



Simulation Statistics

By Sagar and Siddhant
Under the guidance of Dr. Ankhi Roy

May 14, 2021

IIT Indore

Contents

Histograms for verification of energy conservation such as energy resolution of detectors, variation of aggregate tower energy with generated energy, and histograms such as tower counts, variation of tower Φ, θ with generated Φ, θ (and how an elliptical cut in $t\phi$ - $g\phi$ ($d\phi$) vs $t\theta$ - $g\theta$ ($d\theta$) affects them) for the following detector-particle pairs:

- FEMC: Electron
- FEMC + FHCAL: Pion

$t\phi$: tower ϕ , $t\theta$: tower θ , t_{agg} : tower energies aggregated in an event
 $g\phi$: generated ϕ , $g\theta$: generated θ , g_e : generated energy

Simulation Parameters

- Particle: e^- , π^-
- Events: 100,000 per particle
- momentum (p): 0 to 30 GeV/c
- Pseudorapidity (η): -4 to 4
- Azimuth (Φ): $-\pi$ to π

Cuts:

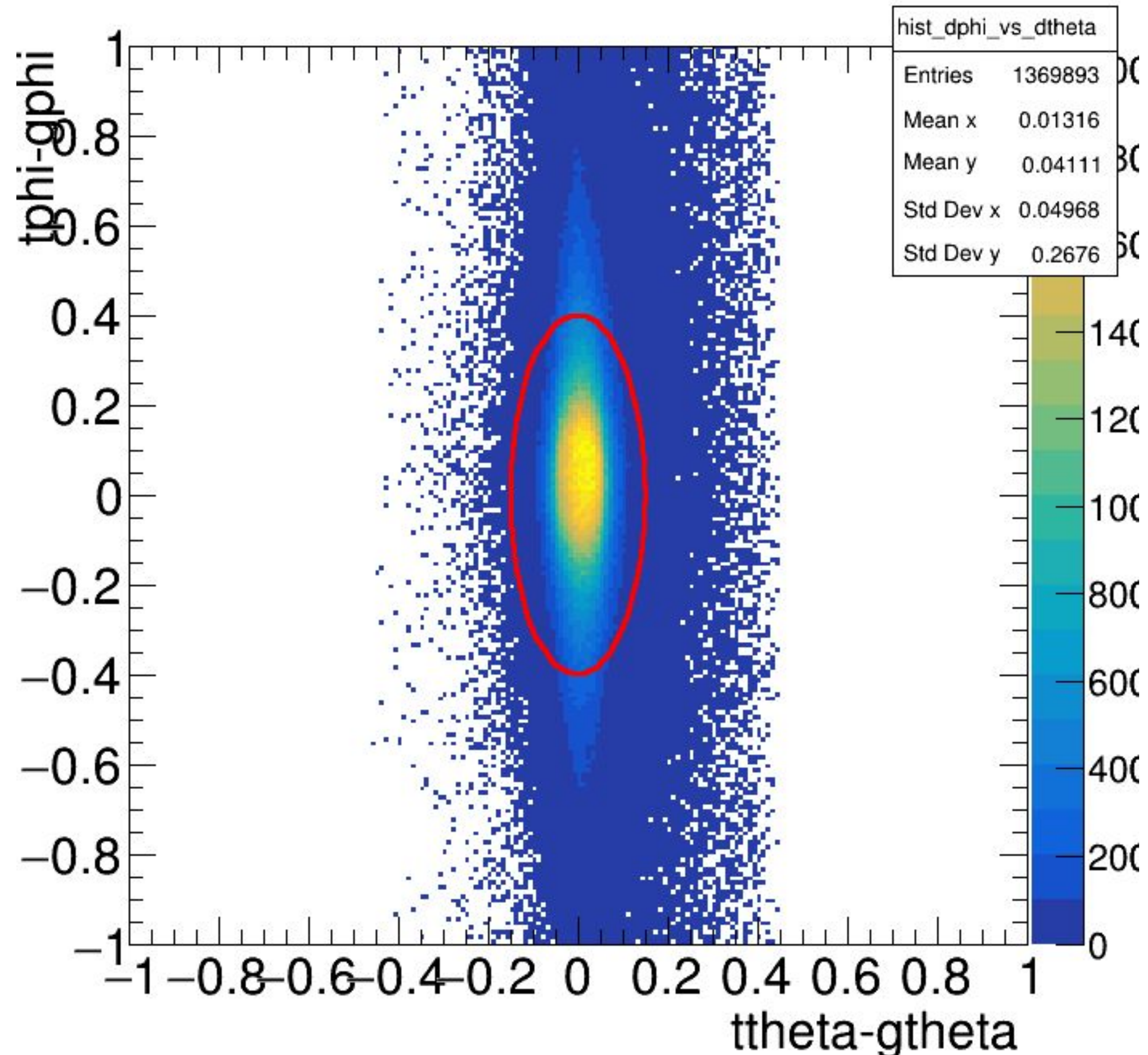
- Detector-wise η cuts (intersection of η ranges in case of detector combinations)
- Detector-wise elliptical cuts in $d\phi$ vs $d\theta$ plots (simultaneously included in case of detector combinations)

A teal-colored geometric graphic consisting of several overlapping triangles and quadrilaterals, creating a faceted, crystalline appearance. It is positioned on the left side of the slide.

FEMC (e^-)

FEMC (e^-)

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



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

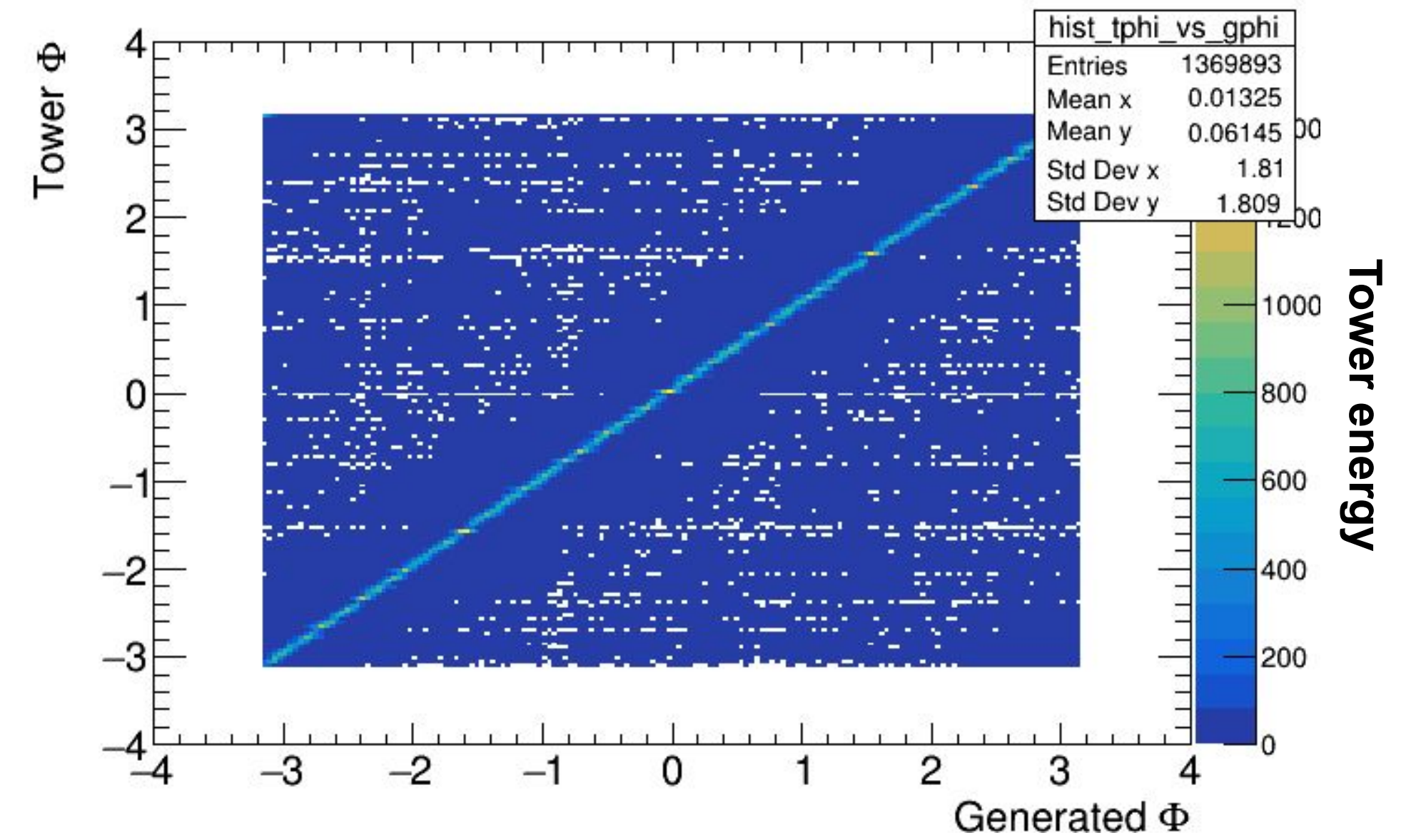
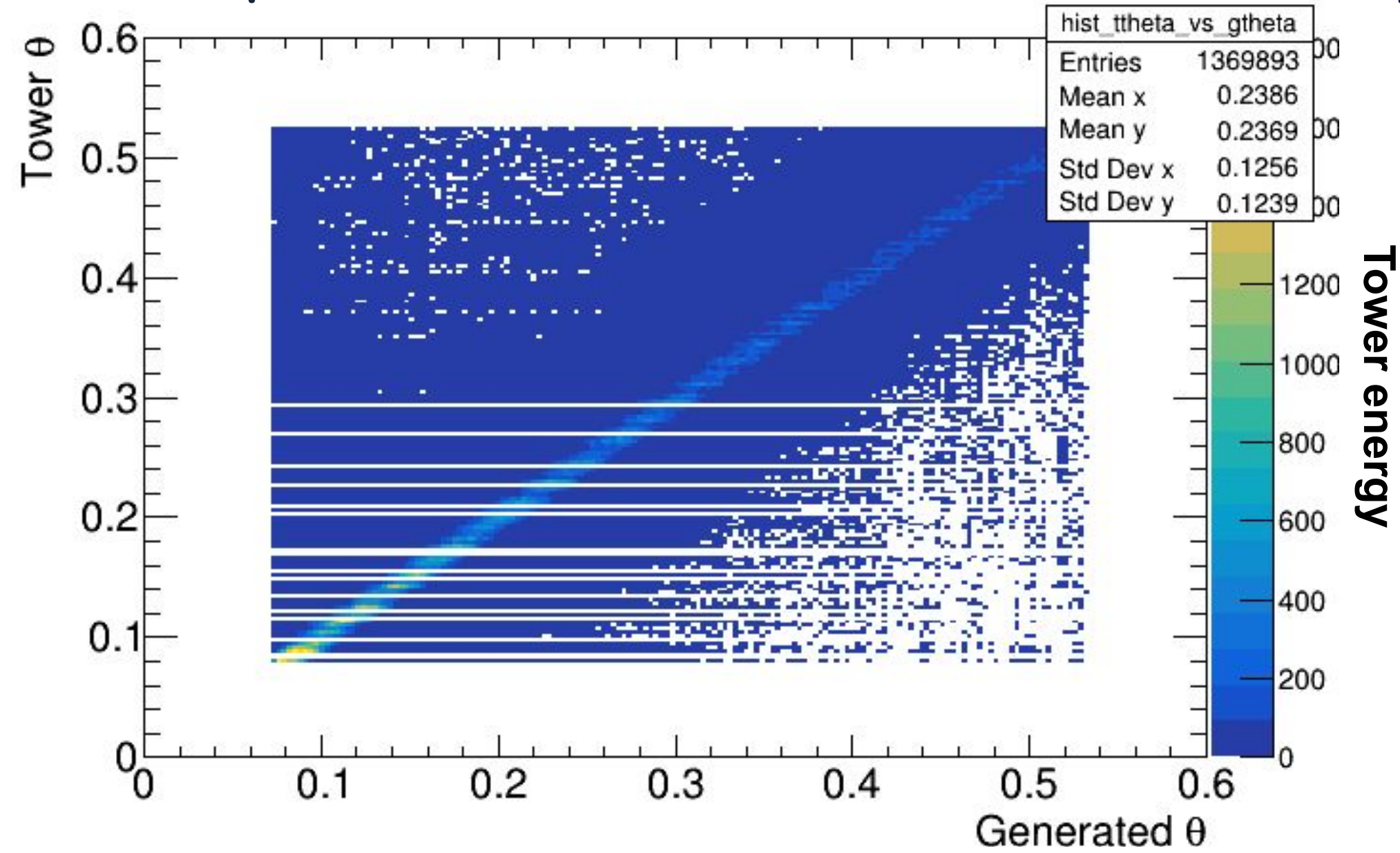
Dimensions:

semi-minor axis = 0.15 units
semi-major axis = 0.40 units

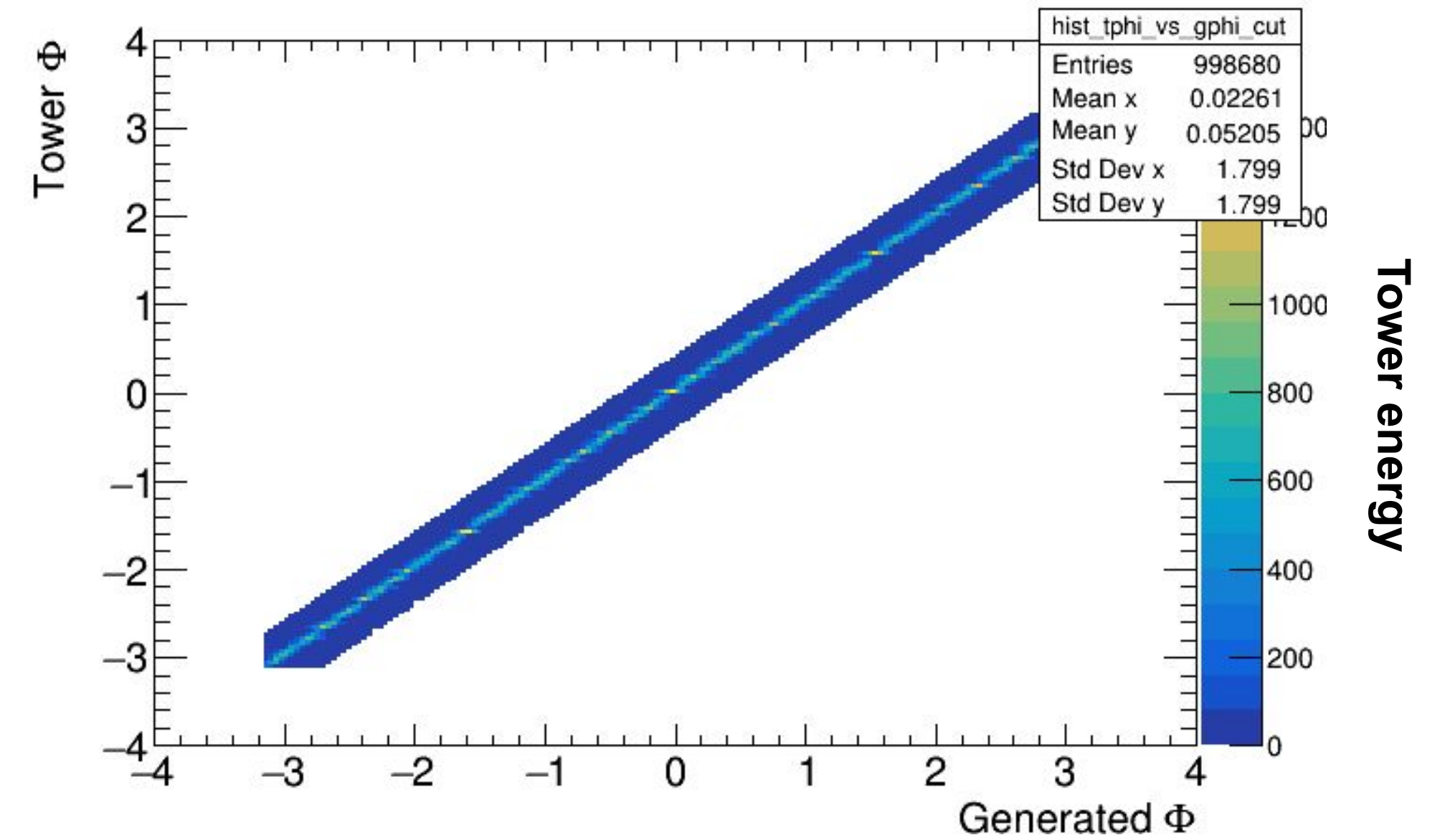
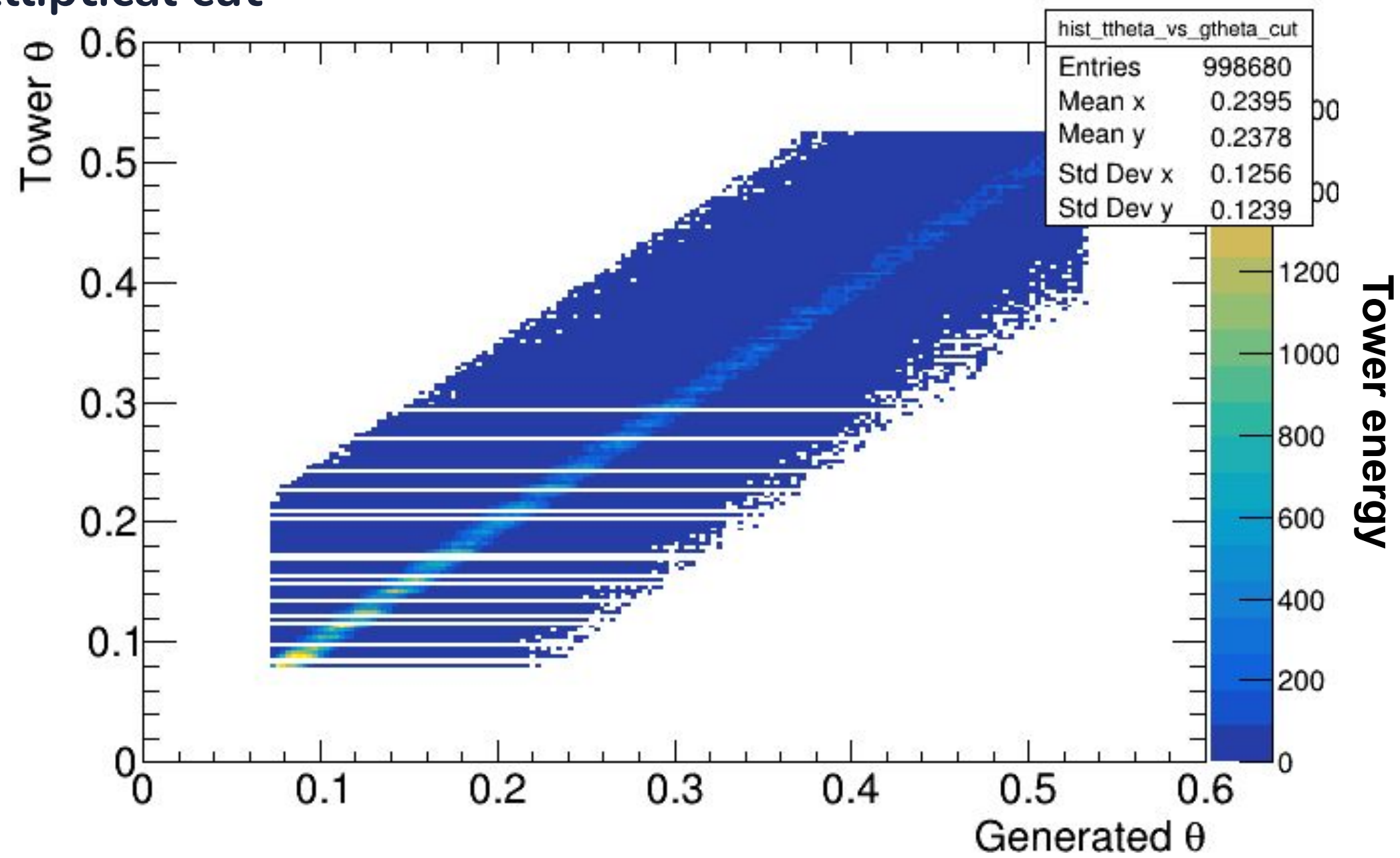
FEMC (e^-)

