# CONSTRUCTION AND CALIBRATION OF THE HOUGHTON COLLEGE X-RAY DIFFRACTOMETER

A Study of Silver Thin Films

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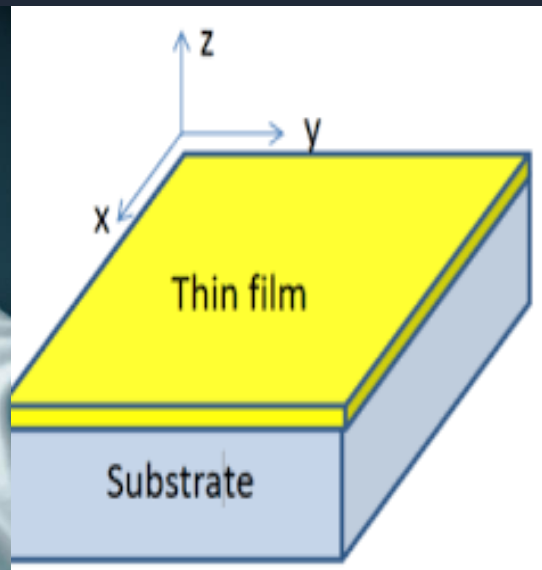
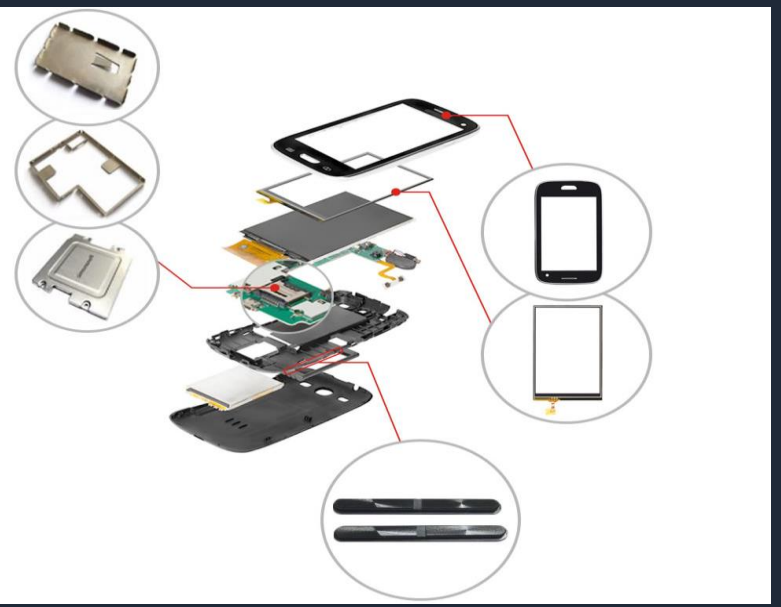
Advised by Brandon Hoffman, PhD

