PHYSICS at ILC / CLIC

Kitakami site for ILC

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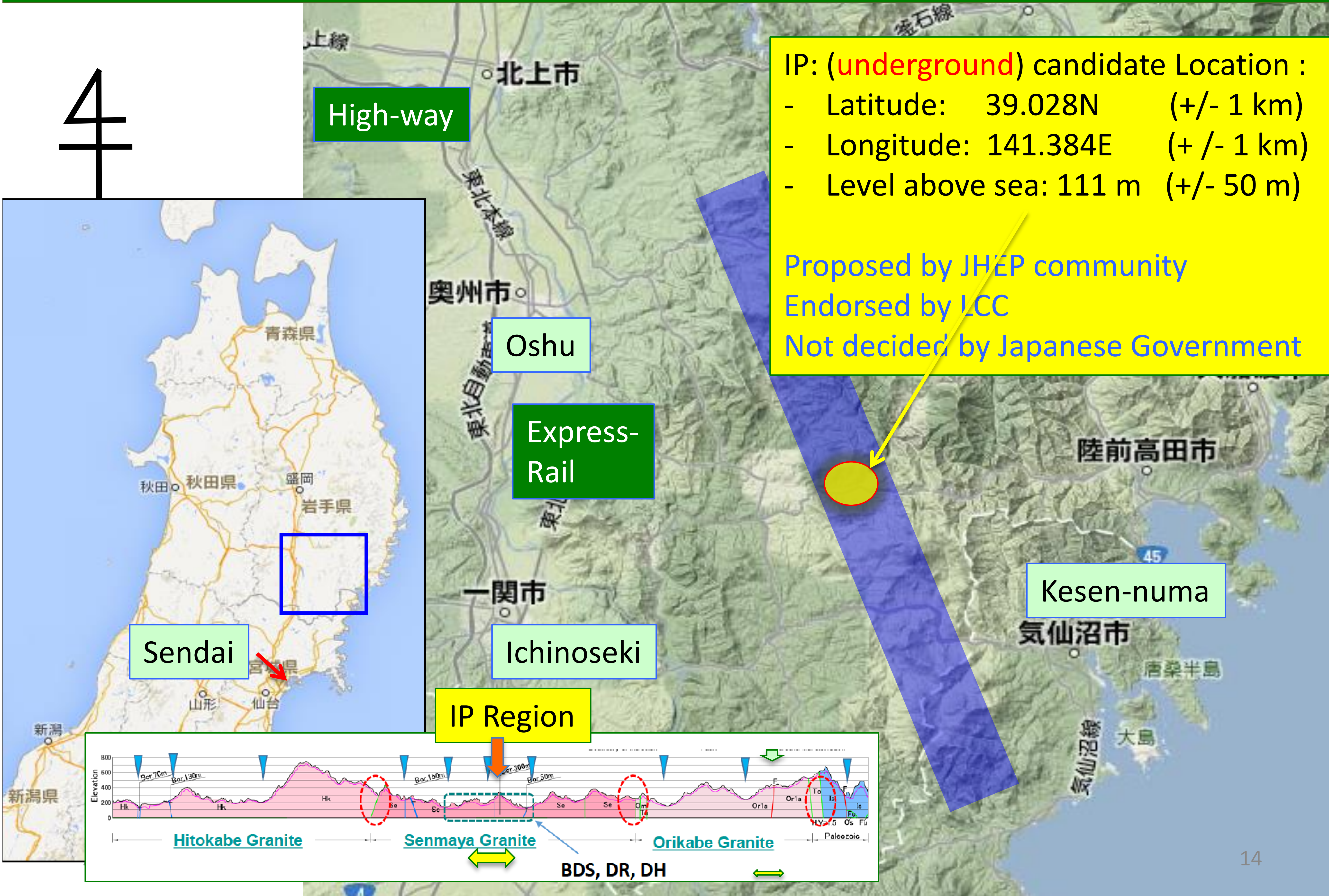
The LTS1, Isola d'Elba, 22 May 2014

ILC Candidate Location: Kitakami Area

IP: (underground) candidate Location :
- Latitude: 39.028N (+/- 1 km)
- Longitude: 141.384E (+ /- 1 km)
- Level above sea: 111 m (+/- 50 m)

Proposed by JHEP community
Endorsed by LCC
Not decided by Japanese Government



Outline :

- Higgs Physics (ILC + CLIC)
- Top Physics (ILC + CLIC)
- EW + QCD Physics (mostly ILC)

Main References

- ILC TDR 2013 / CLIC CDR 2012
- Snowmass Studies 2013 (arxiv:1310.0763,1310.8361,1307.8265, 1307.3962,1311.2028,1310.5189,1310.6708)
- AWLC14, Fermilab, 12-16 May 2014 http://www.linearcollider.org/awlc14/

a lot of work in progress !!!

e^+e^- Linear Collider (LC) Projects

L~ a few $10^{34} cm^{-2}s^{-1}$

- ILC (International Linear Collider)
  - superconducting RF Cavities ➜ accelerat. gradient 31.5 MV/m (proven)
  - aimed at E_{cm} = 500 GeV ➜ 31 Km; possible extension to 1 TeV
  - RDR in 2007; TDR and Detailed Baseline Designs released in 2013; led by Global Design Effort in 2005-2013

E_{cm} tunable, beam polarization... a lot of flexibility !

- CLIC (Compact Linear Collider)
  - normal conducting accelerating structure : two-beam scheme (Drive Beam supplies RF power)
    ➜ gradient 100 MV/m (in development)
  - from Higgs/top threshold up to 3 TeV (upgradable in steps)
    Staged Construction ;
    E_{cm} = 350 GeV ➜ 10 Km, 1.4 TeV ➜ 25 Km, 3 TeV ➜ 48 Km
  - strong accelerator R&D program at CERN (CTF3)
  - currently at CDR stage (Physics and Detectors, http://arxiv.org/abs/1202.5940)

Starting from 2013 new (unified) Linear Collider Collaboration structure (➜ LCC) has been set up, encompassing both ILC and CLIC. Covers both LC accelerator studies and LC physics and detector studies !
(preparing the way for a single linear collider proposal...)

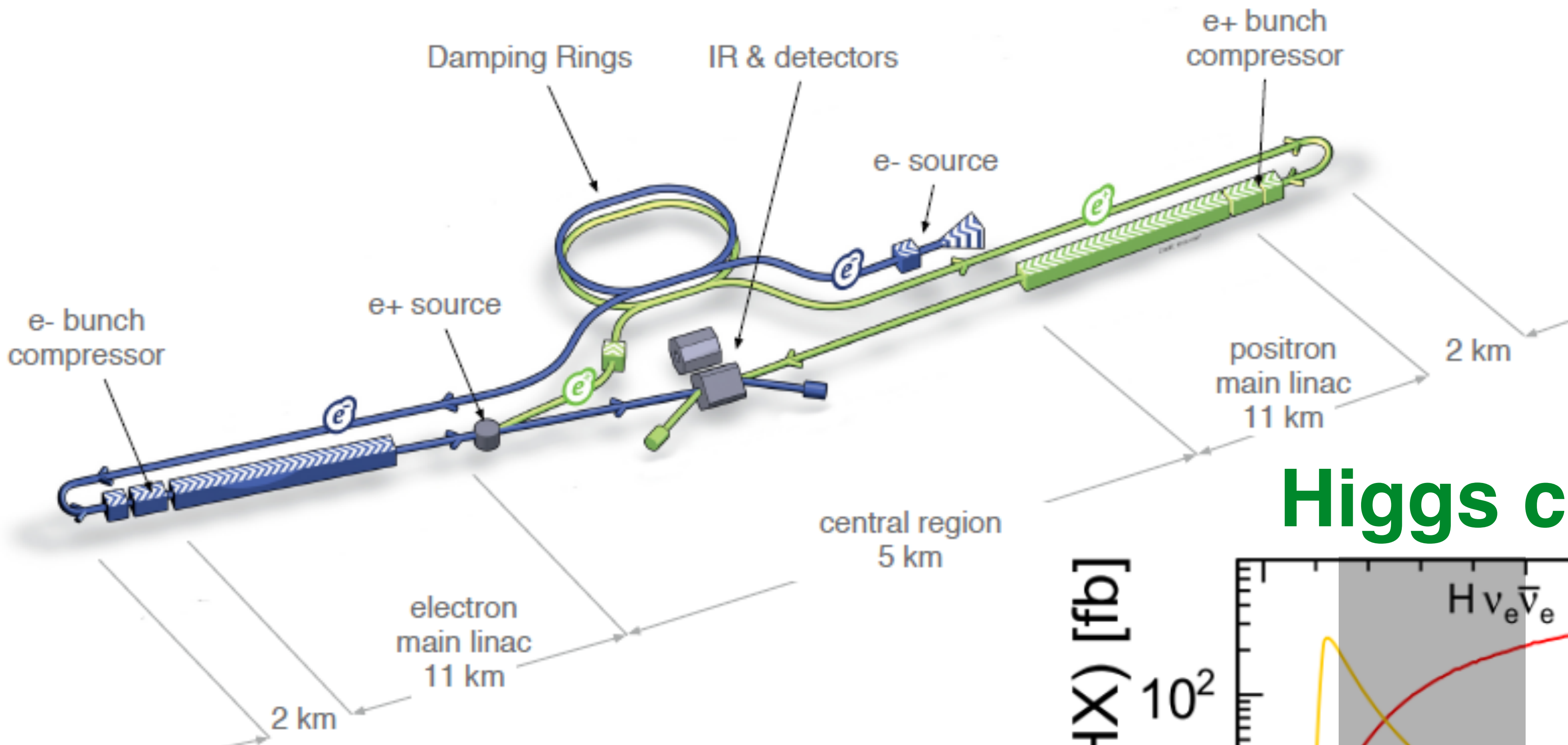
LC potential complementary to LHC / HL LHC

- clean exp conditions! accurate th predictions! EW σ's → democracy!
  can reconst. any hadronic final state → Δm_{jj} and flavor-tagging help !!!
- precision Higgs physics (SM and BSM) :
  σ's, absolute BR's, g_{HXX} (model independent !), g_{HHH} (!),
  mass, total width, inv. width, quantum numbers
- precision top physics (mass,width,asym.s,couplings)

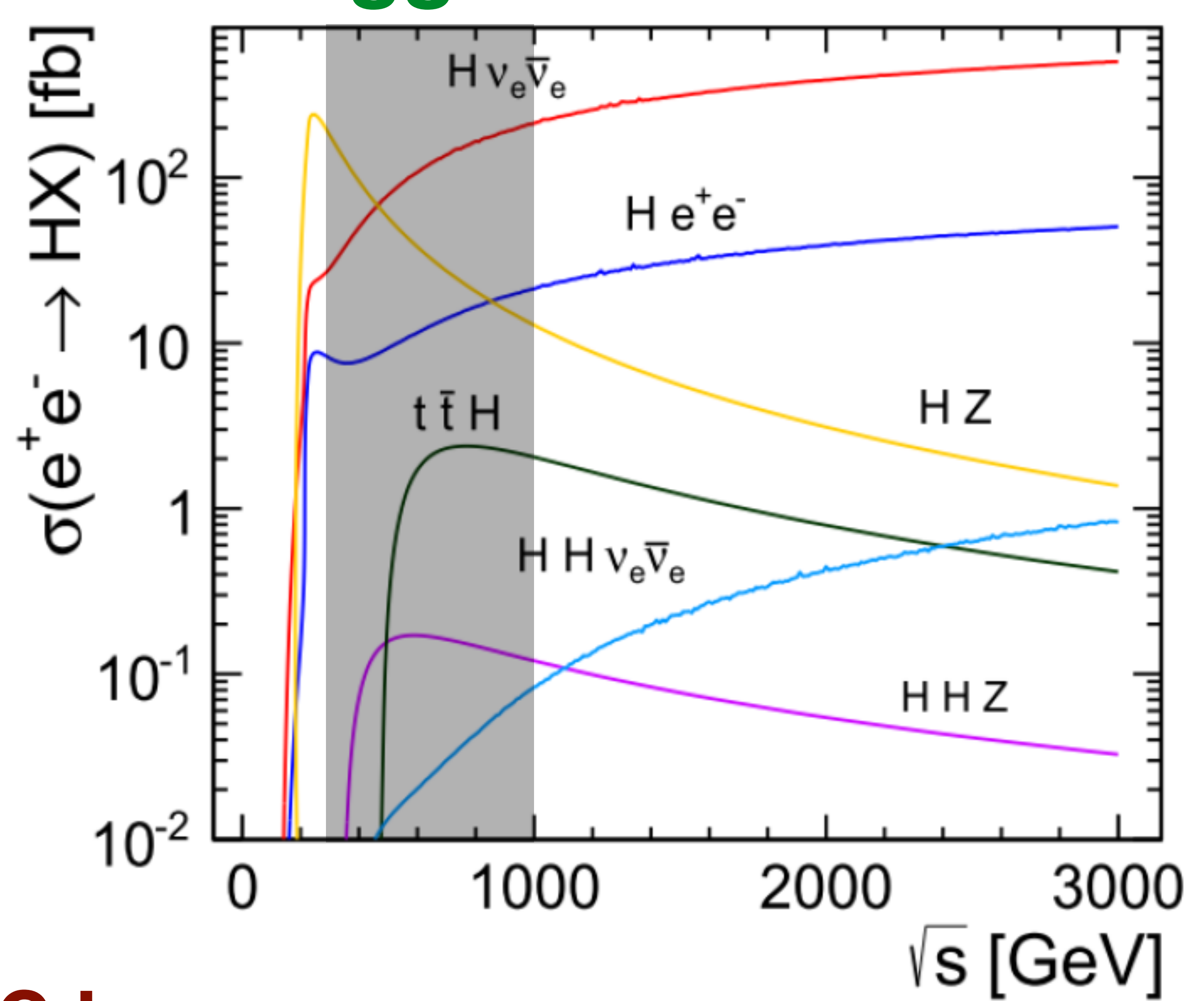
most measurements at the % level !

- access to weakly interacting BSM states,
  like sleptons and ew-gauginos
- could detect what is "invisible" at LHC
  (untriggered operation → could find unexpected signals that do not pass LHC trigger...)
- experimental sensitivities well understood;
  2 detector concepts: ILD and SiD (→ CLIC-variants for higher E and bkgds)
- full simulation/reconstruction done extensively
  (HL and HE lead to high rates for photon induced processes → pile-up of bkgds)

A program of precision Higgs couplings at the
ILC : e^+e^- Linear Collider at 250 GeV < $\sqrt{s}$ < 1000 GeV



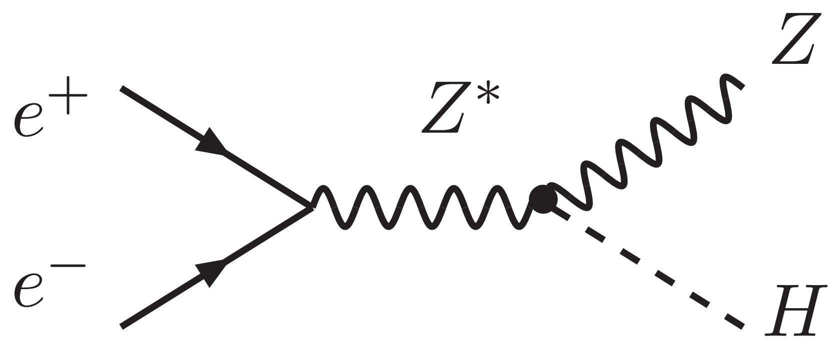
Higgs cross sections



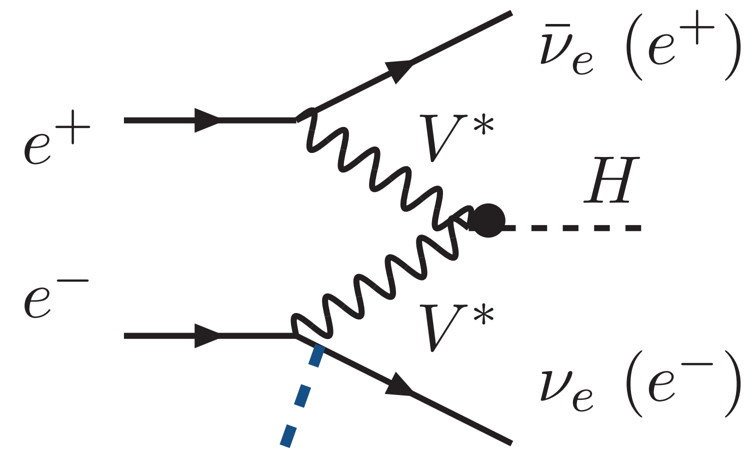
ILC "~ present schedule" :

- **2013-18 Preparatory Phase**
  ~ 2016 *Green Sign* **-> ILC Lab**
- **9 +1 years construction**
  + commission.
- **~ 2028 Physics….**
- **possibly overlapping with HL-LHC !**

