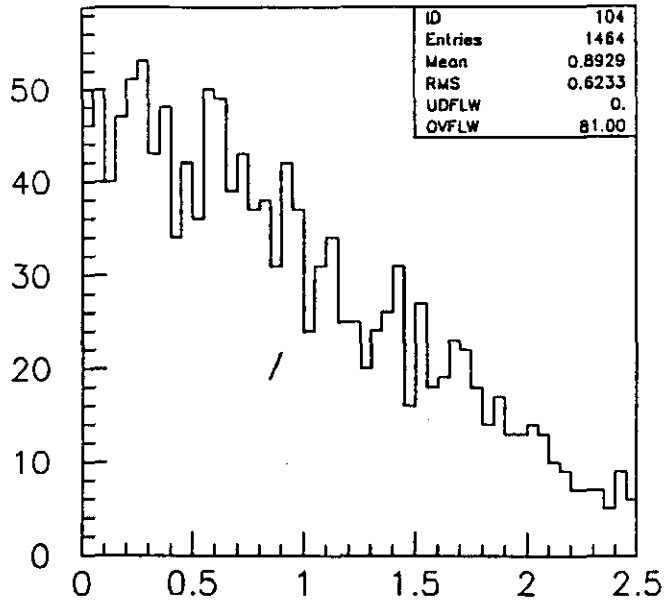

ID 763
Entries 682
Mean 4013.
RMS 202.0
UDFLW 8.000
OVFLW 15.00
χ² 3.125
Constant 86.37
Mean 4000.
Sigma 100.4
0
20
40
60
80
100
120
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
MASS of JETS


102
Entries 932
Mean 4027.
RMS 165.0
UDFLW 0.
OVFLW 17.00
χ² 4.215
Constant 107.3
Mean 4003.
Sigma 88.80
0
20
40
60
80
100
120
140
160
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000
EMASS of Zz0 in eta 2.5

