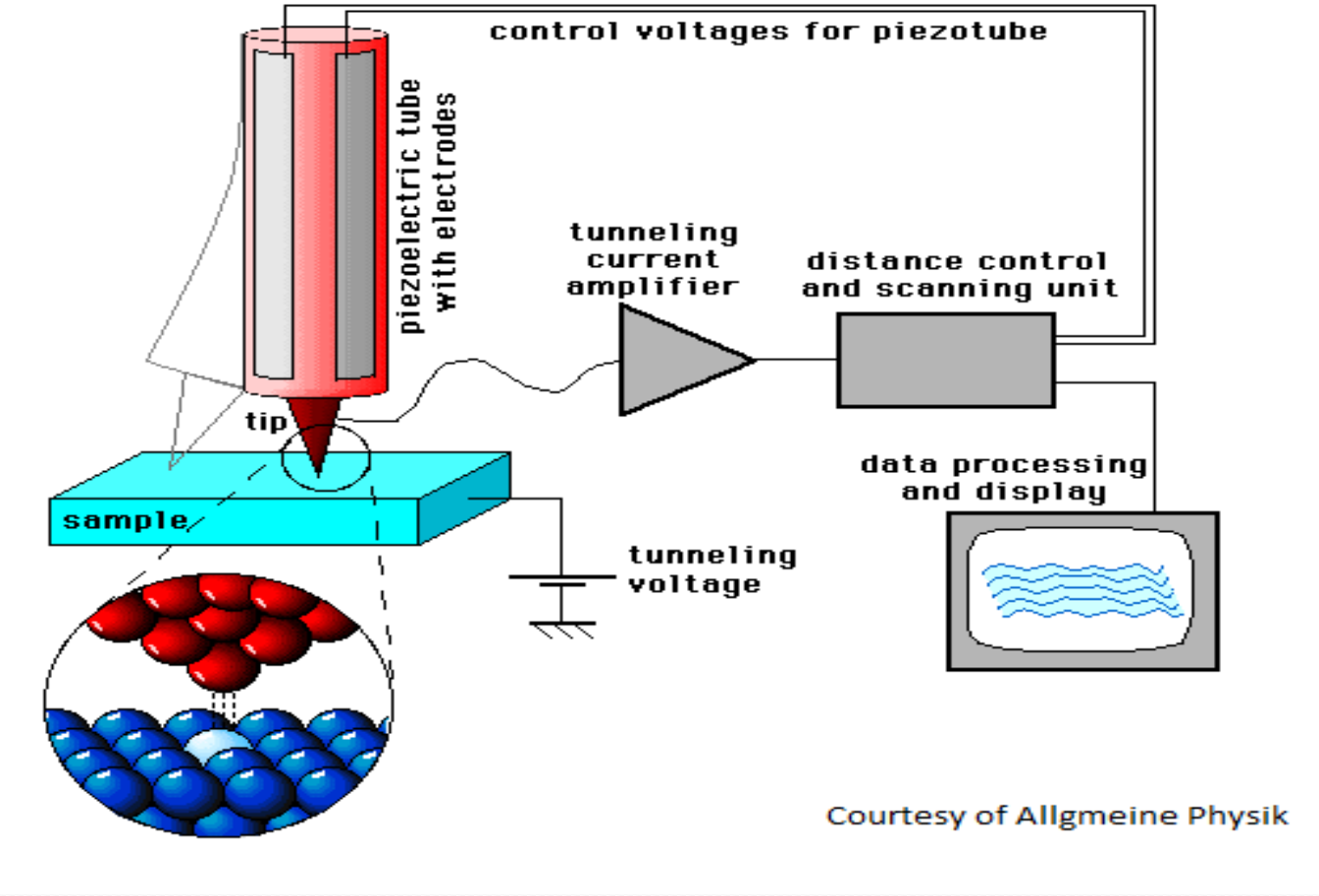
Atomic Force Microscope AFM

- Basic overview and history
- Components and working principle
- Operational modes

Scanning tunneling microscope STM

- Developed in 1981 by Gerd Binnig and Heinrich Rohrer
- Working concept based on quantum tunneling
- Produces three dimensional images
- Scan only electrically conducting samples

STM



A potential difference is applied on the sample surface and a conducting tip is brought very close to that surface which allows electric current to tunnel through the gap.

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- Developed in 1986 by Gerd Binnig, Calvin Quate and Christoph Gerber
- Scans not restricted to conducting samples
- Produces three dimensional topographic images

