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Detector Systems Development for Inter-Bunch Extinction Measurements at the 8 GeV Slow-Extracted Pulsed Proton Beam for the COMET Experiment at J-PARC

The COMET experiment will search for the muon-to-electron conversion process in aluminium with a high single event sensitivity of 10^{-17}. We use the high-intensity proton beam at 8 GeV slowly extracted from the main synchrotron accelerator of Japan Proton Accelerator Research Complex (J-PARC). The beam must form in a pulsed structure with a distance of 1.2 μsec, and the extinction value, the proton-number ratio outside and inside of the bunch, should be less than 10^{-10}. We measured the extinction by counting proton-induced pions at the K1.8BR secondary beamline at the Hadron Experimental Facility in J-PARC, and the analysis is ongoing.

For the measurement, we developed a hodoscope to measure the pion-hitting timings with 132-channel segmented plastic scintillators, read out by silicon photomultipliers and photomultiplier tubes, and its surrounding system, including an amplifier and digitiser electronics and data acquisition (DAQ) software. We prepared three different FPGA-based TDC modules with time resolutions of 1, 5, and 7.5 nsec and optimised their firmware to have distinct advantages for redundancy. The amplifier boards also discriminate signals and distribute them to all three TDC modules. The DAQ software was designed not to limit the data transfer speed and not be suppressed by disk access. The system worked as expected at a hit rate of 12Mπ/beam spill, the maximally allowed beam intensity. The detail and performance of the developed detector system will be presented.

Working group

WG6

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