

AFM/STM Operation Instruction

STM

Place STM head on air table. Please use a level to check the compressed air table before proceeding.

1. Setting up the STM head

- Set up the light and monocular microscope
- *Sample preparation*: using conductive carbon paint to fasten your sample on the disc holder and let it dry (at least one hour at room temperature).
- Load the sample to STM head: turning the thumbwheel on the front of STM to the left to move to the sample stage to near the bottom of its range. Use a non-magnetic tweezers to hold the edge of sample and place it on the magnetic sample mount.
- Tip preparation: Hold 0.2" ~0.4" of the Pt/Ir alloy wire with a pair of needle nose pliers and cut the tip off diagonally with a sharp pair of scissors or wire cutters, as you pull the tip and the rest of the wire apart from each other.
- Mounting the Tip: Hold the tip with your fingers and the tip with the tweezers. Insert the tip into the tip holder all the way with a slight bend.
- Loading the tip into the head: Make sure the sample is near the bottom of its range. Check the tip position indicator on the right side of the head. Make sure it is below the midpoint mark. If not, Turn the controller on and press the "Coarse Retract" switch down (the tip will go up) until the indicator is slightly below center. Use tweezers hold tip hold with the tip pointing down and carefully place it into the STM tip mount until the magnet grabs hold of the tip. Gently rock the tip holder to make sure it sits in place rigidly.

(Note: don't touch the sharp end of the tip or the surface of the sample. Make sure there is enough room before you put either of the tip or sample in the STM head.

After both the tip and the sample are in the head, turn the sample thumbwheel until sample is within 0.5 mm of the tip (use the mono microscope). Make sure tip points to sample flat area you interested.

2. Setting Up The Controller:

Turn the controller on if it is off.

There are two type of data collection mode: Current Mode (for smooth samples, or for very small(<500A)scan fields) and Topographic Mode (for rougher samples, or for large (>500A)scan fields:

- Set the **status monitor knob** to **Bias Voltage**: adjust **Bias Voltage** knob to +0.5V
- Set the **status monitor knob** to Reference Force/Current(nA): Adjust Reference Force/Current knob to 6 nA.
- Proportional gain: 2 o'clock
- Integrator gain: 3 o'clock

- Differentiator Gain: fully CCW
- Low pass filter: 2 o'clock
- Magnification: X2000 for current mode and X2 for topographic mode
- Zero X,Y offset: adjust XY offset controls until two middle indicator bars are lit.

Set the status monitor knob to Actual Force/Current and it should read approximately Zero).

3: Setting up computer and software:

- Turn the computer on if it is off
- Double click PSPM shortcut to launch the program.
- Select Scan control from the Collect menu
- Select Configuration.
- Set the parameters in the configuration window. The following list is a good starting point and you can change it according to your sample:

Parameter	Setting (Current mode)	Setting (Topographic mode)
Data Points in X,Y directions	256	
Number of substeps	0	4
Scan range in X, Y directions	Select equal X and Y values in allowable range	
Scan Range Scale	Automatic	
Pre-Amp Mode	Linear	
Sample Delay	0.00 mSec/Sample	0.2mSec/Sample
Retrace delay	0.00 mSec/Sample	0.2mSec/Sample
Scanline Delay	3.00 mSec/sample	
Frame Delay	150.00 mSec/Frame	
Z Gain Factor	25	1
Contact Mode	Contact	
Data Type	Current	Topographic mode
Tilt Removal	Off	
Linearity	Off	
Single Scan	Off	

Click on OK to exit Configuration.

4. Start Scanning:

- Press the Coarse Retract switch down momentarily if red feedback active light is on;
- Push the auto Approach up momentarily and wait;
- When the red feedback active indicator is on, check the actual Current should equal to the reference current and PZT Voltage (V) is between $-30V \sim +30V$.
- Now set the **status monitor knob** to **Bias Voltage**: adjust **Bias Voltage** knob to $\sim 0.02V$ and then turn the status monitor knob to Actual Force/Current (nA) again.

- Decrease LowPass filter to 12 o'clock; Proportional Gain to 9 o'clock for current mode and 12 o'clock for topographic mode.

Click Scan in the Scan control Window to begin scanning. The mouse is inactive during the scan. Press C key to capture image you like.

5. Shutdown:

Press the Coarse Retract to retract the tip and turn the controller off.
Exit the PSPM software.

AFM

Please use a level to check the compressed air table before proceeding.

1.Startup:

Turn the controller and computer on

Launch the PSPM program (Do not start the software if controller is OFF)

Probe preparation: The tips of probe are either made of silicon(rectangular) or Silicon Nitride("V" shape). Mount the probe on the aluminum probe mount with a drop of probe adhesive. Use the non-magnetic tweezers to gently align the probe with the centerline of the probe mount.

