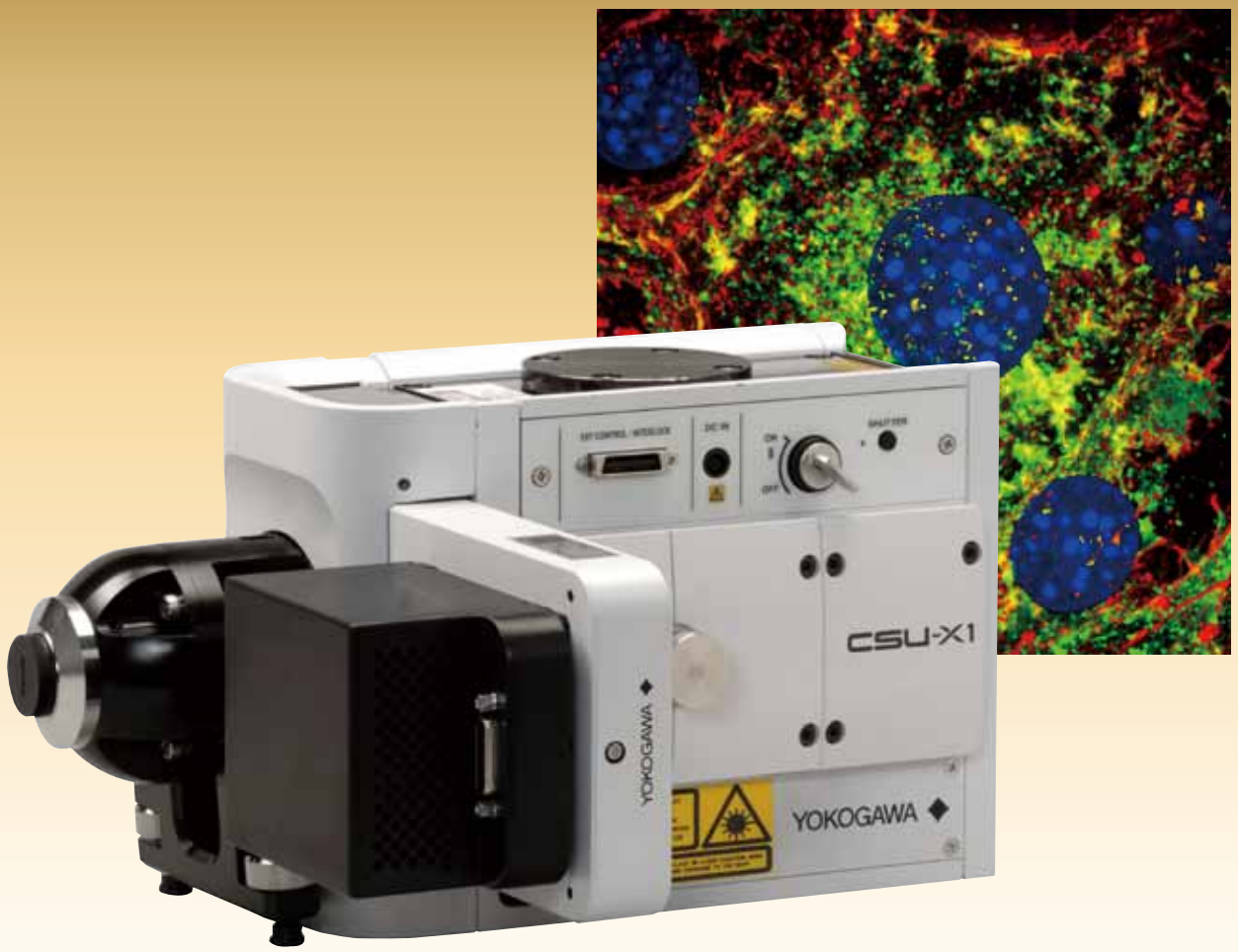
YOKOGAWA

CSU-X1

CSU-X1 Confocal Scanner Unit



Bulletin 80C01C01-01E

Faster, Brighter,[*1] and more Versatile![*2]

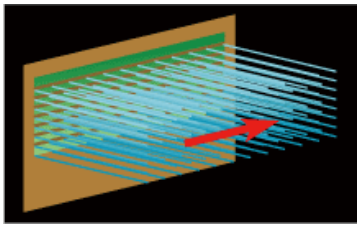
The CSU-X1 is the advanced model of our CSU-series, which are widely recognized as the most powerful tools for live cell imaging.

