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Design and performance of large area, high resolution RPCs for LEPS2 at SPring-8

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The hadron photo-production experiment at LEPS2/SPring-8 will start in 2013. The photon beam with energy up to 3 GeV is produced by backward Compton scattering of laser photons with 8-GeV electrons circulating in SPring-8 storage ring. The development of a 4pi detector is now underway. The momentum of a charged particle is analyzed with the solenoid magnet and drift chambers. The particle identification is performed with the mass reconstructed using the momentum and the velocity, which is measured from the flight length and the time of flight (TOF). For the TOF measurement, large area, high time resolution RPCs is now being developed. The gap size and readout strip size dependence of the time resolution and the efficiency of the RPC is reported.

Pions and Kaons with momenta up to 2.5 GeV/c are produced in LEPS2 experiment. In order to separate 1.1-GeV/c K/pi with 3 sigma from the time difference while traveling 100 cm in the magnet, the time resolution better than 50 ps is required for the time of flight detector. In addition, the detection efficiency better than 99 % is required. The TOF detectors cover a cylindrical area of 550 * 100 cm^2. Although scintillation detectors are difficult to achieve 50 ps time resolution with large area and in magnetic field, RPC is well-suited for these requirements. In order to reduce the number of channels to be less than 1000, the area of each readout strip of the RPC should be larger than 120cm^2.

We developed prototype RPCs with the area of 10 * 50 cm^2. We studied the time resolution and the efficiency by changing gap sizes and readout strip sizes. We tested three gap configurations, namely, 100 um * 14 gaps, 150 um * 12 gaps and 260 um * 10 gaps RPCs with strip sizes from 1.5 * 5.5 cm^2, which corresponds to 6000 channels, to 2.5 * 40 cm^2, which correspond to 1000 channels. We found that smallest strip of 150 um RPC has the best time resolution, 50 ps, and, the efficiency is better than 99%. However, the resolution and the efficiency become worse for larger strip because the pulse height is not enough and the time walk effect is large. The resolution of 260 um RPC does not depend on the strip size and both smallest and largest strip achieved 60 ps resolution with the efficiency better than 99 %. The efficiency of 100 um RPC is not enough even for the smallest strip and the resolution was worse than other gap size RPCs.
The RPC with the 260 um gap works very well. As a future work, we will develop larger RPC with the area of 10 * 100 cm^2 and longer readout strip, which is used for the LEPS2 physics data taking.

Summary

We develop large area, high resolution RPCs for the time of flight detector for hadron photo-production experiment at LEPS2/SPring-8. In order to separate 1.1 GeV/c K/pi, the time resolution better than 50 ps is required. We achieved 60 ps time resolution with 2.5 * 40 cm^2 strip of 260 um * 10 gaps RPC. For a future work, we will develop larger RPC and test longer readout strip.

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