Simulation Statistics

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December 10, 2021

IIT Indore

Contents

Histograms for energy resolution of detectors with manual clustering, theta-parametrized energy cut on aggregate towers of EMCs (FEMC and CEMC) to account for pion-MIPs, and slice-wise calibration, for the following detector-particle pairs:

- Pion: FHCAL + FEMC
- Pion: CEMC + HCALIN + HCALOUT

tphi : tower ϕ, ttheta : tower θ, te_{agg}: tower energies aggregated in an event
gphi : generated ϕ, gtheta : generated θ, ge: generated energy

Simulation Parameters

- Particles: pi^-
- Events: 150,000 pi^- (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): -π to π

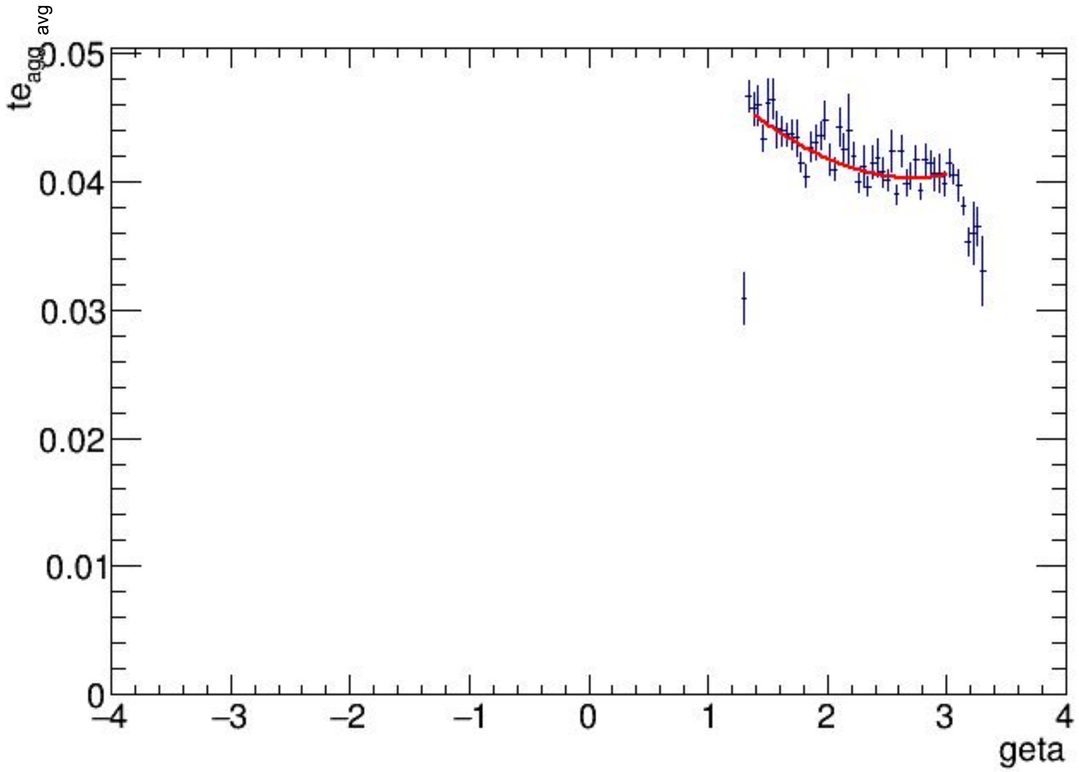
Cuts:

- Detector-wise η cuts, intersection for combinations
- Detector-wise Elliptical cuts in dphi vs dtheta plots
- Theta-parametrized energy cut on aggregate towers of EMCs

FEMC + FHCAL (pi^-)

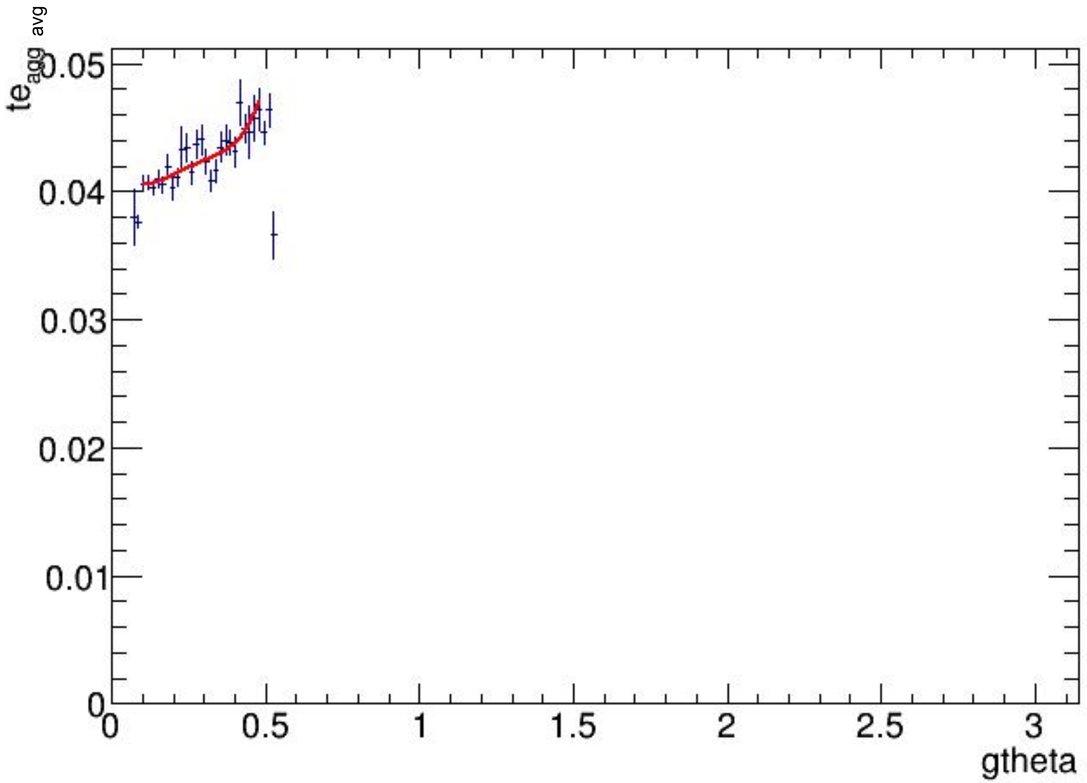
FEMC (mu^-)

Theta-parametrization of muon-MIP energy



NO.	NAME	VALUE	ERROR	STEP SIZE	DERIVATIVE
1	p0	9.35181e-02	1.22226e-03	-8.09464e-04	3.02904e-06
2	p1	-7.89414e-02	8.46330e-04	1.55244e-03	5.29057e-06
3	p2	4.86322e-02	3.51025e-04	-1.09423e-03	1.18692e-06
4	p3	-1.43450e-02	1.34066e-04	3.36191e-04	3.74049e-05
5	p4	1.64902e-03	3.80323e-05	3.80323e-05	-1.85684e+00

reduced_chi2 of eta fit: 1.4317



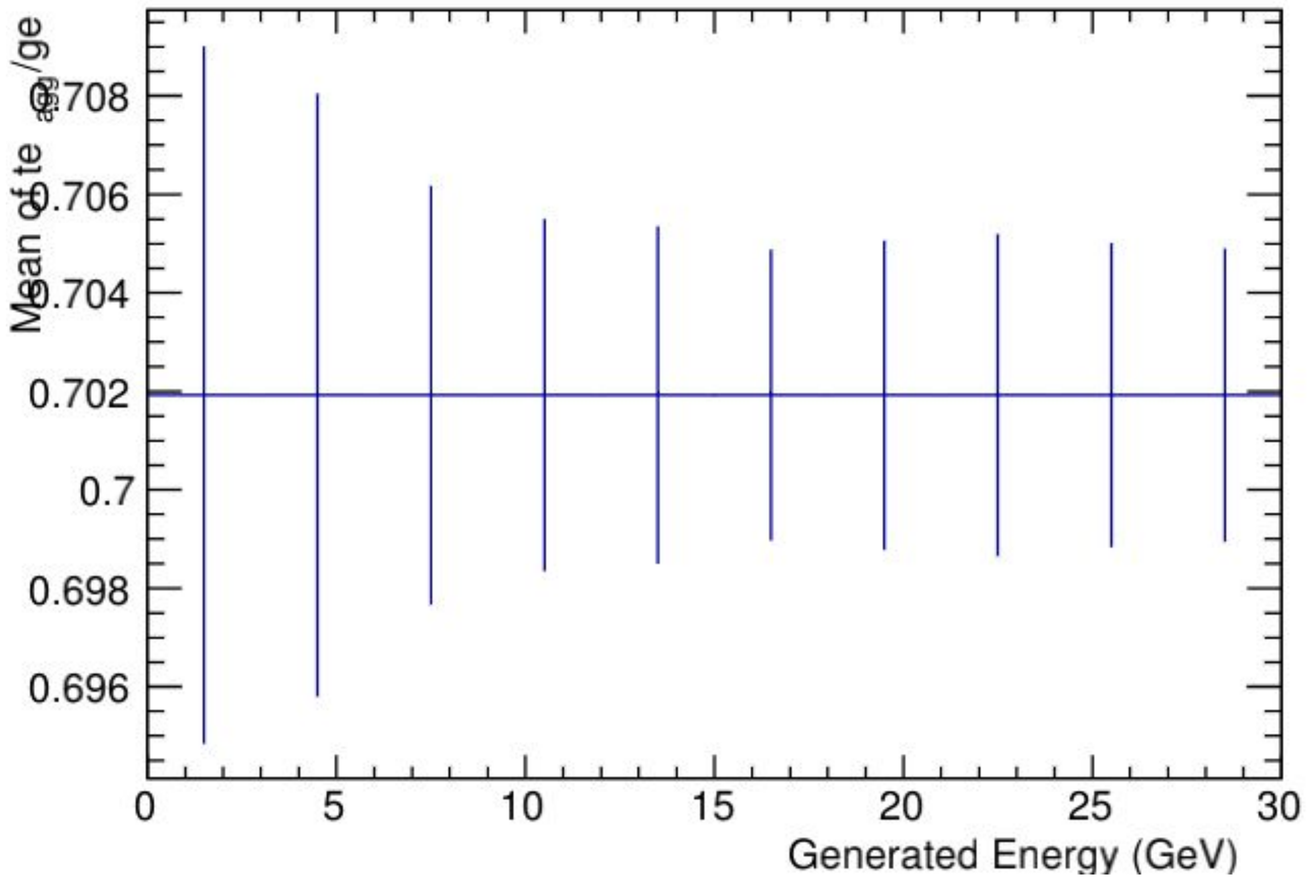
NO.	NAME	VALUE	ERROR	STEP SIZE	DERIVATIVE
1	p0	4.36565e-02	7.74845e-04	-3.89325e-04	1.24100e-07
2	p1	-6.83936e-02	7.24731e-03	7.19970e-03	-2.15257e-09
3	p2	5.00696e-01	2.35243e-02	-4.53787e-02	-1.48674e-08
4	p3	-1.35548e+00	6.59022e-02	1.16653e-01	8.33137e-10
5	p4	1.33188e+00	1.04638e-01	1.04638e-01	-5.47501e-08

reduced_chi2 of theta fit: 1.08146

FEMC + FHCAL (pi^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: 1.4 to 3.0
gtheta-parametrized Aggregate Energy Cuts on EMC Towers

