

NT-MDT Ntegra

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Loading Sample

- Start Nova Px
- Wait for the software to connect to the instrument it will say “SPM OK” instead of “Power Off”

(Figure 1).

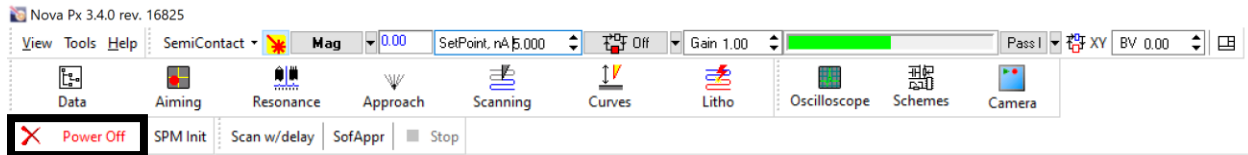


Figure 1: Main control panel of Nova Px

- Figure 2 highlights the location of some of the physical controls of the microscope.

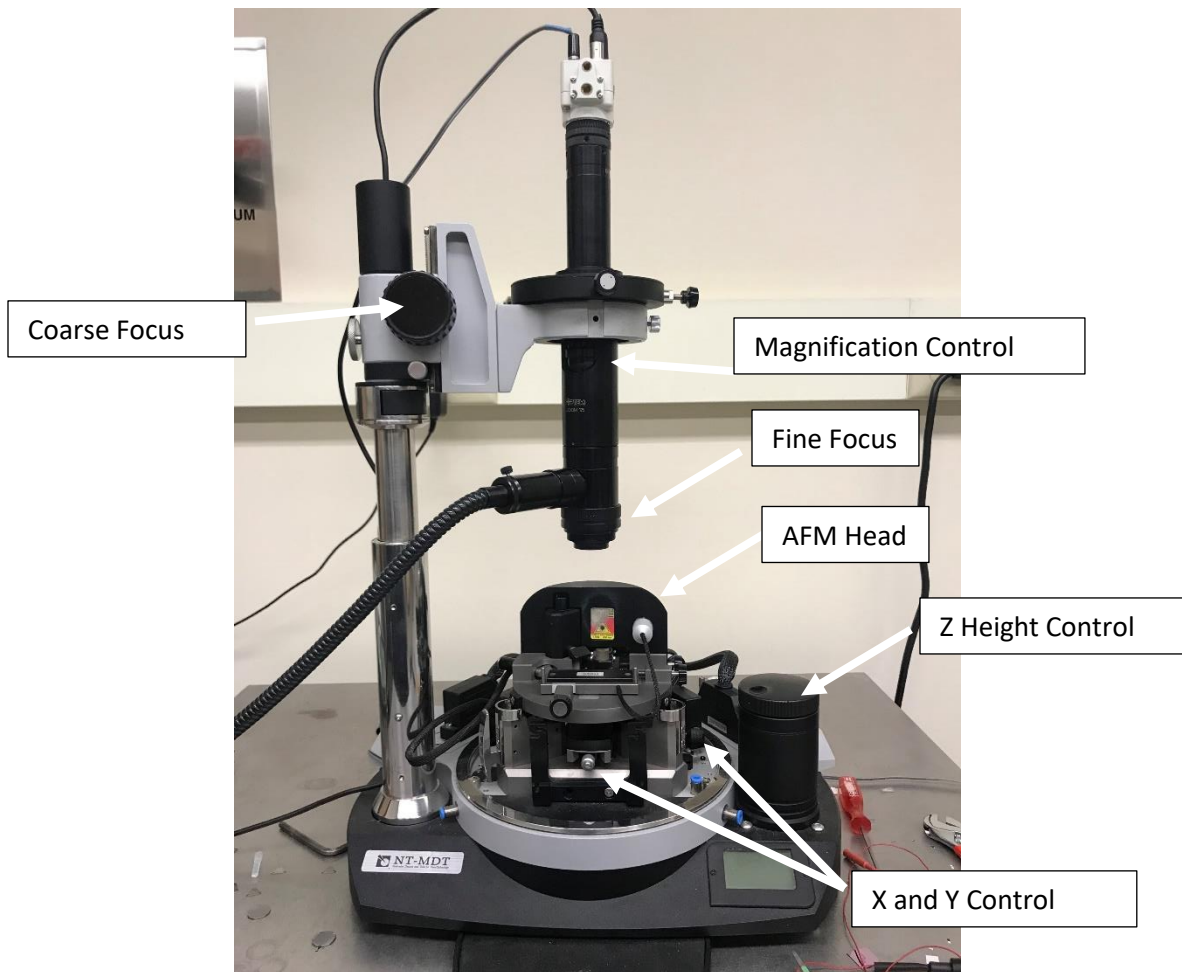


Figure 2: Physical controls of microscope



Figure 3: (Left) AFM head on the instrument (Right) AFM head on docking pad

- Make sure the AFM is off the instrument and resting on the docking space, the safest way to remove it from the instrument is by grabbing the black portion of the head and lifting straight up (Figure 3).
- The piezo stage is magnetic and usually has a 3mm magnetic spacer on it (Figure 2).

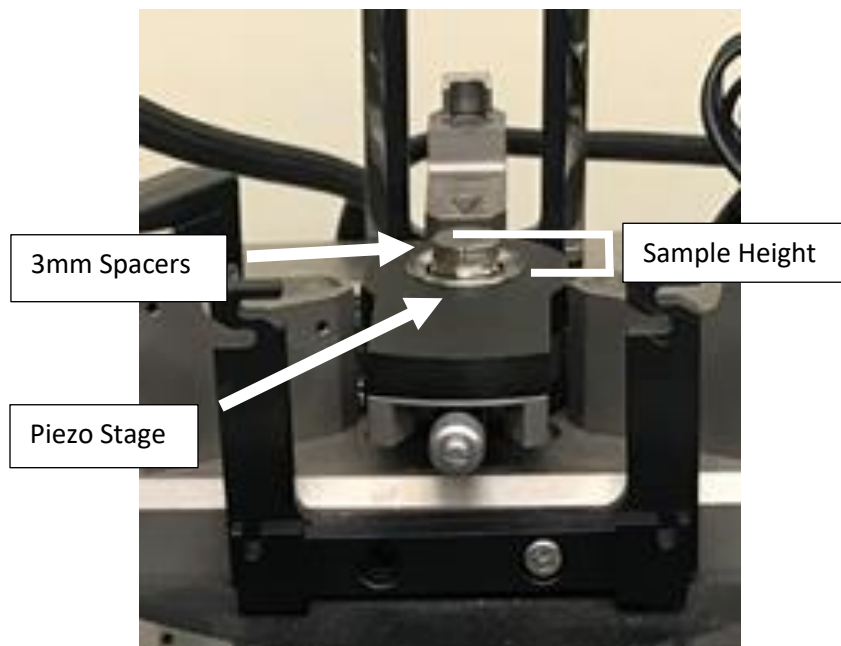


Figure 2: Piezo stage with 3mm spacer

- Samples should be mounted on the steel discs (Figure 2) that are in the lab, using double sided carbon tape or some other adhesion method.
- The sample height needs to be measured using the digital vernier caliper, this includes any 3mm spacers and steel disks being used (Figure 2). Sample height is from the top of the piezo stage to the top of the sample.
- Make sure there is one 3mm spacer mounted on the piezo stage if not mount one. **Remember anytime you mount a magnetic or magnetic material on to the stage slide it from the side, DO NOT place directly down, the downward force can damage the piezo ceramic.**
- Make sure the area of interest on the sample is completely supported by the stage area.
- Once the sample is loaded, use the Z height control to lower the stage all the way down this will help to prevent any probe or sample damage.

