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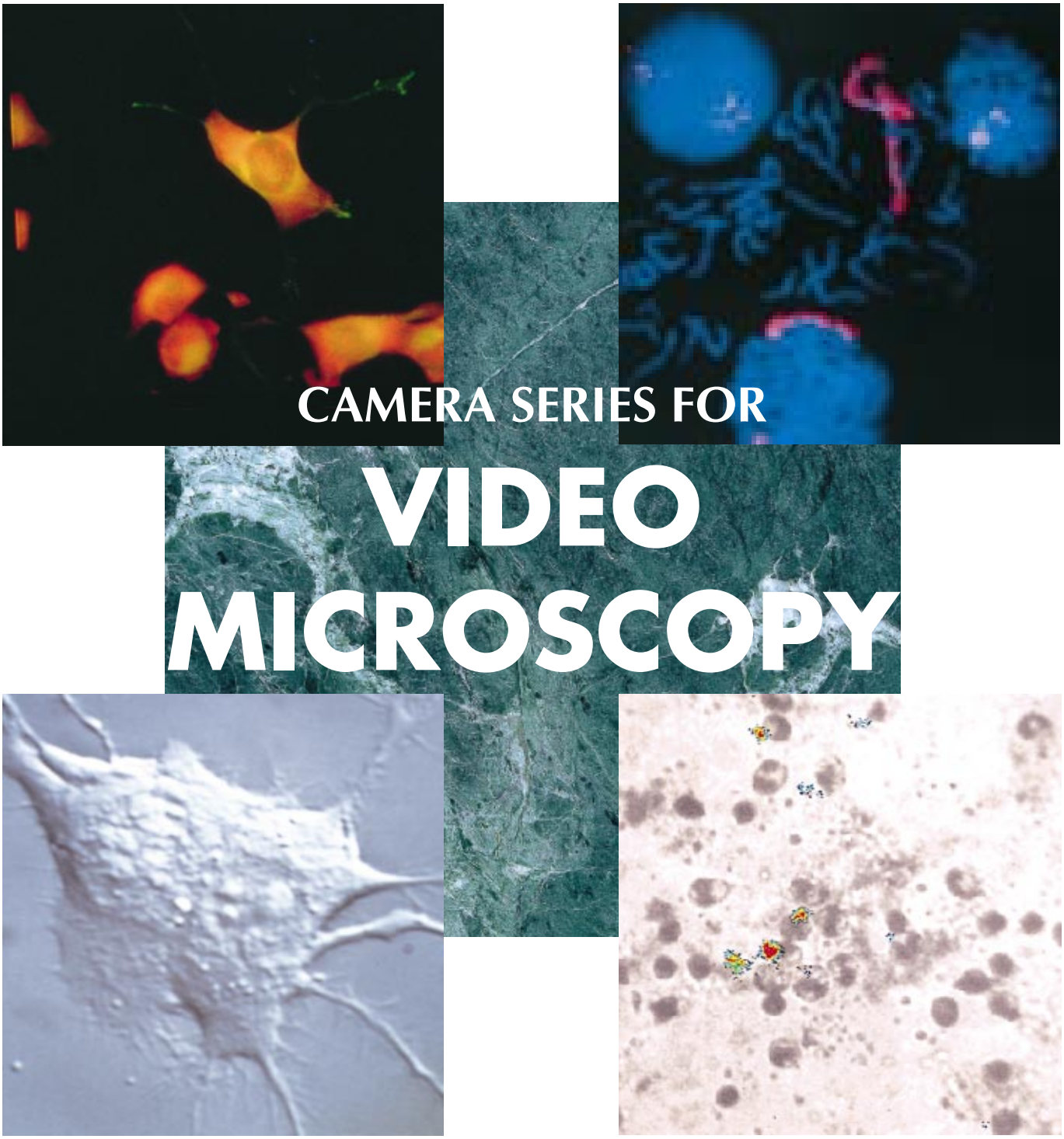
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CAMERA SERIES FOR

VIDEO MICROSCOPY

HAMAMATSU



Improved optical microscope detectability for a wide variety of samples, including brightfield, fluorescence, and low-light microscopy.

The optical microscope is an invaluable tool in biomedicine due to its ability to observe living specimens. Advances in the fields of fluorescence, differential interference, and other types of microscopy have improved the detectability of the optical microscope to the point that it is now possible to observe intracellular fine structure and morphology.

Hamamatsu camera series for videomicroscopy have been specially developed to meet the needs of the optical microscope in biological and medical applications.

A full lineup of quality models covers such diverse needs as fluorescence imaging for fluorescence in situ hybridization (FISH), ultra-low light imaging for gene expression, contrast enhancement for low-contrast samples which can not be seen by differential interference contrast microscopy, and just about any other video microscopy application imaginable.

Moreover, this camera series can be coupled to an image processor (eg. ARGUS-20) for further image enhancement and quantitative analysis.

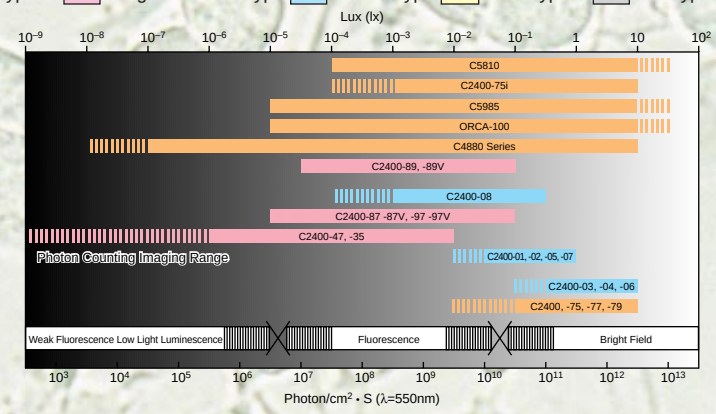
Video Camera Selection Guide For Application Fields

Video microscopy cameras can be broadly classified according to sensitivity, spectral characteristic, response to changes of incident light, and output color (color or monochrome). Selection of the appropriate video camera for a specific application should take into consideration the brightness of the object being measured, the wavelength distribution, and degree of kinetic change.

Main Application	Model	Product Name	Feature	Page
Multiple fluorescence image observation, FISH	C5810	Color Chilled 3-CCD Camera	Simultaneous observation of multiple fluorescence	4
General fluorescence image observation	C2400-75i + ARGUS-20	On- chip Integration Camera	Compact, Lightweight, Non-cooled on-chip integration type	5
FISH, General fluorescence image observation	C5985	B/W Chilled CCD Camera	Cooled on-chip integration type	6
	ORCA-100	Cooled Digital Camera	High resolution of 1.3 million pixels, Progressive scan interline CCD type	7
FISH, General fluorescence image observation, Luminescence blotting	C4880-Series	Dual modes Cooled CCD Camera	High sensitivity, Wide dynamic range, Ultraviolet sensitivity	8
High-speed fluorescence imaging and calcium-ion imaging	C4880-81	Fast Scan Multi Format Cooled CCD Camera	Maximum frame rate of up to approximately 493 frames/sec	9
Real-time fluorescence observation, Calcium-ion imaging	C2400-08	SIT Camera	High resolution (500TV lines of horizontal center resolution)	10
	C2400-89, 89V	Proximity ICCD Camera	Proximity ICCD eliminates image distortion and low lag, High speed shutter function 1 μs, Ultraviolet sensitivity	11
	C2400-87, -87V, -97, -97V	ICCD Camera	High-sensitivity, Suitabe for observation of rapid kinetic change by low lag and no distortion, CCD camera can be used separately	12
Chemiluminescence, Bioluminescence (Photon counting imaging is possible)	C2400-35	PI-CCD Camera	High spatial resolution, Low geometric distortion, Single photon-counting is possible	13
	C2400-47	VIM Camera	High efficiency photon counting rate	
Phase contrast, Differential interference contrast microscopy, IR-DIC	C2400-01	Chalnicon	General microscopic observation	15
	C2400-02	Silicon Vidicon	Visible to near infrared(1100nm)	
	C2400-03	Infrared Vidicon	Visible to infrared(1800nm)	
	C2400-05	UV Chalnicon	UV(200nm) to visible	
	C2400-06	Saticon	Observation of bright and fast moving object	
	C2400-07	Newvicon	General microscopic observation	
	C2400-75	CCD Camera(1/2")	Compact and light weight, Observation of bright and fast moving objects	14
	C2400-77	CCD Camera(2/3")	Compact and light weight, Observation of bright and fast moving objects	
	C2400-79	IR-CCD Camera(2/3")	Compact and light weight, Observation of NIR image	

1) Requires ARGUS-20 CCD type Image Intensifier type Vidicon type Color type B/W type

[Sensitivity]



Hamamatsu video microscopy cameras consist of three types: CCD type, image intensifier type, and tube type. Each type has the features lised below.

CCD Type (C2400-75, -77, -79; C2400-75i; ORCA-100; C4880-Series; C5985, C5810)

These cameras use solid state CCD chip to convert light into video signals, and are suitable for brightfield applications. They are compact, lightweight, and not easily damaged by strong light.

The C2400-75i camera provides better sensitivity by on-chip integration of the electrical charge generated by incident light. The CCD is cooled in order to cut down on heat noise generated by the CCD over the period required for integration of electrical charge. ORCA-100, C4880-Series C5985 and C5810 Series comes equipped with integrated cooling systems for even better cooling efficiency. On-chip integration type CCD cameras are most suitable for FISH and other stationary fluorescence sample observation.

Image Intensifier Type (C2400-35, -47, -87, -89, -97)

These cameras consist of an electron tube called an “image intensifier”, which intensifies light input, and a camera for readout. The image intensifier makes it possible to detect very low fluorescence and luminescence that is invisible to the naked eye. A CCD camera is used for the camera for readout. This type of camera configuration is called “ICCD Camera”. The ICCD camera is best for measurement for kinetic change of fluorescence like intracellular calsium ion concentration measurement and for measurement of fluorescent sample.

Tube Type (C2400-01, -02, -03, -05, -06, -07)

This type of camera converts light to a video signal using a glass-enclosed electron tube. This type of camera is best for brightfield observation, and offers high resolution and sensitivity outside the visible wavelength range that is unavailable with CCD cameras.

Full Color, Fluorescence Observation

Color Chilled 3-CCD Camera: C5810

Full Color | On-chip Integration | SCSI I/F

Simple, superior fluorescent observation



The Color Chilled 3-chip CCD Camera C5810 is high sensitivity, color 3-chip CCD camera developed for observation under low illumination and for monitoring and measurement under faint light conditions which are difficult to achieve with conventional color 3-chip CCD cameras.
CCD exposure time can be specified to any value from 1/10000th of a second to 60 seconds, allowing observation and measurement under conditions ranging from brightfield to darkfield. Peltier + air fan cooling configurations are available to eliminate dark current and white spot problems caused by long time exposures.
Two images memories are built-in, and SCSI interface is provided as standard, making connections possible to almost any type of computer.

