Hadronic Endcap Beam Test

$\frac{e}{\mu}$ Determination from 1998 and Preliminary Results from Protvino August 1999 Analysis

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With majority of work and results from:
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Outline

- Methods and Assumptions for Calculating $\frac{e}{\mu}$
  $\longrightarrow$Results
- 120 GeV & 200 GeV μ energy distributions - August 1999
- 120 GeV μ X-scan - August 1999

Calculating $\frac{e}{\mu}$

just a response ratio. . . $\frac{e}{\mu} = \frac{\text{response to electrons}}{\text{response to muons}}$

$\alpha_{em} = \frac{1}{\text{response to electrons}}$ =constant is well known

$$\frac{e}{\mu} = \frac{E_{\rm dep}(\mu)}{E_{\rm vis}(\mu)} \times \frac{1}{\alpha_{em}}$$

Need care in determining $E_{\rm dep}(\mu)$, $E_{\rm vis}(\mu)$.

Gaussian $\otimes$ Landau

(Symmetric, mean $= 0$) $\otimes$ (Asymmetric, mean $\neq 0$)

- mean
  - conserved (same with or without noise)
  - subject to large fluctuations (due to events in the tail)
  - could also use truncated mean . . .
- most probable
  - well sampled - fluctuations are small
  - need to de-convolute from noise

    result should NOT depend on number of cells in cluster!

Calculating $\frac{e}{\mu}$

$E_{\text{dep}}(\mu)$

- no means of measuring in HEC beam test
- comes directly from MC - no noise effects
- Vavilov regime (+ radiative effects)

$E_{\text{vis}}(\mu)$

- energy loss from: ionization, direct pair production, & Bremsstrahlung
- data includes noise!
- Two methods of unfolding from noise:

Victoria

Fit data to Landau/Gaussian convolution and extract Landau most probable

- $\chi^2 \simeq 1$
- identical results w/ Moyal function
- independent of cluster size

Assumptions:

- data approximates a Landau (radiative processes...)

Protvino

Extract most probable from data, unfold using MC results

$$E_{\text{vis}} = E_{\text{vis}}^{\text{DATA MP}} \times \frac{E_{\text{vis}}^{\text{M.C. MP}}}{E_{\text{vis}}^{\text{M.C.+NOISE MP}}}$$

Assumptions:

