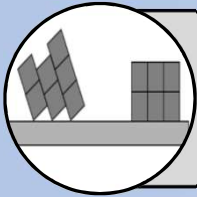


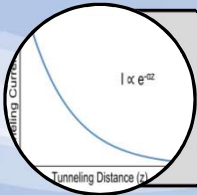
An Ambient Air Scanning Tunneling Microscope to Study the Surface of Thin Metal Films

Josh Wilson, Brandon Hoffman

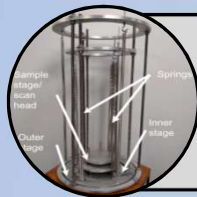
Houghton University



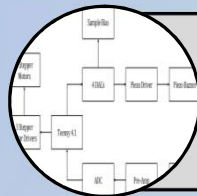
Thin Film Growth and Structure



Potential Energy Barrier



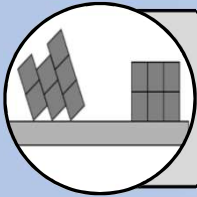
STM Structure



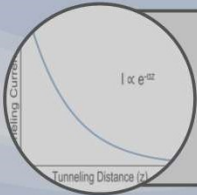
STM Circuit



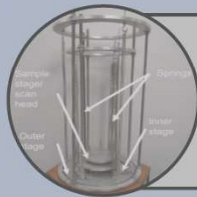
Current Status



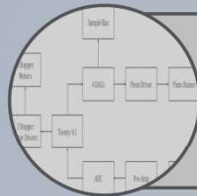
Thin Film Growth and Structure



Potential Energy Barrier



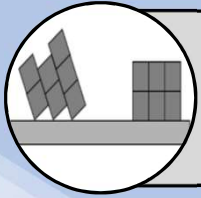
STM Structure



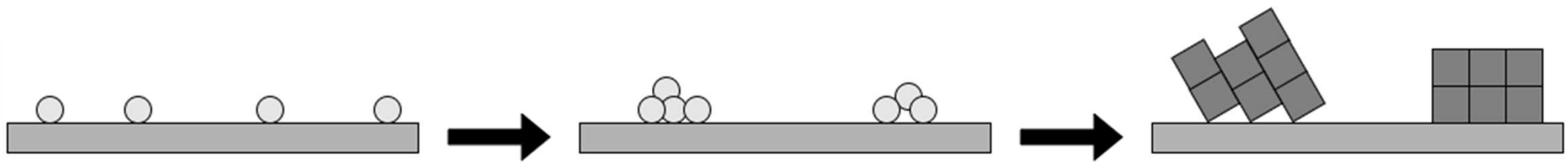
STM Circuit

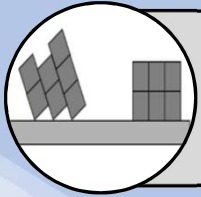


Current Status

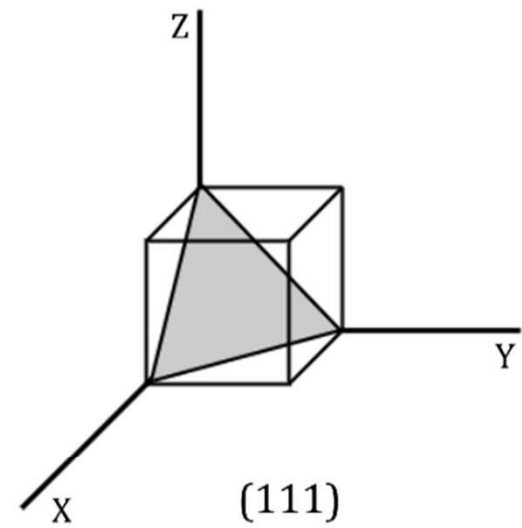
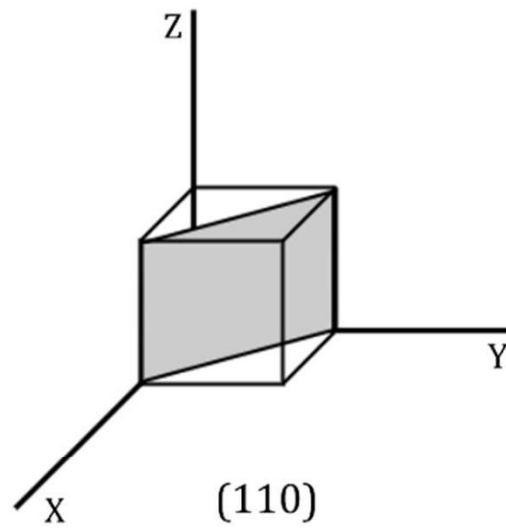
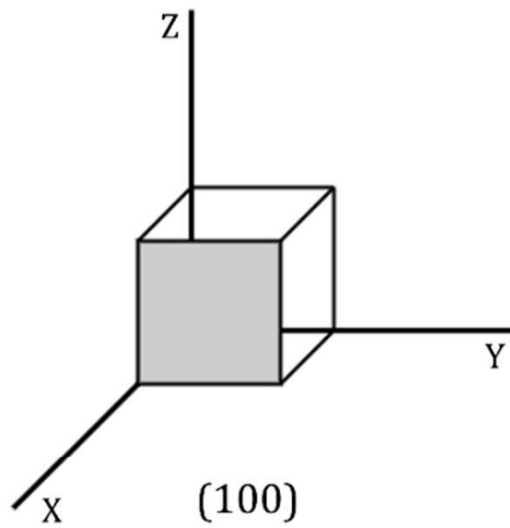


