Review of GlueX FCAL Design

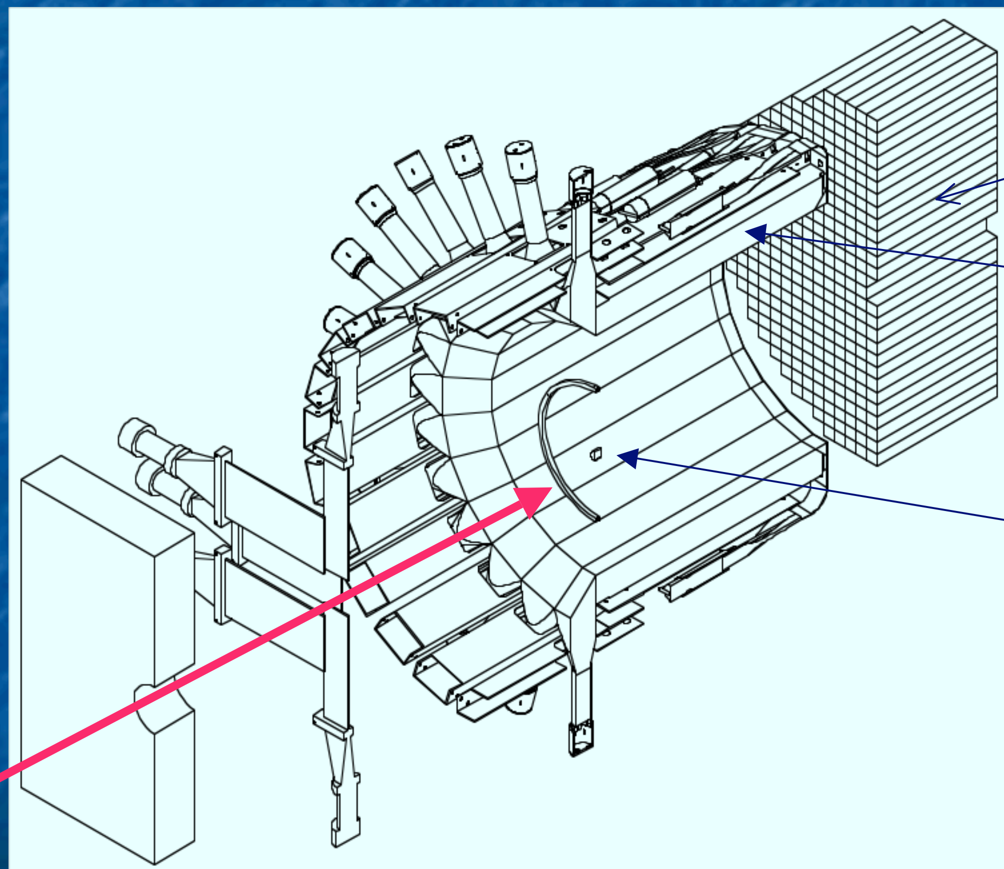
as presented by
Scott Teige, Indiana University

reviewed by
Richard Jones, University of Connecticut

Review Issues

- Performance measured by Radphi
  - energy resolution
  - spatial resolution
  - minimum cluster separation
  - sensitivity to charged tracks
  - electromagnetic background effects
- State of the Monte Carlo simulation
  - **comparison of expected, measured resolution**
  - **design issues affecting photon yield**
  - **efficiency of the reconstruction**

The Radphi Apparatus



The RADPHI Detector

the RADPHI collaboration

R.T. Jones [1], T. Bogue [2], B.E. Evans, M. Kornicer,

Department of Physics, University of Connecticut, Storrs, CT 06268

A.R. Dzierba, R. Gardner [3], J.L. Gunter [4], D. Krop,
R. Lindenbusch, D.R. Rust, E. Scott, P. Smith, C. Steffen [5],
S. Teige,

Department of Physics, Indiana University, Bloomington, IN 47405

D.S. Armstrong, J.H.D. Clark [6], L.J. Kaufman [7], D.J. Steiner,

Department of Physics, College of William and Mary, Williamsburg, VA 23187

E. Frlez, D. Pocanic,

Department of Physics, University of Virginia, Charlottesville, VA 22903

J.J. Kolata, L.O. Lamm, G. Rogachev,

Department of Physics, University of Notre Dame, Notre Dame, IN 46556

C. Campbell, E. Collins, L. McGlinchey, P. Rubin [8] [9],
E. Walker,

Department of Physics, University of Richmond, Richmond, VA 23173

[1] Radphi Spokesman, 2001-present
[2] present address Department of Physics, New Mexico State University, Las Cruces, NM 88003
[3] present address Department of Physics, University of Chicago, Chicago, IL 60637
[4] present address Departments of Diagnostic Radiology and MR Research Laboratory, Mayo Clinic, Rochester, MN 55905
[5] present address National Center for Supercomputing Applications, Champaign, IL 61820
[6] present address American Physical Society, One Physics Ellipse, College Park, MD 20740
[7] present address U. Massachusetts Amherst, Amherst MA 01003
[8] present address Department of Physics and Astronomy, George Mason University, Fairfax, VA 22030
[9] Radphi Spokesman, 1998-2001

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Performance: energy resolution

