Prototype Design for the Cherenkov Detector

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The design and simulation of a Cherenkov detector prototype for polarisation measurements at the ILC is discussed, as are plans for laboratory and beam tests.

1 Introduction

A spectrometer chicane and Cherenkov detector is envisioned for polarisation measurement at the International Linear Collider (ILC). In the following, the design of the upstream Cherenkov detector is addressed, including the construction and operational tests of an early prototype.

2 Cherenkov Detector Prototype

As illustrated in Figure 1, the upstream Cherenkov detector is planned to consist of staggered, U-shaped aluminum channels with a cross section of 1 cm $\times$ 1 cm filled with C_4F_{10} as Cherenkov gas and an apropriate photodetector readout.

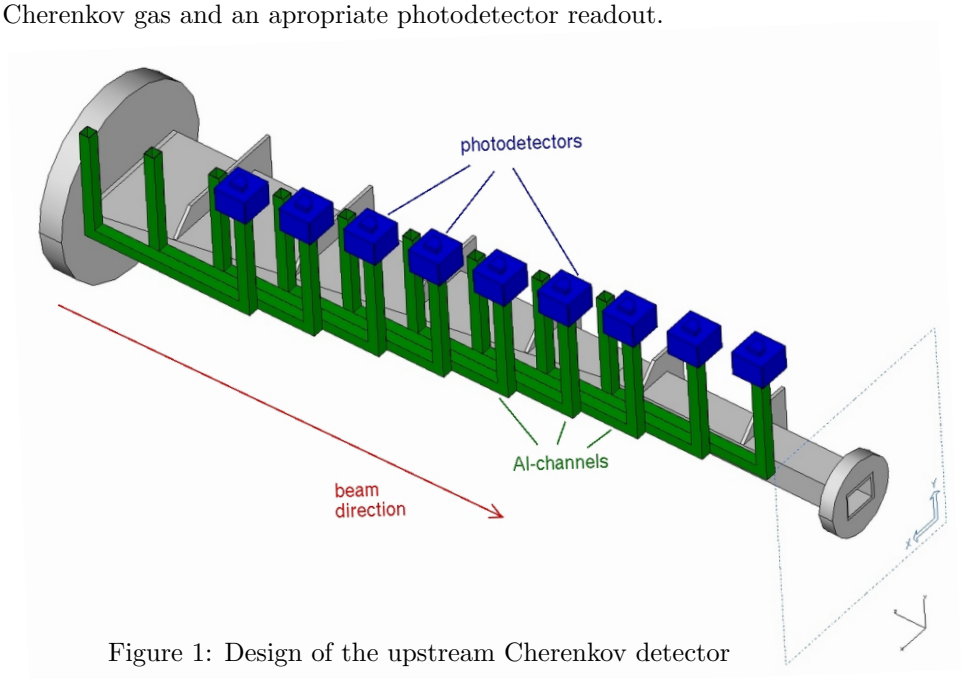


Figure 1: Design of the upstream Cherenkov detector

For safety issues, the distance of the detector from the original beam line (beam stay clear) has to be 2 cm. The channels are staggered along the z-axis to allow for a tapered beam pipe which prevents wake field creation. One leg of the U-shaped gas tubes is equipped with a photodetector and subsequent readout, while the other leg can be used for calibration purposes either via LED or preferably via laser light.

To study the performance of the entire Cherenkov detector design, it is planned to construct (and test) a three channel testbox during the summer/autumn of 2008. Apart from the lower number of channels, there is only one major difference between the testbox and the current design of the ILC-prototype: the three channels of the testbox will not be staggered allowing for a simpler (and thus less expensive) gas system, simply flooding the entire box with C_4F_{10} as the desired Cherenkov gas.

Figure 2 shows a first draft of a two-channel aluminum testbox. The walls between channels will be 0.3 mm thick and there will be two flanges at either end of the two U-legs: one for housing a photodetector module for quick and easy exchange of different photodetectors, the other flange for either housing an LED-system or to hold a thin window to pass laser light into the channels for calibration.

The testbox that will actually be built, will have two thin windows - one entrance and one exit window. Contrary to the box shown in Figure 2, the testbox that will actually be built, will have three, not two channels. This will facilitate the testing of different photodetectors and different readout modes [2] at once and it will also allows to study the crosstalk between channels.

