Opening Comments

2015/06/13 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 LHC has just started its Run2 at 13TeV. This 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 results!

- The ILC project preparation office has been formed in KEK and the MEXT's ILC Task Force is reviewing the project. 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. The next target for us to show our activities to the LC community is LCWS15 on Nov.2-6 in Whistler, Canada.

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.
- 2015/01/08 6th Physics WG Mtg.
  - SSC case study
  - Discussions on the requests from the Expert Panel
- 2015/02/17 7th Physics WG Mtg.
- 2015/03/30 8th Physics WG Mtg.
- 2015/04/21 3rd Expert Panel Mtg.
- 2015/06/25 4th Expert Panel Mtg. <- coming soon.

What we want

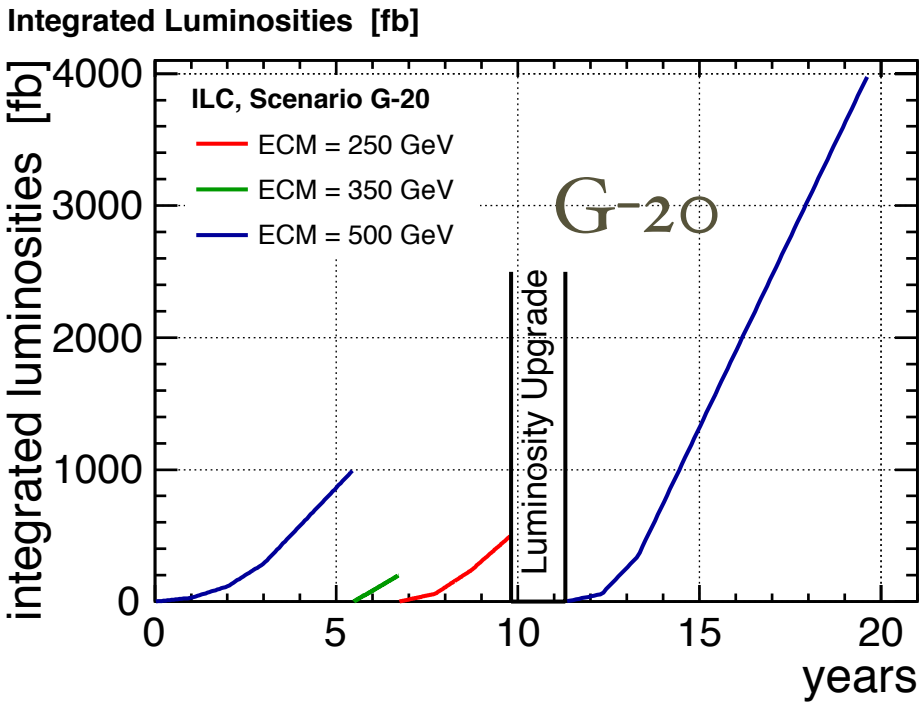
- We have the 125 GeV boson that is a powerful tool to explore the symmetry breaking sector (SBS).
  We need to invent a way to make maximal use of it.
  - Is it possible to map various BSM models in ideally a single and hopefully a small number of generic parameter spaces so as to compare the physics 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, ...

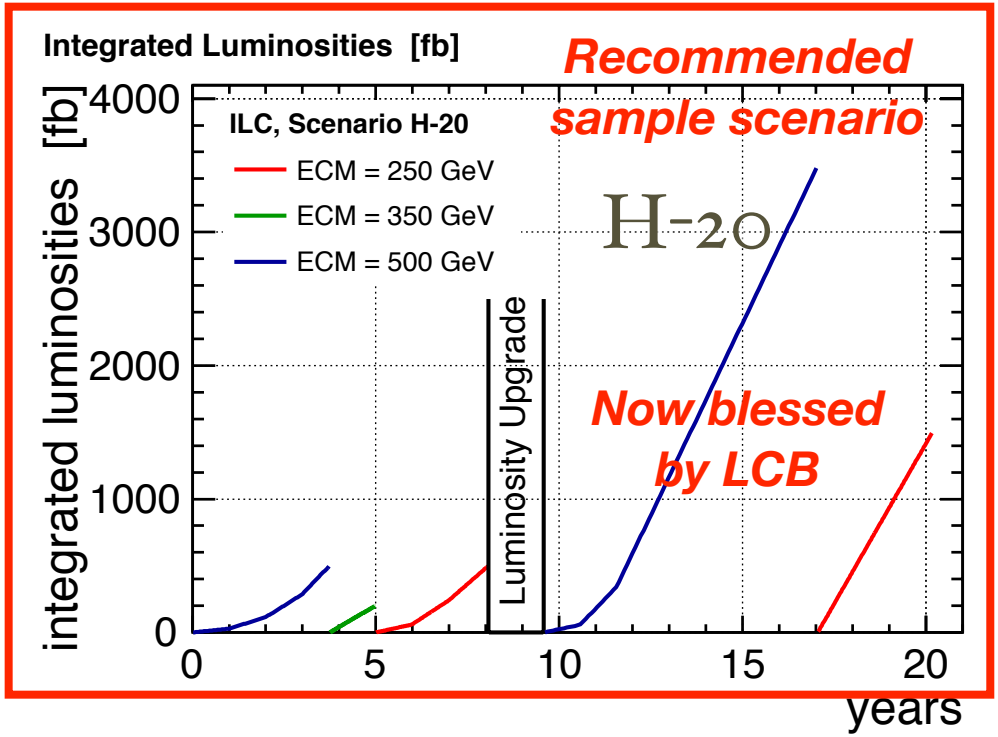
- ILC is an energy frontier machine. We need to re-examine the possibilities given the existence of the 125GeV boson and their relations to the open questions.

