Contribution ID: 497

Towards improved control of laser-wakefield accelerators with multidimensional parameter scans

The quality of electron beams generated by laser wakefield accelerators (LWFAs) is constantly improving to the point where it is now possible to operate novel light sources such as free-electron lasers (FELs), as has been achieved at various facilities. However, this method is still limited by the fluctuations of the electron beam properties, which are difficult to control due to the non-linear nature of injection, cavity formation and laser propagation. This becomes increasingly difficult when aiming at X-ray FEL wavelengths.

We present an in-depth simulation study in which we have reconstructed an experimental LWFA setup with self-truncated ionisation injection (STII) as the injection mechanism using realistic 3D particle-in-cell (PIC) PIConGPU simulations combined with the automated workflow engine Snakemake. Based on the reconstruction, we have created a multidimensional mapping of electron beam parameters to laser and plasma parameters. With these results we present requirements for the laser and plasma configuration to ensure the appropriate onset and truncation of the injection process. In addition, a study of the spectral and longitudinal charge distribution on laser dispersion and focussing in the STII regime is presented. These results are confirmed with experimental observations obtained in a FEL campaign.

Primary author: TIEBEL, Jessica (HZDR)

Co-authors: PAUSCH, Richard (Helmholtz-Zentrum Dresden - Rossendorf); BUSSMANN, Michael (HZDR); CARSTENS, Finn-Ole (Helmholtz-Zentrum Dresden - Rossendorf e. V.); DEBUS, Alexander (Helmholtz-Zentrum Dresden-Rossendorf); HER-RMANN, Franziska Marie (Helmholtz-Zentrum Dresden-Rossendorf); IRMAN, Arie (Helmholtz Zentrum Dresden Rossendorf); SCHOEBEL, Susanne (Helmholtz-Zentrum Dresden-Rossendorf); STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf); WIDERA, René (Helmholtz-Zentrum Dresden - Rossendorf); SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: TIEBEL, Jessica (HZDR)

Session Classification: Poster Session

Track Classification: PS4: Theory and simulations