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# Results from Pilot Run for MEG II Positron Timing Counter

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The MEG II experiment at Paul Scherrer Institut in Switzerland will search for the lepton flavour violating muon decay, $\mu^+ \to e^+\gamma$, with a sensitivity ($4 \times 10^{-14}$) improving the existing limit of an order of magnitude. The positron Timing Counter (pTC) is the subdetector dedicated to the measurement of the positron emission time. It is designed on the basis of a new approach to improve a positron ($e^+$) timing resolution by a factor of two compared to MEG. pTC is composed of 512 ultra-fast plastic scintillator with SiPM readouts. The mean hit multiplicity for signal $e^+$ is evaluated to be $\sim$ 9 and a high timing resolution of $\sim$ 35 ps is expected by averaging the signal time of multiple hit counters. To achieve the target resolution, an internal time calibration with a precision of 10 ps or better is required. We have developed two new methods for the calibration, which meet the requirement: Track-based calibration and Laser-based calibration.

In 2016, We have finished construction of pTC and installed the first one-fourth of pTC into the MEG II experimental area to evaluate the performance using $\mu^+$ beam as a pilot run. We took data of $e^+$ from the dominant $\mu$ decay (Michel Decay, $\mu^+ \to e^+\nu_e\overline{\nu}_\mu$) and applied both time calibration methods. The time offsets of each counter calculated independently from the two calibration methods were consistent and stable during the run within 6 ps. The systematic uncertainty between these methods was 39 ps, which is suppressed with $\frac{1}{\sqrt{N}}$ using multiple hits (N: number of hit counters). The overall timing resolution weighted with a distribution of the number of hit counters for signal $e^+$ of 38 ps was achieved in this pilot run. The prospects towards MEG II physics run are also discussed.

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