DISPERSION RELATION OF THE ELECTRON BEAM INSIDE RELTRON CAVITY

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Reltrons are a class of high power microwave sources that utilize a resonating cavity to cause electrons to oscillate at a desired frequency [1]. This is accomplished by passing a continuous beam of electrons through the Reltron's modulating cavity. The beam of electrons gets compressed longitudinally into bunches due to Lorentz forces from the standing wave inside the cavity. The bunched electrons that oscillate with a common frequency are post-accelerated to the extraction cavity. Microwave energy is then extracted from the beam bunches.

Space charge waves exist because of the oscillating electrons [2]. The dispersion relation for the space charge waves inside an unbounded relativistic electron beam is derived. Boundary conditions consisting of the beam radius and waveguide radius are included to obtain the dispersion relation of the beam inside the cavity. The cavity beam dispersion relation comprises of Bessel functions and is solved numerically. The solution is compared with the semi-analytic solution obtained by Breizman & Ryutov (B&R) [3]. Both curves are found to be in good agreement.

The cavity dispersion relation [4] is plotted with the B&R dispersion relation. The point of intersection gives the frequency of the TM_{010} and TM_{020} modes inside the hot cavity. The MAGIC particle-in-cell code [5] is used to validate the results and provide additional insight on the beam dynamics.

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