Hadronic recoil mass study @ 250 GeV ILC

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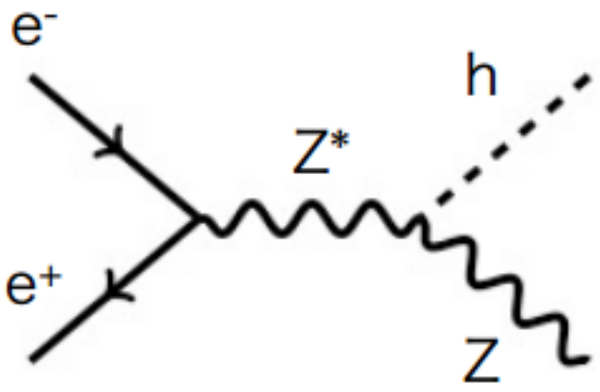
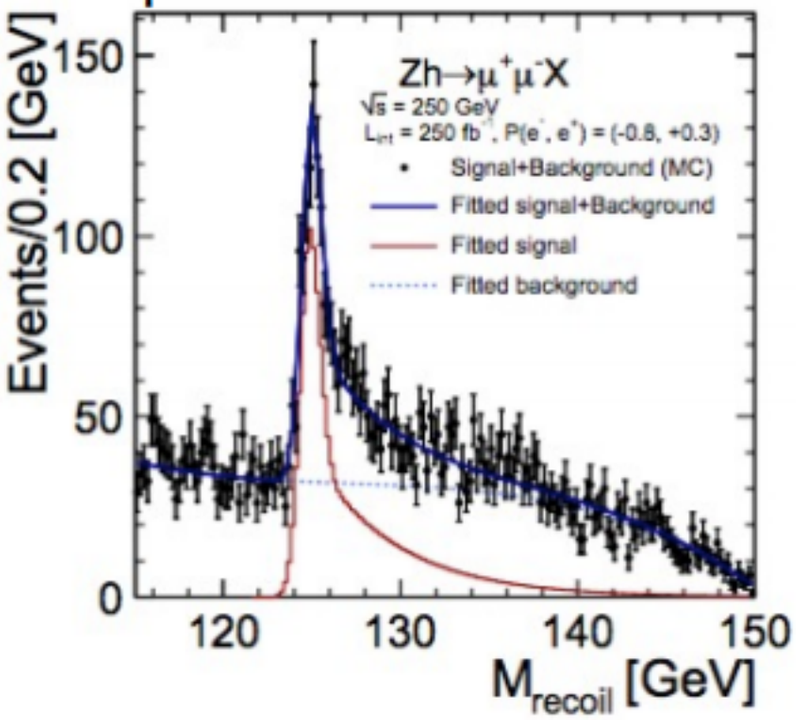
Overview - qqH channel



At lepton collider, we can measure Higgs without looking Higgs directly.

-> Model Independent search



The branching ratio of Z -> leptonic is ~3.5% for each generation.

In contrast, the branching ratio of **Z -> hadronic is ~70%**.

- **More statistics**

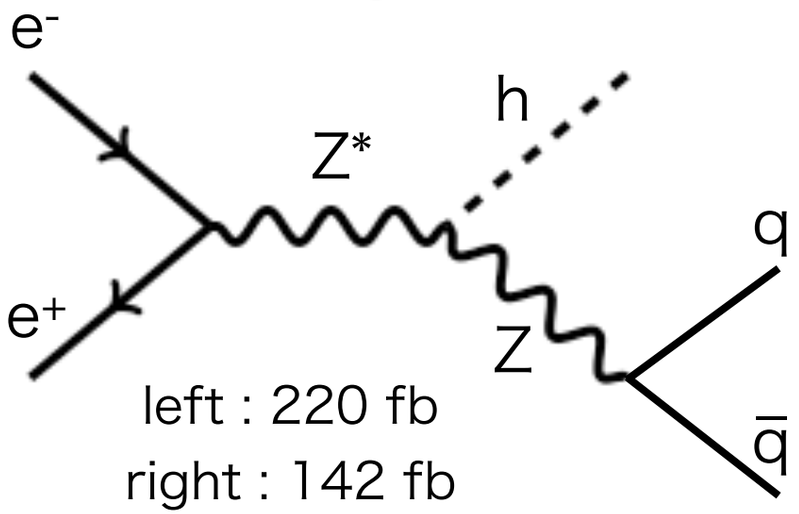
⇕ Model independent?

