# Simulations for the EMC forward end-cap of the PANDA detector

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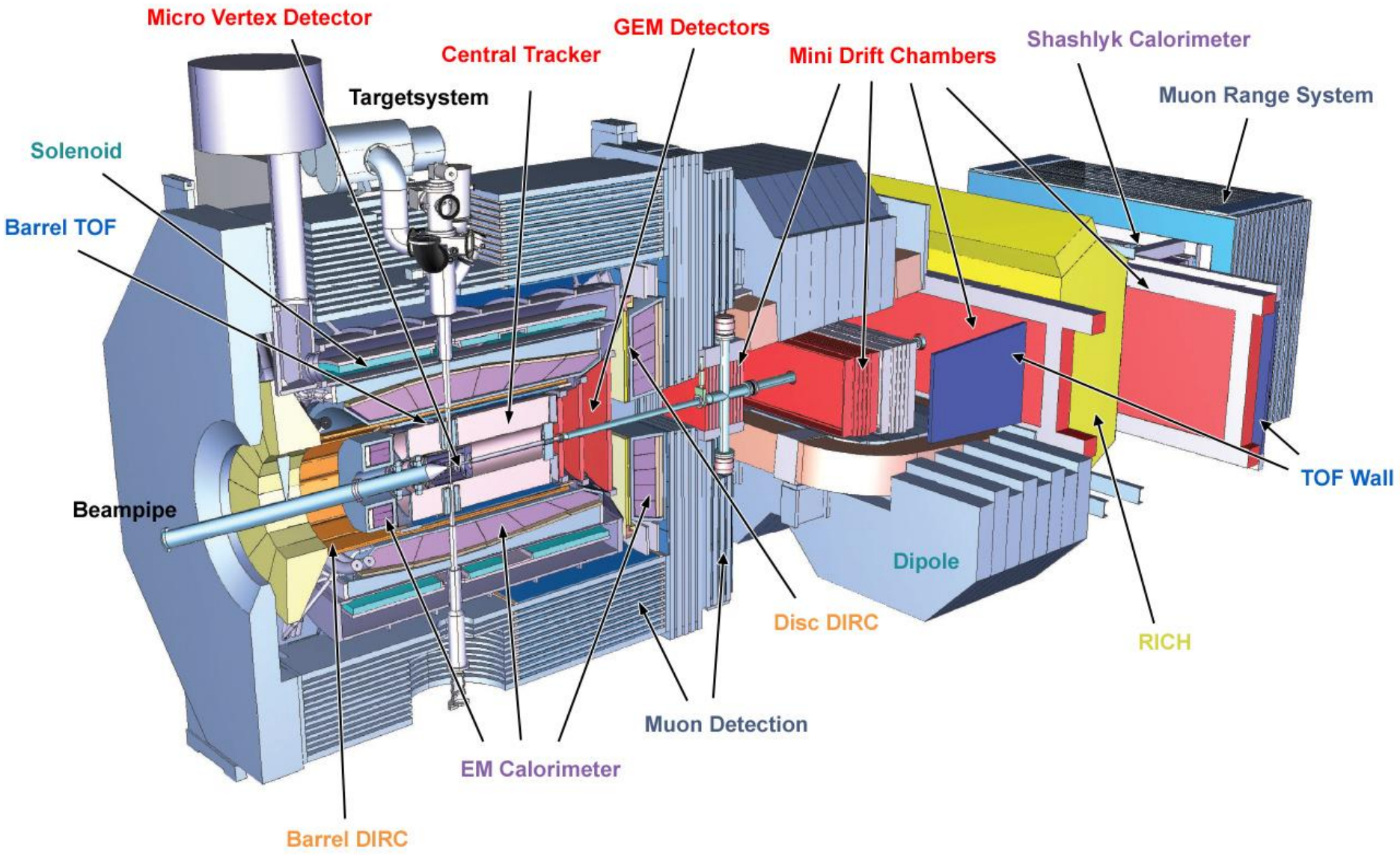
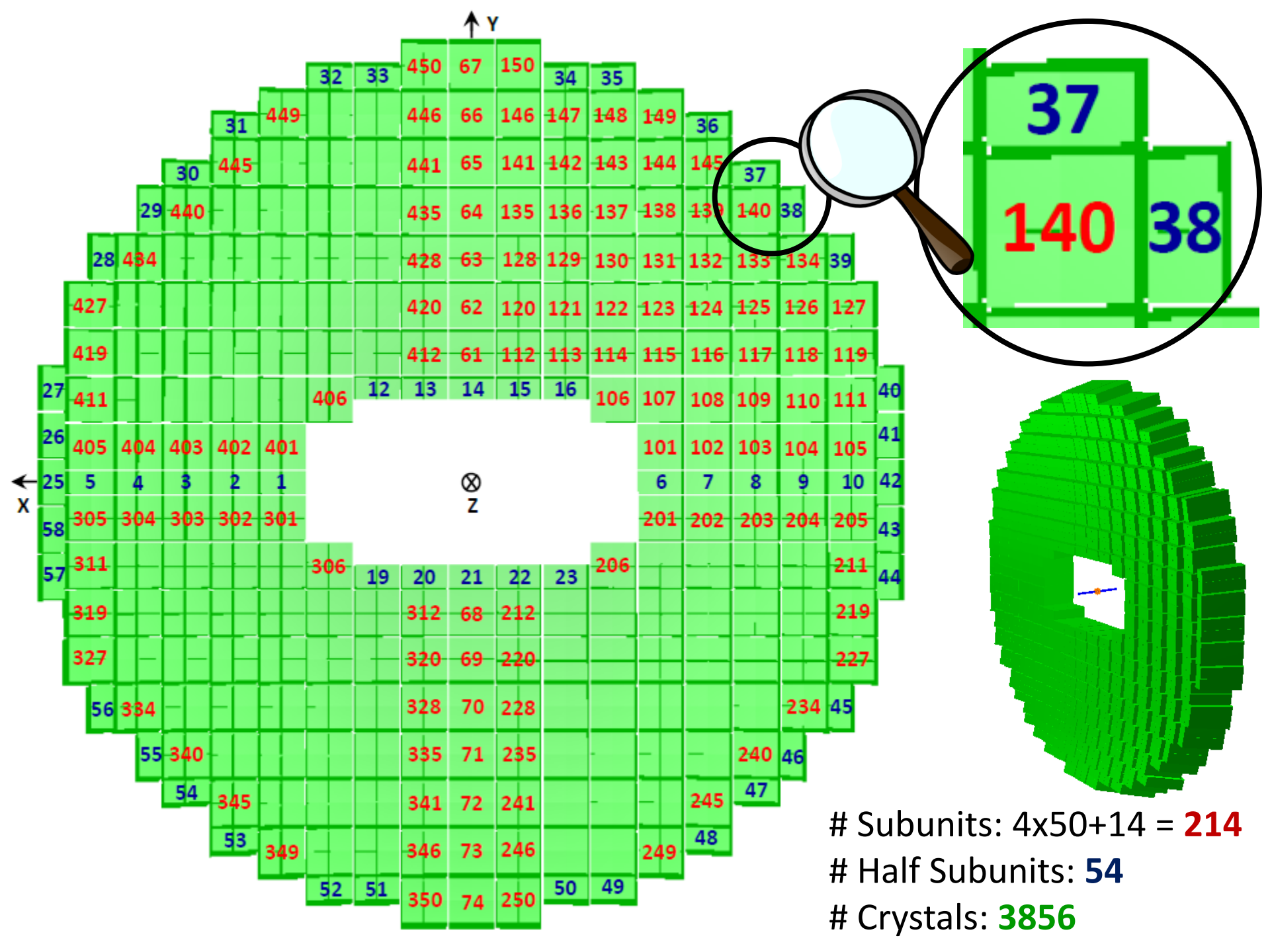
PANDA collaboration meeting 12/12/2011

# Motivatios

- Request for the update of the geometry by the collaboration
- Urgent need to validate the simulation framework
- Investigating the sensitivity of the EMC to physics channels of interest


Micro Vertex Detector
GEM Detectors
Central Tracker
Mini Drift Chambers
Shashlyk Calorimeter
Targetsystem
Muon Range System
Solenoid
Barrel TOF
Beampipe
TOF Wall
Dipole
Disc DIRC
RICH
Muon Detection
EM Calorimeter
Barrel DIRC

