

Shower shape studies with EMC

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KVI / University of Groningen for PANDA collaboration



Outline

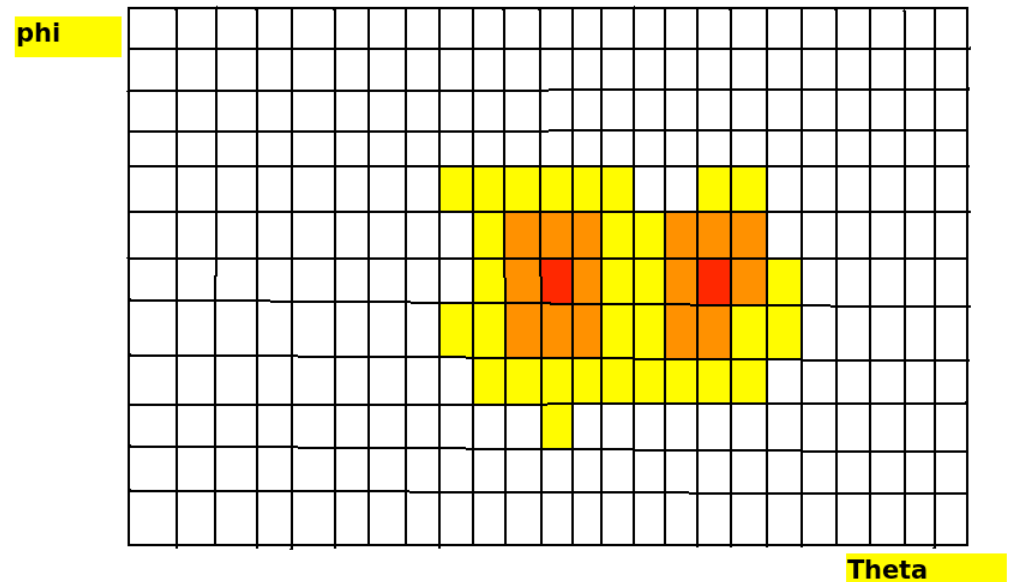
- PID with EMC
- Parameters for PID
- Multivariate analysis for PID
- Validation studies for EMC
- Summary

PID with EMC

- PID parameters e/p , z^2 , E_4 , #bumps, E_9E_{25} ...
- Number of parameters
- PID - separation high momentum π^0, γ

