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Proto60 Simulation and Analysis

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HISKP

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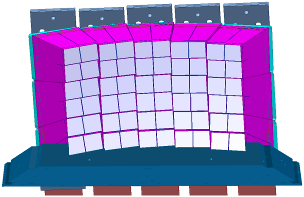
Proto60

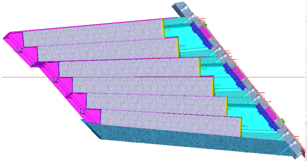
Geometry

- 60 PWO crystals type 6
- APD readout with standard ADCs
- cooled down to $-25\,°\mathrm{C}$

Measurement at MAMI

- 15 photon energies in the range from $150\,\mathrm{MeV}$ to $1500\,\mathrm{MeV}$
- beamspot with maximum diameter of $9\,\mathrm{mm}$
- calibration using cosmic peak at $24.5\,\mathrm{MeV}$





Simulation

Geometry

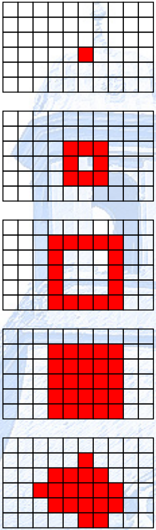
- Proto60 geometry has been implemented in PandaROOT (V. Suyam Jothi)
- Geometry includes dead material (alveoles, mylar, ...)
- Geometry is not exact

Simulation Parameters

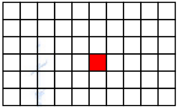
- Geant4 with 1mm range cut
- 10000 photons for each energy
- electronic noise of $240\,\mathrm{keV}$
- poisson distribution for photon statistics with mean of 7.2
- beamspot of $8\,\mathrm{mm}$ square

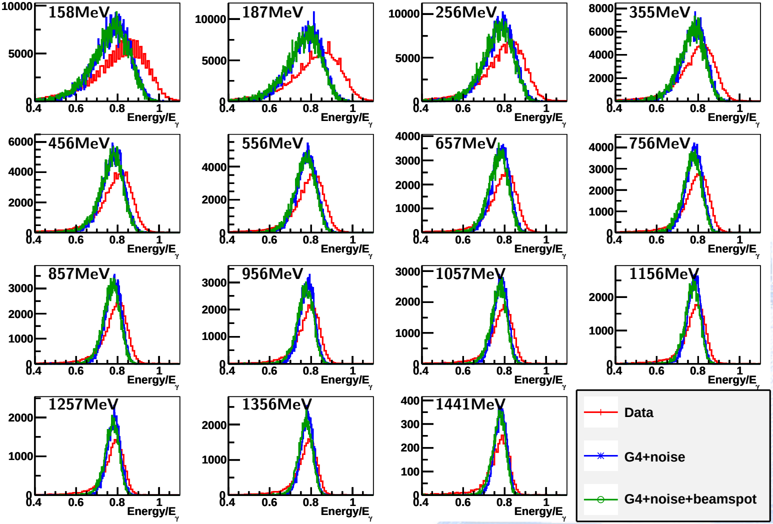
Energy Depositions

- Energy deposition in central crystal
- Sum over energy depositions in the first ring, second ring, 5x5 matrix or cluster
- threshold of $1\,\mathrm{MeV}$
- Energy plotted relative to the photon energy
- Data and simulations have been treated the same way

