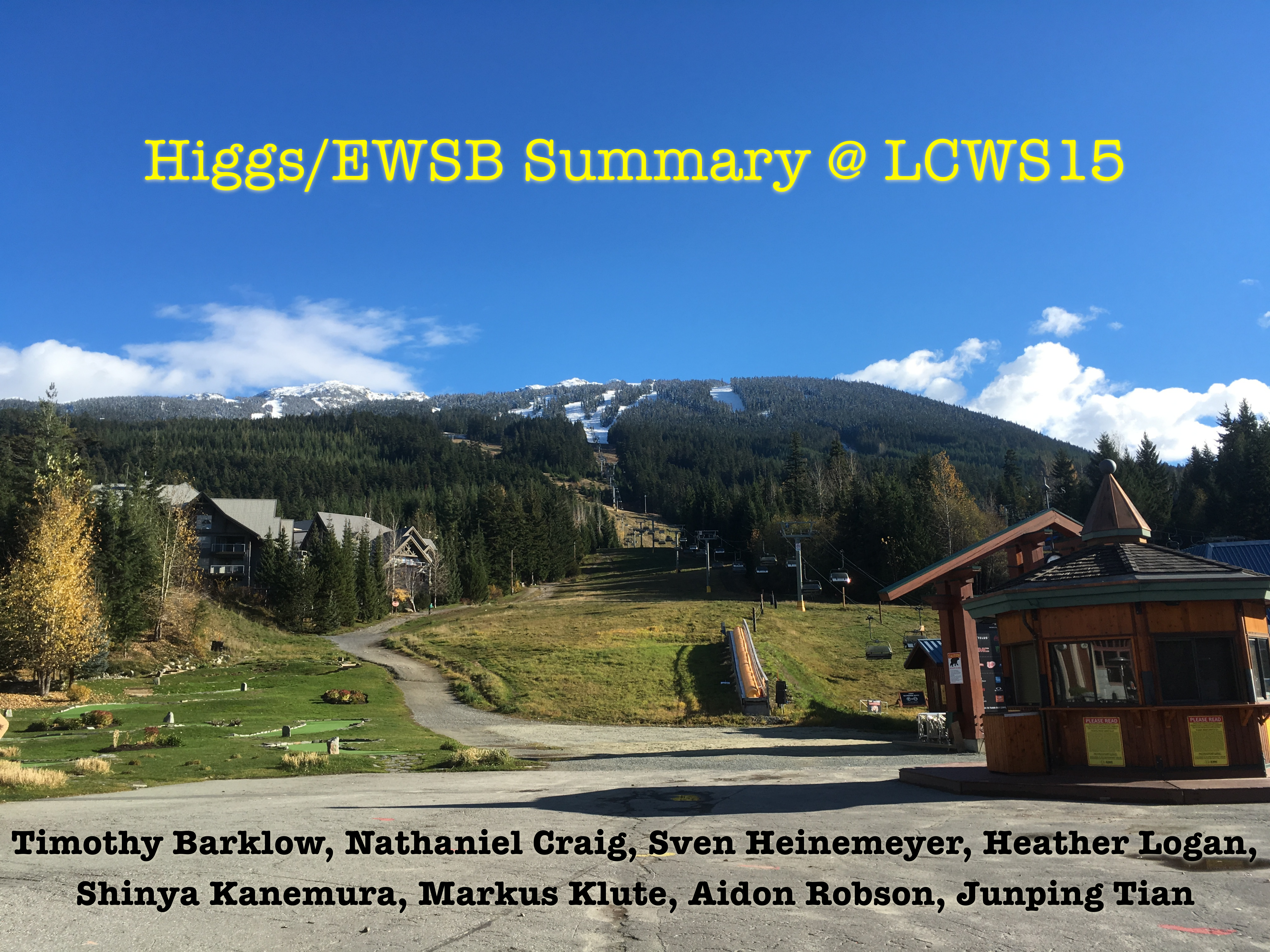
Higgs/EWSB Summary @ LCWS15



**Timothy Barklow, Nathaniel Craig, Sven Heinemeyer, Heather Logan,
Shinya Kanemura, Markus Klute, Aidon Robson, Junping Tian**

20 talks in Higgs/EW & joint Higgs-BSM sessions

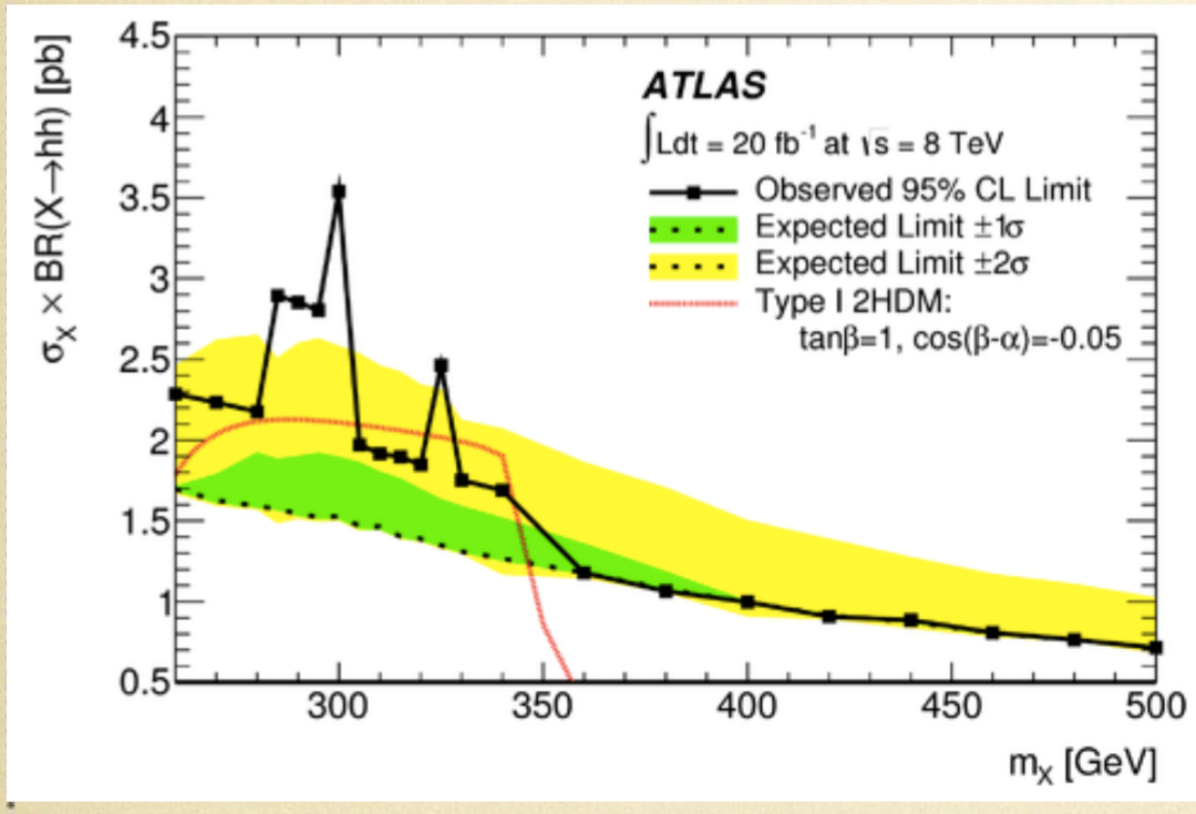
2 LHC:	Caterina VERNIERI, Pilar CASADO
7 ILC:	Masakazu KURATA, Tomohisa OGAWA, Timothy BARKLOW, Aliakbar EBRAHIMI, Jacqueline YAN, Michele FAUCCI GIANNELLI, Graham WILSON
4 CLIC:	Rosa SIMONIELLO, Ivanka BOZOVIC-JELISAVCIC, Marco SZALAY, Philipp ROLOFF
7 Theory:	Kazuhiro ENDO, Mitsuru KAKIZAKI, Sven HEINEMEYER (2), Shinya KANEMURA, Cheng-Wei CHIANG, Mariko KIKUCHI

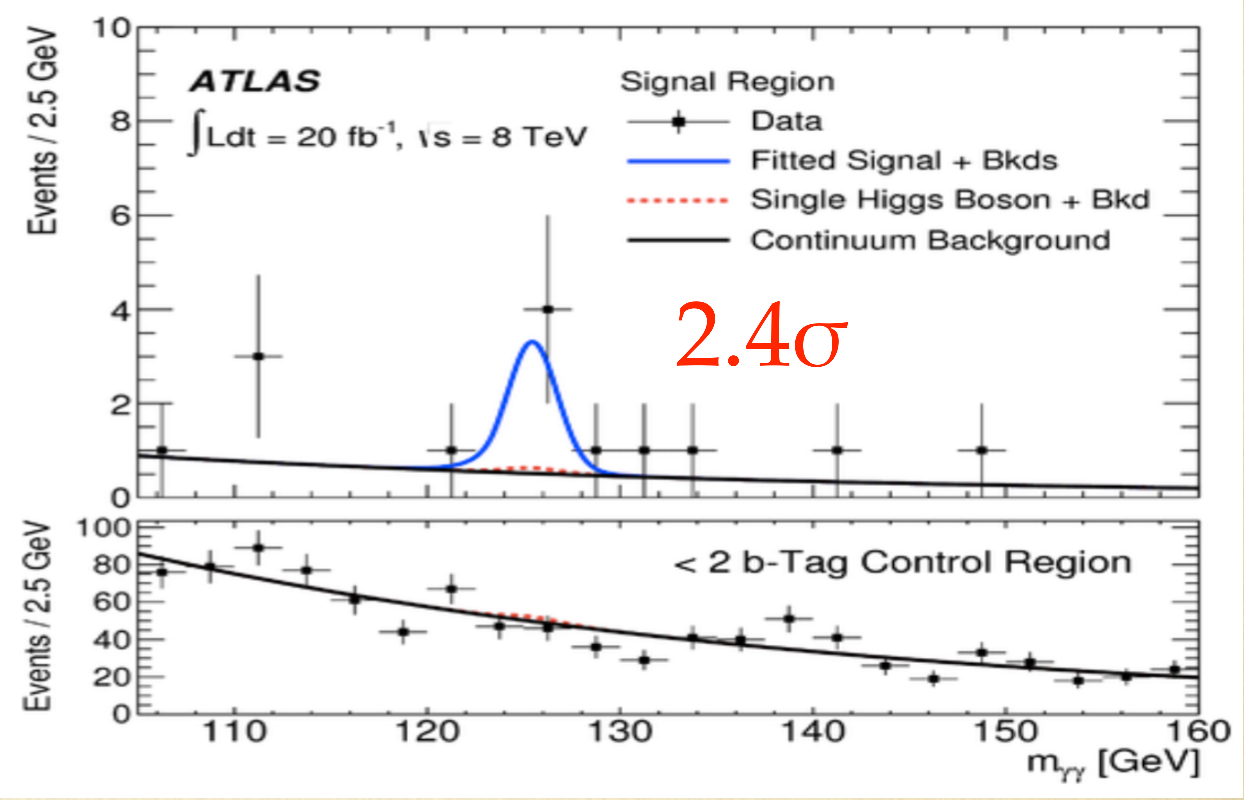
*joint Higgs-Top session will be summarised by F.Simon

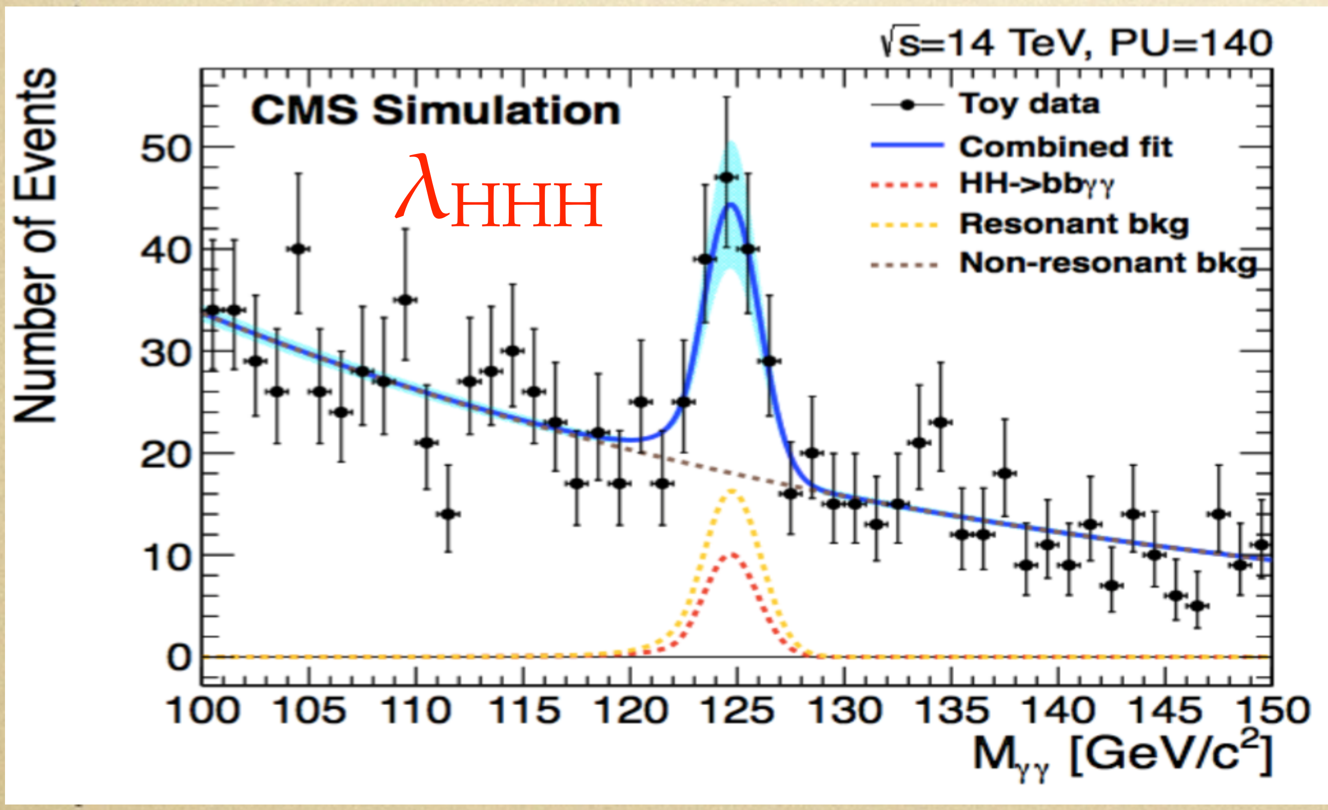
pp—>HH search and λ_{HHH} @ LHC

C. Vernieri

Non-resonant search are far from SM sensitivity (>50x SM)