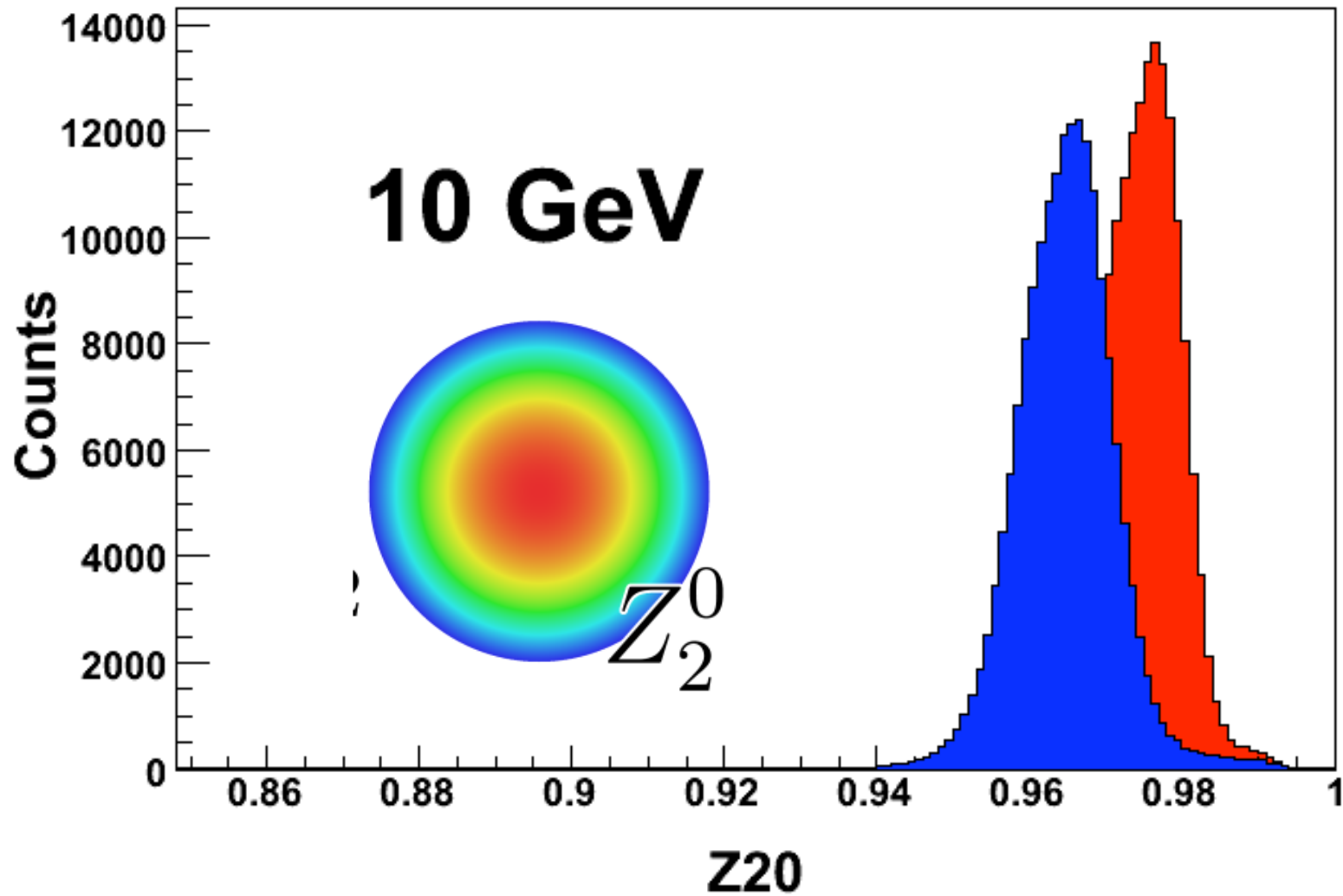
π^0 - γ separation

- Bump splitting
- Invariant mass
- lateral moment
- shower shape
- MVA



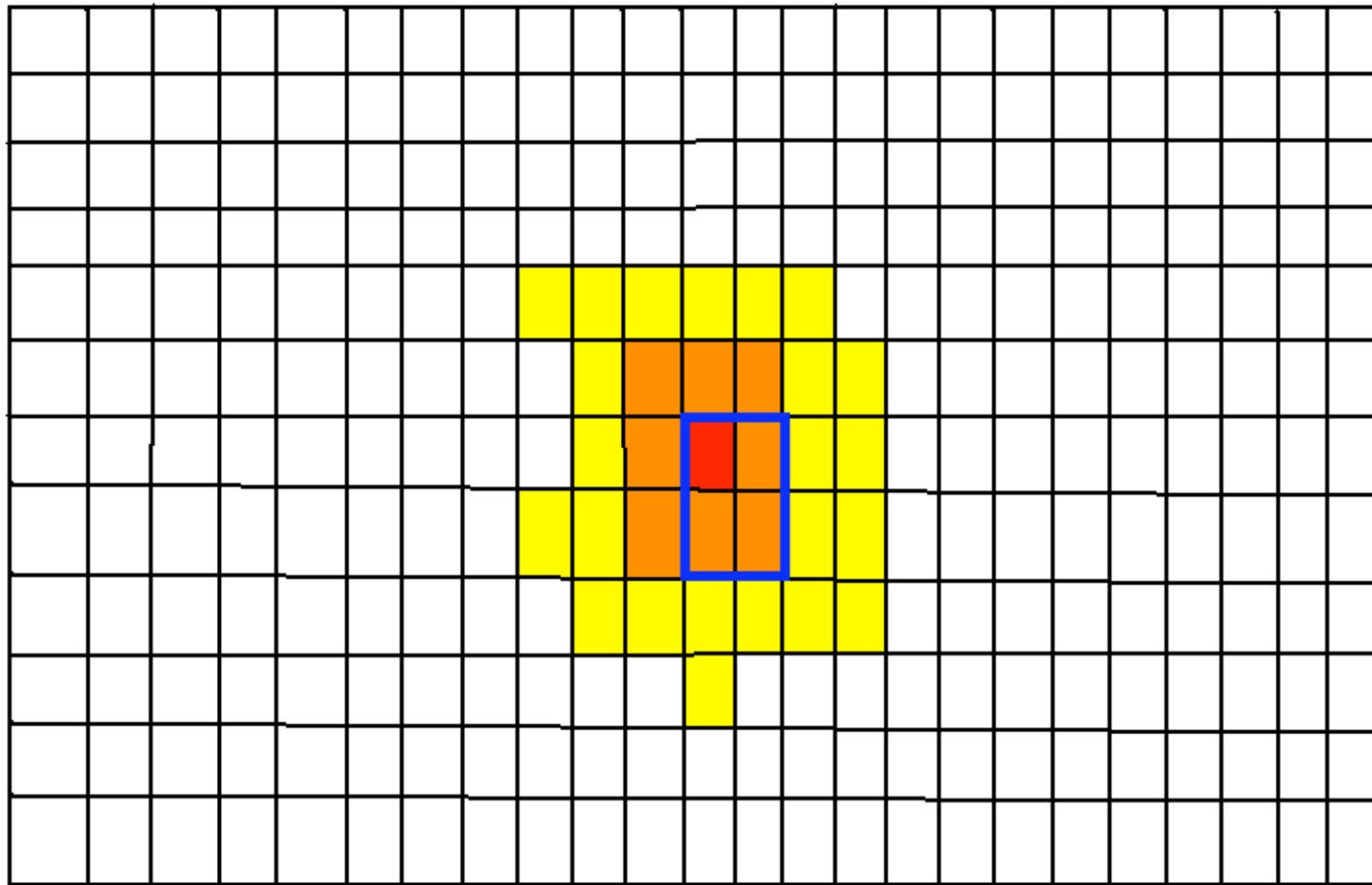
Z20 for $\pi^0 - \gamma$

z20



Shower spread-E4

phi

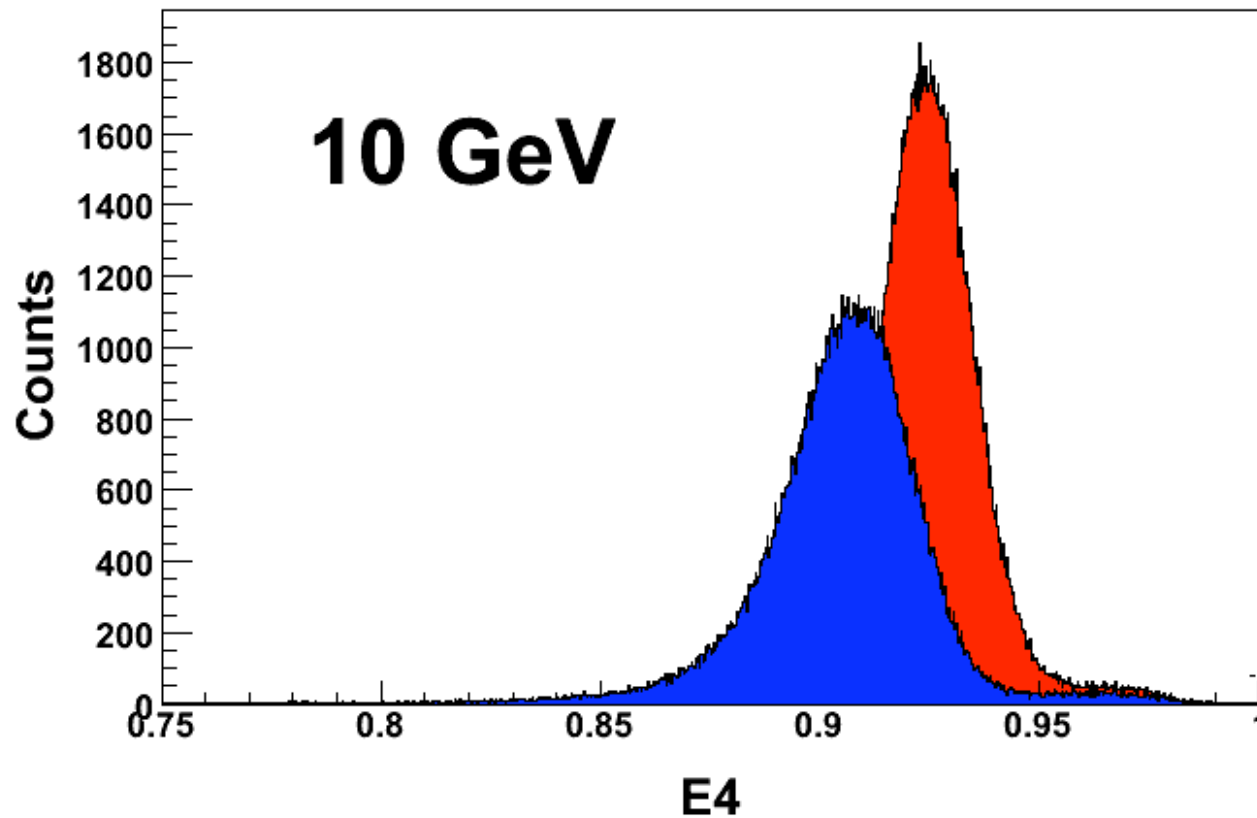


