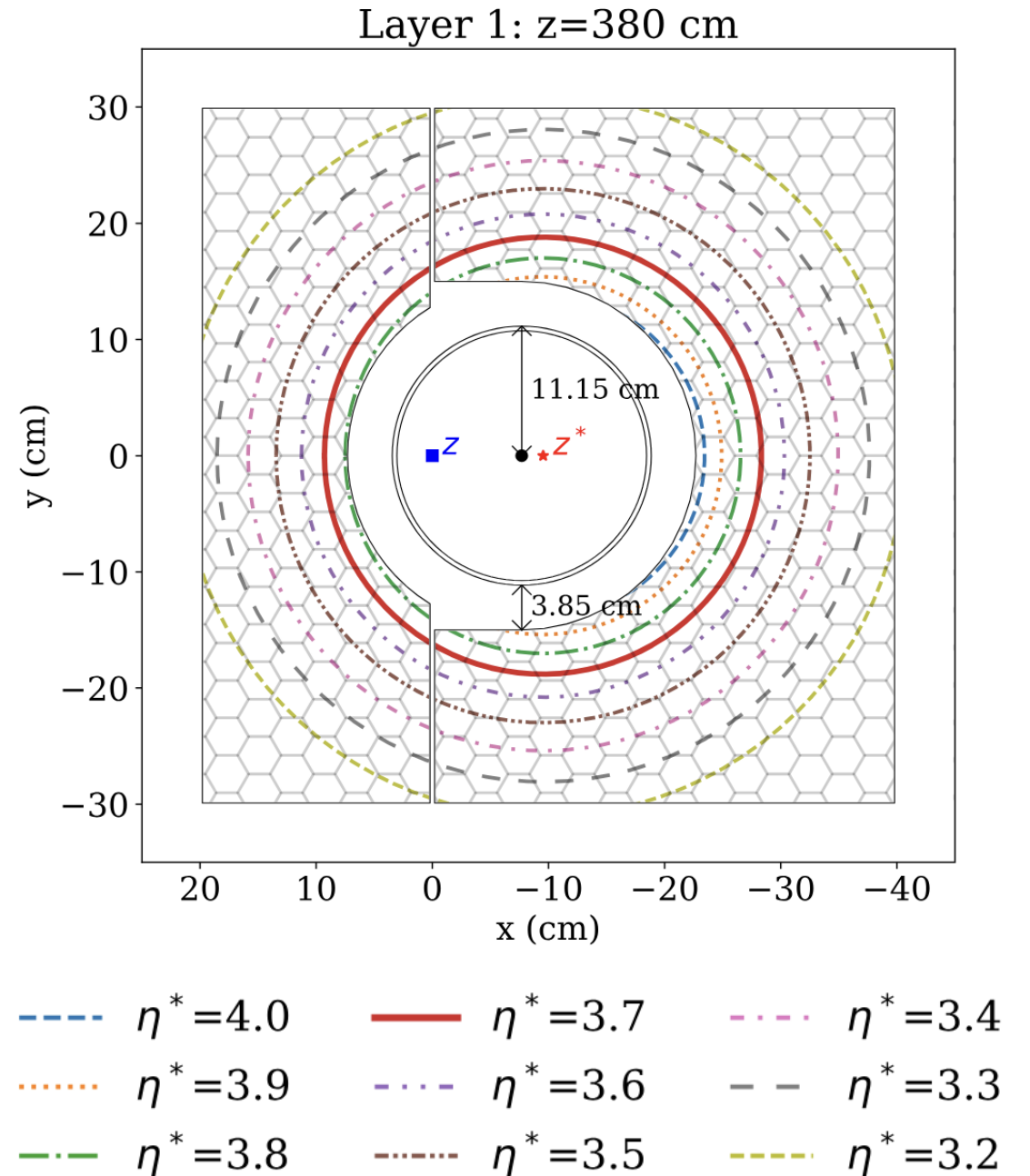


Insert Jet Studies Update

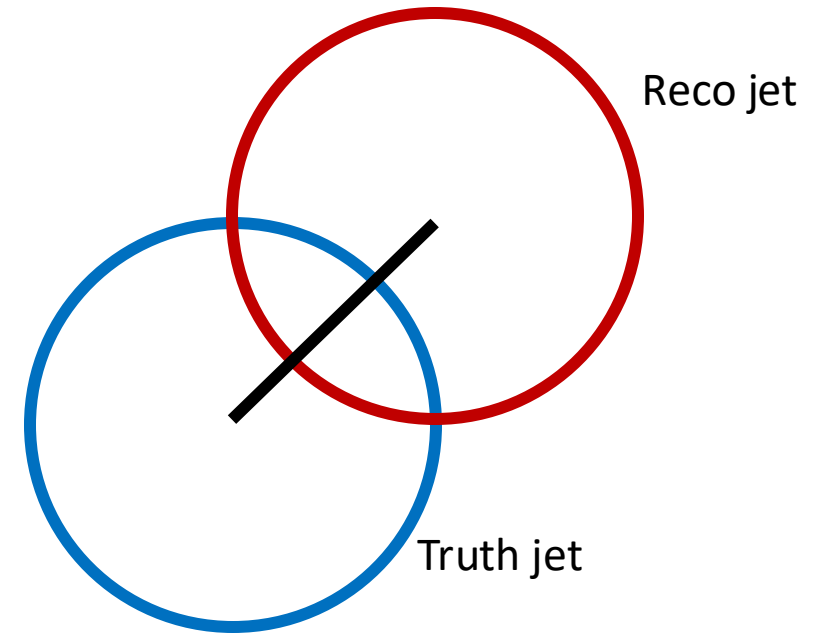
Sean Preins

10/8/25

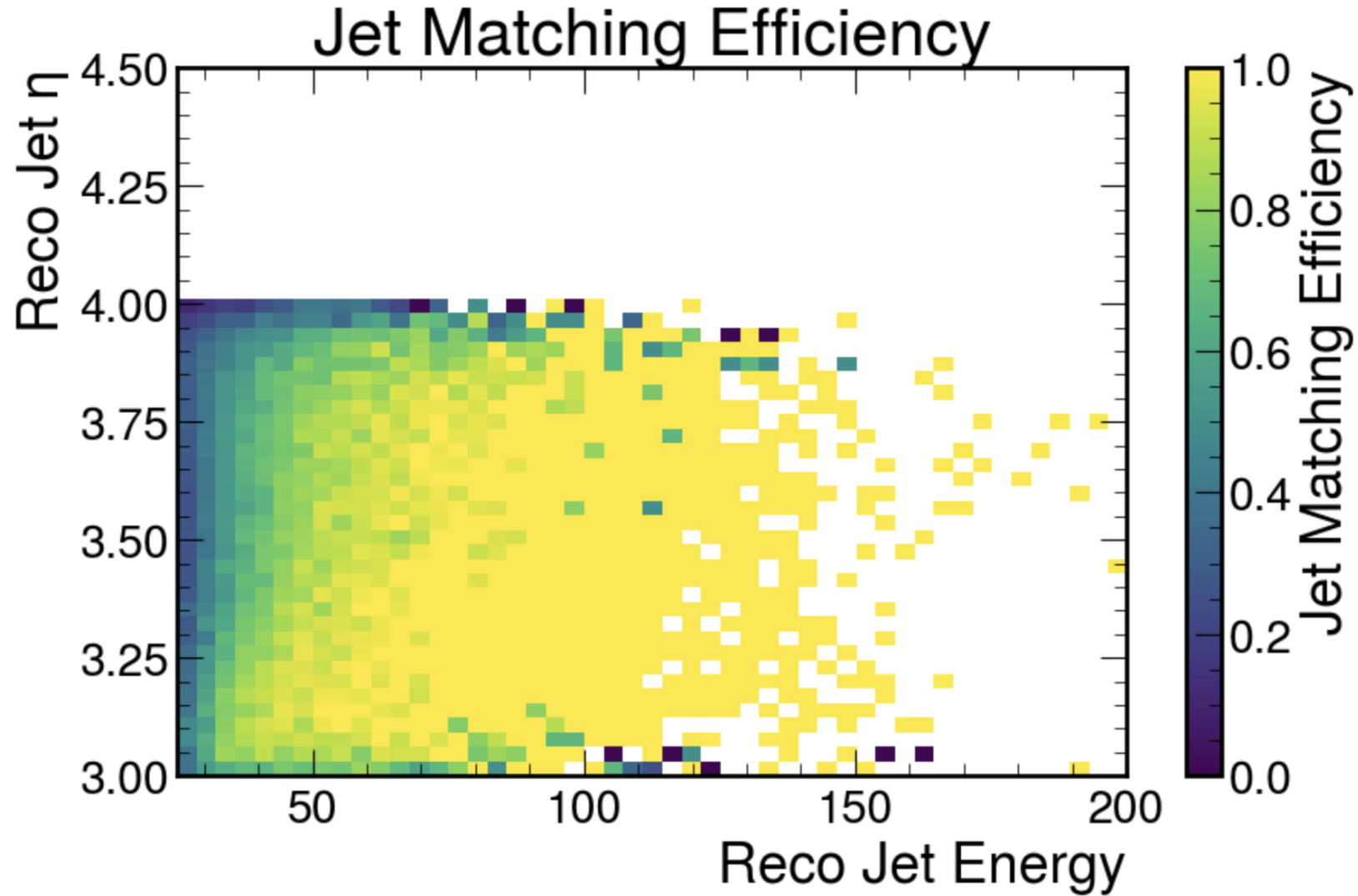
- Insert covers eta range of 3 – 4
- Analyzed 5M events with min Q2 = 1
- Combines clusters from the LFHCAL, ECal endcap, and ECal + HCal insert
- Jets are defined using anti-kt algorithm with R = 0.4
- Reco level cuts:
 - Min cluster E = 1.5 GeV
 - $3 < \eta < 4$
