Updates on Higgs Combination

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Outline

- H->Invisible
- Updated plots
- Fit result

H->Invisible

- Xin's result:

TABLE I: Branching ratio measurements and upper limits

	$Z(e^+e^-)H(\text{inv})$	$Z(\mu^+\mu^-)H(\text{inv})$	$Z(q\bar{q})H(\text{inv})$	Combined
BR	$(0.350 \pm 0.510)\%$	$(0.350 \pm 0.290)\%$	$(0.094 \pm 0.150)\%$	$(0.103 \pm 0.075)\%$
95% CL upper limit	1.30%	0.90%	0.37%	0.24%

  - assume Br in SM value 0.106%

- Comment from Qian:
  - Central value not equal to 1; ->Migrating?
  - Combined result too good

Repeat Xin's result

- Using his data and code
  - In combination using real data S+B model to fit
  - Huge bkg-> large fluctuations
  - All with fit range 120-150
  - Using his code can repeat all his result.

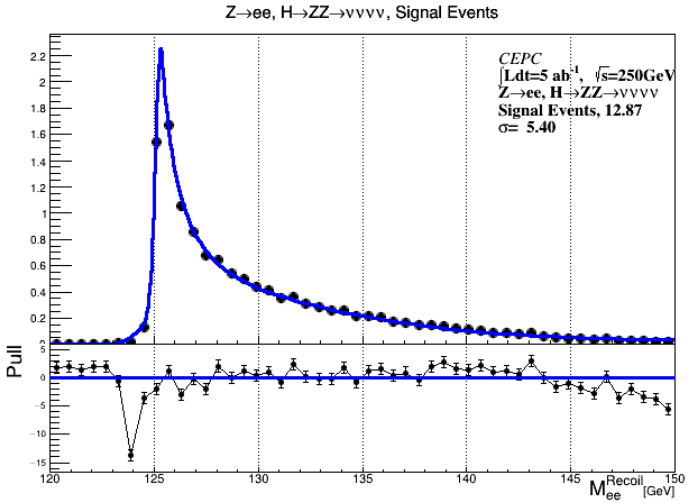
In mH 120~150 (L=5ab^{-1})	signal	bkg	s/b
Z->ee	12.86	4205	0.003
Z->mm	23.69	36540	0.0006
Z->qq	224.41	426540	0.0005

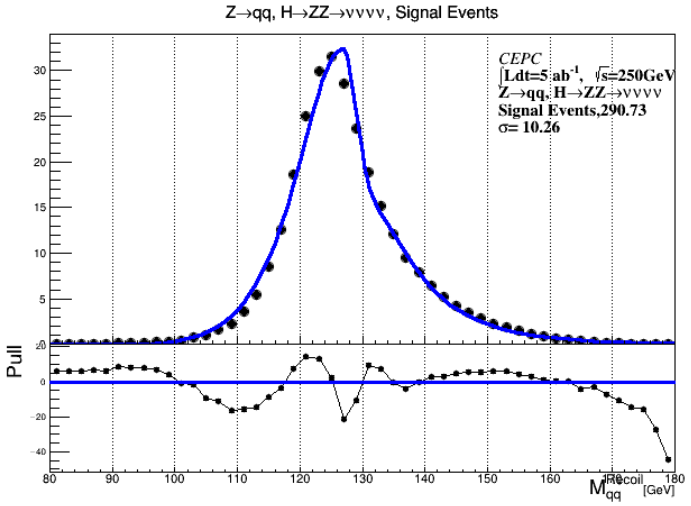
- My attempt using Mo's ntuples
  - on Asimov Data
  - Based on Br*σ
  - same range 120-150
  - Usually Asimov Data performs better?

	Mine	Mo's
Z->ee	$0.97 \pm 350\%$	$3.30 \pm 481\%$
Z->mm	$1.00 \pm 242\%$	$3.30 \pm 273\%$
Z->qq	$1.03 \pm 226\%$	$0.88 \pm 141\%$
Combined	$1.01 \pm 148\%$	$0.97 \pm 71\%$

Discussion

- Central value deviation from 1
  - due to fluctuations
  - narrow the fit range will help
  - or use other fit model
  - toy MC; binned fit……
  - building Asimov data
  - Using more npoints
  - 200->5000 helps.



