



Microscopy
TODAY
2021 Innovation Award

PeakForce Tapping
10 YEARS
How AFM Should Be



TRUE HIGH-SPEED AFM
NANORACER[®]

Highest imaging speeds up to 50 fps/5000 lines per second
Designed for single molecule dynamics applications

NanoRacer® True High-Speed AFM

True real-time visualization of biomolecular dynamics

The **NanoRacer®** High-Speed AFM marks a quantum leap in quantitative imaging capabilities. The real-time visualization of dynamic biological processes with nanometer resolution has never been easier. The **NanoRacer** opens a world of new and exciting possibilities for Life Science applications, enabling researchers to gain an in-depth understanding of complex biological systems and molecular mechanisms, in a way not possible until now.

NanoRacer, pushing the boundaries

The **NanoRacer** High-Speed AFM runs at an incredible **50 frames per sec.** It has been specifically developed for highest resolution applications down to the atomic scale. Combined with JPK BioAFM's renowned stability and user friendliness, it is the ideal choice for single molecule experiments.

Be Inspired! Discover new, exciting applications:

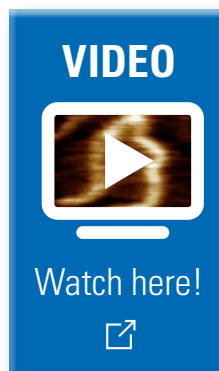
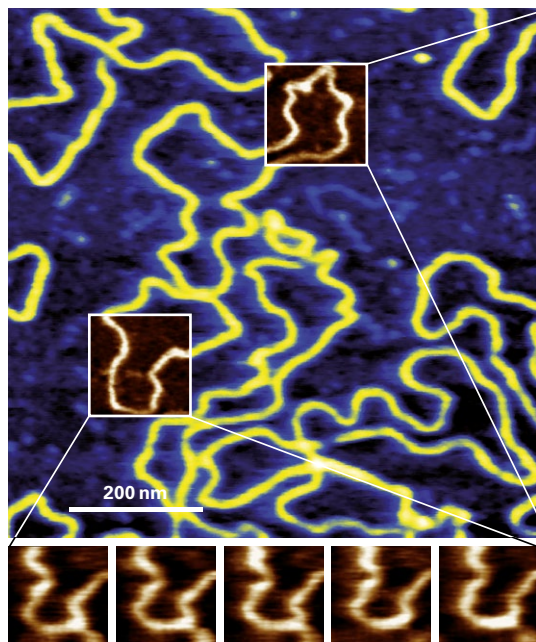
Single molecule binding behavior	DNA origami assembly
Dynamics in two-dimensional protein assemblies	Protein/protein interactions
Monitoring enzyme activity	Motor protein and membrane trafficking dynamics
Assembly and disassembly processes of protein structures	Virus and bacteria morphology and dynamics



“ So many things are still hidden in biological molecules. To uncover their unexplored secrets, there is a true need to directly observe individual molecules during their functional activity. The NanoRacer is the fastest commercial, high-speed AFM available, enabling their direct observation in real-time. A lot of innovative ideas have been incorporated for easy operation and high performance, and it is my utmost wish that many researchers will use the NanoRacer to reach their goals and make exciting discoveries. ”

Prof. Toshio Ando

Nano Life Science Institute (WPI-NanoLSI)
Kanazawa University, Japan



Overview image

Individual DNA molecules imaged in fluid on mica+PLO substrate in closed-loop.
0.5 frames/sec, z-range 3.4 nm

Image-in-image zooms

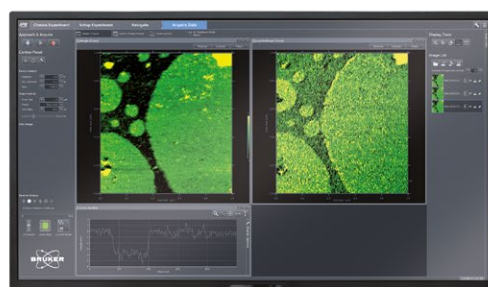
10 frames/sec, z-range 2.3 nm

Lower video sequence zoom

50 frames/sec, z-range 2.0 nm
(shows 17th, 89th, 160th, 252nd and 370th frame of experiment)

right video sequence zoom

50 frames/sec, z-range 1.9 nm
(shows 13th, 176th, 428th, 773rd and 966th frame of experiment)



Discover a new user experience

State-of-the-art capabilities made easy

The NanoRacer marks a new chapter in high-speed AFM and relegates complicated, time-consuming procedures to the past. Developed with the user in mind, the resulting robust and reliable design, with a host of new features, make the NanoRacer easy to use, even for newcomers to AFM.

