

Measurement in contact mode using scanning probe microscope SolverNext

Theoretical part:

1. Explain the piezoelectric effect, where and why is utilized in SPM microscopy.
2. Explain the principle of measurement in Contact regime. On the force-distance curve highlight the region utilized for the measurement in contact mode.
3. List the main measuring modes possible in Contact regime, discuss their advantages and disadvantages.
4. Discuss the measurement in “Lateral forces” mode.

Experimental part:

Task:

Perform the measurement of sample using atomic force microscopy operated in Contact regime, in “Constant force” mode.

SolverNext microscope:

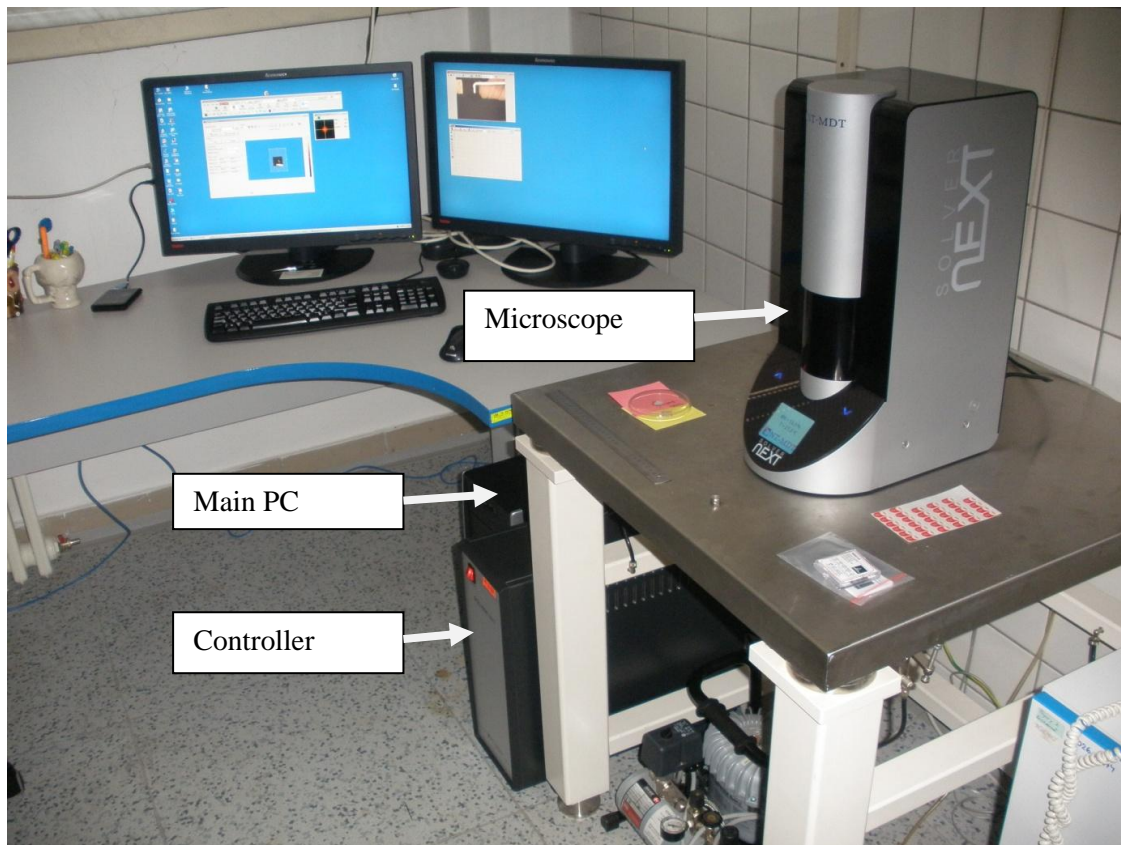


Fig. 1 SPM system SOLVER NEXT

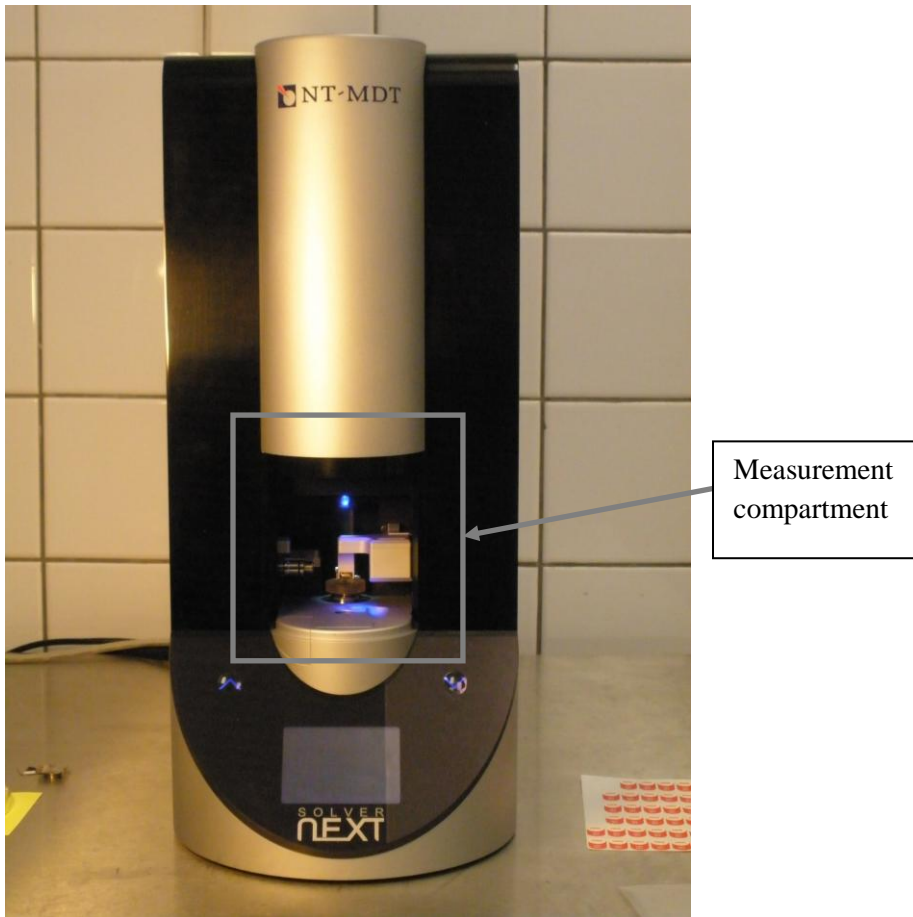


Fig. 2 Detail of the microscope body

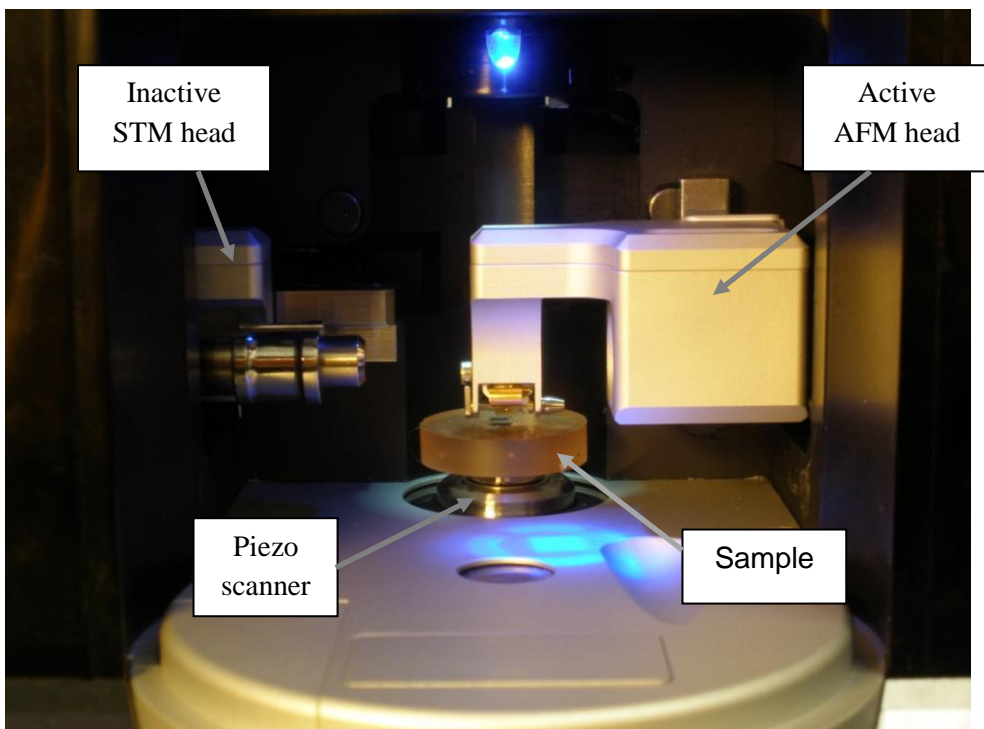
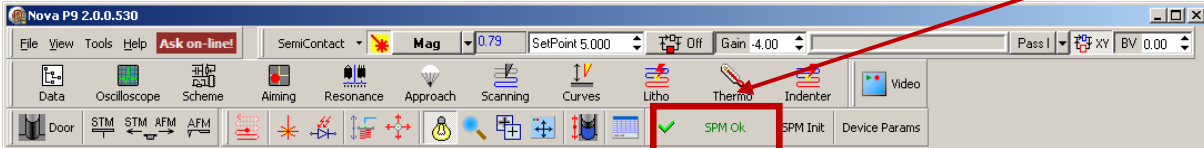


