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# Nonlinear Terahertz spectroscopy and coherent control at accelerator based light sources.

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Terahertz (THz) frequency range contains wavelengths between 3 mm to 30 µm that corresponds to the energies between 0.4 meV to 40 meV. Spectroscopy in this range plays very important role in an understanding the solid state physics as there are multiple low energy excitations (phonons, magnons, Higgs mode etc.) that determine numerous physical parameters of the matter. Not only to perform THz spectroscopy but to coherently manipulate the phase of matter through these excitations it is required to develop high field narrow band THz radiation sources with very sensitive probing techniques.
THz user facility TELBE at Helmholtz-Zentrum Dresden-Rossendorf provides quasi CW SRF accelerator based narrowband THz radiation at high repetition rates. The source is based on superradiant principle that enables high degree of CEP stability, operation in deep THz frequencies tunable between 100 GHz to 3 THz and repetition rates up to MHz range [1]. The bandwidth of radiation is 10-15 % with pulse energies up to 12 µJ (up to 100 µJ as design parameter) that results in few 100 kV/cm peak field strength. Using pulse-resolved technique we can reach few femtosecond synchronization with ultra-fast laser system that is crucial for studying ultrafast dynamics [2]. The listed above parameters outperform state of the art high repetition rates laser based THz sources and are important for observing novel high field THz phenomena. In this contribution we present concept of superradiant THz sources and our recent results on observing novel high field terahertz phenomena making use of such sources [3-5].

References

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