Explicit η cut: 1.3 to 3.3

Without Elliptical cut



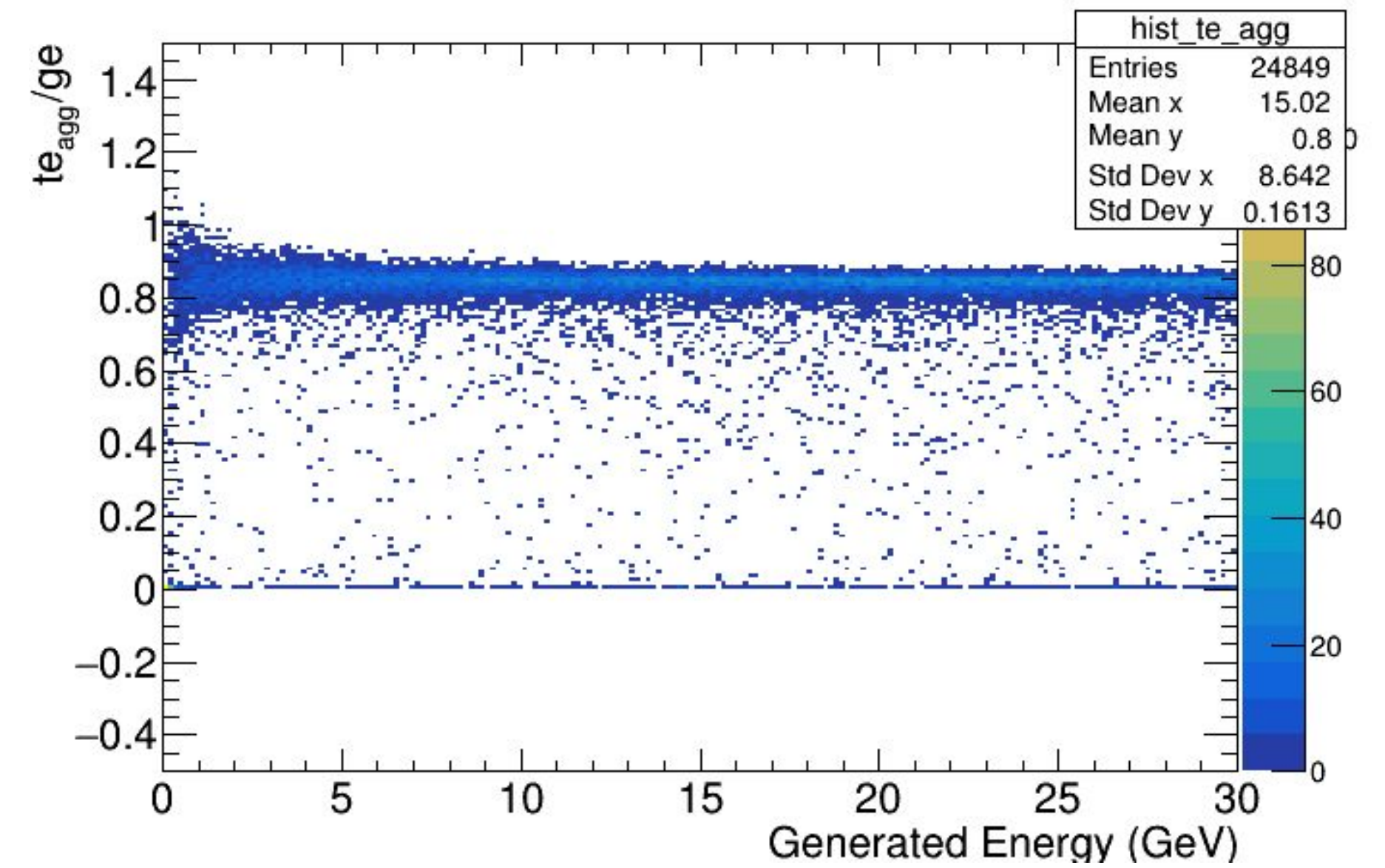
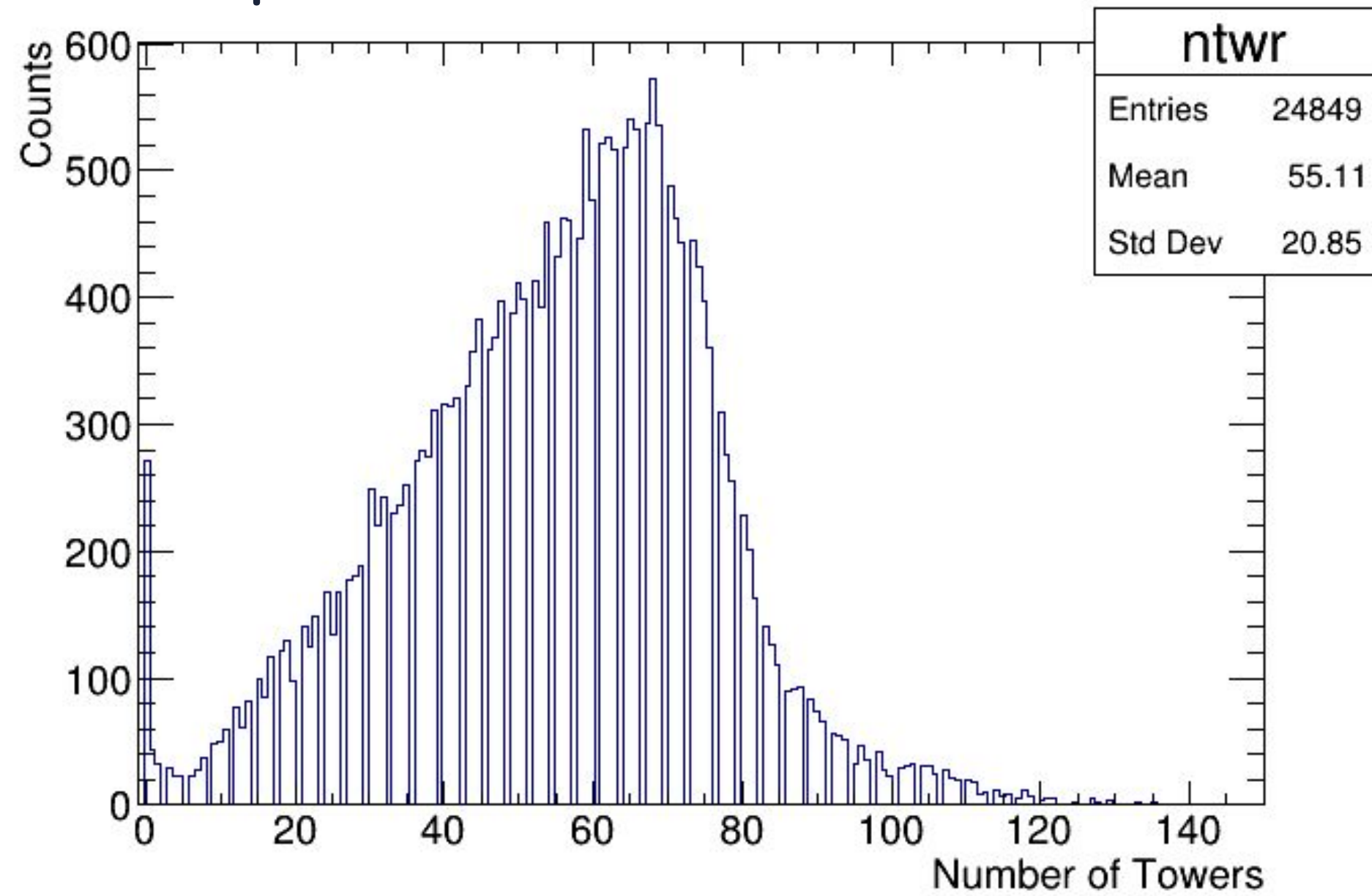
Elliptical cut



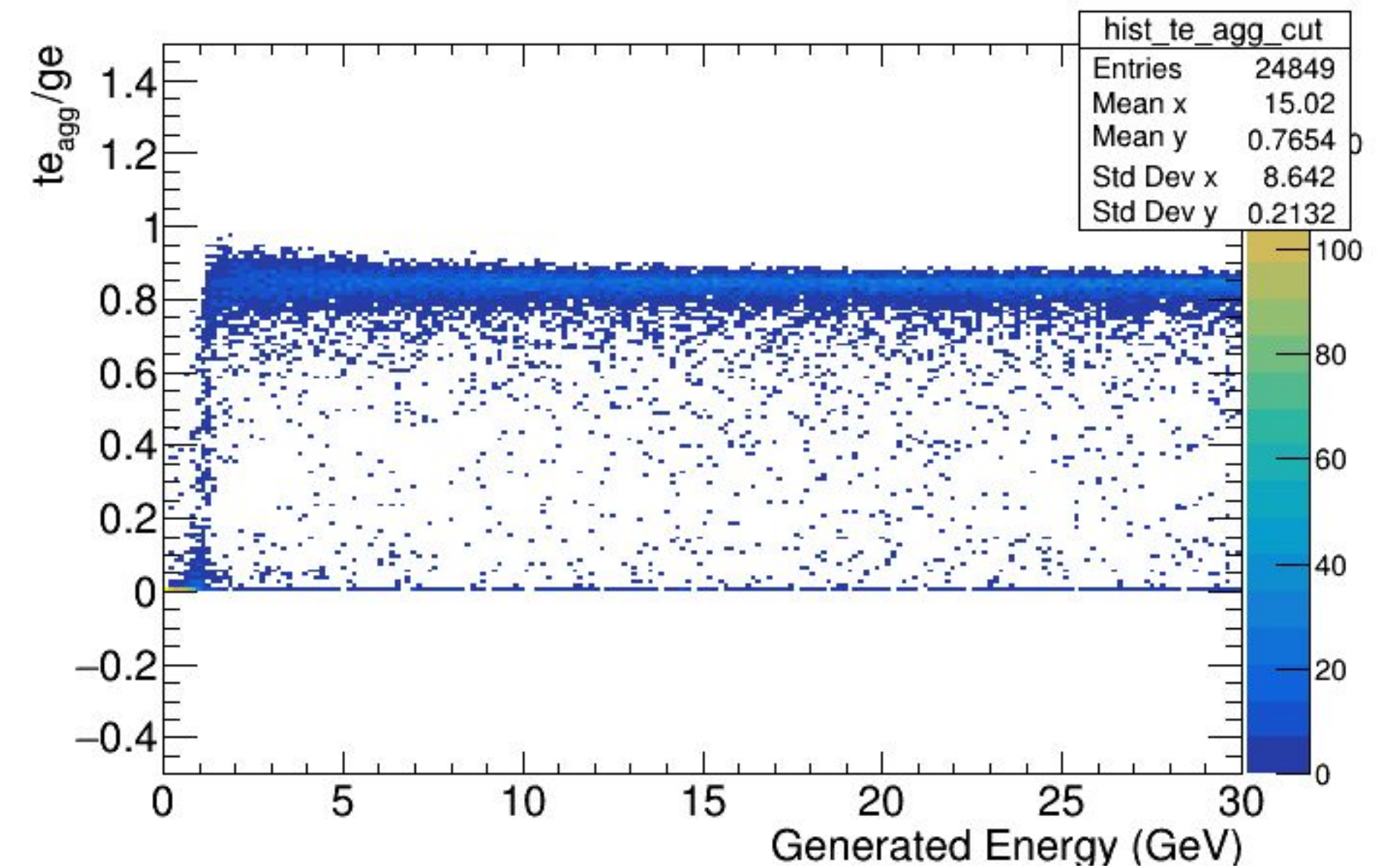
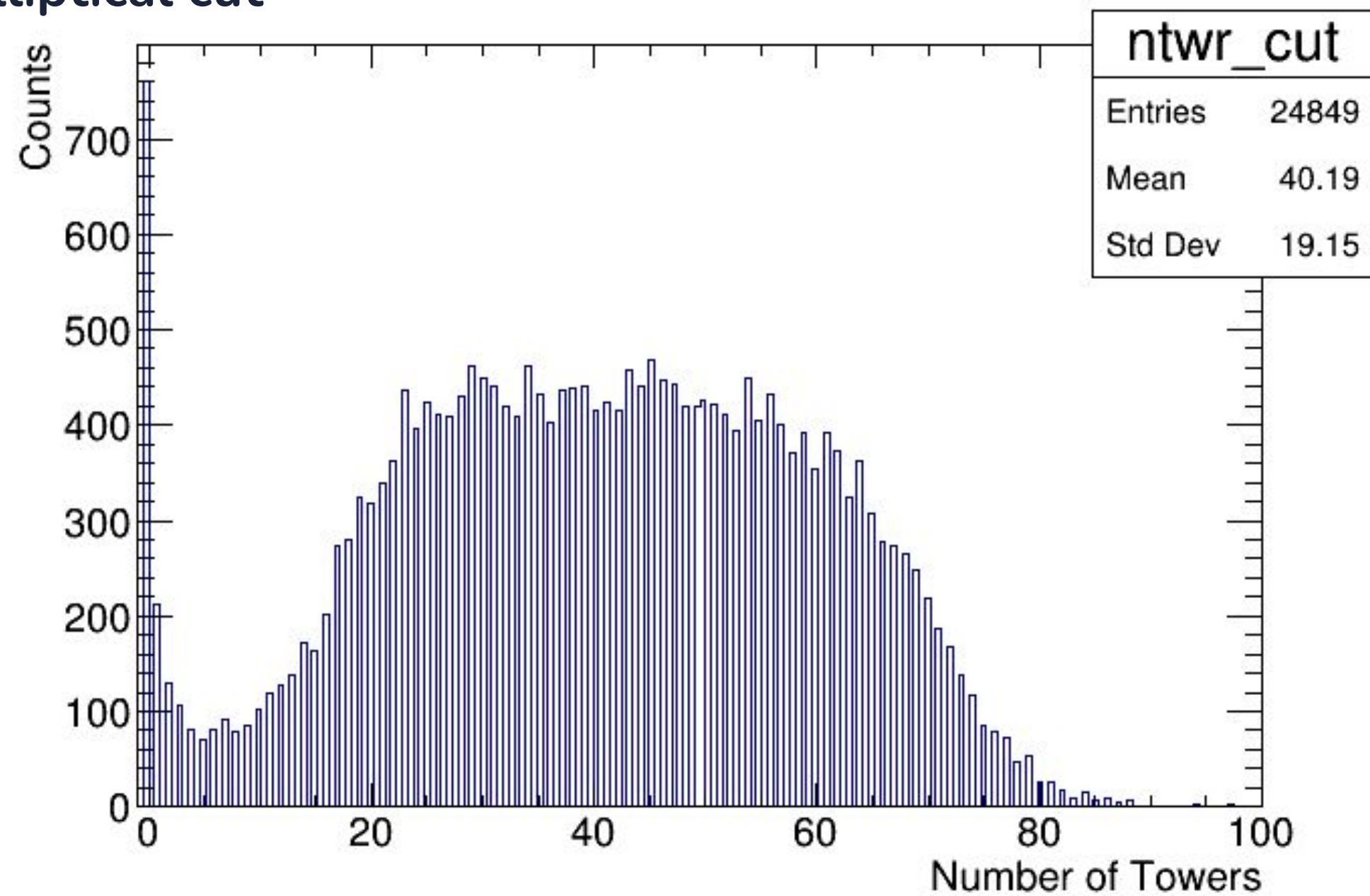
FEMC (e^-)

Explicit η cut: 1.3 to 3.3

Without Elliptical cut

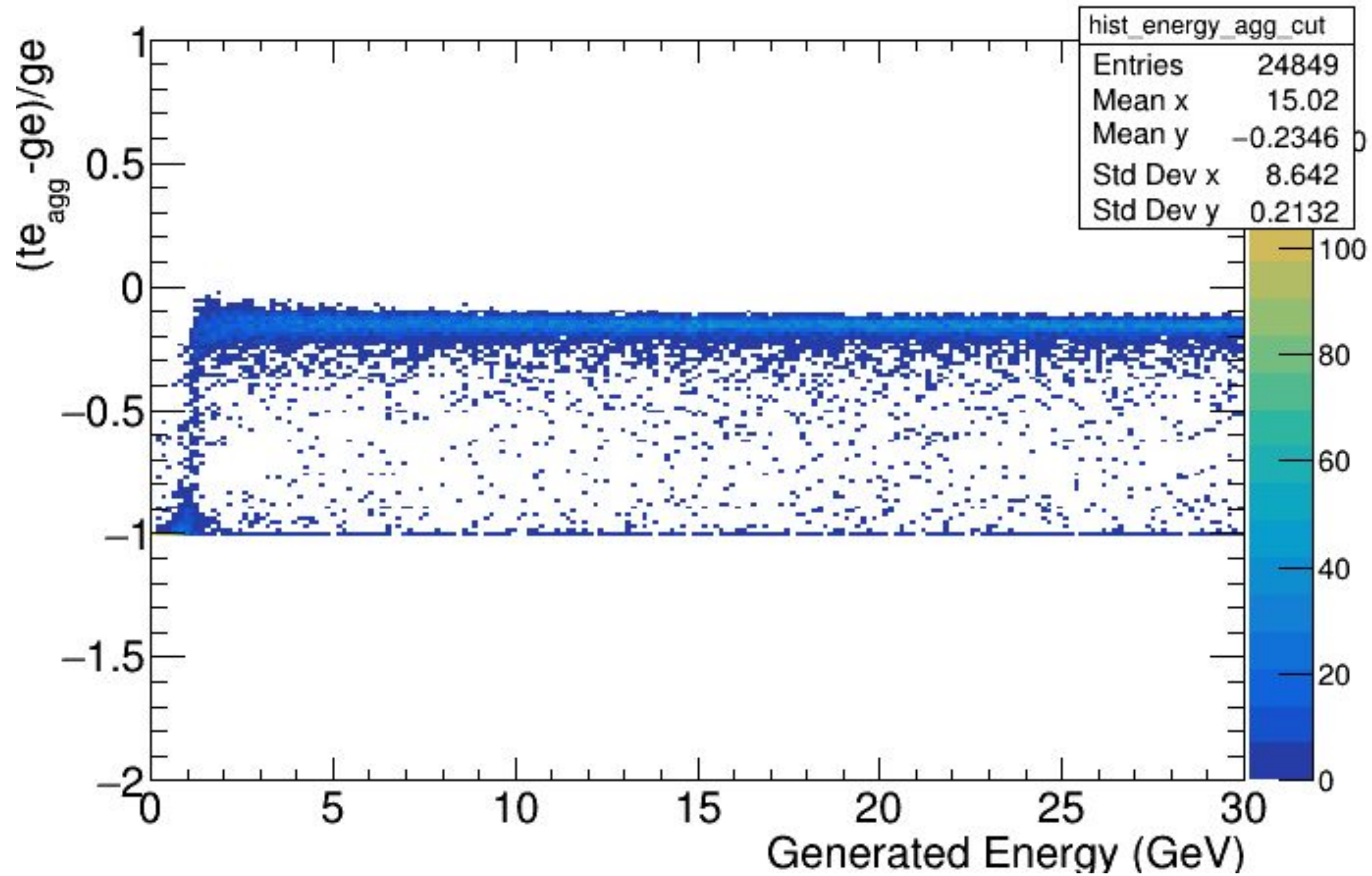


Elliptical cut



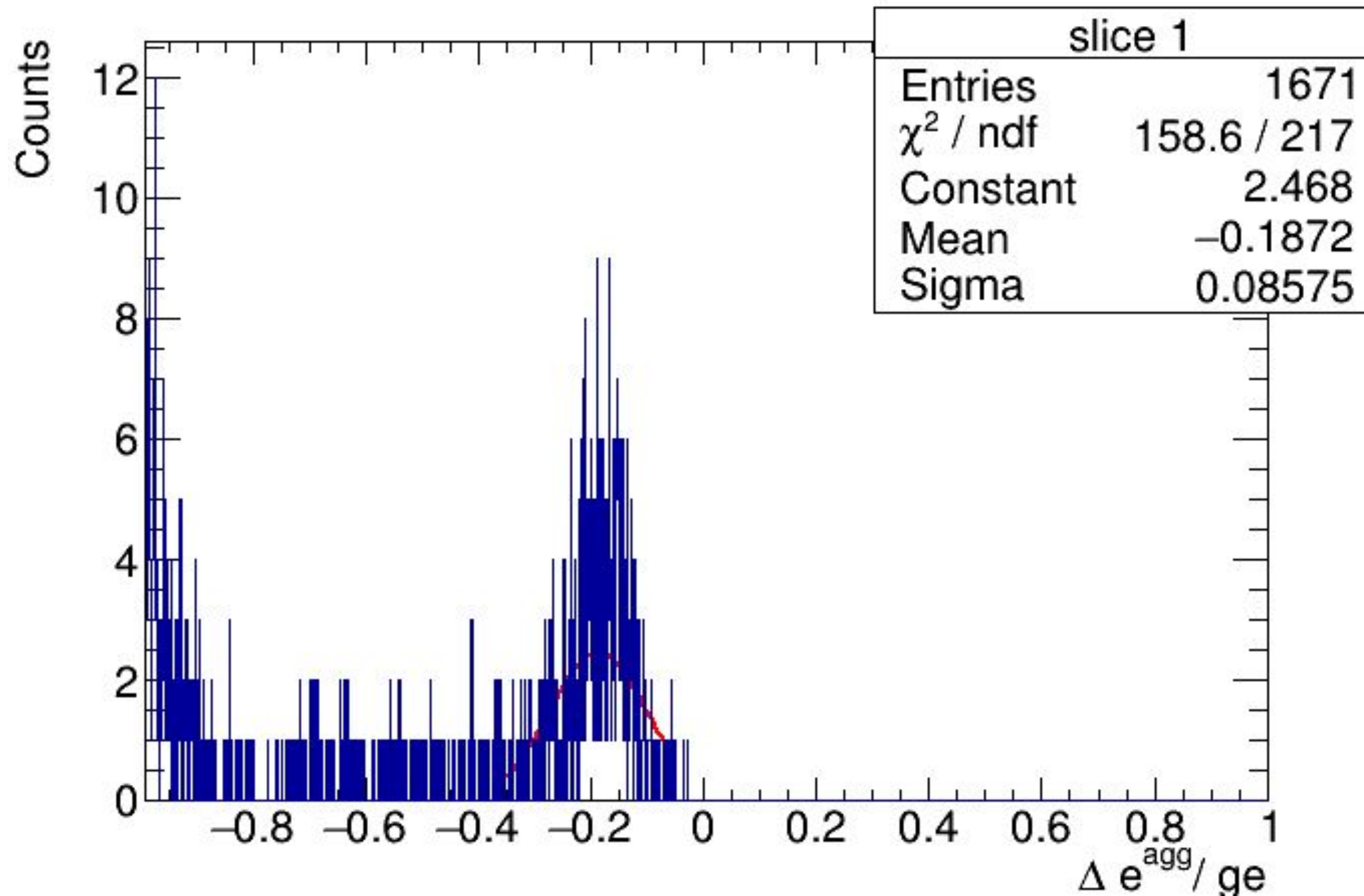
FEMC (e^-)

$(te_{agg} - ge)/ge$ vs ge
Explicit η cut: 1.3 to 3.3
Elliptical cut



FEMC (e^-)

$(t_{e_{agg}} - g_e) / g_e$ vs g_e
Gaussian fit of the first slice (0-2 GeV)



This is the gaussian fit of the first slice of the $(t_{e_{agg}} - g_e) / g_e$ vs g_e plot. (shown on the previous slide)

