

The Aerogel Ring Image Cherenkov counter for particle identification in the Belle II experiment

Tuesday, 23 May 2017 16:48 (18 minutes)

The Belle II spectrometer, an upgrade of the Belle detector, is under construction together with the SuperKEKB electron-positron accelerator at KEK in Japan to search for the New Physics beyond the Standard Model using 50 times higher statistics of $e^+ - e^-$ collisions of the Belle experiment. An aerogel ring imaging Cherenkov (ARICH) counter will be installed into the end cap region of the new spectrometer as a particle identification device to secure 4σ separation of charged kaons and pions up to momentum of 3.5 GeV.

We developed several techniques to maximize the pion-kaon separation performance in 1.5 T magnetic field and a limited space available between the tracker and the calorimeter. Two layers of silica aerogel radiators with different refraction indices are used to focus the Cherenkov lights. We have established a method to process the aerogel radiators with flexible refraction index and high transparency. Hybrid Avalanche Photo Detector (HAPD), which has 144 pixels with 5 mm pitch, was developed to detect the positions of incoming photons in the high magnetic field. Two steps of readout electronics of the HAPDs was introduced in order to process the signals and to merge data and reduce numbers of cables to the outside of the detector. A frontend board attached to the HAPD reads out signals to digitize photon hit patterns; a merger board collects digitized data from several of the frontend boards (up to 6) to send them to the Belle II global data acquisition system. In total, 248 segments of the silica aerogel radiators cover a plane of the end cap, while 420 HAPDs are located in another plane 20 cm behind the plane.

Developments and productions of these detector components were already finished in 2016 and the ARICH counter is under construction, scheduled to be installed into the Belle II detector in summer of 2017. All the segments of the aerogel tiles are fully installed while installation of the HAPDs and the readout electronics are ongoing in parallel with detector test operation using cosmic rays. Cherenkov ring images of cosmic rays were collected using the framework of the Belle II global data acquisition system to study detector response and readout performance. A LED light injection system to monitor the photo detectors was also developed and installed. In addition to the construction. We have also developed slow control software systems of the ARICH detector and the readout system including power supply for high voltages and low voltages.

In this presentation, we will overview the details of the ARICH counter and its construction with results of the cosmic ray test and then show the expected performance after installation to the Belle II detector.

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Session Classification: R1-Particle identification(1)

Track Classification: Particle identification