NT-MDT Co.
Company introduction and products overview

Your choice is granted

History and background

NT-MDT that is:

- **More than 17 years on the SPM market**
- **More than 900 installations in 52 countries**
- **250+ employees in Zelenograd&Moscow offices**
- **Distribution worldwide**

"Zelenograd" means "The Green Town". In the 20th century it became the cradle of Russian microelectronics. Outburst of High-Tech activity that had occurred at the edge of 20-21th centuries named Zelenograd as "Russian Silicon Valley".

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NT-MDT brief introduction

NT-MDT that is:
Leading Nanotechnology instrumentation supplier in Russia

Personal:
NT-MDT: 250 staff,
2 Professors, 29 PhD,
128 engineers +
Holland – 10
Ireland -18
USA - 3

Dr. Victor Bykov

The President and the major company founder started the company in 1989

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Sales map

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NT-MDT Concern structure

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Branch offices in Europe

Holland, Eindhoven

NT-MDT
NanoTechnology Instruments – Europe BV

Ireland, Limerick

NT-MDT
Service and Logistics Ltd.

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Sales and Support in Europe

Ireland:

Assembling
Logistics

Netherlands:

Sales
Customer support

NT-MDT Service and Logistics Ltd.

NT-MDT NanoTechnology Instruments – Europe BV

OMNILAB — **Switzerland**

Axess Tech — **France**

SURFACE — **Germany**

PRA.MA. — **Italy**

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NT-MDT-USA, SANTA CLARA

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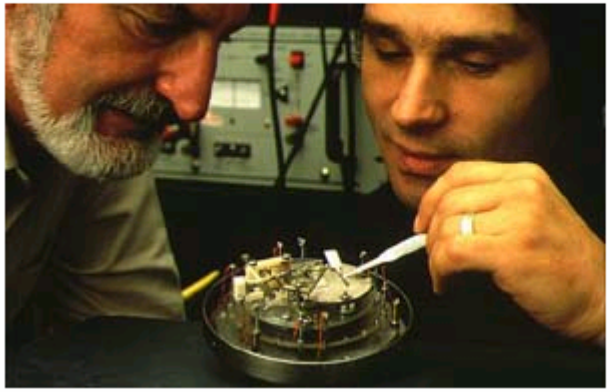
Scanning Probe Microscopy

What is it?

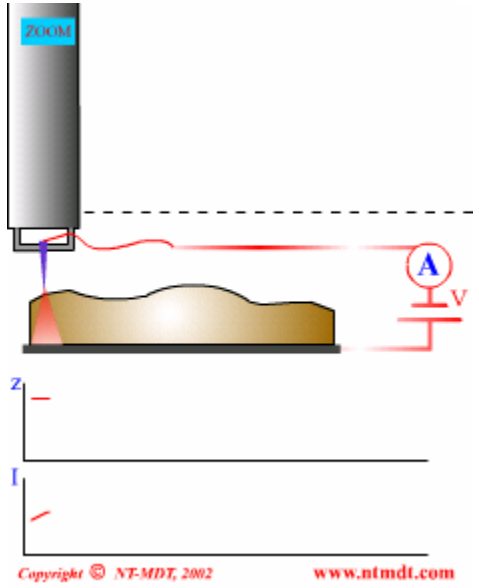
STM invention was awarded by Nobel Price in 1986

Founding Fathers of Scanning Probe Microscopy.

The founders Scanning Probe Microscopy are Binnig и Rohrer. Patent for Scanning Tunneling Microscope was issued Aug. 10, 1982 (Priority Sept. 20, 1979) (Patent., Figures 1-6, Figures 7-12, Figures 13-14).



Heinrich Rohrer, left, and Gerd K. Binnig, right, scientists at IBM's Zurich Research Laboratory in Switzerland, are awarded the 1986 Nobel Prize in physics for their work in scanning tunneling microscopy. The researchers are recognized for developing the powerful microscopy technique, which allows scientists to view individual atoms on the surface of a sample. The photo is kindly submitted for a museum by Dr. G. Binnig.



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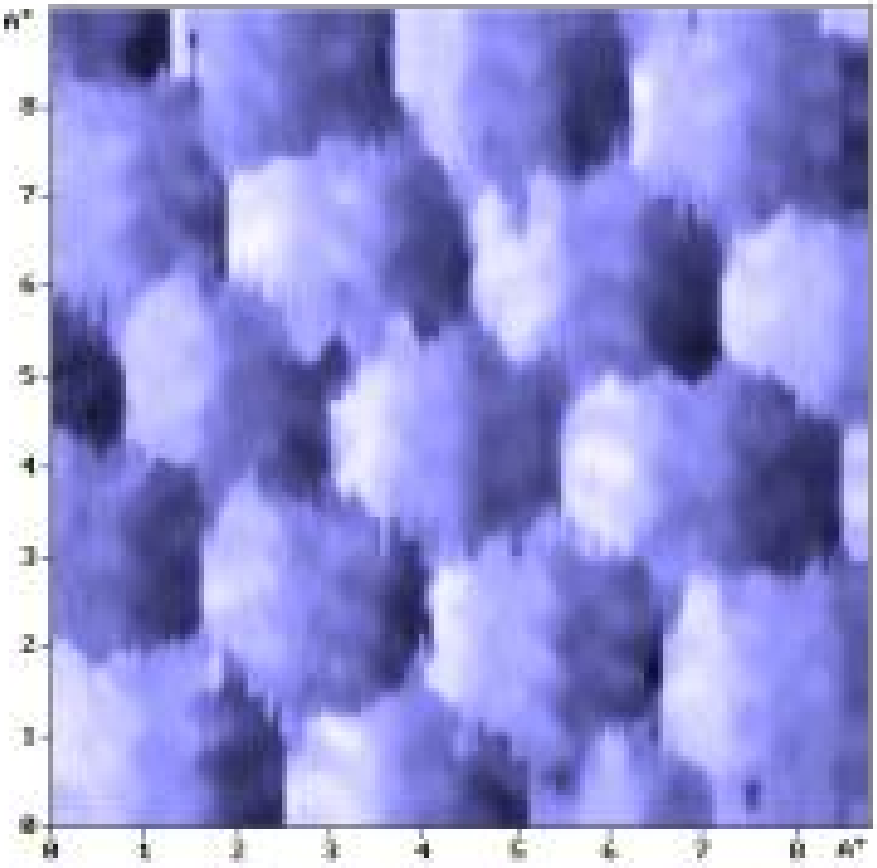
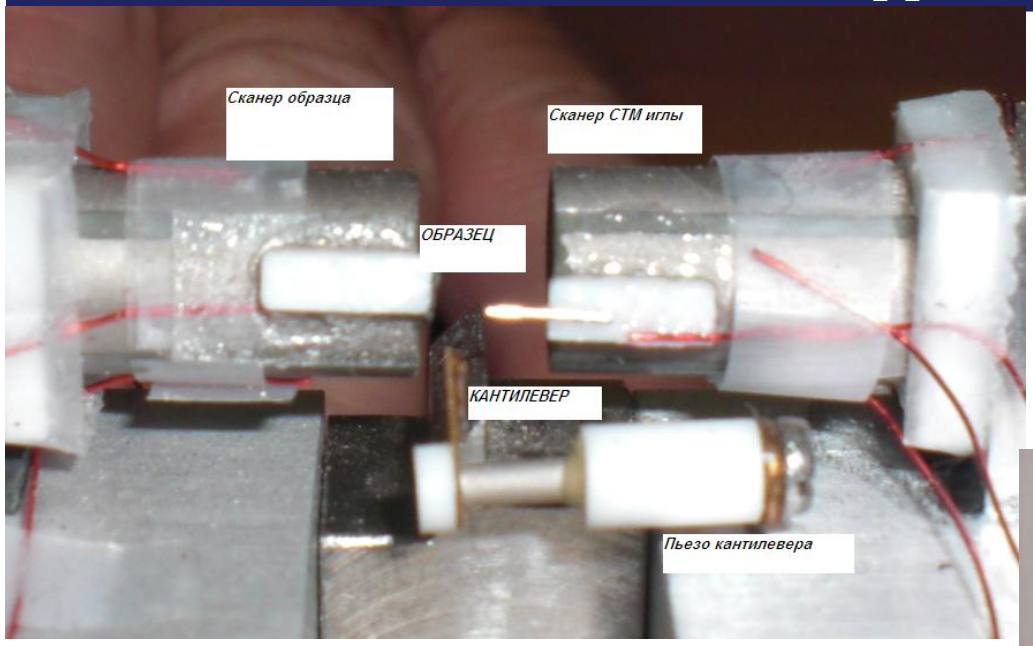
Scanning Probe Microscopy – the way to see atoms

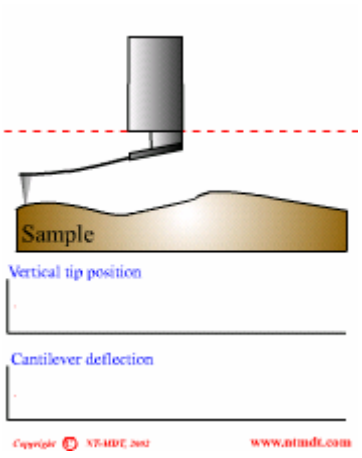


SPM image of graphite surface. Spheres are individual carbon atoms. Image size 8x8 angstrom.

First AFM was built by C. Gerber and expands greatly possible applications



AFM renews the old gramophone concept and boost nanotechnology!



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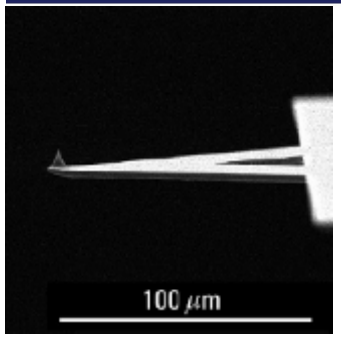
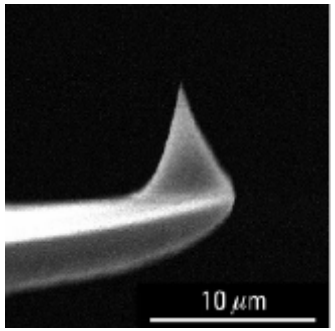
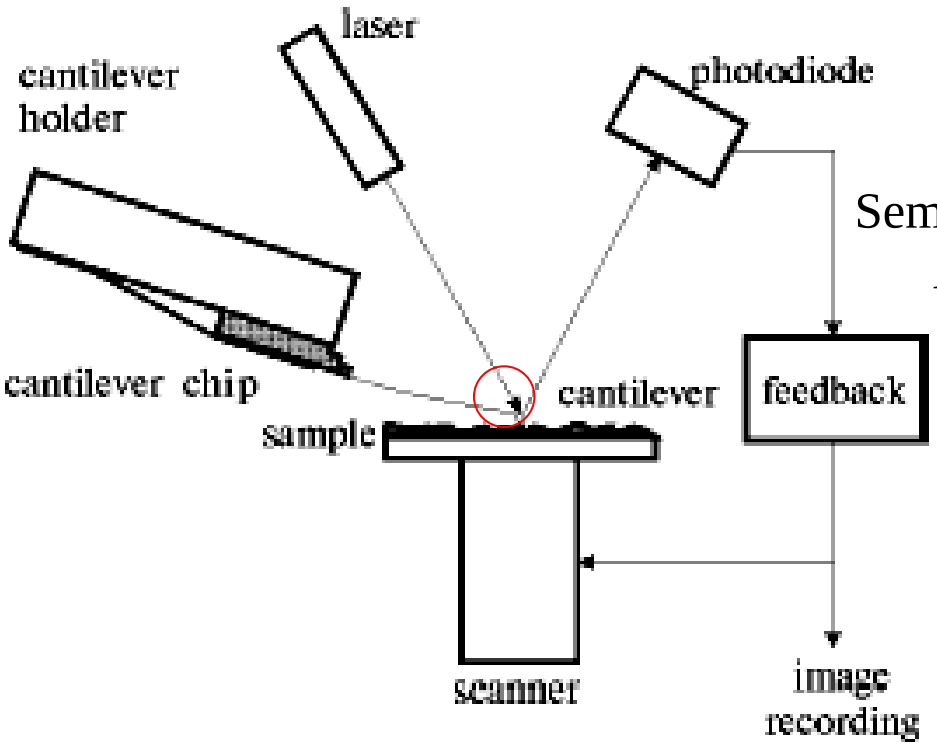
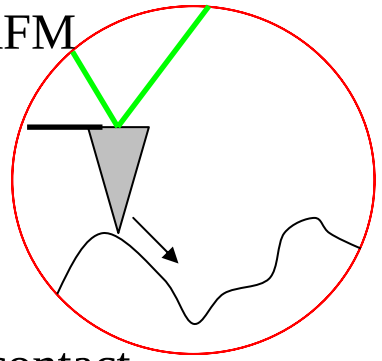
AFM - principles



