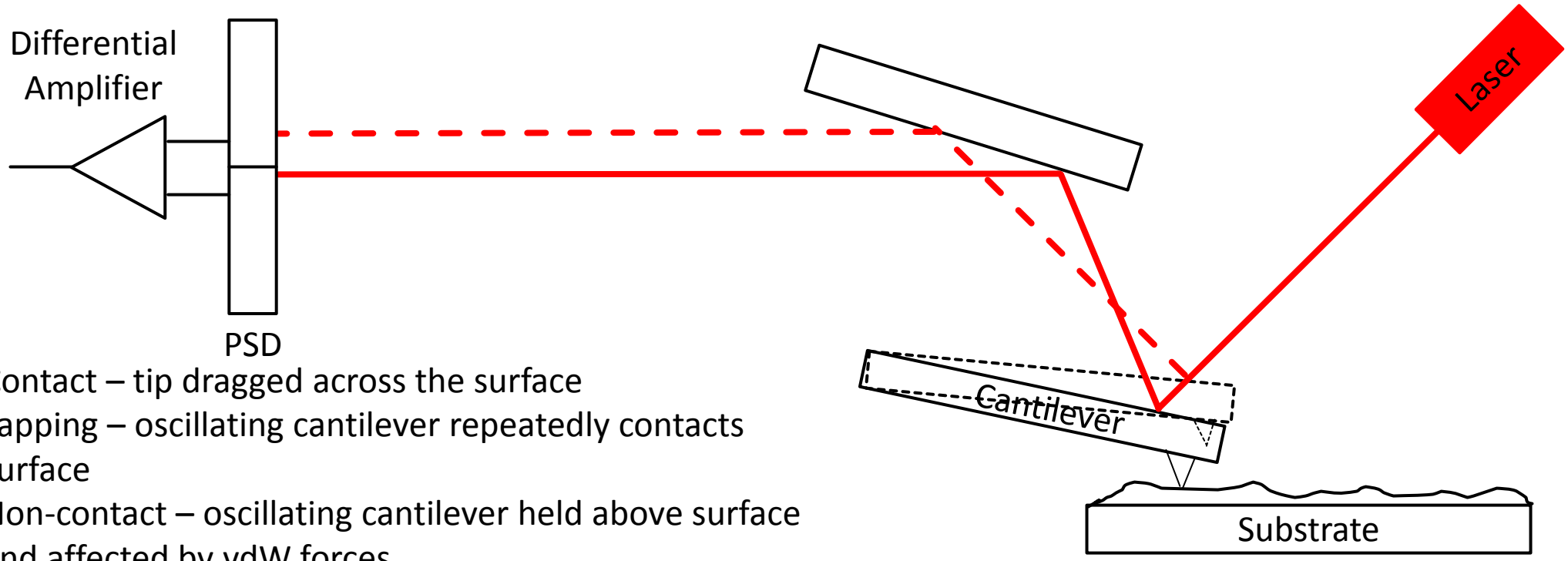
Atomic Force Microscopy

Jacob Grant

Shaw Group Meeting: How-To Talk

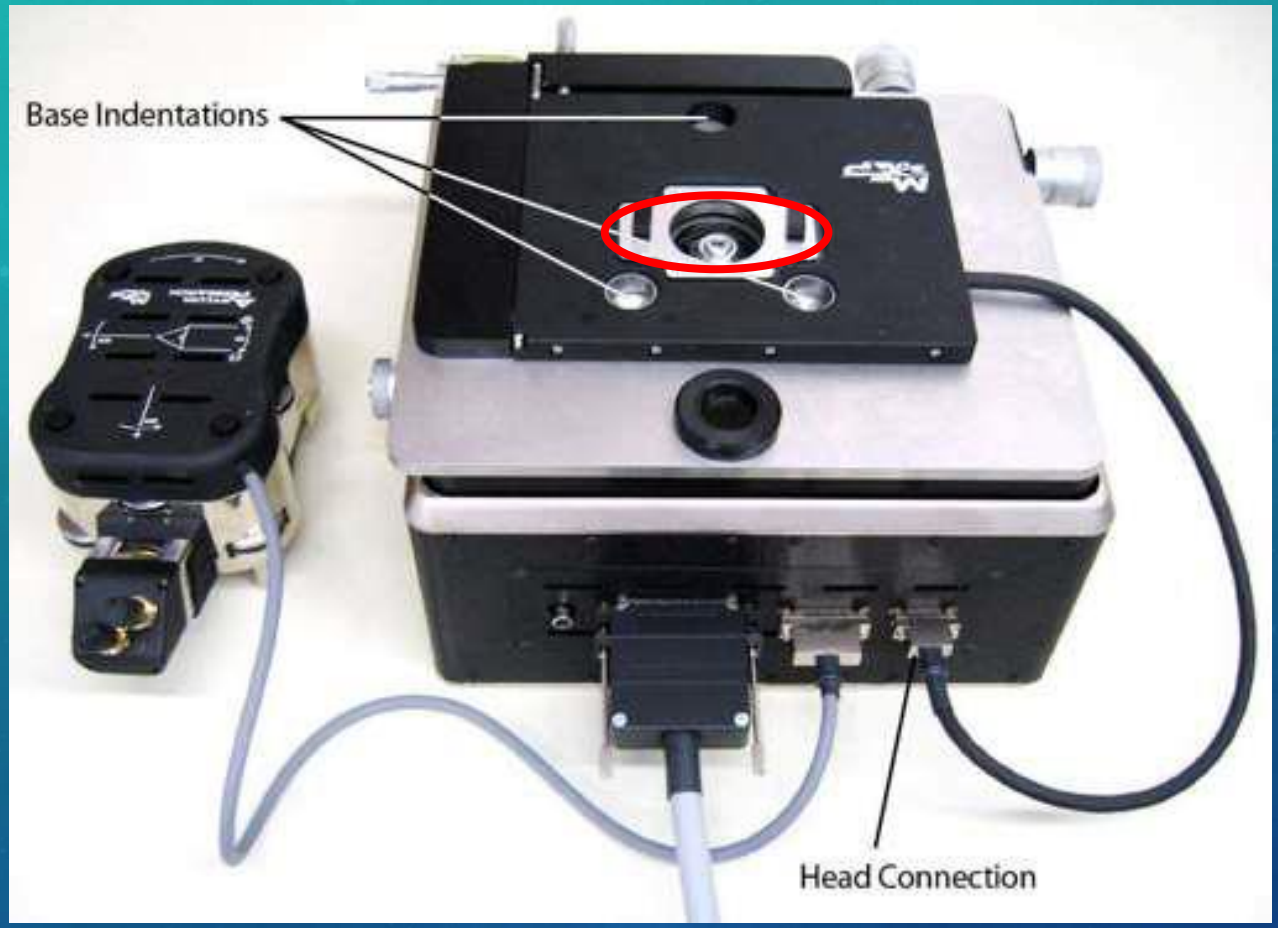
140901

THEORY



Contact – tip dragged across the surface
Tapping – oscillating cantilever repeatedly contacts surface
Non-contact – oscillating cantilever held above surface and affected by vdW forces

