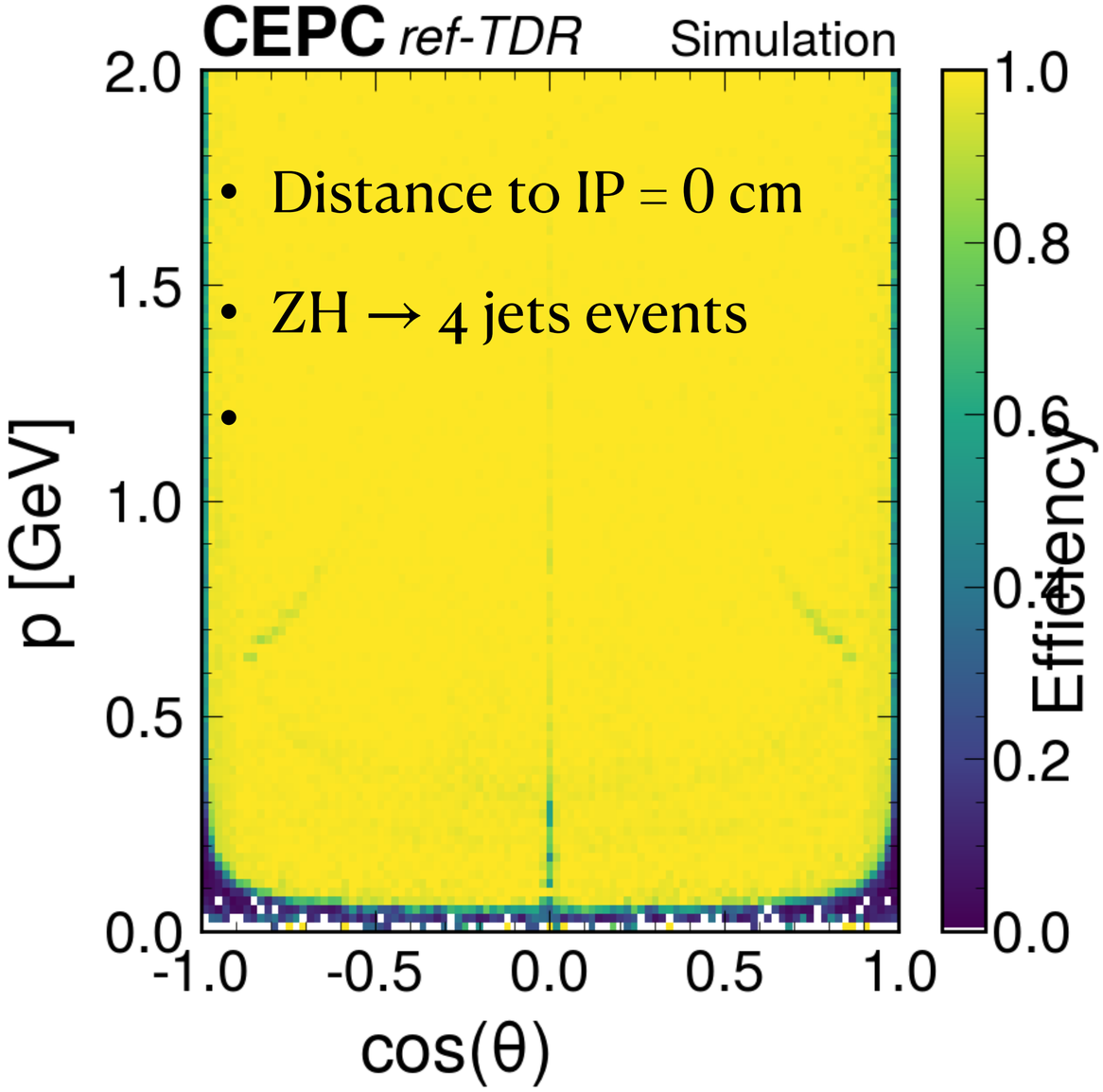
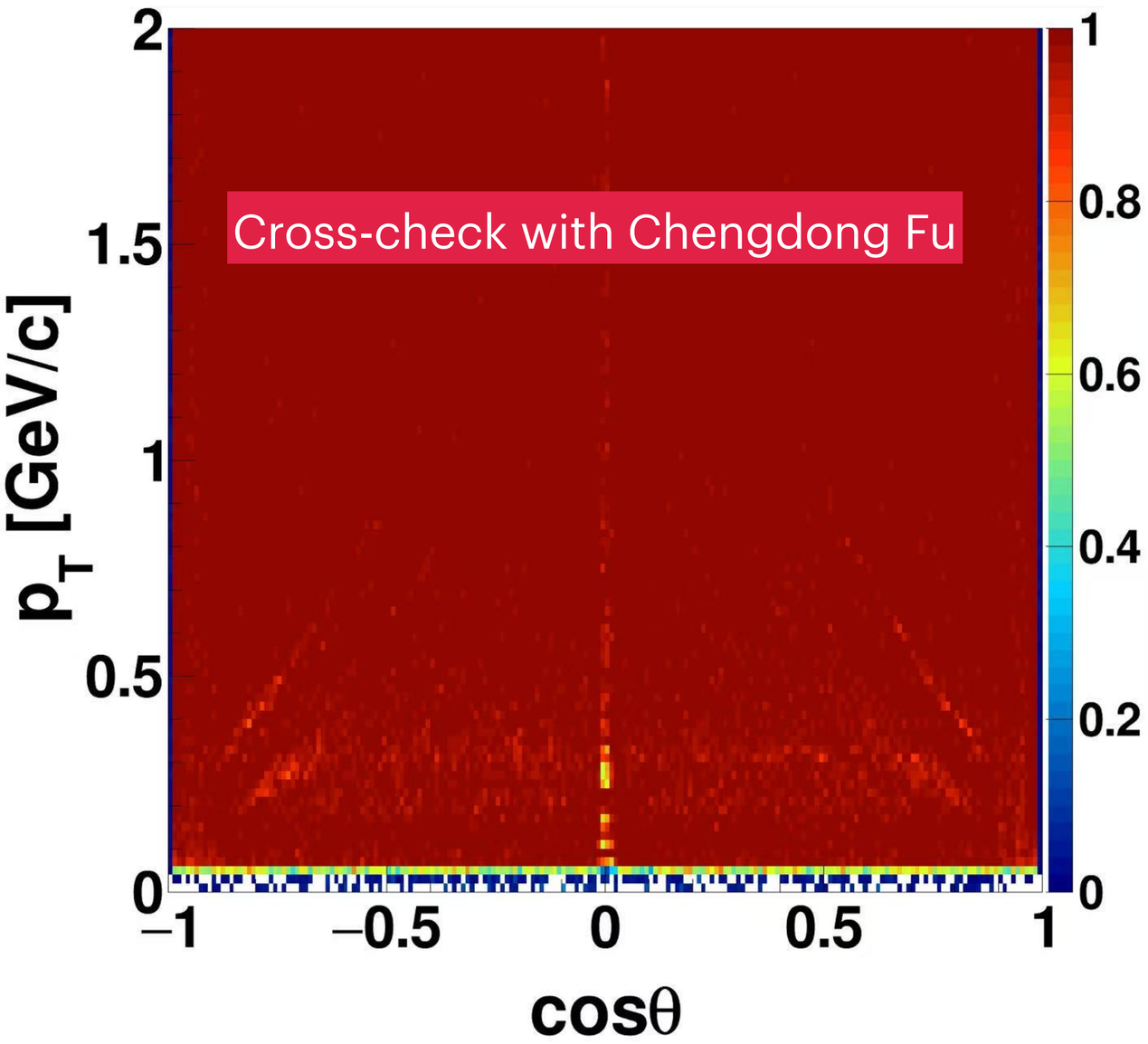
Status Update