Loading Probe

- Loosen the tension screw on the probe holder and place the probe holder on the table probe side up (Figure 3).

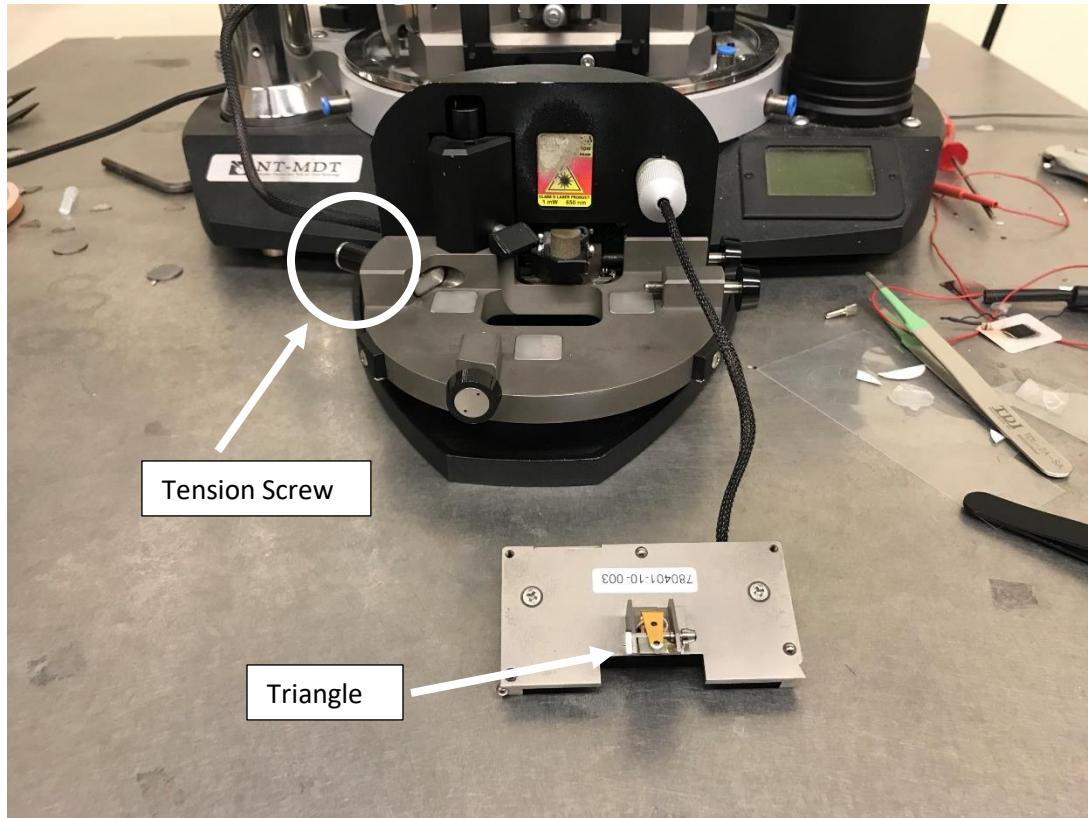


Figure 3: Preparing probe holder for probe

- Release the probe retention clip by rotating the triangle on the side of the AFM head (Figure 3).
- Place a probe on the left side of the shelf and slide under the clip, make sure the back and side of the probe are squarely up against the right edge of the shelf (Figure 6).

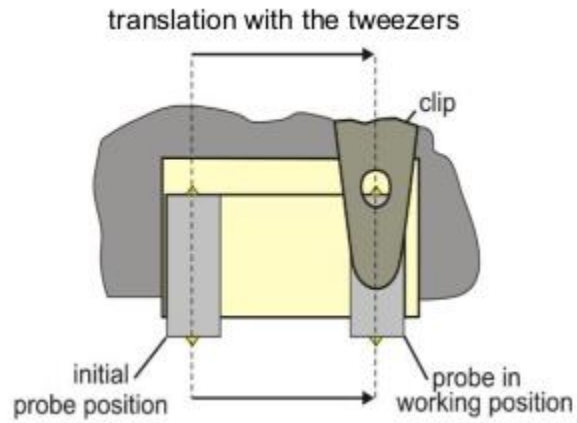


Figure 6: Moving the probe into position

- Using the triangle firmly lock the probe in place with the retention clip.
- Place the probe holder back on the AFM head and use the tension screw to secure it in place.

Laser and Diode Alignment

- First open the “Aiming” menu by clicking the button in the top left of the main menu bar (Figure



1). **Aiming**

- The probe position screws are located on the AFM head (Figure 7), the laser remains fixed an the probe is moved to align the laser on the probe.

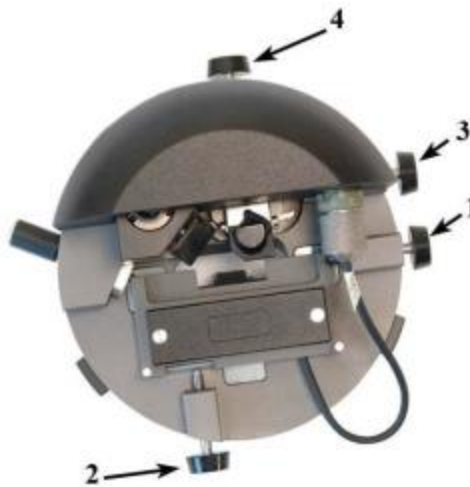


Figure 7: 1 and 2 are for adjusting the probe position, 3 and 4 center the diode

- Hold the AFM head as shown in Figure 8, if there isn't a piece of paper to use the black docking station for the AFM head works as well.

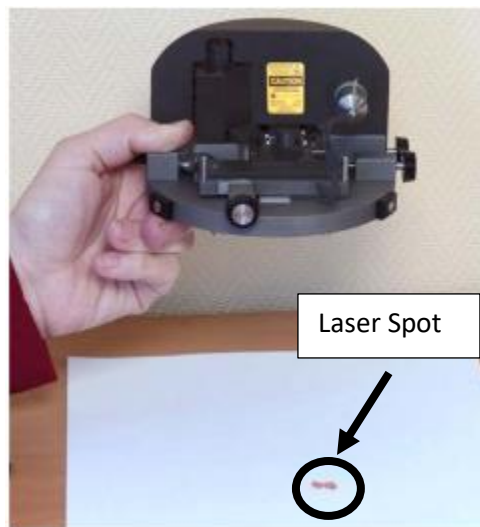


Figure 8: How to hold the AFM while aligning the probe and laser

- The laser spot will change depending what is in the laser path this is demonstrated in Figure 9.