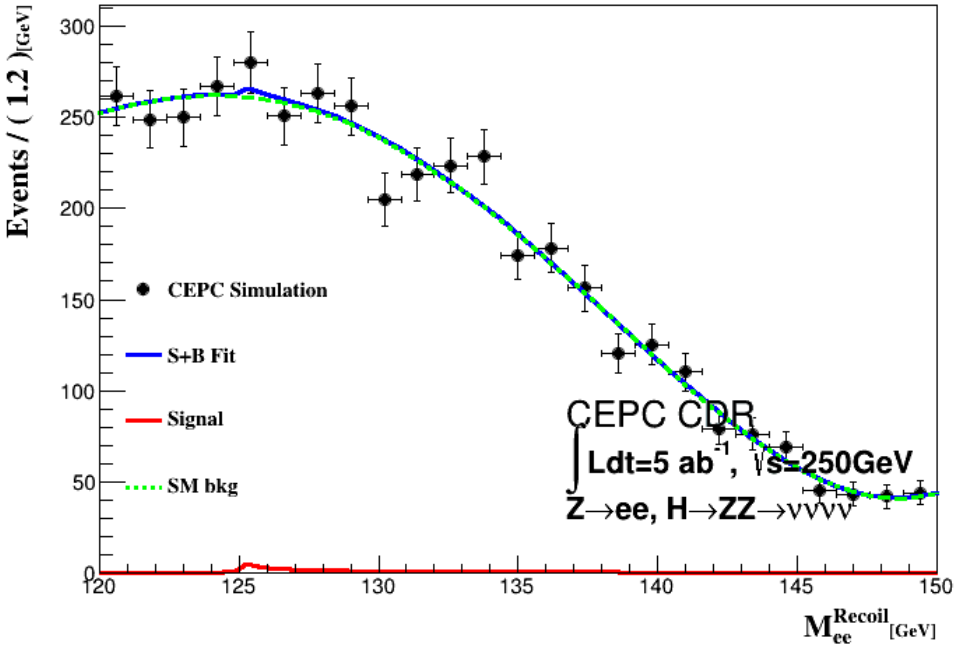


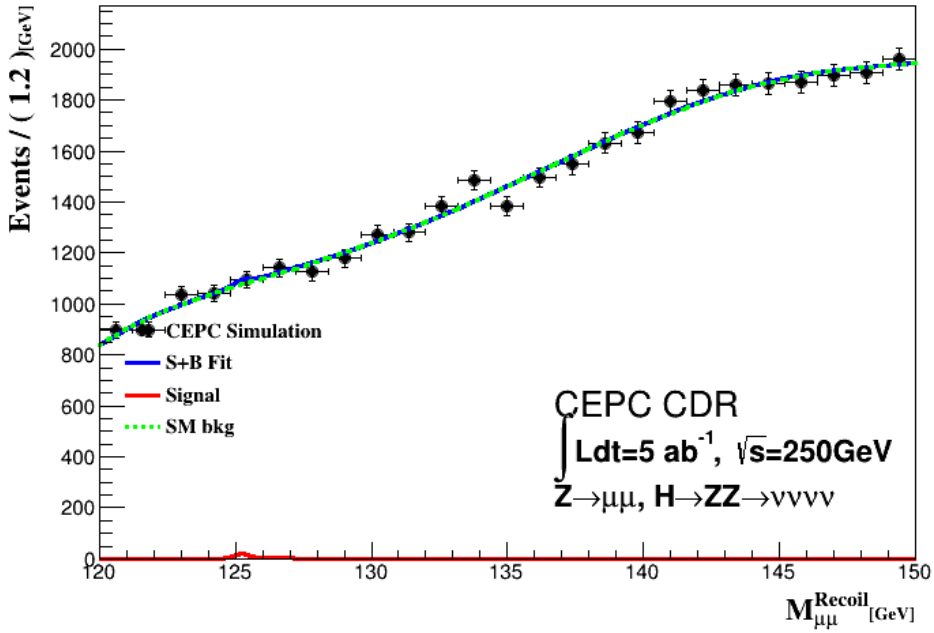
Conclusion

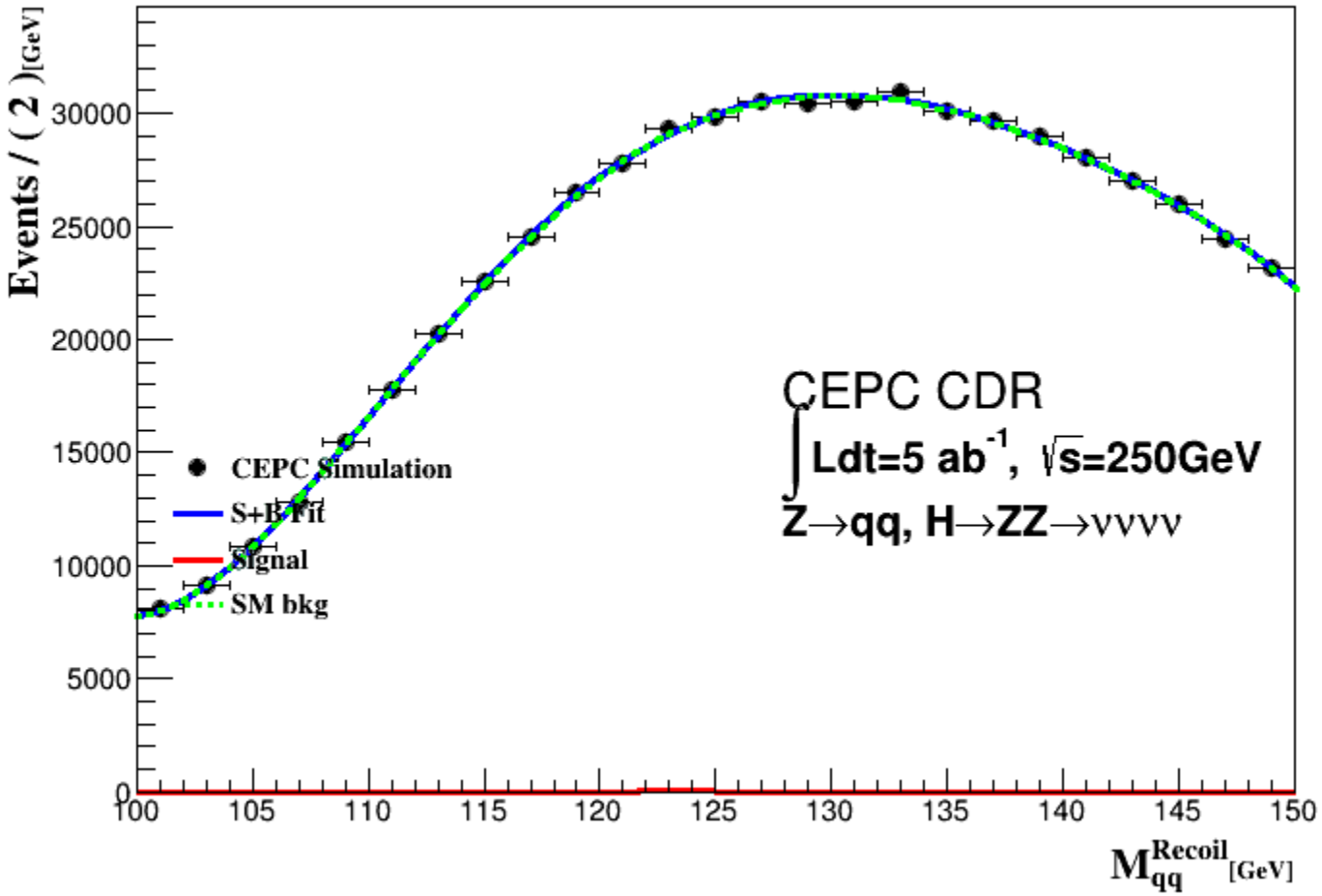
- Combined result too good
- Central value not equal to 1
  - Huge bkg fluctuation
  - I suggest to use my fit result using Asimov data

