Opening Comments

2014/08/30 Keisuke Fujii

WG Objectives

- On July 4, 2012, ATLAS and CMS announced the discovery of a Higgs-like boson with a mass of about 125GeV and the data that followed strongly indicates that it is a Higgs boson indeed. The world has changed since then. The discovery has vaulted the question of its properties on the top of the list of questions in HEP. The 125GeV boson is a window to BSM physics and ILC is the best machine to use it.
  The energy upgrade of LHC will probably bring us more. It is important to stress that ILC, too, is an energy frontier machine. It will access the energy region never explored with any lepton collider. There can be a zoo of new uncolored particles or new phenomena that are difficult to find at LHC but can be discovered and studied in detail at ILC.

  We need to demonstrate that ILC will advance our understanding of particle physics qualitatively beyond the information that will be available from the results expected from the future stages of the LHC. Be prepared for LHC Run2! (longer-term goal)

- The ILC project preparation office has been formed in KEK and the MEXT's ILC Task Force started its review. In parallel, site-specific design started and a new ILC parameter WG was formed to provide information necessary to optimize the staging scenario. Make inputs to the MEXT's physics WG (monthly). The next mid-term target for us to show our activities to the LC community is LCWS14 on Oct. 6-10 in Belgrade.

MEXT's ILC Review (Schedule)

- 2014/06/24 1st Physics WG Mtg.
  - particle physics in general
  - Overview of ILC project and physics
- 2014/07/29 2nd Physics WG Mtg.
  - European strategy and P5 report
  - ILC's physics case discussions
- 2014/08/27 3rd Physics WG Mtg.
  - Cosmic rays, astronomy
  - ILC's physics case discussions
- 2014/09/22 4th Physics WG Mtg.
  - Flavor physics, neutrinos
  - ILC's physics case discussions (Comparison with LHC)
- 2014/10/21 5th Physics WG Mtg.
  - Interim summary
- 2014/11/14 2nd Expert Panel Mtg.

What we want

- We have the 125 GeV boson that is a powerful tool to explore the symmetry breaking sector (SBS).
  We need to invent a way to make maximal use of it.
  - Is it possible to map various BSM models in ideally a single and hopefully a small number of generic parameter spaces so as to compare the physics reach of ILC with that of the future upgraded LHC.
  - If yes, explore the possibility of fingerprinting BSM models in the generic parameter space. --> partially done in the Snowmass process
- The most important Mission of ILC = bottom-up reconstruction of the SBS and clarification of its relation to other open questions of elementary particle physics.
  - Make a strategy to reconstruct the SBS
    - Shape of SBS: Multiplet Structure (a SM-like 2-let main but what about small admixtures of 1-let?, 3-let? If there, how many?, ...)
    - Dynamics behind SBS: weakly/strongly interacting = elementary/composite
  - Clarify relation to other open questions: DM, Baryogenesis, Neutrino mass, Hierarchy, ...

- ILC is an energy frontier machine. We need to re-examine the possibilities given the existence of the 125GeV boson and their relations to the open questions.

More Exercises Needed

- For theorists:
  - ILC can measure various quantities such as mh, gamma_h, ghxx, mt, etc. far better than LHC. But how accurately do we really need to measure them?
  - What will be the ultimate theoretical uncertainties in various predictions for LHC and ILC, respectively?
  - Update various ILC physics plots to accommodate LHC constraints, etc.
- For Experimentalists:
  - Update all the old analyses with mh=120 GeV to mh=125GeV: urgent!
  - Complete the analyses such as rare Higgs decays: urgent!
  - Improve the analyses such as self-coupling, H->gamma gamma, recoil mass (jets?), where the results are not yet satisfactory.
  - Studies at Ecm = 350 GeV : requests from the ILC parameter WG.
  - With the projected running scenarios described in DBD, the most measurements are still statistically limited and should improve by a luminosity upgrade or by running longer. Nevertheless, ILC, too, will hit systematics limits, eventually. It is probably the right time to start more serious studies of expected systematic errors.
    - Identify possible sources of systematic errors
    - Estimate to what degree we can control them (partially done in the Snowmass process)

Parameters for ILC Staging

ILC Parameters Joint Working Group
(presented by Jim Brau)