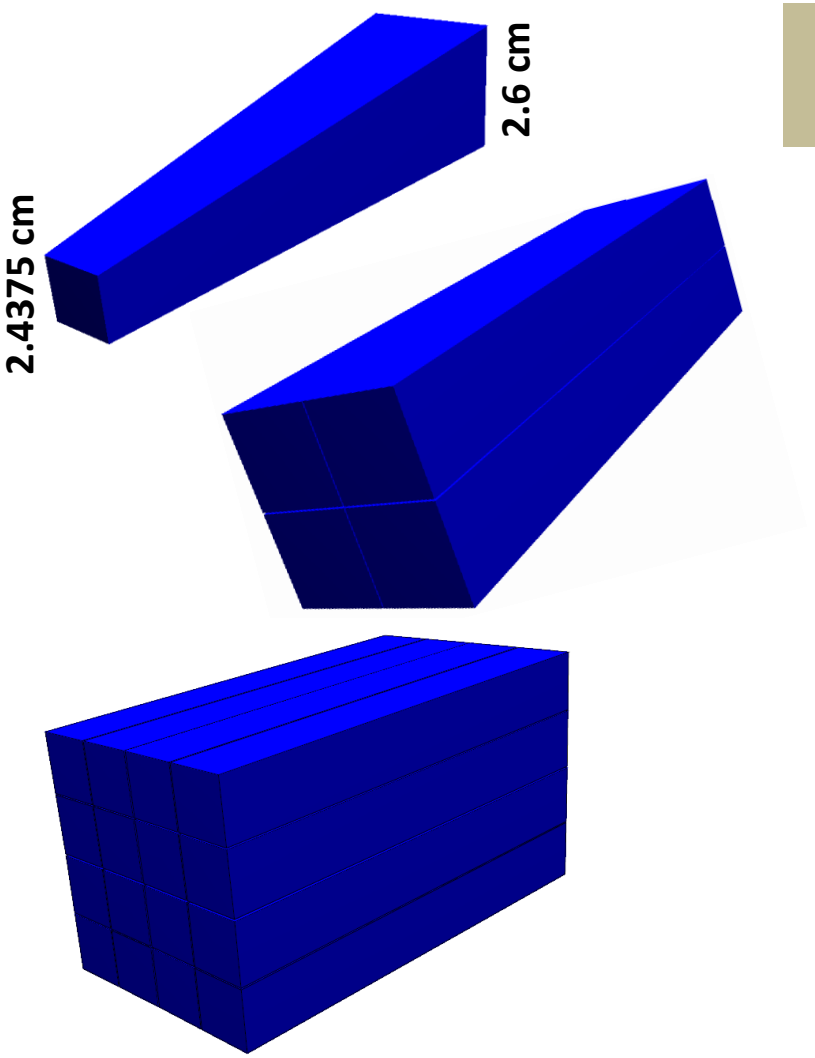


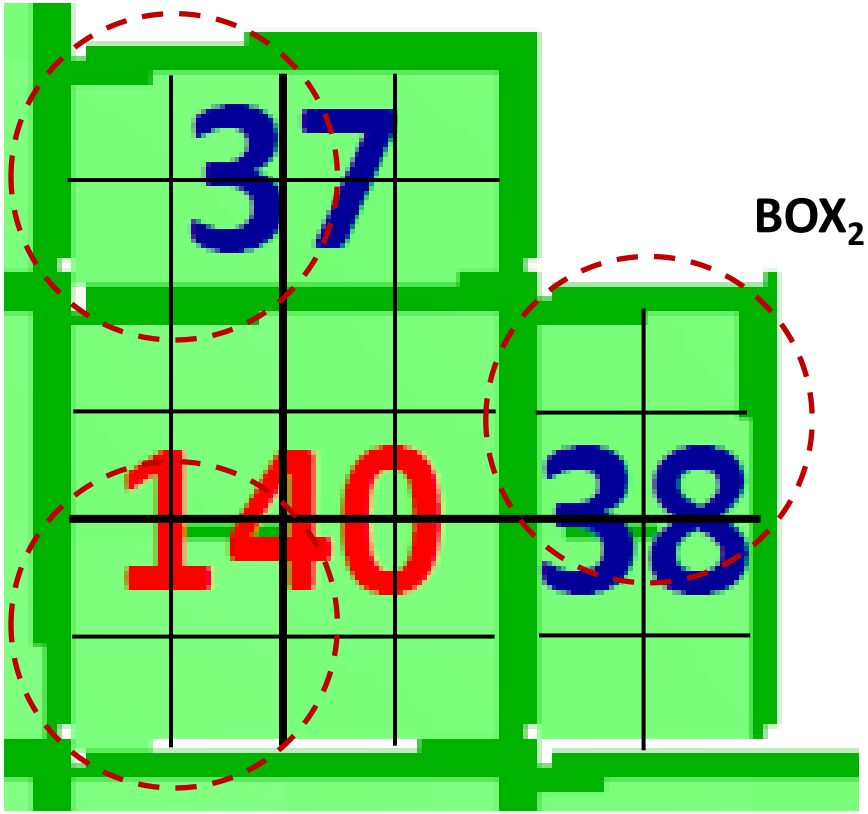

# Subunits: 4x50+14 = **214**

# Half Subunits: **54**

# Crystals: **3856**

# Mapping



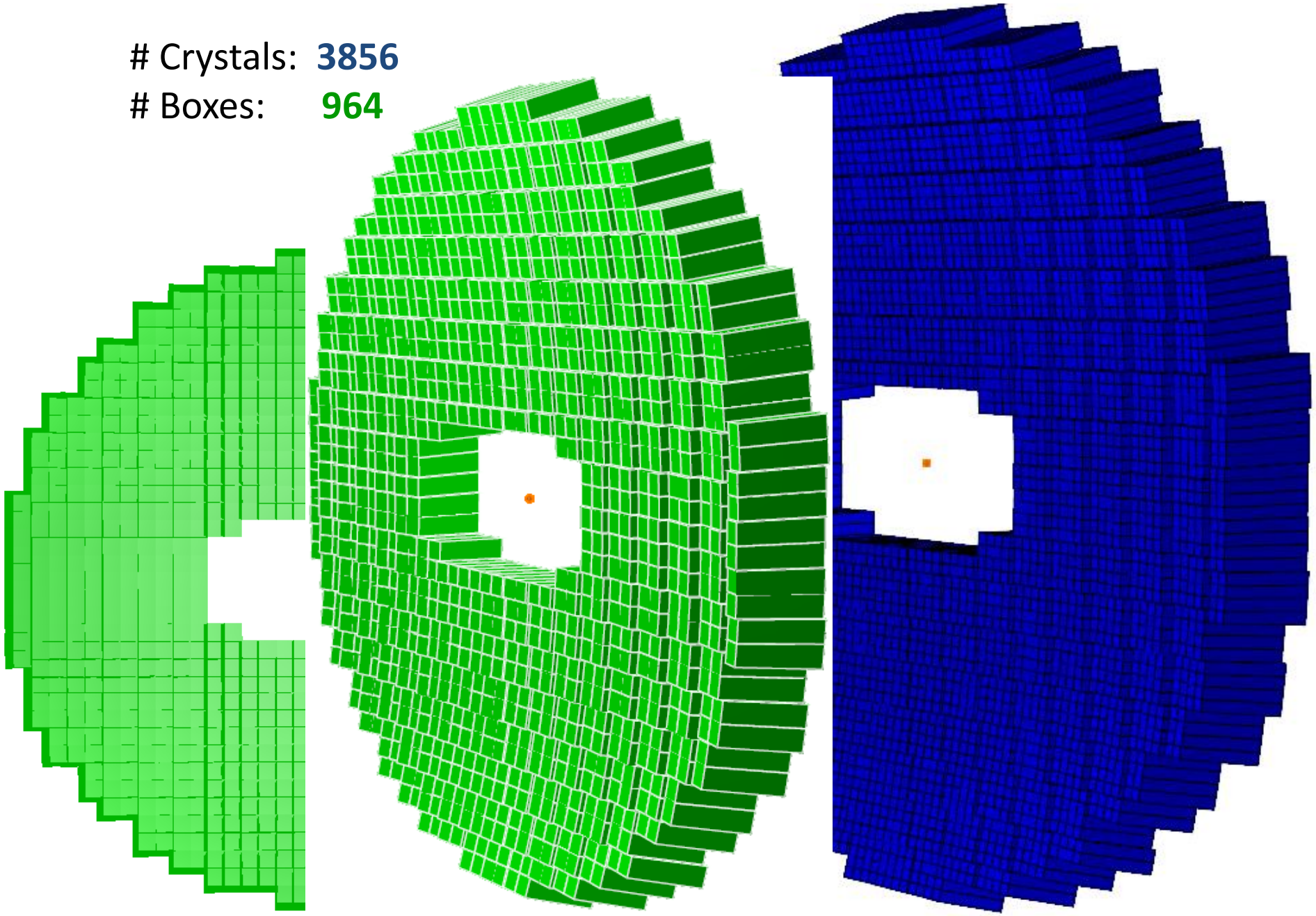

$BOX_1 = \begin{bmatrix} 3 & 1 \\ 2 & 4 \end{bmatrix}$ ⇢ Subunit = $\begin{bmatrix} 4 & 1 \\ 2 & 3 \end{bmatrix}$ 140 & HalfSubunit = $\begin{bmatrix} 2 & 1 \end{bmatrix}$ 37

$BOX_2 = BOX_1 \xrightarrow{90^\circ} = \begin{bmatrix} 1 & 4 \\ 3 & 2 \end{bmatrix}$ ⇢ HalfSubunit = $\begin{bmatrix} 1 \\ 2 \end{bmatrix}$ 38

# Forward End-Cap Subunit/Box/Crystal views

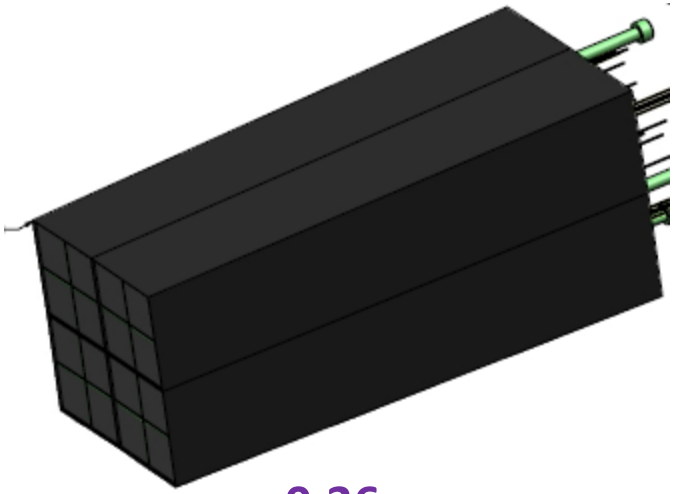
# Crystals: **3856**

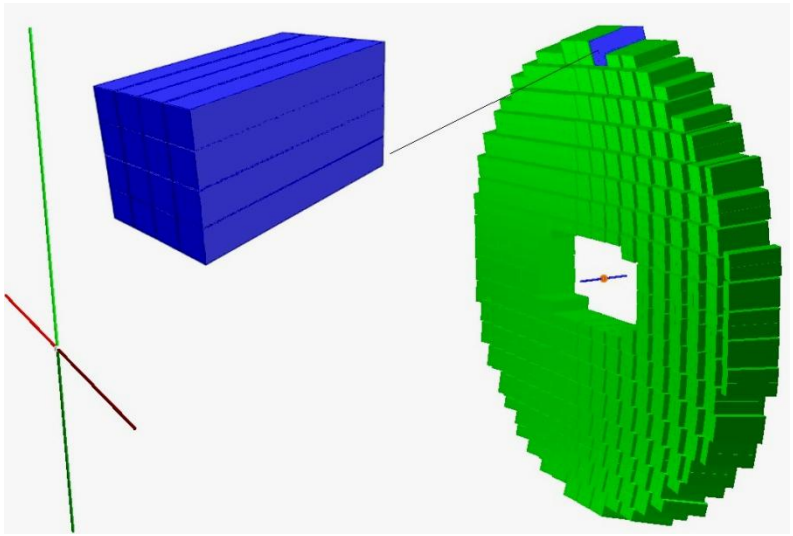
# Boxes: **964**



# Definition of Alveole in the simulations

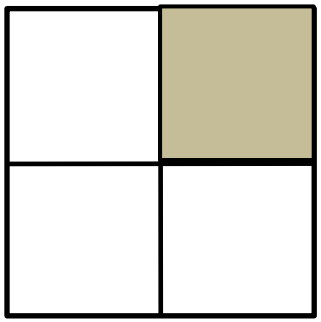
**Tolerance of crystals inside a Box: 0.6 mm**
**Tolerance of Boxes inside a subunit: 2×0.24 mm**





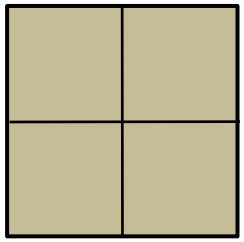
**0.36 mm**

At the level of Subunit :

