Jet Energy Scale Calibration using $e^+e^- \rightarrow qq\gamma$

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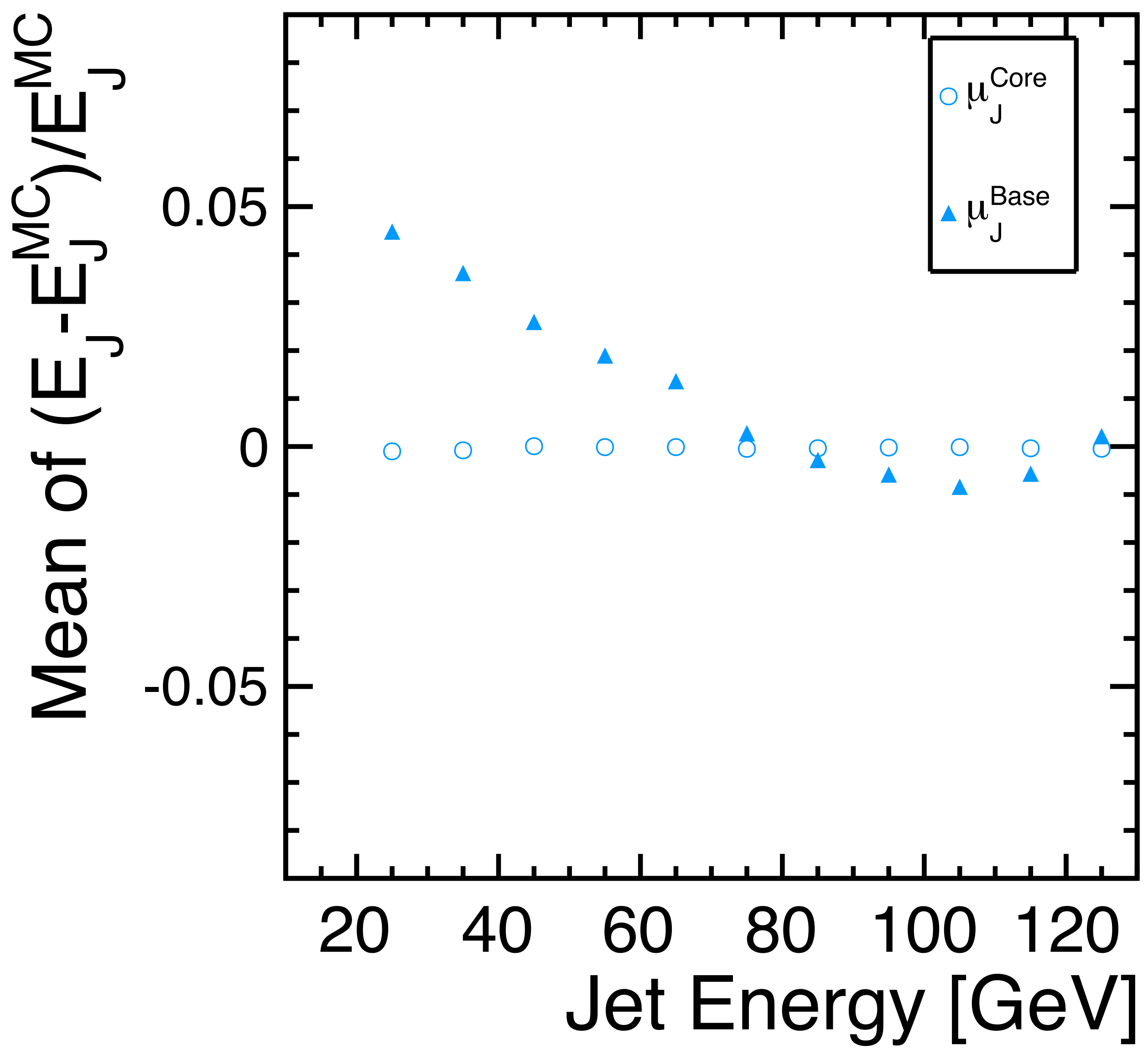
Recent Progress

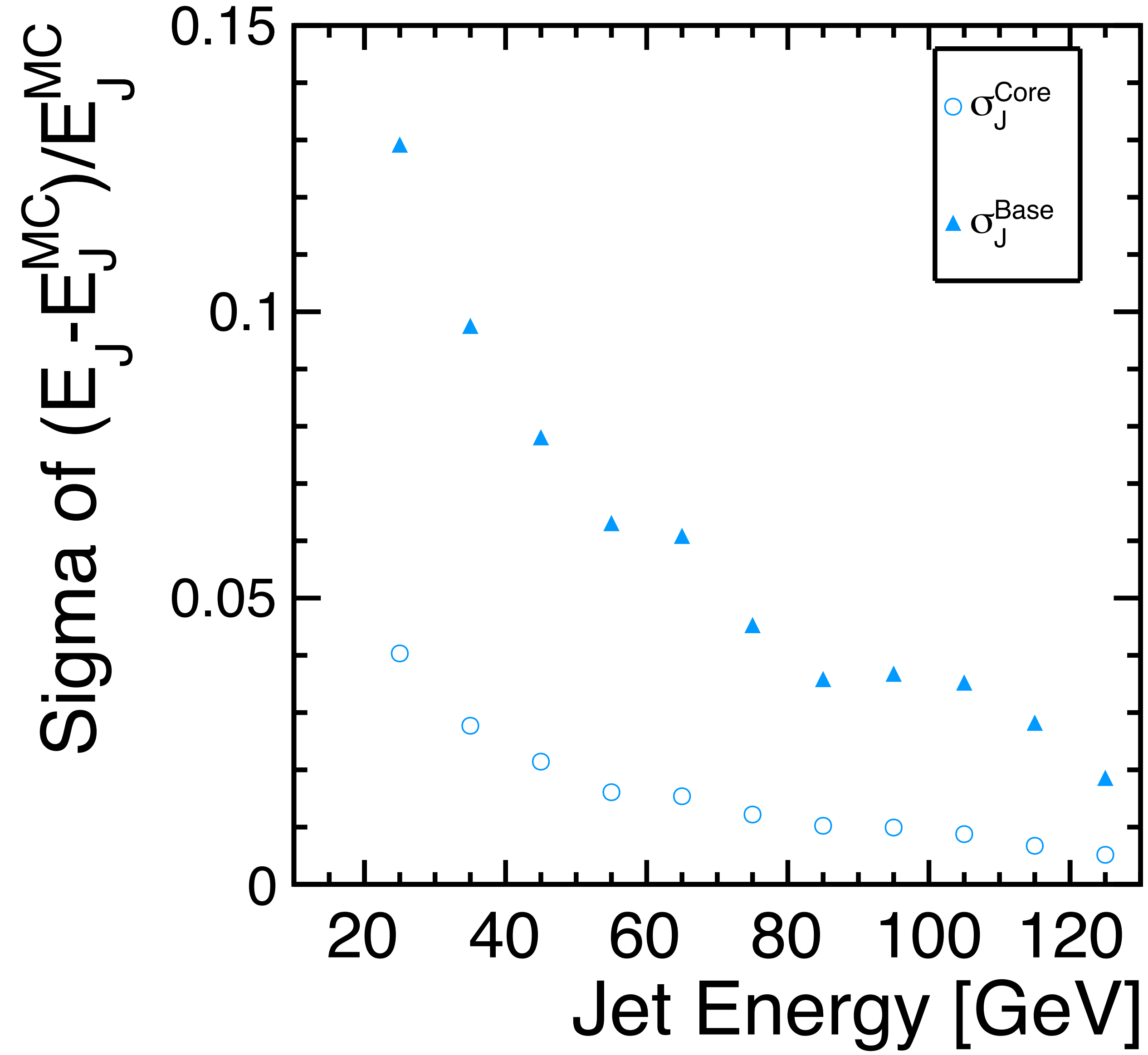
- Last time, I showed energy dependence plot, whose horizontal axis (energy) was Method 3 reconstructed energy. I changed this into PFO.
- I made a presentation material for the KEK student day.
- Preparing a LOI presentation for the EF04 meeting.

M3 Energy dependence (Conventional)