All components are designed for convenient handling, from sample preparation through to fully motorized and automatic optical

alignment. The streamlined handling enables easy data collection and fast results. A short time-to-data is vital for achieving dynamic results on active single molecule samples.

Fully automated alignment and setup within a minute for enhanced efficiency

- Automated cantilever alignment
- Optimized drift compensation
- Automated photothermal laser alignment option
- Internal camera with autofocus
- Automated calibration of cantilever spring constant

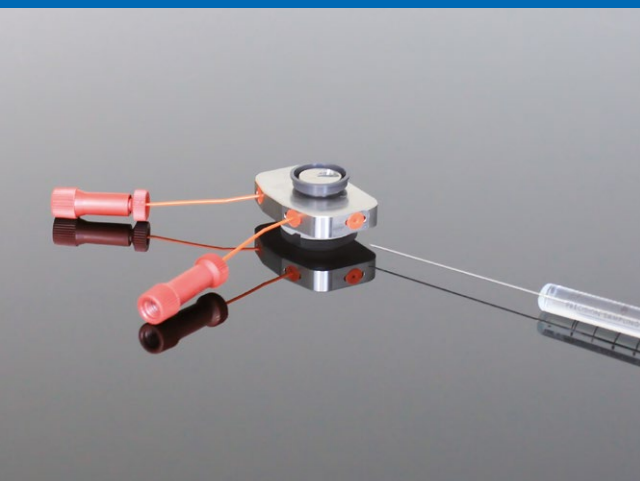
Image left

Newly designed 3-port liquid cell for photothermal excitation.

Image left

Seamless handling for preparation and imaging with the transportable sample scanner.

Prepare the sample conveniently on the bench and load into the NanoRacer to image.



A complete system designed for convenience

Easy sample and probe loading

Transportable sample carrier for convenient sample preparation on the bench

Probe exchange in a few minutes

No calibration needed thanks to closed-loop scanner design

Easy navigation with integrated camera for locating areas of interest on the sample

Fluid exchange via direct injection

Newly designed 3-port liquid cell for photothermal excitation



Focus on your experiment

New, workflow-based software design accelerates scientific output

V7

SOFTWARE

- Intuitive V7 Software for proven ease-of-use
- Fast time-to-data thanks to effective user guidance
- Ideal for multi-user environments and imaging facilities
- User-programmable software for advanced experiments
- ExperimentPlanner™ enables full control of all system parameters, such as scanning positions, experiment settings or external fluidics modules
- State-of-the-art data analysis and processing with video creation and intuitive data storage

Intelligent imaging controls for stunningly sharp images

To scan fragile and mobile sample features at highest speeds and lowest forces, a highly intelligent control software is required.

- Dynamic PID, a key component for the precise investigation of sample morphology
- Rapid response time for cantilever-deflection detection system is ensured by shortest dead times in feedback loop, fastest electronics and intelligent FPGA algorithms
- Drift correction of setpoint and automatic detector realignment
- Cantilever excitation with photothermal option or Bruker's proven DirectDrive™
- Highest scan speed with advanced adaptive scanner algorithms

Image series

DNA metastable bubble formation and closure.