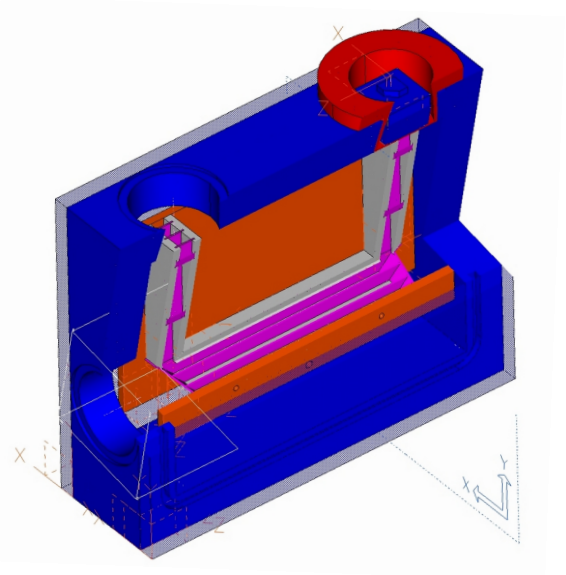
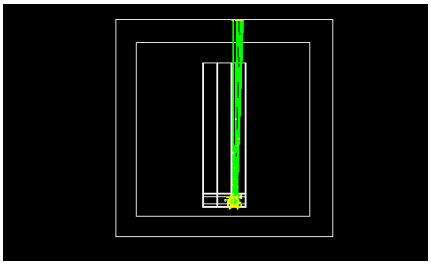


Figure 2: Early draft of the testbox design.

Simulation of the testbox

The optical simulation of the testbox (see Figure 3) is being done using GEANT4 [3]. A three channel aluminum box with a thin 3 mm entrance window (Al so far) has been simulated, whereas the photodetectors are not simulated in GEANT. To be able to quickly simulate different types of photodetectors, the quantum efficiencies (and other characteristics) are applied during the analyses of the simulated data.



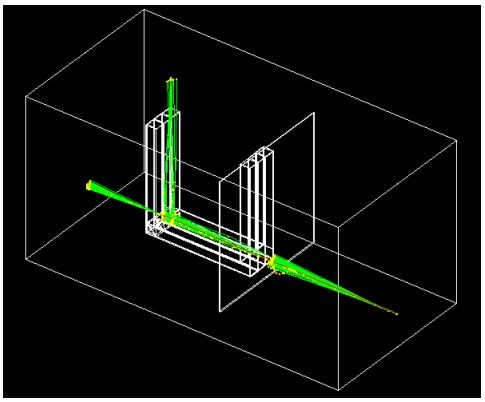


Figure 3: Simulation of single electron events in the testbox (front & side view).

Further studies will be done regarding the channel dimensions, matching for example the channel cross sections in an optimal way with the properties of the magnetic chicane on one hand and those of the photodetectors on the other hand.

3 Testbeam at ELSA in Bonn

Since the three-channel testbox is supposed to be ready by autumn this year (2008), it is planned to do tests with LED-light and an additional beam test at DESY by the end of the year, before moving the box to Bonn for further beam tests. The "Elektron Stretcher Anglage" (ELSA) in Bonn will provide more "ILC-like" conditions than the terciary beam available at DESY. The pulse rate at the ELSA testbeam facility are about 7 to 8 orders of magnitude higher (1-10 nA, 1-10 GHz) than the one of the DESY testbeam (only ≈ 0.2 fA, 2 kHz). In addition, the ELSA testbeam can provide bunches containing about 100-1000 electrons, contrary to the single electron events available at DESY.

In order to allow parasitic operation with other testbeam users, thin entrance and exit windows will allow the electron beam to travel through the Cherenkov detector testbox mostly undisturbed. The box will be mounted on a thin movable stage and placed directly behind the beam extraction from ELSA before the beam enters the designated testbeam area. Although the electron energy will be similar to the one of the DESY-testbeam (on the order of 3 GeV), the actual rate of incident electrons will be orders of magnitude higher, while the beam spot size is smaller.

Acknowledgments

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