## 3rd collaboration workshop on Reinforcement Learning for Autonomous Accelerators (RL4AA'25)



Contribution ID: 4

Type: Talk

## **Geoff: Applications and Developments in 2024**

Friday, April 4, 2025 9:00 AM (20 minutes)

The complexity of the GSI/FAIR accelerator facility demands a high level of automation in order to maximize time for physics experiments. Accelerator laboratories world-wide are exploring a variety of techniques to achieve this, from classical optimization to reinforcement learning.

*Geoff*, the Generic Optimization Framework & Frontend, is an open-source framework that harmonizes access to automation techniques and simplifies the transition towards them. It is maintained as part of the EURO-LABS project in cooperation between CERN and GSI.

We report on results that have been achieved with Geoff at GSI in 2024. The multi-turn injection of the SIS18 synchrotron has been optimized via multi-objective Bayesian optimization for the first time and a Pareto front has been built from real data. The existing optimization has also been analyzed in more detail. In addition, the use of a data-driven Gaussian Process Model Predictive Control (GP-MPC) framework has been studied in simulation.

We have also successfully used Geoff for beam centering and focusing at the GSI Fragment Separator (FRS). This task involved communication with multiple controls systems and between the different networks of the accelerator and the experiment complex. Algorithms as varied as track classification, distribution fitting and black-box optimization were used in tandem and demonstrate the flexibility of Geoff in the face of non-trivial user requirements.

In addition, Geoff has undergone a major update in 2024 that brings it in line with the latest developments of numerical and machine-learning software in the Python ecosystem.

Author: Dr MADYSA, Penny (GSI Helmholtzzentrum für Schwerionenforschung)

**Co-authors:** REINWALD, Christoph; KALLENDORF, Daniel (GSI Helmholtzzentrum für Schwerionenforschung); KAZANT-SEVA, Erika (GSI Helmholtzzentrum für Schwerionenforschung); WEICK, Helmut (GSI Helmholtzzentrum für Schwerionenforschung); BAJZEK, Martin (GSI Helmholtzzentrum für Schwerionenforschung); APPEL, Sabrina (GSI); PIETRI, Stephane (GSI Helmholtzzentrum für Schwerionenforschung)

Presenter: Dr MADYSA, Penny (GSI Helmholtzzentrum für Schwerionenforschung)

Session Classification: Talks