Updates on Higgs Combination

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Outline

- Complete bb/cc/gg ZH bkg
  - Discussion for fit method
  - Correlations
- Explanation for ZZ channel
- Current Fit result
- Fast & Full comparison in qqyy （delayed to next week）

bb/cc/gg

- Template fit: Flavor tagging algorithm
  - For each jet, it has blikeness and clikeness (0~1)
  - using $B_{likeness} = \frac{b_{j1}b_{j2}}{b_{j1}b_{j2}+(1-b_{j1})(1-b_{j2})}$ We get b/c likeness for two jets.
  - $Z \to ee\ \mu\mu\ qq\ vv, \mathrm{H} \to bb/cc/gg$ are studied.
  - 2D binned(20*20) fit, with dijets' b/c likeness; mass info not used;
  - 7 parts, Tot=bb+cc+gg+zh_{ww}+zh_{zz}+zh_{tt}+bkg_{sm}. 6 freedoms
  - Build individual pdf by MC, then fit to determine fraction.
  - all b/c likeness shape is fixed. （Requirement for Asimov Data）
    - Fix sm bkg shape and number means we have a wonderful understanding with bkg, may be more suitable for CEPC.
  - For ZH ww/zz/tt bkg event number, fixed or float?

bb/cc/gg

Event numbers in ee/mm/qq are all increased in the new sample.

New result ZH fixed

Scan	μ_bb	μ_cc	μ_gg
eeH	$^{+0.78\%}_{-0.77\%}$	$^{+8.05\%}_{-7.94\%}$	$^{+4.04\%}_{-4.01\%}$
mmH	$^{+0.59\%}_{-0.59\%}$	$^{+6.58\%}_{-6.52\%}$	$^{+3.42\%}_{-3.40\%}$
qqH	$^{+0.49\%}_{-0.49\%}$	$^{+19.45\%}_{-19.43\%}$	$^{+8.18\%}_{-8.17\%}$
vvH	$^{+0.40\%}_{-0.40\%}$	$^{+3.91\%}_{-3.88\%}$	$^{+1.55\%}_{-1.54\%}$
Combined	$^{+0.243\%}_{-0.243\%}$	$^{+3.028\%}_{-3.009\%}$	$^{+1.294\%}_{-1.290\%}$

Old result

Scan	μ_bb	μ_cc	μ_gg
eeH	$^{+1.27\%}_{-1.26\%}$	$^{+15.25\%}_{-14.98\%}$	$^{+8.29\%}_{-8.22\%}$
mmH	$^{+1.02\%}_{-1.01\%}$	$^{+10.77\%}_{-10.60\%}$	$^{+5.48\%}_{-5.44\%}$
qqH	$^{+0.466\%}_{-0.465\%}$	$^{+16.66\%}_{-16.64\%}$	$^{+7.46\%}_{-7.46\%}$
vvH	$^{+0.402\%}_{-0.401\%}$	$^{+3.94\%}_{-3.91\%}$	$^{+1.56\%}_{-1.55\%}$
Combined	$^{+0.266\%}_{-0.266\%}$	$^{+3.496\%}_{-3.472\%}$	$^{+1.443\%}_{-1.437\%}$

bb/cc/gg

	WW	ZZ	WW fusion bb
with bcg's ww/zz/tt:	$^{+1.29\%}_{-1.27\%}$	$^{+5.06\%}_{-4.93\%}$	$^{+3.01\%}_{-3.00\%}$
w/o bcg's ww/zz/tt:	$^{+1.38\%}_{-1.36\%}$	$^{+5.20\%}_{-5.06\%}$	$^{+3.00\%}_{-2.98\%}$

Seems float zz/ww/tt affects bb/cc/gg a little.
But it can increase ww/zz precision ~0.15%.