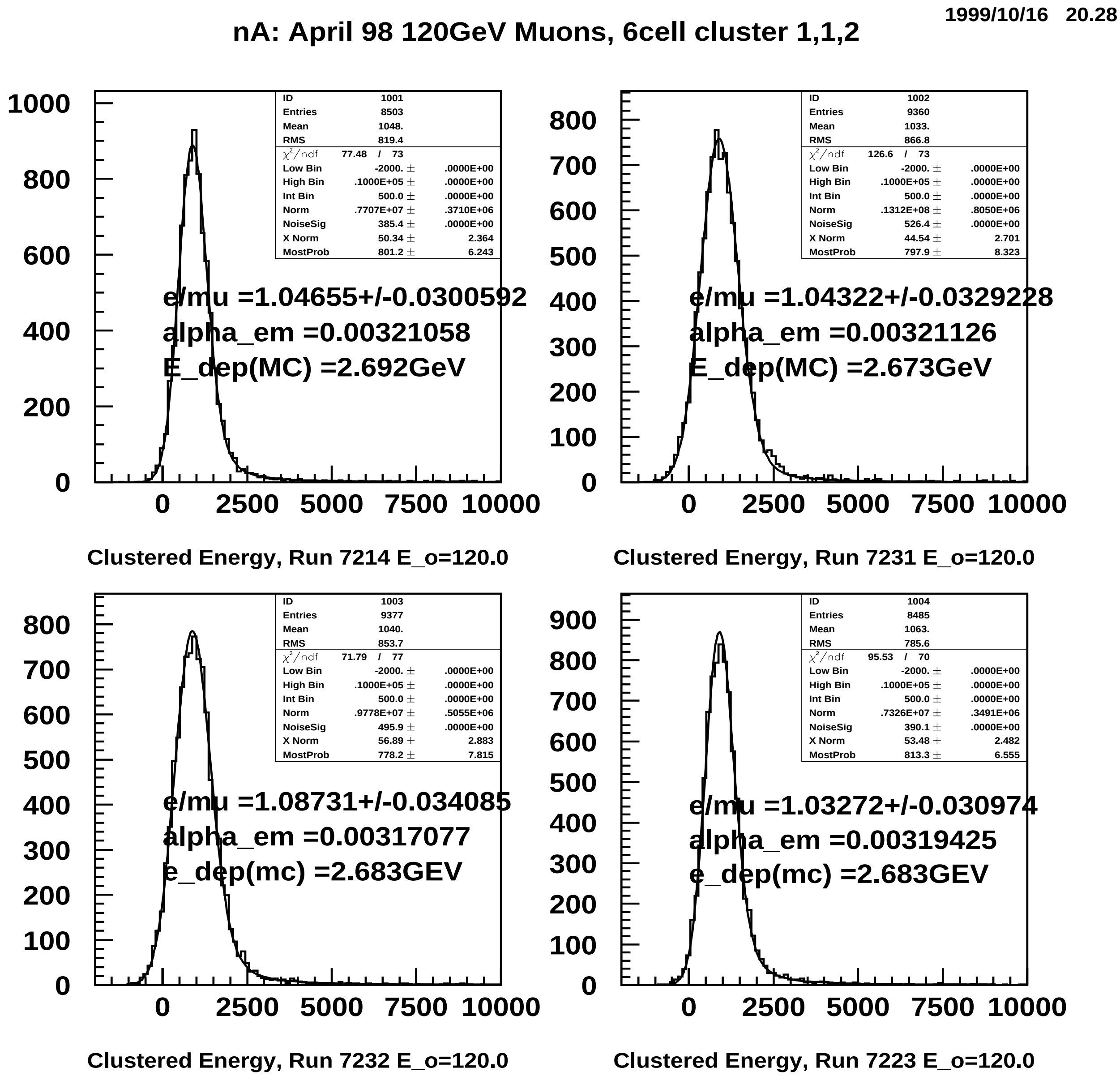
- extra MC dependence

$\frac{e}{\mu}$ Analysis

- 1,1,2,2 depth constants to account for factor 2 Cu thickness in back depth
  - necessary to preserve constant sampling fraction
    otherwise we would need to quote two different values for front/back wheels
  - difficult since electrons do not penetrate to back wheel
  - $\rightarrow$ keeps response ratios constant
- additional constants to account for H.V. problems
  correction factor $= \dfrac{\text{total number subgaps}}{\text{functioning subgaps}}$
- optimal filtering
- 6 cell muon cluster (straight line through calorimeter)
- α_{em} from a 9 cell cluster (using $>$ 9 cells does not change results)
  Victoria/IFVE (Minaenko) results in good agreement

$$\alpha_{em} \simeq 3.2 \frac{GeV}{\mu A}$$

Victoria: $\frac{e}{\mu}$ Results



$\langle \frac{e}{\mu} \rangle \; = \; 1.05 \; \pm \; 0.03$ using most probable of convoluted Landau fit

$\langle \frac{e}{\mu} \rangle \; = \; 1.03 \; \pm \; 0.02$ using statistical mean

Protvino result $\quad \frac{e}{\mu} \simeq$ *consistent*

Protvino Analysis

All work by: Mikhail Levitsky

Data

Muon 120 GeV runs 8492-8534

X scan for Y=13.4cm (X=-24,24; step 2cm)8492-8516

with MWPC data

Muon 200 GeV runs 9336-9362

For comparison 120 and 200 GeV

run 8525 M(X=8cm,Y=.0) 120GeV & run 9340 M(X=8cm,Y=.0) 200 GeV

4 Cell Cluster: ADC channels: 33,58,83,108

Calculation procedures

Pedestals - mean value of 3d sample

Only muon trigger for signal and noise

Noise from first 5 time slices

One method of signal reconstruction

Cleland's method (optimal filter) for 5 samples, files:

runs 8492-8534: dig_weights_amp_aug99_990822.dat & dig_weighte_tim_aug99_990822.dat

runs 9336-9362: dig_weights_amp_aug99_990901.dat & dig_weights_tim_aug99_990901.dat

For ADC channel 61 used weights 57

Calibration files:

coeff_dig_aug99_990822.dat & coeff_dig_aug99_990901.dat

HV Corrections (5 dead EST):