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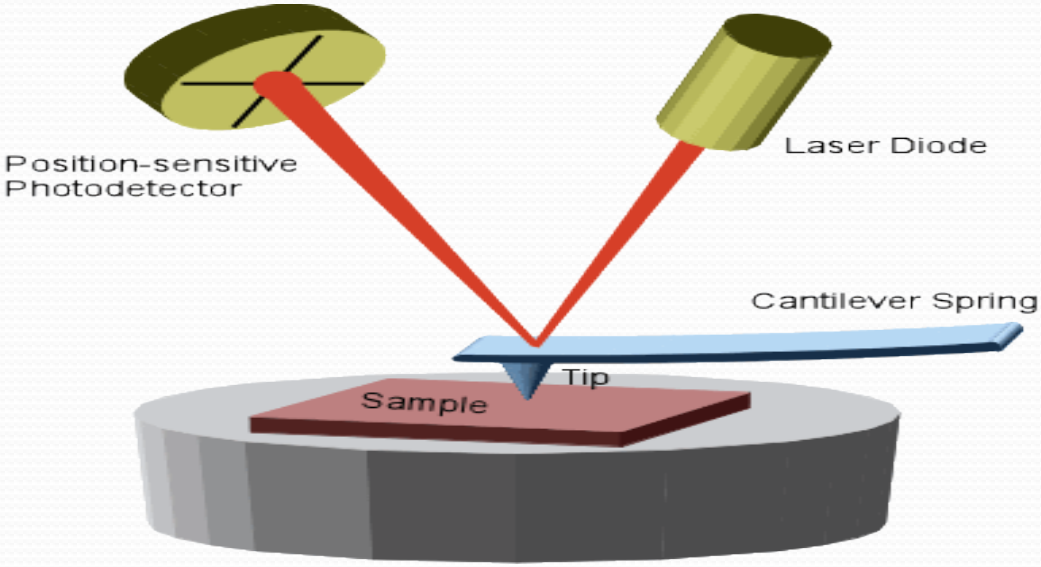
Basic Principle



Surface information is revealed by raster scanning a catilever probe in close proximity with the sample surface and probe sample interaction is monitered.

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Basic Components

- Piezoelectric disk
- Cantilever Probes
- Photo detector
- Feedback Controller

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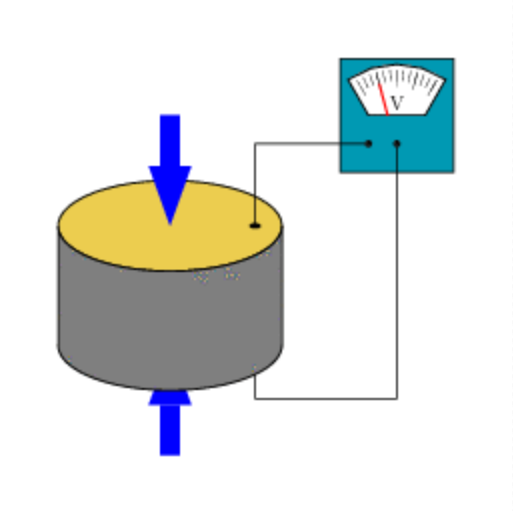
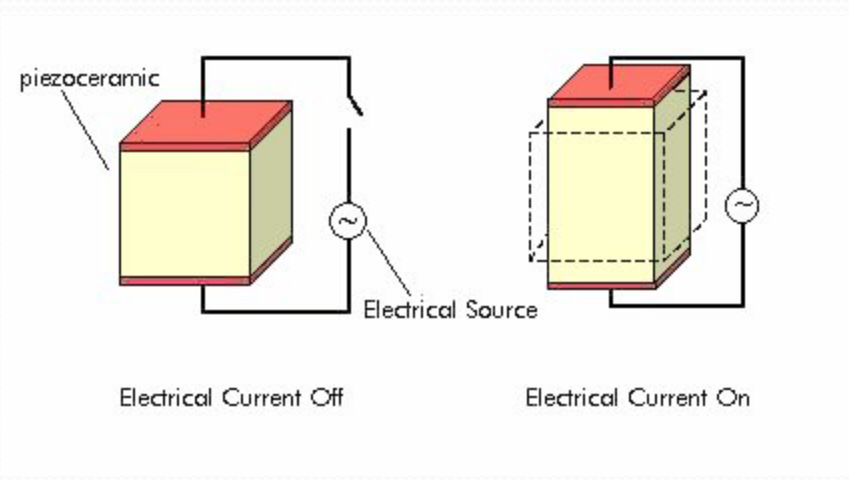
Piezoelectric

- Piezoelectric is a material whose structure is a subject to change, regarding with an external voltage applied to it.





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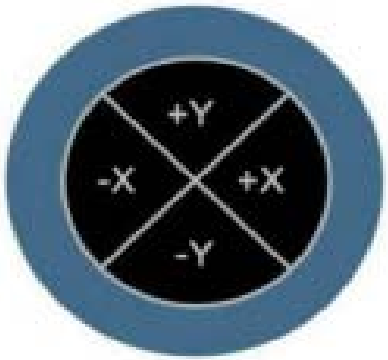
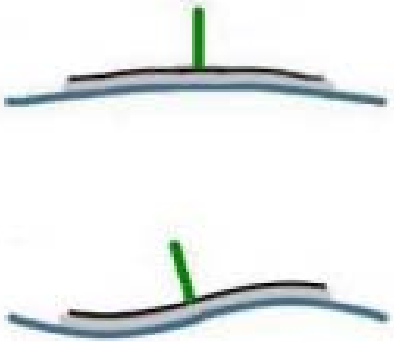
Piezoelectric

- A piezo disk is used to actuate the AFM's sample stage. The circular electrode is divided into four quadrants to enable 3-axis actuation. When the same voltage is applied to all quadrants, the disk wobble upwards giving z-axis motion. Differential voltages applied to opposite quadrants, produces the half side wobble, which moves the stage along the x- and y-axes, with the help of the offset post.





