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Beam shaping and homogenization using combined refractive beam shaper and adaptive optics

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Many kilohertz repetition rate, ultrashort-pulse lasers generate Gaussian-profile beams. Nonlinear post-laser compression using near-field solids is a promising method to obtain high-power, very short laser pulses for accelerator applications, but requires homogenized flat-top profile beams to avoid spatio-temporal coupling. kHz flat-top laser beams are also used in large scale material processing. For laser plasma acceleration (LPA), reversing laser pulses from a flat-top to a Gaussian beam can improve efficiency. Thus, it is important to have high precision, high power techniques that can shape beams from kHz ultrafast lasers. PiShapers are commonly used to transform beams with high spatial coherence from Gaussian to top hat. However, their efficacy is strongly dependent on the incident beam quality and often results in obtuse edges and a less uniform transmitted beam. We show that the addition of a spatial light modulator (SLM) can improve uniformity, in our case from 47% to 94.5% across 90% of the beam area. In high energy and high power applications, deformable mirrors (DM) can be used, instead of SLMs, to facilitate high quality, high throughput beam shaping. This work shows the potential of high-precision beam shaping for high power laser system applications such as LPAs and manufacturing.

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Working group

WG1 : Laser-driven plasma wakefield acceleration

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