- **More background**

Data samples

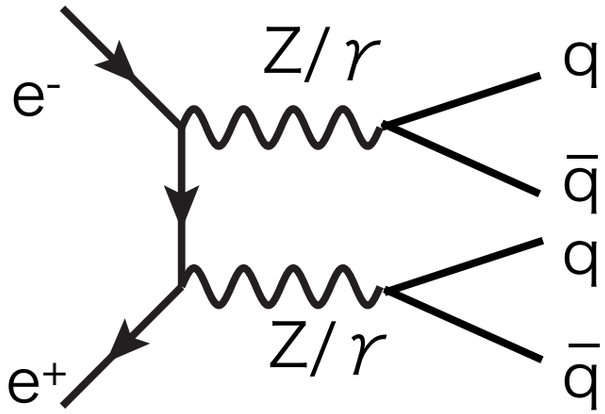
Higgs mass	E_{CM}	Luminosity	Polarization	Detector
125 GeV	250 GeV	250 fb^{-1}	left: (-0.8, +0.3) right:(+0.8, -0.3)	ILD_DBD ver.

signal

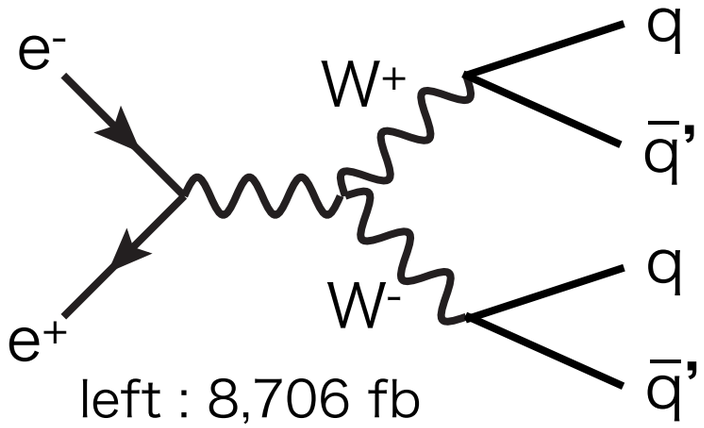


left : 220 fb
right : 142 fb

Major background

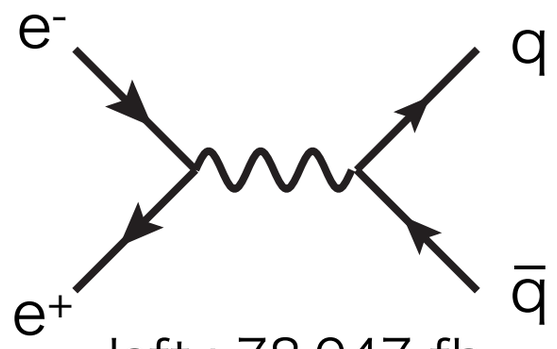


left : 841 fb
right : 403 fb



left : 8,706 fb
right : 600 fb

4 fermion



left : 78,047 fb
right : 46,214 fb

2 fermion

semi-leptonic events
are also considerable BG.

Analysis flow

- To improve jet clustering,
  - Initial state radiation
  - Isolated lepton
  - Hadronic tau jet were removed from events.
- Durham jet clustering was applied to the remaining events.

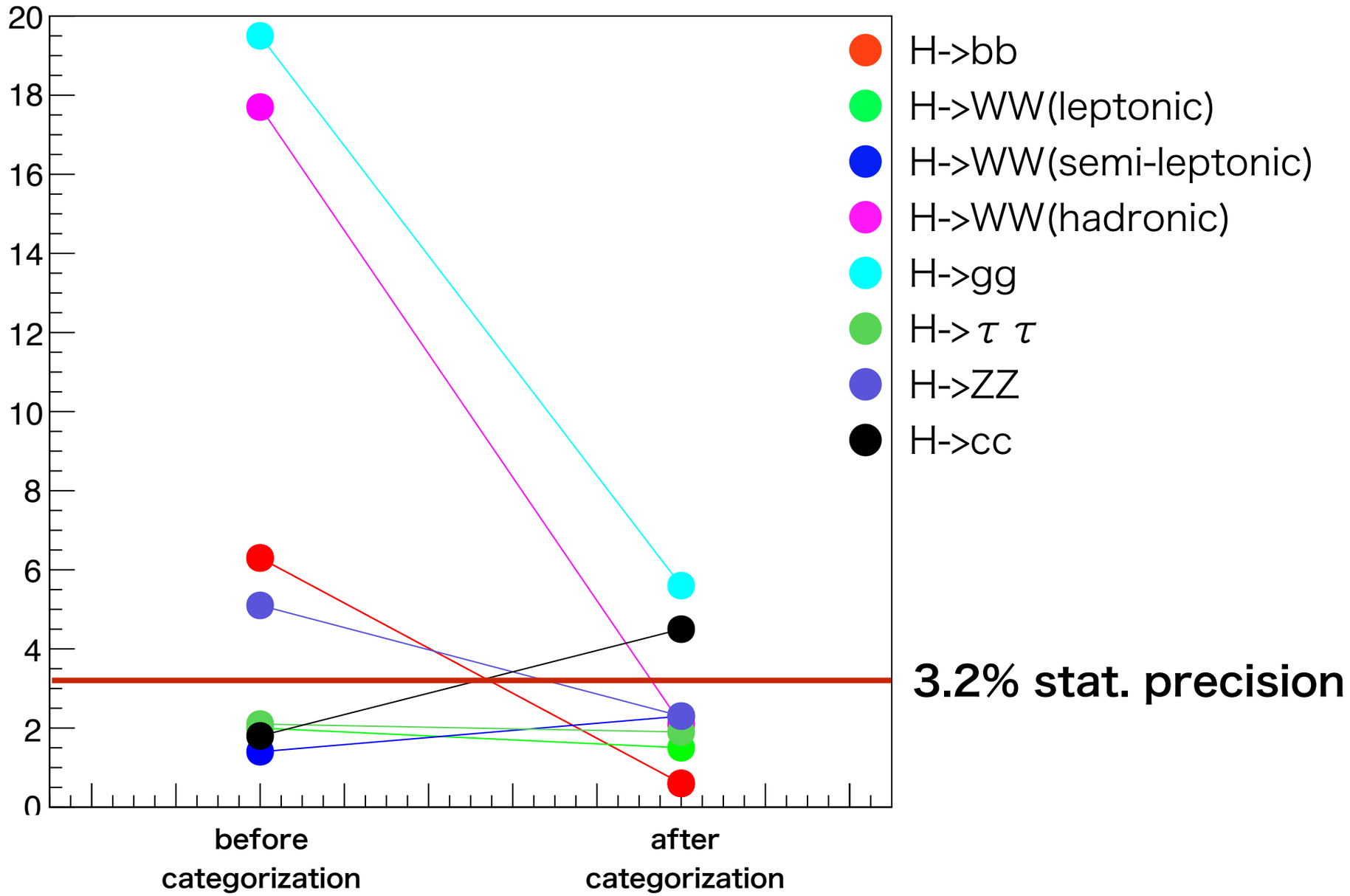
$$y = \frac{2\min(E_i^2, E_j^2)(1 - \cos\theta_{ij})}{Q^2}$$

