

AFM User Manual

October 28, 2024

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1 Start a Measurement

1.1 Open the software

The software icon appears as shown; simply double-click to open it.



Figure 1: Software icon

This page will open. Click on the ScanAsyst option, then click on 'Load Experiment' to select it.

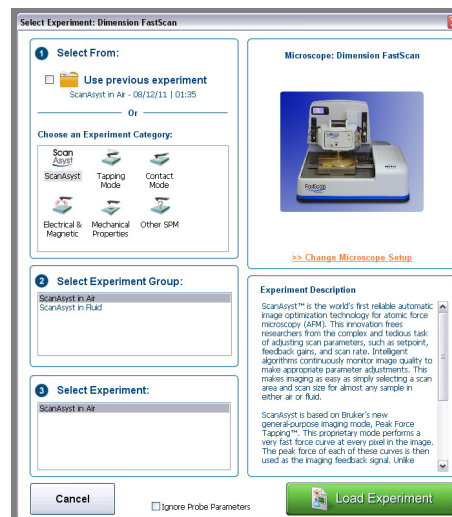


Figure 2: Select experiment

1.2 Setup

After clicking 'Load Experiment,' navigate to the setup menu (See figure 3 circle 1).

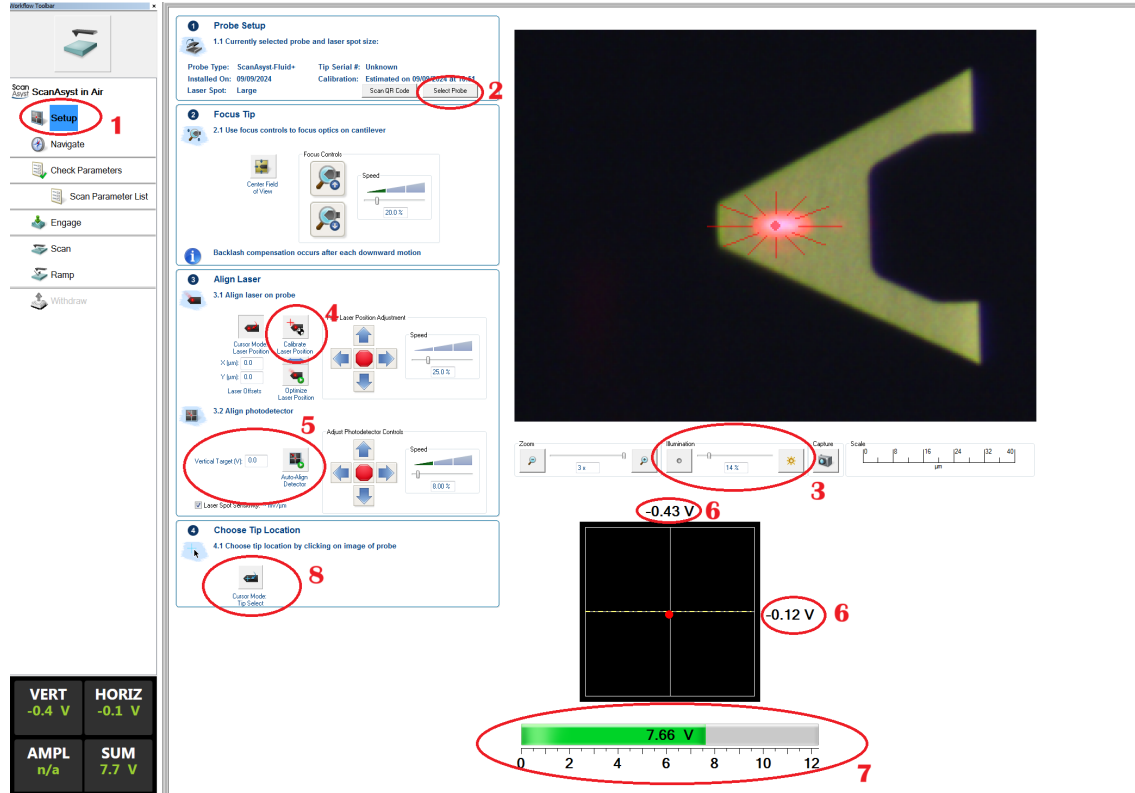


Figure 3: AFM Setup Menu.

