Research Director's Report

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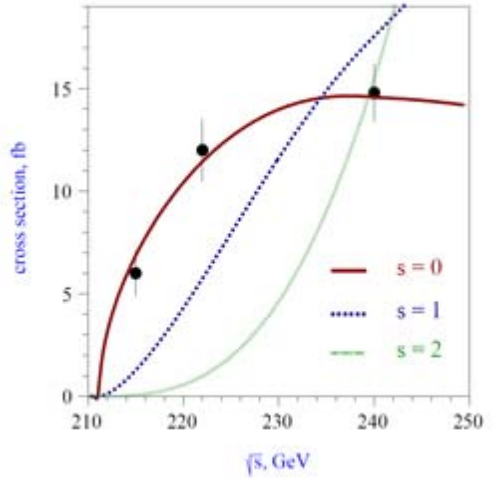
Optimal ILC physics performance at acceptable cost and risk

This month's Research Director's Report was written by Jim Brau, co-chair of the Worldwide Study and regional detector contact for the Americas.

Several years ago, the international community reached a widely held understanding that a linear collider will be needed to study the underlying physics of the new phenomena expected to be discovered at the Large Hadron Collider (LHC). More than 2700 scientists signed the 2003 statement "Understanding Matter, Energy, Space and Time: the Case for the Linear Collider." This statement expressed the world-wide consensus for a linear collider with the necessary features that would enable the excellent physics programme envisioned. It emphasised the understanding of the Higgs boson, and new discoveries beyond the Standard Model, with emphasis on the benefit of precision measurements and the interplay of LHC and the linear collider. Also expressed were the many cross connections between linear collider experiments, neutrino and quark studies, cosmological and astrophysical measurements, and high-energy nuclear physics.

The design of the ILC, defined by the *Reference Design Report* (RDR), was guided by the requirements of this physics programme, as detailed in the "Parameters for the Linear Collider" document which included several key features: initial energy of operation tunable, in the range of 200-500 GeV, upgradeable to 1 TeV, with sufficient luminosity to integrate 500 fb-1 in four years of operation.



A widely used example of the unique physics capability of the linear collider is the determination of the Higgs boson spin through the measurement of the Higgstrahlung threshold cross section. This plot from the simulation study of Dova, Garcia-Abia and Lohmann illustrates this.

Last year, in preparing for the next major design phase, moving from the RDR to the Technical Design at the end of 2012, the Global Design Effort (GDE) initiated a process to evolve the ILC design to improve the optimisation of cost to performance to risk, with major changes that will improve these tradeoffs, with special emphasis on cost savings. An early set of these changes, in the form of a strawman baseline, SB2009, was presented in a plenary session at the Albuquerque ALCPG meeting in September.

In the months following the Albuquerque meeting, the specific parameters of SB2009 were presented. Research Director Sakue Yamada established a physics and detectors SB2009 Working Group to study the impact of the design changes on the physics performance, which is chaired by me. Physics studies were carried out, and presented in a joint plenary session at the Beijing LCWS in March this year. The study group established quantitatively that the low-energy performance of SB2009 was a serious concern for optimal performance at lower energies, such as at and just above the threshold for Z-Higgs (210-350 GeV), an assumed key operating point for the measurement of Higgs properties. In response to these comments from the physics community, the GDE began investigations of concepts which could improve the low-energy luminosity, by increasing the operating rate of the design above the nominal 5 Hertz, and improving the final focusing system.

These studies have been on-going since the Beijing meeting. The physics community anticipates receiving an updated set of parameters from the GDE for the revised new baseline design, incorporating these improvements. The SB2009 Working Group is prepared to reassess the impact based on the new parameters, evaluating the capability to measure Higgs parameters, to measure SUSY parameters, and to execute a study of a variety of states requiring operation at several thresholds, should this be called for by the physics.

Plans are underway for four two-day Baseline Assessment Workshops (BAW). The first BAW will be hosted by KEK, 7 to 10 September 2010. The September workshop (BAW-1) will focus for two days on the 'single-tunnel high-level radiofrequency (RF) systems' and then for a second two days on the 'accelerating gradient'. The second BAW will be hosted by SLAC, 18 to 21 January 2011. The January workshop will focus on 'reduced RF power' and 'positron source location', the baseline changes with direct impact on the ILC physics performance. The physics and detector community is fully participating in the planning for these workshops.

The process, as outlined by Barry Barish (Director's Corner - May 27, 2010), is to first systematically evaluate each major change, with broad inputs to identify issues and study them. The SB2009 Working Group is doing just this regarding the physics performance implications of design changes. This information will then be brought together at the BAWs to assess whether to recommend each change, and to make recommendations to a formal change evaluation process that will be chaired by Barry Barish.

It is very important that the physics community engage in this process over the next several months, and participate effectively in the BAWs at KEK and SLAC.

-- Jim Brau