Sensitivity of Higgs self-coupling in BSM
&
Higgs invisible decay using Z—>ll

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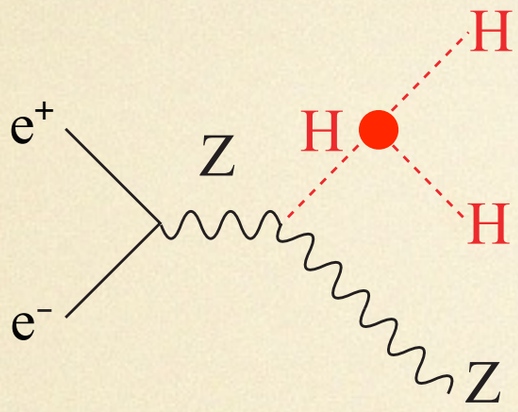
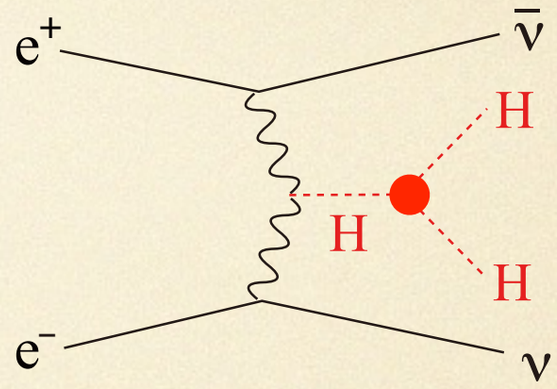
current projections of λ_{HHH} measurement assuming SM





Baseline: 500 fb^{-1} @ 500GeV; 1 ab^{-1} @ 1TeV
LumiUP: 1.6 ab^{-1} @ 500GeV; 2.5 ab^{-1} @ 1TeV
X: 4 ab^{-1} @ 500GeV

P(e-,e+)=(-0.8,+0.3) @ 500GeV
P(e-,e+)=(-0.8,+0.2) @ 1TeV

Full Simulation including
HH—>bbbb and bbWW*

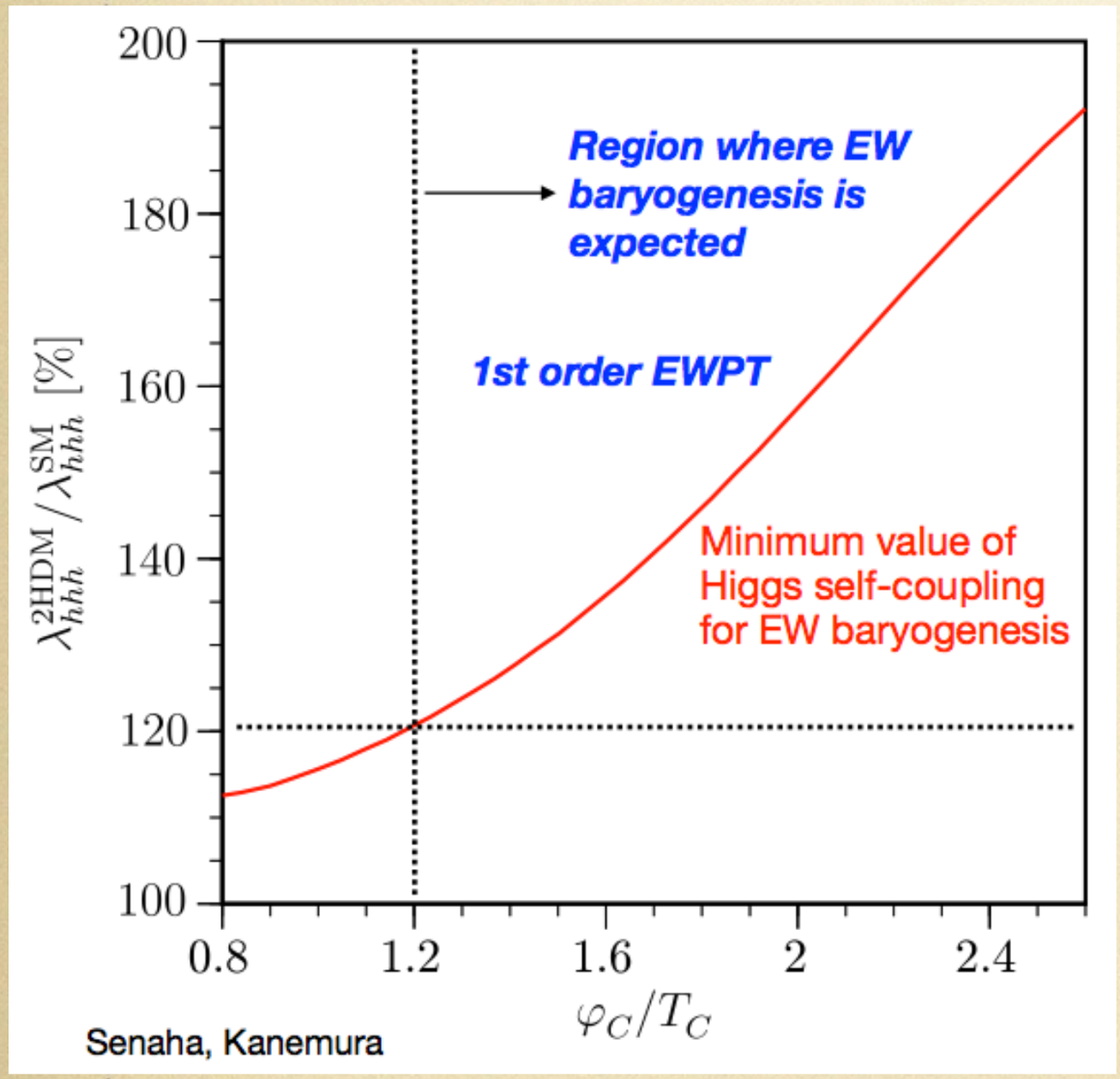
$\Delta\lambda_{HHH}/\lambda_{HHH}$	500 GeV	+ 1 TeV
Baseline	83%	21%
LumiUP	46%	13%
X	29%	

