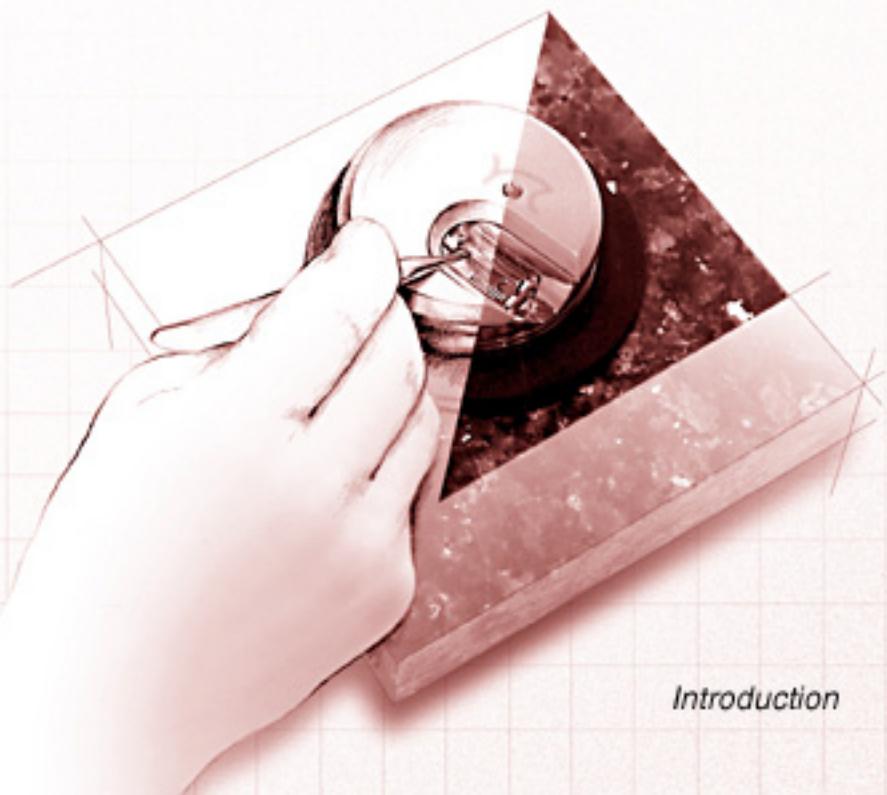


# *easyScan*

STM SYSTEM



*Introduction*

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## Introduction

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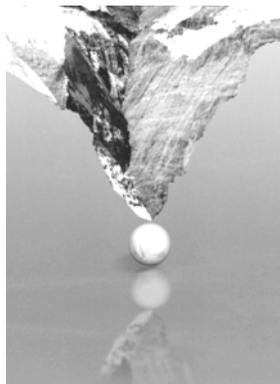
In science, microscopy is one of the most exciting techniques. The insight into small dimensions has led to a new understanding of, the structure of materials and forms of life.

With the help of the scanning tunneling microscope (STM) it is possible to look into the fascinating world of the atoms.

This manual gives step by step operating instructions for the STM 'easyScan'. It is kept short and simple and includes only the most important explanations. The aim is to enable people who don't have a good knowledge of physics to easily get pictures of atomic resolution.

### What is STM?

This completely new microscopy technique works without focusing elements and features atomic resolution (laterally and vertically). A small sharp platinum tip is scanned across the sample's surface, so close that the so-called 'tunneling current' can flow. With the help of that current the tip-surface distance can be controlled very precisely. Therefore an enormous resolution is achieved so that the atomic arrangement of metallic surfaces can be 'probed'.



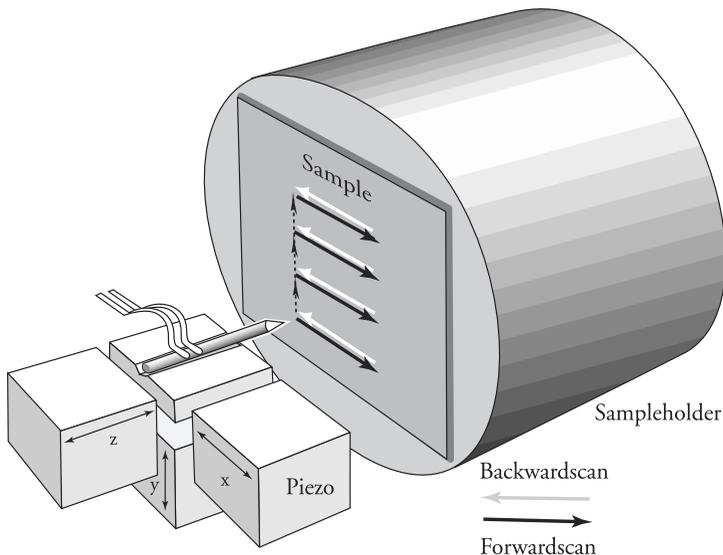
It is incredible to be able to get such excellent pictures of atomic resolution considering that the size of the atom, in relation to the scanning tip, is that of a ping-pong ball to a mountain!

The Scanning Tunneling Microscope was developed by Gerd Binnig and Heinrich Rohrer in the early 80's at the IBM research laboratory in Rüschlikon, Switzerland. For this revolutionary innovation Binnig and Rohrer were awarded the Nobel prize in Physics in 1986.

### Scanning with 'easyScan'

With the easyScan STM the platinum tip is clamped between two tiny springs and a platform which can be moved in all three dimensions.

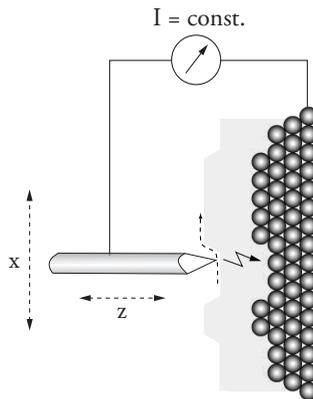
All three axes are driven very precisely in the nanometer range, by piezo-crystal translators.



The sample which is to be examined is brought close to the tip (or approached) to a distance of about 1 nanometer ( $10^{-9}\text{m} = 1\text{nm}$ ). Classical physics would prohibit the appearance of electrons in the small gap between a tip and a sample.

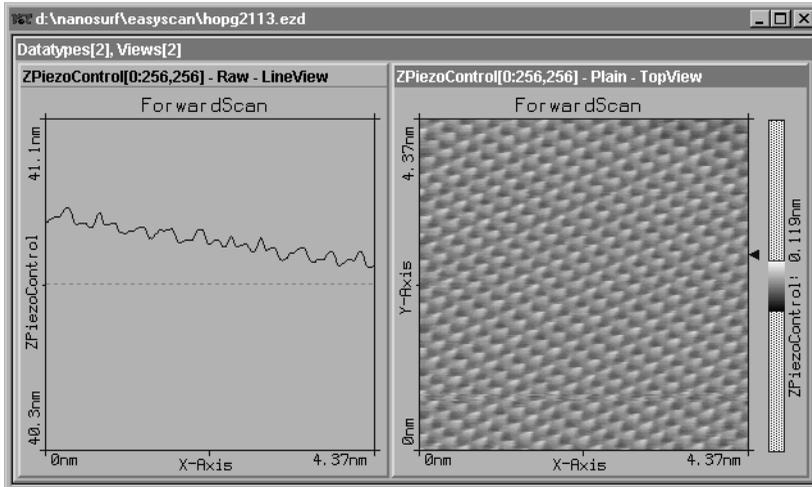
But if a sharp tip and a surface are put under a low voltage ( $U \sim 0.1\text{V}$ ) a very small current ( $I \sim 1\text{nA}$ ) may flow between tip and sample: the tunneling current is a quantum physics effect and the tunneling current depends exponentially on the distance between the tip and the sample. Since this tunneling current is extremely dependent on the distance between tip and sample, the tip movement can accurately be controlled.