# Thin Films

Mechanical and Electronic Properties of thin films

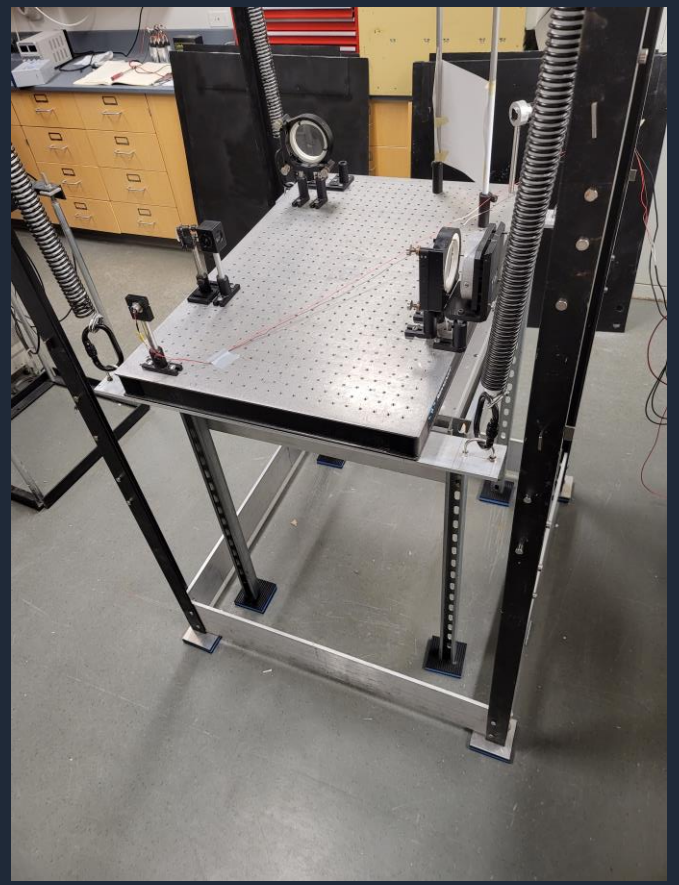


# Thin Films Instruments At Houghton

Deposition Chamber

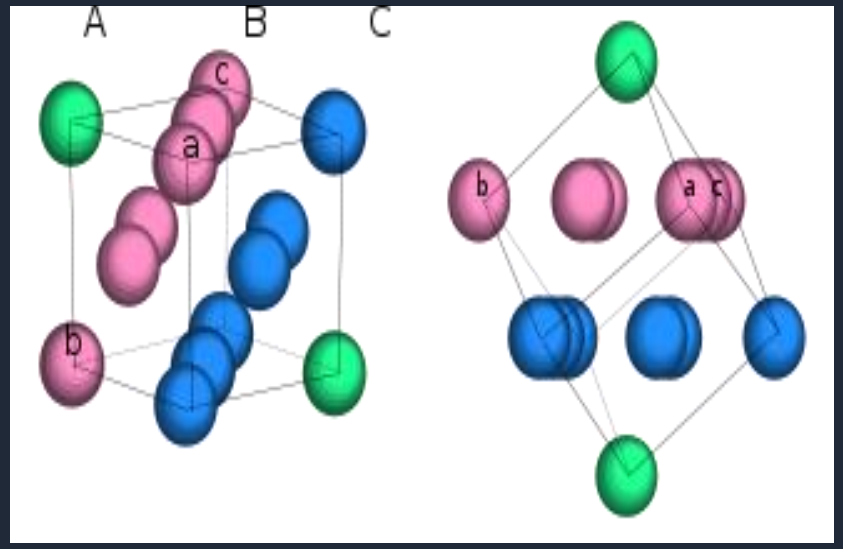
Interferometer

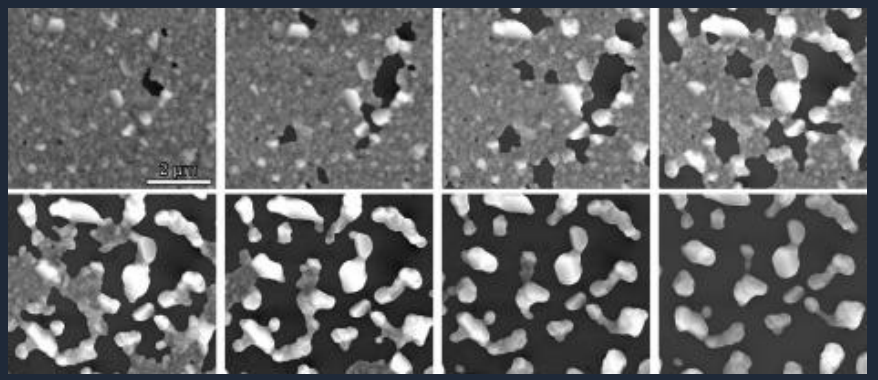


X-Ray Diffractometer

# Properties of Thin Films

Grain Structure, Spacing and Orientation

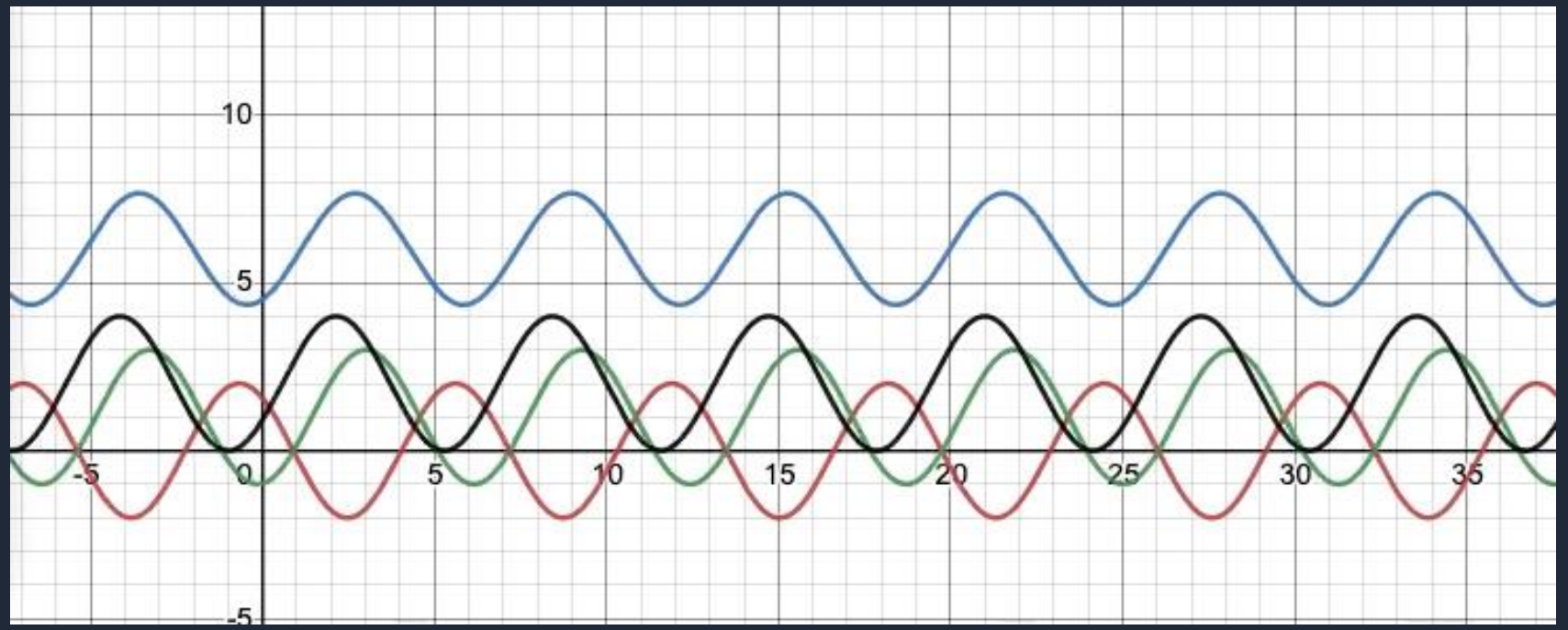


Face-Centered Cubic (FCC) structure, Close-Packed Hexagonal Unit cells

