Contribution ID: **292** Contribution code: **TUE-PO1-104-03** Type: **Poster**

Design of a strong X-Y coupling beam transport line for J-PARC muon g-2/EDM experiment

Tuesday 16 November 2021 13:15 (20 minutes)

Design of a beam transport line for a newly developed three-dimensional spiral injection scheme is discussed. This transport line is unique and one of key equipment for a new experiment at J-PARC, which measures a muon anomalous magnetic moment (g-2) and electric dipole moment (EDM) to explore a new physics beyond the standard model. Very precise measurement on spin precession angular momentum of a muon in a high uniformity magnetic field will allow us to obtain these two fundamental physics values: g-2 and EDM. We apply medical MRI type superconducting magnet technology to perform +/-0.1ppm of high uniformity of three Tesla magnetic field. Relativistic energy of muon beam injection into such MRI sized magnetic field is the world first attempt. Because of axial symmetric field shape of a solenoid magnet, the beam phase-space should be strongly coupled in vertically (=solenoid axis) and radially (so called X-Y coupling), otherwise the stored beam diverges in vertically immediately. In order to avoid vertical dispersion of the stored beam, dedicated beam transport line is designed which realizes required X-Y coupling.
In this poster, we introduce (1) a transfer matrix of the entire beam transport line to meet required X-Y coupling, (2) arbitrarily angle rotating quadrupole magnets to realize X-Y coupling. We also discuss other challenges due to installation of the storage magnet (three Tesla superconducting magnet); (3) dedicated support system for arbitrary angle rotating quadrupoles on the 25-degrees tilted transport line with respect to the horizontal plane, (4) active shield steering magnets at the end of the transport line with connection to the storage magnet point. Finally, we will summarize specifications of all devices along the entire beam transport line and strategy of the beam commissioning of the muon beam injection into the MRI sized compact storage magnet.

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Session Classification: TUE-PO1-104 Accelerator Magnets II: fast cycling, injection, extraction