 - Min jet E = 25 GeV
- Truth level cuts:
 - $3 < \eta < 4$
 - Min jet E = 30 GeV



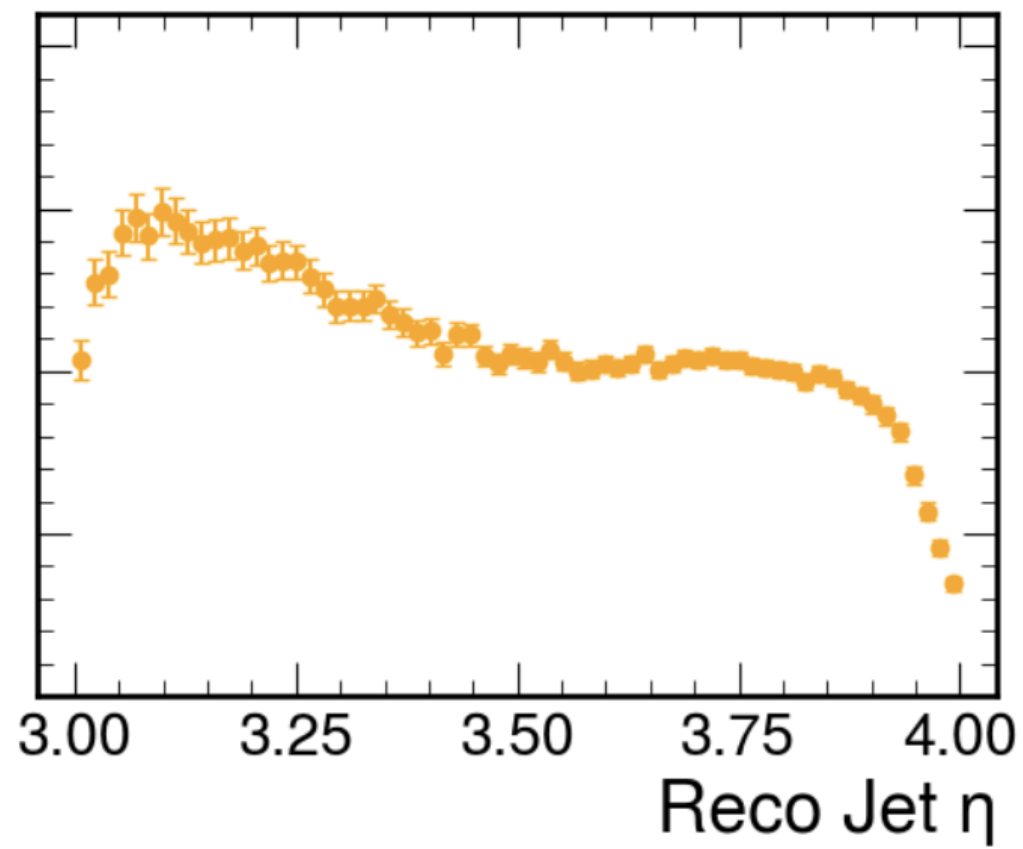
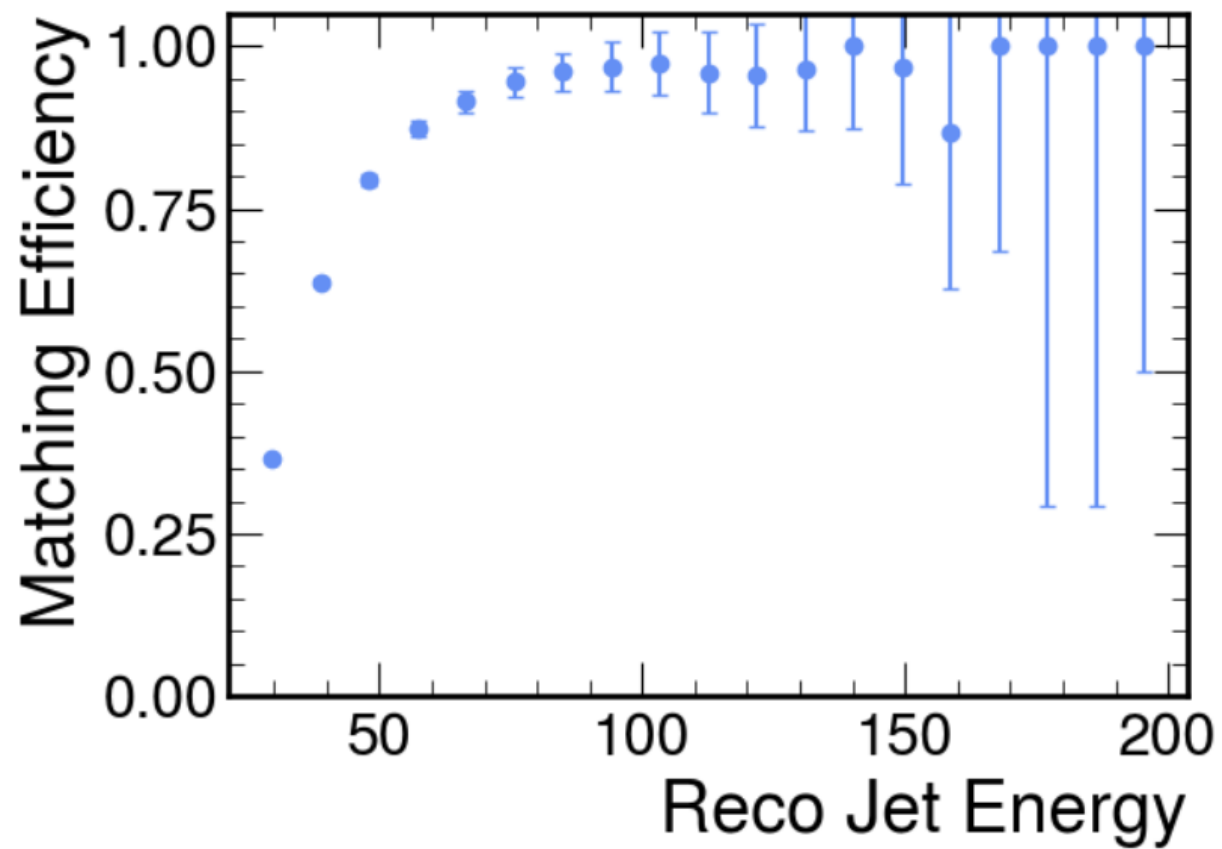
- Truth and reco jets are paired by their proximity in eta-phi space
- Max $dR = 0.4$ (one jet radius)
- 1-to-1 jet matching is enforced
- Total truth jets: 153.5k
- Total reco jets: 131.4k
- Total matched jets: 67.8k
- Total jet matching efficiency: 51.6%



