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Microbunching Instability Studies: a Semi-Analytical Insights for EuPRAXIA@SPARC_LAB

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Microbunching instability (MBI) remains a critical challenge for high-brightness electron beams in linear accelerators, especially for free electron lasers (FEL). We present a comprehensive study of the MBI in the context of EuPRAXIA@SPARC_LAB, the first FEL user facility driven by plasma acceleration, focusing on both the emergence and the mitigation of MBI under various machine configurations. Our approach combines a semi-analytical model—based on the Huang–Kim formalism—to capture the evolution of current and energy modulations caused by longitudinal space charge and coherent synchrotron radiation effects, with an assessment of intrabeam scattering and Landau damping enhanced by the laser heater.

We complement this work with the theoretical outline of a laser heater for EuPRAXIA@SPARC_LAB, designed to provide the operational flexibility required to remain compatible with all the foreseen machine configurations.

Author: CAMPRI, Giovanni (Istituto Nazionale di Fisica Nucleare)

Co-authors: GIRIBONO, Anna (Istituto Nazionale di Fisica Nucleare); VACCAREZZA, Cristina (Istituto Nazionale di Fisica Nucleare); FERRARIO, Massimo (Istituto Nazionale di Fisica Nucleare); DI MITRI, Simone (Elettra Sincrotrone Trieste)

Presenter: CAMPRI, Giovanni (Istituto Nazionale di Fisica Nucleare)

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