GEM TN-92-250

Cathode Strip Chambers Group Meeting - SSCL

December 10, 1992

Abstract:

Agenda, attendees, and presentations of the GEM CSC Group Meeting held at the SSC Laboratory on December 10, 1992.

DRAFT AGENDA OF CSC MEETING THURSDAY DECEMBER 10
3 PM - 7 PM DUNCANVILLE HOLIDAY INN

Introduction - Gena Mitselmakher- 5min

BNL CSCs - status - Vinnie Polichronakos/ Valery Chernyatin - 15 min

Dubna CSC - Yuri Kiryushin - 15 min

UH CSC - Kwong Lau - 15 min

Plans on CSC electronics development: - Dan Marlow/Vinnie Polichronakos - 30 min
- electronics for prototypes in 93
- long term plans and cost evaluation procedure

CSC Trigger development - Maged Atiya - 15 min

Progress on strip boards production - Coleman Johnson/ Cas Milner - 15 min

Chamber parameters optimization for barrel and end caps
(strip width,gap,wire/track angle, differential nonlinearity etc.)
- Valery Chernyatin - 20 min

Organization of working groups - Gena Mitselmakher/ group

DISCUSSION/ CONCLUSIONS/ PLANS - group 30 min

CSC Meeting 12/10/92

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17. Andrey Ostapchuk	OSTAPCHUK@SSCVX1	(214)-708-3007
18. Yuri Bonushkin	BONUSHKIN@SSCVX1	(214)-708-3078
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20. Joe Paradiso	neuromancer@draper.com	617-258-2413
21. Cas Milner	milner@SSCVX1	

gem

γeμ

Presentation by:

S. Whitaker

CSC Tests at RD5

WORK IN PROGRESS ...

Detectors: two doublets 5mm strip T.I.S.
2.5 mm wire pitch
5cm wire gangs

strip readout: Amplex (no preamps)
256 ch LRS FERA ADC's
35 m cable run

anode readout: PNPI preamp / shapers
32 ch ORNL motherboard, discriminators
LRS 2277 TDC each channel
LRS 2228 TDC plane OR's

RD5 DAQ $\rightarrow t_0$

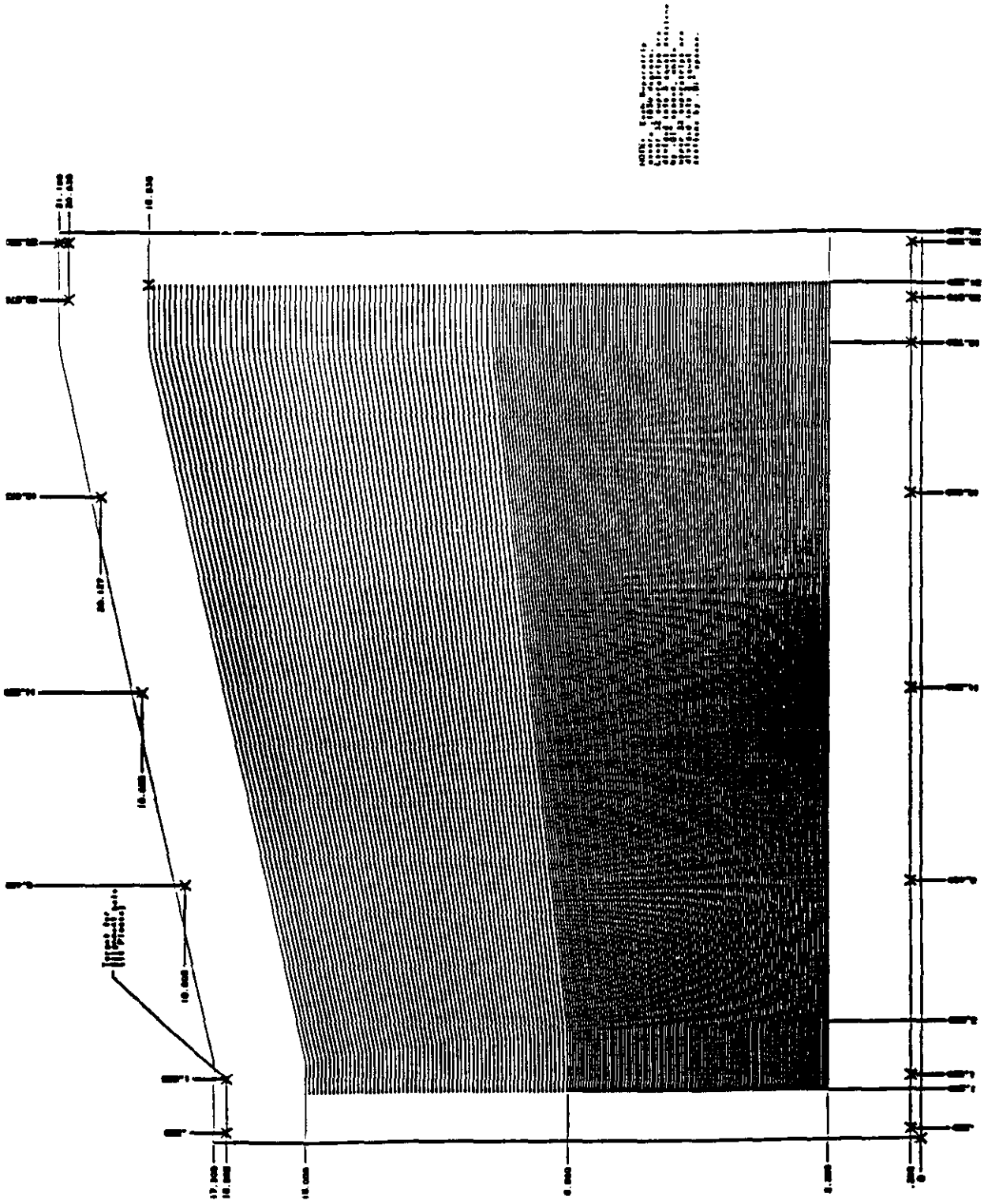
Jim Shank
Dave Warner

Beam: Nov 1-14

π^- 100 - 200 GeV
μ^- 100 - 300 GeV

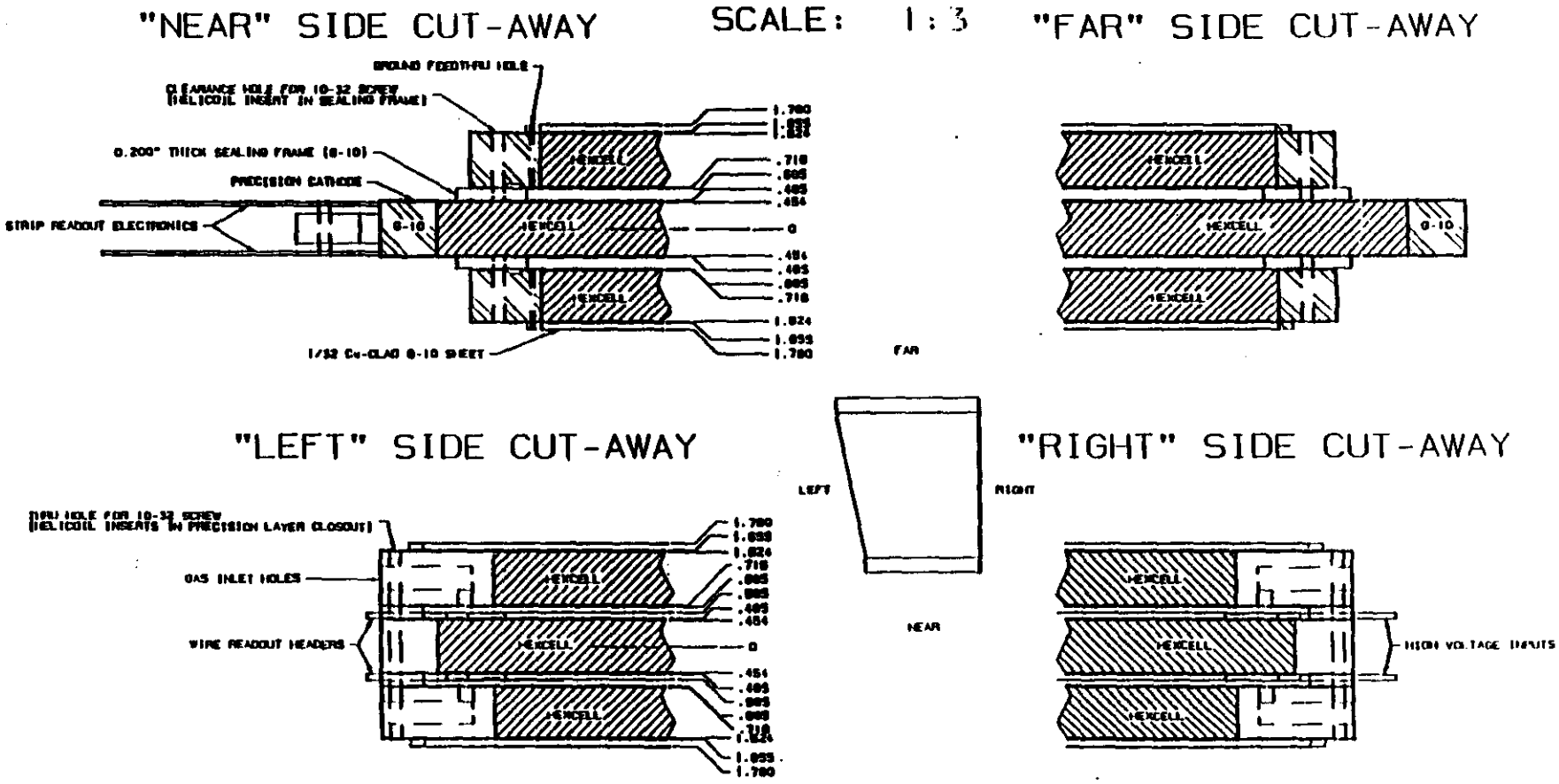
Just upstream from our detector:
$\sim 20\ \lambda$ calorimeter + stuff
RPC

Measured response at various angles...



CSC DOUBLET -- CONCEPTUAL DESIGN

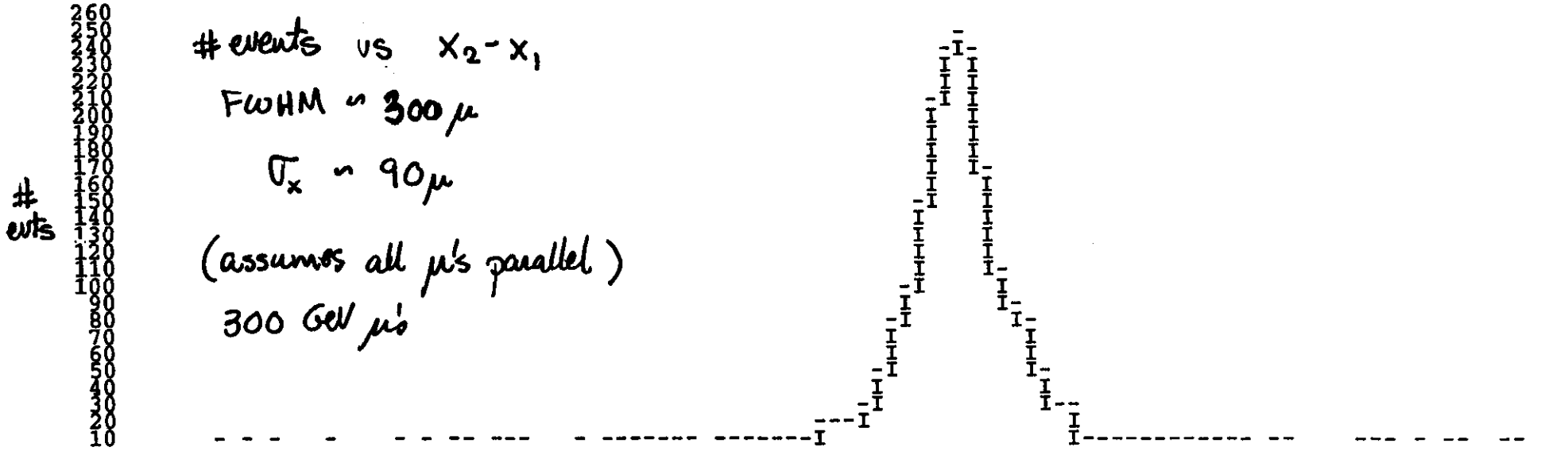
SCALE: 1:3



FIRST GLIMPSE:

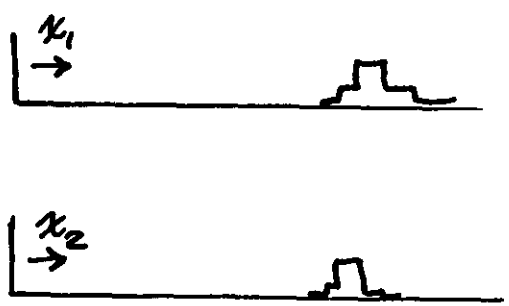
plane 1/2 cluster posn diff

HBOOK ID = 211 DATE 09/12/92 NO = 18



* ENTRIES = 2017 * ALL CHANNELS = 0.1998E+04 * UNDERFLOW = 0.6000E+01 * OVERFLOW = 0.1300E
* BIN WID = 0.5000E-01 * MEAN VALUE = 0.1554E+00 * R . M . S = 0.3243E+00

50μ



Needed:
- pedestal checks
- * gain correction
- alignment constants
- fitted tracks

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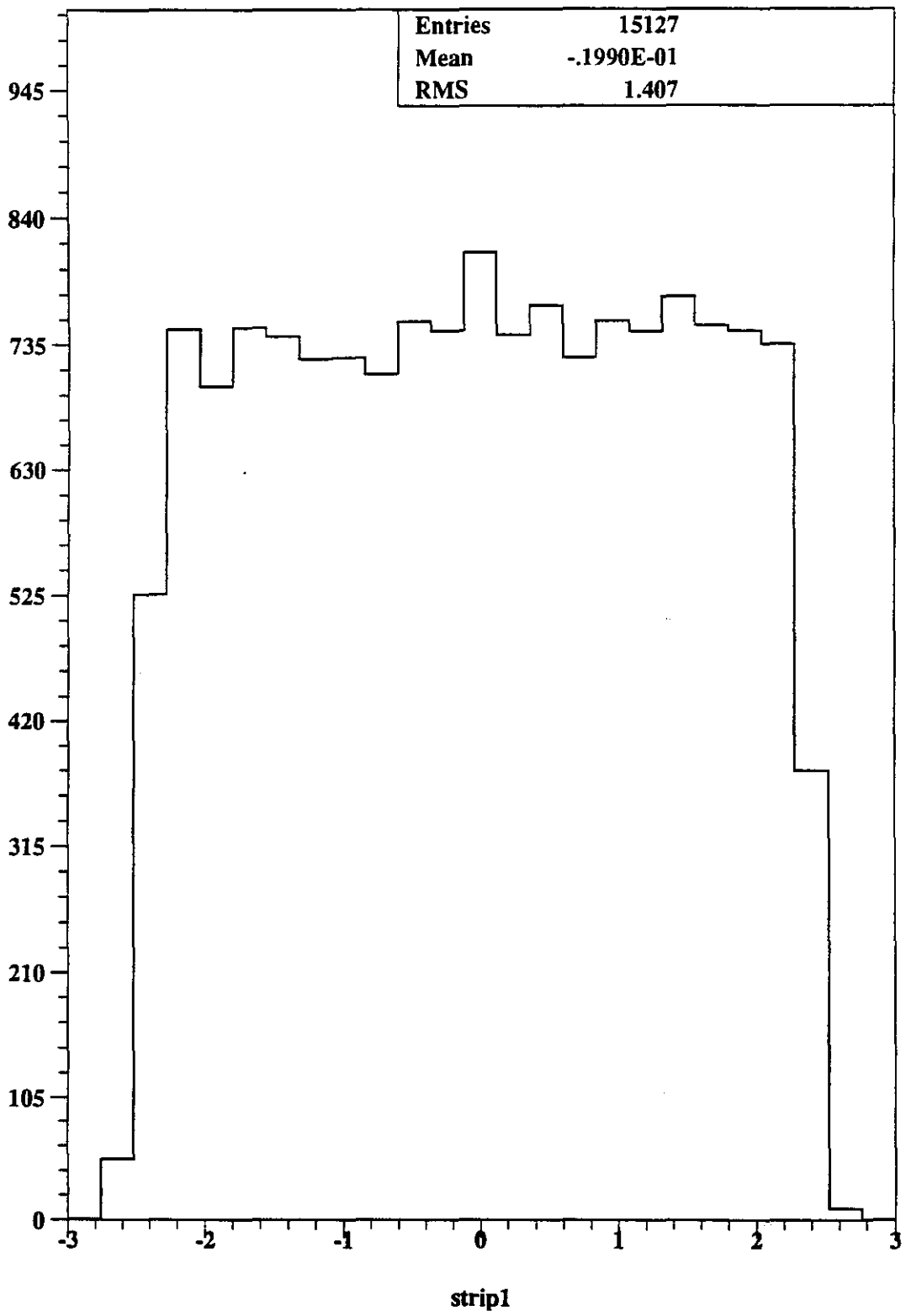
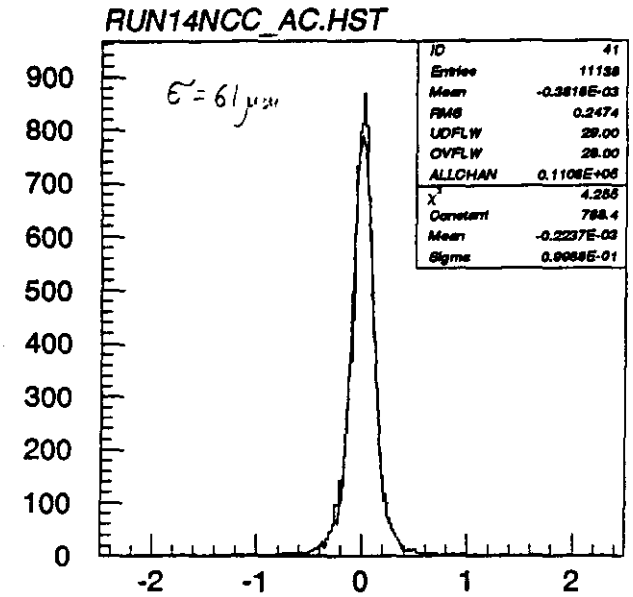
Presentation by:

V. Polychronakos

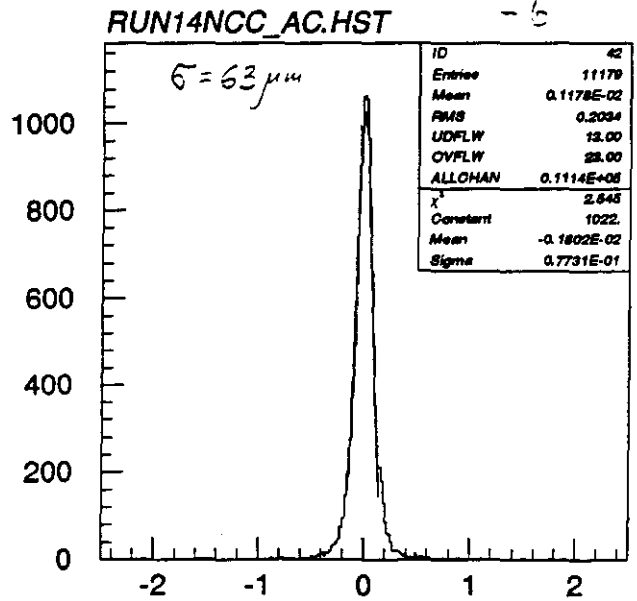

Entries 15127
Mean -.1990E-01
RMS 1.407
945
840
735
630
525
420
315
210
105
0
-3
-2
-1
0
1
2
3
strip1

92/12/08 15.56

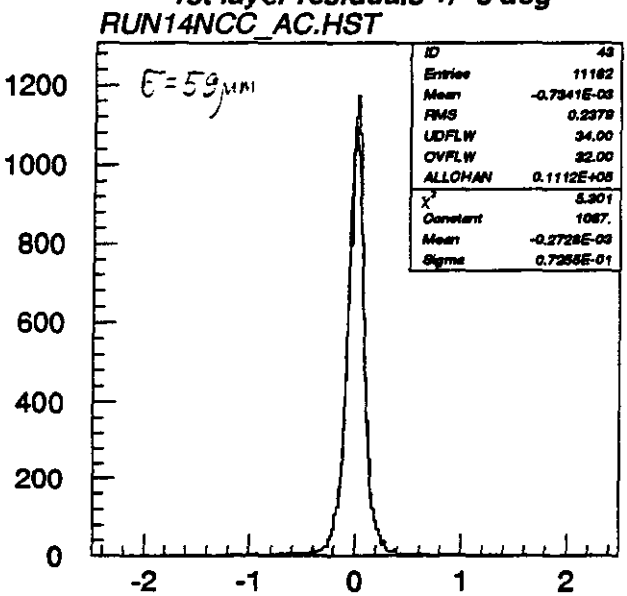
Run 14 <residual>=0 and phi corrected. ratio used