1.2.1 Select probe

First, select the appropriate probe and laser spot size. To do this, click on 'Select Probe.' (See figure 3 circle 2).

Select the installed probe from the rolling menu (See figure 4 circle 1). The most recently installed probe is indicated in a black file next to the AFM computer. After choosing the probe, select the correct laser spot size. To do this, turn the knob on the right side of the AFM's moving head until the laser spot size is no longer red. There are only 3 options (See figure 4 circle 2). Finally, click 'Return' and save the changes (See figure 4 circle 3).

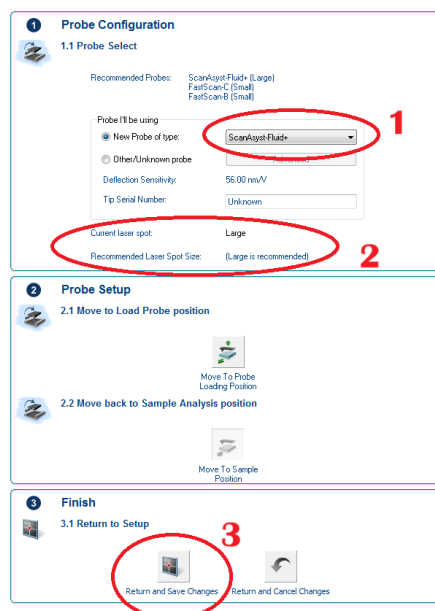


Figure 4: Illustration of the steps for selecting the laser spot size and probe on the AFM.

1.2.2 Positioning the laser

To position the laser, first focus on the cantilever. Use the buttons shown in Figure 5. If the cantilever is not centered in the image, click on it to adjust its position.

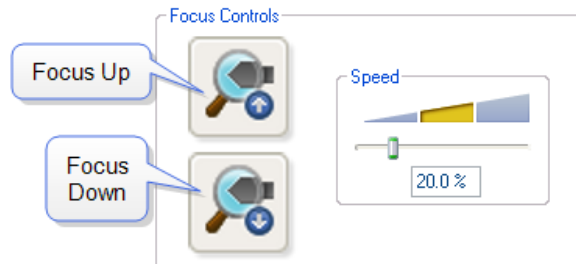


Figure 5: Setup focus [1]

In the center, you should be able to see the cantilever, the laser spot, and the marker (see Figure 7).

If the laser spot is not visible, first try lowering the illumination to around 14% (See Figure 3, circle 3), and click on the cantilever to move the marker onto it. Normally, the laser spot should appear with the marker. If the laser spot is misaligned, you can correct it by clicking the 'Calibrate Laser Position' button (see Figure 3, circle 4). You should now be able to move the laser spot independently from the marker.

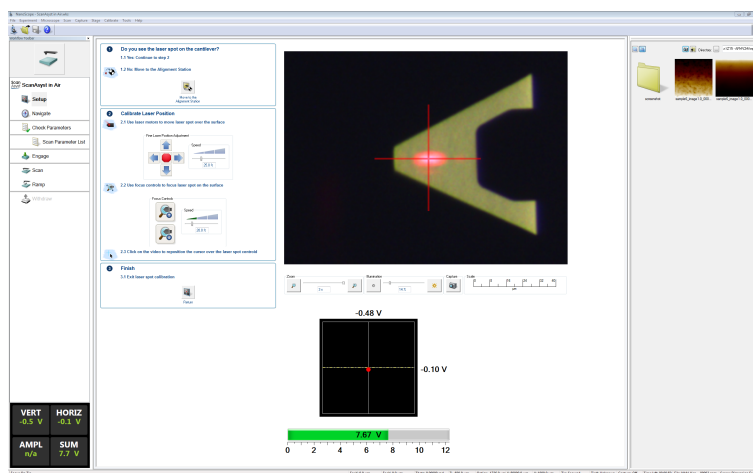


Figure 6: Interface to align the laser with the marker

Finally, when the two are aligned, position the laser in the same location as shown in figure 7. To move the laser spot and the marker, it is preferable to click directly on the image rather than using the arrows on the setup page, as this helps avoid losing track of the marker or the laser spot.

