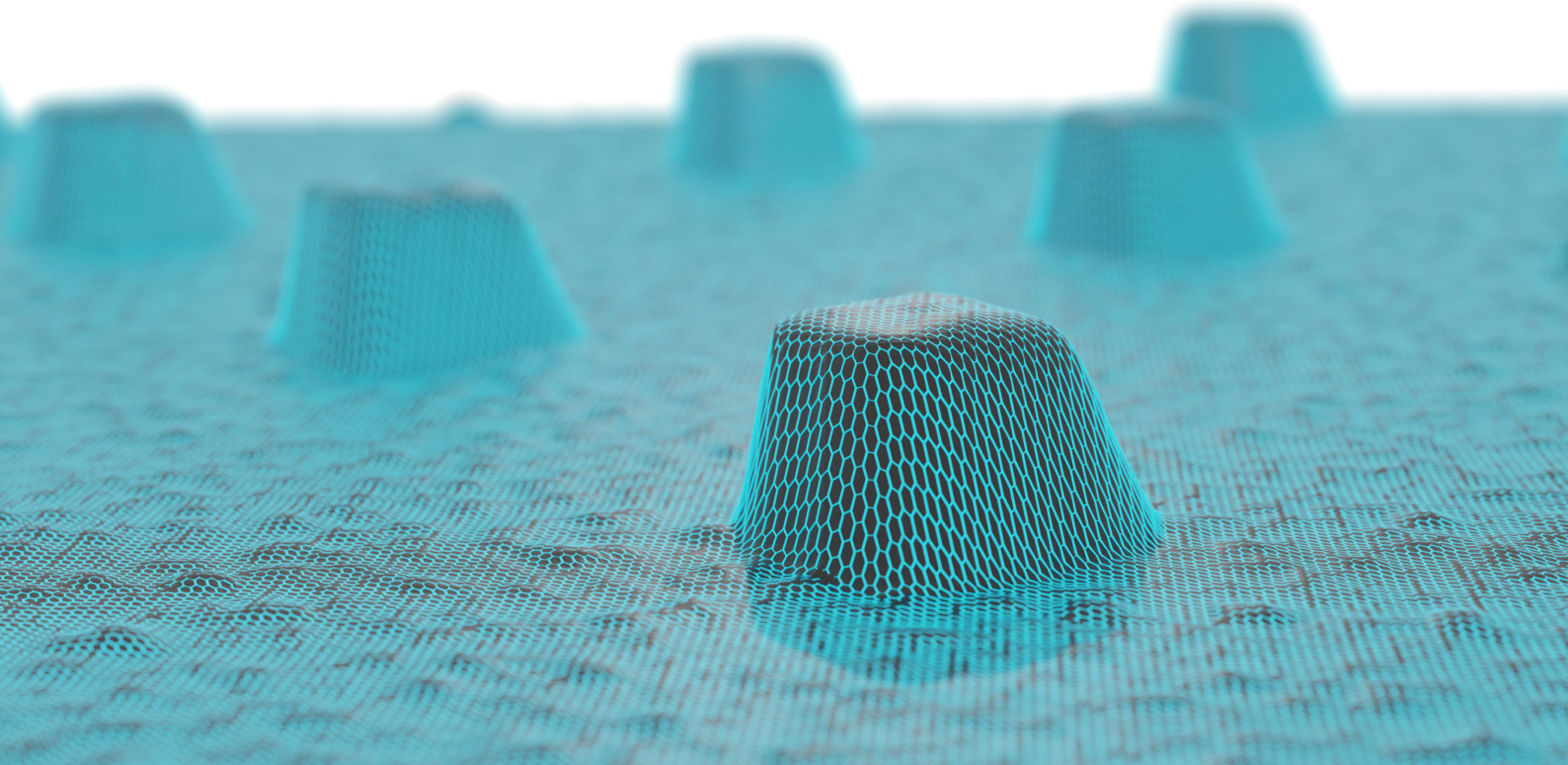
BRISTOL NANODYNAMICS

Vector

Dynamic Scanning Probe Microscope



What is Vector?

Our flagship product, Vector, is a new type of microscope unlike any commercial atomic force or scanning probe microscope (AFM / SPM) available.