$$dR = \sqrt{d\phi^2 + d\eta^2}$$



Jet matching efficiency is worse for low energy jets,
and near the boundaries of the detector



Numerical Inversion Overview

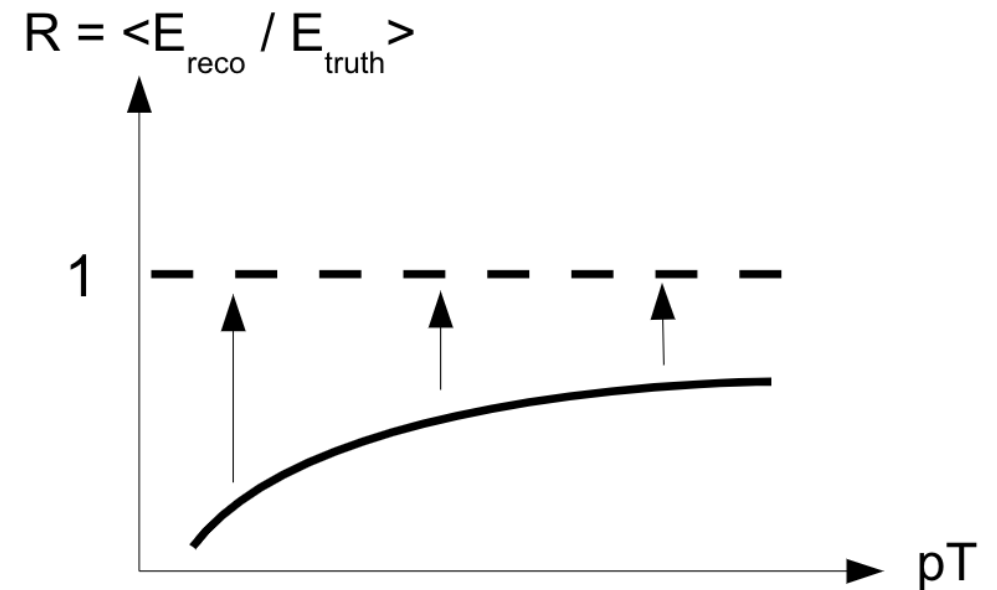
The insert is a non-compensating calorimeter, meaning the same amount of EM or hadronic energy will be reconstructed differently

As jets are composed of a mix of EM and hadronic energy, we need to apply a jet-specific calibration scheme to accurately reconstruct jets

Simply creating a correction factor from

$$\tilde{R}(E) = \mathbb{E}\left(\frac{E}{E_{truth}} \mid E_{reco} = E\right)$$

would be biased from the underlying truth distribution, so numerical inversion is needed to remove this bias



Numerical Inversion Overview

Mathematical properties of numerical inversion for jet calibrations,
<https://doi.org/10.1016/j.nima.2017.03.038>.

