# Simulation Statistics

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Under the guidance of Dr. Ankhi Roy

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IIT Indore

# Contents

Histograms for energy resolution of detectors by applying manual clustering, 100 MeV energy cut on aggregate towers and incorporating slice-wise calibration, for the following detector-particle pairs:

- Electron: CEMC, EEMC, FEMC

tphi : tower $\phi$, ttheta : tower $\theta$, $te_{agg}$: tower energies aggregated in an event
gphi : generated $\phi$, gtheta : generated $\theta$,  ge: generated energy

# Simulation Parameters

- Particles: $e^-$
- Events: 150,000 $e^-$ (100,000 → 0-30 GeV/c, 50,000 → 0-2 GeV/c)
- momentum (p): 0 to 30 GeV/c
- Pseudorapidity (η): -4 to 4
- Azimuth (Φ): -$\pi$ to $\pi$

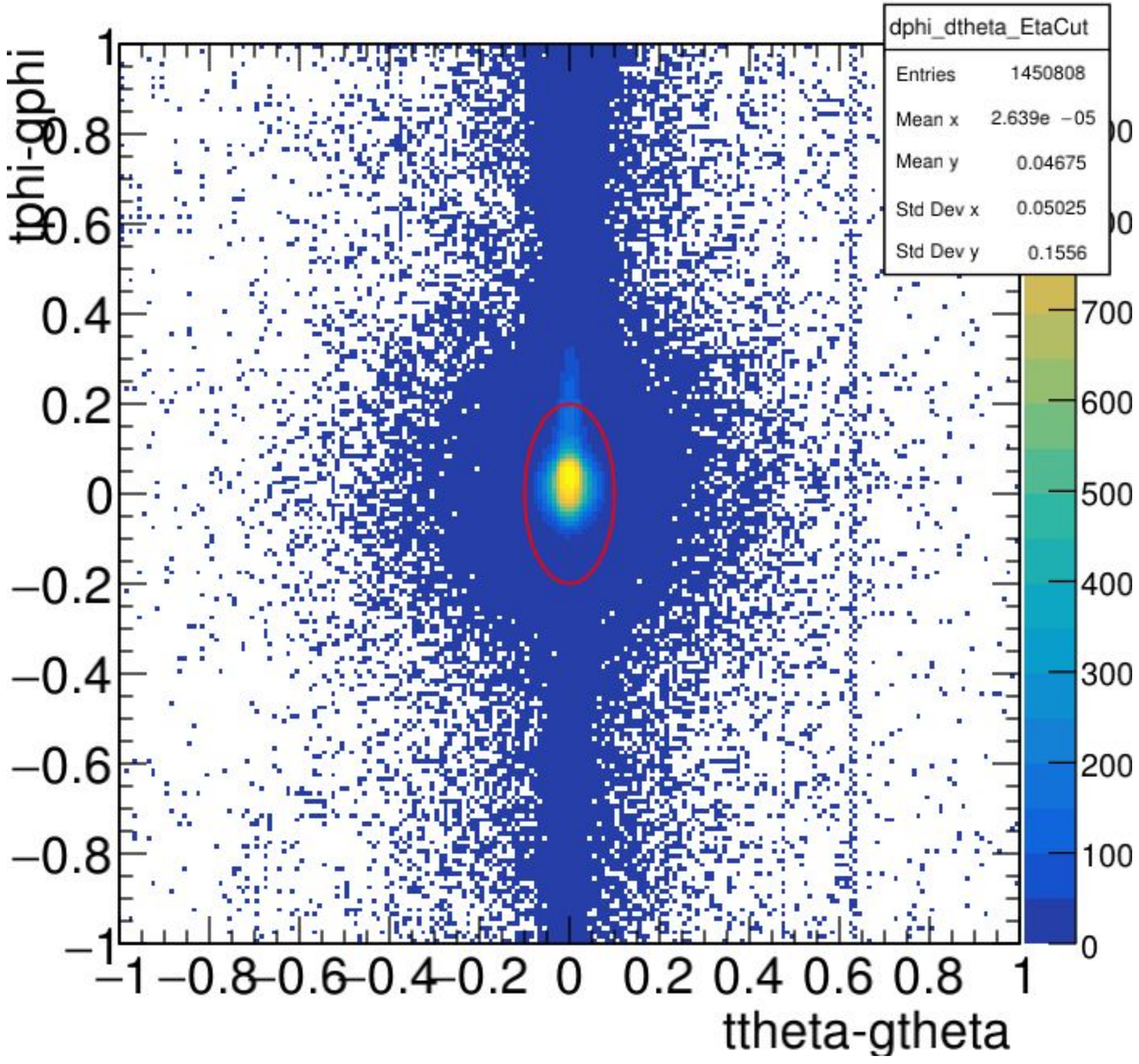
## Cuts:

- Detector-wise η cuts
- Detector-wise Elliptical cuts in dphi vs dtheta plots
- Energy cut on aggregated Towers (100 MeV)

# CEMC ($e^-$)

# CEMC ($e^-$)

Elliptical cut on dphi vs dtheta, Explicit η cut: -1.5 to 1.2, 100 MeV Energy Cut



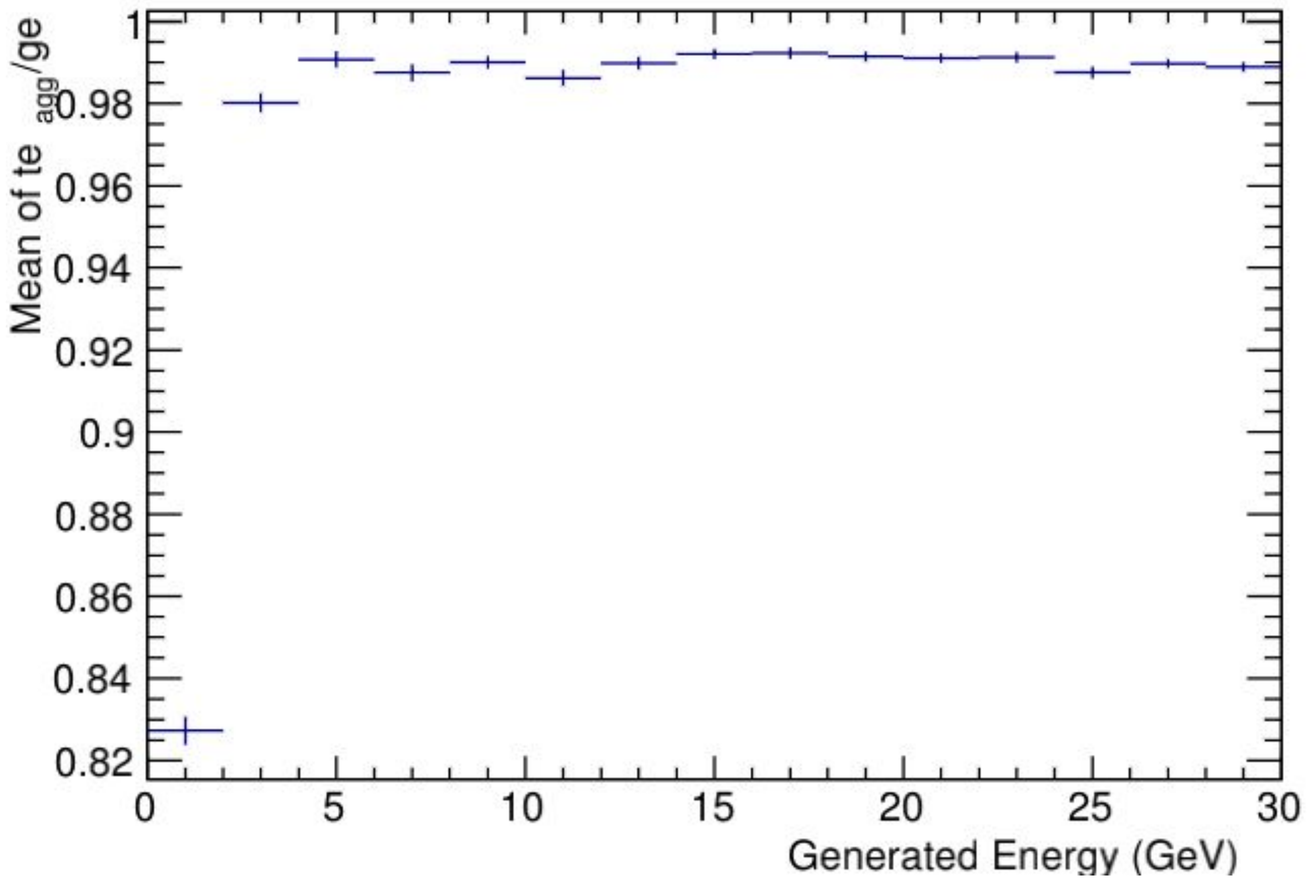

**Elliptical Cut:** Only the towers within the elliptical region (centered at origin) are considered for further analysis.

**Dimensions:**

semi-minor axis = 0.10 units
semi-major axis = 0.20 units

# CEMC ($e^-$)

Elliptical cut on dphi vs dtheta
Explicit η cut: -1.5 to 1.2
100 MeV Energy Cut



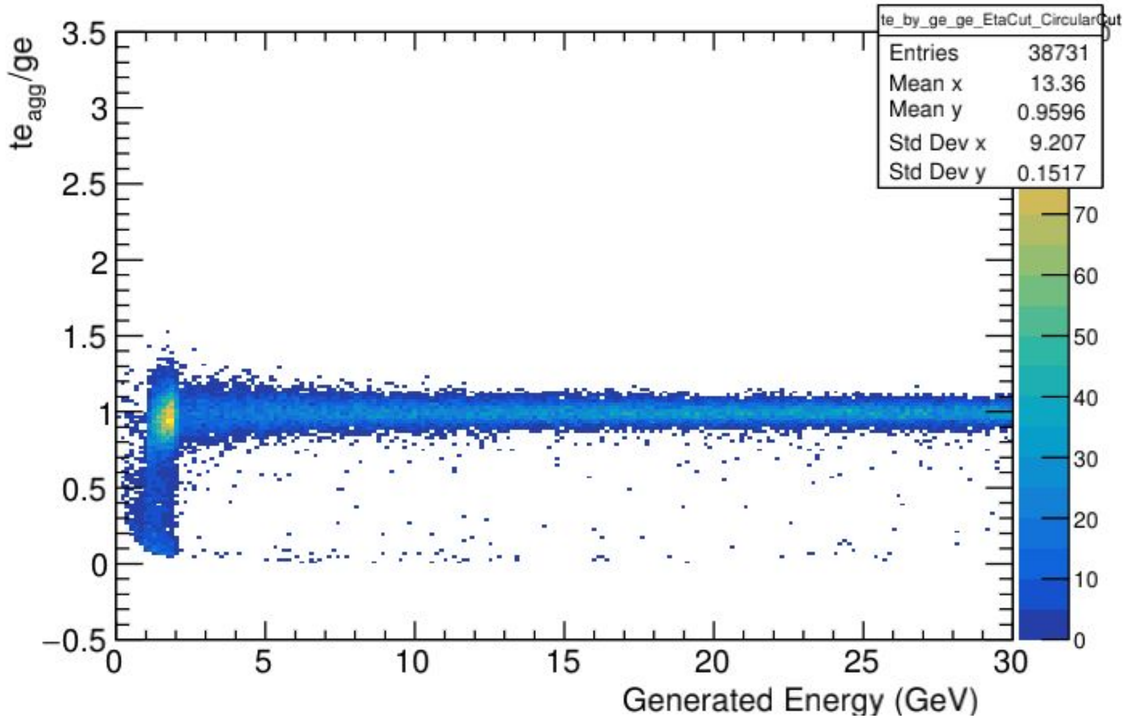

Each slice of $(te_{agg}-ge)/ge$ vs ge plot will be calibrated on the basis of dividing by a calibration factor which equals to the Mean of $te_{agg}/ge$ corresponding to that particular slice in this plot.

*The calibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum.