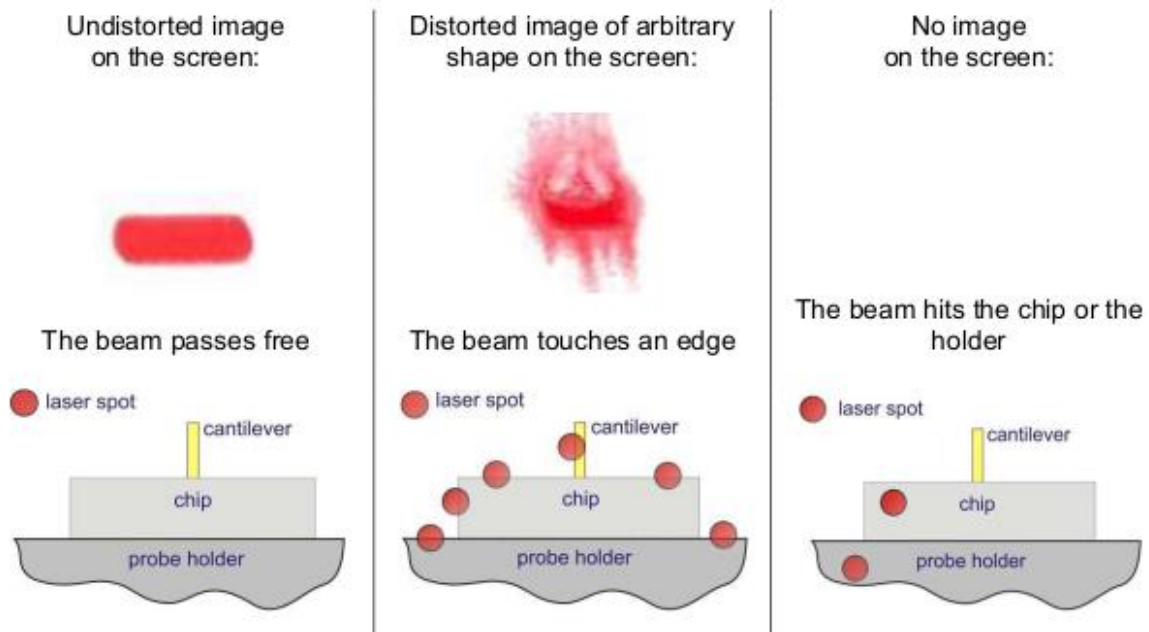


Figure 9: Interpreting laser spot based on position of the probe

- Figure 10 shows how to “walk” the probe to the laser, in general it is easiest to get the laser to the probe holder then to the chip and finally to the cantilever.

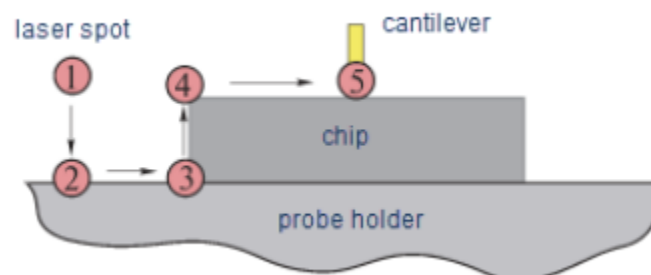


Figure 10: 1-is a possible starting position of the laser spot, 2-move it to the probe holder, 3-move it to the edge of the chip, 4-move it to the front of the chip, and 5-move it to the cantilever

- When the probe is under the laser the resulting laser spot should look like concentric circles for a rectangular cantilever (Figure 11).



Figure 11: Laser spot patterns for different cantilever types

- Place the AFM head on the microscope and reposition the optical camera over the probe.
- Use the optical camera to make final adjustments for laser position (Figure 12).

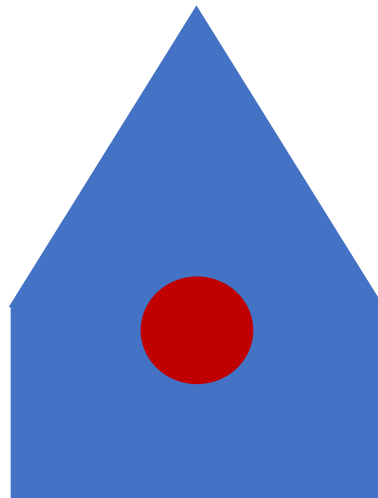


Figure 12: Ideal laser position on probe.

- Centered the diode using the two diode knobs (Figure 7), use the “DFL” and “LF” values to help center the diode (Figure 13).
- DFL represents the up and down position of the laser and LF represents the left and right position of the laser
- The black square with the red dot is a graphical representation of the laser on the diode.
- Both DFL and LF values should be close to zero and not above 0.1 or -0.1.

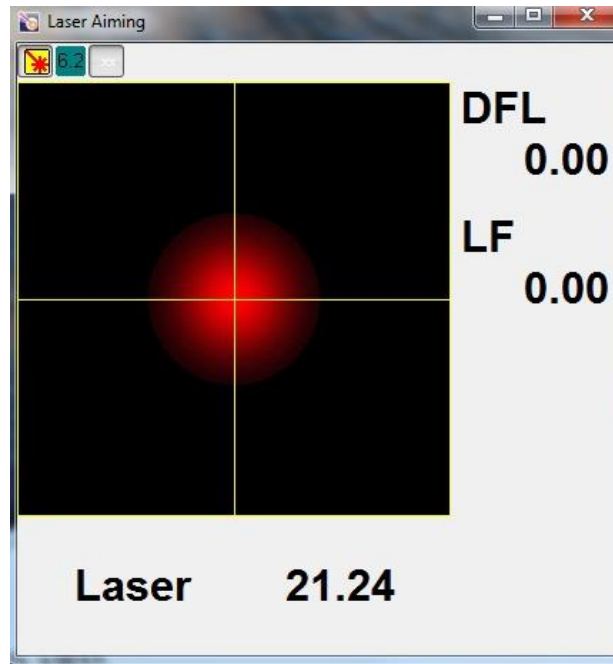


Figure 13: Alignment menu

Resonance

- The next step is to find the resonance frequency of the probe click the “resonance” button



in the main menu tool bar.

- The probes should list a frequency or range of frequencies, under the “Auto” category in the bottom left of the resonance menu enter a range that matches the probe in the From and To boxes (Figure 11).



- Click the “Auto” button in the top left (Figure 14).
- Once it is finished finding the resonance frequency first thing to note is the actual frequency that was found. In this example it was 298.722kHz this is located at the bottom of the top graph (Figure 11). If this is not within the range or close to the value of the probe make sure the range that was set for the auto frequency wasn't too large or small, if the range is correct then the probe is likely damaged.
- Next the top graph or frequency graph should be a bell curve, it's ok if it is slightly asymmetric but if there is any great irregularity to the graph this would imply that the probe is damaged or possibly dirty.