The tip is scanned over the surface. By keeping the current between tip and sample constant by a feedback loop (constant current mode) the distance between tip and surface is also kept constant and the tip follows the structure of the sample's surface.



*The tip is probing the surface in a constant distance  
(viewed from top)*

The movements of the tip are recorded during scanning and the “landscape” of the atomic surface can be simultaneously drawn on the computer screen line by line.



*Scan-images of graphite as views from the 'side' and the 'top'*

The sample can also be scanned in a second mode: Turning the feedback loop off or very slow (P-Gain=0, I-Gain=2) the tip scans at a fixed distance from the sample (constant height mode). This time the variations in the tunneling current are measured and drawn line by line on the computer screen.

### **What is so special about the 'easyScan'?**

With easyScan it is possible to do any STM experiment which can be carried out in air. All functions can be carried out by the computer.

The instrument is designed to be compact, simple and comfortable to operate.

## Preparation

---

In the following sections installation of the 'easyScan' STM is described.

### Important!

To enable measurements of atomic resolution to be made the following precautions must be taken to keep equipment dust and grease free:

- Never touch either the wire for tips (7), the sample (8) nor the open part of the scan head (4) with your fingers.
- Only touch the sample holder at the black plastic end.

Please also pay attention to the chapter 'maintenance'.

### Components

After unpacking the instrument suitcase check for the following items:



- 1 - Serial cable between computer and control electronics
  - 2 - Power pack
  - 3 - Transparent cover
  - 4 - Scan head
  - 5 - Control electronics
  - 6 - Magnifying glass
  - 7 - 30 cm Pt/Ir - wire for tips
  - 8 - Samples HOPG (graphite) and gold thin film
  - 9 - Software installation disc
  - 10- Sample holder
  - 11- Tweezers
  - 12- Cable
  - 13- Vibration isolation platform
- Plus- A test sheet and a sheet with the calibration information.

### **Required additional material**

- Computer with a free COM-Port and Windows 3.1/95
- Wire cutters and flat-nosed pliers (available in the tool set)



- Solvent to clean the tools (e.g. ethanol, acetone)

## Assembly

### Caution:

- Please check that the mains voltage corresponds to that of the power supply (2).
- Make sure that your mains connection is protected against excess voltage.

Choose a steady table where you can work undisturbed. To ensure the faultless operation of the STM it has to be kept away from vibrations, heat emission and air current.



- Put the scan head (4) onto the vibration damping stage (13). Fix the scan head cable under the strain relief clip.
- Connect the scan head (4) to the control electronics (5).

- Make sure your computer is turned off. Then connect the control electronics to a free serial port (COM-Port) on your computer with the serial cable (1).
  - Connect the power supply (2) to the control electronics.
  - Finally plug in the power supply with the aid of the main cable (12).
- Now the scan electronics (LED flashes red) and the microscope are connected.

## Software installation (Windows)

### System requirements for 'easyScan' are:

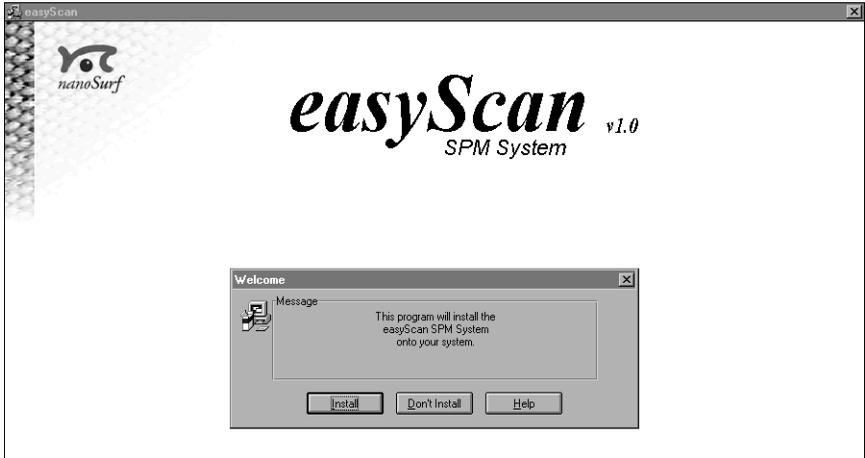
- PC with 486DX / 50 MHz processor or higher (Pentium / 133 Mhz recommended)
  - 8Mb RAM or more (16 Mb recommended)
  - graphics adapter with 800 x 600 resolution and 256 colours or better (resolution of 1024 x 768 recommended)
- Turn on your computer and start Windows.
  - Insert the backup copy of your installation disk (9) into the disk drive.
  - Start the installation program 'setup.exe' from the floppy disk (9):

### Win 95:

- Activate the file 'setup.exe' on the disk; or choose from the 'START'-Menue 'Run...' and type the disc drive name followed by a colon and the setup command e.g. 'a:setup.exe' and then press 'OK'.

### Win 3.1 or Win 3.11:

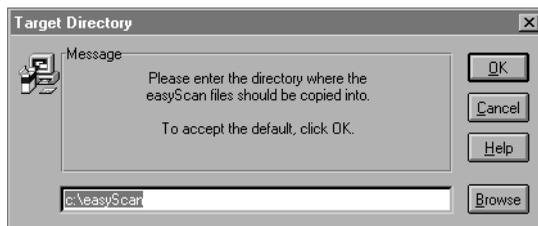
- Choose from the Program Manager 'File->Run...'
- Type in the command line box 'a:setup.exe', and then press 'OK'.



**For all systems:**

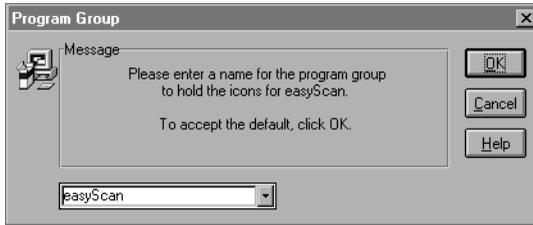
- Select the button 'Install', to install the data acquisition program 'easyScan' on your computer.

Setup will ask for the directory in which the program files are to be copied:



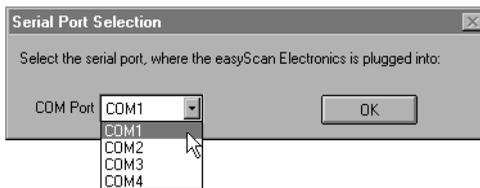
- We recommend putting them under the name 'easyScan' by pressing 'OK'.

