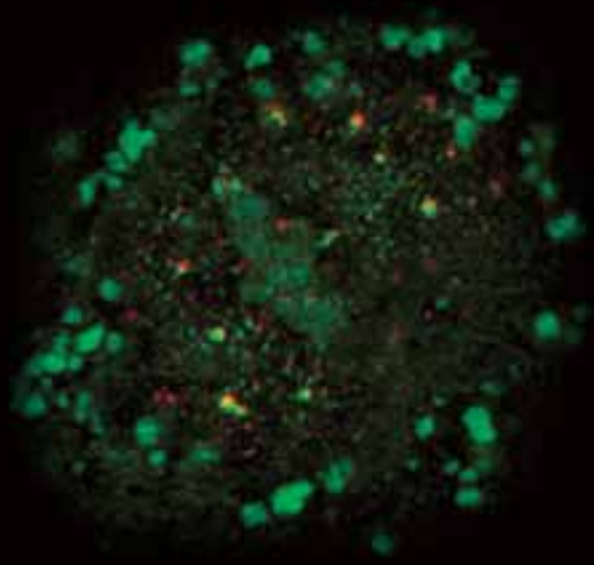
Nikon

Super Resolution Microscope

N-SIM



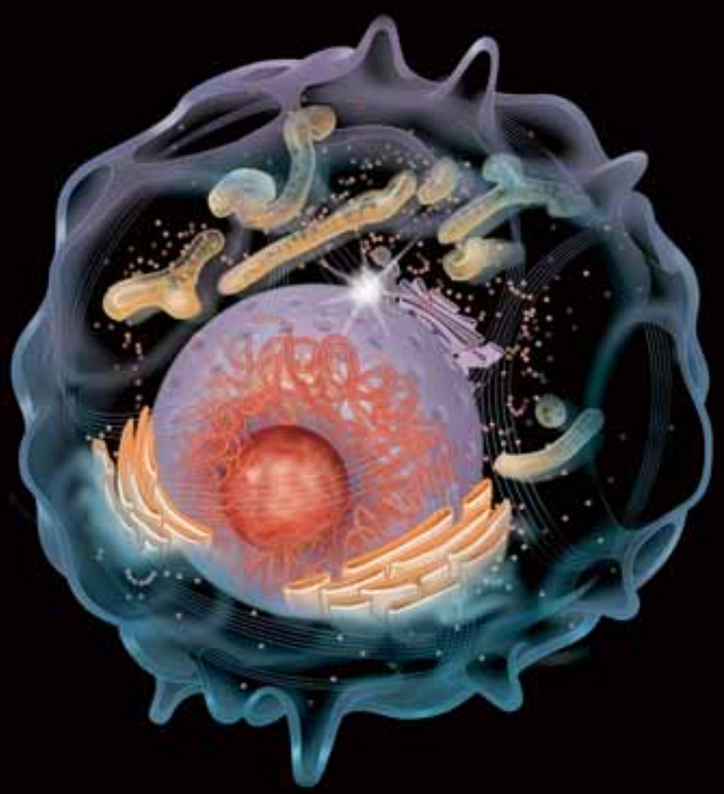
See like you have never seen before

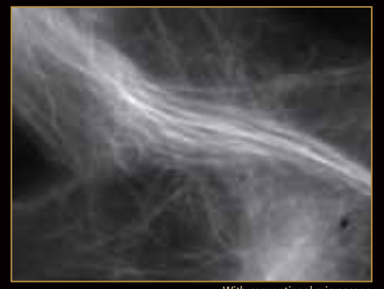
Super Resolution Microscope
N-SIM

Nikon's Super Resolution Microscope brings your research into the world of Nanoscopy beyond the diffraction limit.

Nikon's new Super Resolution Microscope N-SIM enables elucidation of structure and function of the nanoscopic machinery within living cells.
Resolution of conventional optical microscopes, even those with the highest numerical aperture optics, is limited by diffraction to approximately 200nm.
Using high frequency Structured Illumination, the Nikon N-SIM can achieve image resolution of 85nm*, which was previously considered impossible with optical microscopes. Furthermore, with temporal resolution of up to 0.6 sec./frame**, N-SIM enables super-resolution time-lapse imaging capture of dynamic molecular interactions in living cells. The observation of such dynamics at this resolution can open new worlds of discovery.
Nikon's super resolution microscope integrates powerful proprietary technologies, yet brings them to the laboratory in a form designed to be simple for users. N-SIM can dramatically enhance the ability to address questions in the nanoscopic realm, and instills confidence in the conclusions that can be drawn from your data.