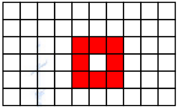


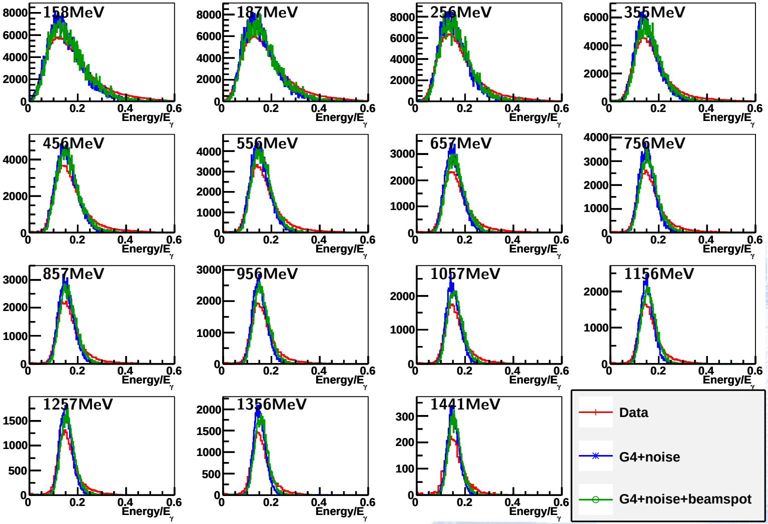
Central Crystal





First Ring




158MeV
187MeV
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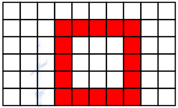
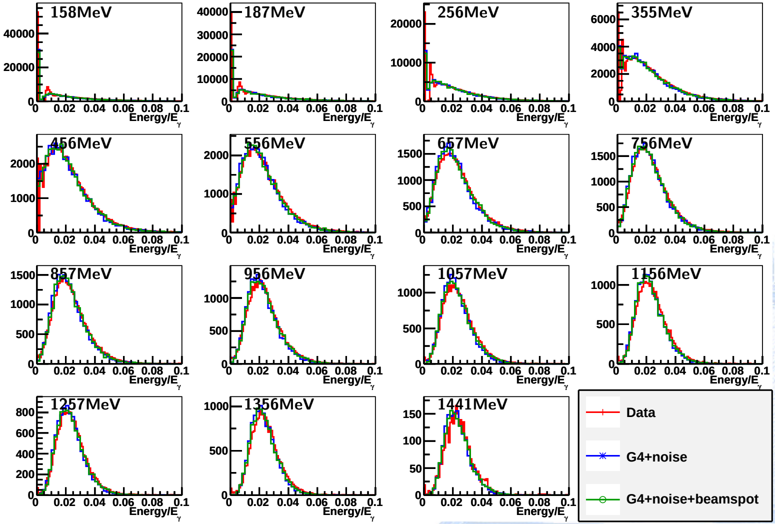
355MeV
456MeV
556MeV
657MeV
756MeV
857MeV
956MeV
1057MeV
1156MeV
1257MeV
1356MeV
1441MeV
Energy/E$_\gamma$
Data
G4+noise
G4+noise+beamspot

Second Ring

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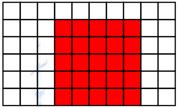
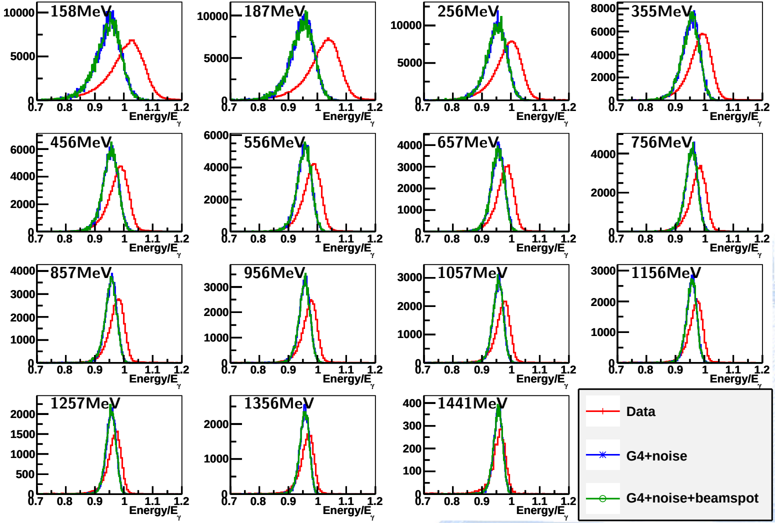
1257MeV
1356MeV
1441MeV
Energy/E$_\gamma$
Data
G4+noise
G4+noise+beamspot

