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Aligning the XE-Series AFM

Fundamentals:

1. Load sample
2. Load cantilever, if necessary
3. Align laser on cantilever
4. Center laser on PSPD
5. Approach tip to sample

Instructions:

IMPORTANT: Please turn only one knob at a time (refer to the "Adjustment-Knob Reference Sheet" to verify the correct adjustment).

1. Load sample
   a) Mount sample onto sample plate using tape or glue. If possible, the best method is to glue the sample using super glue (supplied with system).

   b) If the sample is large, unscrew the magnetic sample holder from the XY scanner and place sample directly on the XY scanner.

2. Load cantilever, if necessary
   a) DO NOT adjust the objective camera position.
   b) The center of the camera on the monitor screen is the approximate position of the last user's cantilever, and therefore the laser . It is very important NOT to adjust the objective knobs in order to make Step 3 much easier.

3. Align laser on cantilever
   a) Pay close attention to how much you turn the X and Y objective adjustments to find the cantilever on the camera. Repeat the EXACT translation, but with the laser position knobs.
   b) Depending how accurate your movements are, the laser should be near the edge of the cantilever or cantilever substrate.
   c) Fine tune the X and Y laser adjustments so the laser is on the front half of the cantilever (see *Figure 1*).

d) If the laser spot cannot be found, locate laser by placing the IR detection card where the sample would normally be.

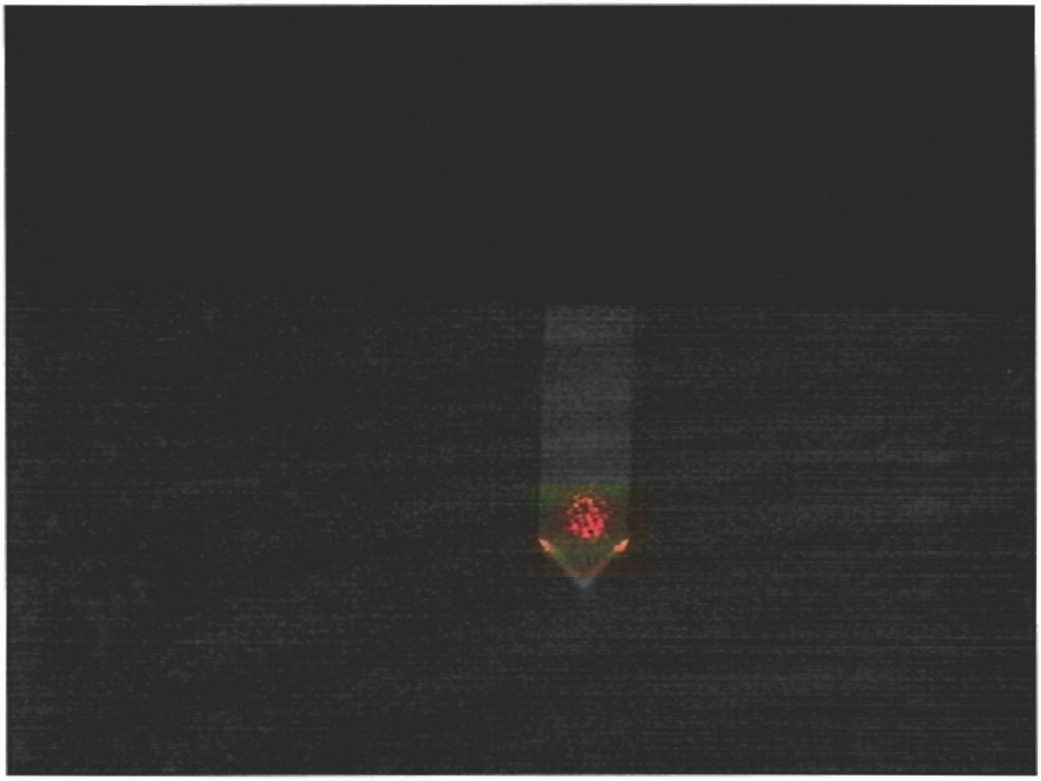

Figure 1

4. Center laser on PSPD
    a) Turn PSPD mirror adjustments (small knobs on front of head) to move red the red dot to the center of the cross hairs on the PSPD (in XEP).
    b) Verify A+B (on the right of the PSPD in the software) is about 2-3 V.
    c) If A+B < 2V then refer to the *Troubleshooting Alignment Procedure* and double check that the direct laser spot is on the cantilever and is centered on the PSPD.