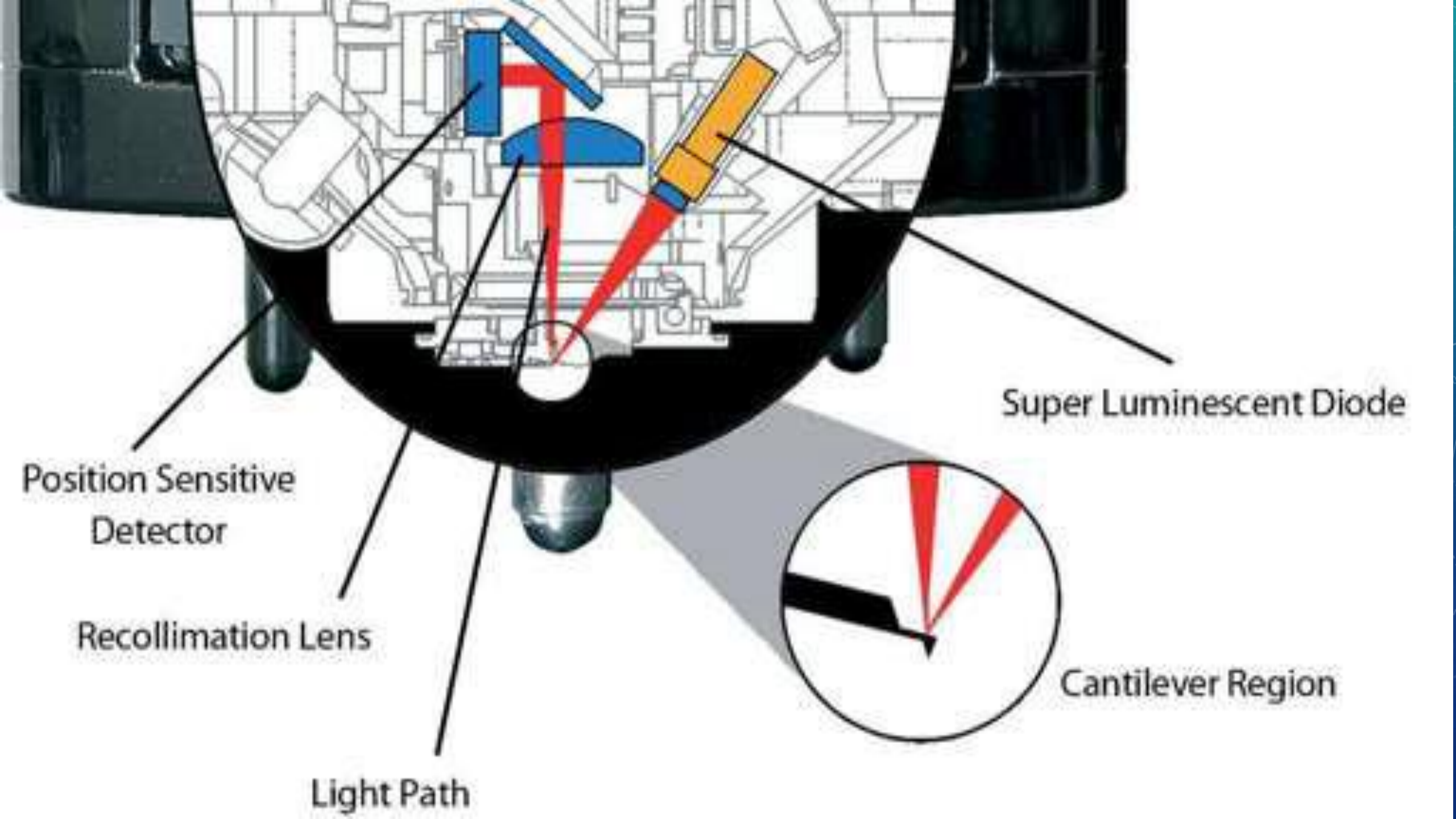
MOUNTING SURFACE ON BASE



- Attach surface to glass or aluminum slide with double stick tape
- Two magnets secure slide to base
- Center the area where imaging is desired

ATTACHING AFM TIP TO HEAD

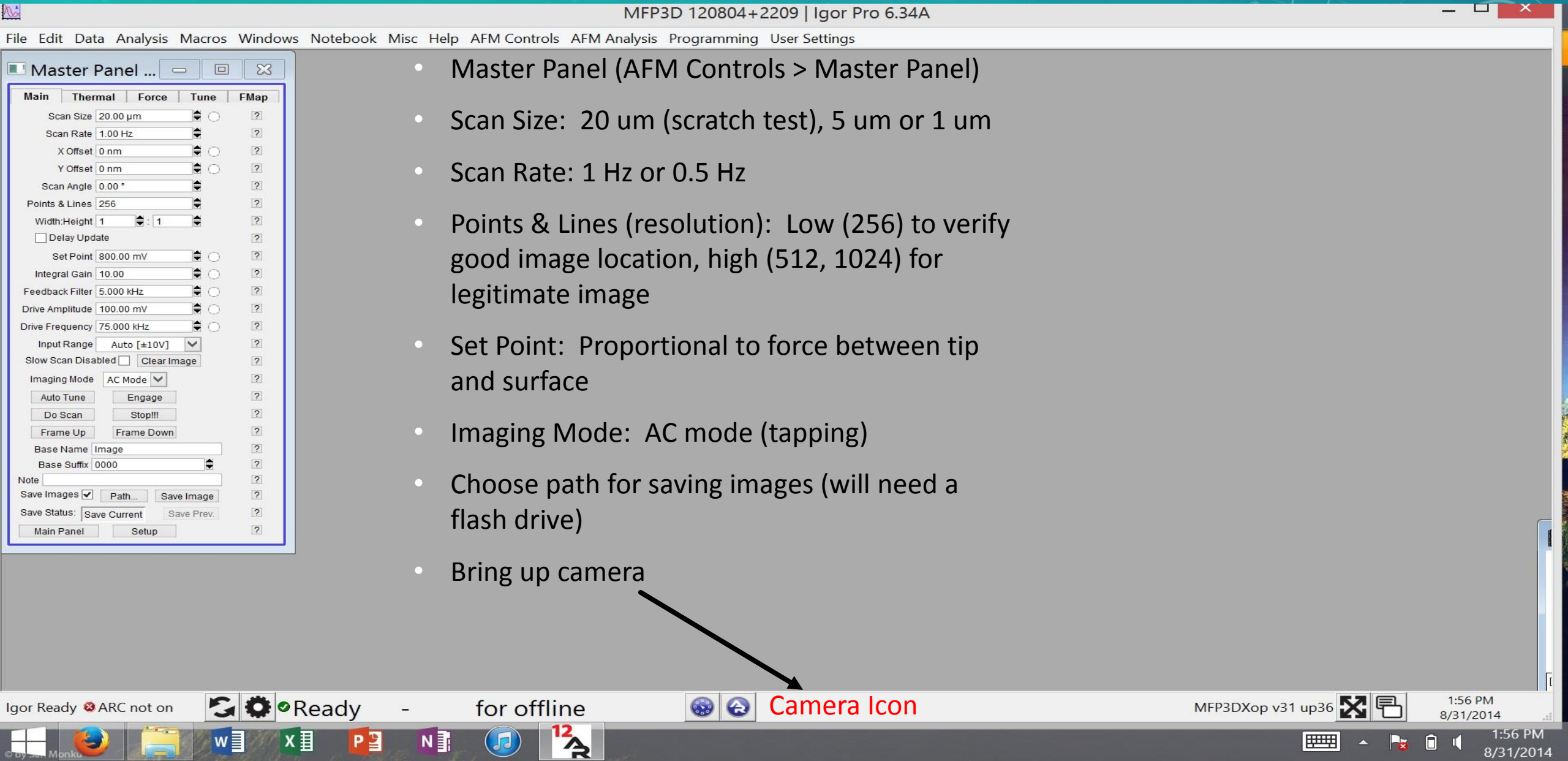
- Secure AFM tip into holder (tip must be straight and immobile)
- Holder locks onto the bottom of the AFM head


