Higgs→ττ Analysis in CEPC

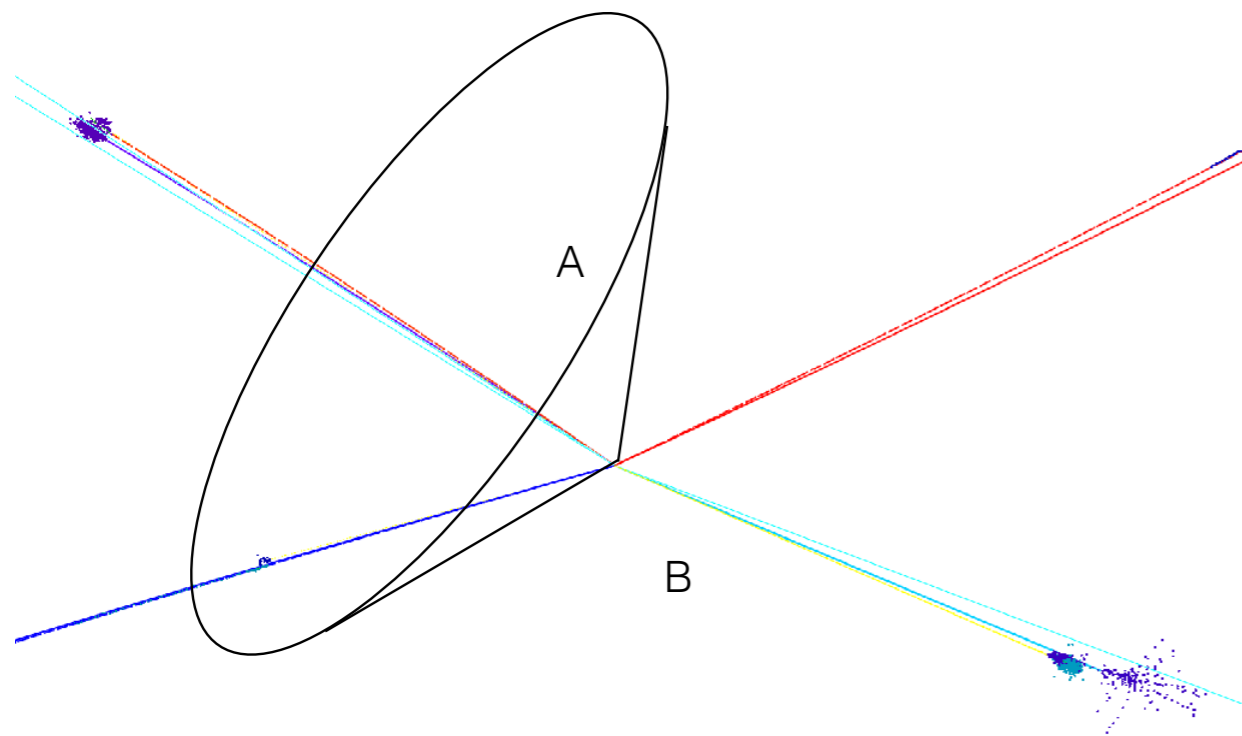15/04/2019 Oxford
Dan YU

Plan

- Introduction

- Tau Finding

  - llH

  - qqH

- BMR dependence

- Summary

Motivation

- Tau is the heaviest SM lepton - large coupling to Higgs boson Br(H → ττ): 6.27%

- Rich relevant physics

- Performance rely on particle separation

  - Testbed for PFA/Objectives for detector optimization

Tau Finder (IIH)

- Veto the two isolate lepton
- Divide the whole space into 2 part
- Use the multiplicity and impact parameter for ττ event selection.
- Fit the impact parameter for signal and background statistics

Parameters & Cut Chain

- Parameters:

  - µµ information

 - Leading electron energy

  - Multiplicity

  - Impact parameters

	$\mu\mu H\tau\tau$	2f	sw	sz	WW	ZZ	mixed	ZH	total Bkg	$\sqrt{S+B}/S(\%)$
total generated	2388	801152078	19517399	9072946	50826211	6389424	21839941	1102582	909900581	1263.17
$N_{\mu^+} > 1, N_{\mu^-} > 1$	2251	22894549	37923	720547	1335231	831861	1251657	567636	27639404	233.56
$115GeV < M_{recoil} < 160GeV$	2111	864849	154	155502	396485	112837	164225	3114	1697166	61.75
$60GeV < M_{invariant} < 105GeV$	2042	662042	0	31145	111376	56642	99874	987	962066	48.08
$E_{Le} < 65GeV$	2026	658199	0	17760	111340	56516	99822	957	944594	48.02
$N_{Trk}(A/B) < 6$ & $N_{Ph}(A/B) < 7$	1900	78	0	996	2576	8019	29	105	11803	6.16
BDT>0.78	1823	0	0	264	231	3682	9	39	4225	4.26
$\tau\tau$ collinear mass fit result										2.84

