Z pole ee→bb forward-backward asymmetry at CEPC

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1 IHEP

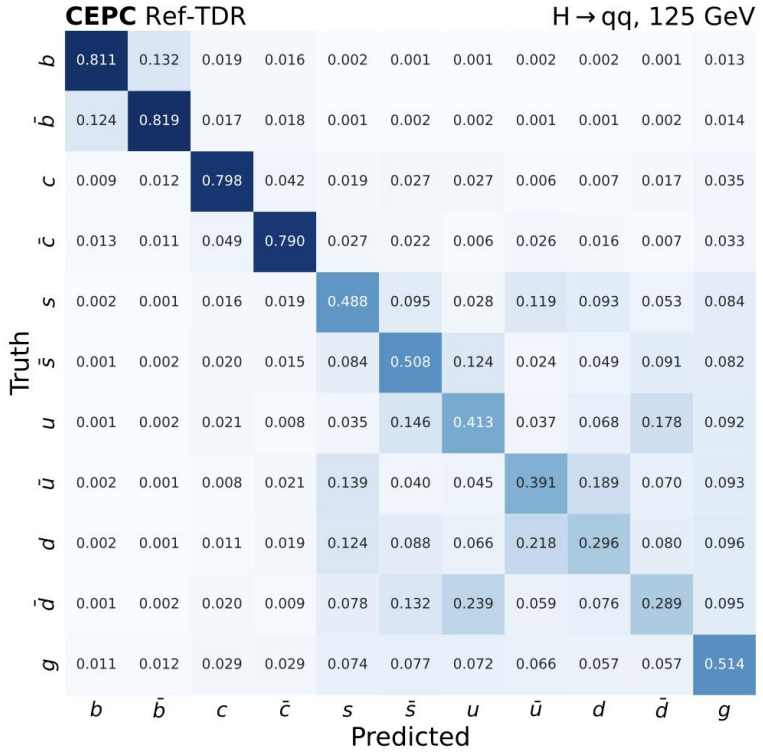
Introduction

- The CEPC data at Z pole energy allow high precision electroweak measurements of the Z boson properties, such as the forward-backward charge asymmetry (AFB) as a function of the effective weak mixing angle.

- The ee→bb is the only channel needs jet charge tagging from JOI

- LEP measured AFB (b) = 0.1015 ± 0.0064 (stat.) ± 0.0035 (sys.). FCC-ee result is estimated to be 0.1010 ± 0.0001.

- It verifies the performance of jet reconstruction and charge tagging.



TDR

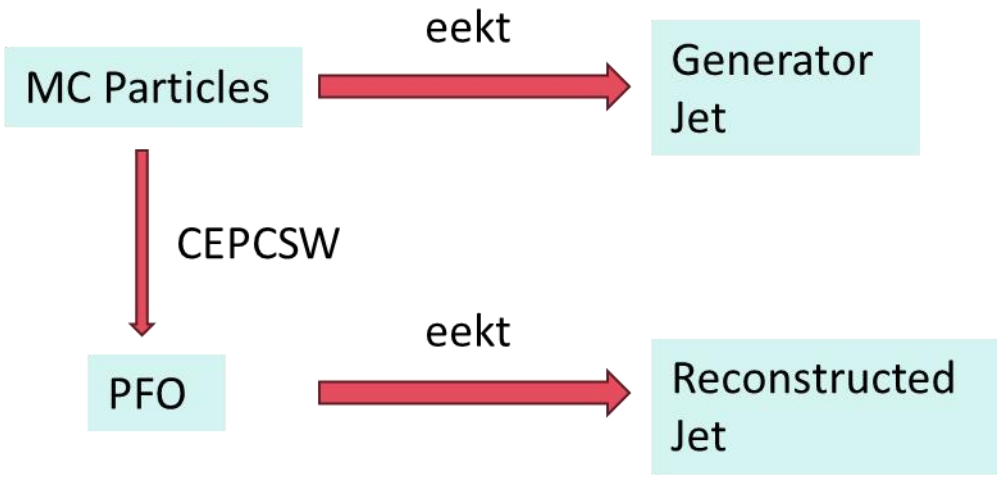
The simulated events

- ee→bb events are simulated with Whizard1.95 at Z pole energy.
  - The W and Z boson mass (width) values are set precisely to 80.377 (2.085) GeV and 91.1876 (2.4952) GeV.
  - Include ISR and FSR.