Super Luminescent Diode
Position Sensitive Detector
Recollimation Lens
Light Path
Cantilever Region

ATTACHING HEAD TO BASE

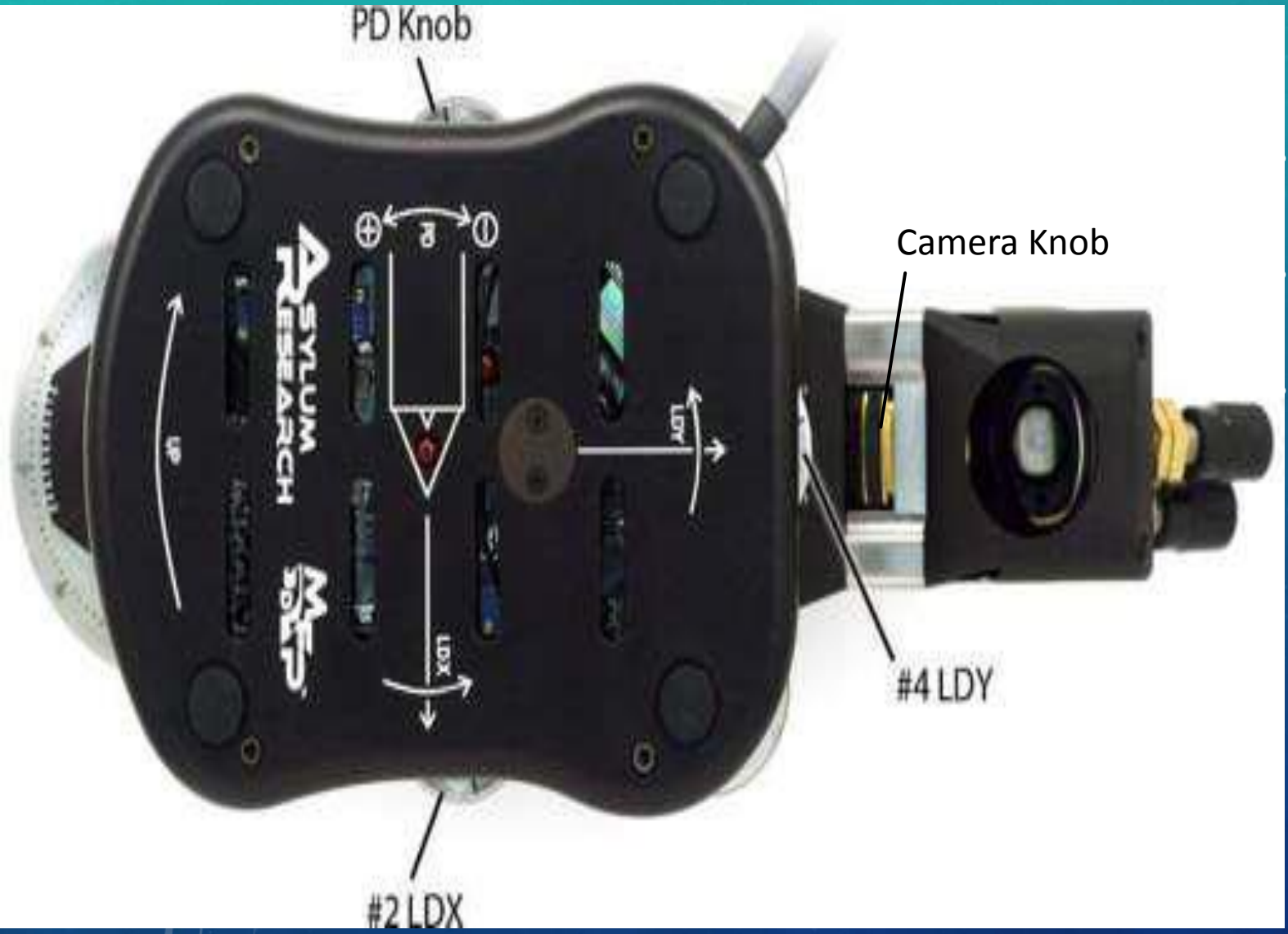
- #1: Front vertical adjustment
- #3, #5: Rear vertical adjustments
- Notes
  - Raise all adjustments before placing head on base to avoid crashing the AFM tip
  - Place head on base rear legs first

OPENING ASYLUM RESEARCH SOFTWARE



- Master Panel (AFM Controls > Master Panel)
- Scan Size: 20 um (scratch test), 5 um or 1 um
- Scan Rate: 1 Hz or 0.5 Hz
- Points & Lines (resolution): Low (256) to verify good image location, high (512, 1024) for legitimate image
- Set Point: Proportional to force between tip and surface
- Imaging Mode: AC mode (tapping)
- Choose path for saving images (will need a flash drive)
- Bring up camera

