

5th ICFA Beam Dynamics Mini-Workshop on Machine Learning for Particle Accelerators



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Type: **Invited talks**

Eliminating mains noise with Machine Learning-15'+5'

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Power supply ripples at various frequencies - characteristic to the magnet circuits or from the electrical network - have always been an issue in accelerator operations, with several mitigation measures put in place over the years. This contribution summarises recent efforts in the CERN SPS to compensate the ripple at 50 Hz and its harmonics in the main quadrupole circuits with ML methods. It will start with introducing the detrimental effects of the ripple at low energy for LHC-type beams and at top energy for slow extracted beams. For optimal conditions of slow extracted beams, a continuous control algorithm had to be conceived. The implementation required hardware modifications on the power converter electronics side, additional new controls infrastructure and the development of adaptive algorithms that can deal with the changes of the electrical distribution network throughout the day. Adaptive continuous control with adaptive Bayesian Optimisation has been in place for slow extracted spill control throughout 2024. The obtained improved spill quality over the year will be discussed. First impressive results with 50 Hz compensation for the LHC ion cycles in the SPS during the ion run at the end of 2024 will also be presented. Finally, ideas for further R&D towards one-shot corrections for beams that are only played on-demand (i.e. LHC beams) will be proposed.

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