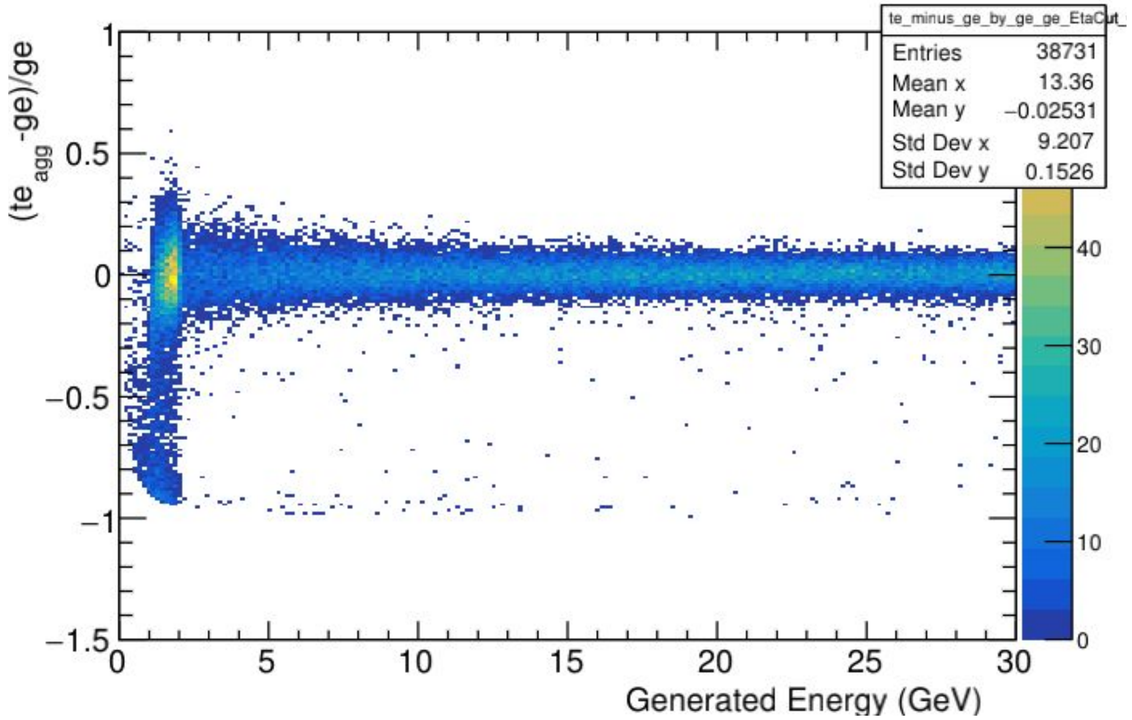
calibrationFactor of first slice = 0.96

# CEMC ($e^-$)

($te_{agg}$-ge)/ge vs ge
Explicit η cut: -1.5 to 1.2
100 MeV Energy Cut

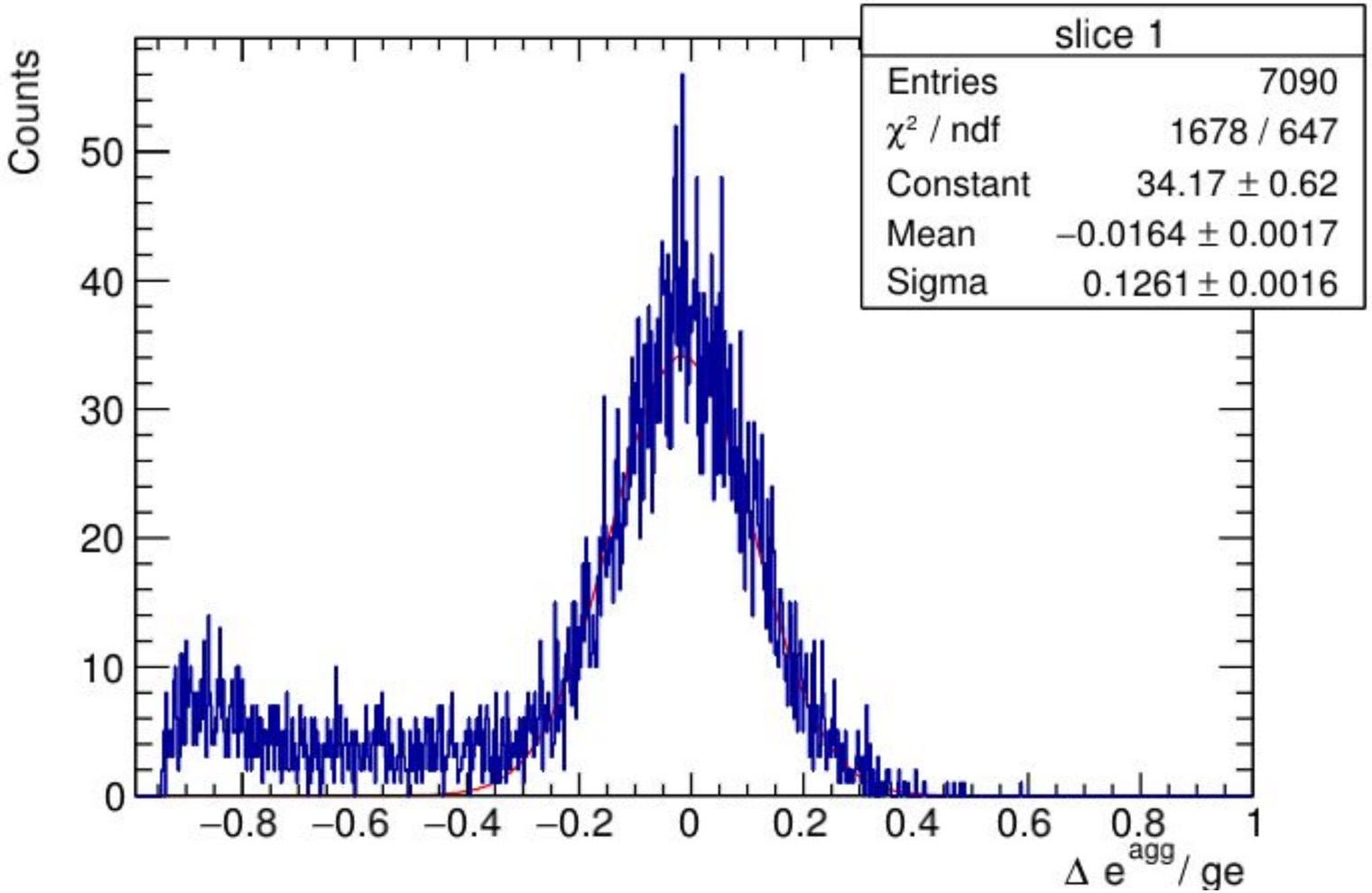



**After calibration** (te → te/calibrationFactor)



# CEMC ($e^-$)

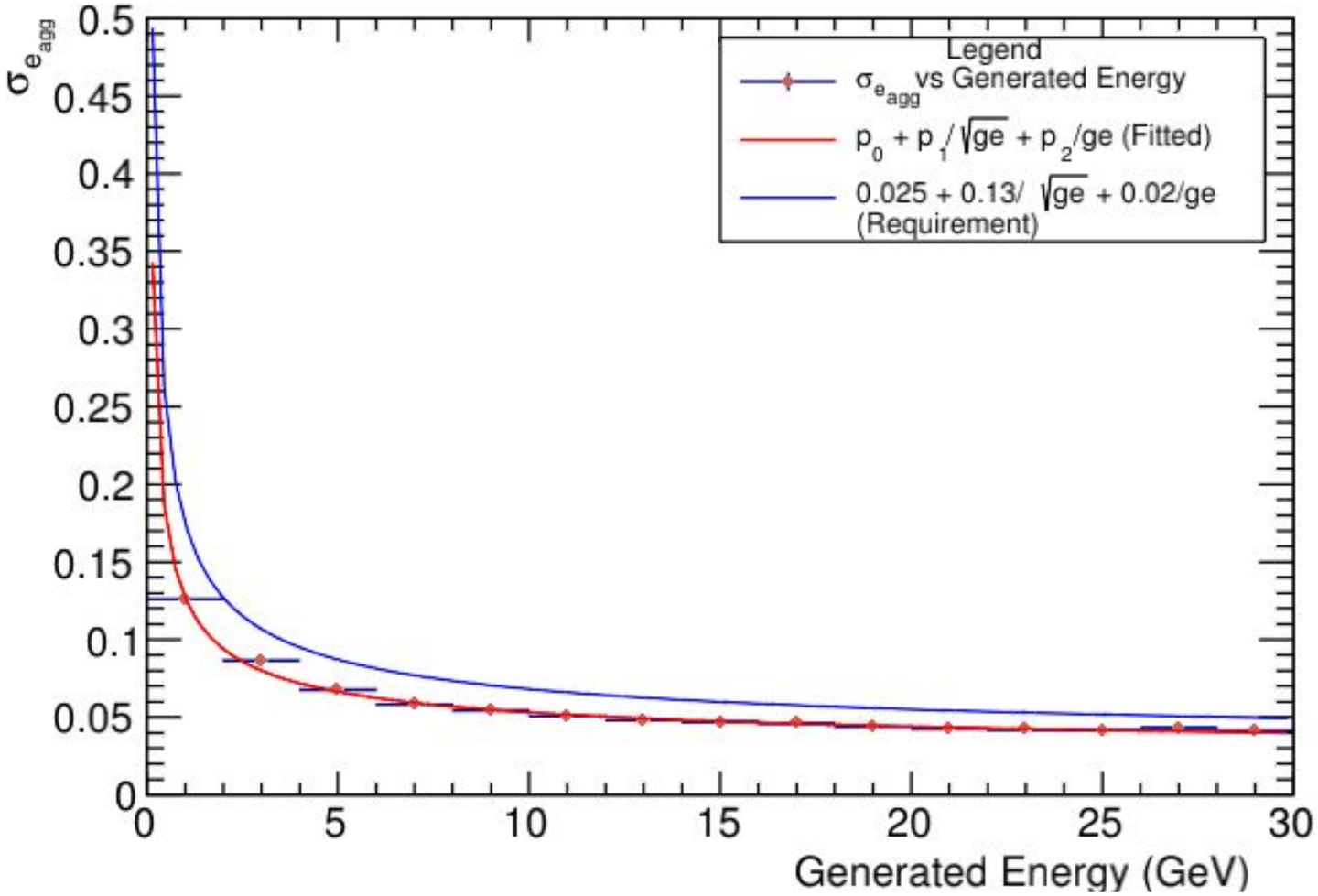
($te_{agg}$-ge)/ge vs ge
Gaussian fit of the first slice (0-2 GeV)




Number of bins = 1000 from -0.99 to +1.0

# CEMC ($e^-$)

$\sigma_e_{agg}$ vs ge
Explicit η cut: -1.5 to 1.2
Elliptical Cut
100 MeV Energy Cut



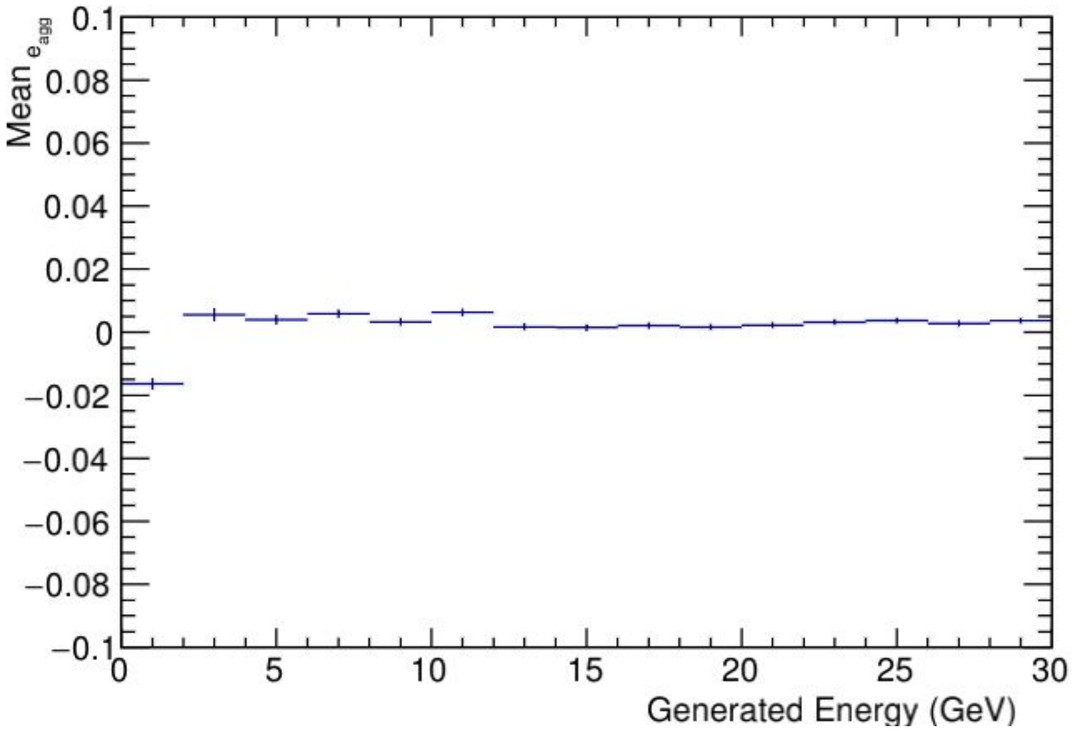

σe refers to the standard deviation of the Gaussian fitted to a slice of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.
(shown on slide 7)

Number of bins = 15
Bin Width = 2 GeV

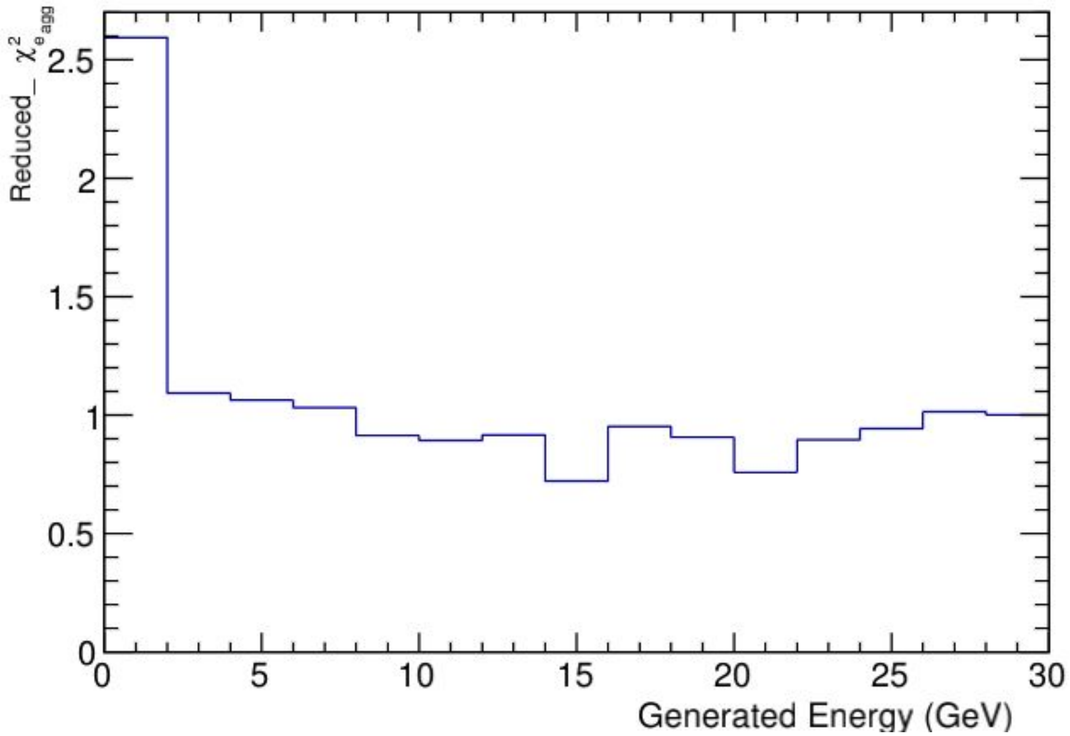
**Fit Parameters:**
$p_o$ = (0.0228119 +- 0.00130113)
$p_1$ = ( 0.0919356 +- 0.00676757) $GeV^{0.5}$
$p_2$ = (0.0123408 +- 0.00619618) GeV

