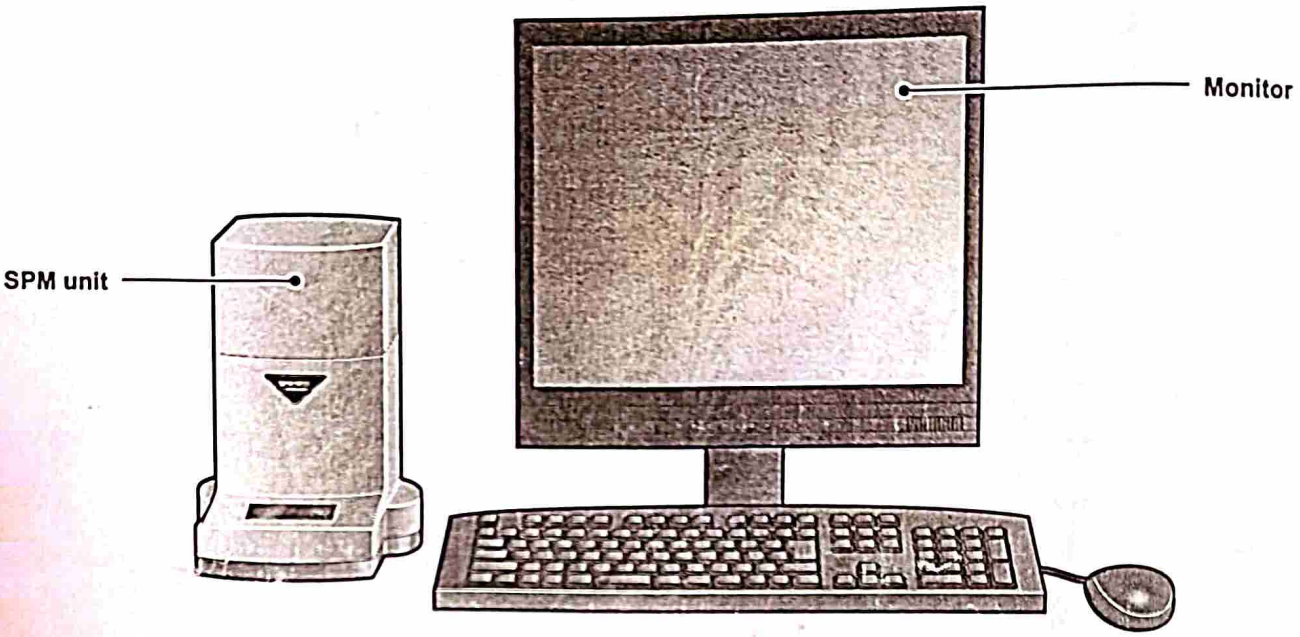
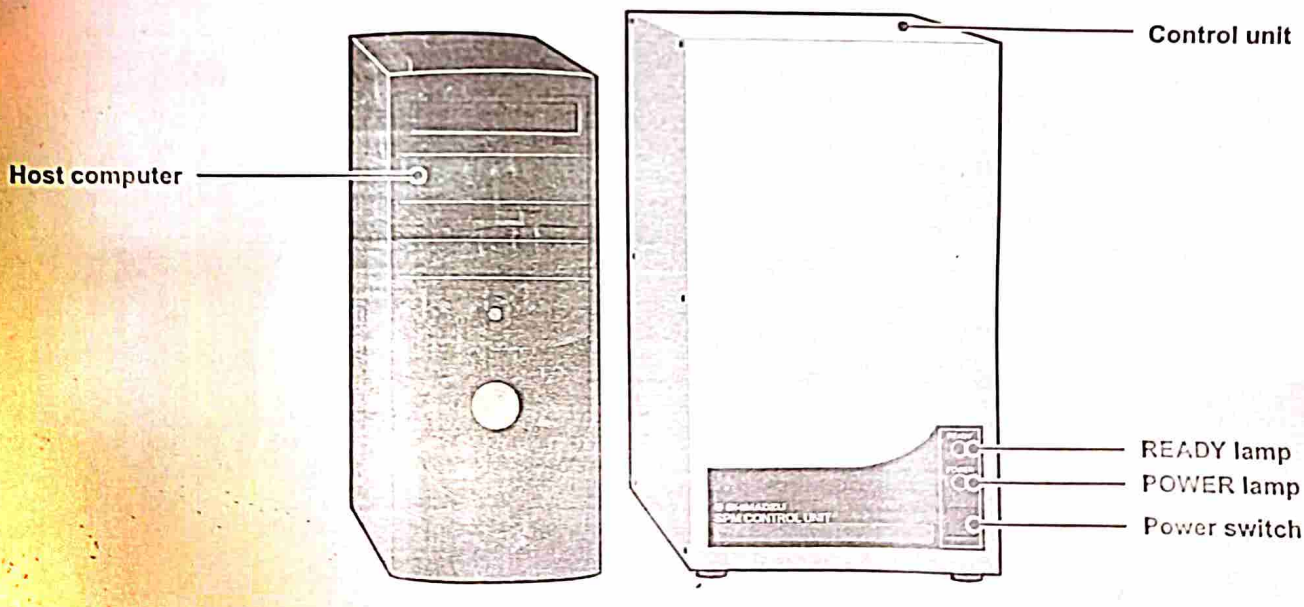
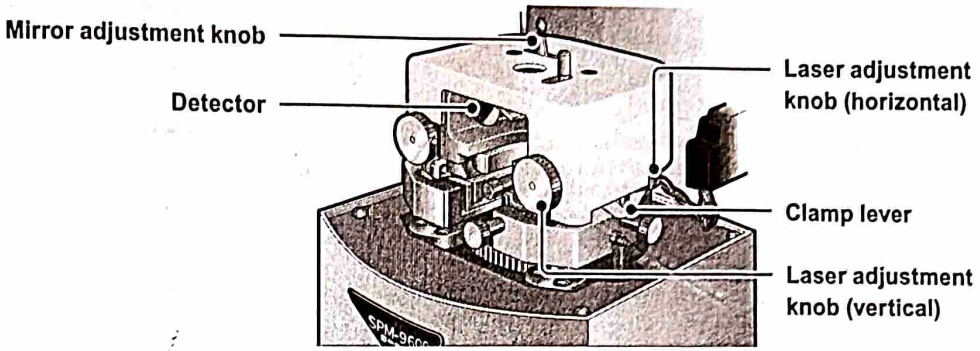
1. Parts of the System

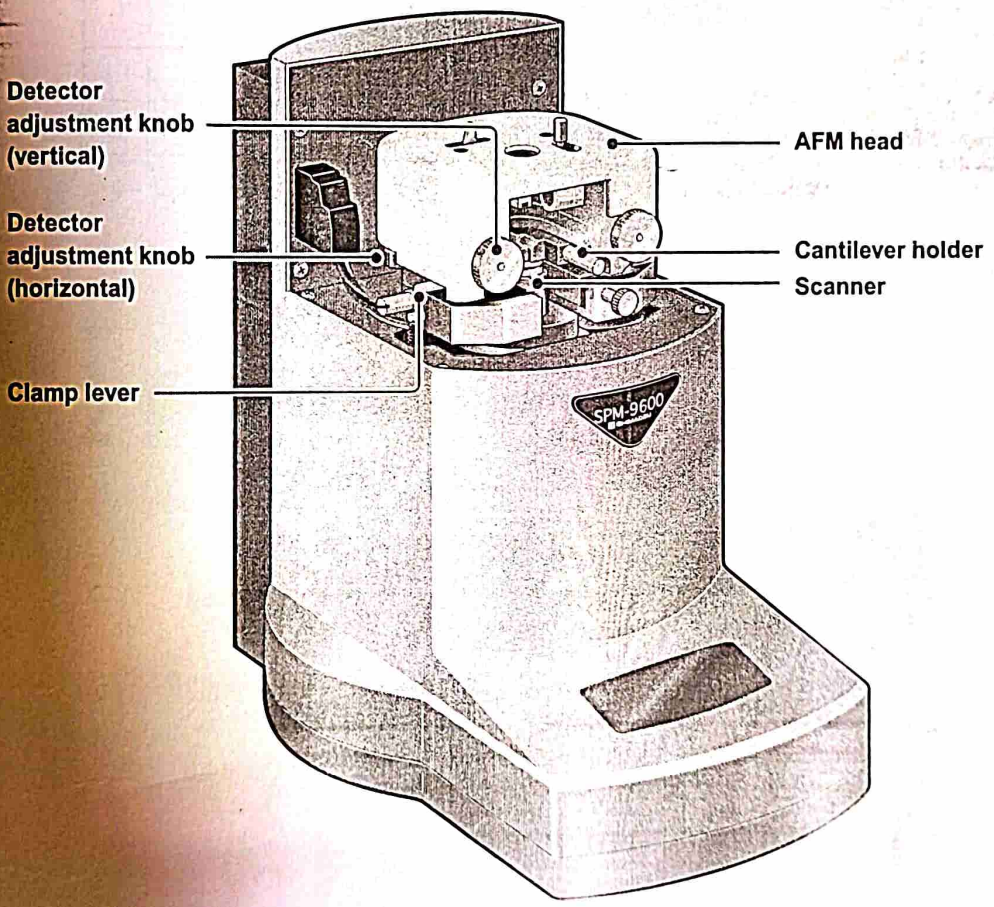
Overall view





SPM unit


Mirror adjustment knob
Detector
Laser adjustment knob (horizontal)
Clamp lever
Laser adjustment knob (vertical)


Detector adjustment knob (vertical)
Detector adjustment knob (horizontal)
Clamp lever
AFM head
Cantilever holder
Scanner
SPM-9600

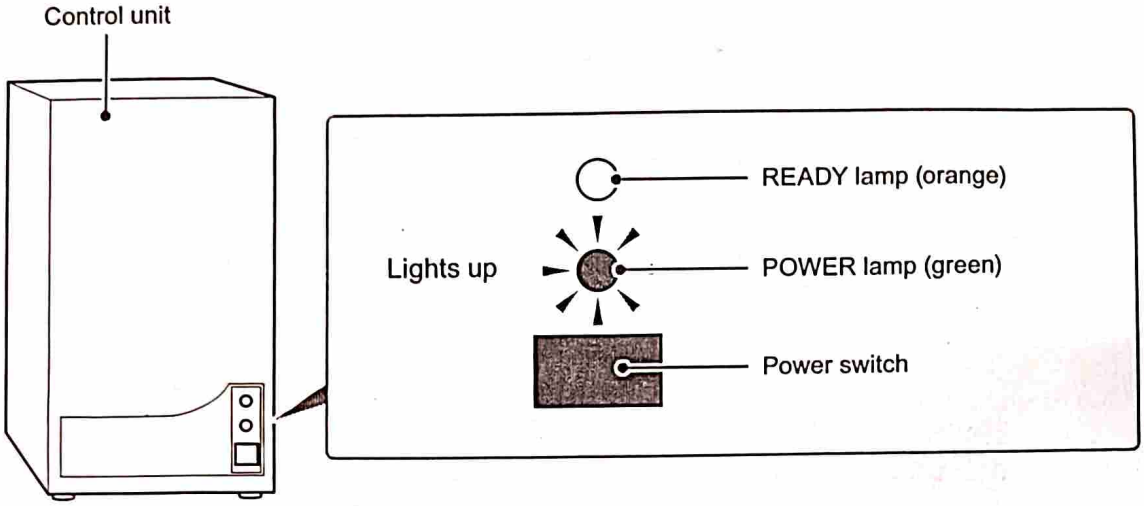
2. Table of Signals

			Signal								
			Height	Deflection (vertical)	AsinD	AcosD	Phase	Amplitude	Deflection (horizontal)	Current	Potential
Mode	Contact		○	○							
	Dynamic		○	○							
	Phase		○	○	○	○	○	○			
	Current/contact	Option	○	○						○	
	Lateral force (LFM)	Option	○	○					○		
	Force modulation	Option	○	○	○	○	○	○			
	Magnetic force (MFM)	Option	○	○	○	○	○	○			
	Surface potential (KFM)	Option	○	○	○						○

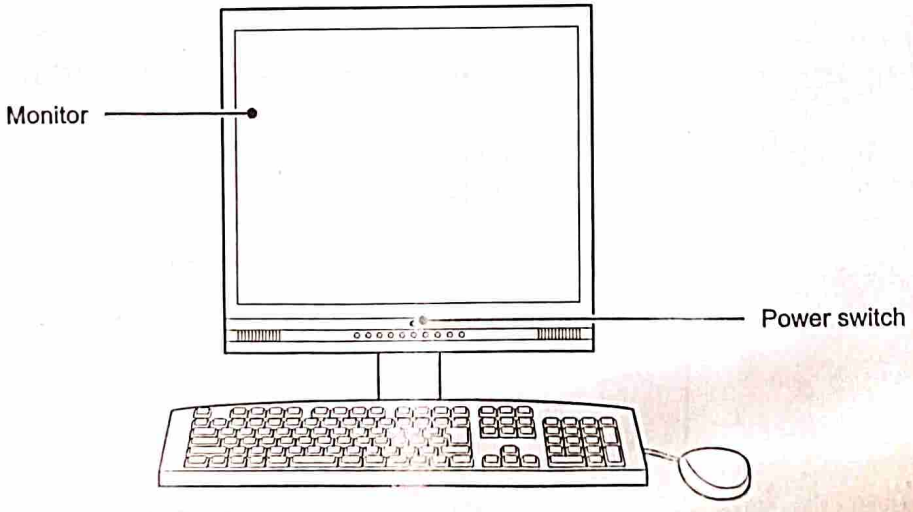
3. Starting Up

1 Turn on the control unit power.

* The POWER lamp (green) lights up.

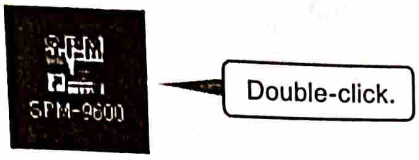


2 Turn on the monitor power.

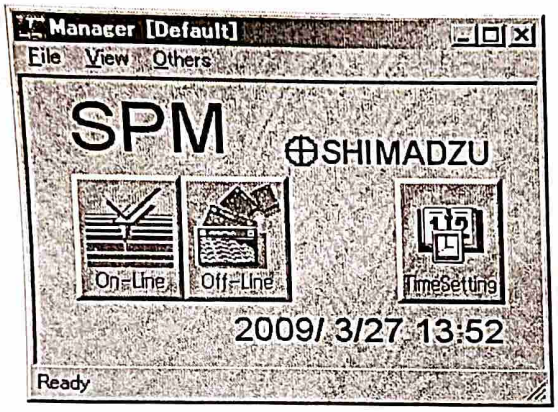


3 Turn on the host computer power.

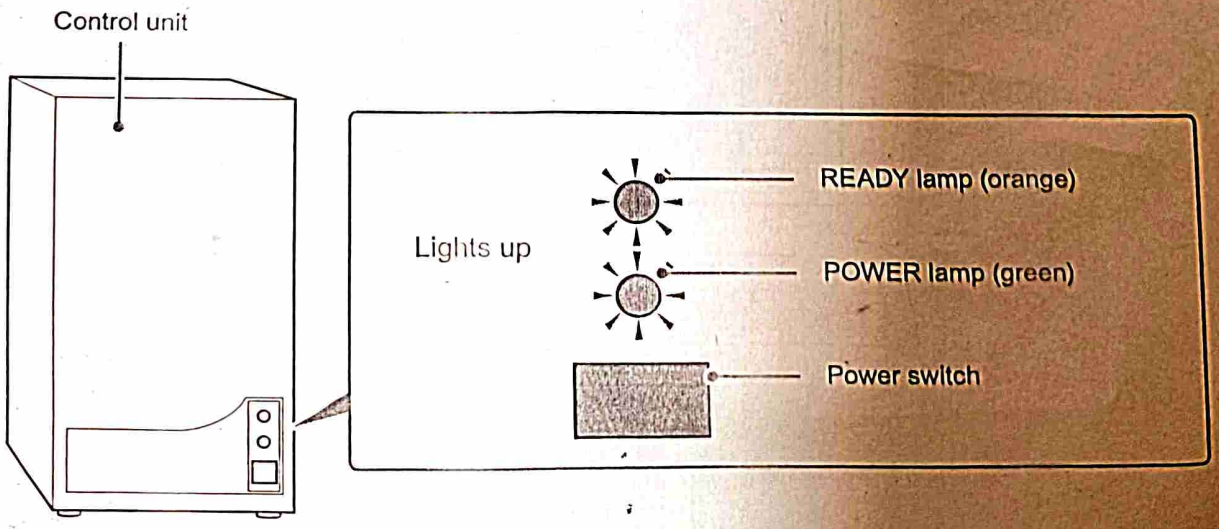
4 Double-click the SPM-9600 shortcut icon.



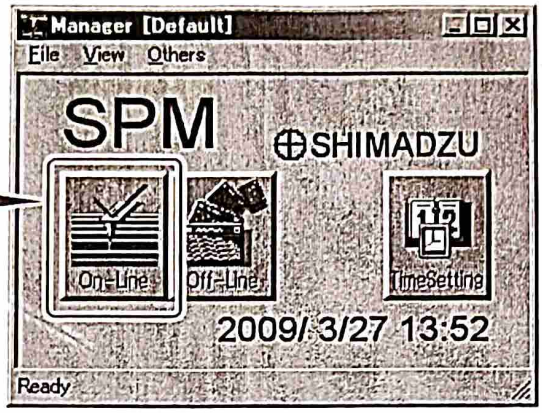
The [Manager] window opens.



5 Make sure that the READY lamp on the control unit is on.

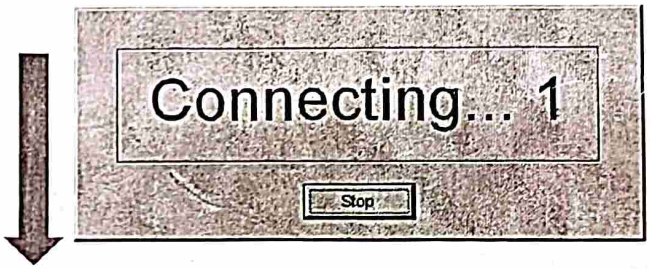


6 Start the SPM online software.



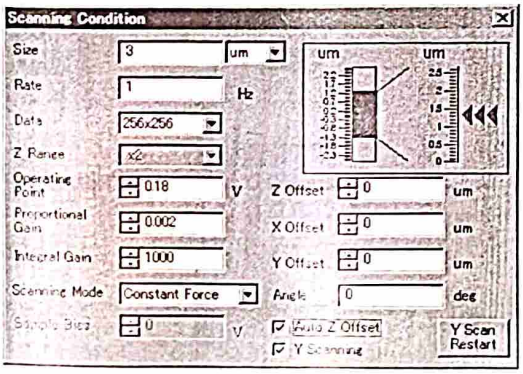
Click [On-Line].

Blinks.

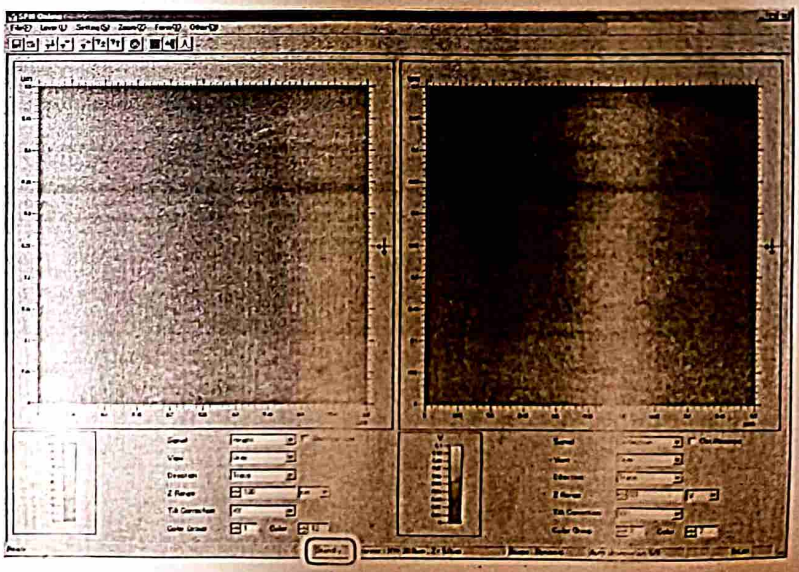


The [SPM Online] window and [Scanning Condition] window appear.

[Scanning Condition] window

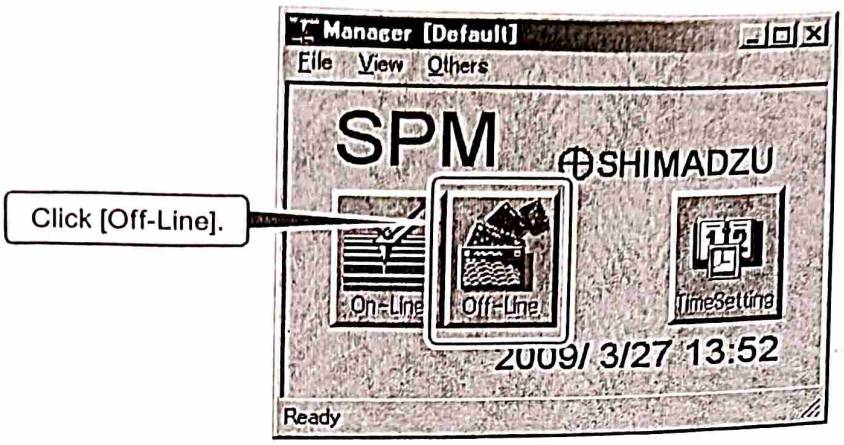


[SPM Online] window



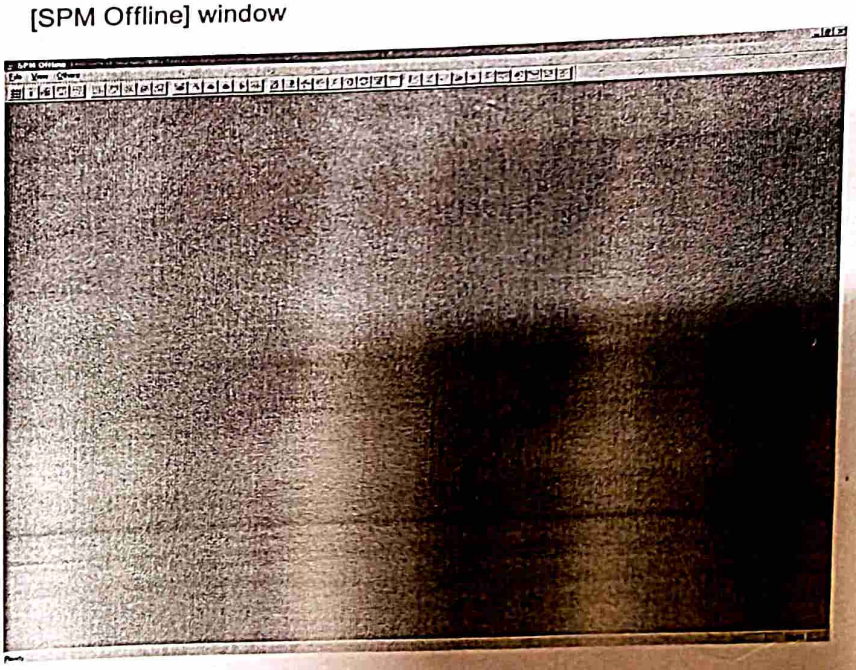
[Standby] appears.

7 Start the SPM offline software.



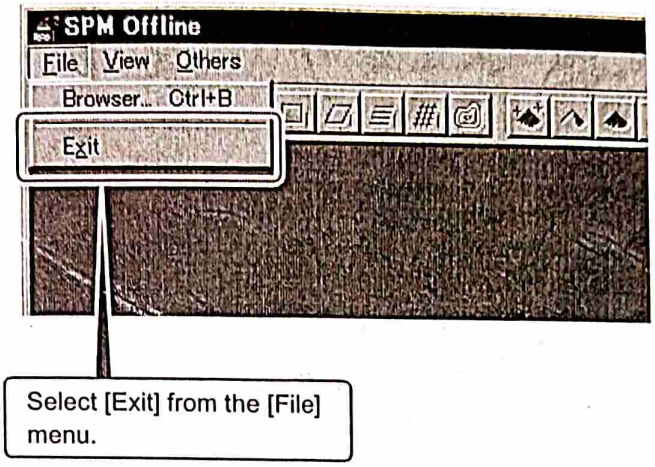
The [SPM Offline] window opens.

[SPM Offline] window



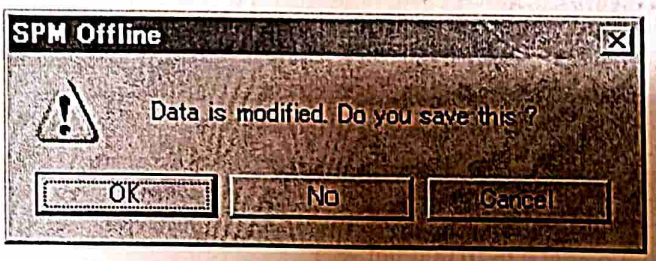
4. Exit

1 Exit the SPM offline software.

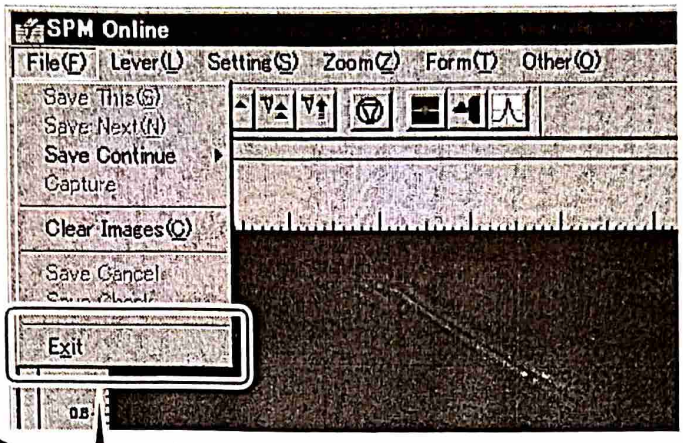


Select [Exit] from the [File] menu.

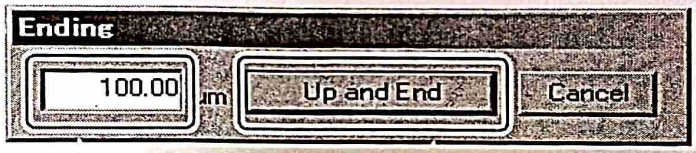
If there is data to be saved, a message will appear. Save the data as needed.



2 Exit the SPM online software.



① Select [Exit] from the [File] menu.

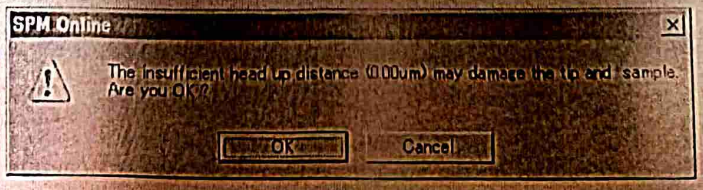


② Enter a value (the default value is 100 µm).
Input range: 0 to 10,000 µm.

③ Click [Up and End].

The cantilever rises the specified distance and the SPM online software closes.

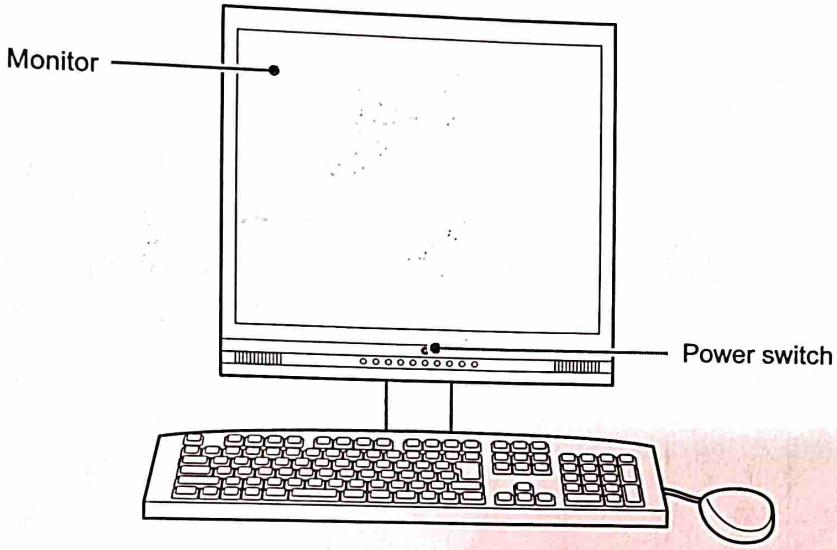
Hint If [Up and End] is clicked with a value less than 100 µm specified, a warning message will appear.



Make sure the sample and cantilever will be safe, and click [OK].

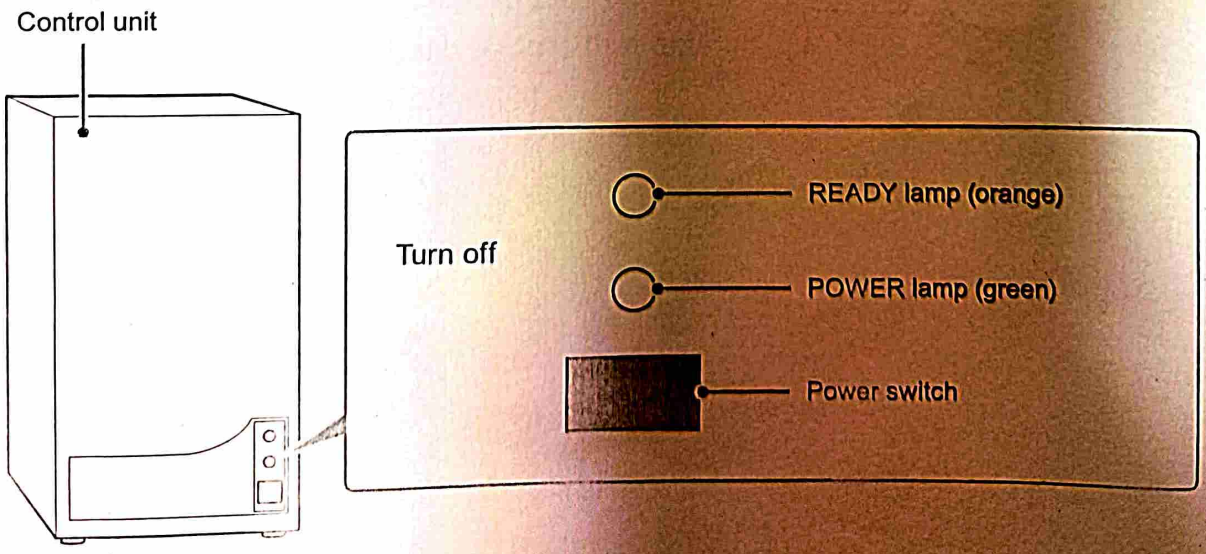
3 Shut down Windows and turn off the host computer power.

4 Turn off the monitor power.



5 Turn off the control unit power.

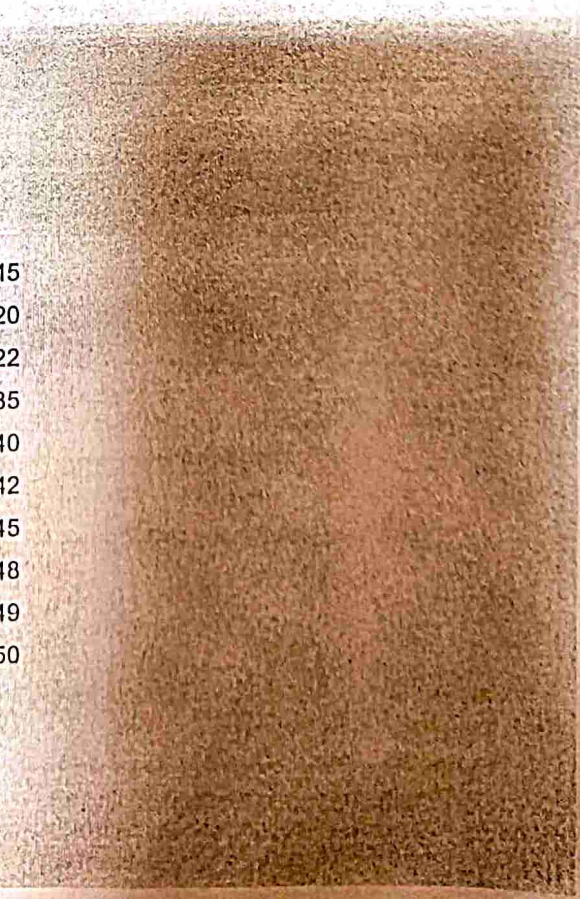
* The POWER lamp (green) and READY lamp (orange) turn off.



Chapter 2 Contact Mode

This chapter explains the procedure for scanning in contact mode.

In contact mode, the surface of the sample is scanned using feedback to keep the repulsive force that acts between the probe and sample constant.



Flow of Contact Mode Scanning

The flow of scanning in contact mode is indicated below. The procedures for displaying, processing, and analyzing a scanned image are described in "Chapter 11 Image Processing".

Installing the Cantilever Reference P.15

↓

Selecting the Mode Reference P.20

↓

Adjusting the Optical Axis Reference P.22

↓

Attaching the Sample Reference P.35

↓

Parameter Settings Reference P.40

↓

Starting Scanning Reference P.42

↓

Adjusting the Image Reference P.45

↓

Saving the Image Reference P.48

↓

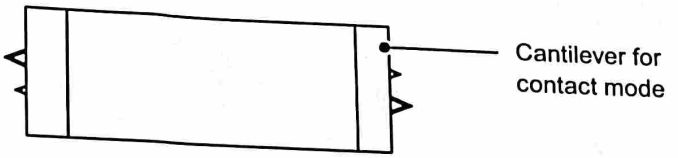
Ending Scanning Reference P.49

↓

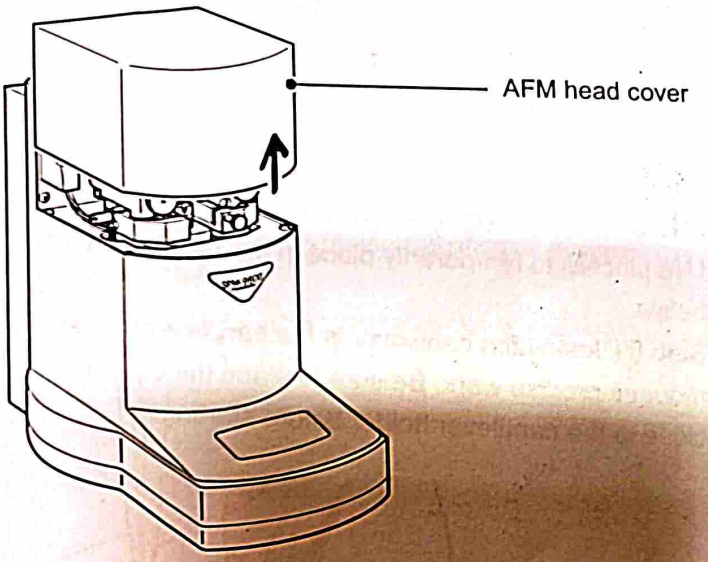
Removing the Sample Reference P.50

1. Installing the Cantilever

Install the cantilever for contact mode in the cantilever holder.