Via a unique passive feedback loop, it delivers nanoscale measurements with a throughput 1,000x greater than any competing SPM technology, enabling vastly improved sample analysis and statistics over large-areas, video-rate observation and real-time surface exploration. **We call this technology Dynamic SPM.**

Capabilities

- **Throughput and area** – Processes large sample sizes and delivers topographical measurements with sub-atomic Z resolution; Dynamic SPM can match any SEM sample size with nanoscale resolution.

- **Video rate in any environment** – Observes and measures nanoscale processes at up to 20 fps in ambient and liquid environments.

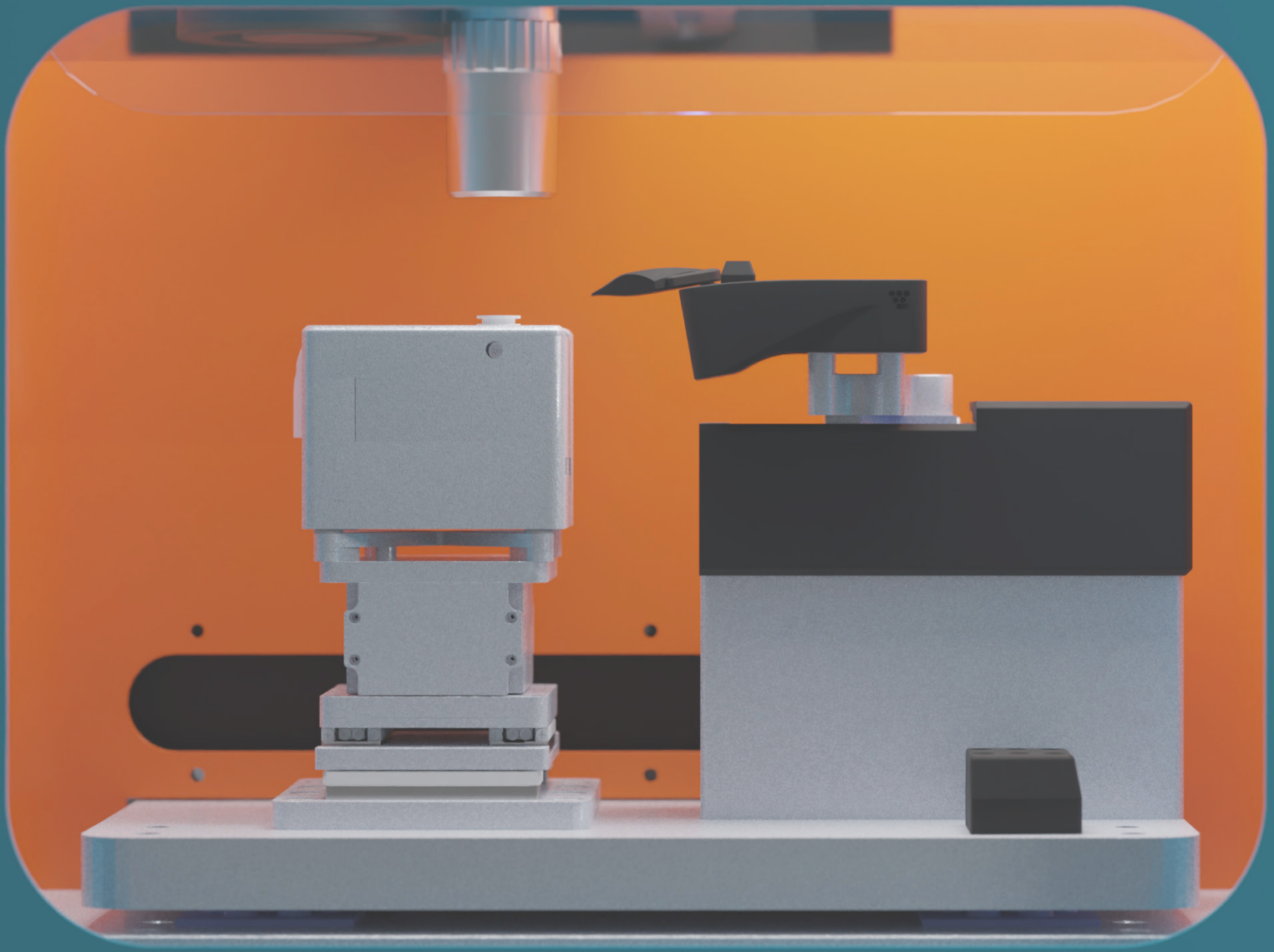
- **Automated processing and analysis** – Vector's data processing includes automated image analysis and feature classification algorithms for a range of measurement types, from nanoparticles and 2D materials, to DNA and molecular analysis.

