



Using Tribology to Optimize a Commercial Polishing Process



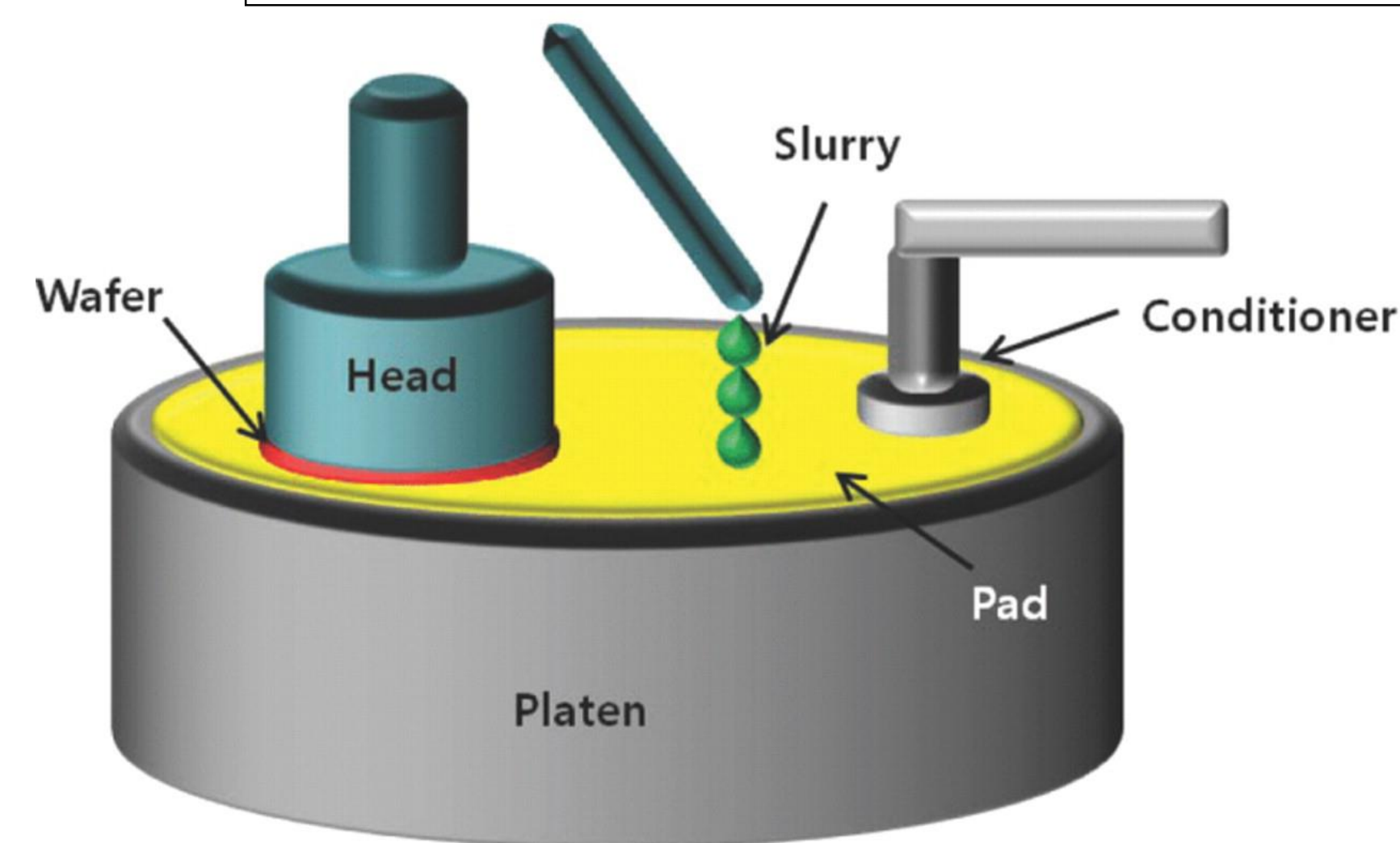
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Introduction

