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Reconstructing the 3D Vector Magnetic Field from the Measured Scalar Magnitude $\|\vec{\mathbf{B}}\|$ in the Fermilab Muon g-2 Experiment[1] NATHAN FROEMMING, MIKE SYPHERS, Northern Illinois Univ, FERMILAB MUON G-2 EXPERIMENT (E989) COLLABORATION — Storage rings and beamline electromagnets with curved longitudinal axes have many applications in accelerator physics, medical physics, fusion & plasma research, as well as fundamental physics experiments like the Muon g-2 Experiment (E989) at Fermilab. In E989, the magnetic field of the muon storage ring is measured using proton-nuclear-magnetic-resonance spectroscopy, however, this technique only gives the scalar magnitude of the magnetic field, not the full 3 vector components. Here, we use toroidal harmonics and global optimization algorithms to explore a large number of candidate magnetic-field configurations plausibly encountered by muons orbiting in the g-2 storage ring, and we demonstrate that optimal candidate solutions agree well with available magnetic-field data. We also incorporate the reconstructed 3D vector magnetic fields into Geant4-based tracking simulations in order to quantify the effect of different magnetic-field configurations on measurements of the muon magnetic and electric dipole moments. The work presented here is generally applicable to situations in which toroidal harmonics are required to accurately model fields and/or sophisticated numerical techniques are needed to solve complex, high-dimensional optimization problems.

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