

**Rensselaer Polytechnic Institute,
Troy, NY**

Research Assistant Professor

July 2010 - November 2011

August 2004 - August 2008

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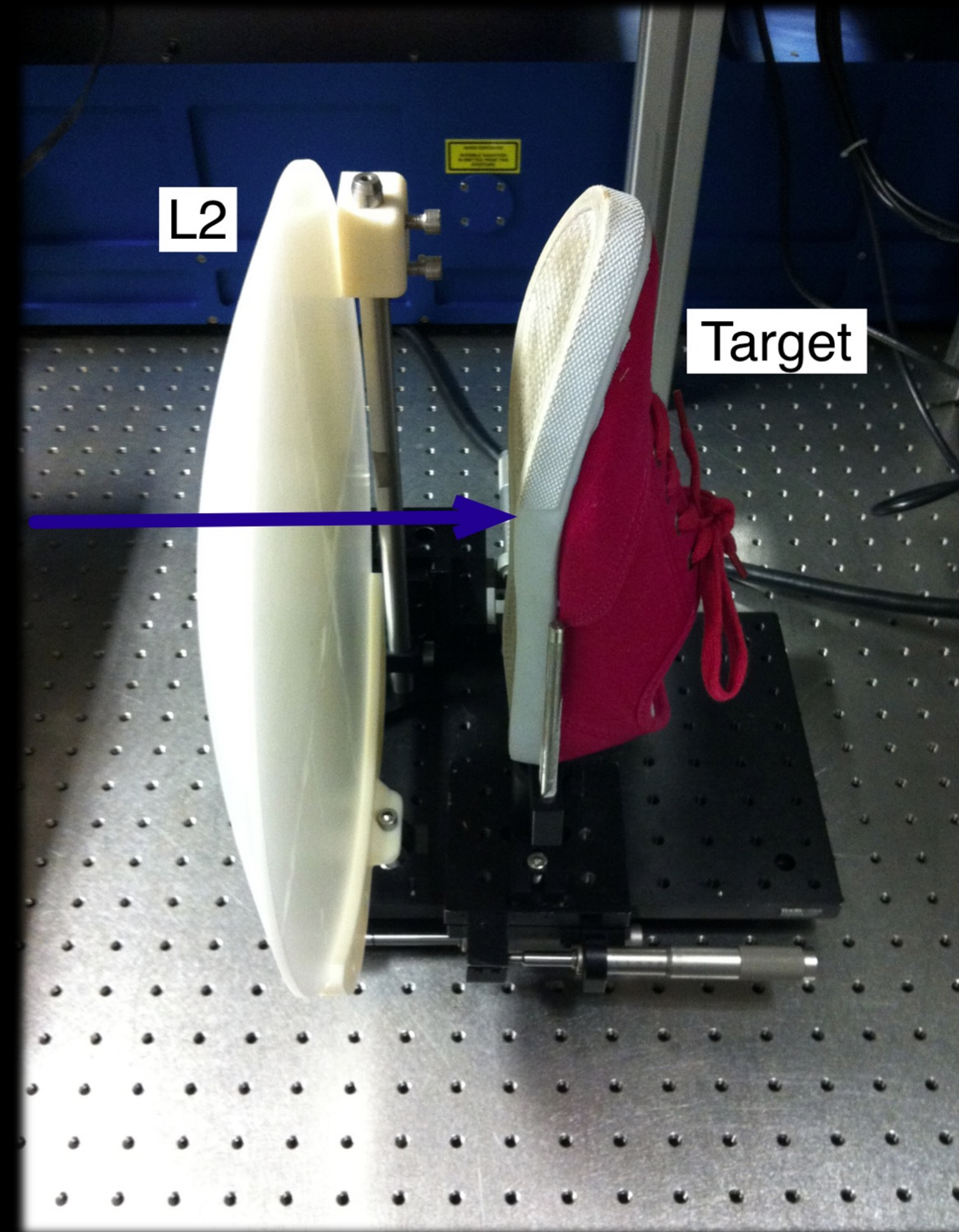
Terahertz shoe scanner

Challenges

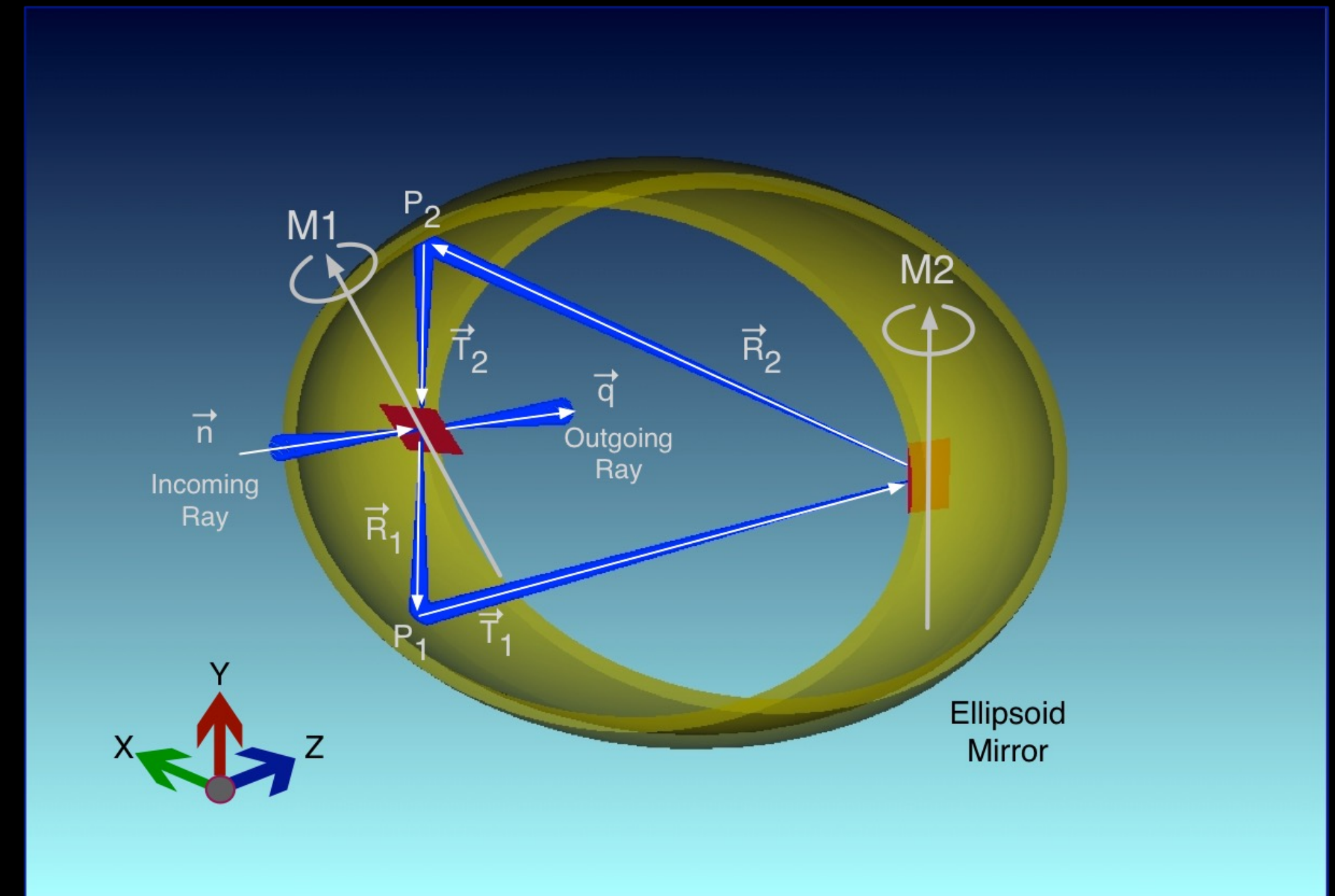
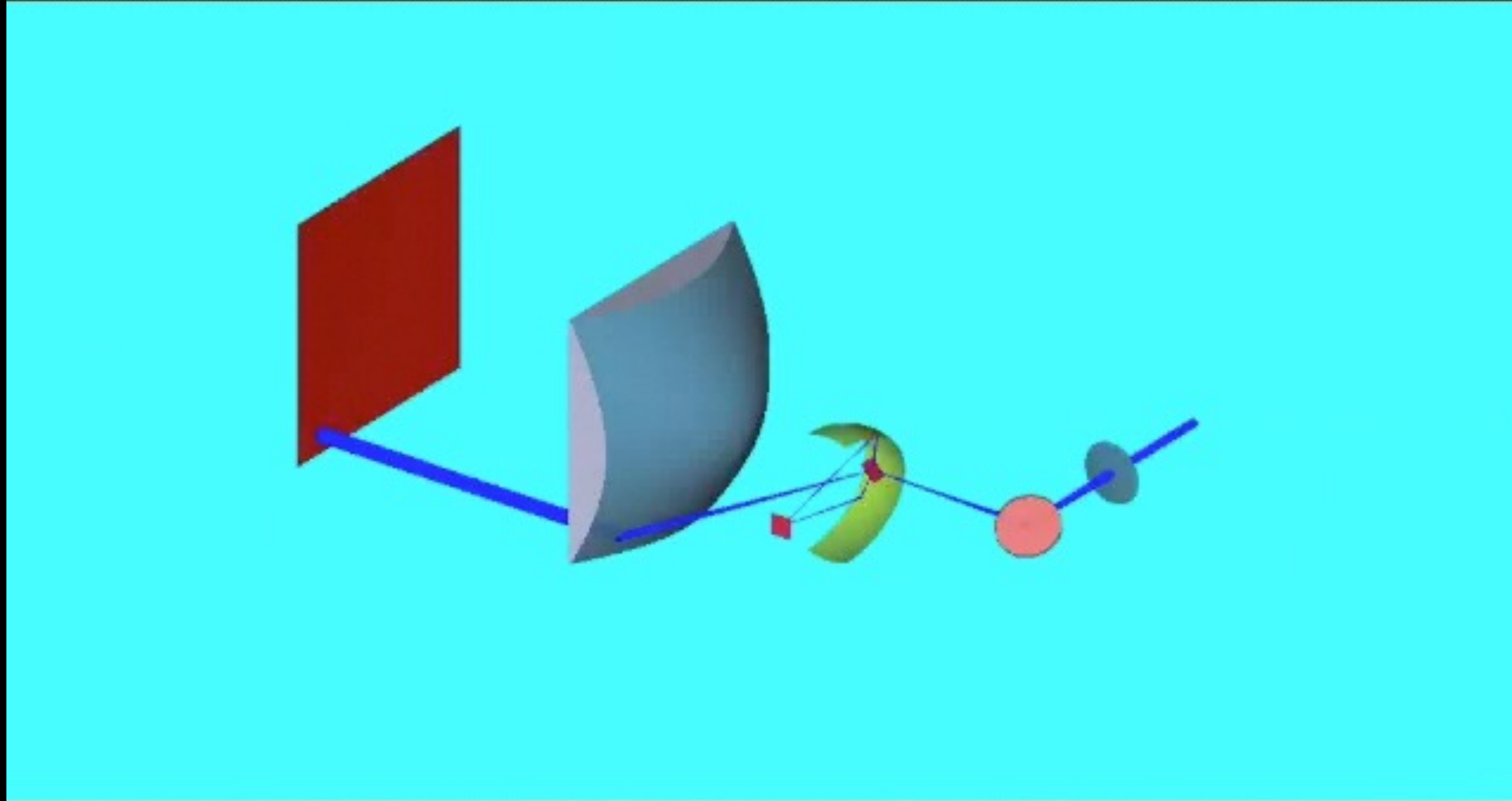
Point emitter-receiver

