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The Mu3e scintillating fiber tracker R&D

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The Mu3e experiment searches for a rare lepton flavour 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 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. To match those requests the experiment has been design based on completely new technologies, one of that given by a tracker made of the thinnest available scintillating fibers coupled to silicon photomultipliers (SiPMs).

We will report in detail the status of the scintillating fiber tracker R&D, from the fiber through the photosensors up to the electronics and the data acquisition, and we will discuss the results obtained with our current prototypes. The final aim would be to provide a fiber tracker detecting 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 below 1 ns and spatial resolution below 100 μm. While expertise on scintillating fibers and SiPMs has been around for a while, nobody has ever built a detector that matches these demands. Current measurements show very promising results: a very high detection efficiency for m.i.p. with a single fiber layer (≥ 95%), and a full efficiency for multilayer configurations (≥ 99%); timing resolutions of the order of 500 ps (multilayer configuration); optical cross-talk between coated fibers at a negligible level (< 1%), for which spatial resolutions < 50 μm are foreseen (multilayer configuration). We will also discuss the very good agreement between data and Monte Carlo simulation predictions.

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