After calibration

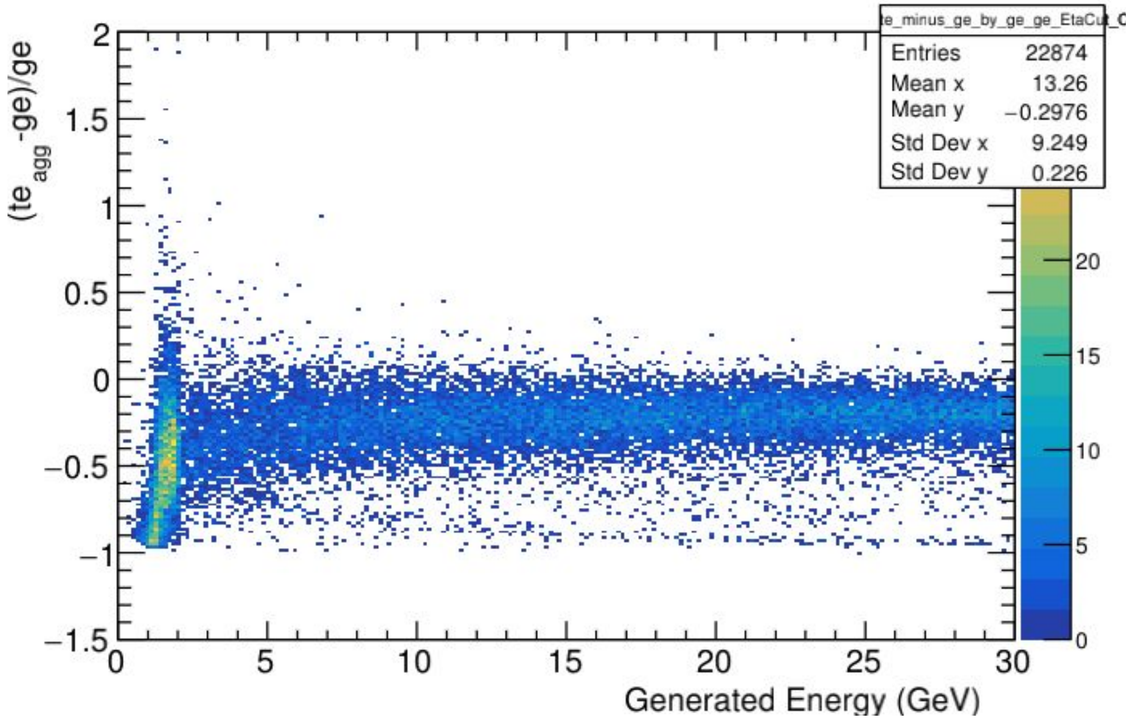


(te_{agg} → ∑(weight*te/calibrationFactor)/mean(∑(weight*te/calibrationFactor))

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.

FEMC + FHCAL (pi^-)

(te_{agg}-ge)/ge vs ge
Explicit η cut: 1.4 to 3.0
gtheta-parametrized Aggregate Energy Cuts on EMC Towers



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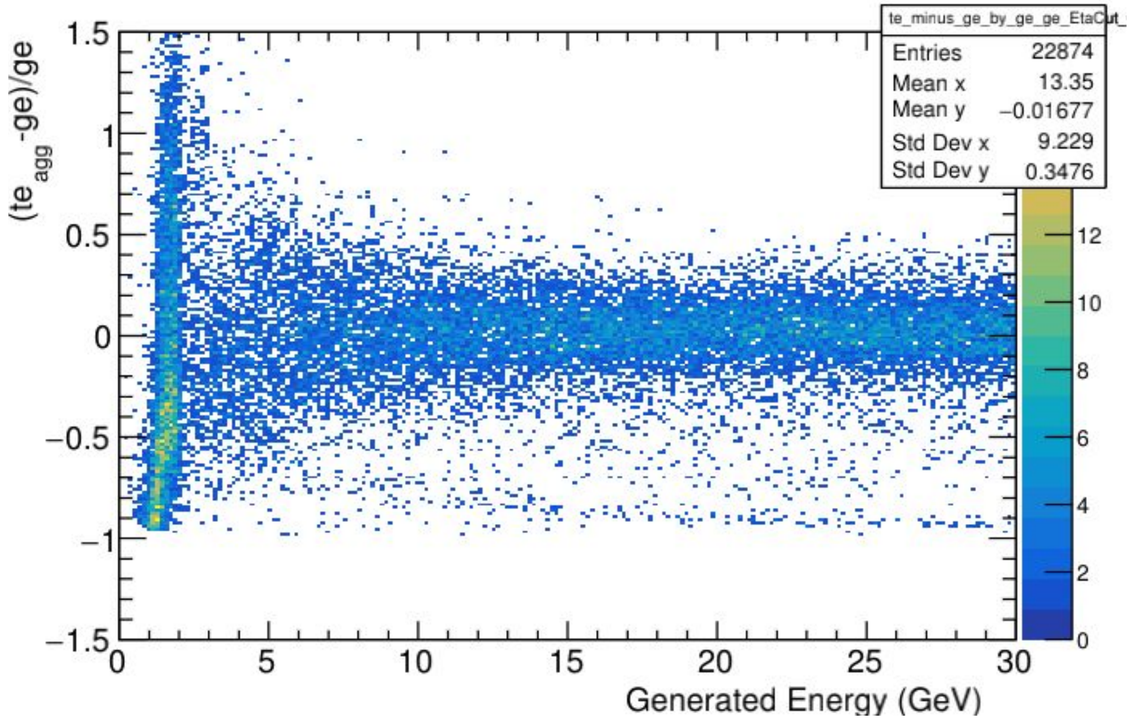


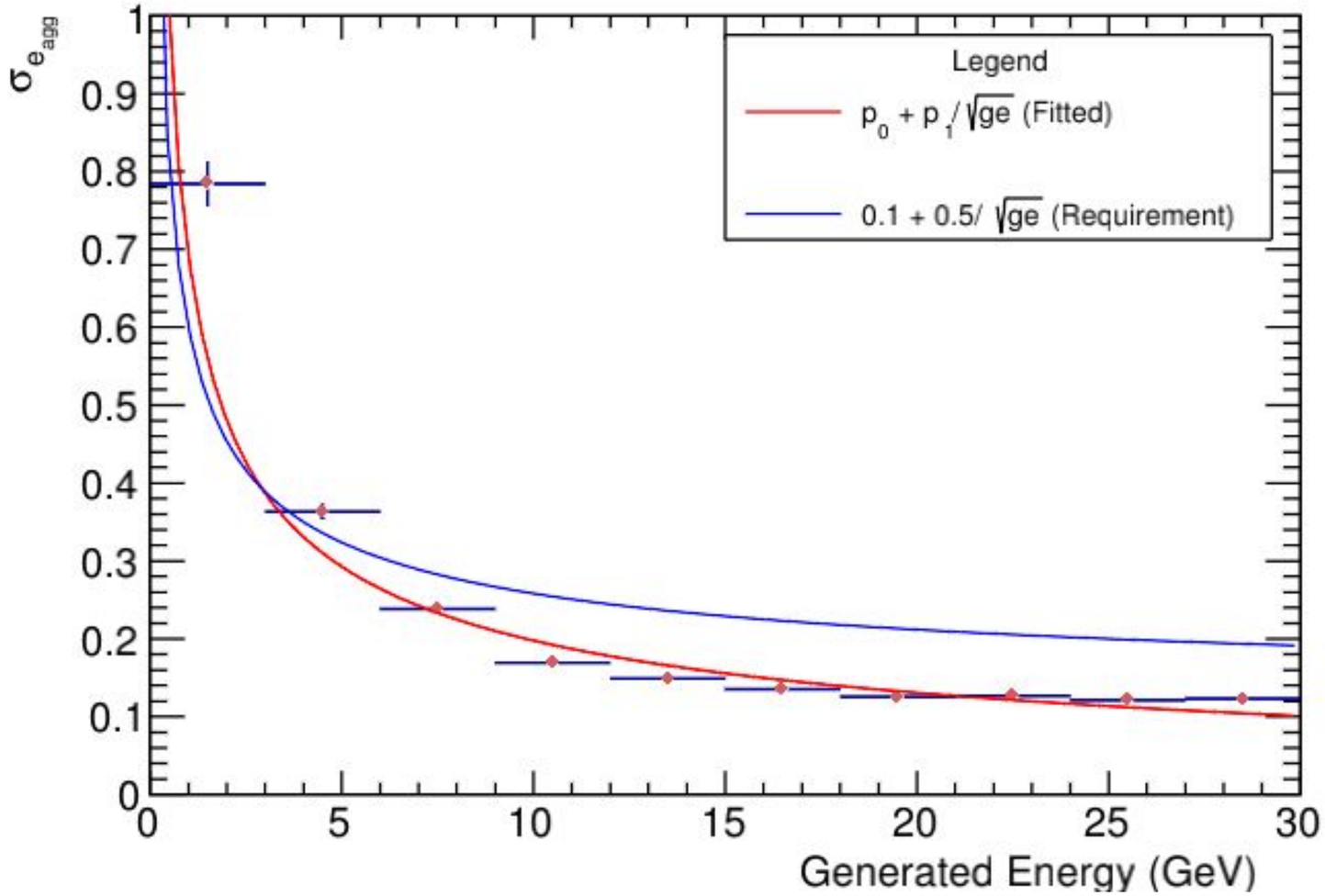
(te_{agg} → ∑(weight*te/calibrationFactor)/mean(∑(weight*te/calibrationFactor))

calibrationFactor(ge) = mean(te/ge) ; detector-wise; function of ge

weight = mean(te/ge) ; detector-wise; independent of ge

FEMC + FHCAL (pi^-)

σ_e_{agg} vs ge
Explicit η cut: 1.4 to 3.0
Elliptical Cut for Manual Clustering
gtheta-parametrized Aggregate Energy Cuts on EMC Towers