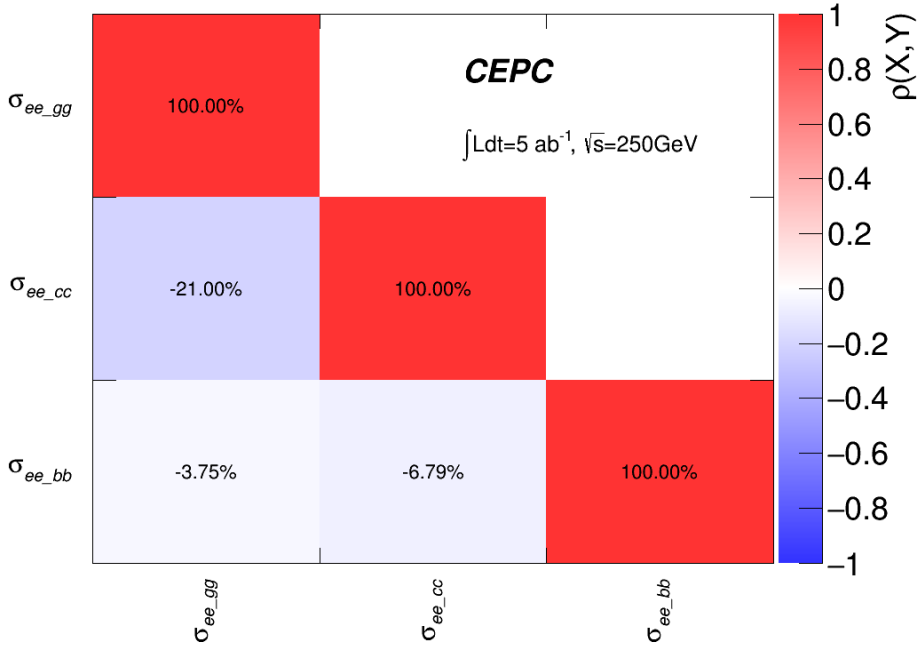
New result ww zz tt float

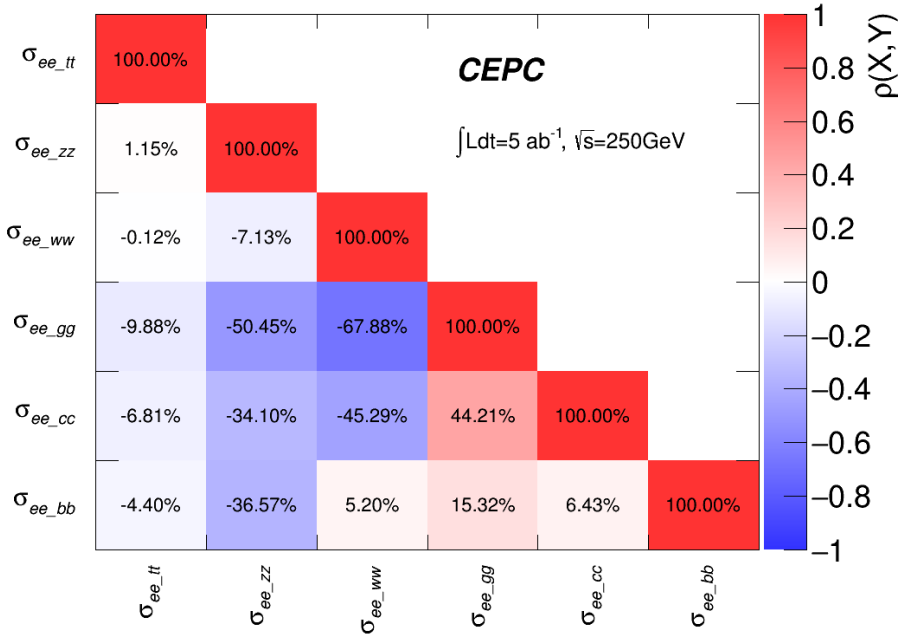
Scan	μ_bb	μ_cc	μ_gg		μ_zz	μ_ww	μ_tt
eeH	$^{+0.83\%}_{-0.83\%}$	$^{+9.93\%}_{-9.80\%}$	$^{+8.46\%}_{-8.48\%}$	precision	44%	86%	>100%
				events	483	2386	26
mmH	$^{+0.65\%}_{-0.65\%}$	$^{+8.92\%}_{-8.86\%}$	$^{+7.51\%}_{-7.52\%}$	precision	38%	71%	>100%
				events	887	4515	34
qqH	$^{+1.04\%}_{-1.04\%}$	$^{+34.95\%}_{-34.94\%}$	$^{+22.07\%}_{-22.08\%}$	precision	95%	22%	>100%
				events	5963	43173	1635
vvH	$^{+0.47\%}_{-0.47\%}$	$^{+4.61\%}_{-4.58\%}$	$^{+2.71\%}_{-2.71\%}$	precision	62%	20%	>100%
				events	612	1573	108
Combined	$^{+0.246\%}_{-0.246\%}$	$^{+3.075\%}_{-3.057\%}$	$^{+1.389\%}_{-1.388\%}$				

As bb/cc/gg result changed, WW fusion bb is also changed due to the correlation. 3.1%->3.0%

