

Report from Physics WG

Keisuke Fujii
on behalf of the Physics WG
Feb. 22, 2017

Actions to be taken

ICFA Letter has been received by
MEXT ILC Advisory Panel

- LCB and ICFA agreed to send explanations on the following three points to the ILC Panel. Draft has been submitted from the Japanese community to LCB.

Followup report of ICFA Letter

- ... a clear vision on the discovery potential of new particles ...
- ... It is appropriate to proceed discussion on a possible international cost sharing scheme of the ILC project ...
- ... solve technical issues and how to mitigate cost risk associated with the project. ...

- ... it is necessary to closely monitor, analyze and examine the development of LHC experiments.

X750 Note

- Surely will do.

- ... general understanding on the project by the public and science communities.

ILC Brochure

- Public relation will be reinforced by KEK and AAA.
- Discussions with scientists of the other fields have been undertaken.

ILC Brochure



ILC communicators with consultation by LCC Physics WG

Essentially completed → to be publicized soon!

And did the homework following MEXT's recommendation

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

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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.

arXiv:1607.03829v2 [hep-ph] 31 Jul 2016

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.

5th authors' meeting held on Dec. 13

Reviewed the status of the draft. Loose ends identified. The current draft is 47 pages long but we decided not to shorten it but to provide an executive summary consisting of 10 or so bullet points. Disclaimer concerning staging options will be added in the introduction. Michael will expand and generalize the DM treatment.

6th authors' meeting held on Jan. 25

Jenny, as the chief editor, made the draft into an at least formally complete form, eliminating loose ends. The draft has 2-page executive summary.

We have submitted the manuscript to arXive, which is now available as:

The Potential of the ILC for Discovering New Particles

Document Supporting the ICFA Response Letter to the ILC Advisory Panel

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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.

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 low energy, either 250 GeV, or 350 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.** → action plan being formulated now.

JHEPC has set up a sub-committee to investigate the staging.

- *Progress report in mid March at the JPS meeting.*
- *Final report expected in May*

Early Physics Goals With Staging

- ❖ 500 fb^{-1} at 250 GeV (first 6 years):
 - ❖ hZZ coupling to 0.75%; elements of coupling to 1%. First 1% measurement.
 - ❖ Ratios: hbb/hWW to 2.3% and $h\tau\tau/hWW$ to 2.6%.
 - ❖ First measurement of hcc coupling (to 5.2%).
 - ❖ First direct, model-independent meas. of hgg coupling (to 4.9%).
 - ❖ First sensitive search for $h \rightarrow$ invisible (95% CL = 0.57%).
 - ❖ First sensitive search for $h \rightarrow$ exotic visible (to 1%).
 - ❖ First tests of CP-violation in $h \rightarrow \tau\tau$ (to CP angle of $\sim 13\%$).

❖ CONTINUED

Preliminary report of LCC Physics Working Group (M. Peskin et al.)

Early Physics Goals With Staging

- ❖ 500 fb^{-1} at 250 GeV (first 6 years): - CONTINUED
 - ❖ First model-independent, absolutely normalized couplings, including total Higgs width (to 9%).
- ❖ Improvement in γWW (LEP / Tevatron / LHC) & ZWW (LEP / LHC) couplings by x5.
- ❖ Improvement of the LEP limits on Z' coupling to leptons, to masses of 2-4 TeV.
- ❖ Search for pair-production of weakly-coupled invisible particle to 120 GeV.
 - ❖ uses initial state radiation.
- ❖ Model-independent search for pair-production of additional Higgs bosons to 120 GeV.
 - ❖ Much higher luminosity and polarised beams adds significant reach wrt LEP2.

Preliminary report of LCC Physics Working Group (M. Peskin et al.)

Further Requests

What does a particular performance figure tell us about new physics?

- Plots to show specifically how the expected precision for 500 fb⁻¹ at 250 GeV can distinguish different BSM scenarios?