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

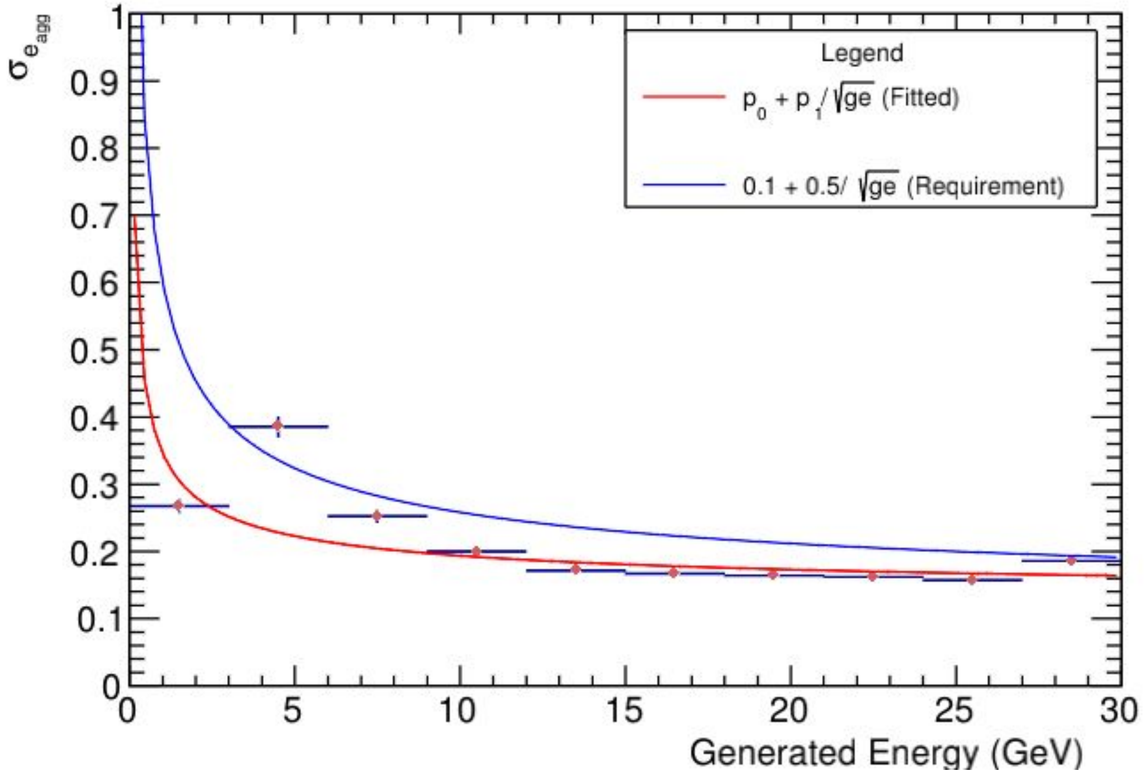
Number of bins = 10
Bin Width = 3 GeV

Fit Parameters:
p_o = (-0.0311684 +- 0.00490995)
p_1 = (0.723779 +- 0.0201562) $GeV^{0.5}$

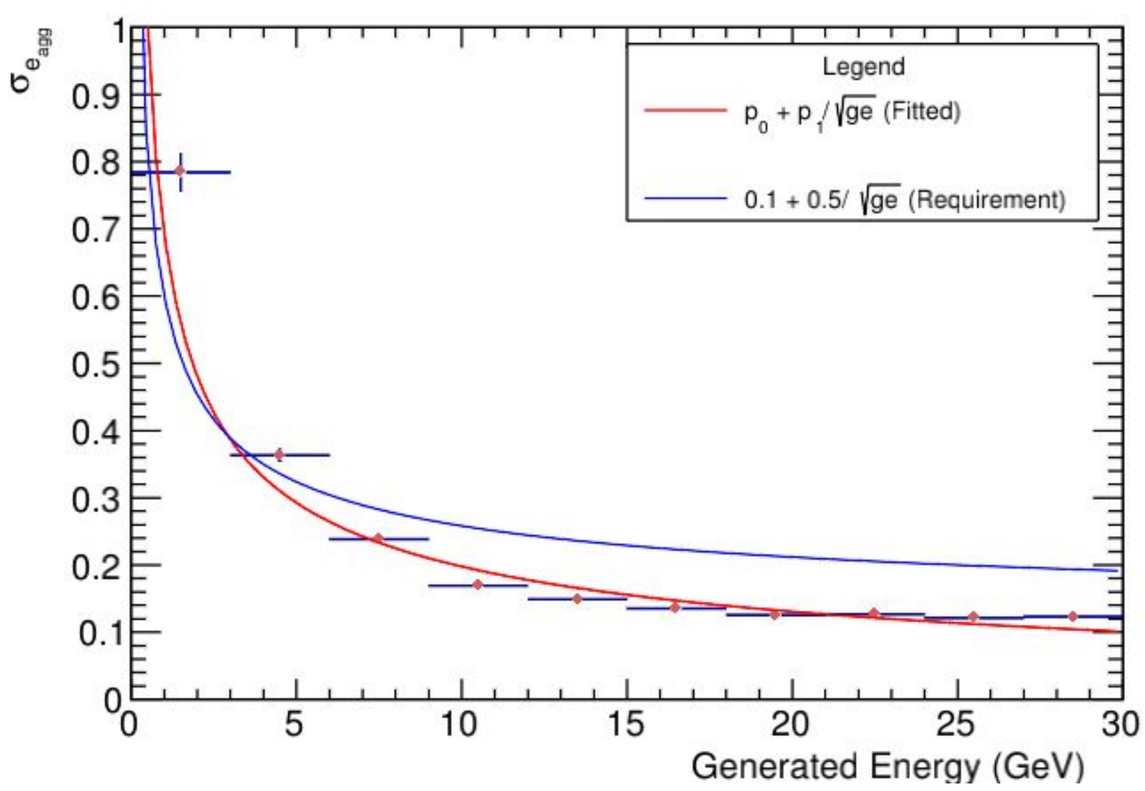
FEMC + FHCAL (pi^-)

Explicit η cut: 1.4 to 3.0
Elliptical Cut for Manual Clustering
gtheta-parametrized Aggregate Energy Cuts on EMC Towers

360 MeV energy cut on aggregate EMC Towers

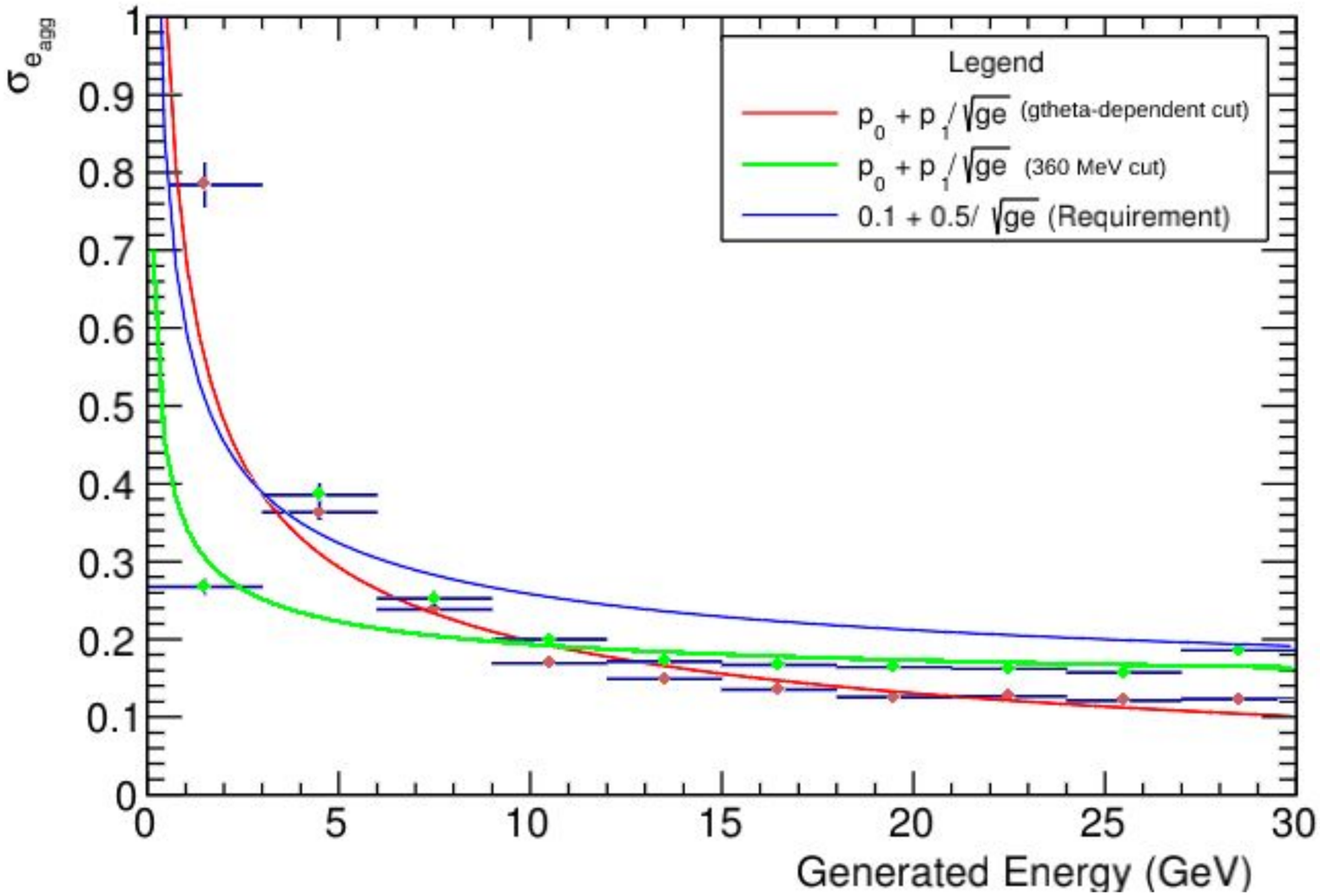


gtheta-dependent energy cut on aggregate EMC Towers



FEMC + FHCAL (pi^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: 1.4 to 3.0
Comparison of Energy Resolutions Obtained



FEMC + FHCAL (pi^-)

