SUPERNOVA-100

Miniature Two-Photon Microscope

Exploring the brain, Lighting up the future

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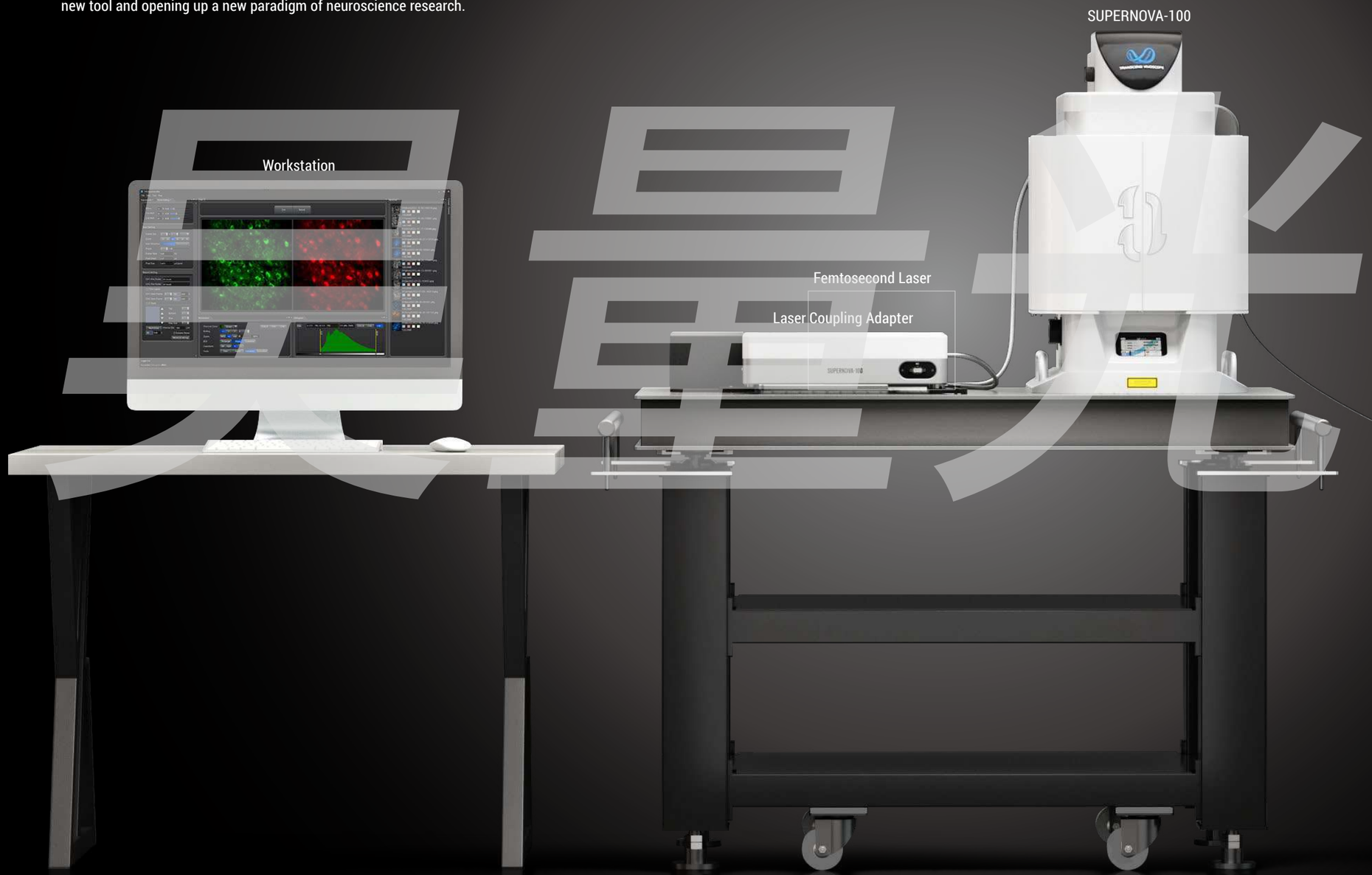
SUPERNOVA-100

Miniature Two-Photon Microscope

The easy-to-wear headpiece of SUPERNOVA-100 makes real of *in vivo* imaging in free-moving animals. SUPERNOVA-100 has already been used in cognition, attention, sensory motor integration researches and a variety of studies in neural circuitry and neurological diseases.

Complete Solutions for *in vivo* Imaging, Revolutionising Neuroscience Research!

Imaging neurons and synapses in the brain of free-moving animals with the resolution of a benchtop two-photon microscope, providing neuroscientists with a revolutionary new tool and opening up a new paradigm of neuroscience research.



Small: Wearable microscope

- 2.6g miniature headpiece, easy for small animals to wear
- All-in-one design and compact system

Superior: Excellent imaging performance

- Imaging single dendritic spine at 0.65 μm resolution
- Recording over 1,000 neurons simultaneously at 1 mm×0.87 mm FOV
- Accessing all layers of mouse cortex as deep as 800 μm

Smart: Flexible and user-friendly

- Compatible with femtosecond lasers from various manufacturers
- Compatible with EEG, EMG and DBS
- Standardized procedure to locate FOV and mount the headpiece

Small

2.6g Headpiece

The headpiece is designed to provide distortion-free conduction of femtosecond laser pulses, high-speed scanning, high-efficiency fluorescence excitation and collection, empowering high-resolution imaging of brain neurons and synapses in freely behaving animals.

FHIRM-HR/U/LF

	FHIRM-HR	FHIRM-U	FHIRM-LF
Lateral Resolution@920 nm	0.65 μm	0.85 μm	1.38 μm
Axial Resolution@920 nm	3.9 μm	7.1 μm	-
FOV Diagonal	418 μm	640 μm	1.33 mm
Working Distance	1.08 mm		
Frame Rate	9 Hz@600×500 18 Hz@300×250		
Weight	2.6g		

Miniature Objectives

TVS-C Series

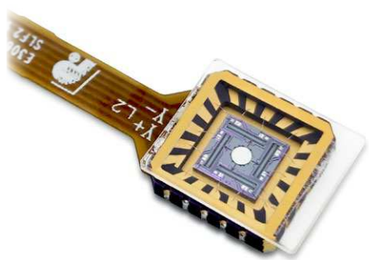
With a diameter of only 3.6 mm, TVS-C Series offer high resolution, large field of view, long working distance, chromatic aberation correction, and imaging optimization for deep scattering tissue.