Afterwards setup will ask for the program group in which 'easyScan' is to be placed:



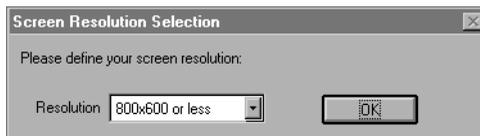
- Accept the program's proposition by pressing 'OK' or type in another name.

The installation setup will now ask for the 'COM-Port':



- Select the serial port to which you have connected the control electronics (5). (see chapter 'assembly')

Finally you have to indicate the settings of your screen area:



- Choose the corresponding data and press 'OK'.



After successful installation you will get this confirmation and find the data acquisition program 'easyscan.exe' in the directory 'easyScan'.

## Controlling the calibration of the scanner

- Please follow the instructions on the 'calibration information' sheet which you received with your easyScan STM system.

### 'Simulate microscope'

You can start the 'easyScan' program without having the microscope connected. In this case a dialogue box says:



By pressing 'Cancel' a simulation of the microscope is started. This imitates most of the functions of the real microscope. The sample is replaced by a mathematical description of an atomic arrangement.

#### **Our tip:**

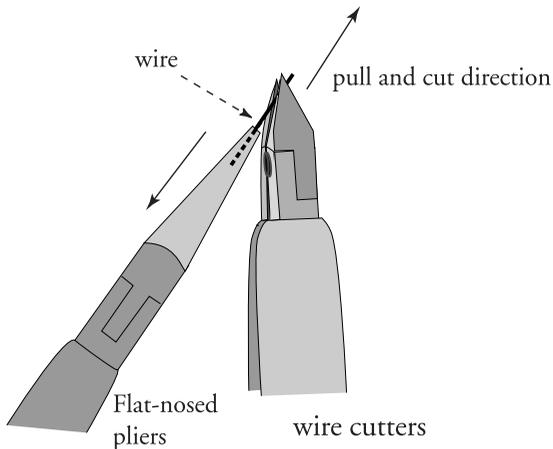
We recommend using this simulation, as the easyScan-system (measurements and software) can be encountered 'offline'!

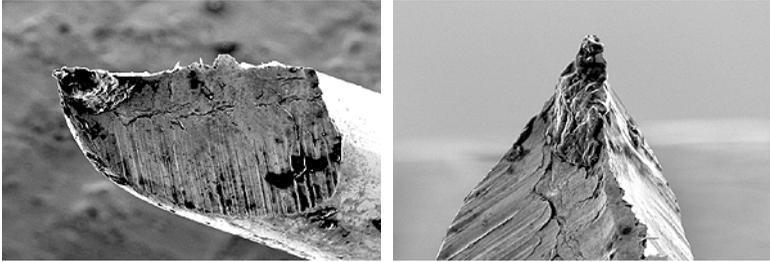
- Make sure that 'Simulate Microscope' in the menu 'Options' is activated and then follow the instructions in the 'Start measurement' chapter .

## Preparing and installing the scanning tip

The scanning tip is prepared and installed by you. This is the most difficult part of your preparations. It usually needs patience and some practise to get the first good tip (Especially because only an accurately cut tip enables optimal measurements.). Cutting and installing should be carried out with great care as a good result relies heavily on the accuracy of this process.

1. First ensure that the cutting part of the wire cutters, the flat-nosed pliers and the tweezers (10) have been cleaned with ethanol. Touch the platin wire (7) with these tools only.
2. hold the end of the wire firmly with the pliers and cut a piece off approximately 5mm long.
3. Still holding this piece of wire with the pliers, place the cutters at the free end, as obliquely as possible. (see picture below)
4. Close the cutters until you can feel the wire, then in the direction shown below, pull and cut at the same time. The tip needs to be torn off rather than cleanly cut off in order to get the required point.

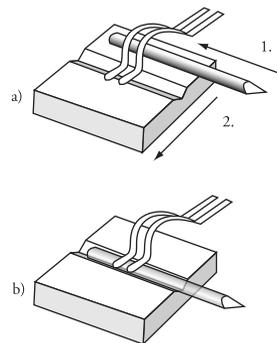




**Important:**

- Never touch the tip end with anything!
  - The golden tip holders in the open part of the scan head are very delicate and not to be twisted!
5. Hold the wire with the tweezers behind the freshly cut tip.
6. Insert it carefully under the golden tip holders in the scan head without twisting them (see below).

**Tip:** First put the end of the wire under the arched part of the tip holders and slide it sideways into the notch: see a) and b):



*mounting the scanning tip*

The freshly cut tip should be well held under the clamps and reach about 2-3mm beyond the tip holder.

The scanning tip is now installed.

## Preparing the sample

The STM can only examine electrically conductive materials. Nevertheless the choice of material is rather small because the surface of the sample must be totally clean and mirror-like to obtain useful results. Because of that some of the samples need special preparation.

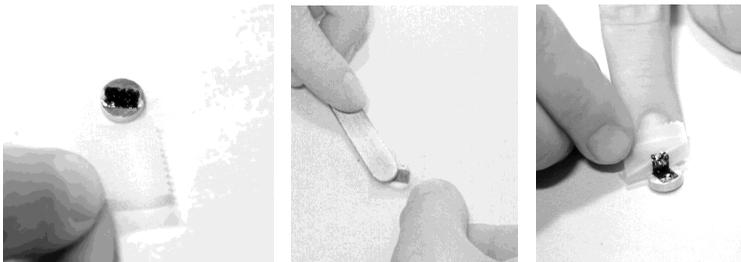
### Gold thin film

Cleaning the sample is neither possible nor necessary. Never touch the sample with your fingers or put it upside down anywhere, this will only make it unusable faster.

### Graphite

The surface of the graphite sample should be cleaned every few months. Due to the layered structure of graphite this can easily be done by using a piece of adhesive tape: (see pictures below)

- Put the sample on the table using the pair of tweezers.
- Stick a piece of adhesive tape gently to the graphite and then pull it off again: The topmost layer of the sample should stick to the tape.
- Remove any loose flakes with the pair of tweezers.

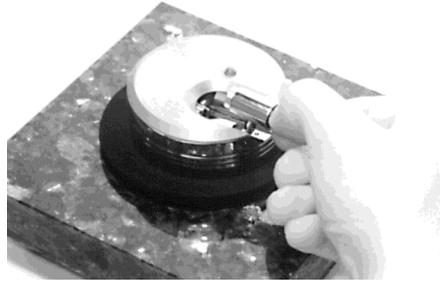
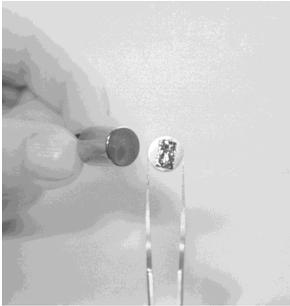


## PREPARATION

The graphite sample is now ready for use and may not be touched with the fingers.

### Installing the sample

- Unpack the sample holder (10) touching only its black plastic end.
- Put the prepared sample onto the magnetic end of the sample holder using a pair of tweezers. (See below)



- Place the sample holder carefully in the scan head so that it doesn't touch the scanning tip (see above).

### Caution!

Avoid strong mechanical impact on the piezo motor while placing the sample holder in the scan head.