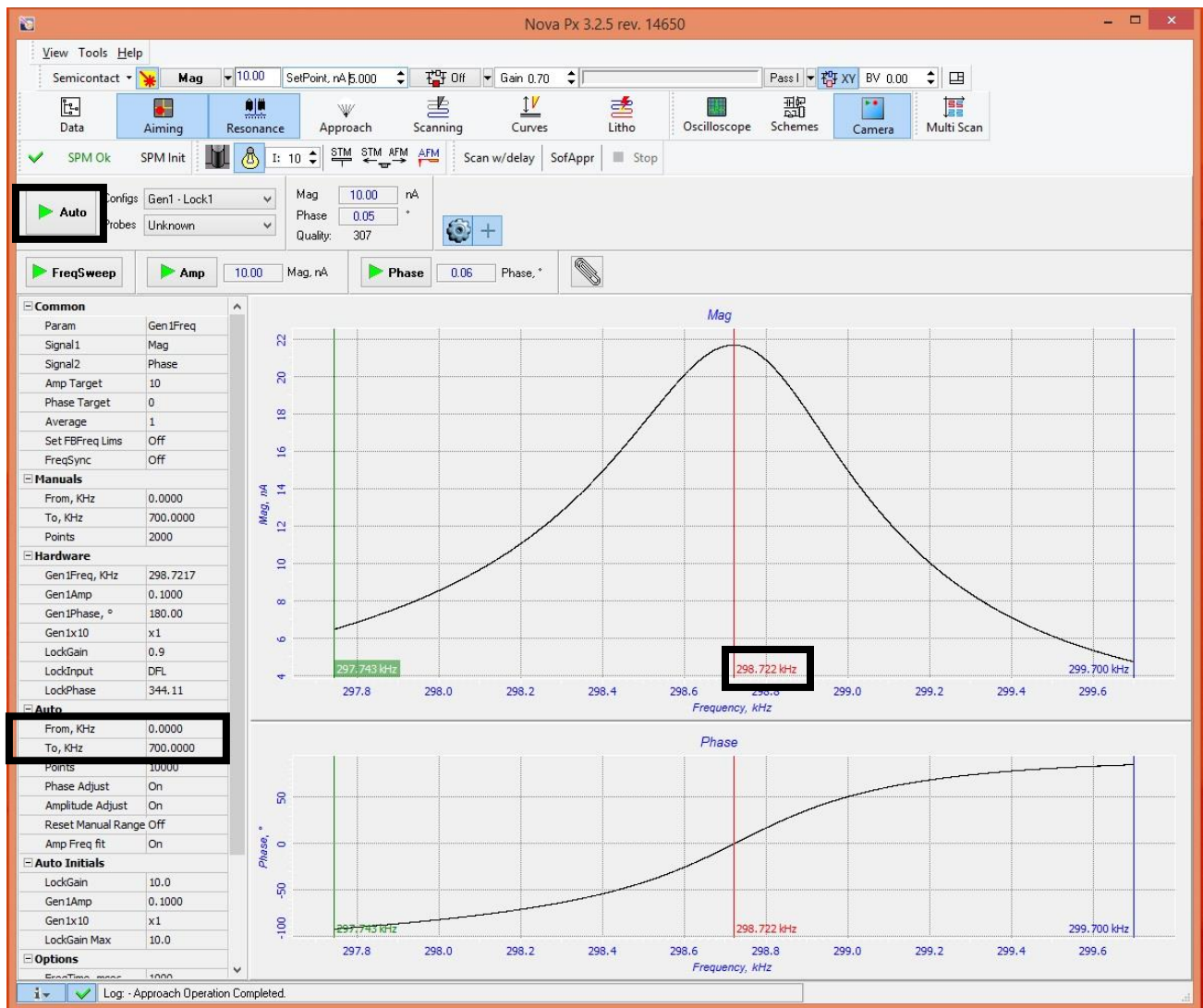


Figure 14: Resonance menu

Approach

- Click the “Approach” button in the main menu bar
- Click the “Mag” and “Phase” button in the top left of the approach menu (Figure 15).



- Click the “SofAppr” button in the top center of the menu (Figure 15).

SofAppr

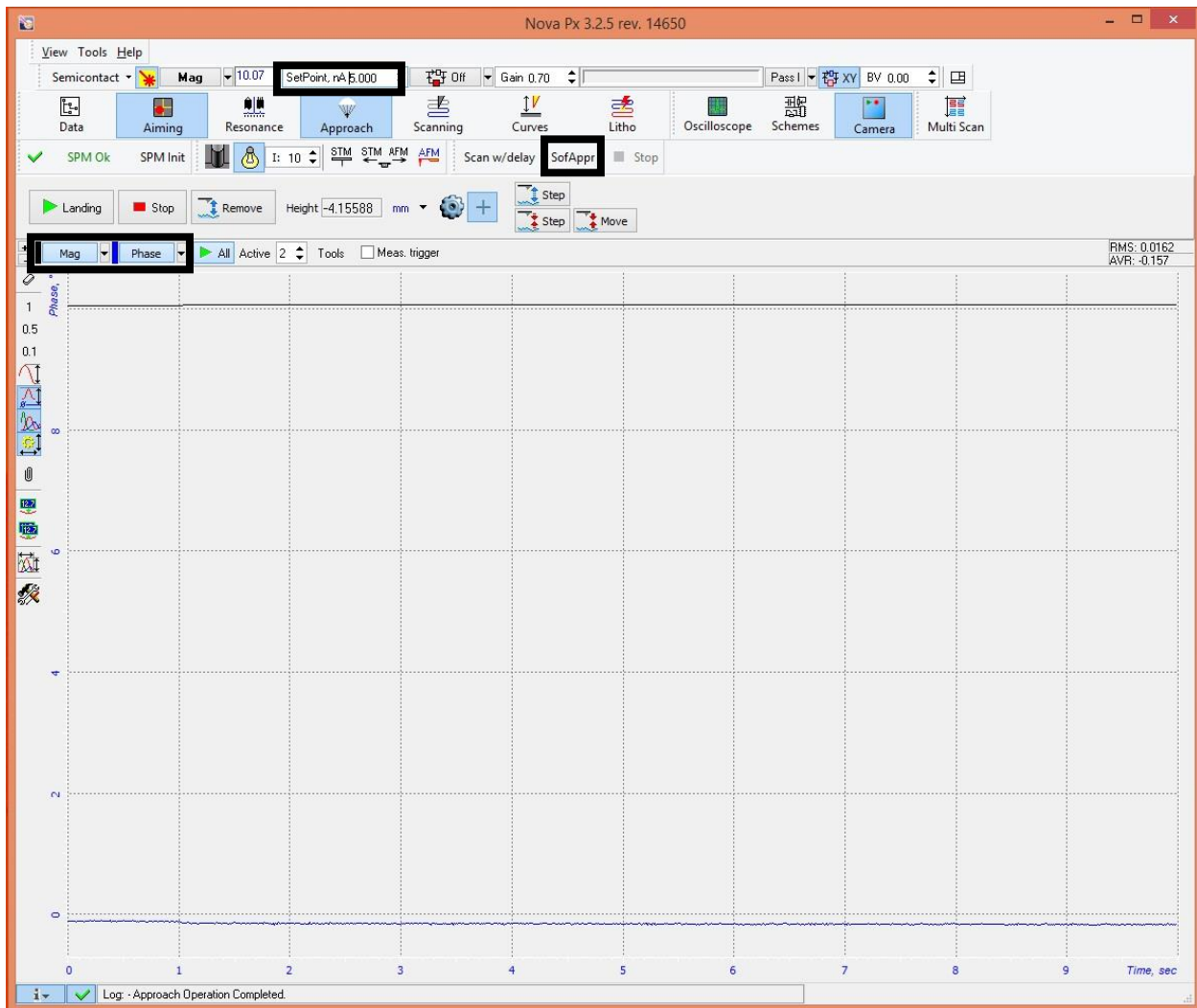


Figure 15: Approach main menu

- The values in the soft approach menu are prefilled and **DO NOT CHANGE THE VALUES** (Figure 16). Click the “Start” button.

- The soft approach script doesn't just land the probe on the sample but it also establishes a set point. When the probe gets close to landing the set point values should fluctuate (Figure 15).

The screenshot shows a software window titled "Show Data" with a standard Windows-style title bar (minimize, maximize, close buttons). The window contains two main sections: "APPROACH PARAMS" and "HARDWARE PARAMS".

APPROACH PARAMS

10.0	% MagErr	Mag change acceptable before
3.0	% decrSP	SetPoint to be reduced in each s
20.0	nm MinDeltaHeight	If Height reduced on this value o
2.0	grad MaxDeltaPhase	If Phase changed on this value o
70	% ZLevelStop	Scanner will be pulled on this p

HARDWARE PARAMS

0.30	FBGain
0.05	GenAmp
20.00	nA TargetAmp

Below the hardware parameters, there is a checkbox labeled "Apply Hardware Params to Device" which is currently unchecked.

At the bottom of the window, there are three buttons: "default", "Start", and "Exit". The "Start" button is highlighted with a thick black border. To the right of the "Start" button is a checked checkbox labeled "Use only phase for landing". Below the "Start" button is a "Stop" button. To the right of the "Stop" button is the text "LAST OPERATION:". At the bottom left is an "Exit" button.

Figure 16: Soft approach script

- When there is a sharp change in the Mag and Phase signal that levels off the probe has landed (Figure 17).