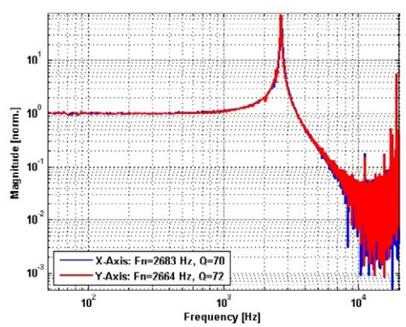
TVS-C Series	4.65X	3X	1.6X
Lateral Resolution@920 nm	0.65 μm	0.85 μm	1.38 μm
Axial Resolution@920 nm	3.9 μm	7.1 μm	-
FOV Diagonal	418 μm	640 μm	1.33 mm
Immersion Liquid	Water/Silicon oil	Water/Silicon oil/Glycerol/Oil	Water/Silicon oil/Glycerol/Oil
Wavelength	400~1100 nm		
Working Distance	1.08 mm		
Diameter	3.6 mm		
Length	11.7 mm		

MEMS Scanning Mirror

TVS-SMM Series

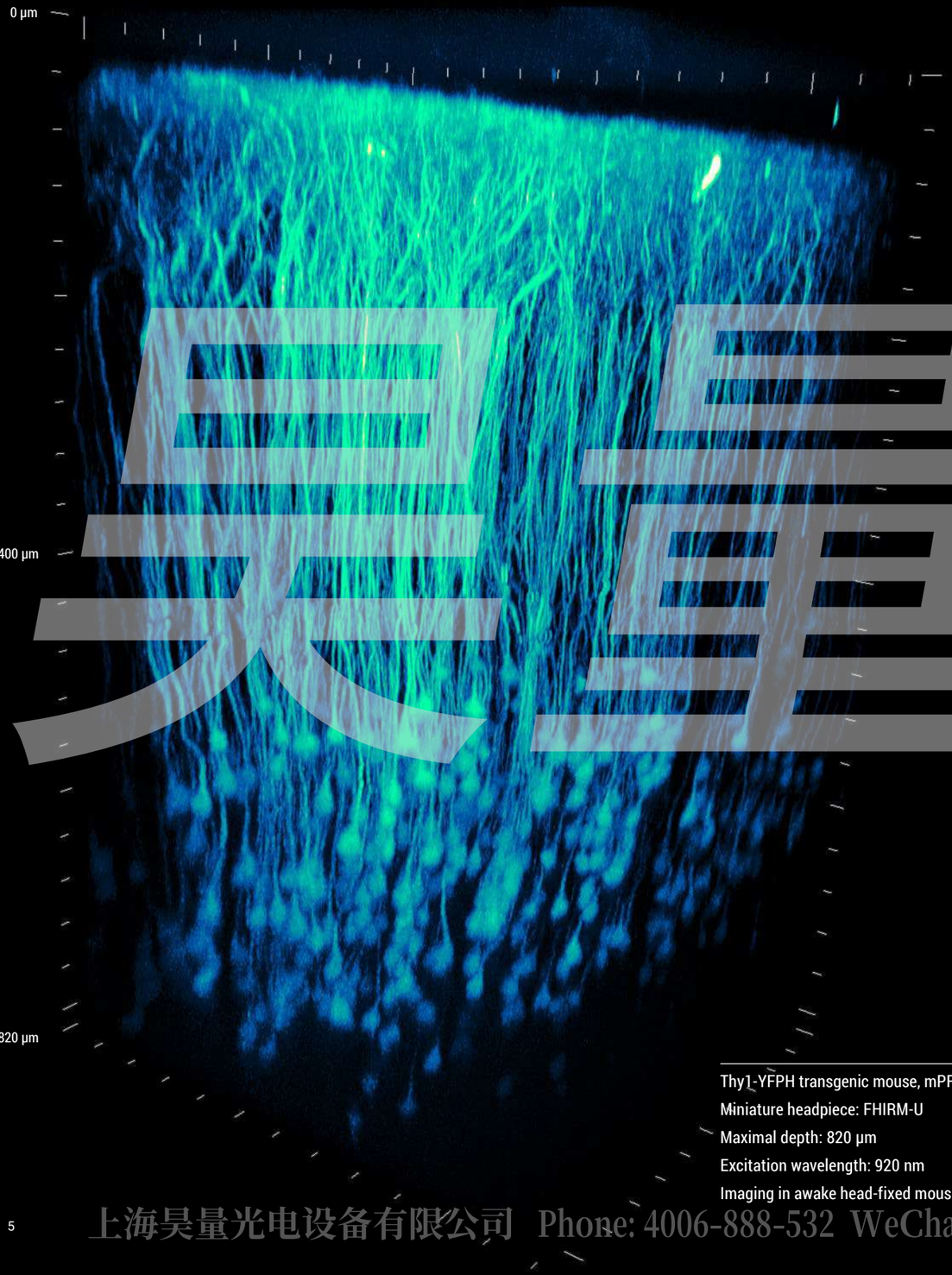
TVS-SMM Series scanning mirrors are monolithically fabricated as an integrated part of the gimbal-less actuator device structure. The package size is 8.89 mm×8.89 mm×1.65 mm, and a series of optional mirror size from 0.8 to 2.0 mm are available. TVS-SMM Series provide selectable resonant frequency from 1200 to 4500 Hz.





Superior

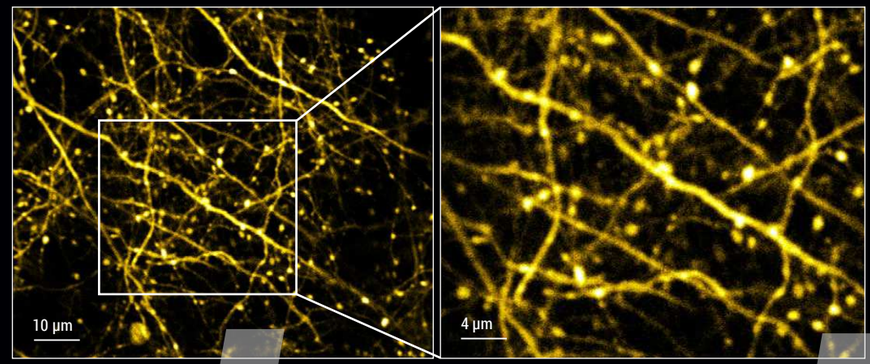
Visualize deep into the brain



Thy1-YFPH transgenic mouse, mPFC
Miniature headpiece: FHIRM-U
Maximal depth: 820 μm
Excitation wavelength: 920 nm
Imaging in awake head-fixed mouse