Faster

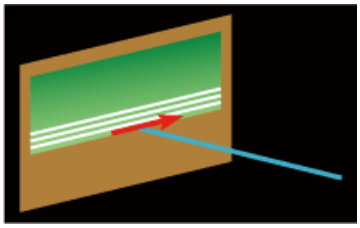
- **The world's fastest scanning speed (up to 2,000fps[*3] in full-frame).**
- **Yokogawa's proprietary filter wheel moves to the adjacent position at 33 ms,[*4] world's fastest speed.**

Principles of the Microlens-enhanced Nipkow Disk Scanning Technology

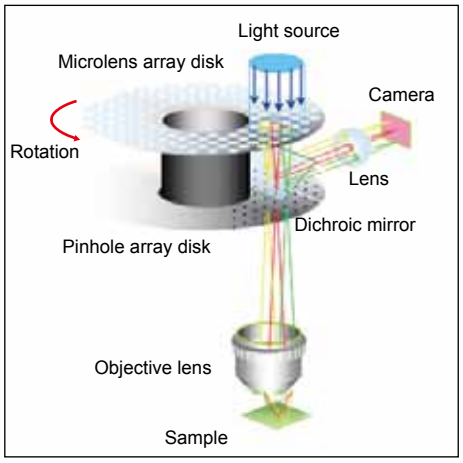
A Nipkow spinning disk containing about 20,000 pinholes and a second spinning disk containing the same number of microlens to focus excitation laser light into each corresponding pinhole are mechanically fixed with a motor, and very rapidly raster scan the field of view with about 1,000 laser beams when rotated. The pinhole and microlens pattern are arranged in our proprietary design to optimize raster scan.
Multi-beam scanning with the CSU-X1 not only increases scanning speed, but also results in significantly lower photobleaching and phototoxicity, because multiple excitation needs only a low level of laser power at the specimen to fully excite fluorescence.



Nipkow Disk method



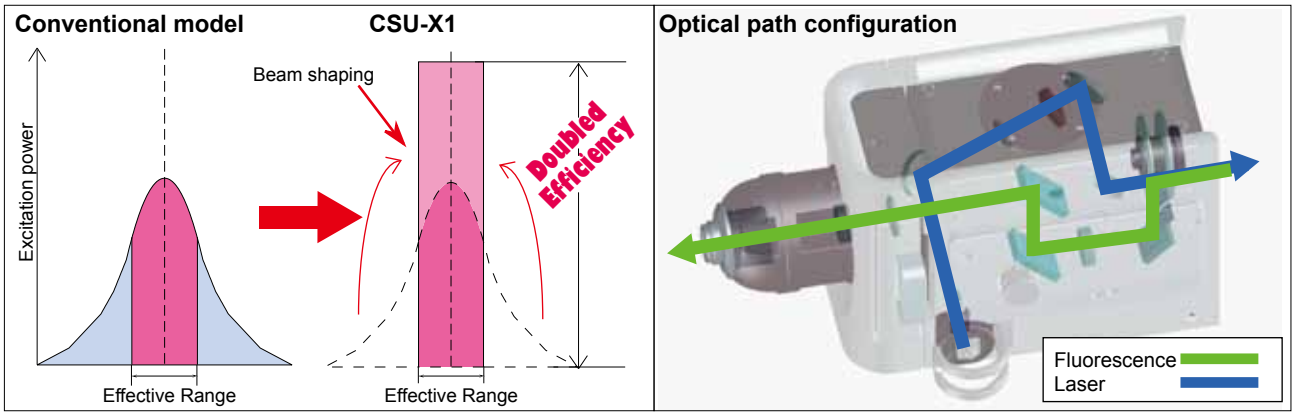
Galvano mirror method
(conventional)



*1 Light efficiency of excitation power. Actual fluorescence intensity depends on the total system including the microscope optics.
*2 Compared to the CSU22/10.
*3 fps：frame per second.
*4 6 position filter wheel. “33ms ” means mechanical movement speed. Actual image acquisition speed depends on your system configuration and communication speed of your computer. In case you find vibration due to the filter wheel operation, please select low-vibration mode.
Please set at least 33ms interval between each operation.

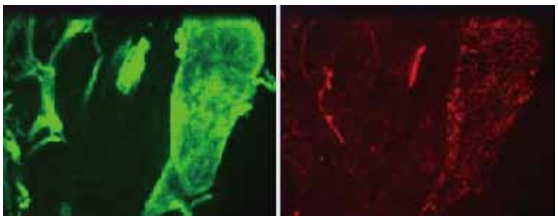
Brighter

- **Doubled excitation power efficiency with newly developed beam shaper lens, allows use of lower power lasers, and may reduce camera exposure time*5.**
- **Triplicated S/N achieved by cutting the background noise, enables really low-light imaging.**
- **Significantly brighter images are enabled by employment of the most efficient dichroic mirrors.**

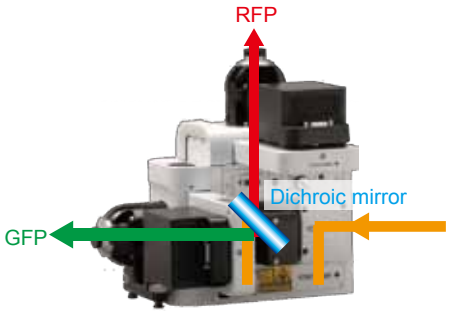


More Versatility

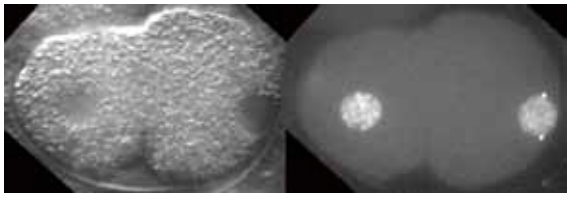
- **Depending on the usage model options widely available.**
  - A second camera port option allows simultaneous multicolor imaging with two cameras*6. Depending on the experiment carried out, two types of cameras can be selected.



