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Transverse EM Fields in a Detuned X-band Accelerating Structure*

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Abstract

Results are presented of a study of the dipole EM fields in detuned accelerating sections excited by a pointlike bunch. The transverse coupling impedance, the kick factors, and the wake functions are found.

The detuned accelerating structure[1][2] has been designed to decrease the transverse wake field. Here we present the results of a study of the deflecting dipole fields for the structure excited by a pointlike charge using the computer code PROGON[3]. The code is based on the field-matching technique for the frequency harmonics of the EM traveling waves. The geometry of the considered section—built out of 204 cells—can be found in Ref. 3. For each coupled-cell mode, including the trapped ones, the EM fields, the group velocity, and the stored energy are calculated. The computer time needed to calculate these quantities for the 204 cell structure (a cell is a cavity and an iris) is approximately 15 minutes on the IBM RISC 6000 workstation. The calculations take into account 16 space harmonics in the cavity region and 30 space harmonics in the iris region. Using the calculated EM fields of the structure, we calculate the transverse impedance, kick factors, and the transverse wake function. The results are matched quite well with the previous results[4][5][6] based on the field-matching technique.

Figure 1 shows a comparison of the dispersion curves for the dipole passbands obtained in our calculations (symbols) with the program TRANSVRS (solid lines for the first and dashed lines for the second dipole passbands, respectively). The dispersion curves are calculated for a periodic structure corresponding to the parametres of the three cells taken at the beginning, in the center, and at the end of the structure. The three cases are labeled by the symbols C, D, and E, respectively. The radii of the iris and the cavity were measured in cm: C) 0.5250 and 1.112; D) 0.4625 and 1.083; and E) 0.4000 and 1.058. The results of our code are shown by full circles for the structure C, diamonds for the structure D, and squares for the cell-type E. Results of the code URMEL are shown with open circles.

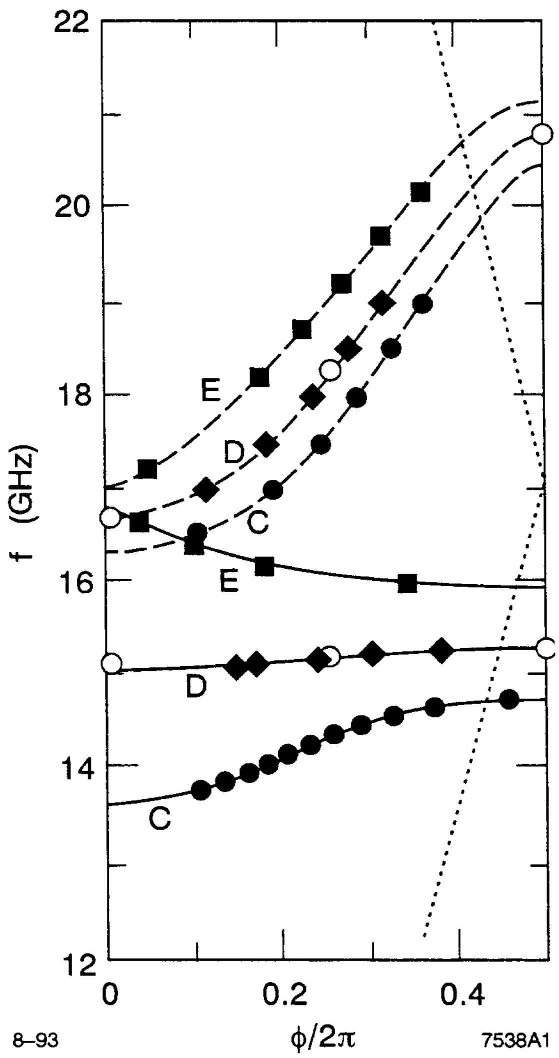

Figure 1. Comparison of dispersion curves for the dipole passbands.