# CEMC ($e^-$)

Explicit η cut: -1.5 to 1.2
Elliptical cut, 100 MeV Energy cut



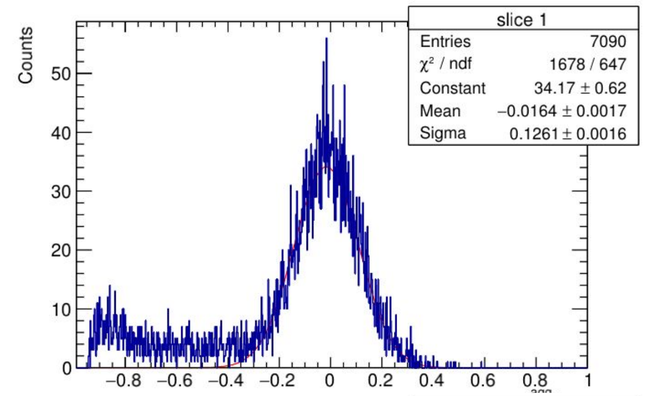

Mean of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

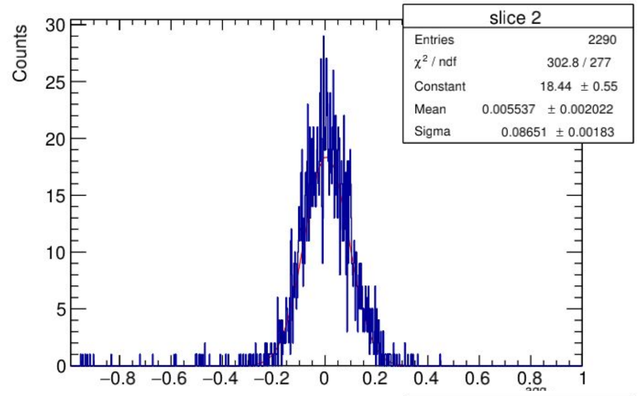


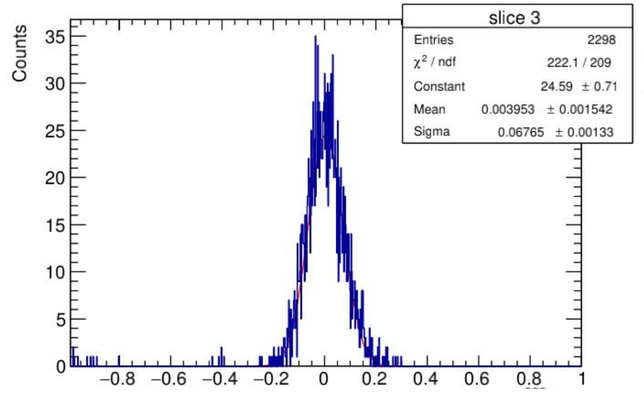

Reduced_χ2 of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

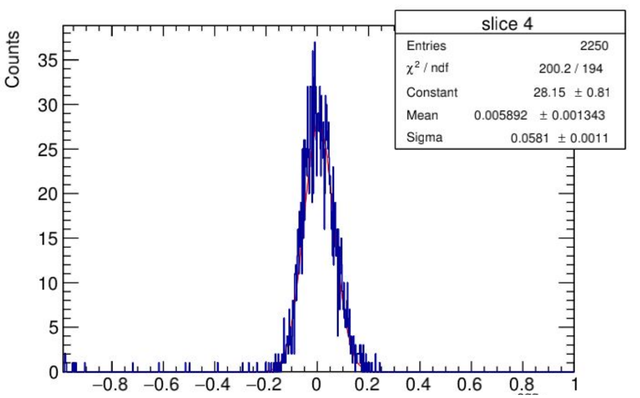
# CEMC ($e^-$)