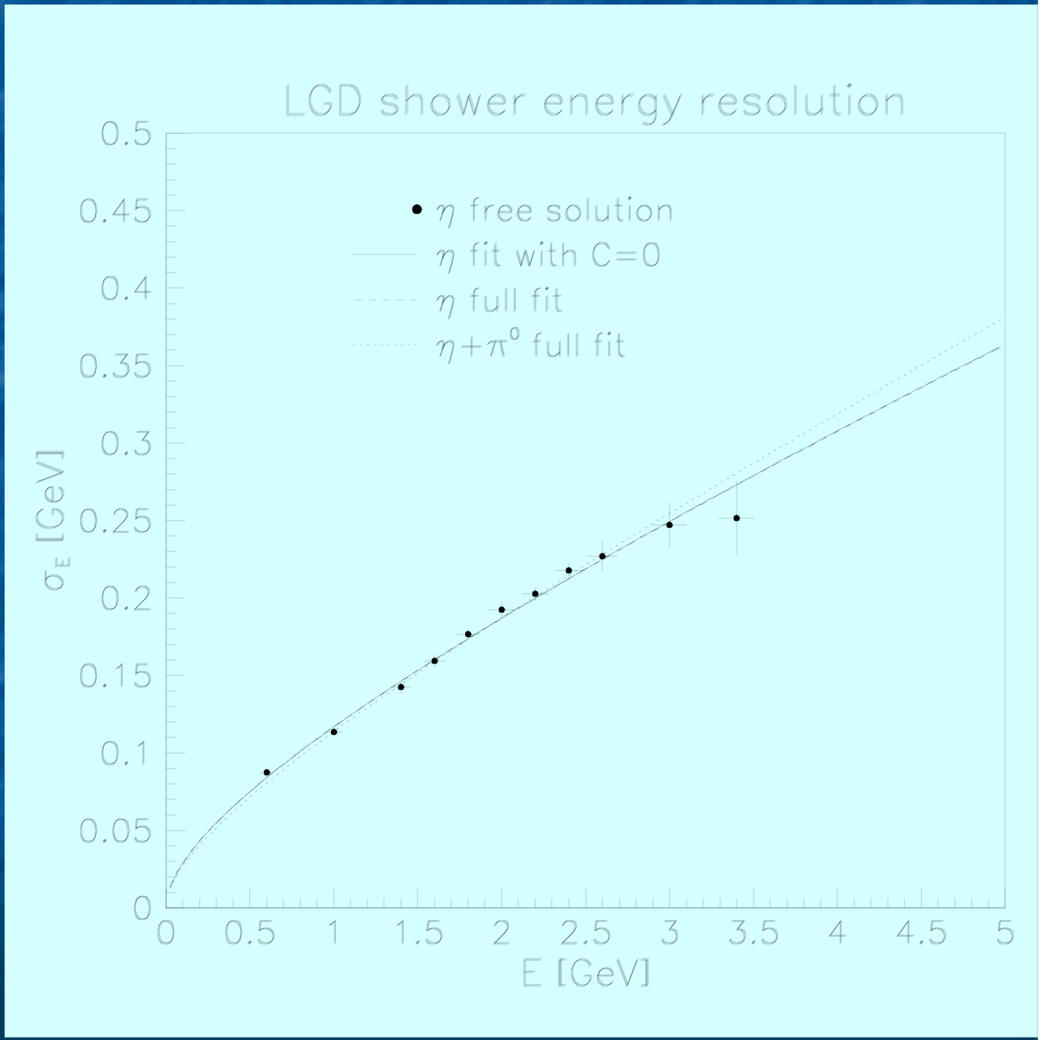
- based on widths of π^0 and η
  - η width mainly δE
  - π^0 width equally δE and $\delta\theta$

- best fit to data:

$$\frac{\sigma_E}{E} = \left(3.5 + \frac{7.3}{\sqrt{E}}\right)\%$$

- GlueX value:

$$\frac{\sigma_E}{E} = \left(2.0 + \frac{5.0}{\sqrt{E}}\right)\%$$



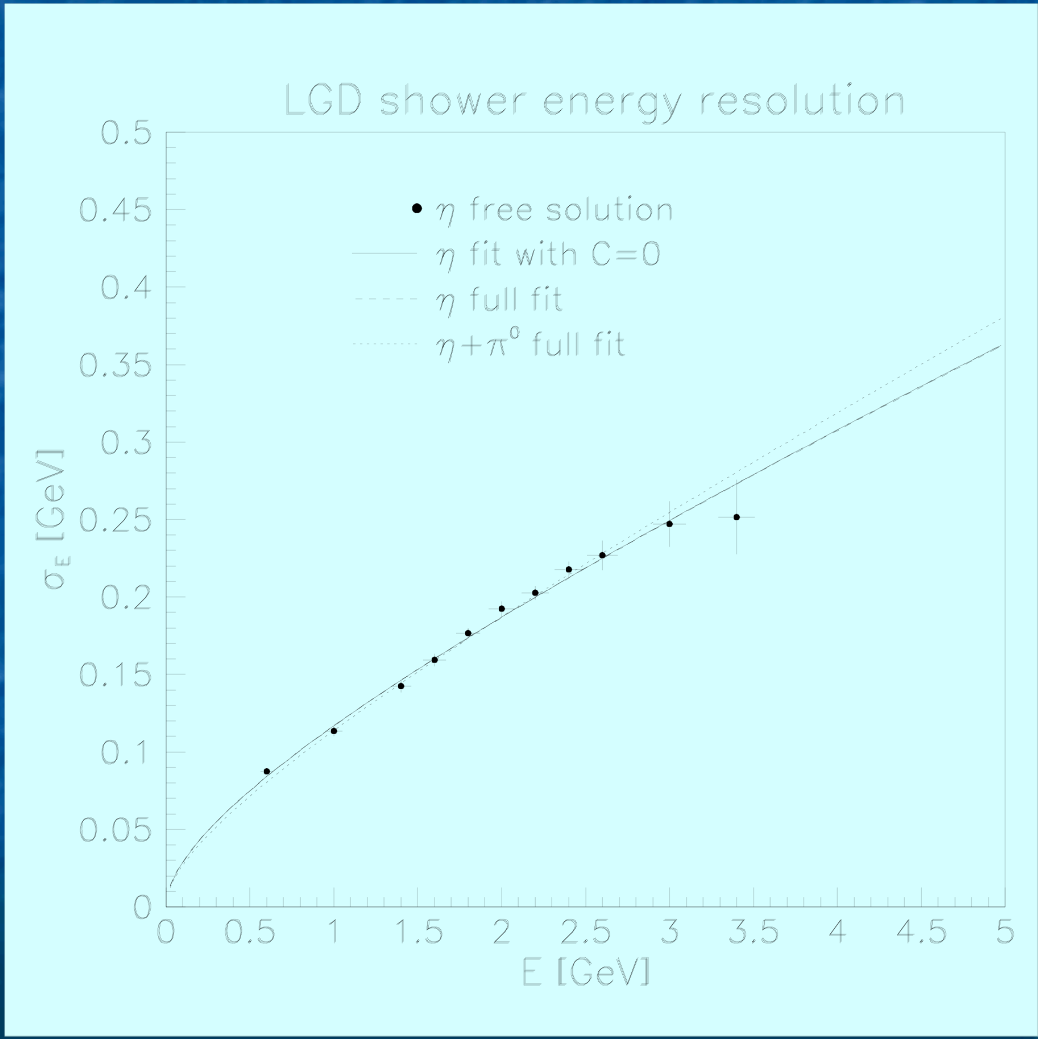
Performance: spatial resolution

- based on width of π^0
  - η width determines δE
  - π^0 width determines $\delta\theta$
- best fit to data:

$$\sigma_x = \left((X_0 \sin\vartheta)^2 + \frac{(7.1)^2}{E} \right) \mathrm{mm}$$