	Mine	significance	Upper limit	Br Upper limit
Z->ee	$0.97 \pm 350\%$		7.97	0.84%
Z->mm	$1.00 \pm 242\%$		5.84	0.62%
Z->qq	$1.03 \pm 226\%$		5.55	0.59%
Combined	$1.01 \pm 148\%$	0.68	3.97	0.42%

- So $Br_{BSM}(H \to inv) < 0.31\%$ at 95% CL.


Events / (1.2)[GeV]
CEPC Simulation
S+B Fit
Signal
SM bkg
CEPC CDR
∫Ldt=5 ab-1, √s=250GeV
Z→ee, H→ZZ→νννν
M Recoil ee [GeV]

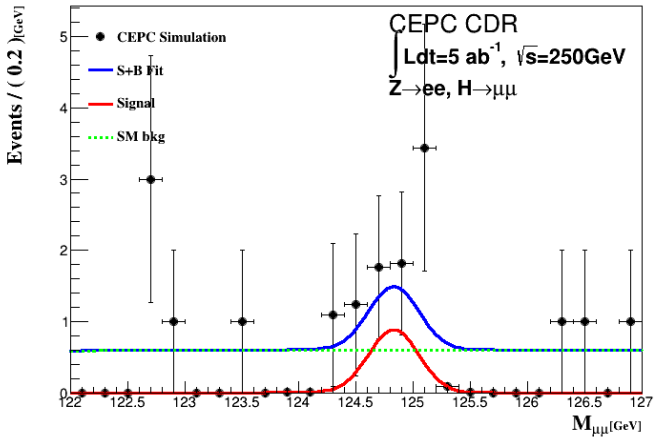

Events / (1.2)[GeV]
CEPC Simulation
S+B Fit
Signal
SM bkg
CEPC CDR
∫Ldt=5 ab-1, √s=250GeV
Z→μμ, H→ZZ→νννν
M Recoil μμ [GeV]


Events / (2)[GeV]
30000
25000
20000
15000
10000
5000
0
100
105
110
115
120
125
130
135
140
145
150
CEPC Simulation
S+B Fit
Signal
SM bkg
CEPC CDR
∫Ldt=5 ab-1, √s=250GeV
Z→qq, H→ZZ→νννν
M Recoil qq [GeV]

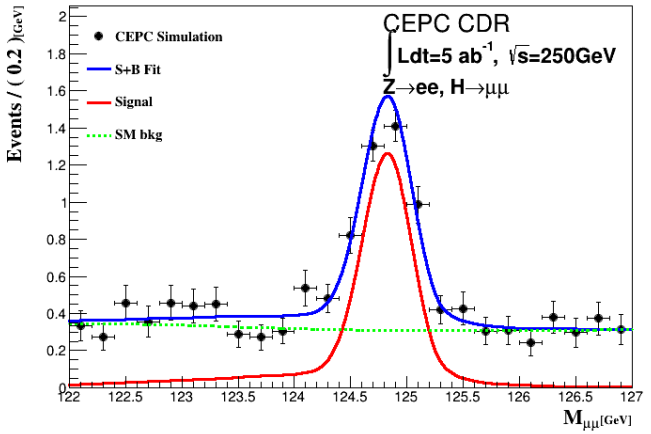
$H \to \mu\mu$: bkg rescaling

Using the bkg distribution before cut,
then rescale to the current number to avoid fluctuations.