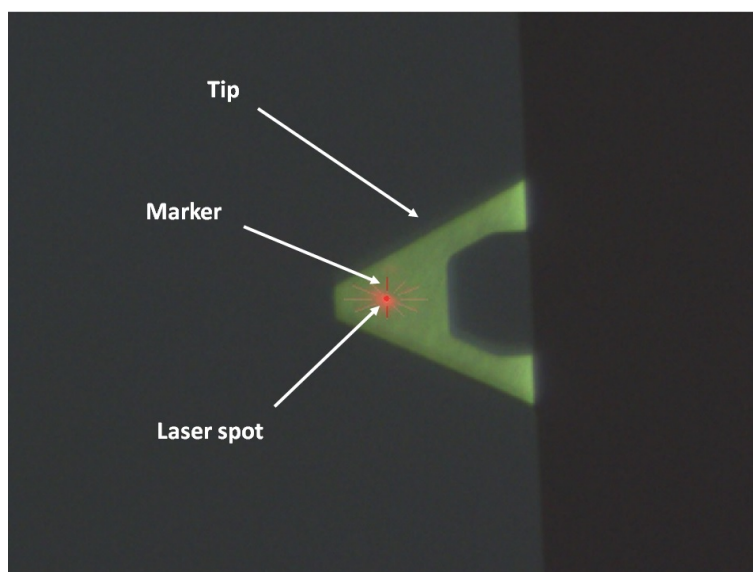


Figure 7: Setup center image [3]

1.2.3 Laser reflection on photo diodes

To align the laser reflection on the photodiodes, first ensure that the vertical target is set to zero. Then click the 'Auto Align Detector' button (See Figure 3, circle 5). This will automatically align the laser reflection. After alignment, verify that the alignment error is below or around 0.20V (See Figure 3, circle 6). If the error is too high, re-click the 'Auto Align Detector' button. The signal should then be higher than 5V (See Figure 3, circle 7).

1.2.4 Probe tip positioning

You can click the 'Select Tip Position Mode' button (See Figure 3, circle 8) to define the tip location for the AFM. A cross will appear, and both the laser and the crosshair will remain stationary when you click on the image. Position the cross over the tip location of the cantilever. This will assist in accurately positioning the AFM tip on the sample later.

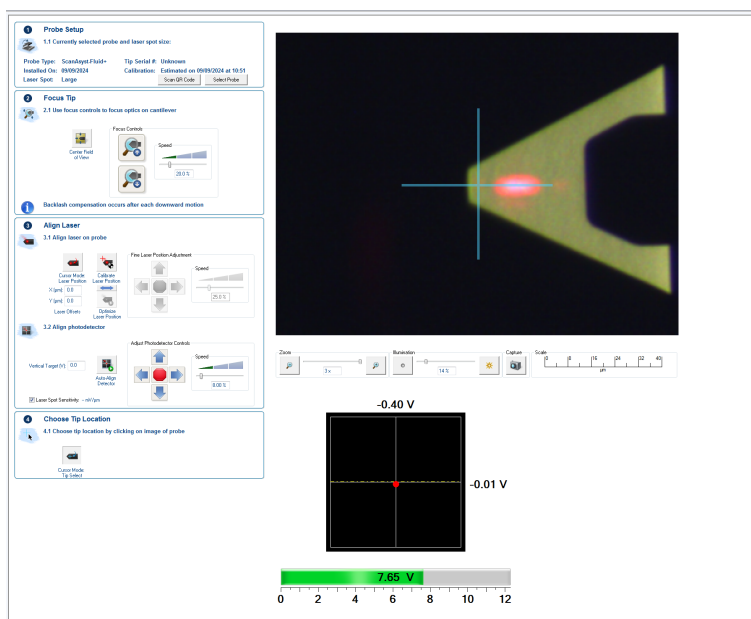


Figure 8: Choose tip location menu

1.3 Navigate

The next menu is the Navigate menu (see Figure 9, circle 1).