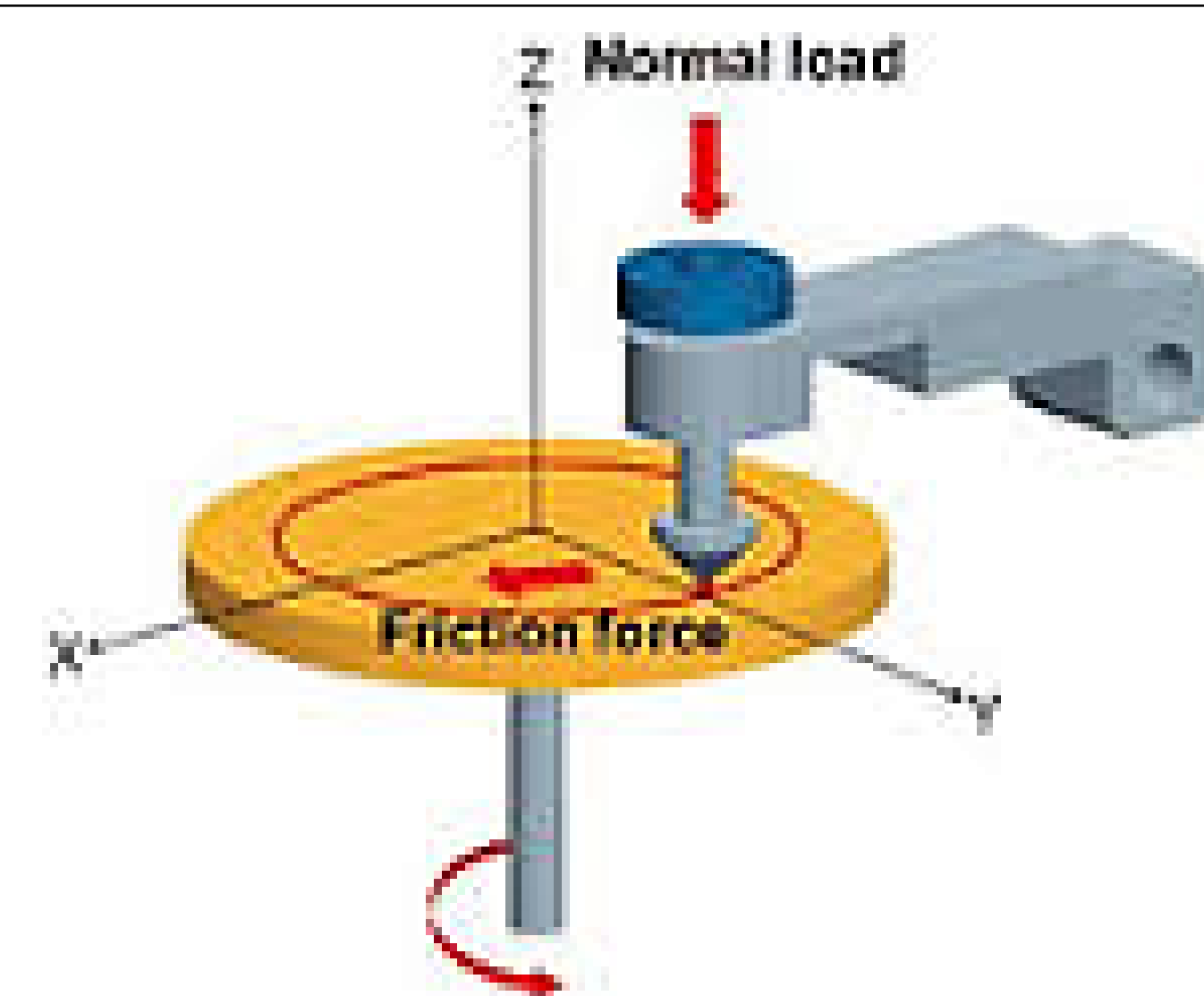
- **Background:**
Tribology is the study of friction and wear. Chemical Mechanical Polishing (CMP) is a manufacturing process used to produce consistently flat surfaces on components such as semiconductors. Currently, there is no valid model that relates the friction forces acting in the system to the rate of material removal.
- **Goals:**
 1. To finalize a research apparatus for studying CMP
 2. To collect data to calibrate the apparatus, so that it can contribute to the optimization of CMP