W(k,n) where k=module & n=segment

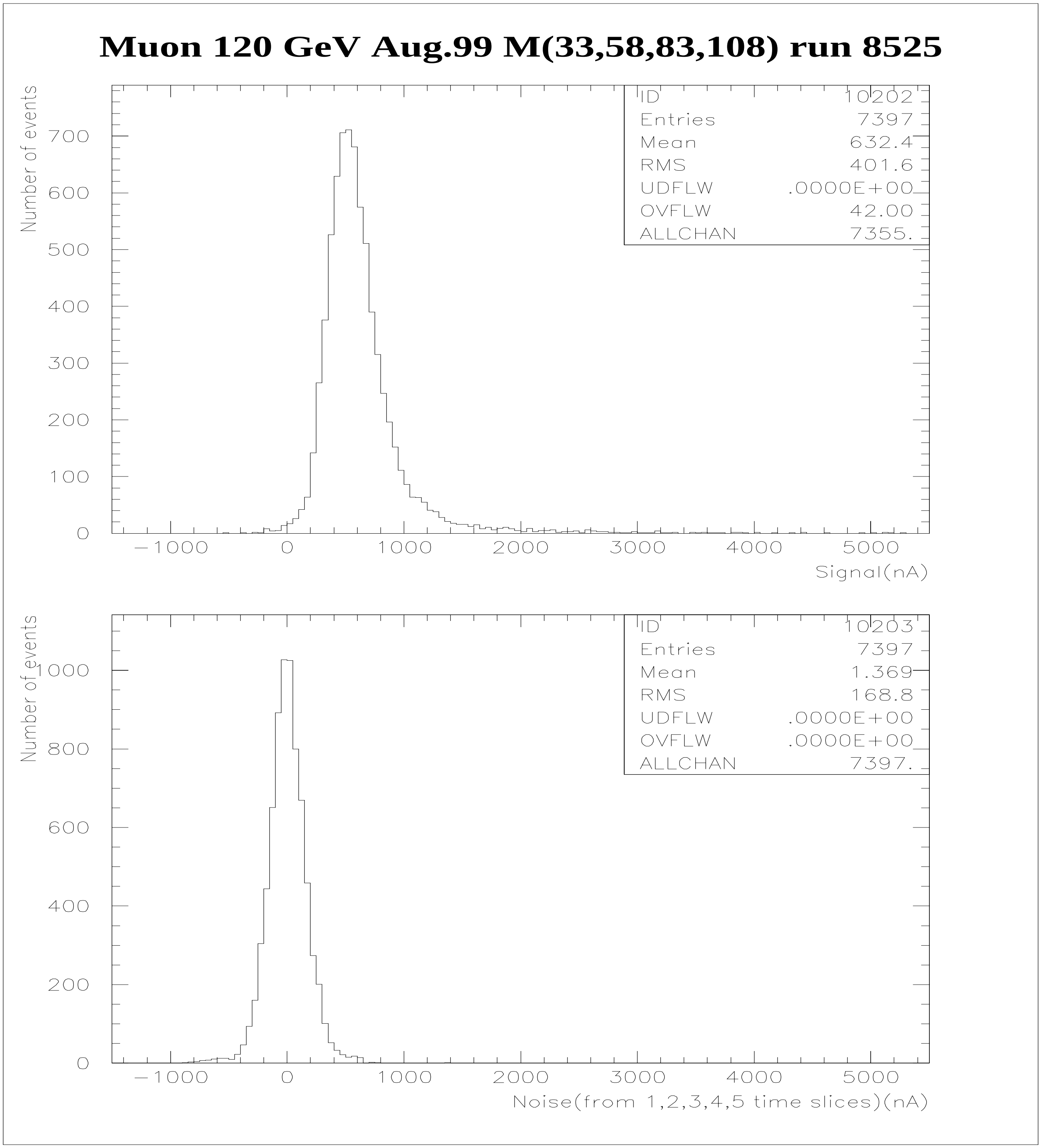
W(1,2)=1.25

W(2,4)=1.25

W(3,2)=2.0

W(3,4)=1.25

August 1999: 120 GeV μ Energy Distribution



mean = 632.4 nA (Compare to 720 nA in August 98)