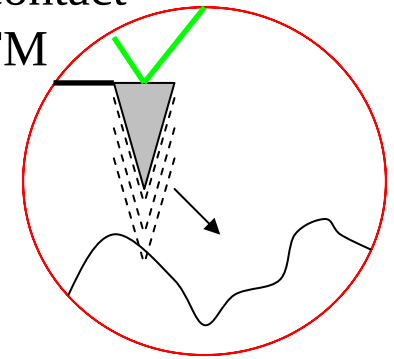




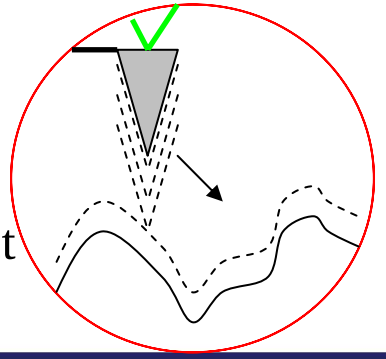
Contact AFM



Semi-contact AFM



Non-contact AFM



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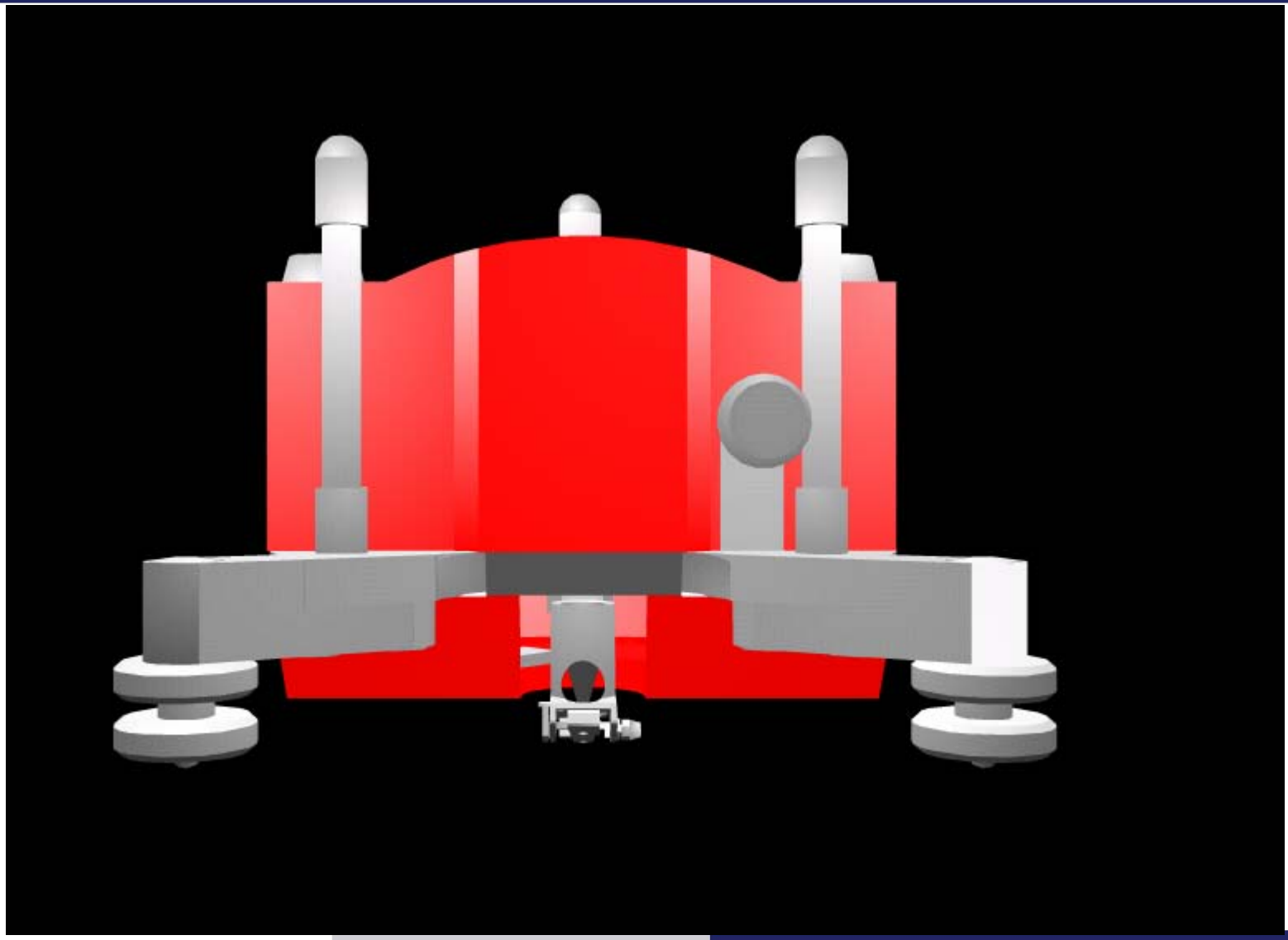
AFM – how it works



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There are 3 different SPM technologies: STM, AFM, SNOM

	 Atomic Force Microscope (AFM)	 Scanning Tunneling Microscope (STM)	 Scanning Near-Field Optical Microscope (SNOM)
Principle	Micro-scale cantilever with a sharp tip (probe) at its end that is used to scan the specimen surface; laser reflection of probe tip measures changes	Electrons hop or "tunnel" from the probe tip to sample; the rate of tunnelling is measured to calculate the distance between the tip and the sample	A tip scans the surface like an AFM while light scatters through an aperture in the end of the tip; light is detected from above or below
Information provided	Surface topography, physical properties	Surface topography, surface electronic structure	Surface topography and optical properties
Possible resolution	2 to 10nm; mainly affected by the curve radius of the tip (7-12nm) and roughness of the surface	Lateral: 0.01nm to 1 nm; vertical: 0.1 nm	30 to 100 nm, depending on mode, probe and sample preparation
Scan area	max. 100 µm x 100µm	100 µm x 100 µm	80 µm x 80 µm
Scan speed	1 to 20 minutes (0.5 to 10 lines per second)	Several minutes; speed of scanning is restricted by the response time of feedback system	20 to 70 µm per second

92% of total SPM market 8%

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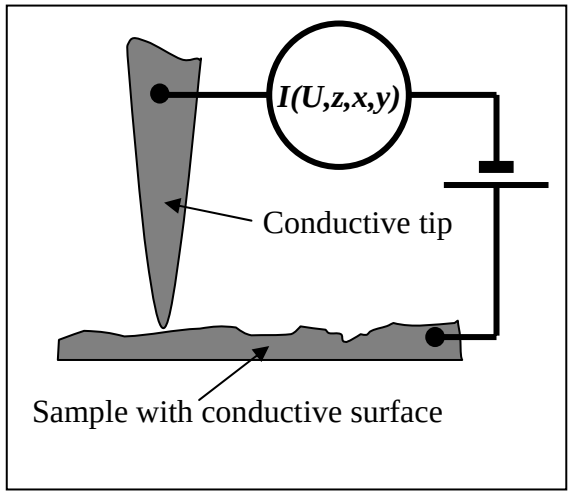
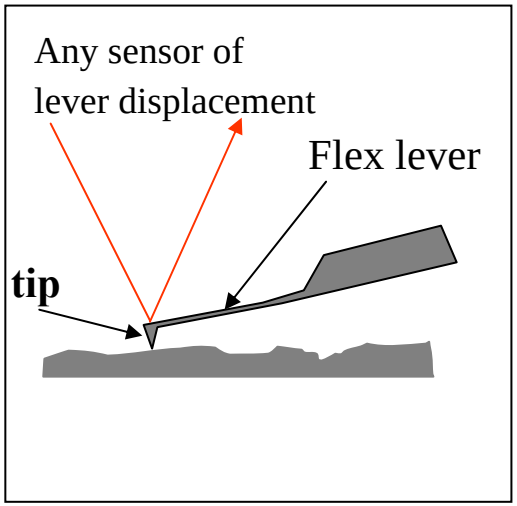
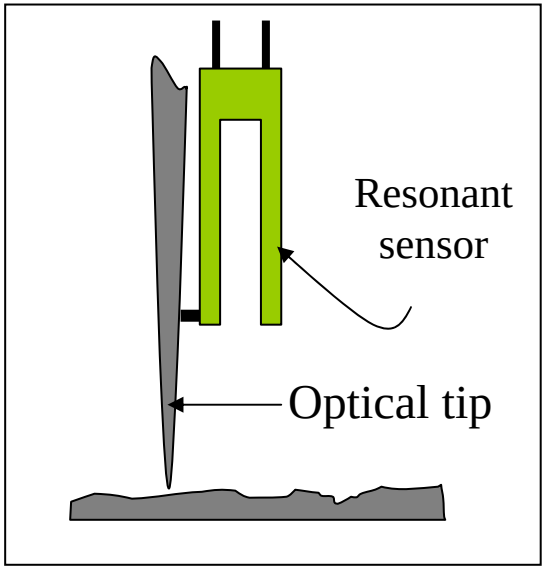
SPM=Scanning Probe Microscopy

Probe tip obtain the information from every point of an object surface.
Different methods get different information.







Scanning Tunneling Microscopy
Conductive sample

Atomic Force Microscopy
Any solid surfaces

Scanning Near-Field Microscopy
Optical properties

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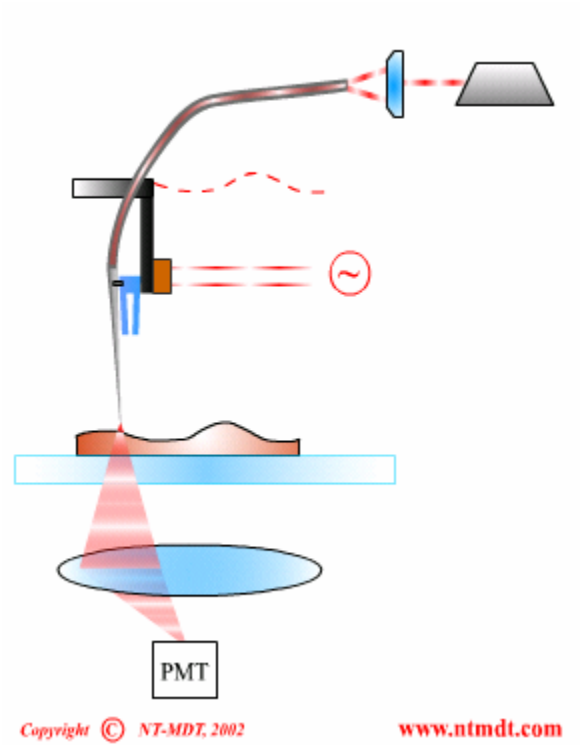
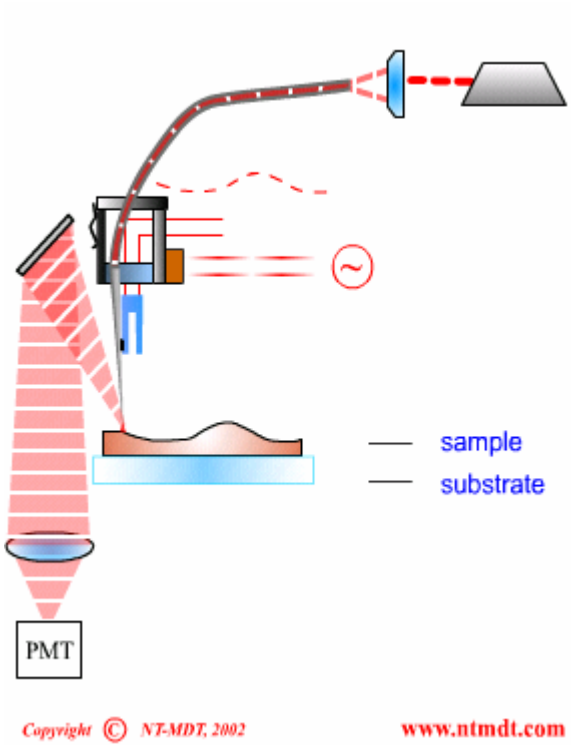
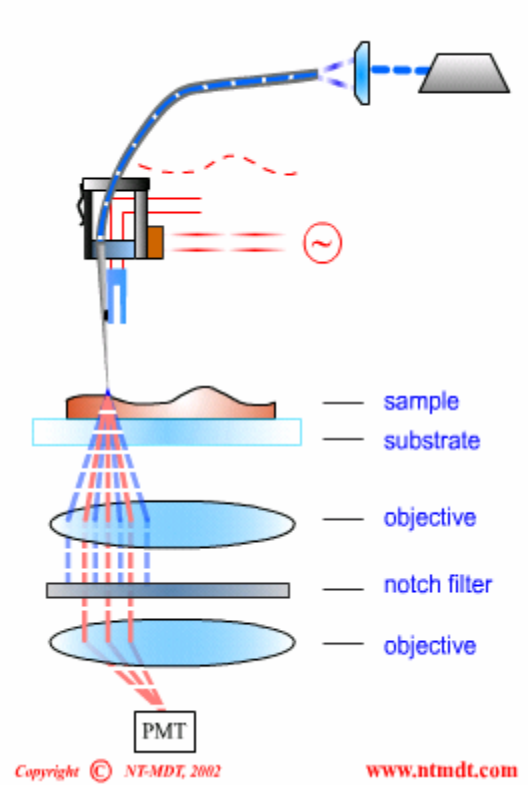
SNOM modes