ττ mass

- Collinear approximation: assuming the momentum of neutrino(s) is proportional to the τ's
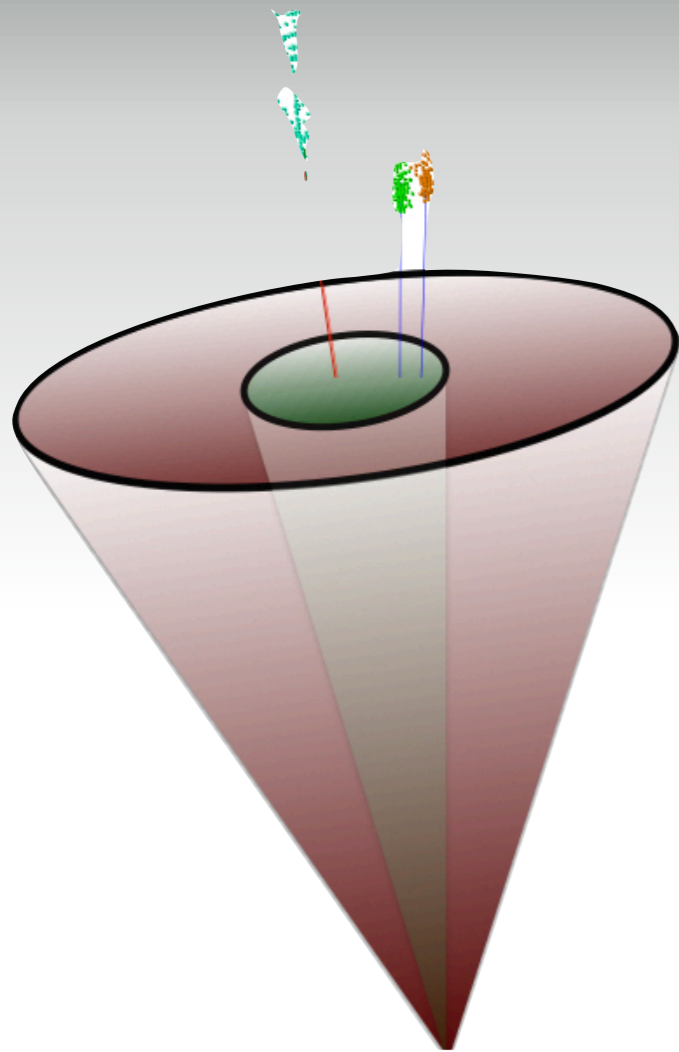