CEPC CDR updates

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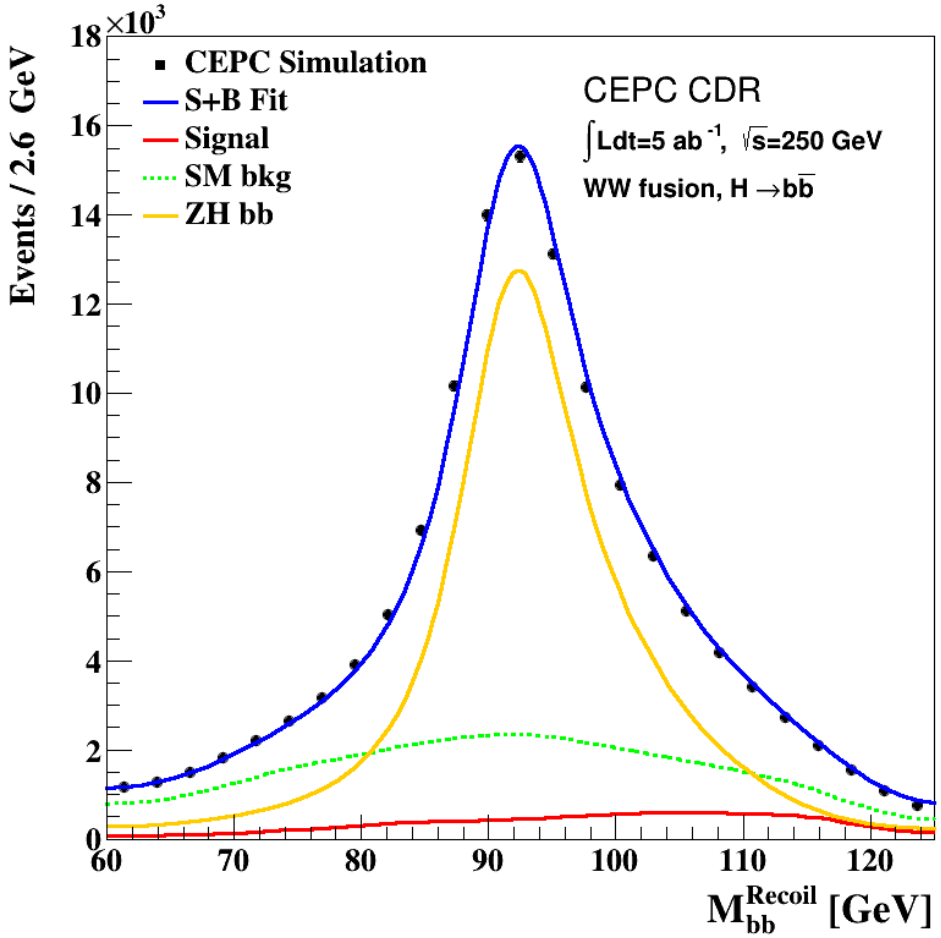
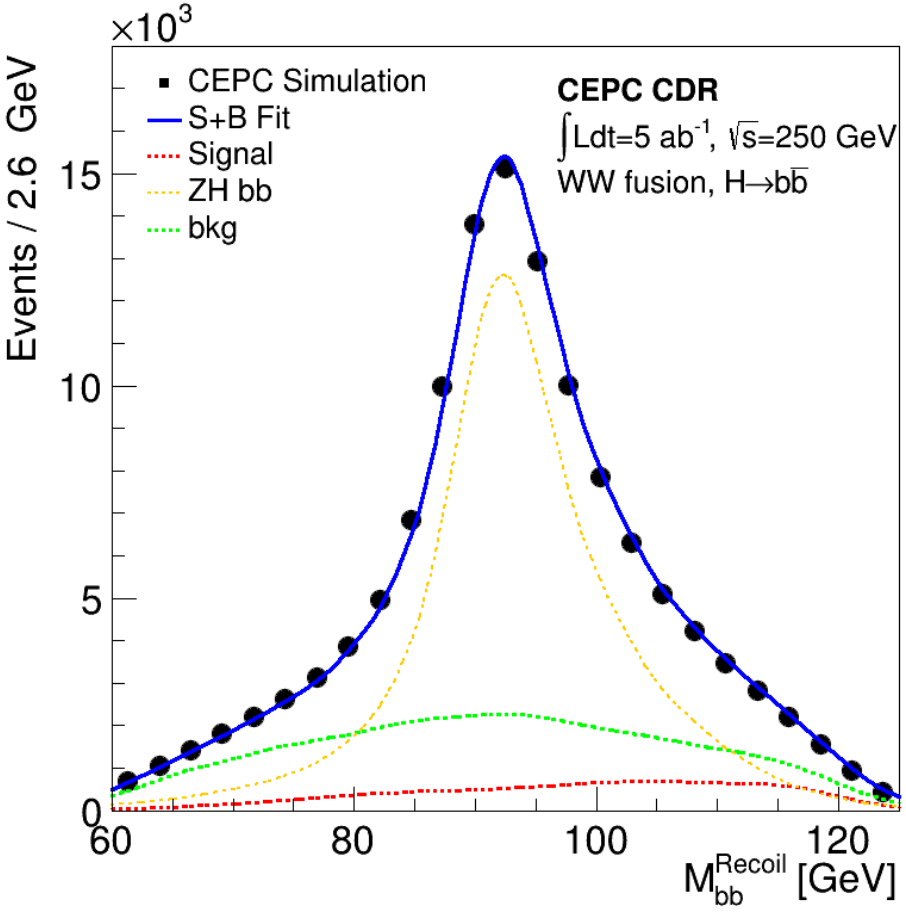
2018.07.12