Scan large areas fast

High losses sample

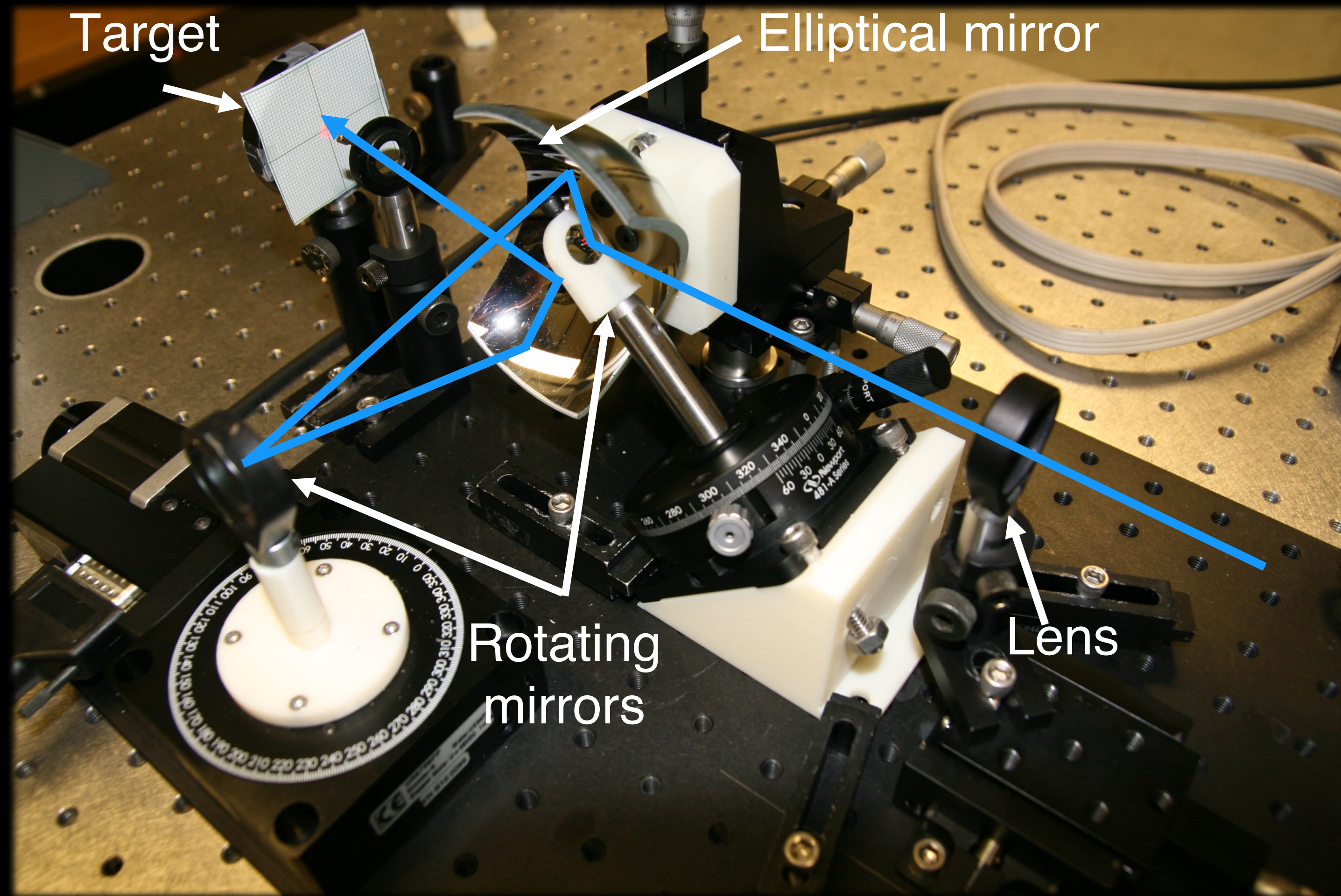


Terahertz shoe scanner: DESIGN



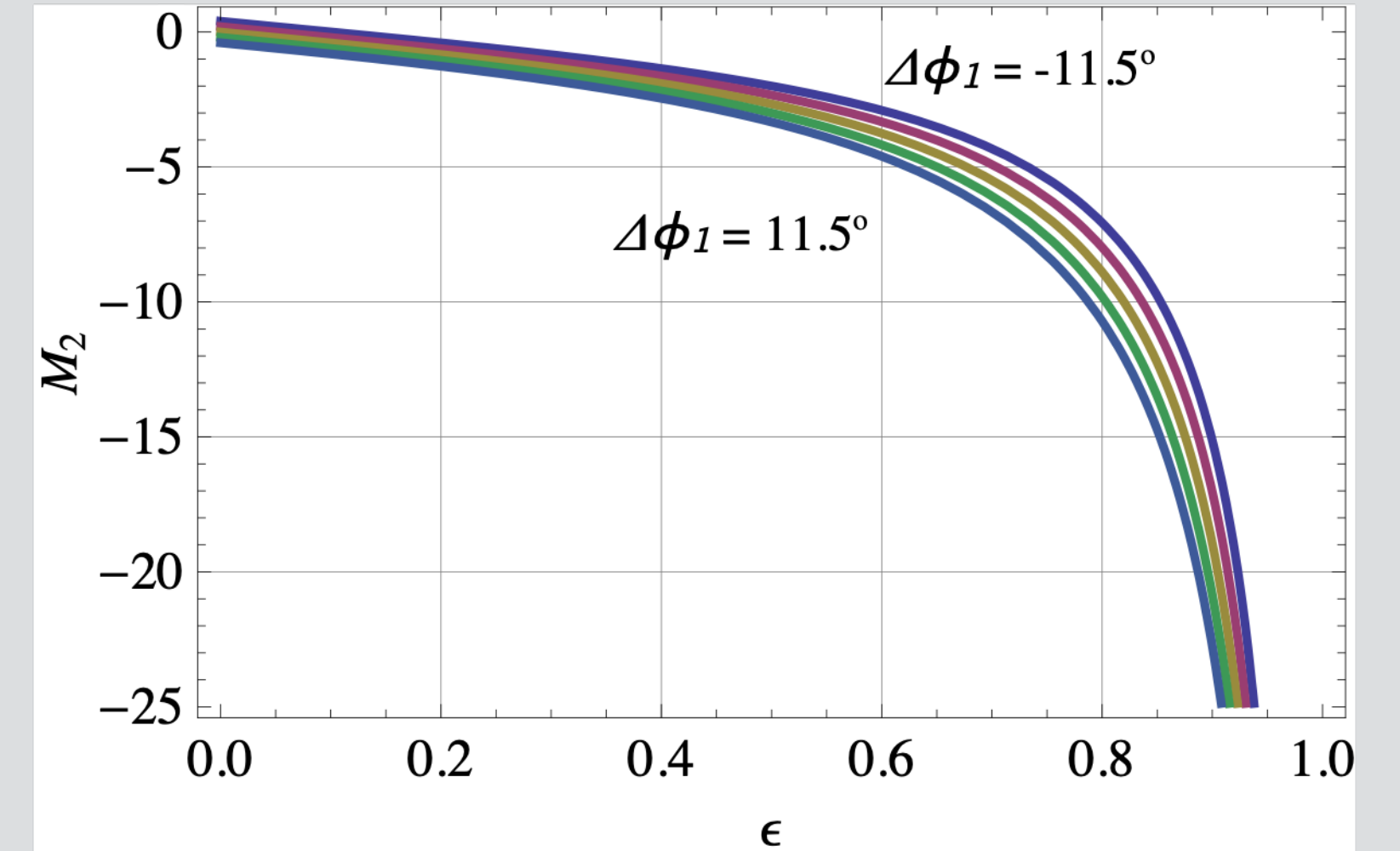
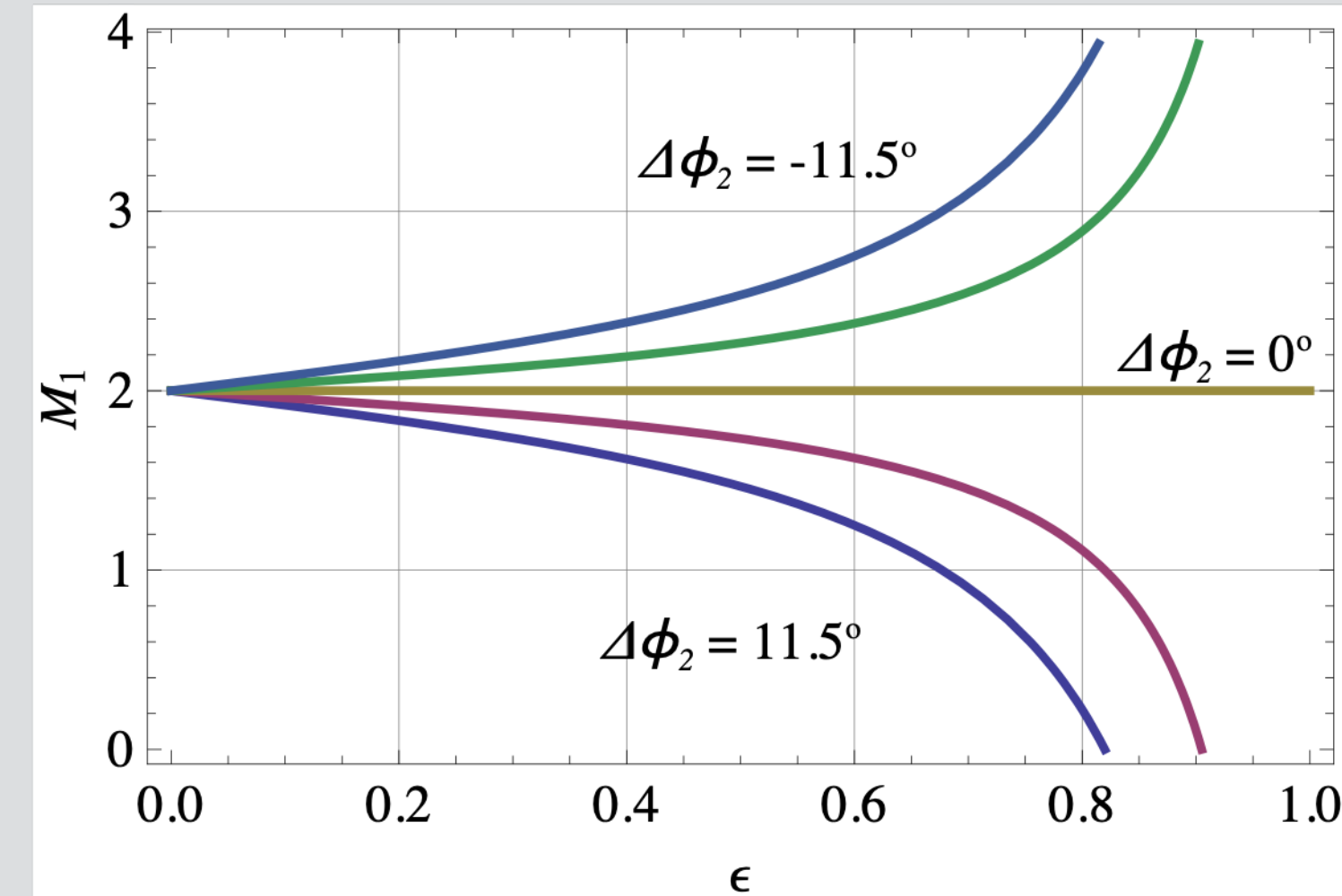
Ellipsoidal scanner

Terahertz shoe scanner: PROTOTYPE



Terahertz shoe scanner: MODEL

$$A_1 = \frac{\psi_1}{\Delta\phi_1} \approx -2\sqrt{2} \left(1 + \frac{2\epsilon\Delta\phi_2}{\epsilon^2 - 1} \right)$$
$$A_2 = \frac{\psi_2}{\Delta\phi_2} \approx -2 \left(\frac{2\epsilon + \sqrt{2}(1 + \epsilon^2)\Delta\phi_1}{\epsilon^2 - 1} \right)$$