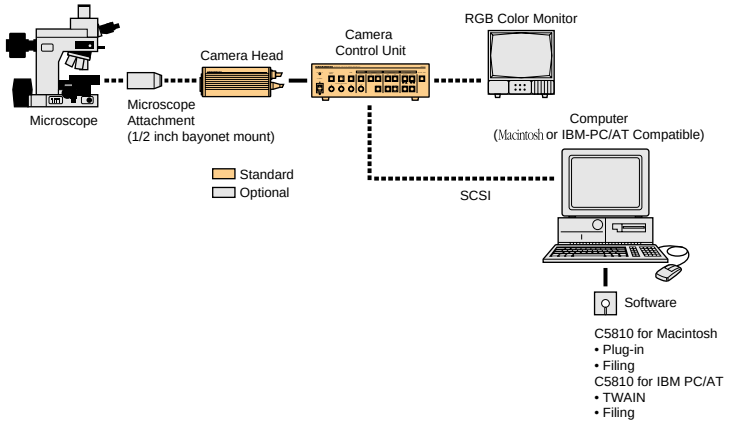
Features

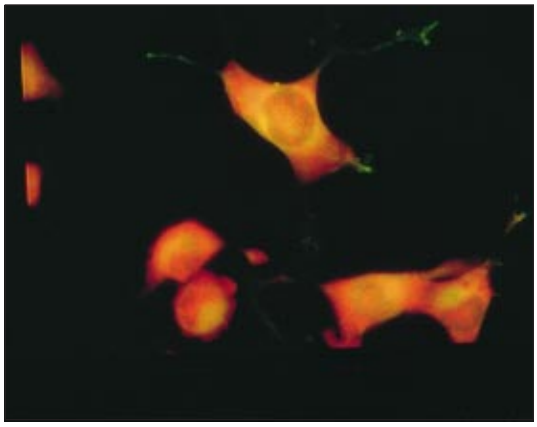
- Auto exposure
- Focus mode
- High sensitivity, high resolution
  (About 1,000 times higher sensitivity than a non-integration type 3-color CCD camera)
- High image quality with low noise
- Built-in image memories
- Addition and subtraction of images
  (Supports subtraction of background fluorescence)
- Built-in computer interfaces (SCSI)
- RGB color output

Applications

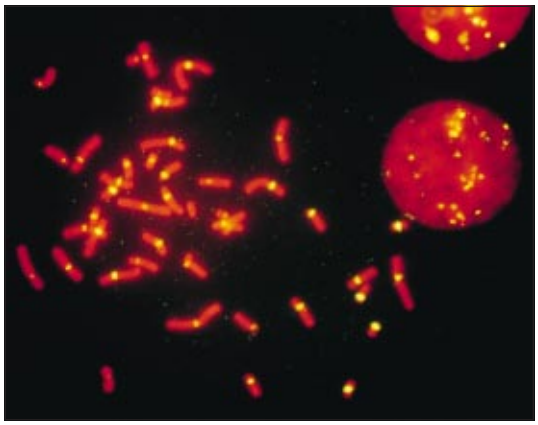
- FISH
- Multi-fluorescence stained samples

System Configuration

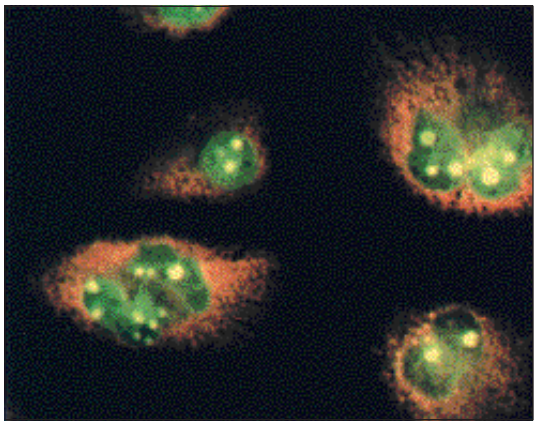




▲ Neuronal cell line NG108-15
(nucleus stained with PI, mitochondria stained with Mitotracker™)



▲ All human chromosome centromers by FISH
(centromer:FITC(green), chromosome:PI(red))



▲ Kidney tissues of rhesus monkeys.
(upper right cell emitting fluorecence is under division Cell supplied by Dr.Takaoka/Utsunomiya-higashi Hospital)

Fluorescence Observation

On - chip integration Camera: C2400-75i + ARGUS-20

On-chip Integration
SCSI I/F

CCD camera for fluorescence image analysis



The C2400-75i is CCD camera for fluorescence image analysis. The C2400-75i employs 1/2 inch CCD. This camera provide better sensitivity by on-chip integration of the electrical charge generated by incident light in combination with the ARGUS-20 Image Processor. The contrast enhancement and image enhancement capabilities of the ARGUS-20 make even low-contrast images easier to view.

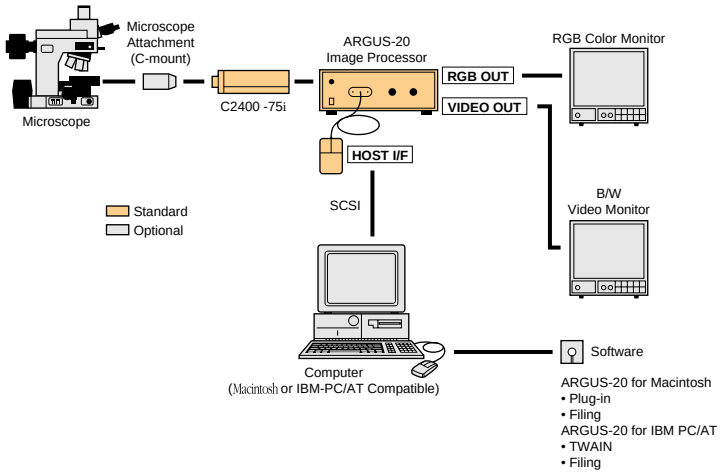
Features

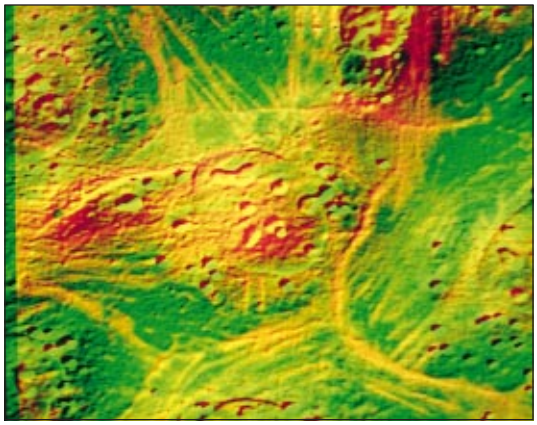
- CCD On-Chip Integration for clear image of fluorescence that's normally difficult to observe with the naked eye
- Compact, lightweight design
- CCD eliminates image distortion
- Fluorescence intensity analysis with the ARGUS-20 Image Processor
- SCSI interface (ARGUS-20) for transfer of images to a personal computer
- Spectral response characteristics (See Page 19)

Applications

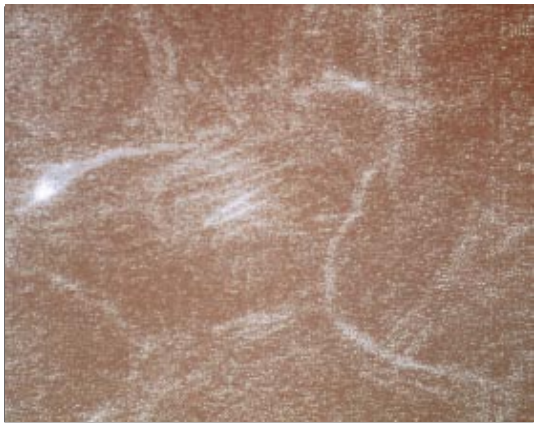
- Observation of fluorescence-stained samples
- Fluorescent antibody technique
- DNA cytometry
- Observation of darkfield images (bacteria flagellum, etc.)
- Stationary sample observation

System Configuration

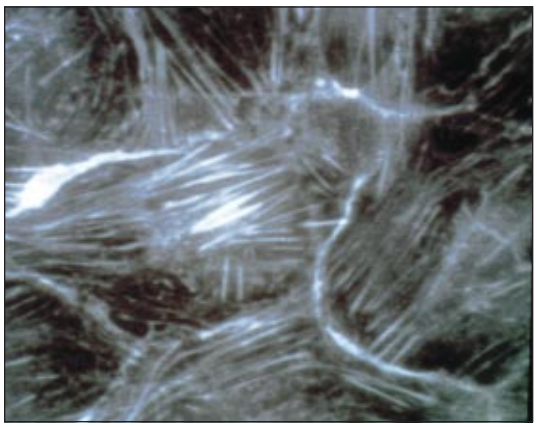




▲ Superimposed pseudo-color display of differential interference image of MDCK cell and f-actin stained with fluorescein-phalloidin



▲ Original image integrated using 256-frame ACCM command of ARGUS-20 (f-Actin of MDCK cell stained with fluorescein-phalloidin)



▲ Image obtained with 10-second on-chip integration

B/W Chilled CCD Camera: C5985

On-chip Integration
SCSI I/F
High-Sensitivity

Simple, superior fluorescence image observation



The B/W Chilled CCD Camera C5985 is a high sensitive and high resolution CCD camera developed for observation under low illumination and for monitoring and measurement under faint light conditions which are difficult to achieve with non-integration type CCD cameras.
The exposure time can be set at certain steps from 1/10000th of a second to 5 minutes, allowing observation and measurement under conditions ranging from brightfield to darkfield, while a background subtraction function makes it possible to eliminate fixed patterns of optics and shading.
Both RS-232C and SCSI interfaces come built in, for easy connection to just about any type of computer.

* When using with ARGUS-20 Image Processor, B/W Chilled CCD camera driver C6391 is required.

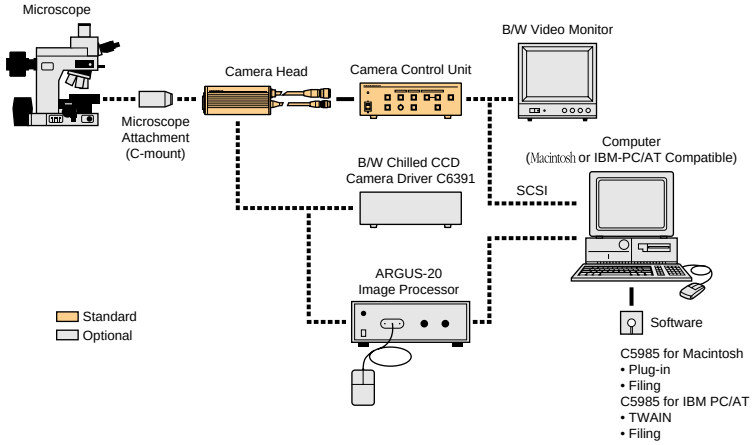
Features

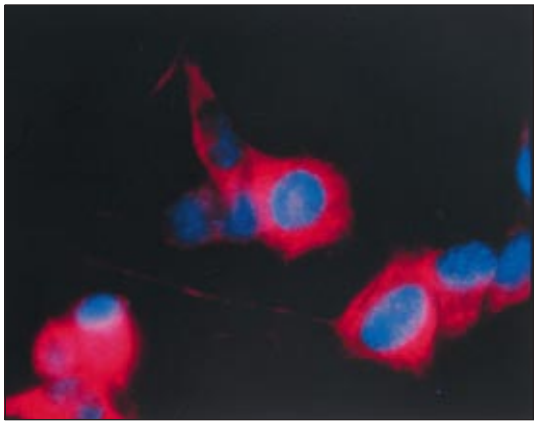
- Auto exposure
- Focus mode
- High image quality with low noise minimized by thermoelectric cooling
- Built-in image memories
- Background subtraction
- Built-in computer interfaces (SCSI) and RS-232C
- Spectral response characteristics (See Page 19)

