CSR Biotech
Transforming Tools Changing Lives

Elliot

Cell Xtreme

Whole Life-Cycle Super-Resolution Microscope

Label-Free Meets SIM
Dual Super-Resolution for Cellular Discovery

360° Insight into Cellular Dynamics

The New Dual-Modality Microscope

Cell Xtreme

The Cell Xtreme is a state-of-the-art super-resolution microscope developed by CSR Biotech for long-term live-cell imaging. Integrating the MI-SIM[1] and MI-ODT[2] modalities, the Cell Xtreme combines a fluorescence super-resolution technology with a label-free super-resolution technique – achieving 1 + 1 > 2!

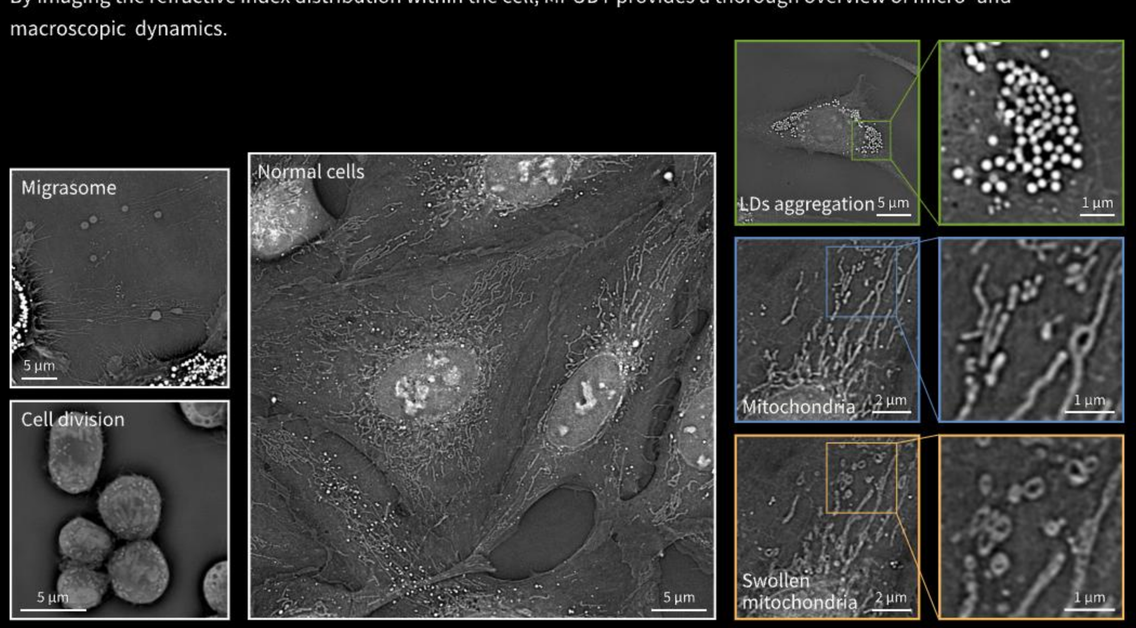
With the MI-ODT module, observe the morphology and dynamics of live cells and organelles through differences in refractive index in your sample. Combine that with super-resolution imaging of specifically fluorescently labeled organelles, proteins, and labels to get the complete understanding of your sample and its context.

The Cell Xtreme integrates numerous imaging modes, reconstruction modes, and advanced features, enabling you to create highly customized experimental workflows that perfectly address your specific research objectives.

MI-ODT

Cellular and Intracellular Organelle Dynamics

By imaging the refractive index distribution within the cell, MI-ODT provides a thorough overview of micro- and macroscopic dynamics.



Data Source: CSR Biotech

[1] Machine Intelligent SIM, MI-SIM
[2] Machine Intelligent ODT, MI-ODT

The Principle of ODT

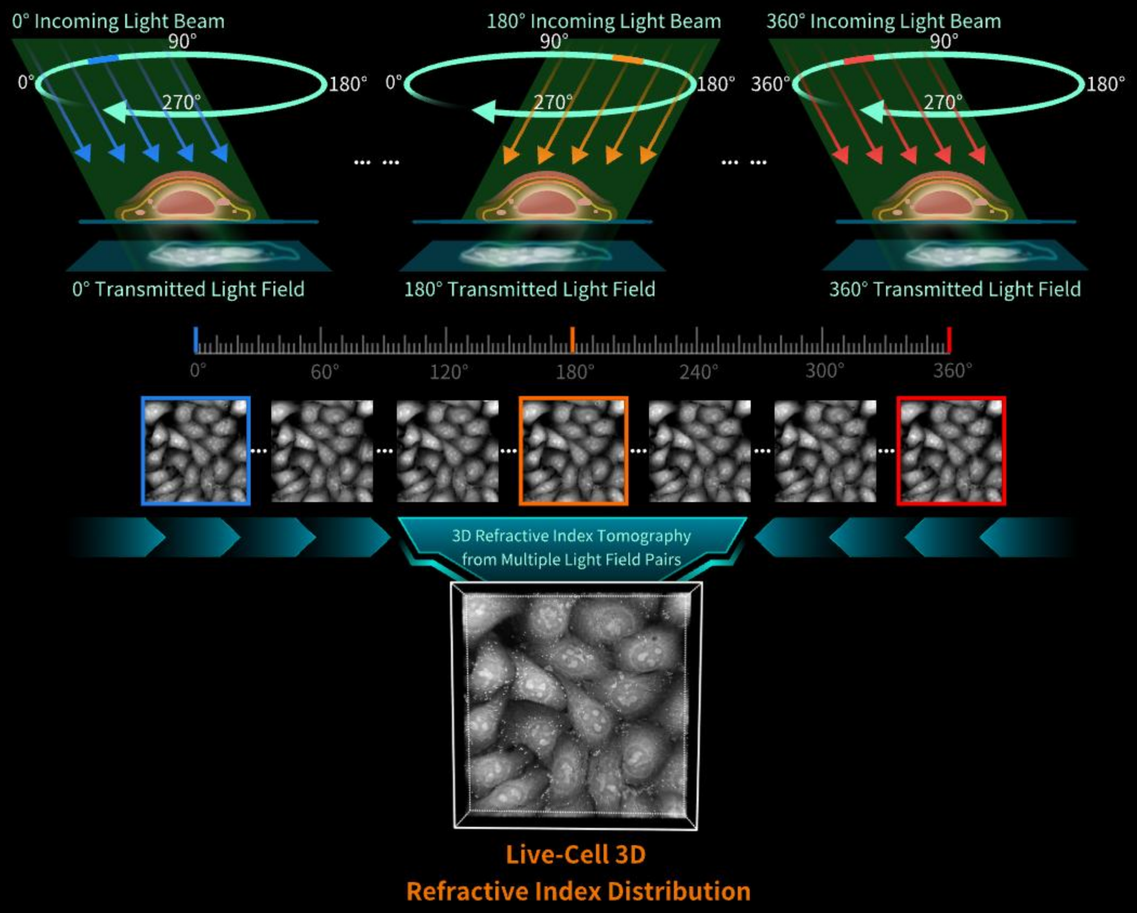
The Principle of ODT

Volumetric Refractive Index Imaging

Refractive Index (RI) is an inherent optical property of biological specimens. Regions with higher material density exhibit higher RI values. When a light beam passes through your sample, local RI variations cause light to propagate at different directions and speeds. Once acquiring both the incoming and transmitted light fields, these RI variations can be retrieved basing on the Coherent Optical Propagation Model and reconstruction algorithm.

In Optical Diffraction Tomography (ODT)[1], your sample is illuminated in coherent light beam from multiple angles. By using interferometric method, all direction light field pairs including both incoming and transmitted light field are acquired, then a 3D RI distribution of your sample is completely reconstructed. This allows you to see organelles that can be distinguished by RI, such as mitochondria, nuclei and lipid droplets at super-resolution quality!