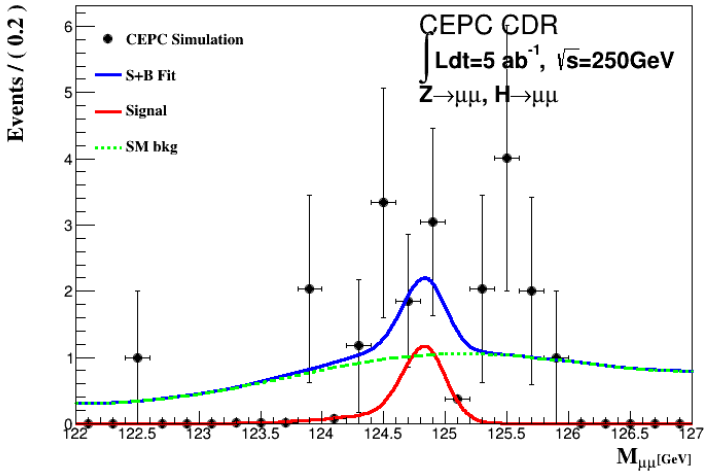
Z->ee, before



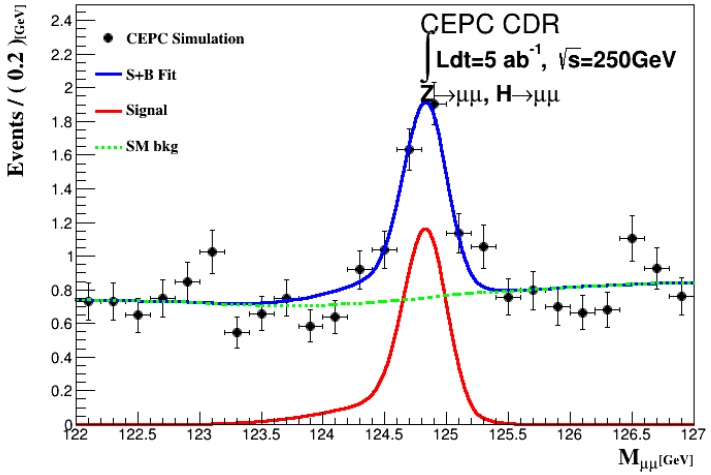
after: 61%



$Z \to \mu\mu$, before

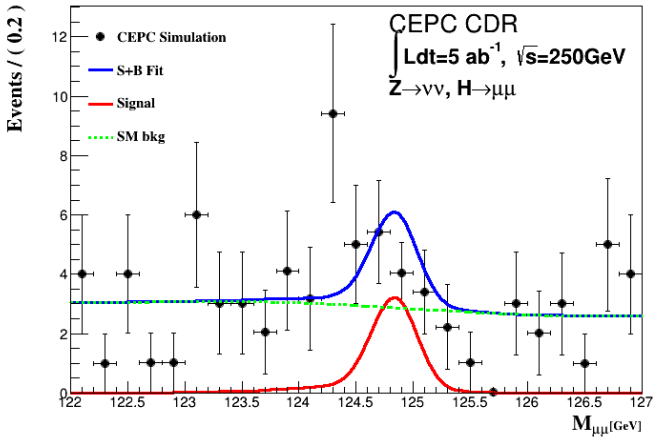


after: 85%

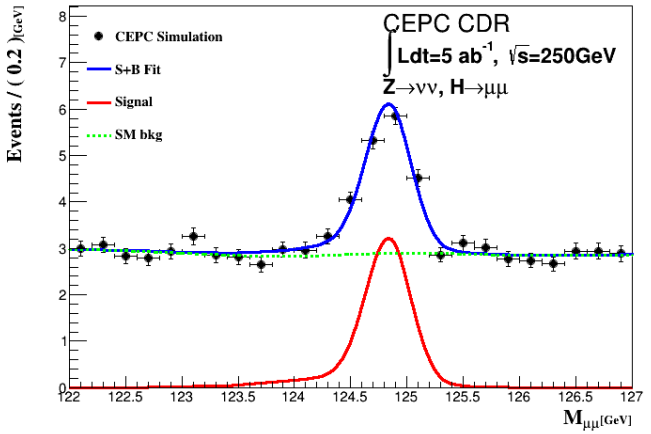


qqmm: 17.5%
After 3 channels bkg rescaling, precision 16.4%->15.9%
Total significance: 7.8sigma