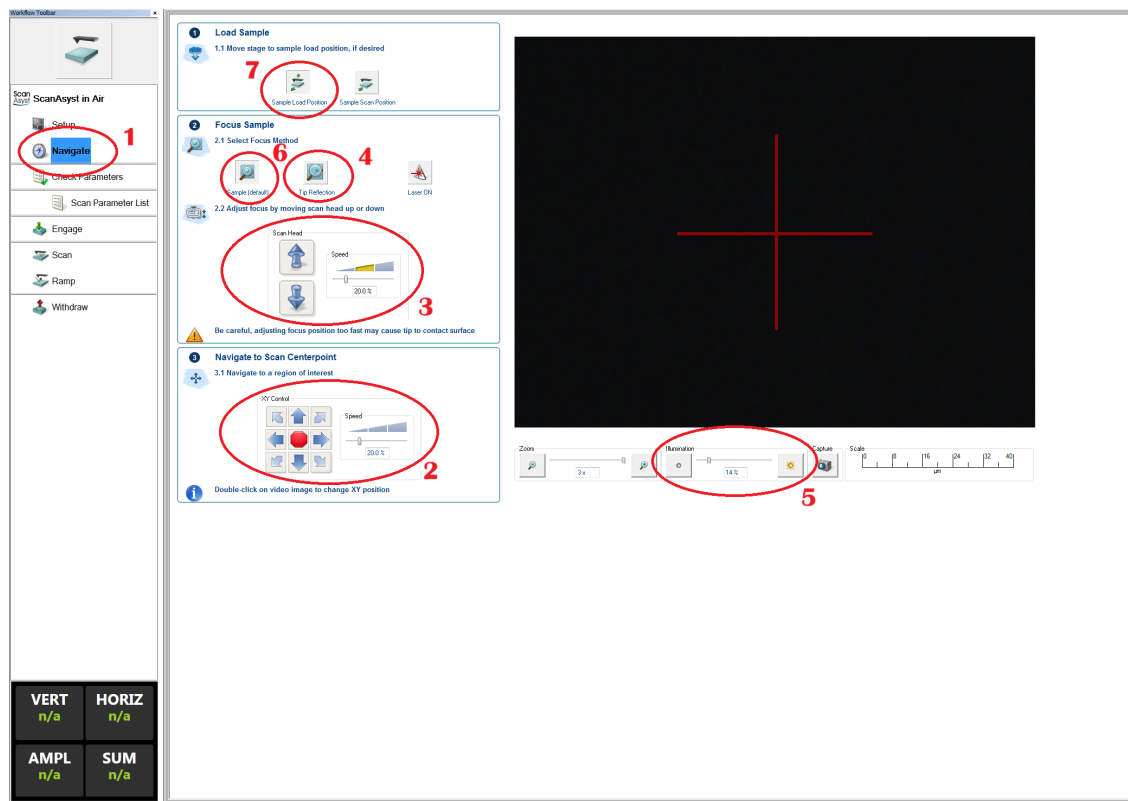


Figure 9: Navigate menu

Next, place your sample on the AFM stage and turn on the vacuum (see Figure 10, red circle). You can verify that the vacuum is holding the wafer in place by gently pushing on it.

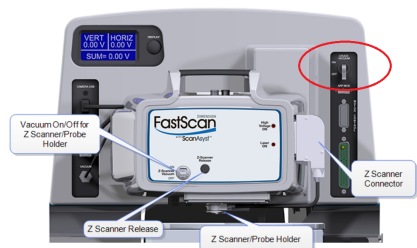


Figure 10: AFM [2]

The next step is to move the sample under the AFM tip. To do this, use the arrow keys at the bottom of the page (see Figure 9, circle 2). Once the sample is positioned under the tip, focus on it by moving the AFM head downwards (see Figure 9, circle 3).

There are two options for focusing:

1. Focus directly on the sample. If the sample lacks clear structure, you might miss the focal point, which could cause the AFM tip to crash into the wafer.
2. Focus on the cantilever, which is generally safer and easier. To do this, click on the "Tip Reflection" button (see Figure 9, circle 4).

Before moving the AFM head down, set the zoom to 0 and the illumination to around 14% (see Figure 9, circle 5). Then, lower the AFM head until the tip is about half a centimeter from the wafer.

At this stage, you should see something. If nothing is visible, adjust the illumination until something appears (often, the image will be split, with a black section on the right). Afterward, focus on the tip (see Figure 11).