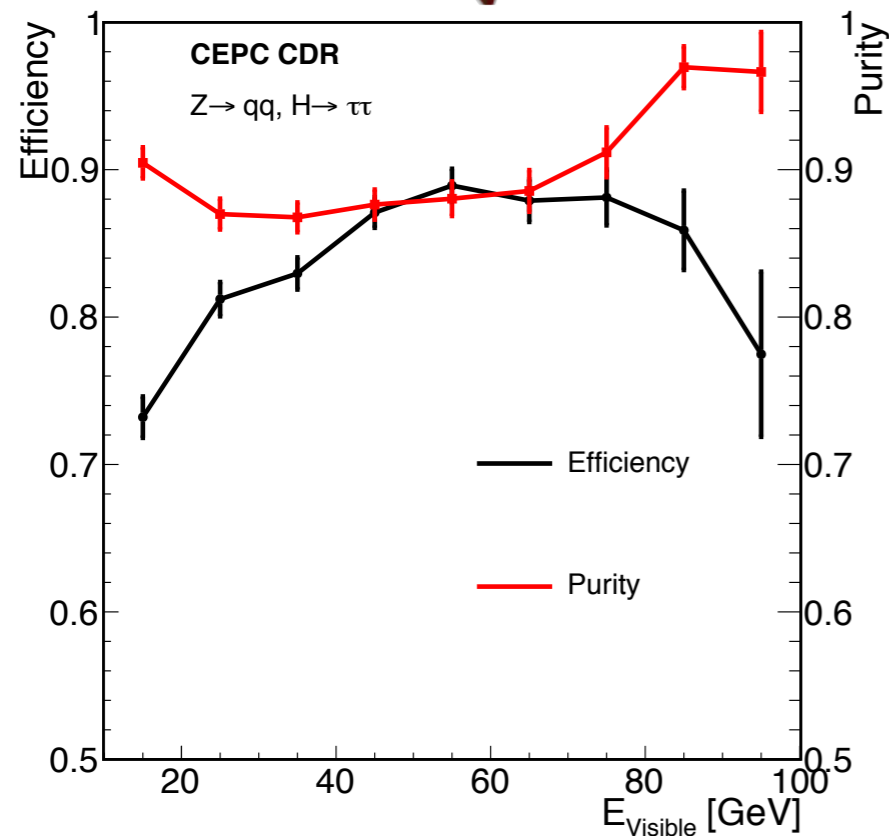
- Accuracy 2.84%
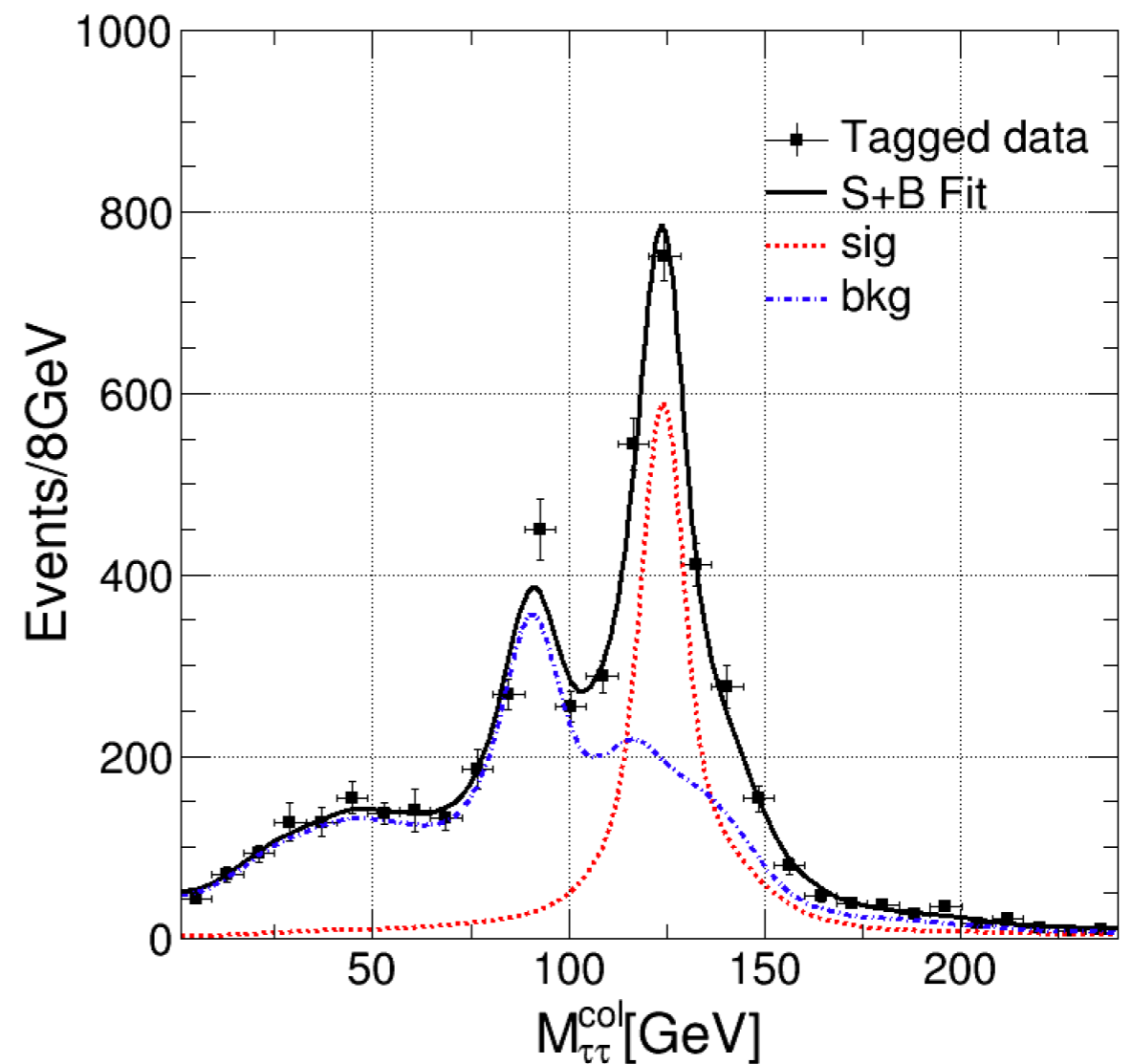
Tau Finder (qqH)
