

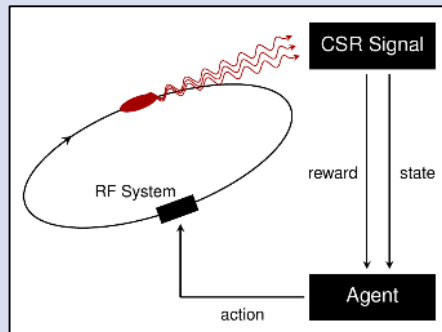
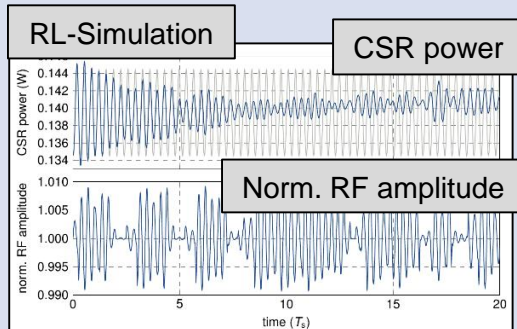
Machine Learning Applications

Andrea Santamaria Garcia, Erik Bründermann, Anke-Susanne Müller
KfB-Workshop »Verbundforschung in der Physik der kleinsten Teilchen« - 07.09.2020

Laboratorium für Applikationen der Synchrotronstrahlung (LAS)

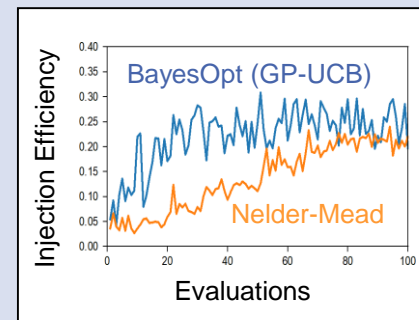
Micro-Bunching Control with Reinforcement Learning

Demonstration of RL-based MB control in simulations using in-house developed Vlasov-Fokker-Planck solver Inovesa



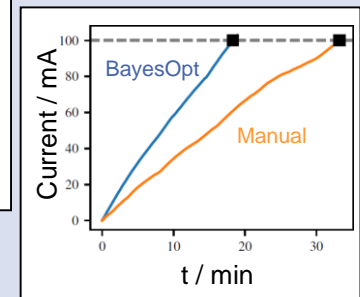
T. Boltz (KIT LAS) et al.,
IPAC2019, MOPGW017

Inject 2x faster than manually



C. Xu (KIT LAS)
Master thesis

Bayesian optimization



Machine Learning Applications

- **Overall Aim:** R&D for Machine Learning (ML) algorithms and their transferability
 - Incl. Big Data analysis and Reinforcement Learning (RL) to progress towards Autonomous Accelerators
- **Background**
 - **Big Data:** Advanced diagnostics and simulations lead to multi-TB data
 - **Experience in applications:** Big Data analysis (classification / unsupervised, supervised) and RL
 - Classification of micro-bunching instability data
 - Very successful injection-optimization with **Bayesian optimization** at storage ring KARA demonstrated
 - Reinforcement Learning demonstration for accelerator control at **storage ring KARA** and in future: **linear accelerators**
 - Collaboration with groups in informatics
 - CERN-KIT collaboration on **magnet technologies** and **damage studies**
- **Objectives/Interests**
 - Test ML algorithms at accessible electron accelerators and at recorded data
 - Compared to CERN: at low energies and in safe conditions
 - Investigate ML for **time series analysis:** from 'Data' to 'Online'
 - With transferability: for example applicable to magnet quench detection and towards prognosis
- **Partners:** CERN, KIT LAS (accelerator physics), KIT IAR (informatics/robotics), TU Dortmund, ...
 - KIT IBPT (access to test facilities: KARA and FLUTE)
- **Resources:** 1 FTE 18 months (PostDoc), 1 FTE 36 months (PhD student), Travel/Consumables: 20k€
- **Contact:** KIT LAS (A. Santamaria Garcia, A.-S. Müller) and at **KfB Workshop (E. Bründermann)**