* Excited with 488nm laser, in TIRF-SIM mode ** With TIRF-SIM/2D-SIM mode

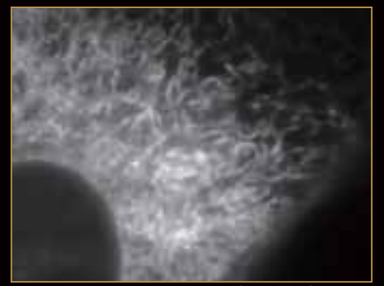




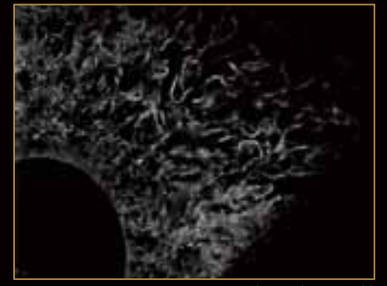
With conventional microscope

With N-SIM (3D-SIM mode)

Microtubules in B16 melanoma cell labeled with YFP
Objective: CFI Apo TIRF 100x oil (NA 1.49) Image capturing speed: approx. 1.8 sec./frame (movie)
Photographed with the cooperation of: Yasushi Okada, Ph.D., Department of Cell Biology and Anatomy, Graduate School of Medicine, University of Tokyo

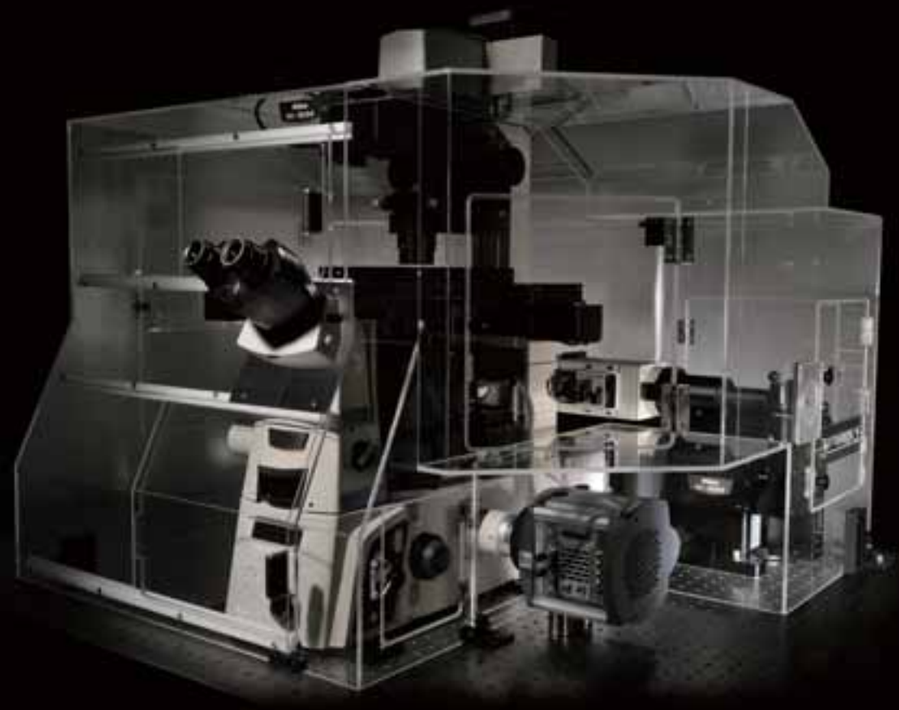


With conventional microscope



With N-SIM (3D-SIM mode)

Endoplasmic reticulum (ER) in living HeLa cell labeled with GFP
Objective: CFI Apo TIRF 100x oil (NA 1.49) Image capturing speed: approx. 1.5 sec./frame (movie)
Photographed with the cooperation of: Ikuo Wada, Ph.D., Institute of Biomedical Sciences, Fukushima Medical University School of Medicine



Temporal resolution of 0.6 sec./frame enables super resolution time-lapse imaging of dynamic live cell events

In Structured Illumination Microscopy, the unknown cellular ultra-structure is elucidated by analyzing the moiré pattern produced when illuminating the specimen with a known high-frequency patterned illumination. Nikon's Structured Illumination Microscopy (N-SIM) realizes super resolution of up to 85nm in multiple colors. In addition, it can continuously capture super-resolution images at temporal resolution of 0.6 sec./frame, enabling the study of dynamic interactions in living cells.