Plot style change

Larger text, marker;
Sans serif font;
All Asimov Data;
Dotted style……

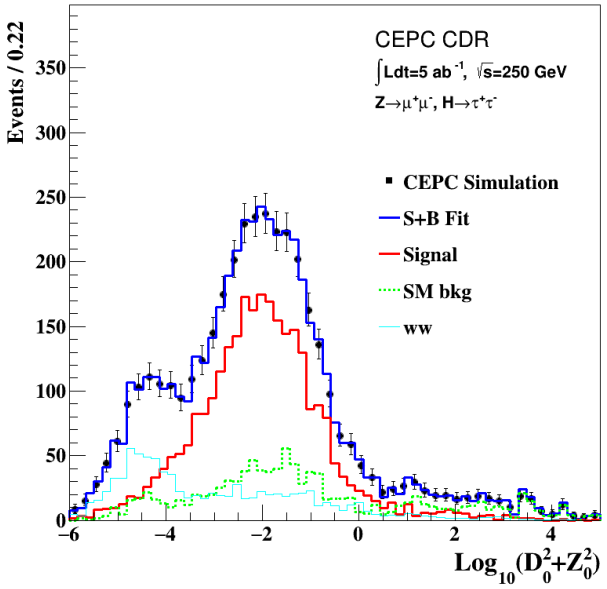


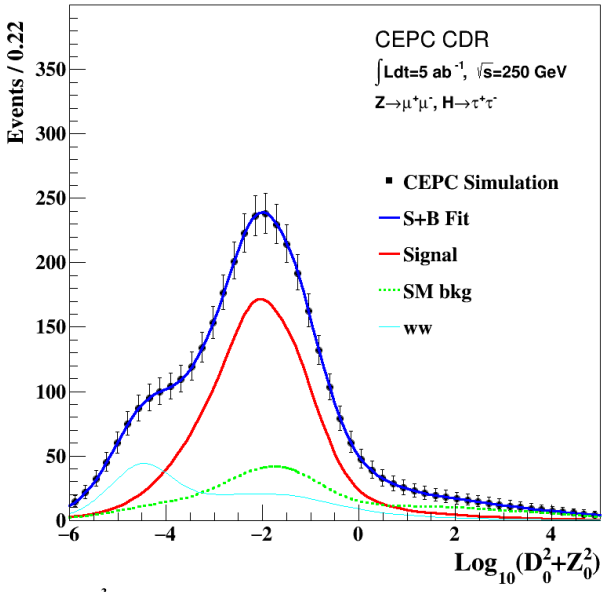


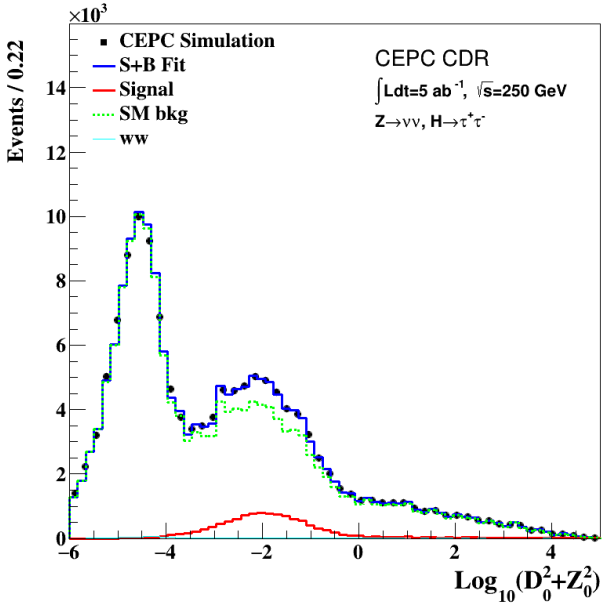
Improve binned fit quality

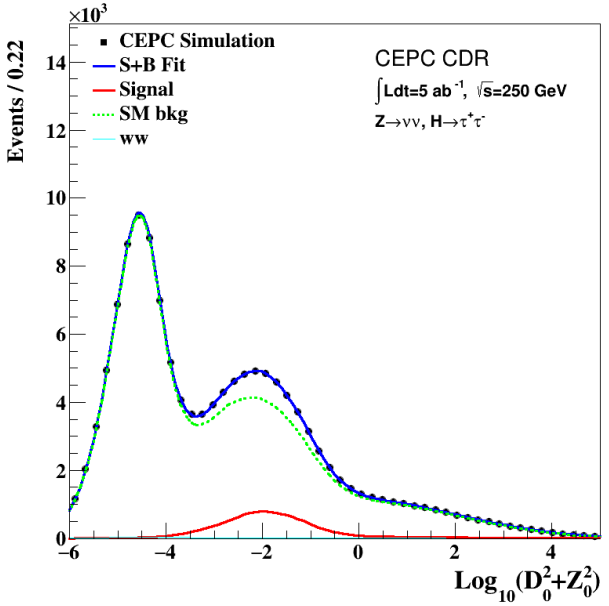
- ww fusion processes firstly use 2d, 15*15 bins in fit.
  - bin number cannot improve since we can't let bin content be zero;
  - lose lots shape information
  - turn to continuum unbinned mass fit+ 50 bin for cos theta;
  - 3.11% ->3.01%
- Use unbinned fit as long as we can;
  - And enlarge the bin number for RooHistPdf (for θ and flavor tagging)
  - Applied for Z->ee/mm H->qq; H->tautau……