$$\frac{\text{signal}}{\text{noise}} = 3.7$$

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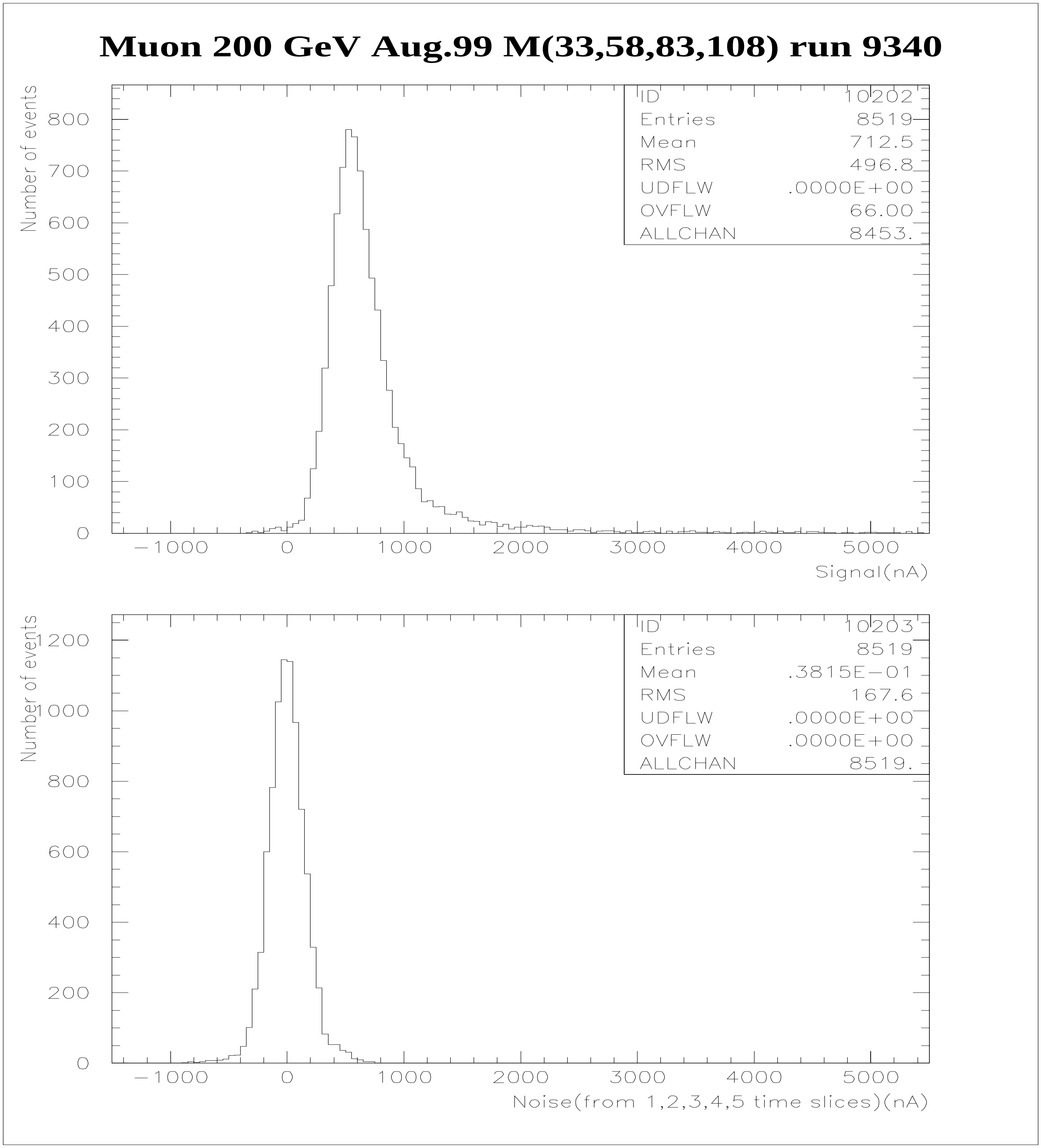
August 1999: 200 GeV μ Energy Distribution