5. Perform frequency sweep (NCMA setup) if imaging in non-contact mode.

6. Verify that the Z-scanner is fully extended (i.e. the Z scanner bar in the "Monitor Window" should be completely green). If not, refer to *Troubleshooting if Z Scanner is Retracted.*

7. Bring tip a few millimeters from sample
    a) Be sure "Focus Follow" is checked. Move head towards surface using the Z-stage motor control in software. Visually inspect the tip-sample separation. Stop when the tip is a few millimeters from sample.
    b) Focus on cantilever.

8. Bring tip 50-100 microns from sample
    a) Using the digital height readout in software, move the focus stage 300 microns below the cantilever by clicking below the center line on the focus-stage motor control in XEP.
    b) Click below the center line on the Z-stage motor until the sample comes into focus (BE SURE FOCUS FOLLOW IS CHECKED).
    c) Focus on cantilever by clicking above the center line in the focus-stage motor control in the software.
    d) Click below center line of focus stage control and use digital readout to move the focus 100 microns below the cantilever.
    e) Move Z-stage down SLOWLY until the sample comes into focus. Be careful not to crash the tip.
    f) Focus on cantilever.
    g) Move focus stage 50 microns below the cantilever. (50 microns accounts for the tip height and cantilever thickness so that the end of the tip will be approximately 25 microns from the sample surface after step 5(h)).
        ***NOTE: If using a specialty probe, check the length spec of your tip and allow for extra clearance if necessary.
    h) Move Z-stage SLOWLY until the sample comes into focus.
    i) Click "Approach" (underneath the Z-stage motor control). When the light to the right of the motor controls stops blinking, the tip will be in feedback.

Troubleshooting Alignment Procedure:

IMPORTANT: Please turn only one knob at a time and verify that you adjust the appropriate knob, the correct axis and in the desired direction (refer to the adjustment-knob reference sheet).

VERIFYING DIRECT LASER SPOT IS ON CANTILEVER

When the direct laser spot is on the cantilever you should observe the following:

- ☐ While turning Y laser position (large knob on the left side of head) CLOCKWISE, you should see the laser spot move UP on the cantilever.
- ☐ A bright spot (Figure 2) when the laser hits the edge of the cantilever substrate.
- ☐ With the laser spot on the edge of cantilever substrate, turn the X laser position. You should see the laser spot move along the edge of the cantilever substrate (*Figure 3*).
- ☐ If you don't observe ALL of the above, then the spot you see on the cantilever is not the direct laser beam.

