Simulation of $\bar{\text{P}}$ANDA barrel DIRC

D. Dutta [1],* M. Patsyuk [2], K. Goetzen [2], R. Hohler [2], K. Peters [2], C. Schwarz [2], and J. Schwiening [2]
[1] *Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai - 400085, INDIA, and*
[2] *GSI Helmholtzzentrum für Schwerionenforschung GmbH, Darmstadt, Germany*

The $\bar{\text{P}}$ANDA experiment [1] at the future Facility for Antiproton and Ion Research (FAIR), GSI, Darmstadt aims to perform a high precision spectroscopy to address many unexplored properties of the strong interaction. The charged particle identification in

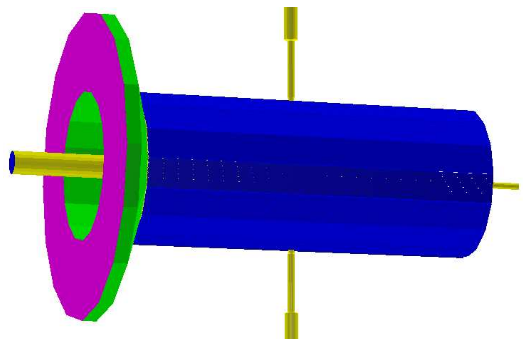

FIG. 1: Picture of barrel DIRC of PANDA detector in the PandaRoot framework. The beam comes from the left.

the barrel region of the $\bar{\text{P}}$ANDA is planned with a very compact imaging Cherenkov detector following the DIRC (Detection of Internally Reflected Cherenkov light) principle [2]. The simulation, realistic digitisation and reliable reconstruction of Cherenkov angle is mandatory for the performance study of the full PANDA detector system. In this contribution, we will discuss the simulation and challenges of reconstruction in the barrel DIRC with emphasis on the possibility of the correction of the chromatic dispersion with fast timing information.

The barrel DIRC of $\bar{\text{P}}$ANDA covers the angular region from $\theta = 22°$ to $140°$. Fig 1. shows the picture of the barrel DIRC as implemented in the PandaRoot [3]. It consists of 1.7 cm thick quartz slabs in a 16 fold geometry (blue colour) surrounding the beam line at a radial distance of 48 cm. The target beam pipe cross the barrel vertically through the split in the barrel. In the forward direction the Cherenkov light is reflected back by mirrors towards the photon detector. In the backward direction, each radiator bar is coupled to a doublet lens at the end. Behind the lens, after a thin air gap, the entrance window of the photon detector vessel (green colour) follows. The Cherenkov photons will be focused by the lens in the photon detector plane (magenta colour) at a distance of 30 cm from the entrance window.

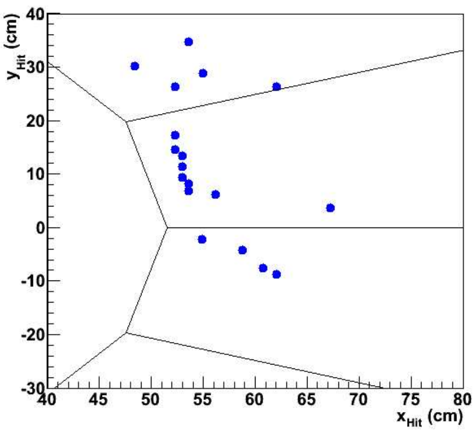

FIG. 2: The expected image in the photon detector plane for incident kaon with momentum 2 GeV/c.

Simulation is a crucial requirement for detector optimisation and a realistic digitisation is necessary to get an output which is close to

*Electronic address: ddutta@barc.gov.in

the expected experimental measurement. The following realistic detector information is included during the hit production [4] in PandaRoot motivated by the expected choice of the photon detector (e.g. MCP PMT)

- Pixelisation of the photon detector,
- Convolution with the detection efficiency,
- Gaussian smearing of the time.

The xy distribution of the hits in the photon detector plane for an incident kaon of momentum 2 GeV/c, after taking account of efficiency and pixelisation of photon detector plane, is shown in Fig. 2. This shows the expected image in the photon detector plane which is used as input for further reconstruction.

The reconstruction in the DIRC uses charged track information provided by the tracking detectors along with the position of the photon detector hits. The photon propagation time t_p and the hit time provide additional constraints and are powerful tools to reject backgrounds. A possible reconstruction algorithm for the barrel DIRC, motivated by the BaBar DIRC [5] encompasses: (i) an initial fast Cherenkov angle θ_c reconstruction based on a look-up table approach and then (ii) followed by detailed likelihood methods. Two types of likelihood approaches, the track likelihood based on each track or the event likelihood which uses the information of all the tracks for a single event, is performed for the final fitting of the Cherenkov angle θ_c.

The dispersion which is large for the solid state radiators worsens the Cherenkov angle resolution [6]. Since the Cherenkov photon flight time depends upon the wavelength, it is possible to determine the colour of a photon through its flight time if the dispersion is large. Fig. 3 shows the time distribution of photons in different wavelength bands $300-350$ nm (blue) and $500-550$ nm (red) for kaons with momentum 2 GeV/c (β=0.97) from the simulation in PandaRoot. This shows an average $\approx$ 250 ps time difference between the two wavelength bands. With a very accurate time resolution (better than 100 ps) it will be feasible to reduce the smearing due to chromaticity and hence improving the PID of the DIRC.

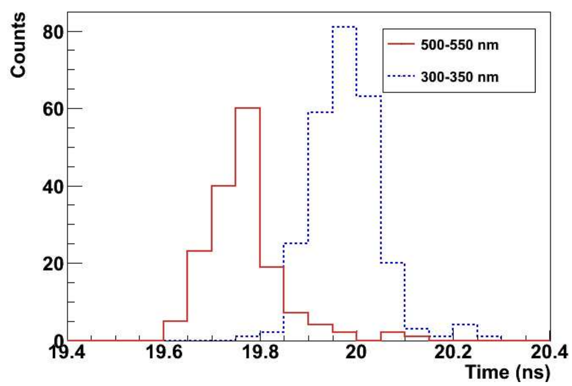

FIG. 3: Time distribution for the different wavelength band ($300-350$ nm (blue-dashed) and $500-550$ nm (red-solid)) for incident kaons with momentum 2GeV/c.

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