Recoil mass;
Comparison with CDR and FCC(5/ab)

C.Zhang/09Mar2025

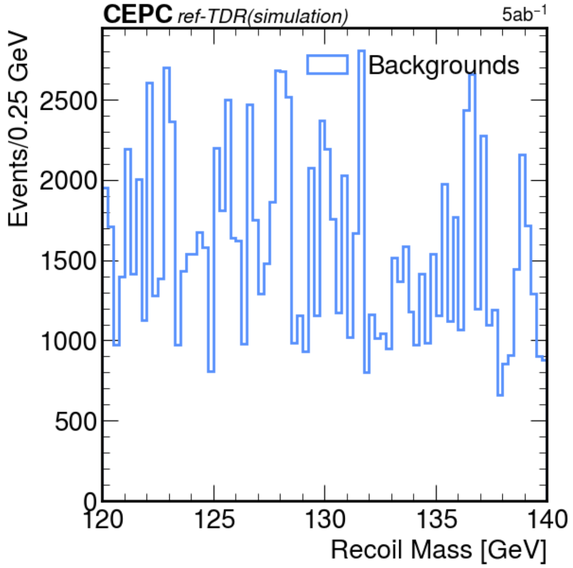
Cut-flow

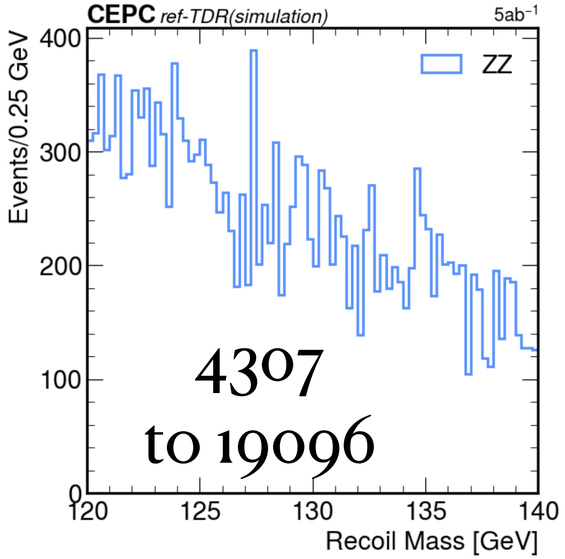
Table 2. Efficiencies of signal and background in the model-independent analysis

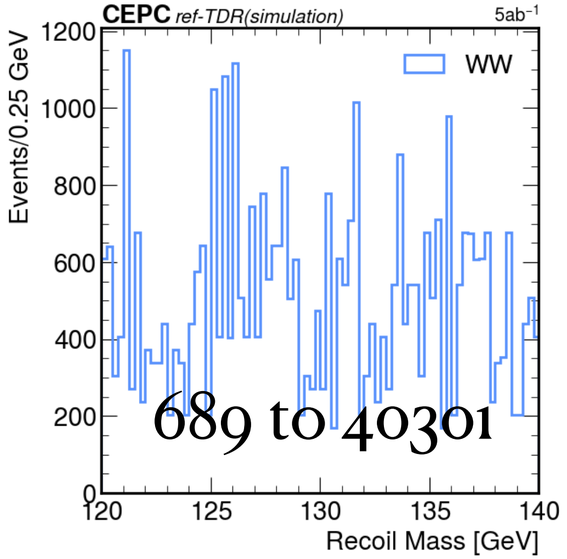
	$Z(\mu^+\mu^-)H$	ZZ	WW	ZZ or WW	single Z	$Z(2f)$	$\gamma\gamma$
total generated	35247	5347053	44180832	17801222	7809747	418595861	161925000
$N_{\mu^+} \geqslant 1$, $N_{\mu^-} \geqslant 1$	95.7%	11.95%	0.65%	3.92%	9.75%	1.64%	17.31%
120 GeV $< M_{\text{recoil}} <$ 150 GeV	93.2%	1.71%	0.23%	0.70%	1.93%	0.17%	3.06%
80 GeV $< M_{\mu^+\mu^-} <$ 100 GeV	85.5%	0.68%	0.06%	0.22%	0.22%	0.10%	0.11%
$p_{T\mu^+\mu^-} >$ 20 GeV	80.2%	0.57%	0.06%	0.17%	0.16%	0.02%	0.04%
$\Delta\phi < 175°$	77.8%	0.51%	0.05%	0.17%	0.15%	0.01%	0.04%
BDT cut	63.0%	0.25%	0.01%	0.05%	0.06%	0.01%	0.01%
fit window	62.8%	0.25%	0.01%	0.05%	0.05%	0.01%	0.01%

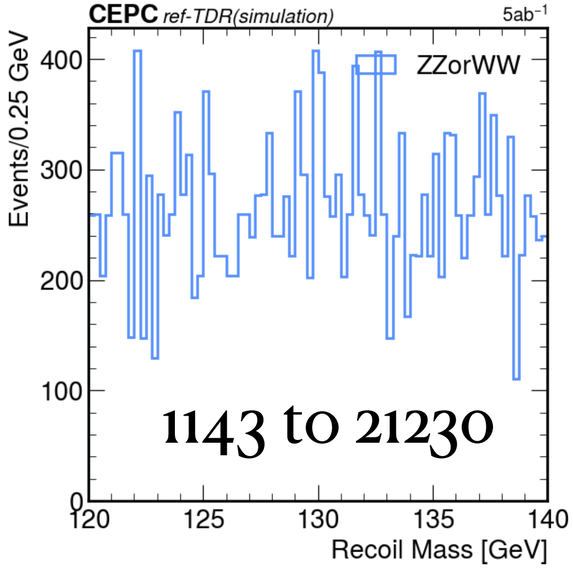
process	mmHX	ZZ	WW	ZZorWW	SingleZ	Z2f	OtherHX
GenN	66112	889030	476400	238083	591904	292716	267001
QEff.	0.9482	0.2677	0.1009	0.2751	0.0928	0.2296	0.0765
pairEff.	0.9482	0.2677	0.1009	0.2751	0.0928	0.2296	0.0765
recoilEff.	0.9059	0.0234	0.0110	0.0249	0.0085	0.0083	0.0018
invmassEff.	0.8416	0.0091	0.0021	0.0085	0.0024	0.0042	0.0006
PTEff.	0.7639	0.0060	0.0019	0.0060	0.0019	0.0007	0.0005
PhiEff.	0.7356	0.0056	0.0017	0.0059	0.0018	0.0005	0.0005
passWindow	47329	4307	698	1143	928	104	95
WindowEff.	0.7159	0.0048	0.0015	0.0048	0.0016	0.0004	0.0004

