Hadronic Endcap
Pion and Electron Energy Scan Analysis

Results from August 1998

Matt Dobbs
Michel Lefebvre
Dugan O'Neil

University of Victoria
Victoria, B.C.

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Outline

- Introduction - April Analysis Note
- April Summary Plots
- Pedestals/Noise in August Data
- Pion Results from August
- Conclusions

Introduction

Draft Note

- Complete summary of the April 1998 energy scan (resolution and response) analysis is available:

  "Hadronic Endcap Modules Zero
  Pion and Electron Energy Scan Analysis
  from April 1998 Testbeam Data "

  Submitted as a LARG note.

- Available from:
  - `/afs/cern.ch/user/l/lefebvre/public/endcap/HEC_UVic_Nov98.ps`
  - `http://wwwhep.phys.uvic.ca/~uvatlas/testbeam/`

April Results

April Electron Analysis:

$$\frac{\sigma}{E} = \frac{22.0 \pm 0.01\%}{\sqrt{E_0}} \oplus 0.0 \pm 0.2\% \oplus \frac{0.54 \pm 0.02}{E}, \qquad \frac{\chi^2}{\text{ndf}} = 3.3$$

Response linear within 1%.

April Pion Analysis

- 20-180 GeV pion beams, impact points: D, E, H, I
- Digital filtering signal peak reconstruction
- Simple depth constants (for constant sampling fraction)
- Large 39 cell cluster
- Parametrization (after noise pre-subtraction):

$$\frac{\sigma}{E} = \frac{A}{\sqrt{E_o}} \oplus B$$

- Combined fit:

$$\frac{\sigma}{E} = \frac{78 \pm 2\%}{\sqrt{E_o}} \oplus 5.0 \pm 0.3\%, \quad \frac{\chi^2}{\text{ndf}} = 1.9$$

April Results

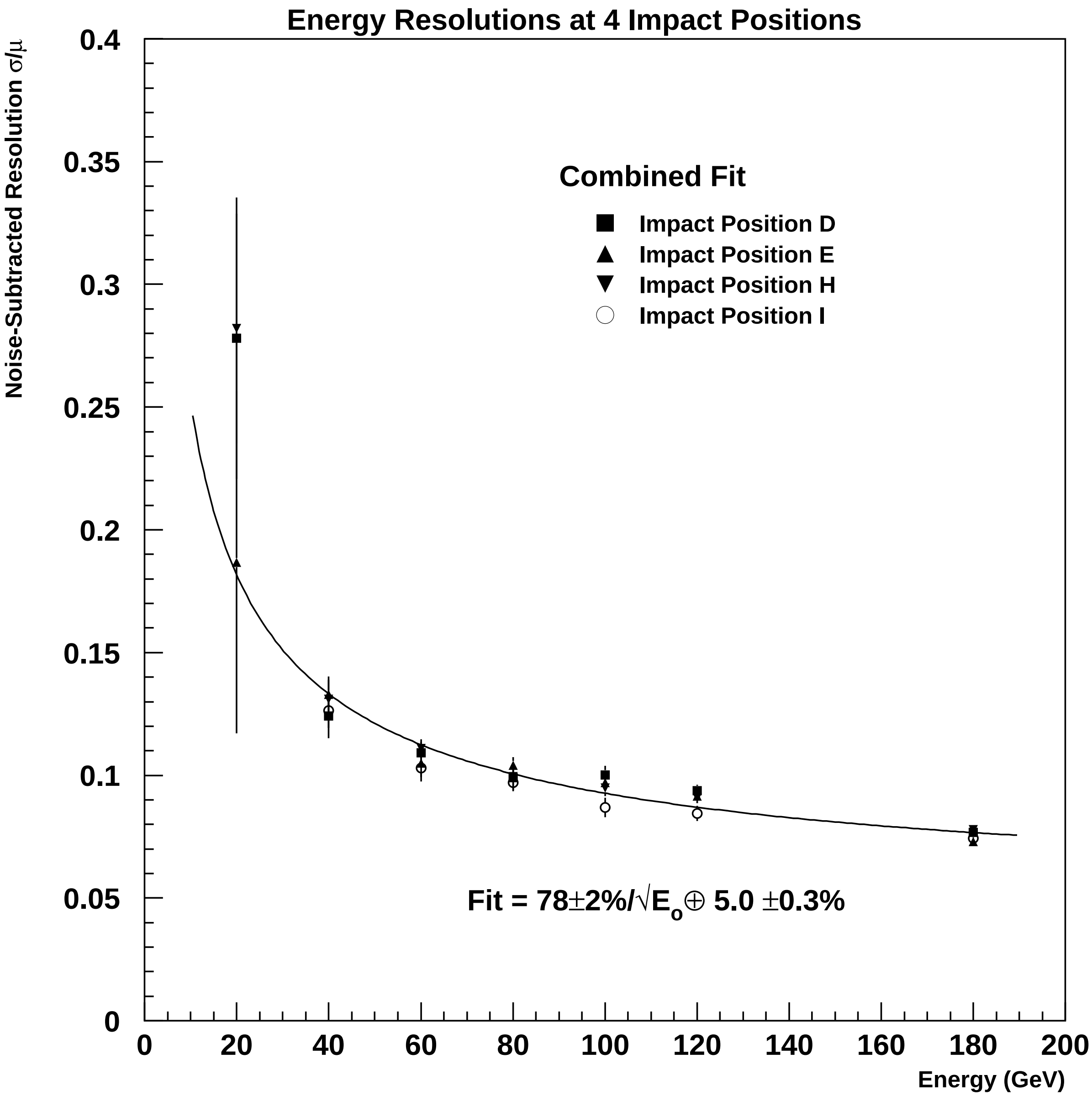

Figure 1: Pion resolution using simple depth constants at 4 impact positions.