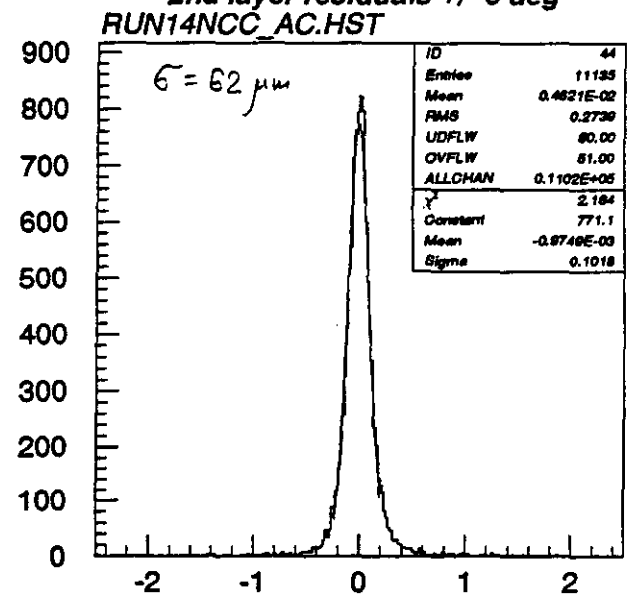
1st layer residuals +/- 6 deg



2nd layer residuals +/- 6 deg



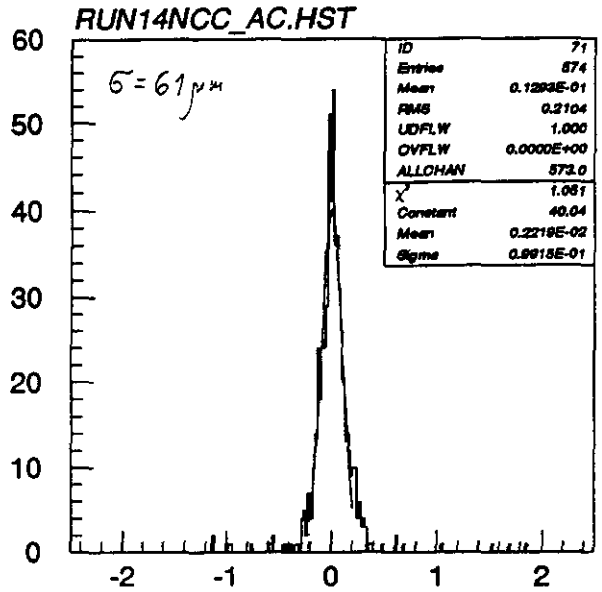
3rd layer residuals +/- 6 deg



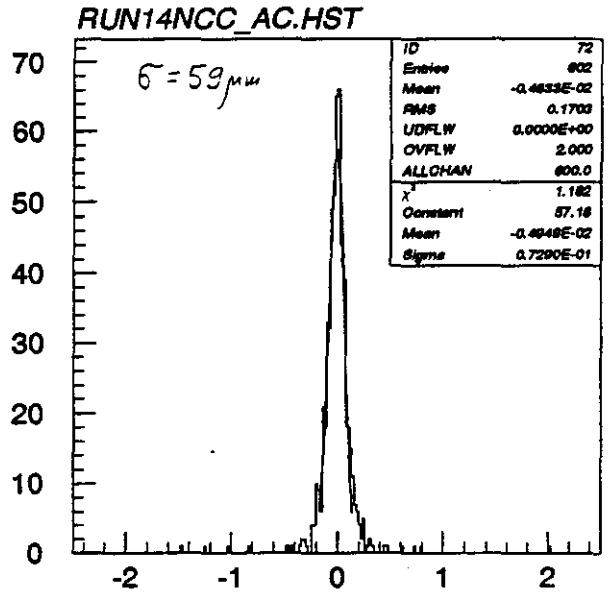
4th layer residuals +/- 6 deg

92/12/08 15.55

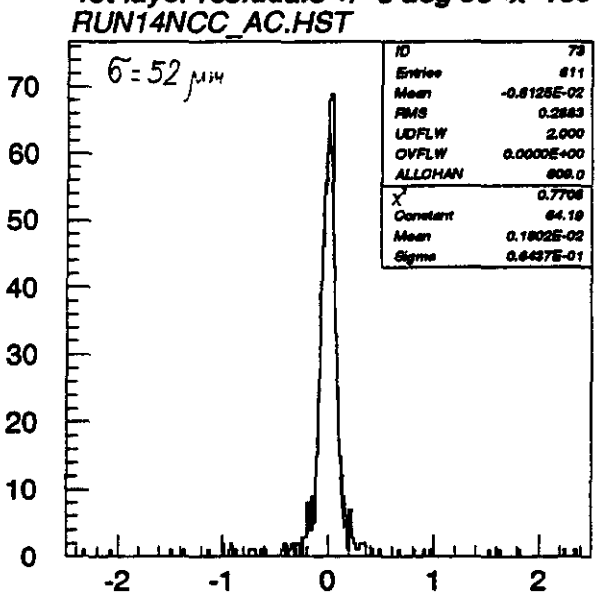
Run 14 <residual>=0 and phi corrected. ratio used



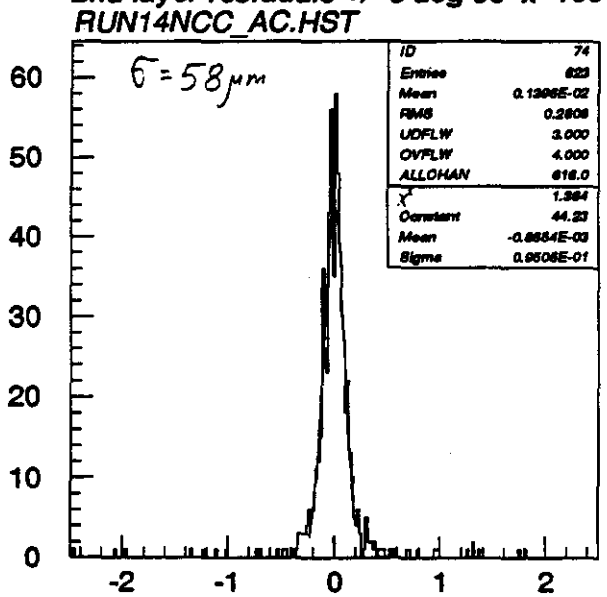
1st layer residuals +/- 6 deg 90<x<100



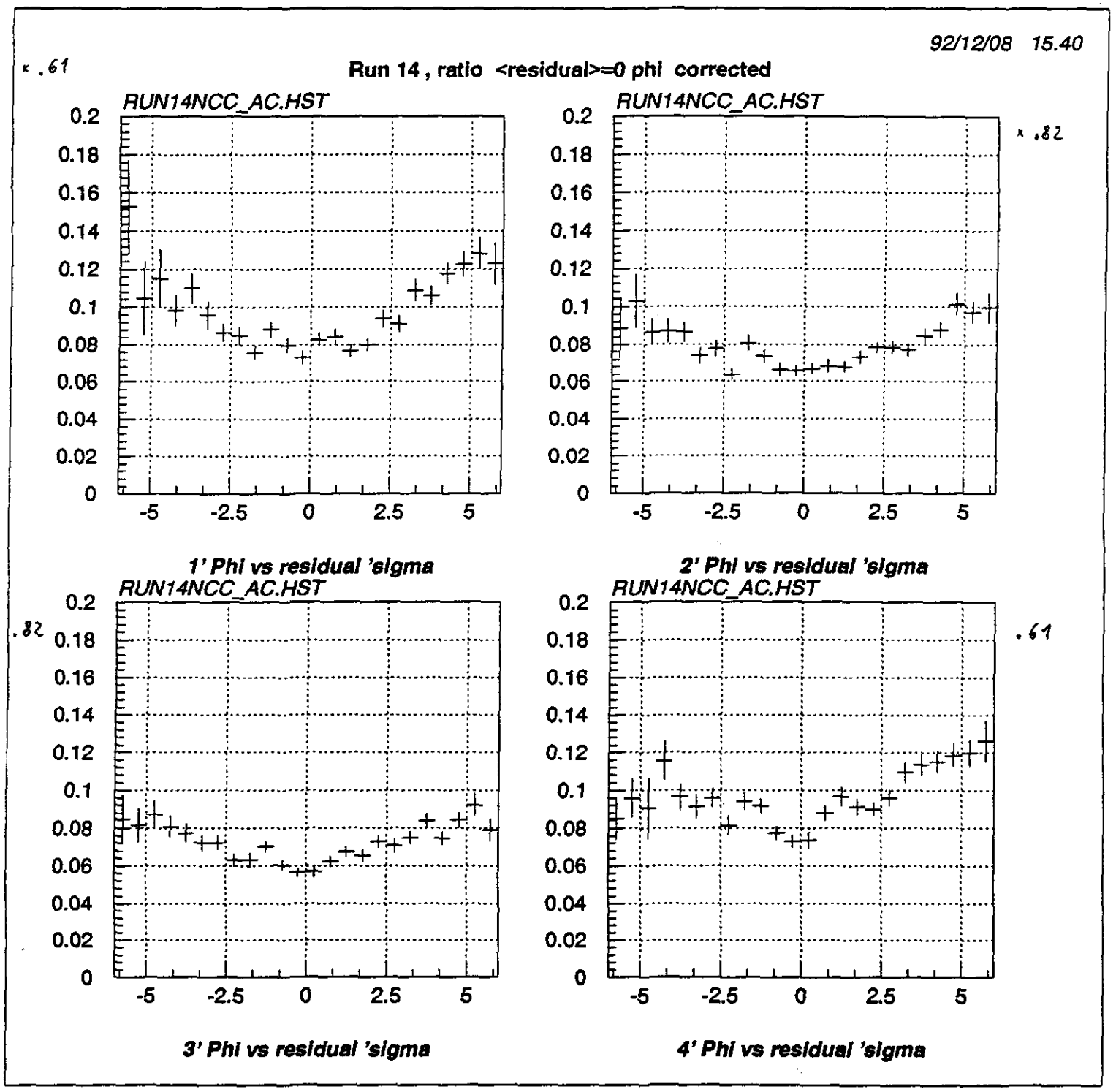
2nd layer residuals +/- 6 deg 90<x<100



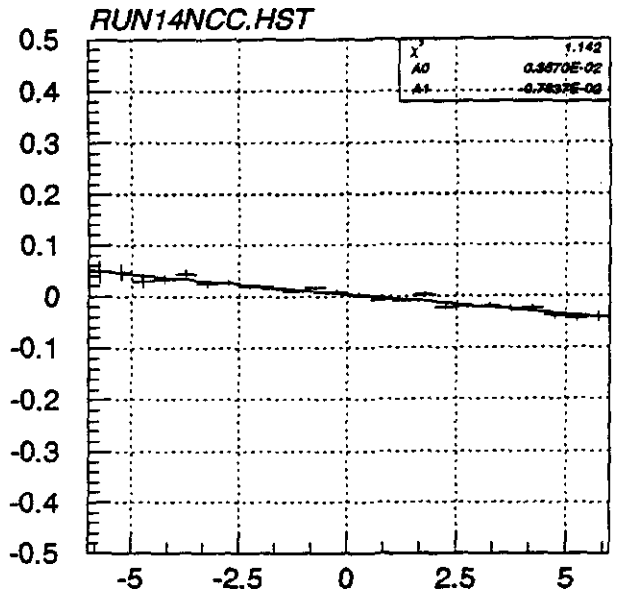
3rd layer residuals +/- 6 deg 90<x<100



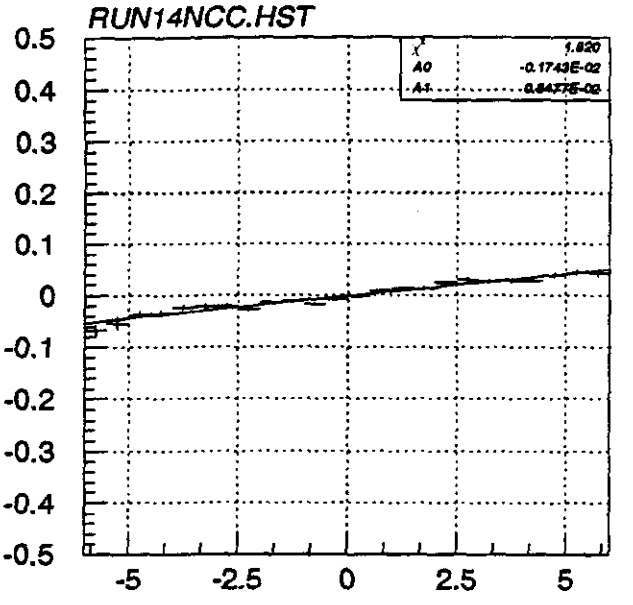
4th layer residuals +/- 6 deg 90<x<100


92/12/08 15.40
Run 14 , ratio <residual>=0 phi corrected
RUN14NCC_AC.HST
1' Phi vs residual 'sigma
2' Phi vs residual 'sigma
3' Phi vs residual 'sigma
4' Phi vs residual 'sigma

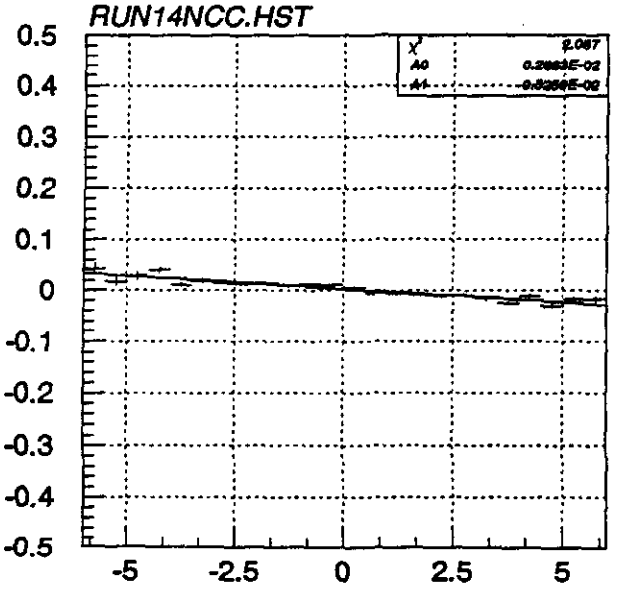
92/12/08 15.07



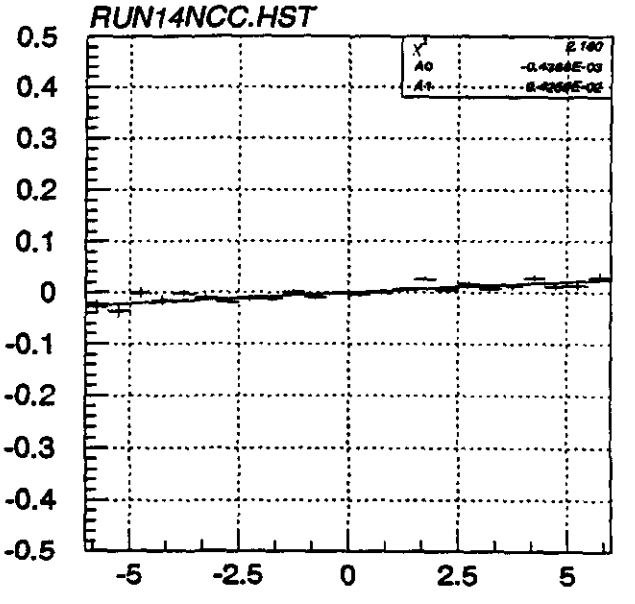
1' Phi vs residual 'mean



2' Phi vs residual 'mean



3' Phi vs residual 'mean



4' Phi vs residual 'mean

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Presentation by:

Yu. Kiryushin

HQV-820M selection

In total - 52
Dead channels - 2
Noisy channels - 6
Single noisy chan. - 6

ADC

Range 9 bit

Input ampl. ± 2v

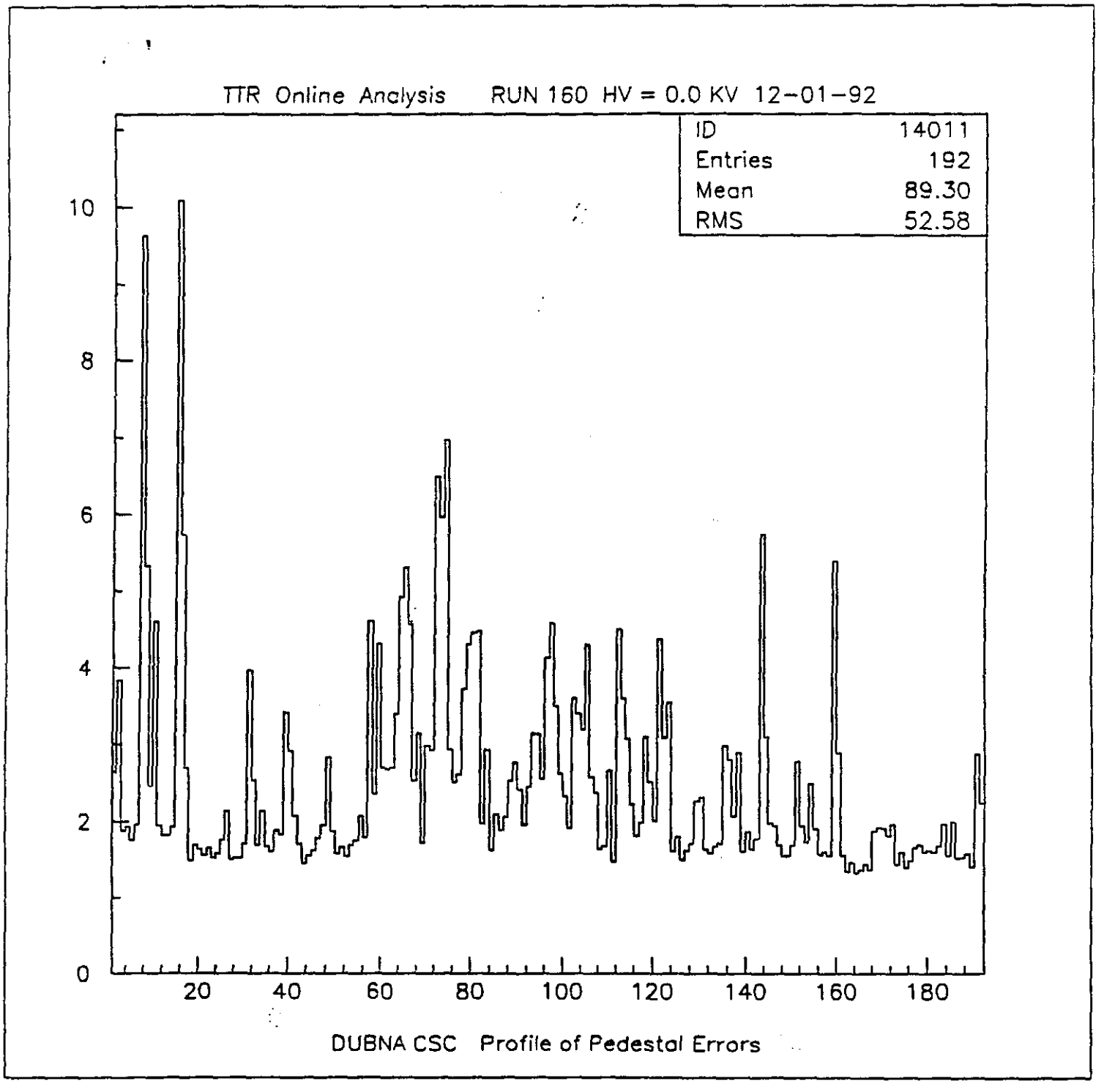
Now ADC has been modified in order to use full range.