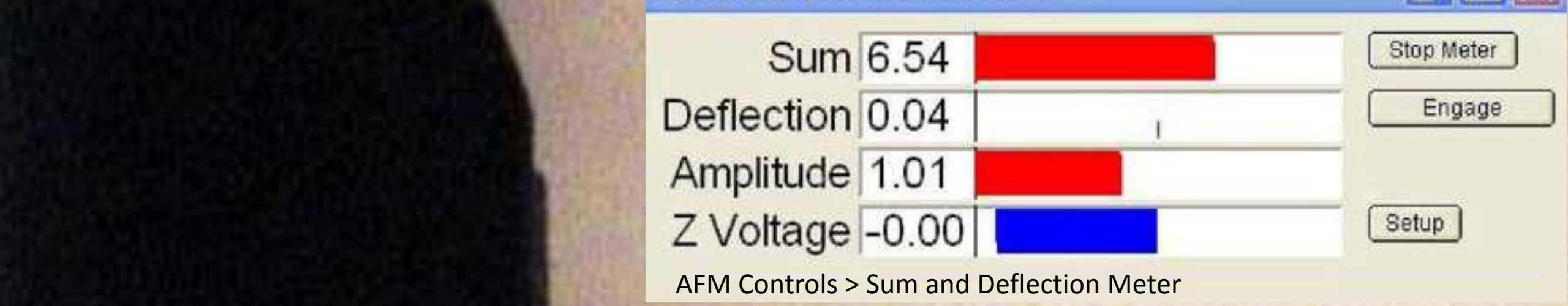
ALIGNING THE LASER



#2 LDX and #4 LDY: adjusts laser in the x- and y-directions

PD Knob: tilts the mirror that directs reflected light off the cantilever into the photodiode

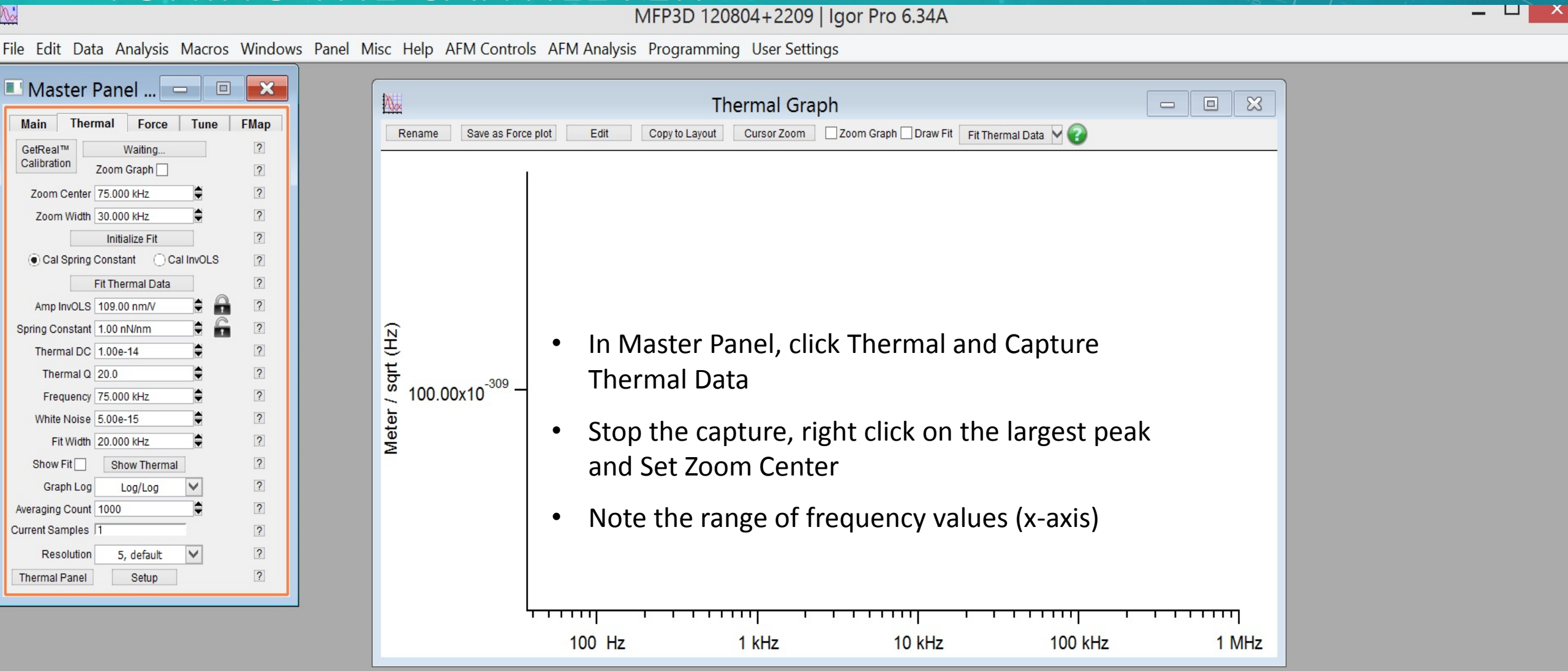
Camera Knob: adjusts the camera to bring the tip into focus



