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Phase-driven calibration of RF cavities in low-energy accelerators via transit time factor

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Accurately calibrating RF cavities is challenging when the beam energy is not precisely known. This study presents a theoretical framework for low-energy accelerators to decouple beam energy from cavity amplitude by leveraging the derivative of the transit time factor (\(T_s \)). The approach involves performing a phase scan and measuring the time of flight between two BPMs. By analyzing the corresponding beam phases against each other, an ellipse is formed, whose semi-minor axis depends on the cavity amplitude (\(V_0 \)) and the beam energy. The rate of change of the ellipse's semi-axes with respect to \(V_0 \) varies for different beam energies due to the derivative of the transit time factor, enabling the disentanglement of beam energy from cavity amplitude.

Footnotes

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