Sensitivity to mechanical deformation

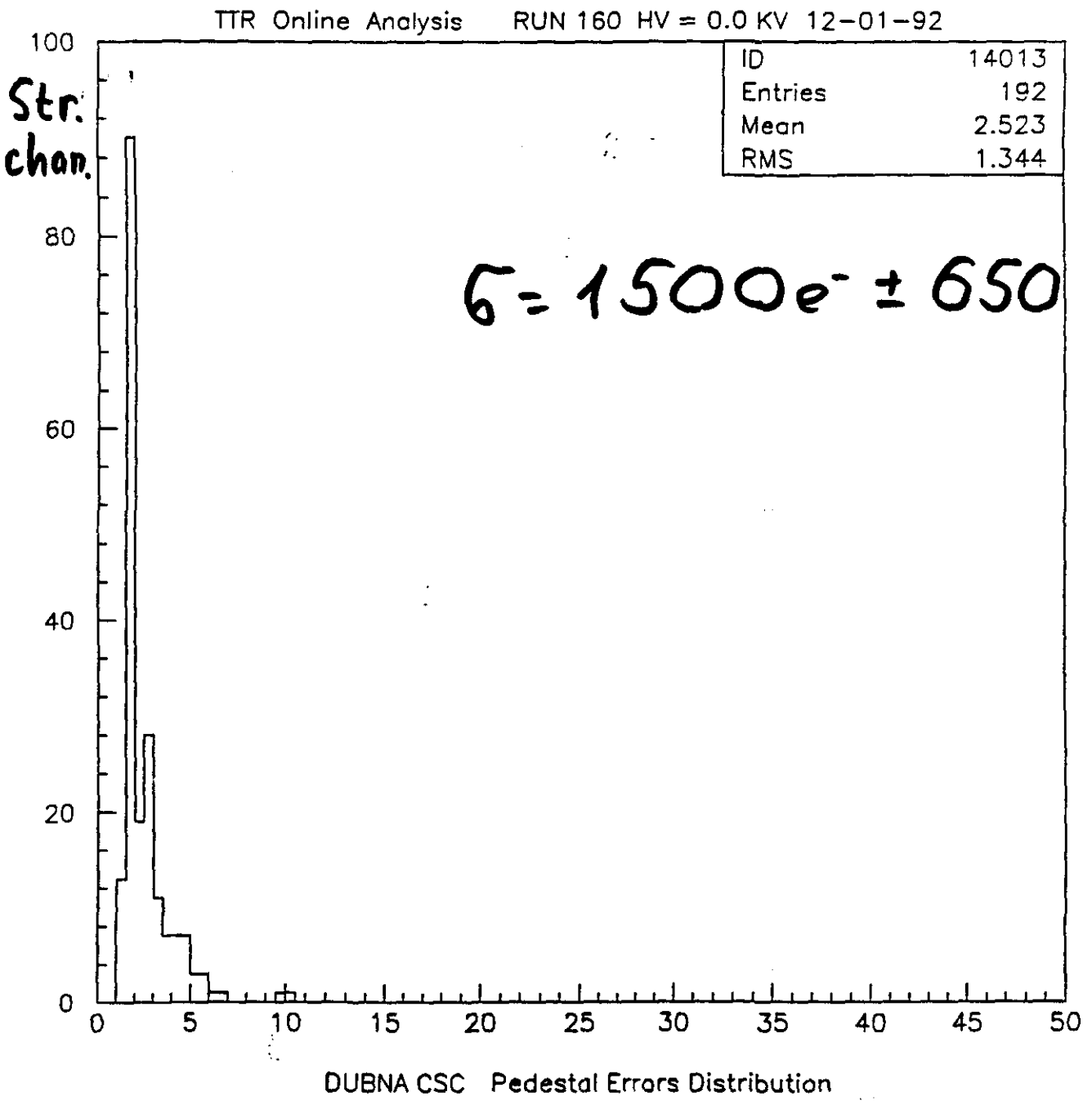
Charge per wire

$$C \times U = Q$$

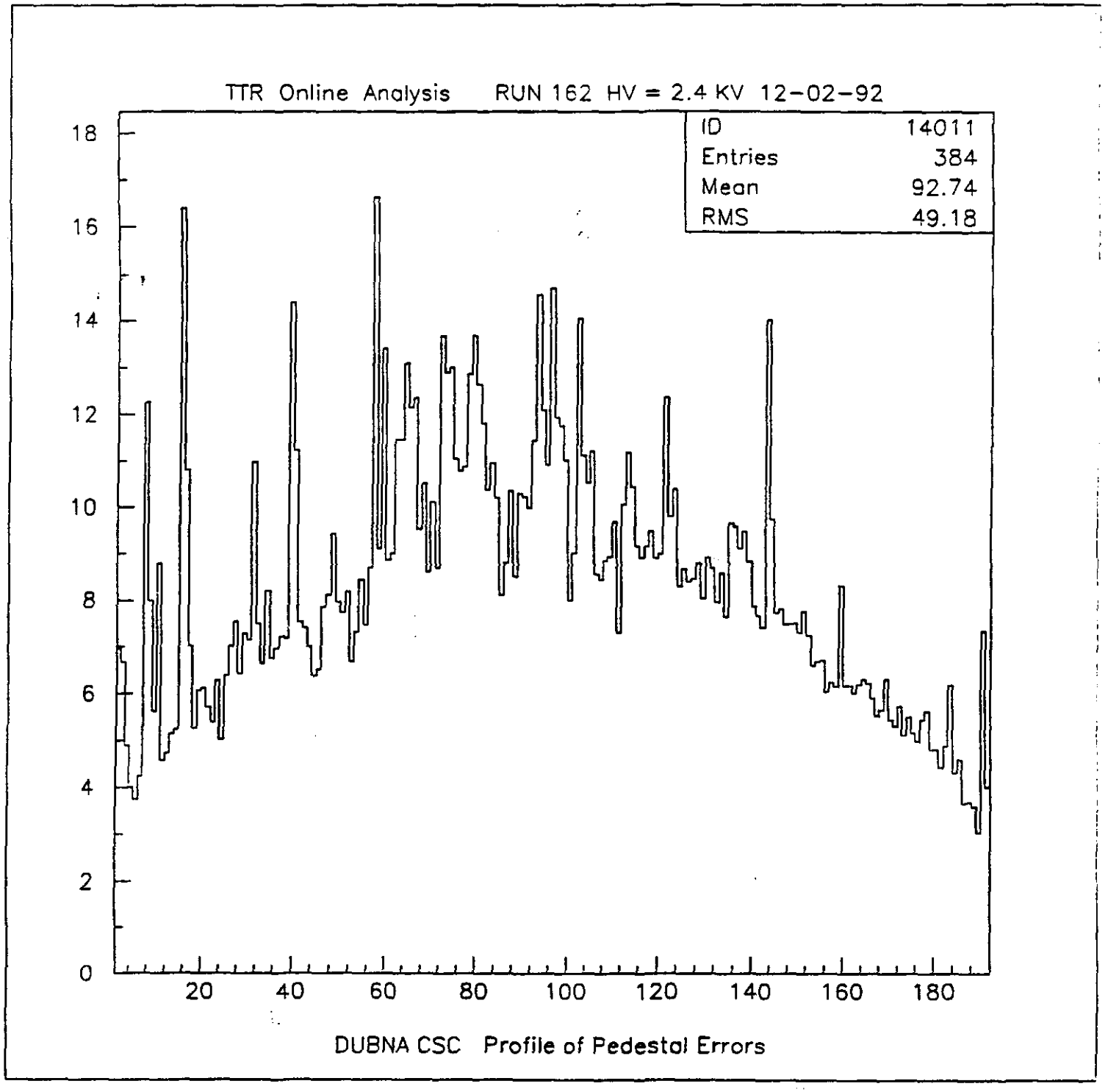
10 pF/m 2600 v 26000 pC


TTR Online Analysis RUN 160 HV = 0.0 KV 12-01-92
ID 14011
Entries 192
Mean 89.30
RMS 52.58
0
2
4
6
8
10
20
40
60
80
100
120
140
160
180
DUBNA CSC Profile of Pedestal Errors

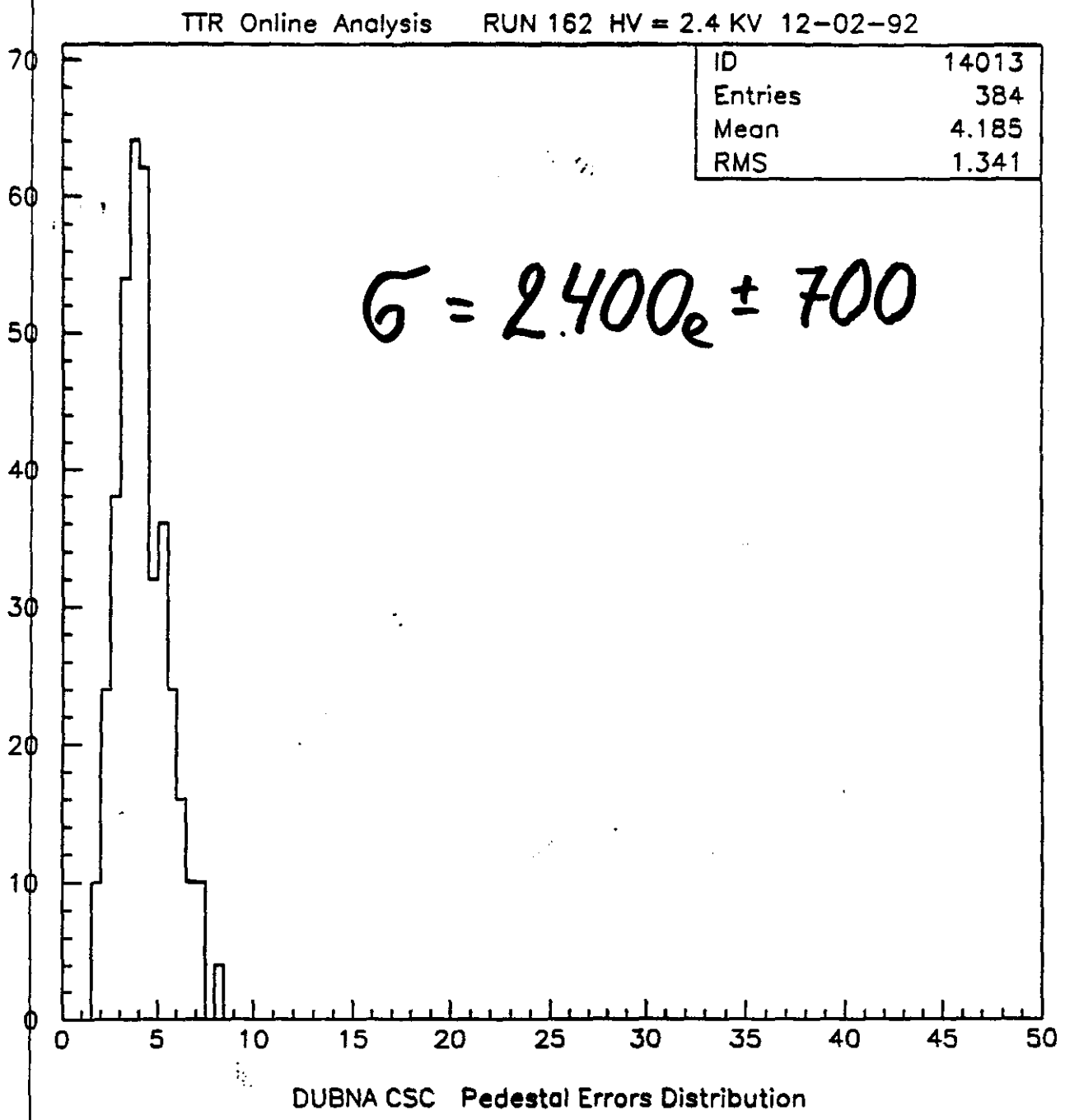
HV = 0

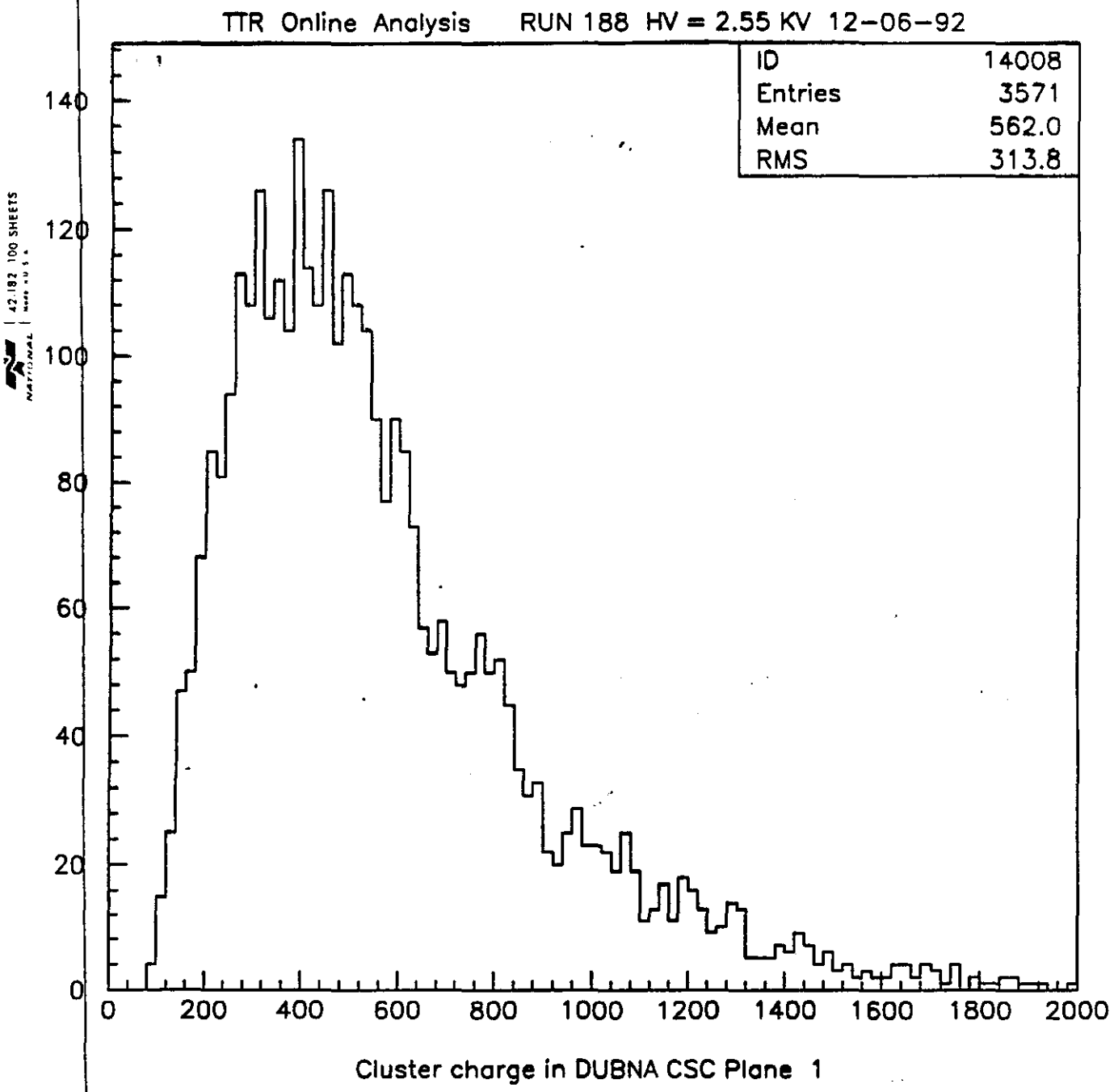

TTR Online Analysis RUN 160 HV = 0.0 KV 12-01-92
ID 14013
Entries 192
Mean 2.523
RMS 1.344
Str. chan.
σ = 1500e⁻ ± 650
100
80
60
40
20
0
0 5 10 15 20 25 30 35 40 45 50
DUBNA CSC Pedestal Errors Distribution

H.V. = 2.4kV


TTR Online Analysis RUN 162 HV = 2.4 KV 12-02-92
ID 14011
Entries 384
Mean 92.74
RMS 49.18
0
2
4
6
8
10
12
14
16
18
20
40
60
80
100
120
140
160
180
DUBNA CSC Profile of Pedestal Errors

H.V. = 2.4KV


TTR Online Analysis RUN 162 HV = 2.4 KV 12-02-92
ID 14013
Entries 384
Mean 4.185
RMS 1.341
σ = 2400e ± 700
0
10
20
30
40
50
60
70
0
5
10
15
20
25
30
35
40
45
50
DUBNA CSC Pedestal Errors Distribution


TTR Online Analysis RUN 188 HV = 2.55 KV 12-06-92
ID 14008
Entries 3571
Mean 562.0
RMS 313.8
0
20
40
60
80
100
120
140
0
200
400
600
800
1000
1200
1400
1600
1800
2000
Cluster charge in DUBNA CSC Plane 1

gem

γeμ

Presentation by:

K. Lau

UH CSC Prototype

- 3 layers of 1.0 m (long) x 0.5 m precision strips (pitch = 5.0 mm = 4 mm Cu + 1 mm gap)
- 3 layers (12 chambers per layer) of 66-cm Iarocci-type carbon-coated (4 kΩ per square) profiles with 45 μm gold-plated tungsten wires
- standard (75/25 Isobutane-argon) gas mixture in proportional mode (3.0 - 3.3 kV)
- 10 (top), 9 (middle), and 10 (bottom) strips at center from the three layers are instrumented with preamps (gain $\simeq$ 1000) and ADCs.
- preamp outputs are routed via 53-m RG174 coaxial cables to Lecroy 2249W ADCs with an integration time of 500 ns
- trigger on 2 top scintillators and all bottom scintillators

Key Milestones

- 9/15 Prototype delivered to SSCL
- 10/15 Prototype installed in TTR
- 11/10 First data run @ 3.1 kV (30 k triggers)
- 11/19 Preliminary results (96.3 μm @ 3.1 kV)
- 11/24 HV scan : chambers operated at 3.1, 3.2, and 3.3 kV (200 k triggers each)
- 12/09 Resolution as a function of HV (Preliminary)

Analysis Procedure

- Fast Filter at TTR
  - select events with at least 1 strip with $\geq$ 100 ADC counts in each layer

- Pedestal and Gain Corrections
  - apply pedestal (20-40 ADC counts) subtraction and gain correction (1.00 $\pm$ 0.10) to all ADC counts.
  - ADC counts set to 0 if corrected counts are $\leq$ 0.

- Fiducial Cut
  - locate peak channel in each layer and require peak channel to be at least 1 or 2 channels from uninstrumented strips

- δ-ray Cut
  - remove any event with 1 or more ADC overflows ($\geq$ 1900 raw ADC counts)

- Locate Cluster Centroid
  - determine c.o.g. of the hits for each layer (z_{cog}) by using a weighted mean of 3-strip ($z^{(3)}$) and 4-strip ($z^{(4)}$) c.o.g.'s

$$z_{cog} = \frac{z^{(3)}}{1 + \frac{2}{w}\left(z^{(3)} - z^{(4)}\right)}$$

w = strip pitch = 5.0 mm

- Systematic Correction
  - apply a 3-term-Fourier-series systematic correction of the following form

$$\Delta z = A \times [sin(\frac{2\pi z_{cog}}{w}) - 0.077 \times sin(\frac{4\pi z_{cog}}{w}) + 0.041 \times sin(\frac{6\pi z_{cog}}{w})]$$

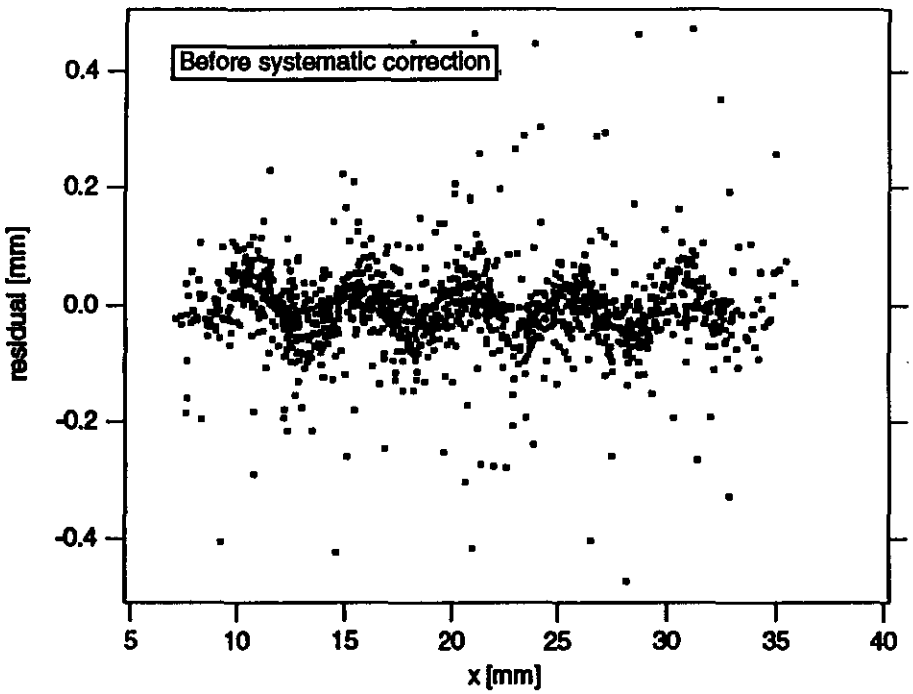
A is varied in the range : $60 \leq A \leq 100$ μm

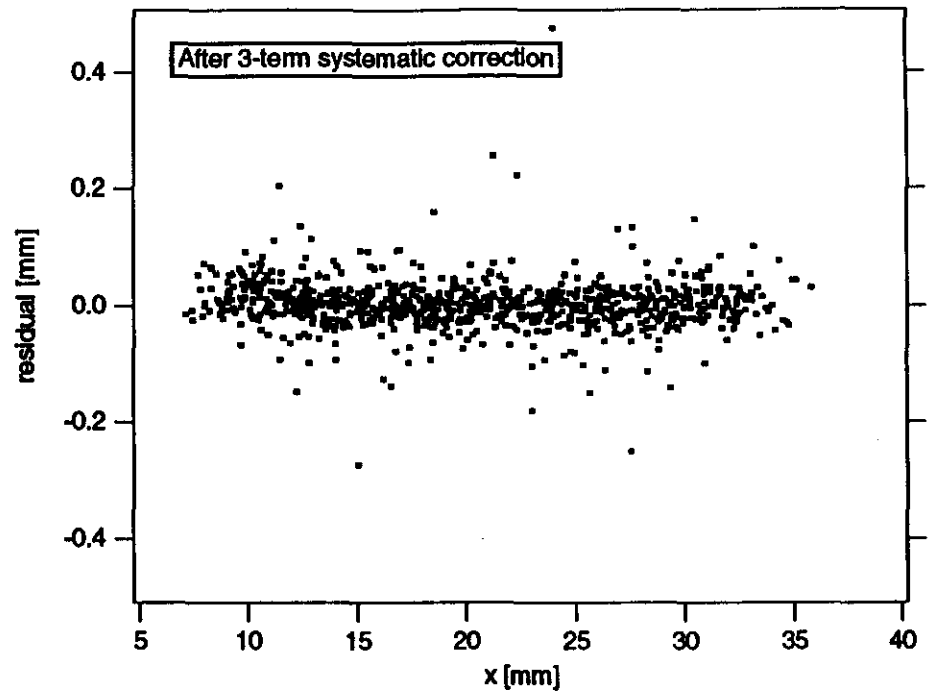
A = 117.1 μm according to monte carlo with a point inducing charge

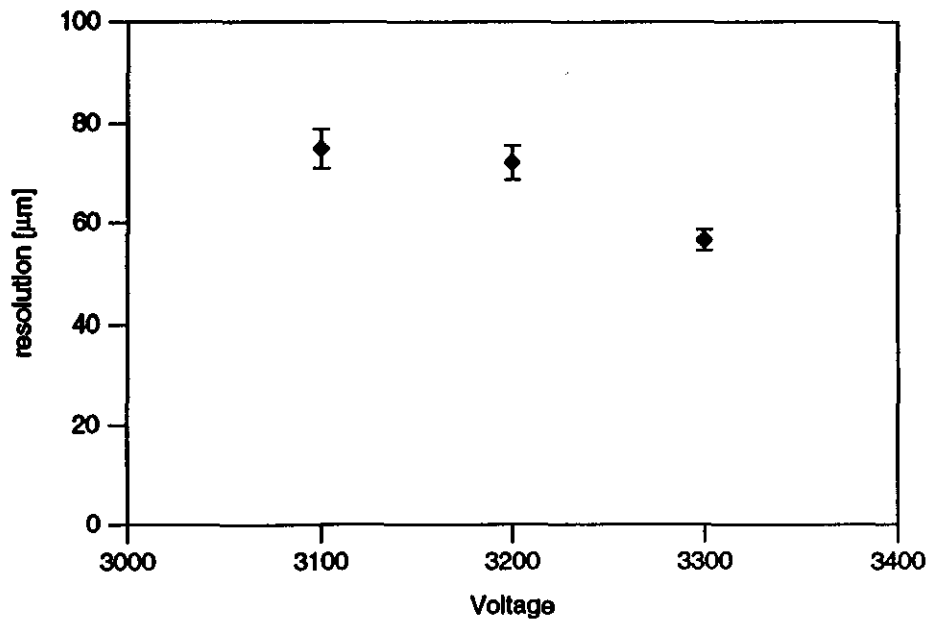
A $\simeq$ 80-90 μm gives best results

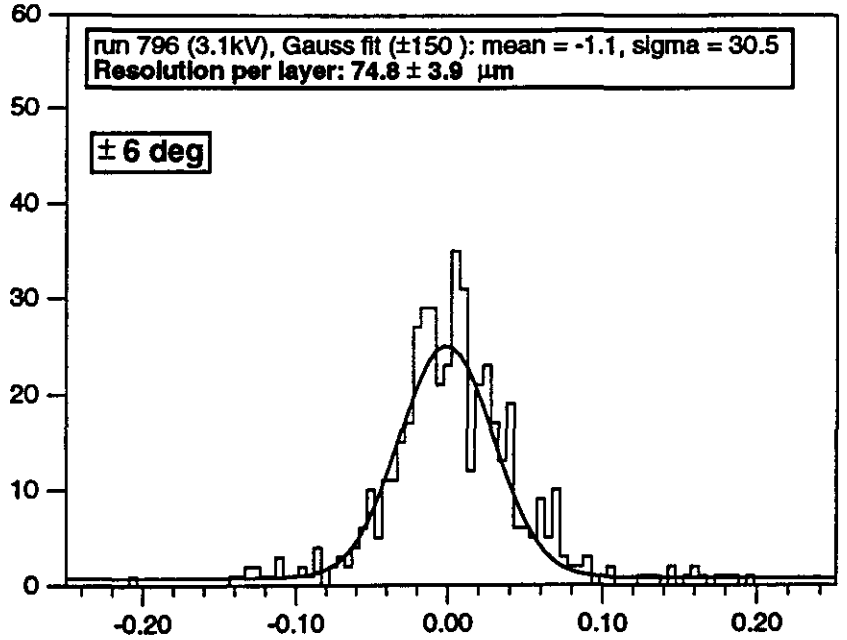
- Systematic Alignment Correction
  - middle plane is found to be off by $\simeq 33 \pm 5$ μm relative to top and bottom layers.
  - correct z_{cog}s in the middle plane by a systematic shift of 33 μm.