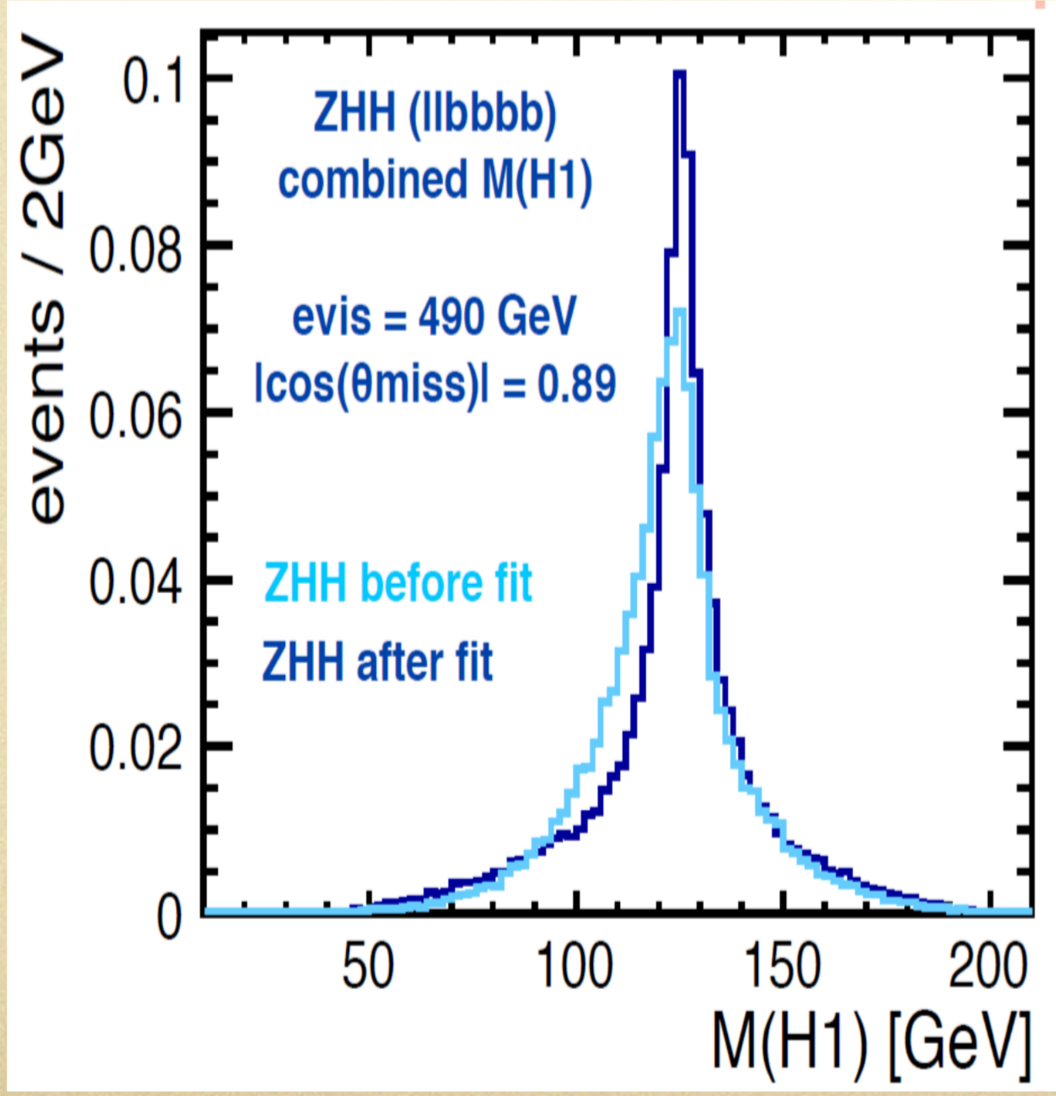
- Very preliminary studies are being performed for the experiment upgrades at HL-LHC
- Cross section for SM hh production is 40.7 fb at 14 TeV
- Sensitivity to non resonant SM hh production can reach
  - ~1.5σ per experiment in the bbγγ channel
  - ~1.9σ combination of bbγγ, bbWW, bbττ

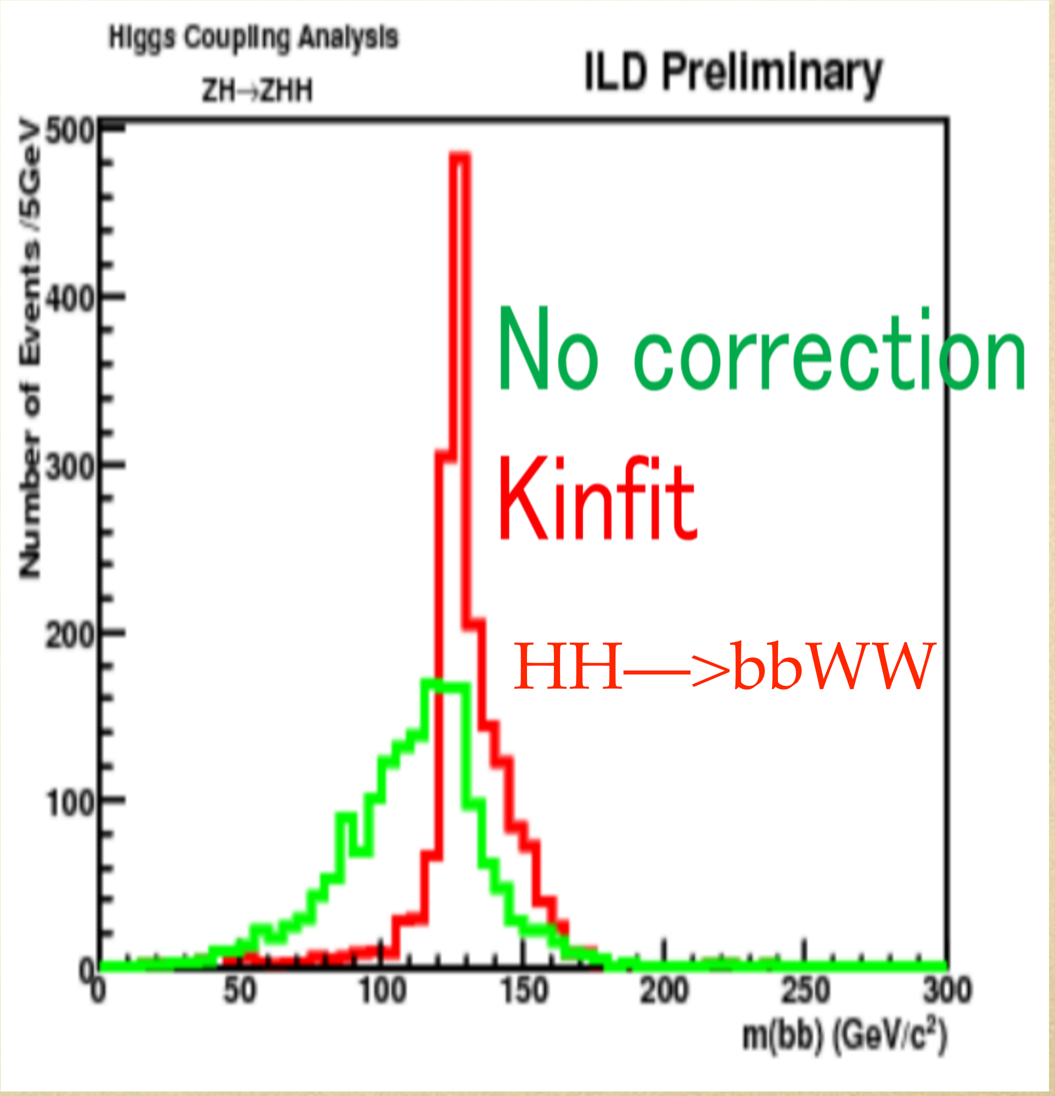
e+e-—>ZHH and λ_{HHH} @ ILC

M. Kurata

$\Delta\lambda_{HHH}/\lambda_{HHH}$	500 GeV	+ 1 TeV
Snowmass	46%	13%
H20	27%	10%

- main update: kinematic fitting with ISR treatment, neutrino recover in b-jet, asymmetric JER in b-jet
- HH—>bbbb: ~20% improvement
- HH—>bbWW*: 6-15% improvement



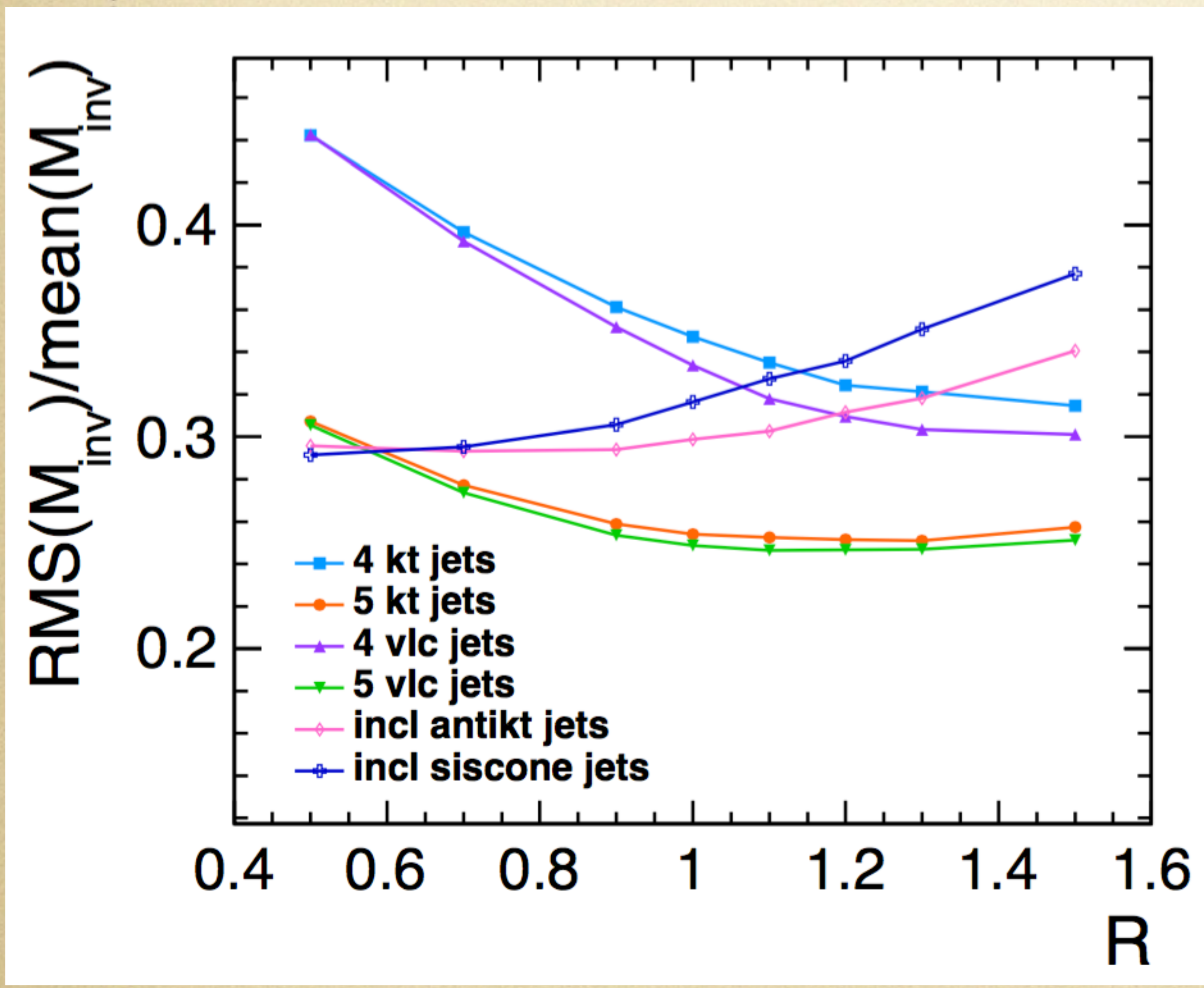


e+e-—>ννHH and λ_{HHH} @ CLIC

R. Simoniello

1.4 TeV (1.5 ab^{-1})	+3 TeV (2 ab^{-1})
21%	10%

- Re-analysis of the double Higgs production has started
- Divide analysis in sub-channels:
  - HHνν->bbbbνν
  - HHνν->bbWWνν->bbqqqνν



ongoing

HHνν—>bbbbνν @ 3 TeV

L [ab^{-1}]	# sig exp	# bkg exp	BDTG cut	S/√(S+B)	# sig	# bkg
2	353	2737527	0.9541	7.06	108	127

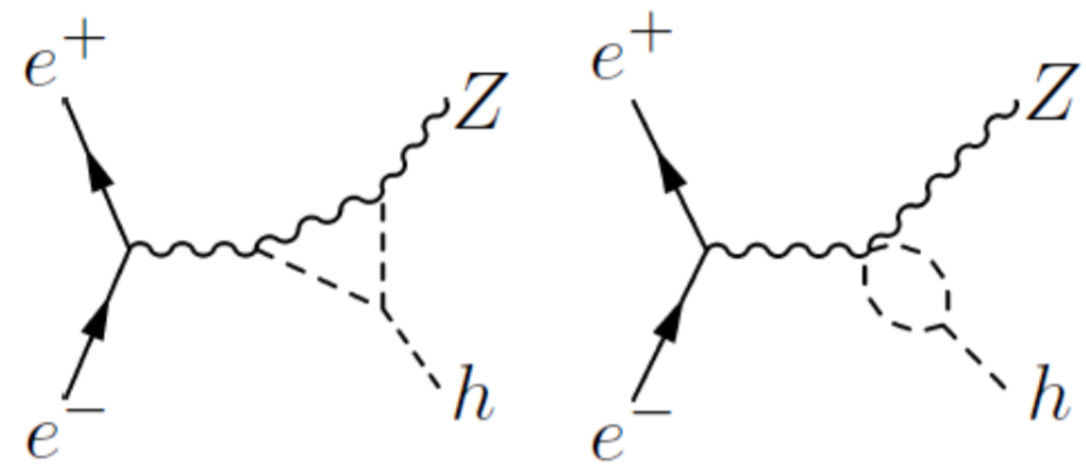
HHνν—>bbWWνν @ 1.4 TeV

L [ab^{-1}]	# sig exp	# bkg exp	BDT cut	S/√(S+B)	# sig	# bkg
1.5	21	45000	0.2047	0.71	2	8

λ_{HHH} @ Circular Collider

T. Barklow

CEPC Higgs Self Coupling Measurement at Ecm=240 GeV



M. McCullough, arXiv:1312.3322

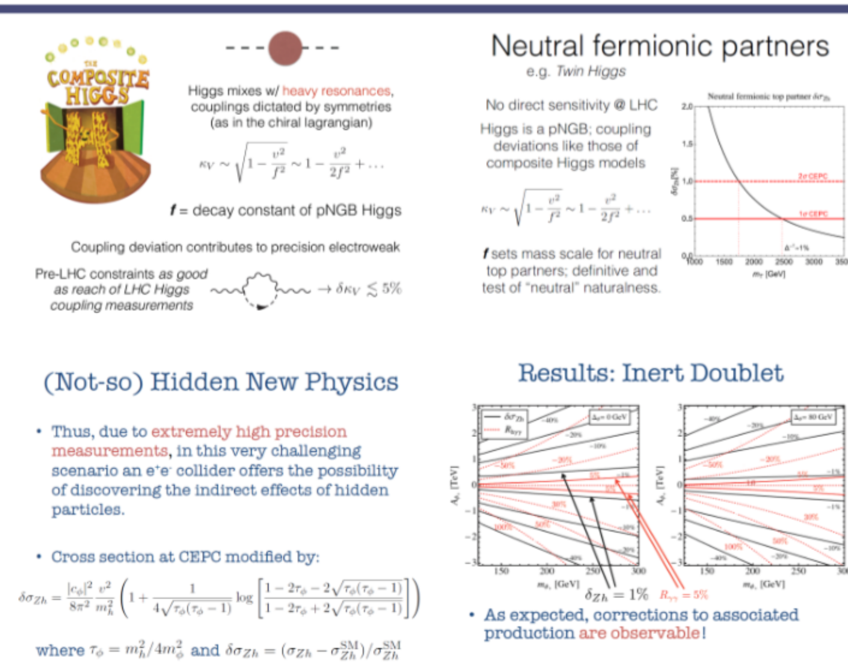
$$\delta_\sigma^{240} = 100\,(2\delta_Z + 0.014\delta_h)\,\%$$

g_{hZZ} fixed to SM value $(\delta_z = 0)$

g_{hhZZ} fixed to SM value

$$\Rightarrow\ \delta_H = \frac{\delta_\sigma^{240}}{0.014} = \frac{0.0051}{0.014} = 36\%$$

Examples of BSM physics with $\delta_z \neq 0$:



comment by M.Peskin: δ_Z can come from anything!

