AFM – Bruker Atomic Force Microscopy System

Standard Operating Procedure

4D LABS Confidential

Revision: 2.0 — Last Updated: February 03, 2020, Revised by Dennis Hsiao

Revision History

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1 Purpose

This document describes how to obtain sample topography using PeakForce-Tapping (PF Tapping) mode with ScanAsyst. This document is intended to be a reference for the trained users; it does NOT substitute a training by the staff of the 4D Labs Nanofabrication Facility.

This document does not go over data analysis software, NanoScope Analysis. However, user can request a free copy from the tool owner and explore the software on their own time. Users are encouraged to read over the help files for the function of interest. The file goes into detail from the math to situation of when it’s applicable.

For other imaging modes, please inquire the tool owner for detail. For a complete list of modes, please refer to section 6.1 (General Information) of this document.

2 Definition

AFM: Atomic Force Microscopy
Substrate: body on which cantilever is mounted on (refer section 6.6 for diagram)
Cantilever: a projecting beam anchored on one end of a substrate (refer section 6.6 for diagram)
Probe/Tip: sharp object interacts with sample surface (refer section 6.6 for diagram)
PF Tapping: Peak Force Tapping
PF QNM: Peak Force Quantitative NanoMechanics
PF KPFM: Peak Force Kelvin Probe Force Microscopy
PF TUNA: Peak Force Tunneling Atomic force microscopy
PSD: Position Sensitive Detector
STM: Scanning Tunneling Microscopy
3 Convention

In this document, the following items are italicized.

- Hardware units
- Software menu items
- Software windows and panels
- Software box names

The following items are underlined.

- Hardware buttons and switches
- Software buttons and check boxes
- Special keyboard keys, e.g., Enter.

Text to be typed is shown inside double quotation marks (e.g., "typed text")

Hazard conventions:

- **CAUTION** indicates a hazard which may cause damage to equipment.
- **WARNING** indicates a hazard which may cause injury to personnel. It may cause damage to equipment as well.

4 Contact Information

Questions or comments in regard to this document should be directed to the tool owner in 4D LABS at Simon Fraser University, Burnaby, BC, Canada. The tool owner is listed on the 4D LABS web page^1

5 Safety

The Dimension Icon features independently motorized components for both sample stage and scanner head. It utilizes laser, and generate secondary voltage. It is critical for user to be conscious at every step to ensure a safe operation of the instrument.

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^1 [https://users.4dlabs.ca/](https://users.4dlabs.ca/), Tool List -&gt; Materials and Device Testing -&gt; Atomic Force Microscope
The scanner head employs a laser to determine the deflection of the cantilever which translates to surface topography. The laser is classified based on their potential cause of injury typically to the eyes. The classification of the laser employed on the Dimension Icon scanner is class 2M. This class of laser is considered safe due to the blink reflex\(^2\) of the eye which will limit the exposure to less than 0.25 seconds. This is true for visible light laser (400 ~ 700 nm). The laser used on our system operates at 650~695 nm at 1.0mW.

\(^2\) [https://www.laserpointersafety.com/resources/Spreadsheet---laser-classes.pdf](https://www.laserpointersafety.com/resources/Spreadsheet---laser-classes.pdf)
6 Overview

6.1 General Information

The Bruker AFM System is a powerful all-in-one tool enabling a variety of imaging/measurement modes listed below

- Contact Mode
- Tapping Mode
- ScanAsyst
- PF Tapping with ScanAsyst (surface topography)
- PF QNM (nanomechanical mapping, modulus, adhesion, deformation, dissipation)
- PF KPFM (surface potential measurement)
- PF TUNA (surface conductivity measurement)
- STM (atomic/molecular resolution)

If any of the imaging mode is of interest, please inform the tool owner well in advance as each mode will take time to develop and optimize. The system is capable of analyzing samples in air and in fluid as well as heating and cooling functions. Currently ScanAsyst/Tapping/Non-Contact/PF TUNA modes are available with other modes to be brought online on a case by case basis according to user demand.

