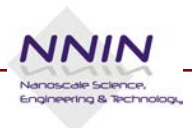# Atomic Force Microscope

## (Veeco Nanoman)

User Manual – Basic Operation

System Startup

- If the system is currently **ON**
  - To start the NanoScope software, double-click the **NanoScope** startup icon on the desktop.
  - From the Menu Bar select:
    - **File > Open Workspace**
  - You now can choose the operating mode. Choose **TappingMode** by selecting:
    - **Tapping in Air NRF.wks**
  - Click on **Scan-Dual**
  - **IF THE SYSTEM IS OFF, CALL 5-7640**

Mounting the Probe

- Select the appropriate probe
  - **TappingMode** (Si crystal probe, OTESPA or FESP)
- Mount the probe in the correct holder
  - Select an **In-air** probe holder
  - Place the holder in a docking station
    of the cantilever installation
    fixture and secure the probe in
    the groove with the spring clip

In-air Probe Holder

In-air Probe Holder
Docking Station
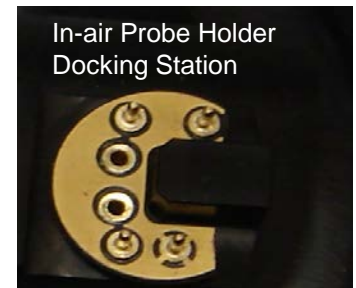
Loading Probe to AFM Head

- Fully tighten the **dovetail knob** (rotate clockwise)

- Lift the AFM head out of the dovetail groove

- Place the tip holder **completely onto** the four pins on the base

- Replace the AFM head into the dovetail grove

- Lock the AFM head by releasing the **dovetail knob** (rotate counter clockwise)

Locate Tip

CAUTION: If **Locate Tip** is not accomplished before **Focus Surface**, there is a danger of crashing the tip during **Engage**.

- Verify that a tip is installed in the probe tip holder, then select **Tools > Stage > Locate Tip** or use the icon:

- The screen will display a caution indicating that the microscope objective is in motion

Locate Tip – Continued

- **Adjust illumination to 100%**

- Zoom Out with the arrow

- Move the tip until it comes focus using the Optics arrows

- You can change the focus speed by selecting **S** (slow) or **M** (med)

- Move the tip to the center of the crosshairs with the **X-Y** knobs to the left of the optics

- Press **OK**
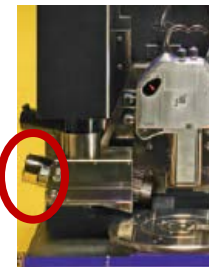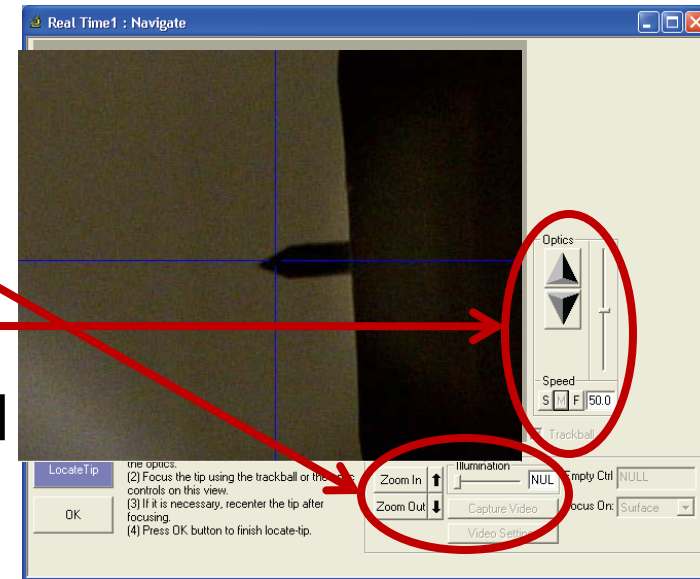
Aligning the Laser to the Cantilever

- **Set illumination to 0%.** Place a piece of white paper below the AFM head on the chuck.

