SUPER-RESOLUTION MICROSCOPY WORKSTATION

Vutara VXL

Single-Molecule Localization for Advanced Biological Imaging

Vutara VXL

See biology in nanoscale detail

The Vutara VXL comprehensive biological workstation enables both core facilities and individual investigators to easily incorporate super-resolution microscopy in their research. This system utilizes single-molecule localization microscopy (SMLM) technology to achieve the highest resolution of all super-resolution techniques. When combined with Bruker's microfluidics unit, Vutara VXL enables multiplexed imaging for targeted spatial genomics, transcriptomics, and proteomics research. With advanced SRX software, researchers can transform complex data into meaningful information to explore new frontiers in disciplines ranging from neuroscience and cell biology to virology and more.

The Vutara VXL advantage:

- SMLM approach delivers the highest resolution, down to 20 nm laterally
- Proprietary Biplane™ technology achieves deepest 3D imaging, with depths of up to 50 µm
- Innovative top-hat illumination enables uniform, quantitative data collection

"Having published with a Vutara super-resolution system, I can confidently say that they offer one of the most advanced super-resolution microscopes available. Their attention to detail and ongoing close collaboration makes them one my preferred microscopy vendors"

– Bridgette Ritter, Ph.D., Boston University

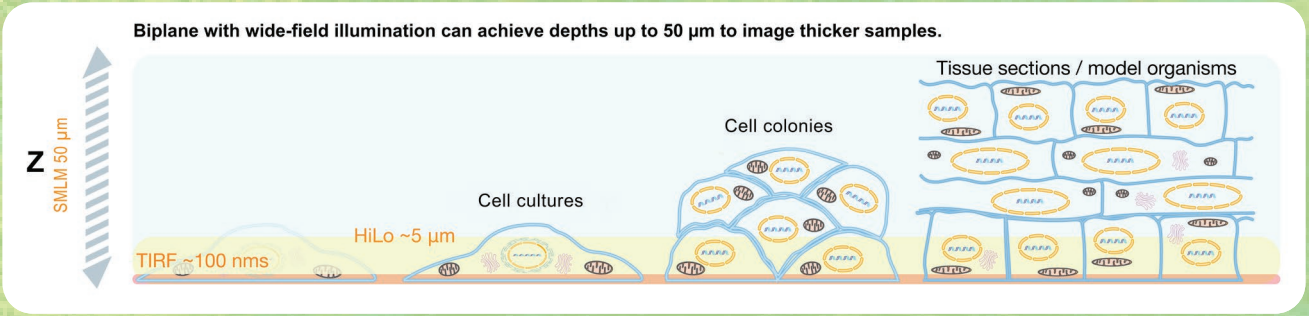
Leading Super-Resolution Technology

Our Approach: Single-Molecule Localization

Bruker has been a leader in super-resolution technology for over a decade, offering the highest quality and most advanced technology on the market. Vutara VXL utilizes single-molecule localization (SML), providing the highest resolution compared to other super-resolution approaches, down to 20 nm laterally. To overcome the optical resolution limit with SMLM, only a limited number of chromophores are activated at a time so that their point-spread-functions (PSF) do not overlap. The microscope detects these chromophores, determines their location, and switches them off. Then another subset of chromophores is activated, localized, and deactivated. This cycle is repeated multiple times to create a high resolution localization map.

Stochastic excitation of molecules can be achieved by either the use of fluorescently labeled proteins or organic fluorescent dyes. Vutara VXL is fully compatible with common and emerging SMLM techniques, including:

- Photoactivated localization microscopy (PALM)
- Stochastic optical reconstruction microscopy (STORM) and direct-STORM (dSTORM)
- Points accumulation for imaging in nanoscale topography (PAINT) and DNA-PAINT



Innovation for Unlimited Potential

Developed in collaboration with leaders in industry and academia, Vutara VXL pushes the boundaries of standard super-resolution capabilities. Proprietary biplane technology, combined with a spatial filter in the emission light path, allows you to acquire 3D data up to 50 µm deep into the sample. The system allows researchers to easily perform a Z series and automatically localizes and reconstructs the entire volume. Additionally, the utilization of top-hat illumination results in uniform data collection across the entire imaging region, enabling reliable quantitative data analysis. Vutara VXL was designed to be a comprehensive biological workstation, tailored to the needs of microscopy experiments from start to finish. The imaging ecosystem—including the Vutara VXL microscope, the microfluidics unit, and the SRX software—supports seamless acquisition and analysis of rich, quantitative data.