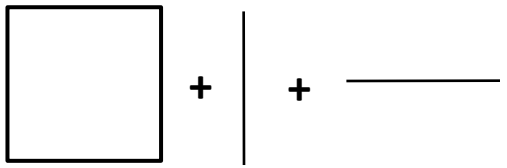


**Plus** at the level of Box :

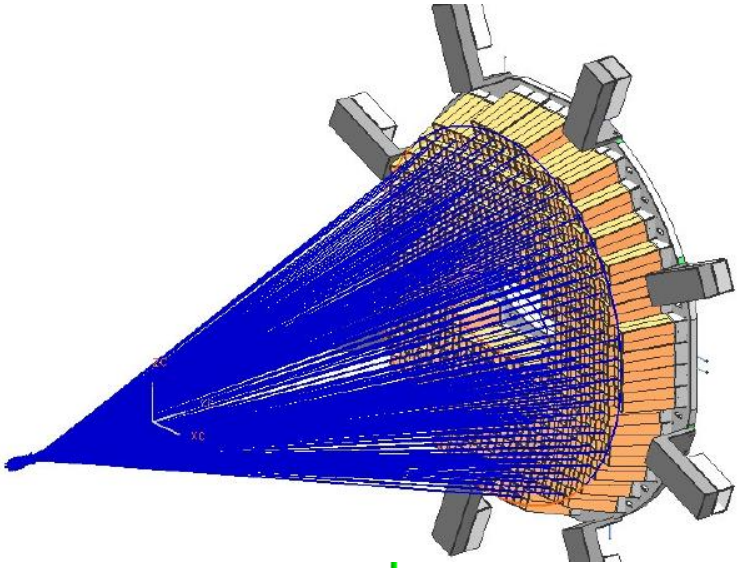
**0.18 mm**

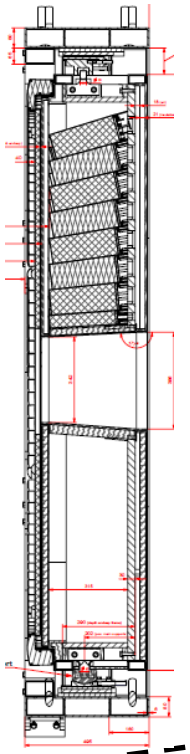


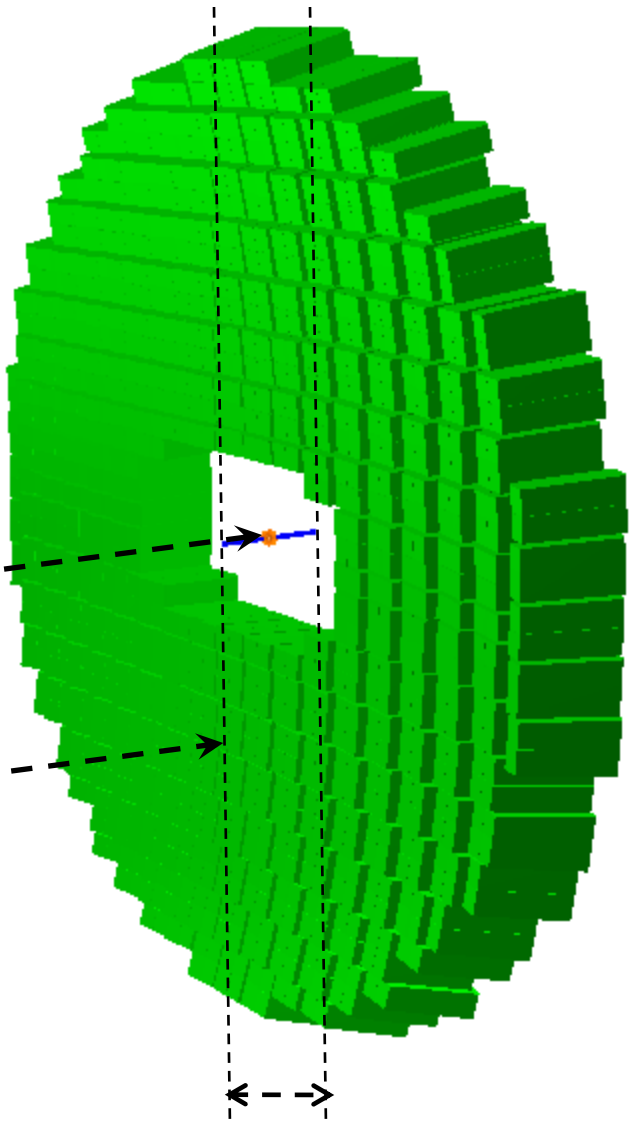
**Which are made as :**

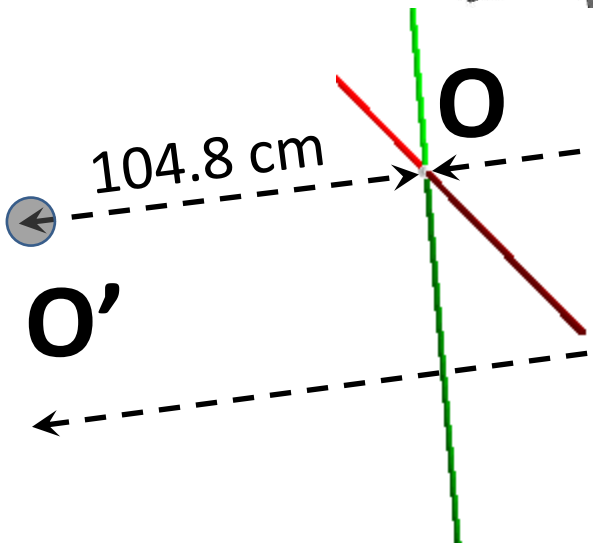


# Positioning the geometry









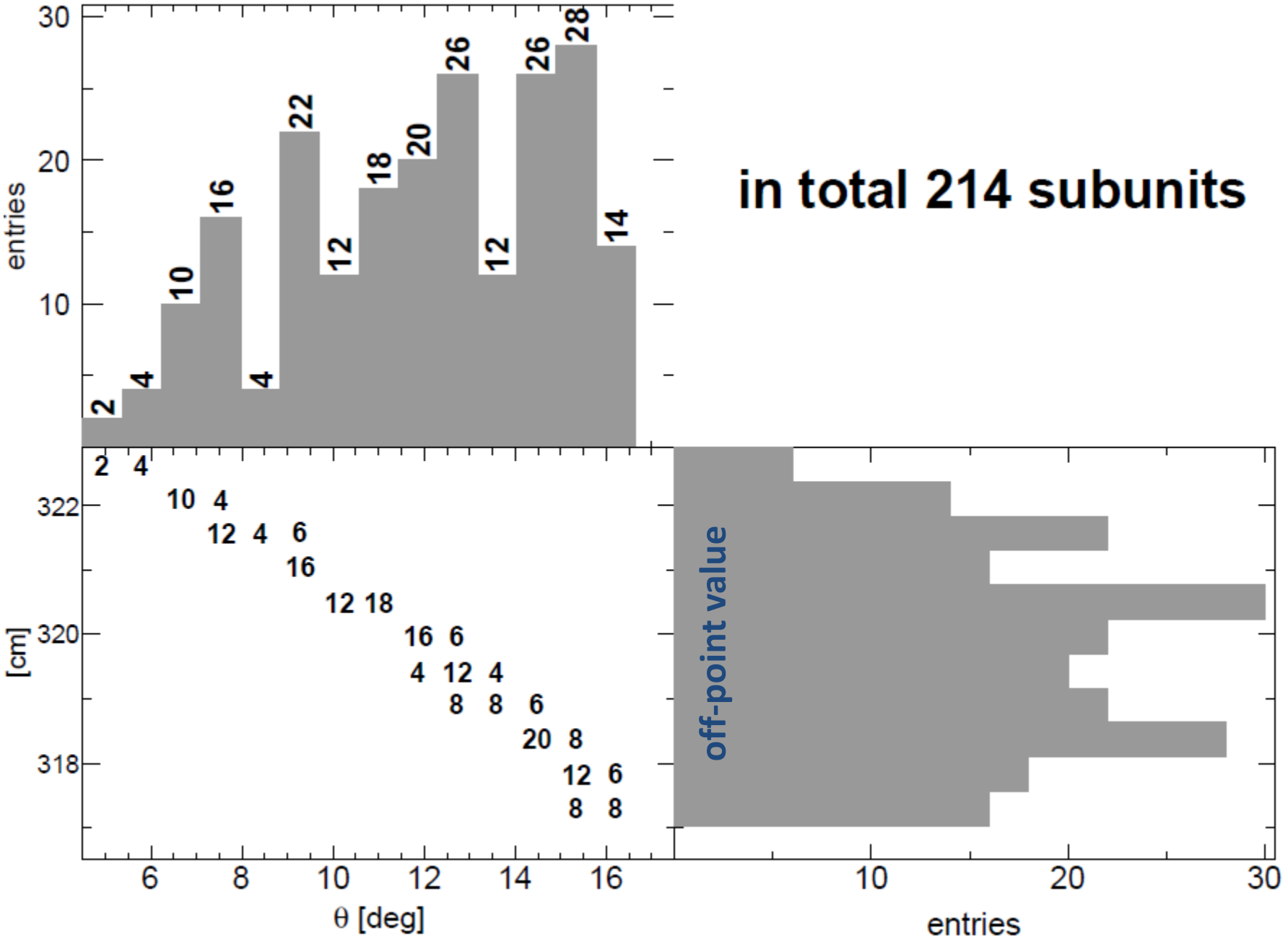

**O : target point**

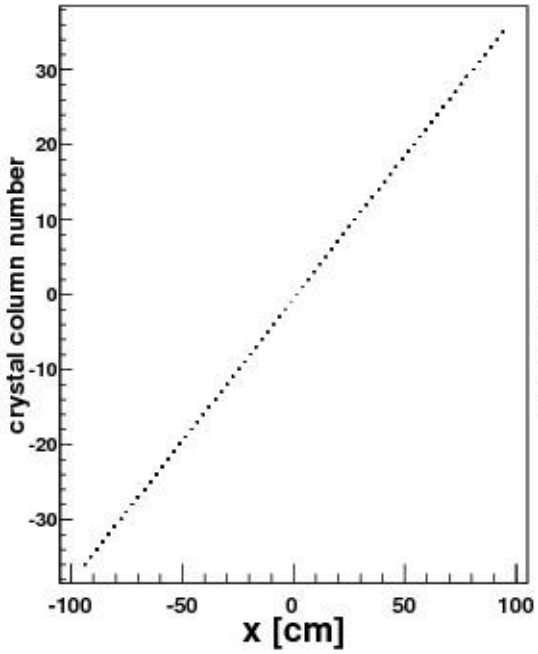
**O’: off-point**

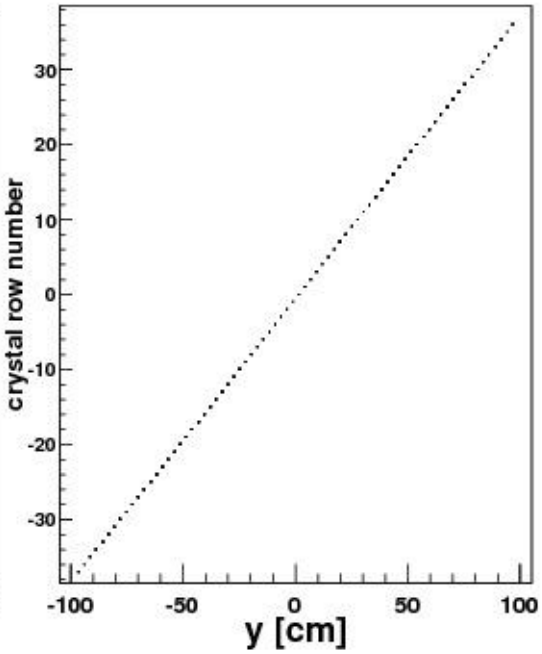
Obtained from simulations

23 cm

# Orientation and beam-line intercept of the full Subunits

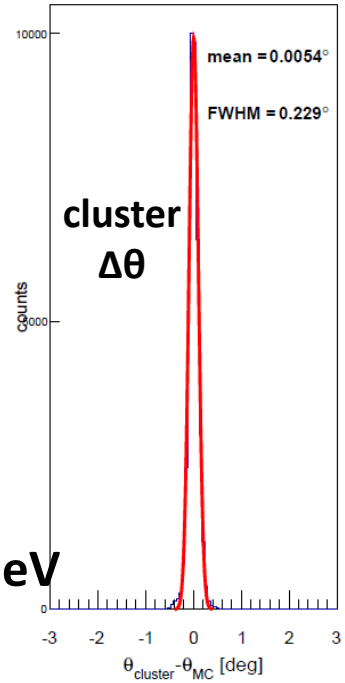


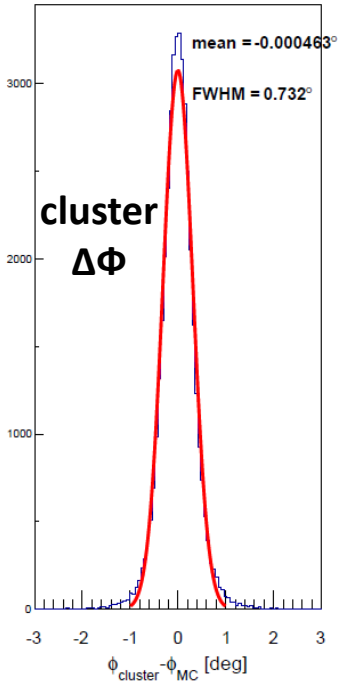


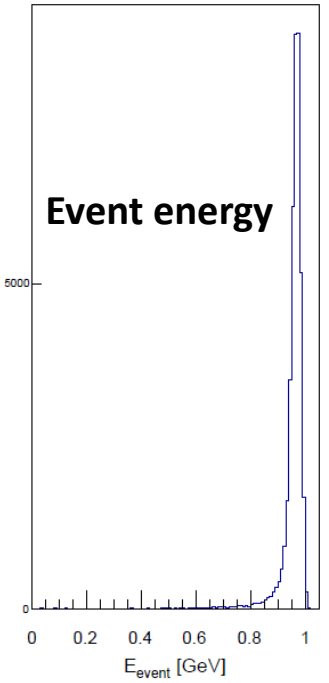




**Correlation between column (row) number of the hit crystal and the x- (y-)position of the crystal**

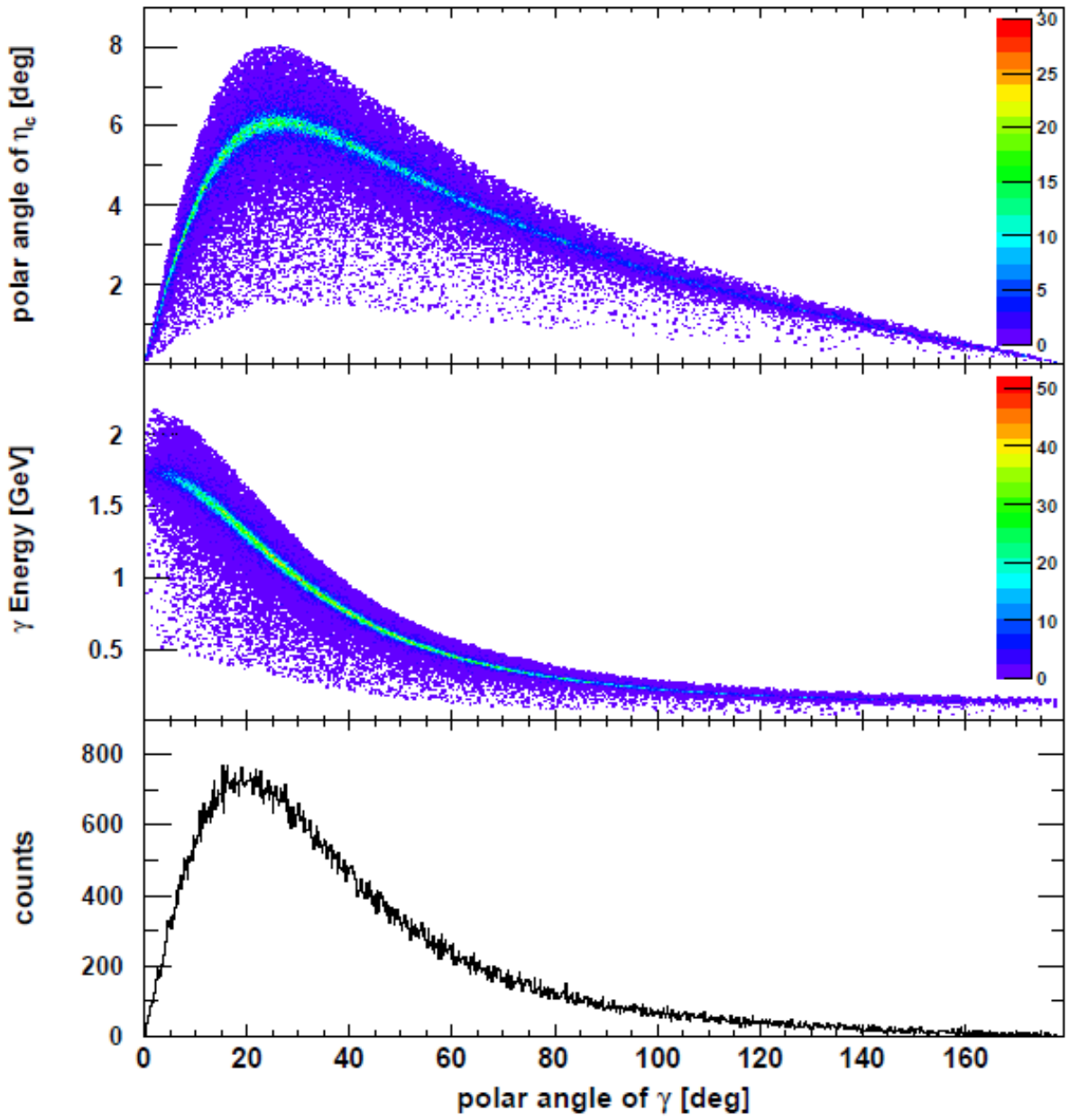
**Difference between the Θ- and ϕ-angles of the clusters and the corresponding MC angles of 1 GeV homogeneously generated photons over the FwEndCap; 30 MeV cluster threshold.**