- Put the sample holder down on to the guide bars first and release it gently on to the piezomotor's support.

## Measuring Graphite

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All the preparations are now done:

The STM is assembled, the software, a scanning tip are installed and a sample is ready.

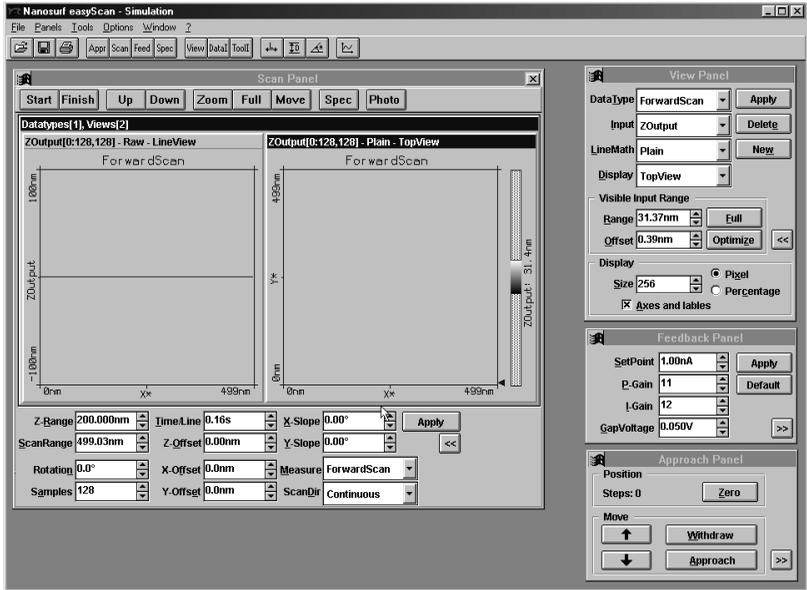
In this chapter step by step instructions are given on how to operate the microscope and get your first pictures. More detailed explanations of the software and the system are given in the software manual.

### Important!

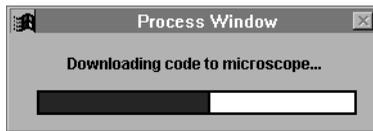
- Never touch the sample surface of the scanning tip! Good results rely heavily on the accuracy of the preparation of the tip and the sample.
- The tip must never come in direct contact with the sample. This damages the fine tip and it has to be cut again.

### Starting the microscope

- Check if the power pack (2) is connected to the AC mains power supply: The red LED of the control electronics (5) flashes or shines.
- Run the data acquisition program 'easyScan' on your computer: The main program window and the 'Scan Panel' appear.



When the red LED of the scan electronics has been flashing then a dialogue box will appear saying ‘Downloading code to microscope...’:



This means your computer is communicating with the control electronics and exchanging important data. This process is performed every time the control electronics have been turned off. After download is completed the red LED changes from flashing to constant and the LED on the scan head (4) shines orange.

Now the system is ready to use.

## Approaching the tip

To start measuring, the sample must be very close to the tip to enable a tunneling current to flow. Approaching the sample without touching the tip, is a delicate operation carried out in three steps. The LED on the scan head tells you about the distance between the tip and the sample:

LED orange: Distance is too big, no tunneling current is flowing.

LED red: Sample touched or 'crashed into' the tip, tunneling current is too high.

LED green: Sample is in the measuring area, tunneling current is flowing.

### 1. Coarse approach by hand

- Push the sample holder (10) carefully to within 1mm distance of the tip.
- If necessary try turning the sample holder a little so that the tip points towards a mirror-like area of the sample.

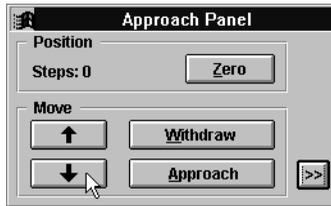


- Put the transparent cover (3) over the scan head without touching the sample holder.

The cover reduces air flow around the scanner to avoid severe thermal drift in measurements at atomical scale.

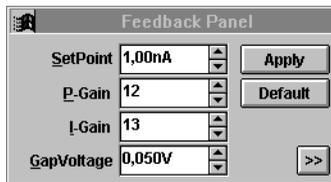
## 2. Fine approach by piezo motor

- Choose the menu 'Panels' of the 'easyScan' program.
- Open the 'Approach Panel'.
- Watch the distance between tip and sample with help of the magnifying glass. Now press  in the 'Approach Panel' to move the sample towards the tip to a distance of a fraction of a millimetre.



**Tip:** Watch the tip and its mirror image on the sample surface with the magnifier.

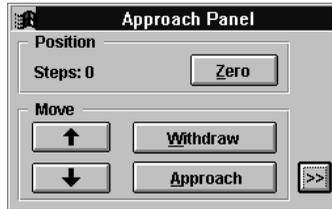
- Open the 'Feedback Panel' in the menu 'Panels'.



- Ensure that the following parameters are set correctly:
  - the 'SetPoint' (tunneling current) on approx. 1.00nA,
  - the 'GapVoltage' (tip-sample-voltage) on 0.05V,
  - the 'P-Gain' on 12 and the 'I-Gain' on 13 (feedback loop parameters).

### 3. Automatic approach

- Press **Approach** in the 'Approach Panel':



With the help of the piezo motor the sample holder is moved towards the scanning tip until the tunneling current defined by 'SetPoint' is detected. Now the distance between sample and tip is controlled automatically by the electronics. If the approach was successfully done the LED on the scan head changes from orange to green and the dialogue box 'Approach done' appears.

- Press 'OK'.

Now the tunneling current which has been set, is flowing between scanning tip and sample.

The sample may „crash“ into the tip:

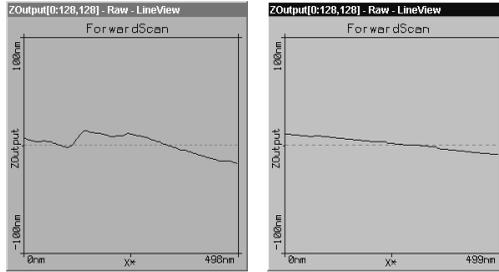
Then the LED changes to red and the scanning tip has to be cut again: (see chapter 'F&F').

### Start measurement

When the tunneling current defined by 'SetPoint' flows between tip and sample (LED green) you can start measuring:

- Press **Full** in the 'Scan Panel' to maximize the range of the scan.
- Start measuring by pressing **Start** in the 'Scan Panel'.

If the preparation of tip and sample and the approach were successful images of the measurement will be drawn showing a line in the ‘LineView’ and a plane in the ‘TopView’. Watch the displays for a while until the ‘TopView’-image has been drawn about three times.



