The Construction of a Deposition Chamber for the In-Situ Study of Thin Metal Films

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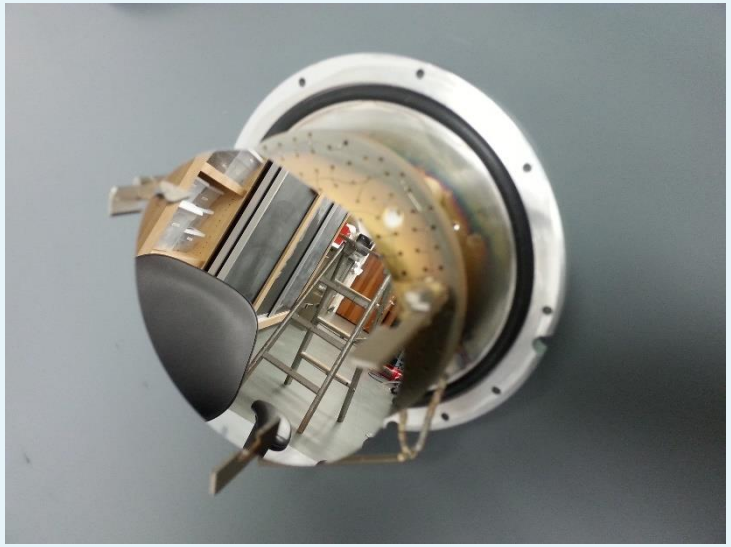
HOUGHTON COLLEGE

Outline

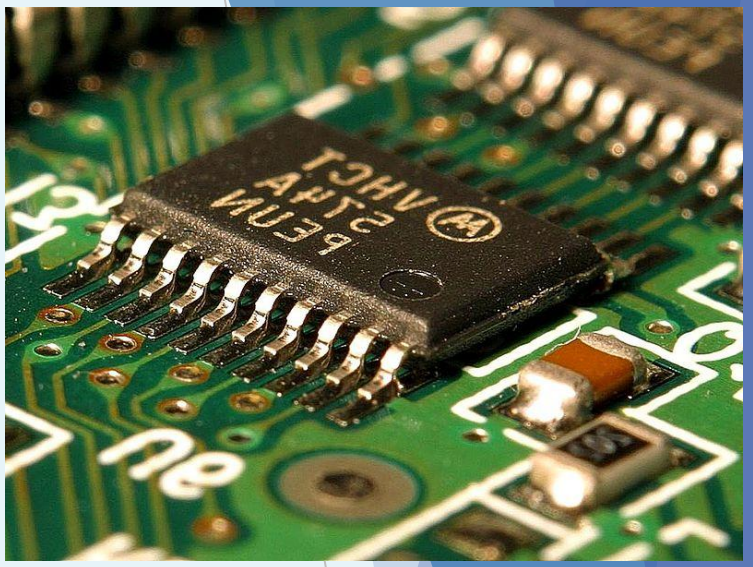
- Thin films
- Commercial use
- Research
- Deposition Chamber
- Current state and future plans



http://www.lorextechnology.com/accessories-for-security-cameras/250GB-SATA-security-certified-DVR-hard-drive/1863.p

Thin Metal Films

- Thickness << length and width
- Commercial use



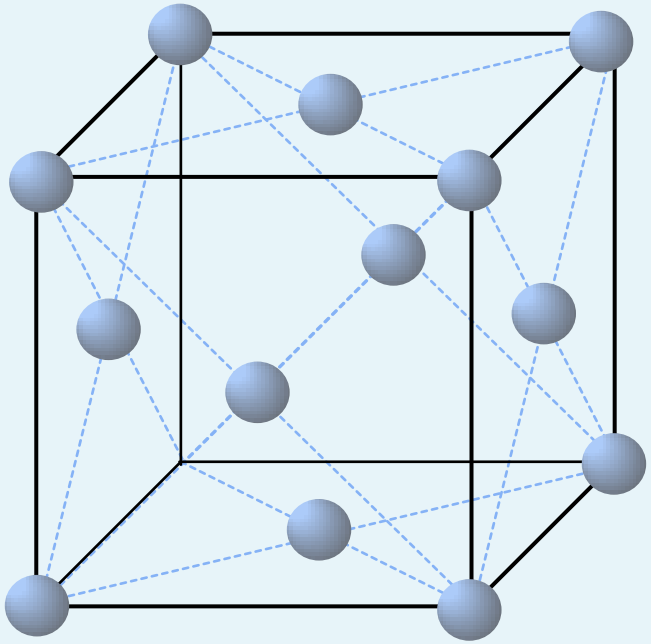
http://commons.wikimedia.org/wiki/File:Computer_chips_circuits_boards.jpg

http://uncyclopedia.wikia.com/wiki/File:Cellphone.png

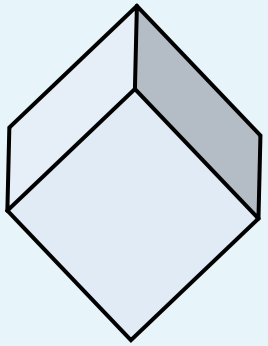
http://www.lorextechnology.com/accessories-for-security-cameras/250GB-SATA-security-certified-DVR-hard-drive/1863.p