Mean of the Fitting Gaussian



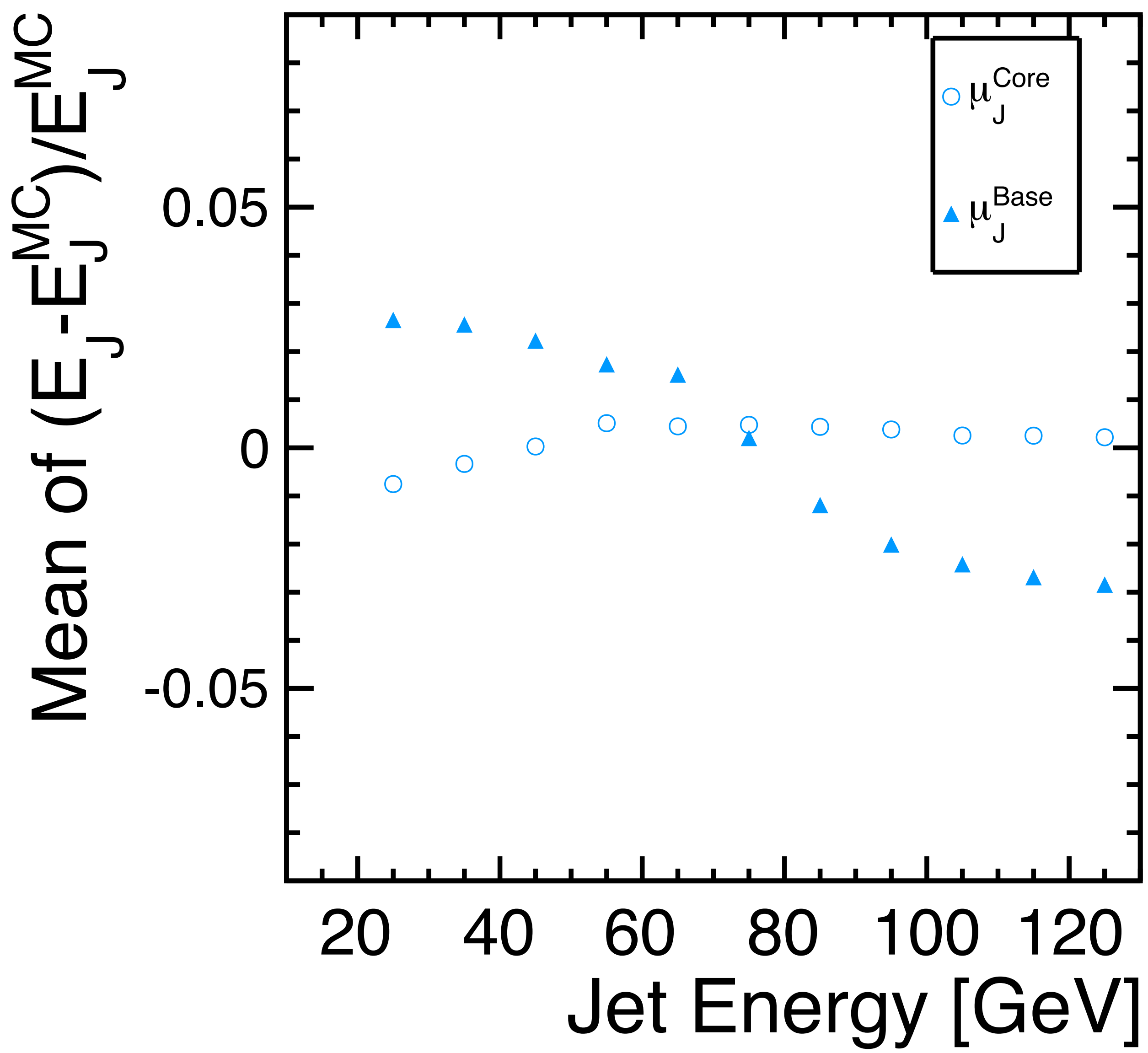
Sigma of the Fitting Gaussian



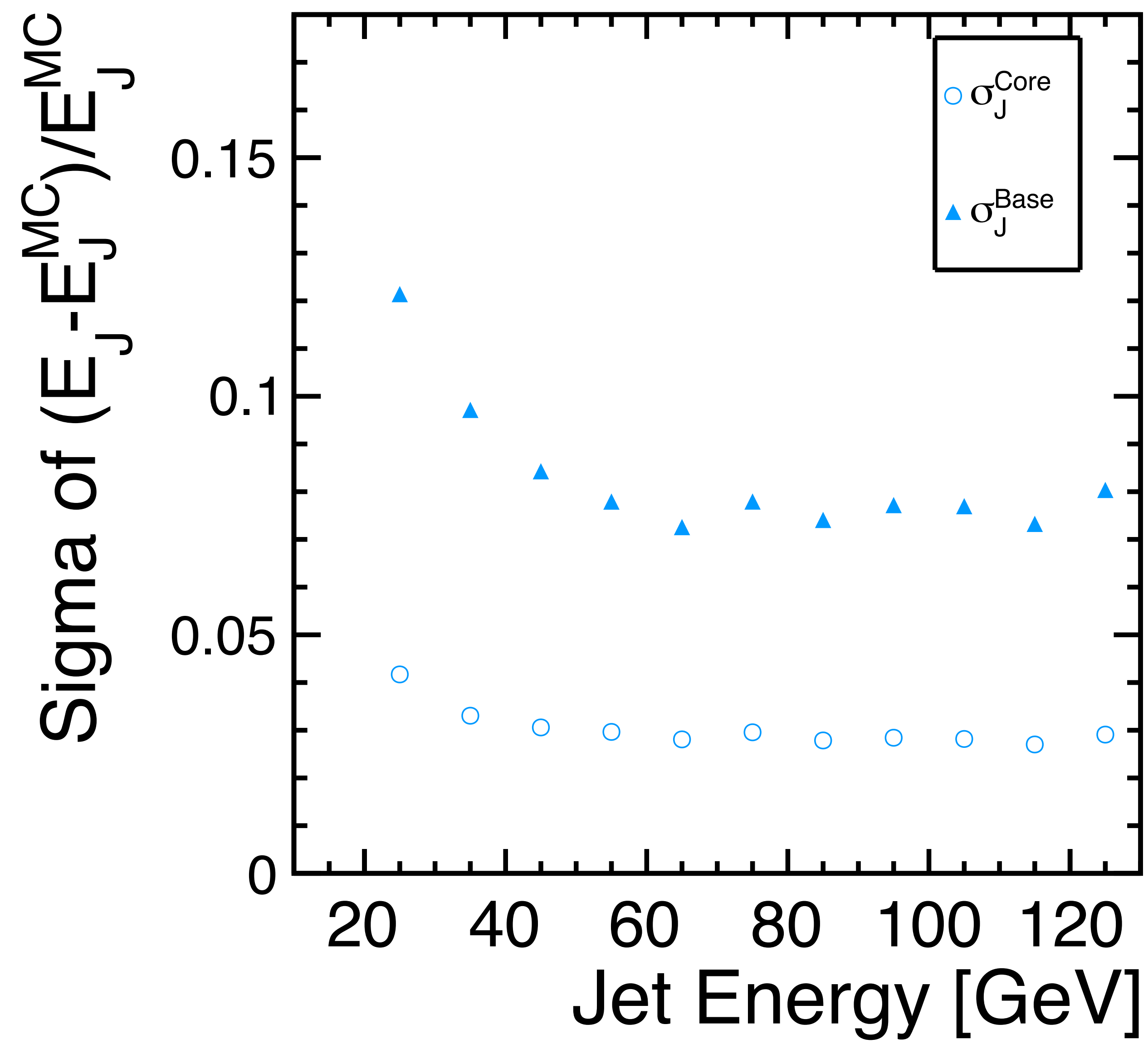
Mean value of the core gaussian is order of 10^{-4} independent on the jet energy.
Sigma value is smaller in the higher energy.

PFO Energy dependence (Conventional)

