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Observations of Sub-Macropulse Electron-Beam Dynamics Correlated with Higher-Order Modes in TESLA-Type Cavities

Monday, 1 October 2018 13:00 (30 minutes)

We report the direct observations of sub-macropulse beam centroid oscillations correlated with higher order modes (HOMs) which were generated by off-axis electron beam steering in TESLA-type SCRF cavities. The experiments were performed at the Fermilab Accelerator Science and Technology (FAST) facility using its unique configuration of a photocathode rf gun injecting beam into two separated 9-cell cavities in series with corrector magnets and beam position monitors (BPMs) located before, between, and after them. Oscillations of ~100 kHz in the vertical plane and ~380 kHz in the horizontal plane with up to 600-μm amplitudes were observed in a 3-MHz micropulse repetition rate beam with charges of 100, 300, 500, and 1000 pC/b. However, the effects were much reduced at 100 pC/b. The measurements are based on HOM detector circuitry targeting the first and second dipole passbands, rf BPM bunch-by-bunch array data, imaging cameras, and a framing camera. Calculations reproduced the oscillation frequencies of the phenomena in the vertical case. In principle, these fundamental results may be scaled to cryomodule configurations of major accelerator facilities.

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