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Exploring Reinforcement Learning for Optimal Bunch Merge in the AGS

In BNL's Booster, the beam bunches can be split into two or three smaller bunches to reduce their space-charge forces. They are then merged back after acceleration in the Alternating Gradient Synchrotron (AGS). This acceleration with decreased space-charge forces can reduce the final emittance, increasing the luminosity in RHIC and improving proton polarization. Parts of this procedure have already been tested and are proposed for the Electron-Ion Collider (EIC). The success of this procedure relies on a series of RF gymnastics to merge individual source pulses into bunches of suitable intensity. In this work, we explore an RF control scheme using reinforcement learning (RL) to merge bunches, aiming to dynamically adjust RF parameters to achieve minimal longitudinal emittance growth and stable bunch profiles. Initial experimental results and ongoing system developments are presented and discussed.

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