

# Generalised Automatic Harmonic Operation in the CERN Proton Synchrotron Booster

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

The Proton Synchrotron Booster (PSB) is equipped with a wideband radio-frequency (RF) system operated at multiple harmonics of the revolution frequency. Beyond acceleration, it stretches the protons bunches to mitigate space-charge effects. To maximize the bunch length throughout the entire acceleration cycle, three RF voltages at different harmonics and their relative phases must be tuned. However, imperfect signal-path compensation, heavy beam loading, and changing operating conditions require tedious adjustments for each beam type and intensity. To automate this optimization, we developed a memory-enhanced reinforcement-learning controller based on long-short term memory (LSTM) cells that learn iterative, profile-based corrections without supervised targets. Trained with simulated data including realistic artifacts and noise, the model was validated with beam. The contribution summarizes the design, training, and validation process.

## Student

Yes

**Primary author:** Mr PASTINANTE, Anibal Luciano (CERN/TU Delft)

**Co-authors:** WULFF, Joel (CERN); Dr ALBRIGHT, Simon (CERN)

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

**Session Classification:** Poster session