# Constructive Interference

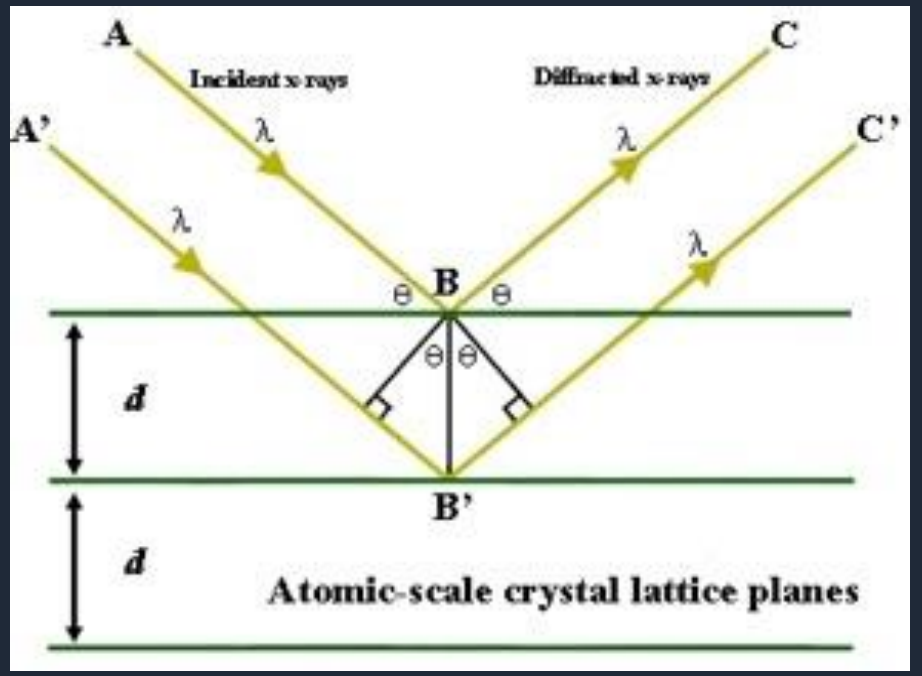
Constructive Interference Visualization

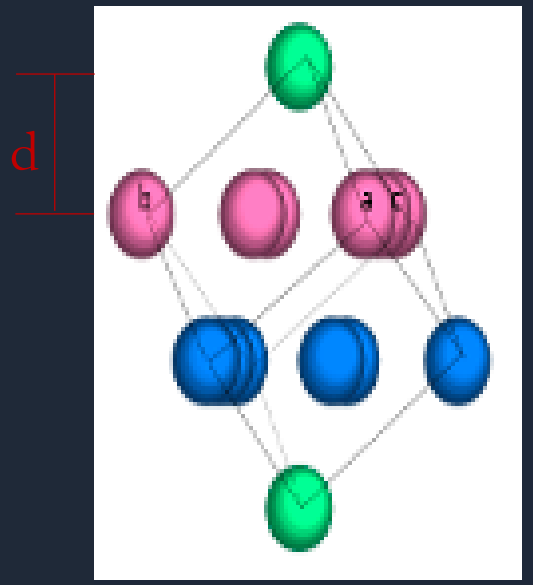


# Bragg's Law

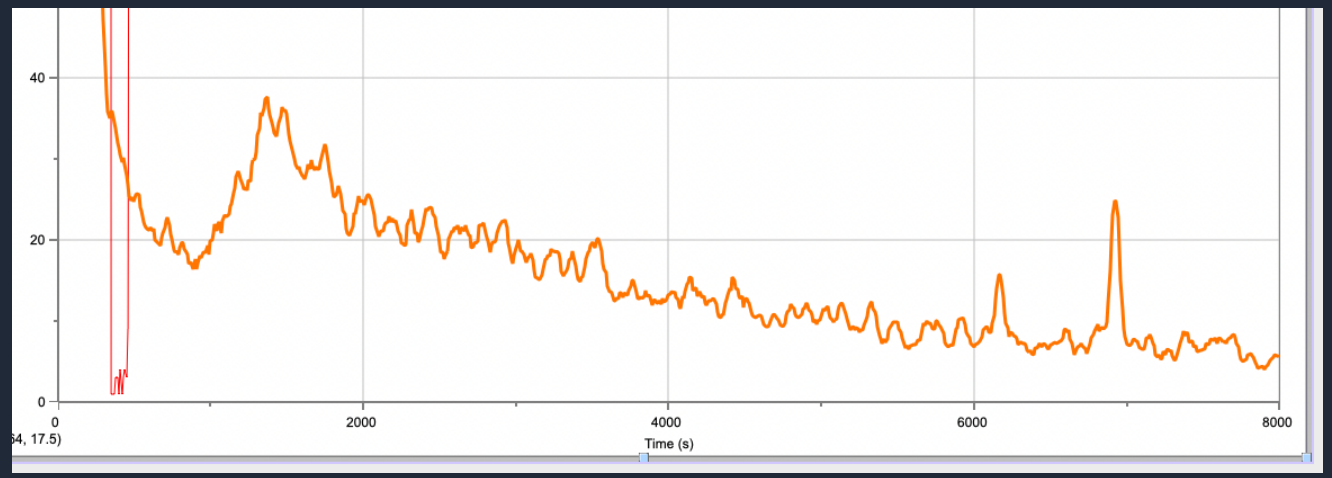
$$n\lambda = 2dsin\theta$$

- Path-Length Difference of Lattice Spacing
- Measuring thin film thickness, calculating d from diffraction-peak pattern, we know lattice cell structure spacing within the film.