Fig. 3 Detail of the measurement compartment

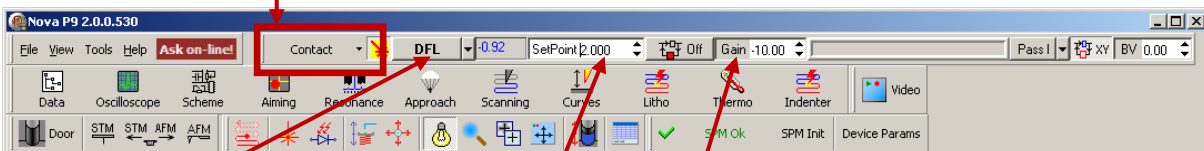
Measuring procedure:

1. Initialization of SolverNext SPM microscope.
 - a. Turn on the “Main PC” (Fig. 1)
 - b. Turn on “Controller” (Fig. 1)
 - c. Start up the program Nova_P9. The initialization of SolverNext SPM microscope run automatically, initialization is finished when message “SPM OK” appears.



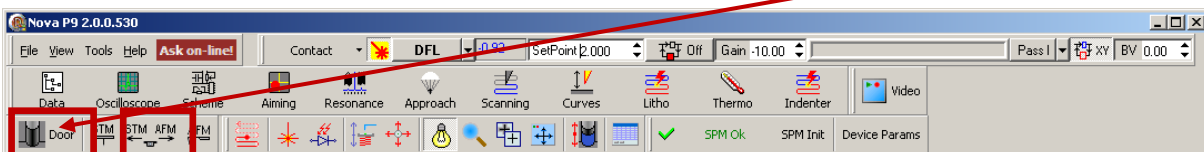
- d. The preparation of the measurement in selected regime is possible. Follow carefully next procedures for successful measurement!

2. Select “Contact” regime

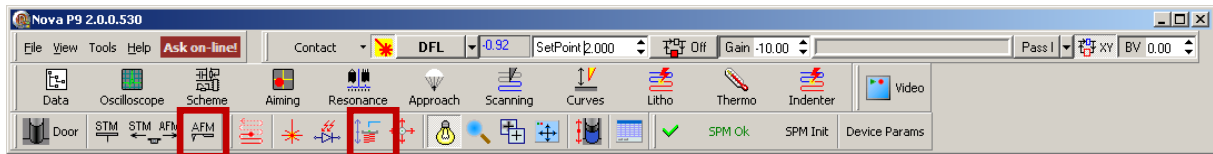


After the “Contact” regime selection the main parameters are set automatically (**DFL** measuring mode is set ... in this mode the bend of cantilever is kept on the constant value during the measurement. **SetPoint** initial value “2” is set ... this value reflects the force between the tip and measured surface, the higher the SetPoint value the higher the force between tip and surface. The initial value of **Gain** “-10” is set automatically ... this parameter reflects the speed of feedback, the higher the Gain value, the faster the feedback response is. These parameters can be adjusted during the measurement to obtain the image of surface with appropriate quality.

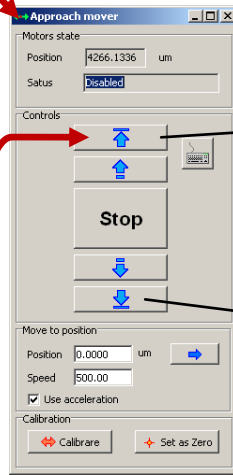
3. Open the door of measuring compartment by pushing the icon *Door*



4. Control the position of **AFM** measuring head (see Fig. 3). If the head is pushed forward, perform its insertion by clicking on the icon *STM AFM*.
5. Check the scanner position (see Fig. 3). If the scanner is pushed forward perform its insertion. If this controlling is omitted the AFM head can strike the sample and the measuring tip can be destroyed. Perform the Scanner insertion:
Push the icon assigned by number 1, the window which enables the moving of the scanner in **z** direction is activated, push the down arrow allowing continual insertion of the scanner to the lowest limit position. Place the sample on the Scanner.