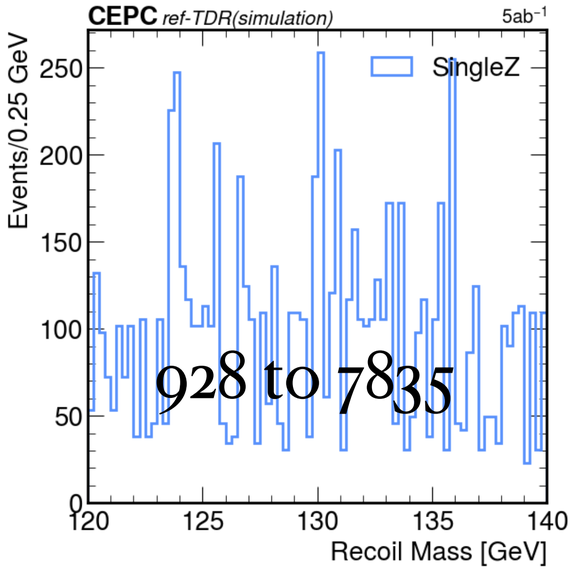
Backgrounds

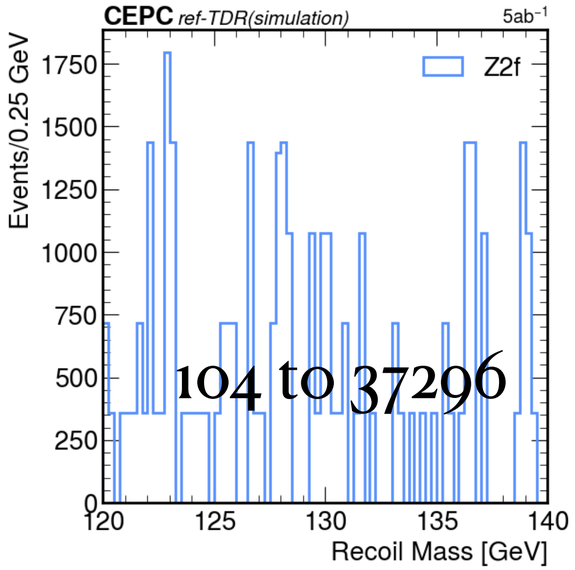


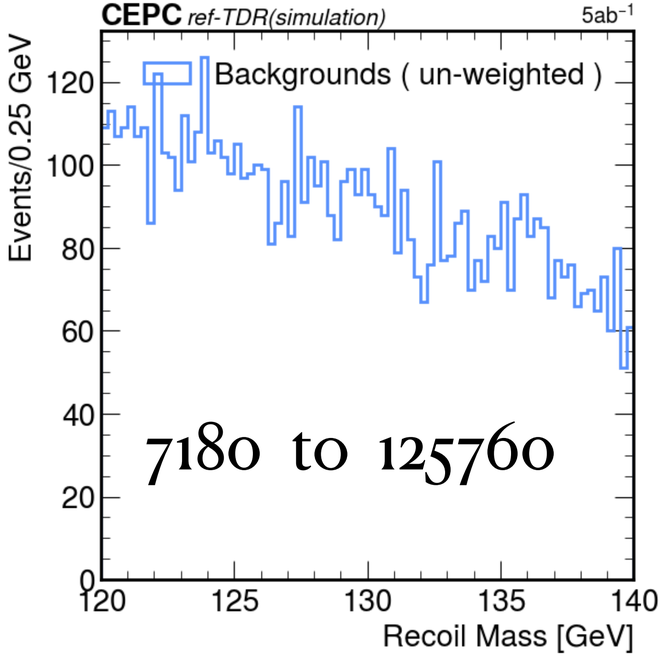