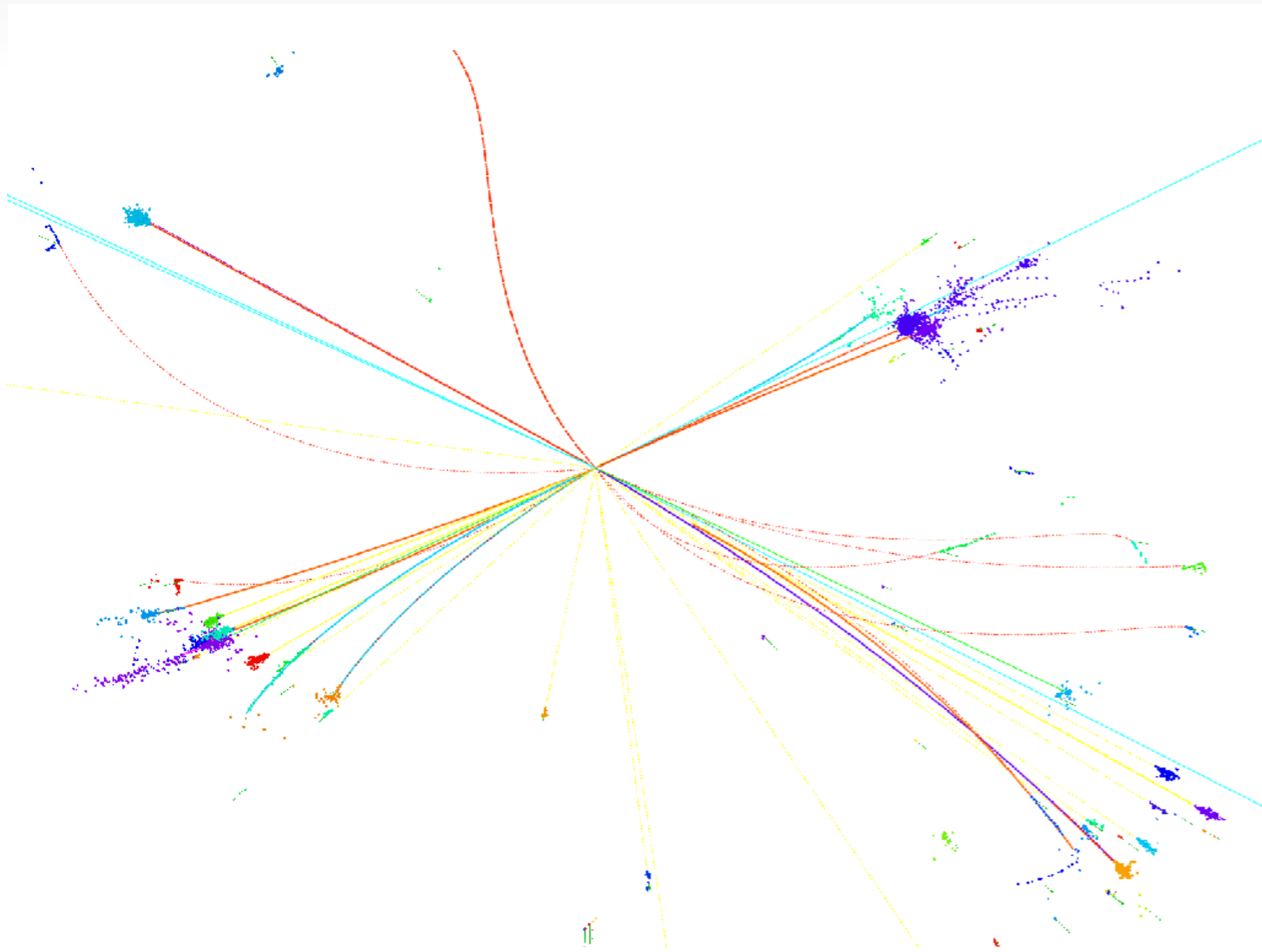
- qq events selection
- Tau reconstruction package: TAURUS
- τ pair selection
- Jet system information