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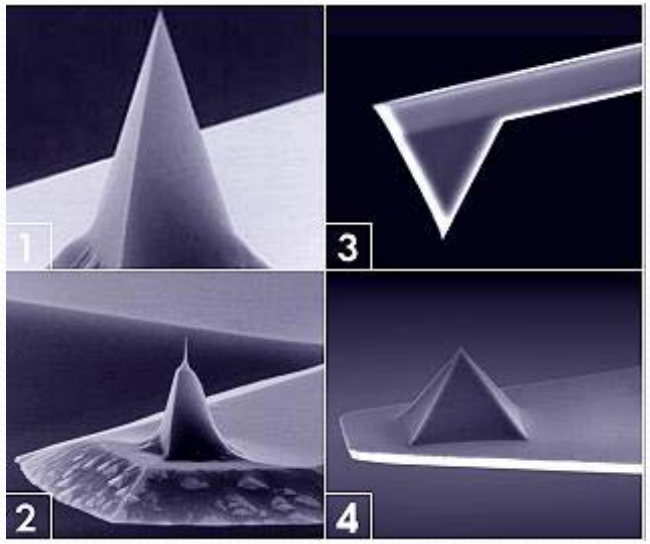
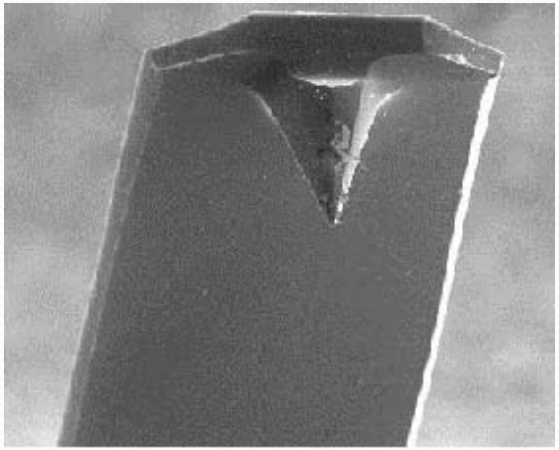
Cantilever Probes

- An AFM probe consists of a cantilever with a small tip at its end. If the tip is brought very close to the sample surface (tip sample distance > 1 nm) we can observe the interaction of Van der Waals forces through the deflection of cantilever.