Transmission



Reflection



Fluorescence

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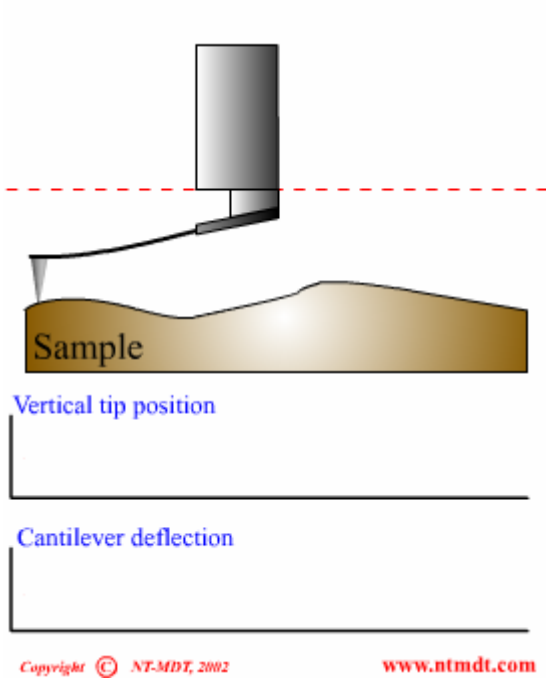
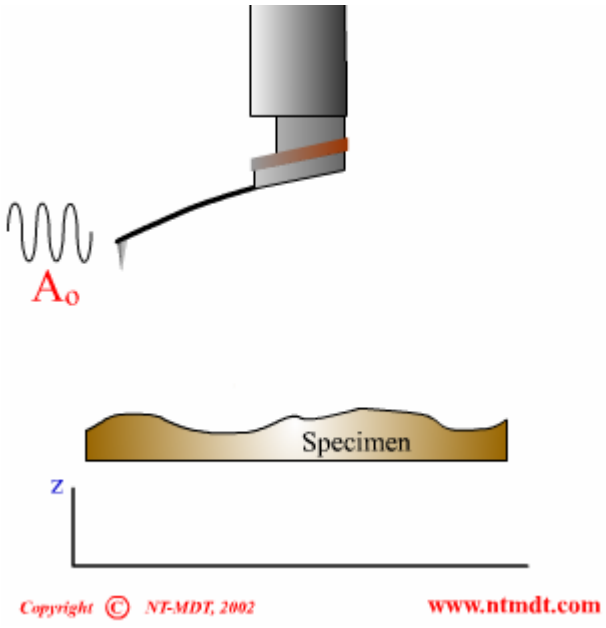
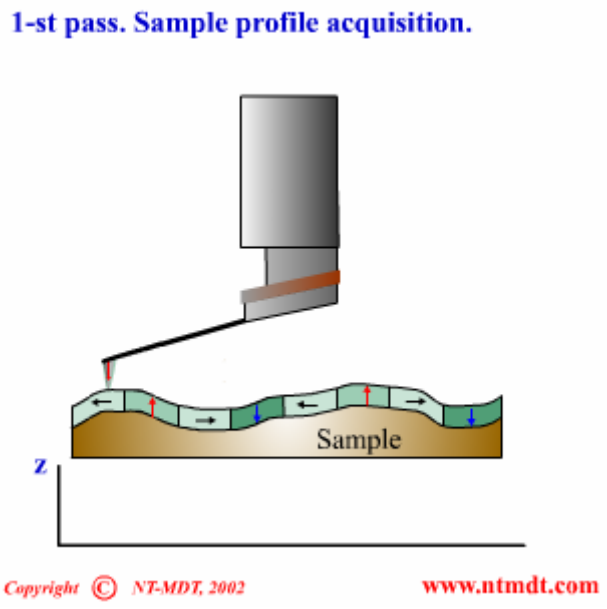
AFM techniques



Contact AFM



Semi-Contact AFM



Many-Pass AFM

There are more than 40 different methods to form an image by AFM

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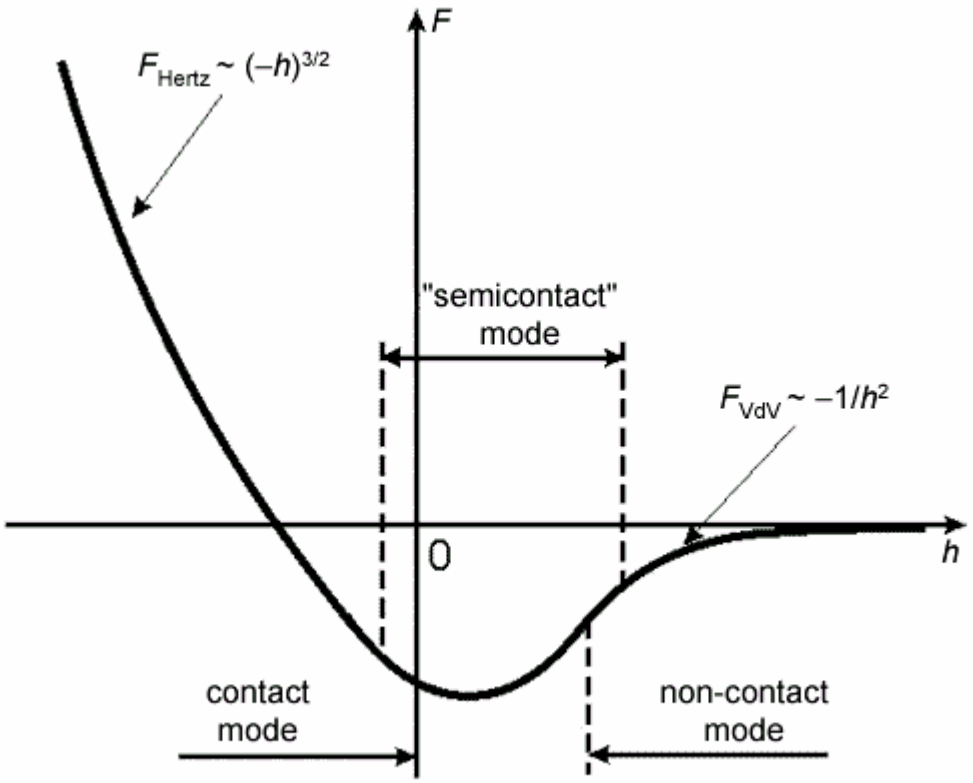
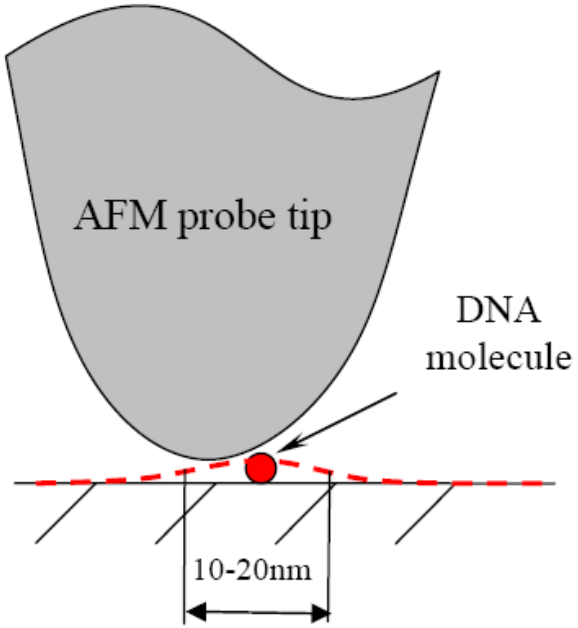
Forces behind AFM

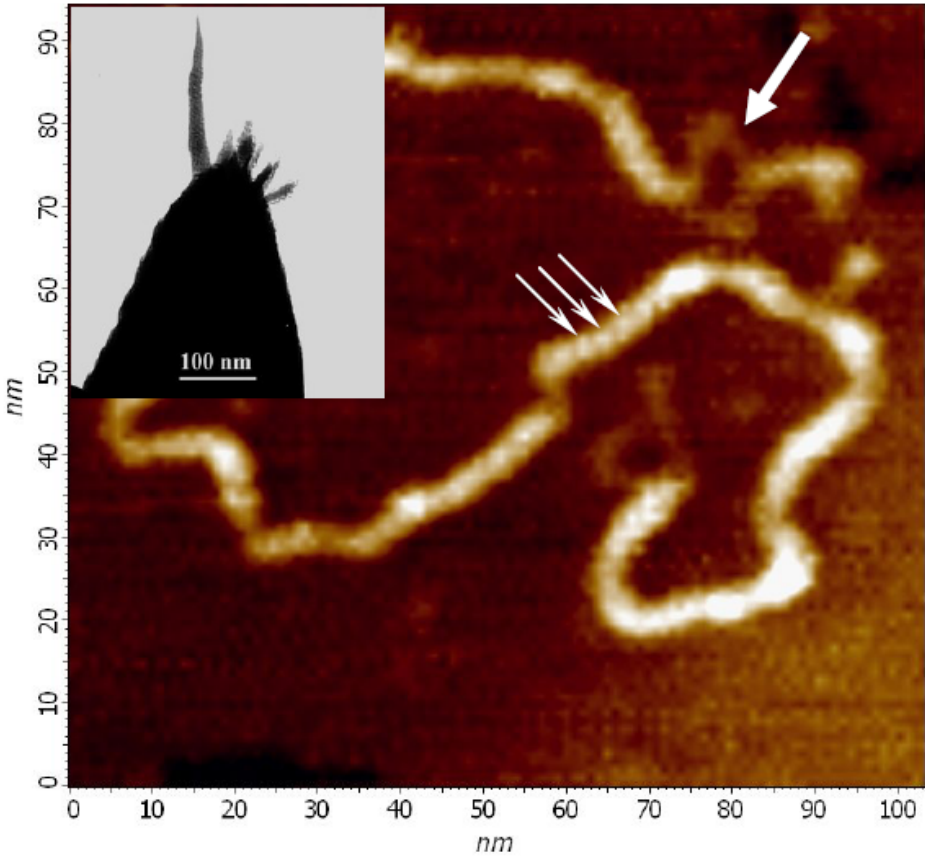


Probe-sample interaction potential.

Resolution is often limited by the probe



Strand width is usually seen in AFM image



Small unwound single-strand fragments can be seen (bold arrow on the scan) and even helical pitch of the DNA molecule can be resolved (thin arrows) with a sharp enough tip (like DLC probe tip shown on the inlet). See comprehensive discussion on sub-molecular imaging in “High resolution atomic force microscopy of duplex and triplex DNA molecules” Klinov D. et al. Nanotechnology (2007), V18, N22, p.225102.

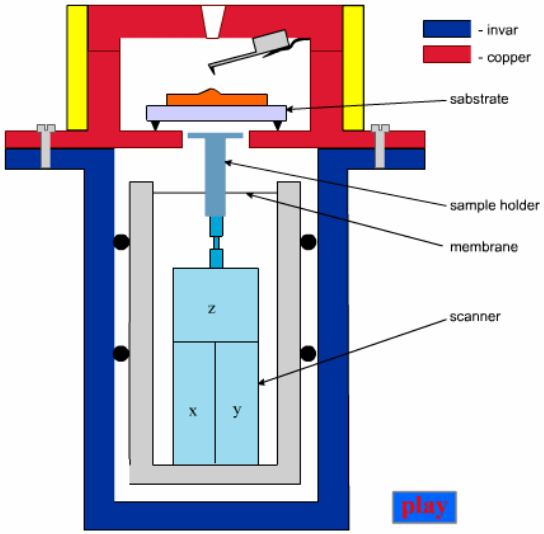
Closed-loop control is essential for nanolithography and metrology applications

Closed-loop correction off

Closed-loop correction on

AFM nanolithography image obtained by electrical local probe oxidation technique on ultrathin titanium film. Scan size 1.9x1.9 µm. Image courtesy of S. Lemeshko, NT-MDT.

Resolution is often limited by the drift



Parameter	Value
Drift XY, less than	**3 nm/hour**
Drift Z, less than	1 **nm/hour**
Thermal drift XY, less than	**20 nm/°C** (with special adjustment about 10 nm/°C)
Thermal drift Z, less than	10 nm/°C

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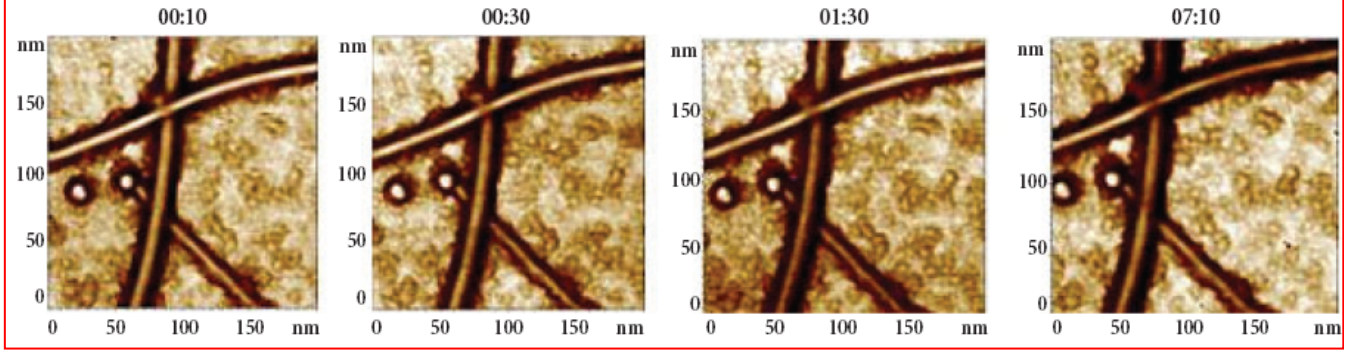
NTEGRA

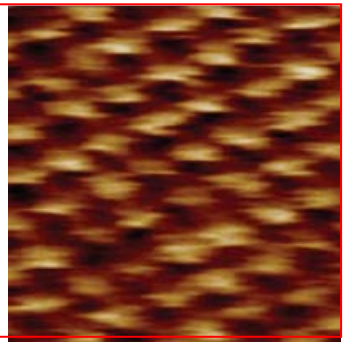
NTEGRA Therma:
the same atoms for hours

Long-term stability (nanotubes at room T)