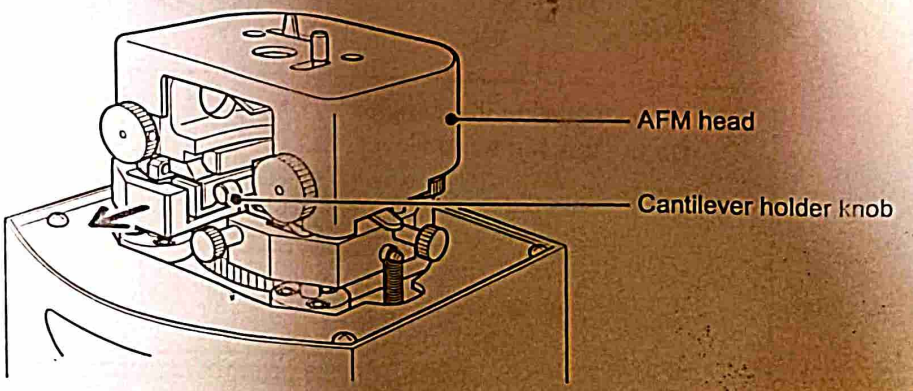


1 Remove the AFM head cover.



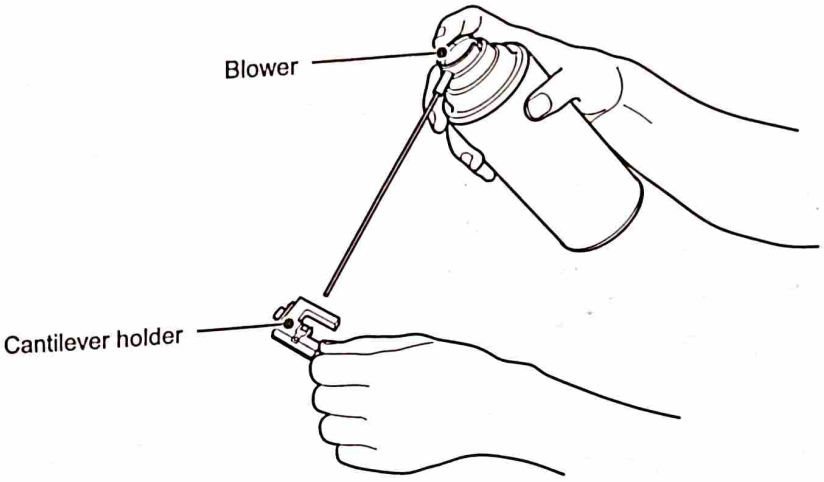
2 Remove the cantilever holder.

While holding the AFM head down, grasp the cantilever holder knob and pull straight out.



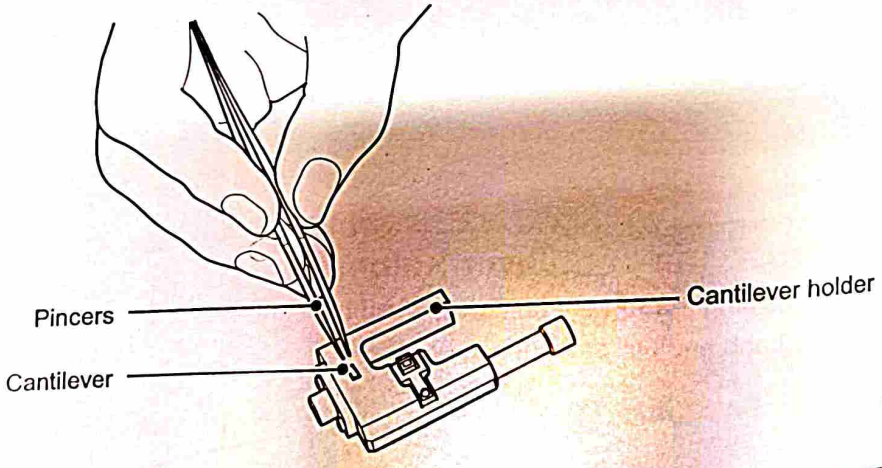
3 Remove dust from the cantilever holder.

Use a blower to remove dust.

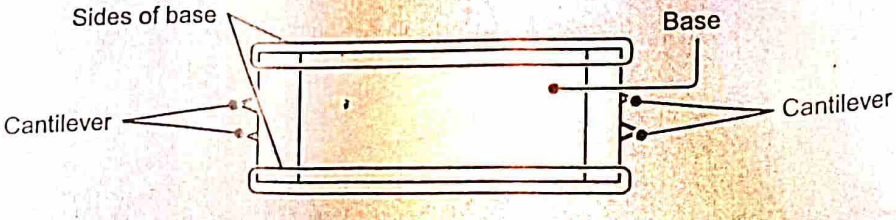


4 Place the cantilever near the cantilever holder.

Use pincers to temporarily place in the position shown below.
Step 5 ("Install the cantilever in the cantilever holder.") requires precise work. Be sure to place the cantilever close to the cantilever holder before starting.

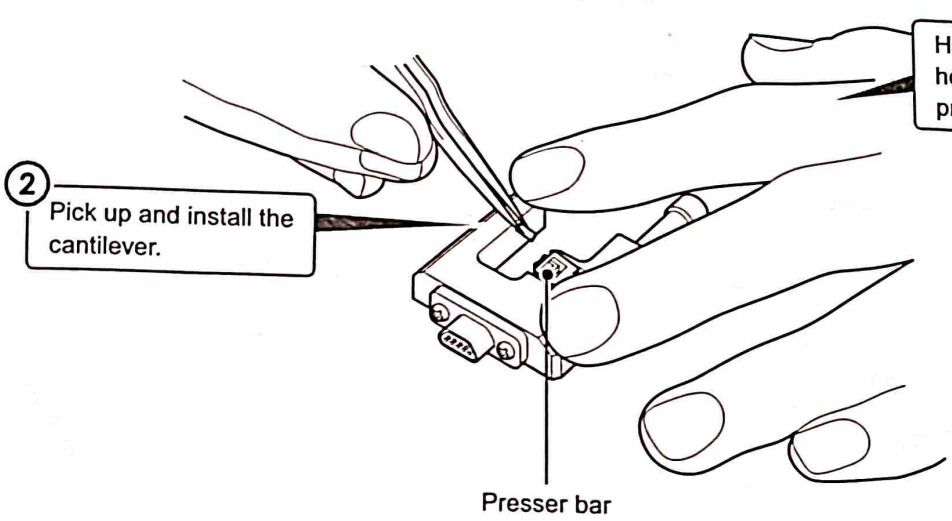


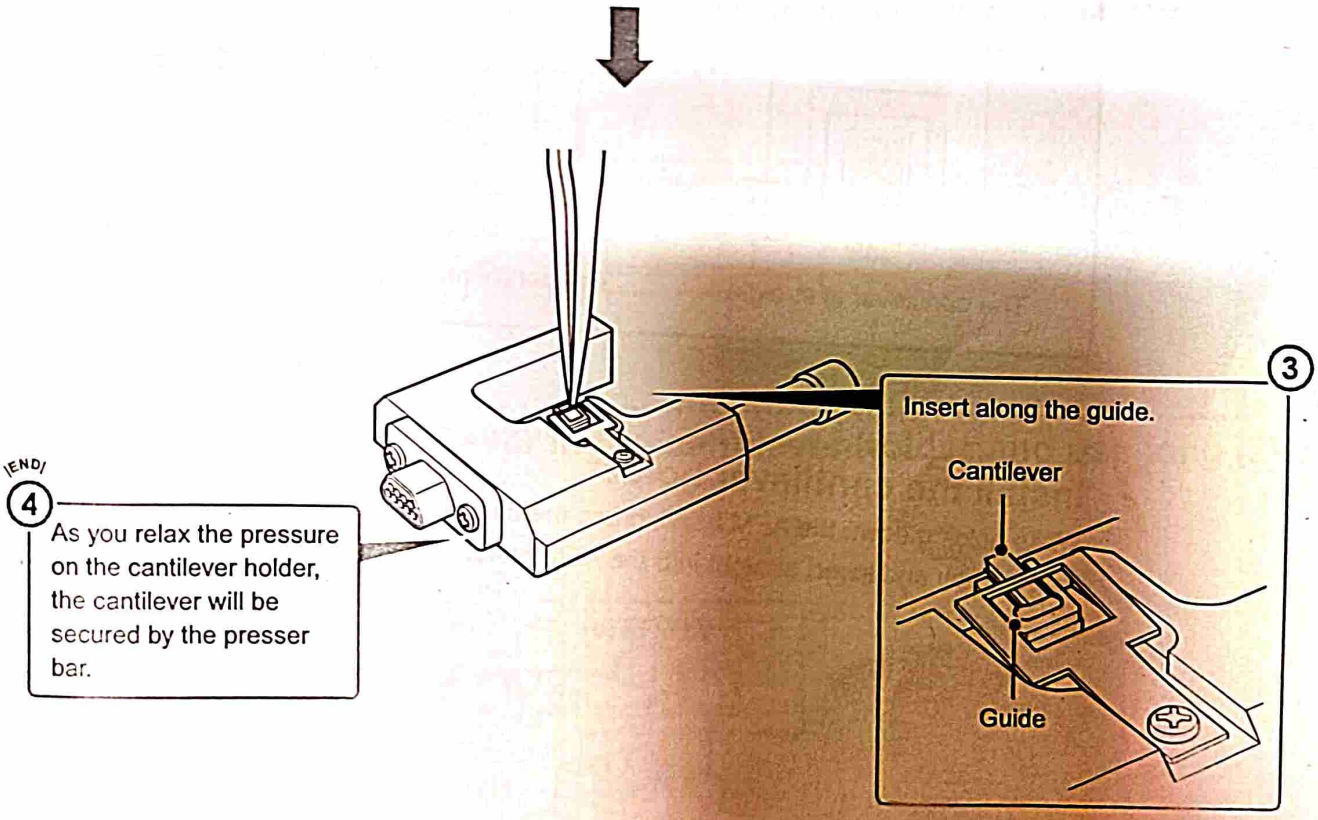
Hint When installing the cantilever, be sure to grasp the sides of the base. Do not touch the cantilever.



5 Install the cantilever in the cantilever holder.

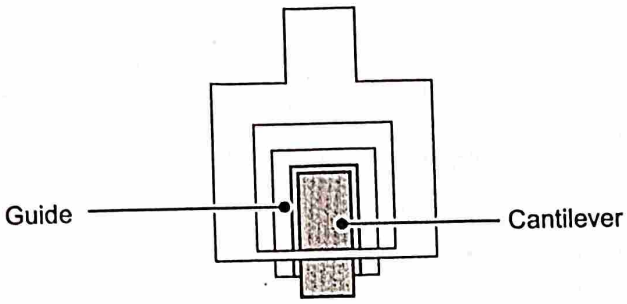
Use the pincers to install the cantilever.



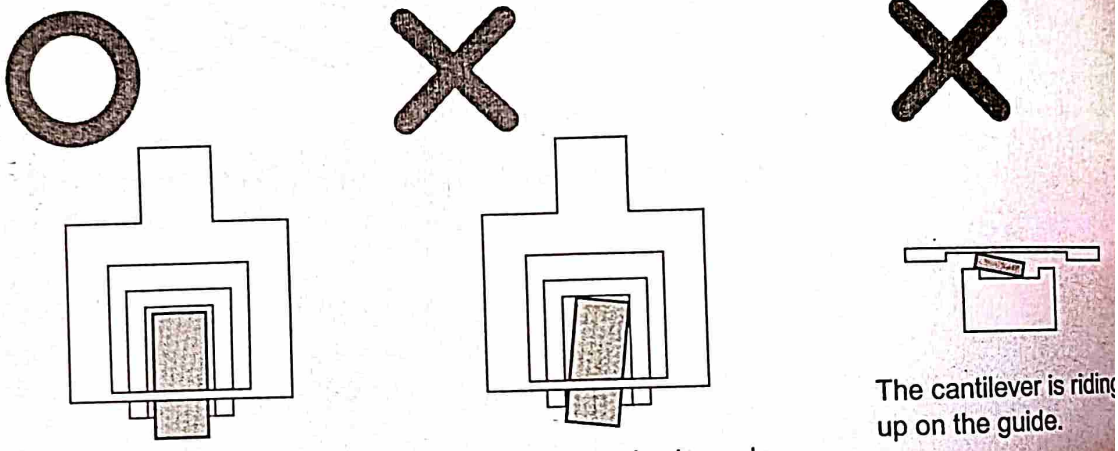


6 Check if the cantilever is correctly installed.

Check using the optical microscope.

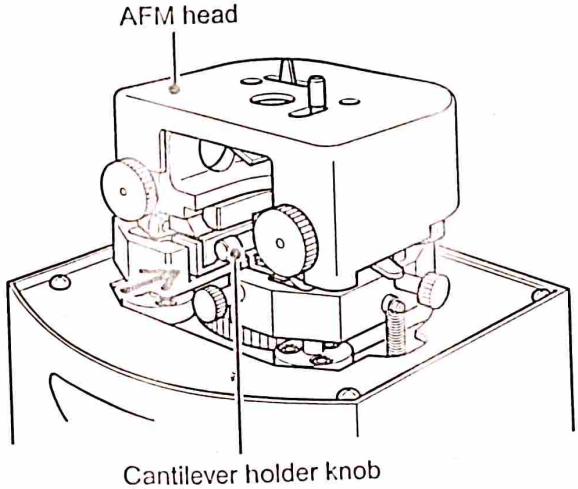


Hint Install the cantilever correctly in the cantilever holder.



7 Install the cantilever holder.

While holding down the AFM head, grasp the cantilever holder knob and insert straight into the AFM head.



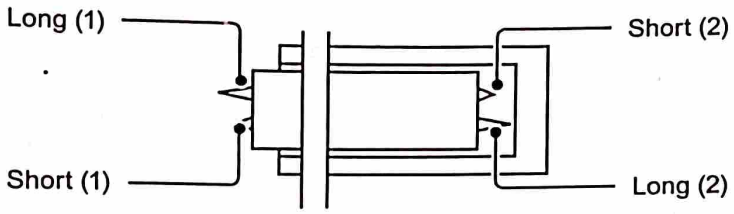
Replacing the cantilever (for contact mode)

The cantilever is a supply item. As the cantilever probes wear down, they become unable to correctly scan the sample surface and a high-quality image cannot be acquired.

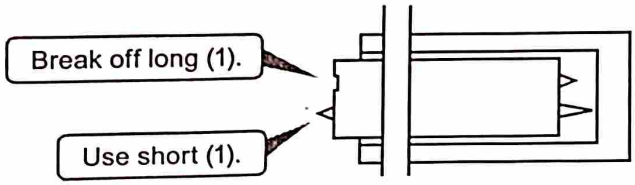
The cantilever for contact mode has four probes (long (1), long (2), short (1), and short (2)).

Follow the steps below to replace the cantilever.

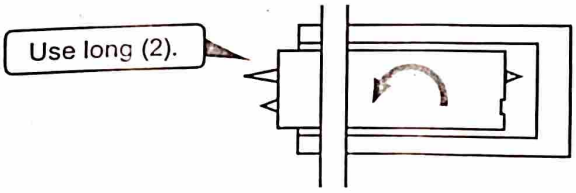
1 Use cantilever long (1).



2 While viewing long (1) through the optical microscope, break it off with the pincers and use short (1).



3 Reinstall the cantilever in the cantilever holder and use long (2) on the opposite side.



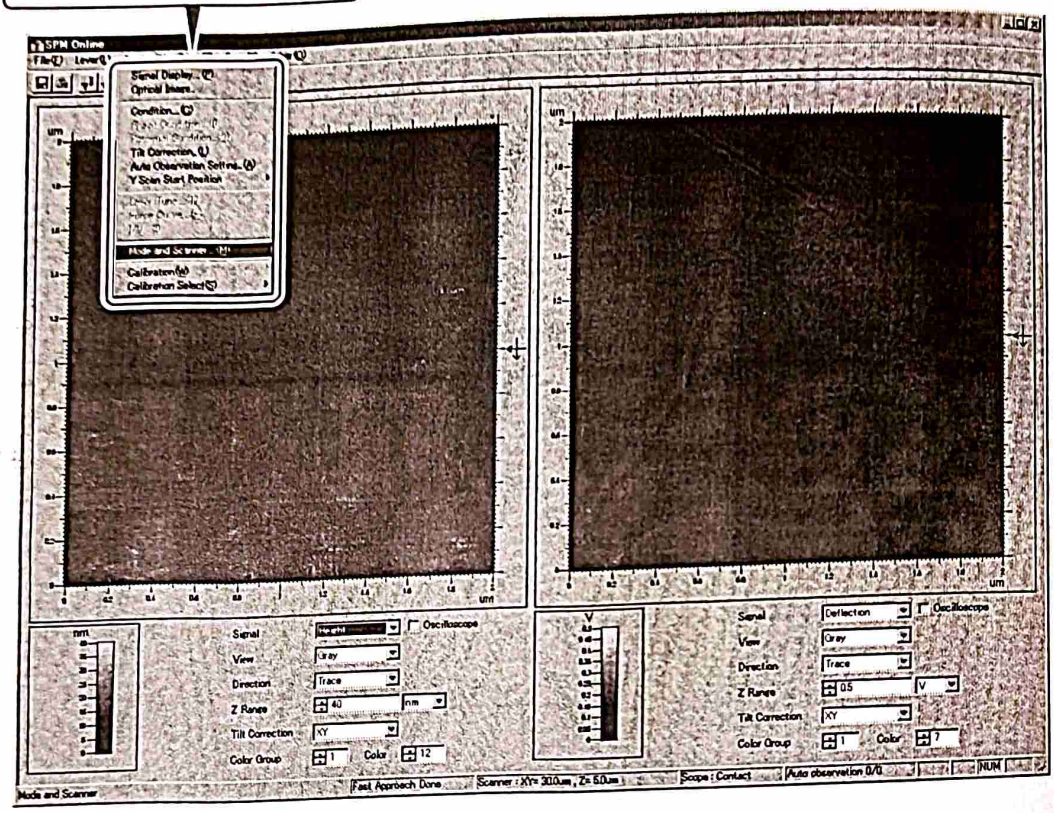
4 See step 2 to break off long (2) and use short (2).

Hint Cantilever long (1) and long (2) are easiest to handle. Until you become used to operation, it is recommended that you only use cantilever long (1) and long (2).

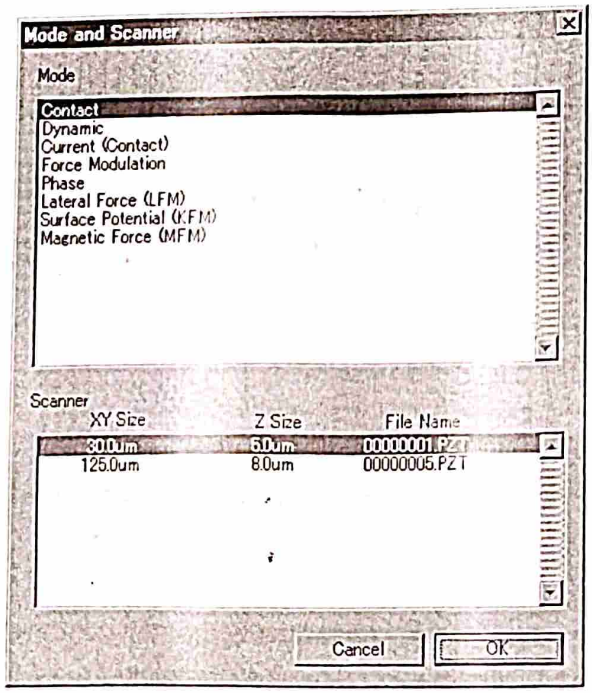
2. Selecting the Mode

1 Open the [Mode and Scanner] window.

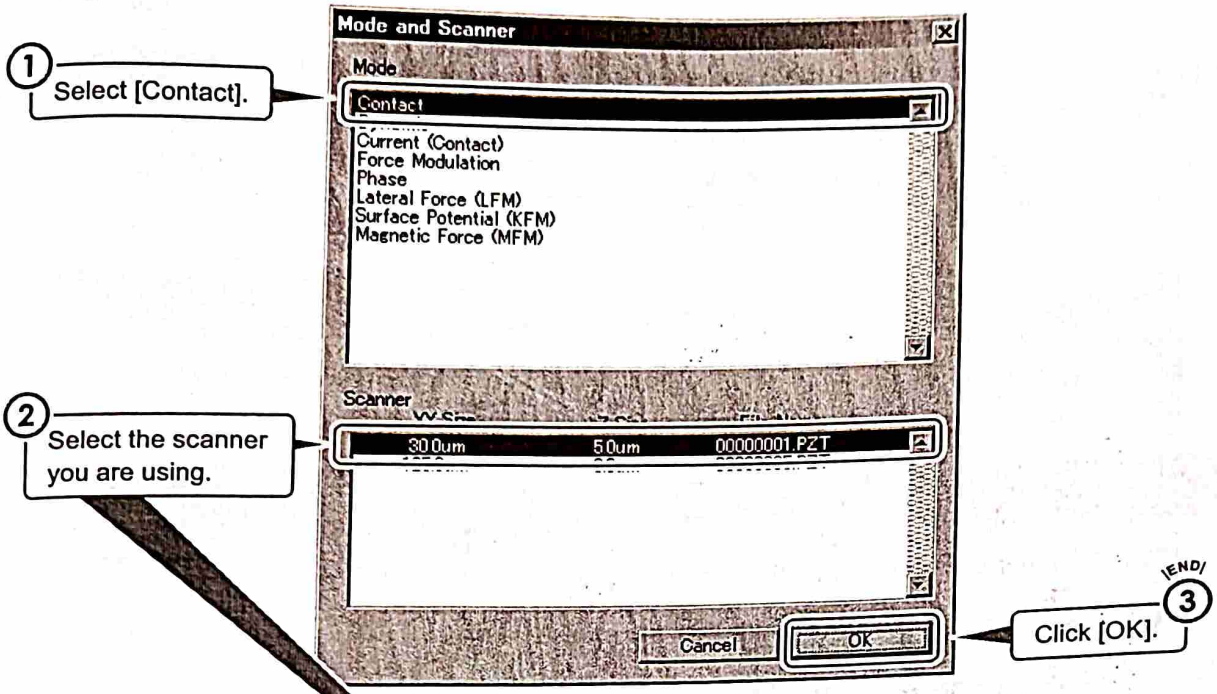
Select [Mode and Scanner] from the [Setting] menu.

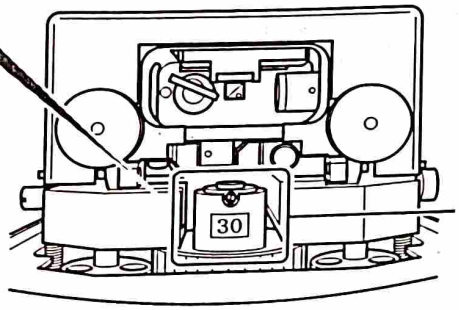


The [Mode and Scanner] window opens.

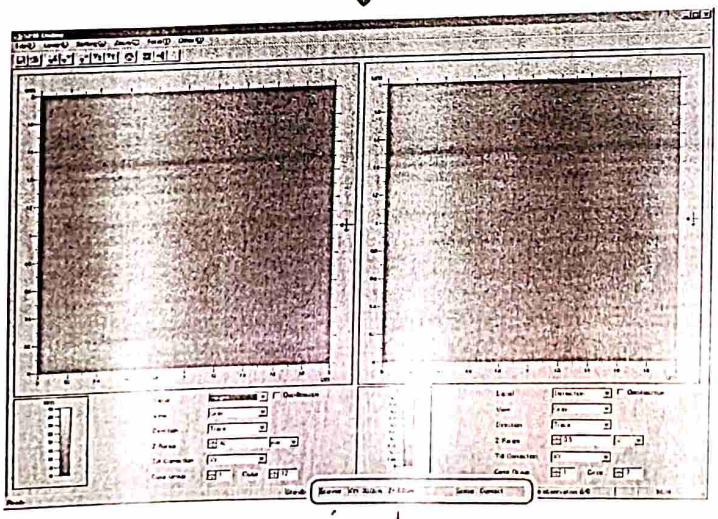


2 Select the mode and scanner.





Scanner
(30 µm × 30 µm × 5.0 µm is shown as an example.)



[Scanner] and [Scope] (mode) appear.

The above screen shows the case of [Scanner: XY = 30.0 µm, Z = 5.0 µm] and [Scope: Contact].

3. Adjusting the Optical Axis

Adjustment of the cantilever (long) is explained as an example.

Rough Adjustment

While looking through the optical microscope (option), shine the laser beam onto the cantilever. ☞Reference P.23

↓

Fine Adjustment

Perform fine adjustment so that the laser beam hits the tip of the cantilever. ☞Reference P.27

↓

Adjusting the Detector Position

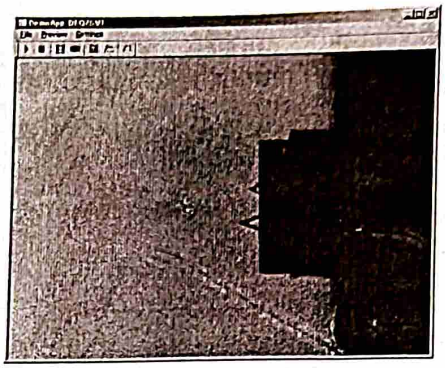
Direct the laser beam reflected off the cantilever onto the center of the detector. ☞Reference P.31

ough Adjustment

e looking through the optical microscope (option),
e the laser beam onto the cantilever.

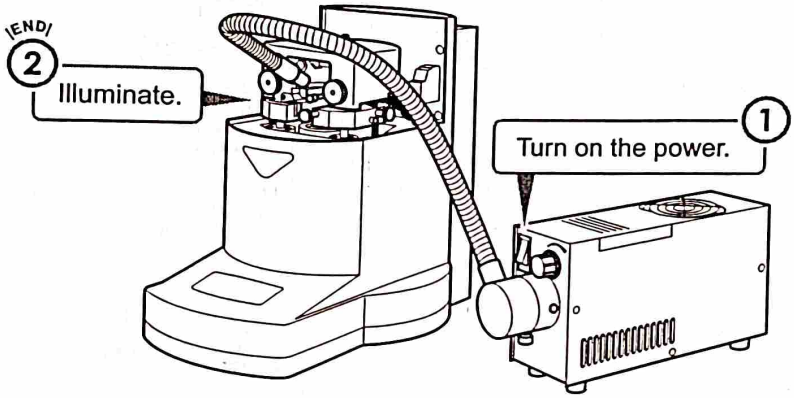
Hint

If the optical microscope is equipped with a CCD camera, an image can be displayed on the monitor of the host computer.
The following explanation assumes that the image window of the CCD camera is being used.



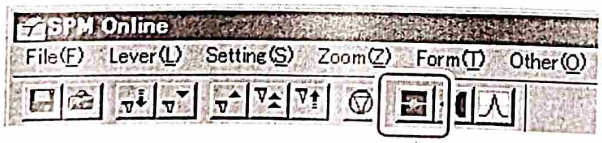
?.31

Use fiber light to illuminate the inside of the AFM head.



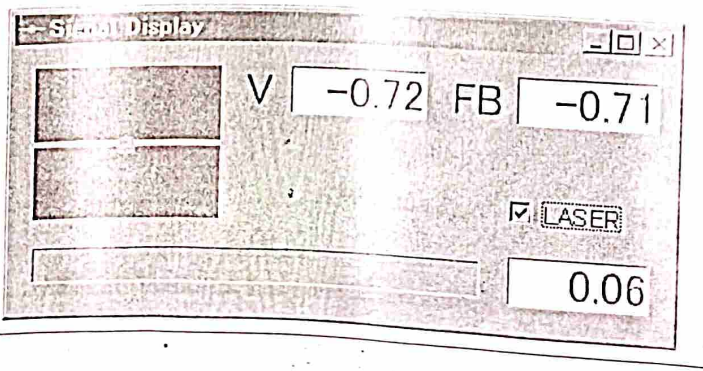
Open the [Signal Display] window.

Toolbar of the [SPM Online] window



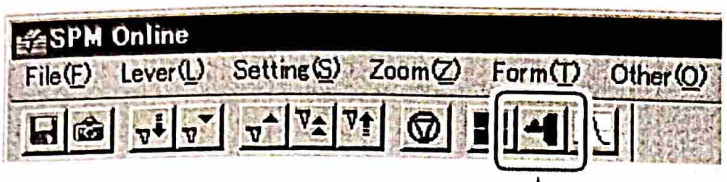
Click the [Signal Display] button.

The [Signal Display] window opens.



3 Display the CCD camera image.

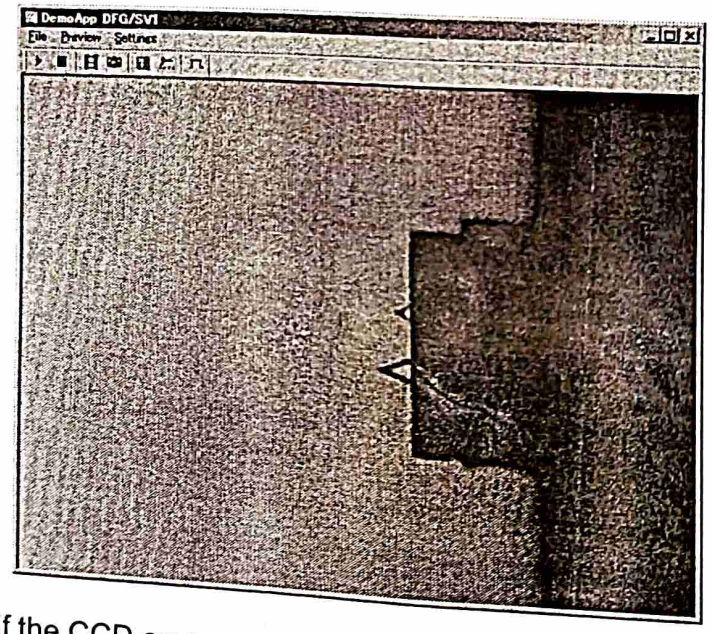
Toolbar of the [SPM Online] window



Click the [Optical Microscope Image] button.

Display the CCD camera image.
(See the manual for the software you are using.)

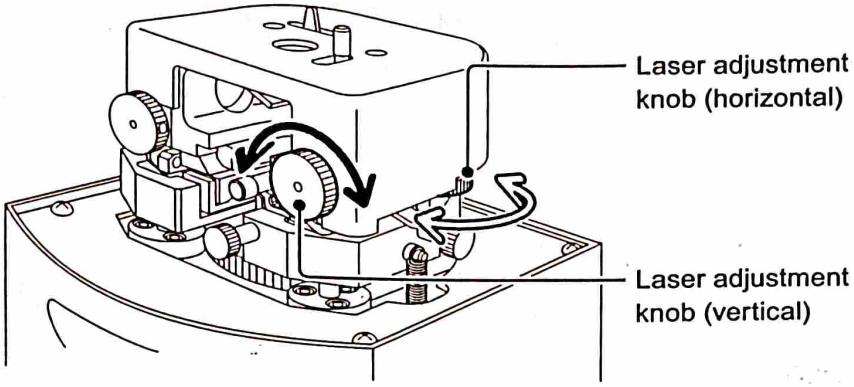
on INSPECX menu → File → select source → ok

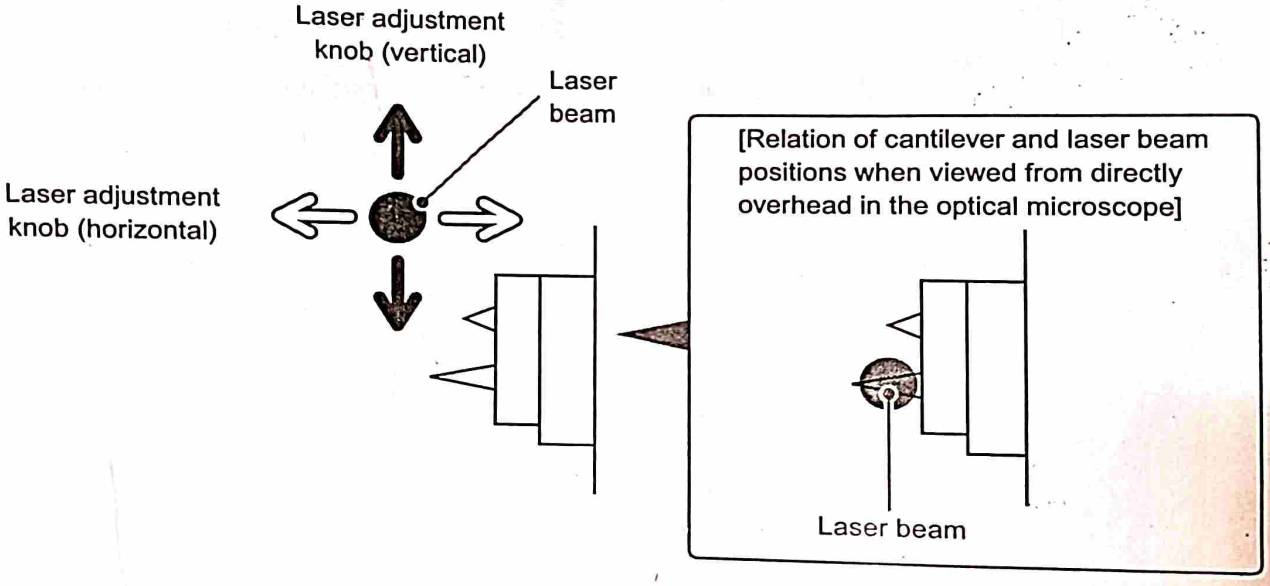


If the CCD camera image is out of focus, adjust the focus of the optical microscope.