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Cantilever Probes

Different shape probes and their effects on topography

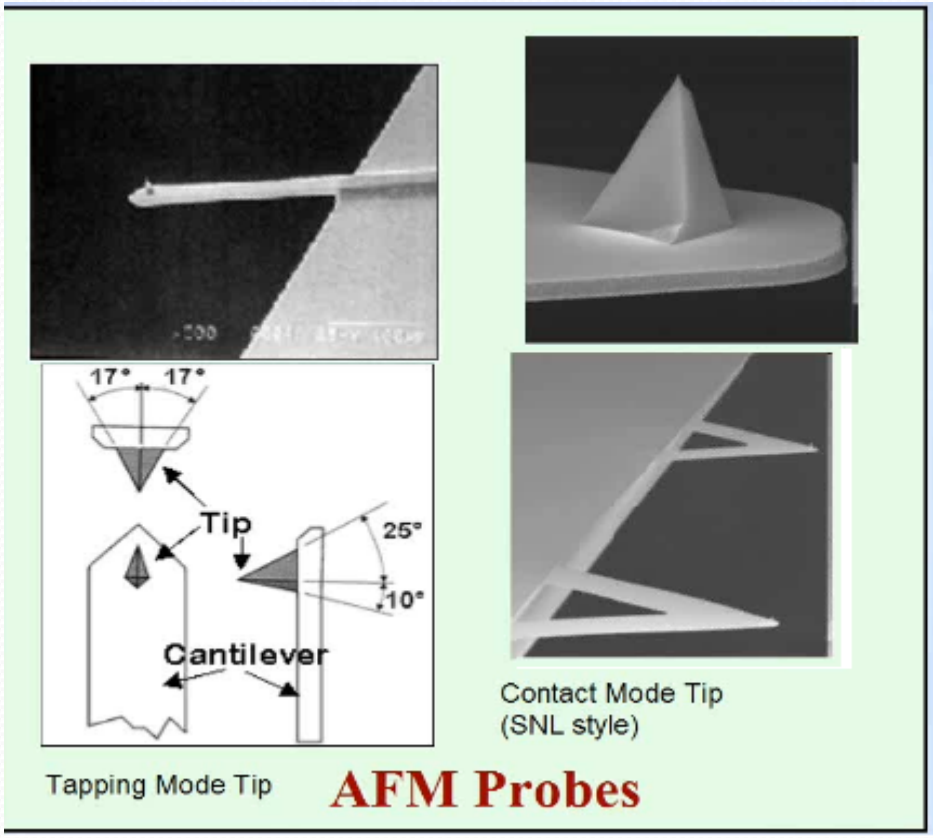

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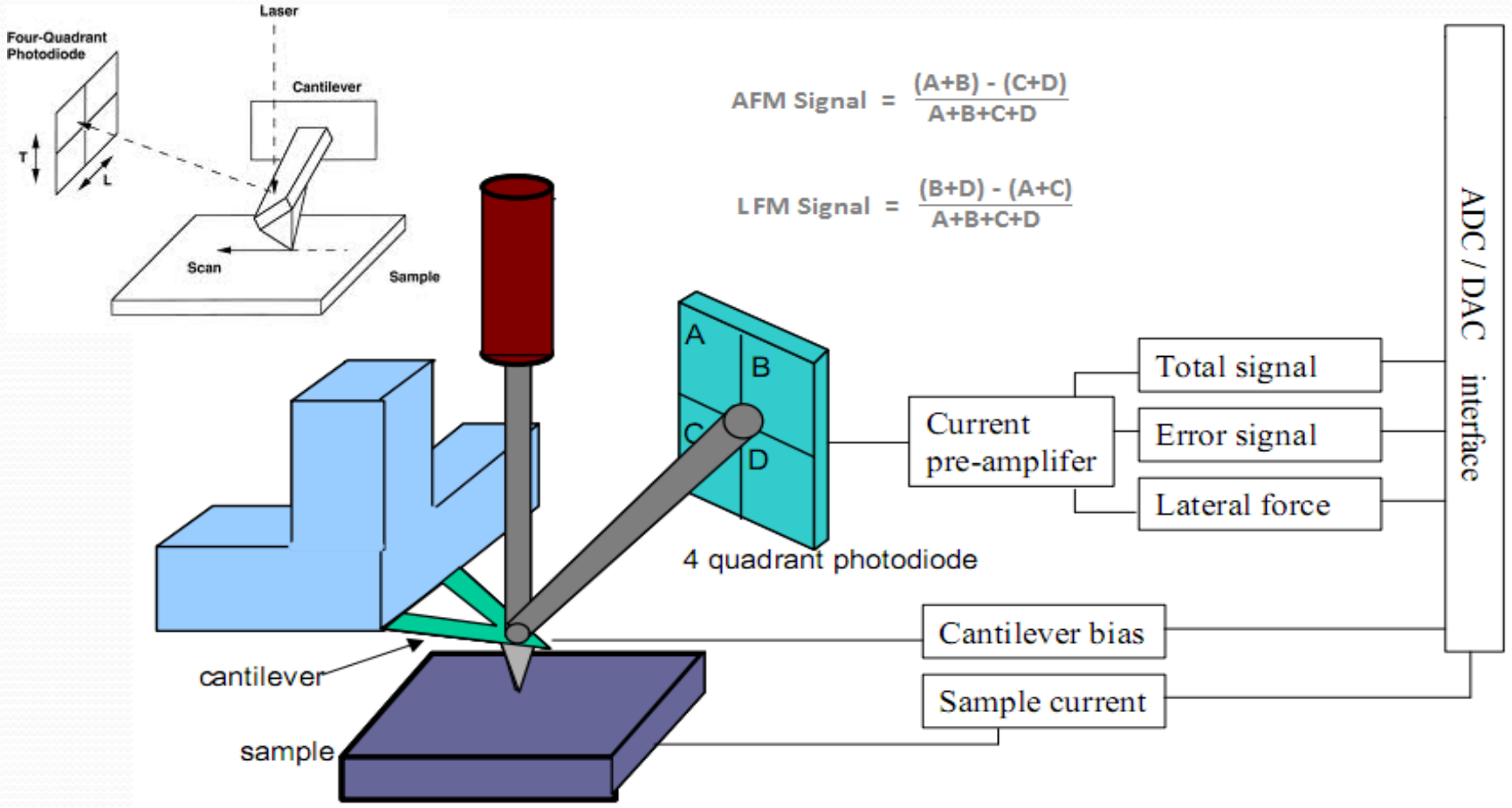
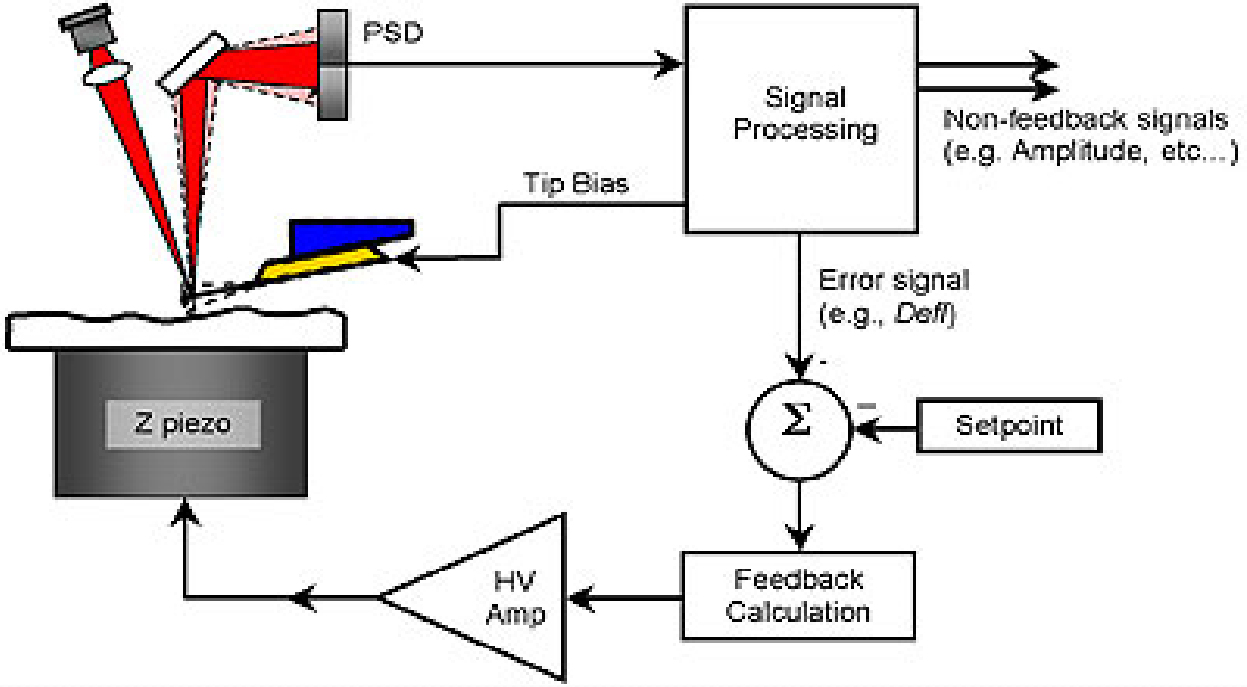
Photo Detector

- A device converts light intensity (no. of photons) into electric current.



