ZH Branching ratio study

ILC physics and software meeting

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Current status

- Template fitting analysis has applied for all the mode
  - Checking consistency with simple flavor cut BR=$N_{H\to xx}/N_{ZH}$
- Small discrepancy in selection efficiency on H→cc/bb should be clarified (Pointed out by Miyamoto-san)
  - Checking each cut parameter plots and scanning cut position →on-going.
- Prepare summary report of BR study at 250/350 GeV

Branching fraction measurement

- Apply flavor-likeness cut after all the BG reduction
  - b-likeness, c-likeness cut at the max. significance (S/√(S+B))

ZH→νvH (Ecm=250 GeV)

b-likeness

ZH All

H→bb

BG

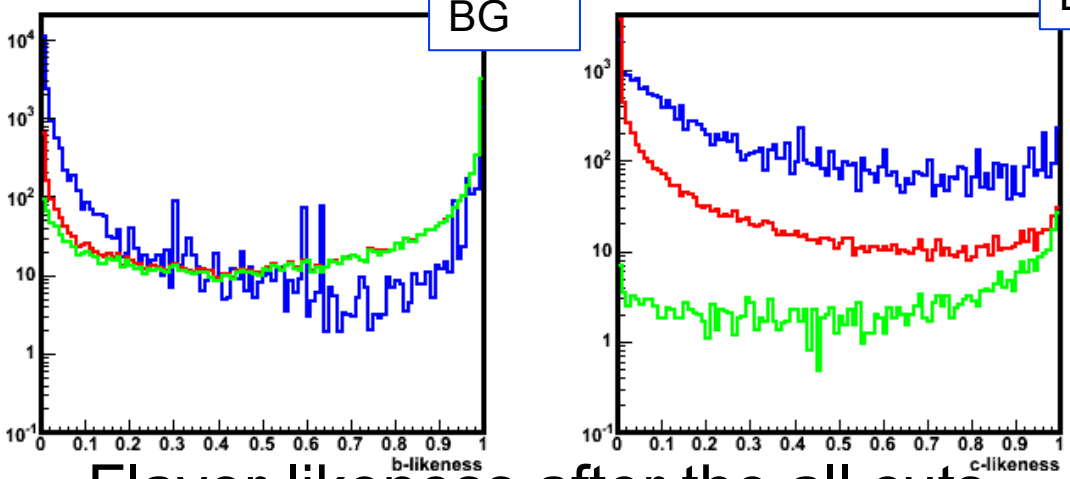
c-likeness

ZH All

H→cc

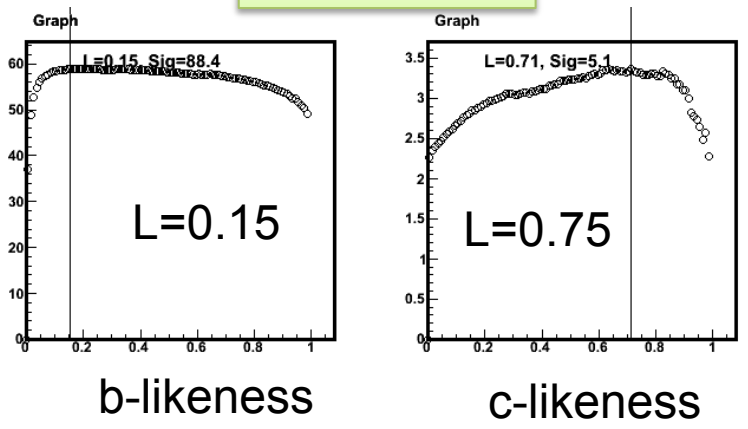
BG

$$Sig. = \frac{S}{\sqrt{S+B}} = \frac{N_{cc}}{\sqrt{N_{cc}+N_{BG}}}$$



Flavor-likeness after the all cuts

Significance



b-likeness

c-likeness

vvH flavor cut base

$$\frac{\Delta\sigma_{cc}}{\sigma_{cc}} = \frac{\sqrt{N_{cc}^{rec} + N_{BG}^{rec}}}{N_{cc}^{rec}}$$

Assuming L=250 fb^{-1}

Ecm=250 GeV
b-likeness>0.155
c-likeness>0.715

Ecm=350 GeV
b-likeness>0.215
c-likeness>0.775

vvH 250 GeV	No cut	All cuts	b-likeness	c-likeness	Signal Stat.
vvcc	697.793	315.379	32.7273	156.044	(cc) 9.73%
vvbb	12904.1	5863.3	5390.28	158.84	(bb) 1.92%
ZH all	19123.8	6730.91	5455.96	327.449	
SM Bkg	44827100	19058.6	2965.6	2099.57	
ZH not cc/bb			65.68	171.405	
sqrt(Sxx+B)/Sxx			1.70%	31.57%	

vvH 350 GeV	No cut	All cuts	b-likeness	c-likeness	Signal Stat.
vvcc	1295.5	427.125	27.962	207.325	(cc) 8.35%
vvbb	24051	7245.1	9107.78	234.712	(bb) 1.48%
ZH all	36098.8	9164.83	9200.47	463.92	
SM Bkg	1.82E+07	43638.1	4356.3	1691.24	
ZH not cc/bb			92.69	256.595	
sqrt(Sxx+B)/Sxx			1.28%	22.39%	

qqH flavor cut base

$$\frac{\Delta\sigma_{cc}}{\sigma_{cc}} = \frac{\sqrt{N_{cc}^{rec} + N_{BG}^{rec}}}{N_{cc}^{rec}}$$

