LINAC-II

Problem II-1: Beam loading voltage

Calculate the beam loaded field in accelerating mode excited in a single cell of ILC cavity where no electromagnetic field exists before beam comes.

Assuming the loaded cavity Q value, Q_L, as $3x10^6$, calculate the voltage attenuation within the arrival of the next bunch and add all to get the saturated beam voltage.

Problem II-2: Suppression of long-range wake field

Suppose that the transverse long range wake field of CLIC should be reduced by factor 100 till the next bunch arrival. Assume the wake is dominated by the lowest-frequency dipole mode, whose frequency is 1.5 times higher frequency than the accelerating mode.

Find possible solutions for the suppression of the wake field following the mechanism stated below. Then, estimate the tolerable frequency error in case 3rd and 4th.

1st: Let the cavity be heavily damped. Find the needed Q value of the mode.

2nd: Let the dipole mode frequencies be spread in the Gaussian manner. Find the needed frequency spread, sigma of the Gaussian distribution.

3rd: Let the dipole mode frequency to set the zero crossing of the dipole mode at the following bunch. Derive the tolerable frequency error.

4th: Make two dipole modes at frequency f1 and f2, which makes the total wake to be beated so that the envelope becomes zero at the following bunch. Find the frequency f1 and f2. Then estimate the tolerable error in frequencies f1 and f2, assuming systematic error, meaning that the same error for both.

Problem II-3: Short-range wake field and autophasing

Deduce the slope of the transverse wake field from Fig. 11 for the case of 2856MHz accelerator structure of SLAC linac. Calculate the slope using the value 0.5 [V/pC/(r_q/a)/cell] at 2psec. Here assume the "a" value is 12mm. Then, estimate the corresponding slope of the CLIC 12GHz structure assuming all the geometries are scaled from SLAC one and only taking into the frequency dependence into account.

Calculate the practical transverse wake field using the eq. (II-3-37), assuming the beam hole aperture a=3mm and disk thickness t=1.5mm. The L is the pitch of the periodic structure with 2π/3 mode operation at 12GHz and $g=L-t$. Compare this value with the above scaled value from S-band SLAC linac and check the consistency within 30%.

Derive the equation (II-3-39) for the initial slope.

Using this practical value of the initial slope, estimate the transverse kick angle for the tail particle at 100GeV while passing the length of betatron wave length / 2π, assuming the head particle with offset by 1mm.

Estimate the needed increase of focusing force at the trailing particle with a separation from the head particle by $2\sigma_z$.

Assuming the betatron wavelength of λ_β=100m, estimate the needed energy slope at the trailing particle.

Calculate the RF off-crest angle for making the above energy slope.

Estimate the energy gain loss due to this off-crest operation.