The image shows the cover of a spiral-bound notebook. The cover is a light brown, textured paper. On the left side, there is a silver metal spiral binding. The notebook is set against a yellow background with a dark brown border on the left and bottom edges.

**Scanning Probe Microscope
(Veeco Dimension 3100)
Training Notebook
(Basic)**

***Nanotech User Facility
Center for Nanotechnology
March 2007***

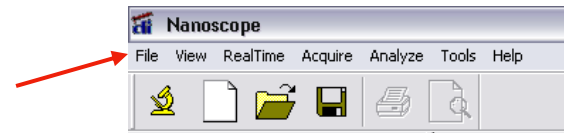
A. Start Operating Software

1. Start **Nanoscope v613r1** software, click on



2. Choose an appropriate default **workspace** file.

- File > Open workspace...
- D3100/default_tapping_air.wks (tapping mode)
or
- D3100/default_contact_air.wks (contact mode)



3. Click on **Scan-Dual** and **Scan ParmList** to open the windows.



In case the system is off, turn on the **computer**,
Nanoscope IVa, and **Stage Controller** in sequence.

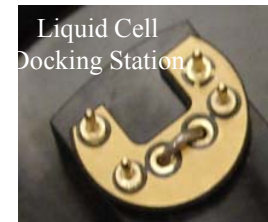
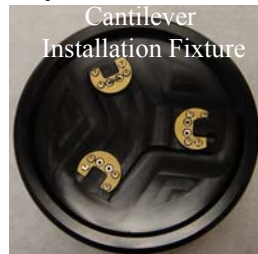


B. Preparation

- B1. Mount Probe
- B2. Load Probe to Head
- B3. Locate Tip
- B4. Align Laser to Cantilever
- B5. Adjust Photodetector
- B6. Mount Sample
- B7. Load Sample under Head
- B8. Identify Surface

B1. Mount Probe

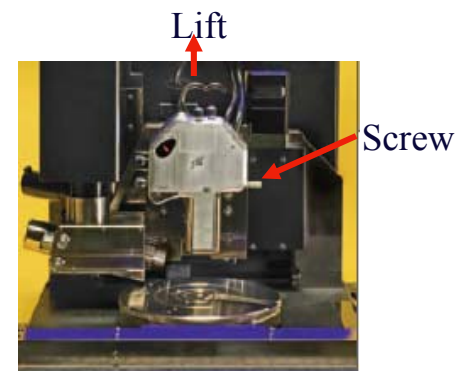
1. Select a **Probe**.
 - Tapping mode (Si crystal probe, FESP or OTESPA)
 - Contact mode (Si_3N_4 probe, DNP)
2. Mount a probe in a **Probe Holder**.
 - Select an **in-air** or **in-liquid** Probe Holder.
 - Plug the **Holder** in a **Docking Station** of the **Cantilever Installation Fixture**.
 - Put the probe in the **Groove**.
 - Push the **Spring Clip** down and then forward all the way, release to secure the probe.



B2. Load Probe to Head

1. Fully tight the **Knurled Head Clamp Screw**.
2. Lift the Head out of the **Dovetail Groove**.
3. Fit the Holder onto **Four Pins** at the Base and check **Four Sockets** touching the Base *completely*.
4. Set the Head back into the **Dovetail Groove**.
5. Lock the **Head** by releasing the **Knurled Head Clamp Screw**.

Pull/push the Holder straight off/in pins to avoid bending the pins.



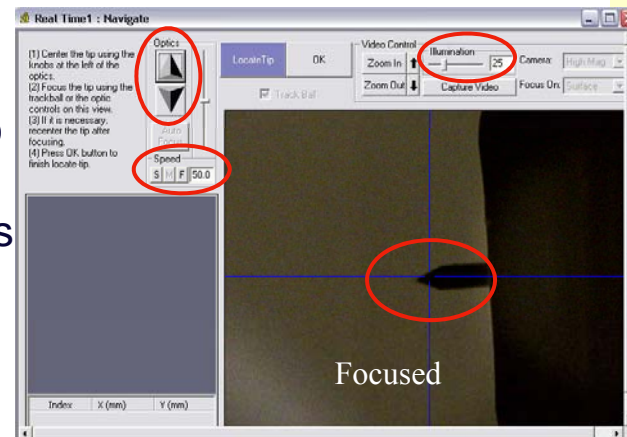
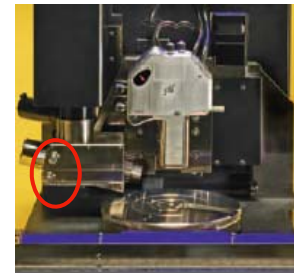
B3. Locate Tip

