Physics Impact of Solid Angle Coverage at CEPC

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Coverage is a vital performance for a detector. By defining our own way of analysis at different solid angle coverages, we quantify the particle collecting efficiency impact on solid angle. We study the major physics processes with the particle information at the generation level at Circular Electron-Positron Collider(CEPC). The Wizard is used as the Monte-Carlo (MC) generator for producing all samples, including signal (the Higgs boson and Z boson) and background.

Introduction

The CEPC, proposed by the Chinese particle physics community, is one of the possible facilities as the Higgs factory. CEPC will operate at a center-of-mass energy of 250 GeV that maximizes the Higgs production cross section through the e+e- → ZH process. The cleaner environment at a lepton collider allows much better exclusive measurement of Higgs decay channels.[1]

To reach the more precise physical measurement the numerous statistic is essential. The coverage of detector determines the data accumulation efficiency. However, if the diameter of beam pipe increases in certain range, beam pipe can bring higher luminosity to a certain extent. Oppositely the increase of the angle of beam pipe would lead to lower coverage.

This study shows the preliminary particles collecting efficiency to accelerator group, and then allows for the better optimization in terms of physics performance between detector and accelerator.

Definition of Efficiency

Particle collecting efficiency =

$$\frac{\text{Number of events wherein all visible particles within detector acceptance}}{\text{Number of events}}$$

Energy collecting efficiency =

$$\frac{\text{Energy of visible particles within detector acceptance}}{\text{Overall visible particle energy}}$$