Crystal Lattice Structure

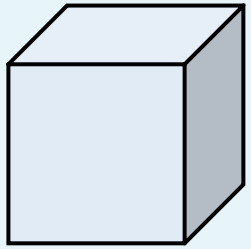
- Face Centered Cubic



- Miller Indices
  - 1 1 1

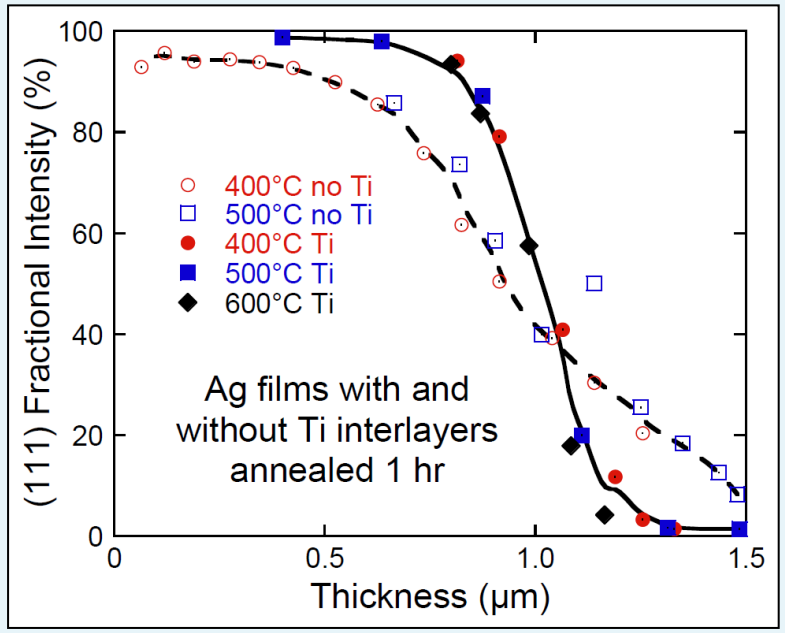


  - 1 0 0

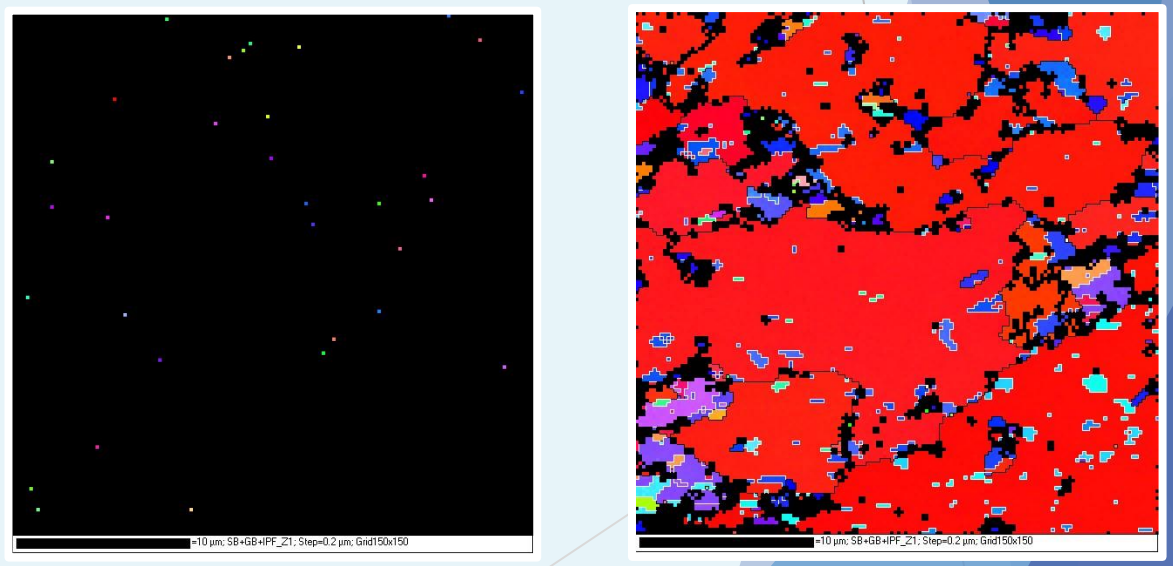


Texture Transformation in Thin Films

- Transformation from (1 1 1) to (1 0 0)
- Driving forces behind texture transformation
- Prevailing Model



Data taken in 2009 at Cornell University by Houghton College students

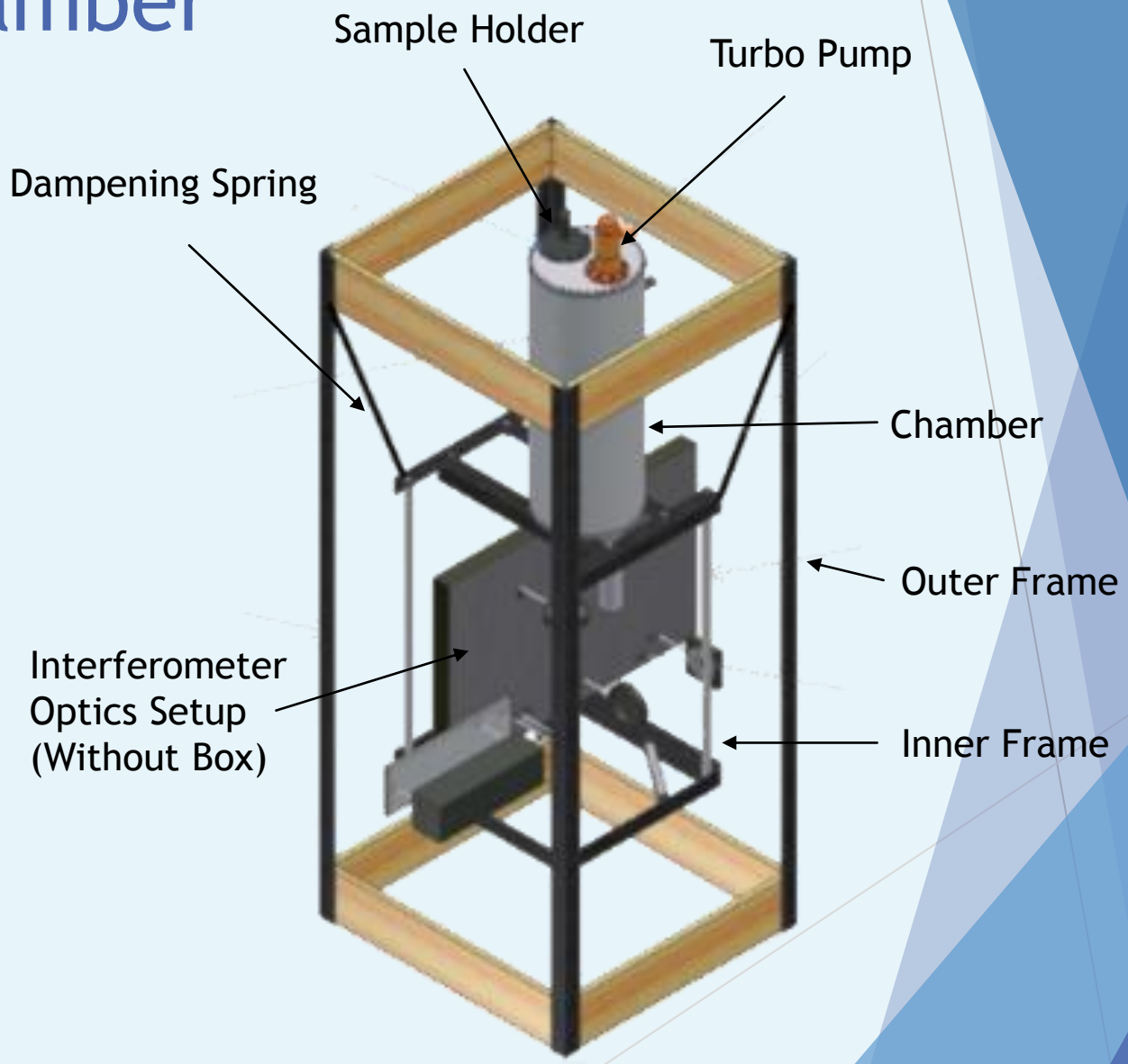


EBSD images of 1800 nm film with Ti, before and after 50˚C anneal for 30 hours.