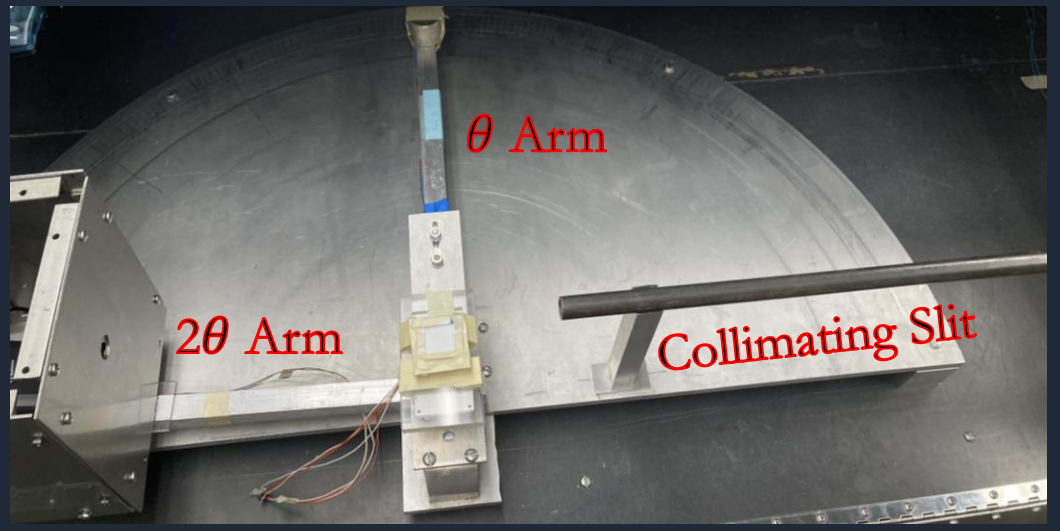



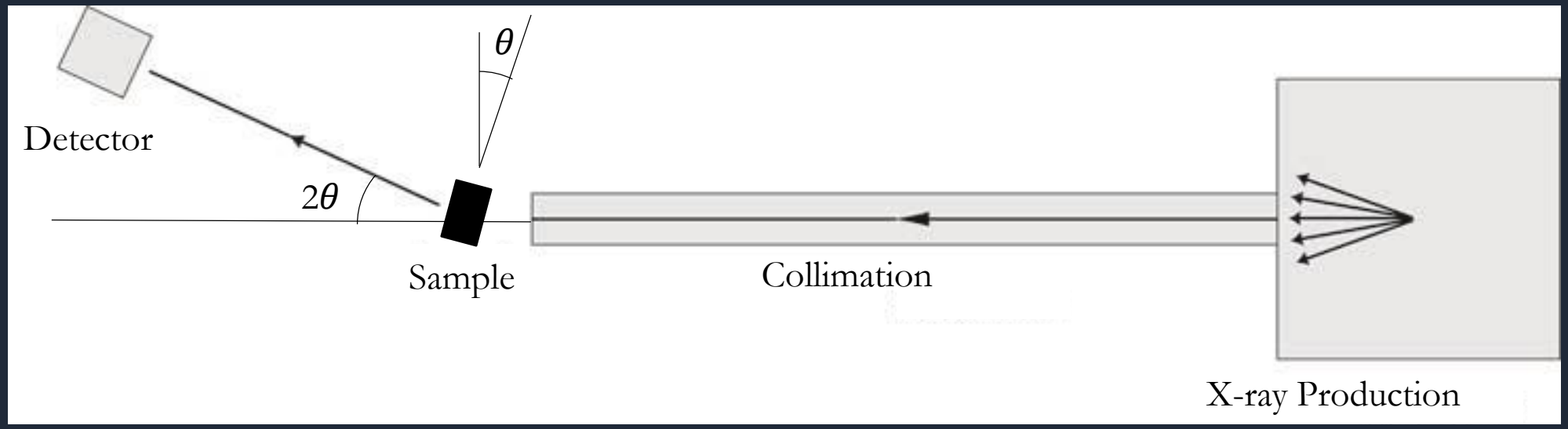

- Diffracted x-rays cause interference patterns



# How the XRD Works

- Sample rotation about vertical axis
- Arduino-Powered Stepper Motor Interval Angle
- Rotation of sample = ½ x rotation of detector
- Spectrum of sample taken from rotation of $\theta$ =0-40°