Higgs Cross Sections at ILC



$$\sigma \sim \frac{1}{s}$$

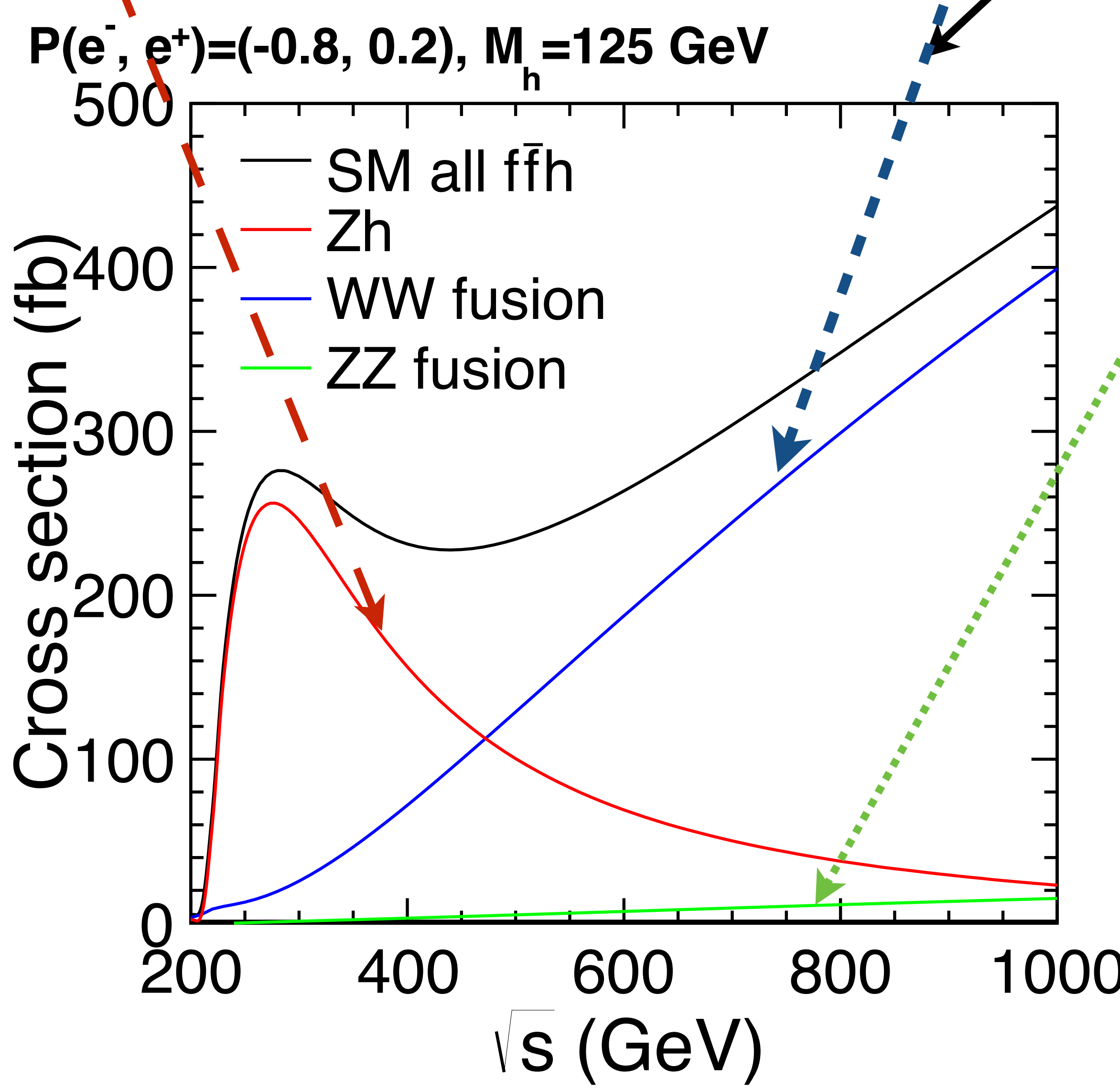


$$\sigma \sim \ln \frac{s}{m_H^2}$$

dominant from ~ threshold up to √S < 400 GeV

accurate reconstruction !

dominant for √S > 500 GeV



ZZ component easy to pin down !

$\Delta(g_{HZZ}/g_{HWW}) < 1\%$

at √S > 1 TeV high statistics, access to sub-leading channels !

(ILC) Energy/Luminosity scenarios

Stage #	nickname	$E_{cm}(1)$ (GeV)	Lumi (1) (fb^{-1})	$E_{cm}(2)$ (GeV)	Lumi (2) (fb^{-1})	$E_{cm}(3)$ (GeV)	Lumi (3) (fb^{-1})	Runtime (years)
1	ILC (250)	250	250					1.1
2	ILC (500)	250	250	500	500			2.0
3	ILC (1000)	250	250	500	500	1000	1000	2.9
4,5,6	ILC(LumUp)	250	1150	500	1600	1000	2500	5.8

- At each stage, the *accumulated* luminosity of a given energy is listed. The runtimes listed consist of actual elapsed *cumulative* running time at the end of each stage. Assuming that the ILC runs for 1/3 of the time, then the actual time elapsed is equal to the runtime times 3.

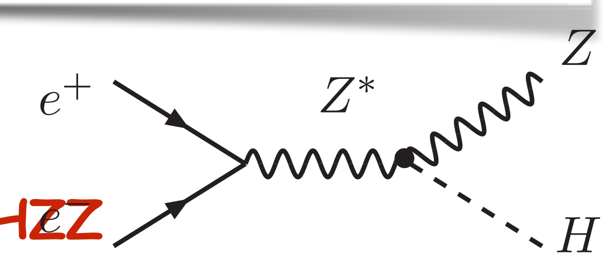
H-strahlung vs WW-fusion ($\sqrt{S}$ ~ 250 GeV - 3 TeV)

expected # of events

	250 GeV	350 GeV	500 GeV	1 TeV	1.5 TeV	3 TeV
$\sigma(e^+e^- \to ZH)$	240 fb	129 fb	57 fb	13 fb	6 fb	1 fb
$\sigma(e^+e^- \to H\nu_e\bar{\nu}_e)$	8 fb	30 fb	75 fb	210 fb	309 fb	484 fb
Int. $\mathcal{L}$	250 fb^{-1}	350 fb^{-1}	500 fb^{-1}	1000 fb^{-1}	1500 fb^{-1}	2000 fb^{-1}
# ZH events	60,000	45,500	28,500	13,000	7,500	2,000
# $H\nu_e\bar{\nu}_e$ events	2,000	10,500	37,500	210,000	460,000	970,000

ee → HZ allows model-indepen. g_{HXX} measurements

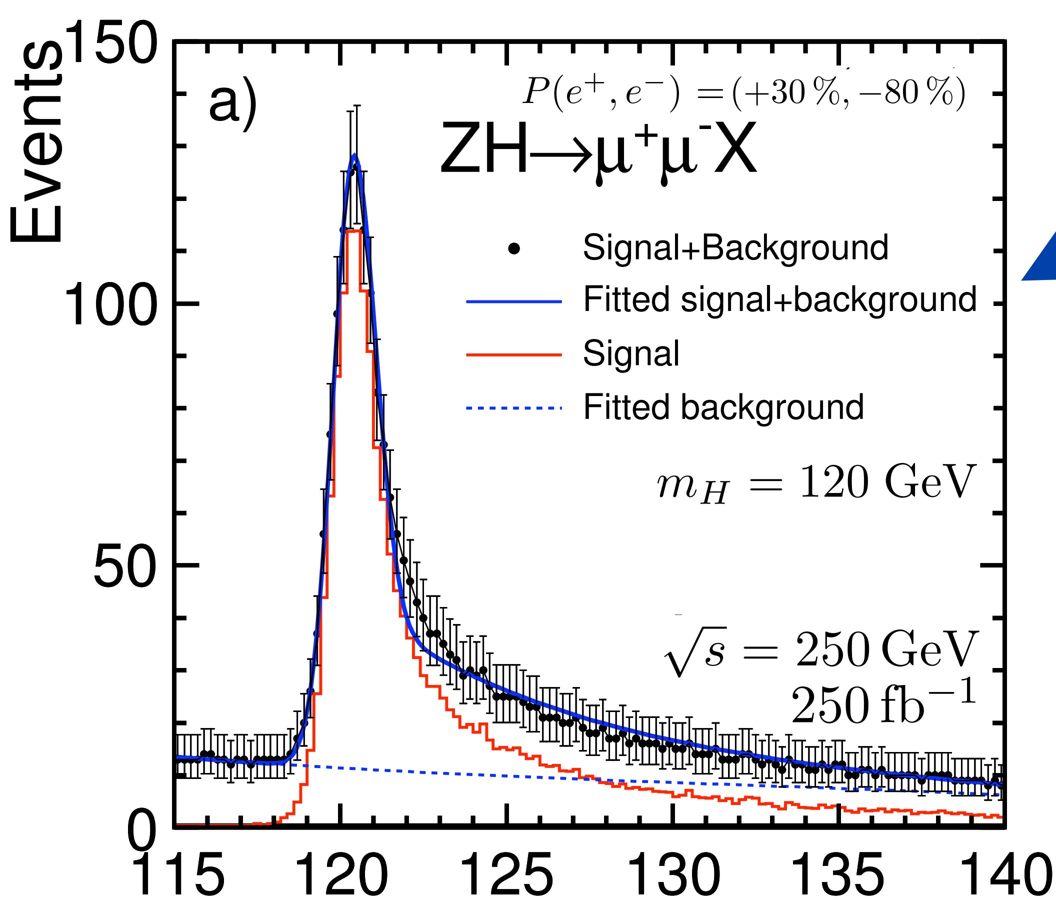
- selected by just identifying Z decay products
  → absolute σ_{tot} (~g_{HZZ}^2) measurement → model indep. g_{HZZ}



- direct access to inv. H decays, H → cc, H → gg

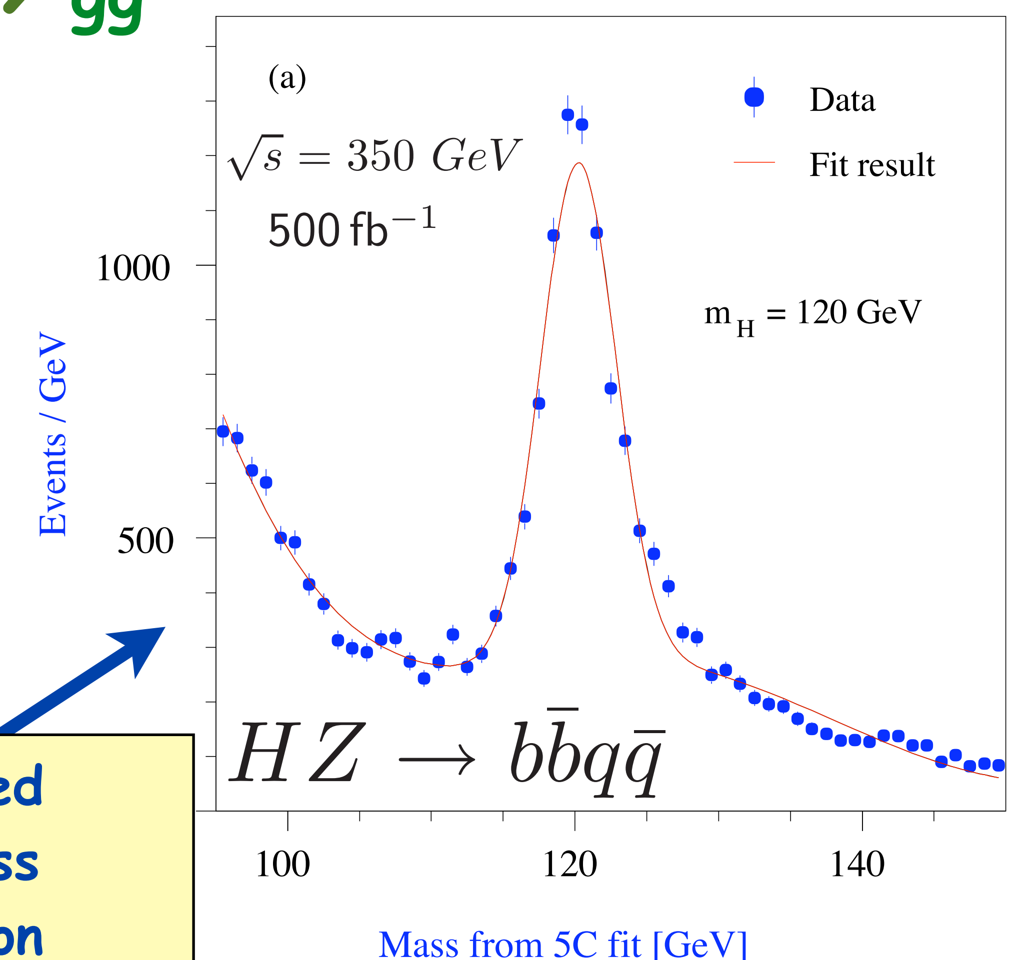
$m_H = 120$ GeV

$\sqrt{s}$	250 GeV	350 GeV
Int. $\mathcal{L}$	250 fb^{-1}	350 fb^{-1}
$\Delta(\sigma)/\sigma$	3 %	4 %
$\Delta(g_{HZZ})/g_{HZZ}$	1.5 %	2 %



Δm_H ~ 30 MeV

independent from H decay



constrained fit to mass distribution
→Δm_H~ 50MeV

by identifying Higgs final states X
→ absolute measurement of BR_X

core of model-independent g_{HXX} measurements

4 kinds of observables :

Y_1-kind missing at the LHC !

$$Y_1 = \sigma_{ZH} = F_1 \cdot g^2_{HZZ}$$

$\rightarrow$ g_{HZZ}

$$Y_2 = \sigma_{ZH} \times \mathrm{Br}(H \to b\bar{b}) = F_2 \cdot \frac{g^2_{HZZ} g^2_{Hb\bar{b}}}{\Gamma_T}$$

$$Y_3 = \sigma_{\nu\bar{\nu}H} \times \mathrm{Br}(H \to b\bar{b}) = F_3 \cdot \frac{g^2_{HWW} g^2_{Hb\bar{b}}}{\Gamma_T}$$

g_{HZZ}/g_{HWW}

$\downarrow$ g_{HZZ}

g_{HWW}

$$Y_4 = \sigma_{\nu\bar{\nu}H} \times \mathrm{Br}(H \to WW^*) = F_4 \cdot \frac{g^4_{HWW}}{\Gamma_T}$$

Γ_T

g_{HZZ}

g_{Hbb} (g_{Hff})

HZ and VBF both crucial to this analysis !

Combined Sensitivity

$$\Delta\left(\sigma_{\mathrm{HZ}}\frac{\Gamma_{\mathrm{vis}}}{\Gamma}\right) = \pm 1.7\,\% \quad + \quad \Delta\left(\sigma_{\mathrm{HZ}}\frac{\Gamma_{\mathrm{invis}}}{\Gamma}\right) = \pm 0.6\,\%$$

$$\Rightarrow \Delta\left(\sigma_{\mathrm{HZ}}\right) = \pm 1.8\,\%$$

(CLIC beam spectrum, 500 fb^{-1} @ 350 GeV, no polarisation)

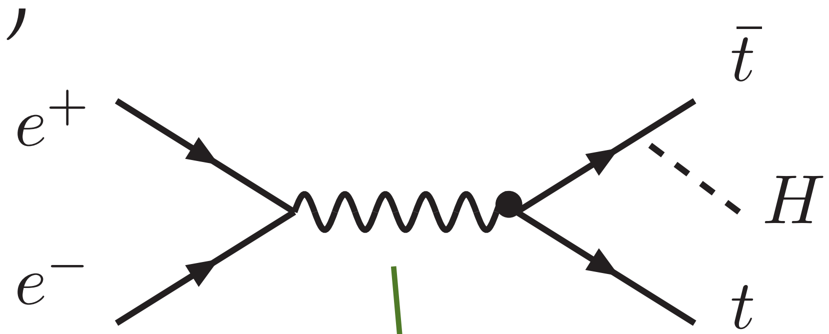
★ **Combined with leptonic recoil mass**

$$\Rightarrow \boxed{\Delta\left(g_{\mathrm{HZZ}}\right) \approx \pm 0.8\,\%}$$

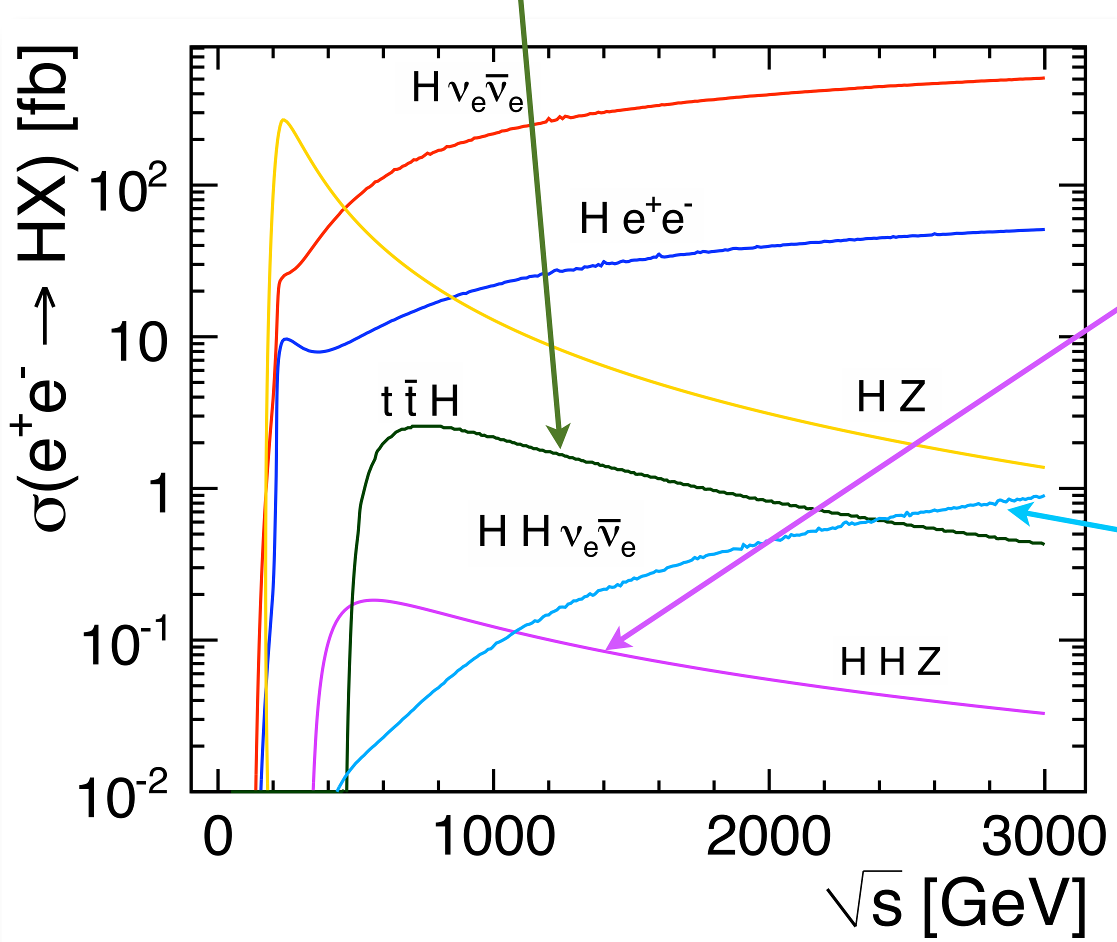
"almost model independent"

