THz Diagnostics at FLASH1.

Ekaterina Zapolnova
THz Team at FLASH, DESY

Mini-workshop on THz@PITZ
15.03.2023

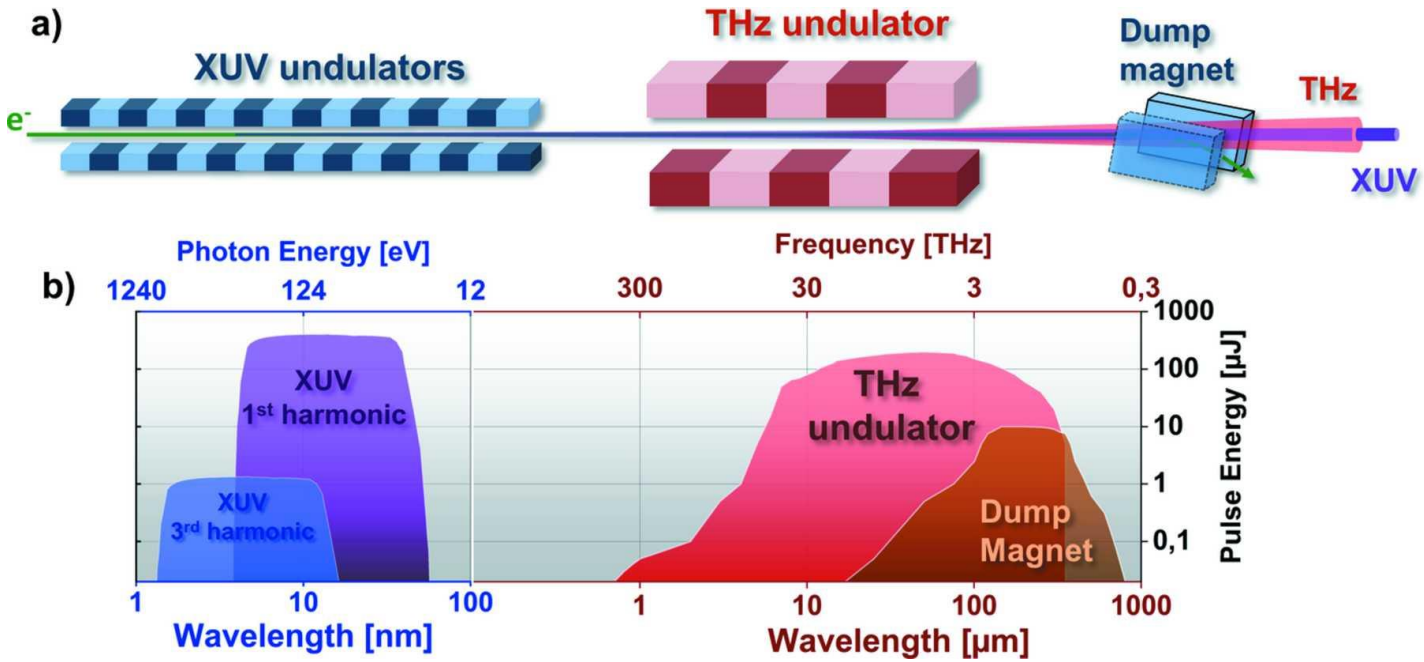
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

INNOVATION & TECHNOLOGIE TRANSFER

DESY.

THz beamline at FLASH1.