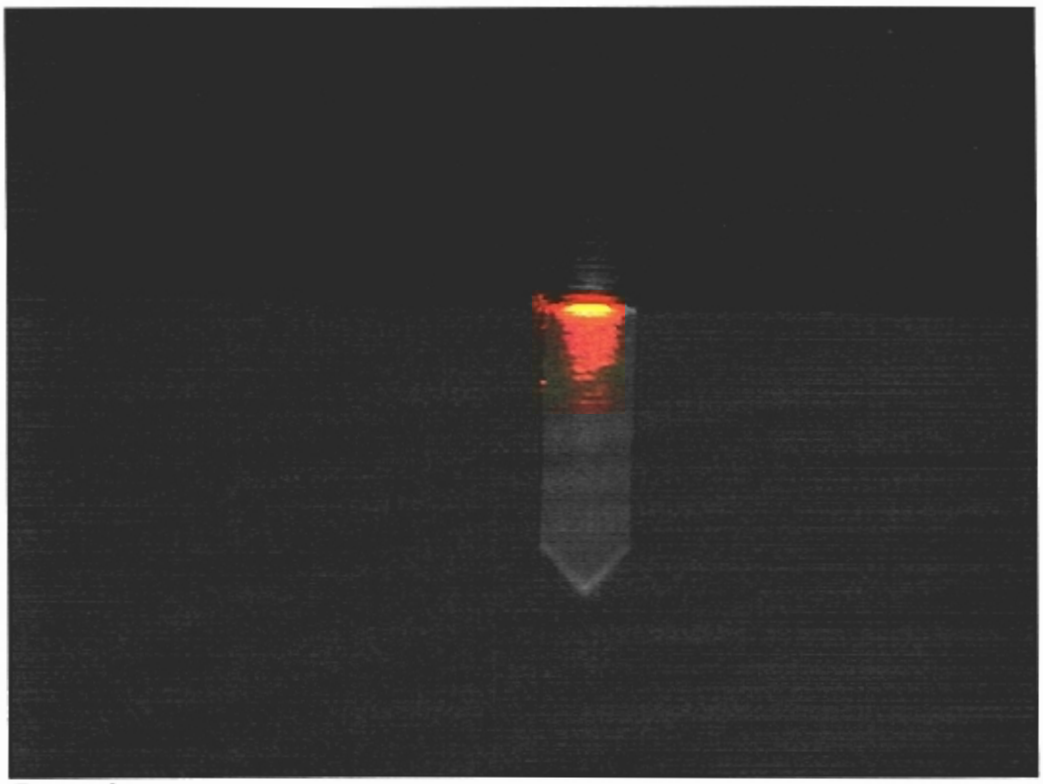

Figure 2

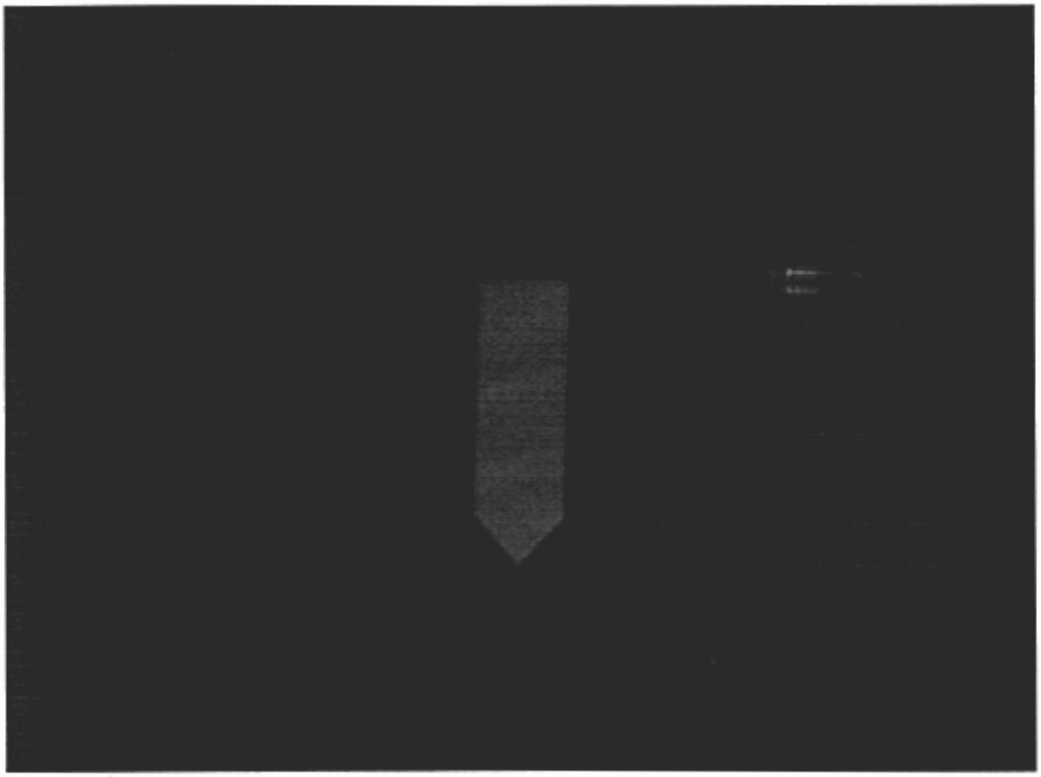

Figure 3

VERIFYING DIRECT LASER SPOT ON PSPD

When the mirror is properly aligned, you should see the following:

- Turning X mirror adjustment (small right knob on front of head) CLOCKWISE will move the red spot on PSPD to the LEFT.
- Turning Y mirror adjustment (small left knob on front of head) CLOCKWISE will move the red spot on PSPD UP.

If the laser doesn't move up-down and left-right as described above, then:

1. Turn Y laser position adjustment (large knobs on head) to maximize A+B.
2. When A+B is maximized, X adjustment knob to maximize A+B.
3. Repeat steps 1 and 2 until laser can be seen on PSPD.
4. Sometimes if the laser is severely misaligned, A+B may go through a minimum point.

After adjusting the direct laser spot on the cantilever and on the PSPD, verify that A+B is 2-3V, and proceed to step 5 of the alignment procedure.

Troubleshooting if Z Scanner is Retracted:

After aligning the laser and PSPD, and executing the frequency sweep the Z scanner bar in the software should be completely green. If the Z scanner is completely or partially retracted, the "auto approach" function will not work.

Do the following in the order given until the Z scanner completely extends (all green):

Non-contact Mode

1. Verify A+B = 2-3V. If not, see *Troubleshooting Alignment Procedure*.
2. Redo the frequency sweep.
3. Increase the Drive% by increments of 10 until the Drive% is 60%.
4. Select a different peak in the frequency sweep (make sure it's within the range of the spec given for the cantilever you are using) by double clicking on the desired peak and Zoom In. You may have to try a few different peaks.

Contact Mode

1. Verify A+B = 2-3V. If not, see *Troubleshooting Alignment Procedure*.
2. Adjust the PSPD mirror (small knobs on head) so the laser is below the center line and A-B is approximately -2V.