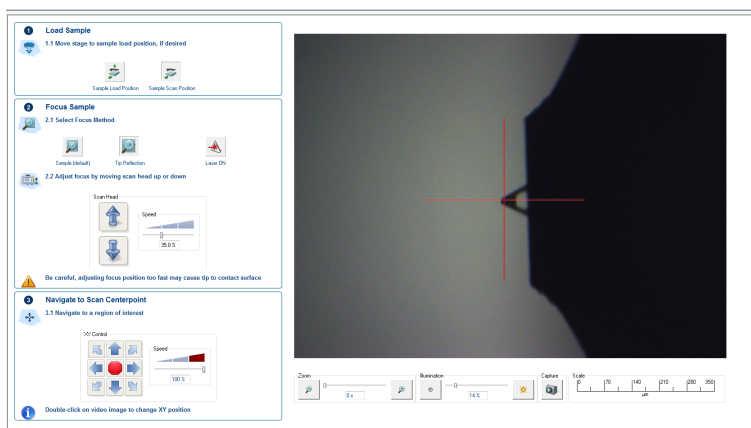


Figure 11: AFM tip in focus

Once the tip is in focus, click the "Sample Default" button (see Figure 9, circle 6). This will move the camera to the AFM head and bring the wafer into focus, allowing you to select the measurement location, especially if there is a specific area on the wafer to be analyzed.

1.4 Check parameters

This part is to check the parameter for the first scanning. Here you have to check that the ScanAsyst Auto control is on (see Figure 12, circle 1).

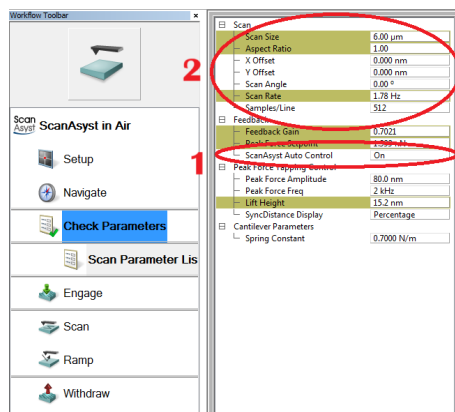


Figure 12: Check Parameter window

A few parameters can be choose by the user (see Figure 12, circle 2).

1. Scan Size : The maximum scan size is 35 μm x 35 μm .
2. Aspect ratio : Modify the scanning area from a square (1:1) to a rectangle (1:2).
3. XY Offset : This function can be useful for limited and precise displacement.
4. Scan Angle : we can enter a scan angle in any direction (0° corresponds to an horizontal scan of the screen). With an AFM, it 's recommended to scan perpendicularly to the step.
5. Scan Rate : The scan rate determine the acquisition time. Around 1.21 is a good starting value. A scan rate too high can damage the AFM tip.

6. Sample/Line : This is the number of points you have for each scan (trace en retrace). Around 512 is a good starting value and it must be a power of 2.

All the cited parameters can be directly changed during the scanning.

1.5 Scanning

1.5.1 Starting measurement

Once the parameters are set, you can click the "Engage" button (see Figure 13, circle 1) . The AFM will then begin the measurement. When the measurement starts, you need to perform three checks.

