

Project name

Post-IP beam diagnostic monitors

Classification (accelerator/detector:subsystem)

Accelerator

Institution(s) and personnel

Tufts University, Department of Physics and Astronomy
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Project overview

The colliding electron and positron beams must be monitored after the interaction point to provide the feedback necessary to maintain the beams in collision. At the interaction point the electron and positron beams are scattered, and secondary gamma ray beams (beamstrahlung) created, by the collective action of the particles in one bunch on the particles in the other bunch. The beamstrahlung has roughly 5% of the power of the colliding beams and is primarily at angles of less than 0.5 mrad to the beam line.

In the ZDR for the Next Linear Collider, the NLC Design Group describes a beam extraction and diagnostic system in which bending magnets separate the primary beams from the beamstrahlung beams to offer two distinct possibilities for monitoring the effects at the IP. Because of the high power (10 MW for the primary beams, 0.5 MW for the beamstrahlung beams) the monitors must be able to operate with a minimal amount of material intercepting the beams. The use of laser beams as minimally invasive monitors is proposed in the ZDR. The scattered radiation of the laser beams is detected to provide information on the structure of the beams emerging from the IP.

We propose to calculate the beam-beam interactions for beams colliding with specified offsets to determine the corresponding effects on the positions and structure of the primary and beamstrahlung beams in the beam extraction region. Having determined these effects we propose to proceed to calculate the corresponding variations in the scattered radiation from the laser beams. With knowledge of the laser beam scattering we then would turn to the design of a detector having sufficient acceptance and sensitivity to enable the unfolding of the beam-offset information. The response of the monitors must be fast enough to enable steering corrections to be implemented in the time between successive bunch trains. It would be desirable, although perhaps not possible, to have response fast enough that corrective action can be taken within the individual bunch trains.

Description of first-year project activities

We propose to begin by importing to Tufts beam-beam interaction software packages (possibly including ABEL) which are in the public domain. These packages will be used to calculate the beamstrahlung and the disruption of the electron and positron beams at the interaction point. If some aspects of these packages are insufficient for our purposes we would work to extend their capabilities. We propose to import software packages (possibly including TURTLE) so we can proceed to calculate the trajectories of the disrupted beams in the beam extraction system. We propose then to calculate the scattering of the laser beams intercepting the primary and beamstrahlung beams at the interaction points in the beam extraction system. We will use the results of the calculations to guide our design of a detector for the scattered laser radiation. The detectors must have sufficient acceptance and sensitivity to be able to provide a handle on the primary beam misalignment which may be present at the IP.

This project would provide a good opportunity for a graduate student to learn the challenges and opportunities of a future linear collider. The student would acquire skills essential for an effective contribution to the development of the collider and could acquire the inspiration required to stay with the linear collider project over the long term.

Future work

We want to work in cooperation with an accelerator-based group such as the IP Beam Instrumentation Working Group at SLAC. We hope our simulation work leads to the design of a promising detector for the scattered laser radiation. We would like to construct such a detector and be involved with performance tests conducted with the detector viewing laser radiation scattered from an electron beam at an accelerator.

Budget

Institution	Item	Cost
Tufts	Academic year + summer salary for one graduate student	\$20,000
Tufts	Indirect costs	\$8,000
Tufts	Travel	\$2,000
	Grand total	\$30,000

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