binned -> unbinned

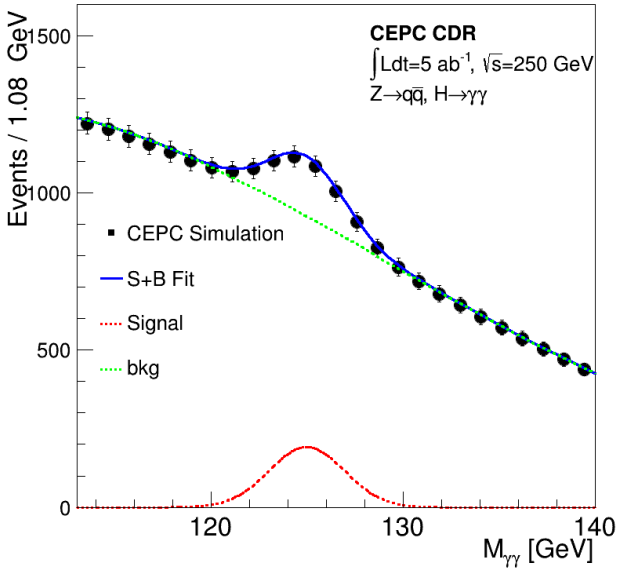


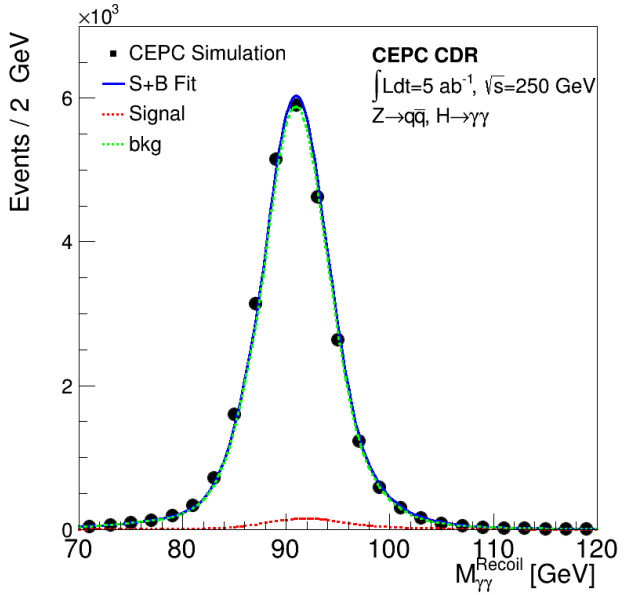






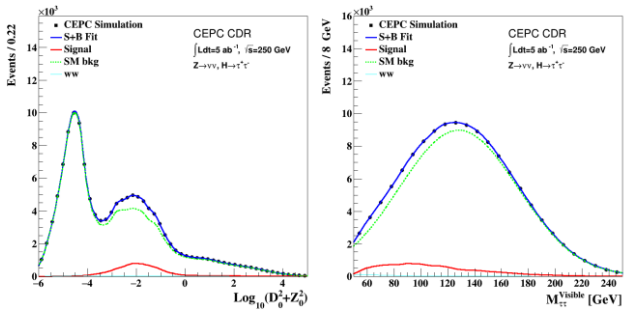
Try 2d fit for possible channel





- 2d pdf has more information to distinguish the s/b.
  - for $m_{\gamma\gamma}$ and $m_{\gamma\gamma}^{Recoil}$? m_{ll} and m_{ll}^{Recoil} can also be used;
  - Currently applied for $H \to \gamma\gamma, \tau\tau, H \to WW \to qqqq$;
  - No significant improvement for most channels
  - But for $Z \to \nu\nu, H \to \tau\tau$,
    - impact parameter+ mass 2.65%
    - mass 3.11%

Under further study



bb/cc/gg

$$\Delta = \frac{\Delta\sigma_{240} - \Delta\sigma_{250}}{\Delta\sigma_{250}}$$

Signal Z	Signal H	250	240	Difference
H->qq				
ee	bb	1.30%	1.35%	3.85%
	cc	11.78%	12.35%	4.84%
	gg	6.17%	6.51%	5.51%
μμ	bb	1.00%	1.03%	3.00%
	cc	9.44%	9.77%	3.50%
	gg	4.90%	5.08%	3.67%
