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COMET Phase-Alpha Experiment to Investigate COMET's New Muon Beamline at J-PARC

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The COMET Phase-I and -II experiments will search for the muon-to-electron conversion process with a sensitivity improving the current upper limit on its branching ratio by a factor of 100 and 10000, respectively. An observation will be a splendid sign of the existence of physics beyond the standard model. The experiment utilises the world's highest-intense proton beam of J-PARC in Japan to generate a considerable number of muons from a fixed pion-production target through pion decays, and its secondary muon beamline is being constructed. In particular, the Transport Solenoid (TS), a bent solenoidal magnet, plays the most crucial role in transporting muons and separating them with their sign of charge and momentum amplitude. In order to study the muon beam and its transport, the COMET collaboration carried out an experiment called Phase-α in February and March of 2023.

Phase-α aims to inject J-PARC's proton beam to the COMET beamline for the first time, profile on the beam transported by the TS, and validate COMET's official simulation tool and data. We developed three detectors as follows. First, Muon Beam Monitor is a scintillating plastic fibre horoscope detector to measure the position and timing of the beam particles. Second, Straw Tube Tracker is a tracker with gaseous proportional chambers to measure its position and direction. Third, Range Counter is a series of scintillating plastic plates to count negative muons in the beam and identify positive pions. It also consists of a copper absorber plate, that lets negative muons stop and decay in it with a much shorter lifetime to be counted separately from other muons, and graphite plates to degrade muons' momentum and control their initial momentum to stop in the absorber. We also installed TiO_2 sensors to measure the primary protons and a beam-masking device in front of the TS to control the initial phase spaces of the transported secondary beam for a detailed investigation of the beam transport along the TS.

We succeeded in observing muon beams transported by the TS in the experiment and collected several datasets valuable to study its details, and the data analysis just began. This talk will present the details of the facility, experiment, and detectors, and show some preliminary results.

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