Methodology

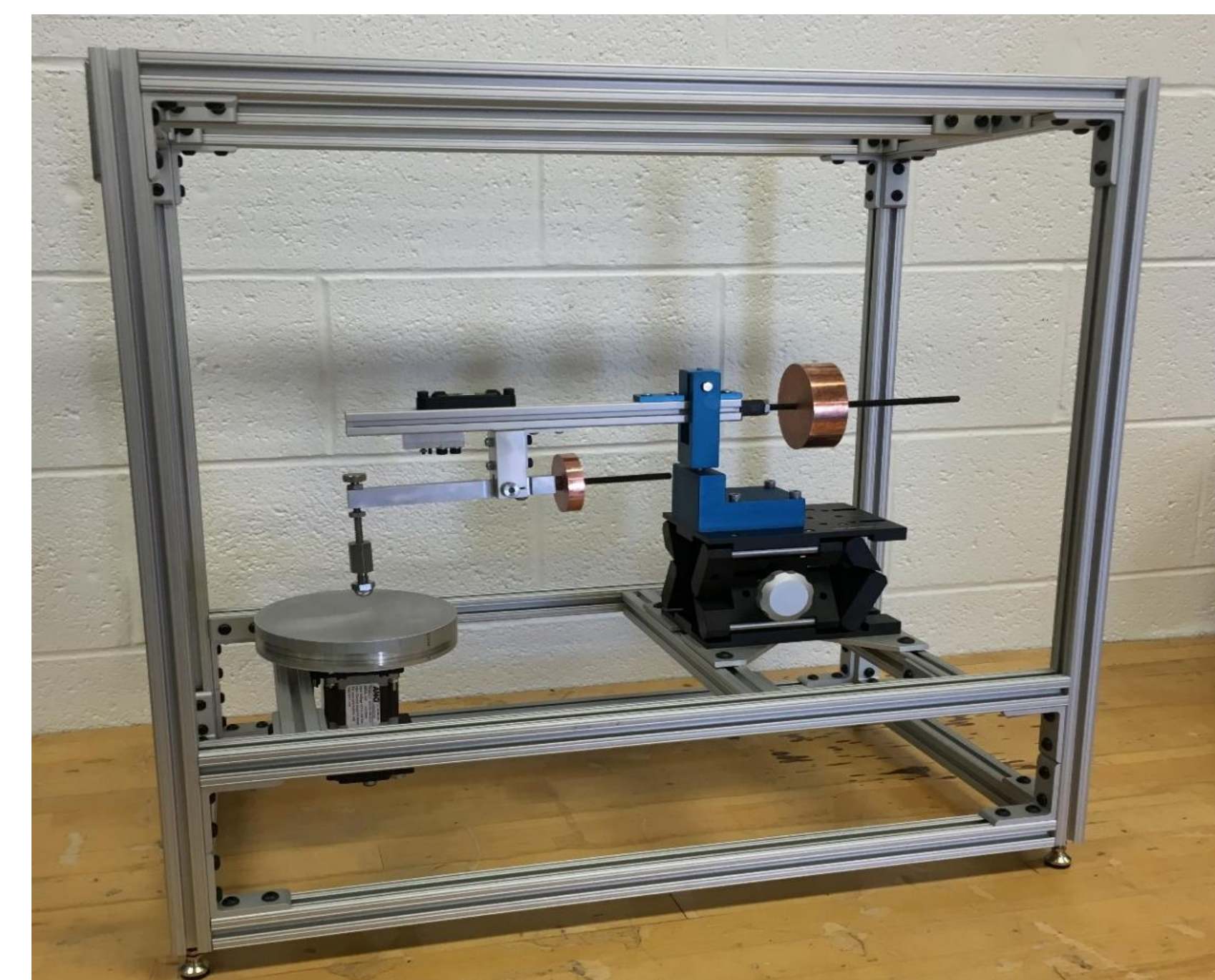
- **Tribometer:** An apparatus to detect changes in sliding friction between a turntable-mounted substrate and a stylus