Physics Goals vs. Energy

250 Gev
- precision Higgs couplings, in particular **g**HZZ
- precision Higgs mass

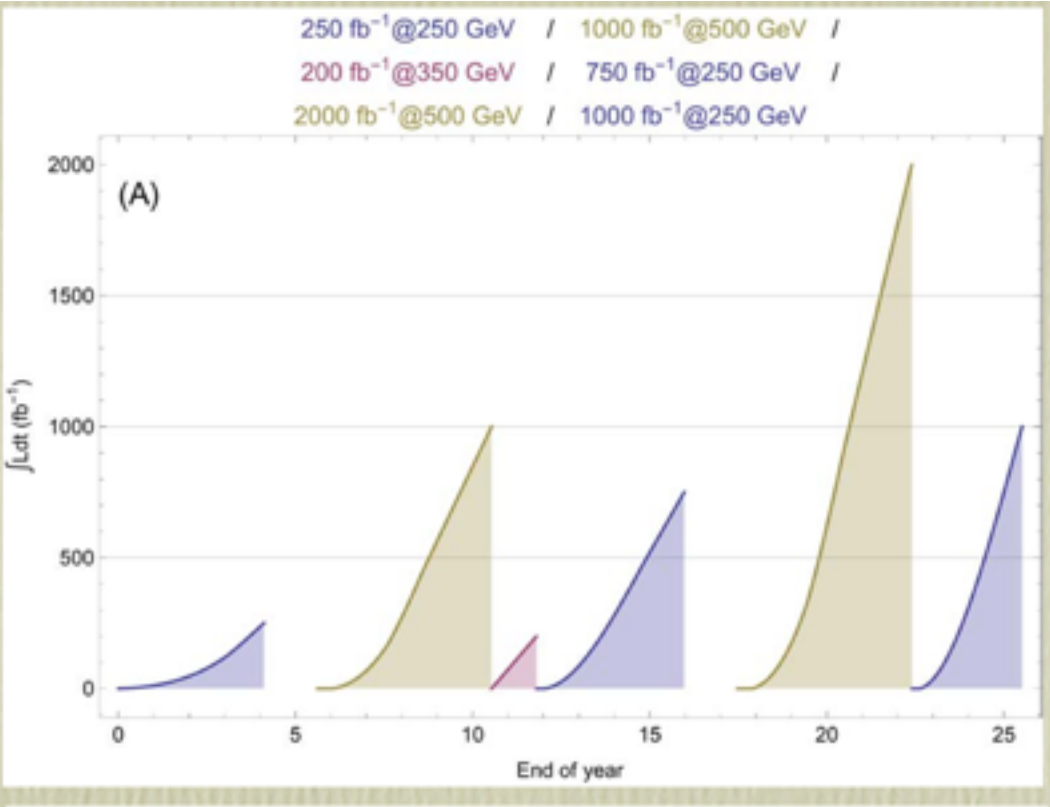
350 Gev
- top quark mass from threshold scan
- precision **W** couplings
- precision Higgs couplings, in particular **g**HWW

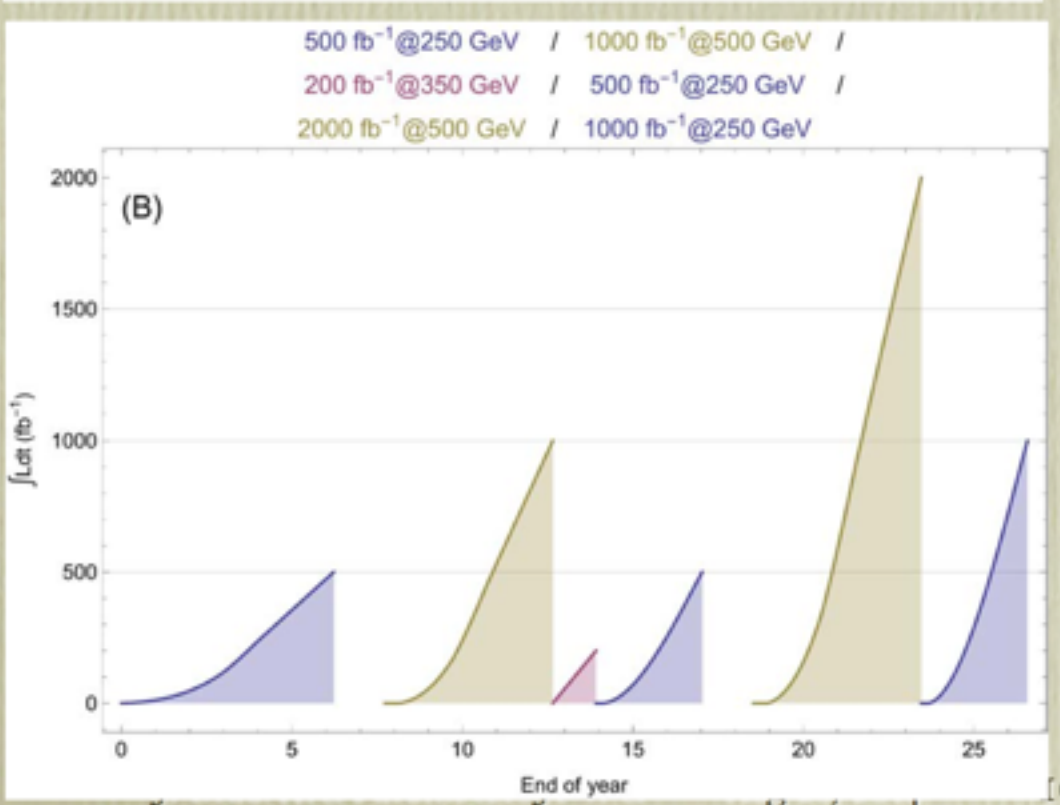
500 Gev
- precision Higgs couplings
- precision electroweak couplings of the top quark
- Higgs couplings to top
- Higgs self-coupling
- precision **W** couplings
- precision search for **Z′**
- search for supersymmetry
- search for Dark Matter
- search for extended Higgs states

