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Extraction line optics in the improved 2mrad alternative ILC crossing angle layout

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Abstract

In this memo we present the optical parameters of the new extraction line for the 2mrad crossing angle layout of the International Linear Collider (ILC). The revised design, separately optimised for both the 500 GeV and 1 TeV machine, directly addresses the beam transport and magnet feasibility issues of the previous designs. Acceptable beam transport capabilities are achieved for all machine energies and beam parameter sets.

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1 INTRODUCTION

The new extraction line optical parameters for the improved alternative ILC 2mrad crossing angle layout [1] are presented here to provide a concrete basis for discussion with magnet designers and facilitate cross-checks within the ILC BDS team. This memo is a follow-up of [2], where the parameters of the final doublets in this improved design were given, implementing the optimisation procedure described in [3].
This minimal layout does not include the additional post-IP energy spectrometer and polarimeter planned in the base-line design [4], while other ideas to perform these measurements are being explored. The proposed optics explicitly aims to simplfy the magnet designs.

2 THE EXTRACTION LINE LAYOUT, OPTICS AND BEAM TRACKING

The beam optics and element parameters for the 500 GeV and 1 TeV extraction lines are presented. All beam transport and power loss calculations are performed using the new ILC beam parameters listed in [5]. The optical functions of the 500 GeV machine are shown in figure 1, and the dispersion function is shown in figure 2.
The final doublet optical system is extended into the extraction line with the first two extraction line quadrupoles, QEX1 and QEX2. The design of these magnets is complicated by the need to contain the beamstrahlung and the outgoing disrupted beam in a common aperture, and the proximity of the incoming beam. The engineering solution is a modified version of a ""Panofsky" quadrupole [6], which provides a large bore for the outgoing beam and a low-field pocket for the incoming beam (with a field of a about 10 Gauss). The distance between the incoming beam and the centroid of the beam is taken to be 150mm. QEX1 and QEX2 are protected by a screening collimator, rated to 15 kW (to cover all parameter sets) and radiatively cooled. The suggested magnet parameters, separately optimised for the 500 GeV and 1 TeV layouts, are shown in table 1 and the inter-magnet drifts are shown in table 2.
BHEX1 is the magnet which performs the first extraction bending after the final doublet. It has an angle of 2 mrad and an orbit separation to the incoming beam of approximately 260mm. The aperture of this magnet is designed to contain both the charged beam and the beamstrahlung cone, and a design of this magnet has been worked out with an acceptable good field region and homogeneity [7]. BHEX1 is protected by a horizontal collimator, designed to protect the magnet against the horizontal beamstrahlung tail and also a vertical photon collimator. This is designed to limit the beamstrahlung vertical extent between the poles of BEHX1 and rated to 5 KW.
Two normal conducting dipoles, BB1 and BB2, have been included downstream of BHEX1 to provide the required separation at the beam dump.
Two primary beam collimators, COLL1 and COLL2, are included to control the growth of the low-energy tail of the beam on the beam dump window. These collimators are rated to 210 kW. The design envisioned uses rotating balls in a water flow [8]. The

collimator parameters can be found in table 3 for the 500 GeV machine. Power losses on these elements are below the ratings shown for all beam parameter sets in [5].

3 CONCLUSION

In this memo, the parameters of the new and improved 2 mrad extraction line for the ILC were presented.
The next focus of this design effort will be dedicated to the magnets, in particular QD0, SD0, QF1 and SF1 (super-conductive and warm quadrupole and sextupole magnets, respectively), and QEX1,2 (the two modified "Panofsky" quadrupoles). With explicit designs for these magnets and iterating the optical parameters if needed, it will be possible to finalise the improved 2mrad crossing angle layout and evaluate its cost.

Table 1: The extraction line magnet parameters.

Magnet	Length [m]	Strength	Radial aperture [mm]	Notes
QEX1 (500 GeV)	4	0.009 m^{-2}	99.9	Panofsky
QEX2 (500 GeV)	4	-0.002 m^{-2}	115.5	Panofsky
BHEX1 (500 GeV)	6	2 mrad	-	inc. beamstrahling
BB1 (500 GeV)	4	1.2 mrad	-	-
BB2 (500 GeV)	4	1.2 mrad	-	-
QEX1 (1 TeV)	6	0.005 m^{-2}	106.7	Panofsky
QEX2 (1 TeV)	6	-0.0002 m^{-2}	125.8	Panofsky
BHEX1 (1 TeV)	8	2 mrad	-	inc. beamstrahling
BB1 (1 TeV)	8	1.25 mrad	-	-
BB2 (1 TeV)	8	1.25 mrad	-	-

Table 2: The inter-magnet drift lengths.

Drift	Length [m] 500 GeV	Length [m] 1 TeV
IP-FD	13.7	16.4
FD-QEX1	32	31
QEX1-QEX1	4	4
QEX2-BHEX1	20	20
BHEX1-BB1	57.25	57.25
BB1-BB2	4	5
BB2-DUMP	167	150.3

Table 3: The extraction line collimator parameters at 500 GeV.