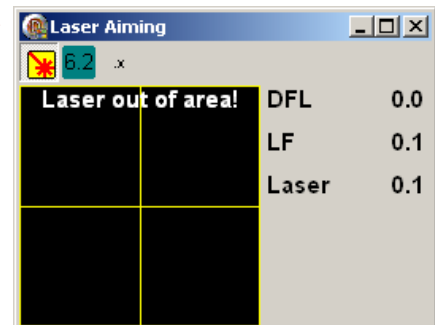
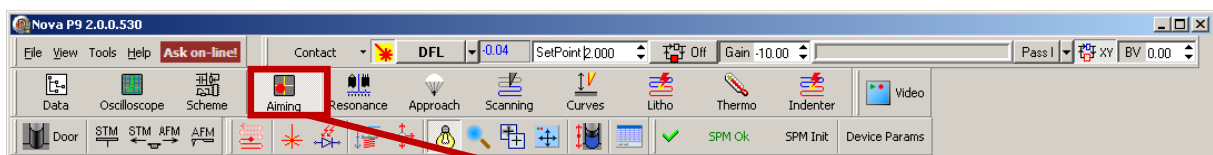
1



Continual protrusion of the scanner to the highest limit position

Continual insertion of the scanner to the lowest limit position

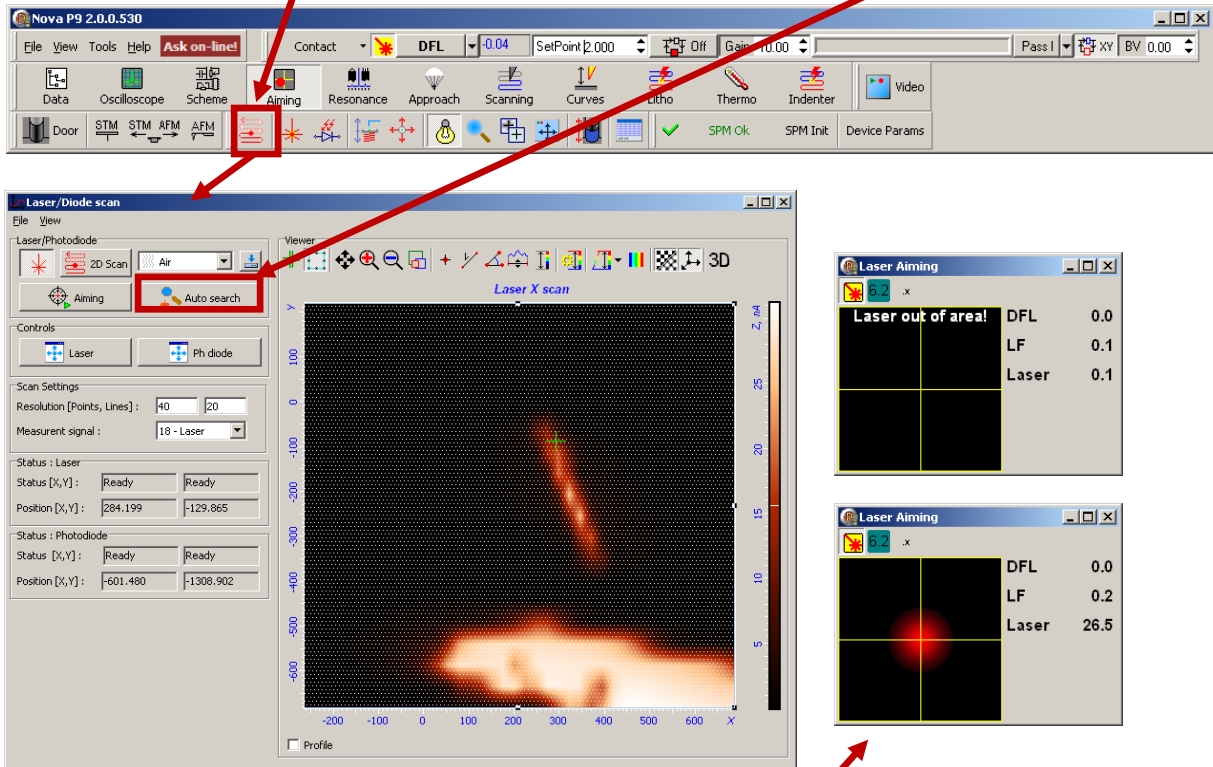
6. Perform the protrusion of AFM head by the clicking on the icon *AFM*.
7. To change tip, ask assistant for instruction.
8. Perform the protrusion of the scanner, during the scanner protrusion **control !!!** the distance between the AFM head and sample surface; if the distance is about 2 mm stop the drawing-out process.
9. Close the door (the same procedure described in paragraph 3).
10. Perform automatic aiming of the laser. Click on the icon *Aiming*, the window **Laser aiming** is activated and schematically shows the position of the laser beam stroked on the photodetector.