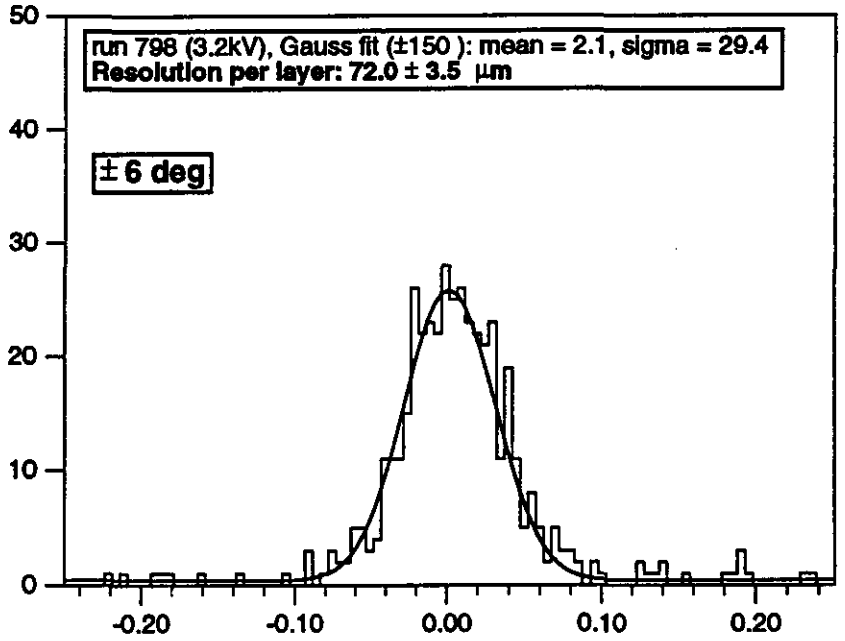
- Track Fitting
  - fit the corrected points (least square) to a straight line
- Resolution per Plane
  - residuals in the top layer (R_1) within $\pm$ 150 μm are fitted to a Gaussian + a constant.
  - resolution per plane $\sigma = \sqrt{6}\ \sigma_{R_1}$

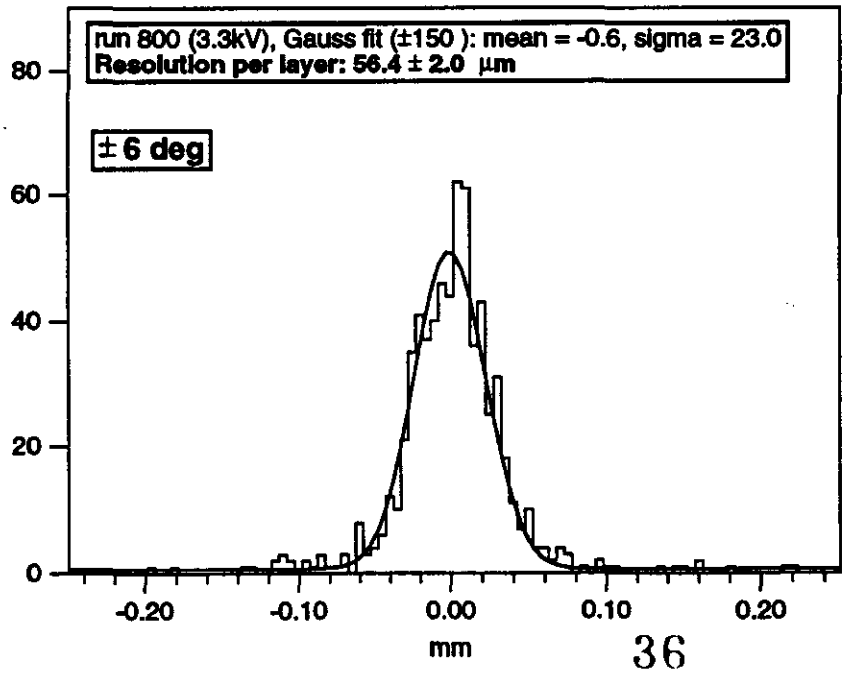

Before systematic correction
residual [mm]
0.4
0.2
0.0
-0.2
-0.4
5
10
15
20
25
30
35
40
x [mm]

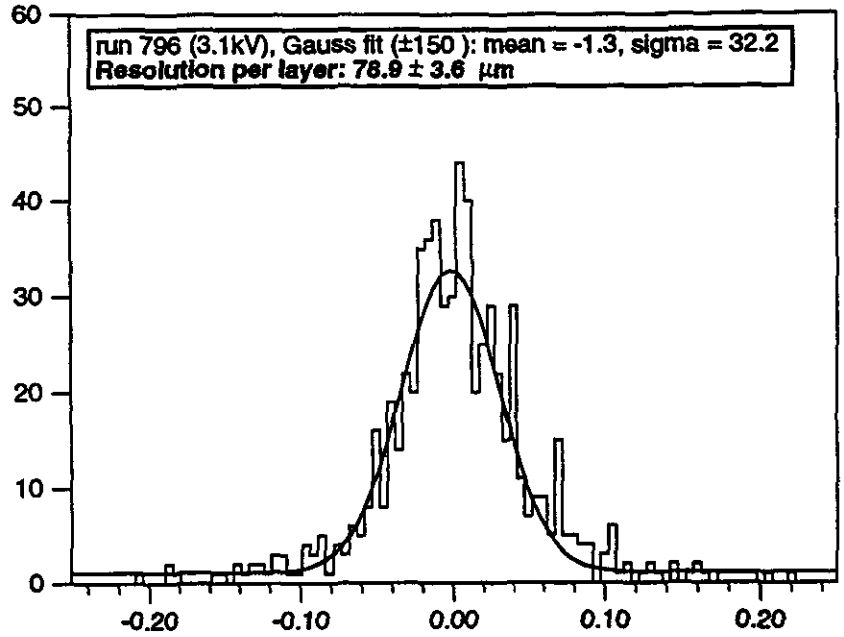

After 3-term systematic correction
residual [mm]
0.4
0.2
0.0
-0.2
-0.4
5
10
15
20
25
30
35
40
x [mm]

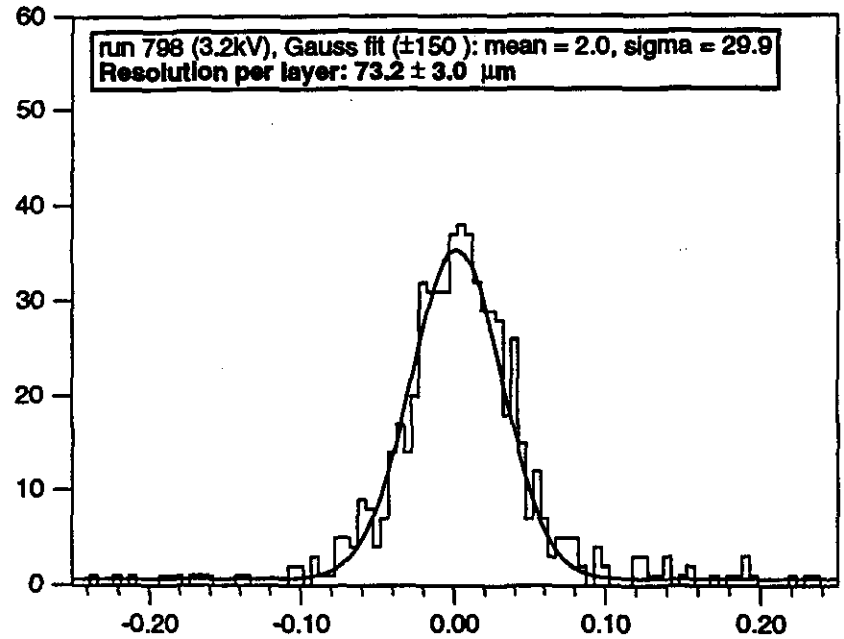

resolution [μm]
100
80
60
40
20
0
3000
3100
3200
3300
3400
Voltage

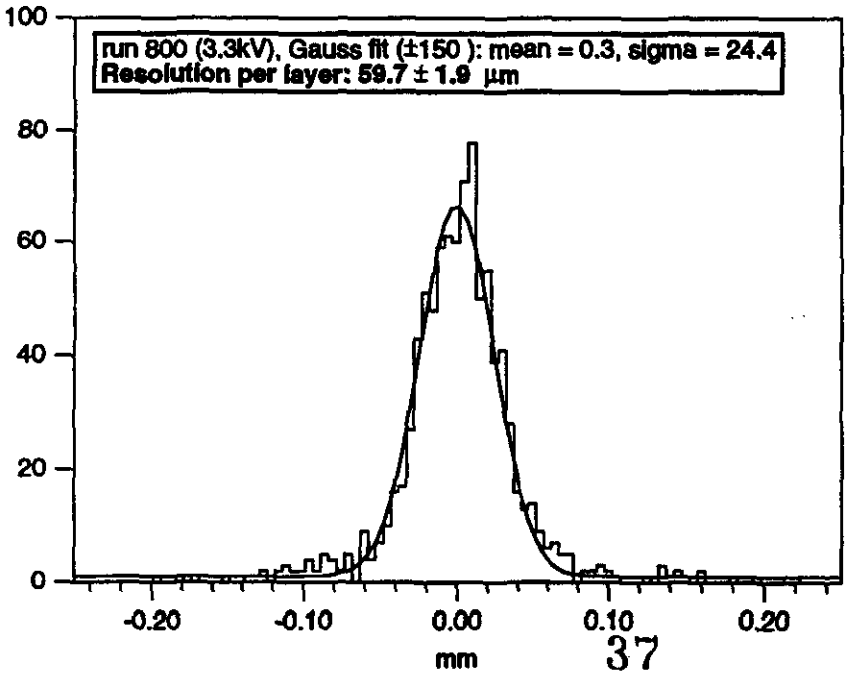

run 796 (3.1kV), Gauss fit (±150): mean = -1.1, sigma = 30.5
Resolution per layer: 74.8 ± 3.9 μm
± 6 deg
60
50
40
30
20
10
0
-0.20
-0.10
0.00
0.10
0.20

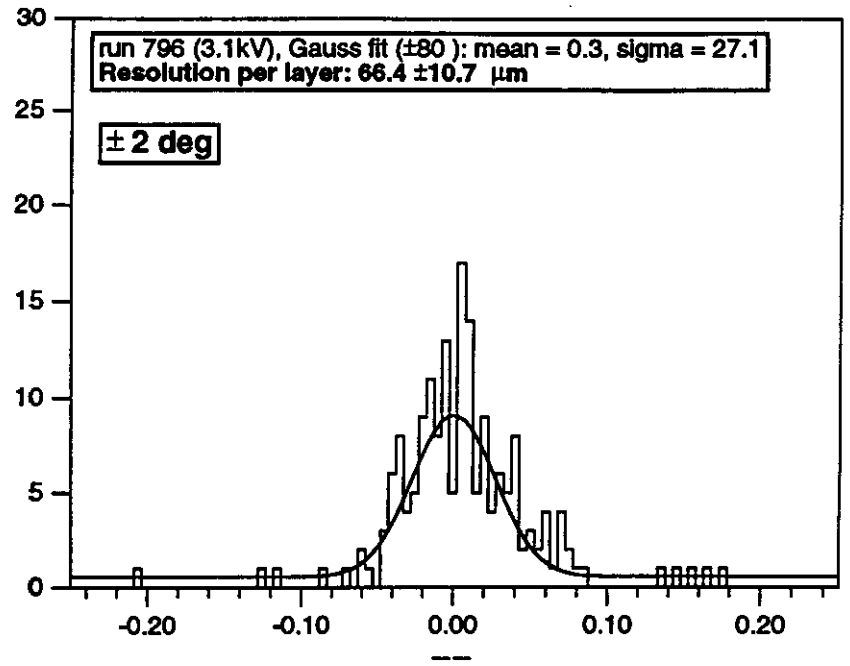

run 798 (3.2kV), Gauss fit (±150): mean = 2.1, sigma = 29.4
Resolution per layer: 72.0 ± 3.5 μm
± 6 deg
50
40
30
20
10
0
-0.20
-0.10
0.00
0.10
0.20

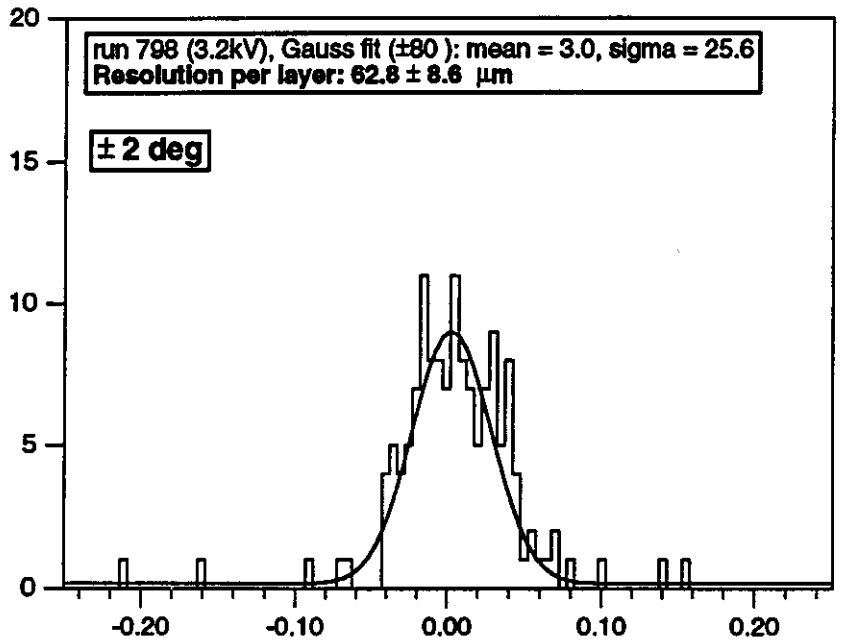

run 800 (3.3kV), Gauss fit (±150): mean = -0.6, sigma = 23.0
Resolution per layer: 56.4 ± 2.0 μm
± 6 deg
80
60
40
20
0
-0.20
-0.10
0.00
0.10
0.20
mm

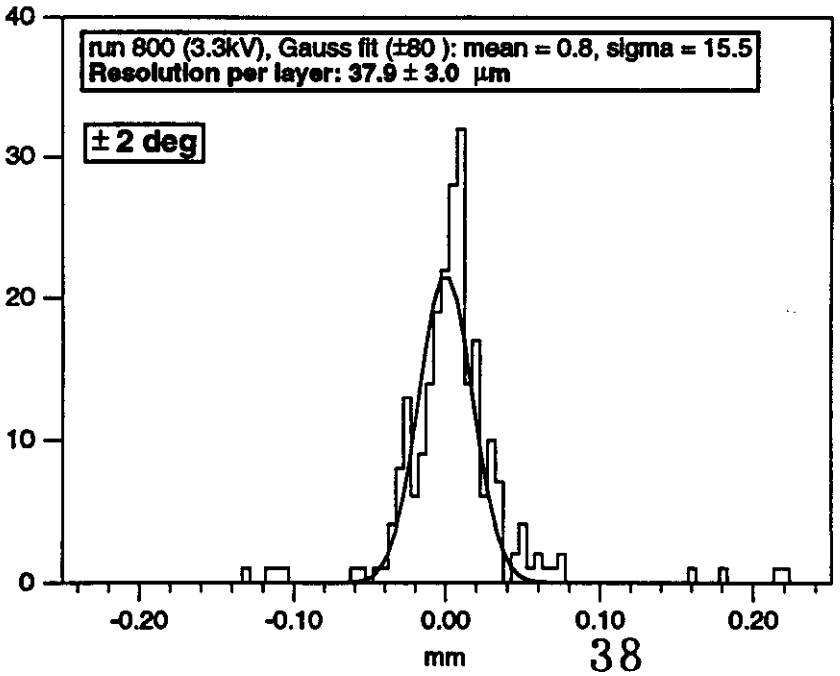

run 796 (3.1kV), Gauss fit (±150): mean = -1.3, sigma = 32.2
Resolution per layer: 76.9 ± 3.6 μm
60
50
40
30
20
10
0
-0.20
-0.10
0.00
0.10
0.20


run 798 (3.2kV), Gauss fit (±150): mean = 2.0, sigma = 29.9
Resolution per layer: 73.2 ± 3.0 μm
60
50
40
30
20
10
0
-0.20
-0.10
0.00
0.10
0.20


run 800 (3.3kV), Gauss fit (±150): mean = 0.3, sigma = 24.4
Resolution per layer: 59.7 ± 1.9 μm
100
80
60
40
20
0
-0.20
-0.10
0.00
0.10
0.20
mm


run 796 (3.1kV), Gauss fit (±80): mean = 0.3, sigma = 27.1
Resolution per layer: 66.4 ±10.7 μm
± 2 deg
30
25
20
15
10
5
0
-0.20
-0.10
0.00
0.10
0.20


run 798 (3.2kV), Gauss fit (±80): mean = 3.0, sigma = 25.6
Resolution per layer: 62.8 ± 8.6 μm
± 2 deg
20
15
10
5
0
-0.20
-0.10
0.00
0.10
0.20


run 800 (3.3kV), Gauss fit (±80): mean = 0.8, sigma = 15.5
Resolution per layer: 37.9 ± 3.0 μm
± 2 deg
40
30
20
10
0
-0.20
-0.10
0.00
0.10
0.20
mm

Summary of Results (Preliminary)

- Averaged over $\pm \simeq 6°$

HV(kV)	$\sigma(\mu m)$
3.1	74.8 ± 3.9
3.2	72.0 ± 3.5
3.3	56.4 ± 2.0

- Averaged over all angles $\pm \simeq 8°$

HV(kV)	$\sigma(\mu m)$
3.1	78.9 ± 3.6 (96.3)
3.2	73.2 ± 3.0
3.3	59.7 ± 1.9

- Normal incidence $\pm$ 2.0°

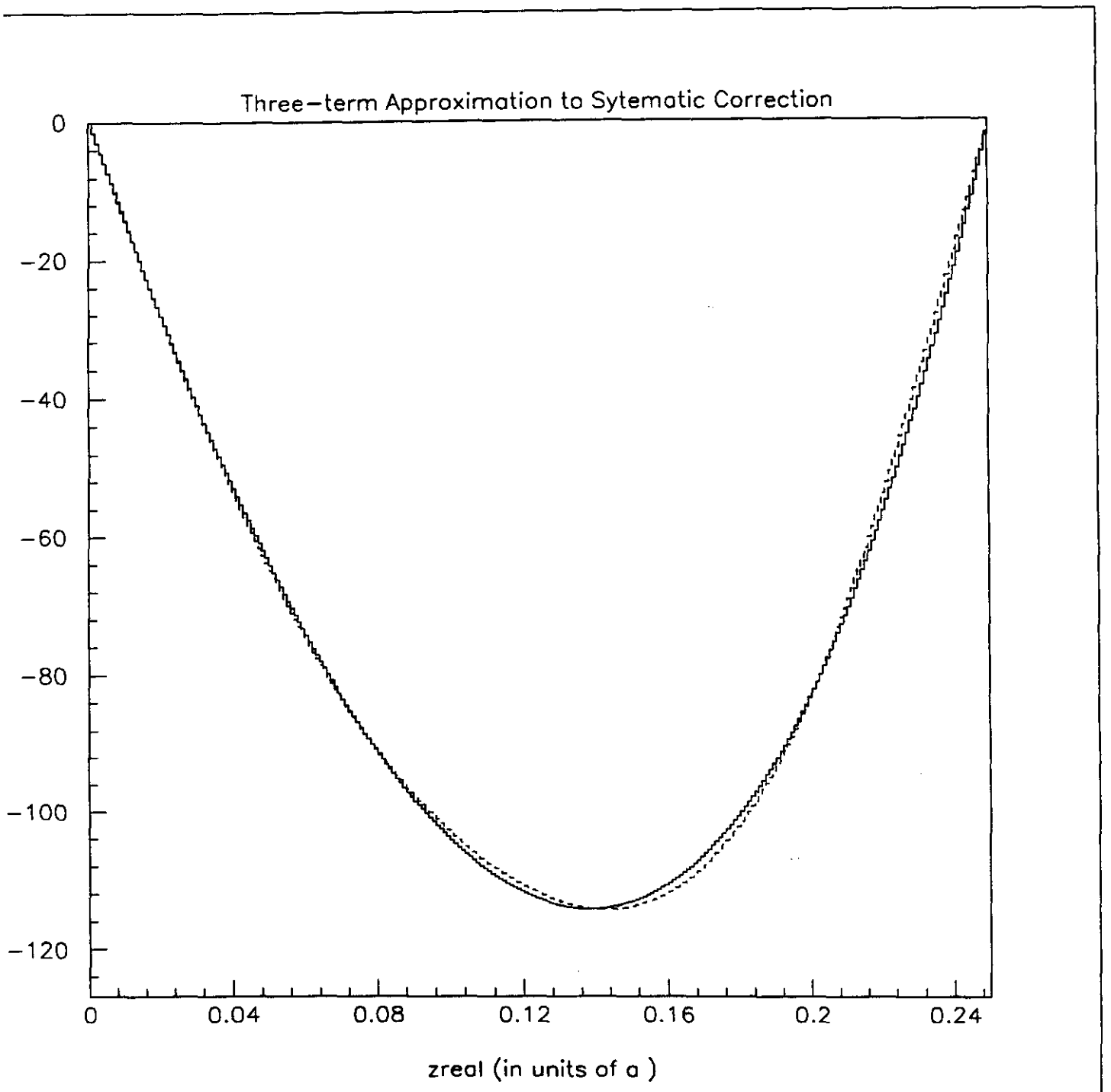
HV(kV)	$\sigma(\mu m)$
3.1	66.4 ± 10.7
3.2	62.8 ± 8.6
3.3	37.9 ± 3.0