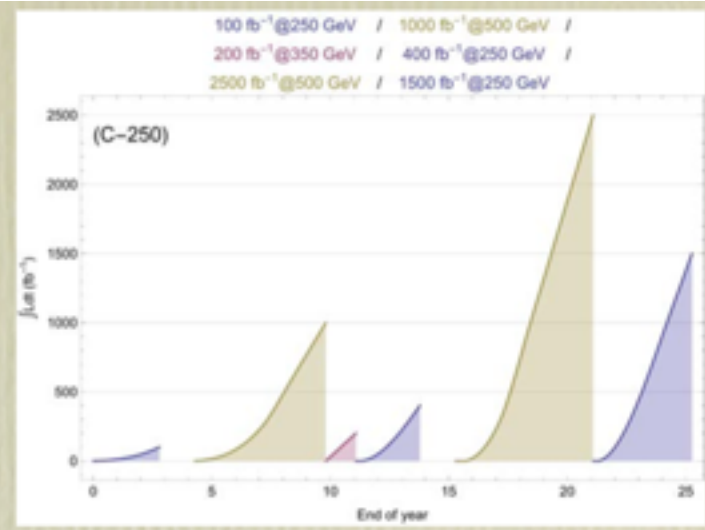
Scenarios

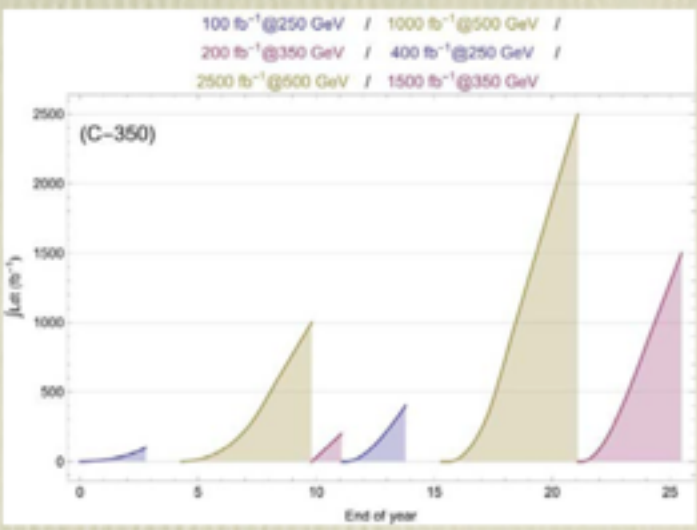
- A: run for 250 fb^{-1} during initial 250 GeV phase (4.1 years)
- B: run for 500 fb^{-1} @ 250 GeV before beginning 500 GeV upgrade (6.2 years)
- C: run for 100 fb^{-1} @ 250 GeV (2.8 years) and then upgrade to 500 GeV
  - 3 variants of C: 250 GeV, 350 GeV, or 500 GeV emphasis in last phase

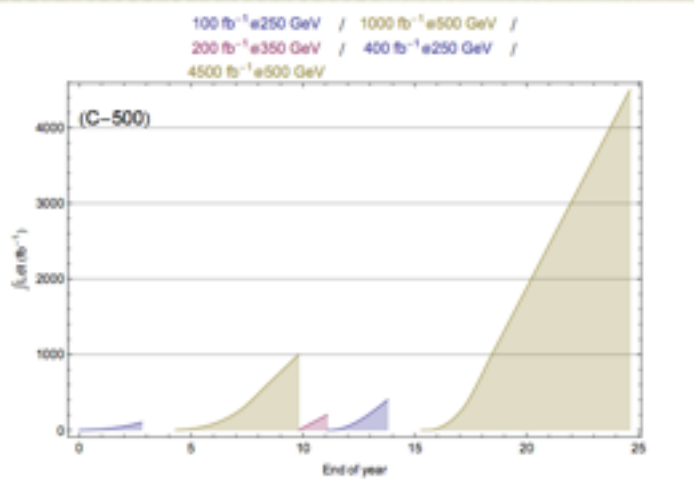
Projected evolution of integrated luminosity with realistic ramp-up and upgrade timelines











