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Instruction for using the Digital Instruments Multimode AFM

(Version 5)

Before using the microscope, first you should look at the AFM **LOG-IN BOOK** to make sure everything is fine for the microscope upon the usage of the previous operator.

Golden Rule: If you don't know what's going on, find somebody who does. If you are having trouble, you have probably forgotten some tiny thing that an experienced user will be able to spot immediately. Not getting help wastes your time and annoys the microscope.

I. Setting up the computer.

1. Sign in to the session via a computer in the hallway
2. At the login screen select 'Nanoscope' user profile
3. Double click on the microscope icon 'Multimode' to start the software using default parameter
4. Click the microscope icon on the toolbar to start the realtime software
5. Choose File -> Open Workspace, then select 'Tapping' (or 'Contact') work space
6. Choose Acquire – scan-triple

II. Setting up the microscope, sample, and tip.

1. Assemble microscope, scanner, and head. (Screw scanner onto base. Attach head onto scanner with two springs.)
2. Set "STM – AFM & LFM-TM AFM" switch on base to "TM AFM"
3. Put sample on stage. (*Caution: avoid excessive sideways pressure on scanner*.)
4. Use "UP – DOWN" toggle switch to make sample surface level with tops of three round bearings.
5. Turn on light source and monitor.
6. Focus optical microscope on sample surface.
7. Put cantilever (also called "tip") in the tip holder.
8. Put tip holder in head above sample and clamp down with screw in the back of the head.
9. Adjust "UP – DOWN" toggle switch so tip is visually close to sample (within about 1 mm).
10. Adjust X and Y controls on base so tip is within field of view on the monitor. (You may need to adjust the focus to find the tip. *Caution: be sure you are focused on the tip, and not the reflection of the tip on your sample*.)
11. Refocus on sample surface, and adjust "UP – DOWN" toggle switch until tip is just out of focus with sample.

III. Aligning the laser, tip, and photo-detector.

1. Locate laser spot on your sample. (May be easier if you turn off the light source.) You may need to use the X-Y controls on the base to find the laser spot.
2. Move laser spot to tip of cantilever using X-Y controls on the top of the head near its center.
3. Adjust "windshield wiper" control on back so "SUM" bar-graph is as large as possible, and difference readout has just changed from +9.9 V to -9.9 V.
4. Adjust the photo-detector adjustment screw in the top left of the head so difference readout has a magnitude less than ± 1Volt.

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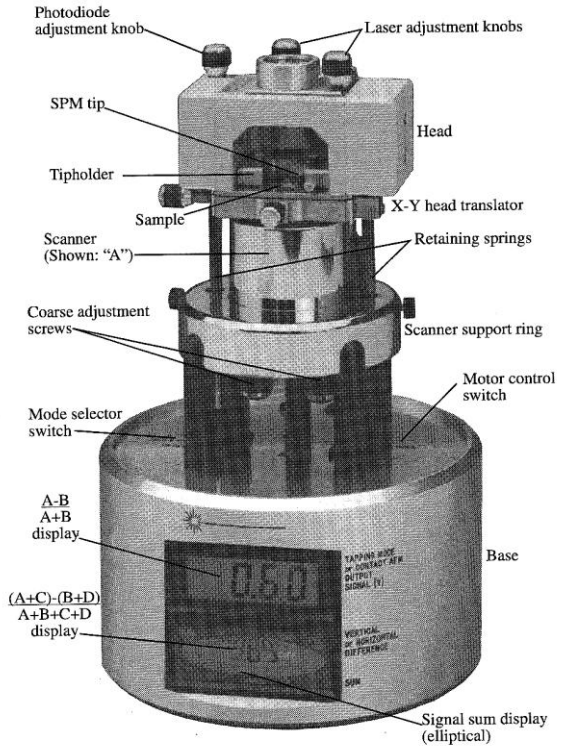
IV. Tuning the cantilever.

1. Click the tuning fork icon in the toolbar, or choose Realtime -> Cantilever Tune
2. Set the "Target amplitude" to 500 mV
3. Set the start and end frequencies to 100kHz and 500 kHz.
4. Set Peak Offset to 10%, engage set point: 1 (0.95 for less sensitive sample, 1.05 for more sensitive sample).
5. Click Auto Tune.
6. When the auto tune is finished, you should see a clear resonance peak on the amplitude (top) graph. The phase (bottom) graph should take an 'S' shape.
7. Click 'Zero Phase' to give a zero phase at resonance. The Drive Amplitude should be between 10 and 500 mV, and the frequency should be between 250 and 350 kHz.
8. Click 'Exit'

V. Double checking laser alignment.

1. Amplitude should now read about 0.5 Volts
2. Adjust laser position with the X-Y controls on the top of the head so that Amplitude is maximized.
3. Readjust the photo-detector adjustment screw in the top of the head so difference readout has a magnitude less than ± 1 Volt.
4. If the maximum Amplitude is way off of 0.5, then retune the cantilever.