Closed-loop correction on very small fields

(mica atomic lattice)



- Drifts at constant T°: < 3 nm per hour
- Drifts at changing T°: < 10 nm/K
- Closed-loop sensors available down to 10 nm

Extremely low drifts at heating or cooling (for the ranges -30…+80°C and RT…+200°C)

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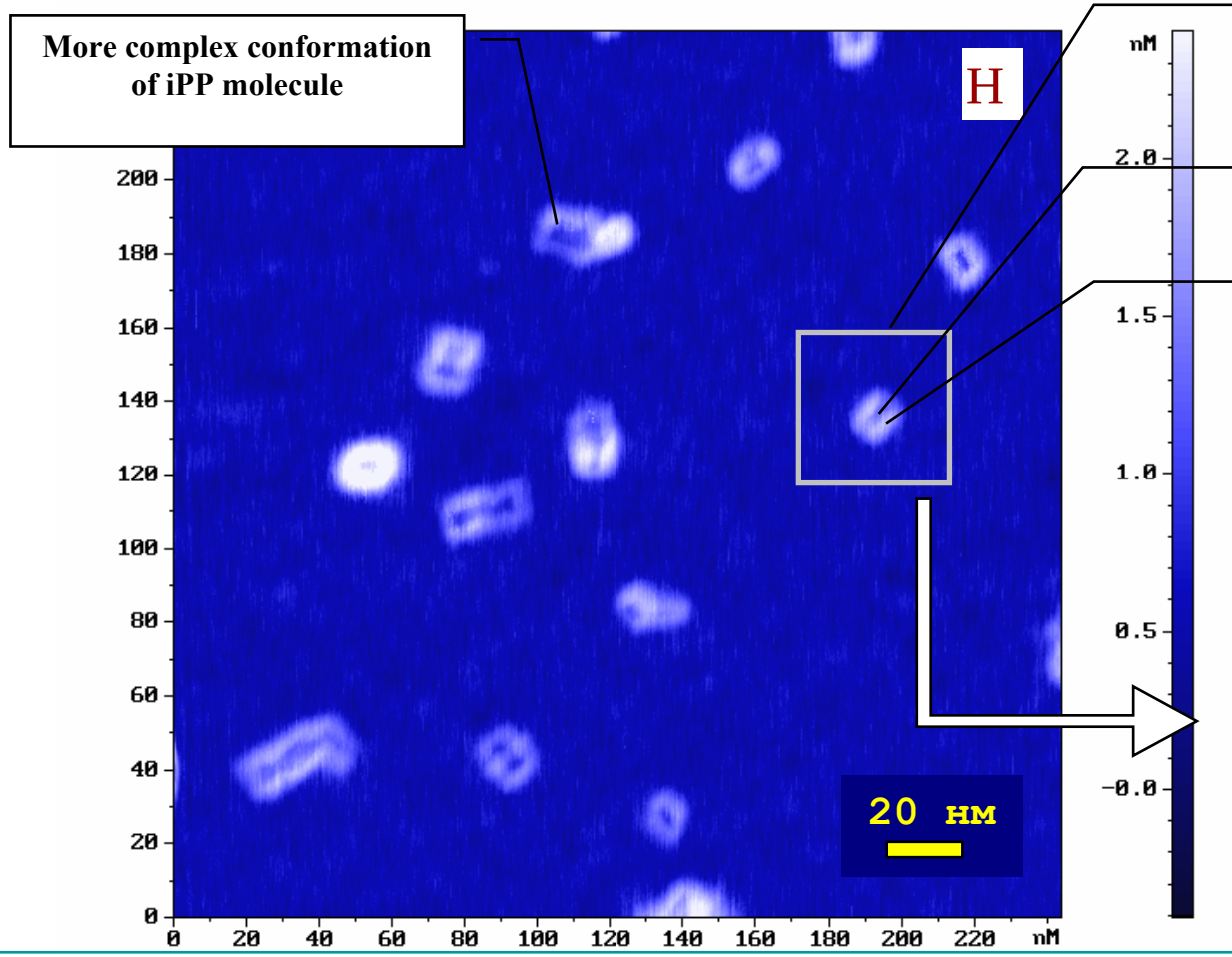
AFM image of world highest resolution – single-molecule crystallites of isotactic polypropylene on mica

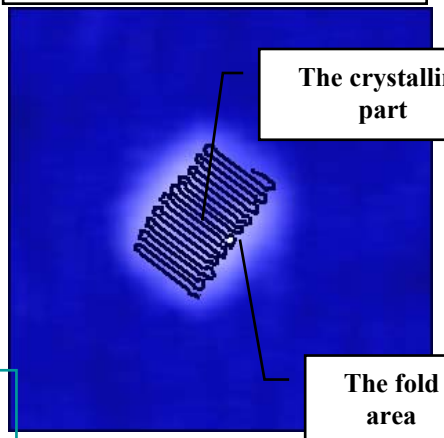


The "simple" crystalline conformation of single iPP molecule

The central (crystalline) part of the nanocrystallite

The "amprphous" part (the fold area)

The interpretation : single polymer chain, folded on indelf many times



AFM images allow to distinguish crystalline and amorphous parts of folded polymer chain even within single polymer molecule

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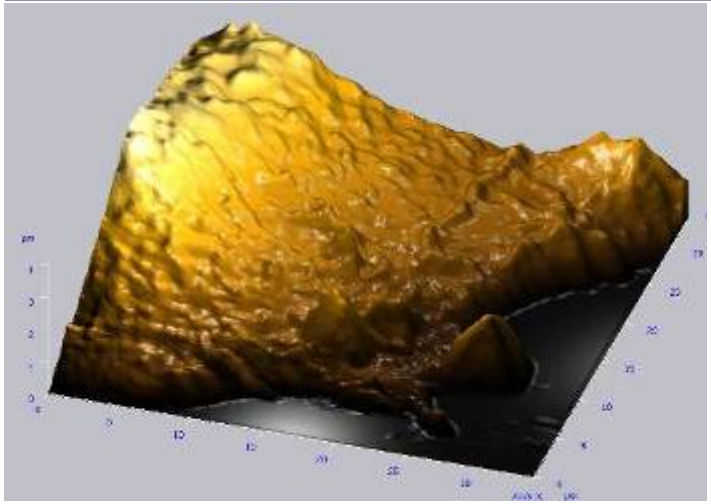
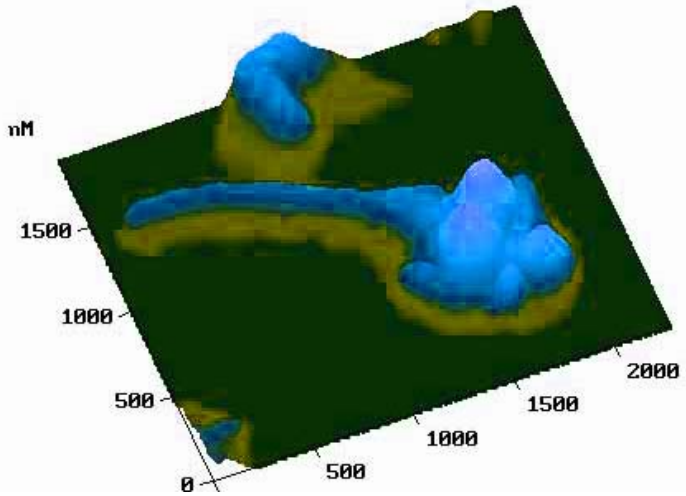
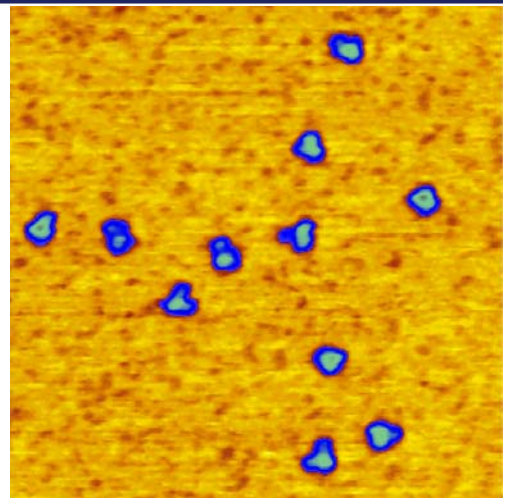
From cells to molecules



Fragment of the canine kidney epithelial cell represented as a 3D model



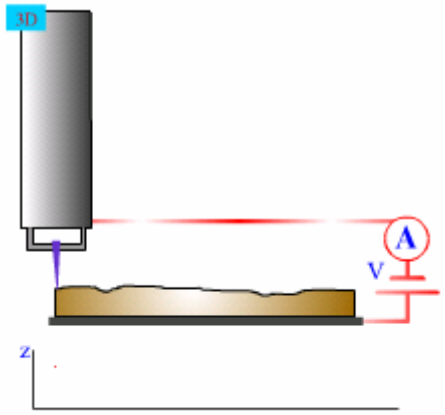
Ebola virus

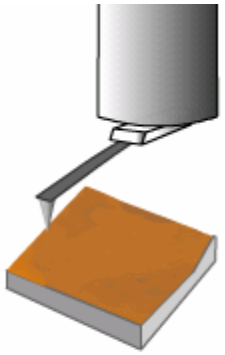


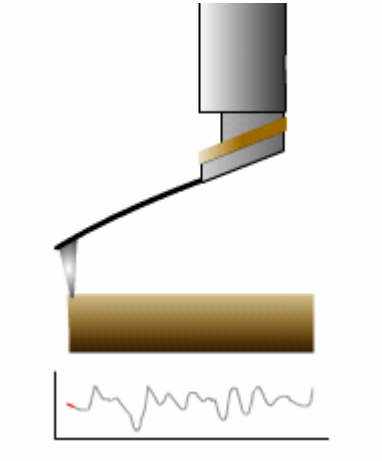
IgG single molecules

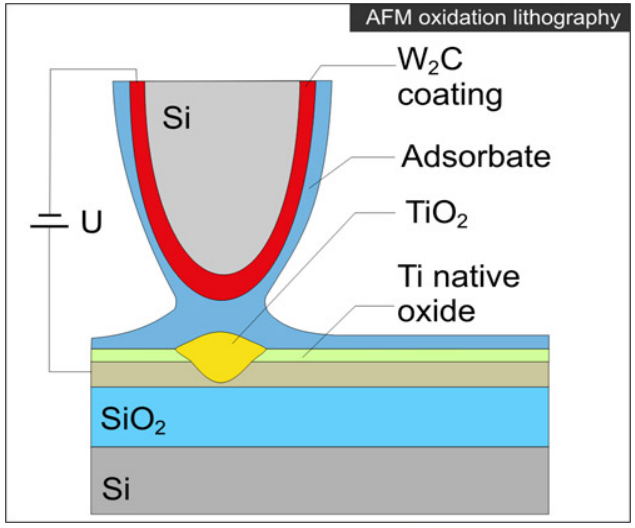
Atomic Force Microscopy (AFM) becomes a powerful tool for studying biological objects at different levels – from whole cells down to single molecules. The object size range is from 10^{-5} to 10^{-10} m!