April Results

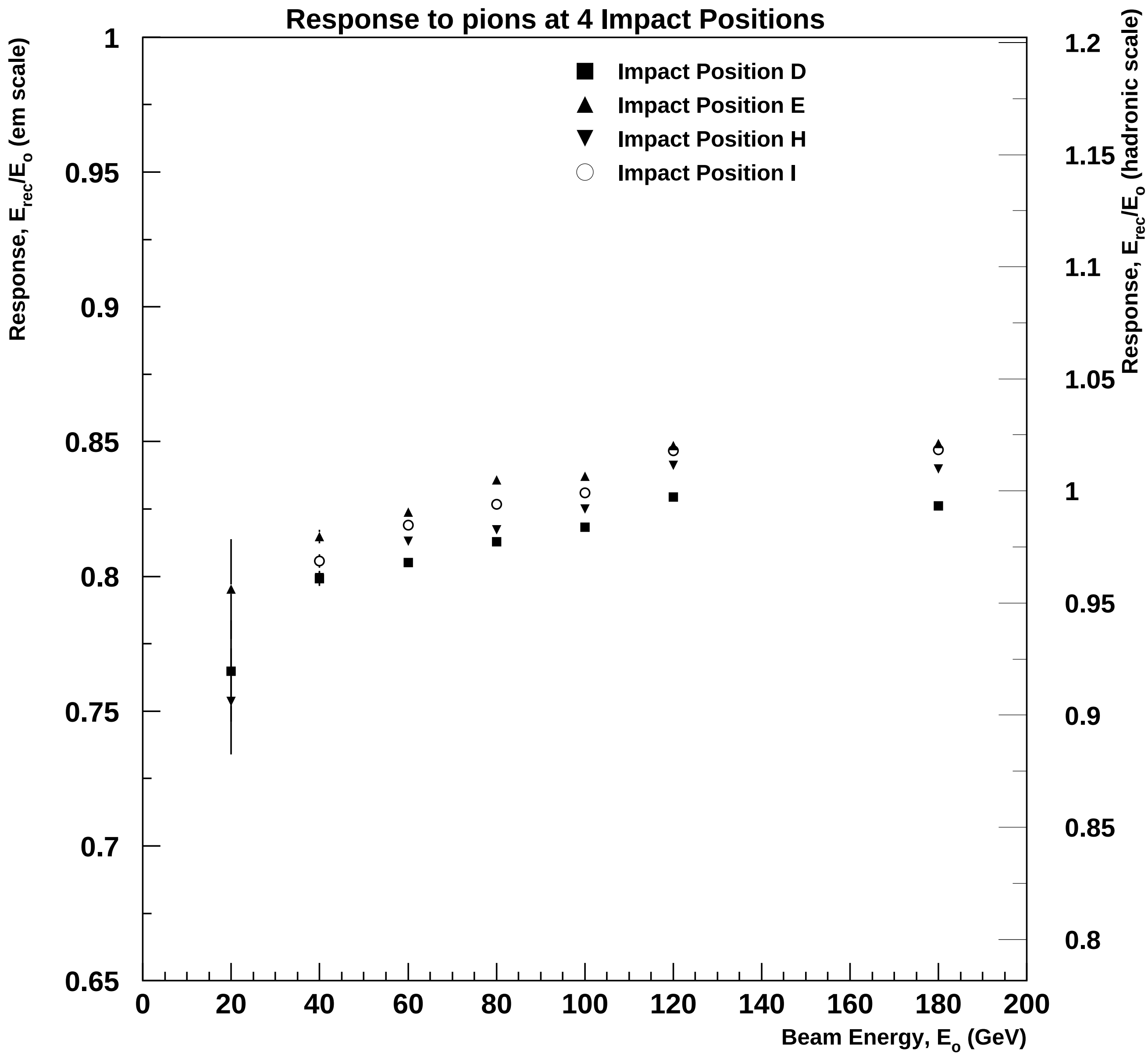

Figure 2: Response to pions using simple depth constants at 4 impact positions.

April Results

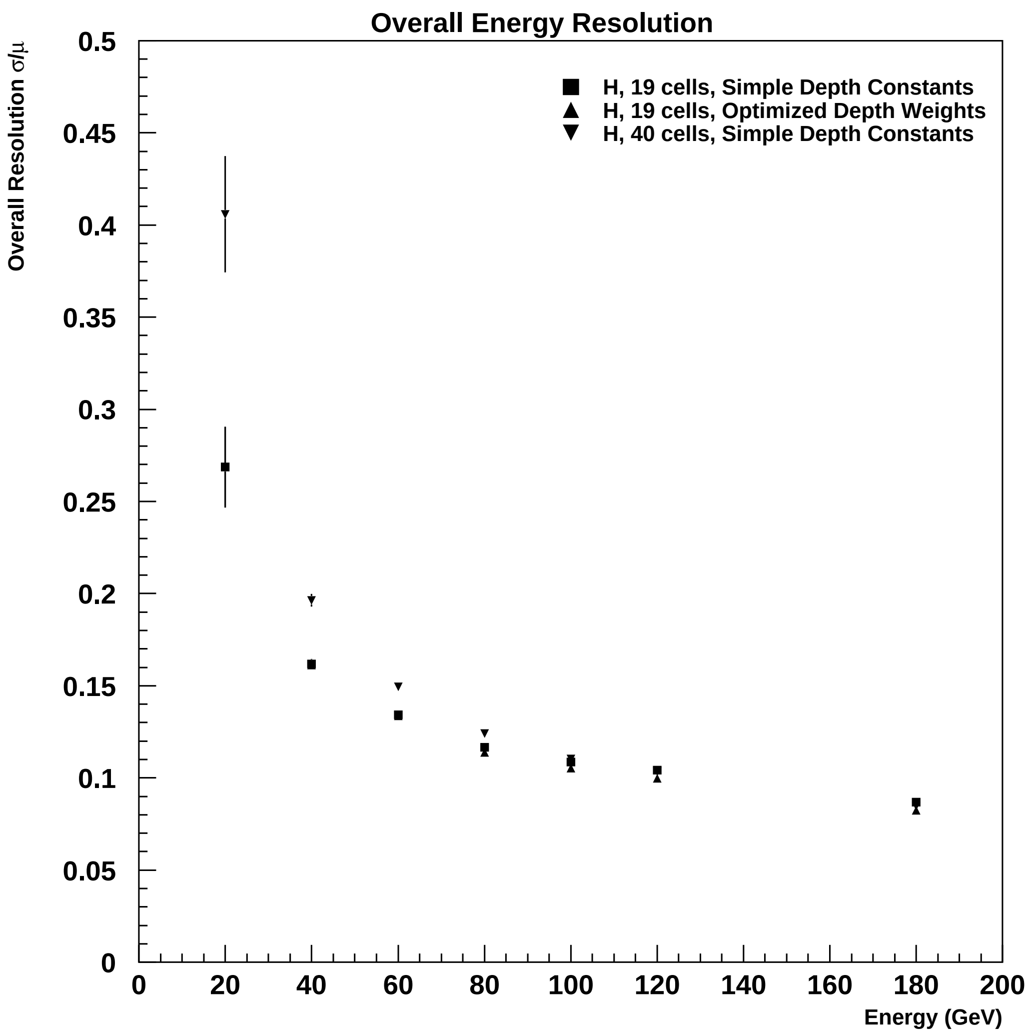

Figure 3: Optimized 19 cell cluster and energy dependent depth weights affect an improvement in the overall resolution.