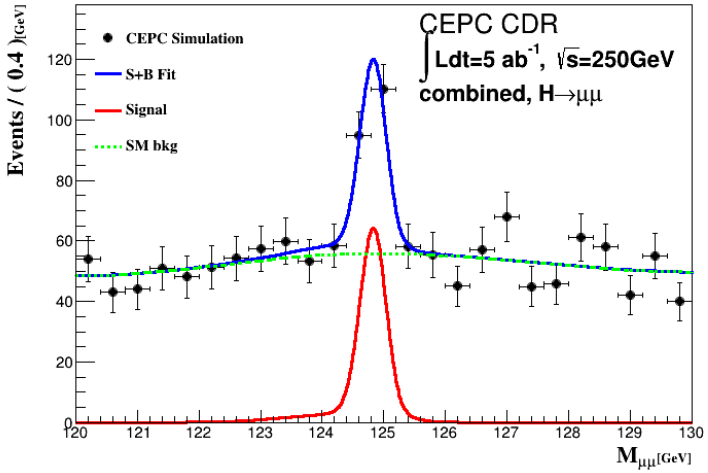
Z->vv, before



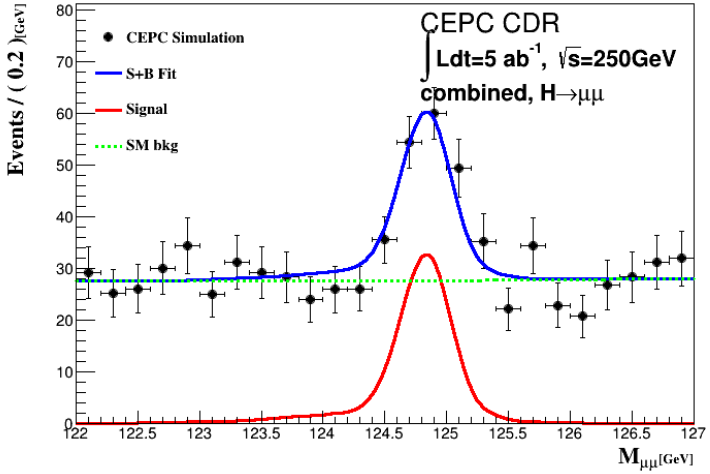
after: 53%



combined, before



combined, after

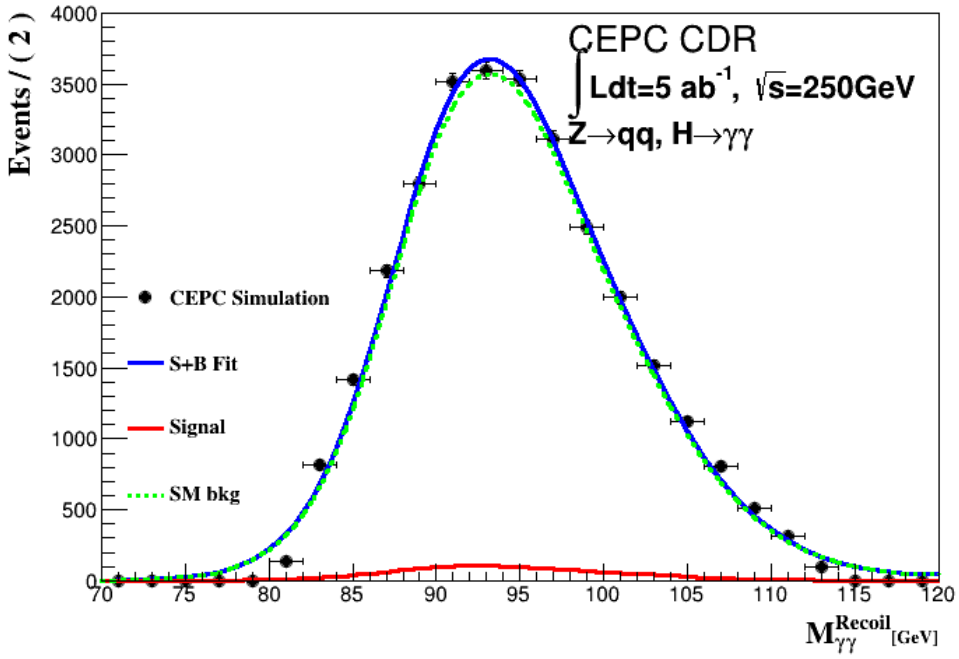


Restriction for recoil mass

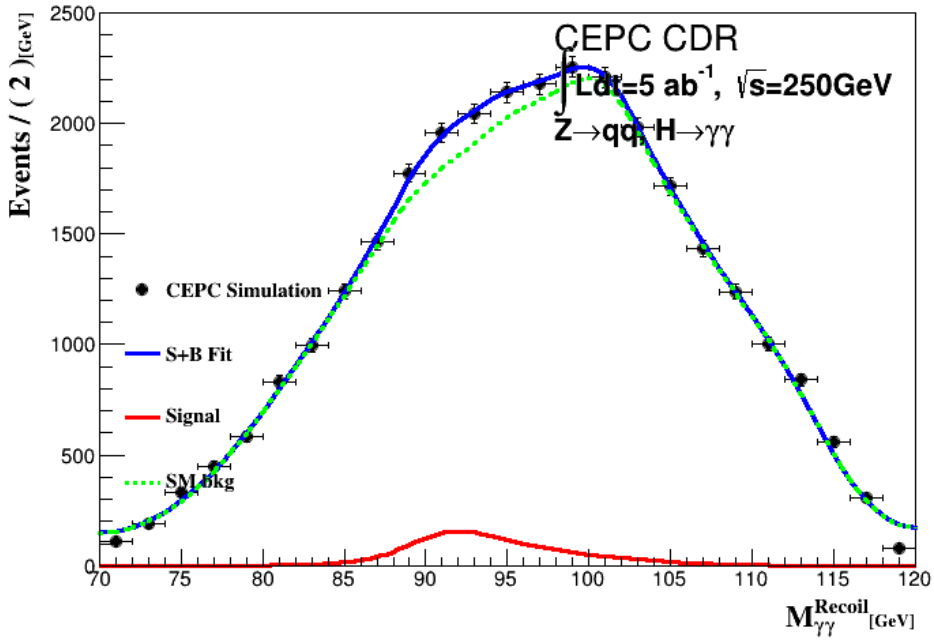
Let $m_{yy} = 125.09$ when calculating recoil mass;