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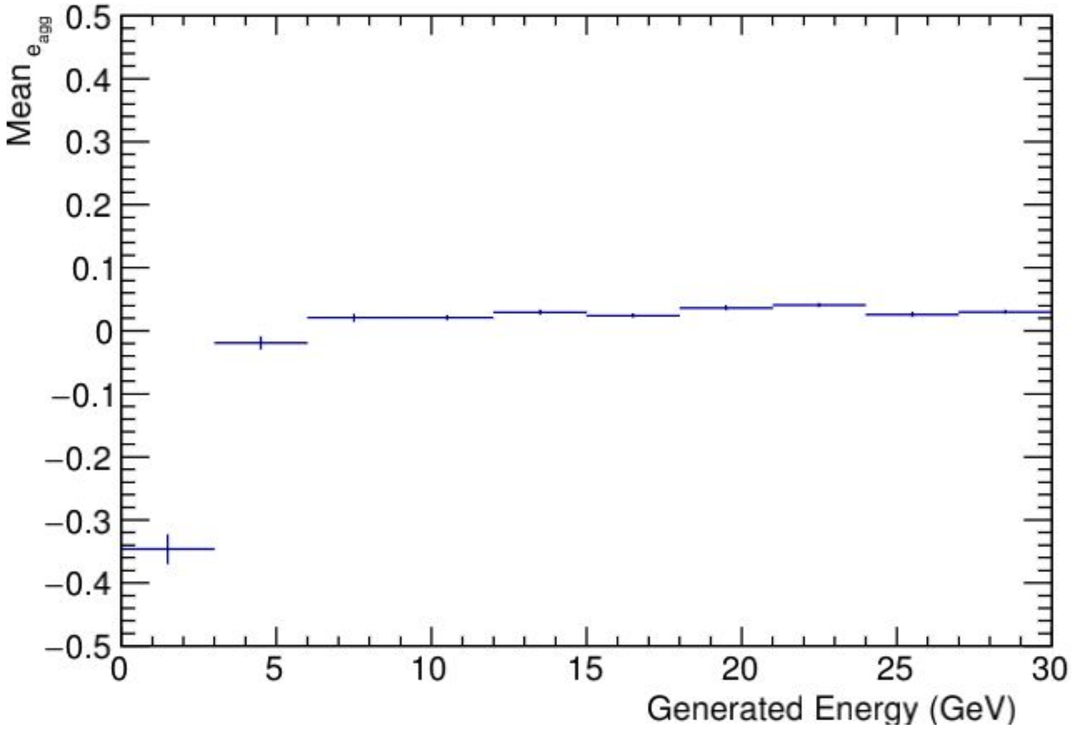
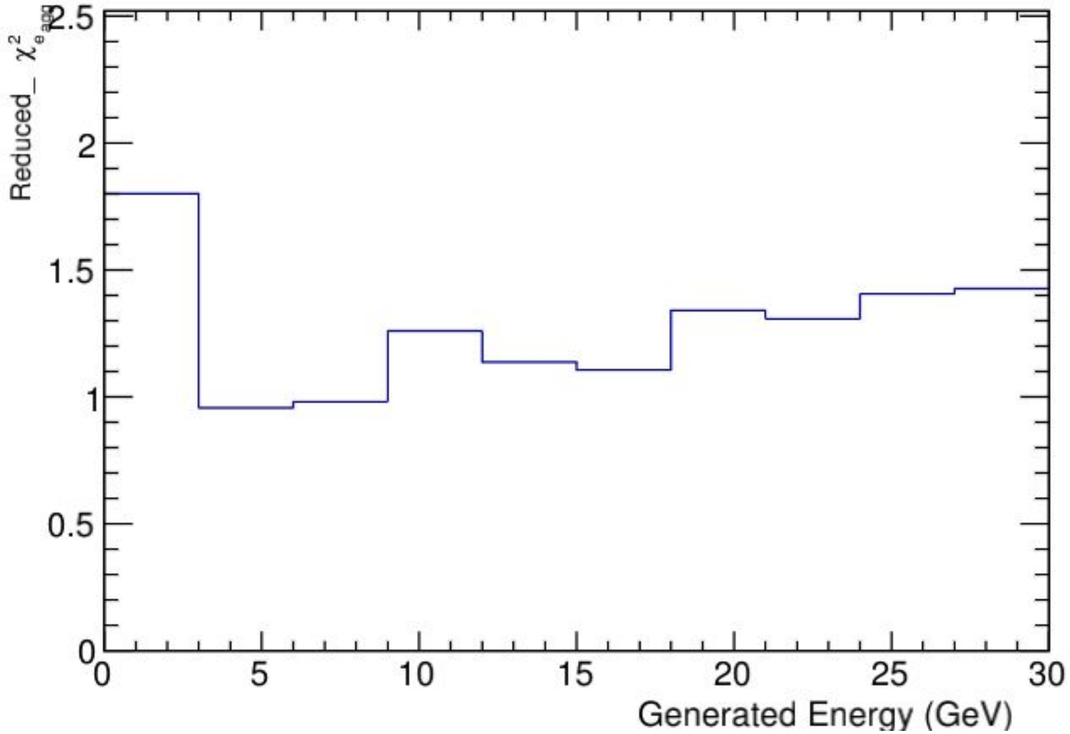


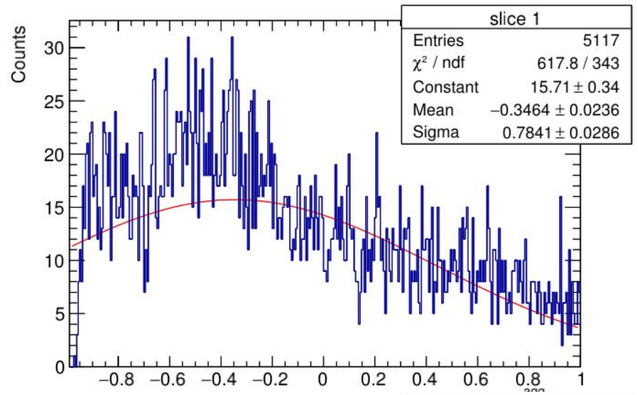
Mean of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

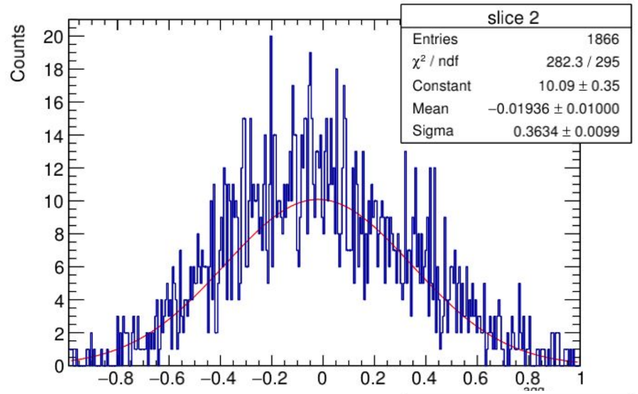


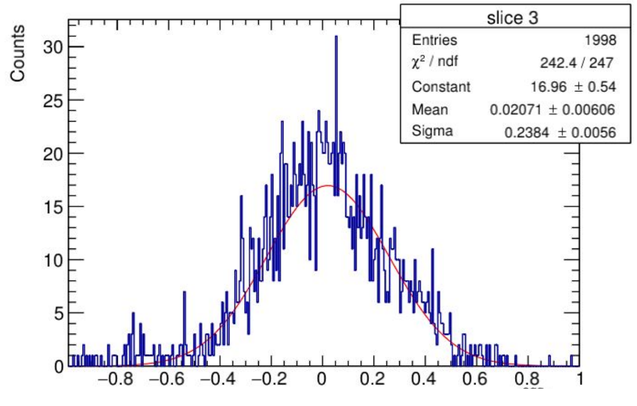
Reduced_χ2 of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

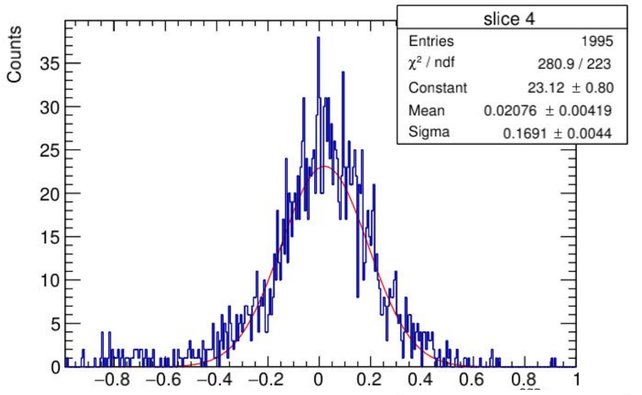
FEMC + FHCAL (pi^-)

