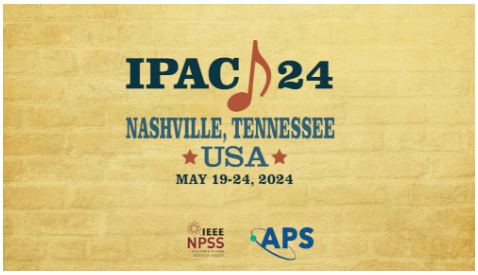

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Sub-picosecond long-wave infrared laser for advanced accelerators

Tuesday, 21 May 2024 16:00 (2 hours)

Ultra-intense, ultra-fast, near-infrared (NIR) solid-state lasers based on chirped pulse amplification (CPA) are main radiation sources to support strong-field scientific research. At the same time, the wavelength scaling of fundamental physical processes calls for extending the spectral coverage into the long-wave infrared (LWIR) domain (8–14 μm). Using optical transitions between vibrational energy levels of molecular gases offers a direct way to access laser wavelengths an order of magnitude beyond those of typical NIR lasers which are based on electronic transitions. CO2 laser operating at 10 μm stands out among molecular gas lasers for its energy efficiency. Our recent breakthroughs in CO2 laser technology, including the first ever implementation of the CPA technique for molecular gas lasers, have made it possible to generate single 2-ps pulses with the peak power of 5 TW. Based on the example of Brookhaven's multi-terawatt, picosecond CO2 laser system, we discuss ongoing R&D aimed at advancing ultra-intense LWIR lasers into the sub-picosecond regime. In our recent experiment, several-joule, 700 fs pulses have been demonstrated at 9.2 μm opening the way to potentially achieving tens of terawatt peak powers in few optical cycles. The use of such lasers might benefit a variety of applications including laser wake field electron acceleration and electrostatic shock wave ion acceleration briefly reviewed here.

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