Summary and Discussions of 50^{th} General Meeting of ILC Physics Subgroup

Feb 4, 2017, KEK

Jacqueline Yan (KEK)

On behalf of the ILC physics WG

Goal of ILC Physics WG

Provide a clear vision on the potential of ILC physics

Higgs/EW   Top   BSM

Most of these point to BSM search in one way or another

- **Direct search for new particles**
  complementary to the LHC

- **indirect search through precision measurements of SM physics (Higgs boson and top quark couplings, 2-fermion processes)**
  a powerful approach guaranteed at the ILC

Thank you for many contributions today

Higgs/EW:

- **T. Ogawa: Anomalous HVV coupling**
- **Y. Kato: BSM Search using Higgs to Invisible Decay** (absent, slides uploaded)

Top :

- **Y. Sato: top cross section and AFB**
- **K. Ozawa: top pair threshold study**

BSM:

- **J. Yan: Light Higgsinos from Natural SUSY at ILC √s=500GeV**

Theory

- **K. Hidaka: Correlation between the decays h^0(125GeV) -> photon photon and gluon gluon in the mSUGRA**

Reconstruction:

M. Kurata: JET CLUSTERING USING (REAL) NEURAL NETWORK

https://agenda.linearcollider.org/event/7509/contributions/38384/attachments/31195/46853/Jetclustering_NN_20170203.pdf

Brief Outline of today's talks

Pls see minutes for details

K. Fujii: Opening and Group activities and workshop schedules
- Support document to the ICFA Letter (next pg) and a JHEPC document
- Meeting of the ILC Advisory Panel (MEXT): discussed staging and New WG

T. Ogawa: Anomalous HVV coupling

-Established several constraints on anomalous couplings on ZZH and WWH vertices based on effective field theory, using angular asymmetries

-Working on b and bt terms and writing paper

J.Yan: Characterizing Light Higgsinos from Natural SUSY at ILC √s=500GeV

evaluated measurement precision of mass and xsec of light Higgsinos with small ΔM (from ～20 GeV down to ～ 5 GeV) at ILC √s = 500 GeV, full ILD simulation

results become input to SUSY parameter determination

H20 : Mass : < ～ 0.5% (ILC1, ILC2) , <～1.5% (nGMM1), xse: <1.5% (ILC1, ILC2)

Next: move towards publication, and analysis at other energies

Brief Outline of today's talks

Pls see minutes for details

Y. Sato: Top electroweak couplings study using di-muonic state at √*s* = 500 GeV
Started realistic study using DBD samples
•kinematical reconstruction accuracy is comparable to that for without ISR/BS
•form factors can be fitted at % precision for case A (detector effects)
•Will apply matrix element method to case B (ISR, beamsstrahlung, gluon emission, etc)

Y. Kato: BSM Search using Higgs to Invisible Decay (slides uploaded)

K. Ozawa: top pair threshold study
•Improved pairing of jets, estimated stat error of peak position of top momentum distribution and top width (24 MeV for left pol and 34 MeV for right pol)
•Next step is correction of peak position , analysis at other √s, study of syst error

K. Hidaka: Correlation between the decays h^0(125GeV) -> photon photon and gluon gluon in the mSUGRA
•Found strong correlation between loop-induced decays DEV(h0-> photon photon) and DEV(h0 -> gluon gluon) in mSUGRA, from a full parameter scan
•deviation of width ratio from SM ~+20%, nearly independent of mSUGRA parameters
• If deviation patterns observed at ILC, strongly suggest discovery of SUSY (mSUGRA)

a support document to the ICFA letter to demonstrate the potential for new physics discovery at the ILC

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]

Cover page of newest version

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,

List of Possible New Studies

Most topics are at √250 GeV

-**single W, Z process (following Tsuchimoto-san of Shinshu Univ)**

-**multi-gauge boson process**

-**2-fermion process**

- Hadronic recoil (model independence)

-**Light Higgsino at √s = 250 GeV**

-**top Yukawa（following Sudo-san's studies）**

-**Exotic Higgs decay, light Higgs, etc....**

And others.....

