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Calculating the transverse shunt impedance from eigenmode results

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The calculation of wake impedances in a resonator is difficult. The wakelength that needs to be considered extends enormously due to the high quality factors of the different resonant modes.
This makes calculating wake impedances with a wake field solver computationally very expensive.
The eigenmode solver was designed to calculate the field distribution of electromagnetic fields in resonant structures. It solves for the desired field values in a quick and precise manner.
The wake impedances \begin{align}
Z_\parallel(\omega) &= - \frac{1}{\tilde{I}} \int_{-\infty}^{\infty}\text{d}z \tilde{E}*z(z)\, e^{jkz}*\\
Z\perp(r_b, \omega) &= - \frac{j}{\tilde{I}\, r_b} \int_{-\infty}^{\infty}\text{d}z \left[\tilde{E}(r_b, z) + v \times \tilde{B}(r_b, z)\right]_\perp \, e^{jkz}
\end{align} can be directly calculated from electromagnetic field components.
It assumes the field to be excited by a beam with the Fourier transformed charge density $\tilde{I}$ travelling with the velocity v in z-direction and a possible transverse offset r_b.
This work aims to find the method to calculate the transverse shunt impedance directly from the field solutions of the eigenmode solver. Thus, the approach will be developed on the basis of the fundamental understanding of wake fields. Finally, the impedances of an exemplary problem calculated using this method will be compared with the results of the common wakefield solver and the analytical solution.

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