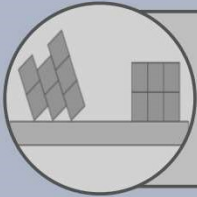
Film Growth



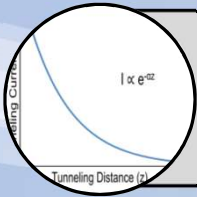


Grain Orientation

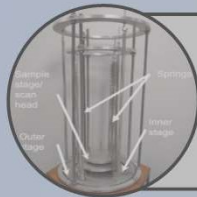




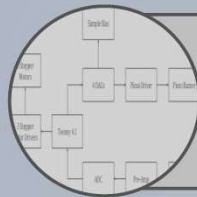
Thin Film Growth and Structure



Potential Energy Barrier



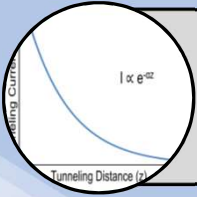
STM Structure



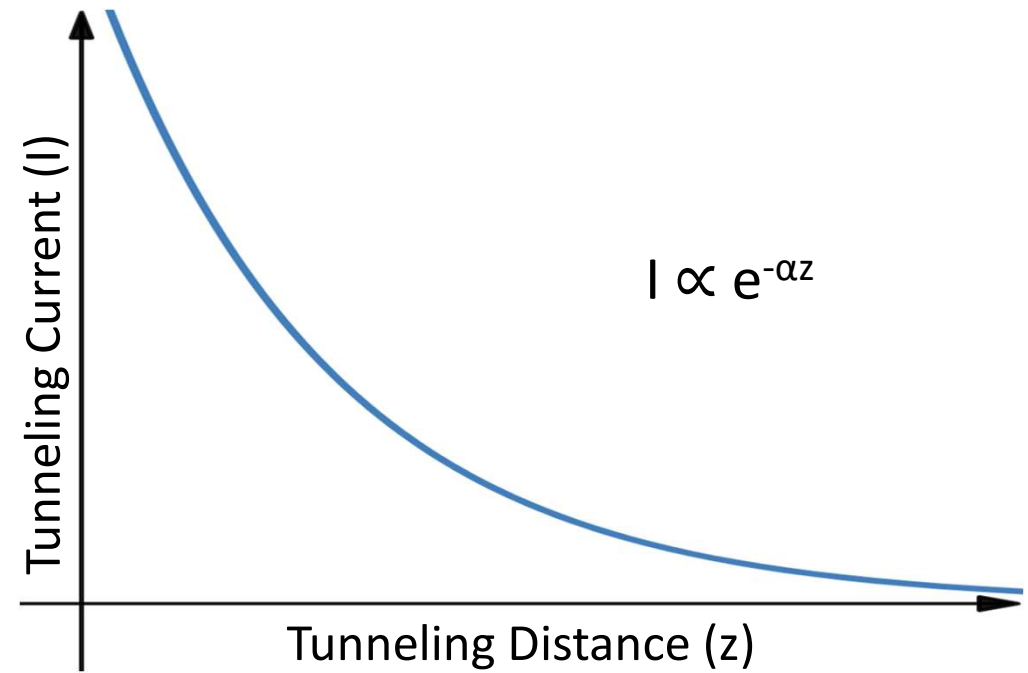
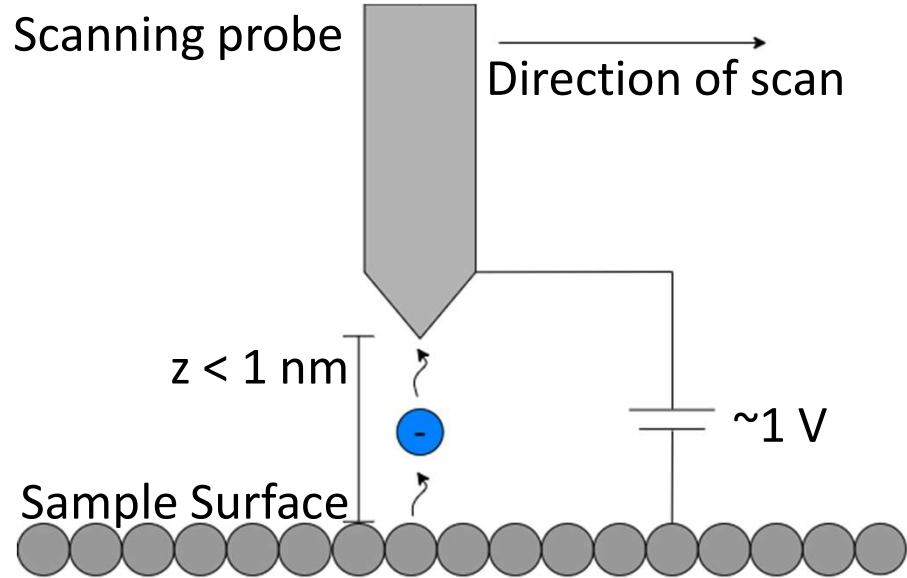
STM Circuit