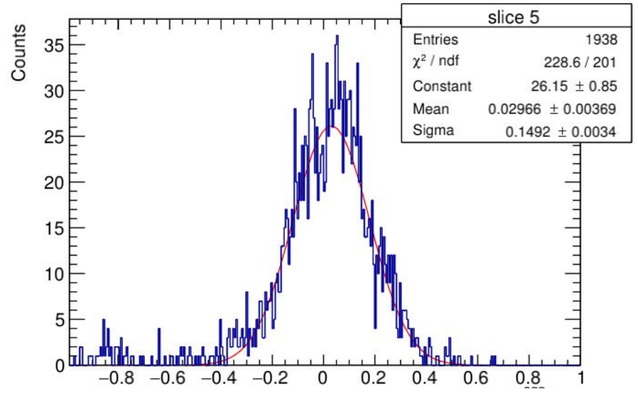
Fitted Gaussians

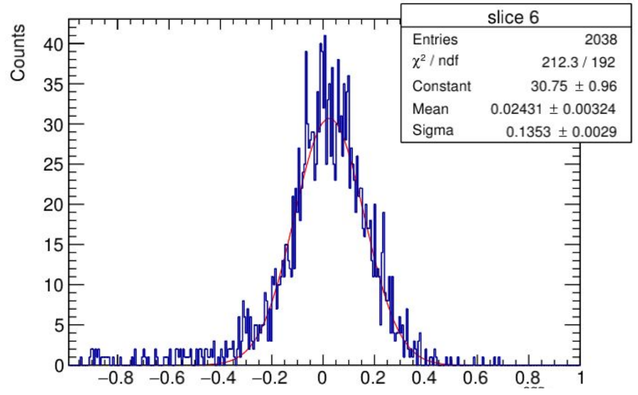


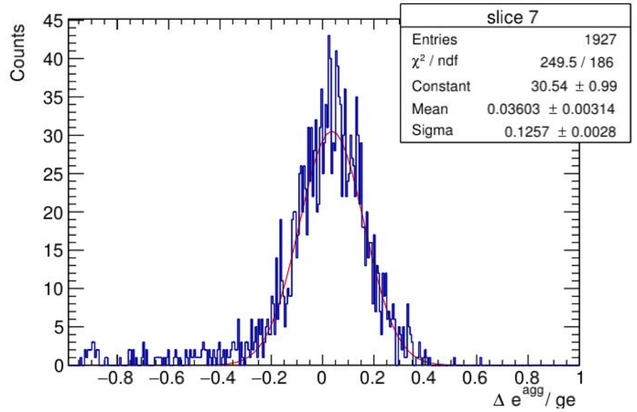


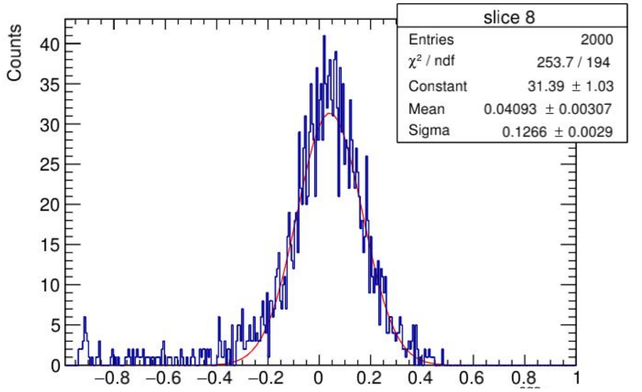


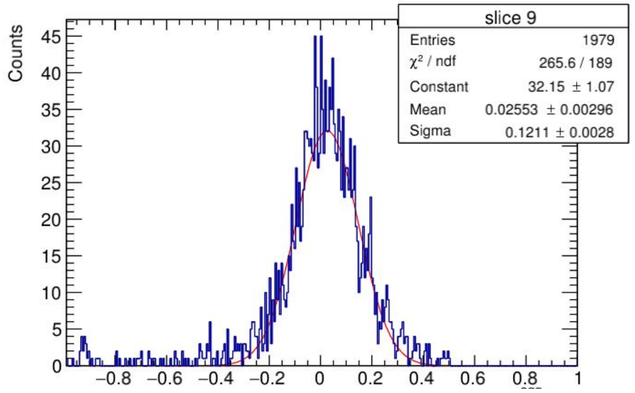


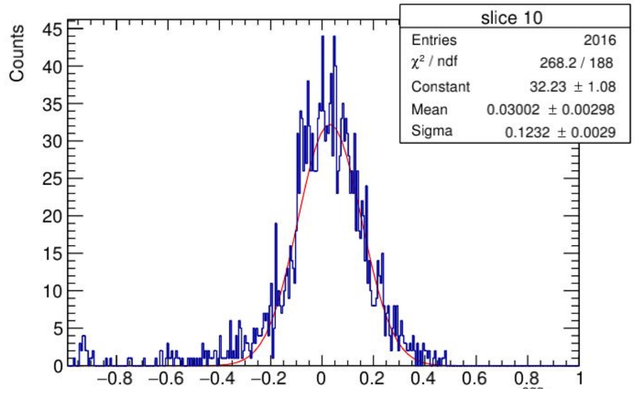










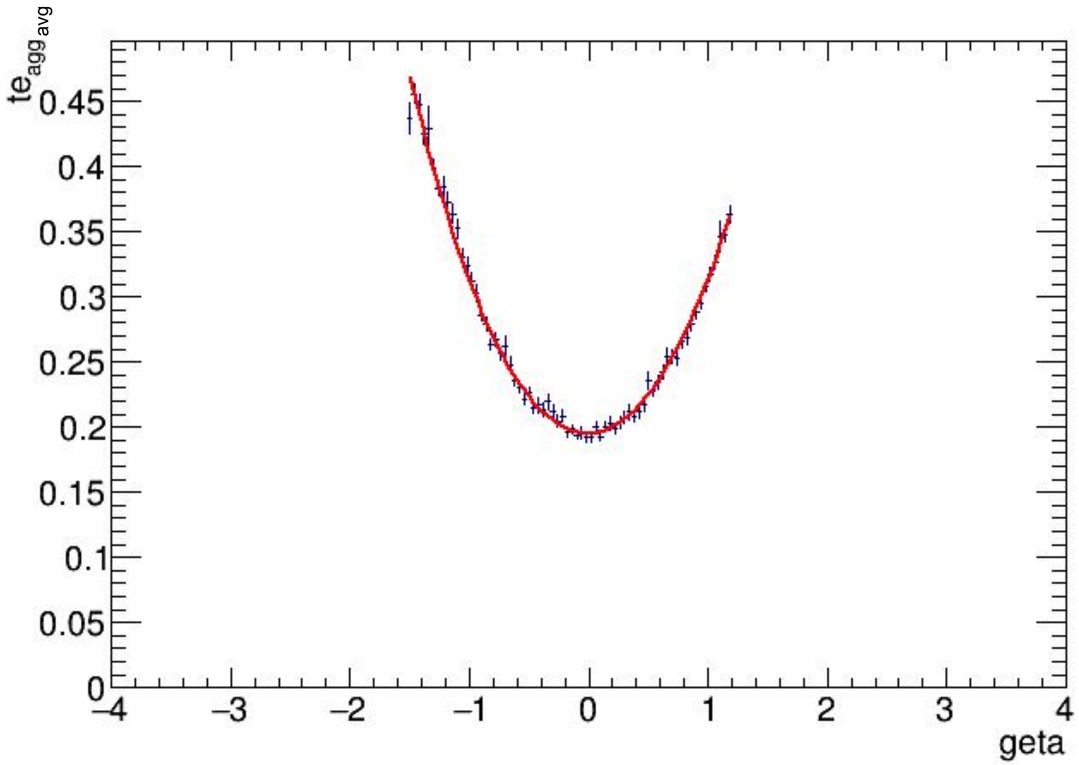


The x-axes denote $\Delta e_{agg}/ge$

CEMC + HCALIN + HCALOUT (pi^-)

CEMC (mu^-)

Theta-parametrization of muon-MIP energy



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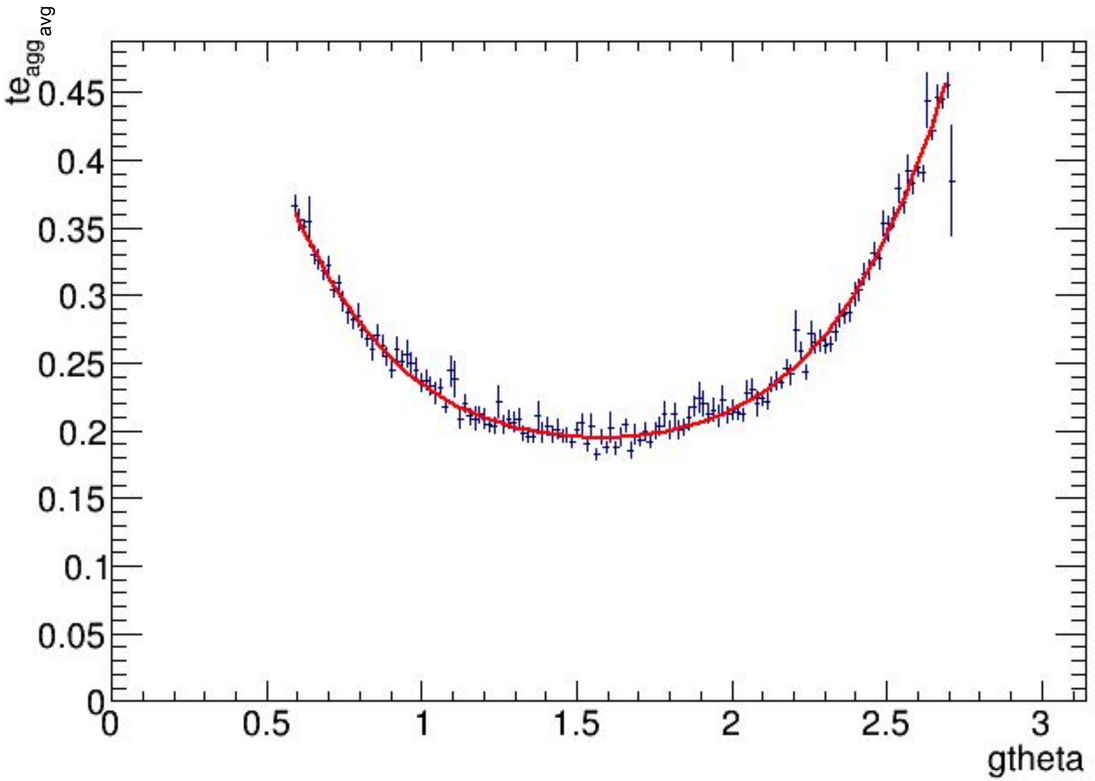
2	p1	4.94077e-04	2.17832e-03	-0.00000e+00	-4.58798e-05
3	p2	1.15078e-01	3.75753e-03	0.00000e+00	5.91976e-05
4	p3	-1.43306e-03	2.35790e-03	0.00000e+00	-2.72666e-04
5	p4	3.01639e-03	2.66675e-03	2.66675e-03	-1.11749e-04

reduced_chi2 of eta fit: 1.0485



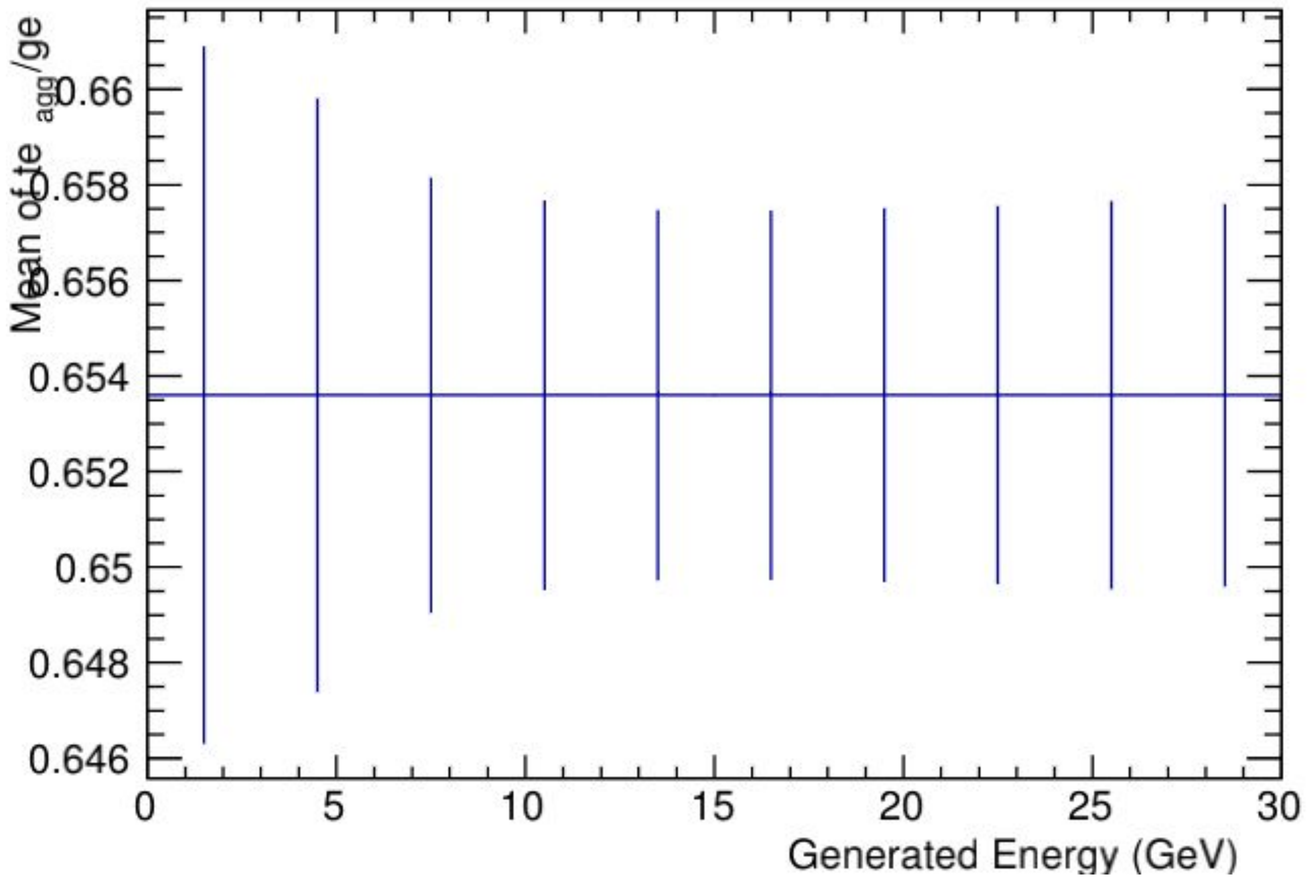
NO.	NAME	VALUE	ERROR	STEP SIZE	DERIVATIVE
1	p0	9.46093e-01	2.68719e-03	-1.23162e-03	4.05204e-08
2	p1	-1.62771e+00	3.43564e-03	3.70185e-03	-5.93767e-07
3	p2	1.37776e+00	1.81743e-03	-3.83630e-03	1.14713e-05
4	p3	-5.49960e-01	8.68094e-04	1.64797e-03	2.56433e-05
5	p4	8.82673e-02	2.50538e-04	2.50538e-04	3.20234e-04

reduced_chi2 of theta fit: 1.03869

CEMC + HCALIN + HCALOUT (pi^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: -0.96 to 0.92
gtheta-parametrized Aggregate Energy Cut on EMC Towers