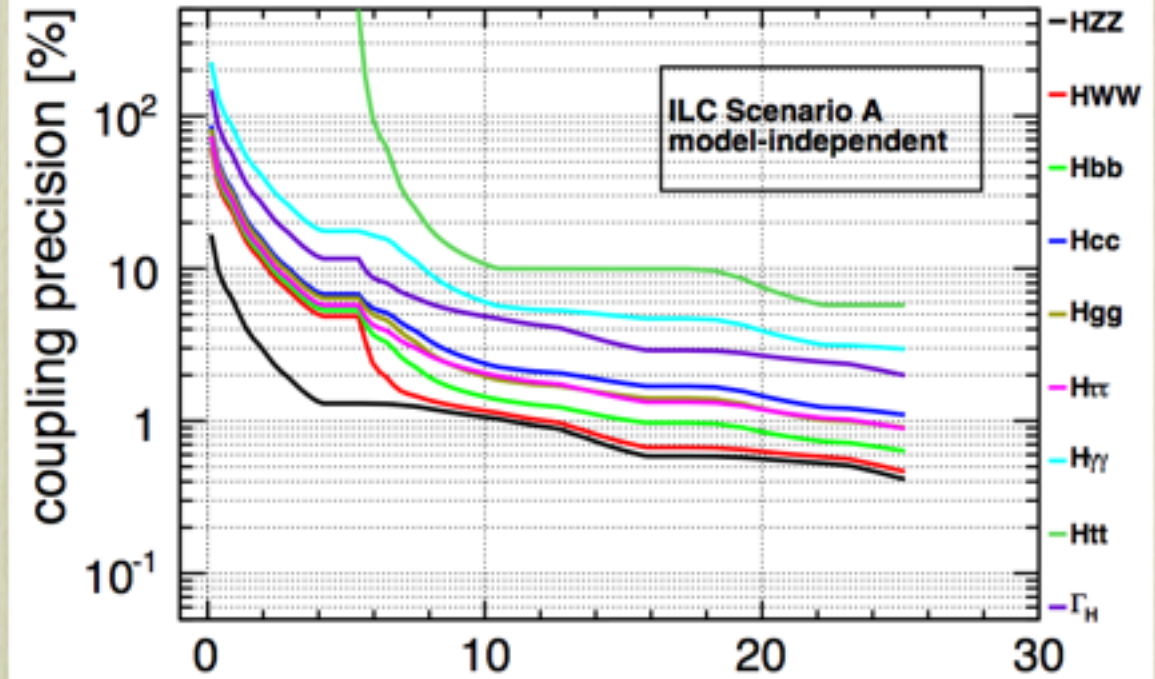
Summary of scenarios

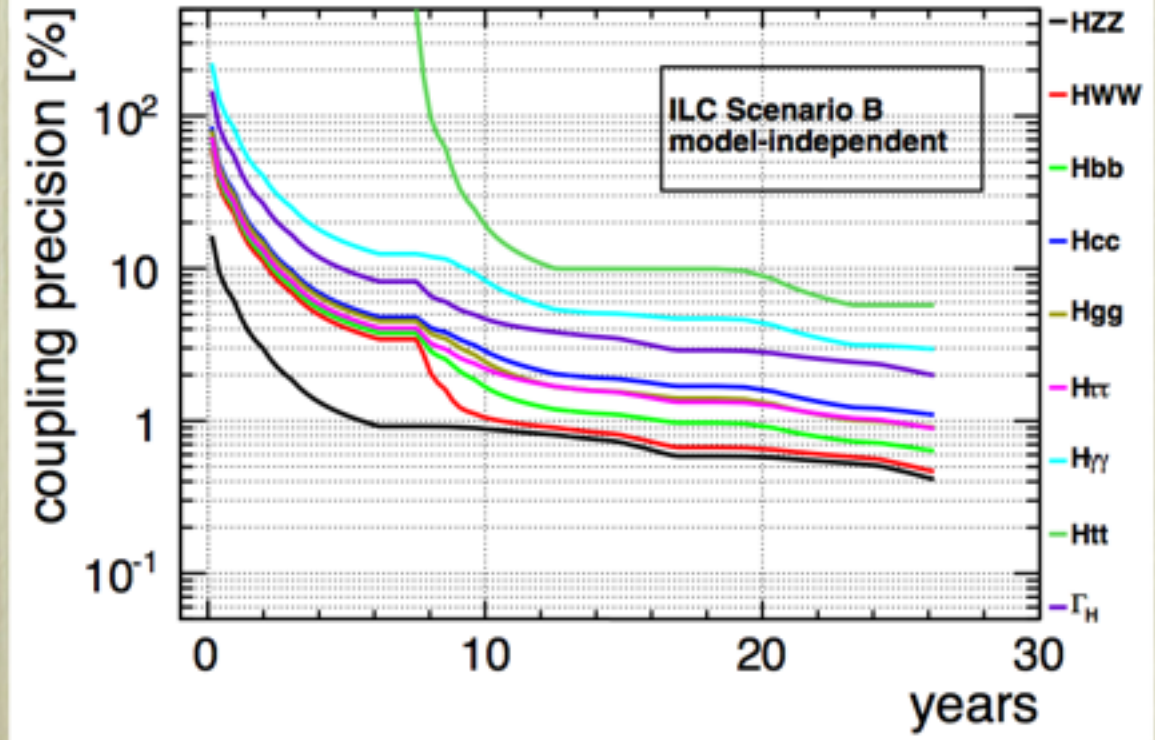
	$\int \mathcal{L}dt$ [fb^{-1}]				
$\sqrt{s}$	A	B	C-250	C-350	C-500
250 GeV	2000	2000	2000	500	500
350 GeV	200	200	200	1700	200
500 GeV	3000	3000	3500	3500	5500

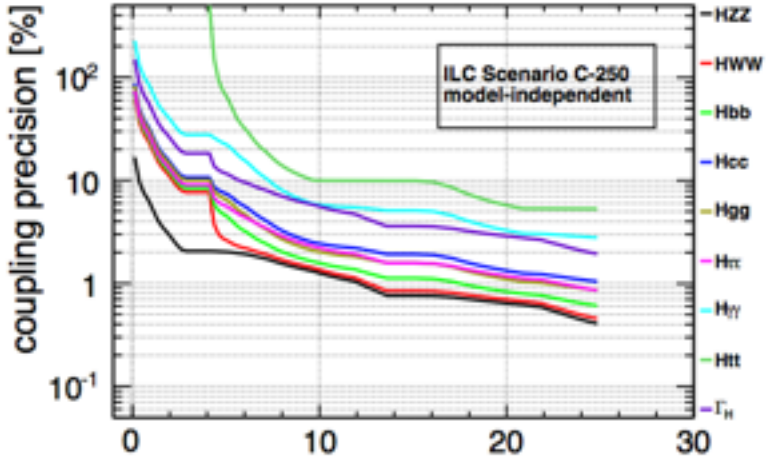
Table 1: Proposed total target integrated luminosities for $\sqrt{s} = 250, 350, 500$ GeV.