Large-Angle Circular Scanning in ODT Lable-Free Imaging



Live-Cell 3D
Refractive Index Distribution

[1] Yongjin Sung et al, *Optics Express*, 2008

MI-ODT in Cell Xtreme

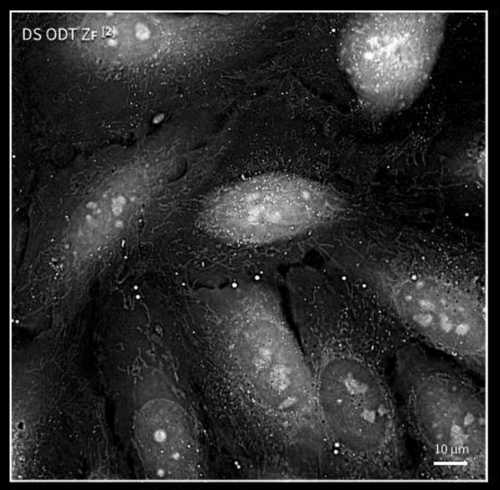
ODT is globally recognized as the most suitable label-free technique for live-cell super-resolution microscopy. Unlike conventional brightfield microscopy, ODT directly quantifies the refractive index distribution throughout the entire cell, delivering a volumetric, super-resolution map of your sample. Cell Xtreme utilizes CSR Biotech's proprietary MI-ODT modality, achieving 3D label-free imaging with 130 nm lateral resolution, combined with unique features optimized for live-cell microscopy.

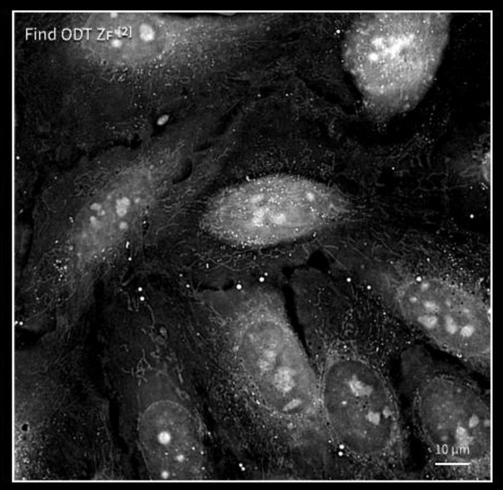
MI-ODT Features

Label-Free SR Preview: Preview your ODT image using 10 Hz real-time ODT reconstruction
Real-Time Virtual Staining: Segment multiple organelles live and post-reconstruction
130 nm[1] Label-Free Super-Resolution: Investigate the finest structures in your sample with excellent resolution
Extremely Low Phototoxicity: Observe your live cells for weeks without phototoxic effects
Multi-Site Tracking: Boost your throughput by tracking cells in multiple FOVs simultaneously
Event-Driven Imaging: Image only when needed, with custom event-driven control

MI-ODT: Label-Free Super-Resolution Preview

- The Find ODT mode allows you to record, reconstruct, and display your ODT data at 10 Hz. Get an impression of the refractive index contrast and capture macro-scale cellular dynamics at < 300 nm resolution, before selecting the sites to record at the highest resolution.
- Figure: DS ODT[2] post-recording reconstruction of live U2OS cells (Left); Find ODT real-time output of the same region (Right).





Scan QR Code to Access Video

Data Source: CSR Biotech

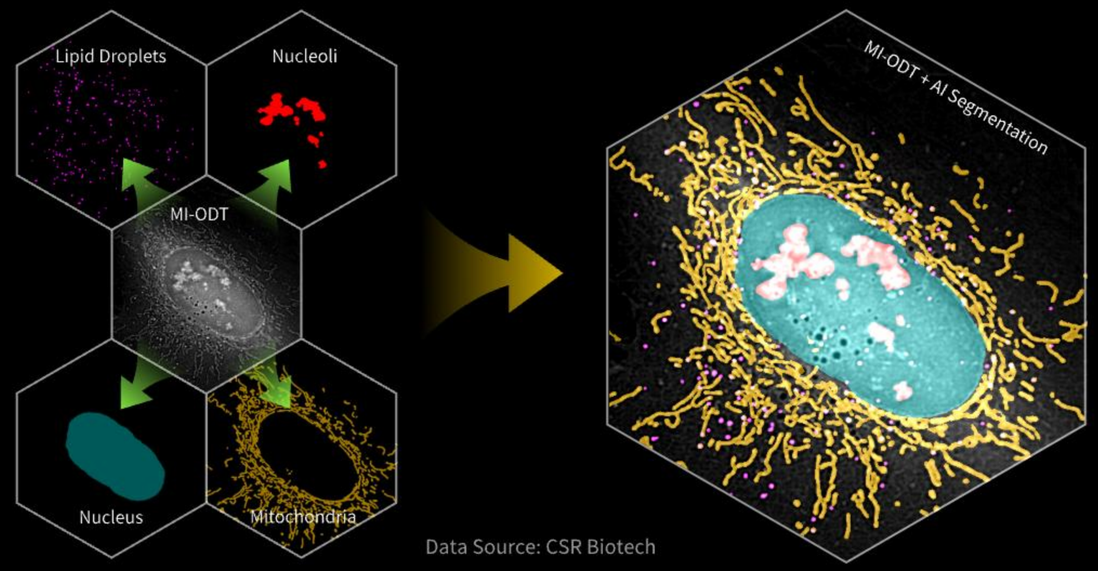
[1] The imaging resolution of MI-ODT is related to the wavelength of the illumination light, imaging parameters, reconstruction algorithms, and post-processing algorithms. A resolution of 130 nm is achieved using 532 nm coherent light illumination, and with 405 nm coherent light, the resolution can reach 110 nm.

[2] DS ODT, Different Scanning ODT, Z_F is the in-focus imaging plane.

MI-ODT Observing Panoramic Cell Dynamics

MI-ODT: Real-Time AI Segmentation of Organelles

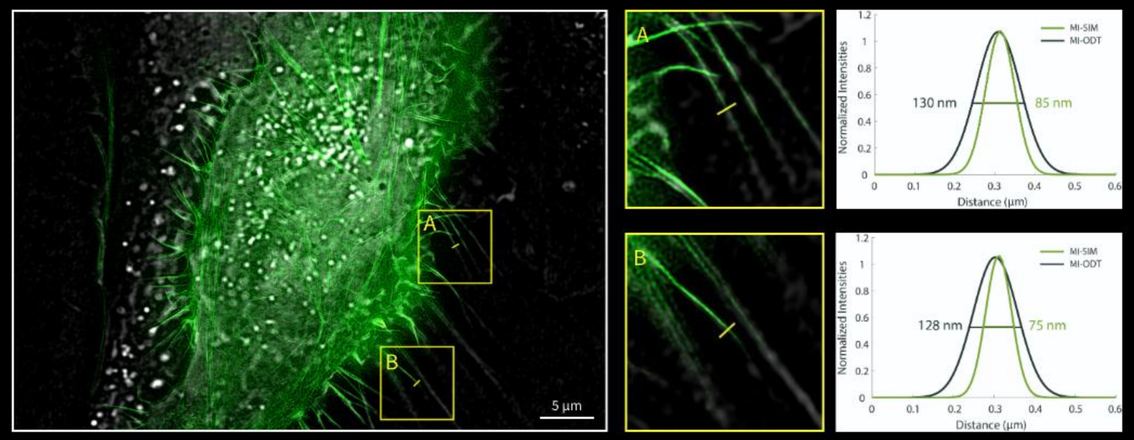
Eliminate the need to fluorescently label your organelles through real-time and post-acquisition AI segmentation algorithms. Separate channels for cell membranes, nuclei, nucleoli, mitochondria, and lipid droplets can easily be extracted from the MI-ODT data, freeing up channels for fluorescence imaging.



Data Source: CSR Biotech

MI-ODT: 130 nm Resolution in Live Cells

Identify structures in super-resolution! MI-ODT was combined with MI-SIM to record super-resolution images without and with fluorescence imaging. Allow MI-ODT to replace the fluorescence organelle reference channels, freeing up channels for fluorescence imaging, while still obtaining super-resolution images up to 130 nm[1].



