Microfabrication of Little Engines

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April 23, 2013

Review Microfabrications

- During class we were exposed to microfabrication with carbon nano-tubes
- We designed small cantilevers and went through the fabrication process
- We then did took optical measurements to characterize the frequency response of the cantilevers
- With microfabrication there is potential for much more than just measuring resonant frequencies

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MEMS Basics

- MEMS: micro-electromechanical systems.
- What are they used for?
  - Wii remote accelerometer
  - Inkjet printers
  - Chemical detectors
  - Motors
- We wanted to make a motor

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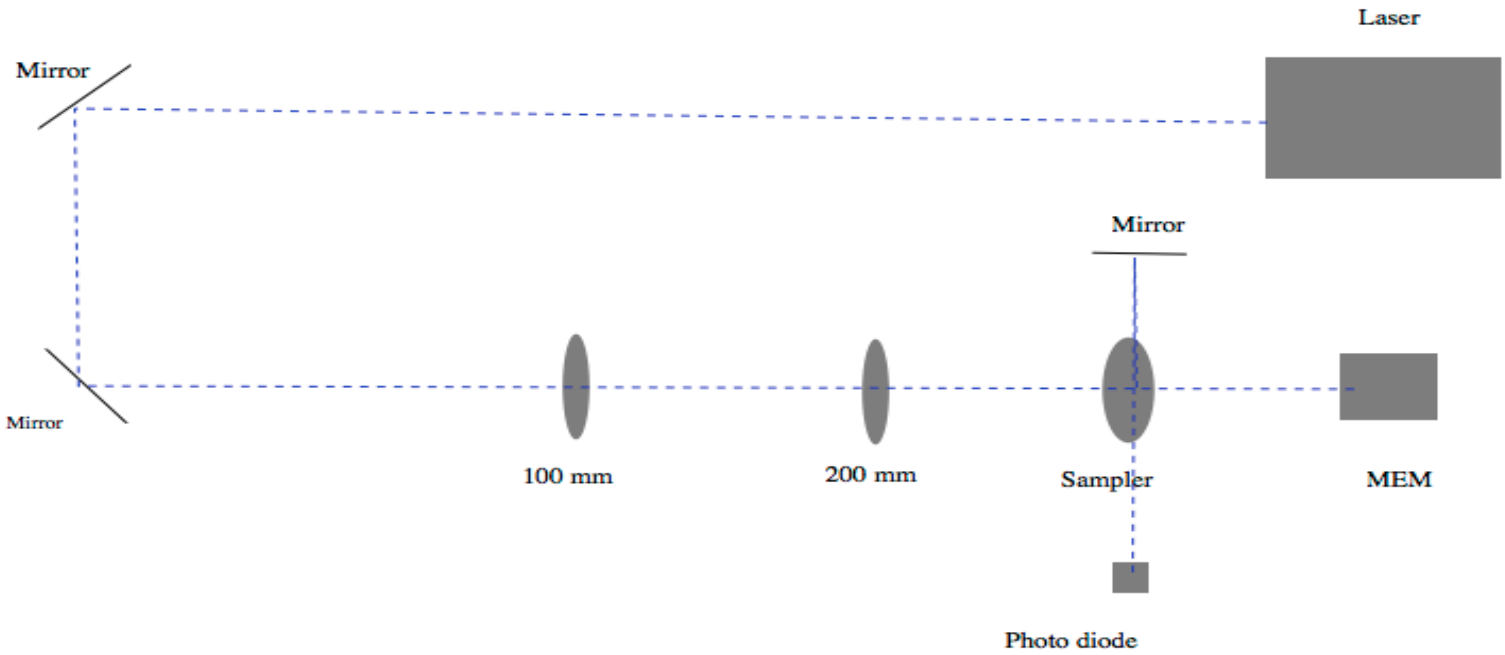
Our Goal

- Our goal was to create and measure the thermo-induced displacement of a micro motor