qq	bb	0.48%	0.49%	2.08%
	cc	11.73%	12.45%	6.14%
	gg	3.68%	3.94%	7.07%
vv	bb	0.41%	0.41%	2.32%
	cc	3.90%	4.10%	5.13%
	gg	1.54%	1.61%	4.55%
vvH(WW fusion)				
vvH	bb	3.01%		
zh	bb	0.32%	0.32%	1.82%
ZH				
Z	bb	0.28%	0.29%	3.22%
	cc	3.30%	3.45%	4.55%
	gg	1.31%	1.37%	4.65%

red: difference since last week's report

bb 0.28% take wwf events as ZH; if not, 0.32%;

WW/ZZ

Signal		250	240	Difference
Z	H			
H->WW				
ee	lvlv	9.36%	9.79%	4.59%
	evqq	4.57%	4.77%	4.38%
	μvqq	3.95%	4.10%	3.80%
μμ	lvlv	7.35%	7.54%	2.59%
	evqq	4.01%	4.07%	1.50%
	μvqq	3.97%	4.07%	2.52%
vv	qqqq	2.03%	2.14%	5.42%
	evqq	4.69%	4.89%	4.26%
	μvqq	4.18%	4.35%	4.07%
	lvlv	11.30%	11.60%	2.65%
qq	qqqq	1.84%	1.93%	4.89%
H->ZZ				
vv	μμqq	7.96%	8.21%	3.14%
vv	eeqq	39.50%	42.19%	6.81%
μμ	vvqq	7.38%	7.56%	2.44%
ZH bkg		10.01%	10.40%	3.85%
ZH				
Z	WW	1.05%	1.07%	2.35%
	ZZ	5.12%	5.21%	1.82%