4 Shine the laser onto the cantilever.

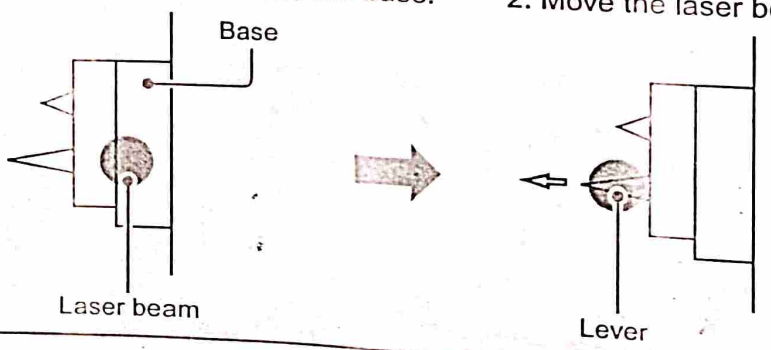
Turn the laser adjustment knobs (horizontal and vertical) to direct the laser beam onto the cantilever.



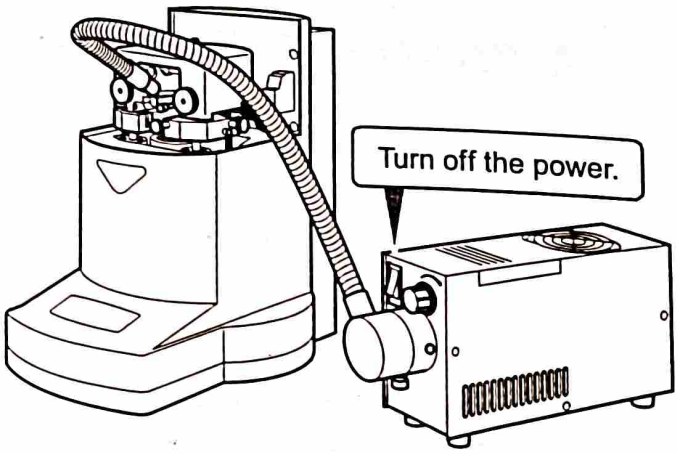


Hint By directing the laser beam onto the base of the cantilever first, it is easy to direct the laser beam onto the cantilever.

1. Direct the laser beam onto the base.
2. Move the laser beam to the lever.



5 Turn off the fiber light power.

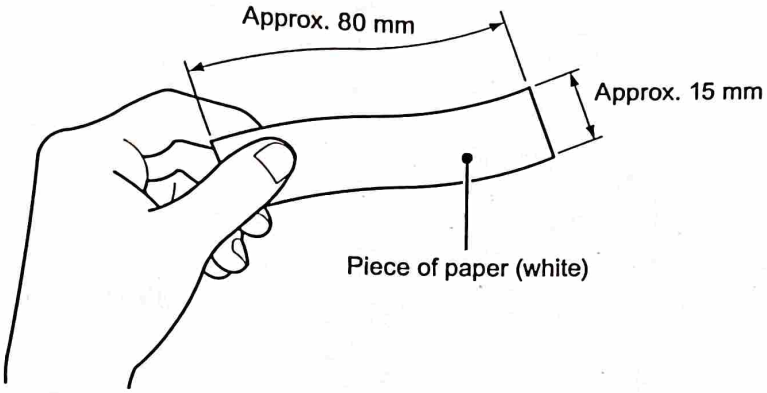


3.2 Fine Adjustment

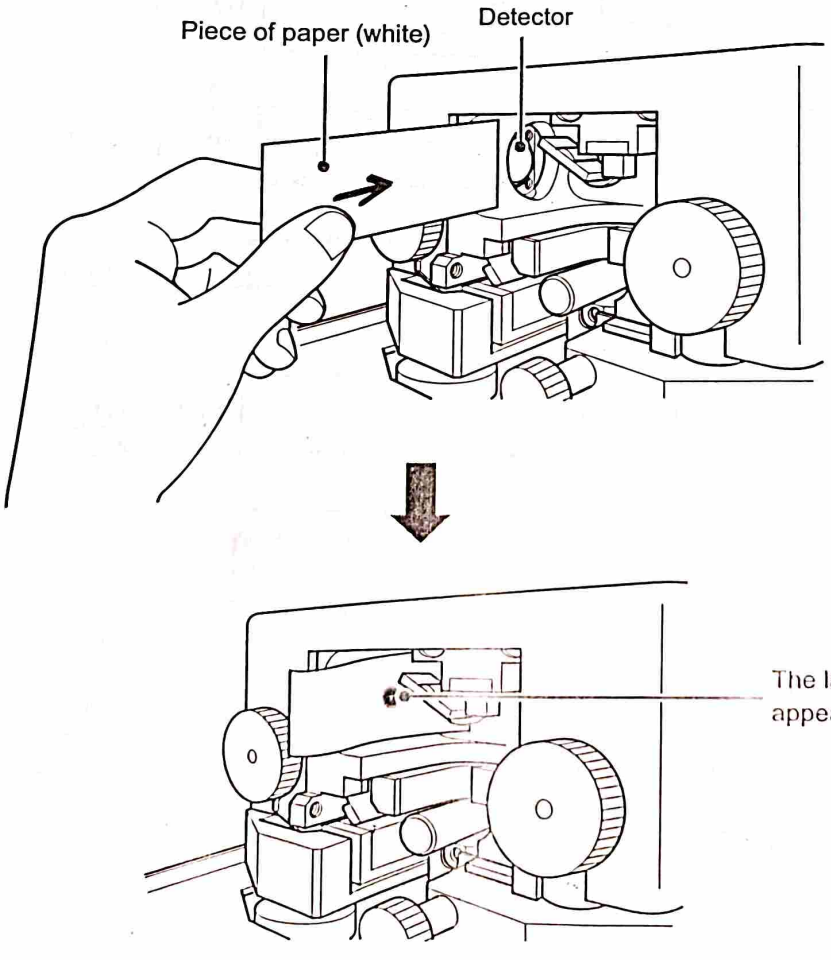
Perform fine adjustment so that the laser beam hits the tip of the cantilever.

1 Prepare a piece of paper.

Prepare a piece of white paper that is approximately 15 mm x 80 mm in size.

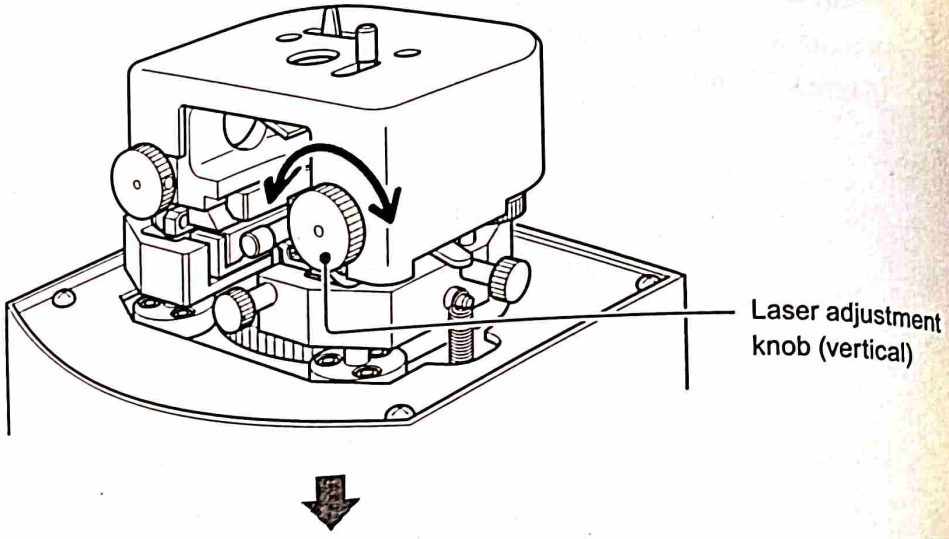


2 Place the paper in front of the detector.

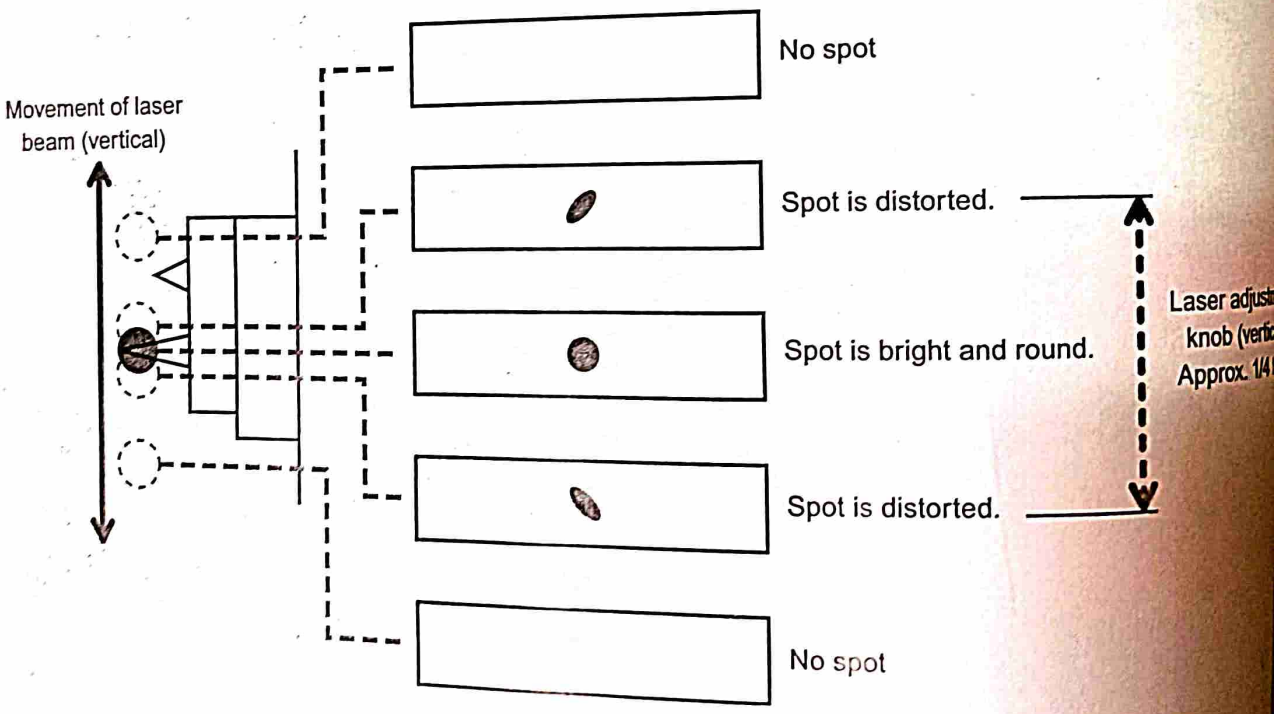


3 Adjust vertically.

Turn the laser adjustment knob (vertical) to move the laser beam in the vertical direction.



Adjust to the position where the laser beam spot is brightest and roundest on the paper.

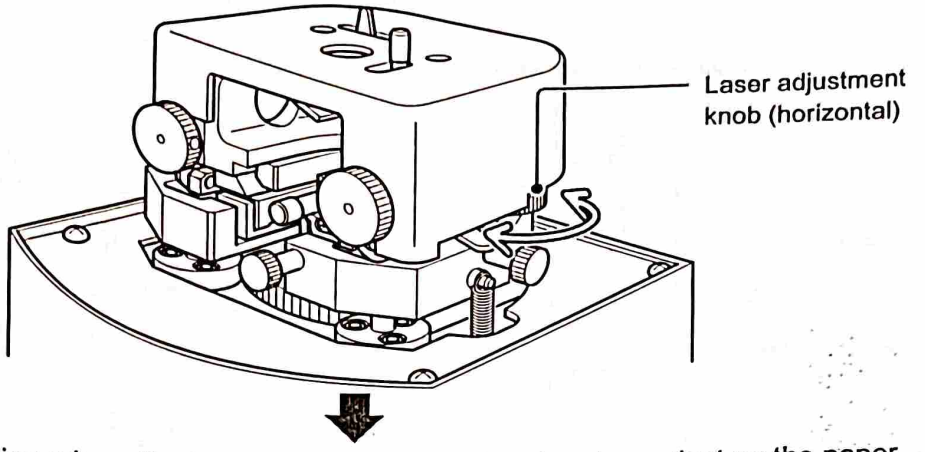


Hint If the spot does not change as shown above when the laser adjustment knob is rotated approximately 1/4 turn, it is possible that the laser beam is not hitting the cantilever. In that case, repeat rough adjustment.

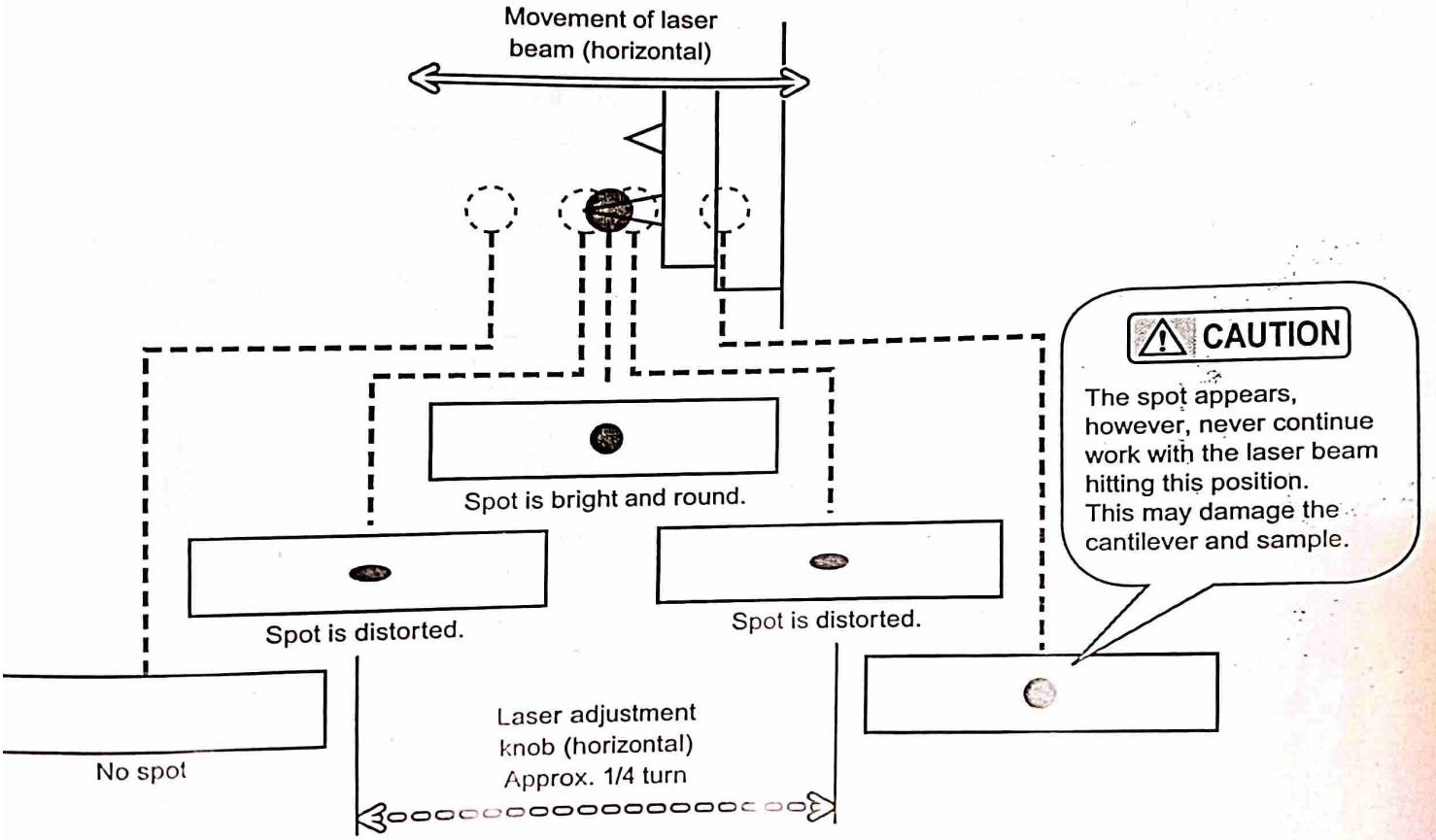
Reference "Chapter 2 3.1 Rough Adjustment" P.23

4 Adjust horizontally.

Turn the laser adjustment knob (horizontal) to move the laser beam in the horizontal direction.



Adjust to the position where the laser beam spot is brightest and roundest on the paper.

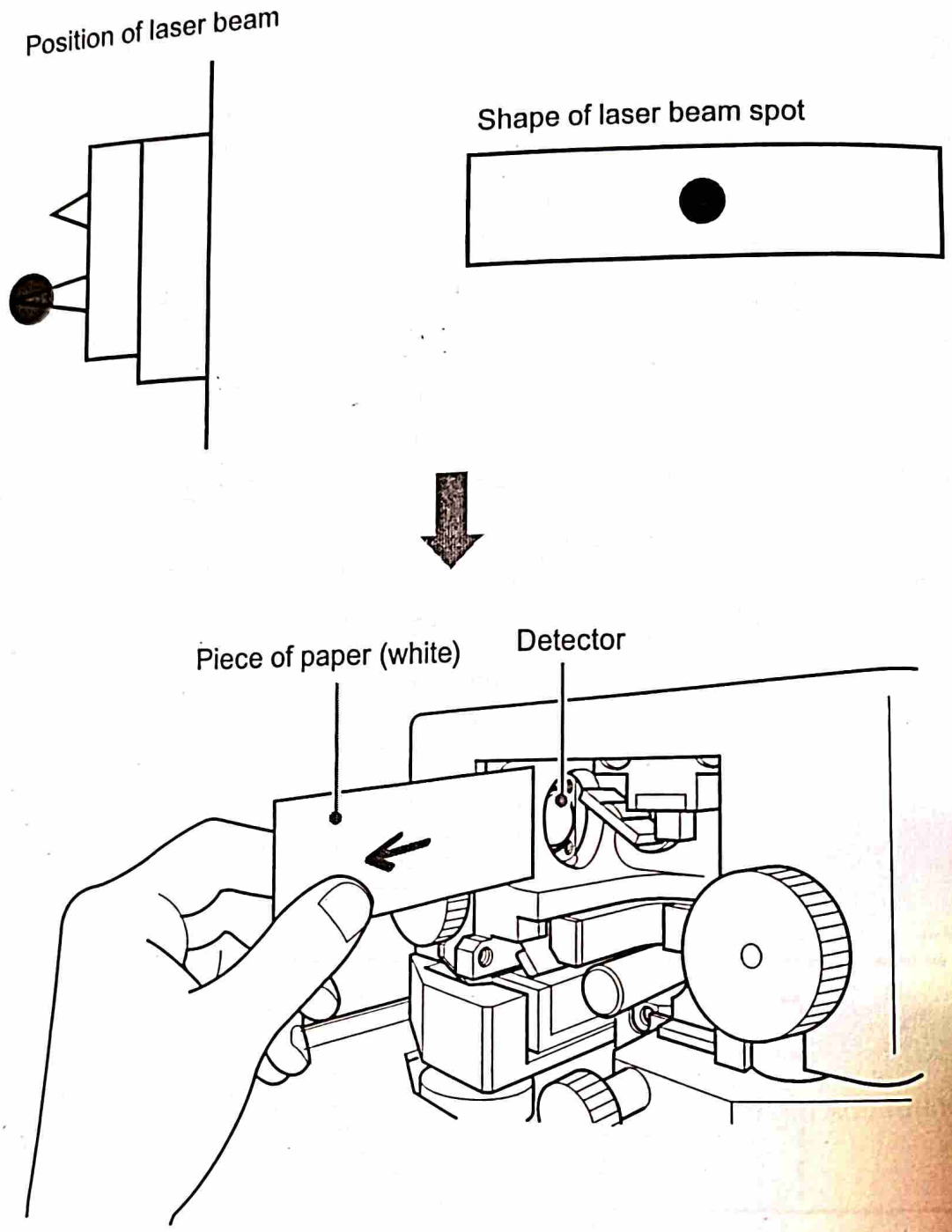


Hint If the spot does not change as shown above when the laser adjustment knob is rotated approximately 1/4 turn, it is possible that the laser beam is not hitting the cantilever. In that case, repeat rough adjustment.

Reference "Chapter 2 3.1 Rough Adjustment" P.23

5 Remove the piece of paper.

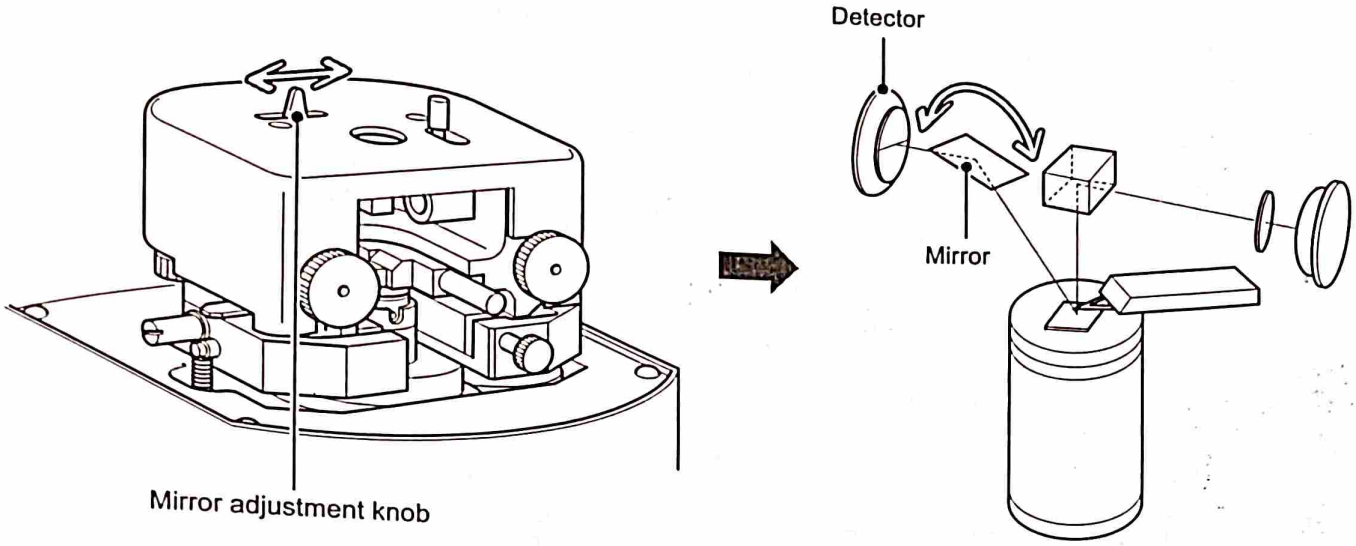
When the laser beam shines on the correct position on the cantilever, remove the piece of paper that was placed in front of the detector.



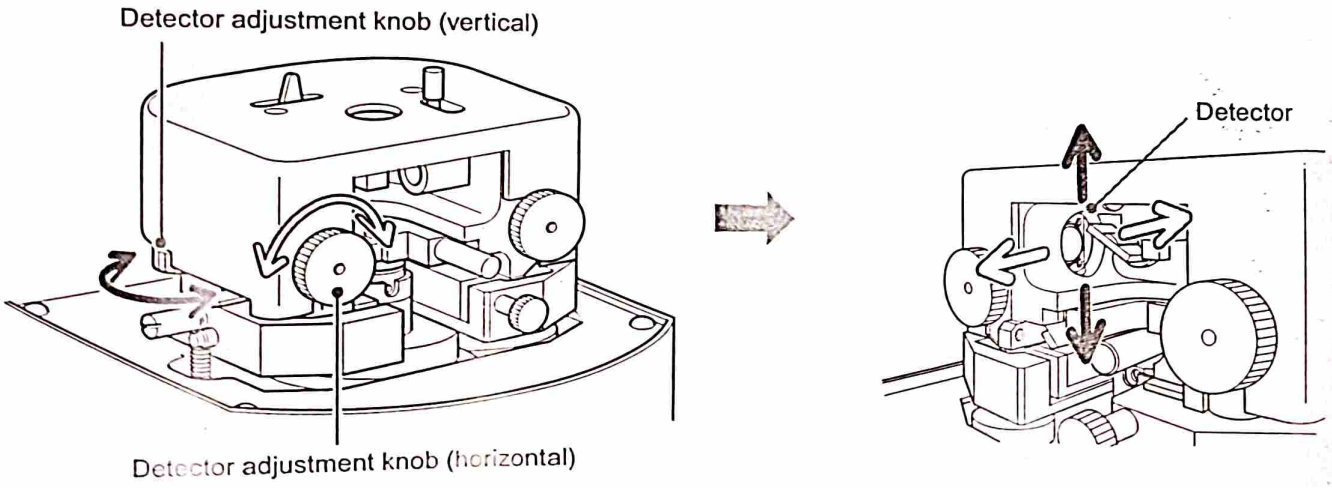
3.3 Adjusting the Detector Position

Direct the laser beam reflected off the cantilever onto the center of the detector.

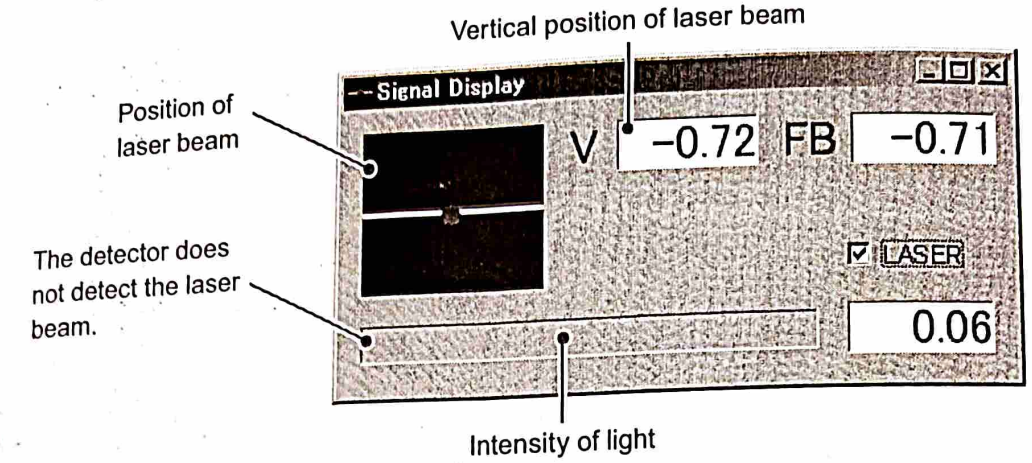
- The angle of the mirror can be adjusted with the mirror adjustment knob.

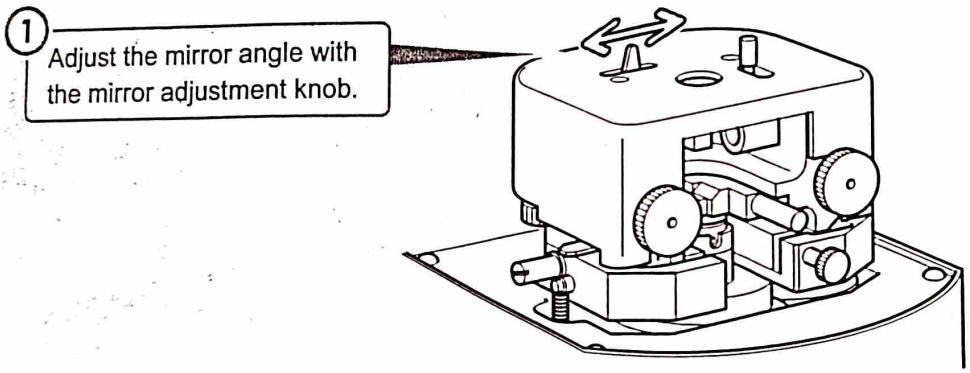


- The position of the detector can be adjusted by turning the detector adjustment knob (vertical).

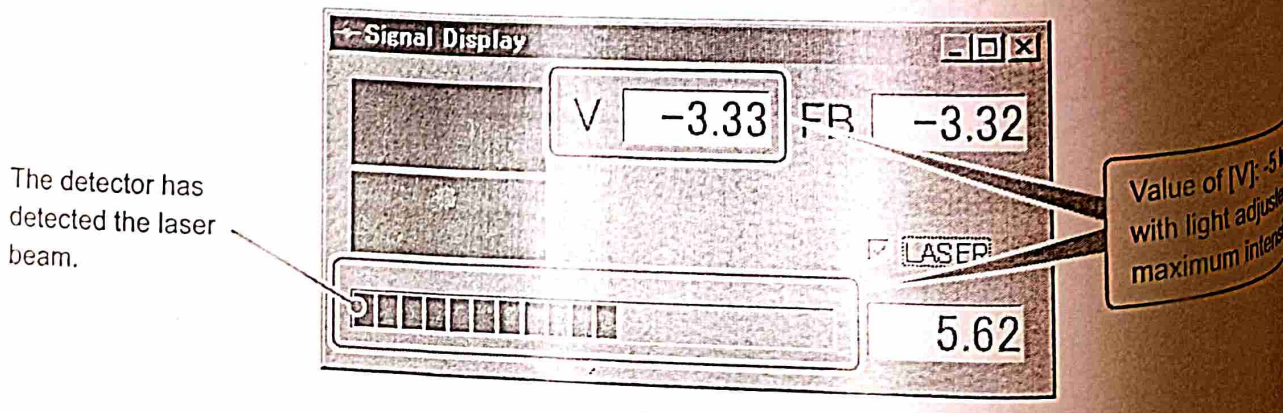


1 Adjust the mirror with the mirror adjustment knob.



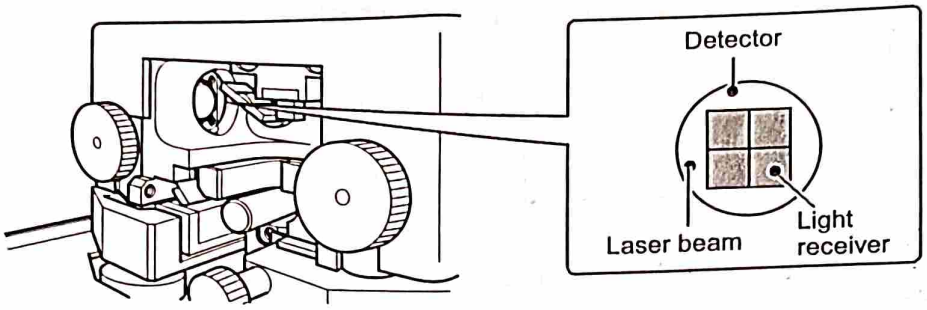


The detector detects the laser beam. The vertical position of the laser beam and the intensity of the light are displayed.

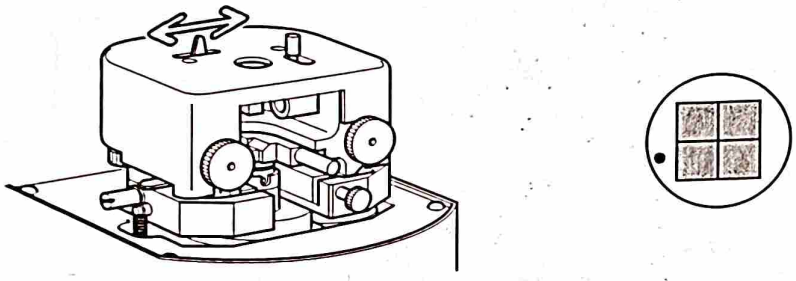


Hint If the laser beam is not detected even after adjustment with the mirror adjustment knob

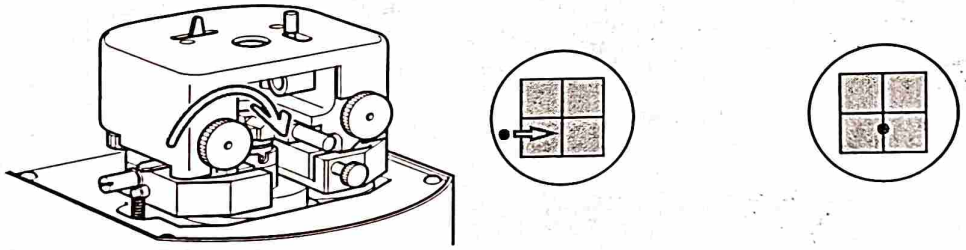
The detector may be far out of position horizontally, preventing the laser beam from entering the light receiver.



1. Use the mirror adjustment knob to move the laser beam close to the outer frame of the detector.

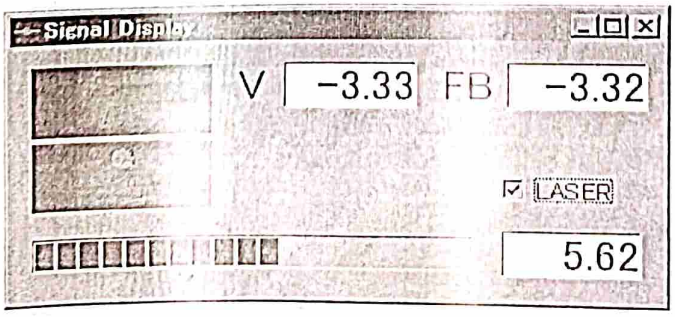


2. Turn the detector adjustment knob (horizontal) so that the laser beam hits the indicated part of the outer frame of the detector.



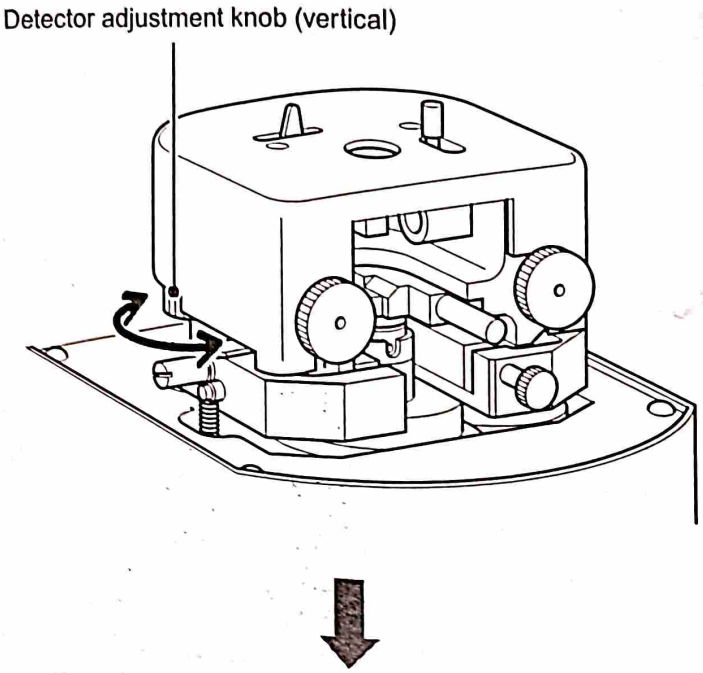
3. Use the mirror adjustment knob to move the laser beam onto the light receiver of the detector.

