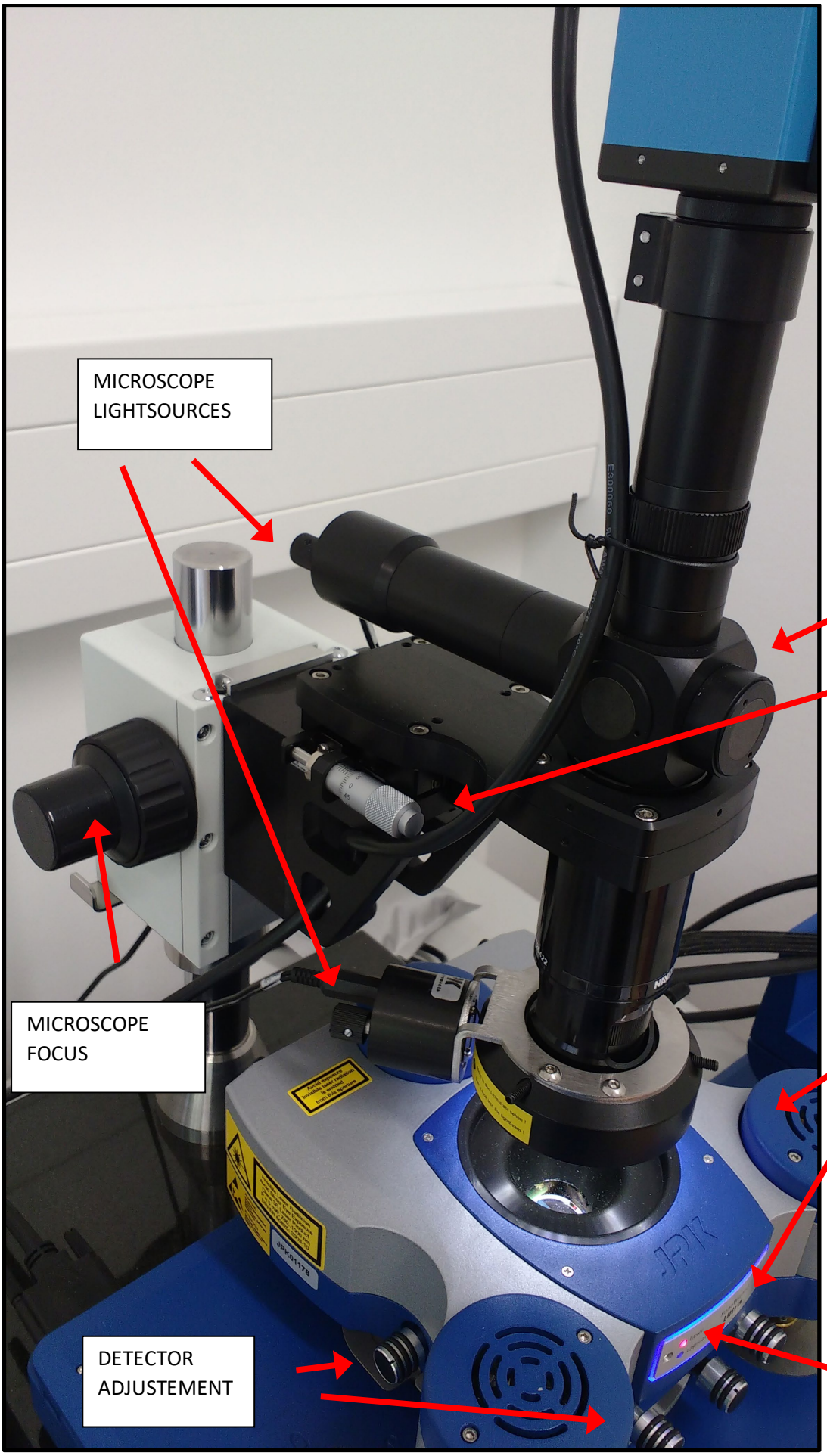
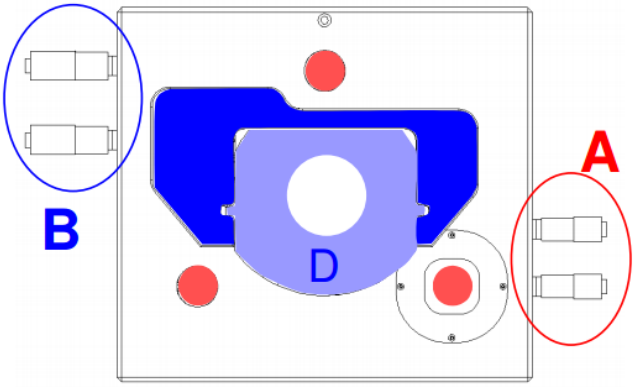
FOR MORE DETAILED INFORMATION CONSULT THE OFFICIAL MANUAL