Mean of the Fitting Gaussian



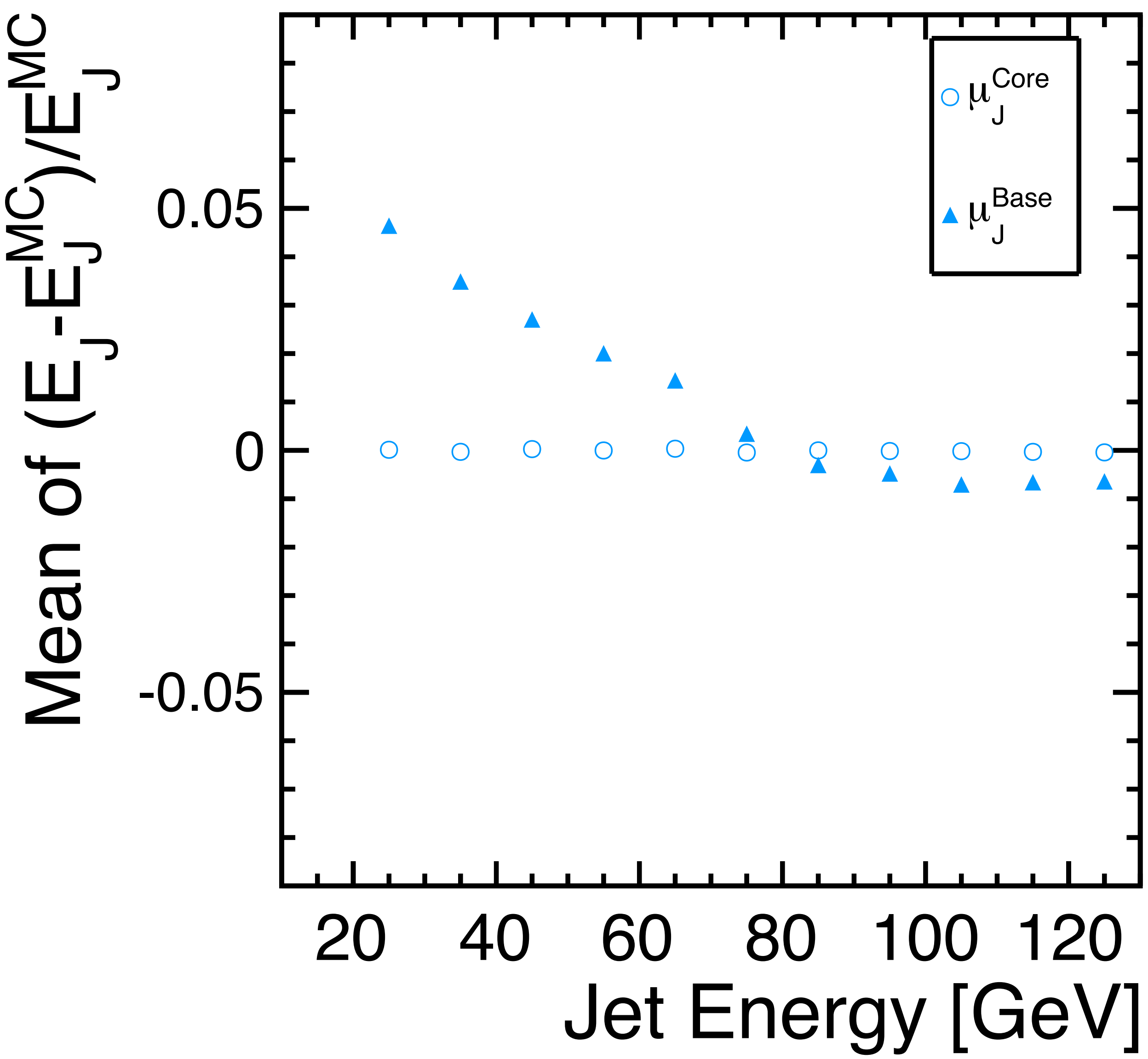
Sigma of the Fitting Gaussian



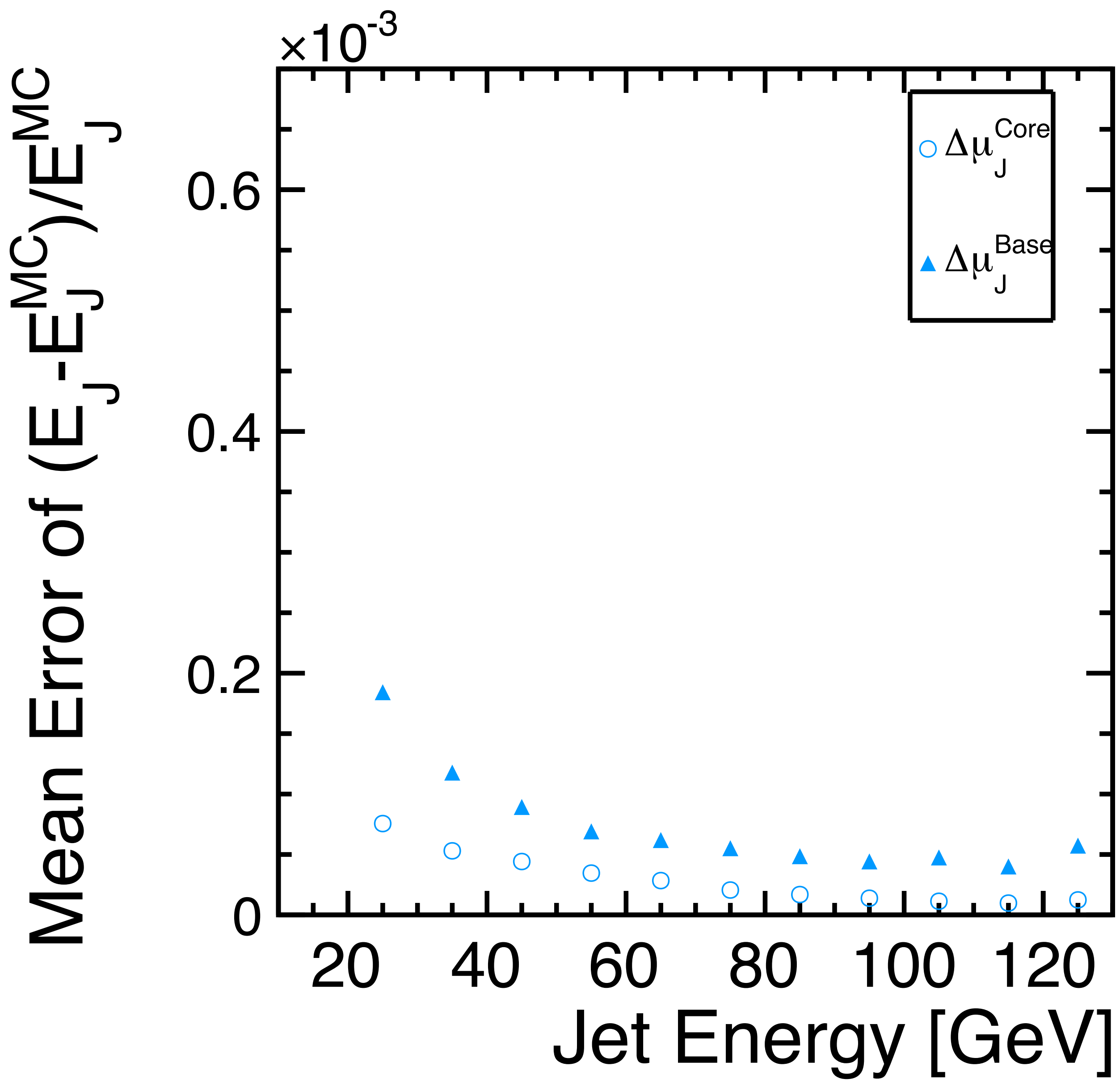
Mean value of the core gaussian is order of 10^{-3} independent on the jet energy.
Sigma value is smaller in the higher energy.

M3 Energy dependence (New)