For other channels,
4 momentum may not available;

Before



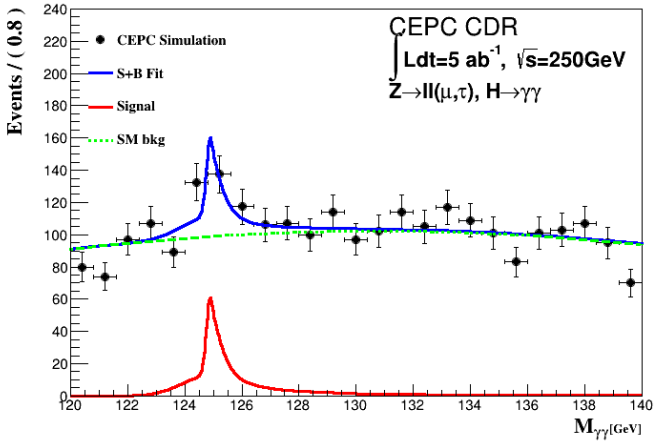
After

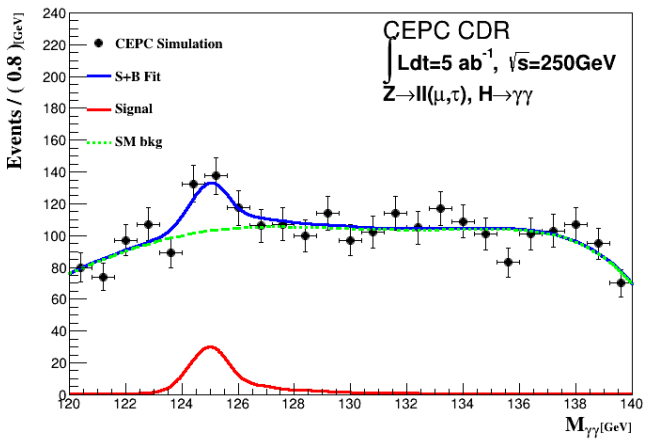


Signal more clear;
Bkg peak shift;

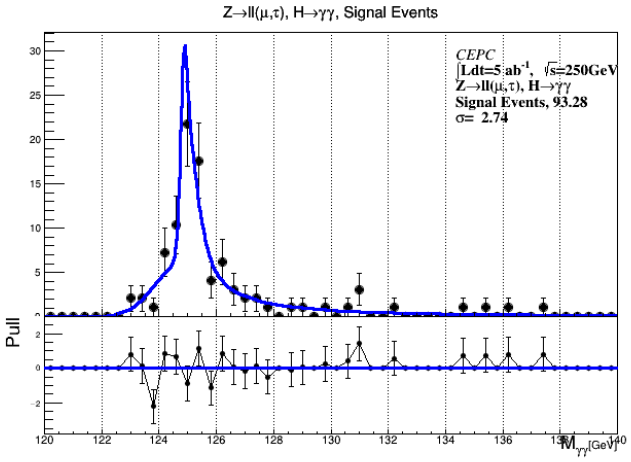
llyy signal shape

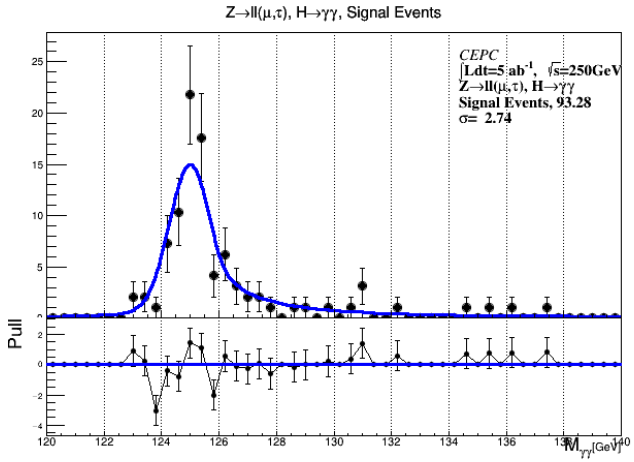
Due to limited stats, signal shape seems strange, change functions