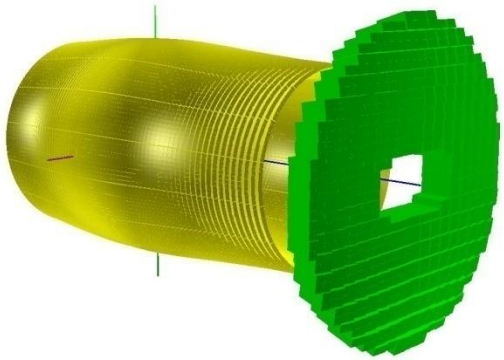



# MC kinematical variables in LAB for the decay channel $h_c \rightarrow \eta_c + \gamma$

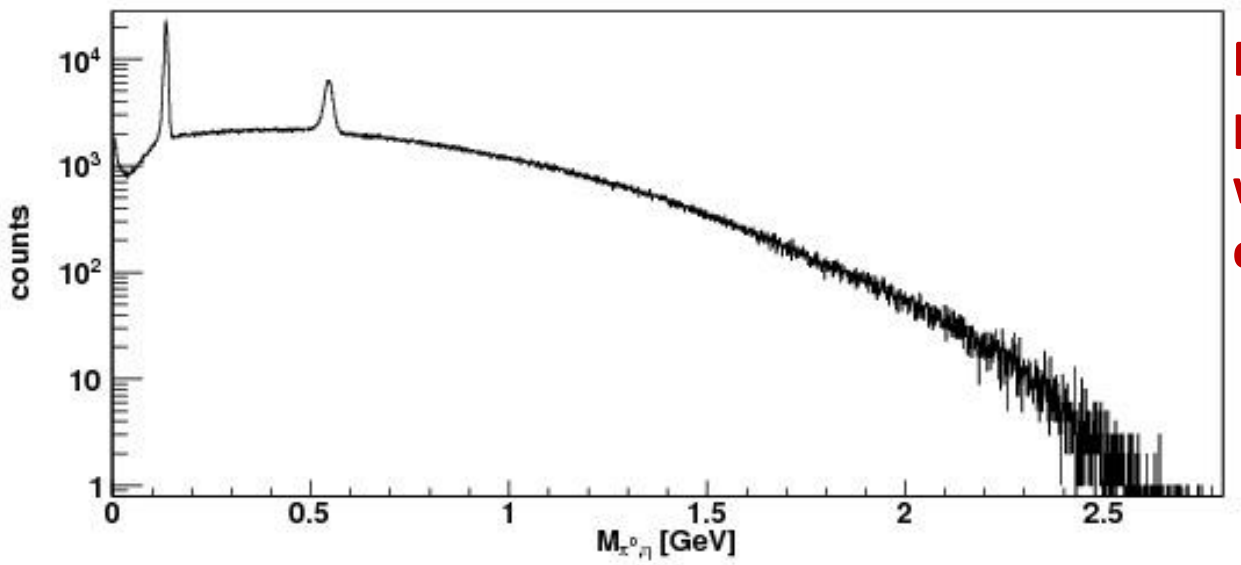



**In the simulations,**
**$E_p + E_{\bar{p}} \approx 4.6$ MeV +**
**$h_c$ production energy**

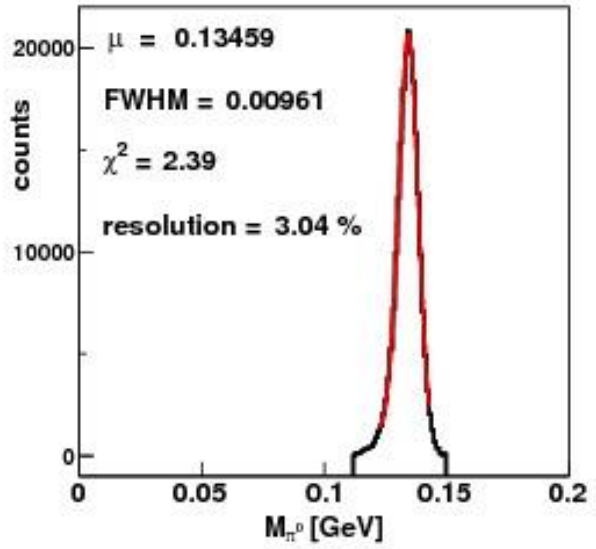
**From PDG:**
**$h_c$ inv. mass = 3.525 GeV**
**Thus,**
**$h_c$ production energy = 6.624 GeV**

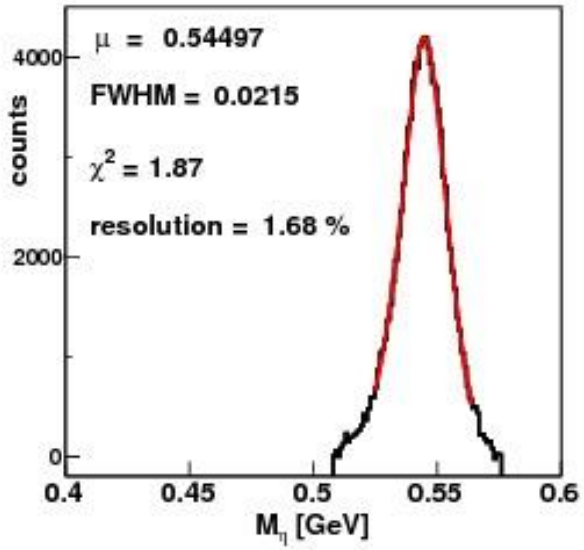


# $\pi^0/\eta$ invariant mass reconstruction in the simulations of the full EMC

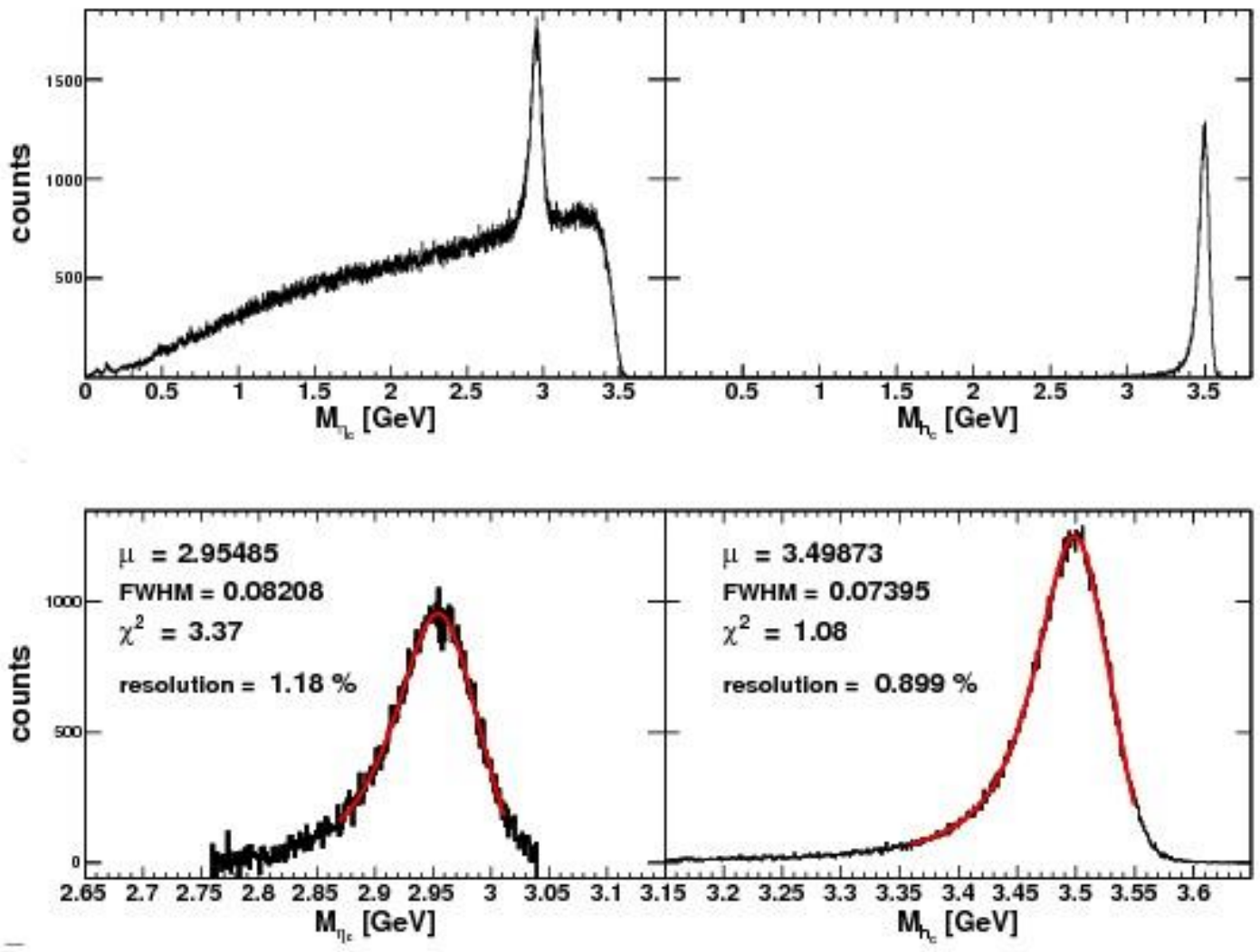



**Number of combinations per event is $C(N_{cluster},2)$ with $N_{cluster}$ >=7 (per event) & cluster thresh. = 30 MeV**



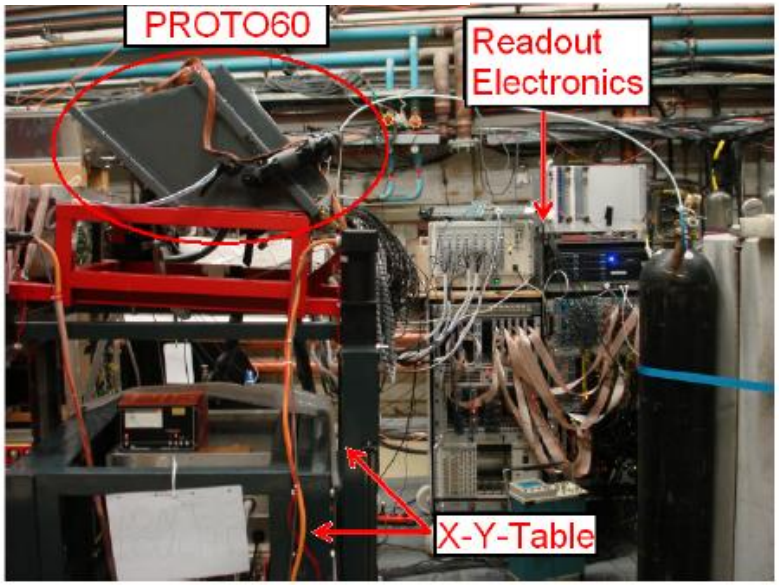
# $\eta_c/h_c$ invariant mass reconstruction in the simulations of the full EMC