(Note: The probes are extremely fragile, The slightest contact with anything will destroy the probe. The fragile tip at the end of the probe is also easily damaged.)

Insert the Probe Mount: Use the COARSE RETRACT button to lower the scanning module so the Probe Mount can be inserted without damage the probe.

Turn the Controller off. (Caution: Always turn off the controller off when changing samples and probes, which will turn the laser power off to keep from deflecting the laser beam in uncontrolled directions.)

Screw the probe Exchange Tool into the threaded hole of the probe mount and insert the probe mount into Probe Mount Holder in the AFM head. Make sure it seat properly, unscrew and remove the exchange tool.

Probe Alignment: (Caution: Do not stare at any laser light that is uncomfortably bright.) Use optical microscope and focus it on the end of probe through the top aperture of the head.

Turn on the Controller and the laser automatically turns on.

Use the X and Y probe alignment knobs on the head until the end of probe is under the laser beam spot. You can check the position of the laser spot on the probe by holding a small piece of white paper in front of the detector and you should see a circular spot (~1 mm) on the piece of paper.

2.Preparing a sample

Use double-sided tape or any other adhesive to attach your sample to a sample mount. The surface to be imaged is dry and parallel to the top of the sample mount.

Insert the sample: Use the COARSE RETRACT button to lower the scanning module so the Probe Mount can be inserted without damage the probe.

Turn the Controller off. (Caution: Always turn off the controller off when changing samples and probes, which will turn the laser power off to keep from deflecting the laser beam in uncontrolled directions.)

Use the tweezers with curved ends to hold the sample mount and insert it into its holder in the Head.

Position the sample: Turn the Controller on. Use the COARSE APPROACH/RETRACT switch to bring the tip to within 0.5 mm of the sample top surface. You can use the magnifying glass to look at the probe and its reflection. Stop push up the COARSE APPROACH/RETRACT switch before the two touch.

3. Detector Alignment:

Launch the PSPM program

Check the controller, if the FEEDBACK ACTIVE indicator is on, press COARSE APPROACH/RETRACT switch down momentarily to turn it off.

Set the SPM MONITOR to the REFERENCE FORCE and adjust reference force to 5.0 volts

Set the SPM MONITOR to ACTUAL FORCE/CURRENT

Select the Detector Alignment from Calibration menu in the software. A target and a cross hair appear on the screen. Adjust the X and Y detector alignment knobs slowly to bring the cross hair to the center of the target. The laser beam is then on the center of the detector. The ACTUAL FORCE/CURRENT should be close to zero. Then click Exit.

4. Set up Controller for Scan:

There are two AFM modes of operation: **Topography (constant force)** and **Force (constant height)** mode. The normal mode for imaging is the topography mode. For approach the settings should be set so that the feedback responds as fast as possible when probe-sample contact is detected. The following is default settings for approach and image and you can adjust the settings as needed to optimize the image quality.

REFERENCE FORCE: 5 volts

Make sure the FEEDBACK ACTIVE light is off.

Set the SPM MONITOR knob to ACTUAL FORCE/CURRENT and the reading should be close to zero.

Proportional Gain: 12 o'clock

Integrator Gain: 12 o'clock

Differentiator Gain : 9 o'clock

LowPass Filter : 9 o'clock

Zero X,Y offset: adjust XY offset controls until two middle indicator bars are lit.

MAGNIFICATION: X1

Configuration parameters:

Select Configuration from the collect menu

Use following default settings:

Data Points in X , Y direction:256

Number of substeps: 0

Scan range in X/Y: 250000 angstroms

Scan range scale: automatic

Sample Delay:0.2 msec

Retrace Delay: 0.2 msec

Scanline Delay; 3 msec

Frame Delay: 150msec

Contact Mode

Data Type: Topographic

Tilt Removal/Linearity: Off

Acquiring the image:

- Press the Coarse Retract switch down momentarily if red feedback active light is on;
- Push the auto Approach up momentarily and wait;
- When the red feedback active indicator is on, check the ACTUAL FORCE on the controller and it should equal to the reference setting (5 volts). Decrease the proportional GAIN or LOWPASS FILTER if feedback oscillations.
- Select Scan Control from the Collect menu
- Select Scan in the Scan control window

Click Scan in the Scan control Window to begin scanning. The mouse is inactive during the scan. Press C key to capture image you like.

To optimize the image quality , for the topographic mode during a scan, take the following steps:

Increase the LOWPASS FILTER to within a range of 12 to 3 o'clock, while monitoring the image with minimal oscillations.

Increase the Proportional Gain or Differential Gain until the feedback oscillates. Then turn it back slightly.

You have to press [H] to halt the scan, or [A] to abort the scan to make configuration parameter adjustments

Change Magnification:?

5. Shutdown:

Press the Coarse Retract to low the sample and turn the controller off.

Exit the PSPM software.