Terahertz shoe scanner: MODEL VALIDATION

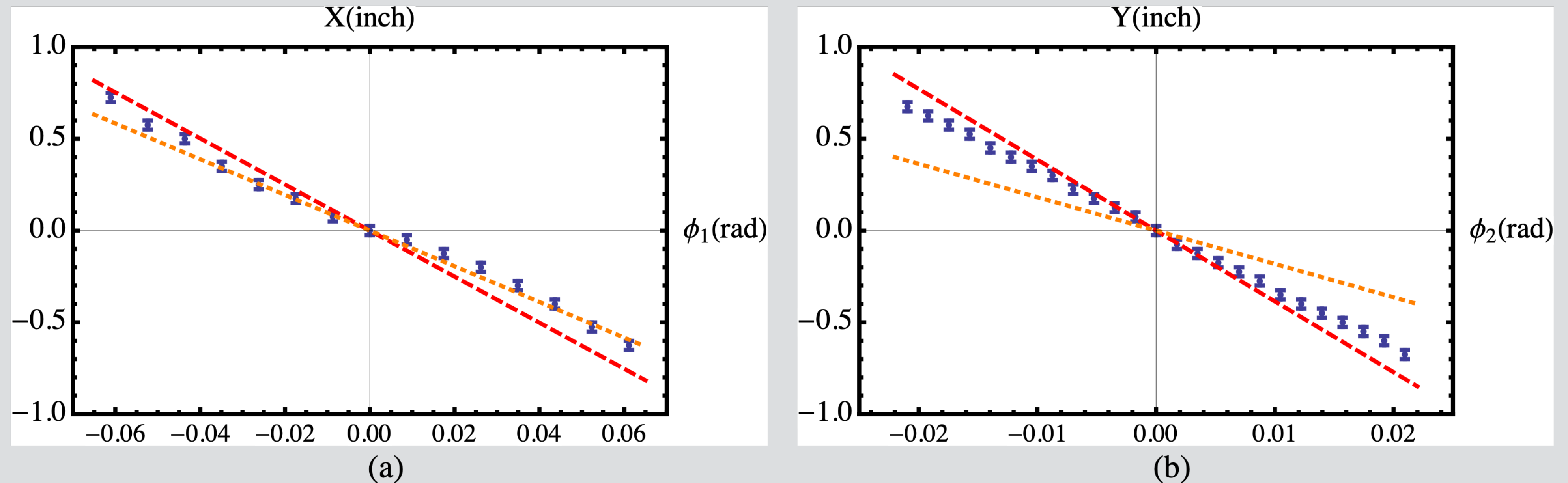
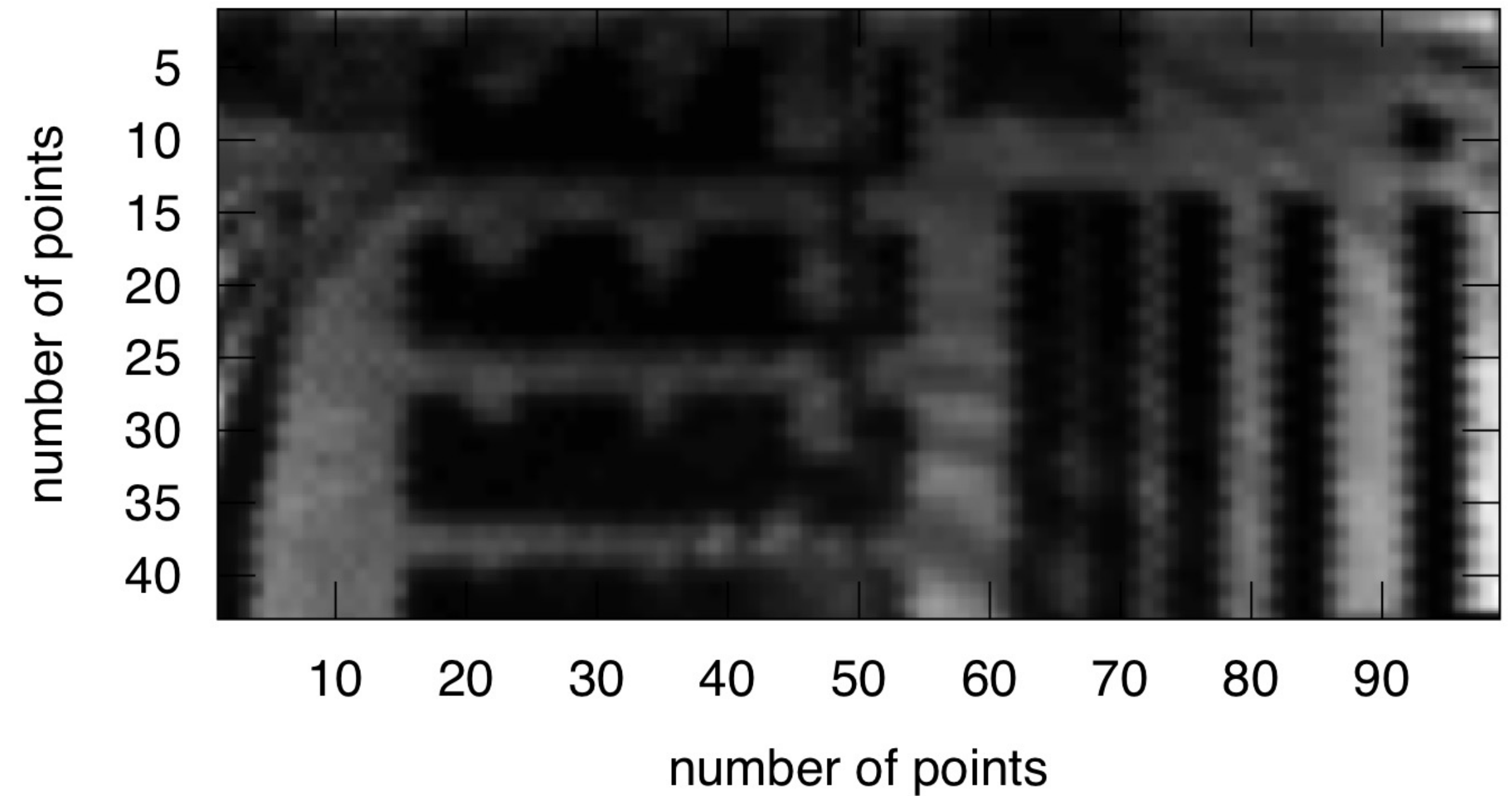