JPK Nano Wizard

Quick Operation Guide

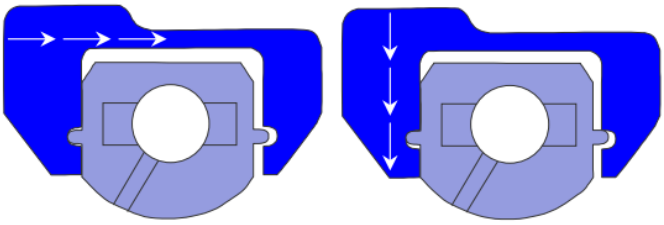
1.) Overview
2.) Cantilever & Sample
3.) Measurement (AC/Cont.)
4.) Conductive AFM


MICROSCOPE
LIGHTSOURCES
MICROSCOPE
POSITIONING
(silver screws)
MICROSCOPE
FOCUS
LASER
ADJUSTEMENT
DETECTOR
ADJUSTEMENT
LASER LED
APPROACH LED

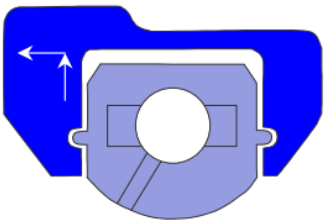


The positioning screws A move the AFM head. The three foot positions are marked in red. The combination of a point, a line and a flat surface ensures reliable positioning, so that the head will always fit stably into the same position. Always ensure that the feet slot firmly into position.

The positioning screws B move the sample holder. The sample is mounted on the inner sample holder D. The arms of C are moved by the positioning screws and push the inner sample holder.



The positioning arms do not grip the sample holder tightly. There is a small gap between the arms and the centre part. The gap is shown here exaggerated, to make it clear how the sample is pushed by the positioning arms.



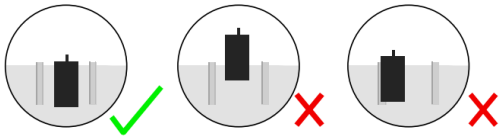
When the sample is in the correct position, the sample holder must be released by turning the positioning screws BACK one quarter turn. In the life science version, one notes that the sample does not move during this de-coupling. The sample holder is then free from contact with the positioning arms, as shown here, but still held firmly by the magnetic contacts underneath.

In our setup, B is electronically driven in our setup by the controller on the table!

For conductive AFM and Kalvin Probe AFM you have to place the corresponding sample holder in the centre hole of D

2.1 Mount the Cantilever

1. Place the glass probe holder in the blue probe stand.
    a. **Never place it anywhere else to avoid scratches.**
2. Loosen the screw and place the tip according to the image below. If the cantilever is wrongly placed, you might have problems during approach.
3. Tighten the screw again in a gentle way.
4. Place the glass probe head in the AFM head with the cantilever facing the right-hand side.



The cantilever chip should be placed centrally between the two grooves, with the cantilever arm over the polished glass part, close to the inclined edge. The cantilever itself should be in the centre of the glass block; do not move the cantilever substrate chip too far forwards.

There is a common way to classify your cantilever in your gel box:

VERTICAL	**unused tip**
DIAGONAL	**used, very good condition**
HORIZONTAL	**used, not good but also not too bad**

defective broken / unusable cantilever have to be directly REMOVED (waste) !!!