April Results

- Evaluation of intrinsic e/h yields

  $\langle \frac{e}{h} \rangle = 1.592 \begin{smallmatrix} \pm 0.004 \; stat. \\ \pm 0.03 \; syst. \end{smallmatrix}$

  Agrees well with MC from TILECAL community:

  $\frac{e}{h}\Big|_{\mathrm{mc}} = 1.58$ (GEANT 3.21 - GCALOR)

- Evaluation of e/μ yields

  $\frac{e}{\mu_{\mathrm{120GeV}}} = 0.96$

  $\frac{e}{\mu_{\mathrm{120GeV}}}\Big|_{\mathrm{MC}} = 0.94$

  $\frac{e}{mip} = 0.83$

  $\frac{e}{mip}\Big|_{\mathrm{Th+MC}} = 0.82$

Noise Problems - August

- "Pedestal shift" reported by M. Levitsky at September 1998 LARG week (Figure 4)
  - In physics events, it appears as though "empty cells" are shifted by -0.5 ADC's relative to pedestals.
  - In Random events, it appears as though "empty cells" are shifted by +0.5 ADC's relative to pedestals.
  - $\Rightarrow$ Shift comes from random trigger events (up 1 ADC), which affects pedestals. Very noticeable in muon runs (large number of randoms).
  - pedestals must be calculated from physics events ONLY.
- Figure 5, time profile for "empty cells" in physics events $\longrightarrow$ ALL time slices are shifted!
  - Shift does not appear to be a physics phenomena (i.e. independent of signal in cells).

Noise Problems - August

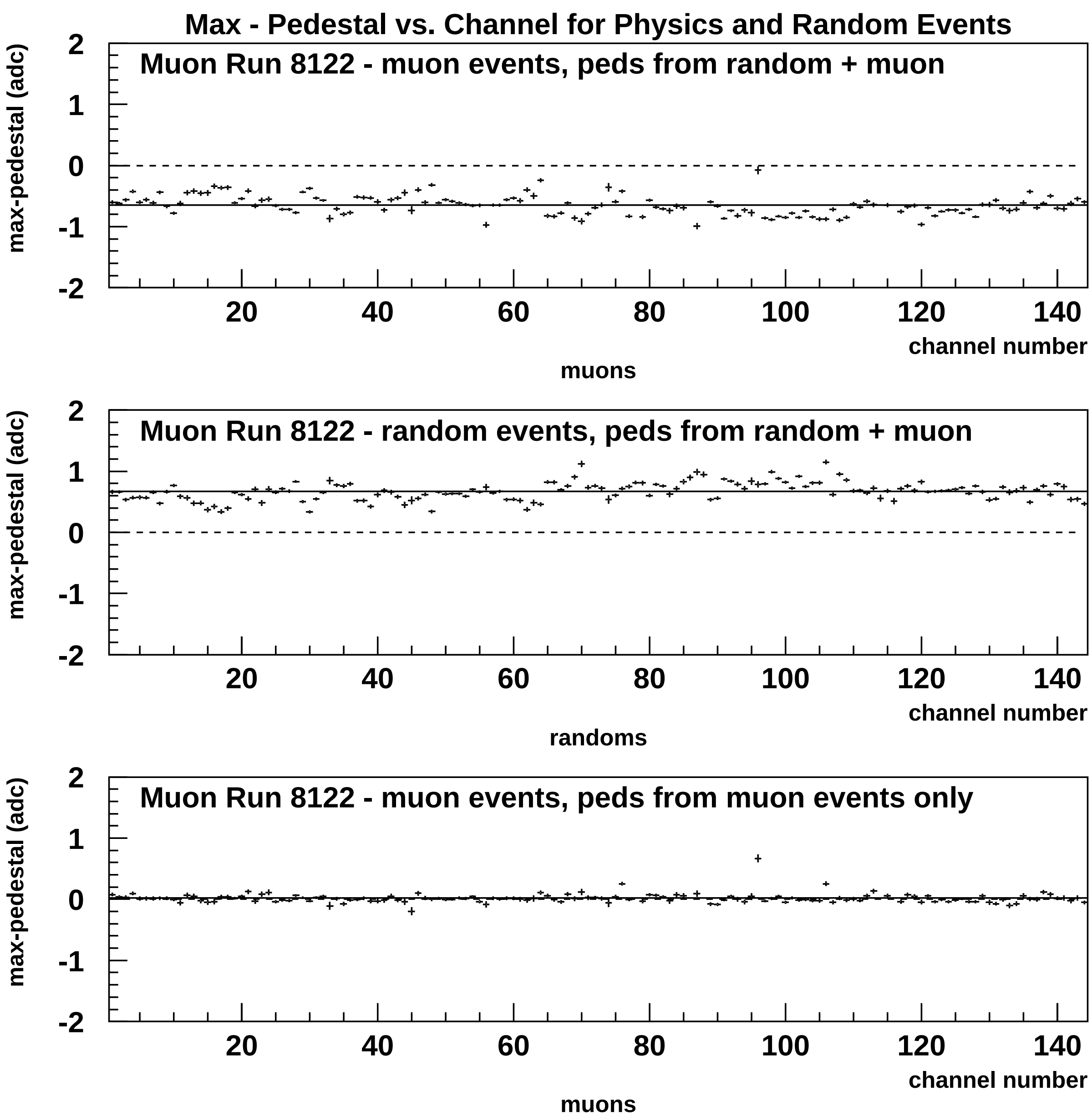

Figure 4: "pedestal shifts" observed in muon runs during August 1998 testbeam.

