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Ultra-high current designer beam generation via laser heater shaping at FACET-II

Precise control of the longitudinal distribution of an electron beam enables new opportunities for accelerator applications, such as high transformer ratio plasma wakefield acceleration or reduced beam degradation from the microbunching instability. Electron beam shaping can be achieved through the use of a laser heater which exploits the coherent interaction between a laser pulse and an electron beam in a magnetic undulator to increase the beam's slice energy spread. By tailoring the properties of the laser heater, it is possible to modulate the beam's current profile on-demand, enabling the generation of designer electron beams tuned for specific applications.

We present the experimental results of using a laser heater to manipulate the electron current profile at the FACET-II facility. We demonstrate the impact of the laser heater's temporal profile on shaping the beam current, with an emphasis on the production of fs-duration current spikes with ultra-high ~0.1 MA peak current. Using these beams, we observe the enhancement or controlled suppression of beam-driven ionization in a He gas target. These beams have further been used to benefit the broader science program at FACET-II including aiding experiments studying narrow plasma column generation, density down ramp injection and probing the transition between wakeless and plasma-wakefield regimes. Our combined simulations and experiments offer an improved understanding of the generation and potential applications of such current spikes, providing another approach for optimizing advanced accelerator performance for future applications.

Working group

WG5 : Beam sources, monitoring and control

Primary authors: EMMA, Claudio (SLAC); MAJERNIK, Nathan (SLAC); SWANSON, Kelly (SLAC)

Co-authors: MARINELLI, Agostino (SLAC National Accelerator Laboratory); HOGAN, Mark (SLAC); O'SHEA, Brendan (SLAC National Laboratory)

Presenter: EMMA, Claudio (SLAC)

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