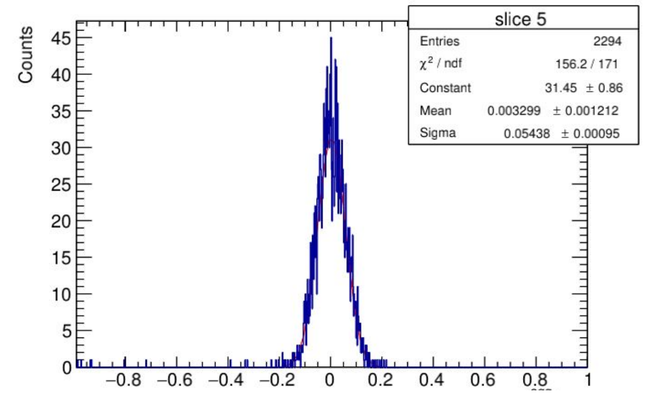
## Fitted Gaussians

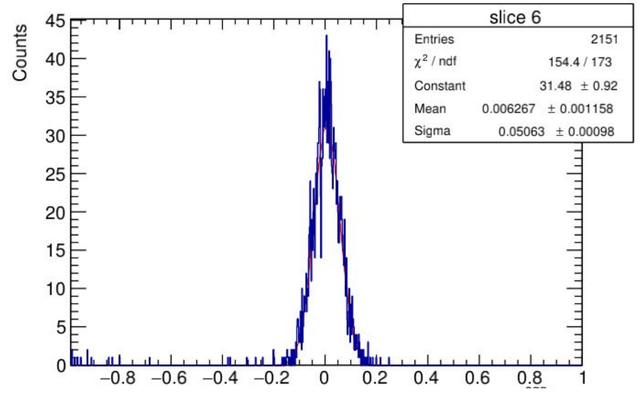


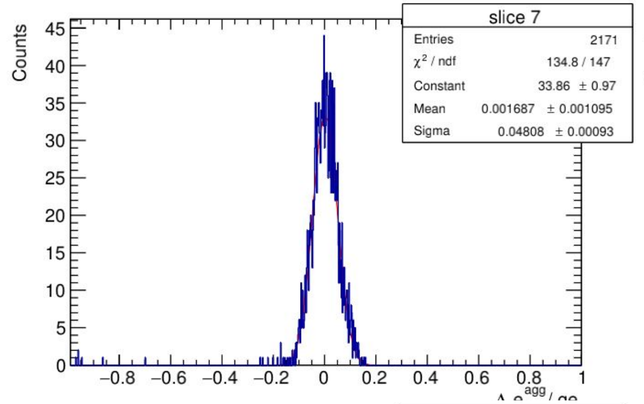



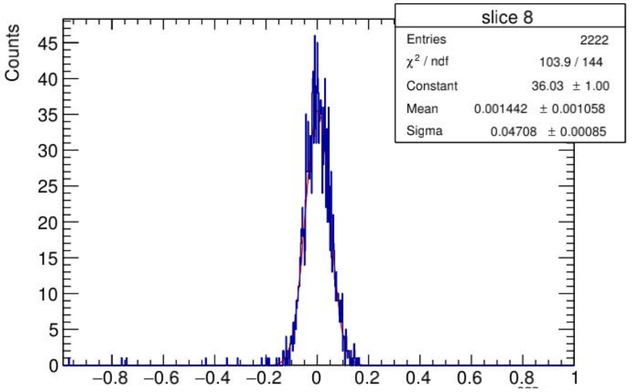



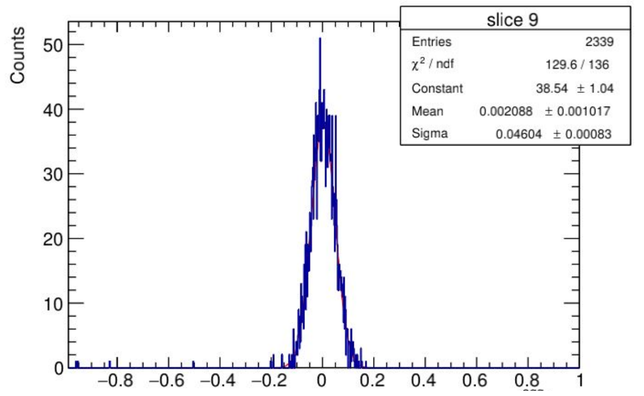



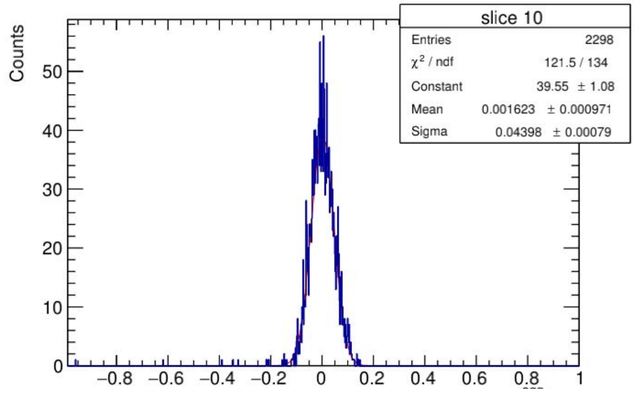



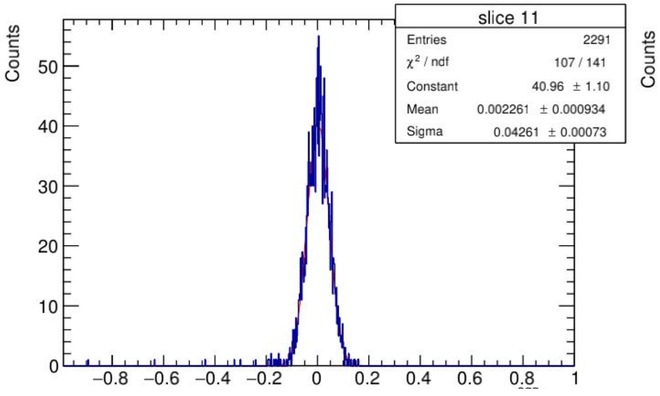



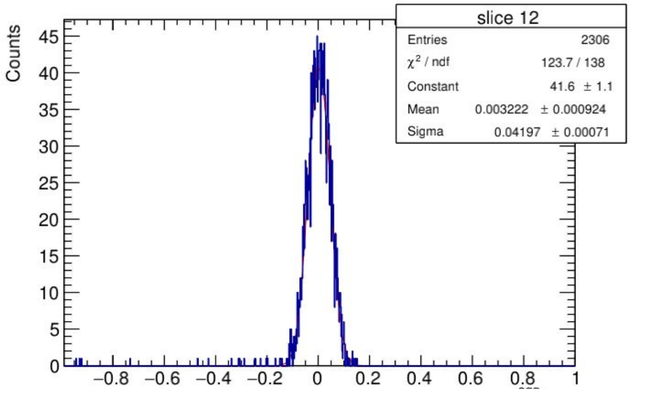



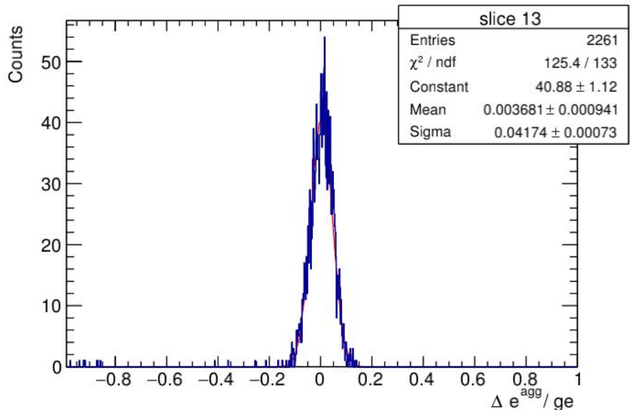



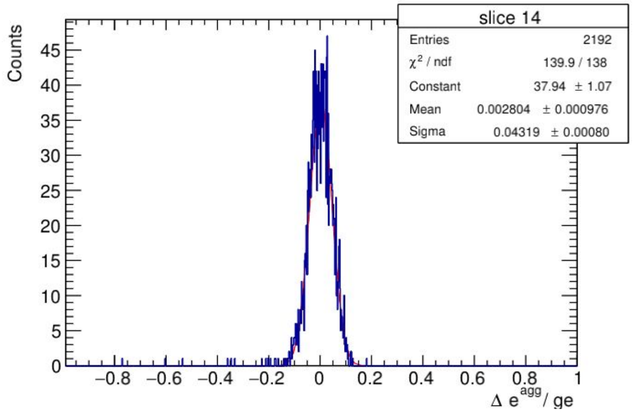



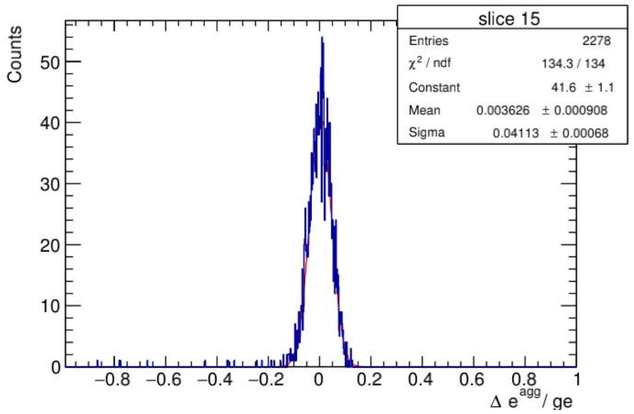

The x-axes denote $\Delta e_{agg}/ge$

# CEMC ($e^-$)

## Fitted Gaussians




The x-axes denote $\Delta e_{agg}/ge$

# EEMC ($e^-$)

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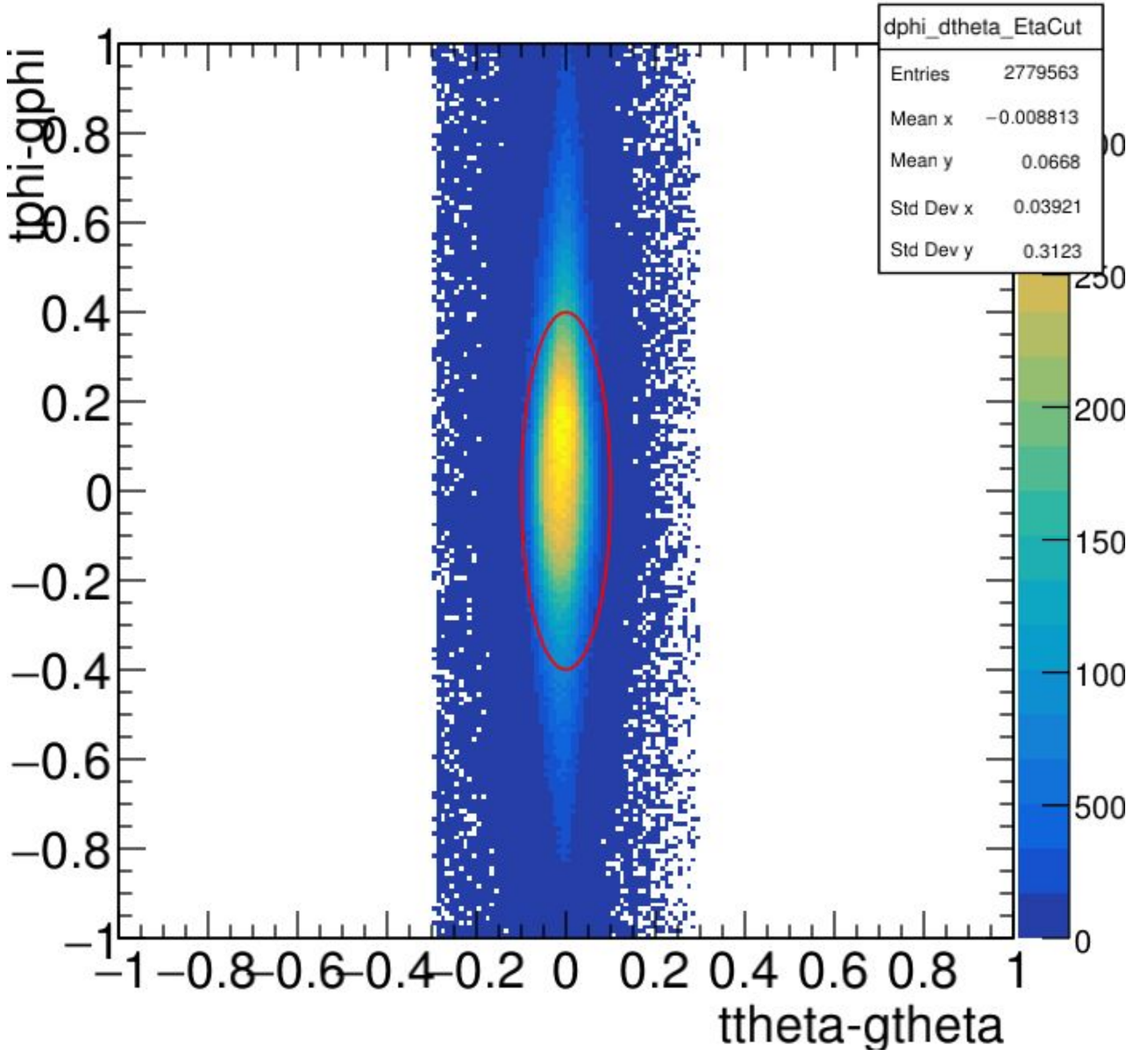
Elliptical cut on dphi vs dtheta, Explicit η cut: -3.5 to -1.7, 100 MeV



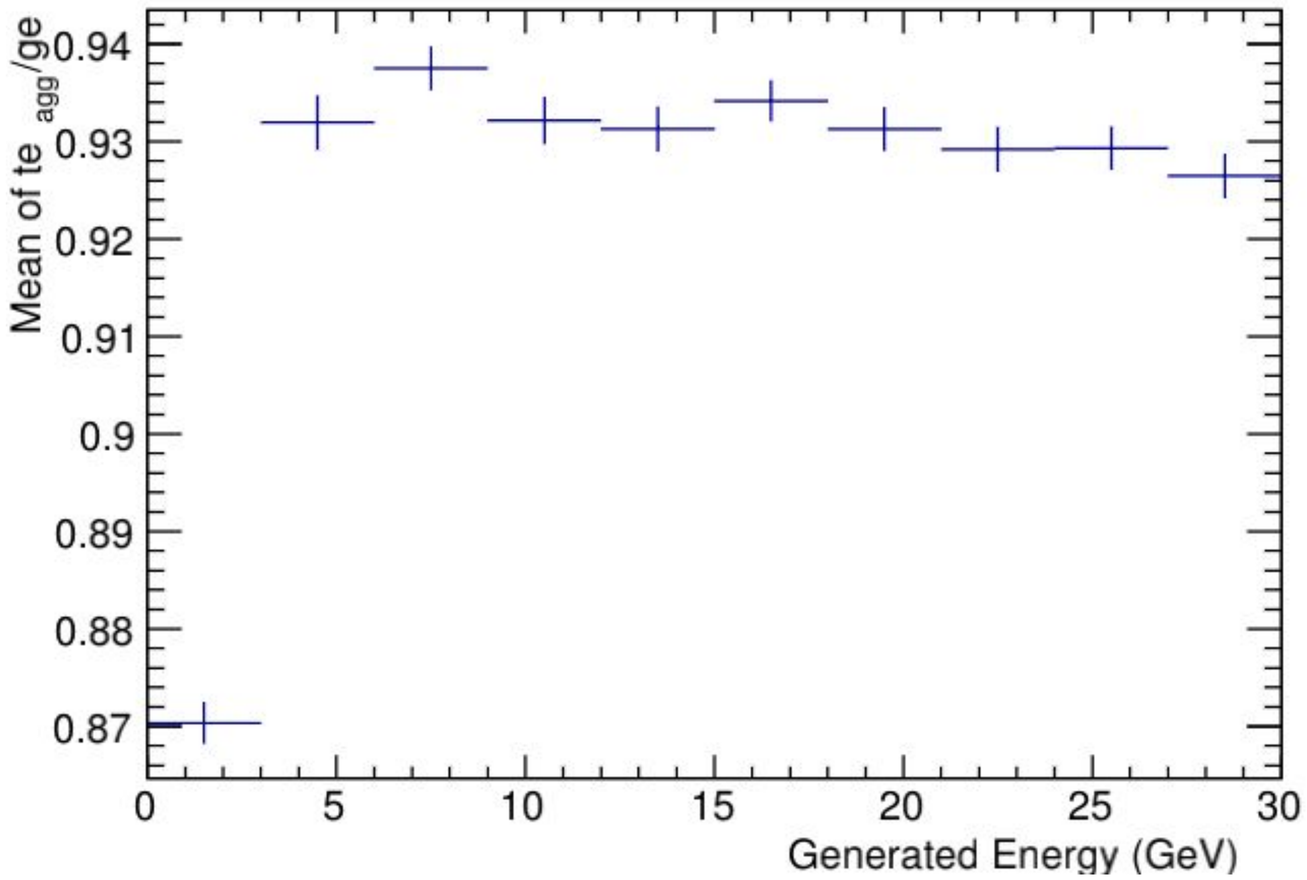

**Elliptical Cut:** Only the towers within the elliptical region (centered at origin) are considered for further analysis.

**Dimensions:**

semi-minor axis = 0.10 units
semi-major axis = 0.40 units

# EEMC ($e^-$)

Elliptical cut on dphi vs dtheta
Explicit η cut: -3.5 to -1.7
100 MeV Energy Cut




(te → te/calibrationFactor)

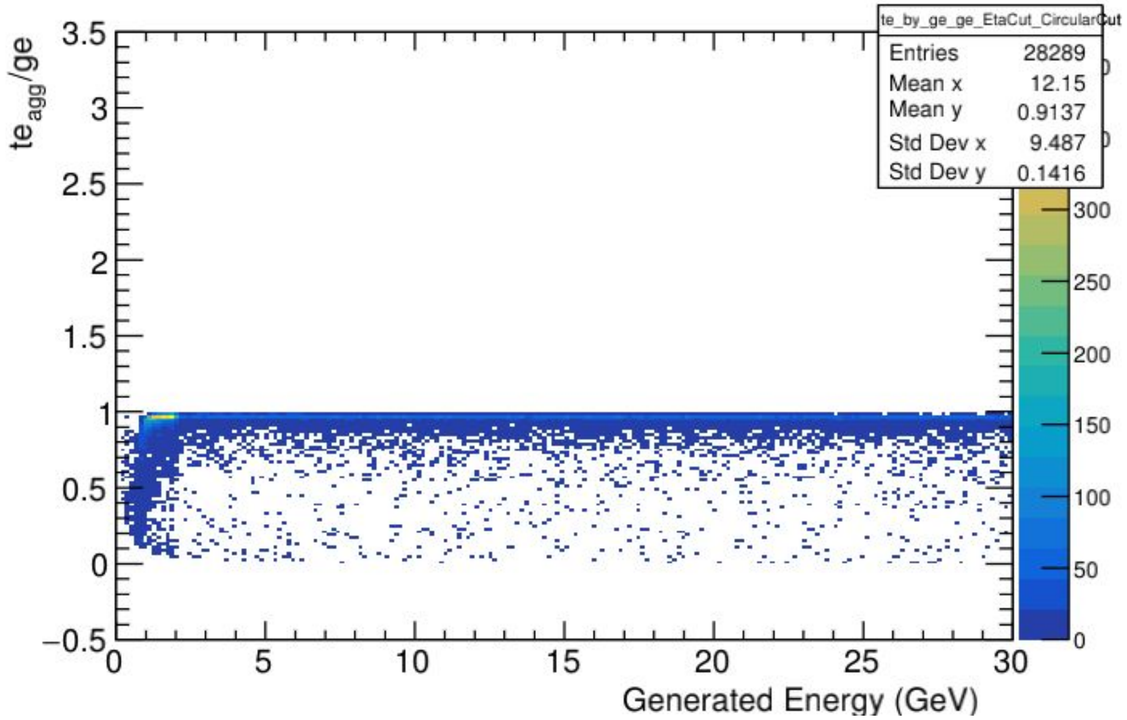
Each slice of $(te_{agg}\text{-}ge)/ge$ vs ge plot will be calibrated on the basis of dividing by a calibration factor which equals to the Mean of $te_{agg}/ge$ corresponding to that particular slice in this plot.

*The calibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum.