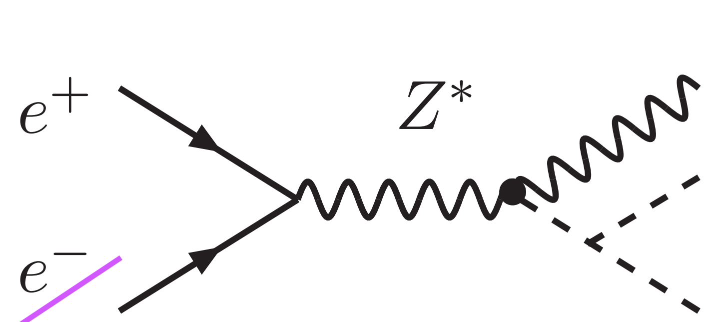
smaller-σ processes

give access to g_{Htt} and H self-coupling (→ λ → Higgs mechanism)

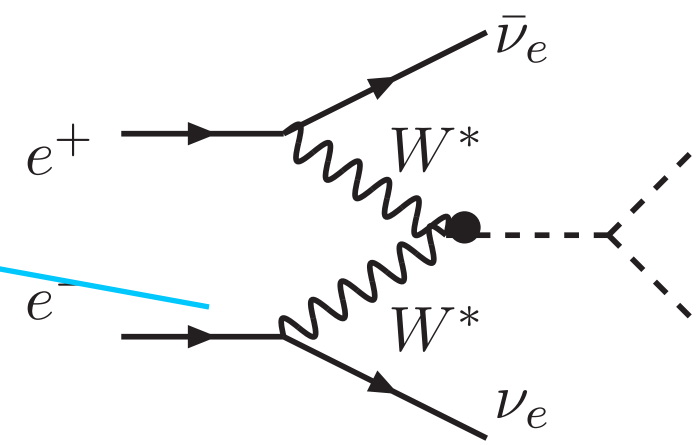


· $\Delta g_{Htt}/g_{Htt}$ ~ 10% √s ~ 500 GeV





√s ~ 500 GeV



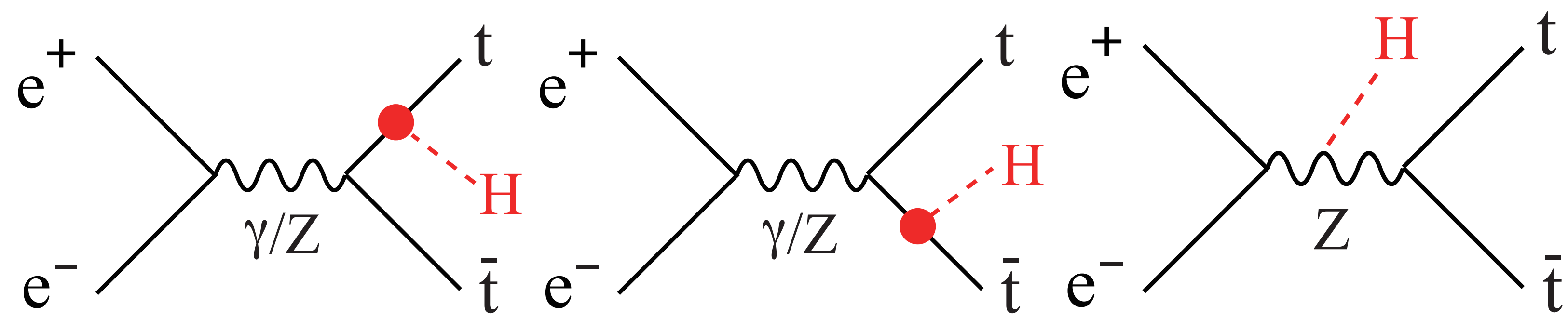
√s > 1 TeV

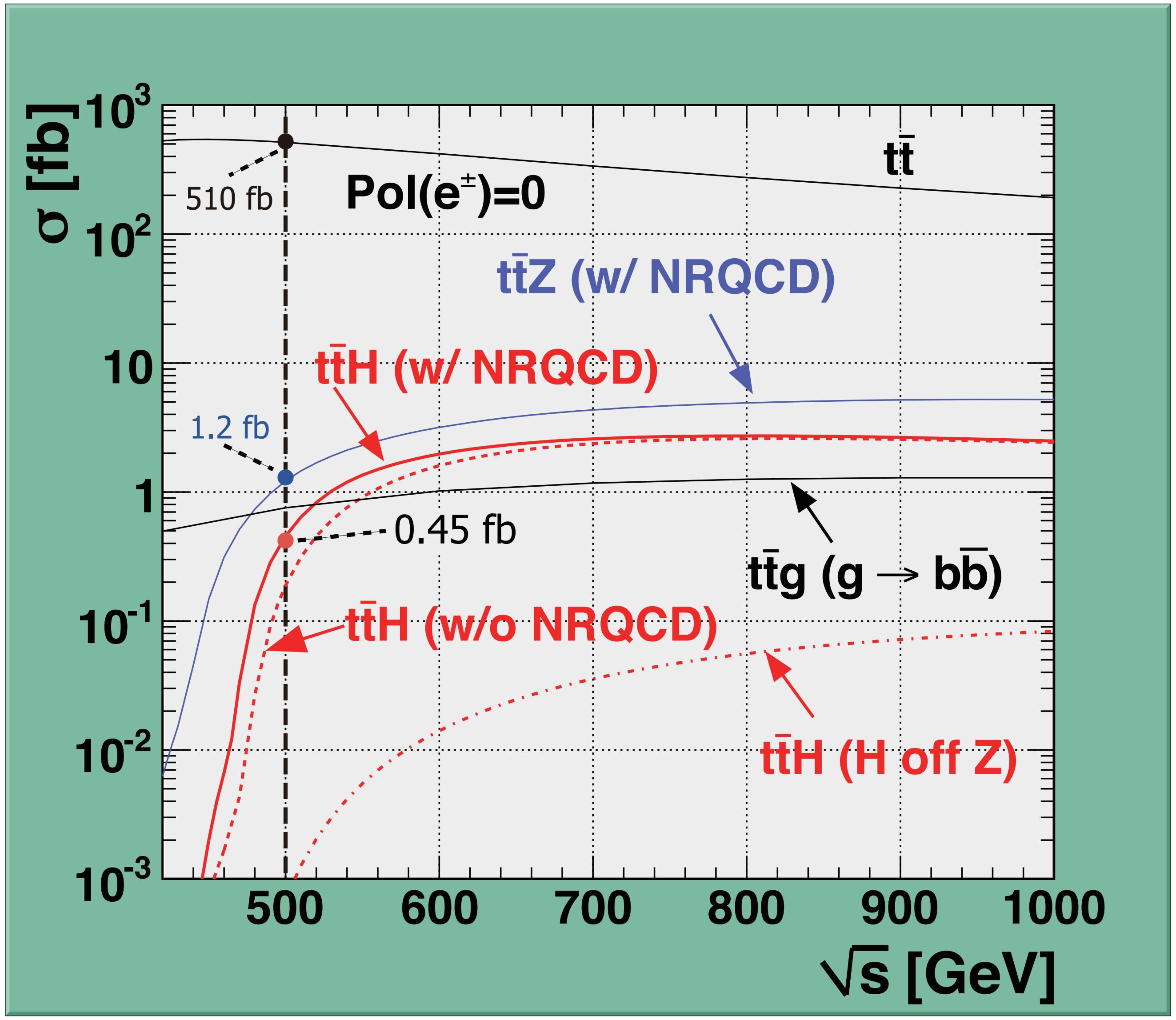
(more sensitive !)

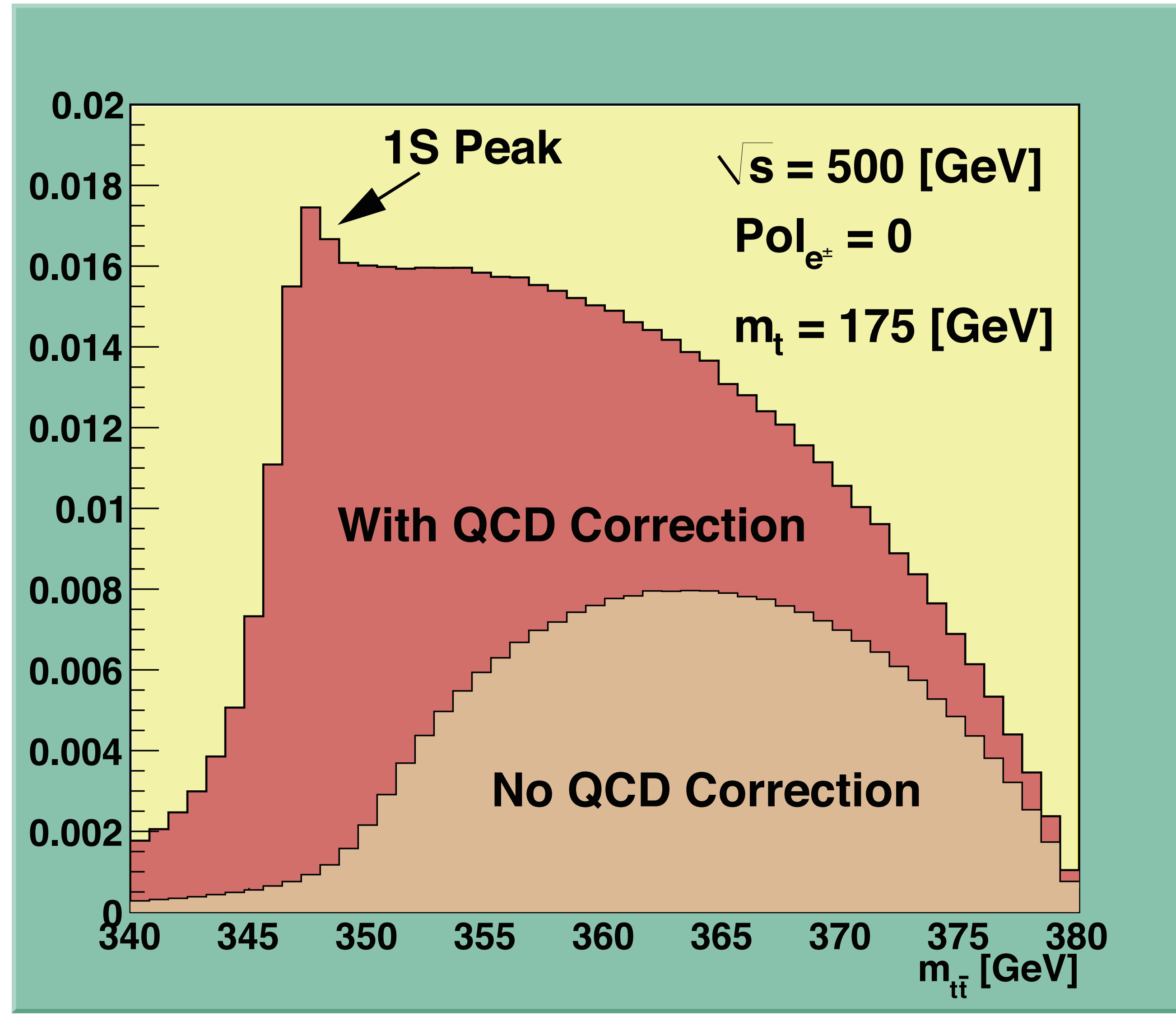
· Δλ/λ ~13% ILC1000up

challenging ! (low σ, mostly HH → bbbb)

top Yukawa coupling





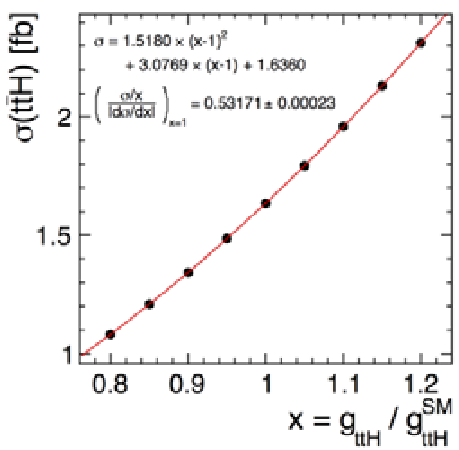


- $\Delta y_{top}/y_{top}$ ~10%

$\sqrt{s}$ ~ 500 GeV
1/ab
$P_e(-0.8,0.3)$

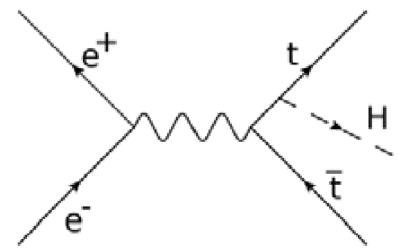
$e^+e^- \to t\bar{t}H$ Philipp Roloff & Yuji Sudo

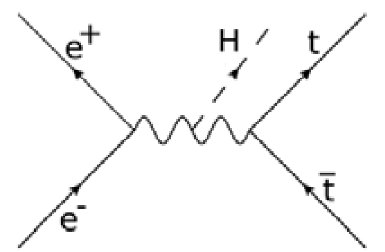
• CLIC 1.4 TeV



$$\boxed{\frac{\Delta y_t}{y_t} = 0.53\frac{\Delta\sigma}{\sigma}}$$

(0.5 without contribution from Higgsstrahlung)





Hadronic channel:
$S / \sqrt{S+B} = 8.36$
$\Delta(\sigma(t\bar{t}H)) = 12.0\%$

Semileptonic channel:
$S / \sqrt{S+B} = 9.17$
$\Delta(\sigma(t\bar{t}H)) = 10.9\%$

Combined:
$\Delta(\sigma(t\bar{t}H)) = 8.1\%$
$\to \Delta(g_{ttH}) = 4.3\%$

$L = 1.5\ ab^{-1}$

→ Precision on g_{ttH} would improve to better than 4% with -80% electron polarisaion

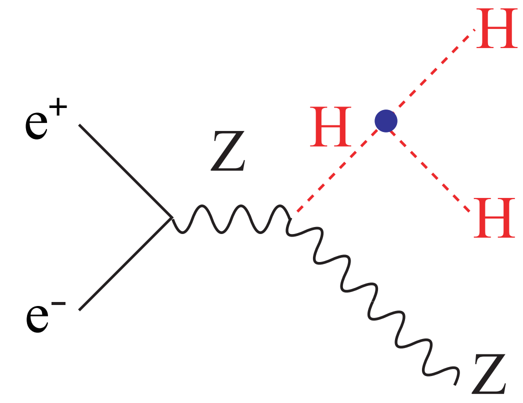
For comparison:
$\Delta(g_{ttH}) = 4.3\text{-}4.5\%$ expected at 1 TeV ILC (form ILC TDR)