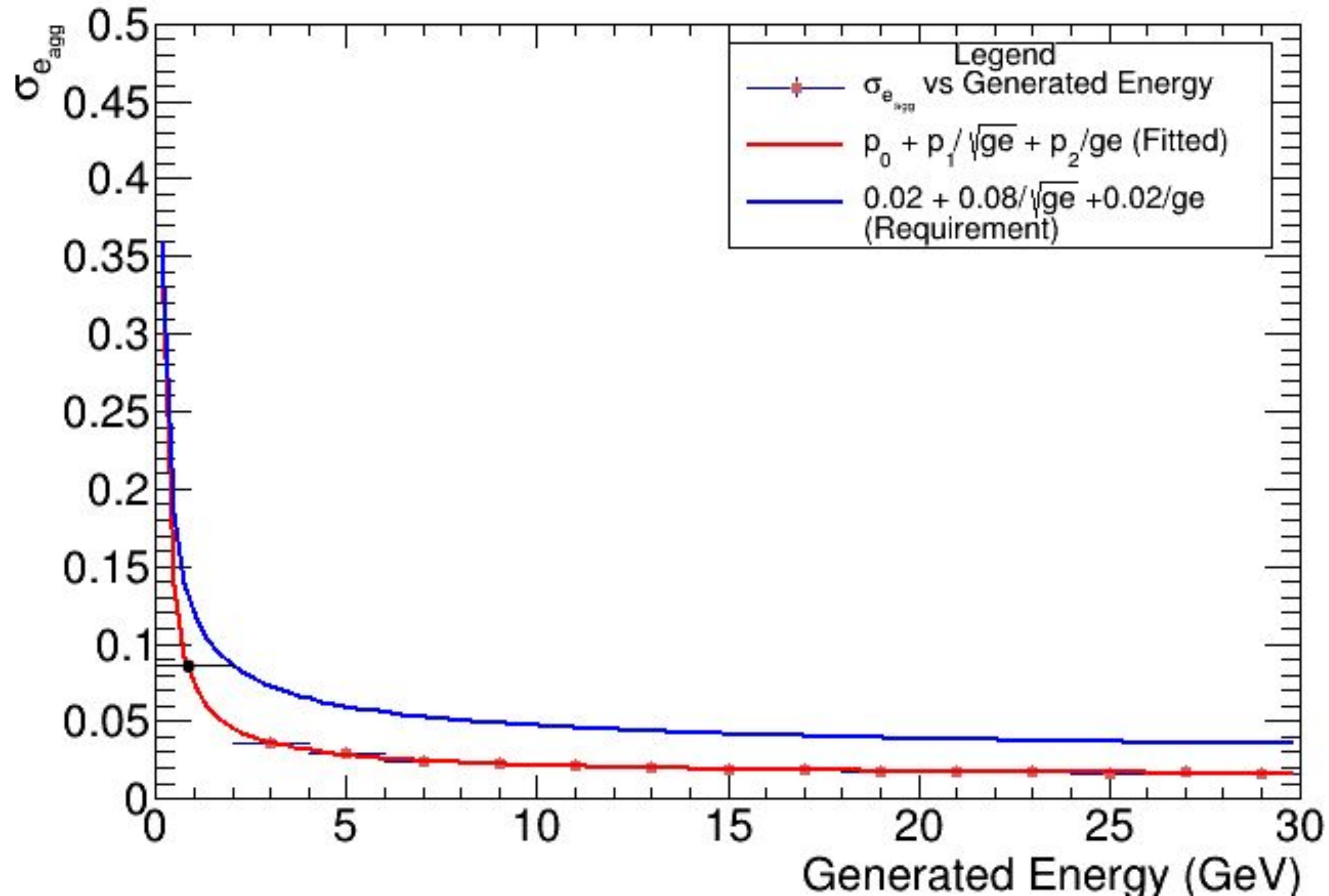
This fit has been done manually by restricting the fit range of the gaussian from -0.35 to -0.05

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

Number of bins = 2000 from -0.99 to +0.5

FEMC (e^-)

$(t_{e_{agg}} - g_e)/g_e$ vs g_e
Explicit η cut: 1.3 to 3.3
Elliptical cut



σ_e refers to the standard deviation of the Gaussian fitted to a slice of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot. (shown on the previous slide)

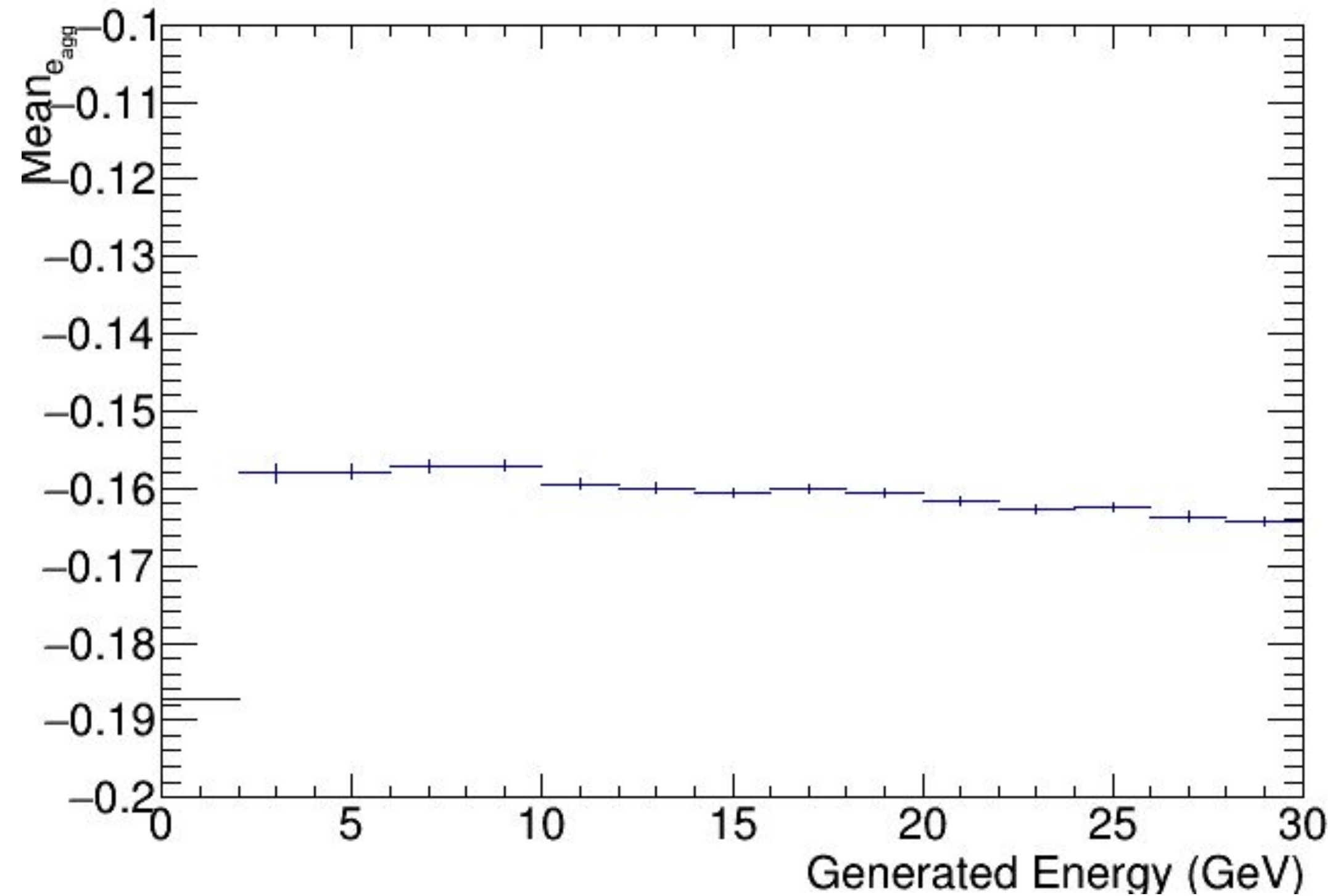
Number of bins = 15
Bin Width = 2 GeV

Fit Parameters:

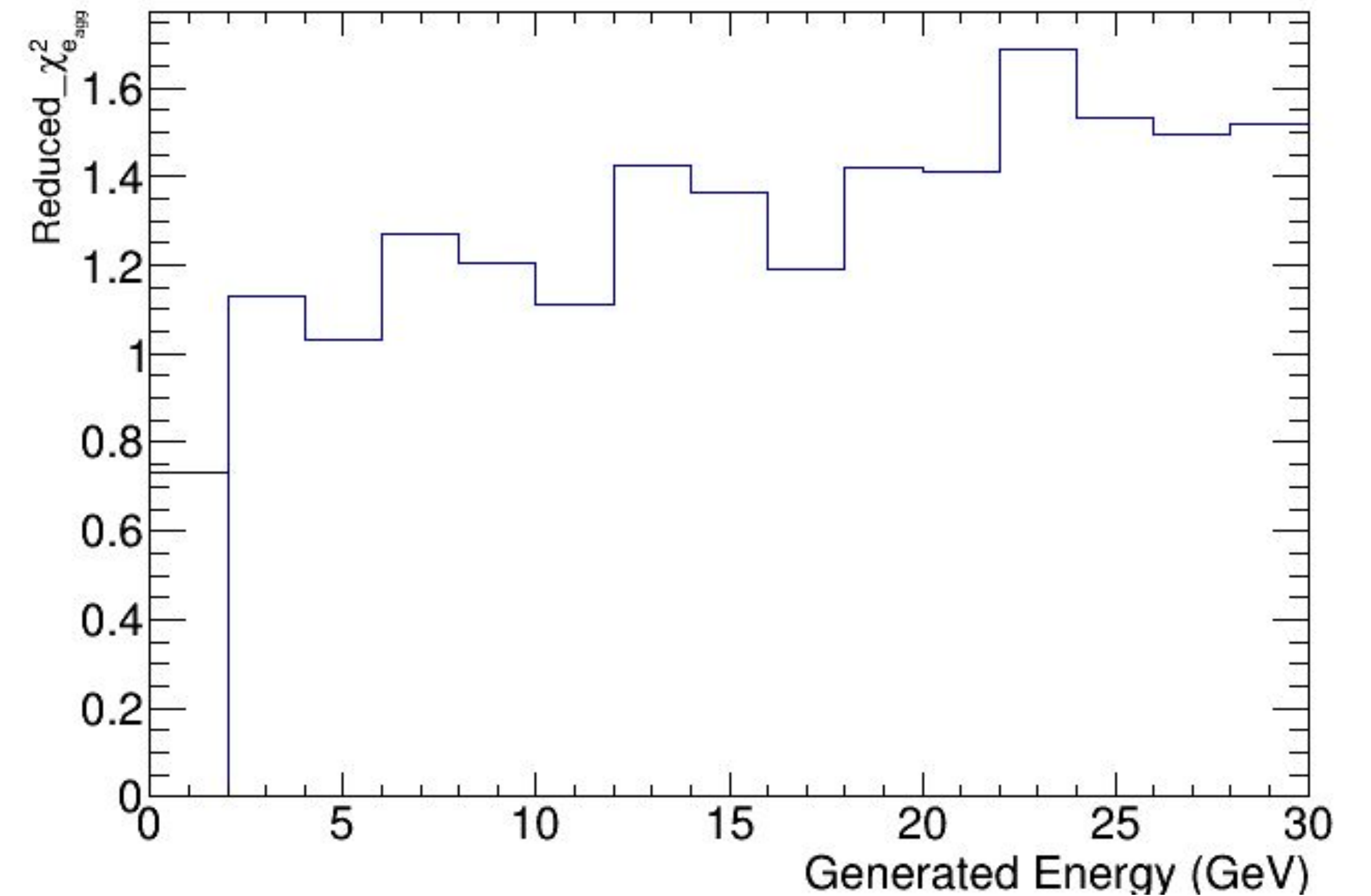
$p_0 = (0.0117390 \pm 0.00160787)$
 $p_1 = (0.0170142 \pm 0.0105064) \text{ GeV}^{0.5}$
 $p_2 = (0.0451540 \pm 0.0157088) \text{ GeV}$

FEMC (e^-)

$(t_{e_{agg}} - g_e)/g_e$ vs g_e
Explicit η cut: 1.3 to 3.3
Elliptical cut



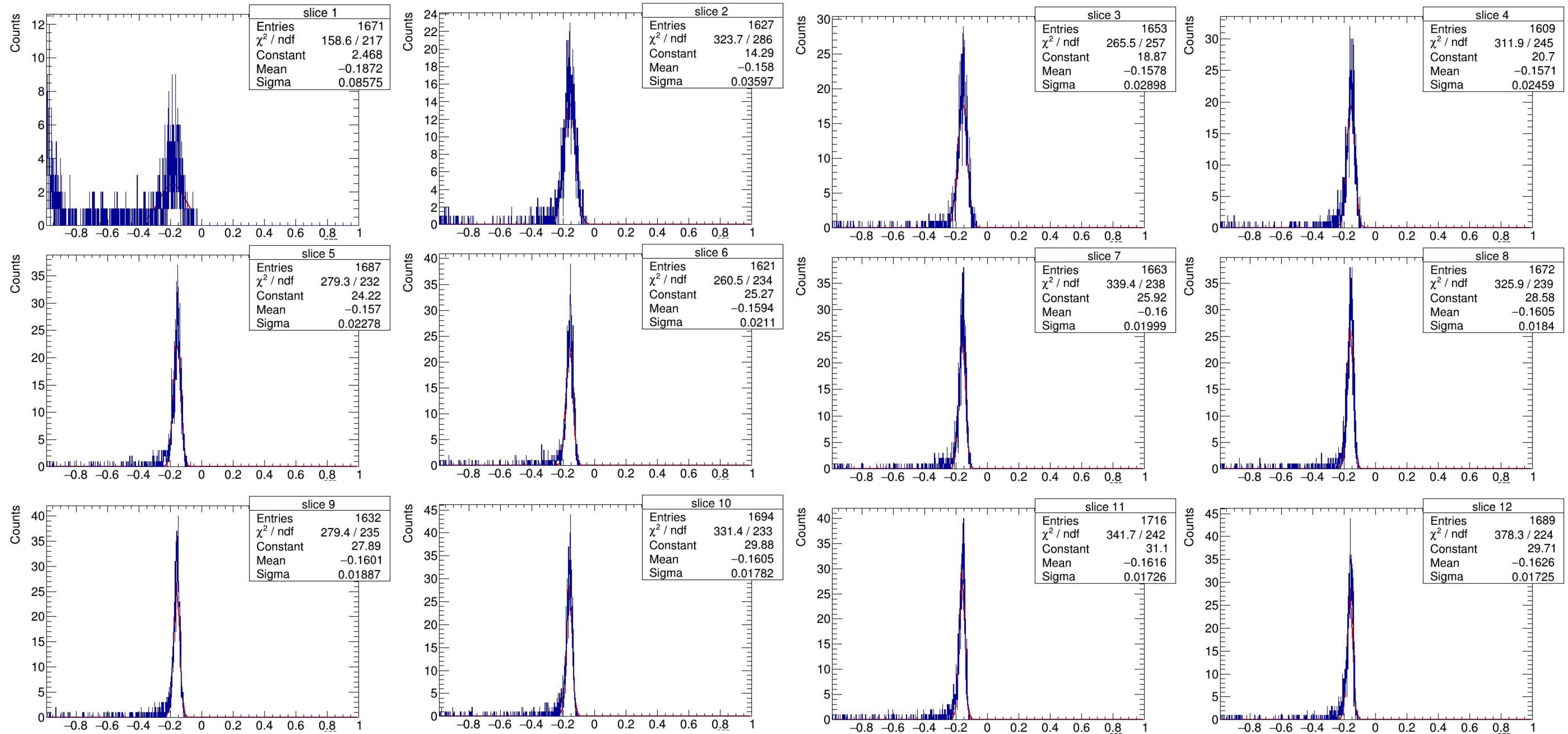
Mean of the Gaussians fitted to the slices of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot.



Reduced χ^2 of the Gaussians fitted to the slices of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot.

FEMC (e⁻)

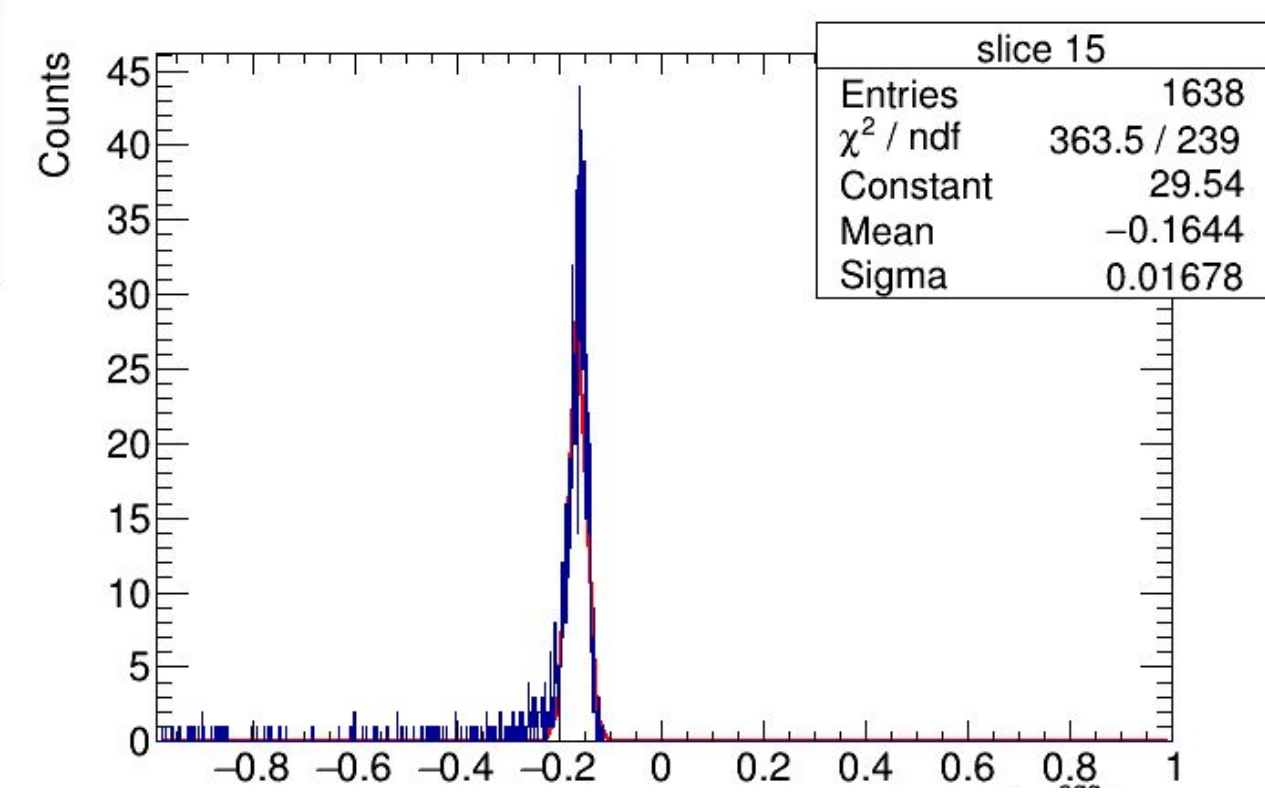
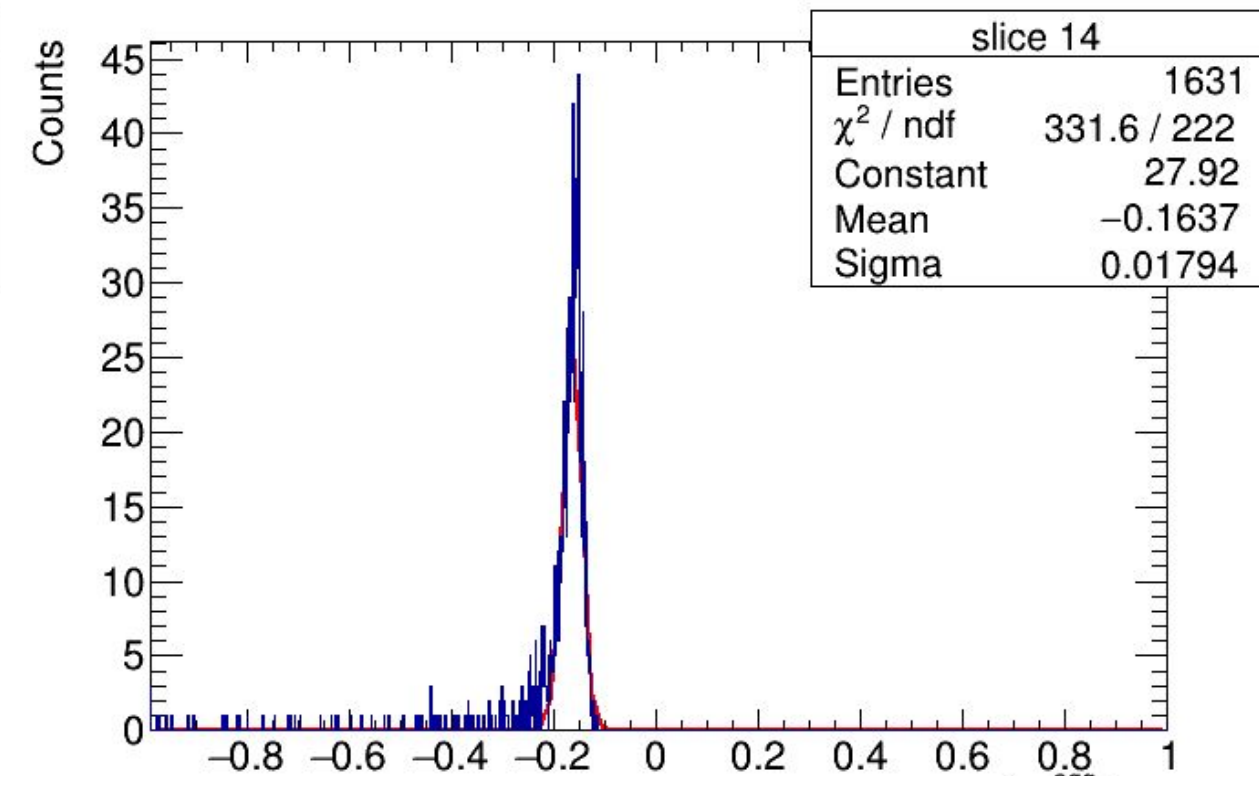
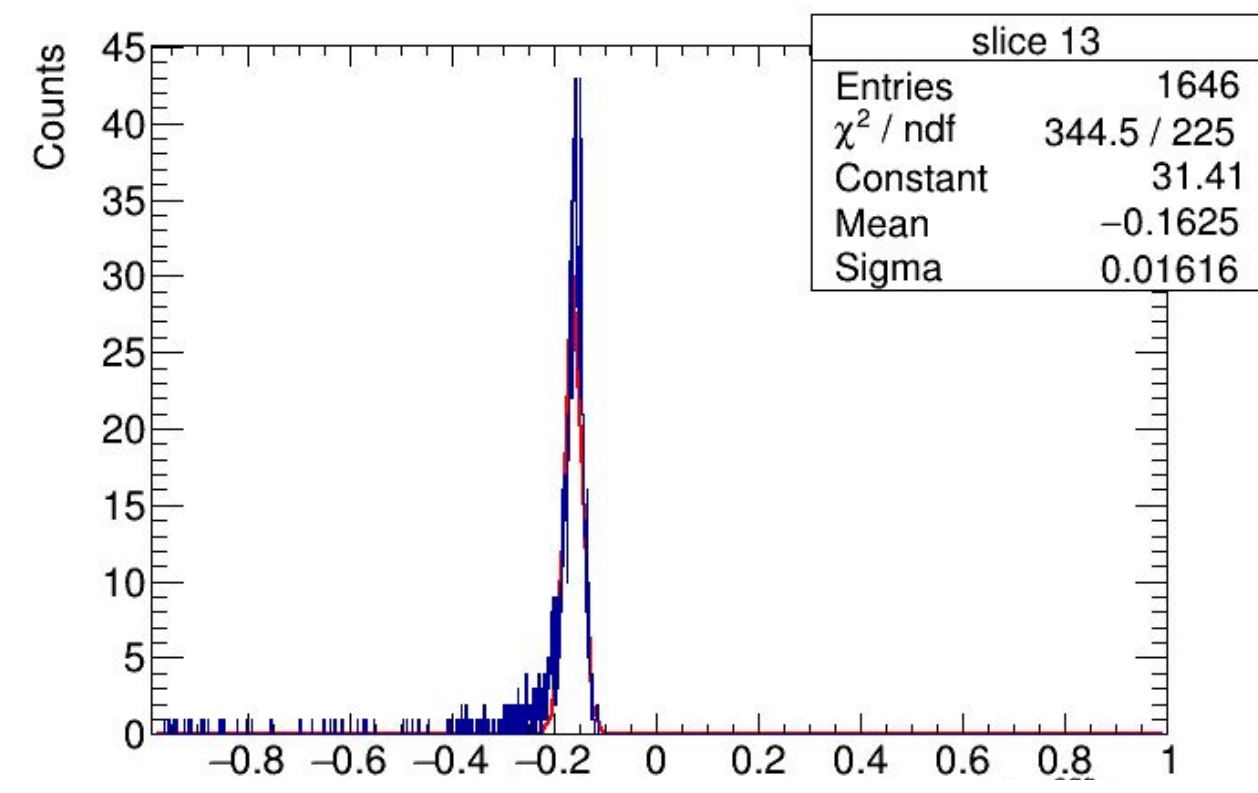
Fitted Gaussians



