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Dielectric laser acceleration of 28 keV electrons with the inverse Smith-Purcell effect

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Dielectric laser acceleration exploiting the large optical field strength of short laser pulses and the proximity of a dielectric structure can support high acceleration gradients and may therefore lead to much smaller accelerators, with future potential application in table-top free electron lasers. We report a proof-of-concept experiment demonstrating dielectric laser acceleration of non-relativistic 28keV electrons derived from a conventional scanning electron microscope column at a single fused-silica grating. The electrons pass the grating as closely as 50nm and interact with the third spatial harmonic, which is excited by 110fs long 800nm laser pulses with a peak electric field of 2.85GV/m. The observed maximum acceleration gradient of 25MeV/m is already comparable to state-of-the-art radio-frequency structures. This work represents the first demonstration of scalable laser acceleration and of the inverse Smith-Purcell effect in the optical regime. For relativistic electrons and otherwise identical conditions up to 2 orders of magnitude larger acceleration gradients are expected.

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