5x5 Matrix

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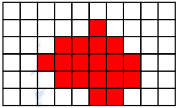
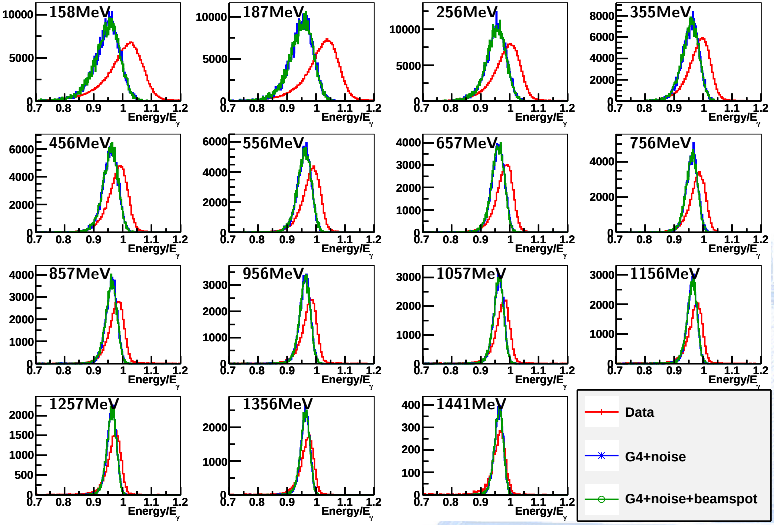
1441MeV
Energy/E$_\gamma$
Data
G4+noise
G4+noise+beamspot

Cluster

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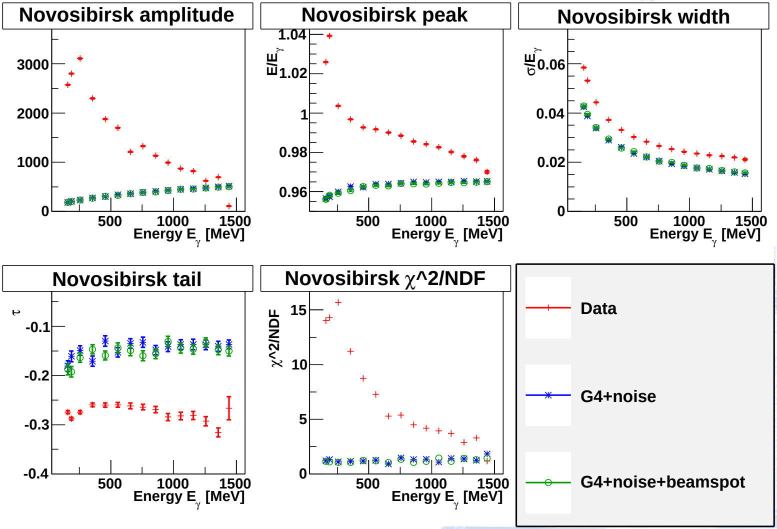
Energy/E$_\gamma$
Data
G4+noise
G4+noise+beamspot

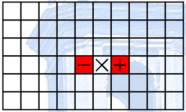
Fit


Novosibirsk amplitude
Novosibirsk peak
Novosibirsk width
Novosibirsk tail
Novosibirsk χ^2/NDF
Energy E_γ [MeV]
E/E_γ
σ/E_γ
τ
χ^2/NDF
Data
G4+noise
G4+noise+beamspot

