Jet Reconstruction at CEPC

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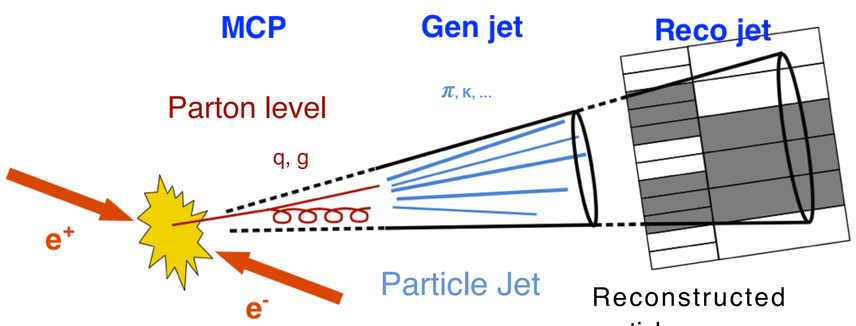
The understanding of both the energy scale and resolution of the jet is crucial for many physical analyses. The study of them are achieved by the Circular Electron-Positron Collider (CEPC) simulation at 250 GeV.

Definition of Simulation Stage

To study the performance of the jet reconstruction at CEPC, we look at the simulation which contains MC particles (MCP), particle jet (Gen jet), and reconstruction particle jet (Reco jet). Both Gen jet and Reco jet are clustered by the ee_kt jet clustering algorithm.[1-2]



Event Selection

A peak when Gen jet θ greater than 3.1 was caused a bug in simulation software. Thus, this region was excluded in this study. To reduce the influence from jet clustering when we studied the detector response, ΔR(Reco-MCP) < 0.1 was required.

Items	JER/JES(Reco-Gen)	JER/JES(Gen-MCP)
Gen jet θ < 3.1	✓	✓
ΔR(Reco-MCP) < 0.1	✓	✗

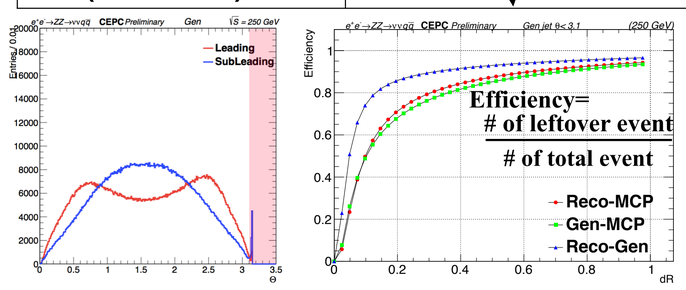
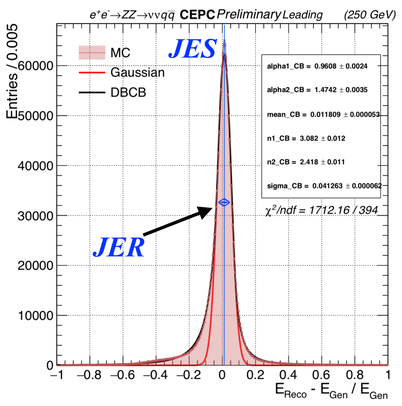


Fig.1.(left) The Gen jet θ distribution.
Fig.2.(right) Cutting efficiencies as the function of the ΔR.

Approach

Double-sided crystal ball(DBCB) function are used to extract energy resolution.



Results

JER & JES between Each Stage

JER/JES between Gen jet and MCP mainly represents jet clustering algorithm performance. Even though the performance of the core part is the best one, its tail parts have the worst performance. This implies us that the jet clustering algorithm can be the significant uncertainty, no matter how we improve the detector. JER/JES between Reco jet and Gen jet mainly represents detector response. From these results, we know the state of the detector is excellent. JER/JES between Reco jet and MCP would combine the previous two results' effects. It teaches us that the total effects of jet final state will bring.