1. Start **Navigate**, click on **Locate Tip** icon.



2. Focus on the tip.

- Adjust **Illumination** for appropriate light.
- Use microscope x-y adjustment knobs to move the tip into the navigate window.
- Move the tip to the center of the crosshair.
- Click on **M** or **S** for the speed to move the **microscope**.
- Click **Up** or **Down** arrow to focus on the tip.

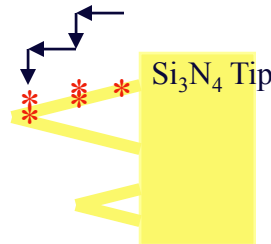
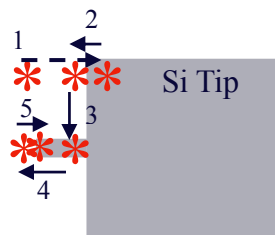


B4. Align Laser to Cantilever

1. Put a piece of white paper on the chuck.
2. Use the x- and y- laser adjustment knobs to move the red laser spot inside the white illumination spot.



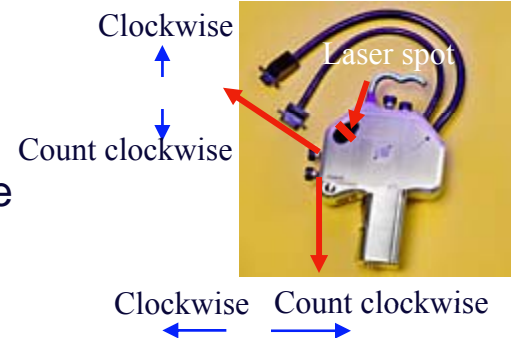
3. Move the laser spot to the right direction until it is blocked (1).
4. Move it backward until it just appears (2).
5. Move the spot along the chip edge to find the cantilever (3).
(Dim laser spot on the white paper and in the meantime a reflection laser spot appears in the head front window).
6. Travel the spot along the cantilever until the spot appears on the white paper and the reflection spot disappear in the front window (4).
7. Move it backward when the spot just blocked and center the spot on the cantilever (5).
8. Move it further backward a little to fully block the laser spot on the white paper and a nice focused reflection spot in the front window.



The same procedures for aligning laser to a Si_3N_4 tip except that
(1) Laser spot should be blocked four times when traveling along the edge of the chip.
(2) Follow the zig-zag pattern to move the laser spot to the free end.

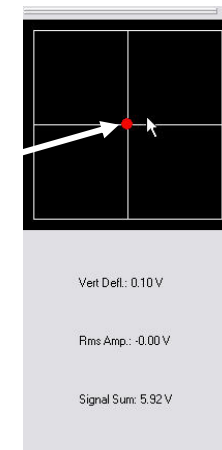
B5. Adjust Photodetector

1. Use two knobs on the left side of the Head to adjust the laser spot to the **center of the photodetector**. The reflection of laser spot should be in the center of the front window of the Head.



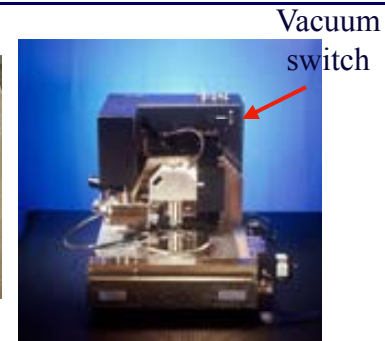
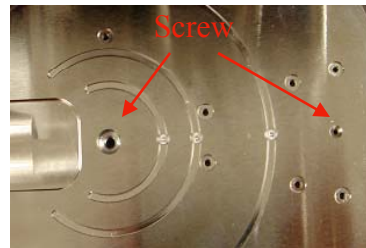
2. Typical values of Signal Sum for different type of tips are listed below.