Unique high-power synchronized XUV and THz combined source for ultrafast pump-probe experiments



Undulator

- Tunable: 10 - 300 µm;
- up to 100 µJ/pulse;
- ~10% bandwidth

Dump Magnet

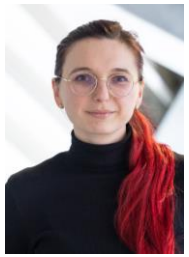
- Broadband at 200 µm;
- up to 10µJ/pulse;
- ~100% bandwidth

THz Team

Rui Pan

Marc Temme

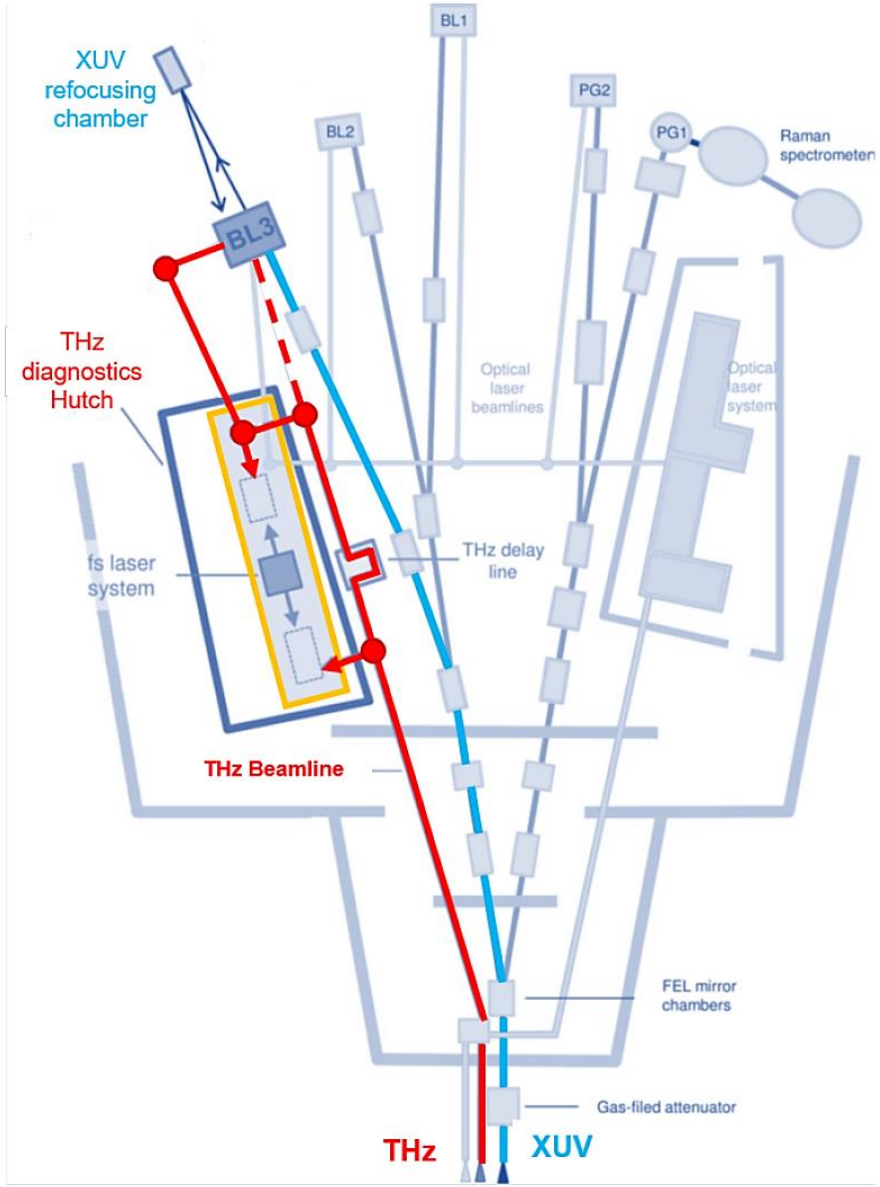
Seung-gi Gang

