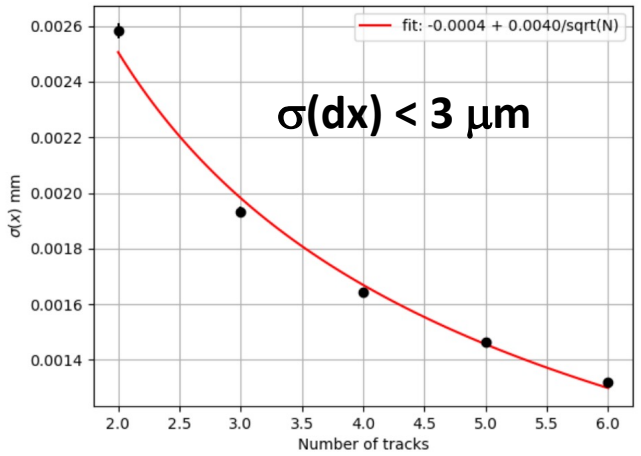
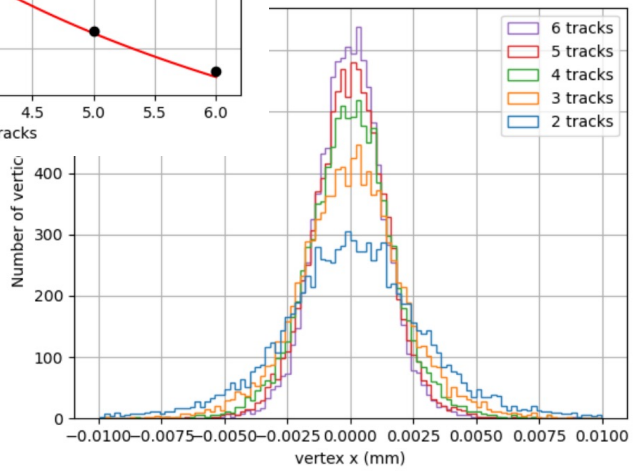
Vertex Performance

Chenguang, et al.

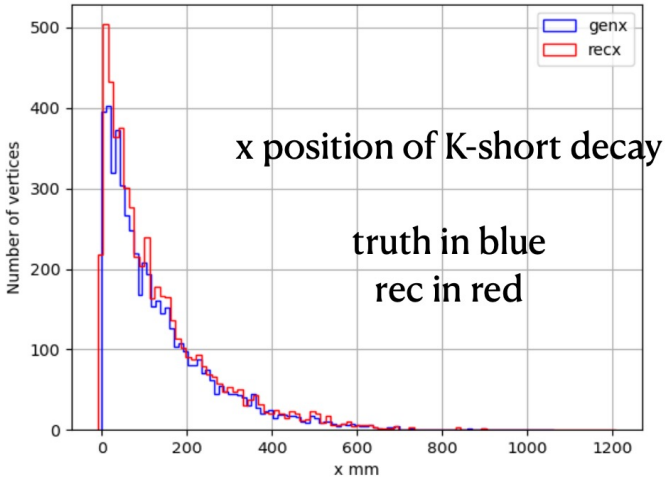
Package for vertex fit migrated, good performance seen in preliminary studies

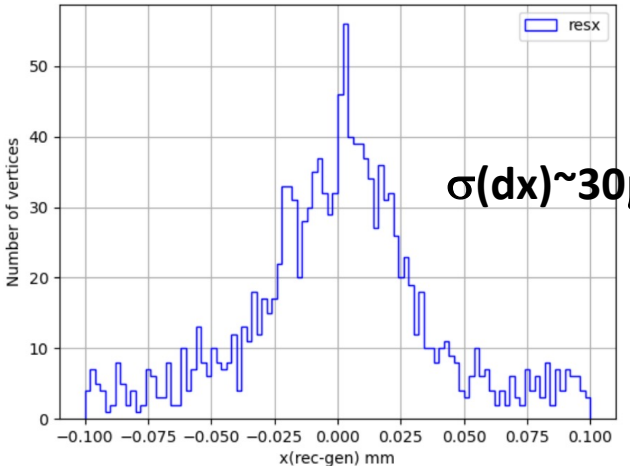
- Primary vertex resolution vs. number of tracks





- For secondary vertex
  - 10k particle-gun K-short, pT=2GeV, $\theta = 85^\circ, \phi = 0^\circ$
    - 70% $K_s^0 \rightarrow \pi^+\pi^-$ events
    - Displaced vertices were reconstructed

