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Muon storage for the Muon g-2 Experiment at Fermilab (15' + 5')

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The muon storage ring for the g-2 experiment at Fermilab poses optimization challenges that couple directly to the statistical and systematic uncertainties of the measurement. The statistical uncertainty in the Muon g-2 Experiment at Fermilab is coupled to the number of measured positrons emitted by muons stored in a weak-focusing magnetic storage ring. The frequency that the ring is filled and the number of muons stored per fill determine the running time to achieve the experimental precision goal of 20 times the data obtained in BNL E821. Coherent betatron oscillation can introduce effects that must be controlled in the extraction of the muon spin precession frequency. Optimizing muon storage involves matching the final leg of the beamline with the storage ring acceptance, subject to very restrictive physical apertures.

The storage ring is anchored by a 7.11 m radius superconducting magnet with a highly uniform 1.45 T vertical magnetic. Additional components include four sets of electrostatic quadrupoles that provide vertical focusing, a series of collimators that define the allowed storage volume, a superconducting inflector magnet that provides a near field-free corridor though which the muons enter the magnet, and a fast magnetic kicker that places the incoming muons on orbit. In practice, relatively pure 120-ns-long bunches of 3.094 GeV/c polarized muons are injected through a hole in the back yoke of the C-shaped magnet, next through the inflector, which has a very narrow constriction, then into the ring. One quarter of the way around the first turn, the kicker imparts a $\sim$ 11 mrad outward deflection to the bunch. After a scraping scheme using the quadrupoles and collimators, muons orbit within a 9-cm circular aperture until they decay. We have used a variety of models to establish the expected storage rate and to demonstrate how tuning parameters affects this rate and the behavior of the stored beam. Instrumentation to provide feedback on rates and profiles of the beam at various locations has been developed. This talk will describe our expected muon storage rates, which exceed that obtained at BNL, as well as our studies of the stored beam dynamics.

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