

# Validation studies for the EMC in PandaROOT

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for the PANDA Collaboration



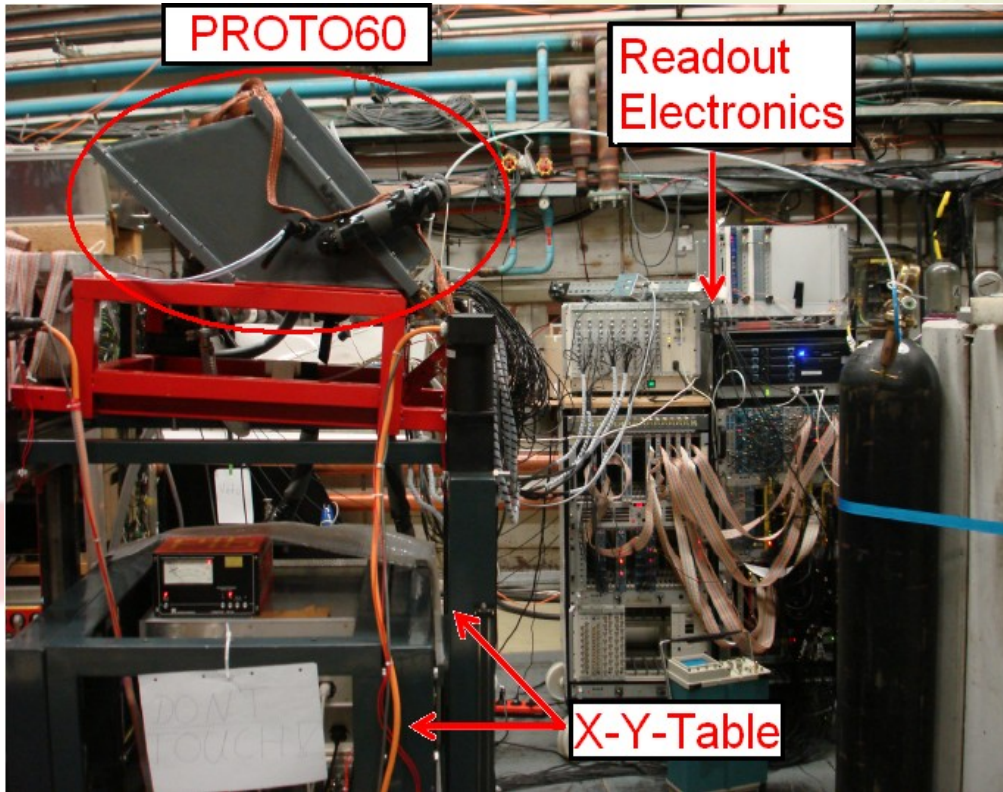
# Outline

- Motivation
- Prototype Experiment
- Geometry & Simulation
- Shower shape & multiplicity
- Summary & outlook

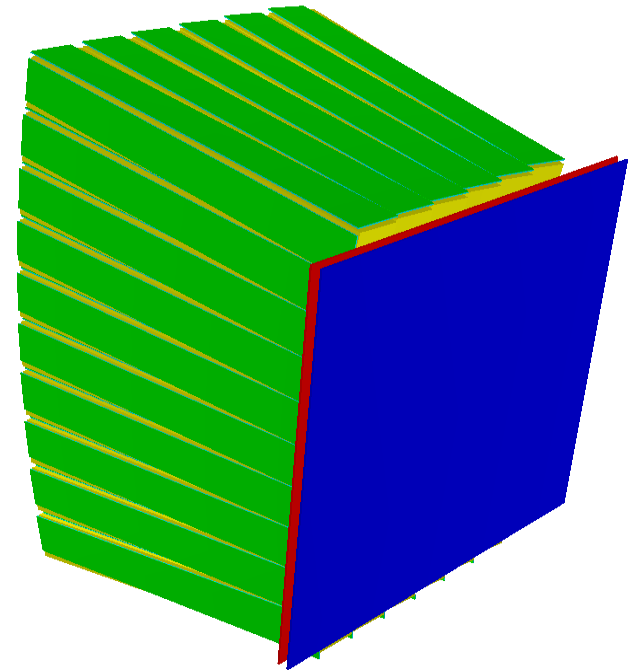
# Motivation

- Aim – **realistic** Monte Carlo simulation and analysis framework
- Validation of the EMC simulations
- Transport model Geant3 or Geant4?
- Tuning of transport model (cuts, thresholds,...)
- Digitalization (photon statistics, noise, signal analysis)