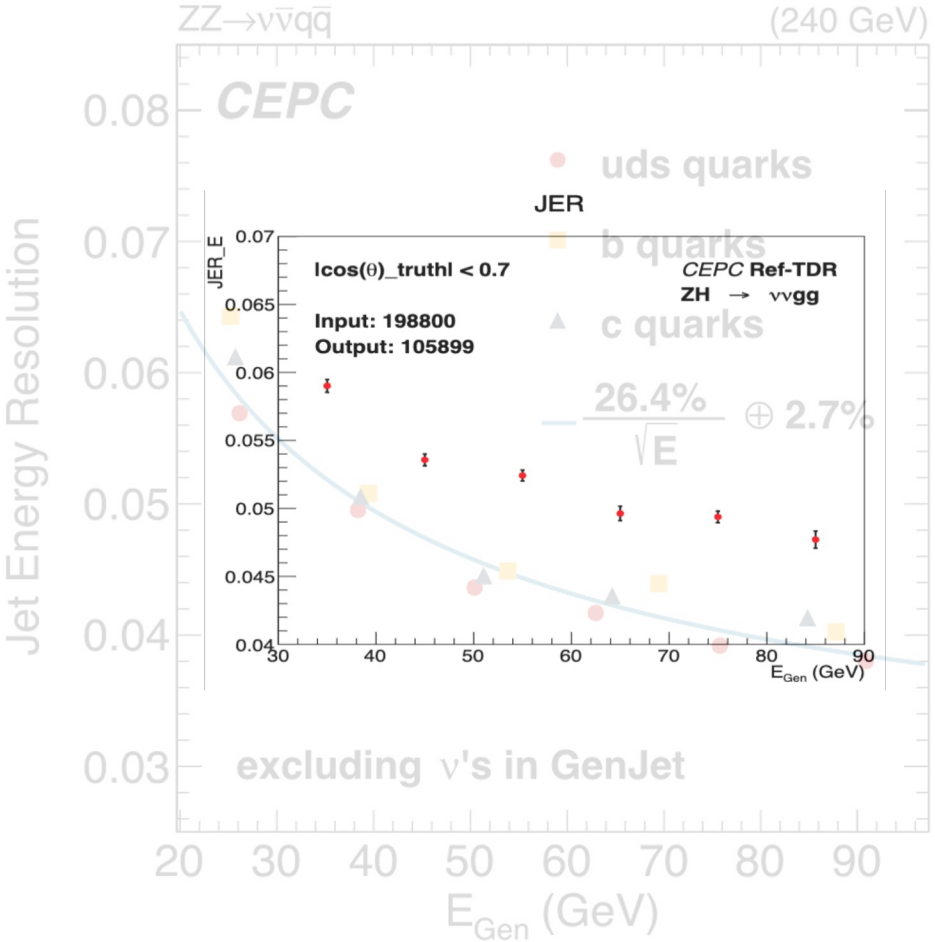




Jet Performance

Yingqi, Xiaotian, Kaili, et al.

- Significantly improved w.r.t. previous version, BMR now reaches ~3.8%, though Barrel only



Process		$ZH \to \nu\nu gg$	$ZH \to \nu\nu bb$	$ZH \to \nu\nu cc$
Cumulative efficiency /%	$\Sigma\lvert Pt_{\mathrm{ISR}}\rvert < 1\mathrm{GeV}/c$	95.3	95.3	95.4
	$\Sigma\lvert Pt_{\nu}\rvert < 1\mathrm{GeV}/c$	89.8	39.5	66.5
	$\lvert\cos\theta_{\mathrm{jet}}\rvert < 0.7$	53.1	22.0	38.0
DSCB BMR/%		3.99 ± 0.02	3.84 ± 0.04	4.04 ± 0.03