- **Workflow integration** – Dynamic SPM is a non-destructive process which works on industry standard mounted sample stubs for EM and other analyses with no additional onerous sample preparation required.

- **Reliable repeatability** – Long-lasting off-the-shelf SPM probes generate reliable data, sample after sample, hour after hour.

Key Differentiators

	Bristol Nano Dynamics D-SPM	Traditional AFMs	Video-Rate AFMs
Pixel Rate	2,000,000 pixels/s	< 10,000 pixels/s	500,000 pixels/s
Image Fidelity at 2 FPS	1,000,000 pixels	✗	250,000 pixels
Image Fidelity at 20 FPS	100,000 pixels	✗	25,000 pixels
Max Video-Rate Image Size	50 µm x 30 µm	✗	< 10 µm x 10 µm
Typical Sample Size	20 mm diameter	12.5 mm diameter	4 mm diameter
Image Tiling of Whole-Sample	✓	✗	✗
Complete Training in 1 Day	✓	✗	✗
Low-Cost Consumables	✓	✓	✗
Easy to Use	✓	✗	✗
Robust in Noisy Environments	✓	✗	✗



Classifying Nanostructures at the Macroscale

Vector will automatically produce a macroscale map of your sample with nanostructures classified by height, shape, hardness and location. Generate custom heatmaps filtered on any of these characteristics to understand their location and distribution across your samples.

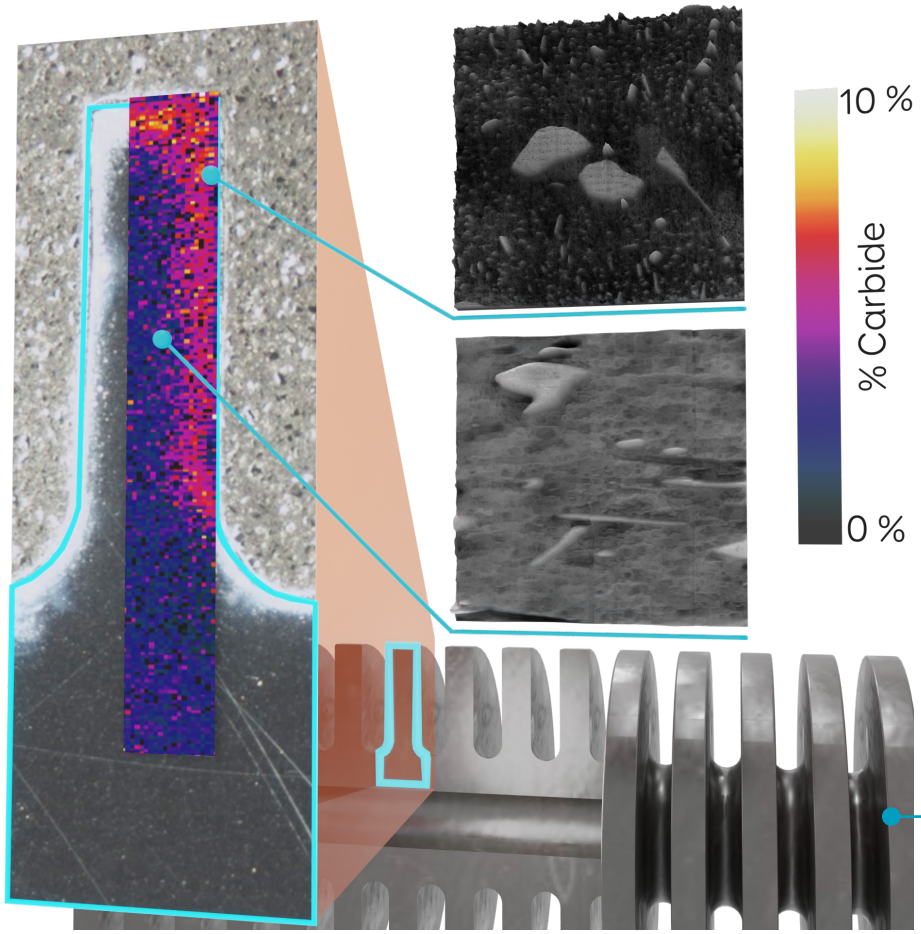
Example: Cost-saving across the UK power generation network

