Study of the Higgs Self-coupling at the ILC

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status

last meeting

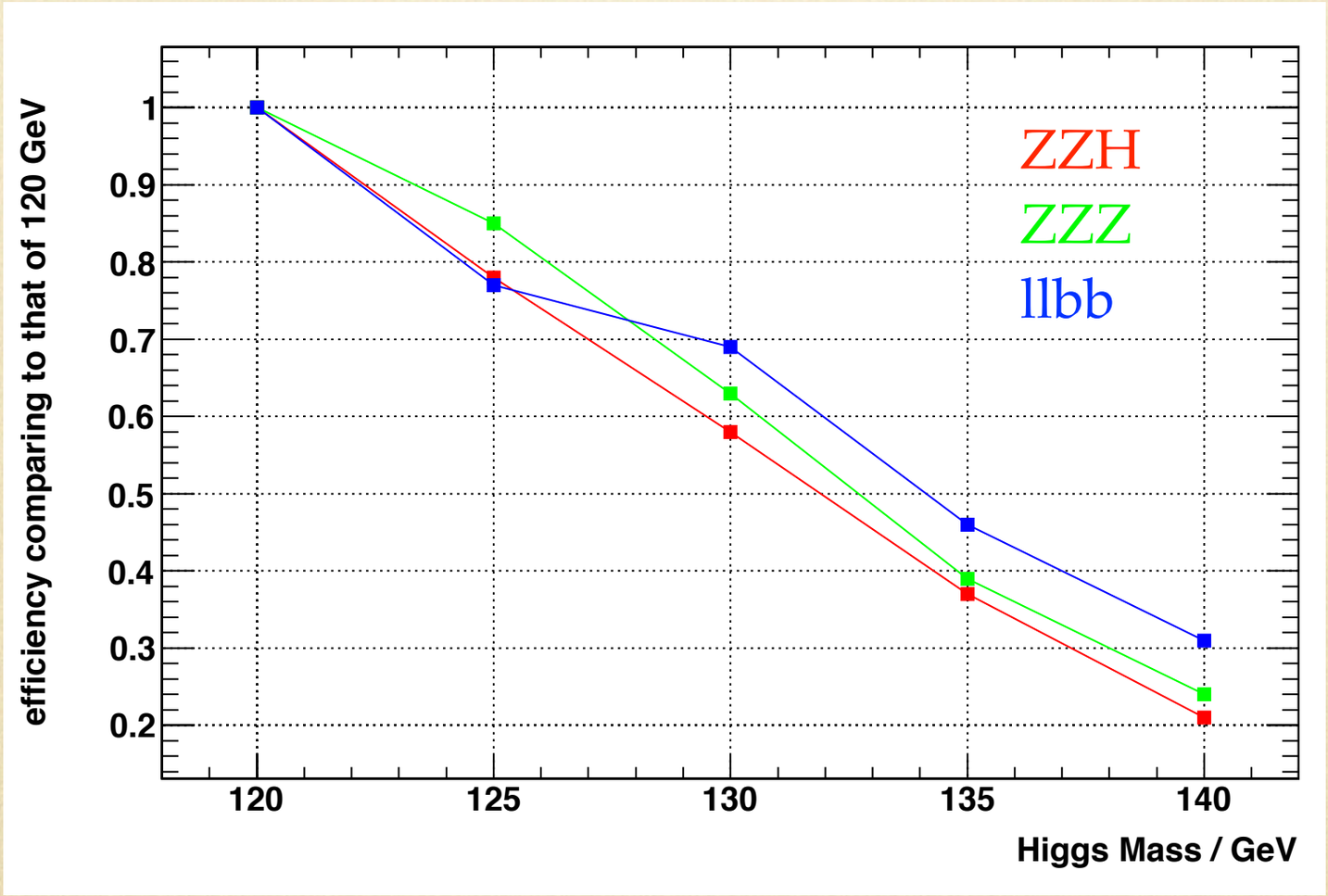
- drop of the cross section of ZHH and drop of the Br of Higgs decays into b-bbar

today

- strategy of extrapolating the efficiencies for different Higgs masses
- expectation of the cross section and self-coupling measurement

efficiency for higher Higgs mass

- assume the signal efficiency unchanged.
- shift the cuts for two Higgs invariant masses to estimate the efficiency drop of the Higgs mass sensitive backgrounds, such as ZZZ, ZZH, llbb.
- keep the t-tbar efficiency unchanged.