After calibration



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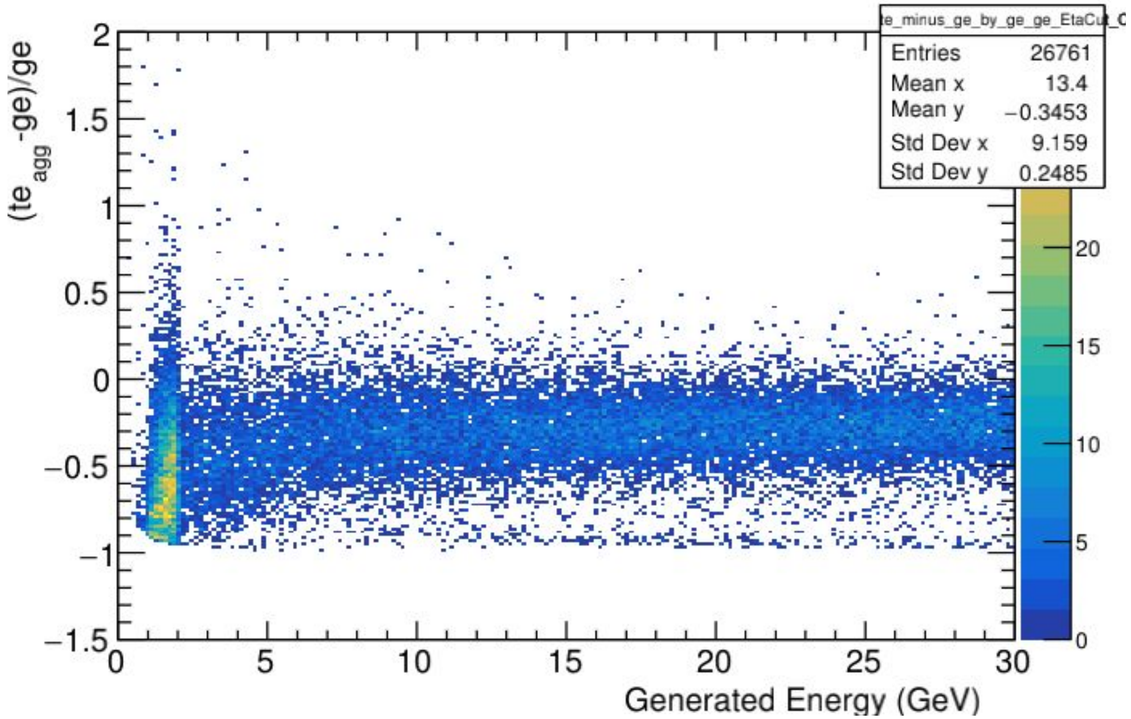

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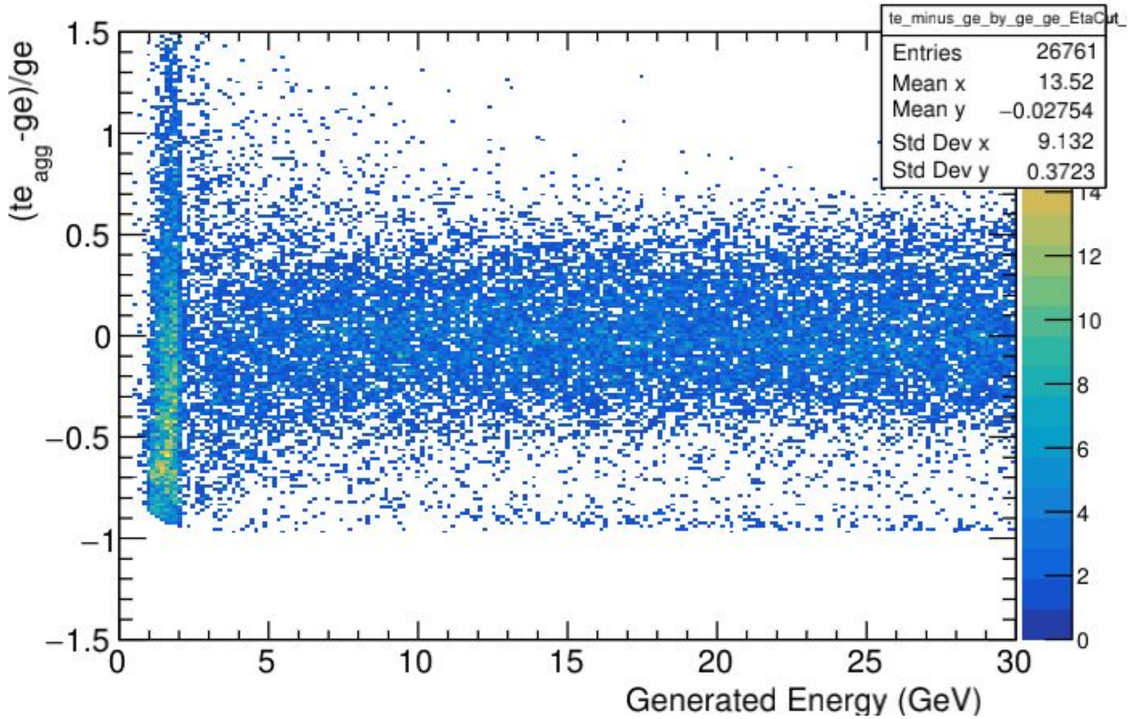

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σ_e_{agg} vs ge
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Elliptical Cut for Manual Clustering
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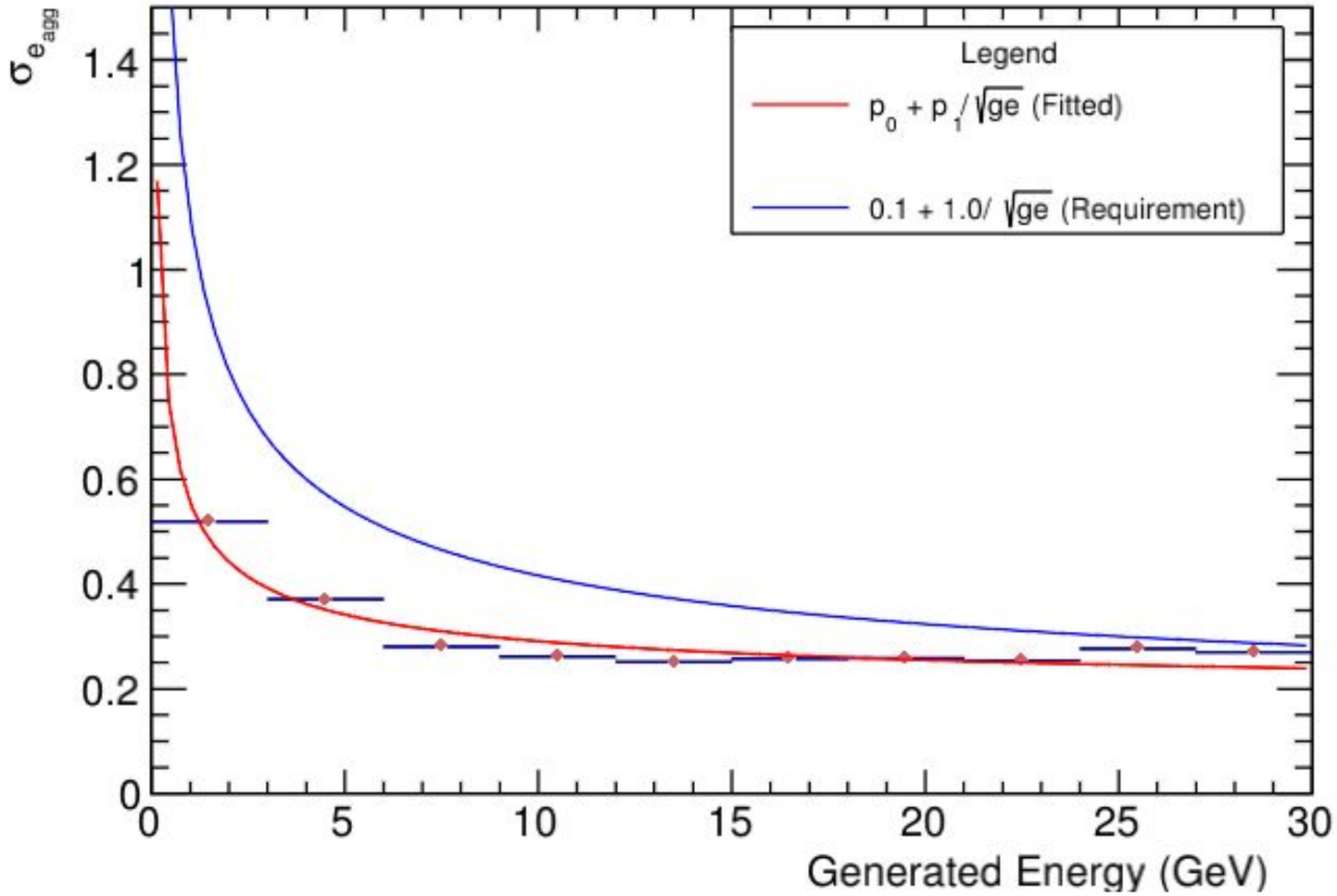


σe refers to the standard deviation of the Gaussian fitted to a slice of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

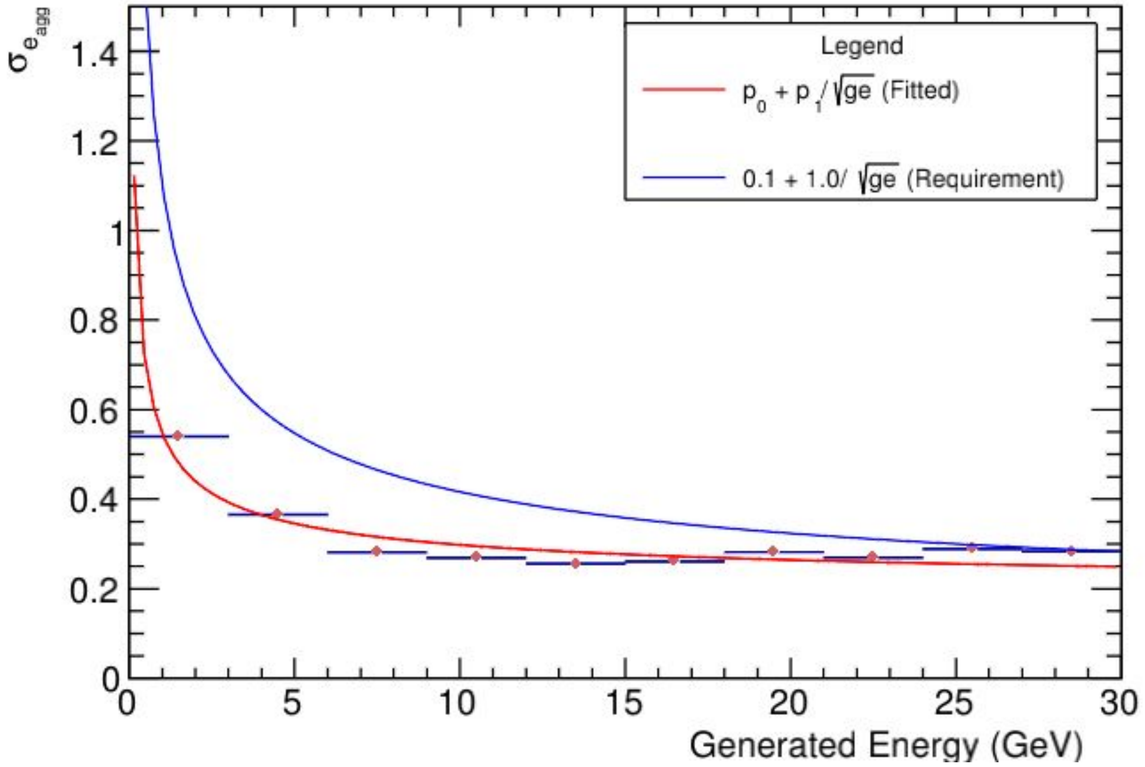
Number of bins = 10
Bin Width = 3 GeV

Fit Parameters:
p_o = (0.168319 +- 0.00460525)
p_1 = (0.387529 +- 0.0151562) $GeV^{0.5}$

