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Modeling of CSR and its cancellation in DBA/Chicane type compressors

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In advanced accelerator-based light sources and colliders, bunch compressors like arc-type (DBA) and linear-type (chicane) are widely used to generate high-quality electron beams with kiloampere (kA)-level peak currents. However, a serious problem in increasing the peak current even higher is the significant degradation of beam quality caused by the Coherent Synchrotron Radiation (CSR) effect. To tackle this, we develop a new analytical model for CSR that can describe beam transport with varying bunch lengths, establish a practical framework for analyzing CSR in both DBA and chicane-type compressors, and design CSR-suppressed DBA compressors (arc-type) as well as non-symmetric C- and S-shaped chicanes (linear-type). General analytical conditions for CSR cancellation are derived for these designs. Simulations show that, with these new compressors, high beam quality can be maintained even when the peak current is increased up to 10 kA. This work provides important guidance for enhancing the performance of existing accelerator facilities, as well as for the development of next-generation accelerator-based light sources and colliders.

Footnotes

Funding Agency

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Yes

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