Live cell imaging at double (to approx. 85nm) the resolution of conventional optical microscope

The N-SIM super resolution microscope utilizes Nikon's innovative new approach to "Structured Illumination Microscopy" technology.
By pairing this powerful technology with Nikon's renowned CFI Apo TIRF 100x oil objective lens (NA 1.49), N-SIM nearly doubles (to approx. 85nm*) the spatial resolution of conventional optical microscopes, and enables detailed visualization of the minute intracellular structures and their interactive functions.

Temporal resolution of 0.6 sec./frame—amazingly fast super resolution microscope system

N-SIM provides ultra fast imaging capability for Structured Illumination techniques, with a time resolution of up to 0.6 sec/frame, which is effective for live-cell imaging (with TIRF-SIM/2D-SIM mode; imaging of up to approx. 1 sec./frame is possible with 3D-SIM mode).

* Excited with 488nm laser, in TIRF-SIM mode

Various observation modes

TIRF-SIM/2D-SIM mode

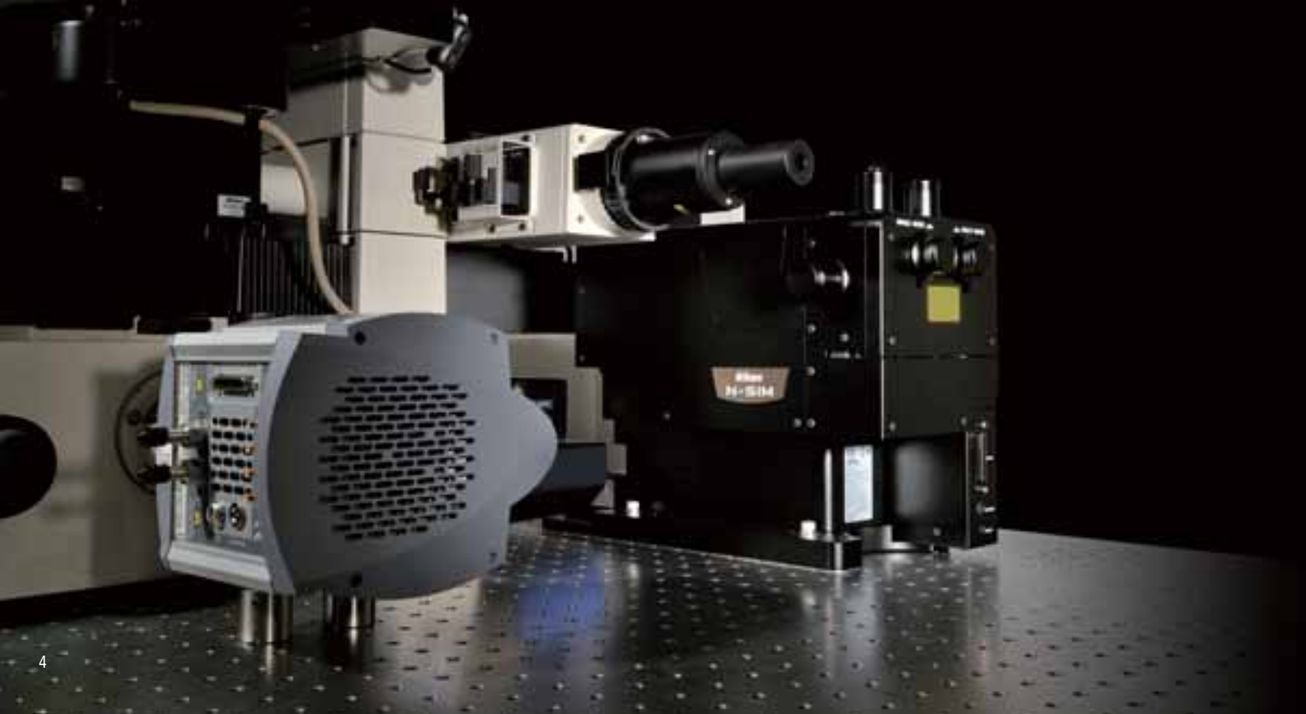
This mode captures super resolution 2D images at high speed with incredible contrast. TIRF-SIM takes advantage of Total Internal Reflection Fluorescence observation at double the resolution as compared to conventional TIRF microscopes, facilitating a greater understanding of molecular interactions at the cell surface.

