Design and performance evaluation of front-end electronics for COMET straw tracker

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Introduction

Lepton Flavor Violation (LFV)

- Experimentally verified $\rightarrow$ neutrino oscillation
- Standard Model (SM) $\rightarrow$ $\nu$ mass:
  - Branching ratio (BR) $\rightarrow (54\%)$
  - Impossible to observe...

- Discovery of charged LFV indicates beyond SM

COMET experiment

(Coherent Muon to Electron Transition) [3]

- $\mu \rightarrow e$ conversion

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Straw tube tracker

- High momentum resolution:
  - $<200keVc/105MeVc$
- Operation in magnetic field of 1 T
- High rate capability:
  - $5 \times 10^9 \mu s$ at muon target

- High intensity, Compact, Operational in high radiation, B tolerant.

A special readout system suited for the straw tracker is indispensable.

ROESTI

Concepts

- Requirements
  - time resolution: $<1$ ns
  - Gain: $16V/pc$
  - Channel number: $>16ch$
  - straw ch $>2000ch$

- Wave form digitizer was adopted.
  - Pileup identification in off-line analysis.
  - Good timing resolution with high-speed sampling.

- Calibration & performance evaluation

  Capacitor specification and limitation of chip process make pedestal and fluctuation of equidistant time bin, respectively. To correct these effects, the function of test pulse input with FPGA was implemented in ROESTI and the scheme using the test pulse was constructed.

- Pattern correction

- Timing correction

- Performance evaluation

Fundamental performance was evaluated using test pulse. Difference between before and after corrections was also compared.

ROESTI

Read-Out Electronics for Straw Tube Instrument

- Prototype
  - ADC $\rightarrow$ 12bits, 33MSIPS
  - FPGA $\rightarrow$ Anitec/XC7A200F

- Schematic view of daisy chain

- S/N $\rightarrow 16$ Fc

- Timing resolution $0.6$ ns

Future work

- Design and performance of ROESTI satisfied our requirements.

Summary & Future Work

Summary

- New charged LFV search at J-PARC, COMET experiment.
- Straw tube tracker
- Readout board, ROESTI
- Evaluation of ROESTI

- We realized the performance of ROESTI satisfied our requirements.

Future work

- Daisy chain test with many boards.
- Fixing other requirements like radiation tolerance.
- Design of production version of ROESTI

[References]

3. O. Sasaki et al., Amplifier-shaper-Discriminator ICs and ASD boards