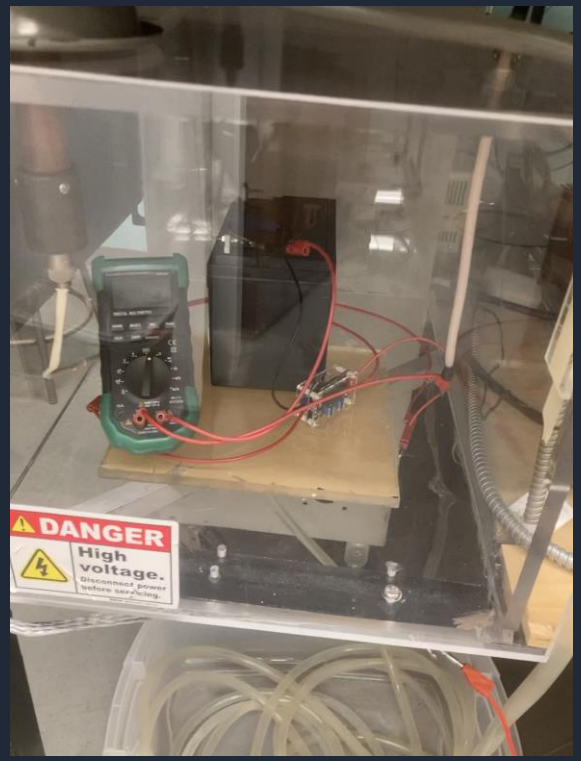


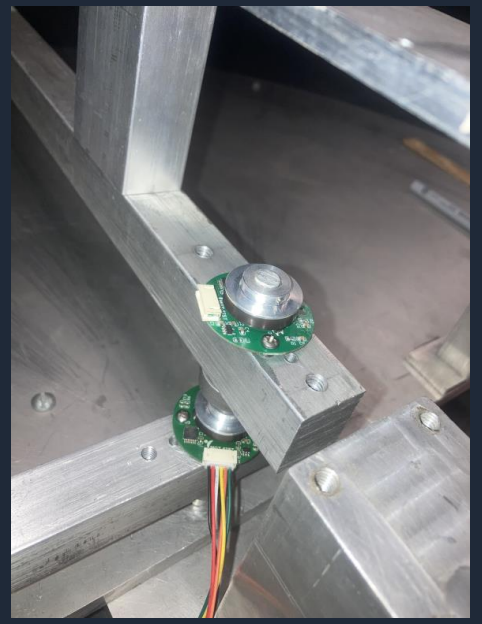



# Work Completed on the XRD

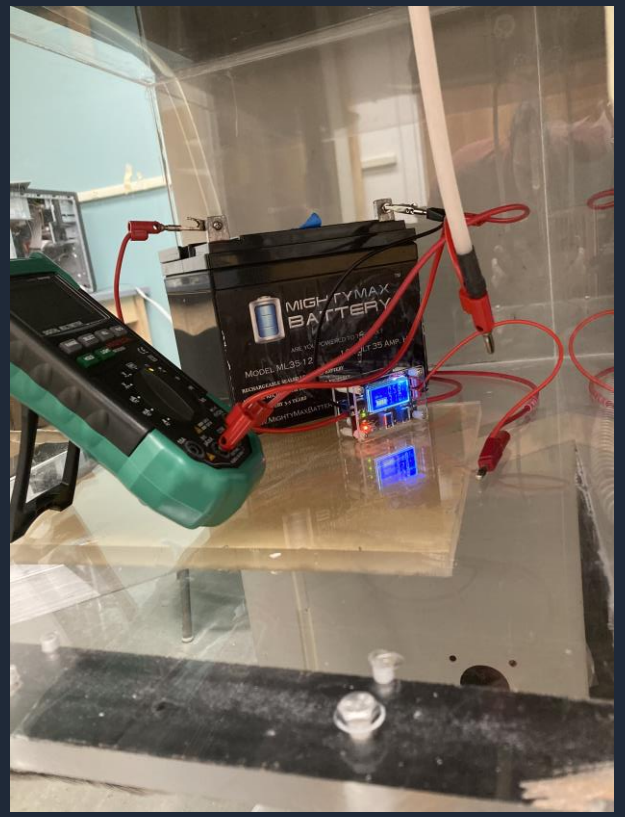
Goals:

- Create replicable data of clear x-ray interference peaks
- Minimization aspects of error