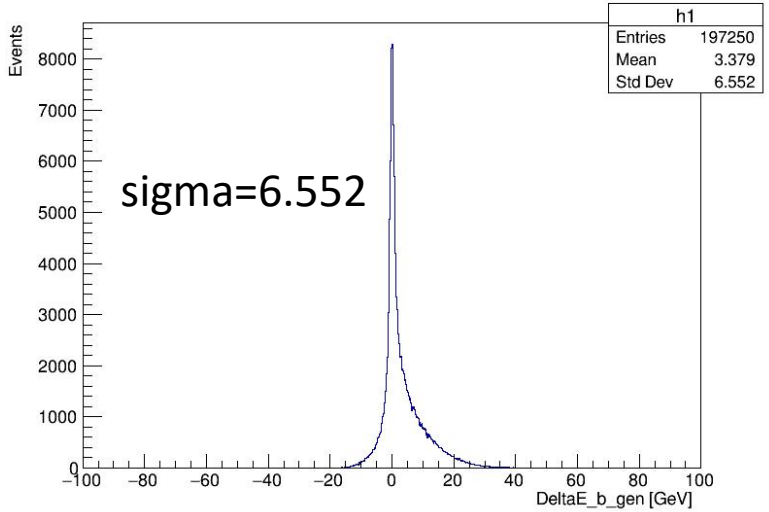
- The AFB(b) at Z pole is 0.14665 ± 0.00222 (Counting) by simulating 200000 events.
  - Not Compatible with LEP result at Z pole, investigating

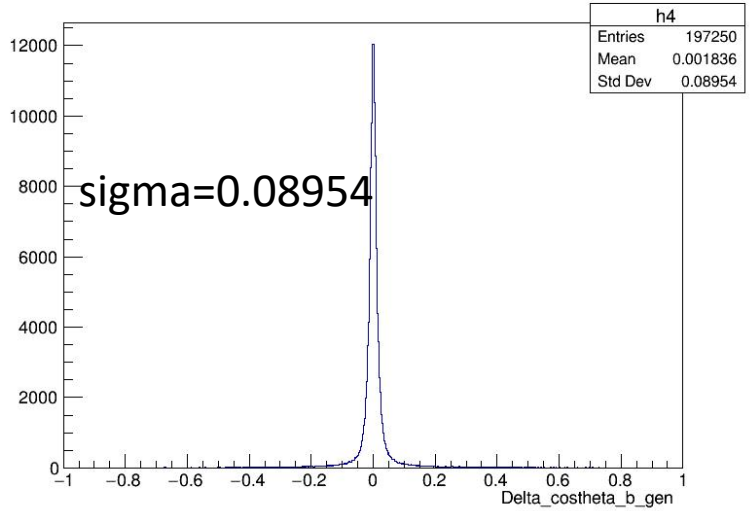
- Reconstruction with CEPC software(CEPCSW).

- Use eekt algorithm for jet-reconstruction.
  - by MissingET Package written by Geliang Liu.
  - Jet truth match with ΔR.



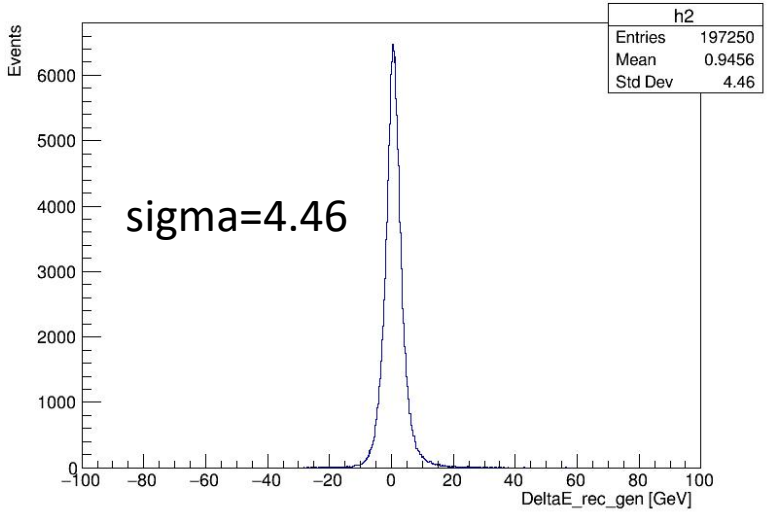
Compare the bias of eekt and PFO on Energy and Costheta