Assuming L=250 fb^{-1}

Ecm=250 GeV
b-likeness>0.545
c-likeness>0.585

Ecm=350 GeV
b-likeness>0.215
c-likeness>0.575

qqH 250 GeV	No cut	All cuts	b-likeness	c-likeness	Signal Stat.
qqcc	1915.59	663.478	40.6213	344.605	6.14%
qqbb	34962.7	11287.3	8193.85	619.789	1.55%
ZH all	52506.9	14386.4	8466.05	1157.53	
SM Bkg	4.48E+07	328338	10447.4	39128.6	
ZH not cc/bb			272.2	812.925	
sqrt(Sxx+B)/Sxx			1.68%	58.24%	

qqH 350 GeV	No cut	All cuts	b-likeness	c-likeness	Signal Stat.
qqcc	1295.5	427.125	35.6872	244.072	7.29%
qqbb	24051	7245.1	6260.89	456.595	1.78%
ZH all	36098.8	9164.83	6409.08	820.307	
SM Bkg	1.82E+07	43638.1	7415.4	4757.13	
ZH not cc/bb			148.19	576.235	
sqrt(Sxx+B)/Sxx			1.88%	30.60%	

μμH flavor cut base

$$\frac{\Delta\sigma_{cc}}{\sigma_{cc}} = \frac{\sqrt{N_{cc}^{rec} + N_{BG}^{rec}}}{N_{cc}^{rec}}$$

Assuming L=250 fb^{-1}

Ecm=250 GeV
b-likeness>0.07
c-likeness>0.37

Ecm=350GeV
b-likeness>0.05
c-likeness>0.15

mumuH 250 GeV	No cut	All cuts	b-likeness	c-likeness	Signal only
mumucc	103.849	62.9575	12.8481	44.8044	16.62%
mumubb	1954	1052.49	988.351	94.9637	4.46%
ZH all	2917.25	1387.2	1027.07	188.319	
SM Bkg	4.52E+06	980.305	218.853	155.53	
ZH not cc/bb			38.719	143.5146	
sqrt(Sxx+B)/Sxx			3.57%	41.39%	

mumuH 350 GeV	No cut	All cuts	b-likeness	c-likeness	Signal only
mumucc	68.9663	35.201	6.46535	27.4717	20.66%
mumubb	1185.64	479.104	450.696	90.0881	6.60%
ZH all	1788.76	638.634	467.557	159.391	
SM Bkg	3.83E+06	465.047	111.911	104.969	
ZH not cc/bb			16.861	131.9193	
sqrt(Sxx+B)/Sxx			5.34%	59.19%	

eeH flavor cut base

$$\frac{\Delta\sigma_{cc}}{\sigma_{cc}} = \frac{\sqrt{N_{cc}^{rec} + N_{BG}^{rec}}}{N_{cc}^{rec}}$$

Assuming L=250 fb^{-1}

Ecm=250 GeV
b-likeness>0.15
c-likeness>0.41

Ecm=350GeV
b-likeness>0.07
c-likeness>0.17

eeH 250 GeV	No cut	All cuts	b-likeness	c-likeness	Signal only
eecc	102.331	48.9302	5.01209	33.5514	19.38%
eebb	1851.47	793.381	721.54	64.2044	5.23%
ZH all	2776.76	1045.33	740.018	128.719	
SM Bkg	4.52E+06	1609.81	264.334	233.446	
ZH not cc/bb			18.478	95.1676	
sqrt(Sxx+B)/Sxx			4.39%	56.72%	

eeH 350 GeV	No cut	All cuts	b-likeness	c-likeness	Signal only
eecc	99.4893	34.1609	4.60701	29.7704	20.17%
eebb	1787.08	416.33	386.019	72.7563	7.14%
ZH all	2740.25	566.614	398.276	140.891	
SM Bkg	3.83E+06	580.777	104.18	145.006	
ZH not cc/bb			12.257	111.1206	
sqrt(Sxx+B)/Sxx			3.57%	41.39%	

Flavor likeness cut based analysis

$$\frac{\Delta\sigma_{cc}}{\sigma_{cc}} = \frac{\sqrt{N_{cc}^{rec} + N_{BG}^{rec}}}{N_{cc}^{rec}}$$

$$\frac{\Delta BR(H \to c\bar{c})}{BR(H \to c\bar{c})} = \sqrt{\left(\frac{\Delta\sigma_{cc}}{\sigma_{cc}}\right)^2 + \left(\frac{\Delta\sigma_{ZH}}{\sigma_{ZH}}\right)^2}$$

Preliminary results

	Δσ/σ(bb)		Δσ/σ(cc)	
Ecm	250	350	250	350
ννH	1.70%	1.28%	31.57%	22.39%
qqH	1.68%	1.88%	58.24%	30.60%
μμH	3.57%	5.34%	41.39%	59.19%
eeH	4.39%	3.57%	56.72%	41.39%

Each flavor cut position is optimized to maximize significance. Not use other flavor and bc-tagging information at now, rough estimation

Δσ/σ(ZH)=2.5%
from the LOI recoil study

Measurement accuracy of H→cc is improved at 350 GeV except for μμH mode
→Same tendency with template fitting relative BR results
Maximizing signal significance achieve best measurement accuracy

Large discrepancy of absolute value between cut based and template fitting
Template binning dependence makes over estimation? Need to clarify this point

Next steps

- Clarify inconsistency between template fitting and cut based analysis
- Cut based analysis has also discrepancy from previous analysis (LOI ~30% in qqH).
  →Comes from worse BG suppression performance?
  kinematical constraint fits
- Check significance in the template fitting bin by bin