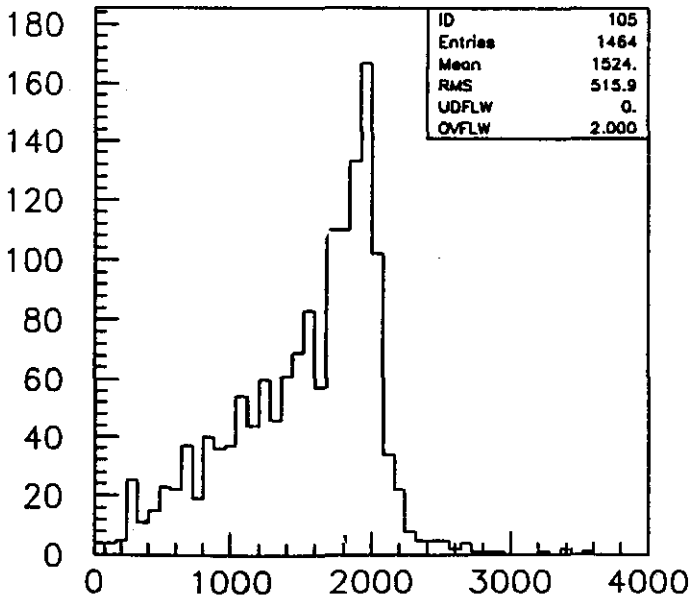
$\Xi' \to ee$



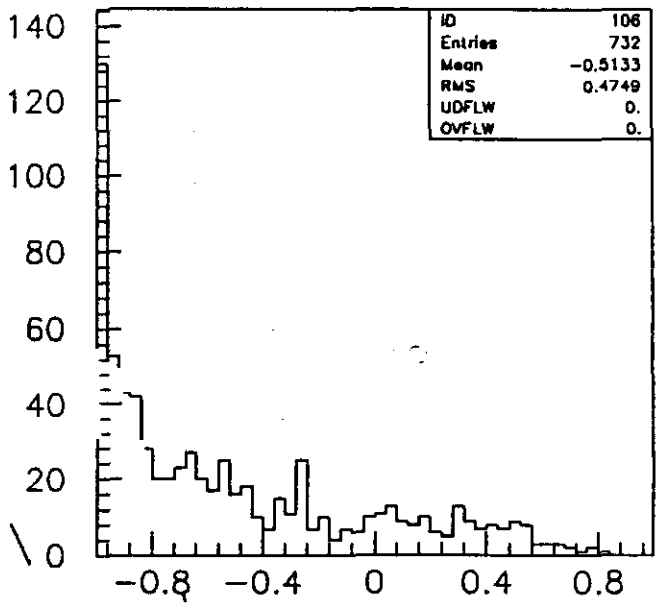
ENERGY of trigger electros



ETA of trigger electrons

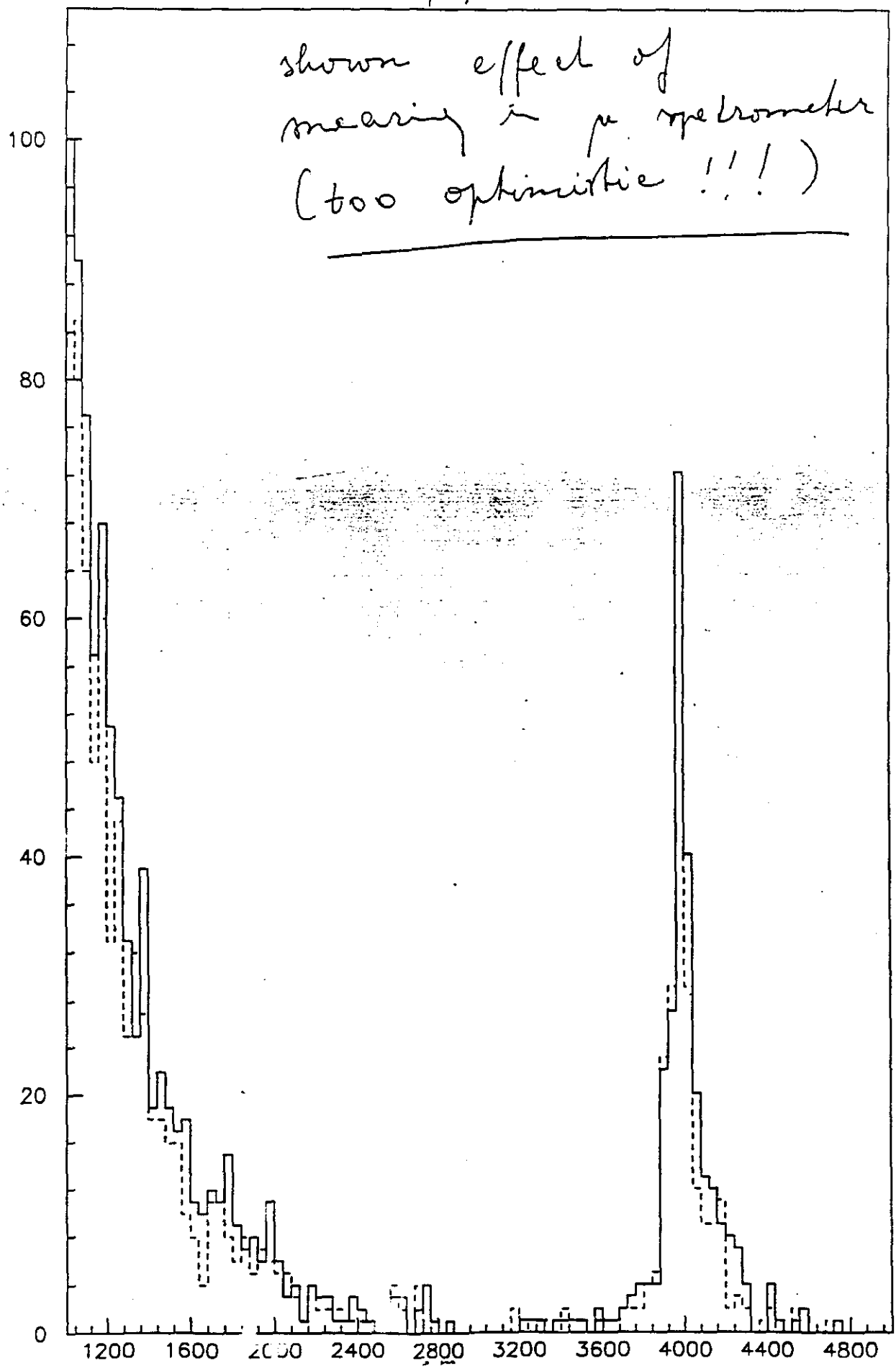


PT of trigger electrons

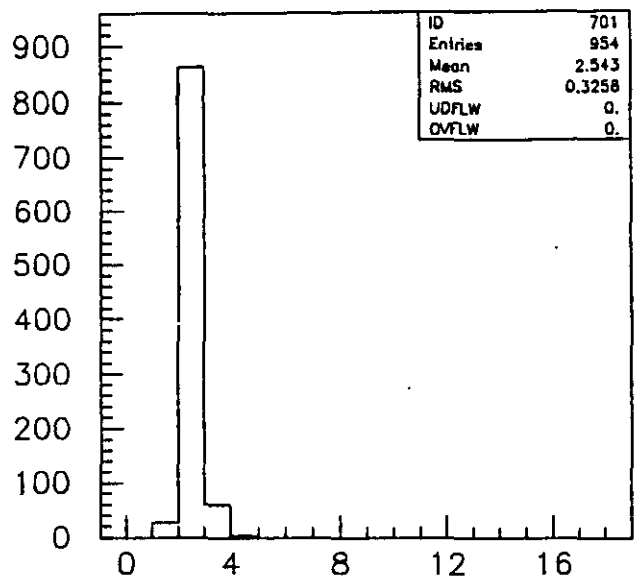


COS(fi) of trigger electrons

$Z^{0\prime} \to \mu, \mu$



$|\eta| < 2.5$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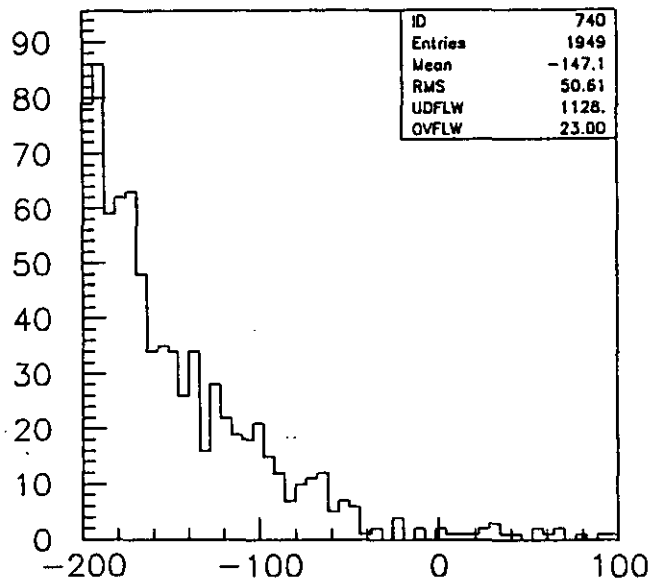
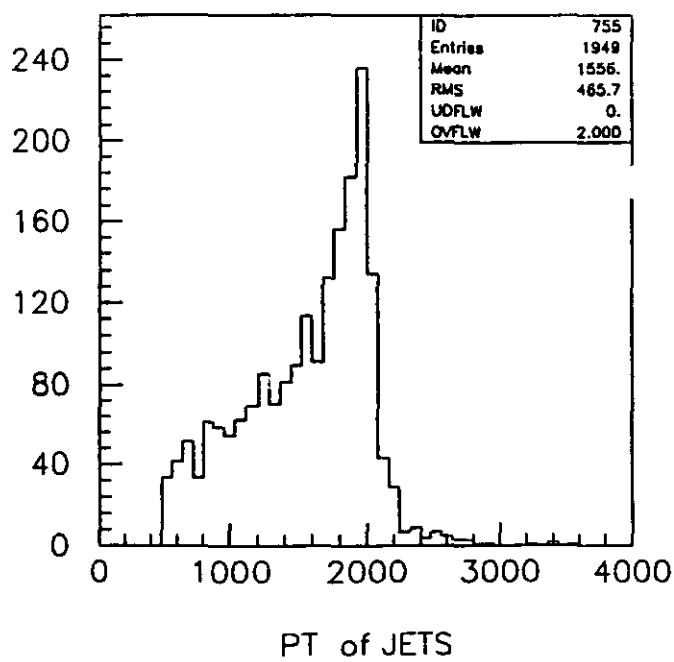
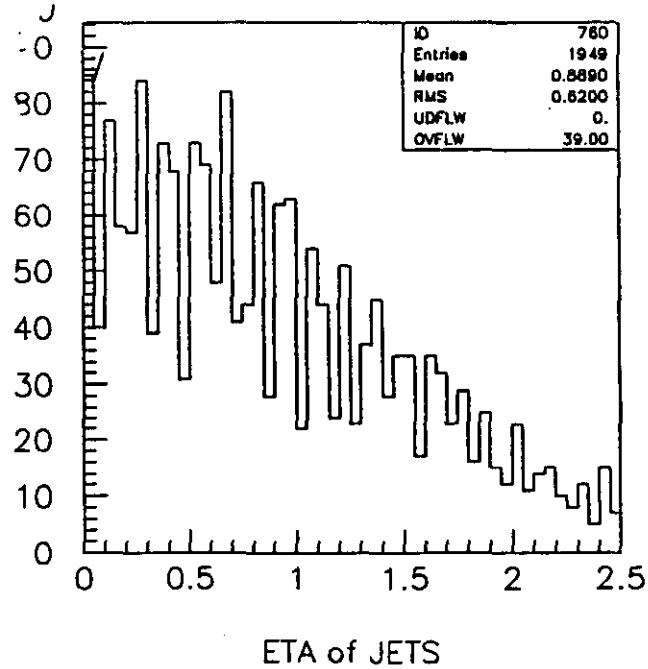
Entries 954
Mean 2.543
RMS 0.3258
UDFLW 0.
OVFLW 0.
NUMBER of all JETS