- Use the **X – Y** laser control knobs located on top of the AFM head to move the laser spot inside the illumination spot.

  - Turn the right-rear laser control knob until the spot begins to disappear (1)

  - Turn the front left laser control knob until the beam crosses the cantilever and a shadow appears in over the laser spot below (2)

  - Turn the rear right laser control knob until the laser crosses the tip end and appears on the surface below, back it up until the laser spot just disappears from the surface below (3)

  - Verify **Signal Sum** is **4 V – 6 V**

Reflections on
Laser View Screen

On cantilever leg
or tip
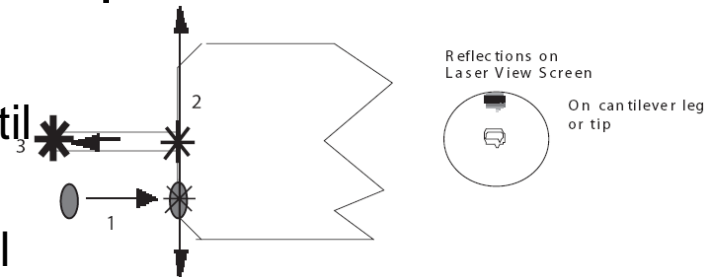
Adjust the Photodetector

- Use the two photodetector adjustment knobs on the left side of the AFM head to adjust the laser spot to the center of the photodetector.

- Center reflected laser light in the viewing window on the AFM head.

- Adjust the **Vertical Deflection to 0 V**
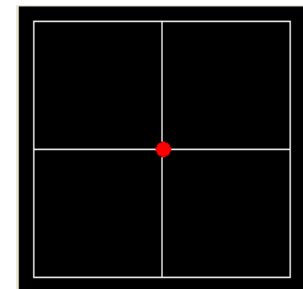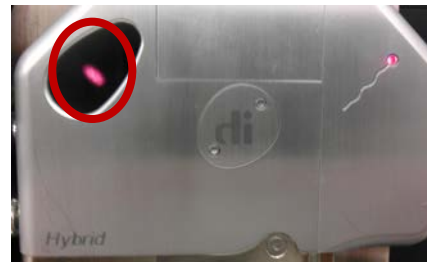
Vertical Deflection: -0.03 V

Amplitude: 509 mV

Signal Sum: 5.46 V

Mounting the Sample

- There are two ways to mount a sample, by:
    - vacuum
    - magnetic stage

- **Mounting on the chuck by vacuum**
    - Take out screws
    - Place sample over holes
    - Turn vacuum **ON**

- **Mounting on a magnetic stage**
    - Place the magnetic stage on the chuck
    - Mount the sample on the puck
    - Set the puck on top of the magnetic stage

Vacuum ON/OFF

Screws

Sample on Magnetic Sample Holder
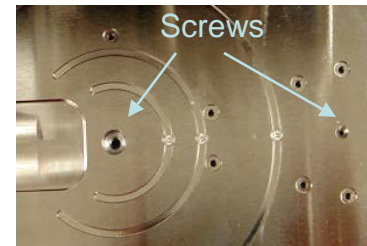
Loading the Sample Under AFM Head

CAUTION: A larger amount of clearance is required for both the magnetic sample stage and the liquid cell tip holder

- Ensure that the clearance between the bottom of the AFM head and sample is large
- Move the Z position of the AFM head to its highest point by clicking the **Withdraw** icon several times
- Very carefully turn the chuck to move the sample under the AFM head

Focus Surface

CAUTION: Since the command **Focus Surface** moves the scanner vertically, be careful when making this adjustment to ensure that the tip does not hit the sample surface.