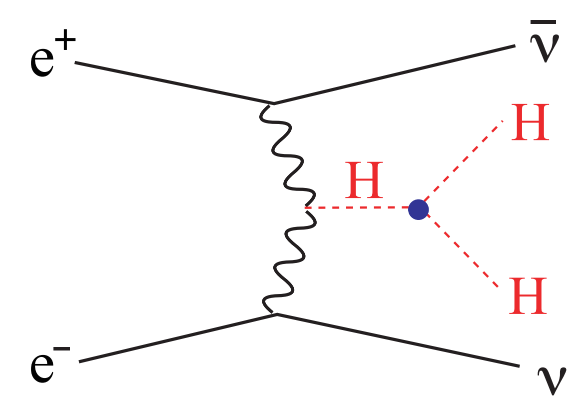
• ILC 500 GeV

- direct top Yukawa coupling measurement with tth channel
- $\sqrt{s}$ = 500 GeV ILC, L = 500 fb^{-1} , Mh = 125 GeV
- cut based event selection and counting analysis
- tth→8jets $S/\sqrt{S+B}$ = 2.04
- tth→ln+6jets $S/\sqrt{S+B}$ = 2.42
- combine → significance = 3.16
  $|\Delta g_t/g_t|$ = 15.7%
- In the cases of lumi-up or $\sqrt{s}$ = 520 GeV, significance reaches 5
  (L = 1600 fb^{-1})

$\sqrt{s}$	: $S/\sqrt{S+B}$	: $\lvert\Delta g_t/g_t\rvert$ %
490	: 2.06	: 24.2
500	: 3.16	: 15.7
510	: 4.19	: 11.9
520	: 5.12	: 9.76
530	: 5.96	: 8.38
540	: 6.70	: 7.45
550	: 7.33	: 6.81

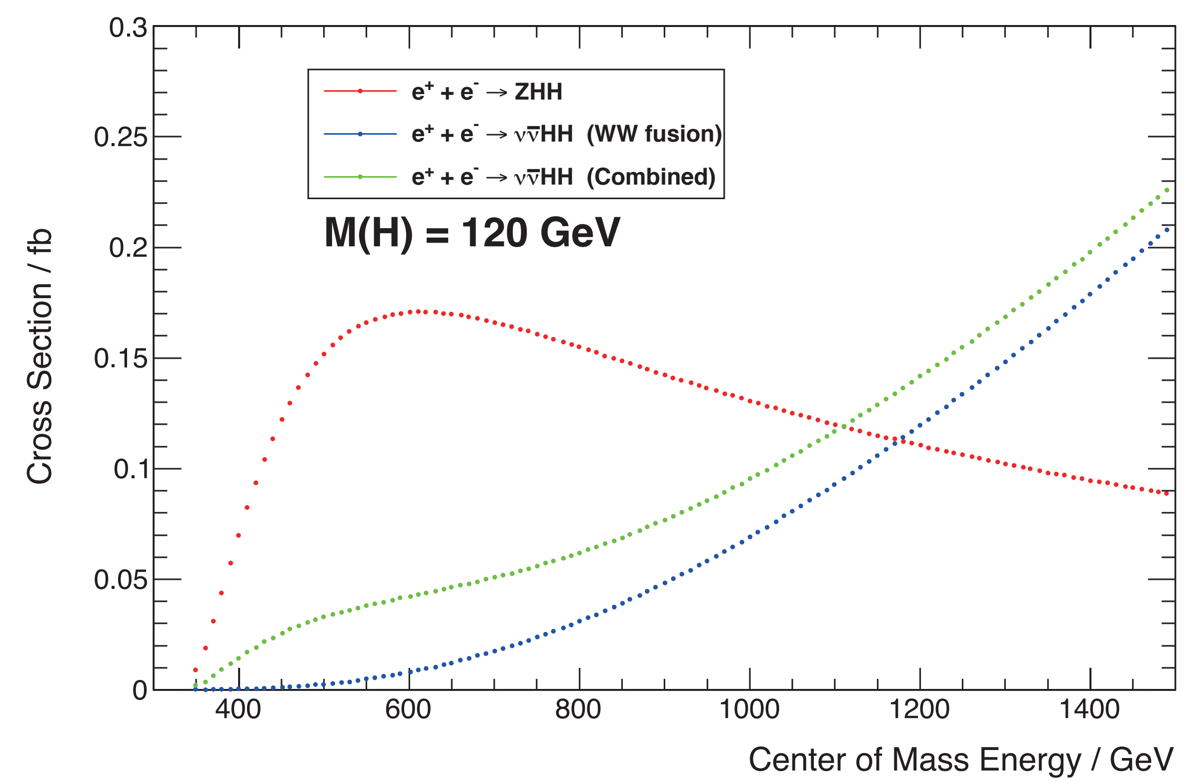
Triple Higgs coupling





including

HH ➜ bbbb, bbWW*



	ILC500	ILC500-up	ILC1000	ILC1000-up	CLIC1400	CLIC3000
$\sqrt{s}$ (GeV)	500	500	500/1000	500/1000	1400	3000
$\int \mathcal{L}dt$ (fb^{-1})	500	$1600^{\ddagger}$	500+1000	$1600+2500^{\ddagger}$	1500	+2000
$P(e^-, e^+)$	$(-0.8, 0.3)$	$(-0.8, 0.3)$	$(-0.8, 0.3/0.2)$	$(-0.8, 0.3/0.2)$	$(0,0)/(-0.8,0)$	$(0,0)/(-0.8,0)$
$\sigma\,(ZHH)$	42.7%		42.7%	23.7%	–	–
$\sigma\,(\nu\bar{\nu}HH)$	–	–	26.3%	16.7%		
λ	83%	46%	21%	13%	28/21%	16/10%

Summary of expected accuracies $\Delta g_i/g_i$ and Γ_T for model independent determinations of the Higgs boson couplings

Mode	ILC(250)	ILC(500)	ILC(1000)	ILC(LumUp)
$\sqrt{s}$ (GeV)	250	250+500	250+500+1000	250+500+1000
L (fb^{-1})	250	250+500	250+500+1000	1150+1600+2500
$\gamma\gamma$	18 %	8.4 %	4.0 %	2.4 %
gg	6.4 %	2.3 %	1.6 %	0.9 %
WW	4.9 %	1.2 %	1.1 %	0.6 %
ZZ	1.3 %	1.0 %	1.0 %	0.5 %
$t\bar{t}$	–	14 %	3.2 %	2.0 %
$b\bar{b}$	5.3 %	1.7 %	1.3 %	0.8 %
$\tau^+\tau^-$	5.8 %	2.4 %	1.8 %	1.0 %
$c\bar{c}$	6.8 %	2.8 %	1.8 %	1.1 %
$\mu^+\mu^-$	91 %	91 %	16 %	10 %
Γ_T	12 %	5.0 %	4.6 %	2.5 %
hhh	–	83 %	21 %	13 %
BR(invis.)	< 0.9 %	< 0.9 %	< 0.9 %	< 0.4 %

The theory errors are $\Delta F_i/F_i$=0.5%. For the invisible branching ratio, the numbers quoted are 95% confidence upper limits.

arXiv:1310.8361

ILC versus LHC

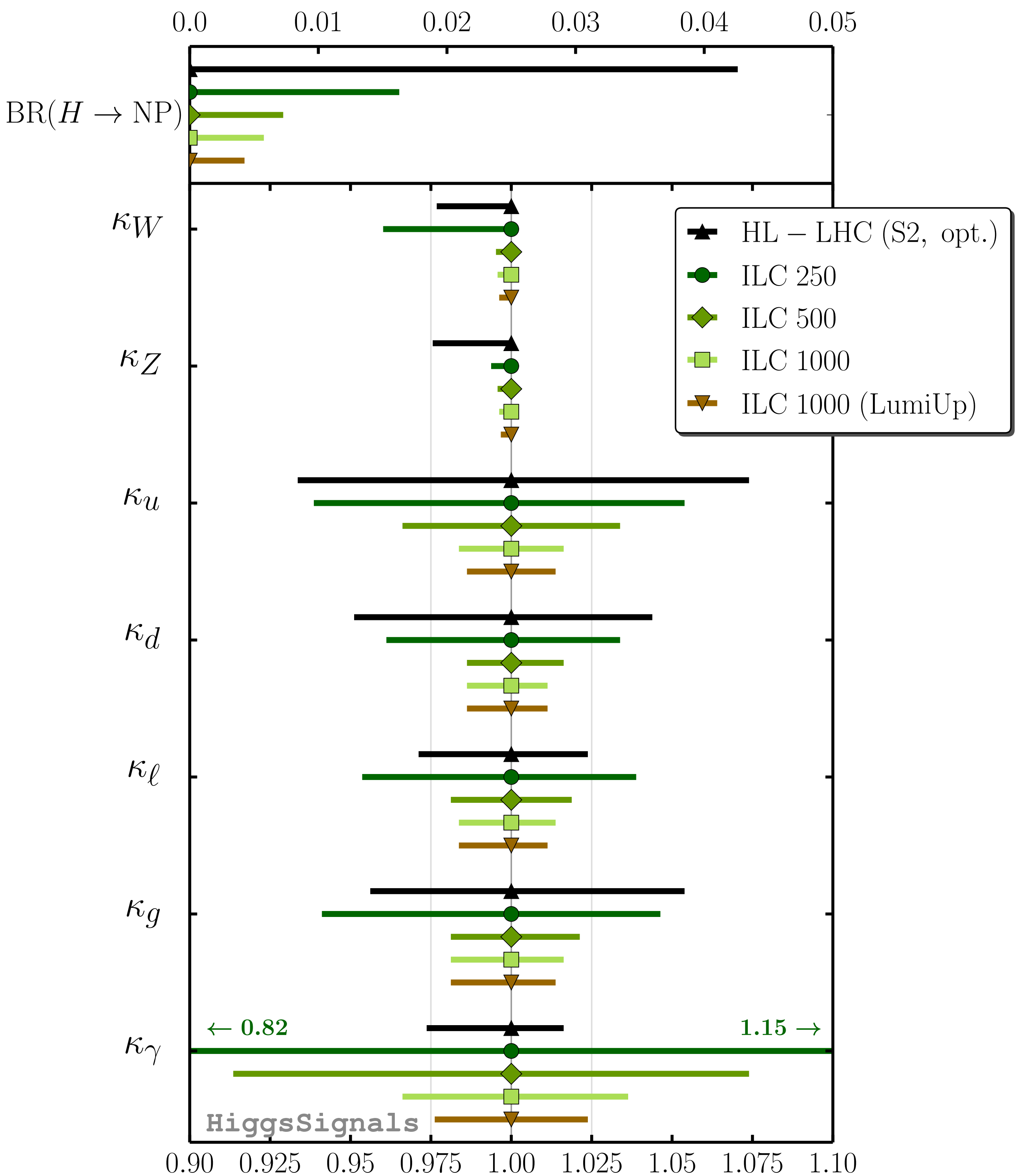
$$\kappa_A = g(hA\bar{A})/(SM)$$

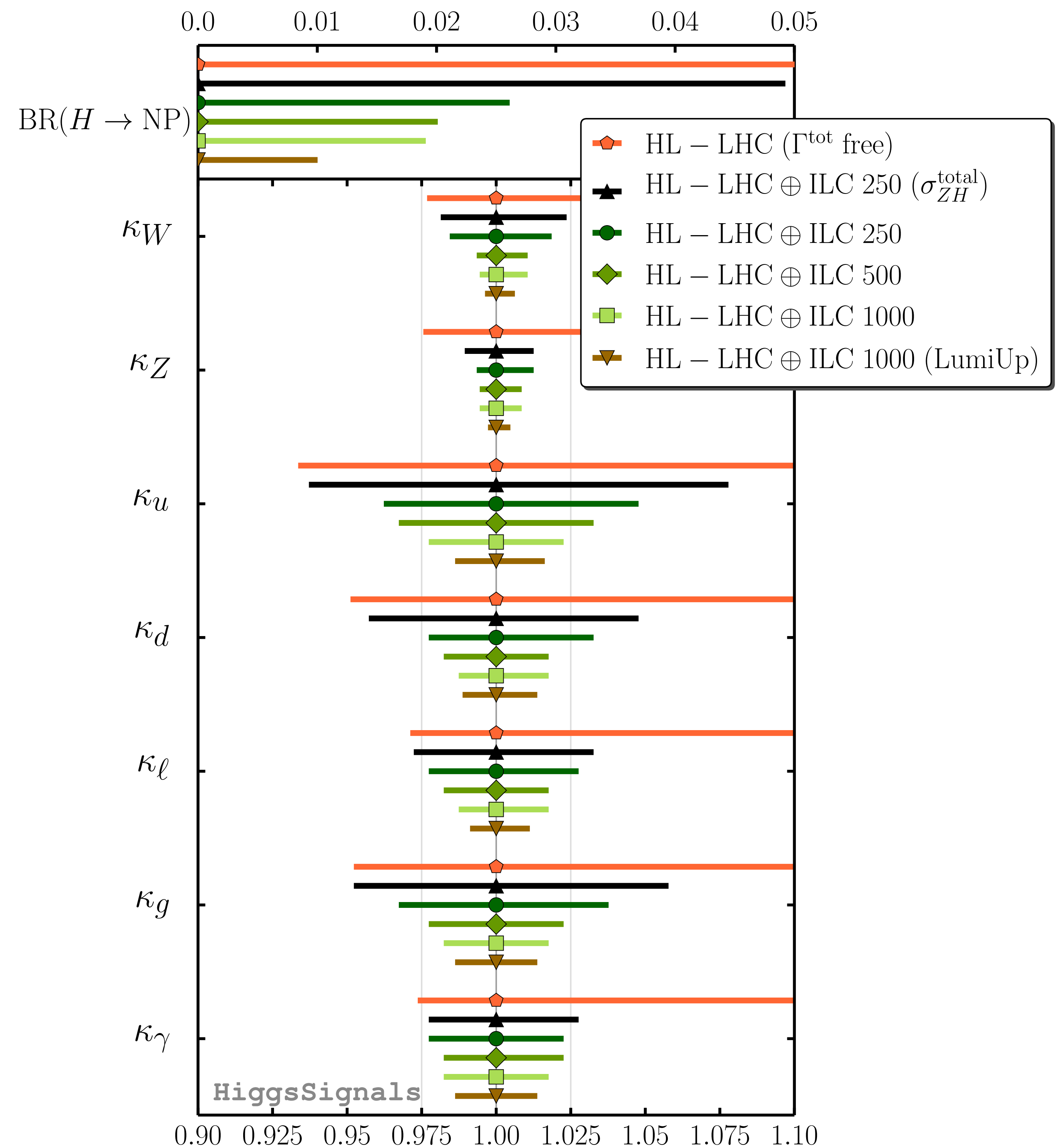
LHC, 7 param.s fit

Luminosity	300 fb^{-1}	3000 fb^{-1}
Coupling parameter	7-parameter fit	
κ_γ	$5-7\%$	$2-5\%$
κ_g	$6-8\%$	$3-5\%$
κ_W	$4-6\%$	$2-5\%$
κ_Z	$4-6\%$	$2-4\%$
κ_u	$14-15\%$	$7-10\%$
κ_d	$10-13\%$	$4-7\%$
κ_ℓ	$6-8\%$	$2-5\%$
Γ_H	$12-15\%$	$5-8\%$
	additional parameters (see tex	
$\kappa_{Z\gamma}$	$41-41\%$	$10-12\%$
κ_μ	$23-23\%$	$8-8\%$
BR_{BSM}	$< 14-18\%$	$< 7-11\%$