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

FEMC (e⁻)

Fitted Gaussians



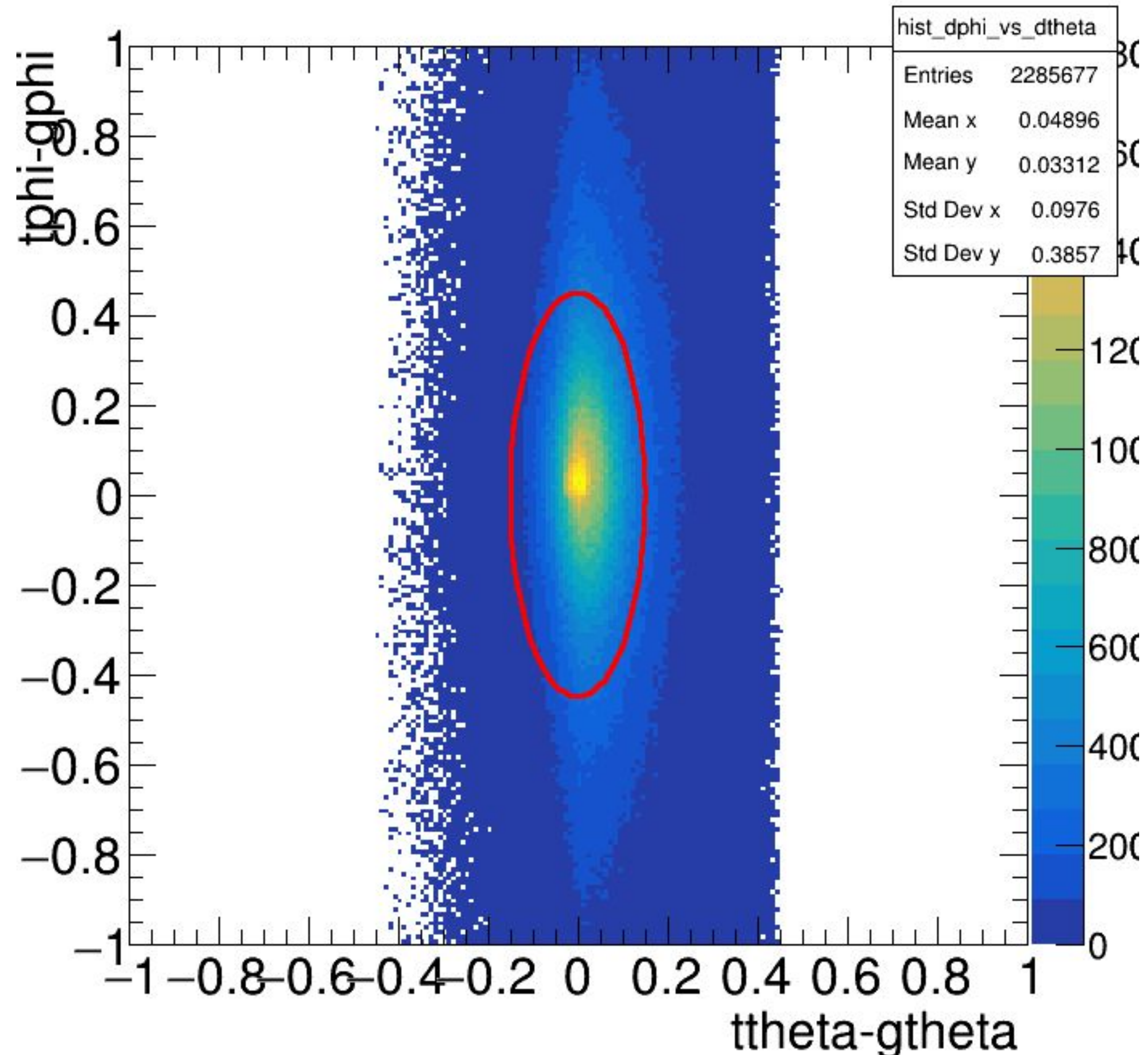
The x-axes denote $\Delta e_{\text{agg}}/g_e$

A teal geometric graphic consisting of several overlapping triangles and quadrilaterals, creating a complex, abstract shape on the left side of the slide.

FEMC (π^-)

FEMC (π^-)

Elliptical cut on $d\phi$ vs $d\theta$, Explicit η cut: 1.3 to 3.3



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

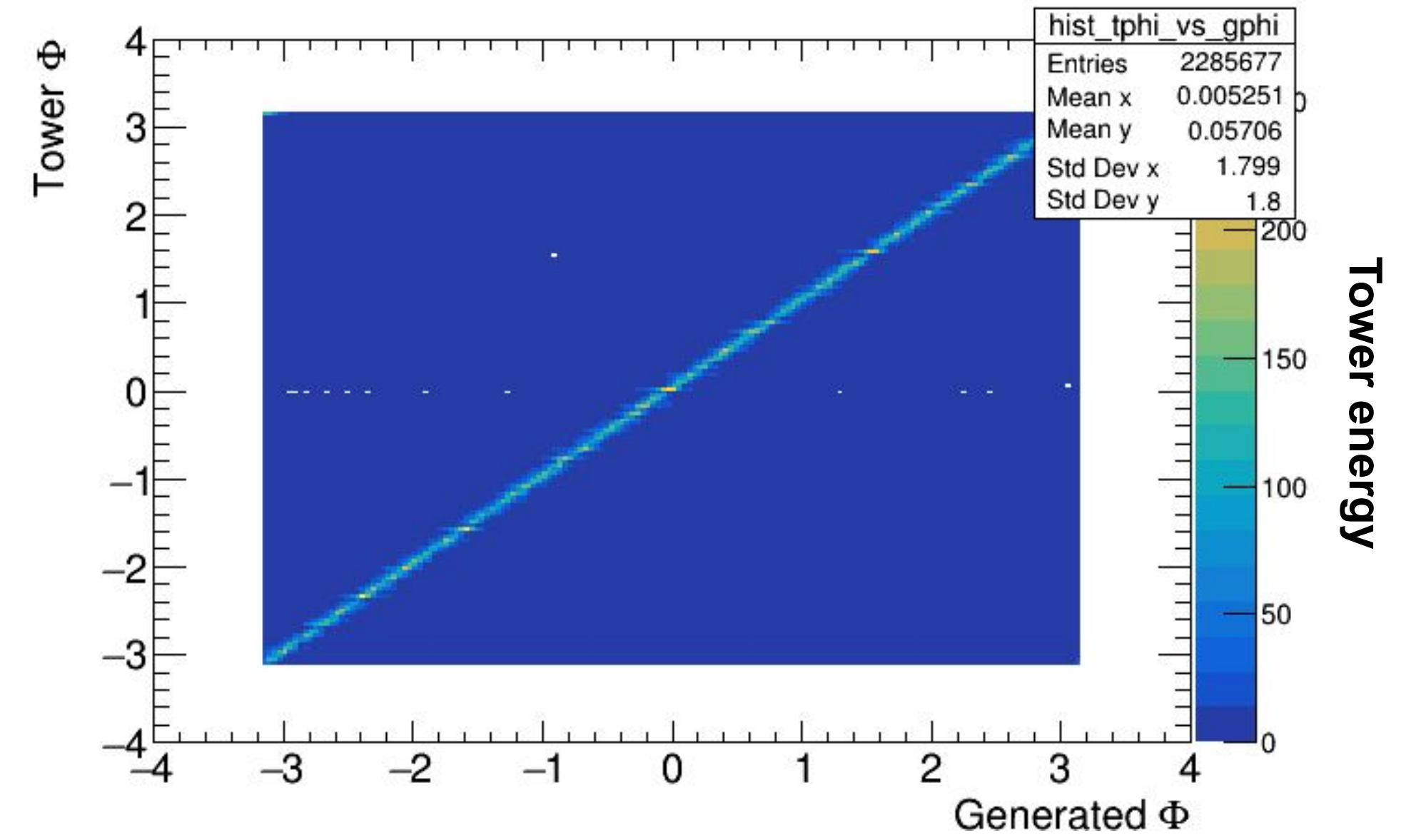
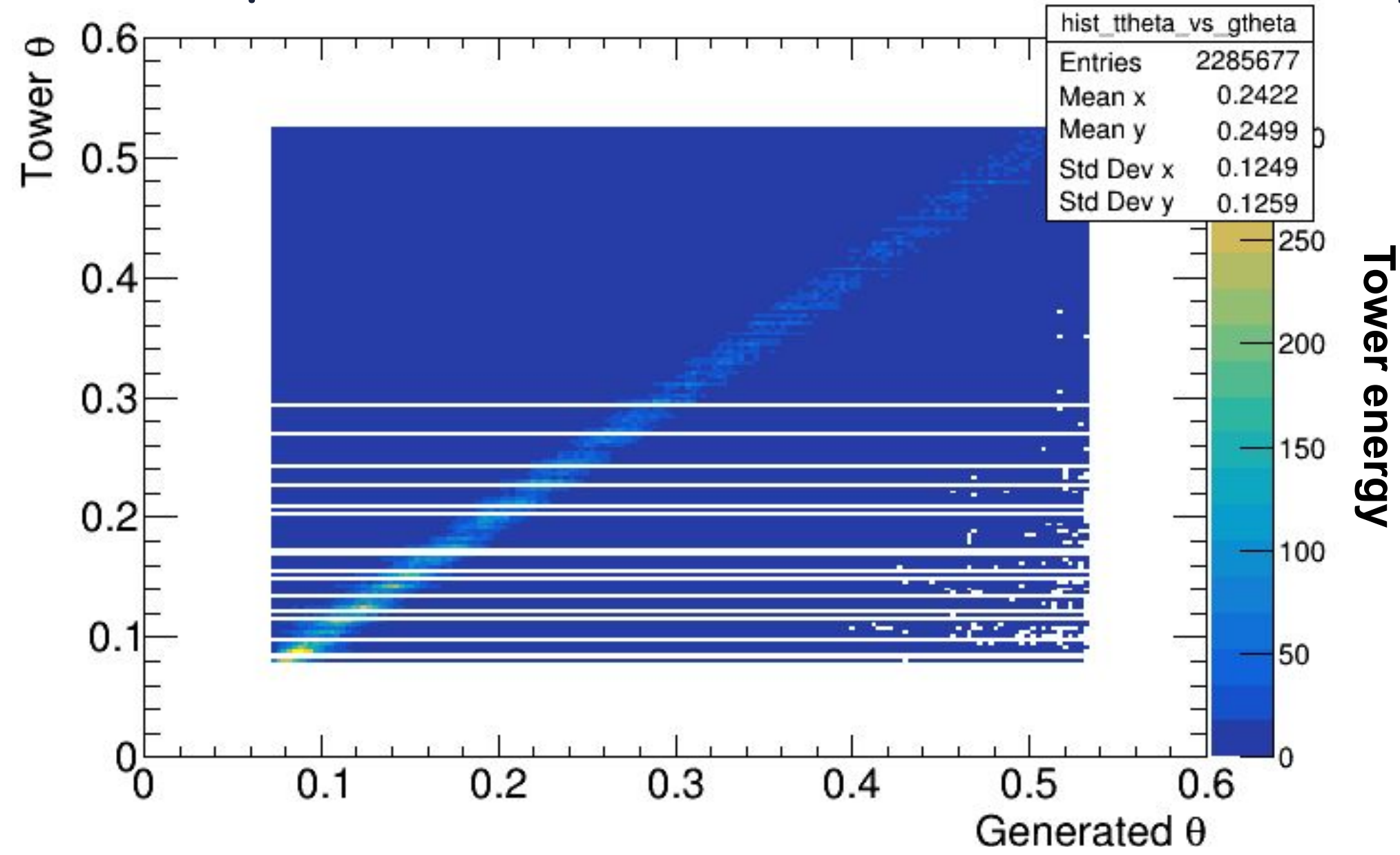
Dimensions:

semi-minor axis = 0.15 units
semi-major axis = 0.45 units

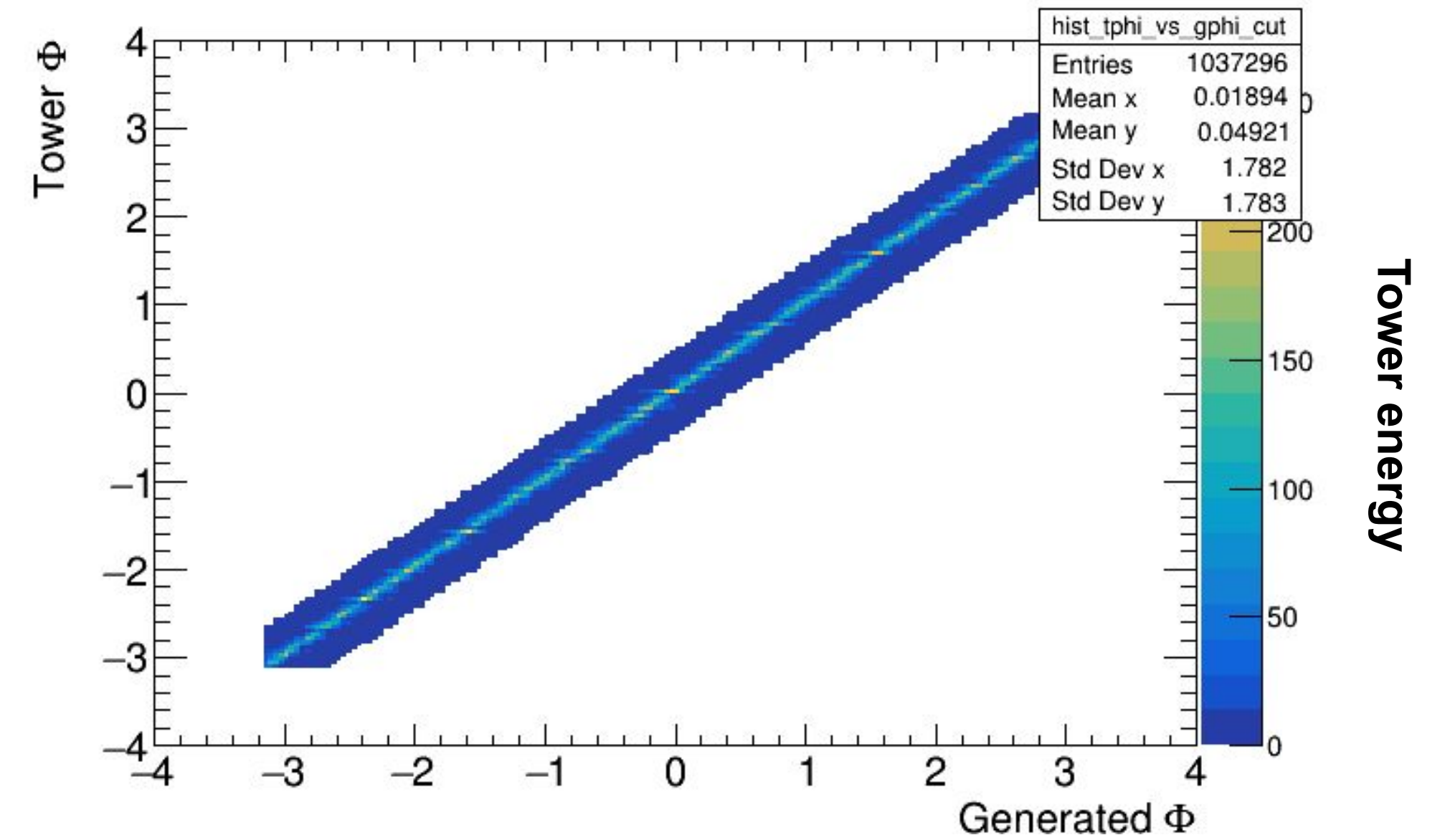
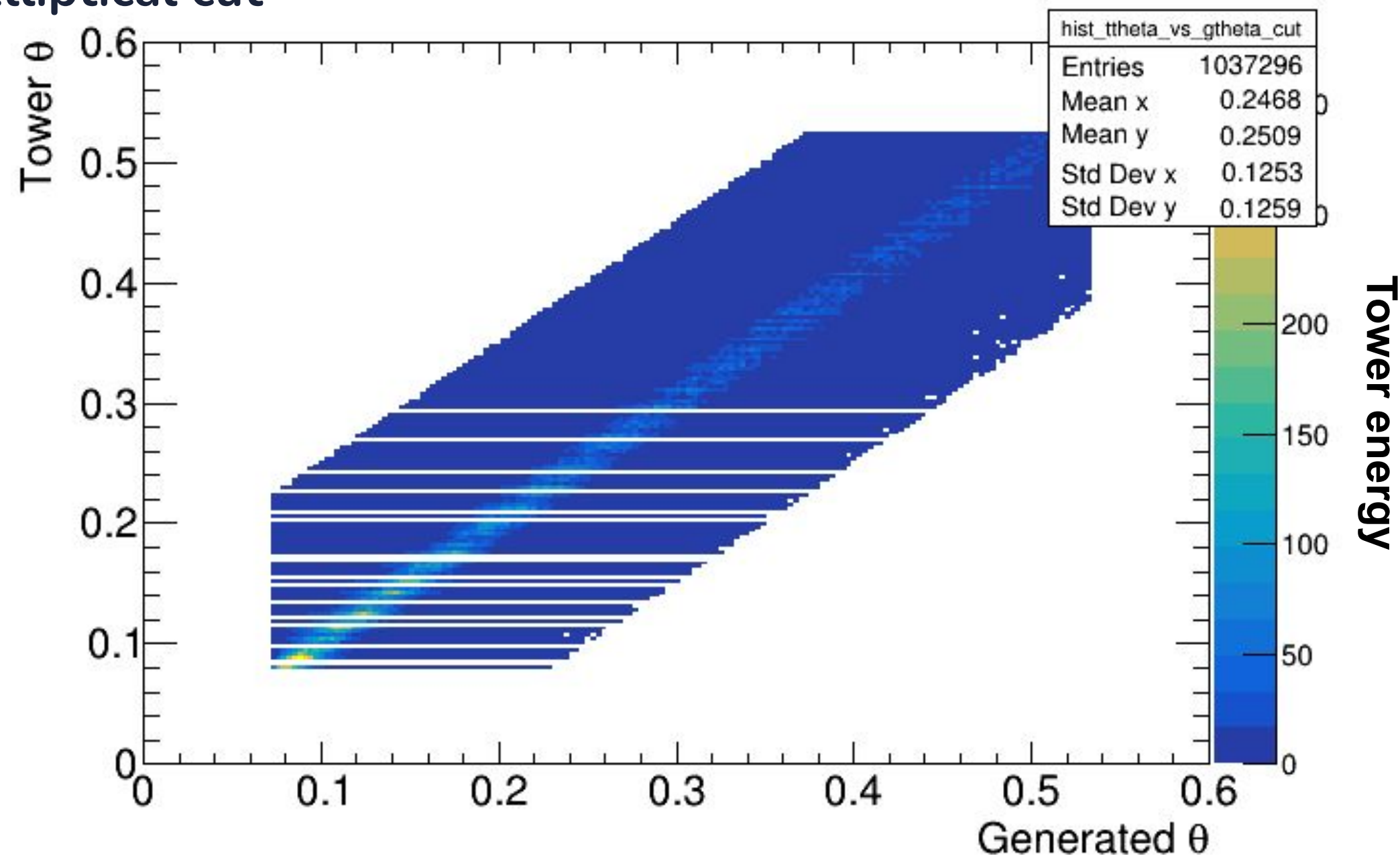
FEMC (π^-)