λ_{HHH} in scale-invariant model for EWSB

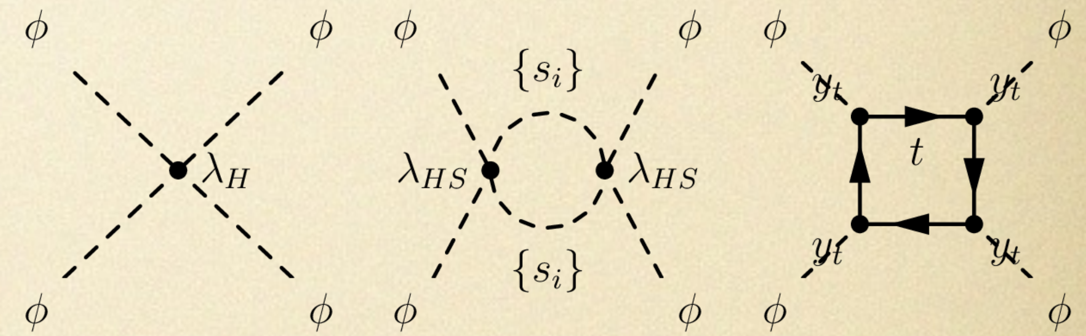
K. Endo

- Is there possibility that ONLY self couplings deviate (substantially) from SM predictions?
- which gives an interesting shape of potential?

$$\mathscr{L} = \mathscr{L}_{\rm SM}|_{\mu_{\rm H}\to 0} + \frac{1}{2}(\partial_\mu \vec{S})^2 - \lambda_{\rm HS}(H^\dagger H)(\vec{S}\cdot\vec{S}) - \frac{\lambda_{\rm S}}{4}(\vec{S}\cdot\vec{S})^2$$

$$H = \frac{1}{\sqrt{2}}\begin{pmatrix} \sqrt{2}G^+ \\ v_{\rm H} + h + iG^0 \end{pmatrix}, \quad \vec{S} = \begin{pmatrix} v_{\rm S}+s_1 & s_2 & \cdots & s_N \end{pmatrix}^{\rm T}$$

SM-singlet, global-O(N) multiplet



$$|\lambda_H| \sim \frac{N{\lambda_{HS}}^2}{(4\pi)^2} - \frac{N_C {y_t}^4}{(4\pi)^2} << 1$$

- One candidate: Scale-invariant extension as a phenomenological model near EW.

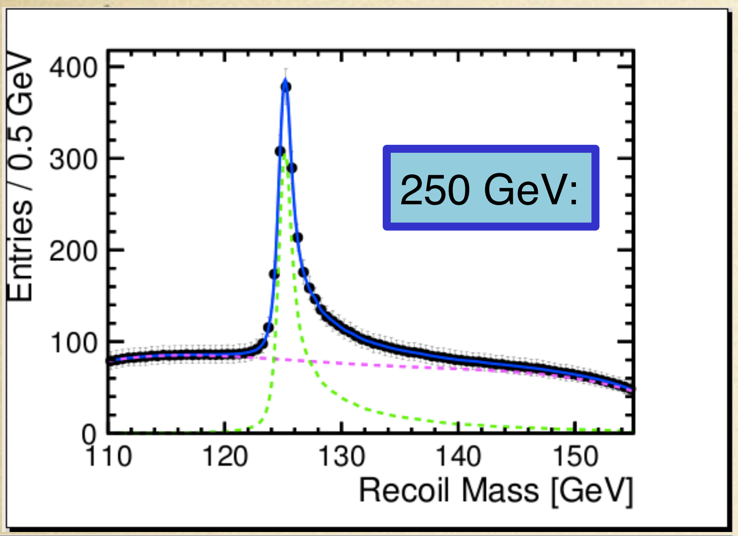
  → EWSB via Coleman-Weinberg (CW) mechanism [S. R. Coleman, E. J. Weinberg, *PRD* 7 (1973) 1888]

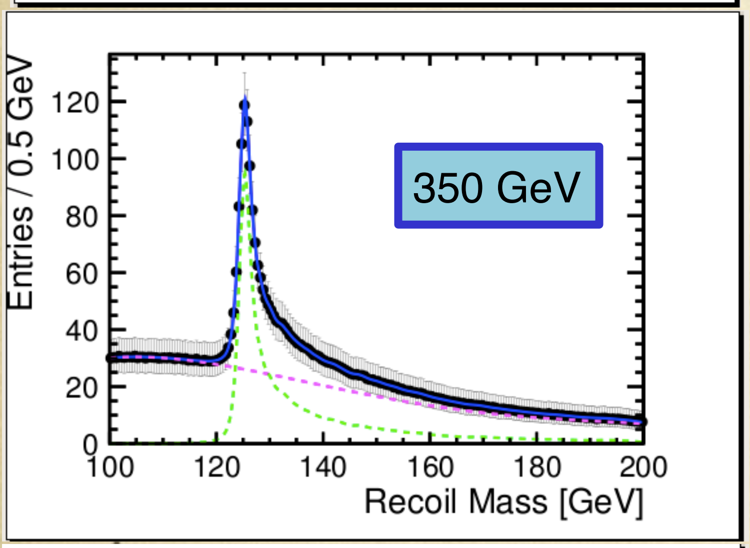
  → Effective potential is like $\phi^4 \log(\phi)$
  - irregular at the origin (e.g. QCD, BCS theory)
  - realise correct VEV and mass of the Higgs,
  - large deviations in self-couplings?
- We dealt with singlet-extension.

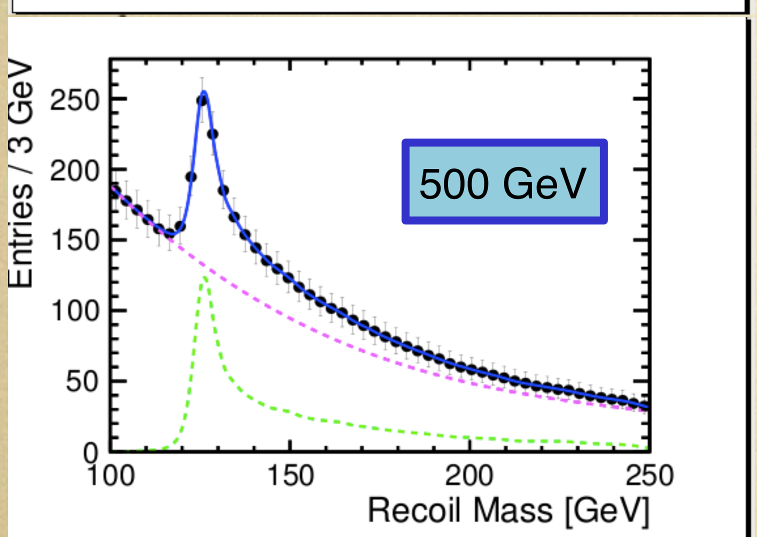
	$N=1$	$N=4$	$N=12$
$\lambda_{hhh}/\lambda_{hhh}^{(\rm SM)}$	1.8	1.7	1.6
$\lambda_{hhhh}/\lambda_{hhhh}^{(\rm SM)}$	4.3	3.2	2.8
λ_{hss}	10	5.0	3.0
λ_{hhss}	13	5.7	3.2
λ_{ssss}	6.5	1.9	0.9

leptonic recoil mass analysis @ ILC

J. Yan







		Xsec_err	Mass_err [MeV]
ECM=250GeV			
(2 ab-1)	left	1.13%	15
	right	2.18%	30
	combined	1.00%	13
ECM=350GeV		xsec	mass
(0.2 ab-1)	left	5.23%	151
	right	10.15%	299
	combined	4.65%	135
ECM=500GeV		xsec	mass
(4 ab-1)	left	2.92%	275
	right	3.12%	316
	combined	2.13%	207
All channels		xsec	mass
(full H20 run)		0.89%	13

$H \to XX$	bb	cc	gg	$\tau\tau$	WW^*	ZZ^*	$\gamma\gamma$
Lepton Finder	93.70%	93.69%	93.4%	93.99%	94.01%	93.74%	93.74%
Lepton ID+PreCuts	92.16%	92.11%	91.8%	92.36%	92.33%	92.21%	92.01%
$M_{inv} \in [73, 120]$ GeV	90.14%	90.27%	89.89%	90.38%	90.27%	90.38%	90.16%
$P_{t,dl} \in [10, 70]$ GeV	89.94%	90.08%	89.68%	90.18%	90.04%	90.16%	89.99%
$P_{t,sum} < 6$ GeV	89.92%	90.06%	89.67%	90.03%	90.01%	90.13%	89.34%
$\lvert\cos\theta_{miss}\rvert < 0.98$	89.92%	90.06%	89.67%	90.02%	90.01%	90.12%	89.32%
$\lvert\cos\theta_{dl}\rvert < 0.90$	83.24%	83.12%	82.89%	83.29%	83.35%	83.53%	82.76%
TMVA	79.48%	79.20%	78.93%	79.36%	79.36%	79.49%	78.87%
$M_{rec} \in [110, 155]$ GeV	78.94%	78.67%	78.40%	78.82%	78.84%	79.02%	78.30%

E_{CM}	250 GeV		350 GeV		500 GeV	
llH	$\mu^+\mu^-X$	e^+e^-X	$\mu^+\mu^-X$	e^+e^-X	$\mu^+\mu^-X$	e^+e^-X
syst. error	0.13%	0.43%	0.13%	0.34%	0.16%	0.13%