Short-term Program (by March 15, 93)

- study angle dependence of resolution
- study effect of noise from environ and RPCs
- study gas dependence (fast vs standard)
- study dependence on resistivity of carbon coating (0.4 to 4.0 kΩ per square)
- study timing of wire signals
- resolution in streamer mode

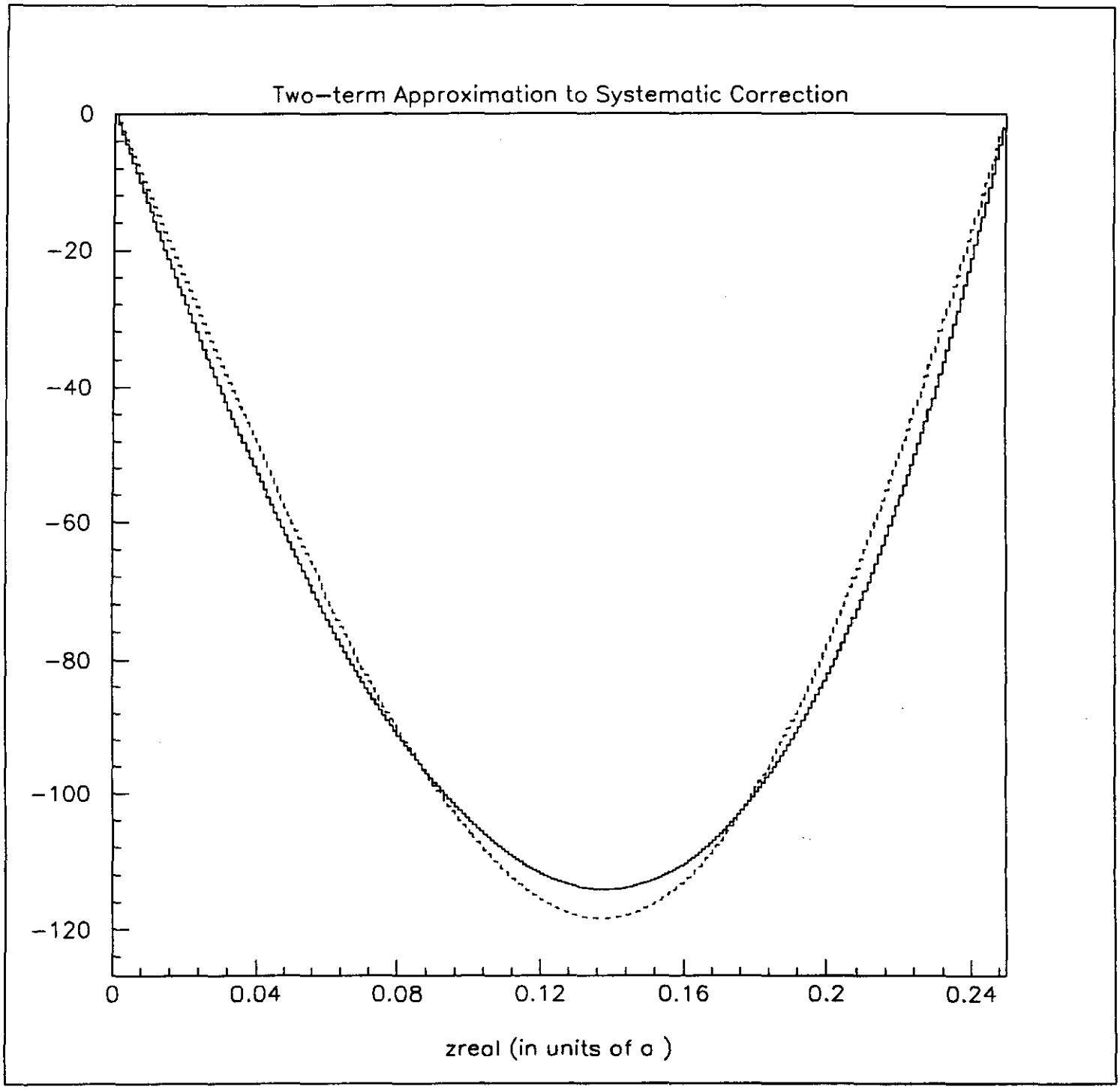
$$\Delta z = -117.07 \sin\left(\frac{2\pi z}{0.5\,km}\right) + 9.07 \sin\left(\frac{4\pi z}{0.5\,km}\right) - 4.85 \sin\left(\frac{6\pi z}{0.5\,km}\right)$$

$$0 < z < 0.25\,km$$

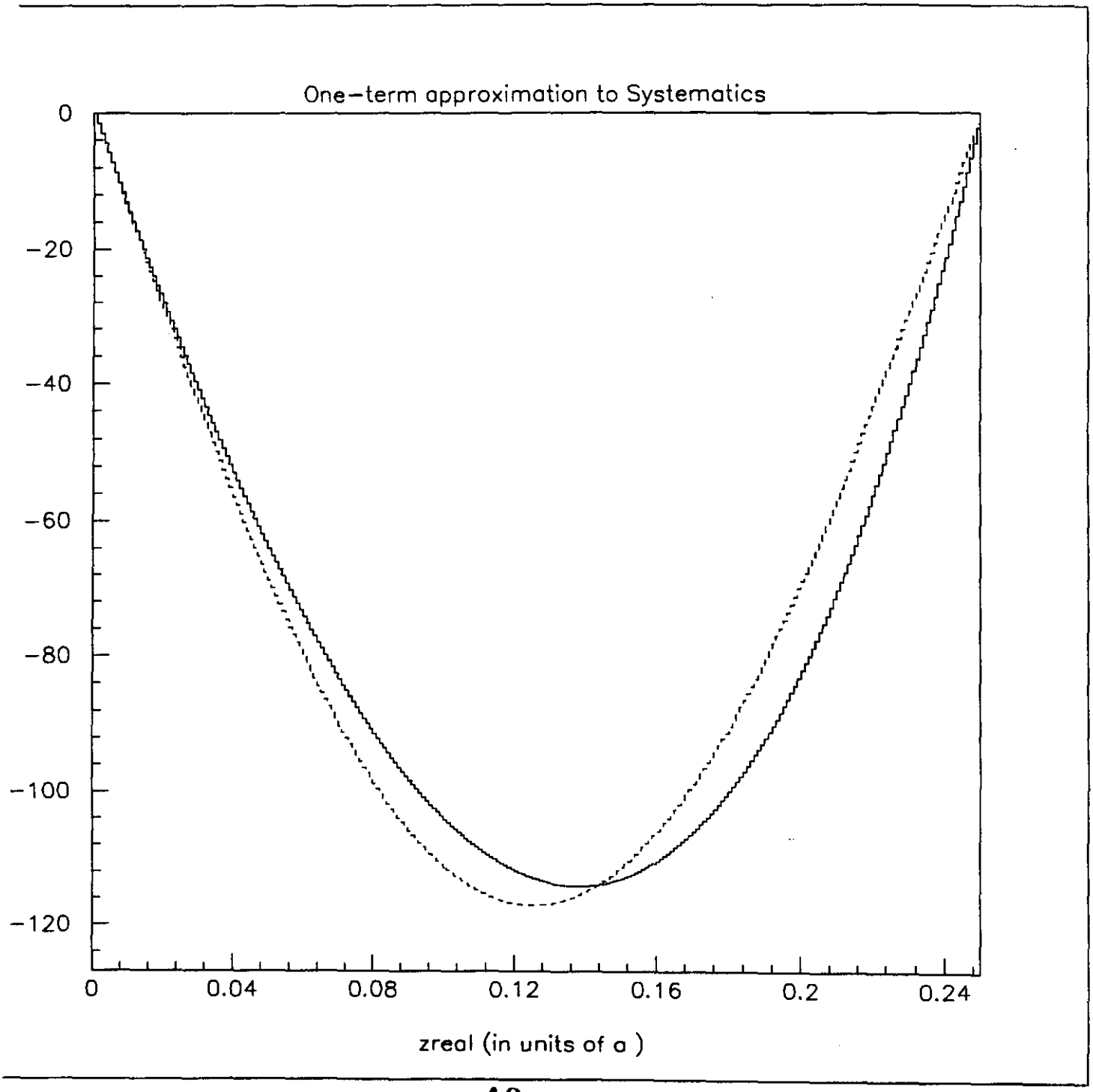


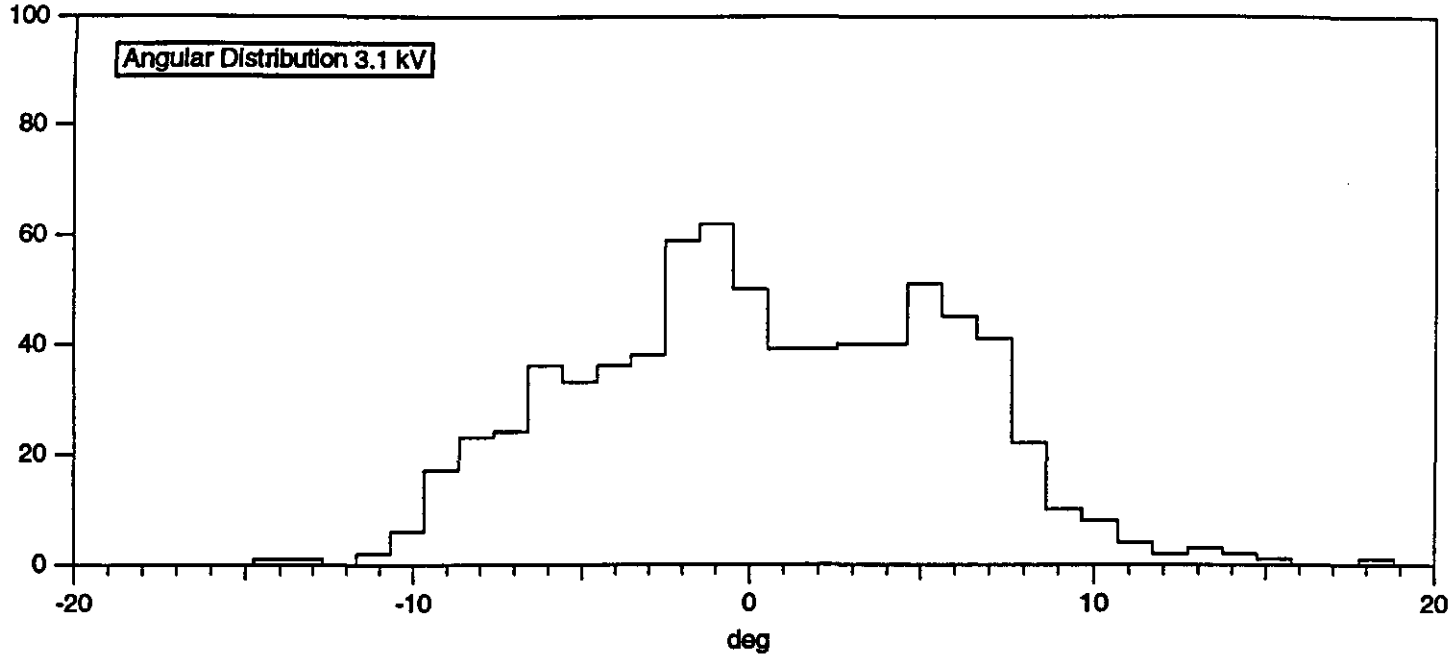
$$\Delta z = -117.07 \sin\left(\frac{2\pi z}{0.5\,cm}\right) + 9.07 \sin\left(\frac{4\pi z}{0.5\,cm}\right)$$

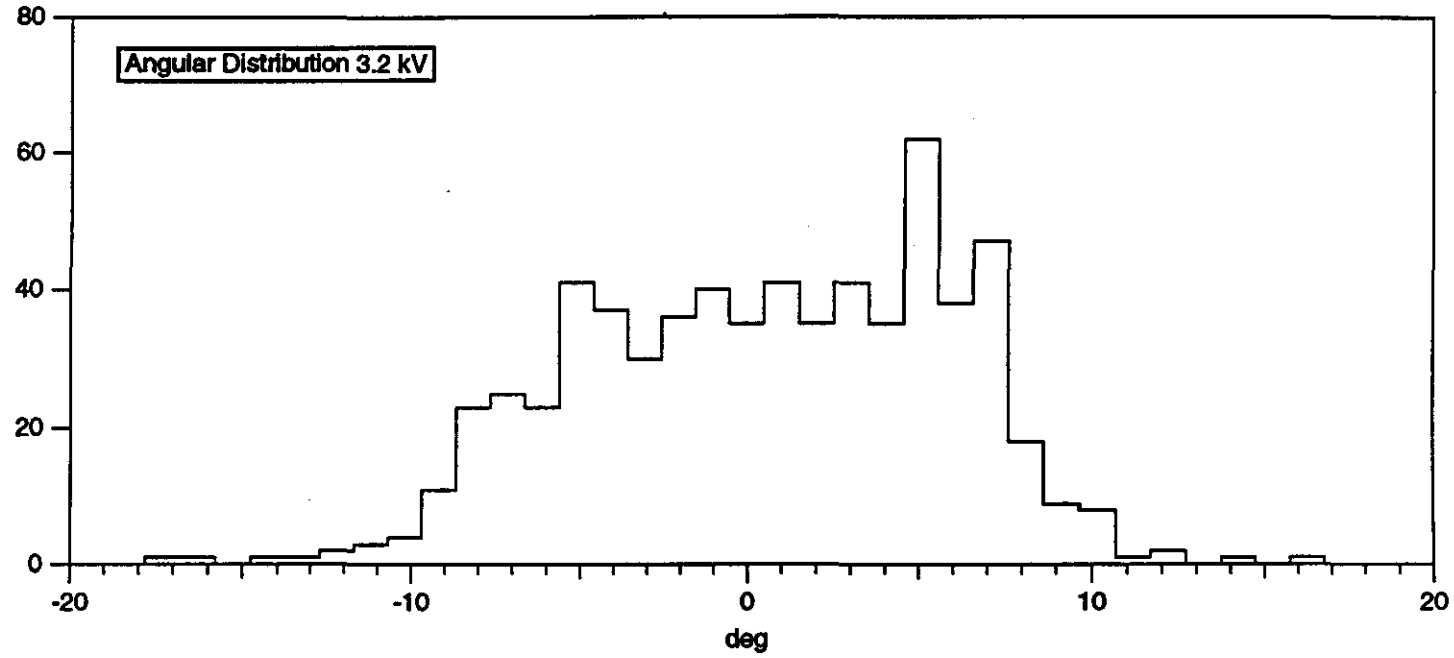
$$0 < z < 0.25\,cm$$

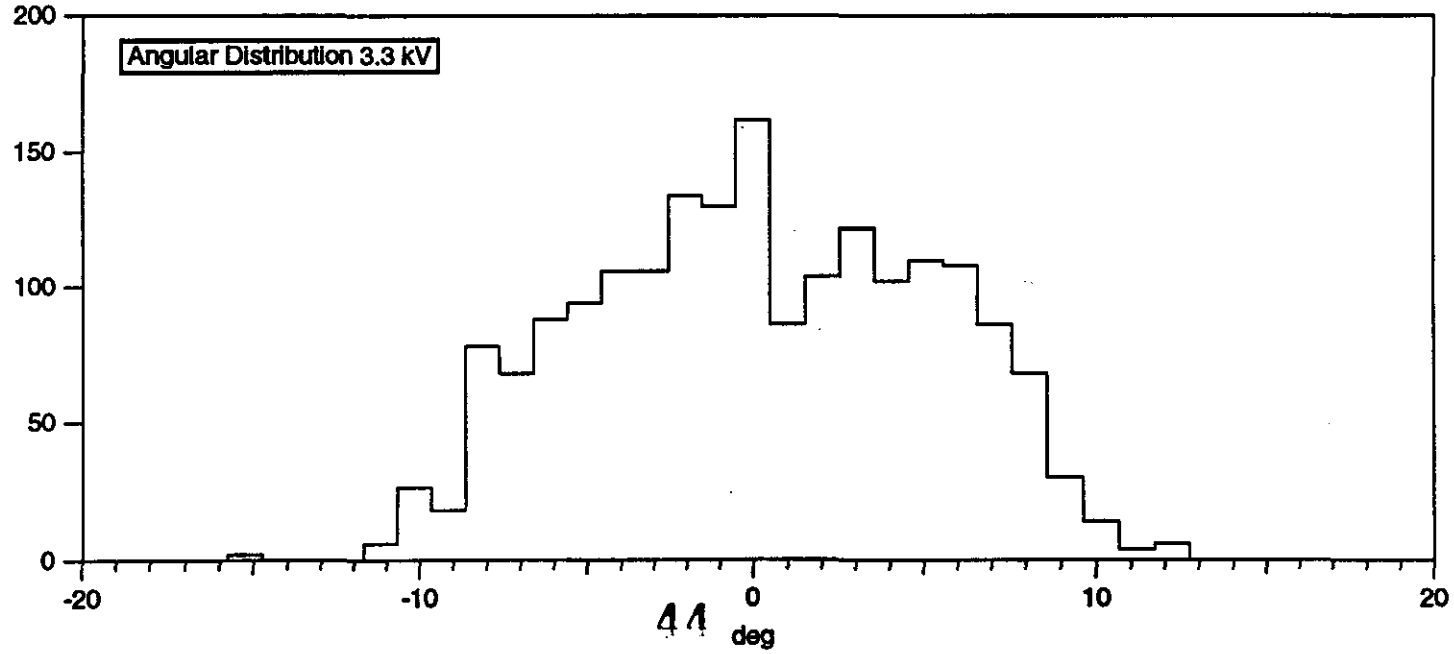


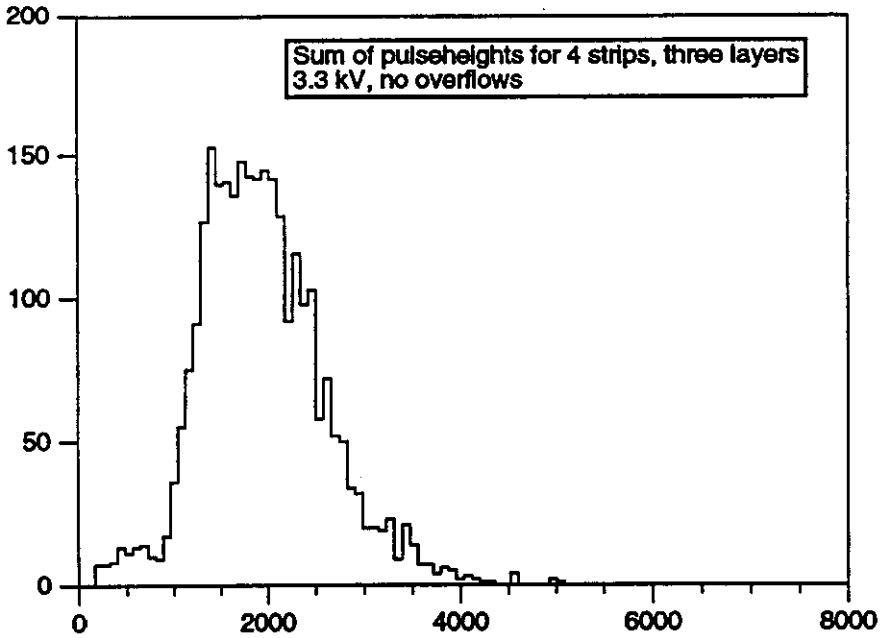
--- $\Delta z = -117.07 \sin\left(\frac{2\pi z}{0.5\,cm}\right) \quad 0 \le z \le 0.25\,cm$

