Analysis and Simulation of Beam-Beam Effects in a Linac-Ring Collider

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A linac-ring collider was earlier proposed by Grosse-Wiesmann as an alternative to the ring-ring collision scenario. Recently such linac-ring collision scheme has been actively studied for Electron Ion Colliders (EIC). The advantages of using a linac for the electron beam is that it avoids the limitations of beam-beam tune shift inherent in a storage ring, retains good beam quality and high polarization. However, the relative high disruption of the electron beam during the beam-beam interaction makes its effect on the stability of the beam in the storage ring an important issue. In this talk, the analytical and numerical study of the beam-beam effects for linac-ring colliders will be presented. A strong-strong beam-beam simulation based on the macroparticle model was developed for the linac-ring design, which has been benchmarked with results of flip-flop beam-beam instability in a ring-ring collider. For the earlier linac-ring B factory design study, this simulation revealed strong kink beam-beam instability with head-tail effect. Our analysis of this effect confirmed the numerical observation and provided further understanding of the process. For recently proposed linac-ring EIC designs, we used two-particle model and Vlasov approach to study this strong head-tail beam-beam instability based on linear beam-beam force approximation. Analytical and numerical studies of the full nonlinear beam-beam effects are still underway.