Theta

Shower spread-E4

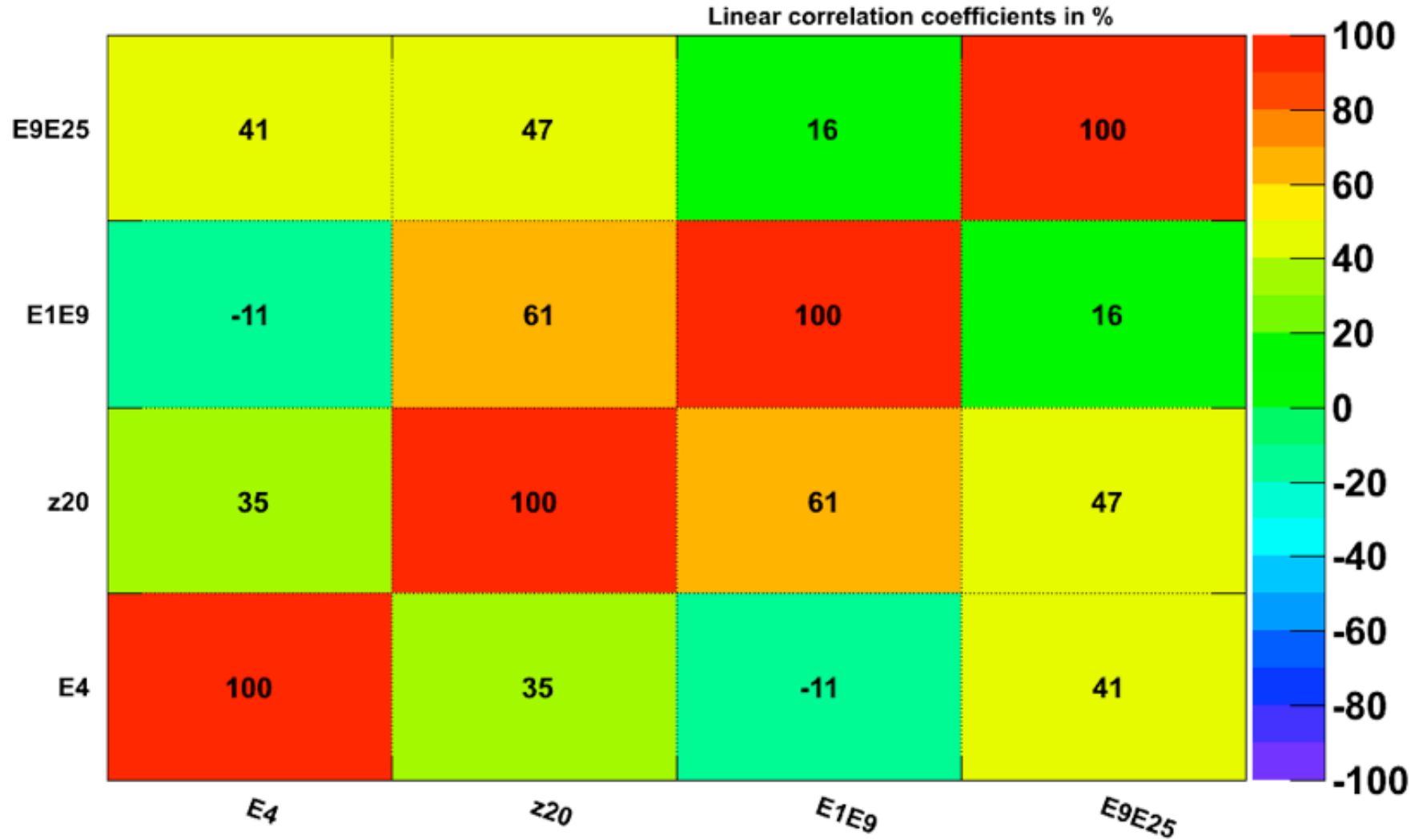
π^0 - γ

E4



Christian Geldmann

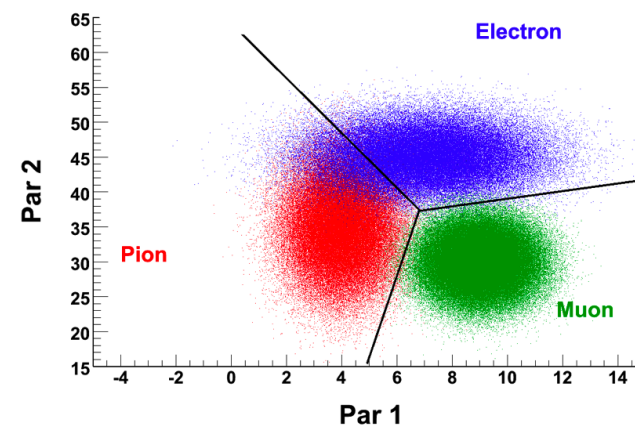
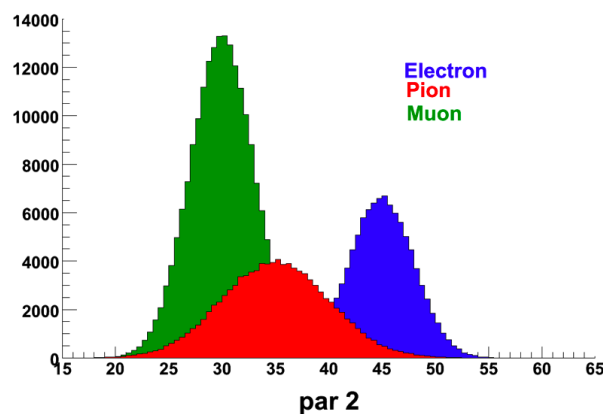
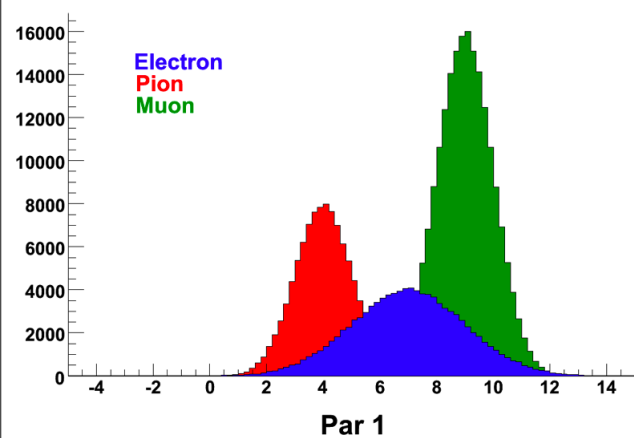
Shower shape-correlation