1. **Tracking Efficiency**
2. $ee \to \gamma_{ISR}\, Z \to \gamma_{ISR}\mu\mu$

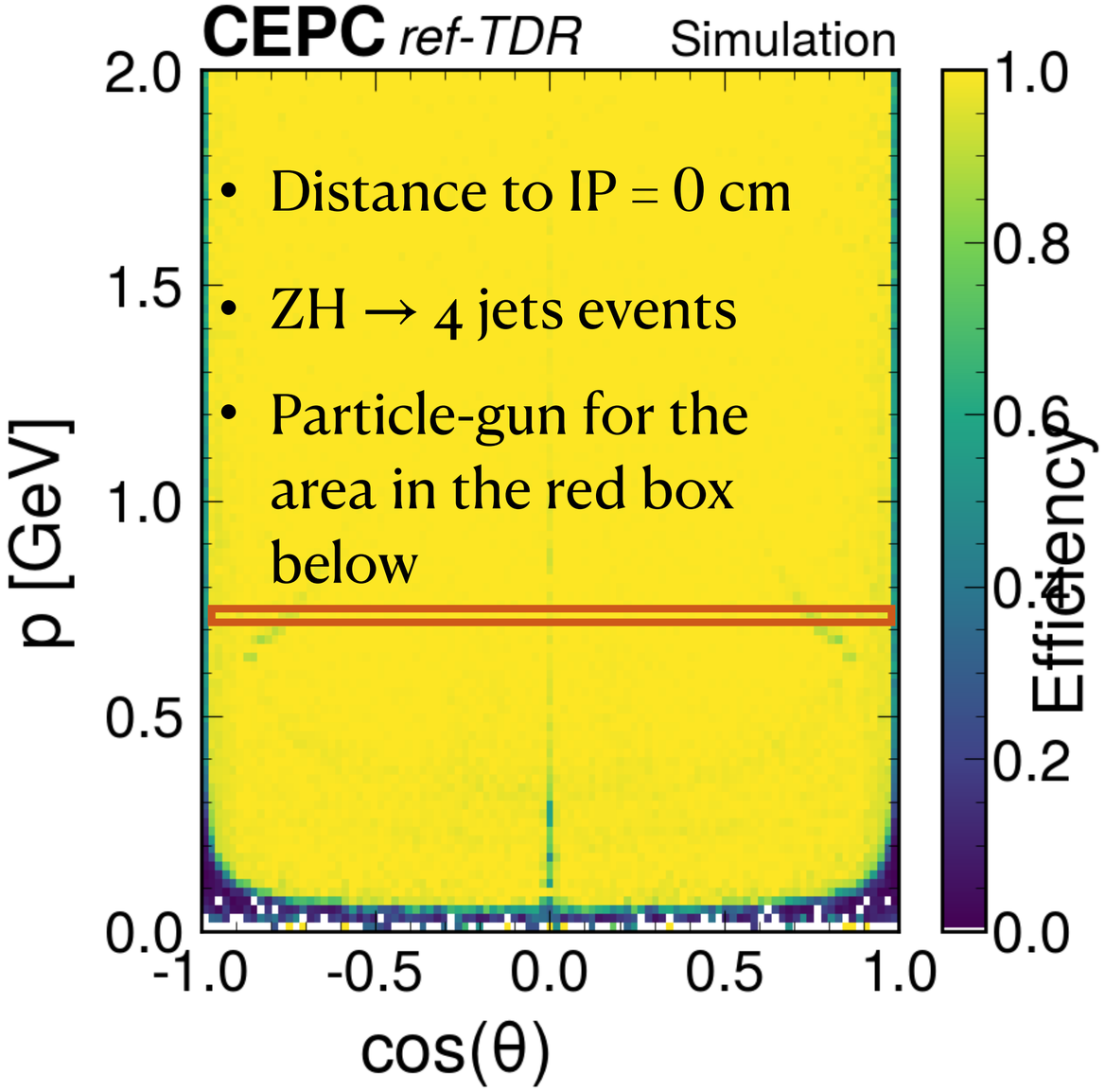
C.Zhang/18Apr2025

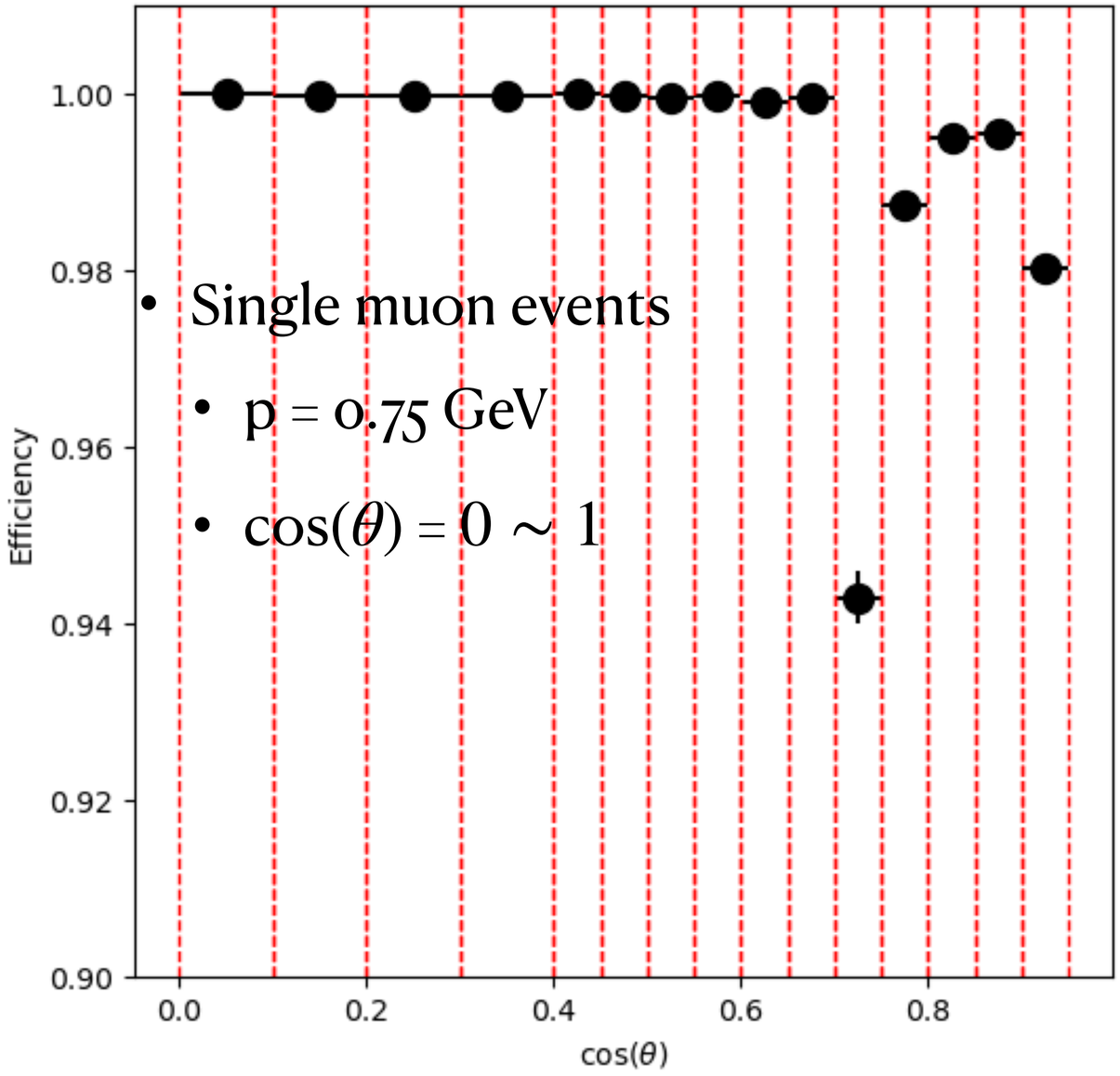