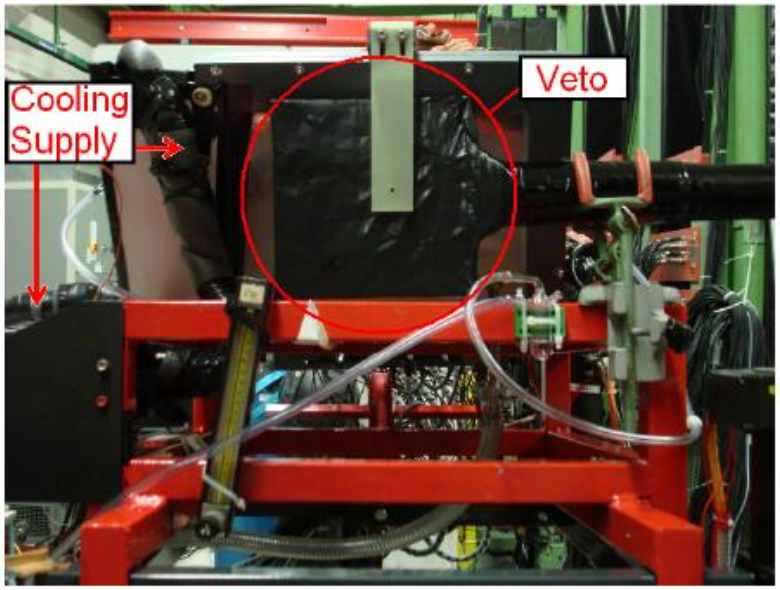


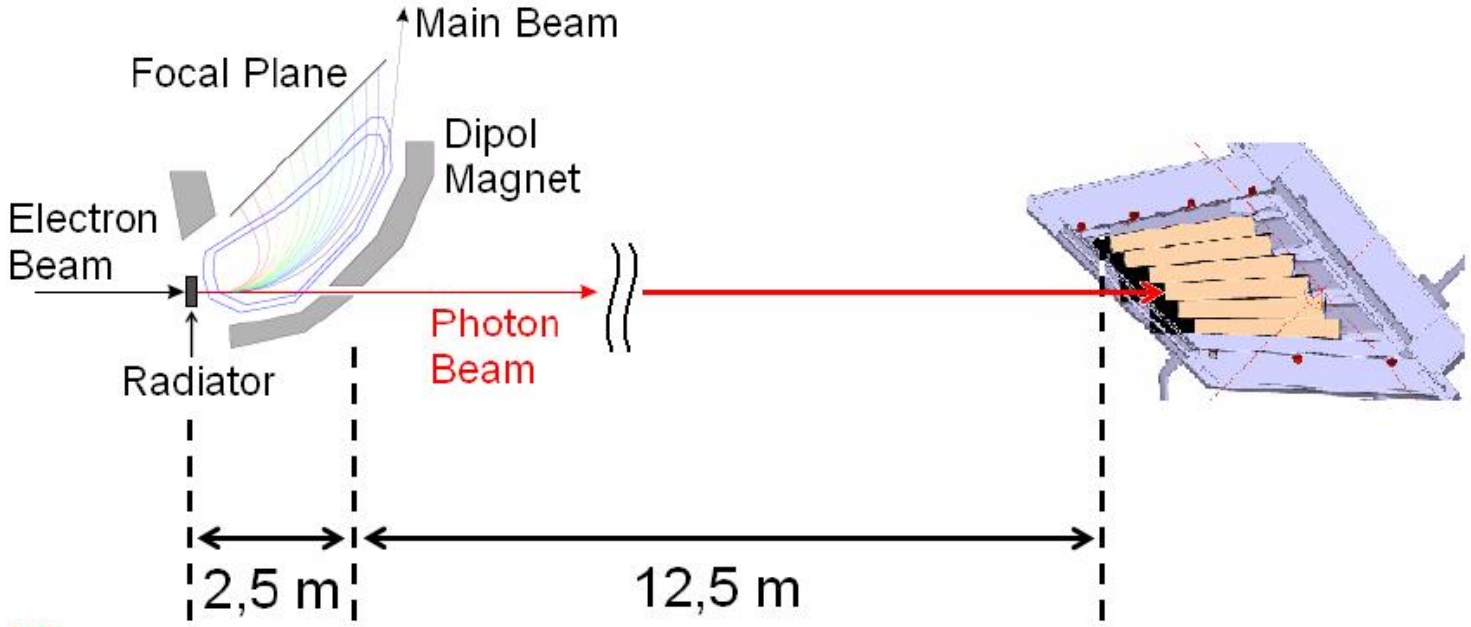

**Number of Combinations per event taken in the case of $\eta_c$ is: $C(N_{cluster},6)$**

**For $h_c$, the inv. mass is considered as the magnitude of the total 4-momenta of all clusters with: $N_{cluster}$ >=7 (per evt) & cluster thr. = 30 MeV**

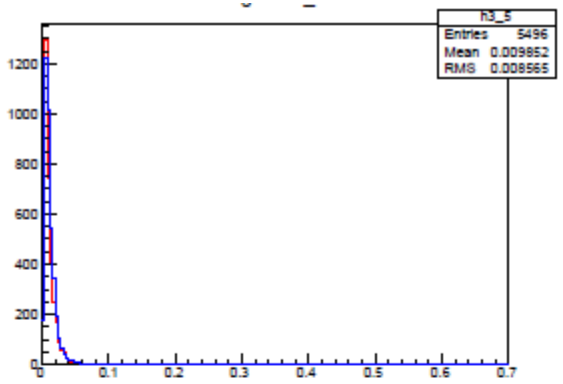
# PROTO60 Setup

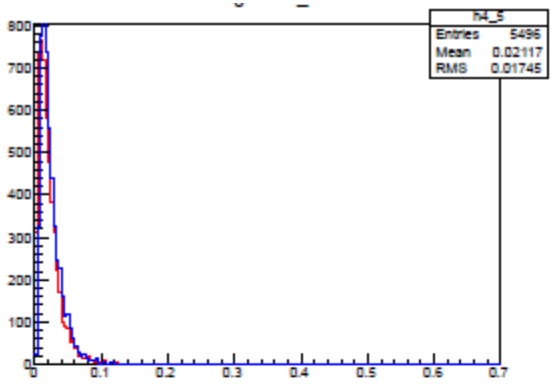


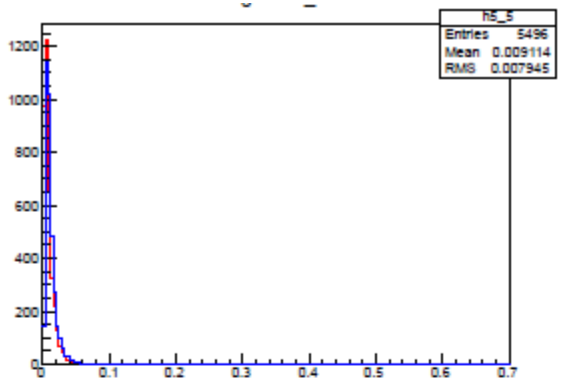



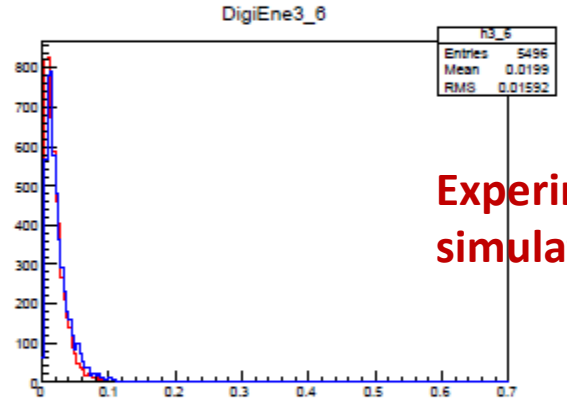



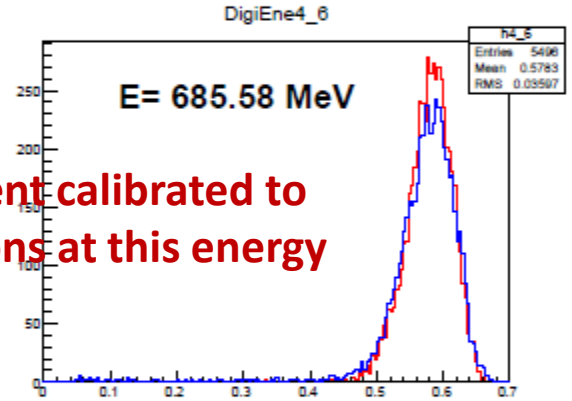
# Energy deposition spectra of the 9 crystals in 3x3 configuration