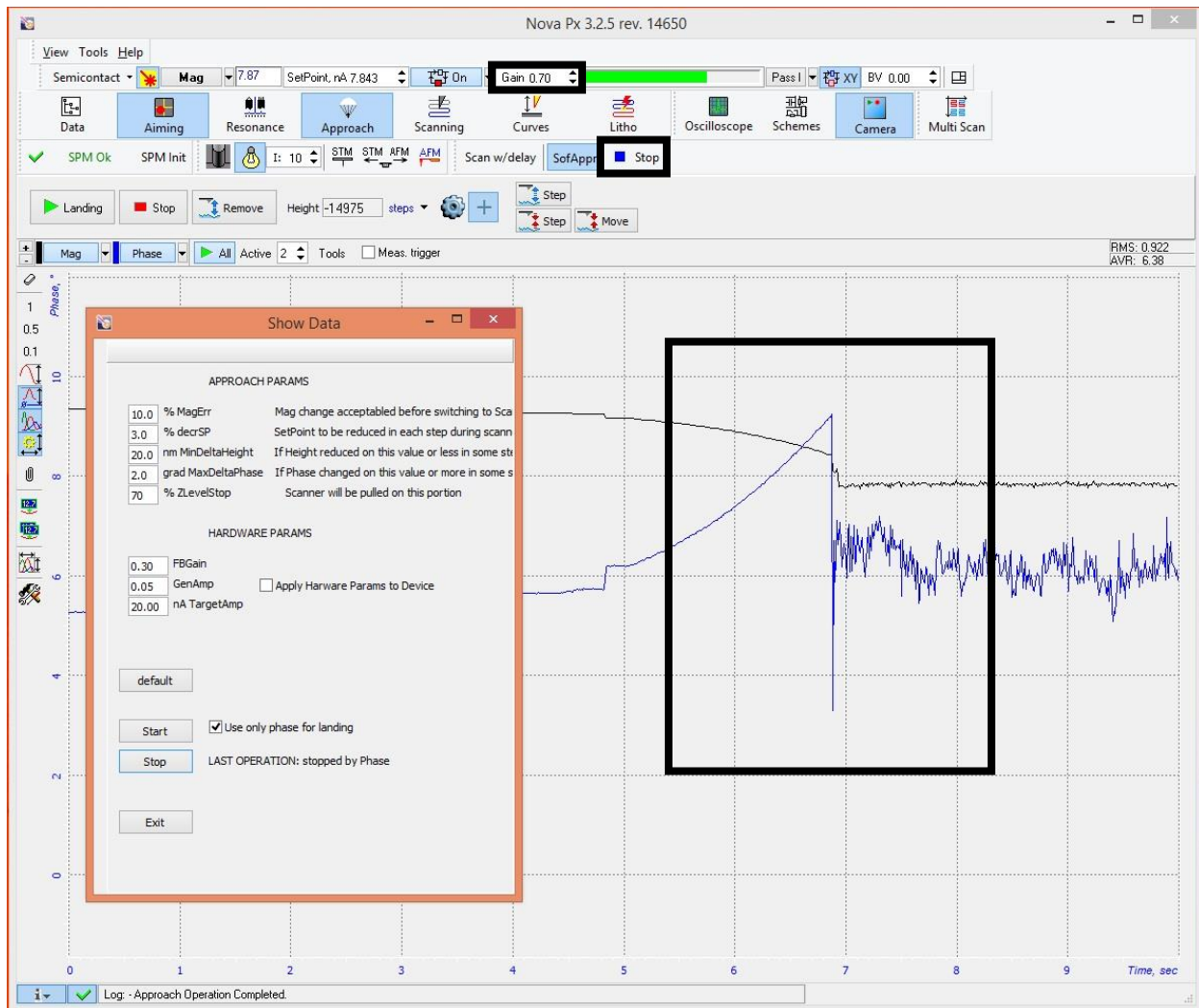

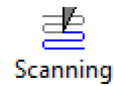


Figure 17: Change in mag and phase signal indicating a landed probe

- Once the probe has landed, close the soft approach menu and click the "Stop" button next to the "SofAppr" button (Figure 17).
- Using the Mag signal, establish a gain value, double-click the gain value (Figure 17) and a sliding bar will appear. 
- As the gain is increasing, there should be a point where the noise increases in the Mag signal. A general rule is to set the gain at half the value that caused an increase in noise.
- If increasing the gain results in no increase in noise or if it requires a high gain to increase the noise, this implies that the set point is too high. The set point represents the force interaction between the probe and the sample; lower the set point for higher force.

Scanning



- Click the “Scanning” button in the center of the main menu bar.
- Click the “Area” button in the top center of the scanning menu (Figure 19).

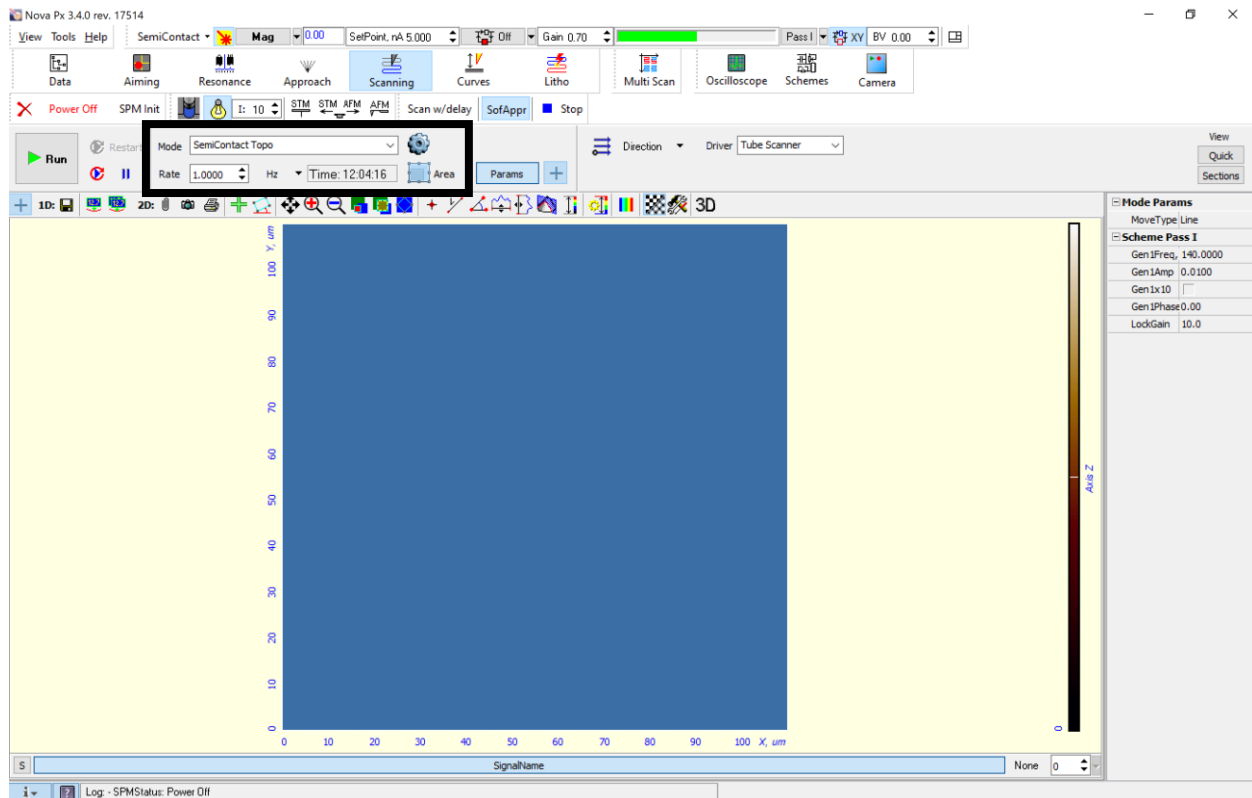


Figure 19: Scanning main menu

- This will bring up the area and resolution options in the top right (Figure 20). The magnification is controlled by the scan area and is always a square.