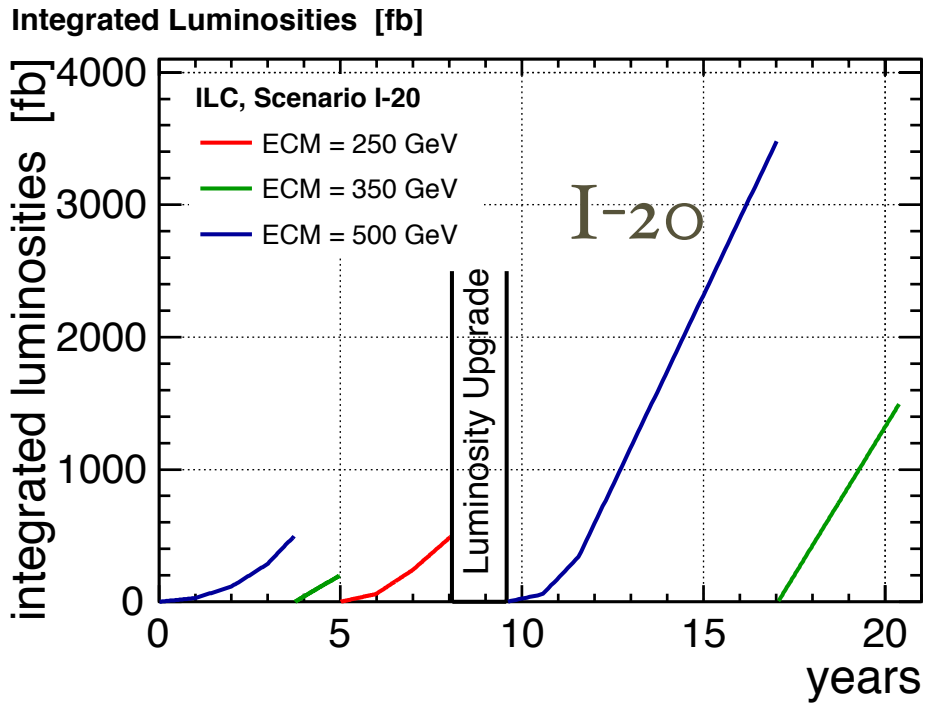
More Exercises Needed

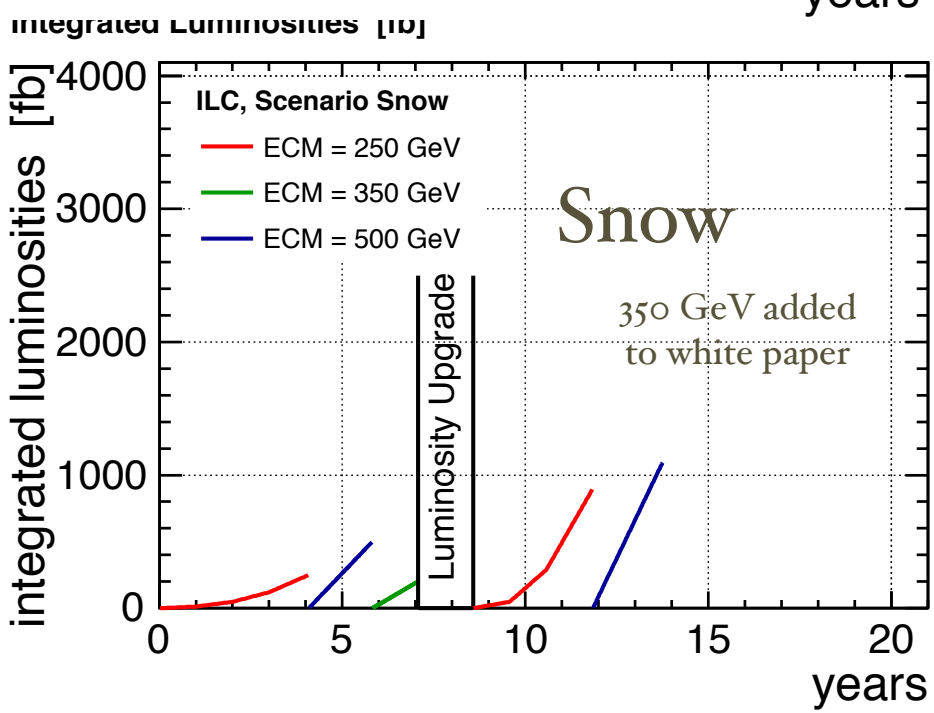
- For theorists:
  - ILC can measure various quantities such as mh, gamma_h, ghxx, mt, etc. far better than LHC. But how accurately do we really need to measure them?
  - What will be the ultimate theoretical uncertainties in various predictions for LHC and ILC, respectively?
  - Update various ILC physics 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)

Running Scenarios


Integrated Luminosities [fb]