Noise Problems - August

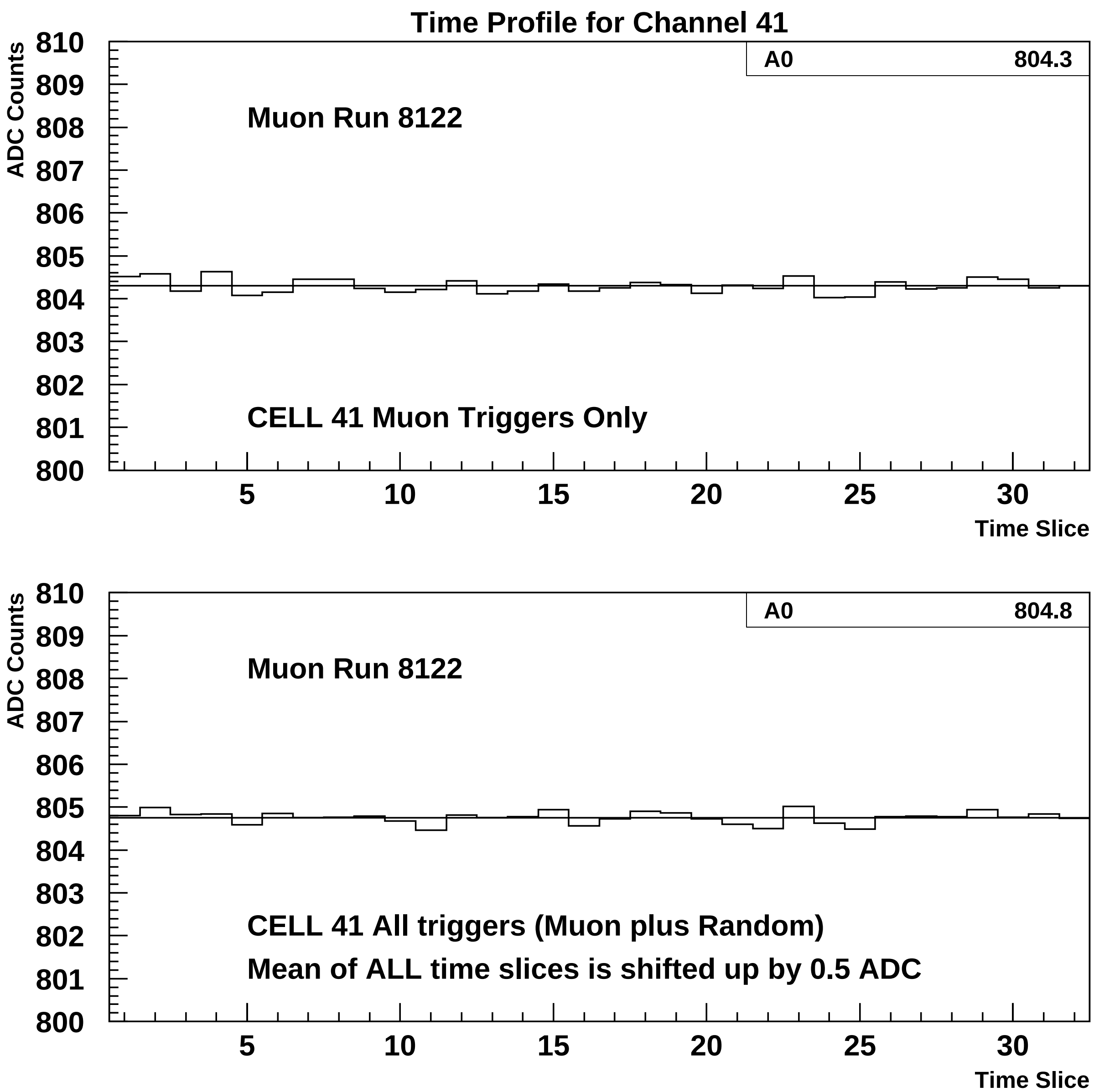

Figure 5: Time profile for an "empty" cell in muon run. Distribution is flat across all time slices: can get valid pedestal by using physics events only. N.B.: this run 50% random triggers, 50% muon events.

Noise Problems - August

- Randoms are shifted. Is width (noise) ok?
- Figure 6: Energy distribution of random trigger events for a 40 cell cluster.
  - High rate in-burst random trigger events have BROADENED and shifted noise distribution. This noise is too large (see Figure 7).
  - Low rate inburst random trigger events appear OK (ie. centred about 0, noise consistent with expectations).
  - Out-of-burst random triggers from dedicated noise runs appear OK, regardless of rate.
  - The same effect is present throughout run period.