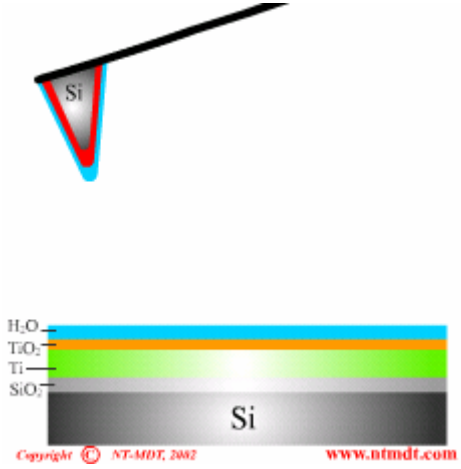
SPM lithography methods











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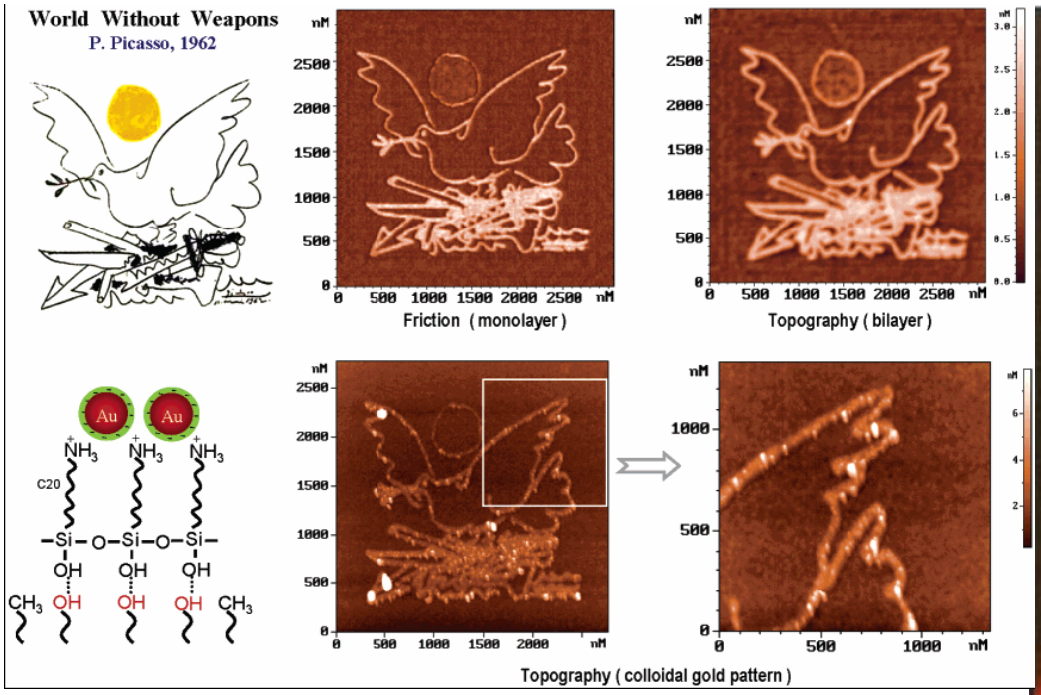
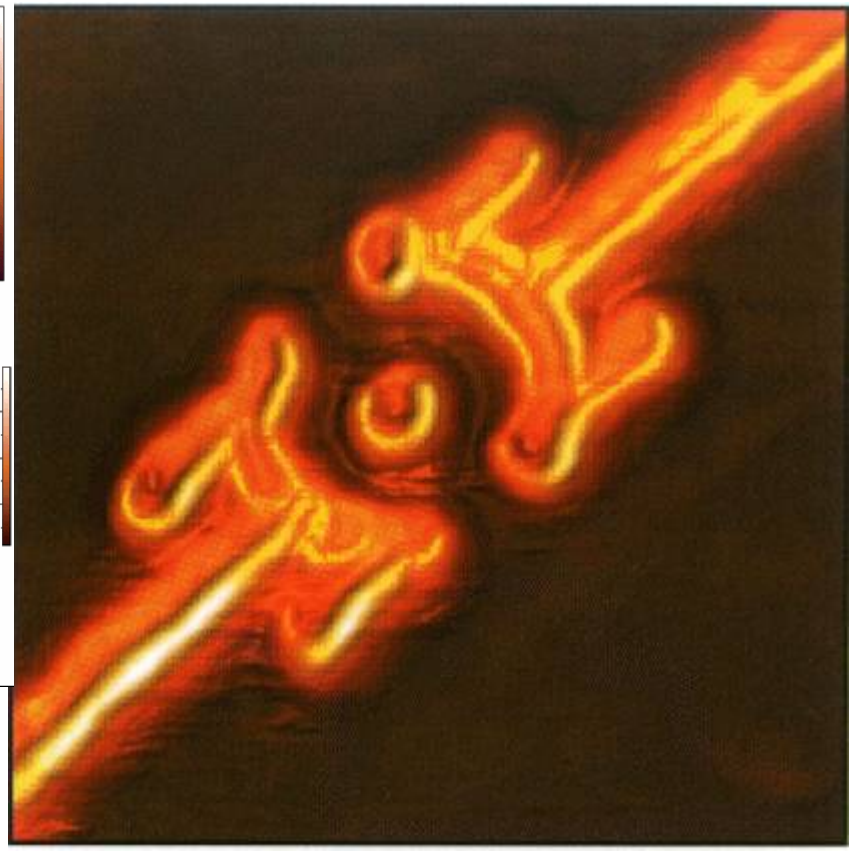
SPM lithography – local`oxidation





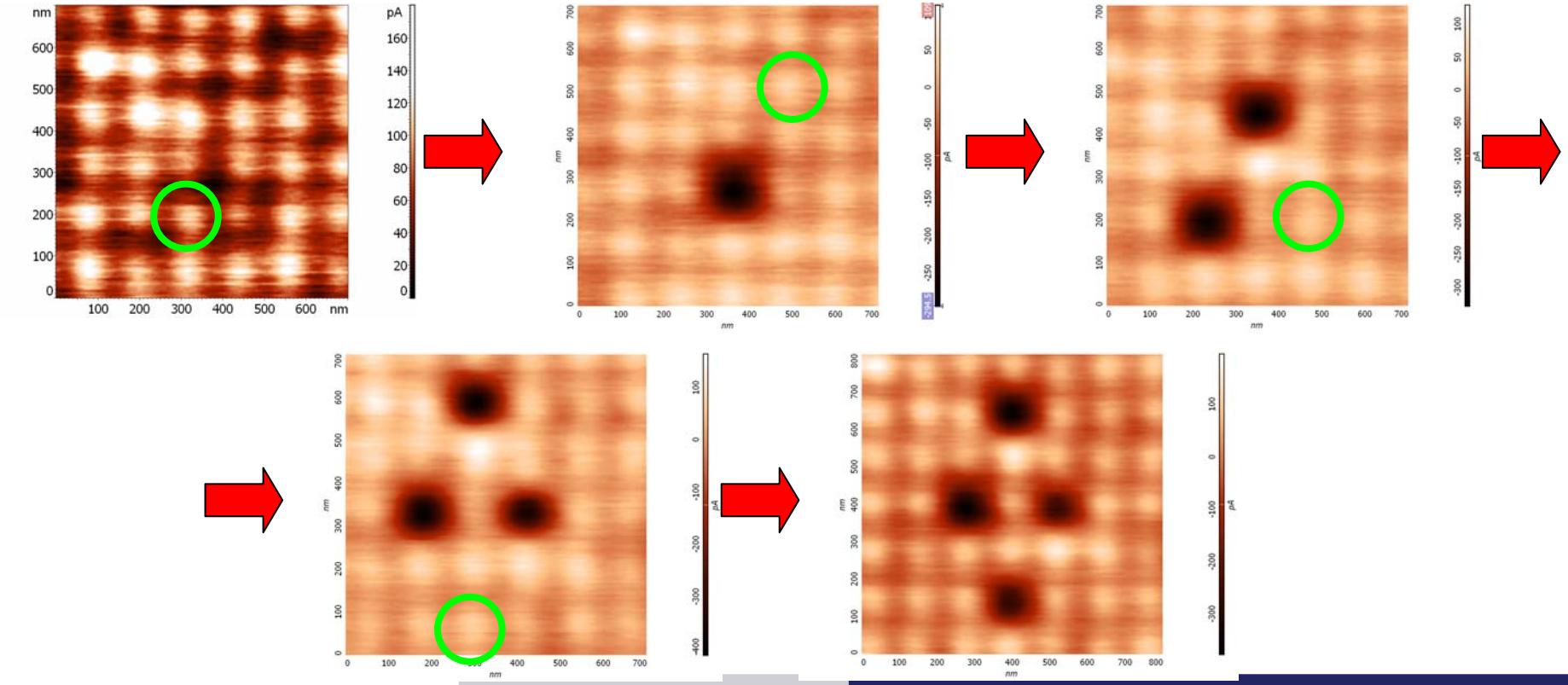
Maoz, R., Frydman, E., Cohen, S., Sagiv, J. - J. Adv. Mater. 2000, 12, 725 – 731.

Scan size 800×800 nm, A. Latushev, Z. Kvon, A. Tropov, D. Scheglov, IPS SA RAS

High magnetic density R/W process

Controllable switching by tip

sample was uniformly magnetized before experiment



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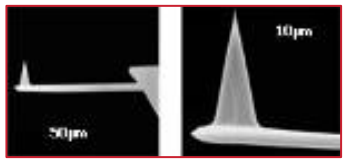
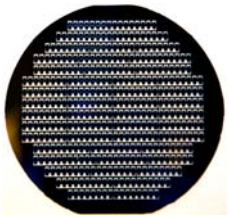
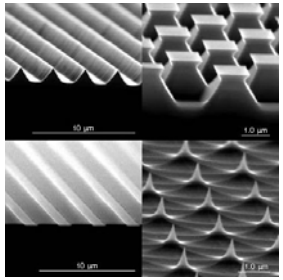
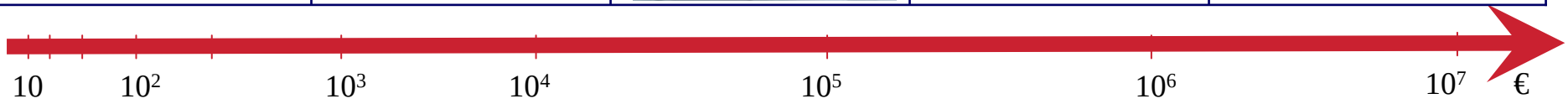
NT-MDT Complete product line=one stop buy concept

Accessories, Parts, Software	NanoEducator	Solver PRO Solver Next	NTEGRA	NanoFab100
				
				
				



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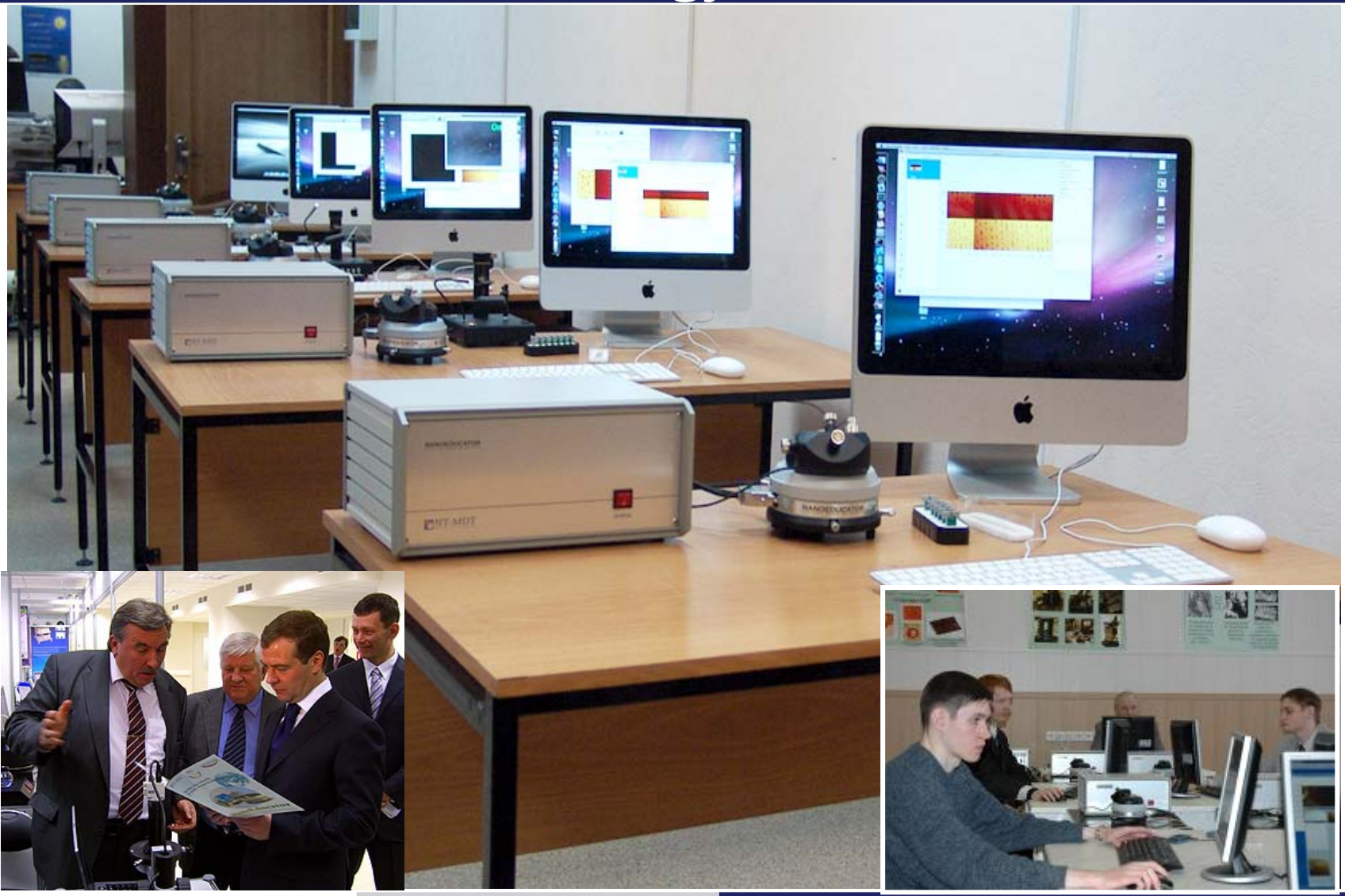
Your choice is granted

Nanoeducator – all you need to introduce nanotechnology to students



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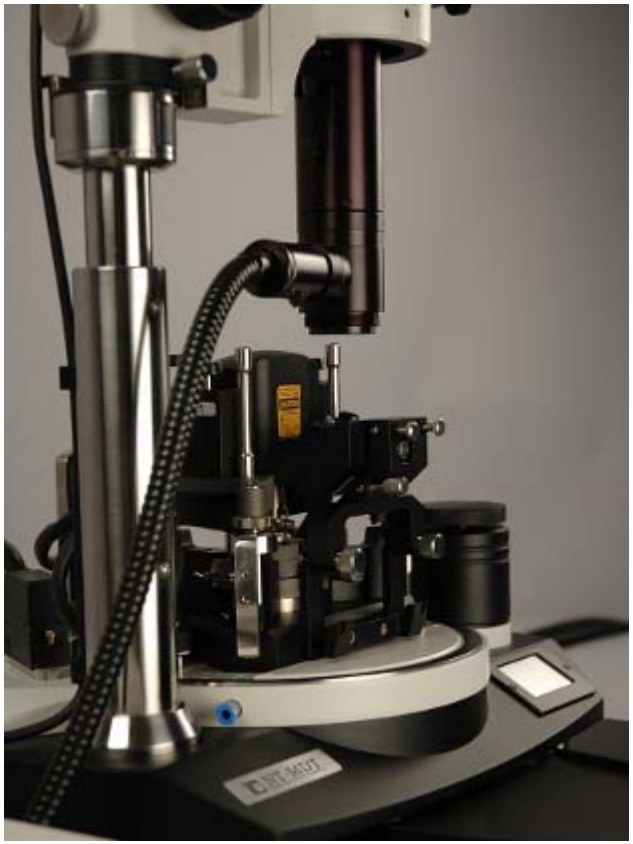
Your choice is granted

VERSATILITY or EASY OF USE? – BOTH!