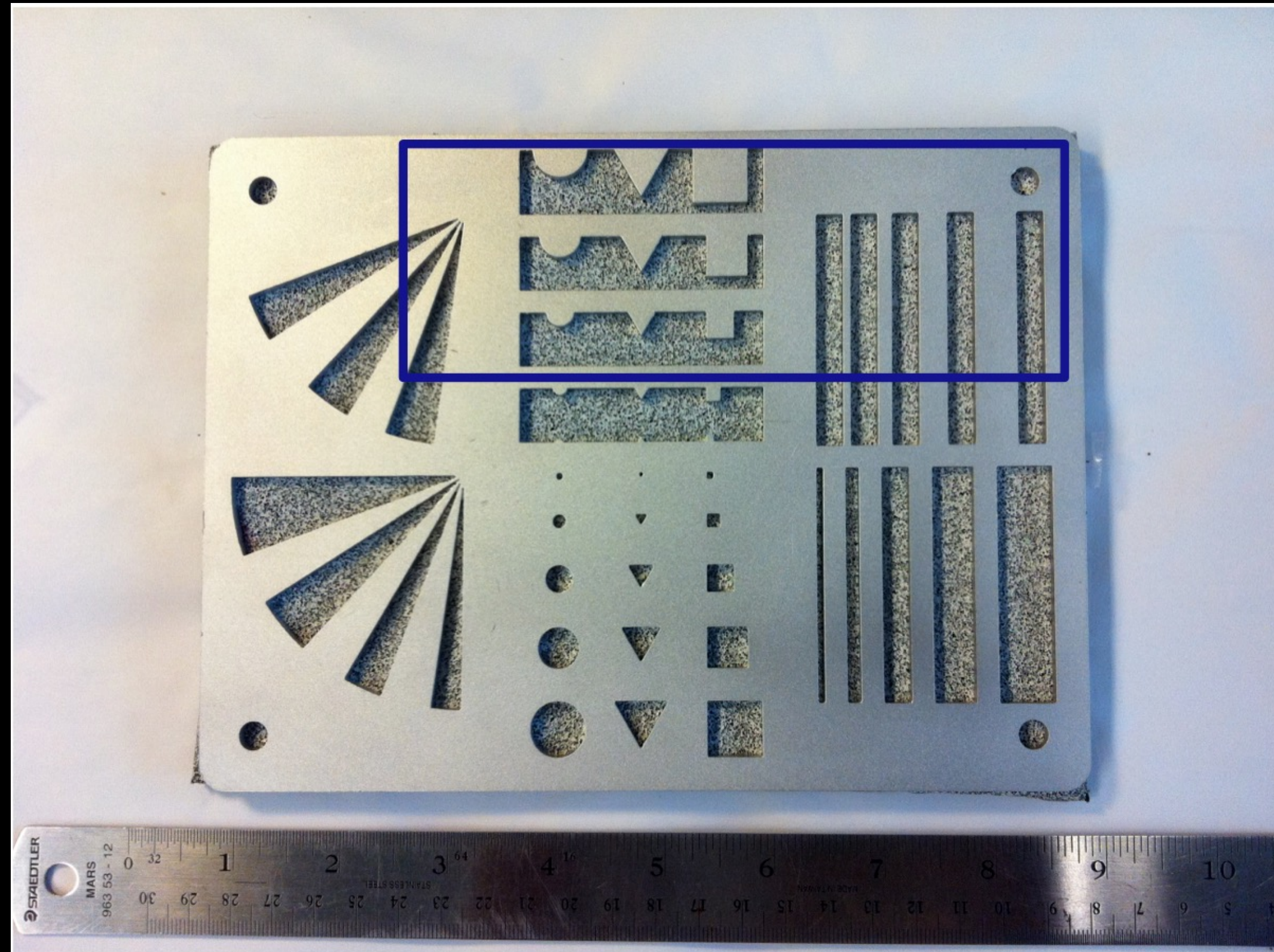
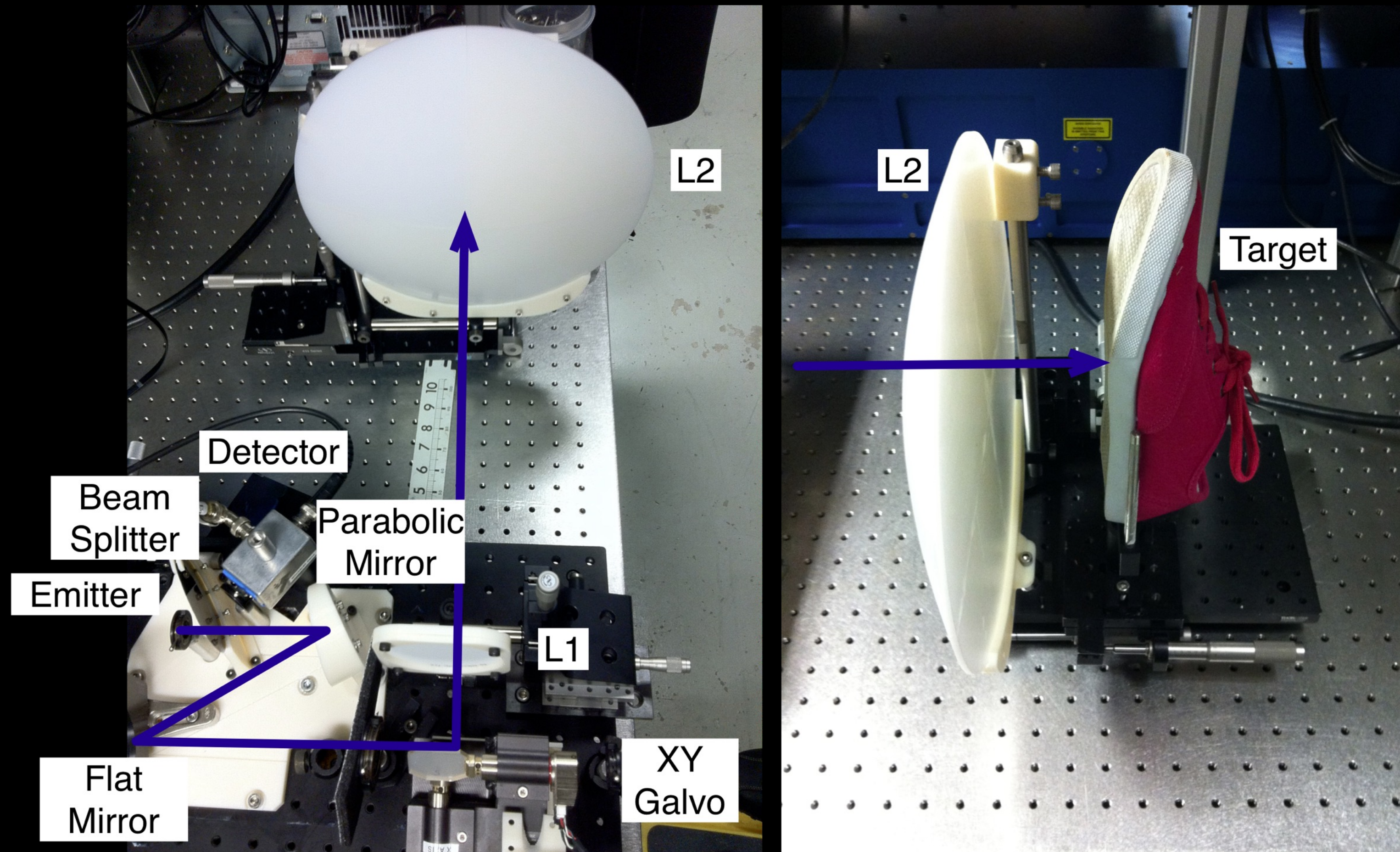