Mean of the Fitting Gaussian

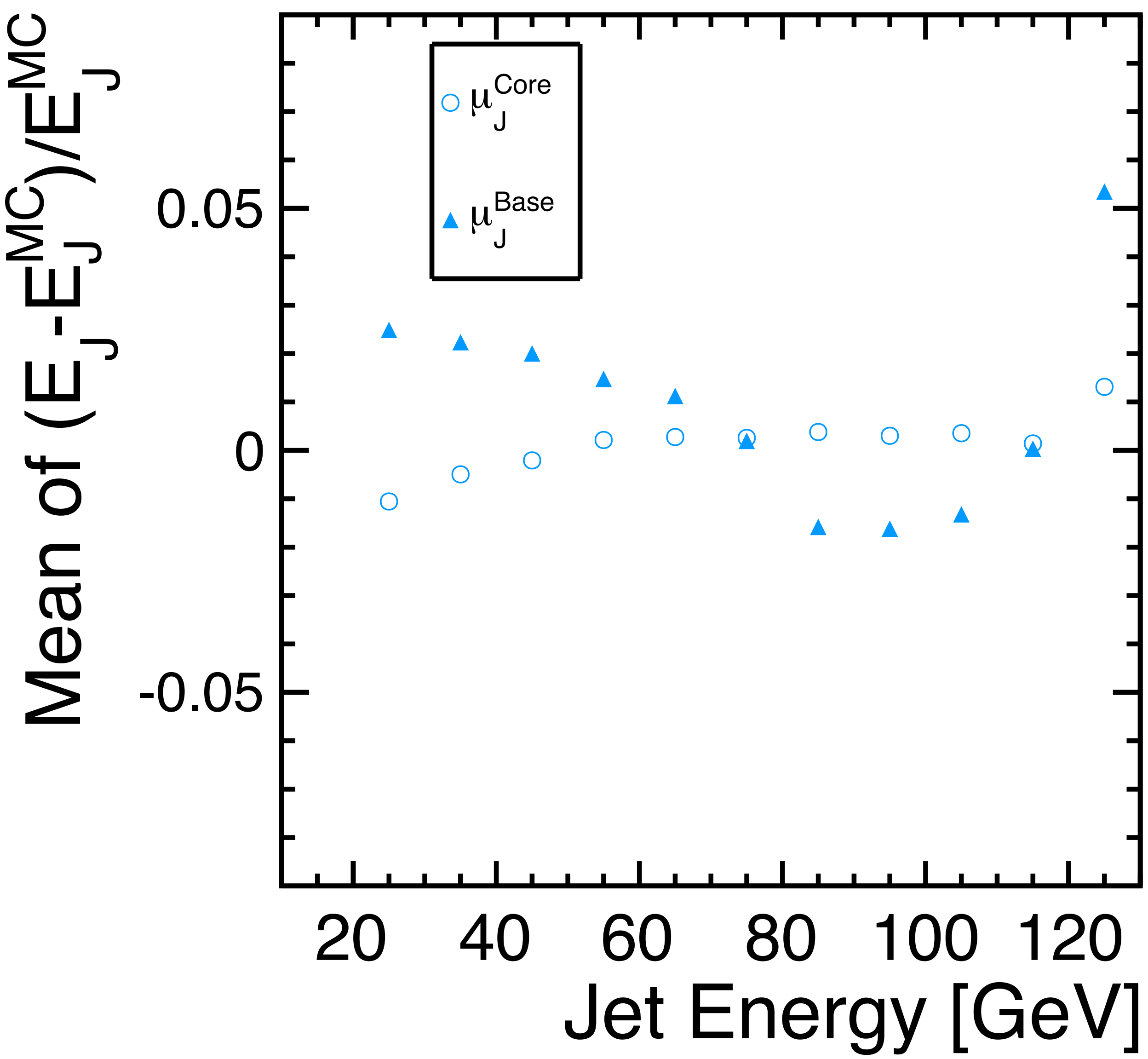


Sigma of the Fitting Gaussian

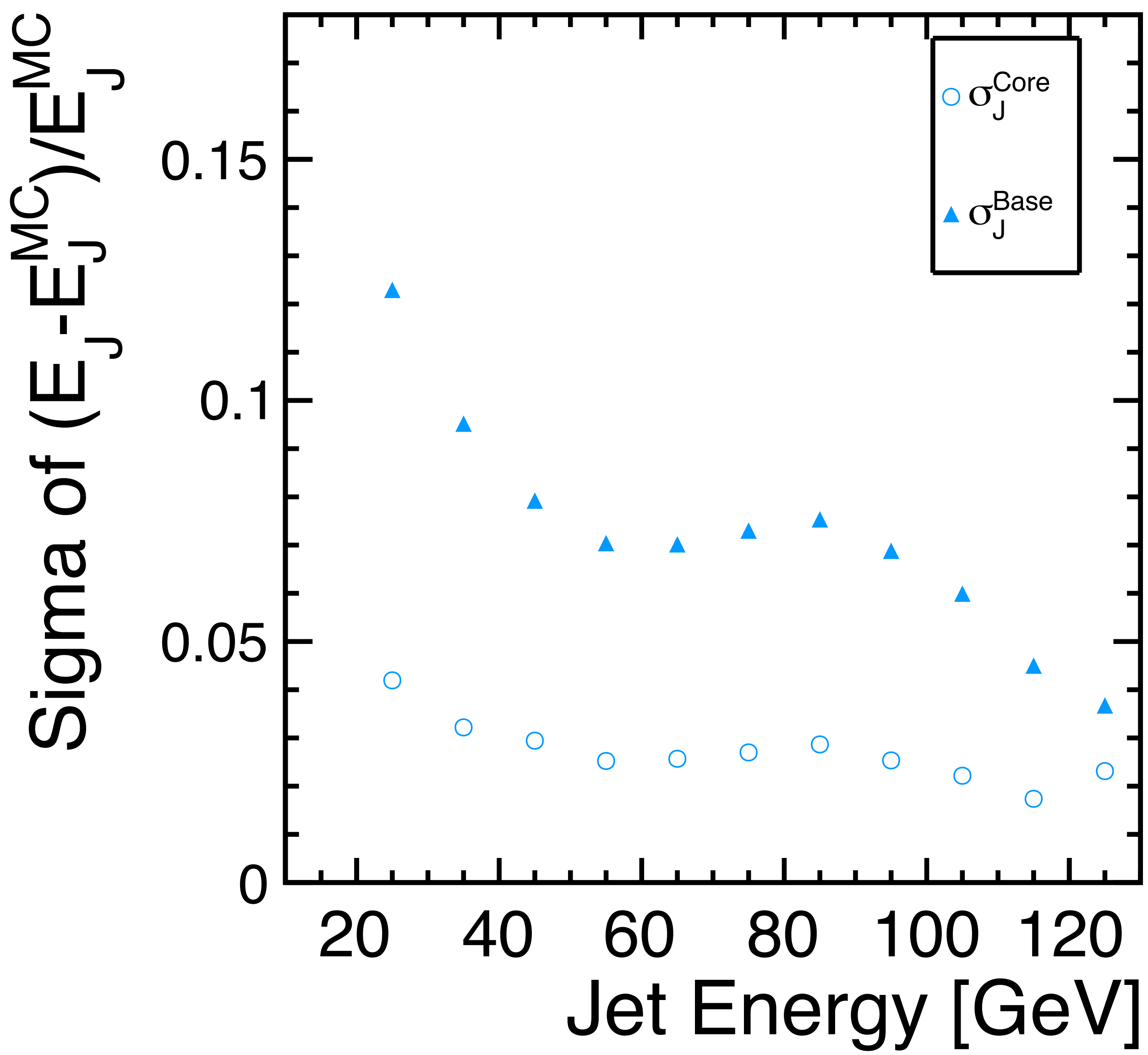


PFO Energy dependence (New)