ILC vs HL-LHC + ILC

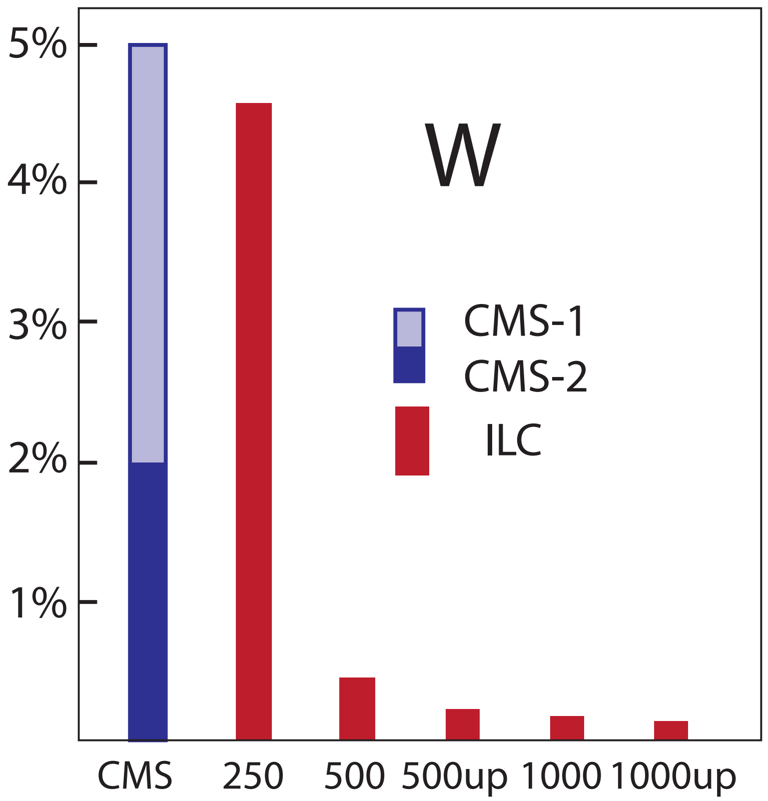
Heinemeyer, 1405.3781

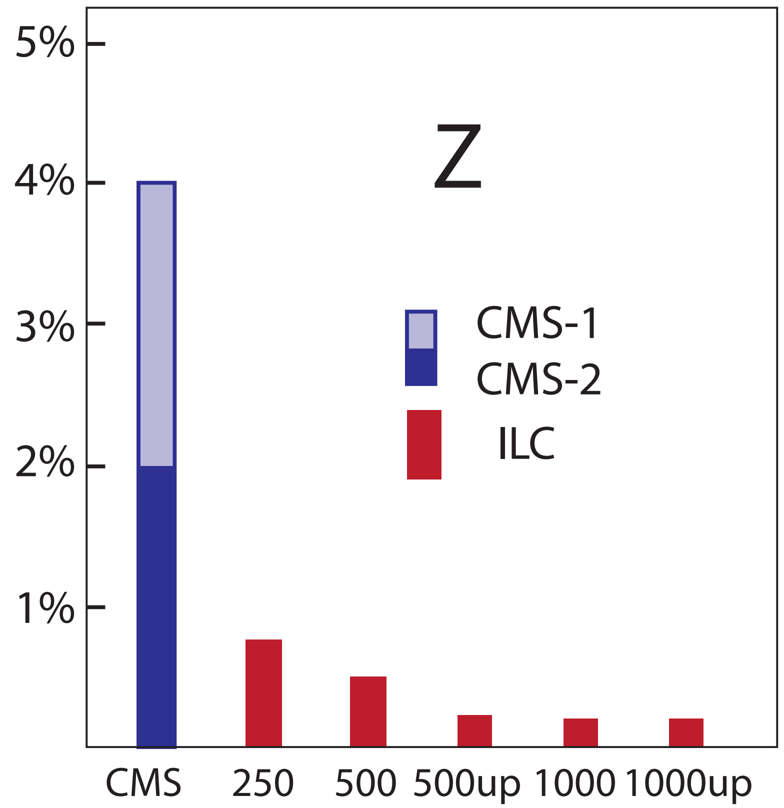


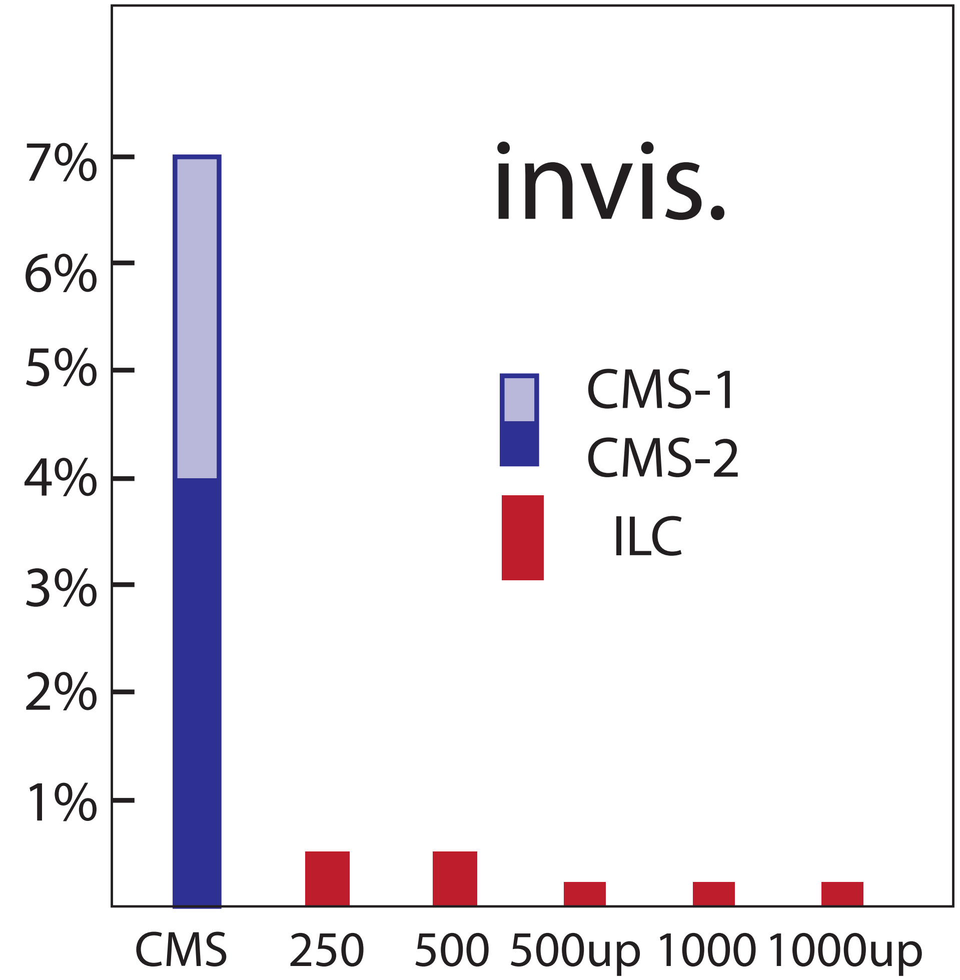


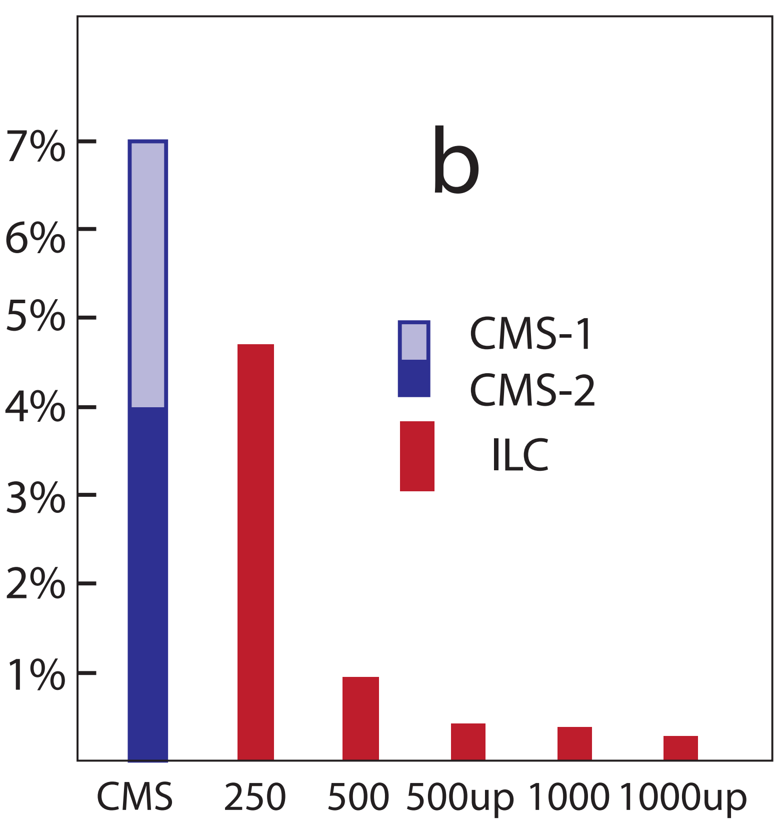
ILC versus LHC

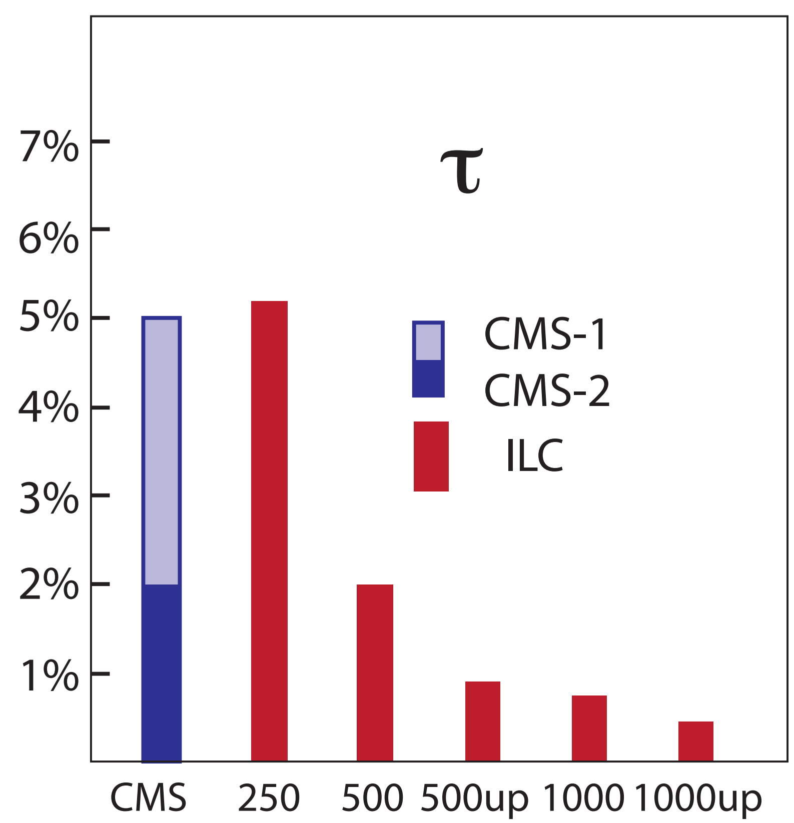
Peskin, 1312.4974

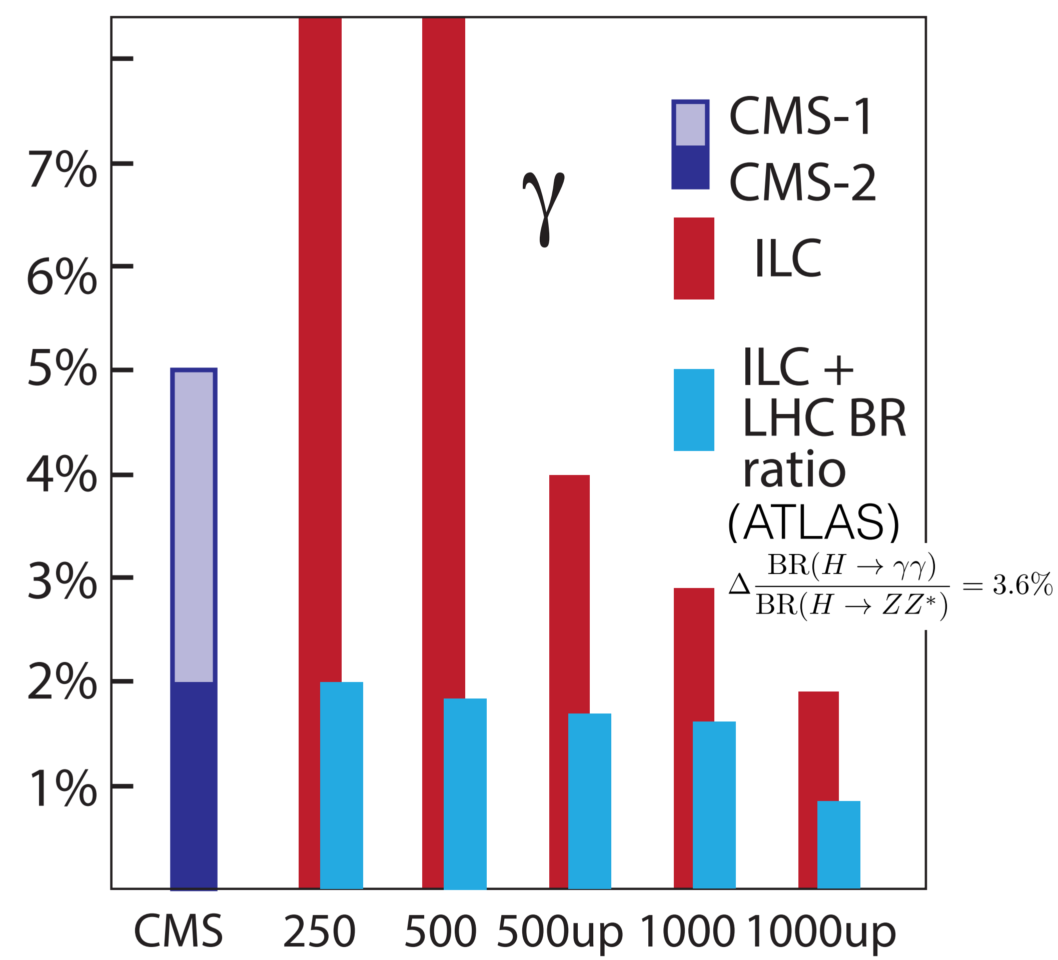












Higgs studies update

Channel	Measurement	Observable	Statistical precision 350 GeV 500 fb^{-1}	1.4 TeV 1.5 ab^{-1}	3.0 TeV 2.0 ab^{-1}
ZH	Recoil mass distribution	m_H	120 MeV	–	–
ZH	$\sigma(HZ) \times BR(H \to \text{invisible})$	Γ_{inv}	0.6%	–	–
ZH	$H \to b\bar{b}$ mass distribution	m_H	tbd	–	–
$H\nu_e\bar{\nu}_e$	$H \to b\bar{b}$ mass distribution	m_H	–	40 MeV*	33 MeV*
ZH	$\sigma(HZ) \times BR(Z \to \ell^+\ell^-)$	g^2_{HZZ}	4.2%	–	–
ZH	$\sigma(HZ) \times BR(Z \to q\bar{q})$	g^2_{HZZ}	1.8%	–	–
ZH	$\sigma(HZ) \times BR(H \to b\bar{b})$	$g^2_{HZZ}g^2_{Hbb}/\Gamma_H$	1%†	–	–
ZH	$\sigma(HZ) \times BR(H \to c\bar{c})$	$g^2_{HZZ}g^2_{Hcc}/\Gamma_H$	5%†	–	–
ZH	$\sigma(HZ) \times BR(H \to gg)$		6%†	–	–
ZH	$\sigma(HZ) \times BR(H \to \tau^+\tau^-)$	$g^2_{HZZ}g^2_{H\tau\tau}/\Gamma_H$	5.7%	–	–
ZH	$\sigma(HZ) \times BR(H \to WW^*)$	$g^2_{HZZ}g^2_{HWW}/\Gamma_H$	2%†	–	–
ZH	$\sigma(HZ) \times BR(H \to ZZ^*)$	$g^2_{HZZ}g^2_{HZZ}/\Gamma_H$	tbd	–	–
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to b\bar{b})$	$g^2_{HWW}g^2_{Hbb}/\Gamma_H$	3%†	0.3%	0.2%
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to c\bar{c})$	$g^2_{HWW}g^2_{Hcc}/\Gamma_H$	–	2.9%	2.7%
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to gg)$		–	1.8%	1.8%
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to \tau^+\tau^-)$	$g^2_{HWW}g^2_{H\tau\tau}/\Gamma_H$	–	3.7%*	tbd
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to \mu^+\mu^-)$	$g^2_{HWW}g^2_{H\mu\mu}/\Gamma_H$	–	38%	16%
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to \gamma\gamma)$		–	15%	tbd
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to Z\gamma)$		–	42%	tbd
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to WW^*)$	g^4_{HWW}/Γ_H	tbd	1.1%*	0.8%*
$H\nu_e\bar{\nu}_e$	$\sigma(H\nu_e\bar{\nu}_e) \times BR(H \to ZZ^*)$	$g^2_{HWW}g^2_{HZZ}/\Gamma_H$	–	3%†	2%†
He^+e^-	$\sigma(He^+e^-) \times BR(H \to b\bar{b})$	$g^2_{HZZ}g^2_{Hbb}/\Gamma_H$	–	1%†	0.7%†
$t\bar{t}H$	$\sigma(t\bar{t}H) \times BR(H \to b\bar{b})$	$g^2_{Htt}g^2_{Hbb}/\Gamma_H$	–	8%	tbd
$HH\nu_e\bar{\nu}_e$	$\sigma(HH\nu_e\bar{\nu}_e)$	g_{HHWW}	–	7%*	3%*
$HH\nu_e\bar{\nu}_e$	$\sigma(HH\nu_e\bar{\nu}_e)$	λ	–	32%	16%
$HH\nu_e\bar{\nu}_e$	with -80% e^- polarization	λ	–	24%	12%

Several updates from the Snowmass paper, comprehensive Higgs paper in preparation

* *preliminary*
† *estimates*

(Roloff et al)