NTEGRA: The platform of choice when range of cross-disciplinary SPM-related methods is quite broad in your lab and if there is a possibility that another SPM specialization is necessary in the future.

Solver: Fully automated=ease of use SPM enables to get SPM data for non experienced users

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Your choice is granted

Integrated AFM with Ultramictrotome

The system is dedicated to reveal internal non-homogeneities within the polymer sample

Material sciences

Life sciences

Critical parameters:

XY resolution	10-20 nm
Z resolution	20-25 nm
Time required to get the stack	5-10 hr

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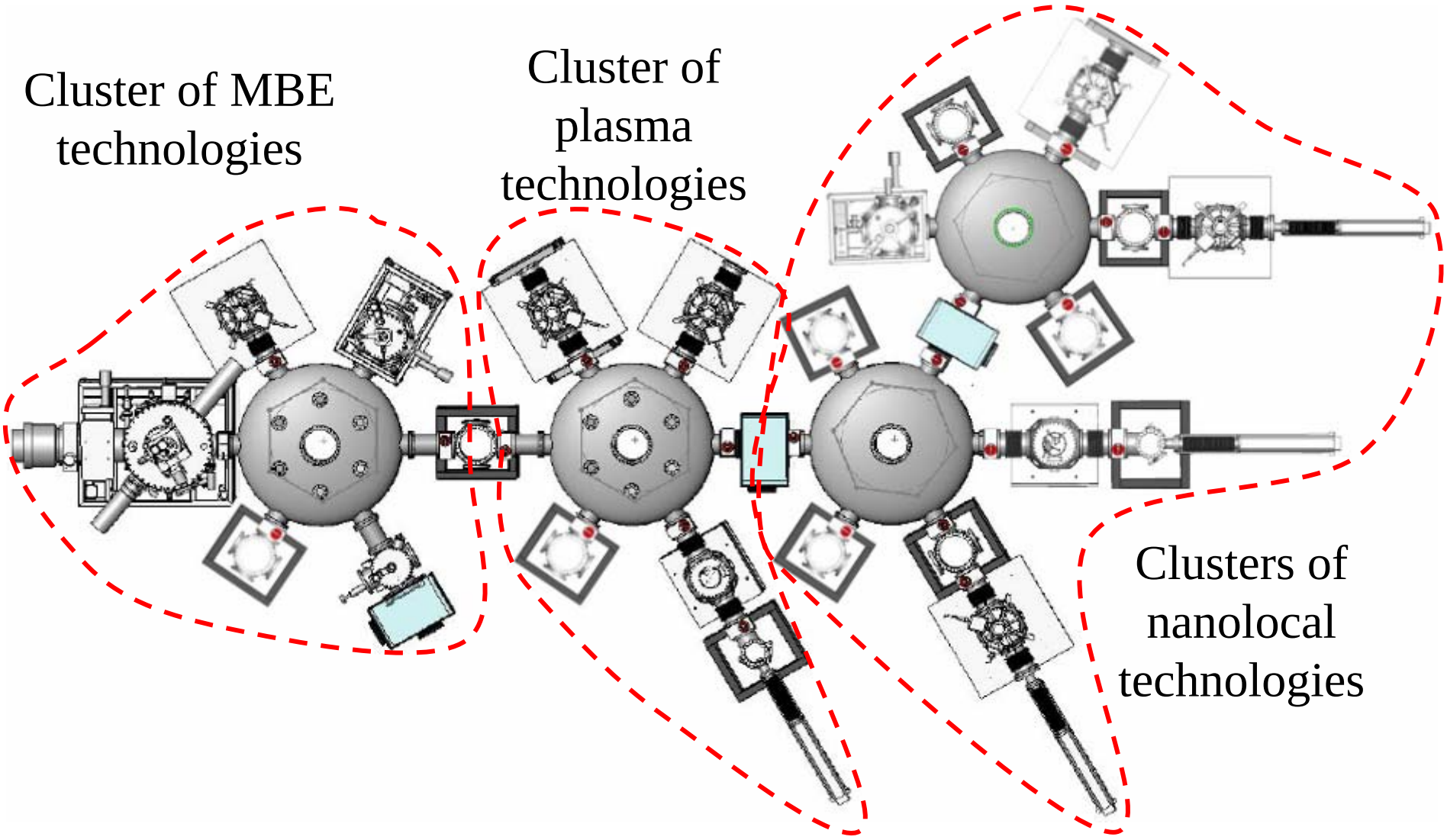
NANOFAB platform



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NanoFab suppose to be one of the major tools for Russian nanoelectronics

NanoFab100 platform has been designed for development, testing and small-series production of nanoelectronics elements.

100 mm wafers can be treated by group technologies (like MBE, PE CVD, MO CVD etc) and by nanolocal techniques (like FIB, SEM, SPM etc)

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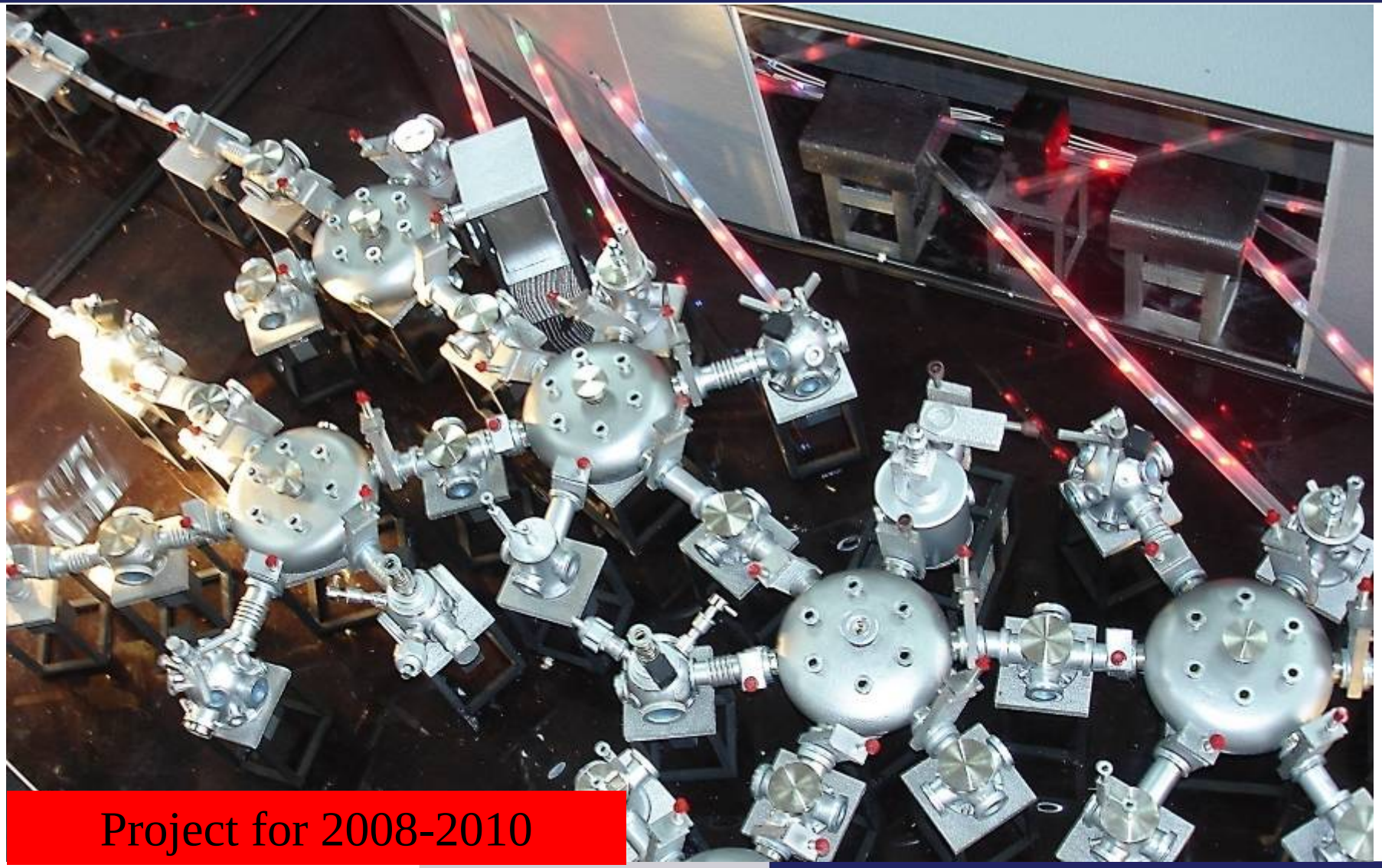
Your choice is granted

Synchrotron-based SuperFab complex



Project for 2008-2010

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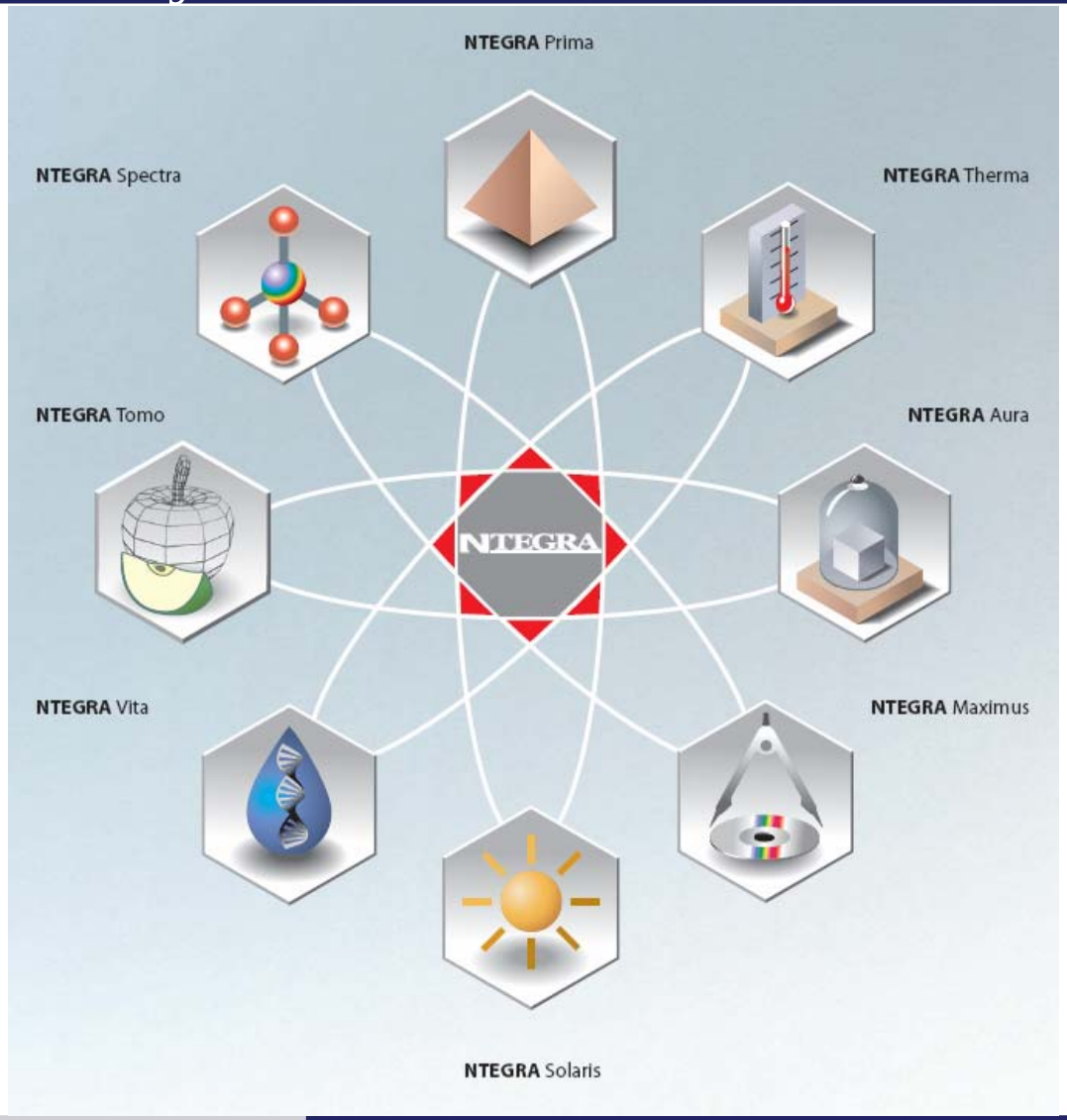
Your choice is granted

Ntegra platform - the basis for AFM integration with another analytical instruments