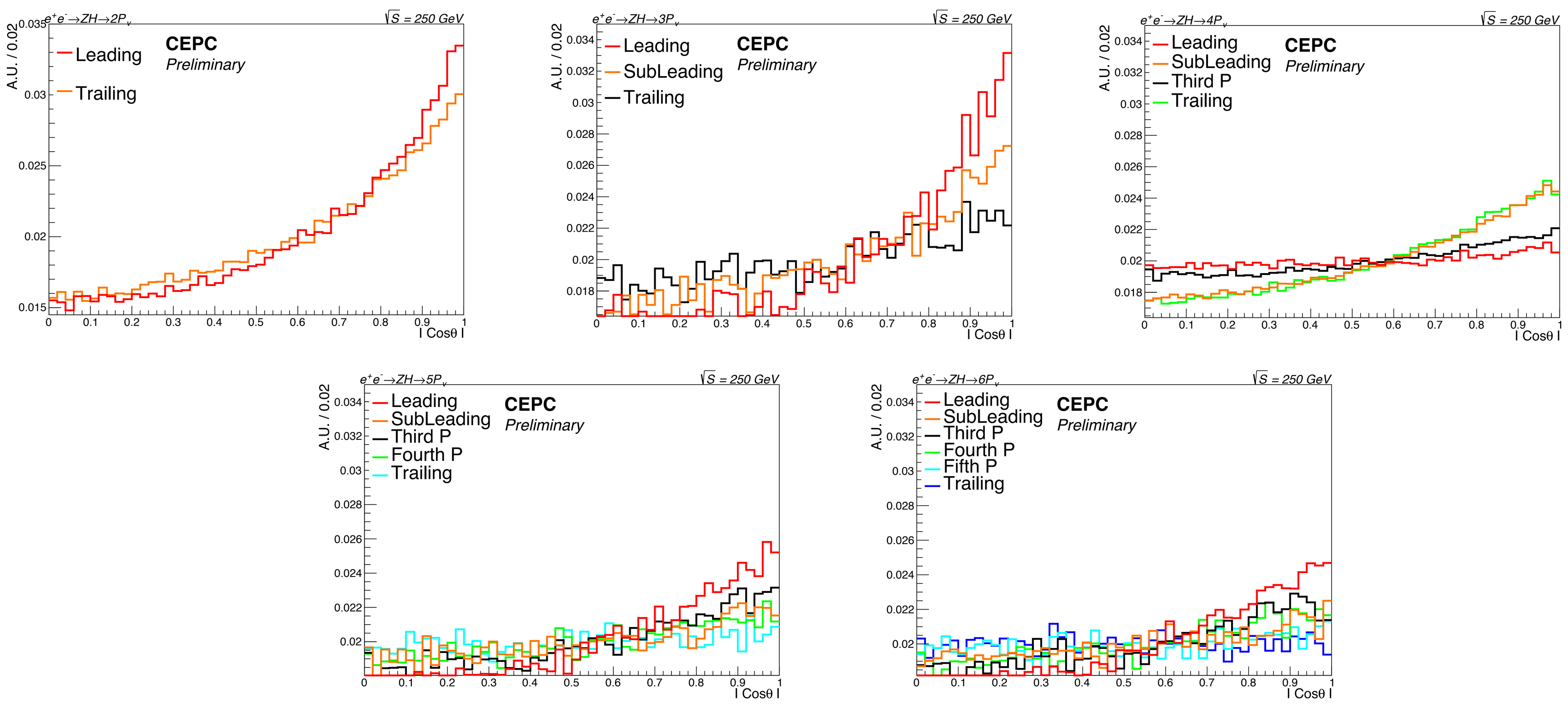
Samples & Event Selection

All samples mentioned were generated by the MC generator Whizard, version 1.95.

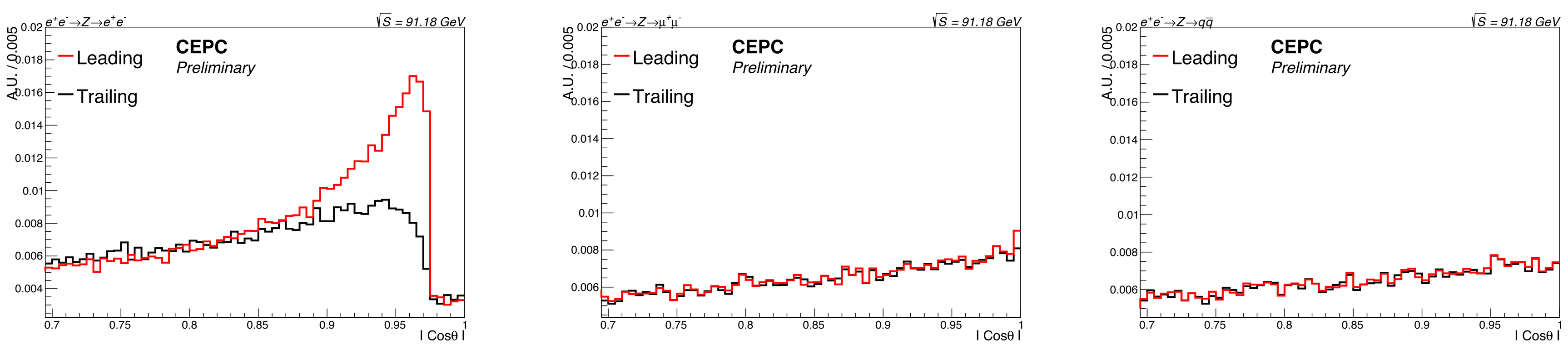
	$\sqrt{s}$ = 250 GeV	$\sqrt{s}$ = 91.18 GeV
Signal	✓	✓
SM Background	✓	✗

	Species	Impact of magnetic field	Visible
Particle collecting efficiency	Parton level	✗	✓
Energy collecting efficiency	Final state	✓	✓

Signal Angular Distribution



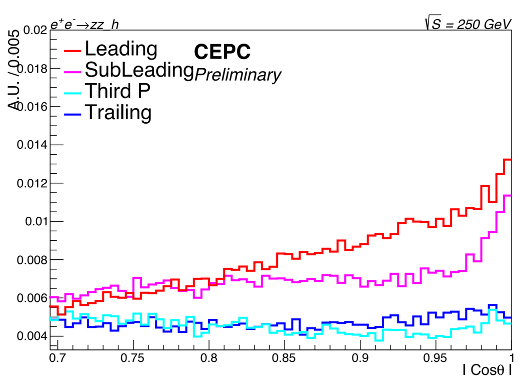
The |cosθ| distribution after sorting the particles momentum. When|cosθ| =(0.9, 1), the leading particle dominates the most signal processes, expect Higgs signal with 4 visible particles process.