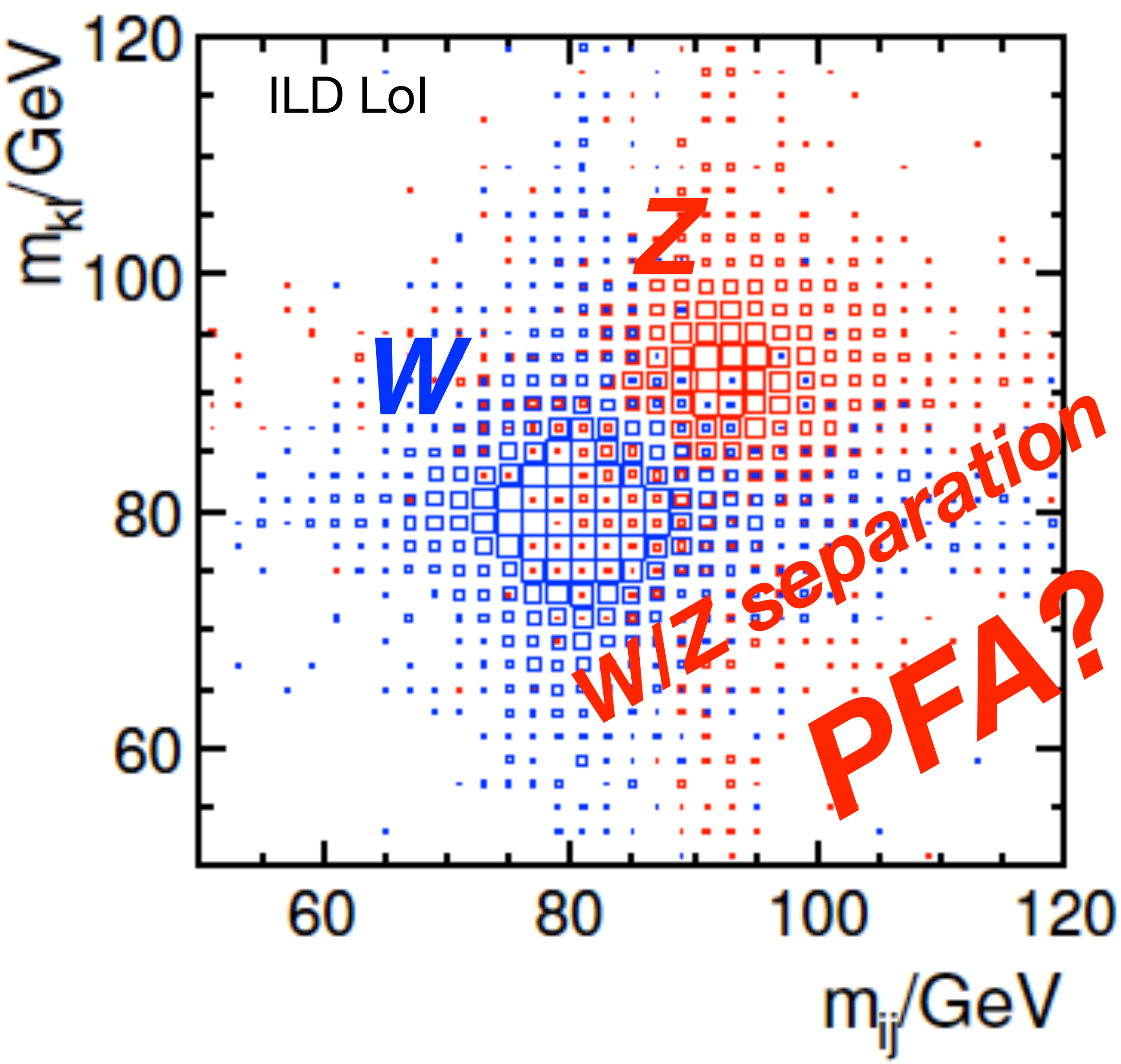
ILC, CLIC vs LHC, HL-LHC 7 parameter fit

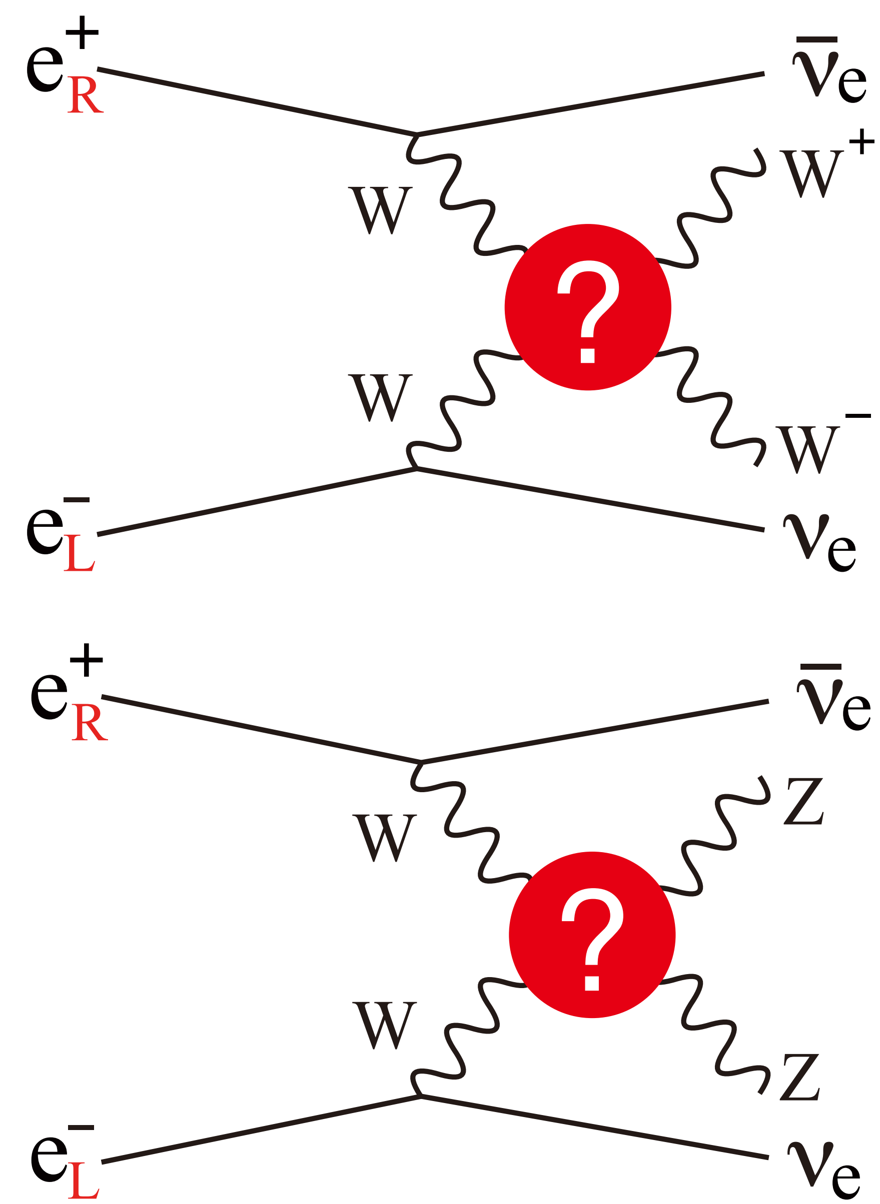
Facility	LHC	HL-LHC	ILC500	ILC500-up	ILC1000	ILC1000-up	CLIC
$\sqrt{s}$ (GeV)	14,000	14,000	250/500	250/500	250/500/1000	250/500/1000	350/1400/3000
$\int \mathcal{L}dt$ (fb^{-1})	300/expt	3000/expt	250+500	1150+1600	250+500+1000	1150+1600+2500	500+1500+2000
κ_γ	$5-7\%$	$2-5\%$	8.3%	4.4%	3.8%	2.3%	$-/5.5/<5.5\%$
κ_g	$6-8\%$	$3-5\%$	2.0%	1.1%	1.1%	0.67%	3.6/0.79/0.56%
κ_W	$4-6\%$	$2-5\%$	0.39%	0.21%	0.21%	0.2%	1.5/0.15/0.11%
κ_Z	$4-6\%$	$2-4\%$	0.49%	0.24%	0.50%	0.3%	0.49/0.33/0.24%
κ_ℓ	$6-8\%$	$2-5\%$	1.9%	0.98%	1.3%	0.72%	$3.5/1.4/<1.3\%$
$\kappa_d = \kappa_b$	$10-13\%$	$4-7\%$	0.93%	0.60%	0.51%	0.4%	1.7/0.32/0.19%
$\kappa_u = \kappa_t$	$14-15\%$	$7-10\%$	2.5%	1.3%	1.3%	0.9%	3.1/1.0/0.7%

Snowmass, 1310.8361

Vector Boson Fusion Processes

A stress test for *W/Z separation* at high energies



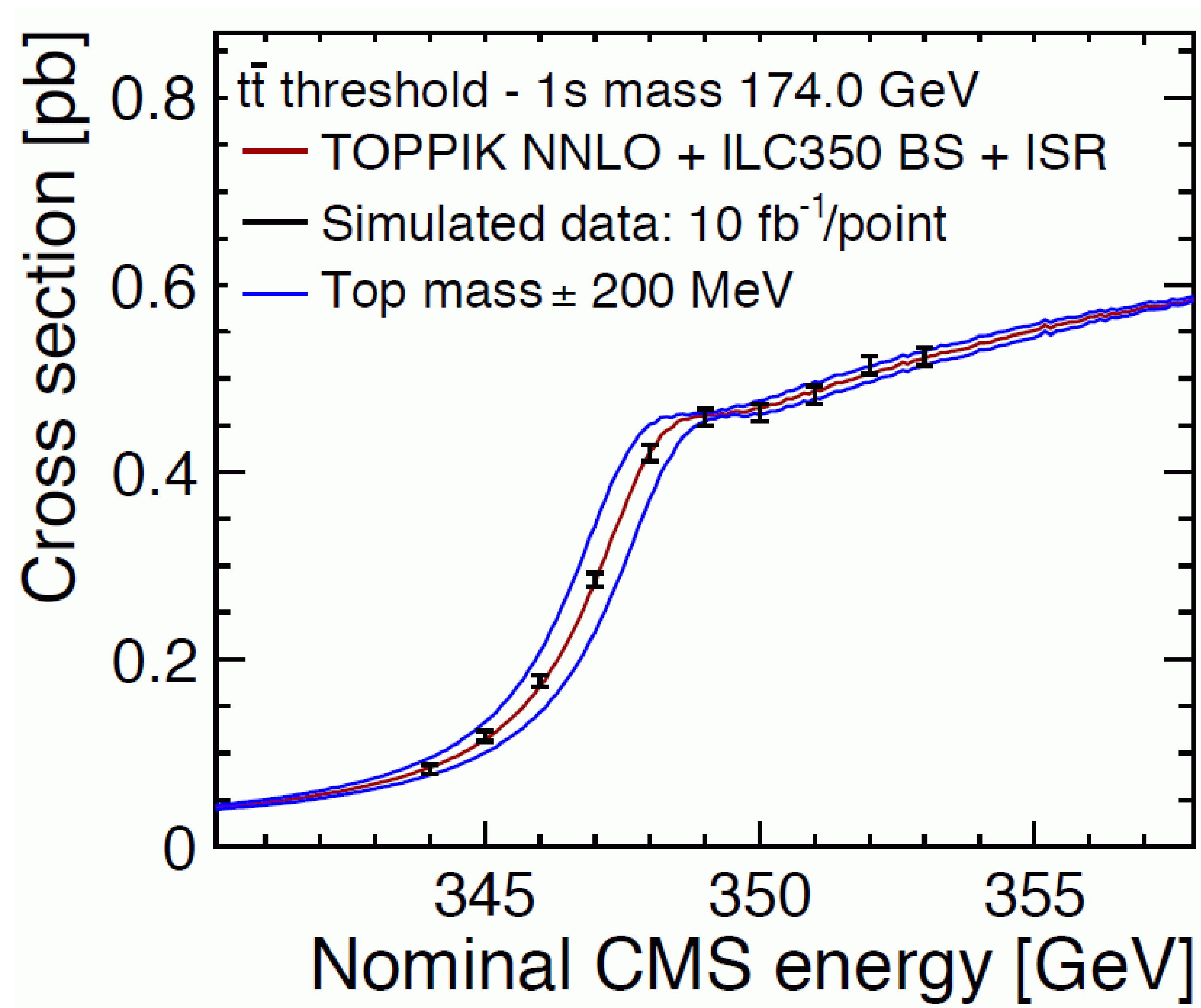


In multi-jet environment, however, M_{JJ} resolution is often controlled by confusion in jet-clustering but by PFA!

Top mass

S. Mantry

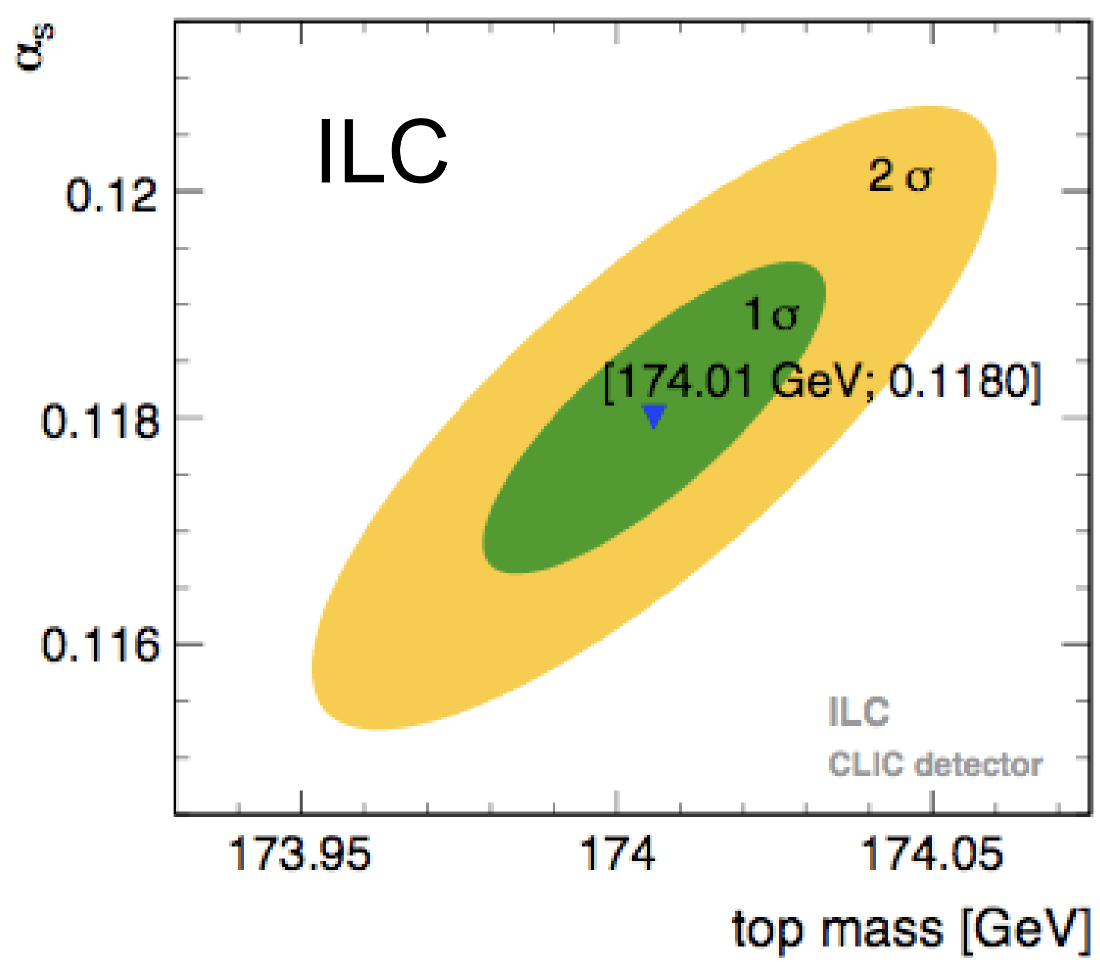
- The top quark mass is not a physical observable: must know what scheme it is measured in.
- At hadron colliders, tension between kinematic reconstruction (excellent sensitivity, poorly defined) and cross-section (well-defined theoretically, poor sensitivity).
- New ideas may push LHC measurement of MS-bar top mass to an uncertainty < 1 GeV
- e.g. σ(tt+jet) vs. m(tt+jet) better sensitivity than σ(tt).