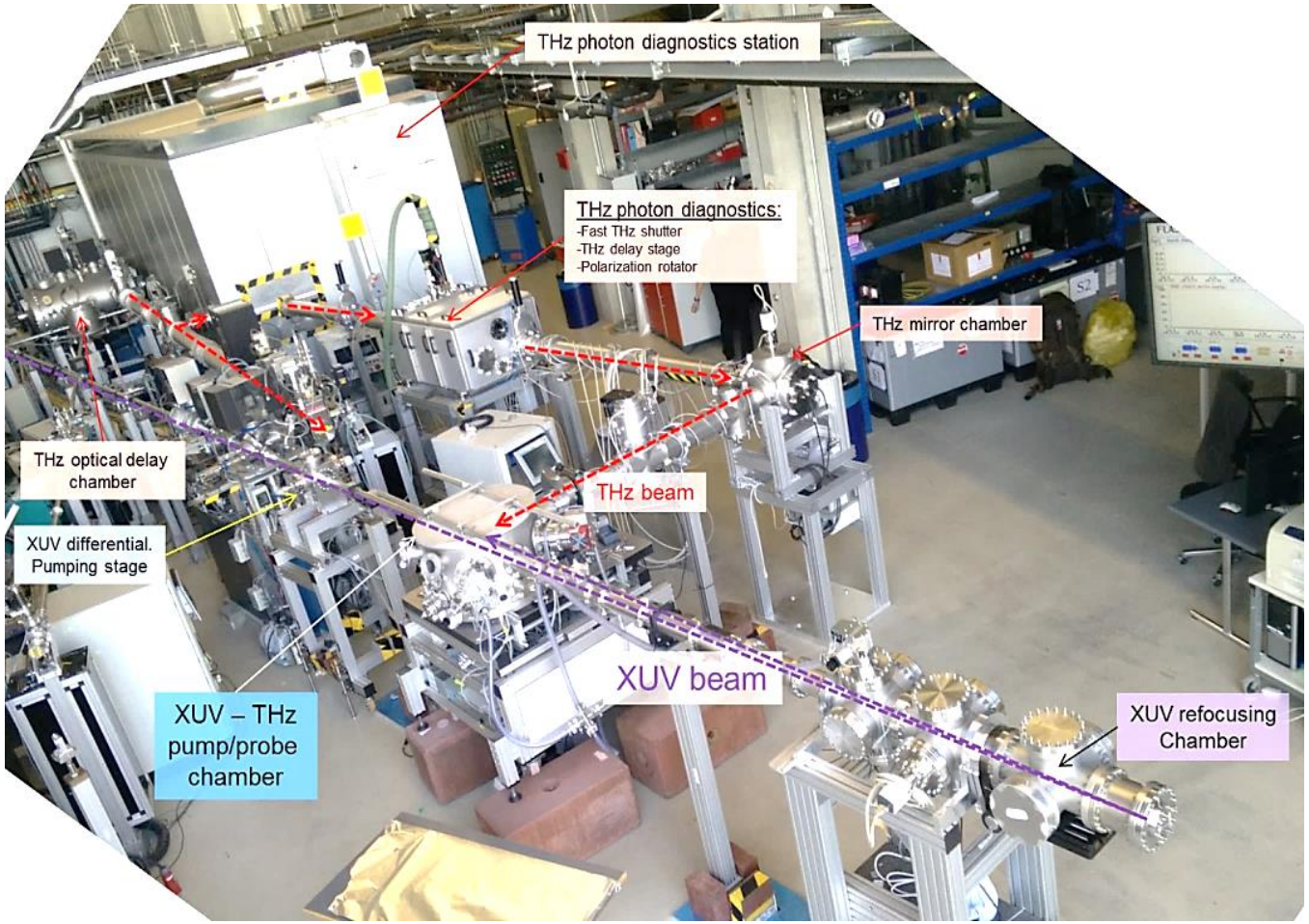


Ekaterina Zapolnova (DGP Project)

• B. Faatz et al., NIM A 475 (2001) 363.
• G. Geloni, E.L. Saldin, E.A. Schneidmiller, M.V. Yurkov, Nucl. Instr. Method A 528 (2004) 184–188.
• Gensch, M. et al. New infrared undulator beamline at FLASH. Infrared Phys. Technol. 51, 423–425 (2008).
• Pan et. Al. J. Synchrotron Rad., 26, 700-707 (2019)

FLASH1 experimental hall.