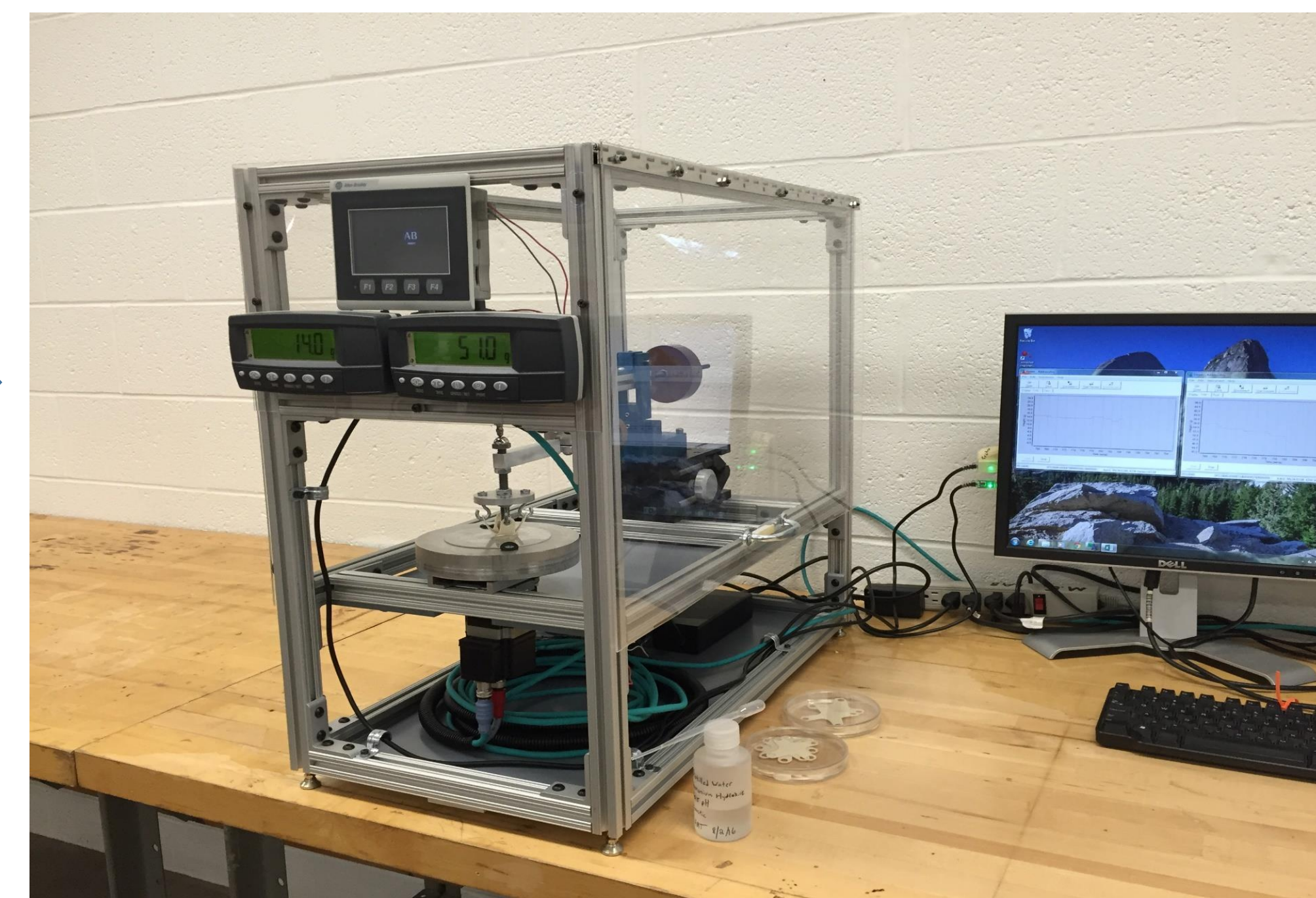
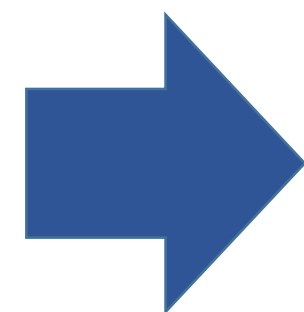
A diagram of the components used in CMP