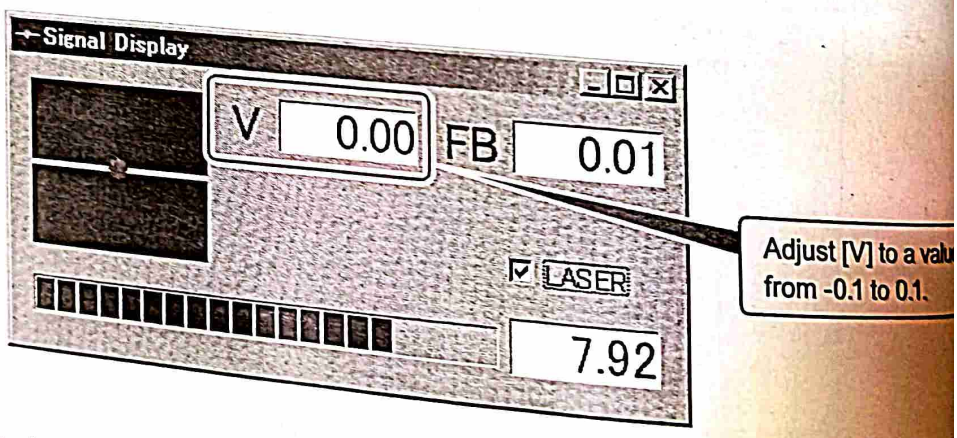
4. Once the laser beam is detected, use the mirror adjustment knob and detector adjustment knob (vertical) to adjust the vertical direction of the detector.



2 Adjust by turning the detector adjustment knob.

Turn the detector adjustment knob (vertical) to perform fine adjustment of the [V] value.



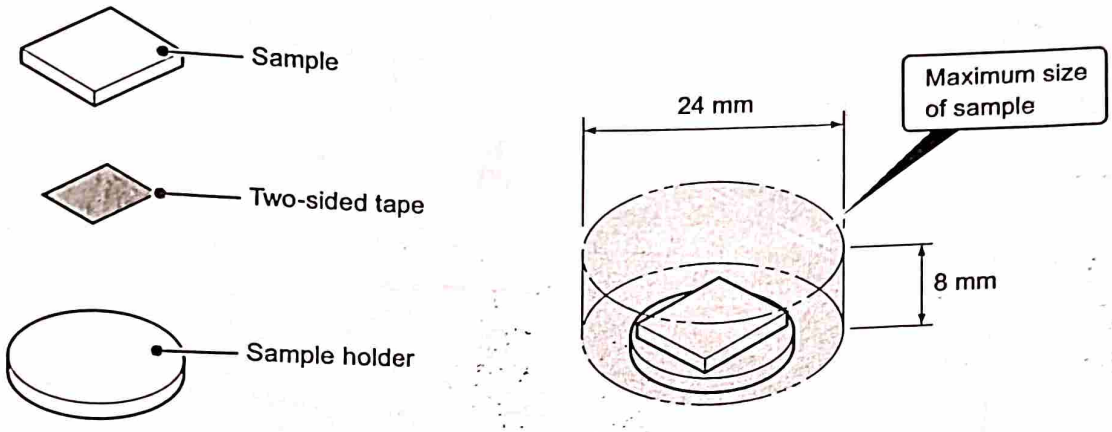


By means of the above steps, the light reflected from the cantilever is adjusted to enter the center of the detector.

4. Attaching the Sample

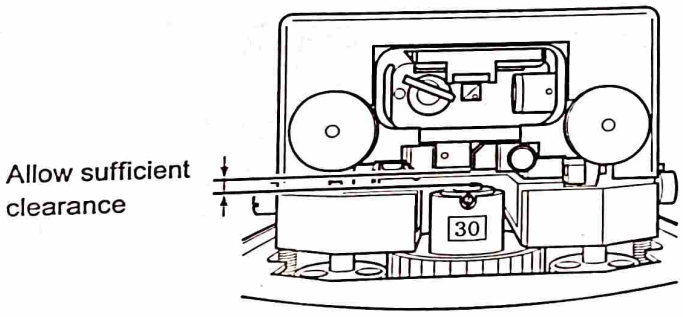
1 Affix the sample to the sample holder.

Use two-sided tape or other means to affix the sample to the center of the sample holder, keeping it as flat as possible.

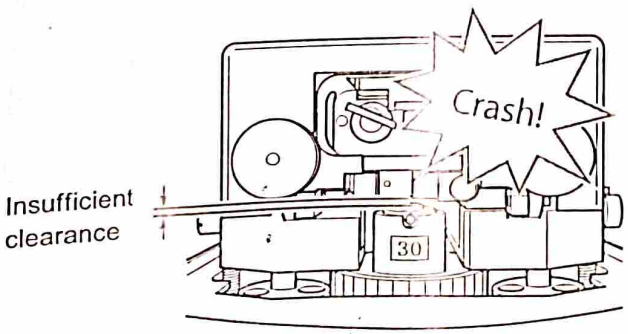


2 Make sure there is sufficient clearance between the sample table and the cantilever.

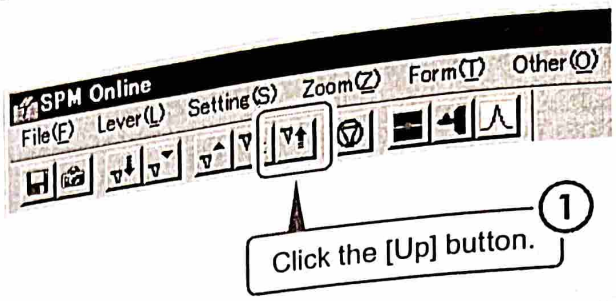
Verify that the sample fits into the gap between the sample table and the cantilever.



⚠ CAUTION Allow sufficient clearance between the sample table and the cantilever. Otherwise, the cantilever may be damaged.

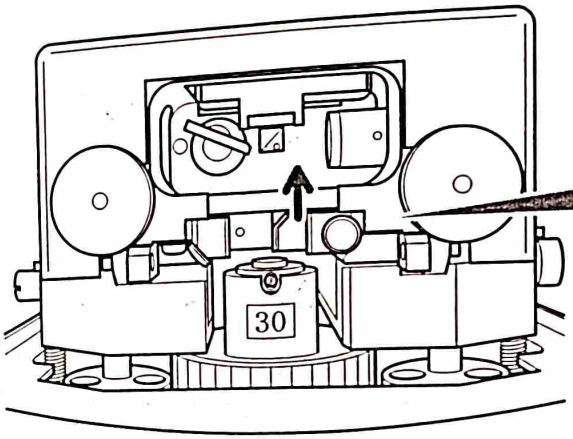


To increase the clearance between the sample table and the cantilever

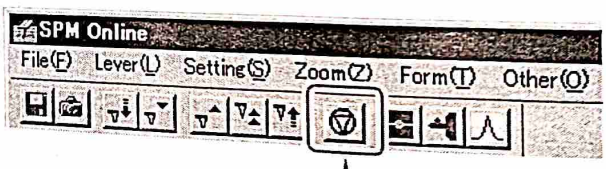


Click the [Up] button. ①

The cantilever rises.

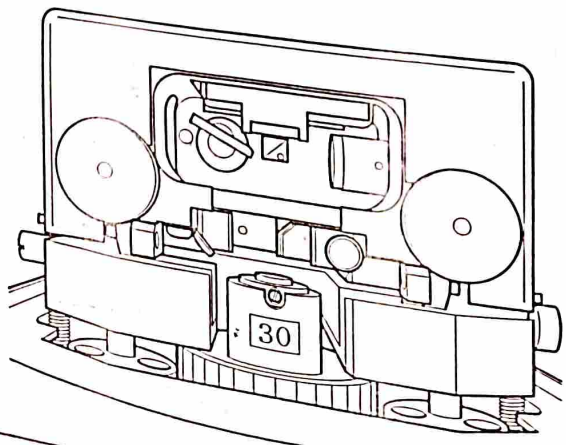


Make sure that the cantilever is sufficiently clear of the sample table. ②

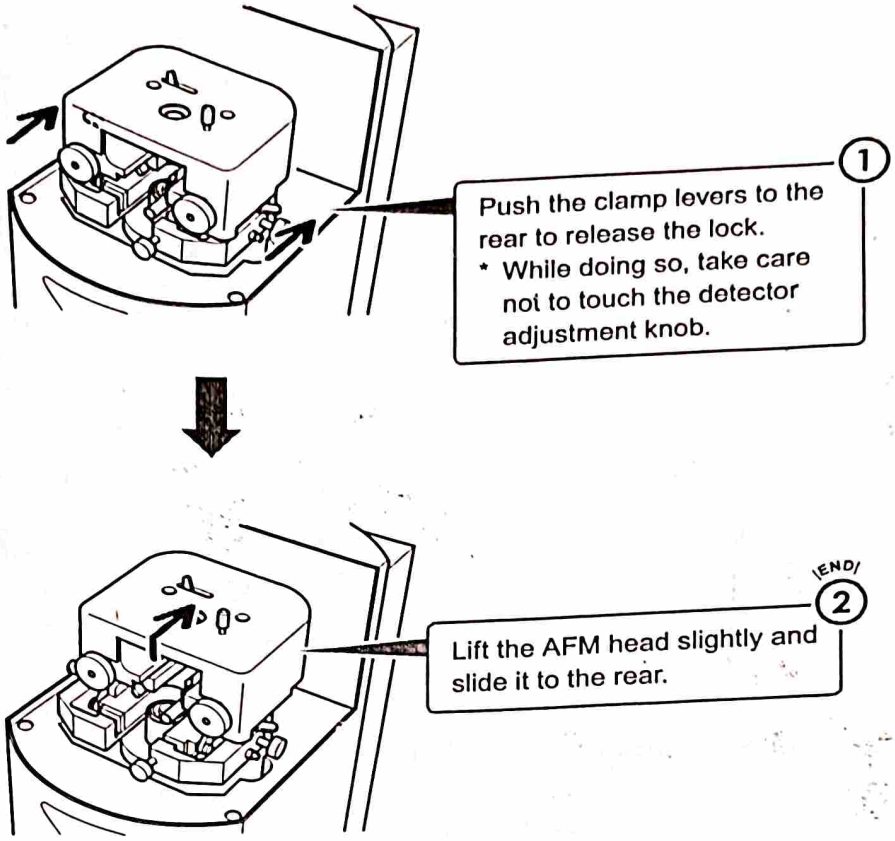


Click the [Stop] button. [END] ③

The cantilever stops rising.

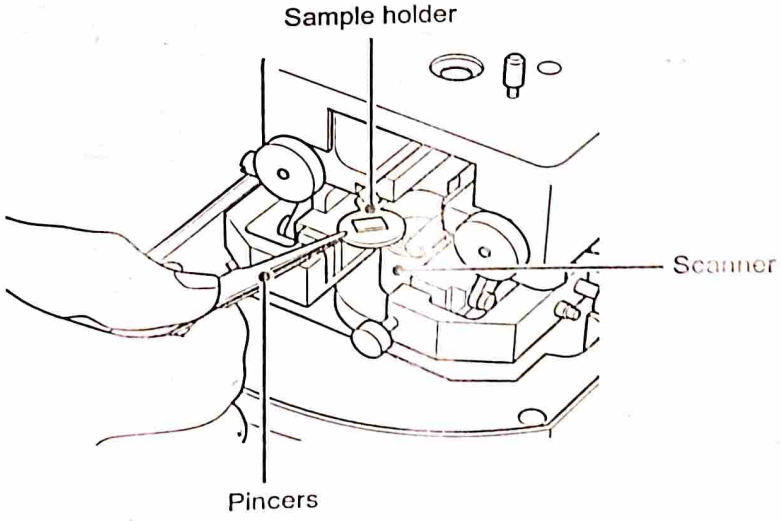


3 Slide the AFM head to the rear.

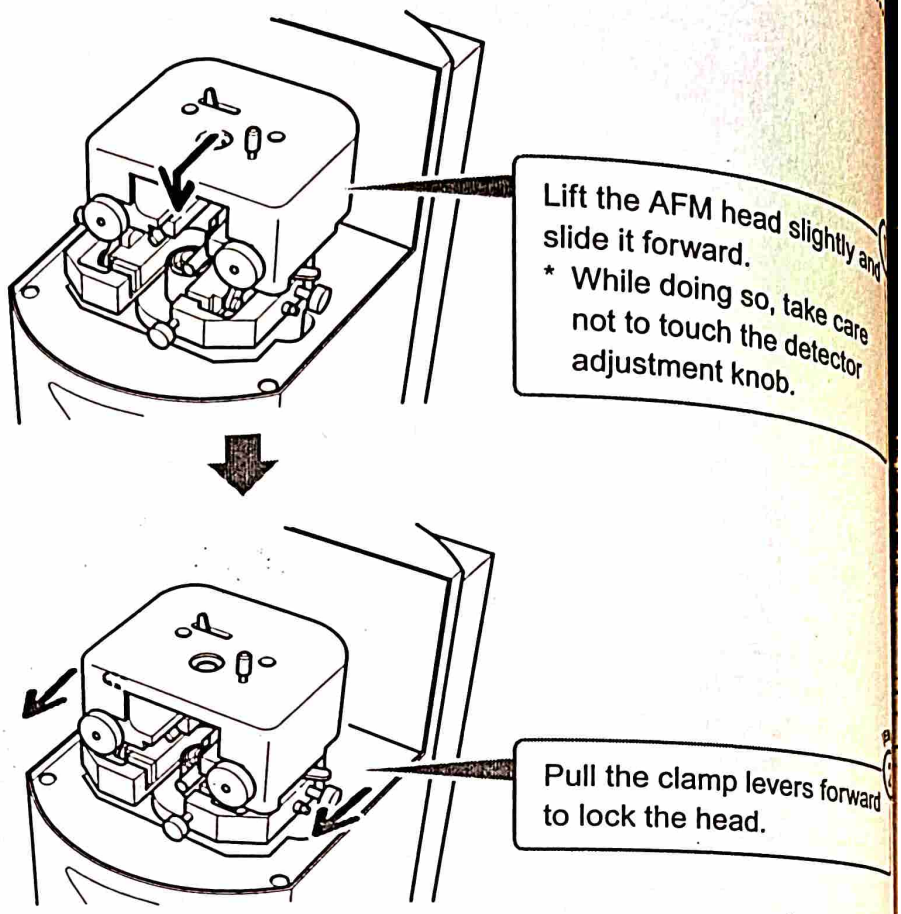


4 Insert the sample holder.

Use pincers to place the sample holder in the scanner.

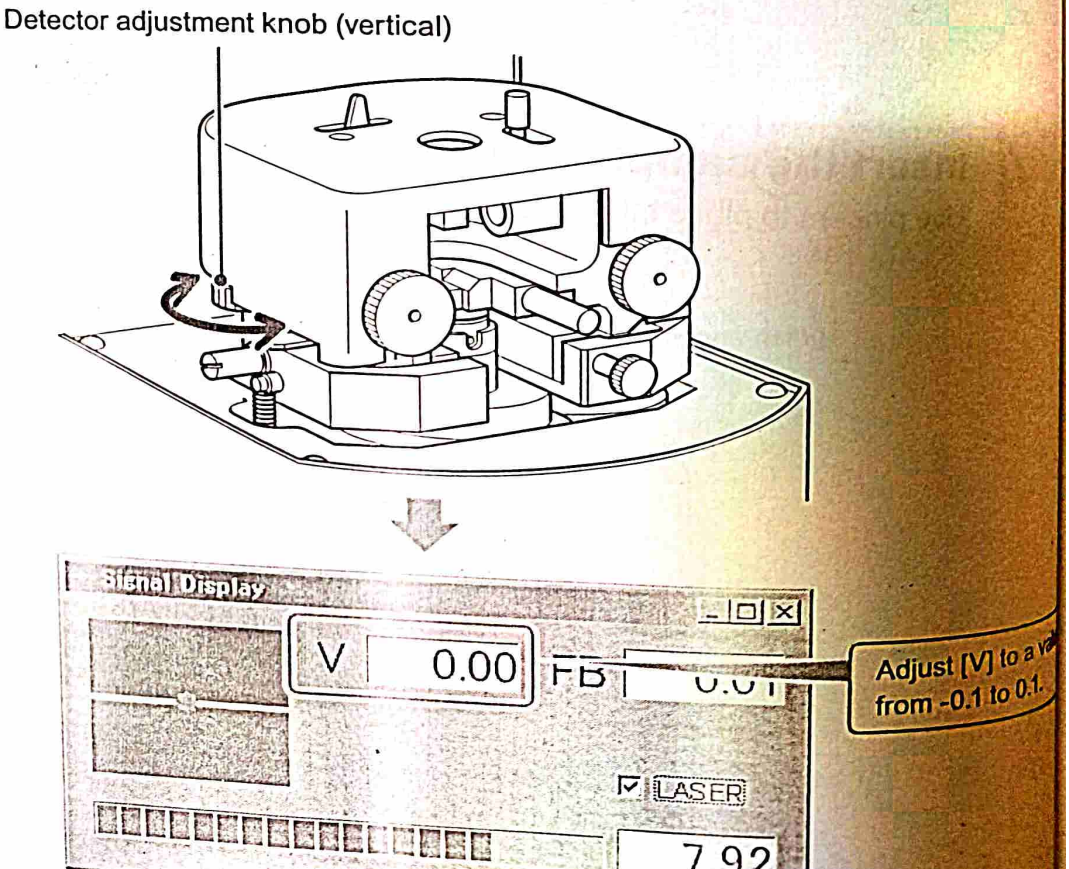


5 Slide the AFM head forward.



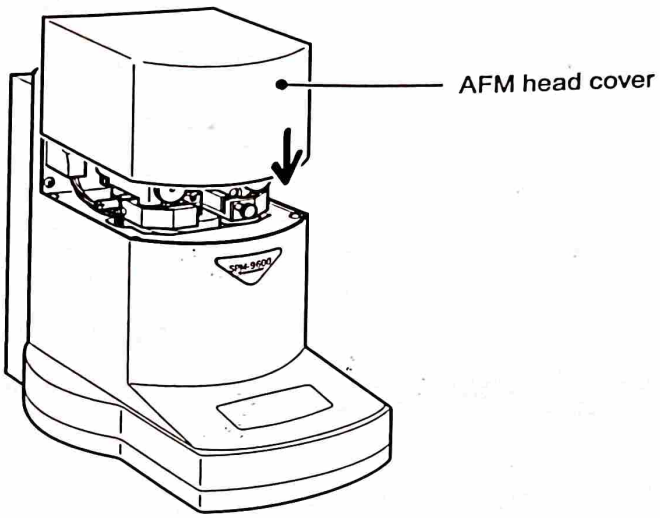
6 Check the signal display.

If the value of [V] in the [Signal Display] window differs greatly from 0, readjust the value of [V].



7 Attach the AFM head cover.

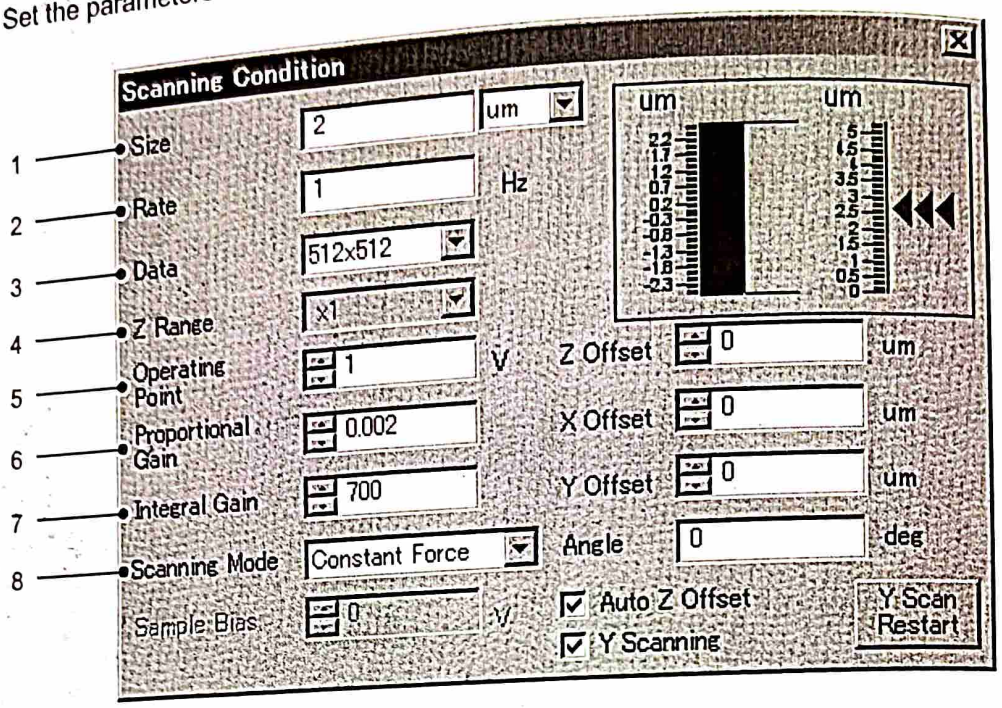
Air movement hitting the AFM head may distort the image. In this case, attach the AFM head cover.



This completes the placement of the sample.

5. Parameter Settings

Set the parameters in the [Scanning Condition] window.



	Parameter	Description	Recomm value at scan
1	Size	The area of the sample surface scanned by the probe (field of vision), indicated as lengths along the X and Y axes.	
2	Rate	The scanning speed for one line expressed as a frequency. When one line is scanned (back and forth) in one second, the rate is 1 Hz.	*
3	Data	Specify the number of pixels of data that is acquired.	256×256
4	Z range	By restricting the dynamic range of the Z feedback signal of the scanner, the feedback resolution is increased. ×1: Feedback from the entire Z range of the scanner is possible. ×2: Feedback is possible over only half the range, but the feedback resolution is doubled. When scanning a relatively flat sample, increasing this sensitivity enables scanning at a higher resolution. If digital bits start appearing in the vertical direction of the waveform when the [Height] signal is monitored in the oscilloscope display, increase the Z range.	×1
5	Operating Point	The force that acts on the sample and probe. In contact mode, the larger this value is, the larger the pressing force.	1 to 2 V
6	Proportional Gain	Indicates the proportional gain with respect to the control signal. A large value is desirable, however, oscillation will occur if the value is too large. Usually the largest value at which oscillation does not occur is set.	0.001

	Parameter	Description	Recommended value at start of scanning
7	Integral Gain	Indicates the integral gain with respect to the control signal. A large value is desirable, however, oscillation will occur if the value is too large. Usually the largest value at which oscillation does not occur is set.	500 to 1200 *
8	Scanning Mode	Select whether or not feedback control is applied to scanning. Constant Force :Feedback is applied, and the sample surface shape is output in the height signal. Constant Height :Feedback is not applied and the current height is held. The sample surface shape is output in the deflection signal.	Constant Force

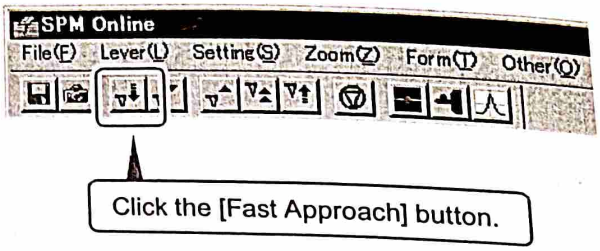
* The rate and integral gain at the start of scanning vary depending on the size.

Start with the conditions below and adjust as you scan.

Size	Rate	Integral Gain
1 to 5 µm	1 Hz	500
5 to 10 µm	1 to 0.8 Hz	800
10 to 20 µm	0.8 to 0.6 Hz	1000
20 to 30 µm	0.6 to 0.4 Hz	1200

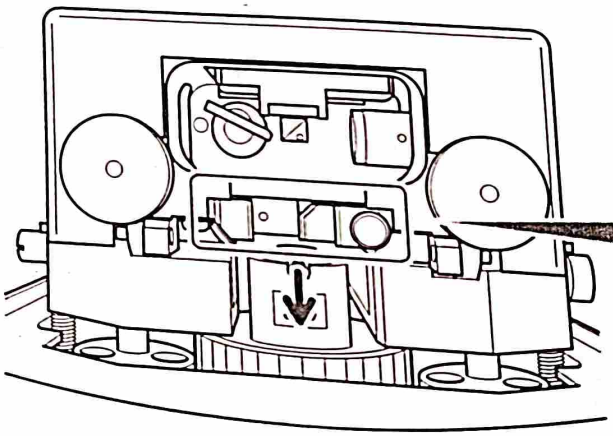
6. Starting Scanning

1 Bring the cantilever close to the sample surface.

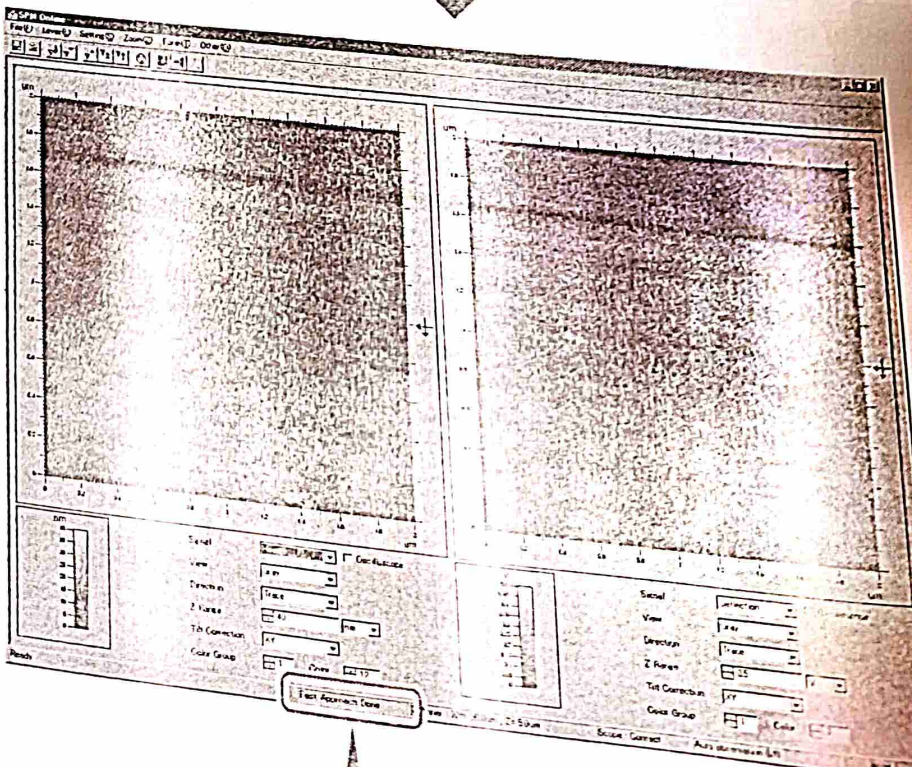


Click the [Fast Approach] button.

Fast approach begins.



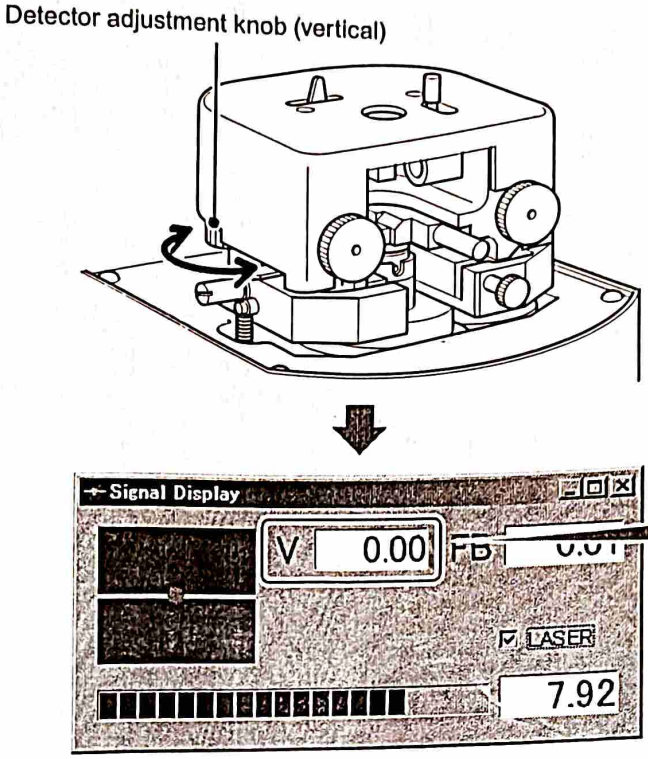
The canti
moves to
10 µm fr



[Fast Approach Done] appears.

2 Check the signal display.

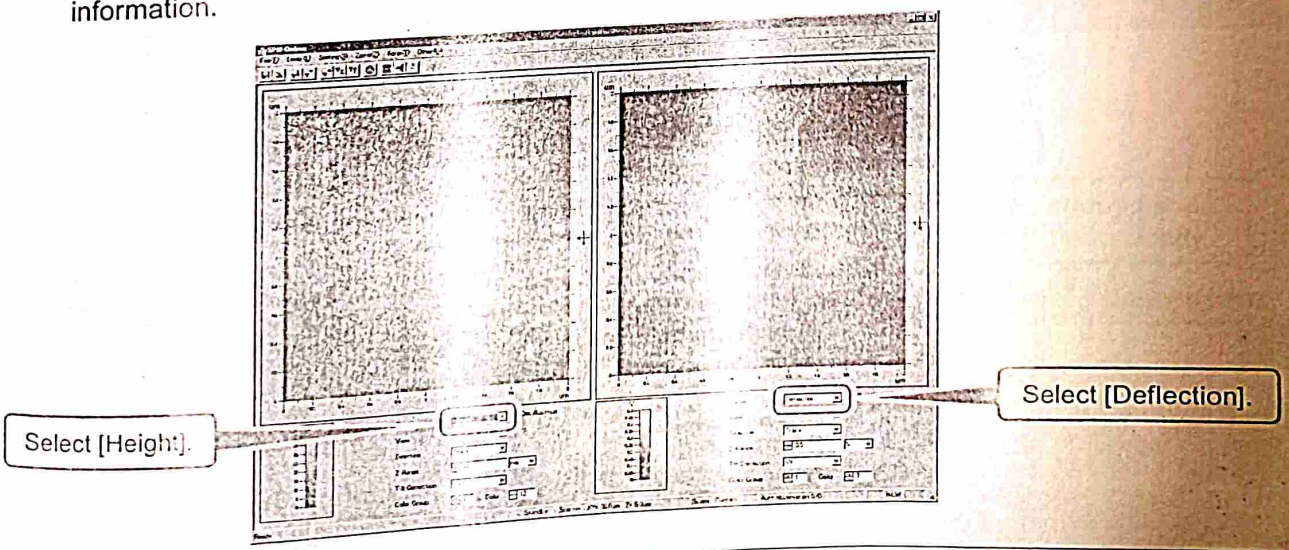
If the value of [V] in the [Signal Display] window is outside the range -0.1 to 0.1, adjust once again.



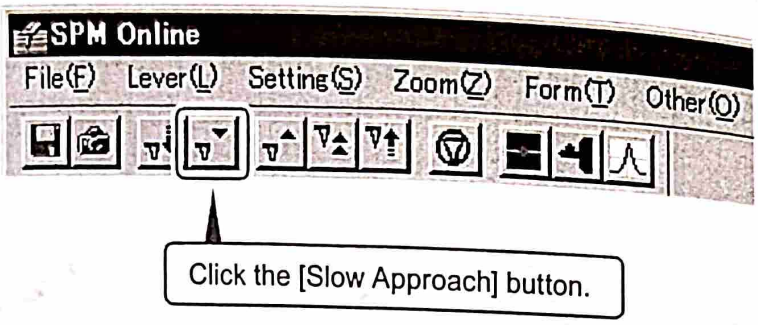
Hint If fast approach ends with a value of [V] that has deviated from 0, it is possible that static electricity on the sample surface affected the cantilever. In this case, the cantilever may not have come in close proximity to the sample surface.
Readjust the value of [V] to -0.1 to 0.1 and then repeat fast approach.

3 Set the signals.

Select [Height], which is sample surface height information, and [Deflection], which is feedback error information.

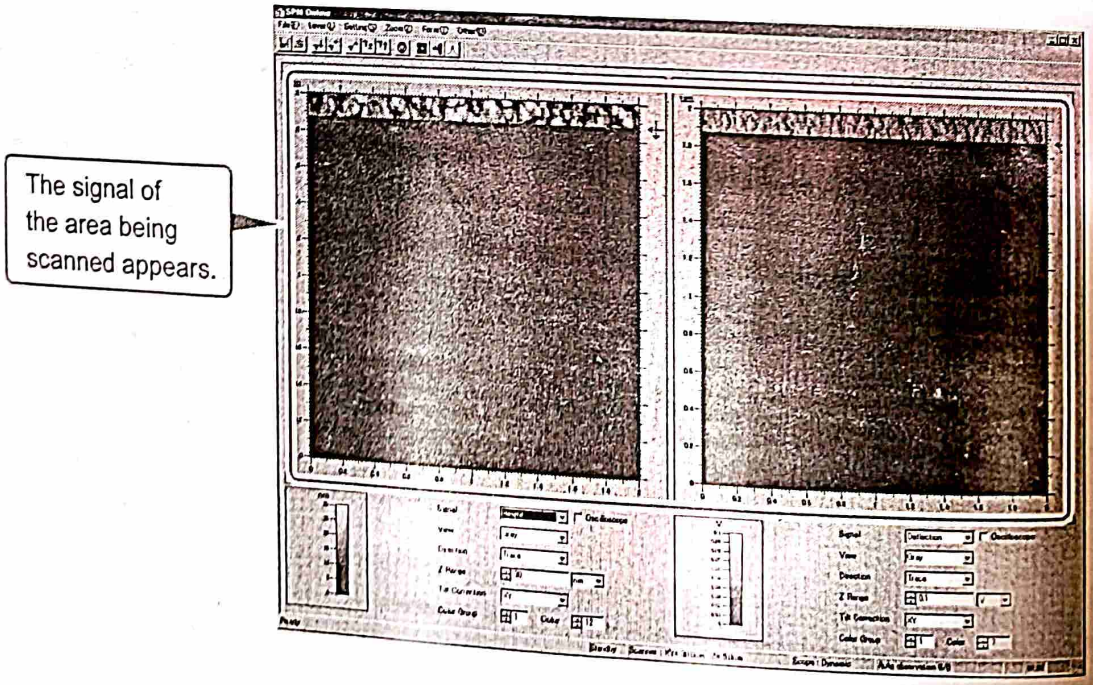


4 Start scanning.



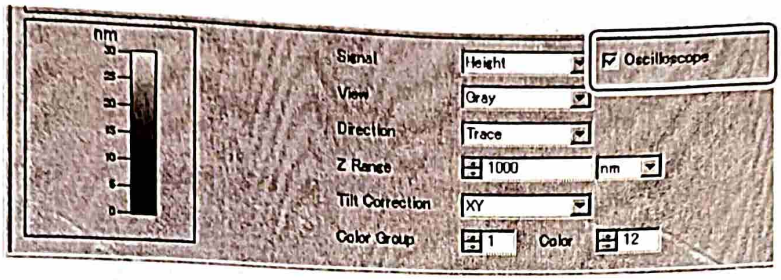
Slow approach begins.