Tip	FESP (Si)	OTESPA (Si, Al coated)	DNP (Si ₃ N ₄)
Signal Sum (V)	1.8 – 2.2	5 - 6	5 - 6



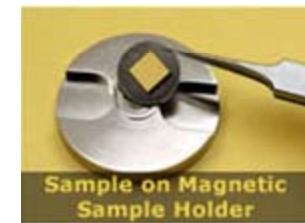
B6. Mount Sample

1. On **Chuck** by vacuum.
 - Take off the screw.
 - Put the sample on top of the hole.
 - Turn on Vacuum.




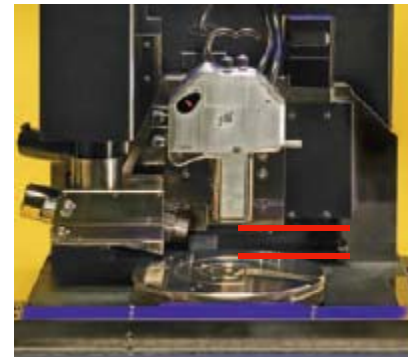
OR

2. On **Magnetic stage**.
 - Put the magnetic stage on Chuck.
 - Mount the sample on a puck.
 - Set the puck on top of the magnetic piece.



B7. Load Sample under Head

1. Check the **clearance** between the bottom of the Head and the sample.
2. Move the Head **UP** by clicking on **Withdraw** icon *several* times. 
3. Carefully turn the **Chuck** to move the sample under the Head.



Much more clearance needed for magnetic sample stage and liquid cell tip holder.

B8. Identify Surface

1. Click **Ok** by **Locate Tip**. Switch Navigate to **Focus Surface**.



2. Focus on surface.

- Check the clearance between the base of the **Head** and the sample.
- Move the Head down to ~2 mm above the sample by:



- Clicking on and holding the **Down arrow** (Speed **M**)
OR

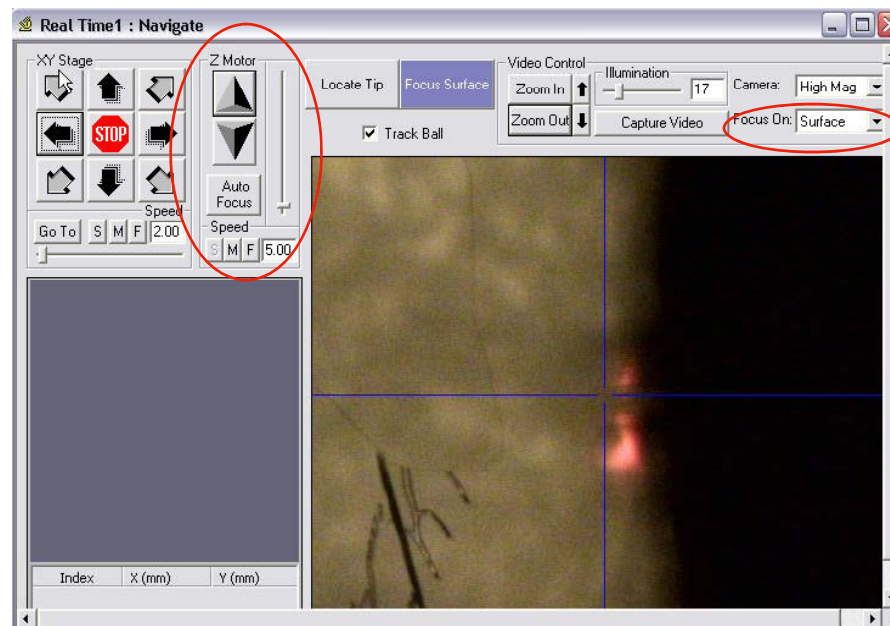
- Holding the **Focus** button on **Trackball** and turning the ball towards user, pushing **Lock** button to stop the Head movement.



Extremely care must be paid to avoid the Head bumps into the sample and damage the scanner.

B8. Identify Surface (Cont.)

1. Click **Down arrow** (Speed **S**) to make the focal plane on surface.
(*Move microscope view area to find features on surface to help focusing.
Or, for reflective samples (Au or Si), try Focus On Tip Reflection. See the following page.*)