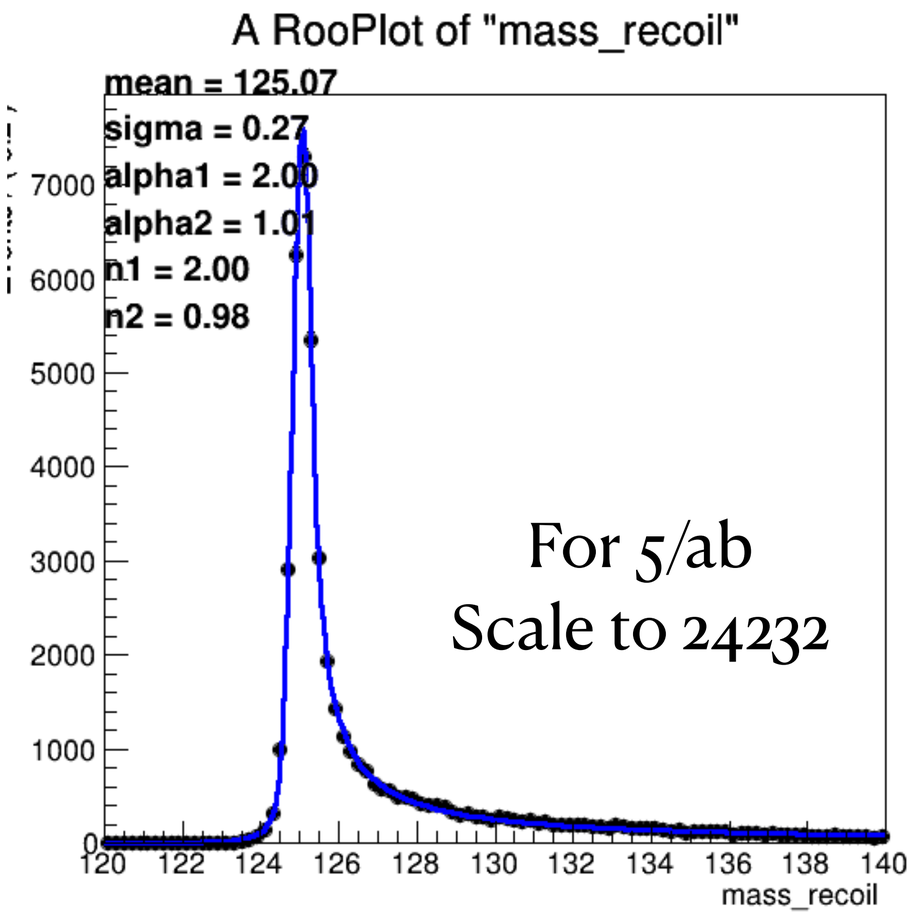




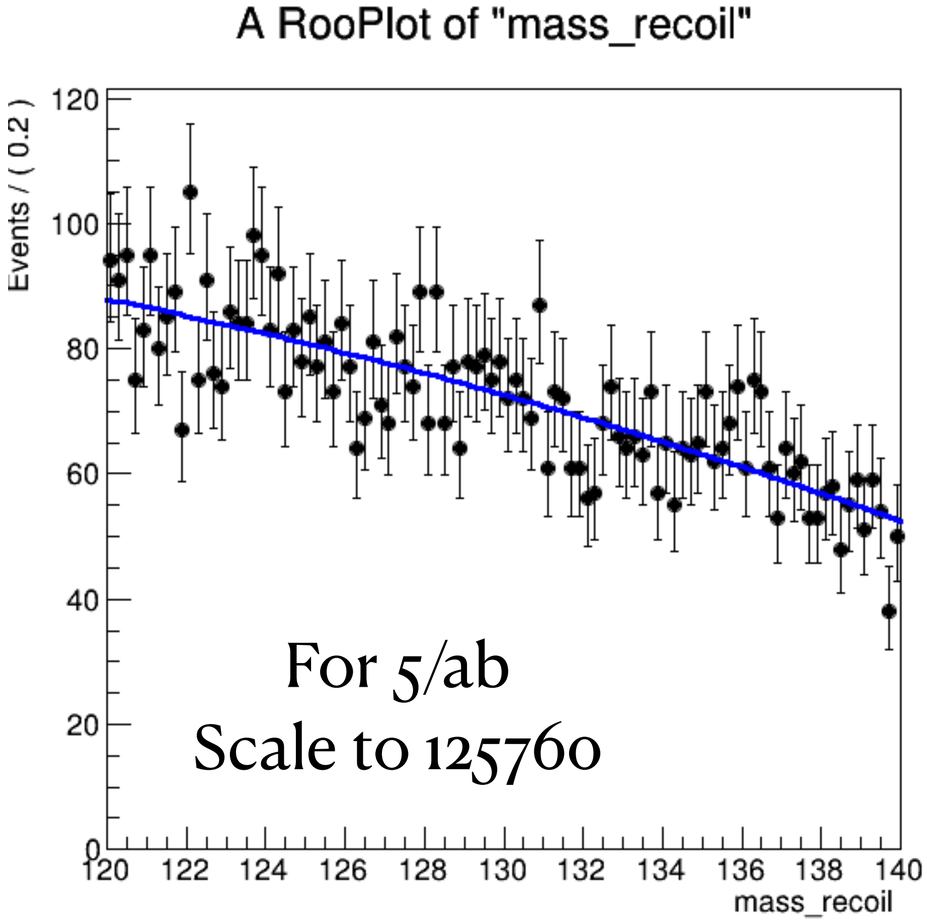




Modelling



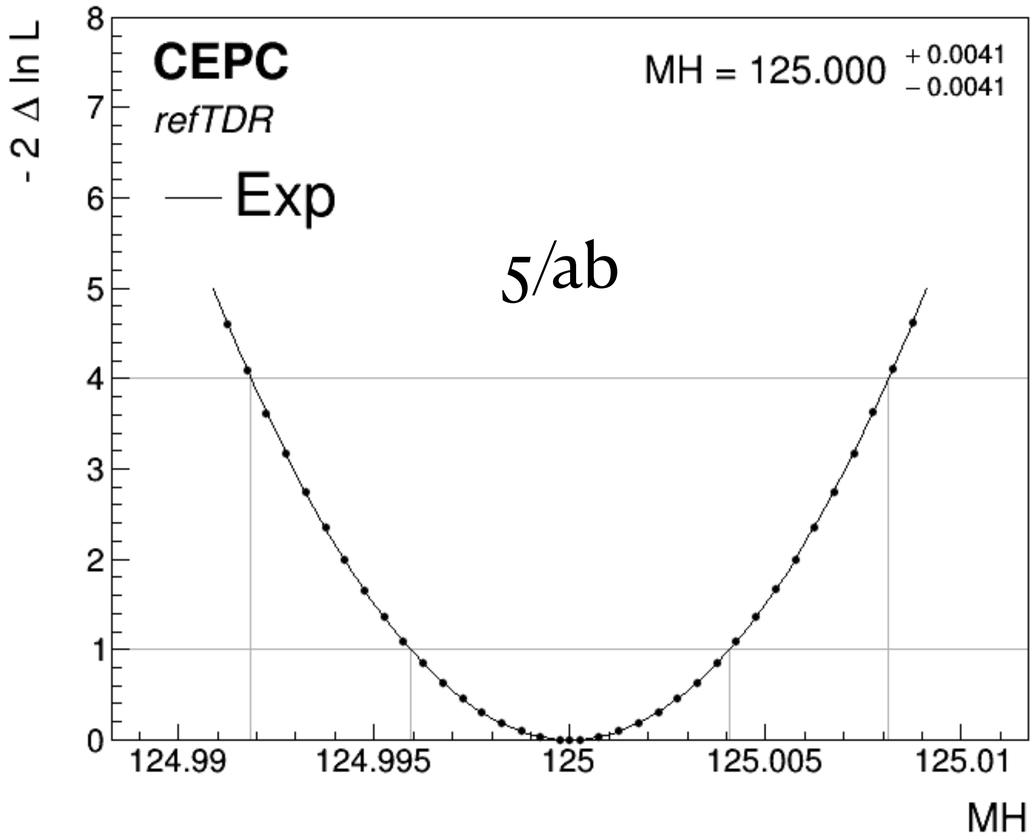
For 5/ab
Scale to 24232

