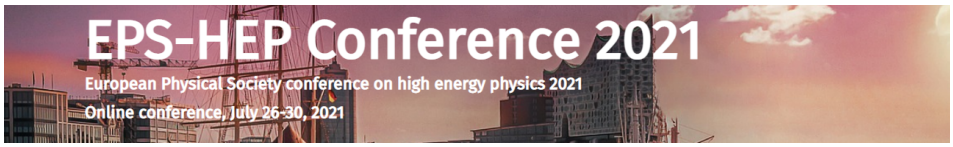

Contribution ID: **1065** Type: **Poster**

Precision measurement of the magnetic field in Run-1 of the Fermilab muon g-2 experiment

The muon $g-2$ experiment at Fermilab recently announced the measurement of the muon anomalous magnetic moment, a_μ, with a precision of 0.46 ppm [1]. The value is in excellent agreement with the previous Brookhaven measurement [2], and the combined average of the two values is in tension with the Standard Model prediction at the 4.2 σ level. The value of a_μ is determined from the ratio of two quantities that are measured in the experiment: ω_a, the anomalous muon spin precession frequency, and $\tilde{\omega_p}'$, the magnetic field weighted by the muon beam distribution. Both quantities must be measured with approximately equal precision in order to achieve the target precision on a_μ. The uncertainty on the run-1 measurement of a_μ is statistically dominated, and the systematic uncertainty contribution from $\tilde{\omega_p}'$ is 0.114 ppm.

In the experiment, a beam of polarized positive muons is injected into a magnetic storage ring with an extremely uniform vertical magnetic field of strength 1.45 T. In order to obtain a precise measurement of a_μ it is crucial to measure the magnetic field that is experienced by the muon beam throughout the experiment. The field in the muon storage region must be measured regularly (every few days) by an in-vacuum field-mapping 'trolley', which drives around the ring and maps out the field gradients. In between trolley runs, a suite of permanently installed NMR probes monitor drifts in the magnetic field over time, which are driven by tiny (ppm-level) changes in the magnet geometry. The final step in the analysis is to weight the magnetic field measurements by the measured muon beam distribution, which is continuously measured by straw tracking detectors.

This talk will cover details of the analysis techniques and results from the run-1 measurement of $\tilde{\omega_p}'$, as well as prospects for future improvements to the measurement.

[1] B. Abi et. al. (Muon g–2 Collaboration), Measurement of the Positive Muon Anomalous Magnetic Moment to 0.46 ppm, Phys. Rev. Lett. 126, 141801, 2021

[2] G. W. Bennett et. al., Final Report of the Muon E821 Anomalous Magnetic Moment Measurement at BNL, Phys. Rev. D 73, 072003, 2006

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Session Classification: T13 - Accelerator for HEP

Track Classification: Accelerators for HEP