ID 740
Entries 1949
Mean −147.1
RMS 50.61
UDFLW 1128.
OVFLW 23.00
JET em

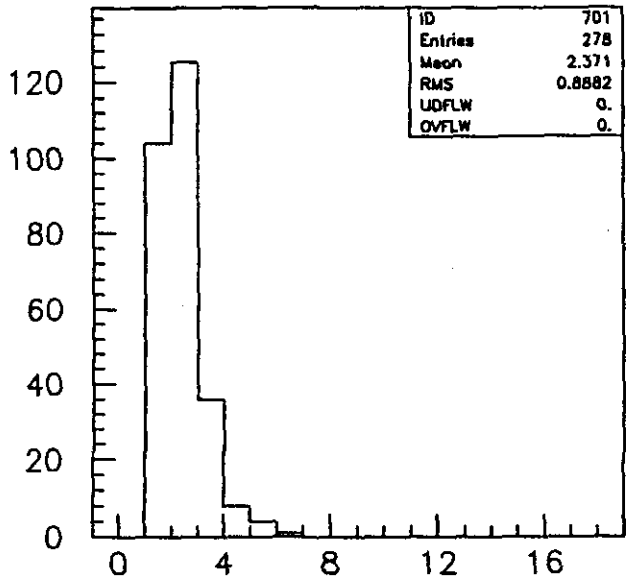

ID 755
Entries 1949
Mean 1556.
RMS 465.7
UDFLW 0.
OVFLW 2.000
PT of JETS

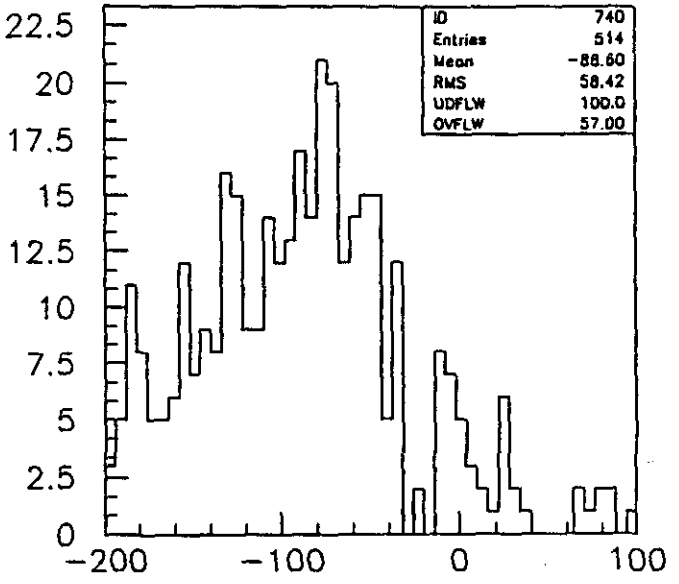

ID 760
Entries 1949
Mean 0.8890
RMS 0.6200
UDFLW 0.
OVFLW 39.00
ETA of JETS

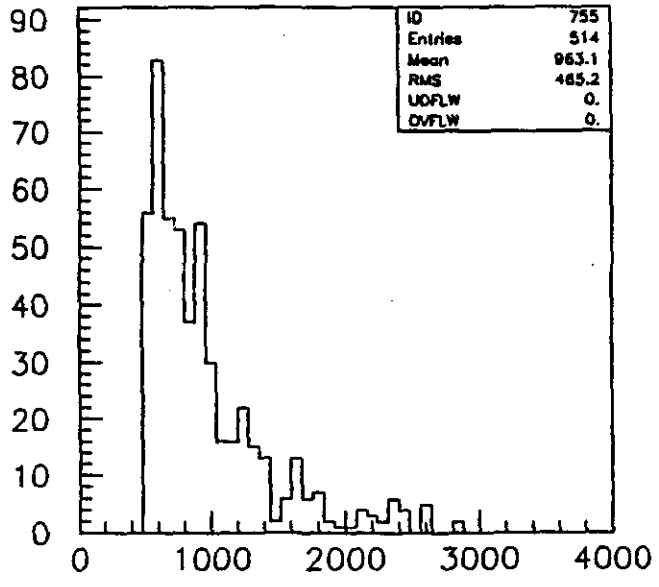
QCD jj + pile up

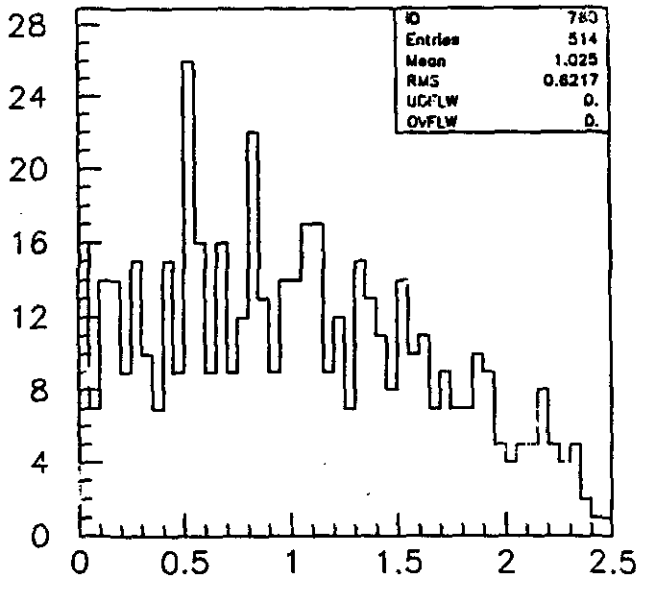
$\sigma = 250$ pb

$3 < M_{jj} < 5$ TeV
$P_T > 500$ GeV
$|\eta| < 2.5$

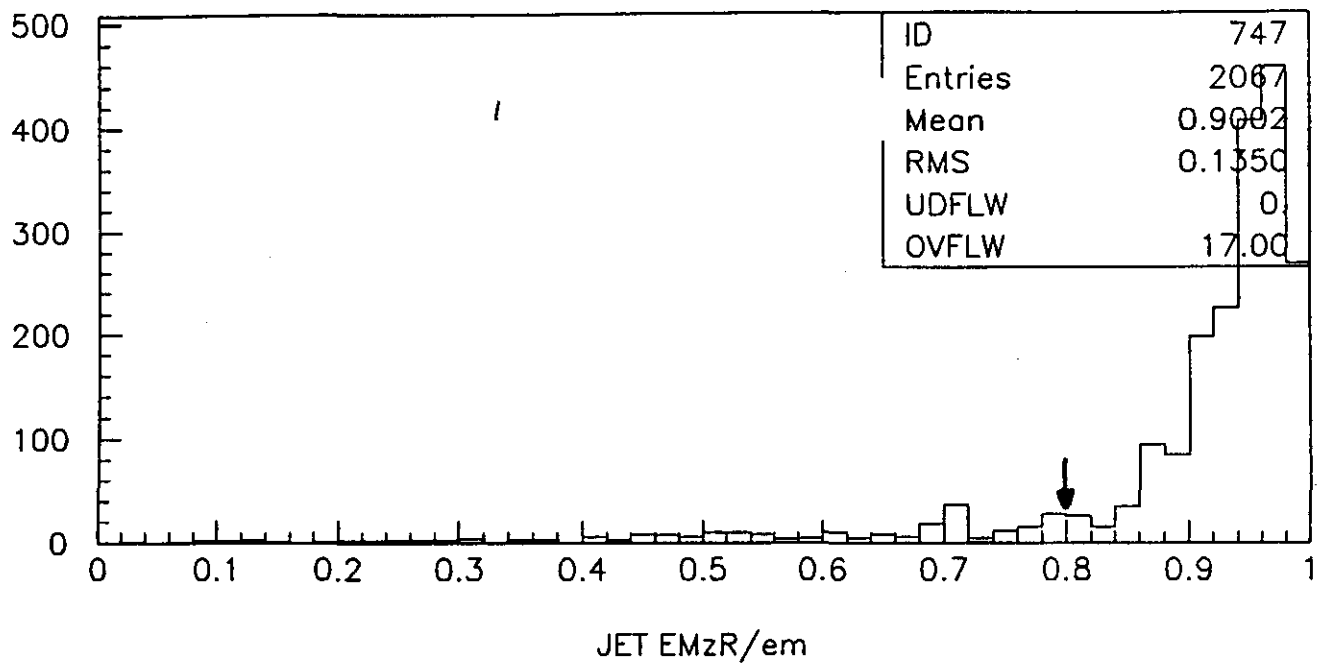


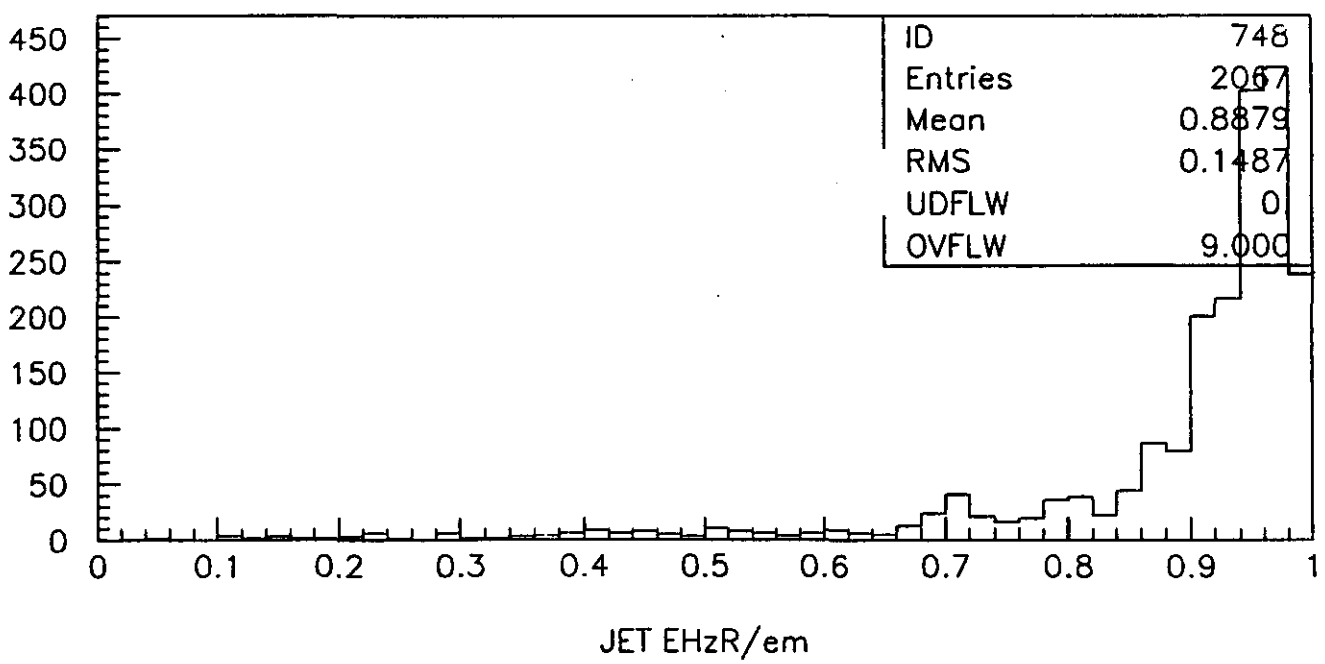


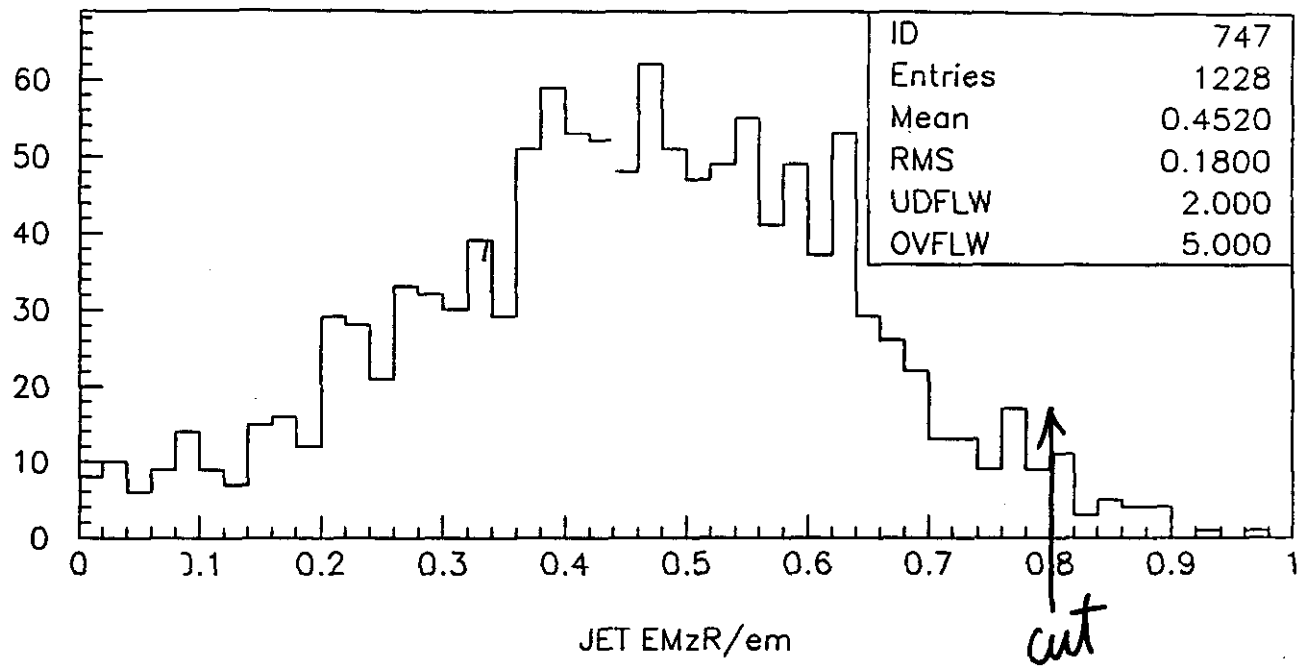




$$R = \frac{E_{em}}{E_{total}}$$






ID 747
Entries 1228
Mean 0.4520
RMS 0.1800
UDFLW 2.000
OVFLW 5.000
JET EMzR/em
cut

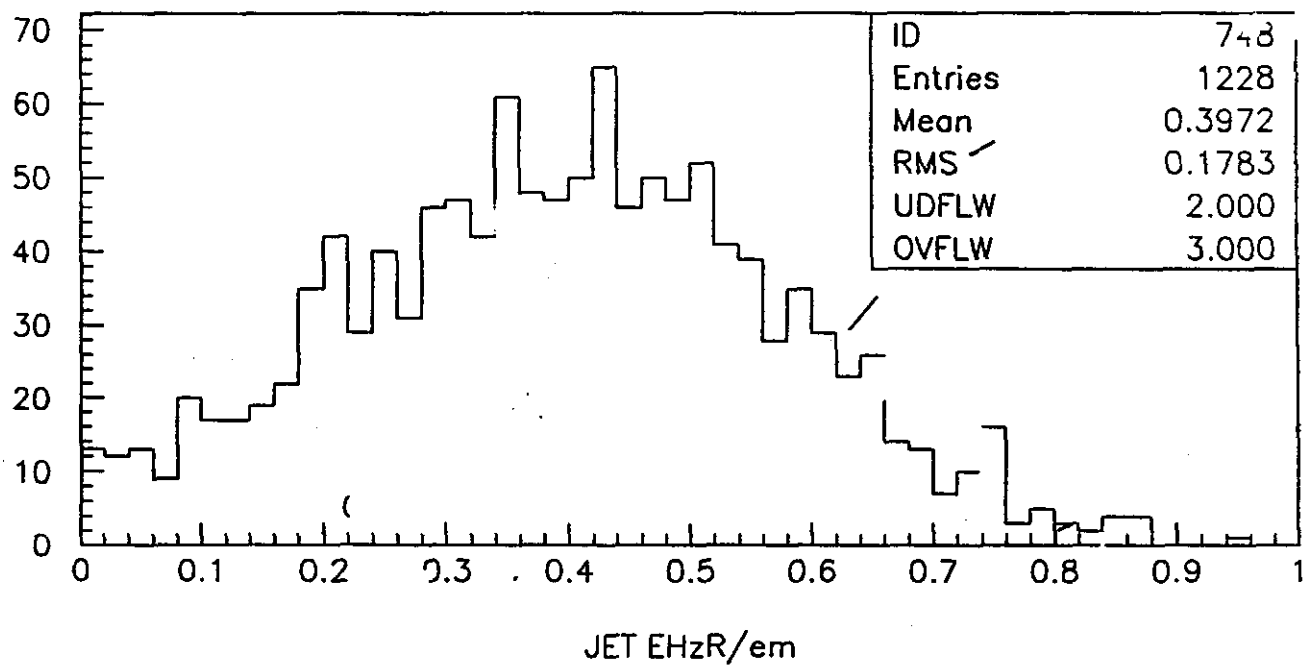
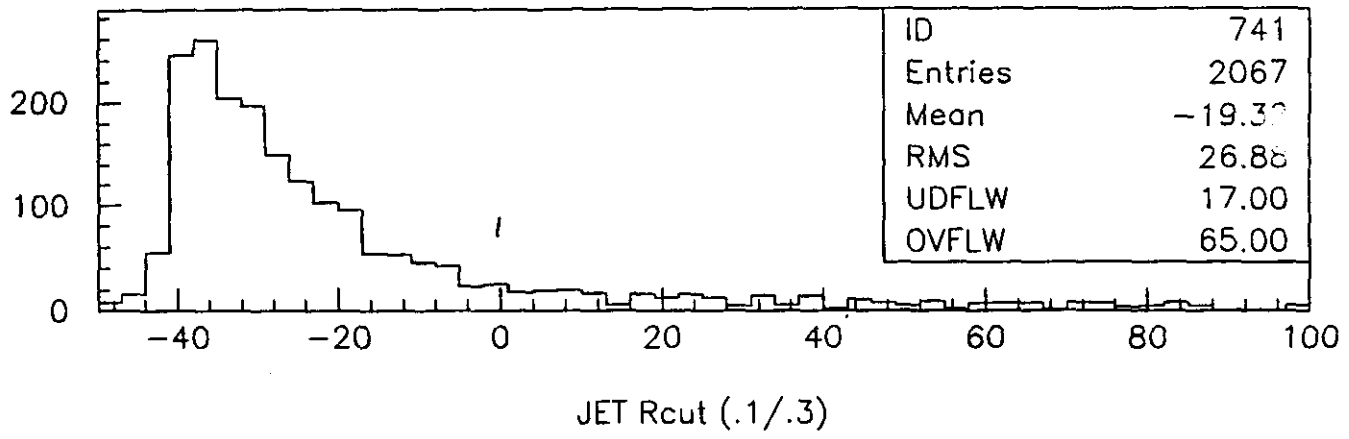
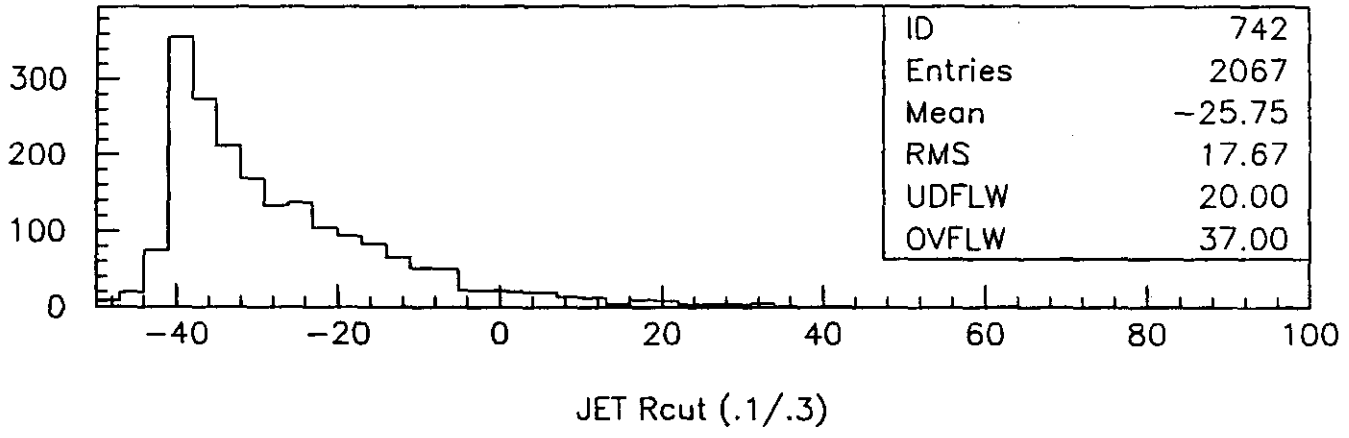