Figure 2 depicts the real part of the impedance (in arbitrary units) calculated by integrating the field of each cell of the detuned structure at the frequencies shown at the top of the plot. The impedance is plotted versus the cell number. Results illustrate the mode trapping.

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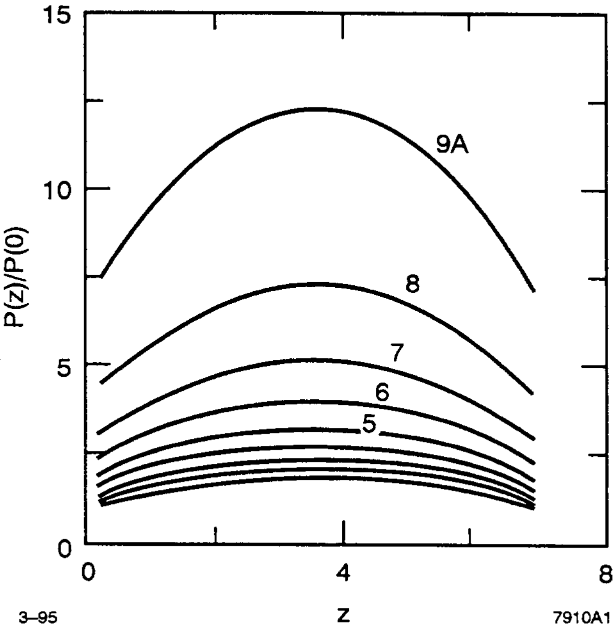

Figure 1. Pressure profile between pumps separated by 7 m for the beam current from 1 A to 9 A. The ion induced threshold current is I_{th} = 10.469 A for W = 24.8 l/sec, and $S = 68$ l/sec.

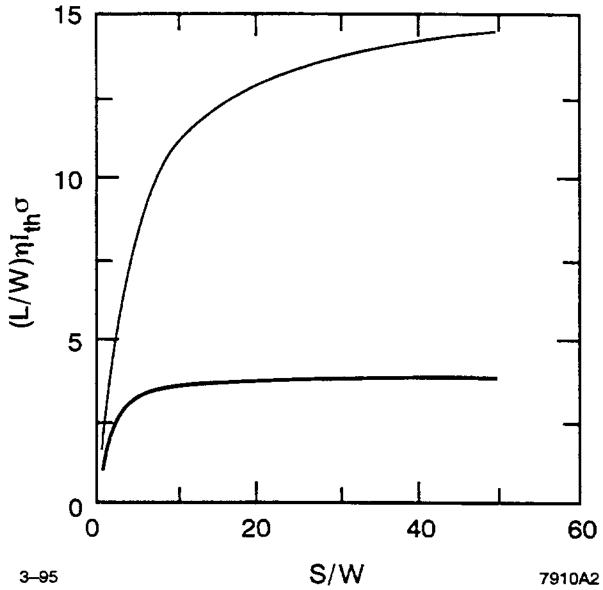

Figure 2. Parameter in the LHS of Eq. (7) versus S/W.

pipe $r = 5\,cm$, $L = 7\,m$, and $\sigma_c = 2\,10^{-18}\,cm^2$. The threshold current is reduced from 10.47 A to 4.75 A for the parameters used above.

The conductance calculated from local conductances (M. Sullivan, private communication) is $W = 84\,l/s$ and $S = 400\,l/s$ for the interaction region $\pm 2.45\,m$ from IP. That gives quite high $\eta I_{th} = 27.4\,A$.

The threshold current is given by the pumping speed s of the distributed ion pumps for the HER arcs: $\eta I_{th} \sigma_c = 1.6 * s$ where s is in l/sec, σ_c is in $10^{-18}\,cm^2$, and I_{th} in A is very high for $s = 120$ l/m/sec.

The situation is less obvious for the wiggler vacuum chamber (under design).

The estimate shows that PEP-II should not have a problem with a pressure instability at nominal pumping speed provided that η remains small, $\eta < 1$.