3D-SIM mode

Axial super resolution observation using the N-SIM system enables optical sectioning of specimens at 300nm resolution in cells and tissues of up to 20μm thickness. Additionally 3D SIM eliminates out of focus background fluorescence resulting in breathtaking contrast.

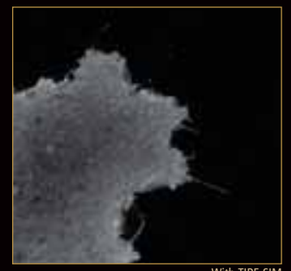
5 laser multi-color super resolution capability

The Nikon LU-5 is a modular system with up to 5 lasers enabling true multi-spectral super resolution. Multi-spectral capability is essential to the study of dynamic interactions of multiple proteins of interest at the molecular level.



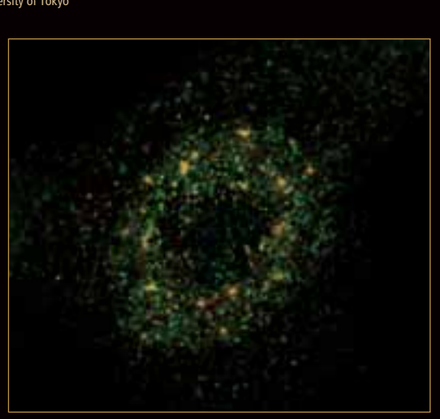
Microtubules in B16 melanoma cell
Mode: 3D-SIM
Objective: CFI Apo TIRF 100x oil (NA 1.49)
Image capturing speed: approx. 1.8 sec./frame
Photographed with the cooperation of: Yasushi Okada, Ph.D., Department of Cell Biology and Anatomy, Graduate School of Medicine, University of Tokyo

With conventional TIRF

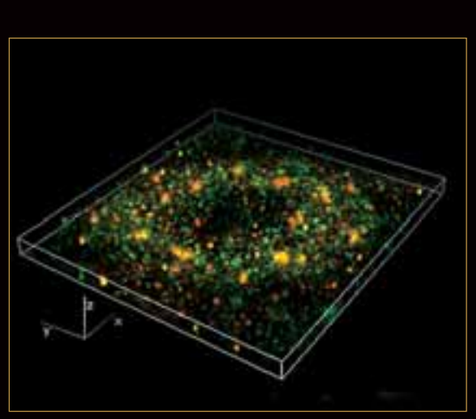


With TIRF-SIM

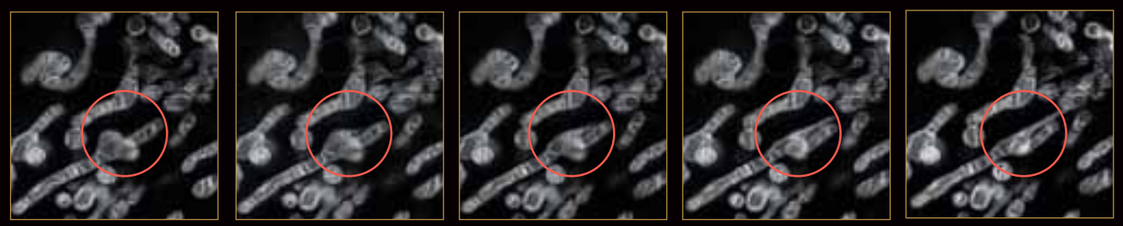
Plasma membrane of B16 melanoma cell labeled with YFP
Objective: CFI Apo TIRF 100x oil (NA 1.49)
Photographed with the cooperation of: Yasushi Okada, Ph.D., Department of Cell Biology and Anatomy, Graduate School of Medicine, University of Tokyo