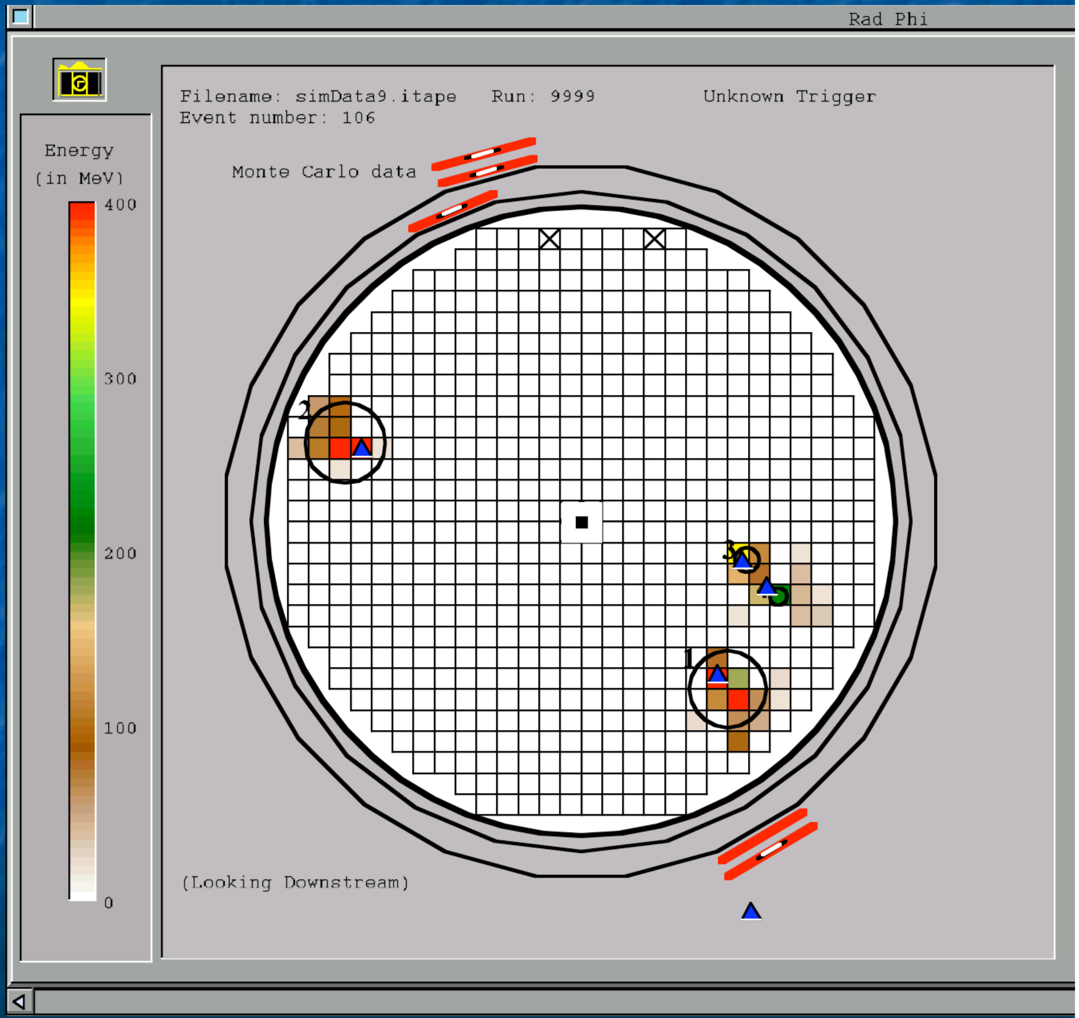
- GlueX value:

$$\sigma_x = 4\,\mathrm{mm}$$



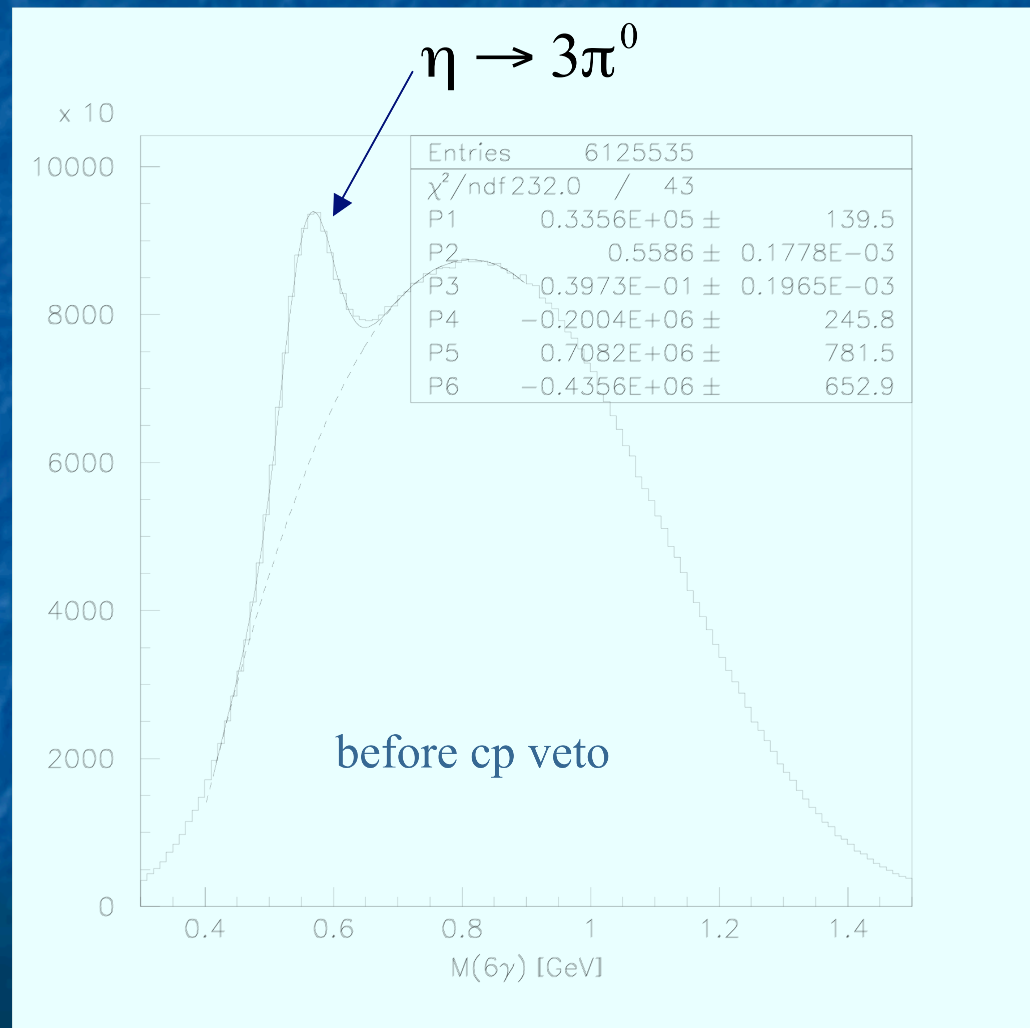
Performance: cluster separation

- reconstruction tuned to
  - minimize split-offs
  - maximize separation
- best compromise:
  - $\varepsilon \sim 50\%$ at 6 cm
  - $\varepsilon \to 0$ at 4 cm
  - depends on energy



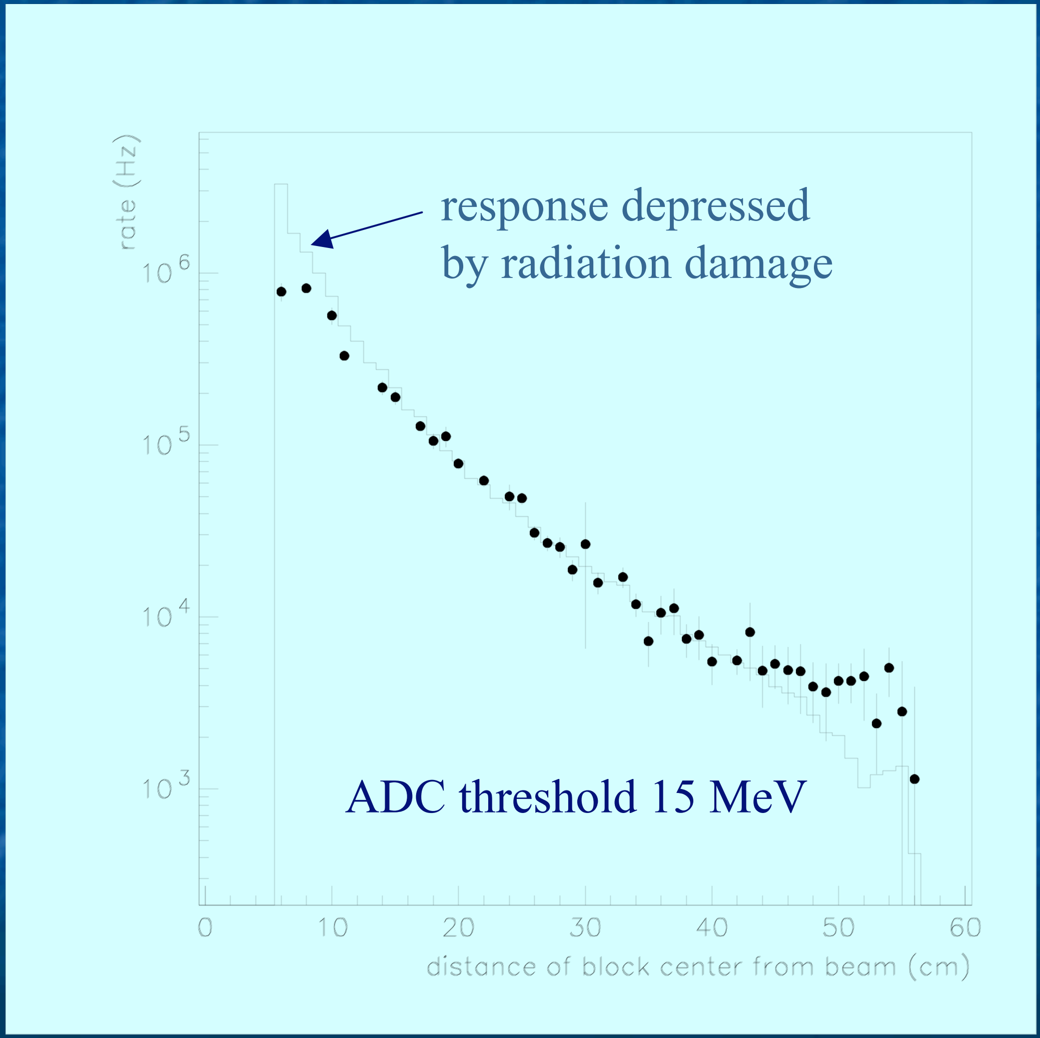
Performance: charged hits

- charged pions make clusters
  - by charge exchange
  - by nuclear absorption
  - typical energy 200 MeV
  - dominate high-multiplicity sample before cp veto
- effects on calorimetry:
  - occupy space
  - odd-shaped clusters
  - affects computation of neutral energy in the trigger

