SPECIFICATIONS AND PERFORMANCE

System Configurations

Probe Head   Operates in C-AFM, NC-AFM, IC-AFM, LFM, and STM modes.

Operation in other modes (e.g., FMM, SThM) requires purchase of optional toolkits.

Measurement Performance

Standard

Scanner   Large Area (~90 µm) piezoelectric scanner.

Scan range   Maximum lateral scan range: ~90 µm.

Maximum vertical scan range: 7.5 µm.

Control resolution   Maximum DAC lateral resolution: 0.25 Å.

Maximum DAC vertical resolution: 0.025 Å.

Optional

Scanner   5 µm piezoelectric scanner.

Scan range   Maximum lateral scan range: 5 µm.

Maximum vertical scan range: 2.5 µm.

Control resolution   Maximum DAC lateral resolution: 0.0013 Å.

Maximum DAC vertical resolution: 0.009 Å.
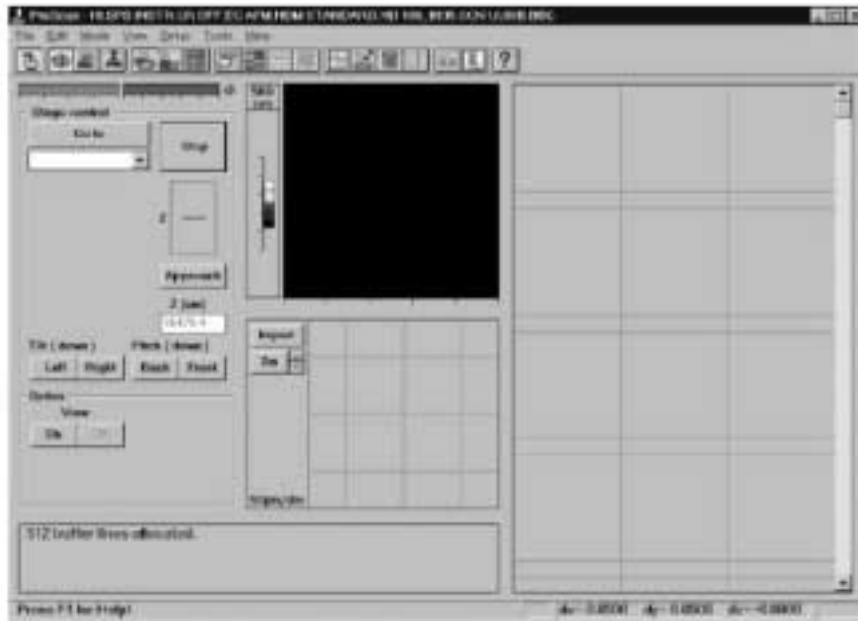
Microscope Stage

Translation range   8 mm x 8 mm.

Sample size   50 mm (w) x 50 mm (l) x 20 mm (h).

Tip-sample approach   Automatic with 3 independent stepper motors.

Optical microscope   Optional on-axis microscope with color video monitor for probe tip and sample view.

5:1 zoom, up to 3,500X magnification.
Standard 20X objective.

Acoustic isolation   Optional acoustic isolation chamber.

Workstation

AEM   20-bit DACs for x, y, and z axes.

16-bit DACs for system control.

Computer   550 MHz Pentium processor,
512K cache memory, 64 MB RAM.

Mass storage   20.5 GB hard drive, 3.5" 1.4 MB floppy disk drive, CD ROM drive.

Starting the AutoProbe CP-R

1. Login to the computer and also sign in to log sheet. This is mandatory prior to using the CP-R.

2. Turn on the AutoProbe electronics module (AEM). The on/off button is located on the front panel of the module. Turn on the color video monitor included with the CP Optics unit. The on/off button is located on the front of the monitor, below the screen. Turn the computer and monitor on. The computer on/off switch is located on the front panel of the computer unit. The computer monitor on/off button is located on the front of the monitor below the screen. When you start the computer, you automatically enter the Windows desktop. (**Use this option only if the system is not on. Usually it is kept on**)

