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Derivation of the conditions under which Boussard's criterion for the microwave instability may apply

Tuesday 12 August 2025 16:00 (2 hours)

The microwave instability is typically driven by perturbations whose characteristic wavelength is much shorter than the bunch. In this case, Boussard argued that the microwave instability threshold can be found using the predictions of an infinite (coasting) beam, with the average current replaced by the peak current*. We revisit this problem, and theoretically show that if the variation of the synchrotron tune with energy can be neglected then Boussard's hypothesis holds provided 1) the longitudinal ring impedance is dominated by frequencies much shorter that the inverse bunch length; 2) the single-particle wakefield is much shorter than the bunch length, or, equivalently, the impedance is slowly varying over frequencies longer than the inverse bunch length; 3) the resulting instability has a sudden onset with growth rate of the order of the synchrotron frequency. The first two conditions imply that perturbations are localized within distances much less than the bunch length, while the last condition means that the instability experiences significant growth before the particles can make one synchrotron oscillation. While these conditions may be "obvious" in retrospect, we believe that the last two have not been clearly stated or widely appreciated. Finally, it appears that these conditions are insufficient if the synchrotron frequency is not a monotonic function of energy; future work will be needed to understand this.

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No

Would you like to submit this poster in student poster session on Sunday (August 10th)

No

Footnotes

*D. Boussard, CERN-II/RF/INT/75-2 (1975)

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Yes

Author: LINDBERG, Ryan (Argonne National Laboratory)

Presenter: LINDBERG, Ryan (Argonne National Laboratory)

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