Beitrag ID: **44** Typ: **Contributed talk**

Gradient descent-based optimization of the acceleration field in sub-relativistic dielectric laser accelerators using the adjoint method

Freitag, 4. Oktober 2024 11:30 (20 Minuten)

Dielectric laser accelerators (DLA) offer the possibility to miniaturize particle accelerators by switching from metal cavities driven by radiofrequency fields to dielectric structures driven by high repetition laser pulses in the optical wavelength regime. In the last years, acceleration in combination with alternating phase focusing was shown, resulting in substantial energy gains in up to 0.5 millimeter-long acceleration structures [1,2].

Due to the drastic decrease in wavelength, the periodicities of the dielectric structures now lie in the range of a few hundred nanometers, placing those structures in the regime of nanophotonics. When designing structures at this length scale, inverse design is a method that has successfully been used for many different applications [3], including the optimization of periodic dielectric laser accelerators to achieve high acceleration gradients [4,5].

We will show how this approach can be expanded to the case of sub-relativistic DLAs where it is necessary to taper the structure, i.e. to increase the width of the unit cells to maintain the phase matching condition as the electron accelerates. In this case it is not sufficient to only optimize a single periodic unit cell like shown in [4,5], but instead it is necessary to design the structure as a whole. We will discuss how a gradient descent-based inverse design approach can be used to precisely control the acceleration in each unit cell of the structure and show how the adjoint method can be used to efficiently obtain the gradient for an arbitrary number of parameters.

[1] Shiloh et al. Nature 597, 498–502 (2021).
[2] Chlouba et al. Nature 622, 476–480 (2023).
[3] Molesky et al. Nature Photon 12, 659-670 (2018)
[4] Hughes et al. Opt. Express 25, 15414-15427 (2017)
[5] Sapra et al. Science 367, 79-83 (2020)

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Sitzung Einordnung: Sessions in Seminar Room 2013/2014

Track Klassifizierung: B-2 Plasma, Laser, Dielectric and Other Acceleration Schemes