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

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Introduction

Lepton Flavor Violation (LFV)

Experimentally verified $v_e \leftrightarrow v_\mu \leftrightarrow v_\tau$ => neutrino oscillation

Never observed yet !!

 $e \rightarrow \mu \rightarrow \tau$



Straw tube tracker

Requirements for detector

- High momentum resolution : <200keV/c@105MeV/c
- Operation in magnetic field of 1 T
- High rate capability :

 $5x10^9 \mu$ /s at muon target





Discovery of charged LFV indicates beyond SM

Beyond SM: BR ~ O(-13) - O(-16) Possible to observe

μ-e conversion



Present best limit : BR $< 7 \times 10^{-13}$ (SINDRUM-II) [1]

- High-intensity pulsed beam at J-PARC Special muon transport with long line using super conducting magnet
- High momentum resolution detectors

Goal sensitivity : ~ 10⁻¹⁷ improve by a factor of **10000** to current limit!



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Straw tube diameter	9.75 mm
Straw tube thickness	< 20 μm
Number of channels	2400 ch
Position resolution	~100 µm
Drift velocity (Ar:C ₂ H ₆ =50:50)	4.8 cm/μs
Expected minimum charge	-16fC
*Current values. Optimization of straw tracker is ongoing in parallel.	





Layout of straw tracker plane

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

ROESTI

Concepts

Requirements

time r	resolution
Gain	

: < 1 ns Posi. res. of Straw tracker ~100um S/N > 5 for min. input charge 16 fC :~1V/pC straw ch > 2000ch **Channel number** : > 16ch High intensity, Compact, Operational in high radiation, B-filed

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.

Wave form digitizer was adopted.

- Pileup identification in off-line analysis.
- Good timing resolution with high-speed sampling.

Block diagram







Summary & Future Work

ROESTI

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]

[1] W. Burtl et al., Eur. Phys. J. C 47 337 (2006) [2] Y. Kuno et al., Prog. Theor. Exp. Phys. 2013 022C01 [3] O. Sasaki et al., Amplifier-shaper-Discriminator ICs and ASD Boards [4] S. Ritt, Nucl. Instr. Meth. A518 (2004) 470 [5] T. Uchida, IEEE Trans. Nucl. Sci. 55 3 (2008) 1631

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