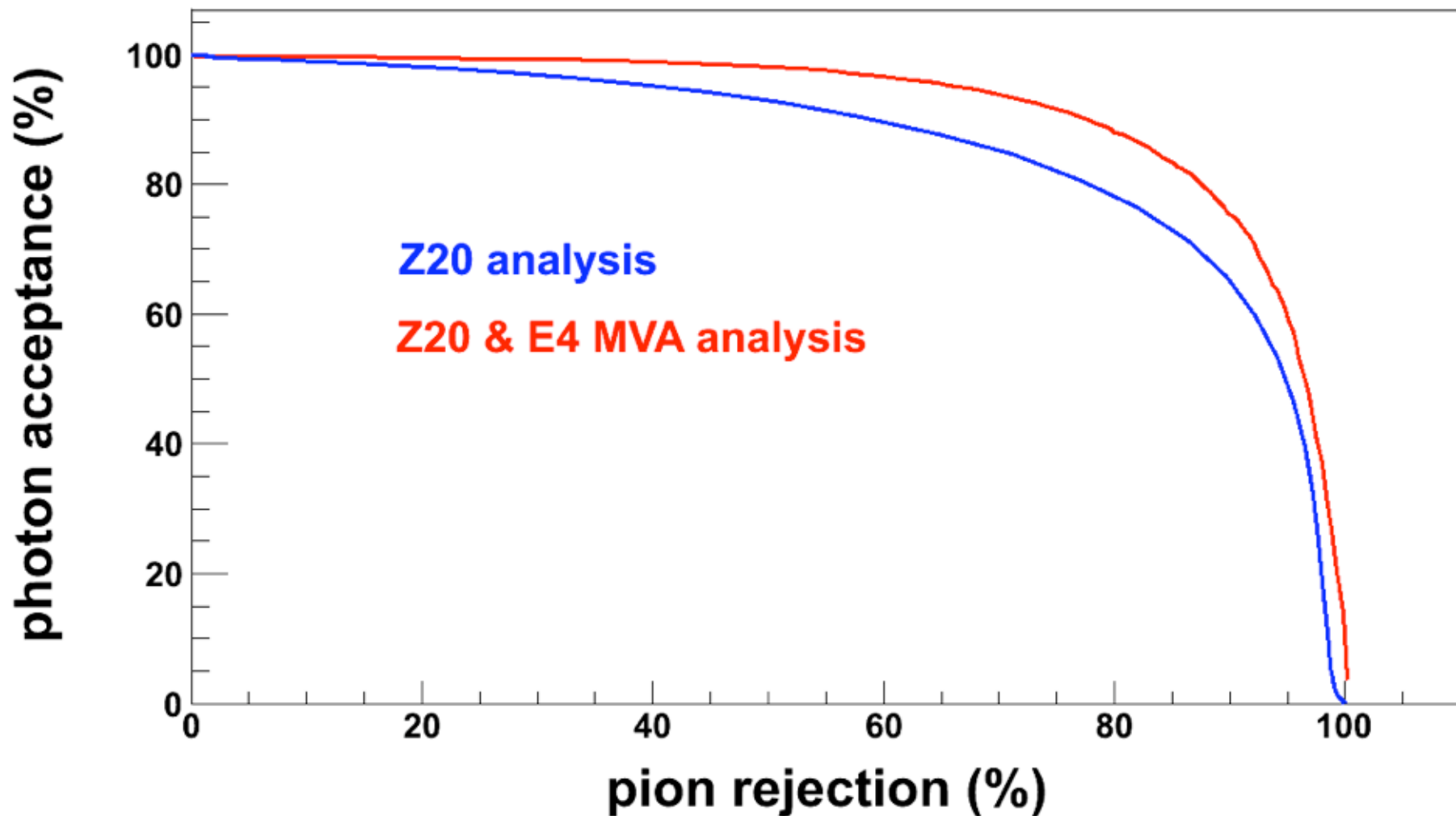
Multivariate analysis

Multivariate analysis is important for understanding the structure of correlated parameters

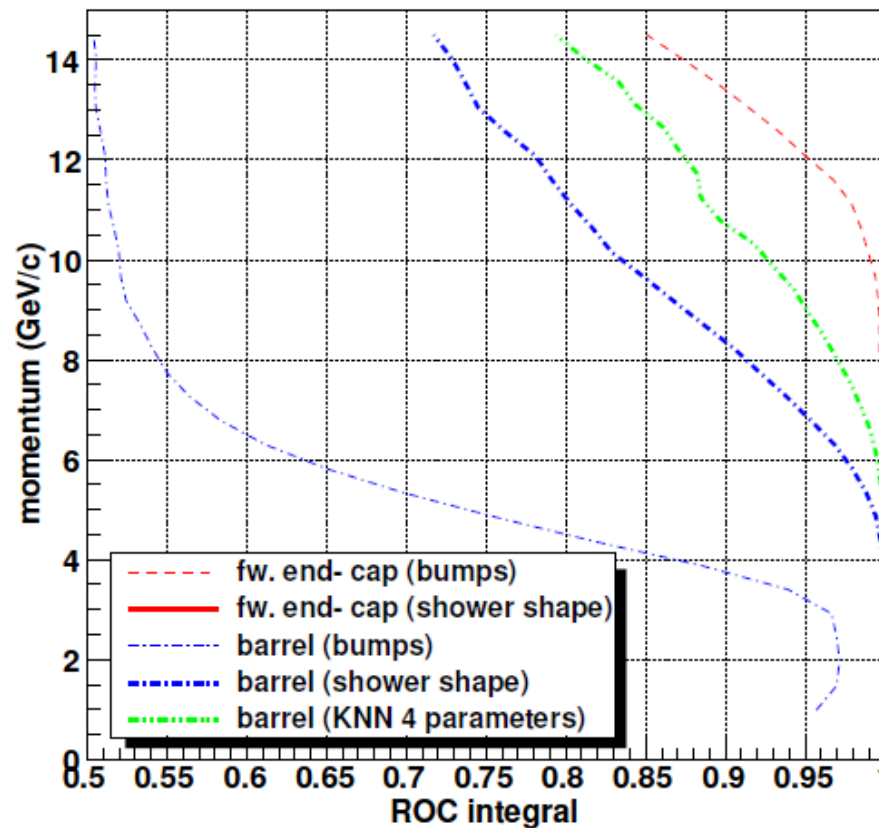
- KNN - large data set, very slow
- LVQ - Sensitive to training data, Fast
- Neural Network - parameterizing the boundary, slow



MVA analysis for π^0 - γ separation



π^0 - γ Separation



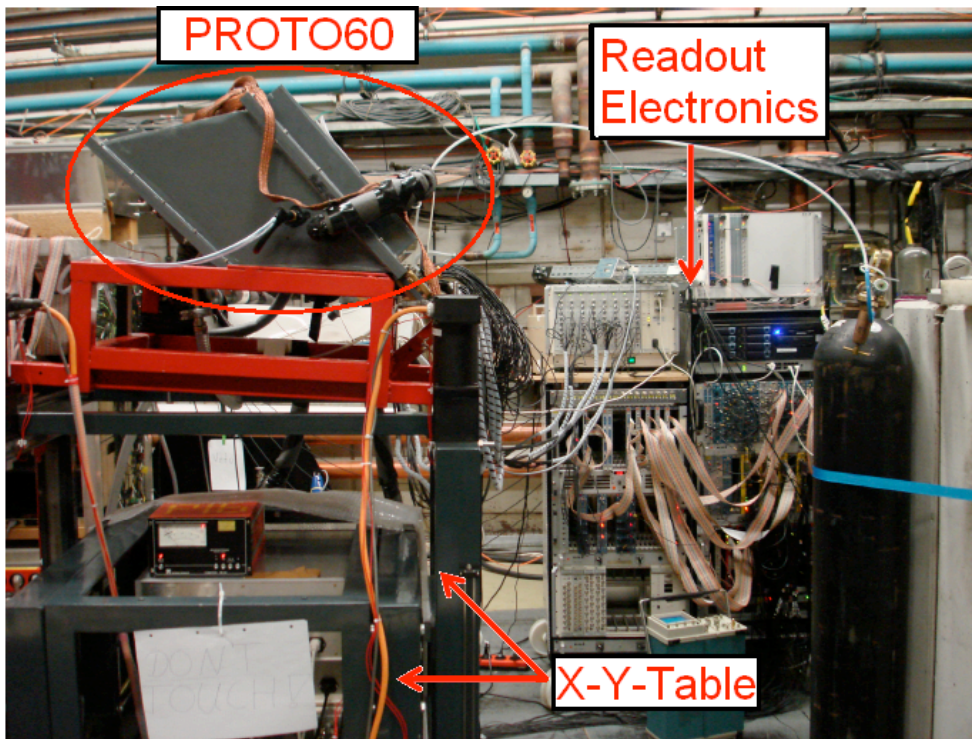
Elwin Dijck

MVA provides optimum identification of particles from a highly correlated parameters