ILC, Scenario G-20
ECM = 250 GeV
ECM = 350 GeV
ECM = 500 GeV
G-20
Luminosity Upgrade
integrated luminosities [fb]
years


Integrated Luminosities [fb]
Recommended
sample scenario
ILC, Scenario H-20
ECM = 250 GeV
ECM = 350 GeV
ECM = 500 GeV
H-20
Now blessed
by LCB
Luminosity Upgrade
integrated luminosities [fb]
years

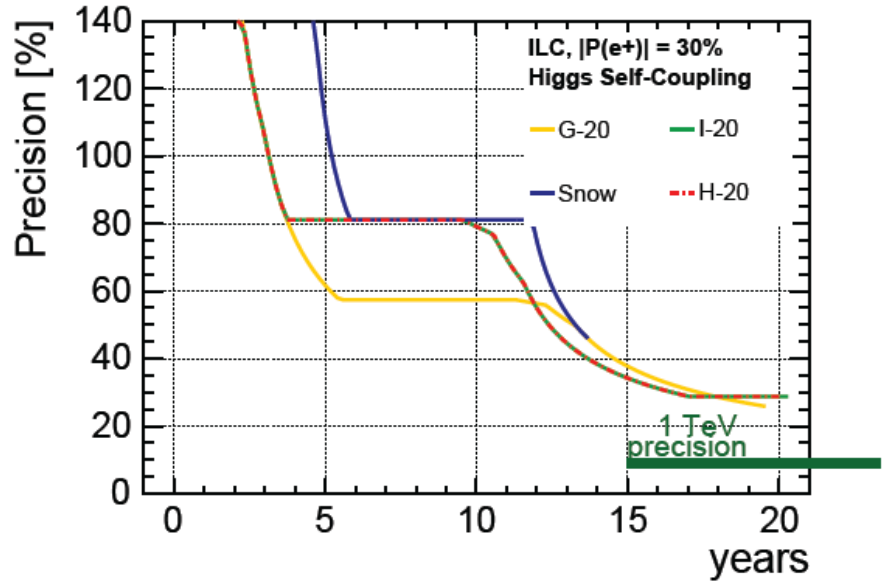

Integrated Luminosities [fb]
ILC, Scenario I-20
ECM = 250 GeV
ECM = 350 GeV
ECM = 500 GeV
I-20
Luminosity Upgrade
integrated luminosities [fb]
years