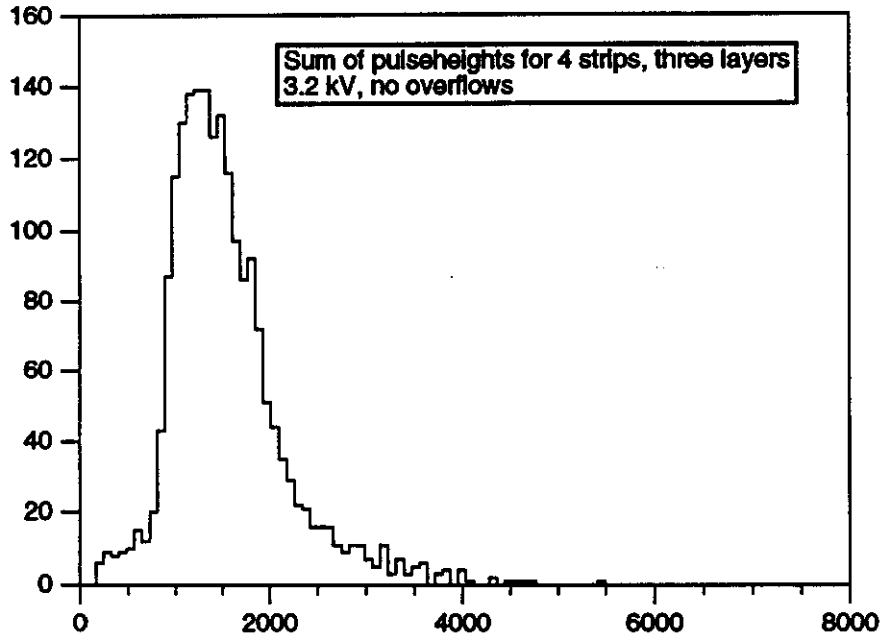


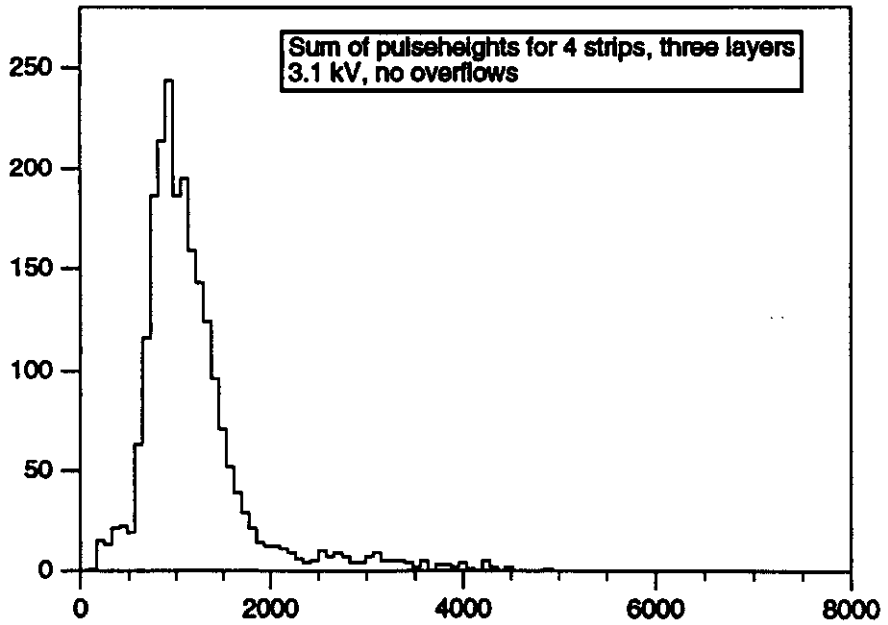

Angular Distribution 3.1 kV
100
80
60
40
20
0
-20
-10
0
10
20
deg


Angular Distribution 3.2 kV
80
60
40
20
0
-20
-10
0
10
20
deg

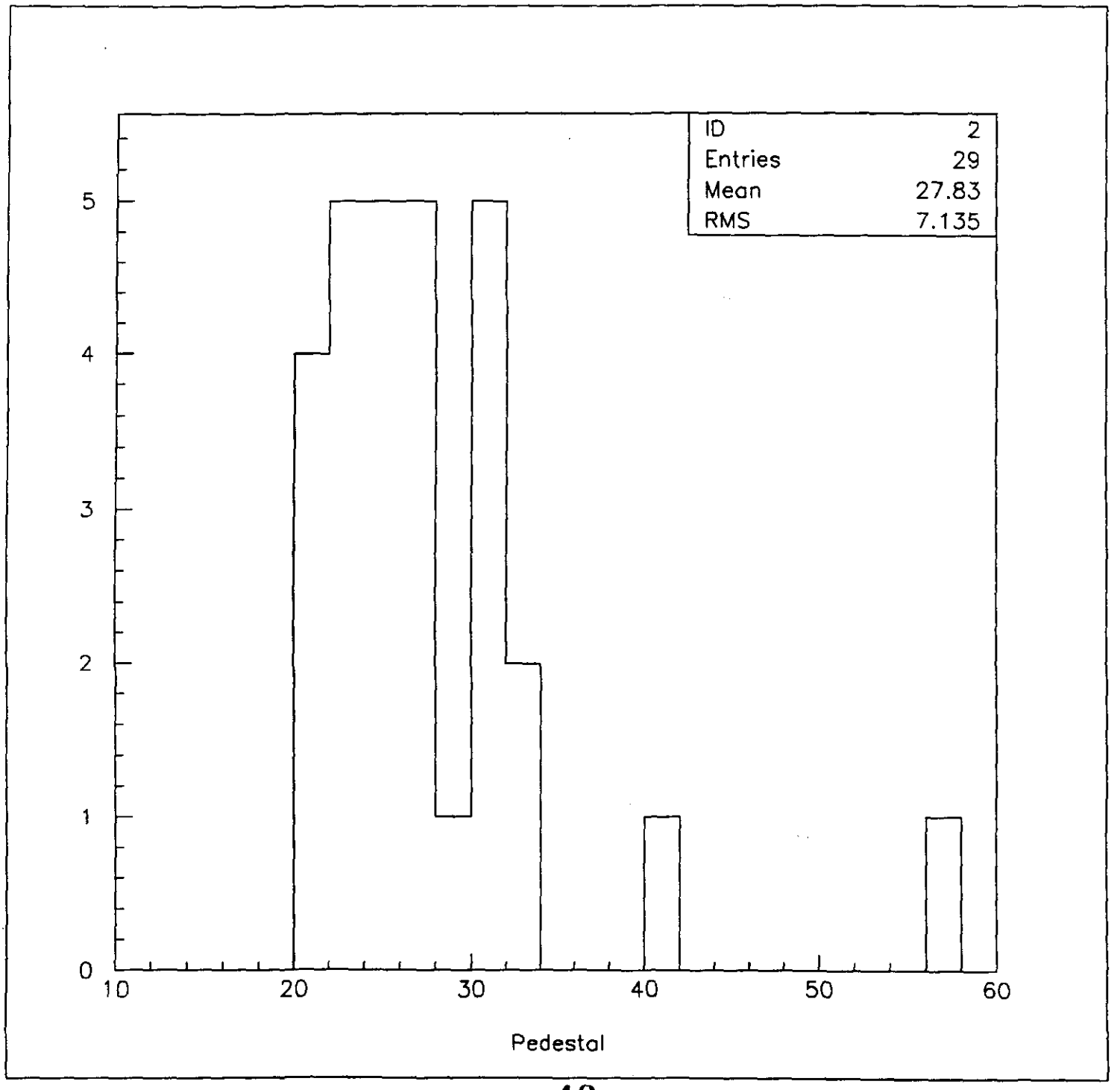

Angular Distribution 3.3 kV
200
150
100
50
0
-20
-10
0
10
20
deg

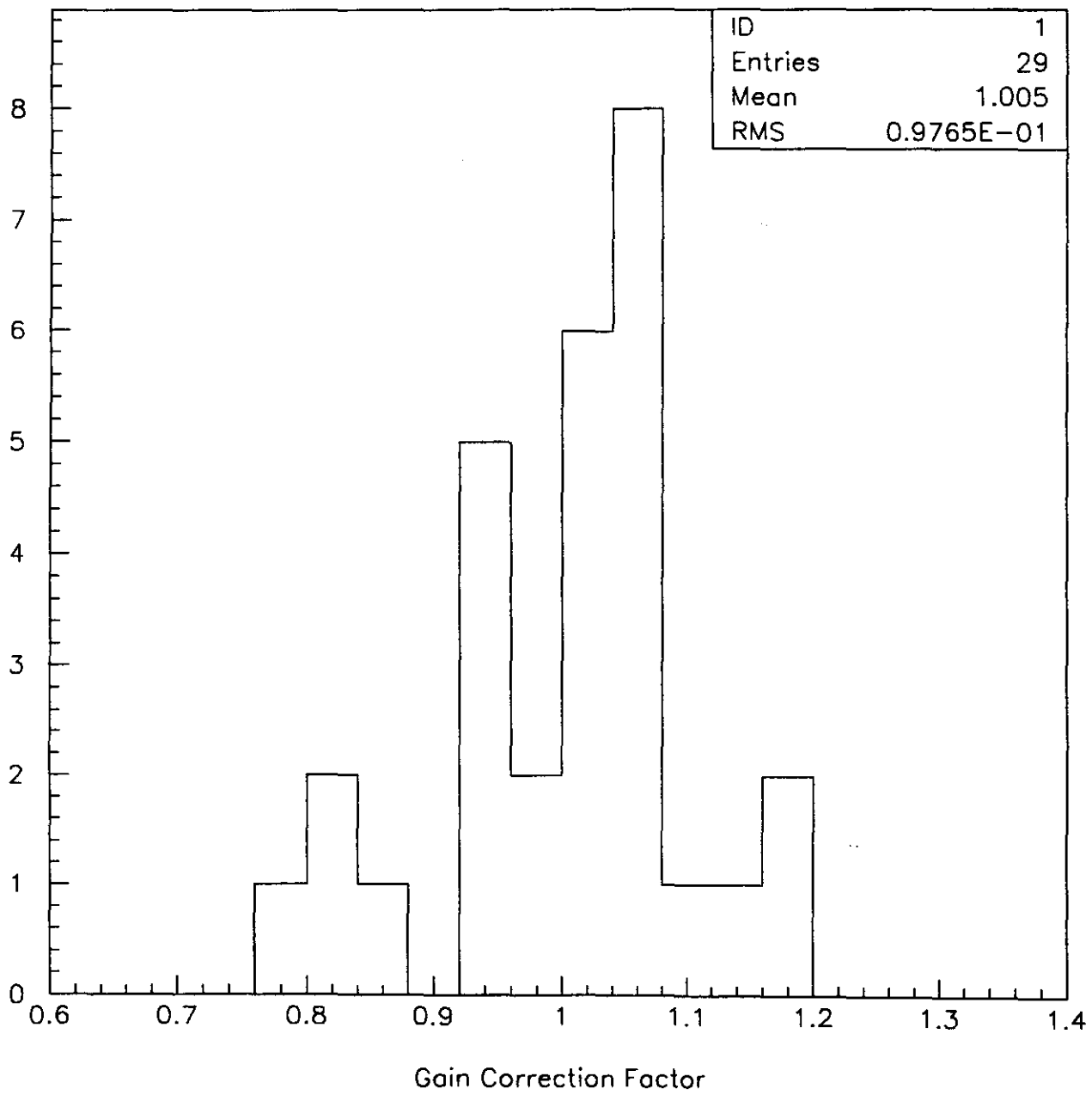

Sum of pulseheights for 4 strips, three layers
3.3 kV, no overflows
200
150
100
50
0
0
2000
4000
6000
8000

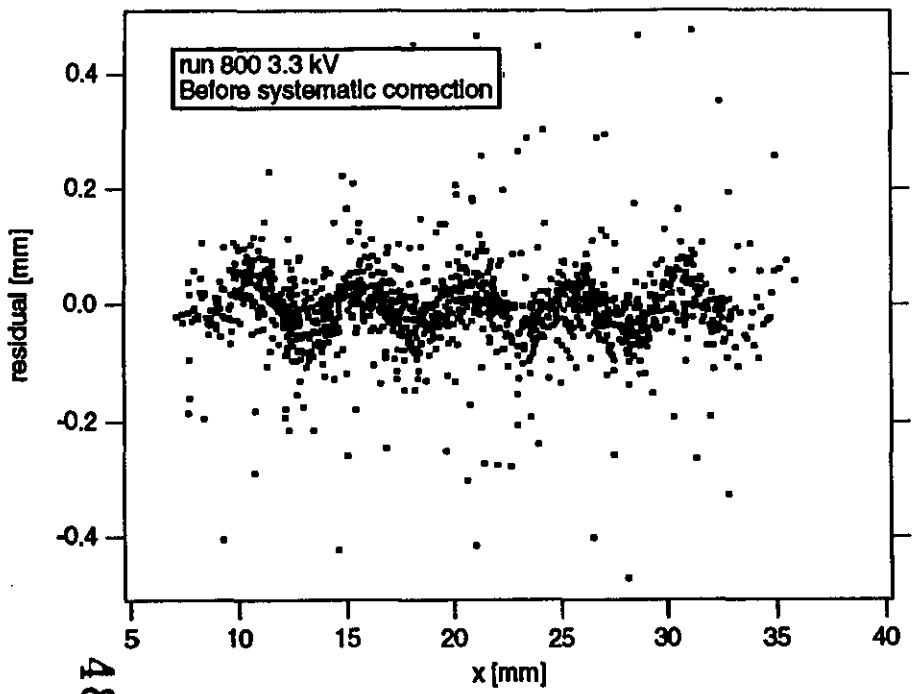

Sum of pulseheights for 4 strips, three layers
3.2 kV, no overflows
160
140
120
100
80
60
40
20
0
0
2000
4000
6000
8000

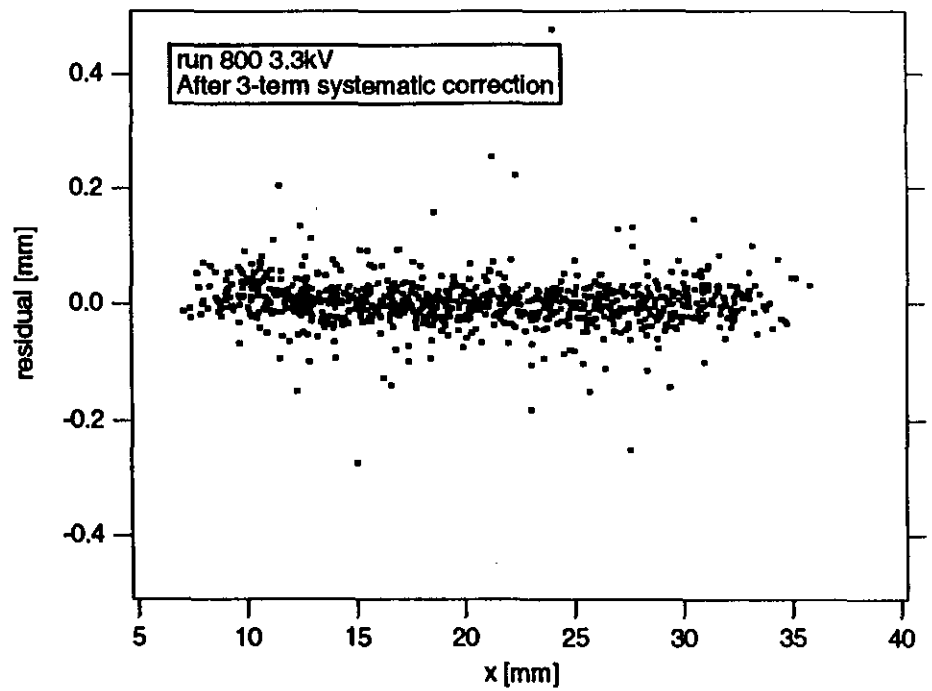

Sum of pulseheights for 4 strips, three layers
3.1 kV, no overflows
250
200
150
100
50
0
0
2000
4000
6000
8000

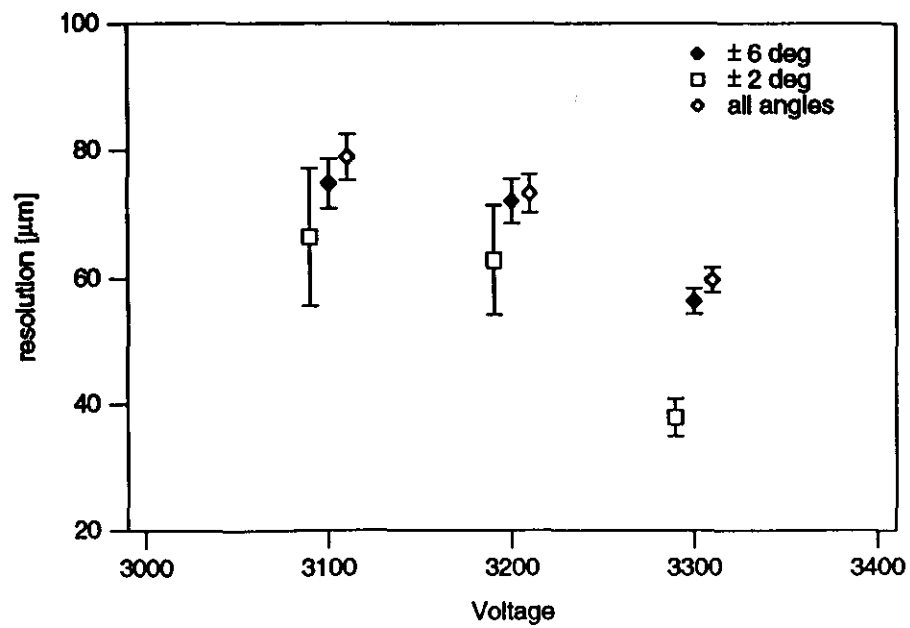
cnt


ID 2
Entries 29
Mean 27.83
RMS 7.135
0
1
2
3
4
5
10
20
30
40
50
60
Pedestal


ID 1
Entries 29
Mean 1.005
RMS 0.9765E-01
0
1
2
3
4
5
6
7
8
0.6
0.7
0.8
0.9
1
1.1
1.2
1.3
1.4
Gain Correction Factor


run 800 3.3 kV
Before systematic correction
residual [mm]
x [mm]

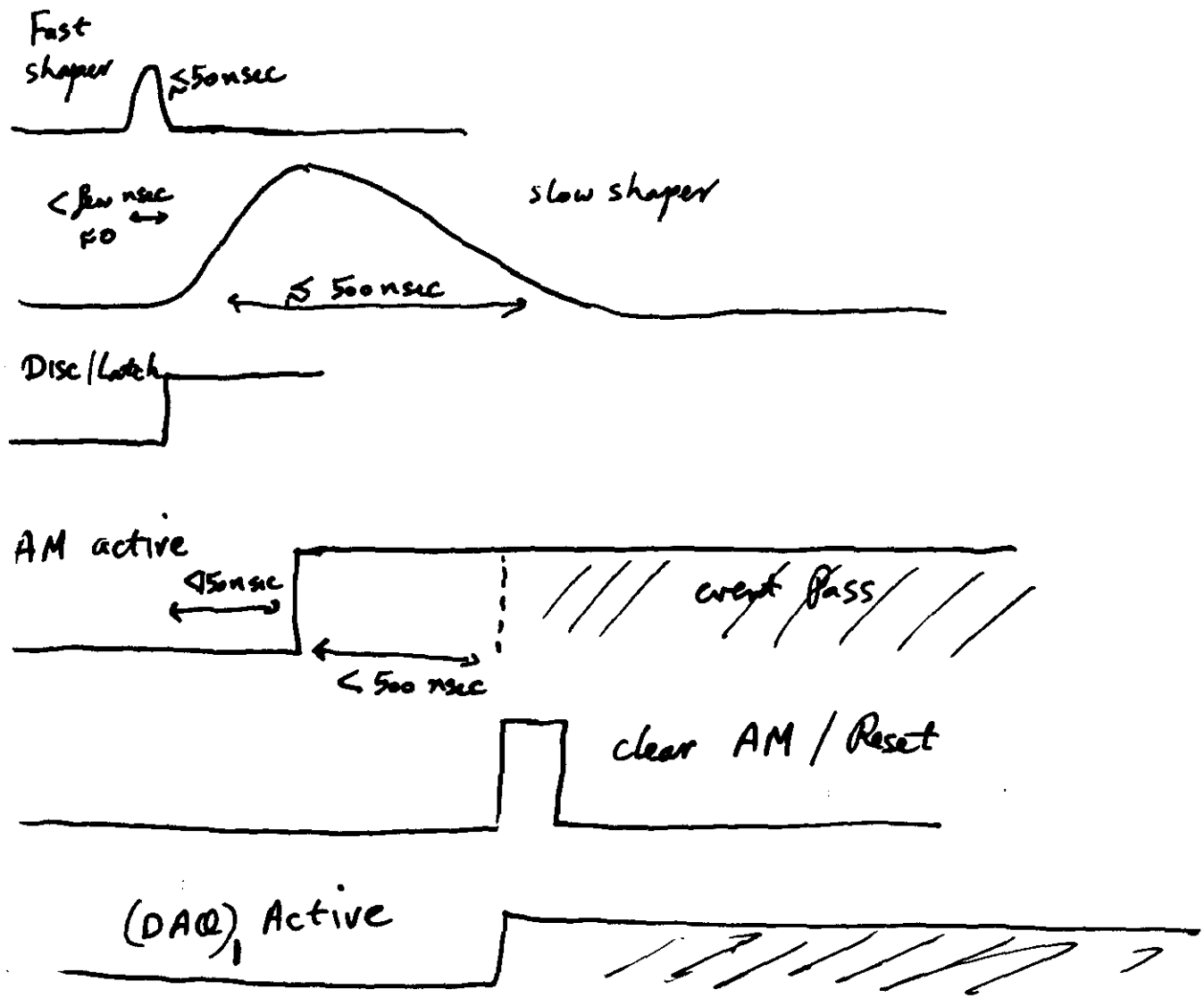

run 800 3.3kV
After 3-term systematic correction
residual [mm]
x [mm]


± 6 deg
± 2 deg
all angles
resolution [μm]
Voltage

Presentation by:

M. Atiya

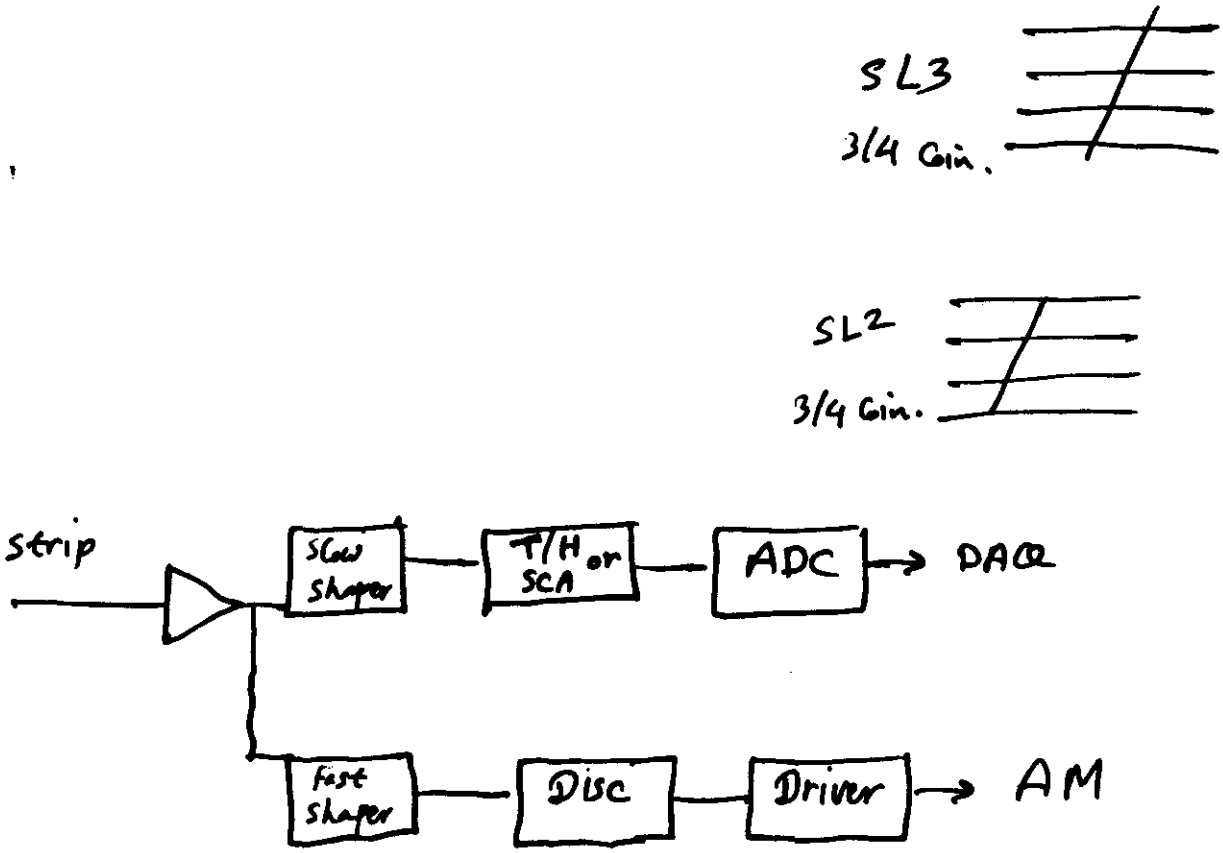
Trigger Timing



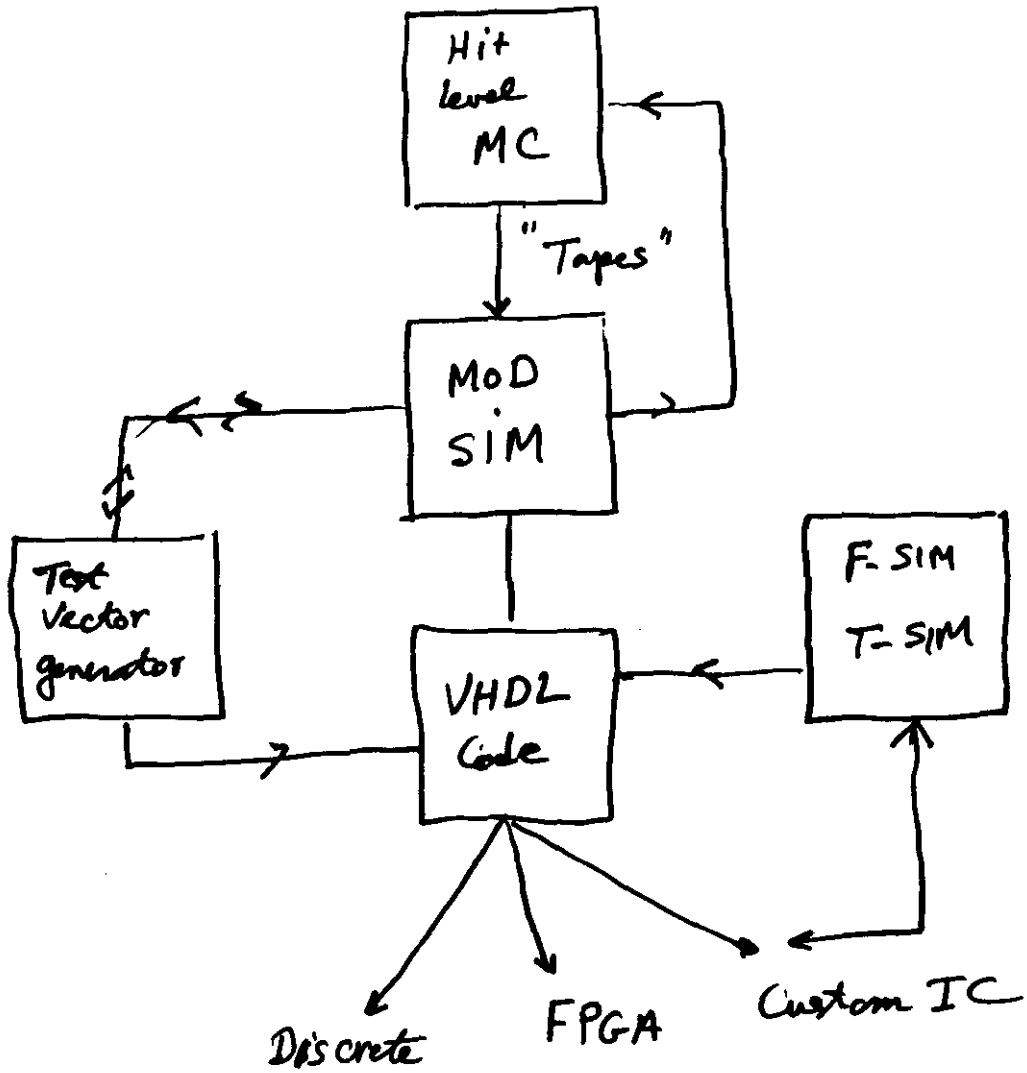
Patterns stored in AM
(5 mm strips !)

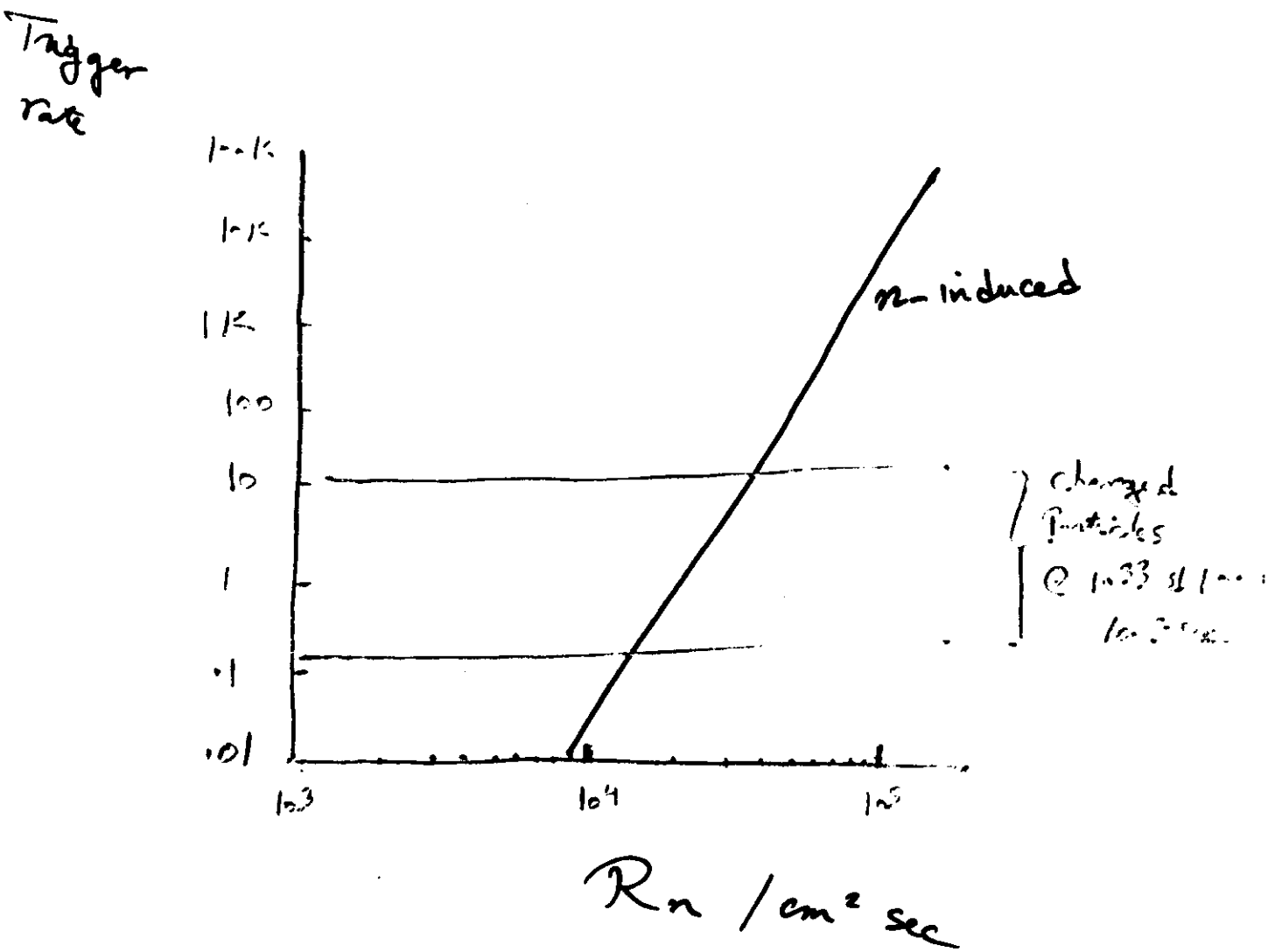
$P_\perp$ Cut	# Pattern /Sector (Barrel
20	85427
30	58744
50	3654

Trigger structure based on Associative Memory



Trigger Design tools





$\epsilon = .005$

$c = 5\,mm$

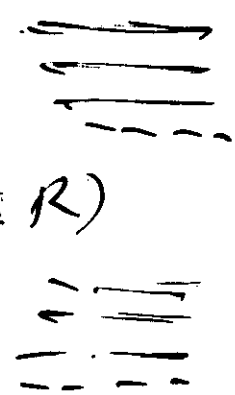
$L = 300\,cm$

$\Delta\phi_{strip} \pm 5$

$t = 50\,nsec$

$k^3 t^2$

$\hookrightarrow (w\,l\,m\,\epsilon\,R)$



gem

γeμ

Presentation by:

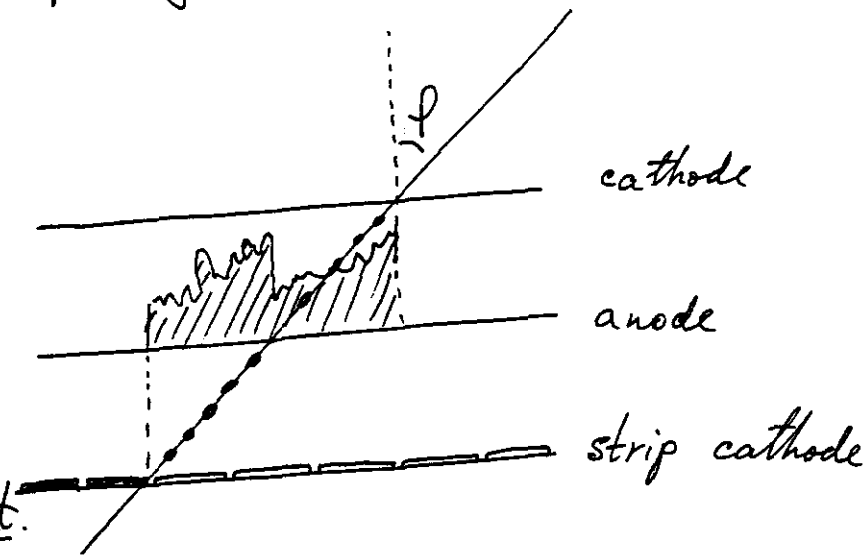
V. Chernyatin

M-K optimisation some geometrical parameters of CSC.

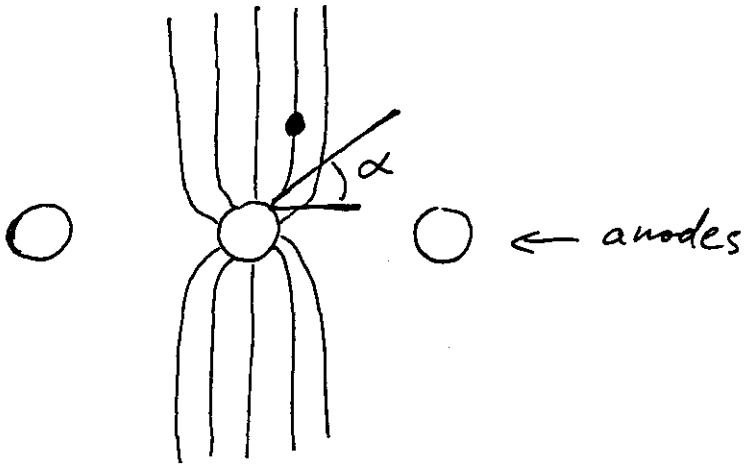
what was calculated?

1. The position resolution depending on θ and φ
2. The influence readout pitch and anode-cathode spacing on chamber accuracy.

① φ- dependence.

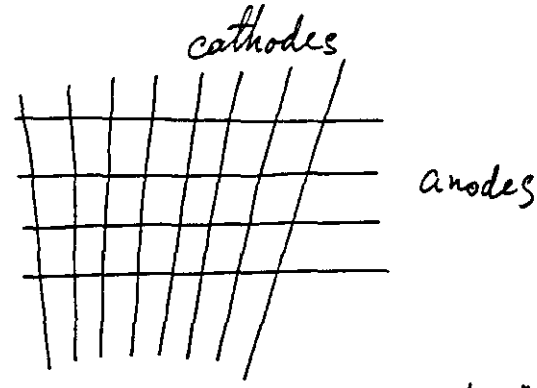


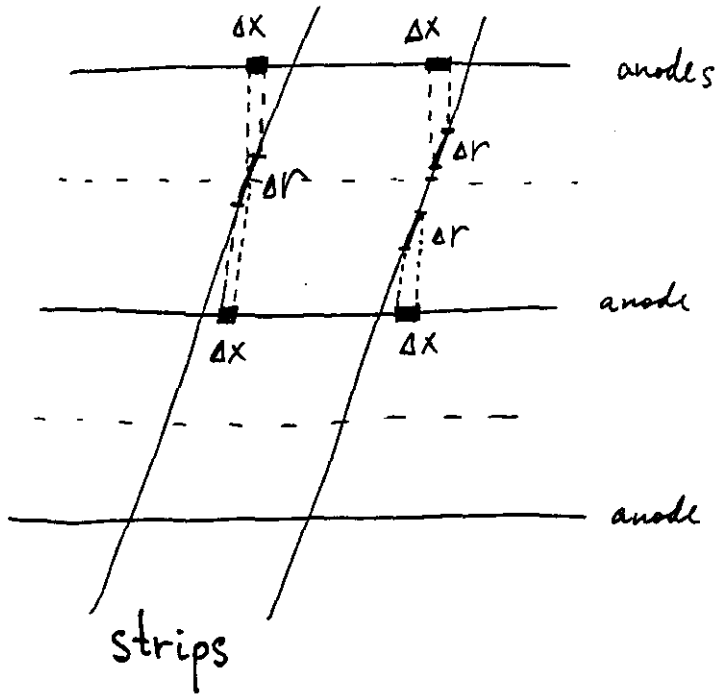
anode screening effect.

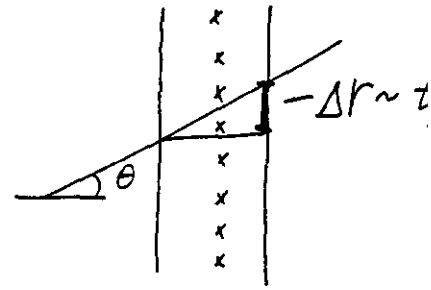


$$\frac{A_{\pi/2}}{A_{-\pi/2}} \cong 1.6$$

Radial geometry: ⟶







② anode - cathode gap. - **h**

+ - more broad induce charge distribution
(can use larger readout pitch)

- - more stronge φ- dependence.

③. readout pitch. (da)

④. Single or floating strips?

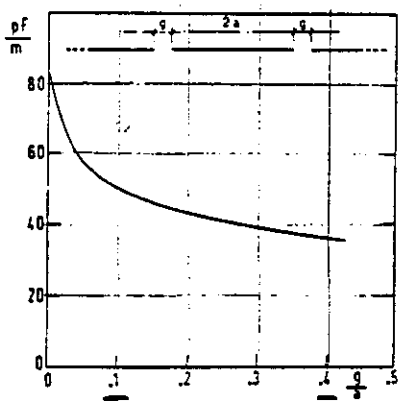
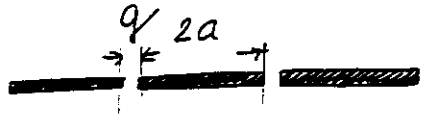


Fig. 6. Capacitance for a unit length of a cathode strip having a given gap g with respect to an infinite electrode plane as shown in the figure.

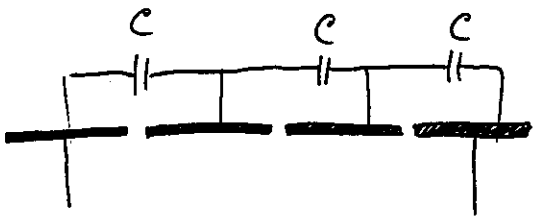


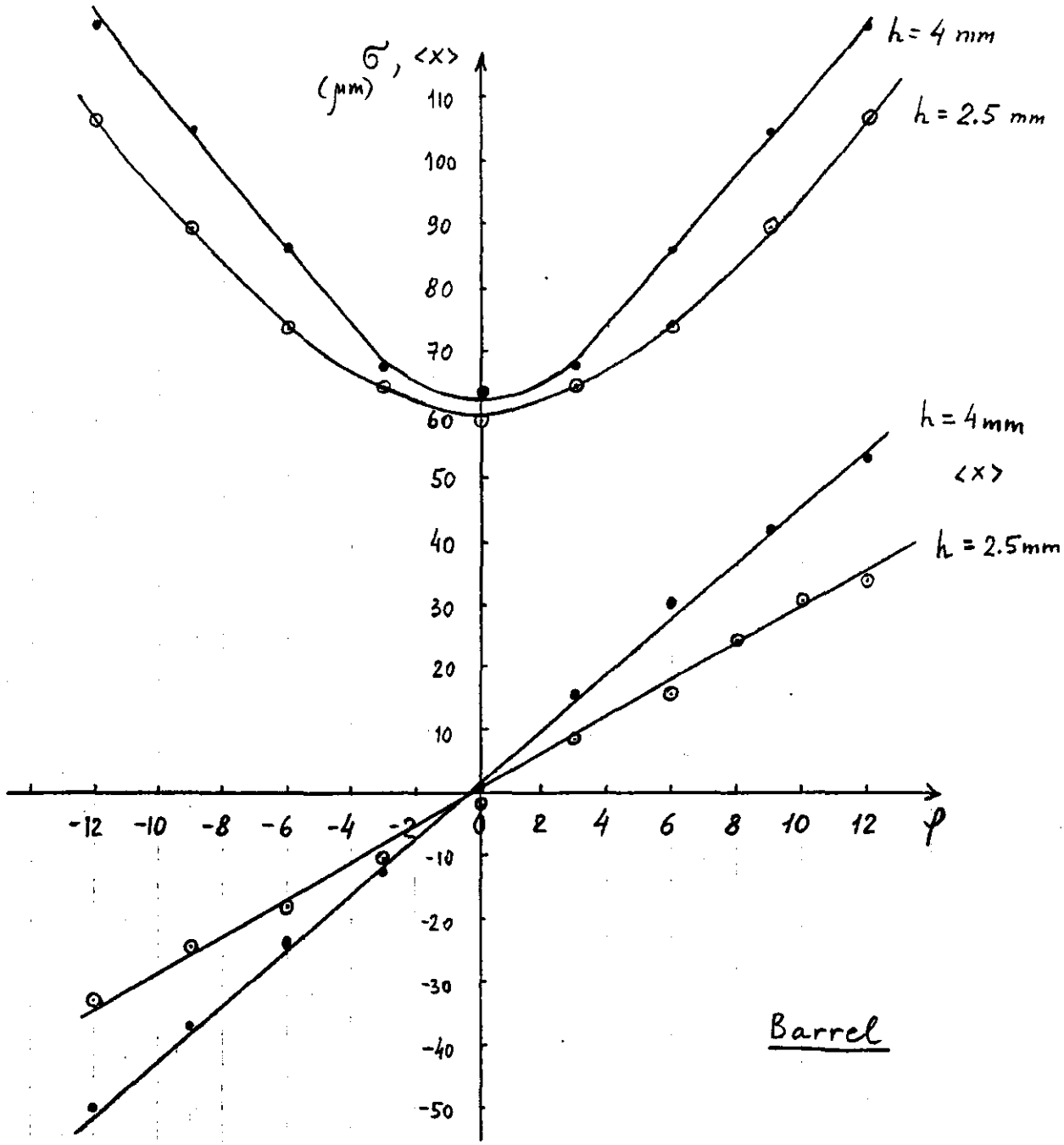
$$\frac{C_{0.1}}{C_{0.4}} \lesssim 1.5$$