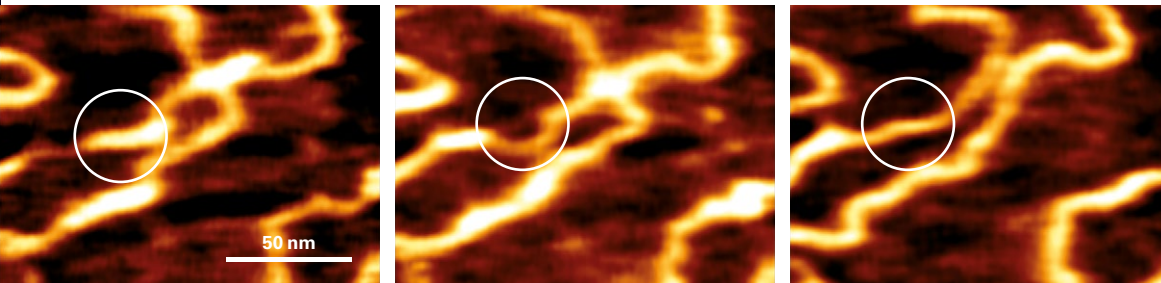
Imaged in fluid in closed-loop at 2000 lines per second, z-range 1.5 nm.

Circles illustrate location of a bubble on DNA molecule ~30 nm in length.

User interface new V7 software

The closed-loop scanning and convenient interface make it easy to set the location directly from an overview image.

Move from place to place with a single click, selecting interesting features and landing wherever you choose, without needing to adjust scan settings.

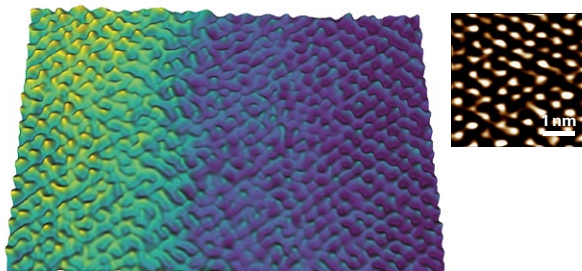
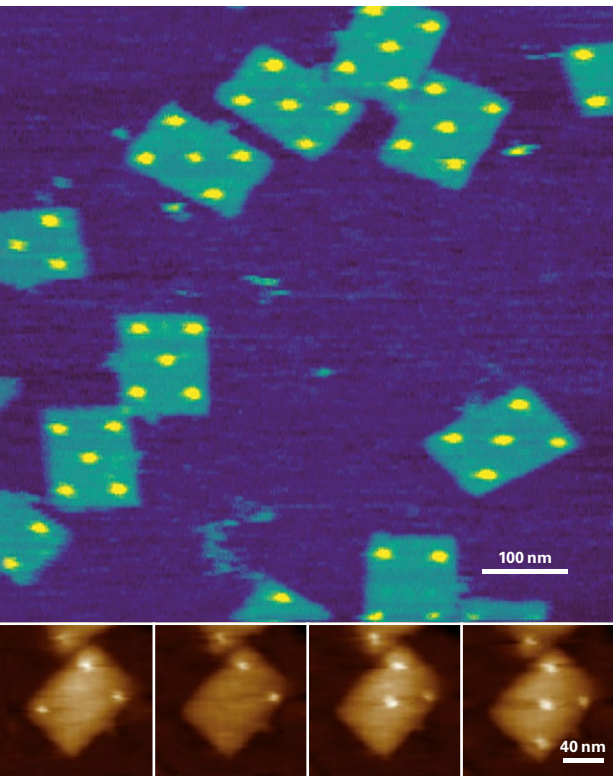


NanoRacer: Maximum Speed, Maximum Performance

The NanoRacer reinforces Bruker's technology leadership in the field of high-speed AFM. With an imaging speed of 50 fps and highest resolution capabilities, NanoRacer marks a milestone in state-of-the-art AFM.

Outstanding resolution

Imaging atomic defects and sub-molecular resolution are now routine. The **NanoRacer** has the lowest noise levels of any commercial AFM system available, thanks to high precision electronics and enhanced accuracy positioning sensors in each axis.



Renowned Stability, Remarkable Accuracy

The NanoRacer reflects the pioneering work of Bruker's BioAFM team in combining technological advances with proven stability, sensitivity, and ease of use.

