Beitrag ID: **18** Typ: **Invited talk**

Machine learning and advanced accelerator optimisation at GSI/FAIR

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The complexity of the GSI/FAIR accelerator facility demands a high level of automation to maximize the time for physics experiments. Accelerator laboratories across the globe are investigating numerous techniques to achieve this goal, including classical optimization, Bayesian optimization (BO), and reinforcement learning. This presentation will provide an overview of recent activities in these domains at GSI. Beginning with conventional optimization, the beam loss during the multi-turn injection into the SIS18 synchrotron was reduced from 40% to 15% in approximately 15 minutes, whereas manual adjustments may take up to 2 hours. The implementation of the Generic Optimization Framework & Frontend (GOFF) at GSI, supported by the EURO-Labs project, has significantly enhanced workflow, requiring only a few hours to adapt to new accelerators and optimization tasks. GOFF has also been effectively utilized at the GSI Fragment Separator (FRS) for beam steering and focusing. Additional experimental endeavors include closed-orbit correction for specific broken-symmetry high-transition-energy SIS18 optics using physically-informed BO, compared to traditional SVD-based correction. The data-driven model predictive control and physically-informed BO for automated injection optimization are currently under investigation via simulation.

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