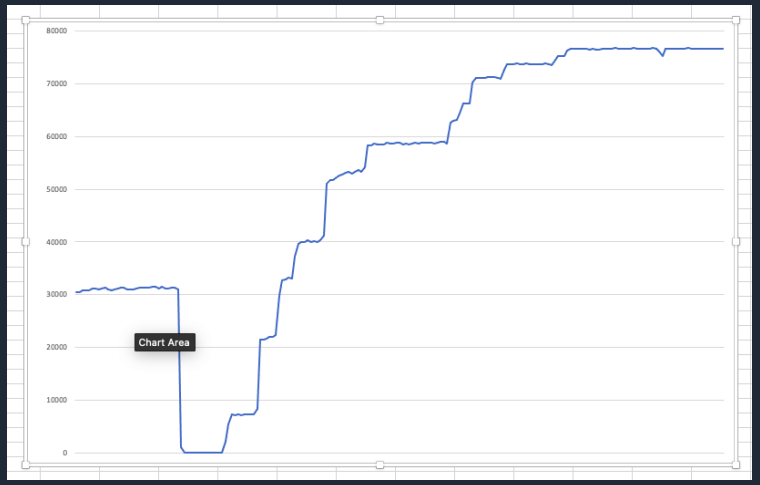



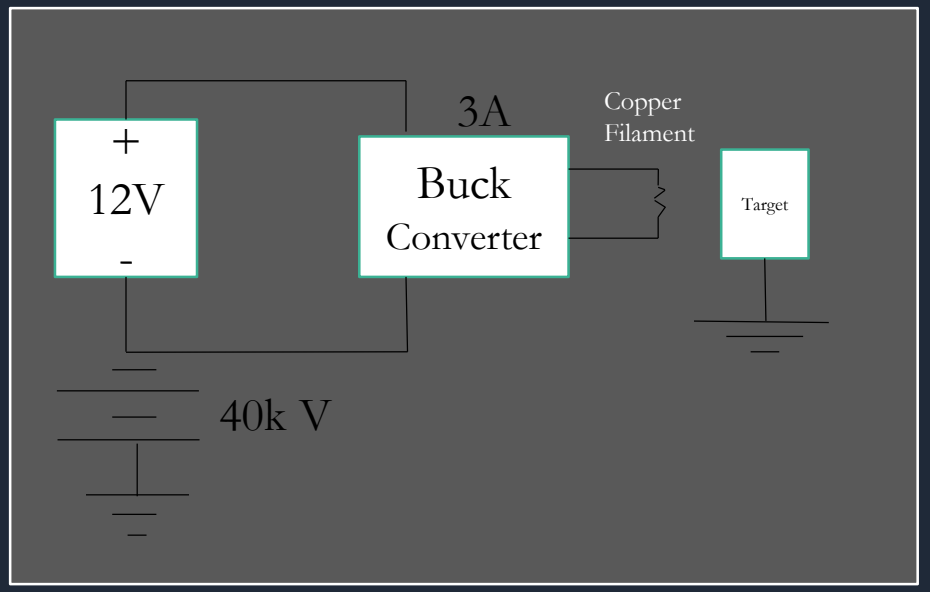
# Electronics Input Optimization




Interior of Electronics Box

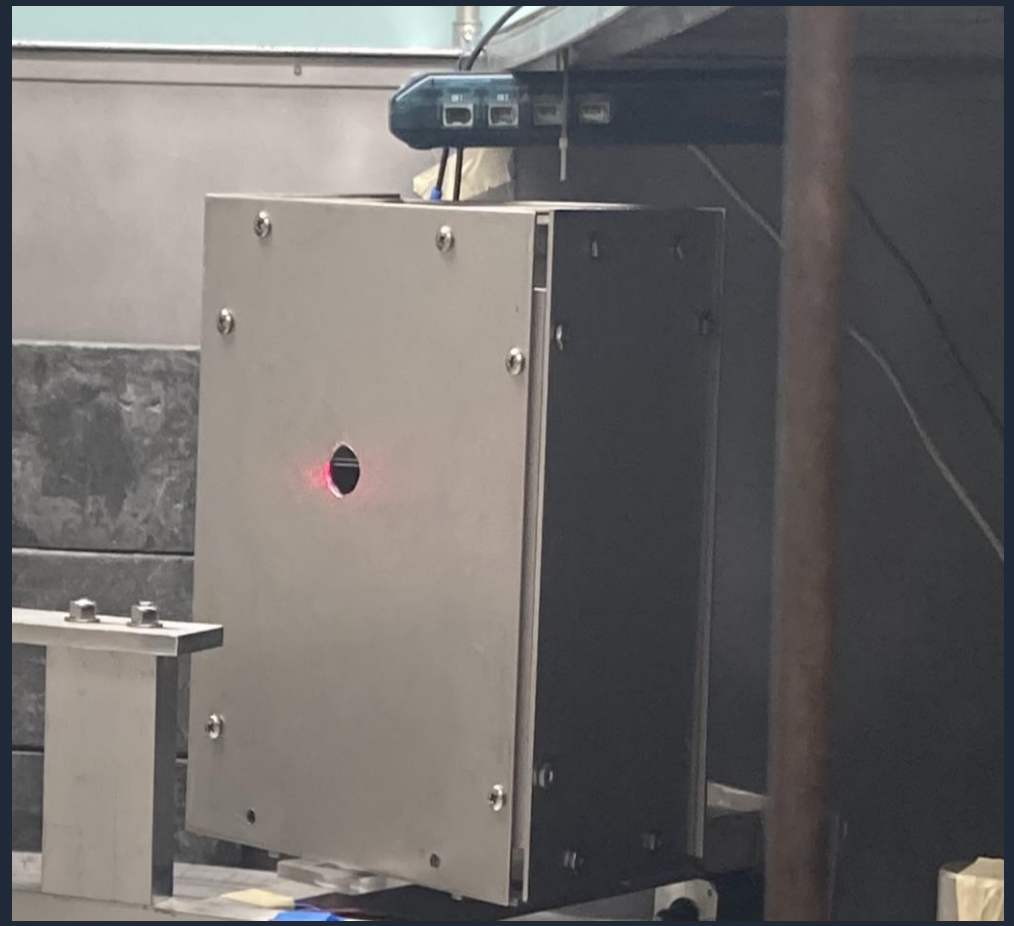
Philips-Norelco x-ray tube



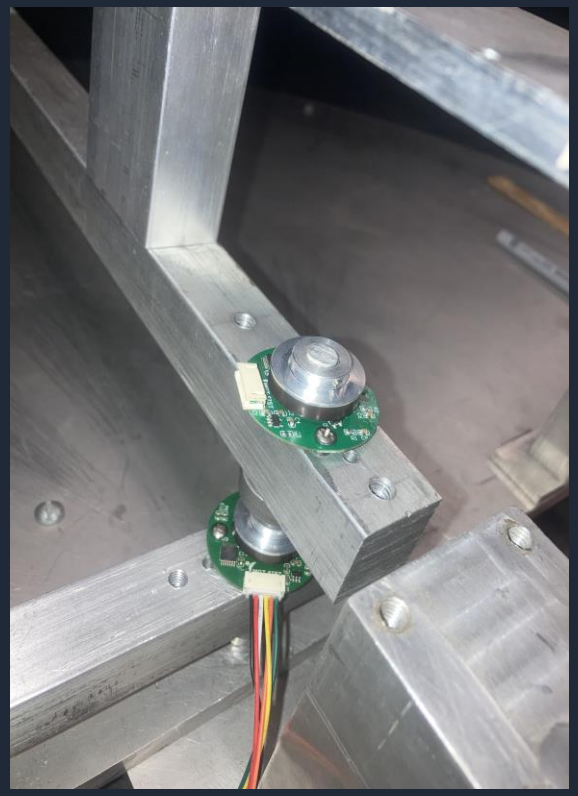
# Radiation Blocking Box

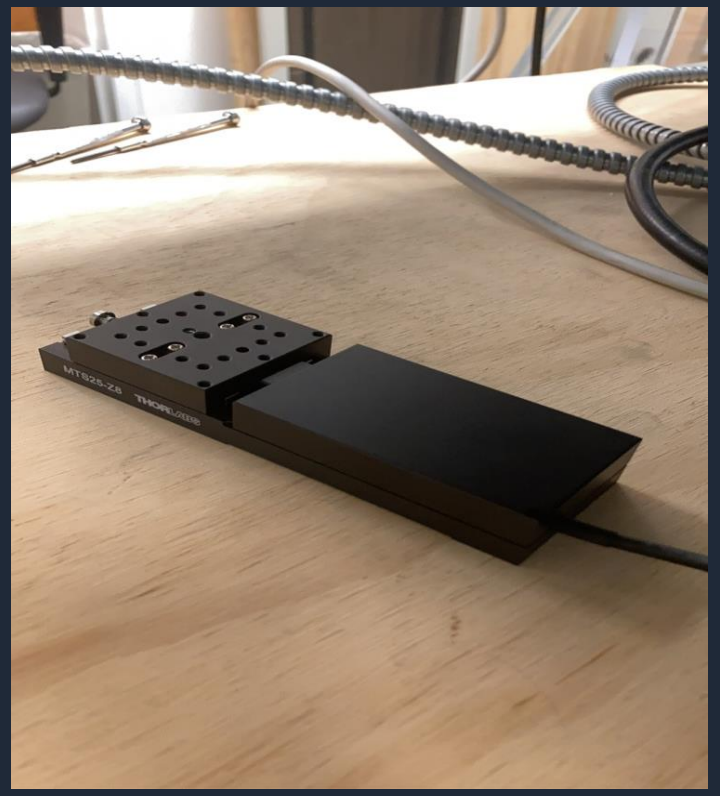
