NT-MDT Solver NEXT

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Contents

Loading Sample and Probe

- Start Nova Px
- Wait for the software to connect to the instrument it will say "SPM OK" instead of "Power Off" (Figure 1).
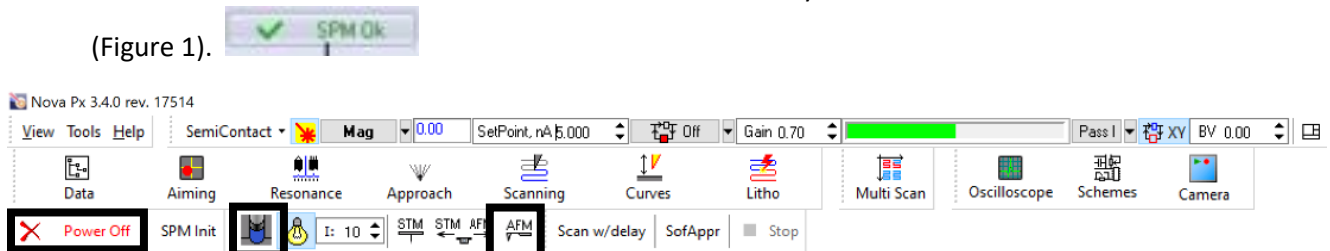

Figure 1: Main control panel of Nova Px

- Open the instrument door by clicking the door icon (Figure 1).
- The piezo stage is magnetic and usually has a 3mm magnetic spacer on it (Figure 2).
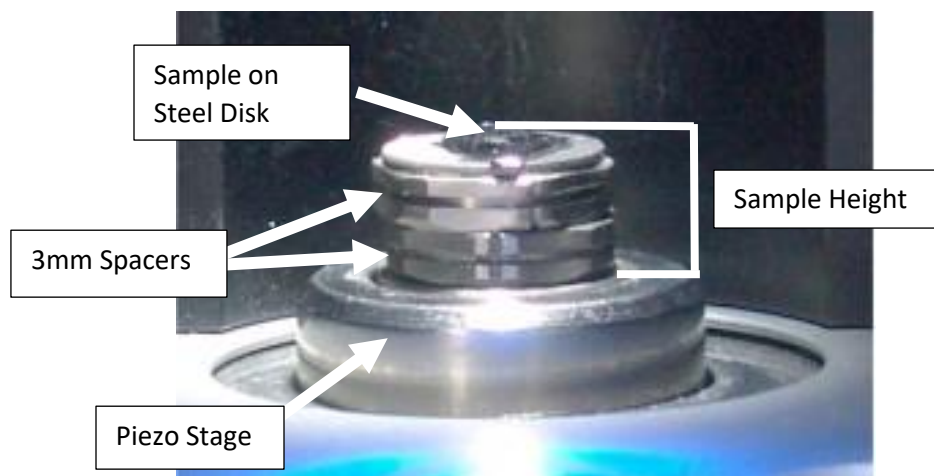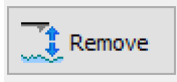

Figure 2: Piezo stage with 3mm spacers

- 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 veiner 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 areas that hangover will flex leading to poor images.

- Once the sample is loaded make sure there is enough room between the AFM head and the sample, if not follow these steps.

  - Go to the "Approach" tab (Figure 3). Approach

  - Click the "Remove" button, this may have to be done several times to sufficiently lower the sample (Figure 3). Remove
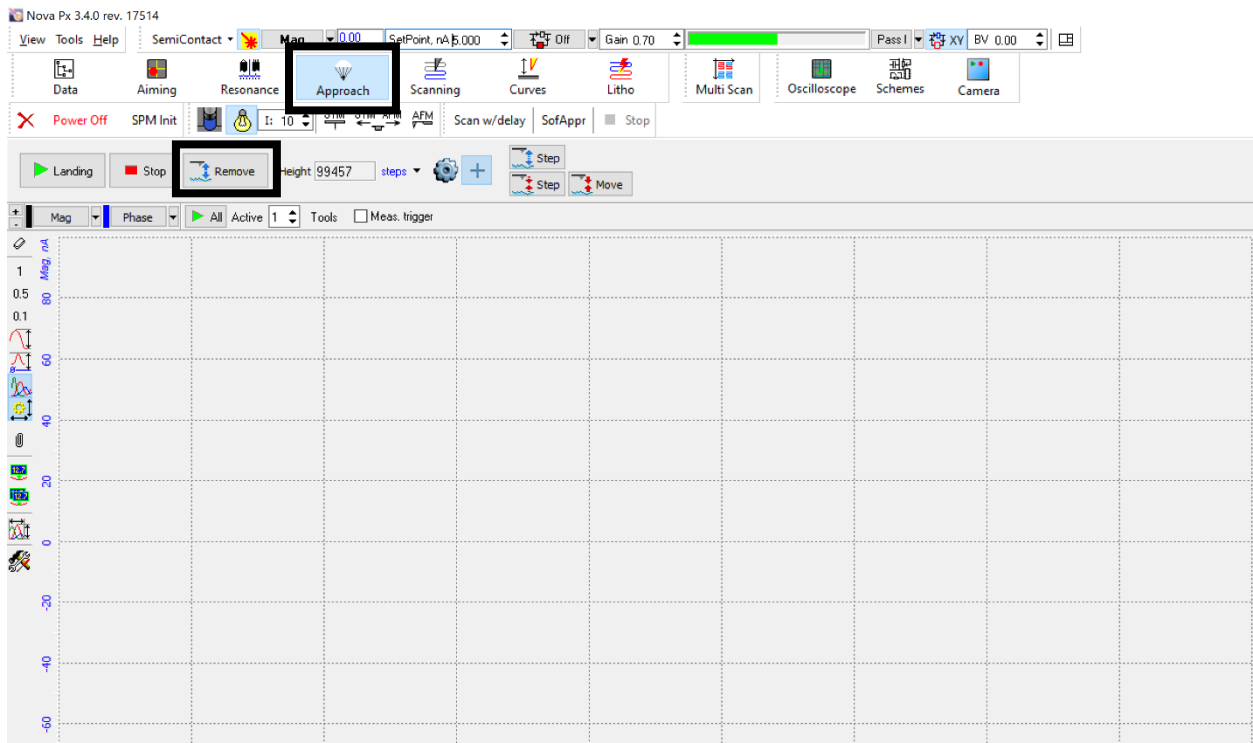

