

## Development of a Gas Plasma-Based THz Time-Domain Spectrometer for the 25 T Florida Split Helix Magnet System.

J. A. Curtis<sup>1</sup>, B. Barman<sup>1</sup>, T. T. Tokumoto<sup>1</sup>, L. M. McClintock<sup>1</sup>, J. Reno,<sup>2</sup> D. Karaiskaj<sup>3</sup>, S. A. McGill<sup>4</sup>, and D. J. Hilton<sup>1</sup>

<sup>1</sup>Department of Physics, University of Alabama at Birmingham, Birmingham, AL 35294, USA

<sup>2</sup>National High Magnetic Field Laboratory, Florida State University, Tallahassee, FL 30201, USA

<sup>3</sup>Center for Integrated Nanotechnologies, Sandia National Laboratory, Albuquerque, NM 87185, USA

<sup>4</sup>Department of Physics, University of South Florida, Tampa, FL 33620 USA

THz time-domain spectroscopy, an ultrafast free-space optical technique at THz frequencies (0.1-15 THz), has been used in recent years in magneto optical configurations to study many interesting material systems including two dimensional electron gasses [1] and two dimensional hole gasses [2]. In order to extend the magnetic field range of these measurements we have developed a gas plasma-based THz time-domain spectrometer (TTDS) for use in the 25 T Florida Split Helix magnet system at the National High Magnetic Field Laboratory at Florida State University. The experimental setup is shown in Figure 1. We have demonstrated that this system is sensitive to THz frequencies in excess of 15 THz in the absence of sample probe and magnet windows. Figure 2 shows the time-domain signal and calculated spectrum. We have recently performed the first high-field TTDS measurements in this magnet system up to 25 T. A high mobility ( $\mu=3.6 \times 10^6 \text{cm}^2\text{V}^{-1}\text{s}^{-1}$ ) GaAs two dimensional electron gas was chosen as a test sample due to its well known effective mass, which corresponds to a cyclotron frequency well within the expected bandwidth of the system. Figure 3 shows the transmitted THz electric field through the sample with the calculated spectra for 6 magnetic fields (0-25 T). The reduced transmitted bandwidth shown is currently under investigation.

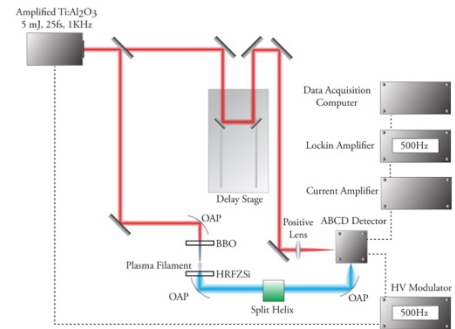


Figure 1. A gas plasma based THz time-domain spectrometer with Split Helix magnet system.

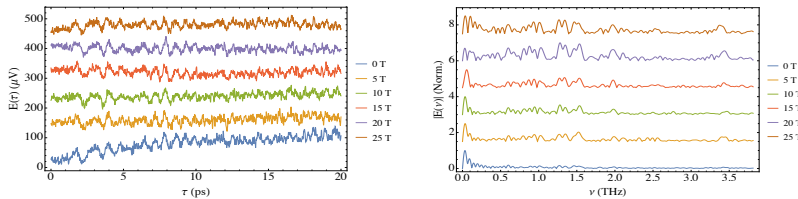


Figure 3. Transmitted THz electric field and calculated spectrum through GaAs high mobility 2DEG inside Split Helix.

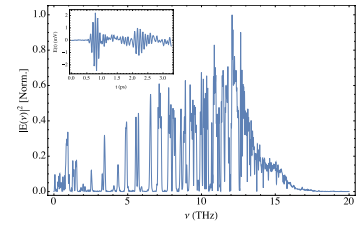


Figure 2. Transmitted THz electric field and calculated spectrum through Split Helix without magnet windows and probe.

[1] Q. Zhang *et al*, Phys. Rev. Lett. **113**, 047601 (2014).

[2] N. Kamaraju *et al*, Appl. Phys. Lett. **106**, 031902 (2015).

Category: MO

Email: dhilton@uab.edu