Development and commissioning of the 30 ps time resolution MEG II Pixelated Time Detector

G. Boca (a,b), P.W. Cattaneo (c), F. Gattii (c,d), M. De Gerone (c), M. Nakao (e), M. Nishimura (e), W. Ootani (e), M. Rossella (a), Y. Uchiyama (a), M. Usami (e)
(a) INFN Pavia (b) The University of Pavia (c) INFN Genova (d) The University of Tokyo (e) The University of Tokyo

Abstract: The experiment MEG II is designed to improve by an order of magnitude the current sensitivity reached by MEG on the search for \( \mu \rightarrow e\gamma \) decay. A crucial part of MEG II is a pixelated Timing Counter (pTC) that was developed to measure the positron timing with increased accuracy. The pTC is segmented into 512 small scintillation counters. Since the positron time is measured independently by several counters (\( \sim 9 \) on average), the timing resolution improves significantly. We constructed and installed the pTC and performed commissioning runs at PSI during 2016 and 2017. The analysis performance is checked by MC and the timing resolution of 38.5 ps is obtained with commissioning run data including some noise contribution.

**Motivation**

In MEG II experiment we search for the charged lepton flavor violation, \( \mu \rightarrow e\gamma \) decay, which is evidence of BSM physics [1]. Precise measurement of emission angle, energy, and timing of positron and \( \gamma \) is essential.

**MEG II Detector**

- **Superconducting Magnet COBRA**
- **Liquid Xenon Gamma-ray Detector**
- **Positron Timing by pTC**

**Pixelated Timing Counter (pTC)**

TC consists of 512 plastic scintillator counters readout with 6 SiPMs at both ends. Since positrons hit several counters, the resolution is \( \sigma \approx 30 \) ps.

**Commissioning Run 2017**

All counters (512) installed and tested in MEG II site, PI5 beam line at PSI.
- **Beam**: DC muon beam. Muons stopped at target (\( \sim 7\times10^4 \) µs). Michel Positrons are measured.
- **Installed Detectors**: pTC, magnet, target, frames of drift chambers.
- **Electronics**: Amplifier (x100), Shaper (PZC), Digitizer (WaveDAQ). Trigger: single hit, coincidence, Track-like

**Clustering**

- Many hits from a positron.
- High rate positrons (few MHz in pTC region.)
- Clustering pTC hits is necessary. All hits from the same track and the same turn included in a cluster.

**Contact**

paolo.cattaneo@infn.pv.it

---

**Figure Description**

- **Event display in 2017 run**
- **Comparison hits Data/MC**
- **Comparison resolution expectation**
- **Overall Resolutions**
- **Summary**

**Reference**