# Motivation



Experiment

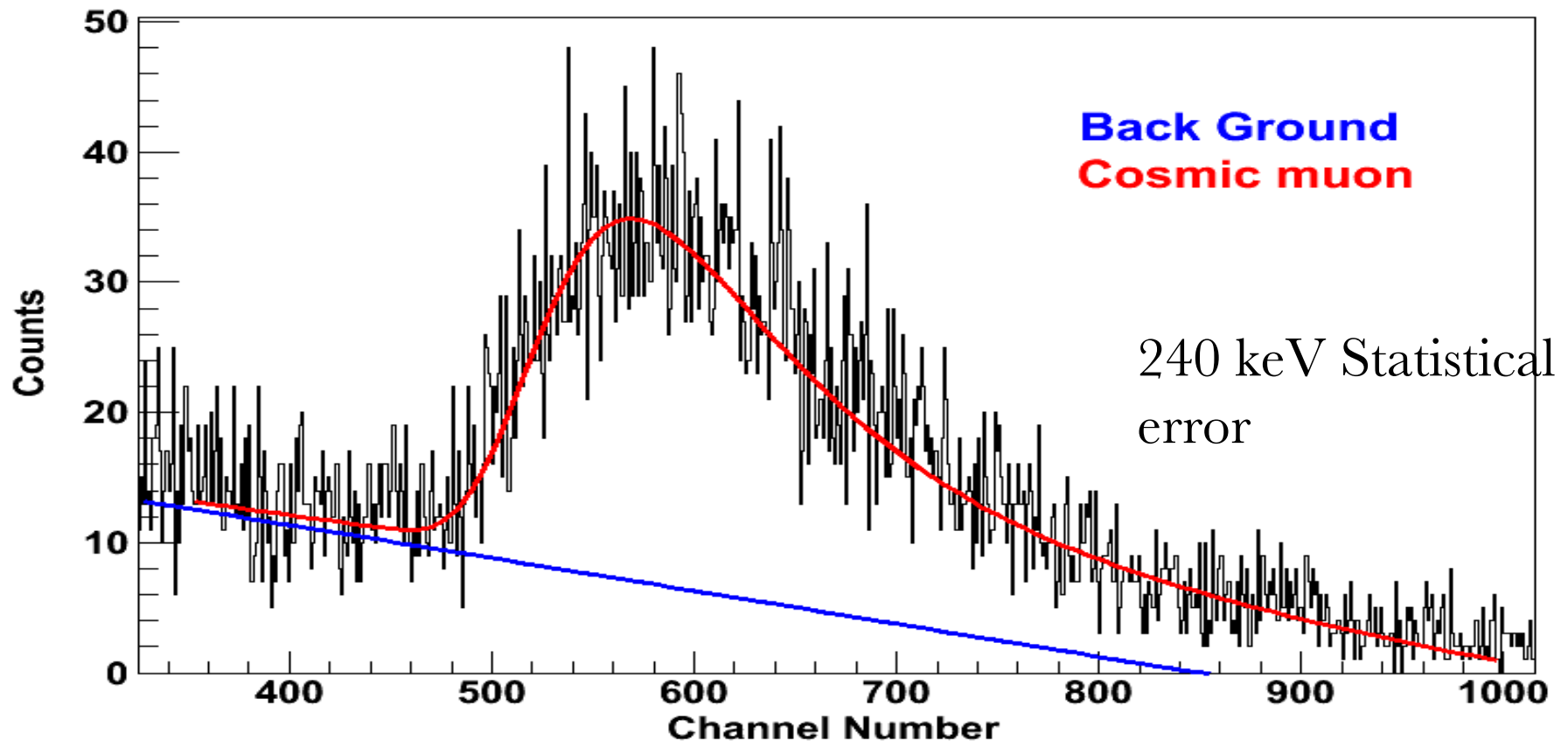


Simulation

Validation

# Cosmic Calibration

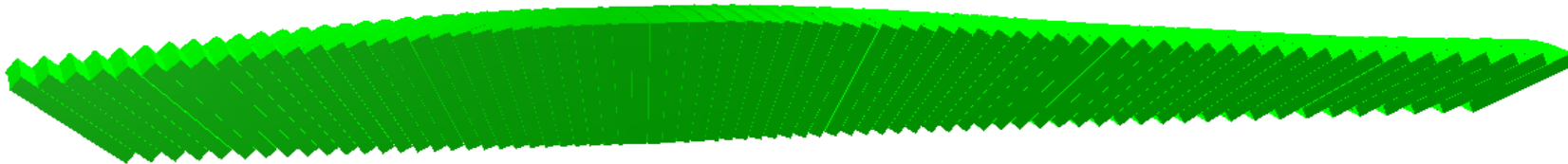
- Stopping power PWO 10.2 MeV/cm
- Mean pass-length per crystal 2.4 cm
- Average energy deposition 24.5 MeV