Trk Efficiency



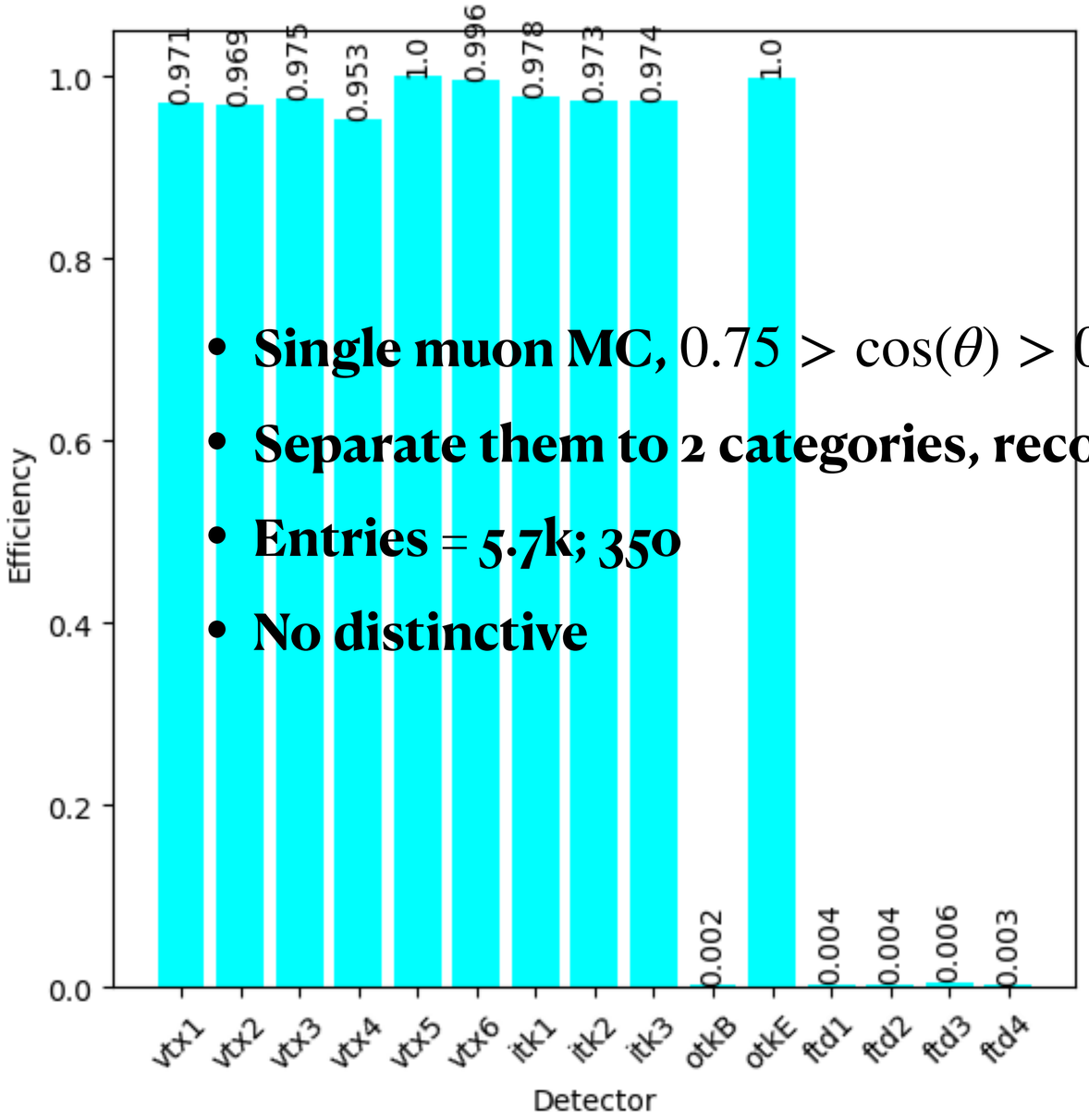


Trk Efficiency

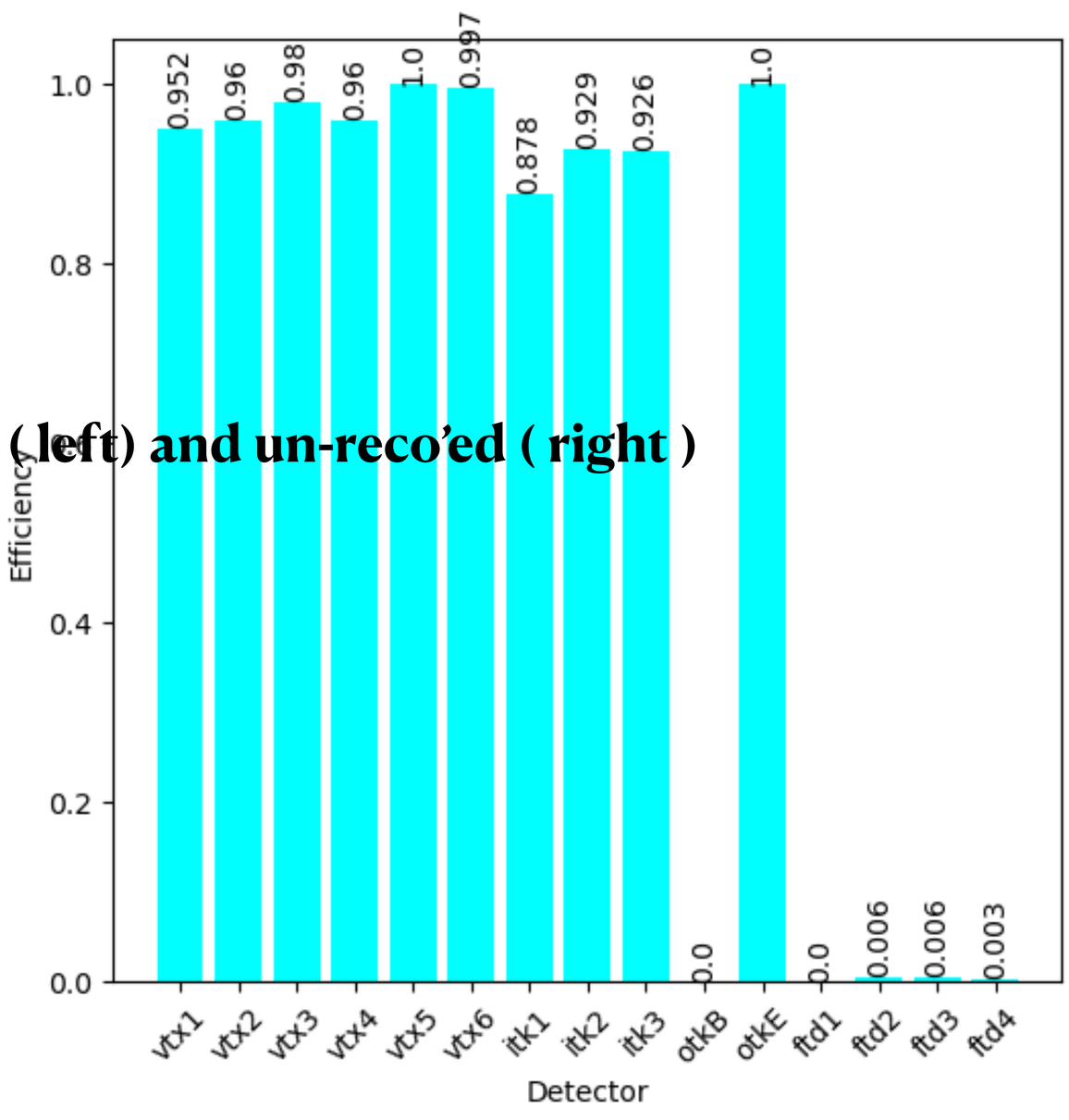




Trk Efficiency



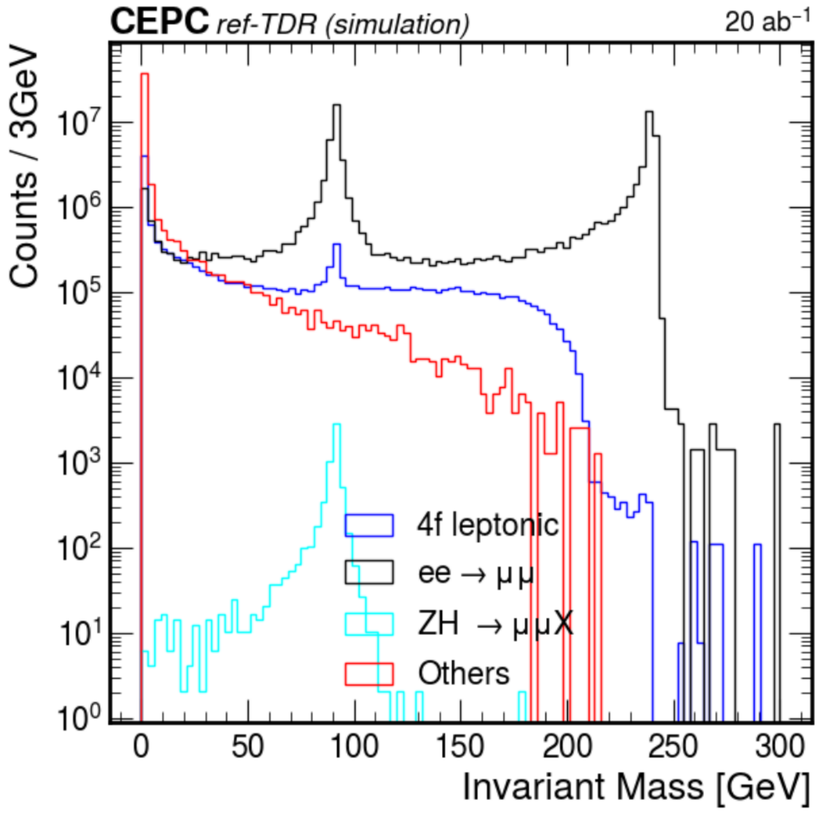
- **Single muon MC,** $0.75 > \cos(\theta) > 0.7$
- **Separate them to 2 categories, reco'ed (left) and un-reco'ed (right)**
- **Entries = 5.7k; 350**
- **No distinctive**