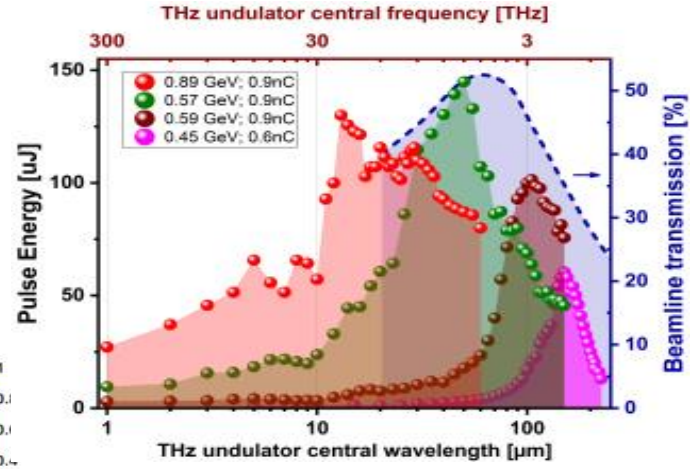




Current Diagnostics

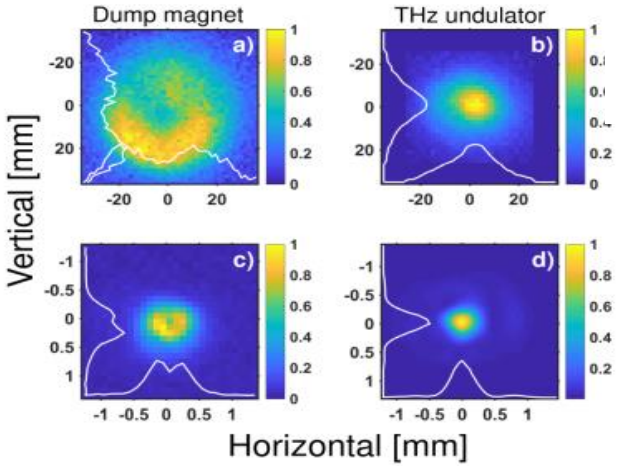
1. THz power

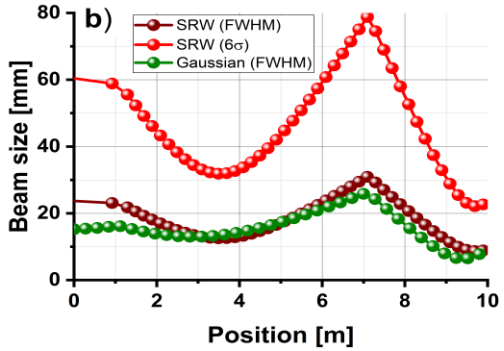
- THz pulse energy vs. wavelength
- Help operator for FLASH tuning



2. Transverse beam profile

- Detector dia. 2mm (with extra pinhole)
- Beam divergence and propagation
- Design for users' individual experiments