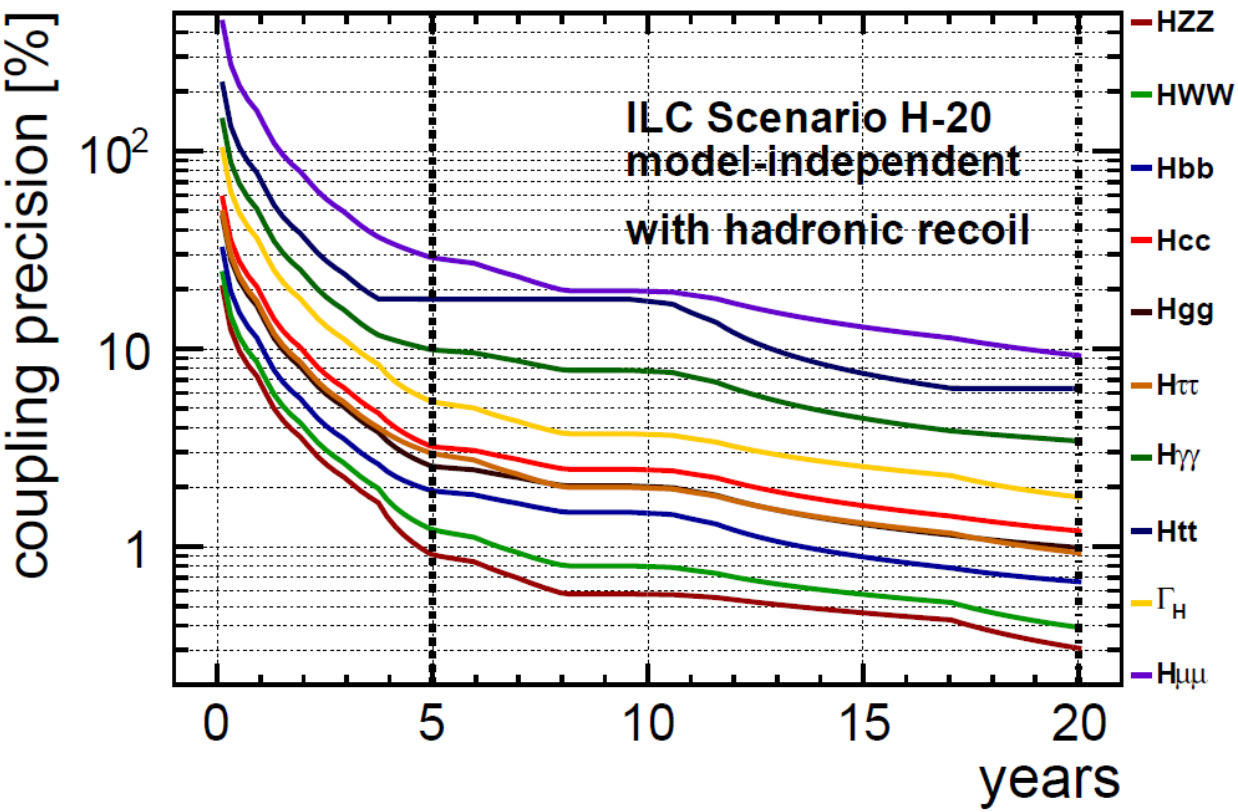

ILC, Scenario Snow
ECM = 250 GeV
ECM = 350 GeV
ECM = 500 GeV
Snow
350 GeV added
to white paper
Luminosity Upgrade
integrated luminosities [fb]
years

Higgs Measurements

H-20

	first phase	lumi upgrade	total
250 GeV	500 fb^{-1}	1500 fb^{-1}	2 ab^{-1}
350 GeV	200 fb^{-1}		0.2 ab^{-1}
500 GeV	500 fb^{-1}	3500 fb^{-1}	4 ab^{-1}
time	8.1 yrs	10.6 yrs	20.2 yrs*