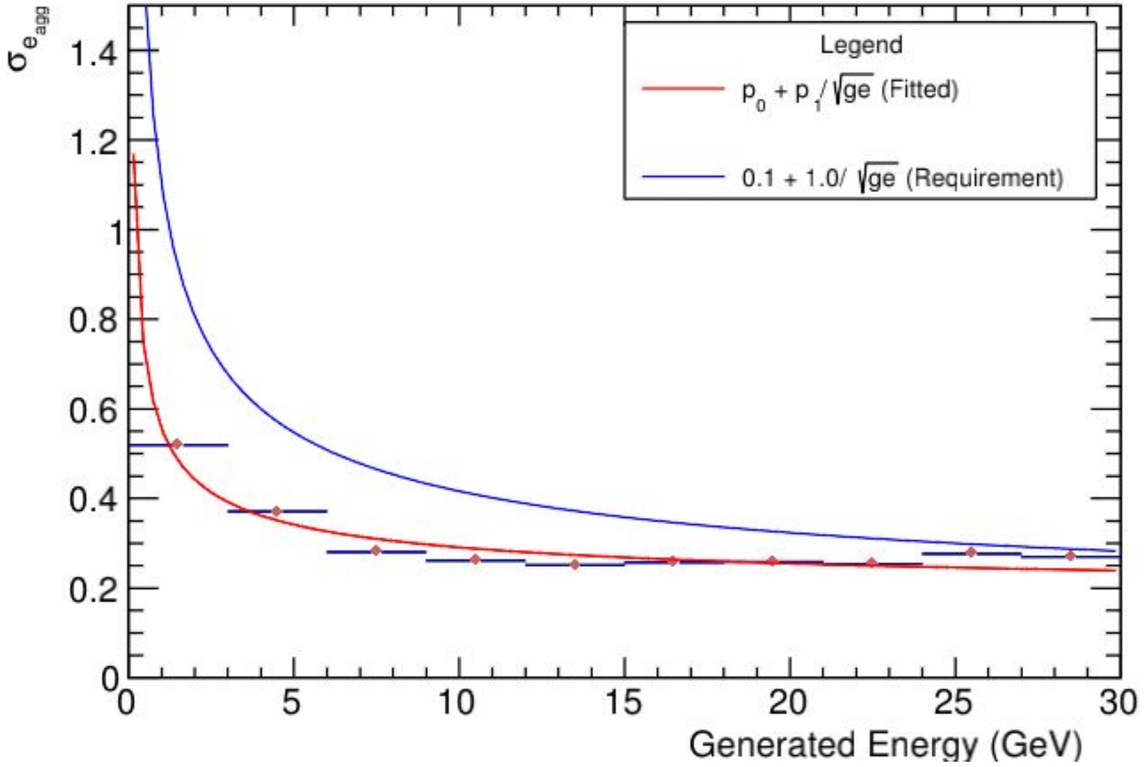
CEMC + HCALIN + HCALOUT (pi^-)

Explicit η cut: -0.96 to 0.92
Elliptical Cut for Manual Clustering
gtheta-parametrized Aggregate Energy Cuts on EMC Towers

360 MeV energy cut on aggregate EMC Towers

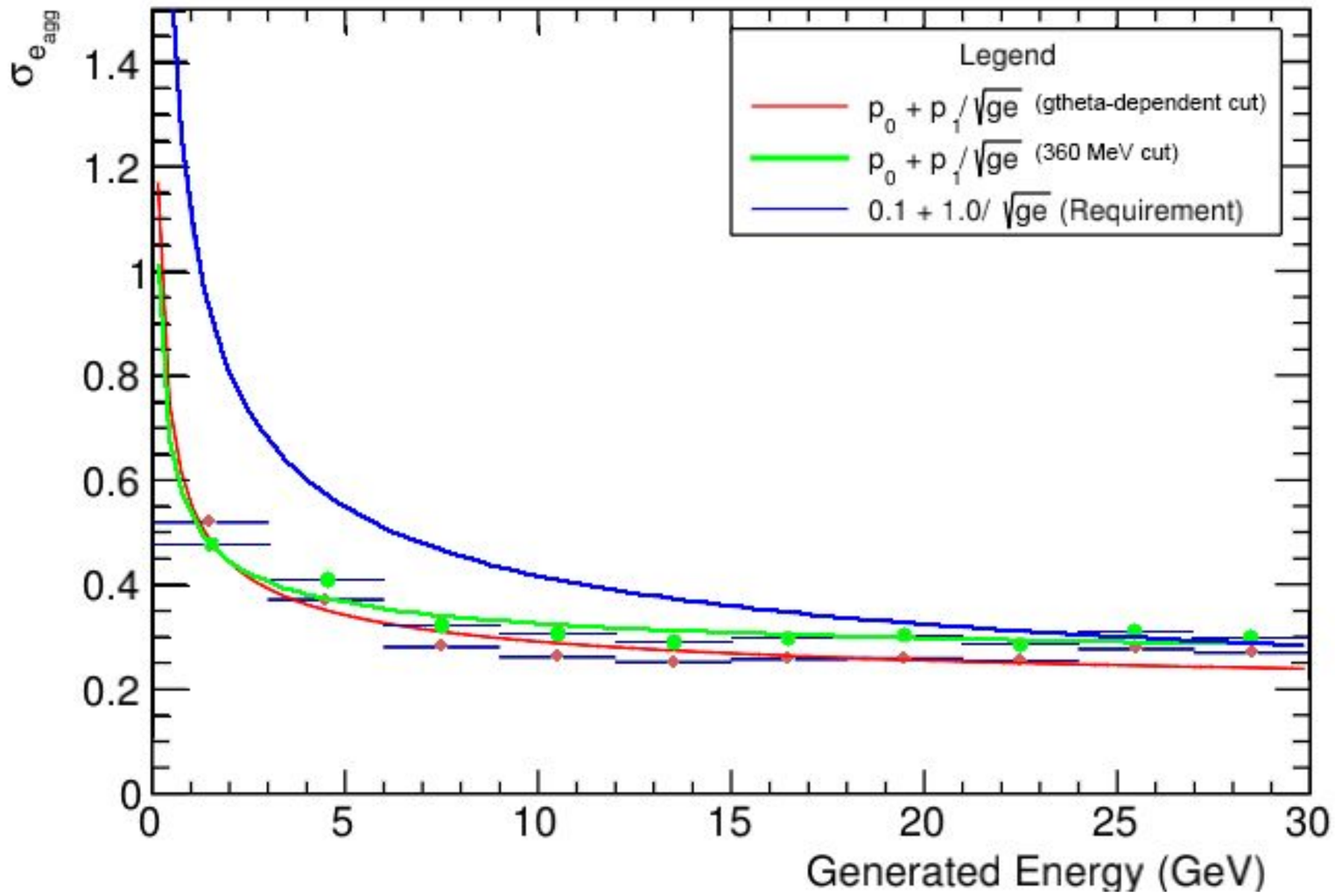


gtheta-dependent energy cut on aggregate EMC Towers



CEMC + HCALIN + HCALOUT (pi^-)

Elliptical cut on dphi vs dtheta
Explicit η cut: -0.96 to 0.92
Comparison of Energy Resolutions Obtained



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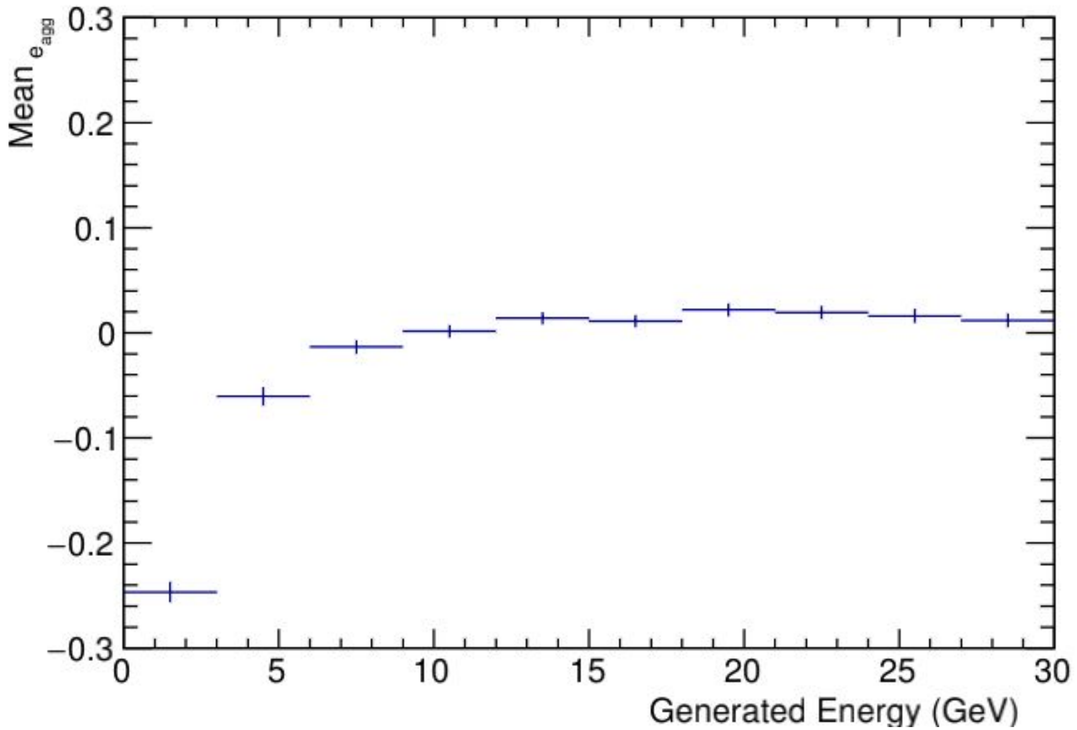
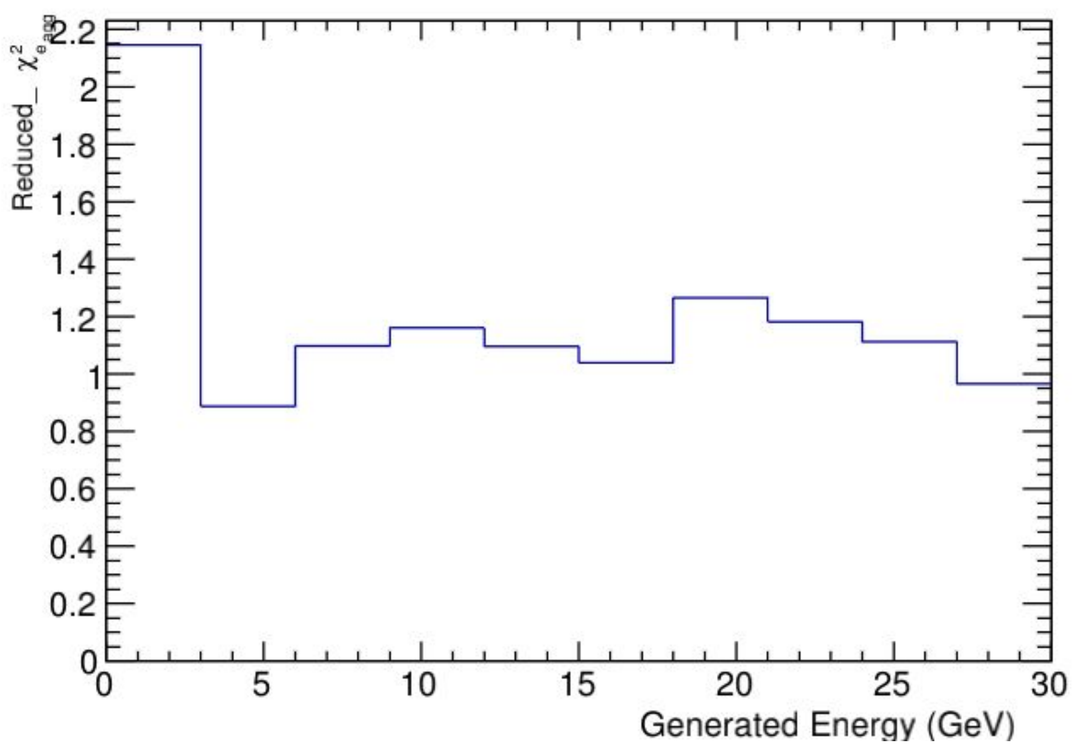