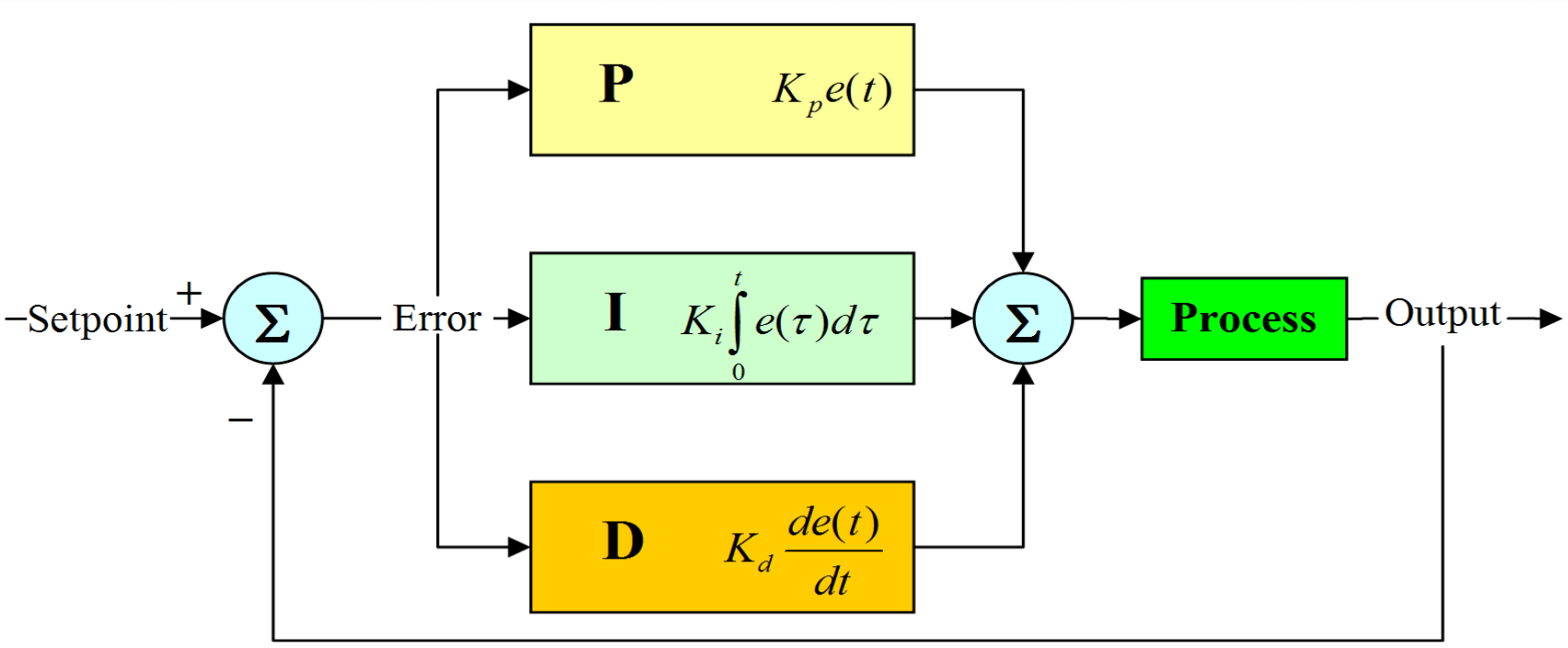
AFM Feedback Controller

- Feedback control system is used to keep the distance between tip and sample constant throughout the scanning.