ID 748
Entries 1228
Mean 0.3972
RMS 0.1783
UDFLW 2.000
OVFLW 3.000
JET EHzR/em

Fig 6


ID 741
Entries 2067
Mean −19.3
RMS 26.88
UDFLW 17.00
OVFLW 65.00
200
100
0
−40 −20 0 20 40 60 80 100
JET Rcut (.1/.3)


ID 742
Entries 2067
Mean −25.75
RMS 17.67
UDFLW 20.00
OVFLW 37.00
300
200
100
0
−40 −20 0 20 40 60 80 100
JET Rcut (.1/.3)

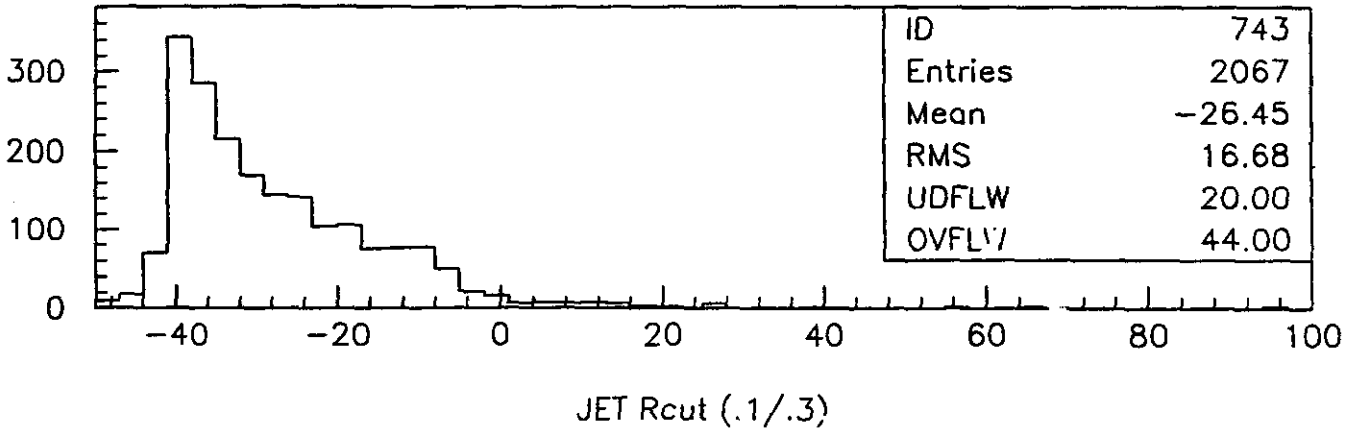

ID 743
Entries 2067
Mean −26.45
RMS 16.68
UDFLW 20.00
OVFLW 44.00
300
200
100
0
−40 −20 0 20 40 60 80 100
JET Rcut (.1/.3)

Fig 7

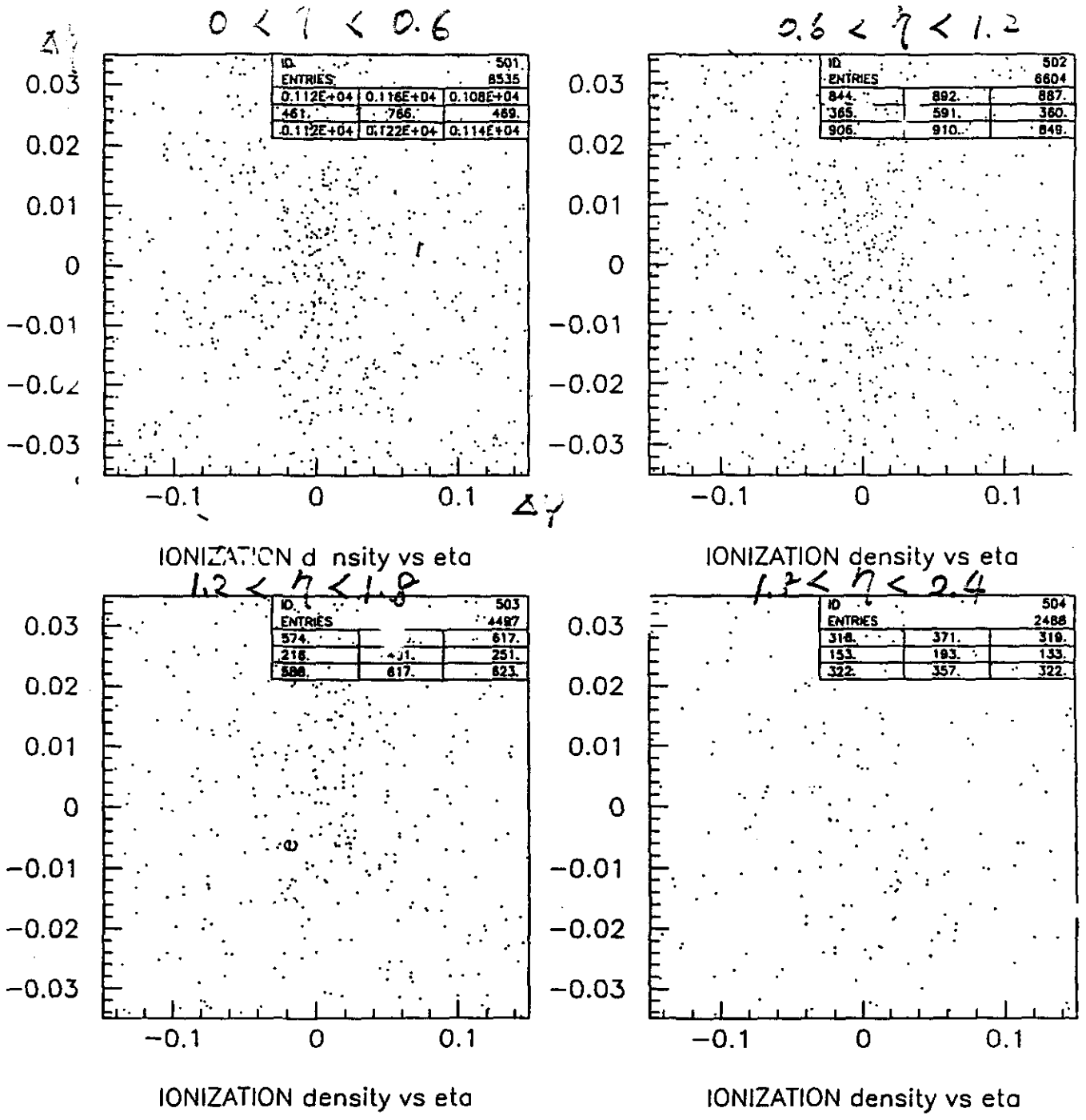

0 < η < 0.6
0.6 < η < 1.2
1.2 < η < 1.8
1.8 < η < 2.4
ID 501
ENTRIES 8535
0.112E+04 0.116E+04 0.108E+04
461. 766. 469.
0.112E+04 0.122E+04 0.114E+04
ID 502
ENTRIES 6604
844. 892. 887.
365. 591. 360.
906. 910. 849.
ID 503
ENTRIES 4497
574. 617.
216. 251.
588. 617. 623.
ID 504
ENTRIES 2488
318. 371. 319.
153. 193. 153.
322. 357. 322.
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.1
0
0.1
Δφ
IONIZATION density vs eta

Fig. 9

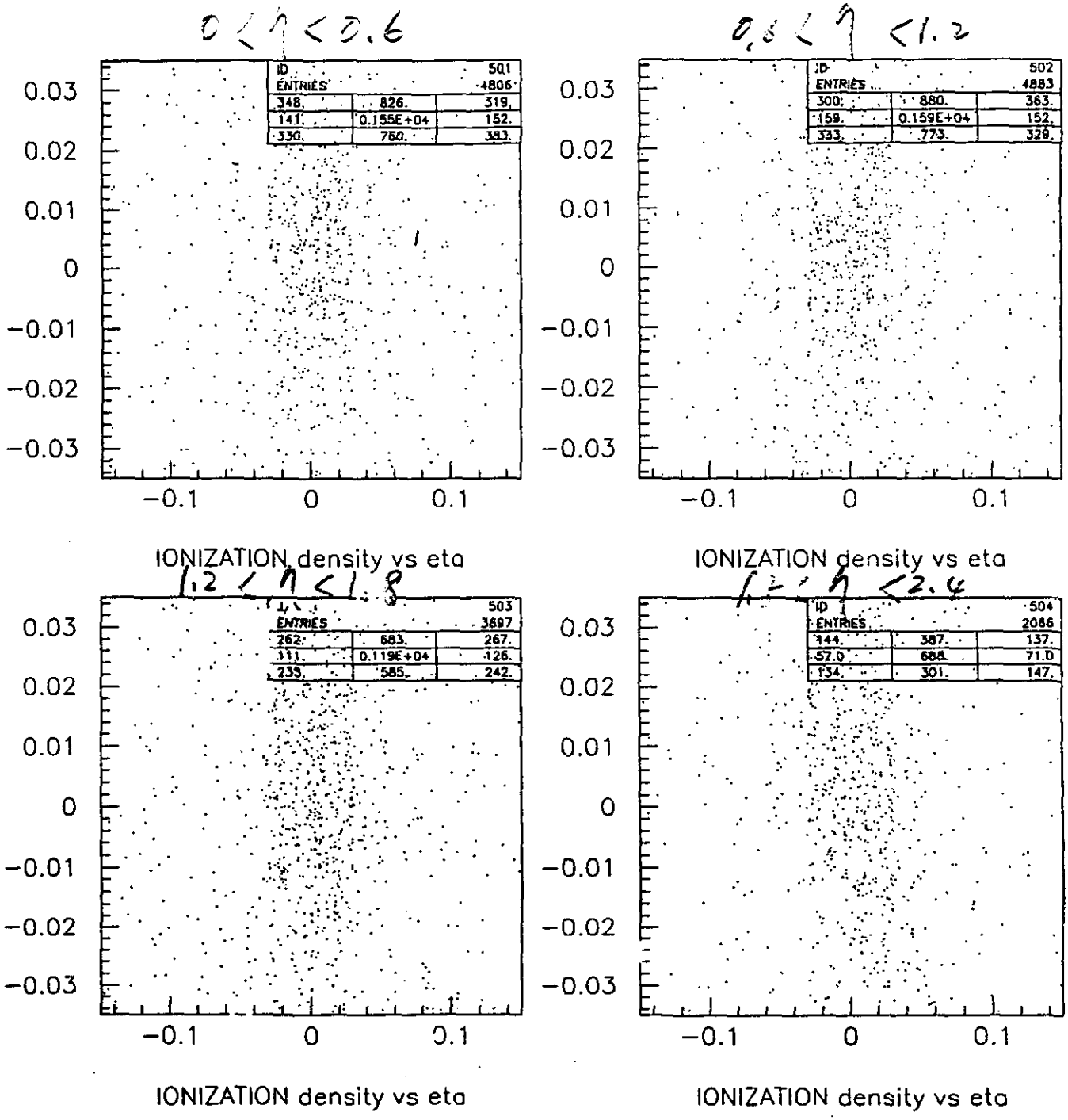

0 < η < 0.6
ID 501
ENTRIES 4806
348. 826. 319.
141. 0.155E+04 152.
330. 760. 383.
0.5 < η < 1.2
ID 502
ENTRIES 4883
300. 880. 363.
159. 0.159E+04 152.
333. 773. 329.
1.2 < η < 1.8
ID 503
ENTRIES 3697
262. 683. 267.
111. 0.119E+04 126.
239. 585. 242.
1.8 < η < 2.4
ID 504
ENTRIES 2066
144. 387. 137.
57.0 688. 71.0
134. 301. 147.
0.03
0.02
0.01
0
−0.01
−0.02
−0.03
−0.1
0
0.1
IONIZATION density vs eta

