

Opening Comments

2016/11/26 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, ICFA sent a letter concerning issues raised there including a 4-page long summary of BSM scenario (new particle discovery potential in particular) in last Dec. Its followup document is due by the end of this year. The next target for us to show our activities to the LC community is LCWS16 on Dec. 5 to 9 in Morioka.

Support Document for the ICFA Letter

Support Document that follows up the ICFA letter

First authors' meeting held on Sep. 9

Discussed the structure and basic ideas about contents together with how to share the writing.

2nd authors' meeting held on Oct. 13

Reviewed the status of the draft and discussed the request from JHEPC and possible readjustment of the contents of the document.

3rd authors' meeting held on Nov. 1

Reviewed the status of the draft (significant progress, but there are still missing parts, expected to be filled in shortly) and discussed the timeline until LCWS 2016.

4th authors' meeting held on Nov. 16

Reviewed the status of the draft (significant progress, most part filled). All the part to be filled and frozen by next Monday for final editing by Jenny and KF until Nov. 28. The draft will then be sent to plenary speakers and LCC physics WG.

The ILC's Potential for Discovering New Particles

Document Supporting the ICFA Response Letter to the ILC Advisory Panel

The purpose of this document is to provide in-depths material supporting statements on the ILC's discovery potential for new particles sketched out in the answer of ICFA to the ILC Advisory Panel of MEXT, taking into account LHC Run II development.

- Target: Particle physicists (a version for the MEXT ILC Advisory Panel will be prepared based on this)
- Length: 25 - 30 pages
- Deadline: originally the end of summer 2016, but since X750 is gone and no immediate action seems to be expected, we could postpone it a little bit. Maybe a first presentable draft by the Morioka WS.

New request from JHEP via Hitoshi Yamamoto

Yet Another Document Planned by JHEPC

To be completed in March 2017
Japanese HEP committee is planning to issue
*a statement on the ILC physics case
based on the LHC Run2 results (so far).*

*Hitoshi hopes that the support document
will be an input to this JHEPC statement*

The recommendation by the MEXT panel

Closely monitor, analyze, and examine the development of LHC experiments

The current LHC Run2 results

indicate that there seem to be *no new particles easily discoverable at the LHC*, which leaves

case 3-1:

No discoveries of new particles at LHC Experiments

Support Document Contents (modified)

- 1. Introduction**
- 2. Overview on BSM Scenarios**
- 3. Summary of ILC Capabilities**

Main body of the document

There are different kinds of discoveries.

Power of precision

ILC is not a gleaner.

Power of cleanliness

4. LHC Discovery Scenarios (at the end of LHC run3)

4-1) LHC Experiments do not discover new particles

4-2) LHC experiments discover relatively light new particles

4-3) LHC experiments discover heavy new particles

5. ILC and LHC, Complementarity and Synergy

including prospects after seeing the Run2 results (as of now)

6. Conclusions

Our Group's Activities

Status & Next Step

Symmetry Breaking & Mass Generation Physics

- ZH : $H \rightarrow bb, cc, gg \rightarrow$ EPJ C (2013) 73:2343, now working on $m_h=125$ GeV case: Ono+Miyamoto
 $H \rightarrow WW^*$ anomalous coupling: analysis done \rightarrow publication: Takubo \rightarrow P.R.D88,013010(2013)
 $H \rightarrow$ other modes: Tino (AA, $\mu^+\mu^-$) + Kawada/Tanabe/Suehara/Daniel ($\tau^+\tau^-$) \rightarrow publication
 \rightarrow EPJC (2015) 75:617.
Recoil mass: Jacqueline \rightarrow accepted for publication in PRD, Suehara (qq), CP mixing in $h \rightarrow \tau^+\tau^-$: Daniel \rightarrow draft being reviewed by ILD, HVV couplings: Ogawa
direct mH reconstruction: Junping
- 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, Jet-clustering: Shaofeng Ge, LCFIPlus: Suehara
New analysis: ZHH \rightarrow ZbbWW*: Kurata, Systematic Error: Tim, Junping
- nnHH : full simulation @ 1TeV, done for DBD: Junping \rightarrow publication
- nnH, eeH : precision measurements of HVV couplings, $m_h=125$ GeV: Junping
BR measurements: Ono, Christian
- 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 publication? (cf. a recent significant theoretical development!): Ozawa
- W mass (m_W) : Koya Tsuchimoto (controlling systematic uncertainties)
- 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** (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**: a new student
- 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) → Ishikawa?
 - **X(750)** : Junping → **published in PRD (Phys.Rev. D94 (2016) no.9, 095015)**
 - **Quark flavor violation in H125→ccbar and bbbar**: Hidaka
 - m_nu, DM, baryogenesis: Machida

