Instruction – Digital Instruments Multimode AFM

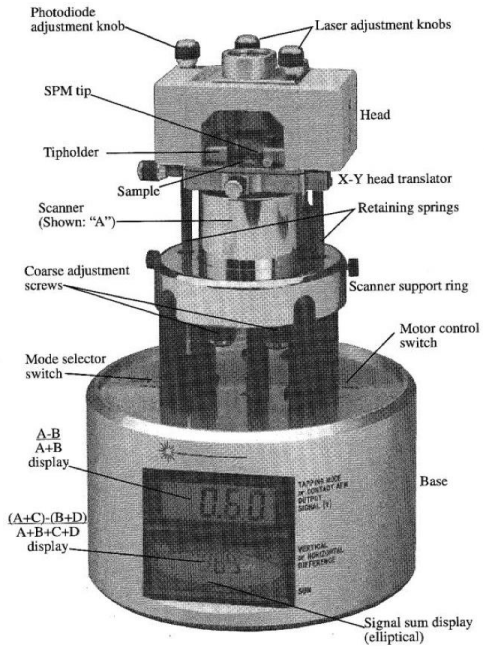
Golden Rules

1. Check the comments about the microscope status left by the previous user in the logbook.
2. Never do tasks other than data acquisition and data transfer on the computer.
3. Never guess. If you are not sure what's going on, ask somebody who knows. Most mistakes are easy to spot by an experienced user, and you will save yourself valuable time while keeping the microscope healthy.

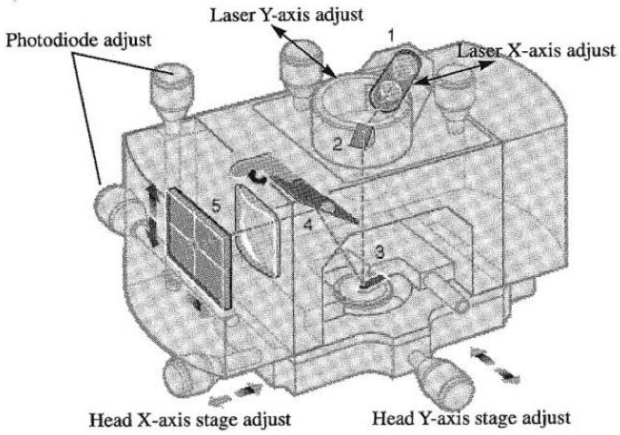
Multimode vs. Dimension AFM

1. While the sample acquisition software for both Multimode and Dimension is the same, the sample/microscope setup procedures are very different. The main differences are that the Dimension has a motorized stage which allows mounting much larger samples; that the scanner moves the tip over the sample rather than the sample under the tip; and that tip engaging is done automatically once the positions of the tip and sample are focused via the optical microscope attached to the scanner.
2. When a large sample (> 5 cm) are to be scanned, remove the center screw on the stage. The hole serves as the vacuum port for large samples. Put the screw back after use.

The microscope and its scanner

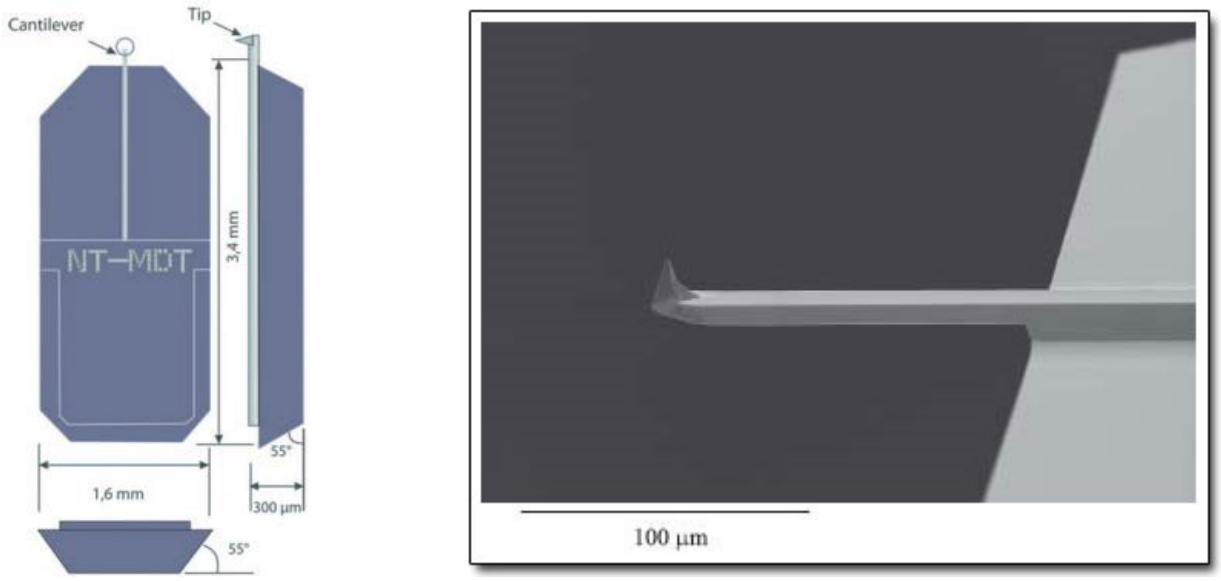


Multi Mode SPM



(Left) The microscopy consists of (1) head, (2) scanner column, and (3) base. (Right) Laser alignment, photodiode alignment, and sample position are adjusted via the knobs on the head.