1

Compute the jet response function:

$$f(E) = \mathbb{E}(E_{reco} | E_{truth} = E)$$

2

Compute the jet scaling function:

$$R(E) = \mathbb{E}\left(\frac{E_{reco}}{E} | E_{truth} = E\right)$$

3

From these, let

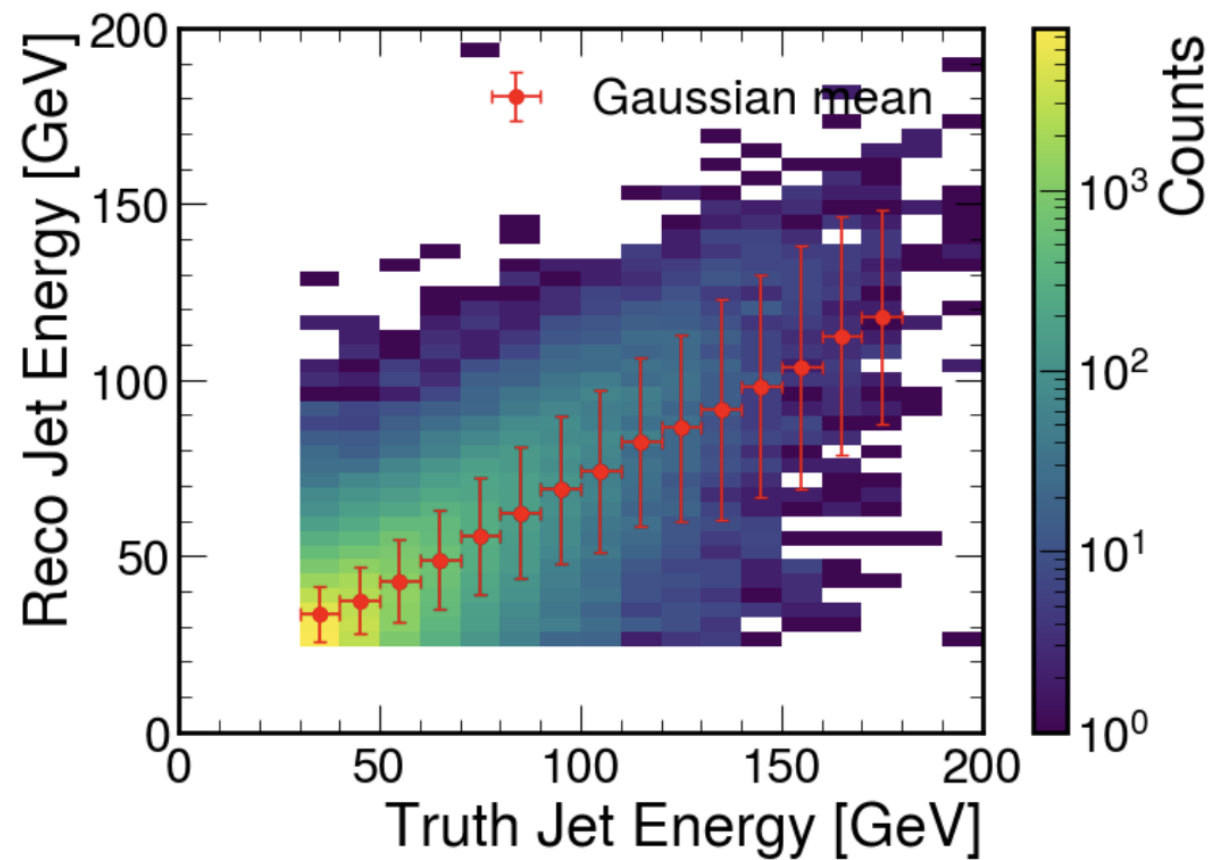
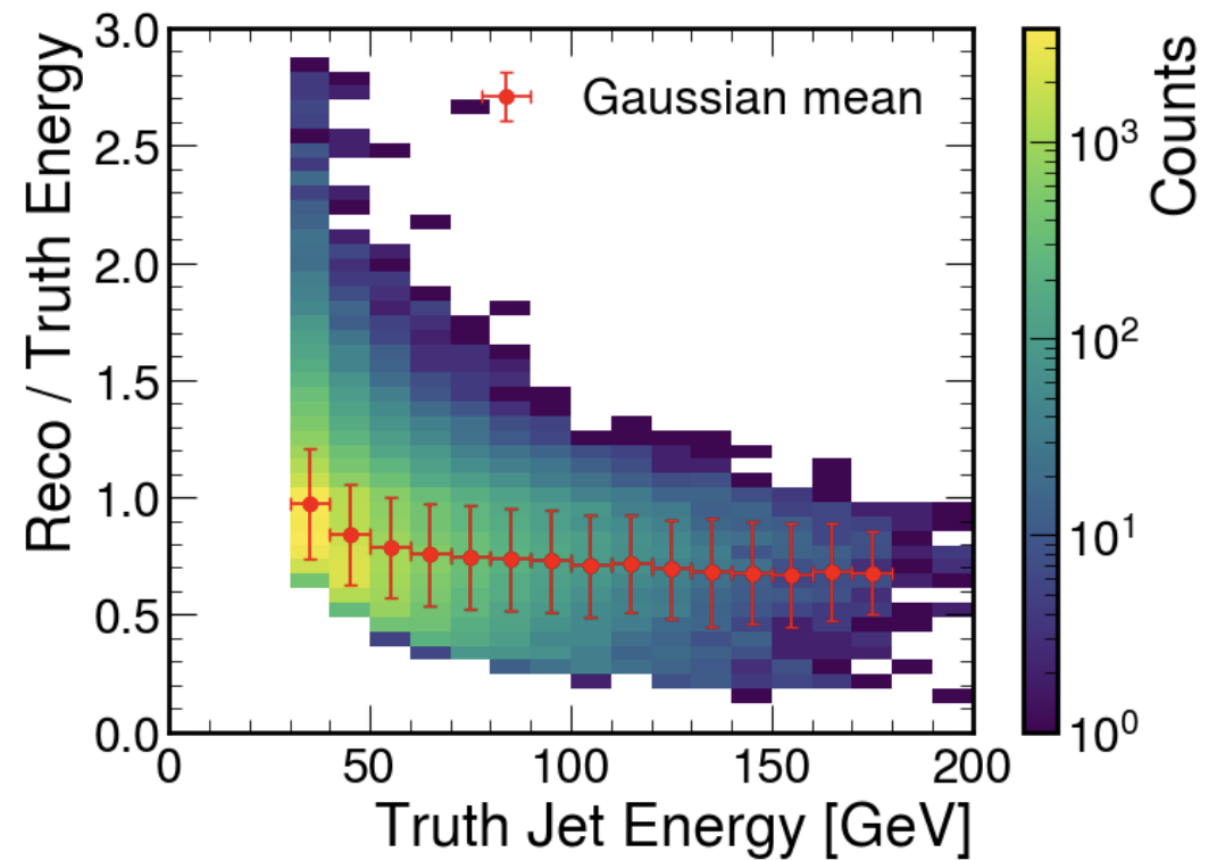
$$\tilde{R}(E) = R(f^{-1}(E))$$