Noise Problems - August

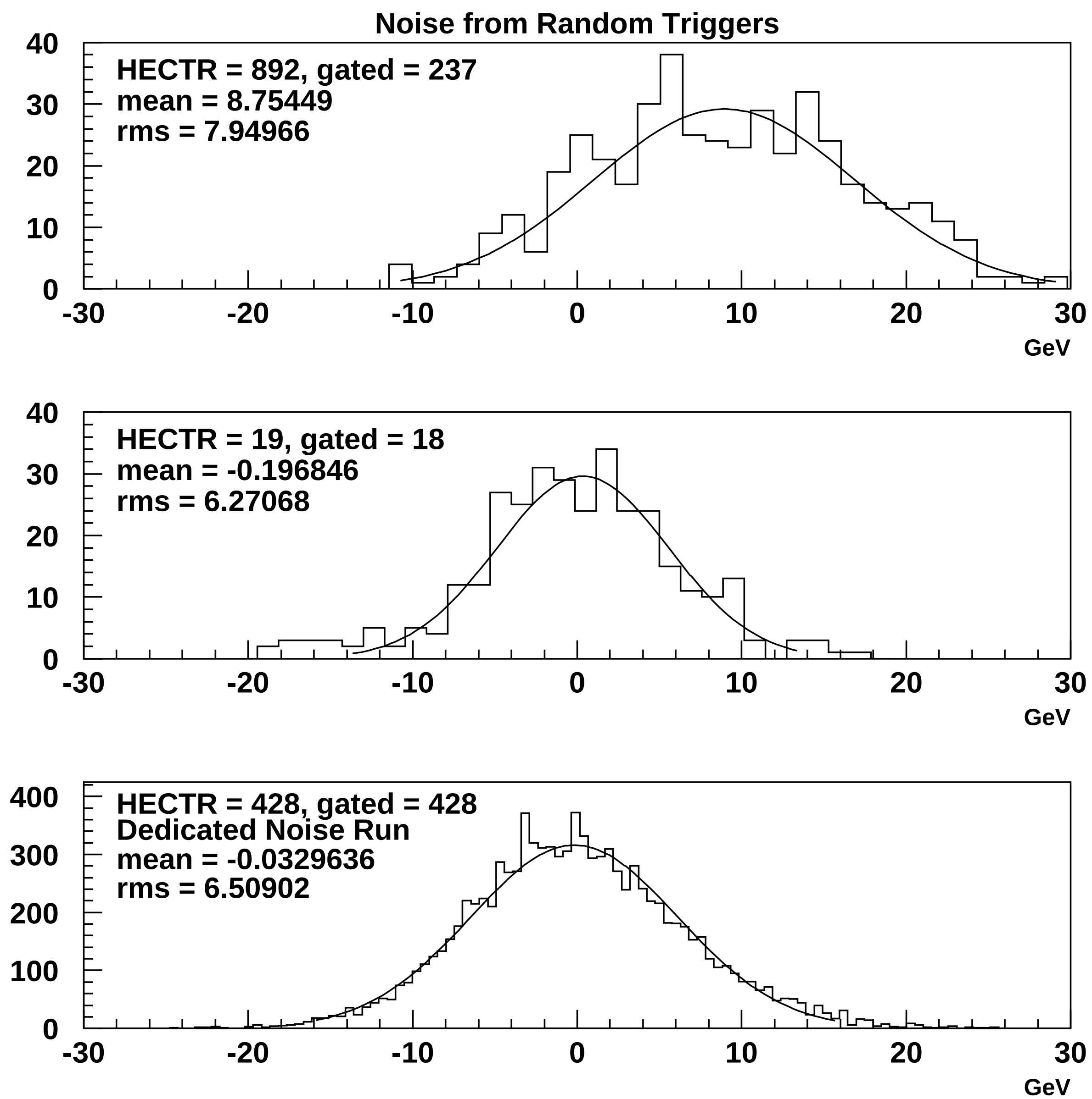

Figure 6: Noise shift and widening is observed for random trigger events or high rate runs (top and middle). No shift or widening is observed in dedicated noise runs (bottom).

Noise Problems - August

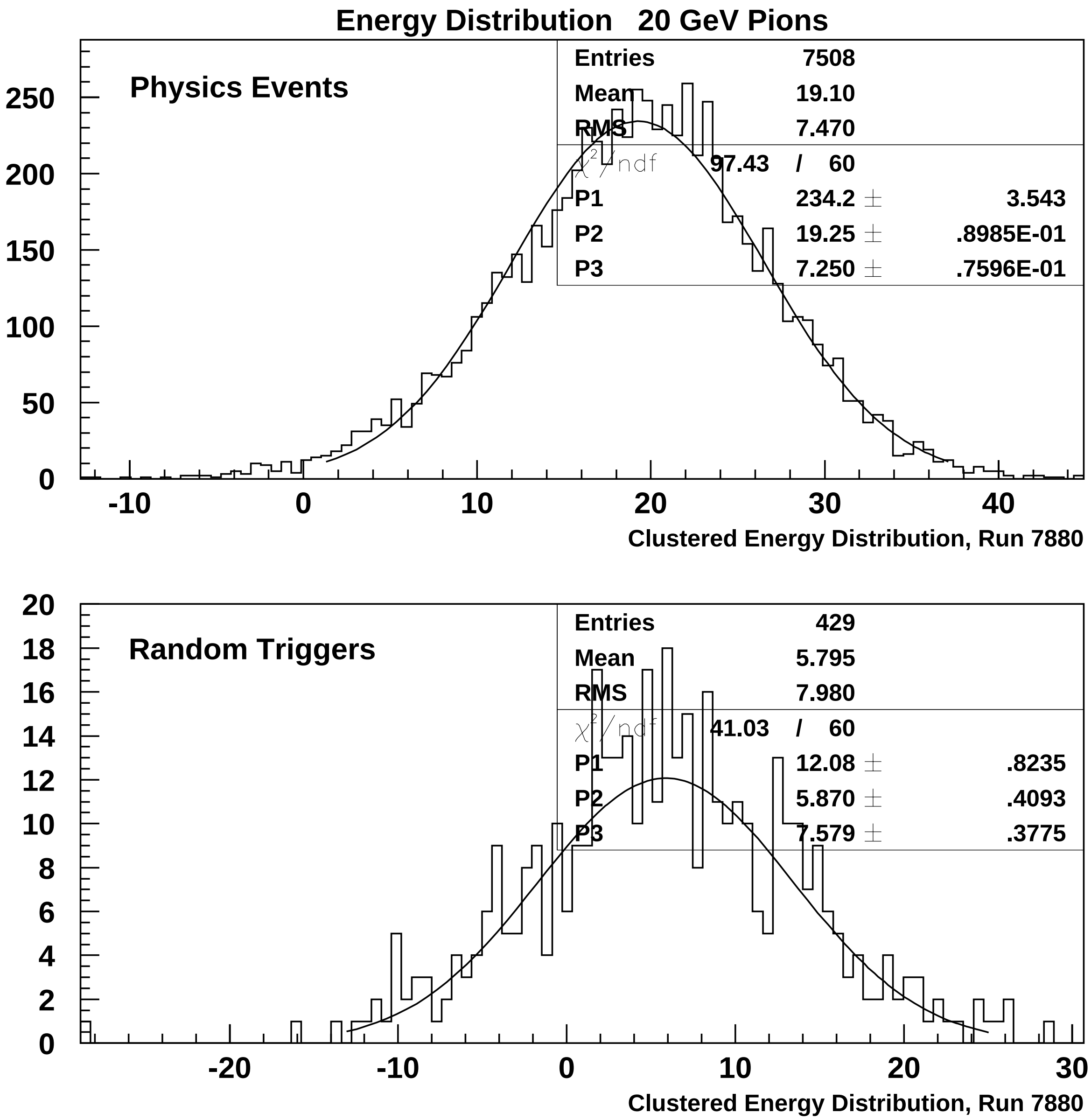

Figure 7: Width of random trigger events from 20 GeV pion run is broader than the signal width.