TAURUS

CEPC CDR
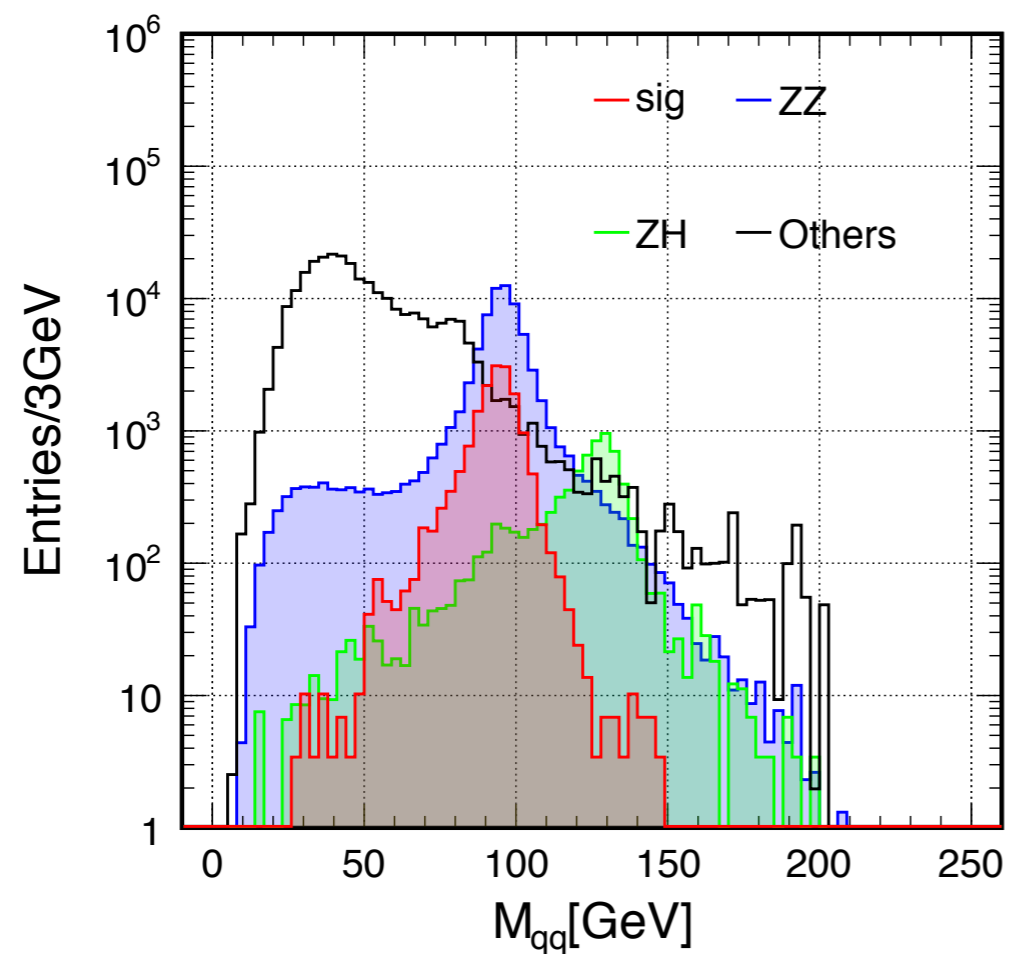Z → qq, H → ττ

- Efficiency
- Purity

- • Double cone based algorith
  - • Find seeds(Tracks with enough energy)
  - • Collect particle in two cones
  - • Use the multiplicity, energy ration between two cones, invariant Mass for τ tagging
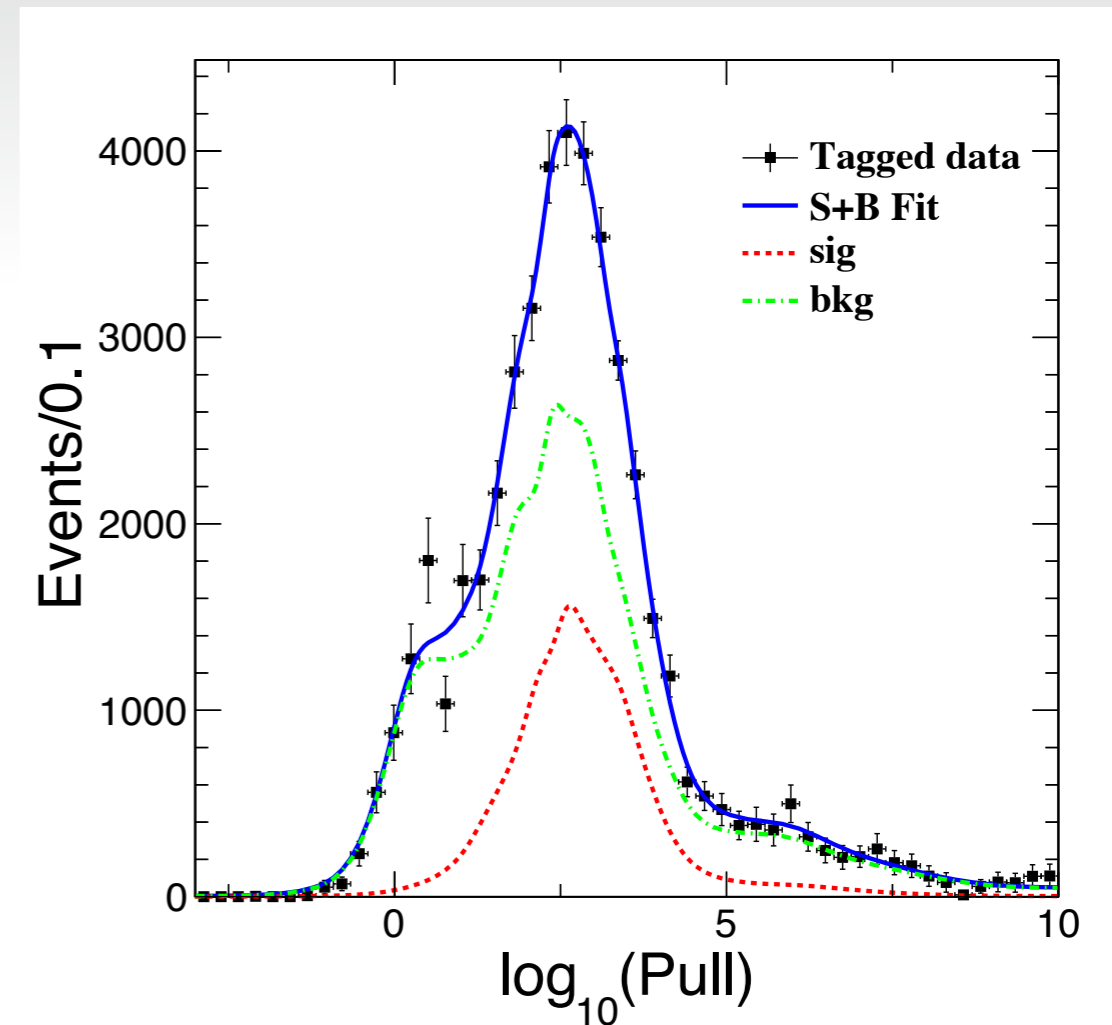- • Event efficiency ~ 60%