remained backgrounds (llHH)

full simulation @ 500GeV

Polarization: (e-,e+)=(-0.8,0.3) $\int Ldt = 2\mathrm{ab}^{-1}$ M(H) = 120 GeV

	llHH	vvHH	qqHH (i)	qqHH (ii)
Signal	6.4	5.2	8.5	16.6
BG	6.7	7.0	11.7	129
ZZZ	1.2	0.6	2.1	6.7
ZZH	4.3	1.5	2.7	7.6
tt, ttqq	-	3.3	5.2	105
llbb, bbbb	1.2	1.6	1.3	9.1

extrapolate from this table

remained S & B for different Higgs masses

(with cross section drop and branching ration drop)

M(H)=125 GeV

	llHH	vvHH	qqHH (i)	qqHH (ii)
Signal	4.5	3.6	6.0	11.6
BG	4.7	6.0	9.7	123

M(H)=130 GeV

Signal	2.9	2.3	3.8	7.4
BG	3.2	5.4	8.4	119

M(H)=135 GeV

Signal	2.9	2.3	3.8	7.4
BG	5.6	4.5	7.1	113

M(H)=140 GeV

Signal	0.9	0.7	1.1	2.2
BG	1.0	4.0	6.3	110

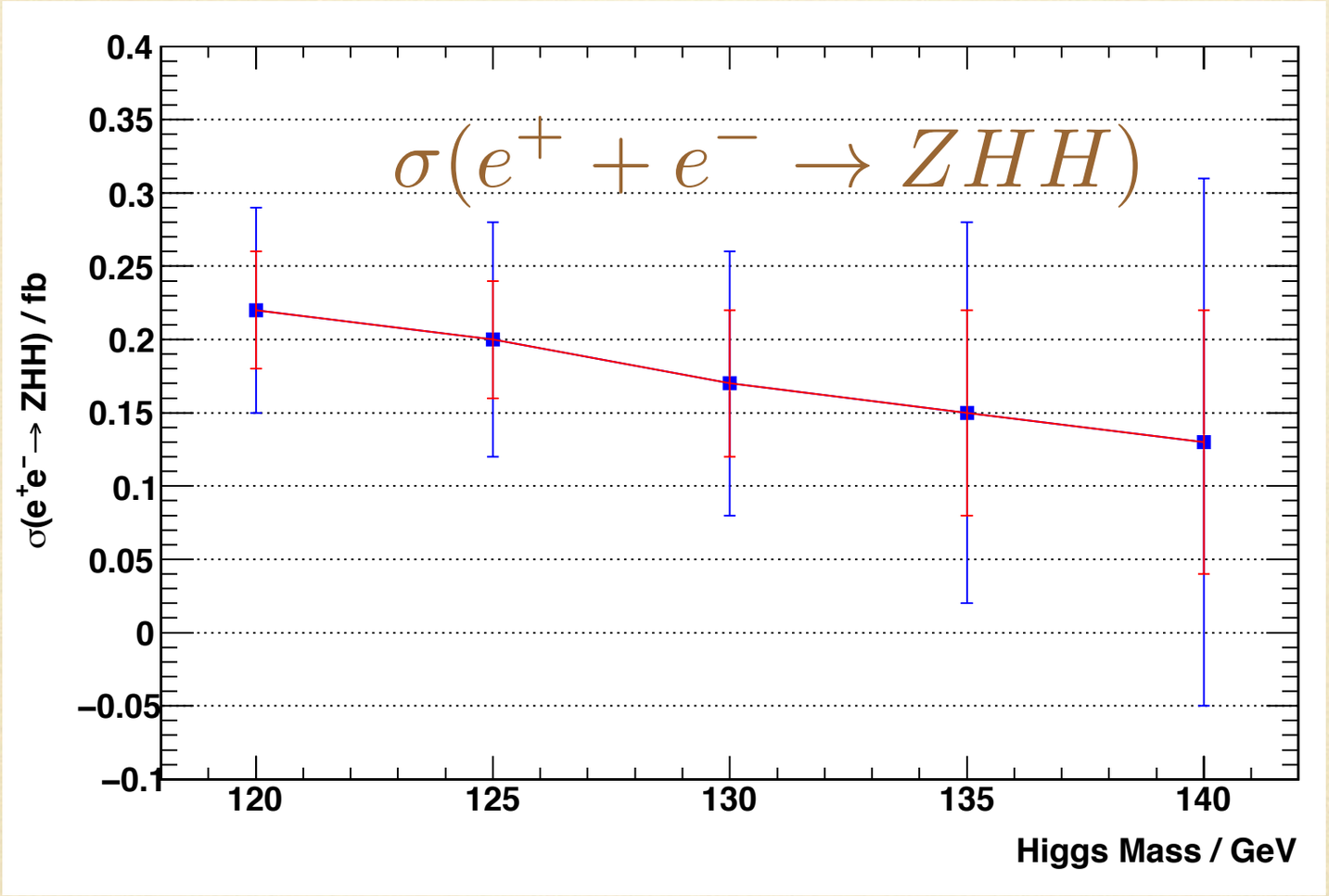
combined significance

Polarization: (e-,e+)=(-0.8,0.3) $\int Ldt = 2\text{ab}^{-1}$

M(H) GeV	120	125	130	135	140
significance	3.9σ	3.4σ	2.2σ	1.4σ	1.0σ
	8.4σ	7.5σ	4.7σ	2.6σ	1.9σ

results for the case we can double the signal efficiency with the future improvement