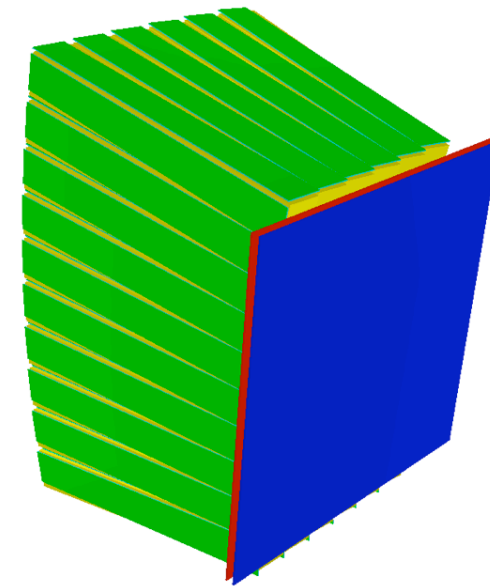
MVA Tools

- KNN, LVQ developed for PANDA by Mohammad Babai
- PndPidAssociator - Global PID
- PndPidEmcAssociator - EMC PID
- trunk/PndTools/MVA/macros
- **note** - rely training data set

Validation study



Experiment

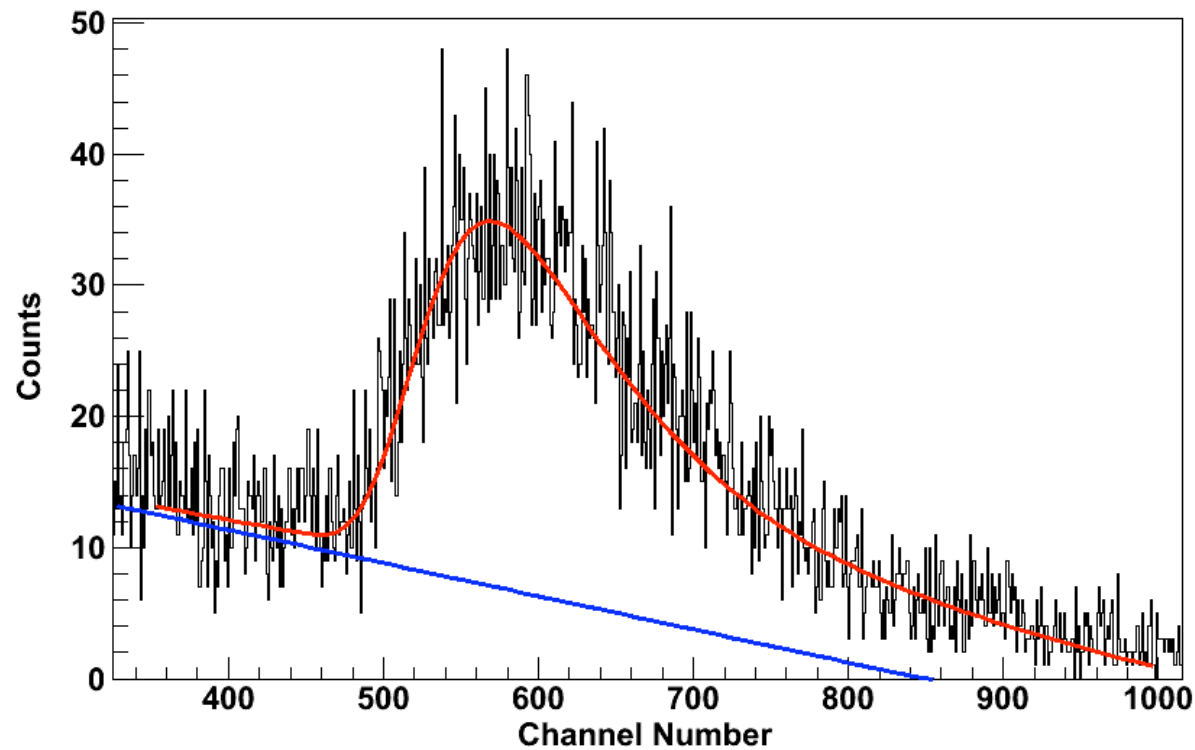


Simulation

Test Experiment of PWO crystals with photons 150 MeV - 1500 MeV in Mainz - Useful for validation