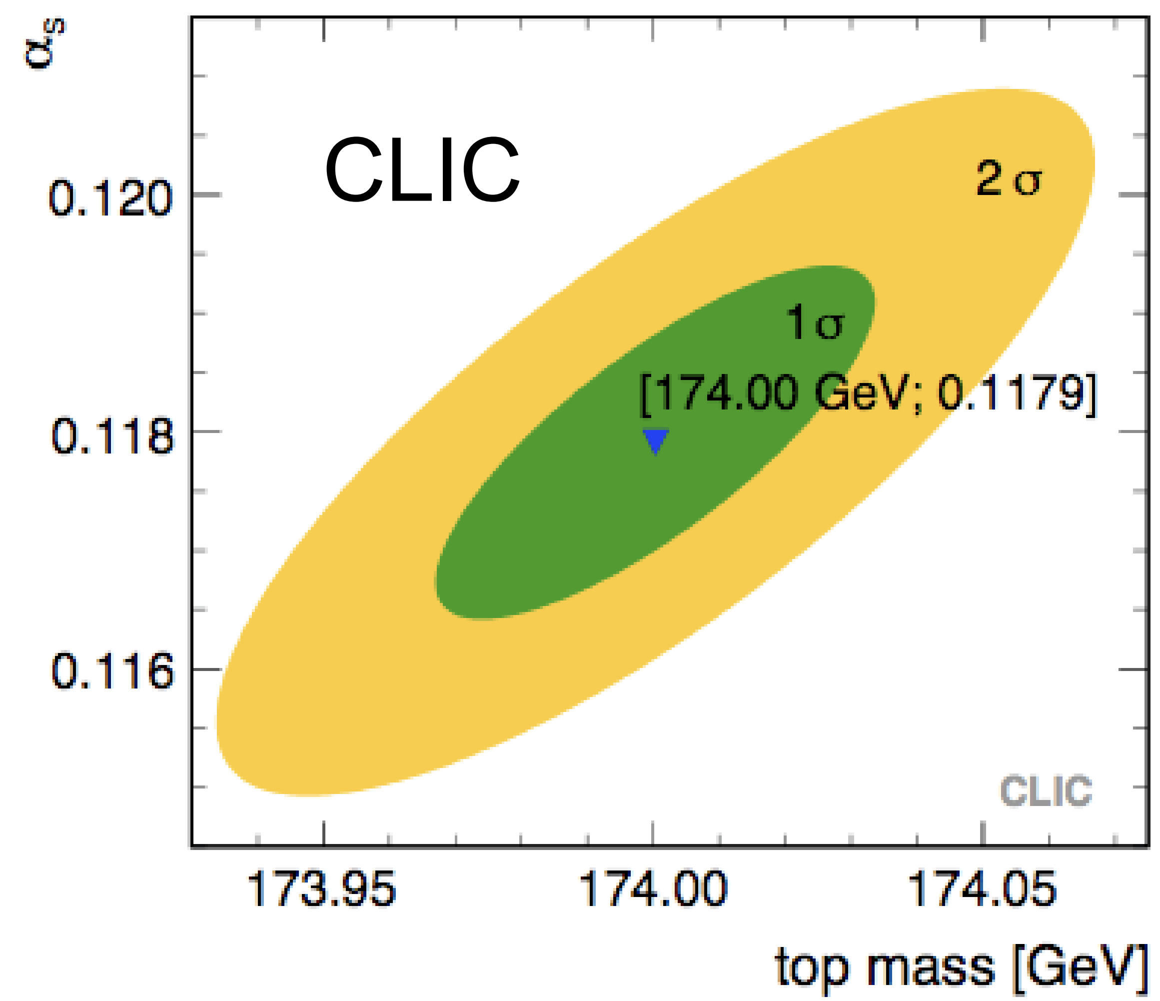


Threshold scan

F. Simon

- Dedicated running at threshold for ultimate precision.
- Important effects from ISR and luminosity spectrum.



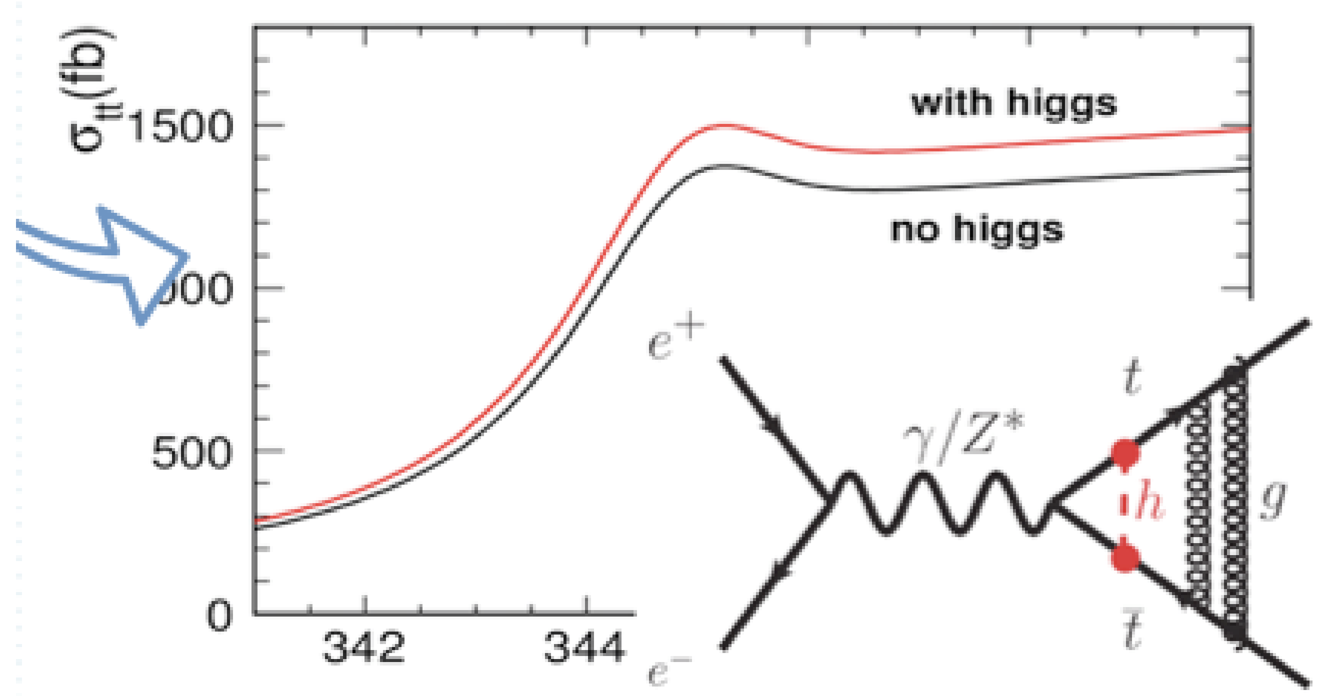


- Statistical uncertainty ~ 30 MeV.
- 10-20% difference ILC/CLIC < systematic O(100 MeV)

Top width, Yukawa coupling

- Sensitivity to top Yukawa coupling through virtual Higgs exchange.

  T. Horiguchi

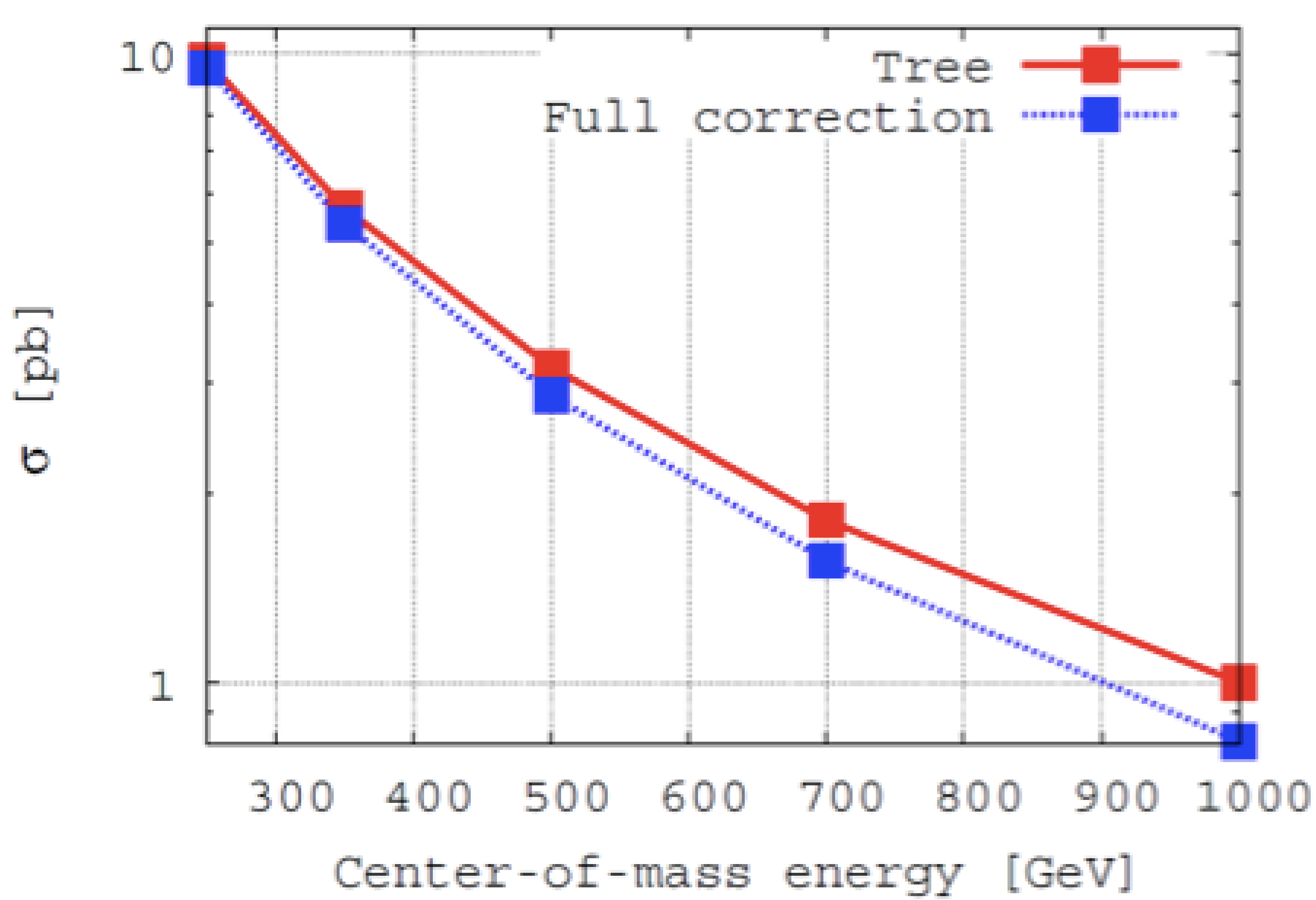


- Simultaneous extraction of mass, width, Yukawa coupling by a fit to threshold cross-section.

	(2 + 1) param fit	3 param fit
m_t	19 MeV	29 MeV
Γ_t	38 MeV	39 MeV
y_t	4.6%	5.9%

EW corrections

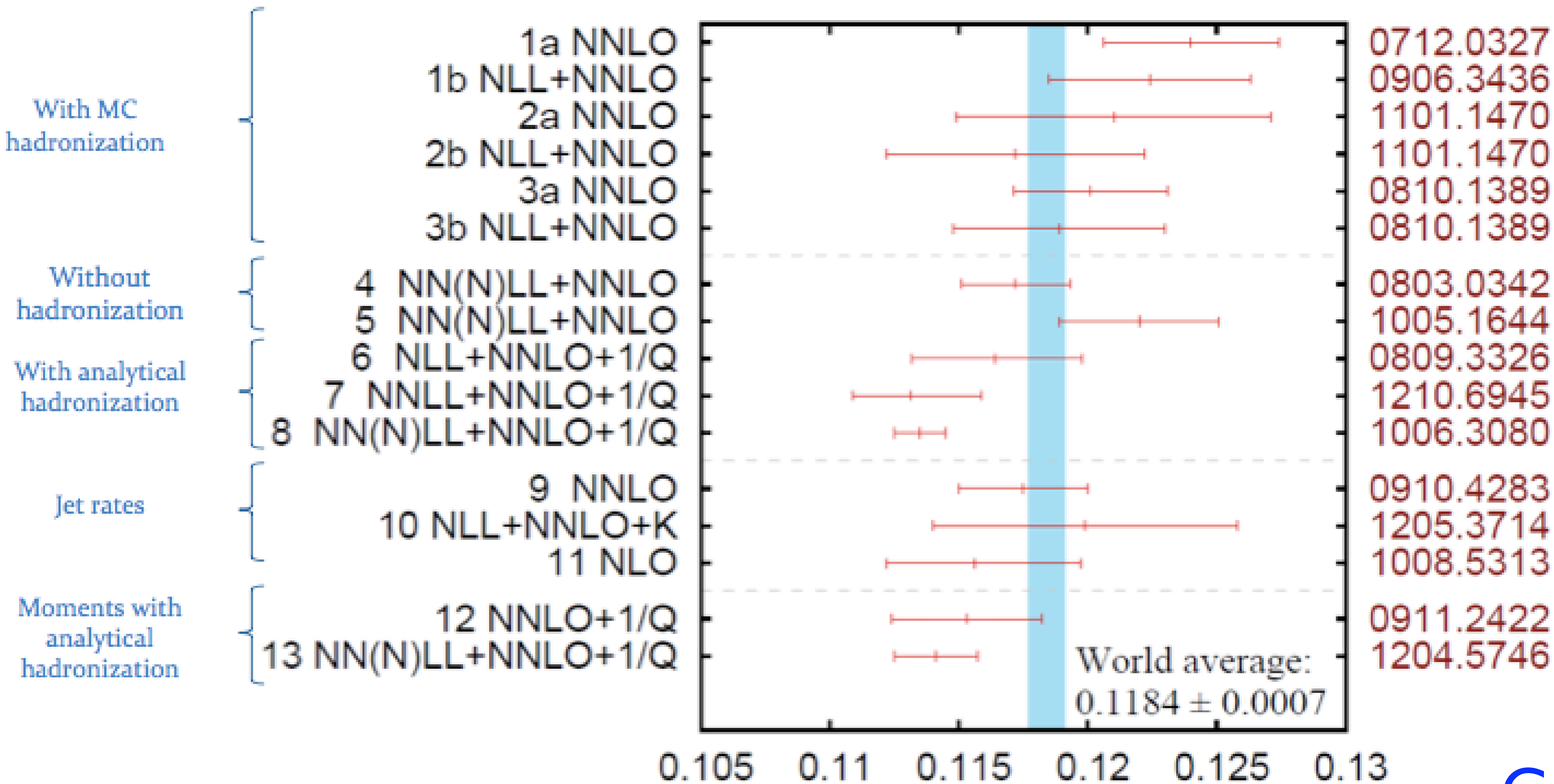
- Goal of luminosity measurement: O(0.1%) uncertainty
  - theory should be known at least as well, but NLO EW corrections to $e^+e^- \rightarrow e^+e^-$ are >1%: need NNLO.
- Step towards NNLO is NLO EW for $e^+e^- \rightarrow e^+e^-\gamma$
  - recently computed in GRACE-LOOP



Y. Kurihara

20% correction
at 1 TeV

Strong coupling



G. Luisoni

- Measurements of α_s a staple of lepton colliders.
- pQCD NNLO+NNLL, extractions limited by understanding of hadronization corrections (generators/analytic).
- automatic gain at future LC, scale as $1/\sqrt{s}$

Outlook

- Higgs resonance at 126 GeV opened up the stage of particle-properties determination, and made the Physics Case for future accelerators stronger than ever !
- theoretical arguments supporting the importance of sub-percent Higgs coupling precision continues to grow …

- HL-LHC can improve g_{HXX} accuracy at the 2%-14% level (modulo actual detector performance in HL experimental environment)
- ILC and CLIC can reach model independent 0.5 - 3% precision on Higgs couplings and 0.2 - 1% precision assuming same model dependence as LHC
- great potential on top mass and couplings (Δm_{top} ~ 100 MeV)
- same on EWPO (did not cover GigaZ option…)
- theory uncertainties can be reduced (with some effort) to a level well-matched to the ILC precision
- lot of activity toward more realistic ILC/CLIC analysis techniques and simulations ongoing.

Working Group on the Physics of a Future e+e- Linear Collider

Promoters: G. Pancheri, S. De Curtis, S. Moretti

Workshop Organizers: P. Ciafaloni, A. De Roeck, D. Dominici, G. Corcella, R. Godbole, M. Piccolo, O. Panella, F. Richard

Conveners: E. Accomando, M. Antonelli, M. Battaglia, F. Borzumati, C. Carloni Calame, D. Comelli, R. Contino, A. Deandrea, G.Degrassi, E. Gabrielli, E. Maina, M. Moretti, M. Passera, F. Piccinini, M. Ricci

Series of meetings and workshops on physics at Linear Colliders, organized in Italy every year since 2006 to stimulate and gather together the Italian community interested in Linear Colliders.

The workshops invite scientists from everywhere in the world to discuss together topical arguments related to e+e- colliders.

Our activity of Meetings, Conferences and Workshops

LC06 Kick-Off: Meeting in Frascati http://www.lnf.infn.it/theory/ilc/frascati.html

LC07 Firenze: ILC Physics in Florence http://www.ggi.fi.infn.it//index.php?p=events.inc&id=15

LC08 Frascati: e+e- Physics at the TeV Scale http://www.lnf.infn.it/conference/lc08/

LC09 Perugia: e+e- Physics at the TeV Scale and the Dark Matter Connection www.pg.infn.it/lc09 - Proceedings Published in Il Nuovo Cimento C, vol. 33C, p. 1-223, BOLOGNA SIF Edizioni Scientifiche ISSN: 2037-4909.