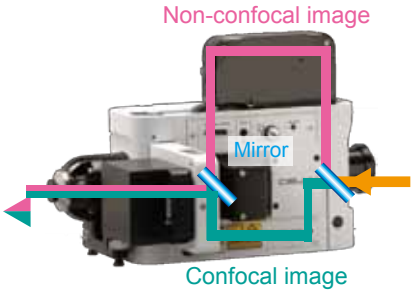
GFP image RFP image



  - A bright field option allows use of one camera for both confocal imaging with the CSU-X1 and bright-field (non-confocal) imaging through it's bypass light path*7.



Non-confocal image Confocal image



  - Easily exchangeable dichroic mirror block*8 and excitation and emission filters.

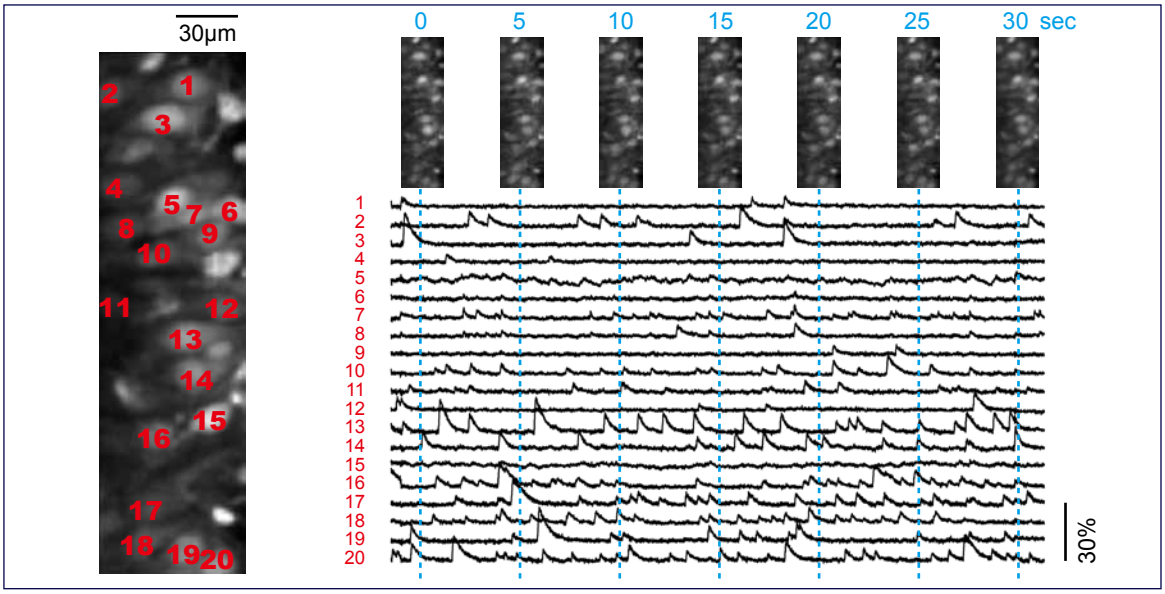
*5 Laser power necessary for excitation varies by condition.
*6 Use your preferred choice of commercially available dichroic mirrors for simultaneous multicolor imaging.
*7 The Bright Field Option is not applicable to some microscopy set-up due to steric interference. Please inquire the applicability.
*8 Please ask for the advice from support service if you wish to exchange the DM unit.

Applications

Ultra high-speed and high-resolution imaging at 2,000fps with the CSU-X1

An example of new development in neuroscience research, which is only made possible by using high-speed / resolution imaging with the CSU-X1.

fMCI : Functional multineuron calcium imaging



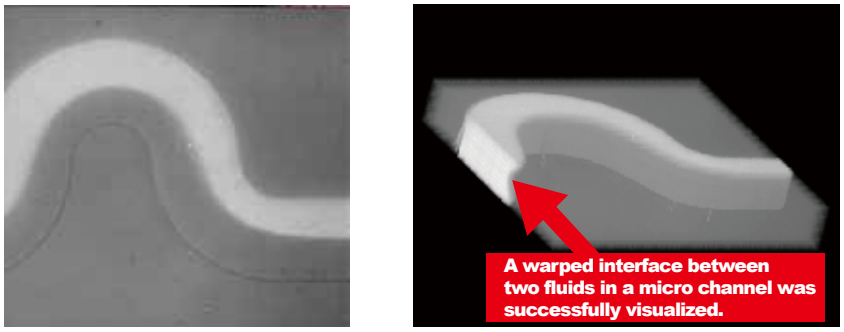
Spontaneous firing-induced somatic calcium spikes of CA3 pyramidal cells in a rat hippocampal slice culture loaded with Oregon Green 488 BAPTA-1AM (Frame rate: 2,000fps, excitation laser power: 10mW)

(By courtesy of Dr. Yuji Ikegaya and Dr. Naoya Takahashi, Laboratory of Chemical Pharmacology, Graduate school of Pharmaceutical Sciences, The University of Tokyo.)

Ultra high-speed microchannel flow measurement (Confocal scanning micro PIV*1)

Use in conjunction with a high speed Z scanning enables 3D analysis of ultra high-speed flow.