3. From the Windows **START** button; select **PROGRAM--→ PSI PROSCAN DATA ACQUISITION** to open the ProScan Data Acquisition software. Data Acquisition opens in Move mode, as shown in Figure .The controls unique to Move mode are located on the left side of the window; the other controls are shared with Image mode.
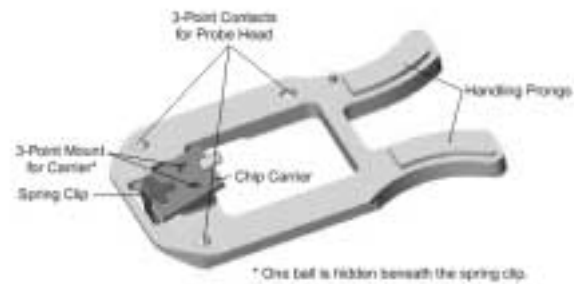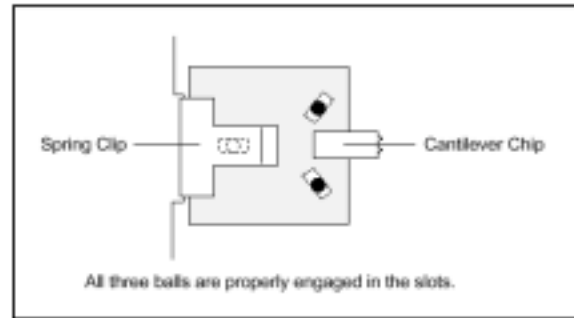