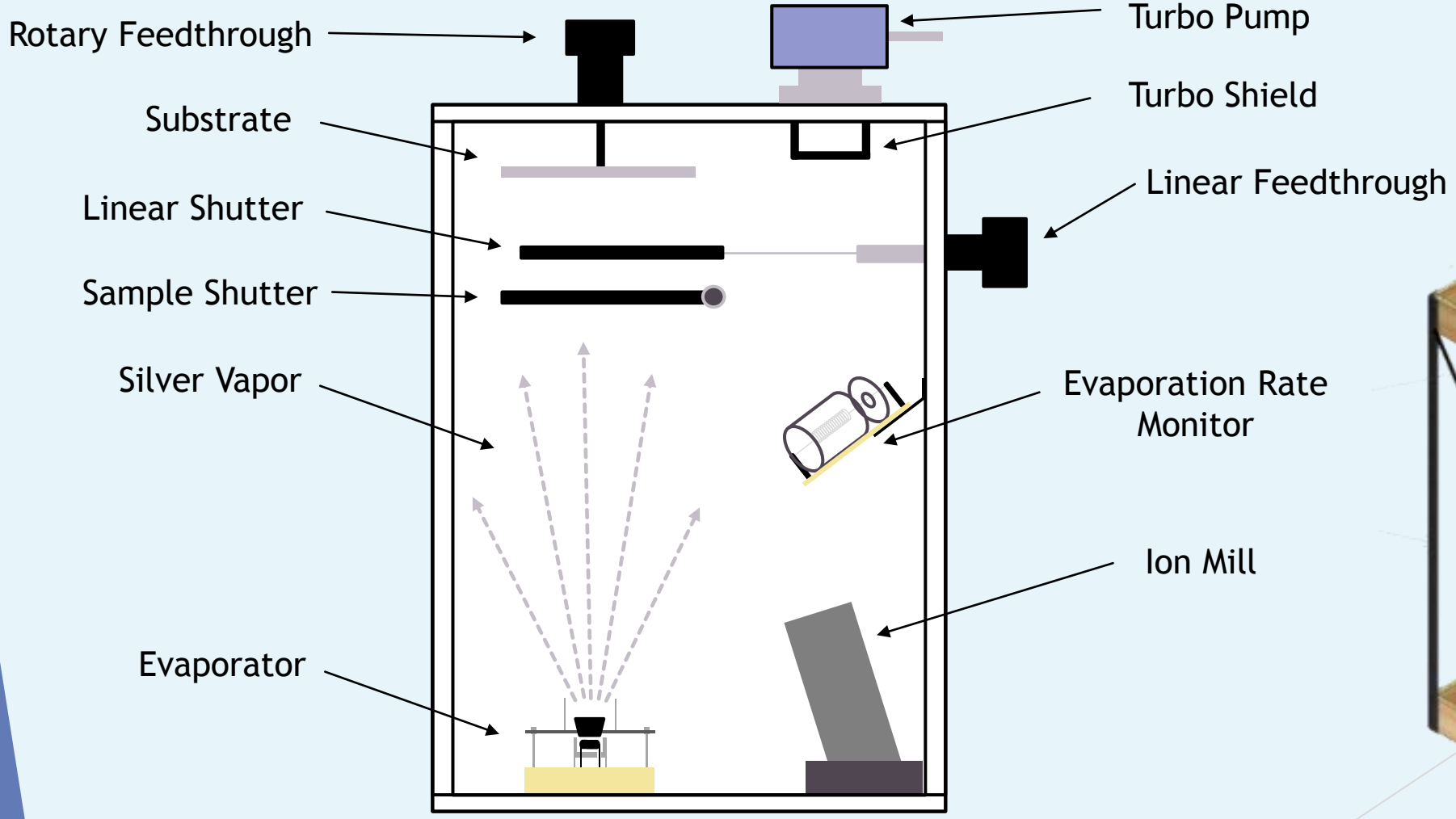
Motivation

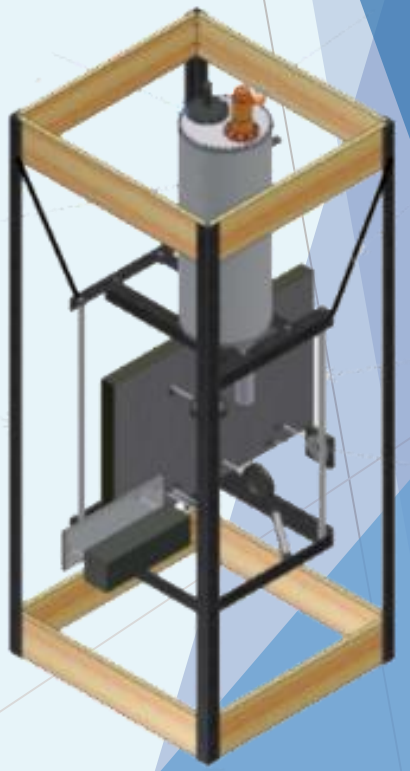
- Build an Apparatus that will allow us to study:
  - Grain Orientation
  - In-situ topography
  - Texture transformation in thin films
  - Forces driving texture transformation