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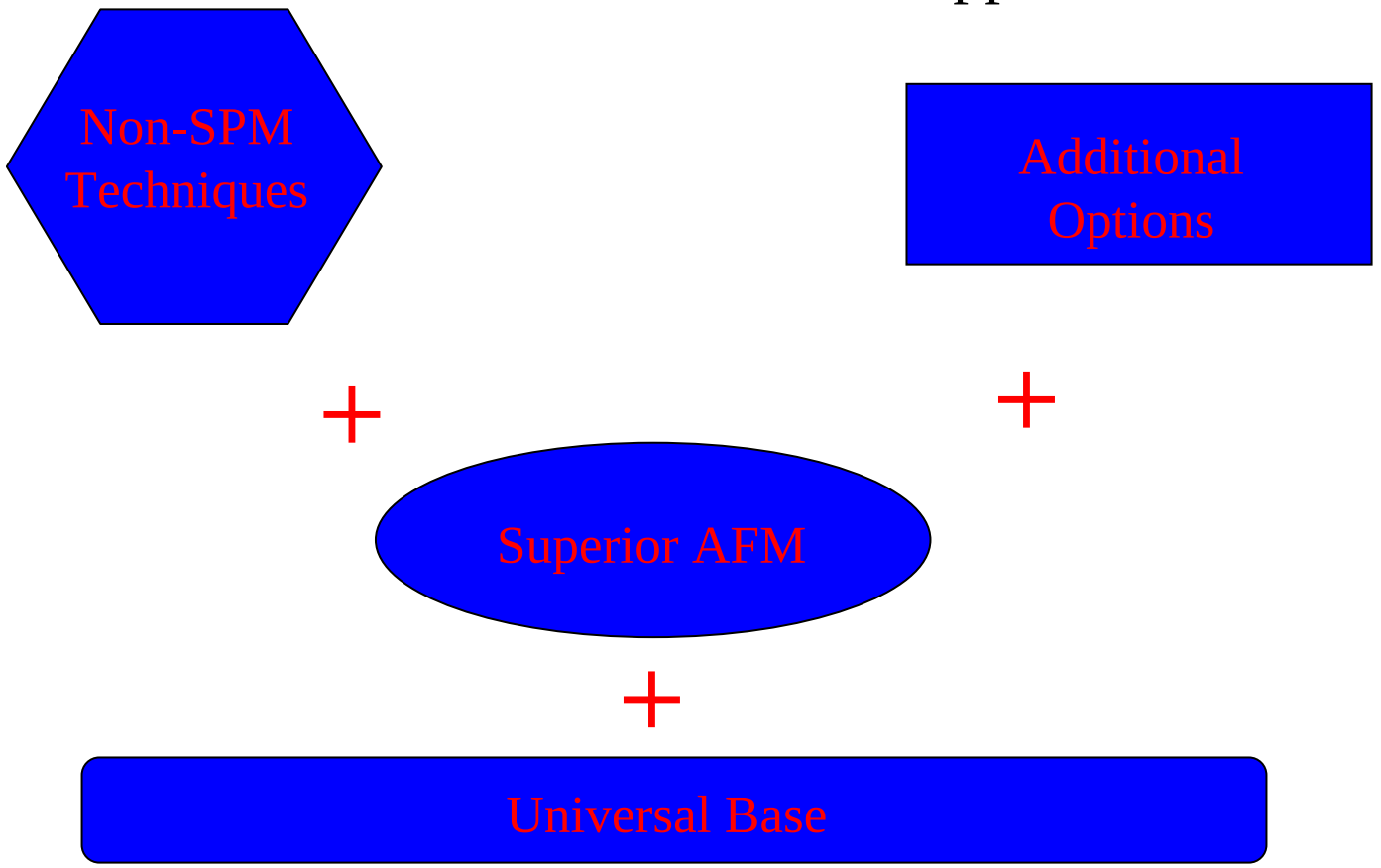
Your choice is granted

NanoLab or “SPM +” concept

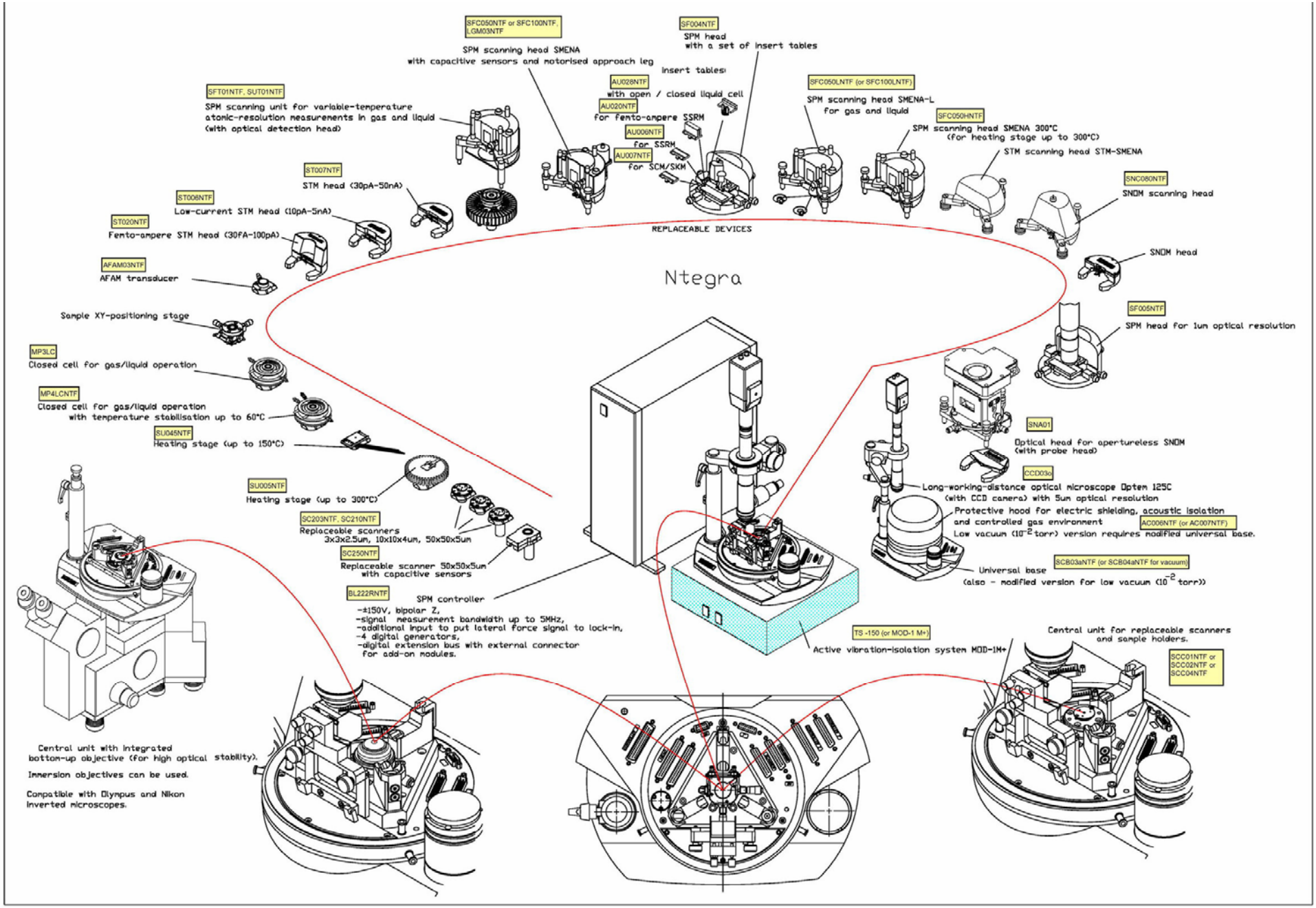
Conception of SPM+ - NOT UNIVERSAL BUT SPECIALIZED SPM with switchable application



Main concept advantages

- Each system is highly specialized and has the best performance in chosen area (material science, biology, polymers, semiconductors)

- Each model can be transformed into another application oriented model within NTEGRA's universal base with modern price of upgrade.



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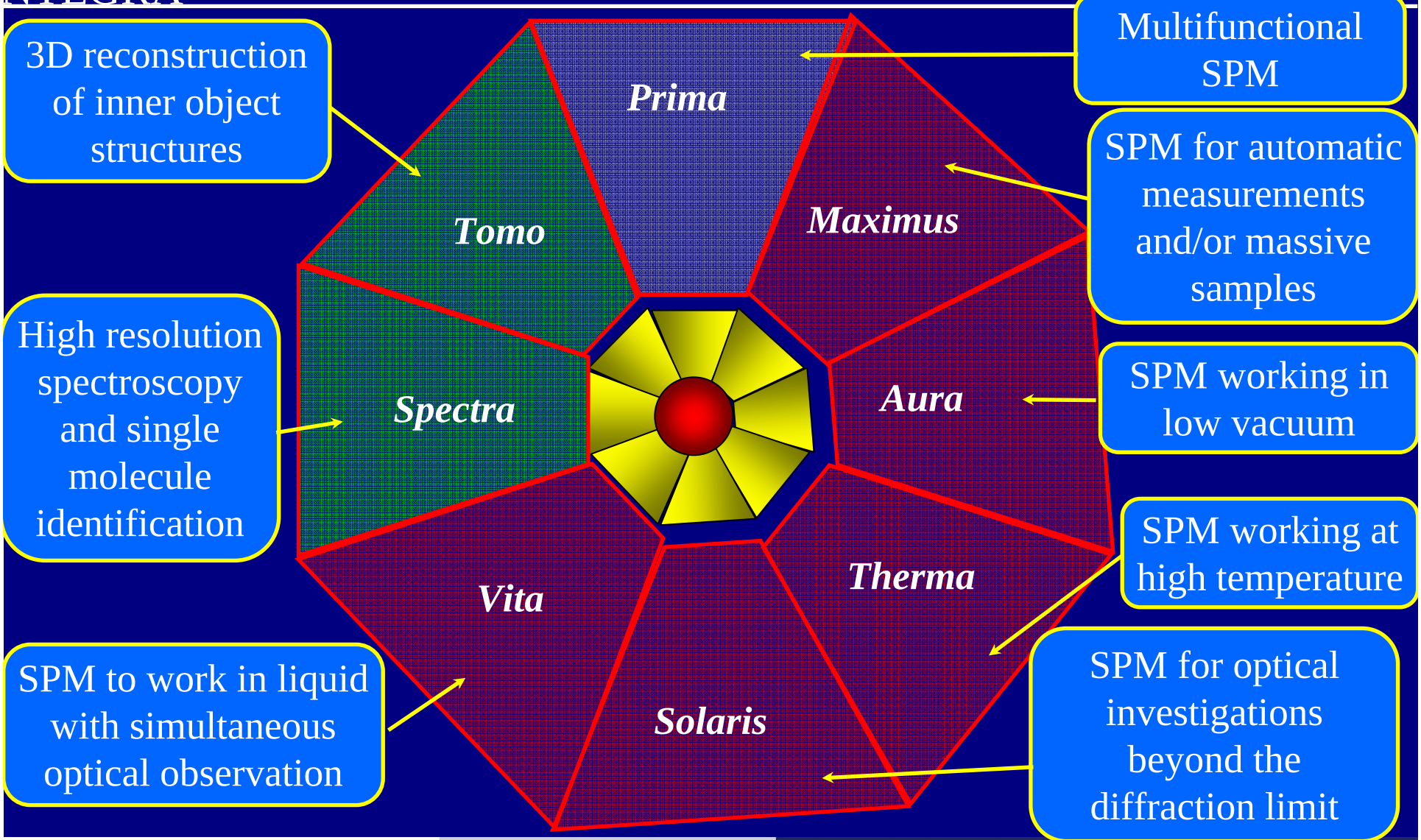
8 application oriented models within Ntegra platform

NTEGRA



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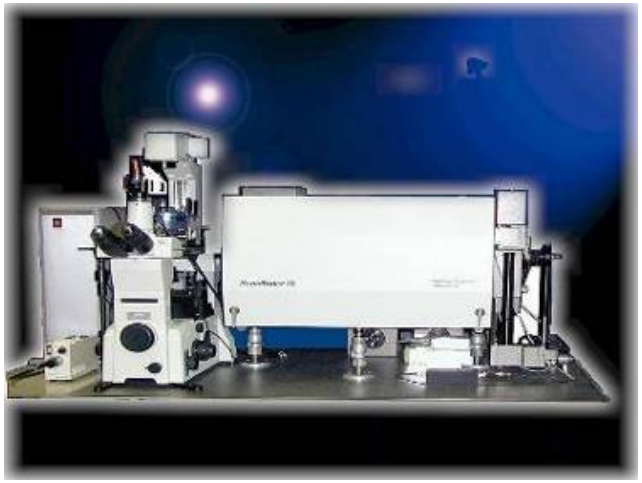
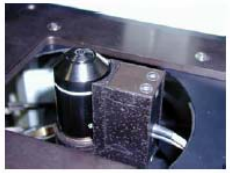
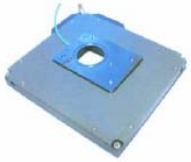
NT-MDT has developed first commercial Raman confocal system in 1998 and first SPM in 1992



