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MeV electron beams at 1 kHz

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We show that using high density gas jet targets approaching critical density makes possible electron acceleration to relativistic energies with low laser pulse energies, enabling high repetition rate operation. The near-critical density is approached in two ways. For 30 fs, lambda= 800nm, <10 mJ pulses from a 1 kHz Ti:Sapphire laser, we used cryo-cooled, continuous flow high density H_2 and He jets, with N_e/N_cr < 0.69. And in the first laser wakefield experiments using ultrashort mid-infrared laser pulses (100fs, lambda= 3.9um, <20 mJ pulses from a mid-IR OPCPA system), the non-cryo-cooled target density reaches N_e/N_cr < 2.2. In both experiments, the high electron density enables onset of relativistic self-focusing and few MeV electron acceleration at millijoule-scale laser energies. In the case of the mid-IR laser driver, we image the onset and scaling of relativistic self-focusing from single filament collapse through the multifilamentation regime.

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