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The Coordinate System for LDC Detector Studies

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Abstract

An agreement on a common definition of a global coordinate system for studies of the ILC Large Detector Concept [1] will have various advantages: Simulation tools can be used without adaptation, data can be exchanged without conversion, and results can be compared without reinterpretation. The following document offers such a definition in a concise, yet general way.

1 Definition of the Coordinate System

Let $\vec{p}^{\,-}$ and $\vec{p}^{\,+}$ be the nominal three-momenta of the incoming electrons and positrons, respectively. The coordinate system is then defined as follows:

1. The coordinate system is cartesian and right-handed.
2. Its origin is located at the nominal point of interaction.
3. The z-axis lies along the mean beam direction, pointing such that $p_z^- > 0$.
4. The y-axis lies along the vertical direction, pointing upwards.

The mean beam direction is the bisecting line of the (smaller) angle between $\vec{p}^{\,-}$ and $\vec{p}^{\,+}$. In the case of a head-on geometry, this angle vanishes and the z-axis is simply parallel to $\vec{p}^{\,-}$ and antiparallel to $\vec{p}^{\,+}$. Note that the direction of the x-axis is already fixed by point 1 in conjunction with points 3 and 4.

2 Definition of the Crossing Angle

The crossing angle, here denoted by θ, is defined as follows: $\theta \in (-90°, +90°]$ is the angle by which $\vec{p}^{\,+}$ has to be rotated around the y-axis such that it becomes antiparallel to $\vec{p}^{\,-}$. If the rotation is right-handed then $\theta > 0$, if it is left-handed then $\theta < 0$. Note that θ will always have the same sign as p_x^- and p_x^+.

Even though $\theta < 0$ must be allowed in order to be able to describe all possible configurations, all studies should use $\theta \geq 0$ unless there is a special need not to do so. This means that both $p_x^- \geq 0$ and $p_x^+ \geq 0$ by default.

Figure 1 shows a top view of a crossing angle geometry with $\theta > 0$, taking into account the definitions from sections 1 and 2.

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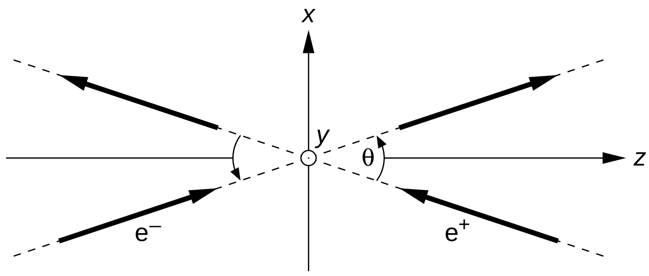

Figure 1: Top view of the coordinate system for a crossing angle geometry with $\theta > 0$. The y-axis is pointing towards the viewer. This should be the default coordinate system for all LDC detector studies.

3 Concluding Remarks

The definition presented in this document has already been proposed to the LDC community in the LDC Phone/Video Meeting of 2005-09-29 [2] and has generally been agreed upon. It is compatible to the coordinate system used by Guinea Pig [3] and to the magnetic field maps provided by the SLAC Beam Delivery Group [4].

Guinea Pig simulates, among other things, the e^+e^- pairs produced by beam-beam interactions for $p_z^- > 0$, $p_z^+ < 0$. The field maps stated above provide values for an optional detector-integrated dipole field (DID) with $B_x < 0$ for $z > 0$. This is in agreement with $p_x^\pm > 0$ for $\theta > 0$.

Furthermore, detector geometries which are compliant with figure 1 will soon be available for the major LDC detector simulation programs, "Brahms" [5] and "Mokka" [6].

References

[1] LDC Web Site, `www.ilcldc.org`

[2] LDC Phone/Video Meeting, 2005-09-29, `www.ilcldc.org/meetings/fourthLDCmeetingfolder/`

[3] Guinea Pig Web Site, `www-sldnt.slac.stanford.edu/snowmass/Software/GuineaPig/`

[4] SLAC Beam Delivery Meeting, 2005-07-26, `www-project.slac.stanford.edu/lc/bdir/Meetings/beamdelivery/2005-07-26/index.htm`

[5] Brahms Web Site, `www-zeuthen.desy.de/lc_repository/detector_simulation/dev/BRAHMS/readme.html`

[6] Mokka Web Site, `polywww.in2p3.fr/geant4/tesla/www/mokka/mokka.html`