Explicit η cut: 1.3 to 3.3

Without Elliptical cut



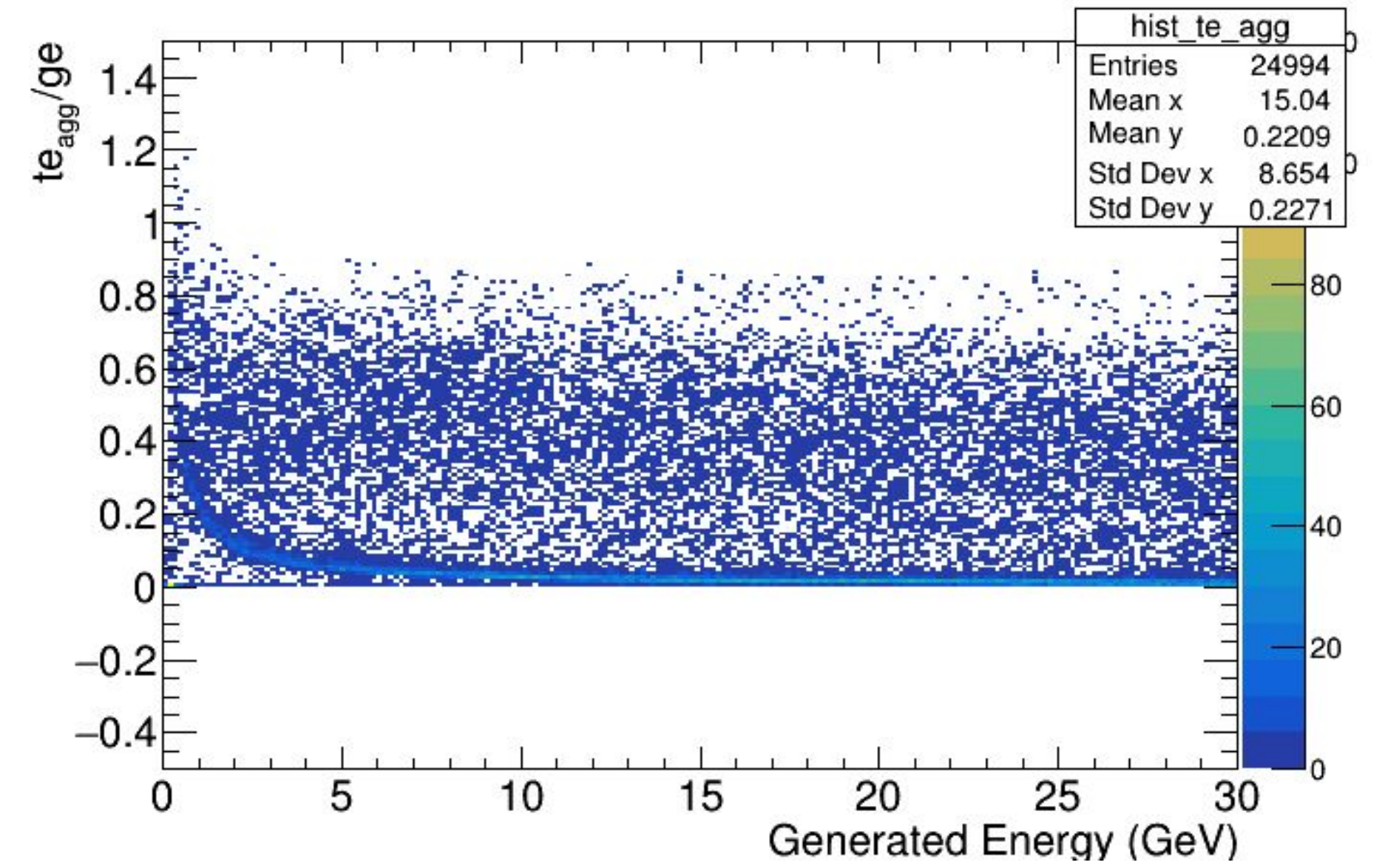
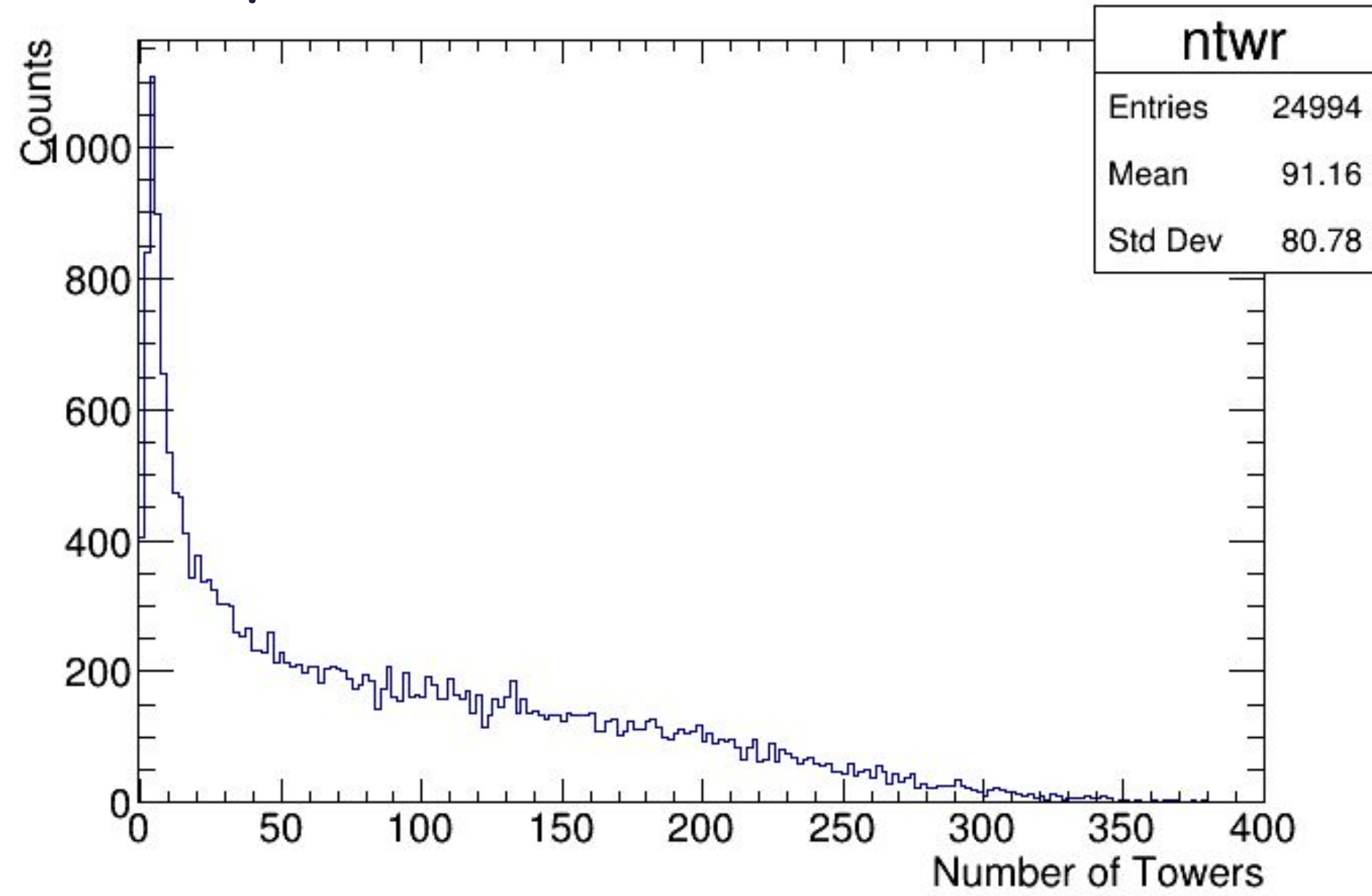
Elliptical cut



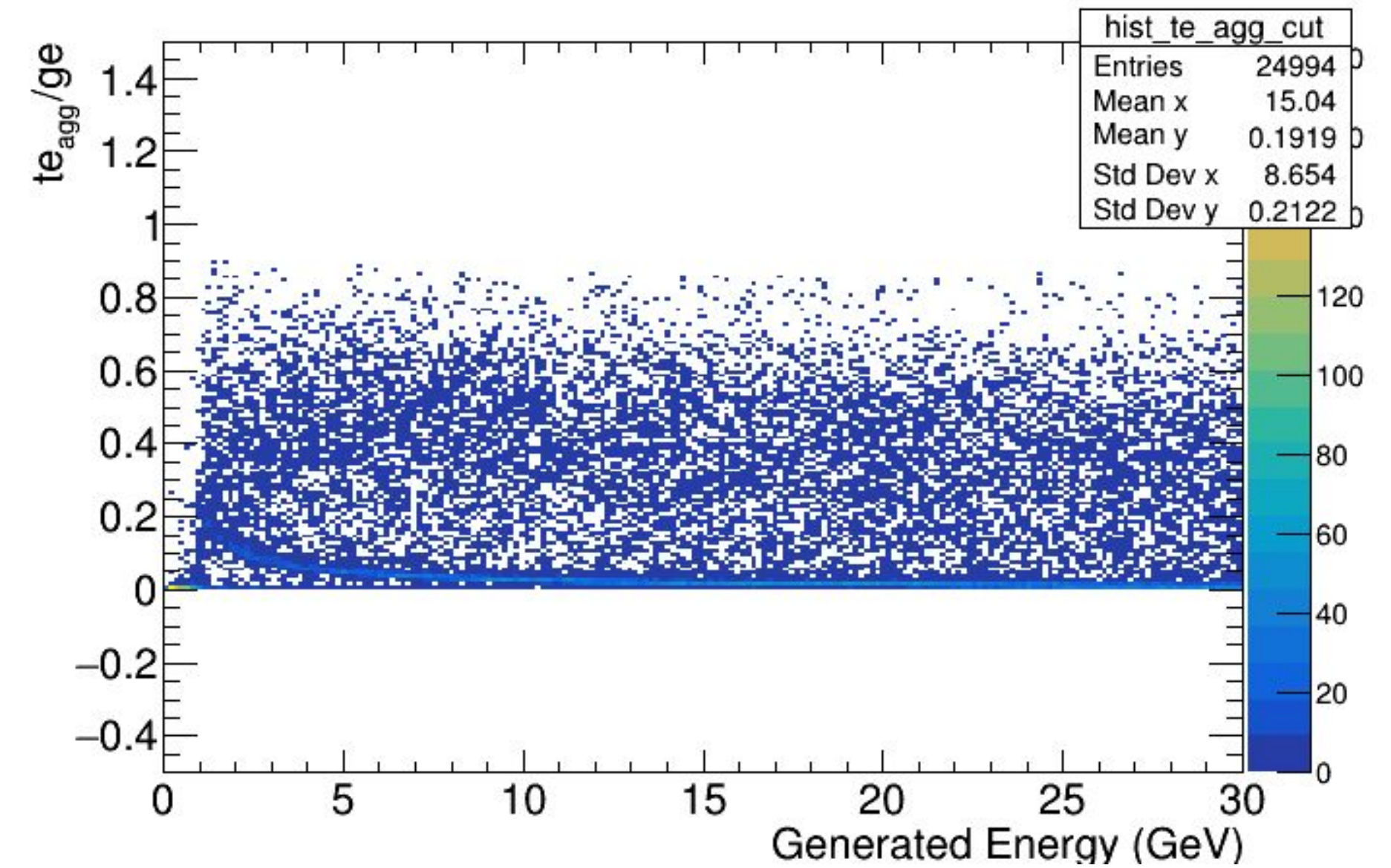
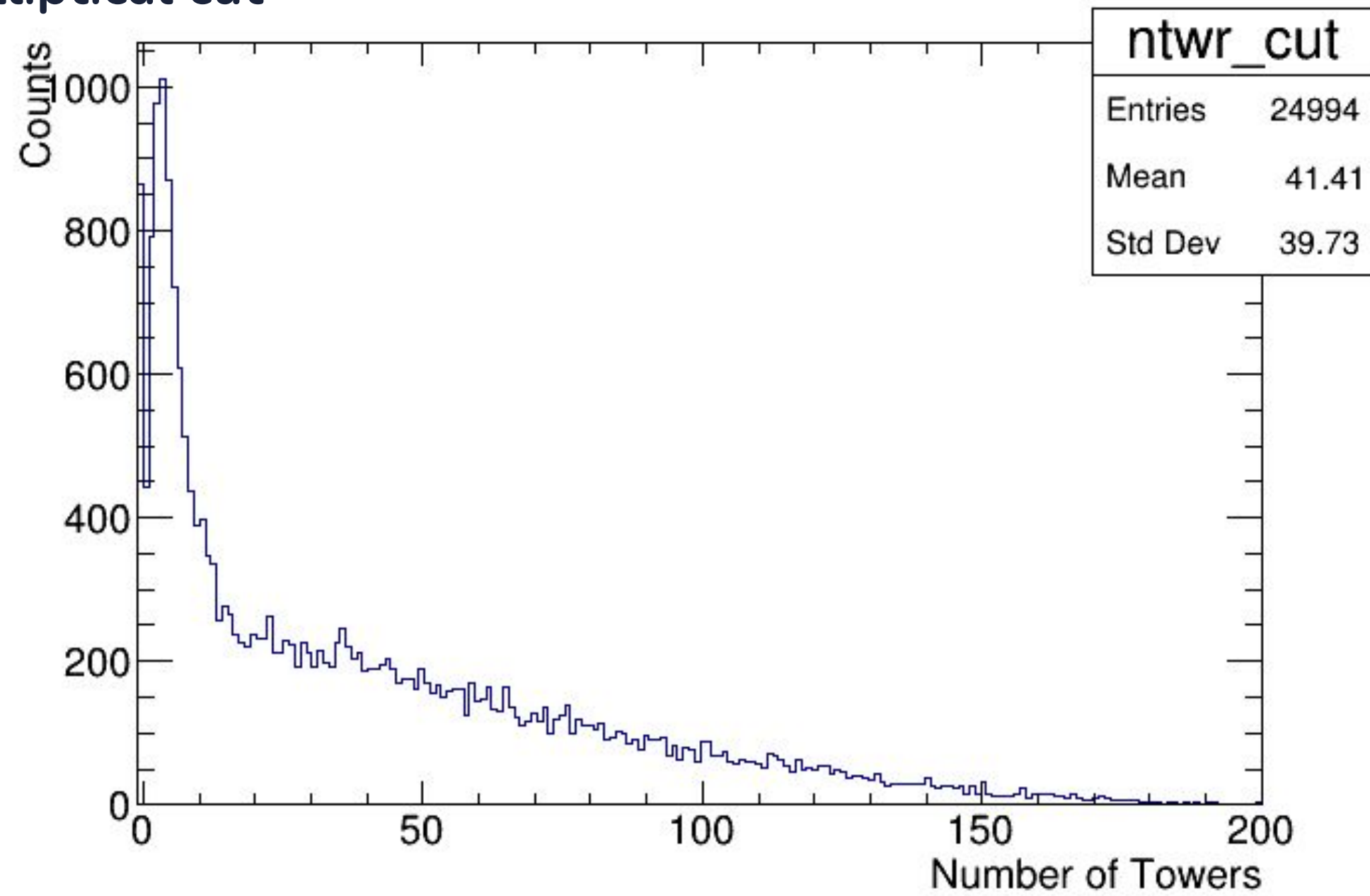
FEMC (π^-)

Explicit η cut: 1.3 to 3.3

Without Elliptical cut



Elliptical cut

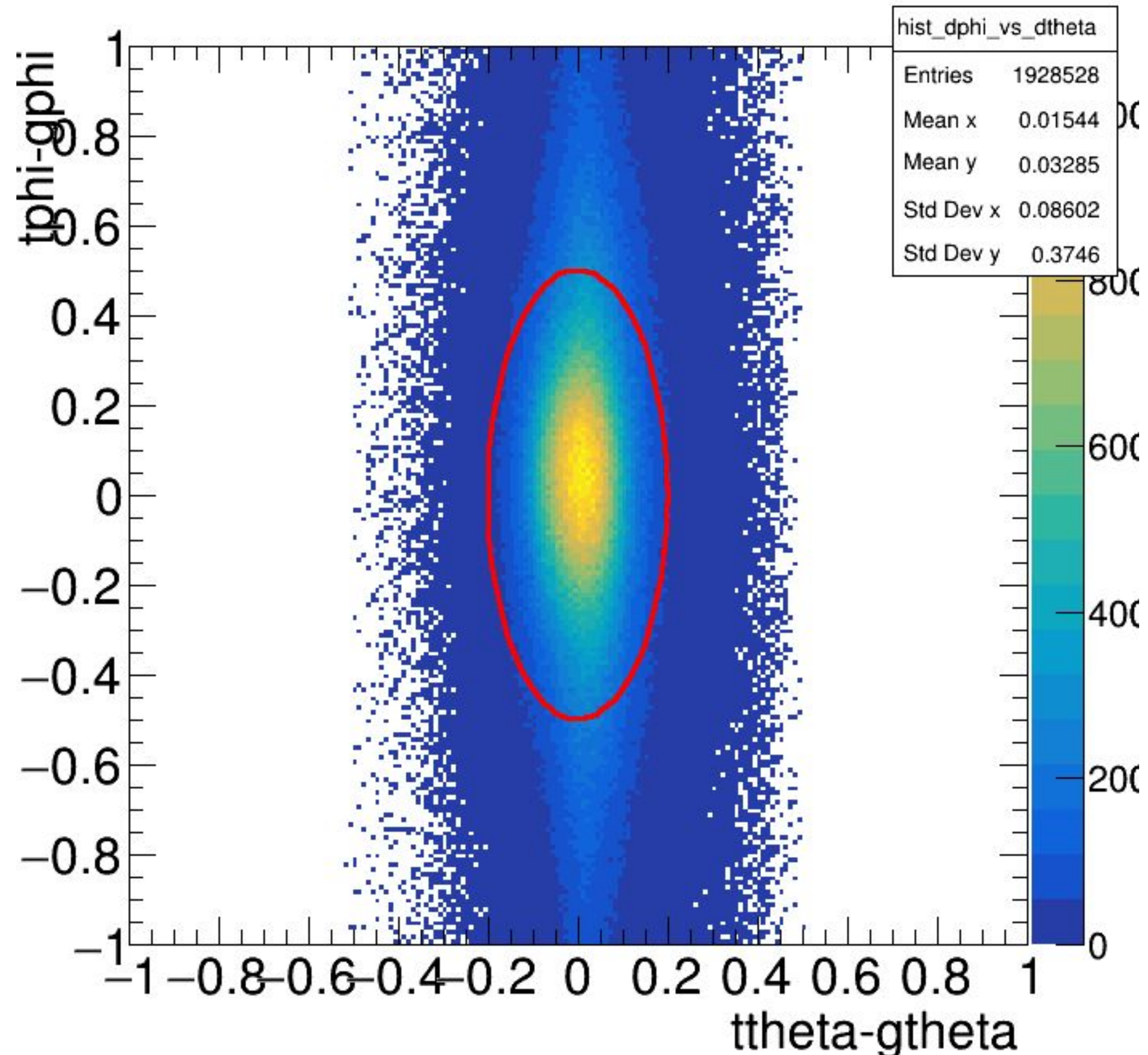


A teal geometric graphic consisting of several overlapping triangles and quadrilaterals, creating a faceted, crystalline appearance. It is positioned on the left side of the slide.

FHCAL (π^-)

FHCAL (π^-)

Elliptical cut on dphi vs dtheta, Explicit η cut: 1.2 to 3.5



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

Dimensions:

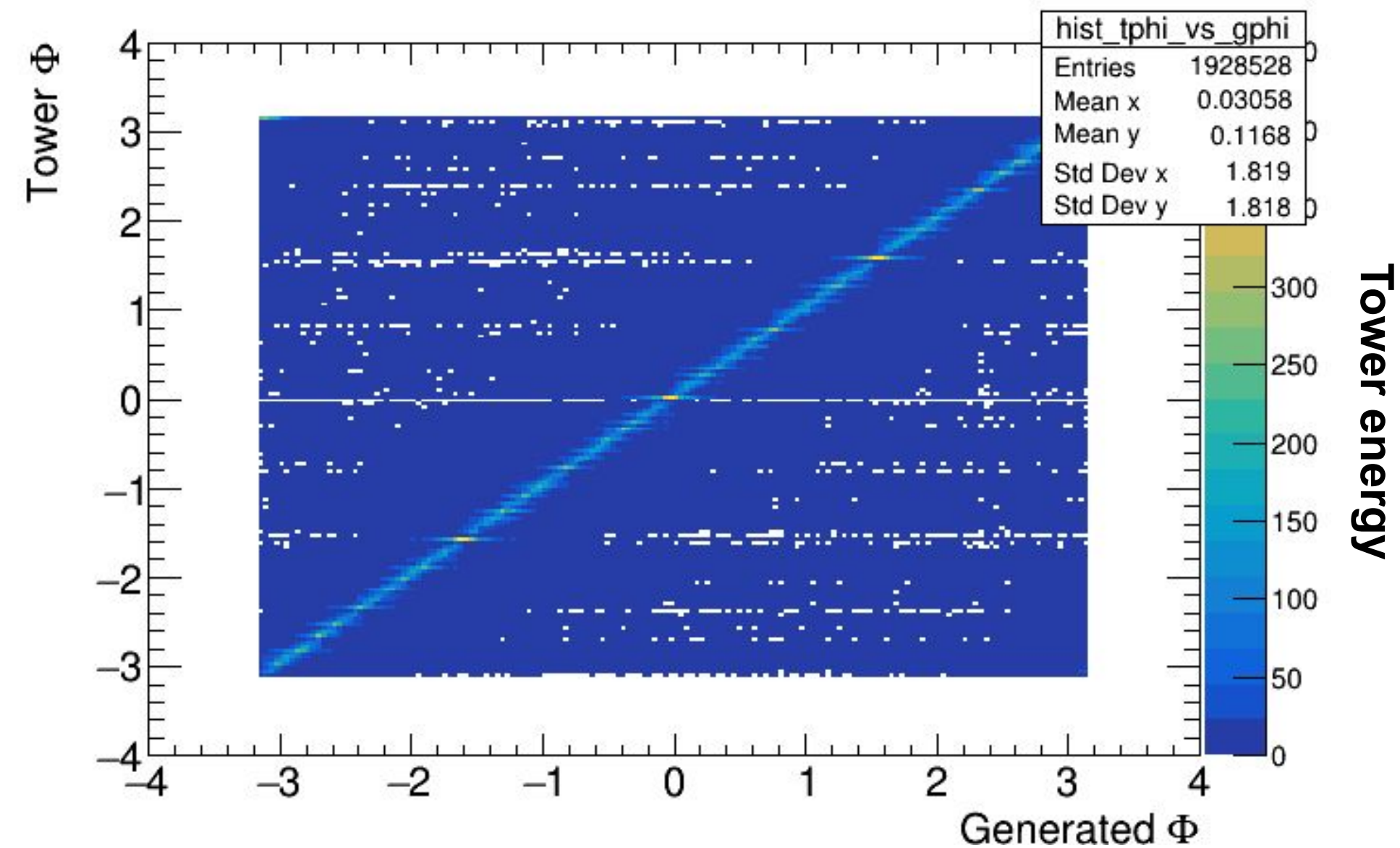
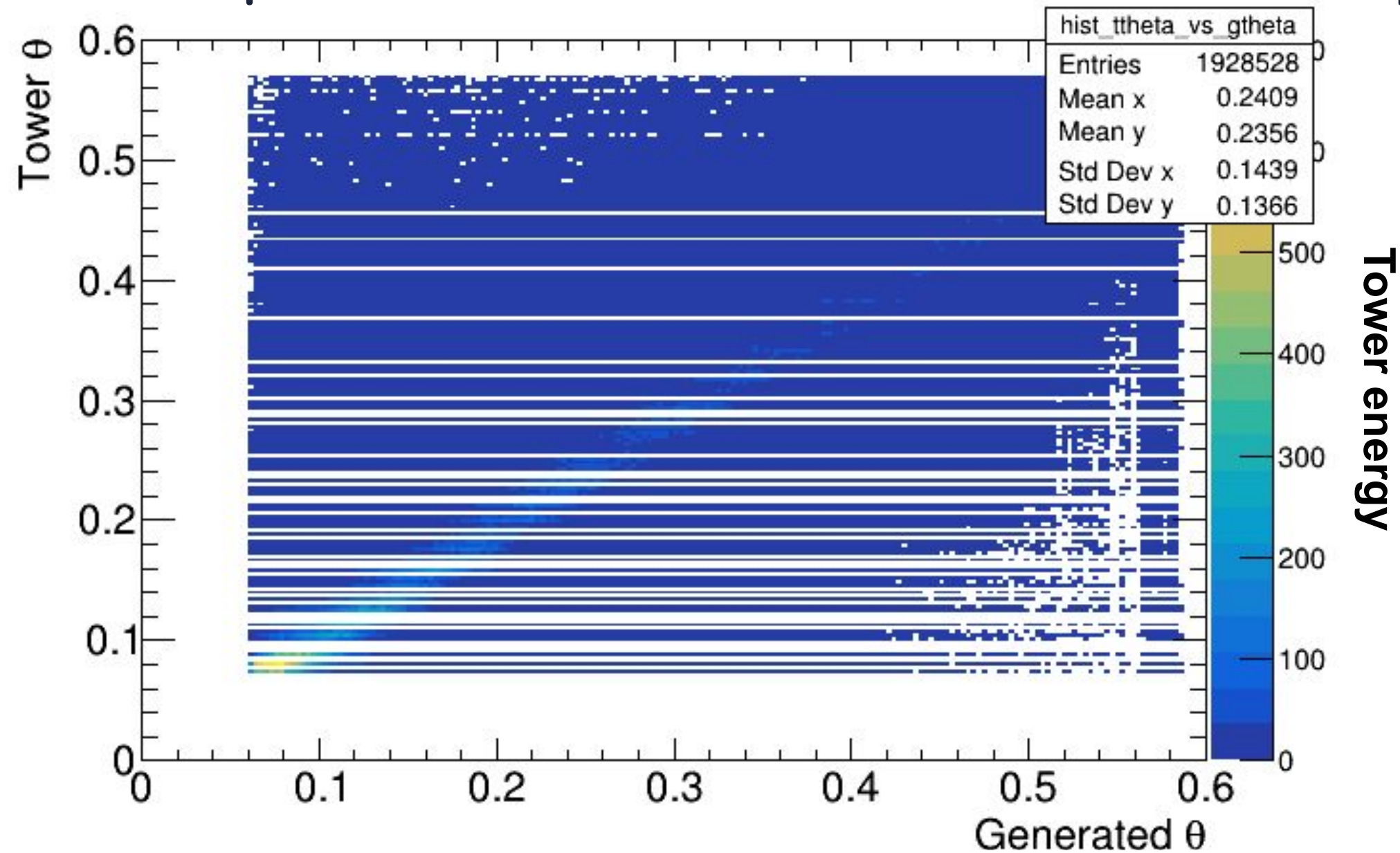
semi-minor axis = 0.20 units