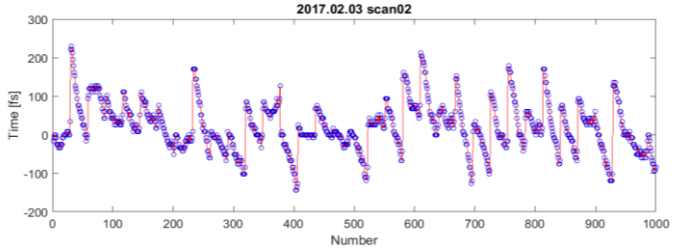




Simulation on beam propagation

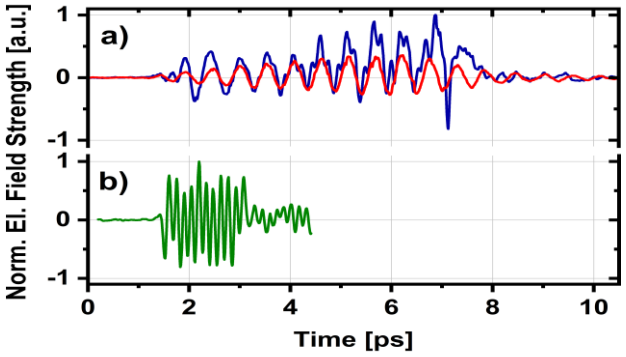
3. Arrival time by EOSD

- single shot arrival time correction down to 8.5 fs (rms)
- burst mode capability at 200 kHz (1MHz with KALYPSO)



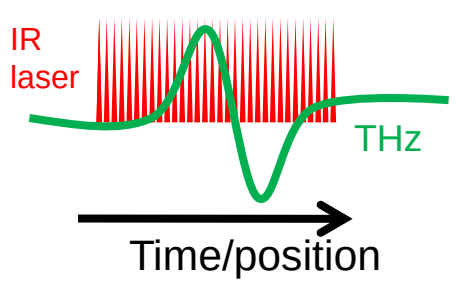
4. Temporal profile by EOS

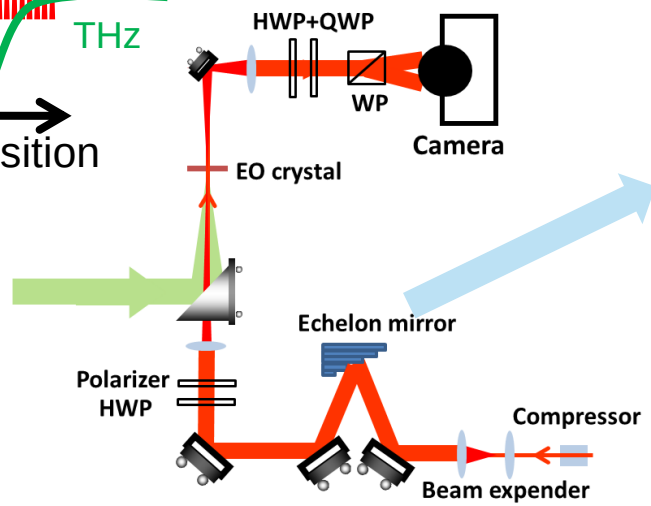
- Distortion free THz electric field resolved detection
- broad THz detection range from 40 μm – 3000 μm (7.5 THz – 0.1 THz)
- Bandwidth resolution 0.05 THz (~20 ps)

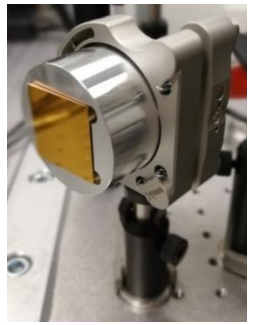


Diagnostics Developement

Single-shot EOS







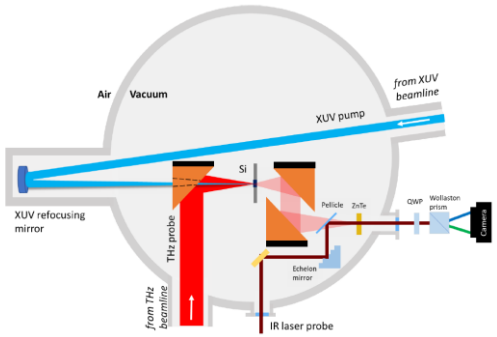
Single-shot monitor for THz temporal profile and spectrum

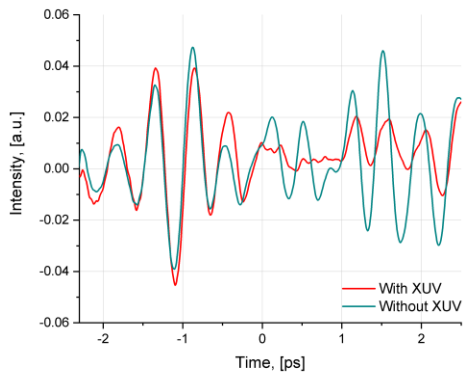
- Arrival time
- Temporal profile
- Spectrum
- Transverse profile (modify)