$$\text{mean} = 712.5 \text{ nA}$$

$$\frac{\text{signal}}{\text{noise}} = 4.2$$

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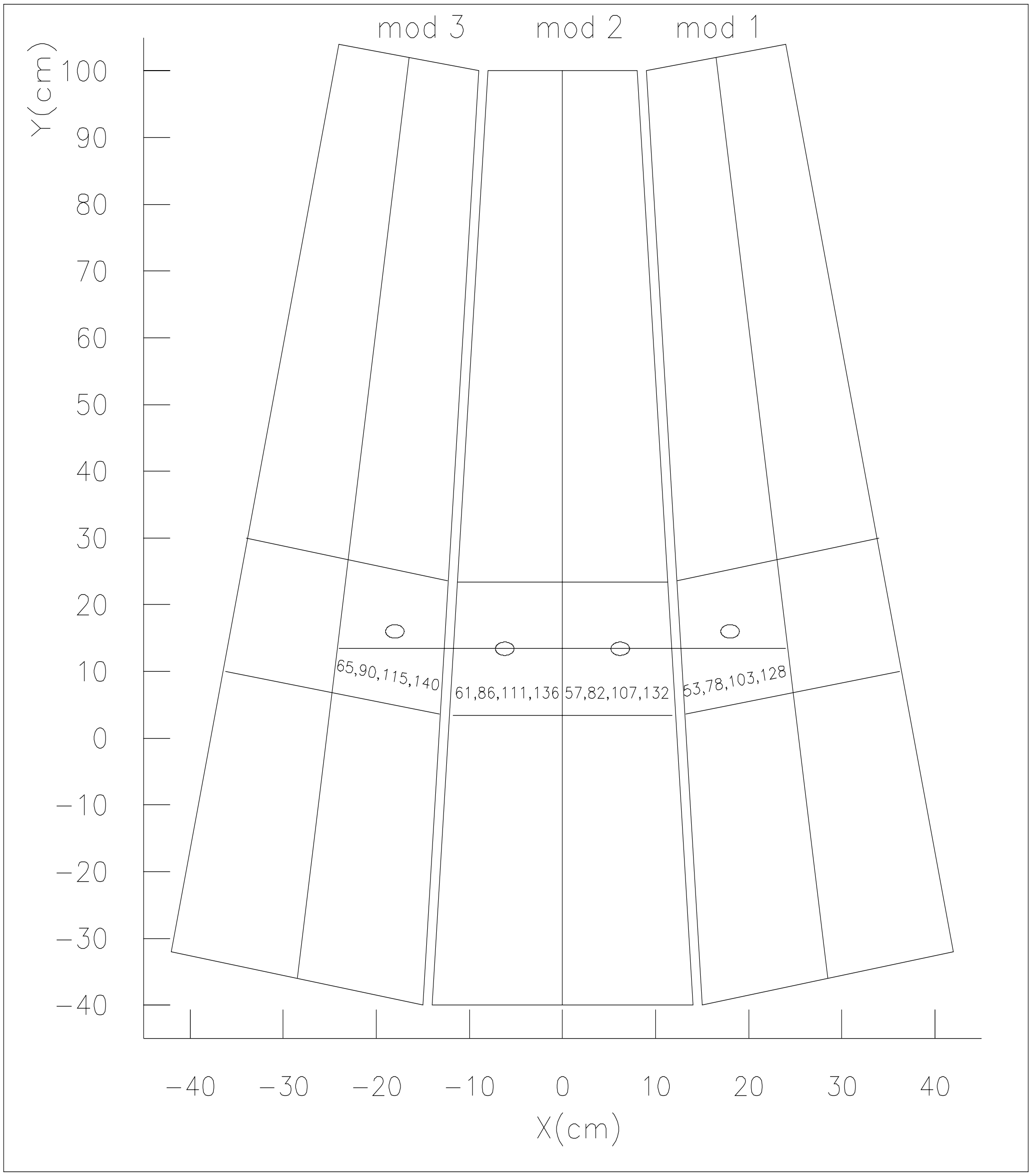
August 1999: 120 GeV μ X Scan