- Plots like

arXiv: 1506.05992

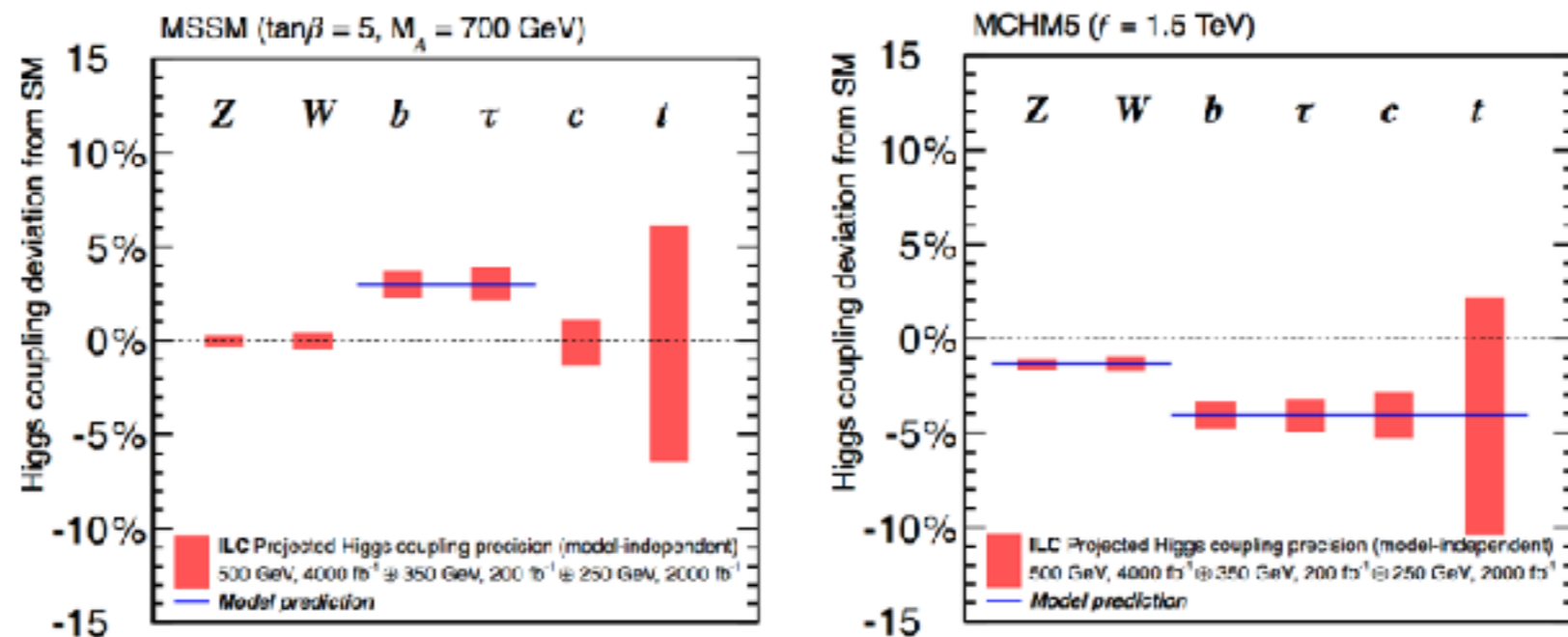


Figure 6: Two examples of models of new physics and their predicted effects on the pattern of Higgs boson couplings. Left: a supersymmetric model. Right: a model with Higgs boson compositeness. The error bars indicate the 1σ uncertainties expected from the model-independent fit to the full ILC data set.

- Model discrimination power: χ^2 vs Λ_{BSM} for a few BSM models.

Physics focus schedule

- Feb 22:** **Higgs/EW (Jenny)**
Mar 7: ***General ILD meeting***
Mar 8: BSM (Frank) : no coordinators' reports
Mar 22: Top/QCD (Akiya)
Apr 5: Higgs/EW (KF)

Conveners' ML:

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Use this mailing list to send your talk request.