- Select **Tools > Stage > Focus Surface** or click the **Focus Surface** icon
- Before continuing, check the clearance between the base of the AFM head and the sample
  - To focus on the surface, move the AFM head down ~ **2mm** above the sample by using the Z Motor arrows
 - **IMPORTANT: Use speed set to S**

Focus Surface Continued

- In the **Focus On** box, choose either **Surface** or **Tip Reflection**

- If the sample is very flat or reflective, choose **Tip Reflection**

  - Note: You may need to adjust illumination and zoom to clearly see the probe

Optional: Visible Laser Alignment w/ CCD

- **Adjust illumination to <25%**
- Laser should now be visible in video screen
     (works best with reflective samples)
- Adjust laser alignment knobs moving laser directly over tip
- Pay attention to both location of laser Signal Sum value
- Adjust Vertical Deflections back **0V**
- Increase illumination to 100%
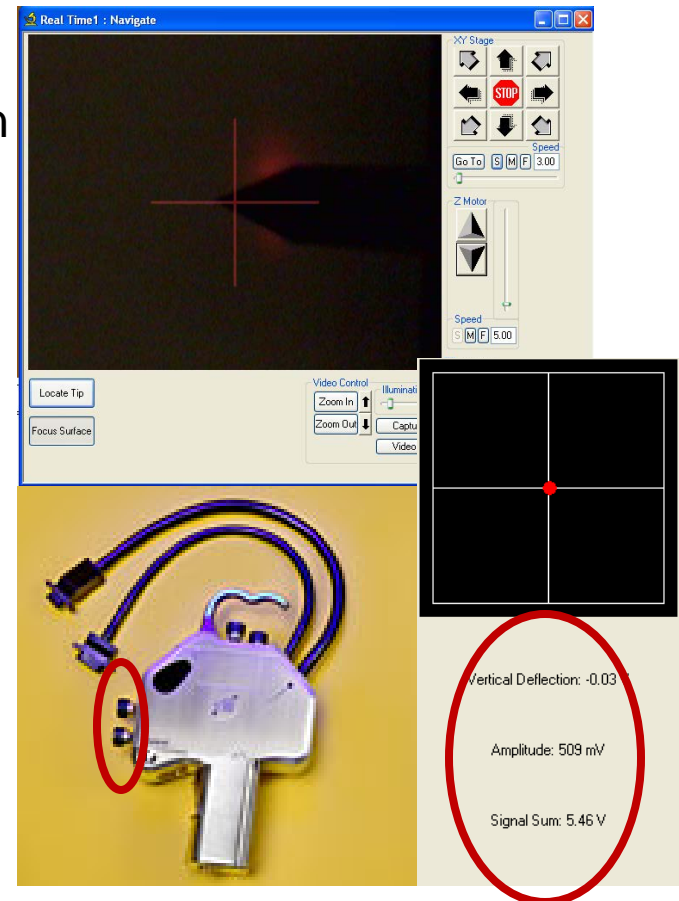
Cantilever Tune – TappingMode

- Select **Cantilever Tune** from the **RealTime > Cantilever Tune** pop-down menu, or click the **Cantilever Tune** icon

- Set the AUTO TUNE parameters

⊟ Auto Tune	
— Start frequency	100.000 kHz
— End frequency	500.000 kHz
— Target amplitude	500 mV
└ Peak offset	5.00 %