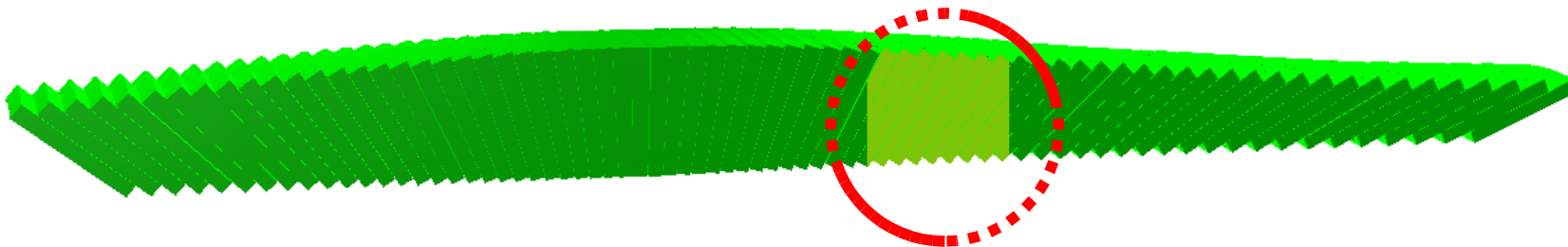
# Prototype Barrel EMC

- Prototype for Barrel EMC for PANDA
- 60 PWO crystals

Barrel Slice



60 crystals of  
a slice



# Geometry

PWO Crystal Geometry - Trapezoid

Front face  $\sim 21 \times 21 \text{ mm}^2$

Back face  $\sim 27 \times 27 \text{ mm}^2$

Carbon – Alveoles

Thickness 200 micron

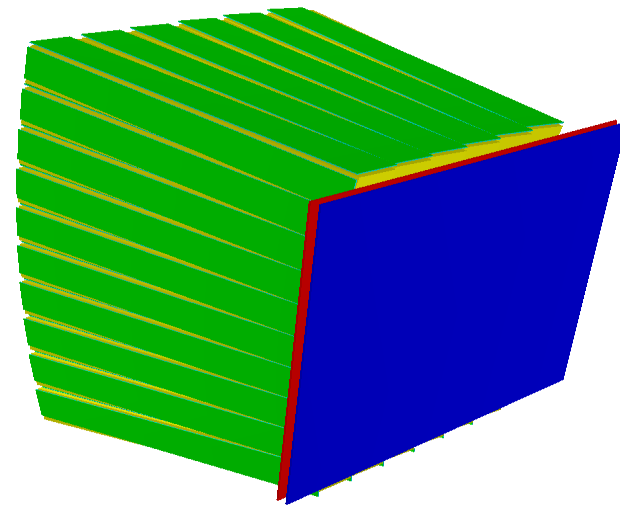
reflector

Thickness 65 micron

coolant cover

1 mm Copper

1 mm Aluminum

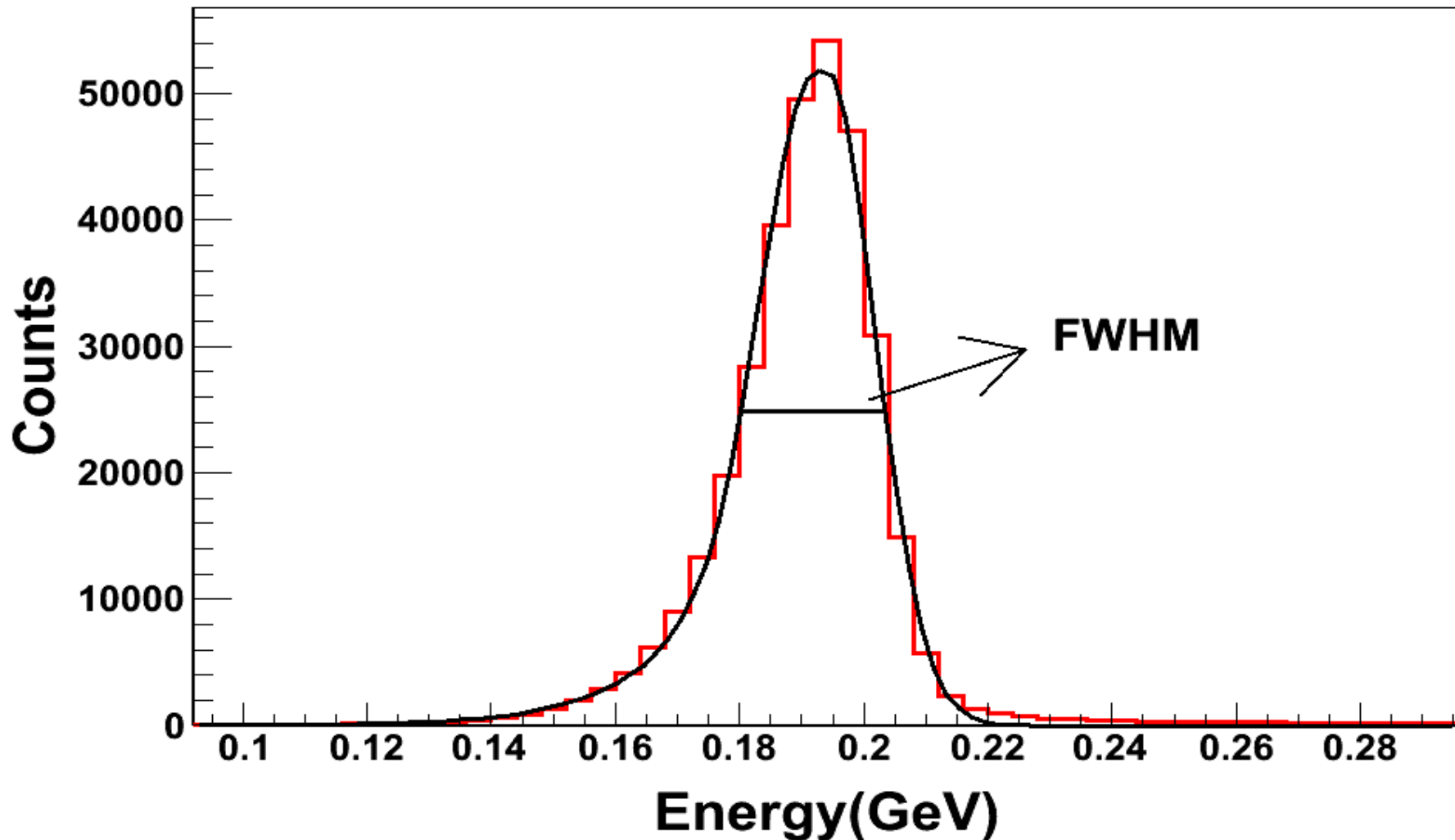


# Simulation

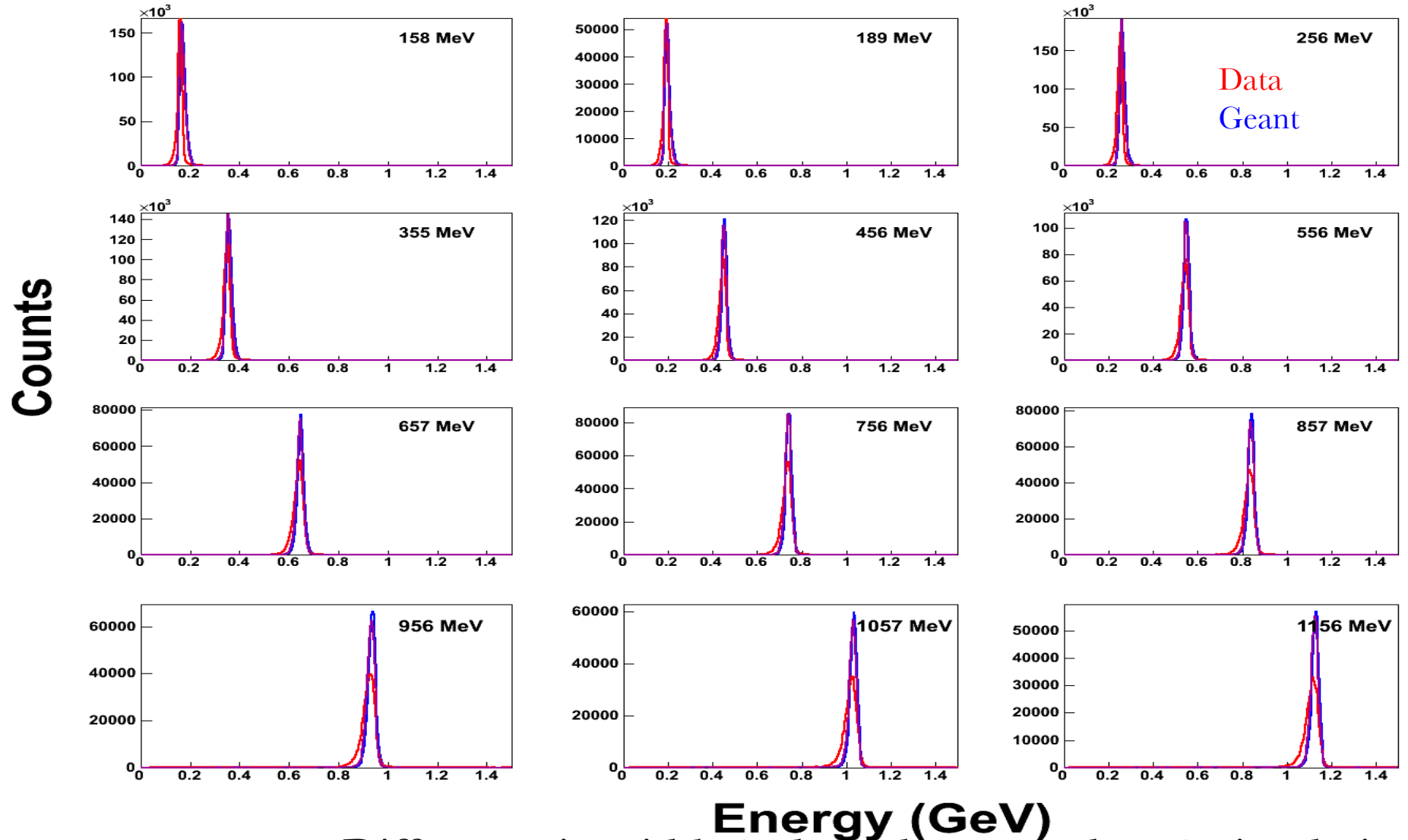
- 15 Photon Energies 150 MeV – 1440 MeV
- $10^5$  Events/Energy
- 20 photo-electrons/MeV
- Assuming analog readout
- Noise 240 keV
- Geant3 & Geant4
- Threshold 1 MeV/crystal
- Gconfig Cut 100 keV
- Pair production, Compton, photo-electric, delta-ray, annihilation, bremsstrahlung, hadron, muon nuclear interactions, decay, energy loss, multiple scattering