AFM Feedback Controller

- PID Controller



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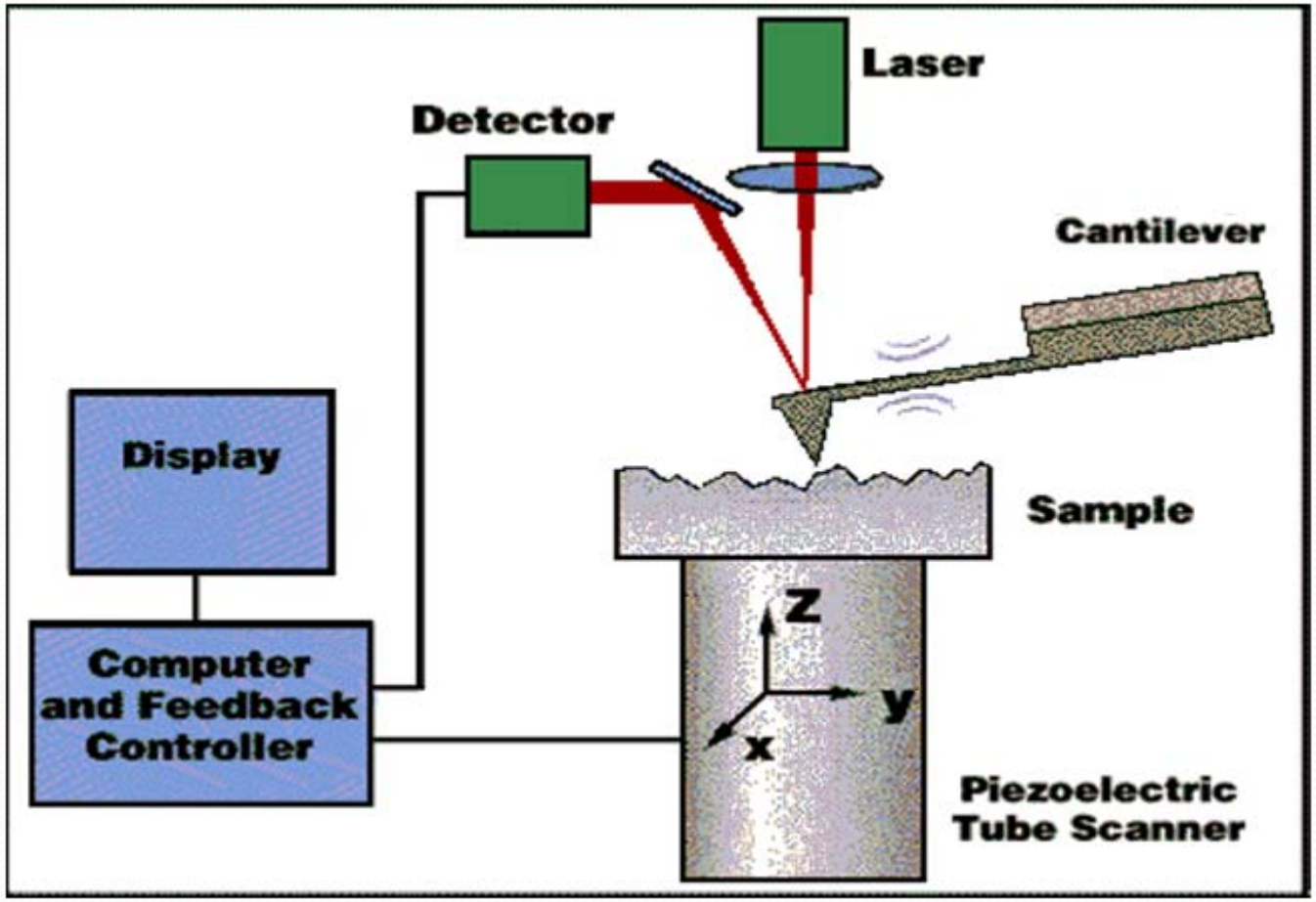
Laser
Detector
Cantilever
Display
Sample
Computer
and Feedback
Controller
z
y
x
Piezoelectric
Tube Scanner

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Operational Modes

- Contact : Tip is in contact with the sample
- Noncontact : Tip hovers very close to the surface
- Tapping : Tip oscillates and tap the surface while scanning.

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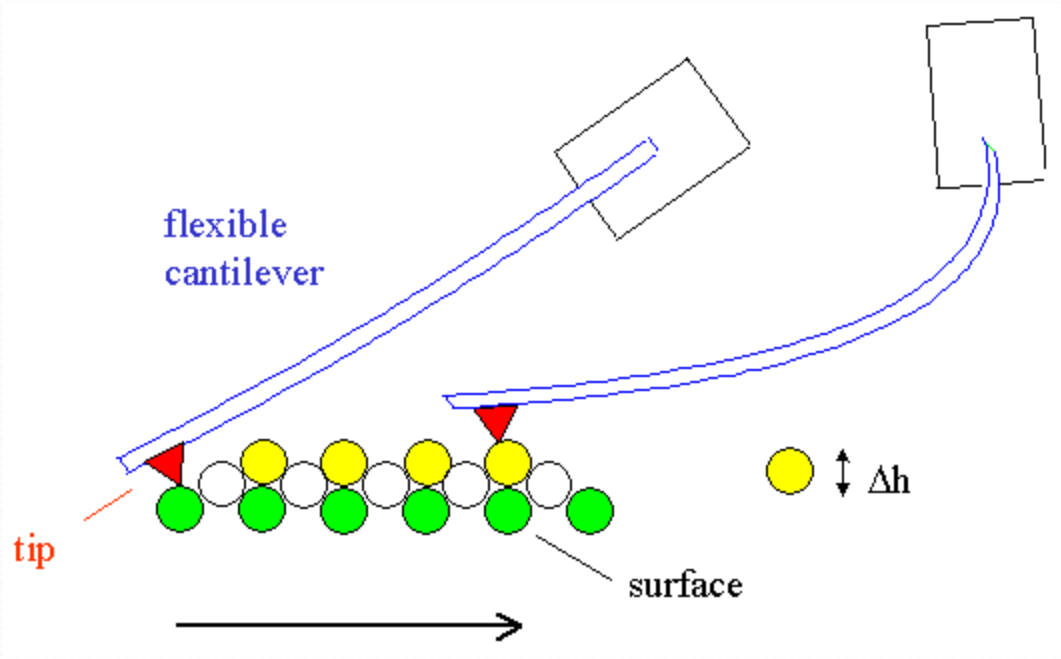
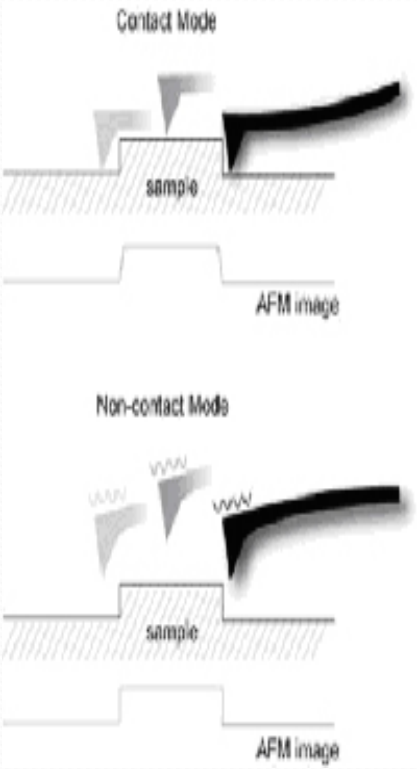
Contact Mode