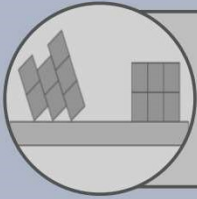


Current Status

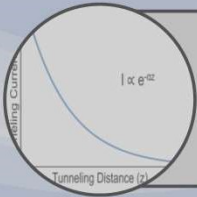


Quantum Tunneling Current

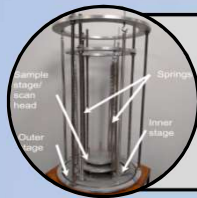




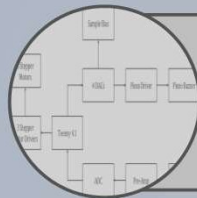
Thin Film Growth and Structure



Potential Energy Barrier



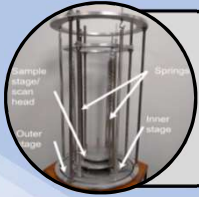
STM Structure



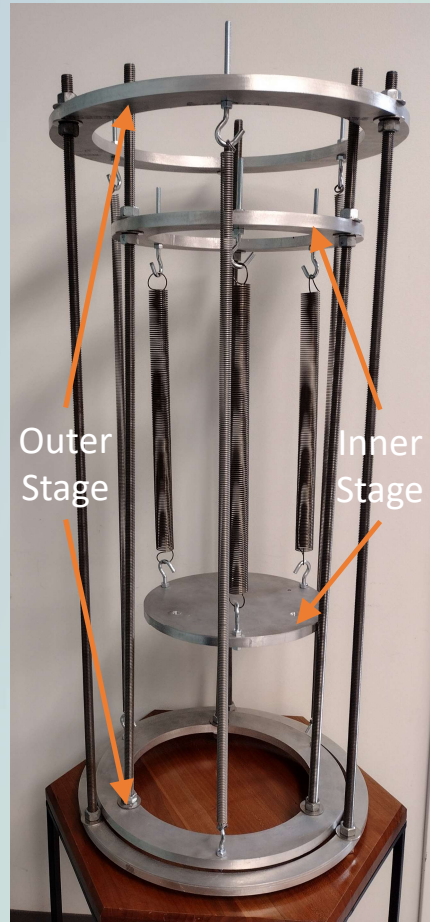
STM Circuit

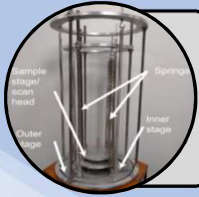


Current Status

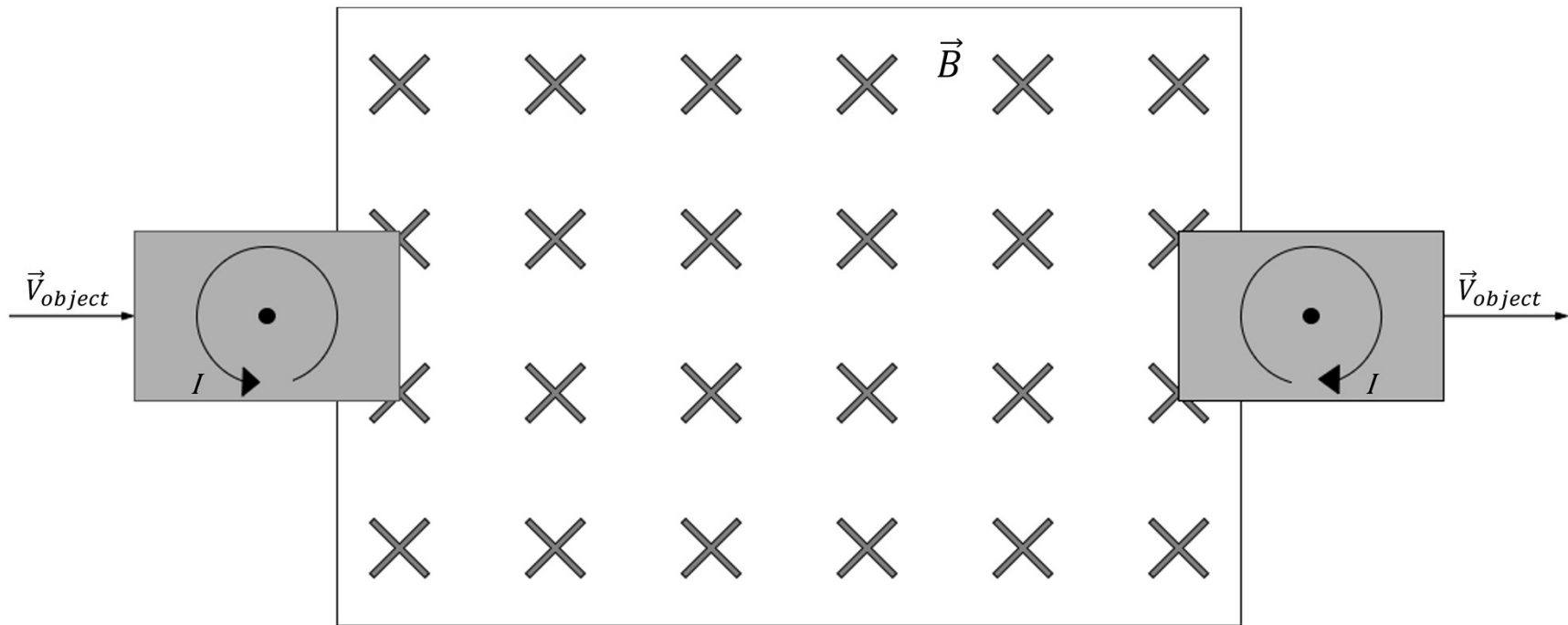


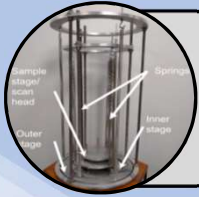
Vibration Isolation





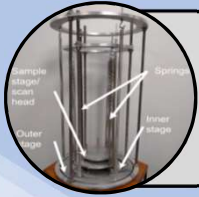
Eddy Current Damping



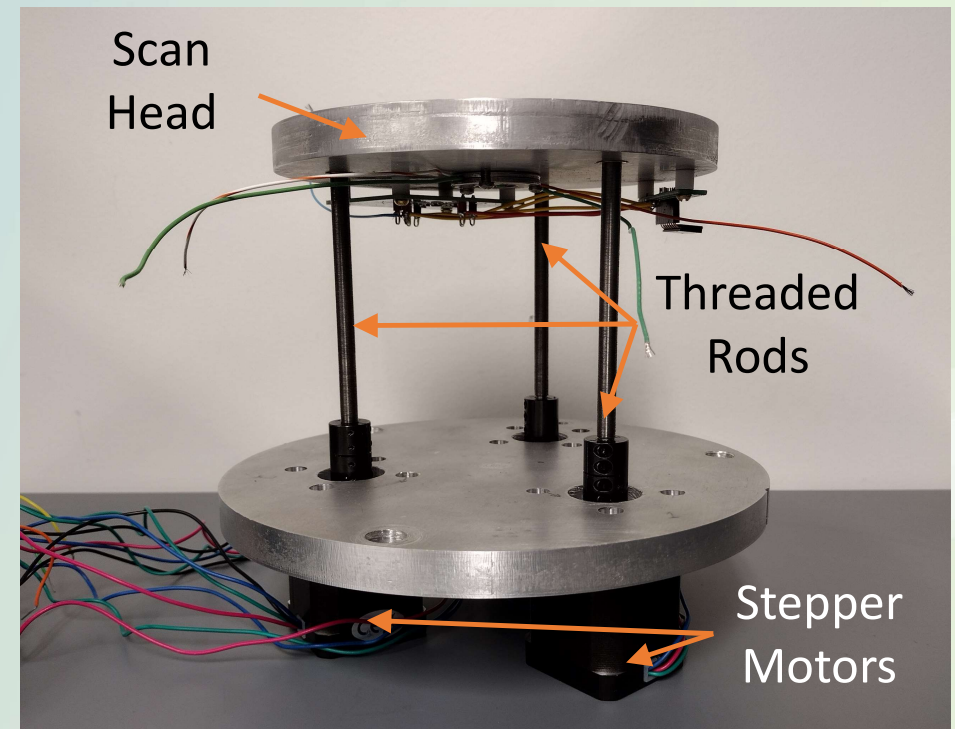
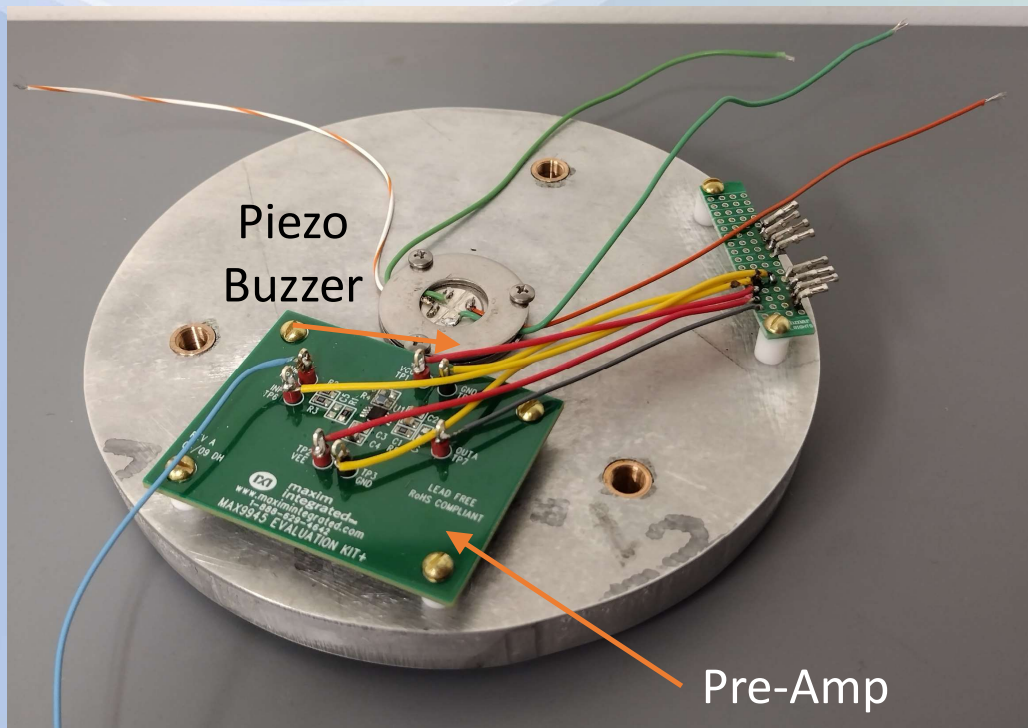