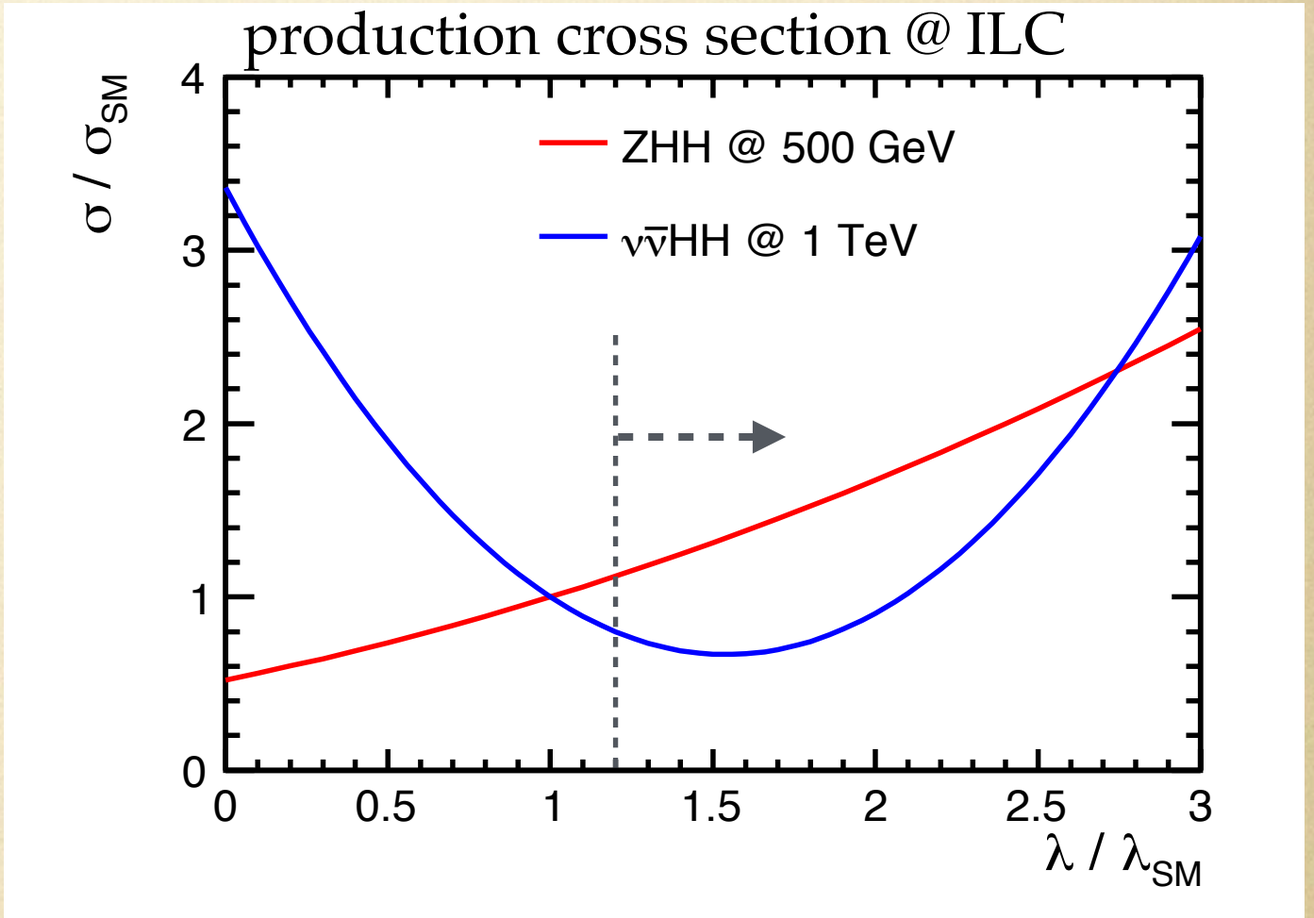
can we make the physics case for λ_{HHH} at 500 GeV stronger?

for analysis update see talks at coming ALCW15 by Claude and Masakazu;
for new ILC running scenarios see talk by ILC Parameters Group

λ_{HHH} in BSM — Electroweak Baryongenesis

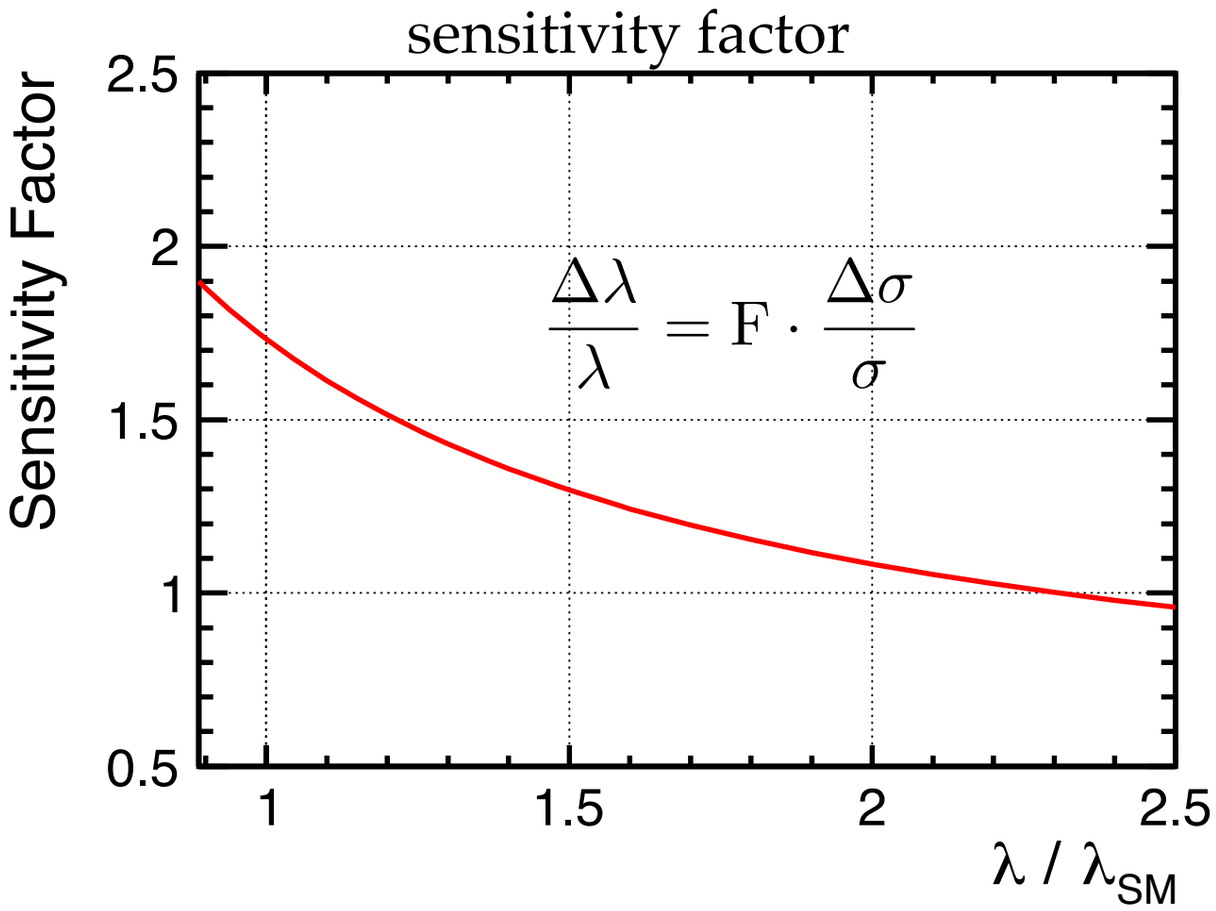
can be significantly enhanced — good for measurement using ZHH @ 500 GeV