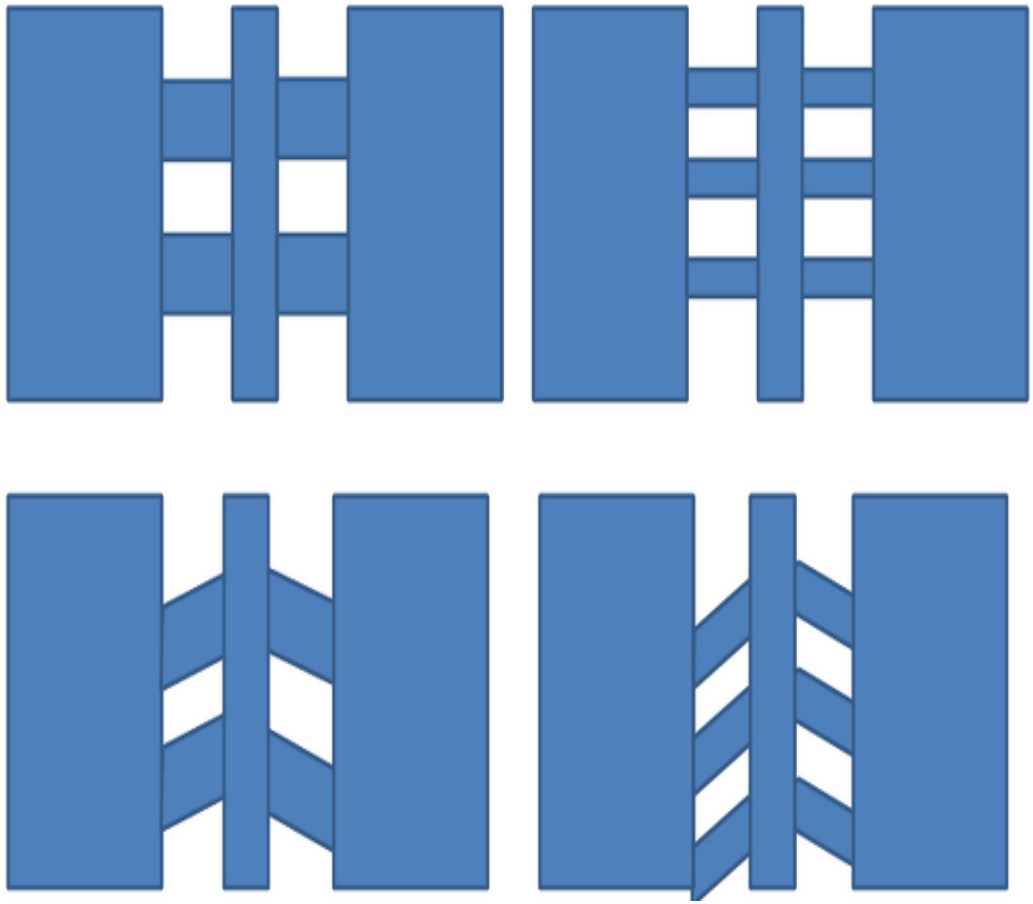
Interferometer

- To measure the displacement we thought we could use an interferometer
- We started with design from class and adapted it slightly:

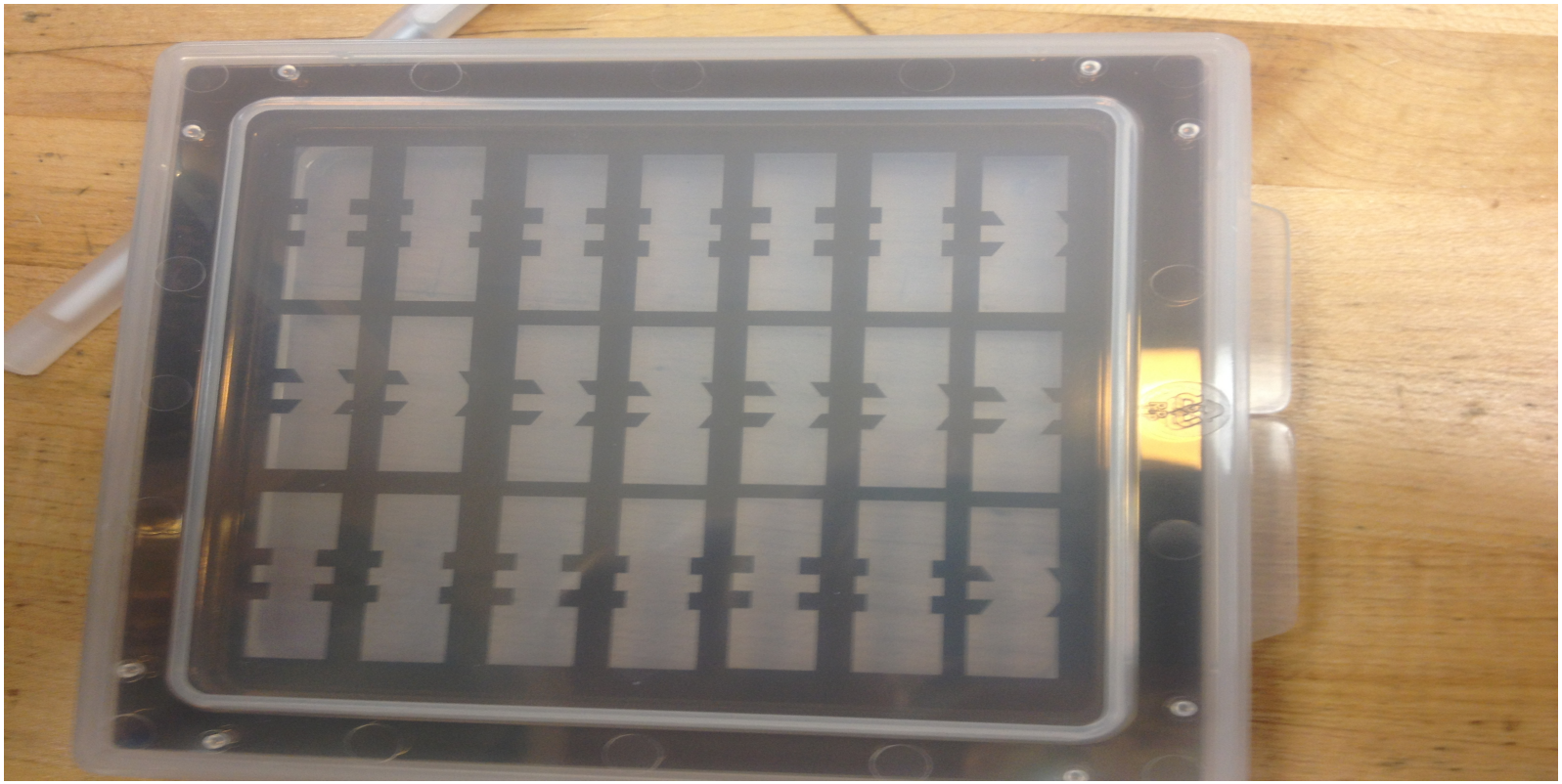


Our Motors Designs

- 4 designs:
  - 2 straight legs
  - 3 straight legs
  - 2 angled legs
  - 3 angled legs



Mask from EE



Sharpie!