Basic training commences with probe tip setup, laser alignment, and basic surface imaging in ScanAsyst in Air mode. Bruker’s proprietary ScanAsyst mode, based on Peak Force Tapping, allows for automatic optimization of the critical parameters such as tapping/contact force, signal gain, scanning rate, and piezo limit (section 7.6 goes over each parameter), which allows for quick and well optimized scanning with minimal input from the user (suitable for novice user).

Advanced training will often require additional training. Users are reminded to not operate the system beyond the scope of their training.
6.2 AFM Working Principle

The interaction (e.g., mechanical/long-short range forces) between the tip and sample surface result in cantilever deflection. The deflection of the cantilever as the tip scans the surface of a sample change the position (relative to the center) of the reflected laser on the quad position-sensitive detector (PSD). The reflected laser position will maintain at the center of the PSD throughout the scan. Changes in the reflected laser position will cause the Z piezo to move up/down to bring the reflected laser back to center. The system continuously records the Z position and uses it to generate an image of the surface topography.

![Image: Feedback loop maintain constant cantilever deflection]

6.3 ScanAsyst Imaging Mode

ScanAsyst imaging mode is based on the general-purpose imaging mode, Peak Force Tapping™. The tip performs a very fast force curve by tapping the sample surface pixel by pixel. The peak force of each of the force curve is used as imaging feedback signal. The system optimized the image resolution as well prolong the tip’s life by using the following 4 parameters (see section 7.6 for details)

- Peak Force Setpoint: amount of force applied to sample
- Feedback Gain: increase sample tracking with high gain
- Scan Rate: how fast the probe is traveling
- Z Limit: reduce vertical scan range to improve vertical resolution (smaller quantization)
6.4 System Specification

XY Scan Range: 90 um x 90 um typical \(^3\)

Z Range: 13 um \(^3\)

Lateral Resolution: 1 nm \(^4\)

Vertical Resolution: < 1A

Sample Size: ≤210 mm diameter and ≤15 mm thick
180 mm x 150 mm with rotating sample chuck

Motorized stage: X & Y:
2 um unidirectional repeatability
3 um bidirectional repeatability

\(^3\) The range varies from piezo crystal to piezo crystal

\(^4\) The lateral resolution will also be affected by the size of the tip
6.5 SPM Scanner

The scanner is one of the most important components of the AFM system. The scanner consists of a laser diode (1.0 mW max at 670 nm), piezoelectric scanner, and quad PSD. The laser is aligned manually by user onto the free end of the cantilever using the two laser aim adjustment knob. The laser is reflects off the cantilever onto the center of the quad PSD by adjusting the detector mirror positioner mounted on a kinematic mount. The reflected laser beam position tracks the deflection of the cantilever while scanning a stationary sample. The piezoelectric scanner controls the probe-sample distance and raster pattern.

![Figure 2: SPM Scanner subassemblies](image)
### 6.6 Piezoelectric Scanner

Piezoelectric scanner in the SPM scanner is made from piezoelectric materials, which will contract and expand upon applied voltage. The scanner is constructed by combining independently operated piezo electrodes for the 3 axes (X, Y, and Z). In the X and Y axes of the tube, each axes have a conjugate section (i.e., when one sides contracts, the other side expands). The Z axes, however, is a single component responsible for the vertical movement.

![Piezoelectric Scanner Diagram]

**Figure 3:** X, Y, Z piezo electrodes

When X and Y piezo electrodes worked together, it can move the probe in a zig zag pattern.

![AC Voltage Diagram]

**Figure 4:** AC voltage applied to X, Y axes producing raster scan pattern
6.7 **Probe Holder**

Depending on the mode of imaging (e.g., Tapping in air/fluid, STM, Conductive), different probe holder are required for different modes. For the purpose of this document, we will only be using the standard probe holder. The probe holder consists of piezoelectric stack (probe oscillation), electrical contact to the drive circuit, gold plated socket and spring-loaded clips securing down the substrate of the probe. The probe holders are very expensive therefore please handle with care.

