Jet Lepton Identification Study and Requirement Analysis for a CEPC Muon System

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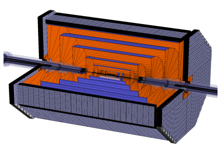
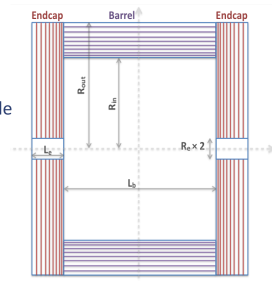
Conceptual Design of Muon Detector

Baseline design is illustrated as below, using CEPC geometry version 1.

Muon system design function:

- ✓ the muon identifier,
- ✓ the solenoid flux return yoke,
- ✓ the support structure for the whole spectrometer.



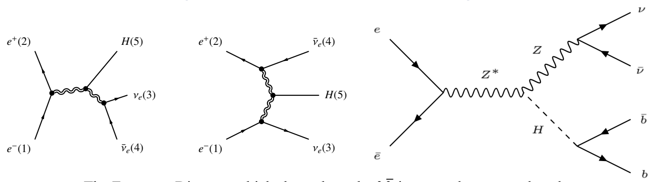


Demo of Muon Detector Geometry
Reference from CEPC CDR Fig 7.1

Parameter	Baseline
$L_b/2$ [m]	4.14
R_{in} [m]	4.40
R_{out} [m]	6.08
L_e [m]	1.72
R_e [m]	0.50
Segmentation in ϕ	12
Number of layers	8
Total thickness of iron ($\lambda = 16.77$ cm)	6.7λ (112 cm) (8/8/12/12/16/16/20/20) cm
Solid angle coverage	$0.98 \times 4\pi$
Position resolution [cm]	$\sigma_{r\phi}$: 2 σ_z : 1.5
Time resolution [ns]	$1 - 2$
Detection efficiency ($P_\mu > 5$ GeV)	$> 95\%$
Fake($\pi \to \mu$)@30GeV	$< 1\%$
Rate capability [Hz/cm^2]	$\sim$60
Technology	RPC (super module, 1 layer readout, 2 layers of RPC)
Total area [m^2]	Barrel: $\sim$4450 Endcap: $\sim$4150 Total: $\sim$8600

The design parameters of baseline CEPC Muon System.
Reference from CEPC CDR Tab. 7.1

Jet Lepton Identification Study



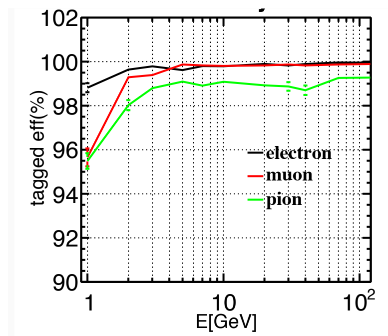
The Feynman Diagram which shows how the $b\bar{b}$ jets samples are produced.

Samples are produced through $e^+ + e^- \to ZH \to \nu\nu b\bar{b}$,

- ✓ All the jet muons in our analysis come from the $b\bar{b}$ jets
- ✓ Totally 9950 events have been simulated

1. Isolated Lepton Case

Efficiency is #(lepton tagged as lepton)/#(linked as lepton)
Purity is #(lepton tagged as lepton)/#(tagged as lepton)



Reference from " Lepton identification at particle flow oriented detector for the future e^+e^- Higgs factories" in Eur. Phys. J. C 77, no.9 591(2017), Fig. 5

Efficiency for tagging e, μ and π Using LICH:

- ✓ Eff for e and μ > 99.5%
- ✓ Eff for pion > 98%

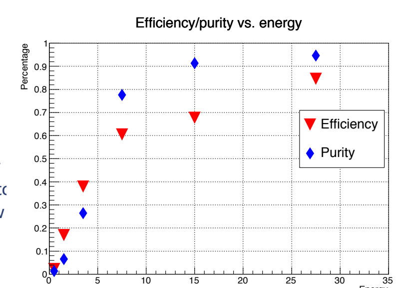
2. Jet Lepton(Muon) Case

The following table gives the analysis for selecting muon from jets using LICH.

Energy(GeV)	< 1	1 ~ 2	2 ~ 5	5 ~ 10	10 ~ 20	> 20
# of total particles	241689	115259	115530	47308	17310	4055
type_rec=muon	6319	11209	3542	1008	738	390
momentum	5277	9575	3042	960	721	378
type_truth=muon	137	875	954	782	674	370
distance_vertex	89	732	935	782	674	370
# of (linked as) Muon	5052	2843	2684	1436	912	455
Efficiency	0.018±0.002	0.257±0.008	0.348±0.009	0.545±0.013	0.739±0.015	0.813±0.018
Purity	0.014±0.001	0.065±0.002	0.264+0.007	0.776±0.013	0.913±0.01	0.949±0.011

3. Efficiency/Purity versus Energy for Jets Muon

The result of Efficiency and purity versus energy. It's obvious that the current algorithm gives better performance in high energy interval, but much needed tc be improved among the low energy interval.



Future R&D

- ✓ **Time Information:** Including time information such as the time that particles stay in detectors.
- ✓ **Long Lived Particle:** Studying long-lived particles that would decay far from the primary vertex but still within the detector.

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