Data Source: CSR Biotech

[1] 130 nm resolution can be obtained with SR ODT mode, namely Super-Resolution ODT mode.

MI-SIM in Cell Xtreme

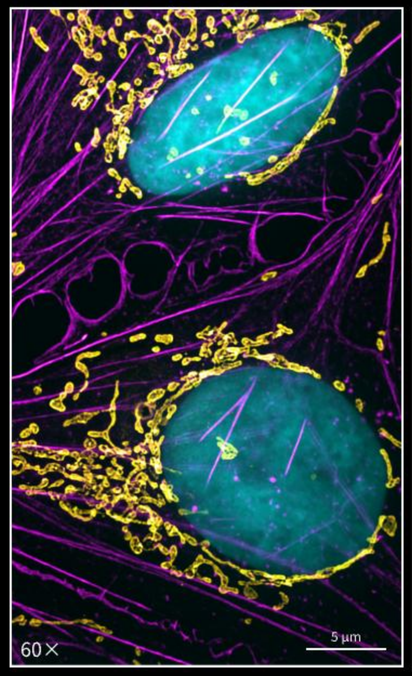
SIM is globally recognized as the most suitable super-resolution technique for fluorescence live-cell microscopy. Compared to confocal microscopy, SIM offers lower phototoxicity, faster imaging speed, and a higher resolution. The Cell Xtreme utilizes CSR Biotech's proprietary MI-SIM module, achieving 60 nm resolution while enabling overnight live-cell imaging with multi-channel, multi-layer, multi-site, auto focus, and auto tracking capabilities.

MI-SIM Features

Real-Time SIM SR Preview: Preview your SIM image using 24 Hz real-time SIM reconstruction
60 nm Ultra-High Resolution: Investigate the smallest structures in your sample with extraordinary detail
1500 fps Ultra-Fast Recording: Capture every movement in your sample
Ultra-Low Photobleaching: Image up to multiple days without phototoxic effects to your sample
Multi-Site Tracking: Boost your throughput by tracking cells in multiple FOVs simultaneously
Event-Driven Imaging: Image only when needed, with custom event-driven control

MI-SIM: Capture The Finest Details with All Objectives

Experience ultimate imaging flexibility through MI-SIM's compatibility with objectives from 20 × to 100 × magnification – ensuring that you can capture everything from single cells to large-scale features.



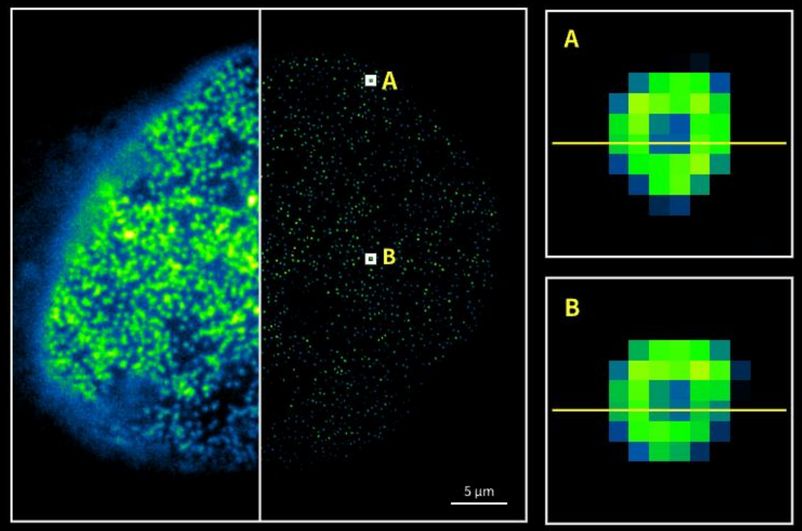
Sample Type: Actin, outer mitochondrial membrane and nuclei in U2OS fixed cells
Data Source: CSR Biotech

Sample Type: Inner mitochondrial membrane of mouse sperm
Data Source: Zhang Lab, Shenzhen Institute of Advanced Technology, CAS

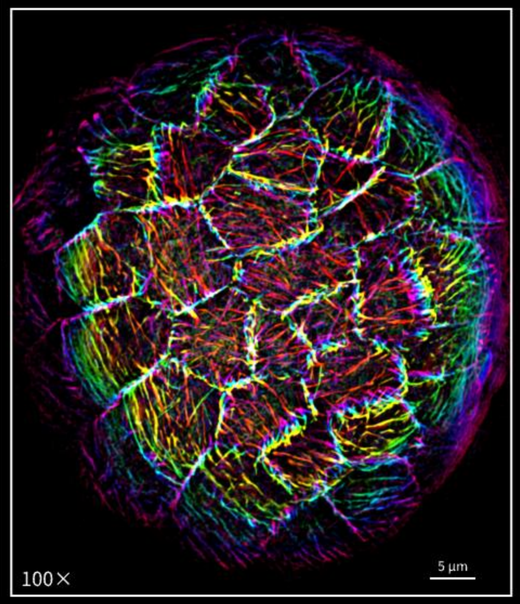
MI-SIM Observing Intracellular Dynamics

MI-SIM: 60 nm Resolution in Live Cells

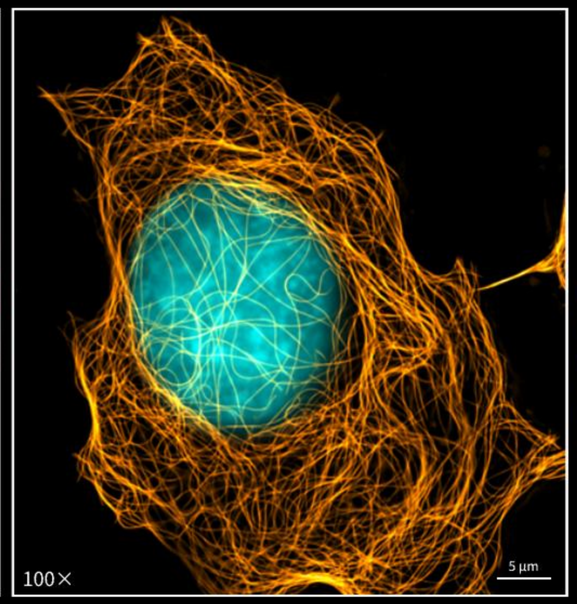
Achieving an ultra-high resolution of 60 nm in live cells, MI-SIM allows for the precise observation of the distribution of fluorescent labels within your sample. This enables insights into the overall structural layout and dynamic changes at the finest level, such as the 60 nm ring-shaped structure of nuclear pores.



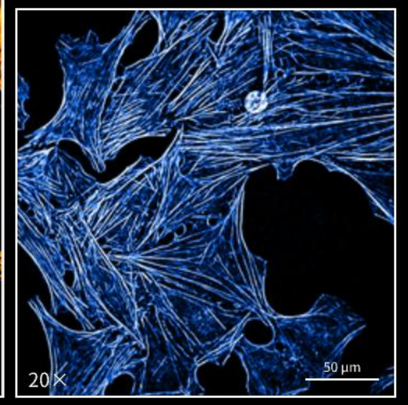
Data Source: CSR Biotech



Sample Type: Arabidopsis leaf microtubules
Data Source: Zhao Lab, Northwestern Polytechnical University