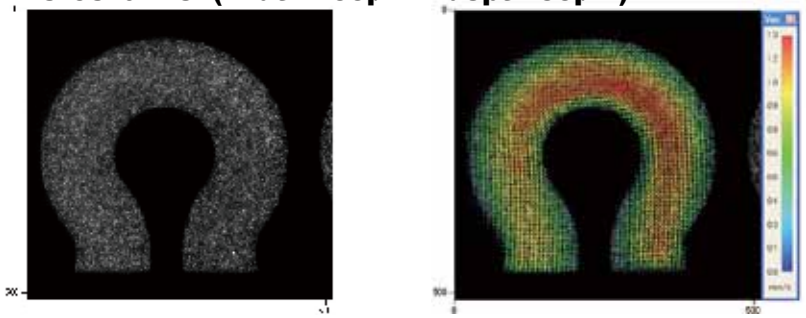
Visualization of warped interface between two fluids at a curve downstream of Y - junction



Left : Curved microchannel (width 100μm × depth 50μm)

Right : Shape analysis by volume rendering.

Instantaneous velocity distribution analysis of fluid flow in a round shape microchannel (width 100μm × depth 50μm)



Left : Image of 500 nm microspheres fast-flowing in a microchannel taken at 2,000fps.

Right : Velocity analysis of high-speed microchannel flow based on the position data of clear particle images.

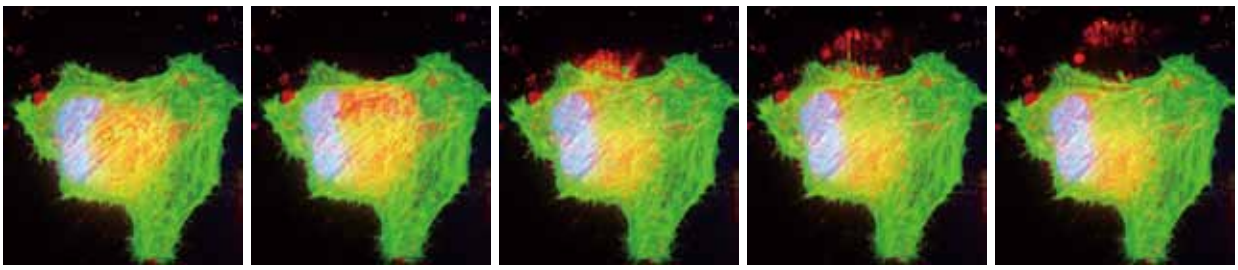
(By courtesy of Seika Corporation. This experiment was done in the collaboration of the Oshima Laboratory, Institute of Industrial Science, The University of Tokyo.)

*1 PIV : Particle Image Velocimetry

Multi-color imaging of live cells and tissues

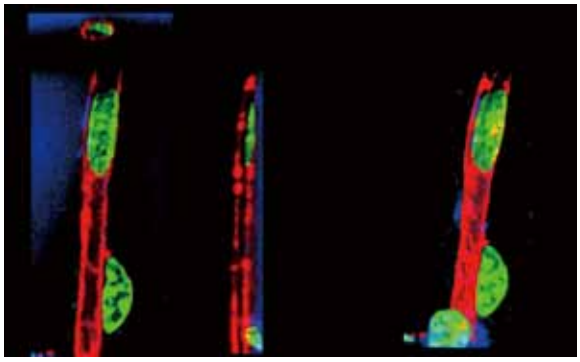
High-speed and high-resolution imaging with minimal photobleaching and phototoxicity makes the CSU-X1 the most suitable tool for imaging quick and delicate changes in live cells and tissues in real-time and for a long time.

Escape of intracellular vesicles induced by mechanical stress



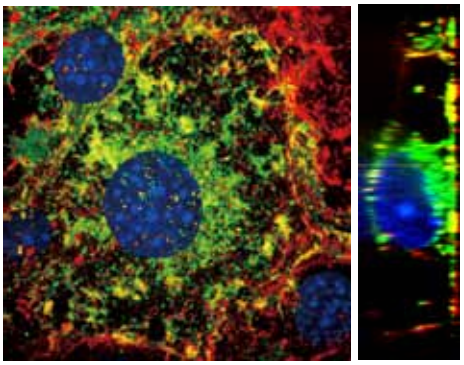
Cultured NIH3T3 cells, excerpt from time-lapse images taken at 3.6 sec. interval.
Blue (Hoechst33342) / Nuclei, Green / eGFP-Actin, Red (Cholera Toxin) / Vesicles

3D reconstruction image of blood vessels in mouse adipose tissues (unfixed)



Blue (BODIPY) / adipocytes, Green (Hoechst33342) / Nuclei
Red (isolectin Gs-IB4) / endothelial cells