Fig. 10

NO CUT

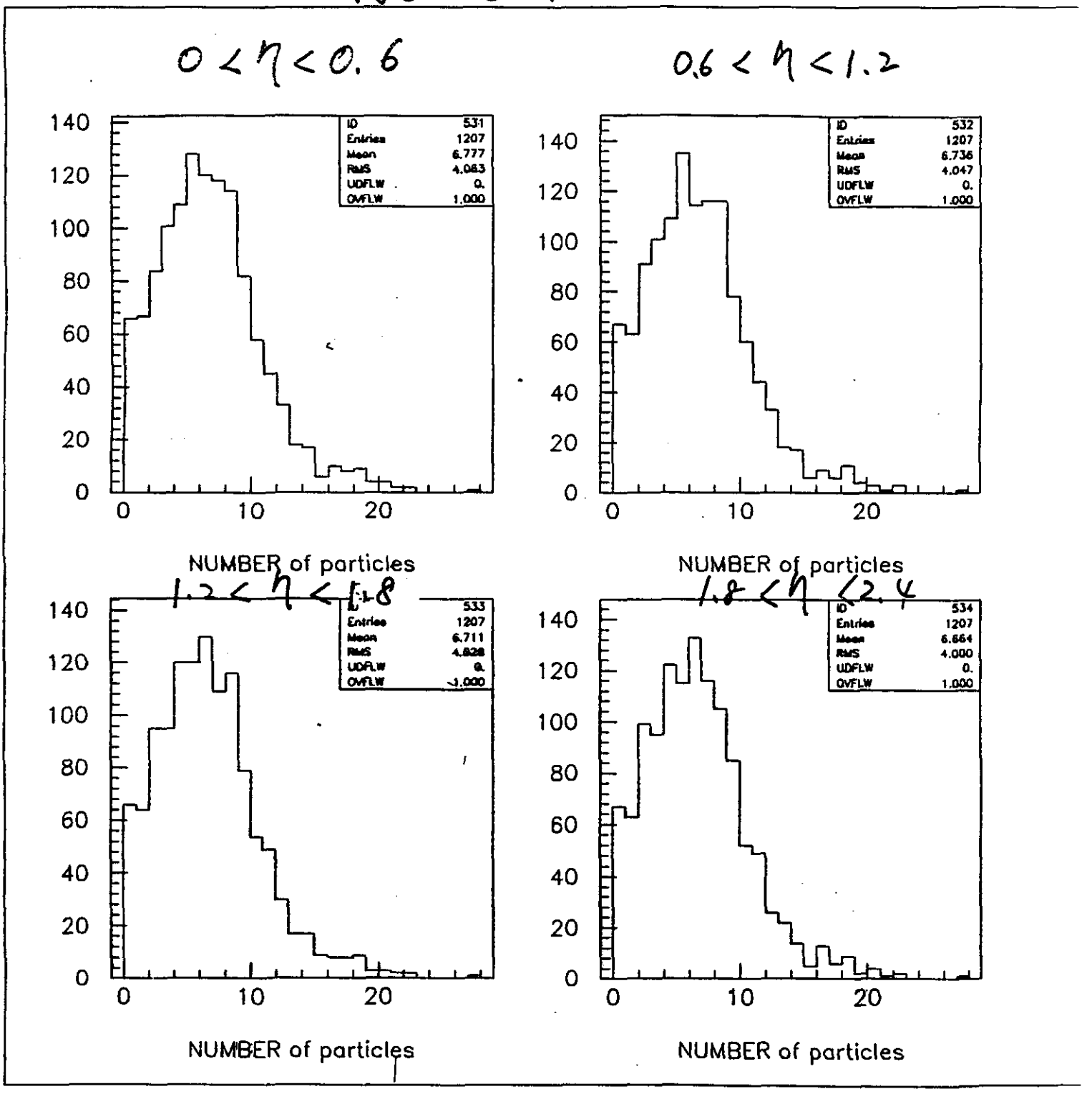
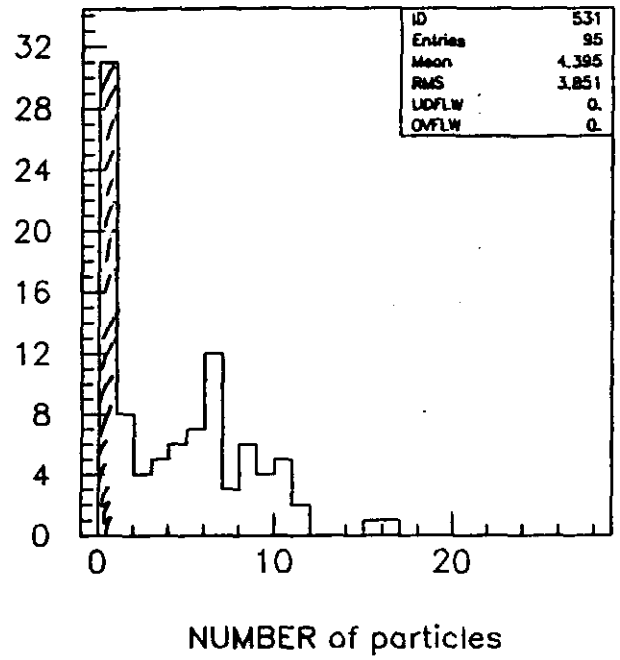
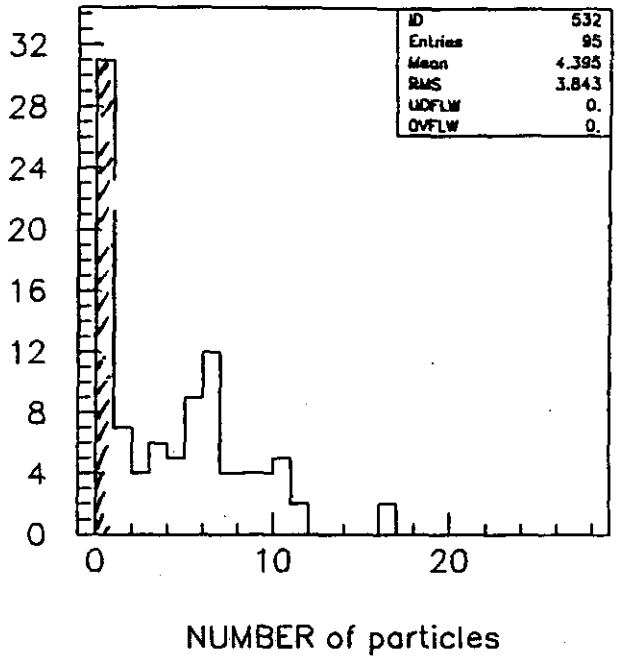
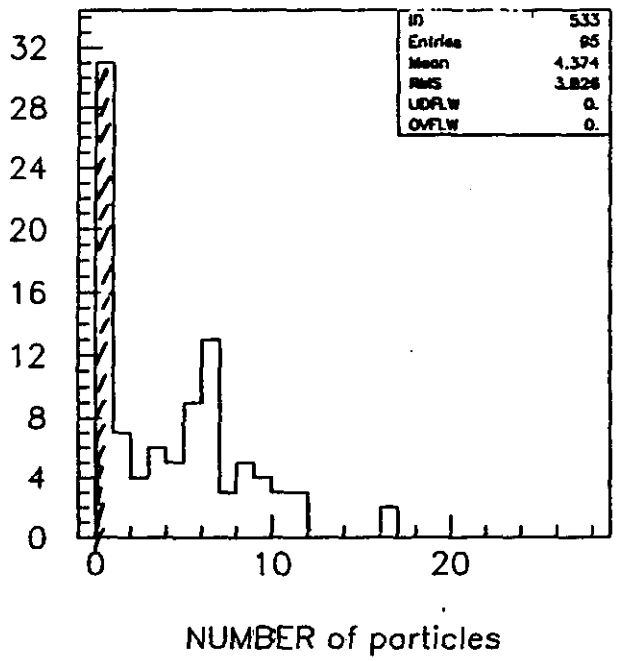

0 < η < 0.6
ID 531
Entries 1207
Mean 6.777
RMS 4.083
UDFLW 0.
OVFLW 1.000
NUMBER of particles
0.6 < η < 1.2
ID 532
Entries 1207
Mean 6.736
RMS 4.047
UDFLW 0.
OVFLW 1.000
NUMBER of particles
1.2 < η < 1.8
ID 533
Entries 1207
Mean 6.711
RMS 4.828
UDFLW 0.
OVFLW 1.000
NUMBER of particles
1.8 < η < 2.4
ID 534
Entries 1207
Mean 6.664
RMS 4.000
UDFLW 0.
OVFLW 1.000
NUMBER of particles