When slow approach ends, scanning automatically begins.



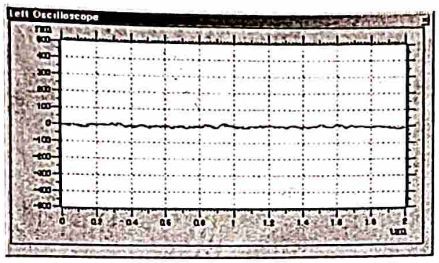
Adjusting the Image

1 Open the [Oscilloscope] window.

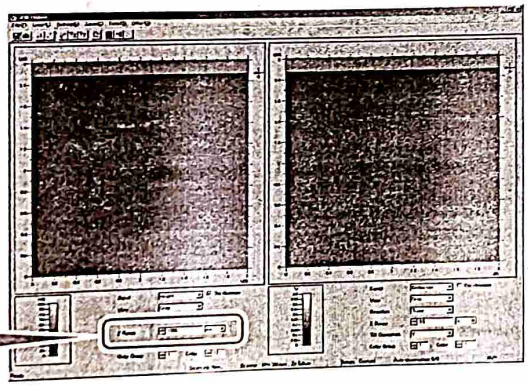


Select the [Oscilloscope] checkbox.

The [Oscilloscope] window opens.

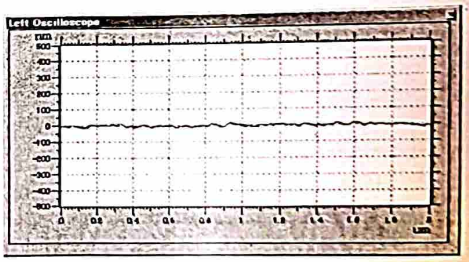


2 Adjust the [Z Range] and image contrast.

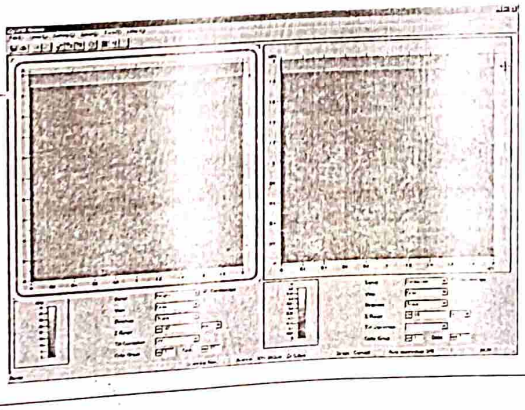


Adjust the [Z Range].

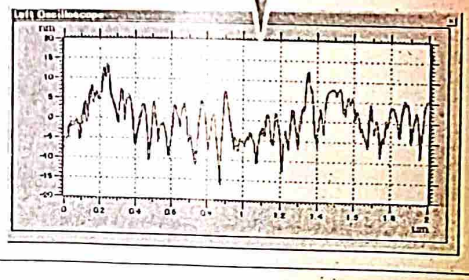
In this example, 1000 nm is changed to 40 nm.



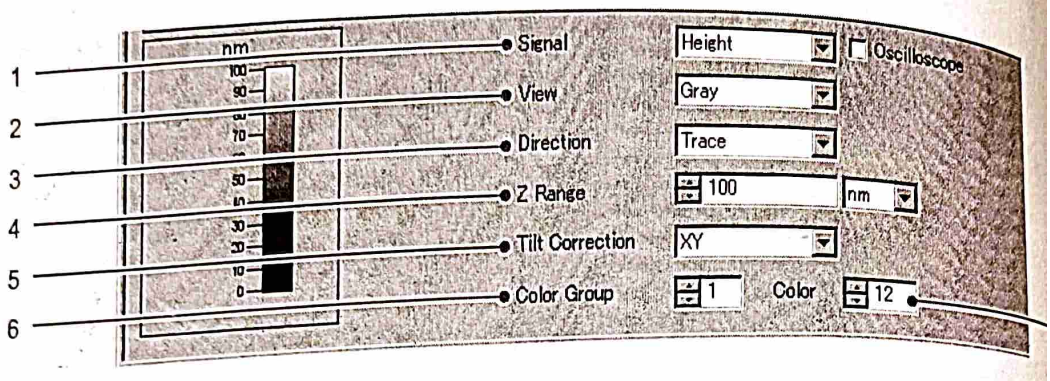
Good contrast is shown.



The Z range is narrowed and protrusions are shown clearly.



3 Set the signal type and the display conditions.



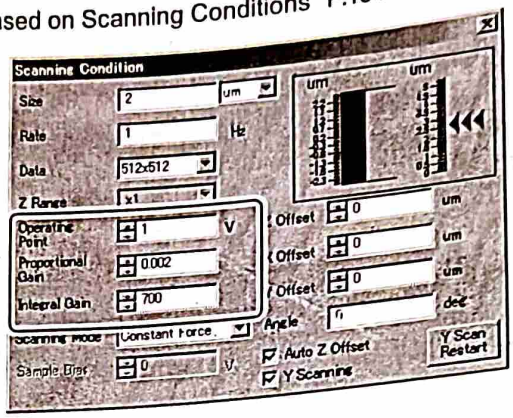
	Parameter	Description	Reco
1	Signal	The signals that can be selected in each mode are indicated in the separate table. Reference "Chapter 1 2. Table of Signals" P.4	
2	View	Select the image display method.	Gray
3	Direction	Select the scanning direction of the signal displayed in the image. Trace :The cantilever scans from left to right in the screen (the red line in the oscilloscope display). Retrace :The cantilever scans from right to left in the screen (the blue line in the oscilloscope display).	Trace
4	Z Range	Set the display range in the Z display direction. The display range is equivalent to the image contrast. Display range : 1 nm to 20 µm Voltage display range : 0.001 V to 20 V µm, nm, or V (voltage) can be selected for the units.	
5	Tilt Correction	Select the tilt correction. XY :Tilt is corrected in the X and Y directions. Y :Tilt is corrected in the Y direction. None :Tilt is not corrected.	XY
6	Color Group	Select the scanning screen color group.	1
7	Color	Select the scanning screen color.	

4 Adjust the red line (trace line) and blue line (retrace line) so that they overlap in the oscilloscope display.

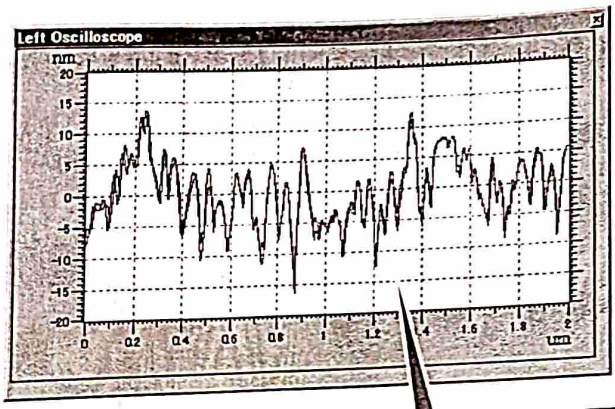
Reference "Chapter 10 Changing Trace/Retrace Based on Scanning Conditions" P.191

① Adjust the [Operating Point], [Proportional Gain], and [Integral Gain].

Reference "Chapter 2 5. Parameter Settings" P.40



Before changing the [Proportional Gain] or [Integral Gain], use the [10 µm Up] button to raise the cantilever off the sample.
After making the change, execute slow approach and scan.



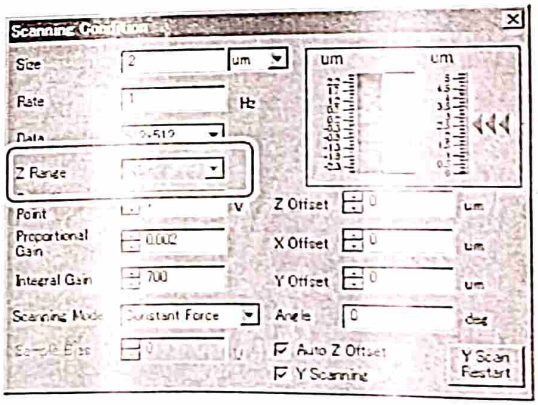
② Make the red line (trace line) and blue line (retrace line) overlap.

Hint If the red line (trace line) and blue line (retrace line) cannot be made to overlap, cantilever wear, static electricity on the sample, tilted sample, and dirt on the sample surface are possible reasons. Remove the static electricity, clean the sample, and readjust.

(END)

③ If digital bits appear in the oscilloscope display, increase the [Z Range] value.

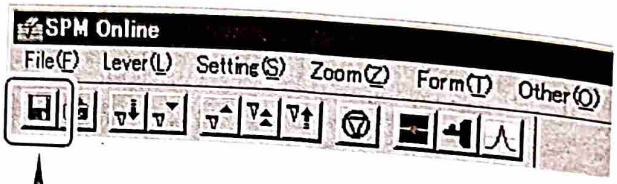
Reference "Chapter 2 5. Parameter Settings" P.40



8. Saving the Image

1 Save the image.

Toolbar of the [SPM Online] window

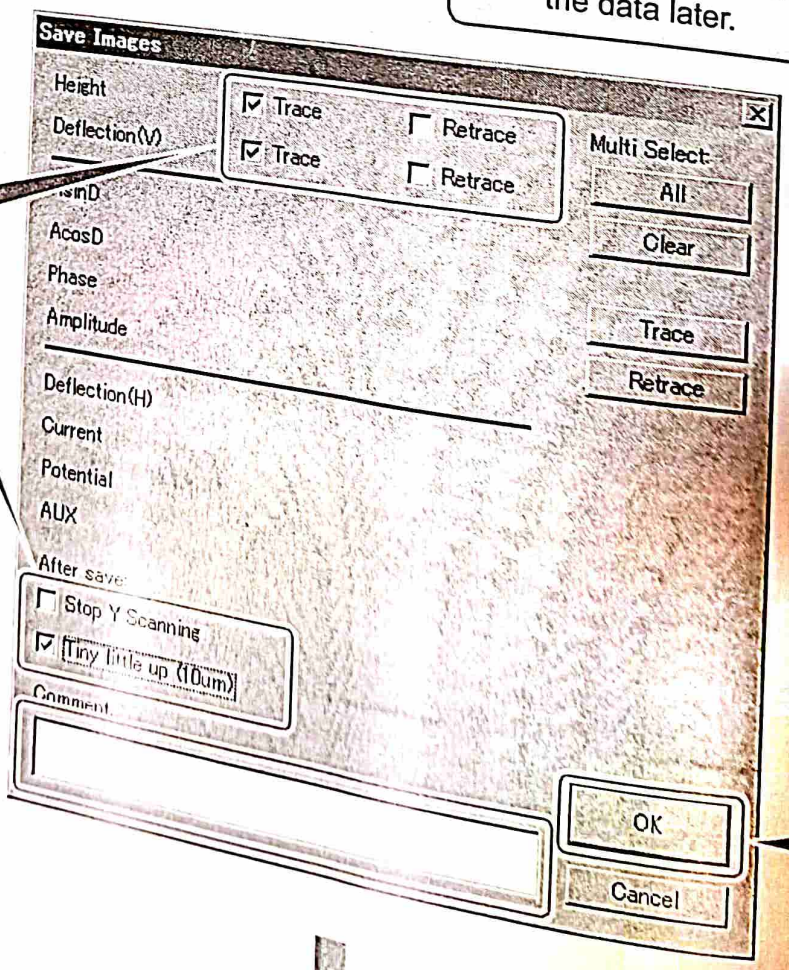


① Click the [Save] button during scanning.

The [Save Images] window opens.

Hint Entering the sample name, experi conditions, and other information i comment box makes it easy to org the data later.

② Select the images to be saved, specify the operation after saving, and enter comments.



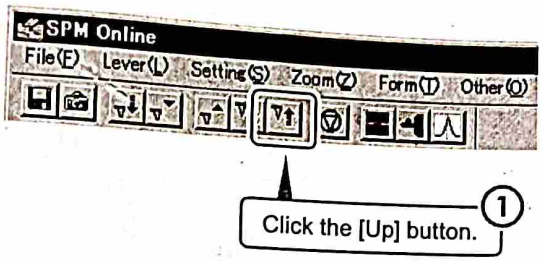
③ Click [OK].

When the scan reaches the top or bottom edge, the displayed image is saved. A file name is automatically assigned based on the time.

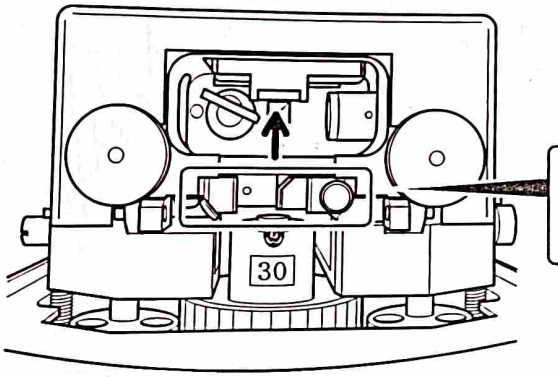
Ending Scanning

1 Remove the AFM head cover.

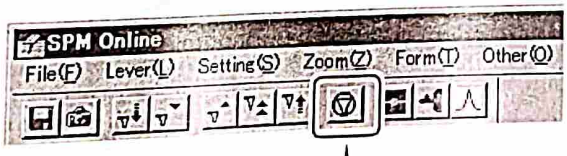
2 Move the cantilever away from the sample.



Click the [Up] button. (1)



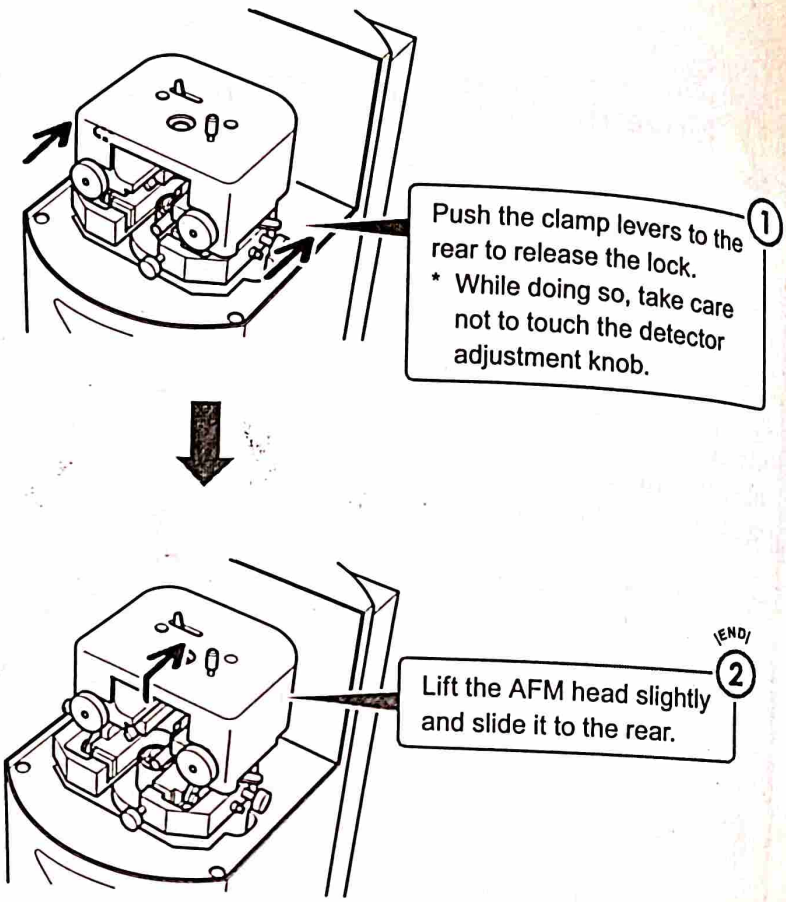
The cantilever rises and moves away from the sample surface.



When the cantilever is sufficiently far from the sample, click the [Stop] button. (END) (2)

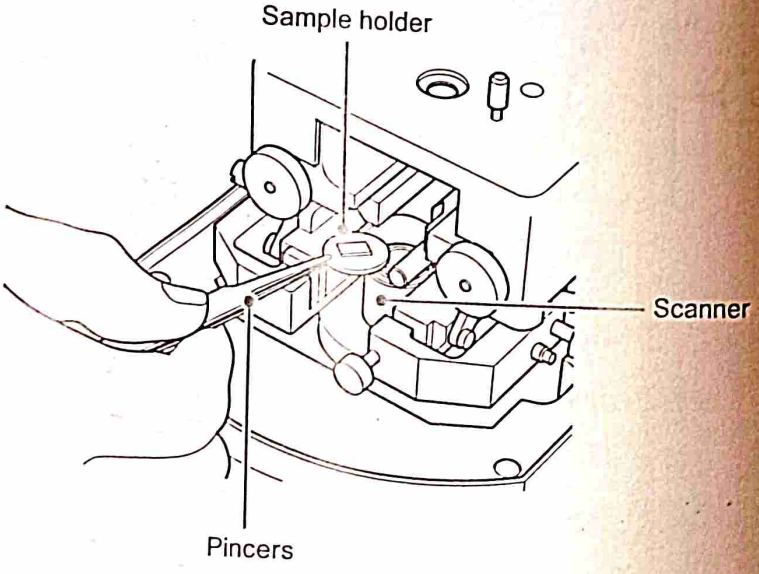
10. Removing the Sample

1 Slide the AFM head to the rear.

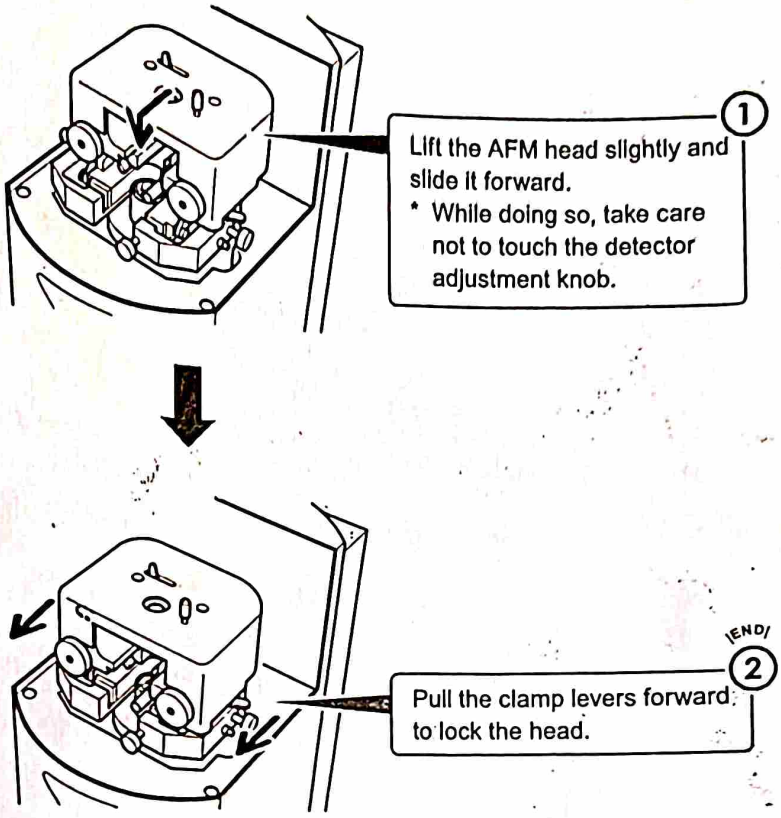


2 Remove the sample holder.

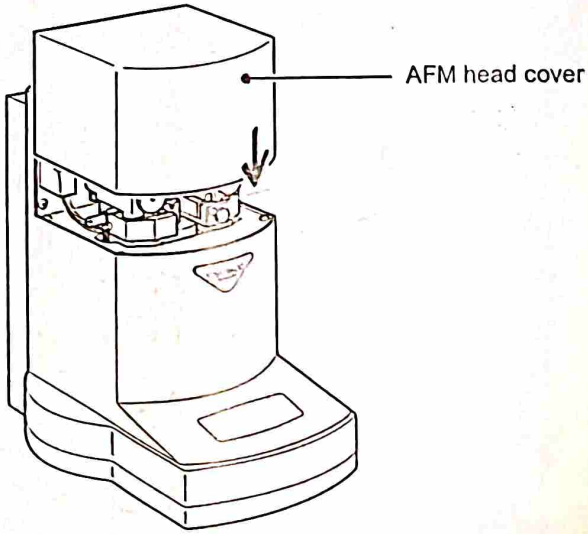
Use pincers to remove the sample holder from the scanner.



3 Slide the AFM head forward.



4 Attach the AFM head cover.



Chapter 3 Dynamic Mode

This chapter explains the procedure for scanning in dynamic mode.

In dynamic mode, the cantilever is made to vibrate near the resonance frequency. When the tip of the cantilever is brought near the sample in this state, the amplitude changes. Making use of this phenomenon, the system operates to keep the amplitude constant, allowing displacements in the height direction of the sample to be acquired.

Flow of Dynamic Mode Scanning

The flow of scanning in dynamic mode is indicated below. This chapter explains steps that are particular to dynamic mode. For steps common to all modes, see the indicated pages and chapters.
The procedures for displaying, processing, and analyzing a scanned image are described in "Chapter 11 Image Processing".

: Explained in this chapter.
: Explained in the indicated chapter.

Installing the Cantilever Reference P.55

↓

Selecting the Mode Reference P.59

↓

Adjusting the Optical Axis Reference P.61

↓

Lever Tune Settings Reference P.74

↓

Attaching the Sample Reference "Chapter 2 4. Attaching the Sample" P.35

↓

Parameter Settings Reference P.85

↓

Starting Scanning Reference "Chapter 2 6. Starting Scanning" P.42

↓

Adjusting the Image Reference "Chapter 2 7. Adjusting the Image" P.45

↓

Saving the Image Reference "Chapter 2 8. Saving the Image" P.48

↓

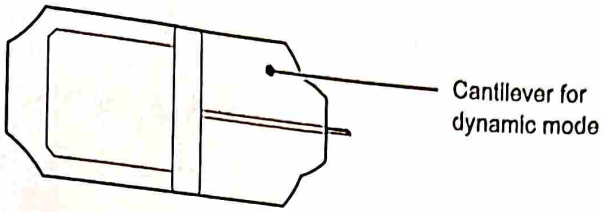
Ending Scanning Reference "Chapter 2 9. Ending Scanning" P.49

↓

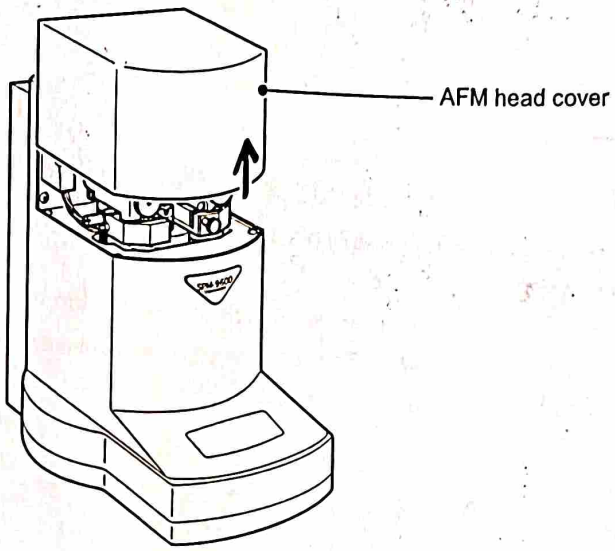
Removing the Sample Reference "Chapter 2 10. Removing the Sample" P.50

Installing the Cantilever

Install the cantilever for dynamic mode in the cantilever holder.

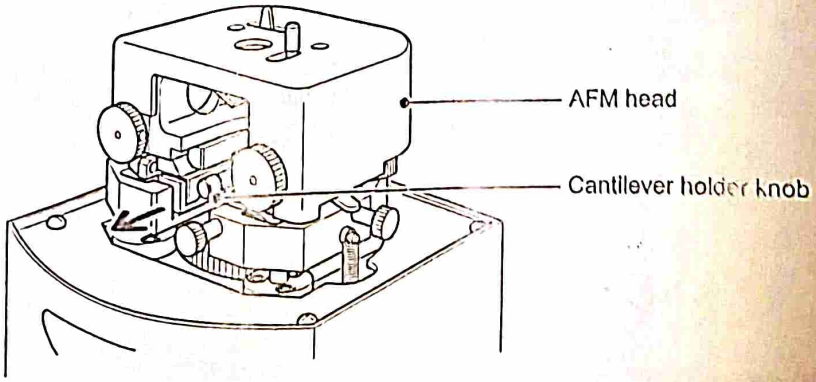


1 Remove the AFM head cover.



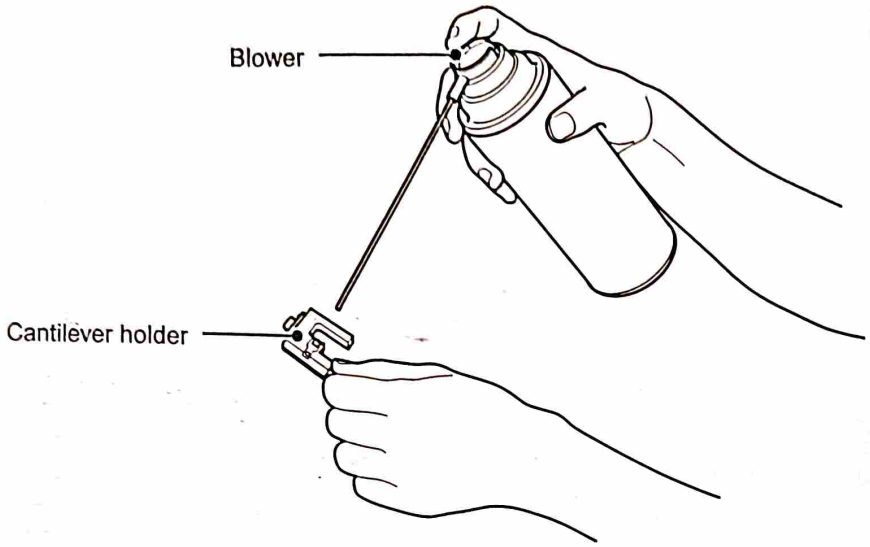
2 Remove the cantilever holder.

While holding the AFM head down, grasp the cantilever holder knob and pull straight out.



3 Remove dust from the cantilever holder.

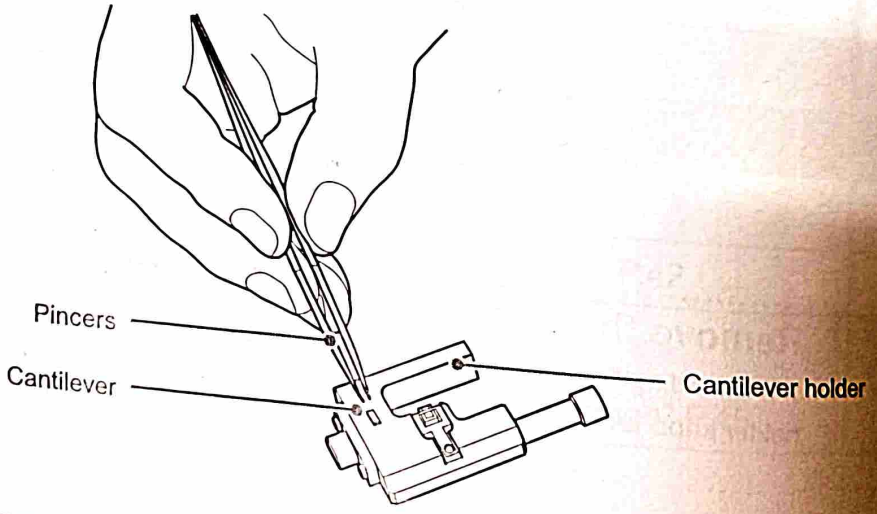
Use a blower to remove dust.



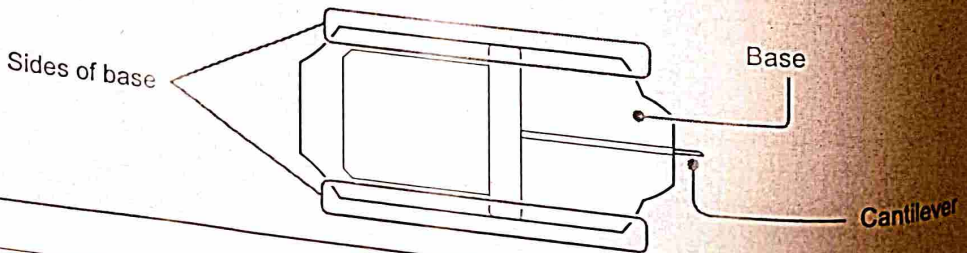
4 Place the cantilever near the cantilever holder.

Use pincers to temporarily place in the position shown below.

Step 5 ("Install the cantilever in the cantilever holder.") requires precise work. Be sure to place the cantilever close to the cantilever holder before starting.

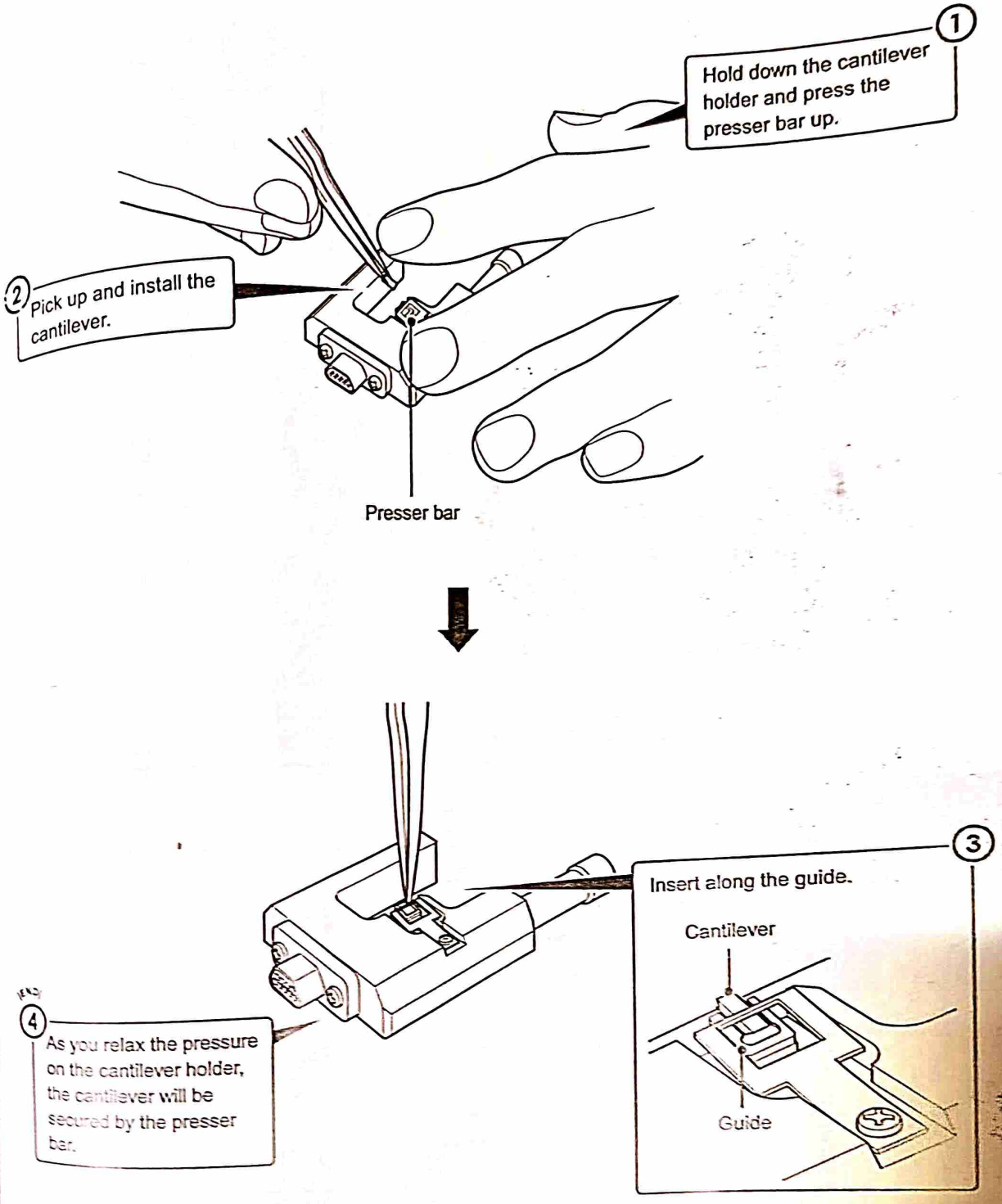


When installing the cantilever, be sure to grasp the sides of the base. Do not touch the cantilever.



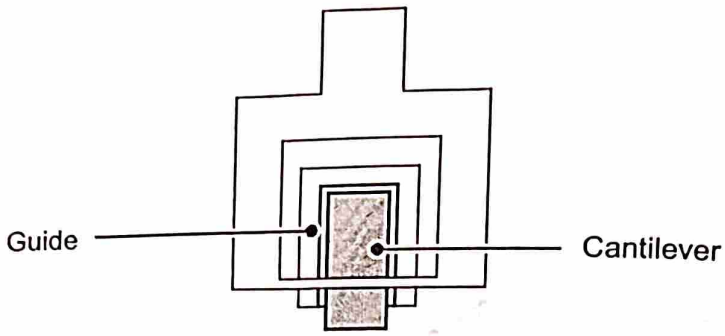
5 Install the cantilever in the cantilever holder.