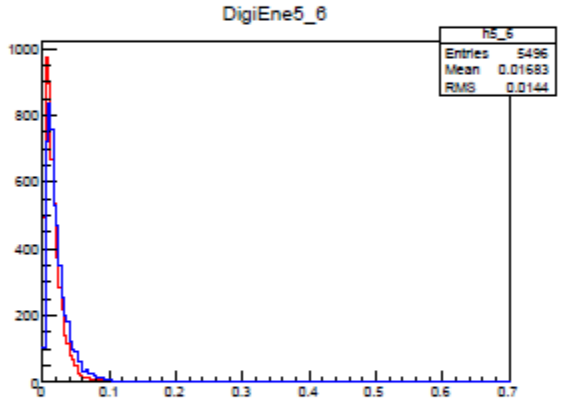



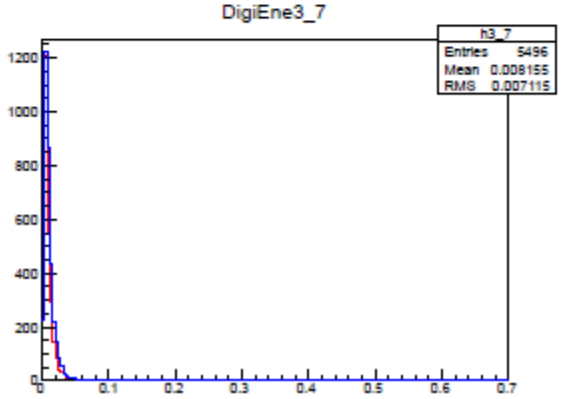



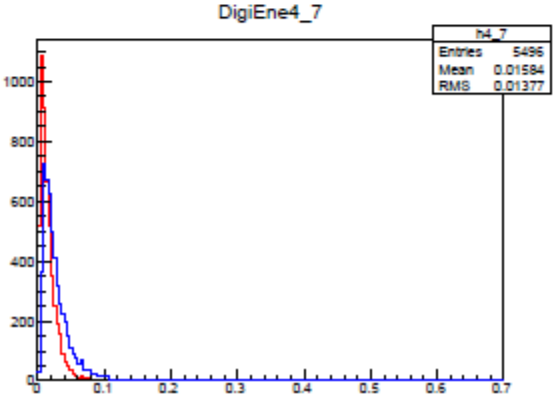



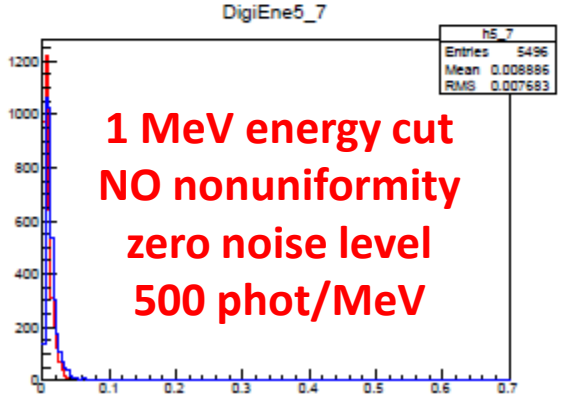




Experiment calibrated to simulations at this energy



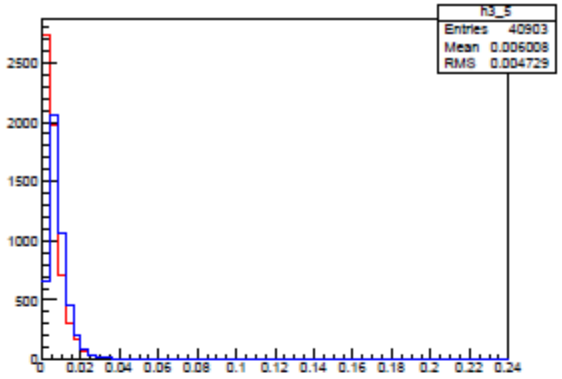



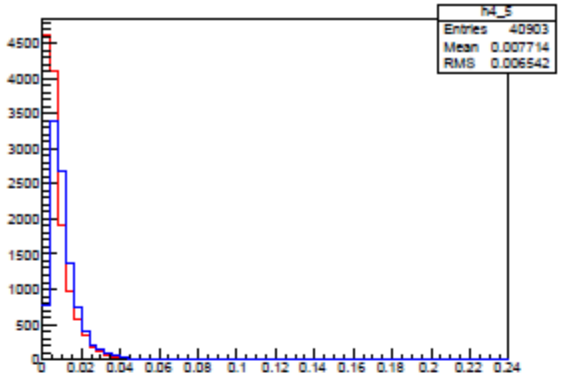



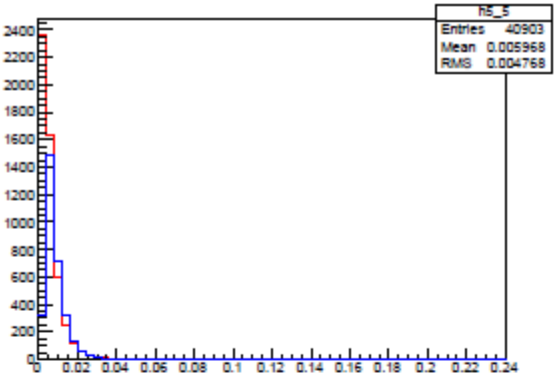




1 MeV energy cut
NO nonuniformity
zero noise level
500 phot/MeV

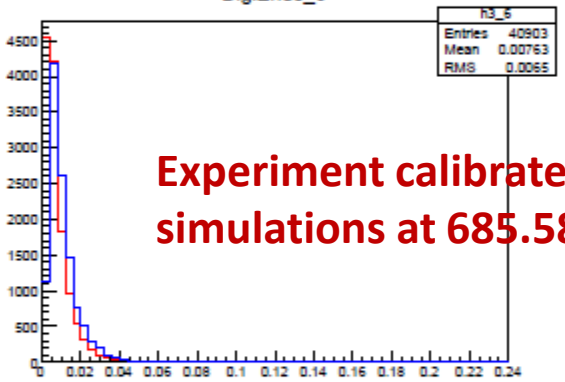
# Energy deposition spectra of the 9 crystals in 3x3 configuration



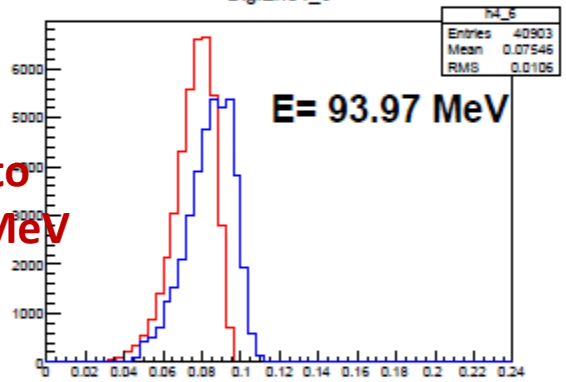




DigiEne3_6



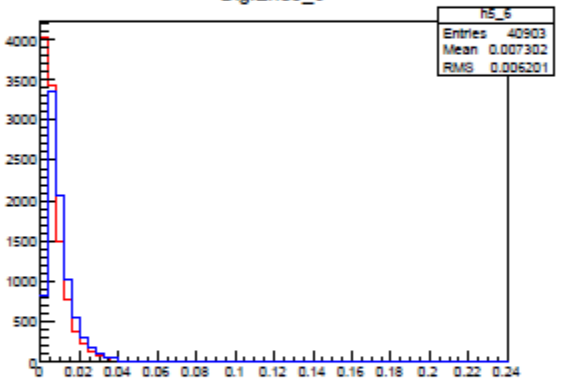

**Experiment calibrated to simulations at 685.58 MeV**

DigiEne4_6

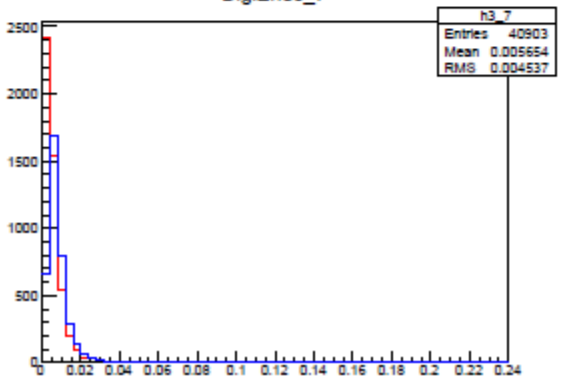



**E= 93.97 MeV**

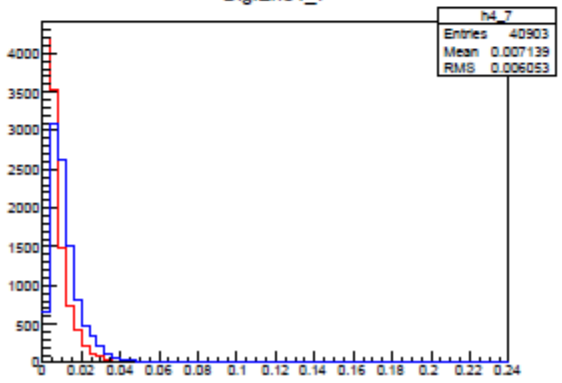
DigiEne5_6



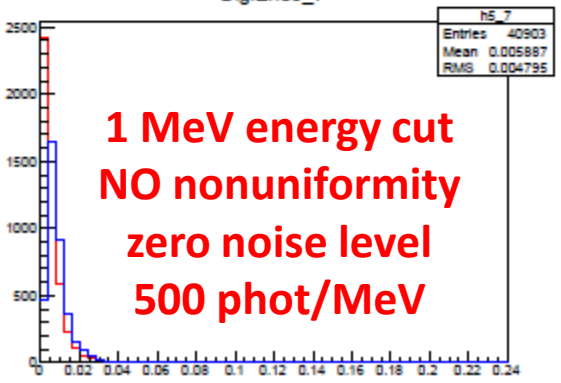

DigiEne3_7




DigiEne4_7




DigiEne5_7




**1 MeV energy cut**
**NO nonuniformity**
**zero noise level**
**500 phot/MeV**

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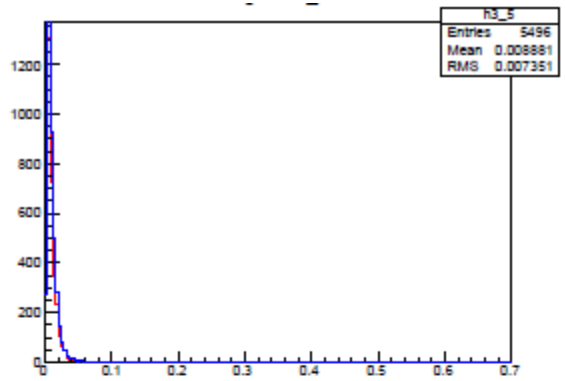
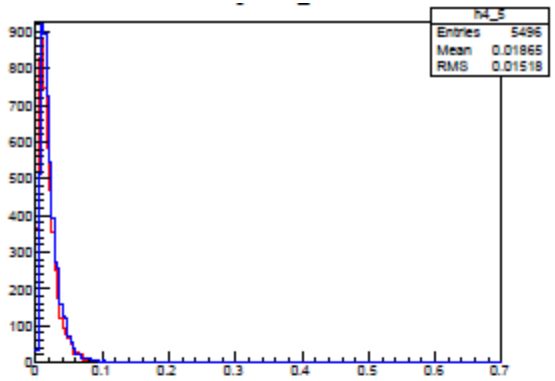
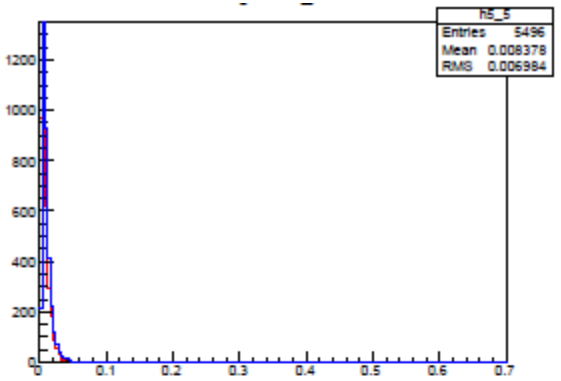
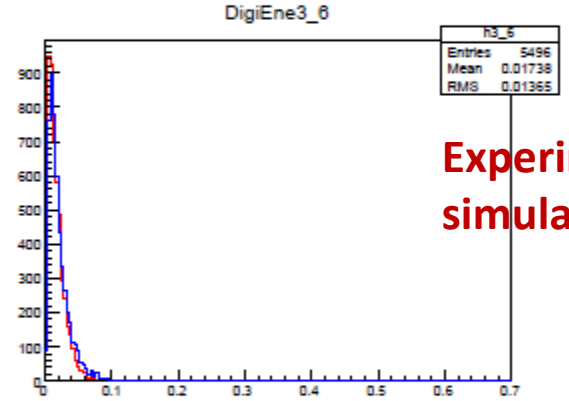
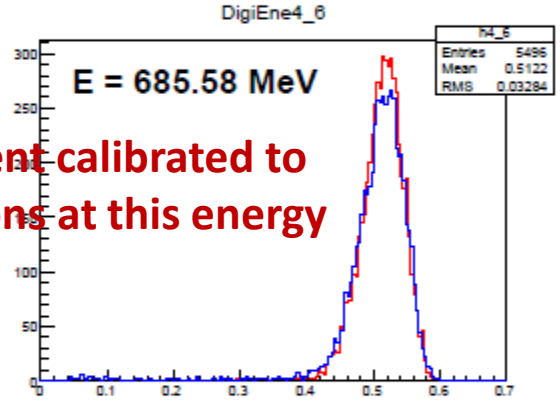
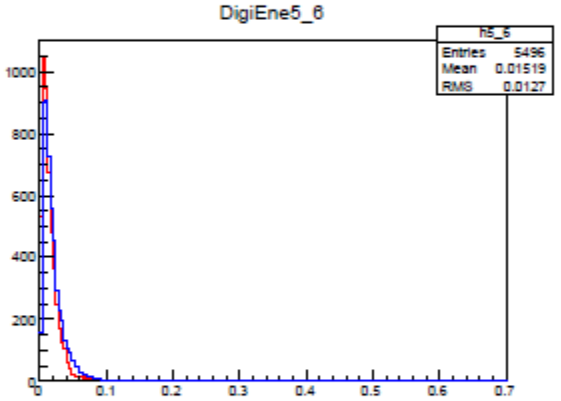