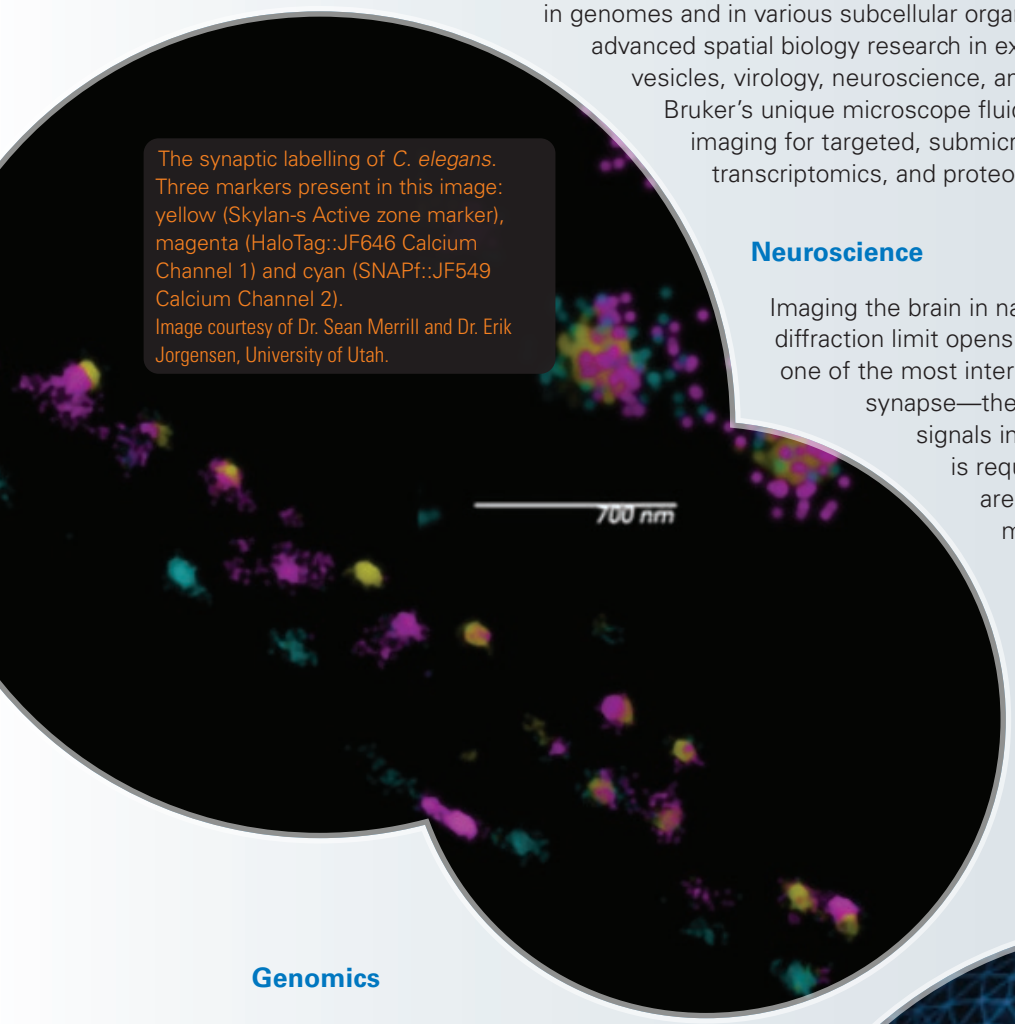
Background image:
Actin-magenta, microtubule-yellow, mitochondria-orange

"With more than 15 years of experience in designing microscopes in academia and in indutry, I am proud to contriubute to the development of Vutara's super-resolution microscopes. With Biplane 3D detection and fast sCMOS imaging, Vutara has the most advanced super-resolution microscope on the market."