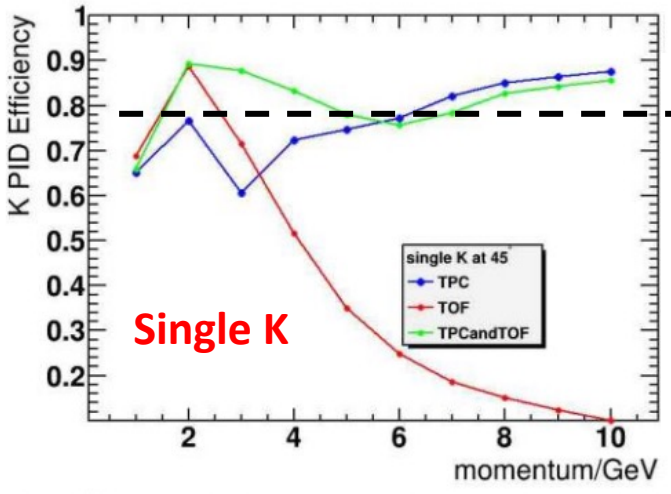
CDR

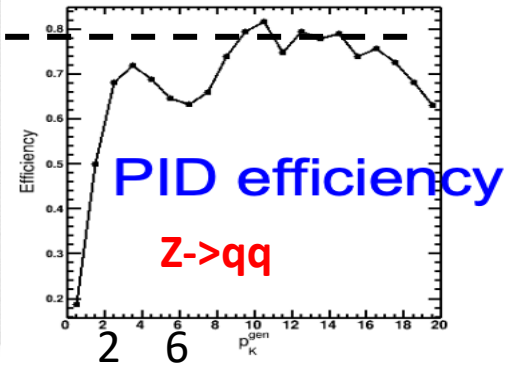
Table 3. Higgs boson mass resolution (sigma/Mean) for different decay modes with jets as final state particles, after event cleaning.

$H \to bb$	$H \to cc$	$H \to gg$	$H \to WW^*$	$H \to ZZ^*$
3.63%	3.82%	3.75%	3.81%	3.74%

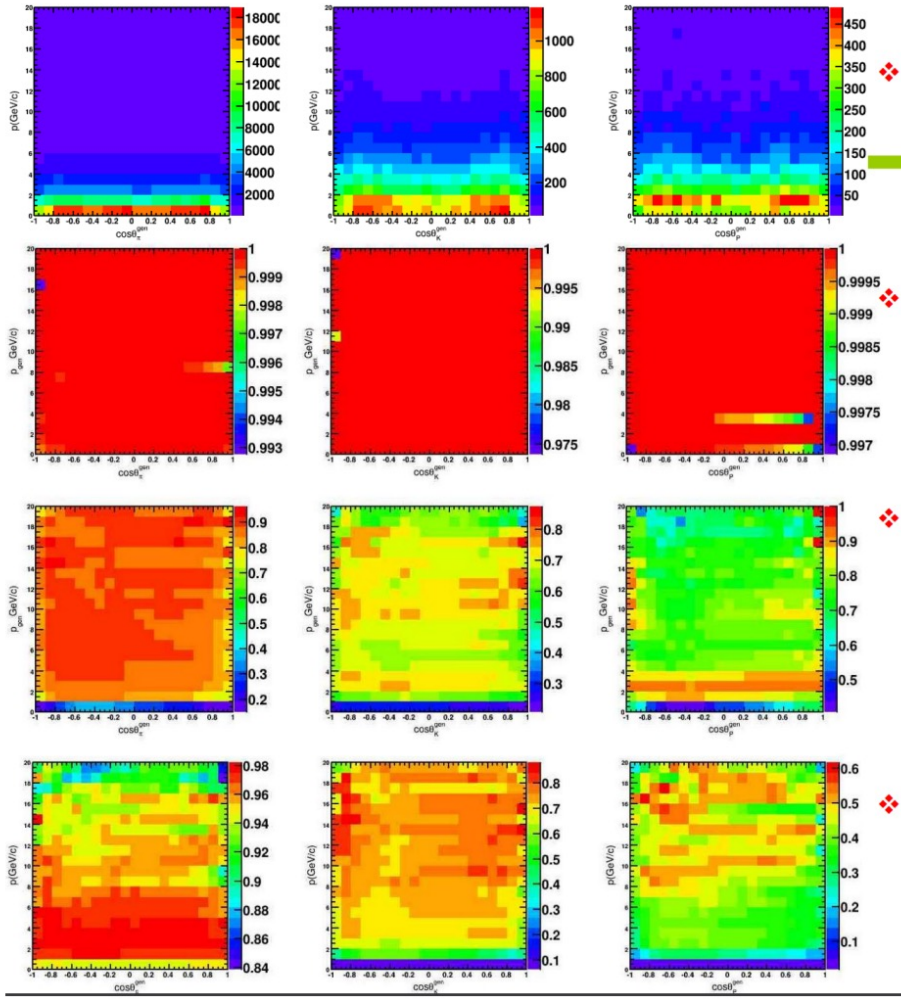
PID Performance

- First look at PID @ $Z \rightarrow qq$. Last week $H \rightarrow gg$ (Xiaotian Ma)
- PID Code for CyberPFO submitted (Chenguang Zhang)