Y = 13.4 cm   -24cm $< X <$ 24 cm   in 2 cm steps

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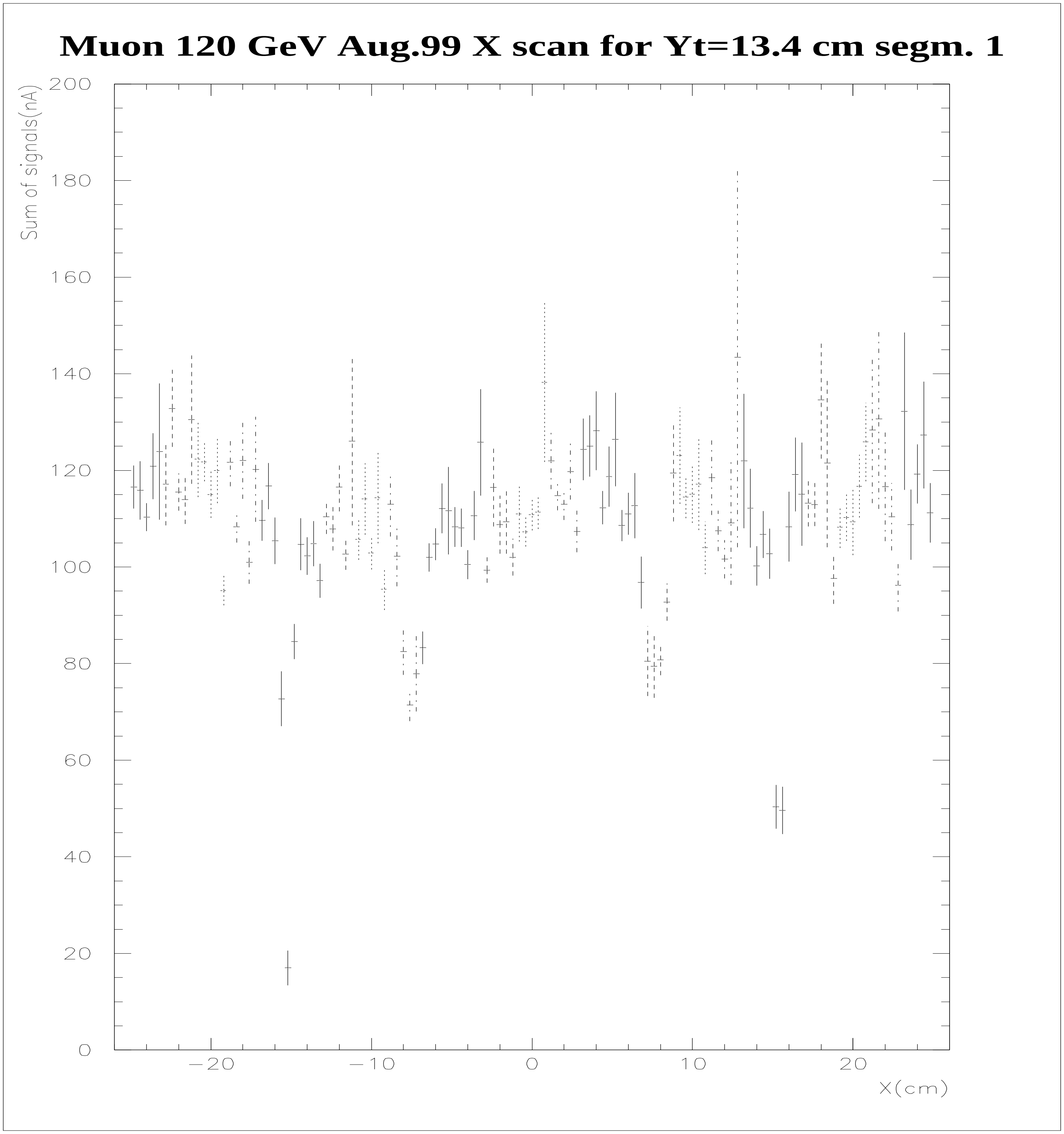
August 1999: 120 GeV μ X Scan



1st segment
tie rods and module cracks are visible
MWPC's give useful information