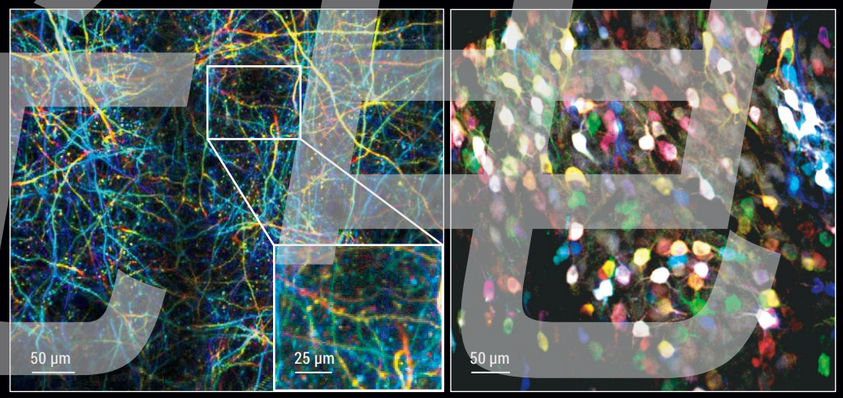
Free-moving animal imaging

Dendrites and spines imaging, 418 μm FOV (diagonal)



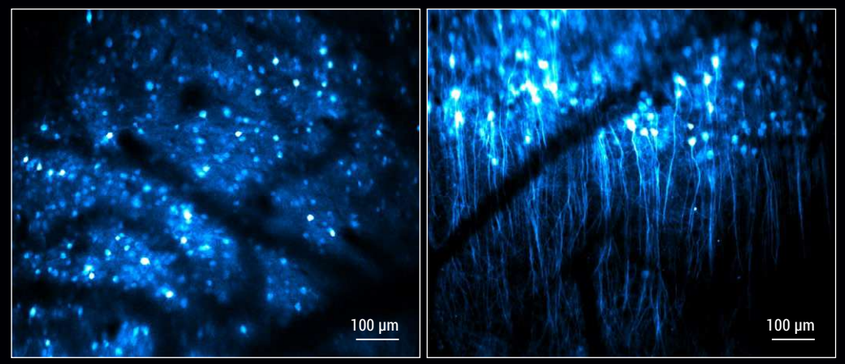
Thy1-YFPH transgenic mouse
Miniature headpiece: FHIRM-HR
Depth: 60 μm
Excitation wavelength: 920 nm
Freely behaving mouse

Single spine visualization, 640 μm FOV (diagonal)



Thy1-YFPH transgenic mouse (Left)
Wild type mice cortex injected with
AAV-hSyn-GCaMP6s (Right)
Miniature headpiece: FHIRM-U
Depth: 0~60 μm Projection (Left)
200~260 μm Projection (Right)
Excitation wavelength: 920 nm
Freely behaving mouse

Visualizing subcellular structures and axons, 1.33 mm FOV (diagonal)



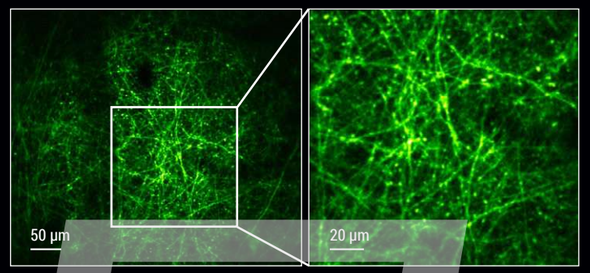
Mouse cortex injected with AAV-hSyn-GCaMP6s (Left)
Thy1-YFPH transgenic mouse (Right)
Miniature headpiece: FHIRM-LF
Depth: 450 μm (Left)
300 μm (Right)
Excitation wavelength: 920 nm
Freely behaving mouse

Superior

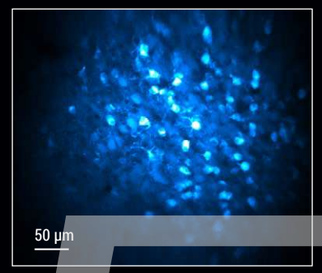
Multiple operating modes

Visualize spines under GRIN Lens

Dendrites and spines were imaged through GRIN Lens using optimized FHIRM-U headpiece.



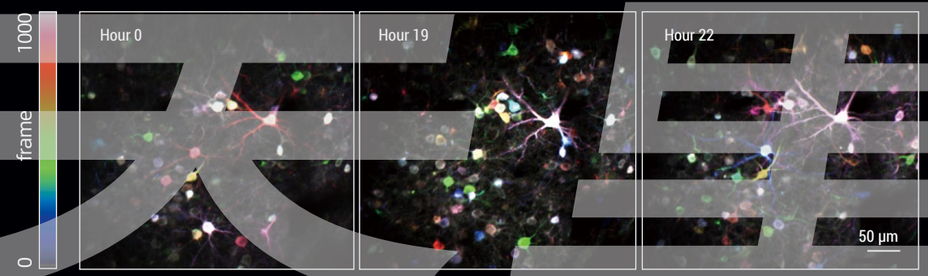
Thy1-YFPH mice cortex, imaging through GRIN Lens



mice (hSyn-GCaMP6s virus labeling), imaging in the hippocampus

Non-stopping continuous imaging

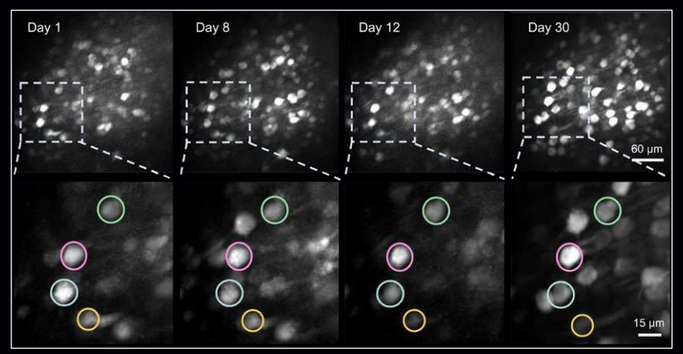
Non-stopping continuous imaging at 5 Hz lasts up to 24 hours.



mice (hSyn-GCaMP6s virus injection)

Long-term imaging

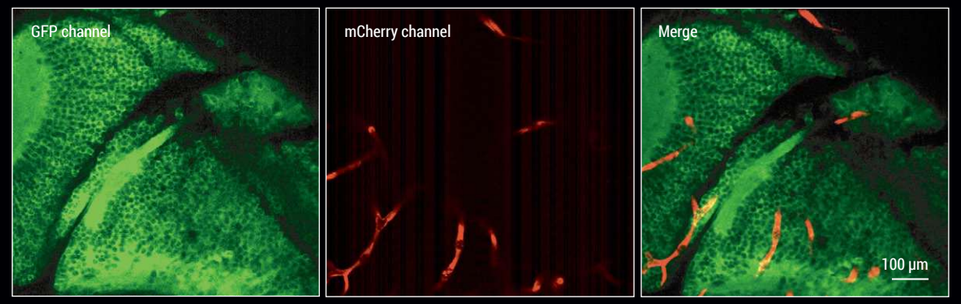
Long-term imaging enables tracking the same population of neuron up to 30 days.



mice (hSyn-GCaMP6s virus injection)