The Deposition Chamber



The Deposition Chamber





Vacuum Pumps

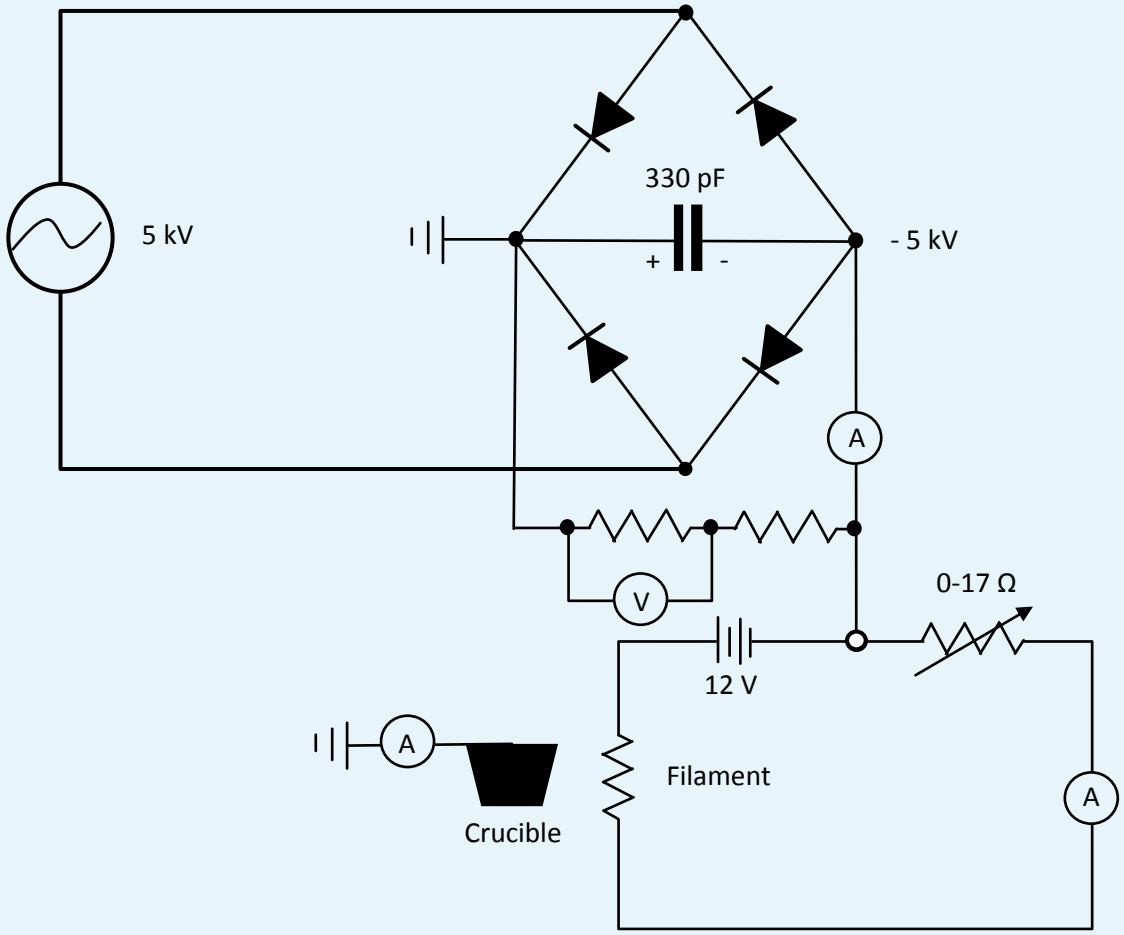
- Rough
  - 3 x 10^{-3} Torr
- Turbo
  - 9 x 10^{-8} Torr
- Ion
  - Reduce vibration while Imaging

