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Operational results of data-driven automated intensity optimization at CERN's LEIR

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At CERN's Low Energy Ion Ring (LEIR), high beam intensities are achieved through phase space painting with up to eight multi-turn injections from the linear accelerator Linac3. After each injection, the beam is cooled and stacked in longitudinal phase space using an electron cooler. During beam operation, key parameters such as RF cavity phases in the linac, the LEIR electron cooler gun voltage, and various magnetic field strengths along the transfer line must be frequently adjusted to compensate for the injection performance degradation occurring over time. The primary cause is the aging of the stripper foil, a thin carbon plate which strips off electrons from the passing ions, altering the energy of the beam injected from the linac. Time of flight measurements in the linac and Schottky signals in the ring provide the necessary diagnostics for correcting the performance degradation and can be encoded to provide a state for an optimizer. In this paper, we compare several data-driven methods, such as Bayesian Optimization and Reinforcement Learning for designing an autonomous controller to optimize and maintain injection performance during both beam commissioning and physics runs.

Footnotes

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