Nanofinder

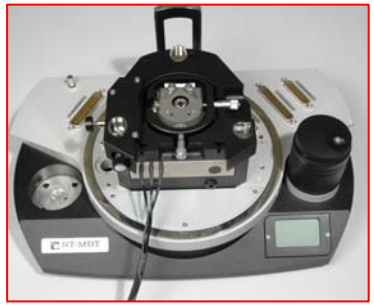


Z axis lens piezo scanner



X-Y piezo stage

Nanofinder 30



NTEGRA platform

Ntegra Spectra

Integrated solution with Renishaw

1998 2002 2003 2004 2006

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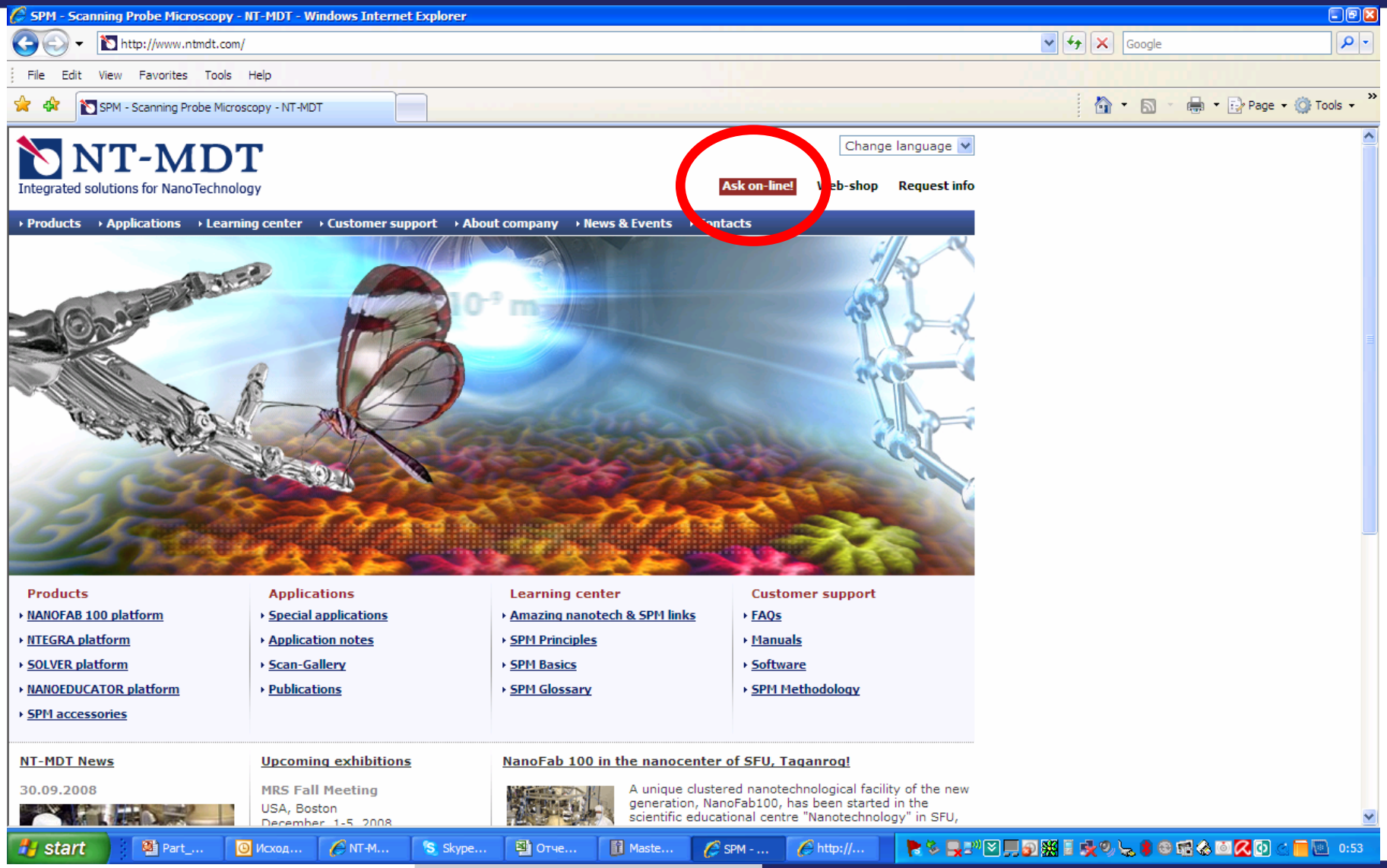
Molecular Devices and Tools for NanoTechnology

Your choice is granted

NT-MDT CRM: ASK ON LINE – ON LINE customer support system



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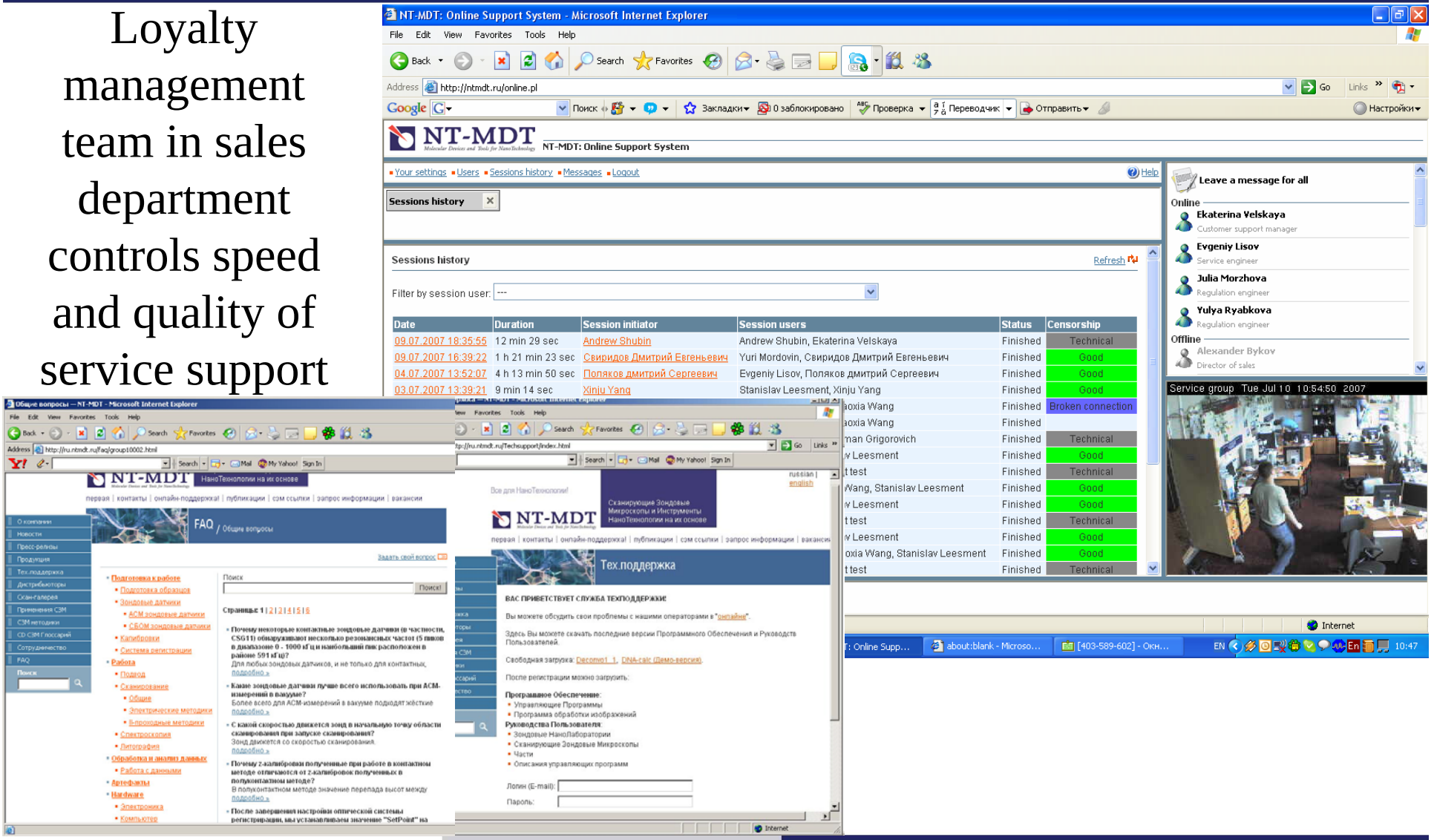
NT-MDT CRM: ASK ON LINE – ON LINE customer support system

Loyalty management team in sales department controls speed and quality of service support



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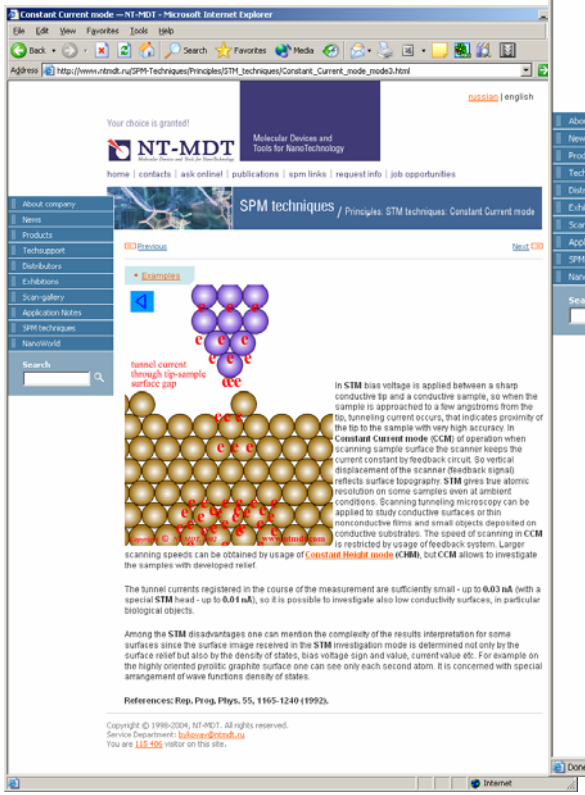
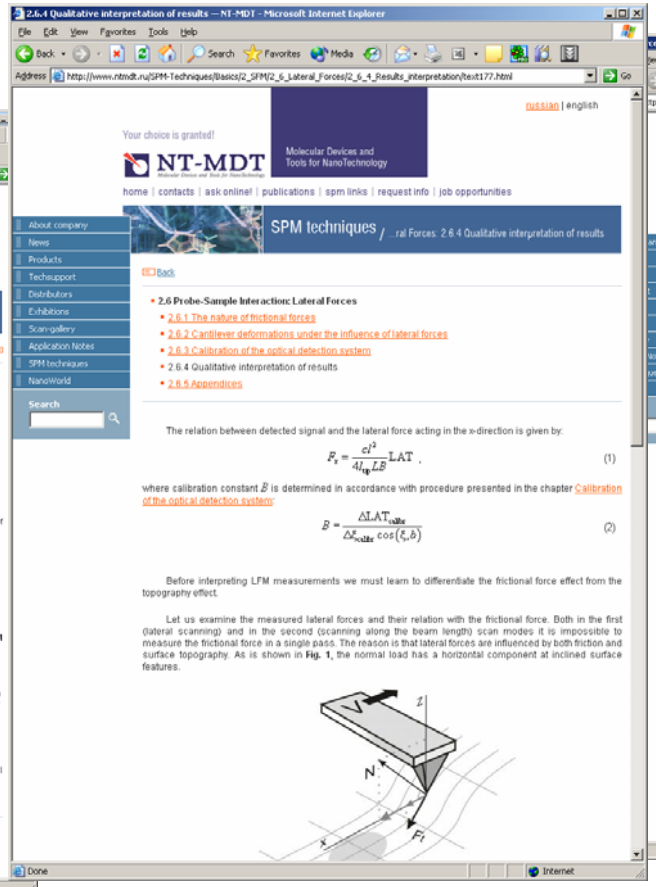
Development of multimedia training materials for customer education and training



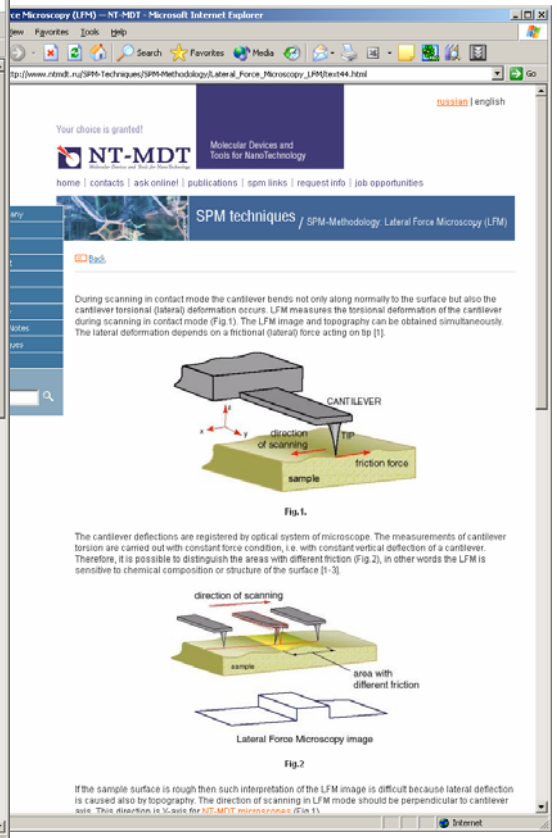
SPM Principles

http://www.ntmdt.ru/SPM-Techniques/Principles/



SPM Basics

http://www.ntmdt.ru/SPM-Techniques/Basics/



SPM Methodology

http://www.ntmdt.ru/SPM-Techniques/SPM-Methodology/

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Your choice is granted

THANK YOU!

YOUR CHOICE IS GRANTED!

http://www.ntmdt.com