3D reconstruction image of cultured adipocyte after insulin stimulation



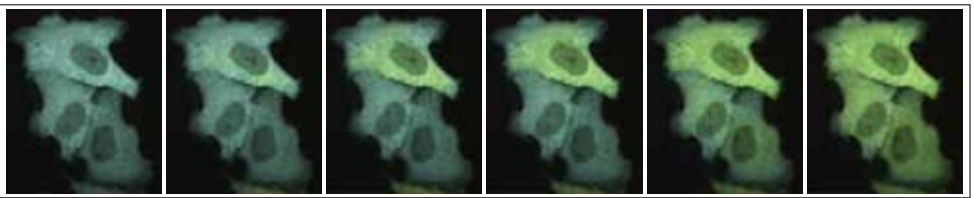
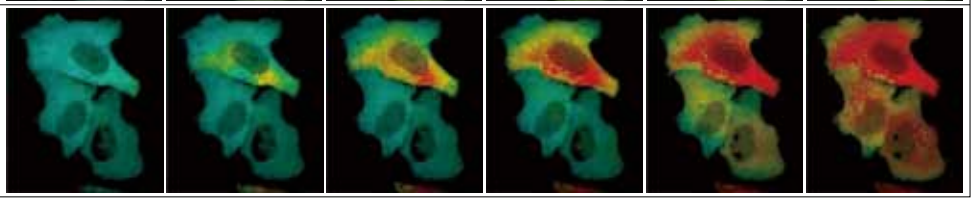
Blue (Hoechst33342) / Nuclei, Green / actin rhodamine
Red / eGFP-GLUT4

(By courtesy of Dr. Satoshi Nishimura, Department of Cardiovascular Medicine, Graduate School of Medicine, The University of Tokyo and Dr. Seiryo Sugiura, Department of Human and Engineered Environmental Studies, Graduate School of Frontier Sciences, The University of Tokyo.)

High-resolution, high-speed FRET Observation

The CSU-X1 is ideal for real-time FRET observation. A wide variety of system configurations is possible for FRET imaging, such as the use of a color CCD camera, simultaneous multicolor imaging with two cameras (second camera option), or high-speed filter wheel.

Real-time, real-color imaging of the initial stage of histamine-stimulated Ca^{2+} concentration in HeLa cell cytosol expressing Cameleon (YC3.60)

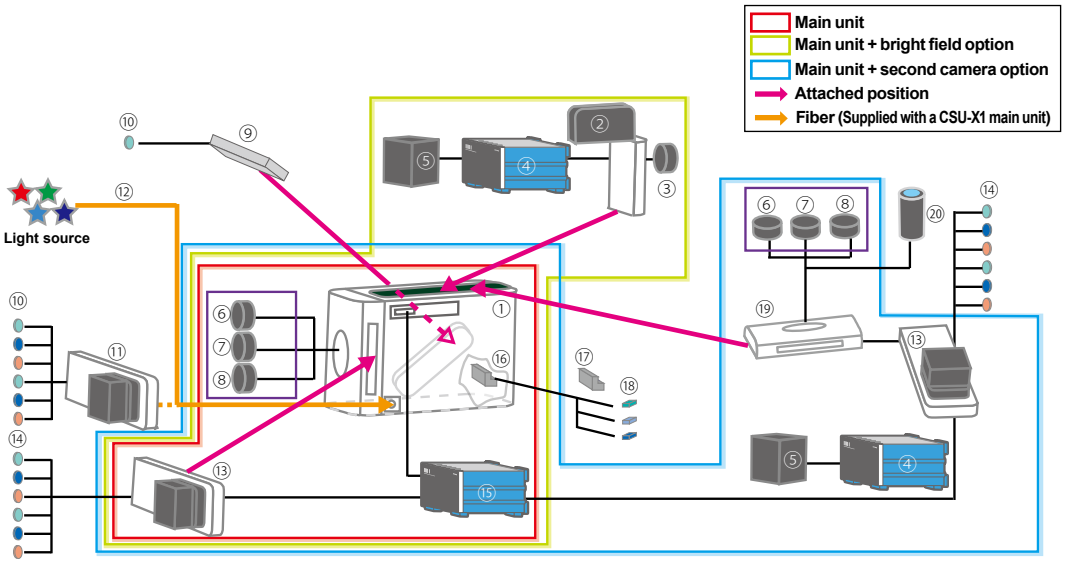
Real-color images	
Ratio images (Pseudo-colored)	

(Video-rate FRET images using a 3CCD color camera: Excerpts at 264ms interval)

(By courtesy of Dr. Atsushi Miyawaki, Advanced Technology Development Group, Brain Science Institute, RIKEN, and Dr. Takeharu Nagai, Nanosystems Physiology Laboratory, Research Institute for Electronic Science, Hokkaido University.)

