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Numerical design of a compact TE11-to-TM01 mode converter for THz-driven electron acceleration

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In recent years the generation of high power millimeter wave and Terahertz radiation has progressed substantially, enabling electron beam manipulation and acceleration in structures with a footprint of several centimeters. However, in many experiments the external driving pulse is coupled collinearly into the waveguide structure which increases the coupling footprint relative to the wavelength tremendously (≈30 or more) in comparison to conventional structures (≈1 or less). Here, the design of a double-bend mode converter for 300 GHz is presented which converts the fundamental TE11 mode quasi-instantaneously to the TM01 mode for the accelerating structure. In comparison to an s-shaped converter, the present design makes an additional waveguide bend obsolete. The structure length along the beam axis is only 4 mm (4), showing a major advance in compactness. Combined with a horn antenna for free-space to waveguide coupling, the maximum power coupled into the structure reaches 83%, while the collinear scheme does not exceed 74%.

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