Applications

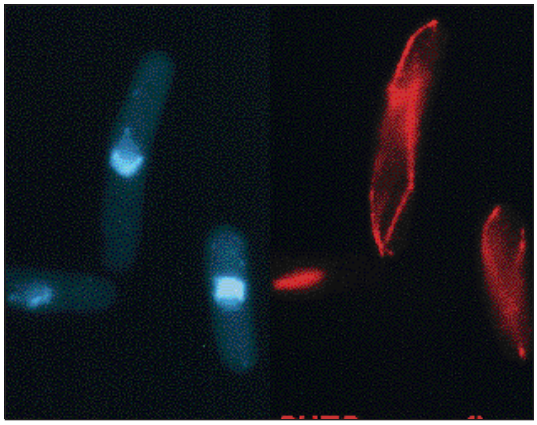
- FISH
- Multi-fluorescence stained samples

System Configuration

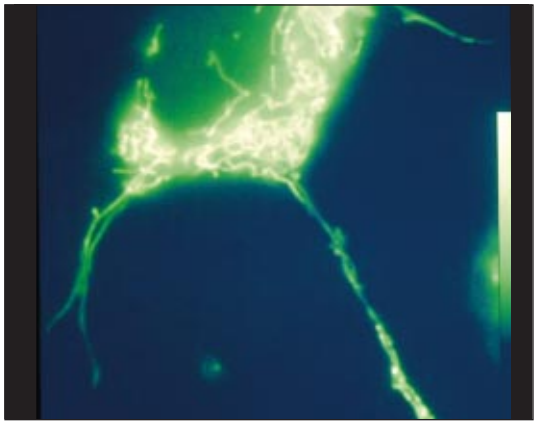




▲ Pseudo-color superimposed display of double stained fluorescence image of neuronal cell line NG108-15 (nucleus stained with DAPI, mitochondria stained with rhodamine 1-2-3 overall chromosome stained with DAPI, chromosome stained with Texas Red)



▲ DAPI stained image of mutant concerning chromosome fission of divided yeast and microtubule structure (rhodamine)



▲ Neuronal cell line NG108-15
(mitochondria stained with rhodamine 1-2-3)

Fluorescence Observation

Cooled Digital Camera : ORCA-100

High Sensitivity
High Resolution
Low Readout Noise

High-resdution, high-quality



The ORCA-100 is a high resolution digital camera using a progressive scan interline CCD chip with no mechanical shutter. In addition to a high resolution of 1.3 million pixels and 10 or 12 bit digital output, a wide dynamic range and high sensitivity of the ORCA-100 offers a wide application range down to low light levels imaging. Peltier cooling* drastically reduces dark noise and minimizes thermal drift which makes camera an ideal choice for demanding scientific and industrial applications. RS422A digital output insures compatibility with a large variety of commercially available frame grabber boards. Furthermore, a standard C-mount lens coupling makes it easy to connect to optical microscopes.

* Cooling temperature : cools the CCD element to 15℃ less them the ambient.

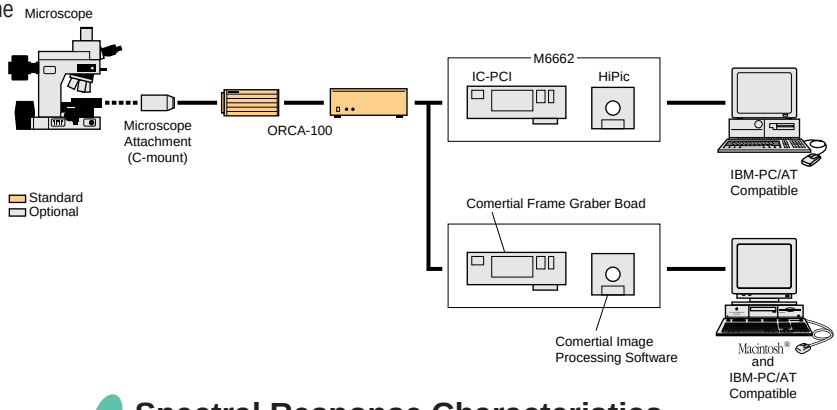
Features

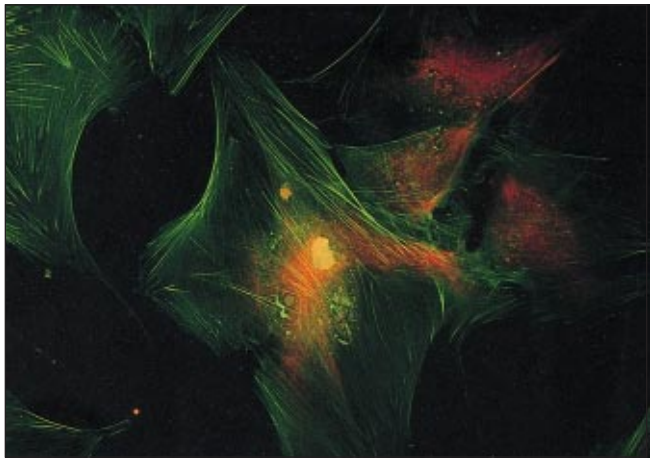
- High resolution of 1.3 million pixels
- Full remote control from PC
- Progressive scan interline CCD chip with no mechanical shutter
- Low readout noise 10 to 15 electrons r.m.s (typ.)
- Binning (2 × 2) function to improve sensitivity and achieve a frame rate of 18 frames/sec
- Low dark noise with peltier cooling for a dynamic range of more than 60dB

Applications

- Observation of fluorescence-stained samples
- Fluorescent antibody technique
- DNA cytometry
- Observation of darkfield images (bacteria flagellum, etc.)
- Stationary sample observation
- FISH

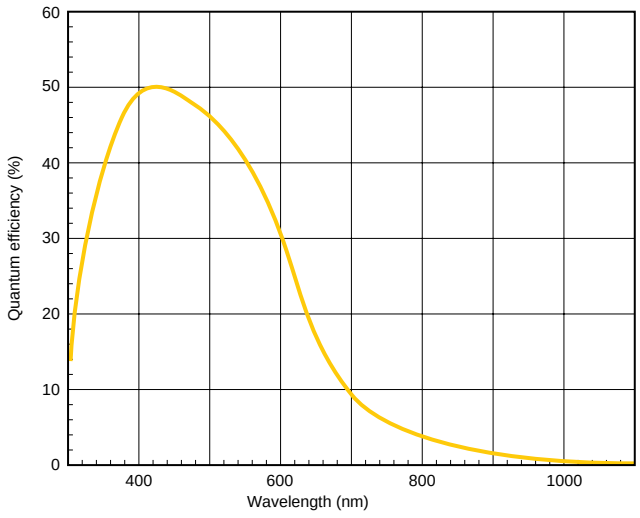
System Configuration





▲ Immuno fluorescence image of mouse fibrobloots (multi stained), fluorescence filters for FITC and Rhodamino emission. B/W images at each fluorescence wavelength were acquired and overlayed with Adobe Photoshop 3.05.

Spectral Response Characteristics



Dual-modes Cooled CCD Cameras: C4880-Series

High-sensitivity, high-precision, high-quality



The C4880 camera series are high resolution, high dynamic range digital cameras. They are cooled to reduce thermal noise allowing long exposure times providing ultrahigh sensitivity. The C4880 series has a fast readout mode as well as the standard high prescision (slow) scan mode. This allows simple and easy focussing and alignment.
The cameras also have special scan modes such as binning and sub-array providing increased sensitivity and frame rates.

Comparison of each camera

Model	CCD Chip	Readout noise (typ.) (electrous r.m.s.)	Dark cunnent (typ.) (electrons/pixel/s)
C4880-10	TC215 (–30°)	12	0.02
C4880-10	TC215 (–50°)	12	0.05
C4880-30	SI 502 A Back-thiuned illuminated	10	1
C4880-40	ICX-061	7	0.02

Features

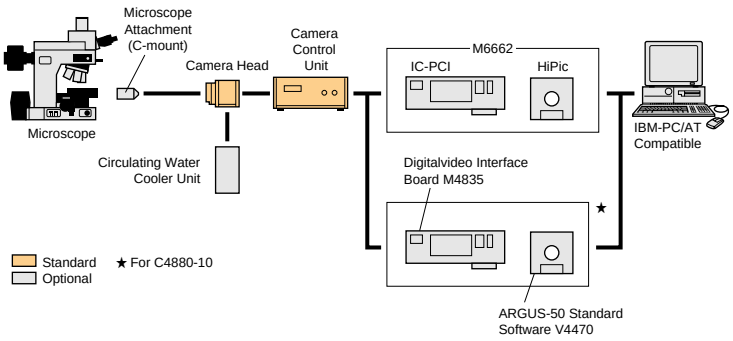
High Sensitivity　High Resolution　Wide Dynamic Range

- High sensitivity
- High resolution (up to million pixels : C4880-10)
  (1.3 million pixels : C4880-40)
- High-precision scan mode and fast scan mode
  (For easy focusing and brightfield observation)
- Digital output (14-bit) (16-bit : Optional)
- Hermetic vacuum sealed type is available.
- On-chip binning and sub array scan
- Back thinned illuminated CCD chip (C4880-30) for higher QE

Applications

- FISH
- Multiple stained samples
- Blotting
- Stationary sample observation
- Intra-cellular ion concentration measurement (Ca^{2+}, pH, etc.)

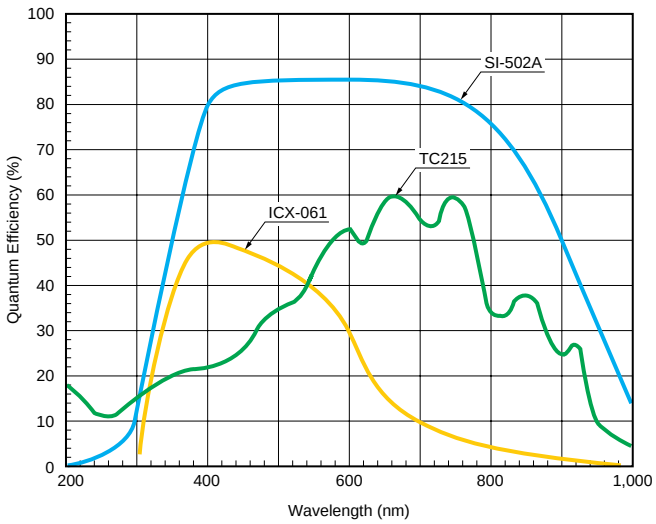
System Configuration





▲ Fluorescent image of intra-celluar microtubule (pseudo-color display)

Spectral Respouse Characteristics



High Speed Fluorescence Observation

Fast Scan Multi Format Cooled CCD Camera: C4880-81

High Frame Rate
Low Readout Noise

High-frame rate, High sensitivity



The C4880-81 are newly developed fast scan, low-noise cooled CCD cameras. To achieve maximum speed, a 1/2-inch progressive scan interline CCD of 659 (H) × 494 (V) pixels is used, enabling scanning of up to approximately 493 frames/sec (32 × 32 binning/fast scan mode).
Two modes are available: a high-precision scan mode with a noise level as low as 5 electrons (typ.), and a fast scan mode with a noise level of 20 electrons (typ.). The CCD is cooled down to 0° C, using peltier cooling.
The high resolusion images of progressive scan interline CCD can be observed at high magnifications under a microscope without image deterioration caused by vibration.