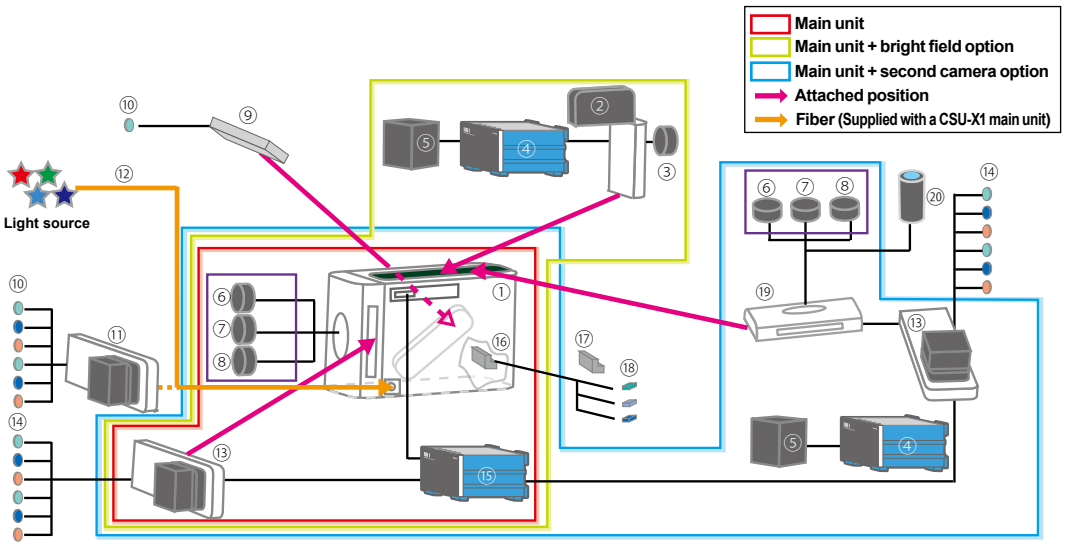
System construction

High-end model（6-position filter wheel）



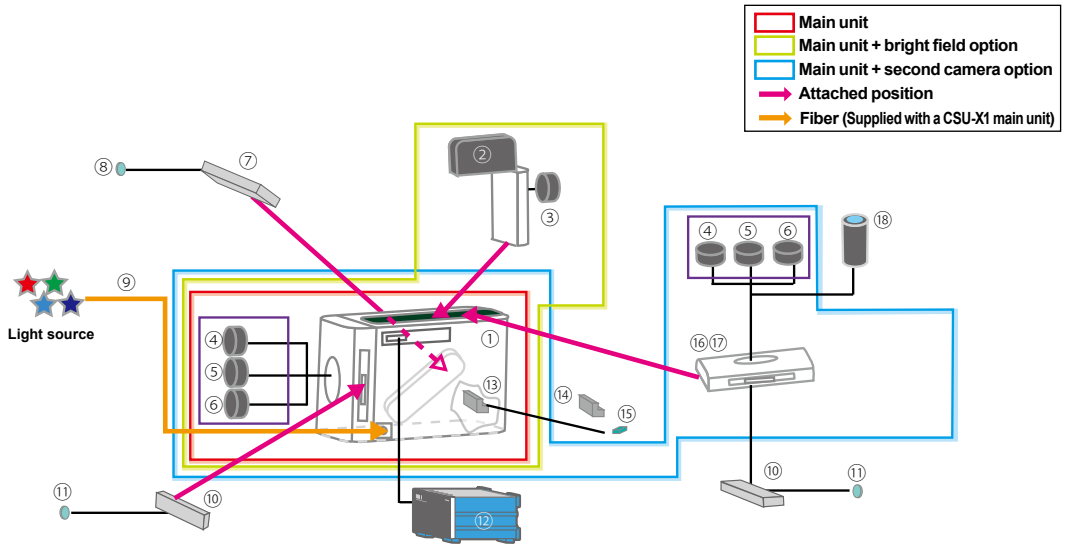
① CSU-X1
② Bright field unit
③ Microscope specific adapter
(for bright field option)*1
④ Control unit
(for light path switching)
⑤ Motorized unit
(for light path switching)
⑥ C-mount adapter*2
⑦ 8×8 EMCCD camera adapter*2
⑧ ENG mount adapter*2
⑨ Manual excitation filter holder
⑩ Excitation filter
⑪ Filter wheel
(for excitation filter)
⑫ Yokogawa's standard fiber
⑬ 6-position filter wheel
(for emission filter)*3
⑭ Emission filter
⑮ Control unit
(for filter wheel control)
⑯ Dichroic mirror block
⑰ Spare dichroic mirror block
⑱ Dichroic mirror
⑲ Second camera base
⑳ Eye piece

High-end model（12-position filter wheel）



① CSU-X1
② Bright field unit
③ Microscope specific adapter
(for bright field option)*1
④ Control unit
(for light path switching)
⑤ Motorized unit
(for light path switching)
⑥ C-mount adapter*2
⑦ 8×8 EMCCD camera adapter*2
⑧ ENG mount adapter*2
⑨ Manual excitation filter holder
⑩ Excitation filter
⑪ Filter wheel
(for excitation filter)
⑫ Yokogawa's standard fiber
⑬ 12-position filter wheel
(for emission filter)*3
⑭ Emission filter
⑮ Control unit
(for filter wheel control)
⑯ Dichroic mirror block
⑰ Spare dichroic mirror block
⑱ Dichroic mirror
⑲ Camera port base
⑳ Eye piece