4. **Loading the Sample**:
   - Move the CP Optics objective lens away from the probe head by rotating the swing arm towards you.
   - Use the z direction pad to raise the probe head in order to provide ample clearance for loading the sample.
   - Secure a sample to one of the sample mounting disks supplied with the instrument.
   - A piece of double-sided tape can be used to attach the sample to the disk.
   - *Gently slide* the mounting disk onto the sample holder (the small round stub attached to the top of the scanner).
   - Position the mounting disk so that the *sample* is centered on the sample holder.
   - Use the z direction pad to lower the probe head to within several millimeters of the sample surface.
   - Move the CP Optics objective lens into position over the sample.
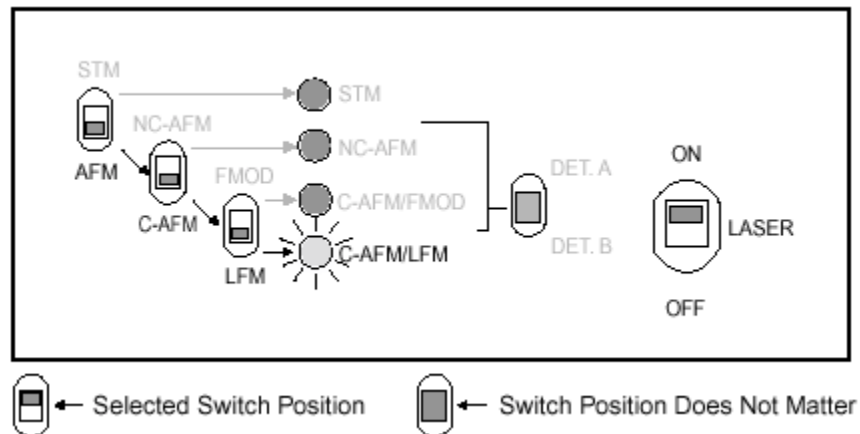
5. Installing the Cantilever in Chip Carrier
   - Take out the chip carrier from its box.
   - Being careful not to touch the chip, grasp the chip carrier between the thumb and forefinger of your right hand with the chip facing up and to the right.
   - Check to see if the cantilevers have broken off before using the chip carrier.
   - A correctly installed chip carrier is shown on the right.
   - A chip carrier should be installed in the probe cartridge.
   - Grasp the probe cartridge by the handling prongs.
   - Insert the probe cartridge into the probe head with the tip facing downwards.
   - Make sure the probe cartridge clicks in to place in the probe head (indicating that the 3-point contacts are positioned correctly).
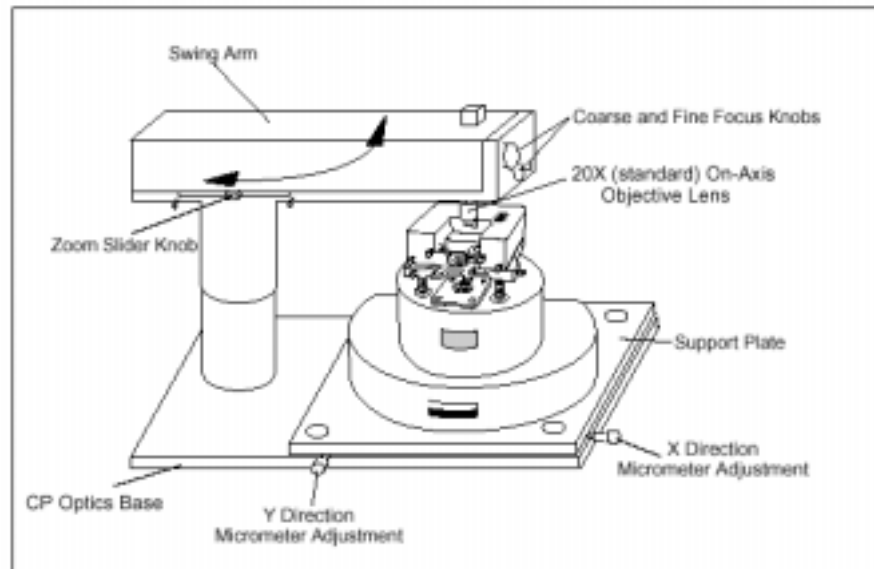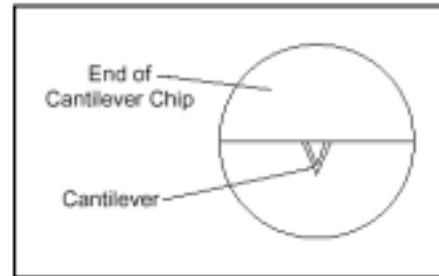
6. **Configuring the CP-R Probe Head** **(Usually it is always set at Contact AFM)**
   - Set the **STM/AFM** switch to **AF**M.
   - Set the **NC-AFM/C-AFM** switch to **C-AF**M. The head is now correctly set for taking images of the Topography signal. The position of the **FMOD/LFM** switch only matters if you are taking Force Modulation Microscopy or Lateral Force Microscopy (LFM) images.
   - Confirm that the green LED for either the **C-AFM/FMOD** or **C-AFM/LFM** head mode is illuminated.
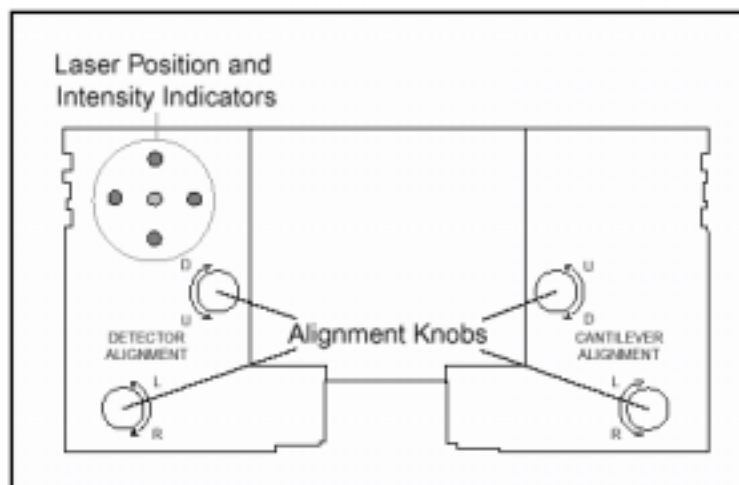
7. **Using the Optical View**

- Slowly rotate the CP Optics swing arm counterclockwise until the objective lens fits between the two arms of the probe head. The lens should be positioned directly over the cantilever and sample.
- Click the VIEW ON button in the OPTICS section of the Move mode window. The sample will be illuminated with light from the CP Optics. The video monitor will brighten and display a blurry image.
- Adjust the coarse focus to move the objective lens up or down using the large focusing knob on the end of the swing arm.
- Monitor the focus adjustment by looking at the video monitor. You should see the end of the cantilever chip with a triangular-shaped cantilever in the center of the optical view.