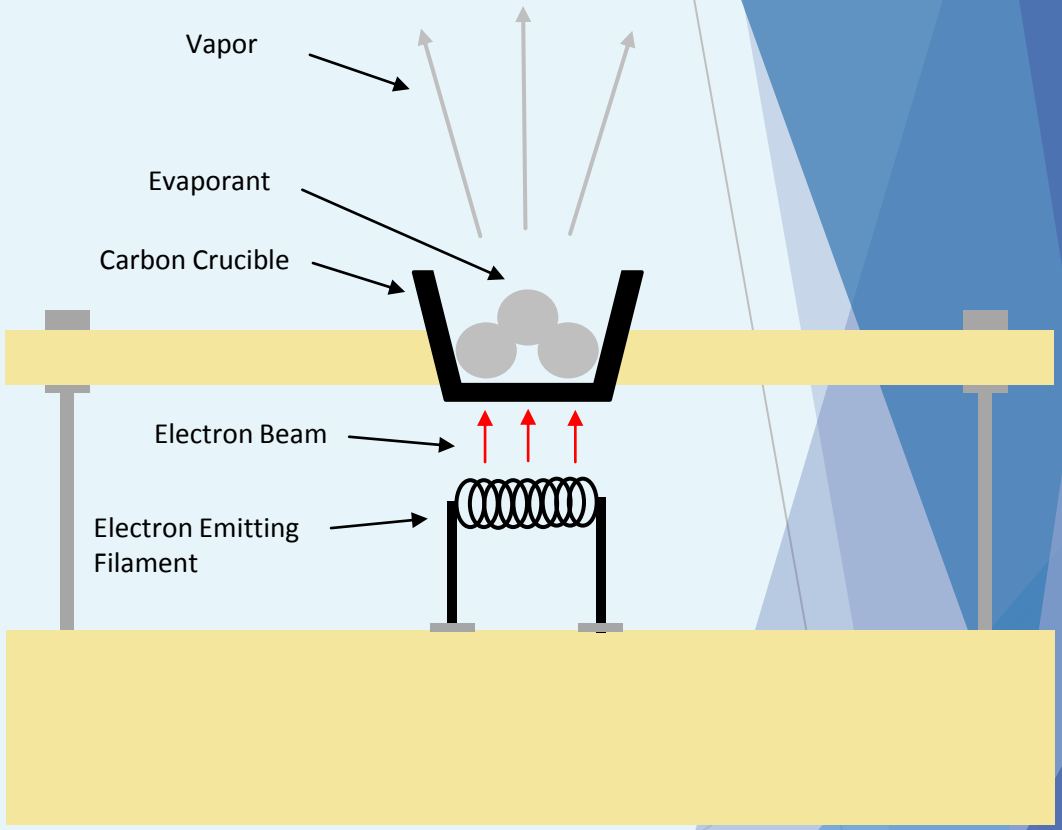
Roughing pump used at Houghton College

Turbo pump attached to top of chamber

Physical Vapor Deposition

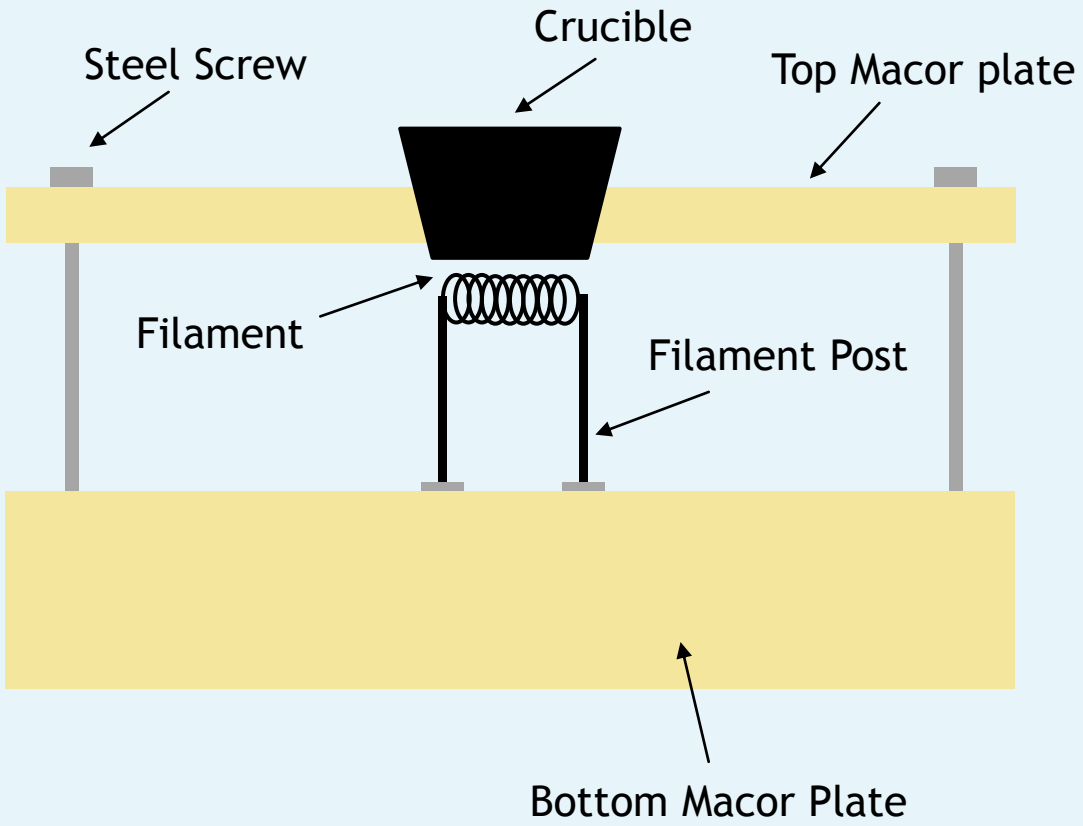
- Electron beam heating





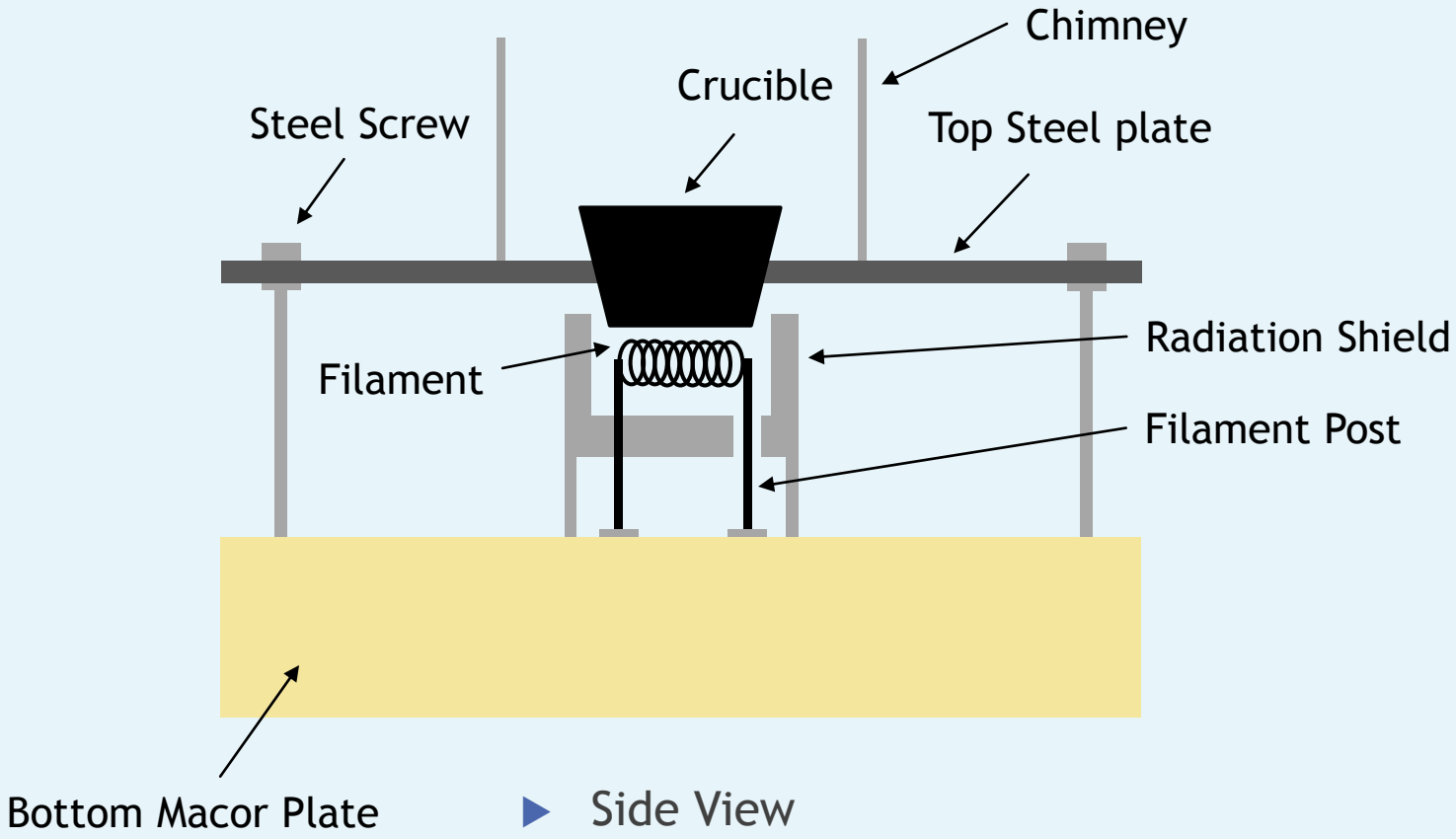
Evaporator

- Original Design

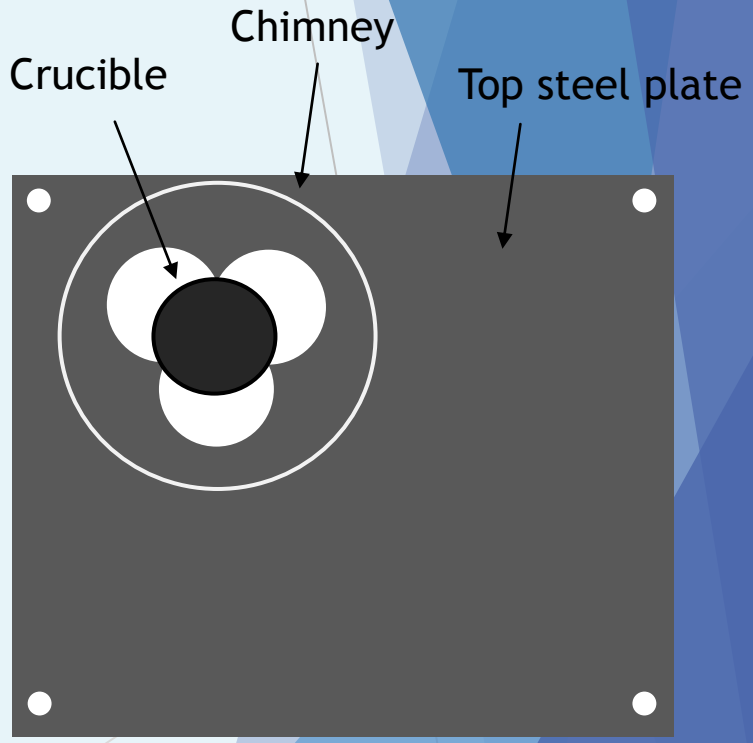


Evaporator

- New Design

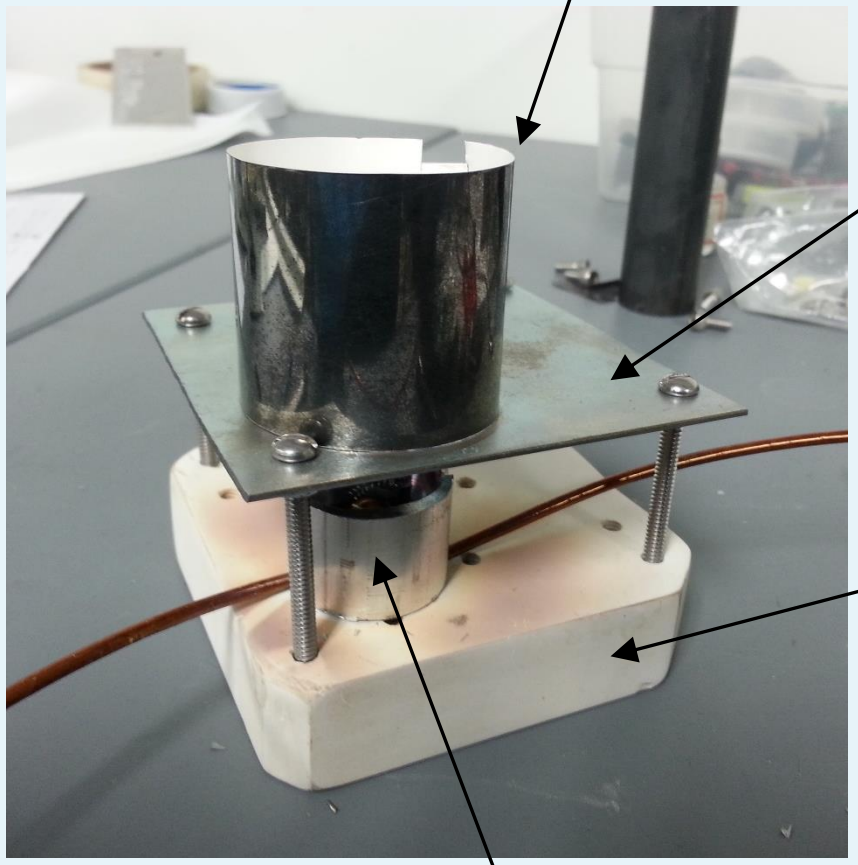


