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Using RL to maximize luminosity at BEPCII

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BEPCII is a double-ring collider operates in the decay mode, as beam currents decrease over time, the beam orbits need to be continuously adjusted to maintain the optimum collision conditions. This job was primarily performed manually, with operators scan three offset knobs (x, y, y') based on the luminosity. There is a critical need to implement advanced automated control method. However, the feedback methods are ineffective due to the constraints imposed by machine characteristics. The optimization method are also limited by the slow response speed of BEPCII and have intrinsic limitations. Reinforcement Learning (RL), which learns from past experiences, provide a new approach for handling such problems. In this work, we implemented two automated control methods: the dither method and the Deep Q-Network (DQN) method. The dither method is a numerical optimization method. we use it to provide more training data to DQN to expedite training. It is also used as acomparison of optimization efficiency. With the help of the historical data from the dither method, we successfully trained a DQN agent to control the offset knobs to optimize luminosity. The DQN method successfully demonstrated superior performance compared to the dither method, showcasing a faster optimization speed and higher resulting integral luminosity.

Footnotes

Funding Agency

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Yes

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