We anticipate your participation to make the ILC physics case as strong as possible!

Additional Material

Z’ : Heavy Neutral Gauge Bosons

New gauge forces imply existence of heavy gauge bosons (Z’)

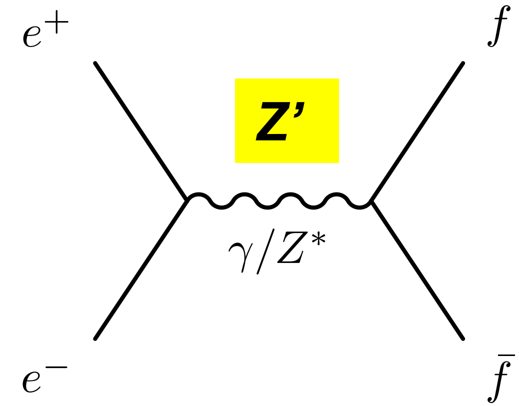
LHC/ILC synergy:

•**LHC discovery** → determine mass of Z’

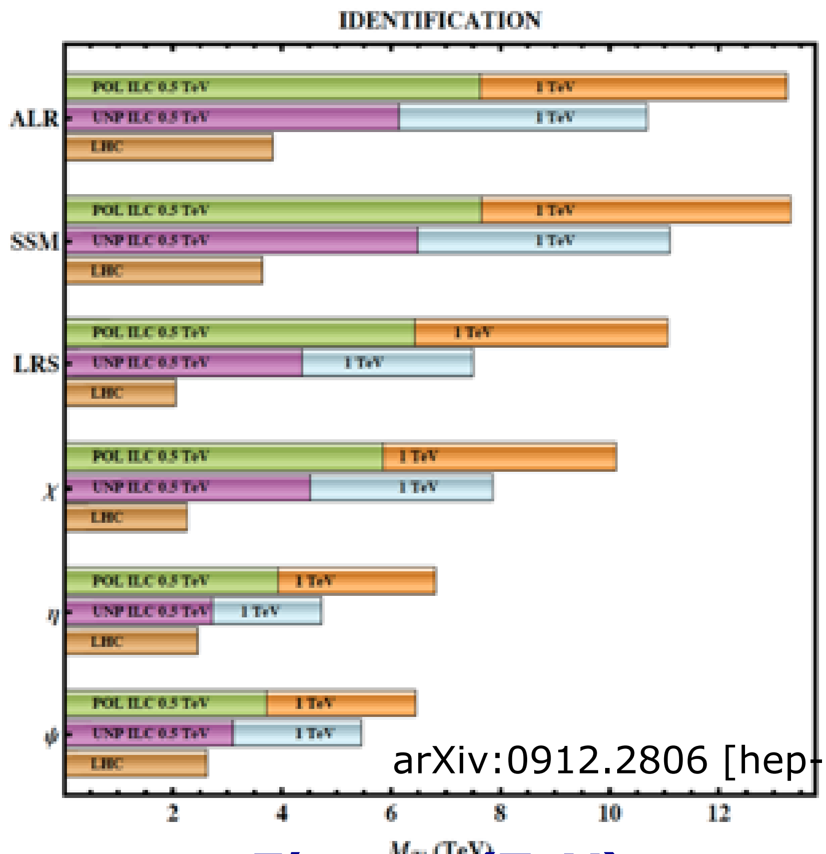
•**ILC measurements** → indirect access to couplings

