PicoLE System
User's Manual

v1.2

Molecular Imaging

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Chapter 1: Initial Setup

Safety Considerations

The AFM scanner system contains a class II laser. Up to 1 mW at 670 nm is emitted from the laser housing. This manual describes alignment procedures using the reflected laser beam. The beam, reflected from the cantilever, is projected onto a frosted screen for viewing safety. Follow the alignment procedures described carefully. Never stare into the beam directly. Irreversible eye damage will occur if the beam is viewed directly for more than ¼ second. Protective eyewear is recommended.

There are no user-serviceable parts inside the scanner module. If any problems are encountered, return the scanner module to Molecular Imaging immediately for service. The laser will not operate unless the unit is plugged into the controller, the controller is switched on, and the laser switch on the microscope electronics is on.

The DB25 cable to the unit provides the high voltage necessary for scanning. If the cable becomes worn or broken it will pose a risk of electric shock and/or fire. Inspect the cable prior to every use of the microscope to ensure it is not hazardous. In the event of any defects, contact Molecular Imaging for replacement.

Unpacking

DO NOT unpack any of the boxes of the equipment if the system is scheduled for future installation by a Molecular Imaging representative. The unpacking of any items by a person other than a Molecular Imaging representative in such case may result in the loss of warranty coverage on these items.

When unpacking any equipment it is advantageous to check for any hidden damage as a result of shipping. A loose part inside the microscope or electronics could have profound consequences on the performance and reliability of the equipment. The best way to detect any possible damage due to shipping is to gently turn the pieces upside down and listen for any rattling noises, which would indicate loose parts inside. Should anything unusual be detected, please contact Molecular Imaging and **DO NOT** use the equipment under any circumstances.

Unpack all the components and retain all packing materials and shipping containers for future shipping and storage needs. The equipment must be placed upright and on a hard surface. **DO NOT** obstruct the ventilation slots in any way, as this could have catastrophic consequences for the equipment. Finally, make sure all equipment is placed far enough away from any solutions or moisture that could result in damage.

List of All Components

The parts list below is for a complete system with all hardware necessary for AFM imaging. Individual parts lists may differ, depending on the options purchased.

General

1. PicoLE Microscope
2. Microscope Electronics
3. Multi-purpose Scanner
4. Environmental Chamber (optional)
5. PicoIC (optional)
6. Tool Set

AFM Package

1. AFM Nose Assembly
2. Sample Plate
3. Large Gold Substrate
4. AFM Cantilevers (10)
5. Photodiode Detector

Choosing a Microscope Location

When used properly, the PicoLE is capable of remarkable performance in noisy conditions. This is due, in part, to the additional acoustic isolation provided by the environmental chamber. For noisy environments, we strongly recommend the PicoIC™, a desktop isolation chamber containing a suspension system for the microscope. Temperature stability is also an important factor; therefore, for optimal stability, the ambient temperature should not change by more than 0.5ºC per hour.

The microscope should be situated in a temperature-controlled room away from windows, doors, and vents. The effect of small local temperature fluctuations is greatly reduced by placing the microscope in a large enclosure (such as the PicoIC). In most cases, sources of mechanical noise and thermal change are least in basement environments. However, since the PicoLE system is engineered to minimize the difficulty of sample handling, we recommend placing the microscope close to the sample preparation area, and making adequate changes necessary to ensure the environment is conducive. Often, using the PicoIC will suffice. Using the PicoIC, the microscope will operate on any convenient sturdy surface.

Installing Calibration Files

The microscope comes with a calibration file supplied on a 1.44MB diskette or on a CD ROM. This calibration file contains a list of parameters that were measured for the piezo scanner at the factory. The PicoScan program already contains several generic files. However, because they are simply "generic" calibration files, the parameters will not give a true representation of the sample. If a complete PicoScan system with a scanner was purchased, the calibration file will have been installed at the factory. If additional scanners have been purchased since purchasing PicoScan, a calibration file will need to be installed. To do this, copy the calibration file to the "hardware" subdirectory of the PicoScan directory.

Once the calibration files have been installed and the program has been restarted, the user is able to easily access them within the program. Depending on the scanner's designated application (STM or AFM), the

file numbers will appear in the program matching the serial number located on each scanner head. Be sure to verify the correct calibration file has been selected for the chosen scanner prior to any scanning. It can be very frustrating when, in the middle of imaging or compiling data, it is realized that the wrong calibration file was chosen for the scanner used.

Calibrating The Scanner

See the PicoScan User's Manual for calibration procedures.

Extended Capabilities of PicoLE:

In addition to the basic AFM and STM functions described in this manual, the PicoLE microscope has ACAFM™ mode capability. This is a non-contact AFM mode that uses an oscillating cantilever. The cantilever is driven acoustically or magnetically. PicoLE also has electrochemistry capabilities, giving the user complete control of the voltage applied to and current through the sample. Temperature and environmental control are also available.

Chapter 2: PicoLE Component's:

The purpose of this chapter is to provide a brief overview of the PicoLE system. Refer to other modules for specific applications and descriptions of the various modes of operation.

Microscope

The PicoLE microscope makes many advances over its predecessor. The rear plunger, used during automatic approach, does not rotate where it contacts the sample stage. This makes it possible to approach the tip to a particular point. The environmental chamber is large and has eight access points for gasses or wires. The sample translation mechanism allows for smooth, fine movement of the sample.

