THz Characterization and Generation of Temperature-Controlled Organic Crystal BNA

S. Mansourzadeh[1], T. Vogel[1], M. Shalaby[2] and C. J. Saraceno[1]
[1]Photonics and ultrafast laser science, Ruhr-University Bochum, Germany
[2]Swiss Terahertz Research-Zurich, Technopark, Zurich, Switzerland

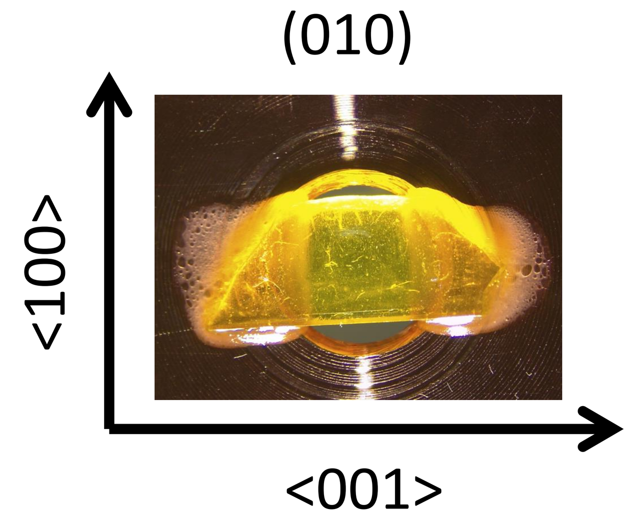
Motivation

- THz sources based on optical rectification in organic crystals:

+ Broadband, high power, and high conversion efficiency
- Poor thermal properties and low damage threshold

- Actively temperature-control crystals as a path to improve their thermal properties
- Temperature-dependent properties of the organic crystal

BNA:
N-benzyl-2-methyl-4-nitroaniline

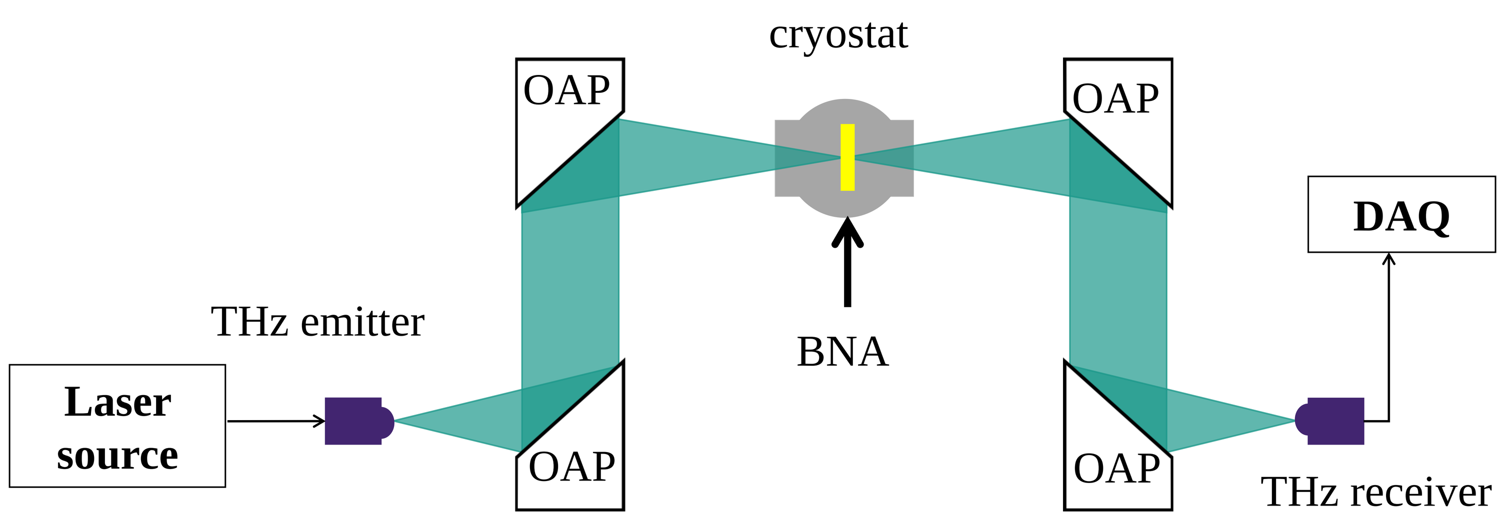


- Biaxial crystal
- <010> axis perpendicular to the cleaved facet of (010)
- <100> and <001> axes on the surface of the crystal