proofed to be model independent, ~0.1% for Zμμ, ~0.4% for Zee

direct mass measurement using H—>bb @ ILC

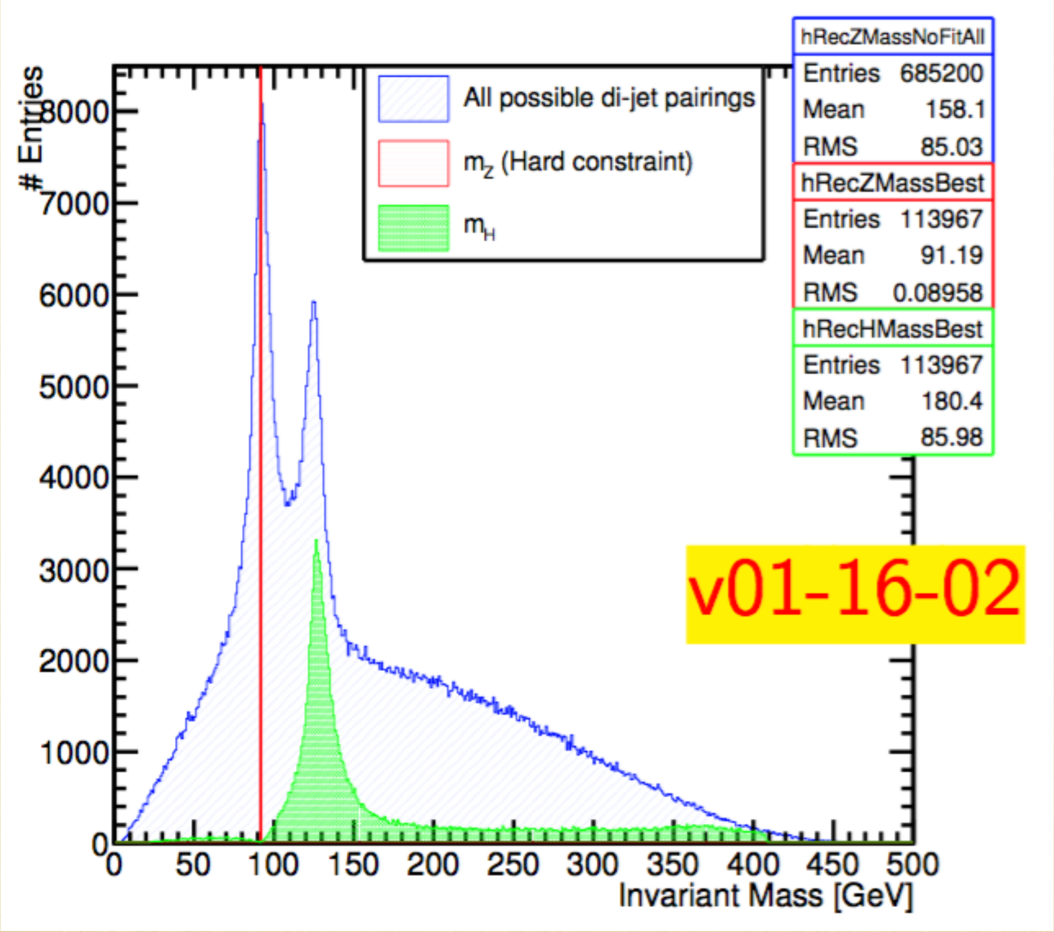
A. Ebrahimi

previous TESLA study

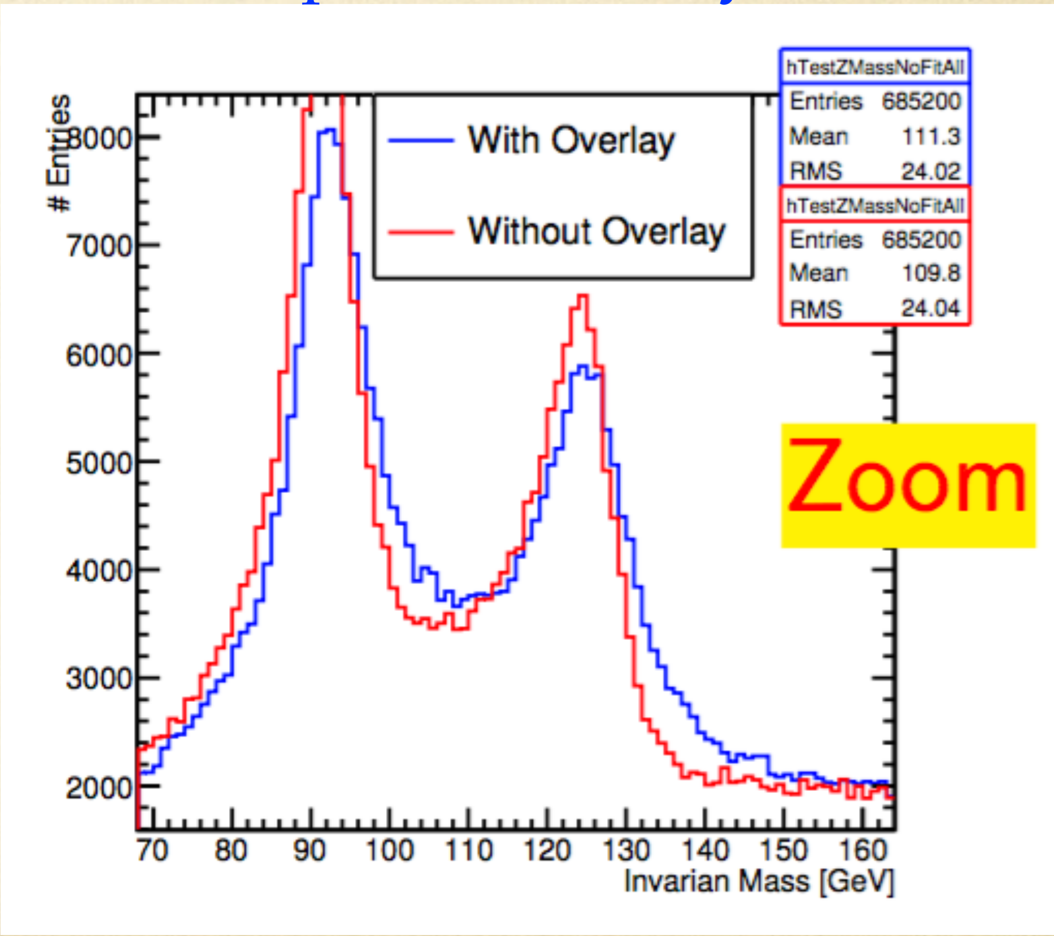
Decay Mode	Δm_H in MeV 120	150	180
$ZH \to l^+l^- q\bar{q}$	85	100	-
$ZH \to q\bar{q}q'\bar{q}'$	45	170	-
$ZH \to l^+l^- WW$	-	90	80
$ZH \to q\bar{q}WW$	-	100	150
Combined	40	65	70

- Redo the analysis of $ZH \to q\bar{q}q'\bar{q}'$ using modern simulation for two center-of-mass energies:
  - $\sqrt{s} = 350GeV$
  - $\sqrt{s} = 500GeV$
- Try to assess systematics of the measurement

kinematic fit



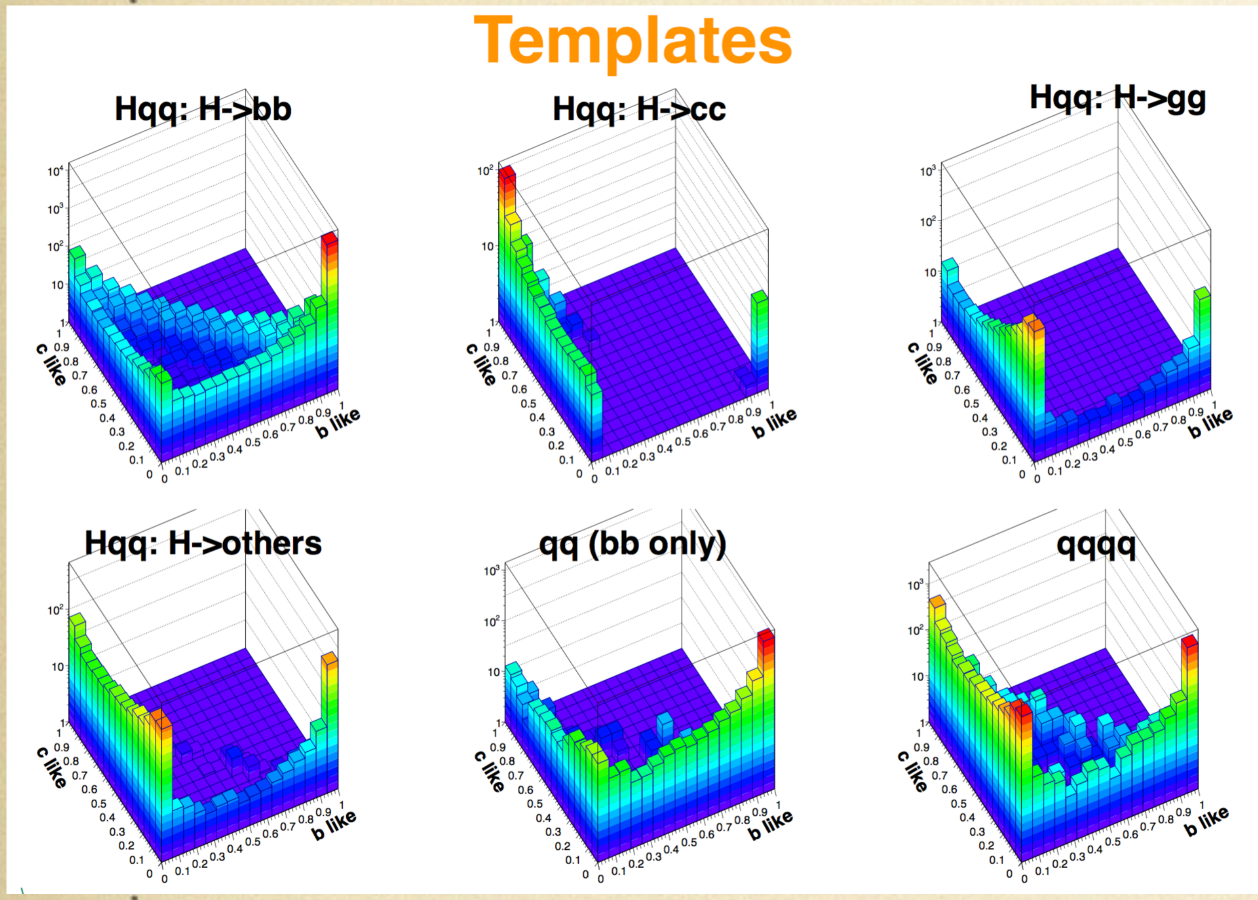
impact of overlay



investigating determination of JER; ongoing

H—>bb/cc/gg @ CLIC

M. Szalay



350 GeV: fit ZH and ννH, H—>bb/cc/gg simultaneously

Hνν fit

Δbb (VBF)	2.2%
Δbb (ZH)	2.0%
Δcc	12.5%
Δgg	4.7%

Hqq fit

Δbb (ZH)	0.99%
Δcc	20.4%
Δgg	6.0%

P. Roroff

1.4 TeV

$\Delta(\sigma \times BR(H\rightarrow b\bar{b}) = 0.43\%$
$\Delta(\sigma \times BR(H\rightarrow c\bar{c}) = 6.1\%$
$\Delta(\sigma \times BR(H\rightarrow gg) = 5.0\%$

3 TeV

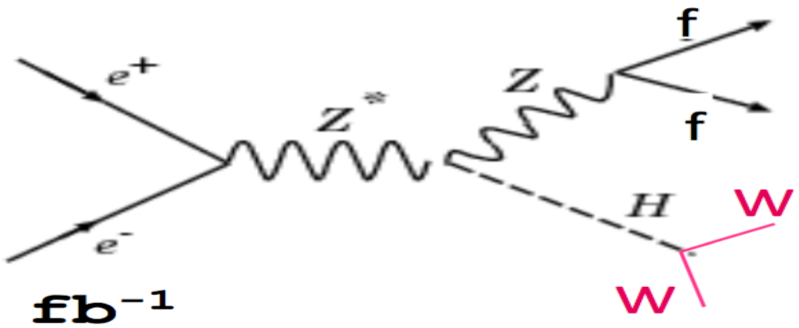
$\Delta(\sigma \times BR(H\rightarrow b\bar{b}) = 0.34\%$
$\Delta(\sigma \times BR(H\rightarrow c\bar{c}) = 6.9\%$
$\Delta(\sigma \times BR(H\rightarrow gg) = 4.3\%$

using single BDT can slightly improve H—>bb

H—>WW* & H—>ZZ* @ CLIC

I. BOZOVIC-JELISAVCIC

$(HZ@350GeV)\ H \to WW^*, W \to q_1 q_2$



- 500 fb^{-1}
- Signature: 4-jet+2l or 6-jet
- BR(H→WW* →4 jets)≈10%
- Z→ll ~700 events(~1%)
- $Z \to q\bar{q}$ ~5000 events (~7%)
- 4jets+2l events: B/S≈10^3
- 6-jet events: B/S≈10^2

$(H\nu_e\bar{\nu}_e @1.4TeV)\ H \to ZZ^*, Z \to q\bar{q} \vee Z \to ll$

- 1.5 ab^{-1}
- Signature: E_{miss} plus(4-jet or 2-jet+2l)
- BR(H→ZZ* →4 jets)≈1.4%
- BR(H→ZZ* →2jets + 2l)≈0.4%
- ~ 5200 4-jet events
- ~ 1500 (2-jet + 2l) events
- 4-jet events: B/S≥10^4
- (2-jet+2l) events: B/S≥10^5

$\sigma(HZ)\times BR(H \to WW^* \to qqqq)$ $Z \to q\bar{q}$		$Z \to e^+e^-$	$Z \to \mu^+\mu^-$
29%	Signal efficiency	42%	55%
1328	No. signal events	95	125
5.9%	$\boxed{\frac{\Delta(\sigma\times BR)}{(\sigma\times BR)} = \frac{\sqrt{S+B}}{S}}$	16.1%	13.1%

$\sigma(H\nu_e\bar{\nu}_e)\times BR(H \to ZZ^*)$ $ZZ \to qqqq$		$ZZ \to qqll$
20%	Signal efficiency	28%
1031	No. signal events	425
17.7%	$\boxed{\frac{\Delta(\sigma\times BR)}{(\sigma\times BR)} = \frac{\sqrt{S+B}}{S}}$	5.6%

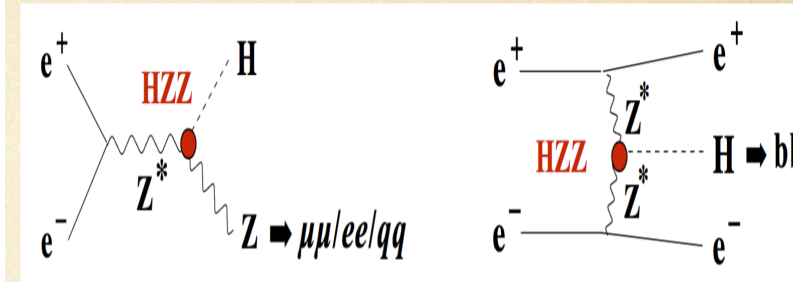
anomalous HVV coupling @ ILC

T. Ogawa

Relevant term is (arXiv:1011.5805)

$$\mathcal{L}_{HVV} = 2M_V^2\left(\frac{1}{v}+\frac{a}{\Lambda}\right)HV_\mu^+V^{-\mu}+\frac{b}{\Lambda}HV_{\mu\nu}^+V^{-\mu\nu}+\frac{\tilde{b}}{\Lambda}H\epsilon^{\mu\nu\rho\sigma}V_{\mu\nu}^+V_{\rho\sigma}^-$$

SM (CP-even) Correction [a] | Tensor Couplings CP-even [b] | Tensor Couplings CP-odd [bt]