- We needed to add the missing legs
- Bailey used a sharpie to draw them in

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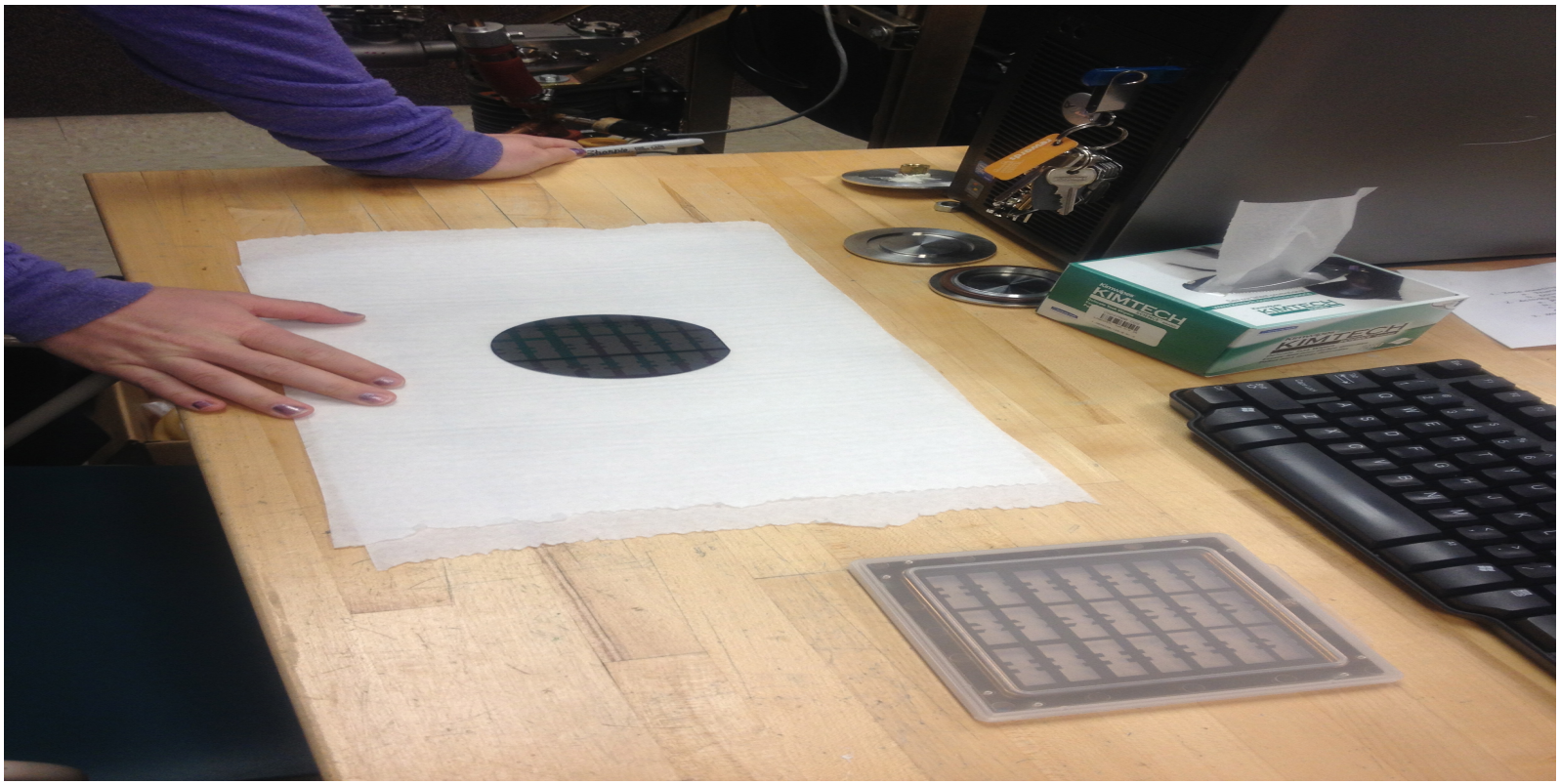
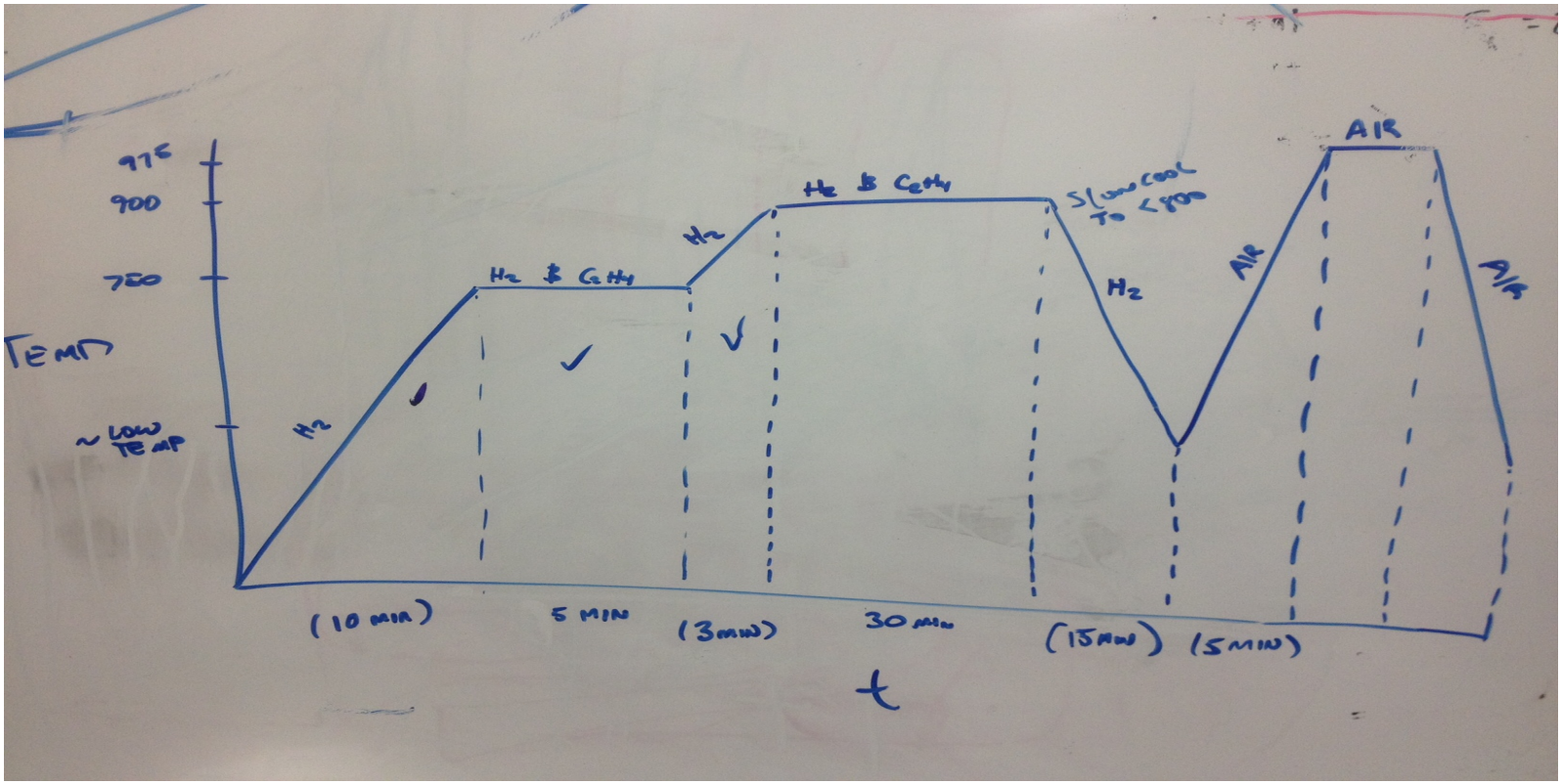


