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Measurements for Control of Magnetic Field Related Systematic Effects for the PSI Neutron Electric Dipole Moment Experiment

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The neutron's electric dipole moment (nEDM) is an observable with extraordinary sensitivity to CP violating new physics phenomena. While the Standard Model predicts a negligibly small value, a wide variety of theories predict values within reach of current and next-generation searches. The PSI nEDM experiment took data in 2015 and 2016, and collected enough statistics to produce a new world-leading result, which is set to be published soon.

In the nearly seven-decade long history of the measurement, the sensitivity to this parameter has improved by six orders of magnitude. Though the results have typically been limited by counting statistics, a crucial part of every experiment has been the control of magnetic field related systematic effects. To this end, an extremely well controlled magnetic environment must be established and monitored using online magnetometry measurements. However, recent studies have shown that higher order magnetic field gradients can produce extremely large systematic effects, which cannot be adequately controlled using the online magnetometry systems.

To control these effects, an automated field mapper device was used in several measurement campaigns before and after datataking to measure the magnetic field at over 3000 points within the vacuum chamber using a fluxgate magnetometer. The field is decomposed in terms of 63 components in a specially chosen basis with convenient properties. These measurements are combined to reconstruct the field within the apparatus during datataking with sufficient accuracy to control systematic effects down to the few $*10^{-27}$ e cm level.

The mapping apparatus and technique used, the data analysis strategy and methods used to correct for these systematic effects will be presented and discussed.

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