Assuming H20 "LR" scenario,

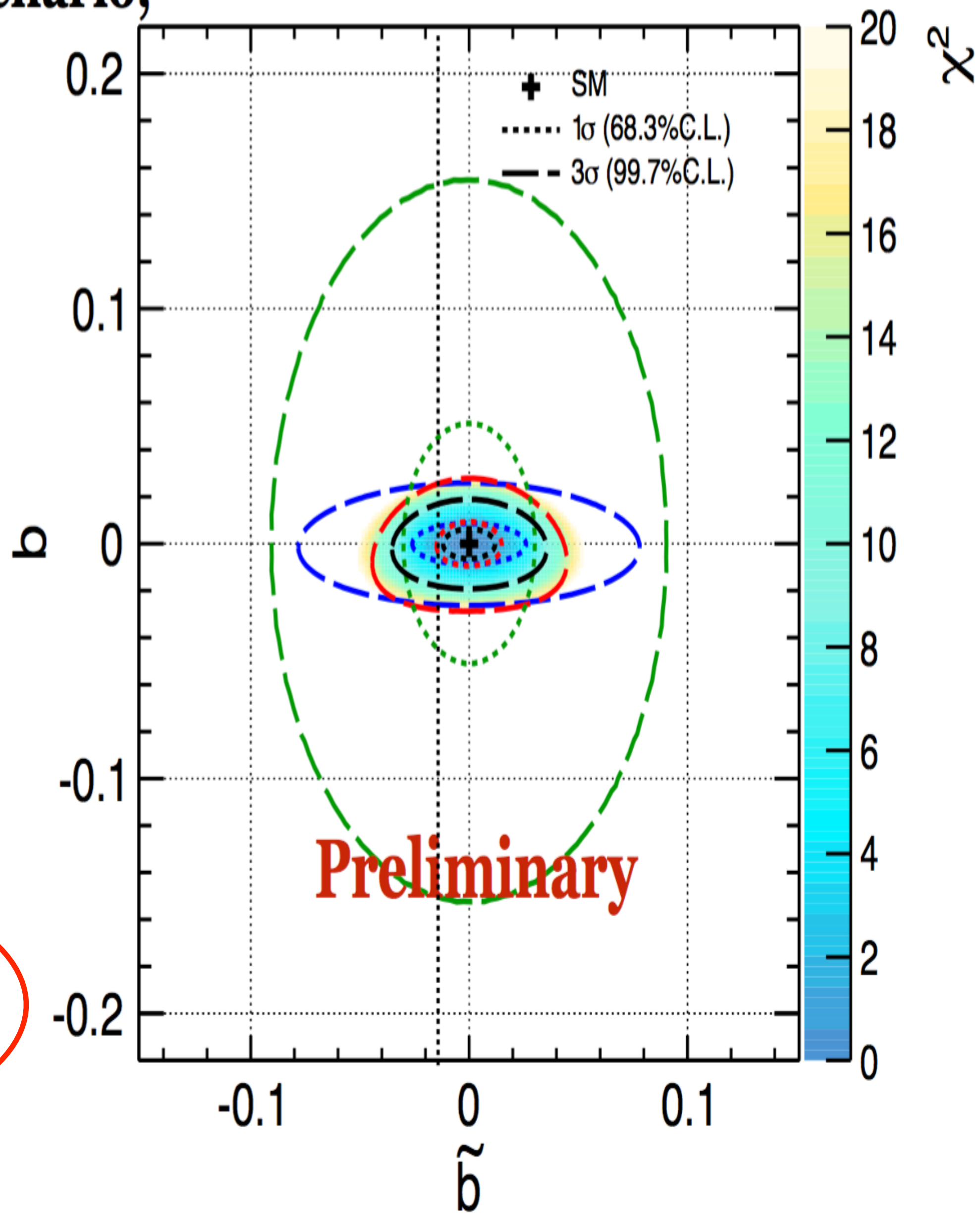
arXiv:1510.05739

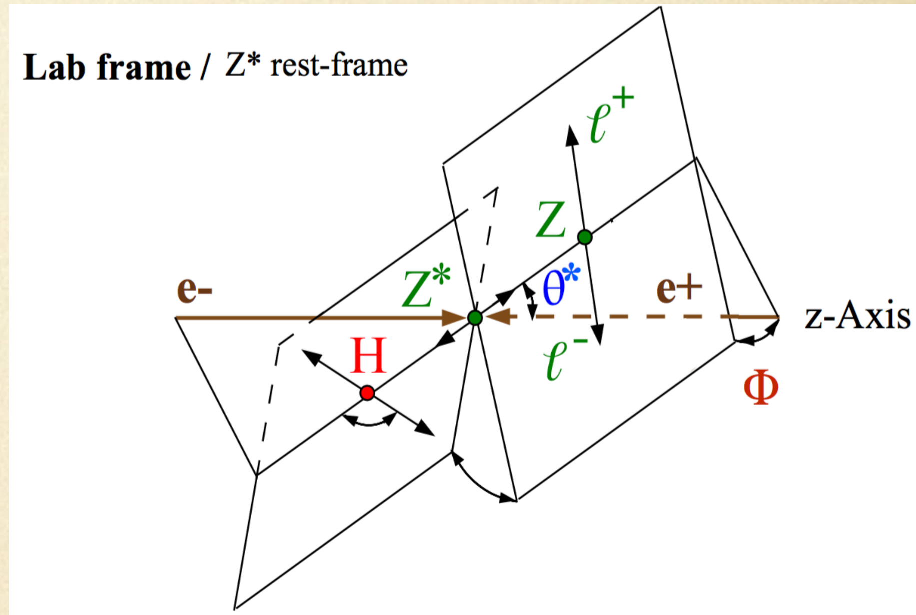
>. 250GeV → 1350 fb-1
(2 [ab-1] * 67.5 [%(LR)])
~ δσ 1.2%

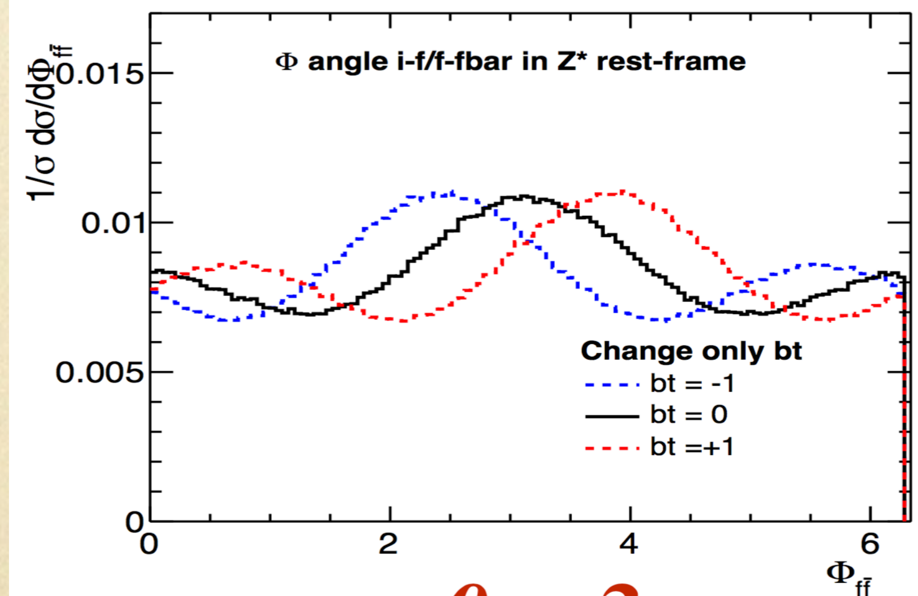
>. 500GeV → 1600 fb-1
(4 [ab-1] * 40.0 [%(LR)])
~ δσ 2.6%

1 sigma sensitivity

b ~ 0.007 (1σ)
bt ~ 0.012 (1σ)





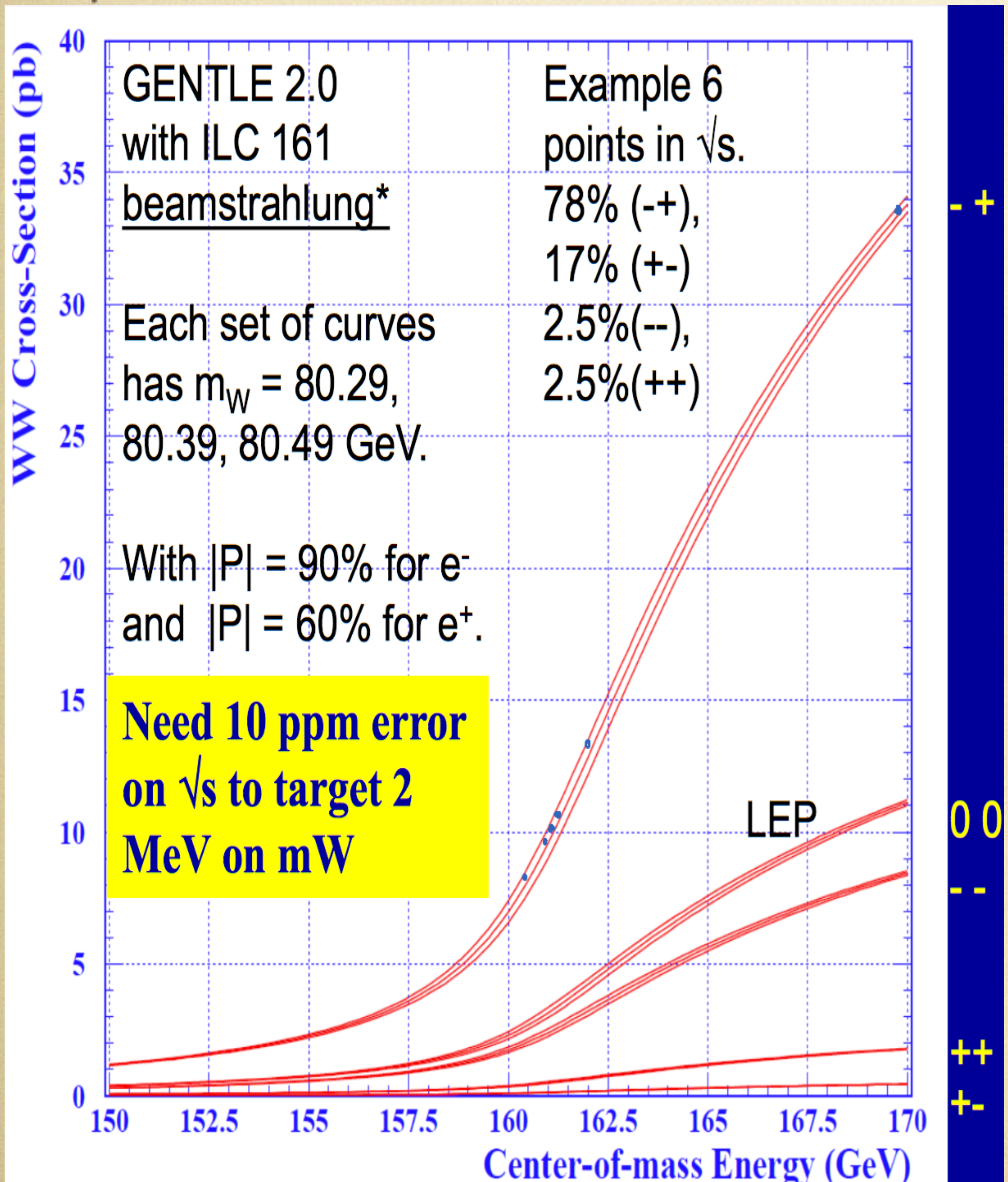


0 ~ 2π

b-tilde ~ O(0.01) —> very sensitive test to CP odd mixture

m_W measurement from threshold scan using polarised beams @ ILC

G. Wilson



Summary I

- Threshold scan can yield a precision measurement of m_W at a linear collider with polarized electron AND positron beams.
  - Errors at the few MeV level can be envisaged.
  - With 100fb^{-1}, find 2.4 (stat.) ⊕ 3.1 (syst.) ⊕ 0.8 (√s) ⊕ theory (MeV)
- ILC design can and should evolve to make this feasible (proof of concept is in the TESLA TDR).
  - Supported machine parameters would be helpful.
  - Better awareness of these issues by LCC management …
- Regressing to no positron polarization should be avoided!
  - Controlling the background is very challenging without it.
    - I am not confident that a useful m_W measurement can be made at threshold with no positron polarization. Limited by absolute polarization measurement – 0.5% systematic.
    - I am certain that a competitive m_W measurement at threshold is very challenging with no beam polarization at all

Take-Home Messages

- ILC has very good prospects for measuring m_W with very high precision
  - Not much work yet on measurements at standard ILC √s values (√s ≥ 250 GeV). Needs more effort.
  - Measurement at threshold expected to be very robust with polarized electrons and polarized positrons (experimentally and theoretically).
- Precision m_W needs precision √s.
  - $\sqrt{s_P}$ method very promising
  - Need precise momentum scale.
    - J/psi method using Z's needs 40M Z's…..
  - Error on m_W from √s knowledge of 0.8 MeV can be targeted.
- ILC accelerator
  - Need to preserve the option to run with high L and highly polarized electrons **AND POSITRONS** at WW threshold. No experimental show-stoppers.
    - This is a great advantage of ILC over other accelerator concepts.
  - We should DEMAND capability for high luminosity for calibration at the Z.
  - We should DEMAND capability for reasonable luminosity at the Z with polarized beams for physics.

complementarity between ILC, CEPC & FCC-ee

T. Barklow

G20	CEPC		ILC+CEPC
Δg_{HZZ}	0.26%	$\Rightarrow$	0.22%
Δg_{HWW}	1.22%	$\Rightarrow$	0.38% *
Δg_{Hbb}	1.30%	$\Rightarrow$	0.68%
$\Delta g_{H\tau\tau}$	1.44%	$\Rightarrow$	0.88%
Δg_{Hgg}	1.53%	$\Rightarrow$	0.97%

H20	ILC	FCC-ee	ILC+FCC-ee
Δg_{HZZ}	0.31%	0.19%	0.16%
Δg_{HWW}	0.38%	0.35%	0.22%
Δg_{Hbb}	0.60%	0.52%	0.38%
$\Delta g_{H\tau\tau}$	0.89%	0.63%	0.49%
Δg_{Hgg}	0.92%	0.85%	0.61%

ILC +CEPC Summary

- ILC helps CEPC:
  - A_{LR} measurement and top mass
  - Precise g_{HWW} measurement reduces errors on all Higgs couplings
  - Top Yukawa coupling
  - ILC $\sigma(ZHH)$ measurement (and others I assume) help interpret precision CEPC $\sigma(ZH)$ meas.
  - New particle searches at 500 GeV

- CEPC helps ILC:
  - Many EW precision measurements: M_Z, Γ_Z, α_S, $N\nu$, MW, …
  - Precise g_{HZZ} measurement reduces errors on all Higgs couplings
  - Much better meas. of Higgs invisible width, BSM decays, rare decays such as $\gamma\gamma$ and $\mu\mu$
  - In general, CEPC gives ILC more flexibility to concentrate on higher E_{cm} running.

- CEPC+ILC combination helps the particle physics community:
  - Higgs Z coupling error Δg_{HZ} = 0.2%
  - Higgs W coupling error Δg_{WW} = 0.3%
  - Higgs b coupling error Δg_{bb} = 0.5%
  - Higgs self coupling error Δg_{HHH} = 22%

ILC + FCC-ee Summary

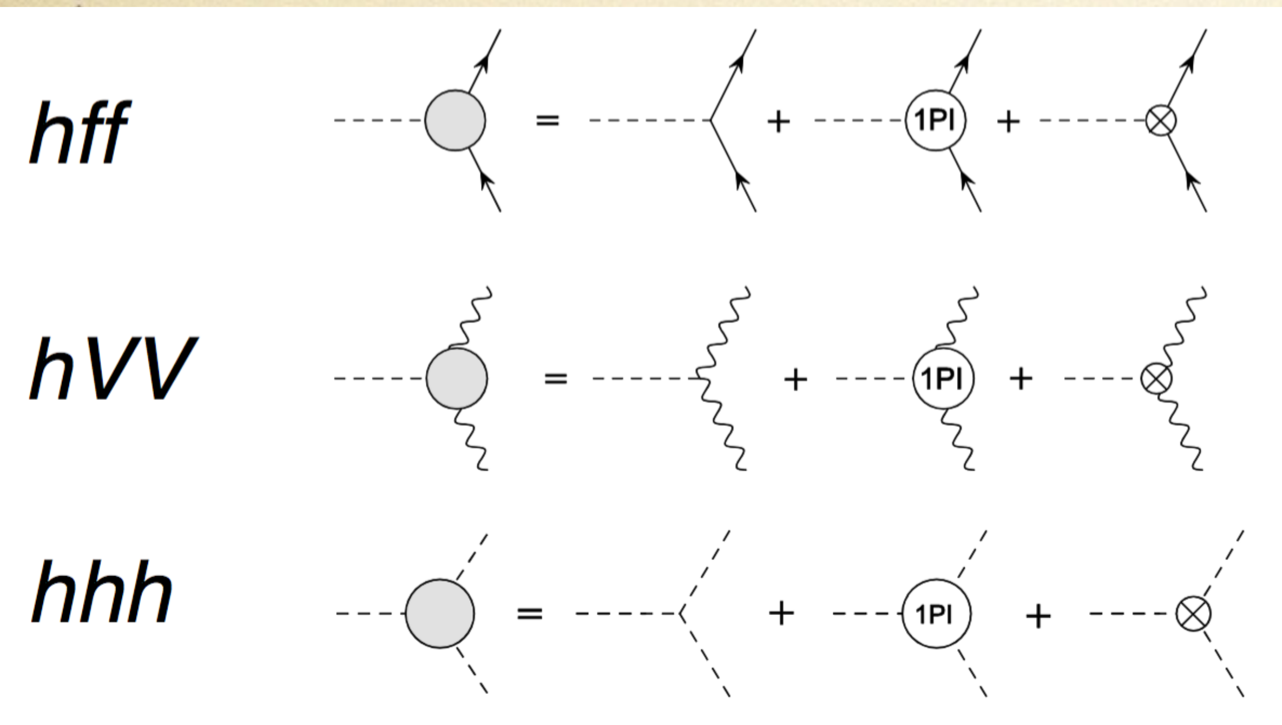
- ILC helps FCC-ee:
  - The 0.25% measurement of $\sigma(\nu\nu h)$XBR(H→bb) reduces errors on all Higgs couplings
  - The 2.4% Top Yukawa coupling measurement from ttH production improves upon the 13% measurement from the tt threshold scan.
  - ILC $\sigma(ZHH)$ measurement provides a 27% tree-level determination of the Higgs self-coupling, and could help clarify a Higgs self-coupling interpretation of the precision FCC-ee $\sigma(ZH)$ measurement.