Kaon PID efficiency in Z->qq ~15% lower than that from single particle gun study



- Phase space $(p_{\mathrm{gen}}, \cos\theta_{\mathrm{gen}})$ 0-20GeV
- Track efficiency distribution of truth $\pi/K/p$ (have dN/dx or t)
- PID efficiency distribution of truth $\pi/K/p$ (minimum combined χ^2)
- Purity distribution of truth $\pi/K/p$

2

Backup

Status of Performance @ 20241203

- Tracking
  - Thanks to SW group, the shift of momentum now fixed (with refined magnet field map)
  - Issue of tracking resolution at low pT understood, being fixed by SW group
- Vertexing
  - ACTS package of vertexing fit integrated in CEPCSW, preliminary results look good
  - Study ongoing for physics events and building secondary vertex
- Jet Performance
  - Working on performance evaluation: differential JER/JES/JAR/JAS, BMR
    - Latest development of CyberPFA (can reach ~3.8% BMR) now integrated in the CEPCSW release (tdr24.12.0 last mid-night).
  - **Next priority for SW group**: Geometry/Digi/Reconstruction of Endcap Calo
- PID
  - Now working on PID performance in physics processes, while dN/dX algorithm optimization ongoing
- Shanzhen and Xuhao working on evaluation of the impact from different ECAL granularity, PID: lamda_c -> p K pi , boosted tau

Chapter content

Physics Performance 2
1.1 Introduction 2
1.2 Recap of sub-detector performance 2
1.3 Detector global performance 2
1.3.1 Tracking 3
1.3.2 Particle Identification: Photon, Electron and Muon ID 6
1.3.3 PID for K, pi, p 8
1.3.4 Jet Flavour Tagging 8
1.3.5 Jet Energy and Boson Mass Resolution 9
1.4 Benchmark Physics studies 10
1.4.1 Event Generation 11
1.4.2 Analysis Tools 12
1.4.3 Higgs mass and production cross-section through recoil mass 12
1.4.4 Branching ratios of the Higgs boson: h -> bb, cc, ss, WW, gg, $\mu^+\mu^-$ 14
1.4.5 More Benchmarks 16
1.5 Challenges & Plan 17
1.5.1 Methods & Considerations for Calibration, Alignment 17
1.5.2 Strategy for the measurement of absolute luminosity 21
1.5.3 Plan of the use of resonant depolarization for W/Z mass 21
1.5.4 Brief mention how the physics performance studies influence further technology decisions/detector optimization 21
1.6 Summary 22

Comments/Recommendations on Performance

- The planned list of channels looks a bit too high for a few months of work, better to focus on demonstrating that the reference detector reaches adequate performance for physics
  - **Select fewer channels, aimed at demonstrating that the reference detector reaches adequate performance for physics. Include some simple topology (e.g. Z→mumu). Encompass H, Z, W and top physics.**
  - **Foresee in the TDR results and figures about performance on basic objects (leptons, photons, jets) as a function of energy and polar angle**
  - A measurement of V_cs during the WW run is probably a more relevant benchmark than V_cb ;
  - The channel to be used for the electroweak mixing angle measurement should be clarified

Plans:

Priority: working closely with software team for the development and performance studies of basic objects

H→ss/cc/sb
H→inv
Vcb
W fusion Xsec
α_s
CKM angle $\gamma-2\beta$
Weak mixing angle
Higgs recoil
H→bb, gg
H→μμ
H→γγ
W mass & width
Top mass & width
Bs→$\nu\nu\phi$
Bc→$\tau\nu$
B_0→$2\pi^0$
H→LLP
H→aa→4γ

