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Parametric resonance in a heavy ion synchrotron

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The Heavy Ion Research Facility in Lanzhou (HIRFL) is a globally significant full-ion acceleration system. Its Cooler Storage Ring (CSR) facility demonstrates versatile capabilities in beam accumulation, cooling, and acceleration. During operational cycles, periodic beam losses have been observed, prompting an investigation into their root causes.Our study focused on analyzing analog dipole magnet power supply ripple currents and magnetic field fluctuations. Through combined experimental measurements and numerical simulations, we established a causal relationship: magnetic field jitter induced orbit distortion, which perturbed beam phase and triggered parametric resonance. The phenomenon was particularly pronounced when the synchrotron tune approached the ripple frequency during acceleration cycles.To address this issue, we replaced the legacy analog power supply system with a digital counterpart. This upgrade achieved a 10-100× reduction in ripple amplitude, effectively suppressing the previously observed beam losses associated with parametric resonance. The findings provide valuable insights for optimizing heavy ion accelerator performance in similar facilities.

Footnotes

Funding Agency

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Yes

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