Opening Comments

2014/04/019 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.
- The DBD physics chapter is completed. The Snowmass 2013 meeting is over and "white papers" submitted. The ILC project preparation office has been formed in KEK and the MEXT's ILC Task Force is about to start 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. The next target is ALCPG14 at Fermilab on May. 12-16.
- The ILC is now an "official project" recognized by MEXT! The MEXT's ILC TF review is vital to the realization of the ILC.

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.

Requests from MEXT

Strengthen the physics case other than that of the 125GeV Higgs boson!

Possible strategy

- For the following 3 cases:
  - 14TeV LHC would find something new
  - 14TeV LHC would see hits of new physics in the 125GeV properties
  - 14TeV LHC would see nothing new
- investigate how far the LHC would ultimately go in each case, and
- consider how the ILC would bring our understanding of particle physics qualitatively beyond that from the future stages of the LHC,
- taking popular/standard new physics models as examples.

We will discuss this more later today

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?
- 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)

The ILC Parameter Joint Working Group – Charge
March 19, 2014

The ILC parameter working group reports to the LCC Directorate. It consists of members from both the ILC accelerator and the physics & detector groups where each team selects a co-convener for this working group.

This working group prepares information on ILC machine parameters and staging scenarios as well as potential upgrade paths in a form readily usable by the LCC. In doing so, the WG will take into account technical machine constraints and physics and detector needs regarding the fundamental ILC machine parameters such as energy, luminosity, crossing angles, etc.

The first task for the working group is to prepare multiple scenarios for staging up to about 500 GeV. The report should contain the pros and cons of each scenario as well as luminosities needed at each energy to produce corresponding physics results.

Extended Parameters Group

- Inital members:
  Jim Brau (chair), Keisuke Fujii, Tim Barklow, JL
- After LCC/LCB in February:
  Nick Walker (co-chair), Kaoru Yokoya and Jie Gao joined
- Key questions:
  - How much initial fb^{-1} required at 250 GeV?
  - How much fb^{-1} ultimatively required at 250 GeV?
  - How much data required at ttbar threshold (350 GeV) and how does this contribute to Higgs physics?
  - Empty tunnel should be built for which top-level energy (before 1 TeV upgrade) – 500 GeV? 550 GeV?

Goal: physics reach for various scenarios

- We're not doing the politics, just provide physics & technical input
- Way forward:
  - define example running scenarios
  - Evaluate physics performance
  - Evaluate running time, production/installation schemes
- Experimental perspective:
  - Need to have simulation results for key physics analyses at the various energy steps
  - Can then scale to any lumi & polarisation!

Example Running Scenarios

a) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV

b) 250 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 550 GeV

c) 250 fb^{-1} @ 250 GeV, 1000 fb^{-1} @ 500 GeV
(for comparison with scenario b)

d) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV,
500 fb^{-1} @ 500 GeV

e) 100 fb^{-1} @ 250 GeV, 200 fb^{-1} @ 350 GeV,
500 fb^{-1} @ 550 GeV

f) 25 fb^{-1} @ 250 GeV, 350 fb^{-1} @ 350 GeV,
500 fb^{-1} @ 500 GeV

g) 500 fb^{-1} @ 250 GeV, 500 fb^{-1} @ 500 GeV

Key Analyses and Questions

- sigma(Zh) and mh from the recoil mass analysis will eventually limit all the Higgs coupling precisions
  - Full simulations with mh=125GeV particularly at Ecm=250 and 350 GeV
  - Full simulations of sigma x BR for mh=125GeV at Ecm=350 and 500 GeV needed for reliable combination of different energies
  - How does delta mh affects the coupling precisions?
  - How much luminosity do we need at Ecm=250 GeV?
- The tth at the top energy (Ecm ~= 500GeV) will be benefited most by slight increase of the top energy.
  - Full simulations of tth at Ecm=500 and 550 GeV
  - How does delta y_t depend on Ecm and Lumi?

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->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 (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
  New analysis: ZHH->ZbbWW*: Kurata
- nnHH : full simulation @ 1TeV, done for DBD: Junping -> publication
- nnH, eeH : precision measurements of HVV couplingsm, mh=125GeV: Junping
  BR measurements at 1TeV benchmark: Ono
- 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 -> Now reactivated!
- 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
- 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
  - Direct search for extra Higgs bosons: Yokoya

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:???)
- Toyama Meeting of New Higgs WG, Apr. 26-27
- Phenomenology 2014, May 5-7
- ALCPG 2014, May 12-16