Wakefields and Impedances

- From the frequency analysis the mode properties were found:

$$f = 500.56\ MHz,\ \ \frac{R}{Q} = 76.57\ Ohm,\ \ Q = 43700$$

- For a bunch with an rms bunch length σ_z = 2 cm the longitudinal wake potential was calculated. During the post processing of the data the total loss parameter was calculated:

$$k_{||\mathrm{tot}} = 3.386 \cdot 10^{11}\ \ {}^{V}/_{C}$$

Questions:
How large is the contribution of the basic 500.56 MHz mode to the total loss parameter ?

Will the contribution of the mode to the total loss parameter change if the bunch length is decreased to σ_z = 1 cm ?

Answer:

1) From the provided data one can calculate the modal parameter:

$$k_{||} = \frac{1}{2} 2\,\pi\, f\, \frac{R}{Q} = 1.204 \cdot 10^{11}\ \ {}^{V}/_{C}$$

For a bunch with an rms bunch length σ_z = 2 cm one obtains

$$k_{||} \exp(-(2\,\pi\, f)^2 (\frac{\sigma_z}{c})^2) = 1.152 \cdot 10^{11}\ \ {}^{V}/_{C} = 0.34 \cdot k_{||tot}$$

The mode contributes about 34 % to the total loss parameter.

2) For a bunch with an rms bunch length σ_z = 1 cm one obtains

$$k_{||} \exp(-(2\,\pi\, f)^2 (\frac{\sigma_z}{c})^2) = 1.191 \cdot 10^{11}\ \ {}^{V}/_{C}$$

Yes, the contribution to the total loss parameter will change. But also the total loss parameter will change. A precise answer requires a new time domain calculation of the total loss parameter.