Figure 3: Approach window

- Once there is clearance between the sample and the AFM head insert the head by clicking this button (Figure 1). AFM
- With the head inserted the AFM probe needs to be installed this is done by rotating the head toward the operator (Figure 4).
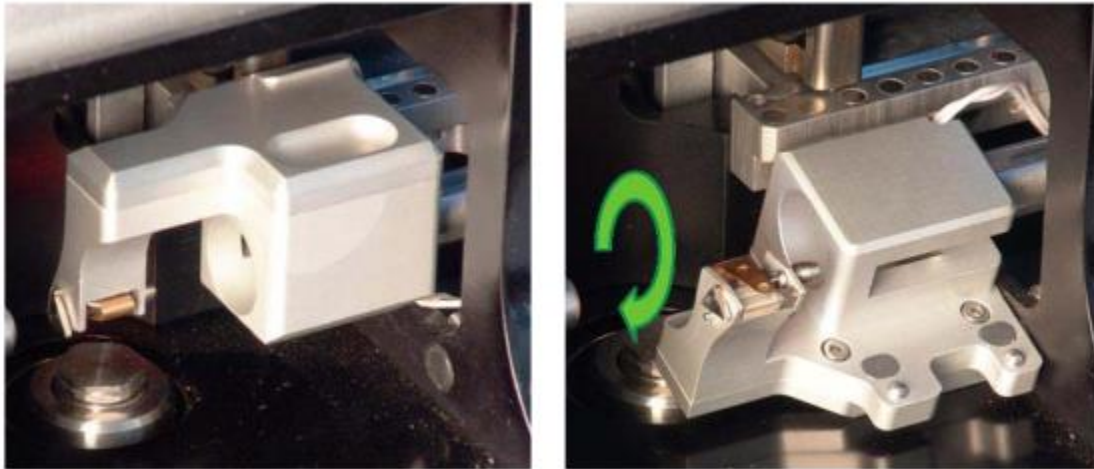
Figure 4: Rotating the AFM head to allow probe instillation

- Release the probe retention clip by rotating the triangle on the side of the AFM head (Figure 5).
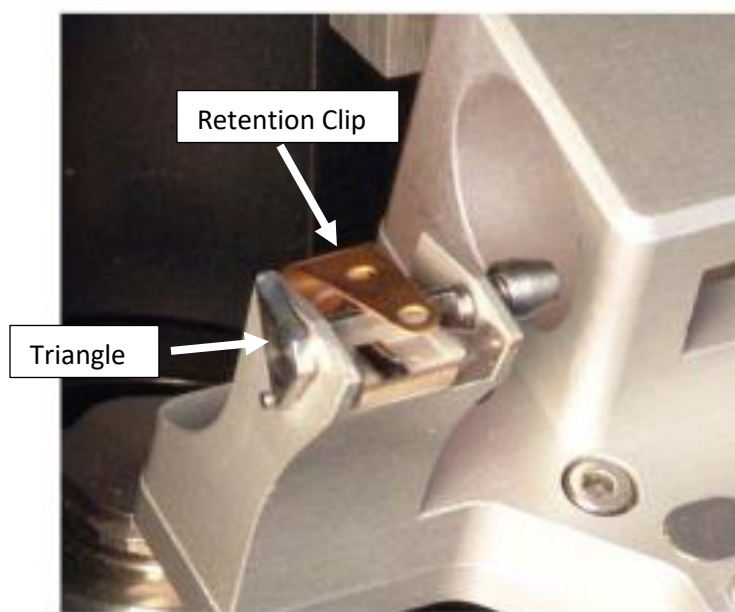

Figure 5: Close up of probe mounting

- 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).
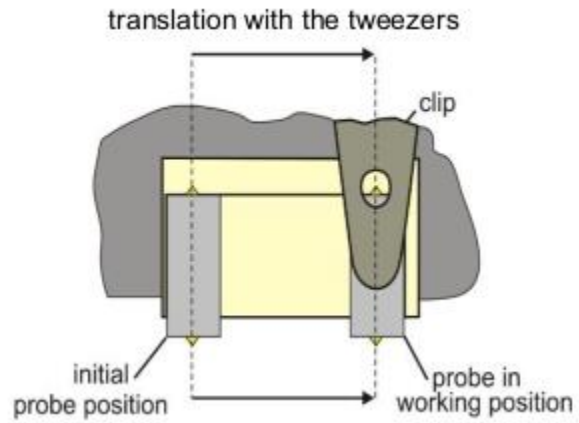
Figure 6: Moving the probe into position

- Using the triangle firmly lock the probe in place with the retention clip
- Rotate the head back to its original position
- Close sample chamber door

Semicontact Topography Scan

- Click the "Camera" button in the top left of the main menu bar (Figure 7).
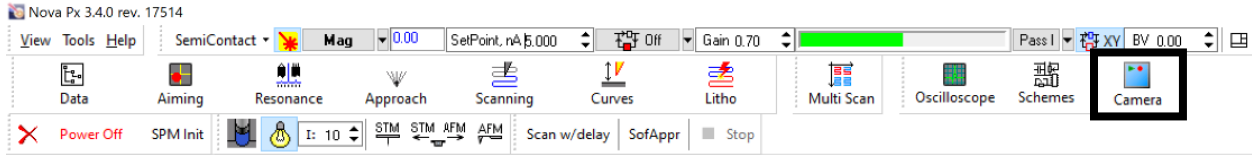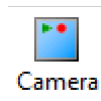

Figure 7: Main menu bar

- The following instructions cover the camera menu controls
    - To turn on the optical camera press the center triangle
    - There are many controls along the perimeter of the menu (Figure 8)
        i. StageX-moves the stage in X direction
        ii. StageY-moves the stage in Y direction
        iii. CameraX-moves camera position in X direction
        iv. CameraY-moves camera position in Y direction
        v. Focus-changes the focus of camera
        vi. Zoom-changes zoom of camera
    - Each control has different increments in each direction, these represent increments of speed rather than individual steps. For example; if x20 is clicked that control will move at the fastest speed until it is clicked again.
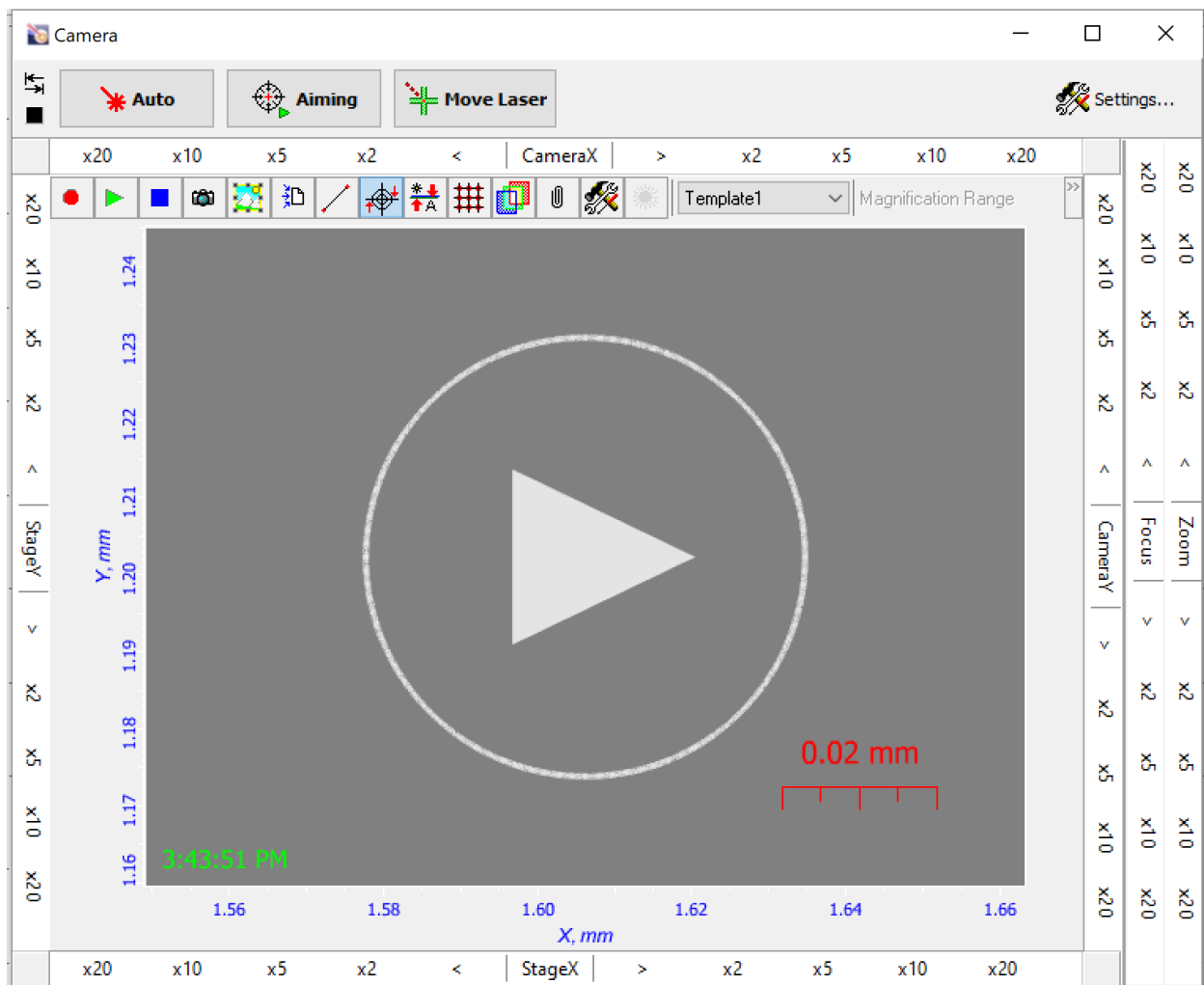
Figure 8: Camera menu