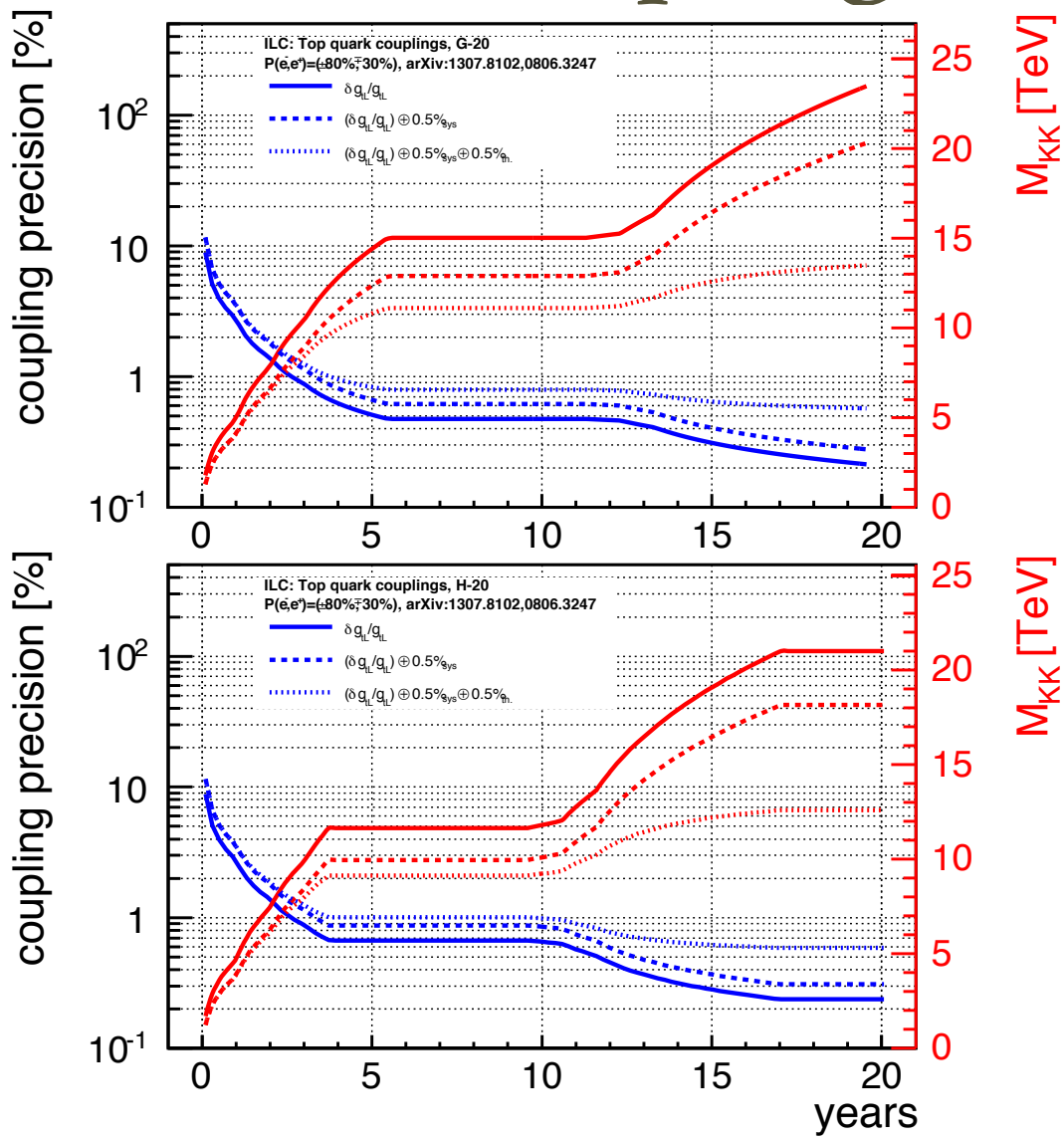
Self-coupling reaches <30% for SM case.
<15% if lamda=2xSM

ILC parameter WG report *Jim BRAU*

Most couplings reach <1% even with model-independent fitting

Top electroweak couplings

- Left-handed top coupling, and the derived mass scale sensitivity for Kaluza-Klein excitations in and extra-dimensions model



Rationales for H20

- high mass reach for new particles from the beginning
- g_{HWW} and Γ_H well balanced with g_{HZZ} in the early running period
- thus better precisions for most fermion couplings in the early running period
- full sensitivity to top quark anomalous couplings from the beginning
- access to ttH and ZHH from the beginning
- higher sensitivity to high scale for 2-fermion processes
- high precision mH and gHZZ will limit the coupling measurements only in the later stage after the luminosity upgrade

Actual running scenario, however, will depend on LHC and early ILC physics results!