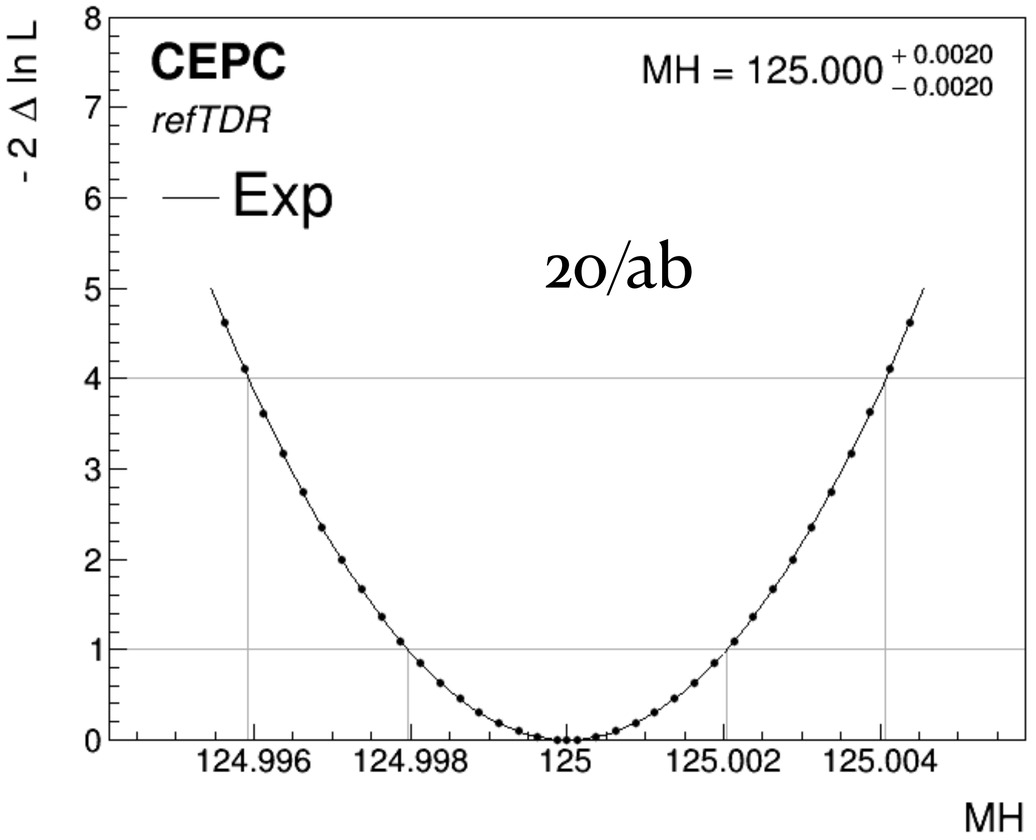


For 5/ab
Scale to 125760

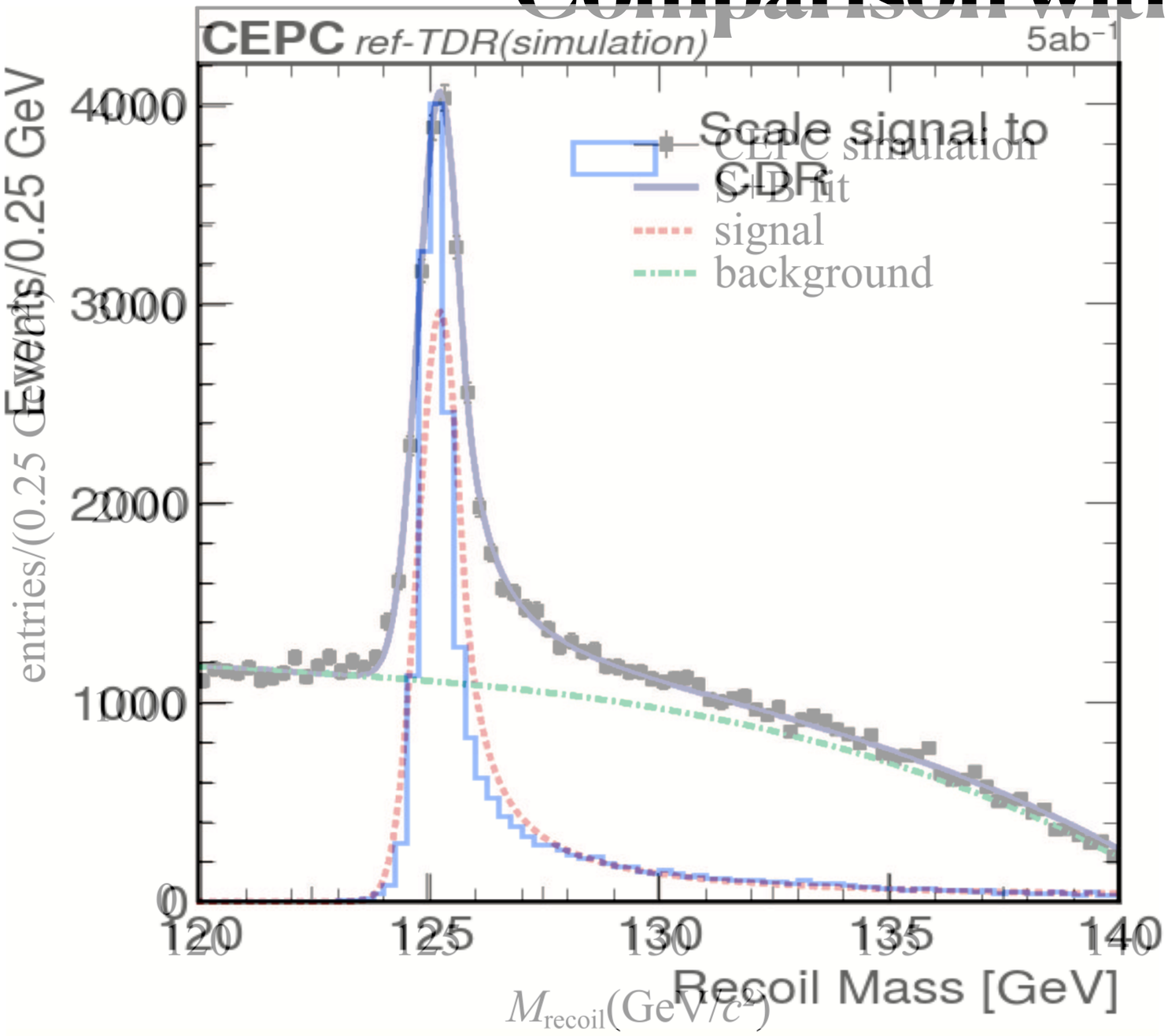
Results

CMS-CombineTool