	Process @ c.m.e	Domain	Relevant Det. Performance
Z→μμ	Z@ 91.2 GeV	Z	lepton ID, tracking
H→γγ	qqH	Higgs	photon ID, EM resolution
Higgs recoil	$\ell\ell$H	Higgs	Lepton ID, track dP/P
H→ss	ννH @ 240 GeV	Higgs	PID, Vertexing, PFA + JOI
H→inv	qqH	Higgs/NP	PFA, MET
Vcs/Vcb	WW→$\ell\nu$qq @ 240/160 GeV	Flavor	PFA, JOI + PID (lepton, tau)
H→LLP	$\ell\ell$H	NP	TPC, TOF, calo, muon detectors
H→μμ	qqH	Higgs	lepton ID, tracking, OTK
Top mass & width	Threshold scan @ 360 GeV	EW	Beam energy
Weak mixing angle	Z→bb @ 91.2 GeV	EW	JOI

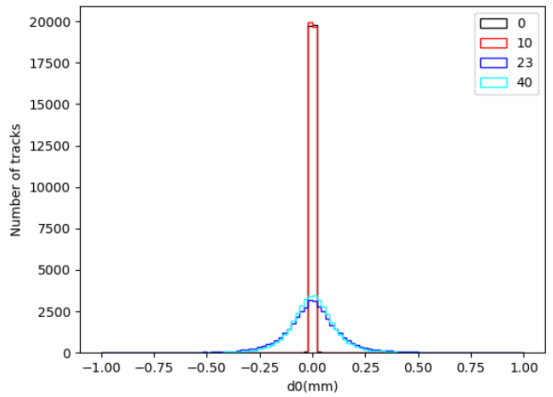
Vtx resolution vs. decay position

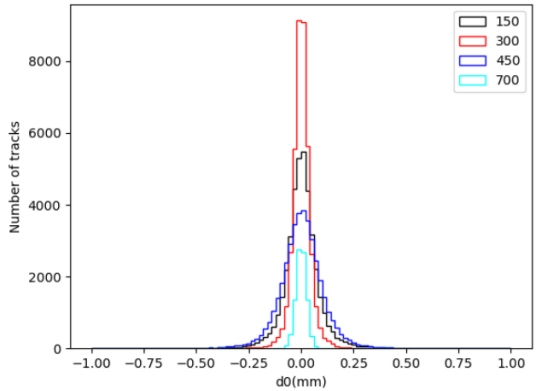
Particle-gun muon pair from (x, 0, 50)

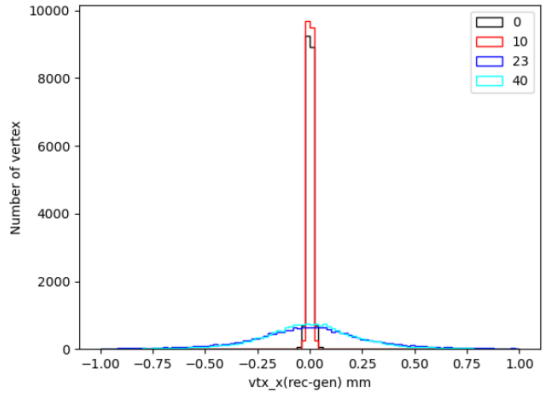
phi=0~60, theta=80~90

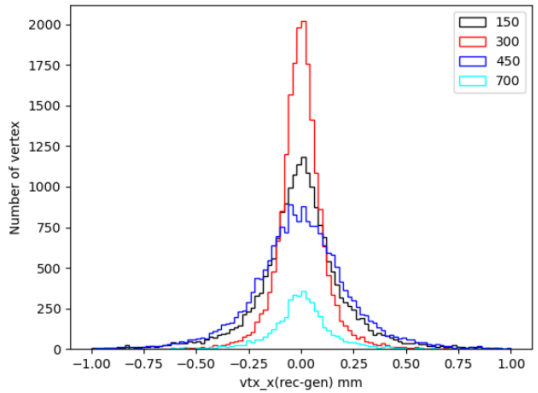
Layer	R(mm)	muon pair x position
		0, 10
VXD-L1	12.5~18	
		23
VXD-L2	28~35	
		40
VXD-L3	45~53	
		150
ITK-L1	240	
		300
ITK-L2	350	
		450
ITK-L3	570	
TPC	600-1800	
		700
OTK	~1800	

Vtx









- d_0 and vertex have the same order of precision variation with position
- From x=10 to x=23, the precision decreases too rapidly
- x=300 is better than x=150 because it is closer to the corresponding first hit than x=150 (to adjust particle-gun position)
- If muon pair originates at x=700, TPC more likely to return a single track. Htrk=2 applied, note its normalisation