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BBU Instability in Rectangular Dielectric Resonator

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One of the significant limitations on the amplitude of the accelerating field in a dielectric wakefield accelerator is the head-tail drive bunch beam breakup (BBU) instability. In this report, we analytically and numerically investigate an arising and evolution of the BBU instability in a rectangular dielectric resonator when excited by a sequence of relativistic electron bunches. The dielectric resonator is a metal waveguide R26 with transverse dimensions 45x90mm with Teflon dielectric slabs (dielectric constant 2.051) with a thickness of 8.2mm located along the wide side of the resonator. The wavelength of the LM21 operating mode having a symmetric profile of the longitudinal component of the electric field is 53.2 mm. The electron energy of bunches is 4.5 MeV, the charge of each bunch is 6.4 nC, the repetition period is equal to twice the wavelength of the LM21 mode. By numerical PIC simulations, the charge losses of electron bunches on dielectric plates are investigated depending on the structure length, the initial offset of the drive bunches relative to the cavity axis. It is shown that the charge losses on dielectric slabs due to the BBU instability do not exceed 5%. When the resonance bunch repetition period is changed (a multiple of the LM21 mode's wavelength) by a period, a multiple of another eigen wavelength (e.g., the LM11 mode), the charge loss of the drive bunches does not change appreciably.

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