- Low stiffness probe is used





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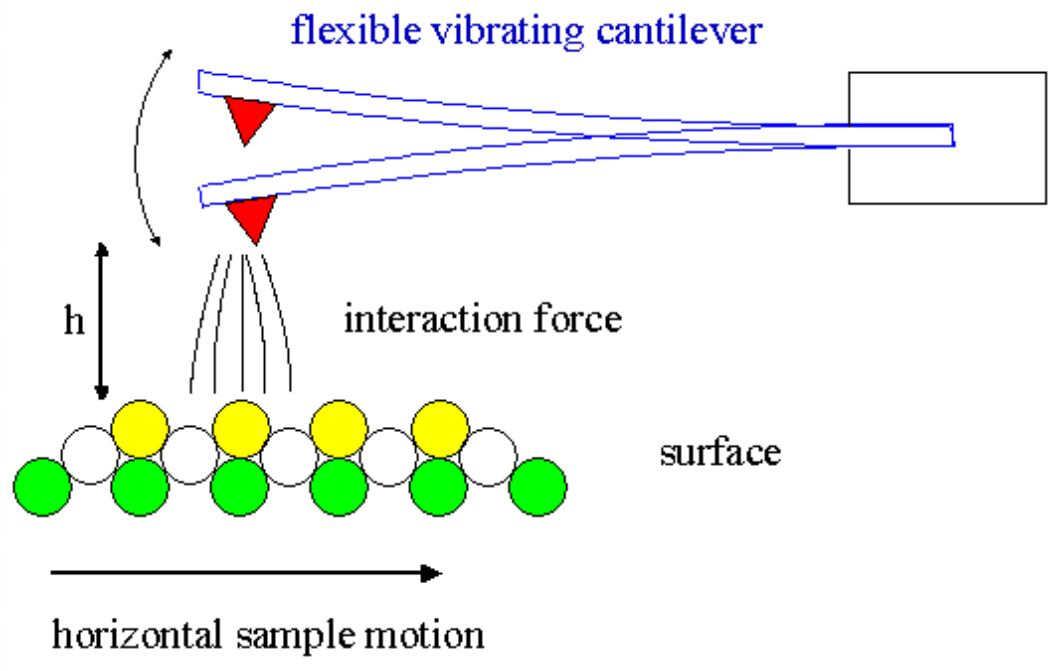
Tapping Mode

- Probe oscillates near its resonance frequency ranging from 50 to 250 KHZ.



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Tapping VS Contact

- Tapping mode is helpful in sampling fragile samples like viscous bio cells.
- Contact mode is helpful in studying different surface features like frictional forces.

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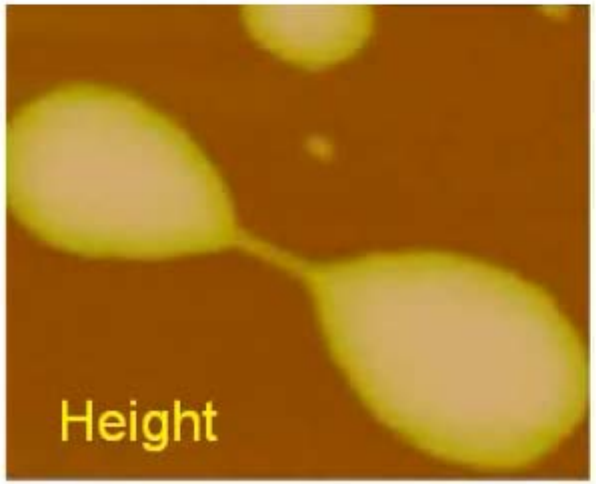
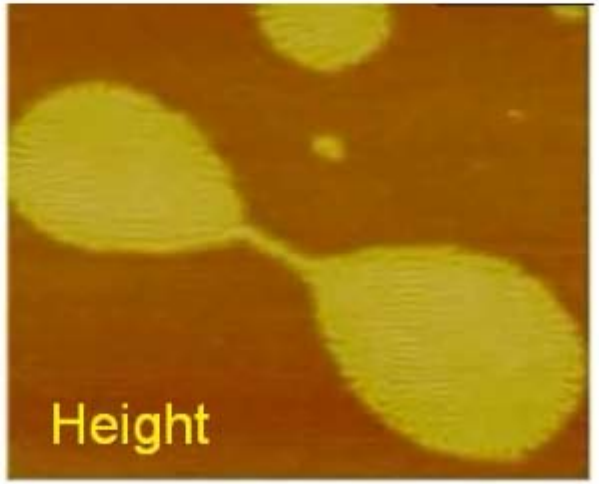
Tapping VS Contact