Noise Problems - August

Summary

- There are problems with random triggers within physics runs in August
- cannot do run-by-run evaluation of noise in August
- Features of problem in August:
  - 32 time slices (april $\longrightarrow$ 16)
  - rate dependent in physics runs
  - in-burst/out-of-burst is different
  - independent of signal

August Pion Analysis

- 10-180 GeV pion beams, impact points: D, E, H, I
- Digital filtering, large 39 cell cluster
- Simple depth constants (for constant sampling fraction)
- Pedestals from physics events only.
- Noise from dedicated noise run (7919).
- The energy resolution at 10 GeV is dominated by noise (Figure 8), making pre-subtraction of noise difficult for low energy points.
  - possible solution → variable cluster sizes

Pion Analysis - August

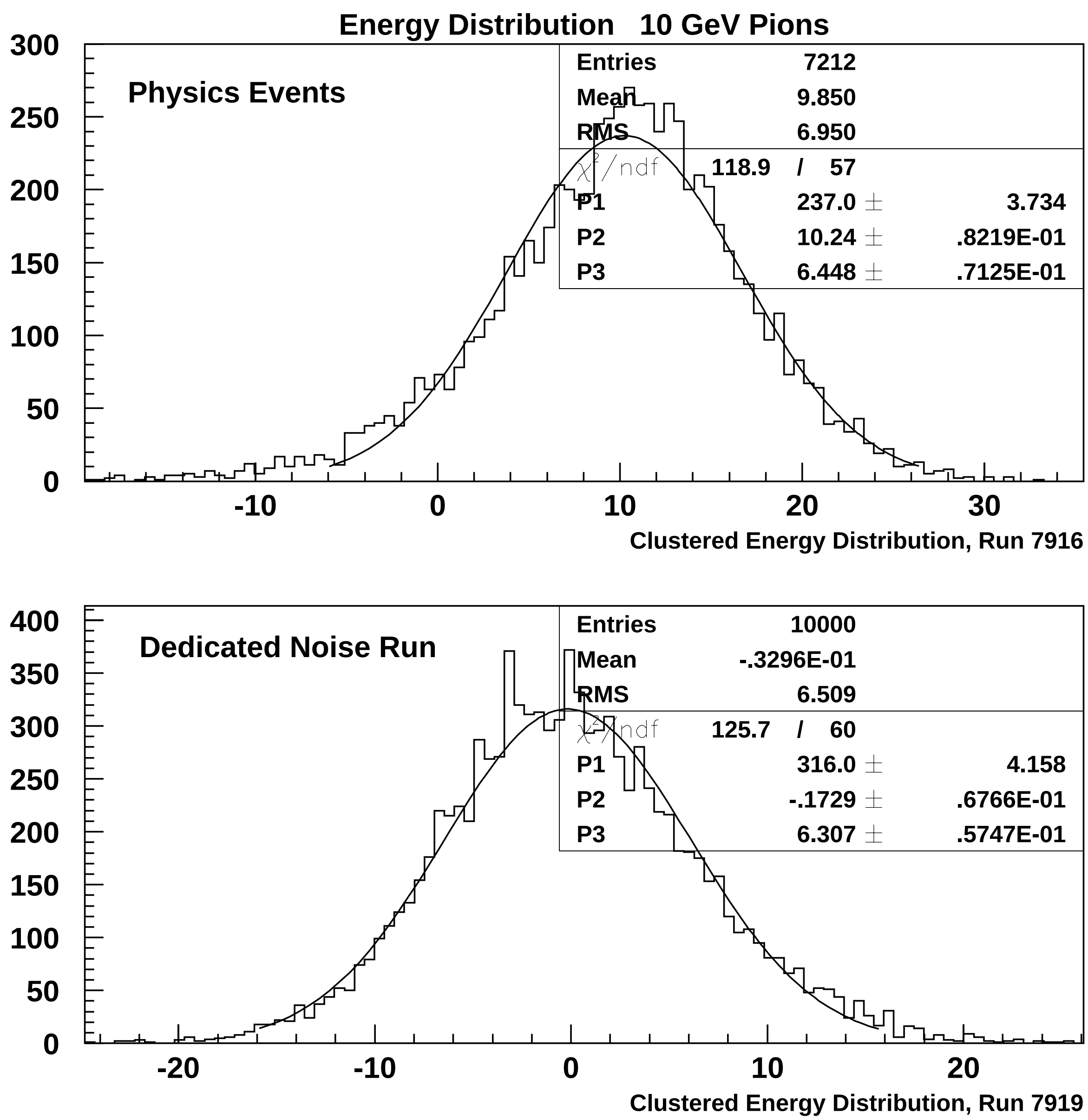

Figure 8: Energy distribution for 10 GeV pions (pad I, top) and noise distribution (bottom) using a 40 cell cluster. The energy resolution at 10 GeV is dominated by noise.

Pion Analysis - August

- Low energy data constrains resolution curve to allow 3 parameter fit (Figure 9), parametrization:

$$\frac{\sigma}{E} = \frac{A}{\sqrt{E_o}} \oplus B \oplus \frac{C}{E}$$

- Combined fit for Module 2 (E, I):

$$\frac{\sigma}{E} = \frac{77 \pm 3\%}{\sqrt{E_o}} \oplus 5.7 \pm 0.2\% \oplus \frac{6.0 \pm 0.1 GeV}{E}$$

- HV problems in segment 2 of Module 1 primarily affect constant term (Figure 10).