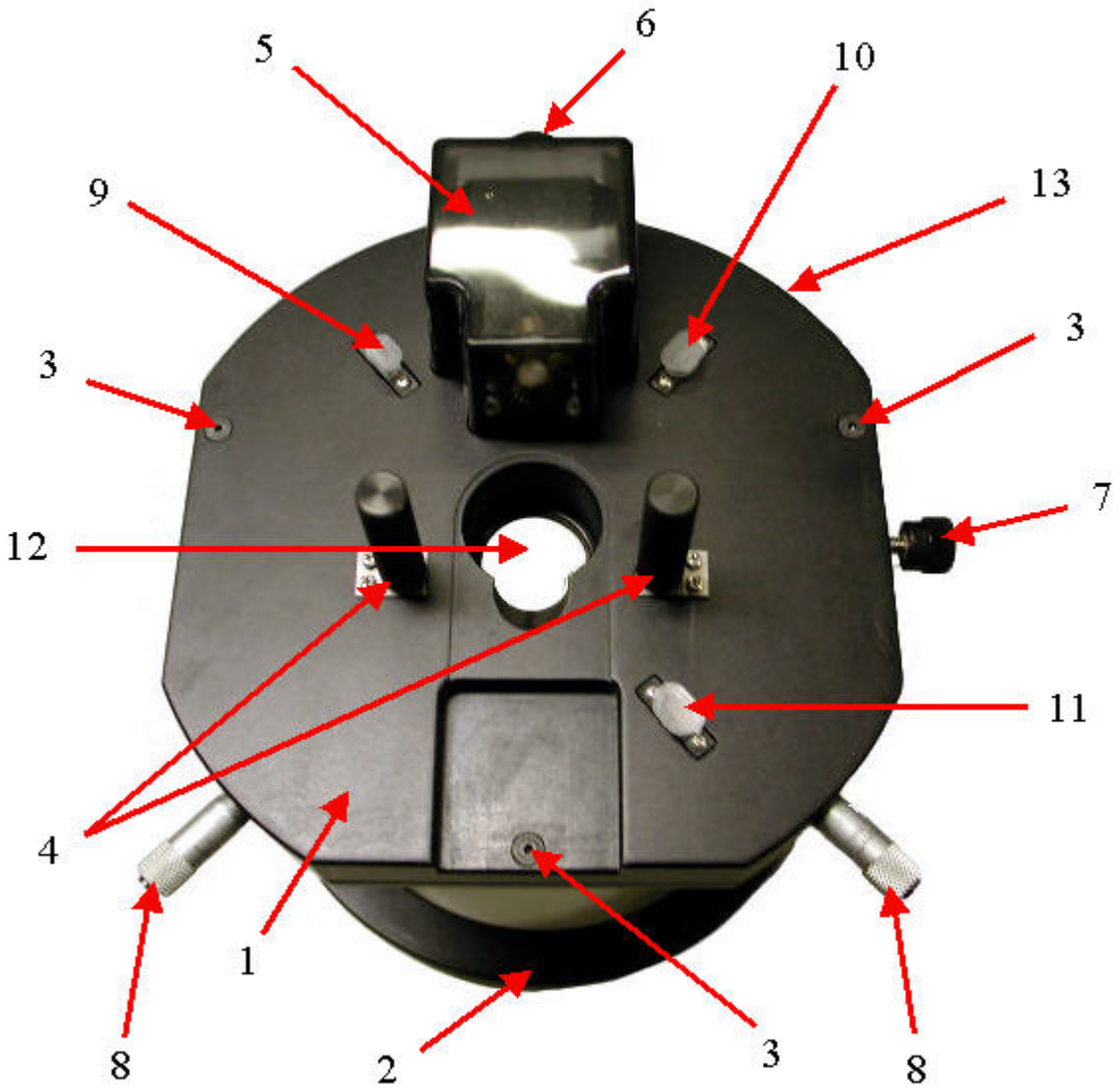

Figure 2.1 (top view of PicoLE microscope)

1. **Microscope Body**: The main housing of the microscope, it holds the scanner, stepper motor, and wiring.
2. **Microscope Base**: Microscope Body fits on this base. May be replaced with Flip Stand. (optional)
3. **Base Mounting Screws**: These screws secure the **Microscope Body** to the **Microscope Base**.
4. **Front Plunger Assemblies**: Adjust the height of the front plungers. Used to coarse approach the sample to the tip before automatic approach.
5. **Stepper Motor**: Used for automatic approach.
6. **Manual Sample Adjustment Knobs**: Use for coarse approach in conjunction with the Front Plunger Assemblies.
7. **Locking Screw**: Tighten to hold the scanner in place.
8. **Translation Screws**: Used to translate the sample in X and Y with respect to the tip. One revolution of the screw moves the sample approximately 0.23mm the translation has a range of 5.0mm.
9. **High Voltage Scanner Connector (polarized mini DB9)**: The scanner connects to this male connector.
10. **Low Voltage Scanner Connector (mini DB9)**: The scanner connects to this female connector.
11. **Photodiode Detector Connector (mini DB9)**: The photodiode detector connects to this female connector.
12. **Scanner Port**: Scanner inserts here.
13. **DB25 Connector**: Connection from Base to PicoLE Electronics Module.

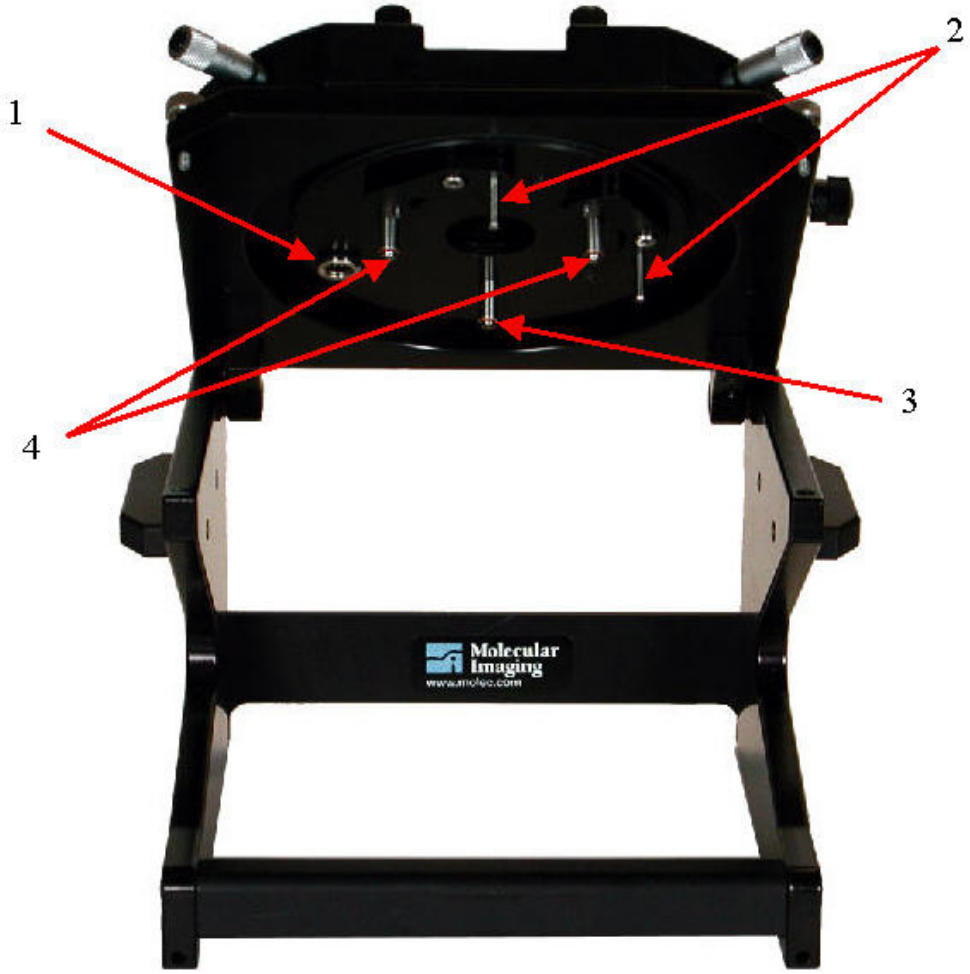

Figure 2.2 (bottom view of PicoLE microscope, mounted on optional flip stand)

1. **EC/MAC Plug**: This is where the EC/MAC cable plugs into the microscope. The leads then plug into the appropriate jacks on the sample plate.
2. **Translation Pegs**: These two pegs allow you to move the sample plate. They go through the two holes on the rim of the sample plate.
3. **Motor Screw**: The motor turns this screw to adjust the height of the sample plate.
4. **Manual Plunger Screws**: These are the two manual height adjustment contact points.

Pico LE Electronics

This box contains all of the electronics that control the microscope. With the PicoSPM, most of these controls and electronics were on the microscope itself.

Front Panel

- **Meter A**: This meter displays the Sum signal from the photo-diode detector when the system is in AFM Mode or the Current signal from the STM Scanner when the system is in STM Mode. The mode for the PicoLE is selected with the STM/AFM Switch described below.
- **Meter B**: This meter displays the Deflection and LFM signals when the system is in AFM Mode. In STM mode this display is meaningless. To change the signal displayed use the Deflection/LFM Switch described below.
- **Laser On/Off:** This switch allows the user to turn the scanner laser power on or off. A green LED lights up when the laser power is on.
- **STM/AFM Switch**: This switch is used to put the PicoLE in the appropriate mode for scanning.
- **Contact/AC Mode/CS AFM Switch**: This switch sets the electronics up for the various modes of AFM that the system will do. It is important that this switch be in the correct position for the three types of AFM imaging. Failure to adjust this switch can cause the microscope to work improperly in a given AFM mode.
- **Deflection/LFM Switch**: This switch changes the signal to Meter B so that the photo-diode can be adjusted correctly for imaging.

