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**An Exact Treatment of Helix Traveling Wave Tubes with Cold Tube Loss**<sup>1</sup> ABHIJIT JASSEM, YUE YING LAU, University of Michigan, PATRICK WONG, Michigan State University — Recent work on an exact treatment of a thin tape helix traveling wave tube (TWT) indicates that Pierce’s classical linear theory requires revision at high beam currents to include space charge effects on the circuit mode [1]. These circuit mode space charge effects are characterized by a new parameter  $q$ , which acts in an analogous manner to the familiar space charge parameter  $Q$  that affects the beam mode. However, this approach has the crucial assumption that there are no ohmic losses in the tube, setting Pierce’s cold tube loss parameter  $d = 0$ . Here, we include these lossy effects by introducing an imaginary component of permittivity into the dielectric support structure and propose a modified dispersion relation that takes the effects of both  $q$  and  $d$  into account. We demonstrate the validity of our model by comparing our results to the classical theory in test cases with both uniform and non-uniform attenuation over the length of the tube. [1] P. Wong, D. Chernin, and Y. Y. Lau, *IEEE Electron Device Lett.* 39, 1238 (2018).

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