Tapping Mode



Contact Mode



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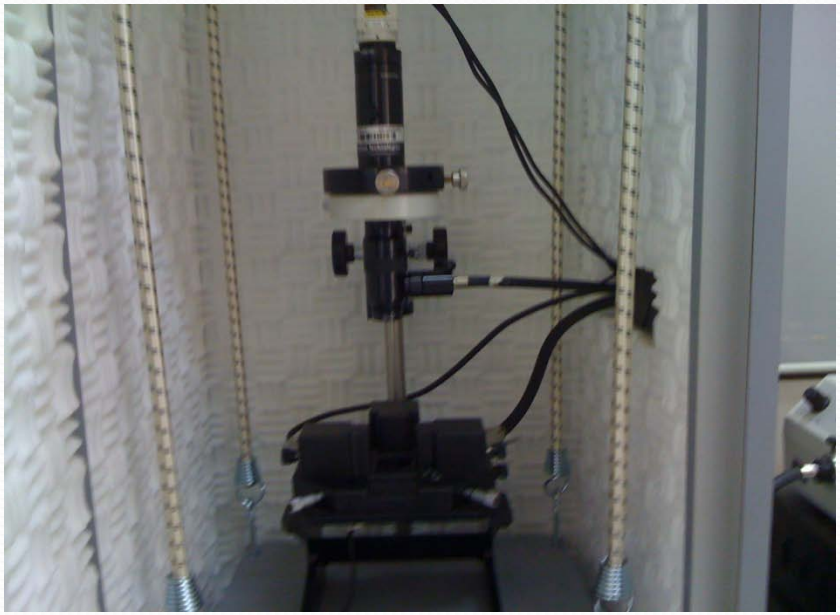
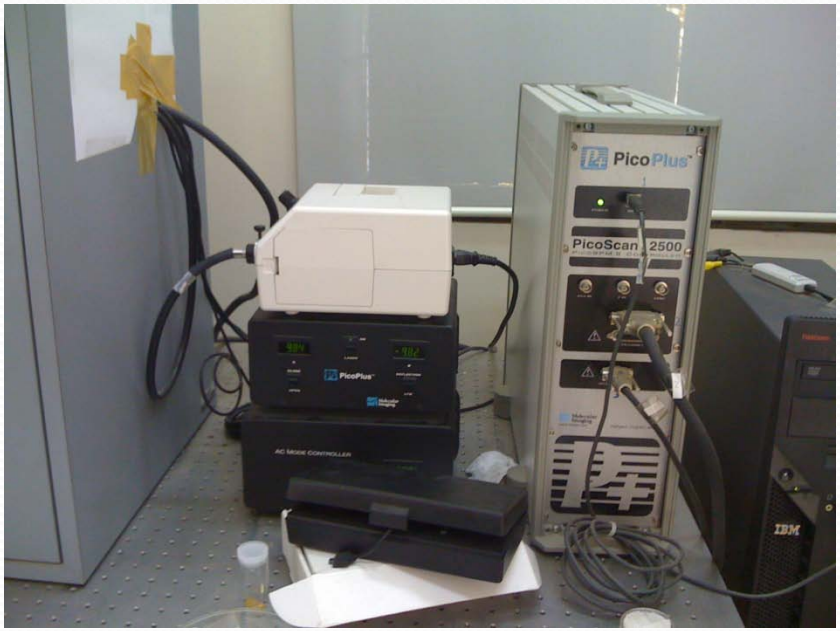
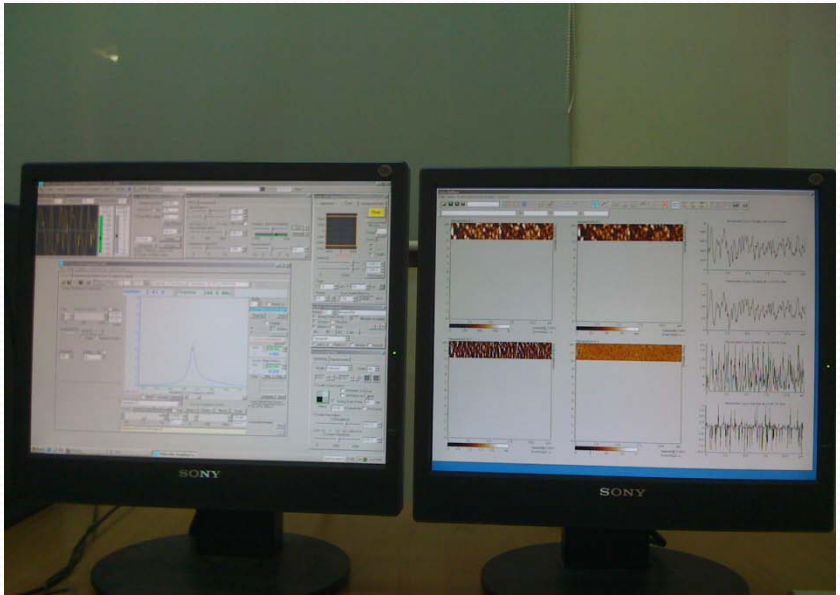



PicoPlus
PicoScan 2500
AC Mode Controller
IBM


IBM
SONY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Questions