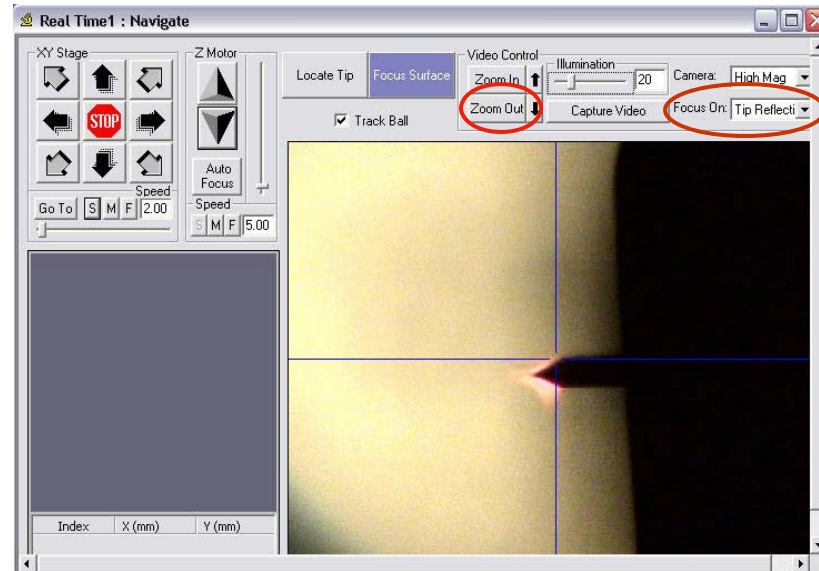


B8. Identify Surface (Cont.)

1. Switch **Focus on** from **Surface** to **Tip Reflection** to focus on the reflection of the tip.
 - Click on **Up** or **Down** arrow (Speed **S**)
2. Click on **Zoom In** for fine adjustment.



3. Switch **Focus on** back to **Surface**.



Zoom Out Tip Reflection

C.Tapping Mode

- C1. Tune Cantilever
- C2. Engage
- C3. Scan

C1. Tune Cantilever

1. Click on **Tune** icon.



2. Set **Auto Tune** parameters:

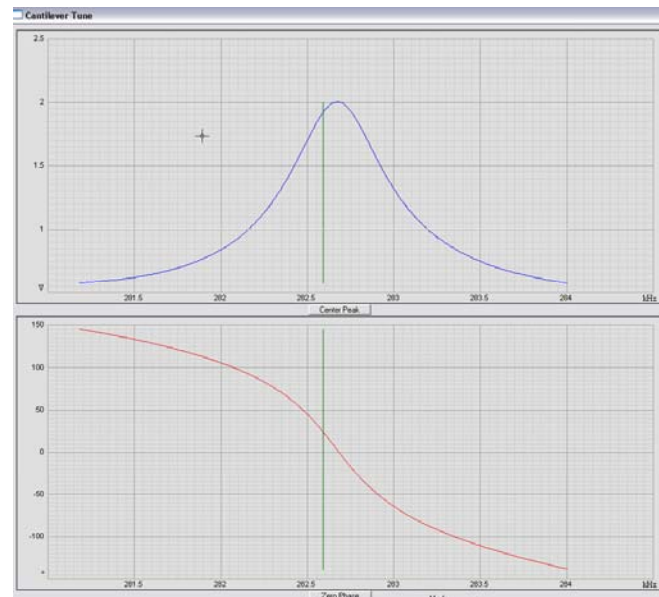
Auto Tune	
Start frequency	0.000000 kHz
End frequency	500.000 kHz
Target amplitude	2.00 V
Peak offset	5.00 %

Tip	FESP	OTESPA
End Frequency	100 kHz	500 kHz

3. Click on **Auto Tune**.

Cursor Mode			
<input checked="" type="radio"/> None	<input type="radio"/> Offset	<input type="radio"/> Zoom In	<input type="radio"/> Zoom Out
Auto Tune	Exit	Compute Q	

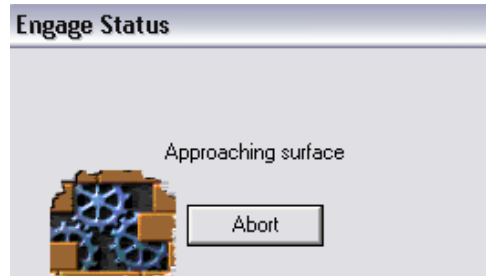
4. Click **Exit** when Auto Tune is done.