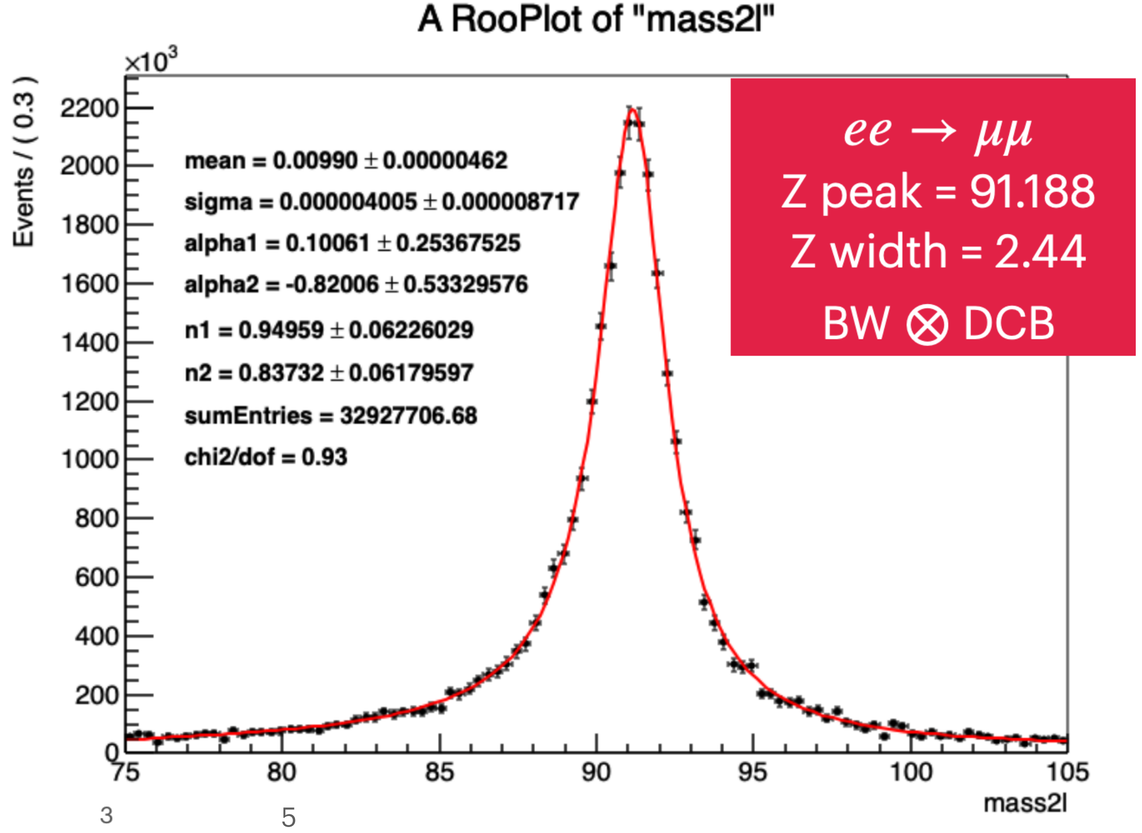


$ee \to \gamma_{ISR}\, Z \to \gamma_{ISR}\mu\mu$ @ 240 GeV

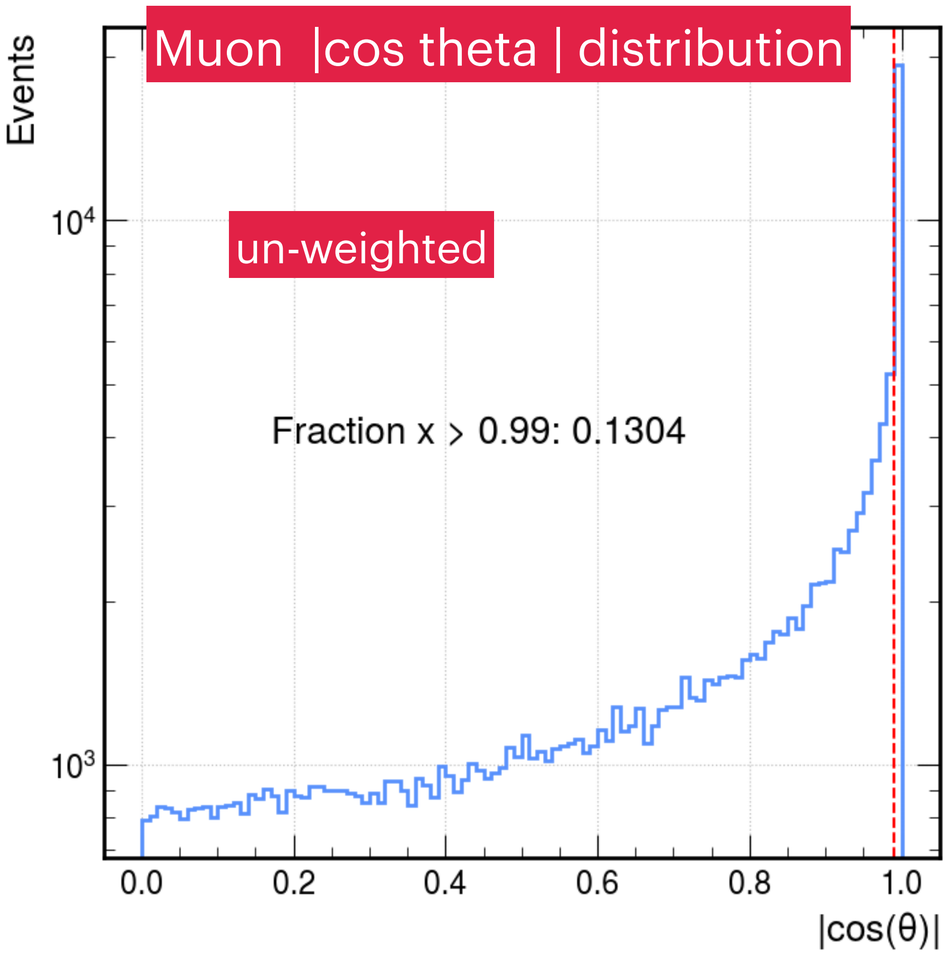
- **Previous status**
  - **98 muID working point results 0.77 efficiency of muon pair**
  - **Difficult handle Z line-shape; Sigma is too small**