- Once the camera is on it is usually easiest to position the area of interest under the probe.
- Next move the laser on to the probe by ctrl + shift + click on the end of the probe and then clicking "Move Laser" (Figure 9).
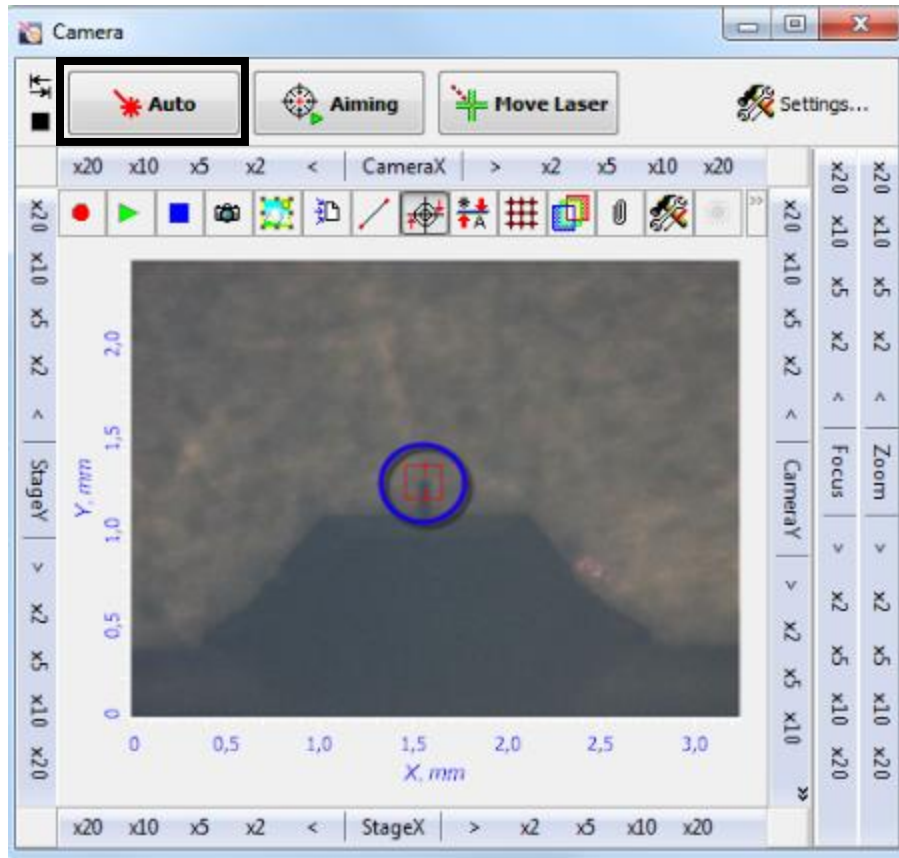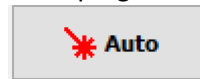
Figure 9: Moving laser to end of probe

- Next open the "Aiming" tab on the main menu bar in the top right.

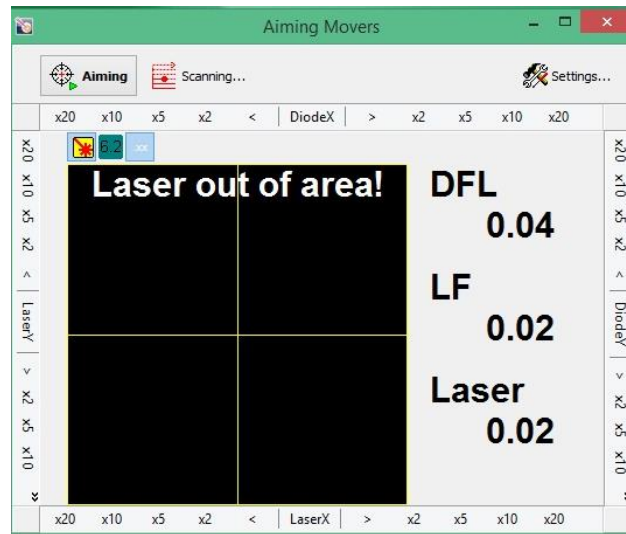- Click "Auto" in the camera menu top right (Figure 9).