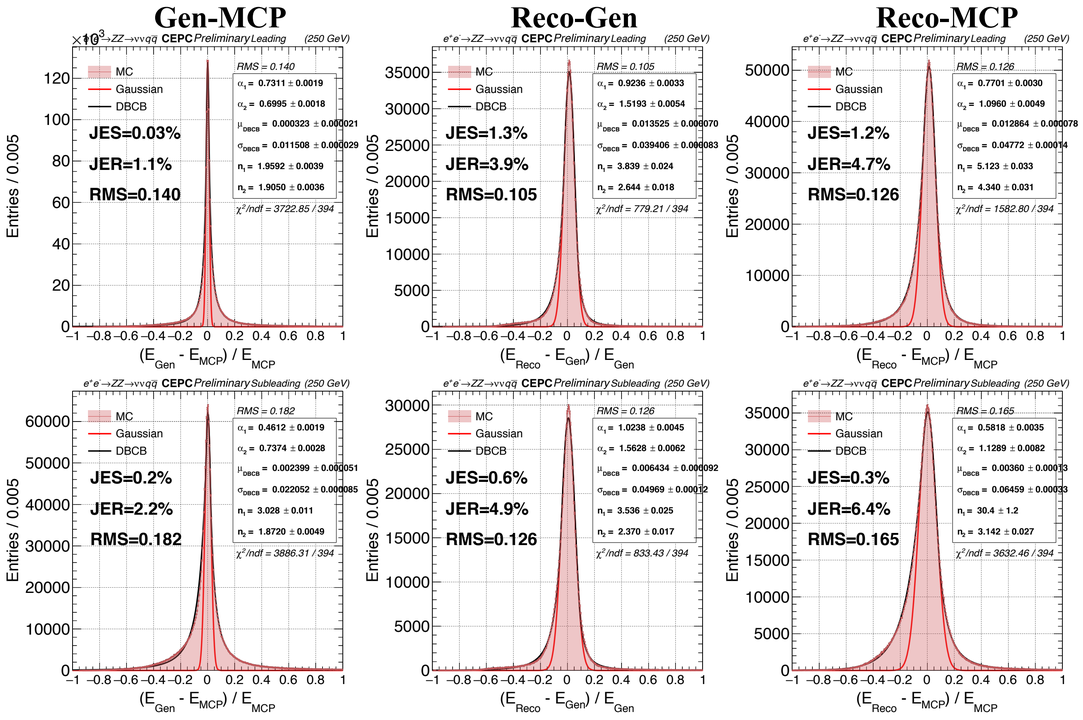


Fig. 3. JER and JES between each simulation stage. The first row is the leading jet performance and the second row is the sub-leading ones.

Angle and Energy Dependence of JER & JES

Along the pseudo-rapidity, JES increases significantly in the overlap part between endcap and barrel. Both JER and JES are large in endcaps than barrel. Interestingly, leading JES is systematically higher than sub-leading and the condition becomes opposite in JER.

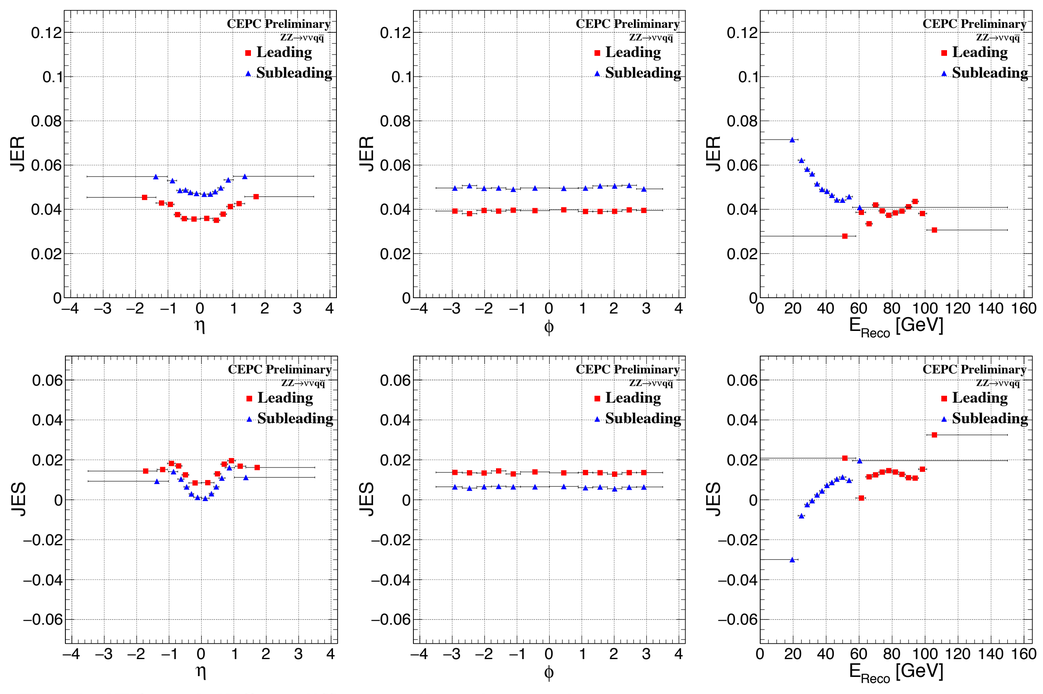
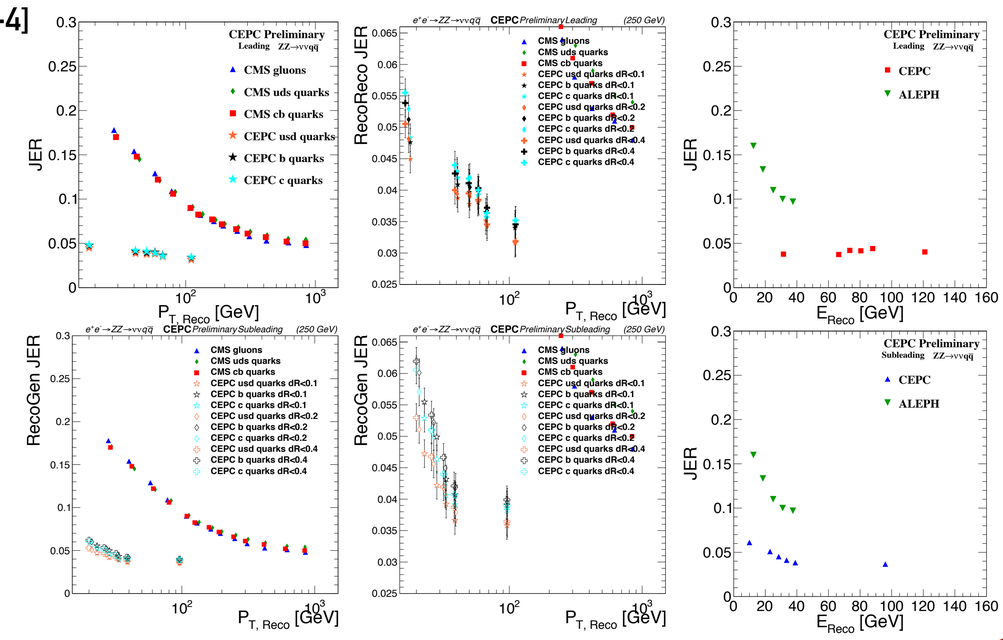