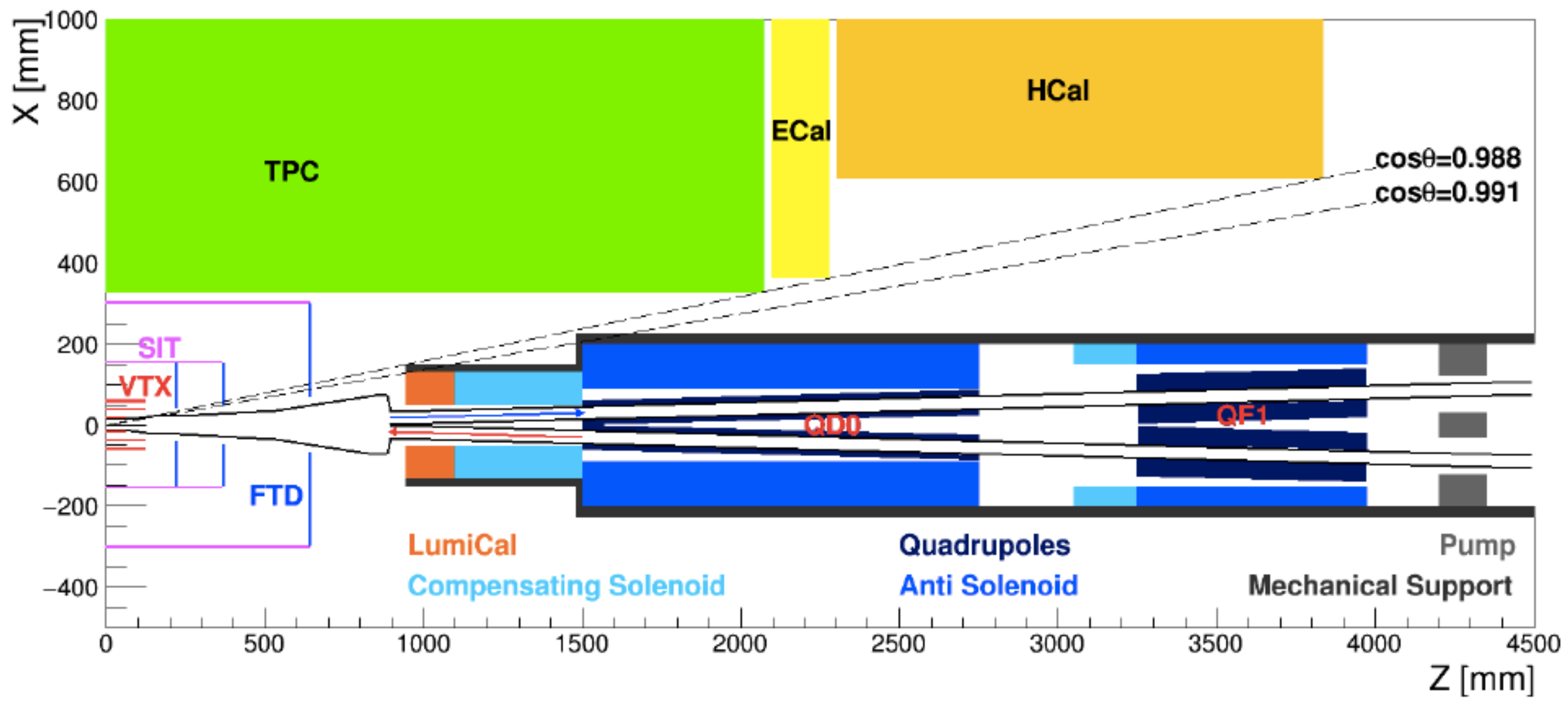
The |cosθ| distribution at Z pole signal process are shown after sorting the particles momentum.