Fig 13

SOFT CUT







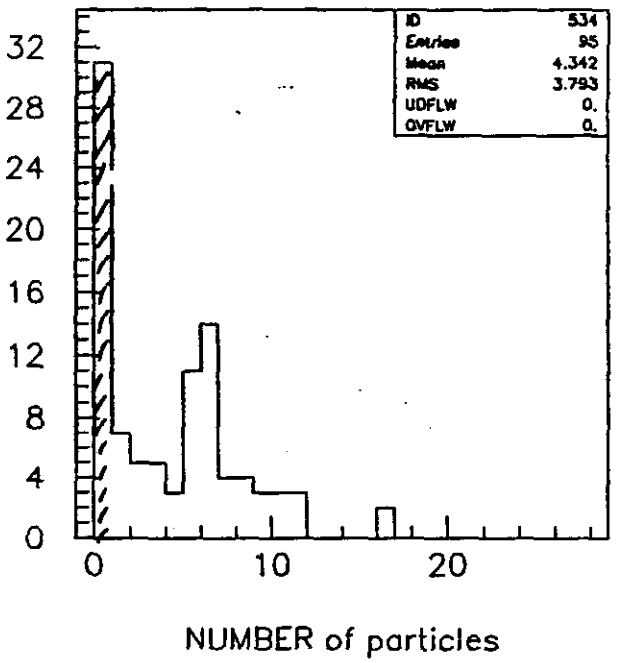


Fig. 11

STRONG CUT

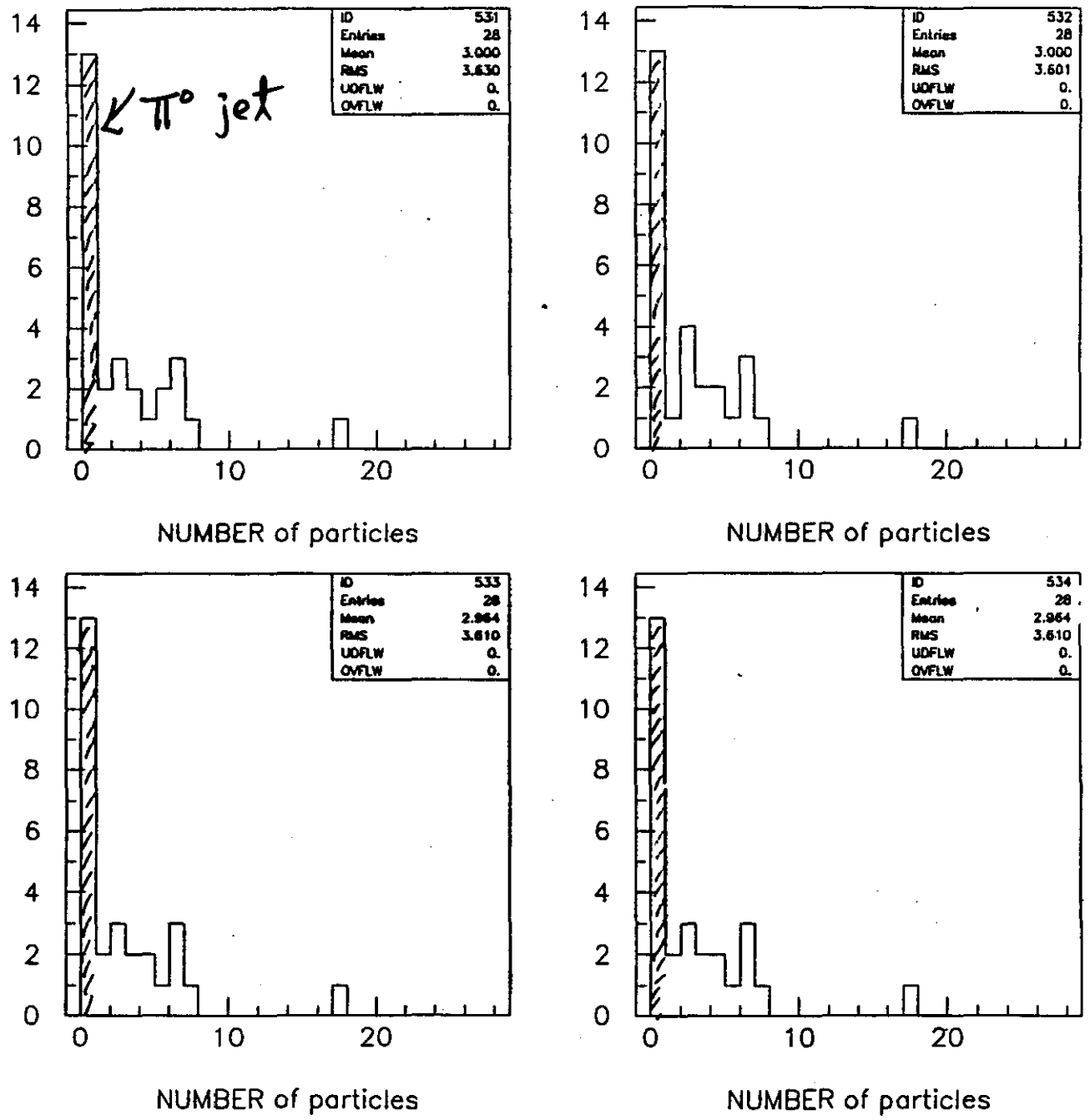


Fig. 12

gem

γeμ

Presentation by:

Chuck Bower

Early Results from IPC Prototype Test

Early Results from IPC Prototype Tests

4 June 1992

Chuck Bower
Indiana Univ.

IPC Prototype

VERY preliminary results

test chamber specs:

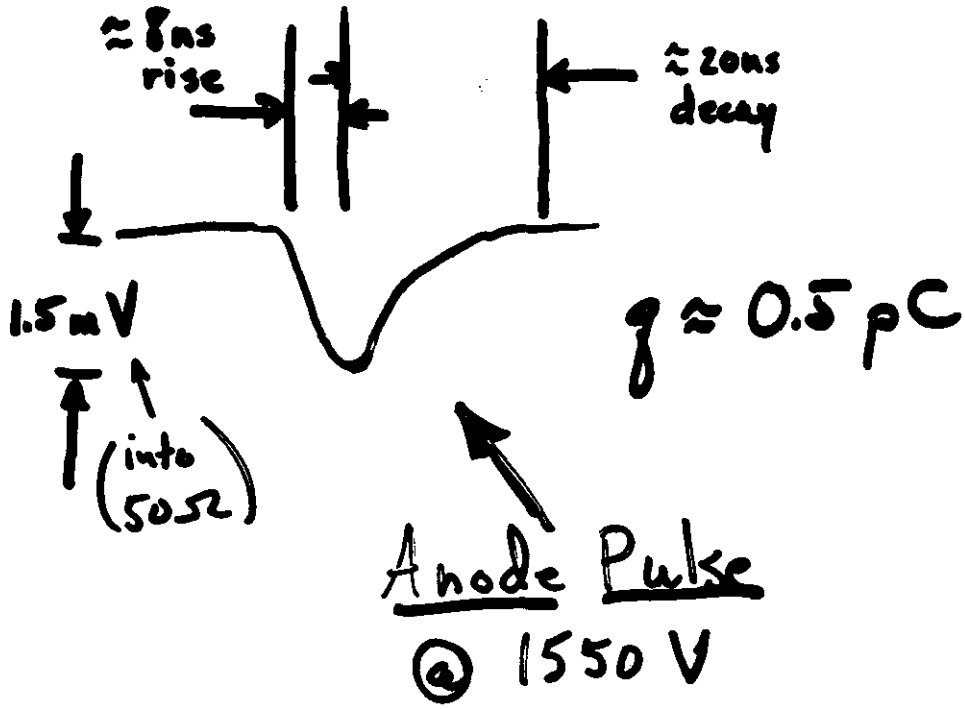
20 μm dia. anodes - Au/W
2 mm anode-anode separation
2 mm anode-cathode "
2.5 mm wide STRAIGHT cathode strips
0.075 mm cathode strip - cathode strip gap

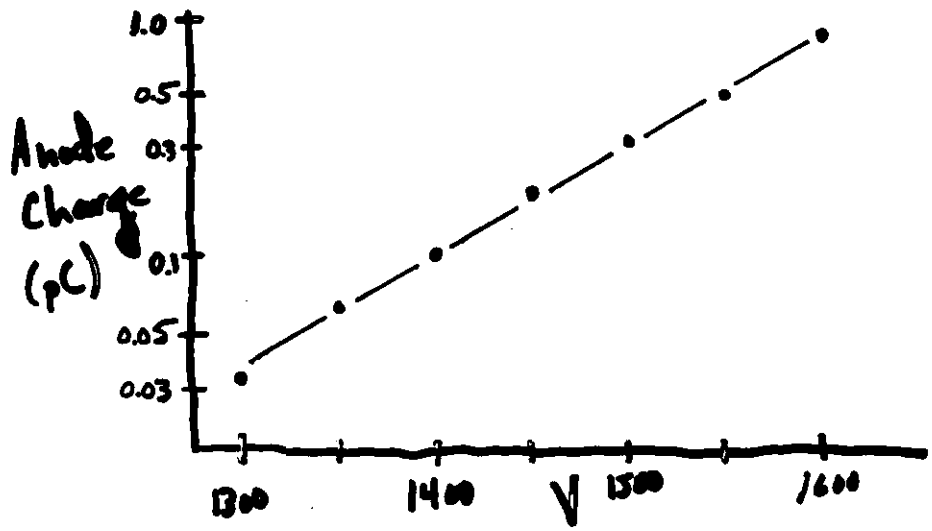
P10 gas
8.05 keV X-rays
24 μm x 37 μm "pinhole" collimator

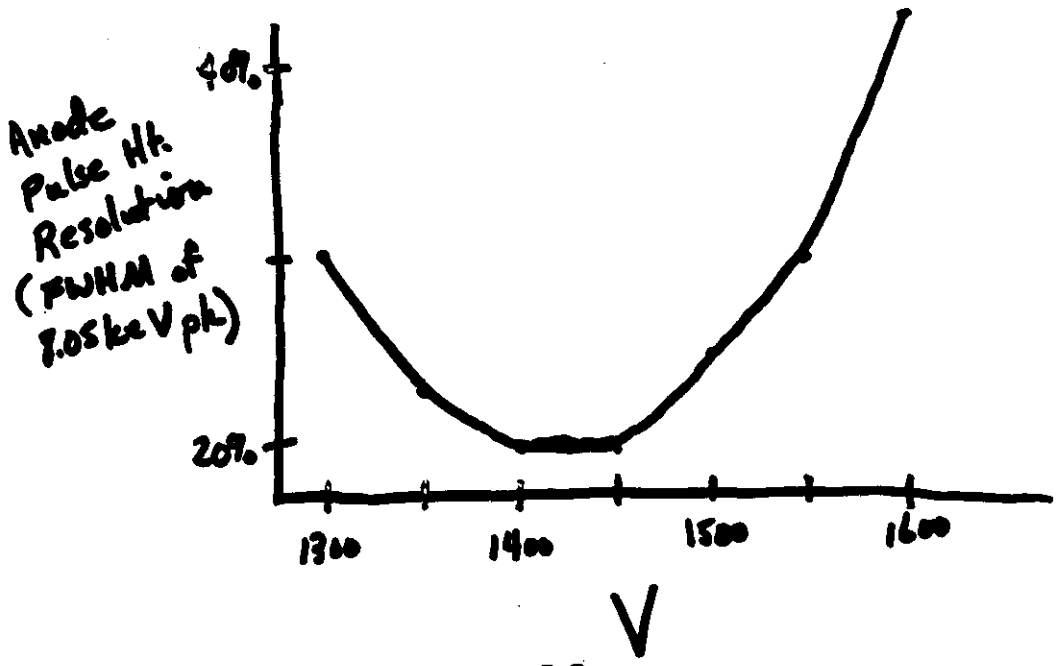
Results:

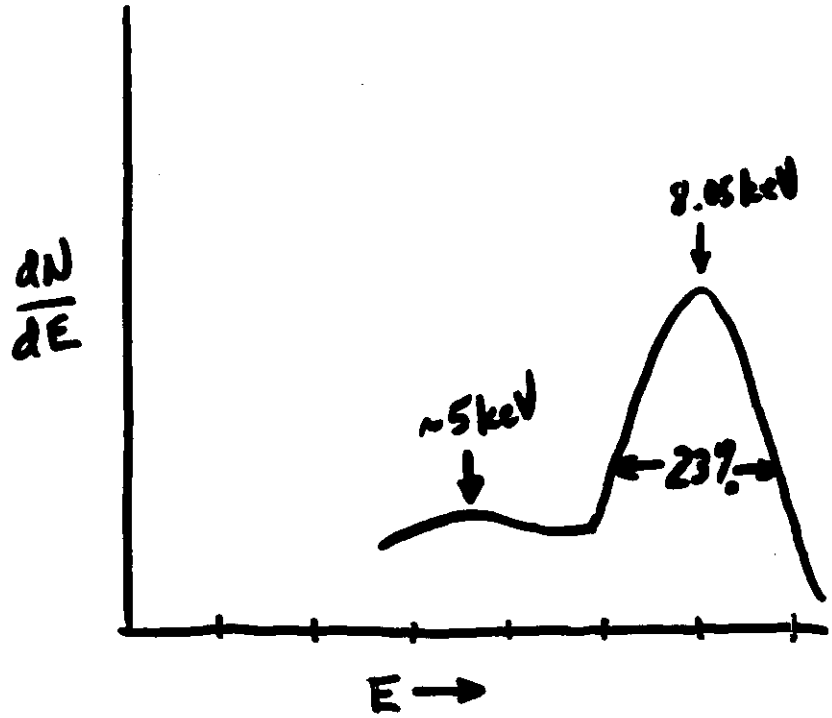
anode signals { best Energy Resolution: 18% (= 2x upper HWHM @ 1450V
spatial PH uniformity: 4.6% (σ/μ for area ≃ 4.5 wires X 5 pads

position resolution: 85 μm RMS (at one spot in chr)
↑ photoelectron range limited??
≈ 500 μm