Figure 9: Laser and diode aiming menu

- The auto alignment will raster the laser back and forth looking for the optimal position on the probe, this works relatively well but will require some fine tuning.
- The aiming menu (Figrue 9) works just like the camera menu with the controls along the perimeter.
    - The perimeter controls are the following:
        i. DiodeX-moves laser diode in X direction
        ii. DiodeY-moves laser diode in Y direction
        iii. LaserX-moves laser in X direction
        iv. LaserY-moves laser in Y direction
    - The three values on the left of the menu represent the following:
        i. DFL-represent how centered the laser is in the up and down direction a value of 0 would be perfectly centered the value should be between 0.1 and -0.1.
        ii. LF- represent how centered the laser is in the left and right direction a value of 0 would be perfectly centered the value should be between 0.1 and -0.1.
        iii. Laser-represent the laser power being reflected off the probe, this value is relative to probe and different AFM instruments so don't expect it to always be the same.
- Once the auto alignment is completed the aiming menu may look like this (Figure 10).
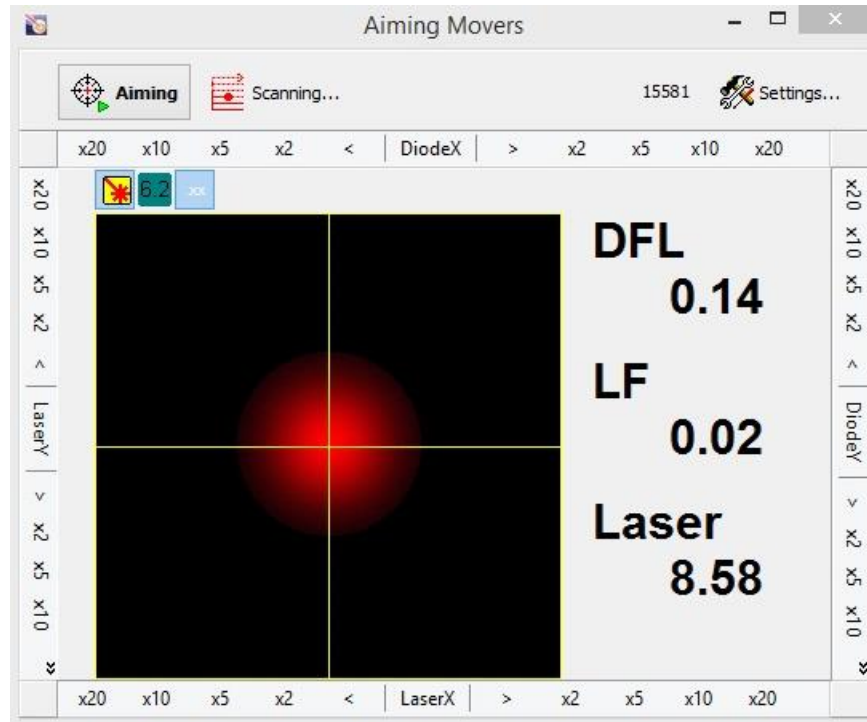
Figure 10: Close to aligned laser and diode

- After auto alignment we should adjust our laser position make sure that the laser is relatively close to the base of the triangle portion of the probe (Figure 11). This can be done using the LaserY control on the aiming menu and looking at the position of the laser in the optical camera.

- Adjust the LaserX control on the aiming menu while watching the laser value, try and achieve the highest value possible.
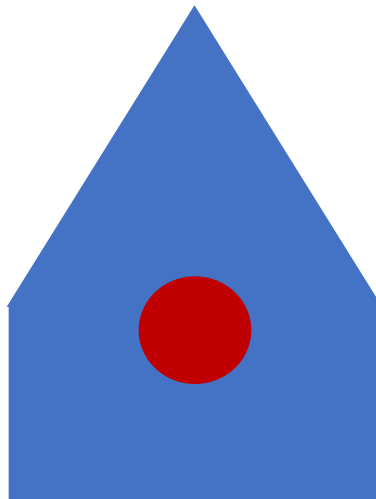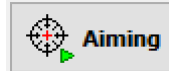

Figure 11: Ideal laser position on probe.

- Once the laser is in position, look at the DFL and LF values for the diode. If the values are with the recommended range of 0.1 to -0.1 move on to step . If the values are far from the

  acceptable range, click the "aiming" button (Figure 10). This button will roughly center the laser diode.
- The red circle in Figure 10 is a graphical representation of the laser on the diode and can help you understand the general centering.
- After clicking the "aiming" button use the diode X and Y controls on the parameter for the final alignment, remember the units are units of speed. If you click 20x it will move at the fastest speed until it is clicked again to stop. For fine tuning its recommend to double click the smallest increment of movement until the acceptable range is reached.
- The next step is to find the resonance frequency of the probe click the "resonance" button
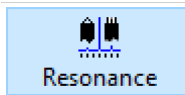
   in the main menu tool bar.
- The probes should list a frequency or rang of frequencies, under the "Auto" category in the bottom left of the resonance menu enter a range that matches the probe in the From and To boxes (Figure 11).

- Click the "Auto" button in the top left (Figure 11).
- 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 with in the range or close to the value of the probe make sure the range that was set for the auto frequency wasn't to 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, its 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.
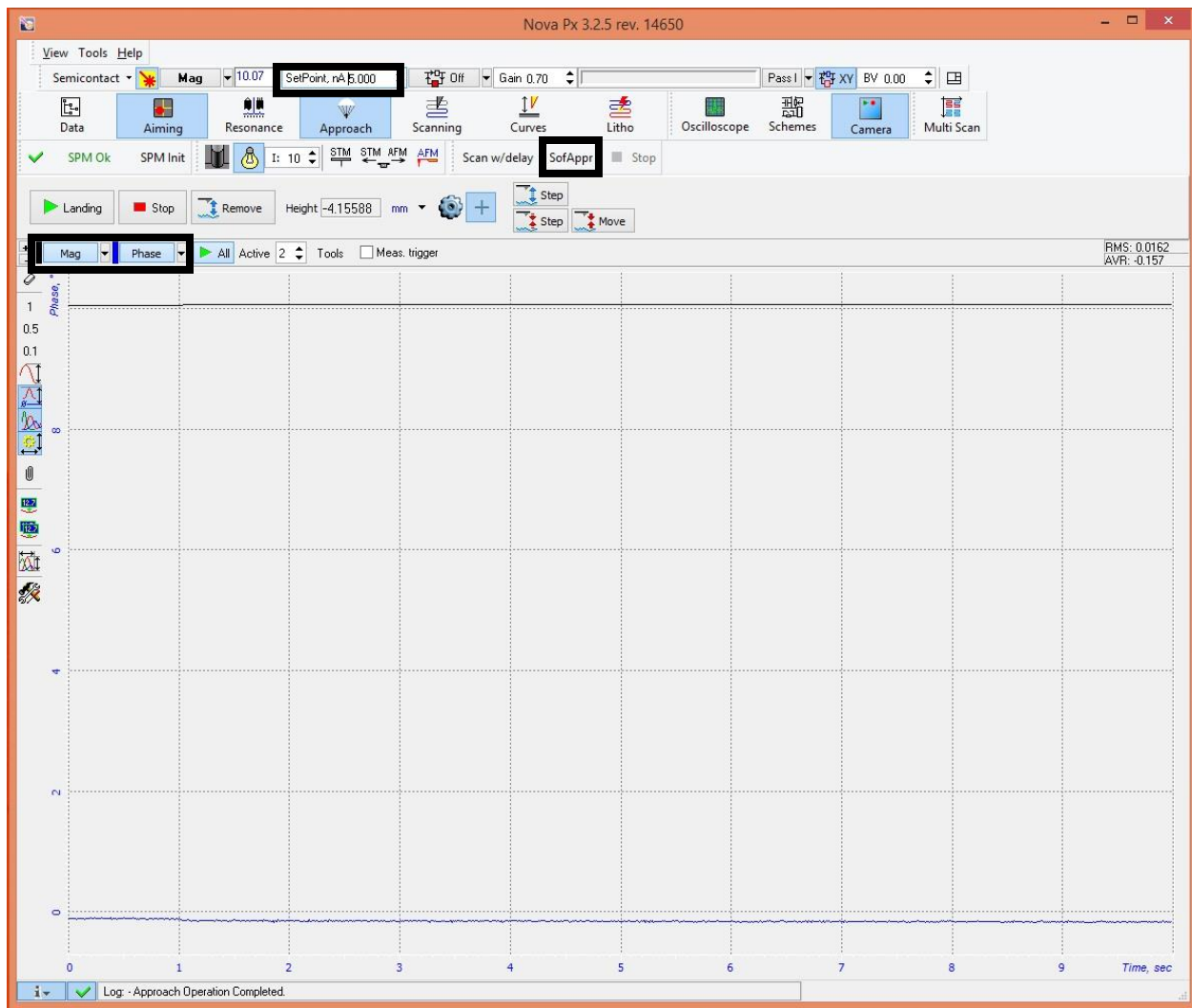
Figure 11: Resonance menu

- Click the "Approach" button in the main menu bar
- Click the "Mag" and "Phase" button in the top left of the approach menu (Figure 12).