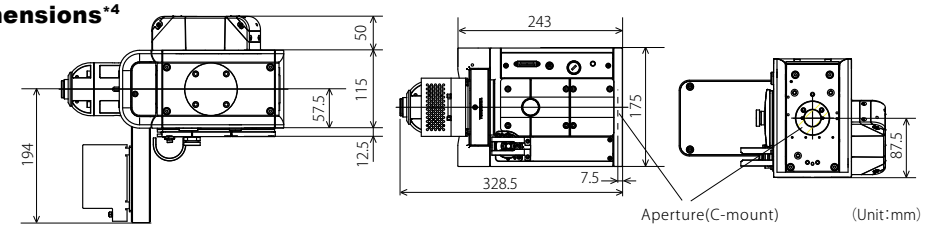
Basic model



① CSU-X1
② Bright field unit
③ Microscope specific adapter
(for bright field option)*1
④ C-mount adapter*2
⑤ 8×8 EMCCD camera adapter*2
⑥ ENG mount adapter*2
⑦ Manual excitation filter holder
⑧ Excitation filter
⑨ Yokogawa's standard fiber
⑩ Manual emission filter holder
⑪ Emission filter
⑫ Control unit
(for disk rotation speed control)
⑬ Dichroic mirror block
⑭ Spare dichroic mirror block
⑮ Dichroic mirror
⑯ Camera port base
⑰ EM filter base
⑱ Eye piece

	Main unit	Bright field option	Second camera option
			
Standard specification	①⑫⑬⑮⑯ Camera port:selecting from ⑥⑦⑧	①②③④⑤⑫⑬⑮⑯ Camera port:selecting from ⑥⑦⑧	①④⑤⑫⑬*3⑮⑯⑲ Camera port:selecting from ⑥⑦⑧
Selectable option	⑨⑩⑪⑭⑰⑱⑳	⑨⑩⑪⑭⑰⑱	⑨⑩⑪⑭⑰⑱⑳

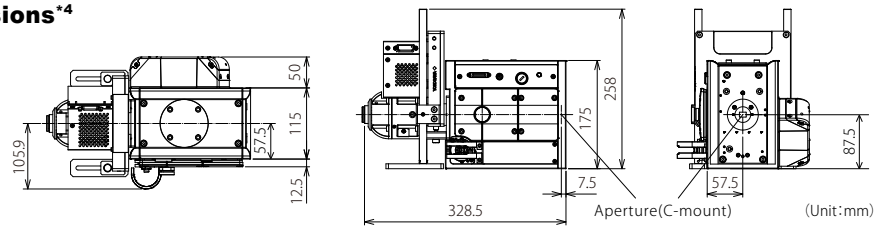
External Dimensions*4



*1 Microscope mount adapter depends on microscope manufacturers
*2 Selecting from C mount camera port, C mount EM camera port or ENG mount camera port
*3 Including 2 filter wheels (standard, for a second camera)
*4 C mount camera port

	Main unit	Bright field option	Second camera option
			
Standard specification	①⑫⑬⑮⑯ Camera port:selecting from ⑥⑦⑧	①②③④⑤⑫⑬⑮⑯ Camera port:selecting from ⑥⑦⑧	①④⑤⑫⑬*3⑮⑯⑲ Camera port:selecting from ⑥⑦⑧
Selectable option	⑨⑩⑪⑭⑰⑱⑳	⑨⑩⑪⑭⑰⑱	⑨⑩⑪⑭⑰⑱⑳

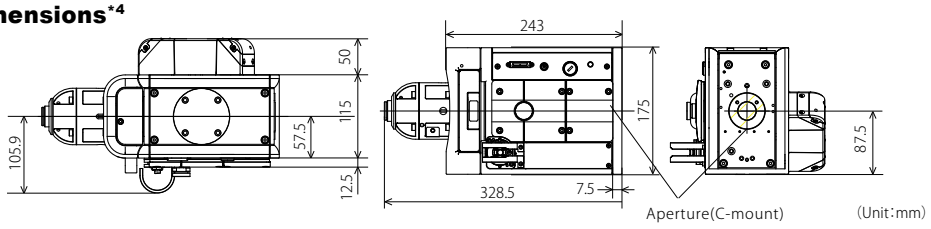
External Dimensions*4



*1 Microscope mount adapter depends on microscope manufacturers
*2 Selecting from C mount camera port, C mount EM camera port or ENG mount camera port
*3 Including 2 filter wheels (standard, for a second camera)
*4 C mount camera port

	Main unit	Bright field option	Second camera option
			
Standard specification	①⑨⑬ Camera port:selecting from ④⑤⑥	①②③⑨⑬ Camera port:selecting from ④⑤⑥	①⑨⑬⑯⑰ Camera port:selecting from ④⑤⑥
Selectable option	⑦⑧⑩⑪⑫*3⑭⑮⑱	⑦⑧⑩⑪⑫*3⑭⑮	⑦⑧⑩⑪⑫*3⑭⑮⑱

External Dimensions*4



*1 Microscope mount adapter depends on microscope manufacturers
*2 Selecting from C mount camera port, C mount EM camera port or ENG mount camera port
*3 High-speed scanning specification (up to 10,000rpm) is possible by adding option ⑫ Please inquireYOKOGAWA
*4 C mount camera port

Examples of Microscope-setup of CSU-X1

Inverted microscopes

Olympus Nikon Zeiss Leica

Upright microscopes

Nikon Olympus Zeiss Leica

The CSU-X1 can be mounted on microscopes from different manufactures.

