Development of Front-end ASIC for Silicon-strip Detectors of J-PARC Muon g-2/EDM Experiment

Yutaro Sato1, Yowichi Fujita1, Eitaro Hamada1, Tetsuichii Kishishita1, Tsutomu Mibe1, Osamu Sasaki1, Masayoshi Shoji2, Taikan Suehara2, Manobu Tanaka1, Junji Tojo2, Yuki Tsutsurnmi2, Takashi Yamanaka3, Takami Yoshidza3 for the J-PARC g-2/EDM collaboration

KEK IPNS1, Kyushu Univ.2, Kyushu Univ. RCAPP3

Abstract
We are developing a front-end ASIC for silicon-strip detectors of the J-PARC muon g-2/EDM (E34) experiment, which aims to measure the muon anomalous magnetic moment (g-2) and electric dipole moment (EDM) to search for new physics beyond the Standard Model. Since the timing of the muon decay is key information in the experiment, the front-end ASIC is required to tolerate a high hit rate of 1.4 MHz per strip and to be stable to the change of hit rate by a factor of 1/150. To accommodate the pulsed muon beam at J-PARC, the ASIC has large buffer memory to save the binary hit information. The prototype ASIC “SliT128B” was fabricated using the Silterra 180-nm CMOS process. We report the performance of SliT128B chip and future prospect.

1. J-PARC muon g-2/EDM experiment
• There is 3.8 discrepancy between the measurement of muon g-2 by BNL E821 [1] and the SM prediction.
• J-PARC muon g-2/EDM experiment [2] aims to measure g-2 with a precision of 0.1 ppm and search for EDM with a sensitivity of 10^{-25} e\cdot cm with a different method from BNL E821 and Fermilab E899 experiment.
• Reaccelerated thermal muon beam with no focusing
• MRI-type storage magnet with a good injection efficiency & high uniformity of local B-field
• Full-tracking detector with large acceptance

2. Silicon-strip Detector
• Position tracks from muon decays are measured by silicon-strip detector. It consists of 40 vanes, and one vane consists of 4 quadrants. Each quadrant has 4 single-sided silicon strip sensors. Two-dimensional position is measured by the two layers of the silicon strip sensors.
• 640 sensors
• 5120 ASICs (=655,360 channels)
• Time walk < 1 ns

3. Prototype Front-end ASIC “SliT128B”
• Timing stability is important for the measurement of the muon g-2.

4. Performance Test
Peaking time and pulse width
• Analog outputs from CSA, CR-Rc shaper, differentiator, and their comparators are observed through monitor lines.
• Peaking time is less than 50 ns and pulse widths is less than 100 ns.

5. Summary and Prospect
• We are developing Front-end ASIC “SliT228” for J-PARC muon g-2/EDM experiment.
• Prototype ASIC “SliT228” has been fabricated and we confirmed most of the requirements are met. A little more improvement especially about time-walk will be done by minor optimization of the circuit design.
• Based on the result of SliT128B, we designed and fabricated next version of the ASIC “SliT228C”. The performance test of SliT228C is starting.
• The production version of the ASIC will be fabricated next JFY.