qq Invariant/Recoil Mass

	signal	ZZ	ZH conjugation
qq invariant mass [GeV]	91	91	125
qq recoil mass [GeV]	125	91	91
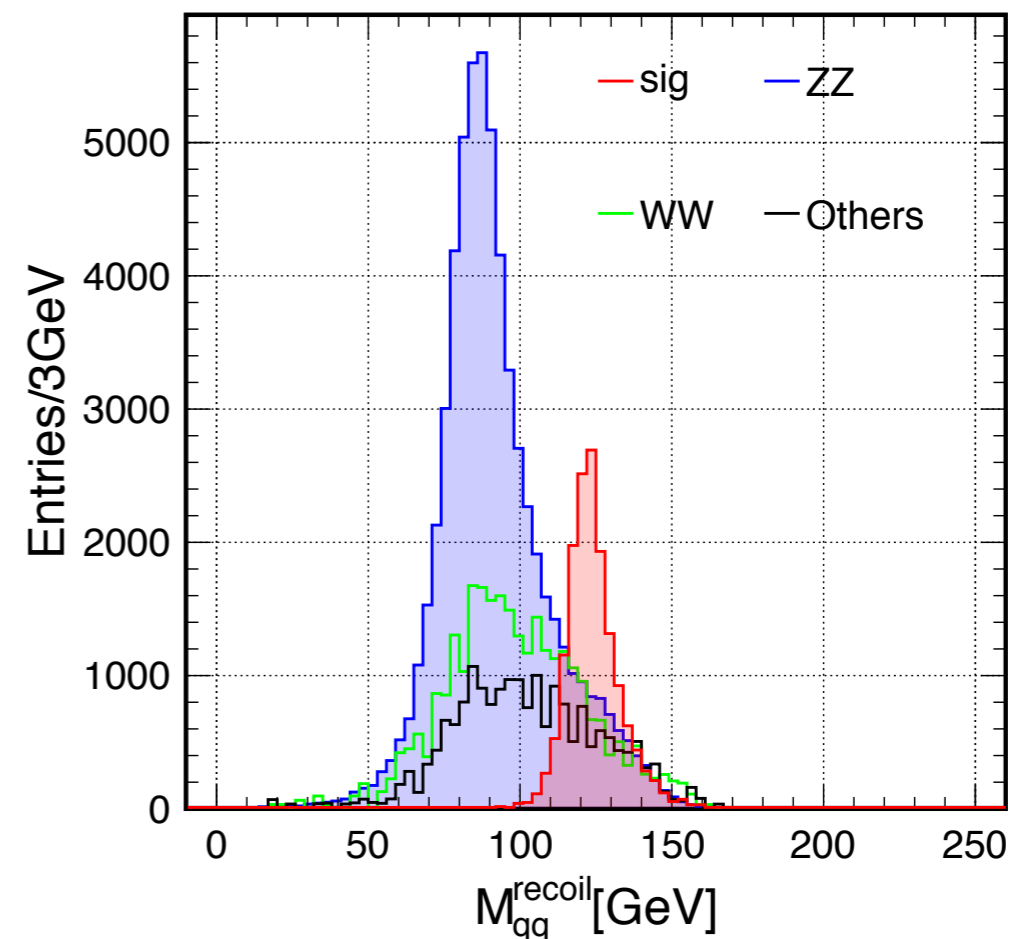
Tau Finder (qqH)

- Pull : $D0^2 + Z0^2$

- Accuracy: 0.9%

	$qqH\tau\tau$	2f	sw	sz	WW	ZZ	mixed	ZH	total Bkg	$\sqrt{S+B}/S$ (%)
Total Statistic	48266	801152078	19517399	9072946	50826211	6389424	21839941	374357	909679268	62.43
NCh>10	47347	272992986	13765307	1969972	47052263	5756249	18020636	331843	359889260	40.07
$110GeV < E_{tot} < 235GeV$	46183	173589861	13159096	942644	31297172	3239464	5154115	264535	227646887	32.67
$E_{Le} < 45GeV, E_{L\mu} < 65GeV$	44093	169589868	3413790	707027	22428227	2911836	4985026	237240	204273014	32.41
$N_{\tau+} > 0, N_{\tau-} > 0$	22414	401147	212183	13999	1129502	171380	193055	16821	2138087	6.55
$90GeV < M_{\tau\tau}^{col} < 160GeV$	17176	9717	21483	1689	135538	62721	7722	5305	244175	2.97
$70GeV < M_{qq} < 110GeV$	16257	1596	4119	1012	26823	52307	1818	717	88392	1.98
$M_{qq}^{rec} (GeV) > 100GeV$	16211	0	1463	637	11071	13814	1265	647	28897	1.31
2-D impact parameter fit result										0.93

