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Beam Based Alignment of a Seeded FEL

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Optimal FEL gain in a seeded FEL requires the careful alignment of different components. As for SASE FELs, the gain is optimized when the electron bunch travels in a straight line along the axis of each undulator in the radiator section. We have recently developed an alignment strategy for the optimization of the FERMI FELs which combines the beam-based alignment of the magnetic elements (undulators and quadrupoles) with the collinear alignment of spontaneous emission from each undulator. The method is divided into 3 steps. In the first step, we measure the undulator spontaneous emission with a spectrometer to fine-tune each undulator gap and set the best electron beam trajectory for collinear emission of each module. In the second step, the alignment of the undulator axis on the electron trajectory previously defined is achieved by looking at the undulator focusing effect. Finally, the seed laser is superposed on the electrons and aligned to maximize the bunching along the defined direction. This procedure can lead to an improvement in the control over the electron beam trajectory and results in a more efficient FEL process characterized by more stable and larger energy per pulse and a cleaner optical mode. A description of the method with the obtained results are reported in this work

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