AAP review of SB2009

The AAP has some comments and concerns about the review that is coming up in January in Oxford. The main agenda item at that meeting is to get our advice on the new ILC baseline that has been developed over the last year and which is near being accepted for continued design and engineering work between now and 2012. This baseline is known as Straw-man Baseline 2009 (SB2009). These baseline changes are major and important. Our concern is that it is important to the GDE for us to give a thumbs up to the changes without too many qualifications and that we will not have enough information to feel comfortable doing this. Our request is that they should list the pros and cons for us in as quantitative a way as possible to help us see the overall improvement. We now give a little more background and some more details.

This new baseline is primarily motivated by the desire to decrease the costs (most likely to make up for other cost increases) and many of the changes have some negative impacts. There is a detailed document describing the baseline changes: http://ilc-edmsdirect.desy.de/ilc-edmsdirect/file.jsp?edmsid=D0000000*865085 . A summary of the changes (from the June 11, 2009 director's corner) follows:

1. A Main Linac length consistent with an optimal choice of average accelerating gradient (currently 31.5 MV/m, to be re-evaluated)
2. Single-tunnel solution for the Main Linacs and RTML, with two possible variants for the HLRF
   a. Klystron cluster scheme (KlyClus)
   b. Distributed RF Scheme (DRFS)
3. Undulator-based e+ source located at the end of the electron Main Linac (250 GeV)
4. Reduced parameter set (with respect to the RDR) with n_b = 1312 and a 2ms RF pulse. (Low power option)
5. ~3.2 km circumference damping rings at 5 GeV, 6 mm bunch length.
6. Single-stage bunch compressor with a compression factor of 20.
7. Integration of the e+ and e- sources into a common "central region beam tunnel", together with the BDS.

These changes from the original baseline were developed in a top down fashion. A lot of work has been done to estimate the cost savings and to develop the designs enough to show they are viable. At the Albuquerque meeting in early October a preliminary cost savings estimate of 11.5% was given. There has not been a change control process. The intention is to restart the change control process after SB2009 is in place. In the past the change control process was very thorough and the change control board (CCB) got input from many people and evaluated many pros and cons. As this has not been done, it makes the job of the AAP that much more important.

While we think some of these baseline changes are merited, we are not sure they all are. Hence we think we need to do a serious evaluation and hence we need enough information presented to us to do so.

The best way to evaluate changes is to have a list of pros and cons associated with each change. These should be as quantitative as possible, but typically at this stage there is a lot of comparing apples and oranges. This type of work was done to help us arrive at the original baseline after Snowmass. It was documented in a series of white papers which are located at http://www.linearcollider.org/cms/?pid=1000095.

There may also be advantages of either layout at the system level, such as simplicity, less critical components or operational aspects. These arguments should be included in the overall discussion.

Maintaining flexibility and headroom in choosing the machine parameters, both those that specify the operation point for the machine and those that are key to the performance of a subsystem, is important. How do the new baseline choices impact parameter choice flexibility and overall machine headroom?

Minimizing downtime by ensuring long MTTF and short MTTR, ease of access, modularity, physical independence of key opertaing areas, etc. should be quantitatively understood for the new baseline configuration and compared with the RDR configuration. Trading reduced construction cost for larger operation costs and less overall data-logging efficiency is an inadvisable optimization.

That concludes the main import of this note. Below, we have a few examples of some pros and cons associated with each of the changes. This list is definitely not complete but it should get people thinking and help make clear the types of pros and cons we have in mind.

1) A Main Linac length consistent with an optimal choice of average accelerating gradient (currently 31.5 MV/m, to be re-evaluated)
    a) At present it looks like the decision will be made to accept a wide gradient spread resulting in an average vertical test gradient of 35 MV/m rather than requiring all cavities to be above this gradient. This makes it easier to get a good yield on the cavities at the expense of needing extra RF power to handle the gradient spread. Construction and operating cost changes should be evaluated.
2) Single-tunnel solution for the Main Linacs and RTML, with two possible variants for the HLRF (DRFS and KlyClus).
    a) Electronics will be in the tunnel and must be put in shielded enclosures. Even with that, radiation could cause single event upsets. We might have to design electronics around this problem at added expense.
    b) The RF unit in the KlyClus is very large and cannot be fully tested before ILC construction. A test is planned that will reach full voltage, but not full stored energy. How big is the risk of a significant problem?

c) This saves xx km of tunnel and $xx money. For klyClus it puts most of the water cooling on the surface saving an extra $xx.

3) Undulator-based e+ source located at the end of the electron Main Linac (250 GeV)

   a) As of the Albuquerque meeting, requirements for e+ yield as a function of beam energy had not been defined and hence the e+ source design (length of undulator, distance from undulator to target) had not solidified. Hopefully this will be done soon. How does the design handle the fact that the electron energy in the undulator will vary with center of mass energy? What is the retuning time? How much is the luminosity degraded at beam energies below 150 GeV and on the Z0? What are the expected operation modes? What do the experimenters think of this and how much running do they plan to do at these lower energies?

   b) The beam will no longer need to be decelerated to get beam energies below 150 GeV. This avoids increased energy jitter and using SCRF to decelerate beam in an as yet untested fashion.

4) Reduced parameter set (with respect to the RDR) with n_b = 1312 and a 2ms RF pulse. (Low power option)

   a) Beamstrahlung will be higher causing a larger effective energy spread for the experiments and maybe larger backgrounds.

   b) Cuts the RF needed by a factor of 2 saving $xx. The infrastructure will be put in place to allow the RF to be added back in later to go back to the original beam power.

5) 3.2 km circumference damping rings at 5 GeV, 6 mm bunch length.

   a) If there is an e- cloud problem or other coupled bunch instability or transient effect due to the ring impedance or the kicker or feedback systems, it cannot be ameliorated by going to larger bunch spacing. (Zimmermann stated this concern at our last AAP review.)

   b) Decreases unscheduled downtime of the DR by xx% because it has fewer components.

6) Single-stage bunch compressor with a compression factor of 20.

   a) This will limit the operational space for coping with the effects due to single or multi-bunch instabilities in the damping ring which require increasing the momentum compaction or the bunch length. In addition, it makes operation at the IP with shorter bunches more difficult if the kink instability or other effects make operation with long bunches more difficult.

   b) Reduces tunnel length by xx km saving $xx.

7) Integration of the e+ and e- sources into a common "central region beam tunnel", together with the BDS.

   a) Saves xx km of tunnel saving $xx, but adds costs of wider tunnel (to accommodate multiple sometimes diverging beam lines) over xx km costing $xx for a net savings of $xx.

b) There are 3 beams in the same tunnel. This can make installation and maintenance more difficult, slower and more expensive. It will also decrease the availability as it will no longer be possible to have beam in the injector or DR while people are doing work in the BDS.