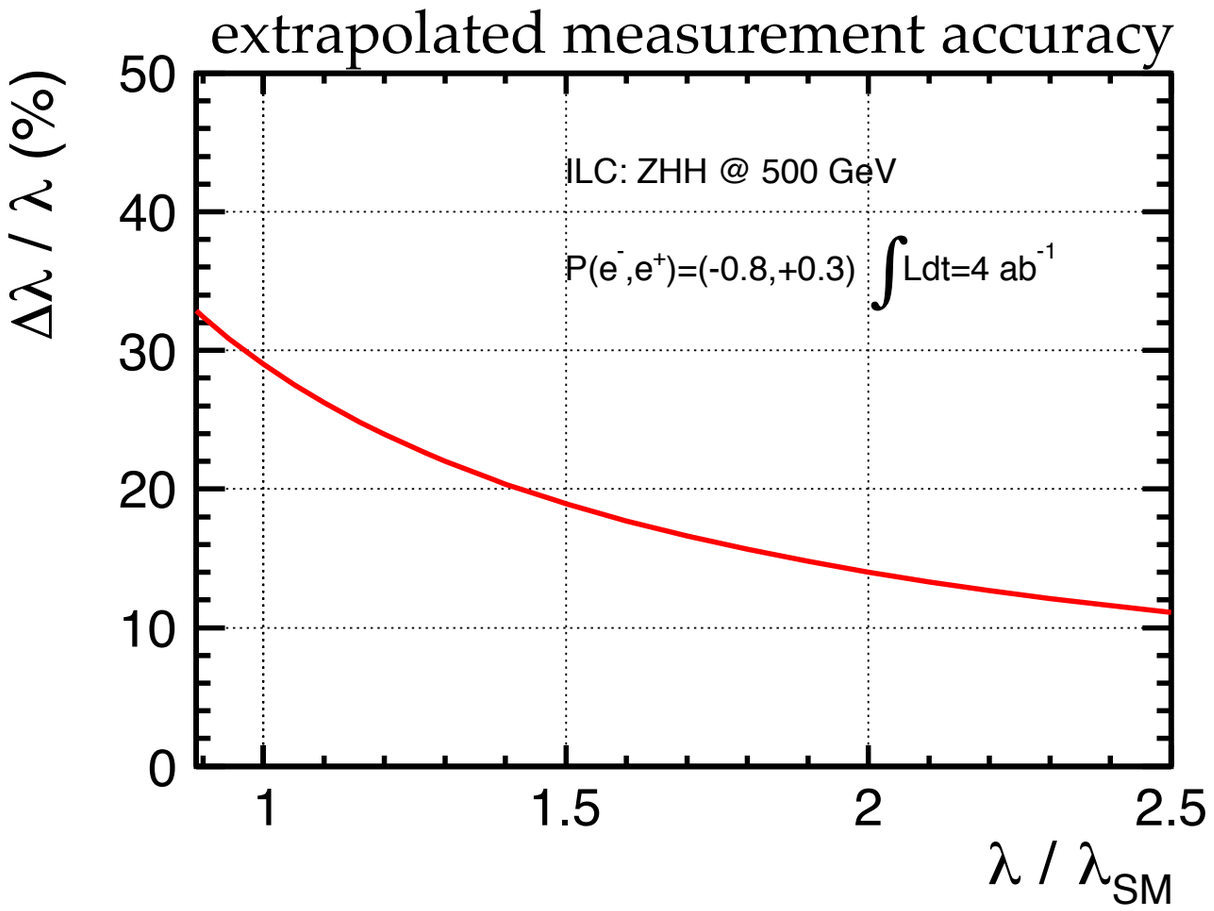




If λ_{HHH} is enhanced — ZHH @ 500 GeV

not only cross section is increased,
but also sensitivity factor is improved





example: if $\lambda_{HHH} = 2\lambda_{SM}$

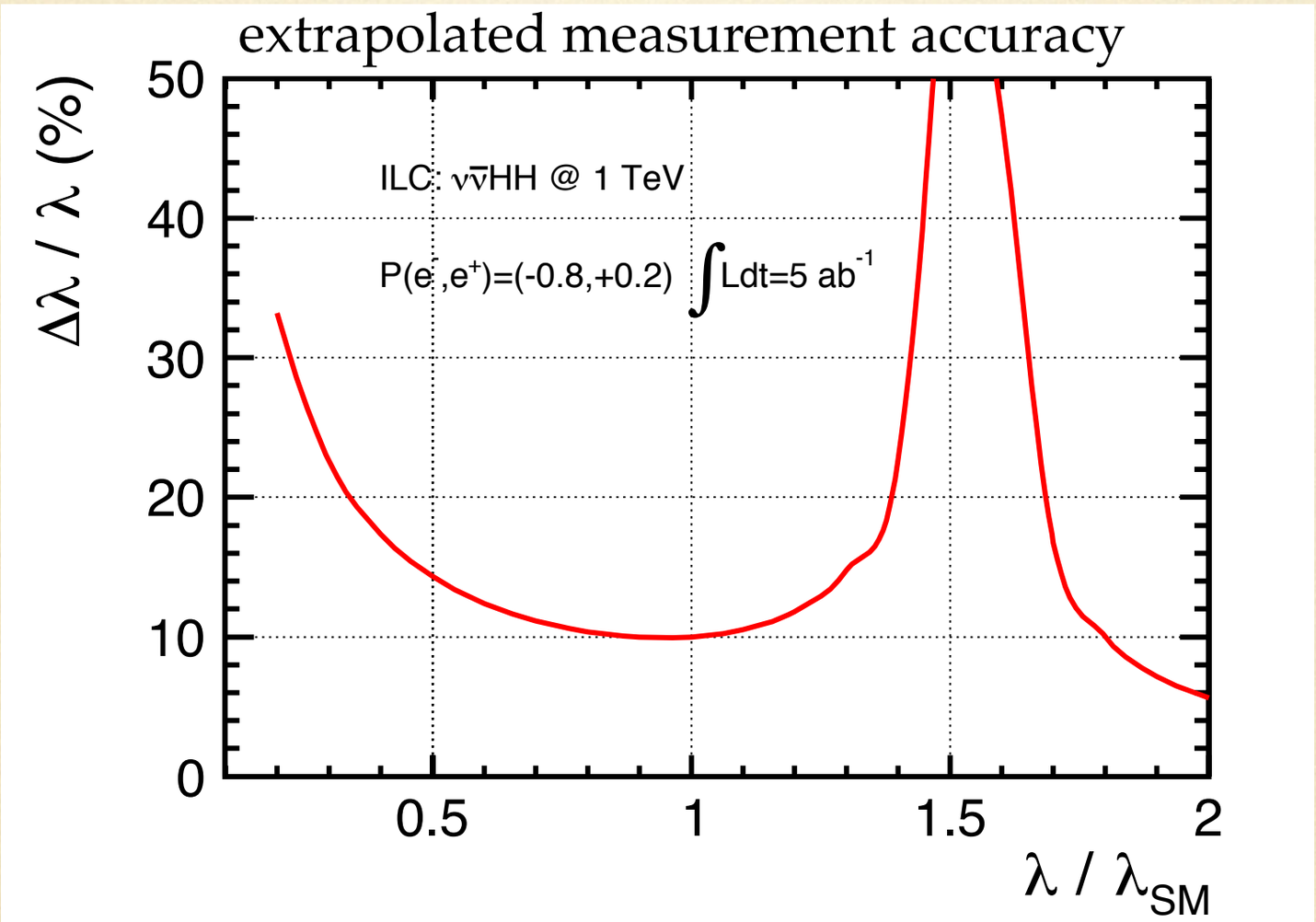
σ_{ZHH} enhanced by 60%; F reduced from 1.73 to 1.08; $\Delta\lambda/\lambda$ improved by a factor of 2

λ_{HHH} will be measured to 14% —> 7σ discovery —> more than 3σ deviation from SM

note: this is without taking into account ongoing analysis improvement and better weighting at larger λ

If λ_{HHH} is suppressed — other BSM cases

probably we need go to 1 TeV by using ννHH



example: if $\lambda_{HHH} = 0.5\lambda_{SM}$

λ_{HHH} will be measured to 14% —> 7σ discovery —> more than 3σ deviation from SM

H—>invisible search

sensitive test to Higgs portal models, opportunity to access Dark Matter