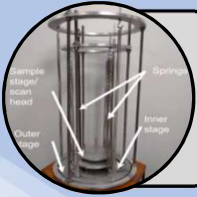
Scan Head/Sample Stage



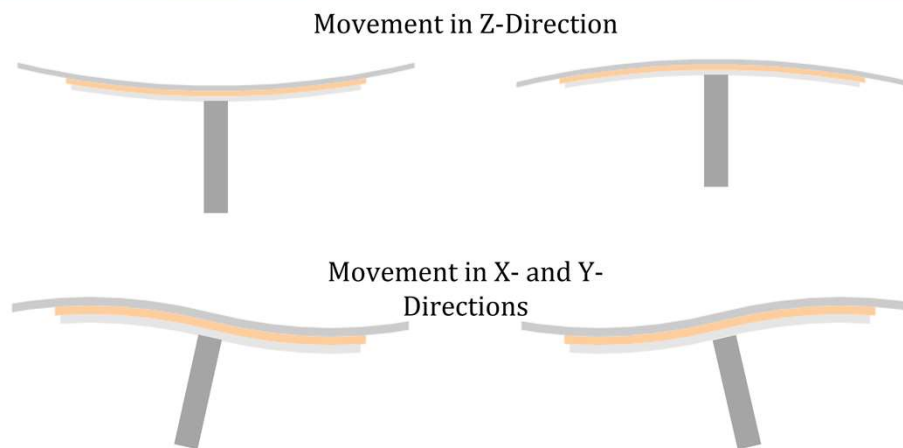
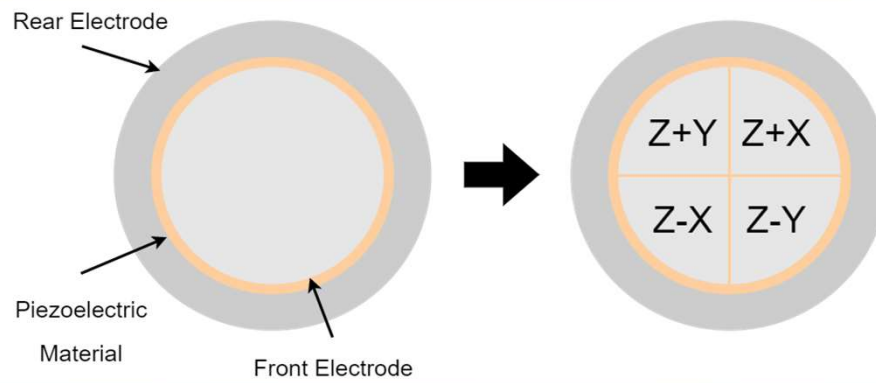


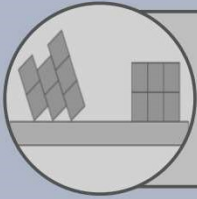
Scan Head/Sample Stage



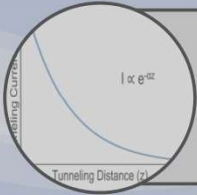


Piezoelectric Control

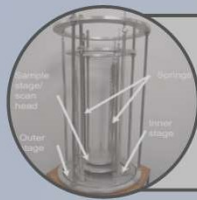




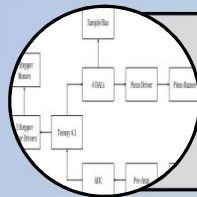
Thin Film Growth and Structure



Potential Energy Barrier



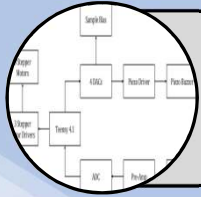
STM Structure



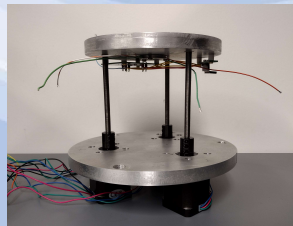
STM Circuit



Current Status



STM Circuit



3 Stepper Motors

3 Stepper Motor Drivers

Teensy 4.1

Sample Bias

4 DACs

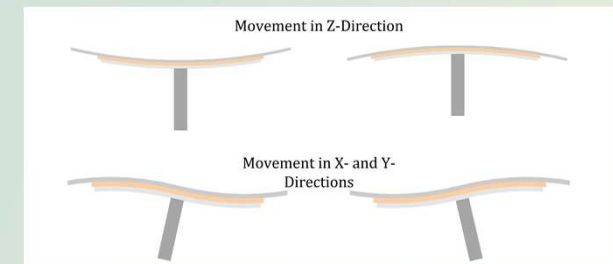
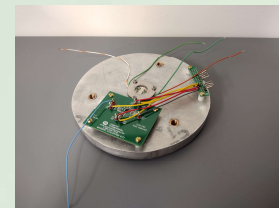
Piezo Driver

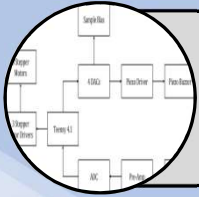
Piezo Buzzer

ADC

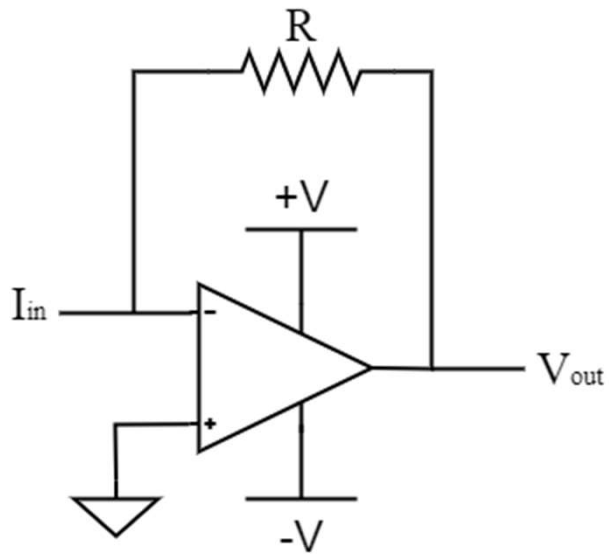
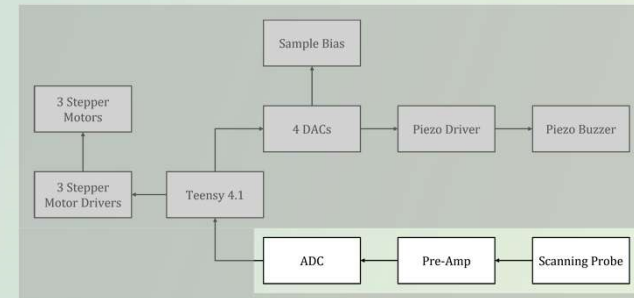
Pre-Amp