- Visible Z peaks
  - $ee \to \mu\mu$ efficiency : 83M/106M ≈ 0.77





$ee \rightarrow \gamma_{ISR} Z \rightarrow \gamma_{ISR}\mu\mu$ @ 240 GeV

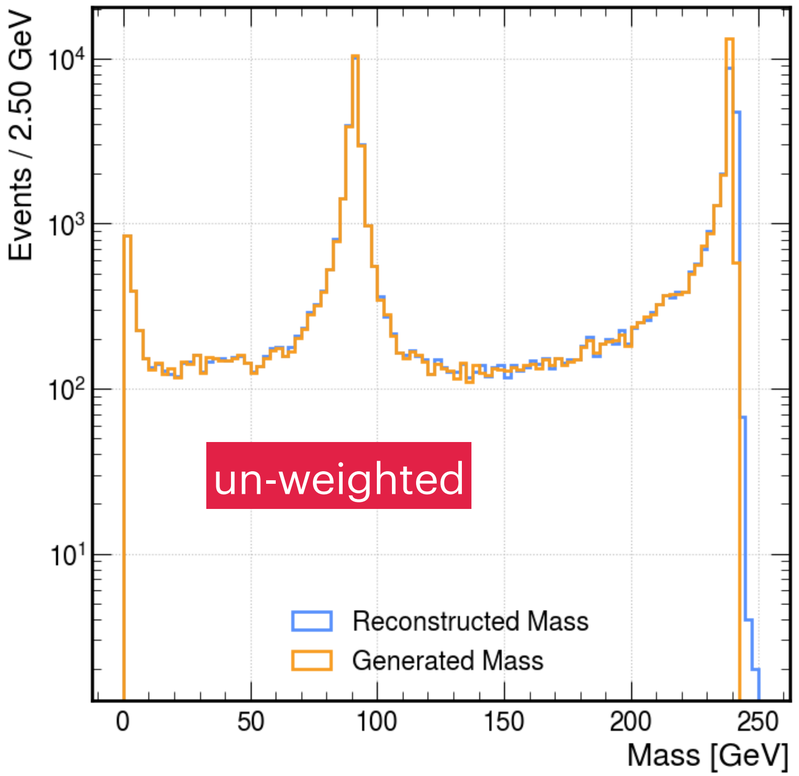


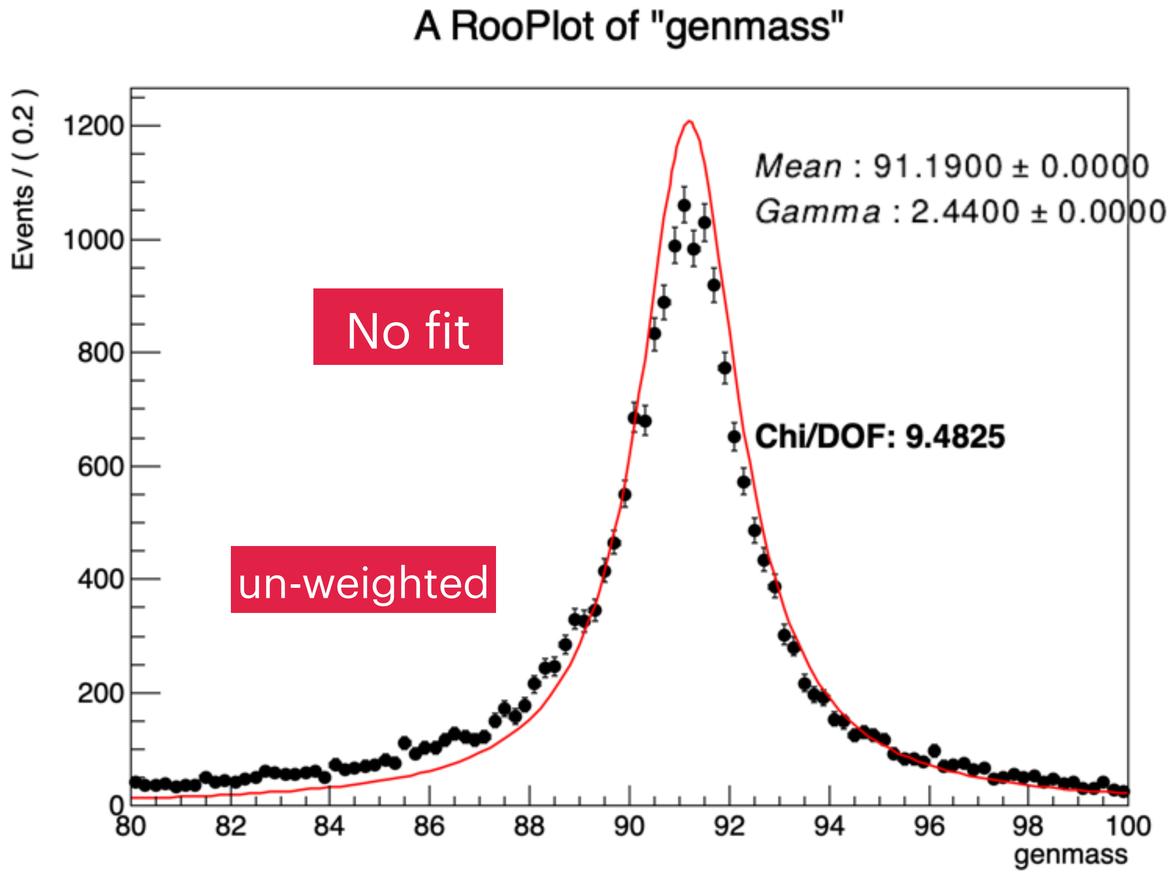
Statistics = 140 k muons with 98-muID		**|cos theta| < 0.99**
MCParticle links to a track	87.1773%	99.9410%
Track links to a PFO	81.1739%	99.9386%
PID gives a response	81.1739%	99.9386%
PID performance (normalised to tot. stat.)		
PID = e	0.61%	0.69%
PID = mu	83.4%	95.62%
Pion	2.35%	2.68%
Kaon	0.39%	0.45%
Proton	0.42%	0.48%