After the AFM tip replacement, in many cases, the laser beam does not strike the cantilever and cannot be reflected to photodetector this situation is announced as “*Laser out of area!*”. In some cases the situation when beam is reflected to the photodetector can occur, but the requirement on the maximal intensity of reflected beam doesn’t have to be fulfilled, thus in this case perform the laser aiming.

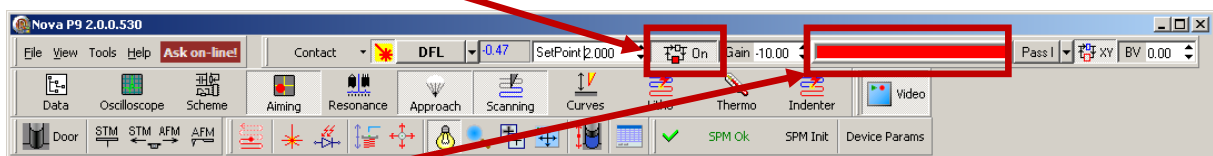
Perform the laser aiming as follow:

Press the icon **Laser/Diode Scan**, the window for the laser aiming occurs. Perform the automatic search of the optimal hardware configuration by procedure **AutoSearch**.



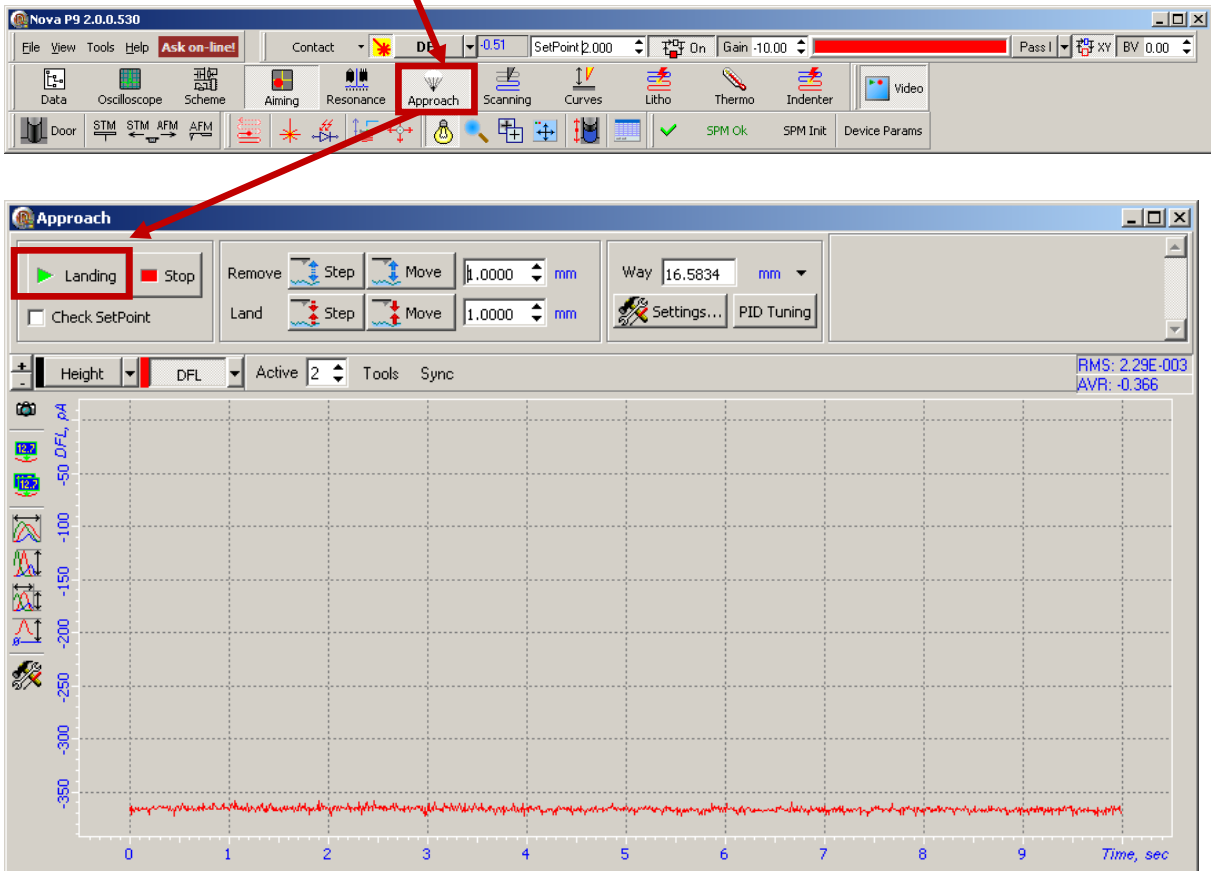
After the successful aiming the window “**Laser Aiming**“ will appear as follows. If the procedure **AutoSearch** fails, ask the teacher for assistance. In conclusion discuss your experience with laser aiming in older SPM system EXPLORER™ and in this new system.

