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Efficient Beam Tuning with Surrogate-Model Based Reinforcement Learning

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Beam tuning in particle accelerators is a complex task, especially when physical modeling is impractical due to the lack of complete beam diagnostics. Manual, iterative adjustment by operators is time-consuming and often fails to converge rapidly on optimal settings.

We propose a reinforcement learning (RL) approach accelerated by a surrogate model trained on limited online data, enabling efficient exploration of the control parameter space. The surrogate model predicts beam responses with sufficient fidelity to guide the RL agent's policy updates, dramatically reducing the number of real-machine evaluations required. We apply this framework to the High-Intensity Proton Injector (HIPI), demonstrating that the surrogate-assisted RL agent achieves robust beam transmission rates of approximately 90% within minutes of online deployment. This strategy provides a practical for automated beam optimization.

Footnotes

Funding Agency

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Yes

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