- Houses Vernier Student Radiation Monitor, detector
- Background scatter elimination
- Further collimation of x-rays
- Alignment tool



# Mechanical Alignment Fixes

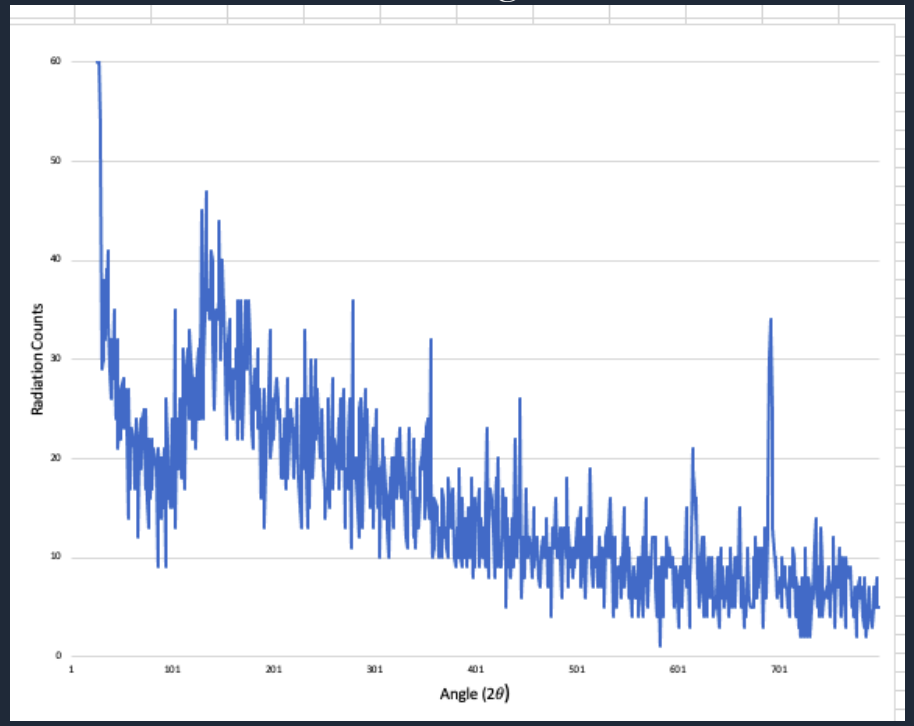
- Mechanical Sample Stage: Aid in sample alignment (Concept)