Use the pincers to install the cantilever.

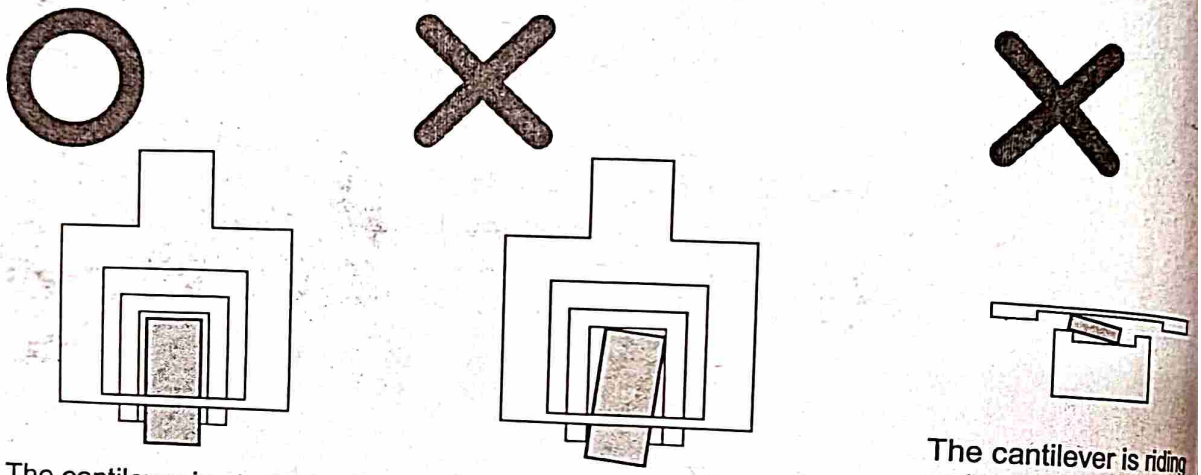


6 Check if the cantilever is correctly installed.

Check using the optical microscope.



Hint Install the cantilever correctly in the cantilever holder.



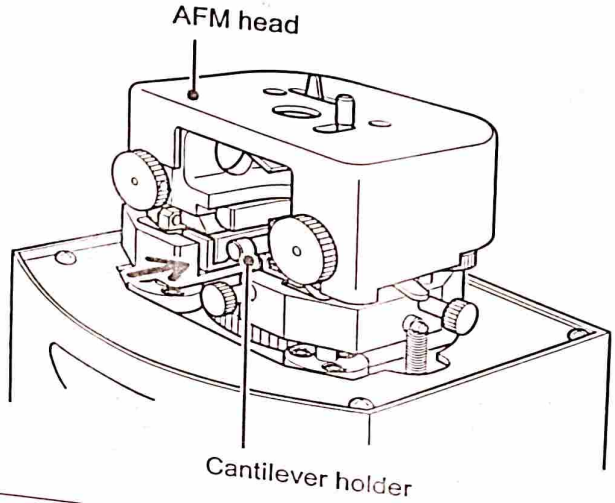
The cantilever is straight.

The cantilever is skewed.

The cantilever is riding up on the guide.

7 Install the cantilever holder.

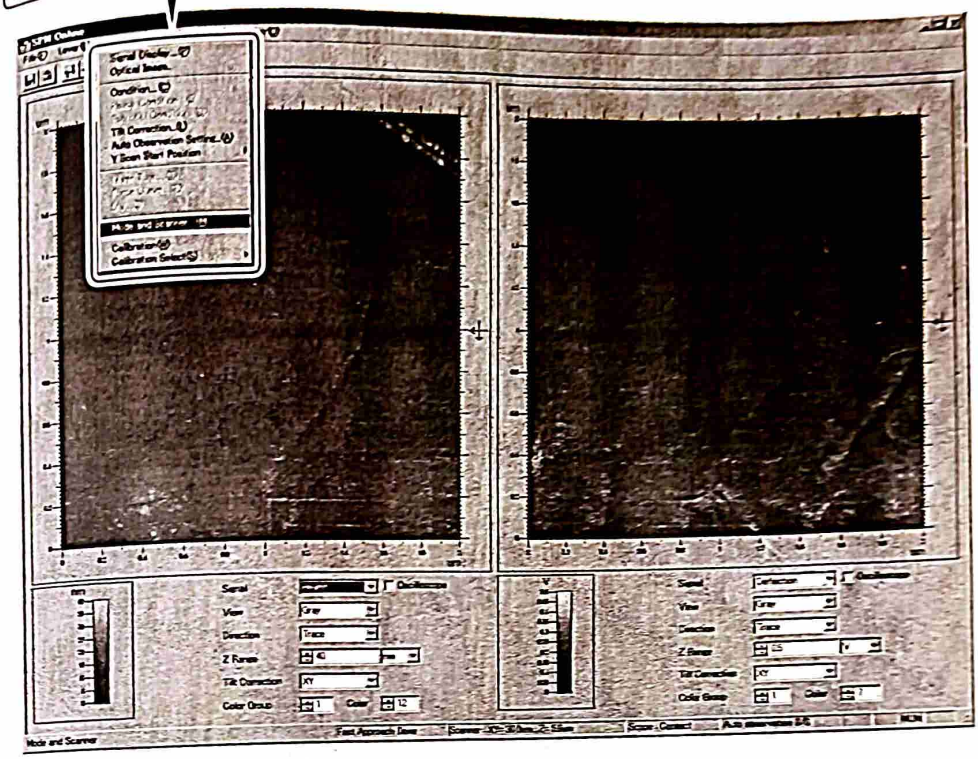
While holding down the AFM head, grasp the cantilever holder knob and insert straight into the AFM head.



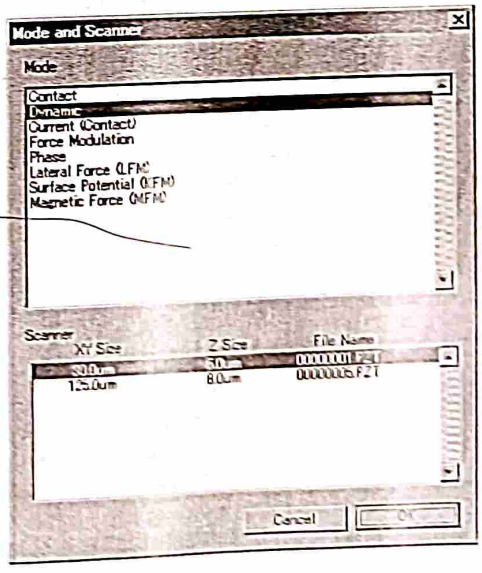
Selecting the Mode

1 Open the [Mode and Scanner] window.

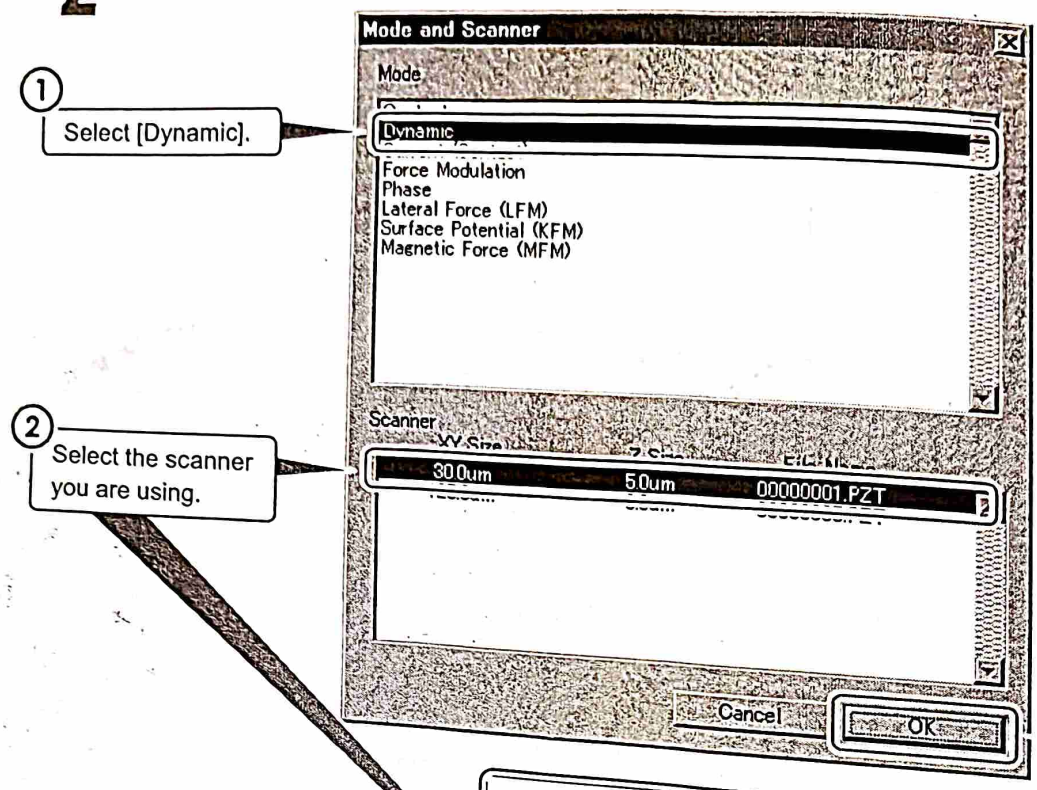
Select [Mode and Scanner] from the [Setting] menu.



The [Mode and Scanner] window opens.



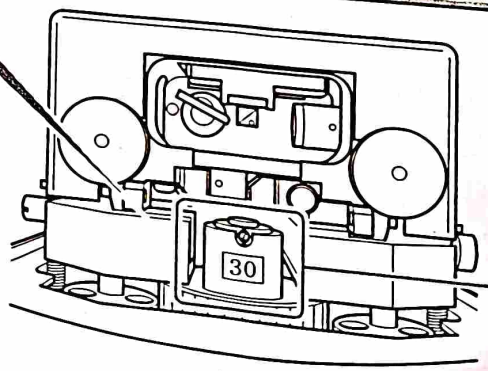
2 Select the mode and scanner.



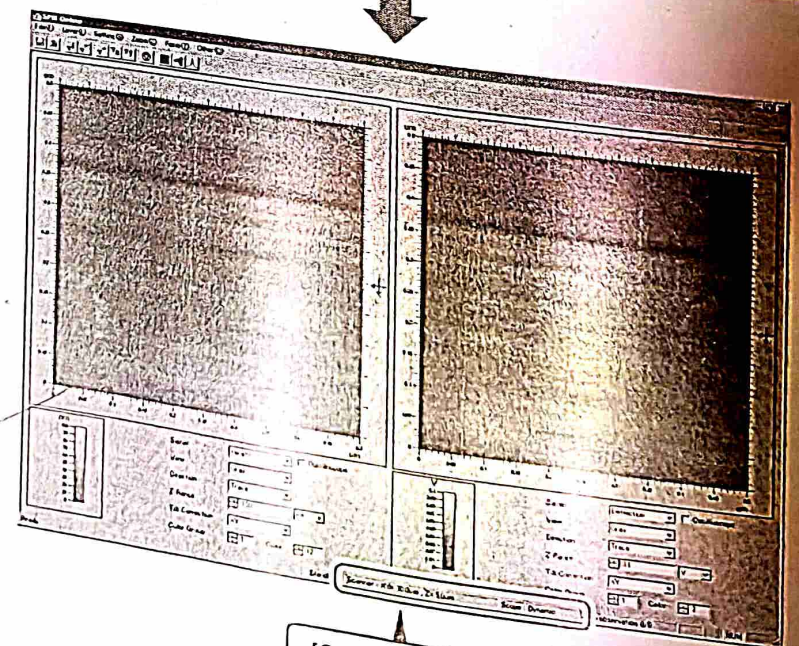
① Select [Dynamic].

② Select the scanner you are using.

Click [OK]. (END) ③



Scanner
(30 µm × 30 µm × 5.0 µm is shown as an example.)



[Scanner] and [Scope] (mode) appear.

The above screen shows the case of [Scanner: XY = 30.0 µm, Z = 5.0 µm] and [Scope: Dynamic].

Adjusting the Optical Axis

Rough Adjustment

While looking through the optical microscope (option), shine the laser beam onto the cantilever. ☞Reference P.62

↓

Fine Adjustment

Perform fine adjustment so that the laser beam hits the tip of the cantilever. ☞Reference P.66

↓

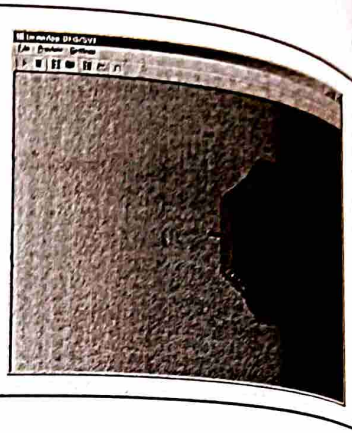
Adjusting the Detector Position

Direct the laser beam reflected off the cantilever onto the center of the detector. ☞Reference P.70

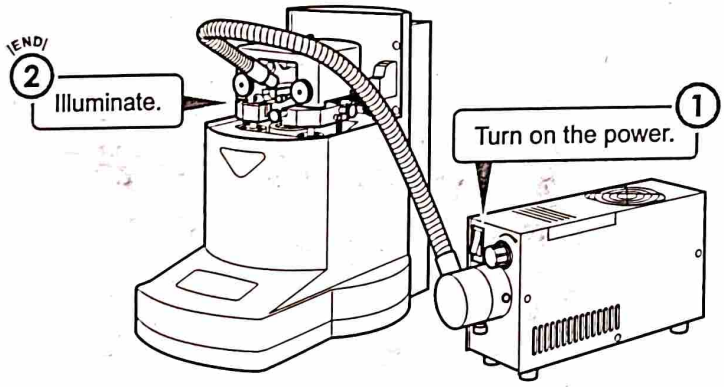
3.1 Rough Adjustment

While looking through the optical microscope (option), shine the laser beam onto the cantilever.

Hint If the optical microscope is equipped with a CCD camera, an image can be displayed on the monitor of the host computer. The following explanation assumes that the image window of the CCD camera is being used.

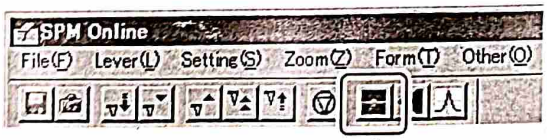


1 Use fiber light to illuminate the inside of the AFM head.



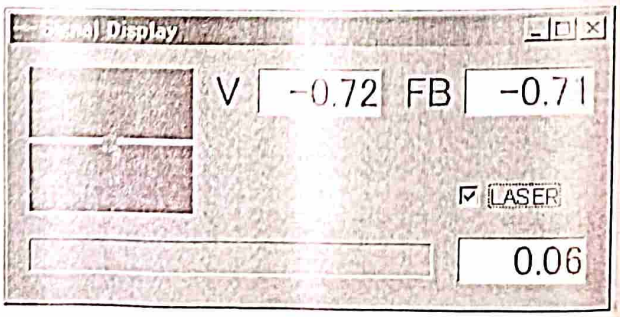
2 Open the [Signal Display] window.

Toolbar of the [SPM Online] window



Click the [Signal Display] button.

The [Signal Display] window opens.

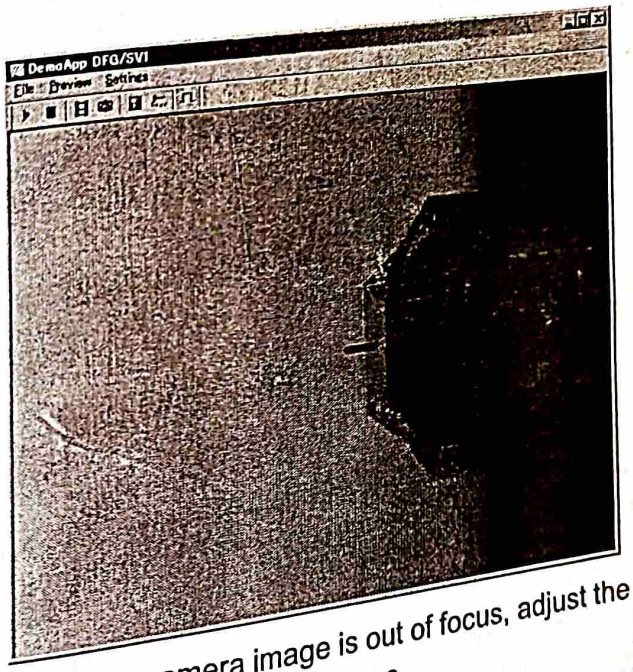


3 Display the CCD camera image.

Toolbar of the [SPM Online] window

Click the [Optical Microscope Image] button.

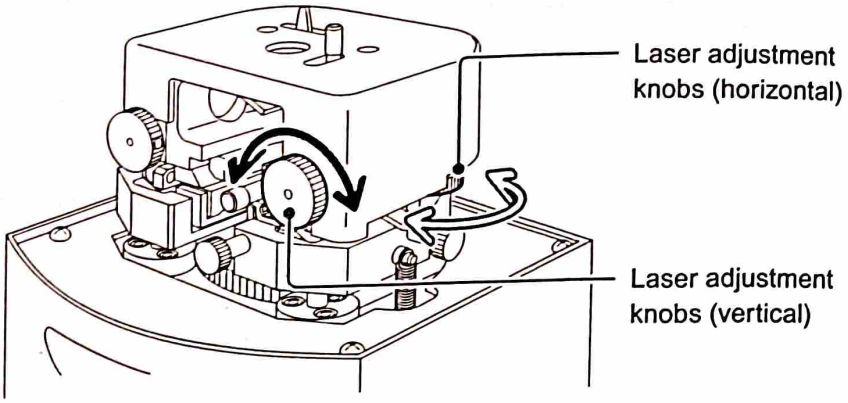
Display the CCD camera image.
(See the manual for the software you are using.)

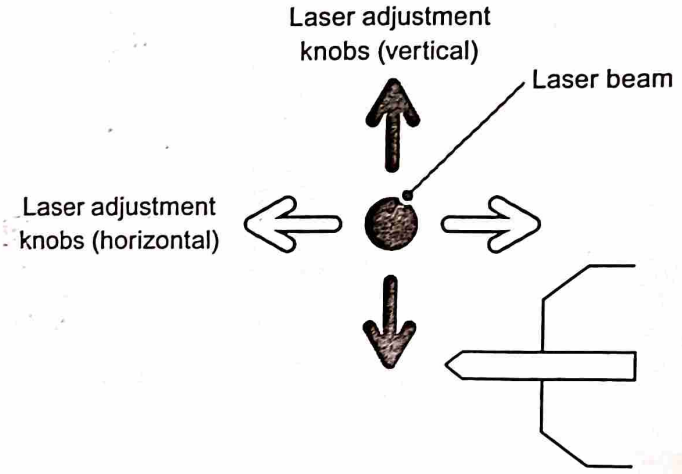


If the CCD camera image is out of focus, adjust the focus of the optical microscope.

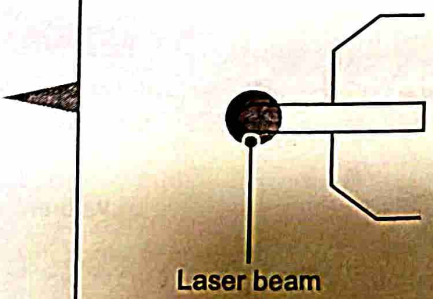
4 Shine the laser onto the cantilever.

Turn the laser adjustment knobs (horizontal and vertical) to direct the laser beam onto the cantilever.



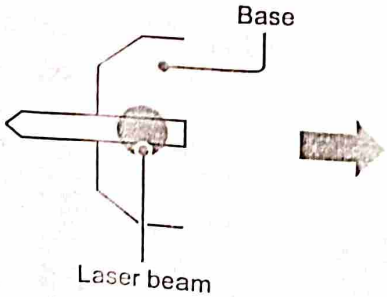


[Relation of cantilever and laser beam positions when viewed from directly overhead in the optical microscope]

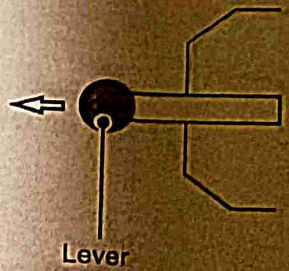


Hint By directing the laser beam onto the base of the cantilever first, it is easy to direct the laser beam onto the cantilever.

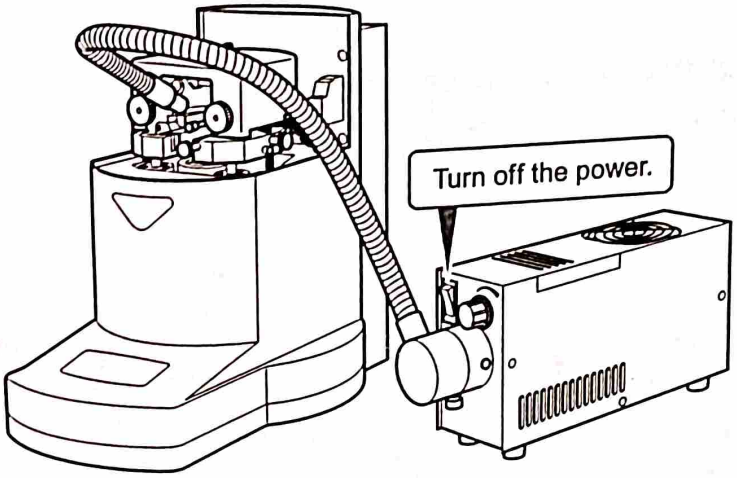
1. Direct the laser beam onto the base.



2. Move the laser beam to the lever.



5 Turn off the fiber light power.

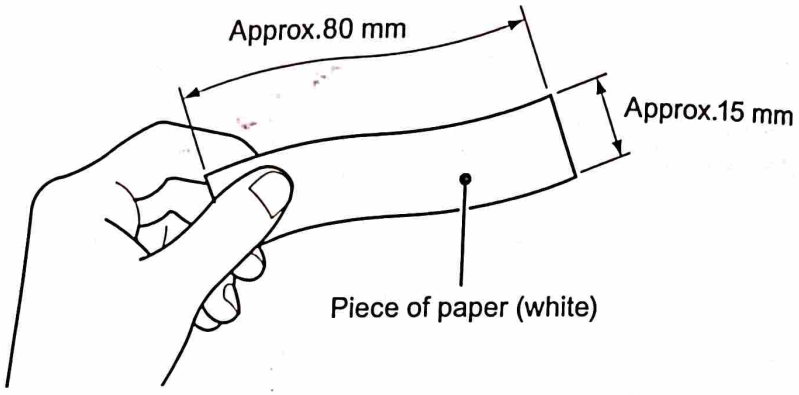


3.2 Fine Adjustment

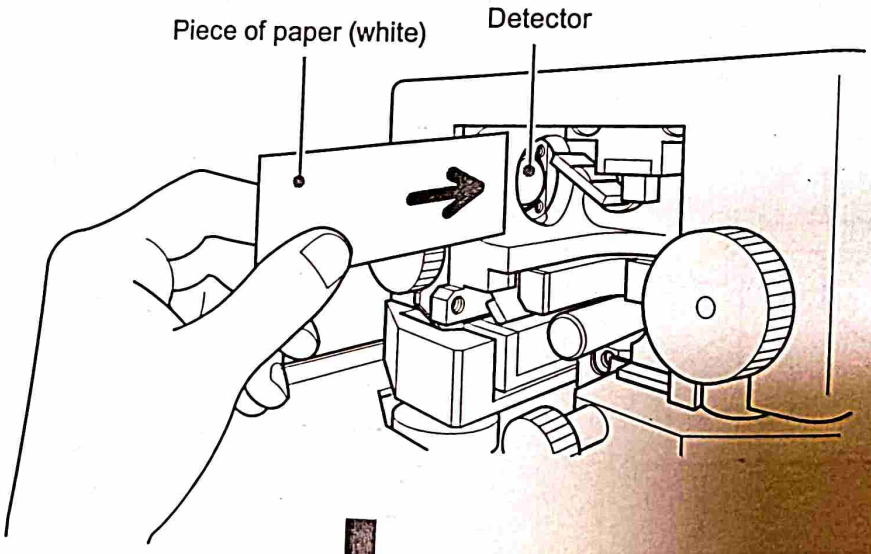
Perform fine adjustment so that the laser beam hits the tip of the cantilever.

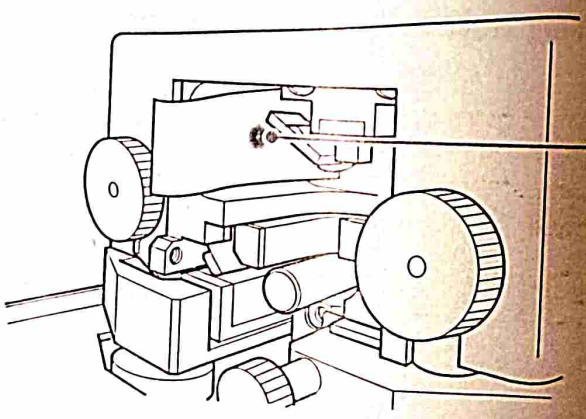
1 Prepare a piece of paper.

Prepare a piece of white paper that is approximately 15 mm×80 mm in size.



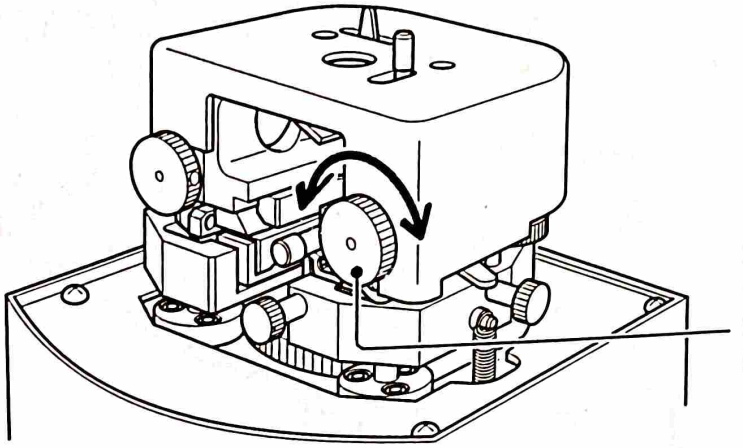
2 Place the paper in front of the detector.



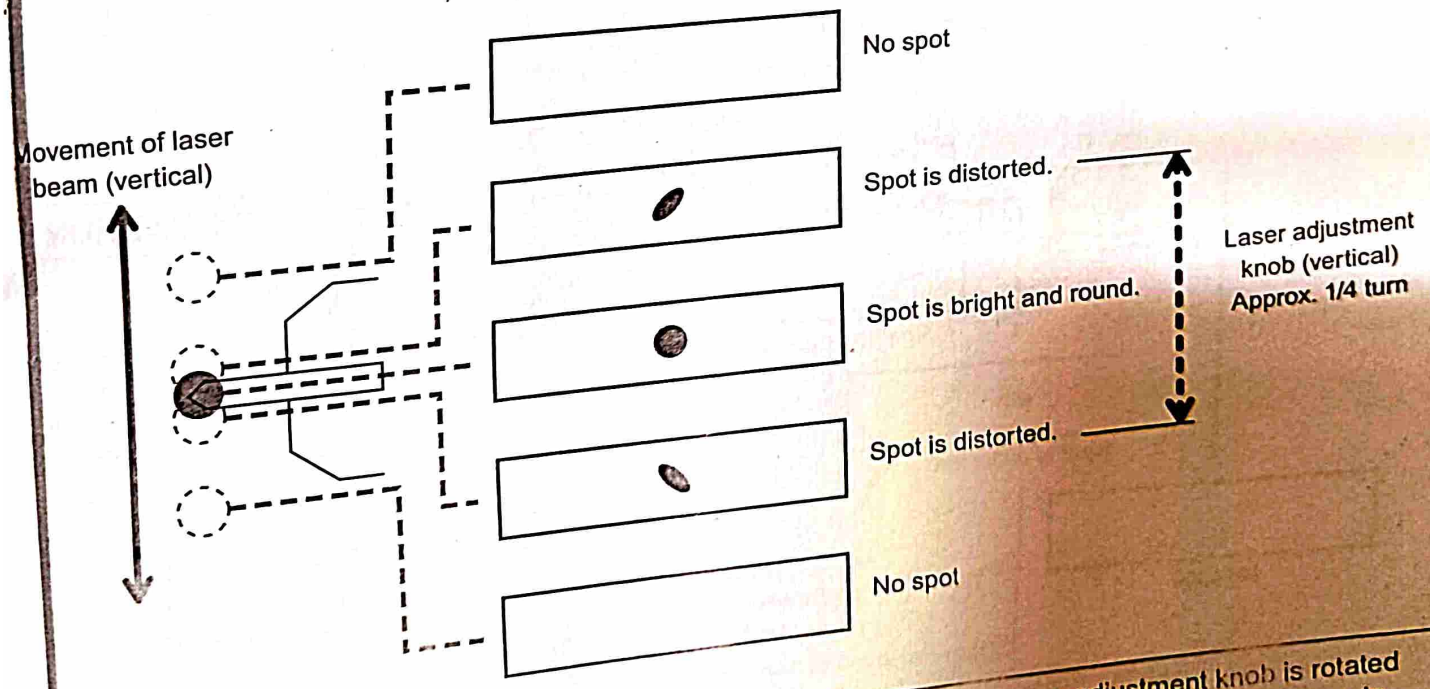


3 Adjust vertically.

Turn the laser adjustment knob (vertical) to move the laser beam in the vertical direction.



Adjust to the position where the laser beam spot is brightest and roundest on the paper.

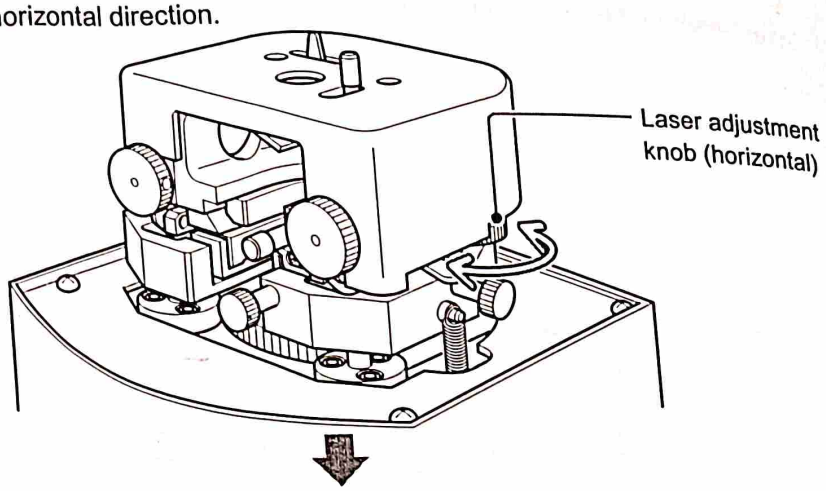


Hint If the spot does not change as shown above when the laser adjustment knob is rotated approximately 1/4 turn, it is possible that the laser beam is not hitting the cantilever. In that case, repeat rough adjustment.

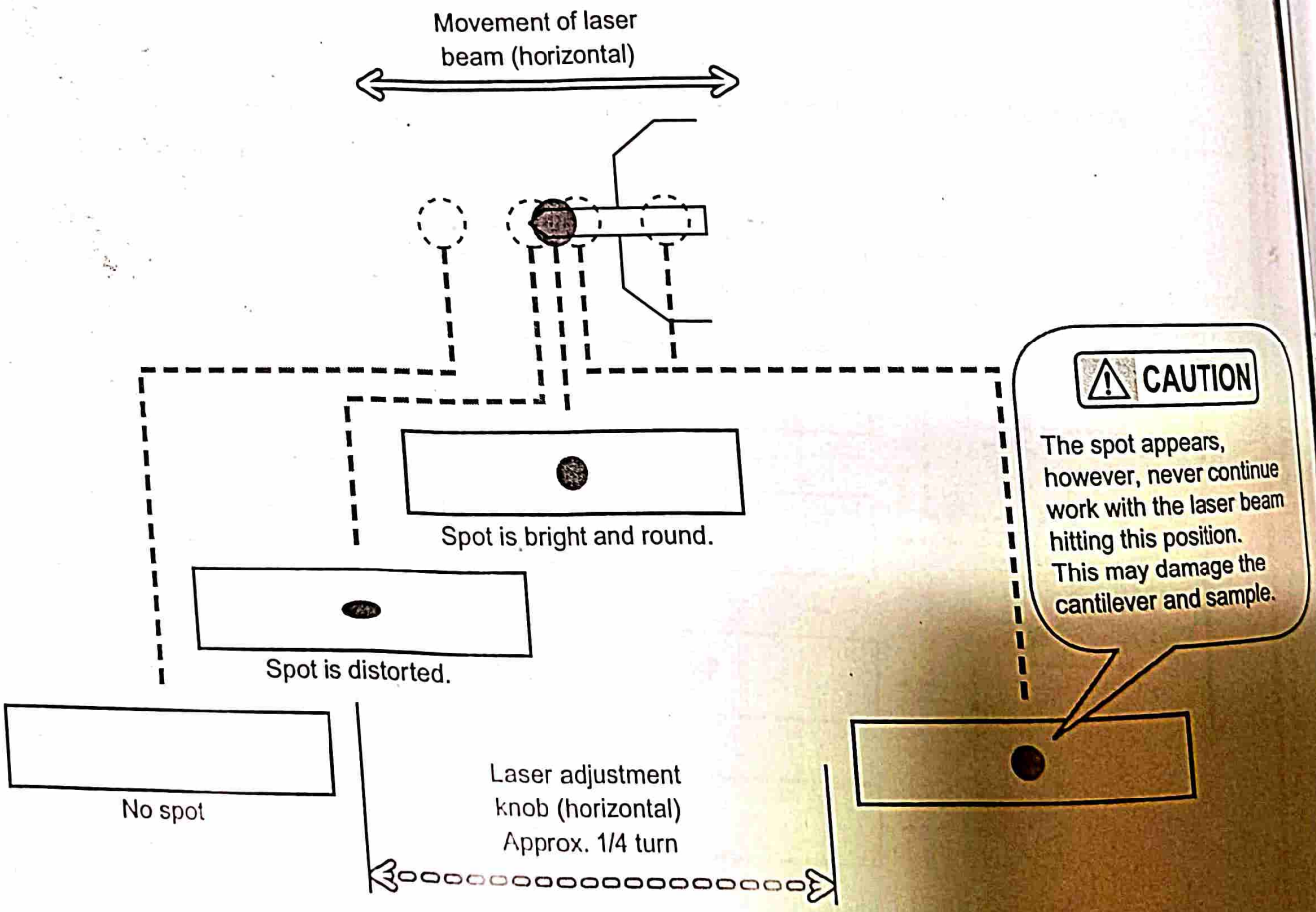
Reference "Chapter 3 3.1 Rough Adjustment" P.62

4 Adjust horizontally.

Turn the laser adjustment knob (horizontal) to move the laser beam in the horizontal direction.