General Specification

CSU-X1

Type	High-end Model (6-position filter wheel)			High-end Model (12-position filter wheel)			Basic Model		
Option	Main unit*1	Bright field*2	Second Camera*2	Main unit*3	Bright field*4	Second Camera*4	Main unit	Bright field	Second Camera
Confocal scanning method	Microlens-enhanced Nipkow disk scanning								
Spinning speed	Choices : 1,500 up to 5,000rpm (Standard : max1,000fps) 1,500 up to 10,000rpm (High-speed : max2,000fps)*5						Choices : 1,800rpm (Standard : max360fps) 1,500 up to 5,000rpm (High-speed : max1,000fps)*5*6 1,500 up to 10,000rpm (High-speed : max2,000fps)*5*6		
External synchronization	Scan-speed synchronization through pulse signals Input : TTL level 300Hz up to 2KHz Corresponding to Nipkow disk spinning speed 1,500 up to 10,000rpm*5						—*6		
Excitation wavelength	405 up to 647nm								
Second port	—	Bright field	Second Camera*	—	Bright field	Second Camera*	—	Bright field	Second Camera
Dichroic mirror	Option*7								
Dichroic mirror switching	Automatic 3CH (Dichroic mirror block can be exchanged)						Manual 1CH (Dichroic mirror block can be exchanged)		
Optical fiber	Yokogawa's standard single-mode polarization-maintaining fiber supplied with each CSU-X1 main unit								
Filter wheel (Emission side)	6-position filter wheel			12-position filter wheel			—		
Emission filter	Option*7								
Operation panel	Switch open / close of laser shutter								
External control	RS-232C interface via Control unit						—*6		
Microscope mount	C -mount adapter								
Operating temperature range	15 up to 40ºC								
Operating humidity range	20 up to 75% RH*8								
Power consumption (main unit)	24VDC 1A max.								
Power consumption (AC adapter)	Input : 100 up to 240 VAC ±10%, 50 up to 60Hz ± 3Hz, 55W max. Output : 24VAC 1.84A max.								
External dimension*9*10	175(W)×328.5(H) ×301.5(L) mm	259(W)×373(H) ×301.5(L) mm	308.5(W)×328.5(H) ×301.5(L) mm	258(W)×329.8(H) ×213.4(L) mm	259(W)×374.3(H) ×248(L) mm	309.8(W)×329.8(H) ×392(L) mm	175(W)×328.5(H) ×213.4(L) mm	259(W)×373(H) ×213.4(L) mm	308.5(W)×328.5(H) ×213.4(L) mm
Weight*10	8.9kg*11	11.7kg*11	13.0kg*11	7.8kg*11	10.6kg*11	12.2kg*11	7.5kg	10.0kg	10.0kg

Control unit for CSU-X1

Type	for 6-position filter wheel (F1)	for 12-position filter wheel (F2)	for bright field (B1)
Operating temperature range	15 up to 40ºC		
Operating humidity range	20 up to 75% RH*8		
Power consumption	Input : 100 up to 240VAC ± 10%, 50 or 60Hz, 200VAmax.		
External dimension	213(W)×132(H)×438(L) mm		
Weight	5.2kg	5.2kg	5.1kg

6-position filter wheel for CSU-X1

Operating temperature range	15 up to 40ºC
Operating humidity range	20 up to 75% RH*8
Power consumption	-*12
External dimension	112(W)×100(H)×226(L) mm
Weight	1.9kg

12-position filter wheel for CSU-X1

Operating temperature range	15 up to 40ºC
Operating humidity range	20 up to 75% RH*8
Power consumption	-*12
External dimension	154(W)×154(H)×98(L) mm
Weight	2.7kg*13

*1 Supplied with a control unit (for 6-position filter wheel) and a filter wheel.
*2 Supplied with two control units (one for 6-position filter wheel and one for bright field) and a filter wheel.
*3 Supplied with a control unit (for 12-position filter wheel) and a filter wheel.
*4 Supplied with two control units (one for 12-position filter wheel and one for bright field) and a filter wheel.
*5 Option.
*6 Requires control unit for rotation speed control and external synchronization.
*7 Filters are not include (Excitation filter , Emission filter ,Dichroic mirror) . Please inquire as you need.
*8 No condensation.
*9 Excluding protruding parts.
*10 Attached C mount camera port.
*11 Including filter wheel.
*12 Power is supplied from control unit.
*13 Including stand.

* Use of Infinity corrected microscope with high NA objective lenses (i.e., Plan Apo) are recommended.
* General specification are subject to change without prior notice. The standard model does not include any peripheral components such as a microscope, a laser unit, camera, image monitor, or image processing unit. For mor information, contact the office indicated below.

Safety Precautions

* Read the user's manual carefully in order to use the instrument correctly and safely.
* If used in combination with a laser light source, this product falls under the category of class 3B laser products. Do not look directly into the beam and avoid touching it or any other direct exposure to it.

YOKOGAWA

YOKOGAWA ELECTRIC CORPORATION
Life Science HQ

Kanazawa 2-3 Hokuyodai, Kanazawa-shi, Ishikawa, 920-0177 Japan
Phone: (81)-76-258-7028, Fax: (81)-76-258-7029

Tokyo 2-9-32 Nakacho, Musashino-shi, Tokyo, 180-8750 Japan
Phone: (81)-422-52-5550, Fax: (81)-422-52-7300

E-mail: CSU_livecell_imaging@ml.jp.yokogawa.com
URL: http://www.yokogawa.com/scanner

Represented by :

[Ed:06/d]
Printed in Japan, 204