- Newly developed high-speed head and scanner unit
- Robust concentric design for utmost stability
- Optimized for small and medium-sized cantilevers
- Cutting-edge electronics

Latest technological advances for perfect imaging results

- Small cantilevers and lowest forces for minimum sample damage
- Infrared laser photothermal excitation option, for clean cantilever drive, easy setup and minimized perturbation of delicate samples
- Advanced algorithms for scanner control and feedback
- Minimized force drift for long-term experiments
- Highest bandwidth digital electronics, with lowest noise, for maximum performance
- Cutting-edge, high-speed power amplifier for perfect scanner drive
- Closed-loop scanning on all axes with minimal noise levels for highest accuracy

Overview image

DNA Origami Nanostructures containing 5 biotin binding sites on mica

Imaged in fluid with streptavidin presence in closed-loop

Overview ~2.1 sec/frame, z-range: 6 nm.

Image series

Streptavidin binding/unbinding dynamics imaged with 5000 lines/sec can be observed as bright dots appearing/disappearing from the origami lattice.

Images show the 218th, 328th, 360th and 491st frame of the experiment recorded at 50 frames/sec, z-range: 2 nm;

In collaboration with C. M. Dominguez, C. M. Niemeyer, Institute of Biological Interfaces (IBG-1), KIT (Germany).



3D image and zoom

Atomic resolution of calcite crystal step edge, imaged in fluid

3D topography 15x9nm²
Zoom 4x4nm²



Technical Specifications

System specifications	<ul style="list-style-type: none"> Maximum scan speed of up to 50 frames/sec with 100x100nm² scan range and 10k pixels Atomic defect resolution in closed-loop Designed for medium to small sized cantilevers for lowest forces and highest scan speeds Ultra-low noise cantilever-deflection detection system IR cantilever-deflection detection light source with small spot size Optional photothermal cantilever drive. 730nm wavelength ensures minimal sample interaction compared to blue-light excitation 	<ul style="list-style-type: none"> Highest detector bandwidth of 8MHz for high speed signal capture Automated laser and detector alignment Scanner unit <ul style="list-style-type: none"> 2x2x1.5µm³ scan range Sensor noise level <0.09nm RMS in xy 0.04nm RMS sensor noise level in z Highest resonance frequency for z axis of >180kHz Typical sample size 4mm diameter
Control electronics	<ul style="list-style-type: none"> Vortis™ 2 Speed controller: State-of-the-art, digital controller with lowest noise levels and highest flexibility 	<ul style="list-style-type: none"> Newly designed, high-voltage power amplifier drives the scanner unit
New workflow-based V7 SPMControl software	<ul style="list-style-type: none"> True multi-user platform, ideal for imaging facilities User-programmable software AutoAlignment and setup Advanced feedback algorithms Fully automated sensitivity and spring constant calibration using thermal noise or Sader method Improved ForceWatch™ and TipSaver™ mode for force spectroscopy and imaging 	<ul style="list-style-type: none"> Advanced spectroscopy modes, e.g. various force clamp modes or ramp designs Powerful Data Processing (DP) with full functionality for data export, fitting, filtering, edge detection, 3D rendering, FFT, cross section, etc. Powerful batch processing of force curves and images, including WLC, FJC, step-fitting, JKR, DMT model and other analyses
Standard operating modes	<ul style="list-style-type: none"> Imaging modes <ul style="list-style-type: none"> TappingMode™ with PhaseImaging™ Contact mode with lateral force microscopy (LFM) 	<ul style="list-style-type: none"> Force measurements <ul style="list-style-type: none"> Static and dynamic spectroscopy Advanced force mapping
Optional modes	<ul style="list-style-type: none"> PeakForce Tapping for imaging Advanced AC modes such as FM and PM with Q-control & Active Gain Control Higher harmonics imaging NanoManipulation ExperimentPlanner for designing specific measurement workflows RampDesigner™ for custom-designed clamp and ramp experiments ExperimentControl™ feature for remote control of experiment 	
Probes compatibility	<ul style="list-style-type: none"> High speed probes from Bruker, Nanoworld and Olympus etc. 	

We regularly come across informative scientific articles relating to AFM life science research. For a regular update on new and interesting scientific publications, sign-up for the BioAFM Journal Club and automatically receive our free, monthly journal club email. Members receive brief reviews of select papers and direct links to the full article.



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JPK BioAFM Business
Nano Surfaces and Metrology Division
Bruker Nano GmbH

Am Studio 2D · 12489 Berlin, Germany
 tel.: +49 30 670990 7500 · fax: +49 30 670990 30
www.bruker.com/bioafm

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