Nov. 17, 2015

Physics and Detector Review Report

The review committee consisting of Paul Grannis, Junji Haba and Sandro Palestini heard brief reports from the ILD, SiD and CLICdp detector consortia and held a discussion with members of the R&D groups associated with Linear Collider subdetectors. Owing to the short time allocated, an in-depth evaluation of technical progress was not possible. Both ILD and SiD reported limitations on their progress due to funding restrictions during the ongoing evaluation of the ILC project within Japan. These are particularly acute in the United States. The reviews offered an opportunity to take a snapshot of the current status and to look toward future activities when a decision to proceed with linear collider construction is made. Both collaborations agreed that the current 'light reviews' are appropriate and look forward to more in-depth reviews once the ILC has formal backing.

ILD status

The ILD consortium consists of 68 institutes, about 2/3 from Europe, 1/4 from Asia and the remainder from the Americas. Recently ILD has formalized its organization with an institute assembly, an elected spokesperson and deputy spokesperson, and coordinators for physics and software. The rest of the executive team is being elected at this time. The current high level strategic goals are the formulation of the scientific case (with SiD and theorists), site specific designs and detector optimization. The consortium continues to feel that the design presented in the DBD is realizable and meets the physics specifications. Optimization studies have focused on potential reductions of costs and simplifications of the design without harming the performance. Possibilities include reduction in the outer tracking radius and optimization of calorimeter segmentation. Considerable attention was paid to extending software tools, as experience has shown that insufficiently detailed simulations can lead to misleading optimizations. For example, new studies have allowed improved track finding efficiency at low pT. The committee applauds the recent focus on optimization of costs and complexity based on the simulated physics performance.

ILD detector R&D has mainly been provided by the independent R&D groups. Generally, ILD has been able to provide proofs of concept for subdetectors and has done some initial system tests, but engineering design has not been undertaken. Traditionally ILD has carried several optional subdetector technology choices, feeling that until a decision to proceed with the project is made, decisions are premature. They do have a defined set of performance benchmarks and an agreed list of options and open issues. The committee suggests however that analyses of the timetables required for making such decisions should be undertaken now, within the global context of ILD. Different subdetector choices will require system tests of different complexity and duration, and the construction schedule implied by the assembly sequence will dictate different schedules for decisions. These evaluations should also include studies of the time required for system integration and detailed engineering.

SiD

The SiD design is aimed at a compact, cost-constrained detector capable of meeting the physics challenges of the ILC. The consortium now comprises 12 institutions from the US, 9 from Europe and 1 from Asia. Its organization has been bolstered by bylaws, an institutional board and a formal change control process for design modifications. Efforts are being made to attract more Asian collaborators, including a recent SiD workshop in Japan. The committee agrees that expansion of the consortium to include strong participation from all regions is very important.

There is some impact on SiD by the R&D groups, but important parts of the SiD R&D tasks are carried out internally. The dominance of the US in SiD and the very low funding there has meant that substantial progress in R&D, integration and even physics simulations has been limited. The problem has been called out by the LCC PAC, and this committee strongly agrees that increased funding is sorely needed.

SiD has been able to conduct the studies needed to inform the planning of the Kitakami site, including accepted changes in the distance to the closest machine quadrupoles and the magnet yoke design (and consequent fringe field). Studies are ongoing to optimize detector sizes, cell segmentations and forward calorimetry. A change of baseline technology for the HCal from resistive plate chambers to SiPM and scintillator has been approved, based on improved SiPM performance and upon safety concerns with the RPCs. The change control process seems to be working well. Potential changes to use Monolithic Active Silicon Pixel detector for both silicon tracking and ECal sensors are being considered. The consortium is moving toward a suite of common software tools with ILD and CLICdp. The committee agrees that the SiD goals for the pre-TDR phase – to solidify detector parameters, make subdetector prototypes, and start on conceptual engineering work—are appropriate.

CLICdp

A review of CLICdp is more appropriate within the context of CERN and the next European Strategy exercise, so at this meeting we discussed the synergies between CLICdp and the ILC. These synergies take many forms. At the outset, using the two well-developed ILC detector models as the basis for CLIC designs helped enable them to converge quickly. (Recently CLICdp has chosen to focus upon only one detector design with silicon tracking in preference to a TPC, owing to the large occupancy expected at a multi-TeV CLIC.) Many of the members of CLICdp are also on ILD or SiD and typically study issues that are relevant for both machines. The R&D groups serve the needs of both CLIC and ILC consortia, and many of these are the same or similar for both. Many examples of the synergies were discussed. Common software tools for event data models, detector geometry, event reconstruction and high level objects have been developed, often with CLICdp leadership. Grid computing systems now serve both CLIC and ILC. Physics studies such as top quark coupling and top mass measurements have been done using the same analyses for both machines. Engineering studies initiated at CLIC on vertex mechanical

structures, cooling and interfaces also benefit ILC detectors. The synergy between CLIC and ILC is being extended now to include technologies developed for the luminosity upgrades for the LHC.

R&D groups

Representatives of CALICE, LCTPC, FCAL, SiTrack and several Vertex Detector groups joined the committee (and ILD, SiD and CLICdp leaders) for a discussion of some topics common to all the R&D groups.

Over the past months, the LCCpd R&D liaisons have worked to prepare a document describing the scope, goals, achievements and plans for detector R&D that would influence linear collider detector designs, and offer information to groups interested in these activities. The questions of where this report will be 'published', and by whom, were discussed. Owing to the different stages of R&D within the various efforts and the need to dynamically evolve the document, the consensus was to post it only on the LC web pages with the R&D liaison and deputy liaison as authors. Each of the 27 R&D efforts included in the report would have a single identified contact person.

Many feel that periodic external review of the R&D group activities is desirable. In the past, such reviews were conducted by the DESY PRC, and subsequently by ECFA. These have commented on the relevance of the R&D, evaluated the quality of the results and suggested appropriate program additions. No indication was reported that such reviews also help influence funding agencies to provide support. The question raised for discussion was how best to conduct such reviews in future. Although it seems somewhat asymmetric that reviews have been commissioned by bodies from just one region, the committees themselves have been drawn from a worldwide pool of experts. When the ILC project becomes real and an international laboratory is formed, that laboratory will take over the review process. The consensus of this discussion was that the reviews needed over the next few years, while the ILC is in the pre-project phase led by the temporary LCC, would best remain under ECFA leadership.

The final item discussed was whether the R&D groups are serving the needs of the detector consortia well. There was general consensus in the affirmative. There were comments that the R&D groups need to seek new innovations, as was done at the outset of the linear collider program (e.g. particle flow calorimetry and minimally thin vertexing and tracking detectors with full timing and analog capabilities). The flexibility to upgrade detector performance with state-of-the-art capabilities should be retained up to the time of freezing for construction. It was also noted that the R&D groups need to not only to do frontier R&D, but also to work on translation of results into real projects.