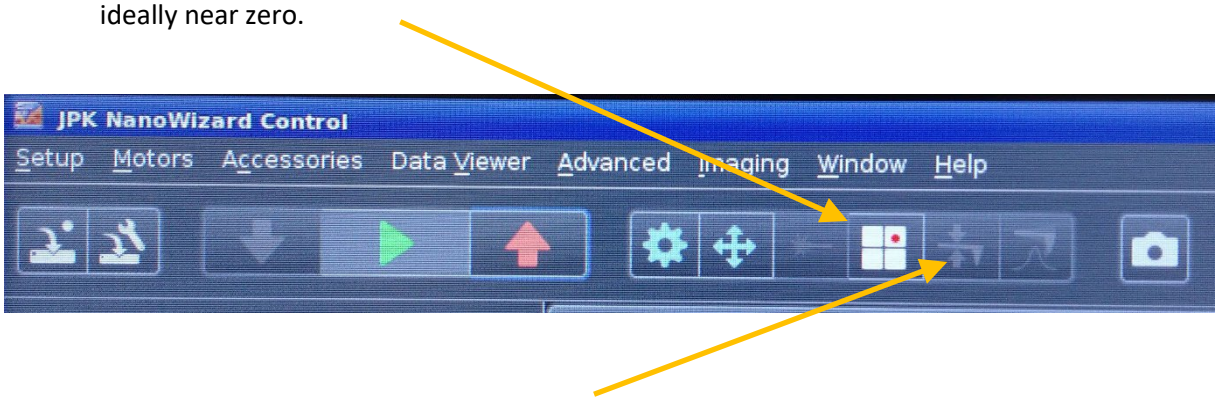
2.2 Placing the Sample and the probe head

1. The probe head is still on the stand right to the right side and the glass
2. Place your sample on the sample holder / glass slide
3. Ensure that there will be sufficient space (some millimetres) between your sample and the mounted cantilever in the probe head.
    a. If this is not, use the software and raise the probe had via the three stepper motors
4. Place the probe head on the scanning table.
    a. Begin with the rear leg, …
    b. then with the right leg, …
    c. and observe if there will be contact…
5. The head is properly mounted, if you can't move it lateral anymore.

For conductive AFM and C-AFM, the sample has to be mounted on an additional sample carrier.

3.1 Before Measurement

1.) Start the SPM software. Close all windows inside as they may be confusing.
2.) Choose the measurement mode (top centre).
3.) Focus the spot of the IR laser with the corresponding screws on the AFM probe head onto the backside of the cantilever.
4.) Centre the reflected laser spot on the DETECTOR as good as possible. The sum of the signal should be sufficiently high (> 2 V). The absolute voltage depends on the type of cantilever and its coating (uncoated, aluminium, or gold). The horizontal and vertical deflection should be ideally near zero.