– Joerg Bewersdorf, Ph.D., Yale University

Enabling Advanced Research Across the Life Sciences

Vutara VXL enables research on DNA, RNA, and proteins, from macromolecular complexes and super-structures to chromatin structure and chromosomal substructures, to studying functional relationships in genomes and in various subcellular organelles. This novel system also supports advanced spatial biology research in extracellular matrix structures, extracellular vesicles, virology, neuroscience, and live-cell imaging. When combined with Bruker's unique microscope fluidics unit, Vutara VXL supports multiplexed imaging for targeted, submicrometer multiomics in genomics, transcriptomics, and proteomics research.



The synaptic labelling of *C. elegans*. Three markers present in this image: yellow (Skylan-s Active zone marker), magenta (HaloTag::JF646 Calcium Channel 1) and cyan (SNAPf::JF549 Calcium Channel 2).
Image courtesy of Dr. Sean Merrill and Dr. Erik Jorgensen, University of Utah.

Neuroscience

Imaging the brain in nanoscale detail beyond the optical diffraction limit opens doors in neuroscience research. Perhaps one of the most interesting components of the brain is the synapse—the junction essential to the transmission of signals in the brain. Super-resolution microscopy is required to visualize these structures that are approximately 20-40 nm wide. The SML method is ideal for the study of neuronal structures and processes such as:

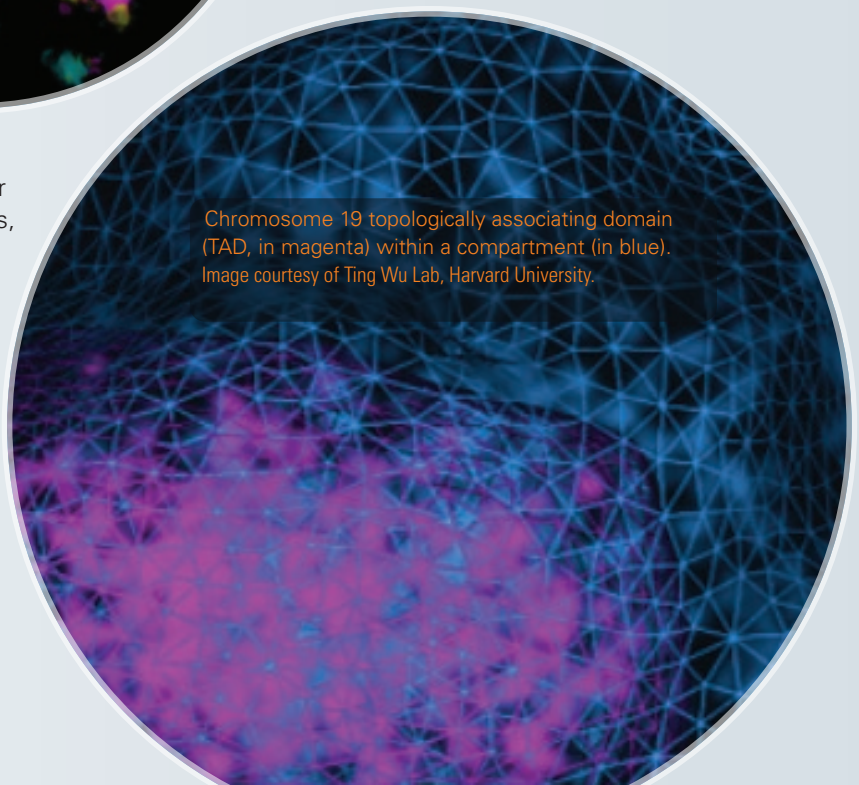
- Neural development
- Neural circuit assembly
- Synaptic formation
- Synaptic transmission
- Synaptic proteins

Genomics

Visualizing genomic organization and structure on a subchromosomal level is necessary for understanding relationships between genes, their regulation, and their environment.