semi-major axis = 0.50 units

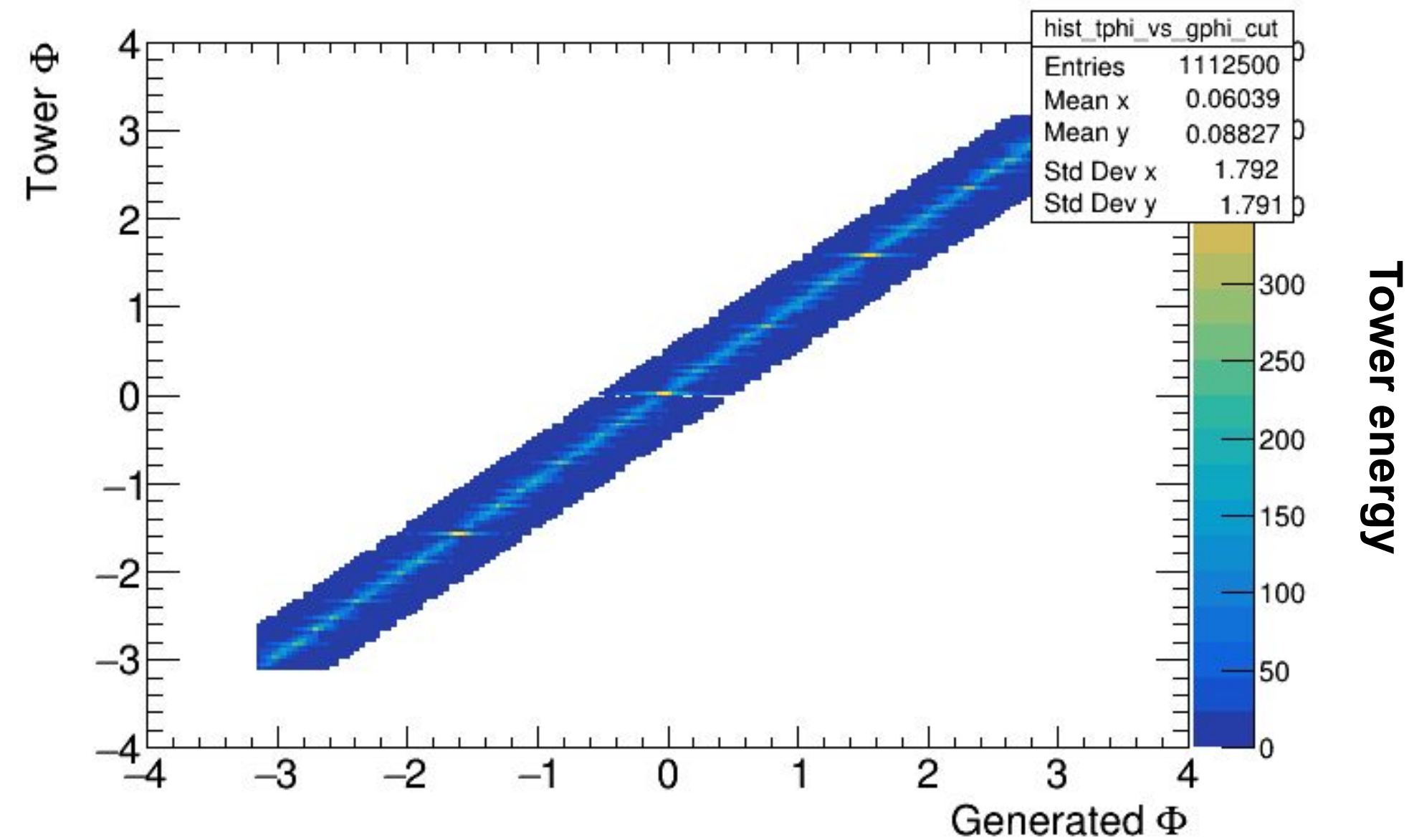
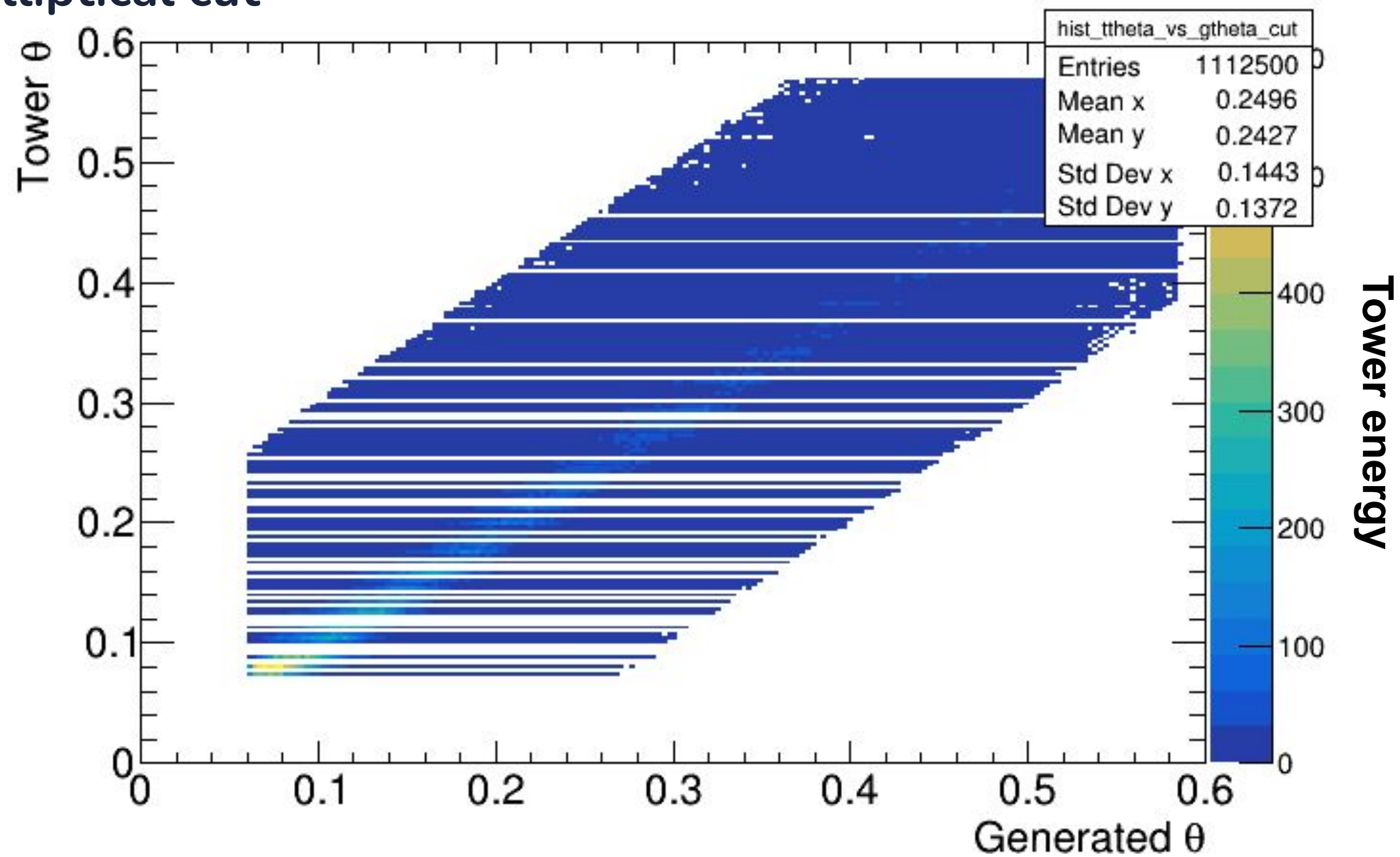
FHCAL (π^-)

Explicit η cut: 1.2 to 3.5

Without Elliptical cut



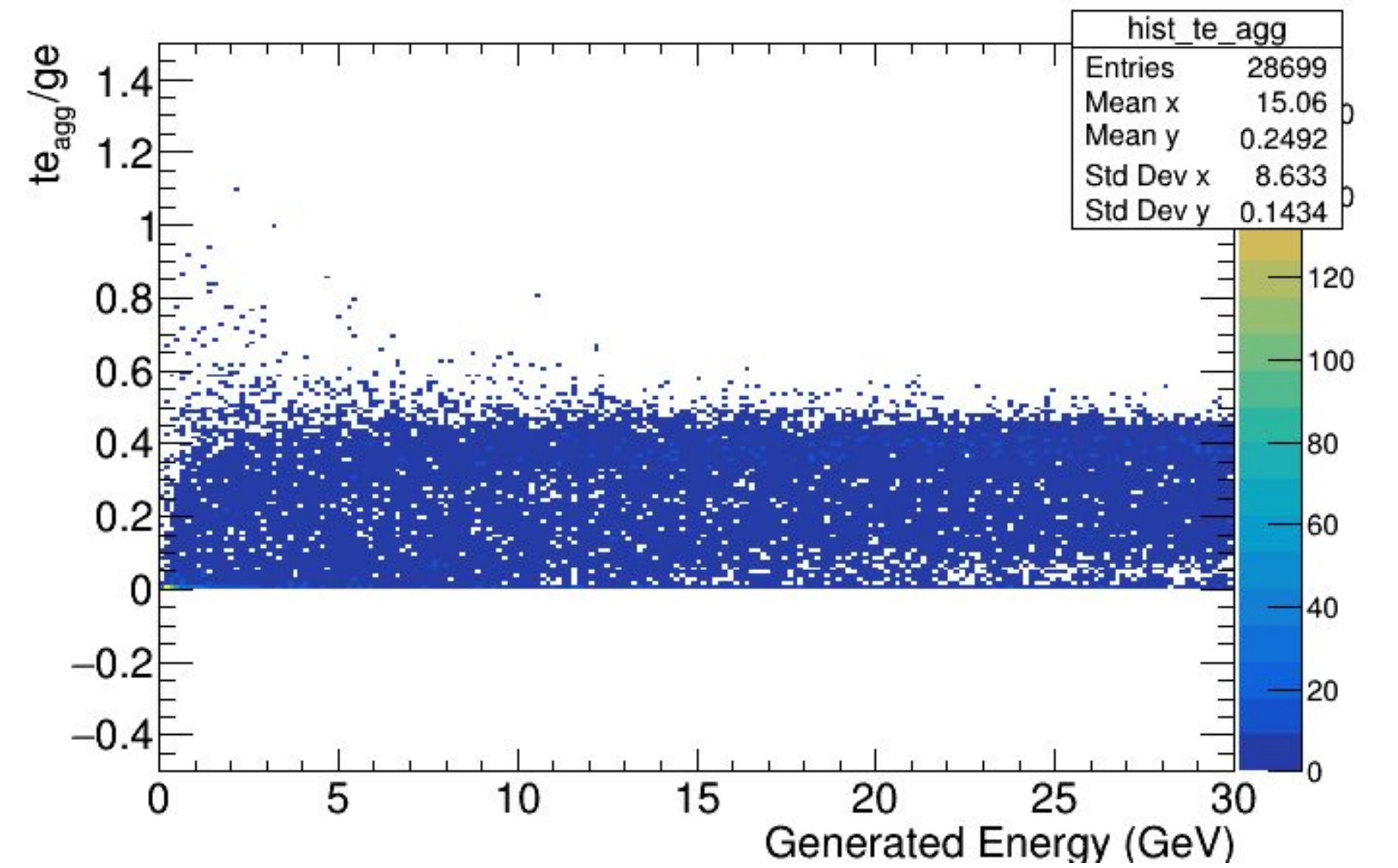
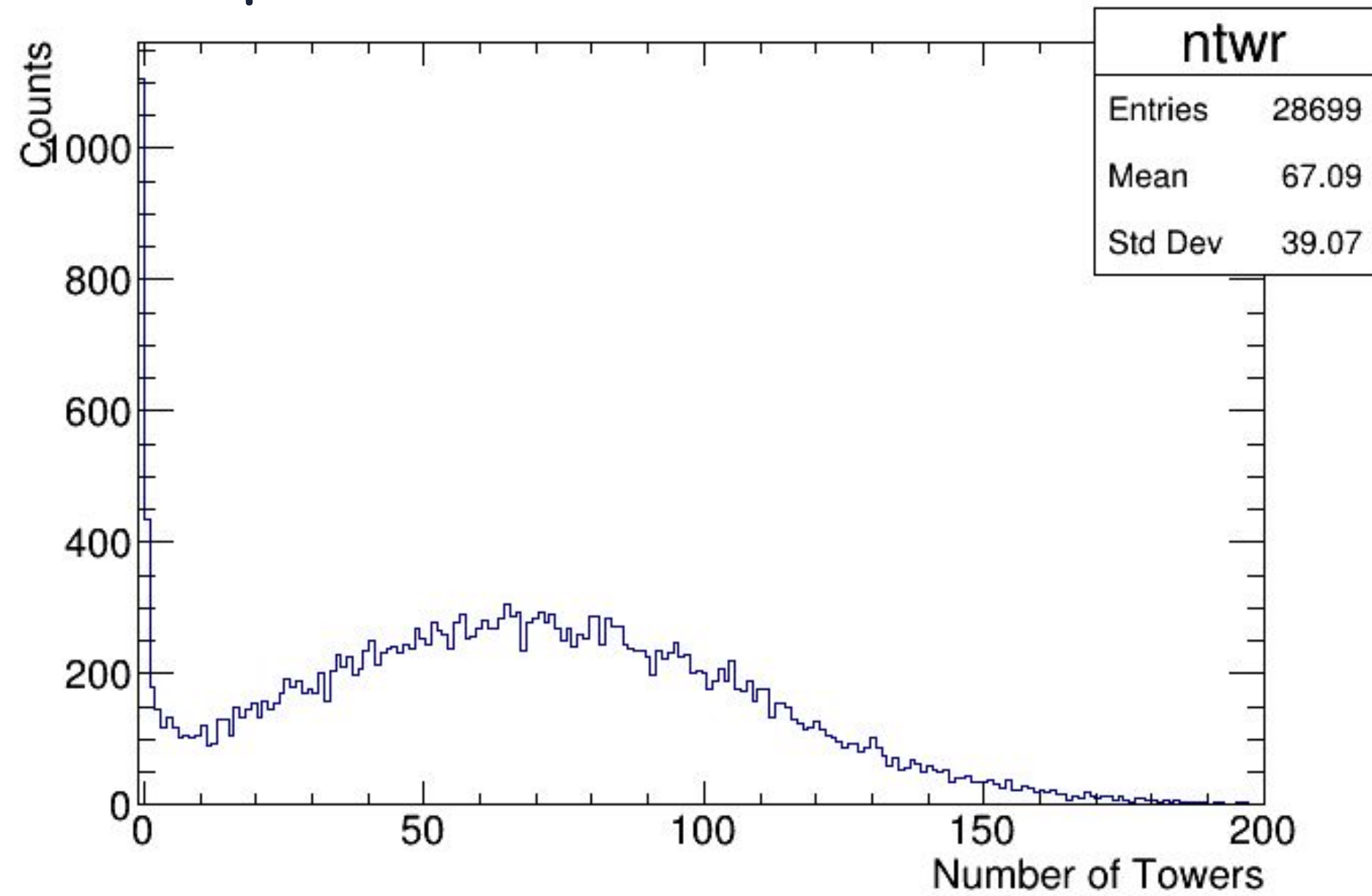
Elliptical cut



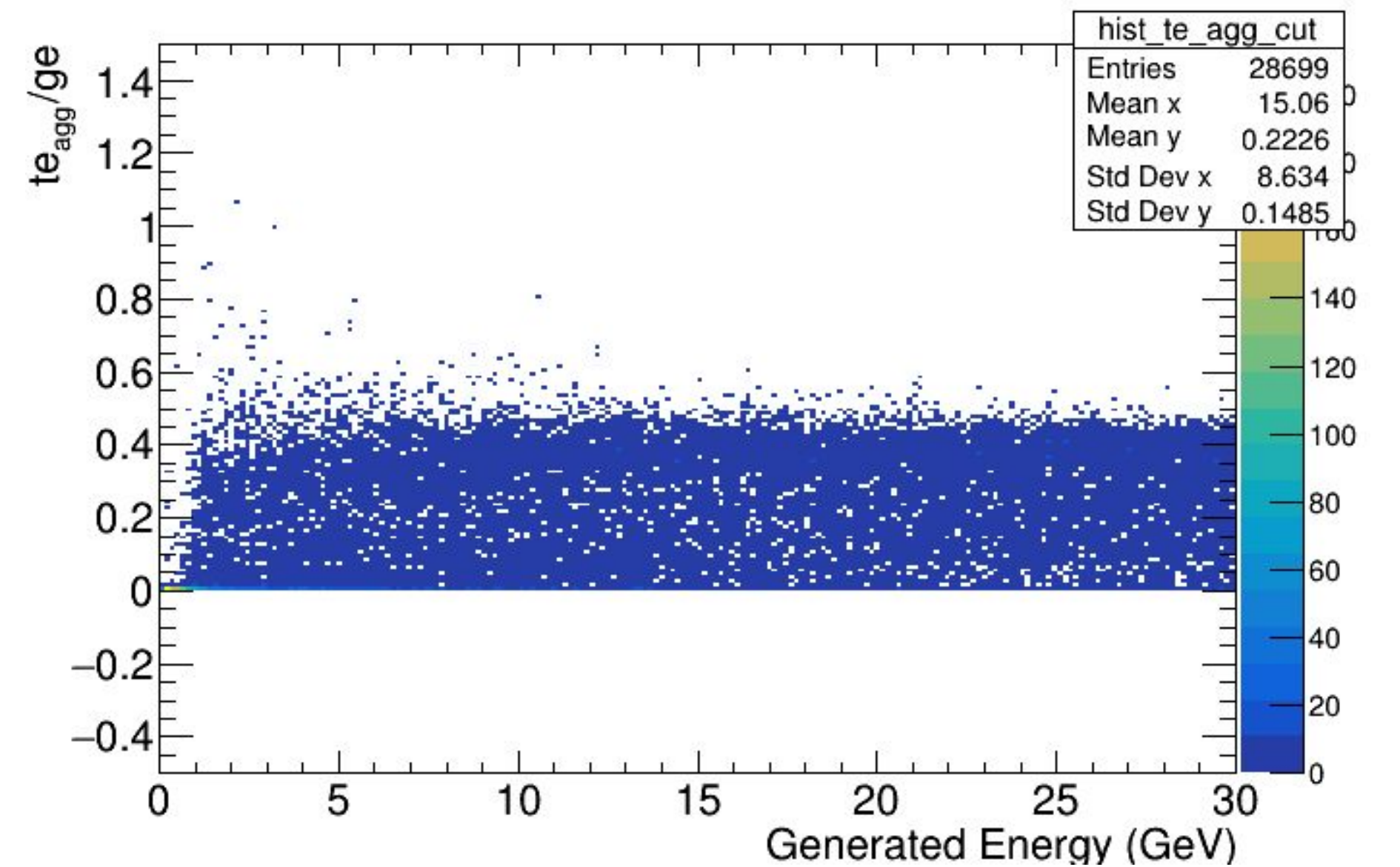
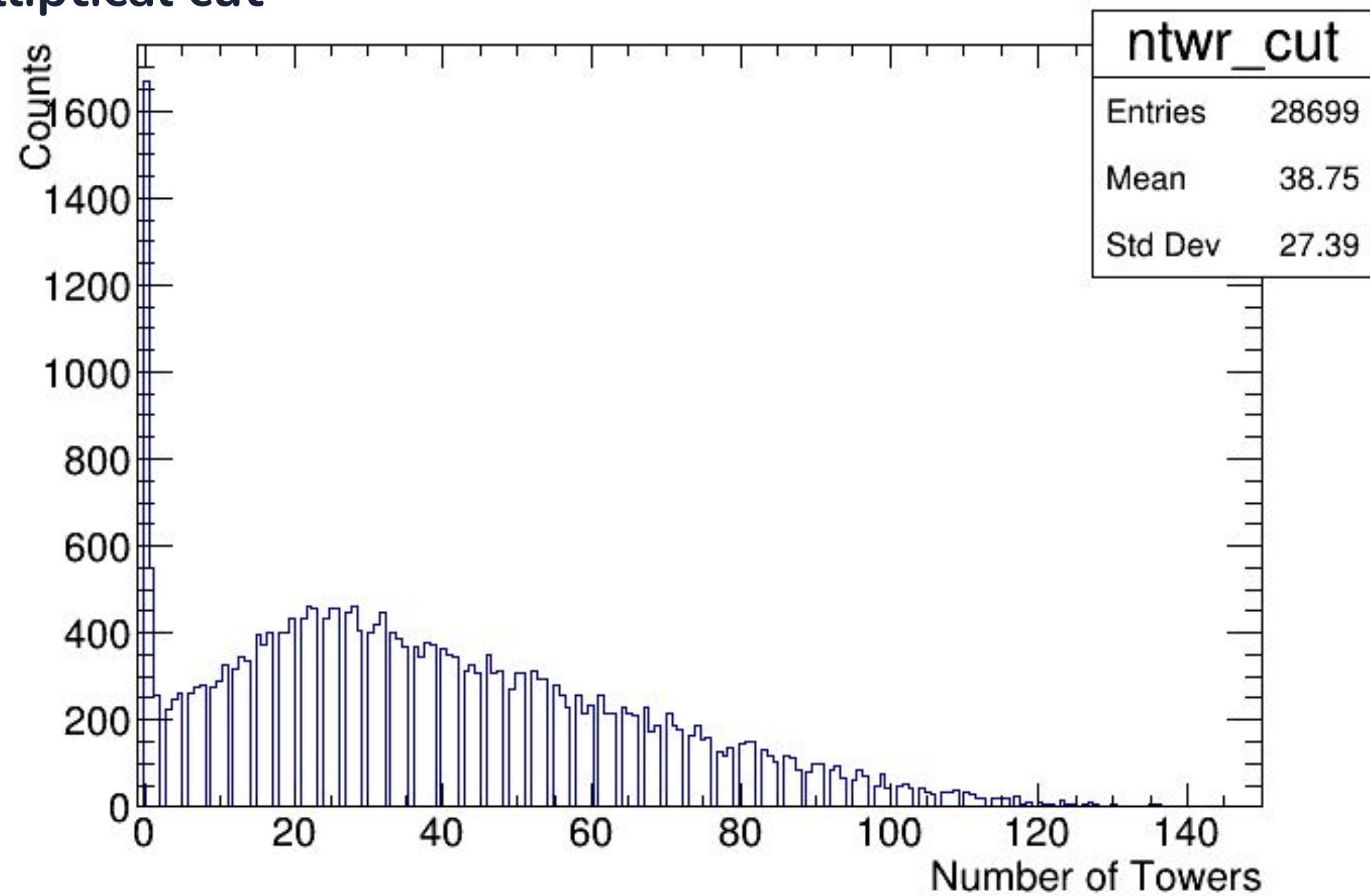
FHCAL (π^-)

