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The Mu3e Scintillating Fiber Timing Detector

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We present a compact scintillating fiber timing detector developed for the Mu3e experiment. Mu3e is a novel experiment that will search for the charged lepton flavor violating neutrinoless $\mu^+ \rightarrow e^+e^+e^-$ decay with unprecedented sensitivity of 10^{-16} . In conjunction with the Si-pixel tracker, the fiber detector will allow for a full 4D track reconstruction (in space and in time).

We will report in detail the development of the SciFi detector, from the scintillating fibers through the SiPM array photosensors up to the front-end electronics and the data acquisition, including the time calibration of the detector. The SciFi detector is formed by staggering three layers of Kuraray SCSF-78 250 μm multicladd scintillating fibers. The fiber ribbons are coupled at both ends to multi-channel silicon photomultiplier arrays. We will focus on the performance of this very thin (thickness of $\sim 720 \mu\text{m}$, i.e. $< 0.2\%$ of a radiation length) fiber detector in terms of the achieved timing resolution of $\sim 250 \text{ ps}$, matched clusters detection efficiency of $\sim 97\%$, and spatial resolution of $\sim 100 \mu\text{m}$. We will also report on developments to improve the light yield of existing scintillating fibers.

The 3000 channels of the fiber detector will be read out with a dedicated mixed mode ASIC, the MuTRiG, especially developed for this experiment. We will discuss in detail the functioning, operation, and performance of the MuTRiG ASIC, and the development of the front-end electronics.

Primary experiment

Mu3e

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