Tip	FESP	OTESPA
End Frequency	100 kHz	500 kHz

- Click on **Auto Tune**

- Click on **Zero Phase**

- Click on **Exit** when done

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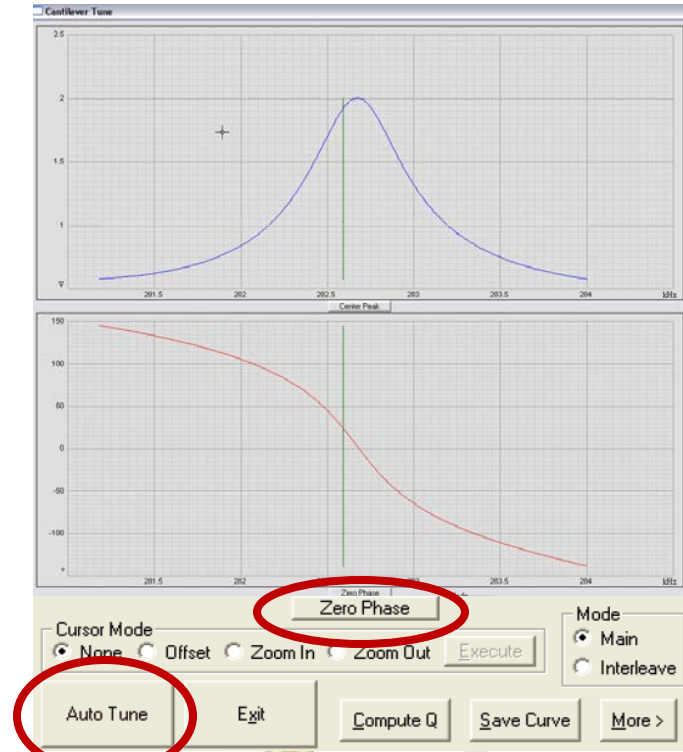
Engage Tip – TappingMode

- First, in the **Scan Controls** panel, set the following:
  - Initial **Scan Size** is set to **1μm** or a small scan size initially
  - **X** and **Y Offsets** are set to **0**
  - **Scan Angle** is set to **0**

- Under **Feedback Controls** panel, set the following:
  - **Set point** is set to **0V**
  - **Integral Gain** is set to **2.0**
  - **Proportional Gain** is set to **3.0**
  - **Scan Rate** is set to **1Hz**

Select **RealTime > Engage**
  or select the **Engage** icon

Real Time1 : Scan Parameter List

| Feedback	
Integral Gain	2.000
Proportional Gain	3.000
Amplitude Setpoint	0 mV
Drive Frequency	302.032 kHz
Drive Amplitude	141.9 mV
Scan	
Scan Size	1.00 μm
Aspect Ratio	1.00
X Offset	0.000 nm
Y Offset	0.000 nm
Scan Angle	0.00 °
Scan Rate	0.996 Hz
Tip Velocity	1.99 μm/s
Samples/Line	512
Lines	512
Slow Scan Axis	Enabled
XY Closed Loop	Off
Limits	
Z Limit	8.019 um
Z Range	11.0 μm
Other	
Microscope Mode	Tapping
Tip Bias Control	Ground
Sample Bias Control	Ground
Units	Metric
Tip Serial Number	

Scanning

- To ensure we have true engagement:
    - **Increase** the tip-surface interaction by **decreasing** the value of **Amplitude Setpoint**
    - Make sure that the Trace and Retrace lines overlap each other

    - Image capture times depend primarily on the number of data points captured and on scan speed.

Optimizing Scanning

- To ensure we have the best image we need to optimize settings such that trace and retrace overlap as shown:

Optimal Scan Signal
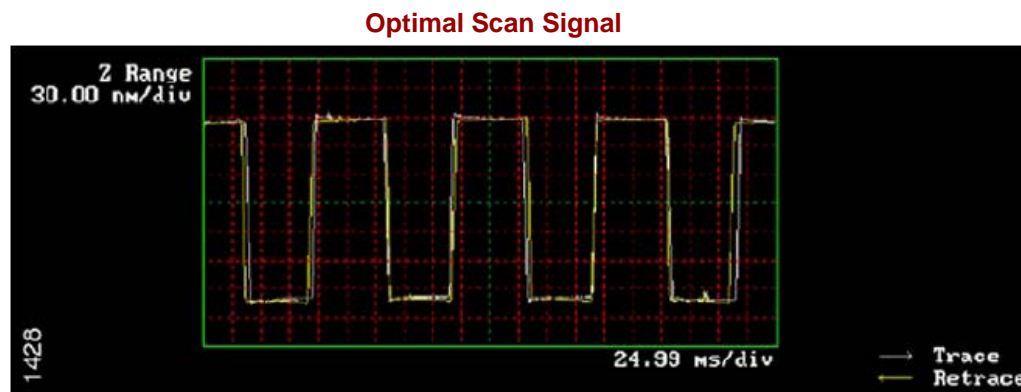
- **First Step - Increase** the tip-surface interaction by **decreasing** the value of **Amplitude Setpoint**
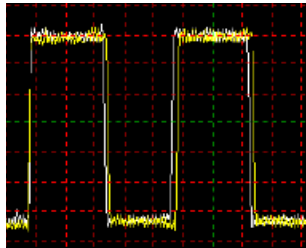
Optimizing Scanning