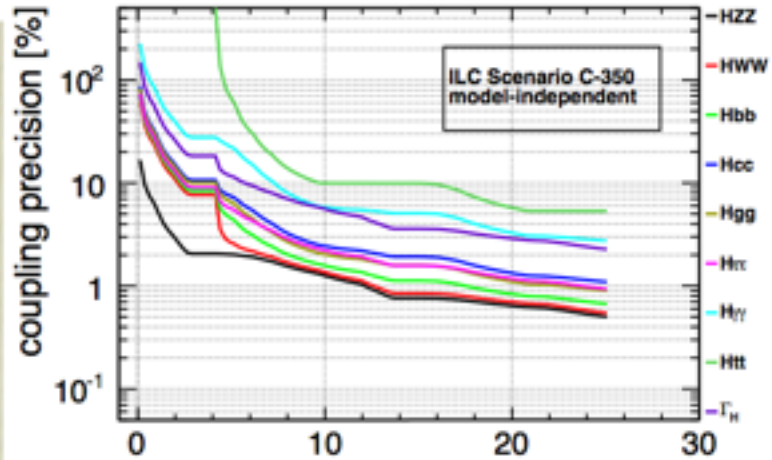
Total calendar time (years) for each scenario

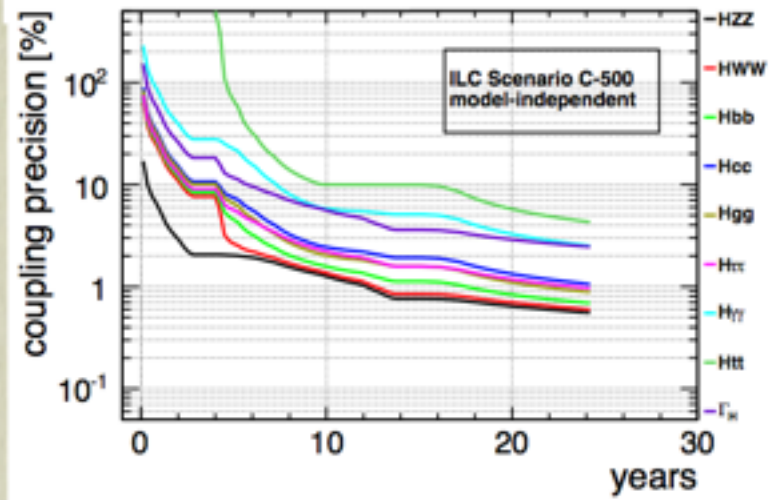
25.5 26.6 25.3 25.5 24.6


ILC Scenario A
model-independent
coupling precision [%]
HZZ
HWW
Hbb
Hcc
Hgg
Hττ
Hγγ
Htt
Γ_H

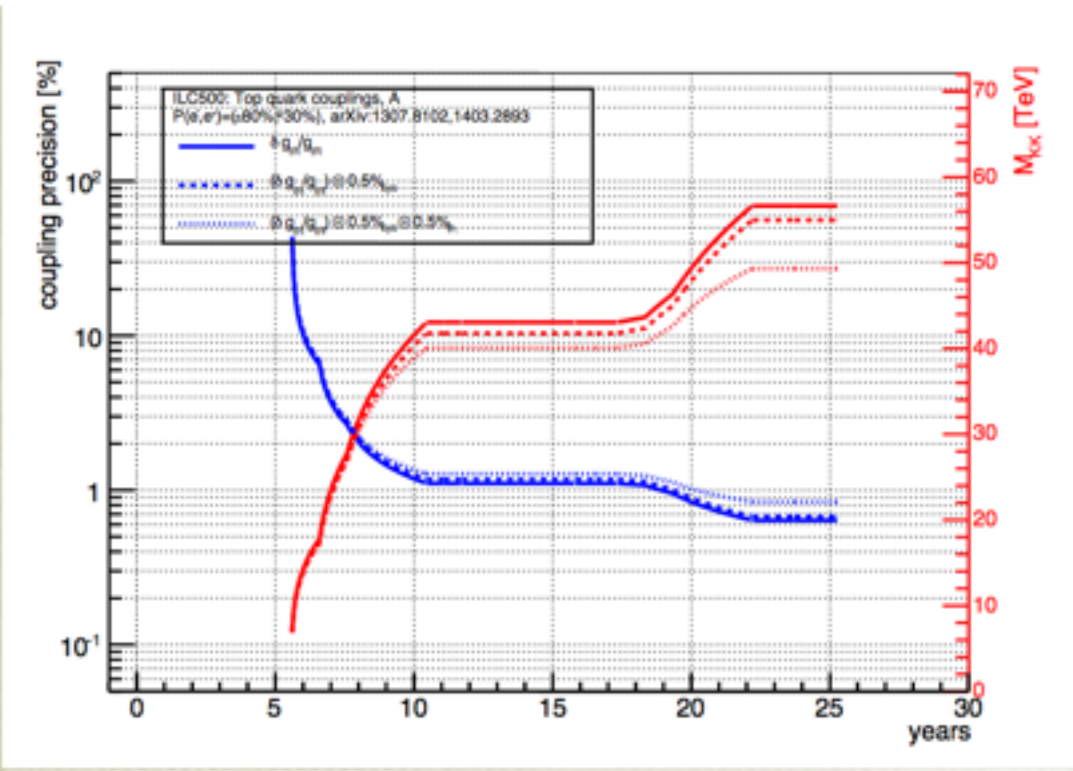

ILC Scenario B
model-independent
coupling precision [%]
years
HZZ
HWW
Hbb
Hcc
Hgg
Hττ
Hγγ
Htt
Γ_H