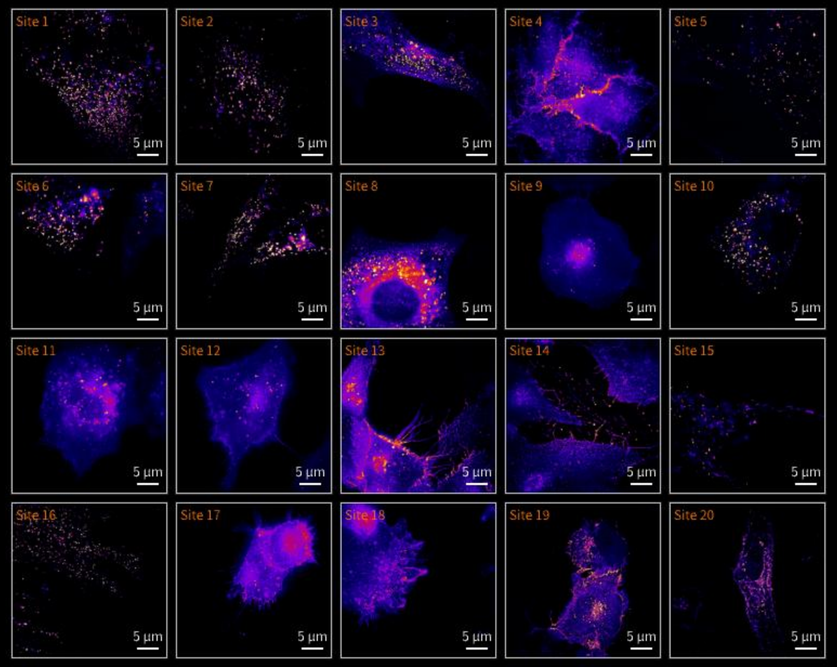
Sample Type: Microtubules and nucleus in U2OS live cell
Data Source: Zhang Lab, Huazhong University of Science and Technology



Sample Type: Actin filaments In U2OS fixed cells
Data Source: CSR Biotech

MI-SIM: Multi-Site Imaging of Bone Marrow Stem Cells Migration

By combining MI-SIM's multi-site imaging and auto-tracking features, significantly improve your throughput and experimental success rate!

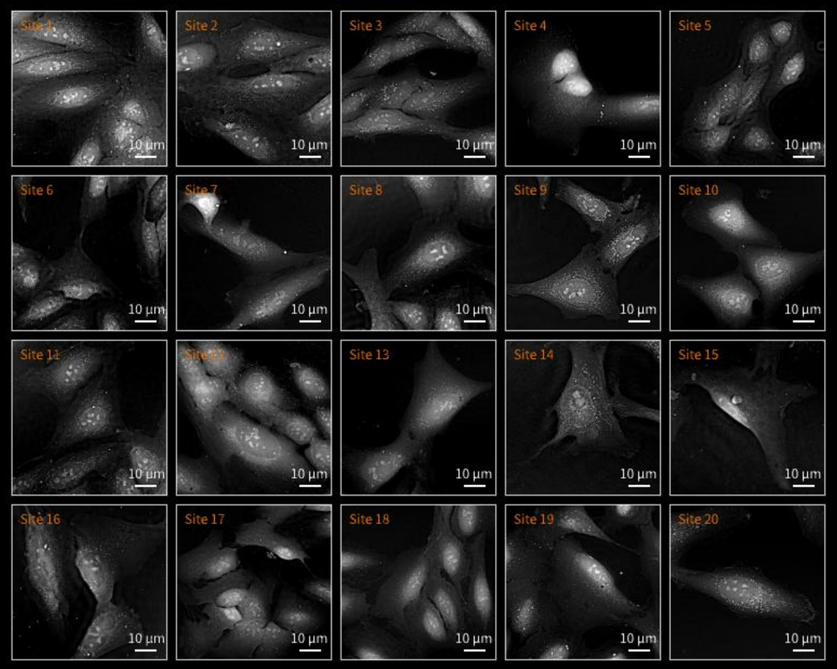


Scan QR Code to Access Video

Data Source: Zhang Lab, Air Force Medical University

MI-ODT: Simultaneous Multi-Site Observation of U2OS Cell Cycle

MI-ODT's multi-site imaging feature allows you to analyze cell growth, division, migration, and death in multiple fields of view simultaneously.



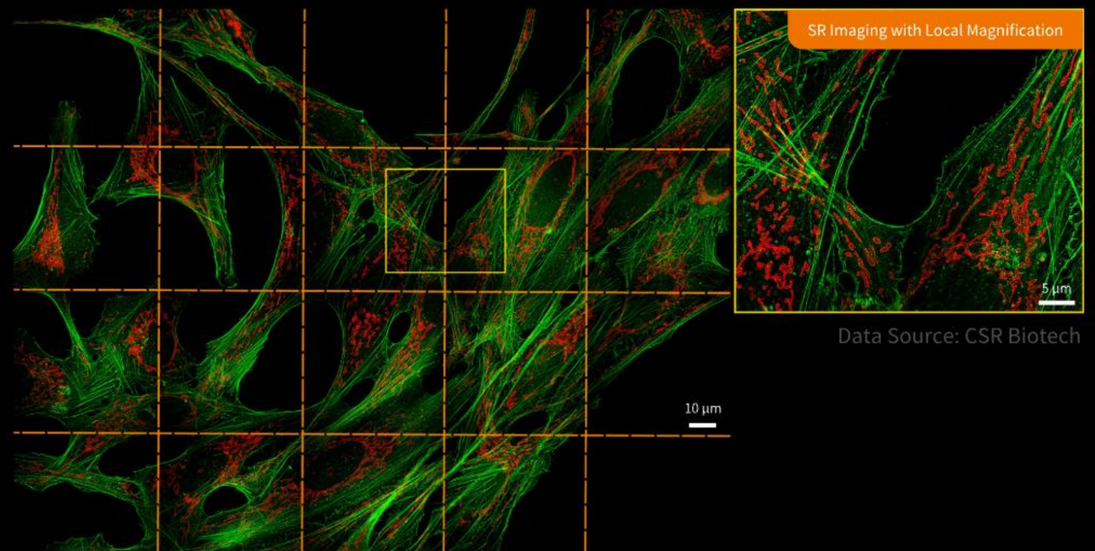
Scan QR Code to Access Video

Data Source: CSR Biotech

MI-SIM: Large Field of View Stitching

Multiple FOVs can be captured and stitched together within the MI-SIM software, ensuring seamless images through vignetting correction algorithms. Create breathtaking panoramas while maintaining MI-SIM's outstanding resolution.

(19 FOVs stitched to a 330 × 265 μm region)

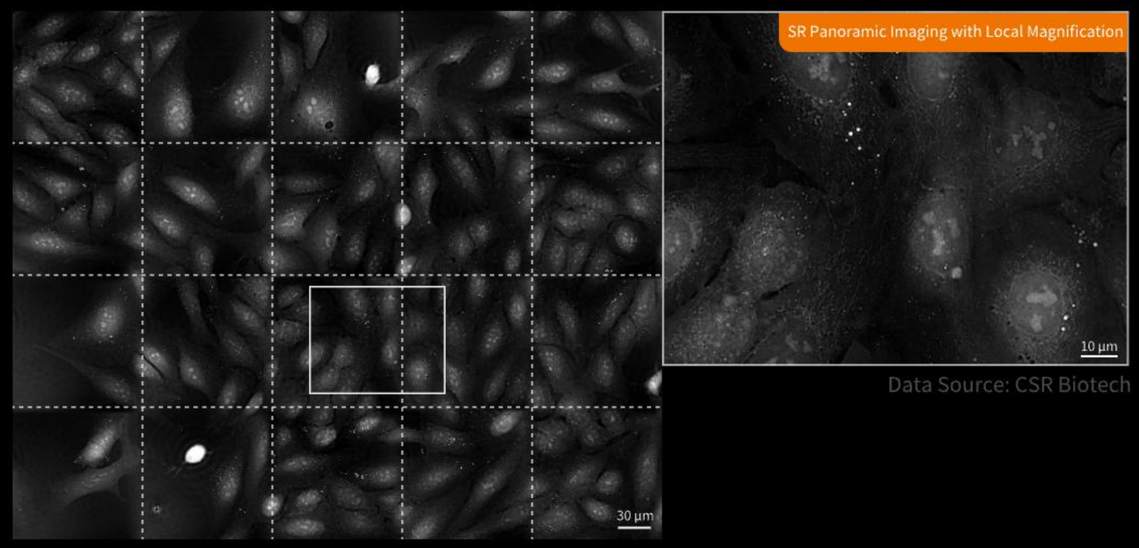


Data Source: CSR Biotech

MI-ODT: Large Field of View Stitching

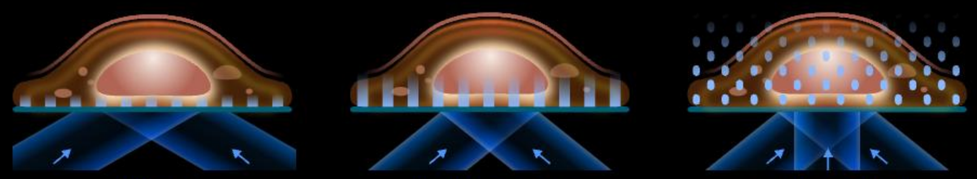
Combine label-free longer-term super-resolution recordings into one image to create datasets with immense amounts of information!