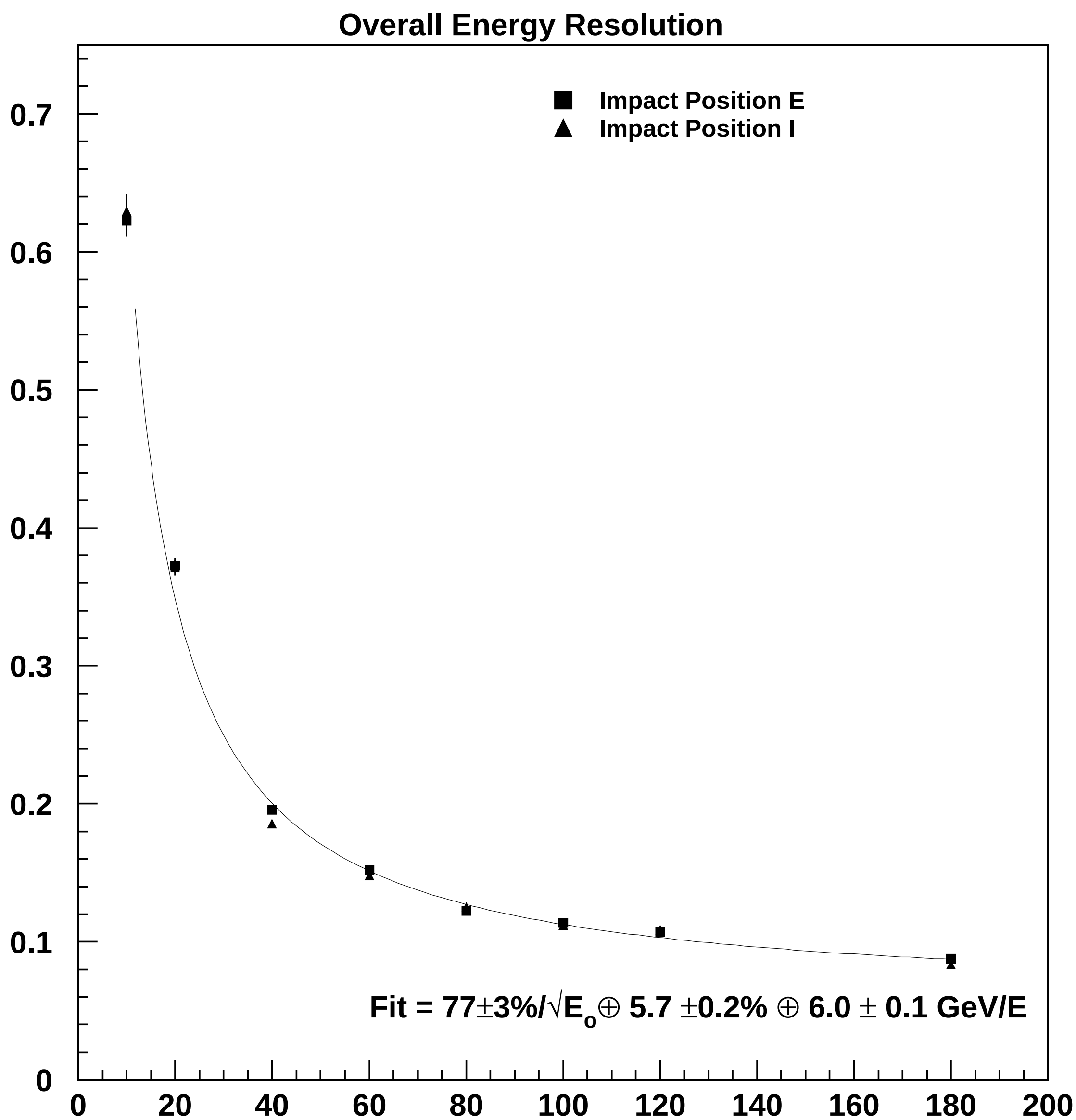

Figure 9: Overall resolution for impact positions E, I (Mod 2), 3 parameter combined fit.

