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Unraveling the Direct Laser Acceleration of electron beams

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Direct Laser Acceleration (DLA) of electrons is a mechanism for superponderomotive energy gain during relativistically intense laser-plasma interactions. As laser facilities reach multi-petawatt powers, DLA will be increasingly important as the main energy exchange mode between the laser and the plasma and create a route to generating high charge, highly-relativistic, broad-spectrum electron beams. Applications of DLA are for bright directional sources of x-rays, or for secondary interactions to create Bremsstrahlung-photons or positrons. The ponderomotive force of the laser pulse acts on the plasma to form a channel with transverse electric and azimuthal magnetic fields that enable energy exchange from the laser to the electrons. We investigate DLA using experiments performed at the OMEGA EP laser facility, particle-in-cell simulations [H Tang et al. New J. Phys. 26 053010 (2024)] and through test particle simulations and theory [R Babjak, et al. PRL, 132, 125001 (2024), AV Arefiev. et al. PoP, 31, 023106 (2024)]. New insights include the importance of laser focal spot size, the significance of the modulation of the experienced laser frequency for the betatron and high-order resonances, and a new mechanism that generates a bright, backward x-ray beam from these interactions [I-L Yeh, et al. arXiv: 2406.04489 (2024)].
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Working group

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