# 5x5 Energy sum @189 MeV

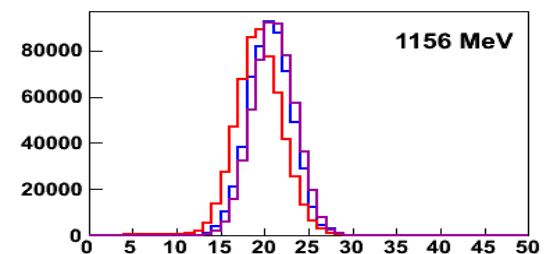
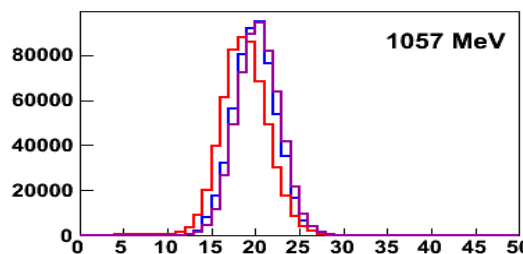
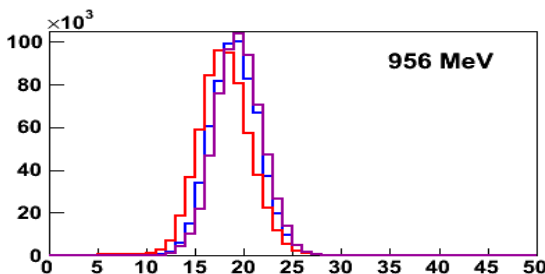
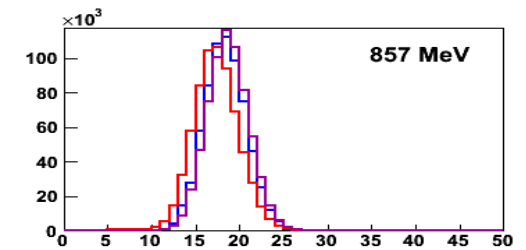
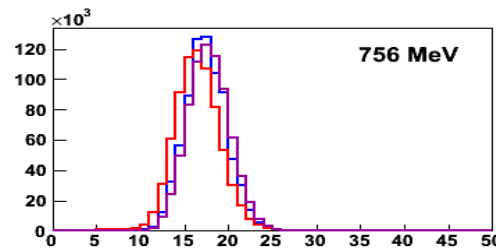
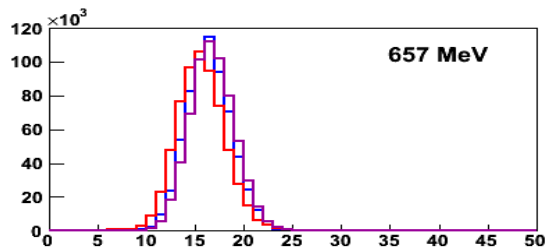
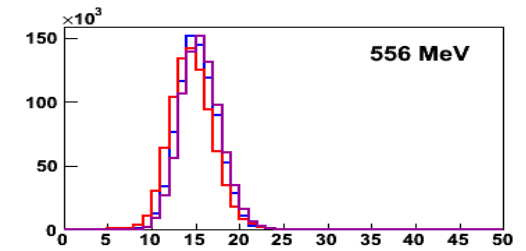
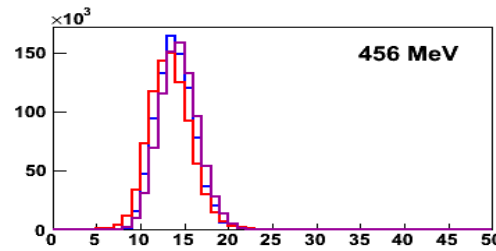
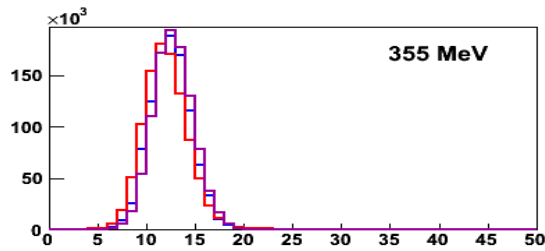
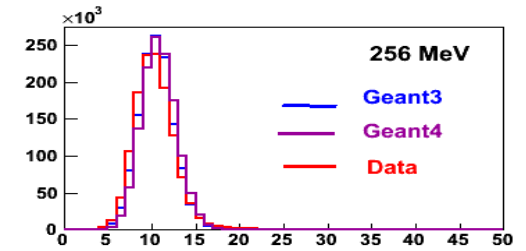
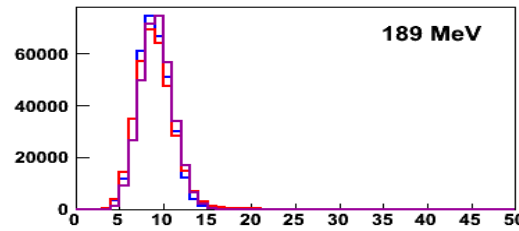
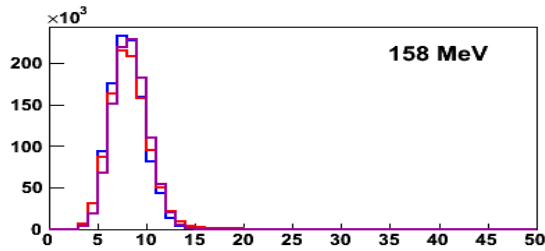