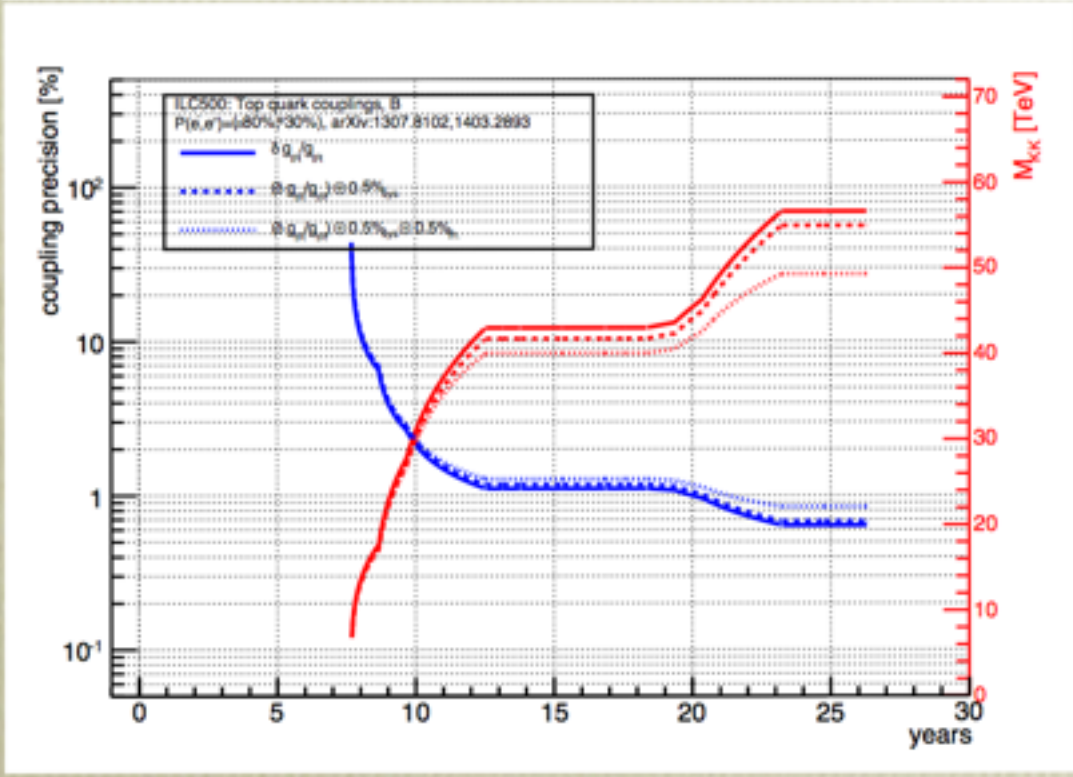

ILC Scenario C-250
model-independent
coupling precision [%]
HZZ
HWW
Hbb
Hcc
Hgg
Hττ
Hγγ
Htt
Γ_H