Explicit η cut: 1.2 to 3.5

Without elliptical cut



Elliptical cut



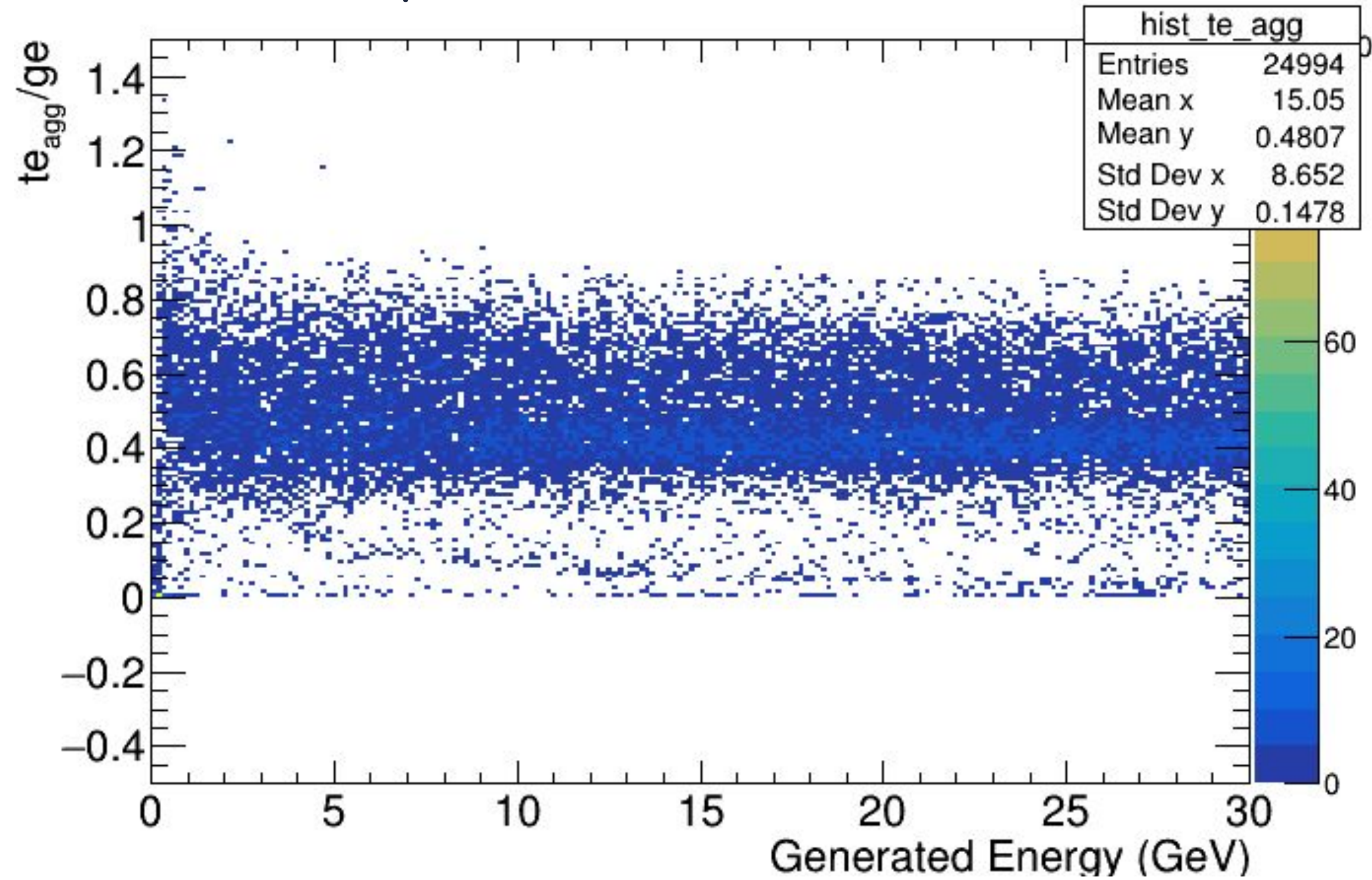


FEMC + FHCAL (π^-)

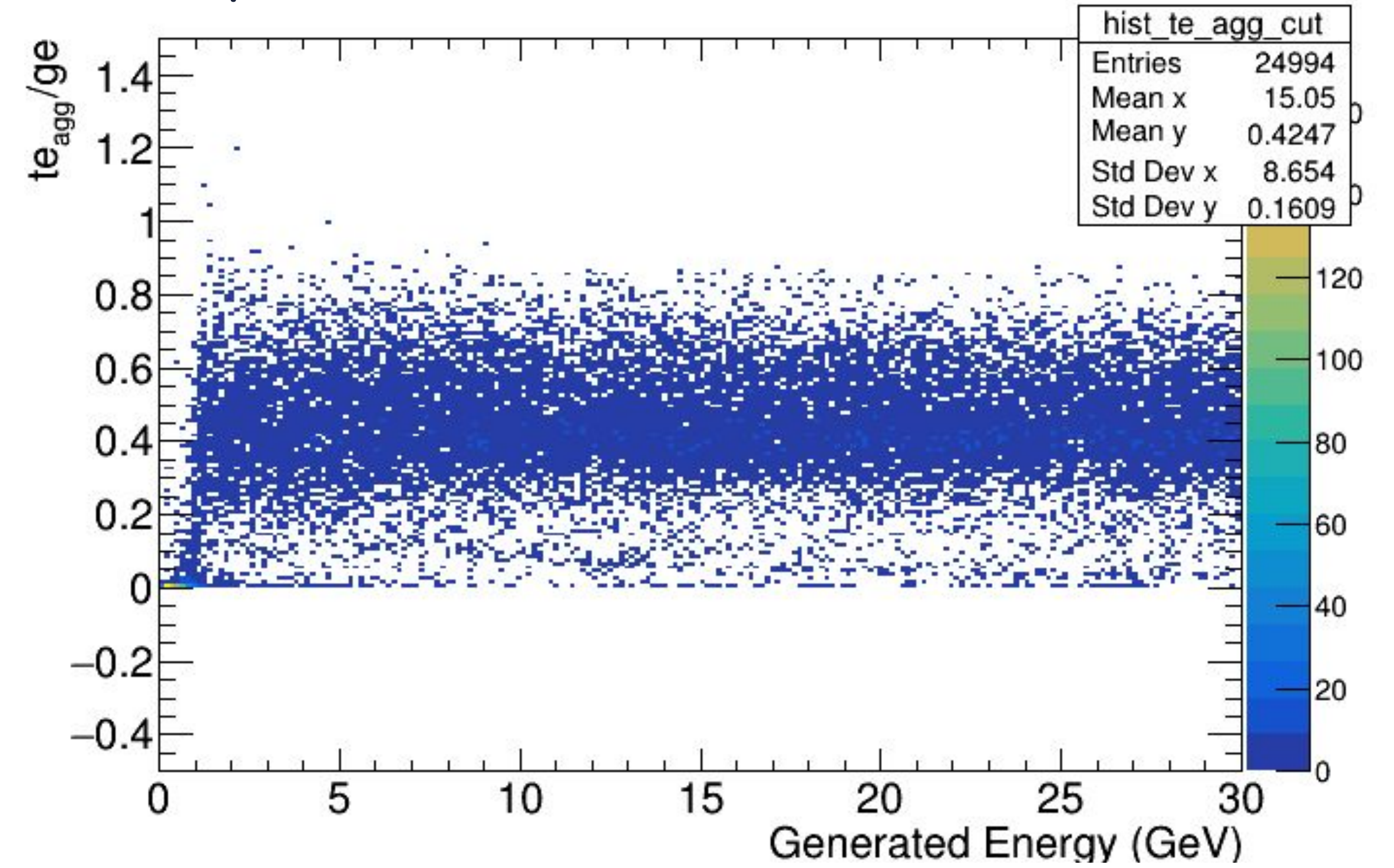
FEMC + FHCAL (π^-)

te_{agg}/ge vs ge
Explicit η cut: 1.3 to 3.3

Without Elliptical cuts

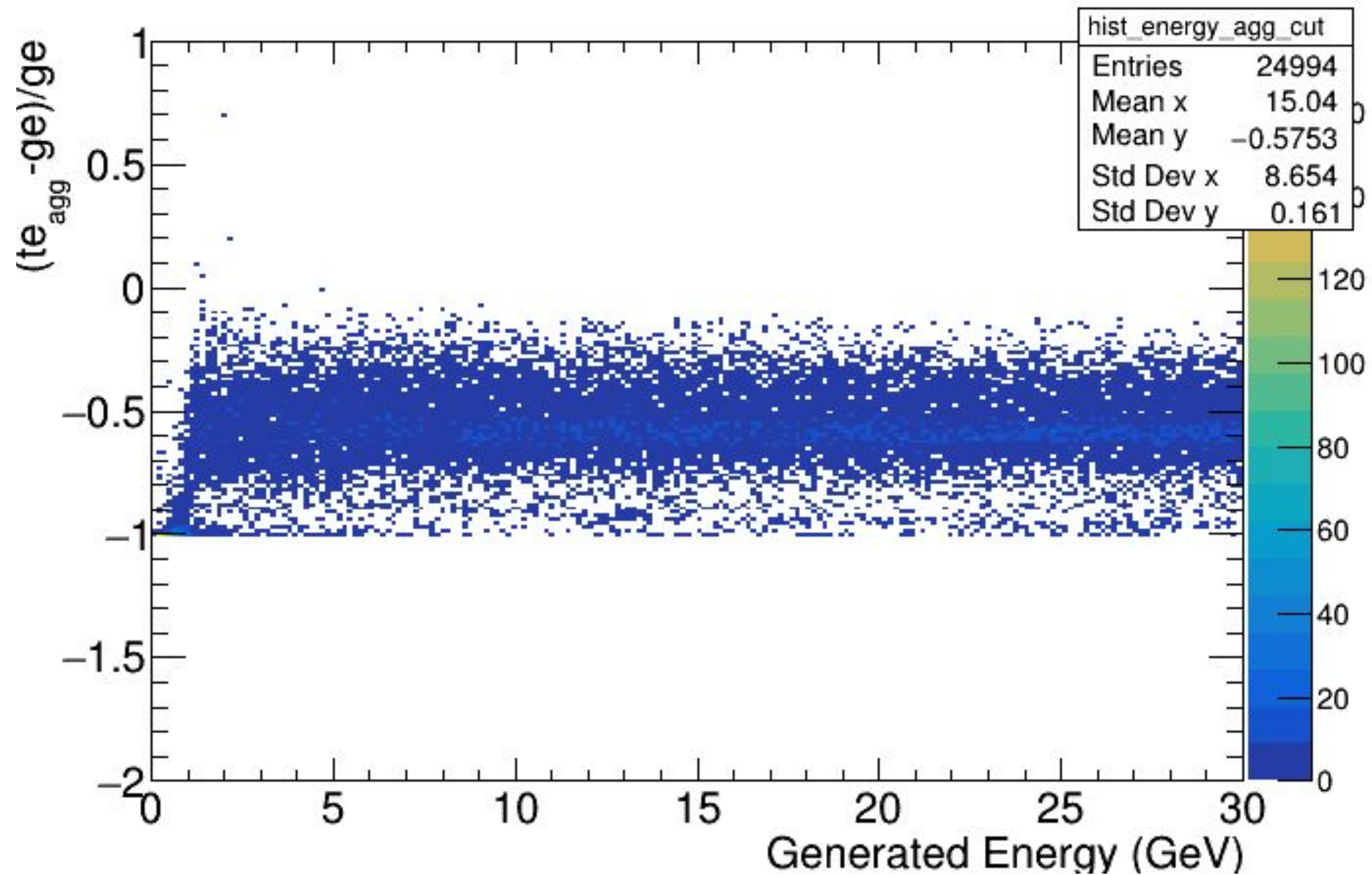


Elliptical cuts



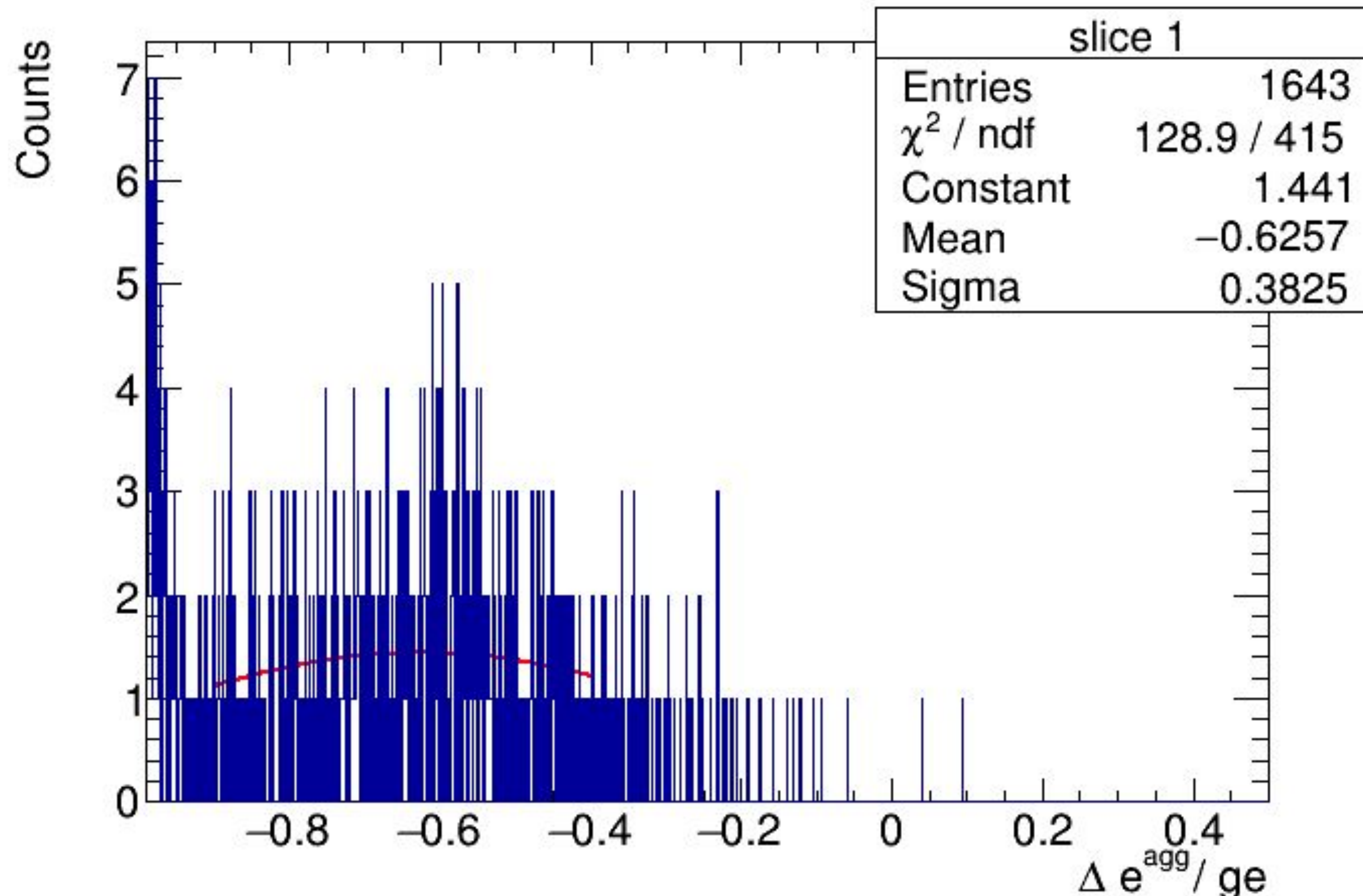
FEMC + FHCAL (π^-)

$(te_{agg} - ge)/ge$ vs ge
Explicit η cut: 1.3 to 3.3
Elliptical Cuts



FEMC + FHCAL (π^-)

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



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

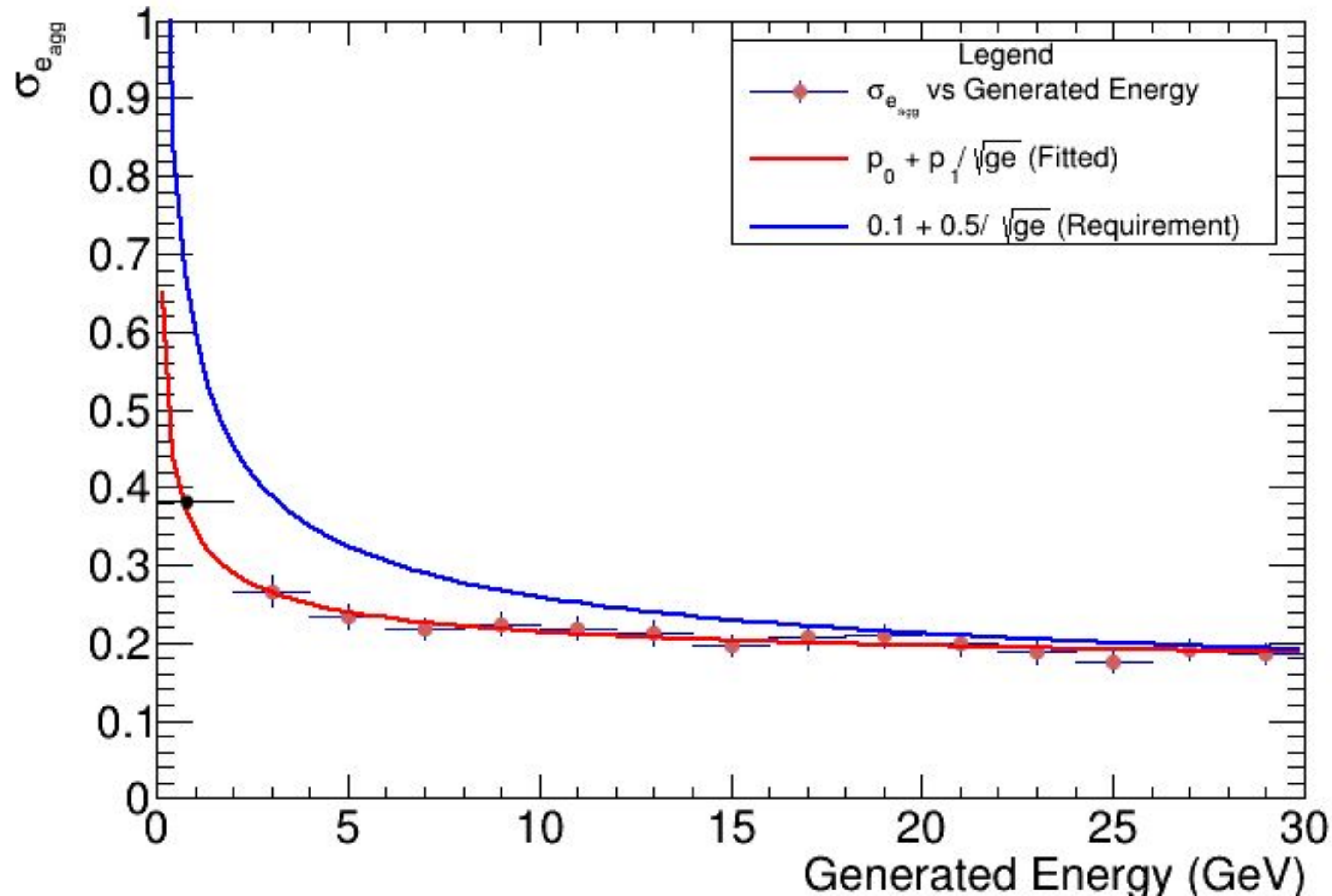
This fit has been done manually by restricting the fit range of the gaussian from -0.9 to -0.4