11. Activate FeedBack loop.

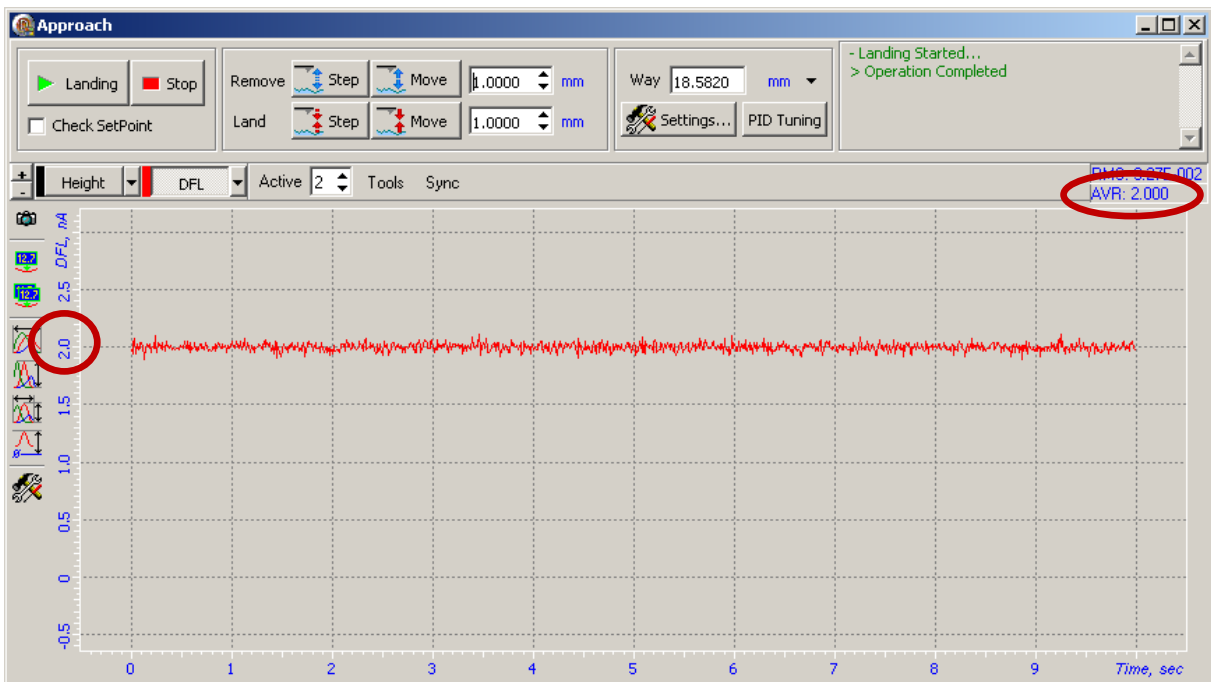


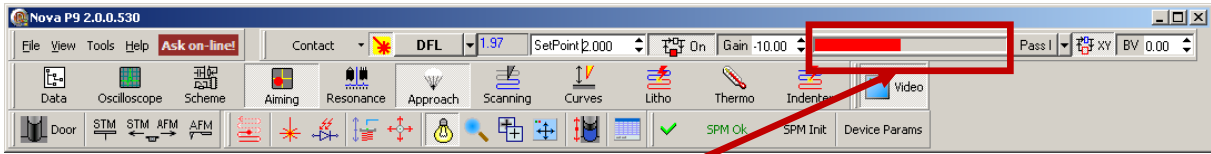
The fully red colored bar signalize maximal protrusion of the scanner in **z** direction.

12. Using procedure **Approach** perform automatic landing of the tip to the sample surface with the force defined by the value **SetPoint**. Push the icon **Landing** and observe the run of the DFL signal.