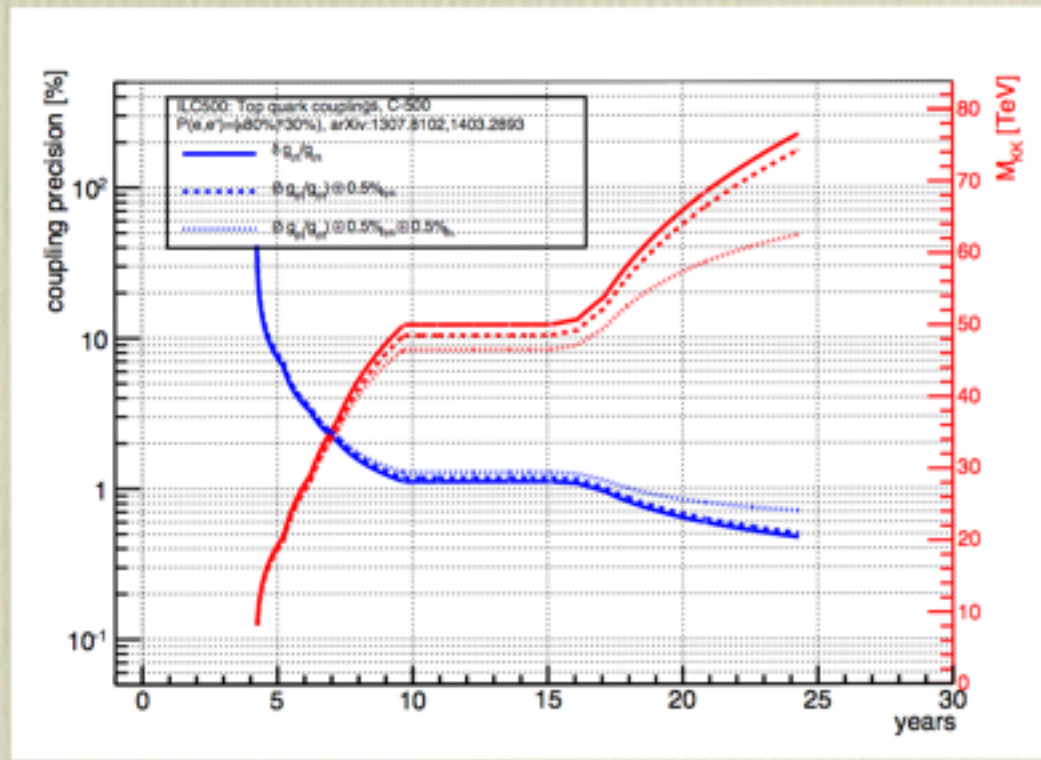

ILC Scenario C-350
model-independent
coupling precision [%]
HZZ
HWW
Hbb
Hcc
Hgg
Hττ
Hγγ
Htt
Γ_H


ILC Scenario C-500
model-independent
coupling precision [%]
years
HZZ
HWW
Hbb
Hcc
Hgg
Hττ
Hγγ
Htt
Γ_H

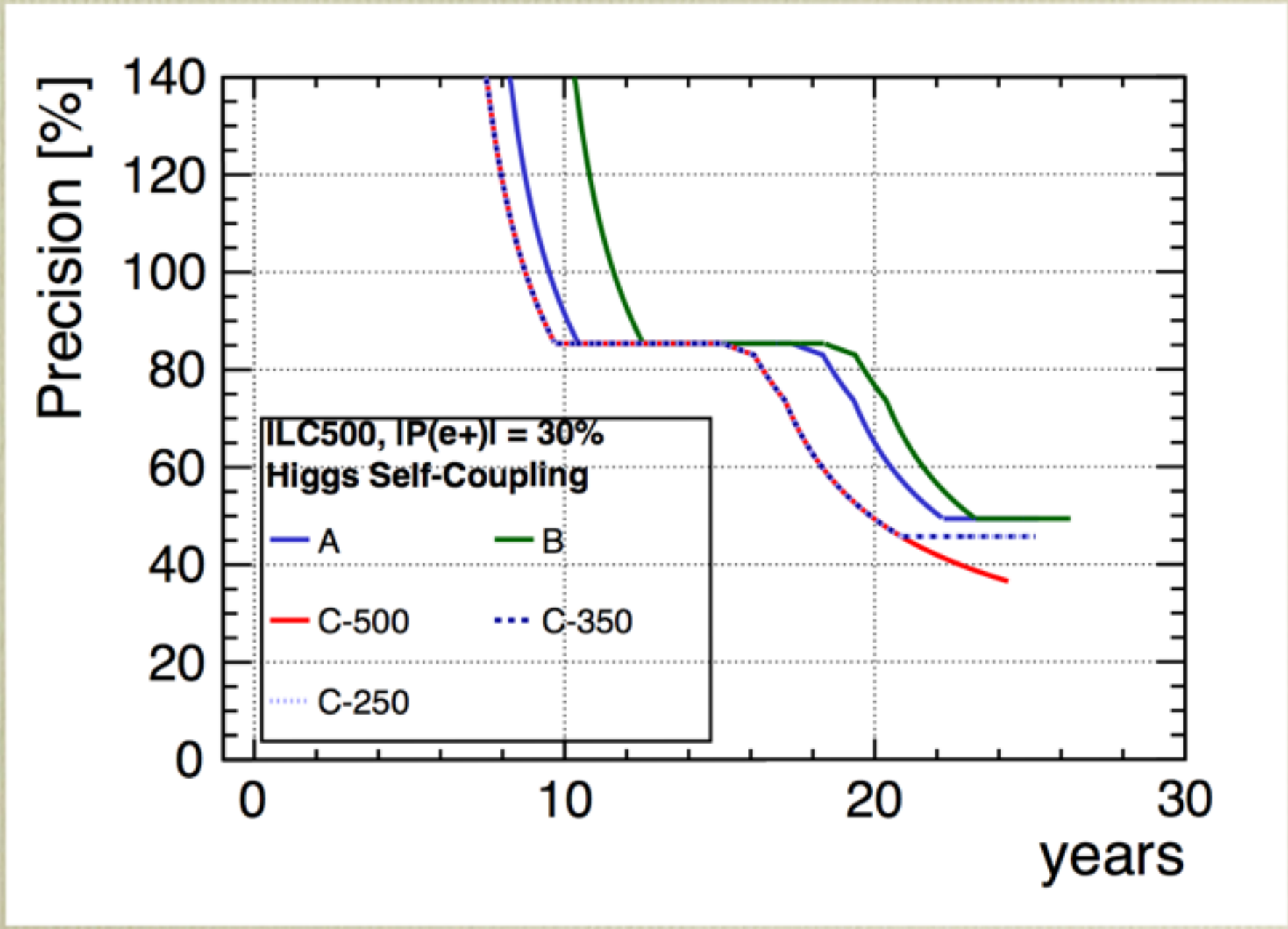
Top RH coupling & sensitivity of KK mass scale







Precision of Higgs self-coupling



Other issues

- Polarization mix
  - importance of positron polarization
- Model independency of $ZH \to q\bar{q}H$
- WW threshold
- Z-pole for physics
- Z-pole for calibration

Next steps

- Comments on DRAFT from Physics WG
- Meet in Tokyo on September 4
- Present updated DRAFT to LCC & LCB
- Respond to LCC/LCB comments
- Prepare DRAFT for comment at LCWS14
  - plenary session
- Finish report by ICFA Seminar

analysis status

Update!

