

# Analysis of Quadrupole Focusing Lattices for Electron Beam Transport in Traveling-Wave Tubes

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**Abstract**—Analysis of quadrupole focusing lattices for high-frequency traveling-wave tubes is presented. This paper is motivated by recent work performed at the Naval Research Laboratory which demonstrated an advantageous case for strong focusing employing a Halbach quadrupole lattice. Using realistic permanent magnet quadrupole (PMQ) field cancellation, the advantage of using PMQ to transport higher current densities than a permanent periodic magnet disappears, while other advantages for employing quadrupole focusing remain.

**Index Terms**—Beam transport, periodic permanent magnet, quadrupole strong focusing, traveling-wave tube (TWT).