SMLM can image three-dimensional chromosome structures at single cell and subcellular levels, making it ideal for genomics applications such as:

- Functional organization of genome within the nucleus
- Multi-location capture of multiple nuclei
- Chromatin tracing



Chromosome 19 topologically associating domain (TAD, in magenta) within a compartment (in blue).
Image courtesy of Ting Wu Lab, Harvard University.

Virology

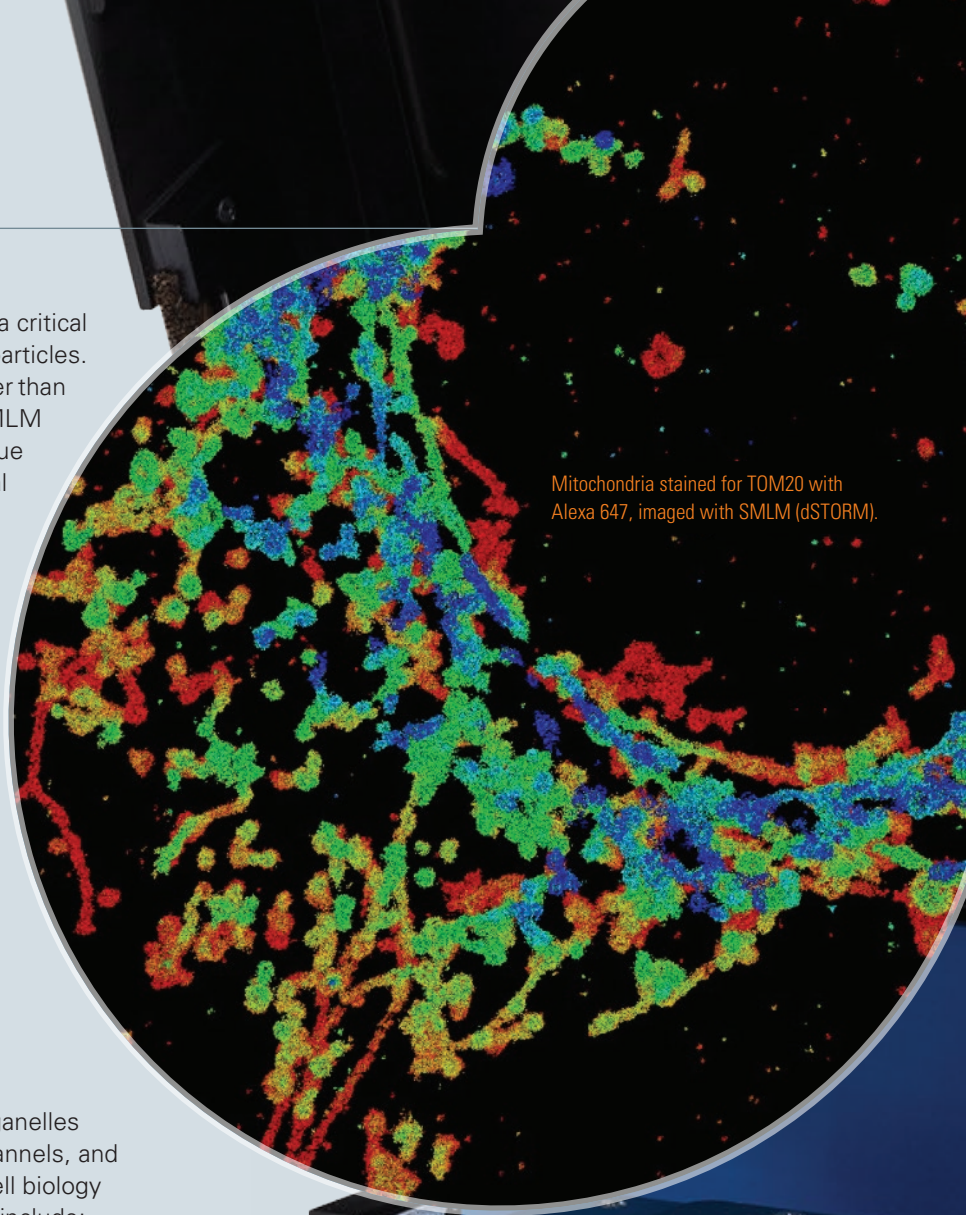
The Vutara SMLM platform has been a critical instrument for understanding viral particles. Viral particles are typically much smaller than the optical diffraction limit, making SMLM the best suited fluorescence technique for resolving virus particle structural details or determining localization of virus components with the cellular machinery. Some key applications for Vutara VXL in virology research include:

- Viral particle structure
- Virus-host interactions
- Virus pathology

Cell Biology

Many interesting cellular structures are smaller than the optical diffraction limit of ~200-300 nm and therefore require super-resolution microscopy for imaging specifically labeled structures at this scale. These include the substructures of most organelles and all macromolecular machines, channels, and receptors. Research applications in cell biology that can be achieved with Vutara VXL include:

- Molecular quantification
- Molecular distribution
- Colocalization of proteins
- Particle tracking



Mitochondria stained for TOM20 with Alexa 647, imaged with SMLM (dSTORM).

Vesicular stomatitis viral particle. Red – VSV-G protein tagged with Alexa Fluor 647.

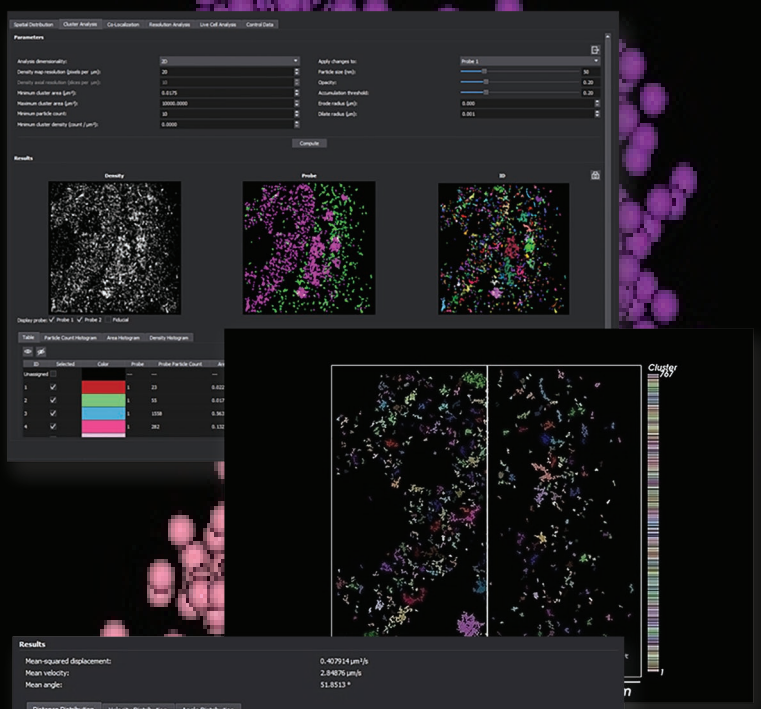
Transforming Voxels into Information

Rich Quantitative Analysis Capabilities

With SRX software and its quantitative localization microscopy analysis suite, Vutara VXL can provide both visual and quantitative information from biological samples. By localizing individual molecules, Vutara can generate stunning 3D images while simultaneously providing in-depth quantitative analysis tools.