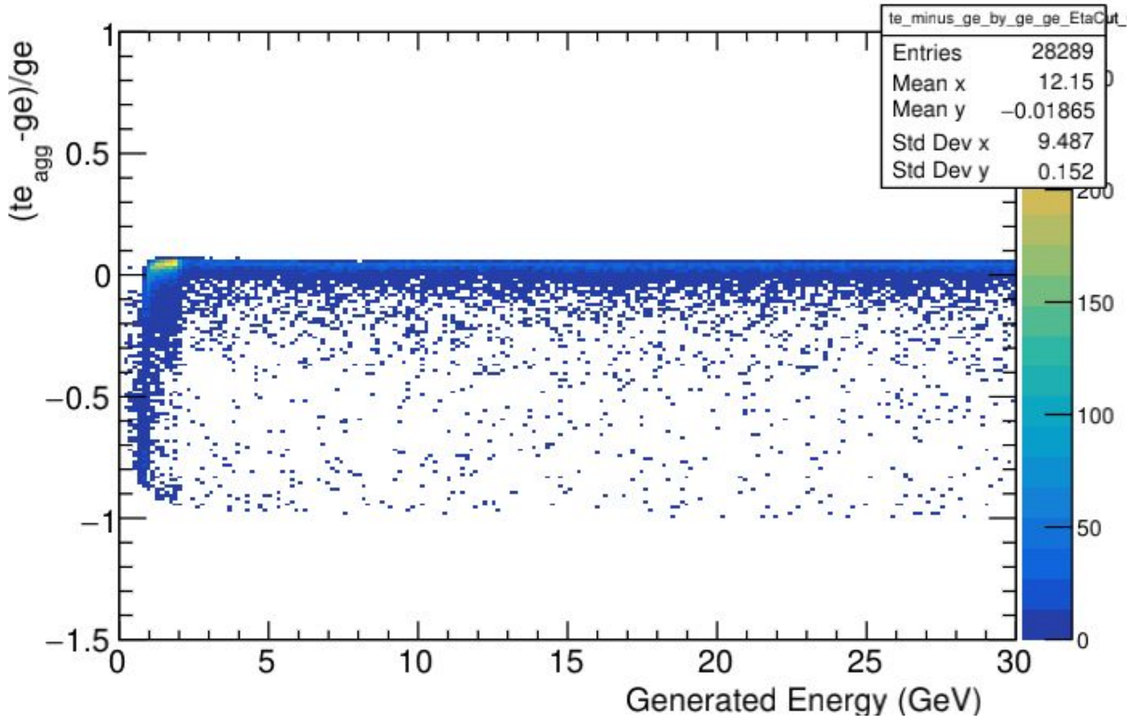
calibrationFactor of first slice = 0.93

# EEMC ($e^-$)

($te_{agg}$-ge)/ge vs ge
Explicit η cut: -3.5 to -1.7
100 MeV energy cut

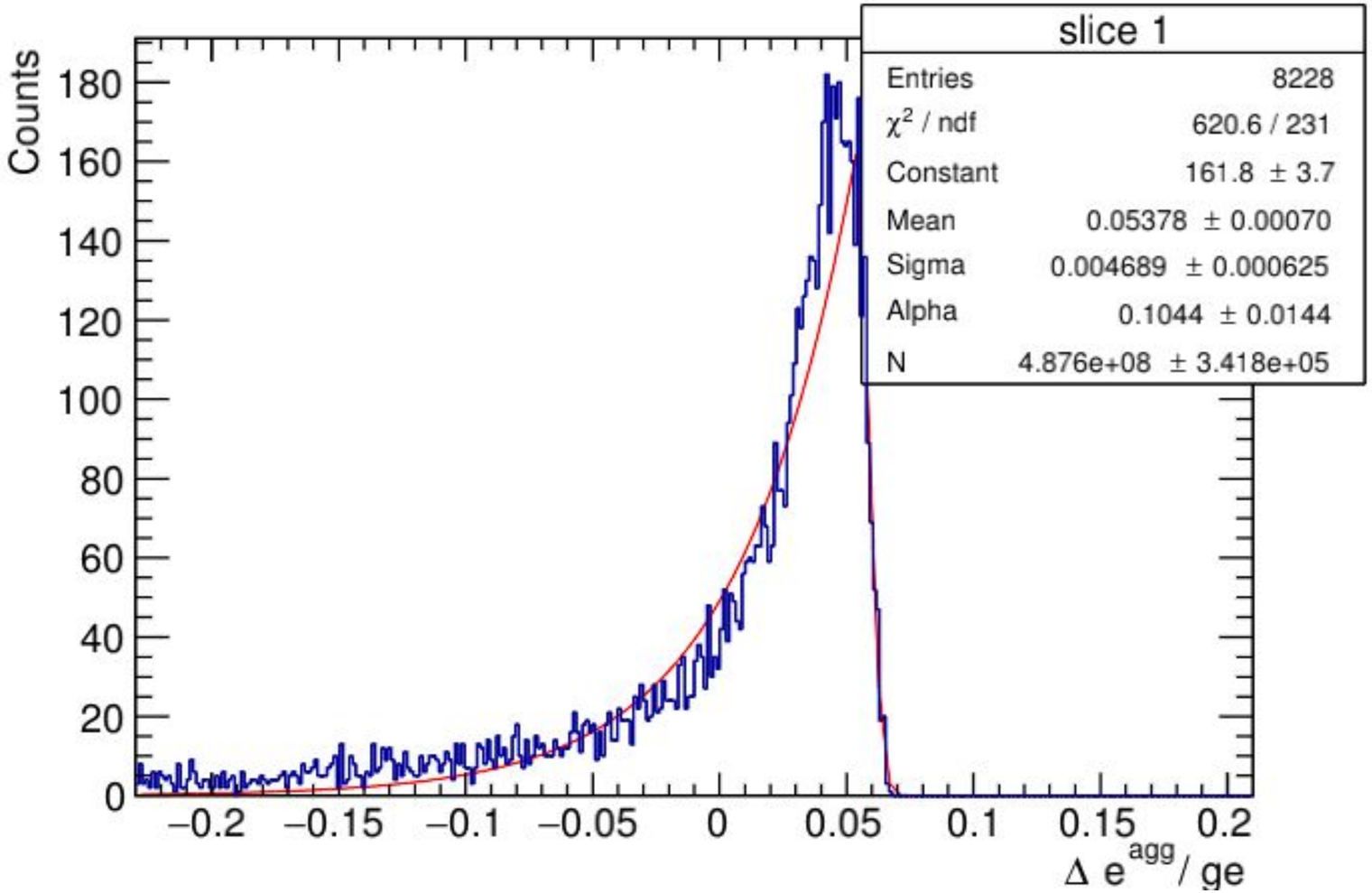



**After calibration** (te → te/calibrationFactor)



# EEMC ($e^-$)

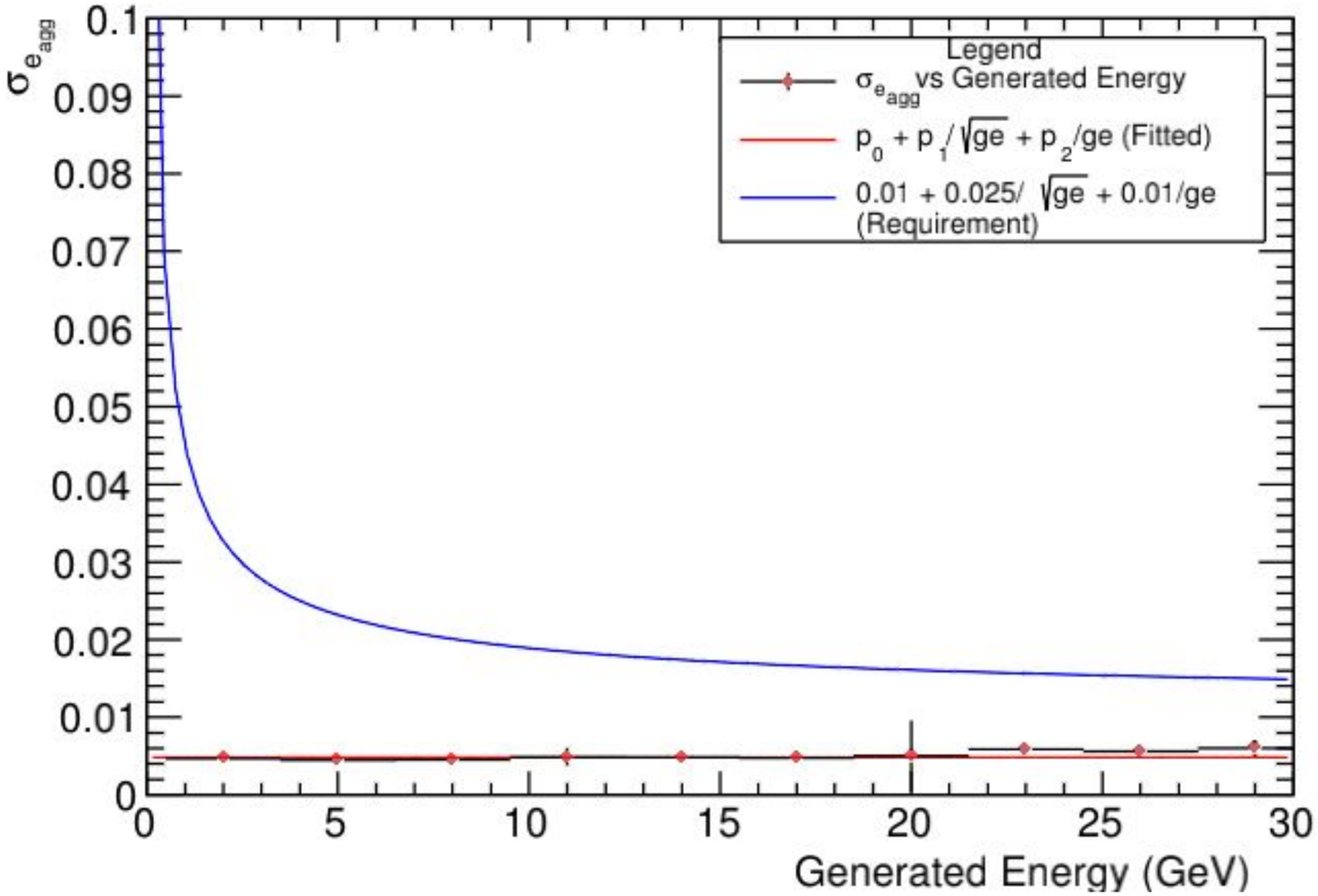
($te_{agg}$-ge)/ge vs ge
Crystal Ball fit of the first slice (0-3 GeV)




Number of bins = 350 from -0.23 to +0.21

# EEMC ($e^-$)

$\sigma_e_{agg}$ vs ge
Explicit η cut: -3.5 to -1.7
Elliptical cut
100 MeV Energy Cut



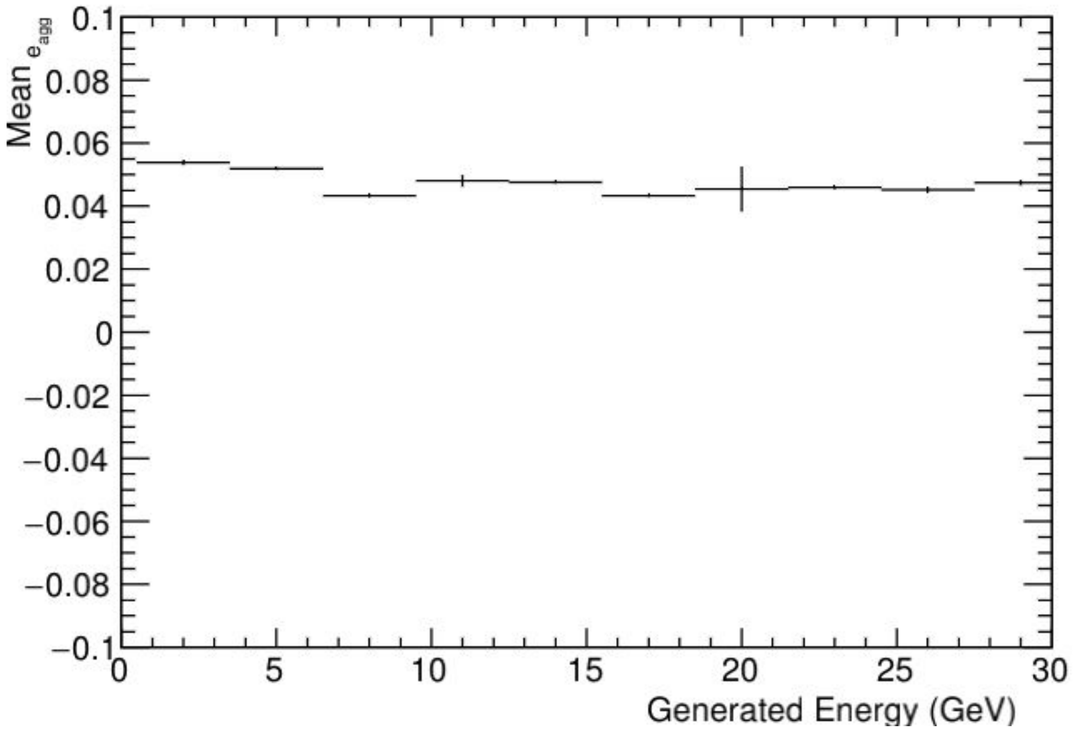

σe refers to the standard deviation of the Gaussian fitted to a slice of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.
(shown on the slide 16)

Number of bins = 10
Bin Width = 3 GeV

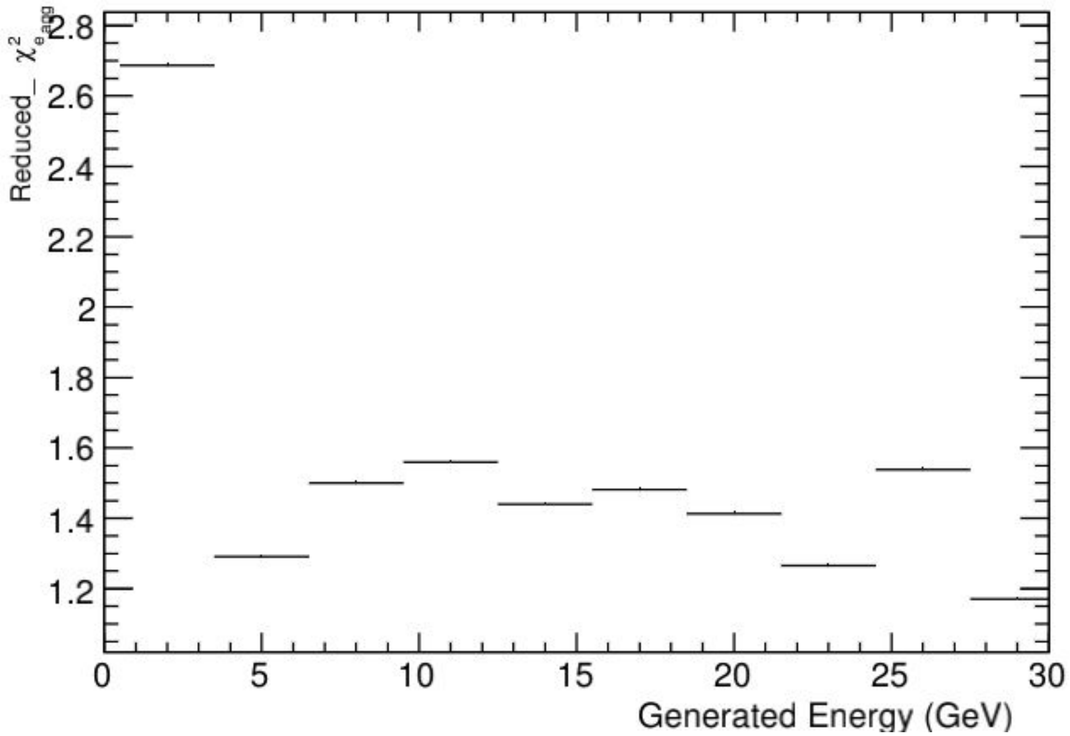
**Fit Parameters:**
$p_o$ = (0.00483728 +- 0.000953093)
$p_1$ = 0 $GeV^{0.5}$
$p_2$ = 0 GeV

# EEMC ($e^-$)

Explicit η cut: -3.5 to -1.7
Elliptical cut, 100 MeV Energy cut



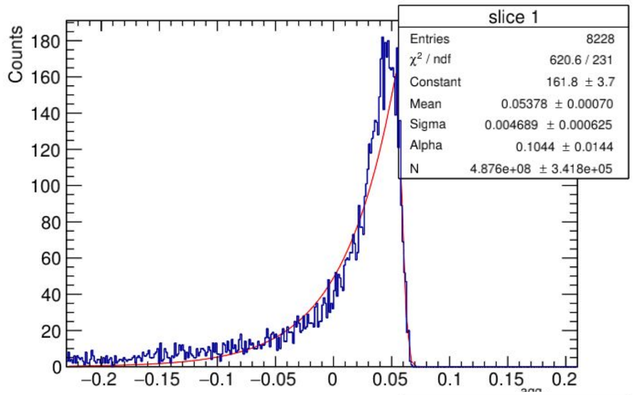

Mean of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

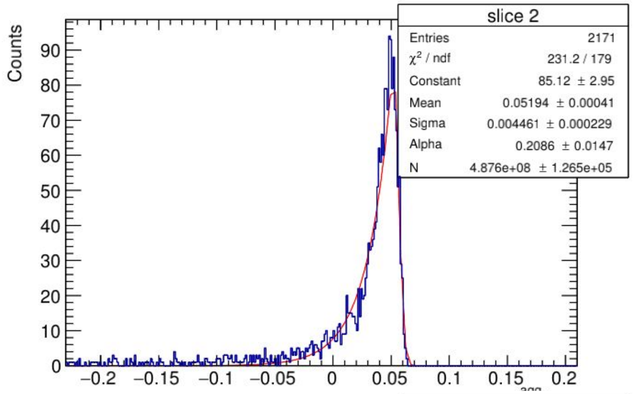


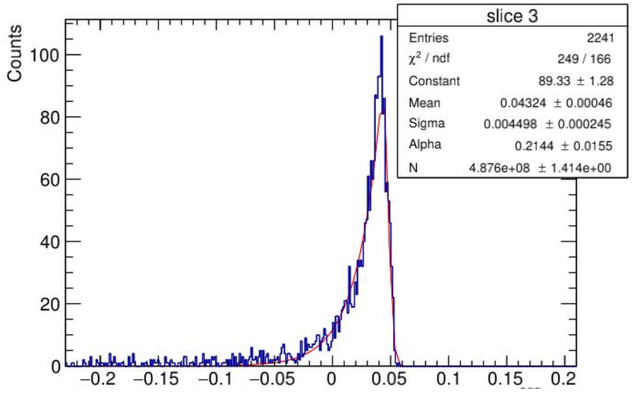

Reduced_χ2 of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

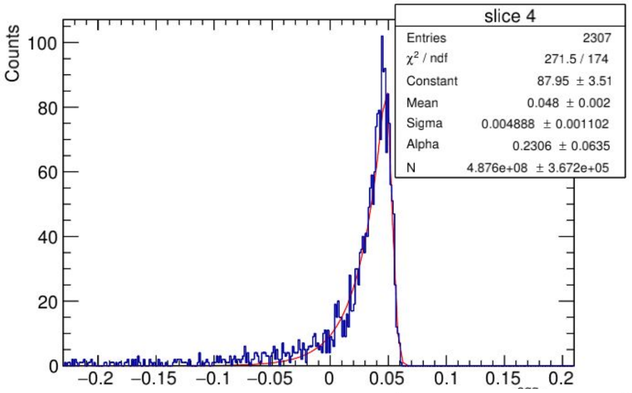
# EEMC ($e^-$)