Figure 2.4 (front panel of PicoLE Head Electronics box)

Rear Panel

- **Controller**: This connector is for the connection of the DB25 Cable from the PicoScan Controller to the PicoLE Electronics box. Depending on the mode of operation there may be additional modules between the PicoScan Controller and the PicoLE.
- **Microscope**: This connector is for the connection of the DB25 Cable from the PicoLE Electronics to the PicoLE Microscope Base. There should be no additional hardware between the PicoLE Electronics and the PicoLE Microscope Base.
- **CS AFM**: This BNC connector is used only when doing CS AFM imaging. It must be connected to the Aux In BNC Connector on the PicoScan controller using the supplied BNC Cable.
- **AAC**: This BNC connector is used only when doing Acoustic AC Mode imaging. It must be connected to the AAC BNC on the back panel of the MAC Mode Controller or AC Mode Controller.
- **MAC**: This BNC connector is used only when doing MAC Mode imaging. It must be connected to the MAC BNC on the back panel of the MAC Mode Controller.

Figure 2.5 (rear panel of PicoLE Head Electronics box)

Scanner Module

The nose assemblies of the scanner are completely interchangeable to allow for any type of imaging using the same scanner module. To change a nose assembly, loosen the setscrew on the side of the scanner nose and pull out the assembly. It is important that the nose be pulled out directly in line with the long axis of the scanner in order to prevent damage to the piezo. The scanners also come with built-in optical access. The imaging lens produces an image 34 mm above the scanner.

Note: Scanners should be placed in a moisture-free environment for overnight storage.

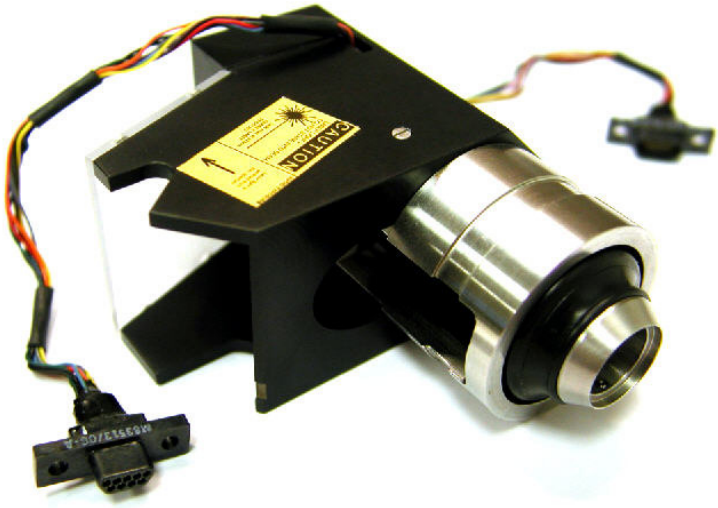

Figure 2.6 (scanner module)

Multipurpose Scanner Preventative Maintenance

In order to maintain optimum scanner performance, it is recommended that the multipurpose scanner be kept clean and dry when not in use by placing it in a desiccator. The scanning head is made of very brittle and fragile piezoelectric ceramics and therefore extra caution should be taken when handling the scanner. Applying excessive lateral force to the nose cone housing when exchanging nose cones or falling a short distance onto a hard surface will damage the scanning head. If the nose cone housing becomes loose or can be wiggled with the fingers when in place, contact MI Support for further assistance. Cracked or broken piezoelectrodes will result in abnormal imaging. ***Damages to the scanner such as those described above are not covered by the MI standard warranty.***

Sample Plate

The sample plate attaches magnetically to the three adjustment screws underneath the microscope. Additionally, the translation pegs underneath the microscope go through the two holes on the rim of the plate, which allow for manual translation of the sample. One revolution of a sample translation screw will move the sample about 0.23 mm. The range of the sample is 5.0 mm in the X and Y directions.

Figure 2.7 (standard sample plate)

Sample Plate Preventative Maintenance

Sample stages (plates) should be kept free of dirt, grease or corrosion in order to prevent drift during imaging or electrical shorting between electrode contacts. The thin glass slide located at the center of some of the sample stages upon which the sample is usually positioned provides some degree of electrical insulation and protection for the sample stage. Care should be taken not to damage the glass slide. ***Physical damage to the glass slide (cracking or breakage) and corrosion of the sample stage are not covered by the MI standard warranty.*** *Should one of these happen, please contact MI Support for repair or replacement.*

Small Cables

All small cables for the PicoPlus/PicoLE system, such as AFM scanner and detector cables, 3-pin EC cable, microscope-to-MAC sample stage cable, etc., can break or have poor contact due to improper user or from normal wear and tear. These cables are warranted for 90 days from the date of purchase.

Chapter 3: Atomic Force Microscopy – AFM

AFM Nose Assembly

The nose assembly is designed to allow the use of cantilevers on one side of the chip while preserving the cantilevers on the other side. To insert a cantilever:

1. Place the scanner on the mounting jig.

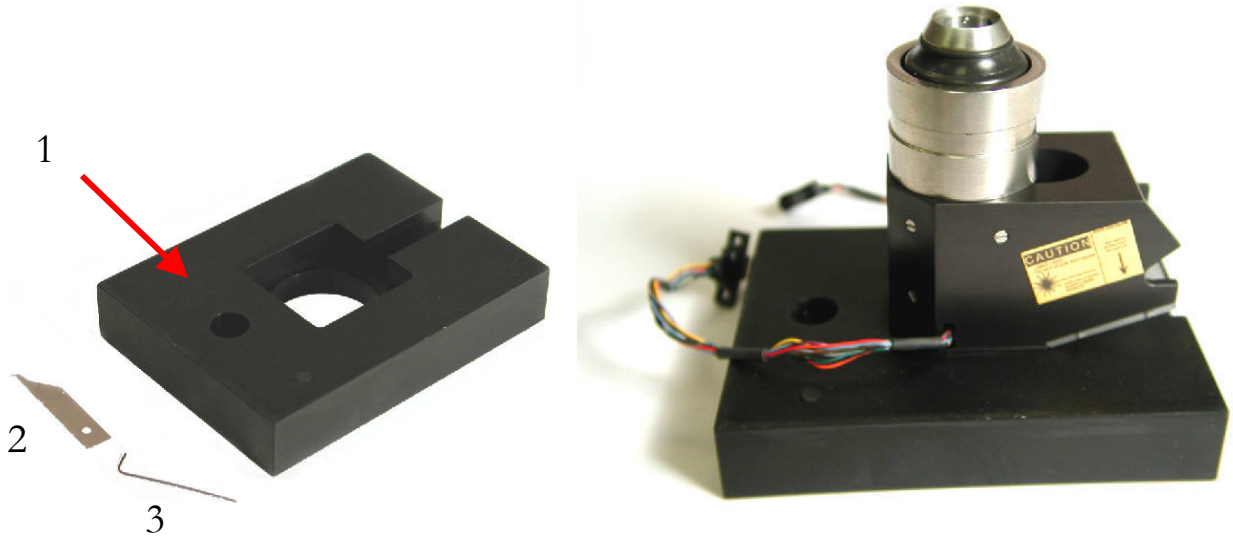

Figure 3.1 (Scanner mounting jig and accessories)
Left: 1. Mounting jig 2. Spring key 3. Allen key
Right: Scanner in place on mounting jig.

The nose assembly may also be removed and placed directly on the mounting jig.