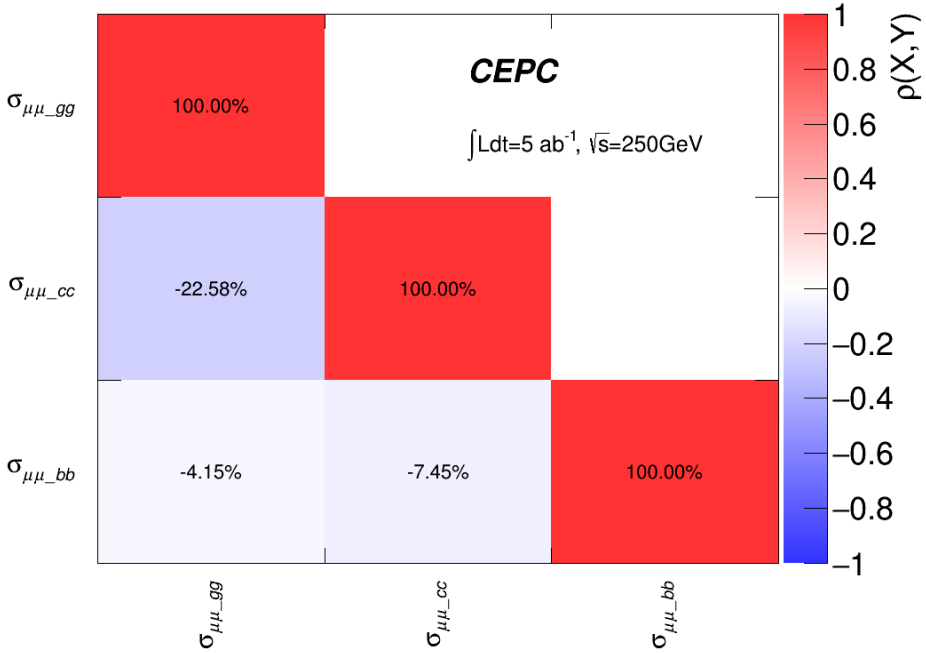
Correlations in Z->ee channel

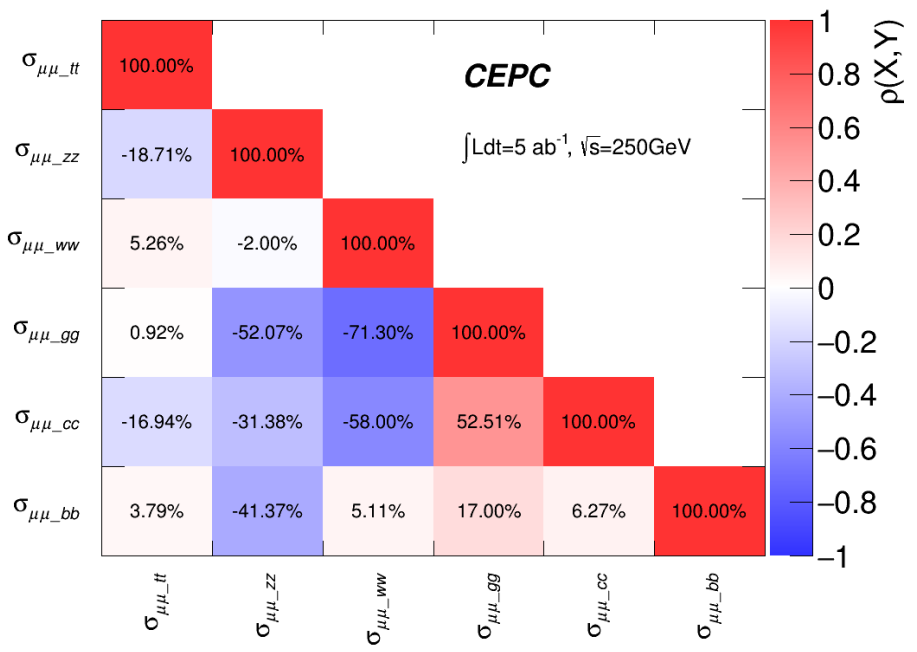
When we float ww/zz/tt, now we have 6 free parameters in 1 single pdf.
It seems the correlation in bb/cc/gg in converted. (from negative to positive)