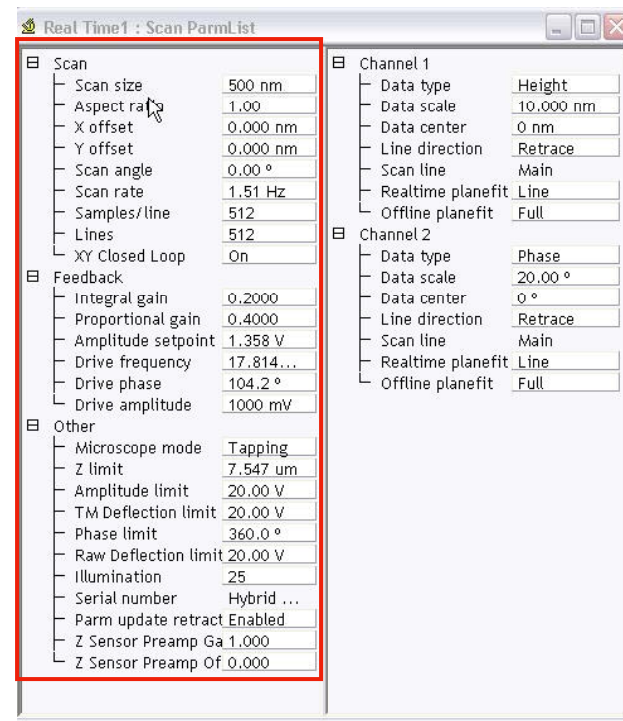
C2. Engage

1. Check engage parameters.

2. Click on **Engage** icon.



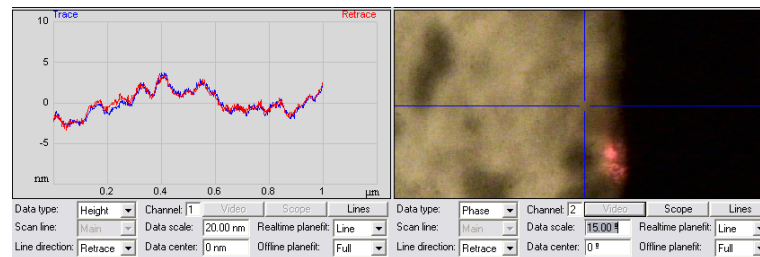
(Motor status window indicates the distance of Z motor moving toward the surface. It is about 250 – 300 μm when engaged.)



Motor 25.0 μm Tip#: XyDrift: Off Capture: Off

C3. Scan

1. Ensure true engagement.
 - Increase the tip-surface interaction by decreasing the value of **Amplitude Setpoint**, and vice versa.
 - Make sure Trace and Retrace lines overlap with each other.



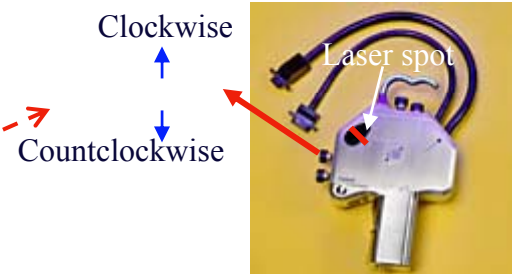
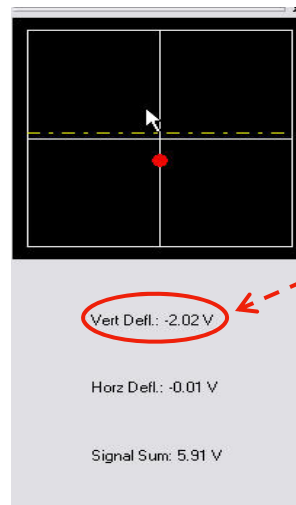
2. Set up scan parameters.
 - **Scan rate** < 1.5 Hz
 - Up to 4096 points/line, 1024 lines/image
3. Change Feedback parameters to get better image.
 - Adjust **Ig** and **Pg** to get trace and retrace lines follow each other.
 - Lower **Z Limit** to get better resolution in Z direction.

D. Contact Mode

- D1. Preparation
- D2. Engage
- D3. Scan

D1. Preparation

1. Select a default **workspace** file.
 - File > Open workspace...
 - D3100/default_contact_air.wks (contact mode)
2. Choose a silicon nitride probe (DNP).
3. Follow all procedures in B to prepare for scanning.
4. Adjust **Vertical Deflection** to -2 V.