The basic mechanics of a tribometer



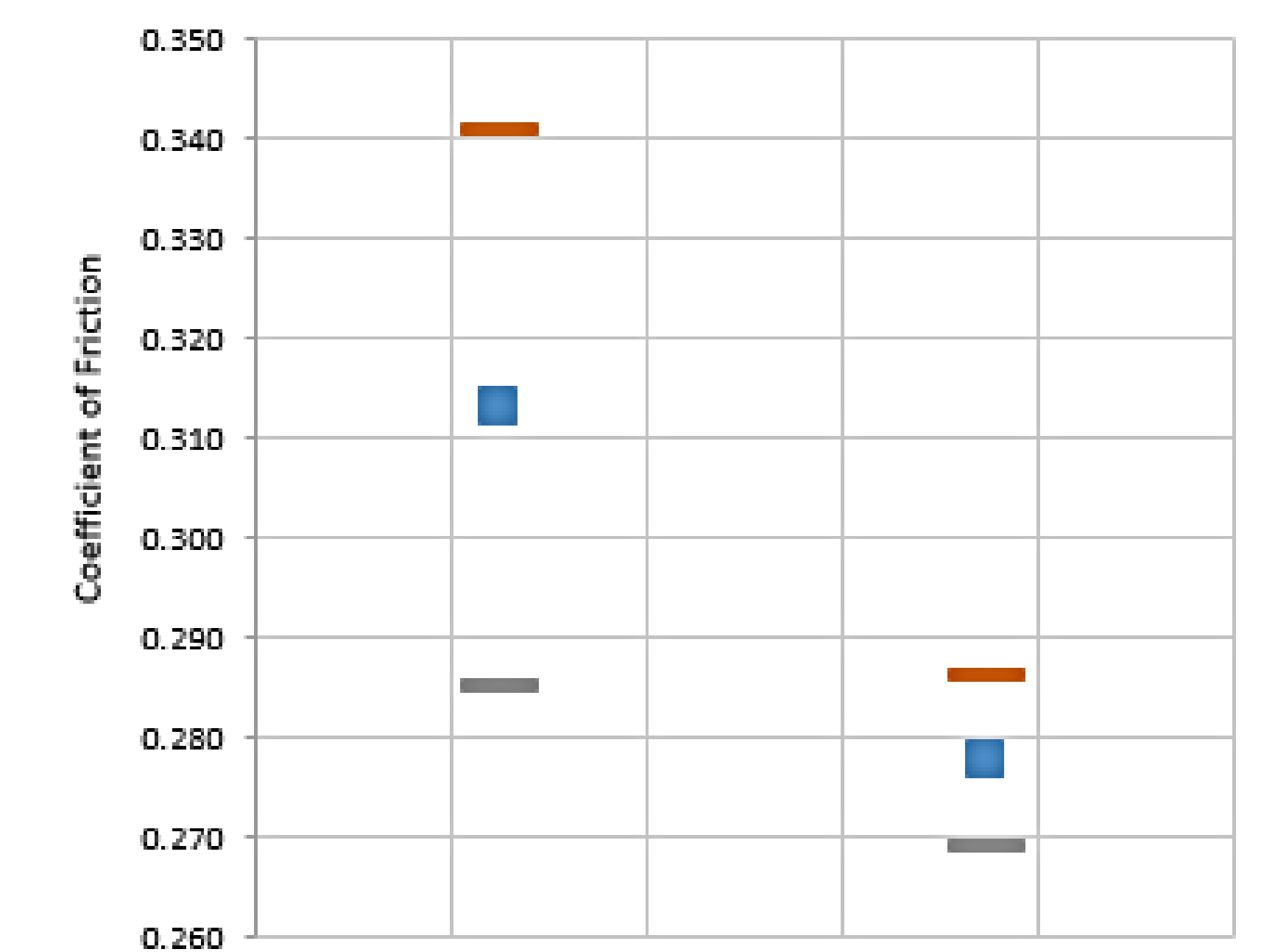
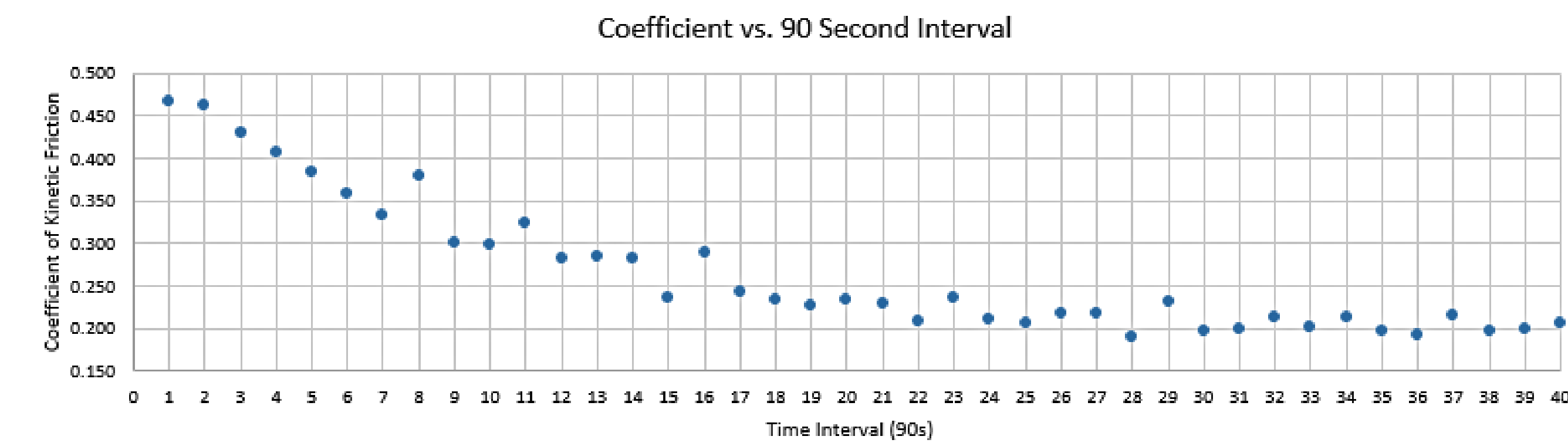
Apparatus prior to project