precision of the cross section

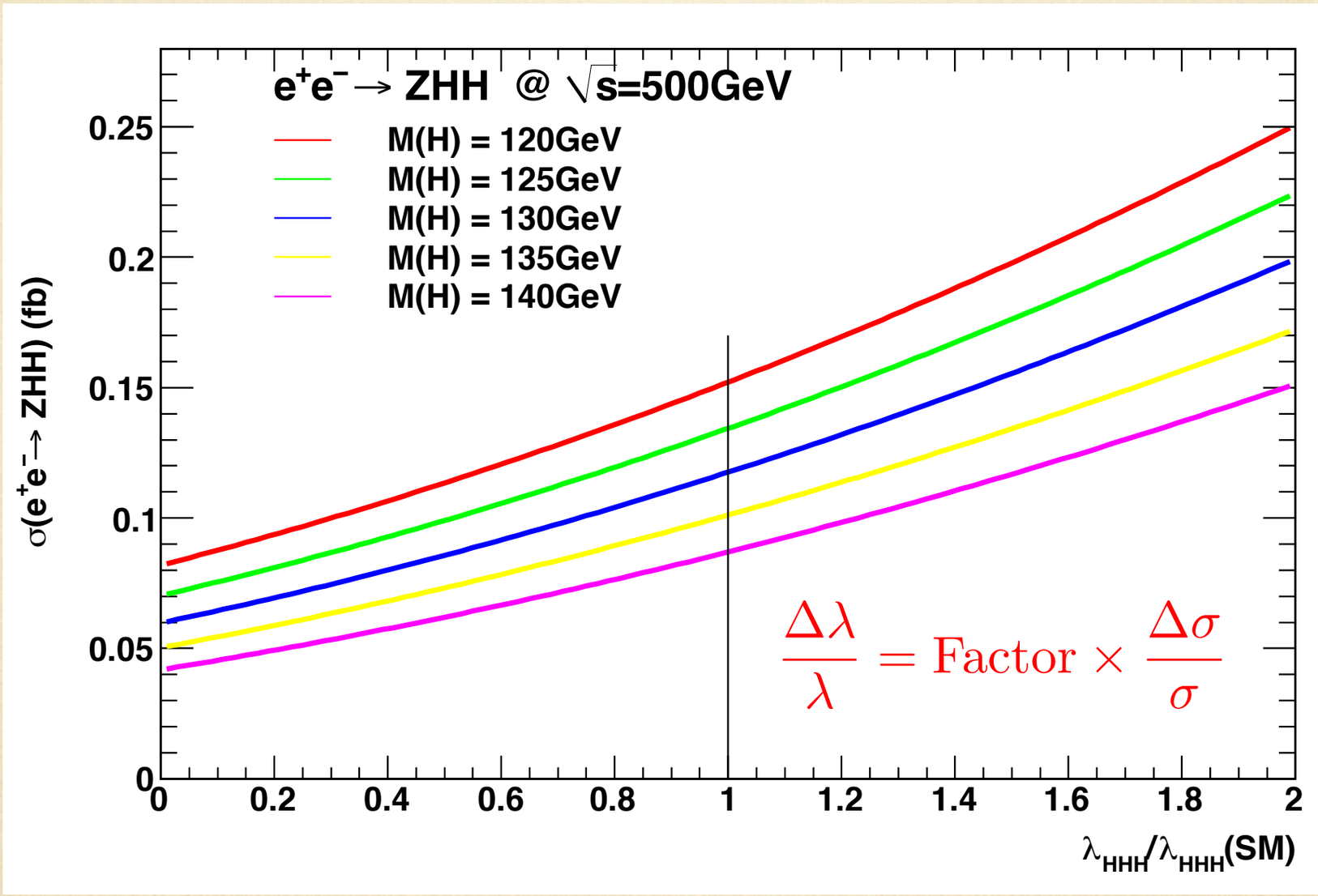


blue: for current analysis technology

red : double the signal efficiency

M(H) (GeV)	120	125	130	135	140
precision	32%	40%	53%	87%	138%
	18%	20%	29%	47%	69%

precision of the self-coupling



effects of irreducible Feynman diagrams

M(H) (GeV)	120	125	130	135	140
Factor	1.80	1.74	1.68	1.63	1.59