Multi Mode SPM

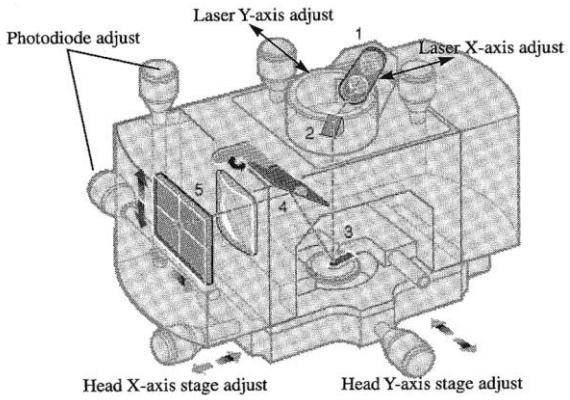


Figure 2.3. MultiMode SPM head and major components: laser (1); mirror (2); cantilever (3); tilt mirror (4); photodetector (5).

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VI. A few suggested starting values

1. On the Scan Controls Window: Scan Size = 5 microns, X and Y offsets = 0, scan angle = 0, Scan Rate = 1 Hz, Samples per line = 512, Slow Scan Axis = enabled.
2. Feedback Controls Window: SPM feedback = Amplitude, Input Feedback = off, Int Gain = 0.35, Prop Gain = 1.5. Lookahead Gain = off.
3. Other control: Microscope mode: tapping; Tip bias control: ground; Sample bias control: ground; Meter display: metric; Z=5μm.
3. Channel 1 Window: Type = height, Data Scale = your best guess at the sample roughness, Line Direction = trace, Realtime Planefit = line, Offline Planefit = full.
4. Channel 2 Window: Type = amplitute, Data Scale = 50 mV, Line Direction = Retrace, Realtime Planefit = line, Offline Planefit = full.
5. Channel 3 Window: Type = phase, Data Scale = 45 degrees, Direction = trace, Realtime Planefit = line, Offline Planefit = full.

VII. Getting an image.

1. Engage the tip by clicking the green down button.
2. When tip is engaged, click on the tuning fork icon. Set 'Tip Offset' to 100 nm. Select 'Cursor Mode', 'Offset' and drag the red line to the left the resonance peak. Then click 'Execute'.
3. In the scan parameter list window select 'Slow scan axis' – disable, close cantilever tune window
4. Reduce the Amplitude Setpoint so that the trace and retrace, for the height data, are similar and accurately reflect the topography of your sample, and the "Z Center Position" bargraph is near the center of its range. Do not reduce the setpoint below 85% of its original value in order to remain in '"light tapping" mode.
5. Optimize the proportional and integral gains. Increasing as high as you can without introducing high frequency noise. Optimize the scan rate to give better tracking.
6. Enable 'Slow scan axis'.
7. Enjoy your data.

VIII. Capturing an image.

1. Choose Realtime -> Capture Filename and enter a filename and directory to save data in: preferably with your initials and the date.
2. To capture an image, choose Realtime -> Capture.
3. To stop capturing, choose Realtime -> Capture_Cancel
4. To capture the current data immediately, choose Realtime -> Capture_Now, or click the camera and exclamation mark icon
5. To capture the last scan, choose Realtime -> Capture_Last
6. The capture status (Off, On, or Next) and the filename are shown at the bottom-right of the screen.

IX. Viewing a captured image.

1. Captured images are held in the offline panel at the right of the screen, select the directory holding your images.
2. Double click the file you wish to view.
3. The file will open in a new window, click on the image you wish to view

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4. Use the ‘Analysis’ menu to manipulate or analyze the data
5. To export images or graphs right click on the image you want and select ‘Export’. Choose export format in the window and enter a filename.

X. Ending your session.

1. Raise the tip by clicking on the red up arrow button.
2. Raise the tip some more by clicking the button a few more times, or using the “UP-DOWN” toggle switch.
3. Remove the tip holder.
4. Remove your sample.
5. Unplug the head to turn off the laser.
6. Turn off the monitor and the light source.
7. Copy your files onto a USB drive
8. Log out of the computer system.
9. Sign the log book. Include any notes on how the AFM worked, especially if anything isn’t working properly.

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