Mean of the Fitting Gaussian

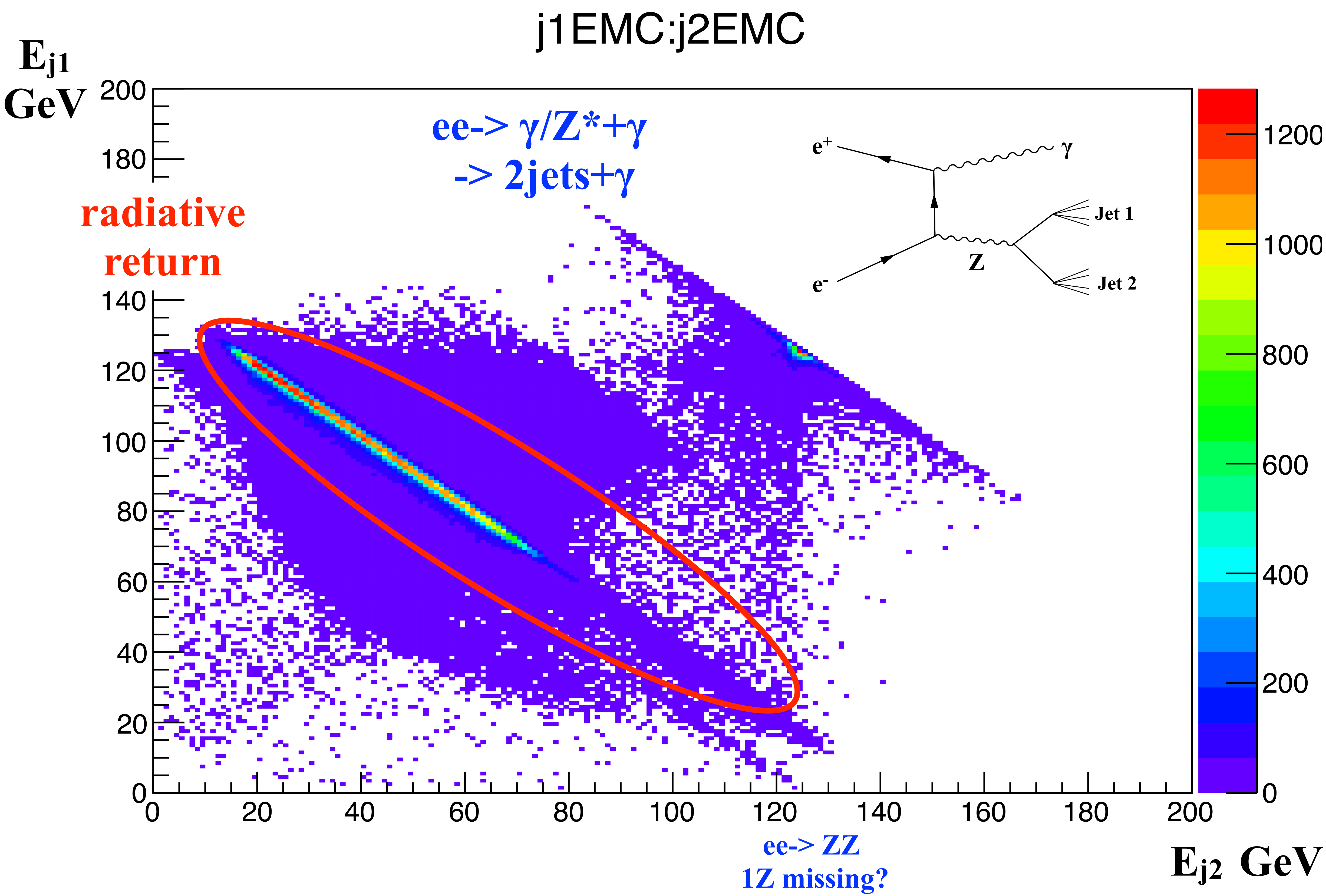


Sigma of the Fitting Gaussian



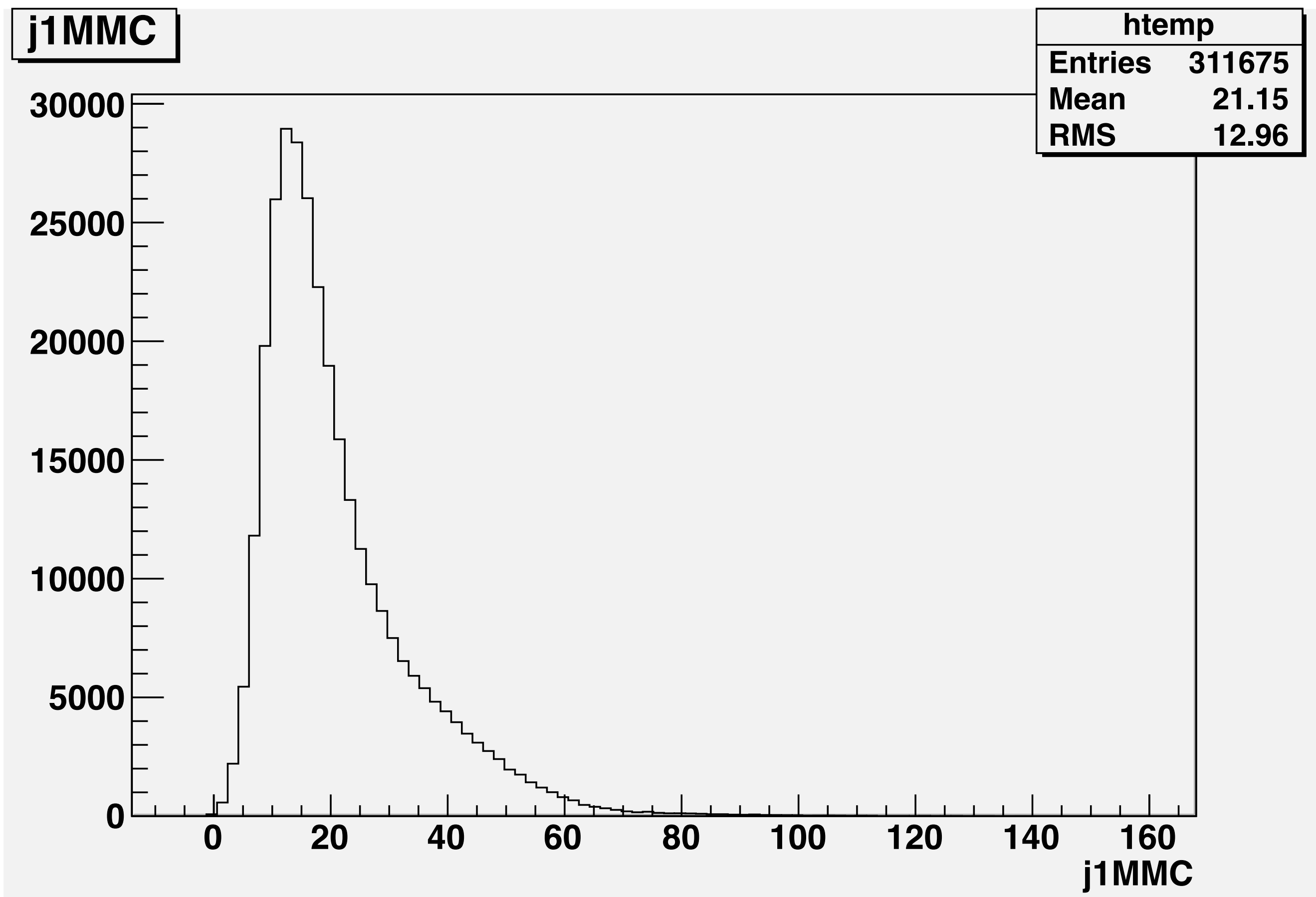
Backup

Jet energy distribution



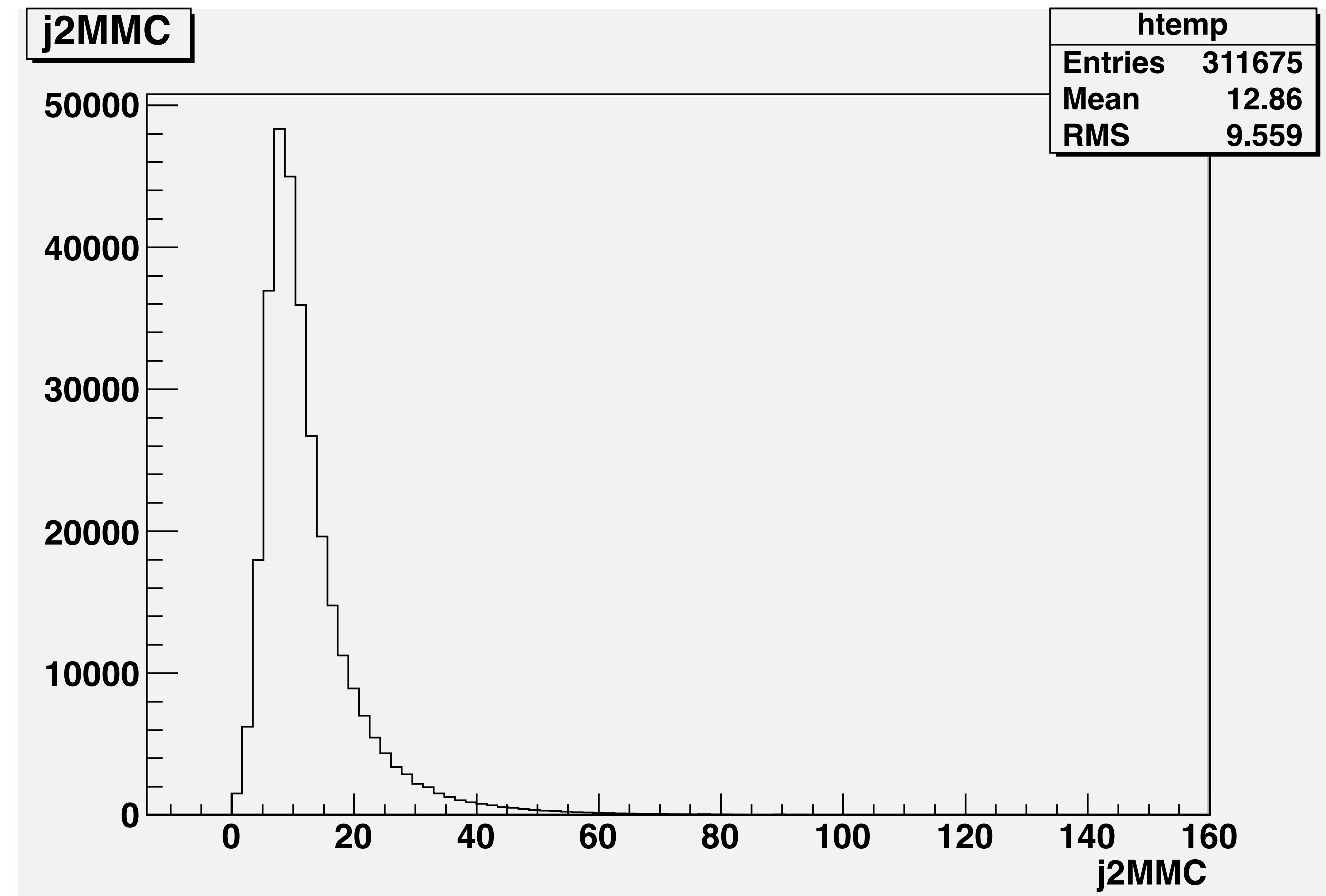
Jet mass distribution

Jet1



M_{Jet1} GeV

Jet2



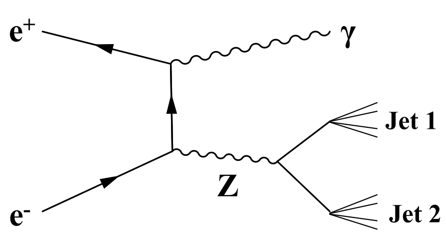
M_{Jet2} GeV

Correct photon selection

E_{vis} (=$E_{j1}+E_{j2}+E_{\gamma}$) vs. $\Delta\theta_{\gamma} = \theta_{\gamma}$(meas)-$\theta_{\gamma}$(MC)

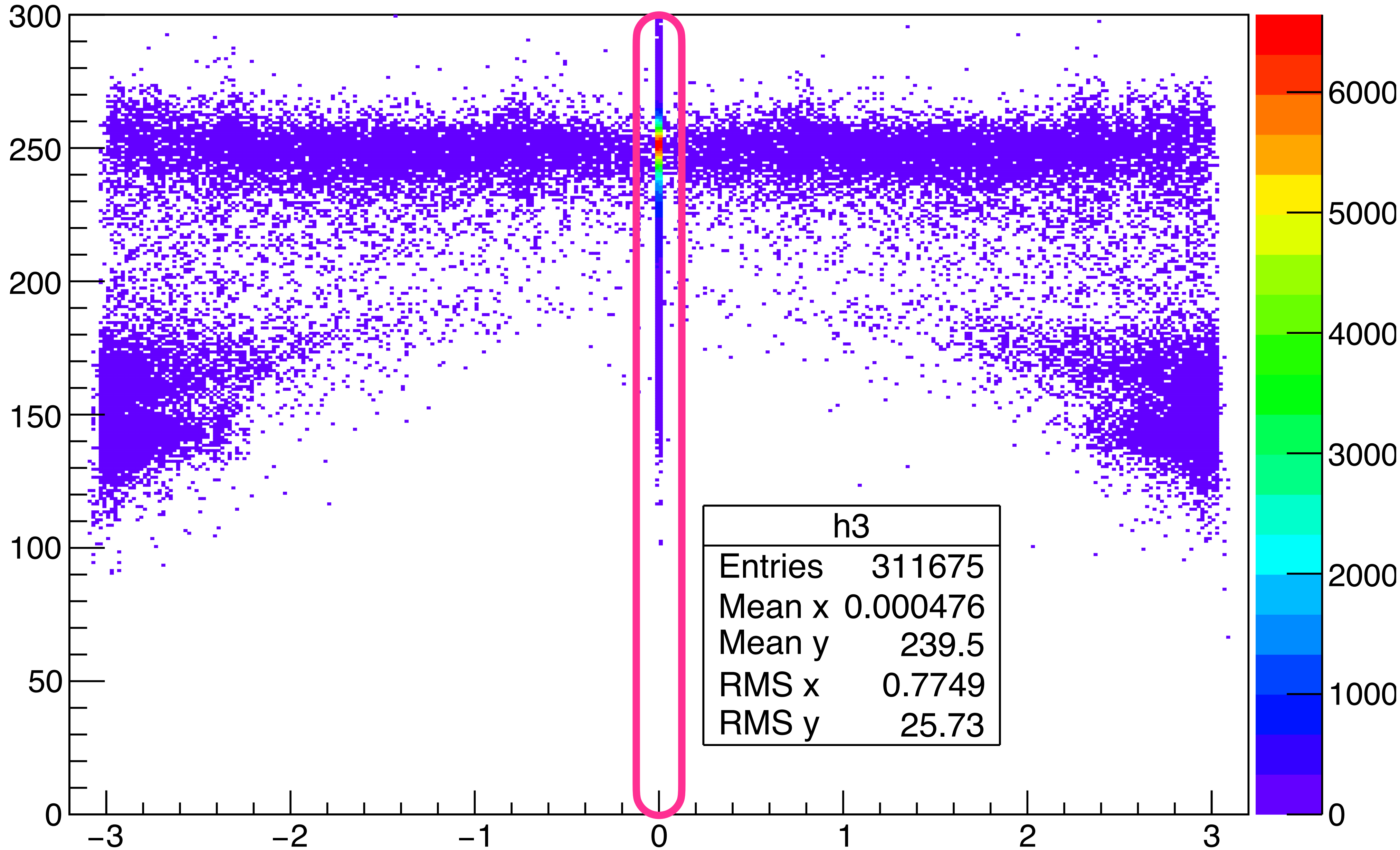
E_{vis} (GeV)