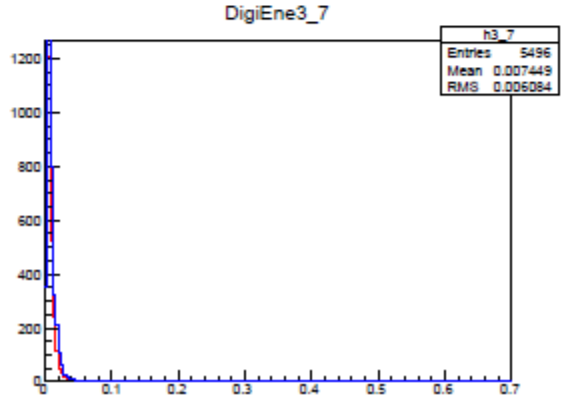



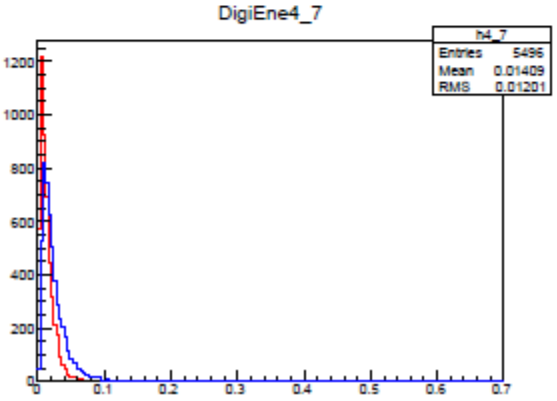



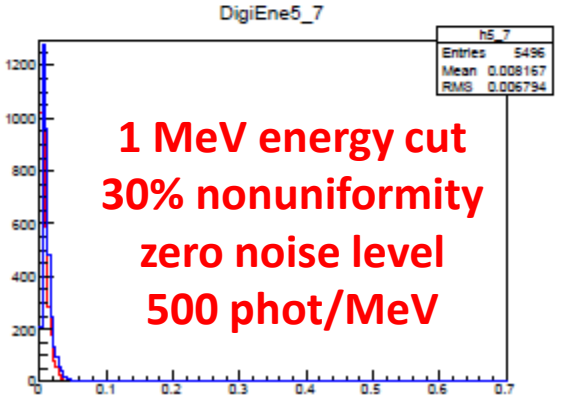




**Experiment calibrated to simulations at this energy**

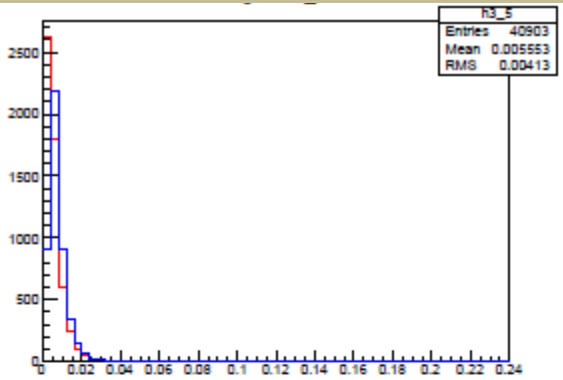


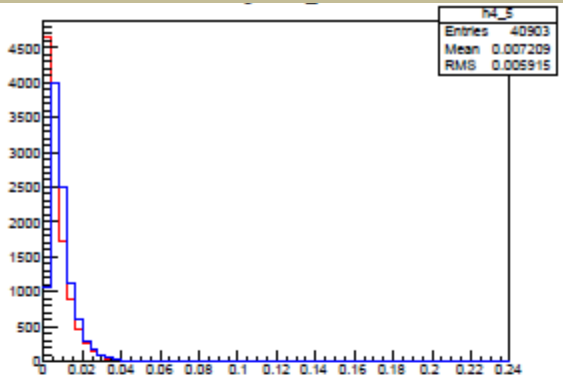



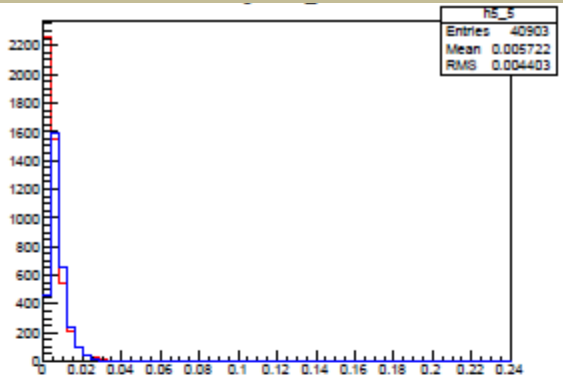



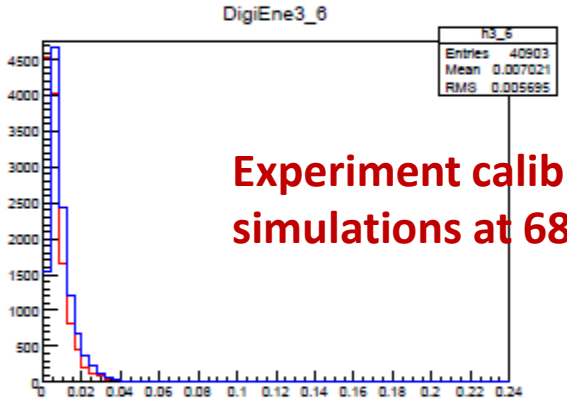

**1 MeV energy cut**
**30% nonuniformity**
**zero noise level**
**500 phot/MeV**

# Energy deposition spectra of the 9 crystals in 3x3 configuration

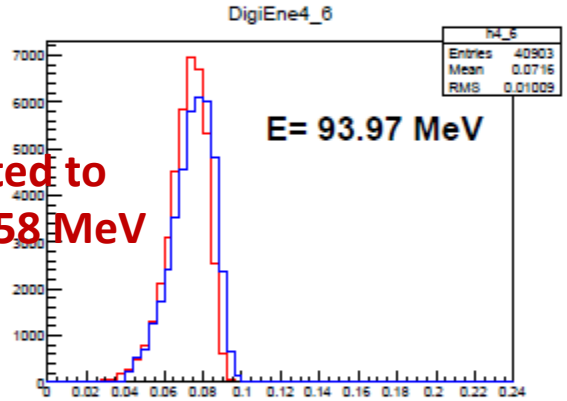


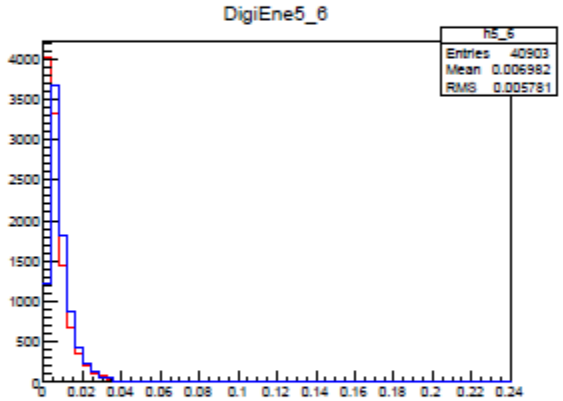



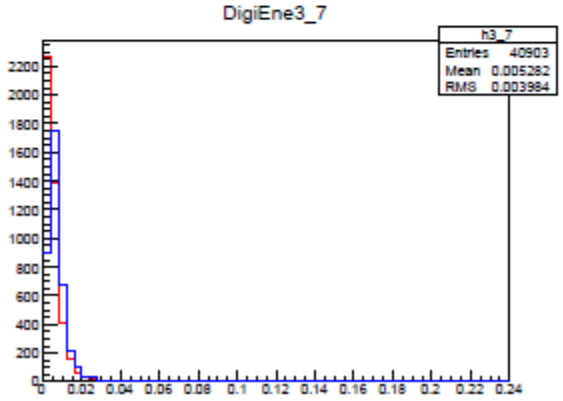



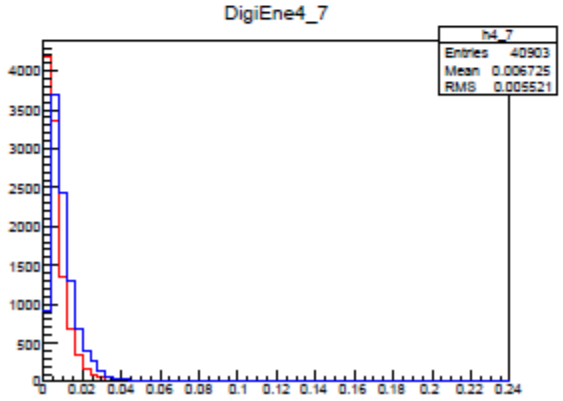

**Experiment calibrated to simulations at 685.58 MeV**

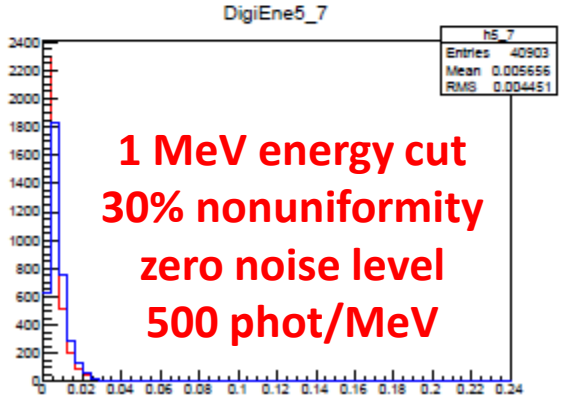



**E= 93.97 MeV**



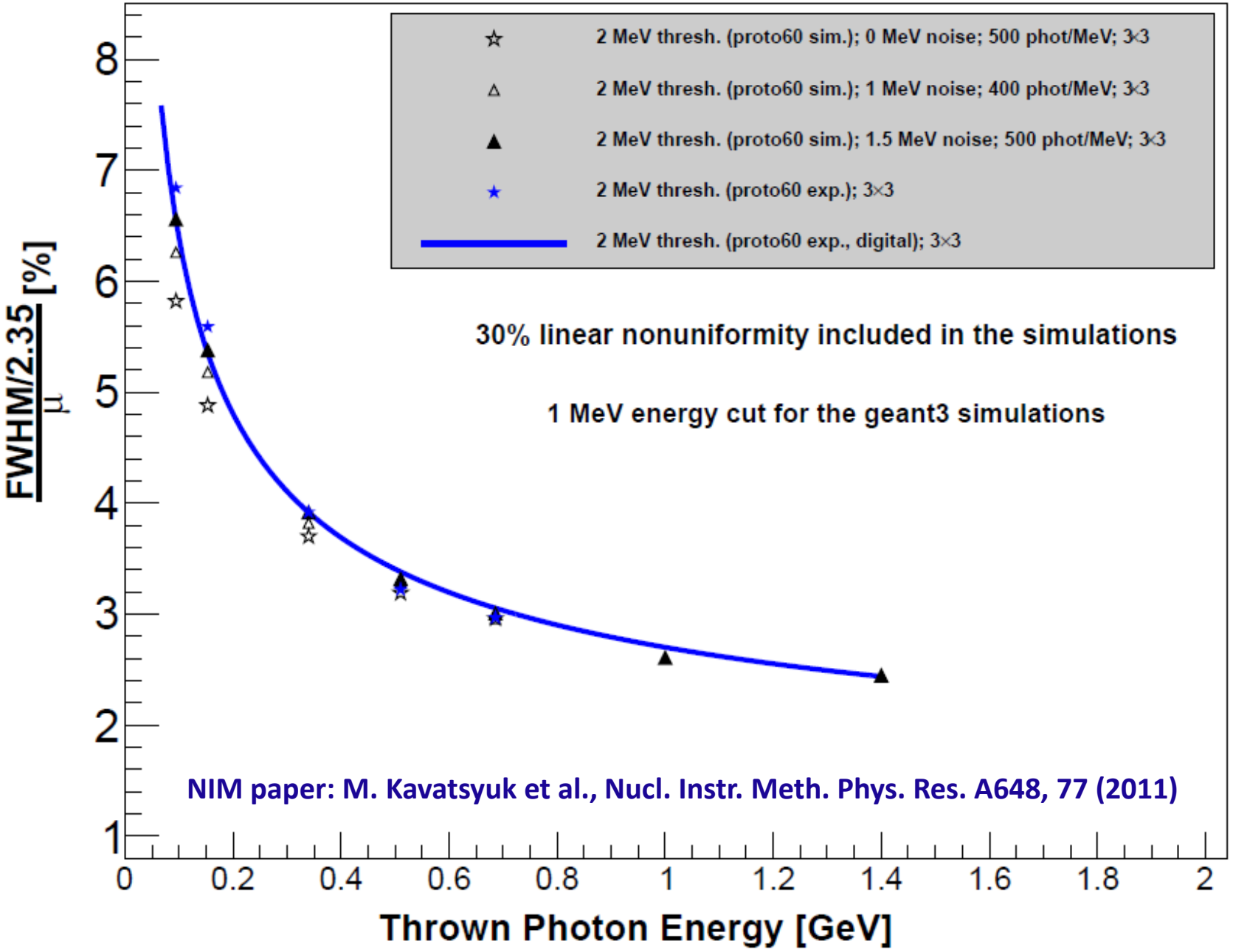




**1 MeV energy cut**
**30% nonuniformity**
**zero noise level**
**500 phot/MeV**

# Energy resolutions obtained using 3x3 crystal configuration

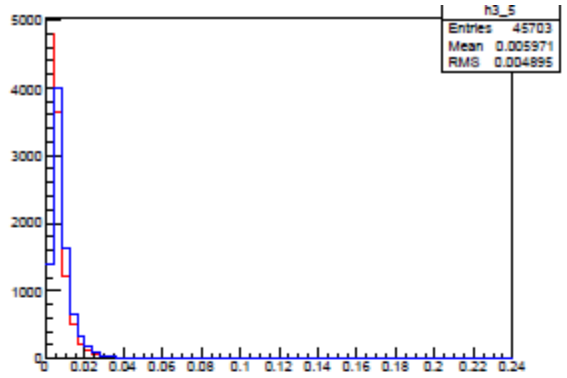


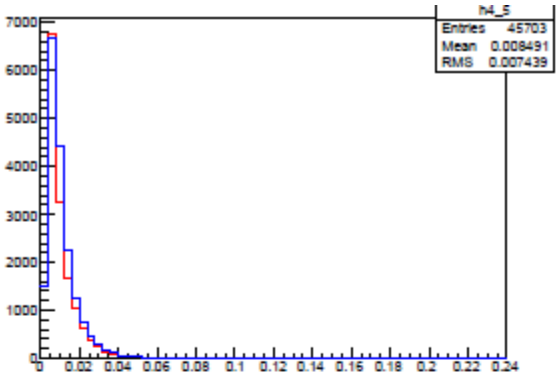

NIM paper: M. Kavatsyuk et al., Nucl. Instr. Meth. Phys. Res. A648, 77 (2011)

