

Studies of Longitudinal Dynamics in the Micro-Bunching Instability using Machine Learning

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Micro-Bunching Instability

Occurrence of Micro-Structures within the Electron Bunch

- self-interaction with emitted CSR leads to the formation of micro-structures within the electron bunch
- micro-structure dynamics change with bunch current and result in fluctuations of the emitted CSR power





Simulation Code Inovesa

VFP Solver to study the Longitudinal Dynamics

- in-house developed at KIT, published as open source project: https://github.com/Inovesa/Inovesa
- simulates longitudinal phase space density
- parallel plates model yields quite comparable results to measured data

Schönfeldt, P. *et al.* Parallelized Vlasov-Fokker-Planck solver for desktop personal computers. *Phys. Rev. Accel. Beams* **20** (2017)

⇒ Inovesa enables comprehensive studies of the micro-bunching instability on low-noise data





Analysis of Micro-Structure Dynamics



Application of Clustering Method k-means



Analysis of Micro-Structure Dynamics



Correlation to the emitted CSR



Analysis of Micro-Structure Dynamics



Correlation to the emitted CSR



Dependence on Vacuum Gap



Further Studies using the Application of *k*-means