- If the cantilever is not in the center of the field of view, adjust the position of the cantilever until you can see it on the video monitor. Move the cantilever chip relative to the optics field of view by using the two-micrometer adjustments attached to the CP Optics support plate to move the entire CP-R instrument base relative to the CP Optics.
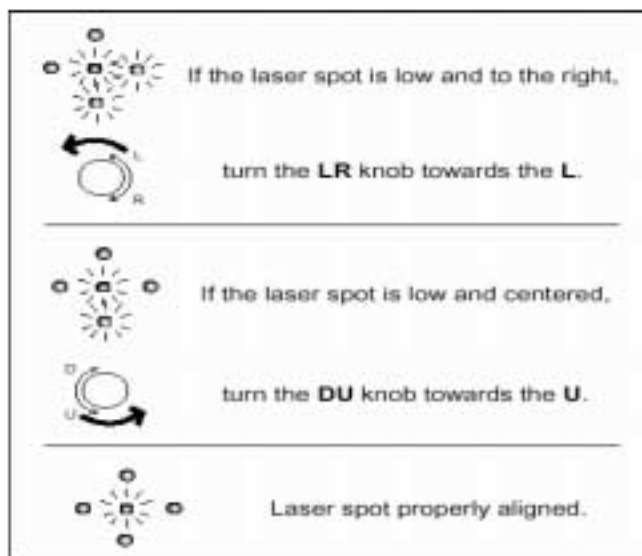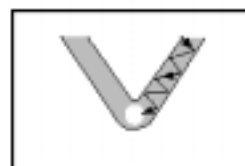

8. **Aligning the Laser Spot**
- Make sure that the power to the probe head is on.
- Turn the LASER ON/OFF switch on the probe head to ON.
- Watching with the naked eye, steer the laser spot onto the cantilever chip using the cantilever alignment knobs, as shown.
- When you see an intense red reflection, the laser spot is at the front of the cantilever chip, above the cantilever itself.

Laser Position and Intensity Indicators

DETECTOR ALIGNMENT

Alignment Knobs

CANTILEVER ALIGNMENT

- Focus on the cantilever with the CP Optics. Look for cantilever shadow.
- Walk the laser spot to the end of the cantilever in a zig-zag fashion, using sequential ¼-turn increments of both cantilever alignment knobs, as shown.

- Carefully center the laser spot on the end of the cantilever, above the tip, using the cantilever alignment knobs.
- Adjust the detector alignment knobs on the left-hand side of the probe head to align the laser spot with the center of the PSPD using the laser position indicators on the front of the probe head as shown in Figure below. The goal is to have the central green LED brightly illuminated, with none of the red LEDs illuminated.
- After making adjustments to the left/right position, you may need to read-just the up/down position, and vice versa. Near the correct position, the red lights are very sensitive, and you may find it difficult to position the detector mirror so that all of the red lights stay off.

If the laser spot is low and to the right,

turn the **LR** knob towards the **L**.

If the laser spot is low and centered,

turn the **DU** knob towards the **U**.

Laser spot properly aligned.

