Construction and Calibration of Compact Optical Pump Terahertz Probe Spectrometer

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Optical pump terahertz probe spectroscopy allows one to explore the conductivity dynamics of a material on the sub-picosecond timescale after optical excitation. Based on the transmission of the THz probe through the sample, one can deduce useful information regarding excited carrier dynamics. This poster will show the validity of using a compact spectrometer design to make THz spectroscopy measurements. The system can be used in both a low repetition high energy system, 1khz 5W system, as well as a tunable high repetition high energy, 50-100Khz 10W. The optical pump has a center wavelength of 800nm. The spectrometer uses 1mm Zinc Telluride crystals to produce the THz by optical rectification as well as measure the THz by electro-optic sampling. The use of two-inch effective focal length parabolic mirrors as well as a short delay stage allow for the overall footprint of the probe to fit on a small 12” x 24” breadboard.

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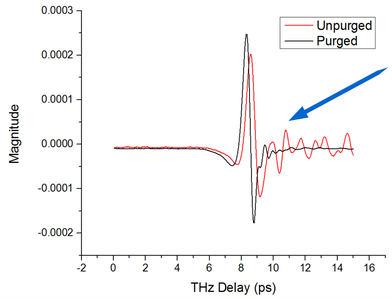
Introduction

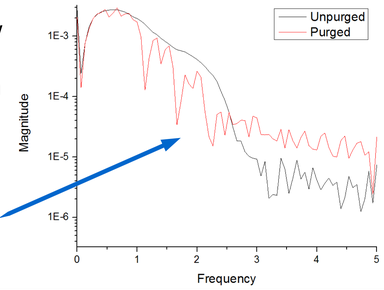
Motive: THz spectrometer systems take up an unnecessarily large amount of table space. Additionally, purging the system with dry nitrogen can take a couple of hours due to the large size of the systems.

Goal: Build compact THz spectrometer that both uses less table space and reduces purge times.



oscillations and low amplitude are due to water absorption

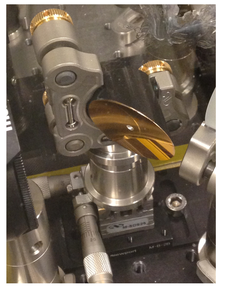
Water absorbs THz at particular frequencies



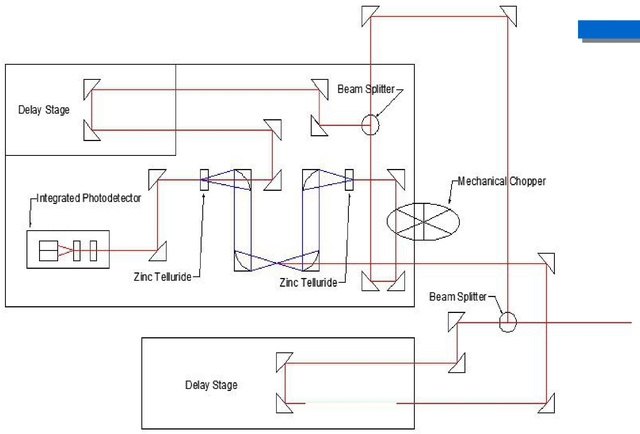
Specifications

Main Specs:
- To be used with 1kHz 5W system, as well as a tunable high repetition high energy, 50-100 kHz 10W
- 1mm ZnTe for generation by optical rectification and detection by electro-optic sampling
- 800nm center wavelength pump

Compact Size:
- Two inch EFL parabolic mirrors
- Short delay stage
- Small 12”x24” breadboard
- Integrated Photodetector system
- Small Purge Box

