Opening Comments

2017/04/15

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 Run2 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 MEXT ILC Advisory Panel says "it is necessary to closely monitor, analyze and examine the development of LHC experiments". 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 the detector optimization effort will continue. In response to the interim summary from the MEXT panel, we published a report on ILC's new particle discovery potential in last Feb. We are now revisiting the staging of ILC as agreed at the LCWS16 in Morioka with the deadline for a report on it being the end of May. The next target for us to show our activities including studies on the staging to the LC community is ALCW2017 on Jun. 26 to 30 at SLAC.

Interim Summary

http://www.mext.go.jp/b_menu/shingi/chousa/shinkou/038/gaiyou/1360593.htm

- ILC Advisory Panel published an interim summary of their discussions based on the reports from the two working groups (Particle & Nuclear Physics WG and TDR Validation WG).

- The interim summary pointed out the following issues
  - Obtain clear vision for international cost sharing
  - Make clear scientific merits (**not only precision studies of Higgs and top but also possibilities of new particle discoveries**) that match the investment
  - **Monitor, analyze, and examine the development of LHC experiments.**
  - Solve remaining technological issues and **mitigate cost risk**.
  - Get **understanding from the general public** and other scientific communities.

Homework 1: Get **understanding from the general public** and other scientific communities.

ILC Brochure

ILC communicators with consultation by LCC Physics WG

Completed → publicized!

Homework 2: **Monitor, analyze, and examine the development of LHC experiments.**

X750 Case Study

ILC–NOTE–2016–067
DESY 16–145, IPMU16-0108
KEK Preprint 2016–9, LAL 16–185
MPP–2016–174, SLAC–PUB–16751

July, 2016

Implications of the 750 GeV $\gamma\gamma$ Resonance as a Case Study for the International Linear Collider

LCC Physics Working Group

Keisuke Fujii[1], Christophe Grojean[2,3] Michael E. Peskin[4](conveners); Tim Barklow[4], Yuanning Gao[5], Shinya Kanemura[6], Hyungdo Kim[7], Jenny List[2], Mihoko Nojiri[1,8], Maxim Perelstein[9], Roman Pöschl[10], Jürgen Reuter[3], Frank Simon[11], Tomohiko Tanabe[12], Jaehoon Yu[13], James D. Wells[14], Adam Falkowski[15], Shigeki Matsumoto[8], Takeo Moroi[16], François Richard[10], Junping Tian[17], Marcel Vos[17], Hiroshi Yokoya[18]; Hitoshi Murayama[8,19,20], Hitoshi Yamamoto[21]

ABSTRACT

If the $\gamma\gamma$ resonance at 750 GeV suggested by 2015 LHC data turns out to be a real effect, what are the implications for the physics case and upgrade path of the International Linear Collider? Whether or not the resonance is confirmed, this question provides an interesting case study testing the robustness of the ILC physics case. In this note, we address this question with two points: (1) Almost all models proposed for the new 750 GeV particle require additional new particles with electroweak couplings. The key elements of the 500 GeV ILC physics program—precision measurements of the Higgs boson, the top quark, and 4-fermion interactions—will powerfully discriminate among these models. This information will be important in conjunction with new LHC data, or alone, if the new particles accompanying the 750 GeV resonance are beyond the mass reach of the LHC. (2) Over a longer term, the energy upgrade of the ILC to 1 TeV already discussed in the ILC TDR will enable experiments in $\gamma\gamma$ and e^+e^- collisions to directly produce and study the 750 GeV particle from these unique initial states.

Homework 3: Provide a clear vision on **the discovery potential of new particles**

The Potential of the ILC for Discovering New Particles

Document Supporting the ICFA Response Letter to the ILC Advisory Panel

LCC Physics Working Group

Keisuke Fujii[1], Christophe Grojean[2,3,4], Michael E. Peskin[5] (conveners); Tim Barklow[5], Yuanning Gao[6], Shinya Kanemura[7], Hyungdo Kim[8], Jenny List[2], Mihoko Nojiri[1,9], Maxim Perelstein[10], Roman Pöschl[11], Jürgen Reuter[2], Frank Simon[12], Tomohiko Tanabe[13], James D. Wells[14], Jaehoon Yu[15]; Howard Baer[16], Mikael Berggren[2], Sven Heinemeyer[17], Suvi-Leena Lehtinen[2], Junping Tian[13], Graham Wilson[18], Jacqueline Yan[1]; Hitoshi Murayama[9,19,20], James Brau[21]

Abstract

This paper addresses the question of whether the International Linear Collider has the capability of discovering new particles that have not already been discovered at the CERN Large Hadron Collider. We summarize the various paths to discovery offered by the ILC, and discuss them in the context of three different scenarios: 1. LHC does not discover any new particles, 2. LHC discovers some new low mass states and 3. LHC discovers new heavy particles. We will show that in each case, ILC plays a critical role in discovery of new phenomena and in pushing forward the frontiers of high-energy physics as well as our understanding of the universe in a manner which is highly complementary to that of LHC.