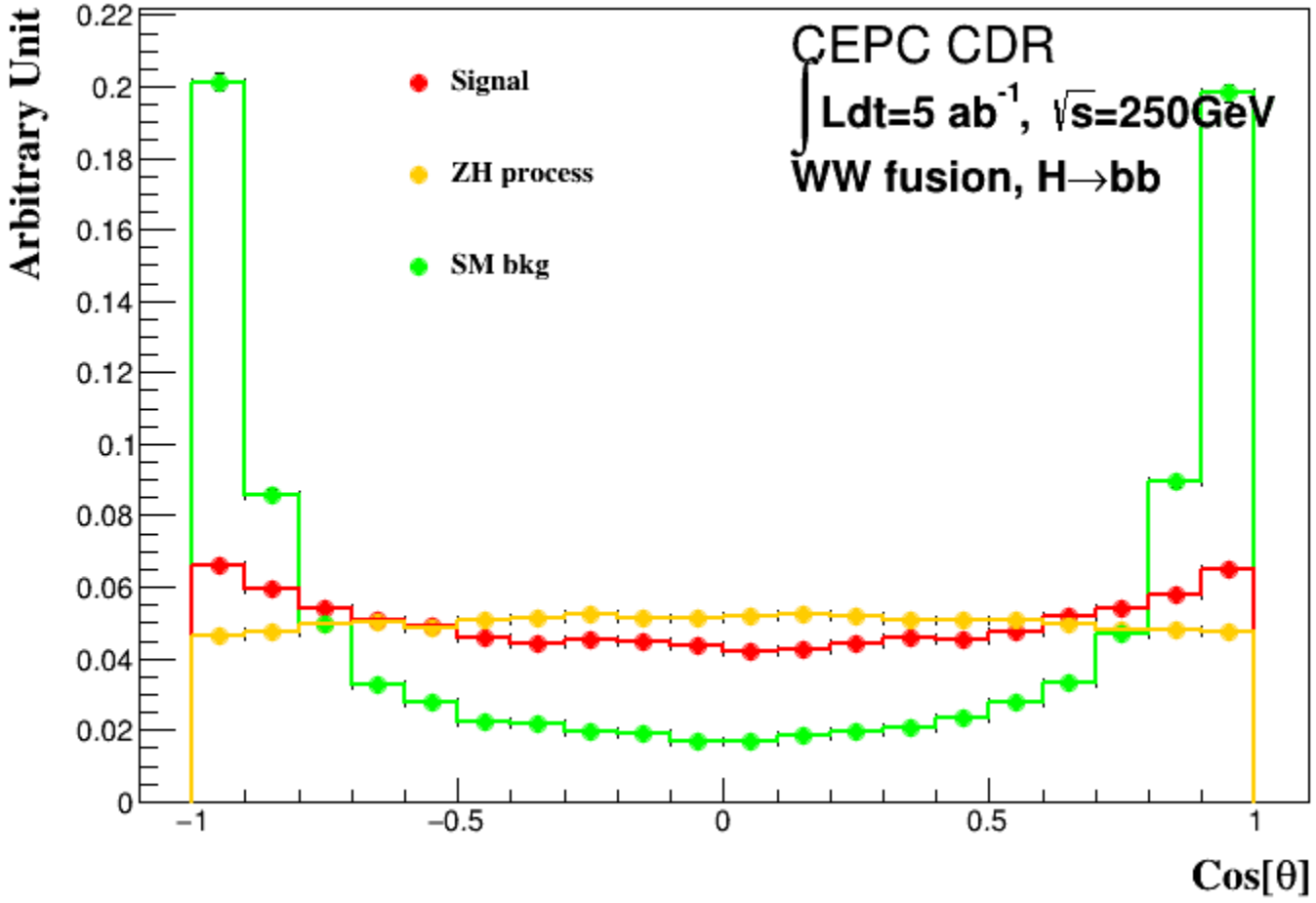
CB+ bifurcated Gaussian



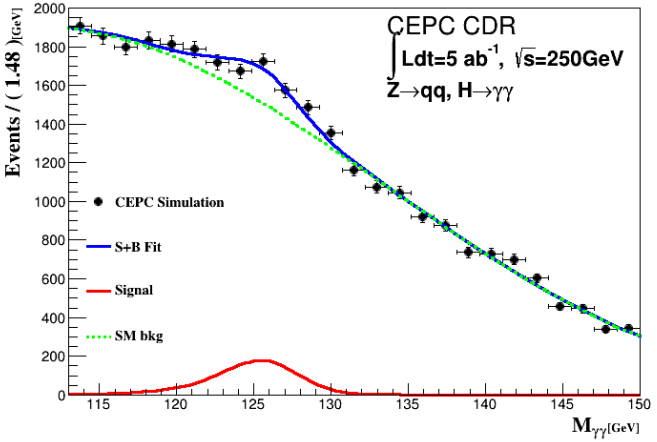


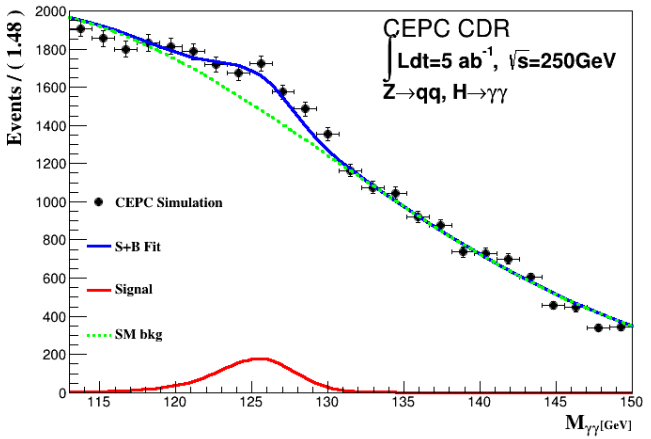
$\nu\nu H \rightarrow bb$: Higgs polar angle