![Diagram of standard probe holder](image1)

**Figure 5:** standard probe holder

6.8 **Probe**

Selecting the right probe for the right job is very important. Below is the schematic of an AFM probe (some probe\(^1\) have multiple cantilever designed for calibration). A lot of people use probe/tip interchangeably.

![Diagram of AFM probe](image2)

**Figure 6:** AFM probe
There are wide varieties of probes that are designed for specific imaging mode/morphology/property measurements. For complete list of probes available\(^5\), please review the section in the help file outlining the probes suitable for different application.

For the purpose of this document, we will only be using ScanAsyst-AIR probe.

6.8.1 Tip Geometry

The quality of an AFM image can be affected by multiple factors\(^6\) and tip quality is one of the major factors. The lateral resolution of the AFM image is ultimately affected by the radius of the tip apex. As the radius of the tip gets smaller, the finer the sample surface feature can be resolved.

![Diagram showing effect of tip radius](image)

**Figure 7:** effect of tip radius

The geometry and angle of each tip is slightly different. Depending on the feature depth and angle, the tip may not be able to track the surface accurately. These features general have steep walls and over few hundred to nanometer to micrometer depth. On top of the angle of the tip, one will need to consider the final

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\(^5\) In the help file, type in probe selection in the search box and click on the result titled probe selection

\(^6\) In the help file, type in afm image quality in the search box and click on the result titled probe selection for other common factors affecting image quality
angle when the probe is mounted on the holder where the FA will add another 10° and BA will subtract 10°. For ScanAsyst-Air, the final FA will be 25° and the BA will be 15°.

6.8.2 ScanAsyst-Air Probe Specification

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>Cantilever Shape</td>
<td>Triangular</td>
</tr>
<tr>
<td>Resonant Freq (Nom)</td>
<td>70 kHz</td>
</tr>
<tr>
<td>Spring Constant (Nom)</td>
<td>0.4 N/m</td>
</tr>
<tr>
<td>Tip Height (h)</td>
<td>2.5 – 8.0 um</td>
</tr>
<tr>
<td>Front Angle (FA)</td>
<td>15 ± 2.5°</td>
</tr>
<tr>
<td>Back Angle (BA)</td>
<td>25 ± 2.5°</td>
</tr>
<tr>
<td>Side Angle (SA)</td>
<td>17.5 ± 2.5°</td>
</tr>
<tr>
<td>Tip Radius (Nom)</td>
<td>2 nm</td>
</tr>
<tr>
<td>Tip SetBack (TSB) (Nom)</td>
<td>5 um</td>
</tr>
</tbody>
</table>

Figure 8: effect of tip angle to feature

Figure 9: tip geometry, refer to the table above for the angles

A) SEM image of ScanAsyst-Air tip  B) side view  C) front view
7 Operation

The scanner head uses a class 2M laser to track the deflection of the cantilever as the probe raster the sample surface. The laser turns on automatically\(^7\) at the start of the software NanoScope 9.1. Even though this laser class is consider safe to use without additional eye protection, one must careful especially when dealing with laser.

7.1 Probe Loading and Unloading

The standard probe holder should always be store in the probe holder stand whenever not in use. The probes should always be kept in a dedicated gel pack\(^8\) and never on a probe holder at the end of the session.

HINT: Users are encouraged to watch the probe loading video tutorial. It can be found on the desktop in AFM Video Tutorial folder

7.1.1 Loading\(^9\)

1. Locate the standard probe holder stored inside the probe holder stand on the computer monitor table. The stand is a 2.5” diameter blacked anodized aluminum cylinder.

2. The standard probe holder (figure 5) have a cantilever mounting groove where the probe will be seated.

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\(^7\) Red LED light on the face of the scanner as well red dot on the sample chuck indicate laser turned on

\(^8\) Can be purchased through 4D LABS

\(^9\) Video tutorial: Desktop/AFM Video Tutorial/Icon_Probe_Load_&_Laser_Align_Video from time 00:11
3. With 2 fingers, press down on the spring loaded probe clip and retract fully
4. With a set of fine tip tweezer, grab the middle section of the substrate and slightly twist of the gel pack to dislodge the probe.