AFM Controls > Sum and Deflection Meter

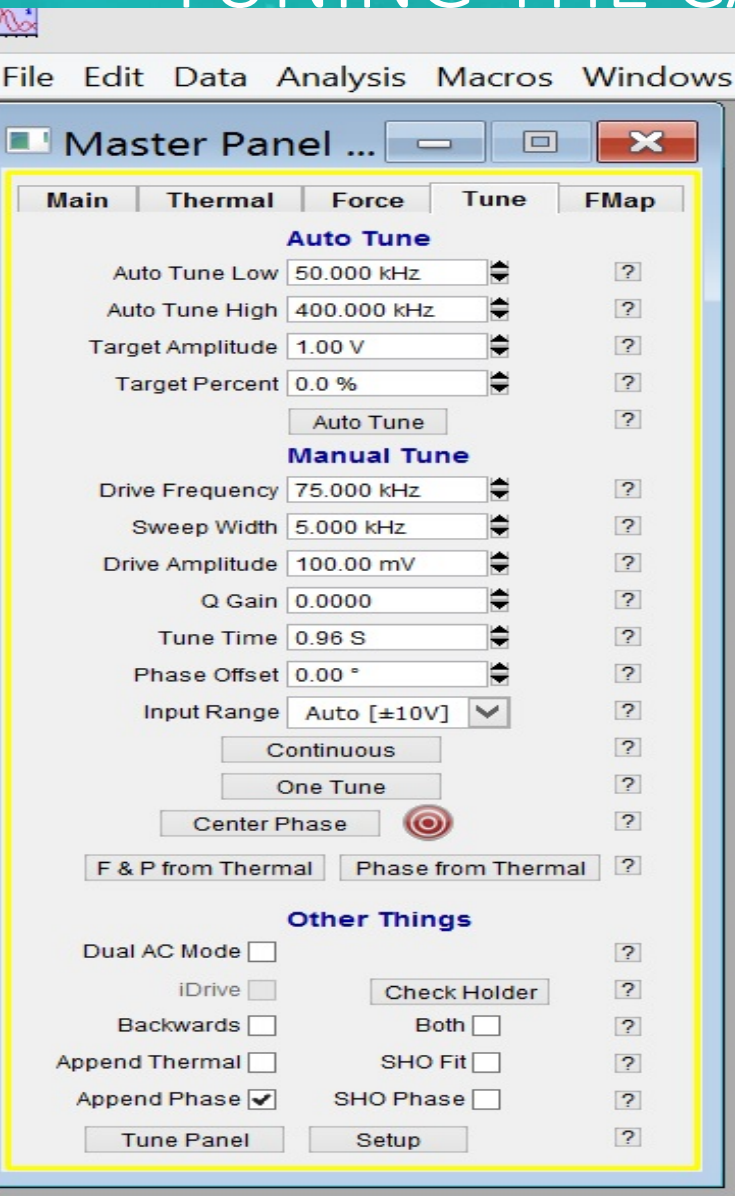
- Align the laser spot (LDX and LDY knobs) on the cantilever so as to give the maximum possible Sum value (want 7-10)
  - Sum is the amount of light collected by the photodetector in volts
  - If cannot attain 6-7, may need to reposition AFM tip
- Adjust the deflection to 0 with the PD knob

TUNING THE CANTILEVER



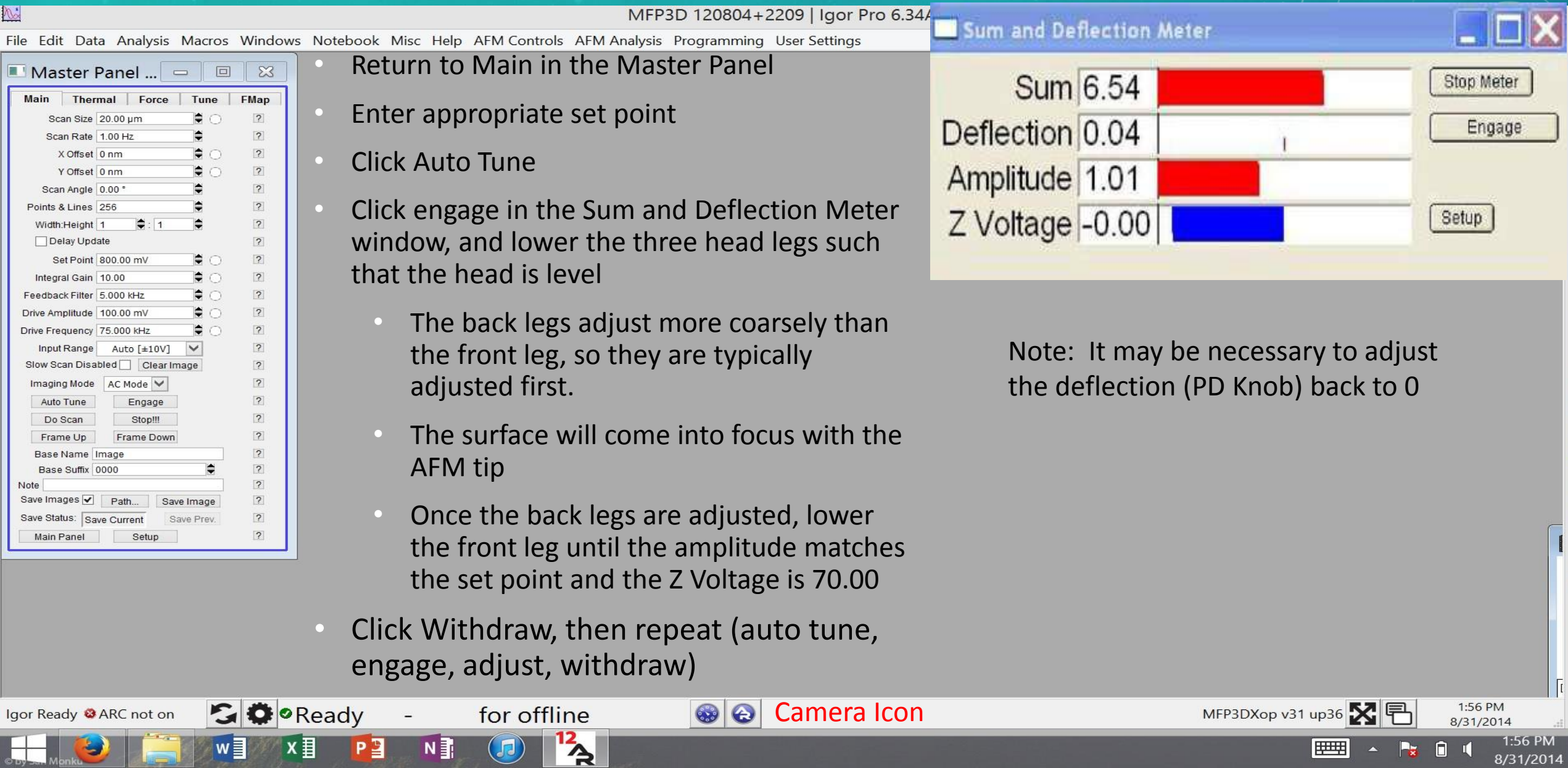
- In Master Panel, click Thermal and Capture Thermal Data
- Stop the capture, right click on the largest peak and Set Zoom Center
- Note the range of frequency values (x-axis)

TUNING THE CANTILEVER



- Click Tune in the Master Panel
- Enter the range of frequency values in the low and high auto tune fields
- Target Amplitude: 1.00 or 1.50 V
- Target Percent: -5.0% (giving a set point of 800 mV or 1.15 V)

