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On-line beam synchronous phase measurement using deep learning models

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The on-line calibration of beam synchronous phase (SP) is crucial for enhancing the operational efficiency of accelerators. Recently, we developed an artificial intelligence (AI)-based beam information measure model that uses transient beam loading information as input while simultaneously predicting beam current and SP. This method employs Long Short-Term Memory (LSTM) to extract multi-dimensional radio frequency (RF) time-series features and incorporates an attention mechanism to evaluate the weights of RF waveforms at different times. The method can work in complex operating conditions such as open-loop, closed-loop, and with or without cavity detuning, and has higher precision and stronger generalization capabilities compared to other online calibration method of SP (such as those based on cavity differential equations or RF beam vector). We validated the consistency of the algorithm results with BPM and BCM measurements on the Buncher of European Spallation Source. Our method achieves an mean absolute error of 0.28° for predicting SP and 0.47 mA for predicting beam current, showing very promising results.

Footnotes

Funding Agency

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Yes

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