Physics Panel of the ILC LOI Common Task Groups

M. E. Peskin
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Last fall, Sakue Yamada constituted a Physics Panel in the LOI Common Task Groups to discuss this issue and other issues connected to ILC physics (e.g. detector benchmarking)

The current members of this Panel are:

Tim Barklow (SLAC)
Stewart Boogert (Rutherford)
Seong Youl Choi (Chonbuk)
Klaus Desch (Bonn)
Keisuke Fujii (KEK)
Yuanning Gao (Tsinghua)
Heather Logan (Carleton)
Klaus Moenig (DESY)
Andrei Nomerotski (Oxford)
Michael Peskin (SLAC)
Aurore Savoy-Navarro (Paris)
Georg Weiglein (Durham)
Jae Yu (Texas-Arlington)

ILD SiD convener

In the past year, we have discussed the following issues:

1. Relation between the LHC physics and the case for ILC
2. Possibility of a staged realization of the ILC
3. Assembly of the ILC capability for precision Higgs physics
4. Suggestion of key benchmark processes for ILC studies in 2010

1. Relation between the LHC physics and the case for ILC

The case for the ILC must take into account what is discovered at the LHC.

It is probably true that we cannot get approval to build the ILC unless there is a major physics discovery at the LHC. At least, we have not succeeded in getting the ILC approved in advance of the LHC results.

One often hears that "the LHC is needed to set the energy of the ILC", even though this is true, at most, in a very limited sense.

So, understanding and even anticipating what will happen at the LHC is important in making the case for the ILC.

Today, we can discuss this in the abstract, but soon, hopefully, the LHC will discover specific phenomena of physics beyond the Standard Model.

We will need to argue that the next step to understand those phenomena requires the ILC. Can we do it ?

To analyze this question, we need to ask:

What will the LHC be able to discover ?
(in particular, what discoveries can be made with the lower energy and luminosity available in 2010 ?)

What does the ILC have to say about those questions ?

The LHC does have the capability to discover SUSY and other "mainstream" models of new physics in 2010.

However, we must also give attention to models with

stable sleptons, composite top, Z' resonances

which can be discovered very early in the LHC program.

It is unlikely that the Standard Model Higgs boson can be discovered at the LHC before 2013. We ought to appreciate this in our planning.

2. Possibility of a staged realization of the ILC

In the fall of 2008, H. Sugawara put forward a proposal for a staged realization of ILC, with a photon-photon collider at the Higgs resonance as the first stage. Our panel was asked to evaluate the physics case for that proposal.

The time scale for response was very short. To address this, some members of our panel and other experts (Tim Barklow, Jeff Gronberg, Michael Peskin, Andrei Seryi) put together a document to argue the case for a photon-photon collider stage. This document was evaluated by the Panel and also by the ILCSC.

Most respondents felt that the physics case was not strong enough, given that the cost would be 50% of the ILC RDR cost.

The physics argument relied heavily on the assumption that the LHC will not be able to observe $h^0 \to b\bar{b}$. But probably, it can be done. Our study has triggered some new work on this problem.

An alternative for staging that seems more interesting is the possibility of e+e- collisions at the peak of the Zh cross section

$$ECM \approx m_Z + m_h + 20 \text{ GeV}$$

For m(h) = 120, this has a cost of 65% of the ILC RDR cost. Experiments at this energy can to most (not all) of the complete ILC precision Higgs program.

We are working on a comprehensive report on the physics that can be done at various ILC stages, including giga-Z, gamma-gamma, and Higgs threshold machines.

3. Assembly of the ILC capability for precision Higgs physics

Even if it will not be the discovery of the Higgs boson that is the immediate motivation for the ILC,

Nature probably contains a Higgs boson, of mass between 113 and 160 GeV, that is responsible for W and Z mass generation.

It will be very important to measure the couplings of this particle to all species to the percent level.

An e+e- collider is the unique facility capable of performing those measurements.

Thus, the capabilities of the ILC for precision Higgs physics are a key part of the physics case that ought to be worked out in detail.

Only pieces of this were done for the LOIs. There are key omissions, including the detailed study of the measurement of the Higgs self-coupling.

We plan to put together a report on the capability of the ILC to measure all Higgs boson couplings.

4. Suggestion of key benchmark processes for ILC studies in 2010

Sakue Yamada has asked our panel for specific suggestions of reactions to be studied with high priority in 2010.

The goals of this study include:

Benchmarking of the detector capabilities for operation at 1 TeV in the center of mass.

Understanding the physics capabilities of the ILC needed to prepare the physics case.

We are finalizing a document; it should be finished in the next week. It will include processes relevant to the three sets of goals discussed in the previous sections.