# Prototype response in the energy range 100-1200 MeV (5×5 matrix)



# Multiplicity (TH I MeV/crystal)

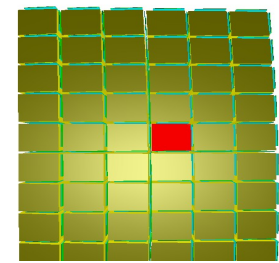
Counts



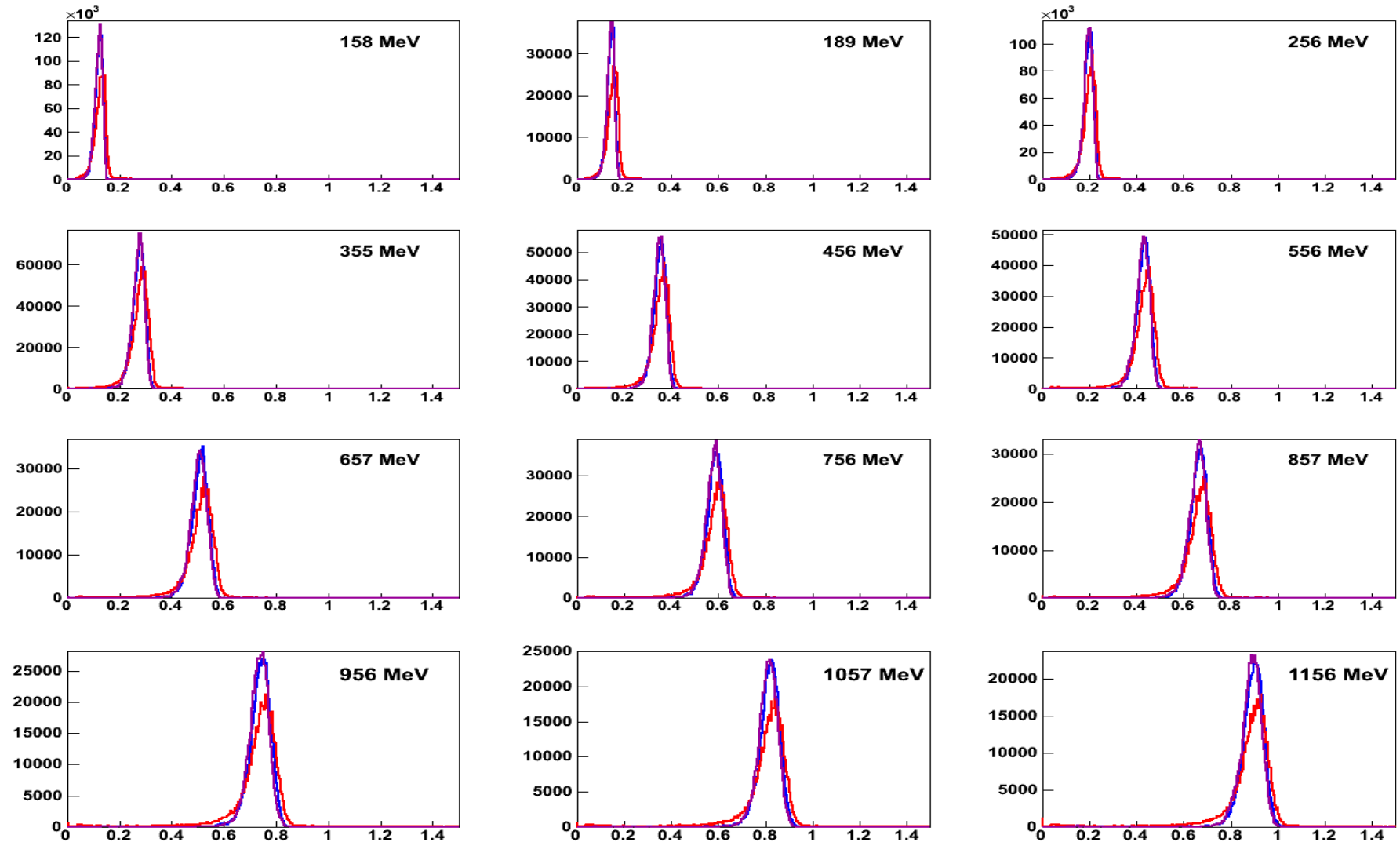
Multiplicity

Difference in multiplicity in higher energies

