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Integrating Machine Learning in Bunch-by-Bunch Feedback Systems for CEPC

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For accelerators like CEPC, which have extremely large storage rings, there is a significant issue with beam instability, making it necessary to employ feedback systems to suppress these instabilities. The damping time that feedback system can provide includes the time for signal acquisition and processing. In traditional bunch-by-bunch feedback systems, the filter processes signals that require data collection over multiple turns. The effect of this data acquisition time on the damping time is not prominent in smaller circumference storage rings, but it can become a major issue in the CEPC, potentially resulting in damping times comparable to the instability growth times. By utilizing appropriate machine learning techniques, it is possible to train on a large dataset of beam oscillation signals to directly compute the feedback signals required for the beam, significantly shortening the data acquisition time, achieving faster damping times than traditional feedback systems, and even realizing single-turn feedback. This project creatively integrates machine learning with the design of the bunch-by-bunch feedback system, exploring new possibilities for the feedback systems required for ultra-large storage rings.

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