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

Number of bins = 2000 from -0.99 to +0.5

FEMC + FHCAL (π^-)

$(t_{e_{agg}} - g_e)/g_e$ vs g_e
Explicit η cut: 1.3 to 3.3
Elliptical Cuts



σ_e refers to the standard deviation of the Gaussian fitted to a slice of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot. (shown on the previous slide)

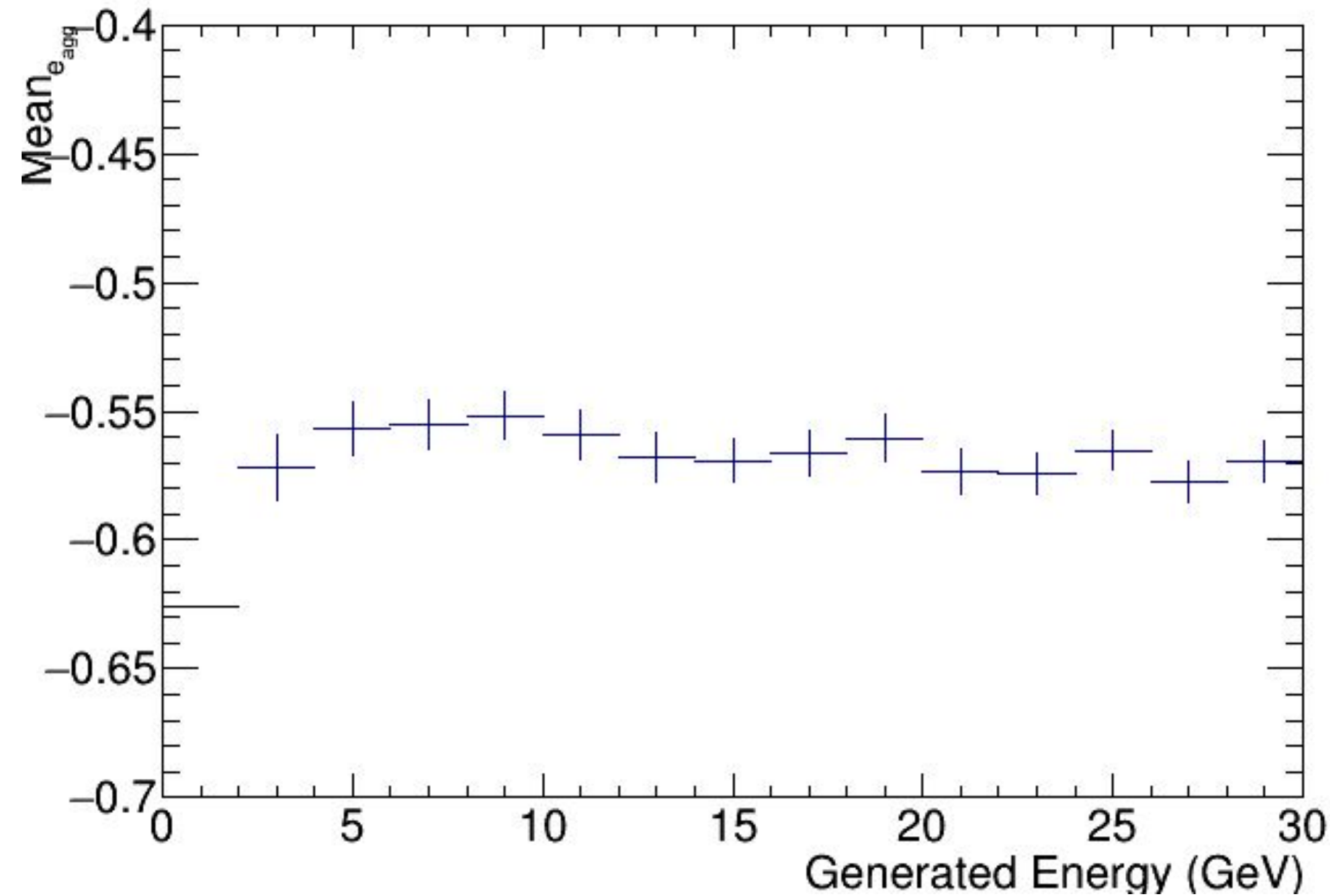
Number of bins = 15
Bin Width = 2 GeV

Fit Parameters:

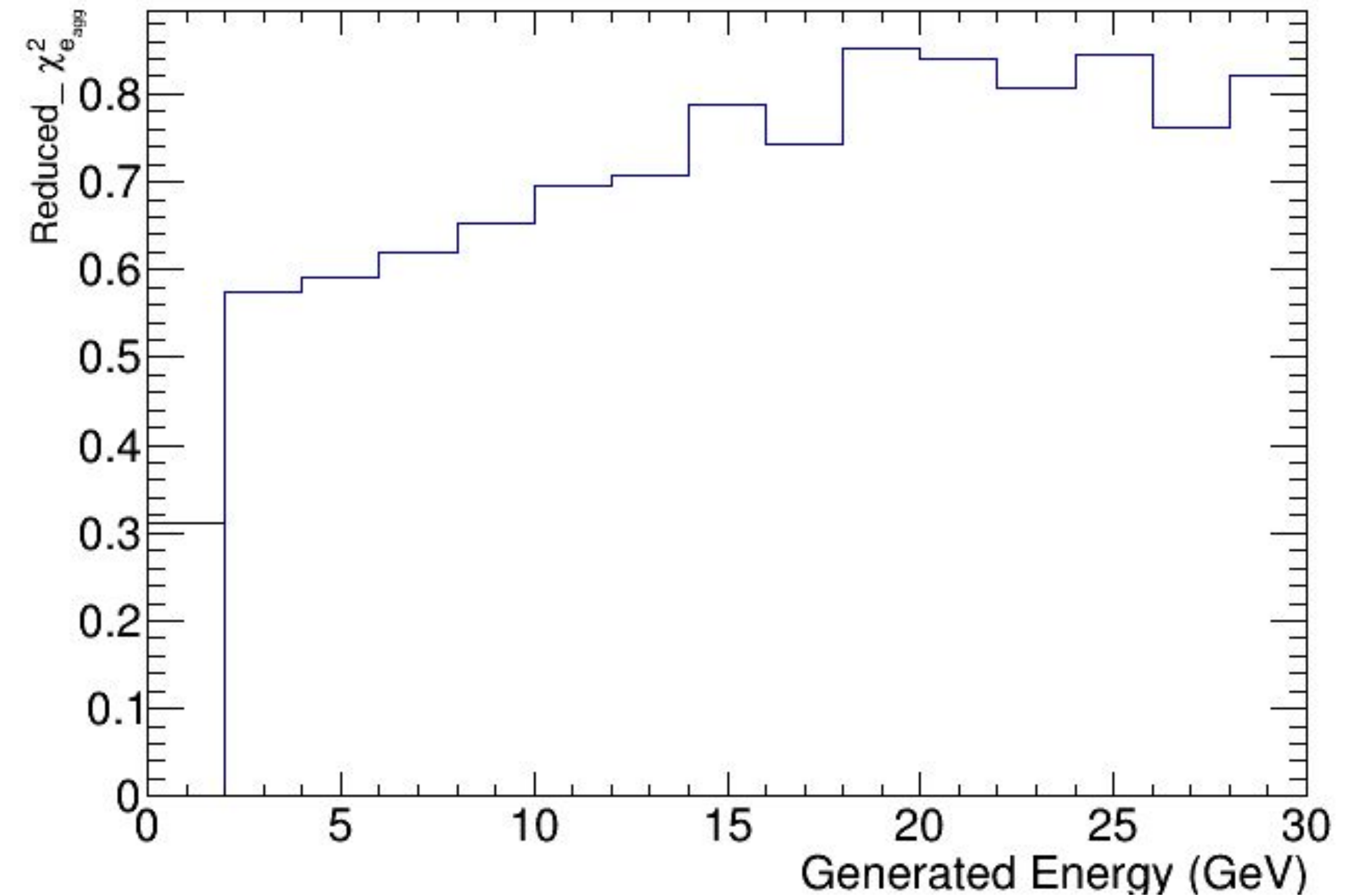
$p_0 = (0.152929 \pm 0.0117704)$
 $p_1 = (0.192765 \pm 0.0404558) \text{ GeV}^{0.5}$

FEMC + FHCAL (π^-)

$(t_{e_{agg}} - g_e)/g_e$ vs g_e
Explicit η cut: 1.3 to 3.3
Elliptical Cuts



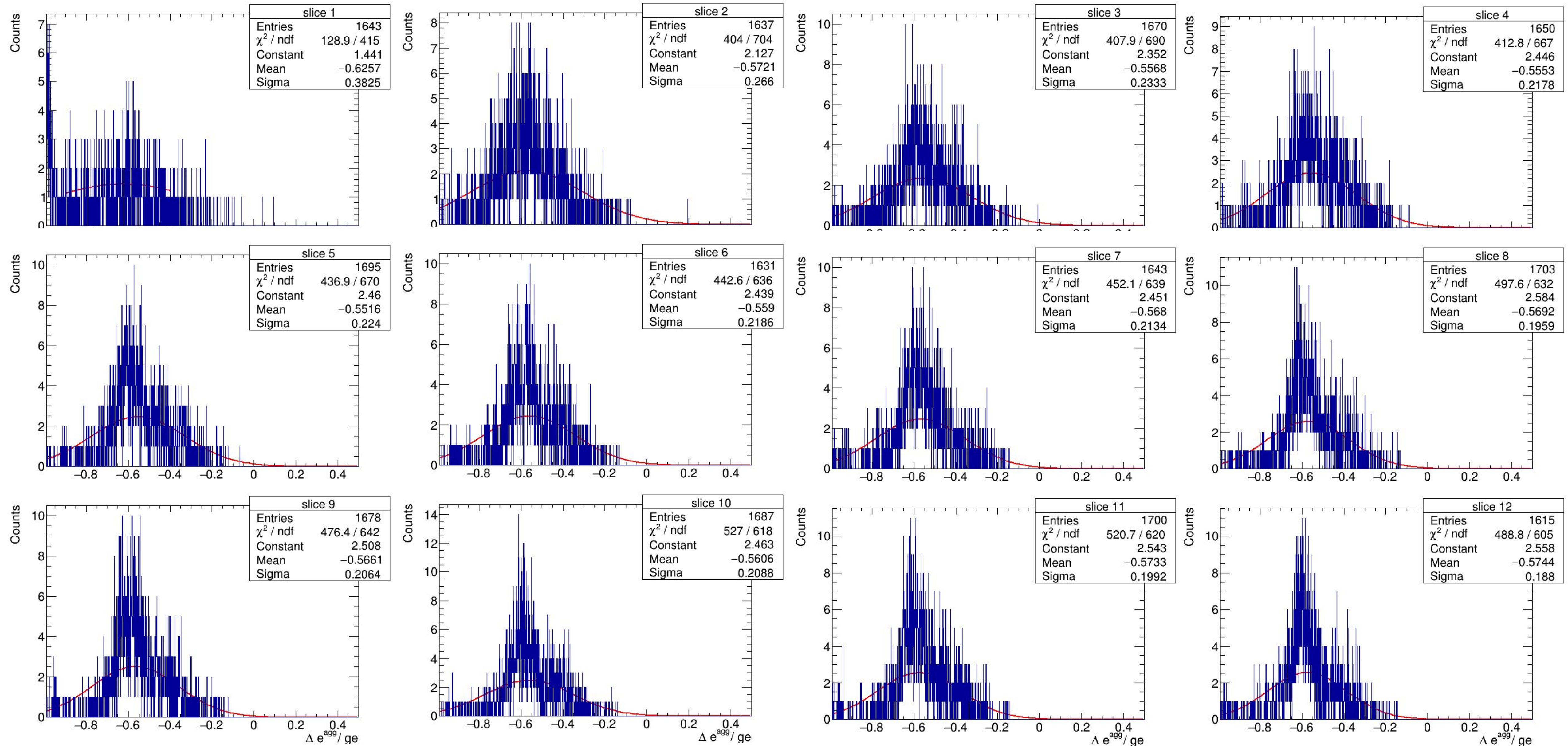
Mean of the Gaussians fitted to the slices of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot.



Reduced_{\chi^2} of the Gaussians fitted to the slices of the $(t_{e_{agg}} - g_e)/g_e$ vs g_e plot.

FEMC + FHCAL (π^-)

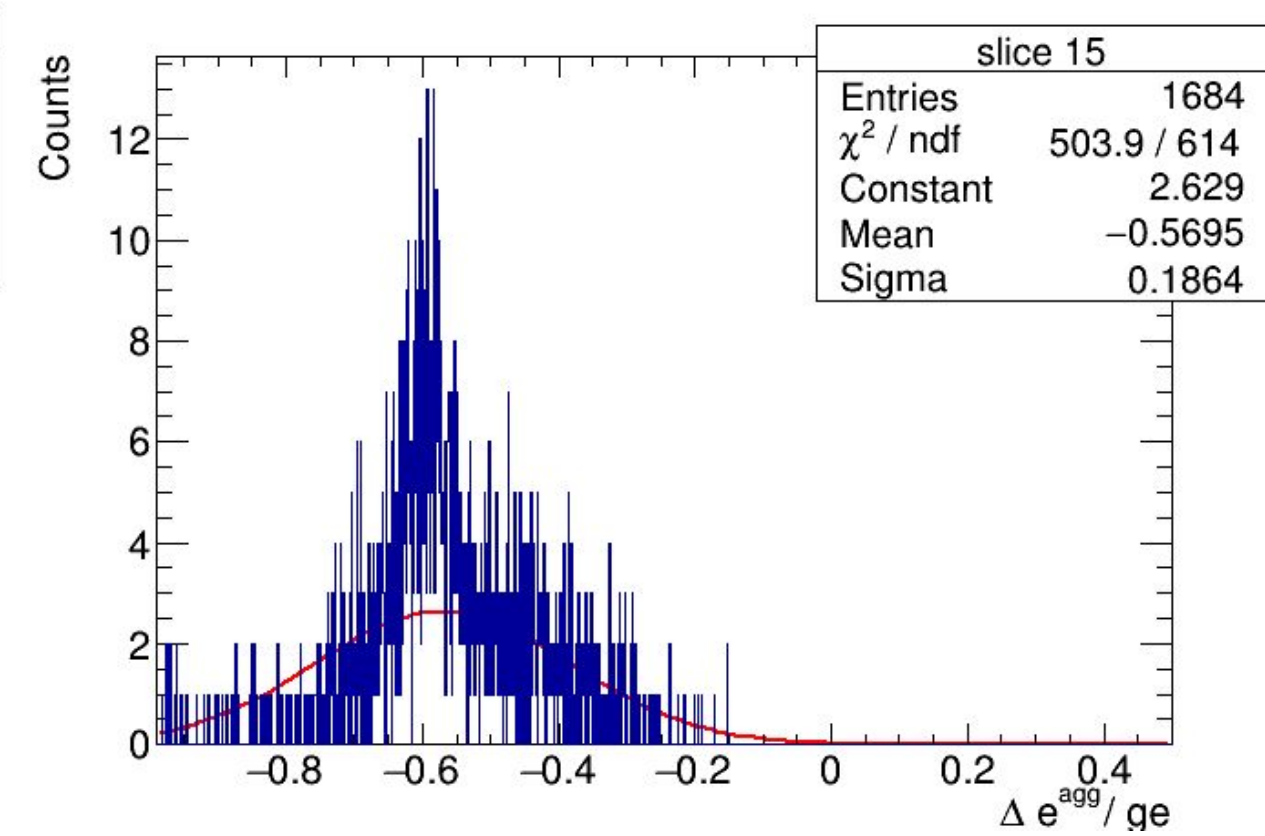
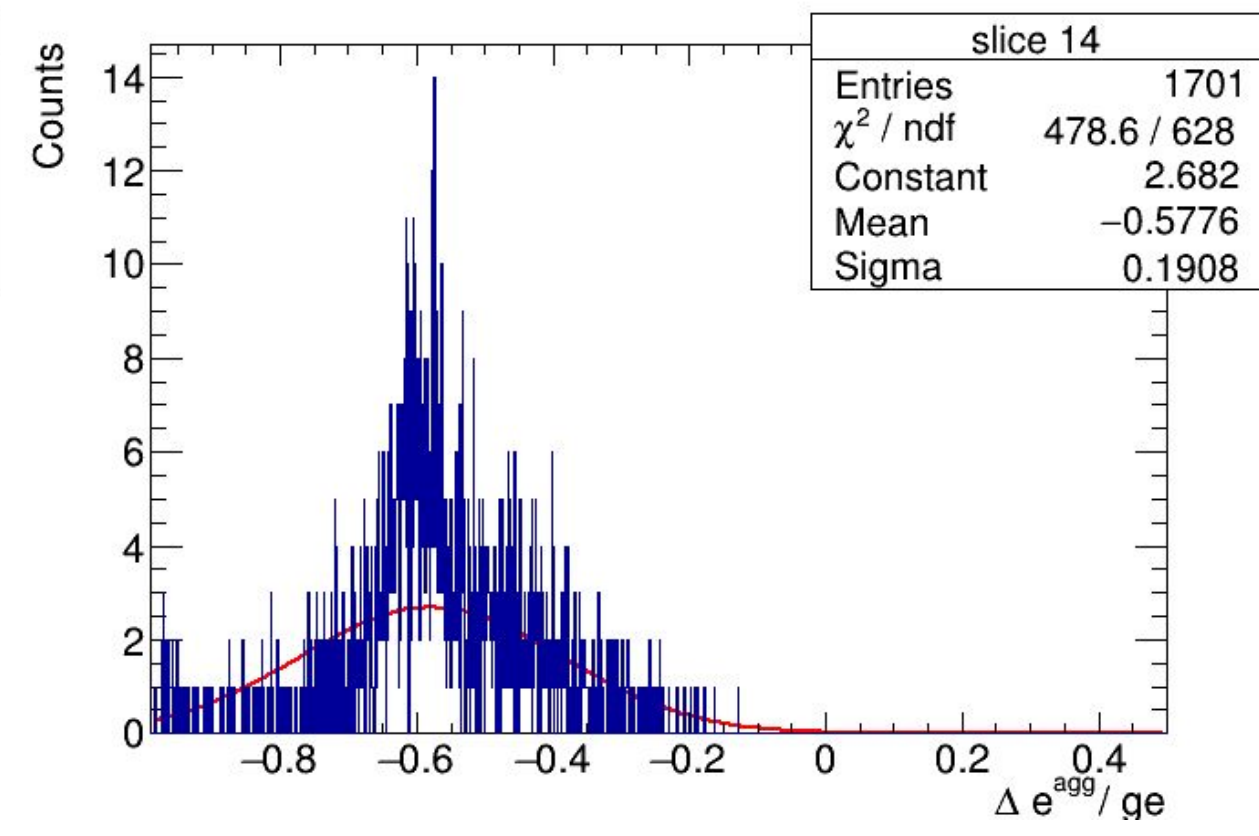
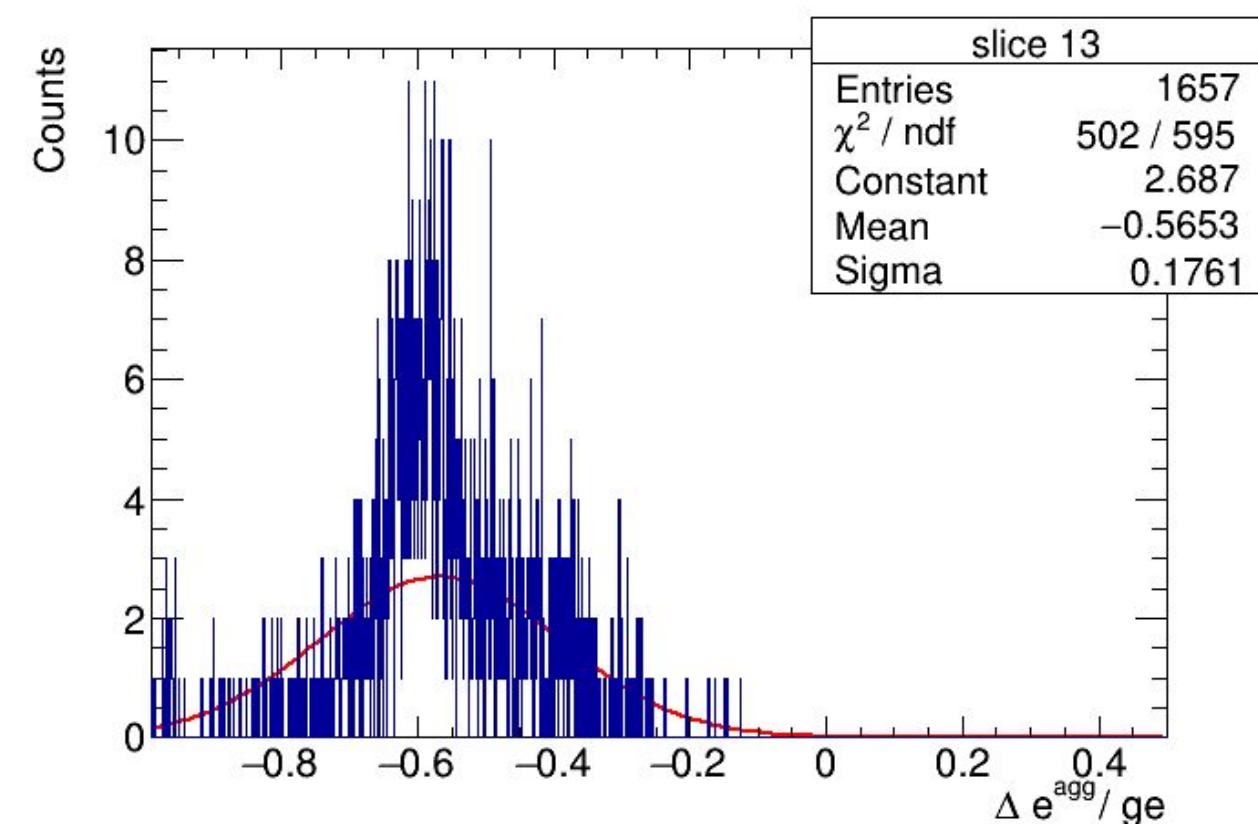
Fitted Gaussians



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

FEMC + FHCAL (π^-)

Fitted Gaussians



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