Asymmetries

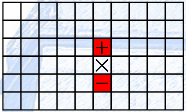
- Asymmetry between crystals left and right of the central crystal
- defined as

$$\frac{right - left}{right + left}$$

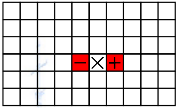


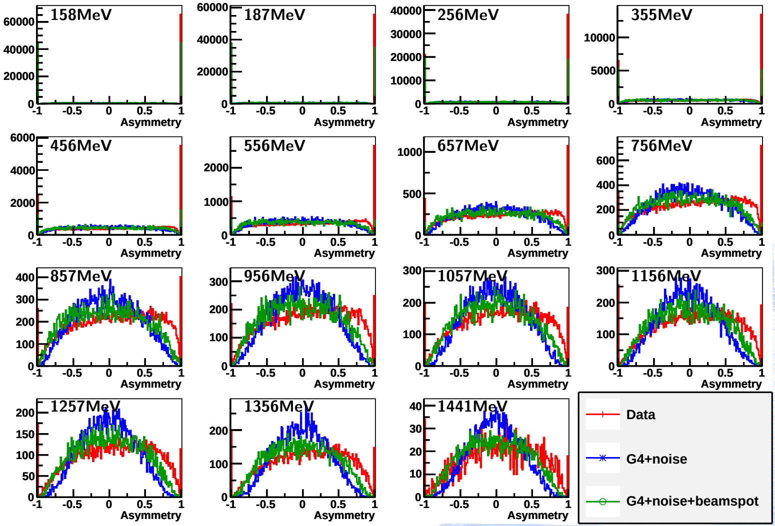
- Asymmetry between crystals on top of and below the central crystal
- defined as