30 mm * 30 mm size
Time step: 50 fs
Time window: 10 ps

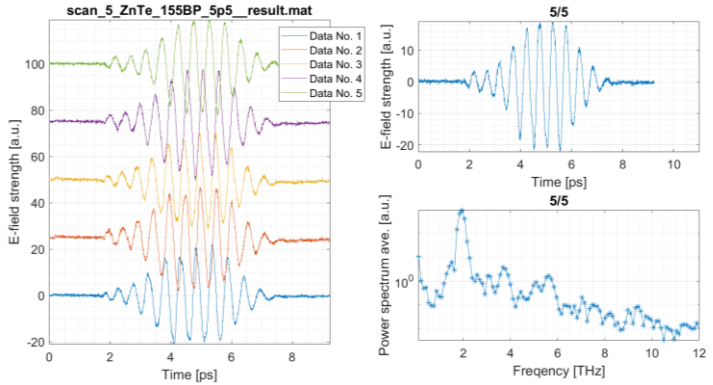
Stephenson Distinguished Programme: Z.Chen, SLAC, USA

Single-shot THz plasma switch

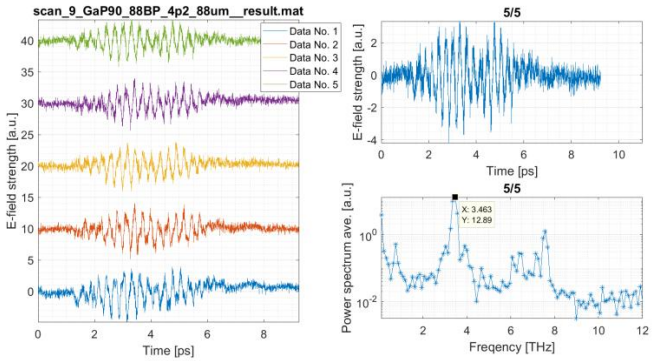




Adapted from E.Zaponova's PhD thesis



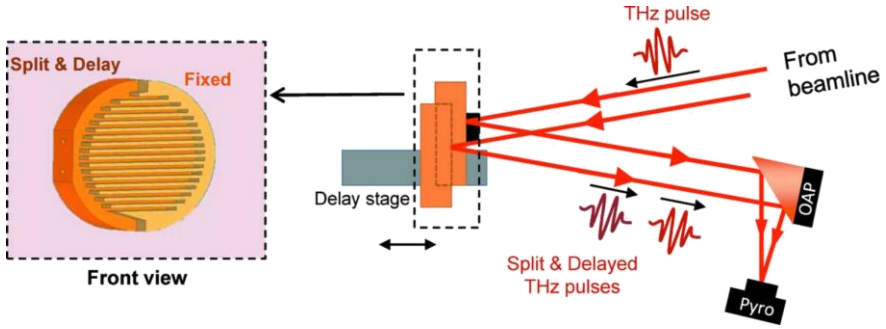
Single-shot measurement by 2mm ZnTe with 155µm Bandpass filter in air