- Click the "SofAppr" button in the top center of the menu (Figure 12).

Figure 12: Approach main menu

- The values in the soft approach menu are prefilled and **DO NOT CHANGE THE VALUES** (Figure 13). 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 12).

Figure 13: Soft approach script

- When there is a sharp change in the Mag and Phase signal that levels off the probe has landed (Figure 14).
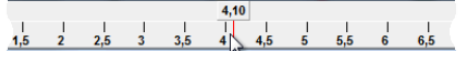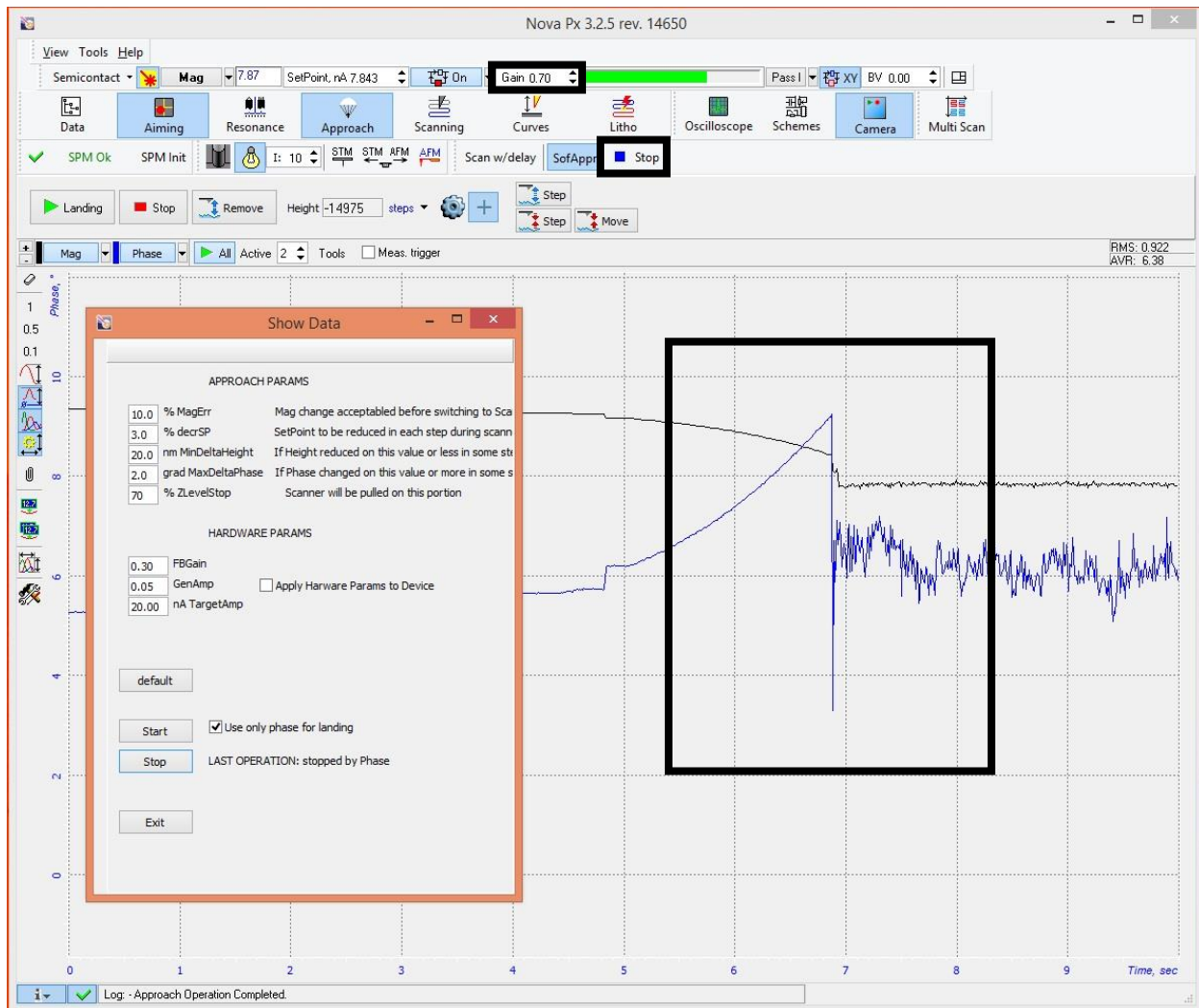

Figure 14: Change in mag and phase signal indicating a landed probe

- Once the probe the landed close the soft approach menu and click the "Stop" button next to the "SofAppr" button (Figure 14).
- Using the Mag signal establish a gain value, double click the gain value (Figure 14) and a sliding bar will appear.
- As the gain is increasing there should be a point that the noise increases in the Mag signal, general rule is to set the gain at half the value that caused an increase in noise.
- If increasing the gain there is no increase in the noise or if it requires a high gain to increase the noise, this implies that the set point is to high. The set point represents the force interaction between the probe and the sample, lower the set point the high the force. (Figure 15)

Insert Figure 15
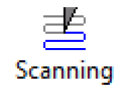
- Click the "Scanning" button in the center of the main menu bar.