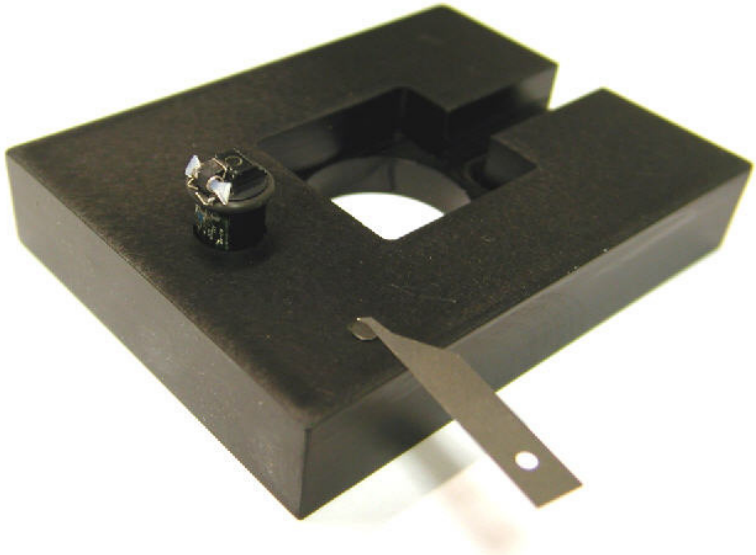

Figure 3.2 (CSAFM nose placed in the mounting jig.
The small magnet is useful to keep track of the spring and Allen keys.)

2. Using the spring key provided, lift the spring.

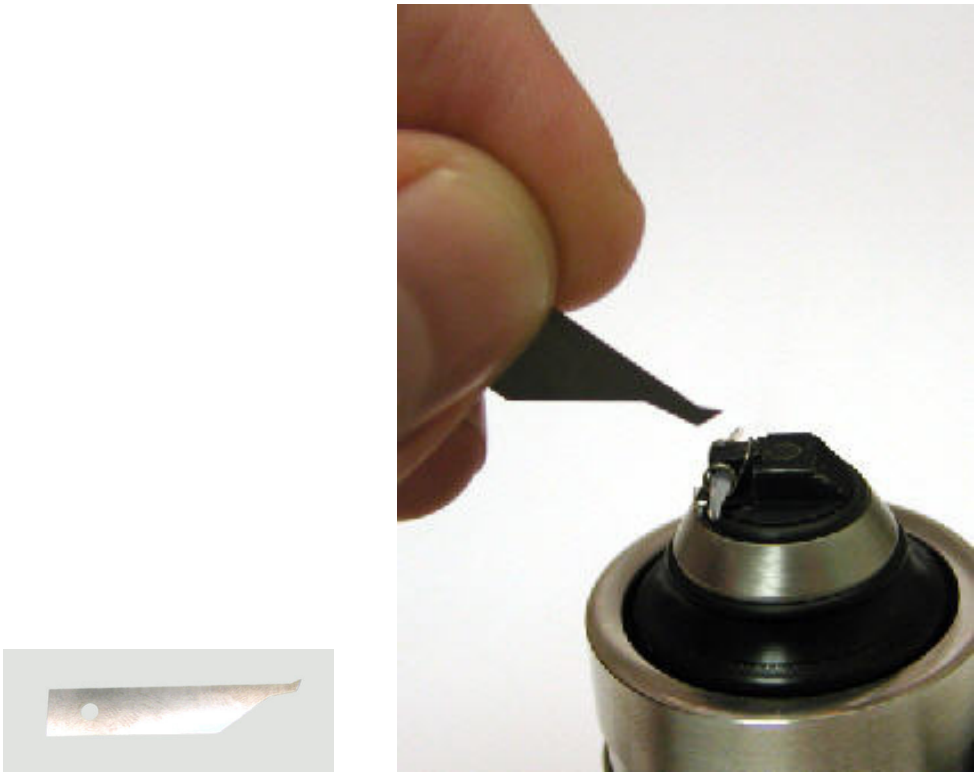

Figure 3.3 (Using the spring key)

3. Use a fine tweezers to place the cantilever chip into the slot while the spring is lifted. Be very careful when lowering the spring back onto the chip, as it can snap down and break the chip. There is no stop in the slot; use Figure 3.4 and Figure 3.5 as a guide.

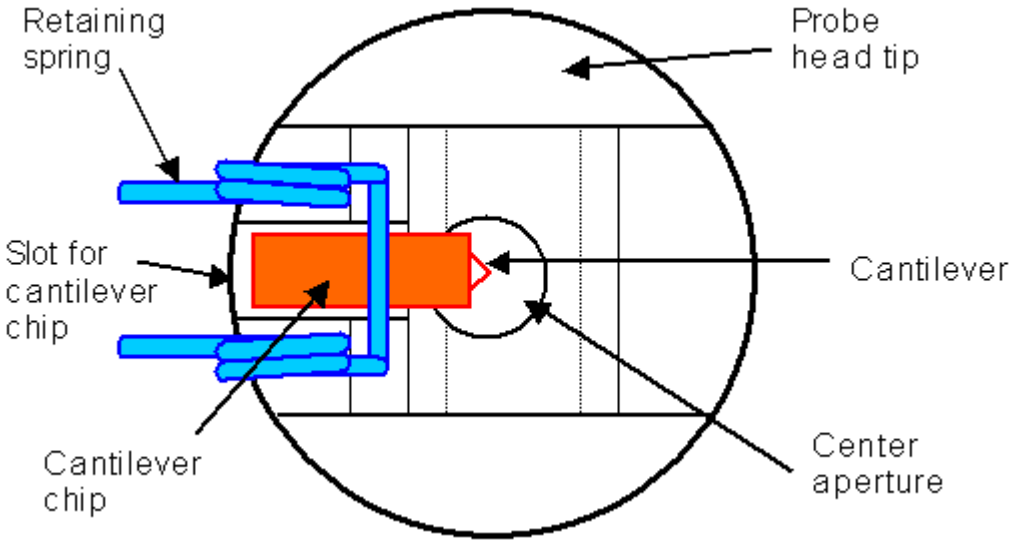

Figure 3.4 (Nose assembly)

Since the cantilever chip is held by the spring from the top only, cantilevers at both ends are preserved. Cantilever position at the end of the nose affects the deflected laser spot on the observing window of the scanner, as shown below in Figure 3.5.

