

Opening Comments

2014/01/018 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**. 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 object is a window to BSM physics and ILC is the best machine to use it.**
The energy upgrade of LHC will be likely to 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.
- The DBD physics chapter is completed. The Snowmass 2013 meeting is over and "white papers" submitted. The ILC preparatory office has just been formed. The next target is ALCPG14 at Fermilab on May. 12-16.

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 m_h , γ_h , g_{hXX} , m_t , 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?
- For Experimentalists:
 - Update all the old analyses with $m_h=120$ GeV **to $m_h=125$ GeV**: urgent!
 - Complete the analyses such as **rare Higgs decays**: urgent!
 - **Improve the analyses** such as self-coupling, $H \rightarrow \gamma\gamma$, recoil mass (jets?), where the results are not yet satisfactory.
 - **Studies at $E_{cm} = 350$ GeV?**
 - 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)

ILC Physics Pamphlet

~20-page document for non-collider physicists

Ready for internal review

Our Group's Activities

Status & Next Step

Symmetry Breaking & Mass Generation Physics

- ZH : $H \rightarrow bb, cc, gg \rightarrow$ [EPT C \(2013\) 73:2343](#), now working on $m_h=125$ GeV case: [Ono](#) + [Miyamoto](#)
 $H \rightarrow WW^*$ anomalous coupling: [analysis done](#) \rightarrow [publication](#): [Takubo](#) (revision done, [resubmitted to P.R.D.](#)) \rightarrow [P.R.D88,013010\(2013\)](#)
 $H \rightarrow$ other modes: [Tino](#) (AA, $\mu^+\mu^-$) + [Kawada](#)/Tanabe/Suehara ($\tau^+\tau^-$) + Recoil mass: [Watanuki \(II\)](#), [Tomita](#)/Suehara (qq), CP mixing in $h \rightarrow \tau^+\tau^-$: [Yokoyama](#)
- ZHH : full simulation of the $H \rightarrow bb$ & $Z \rightarrow$ all modes, fast simulation of $nnuHH$: [finished](#): [Junping](#) + [Takubo](#) ([Ph.D thesis: done](#)) \rightarrow New analysis with improved analysis tools: [Junping](#) + [Claude](#) + [Suehara](#) + [Tanabe](#)
New analysis: $ZHH \rightarrow ZbbWW^*$: [Kurata](#)
- $nnHH$: full simulation @ 1TeV, done for DBD: [Junping](#) \rightarrow publication
- nnH : precision measurements of HVV couplings @ 500GeV, $m_h=125$ GeV: [Junping](#)
BR measurements at 1TeV benchmark: [Ono](#)
- TTH : quick simulation studies with NRQCD corrections
 \rightarrow [P.R.D84,014033\(2011\)](#) \rightarrow full sim. @ 0.5 & 1 TeV: ([Yonamine left](#)) [Tanabe](#) + [Sudo](#)
- TT Threshold : Top Yukawa measurement: [Horiguchi](#) + [Ishikawa](#) + [Tanabe](#), Theory: [Kiyo](#) + [Sumino](#) \rightarrow [Now reactivated!](#)
- AA \rightarrow HH : quick simulation studies, so far $H \rightarrow bb$ and WW BG
 \rightarrow [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
- W-H⁺/W-H⁻: Shinzaki (exp) + Kanemura, yagyu (th)
- Possible new projects?
 - AMSB: Tanabe
 - Single photon (DM search): Tanabe?
 - Heavier Higgs bosons?
 - Flavor violating bosonic squark decay: Hidaka

Short Term Schedule

- Weekly Meeting
 - Every Fri. at 13:30 (conf. ID: to be announced)
- General Meeting
 - 10:30 on Sat. ?? ??, 2014 (KEK MCU2 conf. ID:???)
- France-Japan: Top Physics WS in Paris, Mar.4-6
- ALCPG 2014, May 12-16