Background Angular Distribution

The |cosθ| distribution, after sorting the particles momentum. When |cosθ|=(0.9, 1), leading particle dominates. Here shown zz_h process for example. But there are some processes are not the leading particle dominates when |cosθ|=(0.9, 1). They are zz_l, zz_sl and sze_l.

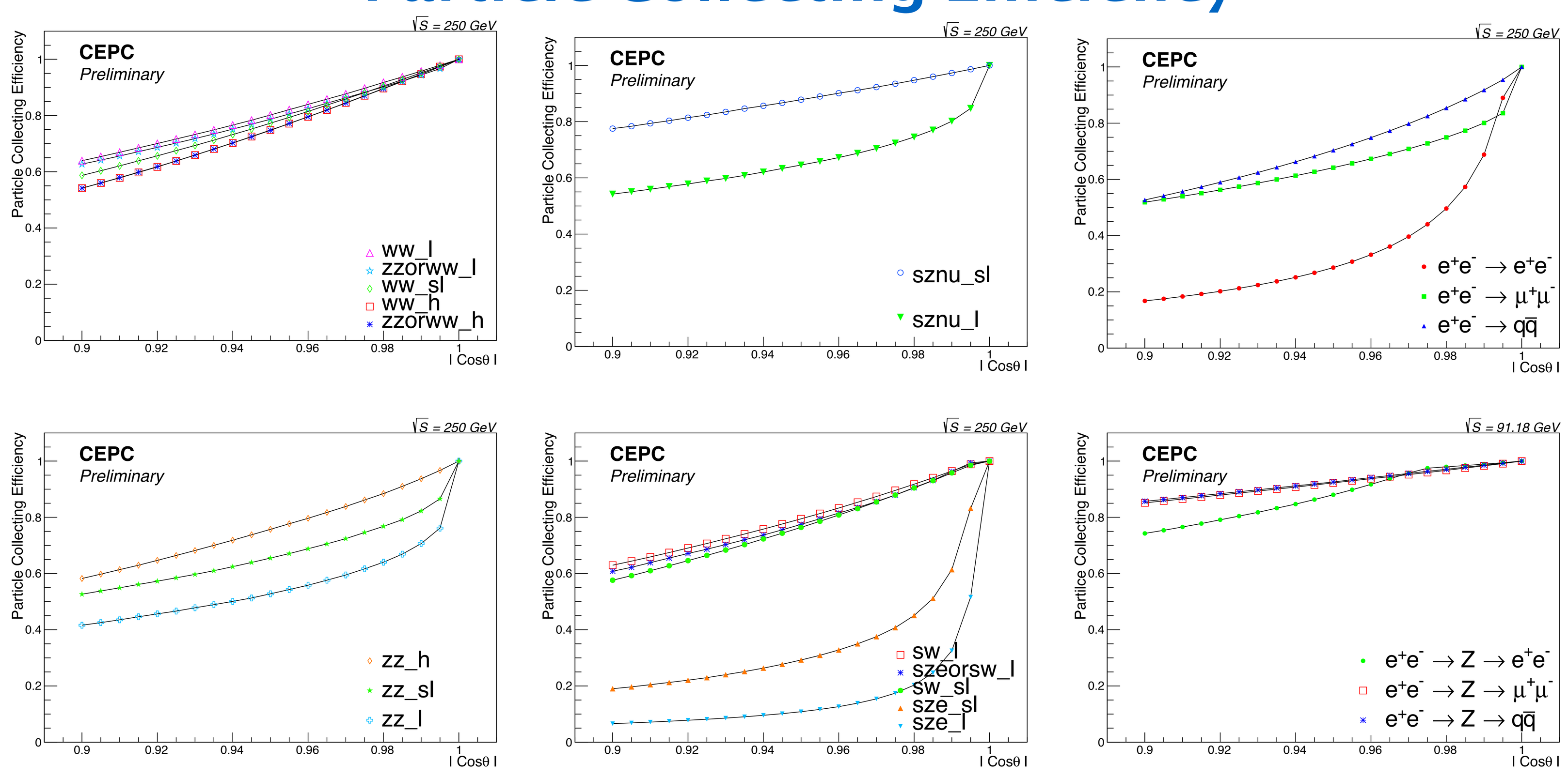


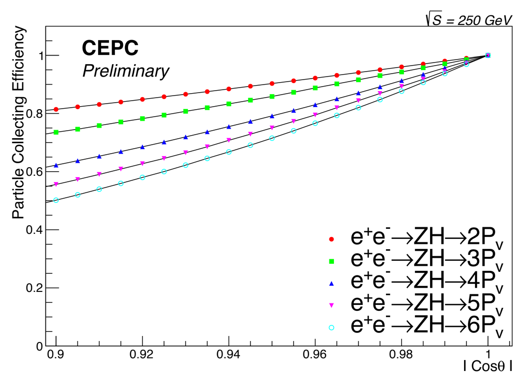
Future Detector



Results

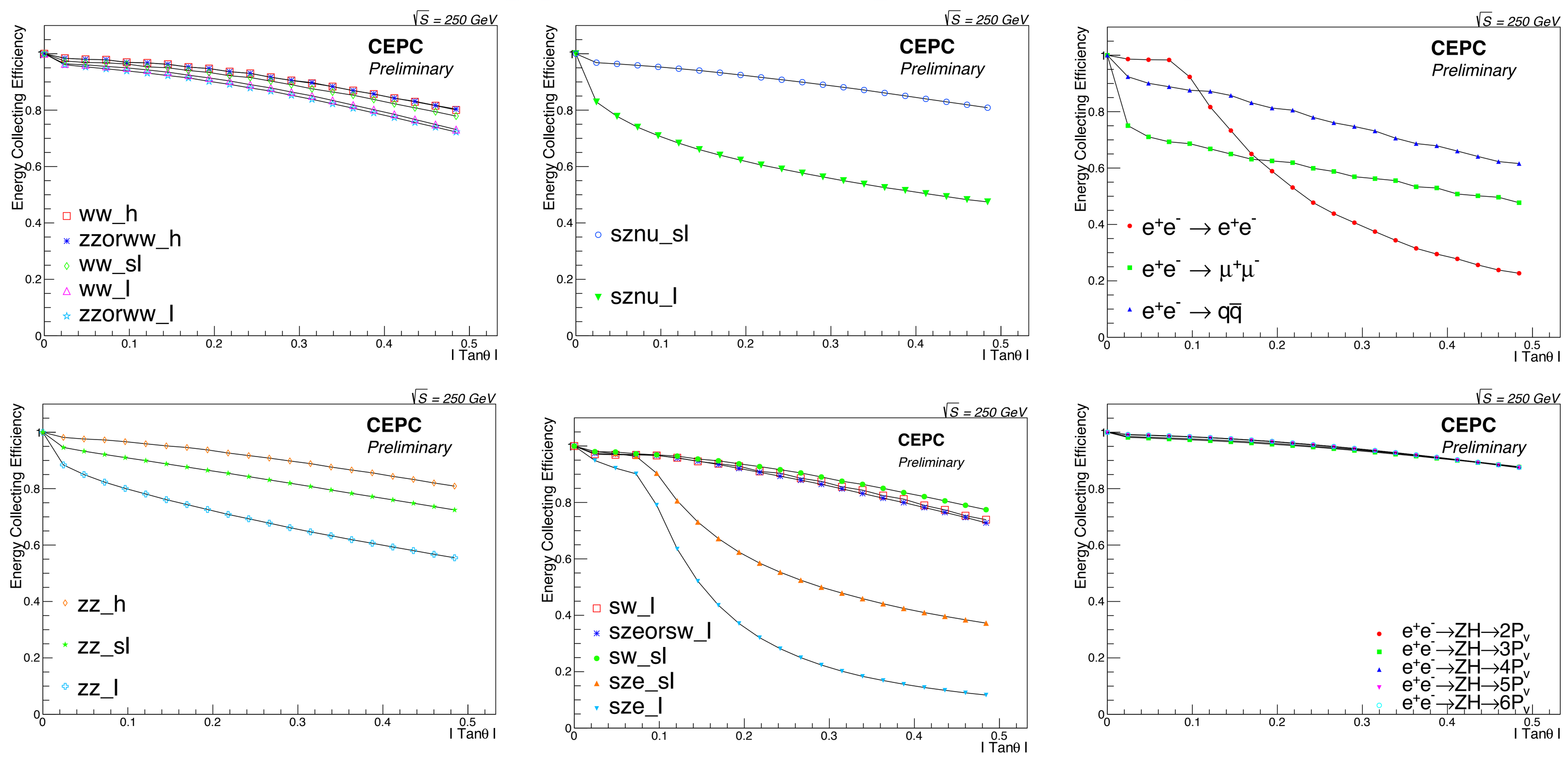
Particle Collecting Efficiency

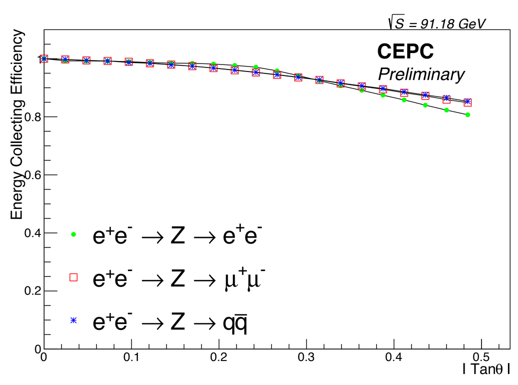