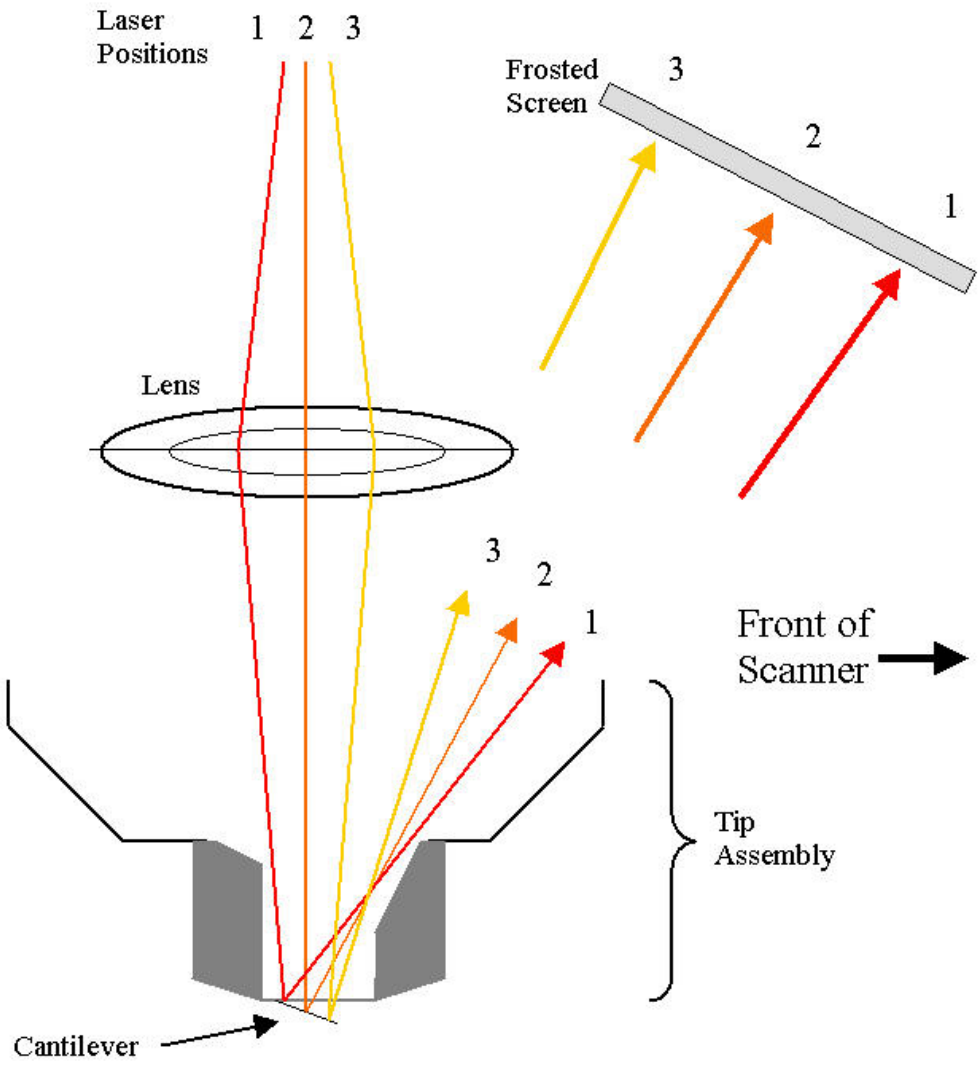

Figure 3.5 (Laser deflection diagram)

The diagram above gives a general rule for mounting cantilevers. Cantilever positions 1-3 lead to different positions of the reflected laser spot on the screen. The closer the cantilever toward the left of the nose window, the farther right the laser spot on the screen.

Due to the variation of cantilever types and vendors, the position of the cantilever needs to be optimized individually. In order to get better laser alignment for imaging in liquid, the deflection spot on the glass window in ambient conditions should be close to position 3.

Nose Cone Preventative Maintenance

Dirt, grease or spots on the glass window of the scanner nose can interfere with the optical path of the laser. For this reason it is important that the window be kept clean in order to maintain optimal imaging performance. The window can be cleaned with cotton or a soft tissue (dry, wetted with water, or with ethanol). The glass is glued to the nose cone with chemically resistive epoxy so if the window breaks there is no easy way to replace it and the entire nose cone will very likely have to be replaced.

Glass window breakage by any means is not covered by the MI standard warranty. *The nose cone spring may become corroded if used extensively in a chemical environment. The spring can be easily replaced and spare springs may be purchased from MI. Contact pins on the nose cones (such as those used for CSAFM, ACC, STM and TopMAC) can become loose or broken due to wear and tear. Contact MI Support for repair or replacement. The nose cone pins are warranted for 90 days from the date of purchase.*

Inserting the Scanner Module

Insert the scanner into the microscope through the scanner port in the center of the microscope as shown in Figure 3.6 below.

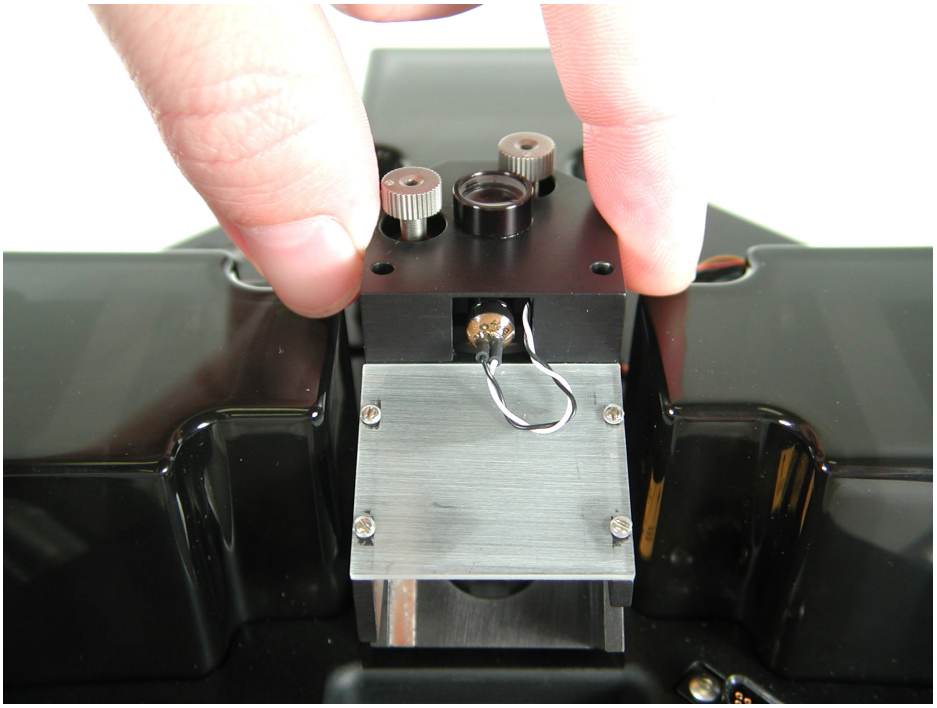

Figure 3.6 (Placing the scanner into the PicoSPM II microscope. The placement is exactly the same for the PicoLE with the exception of the two extra motor housings on either side of the scanner port.)

Plug the scanner cables into the HV and LV scanner connectors on the rear of the microscope. The genders of the two connectors are different, so they cannot be connected incorrectly. Tighten the locking screw on the side of the microscope to secure the scanner in place.

Aligning the Laser Beam

This section will discuss how to align the laser beam on the cantilever. To successfully align the laser, it is important to understand how the scanner operates and what to look for during alignment. Briefly, once the laser is aligned on the cantilever, the incident laser beam will shine through the scanner module and onto the cantilever. The beam then reflects off the back of the cantilever, at an angle, through the scanner and

onto a photodiode detector. A slight deflection of the cantilever changes the angle of the laser beam and thus, the position of its reflection on the detector. This is how the microscope detects sample topography.

The right alignment screw on the scanner translates the laser up and down along the Y line. The left alignment screw translates the laser beam left to right along the X line.

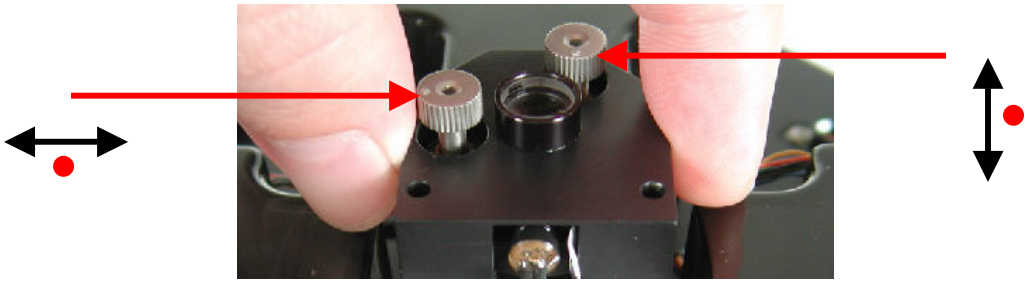

Figure 3.7 (Translation knobs for aligning the laser)

During alignment, a piece of paper can be used to monitor the intensity and shape of the **transmitted** beam – the portion that does not hit the cantilever or chip. The frosted screen on the scanner makes it possible to safely monitor the intensity and shape of the **reflected** beam. DO NOT STARE DIRECTLY INTO THE TRANSMITTED OR REFLECTED LASER BEAM. To properly align the laser beam, take the following steps:

1. Place a small, white piece of paper underneath the microscope where the laser will shine down.
2. Turn on the laser beam switch on the front of the electronics box.
3. Using the laser alignment screws, adjust the position of the beam until a bright, clear spot is visible on either the piece of paper or the screen.
4. With the left screw, move the spot forward, down the Y line. When it suddenly disappears, the front edge of the cantilever chip has been reached. Slowly back the laser off of the chip and stop when the laser beam spot reappears.
5. With the right screw, move the laser spot to the end of the X line (when the spot disappears, bring it back a bit).
6. Next, move the laser back toward the cantilever by turning the right alignment screw very slowly in the opposite direction from Step 5, above. Follow the spot along the X axis on the paper. The edge of the cantilever leg has been reached when the diffracted laser beam is visible on both the screen and paper.

