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The innovative Design of the PANDA Barrel DIRC

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The fixed target experiment PANDA at the High Energy Storage Ring (HESR) of the Facility for Antiproton and Ion Research in Europe (FAIR) in Darmstadt will open unique possibilities to solve fundamental questions of hadron physics by using a cooled high-intensity antiproton beam. Two fast and compact Ring Imaging Cherenkov detectors using the DIRC (Detection of Internally Reflected Cherenkov light) technology will provide excellent charged particle identification (PID) in the PANDA target spectrometer. The Barrel DIRC will cover the polar angle range from 22° to 144° and cleanly separate pions from kaons for momenta up to 3.5 GeV/c. It consists of 16 optically isolated sectors, each comprising three bars, flat mirrors and focusing lenses, a compact fused silica prism as expansion volume, and 11 Microchannel-Plate PMTs (MCP-PMTs) as photon sensors. The bars are made from synthetic fused silica, have a length of 2400 mm and a cross section of 17 mm x 53 mm, and are built to tight optical and mechanical specifications to preserve the photon angle during many internal reflections and to optimize the light transport efficiency. The spherical lens system is designed to efficiently focus the Cherenkov light on a flat image plane on the back wall of the prism where the photons are detected by the array of MCP-PMTs. Detailed Geant4 simulations were performed to optimize the design for performance and cost and two complementary reconstruction algorithms were developed, one primarily based on photon spatial coordinates, the other emphasizing the precise measurement of the photon propagation time. All the key elements of the PANDA Barrel DIRC design were implemented in several complex prototypes and tested in hadronic particle beams at GSI and CERN. The data obtained were used to tune the simulation, validate the reconstruction methods, and to evaluate the PID performance of the design. We will discuss the technical design of the PANDA Barrel DIRC and present results from the test beam campaigns at the CERN PS in 2017 and 2018.

Selected session

Accelerators and Instrumentation

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