Cosmic calibration

PWO Stopping power 10.2 MeV/cm



Background
Cosmic muon

Geometry

PWO Crystal Geometry - Trapezoid

Front face ~ 21 x 21 mm²

Back face ~ 27 x 27 mm²

Carbon – Alveoles

Thickness 200 micron

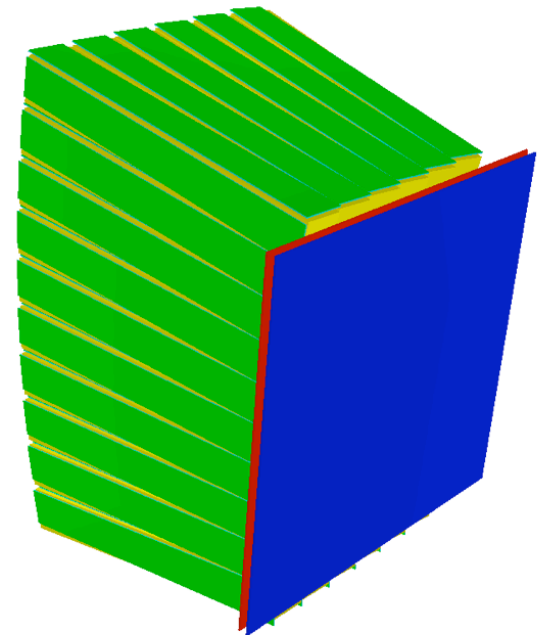
reflector

Thickness 65 micron

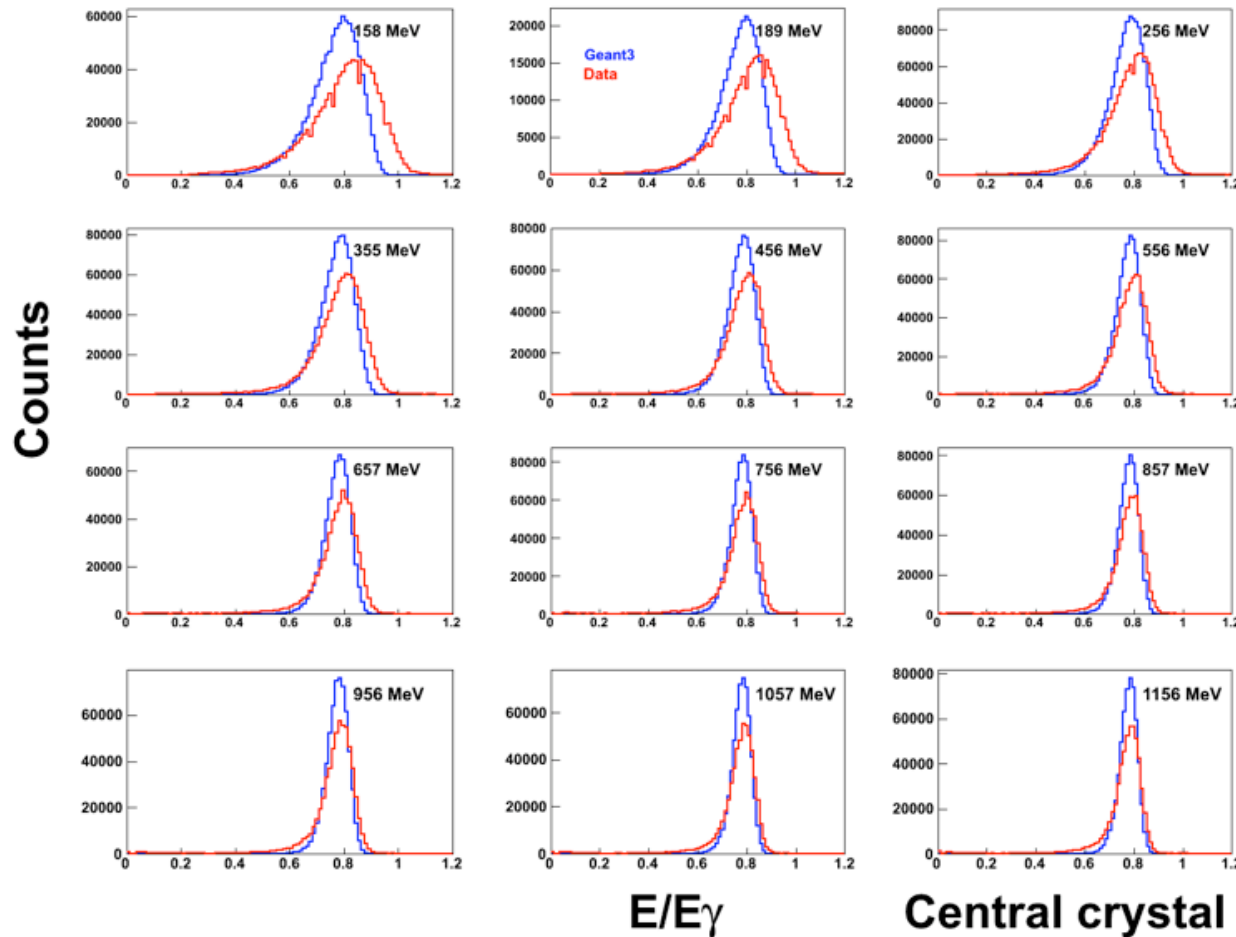
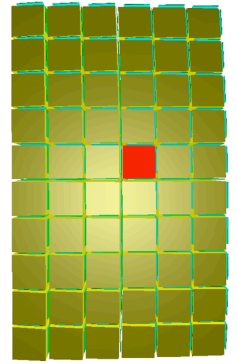
coolant cover

1 mm Copper

1 mm Aluminum



Prototype central crystal response



Geant3

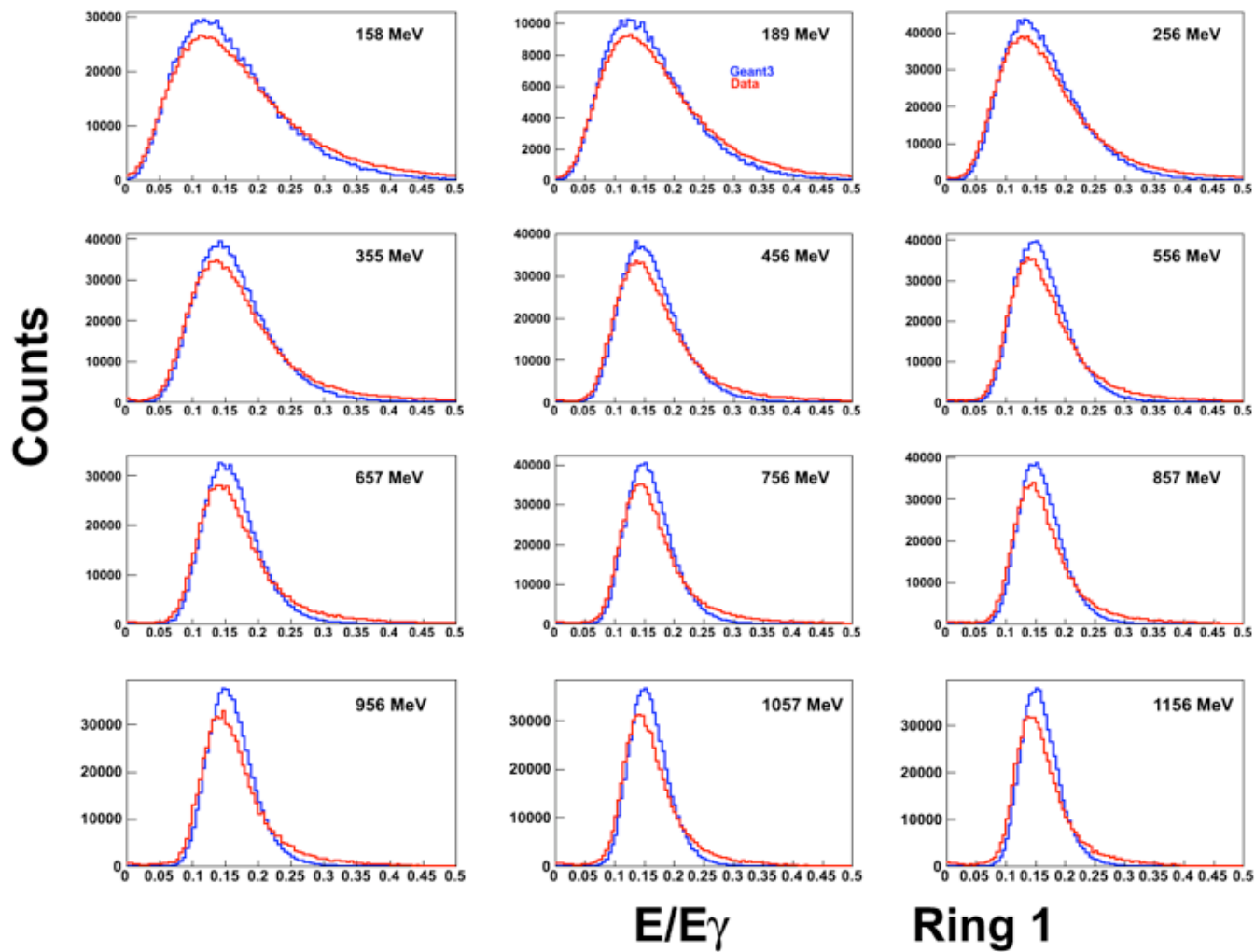
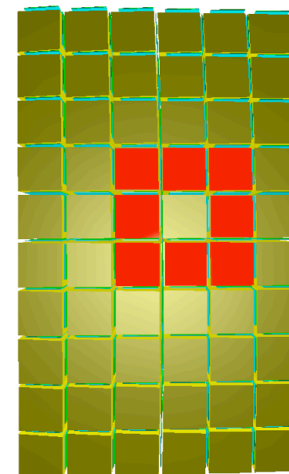
Data