Allows model discrimination

ILC: Beam polarizations improve reach and discrimination power

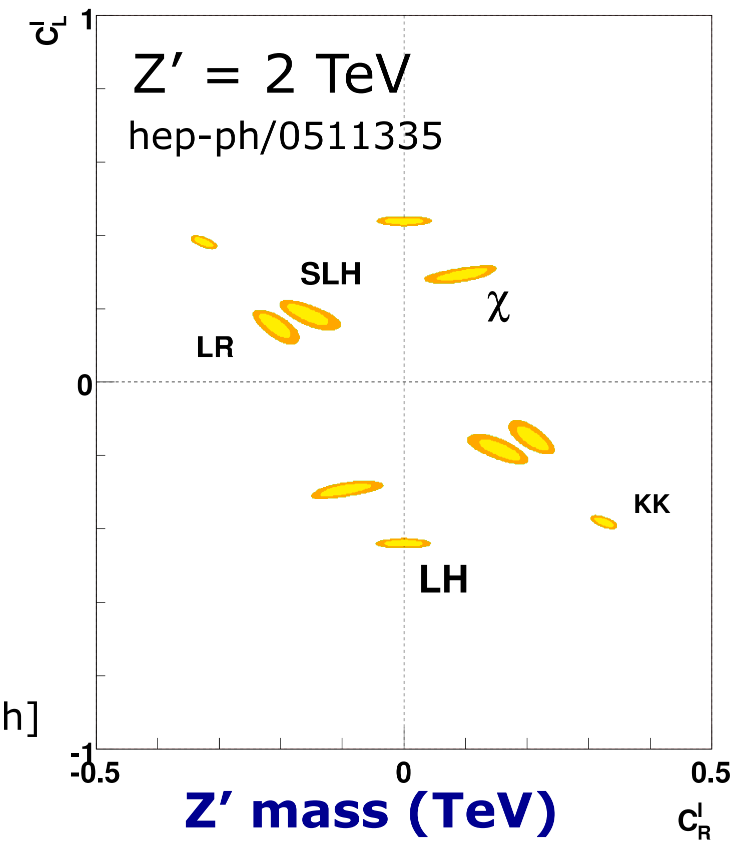


Models with Z’ boson



arXiv:0912.2806 [hep-ph]

Z’ mass (TeV)



Z’ mass (TeV)

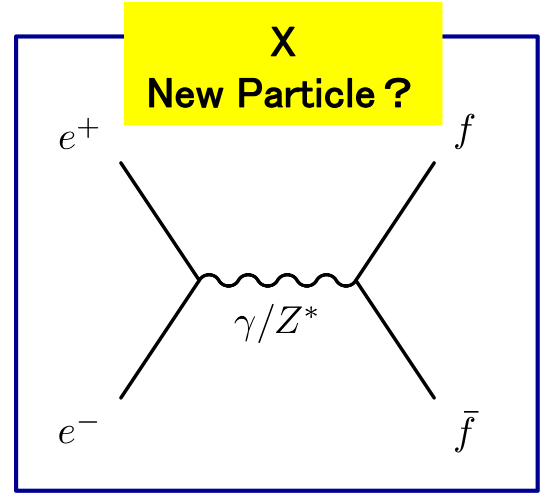
Search for new interaction forces : 2–fermion processes and top precision measurements

Measure the effect of new forces on SM physics

e.g. heavy gauge boson Z'