*A ‘nervous’ and a good starting-picture*

A ‘nervous’ line in the ‘LineView’ indicates a bad tunneling contact. Usually this is caused by the tip being too blunt or instable. This means that you should stop measuring and cut a new tip:

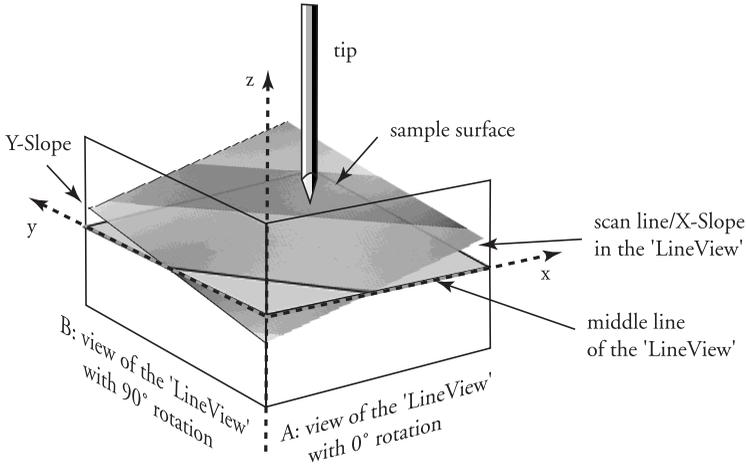
- Press  and follow the instructions of the chapter ‘F&F’.

If the line in the ‘LineView’ is calm and reproduces consistently you can follow the next chapter.

## Adjusting the sample’s tilt coordinates

In the ‘LineView’ window a cross section of the sample’s surface is presented at the actual scan position (= scan line); see schematic view A and B on the next page.

The ideal scan range for the tip lies in the x,y-plane of the piezo-scanner. But mostly the sample is tilted with respect to that ideal plane. Since the sample’s tilt cannot be compensated for directly, the scan coordinates have to be adjusted accordingly. By setting suitable values for X- and Y-slope the scanner’s coordinate system is ‘tilted’ so that the sample’s surface appears to lie in the ideal x,y-plane.



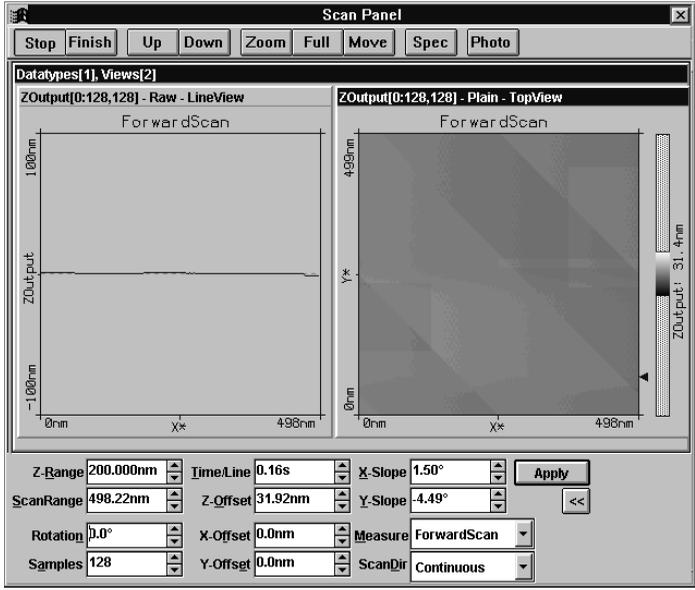
*Sample's orientation before tilt adjustment*

You can alter the various parameters in the 'Scan Panel' by using the arrow buttons  step-by-step or overwrite the old values by typing in the new ones. In the latter case you must confirm your entry by clicking button  or hitting the 'Enter'-key:

1. Alter the value of 'X-Slope' using the arrow buttons until the scan line lies parallel to the x-axis.
2. Enter the value 90 for 'Rotation' to display the scan line in y-direction i.e. the sample's tilt as shown in the schematics view B.
3. If the scan line is not horizontal alter the value for 'Y-slope' until the scan line lies parallel to the y-axis.
4. Reset the 'Rotation' to 0°. The 'LineView' shows the view in A again.

Now the ideal scan range is set to the sample's tilt.

The value of the 'Z-Offset' varies slightly during measurement. This is correct because in the menu 'Options' the option 'Auto. Adjust Z-Offset' should be active.



*Displays after adjusting the slopes*

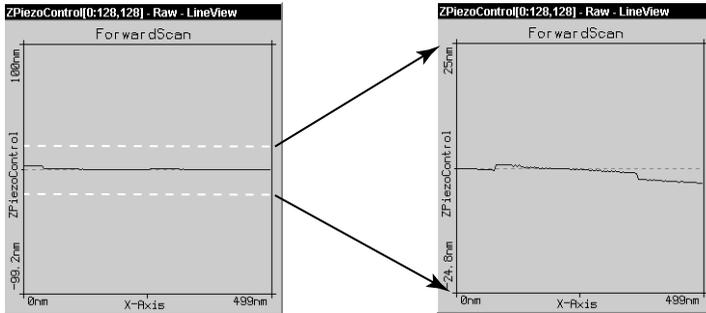
## Achieving atomic resolution

You prepared your measurement so that the scan line in the centre of the 'LineView' is reproducing stably. Now the scan range has to be reduced and the measured signals amplified in order to observe the atomic structure.

Reminder: Measurements on the nanometer scale are very sensitive. Direct light, fast movements causing air flow and temperature variations near the scan head can influence and disturb the measurement. It is best to let a promising measurement run for some time to let it stabilize thermally.

The following statements apply to graphite:

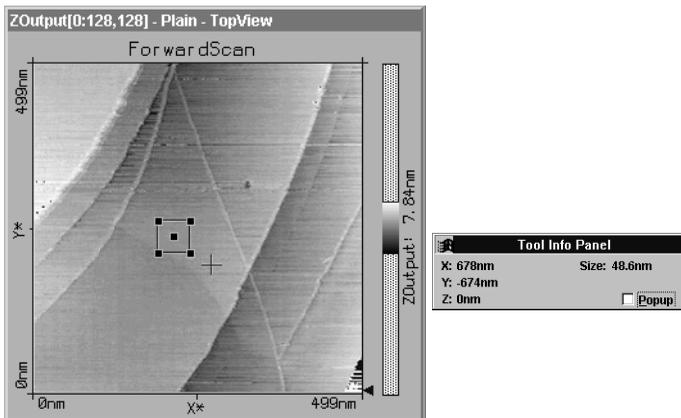
1. Reduce the value of 'Z-Range' in 'ScanPanel' to 50nm in order to concentrate the measurement to this range.



*Diminishing 'Z-Range' amplifies the signal in Z-direction*

2. Limit the scan range as follows:

- click on the 'TopView'-Display to make sure that it is active: its titlebar is the same colour as the main bar.
- click on **Zoom**: The mouse pointer becomes a cross and the 'Tool Info Panel' opens.
- look for a 'flat' region (similar grey values) in 'TopView' and with the mouse pointer make a square there. The size of the square is shown in the 'Tool Info Panel'.



- Release the mouse button when the square's size is about 30-50nm.
- By double clicking on the display using the left mouse button you confirm the selection and consequently the selection is enlarged to the whole display size. You can abort the zoom function by clicking with the right mouse button.

