



Contribution ID: 2101 Contribution code: SUPG026

Type: Student Poster Presentation

Study of the beam-beam interaction in an electron-positron collider with large Piwinski angle and crabbed waist

Sunday, 19 May 2024 16:00 (2 hours)

To achieve very high luminosity, the next generation circular colliders adopt the crab waist collision scheme with a large Piwinski angle. In this scheme, beams collide with high current, low emittances, and small beta functions at the interaction point (IP). However, several effects arising from these extreme parameters, especially the coherent X-Z instability, will significantly impact the collider's performance, necessitating dynamic processing of longitudinal motion in a three-dimensional self-consistent treatment. The transverse vibration becomes coupled with the longitudinal motion, as well as the increase in horizontal beam size alters the interaction between beams and corresponding beam-induced effects. These instabilities limit the stable high luminosity area for the selected working point of the original design. Therefore, it is necessary to optimize the safe area of the working point by readjusting the parameters of the IP. In this paper, based on the Super Tau-Charm Facility (STCF) project in China, the instability caused by beam interactions is studied through numerical simulation. The relationship between the parameters at the IP and the stable selection area of the working point is systematically explored. The regularities found from simulations can assist future high luminosity electron-positron colliders in selecting the corresponding parameters. Additionally, some methods, such as adding adjustable devices to achieve stable high luminosity, are also proposed.

Footnotes

Funding Agency

Paper preparation format

Region represented

Asia

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Session Classification: Student Poster Session

Track Classification: MC5: Beam Dynamics and EM Fields: MC5.D10 Beam-Beam Effects Theory, Simulations, Measurements, Code Developments