Measurements available within the SRX software include:

- Spatial Distribution — Provides a variety of tools for analyzing spatial distribution relationships of particles, including Ripley's K, pair correlation, and nearest neighbors
- Cluster Analysis — Counts clusters, cluster sizes, and cluster densities
- Colocalization — Provides statistical measures on relationships between particles of two different labels
- Resolution Analysis — Quantifies resolution for images derived from localized data
- Live-Cell Analysis — Tracks clusters in live-cell experiments with mean squared displacement and angular displacement analyses



The workflow-oriented SRX software includes powerful statistical analysis tools.

"After scanning the market for super-resolution microscopes and personally visiting and testing most commercially available systems with our own samples, I can say that I am most impressed with the Vutara. In particular, the user friendliness of their imaging software as well as the 3D capability in super-resolution mode impressed me. Vutara has an excellent support team and staff as a whole making our transition to super-resolution a well-supported experience. If you're looking to advance your research by super-resolution microscopy, I can confidently say that Vutara's systems are an excellent choice."

– Thomas Stroh, Ph.D., Core Facility Directory, McGill University.

Multiplexing for Unlimited Imaging Possibilities

Bruker's Microfluidics Accessory

The microfluidics unit is specifically designed to allow sequential labelling to be incorporated into localization microscopy protocols with the Vutara VXL microscope. The unit is controlled by SRX software and allows flexible configuration of fluidics sequences that are run in conjunction with imaging cycles. This enables users to label an unlimited number of probes and image them in a sequential fashion.

With the microfluidics unit, Vutara VXL can be used to address any localization microscopy application that requires a large number of targets to be imaged. Fifteen probe vials are provided and can be interchanged during experiments, thus supporting an unlimited number of targets. Primary localization microscopy applications with the microfluidics unit include:

- OligoSTORM
- RefreshSTORM
- DNA-PAINT
- Multiplexed antibody labelling

Vutara VXL

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Specifications

Imaging Modalities	SMLM with high Z-resolution for STORM, PALM, PAINT, and related super-resolution applications; Localization microscopy with large FOV, optimized for super-resolution multiplexed genomics applications; Epi-fluorescence microscopy with large FOV; Transmitted light microscopy with large FOV
Excitation lasers (nominal laser power at diode)	405 nm, 120 mW 488 nm, 2000 mW (optional) 555 nm, 2000 mW 638 nm, 1200 mW 750 nm, 1500 mW (optional)
Flat Illumination	Flat excitation profile guaranteed by top-hat illumination from a square fiber
Multi-Color Acquisition	≤5 colors sequential
Multi-Plane Imaging	Simultaneous imaging of two focal planes allows 1 µm depth discrimination (larger Z range possible in Z-stack mode)
Camera	Orca Flash 4.0 v3 sCMOS camera; Orca Fusion BT sCMOS camera (optional)
Objective	60x magnification; 1.3 NA; Silicon oil immersion; 0.3 mm working distance; #1.5H cover glass (0.170 ±0.005 mm)
Field of View (FOV)	200 x 200 µm for multiplexed localization microscopy and widefield imaging; 50 x 50 µm for SMLM with switching (STORM, PALM, PAINT) and 3D localization (Biplane detection); Larger FOV with tile scanning
SMLM Resolution	20 nm laterally (XY); 50 nm axially (Z) with Biplane
Imaging Depth	>30 µm (dependent on sample)
XY-Stage	Easy access to sample; 100 x 50 mm travel range; Optical encoder with 1 nm resolution
Z-Focus	Course focus to localize sample; Fine focus for fast Z-stack acquisition
Drift Correction	Active focus drift correction during data acquisition; Focus drift <30 nm over 10 minutes; XY drift correction post-acquisition
Workflow-Oriented Software	Data acquisition; 3D localization based on measured PSF; Particle tracking; Statistical data analysis tools; Visualization
Options	Integrated microfluidics for multiplexed experiments; Live-cell incubation with humidity, CO_2, and temperature control; Network attached storage

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