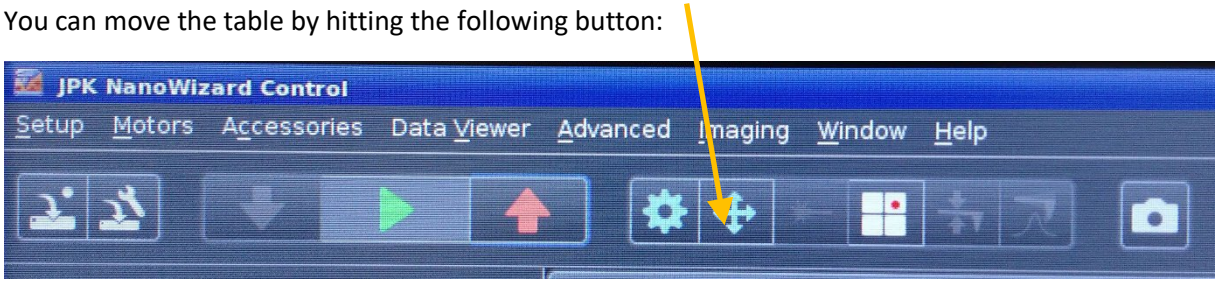


5.) Go to the CALIBRATION MANAGER, choose your cantilever and click on Calibrate. By standard, the calibration is done in air without contact. You may choose differently for liquid AFM measurements.
6.) Find the resonance of the cantilever tip (not necessary for contact mode):
    a. START and END FREQUENCY are set differently for AC mode in air (0-400 kHz) or fluid (0-50 kHz)
    b. Automatic tuning: Click RUN to try and achieve the TARGET AMPLITUDE (default is 1V) that is set. One resulting curve shows the PHASE, the other one the FREQUENCY. After calibration, the voltage is translated to height (nanometres). For our common cantilever (Tap300Al-G, 100 nm amplitude for tapping mode is a good choice)
    c. Click SELECT FREQUENCY RANGE to zoon in around the resonance peak.
    d. FREQUENCY and SETPOINT SELECTION: Click inside the amplitude/frequency plot to get a crosshair of dotted lines. Chose suitable frequency and setpoint. DRIVE FREQUENCY is usually chosen on the left upper rising edge of the peak. The value of the SETPOINT must be lower than the chosen LOCK-IN-AMPLITUDE in the cantilever tuning window. Setpoint is usually 70-80% of the lock-in amplitude at that frequency
    e. Signal-to-Noise-Ratio: Resonance curve must be well-shaped (6:1 or better). Try to keep the peak of the resonance curve below 2V lock-in amplitude.

3.2 Moving, Approaching and Measurement

Moving the table:

You can move the table by hitting the following button:

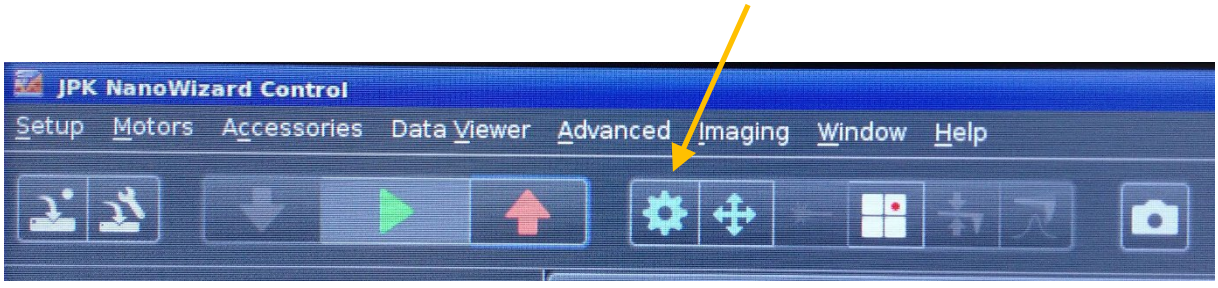


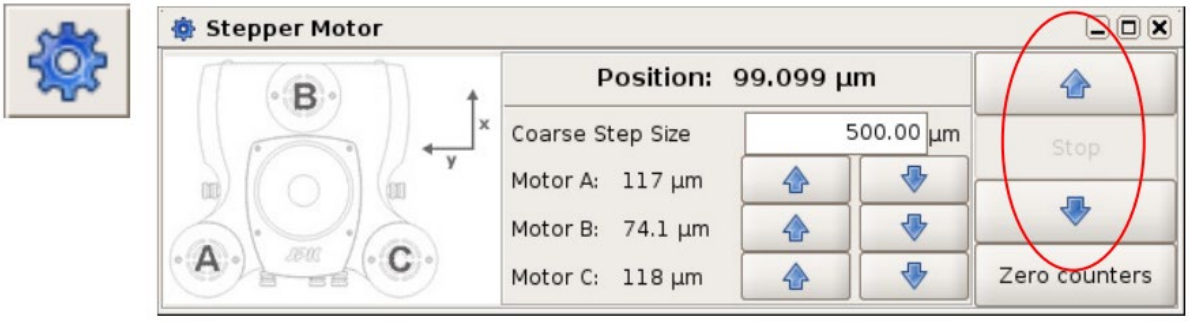
To move the table, you must **engage** the table in the new window. Take care the cantilever is not in contact to the surface (retract it before!). **You can only approach/measure if the table is disengaged!!!**

Focus the microscope the surface on your sample.

Approaching (General)

The AFM head has 3 stepper motors, which allow a wide range of sample heights to be measured. For the actual height measurements, a piezo with a working distance from 6.5 µm is used later. The automatic approach routine can take a long time, if the cantilever is far from the sample surface. Initially, the Cantilever is approached by hand and eye to 2 mm distance.





