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Construction status and performance evaluation of the Straw-Tube Tracker for the COMET experiment

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The muon-to-electron (μ-e) conversion corresponds to the charged lepton flavor violating process, in which a muon captured by an atom converts into a single electron with constant momentum of 105 MeV/c in the case of an aluminum target. The COMET (COherent Muon-to-Electron Transition) experiment at J-PARC is going to search for μ-e conversion in aluminum, aiming for a sensitivity of 10^{-17}, improving the current limit by a factor of 10,000.

The COMET experiment uses a tracking detector known as the Straw-Tube Tracker to measure the momentum of electrons emitted from muonic atoms formed in the muon stopping target. To discriminate such signals from background events, the Straw-Tube Tracker is designed to provide a momentum resolution better than 200 keV/c around 105 MeV/c. The detector consists of 5 stations; each station is composed of 480 proportional counters (straw-tube chambers) made of 20 μm thick aluminized Mylar, each with a diameter of 10 mm, arranged with 240 tubes in both the horizontal and vertical directions. The electronics of the detector are called ROESTI (Read-Out Electronics for Straw Tube Instruments) and 30 ROESTI boards are installed per station. These boards are cooled by the chamber gas (Ar/C_2H_6) itself. The use of this low-mass detector in vacuum further enables strong suppression of multiple scattering.

Construction of the first and second stations has been completed, and 30 ROESTI boards have been implemented in the first station. Construction of the other stations is also underway, and all of the stations are planned to be constructed within fiscal year 2025.

The commissioning of the first station using the COMET beamline has been conducted, successfully achieving the first signal acquisition. Upgrades to the first station are underway to address the issues identified in the commissioning. Fundamental performance (e.g., gas amplification factor, intrinsic spatial resolution) of the first station was also evaluated. To achieve the required momentum resolution, a spatial resolution better than 200 μm is needed and the full-scale prototype achieved ~110 μm. To reach this in the first station, specific noise must be reduced. An offline analysis achieved a ~45% noise reduction. Further improvements in the first station's readout system are underway, and the required spatial resolution is expected after these upgrades.

The construction status and the details of performance evaluation studies will be reported.

Secondary track

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