

Instruction – Bruker Dimension AFM (Nanoman)

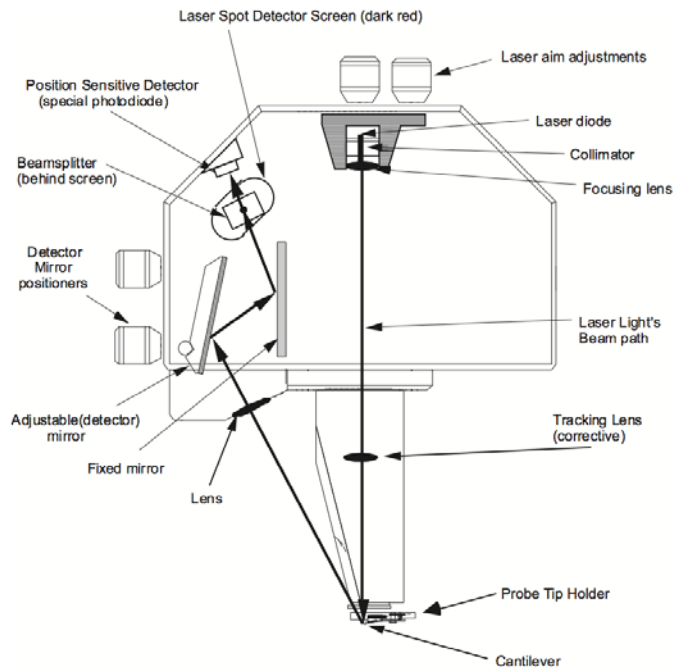
Golden Rules

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

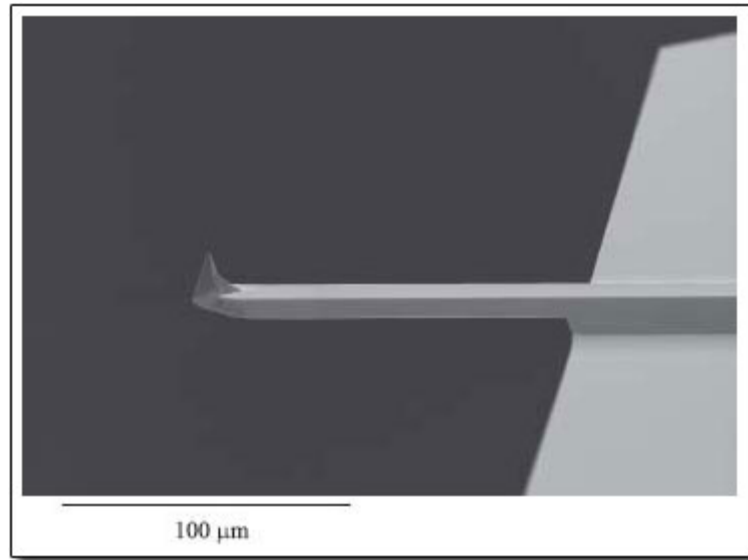
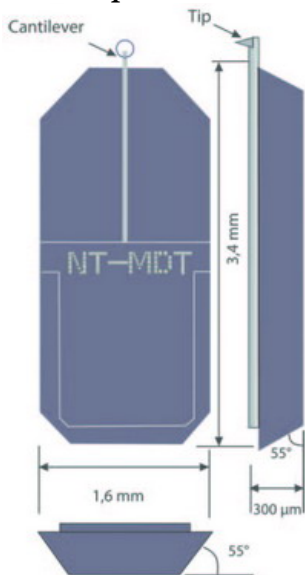
1. While the sample acquisition software for both Multimode and Dimension is the same, the sample/microscope setup procedures are very different. The main differences are that the Dimension has a motorized stage which allows mounting much larger samples; that the scanner moves the tip over the sample 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 Scanner



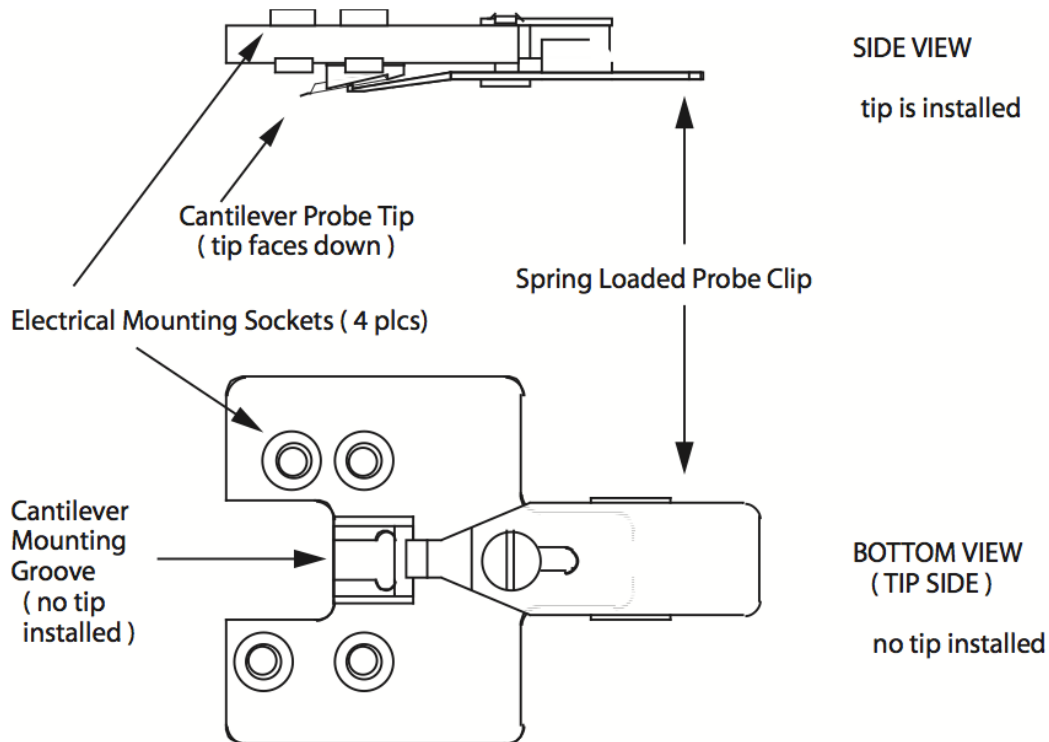
There are four knobs on the scanner – 2 for laser aim adjustments (x and y) and 2 for detector mirror position adjustments (x and y). The tip holder is mounted on the bottom of the scanner.