- Additional adjustments may be made:

  - **Second Step** – **Scan Rate** may be too high.
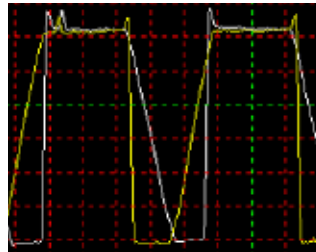
    - For publications use slower scan rates
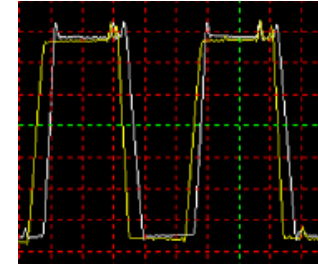
  - **Third Step** – Adjust **Integral** and **Proportional Gain.** If Integral gain is too low or too high you will have the following signatures in the signal:

Integral Gain Too High

Integral Gain Too Low

Capture Images

- Create a file name under **RealTime > Capture Filename**

- Click on the **Capture** icon

- Check the capture status in the bar at the lower right corner of the screen

XyDrift: Of Capture: Off File: Date/Time Scope: Quadrexed D3100

- Capture Options
  - To capture the image in the middle of a scan **RealTime > Capture Now**, or
  - Capture the previously scanned image **RealTime > Capture Before**, or Ctrl + B
  - **Cancel Capture**

Analyze Images

- Once an image is captured, double-click on it in the browser

- Click the height image (Channel 1) to select it

- Remove all tilt and scan line errata from the image by selecting **Analyze > Flatten**

  - Set the **Flatten Order** parameter in the input box to 1st
  - Go to the display window and draw a stop band box over the pit as shown
  - **Execute**
  - Repeat for Ch 2

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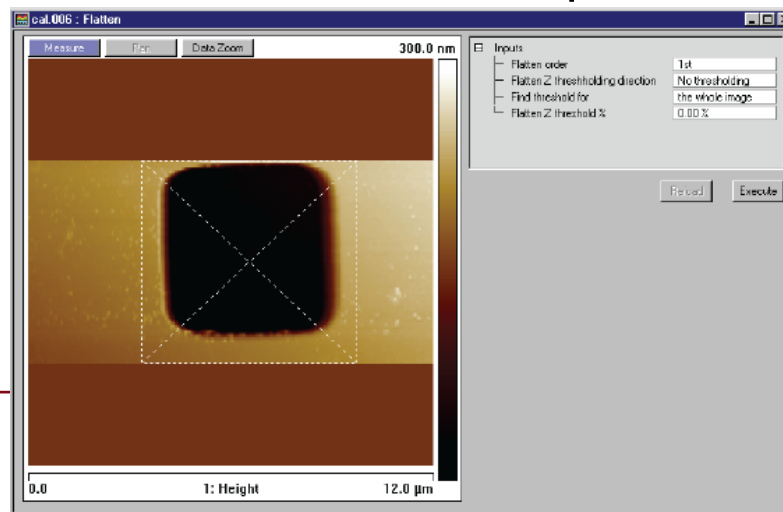
Shutting Down

- Click on the **Withdraw** icon
- Do this several more times or use the **UP** arrow to make sure there is enough clearance between the bottom of the head and the sample
- Remove the sample from the chuck
- Remove the tip holder from the head
  - Loosen the AFM head with the dovetail knob
  - Lift the AFM head out of the dovetail groove
  - Remove the tip holder, pulling it **straight** off the AFM head

Shutting Down – Continued

- Replace the AFM head in the dovetail groove

- Tighten the AFM head with the dovetail knob

- Quit the software without saving changes to the workspace file