- Use a Digital Volt Meter (DVM) window to optimize the position of the PSPD. DVM windows can be used to check instrument signals, such as the signal representing the difference between voltages from the two halves of the PSPD. This signal, called "A-B," should be small (on the order of tens to hundreds of milli-volts) when the PSPD is properly aligned with the laser spot.
- Open a DVM by clicking the DVM icon on the tool bar.
- Click the **CH** button on the DVM to see a selection of channels, or signals, and select **A-B**. The display of the DVM will show the value of the A-B signal, given in volts or mill volts depending on the value.
- Adjust the PSPD forward/backward screw to move the PSPD until the absolute value of the A-B signal is less than 300 mV. The laser spot should now be centered between the A and B halves of the PSPD.
- You can also use a DVM to check the intensity of the reflected laser beam on the PSPD. This signal, called "A+B," should have a value greater than 1 V when the intensity of the laser is optimized. Open new window for A+B signal.
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9. **Approaching the Sample Surface**
   - Make sure that head power is on.
   - Focus on the sample surface.
   - Use the z direction pad to lower the probe until the cantilever begins to come into focus in the optical view. At this point, the cantilever will be close to, but not touching, the sample surface.
   - Before hitting the approach button, go to the **image mode** by clicking on icon as shown on right. Set the X and Y offsets to zero and scan size to 0. Gain should be at 0.5 and force should be 2.5 nN.
   - Switch back to **move mode** by clicking on the icon shown on right. Click on the **approach** button in the move mode to bring cantilever in contact with the sample surface**.** A successful auto approach will bring the probe into contact with the sample surface. Once in contact, the tip will automatically perform a repeated line scan across the surface of the sample.
   - Auto approach will fail if there is any large A-B signal. Removing the red LED using the laser alignment knobs can minimize it**.**
   - **Once the auto approach is completed, you will see that the cantilever and sample surface are focused at the same time and cantilever is in contact mode.**
   - Watch out the position of the Z center. The blue bar (on top of the screen) should be in the center and should not be widened enough. The feedback signal (yellow line) should be tracking properly with the set point value (red line). If you do not see any blue line, that means the tip is not touching the sample surface (or feed back is very unstable and some other portion of the tip is touching the raised features on the surface), while broadening of the yellow line indicates that feedback is not tracking very well the set point value.
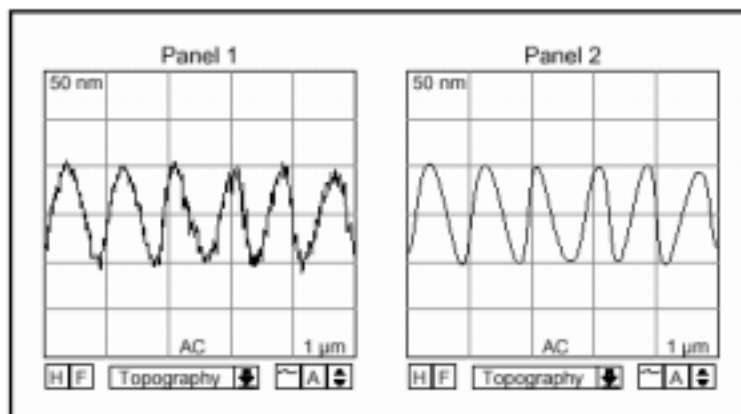
10. **Setting Parameters in the Image Mode**
    - Click the Image Mode icon to switch to the Image mode. The Move mode controls are replaced by the oscilloscope display and scan and feedback control.

- If you do not see the signal trace on the oscilloscope display, click (**A**) to rescale the signal trace to fit the display.
- Remove any tilt in the sample by clicking on X and change the slope until you see a straight line in the oscilloscope. Do the same for Y and finally click on the X. Choose the topography or friction mage by clicking on it.
- Choose the desired scan size, scan rate and then click to acquire an image. The image will be displayed in the Active Display.
- To cancel the scan before it is finished, click **Cancel**.

11. Taking Better Images
- While you are scanning you can adjust the scale also by clicking on the **A.**
- Decrease the scan rate and see the differences in the image. Lower scan rate generally improves the image quality when the scan size is larger.
- Optimize the feedback gain: Click for the GAIN scrollbox in Image mode to increase the gain incrementally. The gain value will increase in 0.001 increments.
- Click until the system begins to oscillate. Stop when you begin to see oscillations appearing on the Oscilloscope
- Lower the gain incrementally by clicking until the oscillations disappear. The goal is to be as close to, but not over, the point of oscillation. The gain value is now optimized.