# Central crystal



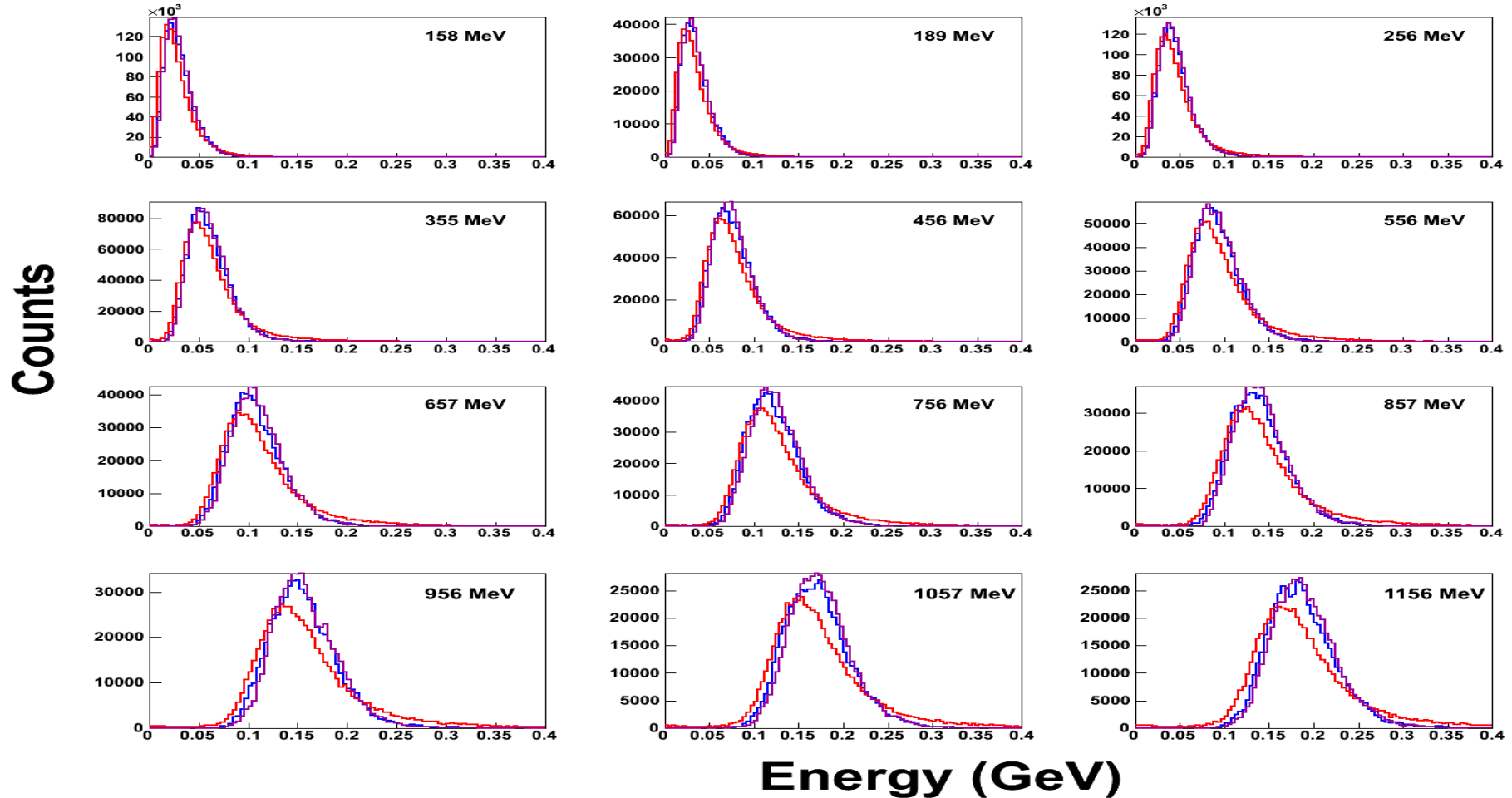
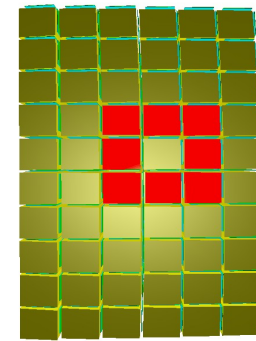
Counts



Energy (GeV)

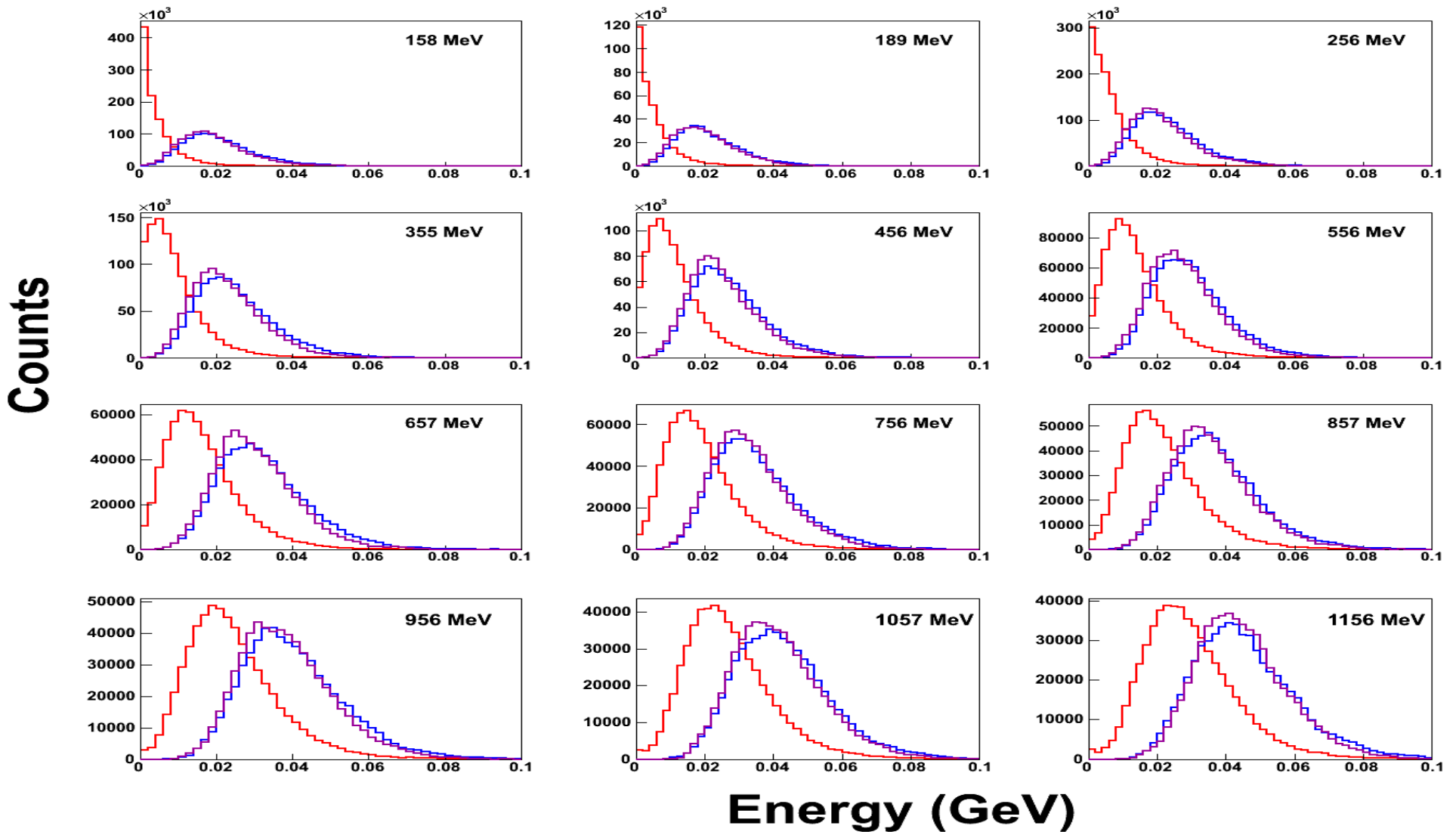
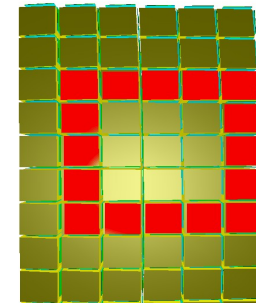
Difference in width & shape could be from the central crystal