**CAUTION:** The probes in the gel pack are stored with the tip facing up therefore when loading the probe onto the probe holder, one should not need to flip the probe.

5. Place the probe carefully in the cantilever mounting groove and ensure the substrate is sitting flush against the back edge of the mounting groove.
6. Again with 2 fingers, press down on the spring-loaded probe clip and gently push it forward all the way without pushing the probes out of position.

**HINT:** Always orientate the probe to one side and to the back of the mounting groove. This will improve the precision of the tip location between runs and reduce the time aligning the laser onto the cantilever.

7. Release the spring-loaded probe clip where it will secure the probe in the mounting groove.

7.1.2 **Unloading**

Unloading of the probe is essentially the reverse of the probing loading except for a tiny exception.
8. Retract the spring-loaded probe clip by pressing down with 2 fingers and pull it all the way back.
9. Remove the probe from the probe holder with a fine tip tweezer.
10. Place it back into the gel pack with the probe’s back end going in first to prevent breaking of cantilever.
7.2 Installing Probe Holder onto Scanner

1. Loosen the dovetail screw (clockwise) located on the right hand side of the Dimension Icon scanner.
2. Using the right hand, lift the scanner straight up out of the dovetail groove by grabbing the scanner handle (video 01:01)

**HINT**: the dovetail mount on the back of the scanner fits snug in the dovetail groove. To make lifting the scanner head out more easily, with the left hand, place 2 fingers at the bottom of scanner head (red line) and life it out while the right hand grabbing the handle.

3. Once the scanner is lifted, turn it so the bottom side faces up (video 01:04). The laser should not be on as the *NanoScope* has not started up. If laser is on, please close the software to shutoff the laser for safe loading of the probe holder.

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10 Video tutorial: Desktop/AFM Video Tutorial/Icon_Probe_Load_&_Laser_Align_Video from time 00:57
4. On the probe holder, align the 4 electrical mounting sockets to the 4 gold plated pins (video 01:10)

![Scanner pins and probe holder holes](image)

**Figure 12:** 4 scanner pins and probe holder holes

*NOTE:* probe holder can only be mounted onto the scanner in one orientation. The left two set of pins are wider apart than the right ones. **DO NOT** force the probe holder onto the scanner if it doesn’t go on.

5. After probe holder is mounted, ensure the dovetail mount is fully inserted into the dovetail groove by looking directly above it (video 01:26)

6. Holding the scanner securely and gently slide the scanner down toward the stage until the top of scanner head is on the same level as the *scanner level* (figure 11)

**CAUTION:** Ensure the top of the scanner head is at the same level before letting go of the scanner. Even a slight mechanical shock to the scanner head when dropped will damage the piezo material.

7. Secure the scanner by re-tightening the dovetail screw.

### 7.3 Align Laser to Cantilever

1. Open *NanoScope 9.1* software on the desktop and the Select Experiment: Dimension Icon window will appear.

2. Choose ScanAsyst under the 3 section in the Select Experiment window as shown in the figure below and click *Load Experiment*.
3. Once the experiment is loaded, Click on the Setup view in the Workflow Toolbar to start aligning the laser on the cantilever.

![Figure 13: experiment selection](image)

**Figure 13:** experiment selection

![Figure 14: setup view](image)

**Figure 14:** setup view
4. In the Setup view, follow step by step starting with Probe Setup. Ensure Probe Type in the Probe Setup section is displaying ScanAsyst-Air. If yes, skip to step 6; If not, proceed to next step.

5. Follow the instruction below to set up the correct probe:
   1) Click on Load Probe
   2) Click on New Probe of type and select ScanAsyst-Air in the drop down menu
   3) Click on Return and Save Changes

6. Click on the Move to the Alignment Station icon in the Align Laser on Probe section and a message will appear. Click on Yes to move to alignment station.
   The scanner will move up and sample chuck will move until the alignment station is directly underneath the scanner head.

Figure 15: probe configuration

Figure 16: position alignment station to scanner
In the video image, the image display will change from tip view to tip reflection view where the tip reflection is the shadow cast onto the silicon wafer of the alignment station.