(20 FOVs stitched to a 690 × 550 μm region)



Data Source: CSR Biotech

Cell Xtreme Innovative Dual-Modality Imaging Solution

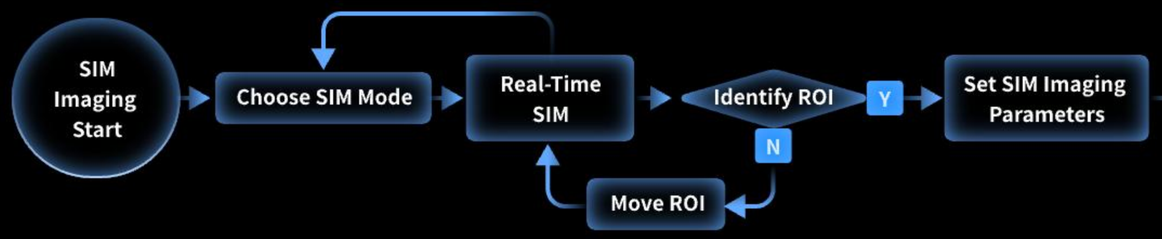


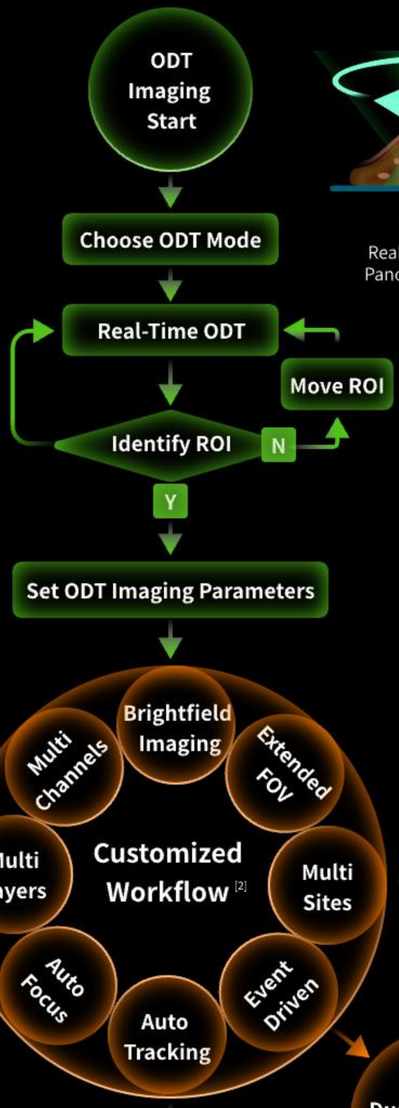
Intelligent Fluorescence Super-Resolution Modality MI-SIM

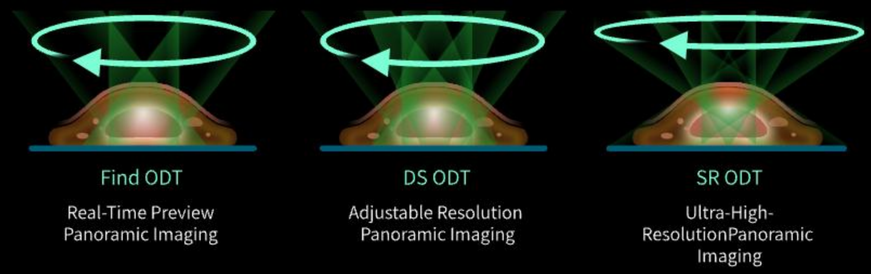
Diverse Imaging Modes: Optimize the imaging and reconstruction modes for your experiment

- Real-Time SIM: Super resolution real-time preview for live cells at 24 Hz
- TIRF-SIM: Image close to the coverslip to study membrane proteins or lipids
- 2D-SIM Slice: Image organelles, proteins, and molecules within single layer of your sample
- 3D-SIM Slice: Increase your axial resolution for densely distributed structures in your sample
- 2D-SIM Stack: Record a stack of 2D images for fast, low bleaching structures
- 3D-SIM Stack: Obtain a 3D stack with the highest axial resolution

MI-SIM modality is equipped with advanced functionalities, featuring real-time preview, extended FOV, full-time tracking, and event-driven imaging





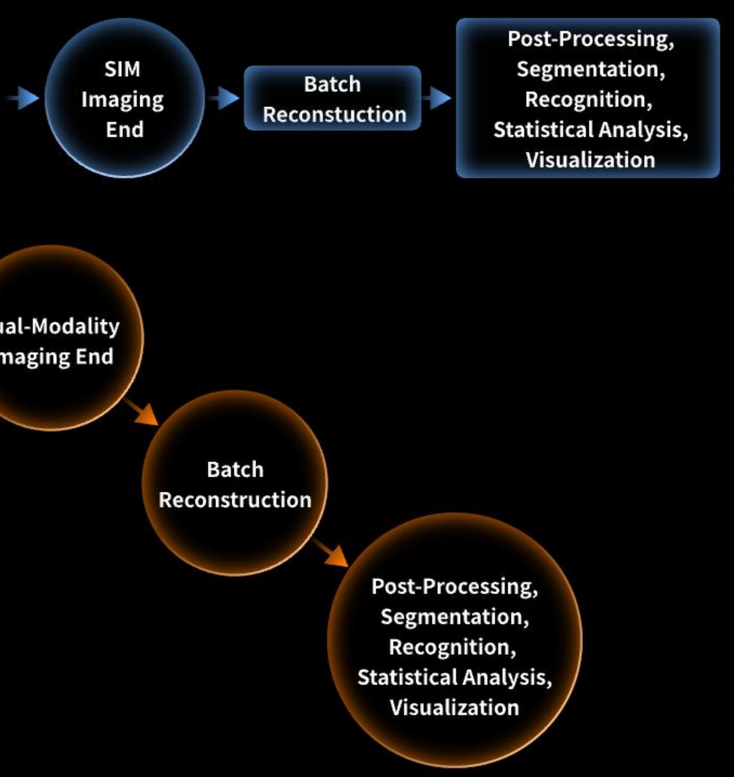


Integrated Label-Free SR Modality MI-ODT

Diverse Imaging Modes: Optimize the imaging and reconstruction modes for your experiment

- Find ODT: See a real-time preview of the ODT reconstruction before recording
- DS ODT: Tune resolution and recording speed to match your experiment
- SR ODT: Select the highest quality of ODT to get the optimal resolution
- Rolling ODT: Significantly increase recording speed of your label-free time series
- Multi-Channel ODT: Immediately segment organelles into different channels [1]

MI-ODT modality is equipped with advanced functionalities, featuring real-time preview, extended FOV, full-time tracking, and event-driven imaging



Integrated Multimodal Imaging with MI-ODT and MI-SIM

Combine the power of MI-ODT and MI-SIM by recording with both modules simultaneously, and use event detection to trigger imaging in the other modality.

Cell Xtreme allows you to customize activation rules for multimodal imaging with MI-ODT and MI-SIM, at each stage, and in every loop. Use the Online Image Analysis (OIA)[3] Platform to detect events in one module to drive imaging in the other.

