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Panofsky quadrupole parameters for the ILC 2mrad alternative crossing angle scheme

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Abstract

In this memo, the parameters of two Panofsky quadrupoles needed for the extraction lines of the newly redesigned ILC 2mrad alternative crossing angle scheme are presented. These quadrupoles are used to focus the outgoing beam in large rectangular apertures accommodating also the beamstrahlung. A smaller low-field region in the immediate vicinity is required for the incoming beam.

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1 INTRODUCTION

The extraction lines for the newly redesigned 2mrad alternative crossing angle layout [1] of the ILC [2] should transport the outgoing disrupted beams and beamstrahlung photons to their appropriate dumps.
Due to energy loss from beamstrahlung emissions, the outgoing beam develops a long horizontal tail following its off-axis magnetic transport through the last lenses of the final focus. This off-axis transport is used to provide the initial angular and spatial separation from the incoming beam in this scheme. The first focusing magnets acting on the outgoing beam beyond the shared region need to be placed as close as possible to limit the divergence of this tail and control the downstream beam size, both horizontally and vertically. The proposed design relies on Panofsky-style quadrupoles [3] with apertures large enough to accommodate both the extracted charged and beamstrahlung beams, modified to include a small low-field region for the incoming beam in the immediate vicinity.
The purpose of this memo is to summarise the parameters of these magnets, to facilitate discussion and evaluation with relevant magnet experts and allow basic feasibility and engineering studies.

2 THE MAGNET PARAMETERS

The required parameters for the two Panofsky-style quadrupoles QEX1,2 (horizontally and vertically focusing, respectively) are listed in tables 1 and 2 for the 500 GeV and the 1 TeV C.M. machines. The apertures of QEX1 for the 500 GeV machine is shown in figure 1.
The separation of the outgoing and incoming beam must allow sufficient main field strength in these magnets, whilst providing a sufficiently low field in the incoming beam pocket. For the present design, this distance is 150mm.
The required aperture half-sizes are shown with respect to the outgoing beam centroid position. They are rectangular and determined by the position and shape of the outgoing charged particle and beamstrahlung photon beams.
The field strengths have been optimised to minimise downstream beam sizes and losses, whilst remaining within acceptable limits in consideration of similar magnets considered in earlier versions of the design [4]. The field homogeneity should extend over the entire space of the aperture and be around 10^{-2}. The exact value of this tolerance can be specified from beam dynamics calculations once a realistic design is engineered. The field in the incoming beam pocket should be small, with a dipole field of about 10 Gauss to avoid affecting the incoming beam dynamics. This pocket should have a radial aperture of 10mm. In the reference system used, the incoming beam is located at $(0, 0)$.

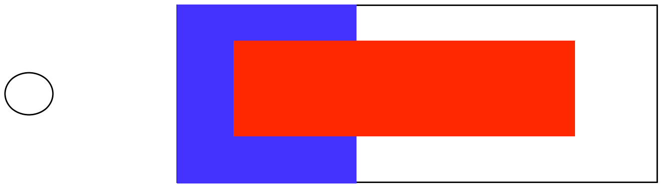

Figure 1: The outgoing and incoming beam apertures of the Panofsky quadrupole QEX1 for the 500 GeV machine. The outgoing beam aperture is represented by the large rectangle, and the nearby incoming beam is represented by the circular aperture. The beamstrahlung cone and estimated extent of the outgoing disrupted beam are indicated in blue and red, respectively. The horizontal and vertical cone sizes used are 0.75, 0.85 mrad, respectively, and result in losses less than 10 Watt for any of the ILC beam parameter sets [5].

Table 1: The parameters for QEX1 and QEX2 for the 500 GeV C.M. machine.

Parameter	QEX1	QEX2
s (start) [m]	45.7	53.7
Length [m]	4	4
Strength [m−2]	0.009	-0.002
horizontal half-aperture [mm]	99.9	115.5
vertical half-aperture [mm]	42.4	49.0
gradient [T m−1]	7.5	1.67
Outgoing beam centroid (start) [mm]	149.2	174.8
Beamstrahlung centroid (start) [mm]	91.4	107.4

Acknowledgement

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References

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R. Appleby *el al*, EuroTeV Memo 2007-001-04
R. Appleby and P. Bambade, JINST 1 P10005 (2006), EuroTeV report-2006-022

[2] http://www.linearcollider.org/wiki/doku.php?id=rdr:rdr_home

[3] L. Hand and W. Panofsky, The Review of Scientific Instruments, Vol.30, Number 10 (1959).

Table 2: The parameters for QEX1 and QEX2 for the 1 TeV C.M. machine.

Parameter	QEX1	QEX2
s (start) [m]	45.4	57.4
Length [m]	6	6
Strength [m−2]	0.005	-0.0002
horizontal half-aperture [mm]	106.6	125.8
vertical half-aperture [mm]	40.3	53.9
gradient [T m^{-1}]	8.3	0.33
Outgoing beam centroid (start) [mm]	154.4	186.1
Beamstrahlung centroid (start) [mm]	94.8	114.8

[4] http://www.linearcollider.org/wiki/doku.php?id=bcd:bcd_home

[5] R. Appleby and P. Bambade, EuroTeV Report 2007-014