BNA inside a cryostat with temperature varied between 80 K and 300 K

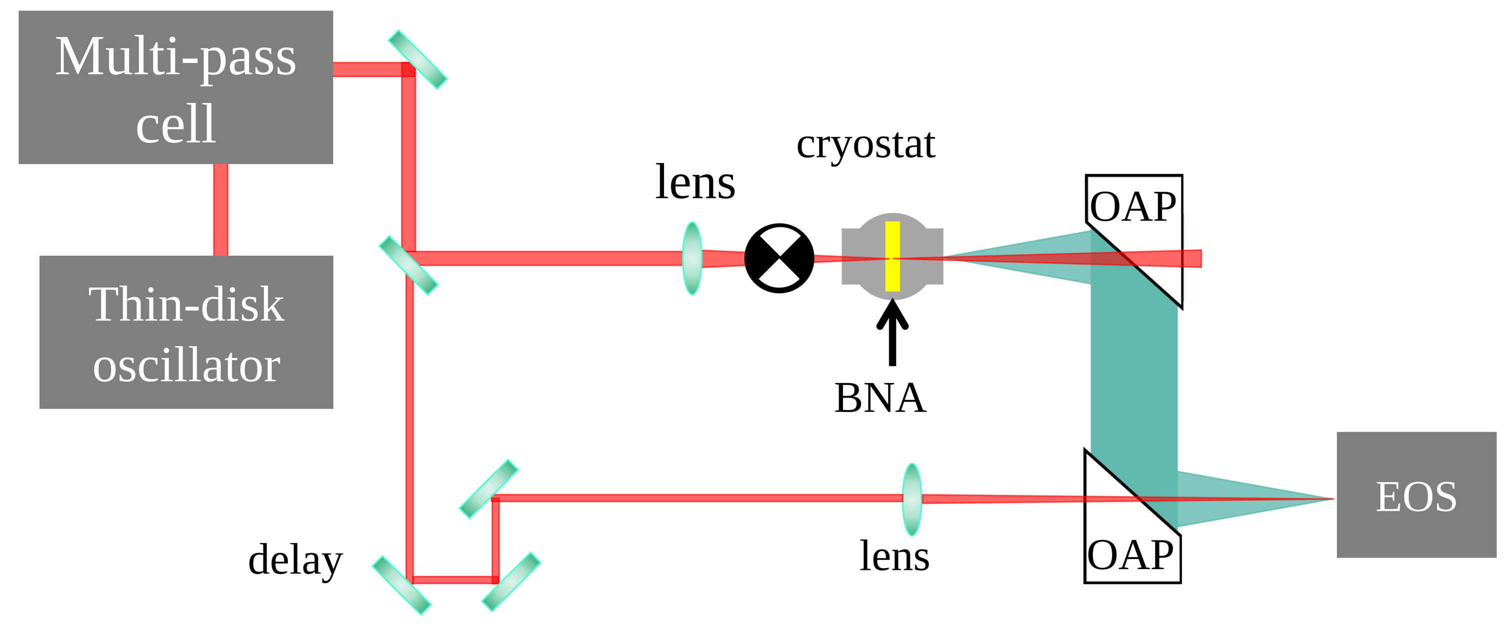
Experimental setup

Characterization:



Refractive index and absorption measurement:
- Commercial THz-TDS (Menlo Systems Tera K15)
- Repetition rate of 100 MHz
- Wide THz spectrum up to 6 THz
- High peak dynamic range of >100 dB after averaging over 1000 traces