Completed apparatus with newly integrated sensors

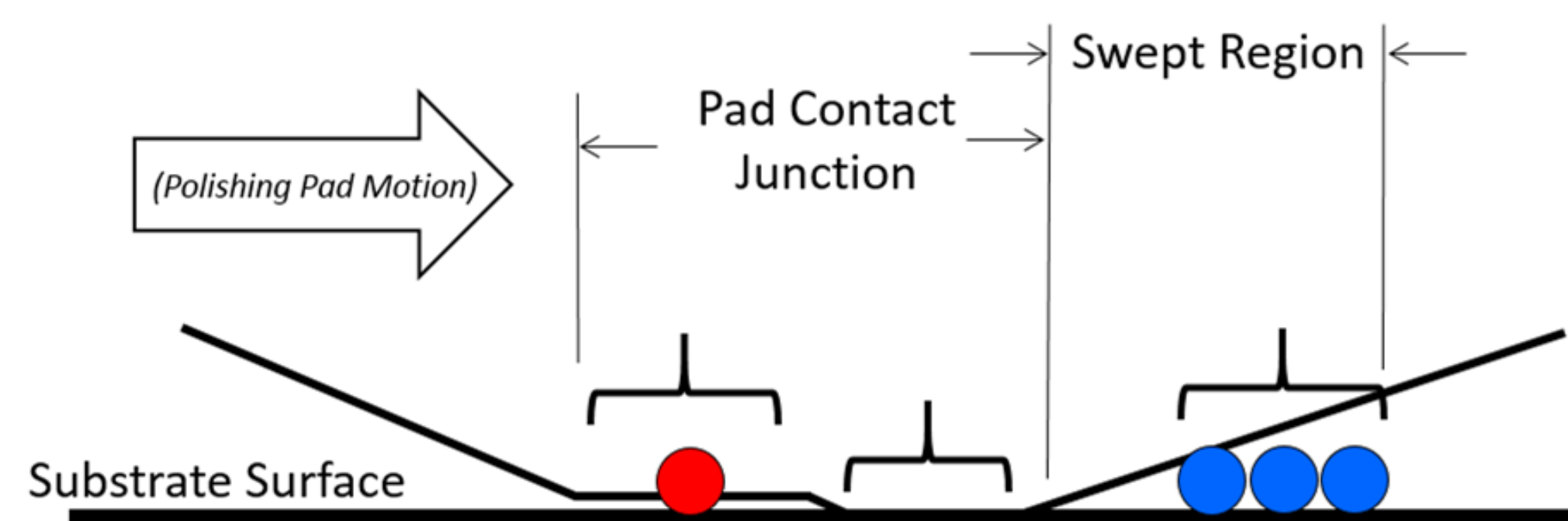
Results

Change in coefficient of friction over time



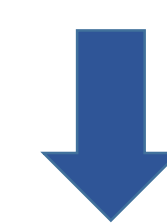
Comparison of data taken by this apparatus and that of another institution. Among 20 data points from each instrument under similar conditions, the average coefficients of friction are similar. In this particular example, the 90% confidence interval for each data set overlap each other.