ECM	@ 250 GeV		@ 350 GeV		@ 500 GeV		@ 1 TeV
luminosity/fb	250		330		500		1000
polarization (e-,e+)	(-0.8, +0.3)		(-0.8, +0.3)		(-0.8, +0.3)		(-0.8, +0.2)
process	ZH	νν̄H	ZH	νν̄H	ZH	νν̄H	νν̄H
cross section	EH	-	G		-	-	-
	σ·Br	σ·Br	σ·Br	σ·Br	σ·Br	σ·Br	σ·Br
H-->bb	EH	F	EH	EEF	EEH	F	F
H-->cc	EH		EH	EEH	EEH	EH	F
H-->gg	EH		EH	EEH	EEH	EH	F
H-->WW*	EH		EEH	EEF	EEH	F	F
H-->ττ	EH		EEH	EEH	EH	EH	EEH
H-->ZZ*	F		EEG	EEG	G	G	G
H-->γγ	G		G	EEF	G	F	F
H-->μμ	-						F
H-->Inv. (95% C.L.)	F		EEF		EEF		-
ttH, H-->bb	-				EH/EF		F

F: done by full simulation w/ mH=125GeV
EH: extrapolated from full simulation w/ mH=120GeV
EEH: extrapolated from full simulation at other ecm w/ mH = 120 GeV
EEF: extrapolated from full simulation at other ecm w/ mH = 125 GeV
G: guesstimate from old fast simulation
black: ongoing or completed
red: still missing

Our Group's Activities

Status & Next Step

Symmetry Breaking & Mass Generation Physics

- ZH : H->bb,cc,gg -> EPJ C (2013) 73:2343, now working on mh=125 GeV case: Ono +Miyamoto
  H -> WW* anomalous coupling: analysis done -> publication: Takubo (revision done, resubmitted to P.R.D.) -> P.R.D88,013010(2013)
  H->other modes: Tino (AA,mu+mu-) + Kawada/Tanabe/Suehara (tau+tau-)
  Recoil mass: Watanuki, Jacqueline, Ogawa (ll), Tomita/Suehara (qq), CP mixing in h->tau+tau-: Yokoyama
- ZHH : full simulation of the H->bb&Z->all modes, fast simulation of nunuHH: finished: Junping + Takubo (Ph.D thesis: done) -> New analysis with improved analysis tools: Junping + Claude + Suehara + Tanabe, Jet-clustering: Shaofeng Ge
  New analysis: ZHH->ZbbWW*: Kurata (P-ID)
- nnHH : full simulation @ 1TeV, done for DBD: Junping -> publication
- nnH, eeH : precision measurements of HVV couplingsm, mh=125GeV: Junping
  BR measurements: Ono, Christian
- TTH : quick simulation studies with NRQCD corrections
  -> P.R.D84,014033(2011) -> full sim. @ 0.5 & 1 TeV: (Yonamine left) Tanabe + Sudo
- TT Threshold : Top Yukawa measurement: Horiguchi + Ishikawa + Tanabe, Theory: Kiyo + Sumino -> publicaton?
- AA->HH : quick simulation studies, so far H->bb and WW BG
  -> P.R.D85,113009(2012) : Kawada, Theory: Harada

Status & Next Step

Beyond the Standard Model

- SUSY : full simulation studies for LOI -> publication
  - EWkino scan: Tanabe
- Extra U(1), etc. -> Z' tail
  - TT : full simulation studies for LOI -> publication in conjunction with tau tau
  - tau tau : full simulation studies for LOI -> ditto
- Hidden Sector / XD : P.R.D78, 015008 (2008)
- LHT : P.R.D79, 075013 (2009)
- Model discrimination: Saito + Suehara .. : P.R.D84, 115003 (2011)
- R-handed neutrinos: Saito : P.R.D82, 093004 (2010)
- LHT: Kato (exp) + Harigaya (th): ZHZH finished, working on eHeH, nHnH, ..: Draft (n-1)?
- Very light gravitino: Katayama (Master's thesis), Tanabe (exp) + Matsumoto (th)
  --> 1st Draft --> New student: Takuaki Mori (Tokyo)
- Quasi stable stau: Yamaura (Master's thesis) + Kotera + Kasama —> reactivated
- Higgs portal/h->Invisible: Honda -> Yamamoto -> Ishikawa, Ogawa
- W-H+/W+H-: Shinzaki (exp) + Kanemura, yagyu (th)
- New projects?
  - AMSB: Tanabe
  - Single photon (DM search): Tanabe?
  - Heavier Higgs bosons?: Yokoya, Abhinav
  - Radiative correction to Higgs couplings in 2HDM: Kikuchi
  - H125->ccbar: Hidaka
  - m_nu, DM, baryogenesis: Machida

Short Term Schedule

- Weekly Meeting
  - Every Fri. at 13:30 (conf. ID: to be announced)
- General Meeting
  - 10:30 on Sat. Nov. 1 ?, 2014 (KEK MCU2 conf. ID:???)
- Toyama Meeting of New Higgs WG, Aug. 18-19
- ILD WS, Sep. 6-9
- LCWS 2014, Oct 6-10