A major UK energy supplier used Vector to understand the vulnerabilities and lifespan of components critical to their power plants. These analyses were previously attempted by this team using SEM at the macroscale, with TEM to analyse small areas of interest.

The team generated heatmaps showing the location and classification of nanostructure characteristics across large areas of boiler cooling fins. Vector's resolution highlighted very early signs of damage, and its large area capabilities accurately measured their distribution and concentration across the whole sample. A far more detailed and accurate outcome than previous techniques.

This success has been published in **Ultramicroscopy**

Classifying Nanostructures at the Macroscale



Left: Vector imaging of an ex-service cooling fin depicting carbide concentrations across the sample presented as a heat map, overlayed onto an optical image. This 5 mm x 0.5 mm area was imaged in 18 minutes, total.

Vector operates at a far higher resolution, identifying much smaller carbides than is achievable with SEM. TEM can only analyse small lift-outs; both result in much lower accuracy in carbide identification and distribution.

Right: Two individual vector frames showing individual carbides.

Unprecedented Sample Statistics

Vector's throughput removes any need to average or assume homogeneity across your samples. Benefit from nanoscale measurements across 20 mm x 20 mm samples in record time to support your analysis or development goals.

Example: Time-saving production of 2D materials

Professor Howard's group at UCL are using Vector to optimise their 2D materials development processes. 2D materials such as graphene are transformative for electronics, energy storage, sensors, coatings, composites, and biomedical devices and research into their development and manufacture is a key goal.

Vector is an integral part of the group's material discovery and production workflow. Its rapid measurement throughput is essential for locating and characterising monolayers and stacks of new 2D materials in each produced batch, providing vital and accurate feedback for rapid assessment and iteration of each material 'recipe'. Vector has reduced the development of new materials from months and years, to weeks.

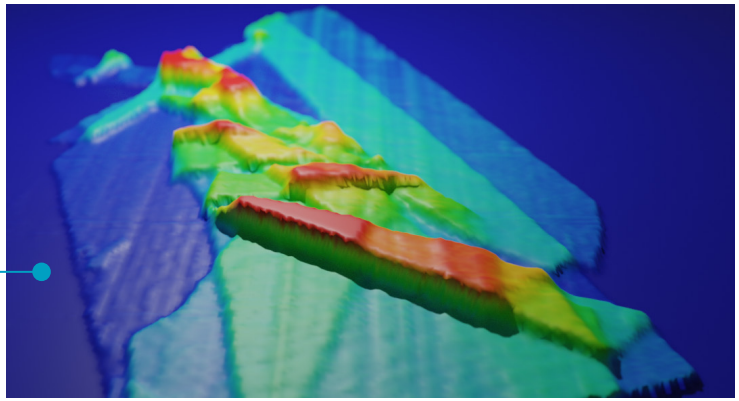
This success has been published in **Nature, Nature Chemistry, Nano Letters & JACS**

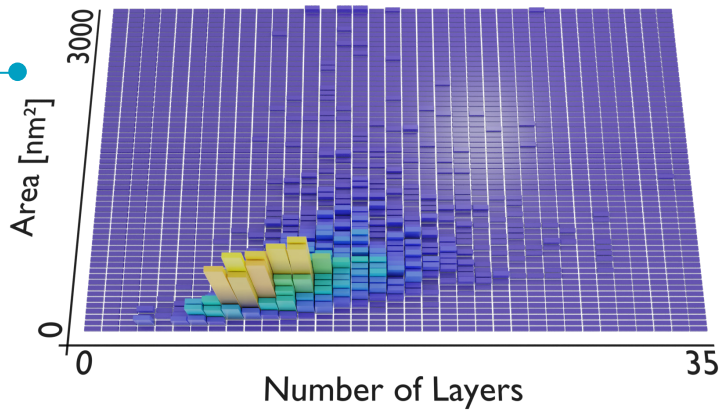
Unprecedented Sample Statistics

Top: Stacked graphene plates in a frame imaged by Vector. The colour scale indicates the number of layers present on the surface.