# First ring sum



Shower shape in the first ring matches reasonably well

# Second ring sum

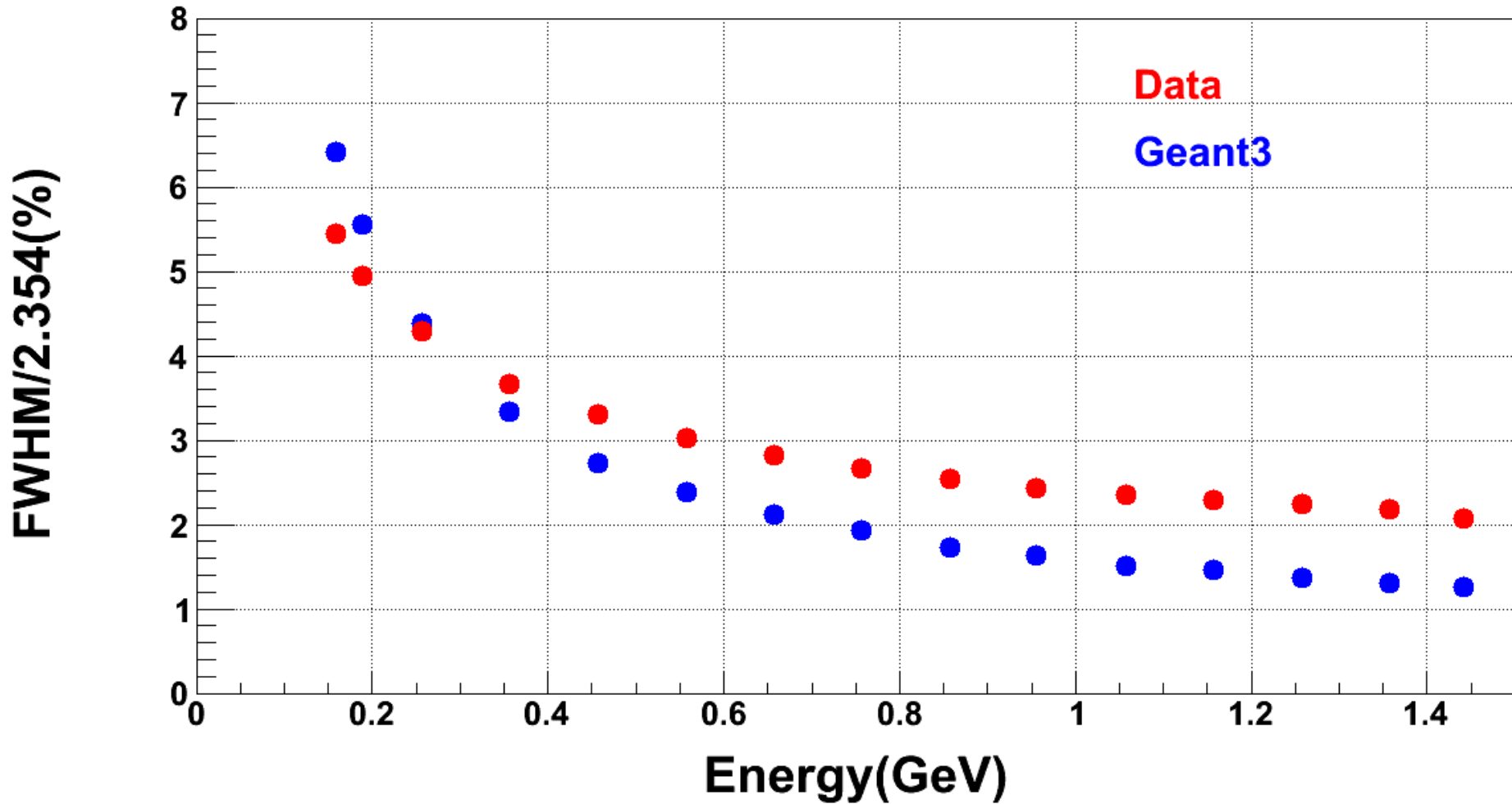


Shower in second ring does not match data?

## Summary & outlook

- Prototype EMC shower shape is compared with Geant3 & Geant4
- Geant3 & Geant4 gives similar response
- Shower in the first ring matches well
- Difference in the second ring of the shower observed
- Does Geant can produce lateral energy distribution?
- Is there any non-linearity at low energies?
- Is the Physics list in low energy has to be optimized?
- To be continued....