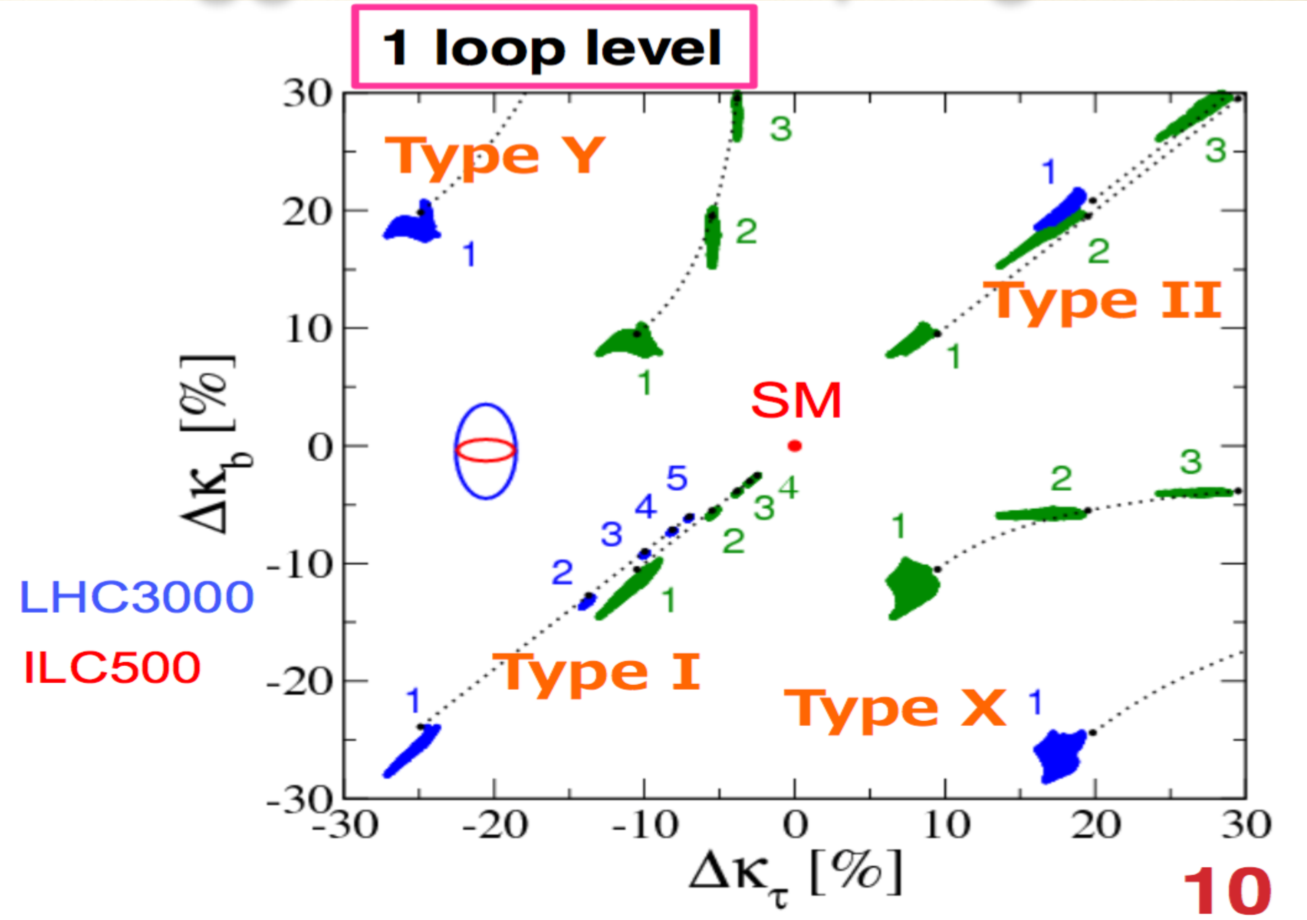
- FCC-ee helps ILC:
  - Precision measurement of g_{HZZ} and various σXBR at 240 GeV help turn the ILC 0.25% measurement of $\sigma(\nu\nu h)$XBR(H→bb) into Δg_{WW} = 0.22%
  - Much better meas. of Higgs invisible width, BSM decays, rare decays such as $\gamma\gamma$ and $\mu\mu$ Note: $\sum BR_i = 1$ can be used to improve all coupling errors if $\Delta BR(H \to BSM) < 1\%$
  - Unique access to Higgs coupling to 1st generation fermions.

- FCC-ee+ILC combination helps the particle physics community:
  - Higgs Z coupling error Δg_{HZ} = 0.16%
  - Higgs W coupling error Δg_{WW} = 0.22%
  - Higgs b coupling error Δg_{bb} = 0.38%
  - Higgs self coupling error Δg_{HHH} = 20%

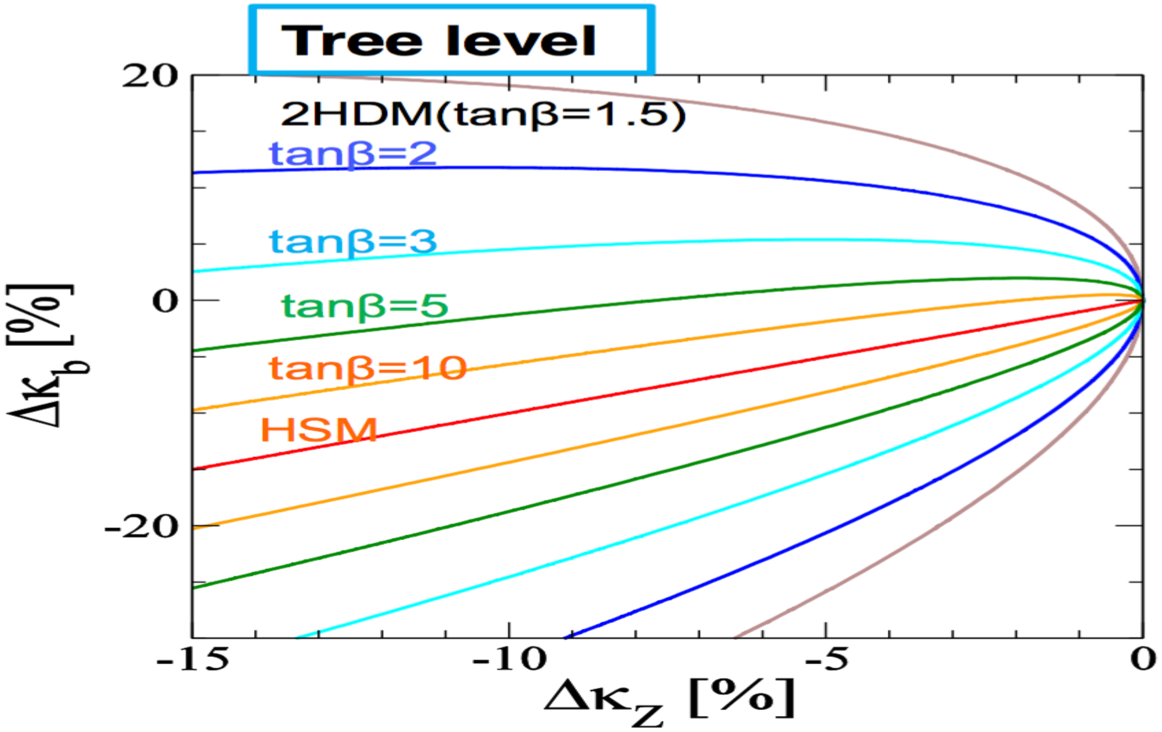
Discrimination of extended Higgs sectors by precision measurement of the Higgs boson couplings

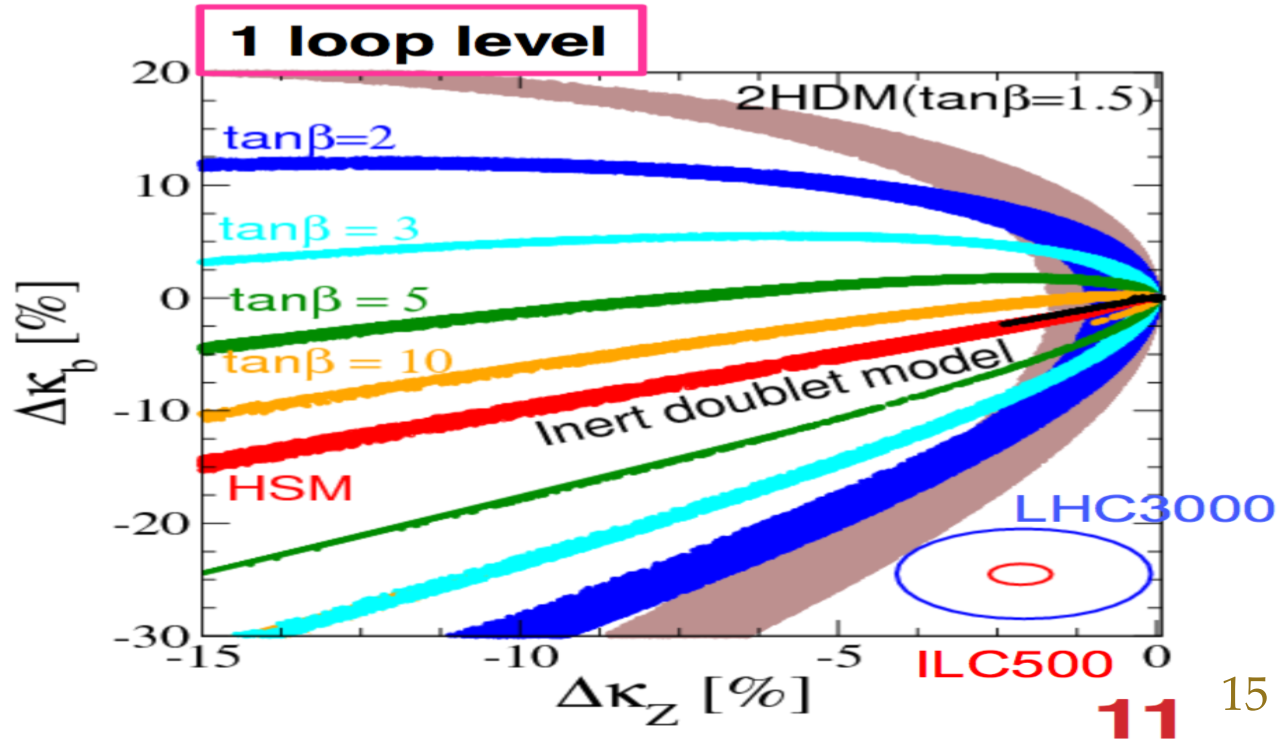
M. Kikuchi





Ex.>> $\Delta\kappa_Z$ VS $\Delta\kappa_b$ in HSM 2HDM(Type I) IDM





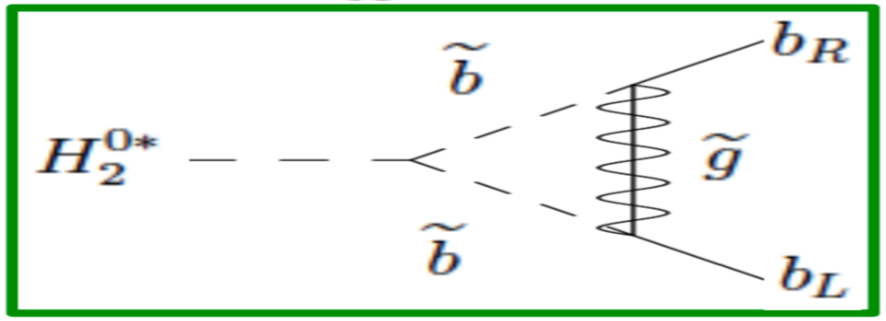
M. Kakizaki

Indirect discovery reach of the additional MSSM Higgs bosons by precision measurements at future lepton colliders

- There are two new mass scales in the MSSM: $m_{\rm SUSY}, m_A$
  - In the limit of large $\mu \sim M_3 \sim A_t \sim m_{\rm SUSY}$ with m_A fixed

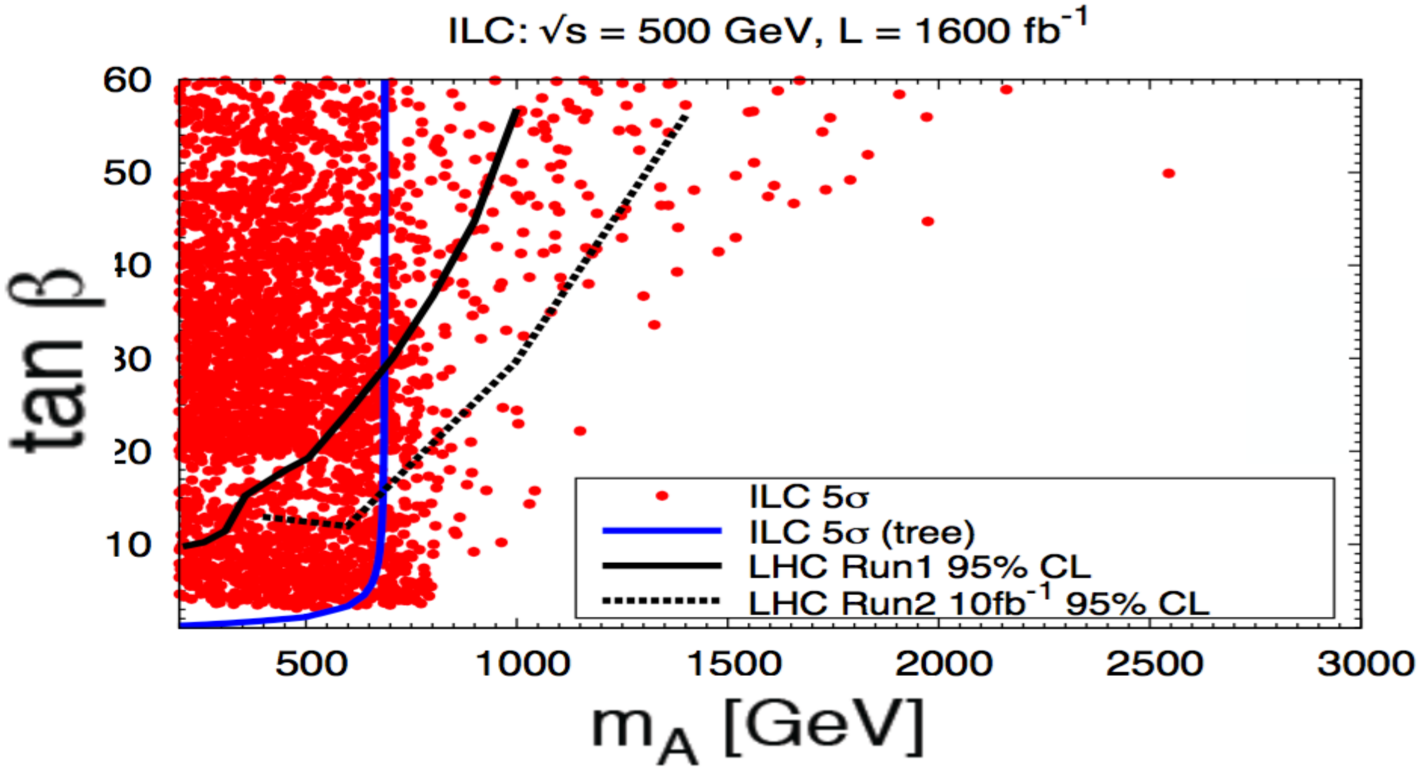
$$g_{hb\bar{b}} \simeq \frac{g m_b}{\sqrt{2} m_W} \frac{\sin\alpha}{\cos\beta} \left[1 - \Delta_b (1 + \cot\alpha \cot\beta)\right]$$

$$\Delta_b \simeq \left(\frac{2\alpha_s}{3\pi} \frac{\mu M_3}{m_{\rm SUSY}^2} + \frac{\lambda_t^2}{16\pi^2} \frac{\mu A_t}{m_{\rm SUSY}^2} \right) \tan\beta$$

