Contribution ID: **54** Type: **not specified**

SP6: Online Longitudinal Bunch Profile and Slice Emittance Diagnostics at the European XFEL

Thursday 20 July 2017 15:15 (3 minutes)

The longitudinal current profile and slice emittance are important bunch parameters for the operation of an X-ray free-electron laser. At the European XFEL, dedicated diagnostic sections equipped with transverse deflecting RF structures (TDS) have been installed for the control and optimisation of these parameters. Travelling-wave TDS in combination with fast kicker magnets and off-axis screens allow for the study of individual bunches without affecting the other bunches in the super-conducting linear accelerator which can generate bunch trains of up to 2700 bunches at 4.5 MHz within 600 microsecond RF pulses at a repetition rate of 10 Hz. The diagnosed bunch is taken out of the bunch train before the FEL undulators while the remaining bunches continue for the generation of FEL radiation. The measurement of the slice emittance is realised in a static FODO lattice equipped with four individual screen stations.
Variations of the longitudinal bunch profile or slice emittance along the bunch train may lead to suppressed FEL performance for parts of the train reducing the effective available number of bunches for FEL operation. By gradually adjusting the timing, individual bunches along the bunch train can be studied in order to optimise the overall beam parameters for all bunches in the train.
In this paper, we describe the diagnostic concept and realisation in detail and summarise first performance studies. Results of emittance measurements along the bunch train are presented.

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Session Classification: Speed-Posterpresentation: Beam Diagnostics

Track Classification: Speedposter_Beam Diagnostics