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Joule-class Yb:YAG lasers for driving plasma-modulated plasma accelerators

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The kilohertz Plasma Accelerator Consortium (kPAC) is developing GeV-scale, laser-driven plasma accelerators, utilizing highly efficient, diode-pumped lasers with kHz repetition rate. The concept is based on the plasma-modulated plasma accelerator (P-MoPA). In such an accelerator, a joule-class pulse with picosecond duration is first spectrally modulated by the wake of a second, millijoule-class pulse with sub-50 fs duration, which co-propagates inside a hydrodynamic optical-field-ionized (HOFI) plasma channel. Afterwards, the spectrally modulated, picosecond long pulse is converted to a train of sub-100 fs long pulses using a dispersion system. This train of pulses can then resonantly drive a subsequent acceleration stage. A first demonstrator of such kind is currently being developed at the Center for Advanced Laser Applications (CALA) of the Ludwig-Maximilians-Universität in Munich.
Here, we present the demonstrator's laser source, a unique combination of two state-of-the-art, Yb:YAG-based laser systems which are able to generate laser pulses with energies of up to 10 J at 700 fs and 10 Hz, and laser pulses with up to 100 mJ at sub-50 fs and 1 kHz. This combination enables a broad range of parameters to thoroughly investigate the creation of HOFI channels as well as the modulation, conversion and acceleration in the P-MoPA demonstrator.

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