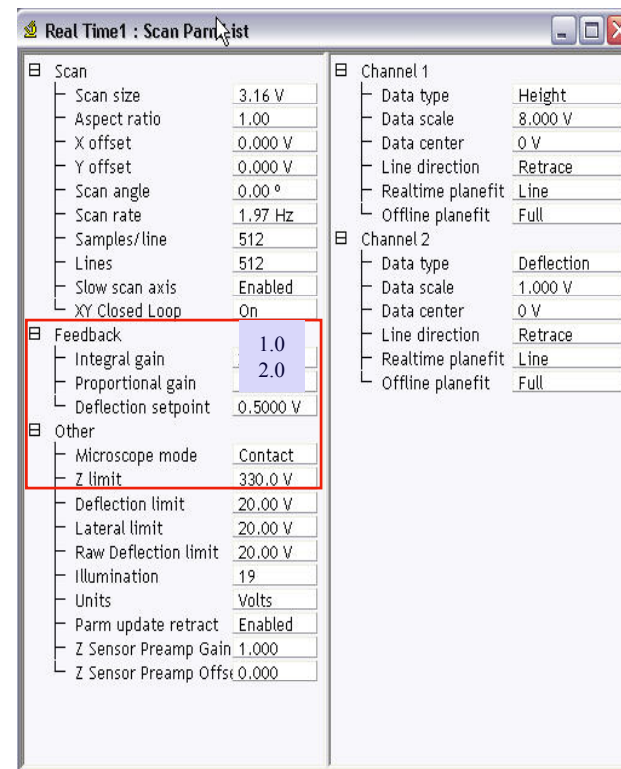
D2. Engage

1. Check engage parameters.
2. Click on **Engage** icon.



(Motor status window indicates the distance of Z motor moving toward the surface. It is about 250 – 300 μm when engaged.)

Motor 25.0 μm Tip#: XyDrift: Off Capture: Off




Real Time1 : Scan Parameters	
Scan	
Scan size	3.16 V
Aspect ratio	1.00
X offset	0.000 V
Y offset	0.000 V
Scan angle	0.00 °
Scan rate	1.97 Hz
Samples/line	512
Lines	512
Slow scan axis	Enabled
XY Closed Loop	On
Feedback	
Integral gain	1.0
Proportional gain	2.0
Deflection setpoint	0.5000 V
Other	
Microscope mode	Contact
Z limit	330.0 V
Deflection limit	20.00 V
Lateral limit	20.00 V
Raw Deflection limit	20.00 V
Illumination	19
Units	Volts
Parm update retract	Enabled
Z Sensor Preamp Gain	1.000
Z Sensor Preamp Offset	0.000
Channel 1	
Data type	Height
Data scale	8.000 V
Data center	0 V
Line direction	Retrace
Realtime plane fit	Line
Offline plane fit	Full
Channel 2	
Data type	Deflection
Data scale	1.000 V
Data center	0 V
Line direction	Retrace
Realtime plane fit	Line
Offline plane fit	Full



D3. Scan

1. Ensure true engagement.
 - Increase the tip-surface interaction by increasing the value of **Deflection Setpoint**, and vice versa.
 - Make sure Trace and Retrace lines overlap with each other.
2. Set up scan parameters.
 - **Scan rate** < 4 Hz
3. Change Feedback parameters to get better image.
 - Adjust **Ig** and **Pg** to get trace and retrace lines follow each other.
 - Lower **Z Limit** to get better resolution in Z direction.


E. Capture Image

1. Create a folder under **E:\ntufuser**.
2. Create a filename.
 - RealTime > Capture file name...
3. Click on **Capture** icon. 
4. Check Capture status in the bar at the right bottom corner of the whole screen.

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

5. Other Capture options.
 - Capture the image scanned so far
RealTime > Capture Now, or 
 - Capture the previous scanned image
RealTime > Capture before, or ctrl+B
 - Cancel Capture 

G. Shut Down

1. Quit scanning.
 - Click on **Withdraw** icon. 
 - Click on **Withdraw** icon several times, or click on the **UP** arrow button to make sure enough clearance between the bottom of the head and the sample.
2. Take away the sample from the sample holder.
(Turn off vacuum if used vacuum to hold the sample.)
3. Take off the Tip Holder from the head.
 - Fully tight the **Knurled Head Clamp Screw** to loose the Head.
 - Lift the Head out of the **Dovetail Groove**.
 - Unplug the Tip Holder from the **Base of the Head**.
 - Plug the Tip Holder to a **Docking Station** on the **Cantilever Installation Fixture**.
4. Quit software. Don't save changes to the workspace file.
5. Sign blue log book and log out usage on website.