Transverse Instabilities

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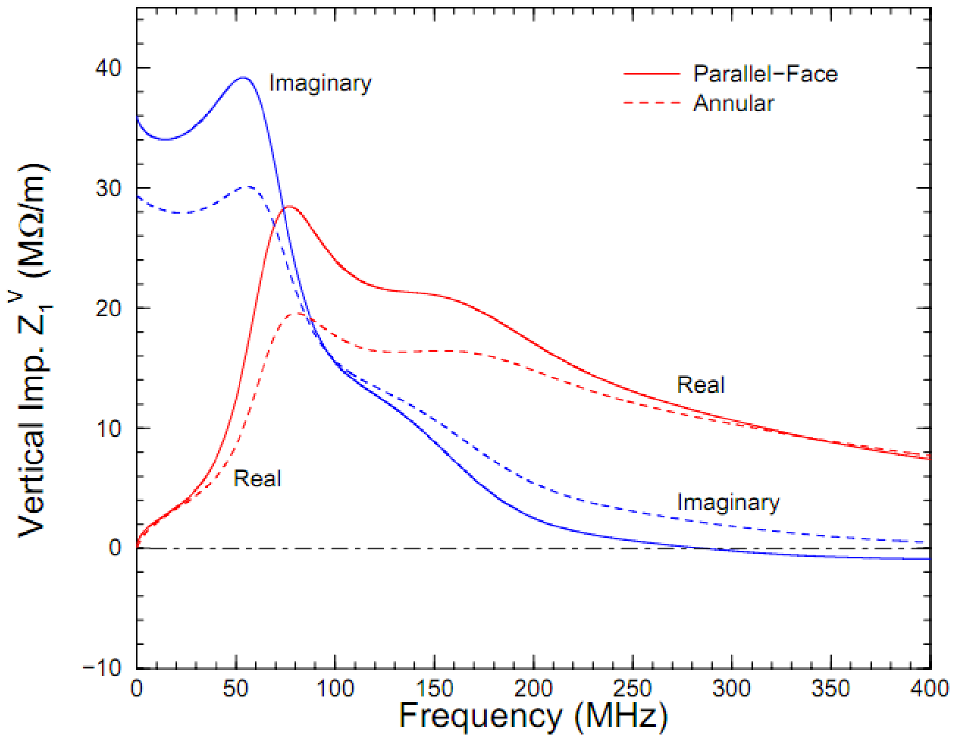
Transverse Impedance

- The transverse Booster impedance is mainly driven by the resistivity of dipole laminations
- Its peak value is achieved at frequency ~100 MHz
- Its maximum value is close to the impedance "careless limit"

$$Z_{\max} = \frac{Z_0}{2\pi}\left(\frac{\sum L_F}{a_F^{\;2}} + \frac{\sum L_D}{a_D^{\;2}}\right)$$

  - For L_{dip} = 2.89 m, a_F = 2.08 cm, a_D = 2.86 cm and 48 dipoles of each type we have $Z_{max} \approx 30$ MΩ/m



Real and imaginary parts of the vertical dipole impedance Z_V of the booster laminated magnets are in the parallel-plate approximation with plate (solid) and the annular ring approximation with radii equal to half the plate-separation (dashed)

K. Y. Ng, "Coupling impedances of laminated magnets", FN-0744, 2004

- My estimate $Re(Z_{\perp x,y})_{max}$ = 7 and 5 MΩ/m (β-function weighted)

Transverse Instabilities

- The maximum instability growth rate (no Landau damping)

$$\lambda_{\max} = \frac{\mathrm{Re}\left(Z_{\perp}\right) I_{beam} R}{2\left(mc^2 / e\right)\beta^2 \gamma \nu}$$

- For 10 MΩ/m, R=75.5 m, $4.5 \cdot 10^{12}$ protons we obtain 0.025 turn^{-1}
- Non-zero chromaticity slows down or stabilizes the instability
- Suppression of instability at the frequency range of ~100 MHz can be difficult if possible