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The Mu3e scintillating fiber detector R&D

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The Mu3e experiment searches for a rare lepton flavor violating μ+ ⟶ e+e+e− decay and it aims at reaching an ultimate sensitivity of 10−16 on the branching fraction of the μ+ ⟶ e+e+e− decay, four orders of magnitude better than the current limit B(μ+ ⟶ e+e+e−) < 10−12. The experiment will be hosted at the Paul Scherrer Institute (Villigen, Switzerland) which delivers the most intense low momentum continuous muon beam in the world (up to a few ×10^8 μ/s).

In order to be sensitive to the signal at this so high level, to reject the background and to run at the intensity beam frontier excellent detector performances are needed.

We will report the R&D that has been performed presenting some of the prototypes of the scintillating fiber detector by defining the path for the final detector. These studies have been supported with detailed Monte Carlo simulations from the fiber through the photosensors up to the electronics and the data acquisition. The fiber detector is designed to detect minimum ionizing particles (m.i.p.) with a minimal amount of material (the detector thickness below 0.4 % of radiation length X0) with full detection efficiency, timing resolutions well below 1 ns, and spatial resolution of ≈ 100 μm. While expertise in scintillating fibers and SiPMs has been around for a while, this detector will be the first to match these demands. A very high detection efficiency (≥ 99%) and timing resolutions < 500 ps have been measured. The optical cross-talk between Aluminum coated fibers has been kept at a negligible level (< 1%), for which spatial resolutions < 50 μm are foreseen. The very good agreement between data and Monte Carlo simulation predictions will be also presented and discussed.

Collaboration

Mu3e

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