Dual-emission channel imaging

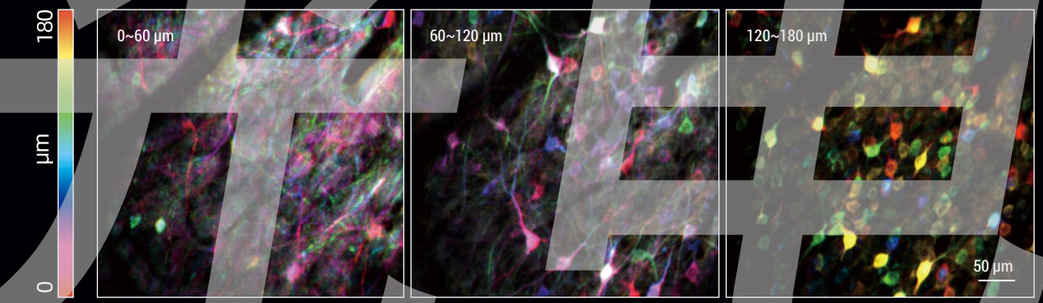
Dual-channel images are acquired simultaneously by using FHIRM-U equipped with 920 nm excitation lasers.



zebrafish (neurons were labeled with GFP and blood vessels were labeled with mCherry)

Volumetric imaging

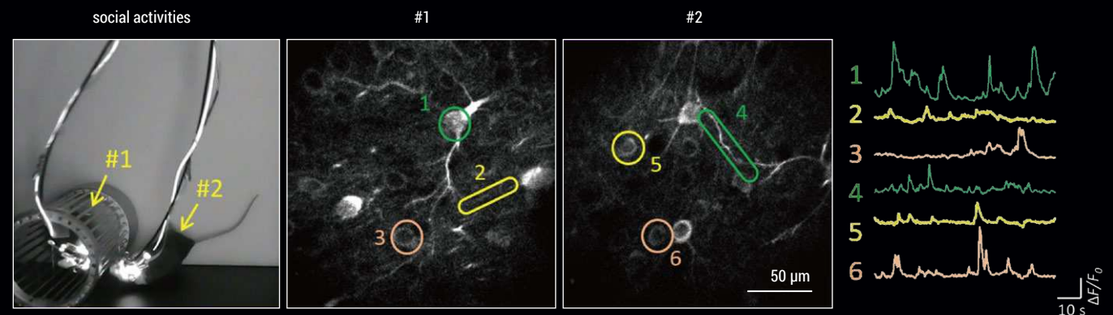
The miniature three-dimensional varifocal unit enables image acquisition at different focal plane.



mice (hSyn-GCaMP6s virus injection)

Multi-FOV imaging

Multiple FOVs can be acquired simultaneously in different brain regions in one animal or in different animals by using FHIRM-HR equipped with multiple headpieces.

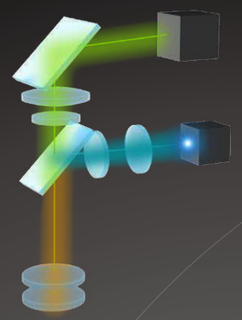


mice (hSyn-GCaMP6s virus injection)
Neuronal activities in prefrontal cortex during social behavior

Smart

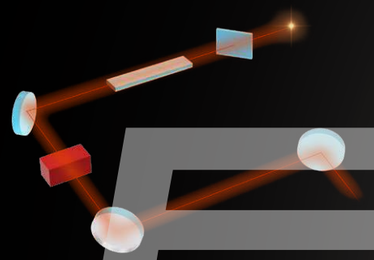
All-in-One system

With a volume of 0.6 m³, the compact SUPERNOVA-100 is designed for easy set-up and move.



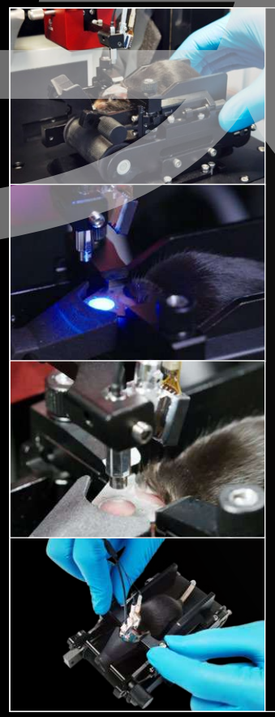
• Wide field fluorescence unit
- Target ROI easily with the 3 mm×3 mm FOV

• Storage box
- Winder the fiber and protect the headpiece
- Display system status with the indicator



• Fiber coupling unit
- Maximize the efficiency of two-photon excitation via dispersion compensation
- Modulate the laser power with AOM
- Auto-adjustment of fiber coupling to maintain constant laser power

• Mode-switching module
- Switch between wide field and two-photon imaging modes
- Find ROI and mount headpiece by the standard procedure



1. Easy to put head-fixed mouse onto the stage
2. Locate the ROI through wide field imaging
3. Switch to two-photon imaging mode
4. Release mouse after imaging

• Animal holder with treadmill
- Reduce stress for experiment animal
- Easy to hold experimental animals without tools

• XYZ-Stage
- Micrometer step accuracy

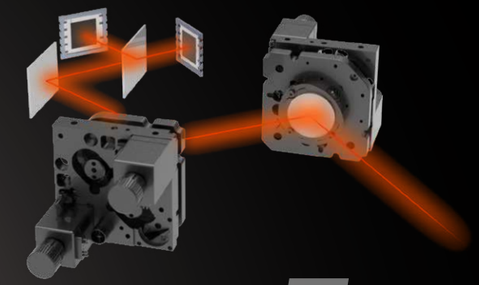
• Microscope touch pad
- Display system status in detail

• Headpiece storage kit
- Fit for different headpieces, FHIRM-HR/U/LF

• Wing doors
- Provide dark room with built-in light shield

Smart

Stable and compatible



- Fluorescence detection unit
  - High sensitivity detection by GaAsP PMT
  - Optimized optical design that effectively captures the scattered fluorescence photons

- Built-in laser beam adjustment device
  - Real-time monitoring of laser pointing
  - Closed-loop locking design to minimize optical path drift

- FPGA based real-time control and acquisition
  - FPGA to control real-time acquisition
  - Scan control at 16-bit precision
  - High speed acquisition at 120 Msps
  - Synchronization at nanosecond resolution