True signal photon: feeble and missing



True signal photon: energetic but missing

Selected photon: from jets



$|\Delta\theta_{\gamma}|$ <0.01 events: 87.8%

$|\Delta\theta_{\gamma}|$ >0.01 events: 12.2%

Correct Photon

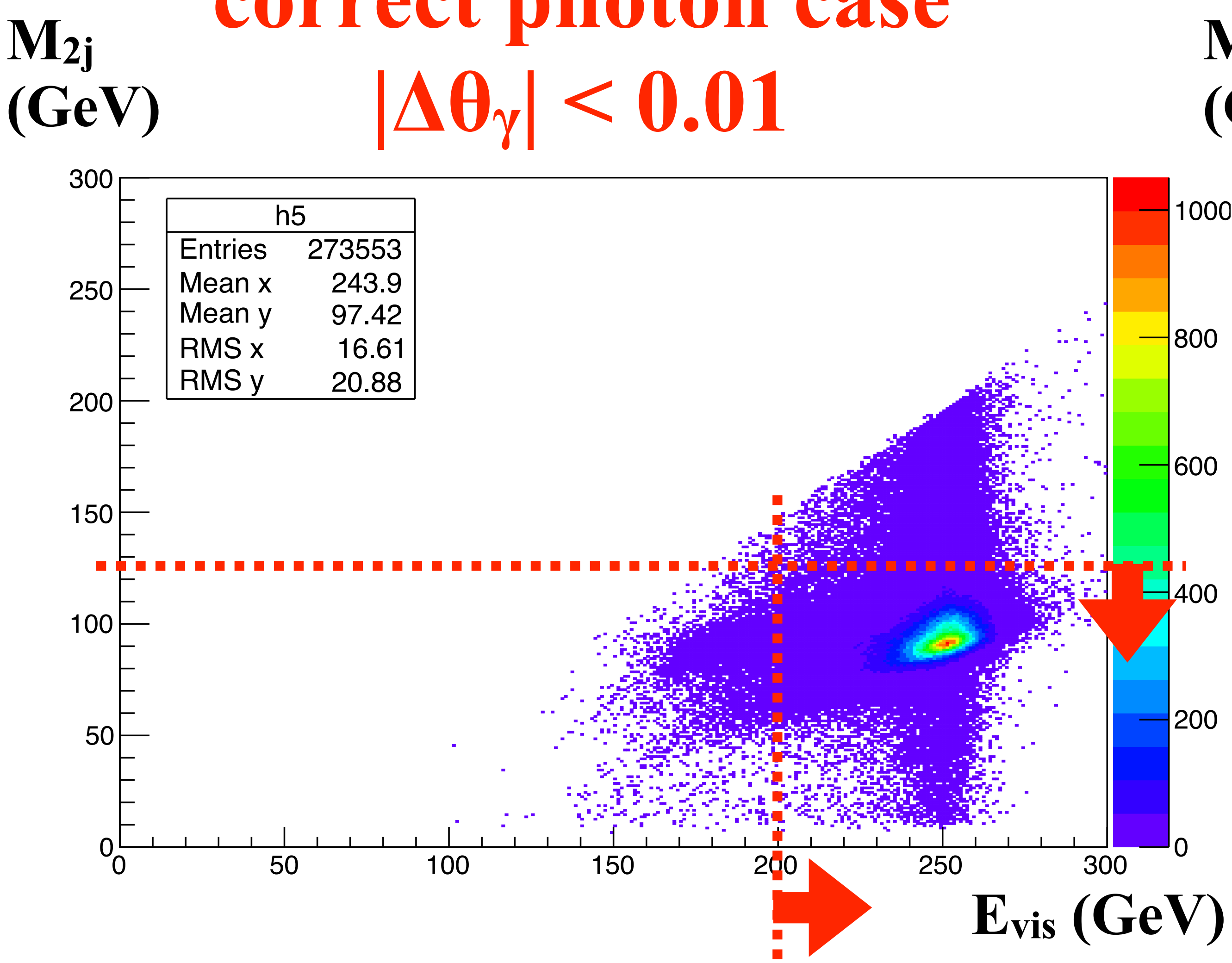
$\Delta\theta_{\gamma}$ (rad)

Correct photon selection cut 1

M_{2j} vs. E_{vis} (=Ej1+Ej2+Eγ)