Deposition

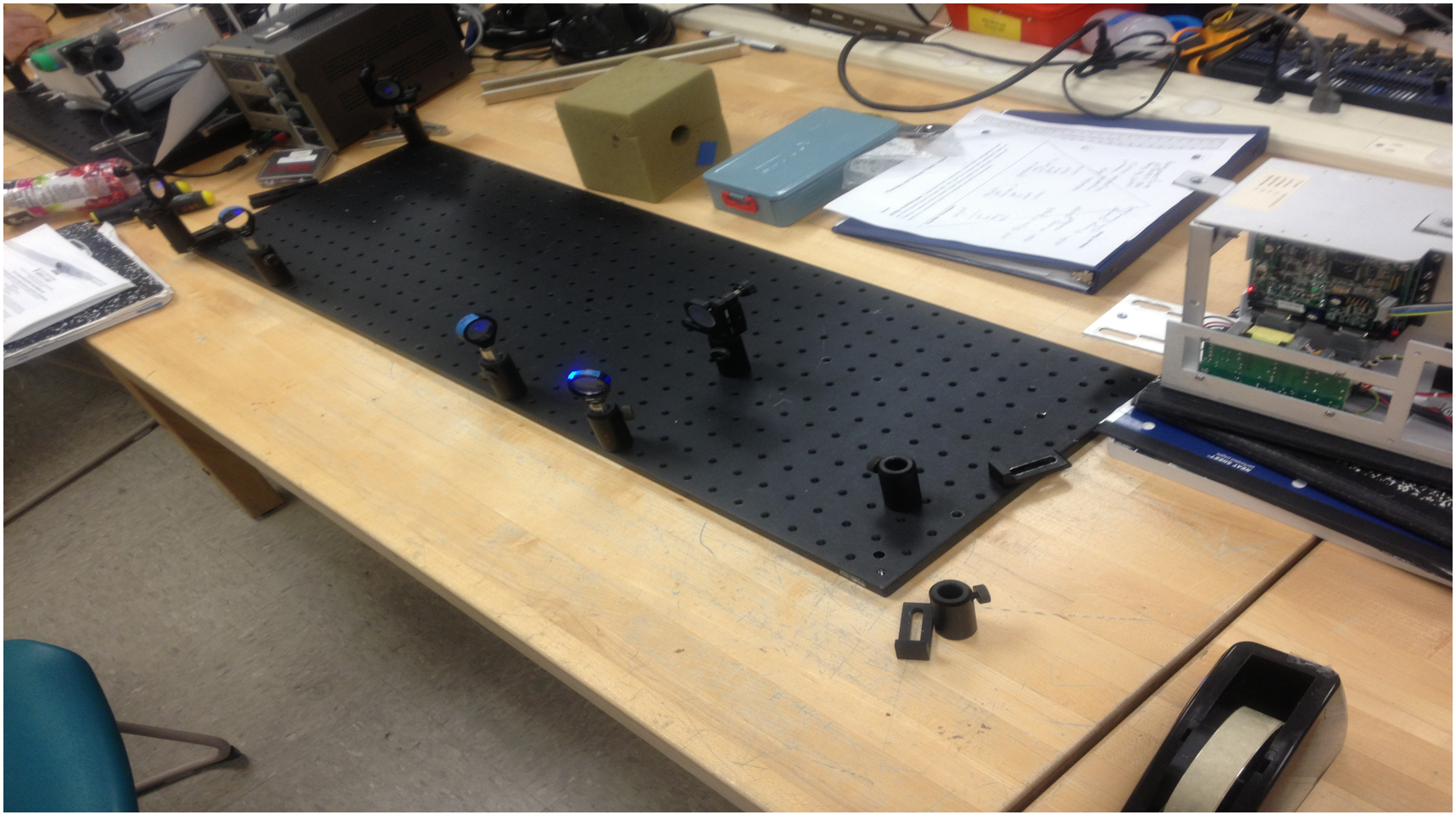
- We followed SOP to deposit iron (see picture and note sharpie marks)

Growth

- Also followed SOP for growing carbon tubes (see image for infiltration details)



Interferometer Setup



Precision

- Optical systems are difficult to set up
- We were trying to measure interference from very small surface ($< 5mm$)
- We weren't able to get that working
- Bailed on the interferometer and went with simpler setup . . .