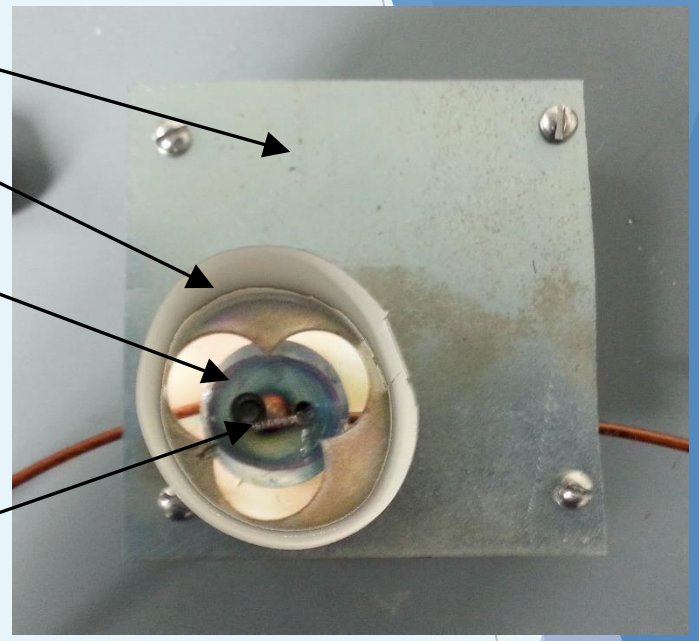
- Side View

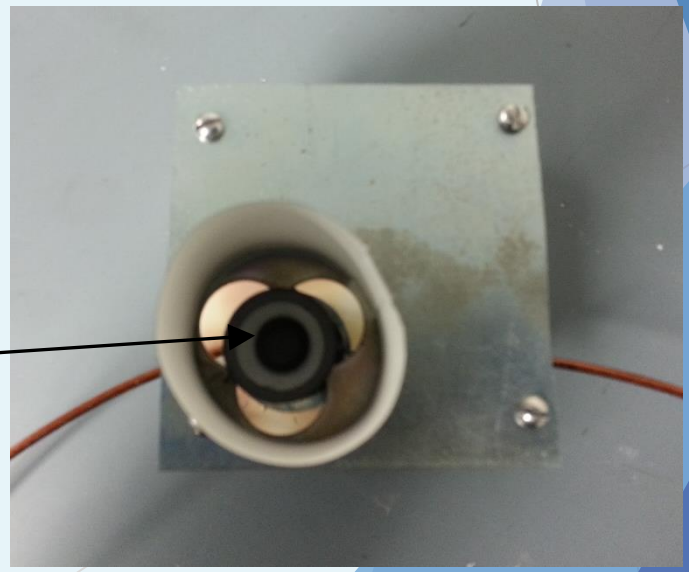


- Top View

Evaporator

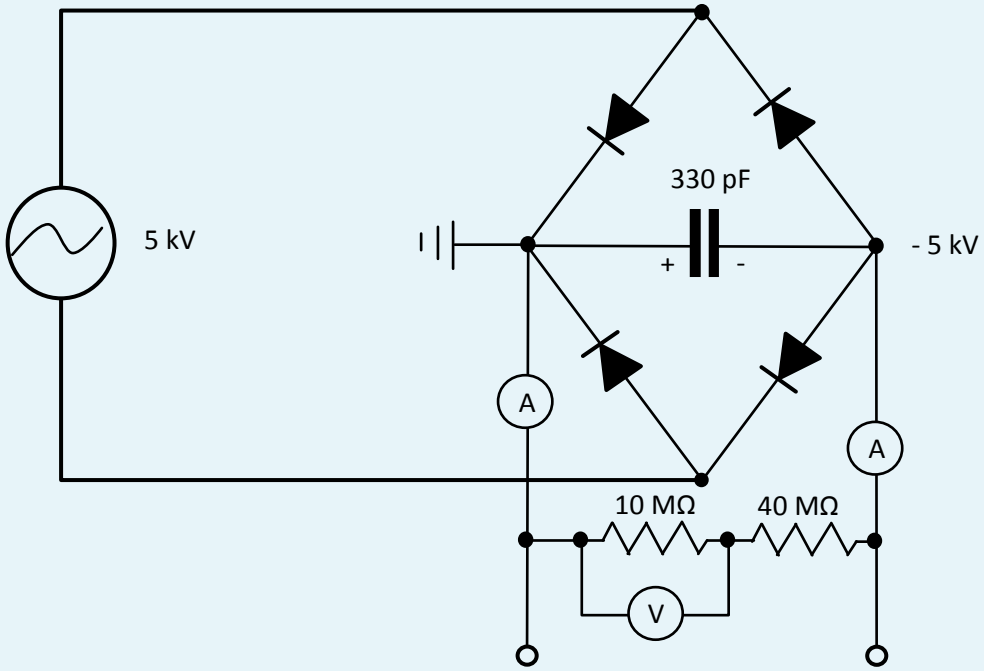

Molybdenum Chimney
Steel Plate
Macor Block
Radiation Shield

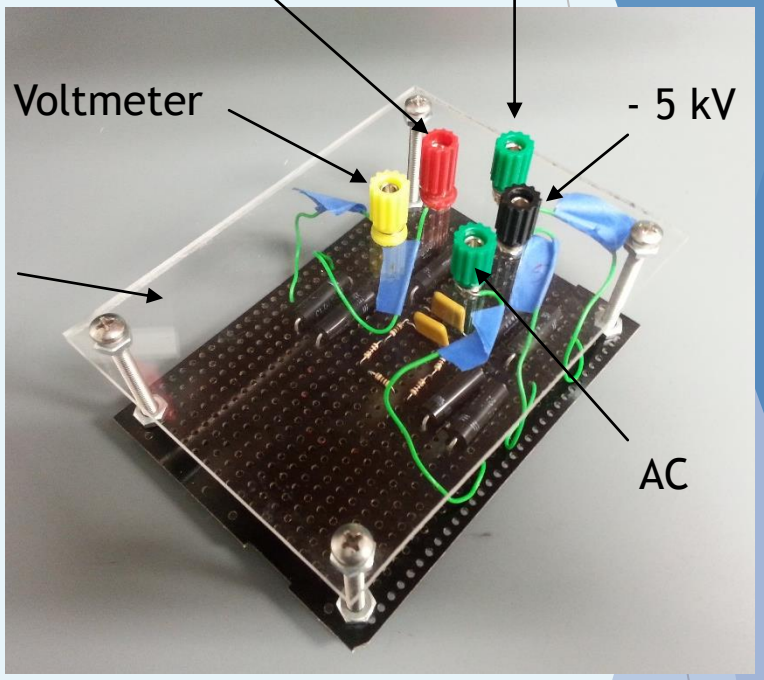

Steel Plate
Molybdenum Chimney
Radiation Shield
Filament

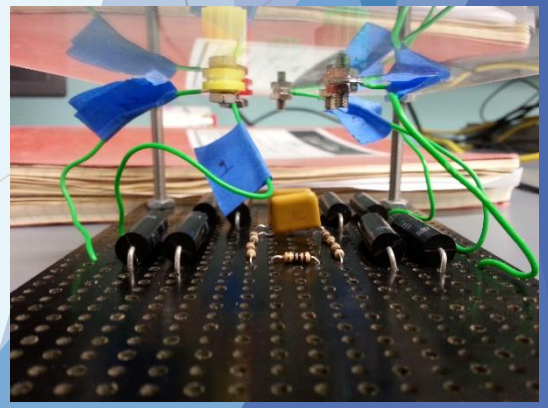

Crucible

Transformer

