Contribution ID: **16**   Type: **Poster**

Robust Real-Time Optimization of SIS18 Injection using Gaussian Process MPC

Tuesday, 31 March 2026 12:00 (2 hours)

We present advancements in the data-driven Model Predictive Control (MPC) framework for optimizing multi-turn injection (MTI) into the SIS18 synchrotron. Building on our prior work on safe, sample-efficient optimization, we systematically investigate the impact of current noise and transverse emittance fluctuations. By incorporating realistic error models derived from dedicated measurements of ion source and UNILAC fluctuations on current and emittance into XSuite simulations, we demonstrate that the Gaussian Process model effectively filters aleatoric uncertainty, maintaining robust operation where standard numerical optimizers degrade. Furthermore, we report on the successful deployment of the framework during live SIS18 tuning. The controller autonomously adjusted injection parameters, demonstrating reliable convergence, enhanced efficiency, and a substantial reduction in tuning iterations compared to model-free RL methods, which often face challenges in real-world applications. These results establish data-driven MPC as a powerful tool for real-time optimization in noisy, high-stakes accelerator environments, setting the stage for safe learning-based control across FAIR facilities.

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