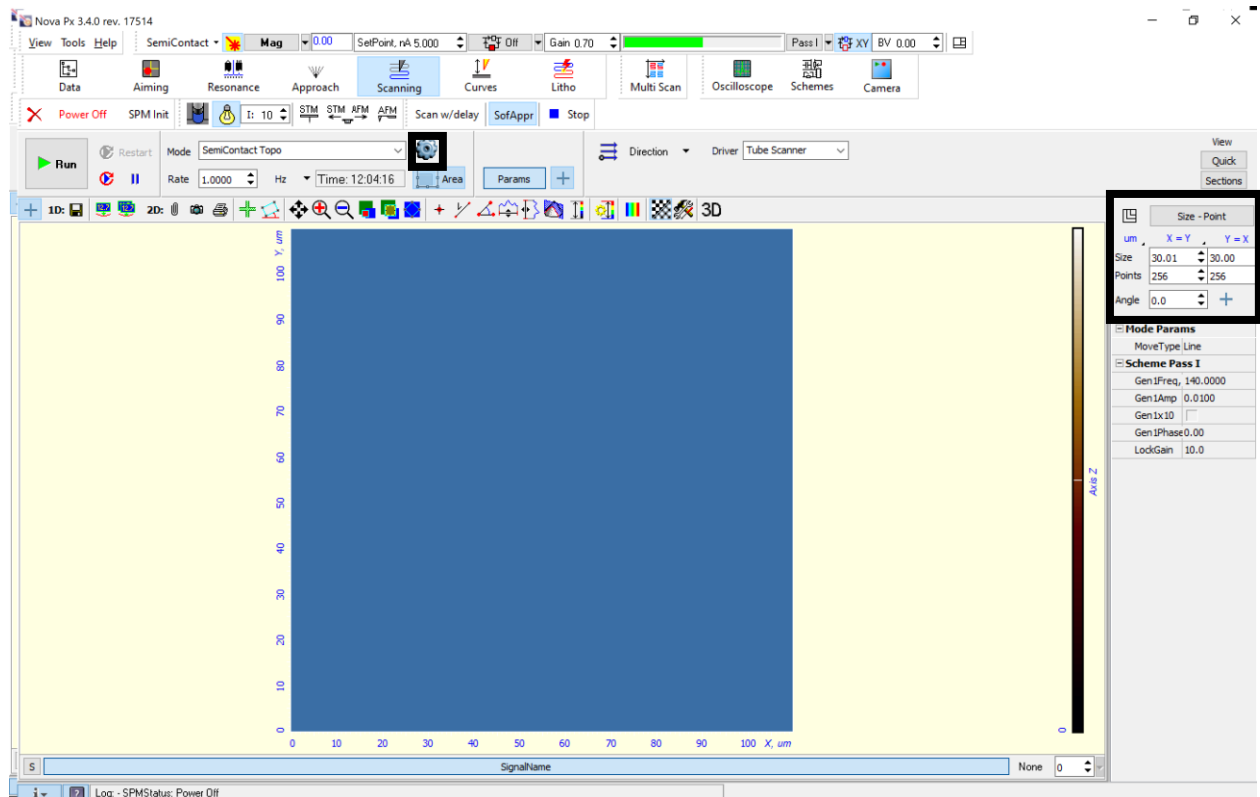


Figure 20: Scan area parameters are found in the top right



- Click the gear icon located right above the “area” button (Figure 20).
- This brings up the settings menu (Figure 21) in this menu select the desired signals. For standard AFM select “height” and “Mag”. **In the bottom right of the menu put in the sample height that was measured earlier, don’t forget to do this.**

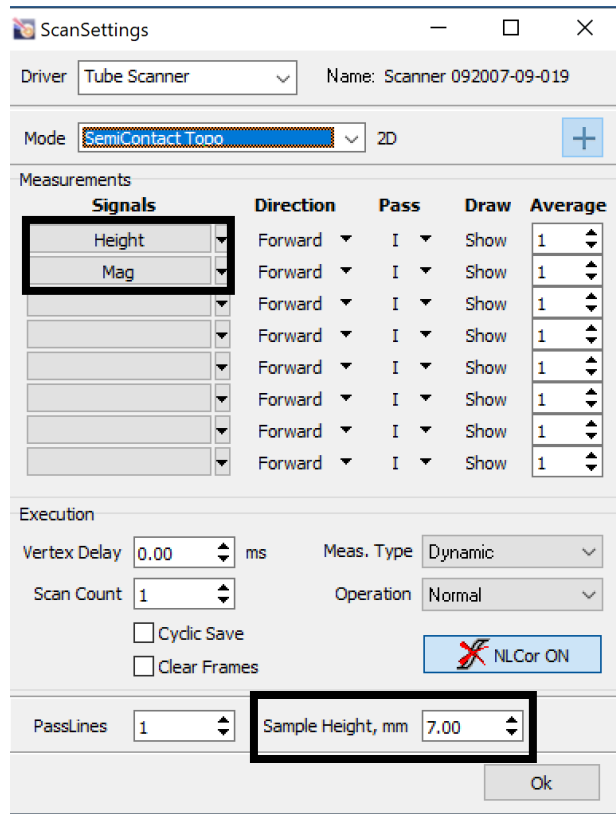


Figure 21: Scan settings menu

- Select the desired scan mode “SemiContact Topo” is general used for topography maps in semi contact or tapping mode. (Figure 19). To learn more about the other scanning modes consult the manufacture’s manual located in the lab.
- Last scanning parameter to check is scan speed, this is located below scan mode. In general most users prefer to change the units from Hz to um/s, when using um/s a good starting speed to use is close to the size of the scan area. For example, if the scan area is 30x30um a scan speed between 30 to35 um/s would be a good place to start.
- Once the initial scanning parameters are set click the “Run” button at the top left of the menu.



- Its help full to pull up a cross sectional view of the scan click the “s” button in the bottom left of the height scan screen (Figure 22).