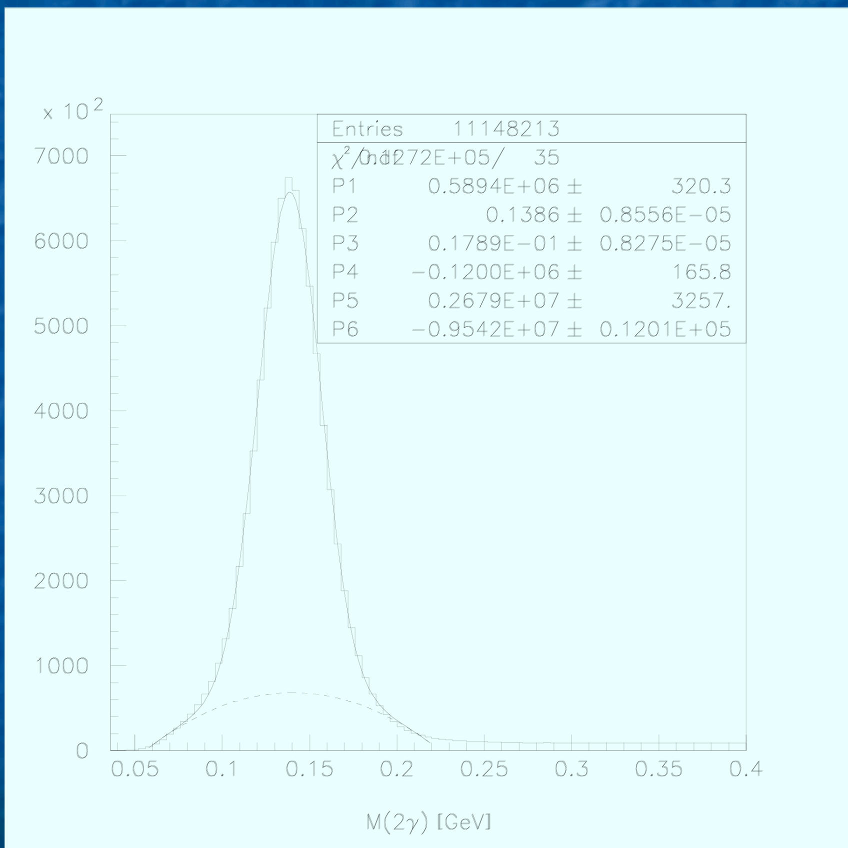


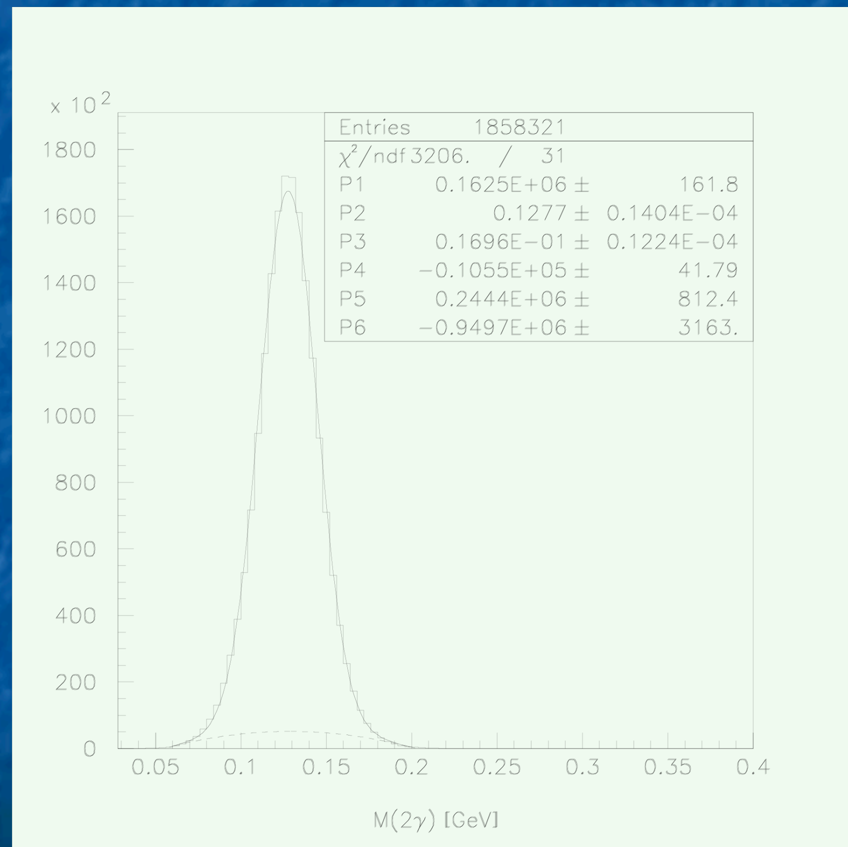
Performance: E-M background

- EM backgrounds about the same for Radphi, GlueX
- Around the beam hole
  - higher rates
  - harder spectrum
  - no sharp cutoff in **r**
- effects on calorimetry:
  - degrades resolution
  - extra small-r clusters
  - radiation damage takes place over time