For the busy reader, a two-page executive summary is provided at the beginning of the document.

Staging Discussion

- In LCWS 2016, Nov. in Morioka, it was agreed to start seriously considering a staging scenario of the ILC ***to significantly reduce the initial construction cost***.
  - 1st stage as a Higgs factory
  - and later stages taking advantage of flexible energy expandability of a linear collider.
- LCB/LCC started working on possible staging scenarios to build consensus among the worldwide HEP community.

The staging option resurfaced again during LCWS 2016!

Following this ILC Parameters Joint WG met on Jan. 4

- Our goal is to consider the physics potential for an ILC that starts operations at 250 GeV.
- **We need to make the 1st stage as attractive as possible**.
  → as high Luminosity as possible for the 1st stage.
- We could consider a different choice for the machine parameters.
- **Official request sent to Shin Michizono for some machine manpower to investigate the possibility.**
  →Kaoru Yokoya, Takashi Okugi, Toshiaki Tauchi, Daniel Jeans started a study. Needs modification of DR design to reduce horizontal emittance.
- Lyn has asked us to provide a first update on the physics impact of the staging possibilities by mid February.

Jim Brau, as the LCC associate director for physics and detector, requested the LCC ILC Physics WG to define the physics goals of the initial stage.

- A short (2-page) report (***a straw man staging scenario***) handed to Jim Brau, **shown on Feb.16 at the ICFA annual meeting in Valencia**:
  https://indico.fnal.gov/conferenceTimeTable.py?confId=13386#20170216.detailed
- **Feed back from Jim to LCC Physics WG**.

ILC Parameters Joint WG met on Mar. 8 → action plan formulated.

- ***Luminosity optimization at 250 GeV → >50% luminosity increase by halving the horizontal emittance.***
- ***Realistic run scenarios being prepared: starting from 250 GeV then after lumi-up either to 350 or directly to >500 GeV***
- ***Final report expected in late May to early June***

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 -> P.R.D88,013010(2013)
  -> H -> WW* to be reexamined: Liao Libo
  H->other modes: Tino (AA,mu+mu-) + Kawada/Tanabe/Suehara/Daniel (tau+tau-)->publication
  -> EPJC (2015) 75:617.
  Recoil mass: Jacqueline -> P.R.D94,113002(2016), Suehara (qq), CP mixing in h->tau+tau-:
  Daniel -> draft being reviewed by ILD, HVV couplings: Ogawa, Yumi Aoki (Hgamma)
  direct mH reconstruction: Junping
- 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, Systematic Error: Tim, Junping
- 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? (cf. a recent significant theoretical development!): Ozawa
- W mass (enW) : Koya Tsuchimoto -> Kotora (controlling systematic uncertainties)->Kotera
- 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 (Compressed Spectrum Case): Jacqueline
- Extra U(1) (Z' tail), Compositeness, Extra Dimensions, etc.
  - TT : full simulation studies for LOI -> New study with MELA: Sato
  - tau tau : full simulation studies for LOI -> ditto
  - 2f: full simulation study: Yamashiro
- 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 --> Takuaki Mori (Tokyo) -> ?
- Quasi stable stau: Yamaura (Master's thesis) + Kotera + Kasama —> reactivated?
- Higgs portal/h->Invisible: Honda -> Yamamoto -> Ishikawa, Ogawa, Junping -> Kato (Tokyo)
- W-H+/W+H-: (Shinzaki), Ishikawa (exp) + Kanemura, yagyu (th)
- Generic DM search: Tanabe
- New projects?
  - AMSB: Tanabe
  - Heavier Higgs bosons?: Yokoya, (Abhinav) -> Christian Drews
  - X(750) : Junping -> published in PRD (Phys.Rev. D94 (2016) no.9, 095015)
  - Correlation btw h->gamma gamma & h->gg in mSUGRA: Hidaka
  - m_nu, DM, baryogenesis: Machida

Short Term Schedule

- Weekly Meeting
  - Every Fri. at 14:00 (conf. ID: to be announced)
- General Meeting
  - 10:30 on Sat. June 17, 2017 (KEK MCU2 conf. ID:XXX)
- Top@LC2017, CERN, June 7-9, 2017
- ALCW 2017, SLAC, June 26-30, 2017
- LCWS 2017, Strasbourg, Oct.23-27