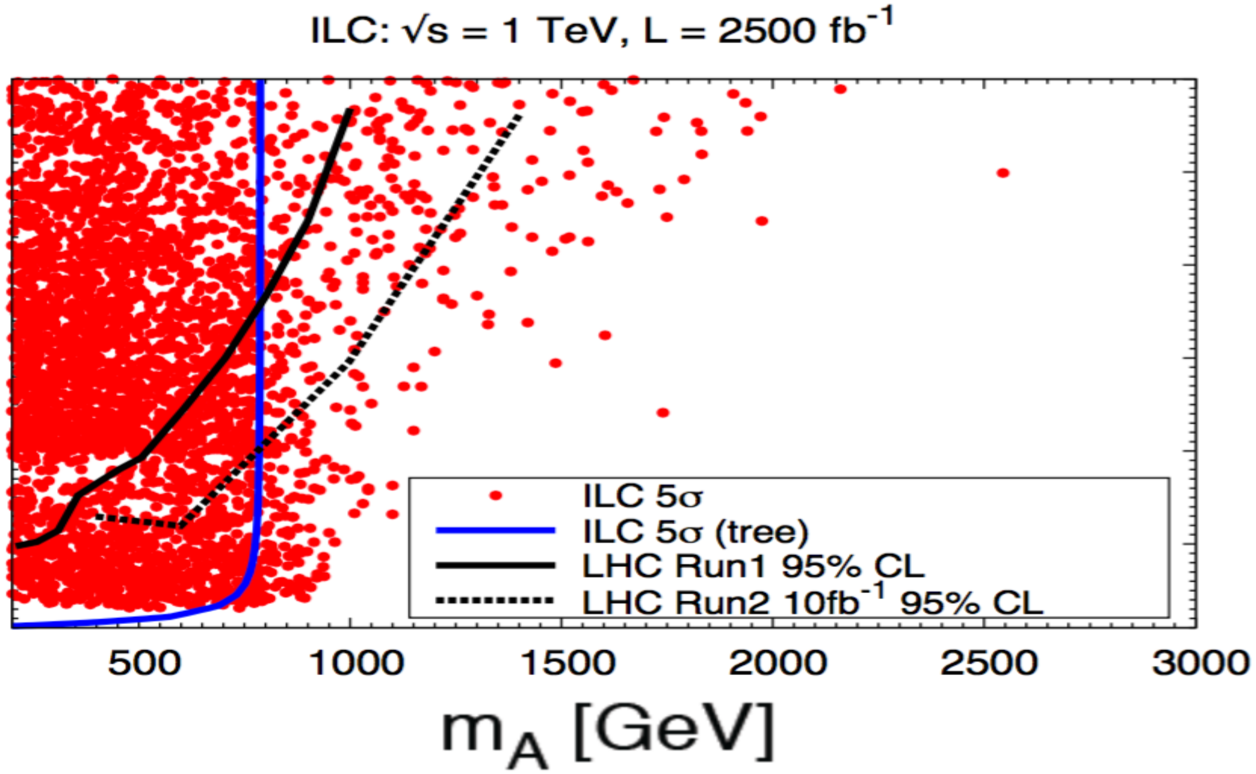


- SUSY loop corrections do not decouple for small m_A and are enhanced for large $\tan\beta$,
(in sharp contrast to the type-II two-Higgs-doublet model)

- ILC 500 LumiUp:



- ILC 1000 LumiUp:



Unitarity bounds in general 2HDM

S. Kanemura

How we constrain extended Higgs sectors ?

Theoretical Bound
- Unitarity
- Triviarity
- Vacuum stability, ...

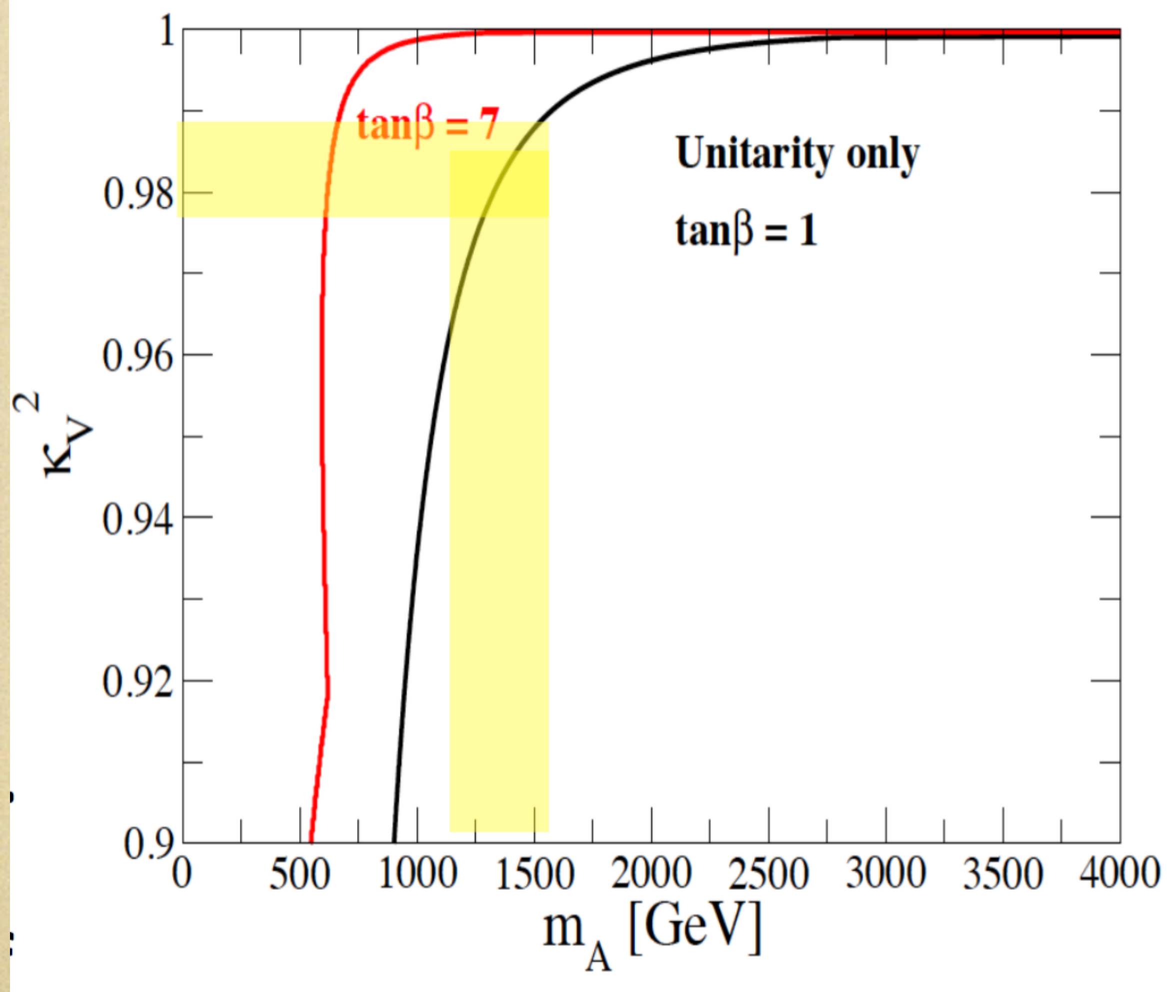
Experimental bounds
- LEP, Tevatron direct searches
- LEP/SLC indirect searches
- LHC direct/indirect searches
- $b \to s\gamma$/g-2/EDM/...

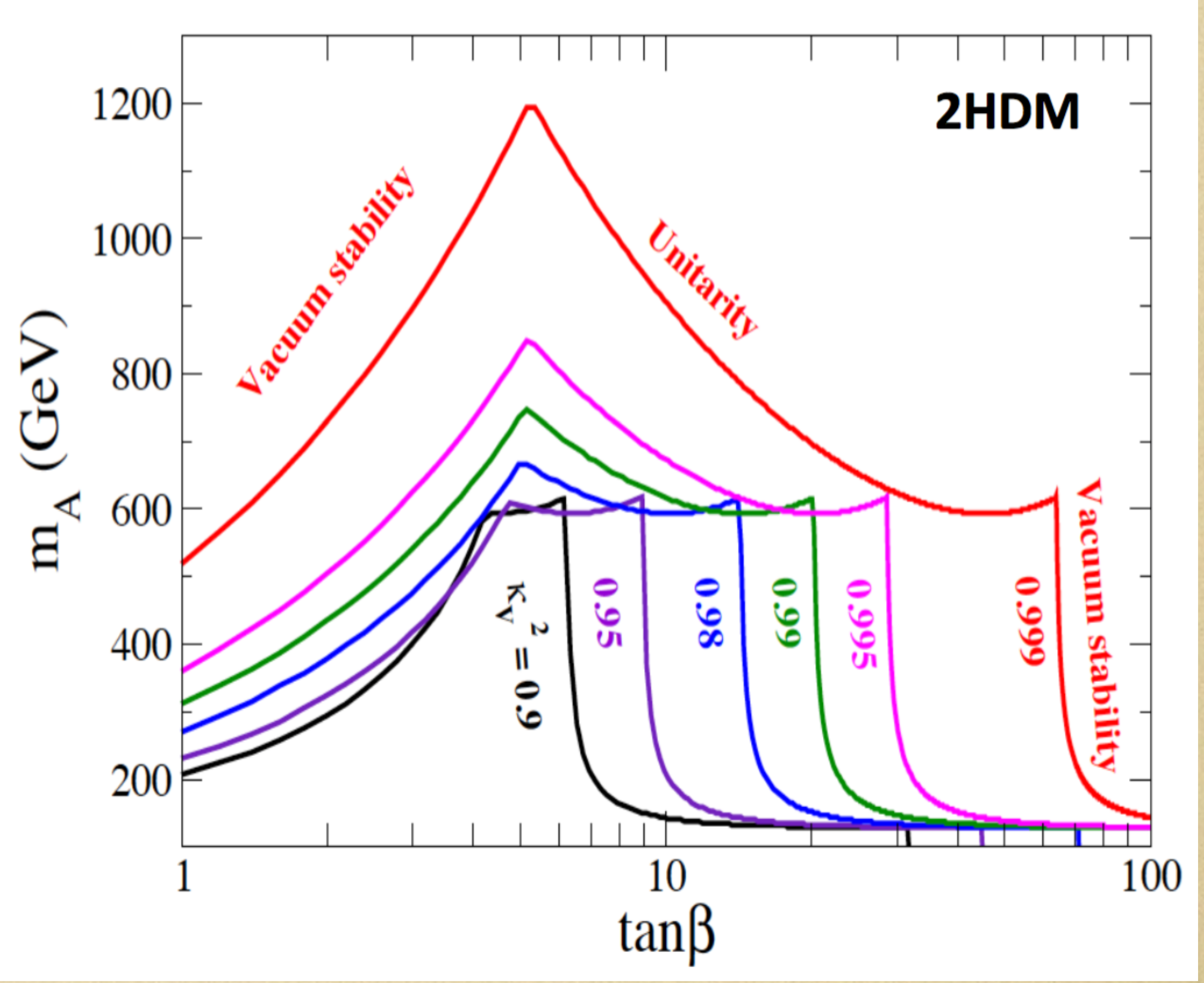
Perturbative Unitarity

Lee, Quigg, Thacker (1977)

$W_L^+ W_L^-$ Elastic Scattering $\quad \epsilon_L^\mu = (p, 0, 0, E)$

$$a^0(W_L^+W_L^- \to W_L^+W_L^-) \approx A\,E^4 + B\,E^2 + C \quad (E \to \infty)$$





e.g. for K_V=0.99, if no second Higgs is found below 700 GeV,the 2HDM is excluded

Phenomenology of Higgs boson in the Georgi-Machacek model

C.W. Chiang

Georgi-Machacek Model

Georgi, Machacek 1985
Chanowitz, Golden 1985

- The Higgs sector includes SM doublet field ϕ (2,1/2) and triplet fields χ (3,1) and ξ (3,0)

$$\Phi = \begin{pmatrix} \phi^{0*} & \phi^+ \\ \phi^- & \phi^0 \end{pmatrix}, \qquad \Delta = \begin{pmatrix} \chi^{0*} & \xi^+ & \chi^{++} \\ \chi^- & \xi^0 & \chi^+ \\ \chi^{--} & \xi^- & \chi^0 \end{pmatrix}$$

$SU(2)_L$ $SU(2)_R$

transformed under $SU(2)_L \times SU(2)_R$ as

$$\Phi \to U_L \Phi U_R^\dagger \quad \text{and} \quad \Delta \to U_L \Delta U_R^\dagger$$

with $U_{L,R} = \exp(i\, \theta_{L,R}^a T^a)$ and T^a being corresponding SU(2) generators.

- Normalize all couplings to those for SM Higgs boson (V = W,Z; F = quarks):

$$\kappa_F = \frac{g_{\varphi FF}}{g_{hFF}^{\rm SM}}, \quad \kappa_V = \frac{g_{\varphi VV}}{g_{hVV}^{\rm SM}}$$

Higgs	κ_F	κ_V	
h	$\frac{\cos\alpha}{\sin\beta}$	$\sin\beta\cos\alpha - \sqrt{\frac{8}{3}}\cos\beta\sin\alpha$	
H_1^0	$\frac{\sin\alpha}{\sin\beta}$	$\sin\beta\sin\alpha + \sqrt{\frac{8}{3}}\cos\beta\cos\alpha$	
H_3^0	$i\eta_f\cot\beta$	0	gauge-phobic
H_5^0	0	$\kappa_W = -\frac{\cos\beta}{\sqrt{3}}$ and $\kappa_Z = \frac{2\cos\beta}{\sqrt{3}}$	quark-phobic

$\eta_f = +1$ for up-type quarks and -1 for down-type quarks and charged leptons.

group factor that makes it possible for the entire factor to be greater than 1 (mixing required)

suppressed by α

independent of α

- With $SU(2)_L \times SU(2)_R$-symmetric Higgs potential and vacuum alignment, GM model preserves custodial symmetry, allows a large v_Δ, and possibly has hVV couplings stronger than SM's.
- There is an [approximate] mass degeneracy in each of the 3-plet, and 5-plet Higgs representations.
- For large v_Δ, VBF processes are useful for searching for exotic GM Higgs bosons, verifying their mass spectrum, and extracting hVV couplings.

