Karlsruhe Institute of Technology

Innovation Pool 2021

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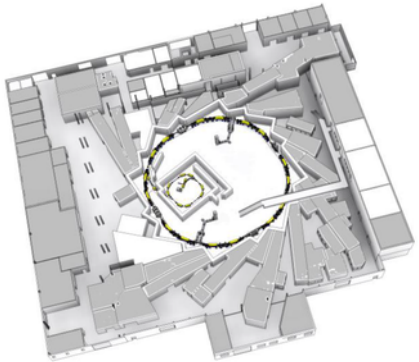
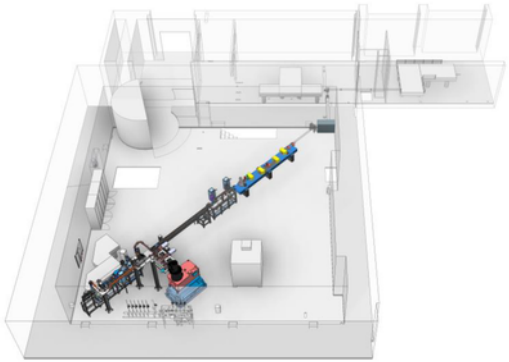
Laboratory for Applications of Synchrotron Radiation (LAS)
Institute for Beam Physics and Technology (IBPT)

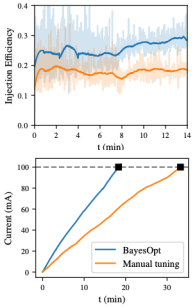




Bayesian Optimization of Injection Efficiency at KARA (2019-2020)

"Parameter tuning of accelerators is known to be a very challenging and time-consuming task, as it usually involves non-linear systems and high dimensional parameter spaces. One example is the beam injection process at Karlsruhe Research Accelerator (KARA) "

Achieved: development of a basic optimization framework for the beam injection problem at KARA by tuning up to 9 parameters.



Timing Modes for Advanced Light Sources Project (2019-2022)

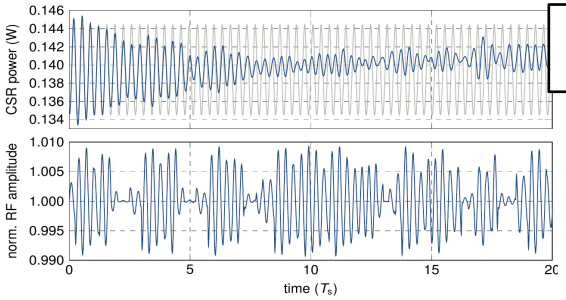
In collaboration with T. U. Dortmund & Helmholtz-Zentrum Berlin

Federal Ministry of Education and Research

"The timing user community demands a large flexibility and variability in pulse length and pulse repetition rate. The main goal is to develop new timing modes for existing user facilities, trying to fulfil many of the user requests"

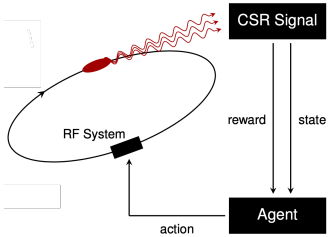
Purpose: development of a longitudinal feedback system to control the micro-bunching instability within short bunches with RL.

Current status: control of the instability via RF amplitude modulations has been achieved in simulations with manual control. The training of the RL agent is ongoing. The development of the feedback system in the accelerator has started.



RL algorithm controlling the CSR signal in simulation

Hardware development and programming in collaboration with Andreas Kopmann (Institute of Data Processing and Electronics)



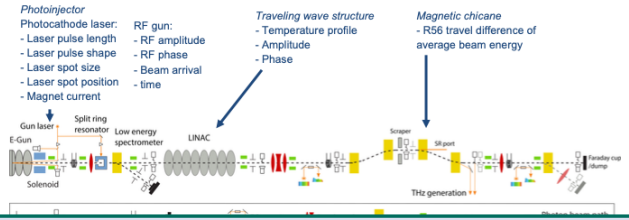
Machine Learning toward Autonomous Accelerators Project (2020-2022)

In collaboration with DESY (coordinating PI: Annika Eichler)

"Modern accelerator facilities are growing in complexity, with increased demand on availability, reliability, flexibility and number of operation modes. The goal of this project is to apply RL for accelerator control with the long-term goal of autonomous start-up"

Purpose: focusing on a subset of control tasks, the longitudinal bunch profile control in ARES and FLUTE. This is to be extended to the transversal bunch profile, laying the pathway to autonomous start-up.

Current status: funded with 200 k€. First funds requested for October 2020. Possibilities for synergy with AMALEA.



KIT long-term goals: R&D in automatization of accelerator control and operation modes. Proposals of further activities:

- Orbit control at KARA (adaptive machine learning feedbacks for time varying systems that depend on many coupled parameters).
- Forest methods and CNNs for anomaly detection (e.g. faulty BPMs) and forecasting (e.g. beam interlocks).
- More applications of Gaussian processes for online tuning (e.g. control vertical emittance by tuning quadrupoles).
- Use the network for knowledge exchange and joined activities and publications.