Scanning Probe

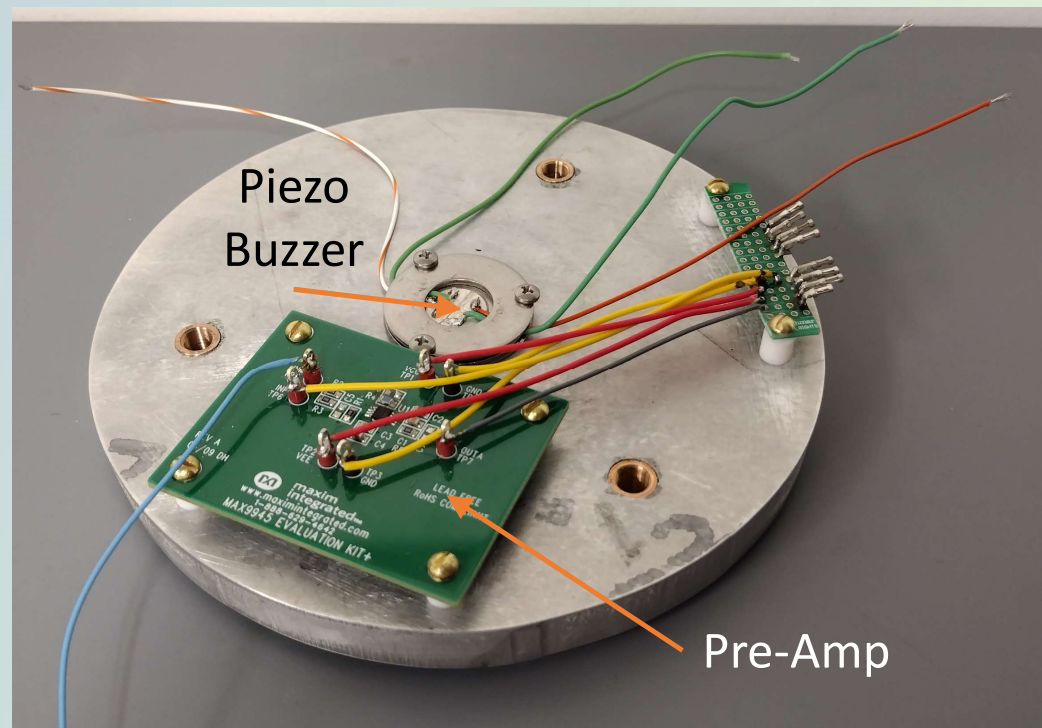


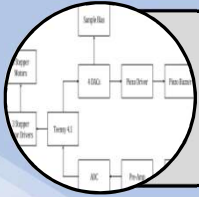


Reading Tunneling Current

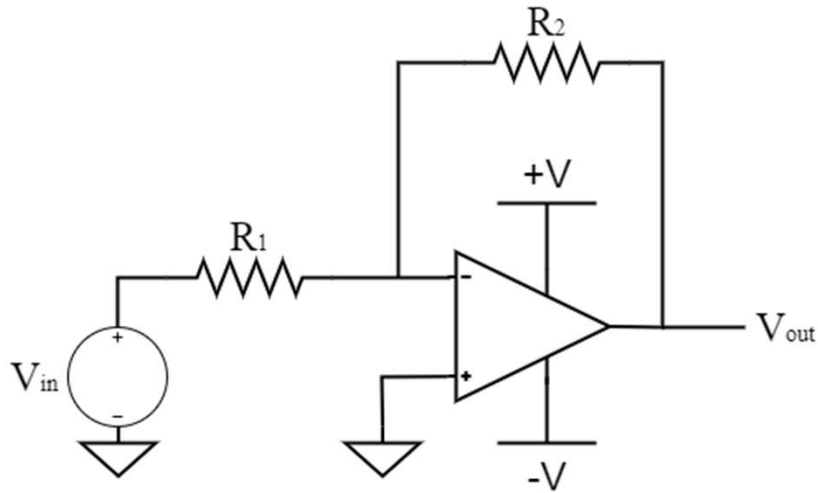
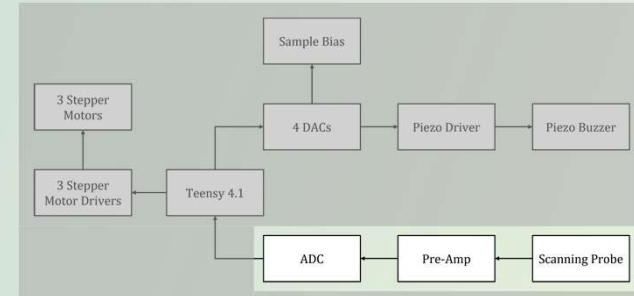


