Contribution ID: **16** Contribution code: **MOP12** Type: **Contributed Poster**

Analysis of Ultra-Short Bunches in Free-Electron Lasers

Monday, 22 August 2022 17:10 (20 minutes)

Free-electron lasers (FELs) operate at wavelengths from millimeter waves through hard x-rays. At x-ray wavelengths, FELs typically rely on self-amplified spontaneous emission SASE emission which contains multiple temporal "spikes"that limit the longitudinal coherence of the optical output; hence, alternate methods that improve on the longitudinal coherence of the SASE emission are of interest. In this paper, we consider electron bunches that are shorter than the SASE spike separation.1 In such cases, the spontaneously generated radiation consists of a single optical pulse with improved longitudinal coherence than is found in typical SASE FELs. To investigate this regime, we use two FEL simulation codes. One (MINERVA) uses the slowly-varying envelope approximation (SVEA) which breaks down for extremely short pulses. The second (PUFFIN) is a particle-in-cell (PiC) simulation code that is considered to be a more complete model of the underlying physics and which is able to simulate very short pulses. We first anchor these codes by showing that there is substantial agreement between the codes in simulation of the SPARC SASE FEL experiment at ENEA Frascati. We then compare the two codes for simulations using electron bunch lengths that are shorter than the SASE spike separation. The comparisons between the two codes for short bunch simulations elucidate the limitations of the SVEA in this regime but indicate that the SVEA can treat short bunches that are comparable to the cooperation length.

1. L.T. Campbell, H.P. Freund, J.R. Henderson, B.W.J. McNeil, P. Traczykowski, and P.J.M. van der Slot, "Analysis of Ultra-Short Bunches in Free-Electron Lasers,"New. J. Phys. 22, 073031 (2020).

*The research used resources of the Argonne Leadership Computing Facility, which is a DOE Office of Science User Facility supported under contract DE-AC02-06CH11357. We also thank the University of New Mexico Center for Advanced Research Computing, supported in part by the National Science Foundation, for providing high performance computing resources used for this work .Funding is also acknowledged via the following grants: Science and Technology Facilities Council (Agreement Number 4163192 Release #3); ARCHIE-WeSt HPC, EPSRC grant EP/K000586/1; John von Neumann Institute for Computing (NIC) on JUROPA at Jülich Supercomputing Centre (JSC), project HHH20. The authors acknowledge helpful discussions with L. Giannessi

I have read and accept the Privacy Policy Statement

Yes

Primary authors: FREUND, Henry (University of New Mexico); Dr HENDERSON, James (University of Strathclyde); Dr TRACZYKOWSKI, Peter (University of Strathclyde); Dr MCNEIL, Brian (University of Strathclyde); Dr CAMPBELL, Lawrence (University of Strathclyde); VAN DER SLOT, Peter (University of Twente)

Presenter: FREUND, Henry (University of New Mexico)

Session Classification: Monday posters

Track Classification: FEL Theory