[1] Pioneering AI recognition and segmentation of label-free panoramic images of live cells, capable of distinguishing up to 8 types of organelle structural distributions.

[2] User-configured module refers to page 11.

[3] Dynamic feature analysis based on label-free segmented images to perceive changes in cellular phenotypes and organelle structures, allowing for assessments of cell status and event determination.

Cell Xtreme Dual-Modality Imaging Software

Process Manager Panel
Easily set up your experiment

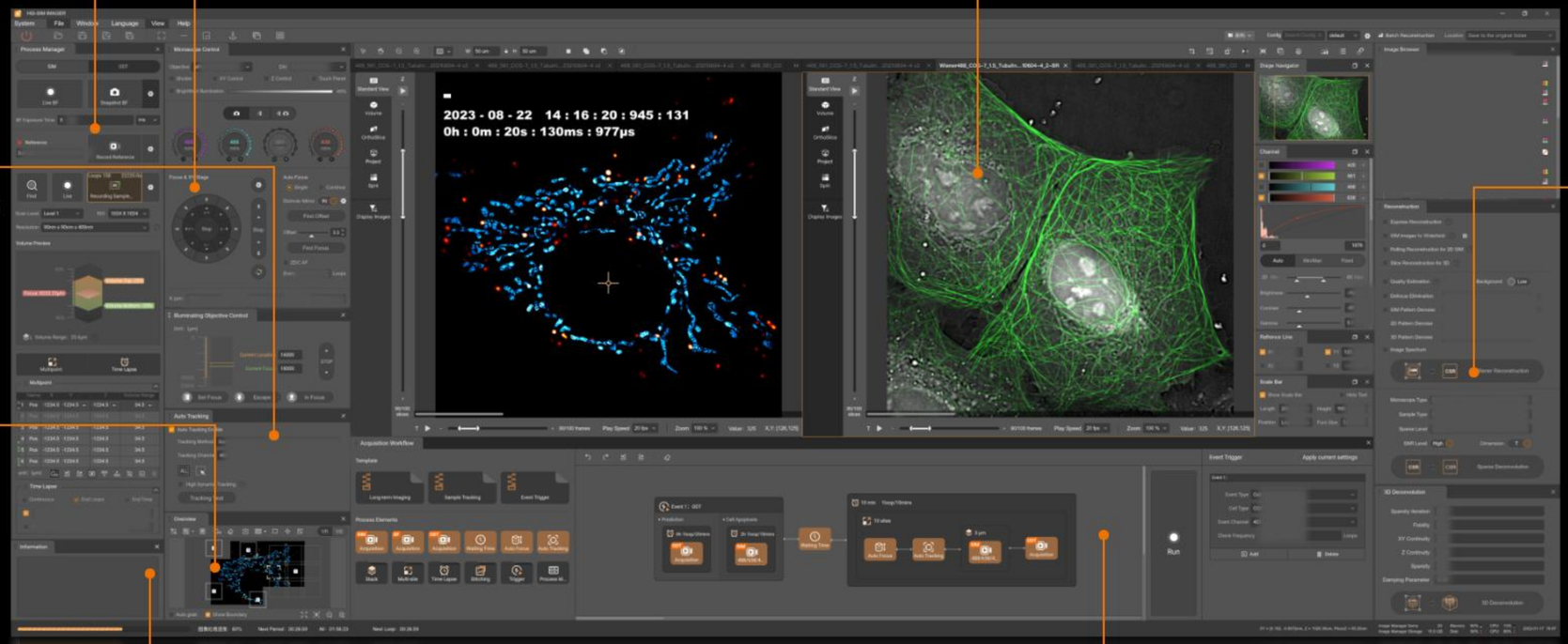
Microscope Control Panel
Control the microscope body within the software

Image Interaction Panel
Preview and adjust your recorded images

Auto Tracking Panel
Select your intelligent tracking method to follow your sample

Extended FOV Panel
Create an overview of your sample and select sites to image

Reconstruction Panel
Reconstruct your recorded data in one easy click

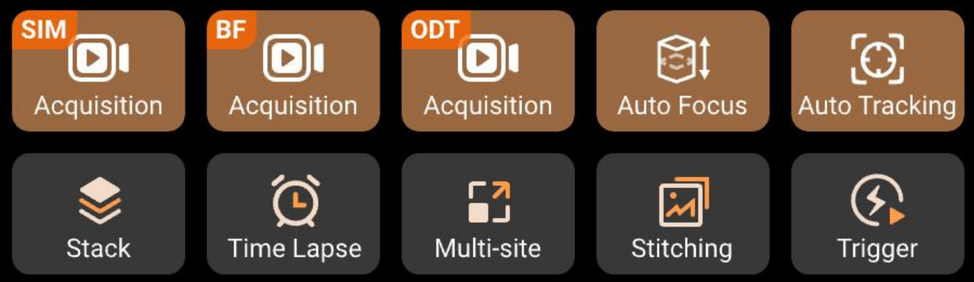


Information Panel
Real-time information on the state of your microscope

Advanced Workflow Assembly Panel
Use building blocks to easily assemble high-dimensional, complex imaging workflows

Customized Setup for Complex Workflow

Imaging Modules can be assembled to create a complex, multi-dimensional imaging workflow. Use the intuitive graphical interface to create unique imaging workflows effortlessly. Optimize your workflow to your experimental plans, experiences, and selected parameters.



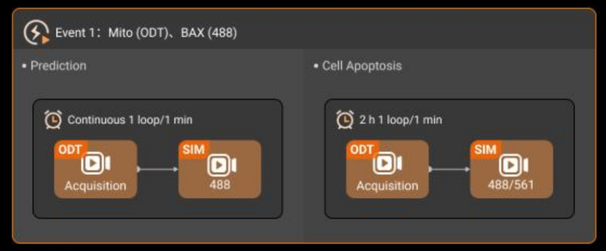
Workflow Example 1

In a 48-hour recording session, multi-site recording is repeated every 30 minutes. Within the multi-site recording, 30 sites are imaged 3 times with SIM (after focus and tracking), followed by an ODT recording.

Workflow setup for experiment on page 13

Workflow Example 2

An event-driven for cell apoptosis is set up. The sample is imaged with ODT and SIM at 488 nm, until the event is detected. After the detection, the sample is imaged once per minute for 2 hours with ODT and SIM at 488 nm and 561 nm.

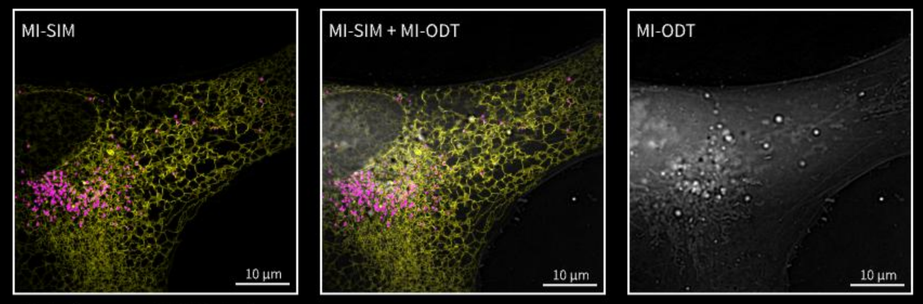


Workflow setup for experiment on page 15

Joint Imaging: Dual-Modality Multi-Channel Merge

Joint Imaging: Label-Free + Endoplasmic Reticulum + Peroxisomes

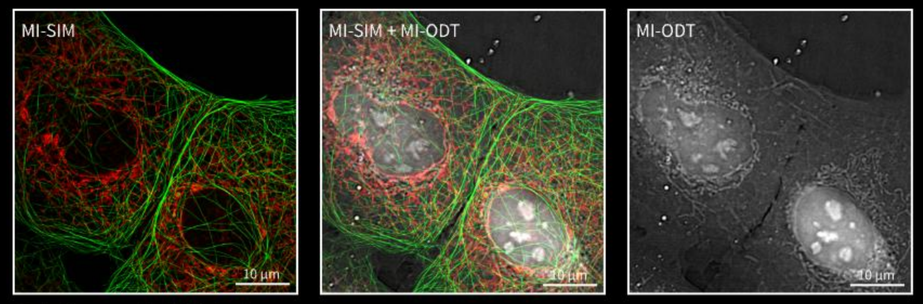
Combine MI-ODT and MI-SIM to image subcellular organelle networks! Using our AI label-free segmentation algorithm, cell membranes, nuclei, nucleoli, mitochondria, and lipid droplets can be segmented from the label-free data. This can immediately be overlayed with the MI-SIM data of organelles invisible to MI-ODT, achieving synchronous imaging of various organelles in live cells.



