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Toward autonomous control: reinforcement learning for improving CLEAR accelerator performance

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Particle accelerators like CLEAR (CERN Linear Accearator for research) are essential tools in advancing various scientific fields. Automating their operation to ensure stability and reproducibility is crucial for future large-scale projects. This paper explores the first steps toward autonomous control of the CLEAR beamline, focusing initially on beam steering and advancing to complex tasks like quadrupole alignment, vital for operational stability. Reinforcement Learning (RL) agents that adapt in real-time via beam screens measurements were trained and tested. The approach is optimized for sampling efficiency, addressing the high cost and invasiveness of data collection in accelerator environments. The method enables single-shot optimization for real operations, reducing the need for manual intervention.

Results show that a few hours of training suffice for effective single-step corrections in the latter part of the CLEAR beamline, inspiring further development by the CLEAR research team.

Footnotes

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