news from search at LHC: (ATLAT-CONF-2015-004)

ATLAS: BR(H—>inv.) < 29% with 95% CL reported at Moriond 2015

(1 month ago at Toyama the upper limit was 50% at HPNP2015)

(main update is from new analysis using VBF production)

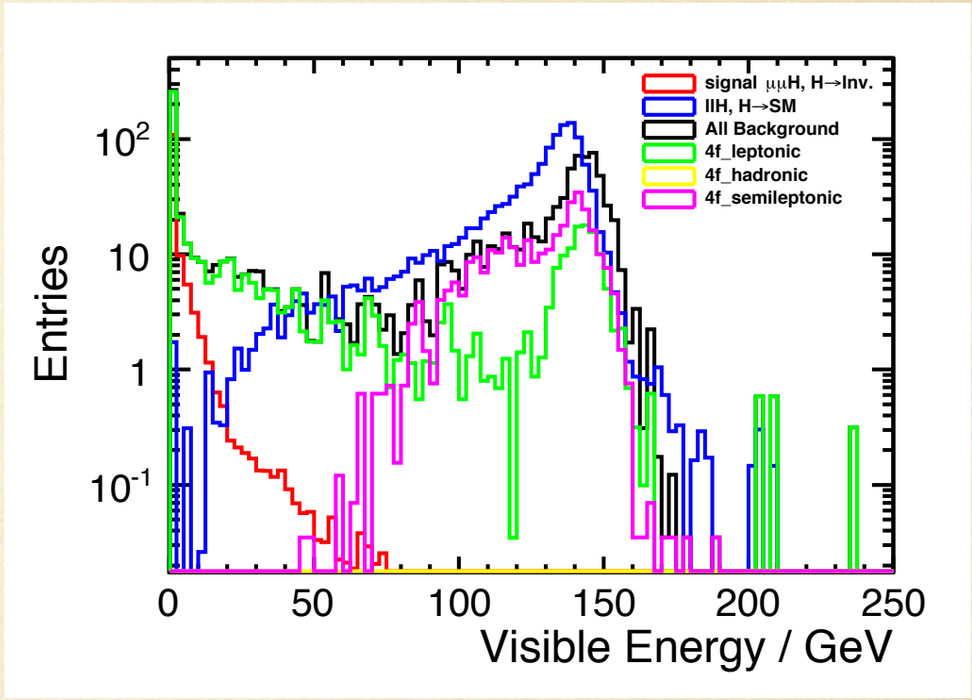
study at ILC (by A. Ishikawa @ LCWS14): using Z—>qq channel

UL on BF [%] (time needed to achieve upper limit of 0.69% [year])	"Left"	"Right"
250GeV	0.95 (5.7)	0.69 (3.0)
350GeV	1.49 (14)	1.37 (12)
500GeV	3.16 (63)	2.30 (33)

Note: search at LHC is not model independent, but is at ILC

update: invisible decay using Z—>ll @ ILC

- analysis is extremely simple: 2-isolated-lepton + missing
- event selections are almost identical to leptonic recoil mass analysis
- except one more cut on visible 4-momentum other than the di-lepton