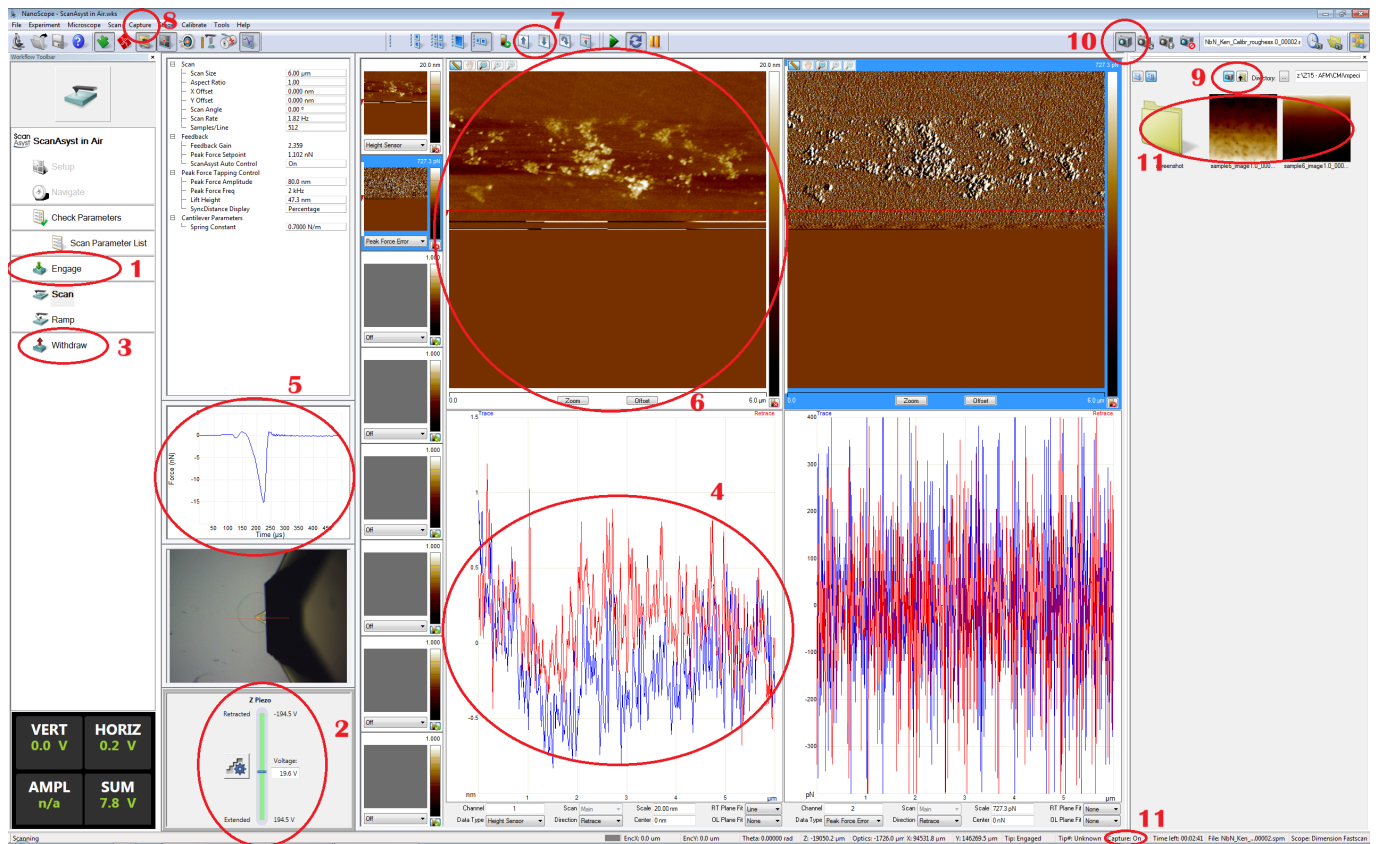


Figure 13: Engage Menu

1. The displacement of the AFM's piezo should not exceed 1.5 μm up or 1.5 μm down. If the displacement exceeds these limits, the indicator will turn orange and then red (see Figure 13, circle 2). If this occurs, withdraw by clicking the "Withdraw" button (see Figure 13, circle 3).
2. The AFM measures the sample line by line. The blue and red lines represent the same measurement. If everything is working correctly, the two lines should be roughly the same (see Figure 13, circle 4). Note that this may not be immediately accurate; allow the AFM to begin the measurement, as it can take some time for the lines to stabilize.
3. You will see a graph representing the force on the tip. It should look roughly like the one in figure 13, circle 5. This will not be immediately accurate; you need to let the AFM initiate the measurement, as it may take some time to stabilize

If the measurement is not working properly, you can try changing the scanning parameters or replacing the tip.

In the center you can see your measurements (see Figure 13, circle 6), by default, the measurement will begin in the middle. To avoid measuring the same area twice, click the button at the top (see Figure 13, circle 7).

1.5.2 Save the measurement

To save your measurement, first choose your folder. Click the "Capture" button (see Figure 13, circle 8) and then select the "Capture Filename" option. A page will open where you need to click the three dots to choose the folder where the image will be saved (see Figure 14, circle 1), and then click "OK" (see Figure 14, circle 2).