100keV cut

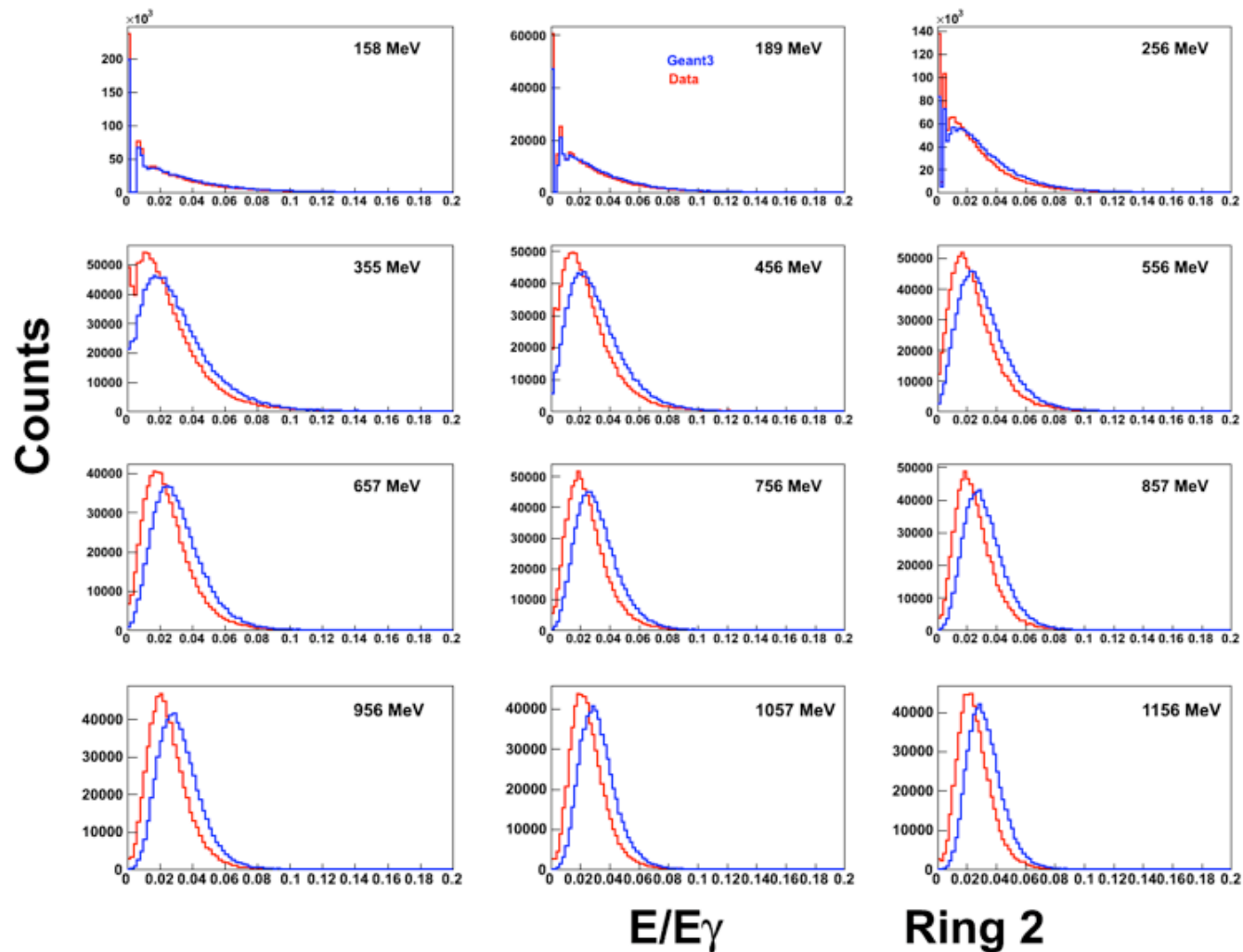
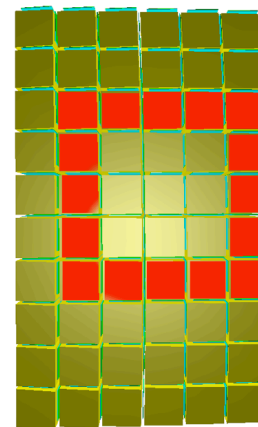
No digitalization