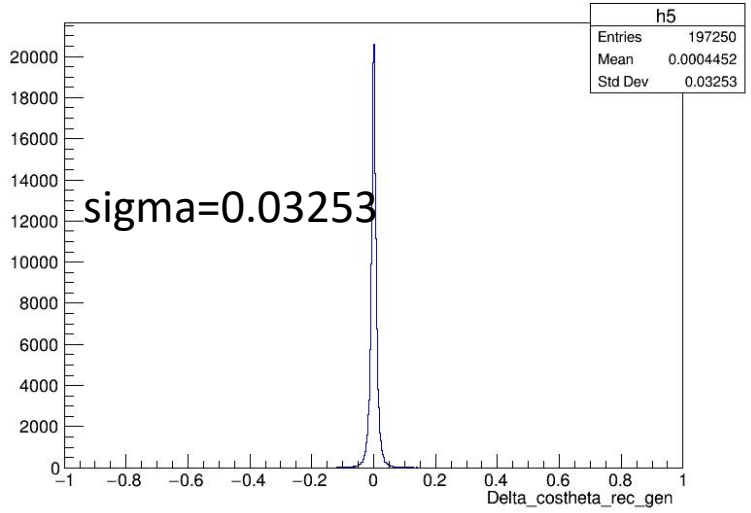




$\Delta E(\text{bias}) = E(\text{Truth}) - E(\text{GenJet})$

$\Delta\cos\theta(\text{bias}) = \cos\theta\ (\text{Truth}) - \cos\theta(\text{GenJet})$

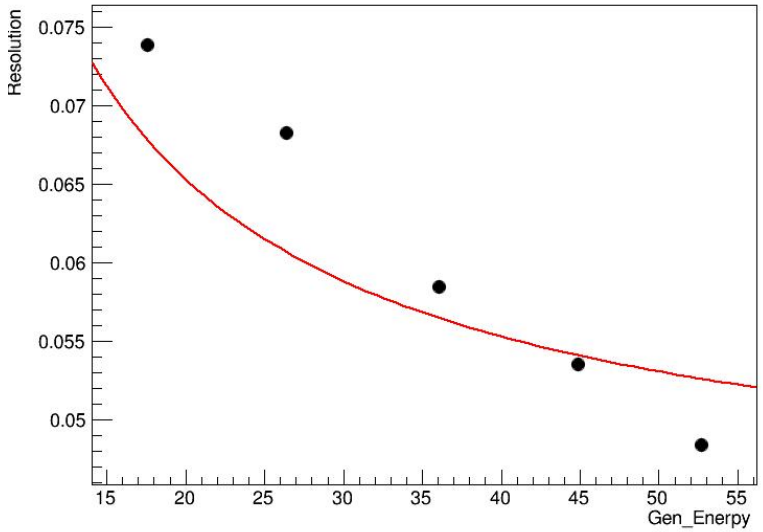




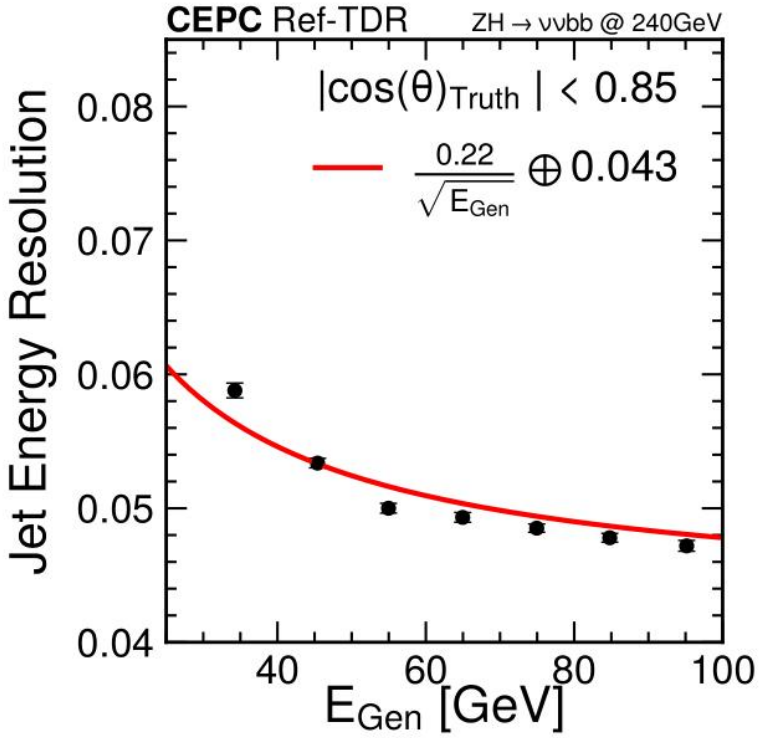
$\Delta E(\text{Resolution}) = E(\text{RecoJet}) - E(\text{GenJet})$

$\Delta\cos\theta(\text{Resolution}) = \cos\theta\ (\text{RecoJet}) - \cos\theta(\text{GenJet})$

Compare the bias of eekt and PFO on Energy and Costheta



Jet Resolution at different generator energy.
Similar to the plots given by TDR.