Higgs Boson Production Cross Sections in the complex MSSM

S. Heinemeyer

Precision calculations in the Higgs sector of the complex MSSM: Towards the LC precision

S. Heinemeyer

Renormalization status:

- LC precision requires all calculations at the per-cent level
- full complex MSSM renormalized
  [A. Bharucha, T. Fritzsche, T. Hahn, S.H., F.v.d. Pahlen, H. Rzehak, C. Schappacher '11 - '13]
- stable and well behaved results over nearly complete parameter space
- available as FeynArts model file
  [T. Fritzsche, T. Hahn, S.H., F. v.d. Pahlen, H. Rzehak, C. Schappacher '13]
- full one-loop calculations possible with FeynArts/FormCalc/LoopTools

Experiment:

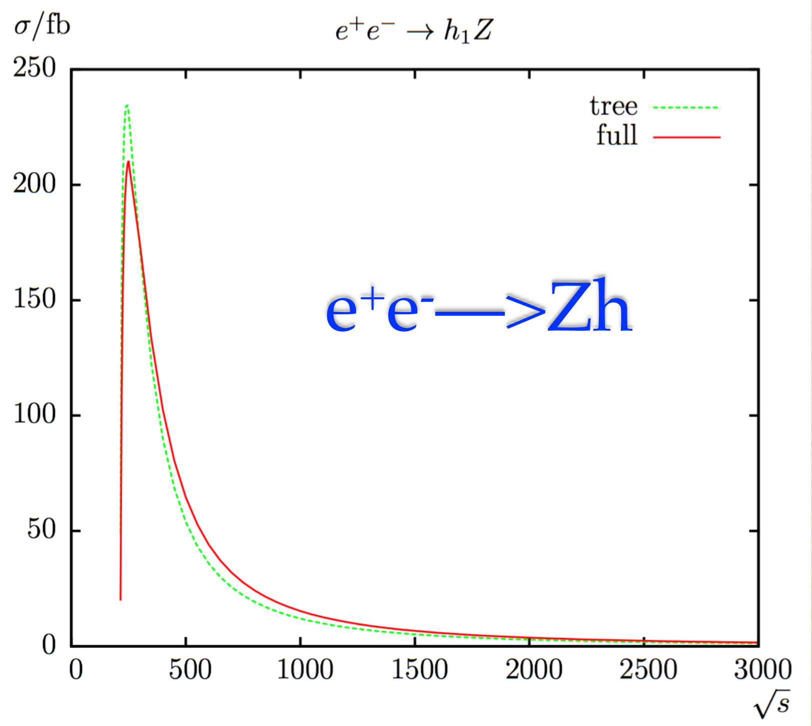
ATLAS: $M_h^{\text{exp}} = 125.36 \pm 0.37 \pm 0.18$ GeV

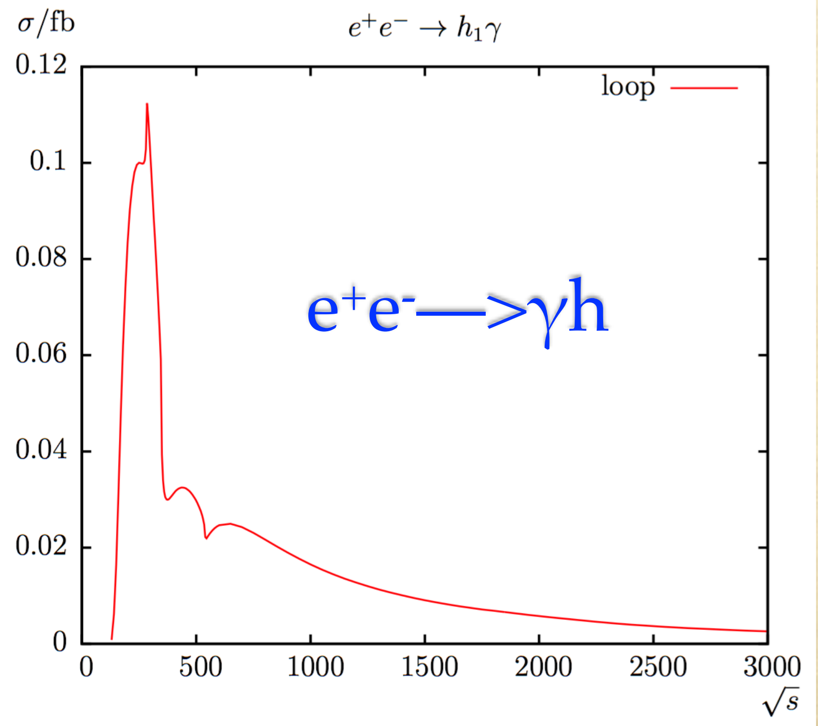
CMS: $M_h^{\text{exp}} = 125.03 \pm 0.27 \pm 0.15$ GeV

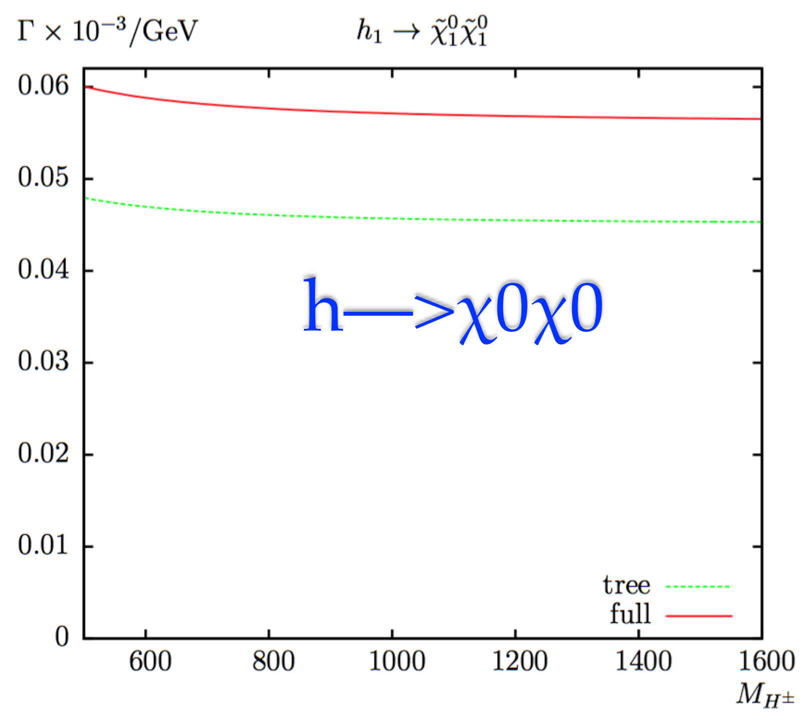
combined: $M_h^{\text{exp}} = 125.09 \pm 0.21 \pm 0.11$ GeV

Theory:

$\delta M_h^{\text{theo}} \sim 3$ GeV

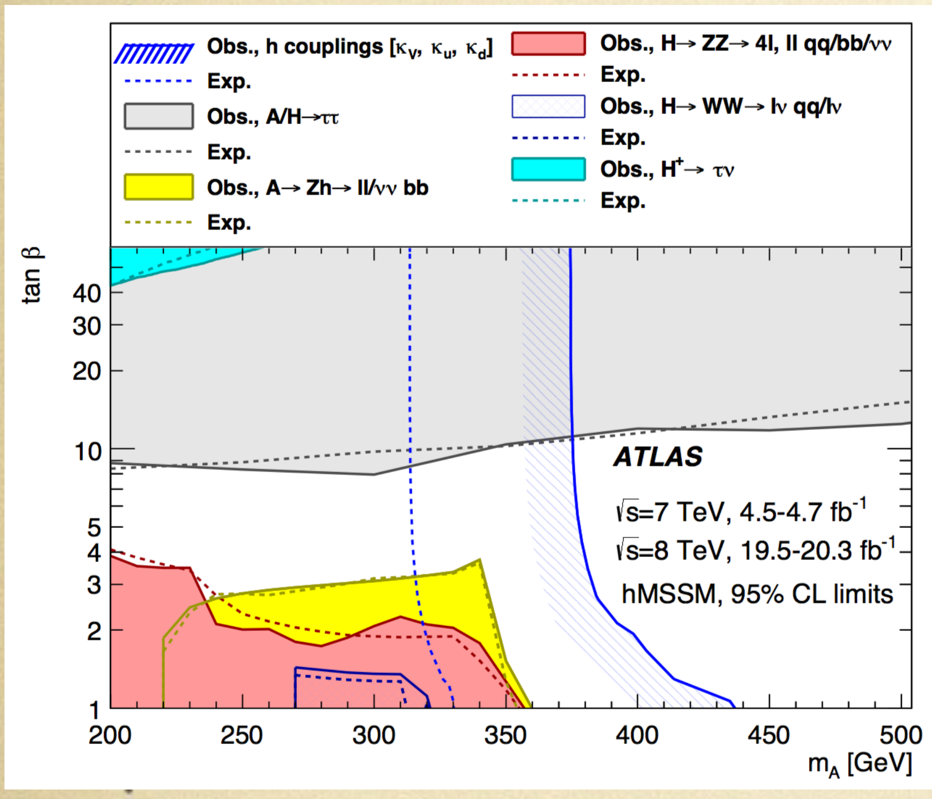


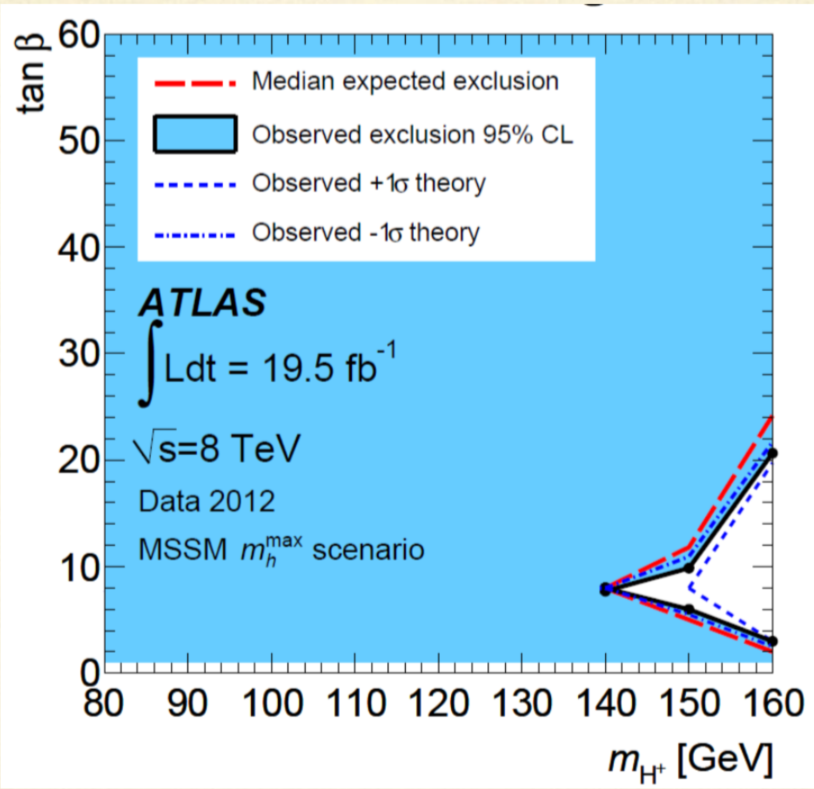


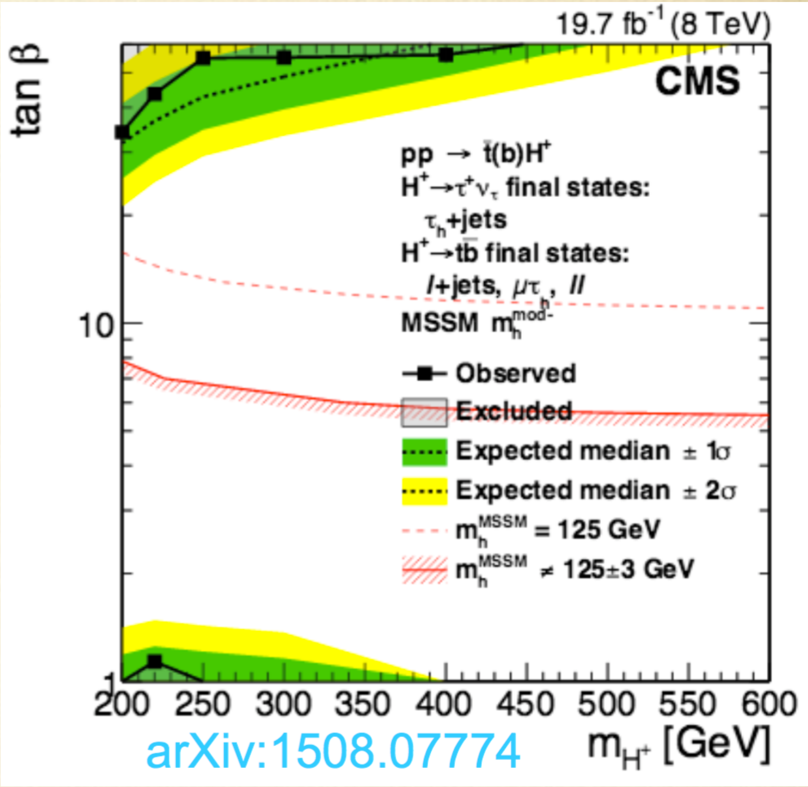


Status and prospects for BSM ((N)MSSM) Higgs searches at the LHC

P. Casado







Conclusions

- No evidence for BSM Higgs yet.
- Current searches constrain large parts of parameter space
  - There are still many things to do be done, and many searches that are still starting up.
  - Expect that this will continue to be a hot area in Run-II.
- For the coming months expect early results in high mass searches.
- For Moriond, search of intermediate-high mass Higgs bosons with full 2015 dataset.
- For summer, update with searches sensitive to additional data collected in 2016.

summary

- Higgs analyses at both ILC and CLIC are continuously being updated and improved, some interesting new analyses have started
- complementarity between ILC and circular colliders has been better understood
- the pattern of Higgs coupling deviations can not only discover indirectly new particles, but also fingerprint different models of new physics
- effort of precision theoretical calculations is ongoing and certainly needed to match the experimental precisions
- LHC searches of extra Higgs bosons already constrain large parameter space; would be nice to have studies of similar search at LCs