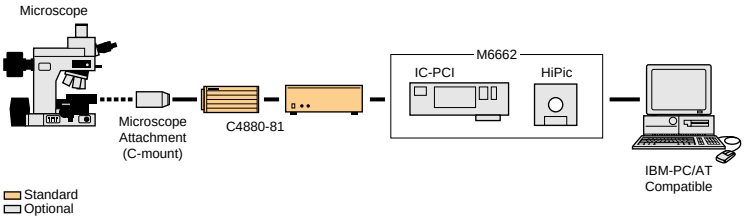
Features

- Progressive scan interline CCD with no mechanical shutter
- Two scan mode as well as sub-array and binning functions available
- Maximum frame rate of up to approximately 493 frames/sec
- Fast scan mode with low noise (20 to 30 electrons r.m.s.)
- High-precision scan mode (Recal-out noise : 5 to 7 electrons r.m.s.)
- Full computer control

Applications

- High speed fluorescence imaging

System Configurations



Binning number and Frame Rate

• High-precision scan mode (A/D Converter 12bit)

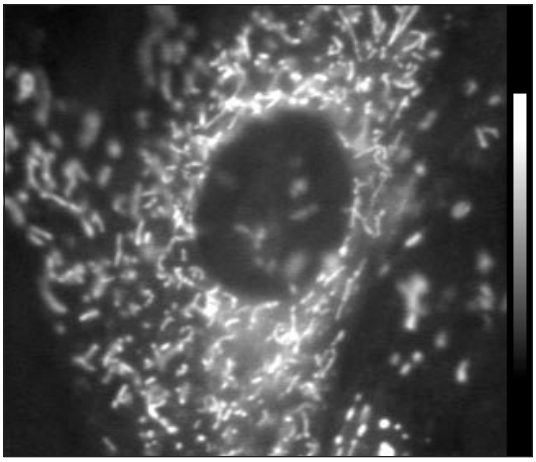
Binning number	1 × 1	2 × 2	4 × 4	8 × 8	16 × 16	32 × 32
No. of pixels (H × V)	659 × 494	329 × 247	164 × 123	82 × 61	41 × 30	20 × 15
Frame rate (Hz)	1	4	14	45	140	320

• Fast scan mode (A/D Converter 10bit)

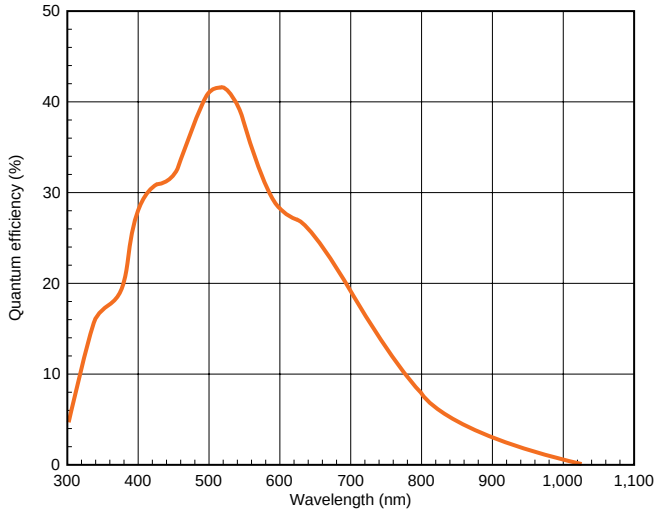
Binning number	1 × 1	2 × 2	4 × 4	8 × 8	16 × 16	32 × 32
No. of pixels (H × V)	659 × 494	329 × 247	164 × 123	82 × 61	41 × 30	20 × 15
Frame rate (Hz)	28	53	102	190	320	493

NOTE: Values for frame rates are typical values.

Spectnal Respouse Characteristics



▲ Imaging of a mitochondorion in a cell, using a fluorescent reagent Mito Tracker™



Realtime Fluorescence Observation

Silicon Intensified Tube Camera: C2400-08

Real Time Observation

High Resolution

Fluorescence observation of samples with kinetic change



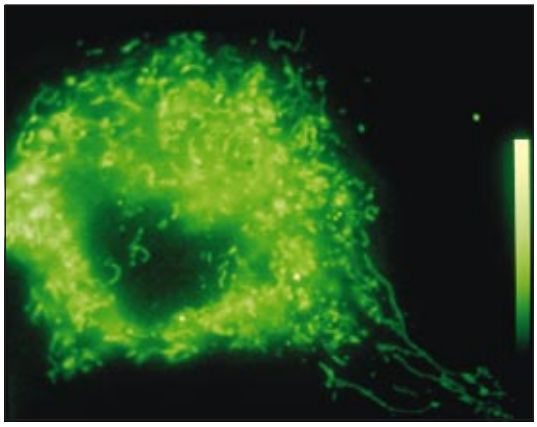
A silicon intensified tube (SIT) provides real-time signal amplification, making it possible to observe fluorescence samples that are not easy to observe with the necked eye. It is suitable for observation of dynamic phenomena, such as changes in the fluorescence intensity of calcium ions.

Features

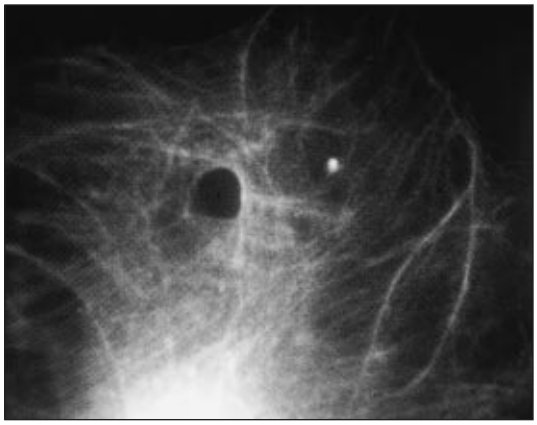
- **Clear image of fluorescence that's normally difficult to observe with the naked eye**
- **High resolution (500-TV lines of horizontal center resolution)**
- **Built-in protection circuitry againt excessive light**
- **Spectral response characteristics (See Page 18)**

Applications

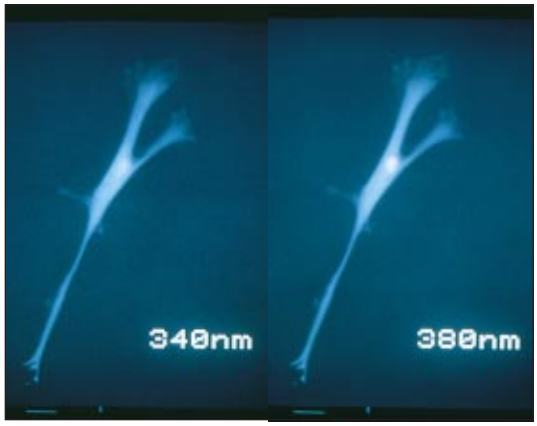
- **Observation of fluorescence-stained samples**
- **Observation of dark-field images**
- **Fluorescence photobleaching recovery**
- **Fluorescent antibody technique**
- **DNA cytometry**
- **Intra-cellular ion concentration measurements (Ca^{2+}, pH, etc.)**
- **Detection of green fluorescence protein (GFP)**



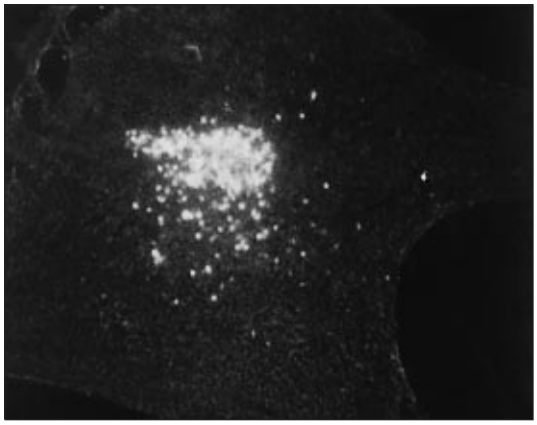
▲ Fluorescence image of intra-cellular mitochondria (neuronal cell line NG108-15; fluorescent reagent: rhodamine 123)



▲ Fluorescence image of microtubule, obtained using fluorescence microscope.



▲ Fluorescence image stained by Fura-2 (fluorescence image by excitation light of 340nm/380nm, sample:3T3 fibroblast)



▲ Observation of virus-infected cell using fluorescent antibody technique (photo courtesy of Dr. T. Bäahi, University Zürich, Switzerland)

Realtime Fluorescence Observation

Proximity ICCD Camera: C2400-89, -89V

Fluorescence observation of samples with kinetic change

Image Intensifier
On-chip Integration
Ultraviolet Sensitivity



An image intensifier with no distortion and a wide wavelength range of **180nm to 850nm** (-89V: **180 nm to 650 nm**) provides higher sensitivity than the C2400-08 SIT Camera. By on-chip integration function in conbination with ARGUS-20 Image Processor, these cameras enhances sensitivity and contrast.

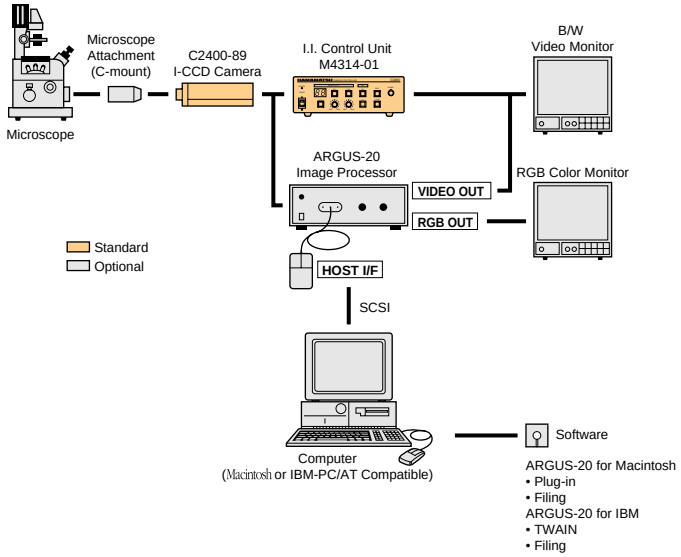
Features

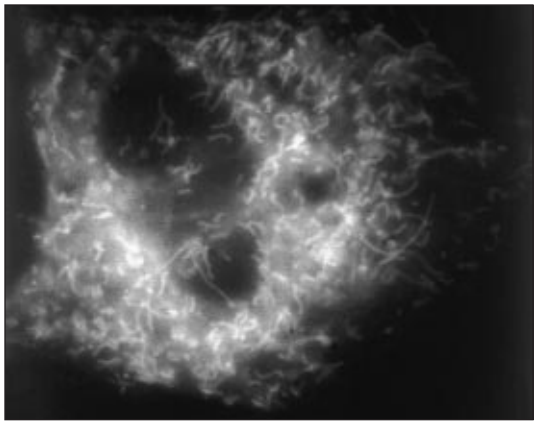
- High sensitivity image acquisition at the video rate
- High resolution
- On-Chip Integration
- Clear image of fluorescence that's normally difficult to observe with the naked eye
- Compact, lightweight design
- Proximity ICCD eliminates image distortion and lag
- High speed shutter function 1 μs
- Ultraviolet sensitivity
- Spectral response characteristics (See Page 18)

