Nonlinear spectroscopy at TeraFERMI

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Strong terahertz (THz) pulses with strong peak electric fields are highly demanded for nonlinear spectroscopy beyond resonant and off-resonant first order effects such as the Pockels-effect utilized for time-domain spectroscopy. Quadratic electro optic effects as observed in perovskites, the THz-Kerr effect e.g. investigated in water, or even out-of-equilibrium dynamics in superconductors require extraordinary THz-sources. TeraFERMI is a THz beamline at the free-electron laser (FEL) FERMI. After passing the FEL's undulator, the electron bunches are refocused on a thin dielectric slab and generate coherent transition radiation (CTR), in the form of strong THz pulses with peak electric fields up to 4 MV/cm or peak magnetic fields up to 1 T. The generated single cycle is sub-ps short and can reveal new interaction regimes within soft and condensed matter.

In this contribution we are going to present recent developments at TeraFERMI including new experiment end stations, namely fluence-dependent spectroscopy, all THz pump-probe transmission spectroscopy, THz-pump NIR-probe spectroscopy and an online diagnostic station in the TeraFERMI lab. A new TeraFERMI offline a table top antenna-based THz spectroscopy setup (independent of FERMI) supports additionally our THz facility for material pre-characterization at lower THz-frequencies up to 3 THz.