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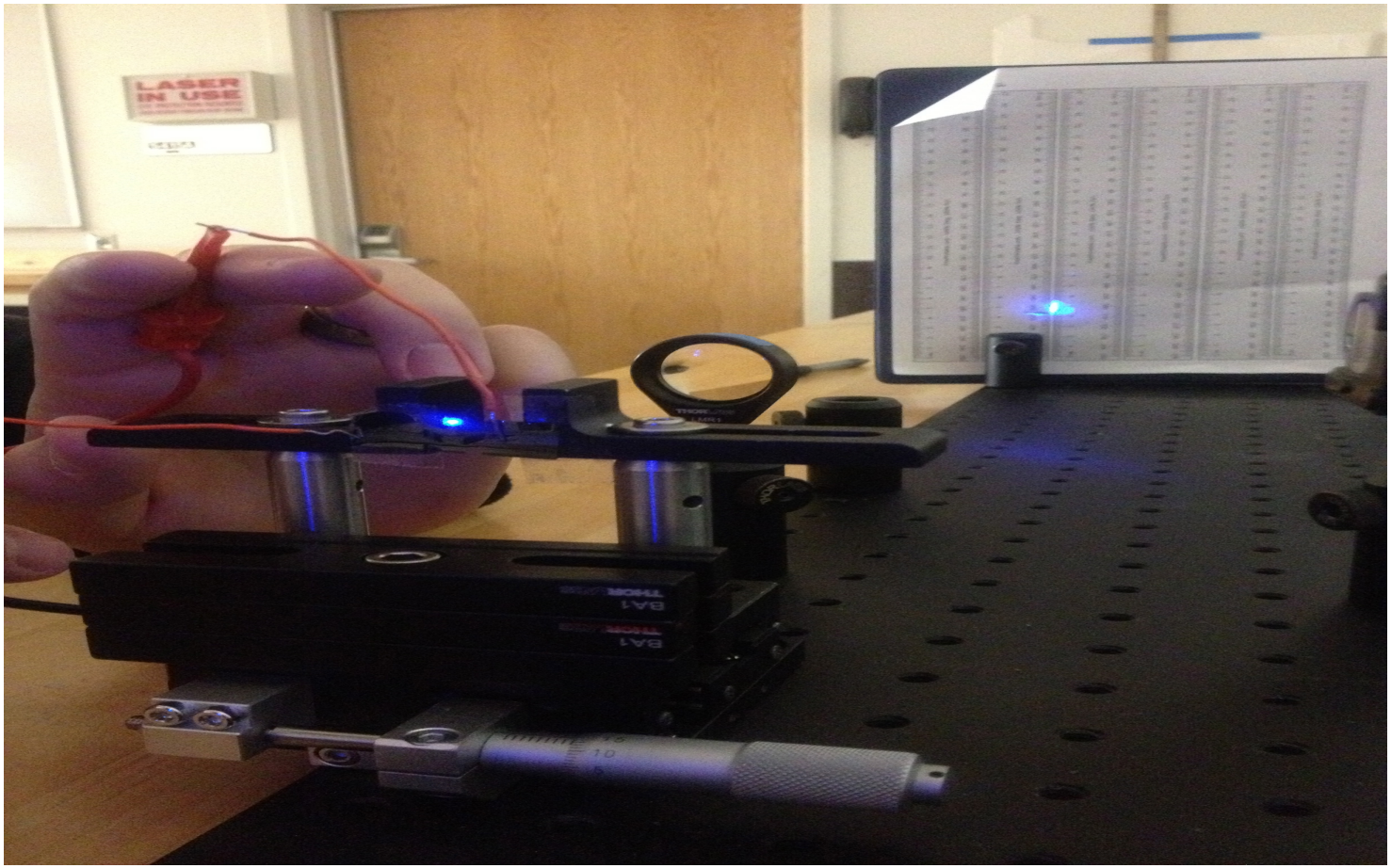
Simple Optics

- Shine laser onto MEM, through lens, onto ruler 75cm away.



Sampling Issues

- We made 4 different designs as outlined before
- When growing the tubes we could only have 4 in the furnace
- We forgot to do one of each design
- By chance we ended up with 3 of one design (3 angled legs) and 1 of another (2 angled legs)