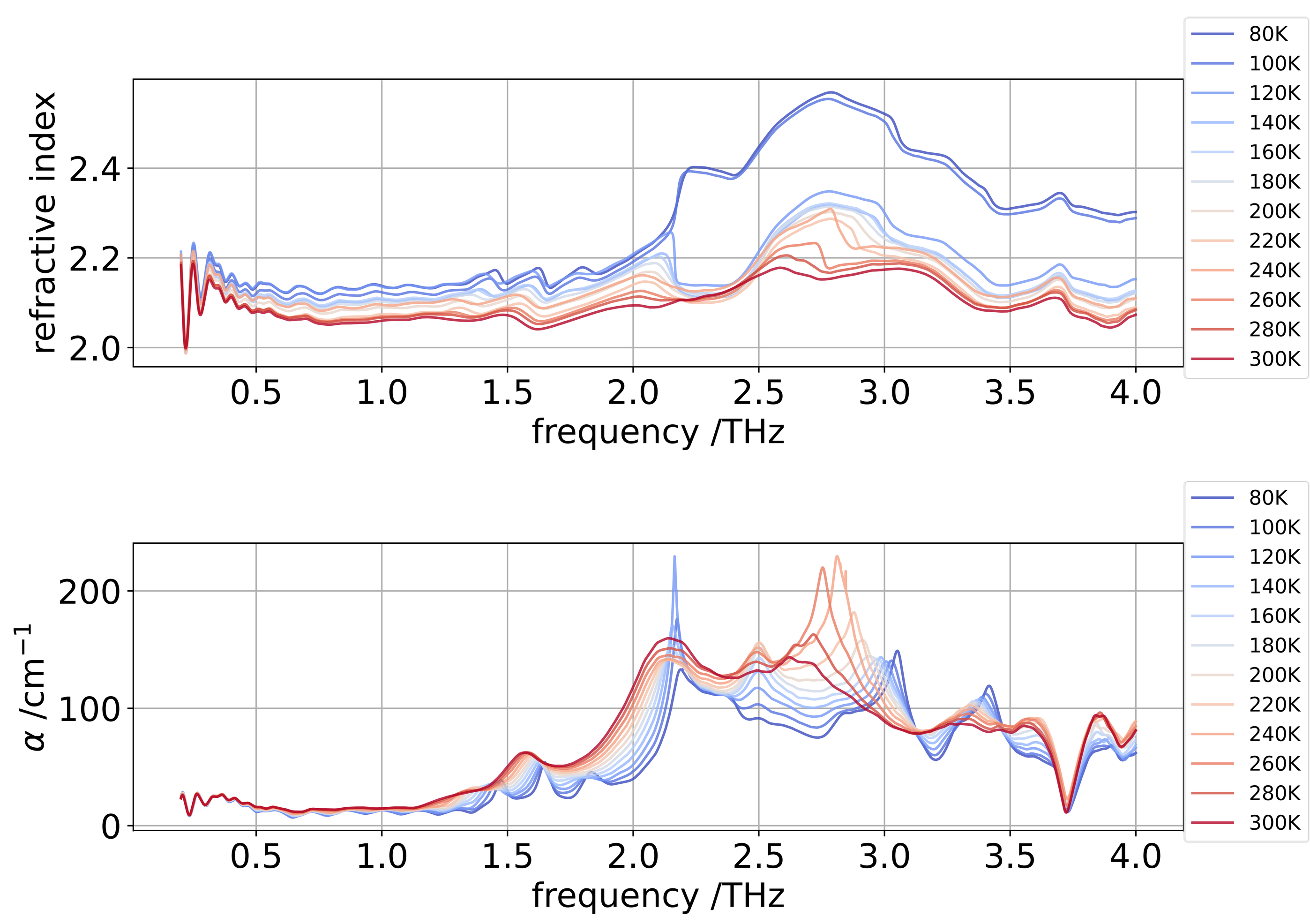
Generation:



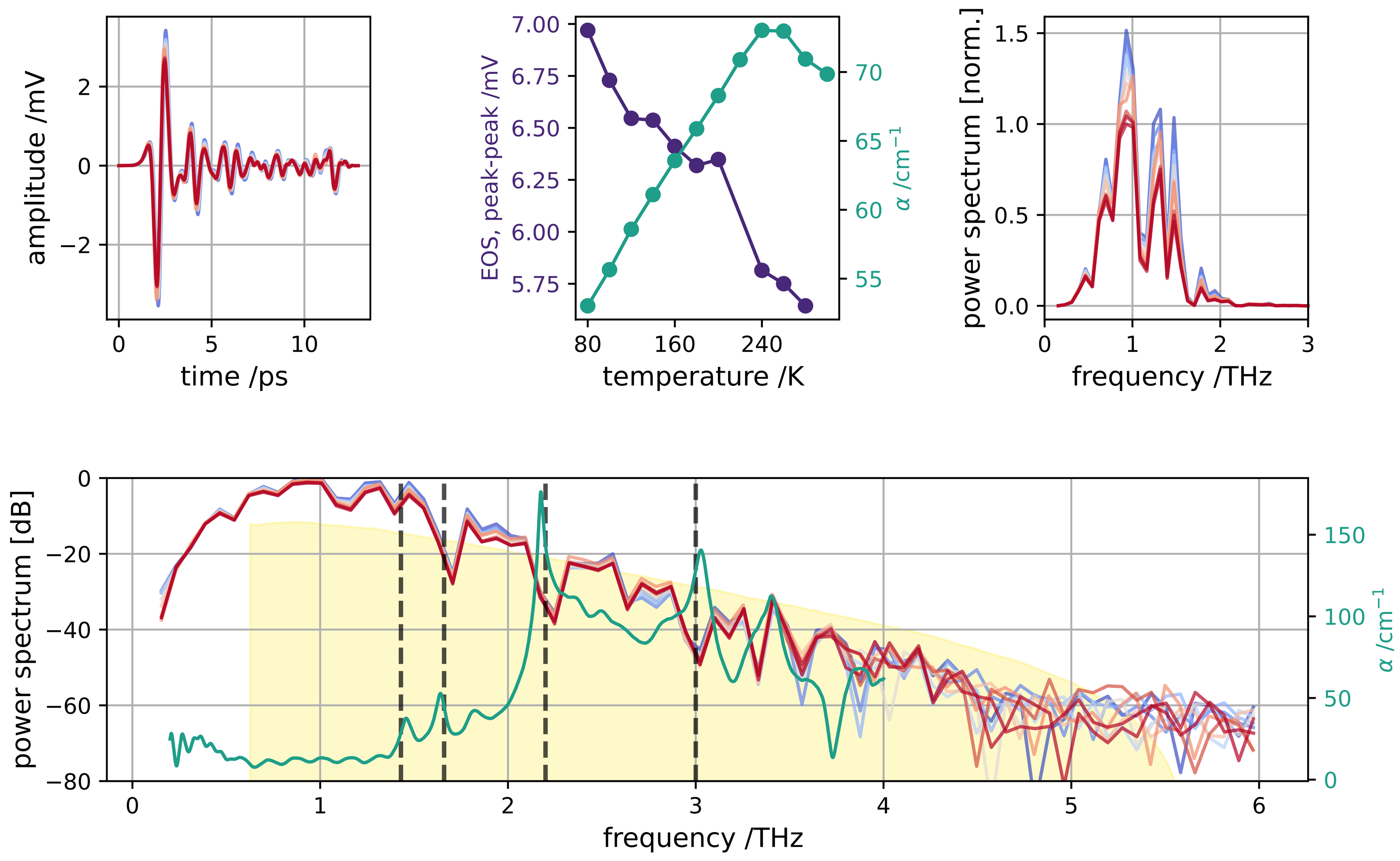
mode-locked thin disk oscillator + Herriot-type multi-pass cell:
- central wavelength of 1030 nm
- Pulse duration 80 fs
- Pump beam diameter on BNA ~0.36 mm
- Optical chopper to remove the thermal load

Results

BNA thickness: 487 µm, BNA orientation: <001>



- Data extraction using home-built open source software
- Minor deviations from room temperature in refractive index
- Averaged THz absorption over the whole frequency range up to 4 THz reduction by -24% by cooling the crystal



- Fixed pumped laser power of 1.3 W
- Peak-peak electric field rise with +23% (from 280 K to 80 K)
- Significant power spectrum enhancement of 50%
- Good agreements between the position of dips in the detected spectrum and the peaks in the absorption curve

Conclusion

- Cryogenic cooling as a straightforward route to enhance the THz efficiency
- Reducing the THz absorption in organic crystals by actively cooing them
- Temperature dependent THz refractive index and absorption measurements for BNA

arXiv-preprint

Github - phoeniks