$$V_{out} = -I_{in}R$$

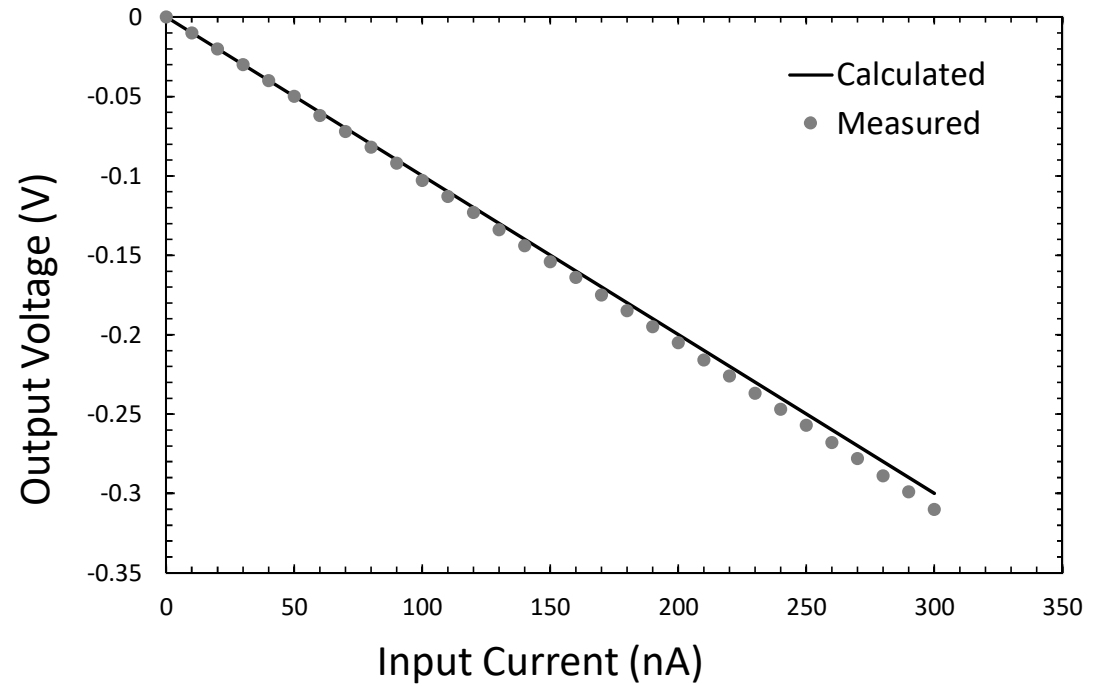


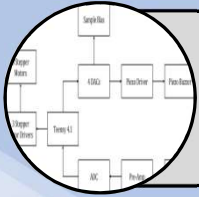


Tunneling Current to Voltage

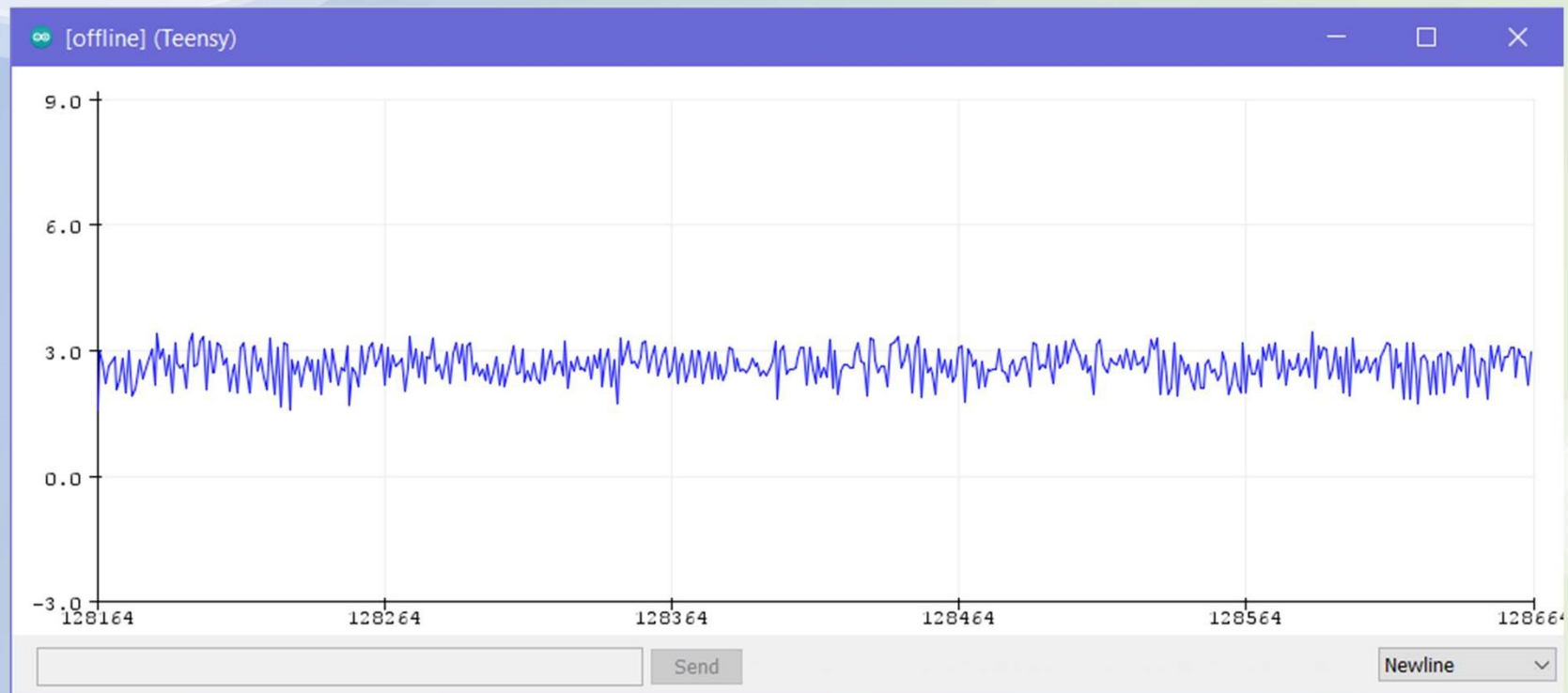
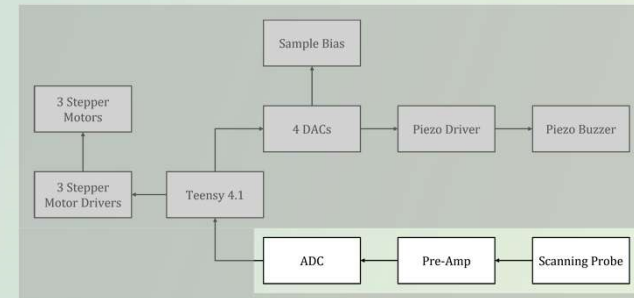


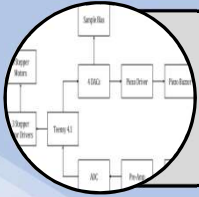
$$V_{out} = -\frac{R_2}{R_1} V_{in}$$



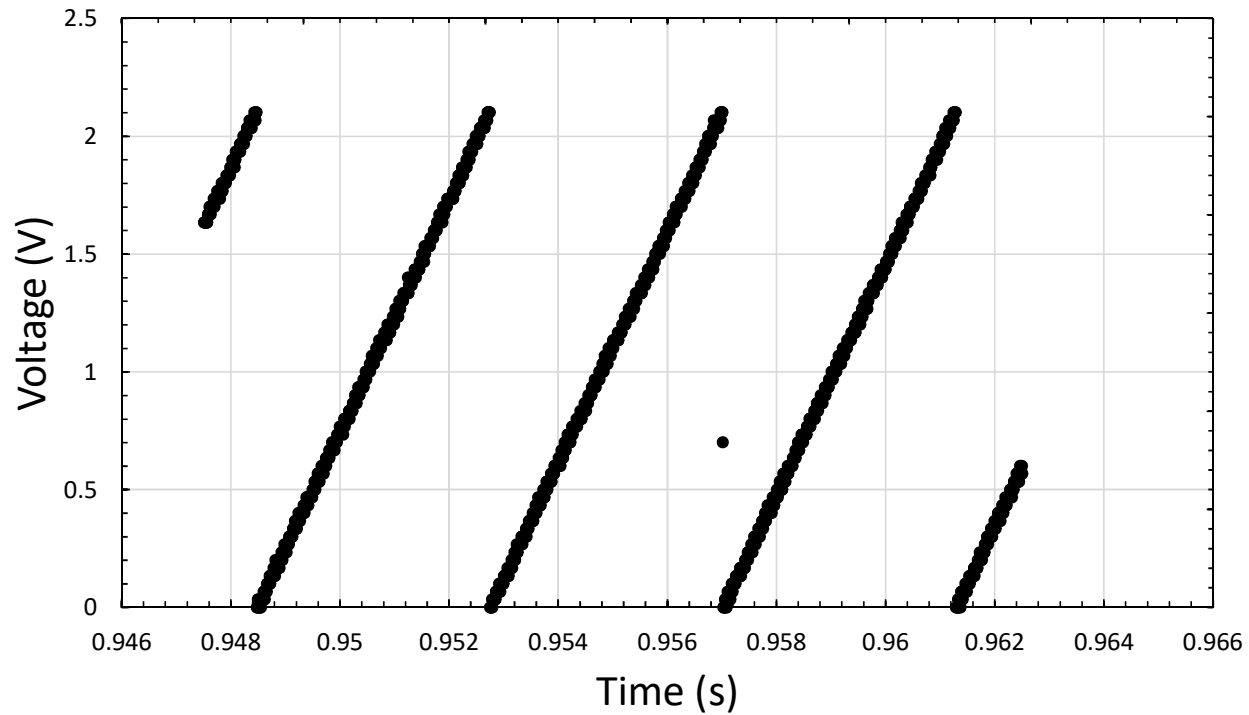
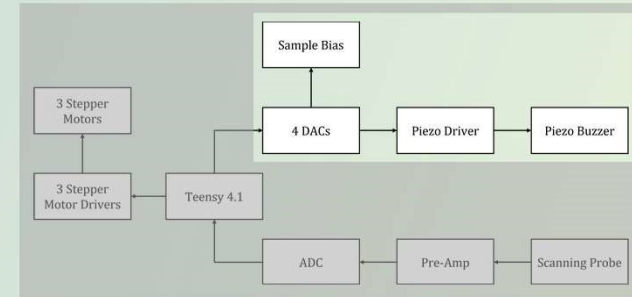