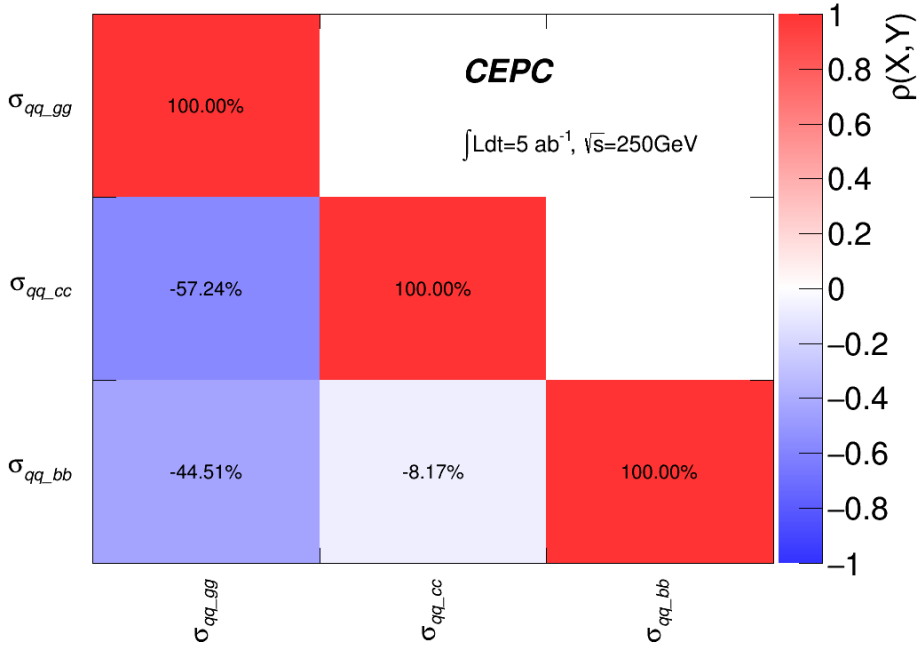


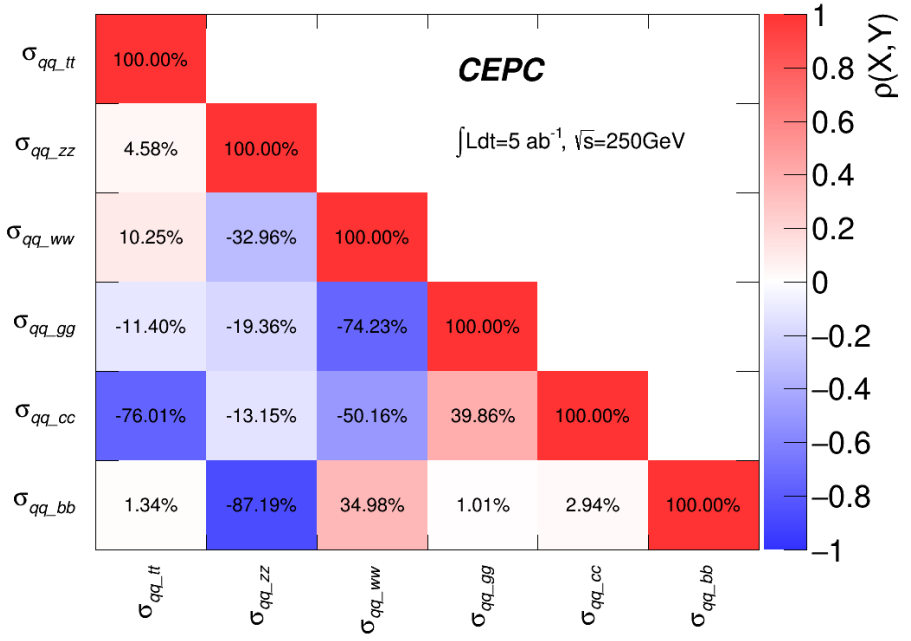
Z→$\mu\mu$ channel



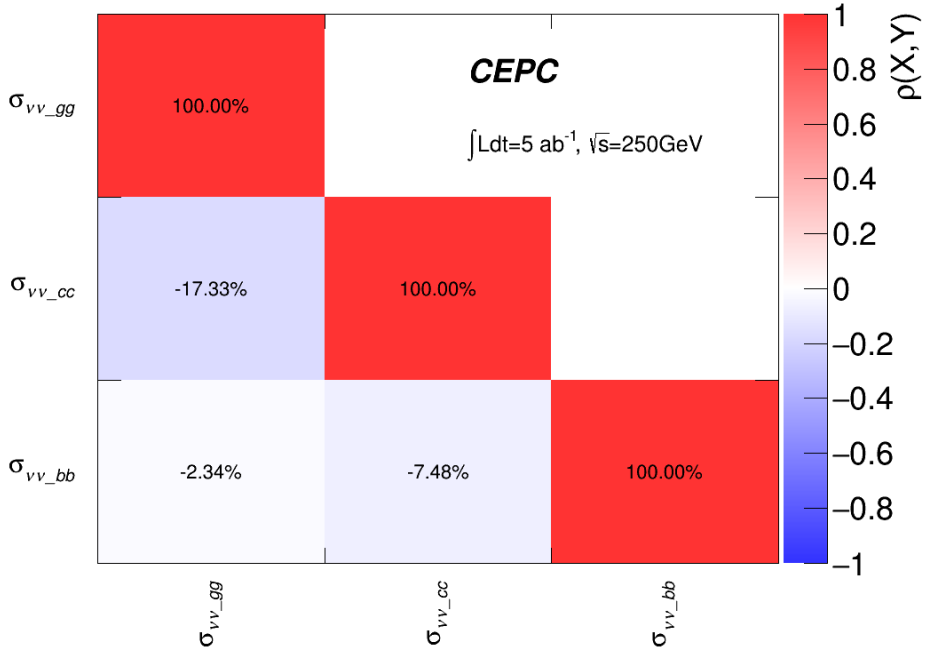


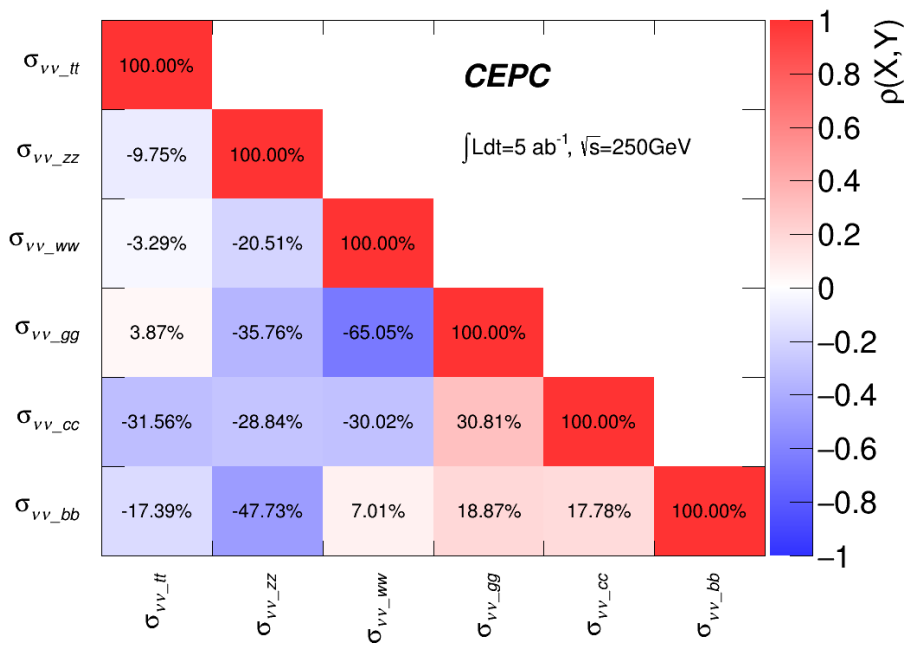
Z→qq channel


CEPC
∫Ldt=5 ab-1, √s=250GeV
σqq_gg
σqq_cc
σqq_bb
100.00%
-57.24%
100.00%
-44.51%
-8.17%
100.00%
ρ(X,Y)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1


CEPC
∫Ldt=5 ab-1, √s=250GeV
σqq_tt
σqq_zz
σqq_ww
σqq_gg
σqq_cc
σqq_bb
100.00%
