LC-M-2003-045

Improved TESLA Optics and Beam Induced Backgrounds Update

Karsten Büßer, DESY and Olivier Napoly, CEA/Saclay

LCWS 2002, Jeju, Korea

Abstract

A new tesla optics with l*=5m is under development. An update is given on the simulation of the beam induced backgrounds in the TESLA detector.

1 Designing TESLA With l*=5m

Increasing the distance l* between the final doublet and the interaction point (IP) to l*=5m would be beneficial for the TESLA IR design. From the accelerator point of view, the SC final quadrupoles would move out of the large field (4T) region of the detector solenoid, thus reducing the need for an optical correction of the solenoid effect on the beam, and also re- introducing the standard NbTi superconducting cable technology as a possible solution in parallel with the more ambitious Nb3Sn technology. From the detector point of view, the forward acceptance would increase at low angles, the TPC and calorimeter background created in the quadrupole cold mass would reduce, and it would offer the possibility of a lighter mask with a simpler support system. In counterpart, it would raise three problems mainly: The correction of the chromaticity proportional to l*, created by the last doublet, the extraction of the spent beam, and the extraction of the synchrotron radiation generated in the last doublet. We discuss these three points successively.

The final focus system By adopting the central idea of the NLC final focus system – a non-zero dispersion function dx/dE in the final doublet to correct its chromaticity locally by inserting a sextupole – the performance of the chromatic correction can be greatly improved. However, the NLC layout as such is not compatible with the TESLA head-on collision scheme and the position of the beam dump. A preliminary design of a final focus system with l*=5m is shown in Figure 1 which offers about 0.5% chromatic bandwidth. It must still be optimized to reduce its total length by about 50 m and to improve its chromatic acceptance.

The spent beam extraction The acceptances of the opposite final doublet aperture have been studied for the cases where l*=3,4,5m. The differences in the maximal angle for a particle leaving the IP as a function of the particle energy are small and the l*=5m case is actually more favorable to extract the low energy particles like the e^+e^- pairs and the $e^\pm$ bremsstrahlung. Tracking simulations must be done to confirm this analysis.

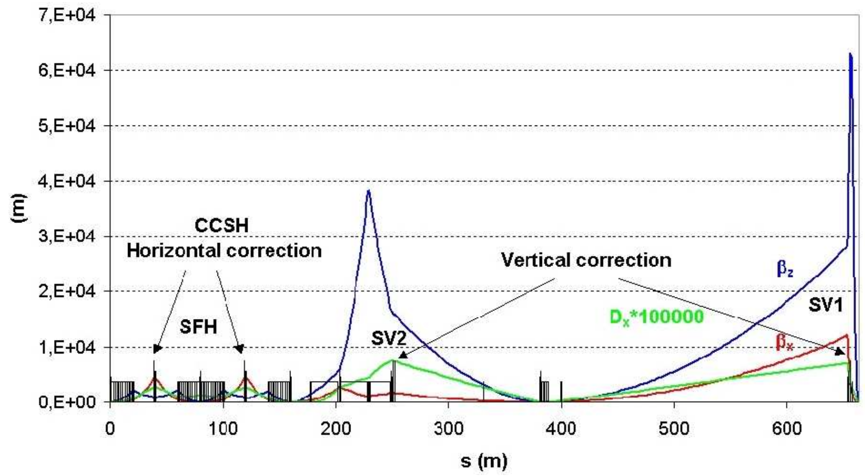

Figure 1: Optics of the TESLA final focus system with l*=5m.

The collimation requirements The collimation requirements are set by the location of the inner mask and by its 24mm diameter aperture. In the old design they were given by $13 \times \sigma_x$ and $81 \times \sigma_y$. In the case where l*=5m and the mask is also translated by 2m the collimation requirements transform to $7.8 \times \sigma_x$ and $42 \times \sigma_y$ respectively. These tight collimation requirements should be met by an improved collimation optics using tail folding by non-linear elements (octupoles).

2 High Statistics Pair Background Studies

The most important background in the TESLA detector will come from the beamstrahlung pairs. This background has been studied intensively as documented in the TESLA TDR [1]. Due to CPU time constraints, the studies presented so far were limited to the full simulation and tracking of a few bunch crossings. A high statistic sample of 100 bunch crossings has been simulated recently still for the old l*=3m optics design. Table 2 shows for $\sqrt{s}$=500 GeV and a 4T magnetic field the averaged numbers of hits on the tracking detectors and the RMS in comparison to the results for one bunch crossing (BX) which were published in the TDR.

References

[1] R.D. Heuer, D. Miller, F. Richard, P. Zerwas (eds.), TESLA Technical Design Report, Part IV, DESY 2001-011, ECFA 2001-209 (2001).

	V1	V2	V3	V4	V5	S1	S2
1 BX (TDR)	351	132	42	26	17	23	7
<100 BX>	372.4	170.8	72.4	37.2	21.8	8.5	7.5
RMS	59.8	40.1	27.1	21.1	15.3	8.8	9.0

	F1	F2	F3	F4	F5	F6	F7	FCH	TPC
1 BX (TDR)	17	17	12	8	8	7	6	63	1560
<100 BX>	22.1	17.5	12.1	9.5	6.7	4.9	3.1	53.8	901.5
RMS	5.0	4.9	3.6	3.1	2.6	2.5	1.9	4.8	505.2

Table 1: Charged pair hits per BX on the vertex detector (Vn) and SIT layers (Sn), forward tracking disks (Fn), the forward chambers (FCH) and the TPC. The numbers for the forward chambers are summed over 12 planes, the TPC numbers represent 3d hits.