Automatic Approach:

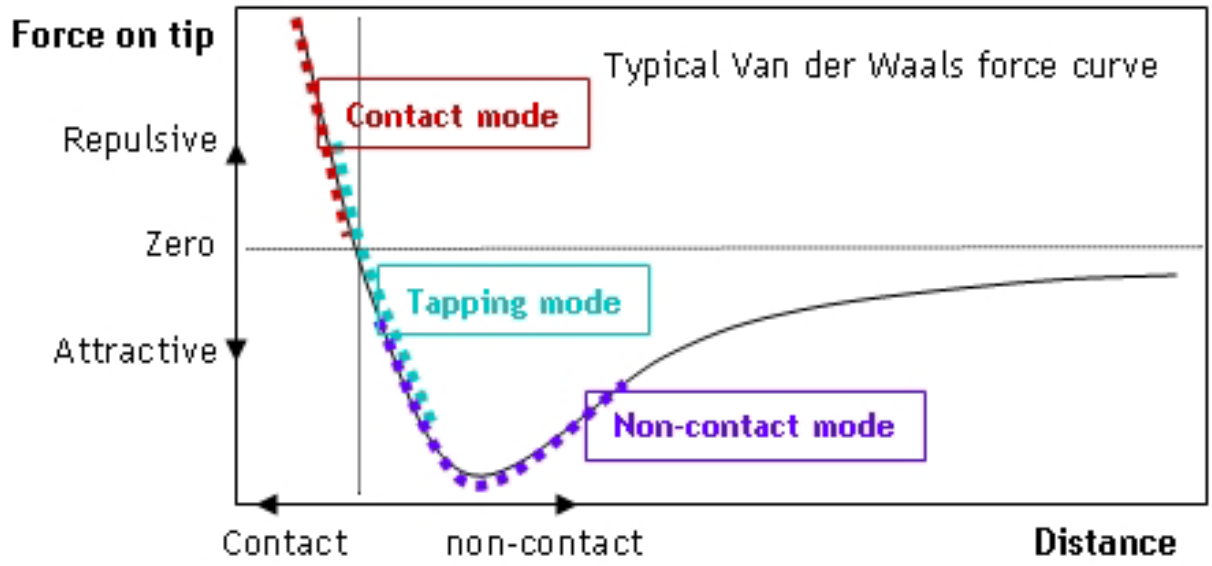
Choose a suitable SETPOINT in the FEEDBACK CONTROL/CANTILEVER TUNING panel for the automatic approach routine. During the approach, the z-piezo extension and retraction can be observed on the left side. It should oscillate from right to left continuously until contact.

You can use either approach with feedback or constant velocity: GAINs must be adjusted if you use approach with feedback. To make a slower approach, reduce the GAINs, or do the opposite for a faster approach. GAINs in the approach window only affects the approach procedure. Change the values in the FEEDBACK CONTROL panel to adjust the gains used for scanning and waiting. Do not approach too fast. During your approach, you will hear the noise of the stepper motors clearly – a good rule of thumb is 1-2 “clicks” per second.

The APPROACH TARGET HEIGH sets the z-piezo height on the surface at the end of the approach. Default: middle position.

Measurement:

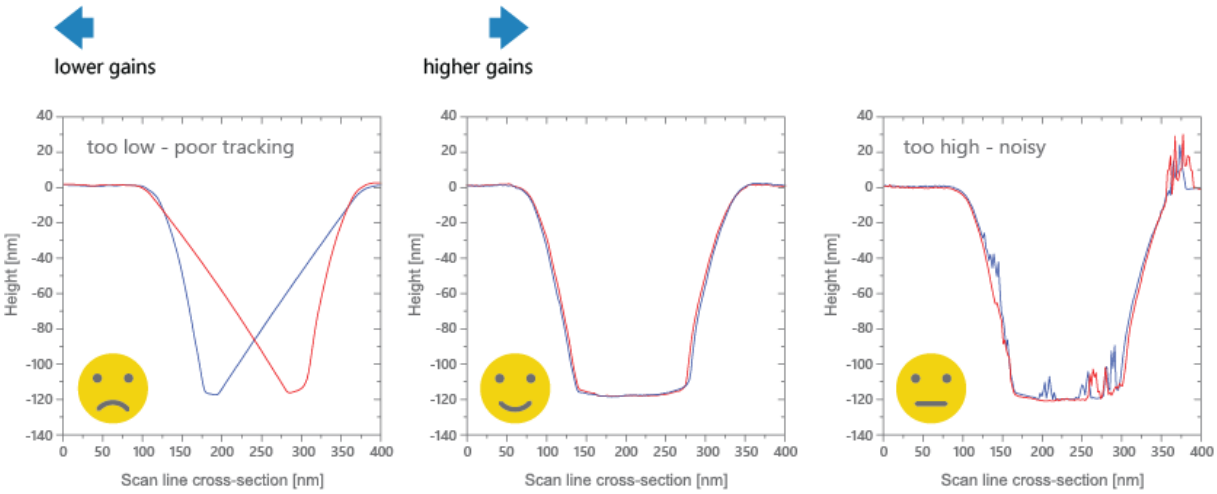
Once you are approached to the surface, you can measure for instance the topology. There are different techniques to probe the surface.