$$.77 \approx .95 \times .95 \times .87$$

$ee \to \gamma_{ISR} Z \to \gamma_{ISR}\mu\mu$ @ 240 GeV

Muon pair mass distribution

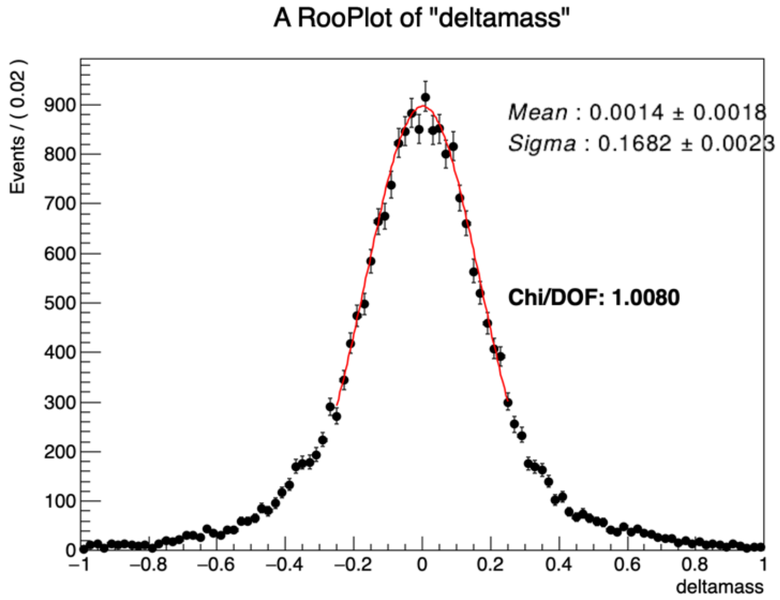


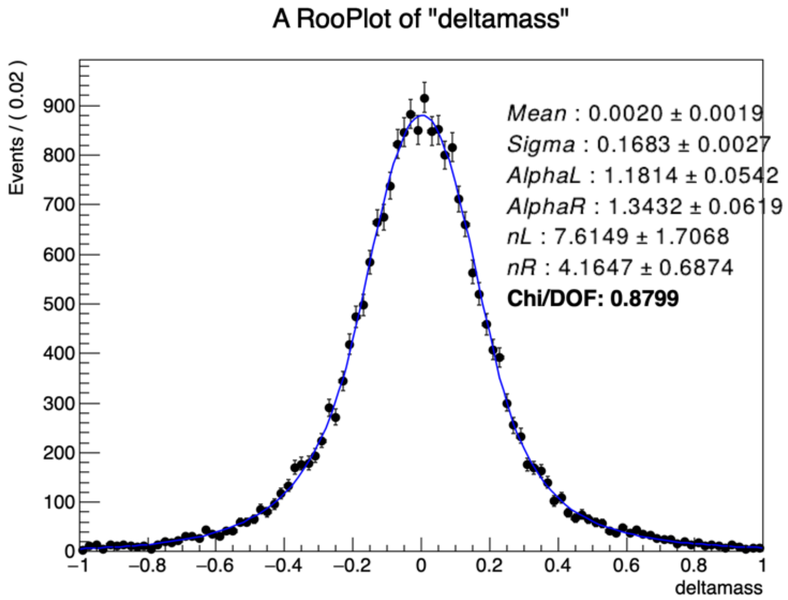


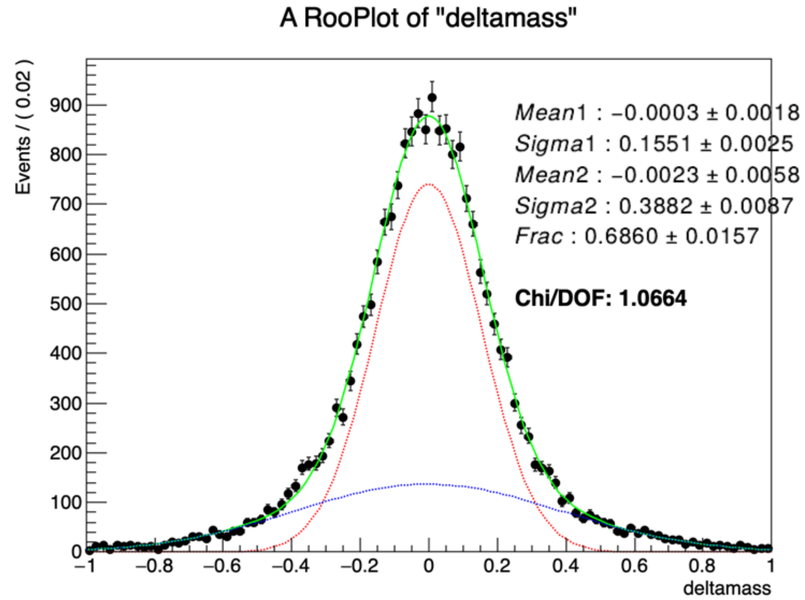
- **As already confirmed, other processes may contribute to the Z peak, but this process dominates it. Therefore, only this process is considered.**
- **The GEN peak can not be described by a Breit-Wigner function.**

$ee \to \gamma_{ISR} Z \to \gamma_{ISR}\mu\mu$ @ 240 GeV

(Rec_mass - Gen_mass) distribution (un-weighted)



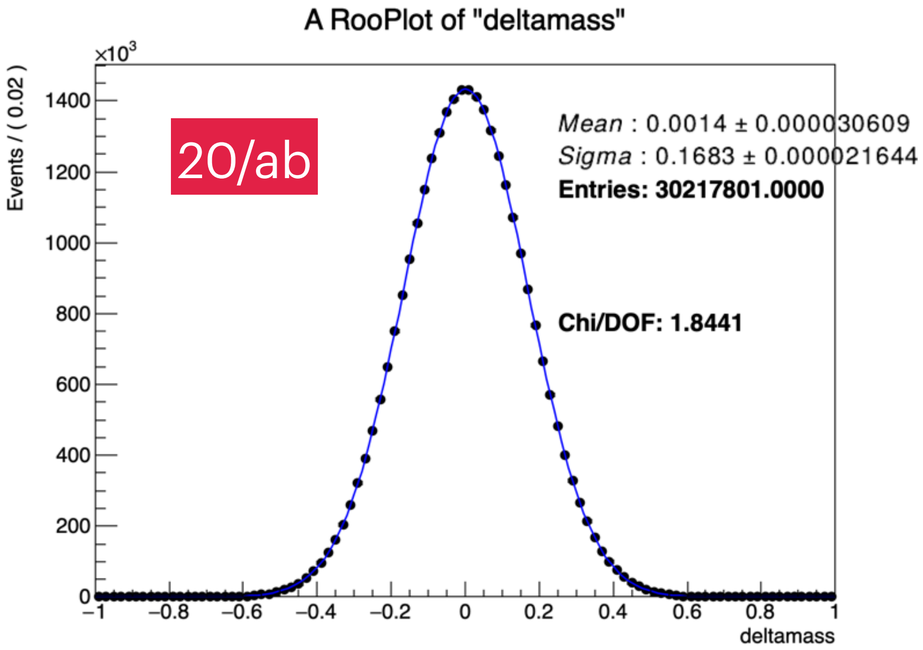




- **Fit the Delta mass (Rec-Gen), three functions tested.**
  - **Single Gaussian, sub-range**
  - **Double-side-crystal-ball, full-range**
  - **Double Gaussian, full-range**
- **Similar scale precision, 1.8 MeV with un-weighted events [50k]**
- **Relative resolution [Sigma] ≈ 0.17%, agree with the observation in tracking performance study.**

$ee \to \gamma_{ISR} Z \to \gamma_{ISR}\mu\mu$ @ 240 GeV

Generate 7.5M and 30M toys [5 and 20/ab] using the single Gaussian model



FCC-ee, 5/ab, IDEA,B=2T

3) Center-of-mass: +/- 2 MeV

- √s parameter in the recoil mass definition → uncertainty induces ~ linear shift the recoil distribution
- Precision estimated to be 2 MeV at 240 GeV using radiative return events Z → ll or Z → qq

4) Muon momentum scale: relative scale uncertainty variation of 1e-5

- Directly affects m(μμ), hence shift in recoil mass
- Statistical potential to measure muon scale ~ 1e-6, but NMR probes so far limited to yield 1e-5 unc

- **The expected precision ~ 60 and 30 KeV for 5/ab and 20/ab respectively.**
- **It agrees with a naive expectation, $\Delta\text{mean} = \frac{\sigma}{\sqrt{N}}$, and is also consistent with preliminary study from IDEA.**
- **It seems that the limitation of this standard candle comes from systematic errors**