$$\frac{top - bottom}{top + bottom}$$

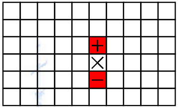


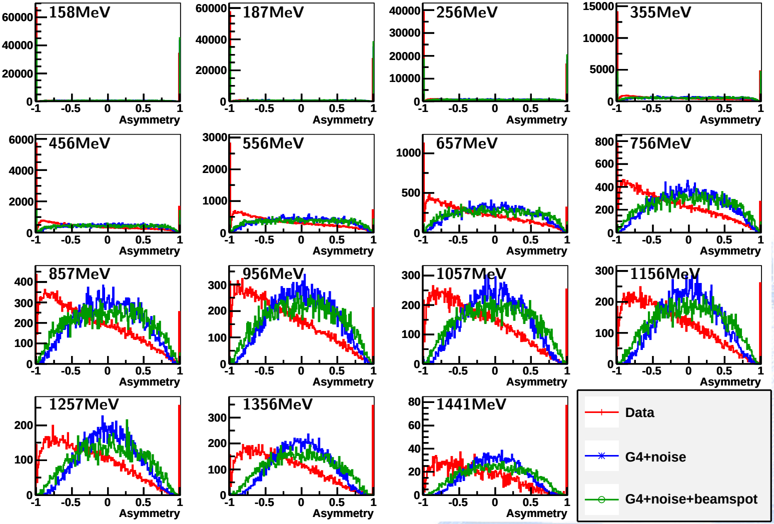
Left Right Asymmetry



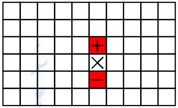


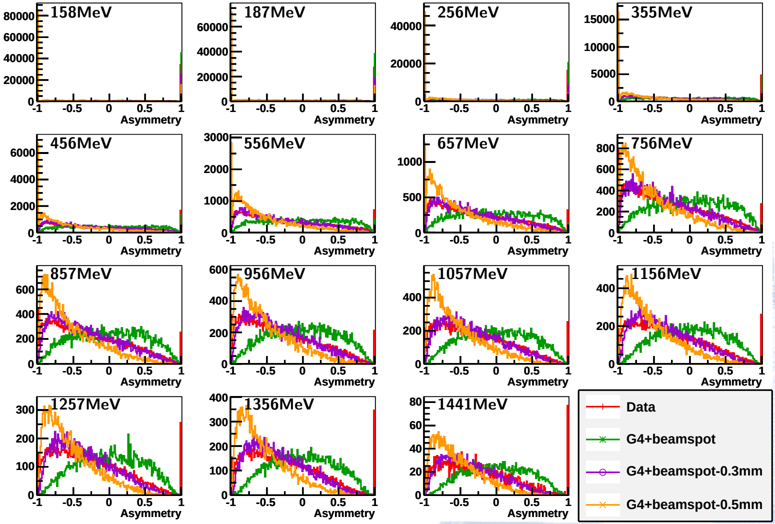
Top Bottom Asymmetry





Top Bottom Asymmetry





Summary

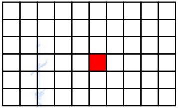
Simulation

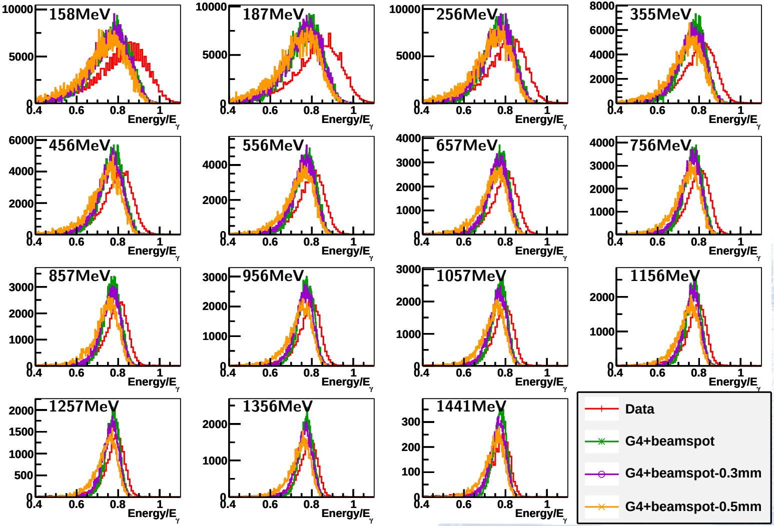
- Geant4 does not reproduce the EM-shower as measured with the Proto60
- Differences cannot be explained by a different energy deposition of the muons
- Cuts in Geant have to be tuned

Next Meassurements

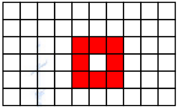
- Better defined muon pathlength for the energy calibration
- Careful positioning of the Proto60