Fig. 2. Actual and expected behavior in the X axis (a) and in the Y axis (b). Dots with error bars are real data while solid lines plot the expected behavior according to the measured d and nominal value for ϵ . The dashed red line plots the estimation considering $d + \Delta d$ and $\epsilon + \Delta \epsilon$, while the dotted orange line plots the estimation considering $d - \Delta d$ and $\epsilon - \Delta \epsilon$.

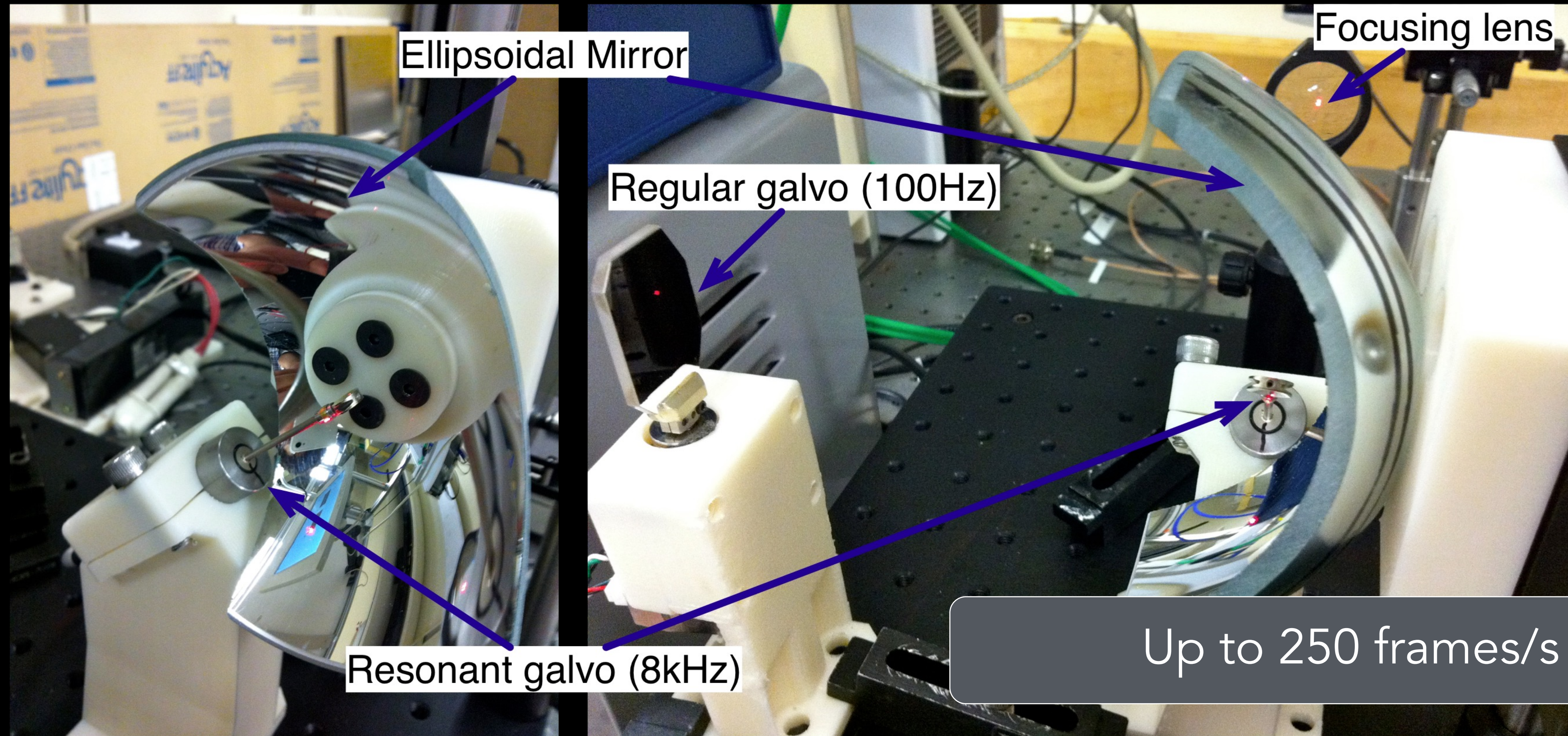
Terahertz shoe scanner: RESOLUTION VALIDATION