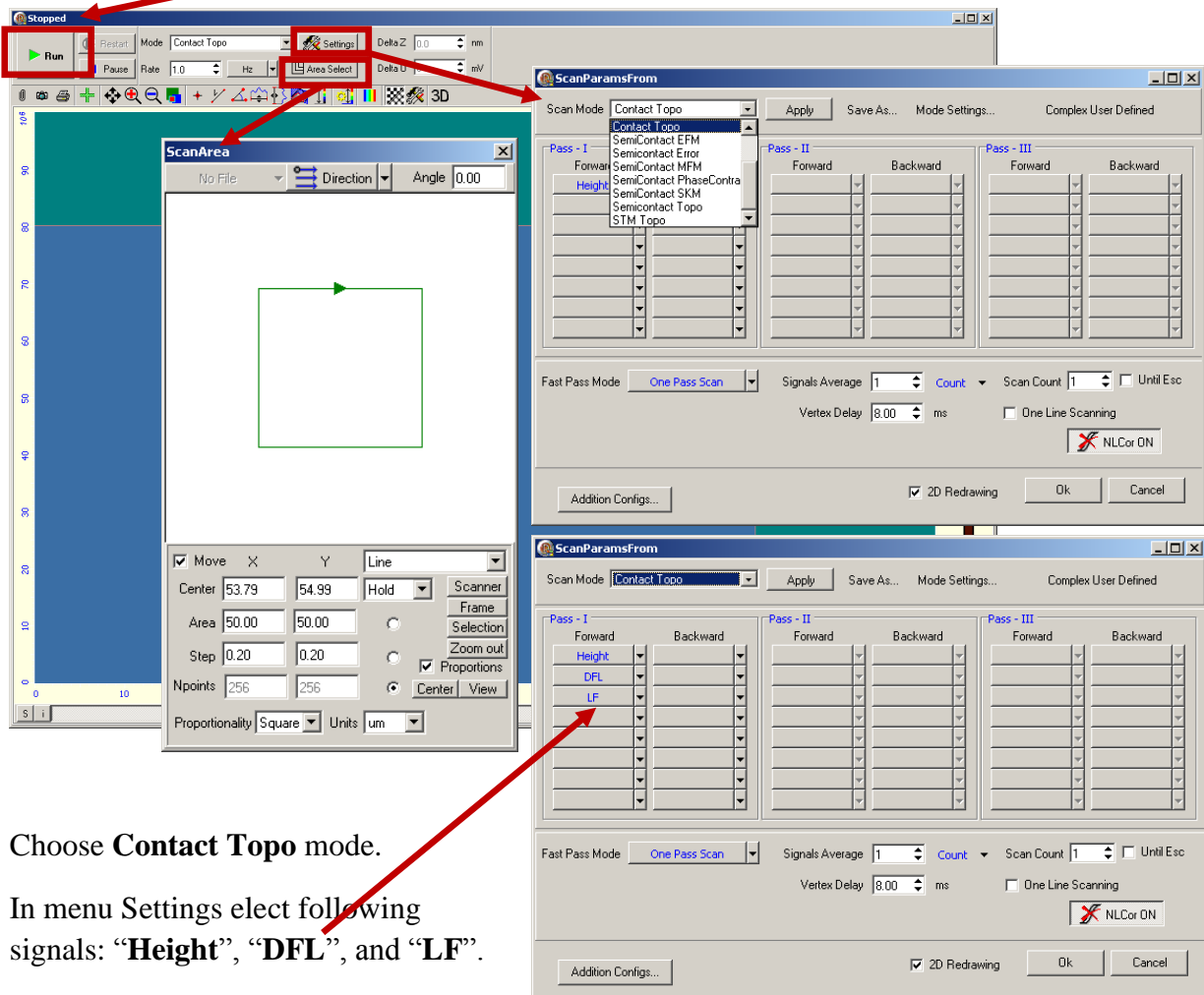
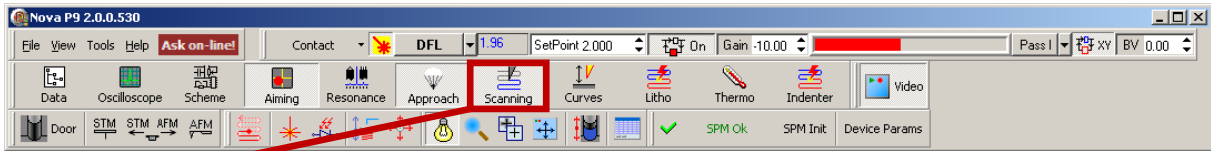
After the successful landing the value of **DFL** signal settles on the value given by the **SetPoint**.





Landing is also signaled as a shortage of red bar signaling protrusion of the scanner.

13. Pushing of the icon “Scanning” initialize the window for the measurement.



Choose **Contact Topo** mode.

In menu Settings elect following signals: “**Height**”, “**DFL**”, and “**LF**”.