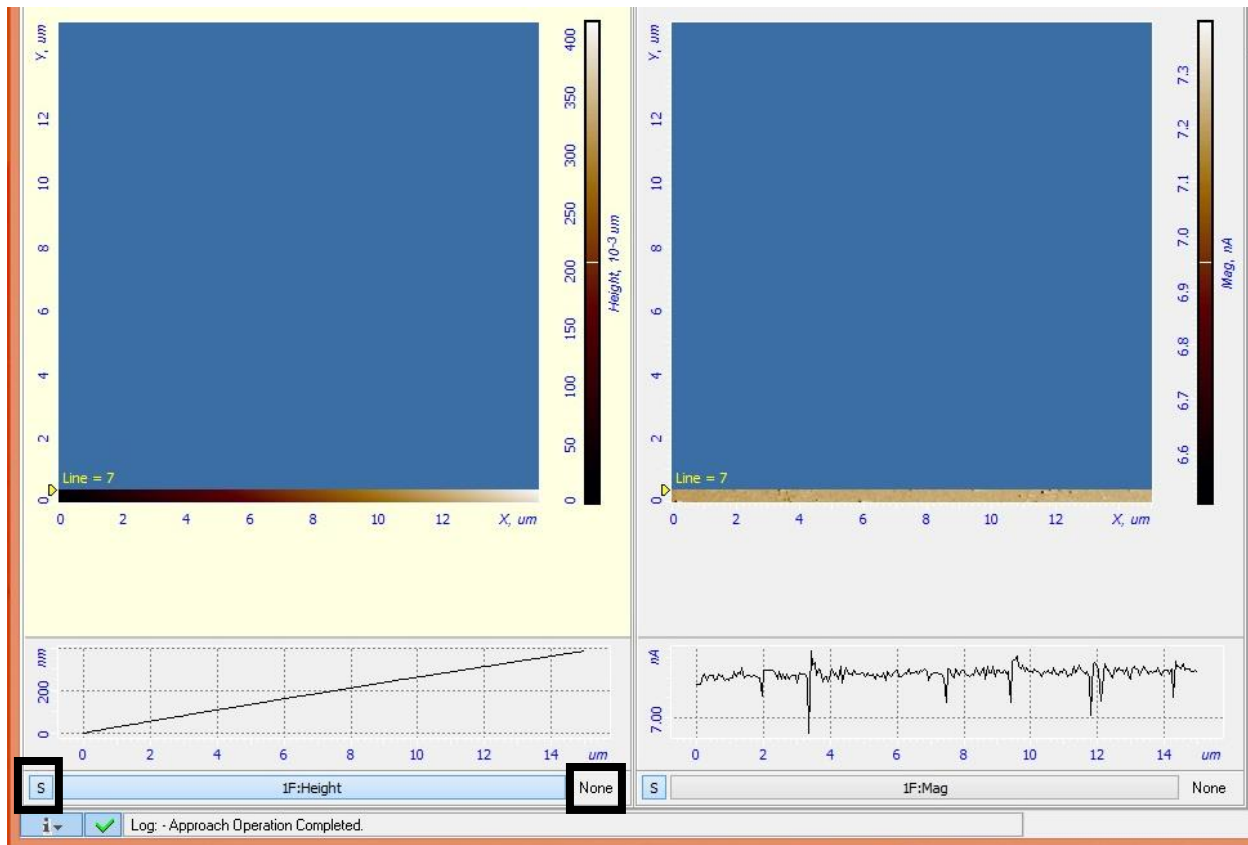


Figure 22: start of scan

- One thing to notice the cross section is sloping, and the scan image has a color gradient this implies that the sample isn't level and often this will be the case. A tilt correction can be used to flatten the image, keep in mind it will not be applied to the data saved.
- Click "None" in the bottom right of the height scanning screen this will activate a drop down menu and select the desired correction (Figure 22).
- In Figure 23 a 2nd order correction has been applied and the gradient in the image is gone and the cross section is level.

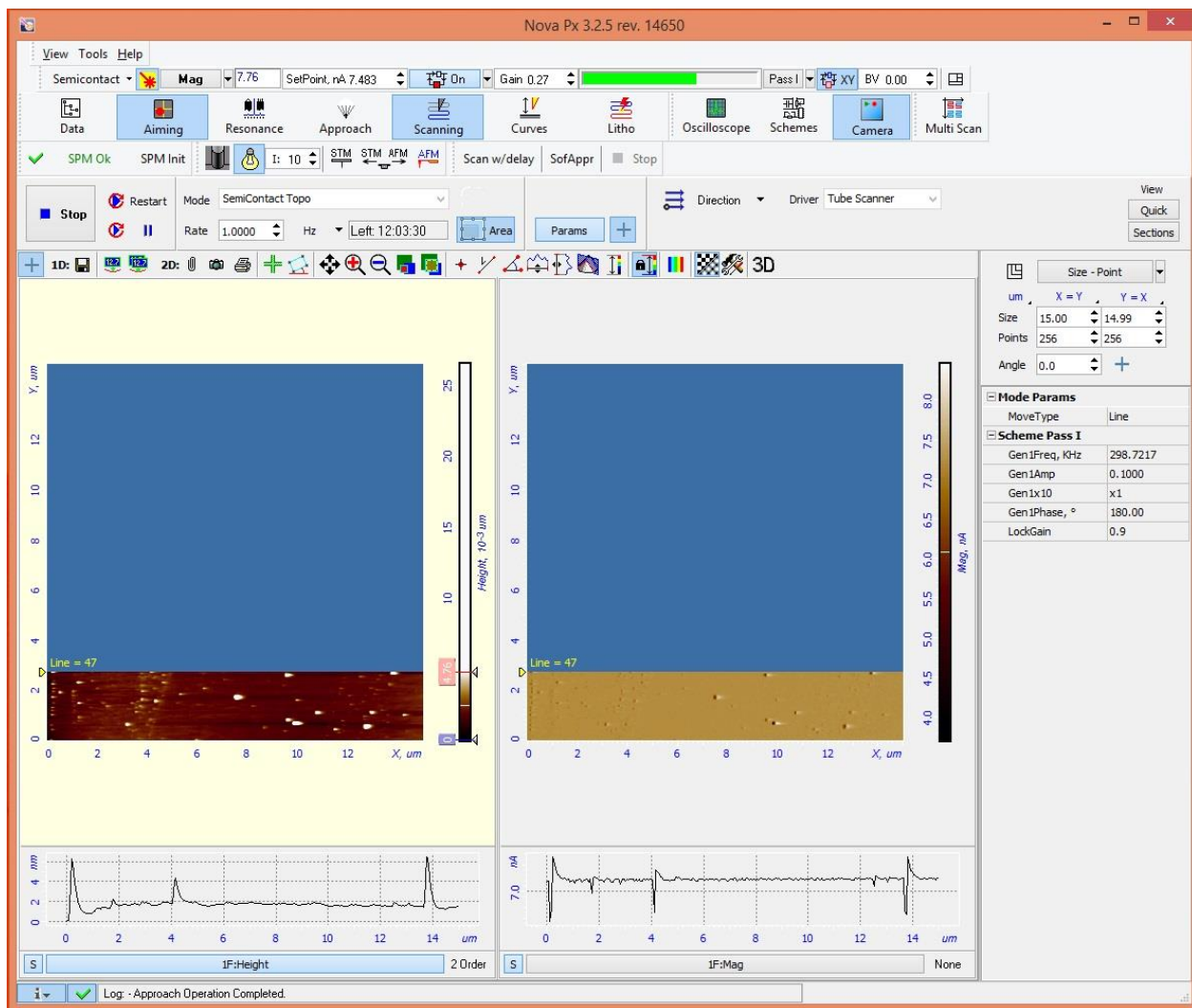










Figure 23: 2nd order tilt correction has been used to flatten cross section and remove gradient from scan image


- Now that the tilt is corrected for it will require some experimentation to find the optimal scanning parameters. For details on how to adjust parameters based on image features please review the attached paper “Recognizing and Avoiding Artifacts in AFM Imaging”.
- The following tools will be helpful during the process of fine tuning parameters: (Figure 24)
 - The pause button will pause a live scan. 
 - “Restart” will restart a scan without saving the data this is helpful if settings have been adjusted to improve an image and the previous data doesn’t need to be saved. 
 - “Stop” will stop a scan and save the data. 
 - Area selection can make it easier to zoom in on a feature. 


- Fit visible area to current scan. 


- Fit visible area to maximum scan area. 

- Measure length. 

- Measure angle. 

- X cross section. 

- Y cross section. 

- Change z coloration by selecting area on scan image. 

- Live 3D rendering of scan image. 



Figure 24: Scanning tools

- Once a scan is complete or the “stop” button is click the data is automatically saved.
- A data tree is created and consists of every scan that has been ran since the software is open.
- When done with the instrument remove the probe form the sample by clicking “Remove” in the approach menu (Figure 25).