**Figure 17**: tip view vs tip reflection view

**HINT**: In tip reflection view on the video panel, if the reflection is not in focus, bring it in focus using the Focus Controls in step 3.2

7. On the top of the scanner, use the two laser position control knobs shown in figure 17 to align the laser to the free end of the cantilever. The rear right knob moves the laser in the X direction where the front left knob moves the laser in the Y direction

**Figure 18**: laser control knobs on scanner

If the laser is not visible, reduce the illumination located under the video panel and try again.

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11 Video tutorial: Desktop/AFM Video Tutorial/Icon_Probe_Load_&_Laser_Align_Video from time 01:49
8. Align the laser onto the free end of the cantilever using 2 knob on the top of the scanner (figure 18)
   1) Turn the rear right knob to move the laser in the X direction until the laser spot is blocked by the substrate. Turn the knob slightly in the other direction to bring the laser into view
   2) Turn the front left knob to move the laser in the Y direction and bring it toward the cantilever
   3) Turn the rear right knob and move the laser first onto the free end of the cantilever and off. Observe the sum signal whereas the laser move off the cantilever, the signal will drop to 0 V. Turn the rear right knob clockwise slowly until max sum signal as shown in figure 19

   ![Figure 19: laser alignment A) aligning steps, B) laser not on tip, C) laser on tip](image)

9. Align the laser reflected from the cantilever to the center of the position sensitive detector (PSD) using the 2 knobs on the side of the scanner (figure 18)
   1) Turn the top left knob to move the laser to the middle of the vertical axes
   2) Turn the bottom right knob to move the laser toward the middle of the horizontal axes
   3) Adjust both top and bottom know until the laser at the center of the photodetector and both vertical/horizontal deflection signal close to 0V as possible (figure 20, red box)

   **NOTE:** if reflected laser does not move horizontally, keep turning the bottom right knob and observe the sum signal. If the sum signal drops drastically, turn the knob the other direction. Eventually the reflect laser will move towards the vertical axes.

   ![Figure 20: reflected laser position on PSD, A) off-center, B) centered](image)
10. When the laser is aligned onto the cantilever and reflected laser centered on the PSD, return the scanner from the alignment station by clicking on Return from the Alignment Station and click Yes to move the scanner back.

![Figure 21: return from alignment station](image)

11. In the video view, the display will change from tip reflection view back to tip view. Adjust the camera using Focus Controls up/down button until the cantilever is in focus.

12. Place the cross hair at 5 μm from the free end of the cantilever (figure 22). This is used as the reference point of where the tip will land when tip engage onto sample surface.

![Figure 22: cantilever focused and cross hair placed](image)

**HINT:** in the video panel, zoom in 3x and use the scale bar as reference to more precisely place the cross hair at correct location.
7.4 Sample Surface Focus

At this step, be extra attentive as focusing of the sample surface involves lowering the scanner towards the sample surface where chances of crashing the probe are high. If for any reason this happens, the only way is to replace the damaged probe with a new one.

1. Switch on the vacuum located at top right of the SPM and load the sample onto the rotating sample chuck

![Vacuum switch and sample chuck](image)

**Figure 23**: vacuum switch and sample chuck

**NOTE**: depending on the size of the sample, different vacuum port can be used. At any one time, only one vacuum port is allowed to open and all other ports are plugged with screws

2. Rotate the sample chuck to bring the vacuum port close to user and load the sample. Ensure sample is properly anchored down by the vacuum port by gently pushing the side of sample using a pair of tweezer

3. Once the sample is loaded and anchored, rotate the sample chuck until the sample is directly underneath the probe

**CAUTION**: ensure enough clearance between probe and sample surface when rotating sample toward the scanner to prevent sample from crash onto the probe
4. Click on the **Navigate** icon in the **Workflow Toolbar** to access the navigation section.

**NOTE**: if the sample is not directly underneath the scanner, use the **XY Control** in step 3.1 under **Navigate to Scan Centerpoint** to move the sample to correct location.

