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International linear collider simulations using BDSIM

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Abstract. Power loss simulations for the 2, 14, and 20 mrad extraction line designs using the BDSIM toolkit are presented. A preliminary study on the backgrounds from the beam losses along the extraction line in the case of 20 mrad with high luminosity parameters is also given.

Keywords. International linear collider; BDSIM; simulation; extraction line.

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1. Introduction

BDSIM is a Geant4 [1] extension toolkit for the simulation of particle transport in accelerator beamlines. It is a code that combines accelerator-style particle tracking with traditional Geant-style tracking based on Runga–Kutta techniques. A more detailed description of the code can be found in [2].

In an e^+e^- linear collider such as the ILC, the beams must be focused to extremely small spot sizes in order to achieve the desired luminosity. This leads to large angular divergence and energy spread for the disrupted beams after the interaction point (IP). Particle losses from the disrupted beam can generate high power loads on magnets and collimators requiring a careful design of the extraction line to ensure the safe transport of the disrupted beam from the IP to the dump. To assist in this design process detailed simulations of losses have been performed for a range of machine parameter configurations and IP crossing angles.

The beam losses will also generate secondary particles – some of which can be scattered back towards the interaction region. A preliminary study of these backscattered particles in the case of the 20 mrad extraction line and SiD concept dectector has been performed to evaluate the background rate in the detector.

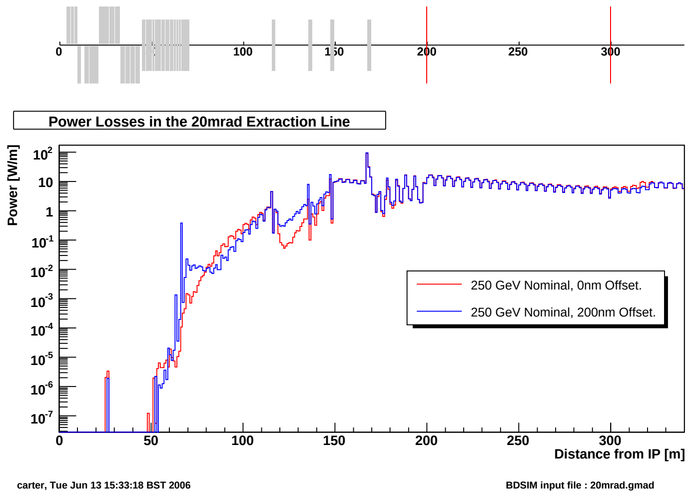

Figure 1. Normalised power losses along the 20 mrad extraction line from disrupted beam and SR. Total integrated power of 1.68 W (1.66 W) for 0 nm (200 nm) vertical offset.

2. Power losses in the extraction lines

The downstream collimation and power losses have been calculated using high statistics for 250–500 GeV 'nominal' and 'high luminosity' beams [3] with zero and non-zero vertical offsets. In these proceedings only the 250 GeV nominal beam losses will be covered (see figures 1 and 2) whilst a more detailed account of the entire results can be found in [4]. Comparisons against simulations without the tracking of synchrotron radiation (SR) show that in both the 2 and 20 mrad extraction lines the power curves are dominated by the SR losses.

3. Simulation of backscattering in the 20 mrad extraction line

The number of secondaries generated, together with the number of possible backscattered particles into the detector, is directly proportional to the number of the particle losses along the extraction line. The choice of the beam collision parameters studied was therefore made such that this loss was maximized in order to investigate the worst case scenario. The high luminosity with 80 nm initial vertical offset parameters at 1 TeV center-of-mass energy was chosen as this gives rise to significant losses in the first 100 m.

The simulation of the disrupted beam was made using the Guinea-Pig beam–beam simulation program [5]; the main beam corresponds to 35×10^3 macroparticles, where for these parameters 1 macroparticle equates to $2\times10^{10}/35\times10^3$ particles. It is important to note that the losses which occur during the transportation of the disrupted beams are almost exclusively from particles with a large energy offset. To allow for a reasonable level of statistics in this region we have increased the

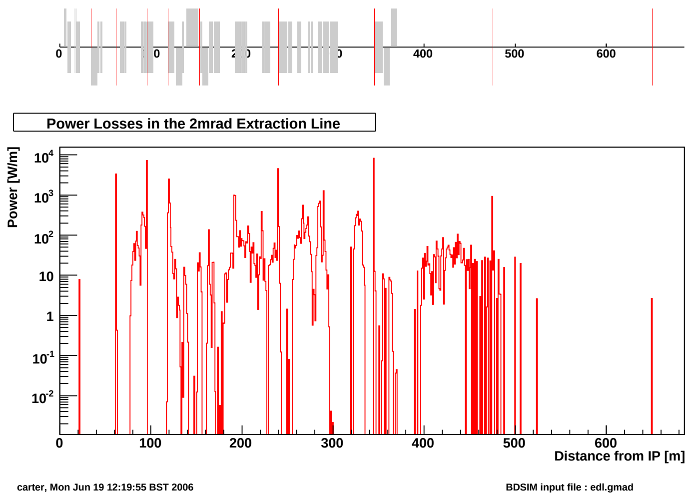

Figure 2. Normalised power losses along the 2 mrad extraction line for 250 GeV nominal disrupted beam with SR but no vertical offset. Total integrated power of 45.8 kW.