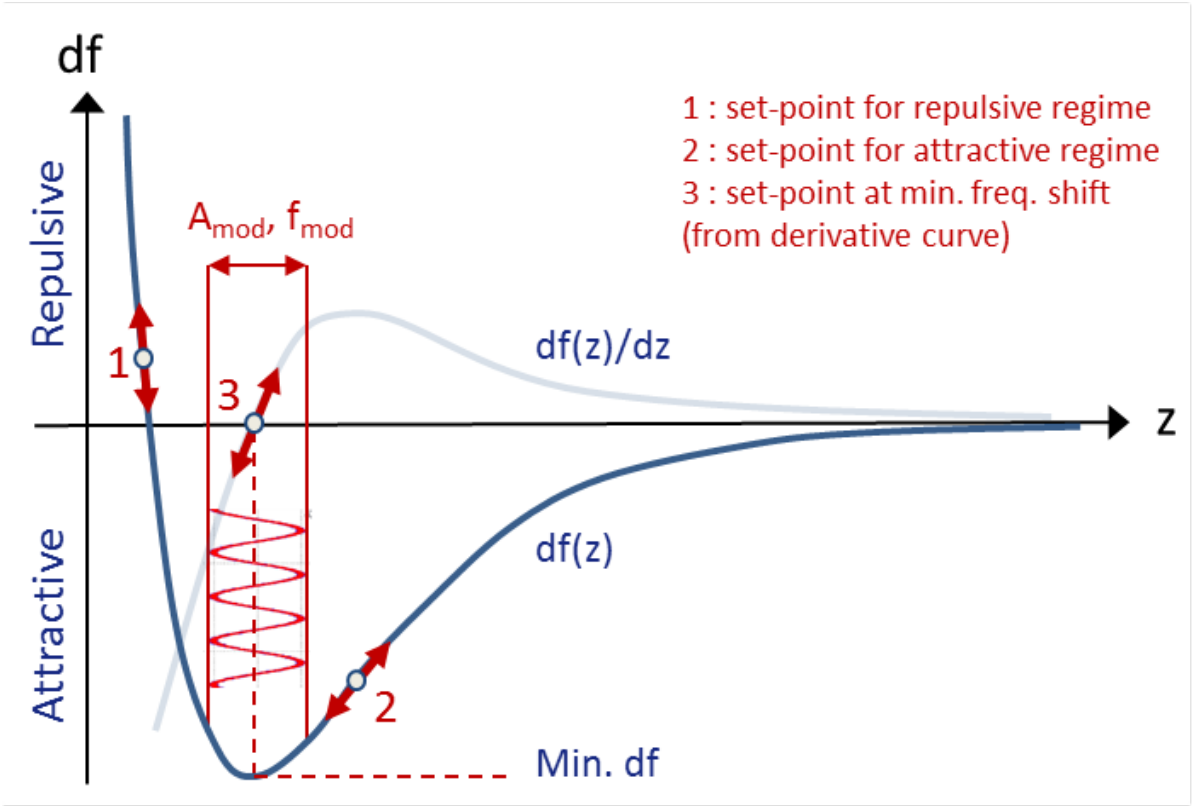


You may see following parameter in the left window which you can use to adjust the quality of your image.