AFM Tip



The AFM tip/cantilever locates at the end of the alignment mark on a probe chip. Always face the alignment mark up or the tip/cantilever will be destroyed.

Tip Holder

There is a button on the back of the holder which lifts the yellow brass pin. The tip can be loaded while the pin is up.
Note| The holder is not cheap ($1735USD)

I. Setting Up the Program

1. Turn on the power strip on the dimension controller.
2. Open Nanoscope program on the desktop.
3. Start with *Real Time* mode by clicking the yellow microscope icon on the top left corner of the program. The red laser status light on the scanner should turn on.
4. Bring up a desired scan window – *Acquire > Scan Duo/Triple/8 Channels.*
5. Bring up the scan control – *Acquire > Scan Parameter List.*

II. Setting up the microscope, sample, and tip

1. Set "STM – AFM & LFM – TM AFM" switch on base to "TM AFM".
2. Put a sample on stage. (Avoid excessive sideway pressure on scanner.)
3. Make sure the sample surface is lower than the three round bearing around the sample stage by toggling "Up – Down" switch on the base.
4. Plug in the laser power cable behind the scanner column.
5. Turn on light source and the monitor.
6. Place the cantilever/tip in the tip holder.
7. Mount the tip holder by aligning it to the three round bearings.
8. Clamp the electrical connection pad to the holder with the knob in the back of the head.
9. Adjust X and Y knobs on the base in order to bring the tip into the optical microscope field of view.
10. Adjust the height of the sample surface by iterating the focus procedure:
    a. Find the optical focal plane somewhere in between the tip and the sample.
    b. Approach the sample surface to the tip by pressing "Down" switch.
    c. Stop the procedure once the tip is slightly off the sample surface focal plane.

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

1. Locate the laser spot in the field of view. (It may be easier if you turn off the light source.) You may need to use the X-Y adjust knobs on the base.
2. Move the laser spot to the tip.
3. Adjust the mirror tilt lever on the back of the head so that "SUM" bar-graph is as large as possible, and the difference readout has just changed from +9.9 V to – 9.9 V.
4. Adjust the photo-detector knobs so that the difference readout falls within ±1 V.

IV. Tuning the cantilever

1. Click the "Autotune" (tuning fork icon) in the toolbar.
2. Make sure the resonance frequency of the tips falls within the tuning frequency range.
3. Click Auto Tune. When the auto tune is finished, you should see a clear resonance peak on the amplitude graph. Make sure the observed frequency matched the specified value.
4. Click "Zero Phase" to give a zero phase at resonance.
5. Click "Exit"

V. Setting Up a Scan and Capturing an Image/Data

1. Select *Scan Parameter List* window and set up initial values:
   Scan Size = 500 nm
   Integral Gain = 1.5
   Proportional Gain = 3
   SPM Feedback = Amplitude
   Microscope Mode = Tapping or Contact
   Amplitude Setpoint, Drive Amplitude, and Drive Frequency will be determined by the program when the tip is engaged. Do not change these values unless you have a clear idea what you are doing.

2. On the Scan window, pick the desired information to be included in the data by selecting channel Data Type (Height, Phase, Amplitude Error, etc.)
3. Start a scan by clicking on the *Engage* button (cantilever with green downward arrow icon). The step motor will begin to approach the tip to the sample surface. You will hear a beep once the tip is engaged to the surface.
4. Fine tune the *Integral* and *Proportional Gains* to make the Trace and Retrace curves as overlap to each other as possible.
5. To save the data, do the following sequence:
   Realtime > *Capture Filename* (name the file and choose the location to be stored)
   Realtime > *Capture* (start data acquisition, the capture status of either Off, On, Next, or Done is displayed on the lower right of the program).

VI. Ending Your Session

1. Withdraw the tip and raise the scanner all the way to its highest z position.
2. Take out the scanner and remove the tip holder and mount it back to the holder block.
3. Gently slide the scanner back to the rail and lock it.
4. Transfer the data to a thumb drive via the USB port on the computer.
5. Close Nanoscope program.
6. Turn off the power strip.
7. Sign the Logbook.

VII. Data Analysis

1. All the data analysis work is done in the computer cluster on the first floor. Nanoscope program is available on every computer in the cluster.