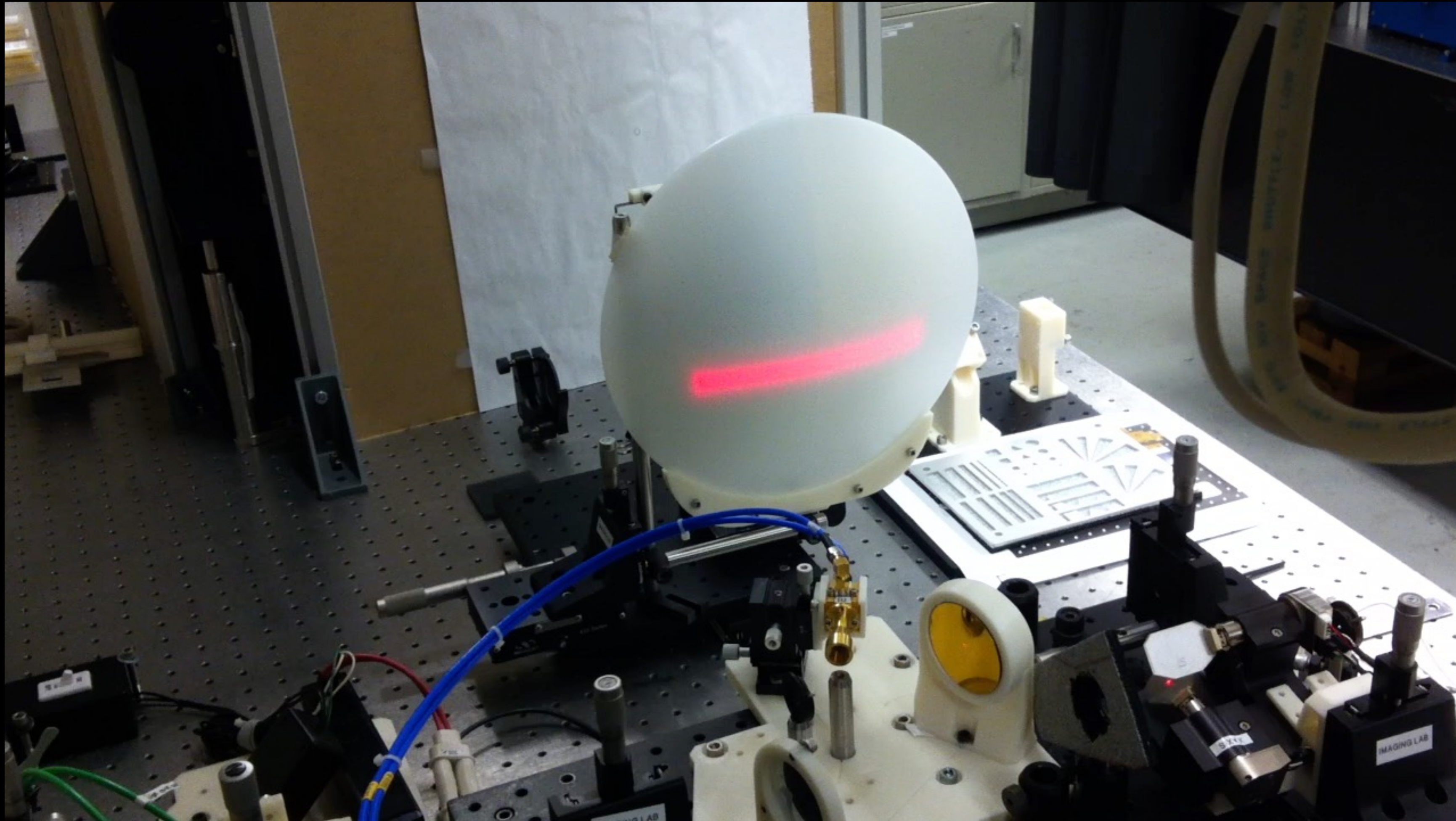
Terahertz shoe scanner: 1st GEN



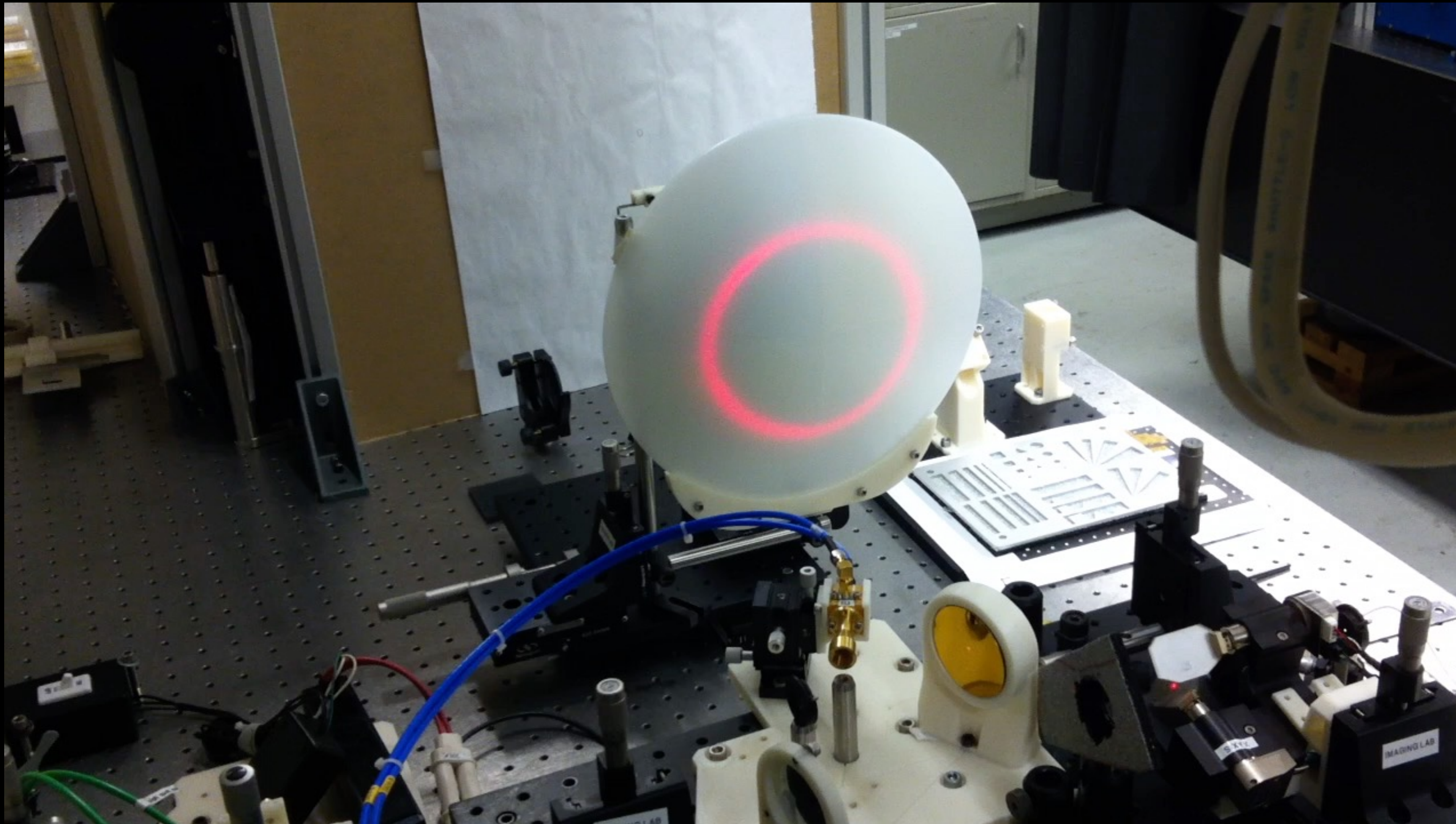
Terahertz shoe scanner: 2nd GEN



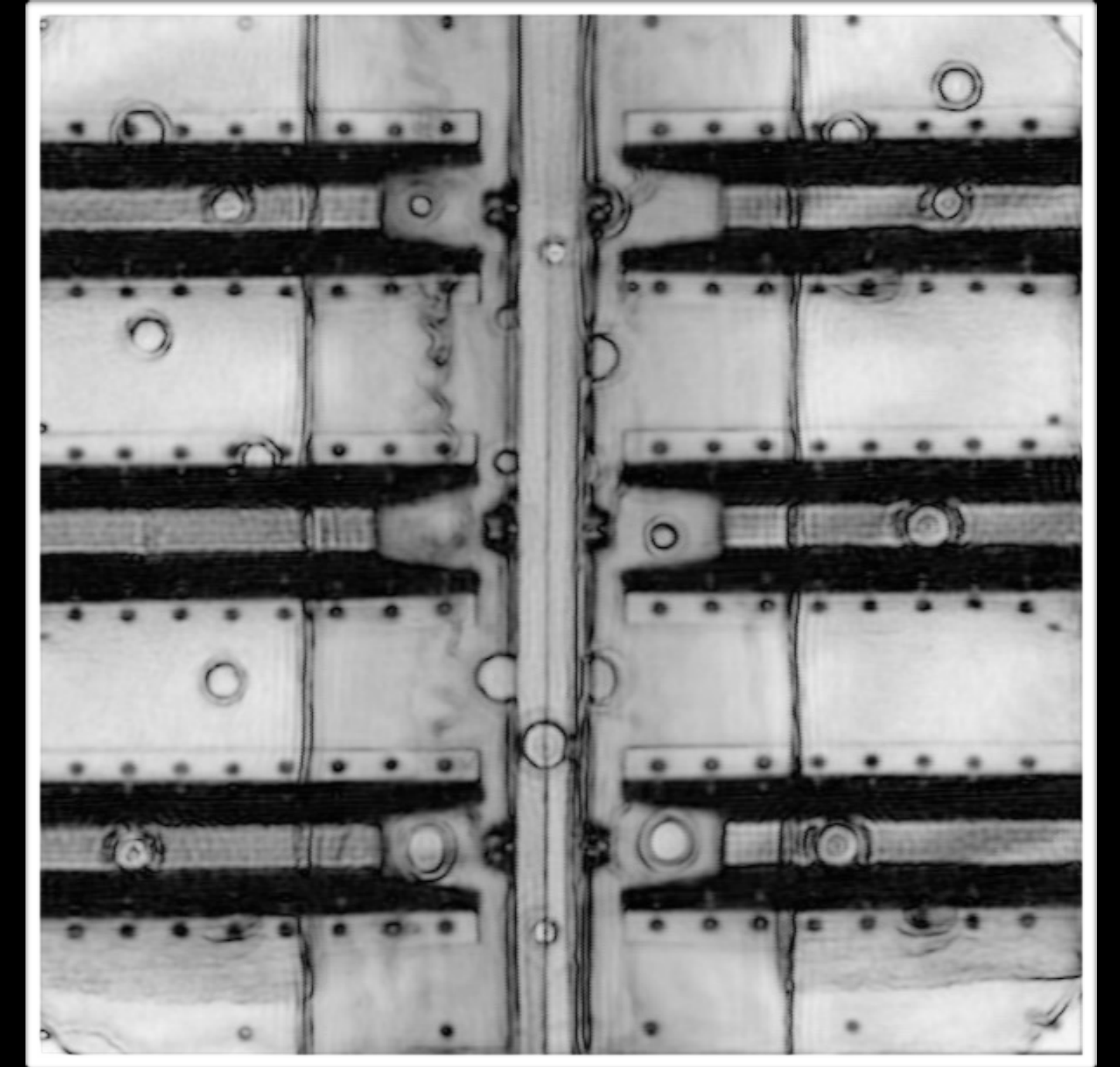
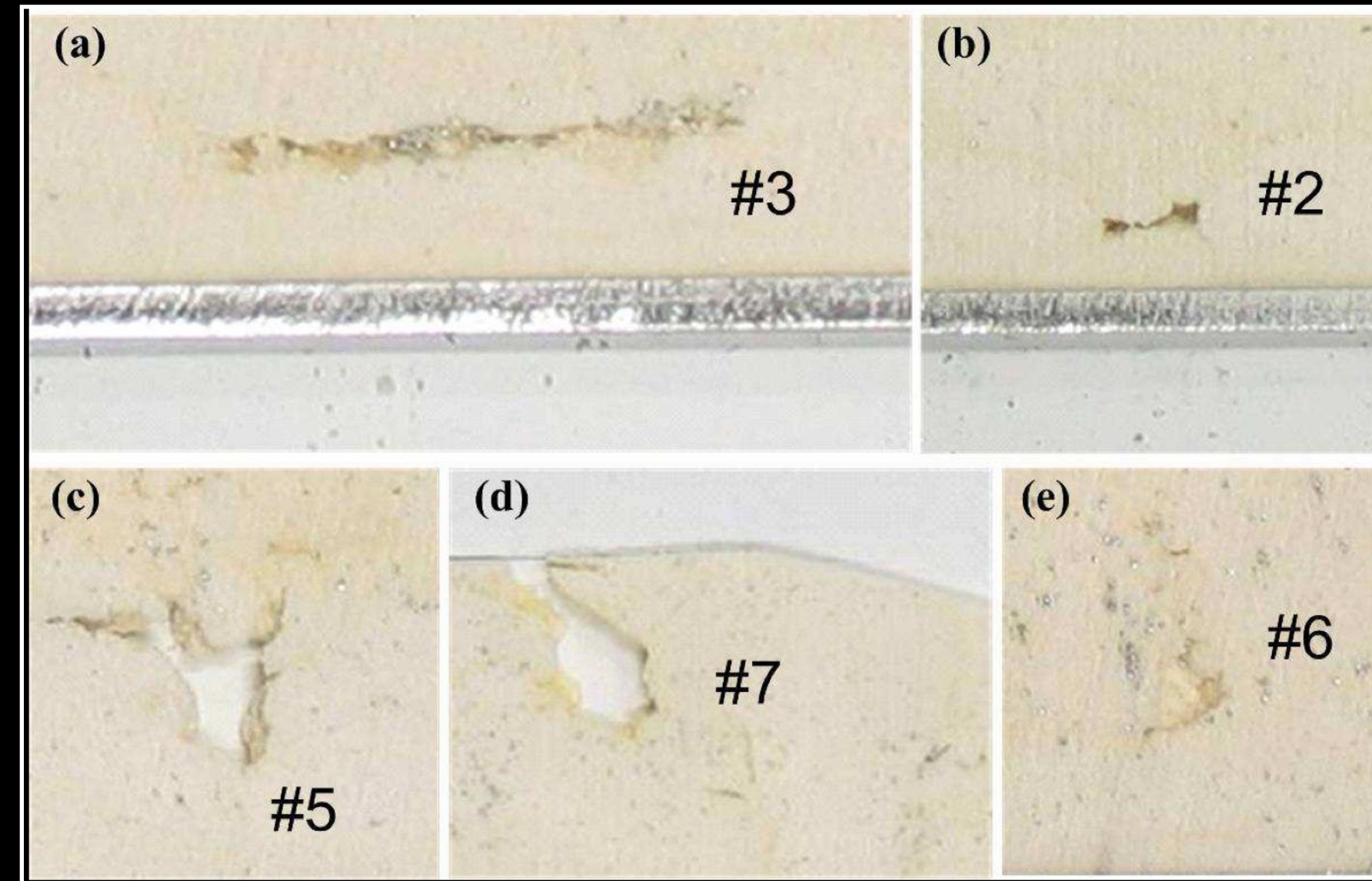