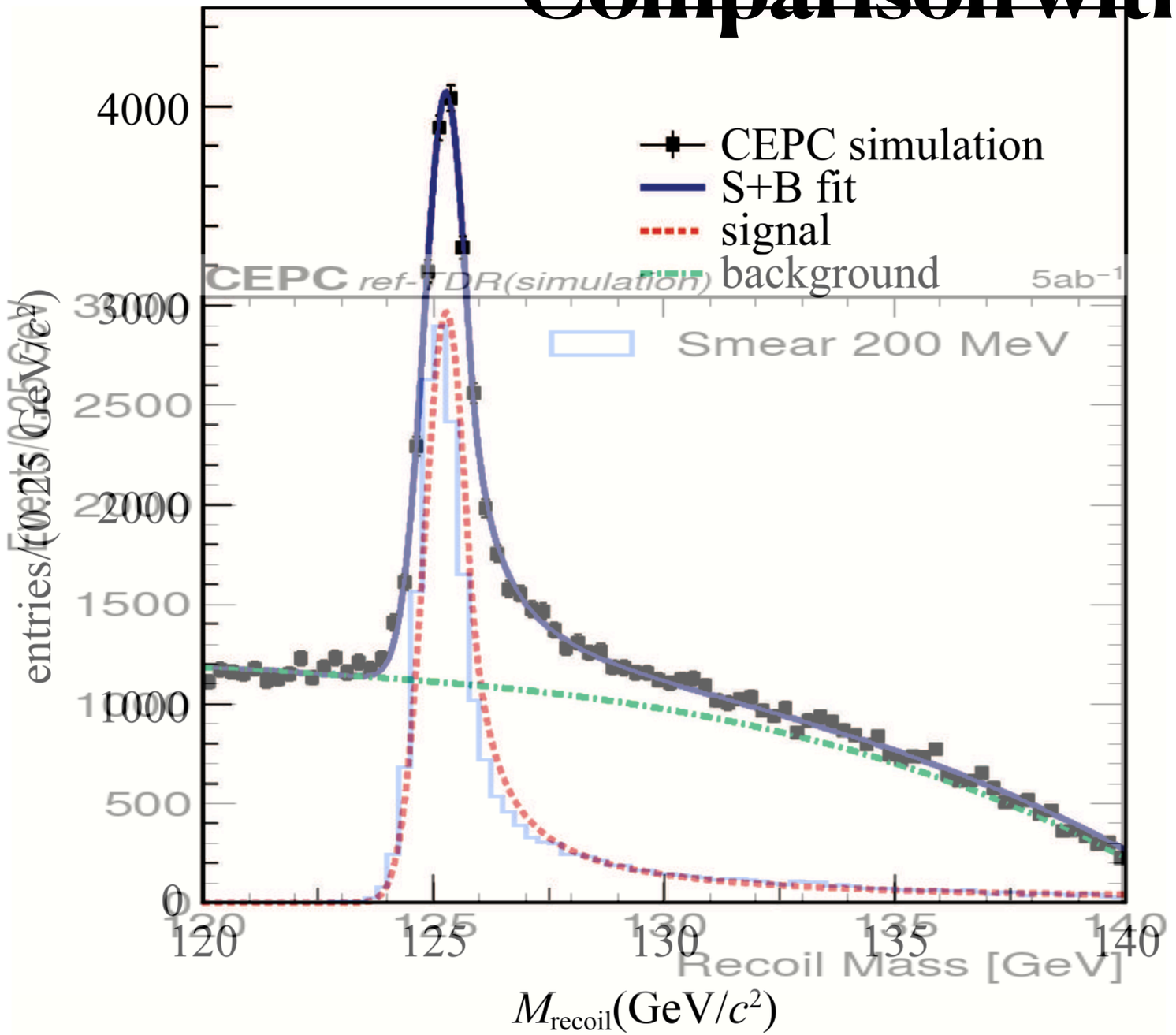
Comparison with CDR



- $\Delta m_{\mathrm{H}} = 6.9$ MV in CDR (5/ab)
- $\Delta m_{\mathrm{H}} = 4.1$ MV in TDR (5/ab)