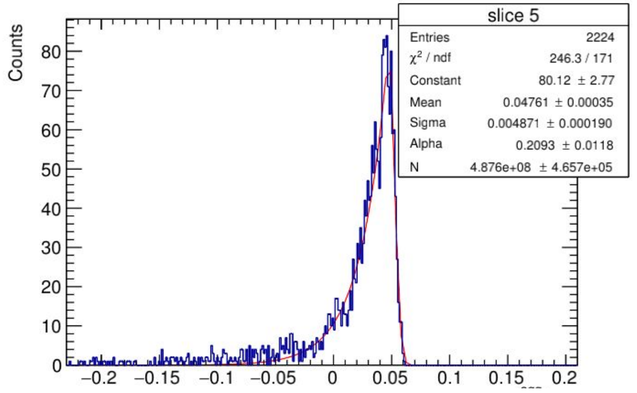
## Fitted Crystal Ball Functions

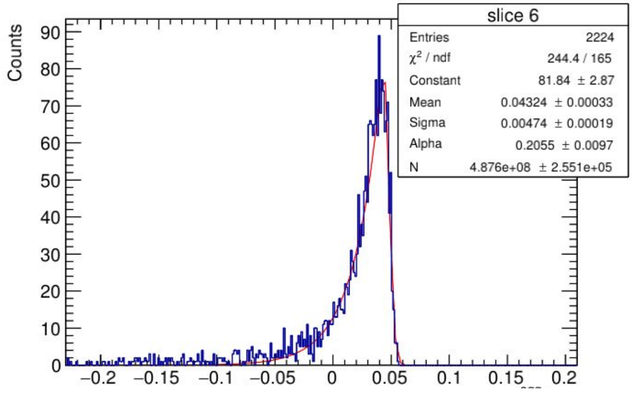


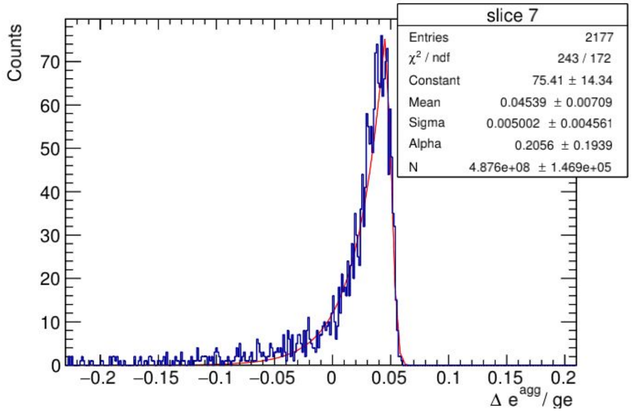



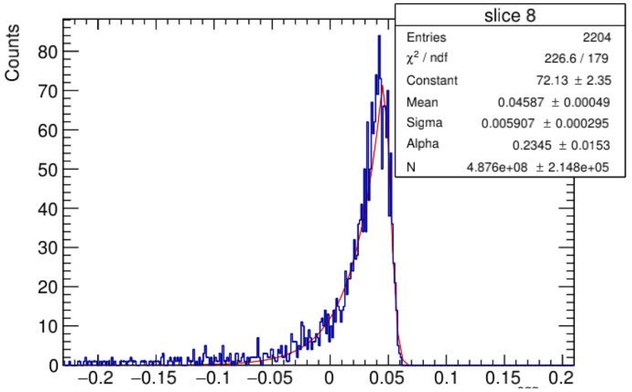



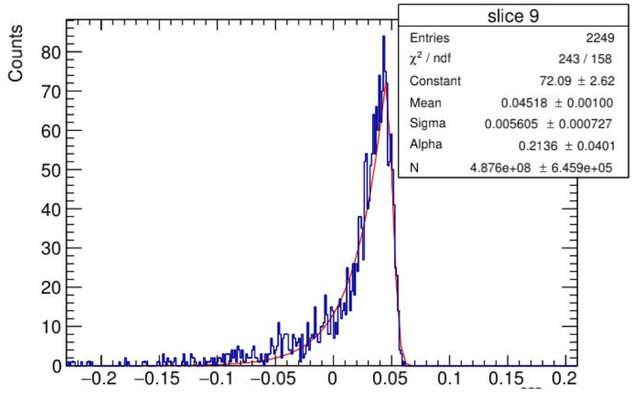



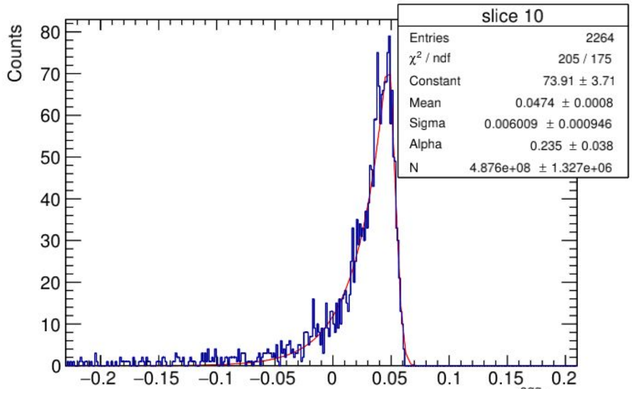



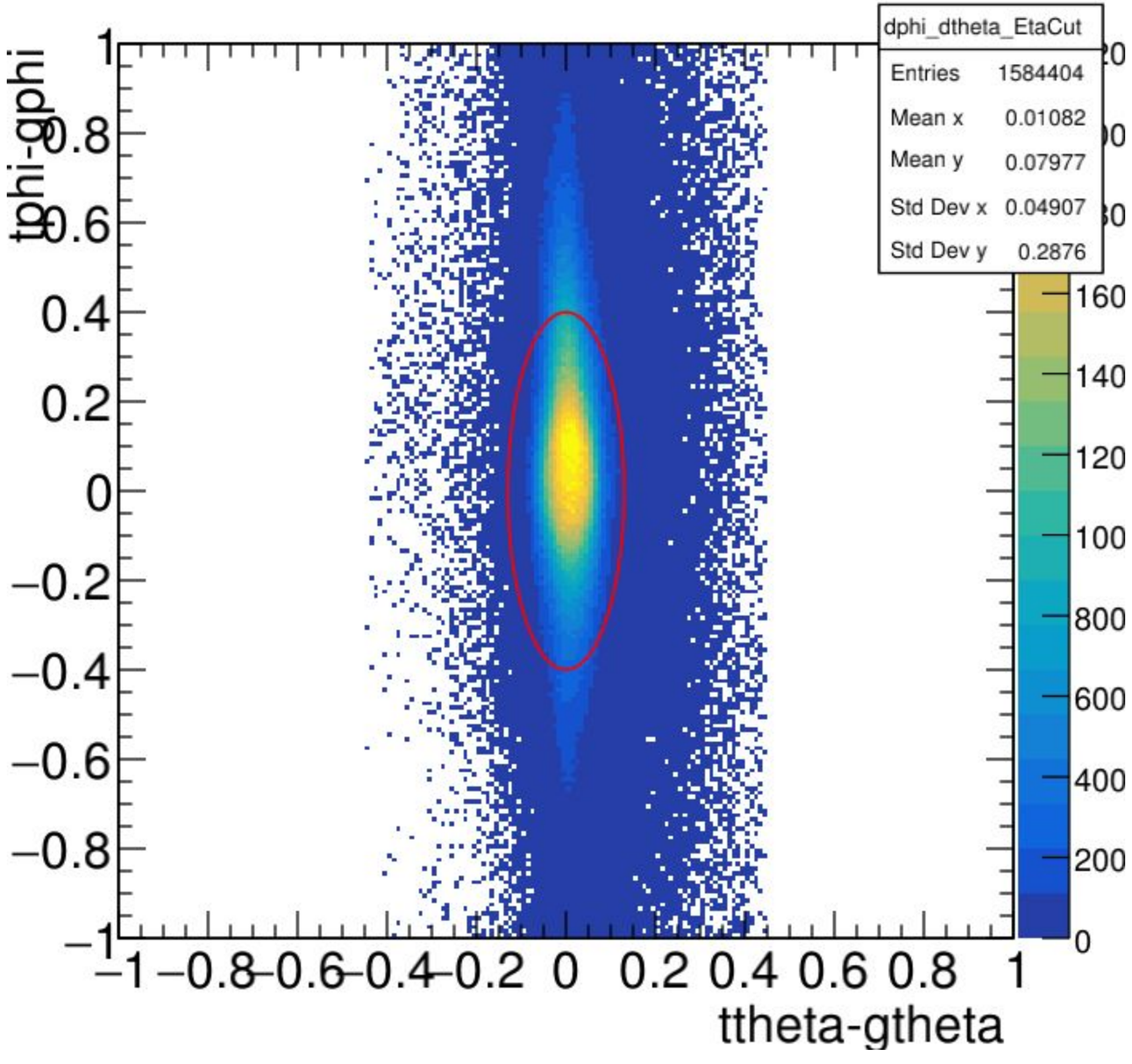




The x-axes denote $\Delta e_{agg}/ge$

# FEMC ($e^-$)

# FEMC ($e^-$)

Elliptical cut on dphi vs dtheta, Explicit η cut: 1.3 to 3.3, 100 MeV Energy



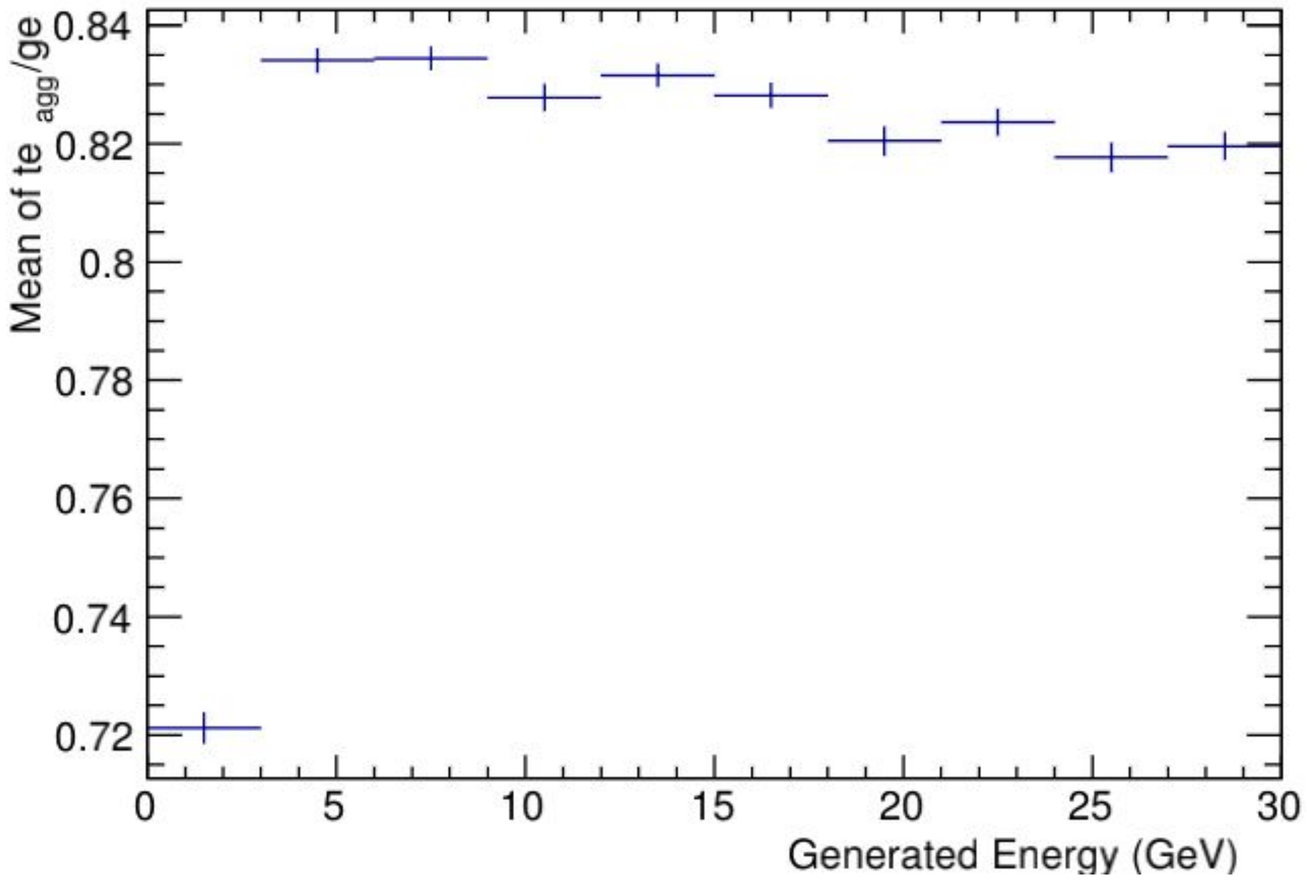

**Elliptical Cut:** Only the towers within the elliptical region (centered at origin) are considered for further analysis.