Panel 1: Oscillating signal trace; Panel 2: Gain optimized.
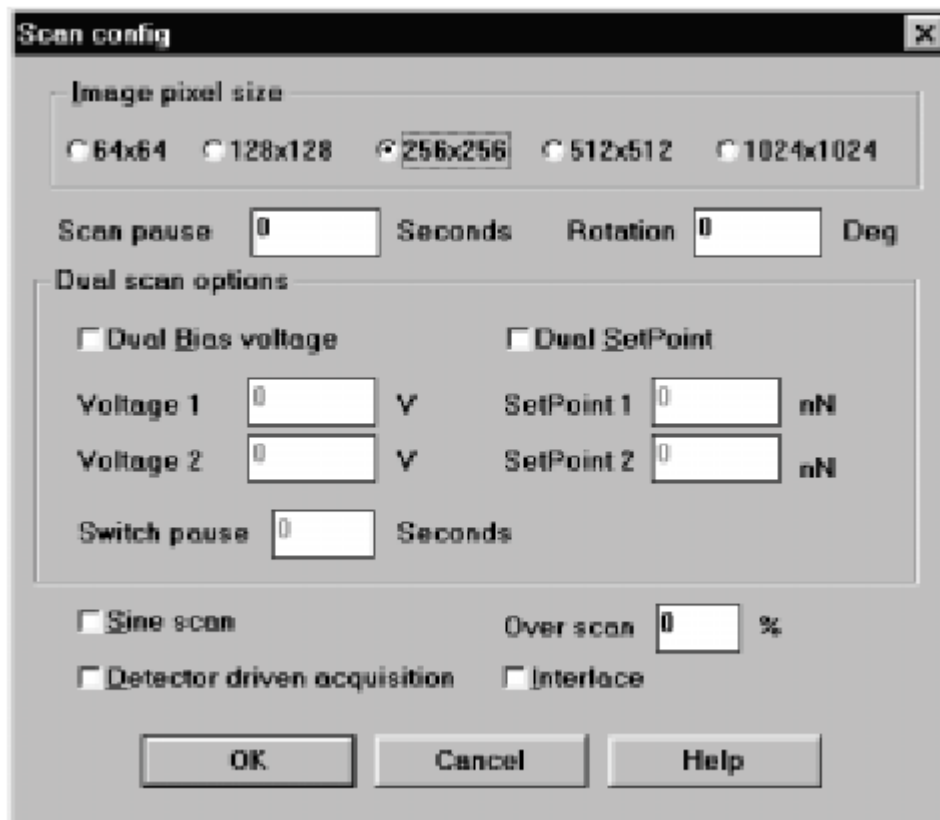
12. Optimized the Set Point
- **In order to properly adjust the set point force, make sure that** both the forward →and reverse ←scan checkboxes are checked for the Topography signal in the Input Configuration dialog box.
- You can click on the set point →Input Configuration. Select topography or any other scans you want by clicking on them and then click on →. You can also select the trace and retrace by click on them. Press Ok to exit that window.
- To adjust the set point, type a new value in the Set Point scrollbox, and then press the [Enter] key. Alternatively, use the scrollbox arrows to scroll through

the range of set point values. The set point can be changed while scanning is progress.

- Compare the forward and reverse traces on the oscilloscope display. When the set point is optimized, the two traces will be nearly identical.

13. Selecting the Number of Data Points and Over Scan

- Select **SETUP→ SCAN CONFIG**, or click the Scan Config icon, to open the Scan Config dialog box, as shown in Figure.
- Click the option button that corresponds to the number of data points that you want. A larger number of data points results in higher lateral resolution, but the scan takes longer.
- It is wise to choose 20 percent over scan, as it will get rid of edges and damaged boundaries once you saved your images.
- Click to close the Scan Configuration dialog box.

14. Saving Images

- All images you take will be displayed in the Image Gallery and saved to your computer's hard drive as long as the Save to Buffer icon on the tool bar is selected. This feature is turned on by default when you launch the ProScan software and can also be controlled by selecting MODE SAVE TO BUFFER..