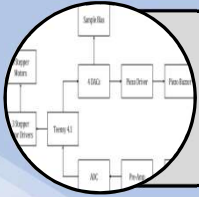
Analog-to-Digital Voltage



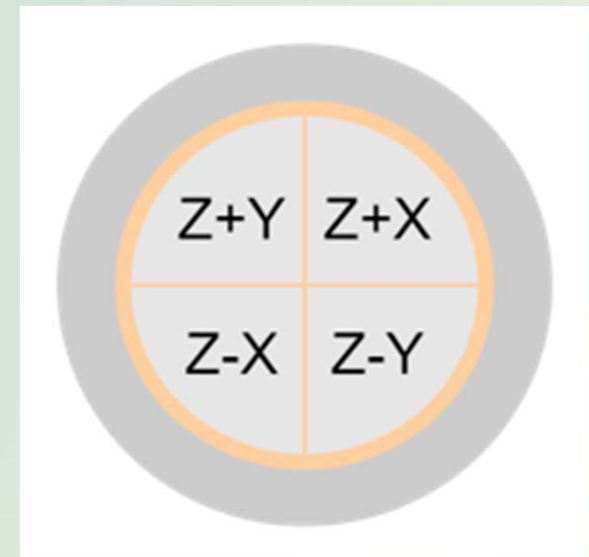
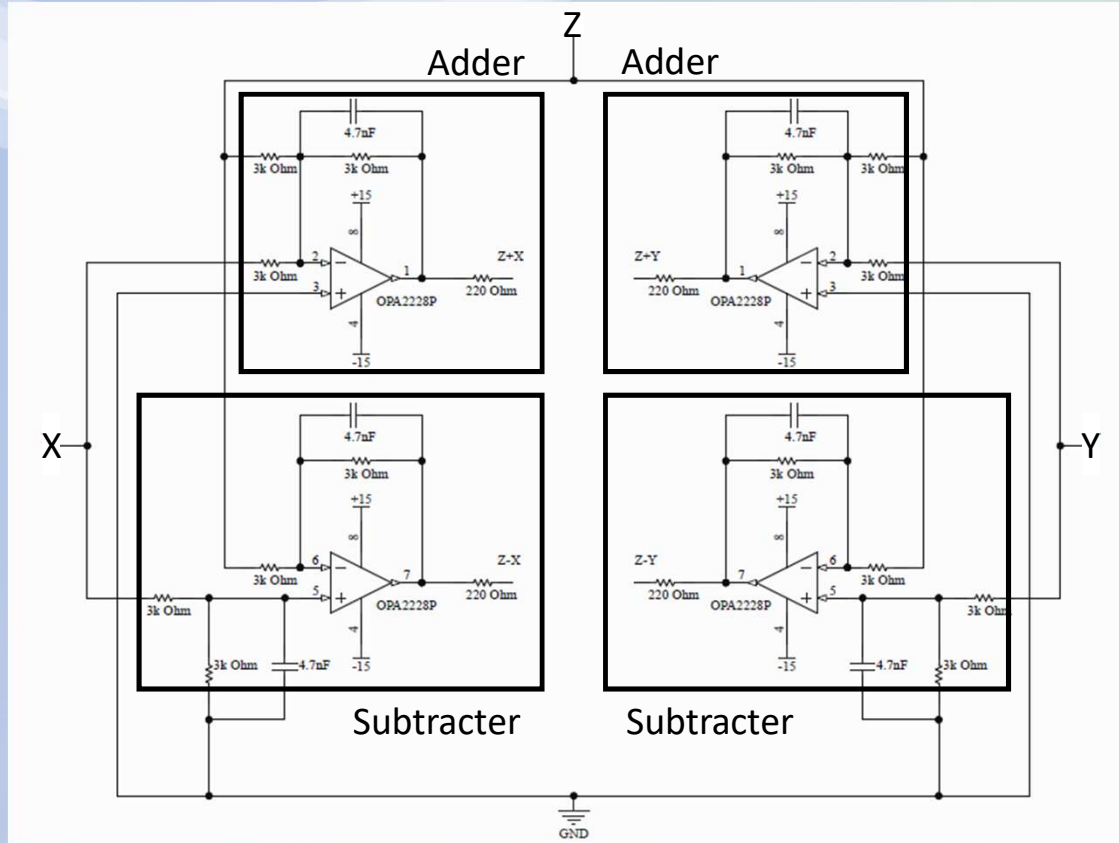
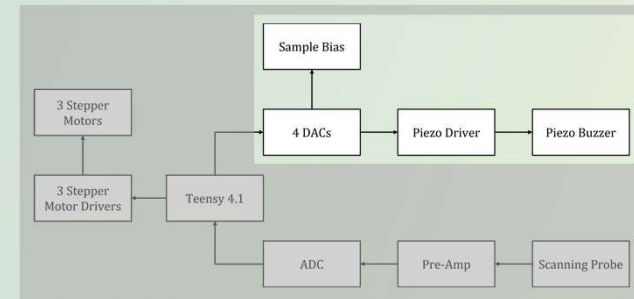


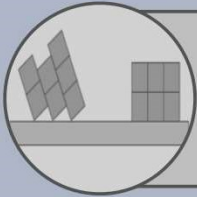
Digital-to-Analog Voltage



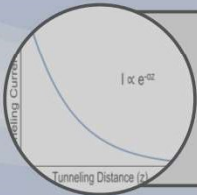


Piezo Driver

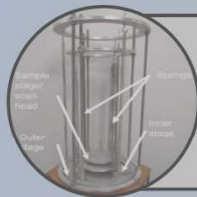




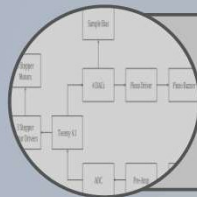
Thin Film Growth and Structure



Potential Energy Barrier



STM Structure



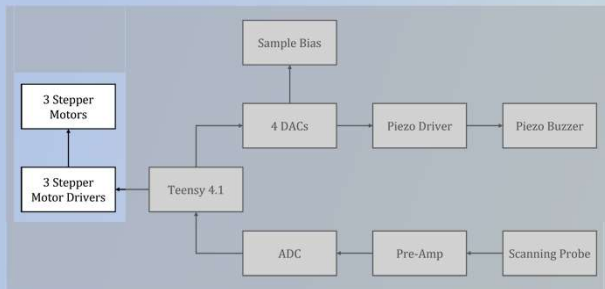
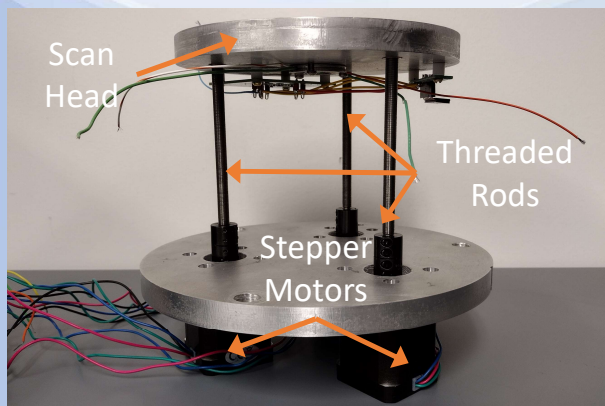
STM Circuit