5. Skip **Load Sample** step under section 1 as the sample should be under the scanner at this point. If not, follow the steps outline in the **NOTE** section above.

6. Focus the sample surface by clicking on the **Sample** under section 2 step 2.1 (Sample is default focus method).

**HINT**: for featureless sample, select **Tip Reflection** where the camera will change it’s focal plane so when the tip reflection is focused, so will the surface of the sample.

7. Focus the sample surface by click & hold the **down arrow** bottom in Scan Head section with the speed at 100% (red, figure 24).

   Bring the attention to the sample in the AFM chamber. Kneel until the eye is level with the sample surface. Using the left hand to control the mouse, click on the down arrow button and bring the Scanner Head down until the probe is roughly 1 mm away from the sample surface.

   **CAUTION**: this step require moving the Scanner Head towards the sample surface where potentially probe crashing onto sample surface is likely especially when the speed is set to 100%.

8. After the probe is approx. 1 mm from the sample surface, bring the attention to the video view and reduce the Scanner Head speed to 20% (yellow, figure 25). Continue to lower the Scanner Head until the sample surface is in focus.
9. After the sample is brought to focus, navigate to the area of interest using the XY Control in step 3.1
10. Once the area of interest is located, click on the Check Parameters icon in the Workflow Toolbar to access the scan parameter section

7.5 **ScanAsyst Parameters**

ScanAsyst mode is based on the PeakForce Tapping mode where the NanoScope will automatically optimize the 4 parameters (Scan rate, Feedback Gain, Peak Force Setpoint, and Z Limit) which even a novice user can obtain a high resolution image.

1. Click on the Expanded Mode icon on the NanoScope Toolbar to see all the available parameters
2. Depending on the feature size and surface roughness, the scan size and scan rate should be changed accordingly. Below is the typical scan parameter (ensure the ScanAsyst Auto Control is on; refer to section 6.3 for parameters explanation)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scan Size:</strong></td>
<td>2um</td>
</tr>
<tr>
<td><strong>Scan Rate:</strong></td>
<td>1 Hz</td>
</tr>
<tr>
<td><strong>Samples/Line:</strong></td>
<td>128</td>
</tr>
<tr>
<td><strong>Lines:</strong></td>
<td>128</td>
</tr>
<tr>
<td><strong>ScanAsyst Auto Control:</strong></td>
<td>On</td>
</tr>
</tbody>
</table>
Although there are number of other parameters \(^{12}\) made available to adjust, the ones mentioned above are ones that should be able to resolve most of the issues encountered.

**HINT:** for samples that are being image for the first time, it’s a good practice to start with a small scan size and scan rate to limit the tip velocity especially on a rough (e.g., hundreds of nm) or soft (e.g., polymer) surface to avoid tip damage.

Another good practice is to start with a low resolution (e.g., \(128^2\) or \(256^2\)) scan to quickly obtain the image of the surface. When the feature of interest is determined increase the resolution (e.g., \(512^2\) or \(1048^2\))

**CAUTION:** if the user is unsure whether the sample surface is rough or not (hundreds nm roughness), start with the lowest scan rate and smaller size (0.1 Hz, 1 um) and gradually increase the scan rate while maintaining good sample and tip interaction.

3. Update the Engage Mode in the Engage Parameters (Microscope -> Engage Settings) from the default Smart to Standard and click OK

![Engage Parameters](image)

**Figure 26:** engage method

4. Click on the Engage icon in the **Workflow Toolbar** to start engaging the tip to the sample. If the engage is not successful for any reason, try again at other region of the sample

**NOTE:** when the tip have successfully engaged onto the sample surface, the software will automatically start scanning where the Scan icon will be highlighted in the **Workflow Toolbar**.

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\(^{12}\) full list of parameters definition can be accessed in the help file by typing in “ScanAsyst and Peak Force Tapping Mode Parameters” in the search box
Below are the list of changes the user will see after successful engagement of the tip to sample surface.