- Connector fiber
  - Flexible connection of the host and coupling adapter

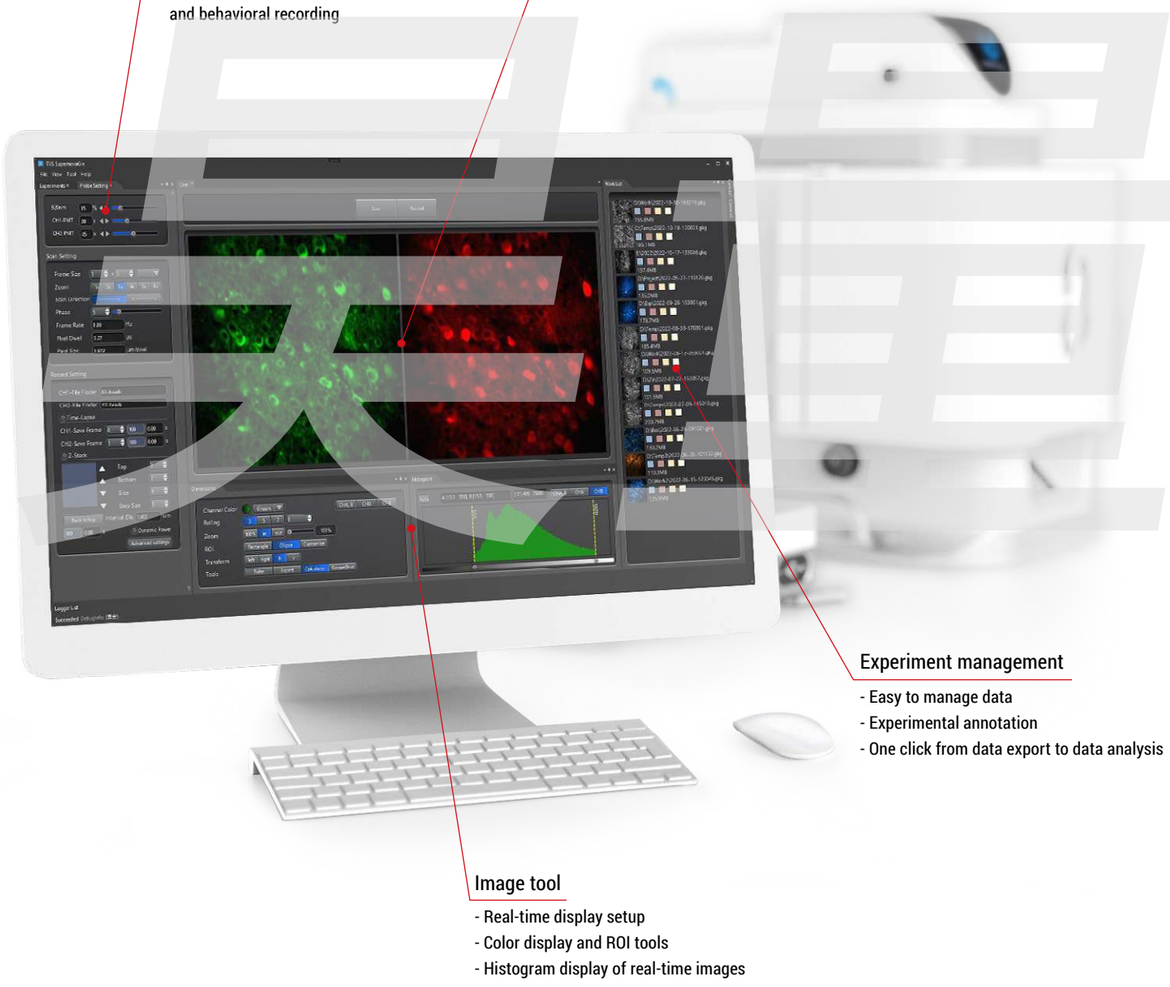
- Laser coupling adapter
  - Integrated with devices for beam adjustment and shaping
  - Compatible with femtosecond lasers from different commercial brands

Smart

Easy-to-use

SUPERGIN System Control and Image Acquisition Software

SUPERGIN is designed for easy use with a short learning curve. The software platform includes modules for image collecting, data processing and analysis.



Control Area
- Hardware configuration setup
- Sampling configuration setup
- Multimodal recording synchronization: imaging and behavioral recording

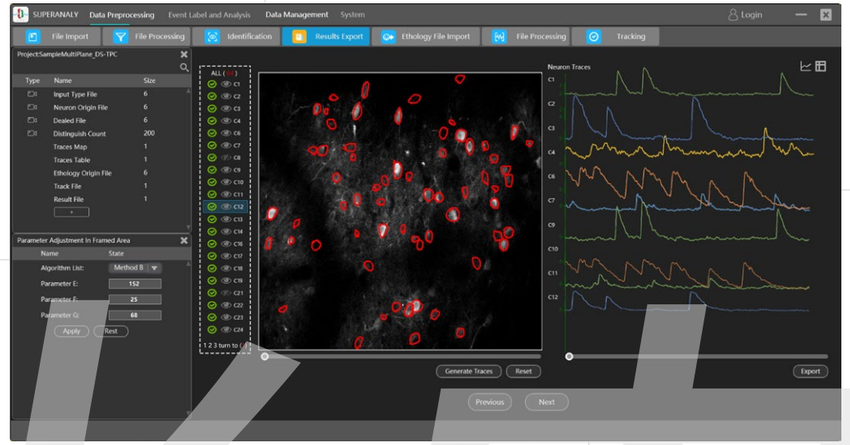
Image View
- Image acquisition parameter setup
- Real-time streaming of multi-chanel images
- Zoom-in or zoom-out control

Experiment management
- Easy to manage data
- Experimental annotation
- One click from data export to data analysis

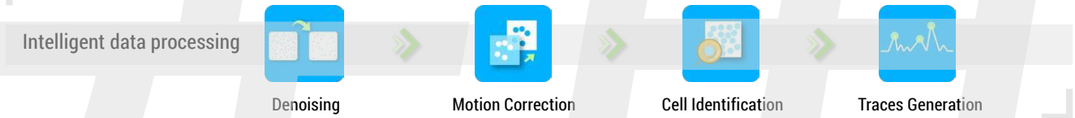
Image tool
- Real-time display setup
- Color display and ROI tools
- Histogram display of real-time images

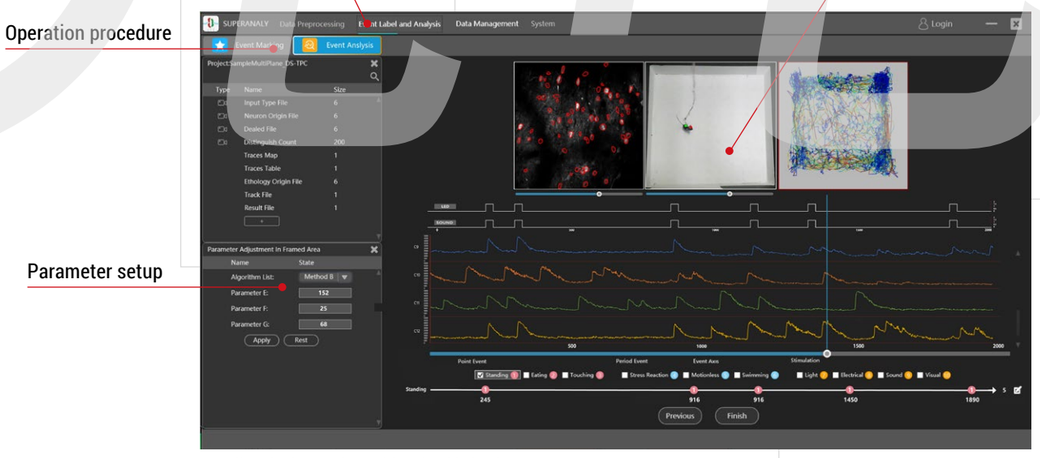
SUPERANALY Data Processing and Analysis Software

SUPERANALY provides functions of imaging preprocessing, automatic neuron identification, proofreading, trace extraction and trace generation. It also supports various correlation analysis between neuronal activities and behavioral events. The software supports different file export formats that are compatible with a variety of external image processing and data analysis software.