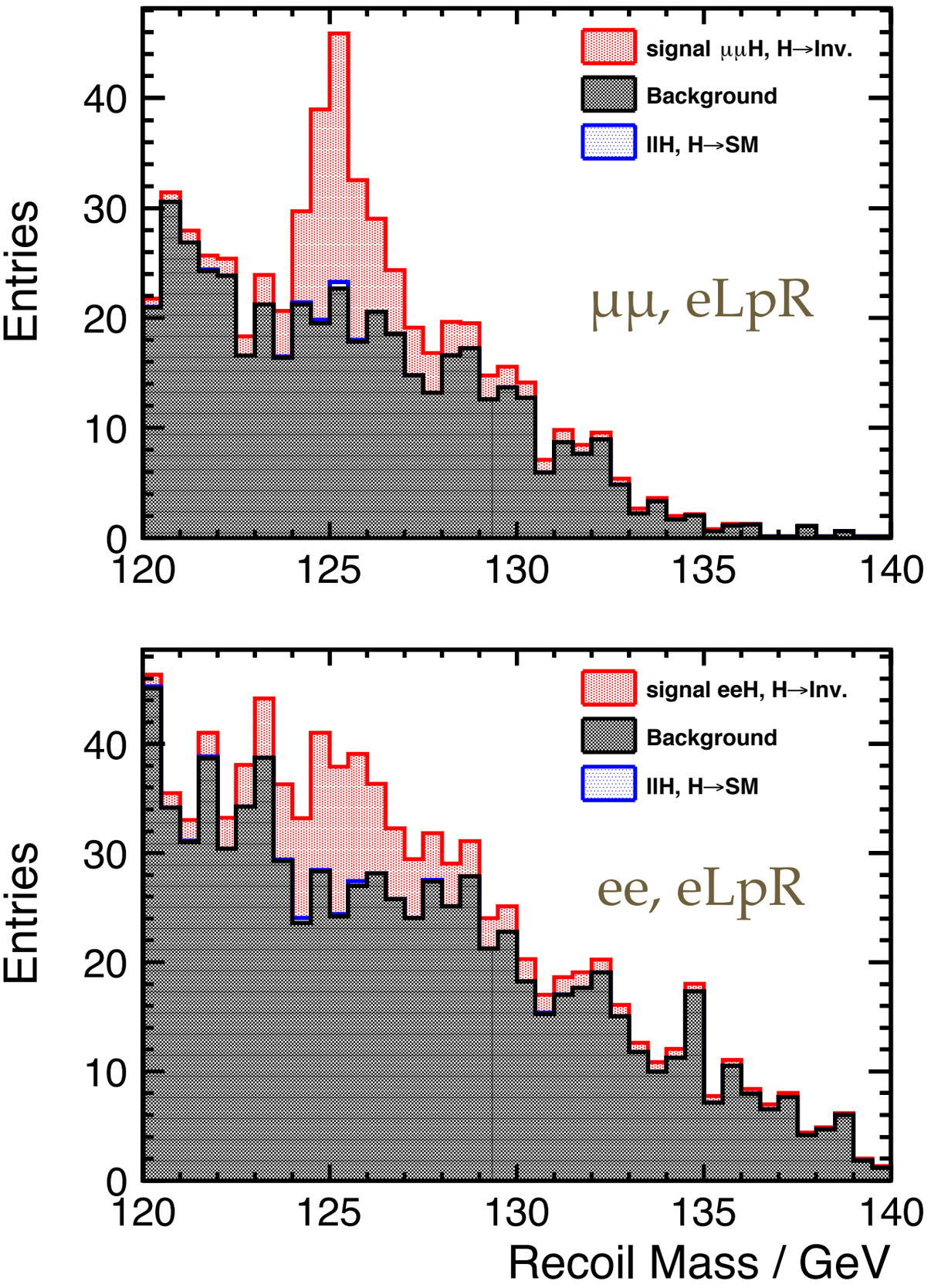
P(e-,e+) = (+0.8,-0.3); 250 fb^{-1} @ 250 GeV

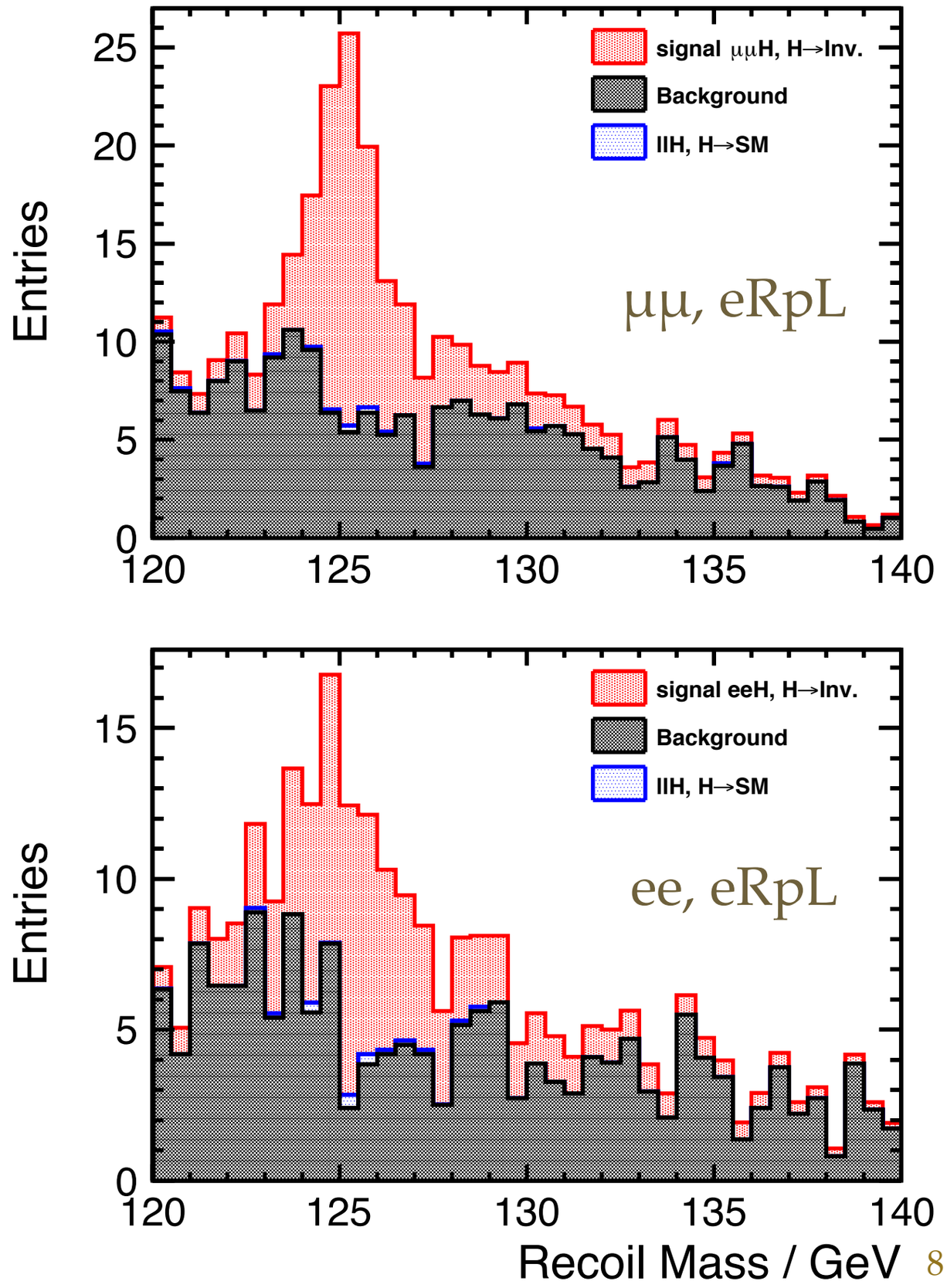
250 GeV BR(inv)=10%	μμH H->inv	llH (SM)	4f_l	4f_sl	4f_h	BG	significance
#expected	176	3778	3.67E+05	5.16E+05	3.92E+05	2.16E+07	0.037
pre-selection	166	1636	1.89E+05	1.30E+05	0	5.20E+05	0.23
cut0	133	1236	542	314	0	1084	2.7
cut_vis	130	3.0	314	0	0	325	6.1
cut_mva	122	2.9	227	0	0	232	6.4