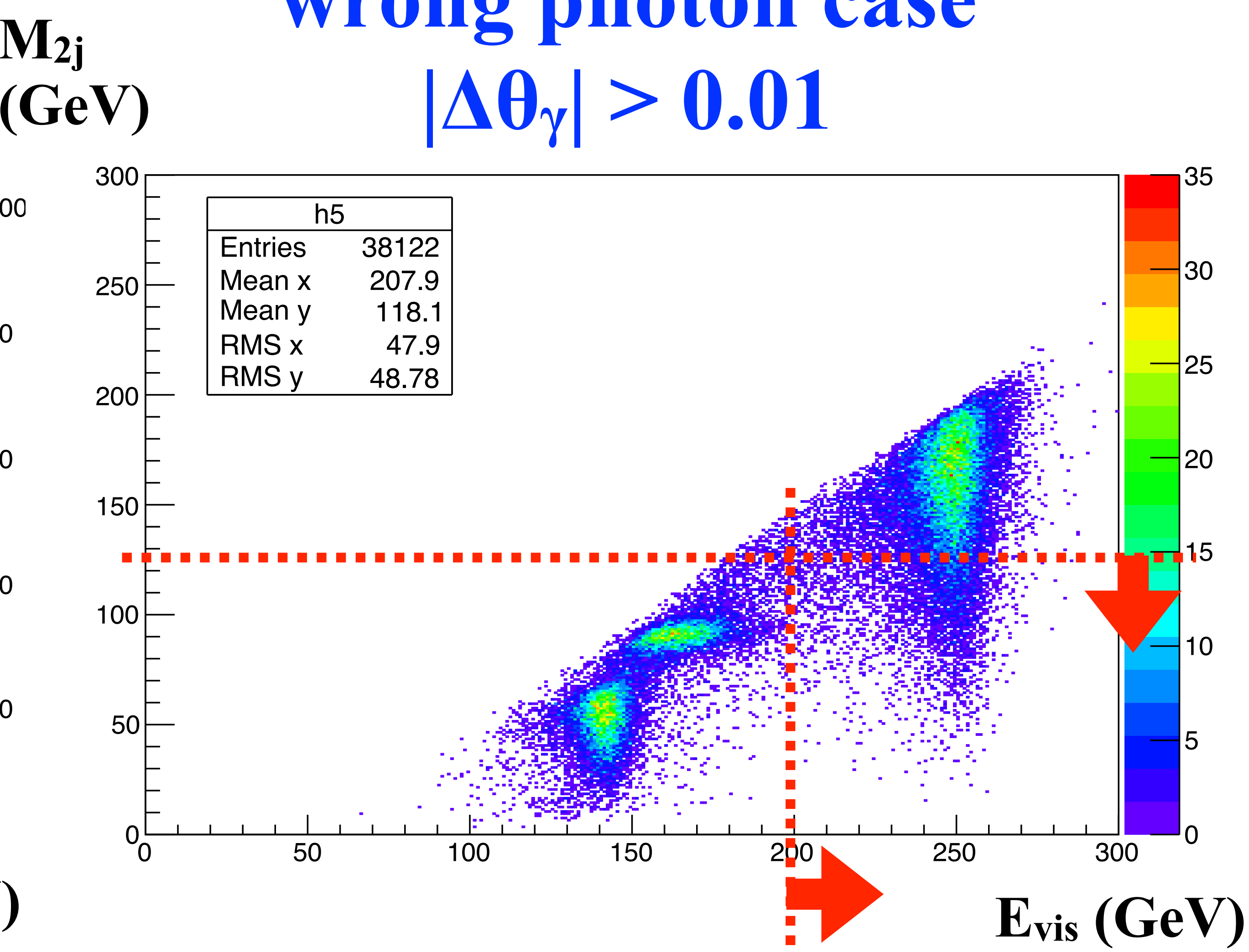
correct photon case

$|\Delta\theta_\gamma| < 0.01$



wrong photon case

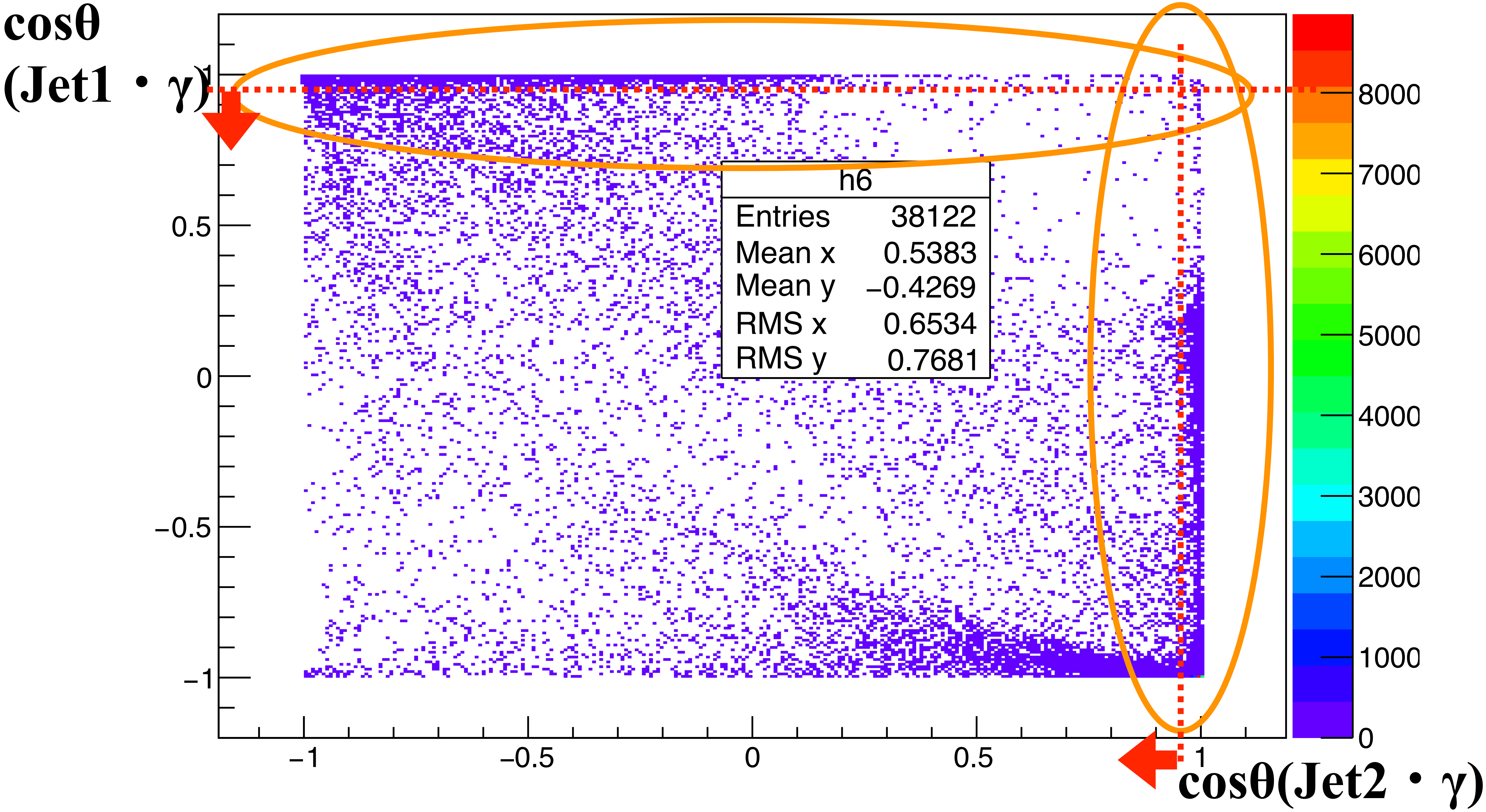
$|\Delta\theta_\gamma| > 0.01$



Cut1: M_{2j} <125 GeV && E_{vis} >200 GeV

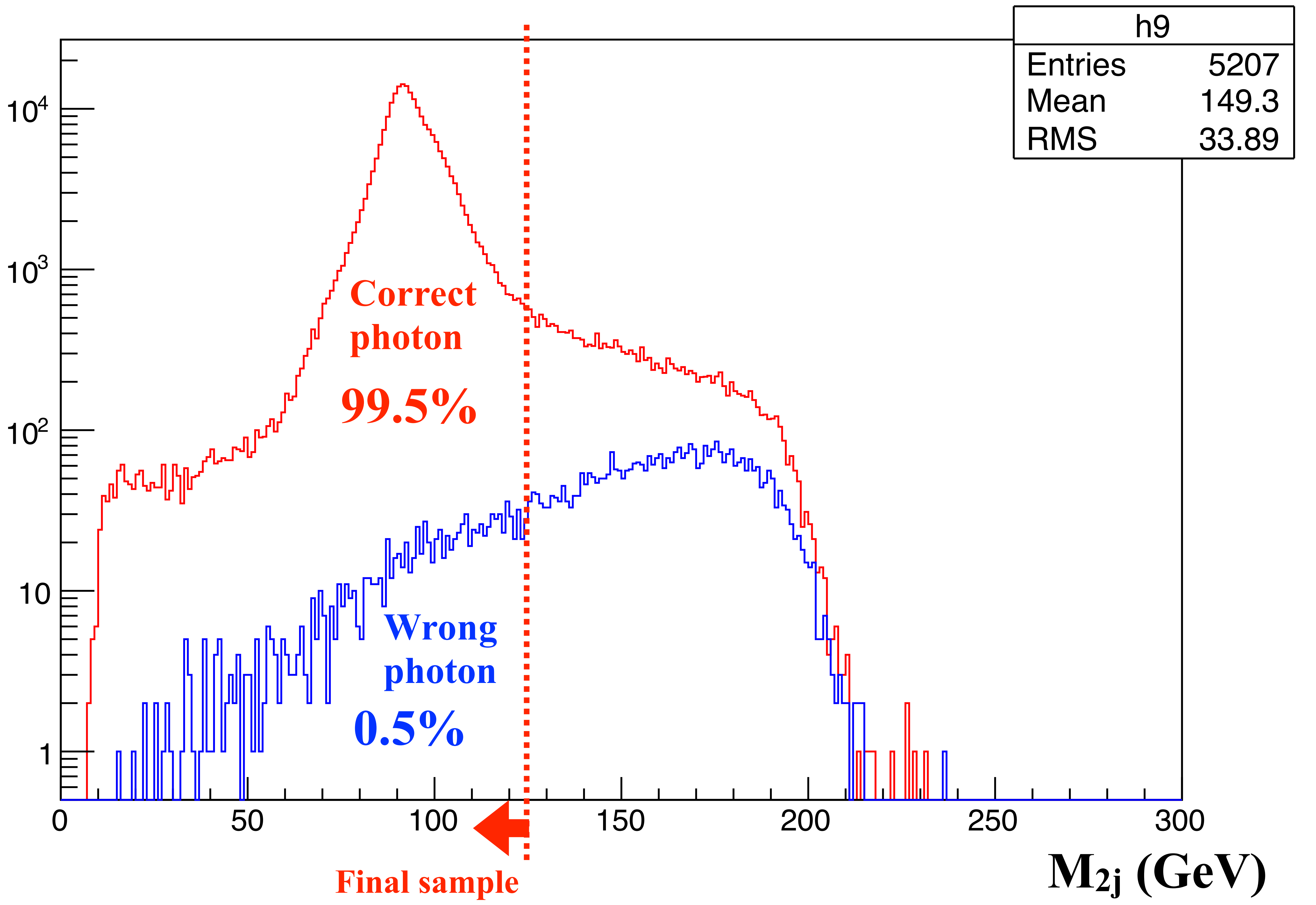
Correct photon selection cut 2

Wrong photons are near jet axes



Cut2: cosθ(Jet1・γ)<0.95 && cosθ(Jet2・γ)<0.95

M_{2j} distribution after all but M_{2j} cut



Source of the bias

Source of the bias is investigated.
-> 2 major source are found.

Inputs and outputs

Using (θ_{J1},θ_{J2},θ_{γ},φ_{J1},φ_{J2},φ_{γ},m_{J1},m_{J2}) -> Determine (P_{J1},P_{J2},P_{γ},P_{ISR})

$$\begin{cases} \sqrt{P_{J1}^2 + m_{J1}^2} + \sqrt{P_{J2}^2 + m_{J2}^2} + |P_\gamma| + |P_{ISR}| = E_{CM} \quad ① \\ \begin{pmatrix} sin\theta_{J1}cos\phi_{J1} & sin\theta_{J2}cos\phi_{J2} & sin\theta_\gamma cos\phi_\gamma \\ sin\theta_{J1}sin\phi_{J1} & sin\theta_{J2}sin\phi_{J2} & sin\theta_\gamma sin\phi_\gamma \\ cos\theta_{J1} & cos\theta_{J2} & cos\theta_\gamma \end{pmatrix} \begin{pmatrix} P_{J1} \\ P_{J2} \\ P_\gamma \end{pmatrix} = \begin{pmatrix} (E_{CM} - |P_{ISR}|)sin\alpha \\ 0 \\ \pm|P_{ISR}|cos\alpha \end{pmatrix} \end{cases}$$