LHC: direct search

ILC: determine new physics model using precise coupling measurements

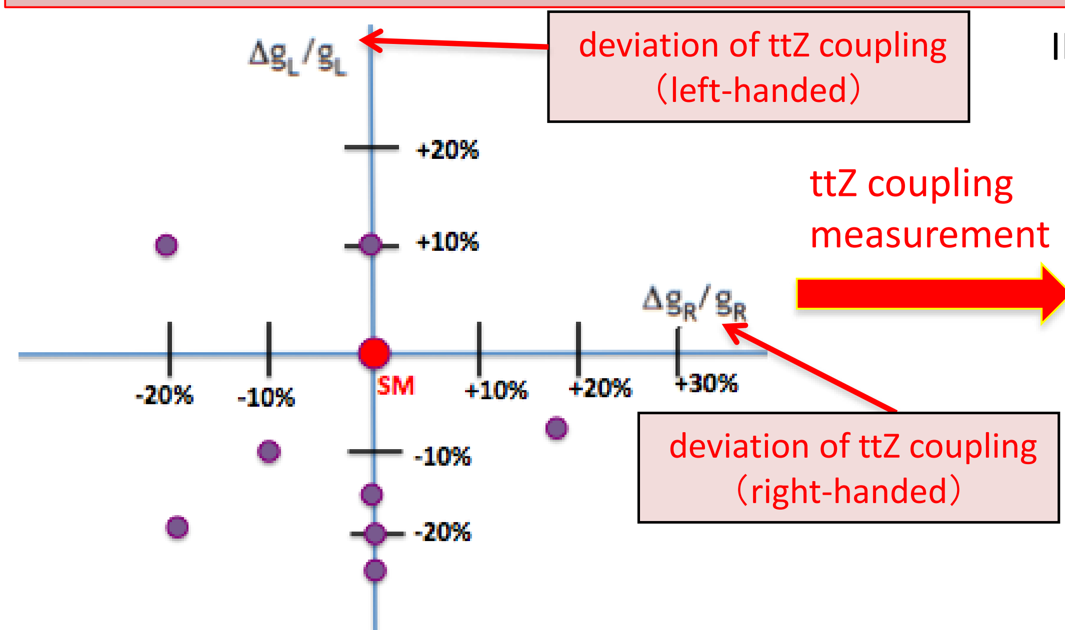


f = top quark, leptons, etc..
X = Z', KK graviton, etc…

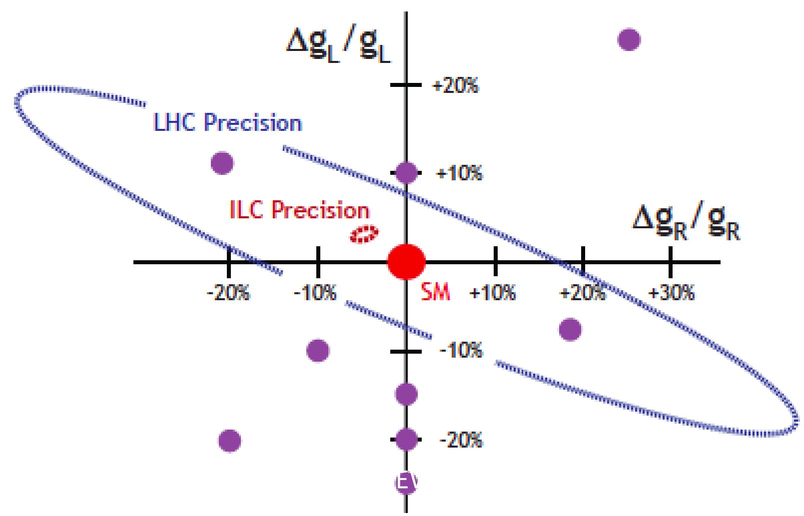
example) **deviation of top quark coupling from SM signifies new physics**

Top coupling anomalies for various new physics models (energy～1 TeV)

Beam polarization is a MUST



ILC can exclude more models than LHC (68% CL)



If new physics signals seen / not seen at 13 TeV LHC

	Precision Higgs	Precision Top	Other Indirect Methods	Direct Searches
SUSY				
Compositeness				
DM				
…				

Active participation from Asian team in many of these cells

However much remains to be done (analysis, software, theoretic studies)

Please join ongoing analysis !

We need to start working here

New Ideas are welcome !

There are a variety of studies newcomers can choose from

BSM Search Strategy at ILC

Focus on three cases based on the results of the (HL)-LHC:

Case 1: No discovery at LHC

- SUSY: Discovery anticipated for light SUSY particles (e.g. Higgsino)
- Dark Matter: Discovery anticipated for DM that can be seen at the ILC
- Precision measurements might give first discovery of new BSM interactions

Case 2: LHC discovers light new particles (can be seen at the ILC)

- SUSY: ILC will probe the new particles in detail; may discover more.
- Dark Matter: ILC will address the question of whether any of the new discovered particles is DM
- Precision measurements sensitive to heavy particles beyond LHC reach.

Case 3: LHC discovers heavy new particles

- SUSY: It is probable that ILC will discover new light particles.
- Dark Matter: Same as in Case 2, via measurements of the new light particles.
- Precision measurements test if there are additional heavy particles beyond the LHC reach.

From slides of T. Tanabe