  Scanning

- Click the "Area" button in the top center of the scanning menu (Figure 16).
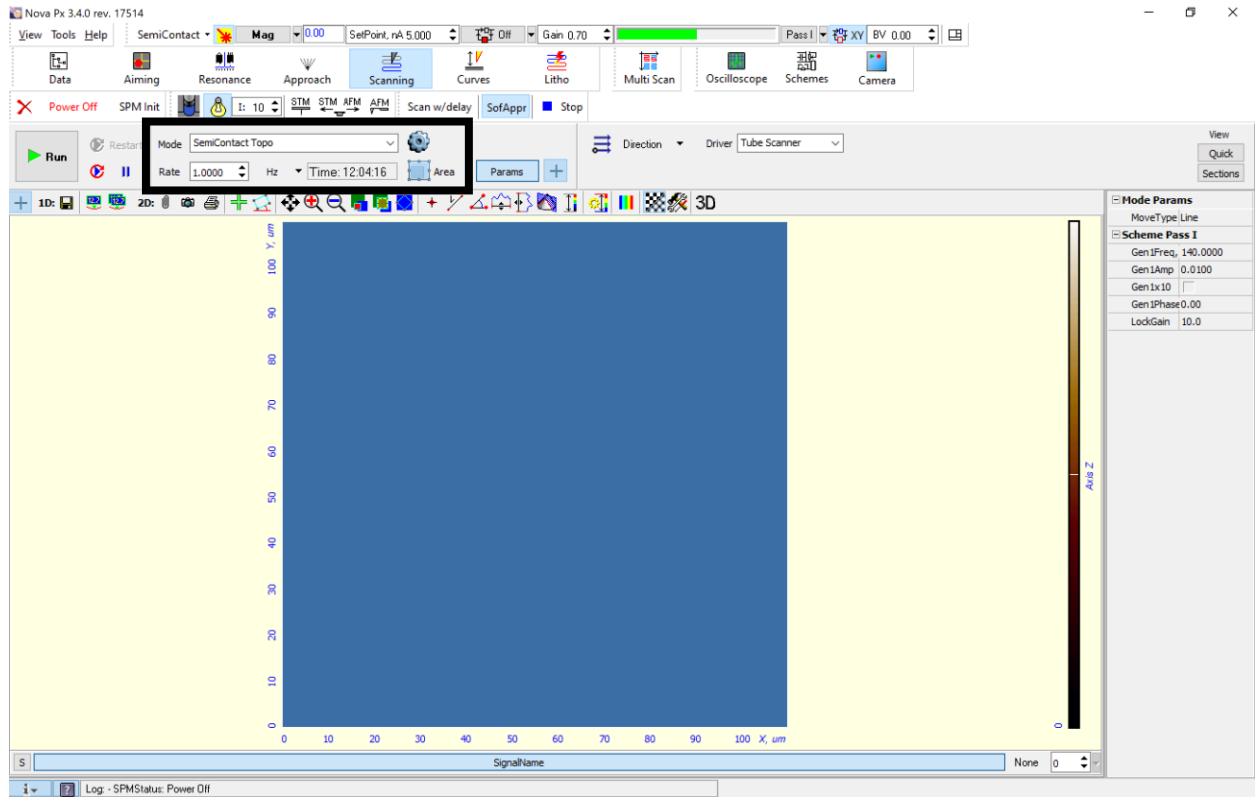

Figure 16: Scanning main menu

- This will bring up the area and resolution options in the top right (Figure 17). The magnification is controlled by the scan area and is always a square.
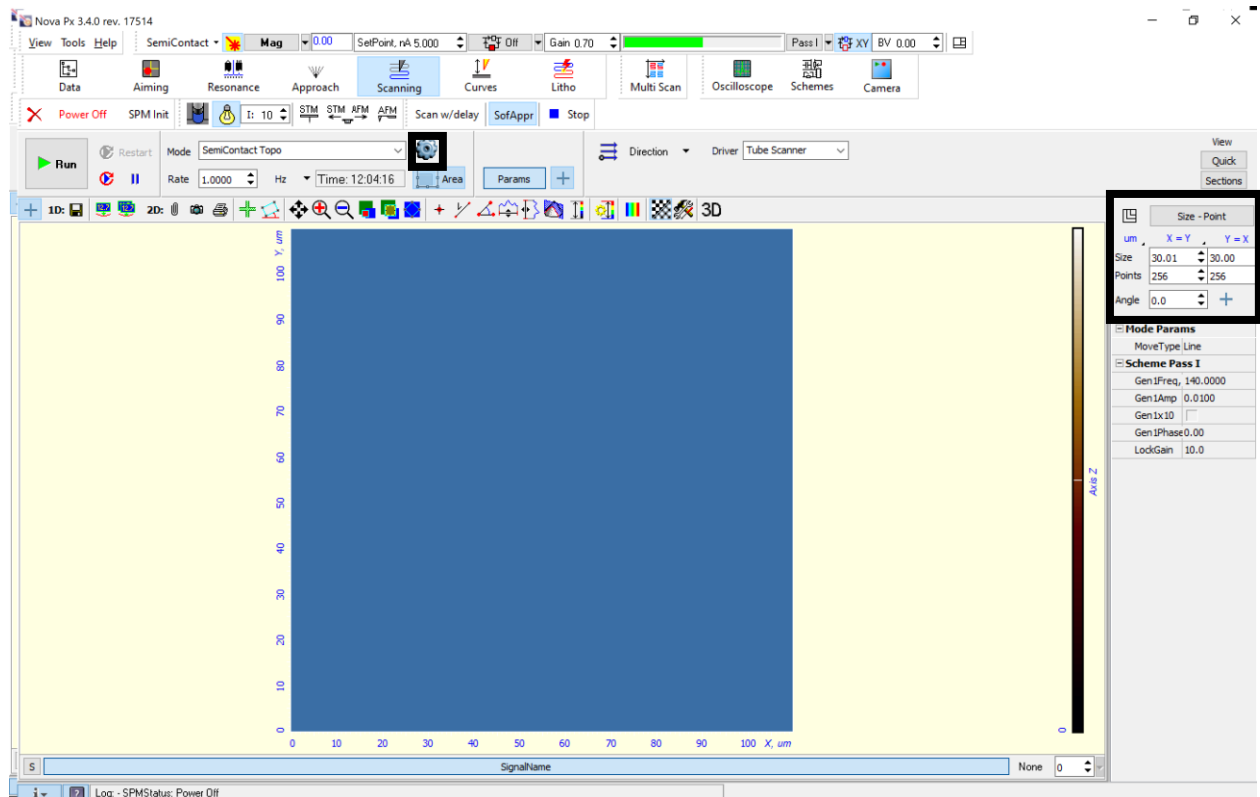
Figure 17: Scan area parameters are found in the top right

- Click the gear icon located right above the "area" button (Figure 17).
- This brings up the settings menu (Figure 18) 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 18: Scan settings menu