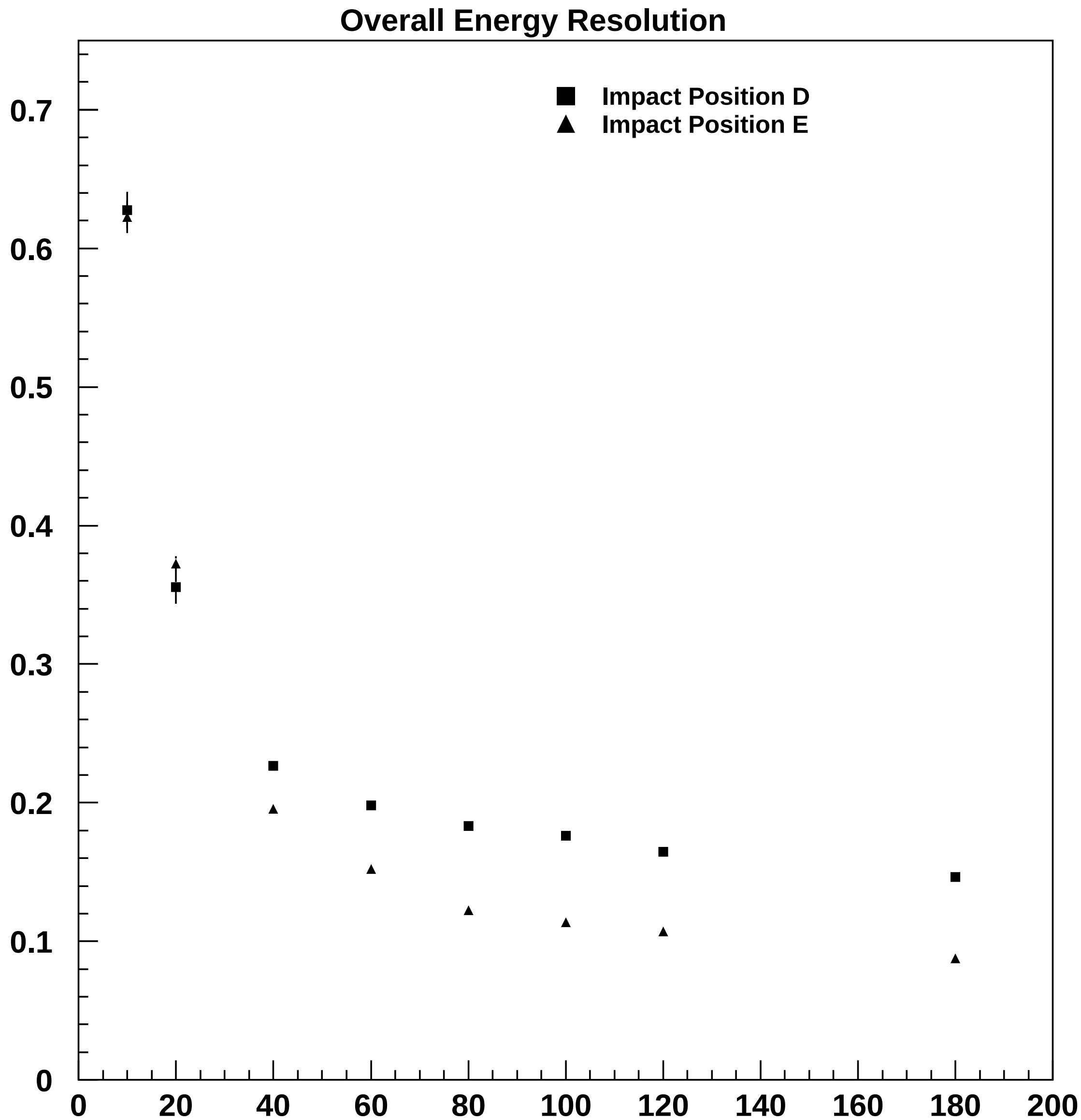

Figure 10: Comparison of overall resolution for Module 1 (pad D, affected by HV problems in segment 2) and Module 2 (pad E). HV problems primarily affect constant term.

Pion Analysis - August

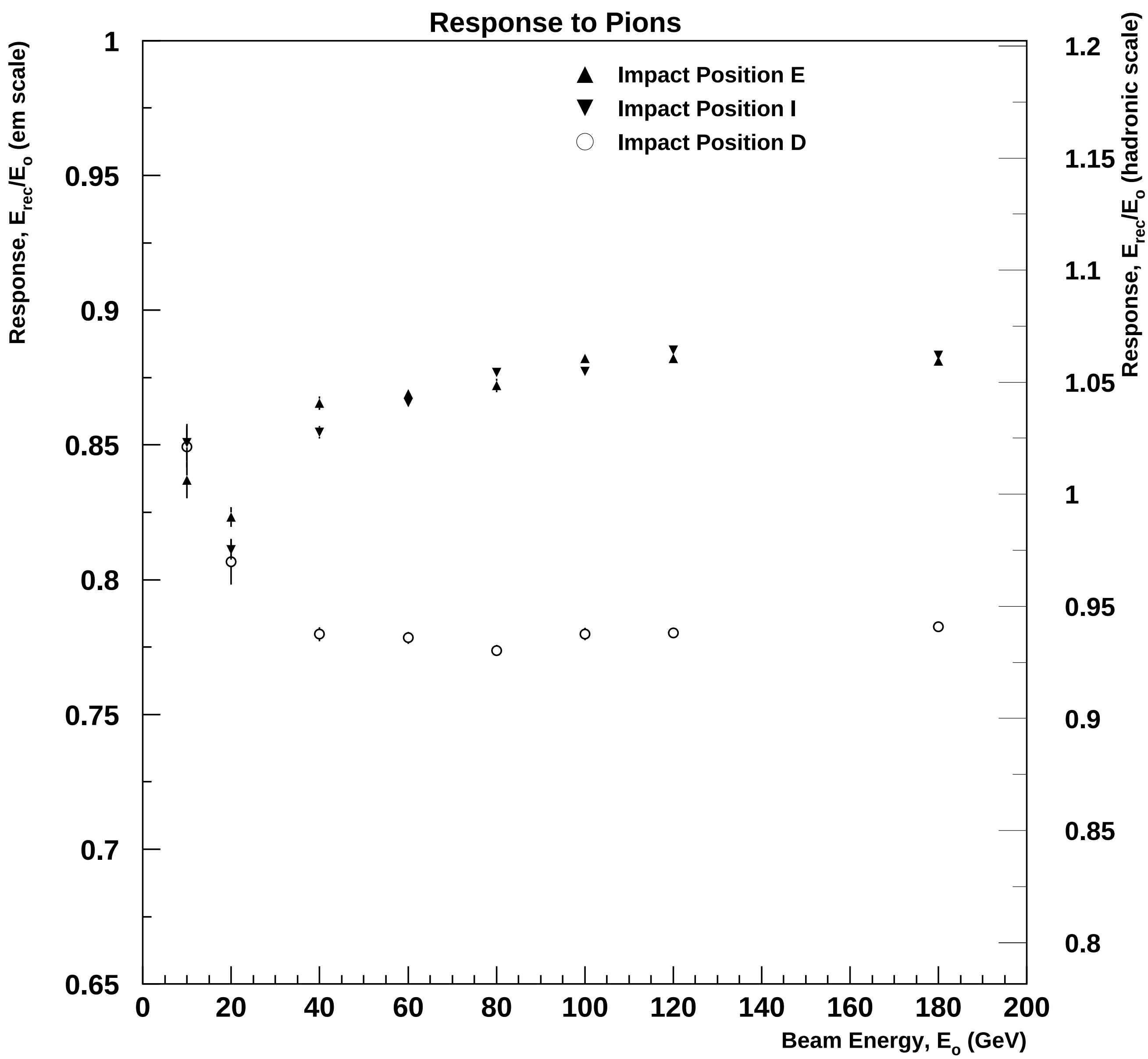

Figure 11: Response (em scale on left, hadronic scale on right) for impact positions E, I (Mod 2), & D (Mod 1).

Conclusions

- April pion energy resolution:

$$\frac{\sigma}{E} = \frac{78 \pm 2\%}{\sqrt{E_o}} \oplus 5.0 \pm 0.3\%, \quad \frac{\chi^2}{\mathrm{ndf}} = 1.9$$

- August high rate in-burst random trigger event energy distribution is shifted and broadened.
  Ideas from DAQ? Hardware experts?

- August pion energy resolution (Mod 2):

$$\frac{\sigma}{E} = \frac{77 \pm 3\%}{\sqrt{E_o}} \oplus 5.7 \pm 0.2\% \oplus \frac{6.0 \pm 0.1 GeV}{E}$$

- HV problems in segment 2 of Module 1 (August) primarily affect constant term.