Neuron auto-recognition and trace generation





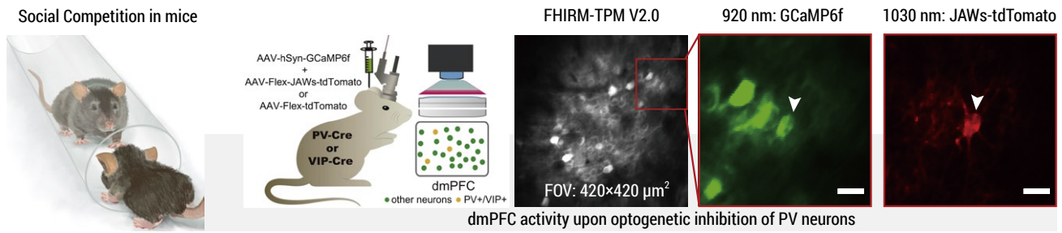
Coupling the image data with animal behavior

Features

1. AI algorithm: Effective denoising without degrading sharpness, automatic neuron segmentation with increased accuracy.
2. Algorithm pool: Powerful and extensive algorithm pool, supporting a variety of applications.
3. Powerful functions: accurate event calibration, multi-dimensional correlation analysis, flexible file adaptability and compatibility.
4. Easy operation: User-friendly through single-button preprocessing and stepwise preprocessing.

Applications

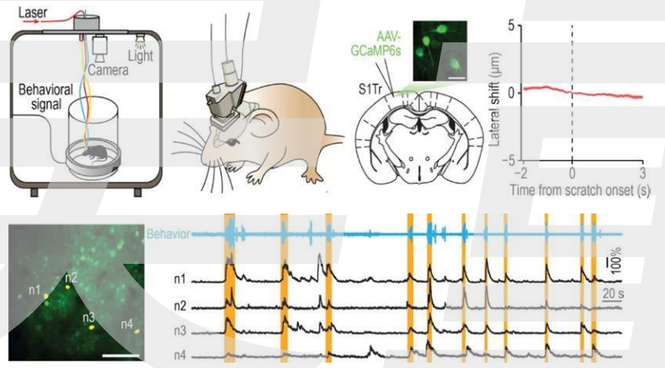
The large-field two-color miniature two-photon microscope combined with the optogenetic module were used to observe overall network activity of dorsomedial prefrontal cortex (dmPFC) after inhibiting PV neurons or VIP neurons. By optogenetic manipulating and calcium imaging of cell-type specific neurons, the neuronal mechanism behind the "winner effect" was revealed.



dmPFC activity upon optogenetic inhibition of PV neurons

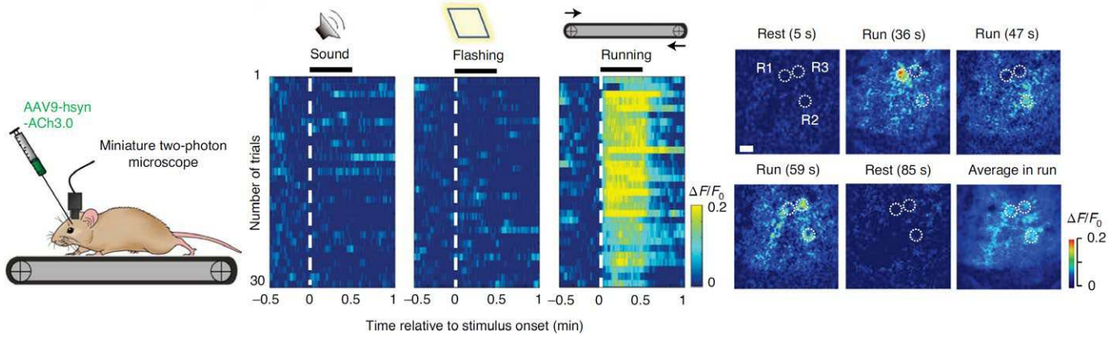
Chaoyi Zhang et al. | Neuron | February 2, 2022

Study of the itch perception in freely behaving animals requires minimal input of stimulus perception. The miniature two-photon microscopy enables neuronal calcium imaging for itch study. Itch was induced by manipulation of GRPR neurons in spinal cord, and activity of S1Tr neurons was recorded while mouse scratching.



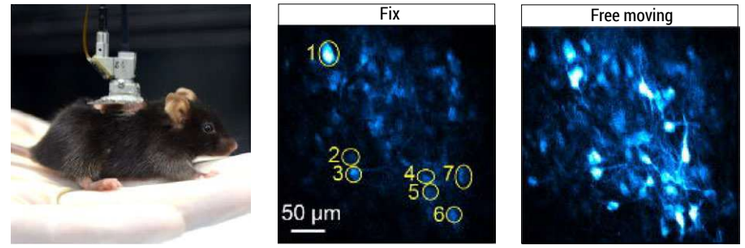
Xiao-Jun Chen et al. | National Science Review | June, 2022

Fluorescence of genetically encoded fluorescent acetylcholine indicator (ACh3.0) was recorded using a miniature two-photon microscope while mouse running, to image the neurotransmitters in real-time in freely behaving animals.



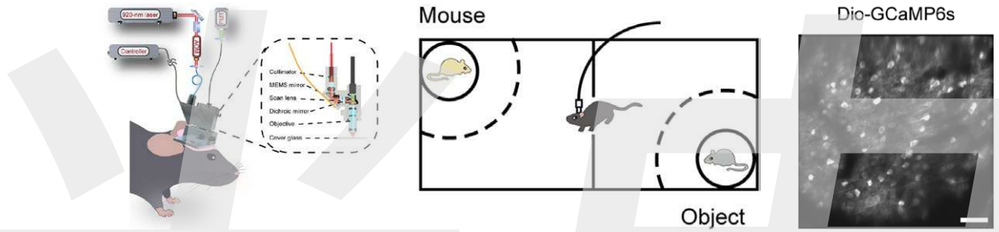
Miao Jing et al. | Nature Methods | September 28, 2020

Long-term imaging of spinal cord in freely behaving mice is been proved to be practical. The function of spinal cord on sensory perception and disorders in freely behaving mice was studied using a miniature two-photon microscope.