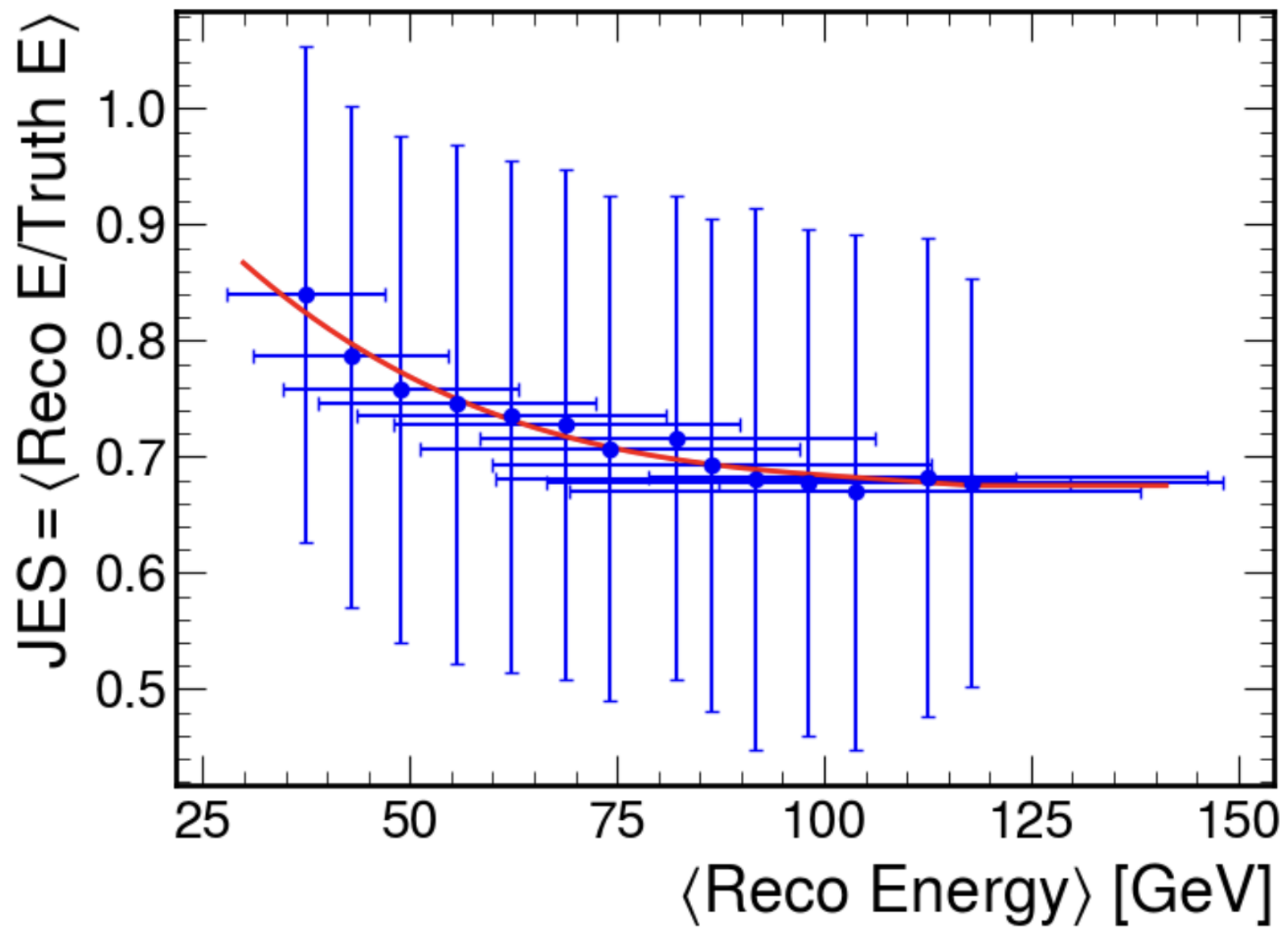
4

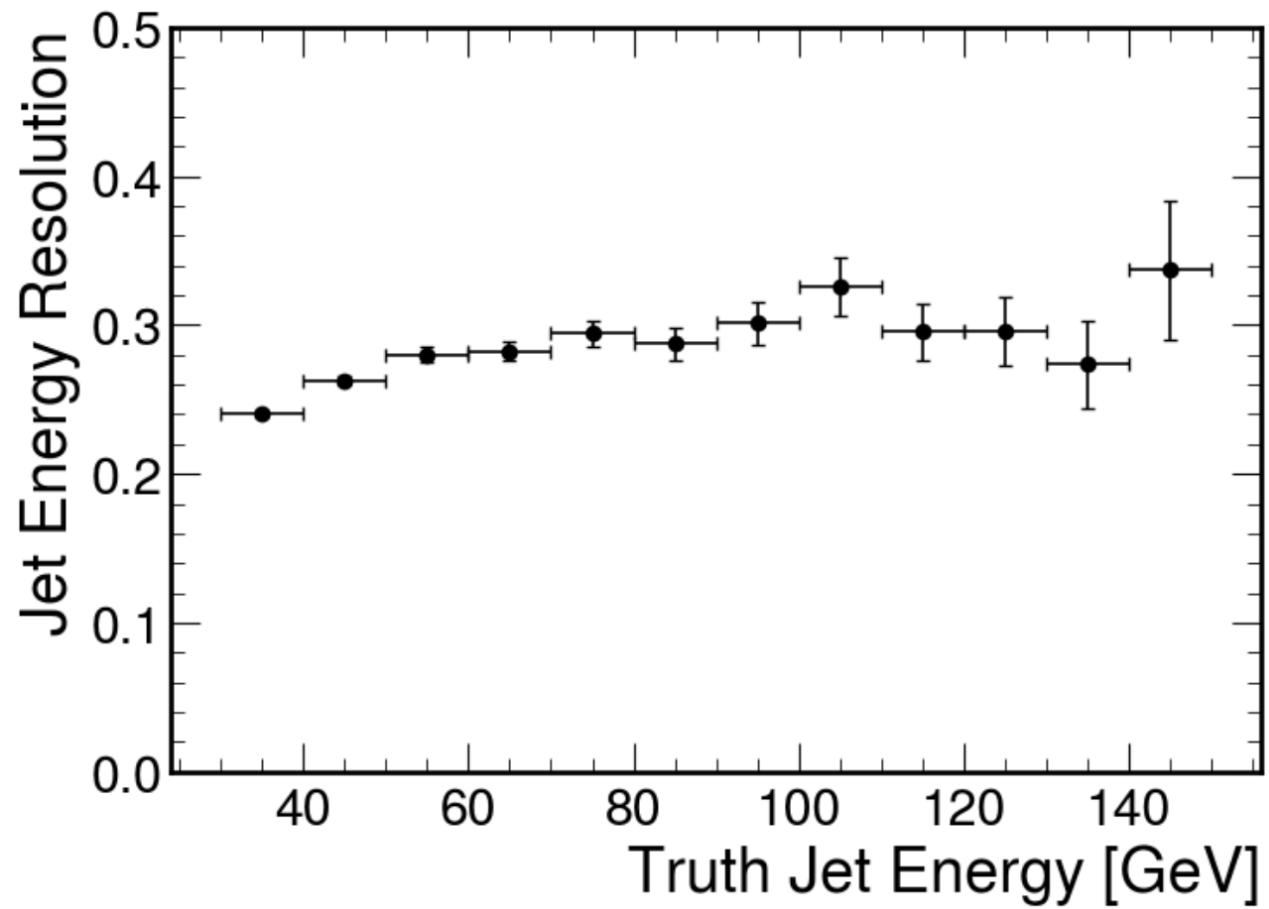
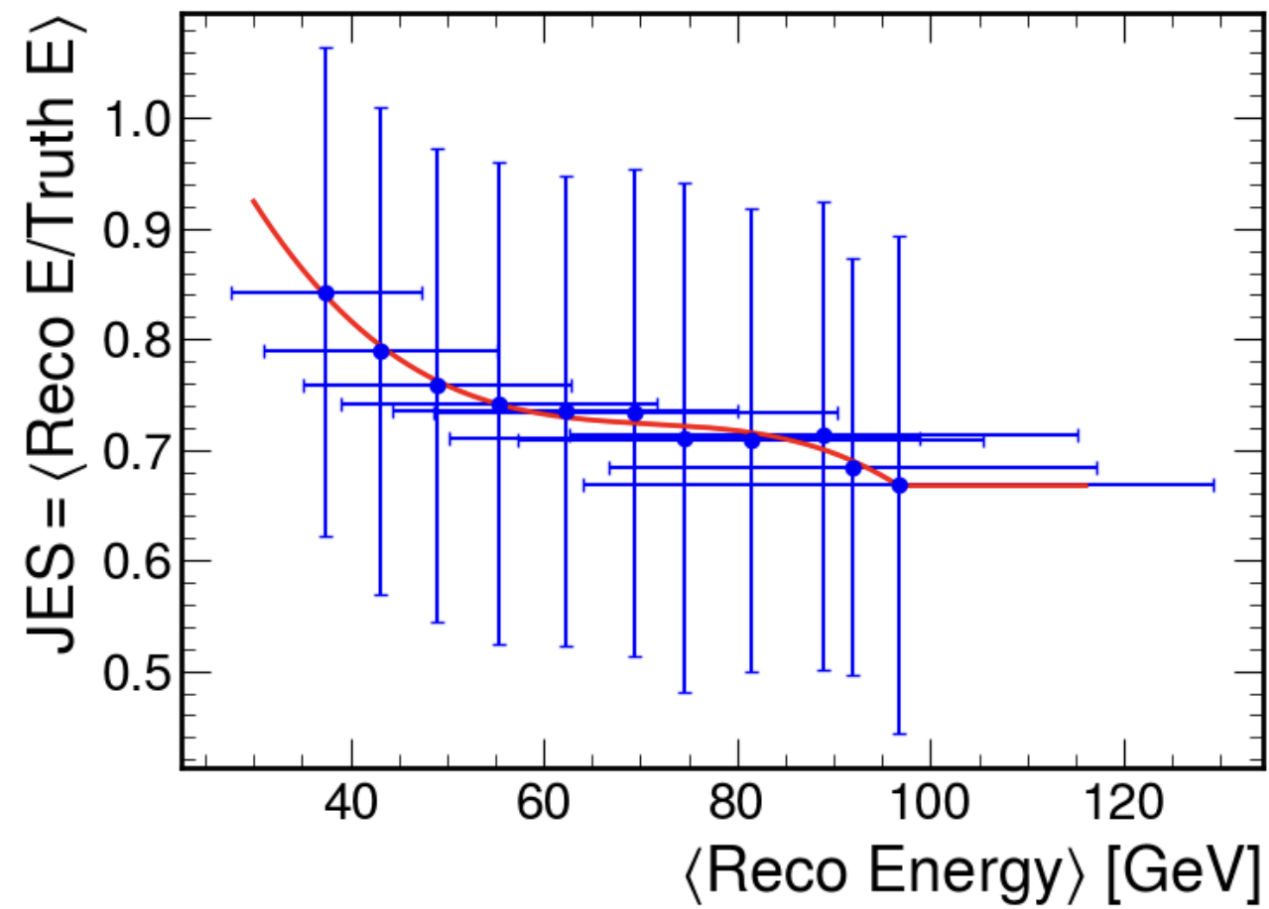
Finally, apply this as a correction jet-by-jet as