Note: cut0 includes all the usual cuts used in leptonic recoil mass analysis

invisible decay using Z—>ll @ 250 GeV

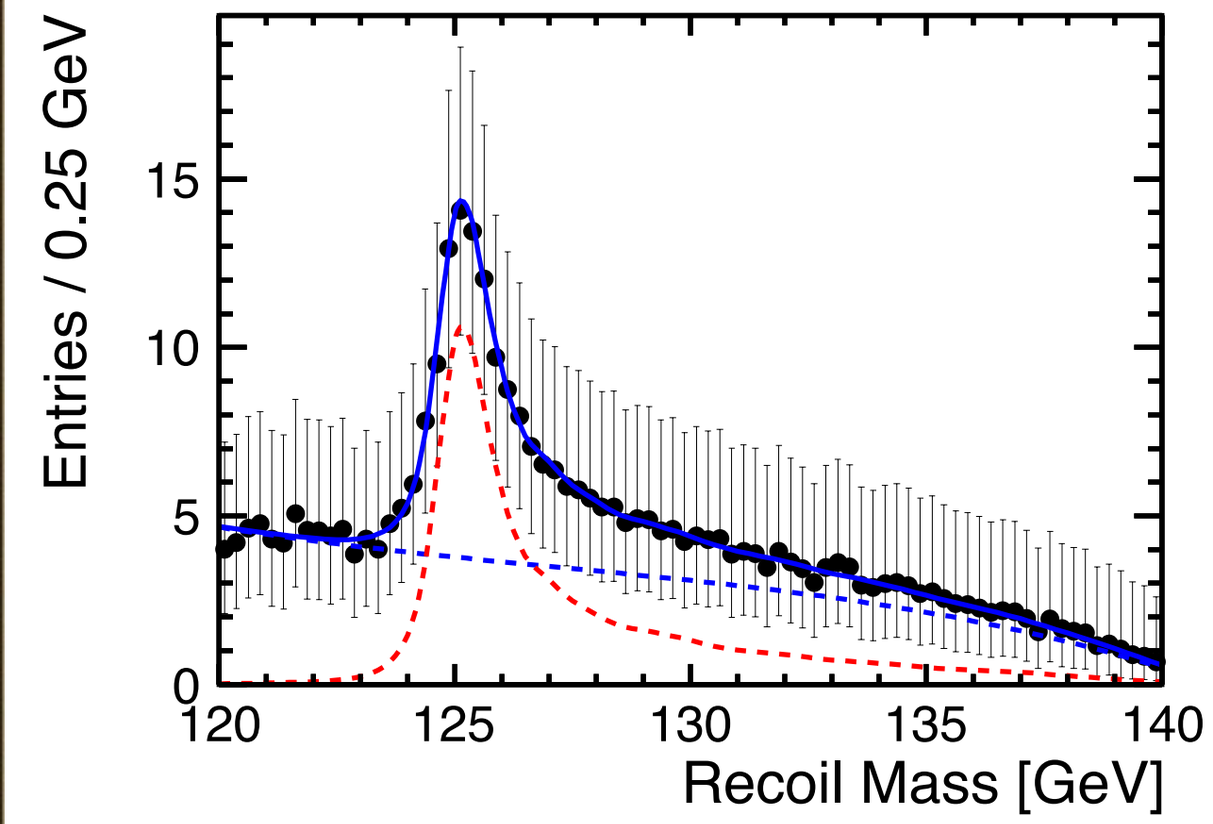
(Br(H—>inv.) = 10%, 250 fb^{-1} data)