Vector's time resolution enables fast and accurate measurements of the size, height and distribution of all deposited material for rapid iteration and assessment of changes to material production recipes.

Bottom: A 3D histogram (N = 2,294) generated by Vector's software for UCL, categorising the 2D materials found by layer count and area to support optimal manufacturing conditions for different yield requirements.





Real-Time Imaging and Analysis

Vector offers unmatched nanoscale video-rate measurement and analysis under any environmental condition. Its unique passive mechanical feedback loop can successfully measure delicate surfaces and rapidly changing processes, making it ideal for imaging dissolution and growth events that are typically unsuitable for nanoscale imaging.

Example: Understanding the physics of electrodeposition to influence new battery technologies

The University of Bristol group headed by Prof. Schwarzacher use Vector to examine the underlying physics of electrodeposition, which has been thus far unachievable with current technologies; SEMs cannot image in liquid, AFMs are too slow and HS-AFMs cannot deliver the combination of spatial and temporal resolution required.

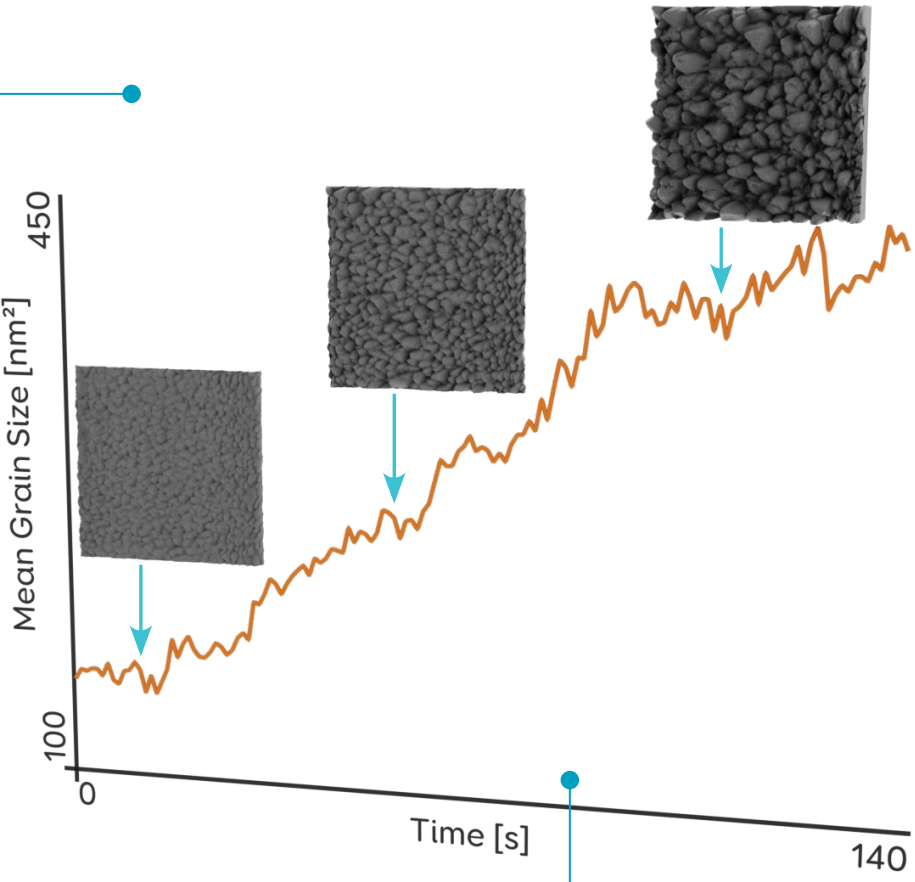
Our Dynamic SPM, Vector, helps this team observe how crystal grains grow and compete with each other during the process of electrodeposition, which is vital for identifying potential limiting factors for battery electrode lifespans.

No other technique on the market has the resolution to deliver this capability.

