Monday, 7 June 1993
3:15 pm - Room 205
ORAL SESSION 2A
Intense Beam Microwaves
Chair: E. Garate

2A1-2

Investigations of the Electromagnetic Properties of Finite Length X-Band Slow-Wave Structures*

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A relativistic high-power backward wave oscillator can be modeled by linearized equations or by more complex nonlinear particle codes. In either case it is necessary to know the electromagnetic properties of the structure. The most important of these are the dispersion relation and the frequency dependent reflection coefficient from the ends of the structure. Both of these can *in principle* be calculated from the geometry of the system, however, this can be difficult for complicated geometries and surface conditions. An alternate approach is to form a slow-wave cavity from the structure and measure the quantities by extending the techniques developed 40 years ago for resonant cavity analysis [1].

We present cold-test results of a slow-wave structure made from a cylindrical waveguide with sinusoidally varying radius. An 8-period version of this structure was used in numerous X-band backward wave oscillator experiments, however, until now there has not been a systematic analysis of the electromagnetic properties of this structure.

To study the dispersion relation we formed a cavity by shorting a section of the structure between metal plates placed at planes of mirror symmetry. A simple axial wire antenna was used to launch azimuthally symmetric TM modes. Discrete points on each branch of the dispersion relation were found by recording resonant frequencies f_r and axial wave numbers β_r for the set of axial modes associated with each transverse magnetic mode. We found β_r by perturbing the field near the axis of the cavity with a small metal bead. The shift in the resonant frequency is proportional to the amount of field energy displaced by the bead and β_r is related to the number of axial variations found for each resonance. The experimental results are compared with numerical calculations. For low order modes (TM_{01} and TM_{02}) the average frequency error was less than 0.3%.

For convenience the dispersion relation was measured on a "cold-test" structure built just for this purpose. This structure had access holes for positioning a bead, both axially and radially, and an antenna for launching TM modes. We chose a structure with six axial periods, giving us seven points on our $\omega\beta$ diagram.

The end reflection was measured on the 8-period beam test structure to include the effect of the output taper. We made plugs to fit snugly in the entrance and exit of the structure. Since the input side was cutoff to all TM modes, we only needed to measure reflection for the output side of the structure. This reflection ρ_{out} was found by measuring the diffractive quality factor Q_d of the structure. The measured values of ρ_{out} vs. frequency are compared with calculations based on the geometry of the system.

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[1] L.C. Maier and J. C. Slater, *J. Appl. Phys.* **23**, 68 (1952)

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