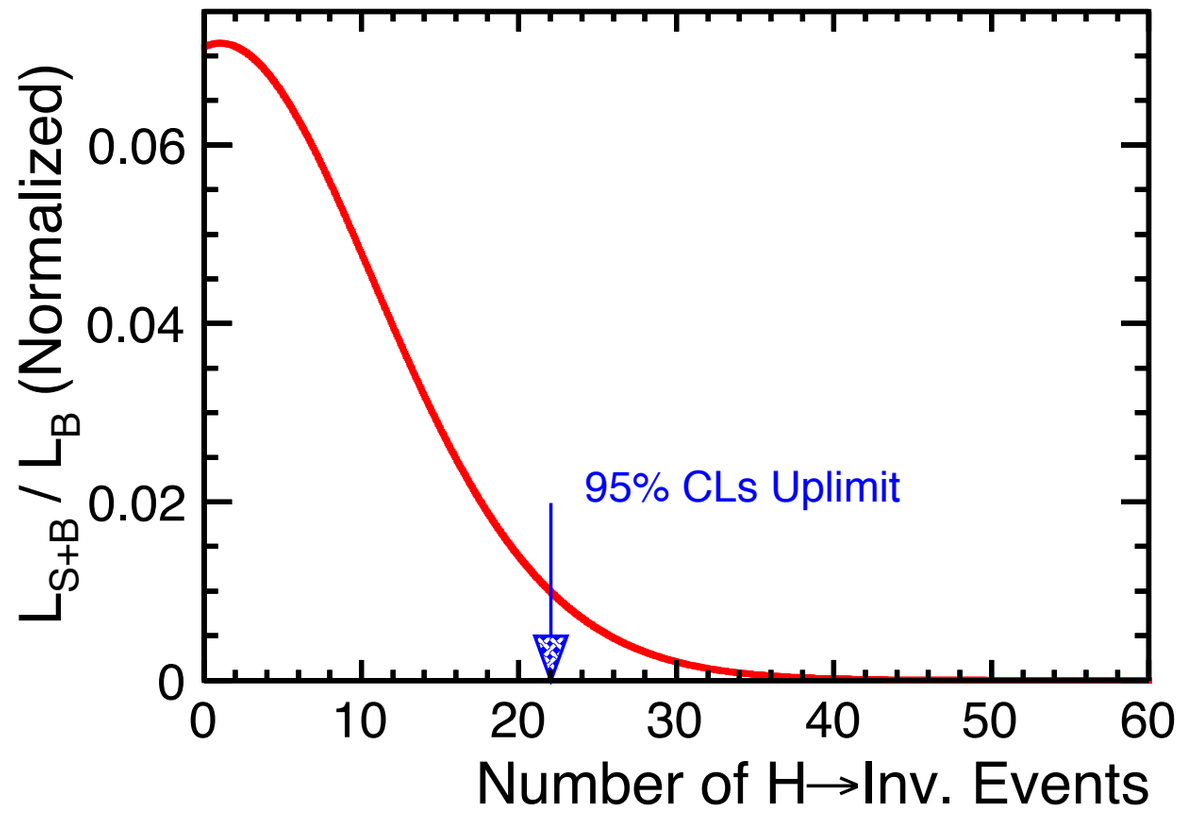




upper limit using CLs method (L_{S+B}/L_B)

Z—>μμ @ 250 GeV, P(e-,e+)=(+0.8,-0.3)





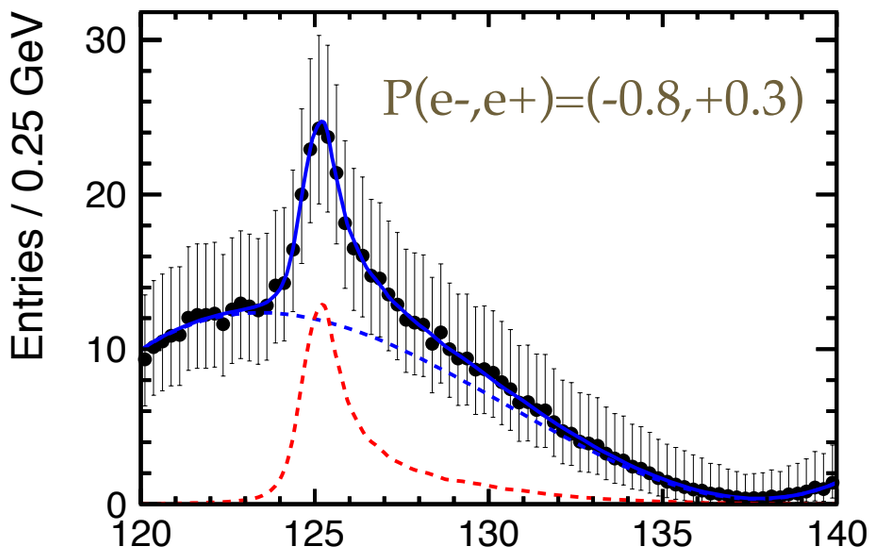
- (left) fitting S+B data with kernel function + polynomial
- (right) calculate L_{S+B}/L_B for B only (assuming no signal) data as a function of number of signal events, and set the 95% C.L upper limit

