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Design Study for an Optical Free-Electron Laser realized by Traveling-Wave Thomson-Scattering

Summary

We present an experimental setup strategy for the realization of an optical free-electron laser (OFEL) in the Traveling-Wave Thomson-Scattering geometry (TWTS). In TWTS, the electric field of petawatt class, pulse-front tilted laser pulses is used to provide an optical undulator field. This is passed by a relativistic electron bunch so that electron direction of motion and laser propagation direction enclose an interaction angle. The combination of side scattering and pulse-front tilt provides continuous overlap of electrons and laser pulse over meter scale distances which are achieved with centimeter wide laser pulses. An experimental challenge lies in shaping of these wide laser pulses in terms of laser dispersion compensation along the electron trajectory and focusing. The poster shows how diffraction gratings in combination with mirrors are used to introduce and control dispersion of the laser in order to provide a plane wave laser field along the electron trajectory. Furthermore we give limits on alignment tolerances to operate the OFEL. Example setups illustrate functioning and demonstrate feasibility of the design.

Primary author: Mr STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf)

Co-authors: Dr DEBUS, Alexander (Helmholtz-Zentrum Dresden-Rossendorf); Dr ALBACH, Daniel (Helmholtz-Zentrum Dresden-Rossendorf); Dr ROESER, Fabian (Helmholtz-Zentrum Dresden-Rossendorf); Mr LOESER, Markus (Helmholtz-Zentrum Dresden-Rossendorf); Dr SIEBOLD, Matthias (Helmholtz-Zentrum Dresden-Rossendorf); Dr BUSSMANN, Michael (Helmholtz-Zentrum Dresden-Rossendorf); Mr PAUSCH, Richard (Helmholtz-Zentrum Dresden-Rossendorf); Prof. SCHRAMM, Ulrich (Helmholtz-Zentrum Dresden-Rossendorf)

Presenter: Mr STEINIGER, Klaus (Helmholtz-Zentrum Dresden-Rossendorf)