precision	57%	70%	89%	142%	219%
	32%	35%	49%	77%	110%

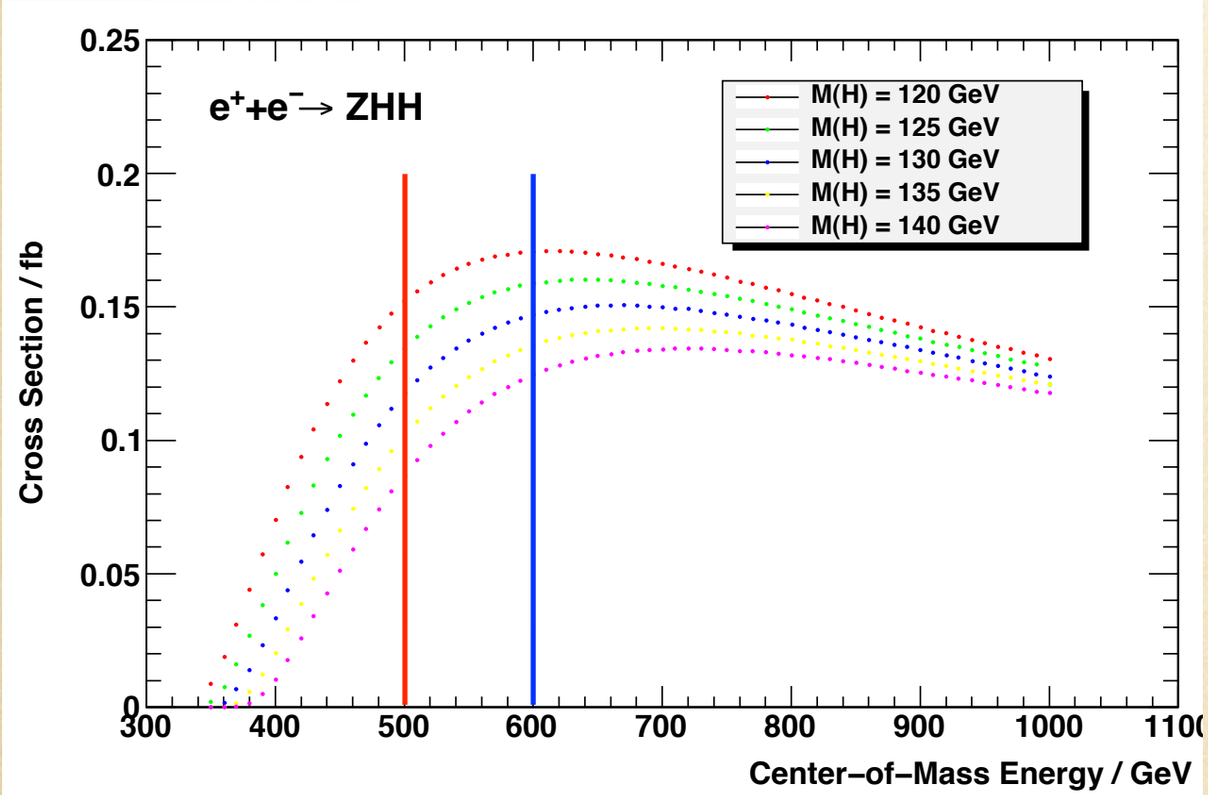
summary

- effects of higher Higgs masses are investigated
- based on previous strategy, self-coupling measurement would be challenge for the mass higher than 130 GeV, even if we can double the signal efficiency by future improved analysis tool. (other Higgs decay modes should be considered in that case)