Applications

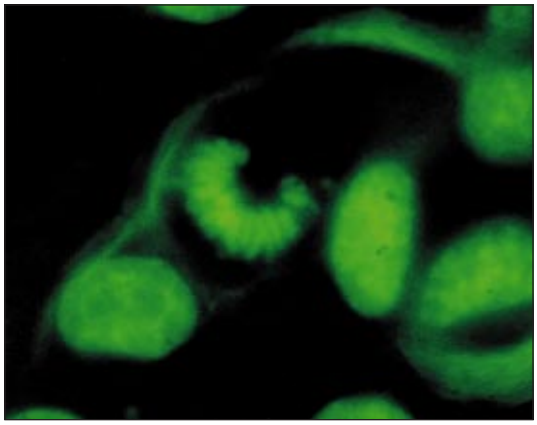
- Observation of fluorescence-stained samples
- Fluorescent antibody technique
- DNA cytometry
- Stationary sample observation

System Configuration

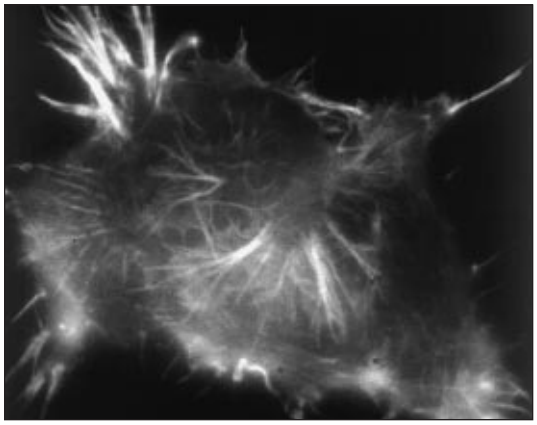




▲ Mitochondria of neuronal cell line NG108-15 stained specifically with Mitotracker (objective 100X)



▲ Nucleic acid of neuronal cell line NG108-15 stained specifically with acridine orange (objective 60X)



▲ Actin of neuronal cell line NG108-15 stained specifically with FITC phalloidine (objective 100X)

Realtime Fluorescence Observation

ICCD Camera: C2400-87, -87V, -97, -97V

Image Intensifier
High Sensitivity
Low Lag

Fluorescence observation of rapid kinetic change, low-light samples



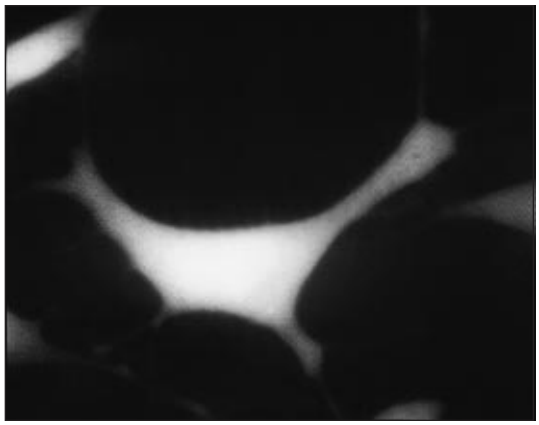
A built-in image intensifier (I.I.) provides enhanced sensitivity, and reduced lag makes these cameras suitable for observing samples that show rapid kinetic change in fluorescence intensity. The C2400-87V/-97V have sensitivity of wavelength range of **350 nm to 650 nm**, and C2400-87/97 **350 nm to 800 nm**. Two configurations are available: the multi-functional C2400-97 and the C2400-87 (without CCD camera control unit).

Features

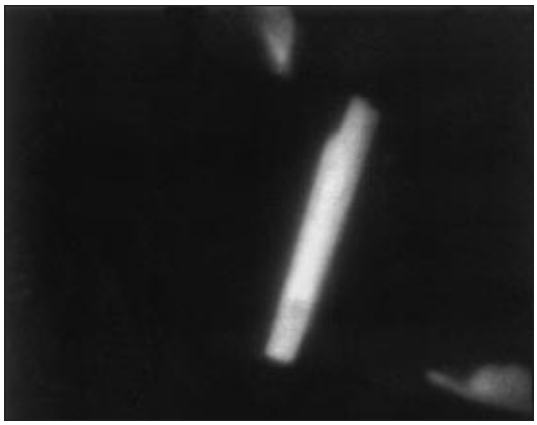
- **Suitable for observation of rapid kinetic change by low lag and no distortion.**
- **High sensitivity, surpassing that of silicon intensified tube cameras**
- **Built-in protection circuitry againt excessive light**
- **Read-out CCD camera can be used alone**
- **Spectral Response characteristics: (See Page 18)**

Applications

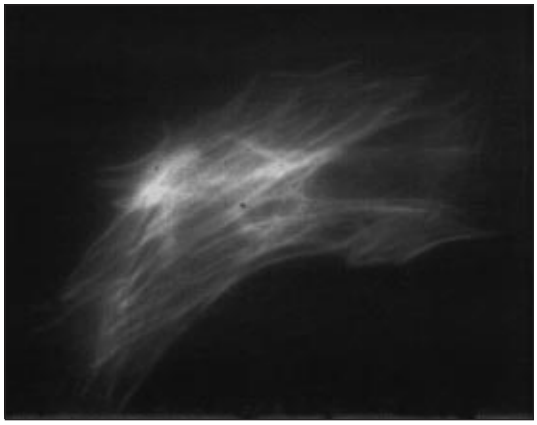
- **Observation of fluorescence-stained samples**
- **Observation of test samples that show rapid kinetic change of fluorescence intensity**
- **Fluorescence photobleaching recovery**
- **Fluorescent antibody technique**
- **DNA cytometry**
- **Intracellular ion concentration measurements (Ca^{2+}, pH, etc.)**
- **Measurement of kinetic changes in fluorescence intensity over time**



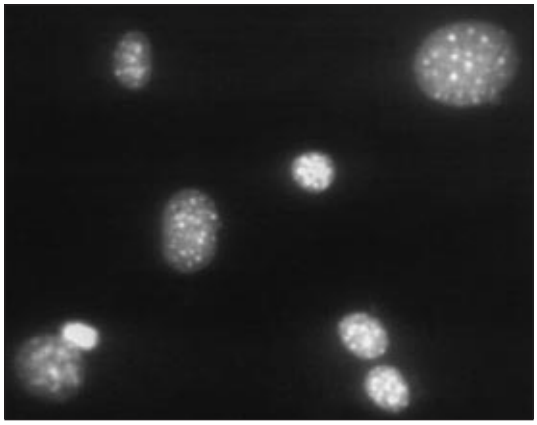
▲ Fluorescence image of fibroblast stained with BCECF using C2400-87 and fluorescence microscope



▲ Fluorescence image of ventricular myocyte (cardiac mustle cell) stained with Indo-1 using C2400-87 and fluorescence microscope (photo courtesy of Prof.Yamazaki and Dr.Hayashi of Hamamatsu Unversity School of medicine, Japan)



▲ Fluorescence image of stained actin using C2400-87 and fluorescence microscope



▲ Fluorescence image of stained nuclei using C2400-87 and fluorescence microscope

VIM Camera: C2400-35, -47

Observation of low light level chemiluminescence and bioluminescence

Image Intensifier
Single Photon Counting



Beside ATP, Ca^{2+}, and active oxygen measurement, luciferin, aequorin, luminol and other luminous reagents are gaining attention as new replacements for radioisotopes as labelling probes for immuno assay.
The C2400-35/-47 are designed for observation of low light level luminescence and fluorescence images, normally invisible to the naked eye. Used together with an optionally available image processor unit (ARGUS-20), these cameras can be used for photon counting imaging. The C2400-35 consists of an image intensifier including a 1-stage MCP and CCD Camera. The C2400-47 consists of an image intensifier including 2-stage MCP and CCD Camera. The above photograph shows the C2400-47.

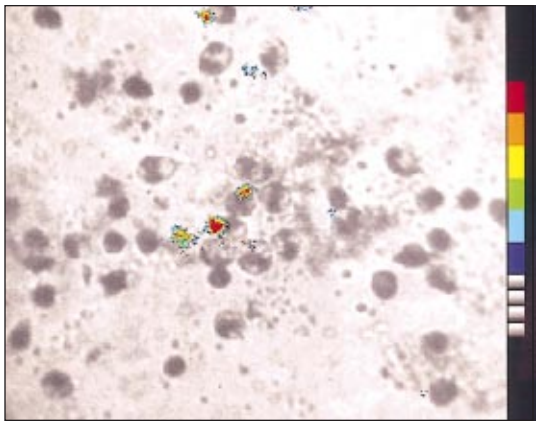
Features

- Low light level observations, down to single photon counting range
- Selectable camera heads based on light level and wavelength
- Built-in protection circuitry againt excessive light
- High spatial resolution (370TV lines : Typical horizontal center resdution)
- Spectral Response characteristics (See Page 19)

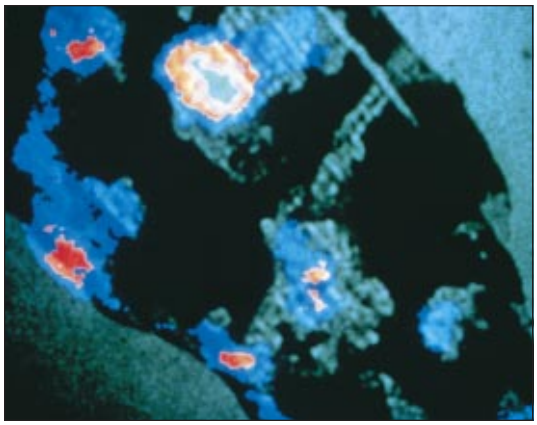
Applications

- ATP measurement using luciferin and luciferase
- Active oxygen measurement using luminol
- Ca^{2+} measurement using aequorin
- Luminescent immunoassay
- Detection of gene expression using luciferase
- Colony screening
- Detection of gels and blots
- Enzyme immunoassay
- Phagocytosis
- DNA hybridization

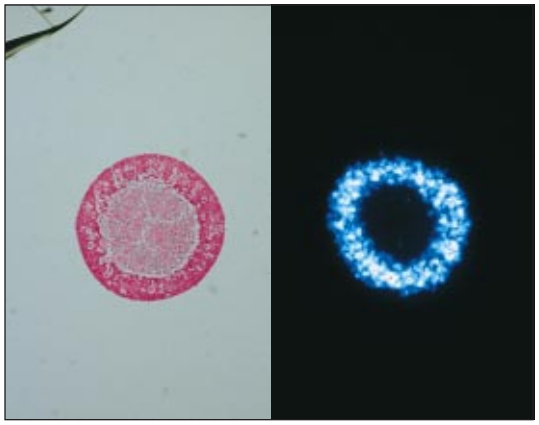
* Quantitative analysis of luminescence and photon counting imaging require an optional image processor. (ARGUS-20)