Adjust to the position where the laser beam spot is brightest and roundest on the paper.

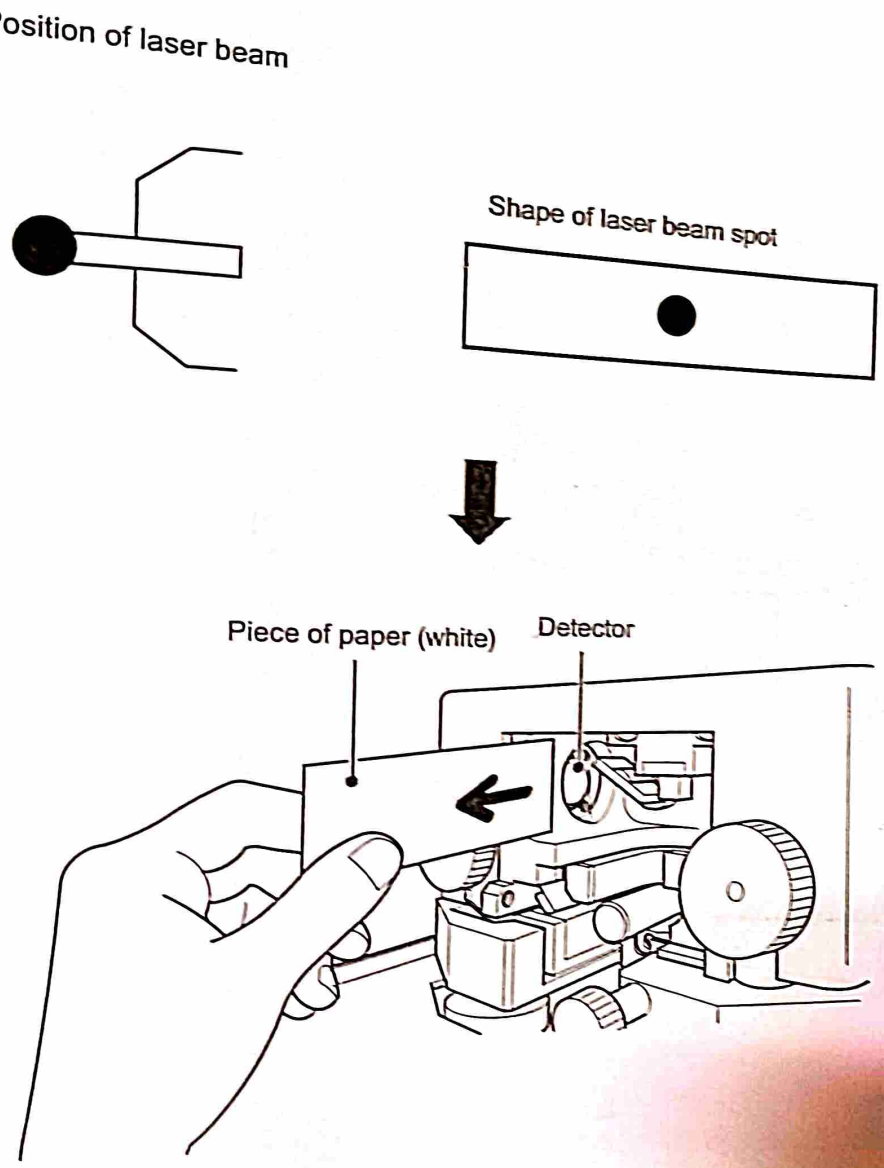


Hint If the spot does not change as shown above when the laser adjustment knob is rotated approximately 1/4 turn, it is possible that the laser beam is not hitting the cantilever. In that case, repeat rough adjustment.

Reference "Chapter 3 3.1 Rough Adjustment" P.62

5 Remove the piece of paper.

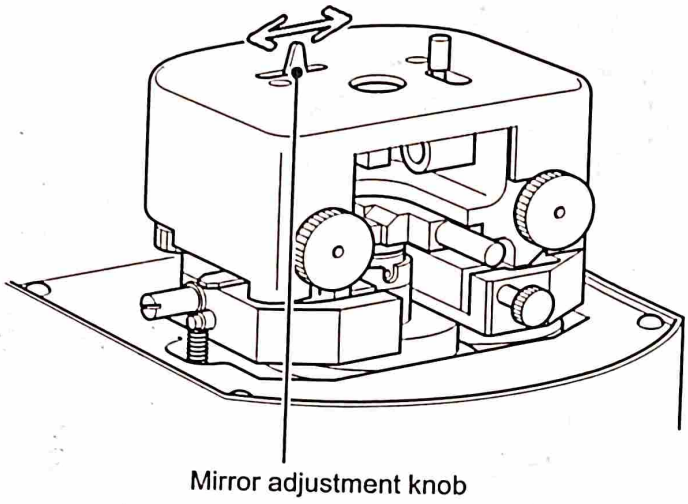
When the laser beam shines on the correct position on the cantilever, remove the piece of paper that was placed in front of the detector.

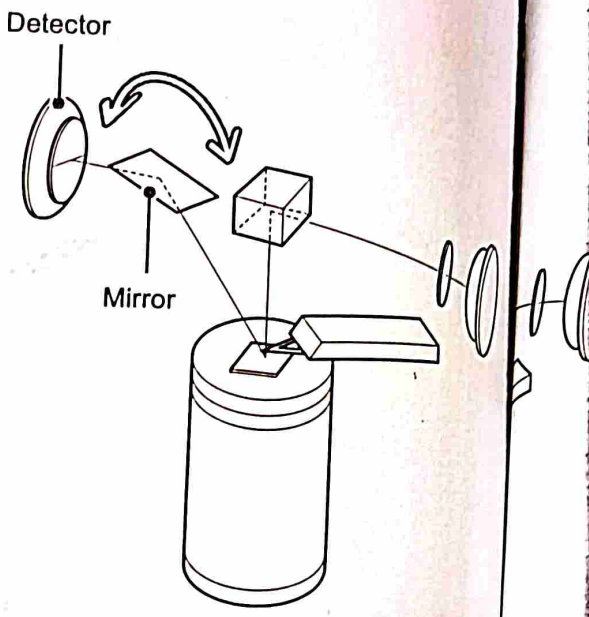


3.3 Adjusting the Detector Position

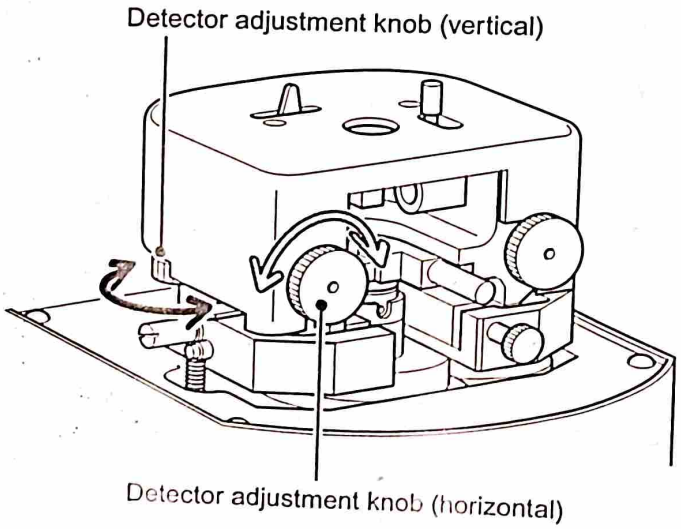
Direct the laser beam reflected off the cantilever onto the center of the detector.

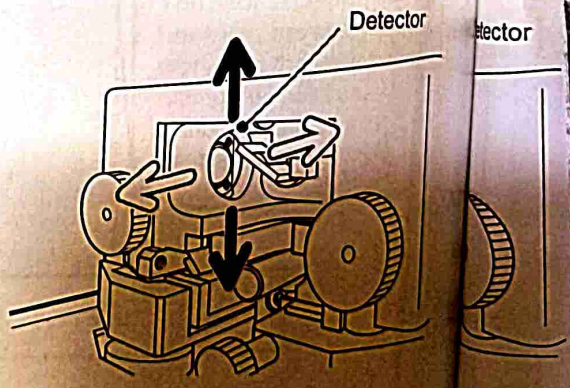
- The angle of the mirror can be adjusted with the mirror adjustment knob.



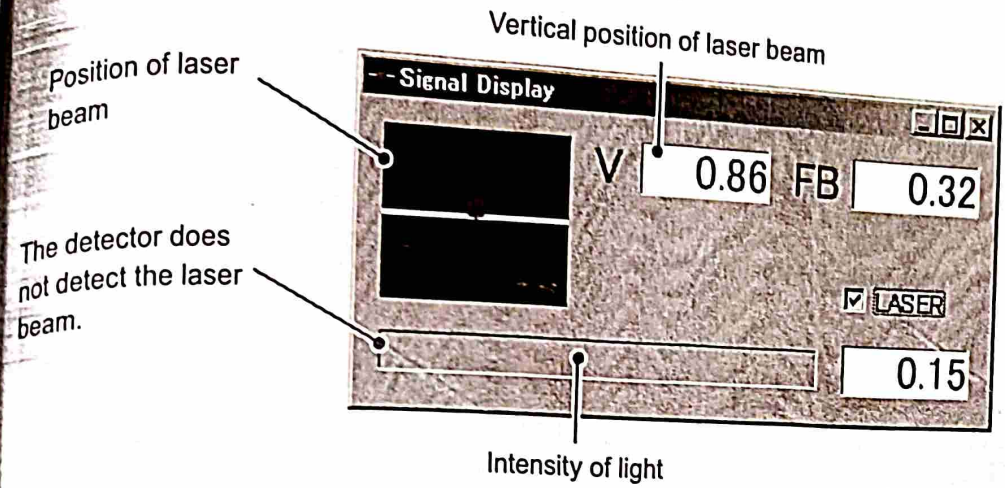


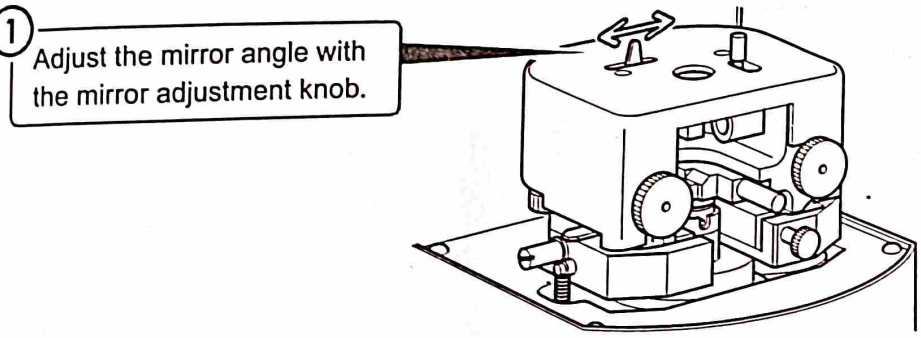
- The position of the detector can be adjusted by turning the detector adjustment knob (vertical).





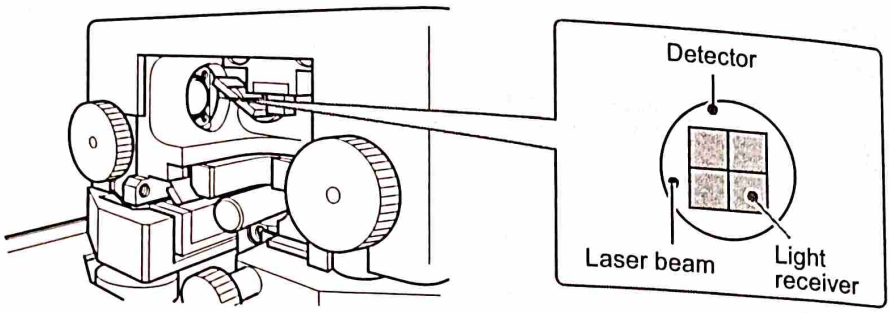
1 Adjust the mirror with the mirror adjustment knob.



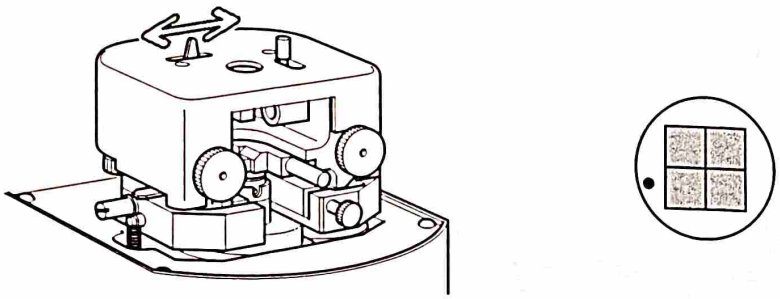


The detector detects the laser beam. The vertical position of the laser beam and the intensity of the light are displayed.

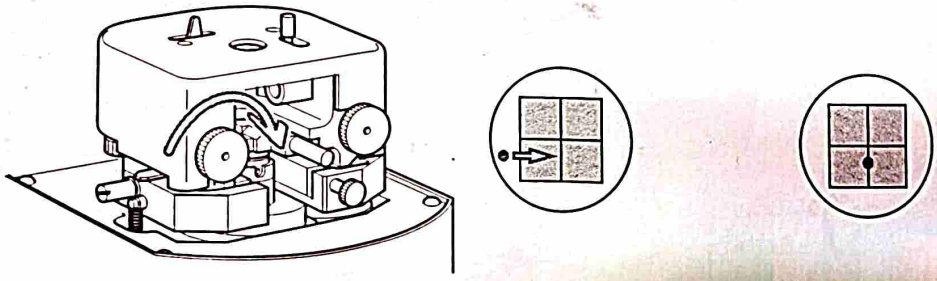
Hint If the laser beam is not detected even after adjustment with the mirror adjustment knob The detector may be far out of position horizontally, preventing the laser beam from entering the light receiver.



1. Use the mirror adjustment knob to move the laser beam close to the outer frame of the detector.

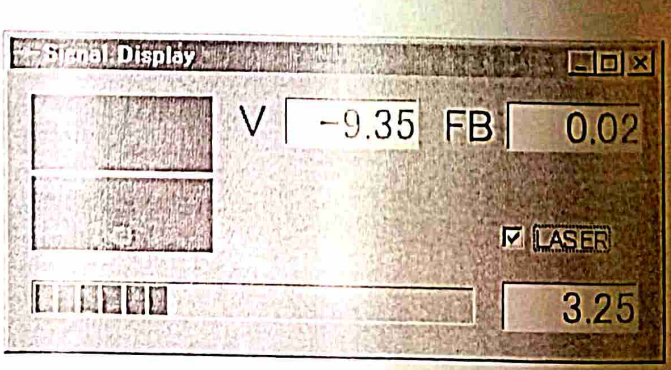


2. Turn the detector adjustment knob (horizontal) so that the laser beam hits the indicated part of the outer frame of the detector.



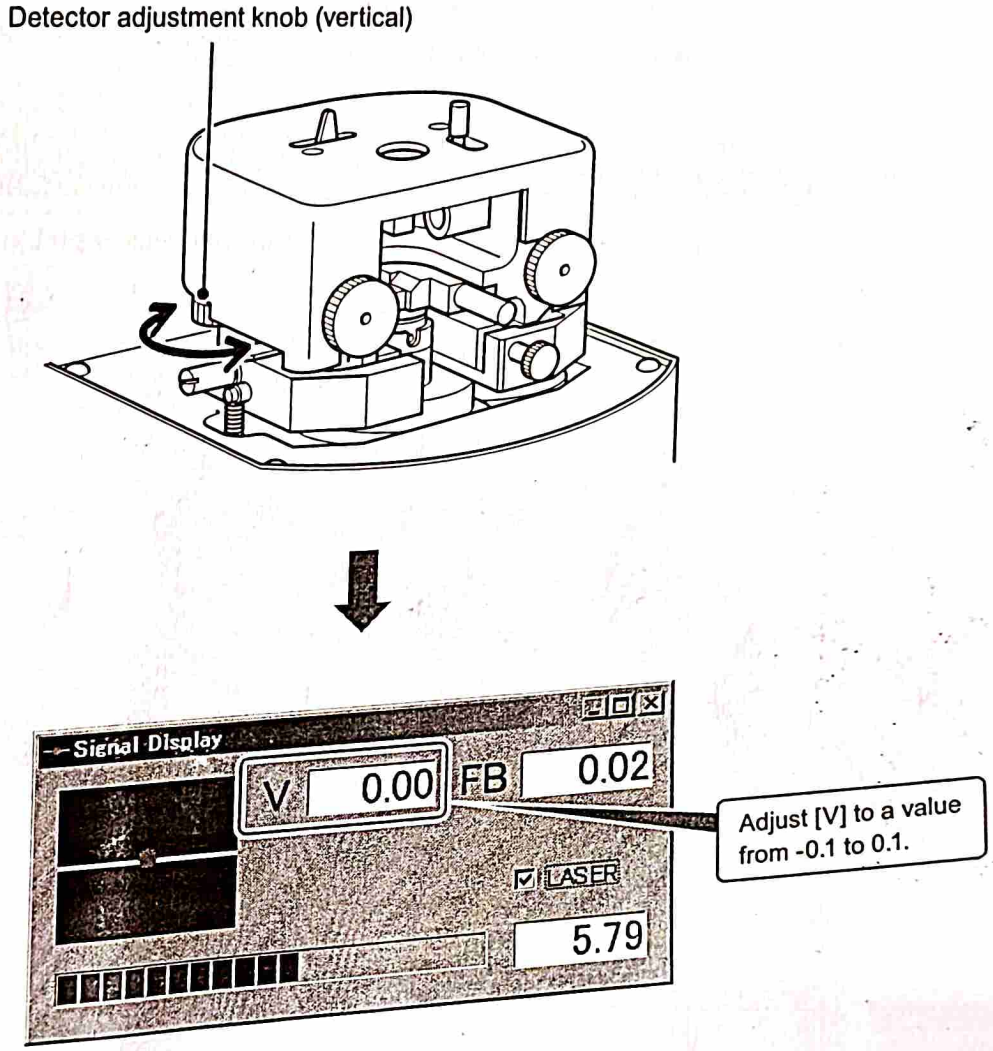
3. Use the mirror adjustment knob to move the laser beam onto the light receiver of the detector.

4. Once the laser beam is detected, use the mirror adjustment knob and detector adjustment knob (vertical) to adjust the vertical direction of the detector.



2 Adjust by turning the detector adjustment knob.

Turn the detector adjustment knob (vertical) to perform fine adjustment of the [V] value.



By means of the above steps, the light reflected from the cantilever is adjusted to enter the center of the detector.

4. Lever Tune Settings

Lever Tune is used to set the operating frequency and operating point.

Auto Tune

Auto Tune automatically sets the operating frequency and operating point. Reference P.77

↓

Lever Tune Fine Adjustment

Manual adjustments can be made to make the conditions more suitable. Reference P.79

↓

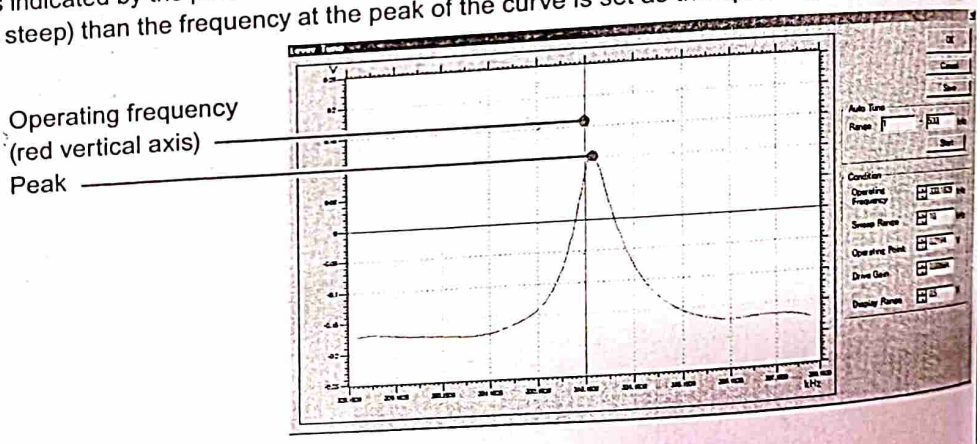
Changing Lever Tune Parameters

The amplitude of the cantilever can be changed to match the properties of the sample. Reference P.82

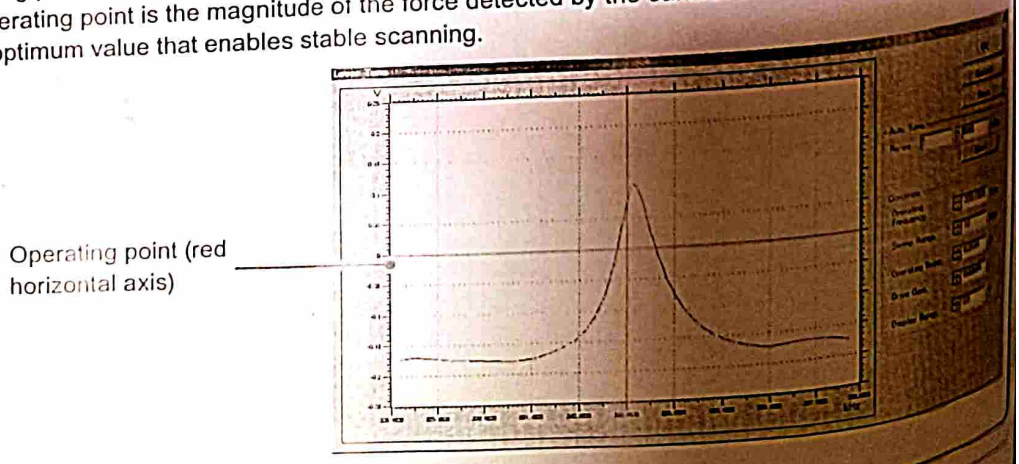
Hint

- Operating frequency
  Cantilevers each have their own particular vibration frequency (resonance frequency). The resonance frequency is indicated by the peak of the curve in Lever Tune. In general, a frequency a little lower (where the slope is steep) than the frequency at the peak of the curve is set as the operating frequency.

check the frequency of cantilever



- Operating point
  The operating point is the magnitude of the force detected by the cantilever. The operating point is set to the optimum value that enables stable scanning.

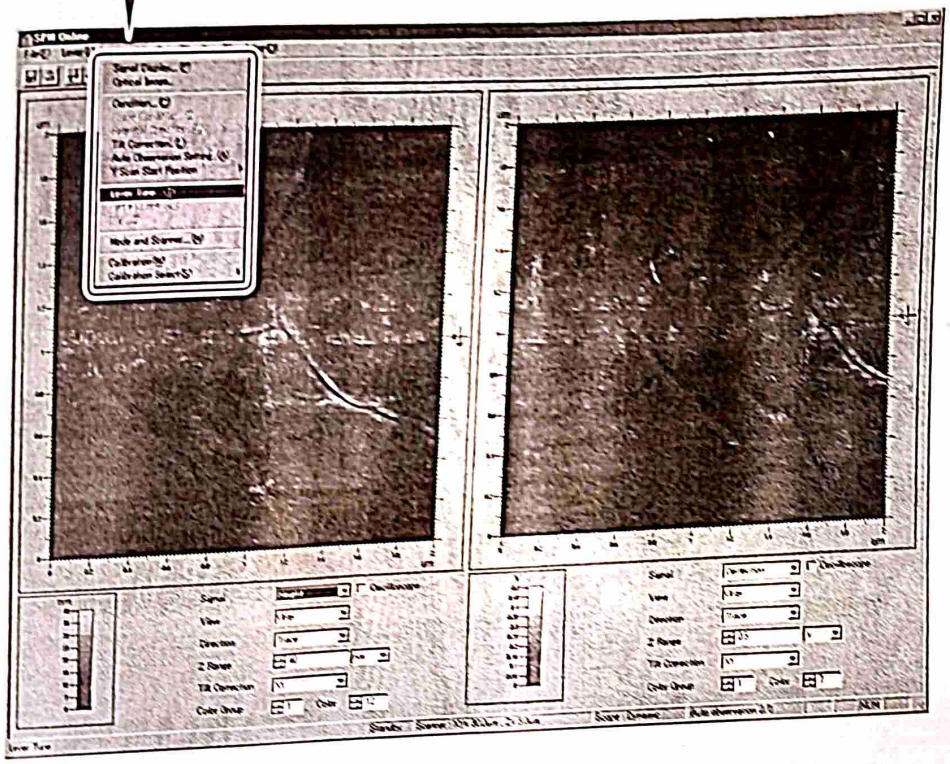


.1 Lever Tune Window

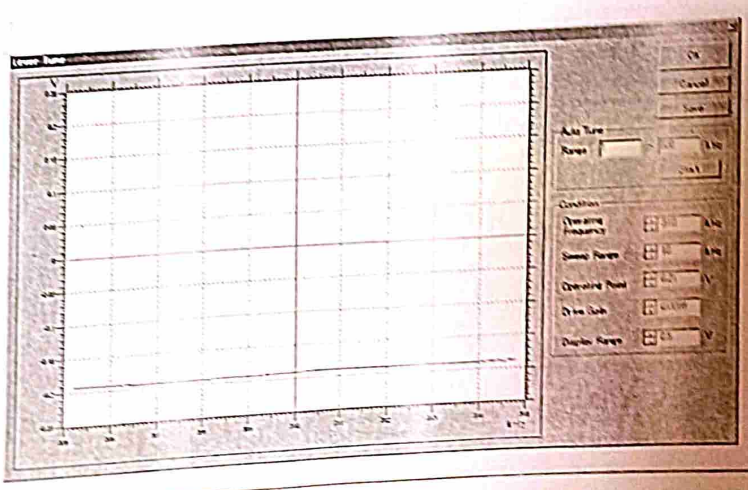
A frequency sweep is performed over the specified range to detect the resonance peak, and the operating frequency and operating point are automatically set.

1 Open the [Lever Tune] window.

Select [Lever Tune] from the [Setting] menu, or click the Lever Tune button ( ) on the toolbar.

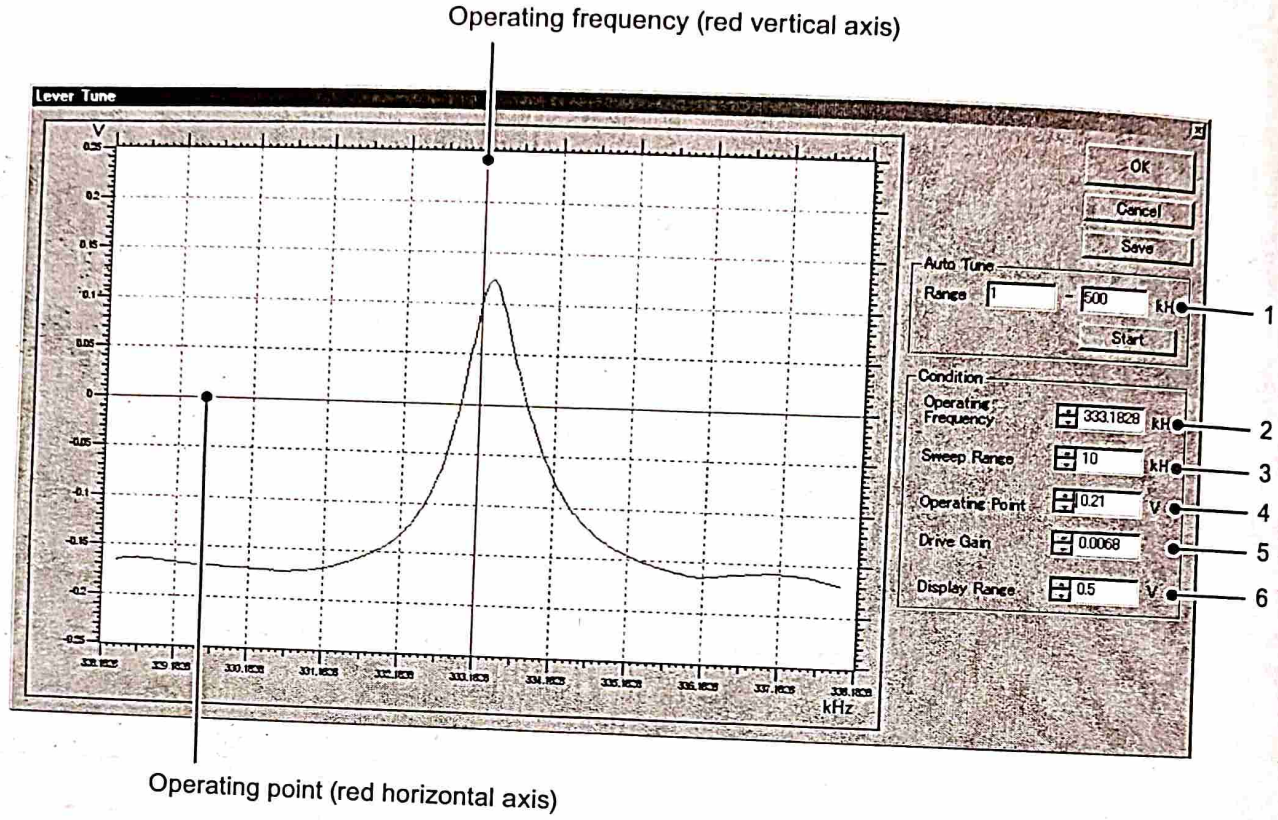


The [Lever Tune] window opens.



Explanation of the [Lever Tune] window

The vertical axis of the Lever Tune window indicates a value proportional to the cantilever amplitude, and the horizontal axis indicates the frequency at which the cantilever is made to vibrate.



	Item	Description
1	Auto Tune	This sweeps the set frequency range to automatically set the operating frequency and operating point.
2	Operating Frequency	The frequency at which the cantilever is made to vibrate
3	Sweep Range	The range of frequencies that is swept (range of horizontal axis of graph)
4	Operating Point	The force that acts on the sample and probe
5	Drive Gain	This specifies the magnitude of the cantilever amplitude.
6	Display Range	The range of the vertical axis of the graph

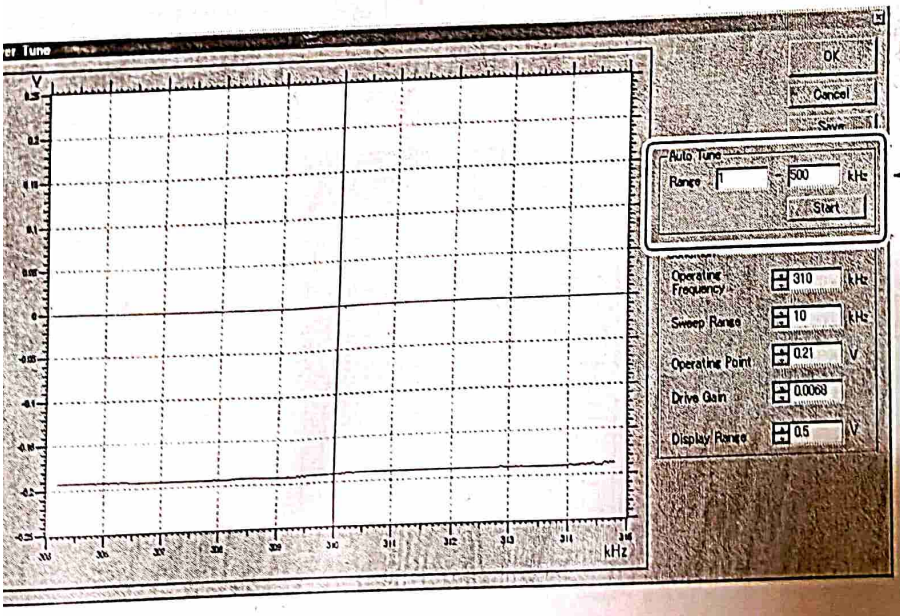
Auto Tune

Specify the frequency range.

The resonance frequency of the cantilever varies by cantilever type. Determine the resonance frequency of the installed cantilever and then specify the Auto Tune range.

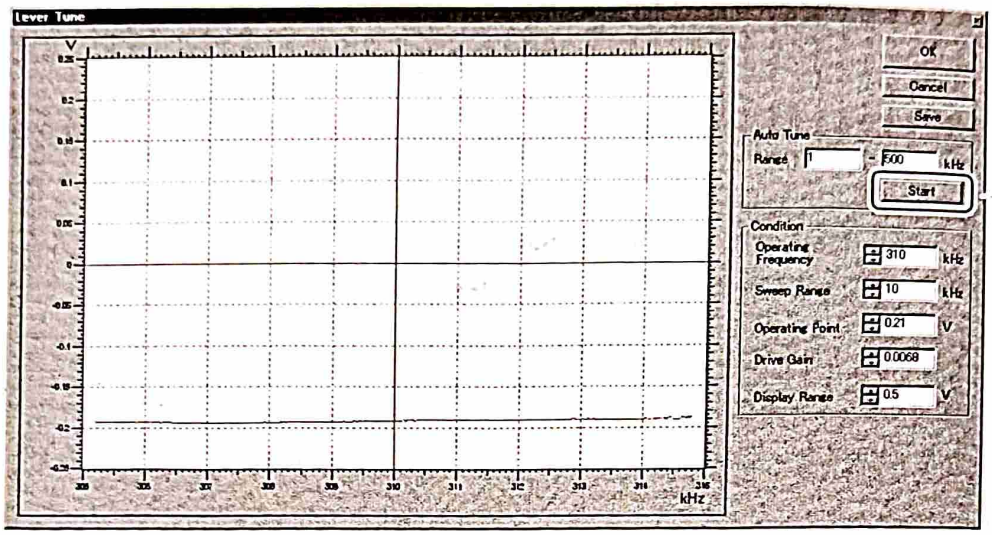
The table below shows resonance frequencies and Auto Tune ranges for standard cantilevers.

