Study of PANDA Barrel DIRC design options*

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A detector based on the DIRC (Detection of Internally Reflected Cherenkov light) principle [1] will be used in the target spectrometer of the PANDA experiment to distinguish between charged pions and kaons for momenta between 0.5 and 3.5 GeV/c. The design of the PANDA Barrel DIRC is based on the *BABAR* DIRC [2] (the first successful DIRC counter) with some important improvements, such as fast photon timing, focusing optics, and a compact expansion volume.

In the PANDA Barrel DIRC baseline design the barrel of 47.6 cm comprises 16 sections with 5 fused silica radiator bars (1.7 cm x 3.2 cm x 250 cm) each. Cherenkov photons, produced along the charged particle track in the bar, are guided inside the radiator via total internal reflection. A mirror is attached to the forward end of the bar to reflect photons towards the read out end, where they are focused with a lens and projected onto a flat photo detector plane behind the 30 cm-deep oil-filled expansion volume. An array of Micro-Channel Plate Photomultiplier Tubes (MCP-PMTs) is used to detect the photons and measure their arrival time with a precision of about 100 ps.

In order to meet the PANDA resolution requirement and reduce the detector cost, the influence of different parameters and geometry options on the detector performance are being studied. One of the design elements that influence the operation and performance of the detector is the material and shape of the expansion volume. A compact fused silica prism can be used as a photon camera in front of each bar box instead of the single volume filled with mineral oil. This option reduces the number of required pixels. Moreover, the prism has much better optical properties, which improves the photon yield. The thickness of the bars defines the number of Cherenkov photons produced per track and the amount of the material in front of the calorimeter, whereas the width influences the detector cost. The use of one wide plate per bar box significantly reduces the total detector production cost in comparison to the baseline design with 5 narrow bars in each bar box, as there are less pieces to be polished. Another important element is the focusing system. It can be a lens attached to the read out end or a focusing mirror on the forward end of the bar.

The detailed simulation of the baseline design and many design options, including different focusing systems, shapes of the expansion volume and bar dimensions, is implemented using Geant [4]. A design using wide plates and fused silica prisms is shown on the Fig. 1. A fast reconstruction method, similar to the approach used for the *BABAR*-DIRC, is utilized to evaluate the performance of each design. The single photon Cherenkov angle resolution and photon yield are determined for a wide range of particle angles using several simplified designs without focusing optics. The results are consistent with expectations and demonstrate that a focusing system is required to achieve the DIRC performance goals for PANDA. The evaluation of more advanced designs, both in simulation and detector prototypes, is currently ongoing.

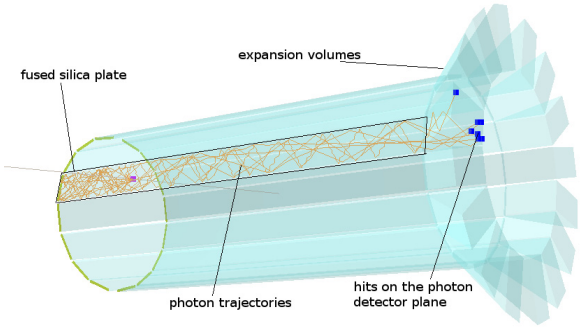

Figure 1: Geant-based simulation of the PANDA Barrel DIRC using radiator plates and compact expansion volumes.

References

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