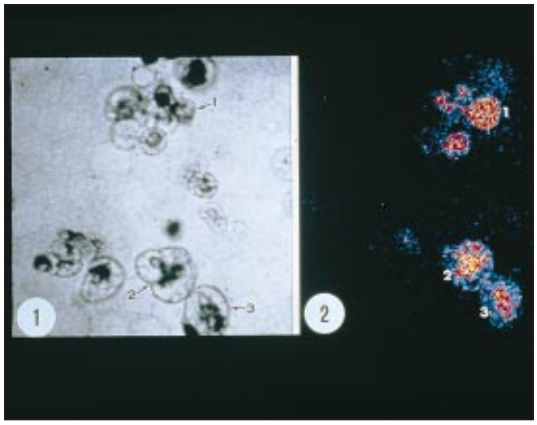
▲ Luminol chemiluminescence by active oxygen in white blood cells, obtained using C2400-47 equivalent, ARGUS-100 and microscope. (photo courtesy of Professor Tsuchiya and Dr. Suematsu of Keio University School of Medicine, Japan)



▲ ATP distribution in a tumortissace detected by luciferin-luciferase luminescence (colored positions are luminescence) (photo courtesy of Prof. Dr. Streffer, University Essen, Germany)



▲ ATP distribution by luciferin luminescence, obtained using C2400-47 equivalent, ARGUS-100, and microscope.
Left: transmitted image; Right: luminescence image (photo courtesy of Dr. W. Müller-Klieser, Univeristat Mainz, Germany)



▲ Detection of gene expression by luciferin luminescence, obtained using C2400-47 equivalent
Left: transmitted image; Right: luminescence image (photo courtesy of Dr. W. J. Lucas, Department of Botany, University of California, U.S.A.)

Bright Field Observation

CCD Cameras: C2400-75, -77, -79

High-quality, high-resolution bright field observation

Compact Light Weight

No Distortion



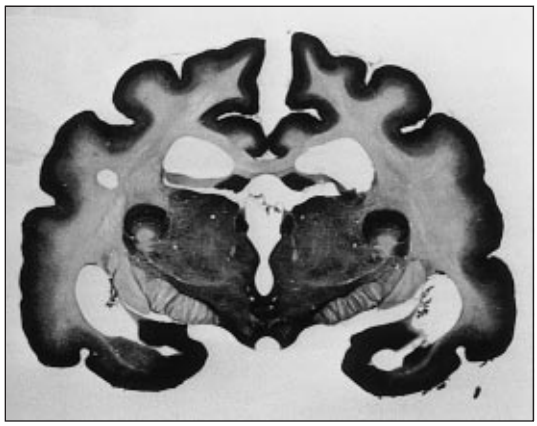
The C2400-75/-77 are CCD cameras for bright field image analysis. (C2400-75 1/2 inch CCD and -77 2/3 inch CCD.)
The C2400-79 is ideal for near-infrared range observation by its spectral response from 400nm to 1200nm (800nm peak). Since light in the near-infrared range passes easily through organisms, this camera can be used to observe phenomena deep inside a tissue.
These compact, lightweight cameras are perfect for observing dynamic specimens. Built-in contrast enhancement and detail enhancement make images clearer and easier to view.
(The Sync. system of C2400-79 is EIA only. For CCIR Sync. system the scan converter (EIA to CCIR) is used.)

Features

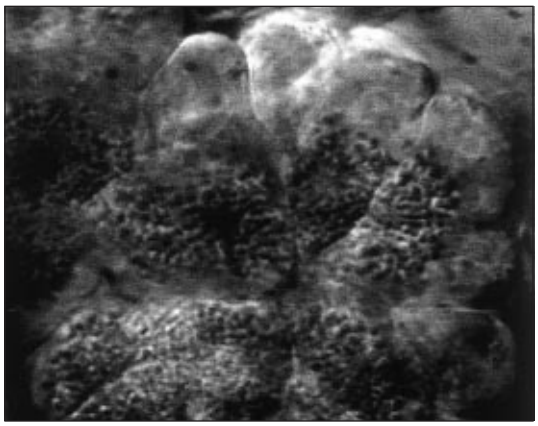
- **Compact, lightweight design**
- **Suitable for observation of rapid kinetic change by low lag and no distortion.**
- **Image quality improvement and image processing functions built-in**
- **Used in combination with the ARGUS-20 provides real-time image quality improvement and personal computer connectivity**
- **Spectral Response characteristics (See Page 19)**

Applications

- **Observation of cells and tissue using phase contrast and differential interference**
- **Observation of dynamic samples**
- **Micromanipulation monitoring**
- **Densitometry (stained specimen, RI film, etc.)**
- **Observation of phenomena deep inside a tissue slices using near-infrared (IR-DIC) (C2400-79).**
- **Tissue slice micromanipulation monitoring**



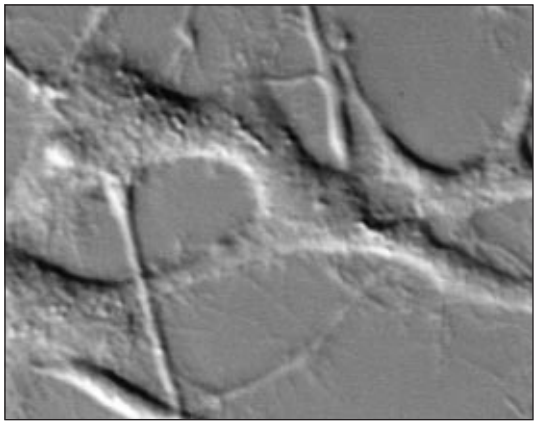
▲ Stained brain slice, obtained using C2400-77 and light box. (photo courtesy of Dr. Uemura and Dr. Shimoyama, of Hamamatsu University School of Medicine, Japan)



▲ Rat pancreas acinus cell
(photo courtesy of Dr.Sakurai, Photon Medical Research Center of Hamamatsu University School of medicine, Japan)



▲ Observation of rat hippocampus CA1 pyramidal cell slice (thick:300 um, depth:50 um) using near-infrared differential interference microscope (objective:60X) and C2400-79.
(photos courtesy of Dr.Kudo and Dr.Miyagawa, Seitaikouji the school of life suience Tokyo University pharmacy and life science Tokyo Pharmaceutical Uni.)



▲ Observation of granule migration in cultured projection by high magnification differential interferance using objective(60X) and relay lens(16X)
(specimen: neuronal cell line NG108-15)

Bright Field Observation

Tube Cameras: C2400-01, -02, -03, -05, -06, -07

High Resolution
High Sensitivity

High-quality, high-resolution bright field observation



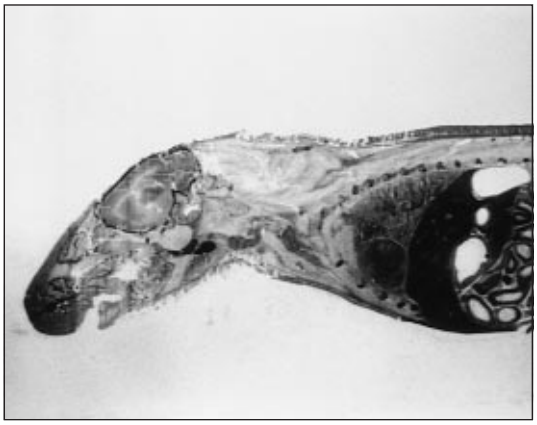
High-resolution tube and contrast enhancement provide images of low contrast samples normally difficult to observe without staining.
A variety of camera heads is available from UV to IR, low lag, high sensitivity, etc.

Features

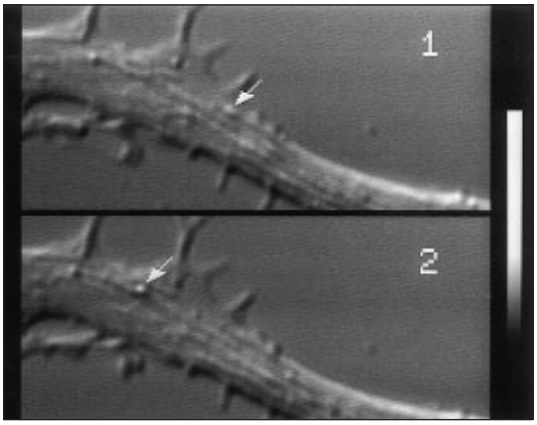
- Contrast enhancement circuit dramatically improves low-contrast images
- Wide selection of camera heads to meet needs from ultraviolet to infrared, low lag, high sensitivity, etc.
- High resolution (more than 700 TV lines horizontal center resolution)
- Spectral response characteristics (See Page 18)

Applications

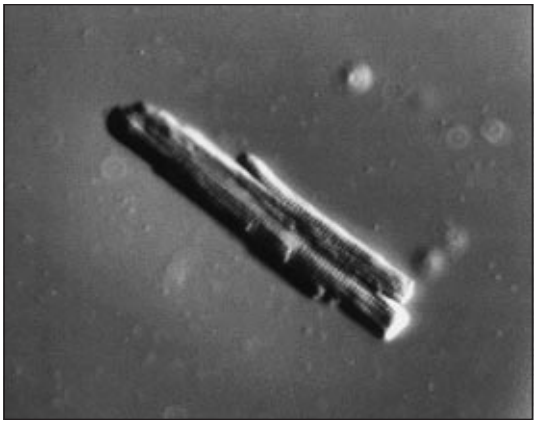
- Observation of cells and tissue using phase contrast and differential interference
- Observation of intracellular granules and fibers
- Micromanipulation monitoring
- Densitometry (stained specimen, RI film, etc.)



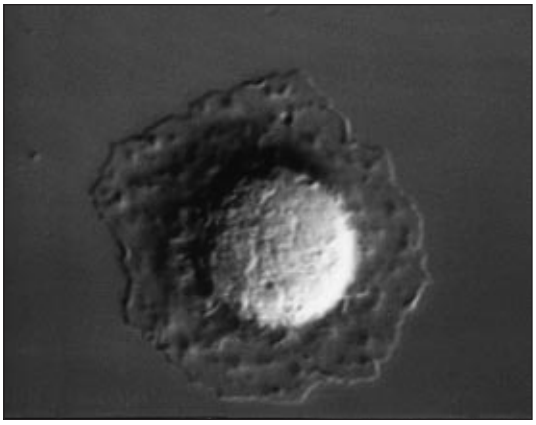
▲ Film exposed by radio isotope, obtained using C2400-07 and light box.