- Select the desired scan mode "SemiContact Topo" is general used for topography maps in semi contact or tapping mode. (Figure 16). 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 19).
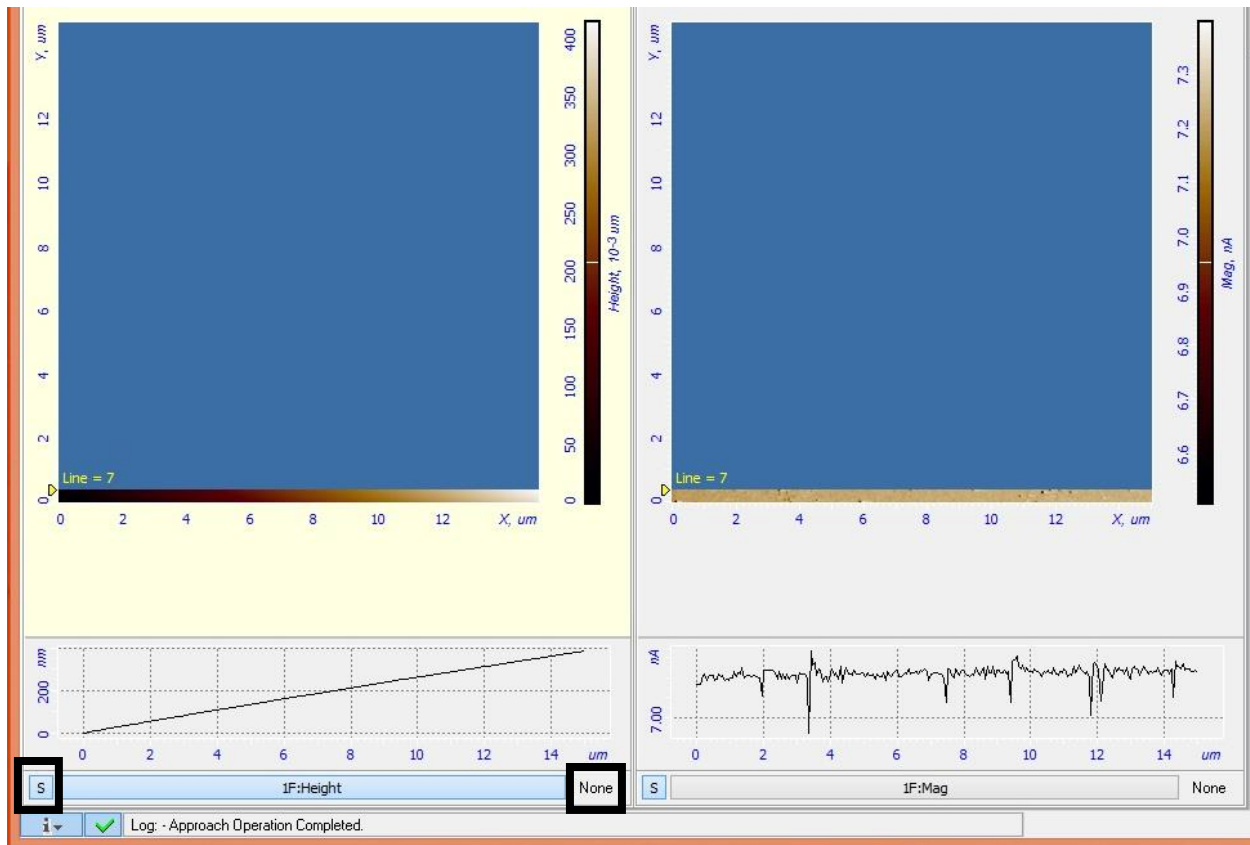
Figure 19: start of scan

- 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 19).
- In Figure 20 a 2nd order correction has been applied and the gradient in the image is gone and the cross section is level.
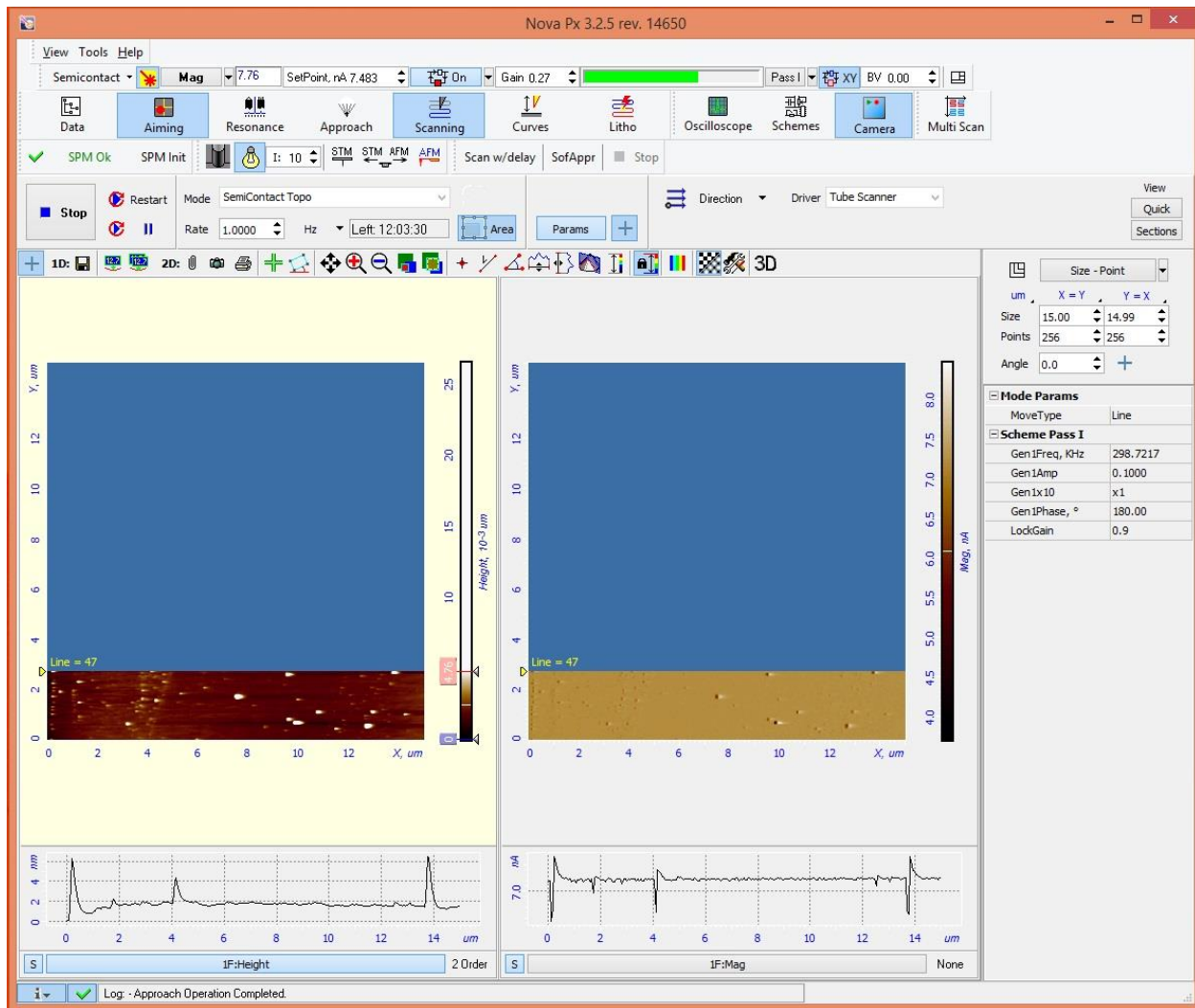
Figure 20: 2nd order tilt correction has been used to flatten cross section and remove gradient form scan image

- 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 21)
    - The pause button will pause a live scan.
        i. "Restart" will restart a scan without saving the data this is helpful if setting 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.

- 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 21: 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 22).

