Research Director's Report

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ILC and Super KEKB

This month's Research Director's Report was written by Hitoshi Yamamoto, co-chair of the World Wide Study and regional detector contact for Asia.

In 2008, KEK formulated the so-called KEK roadmap that defined priorities for the Japanese high-energy physics programme for the following five years. This was a result of intense discussions within the Japanese high-energy physics community and was also reviewed and endorsed by an international review panel. It placed the ILC at the top of a pyramid, with a second tier containing J-PARC, the LHC, and Super KEKB, an upgrade of KEKB to achieve 40 times higher luminosity with a three-year shutdown. Around that time, there was already significant Japanese participation in the LHC at CERN, and J-PARC was moving from its construction phase to the operation phase. Super KEKB, however, had an uncertain future, and the highest priority of KEK was to secure funding for Super KEKB. Then in June 2010, MEXT (the Japanese ministry of education, culture, sports, science and technology) appropriated 100 oku-yen (~120 million dollars) to the KEKB upgrade from a special fund called the 'very advanced research support programme'. Even though additional funds are needed to complete the Super KEKB upgrade, this signaled an essential go-ahead for the project, clearing the way for the ILC.

KEK roadmap. *Image: KEK.*

The Belle experiment at KEKB has accumulated more than 1 inverse attobarn of data, which means KEKB has produced two billion particles containing the beauty quark, and, together with the BaBar experiment at PEP-II (SLAC), contributed critically to the Nobel Prizes awarded to Professors Kobayashi and Maskawa. Super KEKB is scheduled to be commissioned in 2014 and aims to accumulate 50 inverse attobarn by 2020. The design peak luminosity, $8.10^{35}cm^{-2}s^{-1}$, relies on the so-called nano-beam scheme, which was invented by the people at the National Laboratory of Frascati for the Italian Super B factory. This scheme is based on the linear collider technology to produce a super-low emittance. Super KEKB's main goal is to search for signatures of physics beyond the standard model through high-sensitivity measurements in the flavour domain. The timing is such that if and when the ILC is to be built, many physicists will move from Super KEKB to the ILC. This is evidenced by the fact that about 20 Belle detector members who are not currently very active in the ILC signed one of the two validated detector letters of intent for the ILC. Actually, quite a few are already working on both (Super) KEKB and the ILC. A part of the reason for this is that, in many cases in Japan, a student cannot obtain PhD degree unless he or she produces a physics result using real data. That is, working on simulation analyses or detector R&D for the ILC is not sufficient for a PhD degree. In fact, all four of my doctorate students are now analysing KEKB data after working on ILC-related topics for their master's degrees.

There is also a considerable amount of synergy and collaboration between (Super) KEKB and the ILC in the area of detector R&D. One prominent example is the DEPFET collaboration (12 institutions from the Czech Republic, Germany, Poland, and Spain), whose R&D was originally driven by the ILC but found its home as the pixel vertex detector of Belle II, the Super KEKB version of the Belle detector. The requirements in pixel size, readout speed, and material budgets are more demanding for the ILC than for Super KEKB, and developing, producing, and operating an actual DEPFET pixel detector for Belle II can be viewed as an ideal intermediate step toward an application for the ILC. The DEPFET pixel detector will constitute the innermost two layers of the tracking volume of Belle II. It is surrounded by four layers of double-sided silicon strip detectors (DSSD). There is a close and natural collaboration between the groups working on the Belle II DSSD and the SiLC (Silicon tracker for Linear Collider) collaboration, whose emphasis is the ILC. Another example is the Silicon Photo-multiplier (SiPM) or the Multi-Pixel Photon Counter (MPPC) or other names depending on who makes it. This is a type of Geiger-mode avalanche photon detector that is currently creating a revolution in the field of photon detection because of its small size, low applied voltage, ability to work in a high magnetic field, and low cost. It is used as readout sensors of the strip scintillators for the muon system in the case of Belle II, and as readout sensors for calorimeters in the case of the ILC.

These are only a few examples of synergy and collaboration between Super KEKB and the ILC. The performance requirements for an ILC detector in general are wide-ranging and very high, and detector R&D for the ILC are considerably raising the standard of detectors in the area of high-energy physics as a whole. This point has been stressed by the International Detector Advisory Group on more than one occasion. As a result, synergy and collaborations between ILC detector R&D and that of other projects occurs quite naturally. Super KEKB is just one such example.

-- Hitoshi Yamamoto