Single-shot measurement by 100µm GaP with 88µm Bandpass filter in air

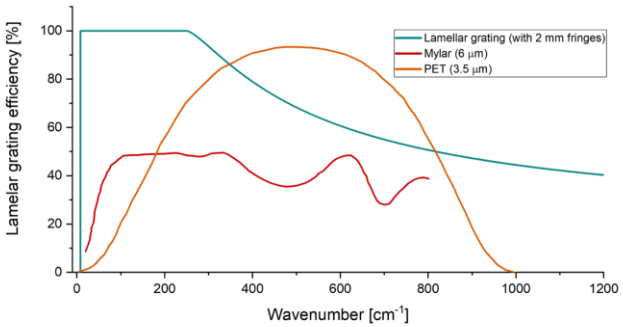
Spectral Diagnostics

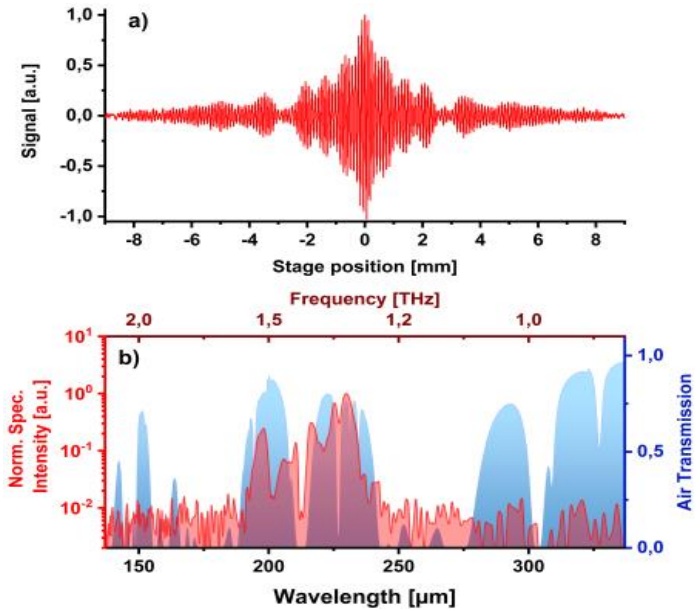
Broadband FTIR Lamellar Grating Spectrometer



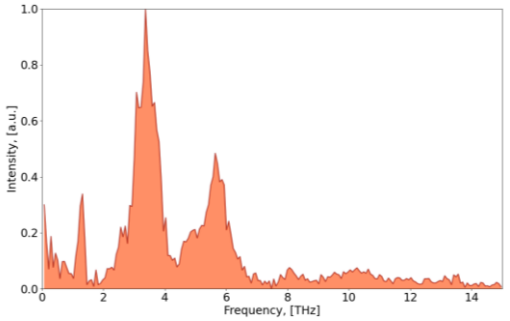
- **Fully reflective** Lamellar Grating based FTIR interferometer
- Currently **30-300 µm / 1 – 10THz,**
- Project goal: **1 µm – 300 µm / 1 THz – 100 THz**
- **Compact and robust** design, suitable for online monitoring in vacuum
- Goal – **½ of A4 sheet** of paper
- Resolution $\mathbf{1cm^{-1}}$

Lamellar vs Michelson

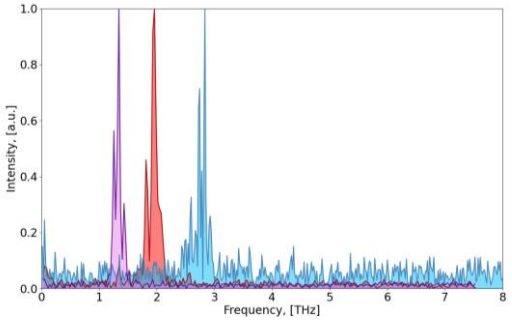




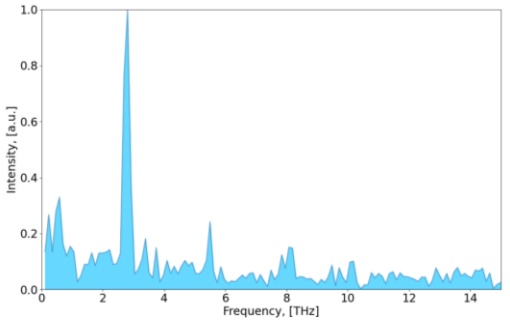
Broadband THz Dump Magnet



Various Band-Pass Filters



THz Undulator @ 105µm



I want to test it everywhere! Please get in touch ☺

Thank you!