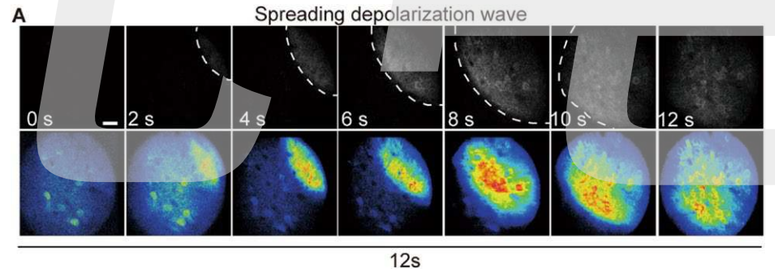
Furong Ju et al. | bioRxiv preprint | January 11, 2022

Social behavior research intrinsically requires animals in a state of freely behaving. To study the neural mechanism behind social behavior at the single-cell level, miniature two-photon microscopy was used here and revealed the neural coding mechanism of social behavior deficits in autistic mice.



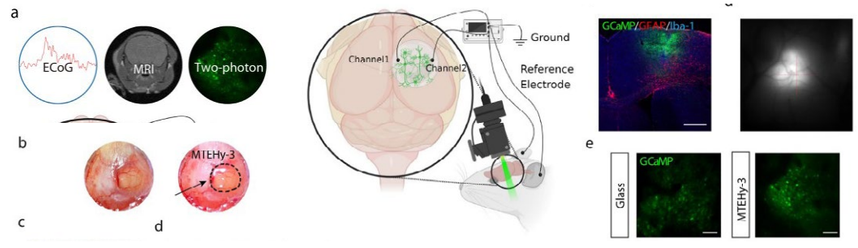
Zhe Zhao et al. | Science Advances | August 31, 2022

To study the seizure propagation in free-behaving animals, miniature two-photon microscopy was used to visualize brain network hyper-excitation coupled with behavioral assessment in freely-moving mice.



Zhuoran Zhang et al. | Neurosci. Bull | May 11, 2022

The miniature two-photon microscopy was utilized to verify a flexible multimodal transparent electrophysiological hydrogel electrode (MTEHy), and also demonstrate its good biocompatibility and reduction of neuroinflammatory response and cortical tissue damage.

