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Type: **Invited Talk**

## Real-time control with reinforcement learning at KARA

*Monday, February 5, 2024 1:00 PM (30 minutes)*

Reinforcement Learning (RL) has demonstrated its effectiveness in solving control problems in particle accelerators. A challenging application is the control of the microbunching instability (MBI) in synchrotron light sources. Here the interaction of an electron bunch with its emitted coherent synchrotron radiation leads to complex non-linear dynamics and pronounced fluctuations.

Addressing the control of intricate dynamics necessitates meeting stringent microsecond-level real-time constraints. To achieve this, RL algorithms must be deployed on a high-performance electronics platform. The KINGFISHER system, utilizing the AMD-Xilinx Versal family of heterogeneous computing devices, has been specifically designed at KIT to tackle these demanding conditions. The system implements an experience accumulator architecture to perform online learning purely through interaction with the accelerator while still satisfying strong real-time constraints.

The preliminary results of this innovative control paradigm at the Karlsruhe Research Accelerator (KARA) will be presented. Notably, this represents the first experimental attempt to control the MBI with RL using online training only and running on hardware.

### Possible contributed talk

Yes

### Are you a student?

No

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**Session Classification:** Invited Talks