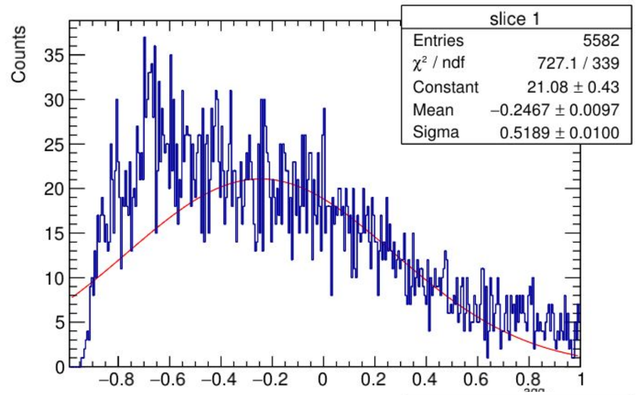
Mean of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

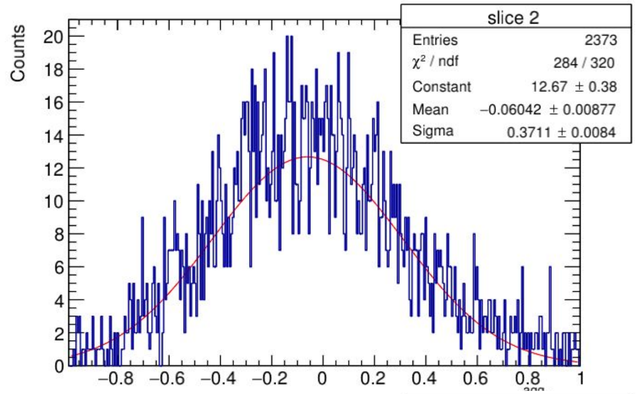


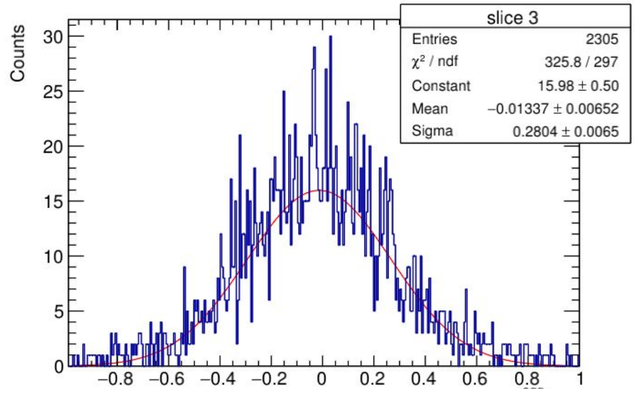
Reduced_χ2 of the Gaussians fitted to the slices of the calibrated $(te_{agg}-ge)/ge$ vs ge plot.

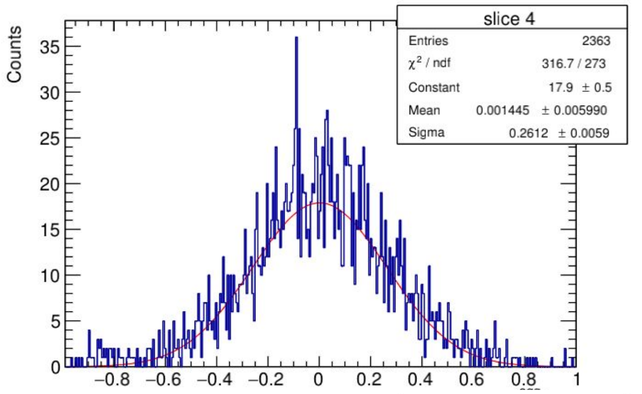
CEMC + HCALIN + HCALOUT (pi^-)

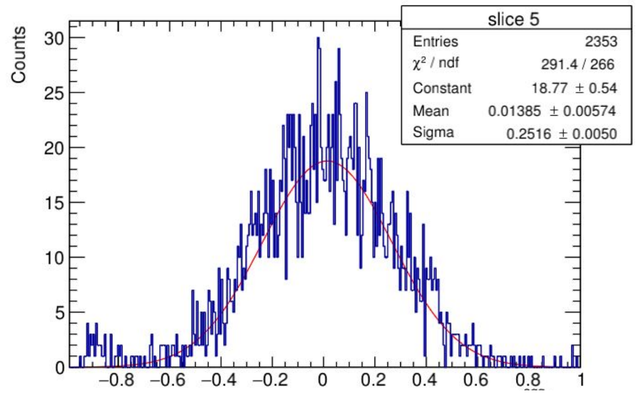
Fitted Gaussians

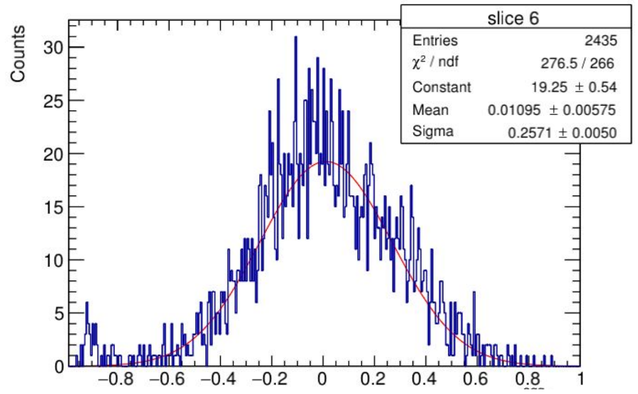


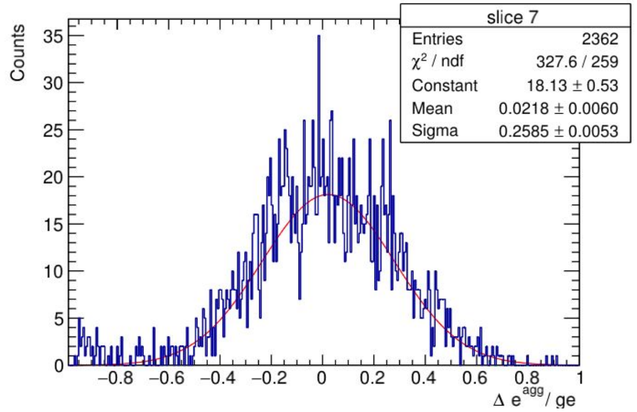


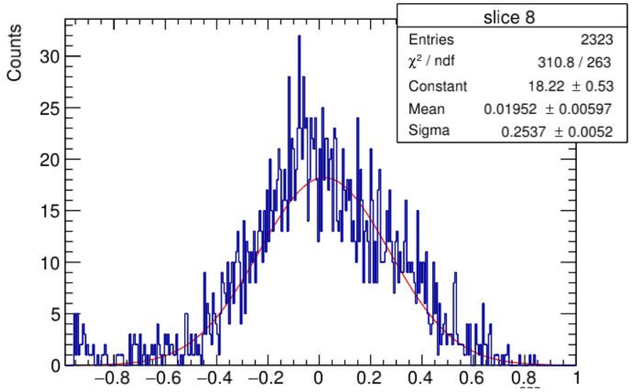


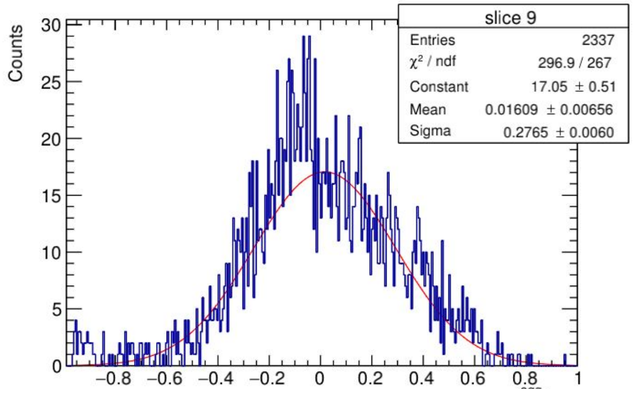


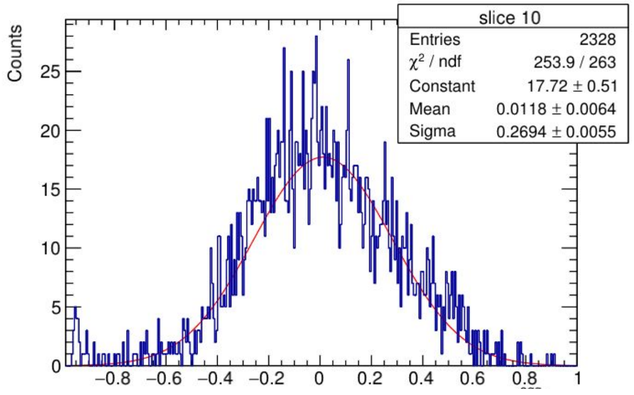












The x-axes denote $\Delta e_{agg}/ge$