- **Scale signal yields to CDR, compare the signal shape**

Comparison with CDR

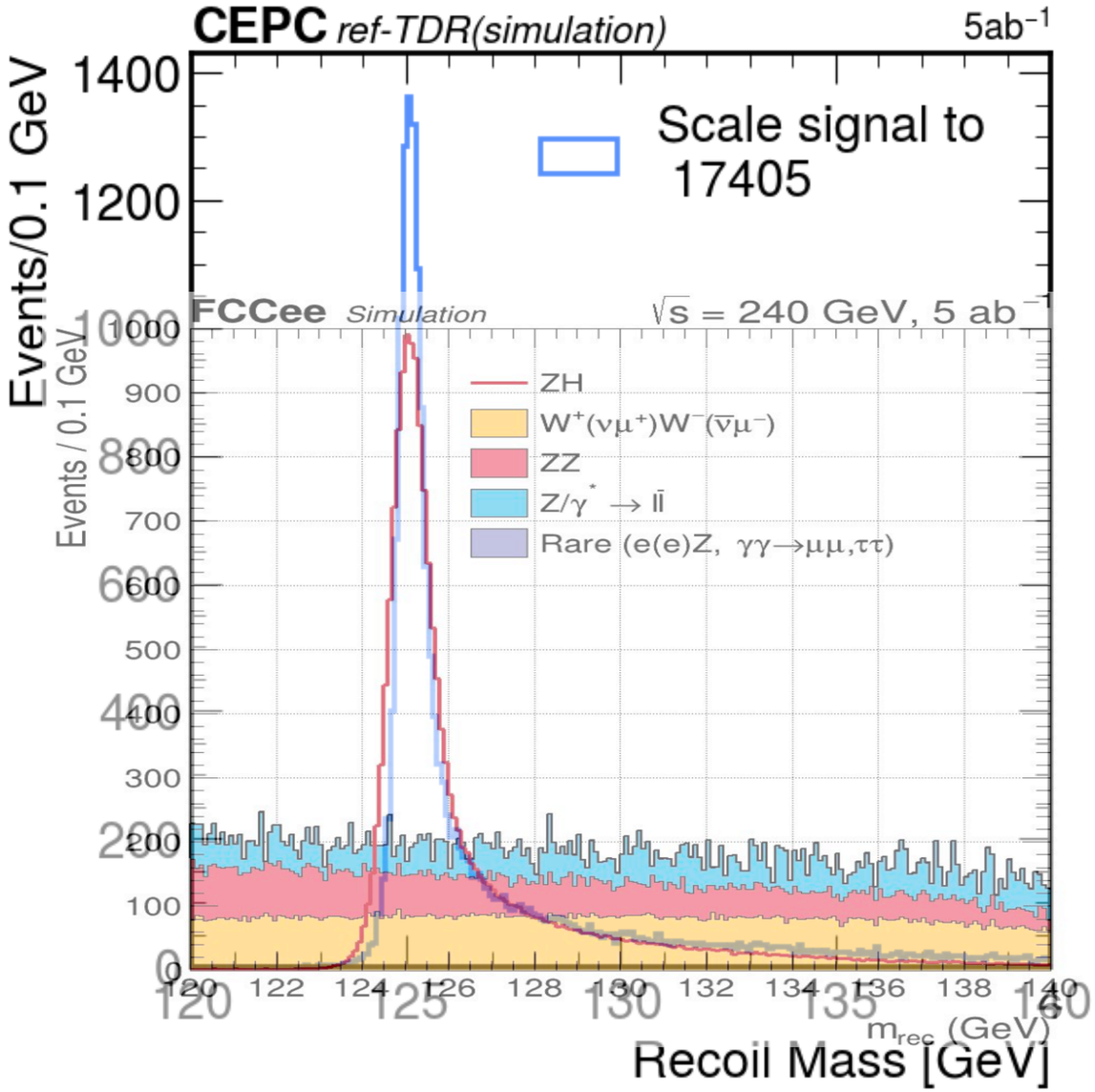


- $\Delta m_{\mathrm{H}} = 6.9$ MV in CDR (5/ab)
- $\Delta m_{\mathrm{H}} = 4.1$ MV in TDR (5/ab)