Fig. 5. JER and JES at different direction and energy range.

Comparison with CMS at LHC and ALEPH at LEP

The performance of JER is compared with CMS at LHC and ALEPH at LEP. CEPC detector is 2-4 times better than CMS and 2-3 times better than ALEPH. [3-4]



Boson Mass distribution in dijet final states

Z, W and Higgs boson in dijet final states can achieve nice separation at CEPC.[5]

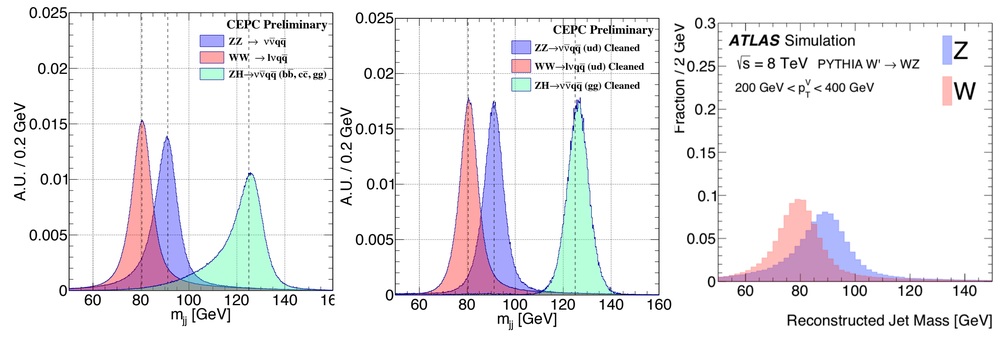


Fig. 4. (left, middle) Dijet invariant masses at CEPC (right) Dijet invariant masses at ATLAS

	JER		JES	
Gen-MCP	Lead	Sub-Lead	Lead	Sub-Lead
Barrel	1%	2%	0	0
Endcaps	1%	2%	0	0
En > 60 GeV	1%	2%	0	0
Reco-Gen	Lead	Sub-Lead	Lead	Sub-Lead
Barrel	3.5%	4.5%	1%	0
Endcaps	4%	5%	1.5%	0.5%
En > 60 GeV	4%	4.5%	1%	1.5%
Reco-MCP	Lead	Sub-Lead	Lead	Sub-Lead
Barrel	4.5%	6%	1%	0
Endcaps	5%	6.5%	1.5%	0.5%
En > 60 GeV	5%	6%	0.5%	1.5%

Conclusion

- Preliminary results for JER and JES were presented at CEPC.
- CEPC shows excellent JER(~4%) and JES(~1%).
- Good jet energy resolution leads to nice boson mass separation.
- The improvement of jet clustering algorithm will be conducted.
- These results are accepted for publication by EPJC.

[1] M Cacciari et al., FastJet user manual, CERN-PH-TH/2011-297 (2011). ArXiv: 1111.6097 [hep-ph]
[2] http://cms.web.cern.ch/tags/particle-jet [4] https://goo.gl/ZvTvoy [5] CERN-PH-2015-194
[3] CMS collaboration,CERN-PH-EP/2015- 305, CMS-JME-13-004, ArXiv: 1607.03663 [hep-ex]