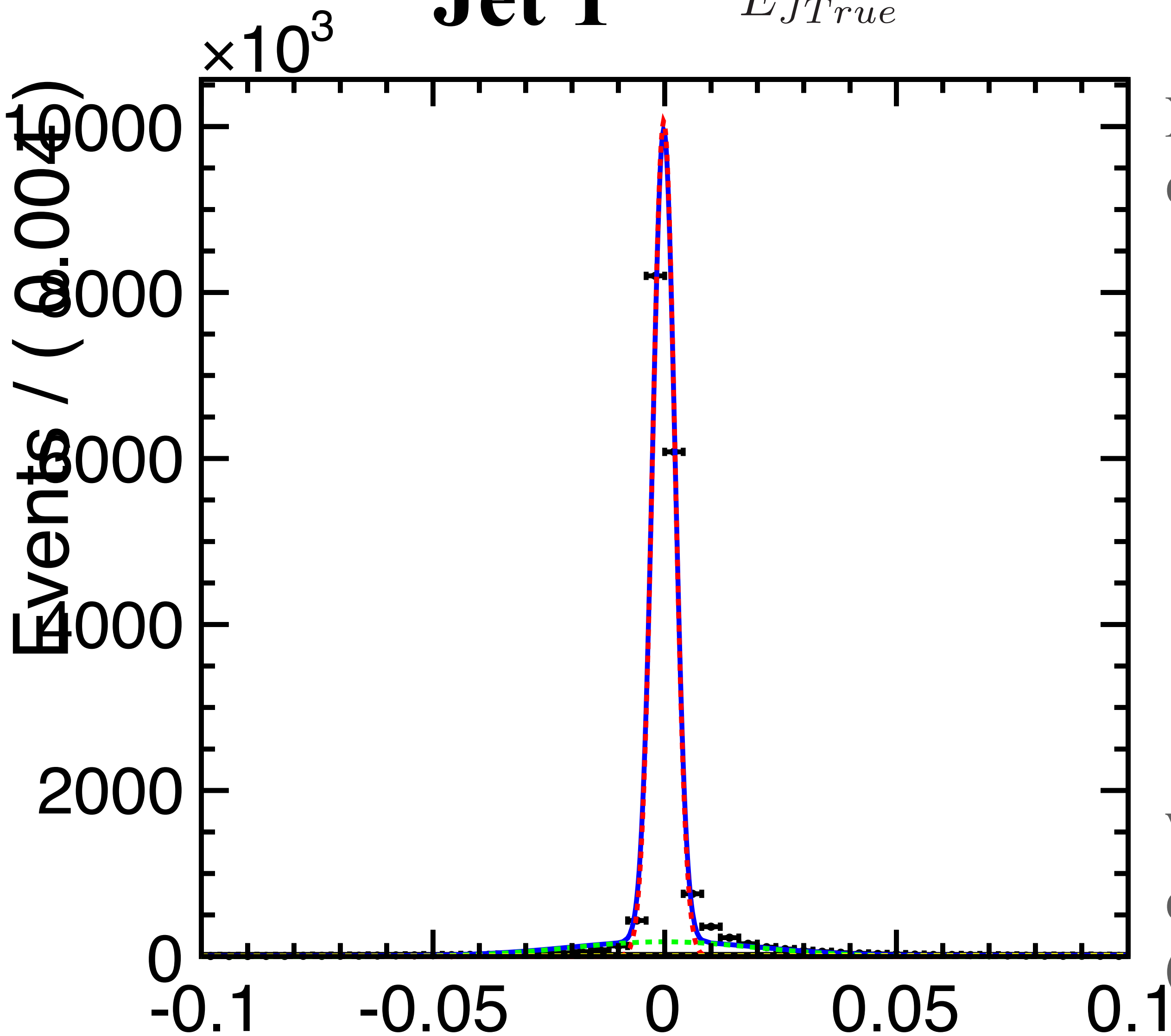
Matrix A → Inverse

(A) Beam energy spread
(B) Error of the jet mass inputs

Source (A): Beam energy spread

When all inputs are all MCtruth,

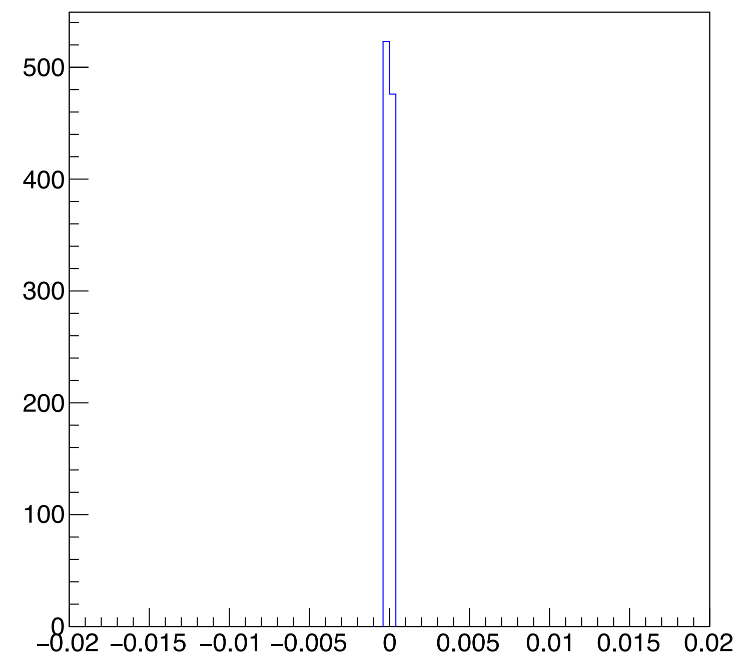
Jet 1 $\frac{E_{JRec} - E_{JTrue}}{E_{JTrue}}$



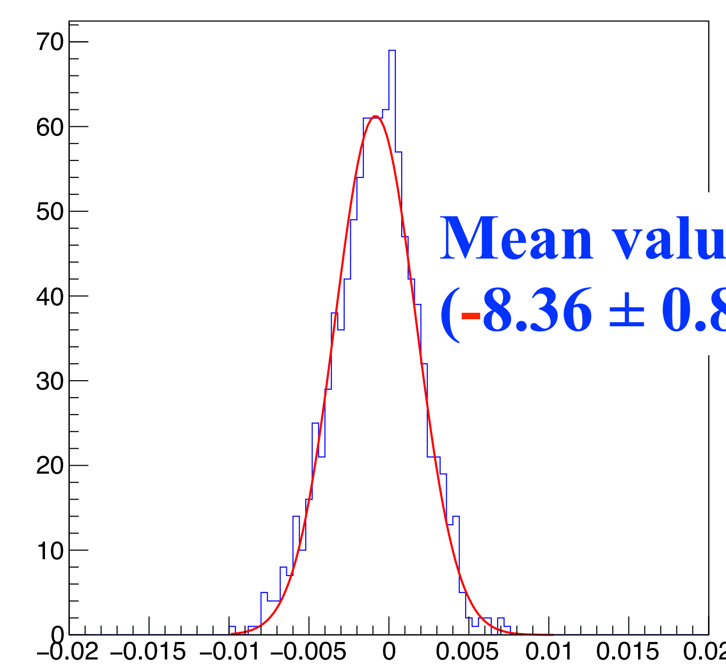
Mean value: (-1.97 ± 0.01) ×10^{-4}

Toy MC Simulation

No beam energy smearing



With beam energy smearing (0.3%)

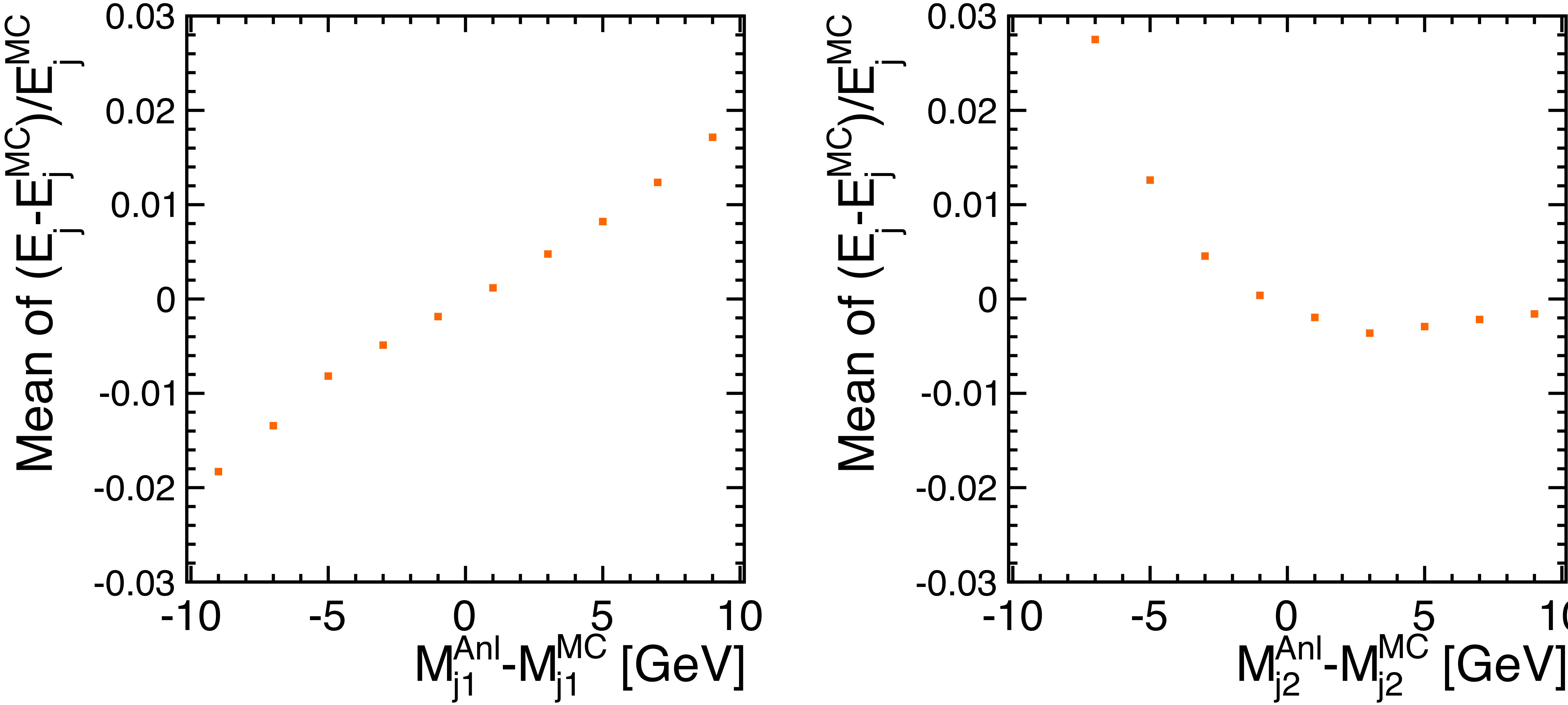


Mean value: (-8.36 ± 0.85) ×10^{-4}

Beam energy spread causes negative bias in jet 1 reconstructed energy. Positive bias in Jet 2 is also confirmed as well.

Source (B): Error of the jet mass inputs

Mean value of the fitting function for the Jet 1 $\frac{E_{JRec} - E_{JTrue}}{E_{JTrue}}$
as a function of the input jet mass deviation



Large dependence on both jet 1 mass and jet 2 mass input deviations. If <8 × 10^{-4} accuracy is necessary, compensation to the reconstructed jet energy should be introduced.