7.8 Calibration of A Heads for Atomic-Scale Measurement

The A head is the smallest head, with a total travel of approximately 0.4 micron along each axis. Its compact design lends excellent stability for atomic scans, and requires slightly modified X-Y calibration procedures. These modified calibration procedures are detailed in this section. For atomic-scale measurements, graphite atoms are substituted for the pits seen on silicon calibration standards.

1. Prepare the sample.

   Note: Use highly-ordered pyrolytic graphite (HOPG) for STM calibration. See the procedure detailed in Appendix A for cleaving highly-ordered pyrolytic graphite to obtain a good flat surface.

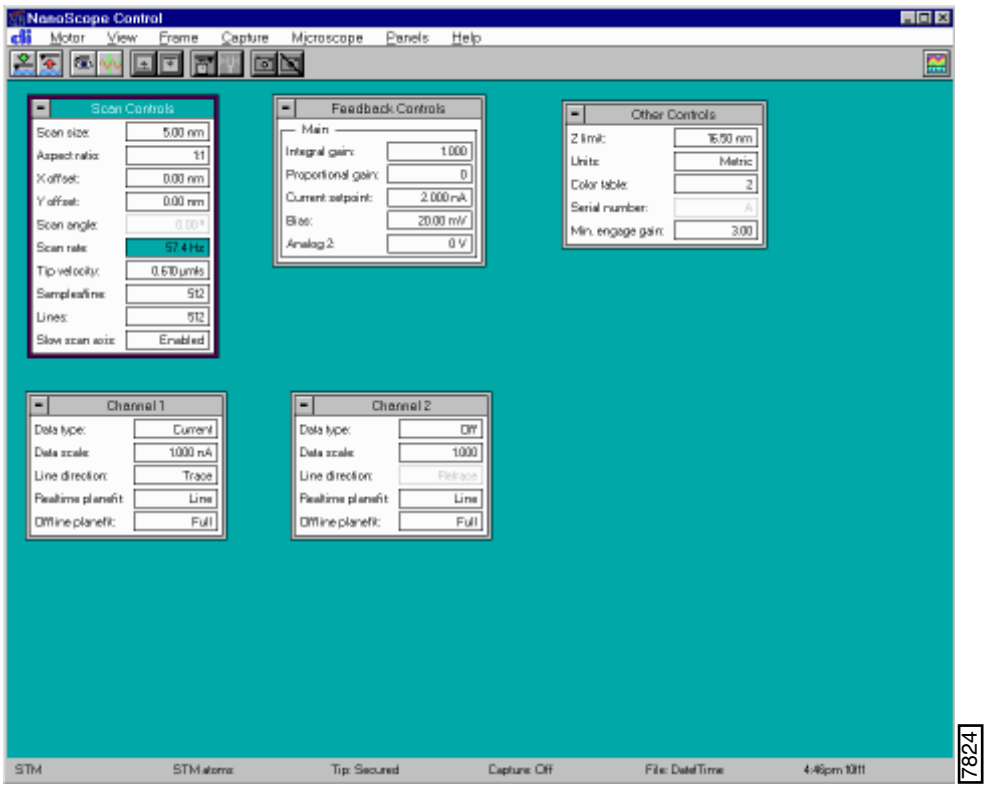
2. Select **Microscope > Profile** to set the microscope to **STM atoms**.

3. Place the sample on one of the bases.

   Note: A base without X-Y capability will have less drift.

4. Verify the **Real Time** parameter settings for A heads (See Figure 7.8a).

Figure 7.8a Typical A Head Parameter Settings



5. Select **Motor > Engage** to engage the surface.

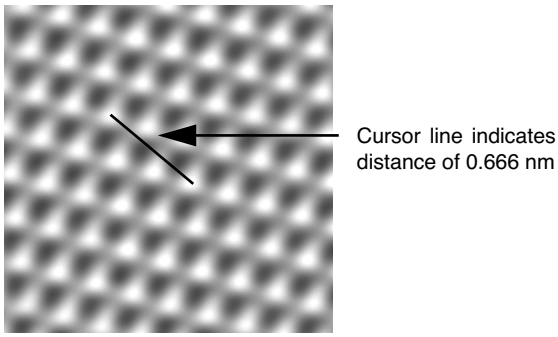
6. Adjust the **Integral gain** and **Setpoint** to obtain a good image in data type current.

   Note: Keep the **Setpoint** low if possible. Notice that the **Scan rate** is set much higher (up to **61 Hz**) for atomic-scale images to defeat some of the variables due to thermal drift. If you find it difficult obtaining an image, **Withdraw** and try a different site on the surface, then **Engage** again. You may find it easiest to obtain good images and measurements if the sample is rotated until atoms are oriented vertically.

7. **Capture** an image.

   Note: The image should appear similar to the image of graphite shown in Figure 7.8b. Note the highly regular lattice of the atoms.

Figure 7.8b Atomic-Scale Image of Graphite

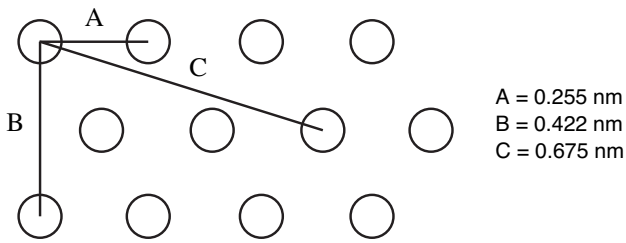


8. Select **Offline > View > Top View**.

9. Measure and record the space between a minimum of 10 atoms using the mouse and cursor.

   Note: The spacings should measure as shown in Figure 7.8c.

Figure 7.8c Atomic Spacing for Graphite



10. Record the space between at least ten atoms observed in the captured image.

Note: For each axis, measure equal numbers of atoms on consecutive images. For example, on consecutive scans, if the atoms align as in Figure 7.8c, then 10 atoms on the X axis average to 2.55 nm (10 atoms x 0.255 nm) and 6 atoms on the Y axis average to 2.60 nm (6 atoms x 0.433 nm).

Correction of the X- and Y-axis is essentially the same procedure as described in the section on Fine-tuning for X-Y Measuring Accuracy. The only significant difference is that the known distances must be adjusted for the smaller, atomic spacings of the atoms. Furthermore, only the sensitivity parameters are adjusted for atomic-scale imaging.

- X fast sens at 0° Scan angle
- Y slow sens at 90° Scan angle

The derating parameters are not adjusted for atomic-scale imaging, including:

- X fast derate
- X slow derate
- Y fast derate
- Y slow derate
- Retracted offset der
- Extended offset der

Complete the following procedure to adjust the **X Fast Sens** value (See Figure 7.8d):

1. Divide the theoretical atomic distance by the measured distance and multiply the quotient by the **X Fast Sens** value used when you collected the image.

$$\frac{\text{Known distance between features}}{\text{STM-calculated distance between features}}$$

2. Enter the new **X Fast Sens** value into the **X Slow Sens** field.

Complete the following procedure to adjust the **Y Slow Sens** value (See Figure 7.8d):

3. Divide the theoretical atomic distance by the measured distance and multiply the quotient by the **Y Slow Sens** value used when you collected the image.

$$\frac{\text{Known distance between features}}{\text{STM-calculated distance between features}}$$

4. Enter the new **Y Slow Sens** value into the **Y Fast Sens** field.

Figure 7.8d Scanner Calibration Panel