▲ Granule migrating through the axon, obtained using C2400-01 and a differential interference microscope. Numerals and arrows input by optional image processor. (photo courtesy of Professor Takenaka, Dr. Kawakami, and Dr. Hikawa of Yokohama City University, Japan)



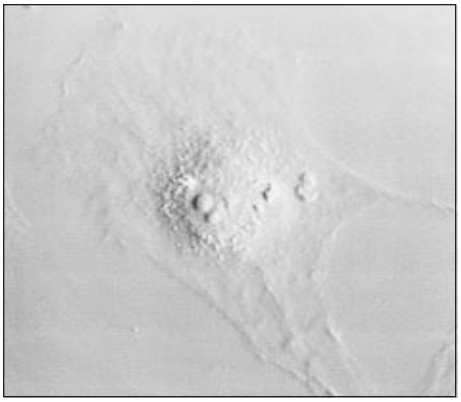
▲ Ventricular myocyte, obtained using C2400-07 and differential interference microscope. (photo courtesy of Dr. Yamazaki and Dr. Hayashi of Hamamatsu University School of Medicine, Japan)



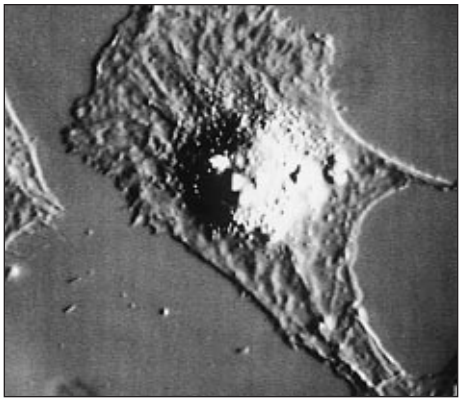
▲ Macrophage, obtained using C2400-07 and differential microscope.

Functions of C2400 Camera Series

● Contrast Enhancement



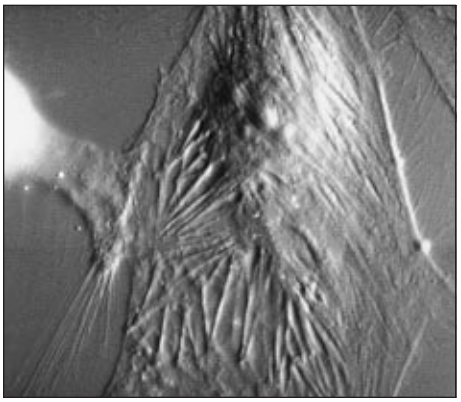
▲Original image



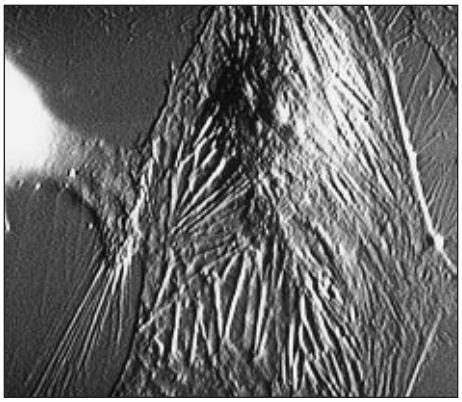
▲Image after contrast enhancement

This function enhances low contrast images to be visualized more clearly.

● Detail



▲Original image



▲Image after outline highlight

This function enhances edges and intensity transitions, dramatically improving the ability to see image detail.

● Automatic Gain Control

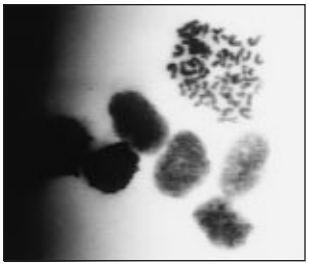
Excellent overall image contrast can be achieved automatically using this feature. This eliminates the need for manual adjustments in situations where light intensity fluctuates over time.

● Level Indicators

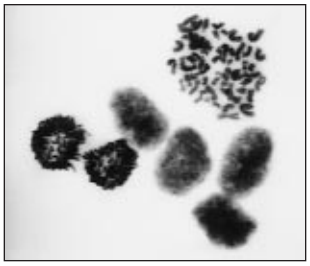
Green and red LED indicators allow the user to easily and accurately adjust the level of incident light for reproducible and optimum camera performance.

● Shading Corrector

This function corrects for uneven intensity across the field of view due to illumination or optical phenomena.



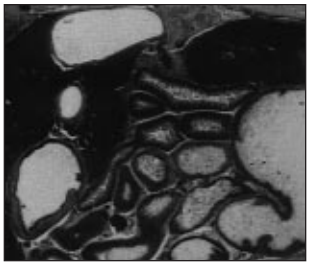
▲Original image



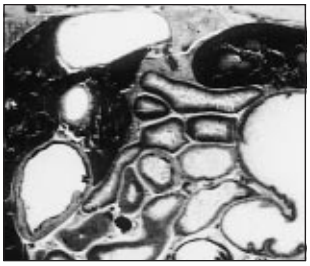
▲Image after shading correction

● Video Booster

The video booster modifies the contrast in dark portions of the image revealing details which were lost due to their low intensity.



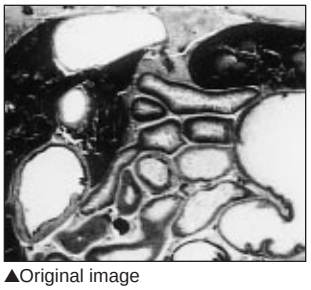
▲Original image



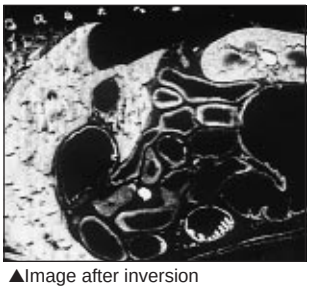
▲Image after contrast boosting

● Video Inverter

This produces a negative image by inverting the video intensity values. It is used when important information is concentrated in the dark portions of the image, rather than in the bright areas. Combining the use of the inverter with the contrast enhancement circuit is very effective.



▲Original image



▲Image after inversion

● Video Tube Protection
A protection circuit has been incorporated to prevent damage to the imaging tube, should the horizontal or vertical syncronization signals be lost.

● Overload Protection
All intensified cameras have a built-in protection circuit to prevent damage in the event the camera is exposed to excessive light.

● External Synchronization Control
When utilizing external equipment, it may be necessary to synchronize the scanning of the camera via this equipment. This circuit automatically switches from internal to external synchronization when external horizontal and vertical signals are provided.

● White Clipper
The white clipper operates to suppress the level of the video signal when it exceeds a preset level, in order to maintain consistently high image quality on the video monitors.

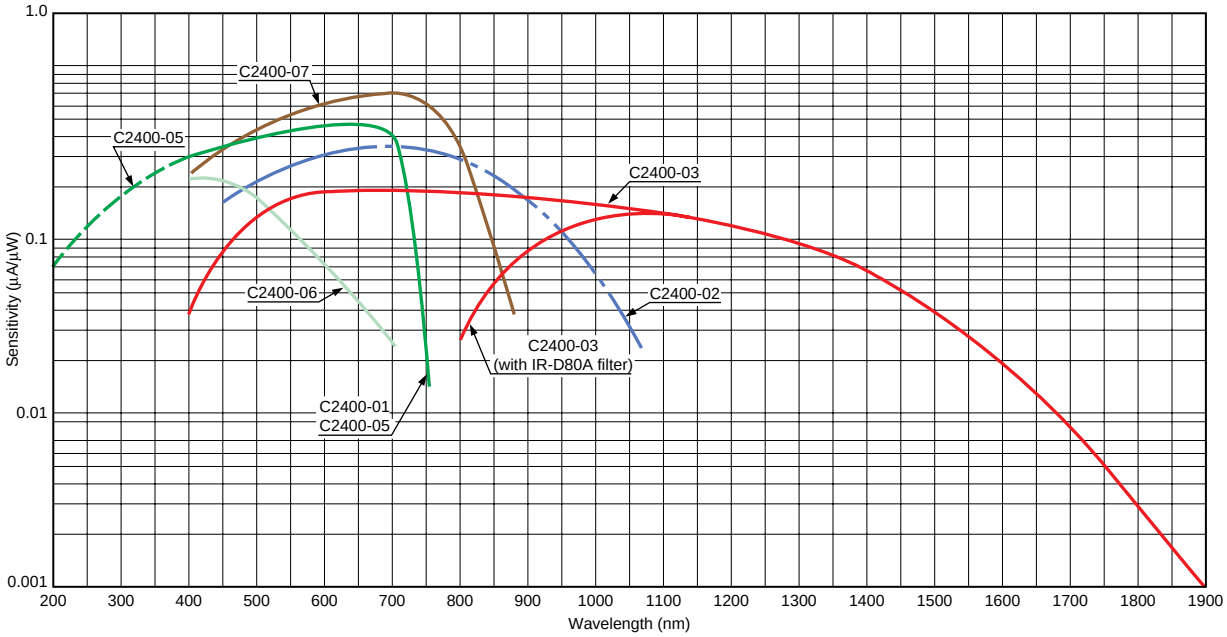
● Operational Video Output
External processing of video signals is simplified by the Operational Video Output. Operational video does not include synchronization signals so it can be used to display DC signals with black level as 0 volts.

Model	Image Pick-up Devide	Contrast Enhancement	Detail Enhancement	Automatic Gain Control	Level Indicator	Shading Corrector	Video Booster	Video Inverter	Tube Protection	Overload Protection	External Synchronization Control	White Clipper	Operational Video Output
C2400-01	Chalnicon	●	–	●	●	●	●	●	●	–	▲	●	▲
C2400-02	Silicon Vidicon												
C2400-03	Infrared Vidicon												
C2400-05	Ultraviolet Vidicon												
C2400-06	Saticon												
C2400-07	Newvicon												
C2400-75	CCD (1/2")	●	●	●	●	●	●	●	–	–	●	●	▲
C2400-77	CCD (2/3")												
C2400-79	NIR-CCD (2/3")												
C2400-08	SIT	●	–	●	●	●	●	●	●	●	▲	●	▲
C2400-87, -87V	I.I. + CCD	–	–	●	–	–	–	–	–	●	●	–	–
C2400-89, -89V	I.I. + CCD												
C2400-97, -97V	I.I. + CCD	●	●	●	●	●	●	●	–	●	●	●	–
C2400-35	I.I. + CCD (PI-CCD)	–	–	●	–	–	–	–	–	●	●	●	–
C2400-47	I.I. + CCD (VIM)												

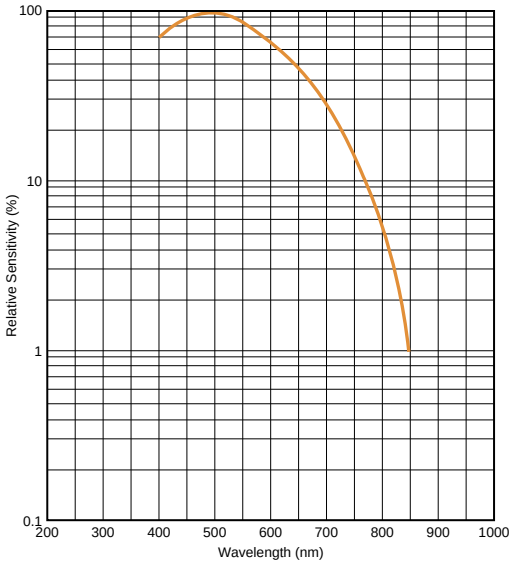
● : Standard equipment ▲ : Optional

Spectral Response Characteristics of C2400 Camera Series and C5985 Series

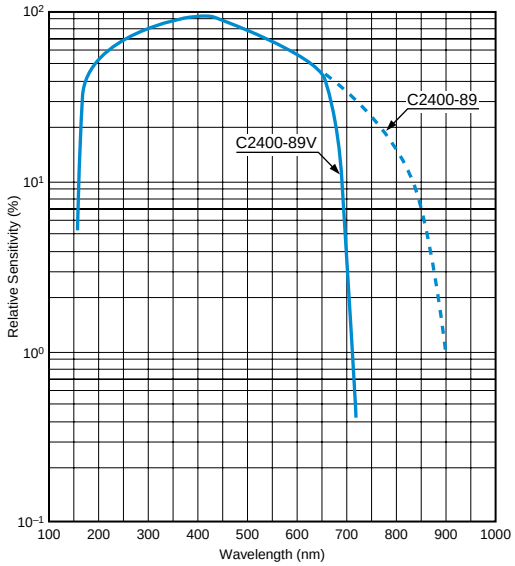
● **C2400-01, -02, -03, -04, -05, -06, -07**



