

# Autonomous Optimization of RF Triple Splitting in the CERN PS

*Tuesday, 31 March 2026 12:00 (2 hours)*

Reinforcement learning (RL) is a powerful technique for optimizing complex beam manipulations. An RL-based autonomous controller has been developed for the triple splitting RF manipulation in the CERN Proton Synchrotron (PS), essential to establish the bunch spacing for the LHC. The system combined a convolutional neural network for initial phase correction with sequential soft actor-critic agents optimizing the RF parameters. Trained with simulated bunch profile data, the controller demonstrated robust and rapid convergence during early beam tests. This motivated the deployment as an on-demand tool and later as a fully autonomous controller. However, changes to the RF voltage program or operating conditions would require offline simulation, dataset regeneration, and retraining. With the experience gained running the RL controller, its replacement by a PID-based solution requiring only gain tuning while achieving comparable performance has been completed. This case study highlights both the strengths and limitations of RL for autonomous accelerator control and underlines maintainability as a key criterion operational implementations.

## Student

No

**Primary author:** WULFF, Joel (CERN)

**Co-authors:** LASHEEN, Alexandre (CERN); BEECKMAN, Amaury (CERN)

**Presenter:** WULFF, Joel (CERN)

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