- Forced 4 jet clustering, y threshold clustering were used.

Cut efficiency and Categorization

- As far as I presented before, cut efficiency of each Higgs decay is different.

- To solve this problem, we used categorization (9 categories).
  (using, number of leptons, number of tau jets, b-tag(>0.6), c-tag(>0.6))



Two Luminosity case

polarization and Luminosity	significance σ_{ZH}	stat. precision σ_{ZH}	stat. precision g_{ZZH}	stat. precision g_{ZZH} (combined)
left (-0.8, +0.3) 250 fb^{-1}	**30.0σ**	**3.3%**	**1.7%**	**1.2%**
right (+0.8, -0.3) 250 fb^{-1}	**32.4σ**	**3.1%**	**1.6%**	**1.1%**
left (-0.8, +0.3) 1150 fb^{-1} (Lumi UP)	**64.3σ**	**1.6%**	**0.8%**	**0.6%**
right (+0.8, -0.3) 1150 fb^{-1} (Lumi UP)	**69.5σ**	**1.4%**	**0.7%**	**0.5%**

The effect of the different BR from SM

bb + 5% (57.7->62.7)	210.27	141.51	+0.1%	-0.1%
bb - 5% (57.7->52.7)	210.06	141.67	-0.1%	+0.1%
cc + 5% (2.9->7.9)	209.07	140.84	-0.5%	-0.5%
cc - 5% (2.9->0.0)	210.77	142.00	+0.3%	+0.3%
gg + 5% (8.6->13.6)	209.95	141.63	-0.1%	~0.0%
gg - 5% (8.6->3.6)	210.38	141.56	+0.1%	~0.0%
WW + 5% (21.6->26.6)	210.01	141.61	-0.1%	~0.0%
WW - 5% (21.6->16.6)	210.15	141.46	~0.0%	-0.1%
tau + 5% (6.3->11.3)	210.4	141.73	+0.1%	+0.1%
tau - 5% (6.3->1.3)	209.93	141.44	-0.1%	-0.1%
ZZ + 5% (2.6->7.6)	210.5	141.86	+0.2%	+0.2%
ZZ - 5% (2.6->0.0)	210.09	141.51	~0.0%	-0.1%

The different BR has only ~0.5 % effect on total cross section of ZH production.
This is much smaller than current stat. precision.

Stat. precision in the “worst case”

- If σtot × BR is not changed from SM, but gZZH is changed.
  The stat. precision of some major decay mode will suppressed.

- bb and tau tau mode were examined.

- about 10 % decrease for bb/tau tau.

- Still keep less than 5 % stat. precision in right polarization

	stat. precision of σZH	stat. precision of gZZH
$\sigma_{tot} \times BR_{bb} = SM$	left : 4.5% right : 3.6%	left : 2.3% right : 1.8%
$\sigma_{tot} \times BR_{\tau\tau} = SM$	left : 3.7% right : 3.4%	left : 1.9% right : 1.7%
$\sigma_{tot} \times BR_{\tau\tau} = SM$ $\sigma_{tot} \times BR_{bb} = SM$	left : 5.8% right : 4.3%	left : 2.9% right : 2.2%

Summary and Prospects

summary

- Using categorization, the difference of cut efficiency is suppressed at most ~ 5 %.

- Stat. precision is about ~ 3 % which is almost the same as leptonic channel (Watanuki-san's results)

- In worst case, the stat. precision is less than 5 % (σZH)

prospects

- 350 GeV

- Invisible decay (ZH->qqZZ->qqnnnn)