15. Ending Your Session with CP-R AutoProbe

- Almost zero the scan size and offsets. Switch to **Move Mode.**

- Use the z direction pad to raise the probe head and move the probe away from the sample.
- Click the Head ON icon to turn off the power to the probe head, and Watch on the head of the microscope to make sure that laser light is off.
- Do not close the software; you can just minimize the screen.
- **Warning**: Never close the AutoProbe controller window as closing this, ProScan will not work.
- Close the DVM windows.
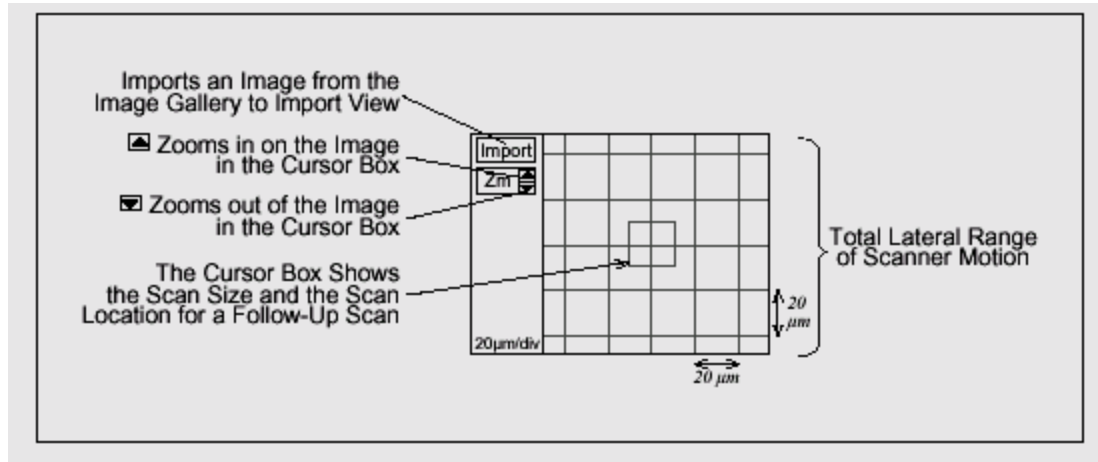
16. **Important things to Remember**
- If you want to observe multiple images on the screen such as topography, friction or error signal, you can do that by click on View-→ Layout and select QUAD option.
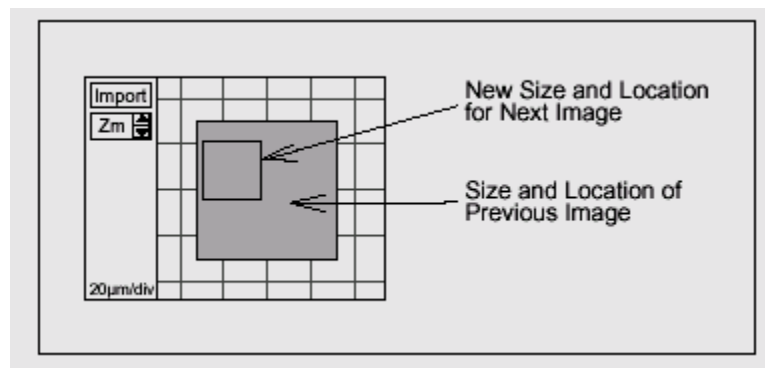
17. **Taking an Image at New Location**
- There are three ways to take an image at a new location on the sample surface: (1) coarse positioning of the probe using the x and y translation screws and CP Optics, (2) fine positioning of the scanner using the green cursor box in the Import View and (3) fine positioning of the scanner by typing new values in the **X OFFSET (...)** and **Y OFFSET (...)** textboxes in Image mode

Use of Import View

- The Import View have a range of motion of up to ~90 υm for the standard Large Area scanner. The units per division of the Import View are indicated in the lower-left corner of the display. The size of a displayed image is proportional to its scan size; the position corresponds to its scanner coordinates, which represent scan location. The scanner coordinates are referenced to the scanner's undeflected (home) position.

- Take an AFM image.
- Select the image in the Image Gallery, and click to transfer the current image from the Image Gallery into the Import View.
- The green cursor box at the center of the Import View will enclose the imported image. The imported image will not completely fill the display.
- To zoom in or out, click, and then successively click or . As you zoom, the units per division of the display panel change.
- Change the size of the green cursor box to select a scan size. Position the cursor near any corner of the green cursor box. The cursor will change to a bi-directional arrow, or **Click** and drag the corner until you reach the desired scan size.
- Select a scan size that lies within the displayed image. The new scan size is displayed in the Size textbox.
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- Drag the green cursor box to a new location to select a region in the image. Position the cursor near the center of the green cursor box. The cursor will change to a four-way arrow.
- Click and drag the green cursor box until you reach the desired scan location. Position the green cursor box within the displayed image. After you reposition the green cursor box, the scanner coordinates displayed in **X OFFSET** and **Y OFFSET** textboxes are updated.
- Click to start a new scan.