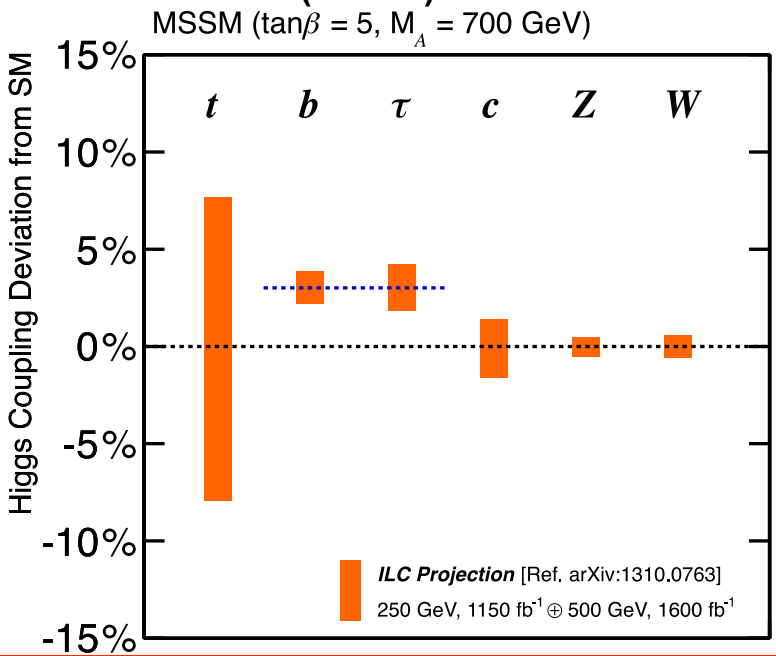
Issues for experiments

- Detectors
  - data taking at various repetition rates
    - 5, 7, 10 Hz
  - Z pole calibration requirement
- Physics
  - prospects for m_h measurement from kinematic reconstruction
  - model-independency of hadronic recoil