Past Research



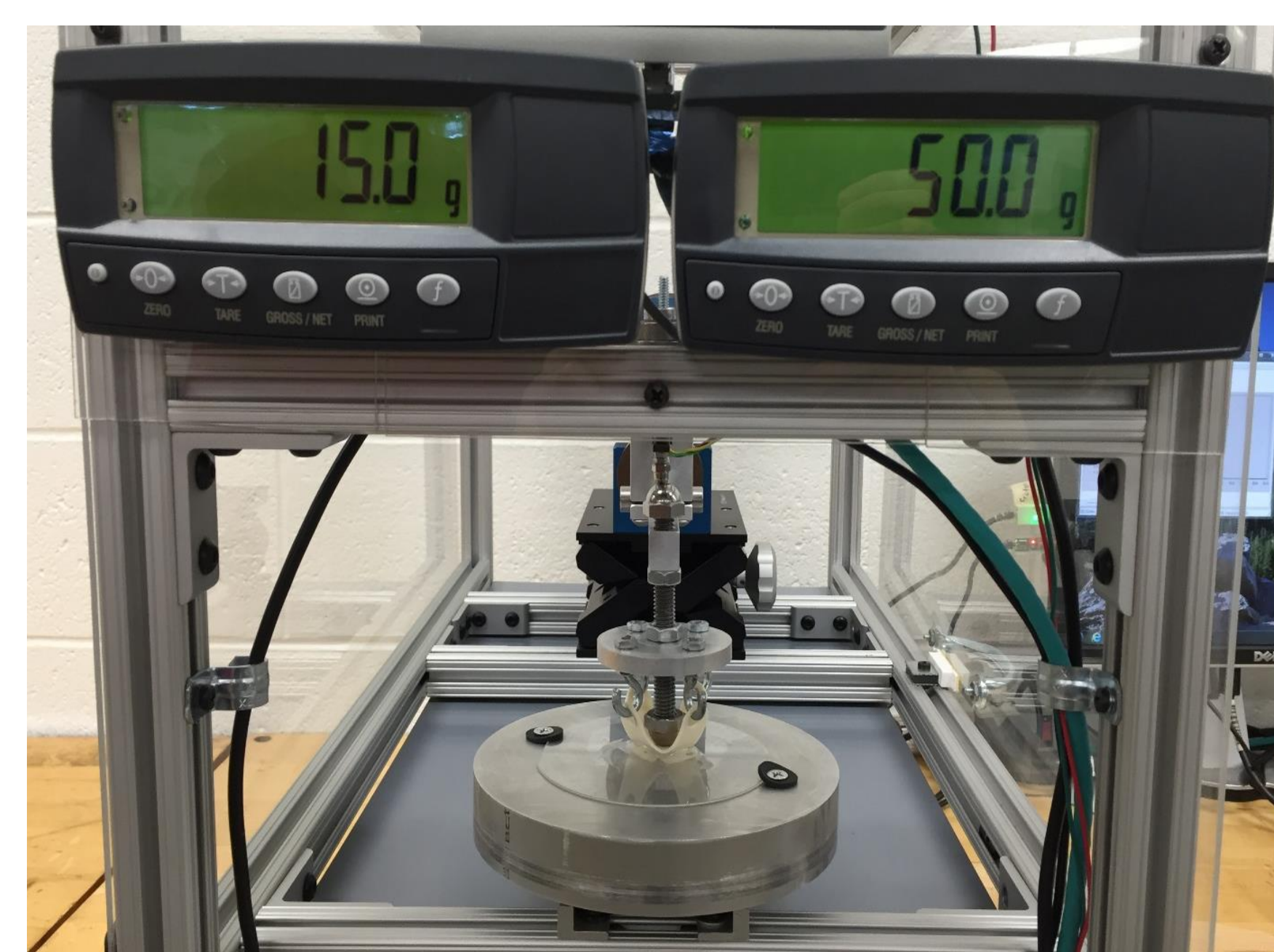
Schematic diagram of pad profile in CMP

$$\frac{\text{Relative Removal Rate of Contact Region}}{\{[(\mu_{pp})(X)(H_{pad})] + [(Y)(f_R)(PF)(4)/(\pi)(D^2)]\}}$$