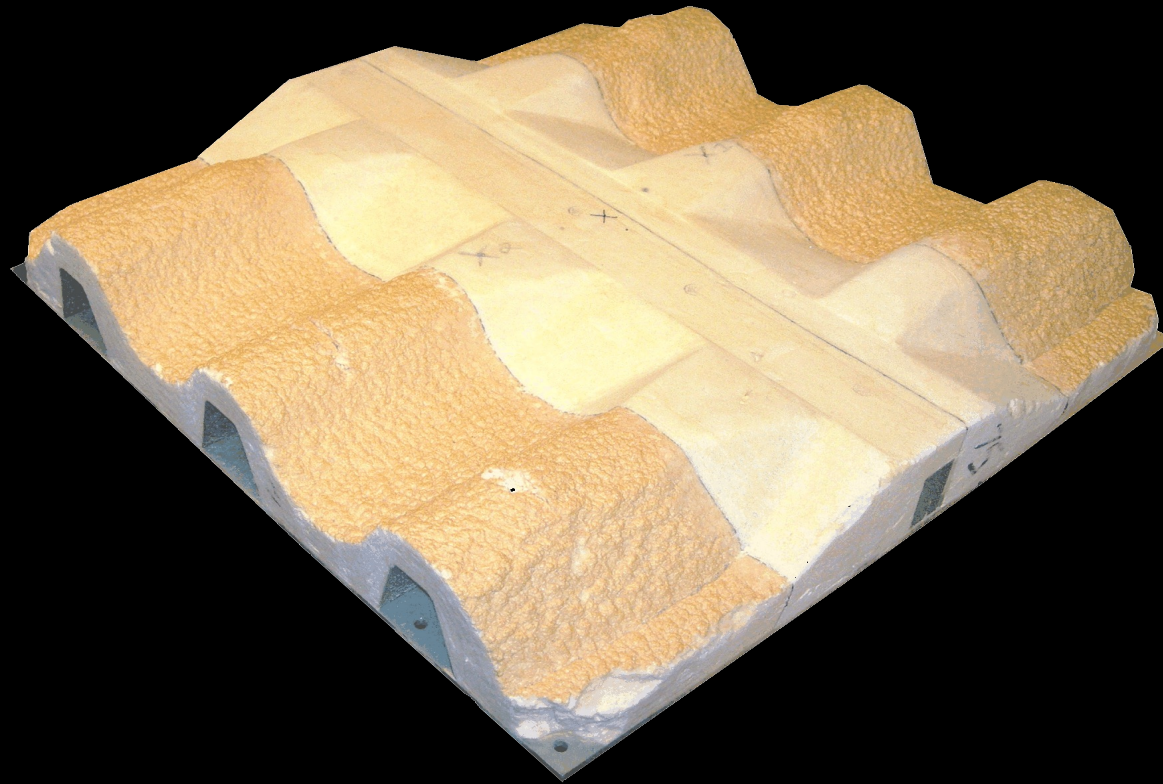
Terahertz shoe scanner: LINEAR SCANNING



Terahertz shoe scanner: CIRCULAR SCANNING



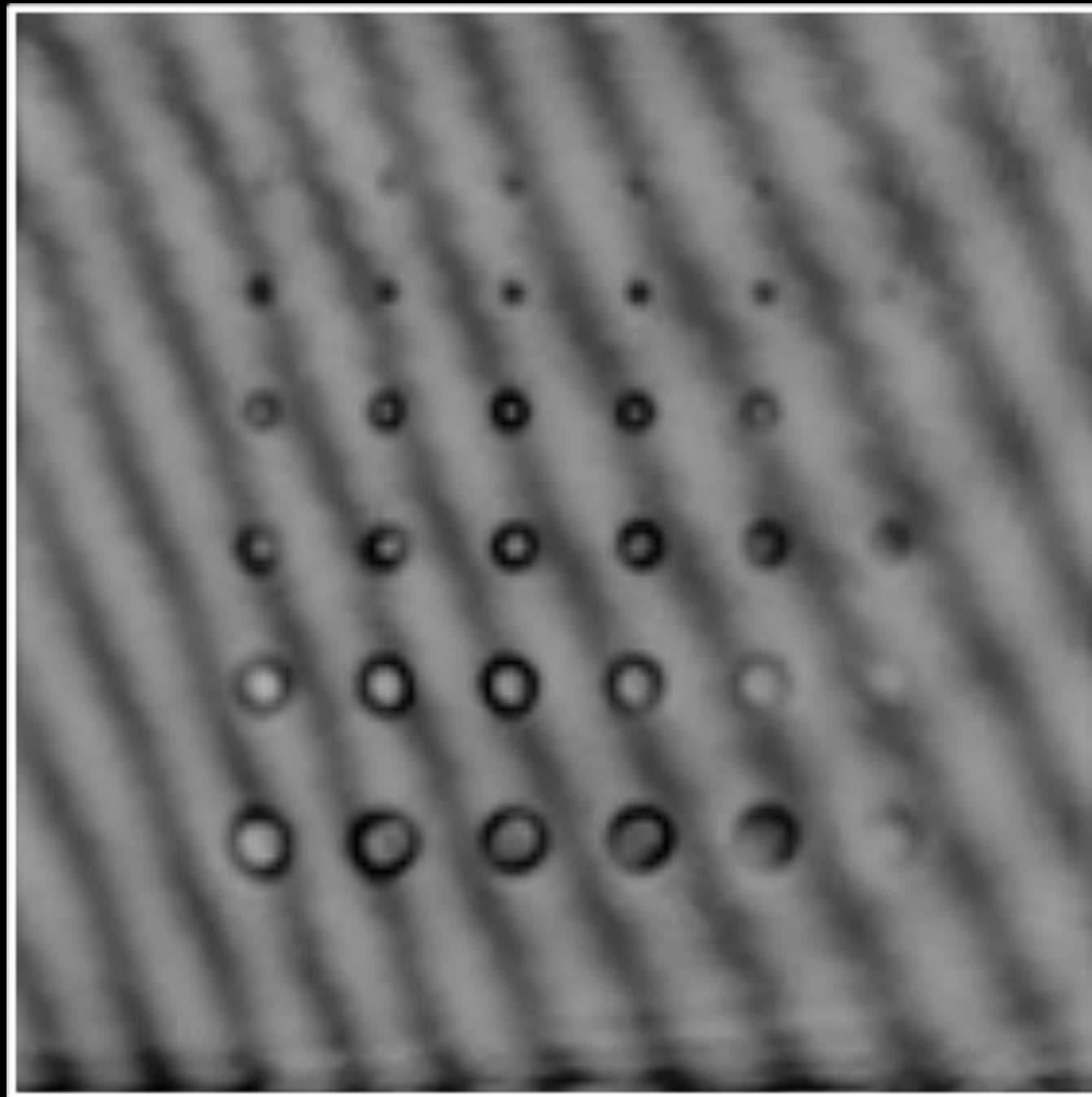
Space Shuttle insulation foam inspection



