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## **Data-Driven Model Predictive Control for Automated Optimization of Injection into the SIS18 Synchrotron**

In accelerator labs like GSI/FAIR, automating complex systems is key for maximising physics experiment time. This study explores the application of a data-driven model predictive control (MPC) to refine the multi-turn injection (MTI) process into the SIS18 synchrotron, departing from conventional numerical optimisation methods. MPC is distinguished by its reduced number of optimisation steps and superior ability to control performance criteria, effectively addressing issues like delayed outcomes and safety concerns, including septum protection.

The study focuses on a highly sample-efficient MPC approach based on Gaussian processes, which lies at the intersection of model-based reinforcement learning and control theory. This approach merges the strengths of both fields, offering a unified and optimised solution and yielding a safe and fast state-based optimisation approach beyond classical reinforcement learning and Bayesian optimisation.

Our study lays the groundwork for enabling safe online training for the SS18 MTI issue, showing great potential for the application of data-driven control in similar scenarios.

### **Possible contributed talk**

Yes

### **Are you a student?**

No

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