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Alternating phase focusing in dielectric laser acceleration

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Utilizing photonic nanostructures and ultra-short laser pulses, dielectric laser acceleration (DLA) provides a scheme for high gradient particle accelerators. In the past, this concept was limited by insufficient beam transport through longer structures and the inability to stage multiple structures without particle loss. The concept of alternating phase focusing (APF) provides a way to transport and accelerate electrons over, in principle, infinitely long structures with little particle loss. By alternating between the phases longitudinally focusing – transversely defocusing and longitudinally defocusing – transversely focusing, the particle beam can be confined both longitudinally and in one transverse direction [1]. We have experimentally demonstrated APF transport in a well-suited nanostructure. The particle beam used consists of 30 keV electrons of an ultrafast SEM. The APF structure used in the experiment shows a boost in electron throughput of up to 100% when illuminated by laser pulses. Preliminary data indicate good agreement with theory simulations.

[1] U. Niedermayer, Thilo Egenolf, Oliver Boine-Frankenheim, and Peter Hommelhoff, *Phys. Rev. Lett.* 121, 214801 (2018)

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