

Magnetometry Cross-Calibration for Muon g-2 Experiments

Precise determination of the muon anomalous magnetic moment in a storage ring experiment relies equally on the ability to measure the muons' spin precession frequency and the magnetic field that the muons experience. In the Fermilab E989 Muon g-2 experiment, the 1.45 T magnetic field is regularly mapped by a "trolley" containing an array of 17 Nuclear Magnetic Resonance (NMR) probes filled with petroleum jelly. The petroleum jelly probes are calibrated twice per year against a water-filled NMR probe whose material perturbations to the magnetic field are precisely known; this provides an absolute calibration relating the frequency measured by the trolley probes to the precise value of the magnetic field in Tesla. Another muon g-2 experiment is currently under development in Japan at J-PARC which will require similar magnetometry to the Fermilab experiment, but at a field of 3 T. The specific NMR techniques for these two experiments differ slightly; Fermilab uses pulsed NMR, while the J-PARC experiment uses continuous-wave (CW) NMR. To verify that both groups' absolute calibration probes agree to high precision, J-PARC style CW-NMR probes and Fermilab-style pulsed NMR probes and the associated signal processing hardware and analysis for each were compared directly by making repeated measurements of the same field in a stable solenoid magnet at Argonne National Laboratory.

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