**Dimensions:**

semi-minor axis = 0.13 units
semi-major axis = 0.40 units

# FEMC ($e^-$)

Elliptical cut on dphi vs dtheta
Explicit η cut: 1.3 to 3.3
100 MeV Energy Cut



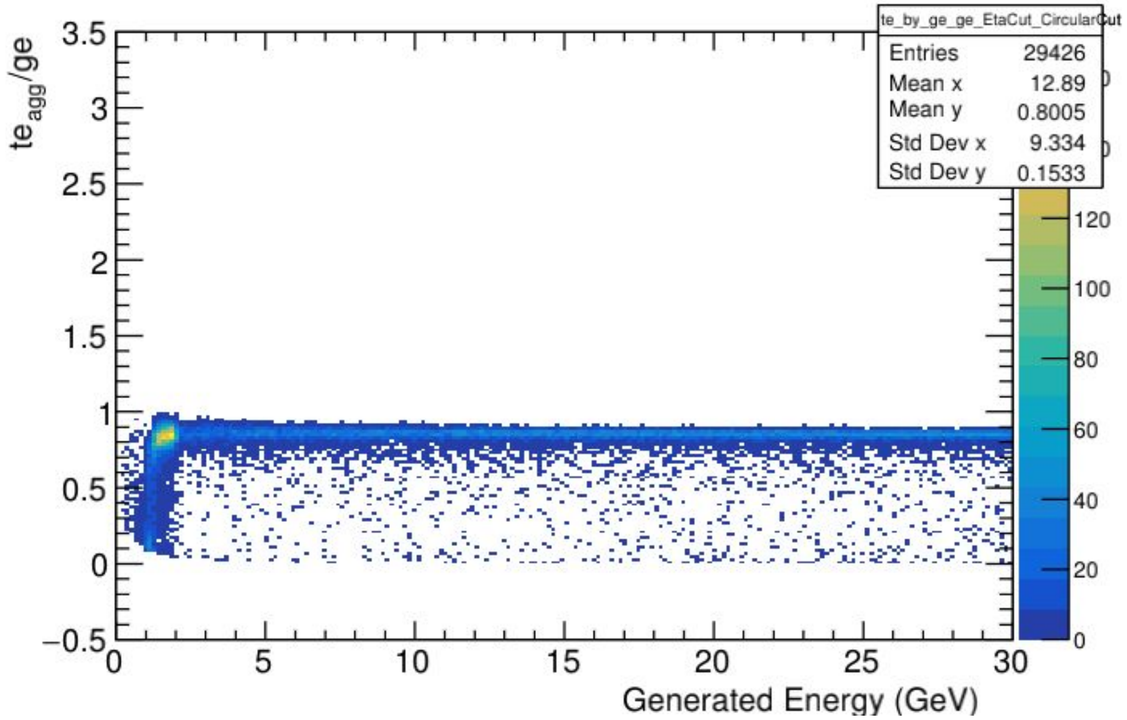

Each slice of $(te_{agg}\text{-}ge)/ge$ vs ge plot will be calibrated on the basis of dividing by a calibration factor which equals to the Mean of $te_{agg}/ge$ corresponding to that particular slice in this plot.

*The calibration factor for the first slice has been decided manually because the value from this plot doesn't seem to be optimum.

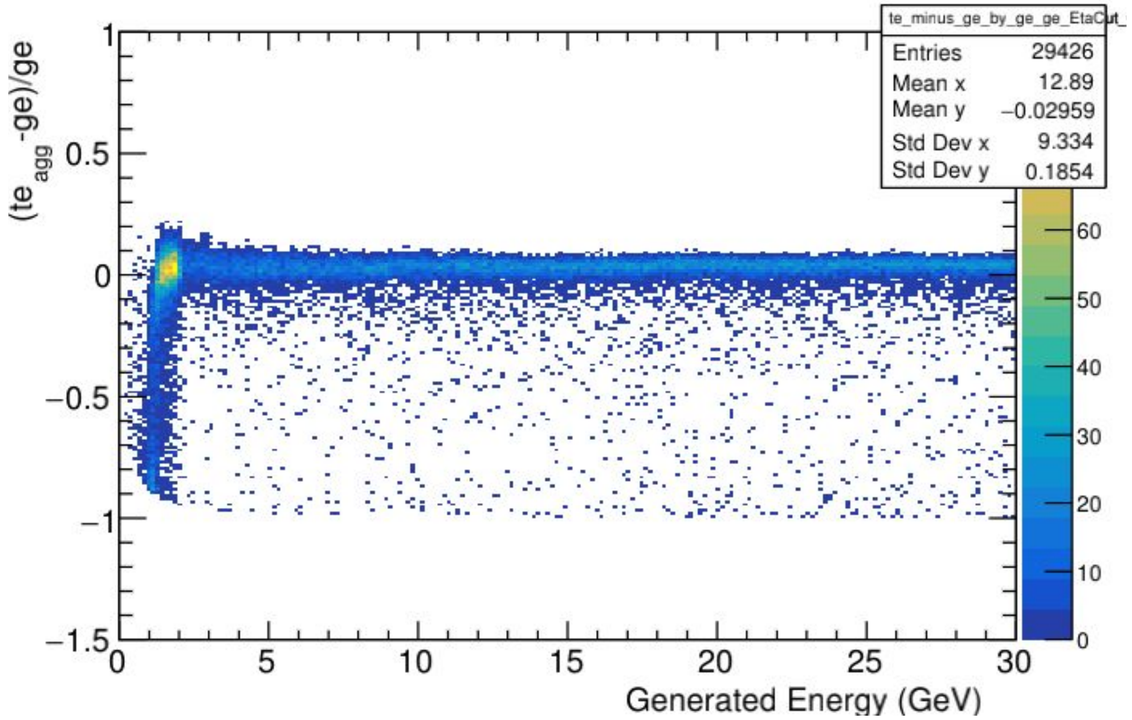
calibrationFactor of first slice = 0.82

# FEMC ($e^-$)

($te_{agg}$-ge)/ge vs ge
Explicit η cut: 1.3 to 3.3
100 MeV Energy Cut

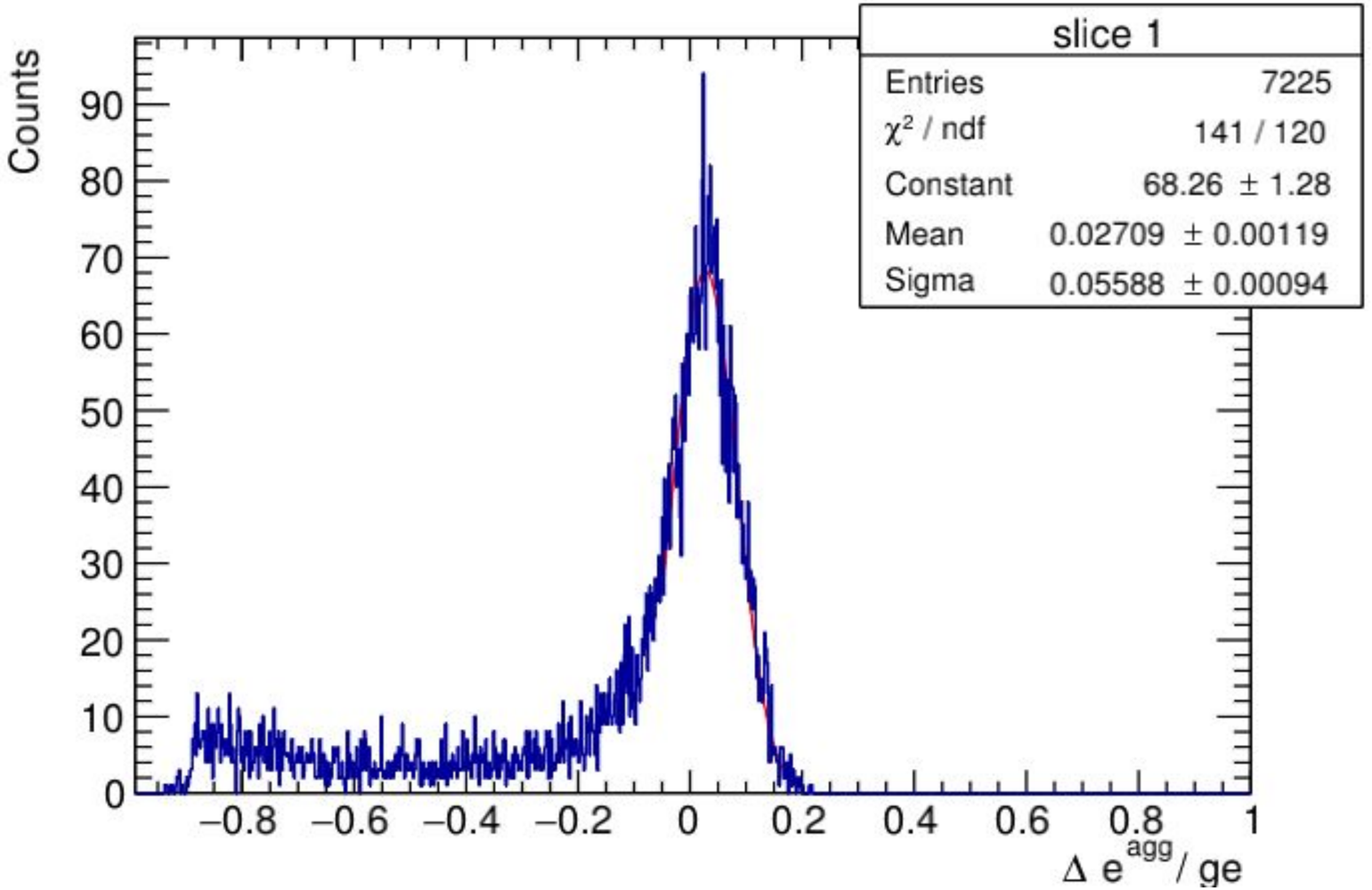



**After calibration** (te → te/calibrationFactor)



# FEMC ($e^-$)

($te_{agg}$-ge)/ge vs ge
Gaussian fit of the first slice (0-3 GeV)




This is the gaussian fit of the first slice of the calibrated ($te_{agg}$-ge)/ge vs ge plot. (shown on the previous slide)

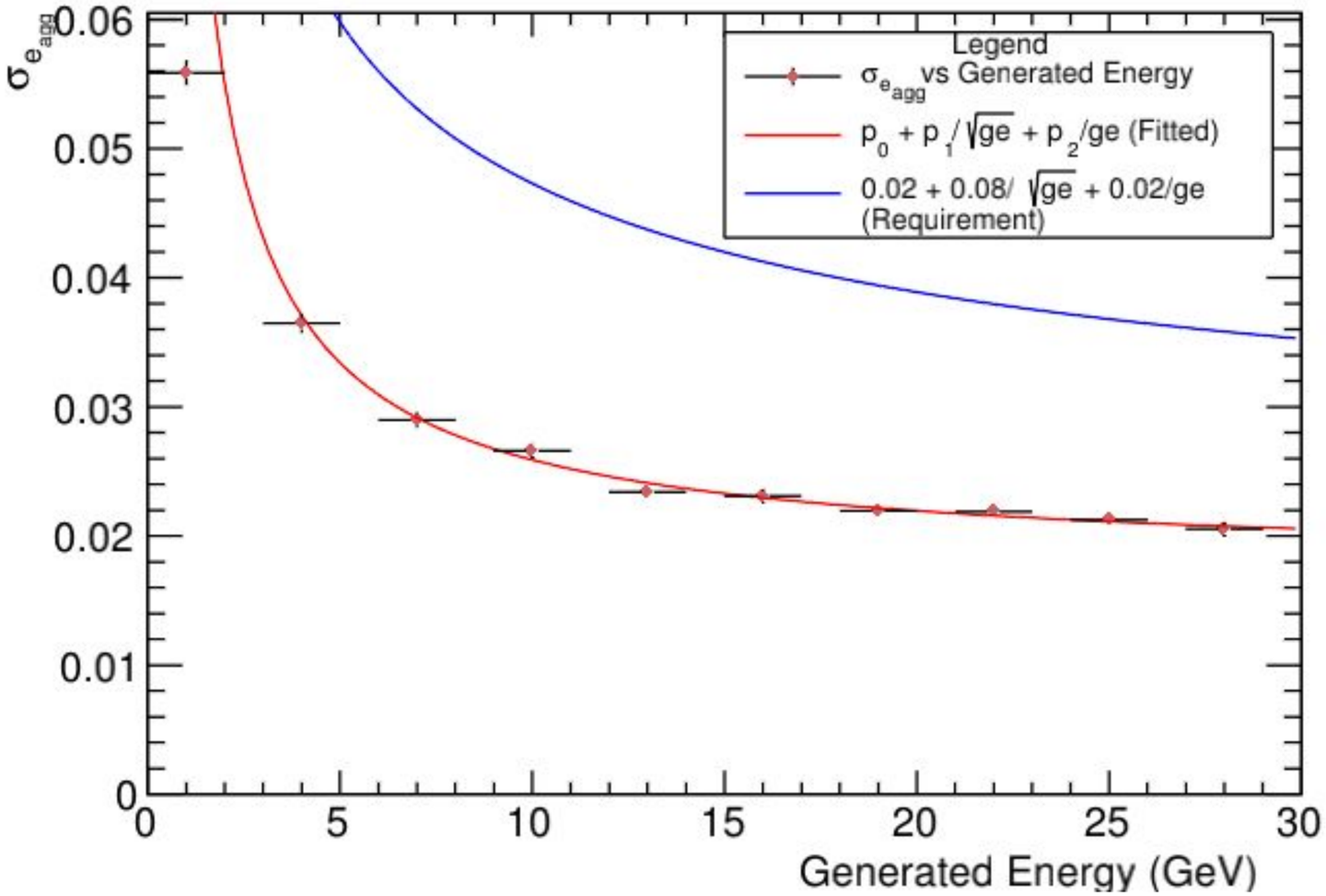
This fit has been done manually by restricting the fit range of the gaussian from -0.05 to 0.20

*All other gaussians have been fit over the entire range.