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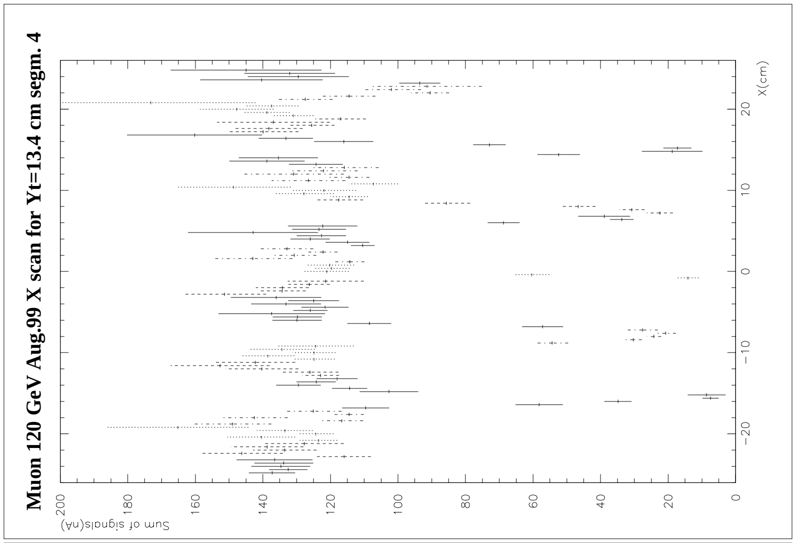
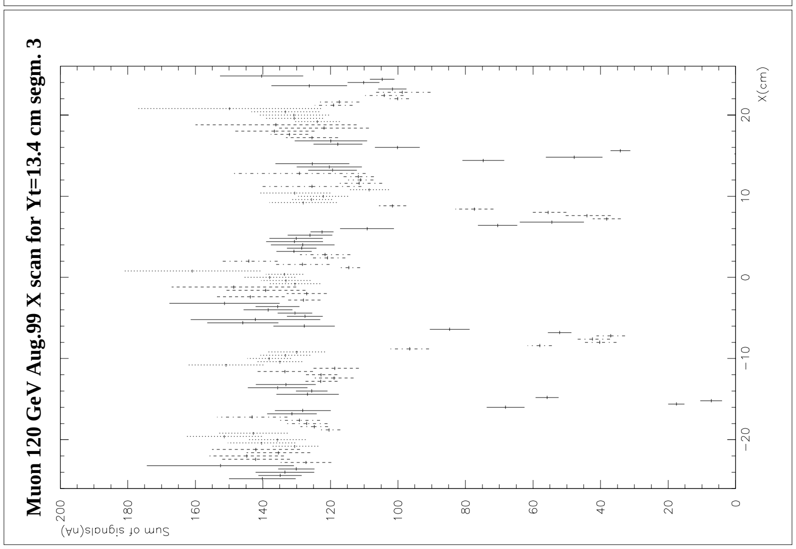
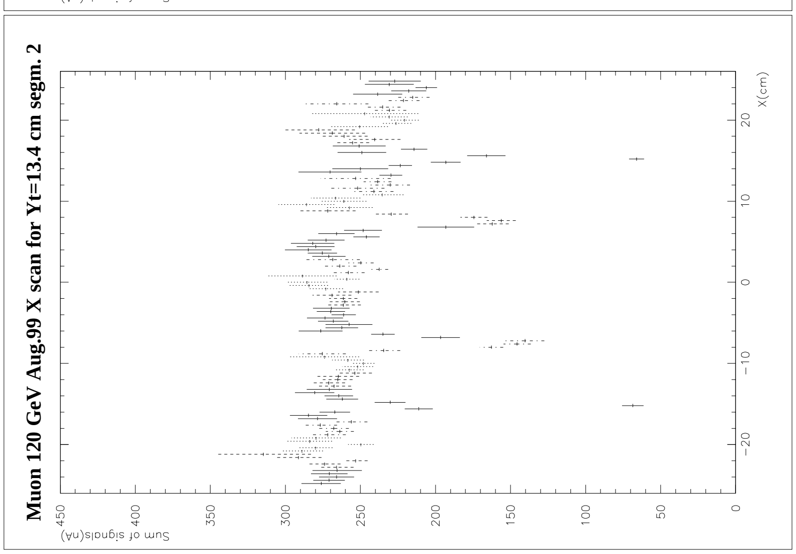
August 1999: 120 GeV μ X Scan







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Conclusions

- $\frac{e}{\mu}$ for 1998 consistent by means of two different analysis methods

$$\frac{e}{\mu} \simeq 1.05 - 1.1$$

- need to repeat with new timing corrections
  $\longrightarrow$ not yet available
- Protvino analysis $\longrightarrow$ shift in mean energy from 1998 to 1999 of 100 nA $\longrightarrow$ needs investigation
- Protvino analysis: good muon signal to noise ratio $\frac{\text{signal}}{\text{noise}} \simeq 4$
- Protvino analysis: tie rods and module crack visible in muon X scan