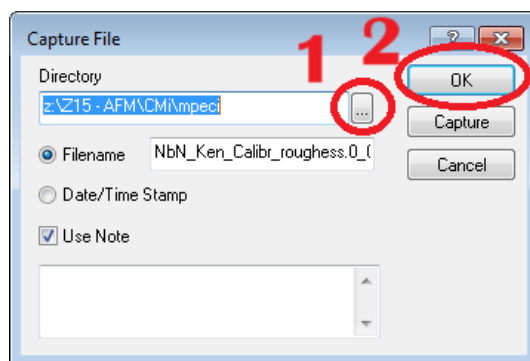


Figure 14: Capture filename menu

After setting the folder, click the small camera and the folder icon next to it (see Figure 13, circle 9). Your folder should then appear on the right (see Figure 13, circle 11). The final step is to click the larger camera icon at the top (see Figure 13, circle 10) to capture the image. To verify that the measurement is being saved, check that the capture status at the bottom left is "On" (see Figure 13, circle 12). Once the AFM has finished scanning, the image will be automatically saved and the capture status will switch to "Done." To save again, you need to restart the capture (see Figure 13, circle 10). The AFM will continuously scan the sample. During the scan, you can adjust the scanning parameters, and the changes will be applied immediately. At the end of each scan, if the capture status is "On," a new image will be saved.

1.5.3 Stop measurement

To stop the measurement, click the "Withdraw" button (see Figure 13, circle 3). To retrieve your sample, return to the navigation menu and click the "Sample Load Position" button (see Figure 9, circle 7). This will move the AFM back to its starting position. Finally, turn off the vacuum holding your sample on the plate and take it.

2 Change the tip

To change the tip, you need to disconnect the AFM Z Scanner/Probe Holder (see Figure 15) from the machine. First, turn off the vacuum holding the holder (see Figure 15) and push a button (see Figure 15) to release it. You need to press the button firmly, and you should hear air being released when you release the button. Finally, unplug the Z Scanner connector (see Figure 15) .

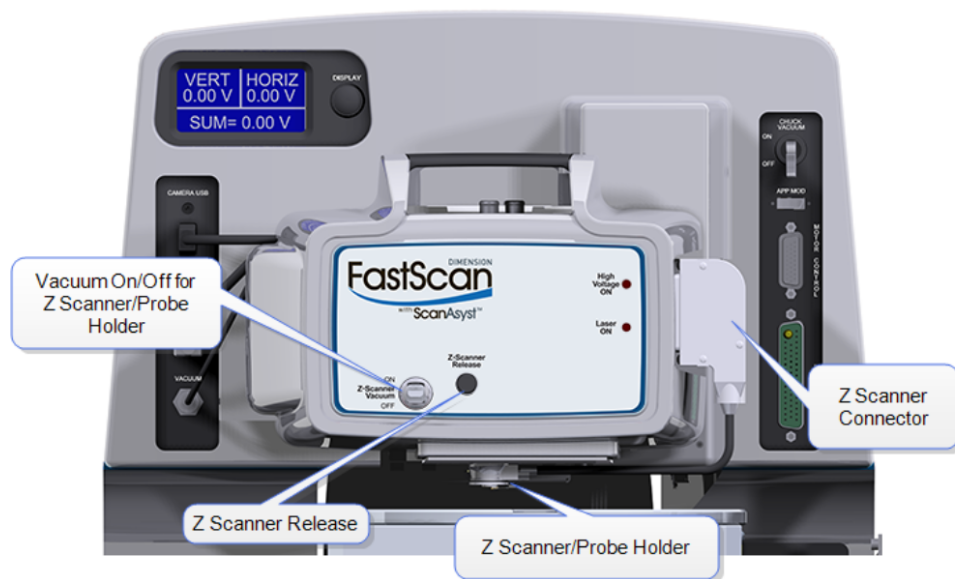


Figure 15: AFM [2]

During this procedure, hold the AFM Probe Holder by the sides and pull it down to detach it. Once the Probe Holder is detached, you can mount it on the Probe Exchange Mount located between the AFM and the computer (see Figure 16). To attach it, simply push it onto the Probe Exchange Mount.