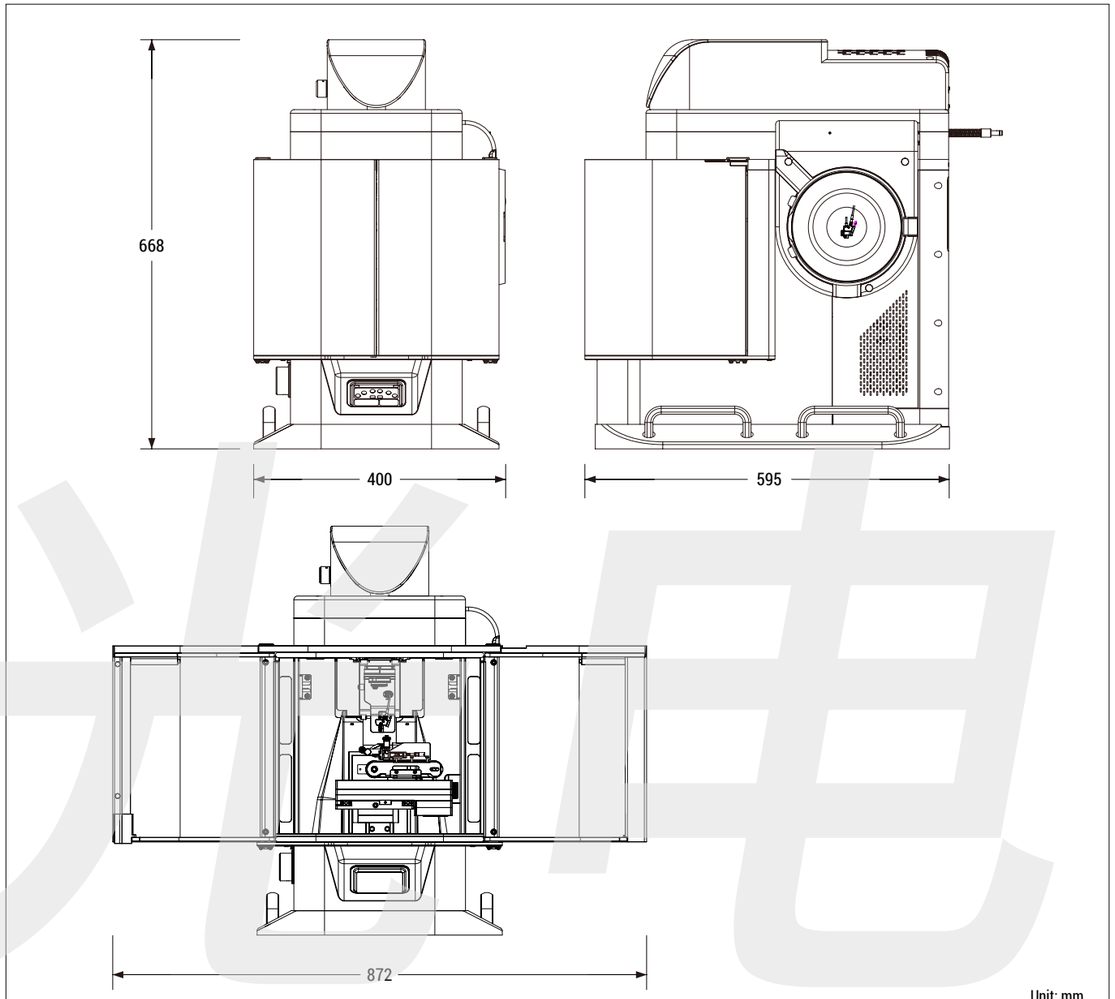


Wei Wei et al. | Acta Biomaterialia| August 28, 2022

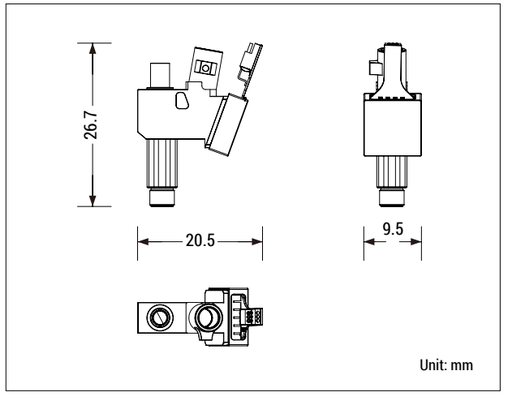
Specifications

Optical Headpiece	FHIRM-HR	FHIRM-U	FHIRM-LF
Resolution	0.65 μm	0.85 μm	1.38 μm
FOV Diagonal	418 μm	640 μm	1.33 mm
Working Distance	1.08 mm		
Frame Rate	9 Hz@600×500 18 Hz@300×250		
Weight	2.6g		
Fluorescence collection module	High sensitivity GaAsP PMT Collection range: 300~720 nm Green fluorescent channel: 520+/-25 nm (GCaMP6/GFP) Red fluorescent channel: 625+/-25 nm (RCaMP/tdTomato/mCherry)		
Controller	Sample Rate: ≥120 Msps	Analog input resolution: ≥14 bit	Analog bandwith: ≥60 MHz
Fiber coupling unit	Built-in AOM (acoustic optical modulator) , response time<250 ns; with laser shutter protection		
Field of view searching module	XYZ Stage, Bidirectional Repeatability, 1 μm Be used for searching field of views and localizing the imaging areas		
Wiled field fluorescence Unit	Excitation wavelength 470 nm		
	CCD Camera, Resolution1920×1200 pixels, full field of view imaging speed ≥40 Hz		
Software	SUPERGIN: System Control and Image Acquisition SUPERANALY: Processing and Analysis of Neuronal and Animal Behavioural Data		
System overall size	595×400×668 mm^3		
Miniature three-dimensional varifocal unit (Option)	~50 μm	~150 μm	~500 μm
Femtosecond pulsed laser (Option)	920 nm femtosecond pulsed laser Compatible with all brands of femtosecond lasers		
Work Station (Option)	Imaging workstation Recommend Specification: OS-Win10, RAM-32G, HDD-512 SSD and 2T HDD		
Animal Behavior Instrument (Option)	This imaging system is suitable for most mice behavior experiment		
Antivibration table (Option)	Recommended size: 1200×750×750 mm^3		
Installation conditions	Temperature: 20~30°C, humidity<60%		

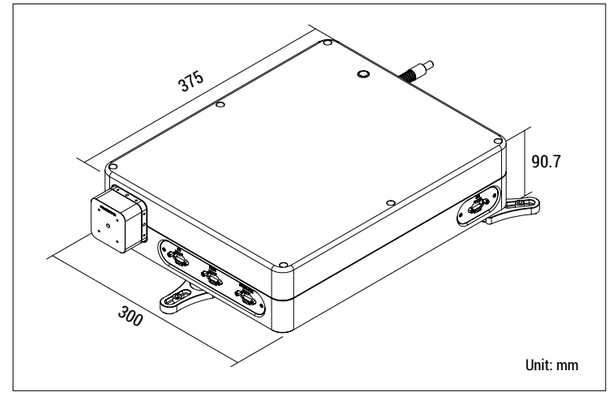
Dimensional Diagram



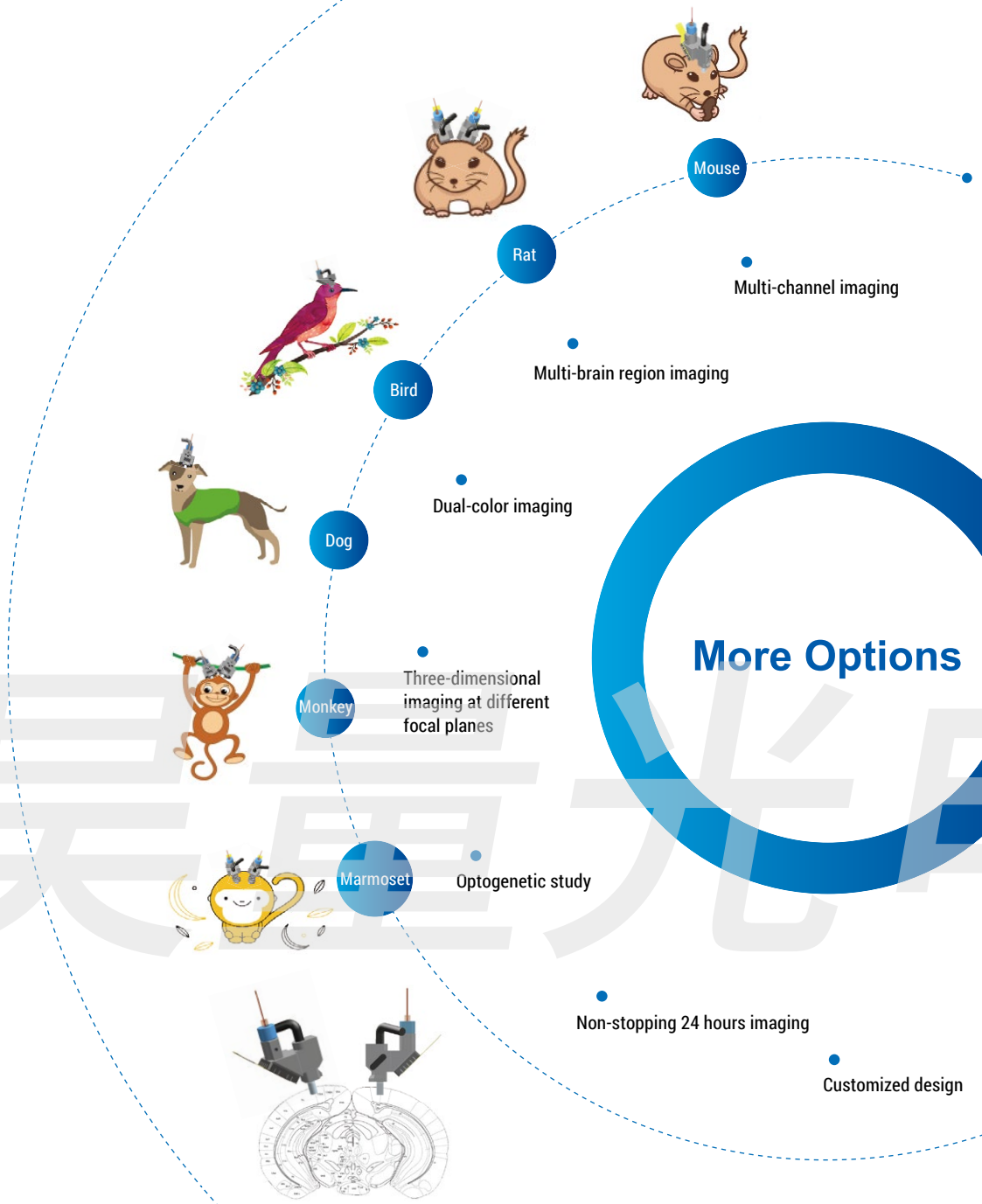
SUPERNOVA-100 Size



Headpiece Size



Laser Coupling Adapter Size



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