Data Source: CSR Biotech

Joint Imaging: Label-Free + Endoplasmic Reticulum + Microtubules

Combine MI-ODT with MI-SIM imaging to study cell dynamics at the highest resolution! The powerful AI segmentation algorithm can extract cell membranes and nuclei, while MI-SIM simultaneously captures the dynamics of the endoplasmic reticulum (red) and microtubules (green). These organelles are not visible to MI-ODT, so by collaborating with MI-SIM, all information can be extracted from the sample.



Scan QR Code to Access Video

Data Source: CSR Biotech

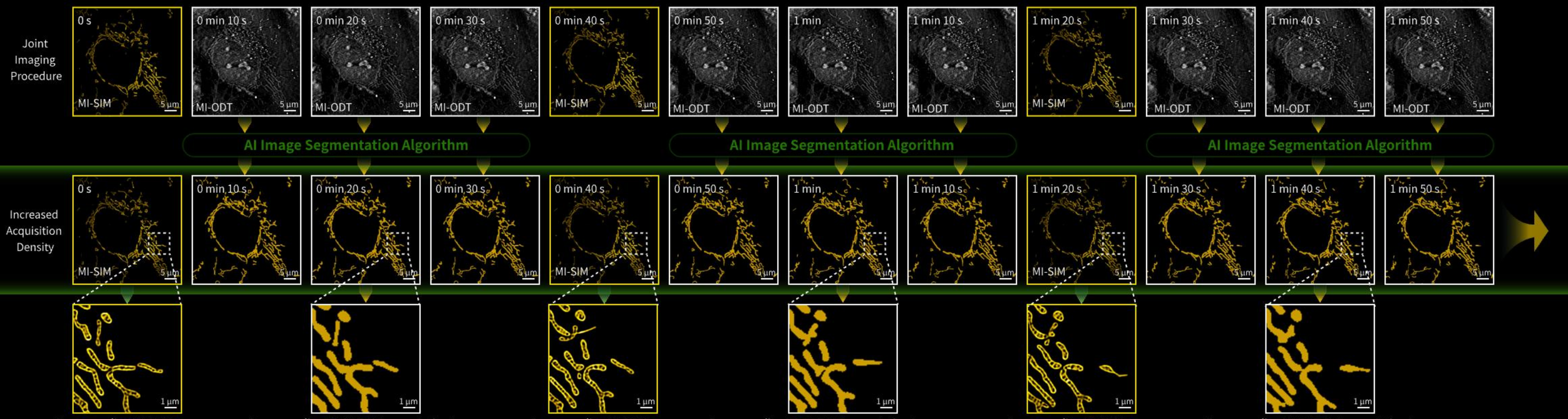
Joint Imaging: Combine MI-ODT and MI-SIM to Minimize Phototoxicity

Joint Imaging: Inner Mitochondrial Membrane + Cellular Panorama (Increased Acquisition Density)

Minimize phototoxicity by combining MI-SIM and MI-ODT segmentation! Employing MI-ODT for high-speed acquisition of live-cell label-free imaging enables the observation of mitochondrial dynamics while minimizing phototoxicity. The powerful AI segmentation algorithm segments the mitochondria, supplementing the morphological changes during the intervals of MI-SIM imaging. This approach enables extended observation of mitochondrial dynamics with minimal phototoxicity.

Scan QR Code to Access Video

Data Source: CSR Biotech



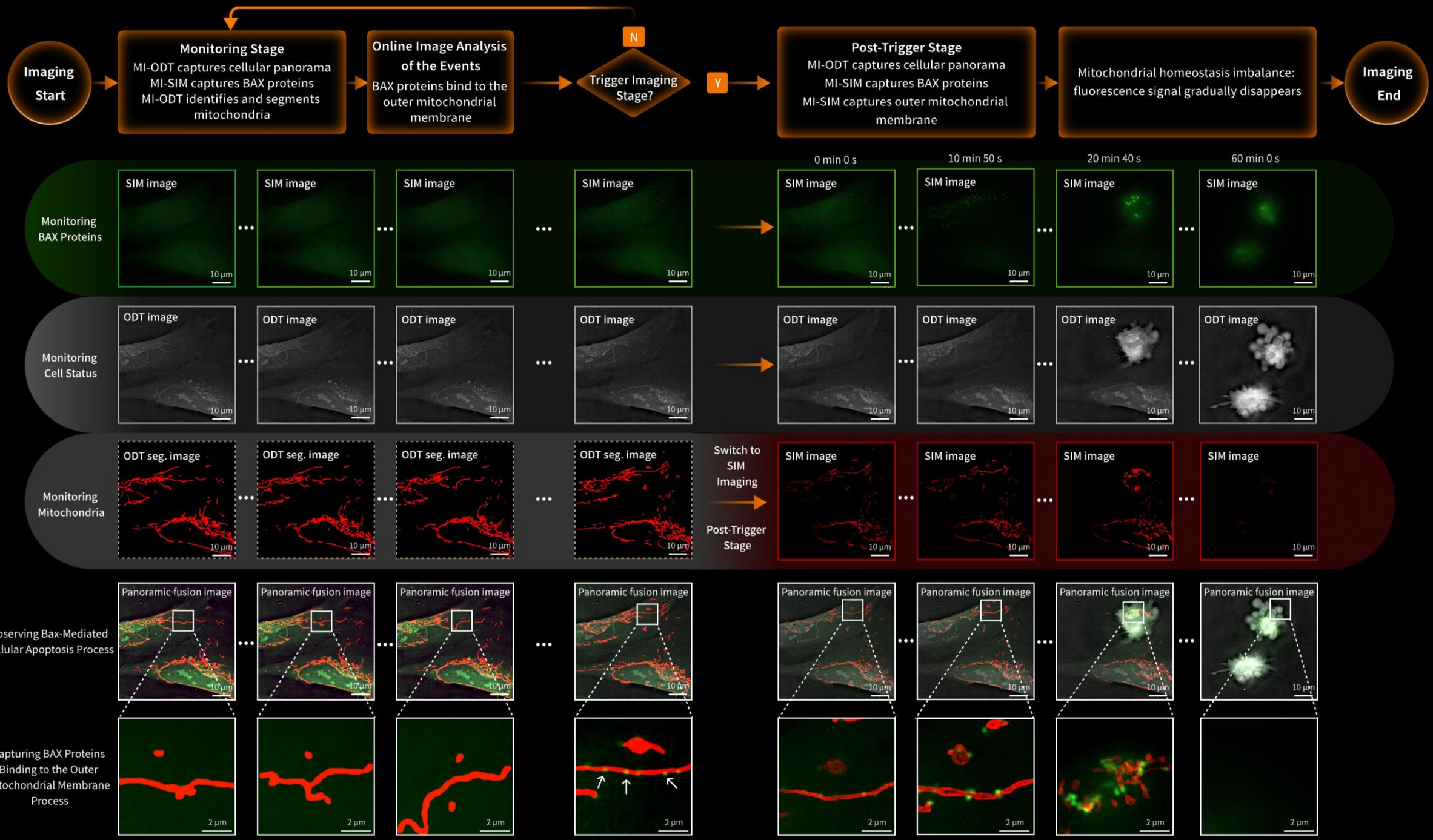
Joint Imaging: Event-Driven by Fluorescence Images

- Event-driven: Intracellular BAX protein gradually accumulates at the outer mitochondrial membrane, announcing imminent cellular apoptosis.
- Monitoring stage: MI-ODT + MI-SIM of BAX (simultaneous imaging)
- Post-trigger stage: MI-ODT + MI-SIM of BAX + MI-SIM of outer mitochondrial membrane (simultaneous imaging)

To prevent phototoxicity and photobleaching, outer mitochondrial membrane fluorescence imaging is not activated during the monitoring stage. Only when the Online Image Analysis (OIA) platform detected the set trigger (clustering of the green BAX signal), the second stage in recording is initiated. The fluorescence channel for the outer membrane is activated, capturing the mitochondrial dynamics at the highest quality.