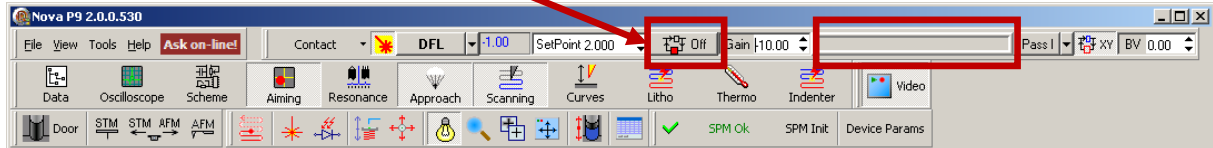
Choose the area going to be measured ... menu “**AreaSelect**”, in the field “**Area**” enter initial sizes 50 x 50 μm . In the field “**Rate**” define the speed of the scanning, for the beginning choose 1Hz.

14. Now the measurement can be started, by pressing of the green button “**Run**”. Perform the measurement in three areas 50 x 50, 20 x 20 and 5 x 5 μm . With the aim to find optimal scanning parameters, change the parameters “**SetPoint**”, “**Gain**”, and “**Rate**”.

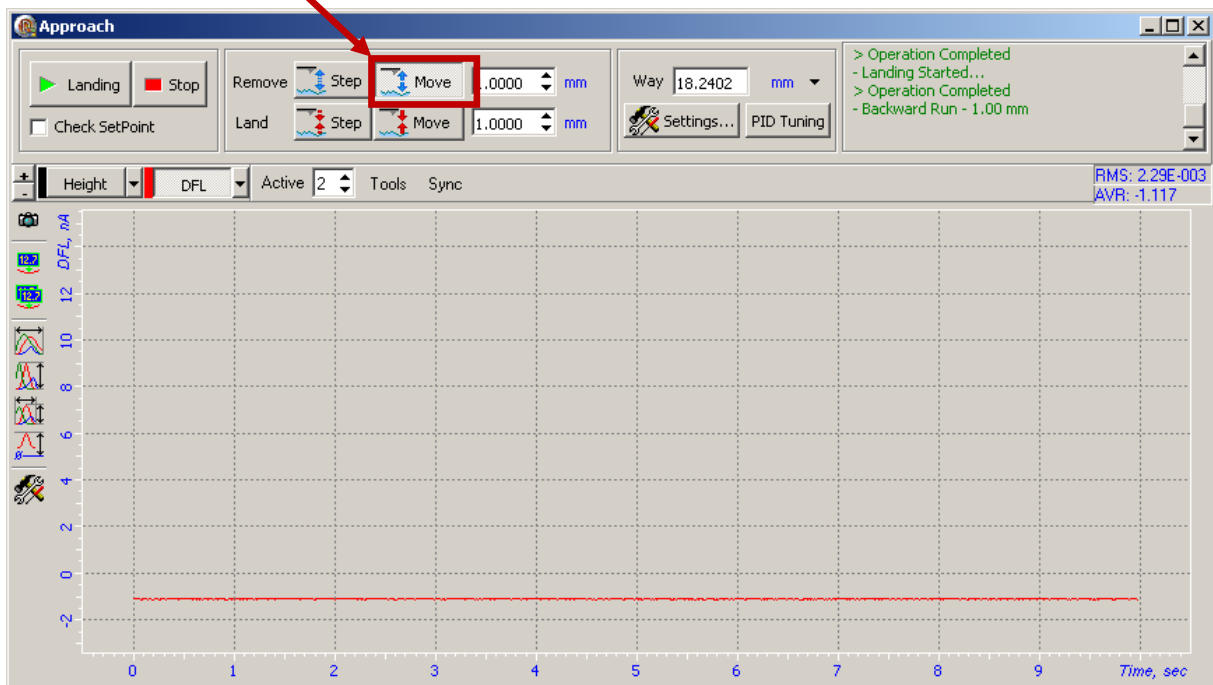
In conclusion discuss how the changes of these parameters influence the quality of the obtained images. After the optimal parameters are found, perform the scanning of whole area at these conditions.

15. After the measurement is finished save obtained images to the folder assigned with number of your group.

16. Switch off “FeedBack” loop.



17. Put back the tip from the surface (for the initialization of this window see paragraph 12).



Summary of results:

- evaluate the measured data using software Gwidion,
- analyze of the selected profiles. At the given profiles carry out the measurement of the periodically appeared parts of the surface and measure the heights of the typical parts,
- perform analysis for each magnification,
- present obtained results in well arranged table, including average values of the measured distances and heights,
- discuss the differences occurred as a result of different magnifications,
- present surface topography in 3D images,
- discuss the image registered in Lateral forces mode.