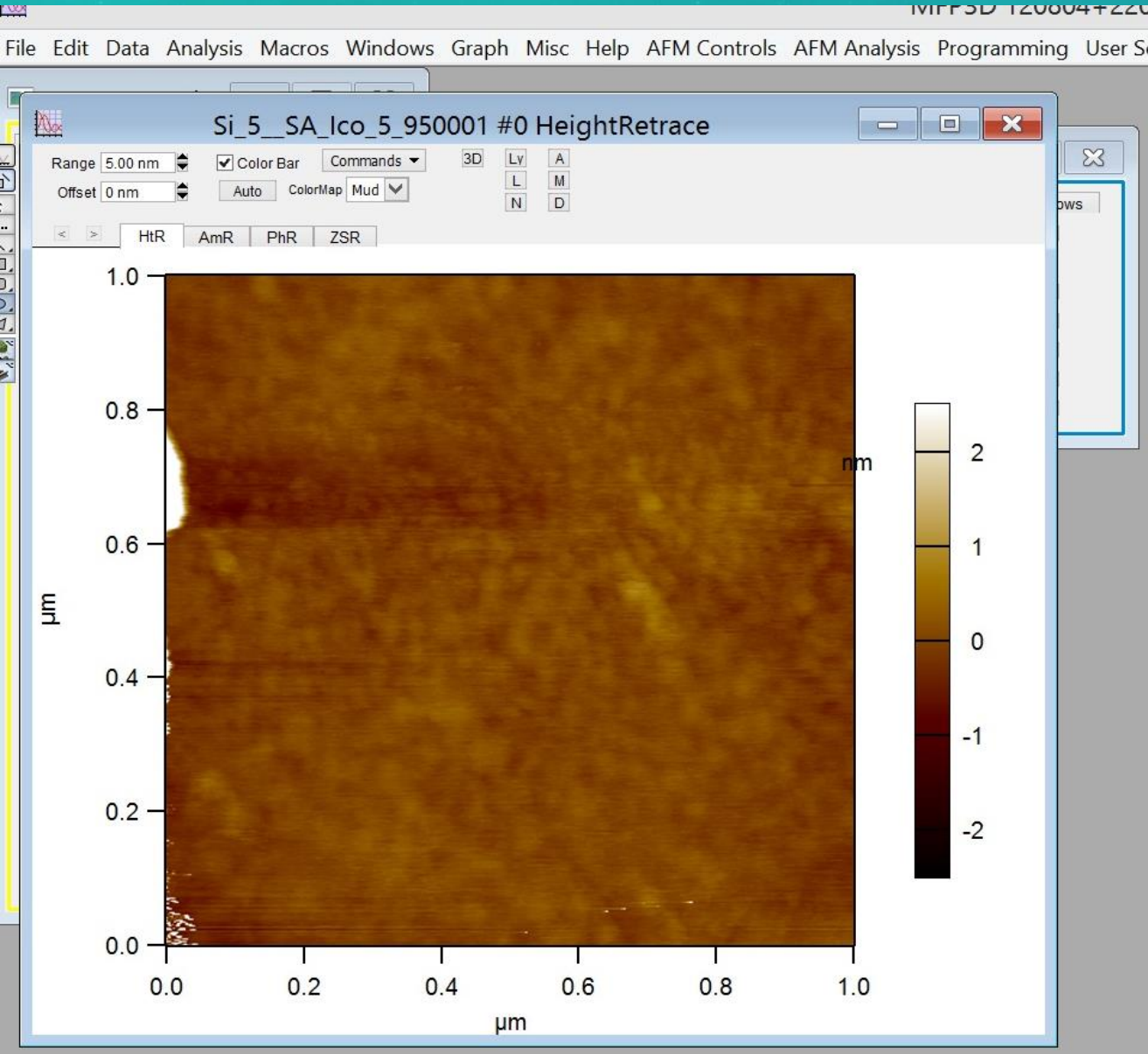
APPROACHING THE SURFACE



- Return to Main in the Master Panel
- Enter appropriate set point
- Click Auto Tune
- Click engage in the Sum and Deflection Meter window, and lower the three head legs such that the head is level
  - The back legs adjust more coarsely than the front leg, so they are typically adjusted first.
  - The surface will come into focus with the AFM tip
  - Once the back legs are adjusted, lower the front leg until the amplitude matches the set point and the Z Voltage is 70.00
- Click Withdraw, then repeat (auto tune, engage, adjust, withdraw)

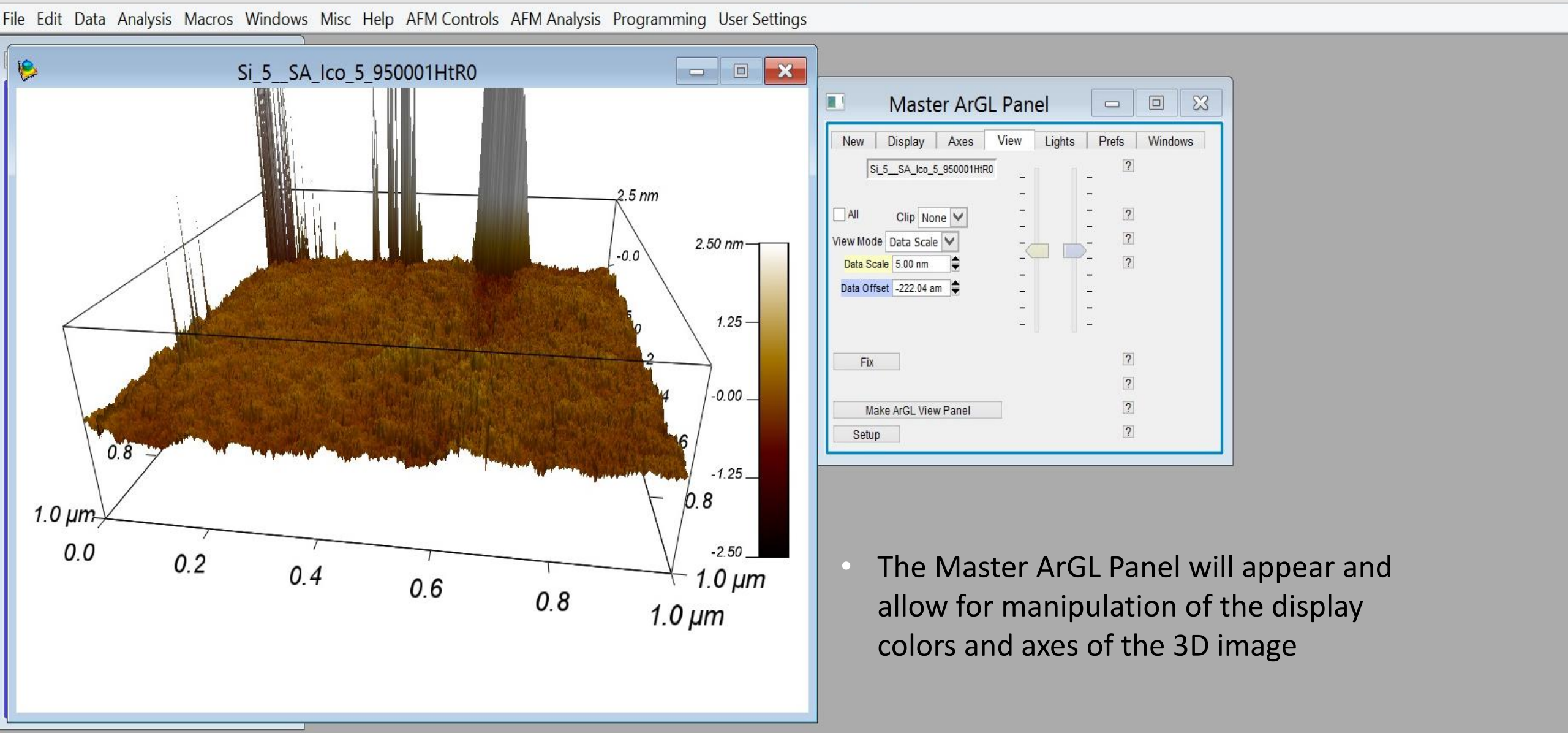
Note: It may be necessary to adjust the deflection (PD Knob) back to 0