Combination & Extrapolation
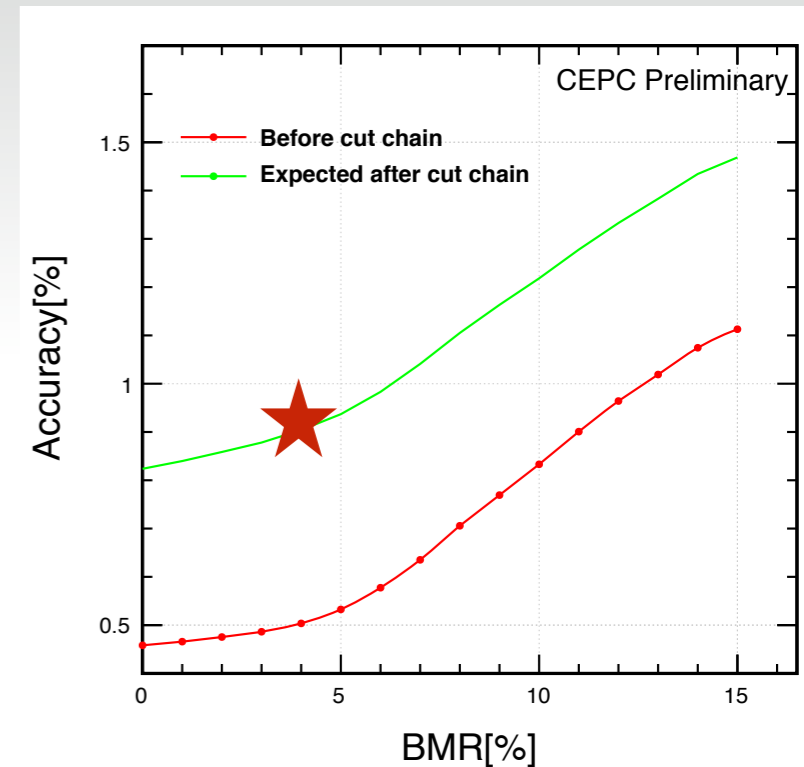
- The combined accuracy (5.6 ab⁻¹)

	$\delta\,(\sigma\times BR\,)/(\sigma\times BR)$
$\mu\mu$H	2.8%
eeH	5.3%
$\nu\nu$H	7.9%
qqH	0.9%
combined	0.8%

- Extrapolating to ILC

	CEPC	ILC(L)	ILC(R)
Luminosity(ab^{-1})	5.6	2	2
Polarization(e^{-},e^{+})	-	(0.8, -0.3)	(-0.8, 0.3)
Total Higgs	1.18M	0.60M	0.40M
Accuracy(%)	0.8	1.09	1.21

