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Characterization of the European XFEL Pulses in the Presence of Microbunching Instability

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One of the serious issues for short electron bunches in electron beam accelerators is the microbunching instability driven by longitudinal wake fields along the accelerator. Over the last decades a tremendous effort has been made in the theoretical understanding and experimental study of the microbunching instability impact on free electron laser performances. At the European XFEL, the compression of the electron beam to high peak current is achieved through three bunch compressors. Normally, the compression factor is more than 100, resulting in around 25 fs RMS bunch length. This high compression factor transfers the microbunching wavelengths to the visible or (very) near infrared radiation wavelength. In this presentation, we discuss our recent MBI study and measurements in European XFEL. By using the matrix model for collective space charge and coherent synchrotron radiation phenomena in electron beam longitudinal phase space and considering existing theories of intera beam scattering, in single pass linacs and multi-bend transfer lines [1], we theoretically characterize the MBI after each bunch compressor at European XFEL machine. We verify our theoretical prediction with longitudinal phase space and FEL radiation measurement.

[1] G. Pasao, S. Di Mitri Scientific Reports 11:7895 (2021)

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