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Observation of Skewed Electromagnetic Wakefields in an Asymmetric Structure Driven by Flat Electron Bunches

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Relativistic charged-particle beams which generate intense longitudinal fields in accelerating structures also inherently couple to transverse modes. The effects of this coupling may lead to beam break-up instability, and thus must be countered to preserve beam quality in applications such as linear colliders. Beams with highly asymmetric transverse sizes (flat-beams) have been shown to suppress the initial instability in slab-symmetric structures. However, as the coupling to transverse modes remains, this solution serves only to delay instability. In order to understand the hazards of transverse coupling in such a case, we describe here an experiment characterizing the transverse effects on a flat-beam, traversing near a planar dielectric lined structure. The measurements reveal the emergence of a previously unobserved skew-quadrupole-like interaction when the beam is canted transversely, which is not present when the flat-beam travels parallel to the dielectric surface. We deploy a multipole field fitting algorithm to reconstruct the projected transverse wakefields from the data. We generate the effective kick vector map using a simple two-particle theoretical model, and particle-in-cell simulations provide further insight for realistic particle distributions.

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