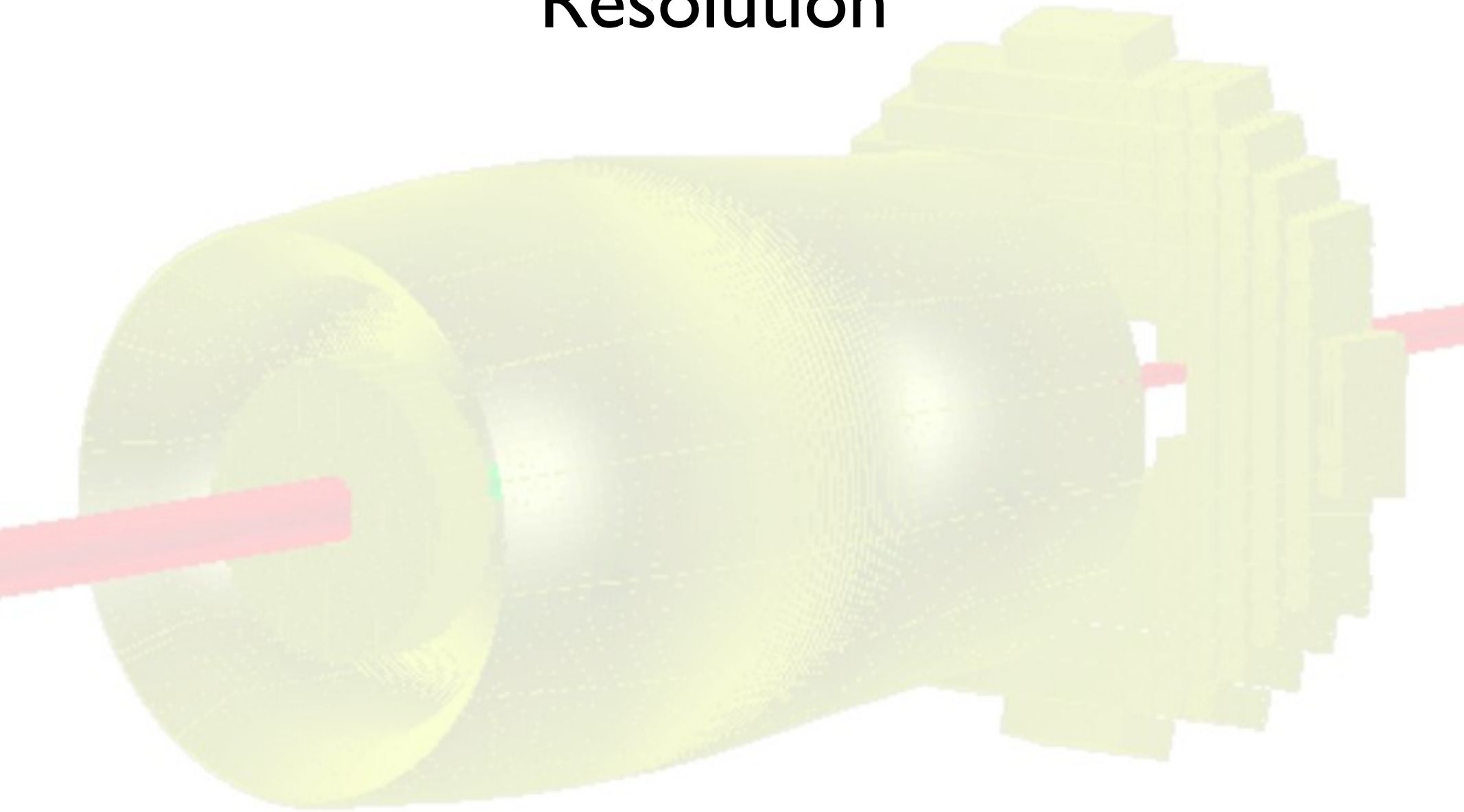
# Resolution



Discrepancy in energy resolution of data & simulation

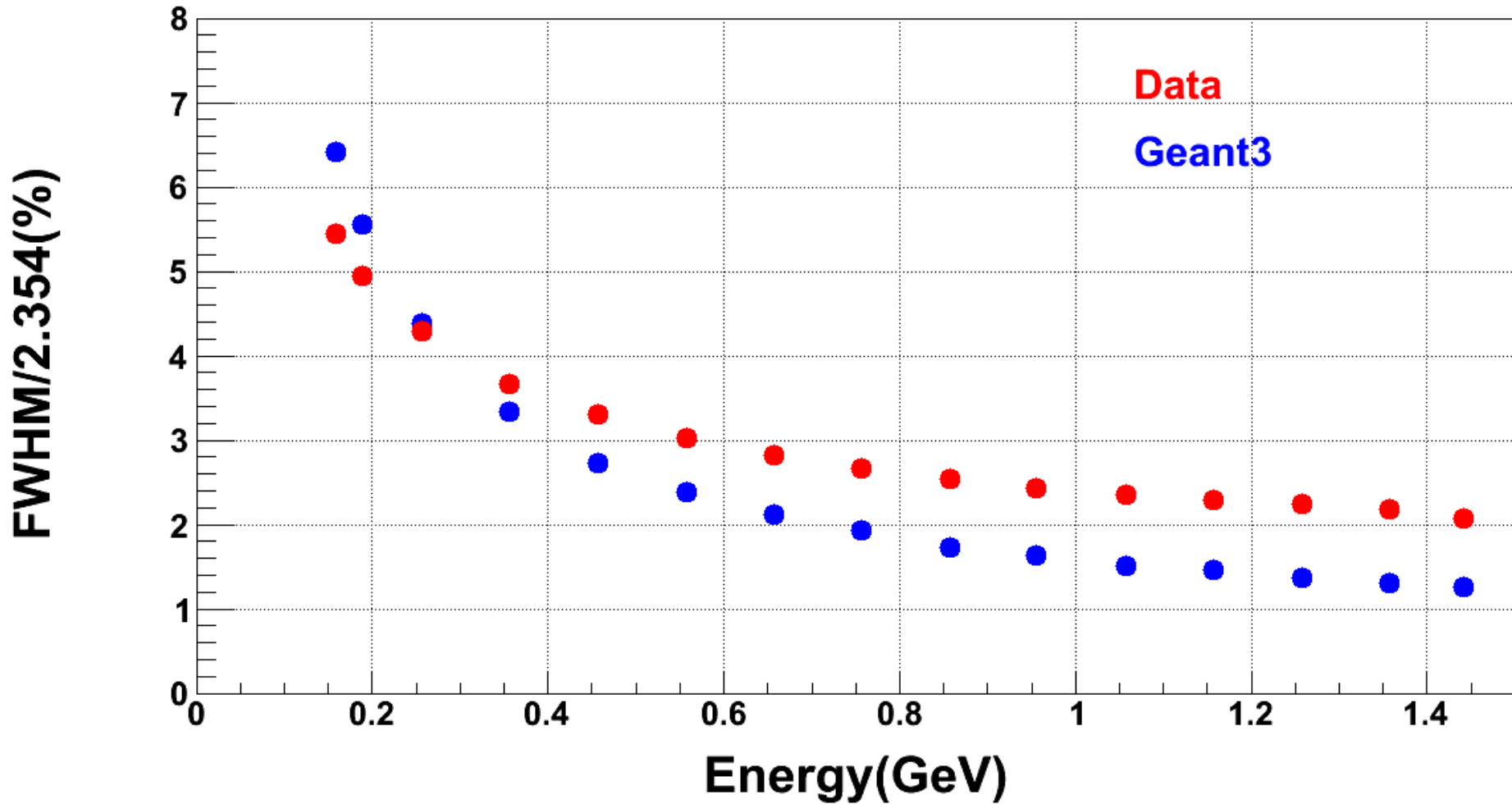


# Resolution



Discrepancy in energy resolution of data & simulation

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