4.58% 100.00%
10.25% -32.96% 100.00%
-11.40% -19.36% -74.23% 100.00%
-76.01% -13.15% -50.16% 39.86% 100.00%
1.34% -87.19% 34.98% 1.01% 2.94% 100.00%
ρ(X,Y)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

Z→νν channel

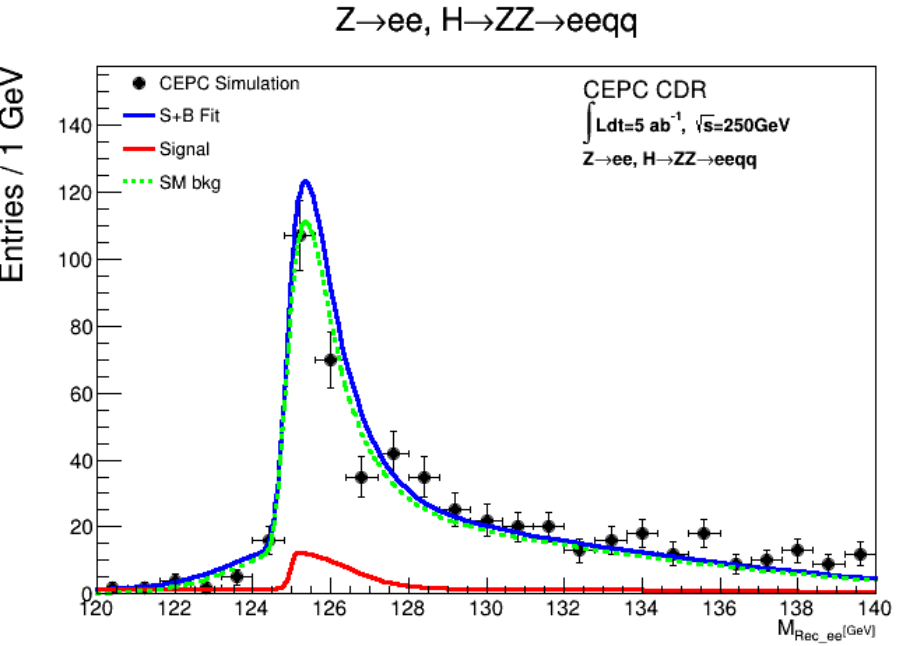

CEPC
∫Ldt=5 ab^{-1}, √s=250GeV
σ$_{νν_gg}$
σ$_{νν_cc}$
σ$_{νν_bb}$
100.00%
-17.33%
100.00%
-2.34%
-7.48%
100.00%
ρ(X,Y)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

