EUROPEAN NETWORK FOR NOVEL ACCELERATORS
EuroNNAc4
NPACT supported by EU via I-FAST

Contribution ID: **54** Type: **Poster (student)**

Hybrid LWFA-PWFA: A stability and beam-quality booster for laser-generated electron beams

Monday, September 19, 2022 7:15 PM (1 hour)

Laser-wakefield acceleration (LWFA) has been investigated as a possible route towards a compact, high-gradient replacement for current RF-based accelerator technology. LWFAs recently made huge progress in terms of achievable energy (multi-GeV), charge (~nC), current (up to 100 kA) and spectral charge density (up to 20pC/MeV). However, due to the sensitive dependence on driver fluctuations and heating by the laser, it remains extremely challenging to generate stable and low emittance electron bunches in LWFA.
In particle driven wakefield acceleration (PWFA) some of these problems can be attributed. So far, however, such research was only possible on a few large-scale accelerator facilities. In past experiments we showed that also high current LWFA-generated electron bunches from 100-TW-class laser facilities are suited as drive beams for PWFA –demonstrating wakefield generation and the injection and acceleration of witness beams.
This contribution summarizes our recent experiments, demonstrating the insensitivity of PWFA to fluctuations in driver energy, making the hybrid scheme comparable or even more stable than pure LWFA. Moreover, due to the high energy transfer efficiency and cold witness injection in our PWFA, the spectro-spatial charge density of our witness beams exceeds that of the LWFA-generated drive beam, giving a real-world performance boost to LWFAs.

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Session Classification: Poster Session