So

$$C_{\substack{\text{Single}\\\text{Strip}}} \simeq 2\, C_{\substack{\text{floating}\\\text{strip}}}$$

(if $g \leq 1$ mm)



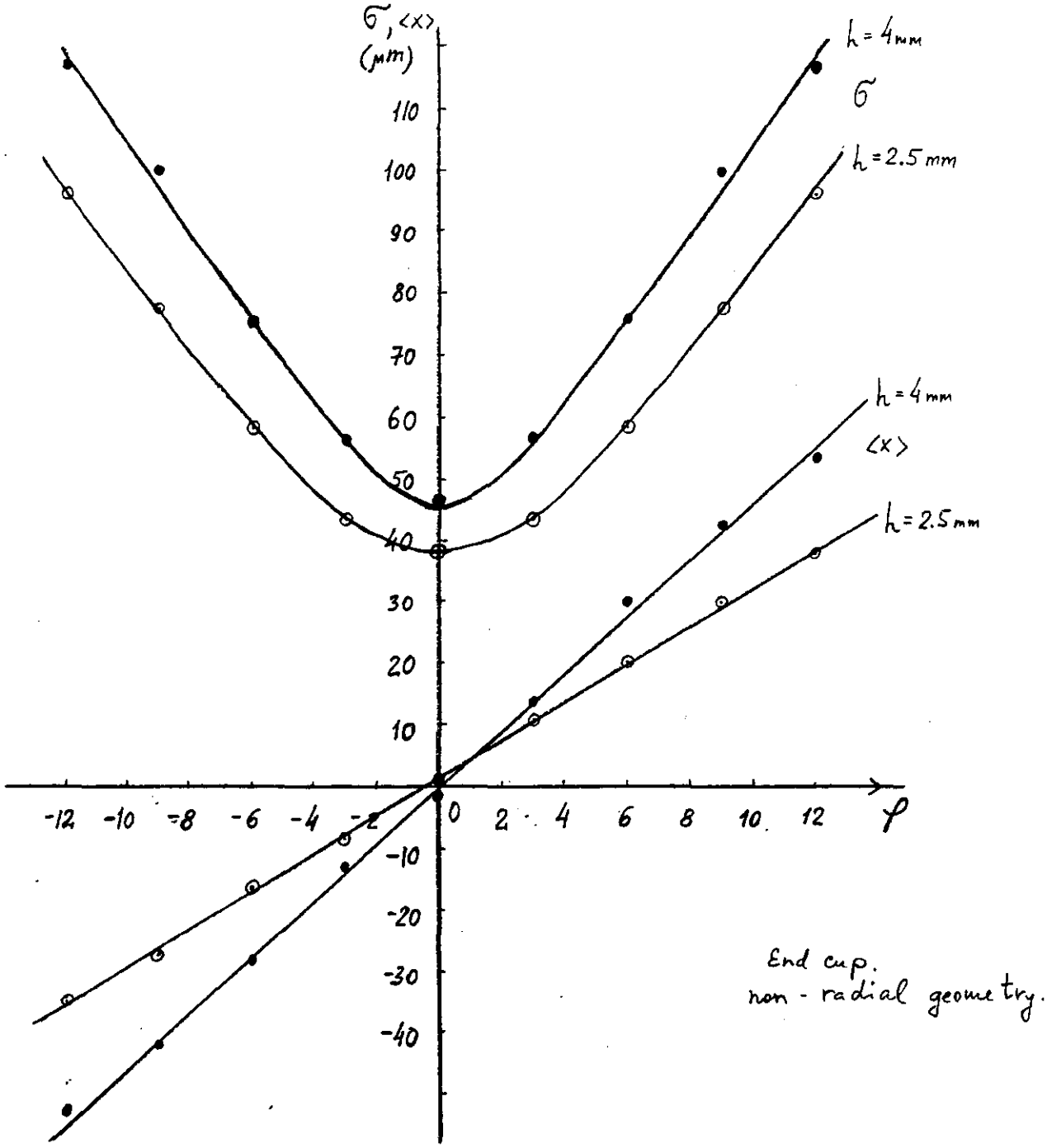


size readout pitch

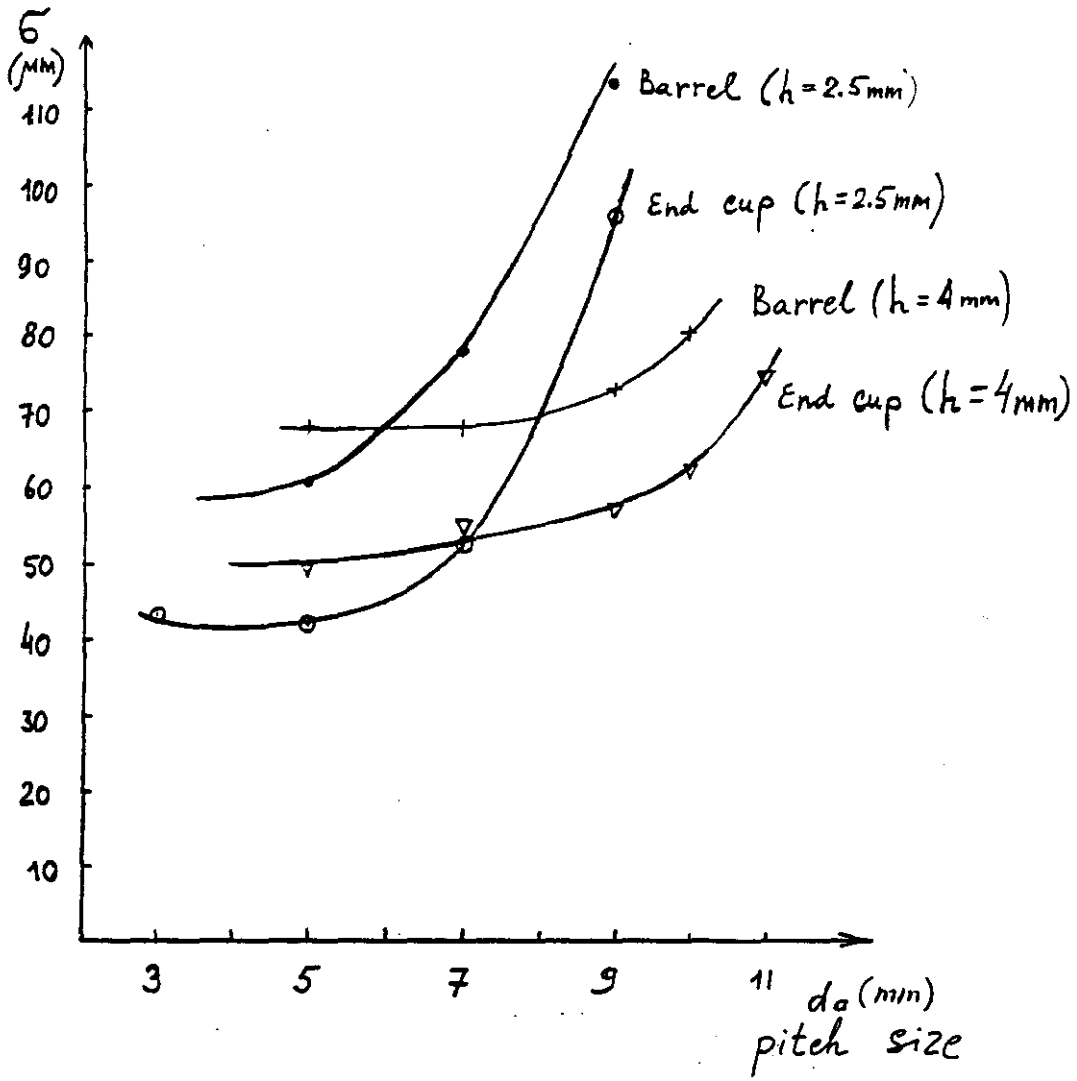
$\sigma_{noise} = 2600e$
$(l_{strip} = 3m)$

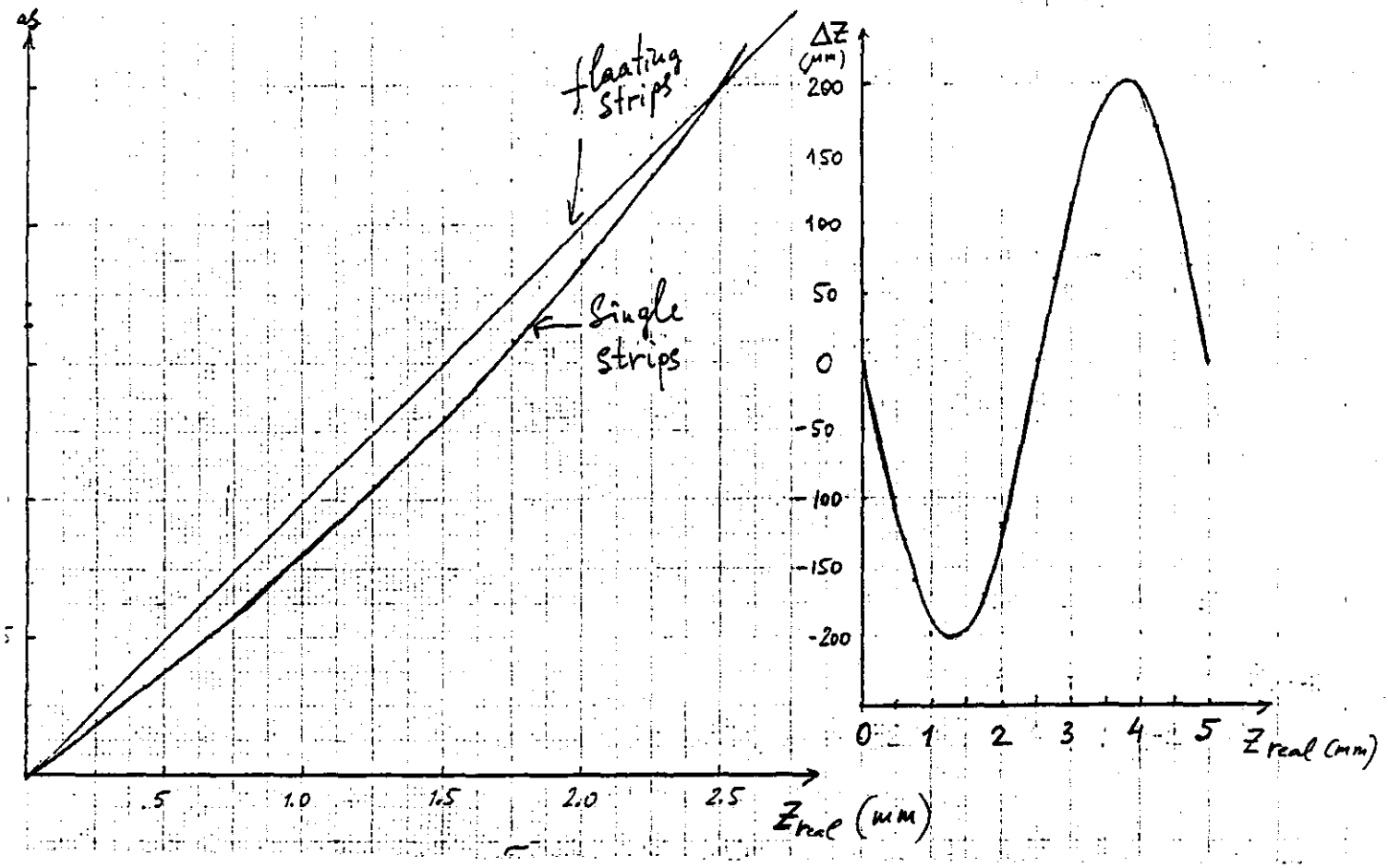
for $h = 4mm$ $d_a = 7mm$

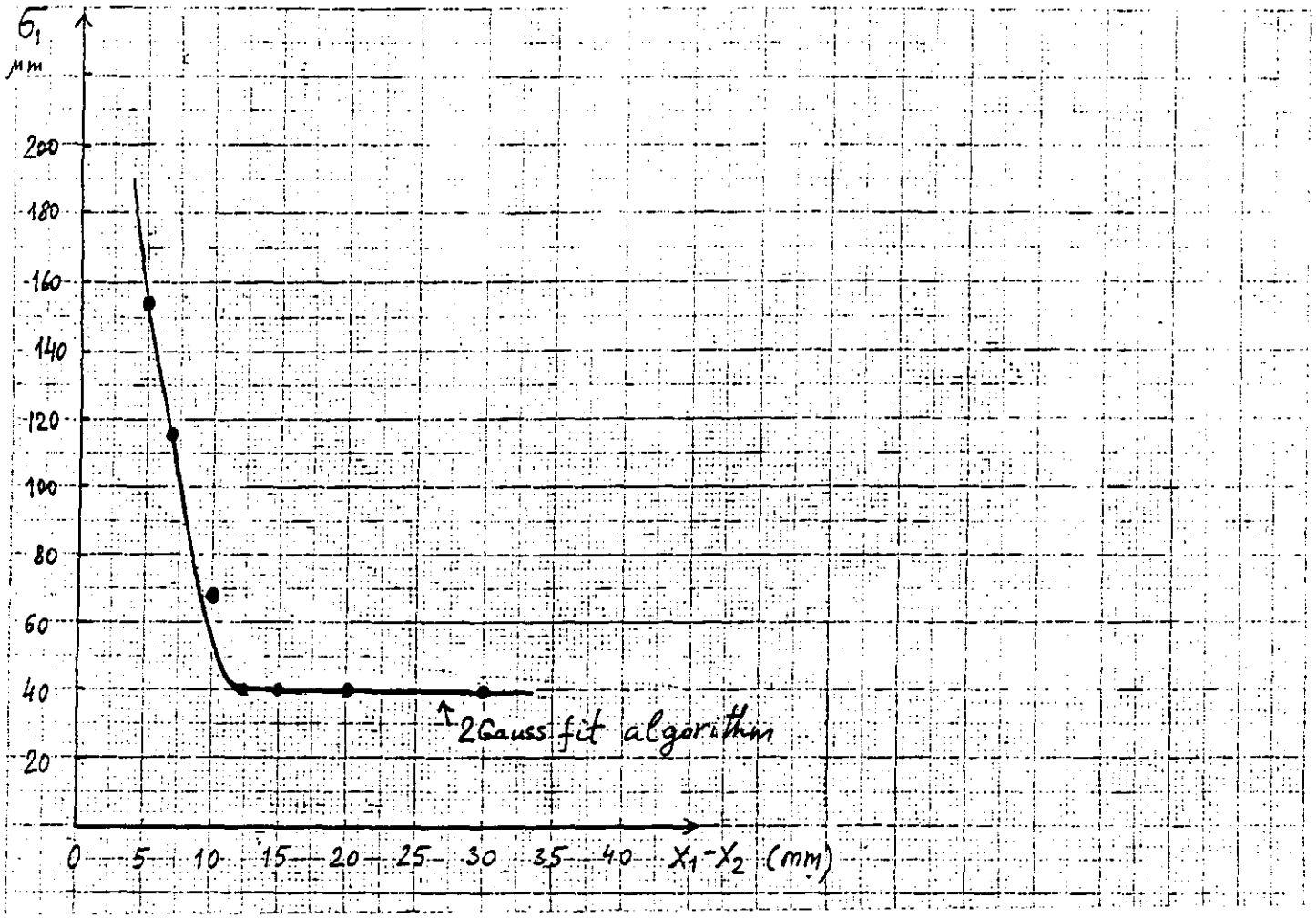
for $h = 2.5mm$ $d_a = 5mm$



$\sigma_{noise} = 1500\,e$.


σ
(μm)
110
100
90
80
70
60
50
40
30
20
10
3
5
7
9
11
d_a (mm)
pitch size
Barrel (h=2.5mm)
End cup (h=2.5mm)
Barrel (h=4mm)
End cup (h=4mm)


floating strips
Single strips
.5
1.0
1.5
2.0
2.5
Z real (mm)
ΔZ (μm)
200
150
100
50
0
-50
-100
-150
-200
0
1
2
3
4
5
Z real (mm)



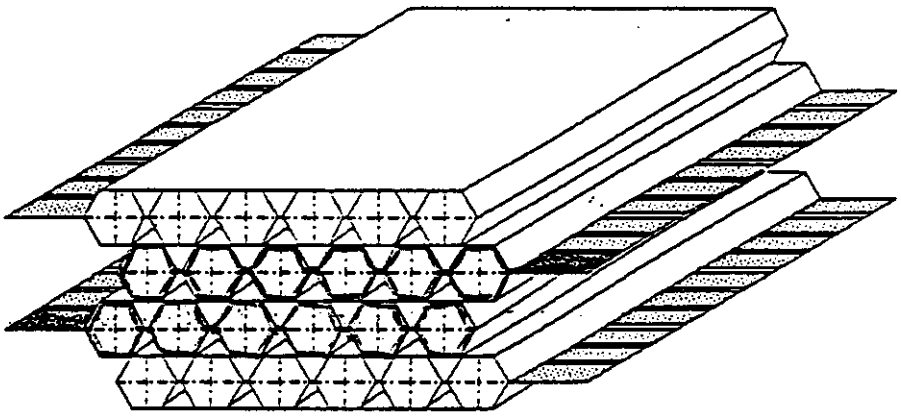
two partical resolution.
$X_1 - X_2$ – distance between particals.

gem

γeμ

Presentation by:

C. Milner



HONEYCOMB STRIP CHAMBER

X COORDINATE: FROM STRIPS

Z COORDINATE: FROM DRIFT TIME; WIRE SIGNALS

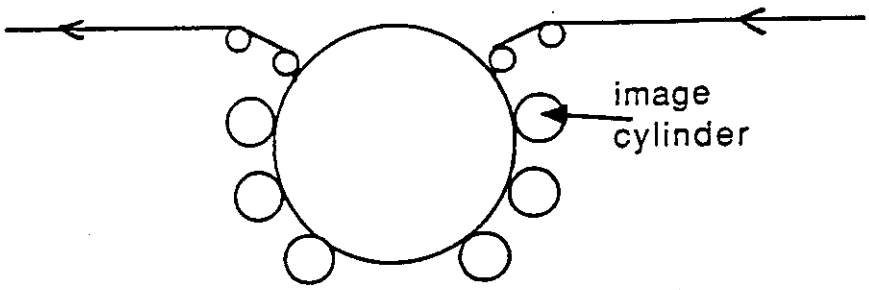
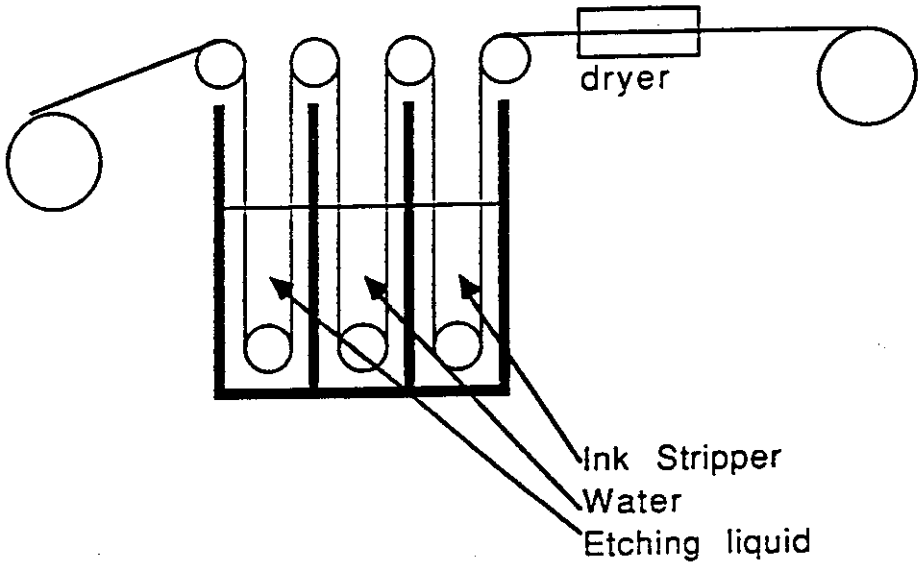


image
cylinder


dryer
Ink Stripper
Water
Etching liquid

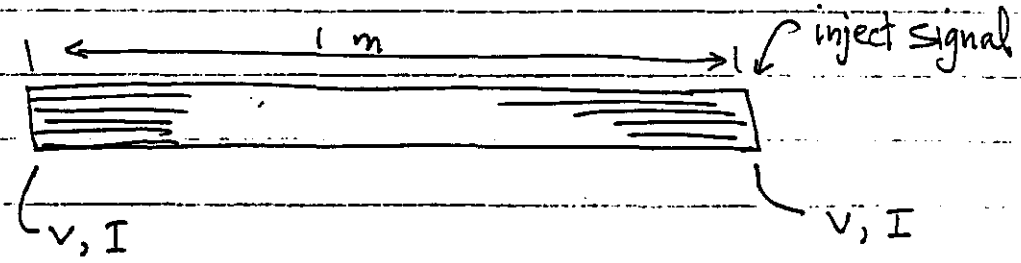
Strip Boards made from "Honeycomb" strips

R&D issues

mechanical

- strip precision measurement (BNL?)
- Hygroscopic behavior
- glueing to substrate for support

Electrical

- electrical connection
  - ~ flex circuit connector?
- skin depth (Pascal Kibuule)
  ($\delta = 7\,\mu m$ @ 100 MHz)

$$Z(\omega) \propto \frac{V}{I}, \quad Im(Z(\omega)) \Longrightarrow L, C$$