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



Note | The electrical mounting sockets are not equally spaced. Only one particular orientation is allowed for holder mounting. Do not force the holder to be mount in a wrong orientation or it will be broken. The holder is not cheap (\$630USD)

I. Setting Up the Program

1. Turn on the power strip on the dimension controller.
2. Open Nanoscope program (7301sr3) on the desktop.
3. *Tools > Select Microscope*. Choose *Dimension V* and proceed to with the default setting.
4. Click OK if Stage Initialization prompt appears. Proceed the initialization sequence.
5. 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.
6. Bring up the optical live view – *Acquire > Navigate*.
7. Bring up the laser/detector alignment window – *Acquire > Meter*.
8. Bring up a desired scan window – *Acquire > Scan Duo/Triple/8 Channels*.
9. Bring up the scan control – *Acquire > Scan Parameter List*.

II. Mounting the Tip to the Holder

1. Locate the tip holder on a black cylindrical holder block. The tip holder is a black piece of plastic circuit board with four holes for electrical connection to the scanner and one metal clip to clamp the tip.
2. Slide the clip all the way to the back such that the groove is fully visible.
3. Carefully place the tip onto the groove and slide the clip all the way to the front such that the tip is securely clamped by the lever.

III. Mounting the Holder to the Scanner

1. Move the scanner all the way to the top if it is not in the top position:
Select *Navigate* window and click the up arrow to move the scanner to the top.
2. Unlock the scanner by tightening the screw on the right of the scanner.
3. Take out the scanner and mount the holder to the scanner:
Face the tip pointing side of the holder to the stage and match the electrical sockets orientation to the pins on the bottom of the scanner.
4. Put the scanner back to the microscope:
Gently and carefully slide the scanner back to the scanner rail.
5. Lock the scanner to the microscope by loosening the screw on the right of the scanner.

IV. Aligning the Laser and Detector Mirror

1. Place a piece of white paper under the tip/scanner assembly so that the laser spot is visible. If the spot is not visible, it means that the laser is blocked by the tip or the holder, and you need to adjust the Laser Aim Adjustment knobs on the top of the scanner until the spot is visible.
2. Reposition the laser so that the spot sits right on the cantilever. When the laser is properly positioned, a symmetrical interference pattern will appear on the paper.
3. Once the laser is properly positioned, the dot that indicates reflected laser signal collected by the photodetector will turn bright red on the *Meter* window.
4. Fine tune the Laser Aim Adjustment knobs to maximize the SUM signal on the *Meter* window.
5. Adjust the Detector Mirror Position knobs on the left of the scanner to center the dot in the center of the square detector area shown on the *Meter* window. This can be a tricky

procedure sometimes, since it is hard to tell if you are moving the knobs in the right direction. If you see the SUM signal goes down, it means that you are turning the knob in the wrong direction.

6. Determine the actual resonate frequency of the tip and check if the tip is properly mounted: Click *Auto Tune* (tuning fork icon) on the tool bar of the program. Set the tuning range according to the spec printed on the back of the tip box and start tuning. Once the frequency is found, AFM imaging acquisition can be started.
7. Remove the white paper.

V. Loading Your Sample and Setting Up the Optical Microscope

1. Place the sample on the vacuum hole and turn on the vacuum to secure the sample.
2. Select *Navigate* window and press *Locate Tip* on the window. The camera should now focus on the tip. Adjust the Microscope position knobs to position the crosshair on the tip.
3. Press *Focus on Surface* to bring back the sample surface view.
4. Use *Stage XY Control* to move the sample to an appropriate position.
5. Find the sample surface by lower the scanner by pressing the down arrow associated to the *Z Motor*. You can bring the scanner down fast at first, until the tip-sample distance is about 5 mm.
6. Switch to Slow and continue approaching the scanner to the sample. Stop lowering the scanner once the surface is in focus. It is recommended to find the surface at the side/corner of the sample first especially for optically transparent/shiny samples. If you go beyond the position where the surface is in focus, you will crash the tip into the sample and might damage the instrument. Be very gentle and careful on adjusting the focus once the tip is close to the sample. Focusing process can be aided by zooming in the optical microscope.
7. Iterate step 2 – 6 one more time.

VI. 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).

VII. 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.

VIII. 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.

Emergency Information:

Medical Emergencies: **Contact 911 and Public Safety (609) 258-1000**

Room / facility emergencies: **Contact Public Safety (609) 258-1000**

Issues related to the instrument:

1. **Contact IAC Staff.**
2. **Shut down program.**
3. **Turn off Controller.**

Audible/Siren Emergency Alerts:

Follow previous steps 2 & 3 and leave the building.

Emergency Contact Information:

Nan Yao: Office (609)258-6394; Cell (908) 922-2236 Email: nyao@princeton.edu

John Schreiber: Office (609)258-0034; Cell (215) 431-4670 Email: js51@princeton.edu

Paul Shao: Office (609)258-3851; Cell (847) 721-086 Email: pshao@princeton.edu