Frequency of cantilever	Auto Tune range
70 kHz	1 to 100 kHz
150 kHz	1 to 200 kHz
300 kHz	1 to 500 kHz



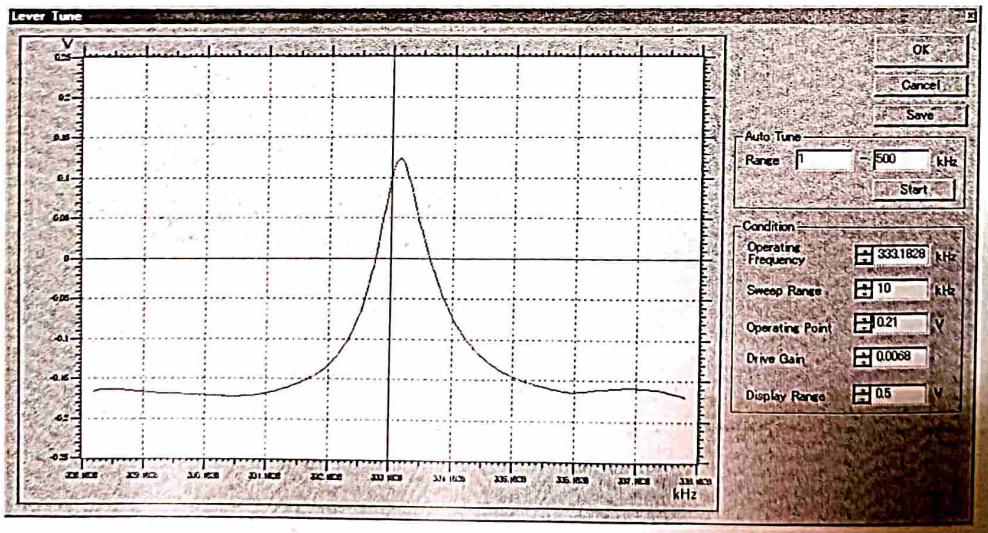
Specify the [Range].

2 Start Auto Tune.



Click [Start].

The operating frequency and operating point are automatically set.



Hint If the waveform does not appear, it is possible that the optical axis is not correctly adjusted or the vibration is not being properly transmitted to the cantilever. Repeat the procedure from cantilever installation.

Lever Tune Fine Adjustment

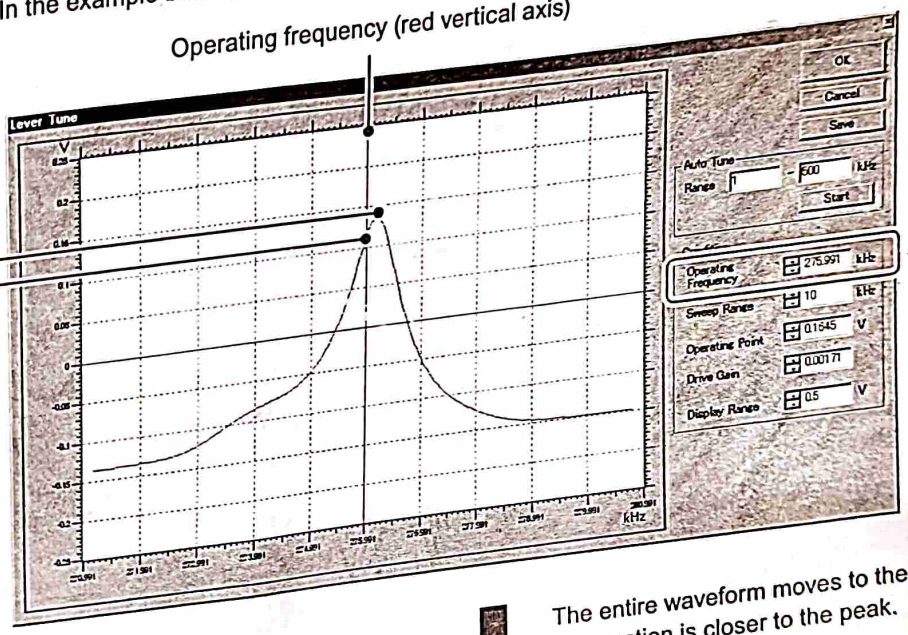
Scanning is possible after Auto Tune; however, if needed you can manually fine tune the operating frequency and operating point to make the conditions more suitable.

1 Adjust the operating frequency.

Change the value of the operating frequency to move the waveform so that the intersection between the red vertical axis (operating frequency) and the waveform is positioned to the left of the peak at a point where the slope is steep.

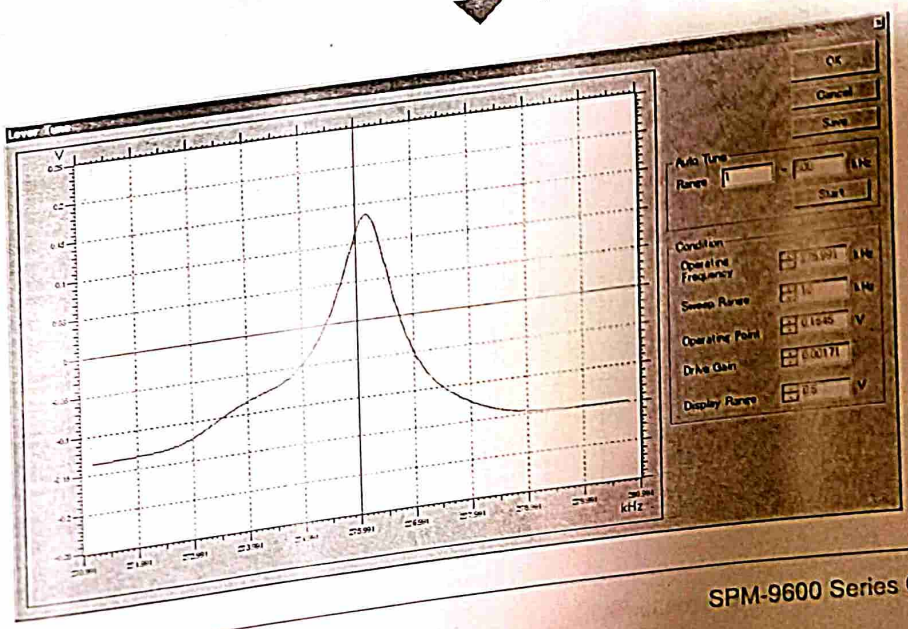
In the example below, the operating frequency has been set lower than the optimum value.

Operating frequency (red vertical axis)



While viewing the movement of the waveform, enter a value in units of 0.05 kHz.

The entire waveform moves to the left and the intersection is closer to the peak.



Lever Tune Fine Adjustment

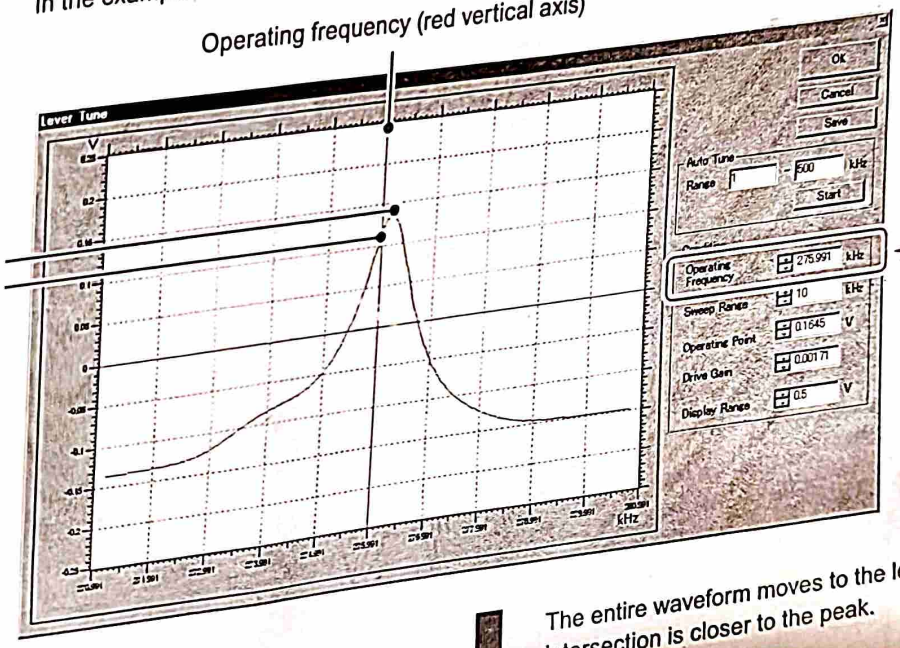
Scanning is possible after Auto Tune; however, if needed you can manually fine tune the operating frequency and operating point to make the conditions more suitable.

1 Adjust the operating frequency.

Change the value of the operating frequency to move the waveform so that the intersection between the red vertical axis (operating frequency) and the waveform is positioned to the left of the peak at a point where the slope is steep.

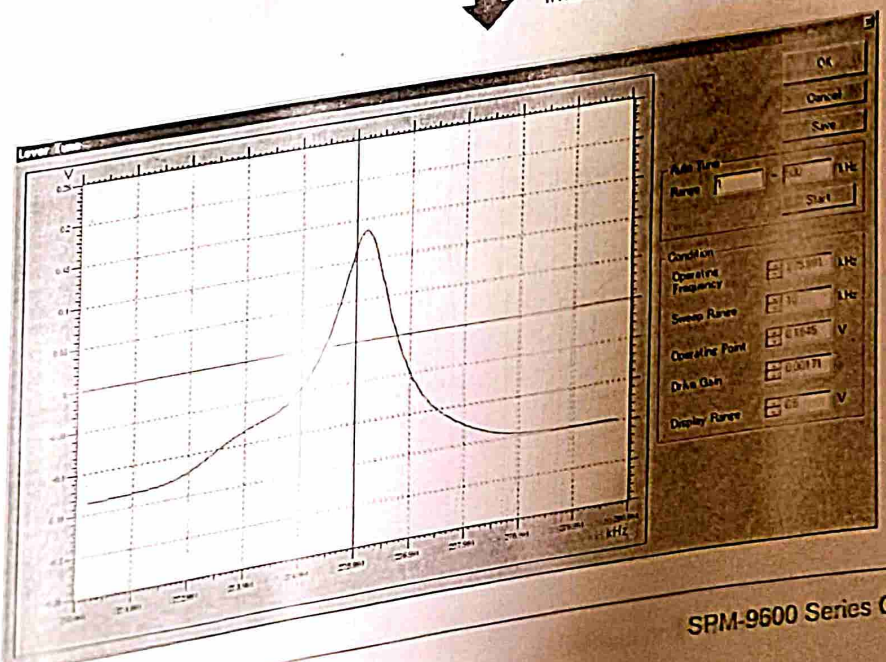
In the example below, the operating frequency has been set lower than the optimum value.

Operating frequency (red vertical axis)



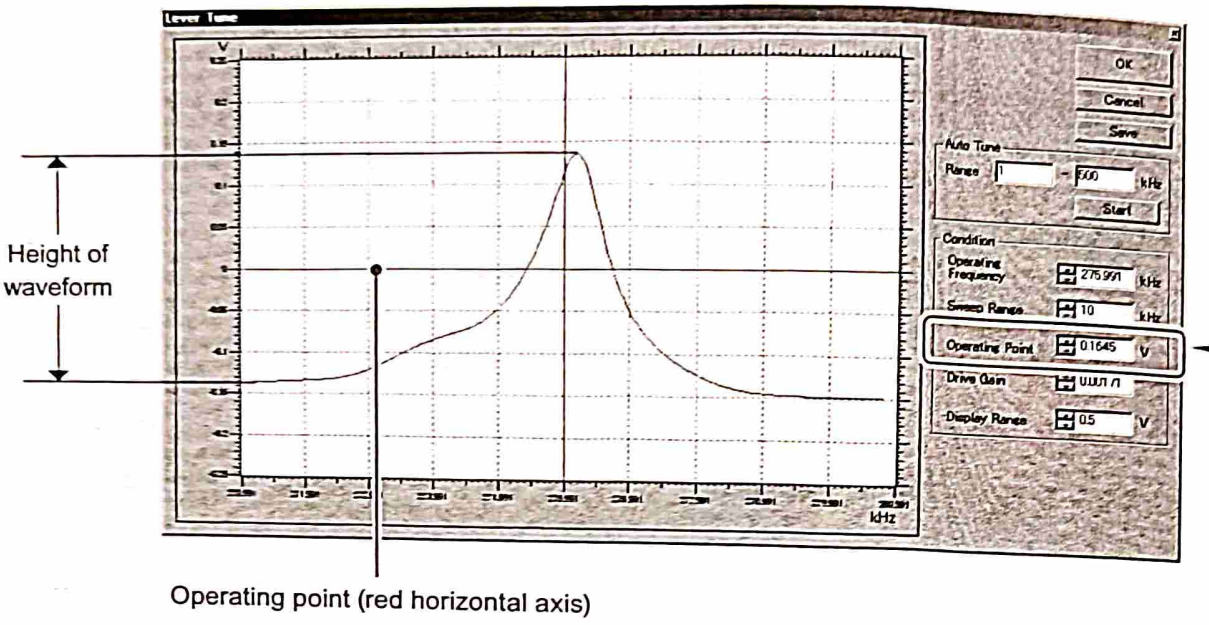
While viewing the movement of the waveform, enter a value in units of 0.05 kHz.

The entire waveform moves to the left and the intersection is closer to the peak.

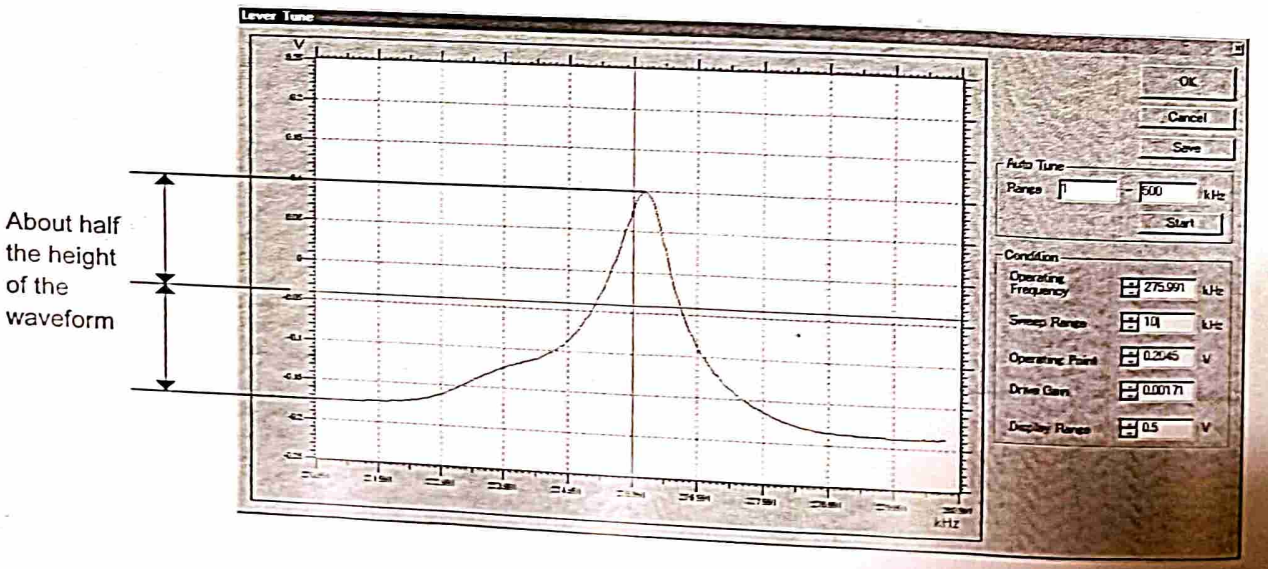


2 Adjust the operating point.

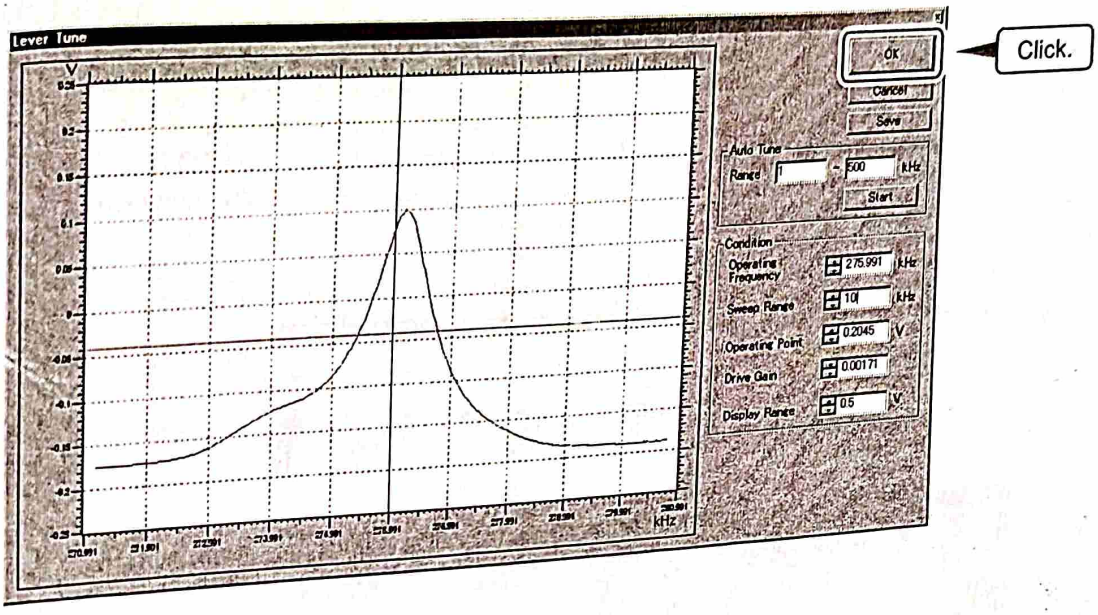
Adjust the operating point to about half the height of the waveform.



The entire waveform moves down.



3 Close Lever Tune.



The current conditions are saved, and the [Lever Tune] window closes with the current operating point and operating frequency reflected in the scanning conditions.

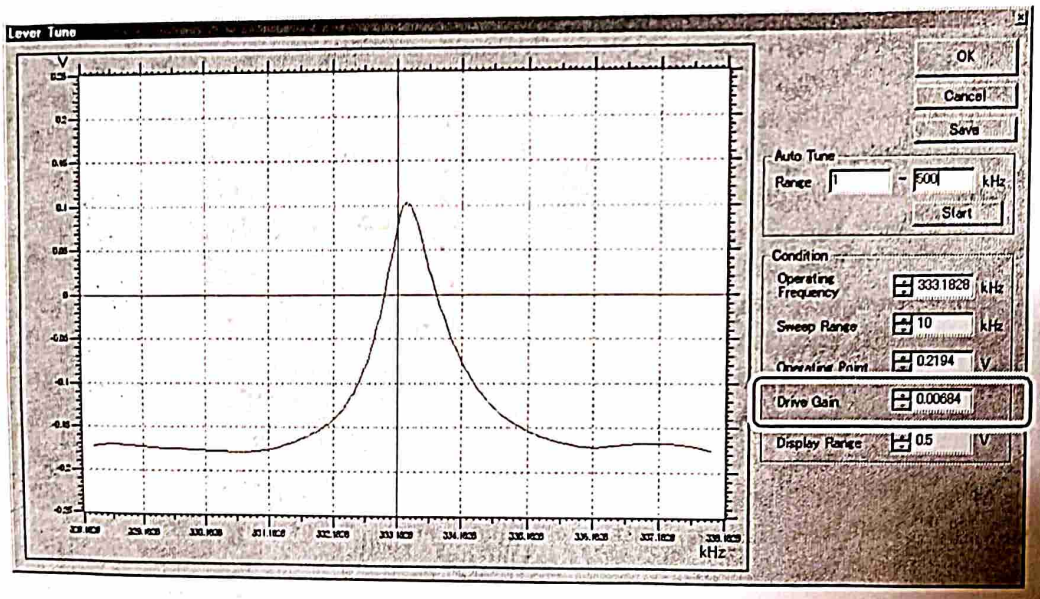
Lever Tune Parameters

cantilever can be changed as
roperties of the sample. The
reasing the amplitude is explained
below.

Hint When the effects of static electricity interfere with scanning, increase the amplitude of the cantilever. When scanning a sample with a hard surface (ITO film, DLC film, etc.), decrease the amplitude of the cantilever. (This prevents wear on the cantilever.)

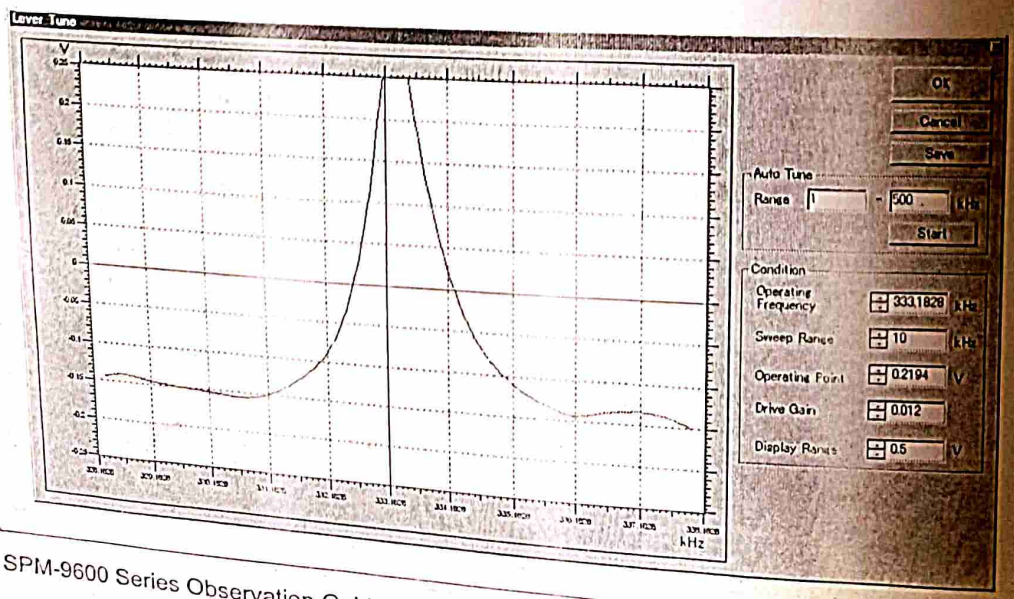
1 Increase the amplitude of the waveform.

Enter approximately twice the value in Drive Gain.
(The value entered varies depending on the sample.
Enter the optimum value for your sample.)



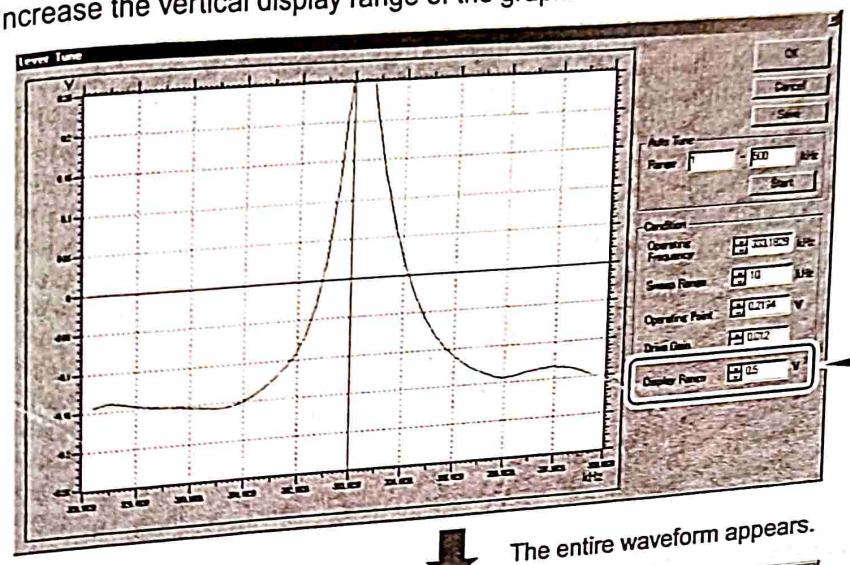
Enter about twice the value.
(Example)
0.0075 -> 0.015

The waveform becomes higher.



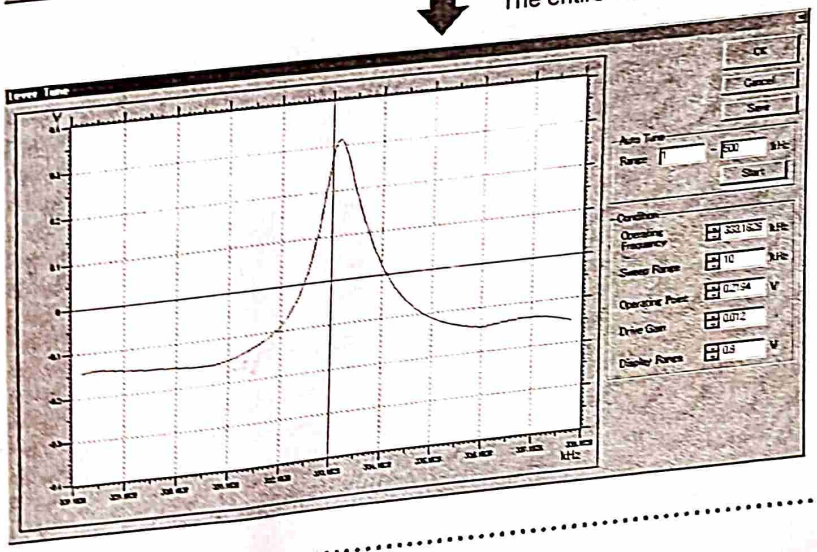
2 Display the entire waveform.

Increase the vertical display range of the graph.



Enter a large value.
(Example)
0.5 V -> 0.8 V

The entire waveform appears.

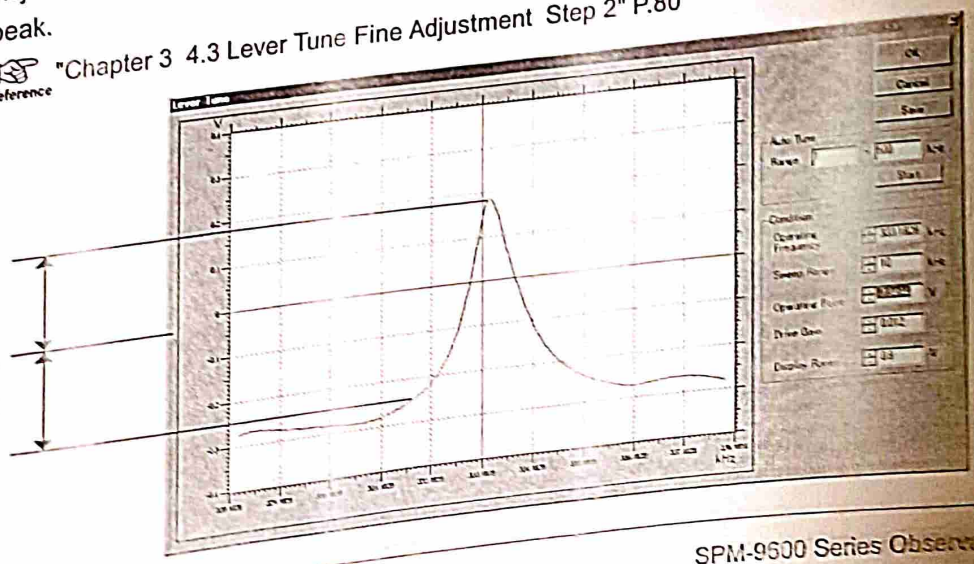


3 Adjust the operating point.

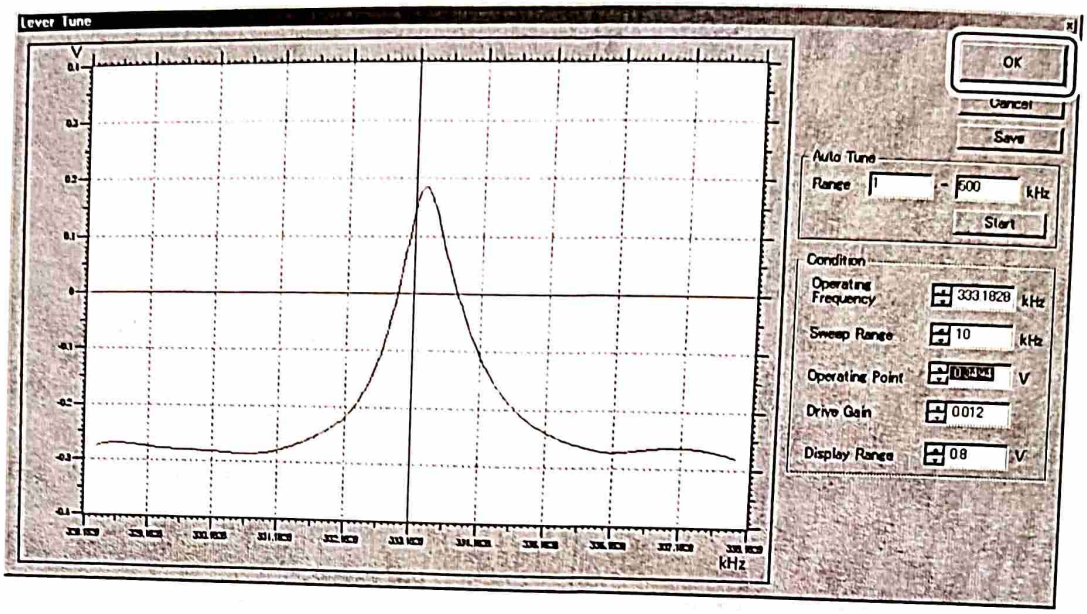
Adjust the operating point to about half the height of the peak.

Reference "Chapter 3 4.3 Lever Tune Fine Adjustment Step 2" P.80

About half the height of the peak



4 Close Lever Tune.

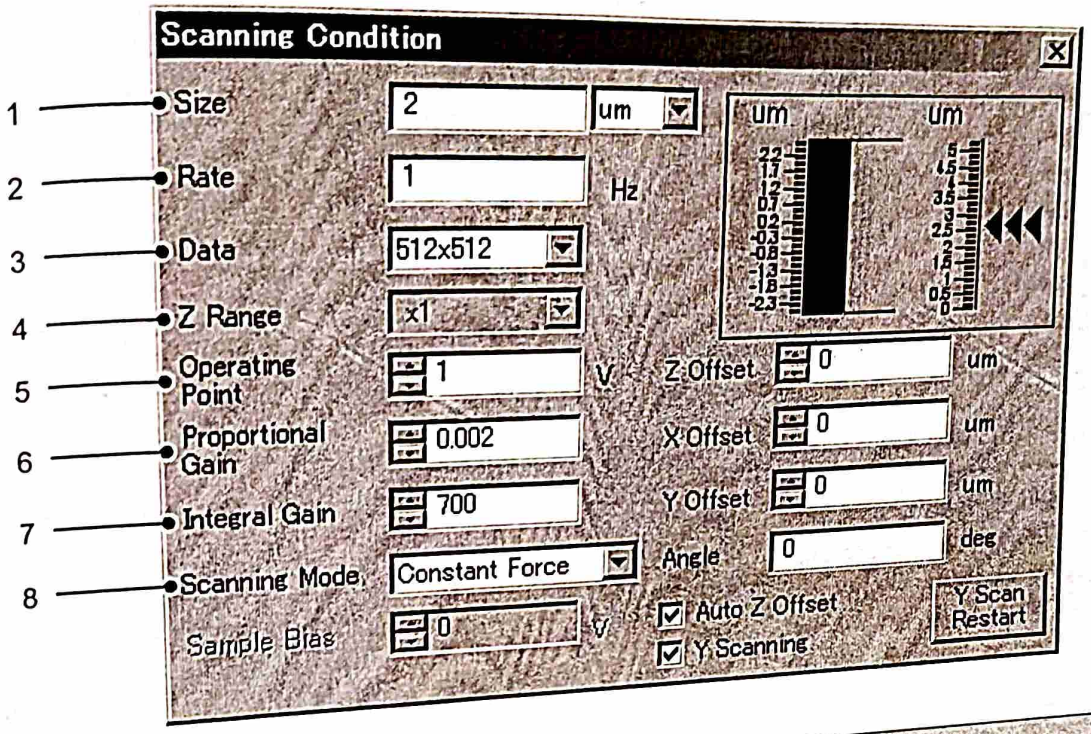


Click.

The current conditions are saved, and the [Lever Tune] window closes with the current operating point and operating frequency reflected in the scanning conditions.

5. Parameter Settings

Set the parameters in the [Scanning Condition] window.



	Parameter	Description	Recommended value at start of scanning
1	Size	The area of the sample surface scanned by the probe (field of vision), indicated as lengths along the X and Y axes.	-
2	Rate	The scanning speed for one line expressed as a frequency. When one line is scanned (back and forth) in one second, the rate is 1 Hz.	*1
3	Data	Specify the number of pixels of data that is acquired.	256×256
4	Z Range	By restricting the dynamic range of the Z feedback signal of the scanner, the feedback resolution is increased. ×1: Feedback from the entire Z range of the scanner is possible. ×2: Feedback is possible over only half the range, but the feedback resolution is doubled. When scanning a relatively flat sample, increasing this sensitivity enables scanning at a higher resolution. If digital bits start appearing in the vertical direction of the waveform when the [Height] signal is monitored in the oscilloscope display, increase the Z range.	×1
5	Operating Point	The force that acts on the sample and probe. In dynamic mode, the smaller this value is, the larger the pressing force.	Value set in Lever Tune
6	Proportional Gain	Indicates the proportional gain with respect to the control signal. A large value is desirable, however, oscillation will occur if the value is too large. Usually the largest value at which oscillation does not occur is set.	0.001

	Parameter	Description	Recommended value at start of scanning
7	Integral Gain	Indicates the integral gain with respect to the control signal. A large value is desirable, however, oscillation will occur if the value is too large. Usually the largest value at which oscillation does not occur is set.	1500 to 3500 *1
8	Scanning Mode	Select whether or not feedback control is applied to scanning. Constant Force :Feedback is applied, and the sample surface shape is output in the height signal. Constant Height :Feedback is not applied and the current height is held. The sample surface shape is output in the deflection signal.	Constant Force

*1 The rate and integral gain at the start of scanning vary depending on the size.

Start with the conditions below and adjust as you scan.

Size	Rate	Integral Gain
1 to 5 µm	1 Hz	1500
5 to 10 µm	1 to 0.8 Hz	2000
10 to 20 µm	0.8 to 0.6 Hz	3000
20 to 30 µm	0.6 to 0.4 Hz	3500

Continue for 'Start Scanning' (section 6), page 42.