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Fragile Motors

- They all ended up breaking before we could take meaningful data:
  1. One was lost
  2. One stuck to the wafer and broke when we tried to remove it
  3. One broke when we tried to move it
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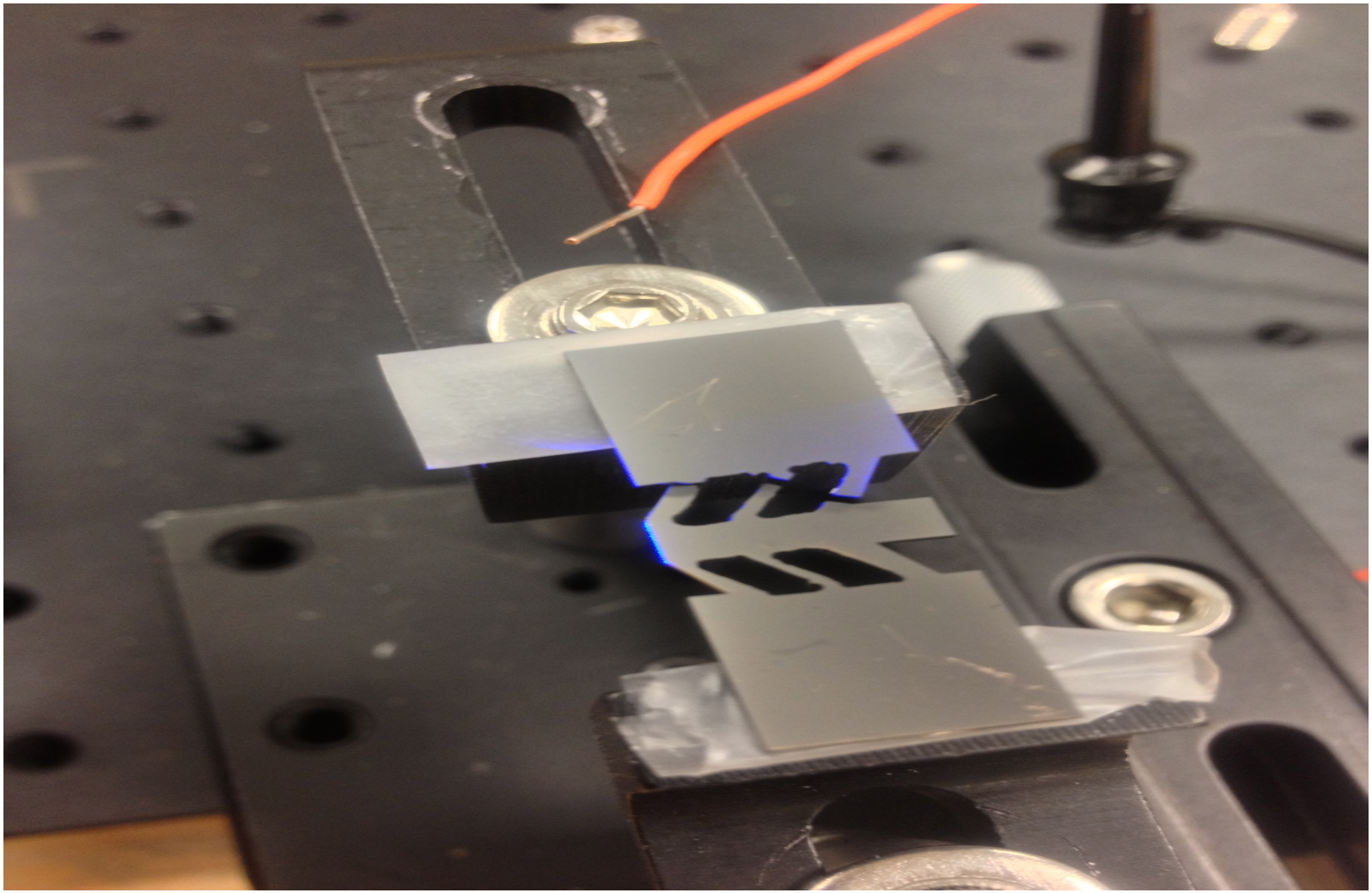
Broken Motor



Back to Drawing Board

- Applying voltage across motor induced heat
- However, we couldn't see any thermal expansion
- To fix this we could:
  - Use a complete mask
  - Make more samples (because some will break)
  - Thinner (fewer) legs → less resistance to expansion
  - More controlled application of voltage

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