$$E_{reco} \mapsto E_{reco} / \tilde{R}(E_{reco})$$

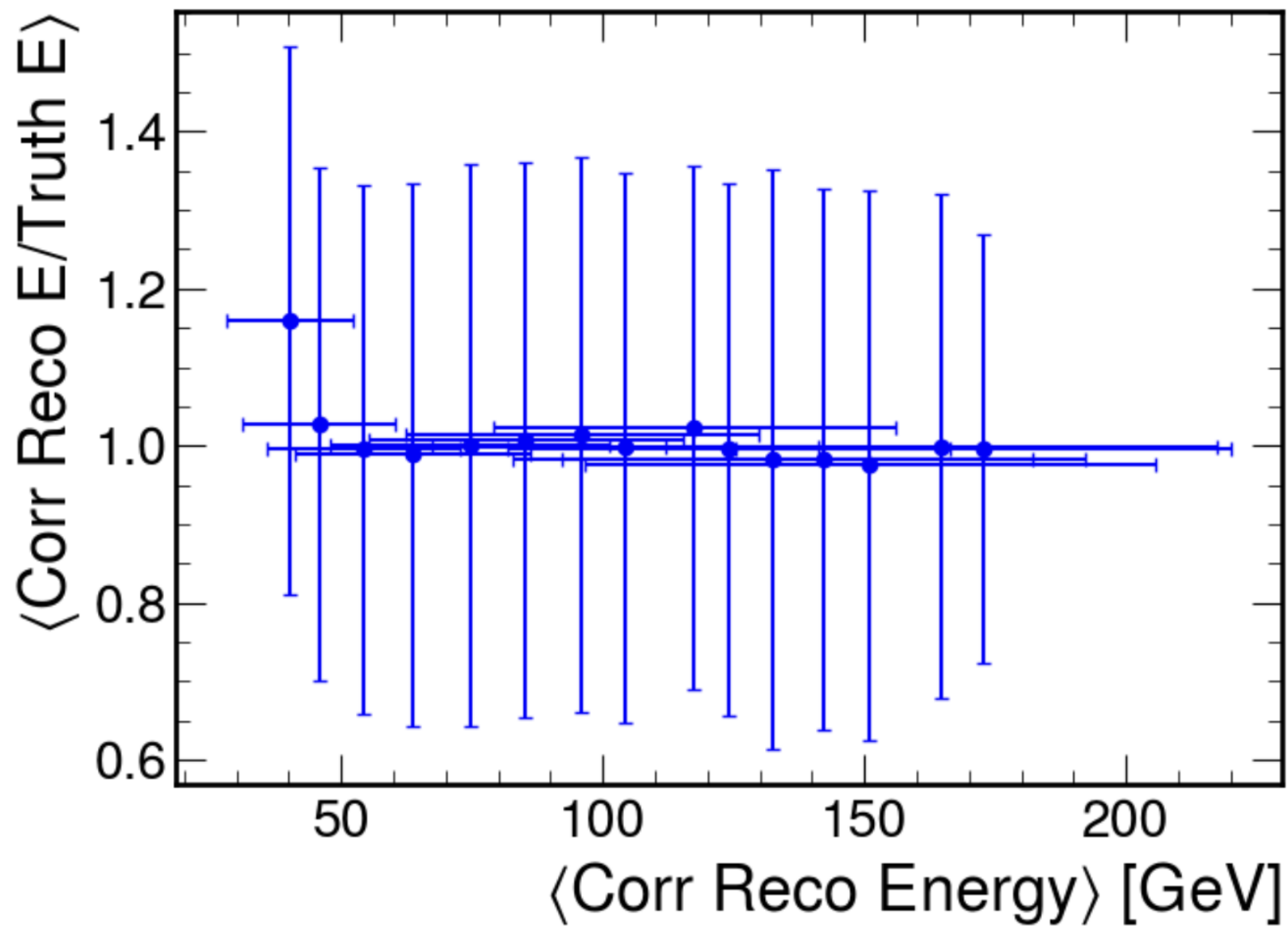
Numerical inversion without binning in eta