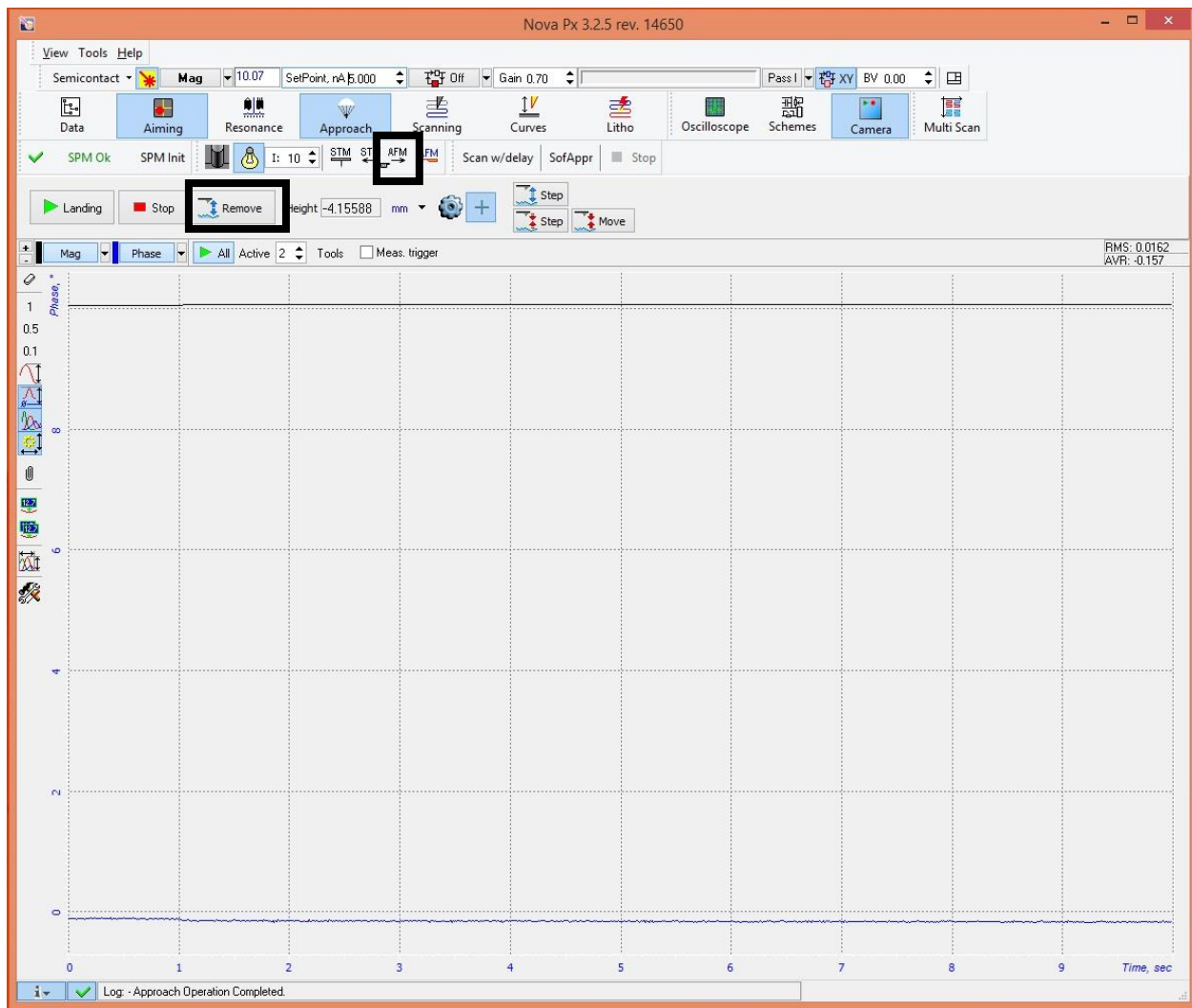
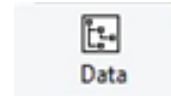


Figure 25: Approach menu showing the remove button

- Return the AFM back to analysis position and retract it using this button (Figure 25).
- Close door and close software.
- Fill out logbook.



Data



- To save data click the “Data” button in the top left of the main menu bar.
- The left side of the data menu is the data tree that is automatically generated (Figure 26).
- To save data as a .mdt file click “file” and “save”. For users using gwyddion for data processing, keep in mind it can open .mdt files. This will save all the images in the data tree.
- Images can be exported in a variety of file types by selecting one or multiply images and going to “file” and “export”.

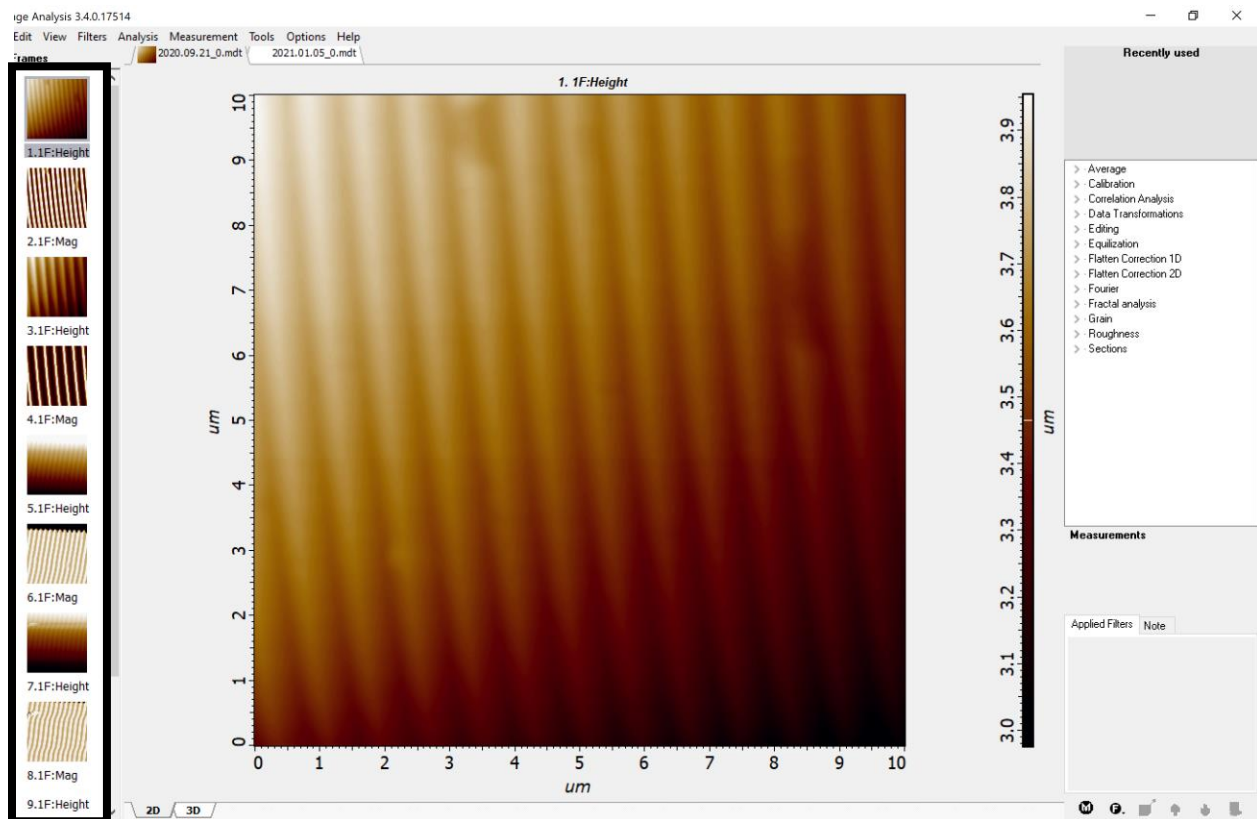


Figure 26: Data menu

- The software can do data processing but it is up to the user to review the data analysis manual from the manufacturer located in the lab.