Study of PANDA Barrel DIRC design options*

R. Dzhygadlo[†1], *K. Götzen*[1], *G. Kalicy*[1], *H. Kumawat*[3], *M. Patsyuk*[1,2], *K. Peters*[1,2], *C. Schwarz*[1], *J. Schwiening*[1], *and M. Zühlsdorf*[1,2]

[1]GSI, Darmstadt, Germany; [3]BARC, Mumbai, India; [2]Goethe Universität Frankfurt, Germany

The PANDA Barrel DIRC detector [1] will be an essential component of the PANDA experiment at FAIR. It will perform hadronic particle identification, in particular to separate charged pions and kaons for momenta between 0.5 and 3.5 GeV/c. The physics program of PANDA requires the separation to be better than three standard deviations for polar angles between 22° and 140°.

To achieve this performance a number of design options for the PANDA Barrel DIRC geometry are considered. In the baseline design 16 modules, each comprising 5 narrow fused silica radiator bars (1.7 cm $\times$ 3.2 cm $\times$ 240 cm) surround the beam line at a radial distance of 47.6 cm. A charged particle passing through a bar produces Cherenkov photons, which are guided inside the radiator via total internal reflection to the mirror at the one side and to the expansion volume (EV) at the other. Fused silica or mineral oil are candidate materials for the EV. The photons are detected by an array of micro-channel plate photomultiplier tubes [2] with a pixel size of about 6.5 mm $\times$ 6.5 mm. A doublet lens between bar and EV focuses the hit pattern on the imaging plane.

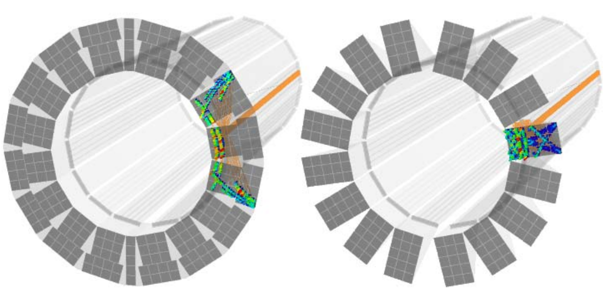

Figure 1: Geant-based simulation of the PANDA Barrel DIRC using narrow bars as radiators in combination with an oil-tank (left) and with compact solid fused silica prisms (right) as expansion volumes. The colored histogram shows the accumulated hit pattern from 20 charged kaons of the same momentum and angle.

In order to optimize the performance and reduce the detector cost, realistic simulations of different design options are performed using Geant [3] within the PandaRoot framework [4]. Fig. 1 shows two example geometries for different EV materials and shapes together with accumulated hit patterns.

The performance of each design is evaluated in terms of the reconstructed single photon resolution (SPR) and the photon yield per particle. The SPR is defined as the difference between the expected and reconstructed Cherenkov angle of each photon. Fig. 2 shows an example of the obtained SPR and photon yield as a function of the kaon polar angle for an oil-tank EV without focusing and with a two-component spherical lens. Of the two geometries only the focusing design, with 12–60 photons per particle and an SPR around 10 mrad, meets the Barrel DIRC requirements for PANDA.

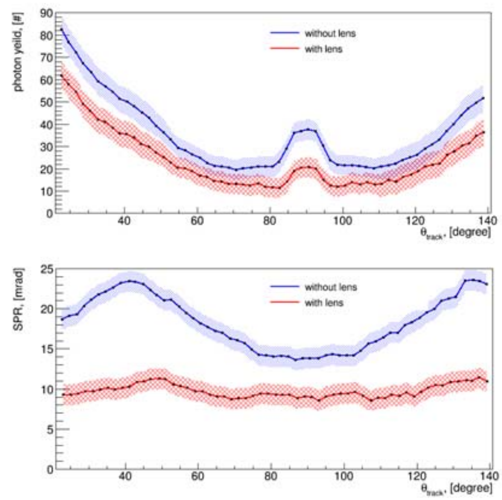

Figure 2: SPR and photon yield for an oil-tank EV with (red line) and without (blue line) a focusing system. The bands correspond to the rms of the distributions in each bin.

The evaluation of others detector design options, in particular the use of wide plates instead of narrow bars, in combination with different cylindrical and spherical lens designs, is ongoing. Several of the most promising designs will be implemented in a prototype and tested with particle beams at GSI in the summer of 2014.

References

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† R.Dzhygadlo@gsi.de

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