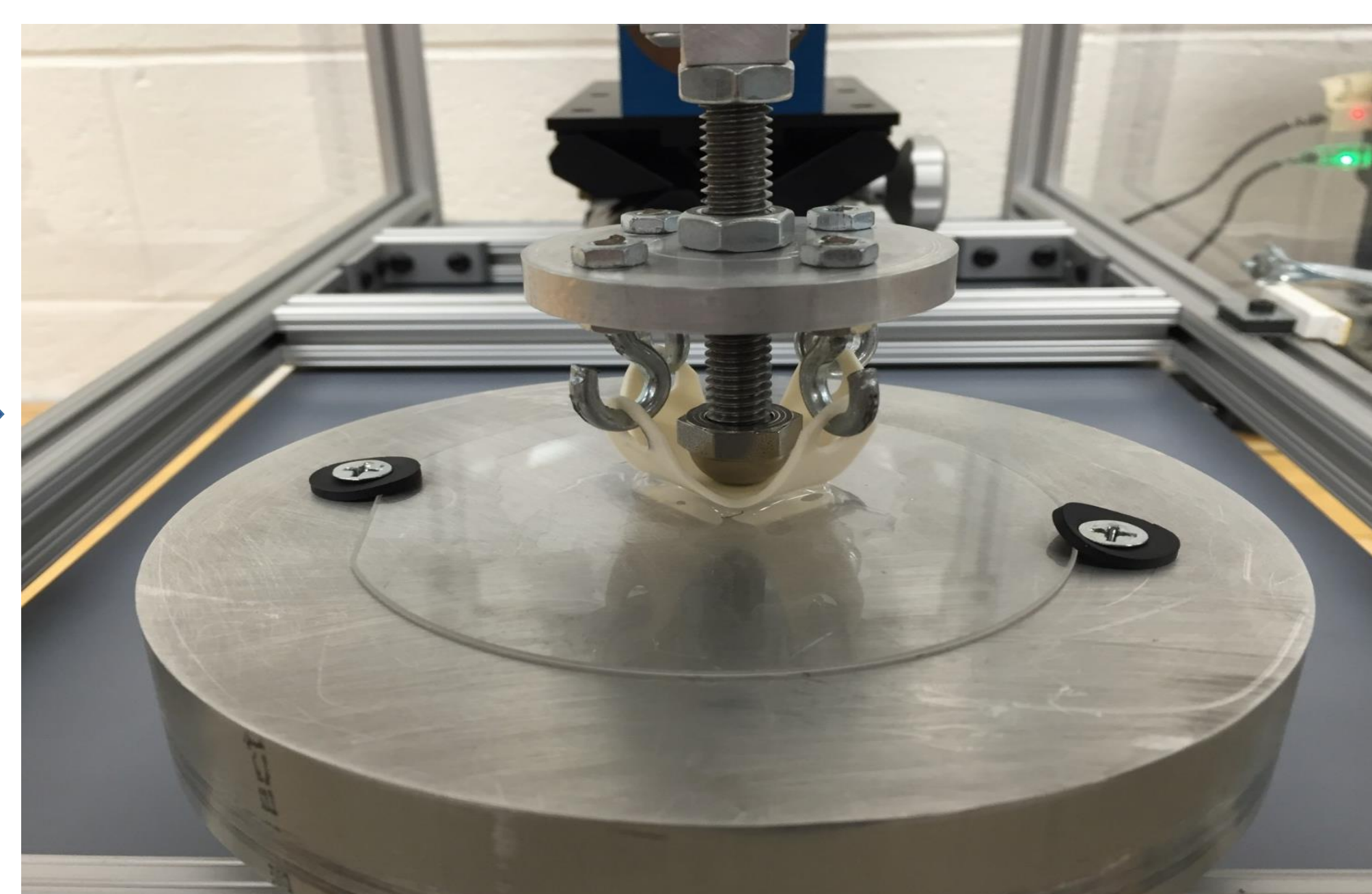
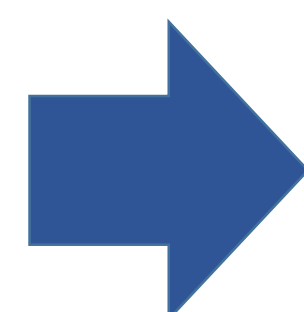


Polishing Rate \propto Friction Force

Surface wear is estimated from this correlation and supported by data



Digital readout of friction force (left) and normal load (right)



Measuring friction between polyurethane pad and SiO₂ wafer in the presence of NH₄OH solution

Future Work

- Testing effects of different substrate and pad materials
- Introducing abrasive particles to polishing slurry
- Measuring material removal with surface profiler and comparing to theoretical value

References:

Levert, Joseph A., Benjamin Mooney, Chad Korach S., and Franklin Lynam. *Model of Particle Contact Area for Friction in Oxide Chemical Mechanical Polishing.*

Acknowledgements:

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