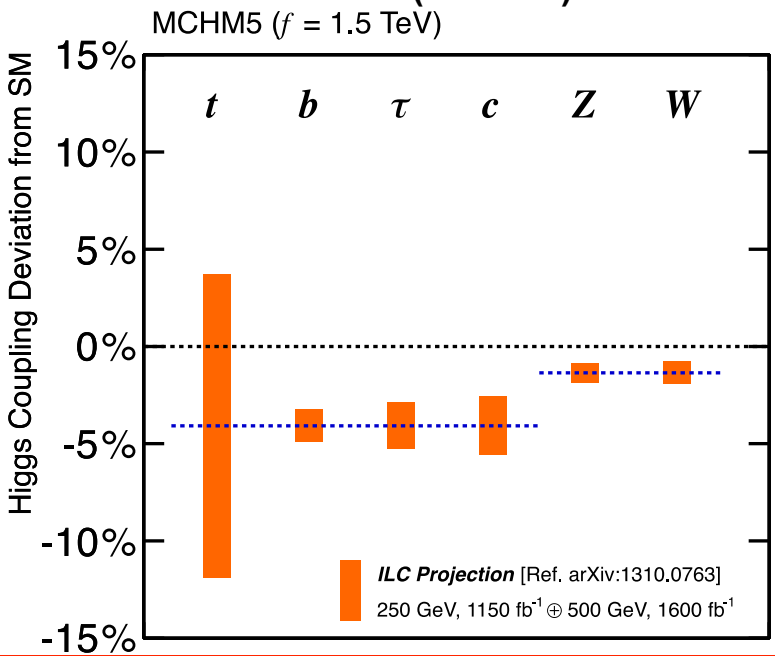
H20 Prospects

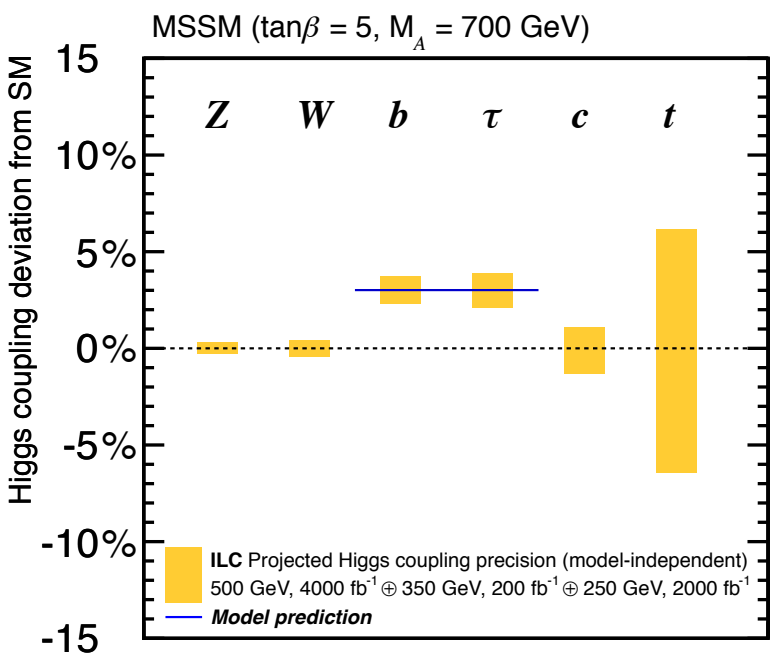
Higgs Couplings

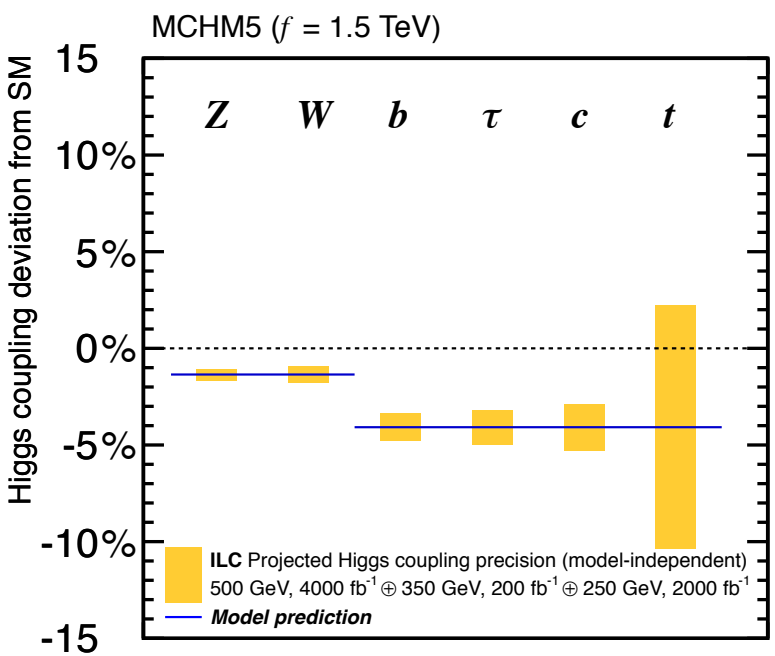
Supersymmetry (MSSM)



Composite Higgs (MCHM5)

