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Transverse Beam Breakup Instability in Dielectric Laser Accelerators

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Dielectric laser acceleration (DLA) is one of the advanced concepts for more compact accelerators. DLA gratings have apertures within the range of optical wavelengths. Wakefields limit the beam intensities of relativistic electrons required for possible applications. Particle tracking is needed to study the intensity limitations due to nonlinear laser fields in combination with wakefields. For this, we present the addition of self-consistent wake kicks to our tracking code DLAtrack6D. The literature on conventional linear accelerators introduces analytical models to describe the transverse beam breakup instability. The comparison of tracking results with these models shows that the respective intensity limits are also valid for DLA gratings, which limits the bunch charge to less than a femtocoulomb. Furthermore, we analyze the nonlinear dynamics in alternating phase focusing (APF) channels by calculating tune footprints of various bunch distributions. The APF scheme confines the beam longitudinally and in one transverse direction by alternating focusing and defocusing phases. We present tune spectrograms, i.e. tune spectra as function of the independent variable, calculated by reconstructing the single particle one-cell matrix. This is the basis to study damping mechanisms as BNS damping of the transverse beam breakup instability in DLA gratings.

Primary author: EGENOLF, Thilo (TEMF, TU Darmstadt)

Co-authors: NIEDERMAYER, Uwe (TEMF, TU-Darmstadt); BOINE-FRANKENHEIM, Oliver (Technische Universität Darmstadt)

Presenter: EGENOLF, Thilo (TEMF, TU Darmstadt)

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