BMR Dependence

- The Boson Mass Resolution is 4% for the current Detector+PFA

- The accuracy degrades to 1.3% if BMR degrades to 10%
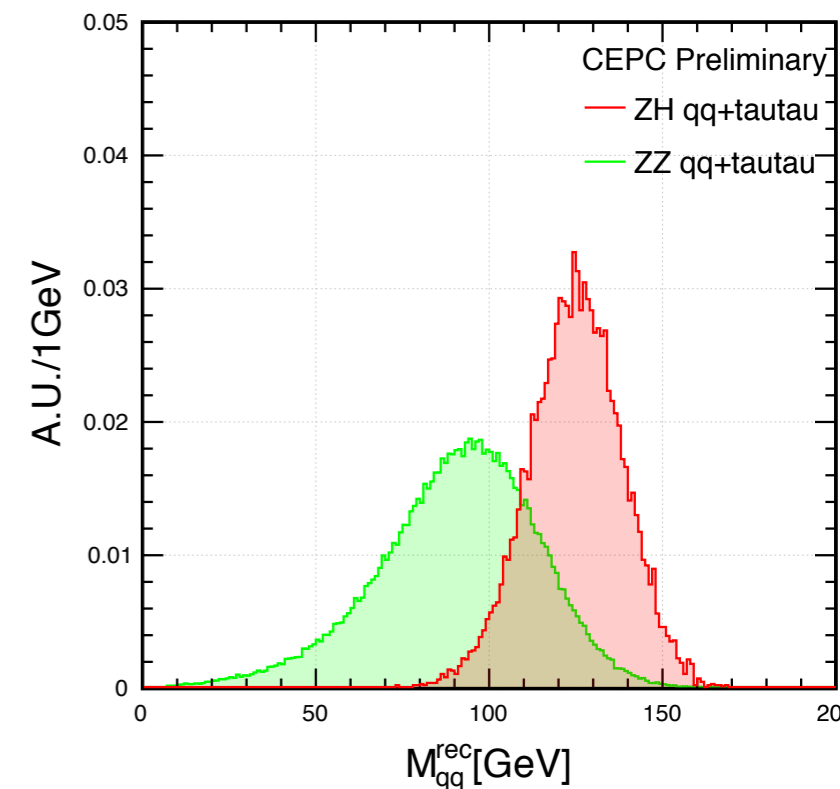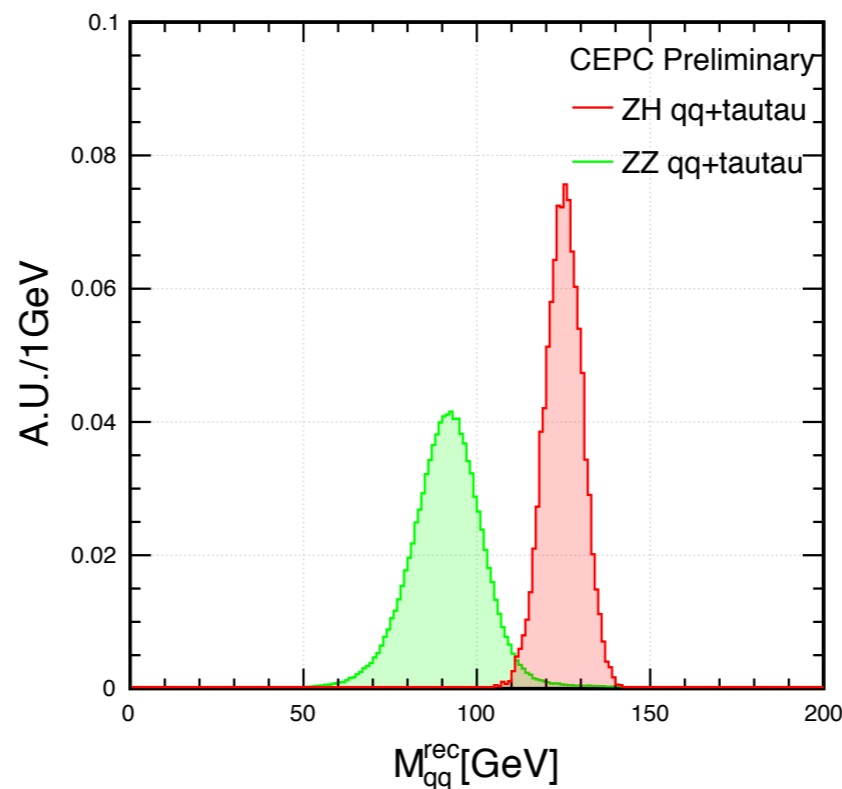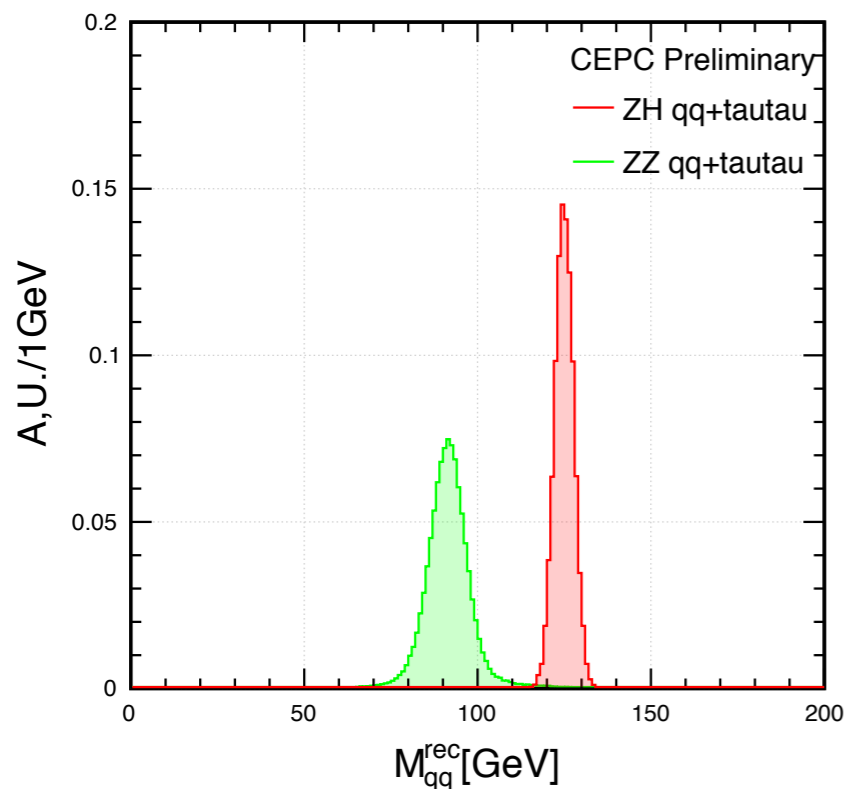
Summary

- The signal events are analyzed according to the existence of jets

  - TAURUS developed with high efficiency and purity

  - Combined accuracy: 0.8%

- The PFA oriented detector and the reconstruction at the CEPC is critical for this analysis

  - proper number of particles

  - the collinear mass of the τ pair

  - qq system information

- Impact parameter is essential for the τ events identification

Thank you for you attention!