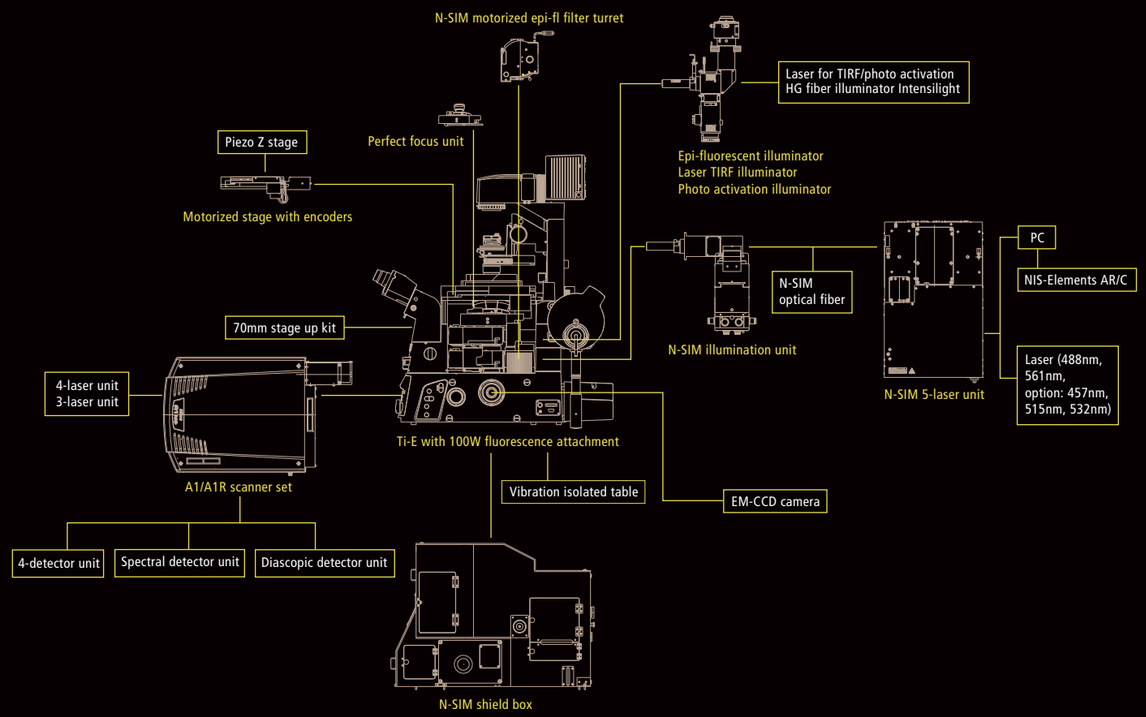
Co-localization images of a target protein of VGEF signaling (Cy3) and its ubiquitin E3 ligase (FITC)
Unprecedentedly detailed structure of the nuclear body can be observed
Mode: 3D-SIM, Z-stack
Objective: CFI Apo TIRF 100x oil (NA 1.49)
Photographed with the cooperation of: Hidetaka Ohnuki, Ph.D., Shigeki Higashiyama, Ph.D., Ehime University Graduate School of Medicine



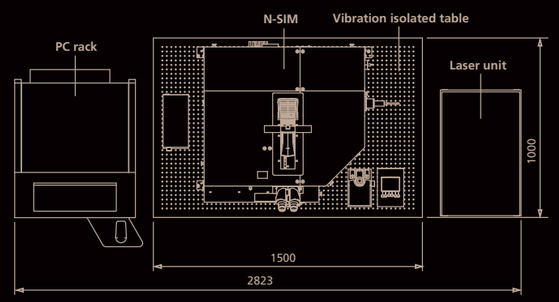
3D reconstruction image approx. 5μm thick (part)



Dynamics of mitochondria stained with Mito-Tracker red
Cristae in mitochondria are visualized and the dynamics of mitochondria can be observed.
Mode: 3D-SIM
Objective: CFI Apo TIRF 100x oil (NA 1.49)
Image capturing interval: approx. 1 sec. (movie)



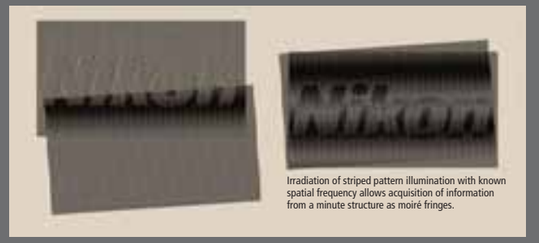
Dimensional diagrams Unit: mm



Principle of the Structured Illumination Microscopy

Analytical processing of recorded moiré patterns produced by overlay of a known high spatial frequency pattern mathematically restores sub-resolution structure of a specimen.

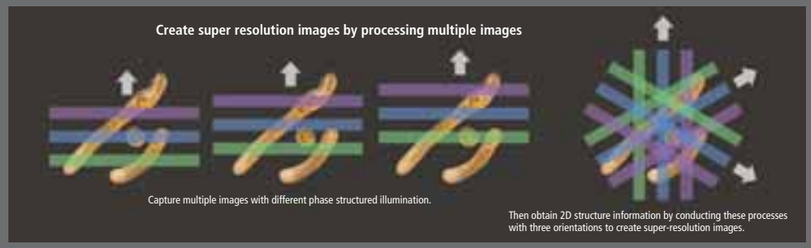
Utilization of high spatial frequency laser interference to illuminate sub-resolution structure within a specimen produces moiré fringes, which are captured. These moiré fringes include modulated information of the sub-resolution structure of the specimen. Through image processing, the unknown specimen information can be recovered to achieve resolution beyond the limit of conventional optical microscopes.