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Diphoton resonances at the ILC

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In this paper, we study the direct production of the diphoton resonance X , which was suggested by 2015 data at the LHC, in $e^+e^- \rightarrow X\gamma/XZ$ processes at the ILC. We derive an analytic expression for the scattering amplitudes of these processes and present a comprehensive analysis for determining the properties of X at the ILC. A realistic simulation study for $e^+e^- \rightarrow X\gamma$ is performed based on the full detector simulation to demonstrate the capabilities of the ILC experiment. Complementary to the searches at the LHC, prospects for the measurement of the absolute values of the production cross section are obtained for the ILC using the recoil technique without assuming decay modes of X . In addition, we studied the searches for $X \rightarrow$ invisible and $X \rightarrow b\bar{b}$ modes, which are challenging at the LHC, and found that these decay modes can be discovered with high significance if their branching ratios are large enough.

DOI: [10.1103/PhysRevD.94.095015](https://doi.org/10.1103/PhysRevD.94.095015)

ILD talks submitted to Higgs/EW sessions at LCWS16

- **“Higgs self-coupling analysis at the ILC”, by C.Duerig (DESY)**
- **“Anomalous VVH couplings at the ILC”, by T.Ogawa (KEK & Sokendai)**
- **“Measurement of the $H \rightarrow WW^*$ decay at 500 GeV ILC”, by M.Pandurovic (University of Belgrade)**
- **“CP measurements in Higgs \rightarrow tau tau at ILC”, by D.Jeans (U’ Tokyo)**
- **“BSM search using Higgs to invisible decay at the ILC”, by Y.Kato (U’ Tokyo)**
- **“A new method for Higgs mass measurement”, by J.Tian (U’ Tokyo)**
- **“Model-Independent Determination of the Triple Higgs Coupling at e^+e^- Colliders”, by T.Barklow (SLAC), (ILD-SiD-Theorists collaboration)**

ILD talks submitted to Top/QCD sessions at LCWS16

- **“An analysis of top pair creation at $E_{cm} = 500 \text{ GeV}$ ” by Yo Sato (Tohoku)**
- **“ $b\bar{b}$ analysis” by S. Bilokin (LAL)**
- **“ m_t measurement with radiative $t\bar{t}b\bar{b}$ production” by M. Vos**

ILD talks submitted to BSM sessions at LCWS16

	Topic	Contact	Session	arXiv	Speaker	Title
A1	Review NP	J	BSM		Baer	Direct searches of New Physics at
A2	Review EXP LHC	R	BSM		CMS Speakers Bureau	Supersymmetry and other direct
A3	Light scalars@LHC	R	BSM	1609.06089	Barducci	Review of LHC experimental
A4	WW scattering	P	BSM	1607.03030	Kilian	Scattering of W and Z Bosons at
C1	Review Exotics EXP	R	BSM		Daniela Paredes Hernandez (Yale, ATLAS)	Exotica searches at the LHC
C2	h->aaa	Call		1609.08127	Helmboldt	Prospects for three-body Higgs
C3	gamma gamma	KJ	BSM	1602.01231	H. Ito	Di-Higgs decay of stoponium at a
B1	Wimp TH	KJ	BSM		Katayose	WIMPs at LCs
B2	WIMP EXP	KJ	BSM		Tanabe, T.	WIMPSs at LCs
B3	WIMP composition	Call		1609.06555 - Kakizaki, M. and		
D1	Natural SUSY loops	KJ	BSM	1609.07868	Jimbo	One loop effects of natural SUSY
D2	Light Higgsino	KJ	BSM		J. Yan	Search for Light Higgsinos with
D3	SUSY parameters	KJ	BSM		Lehtinen, S.-L.	SUSY parameters extraction
D4	co-annihilation	KJ	BSM		Mikael Berggren	

Short Term Schedule

- Weekly Meeting
 - Every Fri. at 14:00 (conf. ID: to be announced)
- General Meeting
 - 10:30 on **Sat. Feb. 4, 2017** (KEK MCU2 conf. ID:XXX)
- **LCWS 2016, Morioka, Dec. 5-9, 2016**
- **ALCW 2017, Santa Cruz, June 26-30, 2017**