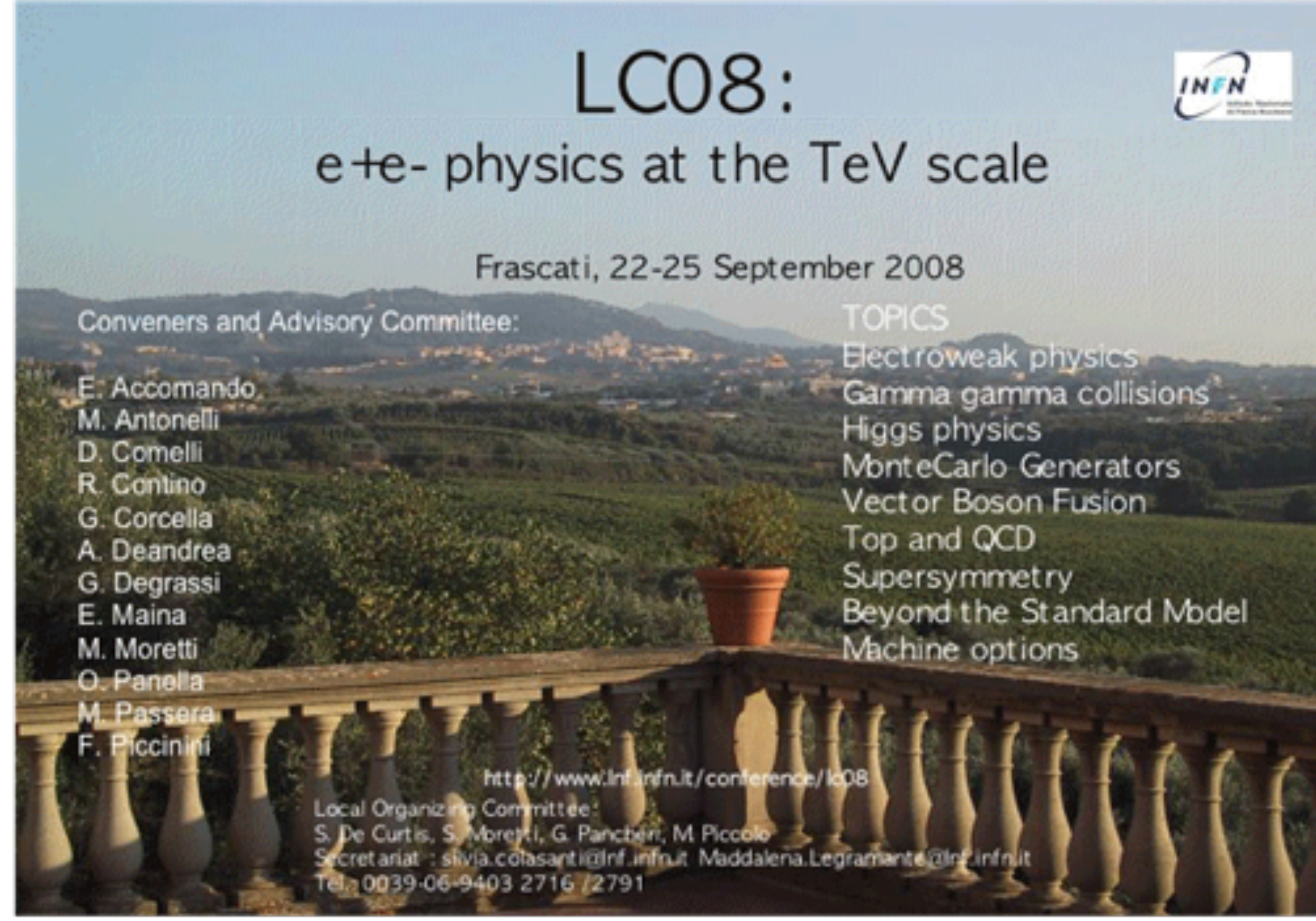
LC10 Frascati: New Physics: Complementarities Between Direct and Indirect Searches http://www.lnf.infn.it/conference/lc10/ Proceedings Published in Il Nuovo Cimento C, vol. 34C, p. 1-146, BOLOGNA SIF Edizioni Scientifiche ISSN: 2037-4909.

LC11 ECT*: Understanding QCD at linear Colliders in Searching for Old and New Physics http://www.lnf.infn.it/conference/2011/lc11/ - Proceedings Published in Frascati Phys.Ser. 54 (2012) pp.1-392 ISBN:978-88-86409-60-5

LC13 ECT*: Exploring QCD from the IR Regime to Heavy Flavour Scales at B-factories, the LHC and a Linear Collider http://www.lnf.infn.it/conference/LC13/ - Proceedings to be published in Il Nuovo Cimento C

Presently preparing the proposal for:
LFC2015: Workshop on prospects for Linear and Future Colliders


INFN
The Galileo Galilei Institute for Theoretical Physics
Arcetri, Florence
ILC Physics in Florence
September 12-14, 2007
in connection with the program: Advancing Collider Physics: from Twistors to Monte Carlos
at the Galileo Galilei Institute of Theoretical Physics, Arcetri, Florence,
August 27, 2007 - October 26, 2007
The aim of the event is to gather together the italian particle physics community involved in theoretical and phenomenological studies of the physics potential of an International Linear Collider, ILC, in order to assess how it can best contribute during the crucial upcoming years to obtaining final approval of this machine.
The meeting will be organised in plenary sessions with both review and topical presentations, the latter scheduled according to working group activities on Higgs, QCD&Top, LoopVerein, Electroweak, Monte Carlo, Vector Boson Fusion, SUSY, Physics Beyond the SM.
Review talks by:
M. Battaglia, M. Caccia, S. Dittmaier, A. Djouadi, R.M. Godbole, E. Gross, W. Hollik, J. Kalinowski, M. Krawczyk, L.H. Orr, P. Osland, F. Richard, P.M. Zerwas.
The complete list of the speakers can be found on
http://ggi-www.fi.infn.it/activities/conferences/ILC/ILC_conf.html
Conveners of the Working Group Sessions:
E. Accomando, F. Borzumati, D. Comelli, G. Corcella, E. Gabrielli, E. Maina, M. Passera, F. Piccinini.
The deadline for registration is July 31, 2007.
Organizing Committee:
Paolo Ciafaloni (INFN and Univ. Lecce)
Stefania De Curtis, Daniele Dominici (INFN and Univ. Florence)
Stefano Moretti (NExT Institute, Southampton/RAL)
Giulia Pancheri (INFN Nat. Lab. Frascati)
Conference Secretary:
Mrs. Antonella Pagliai - Tel: +39 055 4572074 - mail: pagliai@fi.infn.it
http://ggi-www.fi.infn.it/activities/conferences/ILC/ILC_conf.html
GGI: http://ggi-www.fi.infn.it
HAMAMATSU Global
COMPAGNIA di San Paolo


LC08:
e+e- physics at the TeV scale
INFN
Frascati, 22-25 September 2008
Conveners and Advisory Committee:
E. Accomando
M. Antonelli
D. Comelli
R. Contino
G. Corcella
A. Deandrea
G. Degrassi
E. Maina
M. Moretti
O. Panella
M. Passera
F. Piccinini
TOPICS
Electroweak physics
Gamma gamma collisions
Higgs physics
MonteCarlo Generators
Vector Boson Fusion
Top and QCD
Supersymmetry
Beyond the Standard Model
Machine options
Local Organizing Committee:
S. De Curtis, S. Moretti, G. Pancheri, M. Piccolo
Tel. 0039-06-9403 2716 /2791


LC09
e+e- Physics at the TeV Scale and the Dark Matter Connection
Corso di Formazione INFN
Perugia, 21-24 September 2009
Dipartimento di Fisica and INFN Sezione di Perugia
Topics
Electroweak Physics
Vector Boson Fusion and Photon Collider
Higgs Physics
Supersymmetry
Beyond the Standard Model
Dark Matter
Top and QCD
Tools
Machine and Detector Options
Conveners
Elena Accomando
Francesca Borzumati
Carlo Carloni Calame
Denis Comelli
Gennaro Corcella
Aldo Deandrea
Giuseppe Degrassi
Ezio Maina
Massimo Passera
Fulvio Piccinini
Organizing Committee
Stefania De Curtis
Stefano Moretti
Giulia Pancheri
Orlando Panella
Marcello Piccolo
Local Organizing Committee
Andrea Achilli, Mirco Cannoni, Simone Pacetti, Orlando Panella, Yogendra N. Srivastava
Secretariat
Anna Drakopoulou
Email: Anna.Drakopoulou@pg.infn.it
Tel: +39 3207136419
Information and registration
http://www.pg.infn.it/lc09
LC09@pg.infn.it
INFN
The workshop will take place in the Physics Department of the University, Via A. Pascoli

LC10 Workshop

New Physics: Complementarities between Direct and Indirect Searches

To be held together with the Bruno Touschek Memorial Lectures

INFN - Laboratori Nazionali di Frascati
30th November - 3rd December 2010

Corso di formazione INFN

Organizing Committees

Conveners and Advisory Committee
Elena Accomando
Marco Battaglia
Francesca Borzumati
Carlo Carloni Calame
Denis Comelli
Gennaro Corcella
Aldo Deandrea
Giuseppe Degrassi
Ezio Maina
Massimo Passera
Fulvio Piccinini
Marco Ricci

Organizing Committee
Stefania De Curtis
Stefano Moretti
Giulia Pancheri
Orlando Panella
Marcello Piccolo

Local Organizing Committee
Giulia Pancheri
Marcello Piccolo
Marco Ricci

Secretary
Maria Cristina D'Amato
Tel: +39 06 94032373 , Fax: +39 06 94032475
lc10@lnf.infn.it

LC11 Workshop: Understanding QCD at Linear Colliders in searching for old and new physics

12-16 September 2011
ECT*, Villa Tambosi, Trento (Italy)

ECT*, Strada delle Tabarelle 286, I-38123 Villazzano (TN) Italy
Tel.+39 (0461) 314-730 or 722
Fax: +39 (0461) 935-007
Mail: ectweb@ectstar.eu

This Workshop is part of a series of workshops on physics at Linear Colliders, organized in Italy every year to stimulate and gather together the Italian community interested in Linear Colliders (LCs). The workshop invites scientists from everywhere in the world to discuss together topical arguments related to LCs. Previous editions have taken place in Florence, Perugia and Frascati (twice).

Conveners:

Elena Accomando, *NExT Institute, Southampton U.* (**Higgs**)
Francesca Borzumati, *Tohoku U.* (**SUSY**)
Carlo Carloni Calame, *NExT Institute, Southampton U.* (**Tools**)
Denis Comelli, *INFN Ferrara* (**Astroparticles**)
Gennaro Corcella, *INFN LNF, Frascati* (**Top and QCD**)
Aldo Deandrea, *IPN, Lyon* (**Beyond the SM**)
Giuseppe Degrassi, *Roma III U. and INFN Roma III* (**EWP**)
Massimo Passera, *INFN Padova* (**EWP**)
Fulvio Piccinini, *INFN Pavia*(**VBF**)

Organizing Committee:

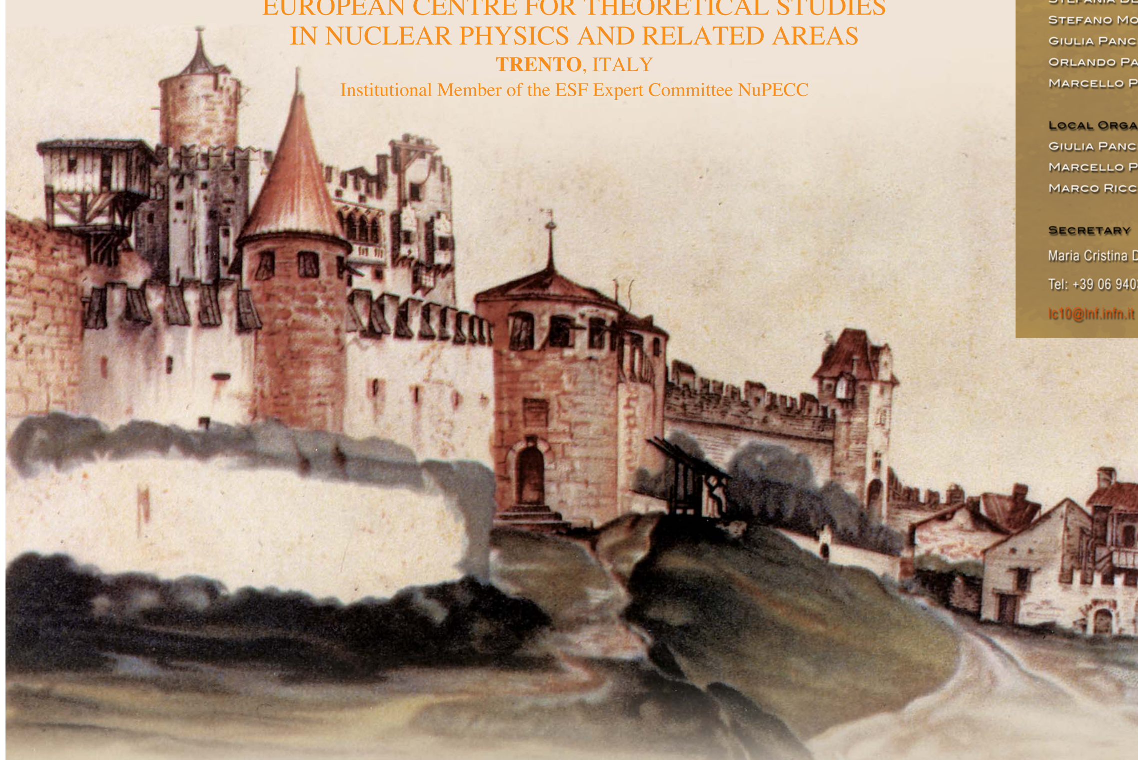
Stefania De Curtis, *INFN Firenze*, **Albert De Roeck**, *CERN*, **Stefano Moretti**, *NExT Institute, Southampton U.*, **Giulia Pancheri**, *INFN LNF, Frascati*, **Orlando Panella**, *INFN Perugia*, **Francois Richard**, *LAL Orsay*

Topics*:*

- Status of the LC projects and their connections with the LHC
- Precision measurements at e+e- colliders and elsewhere
- The structure of QCD from the multi-TeV to the GeV scale
- QCD: from partons to hadrons
- Higgs and Top physics
- Physics beyond the Standard Model
- DIS & photon-photon physics
- The future of QCD in e+e- physics

ECT*

EUROPEAN CENTRE FOR THEORETICAL STUDIES IN NUCLEAR PHYSICS AND RELATED AREAS
TRENTO, ITALY
Institutional Member of the ESF Expert Committee NuPECC



Castello di Trento ("Trint"). watercolour, 19.8 x 27.7, painted by A. Dürer on his way back from Venice (1495) British Museum, London.

LC13: Exploring QCD from the infrared regime to heavy flavour scales at B-factories, the LHC and a Linear Collider

Trento, September 16-20, 2013

Main Topics

Status of the LC projects
Review of LHC results and future prospects
Precision measurements in flavour physics and QCD infrared behaviour
Top physics measurements and uncertainties from the QCD infrared region
Phenomenological aspects of the QCD infrared regime at the LHC and LC
Theoretical updates on the infrared structure of QCD
Total and elastic proton-proton cross-section: LHC and cosmic ray results
Infrared effects in low energy precision physics: QCD Tools in the infrared region

Participants include

Patrizia Azzi (INFN Padova, Italy), Martin Beneke (TUM, Munich, Germany), Simone Biondini (TUM, Munich, Germany), Massimo Caccia (University of Insubria, Como, Italy), Mauro Chiesa (University of Pavia and INFN, Italy), Mrinal Dasgupta (University of Manchester, UK), Giuseppe Degrassi (University of Rome 3 and INFN, Italy), Lyn Evans (CERN, Switzerland), Mario E. Gomez (Universidad de Huelva, Spain), Shinya Kanemura (University of Toyama, Japan), Emi Kou (LAL, IN2P3, Orsay, France), Olivier Mattelaer (Louvain University, Belgium), Barbara Mele (INFN Rome, Italy), Hitoshi Murayama (IPMU, University of Tokyo, Japan, and UC at Berkeley, US), Luca Panizzi (Southampton University, UK), Ignazio Scimemi (University of Madrid, Spain), Ana Texeira (CNRS/IN2P3, Clermont Ferrand, France), Alfredo Urbano (SISSA, Trieste, Italy)

Website http://www.lnf.infn.it/conference/2013/LC13

Organizers

Gennaro Corcella (gennaro.corcella@lnf.infn.it), Stefania De Curtis (stefania.decurtis@fi.infn.it), Rohini M. Godbole (rohini@cts.iisc.ernet.in), Stefano Moretti (s.moretti@soton.ac.uk), Giulia Pancheri, coordinator (pancheri@lnf.infn.it), Francois Richard (richard@lal.in2p3.fr).

Study of Strongly Interacting Matter
HadronPhysics3

Conveners

Elena Accomando, NExT Institute Southampton Univ., UK (Higgs physics); Francesca Borzumati, Tohoku Univ., Japan (ILC); Denis Comelli, INFN Ferrara, Italy (EW); Aldo Deandrea, IPN Lyon, France (BSM); Orlando Panella, INFN Perugia, Italy (Photon-photon); Massimo Passera, INFN Padova, Italy (SM); Fulvio Piccinini, INFN Pavia, Italy (MC)

Director of the ECT*: Professor Wolfram Weise (*ECT**)

The ECT* is sponsored by the "Fondazione Bruno Kessler" in collaboration with the "Assessorato alla Cultura" (Provincia Autonoma di Trento), funding agencies of EU Member and Associated States and has the support of the Department of Physics of the University of Trento.

For local organization please contact: *Ines Campo - ECT* Secretariat - Villa Tambosi - Strada delle Tabarelle 286 - 38123 Villazzano (Trento) - Italy*
Tel.:(+39-0461) 314721 Fax: (+39-0461) 314750, E-mail: ***ect@ectstar.eu*** *or visit* ***http://www.ectstar.eu***

www.la-reclame.it