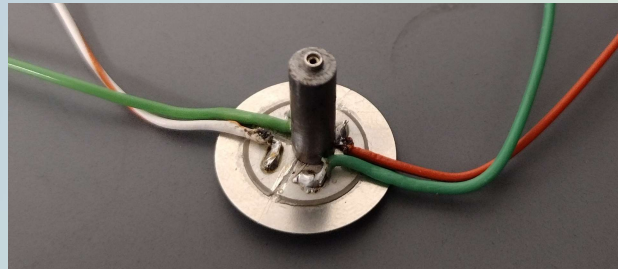
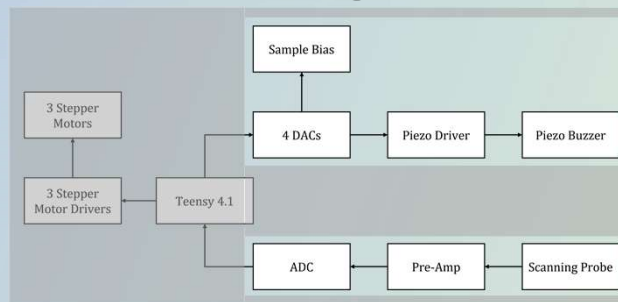
Current Status

Progress/Future Plans

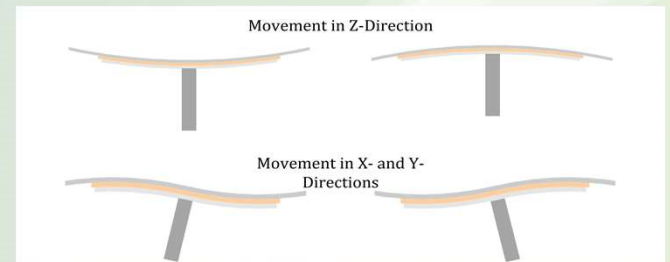
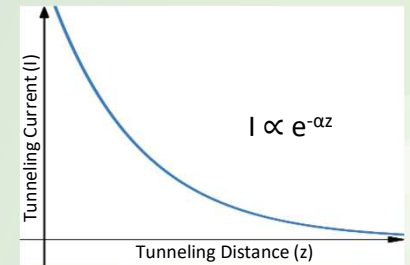
Completed

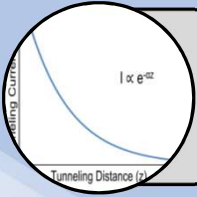


In Progress

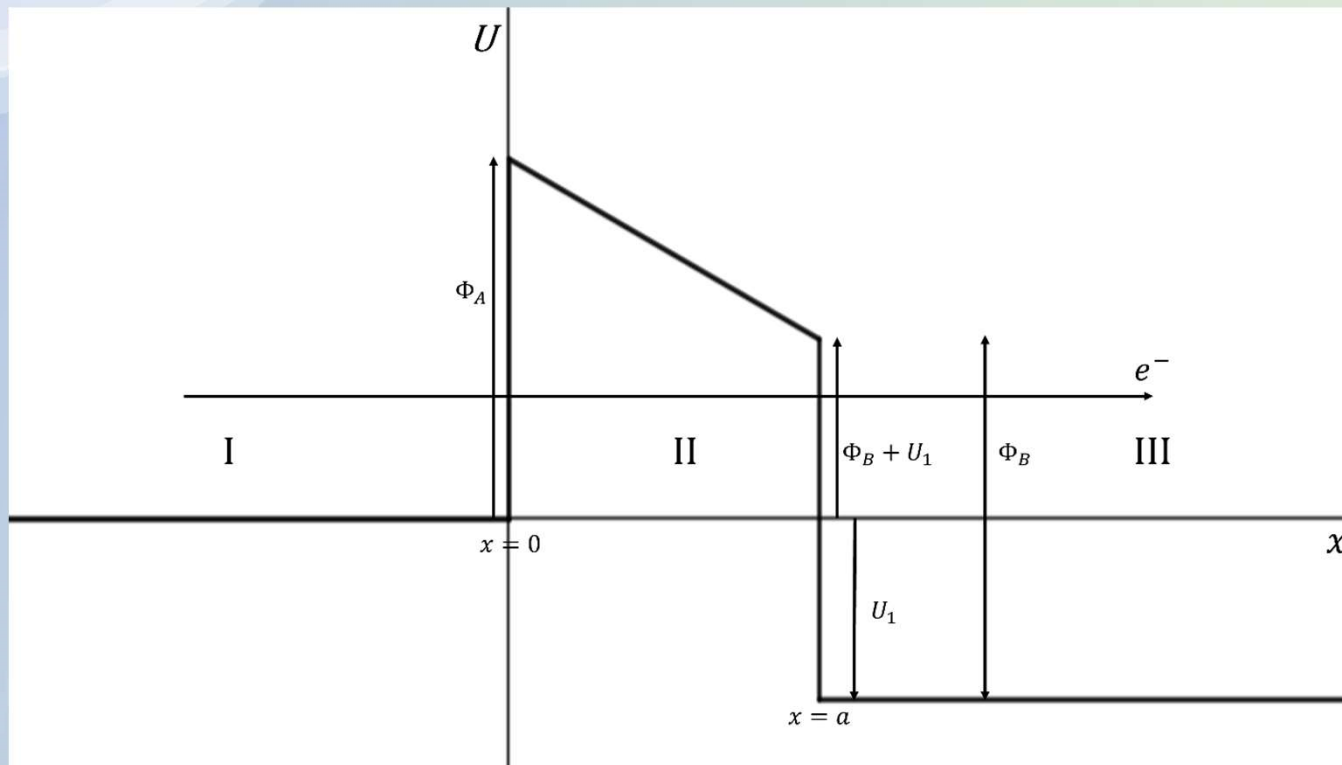


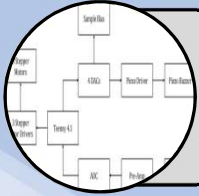
Moving Forward



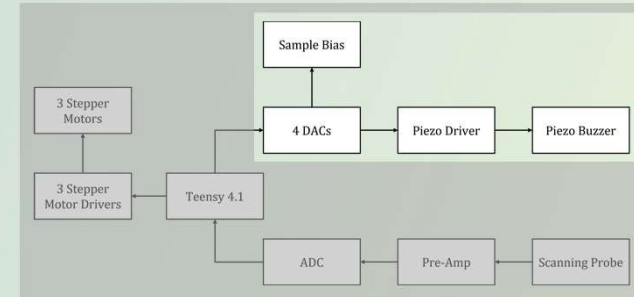


Potential Energy Barrier

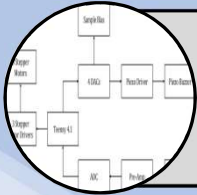




Piezo Buzzer Control



| X | Y | Z | Z+X | Z-X | Z+Y | Z-Y |
|----|----|----|-----|-----|-----|-----|
| 0V | 0V | 1V | -1V | -1V | -1V | -1V |
| 1V | 1V | 1V | -2V | 0V | -2V | 0V |
| 1V | 1V | 2V | -3V | -1V | -3V | -1V |
| 2V | 2V | 1V | -3V | 1V | -3V | 1V |



Stepper Motor Control