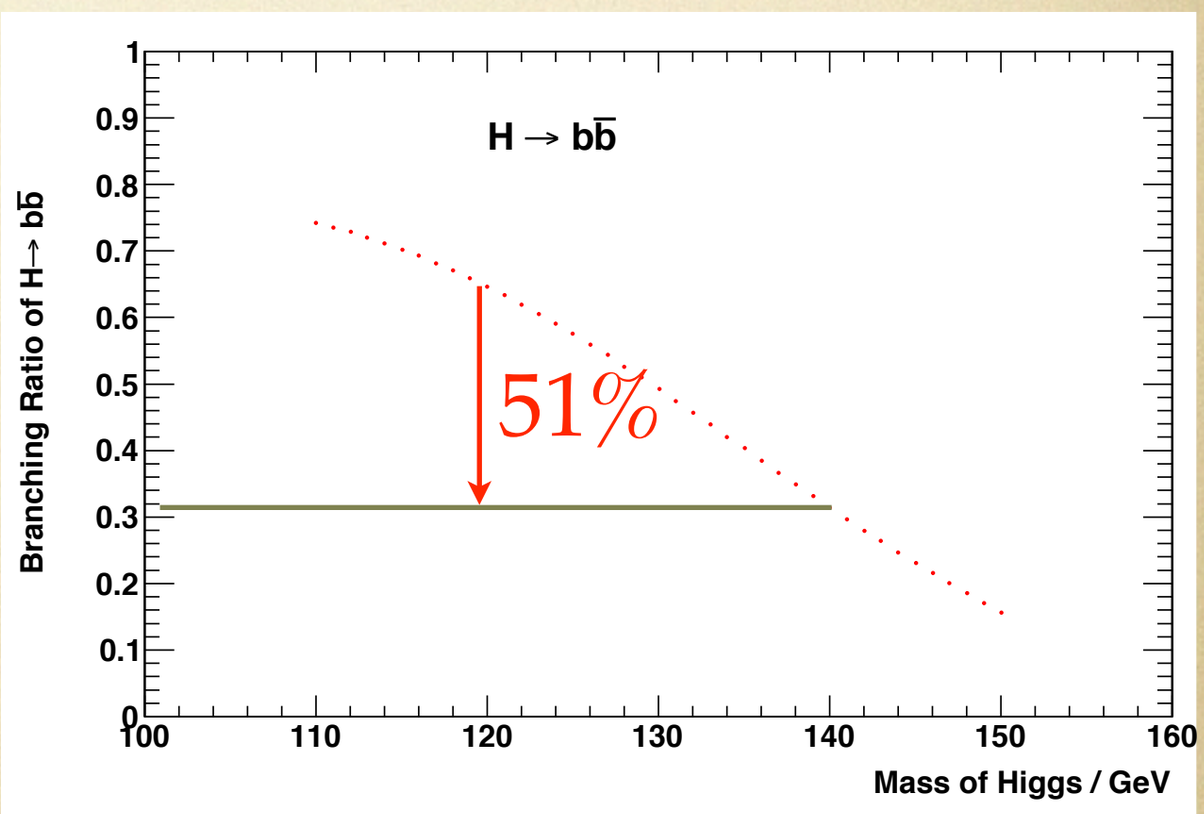
backup

analysis with different Higgs masses

cross section drops quickly



Br(H-->bb) drops quickly



For 140 GeV Higgs, σ(ZHH-->Zbbbb) will be only 13% of that for 120 GeV

we need more efficient selection and consider H--> WW* mode

Expected number of events of $e^+ + e^- \rightarrow ZHH \rightarrow Z + 4$ b-jet

$$\int Ldt = 2\text{ab}^{-1}$$

Ecm	P(e-,e+)	M(H)=120GeV (~42%)	M(H)=140GeV (~10%)
500 GeV	(0.,0.)	127	17
	(-0.8,+0.3)	180	24
540 GeV	(0.,0.)	137	21
	(-0.8,+0.3)	194	30

challenge!

we have to consider H ---> WW*, ~50% for 140 GeV