3. Atomic arrangements can normally be made out at a 'ScanRange' of about 4 nm and at a 'Z-Range' of about 1.5 nm.

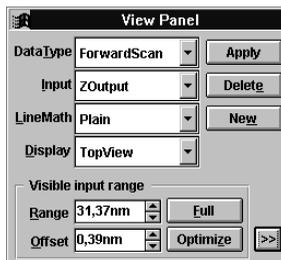
- Set these values in 'Scan Panel' one after the other. Have a play with these values, they can be reduced even further. Between changes always allow the computer to scan the picture a couple of times before continuing.
- Pay attention to the height of the signal in the 'LineView' window. It should not exceed the window height, if so the z-Range is set too small and should be increased.

To help you understand the 'Dimensions': One nanometer is between four and eight atoms.

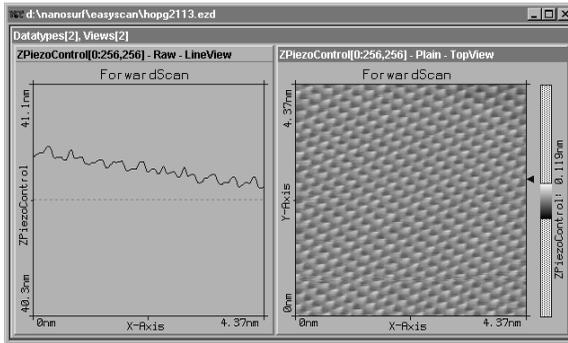
4. Some parts of the scan head react to the slightest temperature changes. As these thermal 'movements' influence the measurements on the nanometer scale, the sample has to be scanned as fast as possible.

- Set the 'Time/Line' in the 'ScanPanel' to 0.06s for atomic resolution.

5. In the 'TopView' window the values which do not fit in the selected colour range appear coloured: red points are too 'high' and blue points are too 'low'.



- If a lot of blue and red points appear, open the 'View Panel' and select **Optimize** in the 'Visible Input Range' section



*good images of a successful measurement*

## Snapshots of images

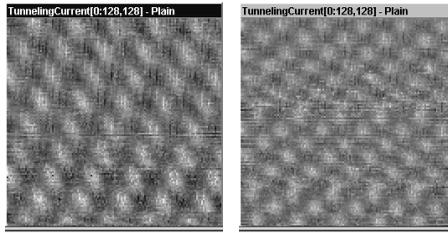
If you are happy with your image and would like to keep it, you can take a snapshot and save it later:

- When you see that a good image is being produced line by line then during the measurement you can select **Photo** in the 'ScanPanel'. After having completed the actual frame, a copy of the measured image is taken and displayed in a separate window behind the 'ScanPanel'.
- If you would like to take the snapshot of the view as it appears during the measurement without waiting to finish the frame, you have to stop the scanning by using **Stop** and generate a copy of the view using **Photo**.
- After having finished the measurements you can store the 'photographs' of your measurements in a storage medium e.g. your PC's hard drive (see Chapter 'Finish measuring and save images')

## Judging the quality of the images

From the quality of the measured images the quality of the scanning tip and consequently that of the tunneling contact can be observed. A good tunneling contact is necessary for high quality images of atomic resolution.

- If temperature variations are present they cause so called ‘thermal drift’. Consequently the images are stretched. This effect can be observed when e.g. the upward scan is much different from the downward scan showing two differently distorted lattices.

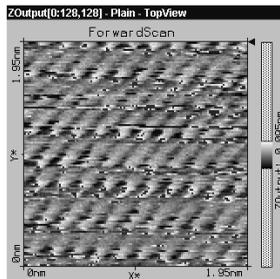


*consequent upward and downward scan showing thermal drift*

Thermal drifts are very clearly perceptible on an atomic scale. Already variations of  $1/10^{\circ}\text{C}$  cause variations in the length of e.g. the sample holder (steel) of several nanometers!

In this case it is important to keep the measurement running for some time to let the system stabilize (up to about one hour).

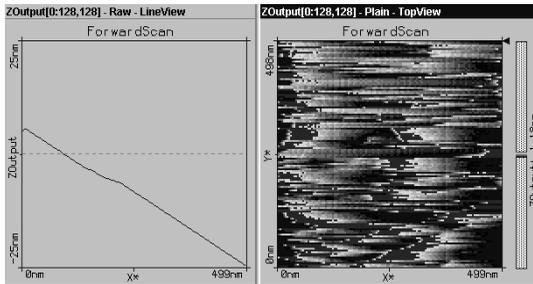
- If during a good measurement the image quality diminished dramatically the tip has most probably picked up some particles.



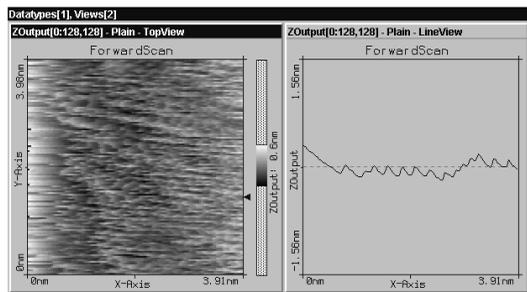
- See chapter 'F&F: Image quality suddenly deteriorates'

In the following cases the scanning tip has to be replaced i.e. cut freshly in order to establish a stable tunneling contact and high image quality:

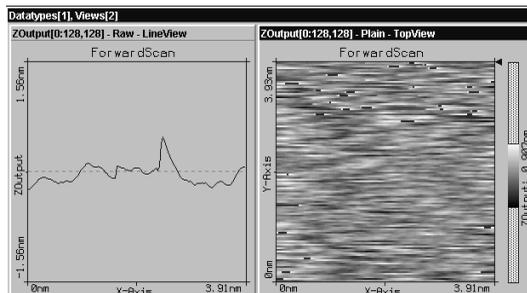
- If images in top view consist of only of uncorrelated lines:



- If the images are 'smeared out' on one border (here on the left border):

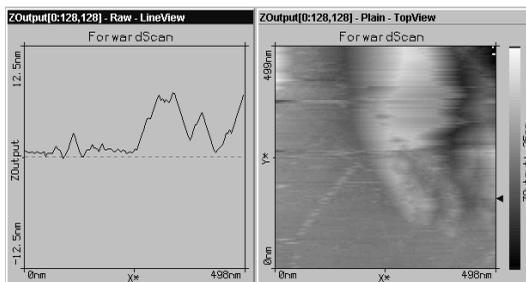


- If each image looks different:



## MEASURING GRAPHITE

- If the scan lines in 'LineView' are unstable and the image in the 'TopView' is not 'sharp':



## Turning off and putting away the 'easyScan'

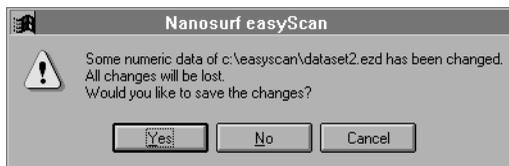
### Finish measuring and save images

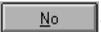
- To stop a measurement click onto the button .
- By hitting  then pressing  in 'Approach Panel' you can retract the sample holder to a safe and visible distance from the tip.
- Close all panels in order to see the saved 'snapshots'.
- Activate the 'snapshot' that you would like to save, by clicking onto the image. Select the menu 'File->Save as...'. Select the name and the folder where you would like to store the images (filename with a maximum of 8 characters).

These stored images and all the corresponding data can be opened with the 'easyScan' software, viewed, analyzed and printed (ref. also 'Software Reference' manual) anytime.