Number of bins = 1000 from -0.99 to +1.00

# FEMC ($e^-$)

$\sigma_e_{agg}$ vs ge
Explicit η cut: 1.3 to 3.3
Elliptical Cut
100 MeV Energy Cut



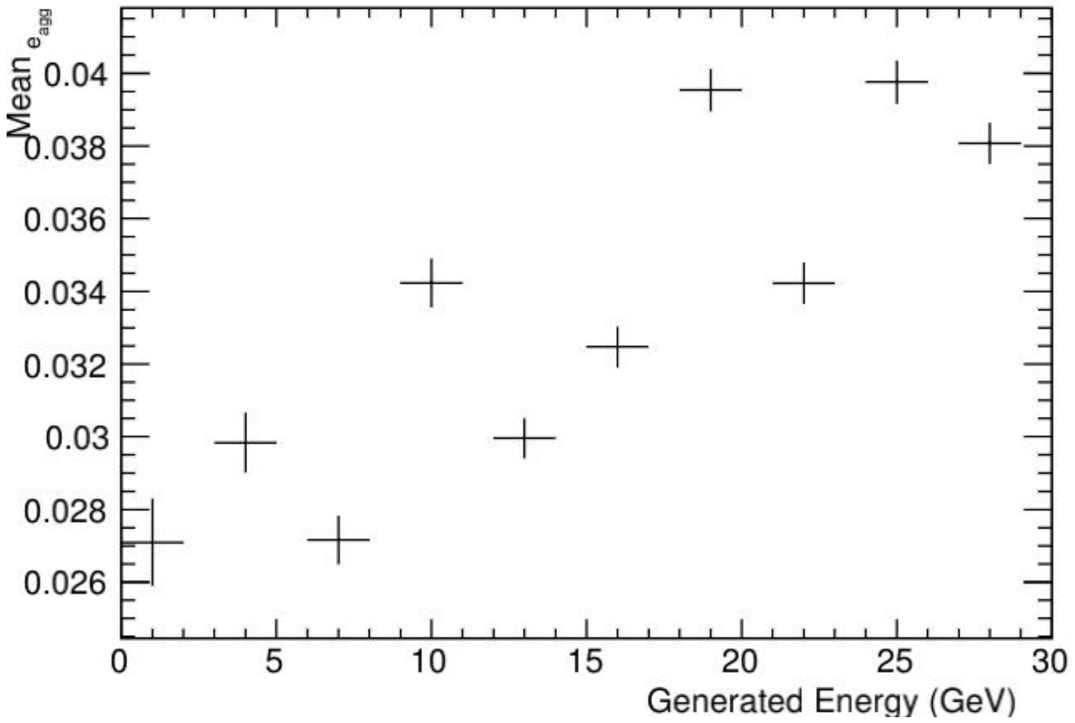

σe refers to the standard deviation of the Gaussian fitted to a slice of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.
(shown on slide 24)

Number of bins = 10
Bin Width = 3 GeV

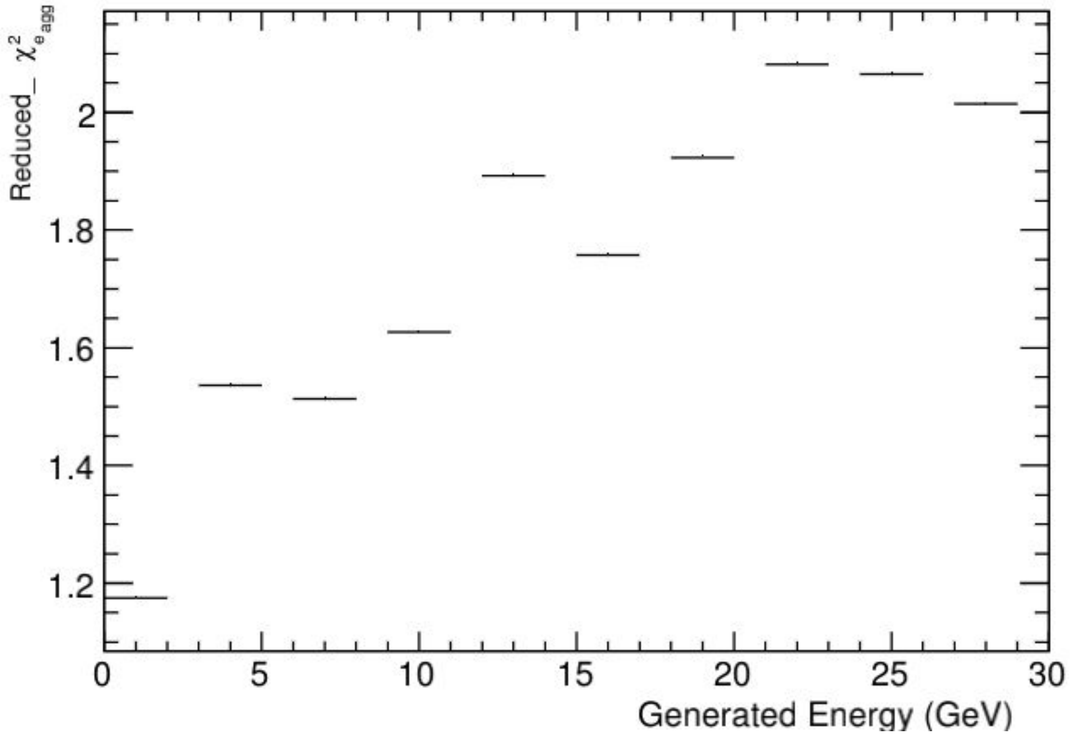
**Fit Parameters:**
$p_o$ = (0.0170581 +- 0.00502211)
$p_1$ = (0.00502211 +- 0.0385539) $GeV^{0.5}$
$p_2$ = (0.0656204 +- 0.0714995) GeV

# FEMC ($e^-$)

Explicit η cut: 1.3 to 3.3
Elliptical cut, 100 MeV Energy Cut



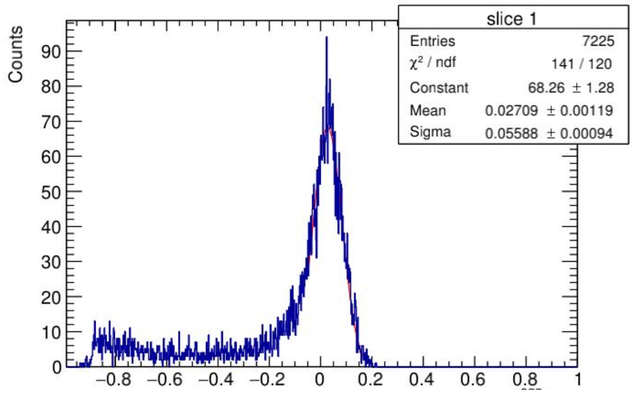

Mean of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

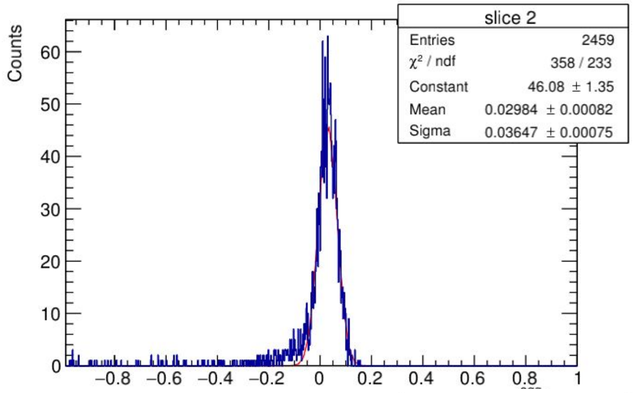


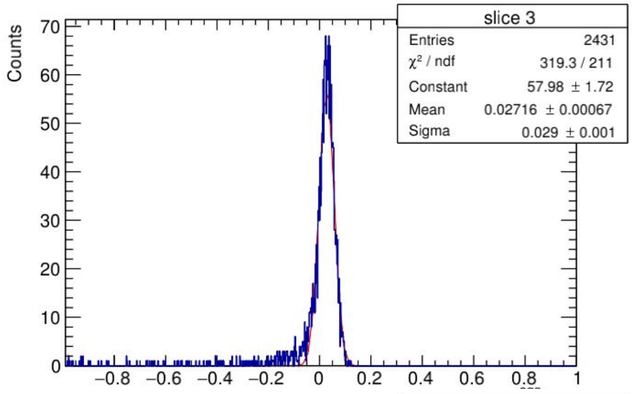

Reduced_χ2 of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

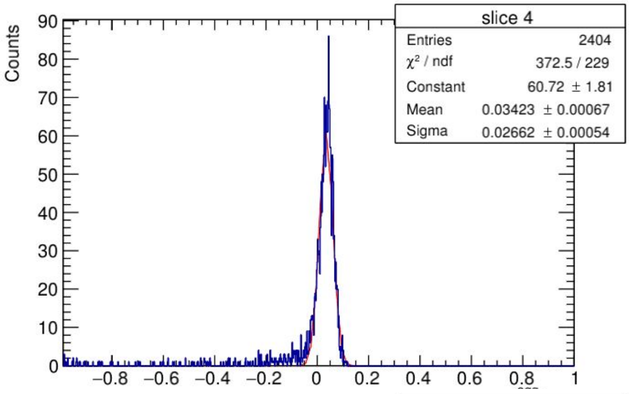
# FEMC ($e^-$)

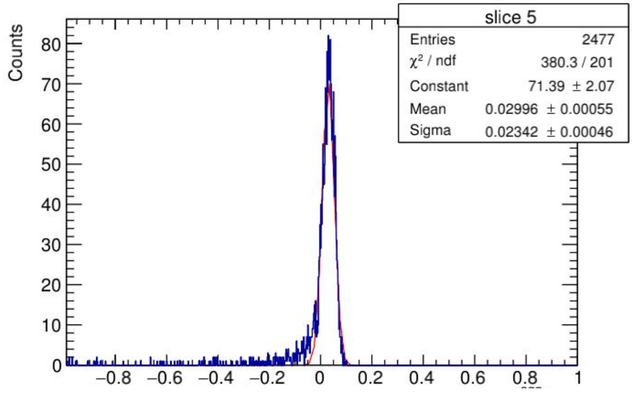
## Fitted Gaussians

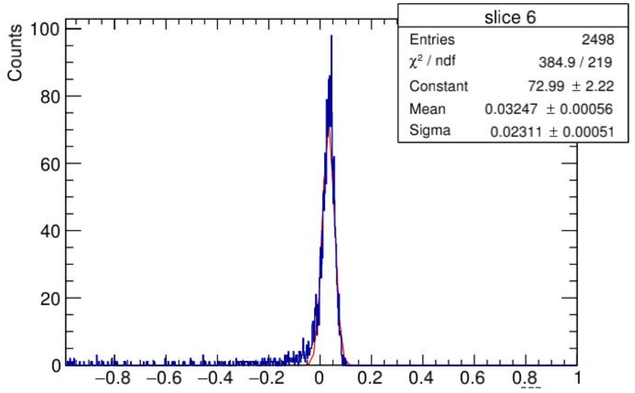


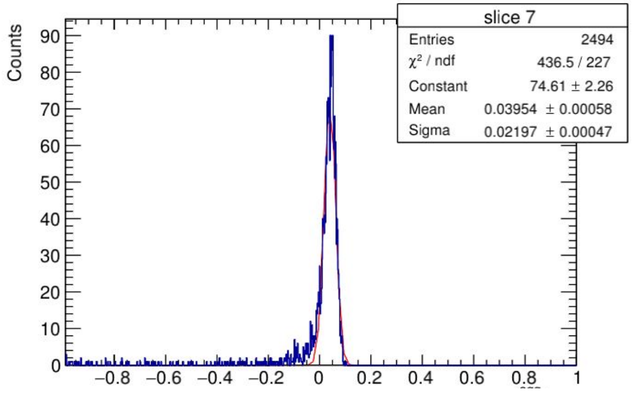



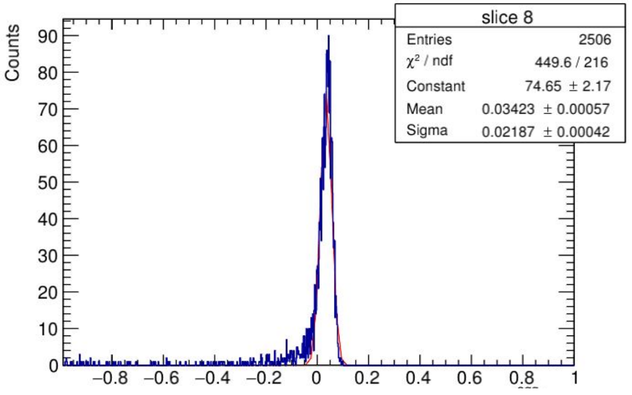



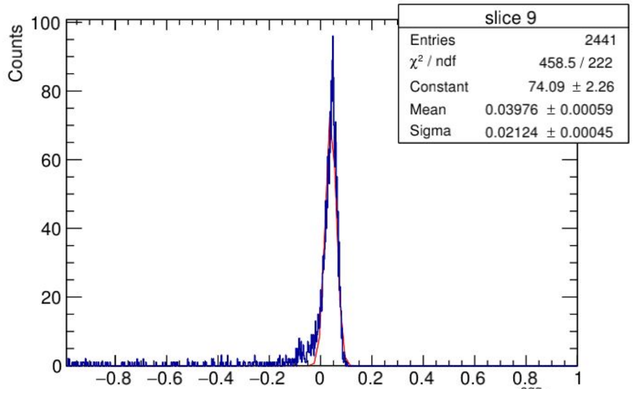



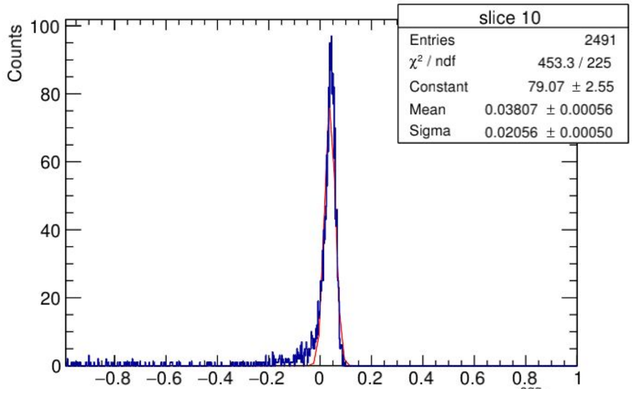




The x-axes denote $\Delta e_{agg}/ge$