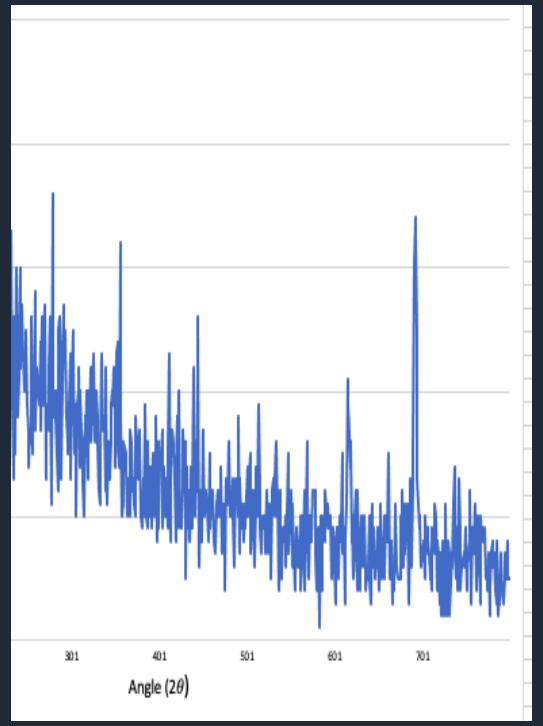


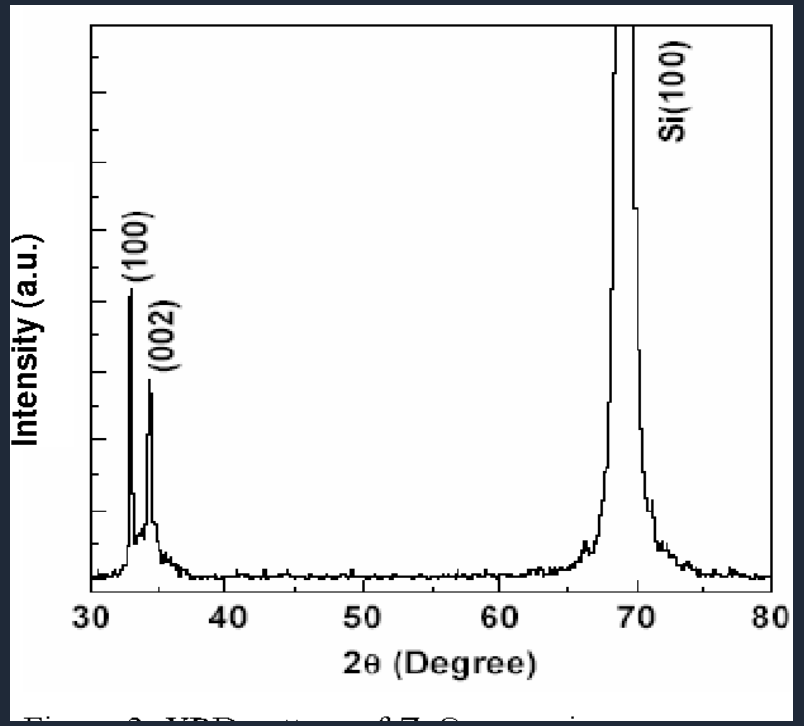


# Results from Testing

- On 06/25/2021, during a 3-hour high-voltage test, a peak was discovered on the Logger Pro Spectroscopy scan.
- Peak Recorded at Angle $2\theta$=69.2°

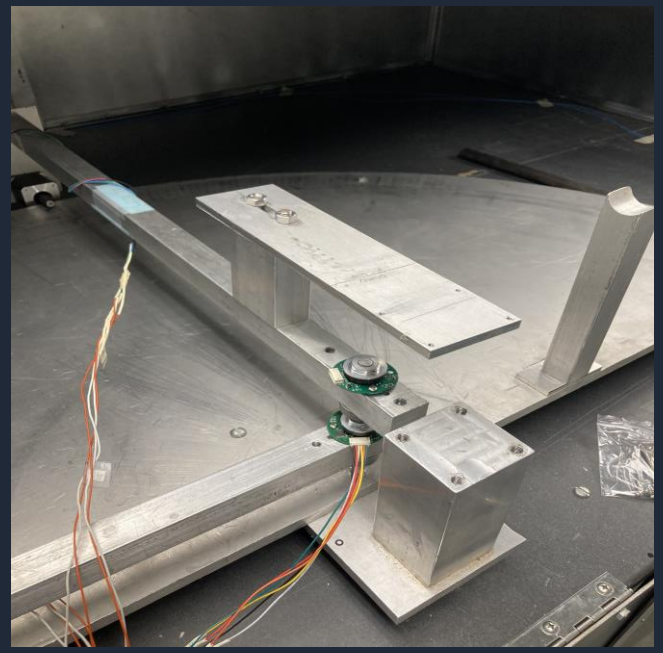


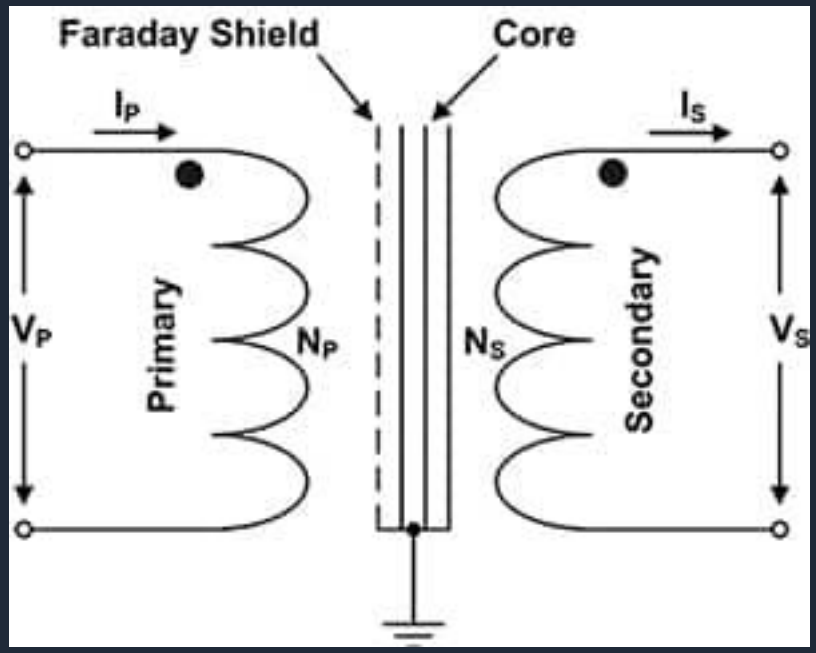



# Moving Forward with the Project

- Small Angle Analysis, alignment checks, and power substitutions






https://www.digikey.com/en/articles/the-basics-of-isolation-transformers-and-how-to-select-and-use-them

Thank You!

# Sources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- **Grffiths, David J:** ***Introduction To Electrodynamics***
- L. Junyi , D.S. Balint: *A parametric study of the mechanical and dispersion properties of cubic lattice Structures*