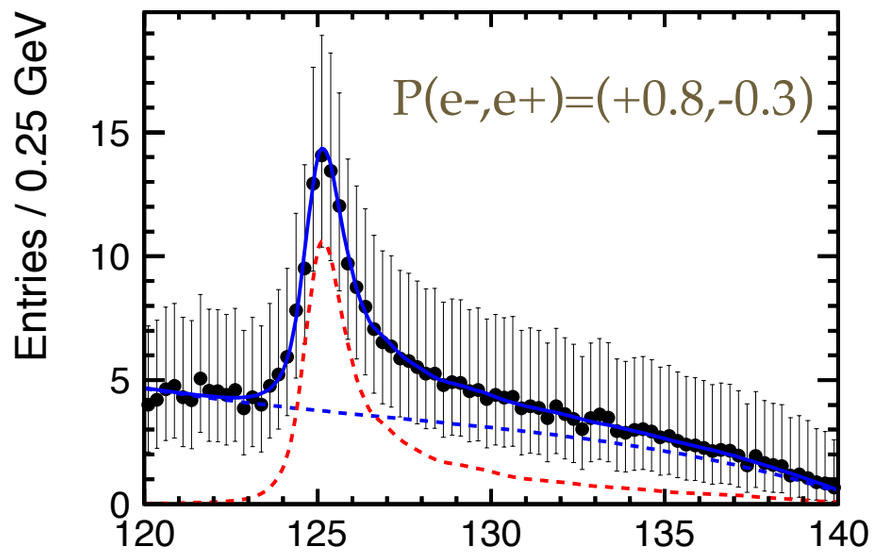
Z—>μμ

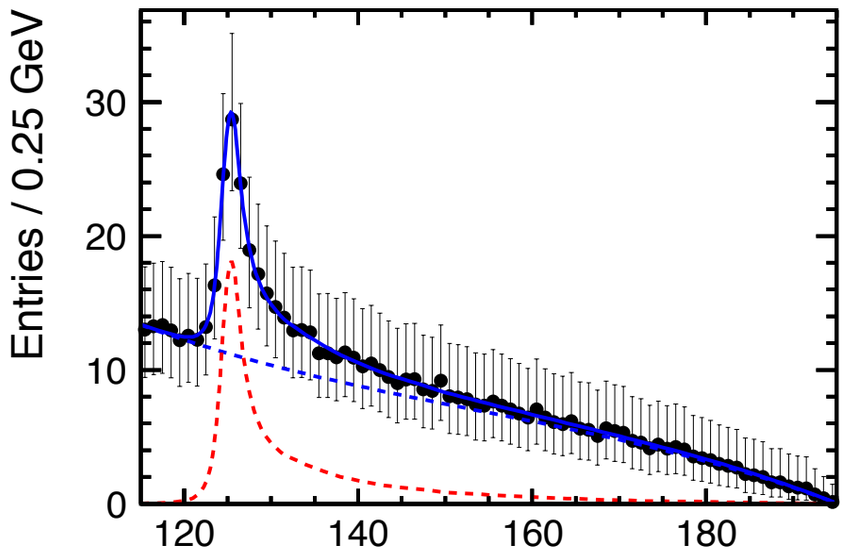
250 fb^{-1}
@ 250GeV

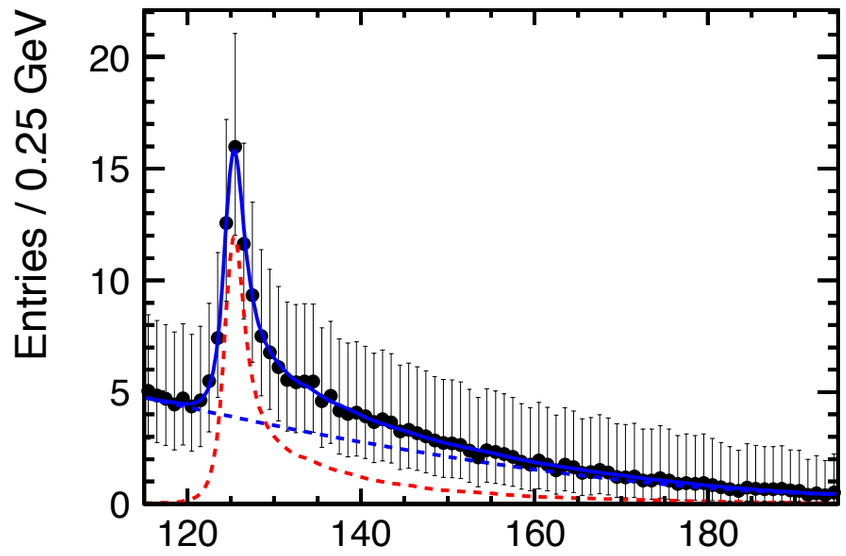
330 fb^{-1}
@ 350GeV

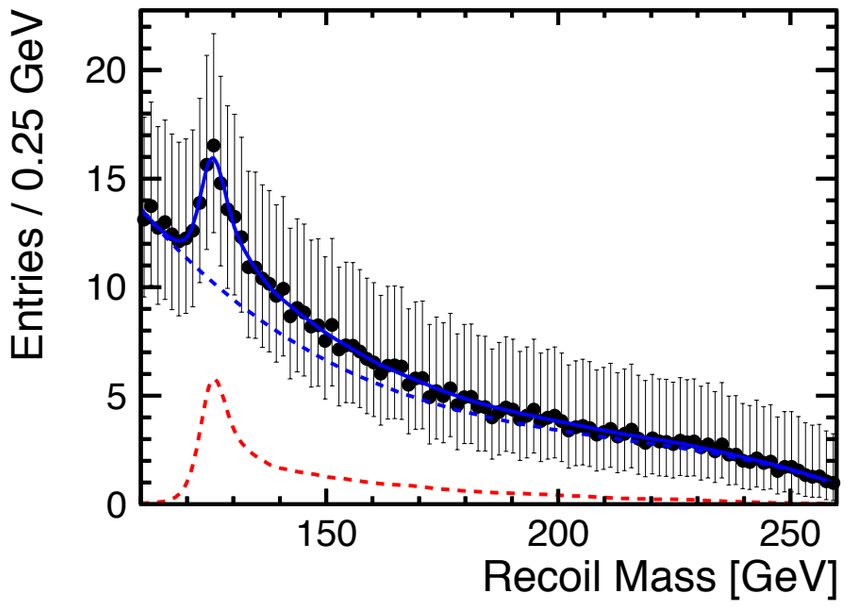
500 fb^{-1}
@ 500GeV

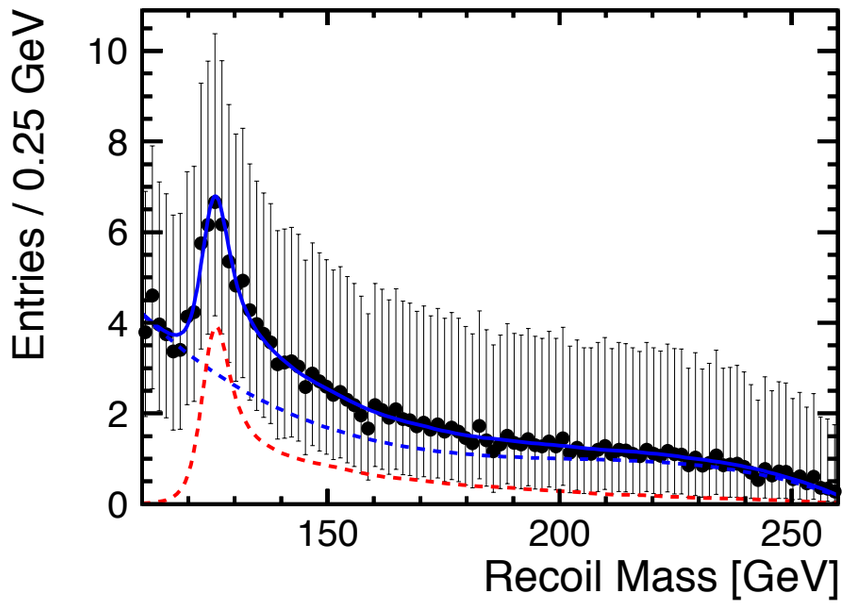












upper limit of H—>invisible (95% CL)

BR(inv) upper limit	Z—>ll	(-0.8,+0.3)	(+0.8,-0.3)
250 fb^{-1} @ 250 GeV	μμH	2.46%	1.57%
	eeH	3.56%	2.22%
	combined	2.02%	1.28%
330 fb^{-1} @ 350 GeV	μμH	2.36%	2.09%
	eeH	4.17%	3.42%
	combined	2.05%	1.78%
500 fb^{-1} @ 500 GeV	μμH	4.31%	3.28%
	eeH	6.78%	4.46%
	combined	3.64%	2.64%

Z—>qq
(A.Ishikawa)

UL on BF [%] (time needed to achieve upper limit of 0.69% [year])		"Left"	"Right"
250GeV	(250 fb^{-1})	0.95 (5.7)	0.69 (3.0)
350GeV	(350 fb^{-1})	1.49 (14)	1.37 (12)
500GeV	(500 fb^{-1})	3.16 (63)	2.30 (33)

upper limit of H—>invisible by combining Z—>qq and Z—>ll

BR(inv) upper limit	P(e-,e+)=(-0.8,+0.3)	P(e-,e+)=(+0.8,-0.3)
250 fb^{-1} @ 250 GeV	0.86%	0.61%
330 fb^{-1} @ 350 GeV	1.23%	1.10%
500 fb^{-1} @ 500 GeV	2.39%	1.73%

back up

λ_{HHH} at LHC