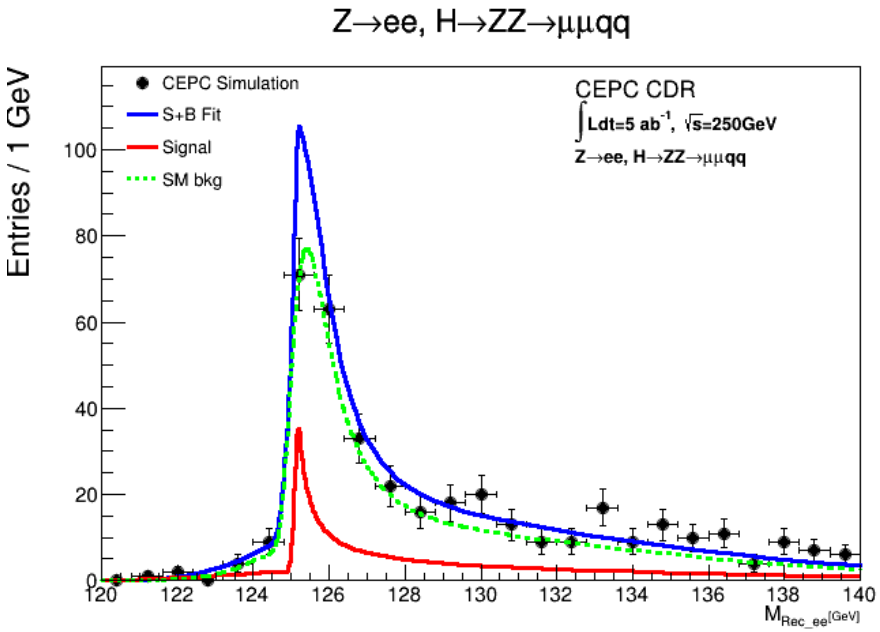

CEPC
∫Ldt=5 ab^{-1}, √s=250GeV
σ$_{νν_tt}$
σ$_{νν_zz}$
σ$_{νν_ww}$
σ$_{νν_gg}$
σ$_{νν_cc}$
σ$_{νν_bb}$
100.00%
-9.75% 100.00%
-3.29% -20.51% 100.00%
3.87% -35.76% -65.05% 100.00%
-31.56% -28.84% -30.02% 30.81% 100.00%
-17.39% -47.73% 7.01% 18.87% 17.78% 100.00%
ρ(X,Y)
1
0.8
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−1

ZZ, Z->ee, H->ZZ->llqq:

Bkg of these 2 channels are mainly sze_sl
And it seems share the same shape with signal:

Now with bb/cc/gg ZH contribution,
ZZ precision reach 5.0%

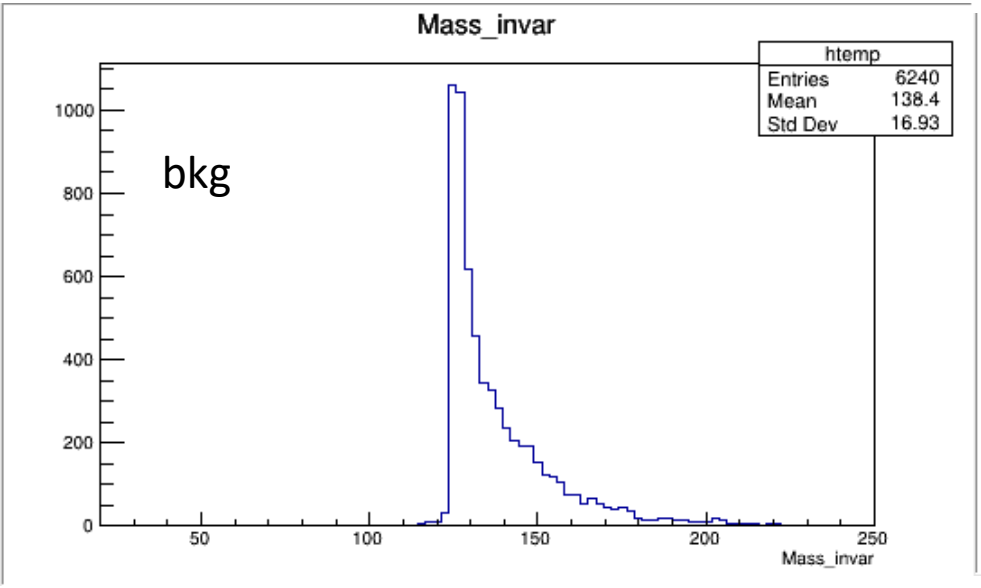


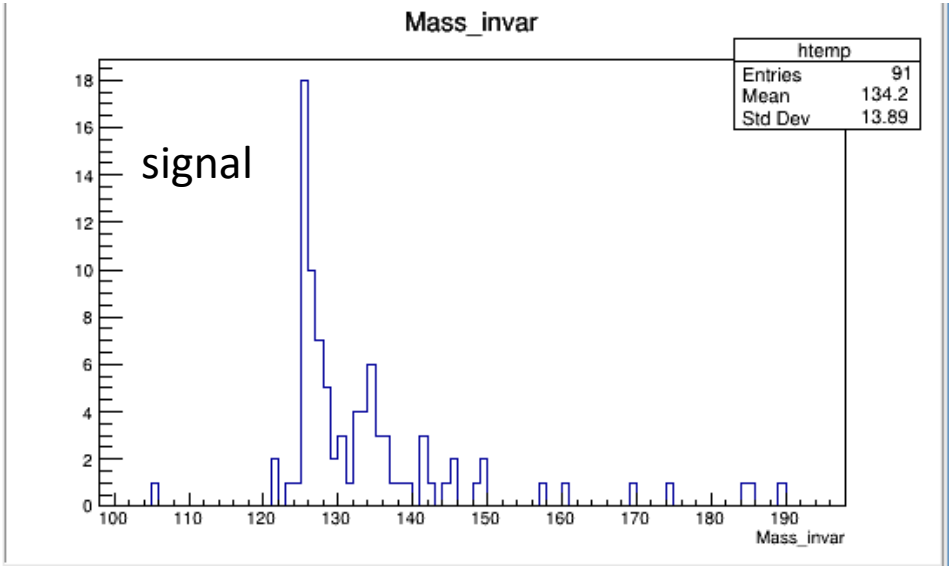


ZZ, Z->ee, H->ZZ->llqq:

The bkg is the cutted tail from a long smooth shape;
Yuqian doesn't give the details about how he get this.

So it looks their shape is similar.





Channels Table

Observed=tagged signal after cutflow and in fit range.
All events are weighted and normalized to 5ab^{-1}.