iGAIN + pGAIN GAIN (see image below)	In contact mode, you will find the integral and proportional GAIN parameter.
	In AC mode, you will find only one combined GAIN parameter.
	The GAIN is a parameter for the reaction velocity. With ideal GAIN, the trace and retrace match perfectly and the line shape is not noisy. With a too low gain, trace and retrace do not match. The cantilever is too slow to follow alterations in height. With a too high gain, small features are sensed very strong. The "overreaction" of the cantilever leads to a high signal-to-noise ratio.
SETPOINT (see image below)	The Setpoint is a measure for the "contact-pressure" of the cantilever onto the surface. In AC mode, a lower setpoint reduces the swinging amplitude of the cantilever and thus, the cantilever will hammer harder on the surface. In contact mode, a lower Setpoint reduces the preasure of the cantilever to the surface as it is here a measure of the deflection.
DIMENSIONS (X / Y)	Your scanning area. In stead of X and Y the terms fast axis and slow axis are used.
SCAN FREQUENCY / Line Rate	This parameter represents the scanning velocity.

In general, the parameter SCAN FREQUENCY, GAIN and DIMENSIONS affect each other. For example, increasing the lateral size of the image (DIMENSIONS) leads to a faster movement of the cantilever. Thus, you have to adjust the SCAN FREQUENCY (reduces the probe velocity) or alternatively increase the GAIN (higher).


lower gains
higher gains
too low - poor tracking
too high - noisy
Height [nm]
Scan line cross-section [nm]


df
Repulsive
Attractive
z
A_{mod}, f_{mod}
1
2
3
df(z)/dz
df(z)
Min. df
1 : set-point for repulsive regime
2 : set-point for attractive regime
3 : set-point at min. freq. shift
(from derivative curve)

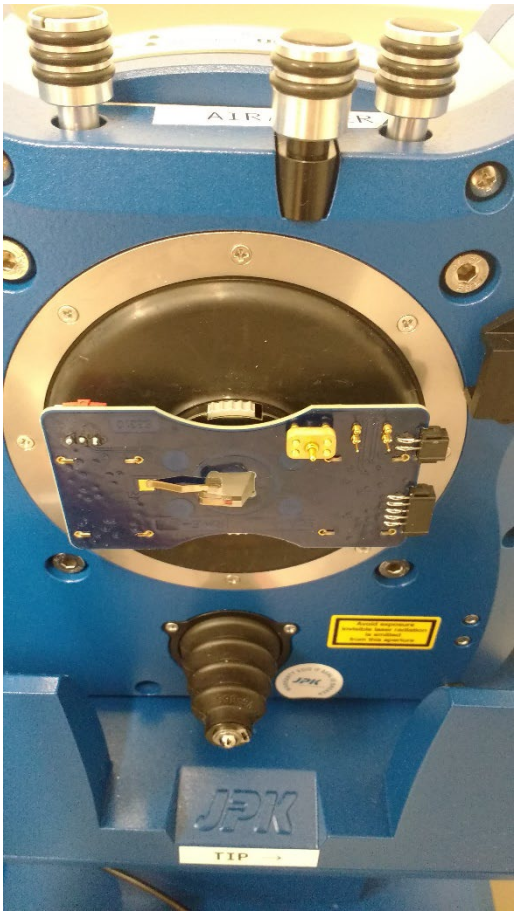
Liquid-AFM (contact mode)

- In general, proceed as usual but modify following.
    - You have to glue your sample into a petri dish with double sided adhesisve tape. Elsewise, you will observe a drift of your sample!
    - In the calibration manager, you have to switch from AIR to Liquid/Water
    - You have to use the centre screw (AIR/WATER) on the probe head to adjust the laser deflection with the mirror.

Conductive-AFM (short)

Here, you don't use the regular glass probe head but an alternative board (see Image).

1.) Mount a suitable cantilever on the board with a special spring. This is very tricky!
2.) Connect the DE-9 cable (power) to the controller.
    a. The cable should be already connected to the controller.
3.) Mount the board in the probe head and connect the conductive-AFM cable.
    a. Ensure, that the cable is not free but clamped to the big plug.
4.) Choose conductive AFM mode (top centre).
5.) Focus laser and centre the detector as usual.
6.) Do the calibration as usual.
7.) Go to Accessories -> C-AFM
8.) During measurement, you have to choose the channel **Precision5**.



1. Set of the Current via Voltage Control. You can use "subtract offset"