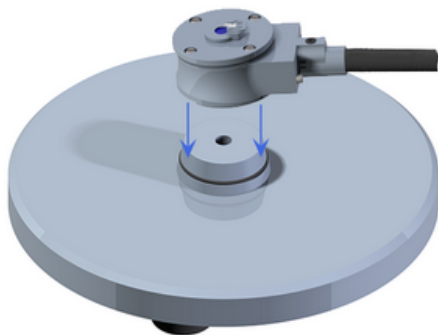


Figure 16: Probe Exchange Mount [2]

When it is mounted, release the tip (see Figure 17) by opening the fork holding it.

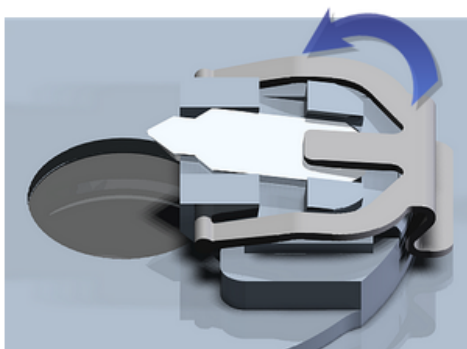


Figure 17: Releasing the tip [2]

Use tweezers to take the tip (see Figure 18). The tip in the box (see Figure 19) doesn't have to be flipped, and the pointy side must face the open side (see Figure 17). Be careful not to let the tip fall, as it may break. When installing the tip, ensure that its flat end touches the bottom of the holder.



Figure 18: Taking the tip [3]



Figure 19: Tip box

To reattach the tip holder, first go to the setup menu. Then, take the Probe Holder in your left hand and the Z Scanner connector in your right hand (see Figure 15). First, push the holder on the AFM emplacement, two pin will hit the alignment groove (see Figure 20). Then, rotate the holder until it aligns with the "Connector Pin Hole" (see Figure 20). Just rotate it until you can't. It's easier to turn it with the help of the connector cable. Finally, push the holder all the way up and reconnect the Z Scanner connector. Do not forget to put the vacuum on again (see Figure 15). If the holder is installed correctly, the probe should appear on the setup menu.

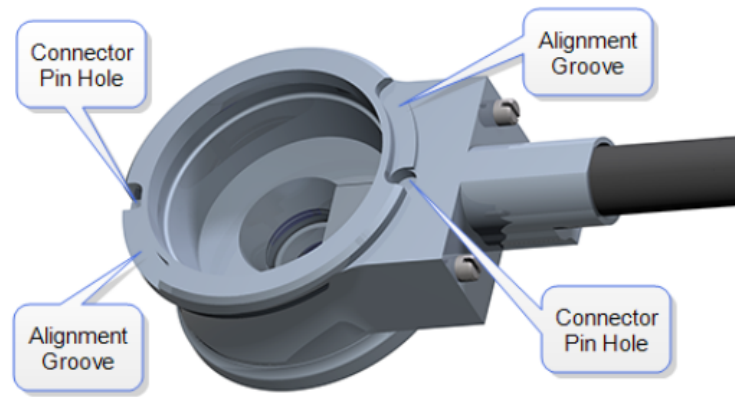


Figure 20: Probe Holder Fixation [2]

3 Références

- [1] Bruker Corporation. *Focus Tip*. URL: https://www.nanophys.kth.se/nanolab/afm/fast-scan/bruker-help/DIcon_webhelp.htm#Basic%20AFM%20operation/FS_Focus%20Tip.htm. (consulté le 16.09.2024).
- [2] Bruker Corporation. *Load a Probe on the Z Scanner*. URL: https://www.nanophys.kth.se/nanolab/afm/fast-scan/bruker-help/DIcon_webhelp.htm#Basic%20AFM%20operation/Load%20a%20Probe%20on%20the%20Z%20Scanner.htm. (consulté le 16.09.2024).
- [3] EPFL. *Bruker FastScan AFM*. URL: <https://www.epfl.ch/research/facilities/cmi/equipment/metrology/bruker-fastscan-afm/>. (consulté le 16.09.2024).