NLTSF – Nonlinear THz Spectroscopy Facility

The Nonlinear Terahertz Spectroscopy Facility (NLTSF) consists of three main units: (i) a multi-mJ femtosecond pump laser, (ii) the THz pump—THz probe (TP2) system, and (iii) the multi-spectral imaging (MSI) system. The TP2 and the MSI systems can be used alternatively, but not simultaneously.

TP2 enables **time-resolved studies of THz-induced phenomena** by using a strong THz pulse to initiate changes in the sample and a weaker THz pulse to detect these. MSI is the spatially and spectrally resolved detection of THz radiation passed through an extended sample.

The TP2 system will be **available for users from October 2019**. (The MSI system will be available at a later time.)

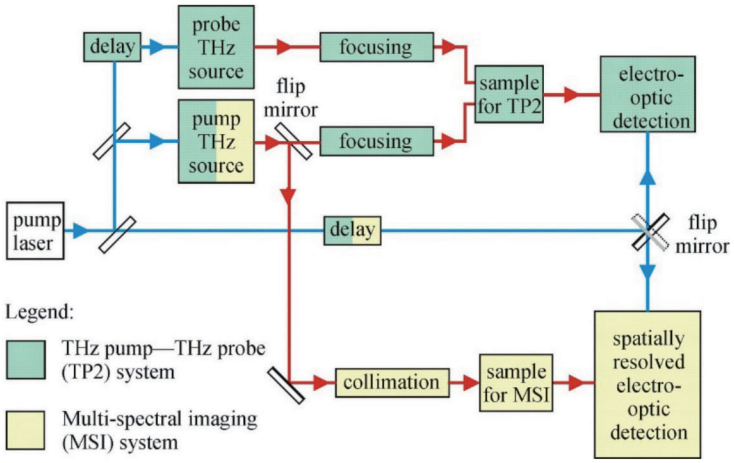

Fig. 1. Scheme of the NLTSF.

Pump Laser

The cryogenically cooled Yb:CaF2 femtosecond pump laser, operating at 1030 nm wavelength, drives the THz sources of the system. The pulse energy is 6 mJ and the repetition rate is 1 kHz. The 200 fs pulse duration is sufficiently short to support the specified THz bandwidth (0.15–1.5 THz for the THz pump and 0.2–2.5 THz for the THz probe).

The THz pump—THz probe (TP2) spectroscopy system

In the TP2 system, shown in Fig. 1, the optical pump pulse is split into 3 parts. The strongest part (typically 50–90% of the total energy) drives the source for the THz pump pulses. The generated single-cycle THz pulses with up to 10 μJ energy are tightly focused to achieve a peak electric field strength of up to >200 kV/cm in the sample to be investigated.

Another part of the optical pump (typically 10–40% of the total energy) generates the THz probe pulses, which propagate through the sample collinearly with the THz pump. The remaining weakest part of the optical beam is used to provide the sampling pulses for EOS. Behind the sample the waveform of the probe pulse is detected by electro-optic sampling (EOS), which enables to extract

maximum information from the measurement. Examples of measured waveforms and spectra are shown in Fig. 2. The variable pump-probe delay enables time-resolved studies in the THz range of the processes induced by the strong THz pump pulse.

Specifications for the system are provided in tables below.

TABLE 1. PUMP LASER PARAMETERS.	
Central wavelength	1030 nm
Pulse duration	~ 200 fs
Pulse energy	≥6 mJ
Repetition rate	1 kHz
Energy stability	< 2% RMS
FWHM bandwidth	20 nm
Jitter to external clock	≤100fs

TABLE 2. PUMP THZ PARAMETERS.	
Pulse energy	≥10 uJ
Spectral maximum	0.3-0.6 THz
Useful Spectral coverage	0.15-1.5 THz
Peak THz field	≥200 kV/cm

TABLE 3. ELECTRO-OPTIC SAMPLING.	
Spectral resolution	≤50 GHz
Useful Spectral coverage	0.2-2.5 THz
Dynamic range	70 dB

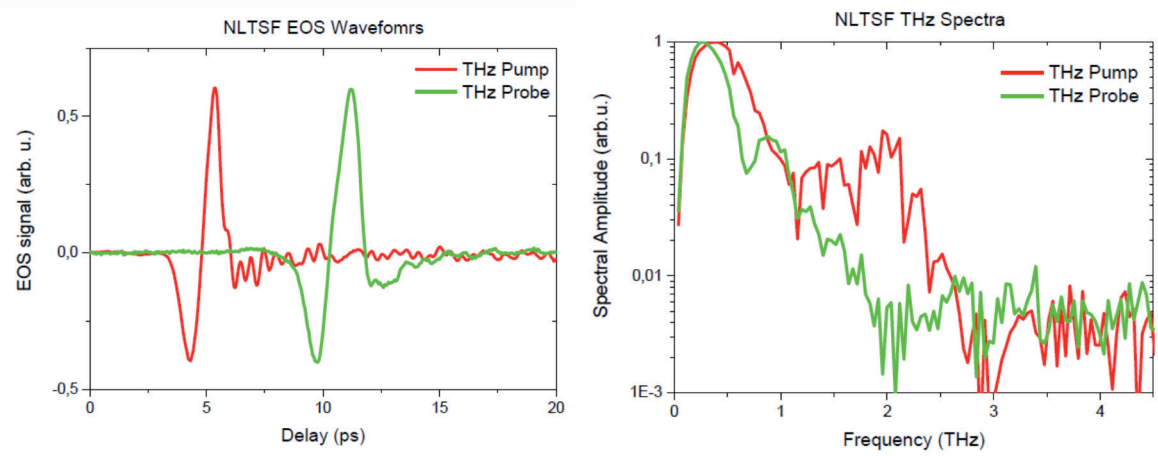

Fig. 2. Test measurements with the NLTSF. Left panel: Temporal waveforms of pump and probe THz pulses measured by EOS. Right panel: Retrieved spectra of the THz pulses.