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Plasma channel undulator excited by high-order laser modes. JINGWEI WANG, Helmholtz Institute Jena, CARL SCHROEDER, Lawrence Berkeley National Laboratory, MATT ZEPF, SERGEY RYKOVANOV, Helmholtz Institute Jena — The possibility of utilizing plasma undulators and plasma accelerators to produce compact and economical ultraviolet and X-ray radiation sources has attracted considerable interest for a few decades. This interest has been driven by the great potential to decrease the threshold for accessing such sources, which are now mainly provided by a very few dedicated large-scale synchrotron or free-electron laser (FEL) facilities. However, the typically broad radiation bandwidth of such plasma devices limits the source brightness and makes it difficult for the FEL instability to develop. Here, using multi-dimensional electromagnetic particle-in-cell simulations, we demonstrate that a plasma undulator generated by the beating of a mixture of high-order laser modes propagating inside a plasma channel, leads to a few percent radiation bandwidth. The strength of the undulator can reach unity, the period can be less than a millimeter, and the total number of undulator periods can be significantly increased by a phase locking technique based on the longitudinal density modulation. According to analytical estimates and simulations, in the fully beam loaded regime, the electron current in the undulator can reach 0.3 kA, making such an undulator a potential candidate towards a table-top FEL.

Jingwei Wang
GSI Darmstadt

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