ND*nano* Undergraduate Research Fellowship (NURF)
2013 Project Summary

1) Student name: Akash Kannegulla
2) Faculty mentor name: Prof. Li-Jing Cheng & Prof. Lei Liu
3) Project title: Photo-Induced Reconfigurable THz Circuits and Devices.

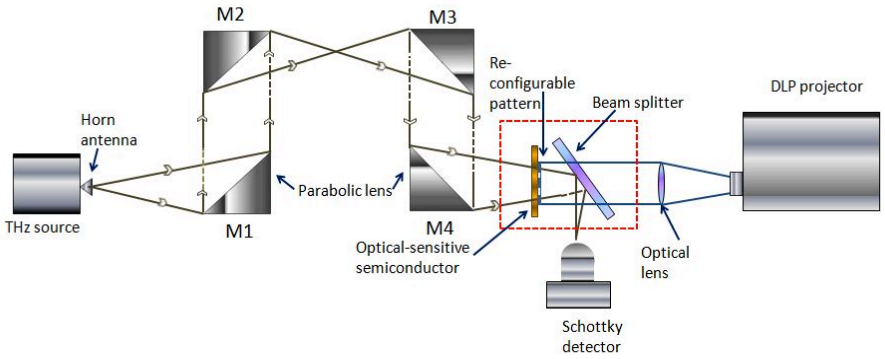
4) Briefly describe any new skills you acquired during your summer research:
I have learnt the basics of THz technology and further how to implement it. I have learnt how to make posters and presentations during this summer research. Finally, I learnt to perform THz imaging by implementing two different methods.

5) Please briefly share a practical application/end use of your research:
The technique of this research project could be applied to realize a variety of novel reconfigurable quasi-optical THz circuits and components such as universally tunable filters, planar tunable zone-plates and spatial arrays for much improved THz wave manipulation capability desired in THz imaging, sensing and communication.

Project summary:

Terahertz technology holds key applications in THz imaging, sensing, radio astronomy and communication. Recent works in THz technology was to develop THz sources and detectors. However, the research into active components for modulation of THz radiation is still in its infancy. In this project, a novel technique is implemented to obtain the THz components (e.g. THz modulator), needed in THz imaging. Existing methods like focal plane array imaging and micro fabrication processes are expensive, whereas, this technique is implemented using commercially available Digital Light Processing (DLP) projectors.

One of the key components mostly desired for advanced THz circuits and systems is a tunable THz modulator. When a semi-insulation silicon wafer is photo-excited, free carriers generated within the penetration depth form a layer of electron plasma that interacts with THz radiation. The modulation depth of ~20 dB is achieved at the frequency of 585 GHz.



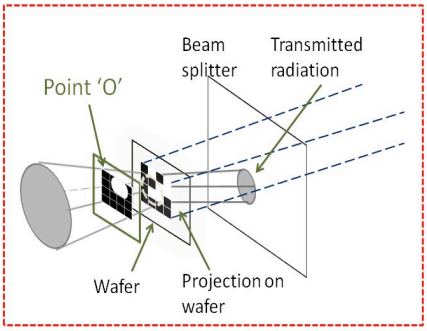


Figure 1: Experimental setup for continuous wave THz modulation and reconfigurable THz quasi-optical component using photo-induced pattern on semi-insulation silicon.

Inset: Projection of patterns, obtained by Hadamard matrix. For 4X4 pixel resolution, the number of patterns projected in Hadamard imaging is 32. The measurement for finding the image of the object is performed by inserting it at point 'O'.

Finally, Thz imaging is performed by using two methods: scanning each pixel and Hadamard imaging. In first method, each pixel is closed for four seconds and the transmission is recorded. In Hadamard imaging, the patterns are obtained by Hadamard matrix and the transmission for every pattern is recorded. The image in both the methods can be reconstructed by using the recorded transmission.

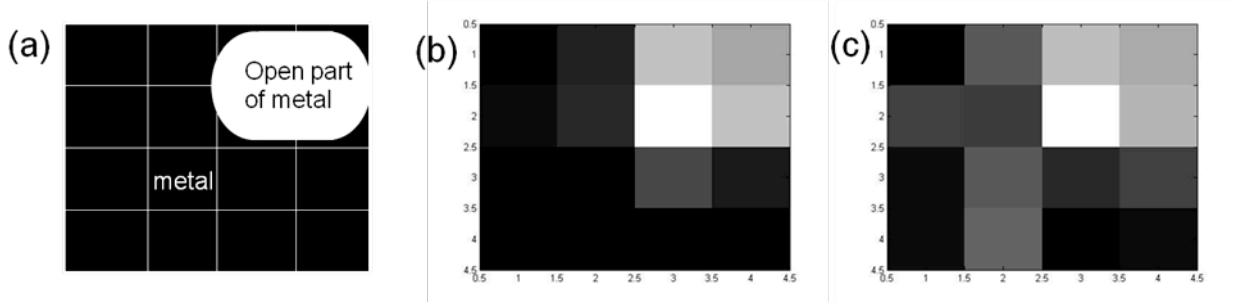


Figure 2: (a) Metal piece having a hole, placed at point 'O' (b) Reconstructed image of the metal piece obtained by closing each pixel at regular time intervals. (c) Image is reconstructed by projecting the patterns obtained by Hadamard matrix

Publications (papers/posters/presentations):
Paper: A. Kannegulla, Z. Jiang, S. Rahman, L.-J. Cheng and Lei Liu, "THz Coded-Aperture Imaging Using Photo-induced Aperture Arrays for Mapping THz Beams", Applied Physics letters, Submitted: August 2013
Poster and Oral Presentations: Presented on SURS 2013.