Jet Resolution for ZH → νν̄bb process given by TDR.

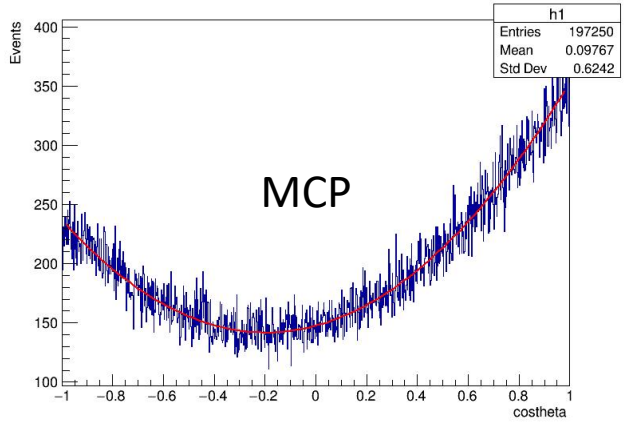
AFB Calculation

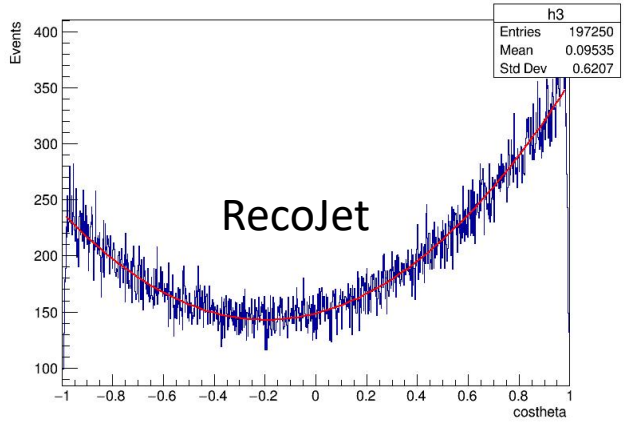
- Two ways to calculate AFB:
  - Counting AFB: (forward – backward)/ (forward + backward). $A_{FB} = \frac{\sigma_F - \sigma_B}{\sigma_F + \sigma_B}$
  - Fitting AFB: Fitting the Costheta distribution. $\frac{d\sigma}{d\cos\theta} = \sigma_{b\bar{b}}^{tot}\left[\frac{3}{8}(1+\cos^2\theta) + A_{FB}^{b}\cos\theta\right]$

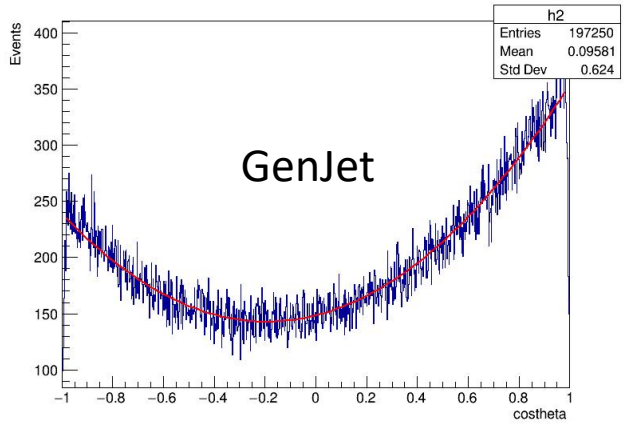
We calculate AFB without any cut.

	MC Particle	Generator Jet	Reconstructed Jet
Counting AFB	0.14641 ± 0.00223	0.14324 ± 0.00223	0.14303 ± 0.00223
Fitted AFB	0.14691 ± 0.00210	0.14428 ± 0.00210	0.14511 ± 0.00209

- AFB of Generator Jet is smaller than MC Particle. Missing energy taken by neutrinos can't be reconstructed using eekt.
- CEPCSW reconstruction don't affect AFB in general.







Summary

- Simulate ee to bb channel and compared the AFB results from MC particles, Gen jets and Reco jets.
  - Consistency among three AFB results shows the good performance of eekt and CEPCSW on reconstruction.
  - eekt algorithm should solve missing energy problem from neutrinos.

- Next Step.
  - Include background sample and consider selections.
  - Use machine learning based jet origin identification (JOI) for jet flavor tagging.

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