The physics impact of solid angle coverage with the major physics processes at the generator level at CEPC is shown. These particle collecting efficiency are calculated with parton level particles.

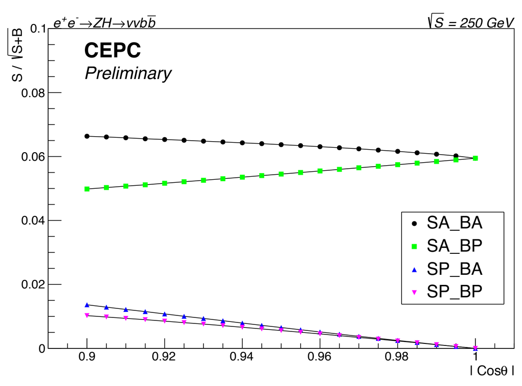
Energy Collecting Efficiency





The physics impact of solid angle coverage with the major physics processes at the generator level at CEPC has been shown. These energy collecting efficiency are considered using final state particles. Additionally, impact of magnetic field(3.5T) is also considered.

Significance of benchmark $Z(\rightarrow \nu\nu)H(\rightarrow b\bar{b})$



The significant of $Z(\rightarrow \nu\nu)H(\rightarrow b\bar{b})$. "S" means signal, "A" means complete collection, "B" means background, and "P" means partial collection. The signal and background have different collecting efficiencies as function of diameter of beam pipe.

Conclusion

The collecting efficiency as the function of diameter of beam pipe and significant of benchmark are performed. The results shown the nice coverage can be achieved with |cosθ|=0.995. The dominant influence to collecting efficiency is the leading particle in most processes. The reason for dominant influence to collecting efficiency is not the leading particle still need to be studied.

Reference: [1] CEPC-SPPC Preliminary Conceptual Design Report