Signal Z	Signal H	Observed Events		Who takes charge	Precision
H->Inclusive					
νν	Inclusive	164170		Liao Libo	\
μμ	Inclusive	29552			
ee	Inclusive	22200			
H->qq					
ee	bb	7655	18742	Bai Yu	
	cc	351	838		
	gg	1058	2563		
μμ	bb	11108	33253		
	cc	567	1537		
	gg	1762	4473		
qq	bb	176542	190768		
	cc	8272	9521		
	gg	25293	32048		
νν	bb	70608	70608		
	cc	3061	3061		
	gg	9633	9633		
H→γγ,Zγ					
ll	γγ	93		Wang Feng	24.8%
νν		309			11.7%
qq		822		Sun Yitian	13.0%
qq	Zγ	219		Yao Weimin	21.0%
H->Invisible					Br, Upper
qq	νννν	202		Mo Xin	0.3%
ee		8			1.1%
μμ		18			0.7%
νvH(WW fusion)					
νν	bb	10256		Liang Hao	3.0%

Signal Z	Signal H	Observed Events	Who takes charge	Precision
H->WW				
μμ	μνμν	52	Liao Libo	2.6%
	evev	36		
	evμν	105		
	evqq	663		
	μνqq	717		
ee	μνμν	44		2.8%
	evev	22		
	evμν	81		
	evqq	612		
	μνqq	684		
νν	qqqq	10793		1.9%
H->ZZ				
νν	μμjj	179	Wei Yuqian	8.2%
νν	eejj	64		35.2%
μμ	νjj	200		7.3%
ee	eejj	55		35.1%
ee	μμjj	81		23.0%
H→ττ				
ee	ττ	\	Yu Dan	3.0%
μμ		2135		2.7%
qq		23168		1.9%
νν		8809		3.7%
H→μμ				
qq	μμ	71	Cui Zhenwei	15.4%
ee		1		
μμ		4		
νν		14		

Channels Table

Observed=tagged signal after cutflow and in fit range.
All events are weighted and normalized to 5ab^{-1}.

Signal		Observed Events		Who takes charge	Precision
Z	H				
H->Inclusive					
νν	Inclusive	164170		Liao Libo	\
μμ	Inclusive	29552			
ee	Inclusive	22200			
H->qq					
ee	bb	7655	18742	Bai Yu	
	cc	351	838		
	gg	1058	2563		
μμ	bb	11108	33253		
	cc	567	1537		
	gg	1762	4473		
qq	bb	176542	190768		
	cc	8272	9521		
	gg	25293	32048		
νν	bb	70608	70608		
	cc	3061	3061		
	gg	9633	9633		
H→γγ,Zγ					
ll	γγ	93		Wang Feng	24.8%
νν		309			11.7%
qq		822		Sun Yitian	13.0%
qq	Zγ	219		Yao Weimin	21.0%
H->Invisible					Br, Upper
qq	νννν	202		Mo Xin	0.3%
ee		8			1.1%
μμ		18			0.7%
vvH(WW fusion)					
νν	bb	10256		Liang Hao	3.0%

Signal		Observed Events	Who takes charge	Precision
Z	H			
H->WW				
μμ	μνμν	52		2.6%
	evev	36		
	evμν	105		
	evqq	663		
νν	qqqq	10793		1.9%
H->ZZ				
νν	μμjj	179	Wei Yuqian	8.2%
νν	eejj	64		35.2%
μμ	νvjj	200		7.3%
ee	eejj	55		35.1%
ee	μμjj	81		23.0%
H→ττ				
ee	ττ	\	Yu Dan	3.0%
μμ		2135		2.7%
qq		23168		1.9%
νν		8809		3.7%
H→μμ				
qq	μμ	71	Cui Zhenwei	15.4%
ee		1		
μμ		4		
νν		14		

Z->νν, H->WW->4q, Current sample allows more ZZ events in. We found previously we multiused 3k signal events two times, so the real precision is 1.9%, not 1.3%. (WW from 1.2% to 1.3%)