- **Scale signal yields to CDR, compare the signal shape**

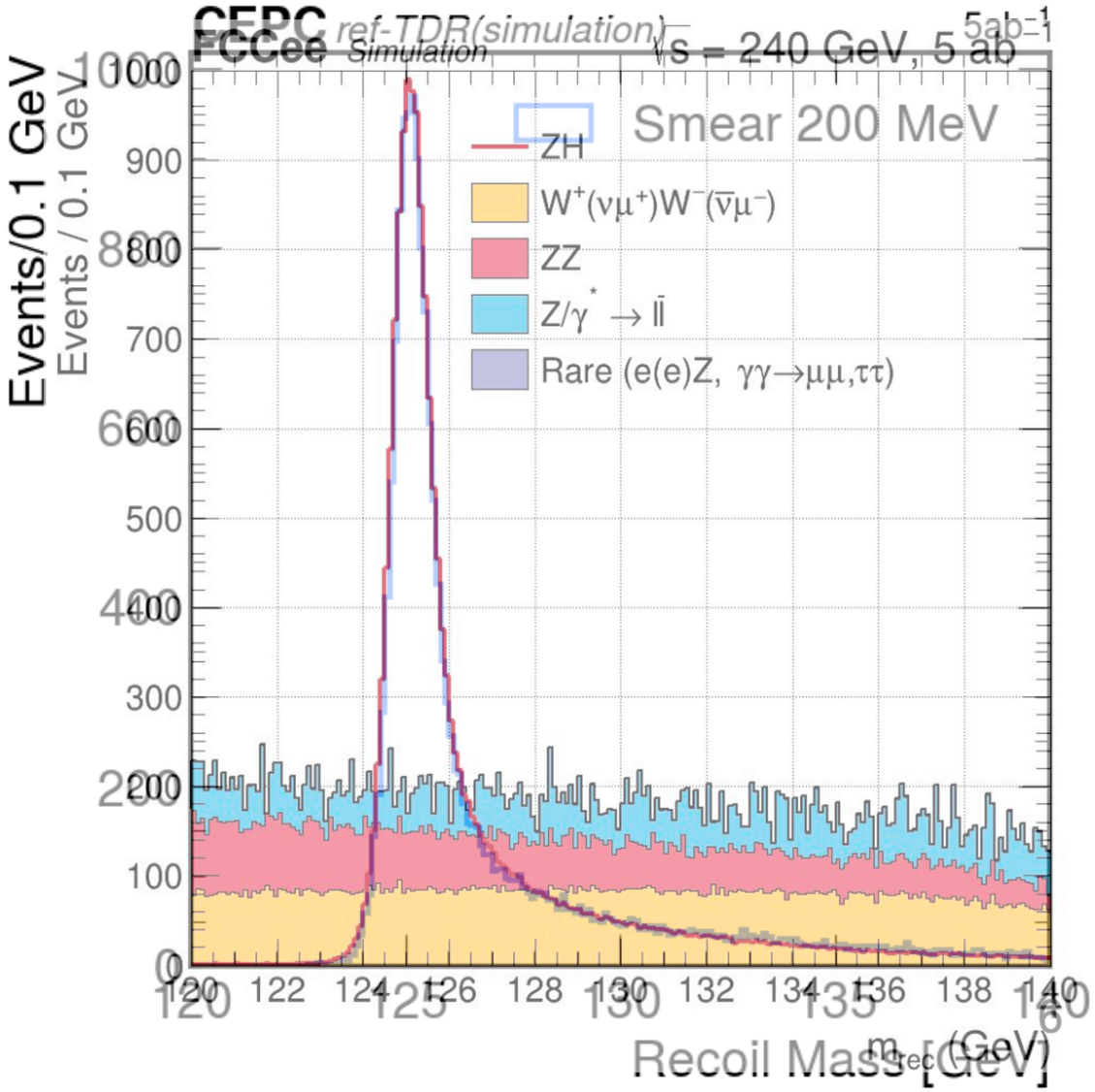
- **Smear signal spectra by 200 MeV, compare the signal shape**

Comparison with FCC-ee



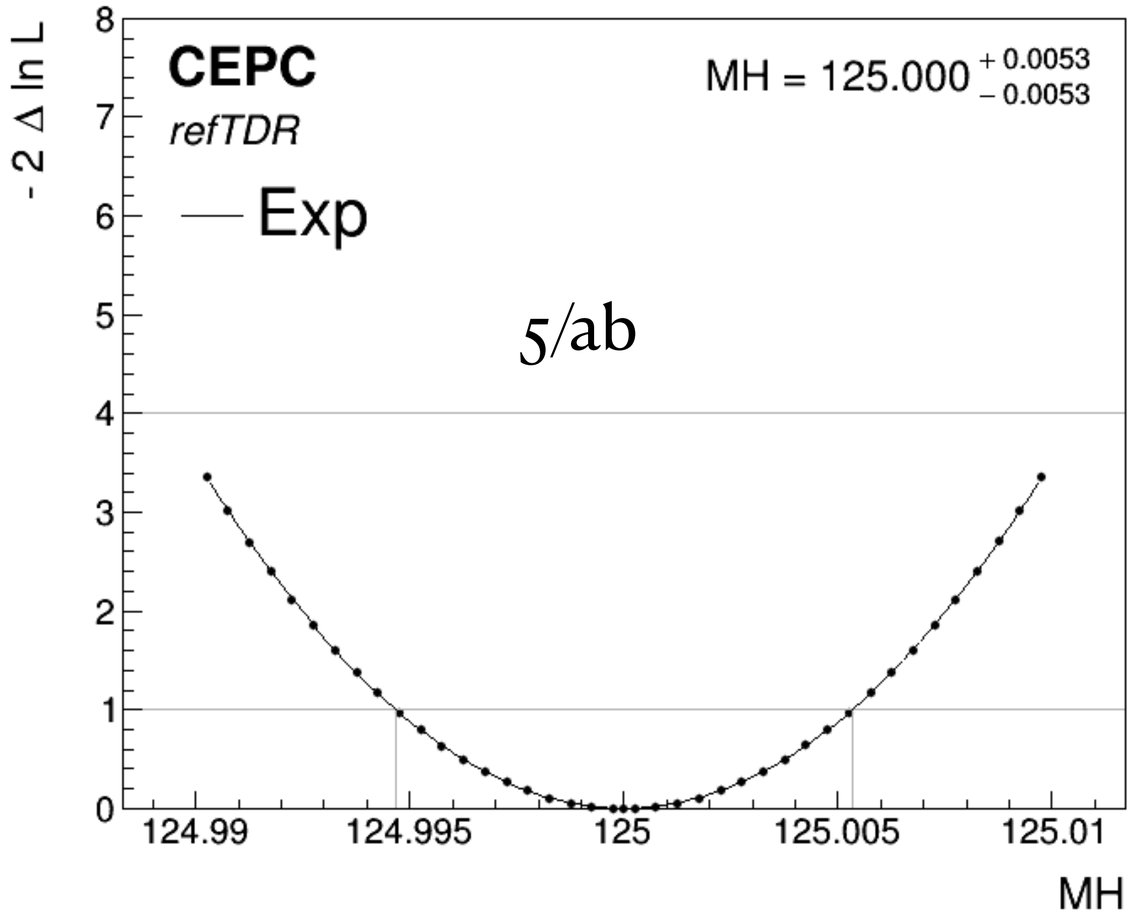
- $\Delta m_{\mathrm{H}} = 6.7$ MV in FCC-ee (5/ab)
- $\Delta m_{\mathrm{H}} = 4.1$ MV in TDR (5/ab)
- **Scale signal yields to FCC-ee, compare the signal shape**