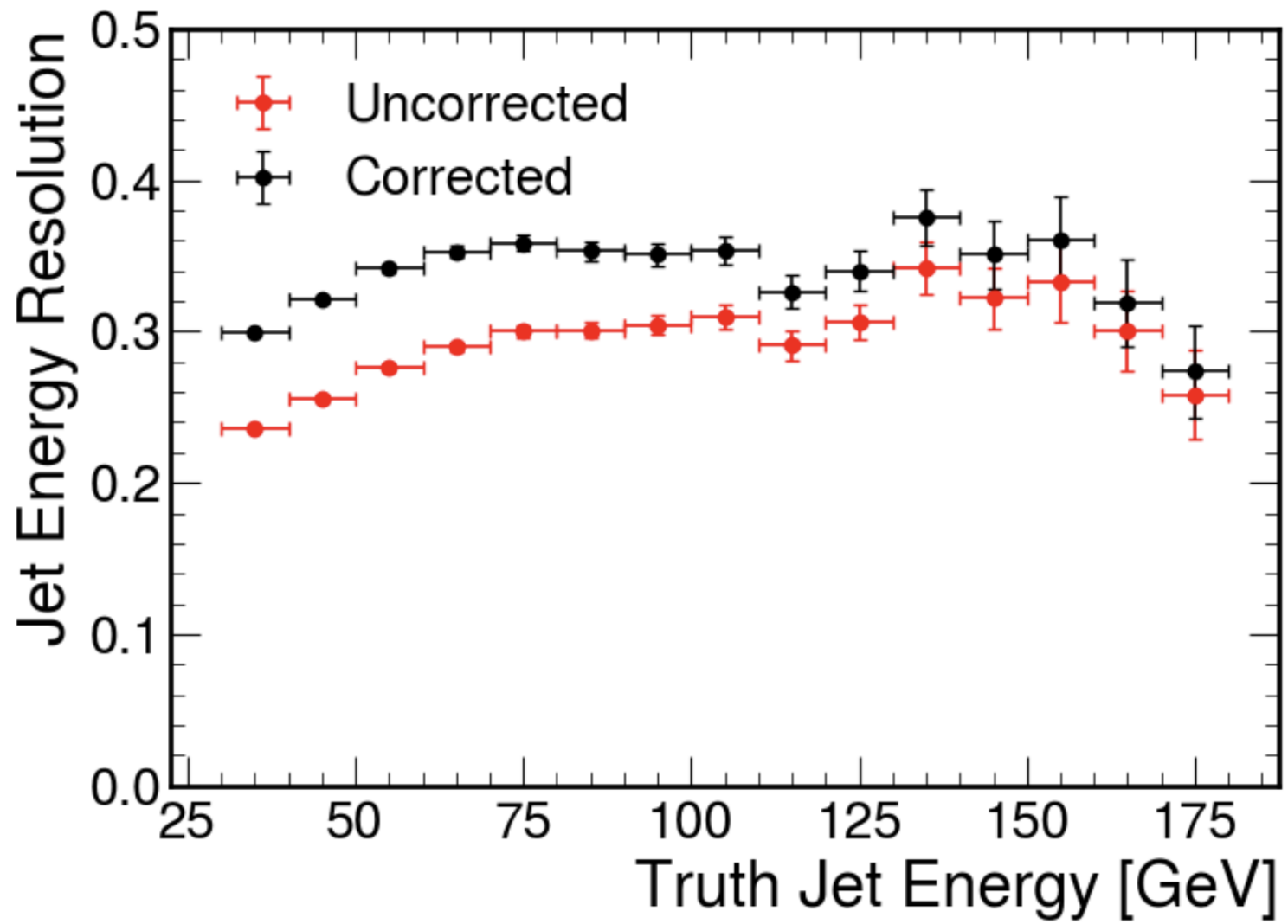






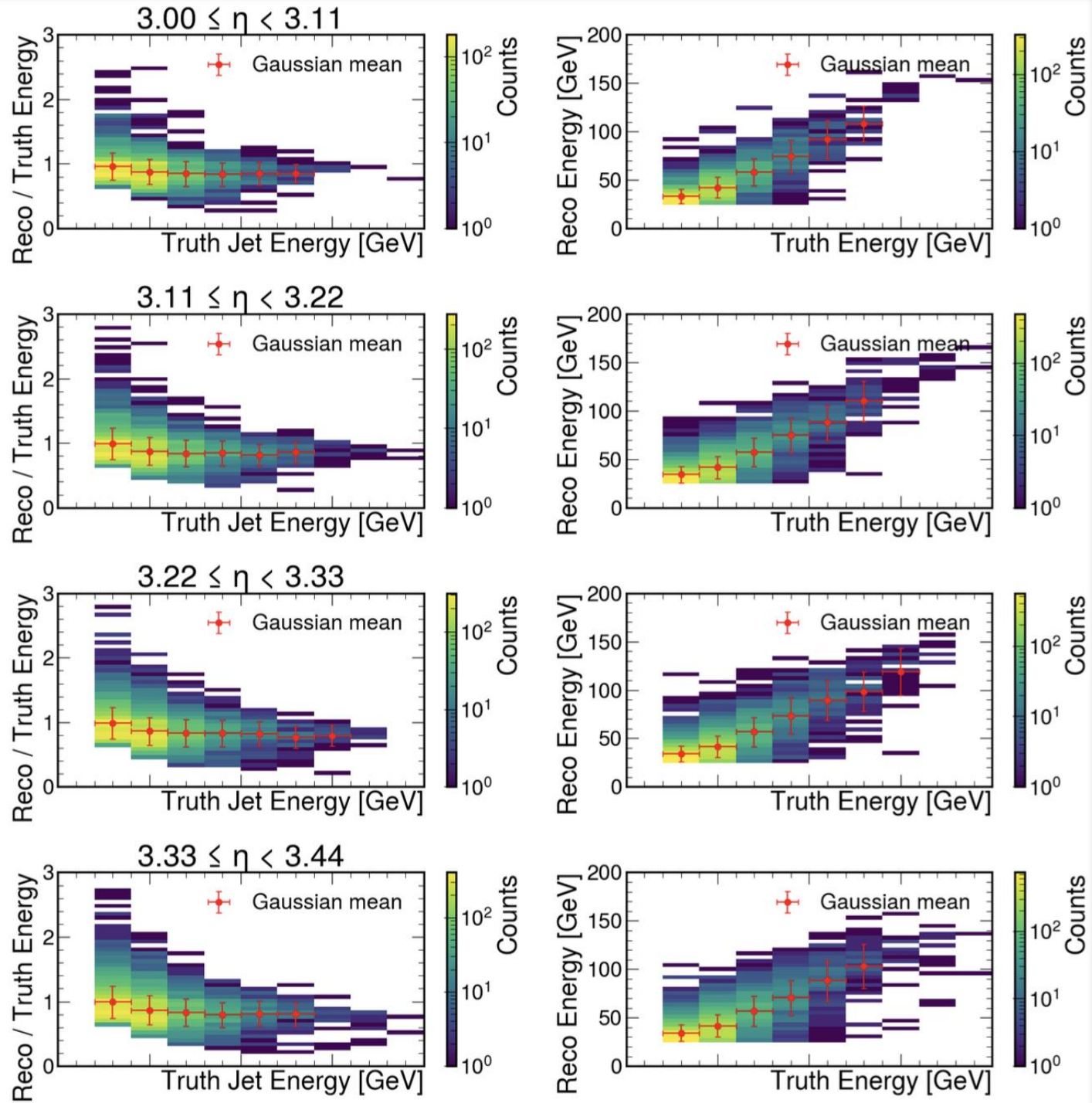
Apply JES calibration back on the data, closure tests

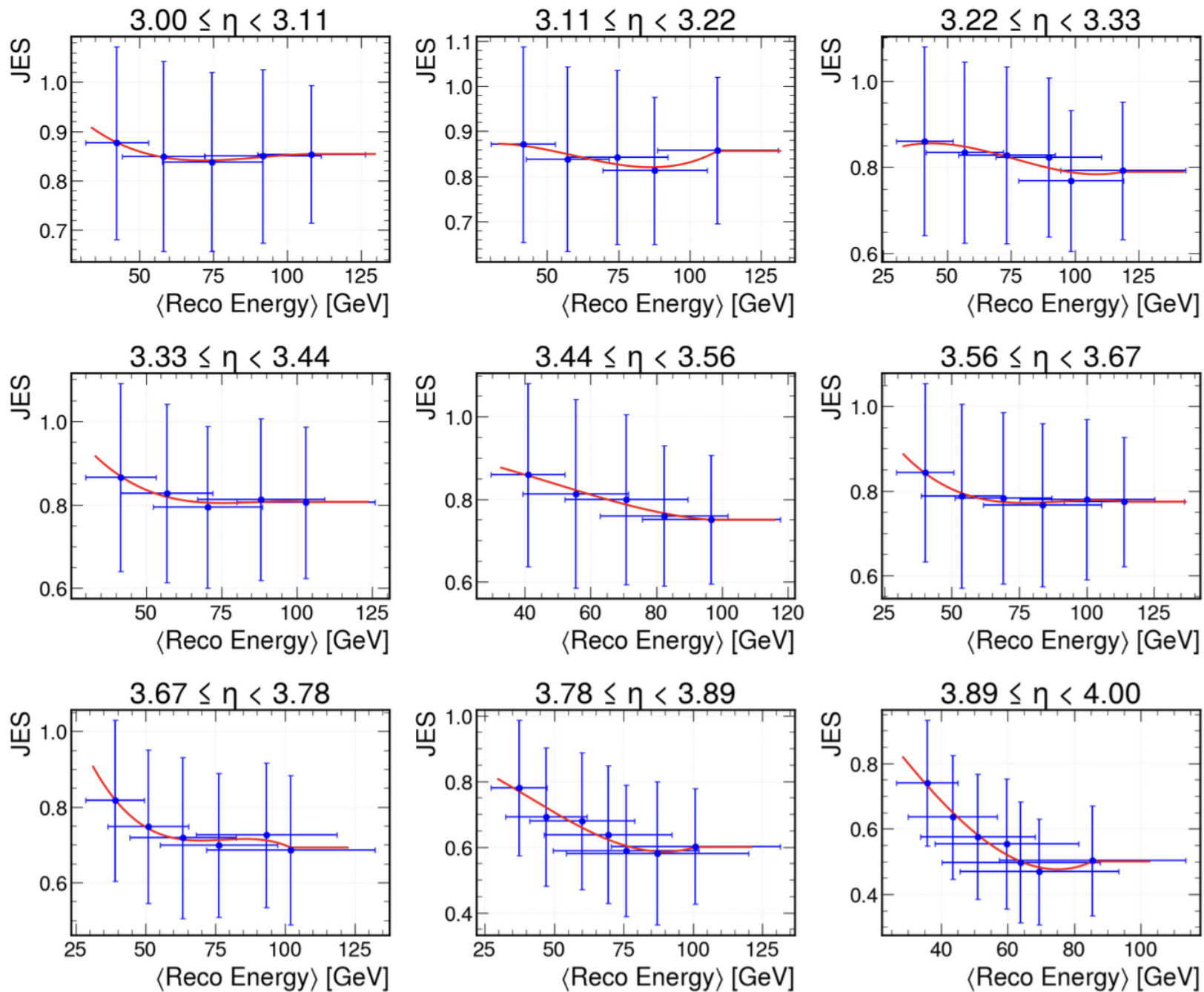




Jet energy resolution appears to get worse after correction, and does not improve with energy

Numerical inversion
+ binning in eta





Resolution still does not improve
when corrected

