Contribution ID: **2776** Contribution code: **SUPM072** Type: **Poster Presentation**

Calculation for a compact laser plasma undulator beamline based on the experimental electron parameters at NCU

Sunday, 7 May 2023 16:00 (2 hours)

Laser-wake field accelerators (LWFAs) are potential candidates to produce intense relativistic electron beams to drive compact free electron lasers (FELs) in VUV and X-ray regions. In High-Field Physics and Ultrafast Technology Laboratory at National Central University (NCU), an LWFA is being developed to produce a 250 MeV high-brightness electron beam by their 100-TW laser system. An FEL seeded by a 266-nm UV laser is under design to generate extreme ultraviolet (EUV) radiation. The initial phase of the project is to develop a beam energy modulator through the interaction of the LFWA-produced electron beam with the 266-nm seed laser in a 10-period planar undulator of 35-mm period length. An electron beamline has been designed based on linear optics to deliver the intense electron pulse from LWFA to the undulator and focus properly. However, due to the large energy spread of the beam, chromatic effects on beam transportation may be severe. In this work, we perform a detailed simulation of the LWFA FEL from experimental data of the NCU LWFA electron source. A 6D phase space analysis of multi-particle dynamics using IMPACT code [1] is to determine how significant the effects of beam energy spread on beam properties along the beamline are. The electron beam is then transferred to GENESIS [2] and Puffin [3] to see the laser beam interaction in the undulator. Further study of the HGHG scheme is evaluated using both FEL codes to see the influence of ultra-short electron bunch.

Funding Agency

Footnotes

"[1] Ji Qiang, Robert D. Ryne, Salman Habib, Viktor Decyk.An Object-Oriented Parallel Particle-in-Cell Code for Beam Dynamics Simulation in Linear Accelerators.,Journal of Computational Physics,Volume 163,Issue2,Pages 434-451(2000)"
"[2] S.Reiche, GENESIS 1.3: a fully 3D time-dependent FEL simulation code., Nucl.Instrum. Methods Phys. Res., Sect.A 429,243 (1999)."
"[3] L. Campbell and B. McNeil, Phys. Plasmas 19, 093119 (2012)."

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Session Classification: Student Poster Session