Fit results

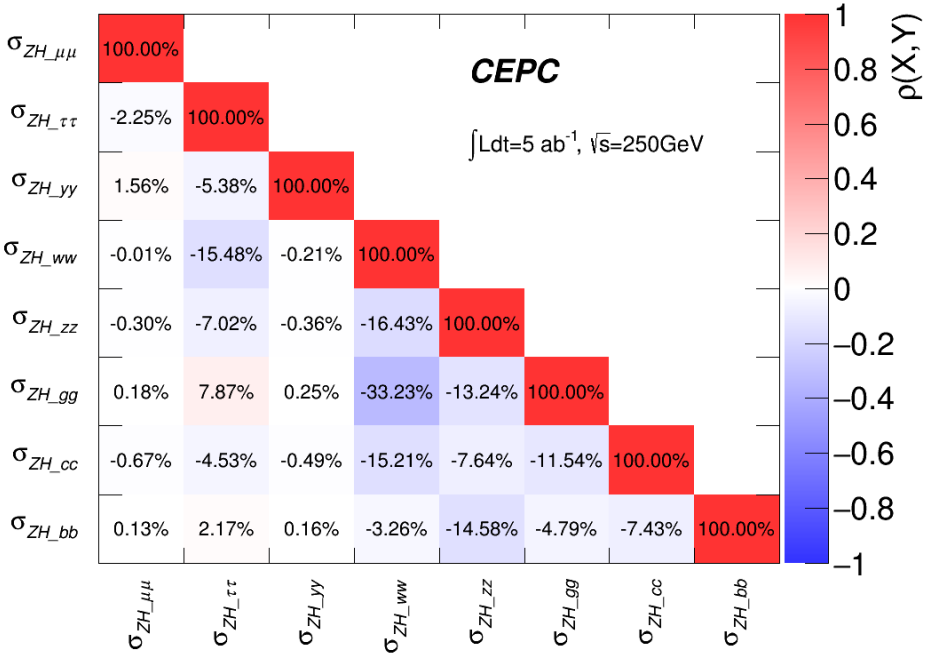
($5ab^{-1}$)	Pre_CDR	Previous version	Current
$\sigma(ZH)$	0.51%		0.50%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{bb})$	0.28%	$^{+0.27\%}_{-0.27\%}$	$^{+0.246\%}_{-0.246\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{cc})$	2.2%	$^{+3.46\%}_{-3.44\%}$	$^{+3.08\%}_{-3.06\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{gg})$	1.6%	$^{+1.44\%}_{-1.44\%}$	$^{+1.39\%}_{-1.39\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{WW})$	1.5%	$^{+1.20\%}_{-1.20\%}$	$^{+1.29\%}_{-1.27\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mathrm{ZZ})$	4.3%	$^{+5.25\%}_{-5.10\%}$	$^{+5.06\%}_{-4.93\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \tau\tau)$	1.2%		$^{+1.34\%}_{-1.34\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \gamma\gamma)$	9.0%	$^{+8.20\%}_{-8.12\%}$	$^{+8.21\%}_{-8.07\%}$
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to \mu\mu)$	17%		$^{+15.8\%}_{-15.0\%}$
$\sigma(\mathrm{vv}H) * \mathrm{Br}(\mathrm{H} \to \mathrm{bb})$	2.8%	$^{+3.12\%}_{-3.11\%}$	$^{+3.01\%}_{-3.00\%}$
$\mathrm{Br}_{\mathrm{upper}}(\mathrm{H} \to \mathrm{inv.})$	0.28%		0.24%
$\sigma(ZH) * \mathrm{Br}(\mathrm{H} \to Z\gamma)$	\		$4\sigma(^{+21.0\%}_{-21.4\%})$

7κ	Pre_CDR
1.2%	1.2%
2.0%	1.6%
1.5%	1.5%
4.3%	4.7%
1.4%	1.3%
0.12%	0.16%
1.2%	1.2%

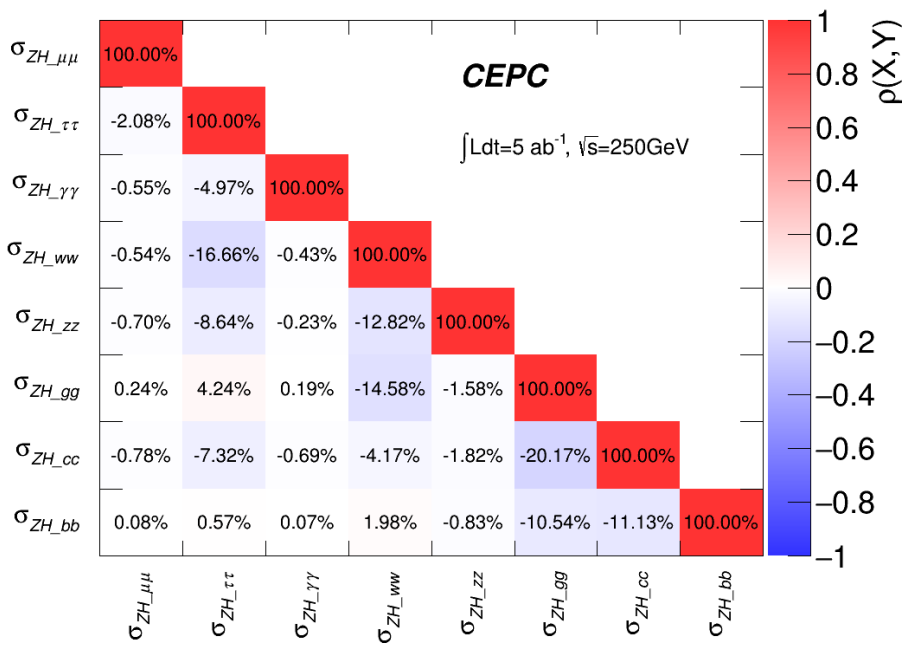
10 kappa result, and Higgs width, wait Zhen to update.
Numbers are updated in git but not the text.

Correlations in channel

New



Old



Fremework on Git

- Now the data seems complete
- I also migrating all my fit framework from ROOT5 to 6.
- a repository on http://cepcgit.ihep.ac.cn/zhangkl/HiggsCombination
- Including all the data used and codes for building workspace, fitting and plotting.