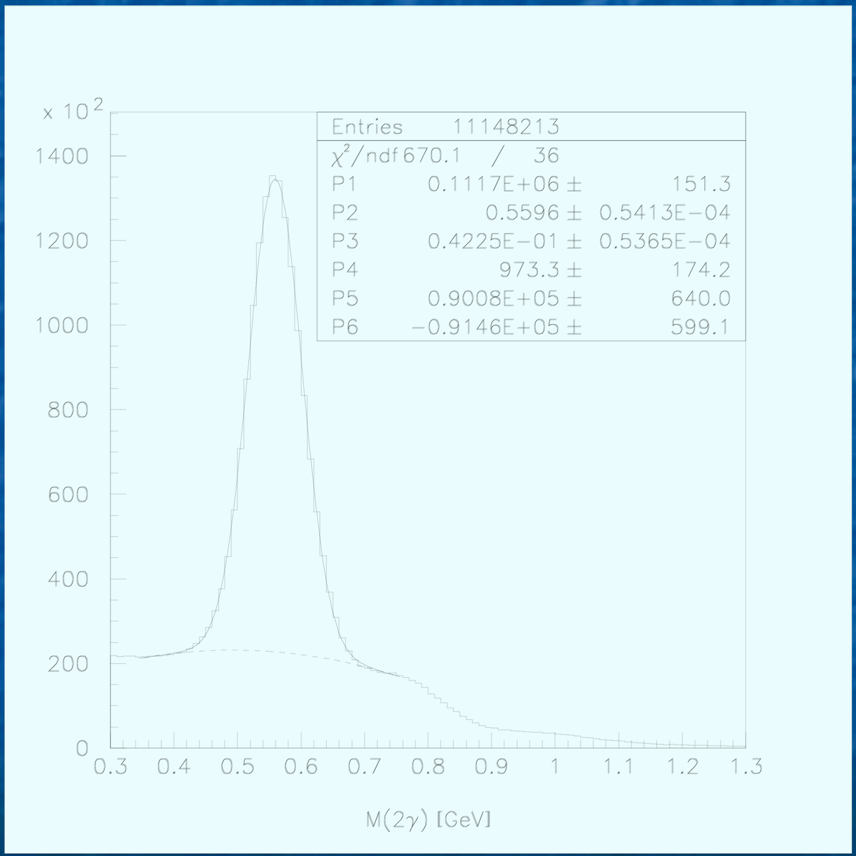


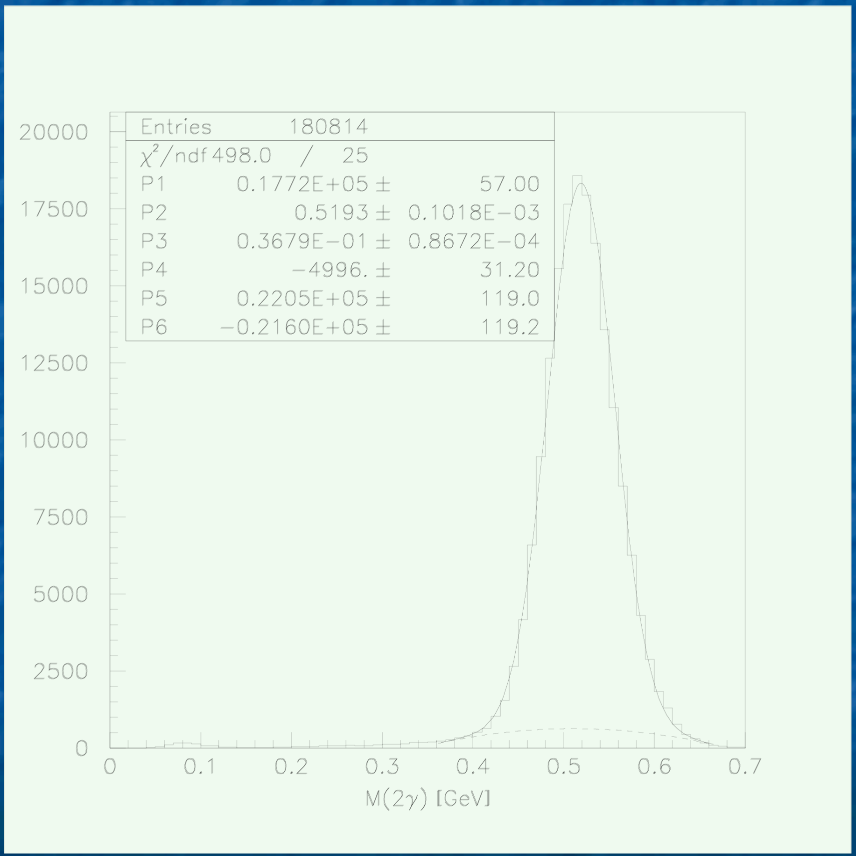
Simulation: comparison



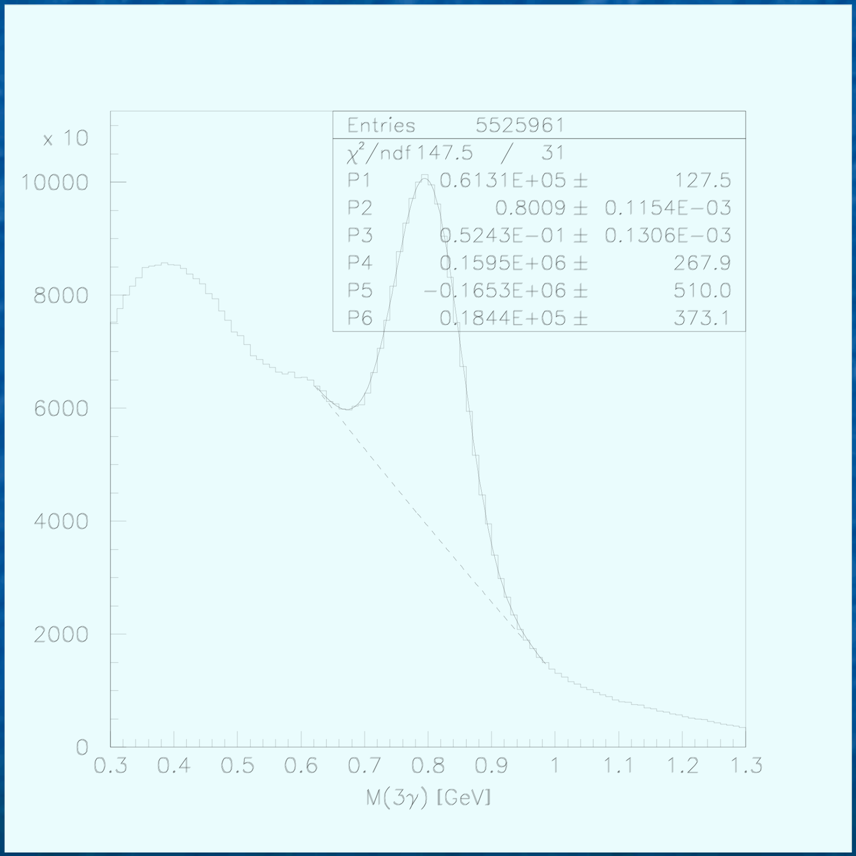


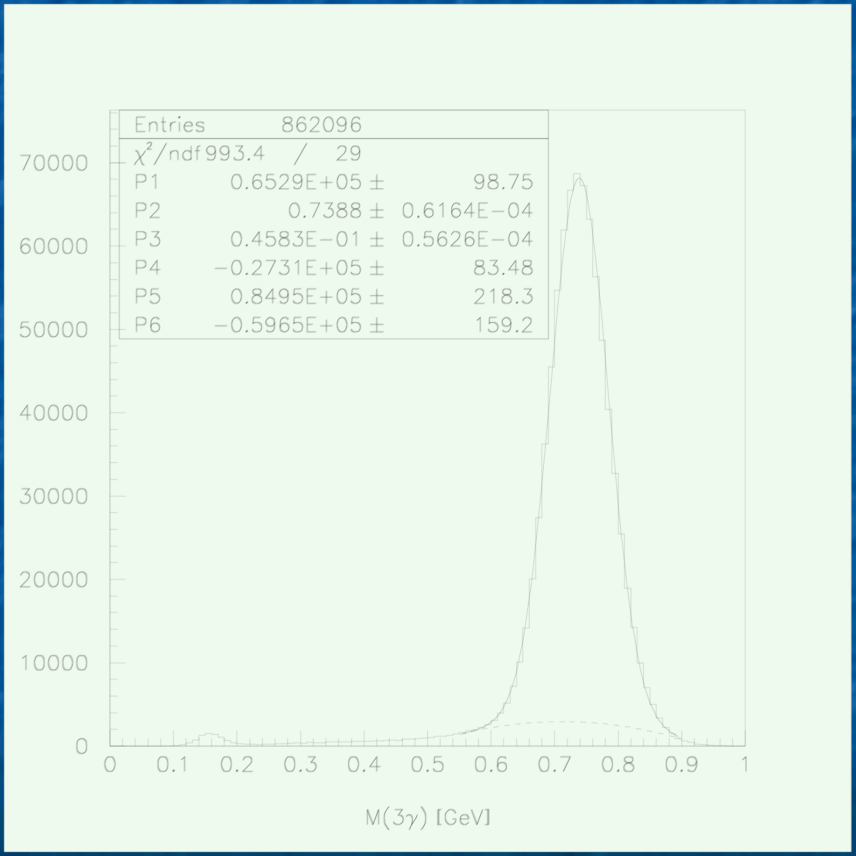
Simulation: comparison



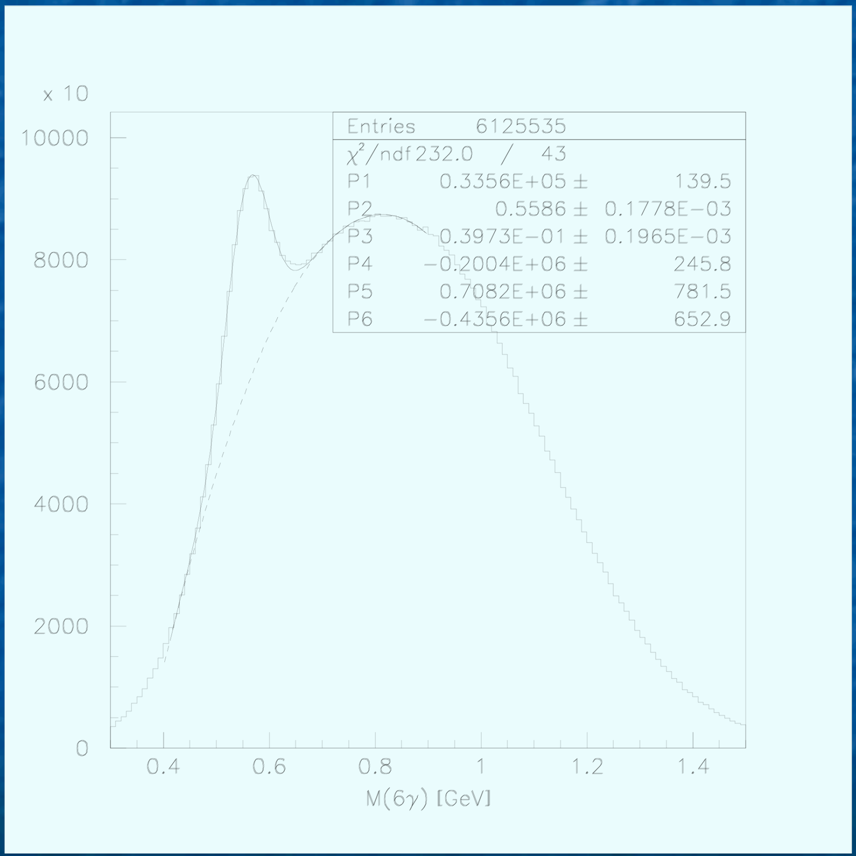


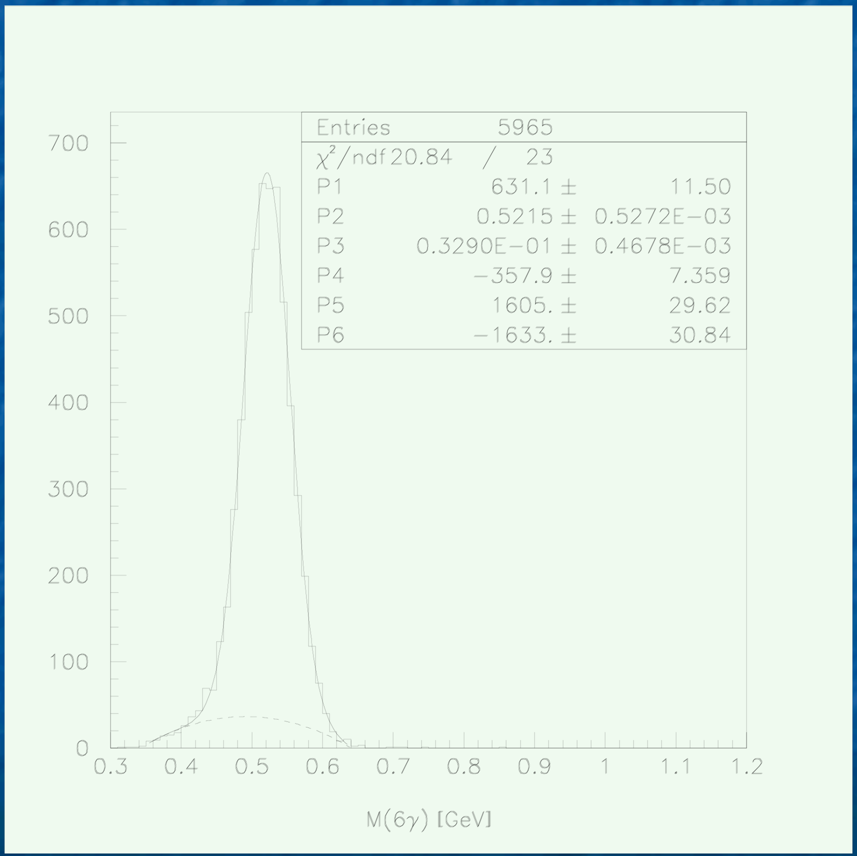
Simulation: comparison



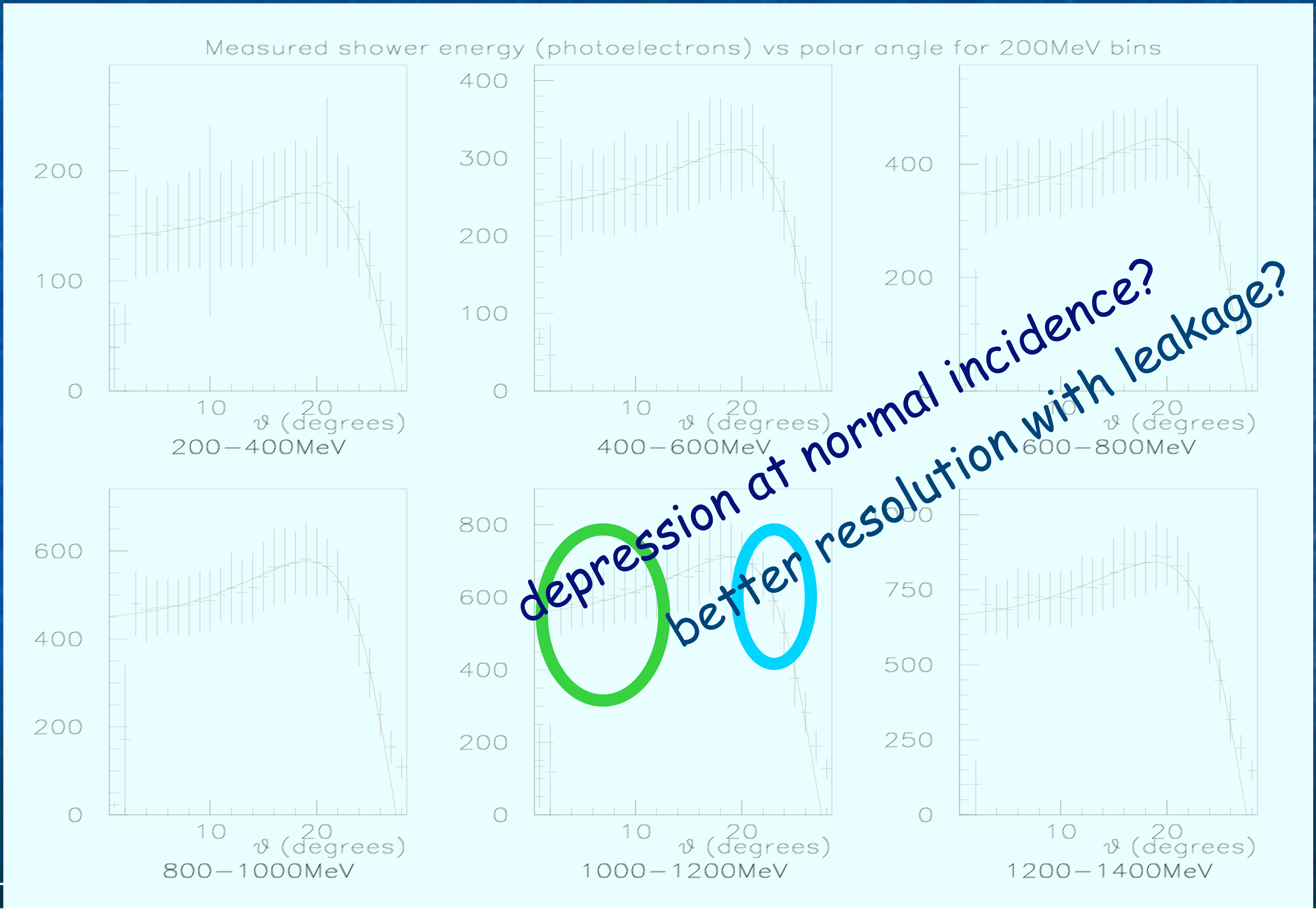


Simulation: comparison



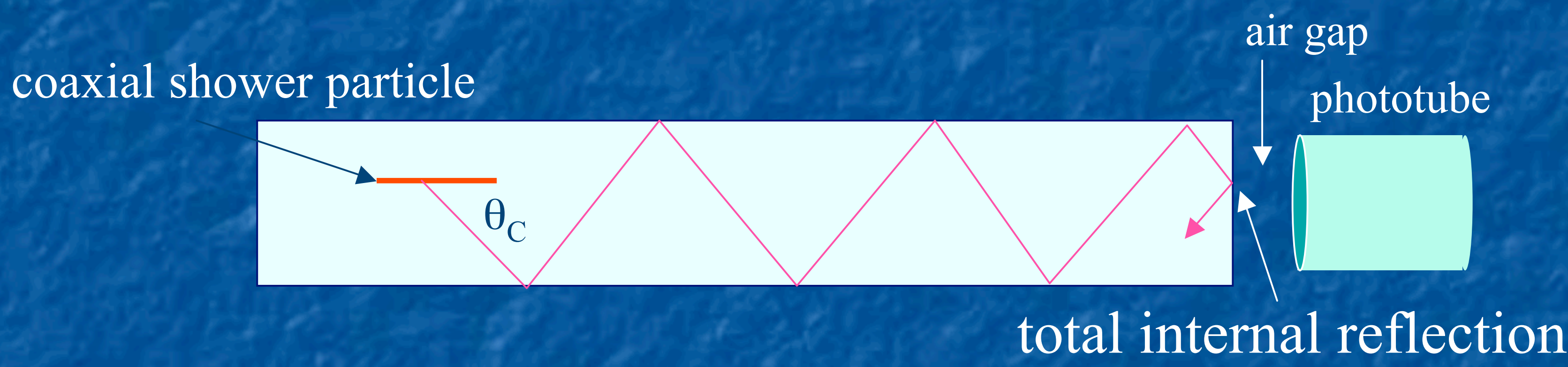


Simulation: light yield



Simulation: light yield

- depression at normal incidence?



  - not severe: most shower tracks are randomized
  - shower core preferentially suppressed
  - for perfect blocks "hole" is ±15°
  - contributes extra fluctuations in light yield
  - design issue: <u>optical coupling between glass and PMT</u>

Simulation: light yield

- better resolution with leakage?
  - showers fluctuate in depth by 1 X_0
  - attenuation effects:
    - late-forming showers have higher yields
  - leakage effects:
    - late-forming showers have higher losses from leakage
- competition between attenuation and leakage !
  - There is an ideal depth for a lead-glass calorimeter which depends on energy scale.
  - for GlueX design, attenuation dominates
  - design issue: <u>optical properties of wrapping around blocks</u>

Simulation: reconstruction efficiency

- must be included for realistic acceptance
- For Radphi, efficiency is 89% per photon in the final state for exclusive all-neutral channels, counting only photons that hit the lead-glass detector in the "strike zone".
- should be better for GlueX than for Radphi
  - Radphi showers are twice as far from normal incidence
    - showers leak out the side of the detector
    - centroid resolution is degraded by depth fluctuations
  - GlueX showers are better resolved by a spatial factor of ~3