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Bayesian Optimal Experimental Design for AGS Booster Magnet Misalignment Estimation

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Magnet control is important to improve beam quality as its misalignments cause beam degradation and prevent the beam from reaching the desired specifications (e.g., polarization). Magnet misalignment measurements serve as the reference values in operations and provide a foundation for effective control. However, use of the historical measurement data may cause a significant deviation from the target physical system, as the magnets shift over time. Due to a lack of accurate reference values, the current practice of beam control relies mainly on empirical tuning by experienced operators, which may be inefficient or sub-optimal. To address this, we propose a Bayesian optimal experimental design (BOED)-based approach for identifying the magnet misalignments using a Bmad model of the Booster –one of the synchrotrons in the RHIC pre-accelerator chain. In the present application, the BOED approach is used to determine magnet control variables (i.e., currents) which are expected to lead to beam position data that most reduces uncertainty in the magnet misalignment parameters. This data is then used to calibrate the physical model of the Booster, leading to a more accurate simulation model for future polarization optimizations. This case study represents a new calibration paradigm for accelerator operations that makes use of models and data to optimally guide experiments and, ultimately, improve polarization performance in RHIC via uncertainty reduction.

Primary Keyword

Secondary Keyword

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