non-linear
energy
response

Ring 1



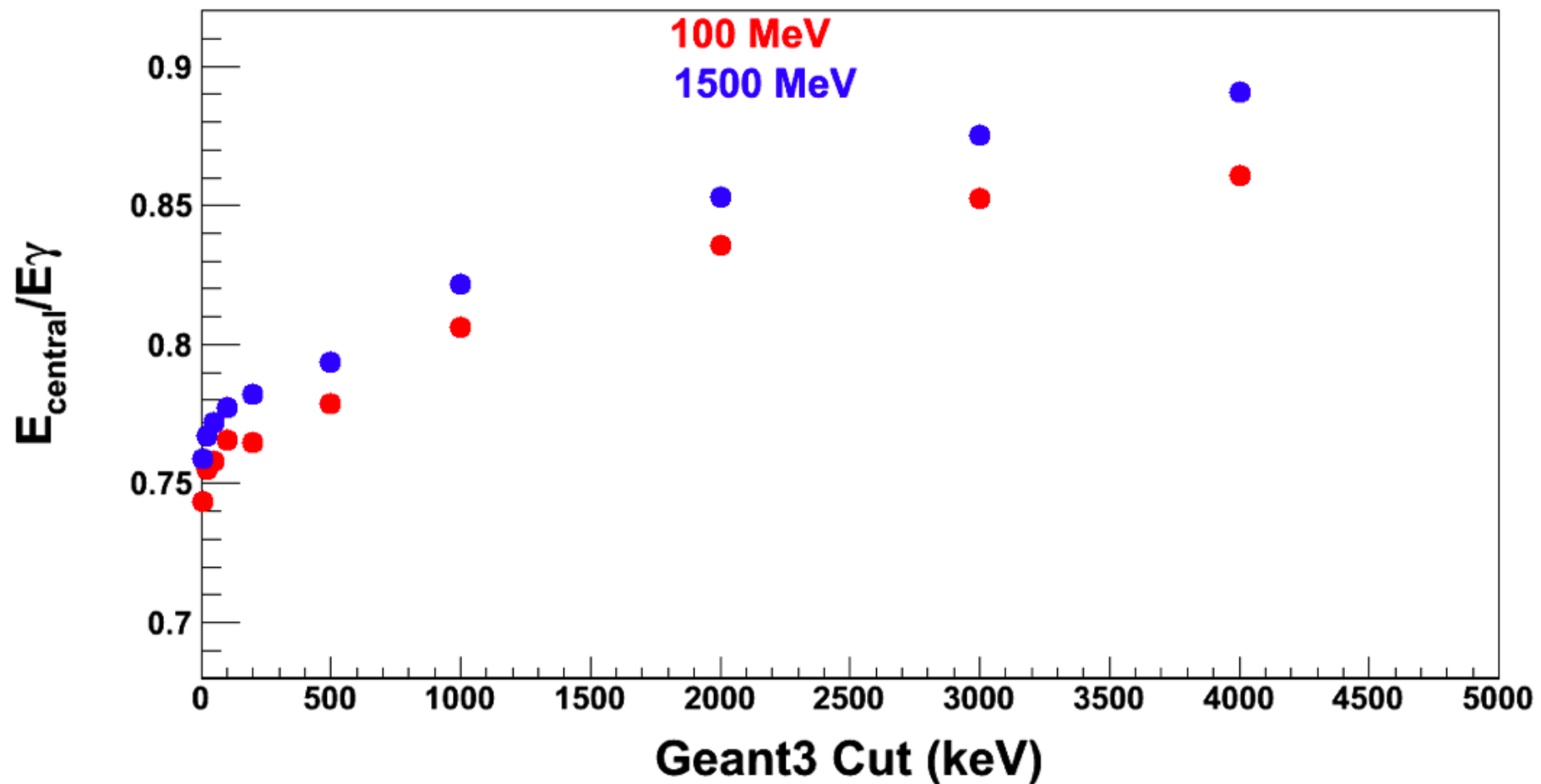
Ring2



- Observations Simulation - Data
 - Non-linear energy response
 - Different lateral shower profile
- How to tune the simulation
 - Optimizing cuts in the transport model
 - Optical light response
 - Light yield along Z - Christian Hammann
 - New data

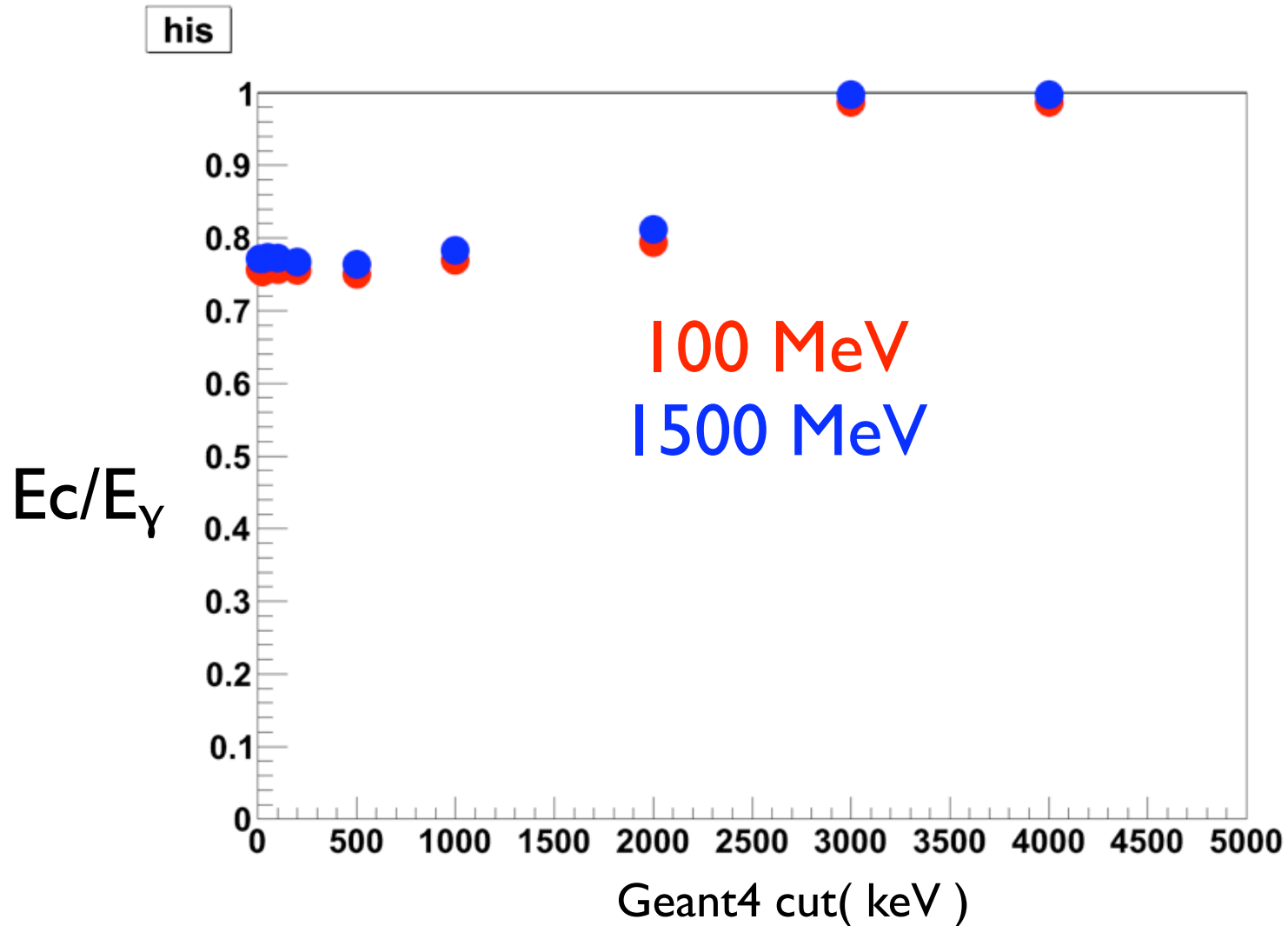
Ecen vs Geant3 cut

cut - lowest energy below which particle will not be tracked



sensitive to the Geant3 cut!

Ecen vs Geant4 cut



Not sensitive to the cut

- Though energy response is sensitive to the Geant3 cut, non-linearity in the central crystal can not be reproduced.
- Lowering geant3 cut will diffuse the energy to the outer ring and match with the data in outer shower.
- Geant4 energy response is not sensitive to the cut.

Summary

- Parameters identified for PID- $E/p, E4, Z20$
- MVA is important for extraction of de correlated information from parameters
- MVA tools are available in PANDA-root
- Validation of shower shape against data is ongoing. Cut, noise parameters are inconclusive
- Acceptance Studies of optical photon is in progress