Data Source: CSR Biotech

Scan QR Code to Access Video



Cell Xtreme Specifications

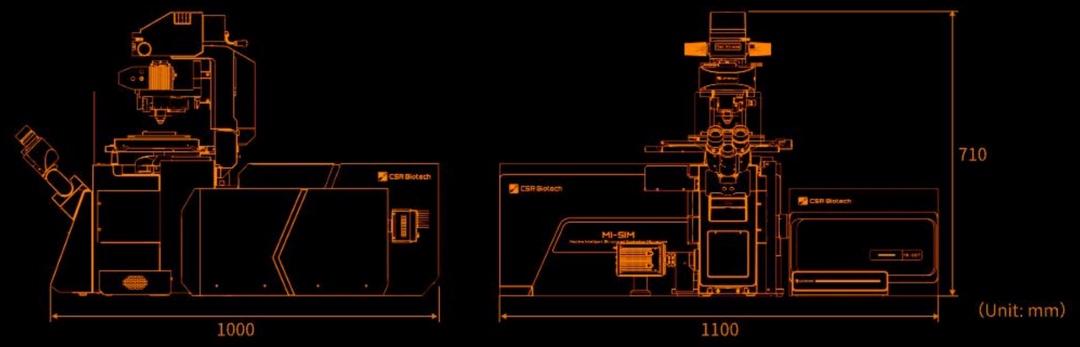
Modalities	MI-ODT	MI-SIM
Imaging Modes	Brightfield Find ODT: real-time preview DS ODT: multiple angles & multiple scanning interval SR ODT	Brightfield Widefield: including oblique widefield TIRF: multiple angles TIRF-SIM: multiple angles, real-time preview 2D-SIM Slice: multiple angles, real-time preview 3D-SIM Slice: multiple angles, real-time preview 2D-SIM Stack: multiple angles 3D-SIM Stack: multiple angles
Resolution	XY：110/130 nm[1] Z：350 nm	XY：60 nm, 85 nm[2] Z：200 nm, 300 nm[2]
Imaging Speed	1.4 fps @3072 × 3072 × 360 angles 2.8 fps @3072 × 3072 × 180 angles 4.2 fps @3072 × 3072 × 120 angles 8.4 fps @3072 ×3 072 × 60 angles 16.8 fps @3072 × 3072 × 30 angles	Max. 25 fps @16 bit/4608 × 4608[3] Max. 49 fps @16 bit/2048 × 2048[3] Max. 79 fps @16 bit/1024 × 3320[3] Max. 112 fps @16 bit/512 × 3320[3] Max. 1500 fps @limited ROI[3]
Field of View	Max. 138 × 138 μm @100 × objective Max. 230 × 230 μm @60 × objective	Max. 108 × 108 μm @100 × objective (150 × 150 μm on demand) Max. 180 × 180 μm @60 × objective (250 × 250 μm on demand)
Imaging Duration	Continuous imaging extends beyond one week (7 days)	Continuous imaging extends beyond 100 hours
Illumination Source	High coherence laser Standard: 532 nm Optional: 405 nm	Compatible multi-color coupled lasers: Standard: 405 nm, 488 nm, 561 nm, 640 nm Optional: 445 nm, 473 nm, 515 nm, 532 nm, 594 nm, 607 nm, 647 nm, 808 nm, 980 nm[4]
Objectives	Apo 100 × /1.5 Oil Optional: Apo 60 × /1.5 Oil Suitable for 40~100 × with immersion of oil, silicone oil, water and air	Apo 100 × /1.5 Oil Optional: Apo 60 × /1.5 Oil Suitable for 20~100 × with immersion of oil, silicone oil, water and air
Multi-Channel Imaging	Label-free samples have no spectral properties	High-speed sequence imaging with multi-color filter wheel Multi-FOV, multi-channel with multi-camera imaging
Microscope	Evident IX85 / Evident IX83 / Nikon Ti2-E	

[1] The imaging resolution is obtained by illuminating the sample with coherent light at 405 nm and 532 nm, followed by reconstruction and necessary deconvolution processing.
[2] 60 nm and 200 nm correspond to Sparse SR, 85nm and 300 nm correspond to optical SR.
[3] The imaging speed is achieved using a Hamamatsu camera, such as the Fusion BT.
[4] It is compatible with common fluorescence excitation wavelengths.

Advanced Functions

Real-Time SR	Provides real-time capture, reconstruction, and preview functions for both super-resolution fluorescence and label-free imaging. Reconstruction speed is enhanced by 2~3 orders of magnitude through algorithm optimization and high-performance computing. Currently, 2D-SIM imaging achieves 24 Hz, and Find ODT imaging reaches 10 Hz
Overview	Real-time imaging preview for the entire area based on user-specified ROIs (typically large FOV), allowing users to establish subsequent imaging sites and regions, and plan imaging routes and strategies
Multi-Site	Based on user-confirmed imaging sites and ROIs, a multi-site imaging plan is provided, mapping traversal paths. It supports differentiated imaging modes and parameters for each site during imaging
Stitching	For user-confirmed imaging areas larger than the optical system's FOV, a stitching imaging solution is provided. It supports stitching of irregularly shaped connected regions, allowing users to design stitching areas based on cell distribution, avoiding ineffective FOVs
Auto Tracking	During long-term imaging of live cells, the use of slide locking, simultaneous capture and reconstruction, and the online image analysis (OIA) platform allows for monitoring whether the user-confirmed imaging area experiences defocus or field shift, enabling real-time adjustment of displacement devices to lock the area
Event-Driven	The online image analysis (OIA) platform monitors events based on user-specified images or channels, facilitating staged imaging. User-defined events include changes in image intensity, morphological alterations of cells or organelles, and the movement of proteins or molecules
Joint Imaging	Based on fluorescence MI-SIM and label-free MI-ODT, a dual-modality imaging solution is provided, allowing users to apply single-modality high-dimensional complex imaging processes to dual-modality workflows. It supports event-triggered imaging between the two modalities and allows users to define the activation rules for each stage and loop in the combined imaging process

Product Dimensions



Transforming Tools
Changing Lives

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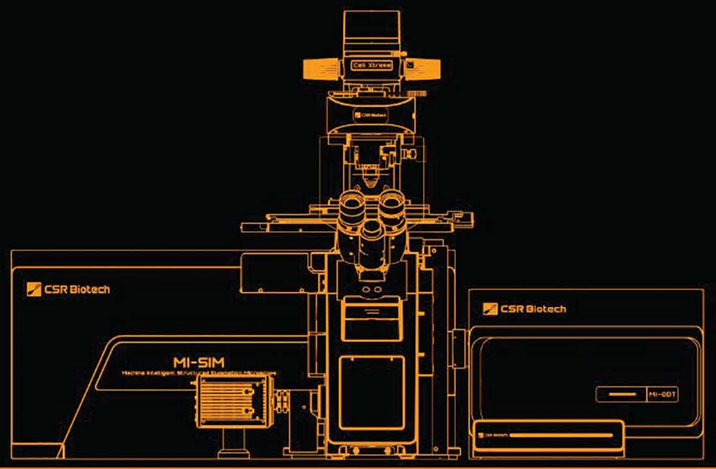

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