Solving the interference pattern

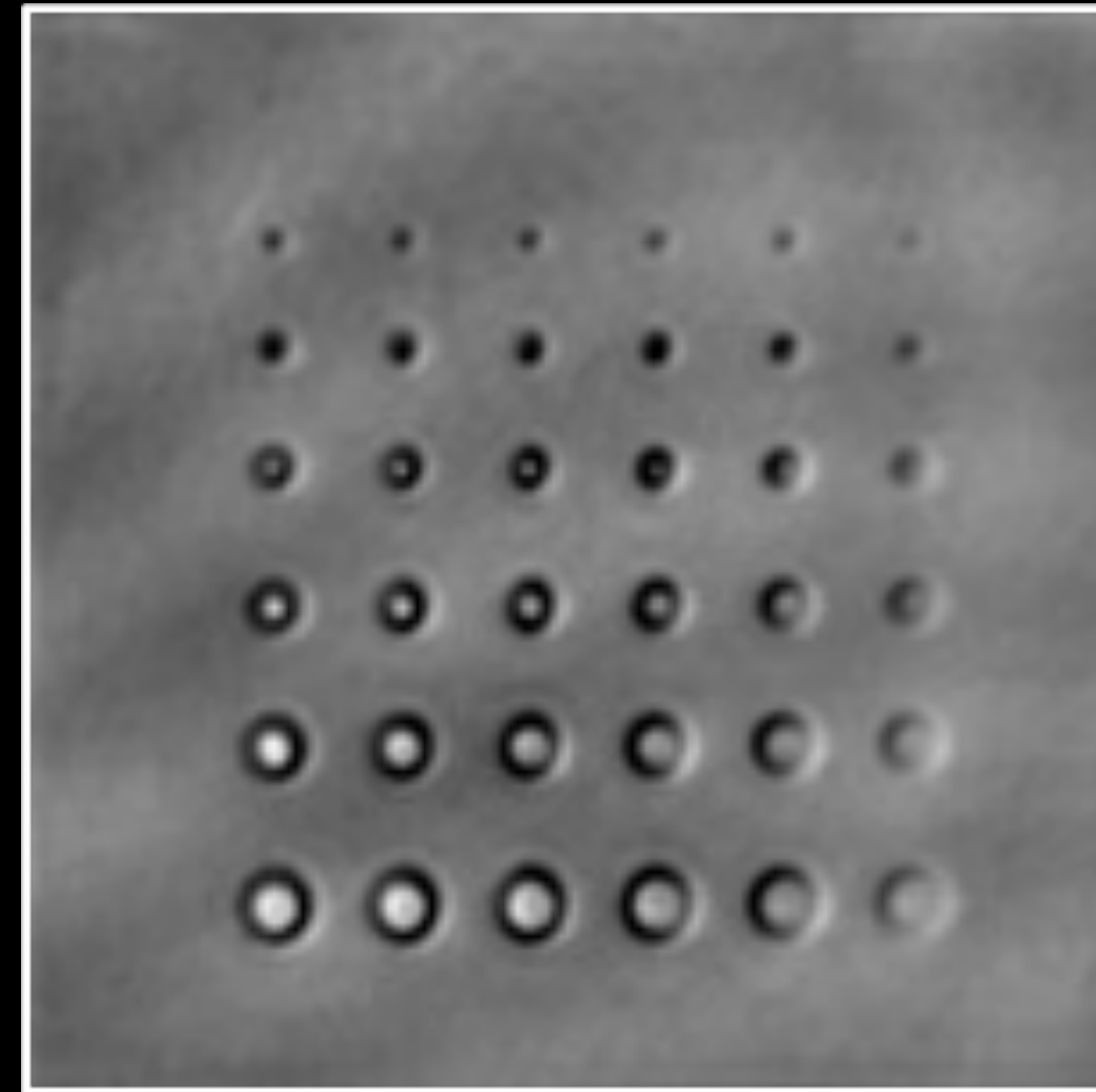
CW systems generate images with interference patterns caused by standing waves

SWR = 1.20



Mitigation

SWR = 1.03



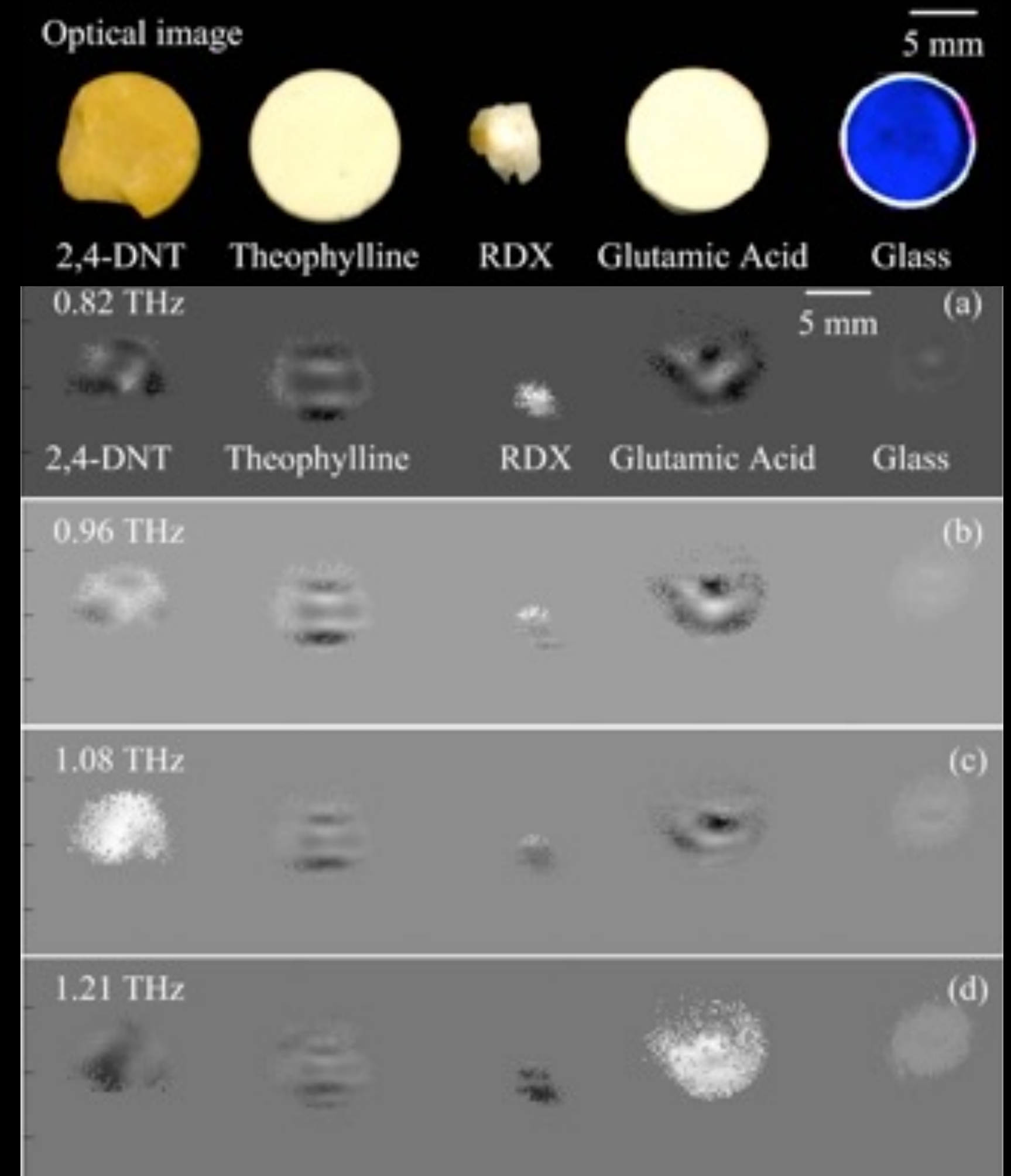
Redo-Sanchez, A., Karpowicz, N., Xu, J., & Zhang, X.-C. (2006). Damage and defect inspection with terahertz waves. In The 4th International Workshop on Ultrasonic and Advanced Methods for Nondestructive Testing and Material Characterization

Spectral imaging

Focal plane array for fast terahertz image acquisition

Principal component analysis to reduce dimensionality

Neural networks for chemical identification



Zhong, H., Redo-Sanchez, A., & Zhang, X.-C. (2006). Identification and classification of chemicals using terahertz reflective spectroscopic focal-plane imaging system. *Optics Express*, 14(20), 9130. doi:10.1364/oe.14.009130