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Longitudinal collective dynamics in laser modulators of an SSMB storage ring based on macroparticle model

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The mechanism of the steady-state microbunching (SSMB) storage ring is being actively investigated. In the conceptual design, a laser modulator used to modulate the electron beam include the co-propagating laser beam, undulator magnets and potential cavity mirrors, forming a laser modulator cavity. In this work the longitudinal single-bunch and multi-bunch collective dynamics are studied that may arise due to coherent undulator radiation, based on the macroparticle model. For multi-bunch multi-turn case, the dispersion equation is derived, and a detuning parameter is introduced to characterize the frequency deviation between the external laser and the resonant undulator radiation, and solve for the instability growth rates of different multibunch modes. When the detuning approaches a specific multi-bunch mode divided by the number of total microbunches, this instability mechanism tends to amplify that mode. Furthermore, possible mitigation effect of the potential well on the instability is discussed. This work may shed light on the underlying physical mechanisms of longitudinal collective beam dynamics in the laser cavity modulators of an SSMB storage ring.

Footnotes

Funding Agency

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