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Optimized Photonic Crystal Structures for Accelerators

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Long-range wake fields are significantly reduced in accelerator structures that are based on dielectric photonic crystal cavities, which can be designed to trap modes only within a narrow frequency range (the band gap of the photonic crystal). A 2D photonic crystal structure can be used to create a 3D accelerator cavity by using metal end-plates to confine the fields in the third dimension; however, even when the 2D photonic structure allows only a single mode (in 2D), the 3D structure may trap higher order modes (HOMs), such as guided modes in the dielectric rods, that increase wake fields. For a 3D cavity based on a triangular lattice of dielectric rods, the rod positions can be optimized (breaking the lattice symmetry) to reduce radiation leakage using a fixed number of rods; this optimization can reduce leakage by more than 2 orders of magnitude while reducing the wake fields in the structure.

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