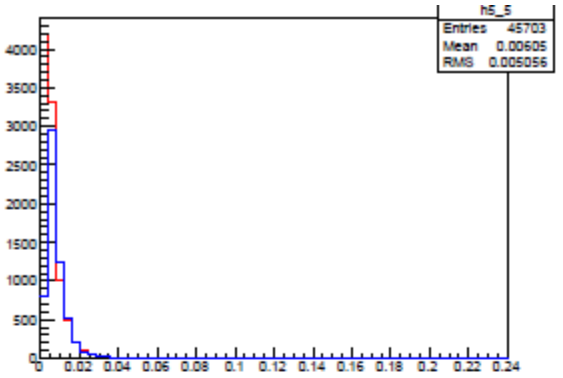
# Conclusions and Outlook

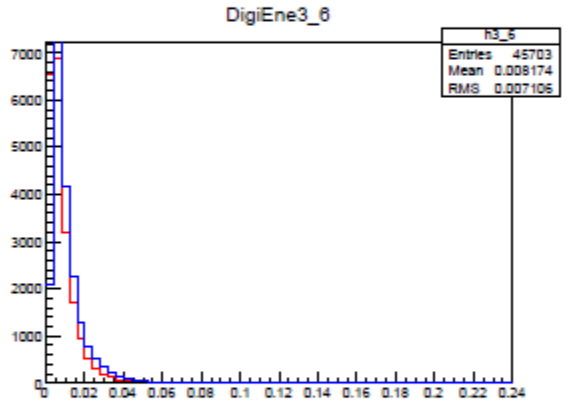
- Geometry of the EMC forward end-cap updated (implemented in release nov11)
- Parameters for Barrel EMC validated and optimized up till 1.4 GeV (to be updated in PandaRoot asap)
- Yet to be performed: validation of the simulations for higher energies; updating the energy calibration map; physics benchmark channels

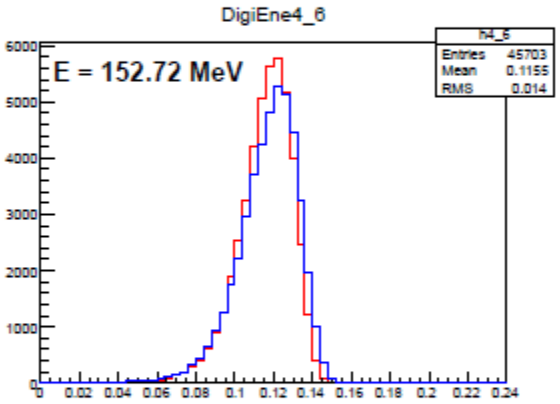
# Energy deposition spectra of the 9 crystals in 3x3 configuration

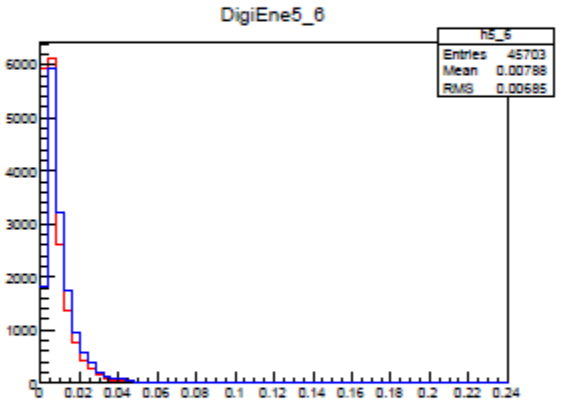


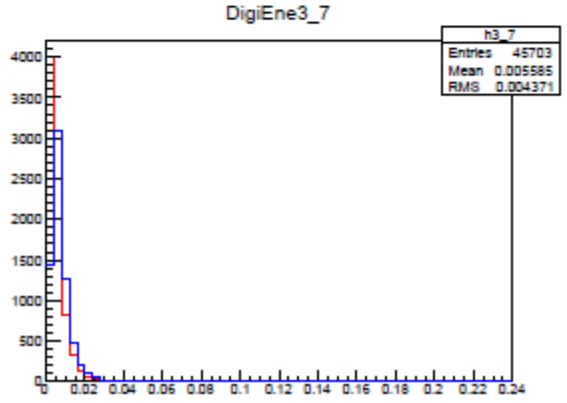



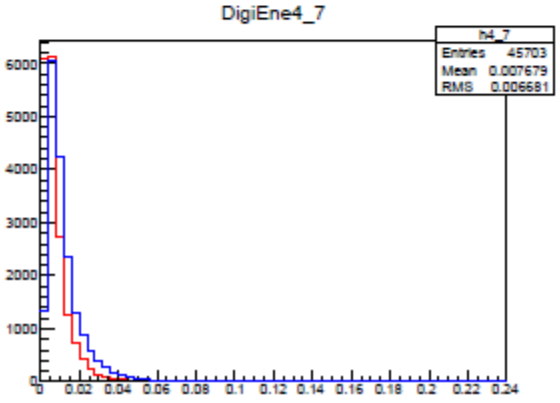



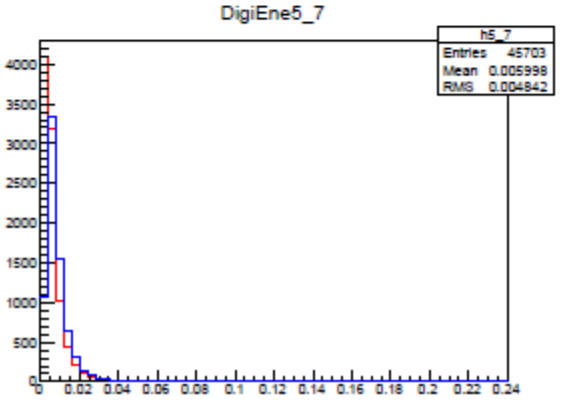



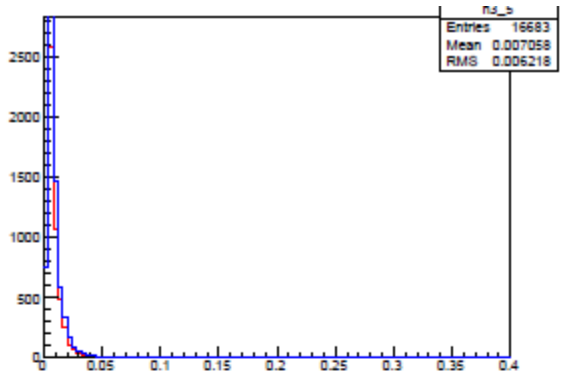



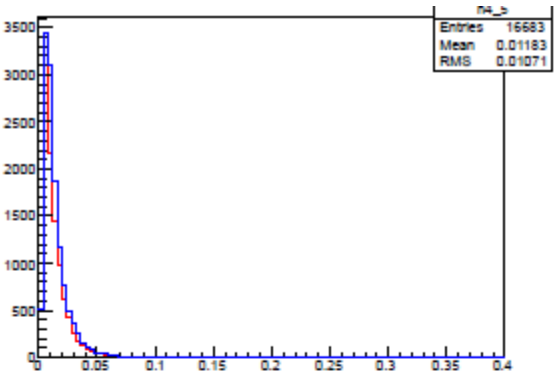



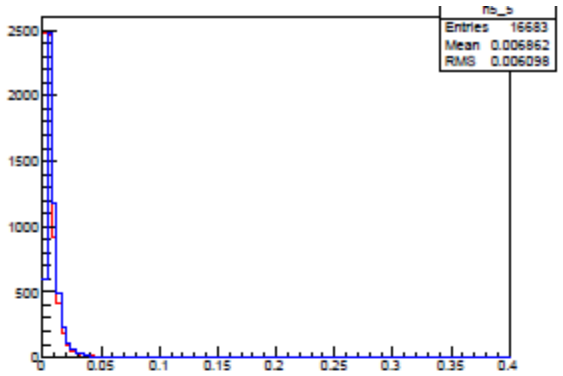



# Energy deposition spectra of the 9 crystals in 3x3 configuration

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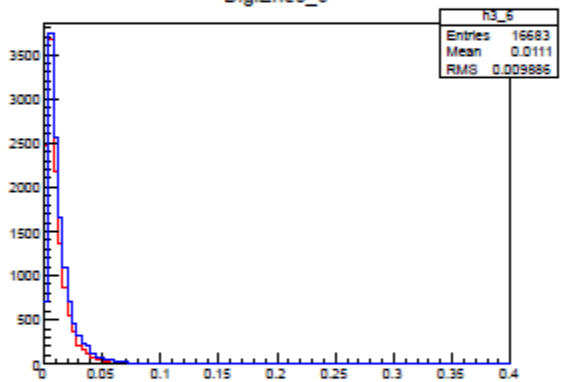


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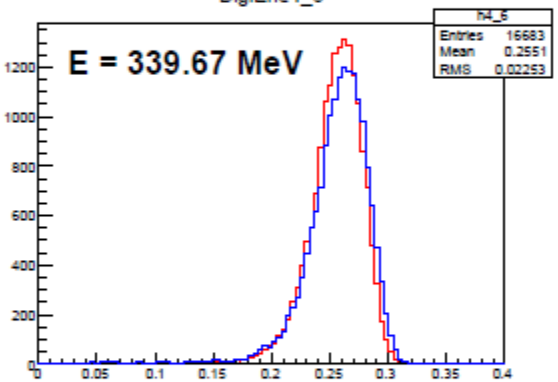


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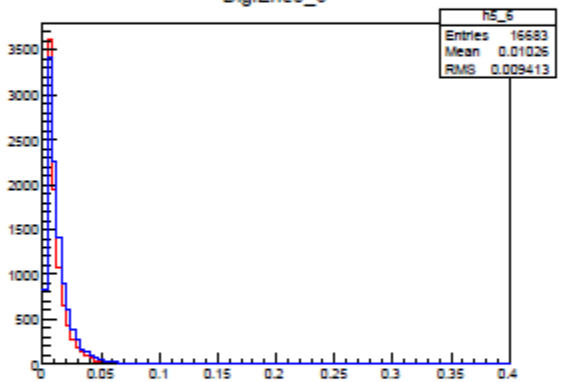


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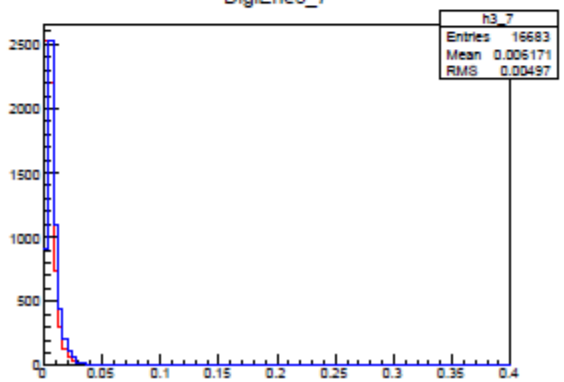


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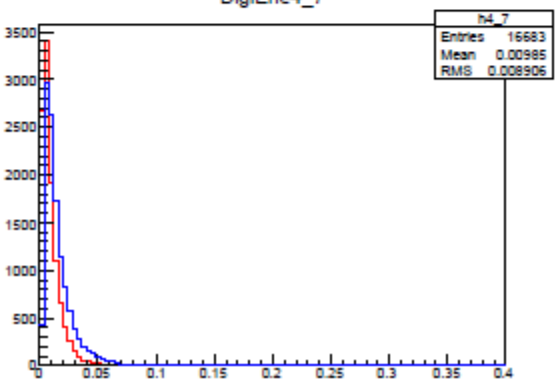


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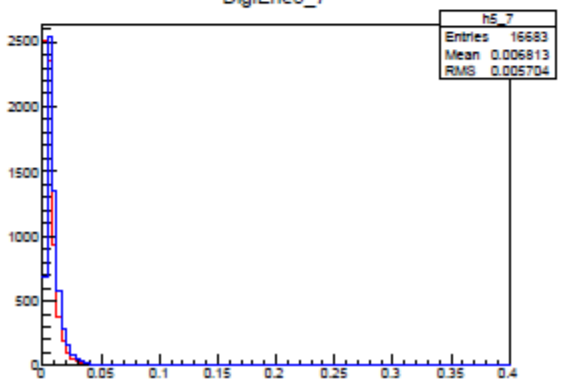

# Energy deposition spectra of the 9 crystals in 3x3 configuration