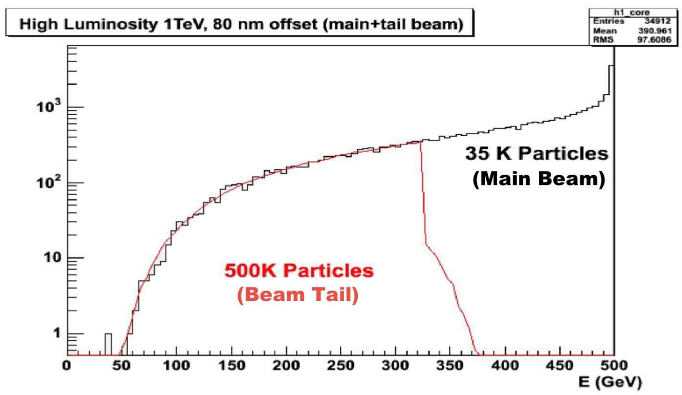

Figure 3. Energy spectrum for the high luminosity 1 TeV, 80 nm vertical offset, disrupted beam.

population below 325 GeV to 500 $\times$ 10^3 particles (figure 3). The power losses deposited along the extraction line from an incident disrupted beam with a total power of 18 MW is presented in figure 4.

4. Preliminary result for backscattered particles

The detector used in the simulation was based on the SiD concept and included the appropriate solenoidal field map. In this design a 50 cm thick tungsten mask is located 3 m downstream from the IP. Tracking all backscattered particles reveals that 116 particles (mostly photons) are propagated towards the IP. The simulation

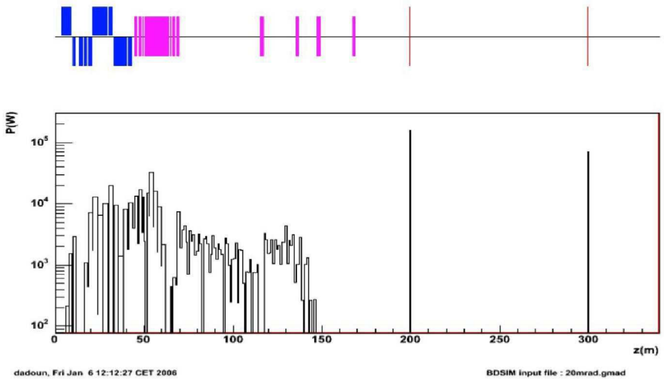

Figure 4. Power loss along the 20 mrad extraction line for the high luminosity 1 TeV, 80 nm vertical offset beam.

shows that the tungsten mask absorbs all the backscattered photons, leaving only electrons arriving at the IP. Extrapolating these seven remaining electrons (from 500×10^3 macroparticles) to the full beam (2×10^{10} particles) we obtain 70×10^3 electrons. The next logical step is to investigate the probability of these particles hitting the vertex detector. Although this will likely depend on the detector integegrated dipole (DID) or anti-DID field configuration [6], the extrapolated number of particles reaching the detector appears to be of an unacceptable level and further shielding and/or collimation techniques may need to be implemented.

5. Conclusions

BDSIM is a useful tool for studying beamline backgrounds and performing collimation simulations. In terms of power losses, the performance of the 20 mrad extraction line is found to be satisfactory whereas the radiation loads on the 2 mrad extraction line indicate that further optimisation is required. To have more realistic results for the backscattering study, the inclusion of a DID/anti-DID field map as well as an increase in the statistics of the disrupted beam are necessary.

References

[1] S Agostinelli *et al*, *Nucl. Instrum. Methods* **A506**, 250 (2003)
[2] The BDSIM toolkit EUROTeV-Report-2006-014-1
[3] T Raubenheimer, *Suggested ILC Beam Parameter Range*, Feb 2005, http://www-project.slac.stanford.edu/ilc/acceldev/beamparameters.html
[4] J Carter, Ph.D. Thesis (to be submitted) (Royal Holloway University of London, 2006)
[5] D Schulte, TESLA-97-08 (1996)
[6] B Parker and A Seryi, *Phys. Rev. ST Accel. Beams* **8**, 041001 (2005)