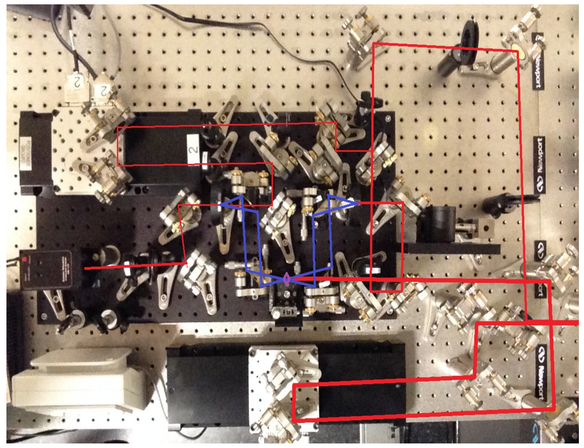


Design Process



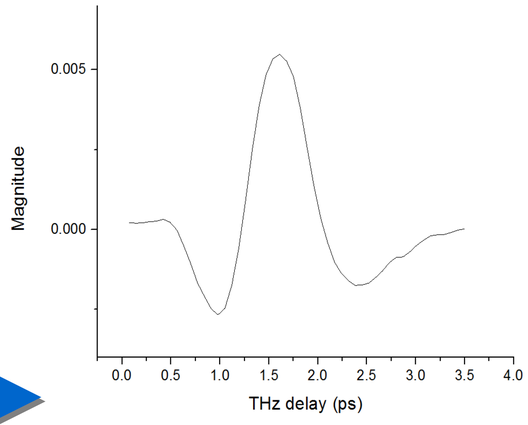
Prior to arrival at OIST:
AutoCAD Design
- Optics fit on breadboard
- Gating and generation beams are same length

Upon Arrival:
- Optics put on breadboard
- Initial alignment done with HeNe laser

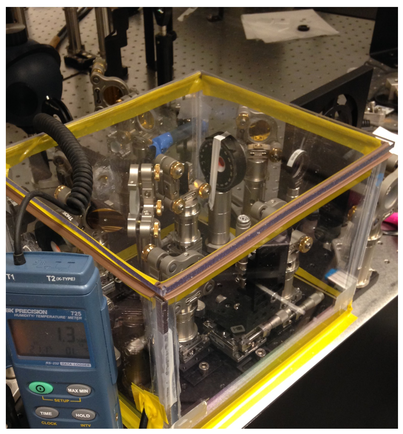


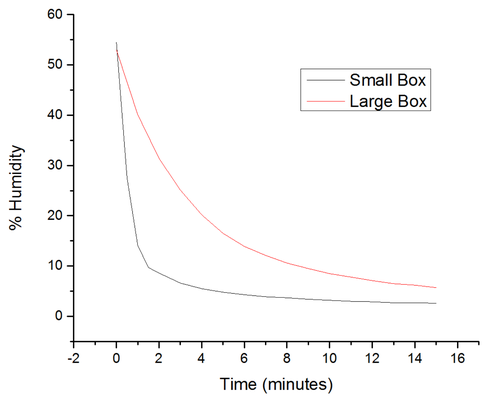
Finding Terahertz:
- Lenses added to telescope and focus beam
- Mechanical chopper used to modulate signal in junction with lock-in amplifier.

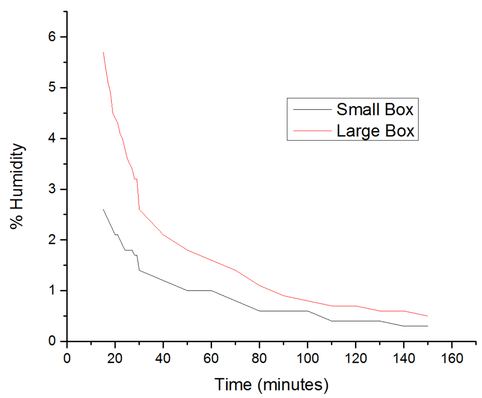
Maximizing Signal:
- ZnTe rotated to maximize signal
- Optics iteratively adjusted to maximize signal

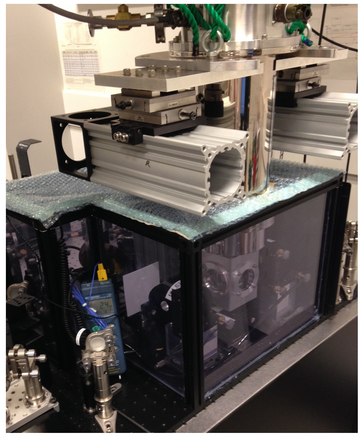


Results









Conclusion

- The spectrometer was successful constructed and used to measure THz.
- The compact size allowed the system to purge nearly twice as quickly as a standard system.
- The next step is to align and calibrate the pump beam to make optical pump THz probe measurements

Acknowledgments

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