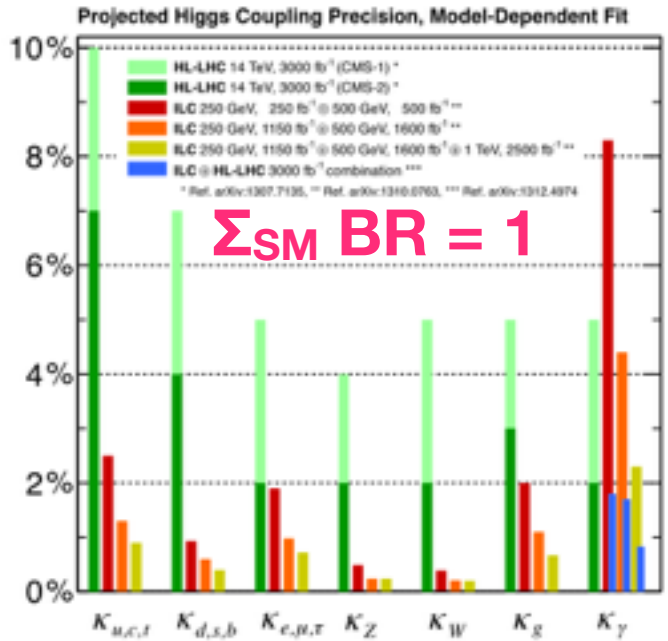




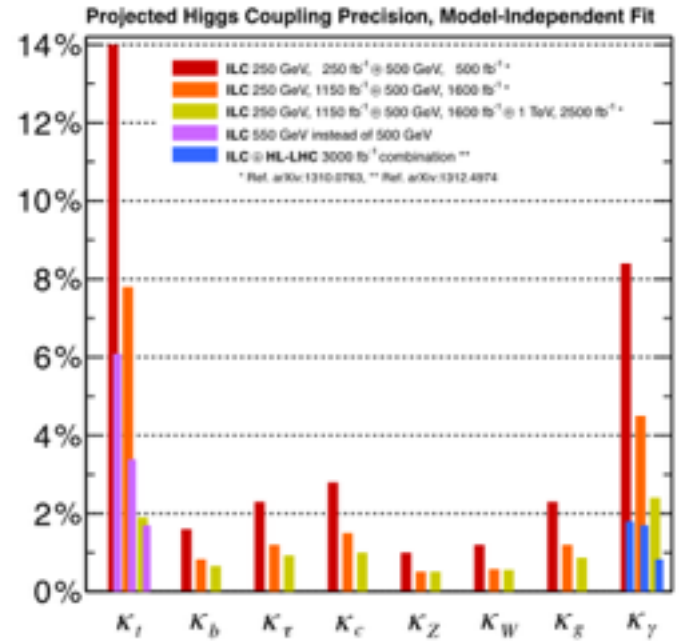


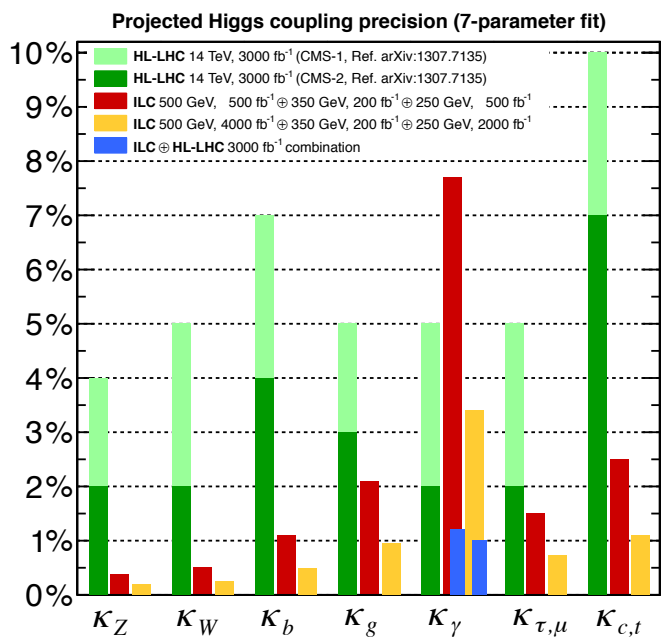
Higgs Couplings

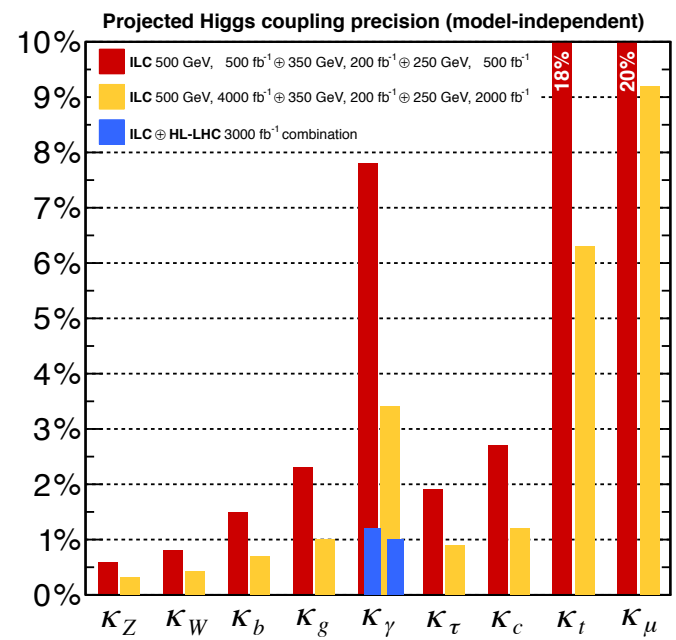
LHC-style 7-parameter fit



ILC-style model independent fit







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/Daniel (tau+tau-)
  Recoil mass: Watanuki, Jacqueline, Ogawa (ll), Tomita/Suehara (qq), CP mixing in h->tau+tau-: Yokoyama, Ogawa (HVV couplings), CPV in Zh production (Watanuki)
- 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, LCFIPlus: Suehara
  New analysis: ZHH->ZbbWW*: Kurata (high level reconstruction)
- 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 -> publication?
- New analysis (enW) : Koya Tsuchimoto
- 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, Junping
- W-H+/W+H-: (Shinzaki), Ishikawa (exp) + Kanemura, yagyu (th)
- New projects?
  - AMSB: Tanabe
  - Single photon (DM search): Tanabe
  - Heavier Higgs bosons?: Yokoya, (Abhinav) -> Ishikawa?
  - 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. Aug.29?, 2015 (KEK MCU2 conf. ID:XXX)
- LCWS 2015, Whistler (Vancouver), Nov. 2-6, 2015