Irradiation of striped pattern illumination with known spatial frequency allows acquisition of information from a minute structure as moiré fringes.

Create super resolution images by processing multiple moiré pattern images

An image of moiré patterns captured in this process includes information of the minute structures within a specimen. Multiple phases and orientations of structured illumination are captured, and the displaced "super resolution" information is extracted from moiré fringe information. This information is combined mathematically in "Fourier" or aperture space then transformed back into image space creating an image at double the conventional resolution limit.



Utilizing High Frequency striped illumination to double the resolution

The capture of high resolution, high spatial frequency information is limited by the Numerical Aperture (NA) of the objectives, and spatial frequencies of structure beyond the optical system aperture are excluded (Fig. A).
Illuminating the specimen with high frequency structured illumination, which is multiplied by the unknown structure in the specimen beyond the classical resolution limit, brings the displaced "super resolution" information within the optical system aperture (Fig. B).

When this "super resolution" information is then mathematically combined with the standard information captured by the objective lens, it results in an effective doubling of the NA, and therefore resolution of the optical system (Fig. C).

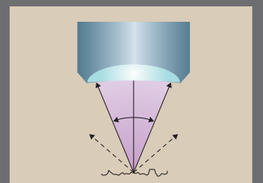


Fig. A: Resolution is limited by the NA of the objective

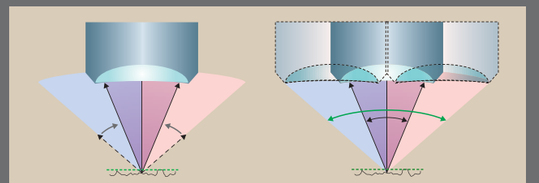
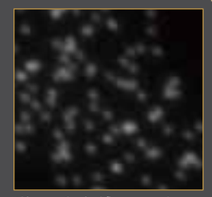


Fig. B: The product of Structured Illumination and normally unresolvable specimen structure produce recordable moiré fringes containing the specimen information at double the conventional resolution limit.

Fig. C: Rays with approx. double the angle of the NA are captured

Comparison images: with TIRF-SIM and with conventional microscope

Images of ø100nm fluorescent beads captured with a conventional microscope and super resolution microscope N-SIM. The intensity profiles of single point images indicate that the resolving power of the super resolution microscope is about double that of the conventional epi-fluorescence microscope.



With conventional epi-fluorescence microscope

With TIRF-SIM

Intensity profiles

Specifications

	N-SIM
XY resolution	Approx. 100nm (up to 85nm: theoretical, in TIRF-SIM mode, 488nm excitation)
Z-axis resolution	Approx. 300nm
Image acquisition time	Up to 0.6 sec./frame (TIRF-SIM/2D-SIM) Up to 1 sec. (3D-SIM) (needs more 1-2 sec. for calculation)
Imaging mode	TIRF-SIM (TIRF XY super resolution) 2D-SIM (XY super resolution, up to 3μm deep) 3D-SIM (XYZ super resolution, up to 20μm deep)
Multi-color imaging	Up to 5 colors
Compatible Laser	Standard: 488nm, 561nm Option: 457nm, 515nm, 532nm
Compatible microscopes	Motorized inverted microscope ECLIPSE Ti-E Perfect Focus System Motorized XY stage with encoders Piezo Z stage
Objectives	CFI Apo TIRF 100× Oil (NA1.49) CFI Plan Apo IR 60× WI (NA1.27)
Camera	Andor Technology iXon DU897 EMCCD camera
Software	NIS-Elements Ar/ NIS-Elements C (with confocal microscope A1)
Recommended installation conditions	25℃±0.5℃

Cover image (bottom) photographed with the cooperation of: Hidetaka Ohnuki, Ph.D., Shigeki Higashiyama, Ph.D., Ehime University Graduate School of Medicine

⚠ WARNING TO ENSURE CORRECT USAGE, READ THE CORRESPONDING MANUALS CAREFULLY BEFORE USING YOUR EQUIPMENT.

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