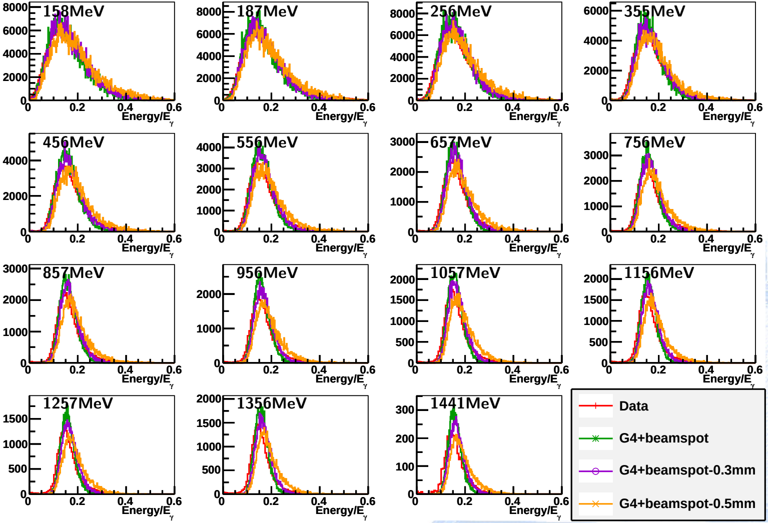
Central Crystal





First Ring

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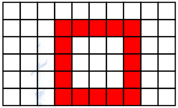
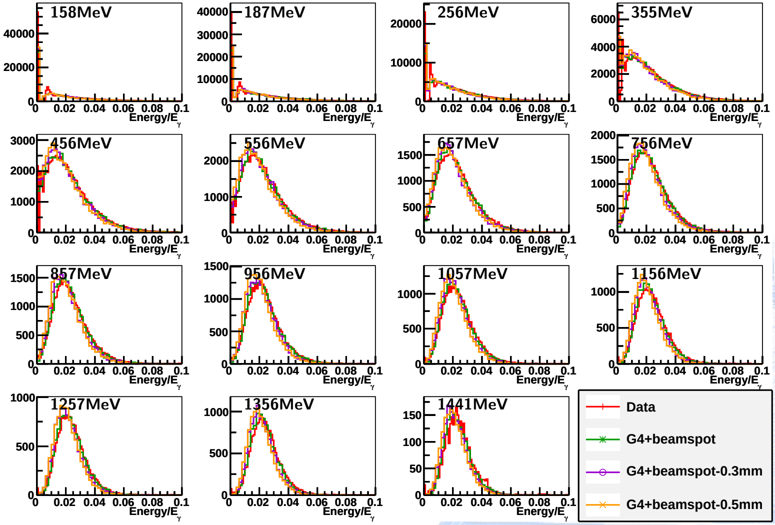
Energy/E$_\gamma$
Data
G4+beamspot
G4+beamspot-0.3mm
G4+beamspot-0.5mm

Second Ring

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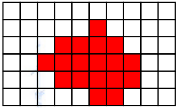
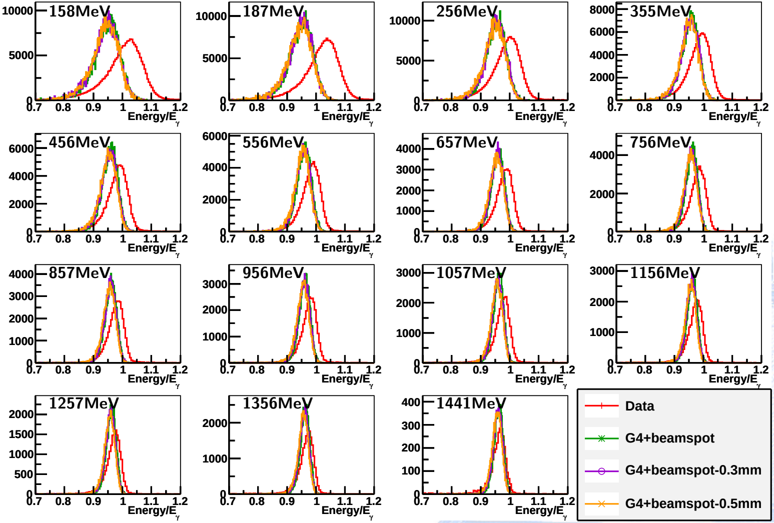
Cluster

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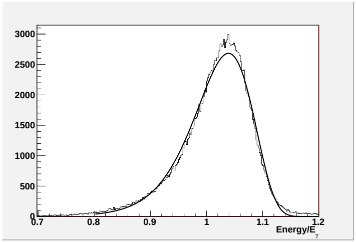
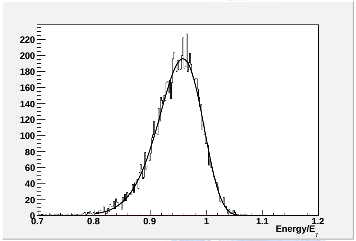
Energy/E$_\gamma$
Data
G4+beamspot
G4+beamspot-0.3mm
G4+beamspot-0.5mm

Fits

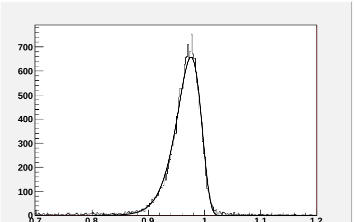
Data $E_\gamma = 187\,\mathrm{MeV}$



G4+noise+beamspot $E_\gamma = 187\,\mathrm{MeV}$



Data $E_\gamma = 1356\,\mathrm{MeV}$



G4+noise+beamspot $E_\gamma = 1356\,\mathrm{MeV}$