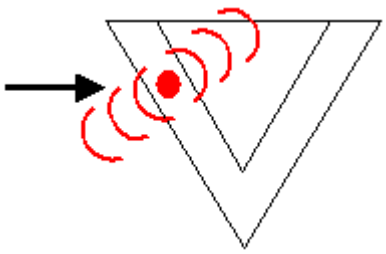

Figure 3.8a

7. Continue to move the spot in the same direction. The spot should reappear. The laser beam is now situated between the legs of the cantilever.

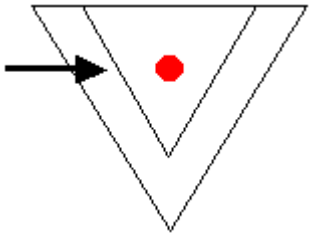

Figure 3.8b

8. Continuing the motion of the laser beam in the same direction will make the spot disappear, this indicates that the other cantilever leg has been reached and diffraction of the laser beam will again be apparent.

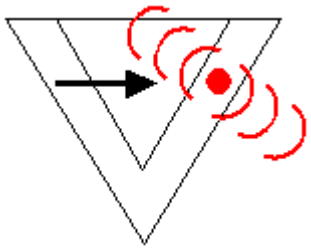

Figure 3.8c

9. If the laser spot disappears then appears with continued laser adjustment in the X direction, this indicates that the laser has passed over the second leg and is now past the cantilever.

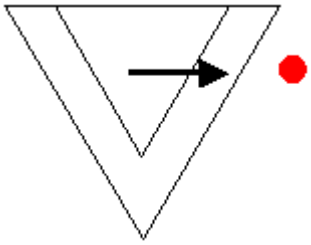

Figure 3.8d

10. Move the laser back in between both cantilever legs again.

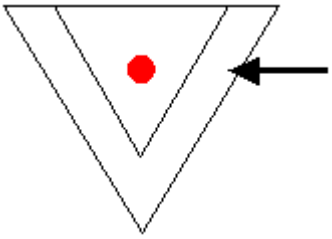

Figure 3.8e

11. Find the cantilever center, and then move the laser to the tip of the cantilever by turning the left assembly screw. The spot on the paper should be almost completely obscured by the cantilever.

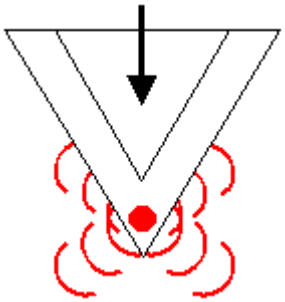

Figure 3.8f

12. The final spot on the paper should look more like an X. This pattern will occur because the laser beam is directly on the tip of the cantilever. A strong reflection signal should still be apparent on the screen, indicating that the cantilever is positioned correctly and that the cantilever is in good working order.

Notes

- REMEMBER: Unless the beam is hitting the cantilever or the cantilever chip, a clear spot will be seen on the paper underneath the head.
- Because of the tracking lens, motion in the Y direction will appear on the paper to be in the opposite direction to the motion of the spot on the chip (because the focus is on the chip).
- Be careful not to move the spot so far that it leaves the tracking lens. Position the beam near the center.
- When the spot is extinguished rapidly twice in succession as it is swept parallel to the edge of the chip, it is clearly passing the legs of the cantilever.

Placing the Sample

There are three plungers that contact the sample plate. The front two can only be adjusted manually, while the third (motorized) plunger can be adjusted through the software or by hand. Also, two translation pegs go through the two holes on the rim of the sample plate. To mount the sample plate when not using a liquid cell:

1. Prepare and load the sample as desired. The standard translatable sample plate has a magnetic core that will securely hold any samples mounted on magnetic backings.
2. Place the sample plate in position on the underside of the microscope. The plate will "clip" into place as the magnets hold the plate to the adjustment screws. If using the translation pegs, be sure that they pass through the translation holes on the sample plate.
3. Adjust the screws to bring the sample close to the cantilever with the sample plate as level as possible.

If using a liquid cell, follow the above procedure before mounting the liquid cell to the sample. Remove the sample plate and assemble the liquid cell on the sample plate as described in the **Liquid Cell module**, then carefully reattach the sample plate to the magnetic plungers with the liquid cell in place. The laser spot on the screen will move forward when the cantilever is submerged.

Notes

- Due to reflections, the shape of the laser spot on the screen may change slightly when the sample plate is mounted.

- Since the laser was previously aligned on the cantilever, it will be easy to determine if the tip crashed during placement of the sample on the sample plate. If this occurs, the laser dot will no longer be visible on the screen.
- A flashlight might help in determining the exact distance between the sample plate and the cantilever.
- The cantilever tip should be a distance of 0.5 mm to 0.25 mm from the sample.

Aligning the Photodiode Detector

It is necessary to align the detector for getting AFM topography, deflection and lateral force (Lateral Force Mode or LFM) images. This is a fairly straightforward process. Normal contact AFM measures the three-dimensional topography of a sample surface with angstrom resolution, while LFM measures the lateral or frictional forces exerted by a probe on the sample surface.

