GDE Change Evaluation Panel

TLCC-4 – Decision Memo
17 March 11

Proposal: Relocate the positron source from mid-linac to the end of the linac

Components of the proposal:
1) A relocation of the positron source systems from the nominal 150 GeV point of the electron Main Linac, to the exit of the electron Main Linac ($\leq$ 250 GeV depending on physics scenario). The source is then integrated into the beginning of the Beam Delivery System.
2) The new baseline proposal includes a description of a possible low-energy operations scheme. The scheme (10 Hz alternate pulse running) is consistent with the RDR: "Physics runs are possible for every energy above $\sqrt{s}$ = 200 GeV." The positron yield is $\geq$1.5 over this energy range and enables operation with the RDR parameters or the 'Reduced Beam Parameter Set.'

Decision:

YES, with considerations below.

Discussion:

This proposal is very beneficial from a radiation safety and environmental impact point of view, by moving the positron target and capturing system to the end of the linac within the central area. This reduces the total impacted area to be mitigated. We encourage continuing engineering studies aimed at the TDR, costs and site specific designs including optimization of tunnel cross sections, alcoves and vaults.

In this proposal there is a section to discuss *Electron RTML (bunch compressor),* it is recommended that this section take into account the two bunch compressor scheme, and this recommendation is consistent with the discussion of the reduced parameter set.

However, in addition to the comments made in regard to the cost analysis in the "Adopt a Reduced Parameter Data Set" proposal (TLCC-3), the following is worth mentioning also:

The positron source relocation needs some adjustment to compare to the RDR. The KCS impact was not factored into the original positron source location and the biggest CFS cost impact is in the process cooling water and HVAC and electrical, which requires an in depth analysis in the TDR There are potential issues with BDS having a tight space temperature stability located in the same tunnel as the other two beamlines (high energy positron source & rtml)

There were also concerns not directly related to moving the positron sources to the end of the linac and were expressed by the panel. They are indicated below:

QWT
Quarter Wave Transformer is mentioned as “Other Issues (not TLCC)”. The choice between QWT and FC (Flux Concentrator) is only technical and can be easily changed later without greatly affecting other parts of the collider. Nonetheless one of them should be chosen as the present baseline. Otherwise the documentation would be complex and confusing, e.g., evaluation of the target survivability, beam energy spread for physics simulation, etc. In view of the present technology QWT should be chosen at this moment. When the R&D for FC turns out to be successful, we can change back to FC, perhaps without going through TLCC process.

10Hz operation
The last paragraph of the section “Sub 300GeV …” starting with “The operational region….” might be a little bit confusing. The design issues and operational issues should be clearly separated. For the design, it is sufficient to say “5Hz above E_{CM} = 250GeV and 10Hz below it (alternating 150GeV and E_{CM} /2)”. Once we build such a machine and get sufficient experience, we may be able to operate in an improved mode above E_{CM} = 250GeV. This also includes possible operation above 5Hz for 300GeV < E_{CM} < 500GeV. It is possible at beam energies below 250 GeV (cms Energy below 500 GeV) to apply the available power to increase the rep rate above 5 Hz to achieve improved luminosity.

Photon divergence angle
The relocation of undulator makes the photon divergence angle smaller at E_{CM}>300GeV. This is mentioned in the section “Physics Implication” in the context of collimation for polarization. However, the smaller angle also influences the target survivability. This should now be more seriously studied. (The choice of lower field with fixed undulator length for higher polarization at E_{CM} > 300GeV would make the photon spot size even smaller for given beam energy, though slightly.)

Auxiliary Positron Source
RDR adopts Keep-Alive source (KAS) with 10% intensity for commissioning and maintenance when high energy electron beam is not available. This is replaced with auxiliary source in the present proposal although it is not listed in the “Scope of the Proposal”. The choice of 10% KAS was made by the task force right after Snowmass Workshop in 2005 (see added point of information below). The auxiliary source would use ~500MeV electron (~10 times lower than usual conventional source) and share the thin target of undulator source (~10 times thinner than usual target). What level of intensity is required and what level can be achieved by the auxiliary source should be investigated.

Although additional concerns were expressed about the strength of the auxiliary source, it was recognized by the CEP panel that it is not clear what extra work would be needed to resolve this question.

Extra point of information on auxiliary source

For completeness, we recall below the "logic" that went into deciding that the keep alive source should provide 10% of full intensity:

1. We want it to be strong enough to do Machine Development, MD, in the e+ system when the e- system is not available and to allow the e+ DR, linac, BDS to be kept active and working during e- system downtimes. The first of these is the greater requirement. Note that it allows MD to be done in e+ and e- systems simultaneously on MD days and also allows opportunistic MD to be done in the e+ system when the e- system is down.

2. The single biggest thing that is needed to do MD that does not need to be repeated later is to have diagnostics (mainly BPMs) operate at their best resolution. Some DR MD requires full intensity fills but we thought there would not be a big penalty for that type of MD because we could accumulate in the DR to get full intensity. I now think that was wrong as the DR is not designed to allow accumulation. However, it is not a huge error as high intensity DR R&D is a small fraction of the total MD which must be done.

3. We asked Steve Smith who was involved in the ILC diagnostics group at the time how big a decrease in e+ intensity would still allow the BPMs to read at full resolution.

4. His answer was that the BPMs could still read at the requirements specified by the project at 1% of the design intensity.

5. As normally BPM resolution improves linearly with intensity unless something else (e.g. number of ADC bits) limits it, we interpreted this to mean either that the resolution at design intensity would be much better than specified or we would be purposely throwing away resolution with something like programmable attenuators. If the resolution at full intensity is much better than requirements, we expect that clever accelerator physicists will learn how to take advantage of that good resolution and end up really needing it.

6. We have had too many experiences where large changes in intensity cause systematics to change readings on diagnostics. This includes cases where factors of 2 caused problems.

7. So we felt 1% intensity was too likely to reduce the BPM resolution or introduce systematic offsets.

8. We chose 10% as a compromise.

The reason for giving all this detail is to explain that even if it is quantified what the intensity of the auxiliary source will be, I cannot think of reasonable work that can be done to quantify the intensity needed to keep BPM resolution from degrading enough to keep MD from being fully efficient with that reduced intensity.

Having an adequate keep alive source is a significant effect. According to antique availSim studies done on old ILC configurations, having a keep-alive source improves numbers as follows:

	% time integrating lum	%time sched MD	%time opportunistic MD
No keep alive source at all	68.6	10.9	1.6
Good enough KAS to do MD	78.5	4.8	2.6

So a KAS allows 10% greater integrated luminosity. Over half of this comes from being able to do scheduled MD in the e+ and e- systems simultaneously. The rest is fairly evenly split between the ability to do opportunistic MD in the e+ systems when e- are down and from the reduced recovery time from e- problems due to the e+ systems being kept hot.

Finally we note that the last paragraph in the Introduction section contains a few typos:

- *At a beam energy 250GeV ---> At a beam energy 125GeV*
- *At beam energies above equal to or above 300GeV*
  --> At center-of-mass energies equal to or above 300GeV