Others

Signal Z	Signal H	250	240	Difference
H->Invisible				
qq	ZZ(vvvv)	220.00%	235.00%	6.82%
ee		325.00%	349.00%	7.38%
μμ		229.00%	250.00%	9.17%
Tot		150.24%	159.88%	6.42%
H→γγ				
μμ+ττ	γγ	38.18%	41.10%	7.65%
vv		10.33%	10.90%	5.52%
qq		9.58%	10.40%	8.56%
Tot		6.90%	7.38%	6.96%
H→μμ				
qq	μμ	17.75%	18.70%	5.40%
ee		61.38%	64.71%	5.42%
μμ		86.10%	90.74%	5.39%
vv		53.32%	56.93%	6.77%
Tot		15.90%	16.84%	5.91%
H→ττ				
ee	ττ	2.72%	2.69%	-1.10%
μμ		2.26%	2.21%	-2.21%
qq		0.93%	0.97%	4.30%
vv		2.65%	\	\
Tot		0.79%	0.82%	3.06%

for yy channel,
we use 240 data, and extrapolate it back the 250 result.

Use Dan's result in ee and mm;
Due to the better significance in v4.

Result

As ww fusion channel is important, I suggest update to 3.01%. But channels like Z->vv H->tautau do not change and wait for further study;

	250GeV	240GeV	Difference
$\sigma(ZH)$	0.50%	0.50%	\
$\sigma(ZH) * Br(H \to bb)$	0.28%	0.29%	3.22%
$\sigma(ZH) * Br(H \to cc)$	3.30%	3.45%	4.55%
$\sigma(ZH) * Br(H \to gg)$	1.31%	1.37%	4.65%
$\sigma(ZH) * Br(\mathrm{H} \to WW)$	1.05%	1.07%	2.35%
$\sigma(ZH) * Br(H \to ZZ)$	5.12%	5.21%	1.82%
$\sigma(ZH) * Br(H \to \tau\tau)$	0.79%	0.82%	3.06%
$\sigma(ZH) * Br(H \to \gamma\gamma)$	6.90%	7.38%	6.96%
$\sigma(ZH) * Br(H \to \mu\mu)$	15.9%	16.8%	5.91%
$\sigma(\mathrm{vv}H) * Br(H \to \mathrm{bb})$	3.01%		
$Br_{\mathrm{upper}}(H \to inv.)$	0.42%	0.44%	6.42%
$\sigma(ZH) * Br(H \to Z\gamma)$	4σ	4σ	\

backup

Cross Section current

Cross Section, 250GeV cited from Moxin's note on cepcdoc and 240GeV calculated by Gang in Whizard 1.9.5

Type	250 GeV	240 GeV	Ratio
Signal (fb)			
Total	212.13	200.66	96.0%
Sum	214.13	203.65	95.1%
eeH	7.60	7.05	92.8%
mmH	7.10	6.77	95.4%
ττH	7.08	6.75	95.3%
vvH	48.96	46.32	94.6%
qqH	143.39	136.76	95.4%
eeH(ZZ fusion)	0.63	0.28	44.4%
vvH(WW fusion)	6.85	6.19	90.3%

Ratio=250GeV/240GeV;

Technical issue makes a difference in Total Cx and Sum Cx.

These 5 channels conclude fusion.