- Issues achieving power from
  High voltage source
- The solution



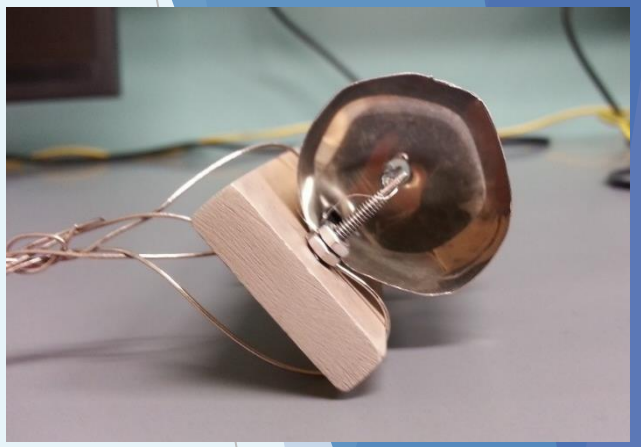




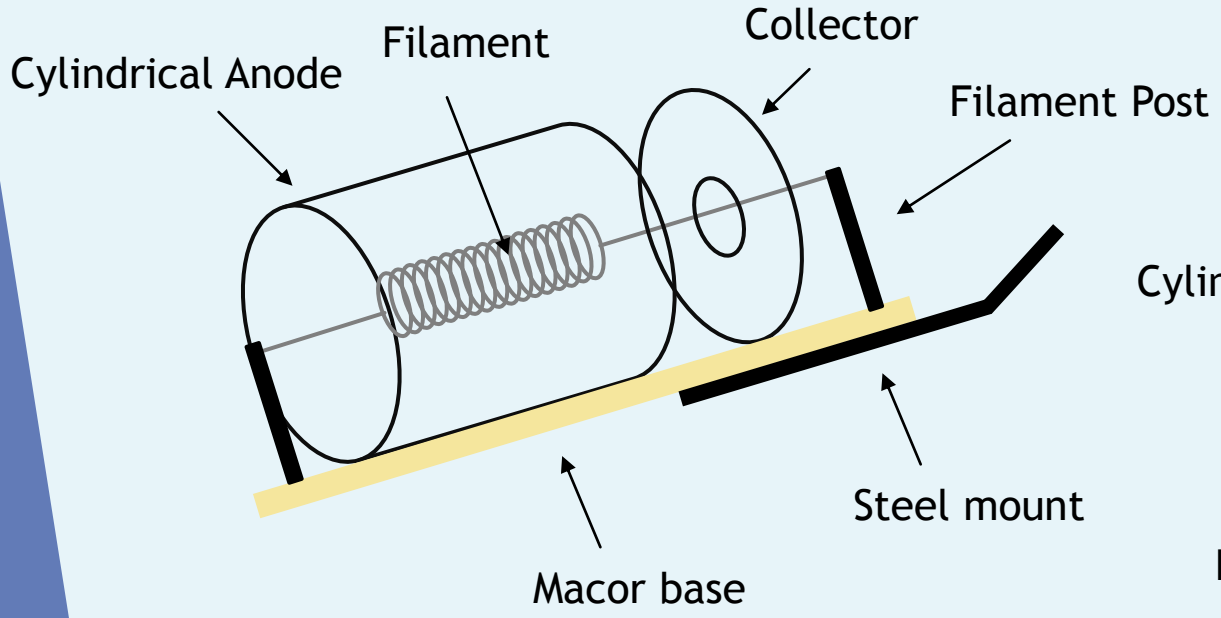
Rate Monitor

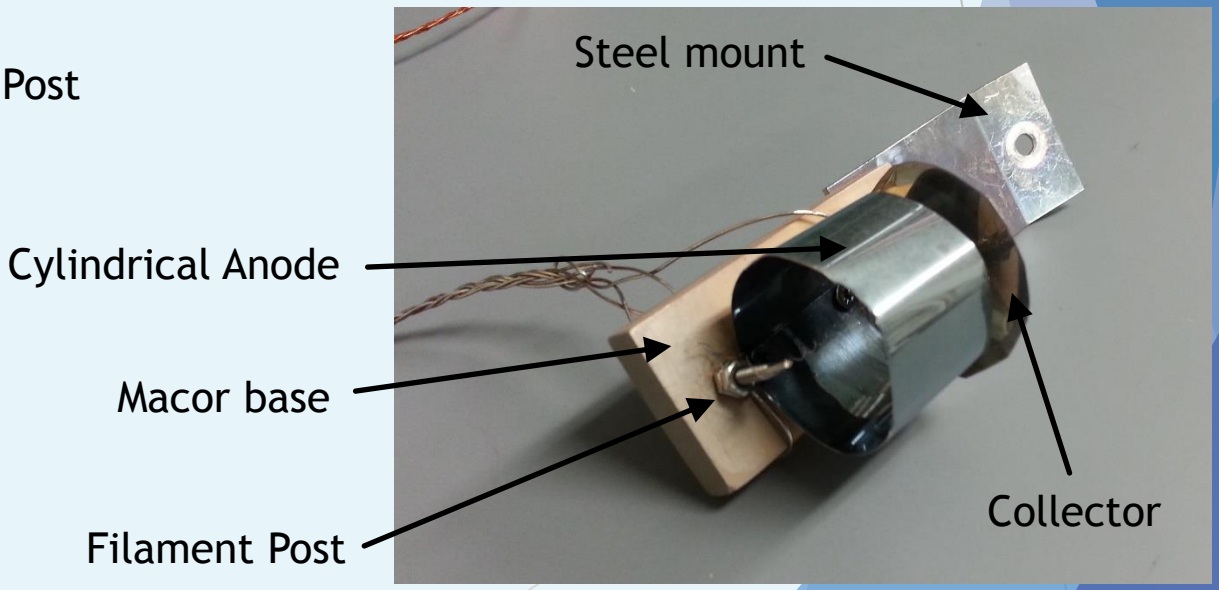
- QCM
- Evaporation Rate Monitor
  - G.R. Giedd and M.H. Perkins (1960)

ERM mounted half way up deposition chamber wall.



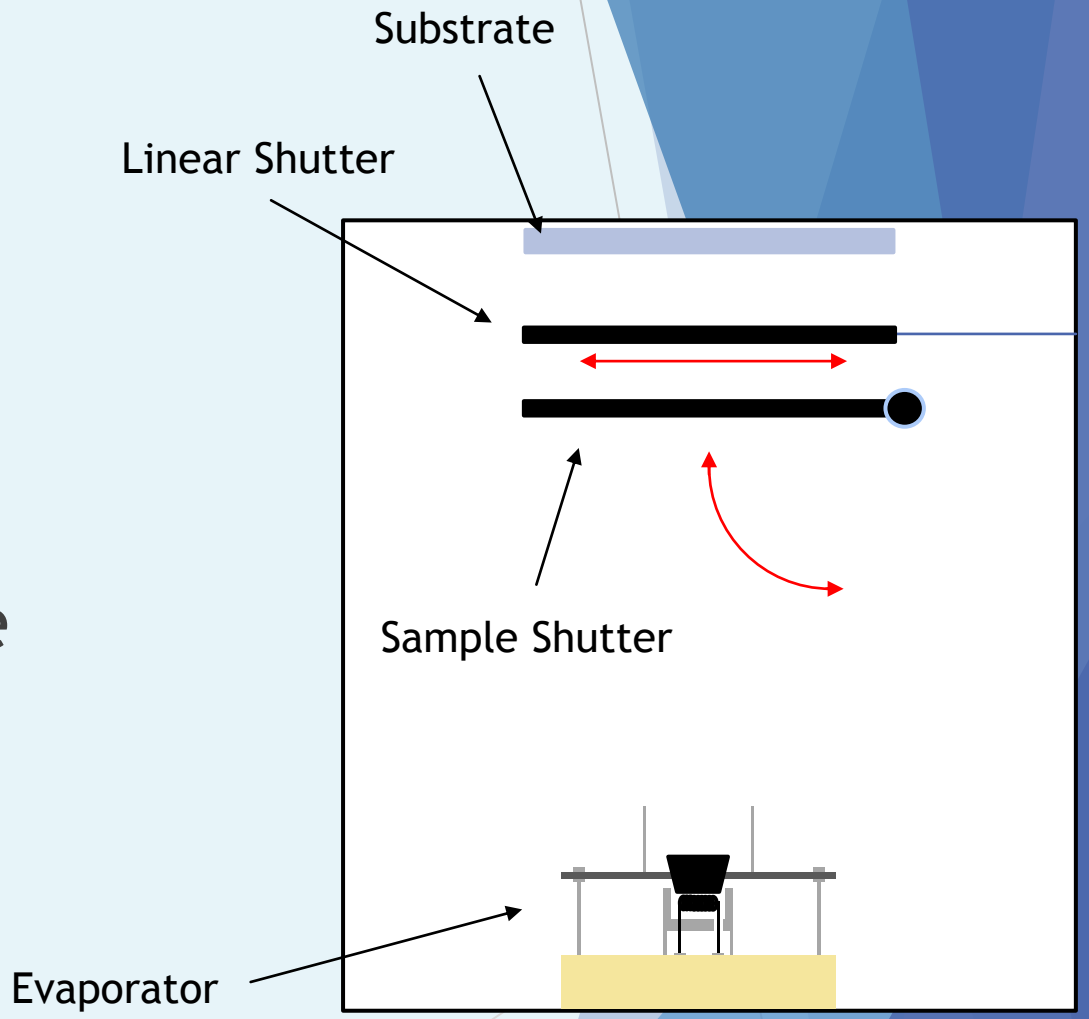
View of ERM looking straight into anode cylinder





Shutters

- Shutter to create gradient sample
  - Linear feedthrough
- Shutter to completely cover sample
  - Rotary feedthrough



Current Status

- Most recent Evaporator design is working
- Can make films of a single thickness

- Need to refine rate monitor
- Use Ion mill to clean substrate before deposition
- Use Ion pump to maintain High Vacuum