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Recent developments in data reconstruction for aerogel RICH at Belle II

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In the forward end-cap of the Belle II spectrometer particle identification is provided by a proximity focusing RICH detector with an aerogel radiator (ARICH). Its main purpose is to provide good separation between pions and kaons in the momentum range from 0.5 GeV/c up to 4 GeV/c, and in addition to contribute to the identification of low momentum leptons. Since the start of its operation, Belle II has collected more than 200 fb^{-1} of data. Based on this large data sample studies of several effects impacting the performance of the ARICH detector were carried out. Findings helped us to improve the detector performance, either by implementing new calibration algorithms or improving the method of data reconstruction and to improve the agreement between the measured data and data from detector simulation. We will report on the detector alignment methods, including alignment of its global position, alignment of planar mirrors on the outer edges of the detector, and a novel algorithm for the alignment of aerogel tiles based on the computer vision methods. We have studied very detailed features of the observed Cherenkov ring image and identified their origin, these include photons produced in the photo-detector quartz window and their possible reflections within the photo-detector, photons produced by delta electrons, and a few other effects. We were able to reproduce these effects in the simulation, resulting in a very good agreement between the data and the simulation. In addition, the observed features were included in the calculation of the expected ring image on which the evaluation of the PID likelihood is based. Finally, we will discuss the impact of particles that decay in flight or scatter in the material before entering the ARICH detector on the PID performance. We demonstrate that these particles have a significant contribution to the observed particle misidentification rates and present our efforts to mitigate this adverse effect by trying to identify the cases when the track is extrapolated to the ARICH but no particle actually entered it, based on combining the response of several Belle II sub-detectors.

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