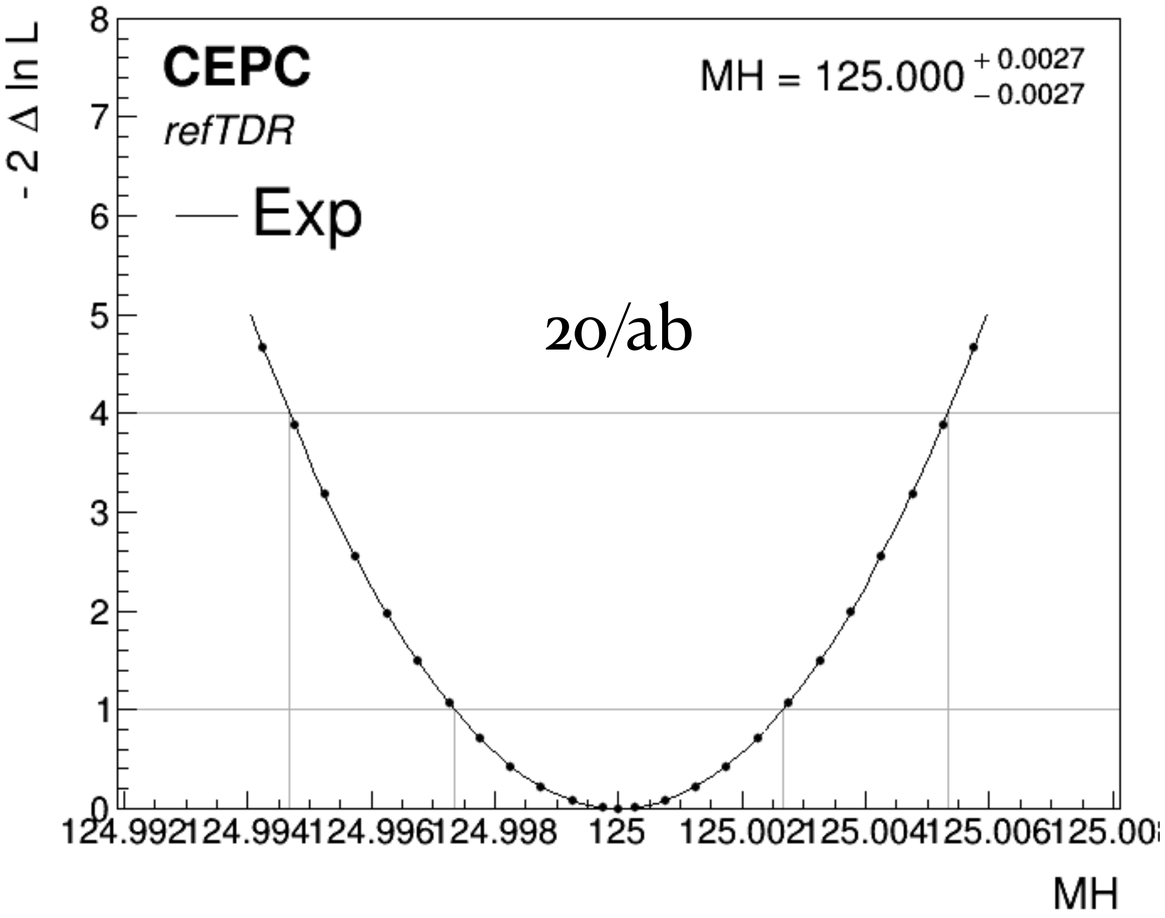
Comparison with FCC-ee



- $\Delta m_{\mathrm{H}} = 6.7$ MV in FCC-ee (5/ab)
- $\Delta m_{\mathrm{H}} = 4.1$ MV in TDR (5/ab)
- **Scale signal yields to FCC-ee, compare the signal shape**
- **Smear signal spectra by 200 MeV, compare the signal shape**

Results with smeared signals





Signal and background samples

Monte-Carlo campaign ("Spring2021"):

- Center-of-mass 240 GeV, luminosity of 5 /ab
- ISR, FSR enabled, Beam Energy Spread (BES) set to 0.165% = ± 198 MeV (cfr. CDR)
- IDEA detector; detector response modelled with Delphes

Signal samples (Whizard+Pythia6)

- Z(μμ)H 0.0067656 pb
- Z(ττ)H 0.0067518 pb
- Z(ee)H 0.0071611 pb
- Z(qq)H 0.13635 pb
- Z(νν)H 0.046191 pb

→ nominal Higgs mass 125.00 GeV

→ off-mass samples generated at +/- 50 and +/- 100 MeV

Background samples (Pythia8)

- ZZ 1.35899 pb
- WW→μμ 0.25792 pb
- Z/γ*→ll 13.7787 pb
- Z/γ*→qq 52.6539 pb
- e(e)Z (*) 0.20736 pb
- γγ→μμ (*) 1.5523 pb $[m_{gen}(\mu\mu) > 60\ GeV]$
- γγ→ττ (*) 0.836 pb $[m_{gen}(\tau\tau) > 60\ GeV]$

(*) Generated with Whizard+Pythia6

Background yields

Background samples (Pythia8)

- ZZ 1.35899 pb
- WW→μμ 0.25792 pb
- Z/γ*→ll 13.7787 pb
- Z/γ*→qq 52.6539 pb
- e(e)Z (*) 0.20736 pb
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- γγ→ττ (*) 0.836 pb $[m_{gen}(\tau\tau) > 60\ GeV]$

(*) Generated with Whizard+Pythia6

4

CEPC	pb
ZZ inclusive	1.14
ZZorWW, vvmumu	0.22
ee ee	930
ee mumu/tautau (include gamma)	5.3/4.7
ee qq	54
sze_l0mumu; eemm	0.845
sznu_l0mumu; veve mm	0.043
WW inclusive(no mu-pair final-state)	9

CEPC	fb
ZZ 4mu	0.0156
ZZ mumuup	0.0879
ZZ mumudown	0.13614
ZZ l0mumu	0.0193

Backgrounds