IMAGING THE SURFACE



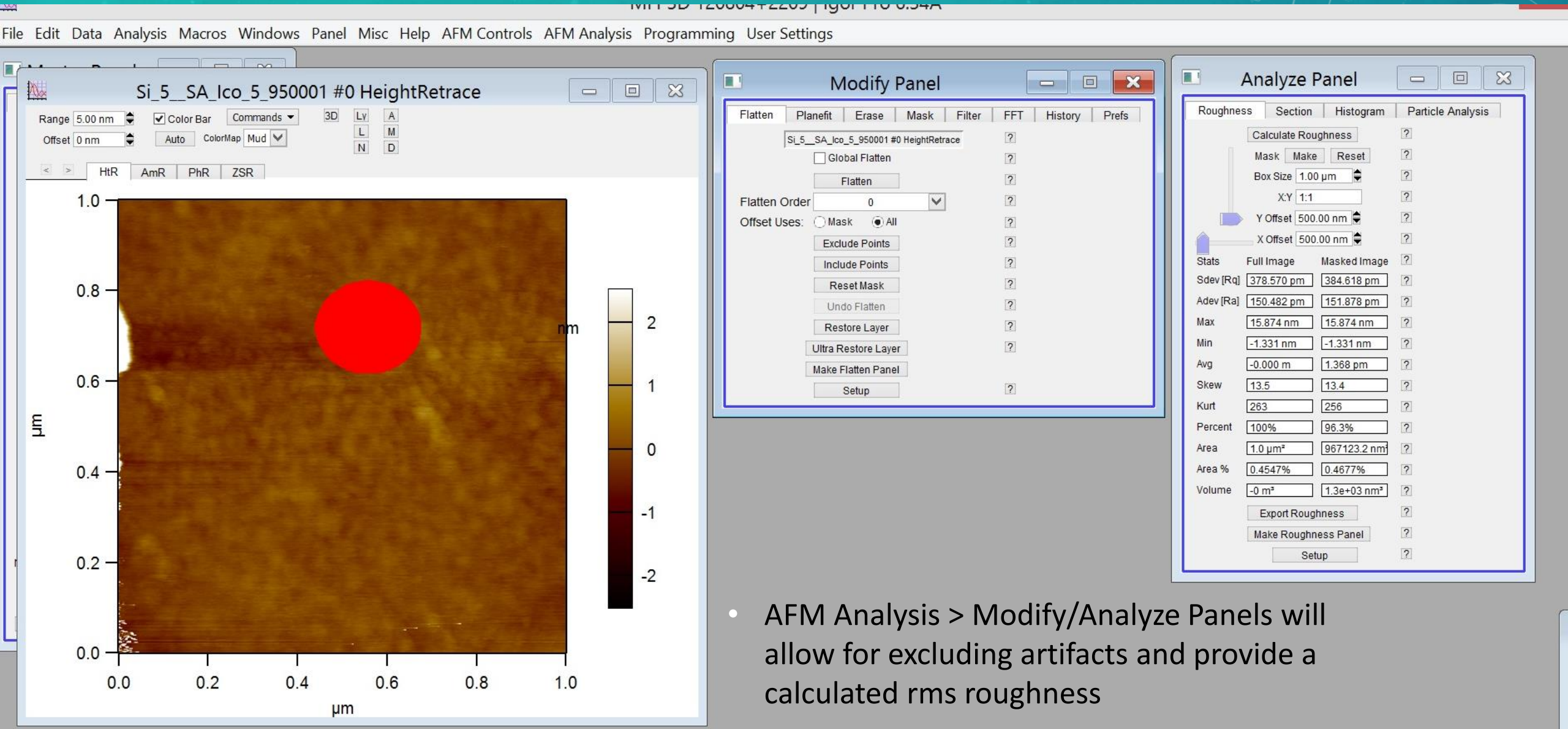
- Click Do Scan, then Last Scan and a 2D image will appear as it is generated
- Once the scan is complete, the 2D image can be opened as shown here
- Clicking 3D will open a prompt for a 3D image