### Turning off and storing the instrument

- Finish the program 'easyScan' after having stored all desired images. If you leave the program without saving some data the program asks if you really do not want to save them (safety):



If however you would like to save some images use . If not you can leave the program with .

- Disconnect the power pack from the power supply.

TURNING OFF AND PUTTING AWAY THE  
'EASYSKAN'

If you perform measurements regularly leave the instrument with the cover over the scanner to protect it against dust.

If you do not operate the instrument for several weeks you should put it back into the instrument suitcase:

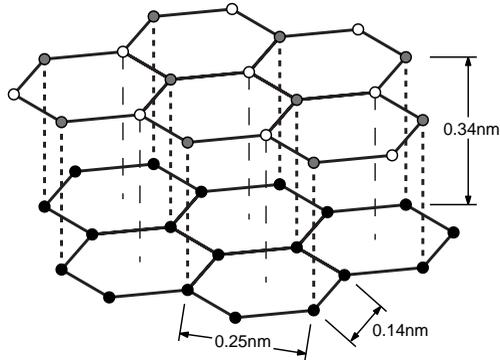
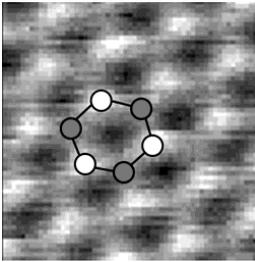
- remove sample and sample holder and pack up all parts. The scanning tip can be left in the scanner.

By storing the instrument in the suitcase it is protected from dust. Simultaneously the rubber feet of the vibration isolation platform should be relieved. The damping capability may decrease with time.

## Notes about the graphite surface

In a good top view image of graphite you will see a pattern consisting of white, grey and black spots. It looks like a three dimensional image of balls lying next to each other, but be careful: these are not the single atoms!

To interpret the image correctly you must first be aware that bright spots show high points and dark spots low ones (except in 'LineMath' 'Derive').



Out of the lattice model of graphite one can see that there are two different positions of the carbon atoms in the graphite crystal lattice: One with a neighbouring atom in the plane below (grey) and one without a neighbour in the lattice below (white).

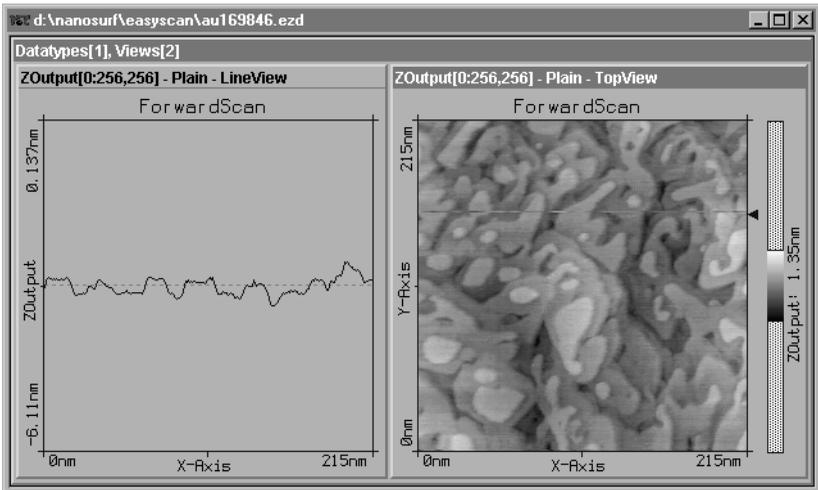
Consequently the electrical conductivity of the graphite surface varies locally slightly so that the atoms without neighbours appear higher than the others.

This also causes the lattice constant between the bright 'hills' to have the higher than normal value of 0.25nm.

# Measuring Gold

It is more difficult to obtain good images of a gold.

Atomic structures are difficult to observe because the electrons on the surface are much more homogenously distributed unlike graphite. But with some training the mono atomic gold steps can be observed.



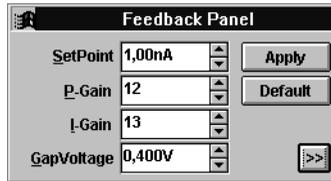
Due to the fact that the gold sample cannot be cleaned by simple means it is possible that with time contaminants may prevent you obtaining good results.

## Tip:

Before you do any experiments with the gold sample it is necessary to practise on the graphite sample. You should also test the quality of your tip using the graphite sample.

- Proceed as you did with the graphite sample (preparation & slope compensation), but there are two exceptions to note:

- select a gap voltage between 0.3-0.5V.



- increase the value of parameter 'Time/Line' to 0.3s in the 'Scan Panel'.

If you do not get stably reproduced scan lines you should look for another clean measuring spot.

- First try with **Withdraw** followed by **Approach**. If that does not change much retract the sample holder and rotate it a little by hand. Repeat the approach.
- If the image reproduces stably decrease the 'Z-Range' to 50nm and select a 'ScanRange' between 200 and 300nm.
- Now decrease the 'Z-Range' to 12nm or less.

Of course you can evaluate your measurements in the same way as you did with the graphite images, zoom, measure, save etc.

## Maintenance

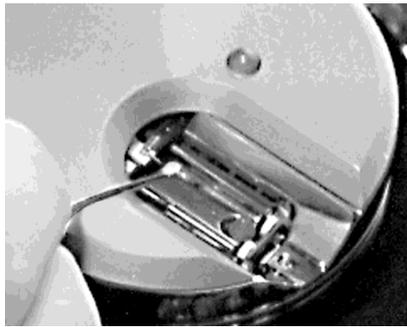
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To ensure a faulty free operation of the microscope the following instructions for maintenance have to be followed.

### Scan head

It is very important to keep the sample holder and the open part of the scanner clean. If exposed to moisture (high humidity), corrosion will appear.

- If anyone touches the metal part of the sample holder or it does not move freely, clean it with a soft cloth moistened with alcohol.
- Clean the sample holder guide bars (see picture above), the surfaces of the piezo motor and the tip holder with a cotton swab lightly moistened with alcohol, ensure the tip is removed when doing this!



### Scan electronics

Clean the cabinet and the controls with a soft cloth lightly moistened with a mild detergent solution. Do not use any abrasive pad or solvent like alcohol or benzine.

## F&F: Frustrations & Failure

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### 'Approach' is too slow / stops sometimes

- Clean the sample holder guide bars, the surfaces of the piezo motor with a cotton swab lightly moistened with alcohol. Let the parts dry sufficiently.
- If cleaning was no improvement open the 'Approach Panel's extended configuration using its  button.
- Increase the value of 'Stepsize' and press .

Now the motor moves the sample holder with larger steps during automatic approach.

- Save the new value for 'Stepsize' using menu 'File->Parameters->Save'

### Tip often crashes into sample during 'Approach'

In this case the motor moves the sample holder with too bigger steps towards the scanning tip:

- Open the 'Approach Panel's extended configuration using its  button.
- Decrease the value 'Stepsize' in 'Automatic Move Configuration' by about 10% and press .
- Repeat the approach with a new tip. If the approach fails again, reduce 'Stepsize' further.
- Save the best 'Stepsize' value using menu 'File->Parameters->Save'

### Image quality suddenly deteriorates

- When a scan line suddenly starts reproducing badly, the tip may have picked up some particles:
  - Continue measuring for a while (4-5 images) eventually the tip looses the picked up material again.