Collimator	Length [m]	Power rating [kW]
QEX1COLL	1	1
QEX2COLL	1	1
BHEX1COLL	1	1
COLL1	2.5	60
COLL2	2.5	210

Acknowledgement

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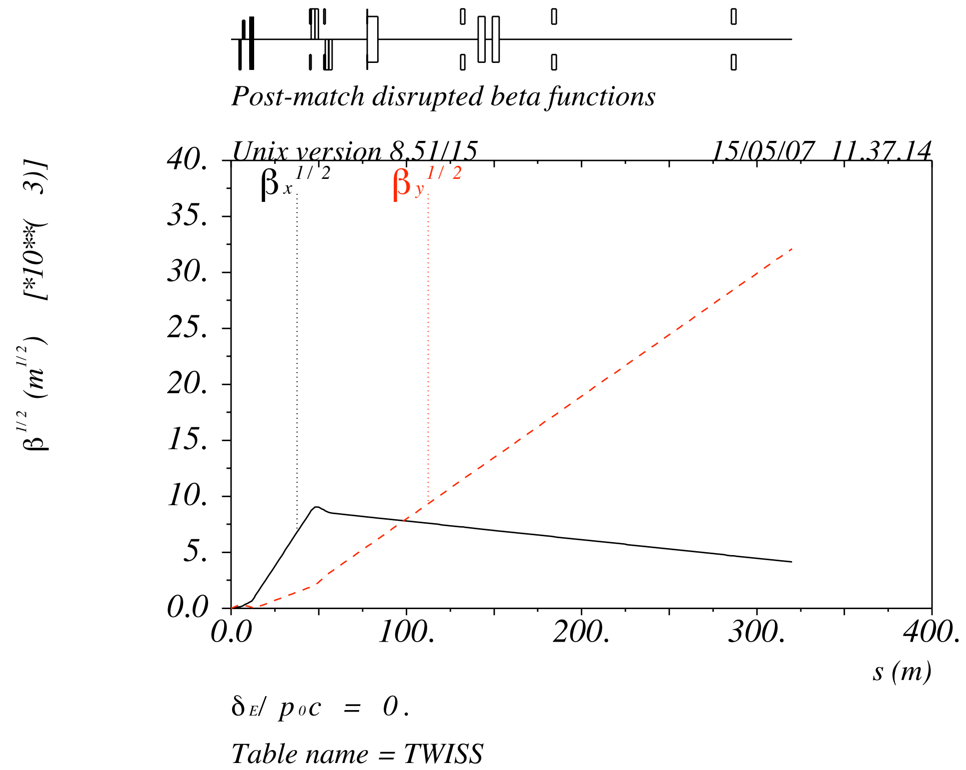

Figure 1: The β-functions for the 500 GeV extraction line.

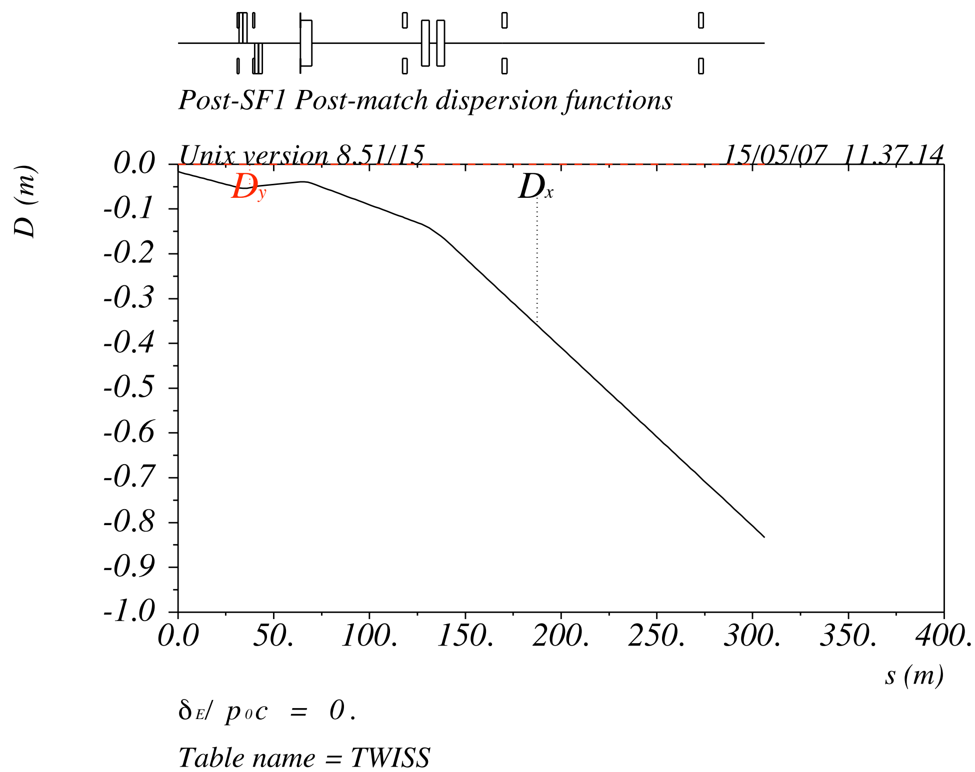

Figure 2: The horizontal dispersion function for the 500 GeV extraction line.