This work has been published in the **Journal of the Electrochemical Society**

Real-Time Imaging and Analysis

Still images: These are frames from a video taken from the time series clearly showing the growth of copper grains and the overall roughness of the electrodeposited copper film over 140 s.



Graph: This graph was automatically generated by Vector's analysis software; It denotes mean grain area as a function of deposition time. Data was collected at 2 frames/s to provide a 500 ms time resolution to the measurements.

Integration into Existing Workflows

Vector boasts automated calibration, measurement capture and analysis of its vast datasets, enabling you to get the answers you need without onerous manual processing.

Non-destructive imaging, the use of standard mounts and consumables, and simple sample preparation allow Vector to fit seamlessly into existing multi-instrument workflows.

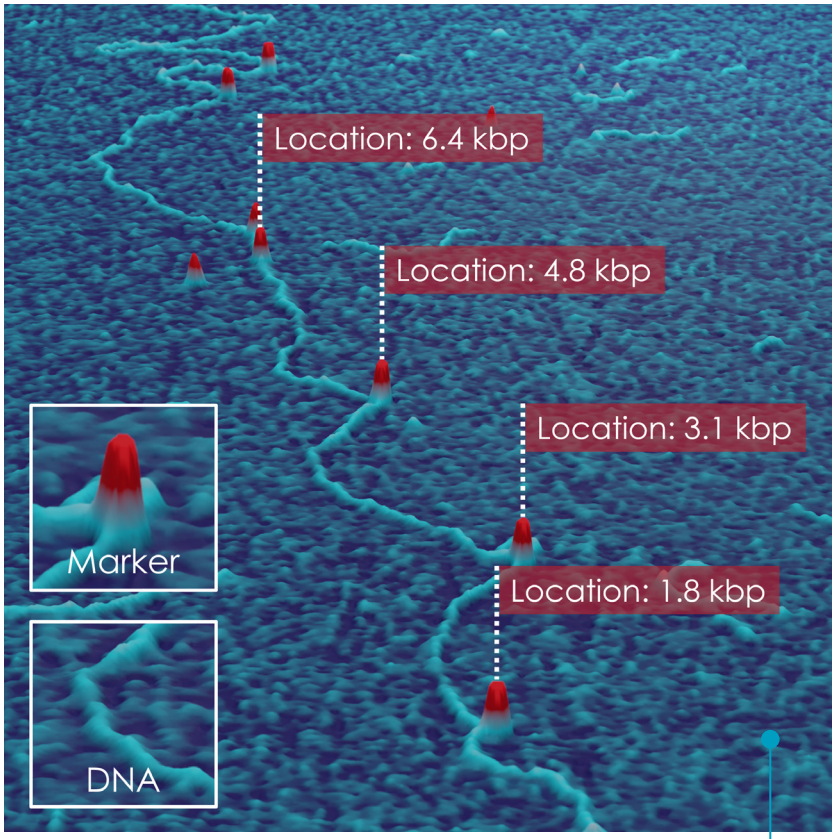
Example: Single DNA molecule analysis in hospital labs

Next-Generation Sequencing techniques are unsuitable for diagnosing certain inherited diseases and blood cancers due to the need to fragment the genome, making certain abnormalities e.g., translocations difficult to measure.

Prof. Reed at Virginia Commonwealth University successfully used a previous D-SPM version on existing clinical samples from various trials to accurately identify these abnormailites in CRISPR-labelled genomic DNA. This analysis fitted into the existing analysis workflows for the samples' respective trials, and was accomplished by lab technicians – users unfamiliar with D-SPM – with little to no manual intervention required for set up and analysis.

This work has been published in **Nature Communications, ACS Nano & Analytical Chemistry**

Integration into Existing Workflows



Labelled BRCA1 DNA molecule imaged by D-SPM in 500ms. Measuring the location of the markers along the DNA backbone enables precise identification of the molecule and detection of a wide variety of insertion/deletion and rearrangement genomic variations. The imaging and measurements were produced automatically by the D-SPM's software.

Customers & Collaborators

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Find Out More

Contact us for a chat, or to arrange to visit our offices for a tour and a demonstration of Vector's capabilities

CEO

CTO

Lead Engineer

Lead Staff Scientist

Lead Designer

Business Advisor

Communications Officer

Scientific Advisor

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