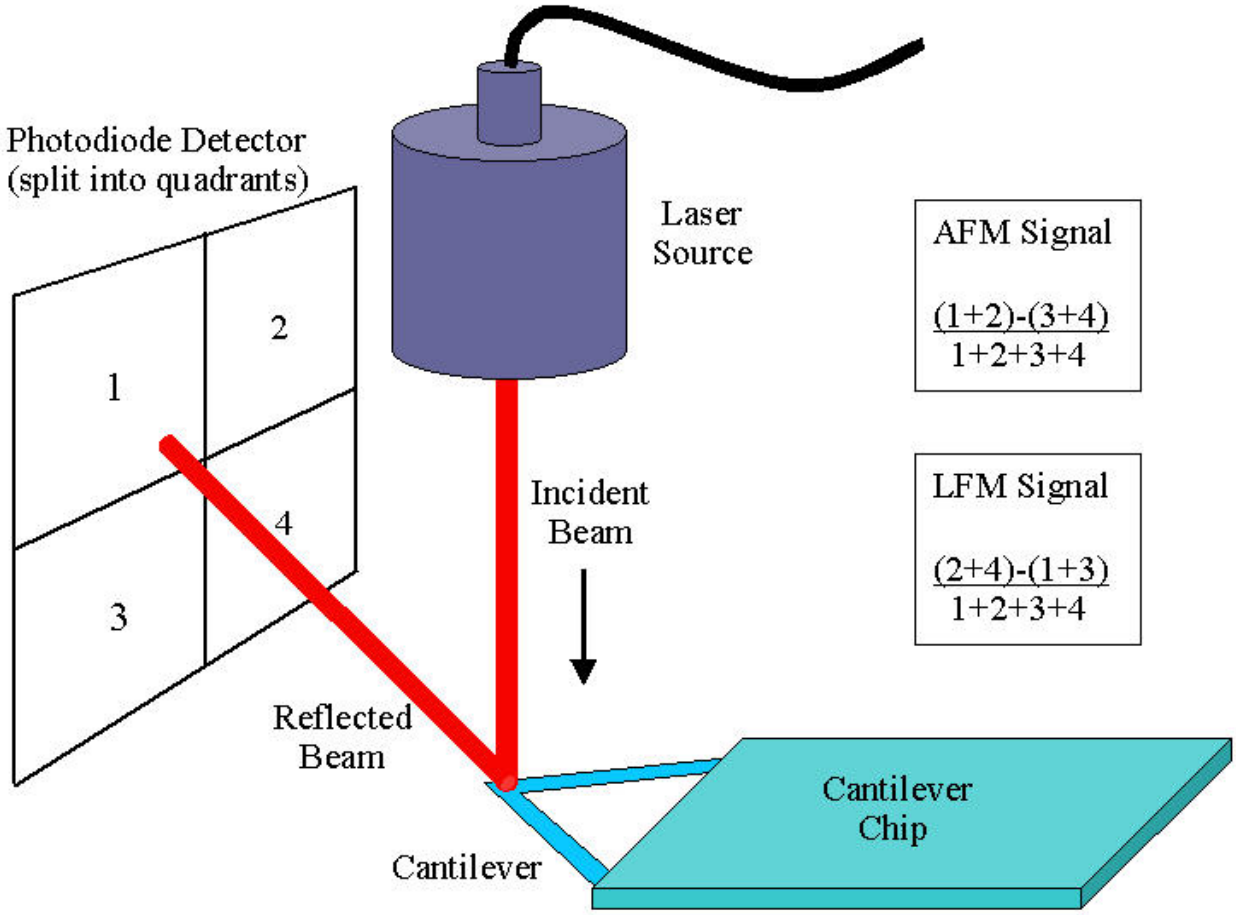

Figure 3.9 (Photodiode detector alignment)

In normal AFM mode, the optical detection system senses the vertical deflection of the cantilever as the tip encounters features on the sample surface. The basic idea is to position the photodiode detector such that the reflected laser beam is centered top to bottom on the detector (see AFM Signal in the schematics). The LFM mode uses additional photodiodes and electronics to measure twisting, or torsional deflection, of the cantilever. Thus the detector is positioned such that the reflected laser beam is centered left to right on the detector (see LFM Signal in the schematics).

The photodiode detector consists of four quadrants. The top and bottom halves (A and B) are used in AFM imaging, while the two side halves (C and D) are used in LFM imaging (See Figure 3.9 above). The detector has a 9-pin cord and plug, which connects at the front right of the microscope. The detector fits snugly in the scanner assembly, and can slide into place while the scanner is mounted in the microscope. See Figure 3.10 below.

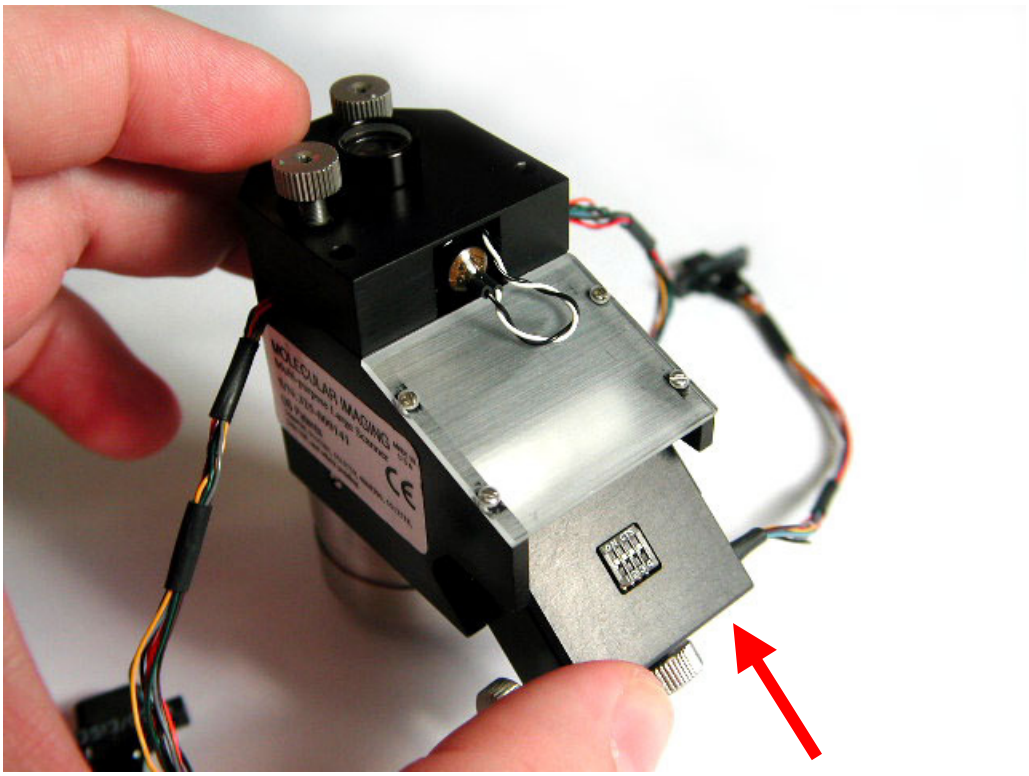

Figure 3.10 (The photodiode detector assembly slides snugly into place from the front of the scanner assembly.)

To properly align the detector for AFM use:

1. Insert the detector assembly, detector facing down, into the scanner assembly. Before doing so, use the two adjustment knobs on the detector unit to position the detector roughly where the laser spot will be. See Figure 3.11 below.
2. Move the detector using the two wheels until the SUM signal is maximized.

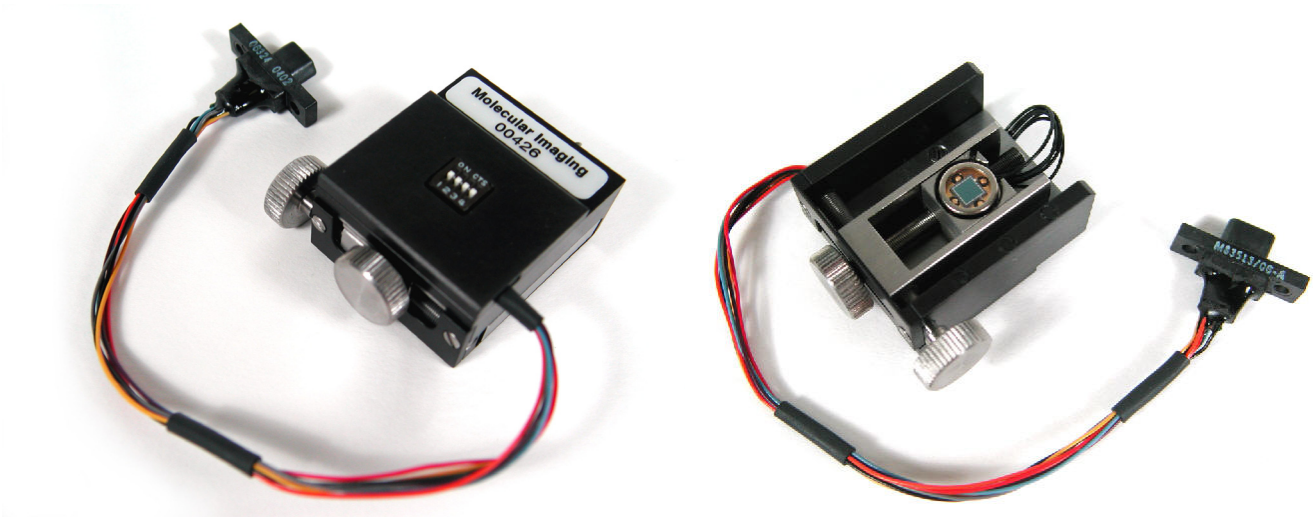

Figure 3.11 (Photodiode detector unit; top view on the left and bottom view on the right. The photodiode chip is visible in the bottom view.)