Data
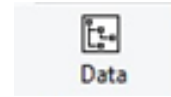
- To save data click the "Data" button in the top left of the main menu bar.
- The left side of the data menu is the data tree that is automatically generated (Figure 22).
- To save data as a .mdt file click "file" and "save". For users using gwyddion for data processing, keep in mind it can open .mdt 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".
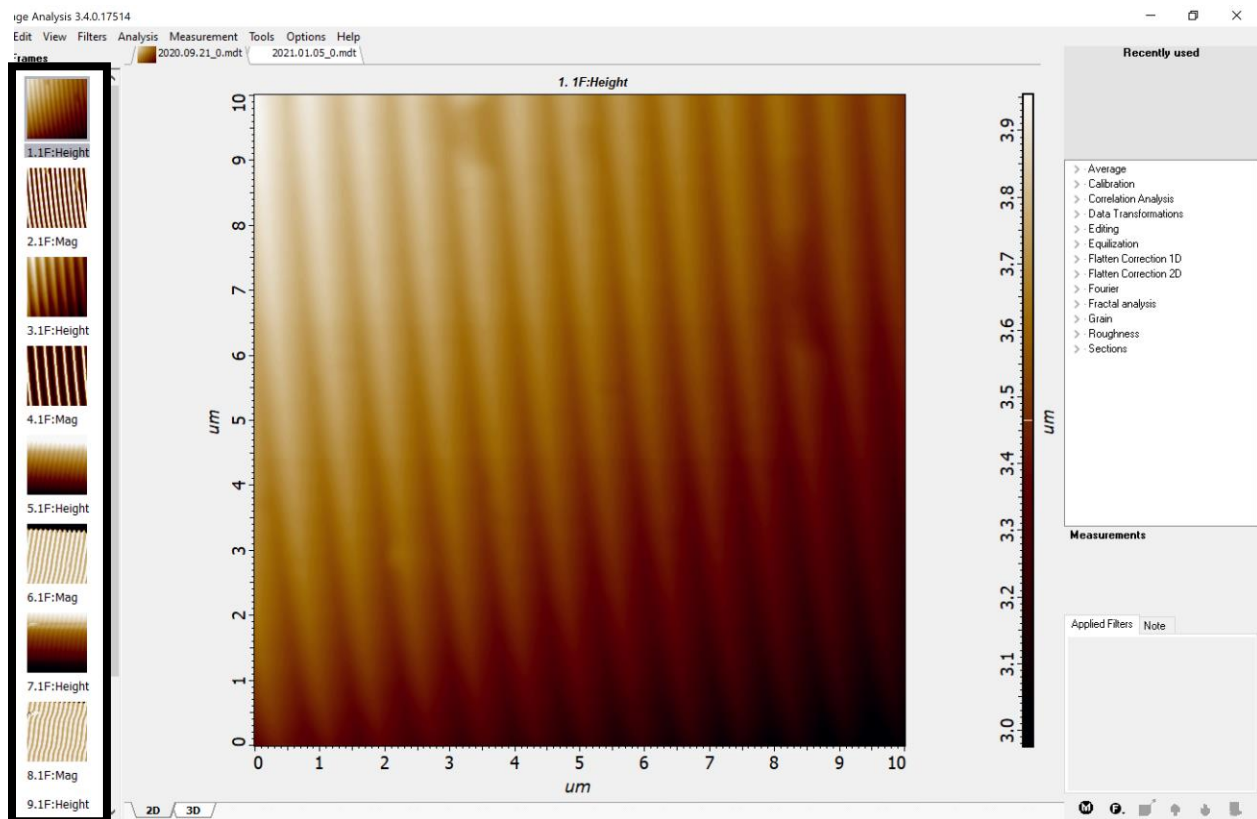

Figure 22: Data menu

- 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.
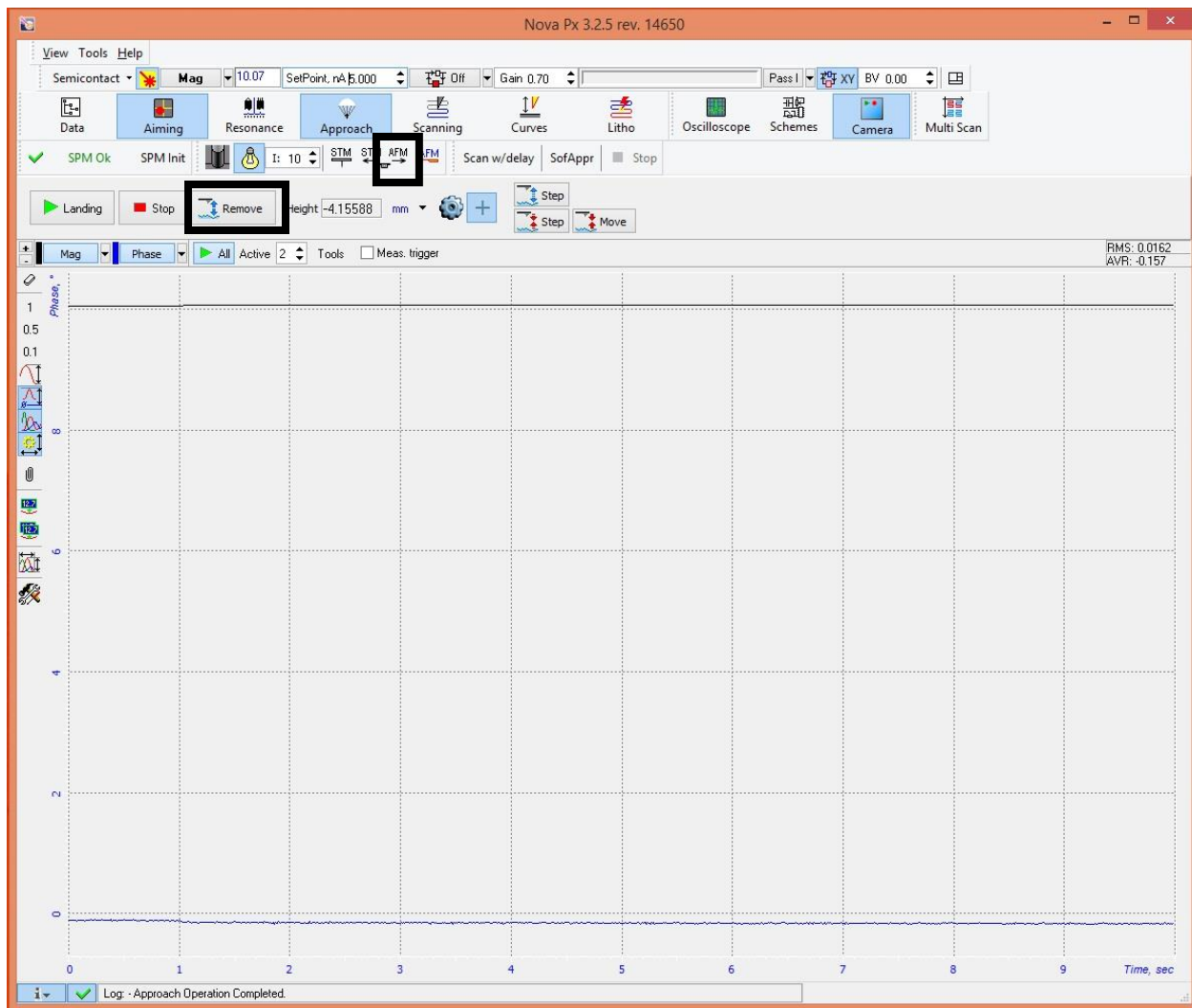
Figure 22: Approach menu showing the remove button

- Once the sample is removed from the sample open the door and remove the probe from the AFM head.

- Return the AFM back to analysis position and retract it using this button (Figure 22).
- Close door and close software.
- Fill out logbook.
- To access data, click the "data" button in the top left of the main menu bar.