LINAC-I

Problem I-1:

Calculate the cell pitch, *d*, of ILC 1.3GHz cavity operating in π mode.

Assume the accelerating mode to be TM_{010} mode in a pillbox cavity. Then, calculate the radius of the pillbox, *a*.

The measured frequency spectrum of the transmitted RF power from left end of the ILC 9-cell cavity to the right end is shown in Fig. 19 of LINAC-II note or page p54 of LINAC-II presentation. In order to identify these modes appeared in the transmission measurement, calculate the frequencies of some of the low frequency region appeared in the figure. Here let us assume the cell length is 10% short compared to that obtained above, thinking the effective length shortened by the iris thickness.

Note that the TE mode, the formula is the same as TM modes but ρ_{mn} is replaced by the zero of the derivative of Bessel's function, ρ'_{mn}. The values are listed in the table.

ρ_{mn}	n=1	n=2
m=0	2.405	5.520
m=1	3.832	7.016

ρ'_{mn}	n=1	n=2
m=0	3.832	7.016
m=1	1.841	5.331

Then, compare your estimation and the measured spectrum to identify the modes of 3 passbands in low frequency side.

Estimate the pillbox shape for the X-band 11.424GHz cavity in the same manner. Here note that the accelerating mode is in 2π/3 mode. Compare the calculated frequency with the measured spectrum in Fig. 24 of LINAC-II text or page 58 of LINAC-II presentation. Estimate the mode of the passband at about 15GHz region.

Problem I-2:

Calculate the cavity parameters, Q, G and R/Q for the single cell ILC cavity assuming the pillbox cavity operated at TM_{010} mode in the cell. Here we assume the cell length of $\lambda/2$ when we think about the relationship between cells among 9 cells in the actual cavity. Assume that the cavity is made of Niobium operated at the temperature of 2K and the surface resistance is only due to the BCS resistance. Use the practical formula of the BCS resistance shown in section 3.5.

Calculate the cavity parameters, Q, G and R/Q for the single cell CLIC cavity assuming the pillbox cavity operated at TM_{010} mode in the cell. Here we assume the phase advance per cell π/cell in SW mode, even though actual phase advance is $2\pi/3$ / cell in TW mode. Assume that the cavity is made of copper. The volume conductance of copper is 5.8×10^{7} $[1/(\Omega m)]$.

Finally for both ILC and CLIC cases, calculate the stored energy per cell for the case with the accelerating field of 50MV/m and estimate the associated wall loss.

Problem I-3:

In a TW linac, the frequency error introduces the phase slippage between the RF phase and the beam. Estimate the tolerable of frequency error for the 12GHz CLIC structure to suppress the energy gain loss within 0.1%. Assume the number of cells per a structure Ns=30, phase advance per cell is 120 degrees/cell and the group velocity of the TW propagation along the structure is 3% of light velocity. We assume that the phasing of the RF w.r.t. beam can be adjusted to minimize the loss of energy gain.

Then estimate the corresponding geometry tolerance of the cavity radius.

Problem I-4:

Prove the following in the TW structure. In CG case, prove that the total attenuation becomes τ when the group velocity is designed to vary as eq. (I-7-15). Then, calculate the filling time to prove eq. (I-7-16). Prove that that filing time is the same both in CG and CZ cases if expressed in Q, ω and τ.

Problem I-5:

Obtain the input RF peak power for making a 100MV/m acceleration with or without beam in CZ or CG travelling wave structure for the CLIC beam. Assume the length of the structure is 0.3m, the total attenuation parameter τ=0.5, and shunt impedance r=80MΩ/m.