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BEETLE: Laser plasma acceleration using a post-compressed industrial Yb-laser system with 1kW average power

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Increasing the repetition rate of >100 MeV laser plasma accelerators to the kilohertz range is critical for many real-world applications. However, this requires drive lasers with pulse durations of tens of femtoseconds, pulse energies of hundreds of millijoules, and thus average power in the kilowatt range. Achieving this is challenging, especially with the Ti:sapphire technology widely used to drive such accelerators. However, industrial kW-level laser systems based on Ytterbium gain media do exist, and recently the compression of 200mJ laser pulses at 5kHz repetition rate to sub-40fs duration has been demonstrated using nonlinear post-compression in a gas-filled multi-pass cell.
In this contribution, we present the BEETLE project, which will use this laser system for laser plasma acceleration (LPA) at up to 5kHz repetition rate and 1kW average power of the drive laser. We give an overview of the project, the current status of the experimental setup and present an end-to-end simulation tool chain that allows us to simulate both the nonlinear spectral broadening and the plasma acceleration process itself. This enables a detailed design of the experimental setup, as well as studies of the LPA process using laser pulses with the complex temporal shape inherent in nonlinear post-compressed laser systems.

Primary authors: EICHNER, Timo (Deutsches Elektronen-Synchrotron DESY); Dr NECHAEVA, Tatiana (Deutsches Elektronen-Synchrotron DESY); JALAS, Sören; Dr WANG, Haochuan (TRUMPF Scientific Lasers GmbH + Co. KG); MANZ, Jonas (TRUMPF Scientific Lasers GmbH + Co. KG); METZGER, Tom (TRUMPF Scientific Lasers); PALMER, Guido (Deutsches Elektronen-Synchrotron DESY); WINKELMANN, Lutz (DESY); KIRCHEN, Manuel; MAIER, Andreas (DESY)

Presenter: EICHNER, Timo (Deutsches Elektronen-Synchrotron DESY)

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