≈ 8ns rise
≈ 20ns decay
1.5 mV
(into 50Ω)
q ≈ 0.5 pC
Anode Pulse
@ 1550 V


Anode Charge (pC)
1.0
0.5
0.3
0.1
0.05
0.03
1300
1400
1500
1600
V

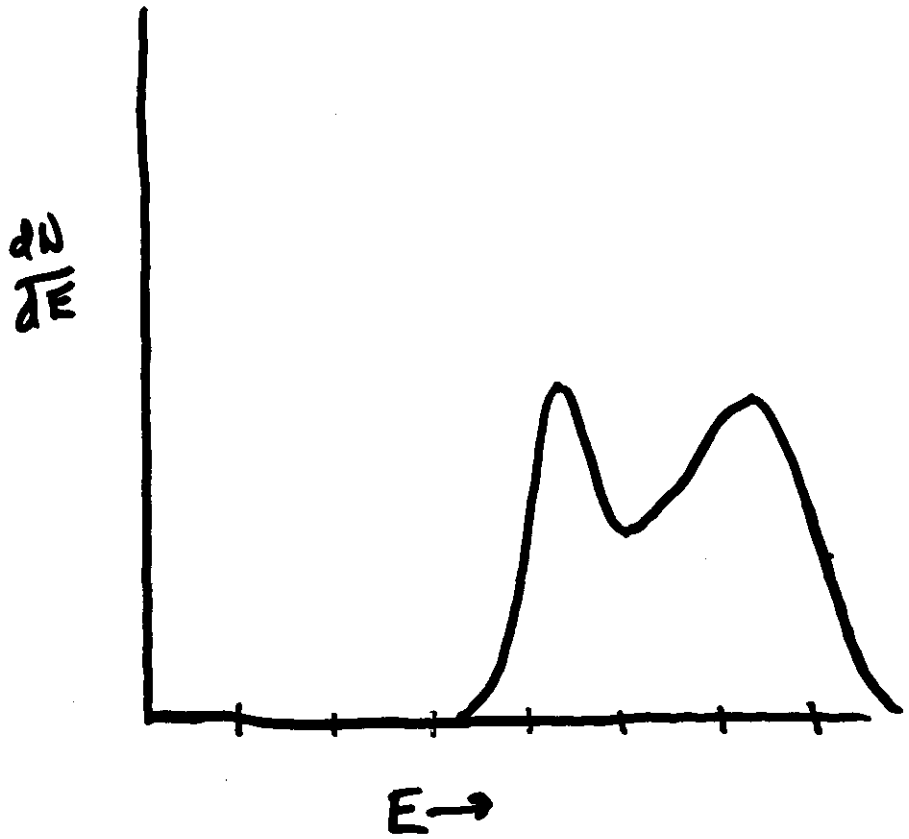

Anode Pulse Ht. Resolution (FWHM of 8.05 keV pk)
40%
20%
1300
1400
1500
1600
V



Anodes (all)

Pulse Ht. (Energy) Distribution

HV = 1350 V
P10 gas (90% Ar, 10% CH_4)
8.05 keV X-rays (Cu-K)
spot size ~ 100μm x 150μm



1 Cathode

P.H. Distr.

@ Center of Pad

Future Changes (improvements?) & tests

~1 week

new chamber (gold upper cathode instead of Aluminum)
improve collimator
try CF_4-CO_2 gases
DFNL test
Chevron cathode test

~1 month

CR μ-on telescope in 8kG magnetic field
IUCF beam test (to look @ space charge saturation
+ "crude" track resolution)

~3 months

new (fast) electronics
IUCF beam test (to investigate dosage effects)

gem

γeμ

K. Morgan

Integration Issues

Integration Issues 6-4-92

Simulations Questions

1. Material Calculations in SDC format
2. Alignment WRT real beam position
3. Tolerance of non-uniformities in B-field
4. μ chamber/tracker alignment

Preparations for Baseline 2

Subsystem to Subsystem Interface

Boundaries

BaF2 ideas

Test Beam

Plan still the same

No Los Alamos test this summer

No knowledge of where beam is available/when

"Acquisition Plan"

'92 - Fastbus readout electronics shaping time

'93 - Precision telescope resolution
Trigger scintillators and PMT's

'94 - Additional ADC's for high channel count test

'95 - Final electronics (no major additions to read out or test equipment)

#34 29-MAY-1992 19:13:46.26 MAIL
From: SMTP%"@surname.draper.com,@ccfvx3.draper.com:Joseph_Paradiso@qmlink.drap
er.com"
To: MORGAN@sscvx1.ssc.gov
CC:
Subj: Track Linking

Date: 29 May 1992 17:38:26 -0500
From: Joseph Paradiso <neuromancer@draper.com>
Subject: Track Linking
To: MORGAN@sscvx1.ssc.gov
Message-id: <FF1555EA6040C680@ccfvx3.draper.com>
X-Envelope-to: MORGAN@sscvx1.ssc.gov

Reply to: Track Linking

Kate:

Frank Taylor and I have been thinking lots about accuracy requirements driving the global alignment (to the IP) of the GEM muon array. A basic set of "global" alignment requirements are needed for the muon trigger (i.e. a high pt muon coming from the IP has to hit a full row of strips), and physics needs contribute some loose constraints (longitudinal vs. transverse momentum

Press RETURN for more...

MAIL>

#34 29-MAY-1992 19:13:46.26 MAIL

combinations vs. eta, and opening angles for invarient mass), plus this 200 micron momentum-resolution-driven goal in r-phi (which is not discussed as often these days). A logical constraint, however, may arise from track linking with the central detector (where the muon angle can indeed be measured very well!). I'd be interested in an estimate from a central detector person as to what kind of angle error would you want to see between central tracker and muon array for adequate track linking (the calorimeter, of course, will contribute considerable scattering at low momentum, and the linking error will be driven by the multiplicity seen in the tracker). If you (or a colleague) have any comments on this, please send them over when you get a chance.

Thanks --Joe--

Suggestions for IMprovement of Baseline 1
M. Marx
June 2, 1992

We intend to upgrade and improve the baseline 1 document for the dual purposes of providing more coherent information to the collaboration and to use as a major part of our submission to the PAC in J . For the former we request help from the subsystems in upd ıg the information, improving the format, adding material where needed, and weeding out extraneous material. For the latter, we intend to b up the textual material as a guide for the PAC tc our current de status It is worthwhile to recall that the last submission to the PAC was our LOI in December - this had no FFS, a completely different tracker, no mobile magnet, etc...

We list below requested changes in the baseline. First general changes and additions are listed, and then subsystem specific comments are indicated. Further improvements suggested by each susbsystem are welcomed, and suggestions of others will be forwarded. You are urged to look critically at all subsystems - this volume is intended to be read and used by non-experts as well as afficionados!

General Comments:

1 We will a 2 new sections on Radiation Levels/Activation and on SSC Test Beam Facilities and Plans.

2 All technical drawings should conform to standard engineering practices.

3. All drawings, plots, and illustrations should be provided with clear captions, if at all possible, directly on the figure.

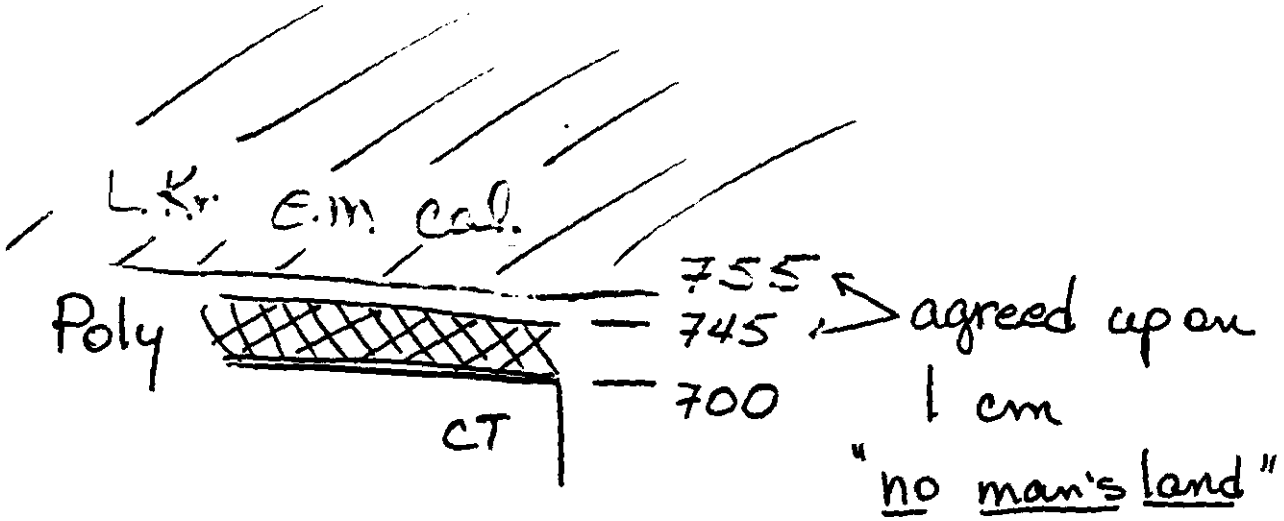
4. All subsystems should revisit the introductory texts from the point of view of explanation to the PAC of changes from the LOI (and rationale), and the current staus of the design and the outstanding issues. **These should be submitted within 1 week (due June 12).**

5 All subsystems should re-examine the statements of physics and engineering specifications which preface the sections. These should provide a clear statement of the highest level specifications, goals, purposes and constraints within which the design is proceeding.

6. All plots of performance calculations should reference existing or future GEM notes to provide the basis of the calculations. This includes resolutions, acceptance, efficiencies, etc.

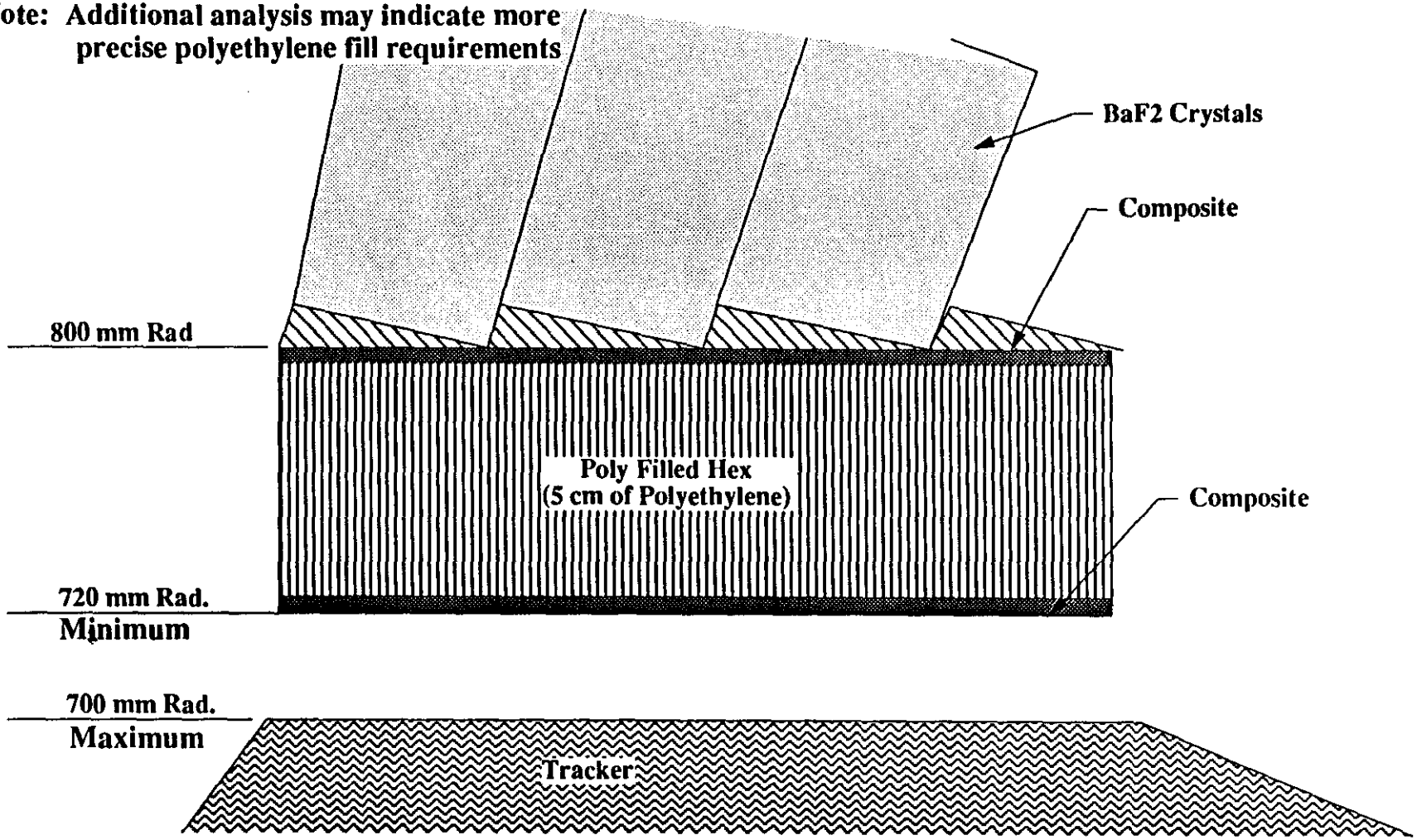
7. All drawings showing more than one subsystem should show baseline versions of each system for consistency.
8. All systems should provide abbreviated lists of key milestones to augment the general GEM and facility milestones. **These are due by June 12.**
9. All submissions to the new baseline should be complete by June 25.