Calculated by e1e1h-e2e2h, n1n1h-n2n2h. (Ignore the interference)
WW fraction from 14%(250GeV) to 13.3%(240GeV).
Add all the interferences to vvH would underestimate 250GeV result, and overestimate 240GeV result.

bkg Cross Section

Type	250 GeV	240 GeV	Ratio
2 fermion			
e+e−	24992.2	24770.9	99.1%
μ+μ−	4991.9	5332.7	106.8%
τ+τ−	4432.2	4752.9	107.2%
νν	53598.4	54099.5	100.9%
veve	45390.8	45390.8	\
νμνμ	4416.3	4416.3	\
νττν	4410.3	4410.3	\
qq	50105.4	54106.9	**108.0%**
uu	10110.4	10899.3	107.8%
dd	10010.1	10711.0	107.0%
cc	10102.8	10862.9	107.5%
ss	9924.4	10737.8	108.2%
bb	9957.7	10769.8	108.2%

Type	250 GeV	240 GeV	Ratio
4 fermion			
sw_l0mu	429.8	436.7	101.60%
sw_l0tau	429.8	435.9	101.40%
sw_sl0qq	2583.6	2612.6	101.10%
sze_l0e	82.5	78.5	95.20%
sze_l0mu	0	845.8	\
sze_l0nunu	29.6	28.9	97.90%
sze_l0tau	150.3	147.3	98.00%
sze_sl0dd	128.7	125.8	97.70%
sze_sl0uu	195.9	190.2	97.10%
szeorsw_l0l	249.8	249.5	99.90%
sznu_l0mumu	43.2	43.4	100.50%
sznu_l0tautau	14.6	14.6	99.70%
sznu_sl0nu_down	91.4	90	98.60%
sznu_sl0nu_up	56.1	55.6	99.10%
ww_h0ccbs	5.7	5.9	102.80%
ww_h0ccds	165.8	170.2	102.70%
ww_h0cuxx	3395.6	3478.9	102.50%
ww_h0uubd	0.1	0.1	100.00%
ww_h0uusd	166.6	170.5	102.30%
ww_l0ll	393.9	403.7	102.50%
ww_sl0muq	2366.4	2423.4	102.40%
ww_sl0tauq	2362.3	2423.6	102.60%
wwbosons	16218.2	16721.8	**103.10%**

Type	250 GeV	240 GeV	Ratio
4 fermion			
zz_h0cc_nots	95.7	99.0	103.4%
zz_h0dtdt	225.3	233.5	103.6%
zz_h0utut	82.8	85.7	103.5%
zz_h0uu_notd	95.6	98.6	103.1%
zz_l04mu	14.5	15.6	107.3%
zz_l04tau	4.4	4.6	105.3%
zz_l0mumu	18.2	19.4	106.7%
zz_l0taumu	17.6	18.7	106.3%
zz_l0tautau	9.2	9.6	104.6%
zz_sl0mu_down	127.8	136.1	106.5%
zz_sl0mu_up	82.5	87.4	106.0%
zz_sl0nu_down	135.2	139.7	103.4%
zz_sl0nu_up	81.8	84.4	103.1%
zz_sl0tau_down	64.4	67.3	104.6%
zz_sl0tau_up	39.8	41.6	104.5%
zzbosons	1066.4	1110.4	**104.1%**
zzorww_h0cscs	1565.4	1607.6	102.7%
zzorww_h0udud	1572.9	1610.3	102.4%
zzorww_l0mumu	214.7	221.1	103.0%
zzorww_l0tautau	205.4	211.2	102.8%

In most channels, the dominant bkg is 4 fermion; 3%

bkg extrapolation

- Most channel use bkg +3%
  - 4 fermion bkg dominant; 2 fermion are reducible after selection
- Except:
  - Z->qq/vv, H->bb/cc/gg: 2f:4f=3:1; +4%;
    - As well as Z->qq, H->vvvv; (Not in H->WW->4q; 4f dominant, +3%;)
  - H->mm Z->qq/vv, : zz_l04mu, +6%;
  - H->mm Z->mm: zz_sl0mu_down/up, +7%;
  - H->yy 2fermion;
    - Z->mm: +7%; Z->qq: +8%; Z->vv: +1%;

Signal extrapolation

- For all ZH events,
  - eeH: -7.2%;
  - mmH: -4.6%
  - qqH: -4.6%
  - vvH: -5.6%
- For $vvH, H \rightarrow bb$,
  - use the weight after selection by Liang Hao
  - WW fusion process: *0.971537
  - ZH process: *1.013535
  - SM bkg: *1.052864