**Force Curve** — the Force vs. Time plot with the shape commonly refer to the “heartbeat”. This shape gives the user a good indication that the tip is tracking the sample surface successfully.

**Video Panel** — the sample surface should be in focus after successful engagement of the tip onto the sample surface.

**Realtime Status** — this status panel will change from the Meter View to the Z Piezo position indicator view in which the slider (blue horizontal line at the middle of the green bar) illustrate the extend of which the Z Piezo is extended (slider at the bottom of the bar) or retracted (slider at the top of the bar).

**Figure 26**: before and after engaged
7.6 **Image Optimization**

Although the ScanAsyst mode will optimize an image on behalf of the user, the user can manually improve the image quality by turning off the *ScanAsyst Auto Control*. As mentioned previously, this mode controls 4 parameters (Gain, Setpoint, Scan Rate, and Z Limit) which affects the image quality.

The *ScanAsyst Auto Control* setting can be accessed under *Feedback* by changing *On* to *Individual* where the 4 parameters will appear.

![ScanAsyst parameters](image.png)

**Figure 27: scanAsyst parameters**

*ScanAsyst Auto Gain*: adjusts the gain to balance image tracking bandwidth and image noise. Increasing the feedback gain can improve surface tracking; but too high a gain value will cause oscillation of the system and increase noise. Decreasing the feedback gain will lead to poor surface tracking.

*ScanAsyst Auto Setpoint*: increasing the Peak Force Setpoint will increase the interaction force between tip and sample which will result in good surface tracking but risks damaging the tip or the sample. It is generally desirable to reduce the Peak Force Setpoint to as small a value as possible.
ScanAsyst Scan Auto Scan Rate: Increasing the Scan Rate may lead to poor surface tracking. Because there are only 2000 Peak Force Tapping cycles in each second, a too high scan rate results in insufficient data points and lower XY resolution. User sometimes needs to decrease Scan Rate to optimize the image quality.

ScanAsyst Auto Z Limit: Decreasing the Z Limit can improve z resolution and avoid bit noise. A small Z Limit is usually used for imaging very smooth surfaces.

Figure 28: poor tracking (left) and good tracking (right)
7.7 Capturing an Image

Once the user has optimized the scan parameters and satisfied with the image, user is ready to capture the image data.

1. First click on the Select Capture Directory icon on the top right of the screen and a window, *Browse For Folder*, will pop up to allow user to select/create the folder where the image will be store.

2. Click on the Director located under the *Select Capture Directory* to display the content of the folder on the right hand window.

**HINT:** it is good practice to display the destination folder to ensure the image is successfully saved.

3. In the filename box, enter a name for the image that is going to be captured. The file extension will display *xxx.000* when enter

4. Click on the *Capture* icon to initiate the image capture

5. Depending on where the red dotted line is on the real time scan, click on *Top Down* or *Bottom* icon if the line is closer to the top or bottom of the frame. Once the scanner finishes scanning, a file will appear on the right hand column of the screen.

**HINT:** it’s good practice to not tamper with the scanning parameters during image capture. If any parameters are changed, the capture is interrupted and will not be saved.

*Continuous Capture* – the software automatically save an image whenever the scan is complete with the file extension update in numerical sequence (e.g., 000 -> 001-> 002)

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13 Data folder location: Computer\Data (E:\)\capture
8 Wrapping Up

1. Click on the Withdraw button on the Workflow Toolbar where the scanner will move up in the Z direction ~1 mm
2. Wait for the withdraw action to complete\(^{14}\) and click on the Withdraw button 2 more times with few seconds apart for the system to complete the action
3. Close the software after complete by red x button on the top right. The instrument control unit and the laser on the scanner will turn off.
4. Remove the probe holder off the scanner head by reversing the procedure outlined in section 7.2
5. Remove the probe from the probe holder by reversing the procedure outline in section 7.1
6. Place the probe back into the gel pack and gently tap on probe
7. Record the sign out time in the AFM usage booklet
8. Create an usage ticket for the time used

9 References and Files

1. NanoScope Help files

\(^{14}\) Bottom left of the screen will display withdraw during the tip withdrawing process