- You can try to induce changes at the tip's end: While measuring increase the gap voltage in the 'Feedback Panel' to 2V then reduce it to the old value again.
- You can also induce changes of the tip's end by increasing the tunneling current to 20nA for a short time then reducing it to its old value again.
- Retract the sample using  then perform a new approach.

If after these procedures no improvement can be seen, you have to prepare a new tip.

- Did the scan line in the 'LineView' suddenly disappear and the LED on the scanner turns orange the tip has lost contact:
  - Use  in the 'Approach Panel' then repeat the steps in chapter 'Start measurement'.
- If the LED flashes green-orange while measuring then the tip is losing contact from time to time and the tunneling contact is very unstable.
  - In the 'Approach Panel' select  then  and repeat the steps in chapter 'Start measurement'.

## Cutting a new scanning tip

After a crash (the scanning tip with the sample) or when scan lines start reproducing badly and consequently the image deteriorates you should proceed as follows:

- Remove the transparent cover from the scan head.
- Retract the sample holder first by using  then . Remove the sample holder by hand.
- Pull the tip out from under the tip holders carefully, using a pair of sharp tweezers.
- Carefully follow the instructions in chapter 'Preparing and installing the scanning tip'.
- Repeat procedures in chapter 'Measuring graphite'.

## Sample holder moves too slowly / stops sometimes

If the fine approach using  and  is affected:

- Clean the sample holder, guide bars and the surfaces of the piezo motor with a cotton swab lightly moistened with alcohol.

## 'No connection to microscope!'



This error message appears when the scanning software is waiting for an answer from scan electronics. This can have various reasons:

- The microscope is not connected:
  - If you wish to perform a simulated measurement select . otherwise check the connection and select .
- The scan electronics is not connected to the power supply:
  - check the connection.
- The scan electronics is not connected to the computer with a serial cable:
  - check the connection.
- The scan electronics performs a task which lasts an unforeseen length of time causing a timeout. Using Windows NT this can happen when the system is occupied with itself and blocks the serial port:
  - Use .
- During software installation the wrong COM-port has been selected:
  - Use  and exit the program 'easyscan'.
  - Check which port the scan electronics is connected to.
  - Open folder 'easyScan' and edit using a text editor the file 'Easyscan.ini'

- Set the correct port number in section '[WinSer]' under item 'ComPort= '.
- Caution: Do not alter any other values in this file!
- Save the file 'Easyscan.ini' and restart the 'easyscan'-program.
- The electronics is broken.
  - Contact your dealer.

## **Z-Offset does not change automatically**

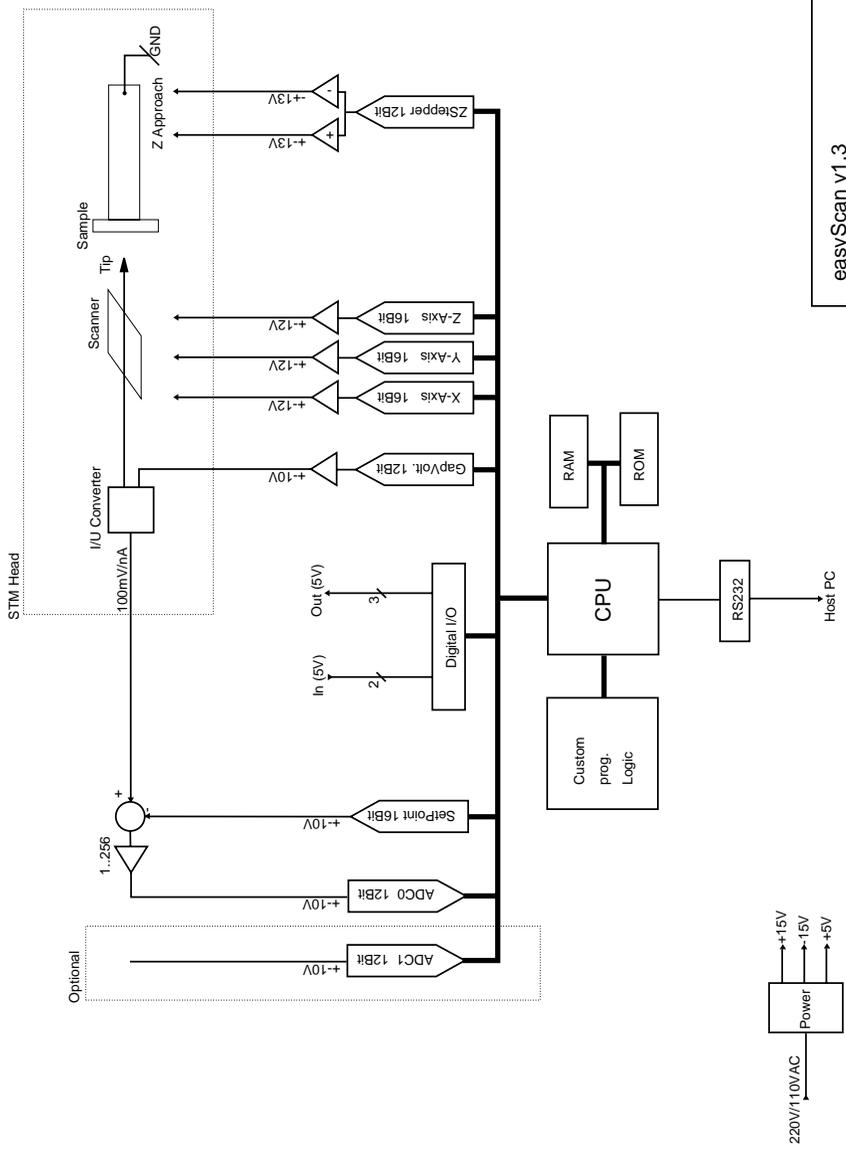
In the default configuration of the easyscan software the item in menu 'Options->Auto. Adjust Z-Offset' is activated. If the numeric value of 'Z-Offset' in the 'Scan Panel' does not alter slightly during scan:

- Check whether the option is activated.
- Eventually the tip is at one of the limits of the z-piezo. Use  then .
- The scan line is at the one of the limits of the z-range. Increase the value of 'Z-Range'.

## Technical Data

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- scan range max.:  $0.5\mu\text{m} \times 0.5\mu\text{m}$  in x - and y - directions.
- scan range max.: 200nm in z - direction.  
(the exact values are dependent on the calibration of the piezo elements.)
  
- scan speed: 60ms per 128 datapoints
- minimal step size: 0.015nm
- gap voltage:  $\pm 10\text{V}$  in 5mV steps
- set point current:  $\pm 100\text{nA}$  in 25pA steps
- feedback loop bandwidth: 3 kHz
  
- baud rate controller-host: 38400 bps



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**Nanosurf AG**  
Austrasse 4  
CH-4410 Liestal

**E-Mail**  
[info@nanosurf.com](mailto:info@nanosurf.com)

**World Wide Web**  
[www.nanosurf.com](http://www.nanosurf.com)