3. Using the wheel at the bottom of the detector assembly, move the detector until the DEFLECTION signal is about –0.7. The greater the magnitude of this number, the more force the tip will exert on the sample.
4. Using the wheel at the left of the detector assembly, move the detector until the LFM signal is close to 0 (zero). While this step is not crucial for non-LFM imaging, it can help to maximize signal strength. If performing LFM imaging, the closer this value is to 0, the better.
5. Repeat 3 and 4 until the signals are close to their desired values. See the AFM tutorial in the software user's manual for further procedures for AFM imaging.

Notes

- Lateral force on the cantilever is caused both by friction and by the tip touching the edges of sample surface features. Therefore, it is important to verify that the data on the friction channel is a result of friction between the cantilever and the sample.
- Rotating the scan angle can maximize separation between trace and retrace – increasing lateral friction. This occurs because friction force is measured by the amount of cantilever twisting. A setting of 0° usually works best for LFM imaging.
- It helps to adjust the deflection last. Turn the X and Y translation screws (see Figure 2.1) back slightly after adjusting in order to release the tension on the stage and reduce the risk of detector drift.

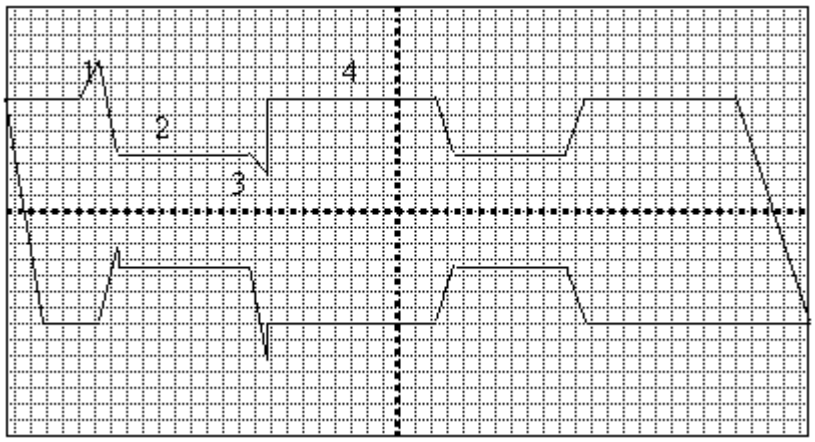

Figure 3.12 (Example of lateral force scan and retrace)

- The graph in Figure 3.12, above, depicts an ideal trace and retrace on-scope for a sample with low friction areas where one is a flat bump (possibly due to some low friction material sticking to a high friction surface). Notice on the trace that as the probe strikes the edge of the bump (1), the lateral force increases momentarily and then decreases as the tip begins scanning across the low friction bump (2). At the other edge of the bump, the lateral force may decrease as the probe comes off the bump (3), and then will increase as the probe scans across the high friction surface (4). On the retrace, notice the sign of the frictional force will change, but the shape will remain the same. The lateral forces due to topography shift to the other side of the bump and also change sign.

Freestanding Operation

Freestanding operation mode (FSOM) can be used to image larger samples, or samples that require special setup which do not fit into the standard sample stage. In this mode, the microscope is placed onto a larger, flat, hard surface, which can be a sample surface itself, or a platform with the sample placed on it.

1. The two translation pegs must be removed. To do this, remove the screws holding the pin assemblies in place from the bottom side of the microscope. There are 4 pieces of hardware per leg assembly (screw, leg assembly, curved washer and bronze top washer). Be careful not to lose any of the hardware. It is now possible for the microscope to rest on the three plunger screws.
2. Using the sample plate, adjust the height of the microscope with respect to the sample, by using a dummy sample of similar height. This is to ensure the real sample is not higher than the surface on which the microscope will be resting.
3. Follow all procedures, as previously discussed, to mount the cantilevers and operate the AFM scanner and microscope.

Chapter 4: PicoLE Troubleshooting

Imaging either in STM or AFM is fairly easy but may take some time to master. Listed below are a few troubleshooting ideas that might be of assistance while imaging. If still unable to obtain quality images, please feel free to contact any one of our support staff or application scientists at Molecular Imaging and they will be more than eager to offer their assistance. Contact: support@molec.com.

Noisy or Streaky Images

- It is likely that the tip is bad. Replace the tip and try again. The cost of trying a new tip is neither worth the time nor frustration of not having an image turn out as expected.
- A dirty sample is a possibility. Take care in preparation and ensuring the sample is as clean as possible.
- Is the laser correctly aligned on the cantilever? See the **Aligning the Laser Beam** section on page **13** for additional information about aligning the laser on the cantilever.
- If imaging a biological sample in solution, the tip may have picked up part of the sample (this usually occurs when working with a soft sample). Try to knock the contamination off the tip by continuing to image for a while or by performing a force-distance spectroscopy. If this does not help, change the cantilever.
- For atomically flat surfaces, try reducing the **Servo Range** in PicoScan. This will increase Z resolution. Be careful that the sample remains in the range you specify. Do not attempt this for rough surfaces (features > 200nm) as it may crash the tip.
- The integral and proportional gains in PicoScan may be too high. Try reducing them.
- A poorly insulated STM tip may give high tip leakage current in liquid. If this is the case, the tip needs to be replaced.
- The microscope may pick up acoustic or electrical noise from certain environments. Place the microscope in the PicoIC™ and close the door.
- Old bungee cords in the PicoIC may have lost their elasticity, or the suspended block is touching something in the PicoIC. Either case would result in poor vibration isolation.

Excessive Drift

- The key element attributed to drift is creep in the STM tip wire. Follow the procedure in the manual for STM alignment.
- If using AFM, be certain the cantilever holder is not touching any part of the sample plate, and if using a liquid cell, be certain the cantilever holder is not touching any part of the liquid cell.
- Make certain the sample plate is level in the XY plane.
- Make certain all connections are correctly in place.
- If using a coated STM tip, make certain the tip holder is not contaminated with the coating, such as the wax.
- Grease and oil from fingers can cause drift. Be careful not to touch the tip, cantilever, motor screws, liquid cell, or the sample plate with bare hands.
- Make sure the tension on the photodiode detector alignment screws and on the plungers is reduced by turning the adjustment screws in the opposite direction (see Figures 2.1 and 3.11).

Laser Alignment

This could be the most common problem with AFM imaging. However, do not be alarmed, for in the beginning this causes trouble for all. In fact, even seasoned AFM users will occasionally be unable to find the cantilevers or align the laser beam. REMEMBER: Aligning the laser beam on the end of the cantilever is crucial for high quality, accurate images, so take the time to make certain that the laser is properly aligned on the end of the cantilever.

- Refer to the **Aligning the Laser Beam** section on page **13** for instructions on how to align the laser on the cantilevers. Pay particular attention to the advice offered in the Notes section as well.
- If unable to find the cantilever chip at all while aligning the laser, remove the scanner module and verify the cantilever chip is not off-center in the holder.
- When using a liquid cell, if after placing the sample plate back into the microscope with the liquid cell in place, the laser spot no longer appears on the frosted screen, follow the adjustment procedures outlined for liquid cell use. However, it is a common mistake when placing the liquid cell to hit the edge of the liquid cell either on the cantilever holder, shifting the entire cantilever chip, or hitting the cantilever itself and breaking it off. Be careful when placing the sample plate to avoid these common mistakes.