Specific System Comments:
Magnet and Field
    Check that Baseline is coinsistent with TDR
Tracker
    Fix consistency of calorimeter drawings
    Wire readout to stereo pads
    Material budgets for silicon and IPC - plots for all eta
    Drop cabling requirements
Calorimeter
    Legitimize new baseline
    Show module details - EM and Hadron
    Show plots of X0 and lambda vs eta,phi
    Resolution vs eta
    Acceptance for e,gamma
Muon
    Show technical details of technologies
    Show truss details for barrel and ends
    Fix table p 11-17
    Captions and Figures in Sec 4 don't match
    DEpth doesn't match calorimeter baseline
    Does energy loss include calorimeter measurements??
    Trigger plots hand drawn!!! General quality poor
Alignment
    Needs beef



GEM Wide agreement on
1cm / subsystem - "no man's land"
Relaxed for CT/EM cal interface due
to "soft" poly liner

Note: Additional analysis may indicate more precise polyethylene fill requirements

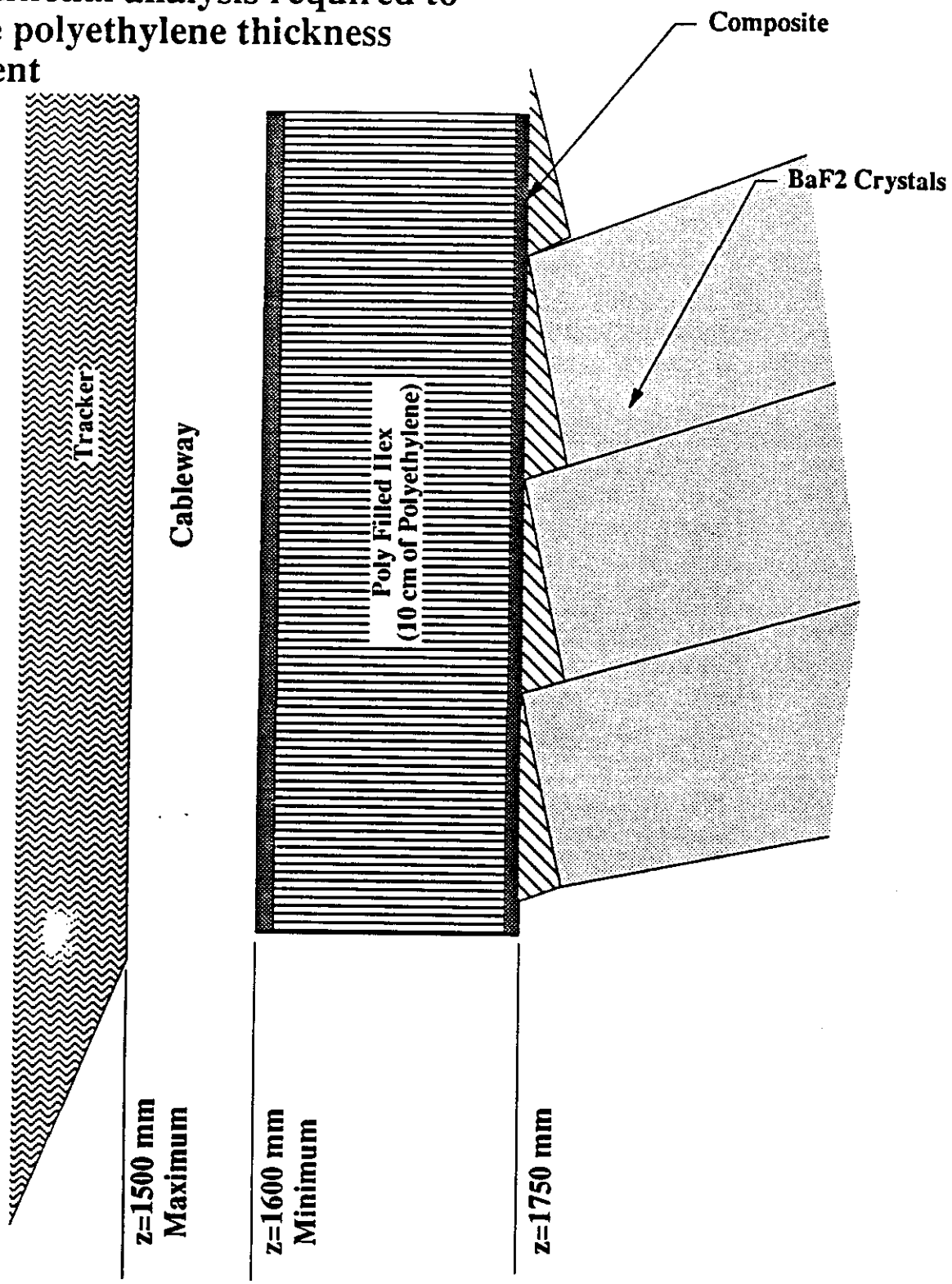


GEM Detector
BaF2/Tracker Interface
at Eta=0.0

G.03.BF.029

Rennich

Note: Additional analysis required to determine polyethylene thickness requirement



GEM Detector
BaF2/Tracker Interface
at Eta=3.0

G.03.BF.030

Rennich

GEM Central Tracker
Interpolating Pad Chamber
Test Beam Needs 1992 - 1995

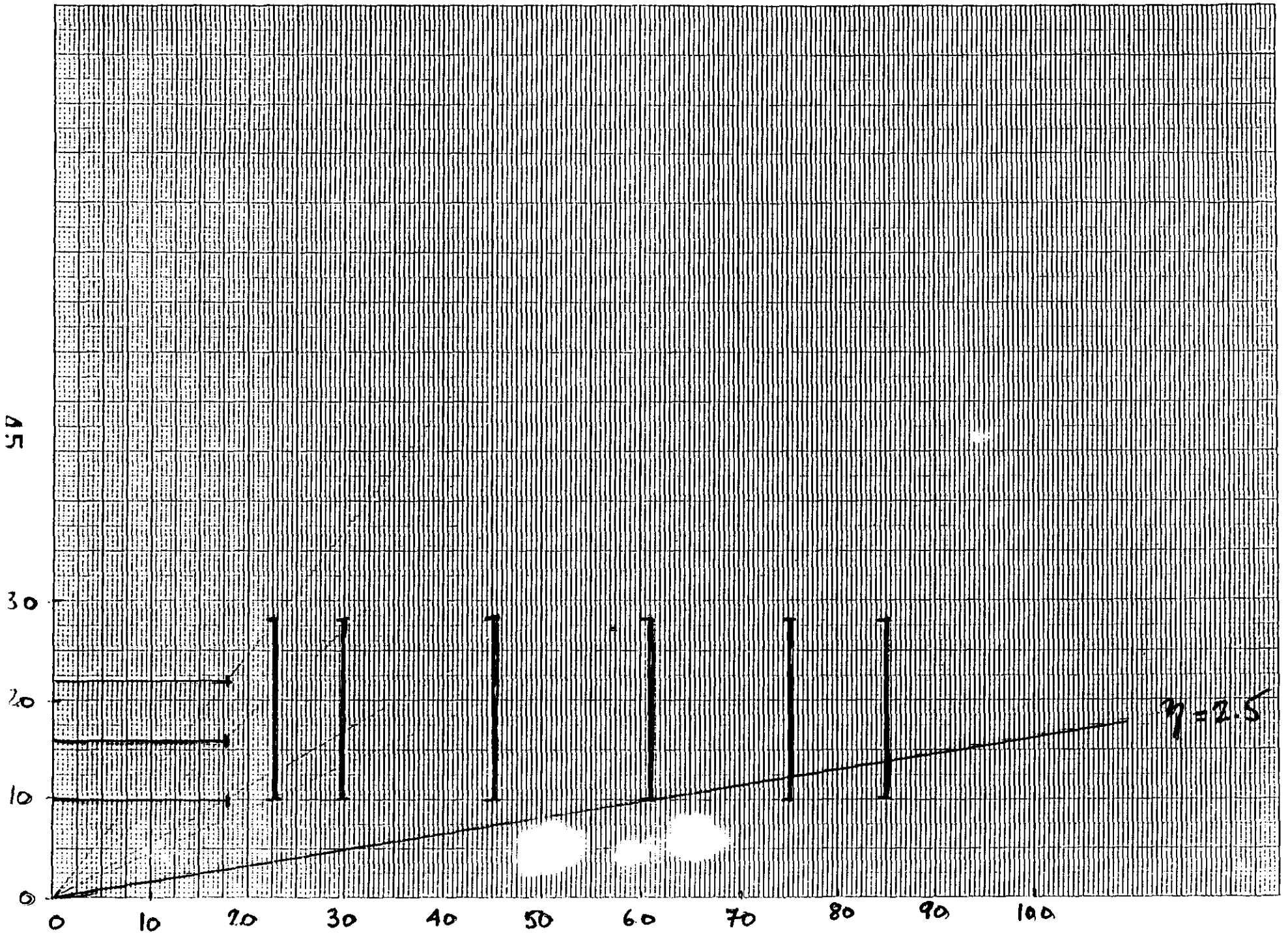
Time	Device/Test	Beam Location or Parameters	Required Beam Time
mid 1992	operating parameters of a small chamber	~~Los Alamos~~, no low rate secondary beam, a few hundred MeV e's, μ's, π's	1 month
early 1993	Resolution of full sized prototype of barrel pad chamber, scan over the full length of the device	e's, μ's, π's of a few GeV, protons $\geq$ 5 GeV, rate: a few particles/sec. well collimated beam with position measurement	3 months
early 1994	rate capabilities of full sized prototype, both barrel and end caps, with final electronics	high rate secondary beam ~10^9 particles/sec. which can be spread over ~30 cm^2 in the chamber	3 months
1995	Systems Tests: gas, cooling, mechanics, etc. of final design	same as 1994	3 months

2/18/92-KM

gem

γeμ

Silicon Optimization

KEUFFEL & ESSER CO. MADE IN U.S.A.

June 1, 1992