All pre cut;

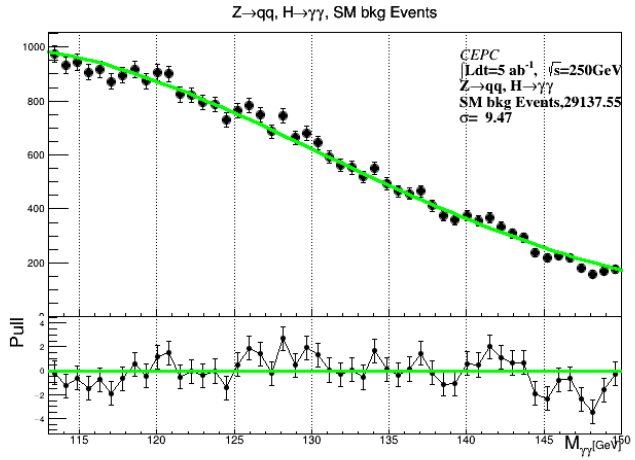


qqyy: bkg shape

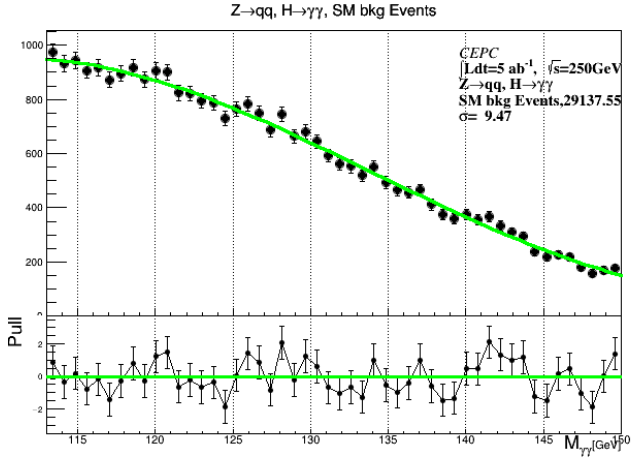




Bkg, 5th chebyshev



Bkg, 2nd order exp



Channels Table

Done/Almost Done:

Signal		Precision
Z	H	
H->qq		
ee	bb	1.6%
	cc	23.6%
	gg	13.3%
μμ	bb	1.1%
	cc	14.8%
	gg	8.0%
qq	bb	0.5%
	cc	11.9%
	gg	3.9%
vv	bb	0.4%
	cc	3.9%
	gg	1.5%
H→ττ		
ee	ττ	3.0%
μμ		2.8%
qq		0.9%
vv		3.7%
H→γγ, Zγ		
μμ+ττ	γγ	24.8%
vv		11.7%
qq		12.8%
vv	Zγ(qqγ)	21.2%

Signal		Precision
Z	H	
H->WW		
μμ	μνμν	7.3%
	evev	
	evμν	
	evqq	4.0%
	μνqq	4.0%
ee	μνμν	9.2%
	evev	
	evμν	
	evqq	4.6%
	μνqq	3.9%
vv	qqqq	2.0%
	evqq	4.7%
	μνqq	4.2%
qq	lvqq	2.2%(ILC)
ZH bkg contribution		3.0%
H->ZZ		
vv	μμqq	8.2%
vv	eeqq	35.2%
μμ	vvqq	7.3%
ee	eeqq	35.1%
ee	μμqq	23.0%
ZH bkg contribution		19.4%

Signal		Precision
Z	H	
vvH(WW fusion)		
vv	bb	3.1%
Rare Decays		
H→μμ		
qq	μμ	15.8%
ee		
μμ		
vv		
H->Invisible		Br, Upper
qq	ZZ(vvvv)	0.3%
ee		1.1%
μμ		0.7%

Z->qq, H→ττ:
Now Dan use qq information to separate signal and bkg.
Data updated soon.

Fit results

Standalone: Regardless any ZH bkg contribution;
Different impact on w/z and b/c/g/τ.

($5ab^{-1}$)	Pre_CDR	Combined	Standalone
$\sigma(ZH)$	0.51%	0.50%	
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{bb})$	0.28%	0.3%	0.3%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{cc})$	2.20%	3.5%	3.5%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{gg})$	1.60%	1.4%	1.4%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{WW})$	1.50%	1.0%	1.2%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{ZZ})$	4.30%	5.0%	5.2%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \tau\tau)$	1.20%	0.8%	0.8%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \gamma\gamma)$	9.00%	8.1%	8.2%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mu\mu)$	17%	15.4%	15.4%
$\sigma(\mathrm{vv}H) * \mathrm{Br}(\mathrm{H} \to \mathrm{bb})$	2.80%	3.1%	3.1%
$\mathrm{Br}_{\mathrm{upper}}(\mathrm{H} \to \mathrm{inv.})$	0.28%	0.24%	0.24%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to Z\gamma)$	\	4σ	4σ

1.3%->0.8%