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Khz rep-rate, kW average power class laser development with Tm-based ceramics

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Increasing the luminosity of laser-driven electron accelerators to the level required for future FEL or TeV-class collider applications ideally requires a 100-1000 fold stepping up in the average power of driver lasers, translating into ultrashort/ultraintense systems close to or exceeding the kHz repetition rate and the 1-10kW average power. Scaling current technology based on Nd-pumped TiSa amplifiers to these levels is hindered by thermal management issues and complexity. A novel approach has recently been investigated, consisting in replacing TiSa with longer upperstate lifetime materials and extracting the stored energy over multiple pulses (Multi-Pulse Extraction, MPE); advantages include the possibility of (quasi)CW, direct pumping with commercial diodes, thus dramatically increasing the wall-plug efficiency, less stringent requirements on the extraction fluence, and so on.
Here we report on the design and development of a kW-class average power system based on MPE. The system, based on a commercial OPA, mJ energy front-end, will feature Tm-based multipass amplifiers with active-mirror configuration, and aims at delivering <100fs duration, >500mJ energy, 2μm-wavelength pulses at >1KHz rep rate. Issues including the (direct) pumping geometry optimization, the thermal management on each amplifier and the MPE temporal dynamics will be discussed.

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