3D IMAGE



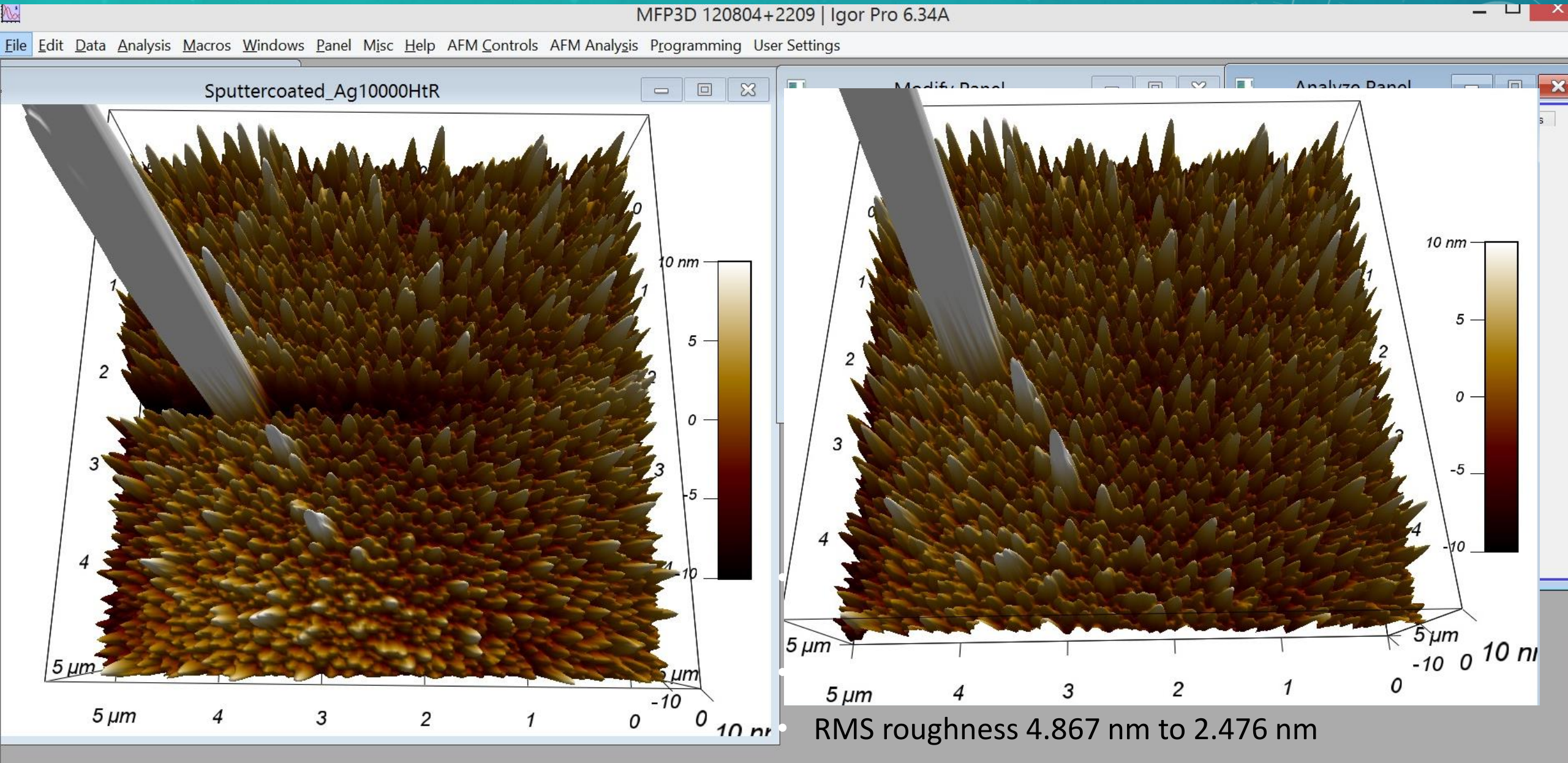
- The Master ArGL Panel will appear and allow for manipulation of the display colors and axes of the 3D image

IMAGE ANALYSIS



- AFM Analysis > Modify/Analyze Panels will allow for excluding artifacts and provide a calculated rms roughness

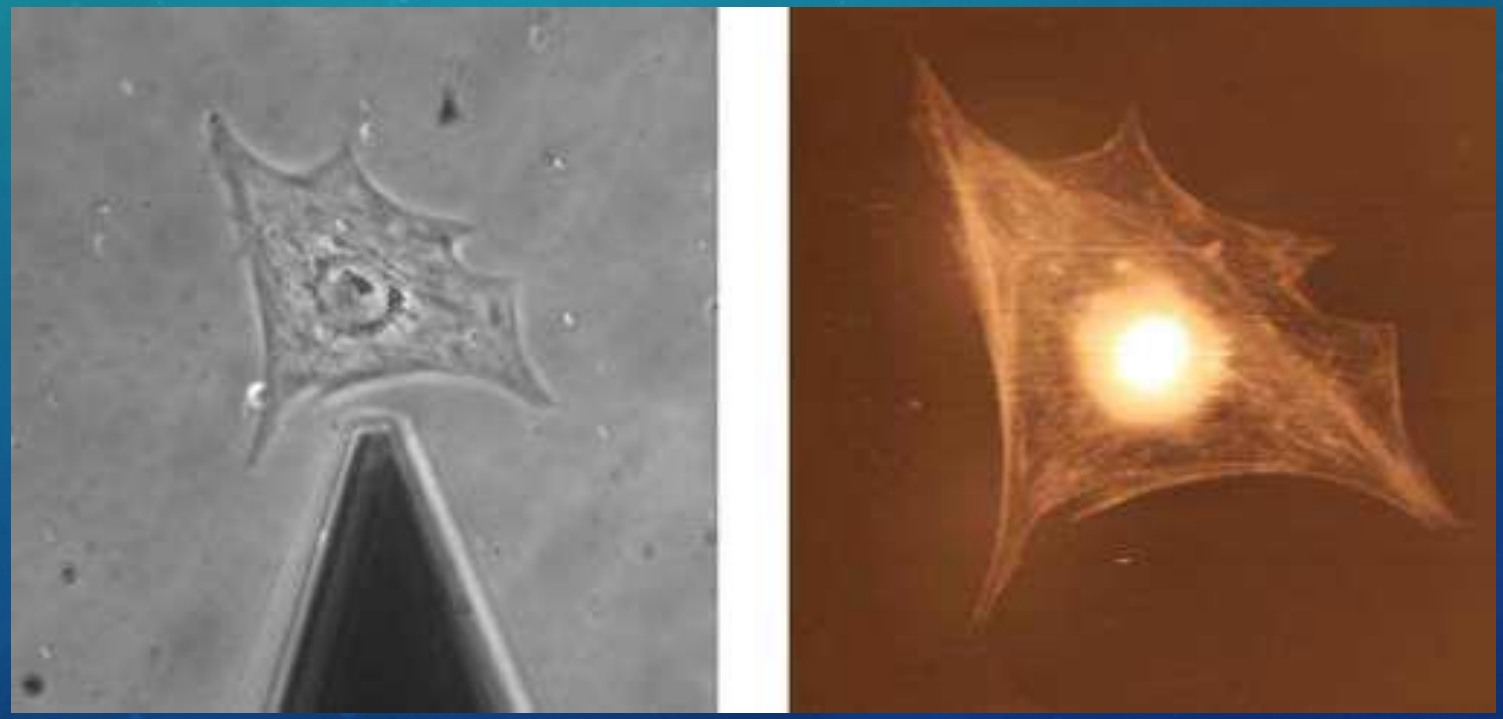
FLATTENING



- RMS roughness 4.867 nm to 2.476 nm

REFERENCES

- Asylum MFP-3D Manual
  - http://mmrc.caltech.edu/Asylum/Asylum%20MRP-3D%20manual.pdf
- Asylum MFP-3D Manualette
  - http://nano.indiana.edu/Files/MFP3D/MFP3D%20Manual2.pdf
- Sam and Radhika



Simultaneous optical phase and contact mode topography of a living cardiac myocyte