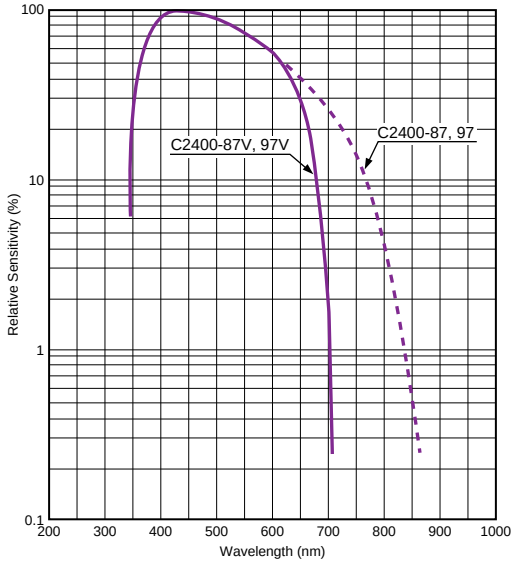
● **C2400-08 (SIT)**



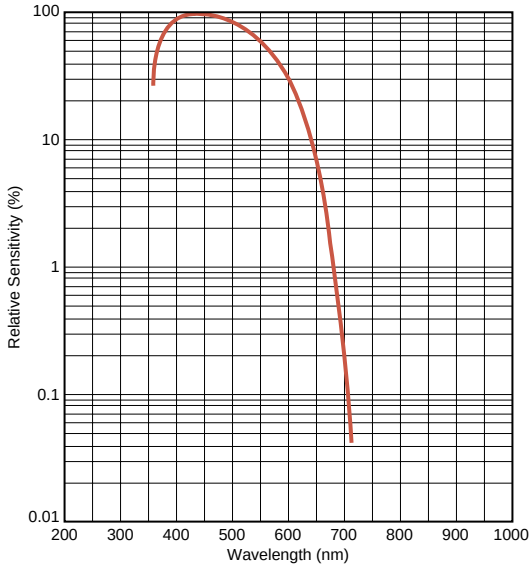
● **C2400-89 (ICCD)**



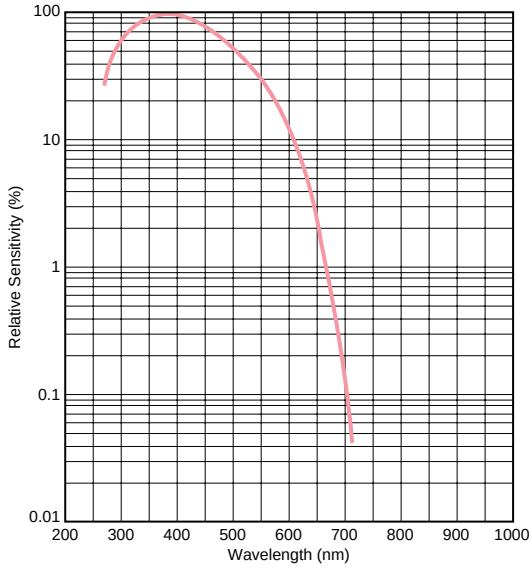
● **C2400-87, -97 (ICCD)**



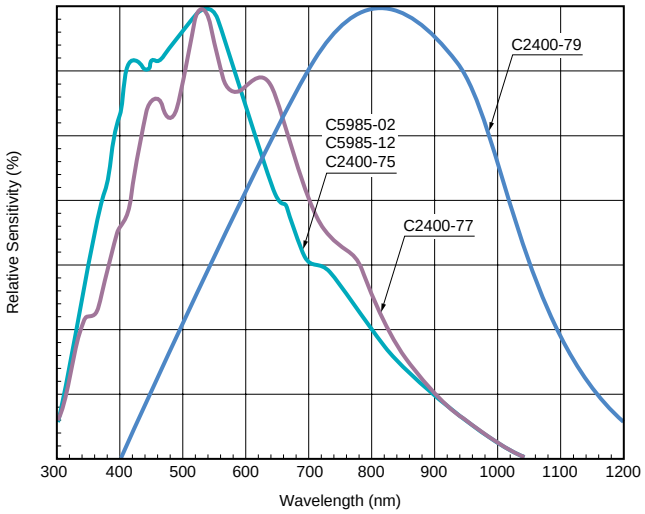
● **C2400-35 (PI-CCD)**



● **C2400-47 (VIM)**

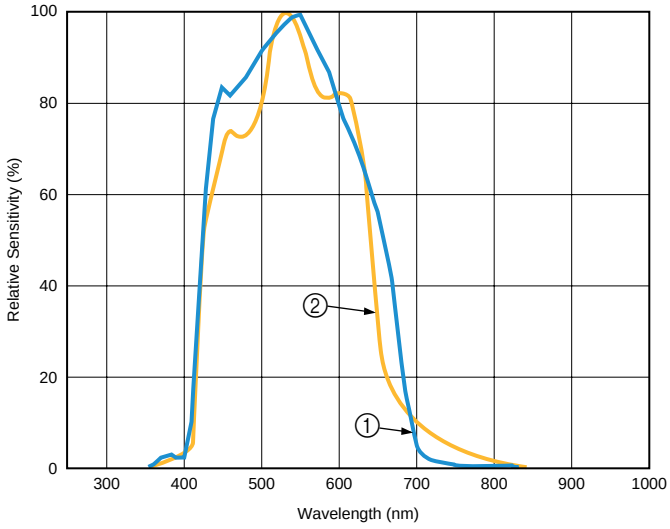


● **C2400-75, 77, 79, C5985-02, C5985-12**



* Each profile is normalized at the peak point.

● **C2400-75, 77, C2400-75i, C5985, C5985-10**



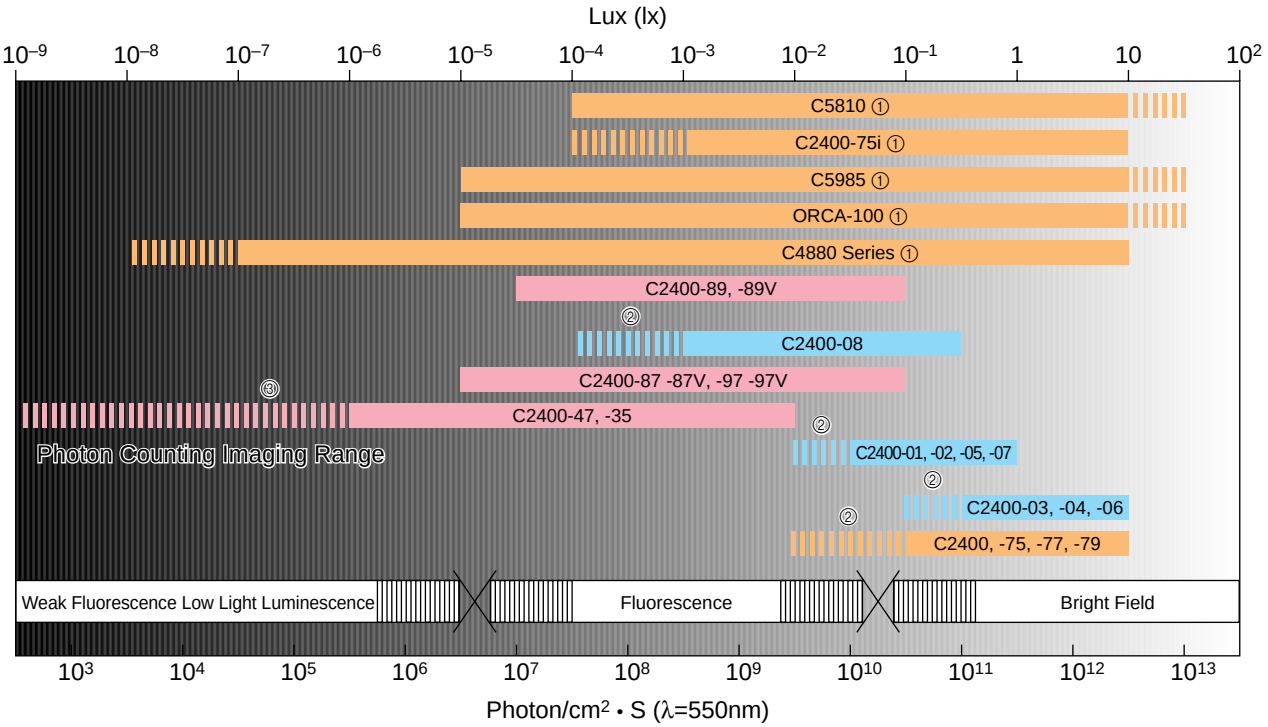
• An infrared cut filter is supplied as standard.
① C2400-75, C2400-75i, C5985, C5985-10
② C2400-77
* Each profile is normalized at the peak point.

Performance Comparisons of All Camera

Model	Product Name	Main Application	Features	Spectral response Typ.(nm)	Horizontal Center Resolution Typ. (TV lines)	Gemetric Distor-tion Max (% within in-scribed circle)	Shading Max. (% within in-scribed circle) ❷	Lag Typ. (%) ❸	Gamma Typ.	S/N Min CB (p–p/r.m.s) ❺	Camera Control Interface	Image Data Transfer Interface	Micro-scope Attach-ment
C5810	Color Chilled 3-CCD Camera	Multiple fluorescence image observation, FISH	Simul tinuous observation of multiple fluorescence	400 to 700	700						SCSI		1/2 Bayonet mount
C2400-75i +ARGUS-20	On-chip integration Camera	General fluores-cence image observation,	Compact, Lightweight, Non-cooled on-chip integration type.	400 to 700	570					56 (54)	SCSI	SCSI	
C5985 C5985-10	B/W Chilled CCD Camera	General fluores-cence image observation, FISH	Cooled on chip integration type.	400 to 700	570						SCSI RS–232C		
C5985-02 C5985-12				300 to 1000									
ORCA-100	Cooled Digital Camera		High resolution of 1.3 million pixels, Progressive interline scan CCD type	300 to 800	1280 × 1024 ❻	–	–	–		60	Conforms to RS–232C	Dedicated Digital I/F (Conforms to RS–442)	
C4880-10	Dual modes Cooled CCD Camera	FISH, General fluorescence image observation, Luminescence blotting	High sensitivity, Wide dynamic range, Ultraviolet sensitivity.	200 to 1000	1000 × 1018 ❻					–	Conforms to RS–232C	Dedicated Digital I/F (Conforms to RS–442)	
C4880-30				300 to 800	1280 × 1024 ❻								
C4880-40				200 to 1100	512 × 512 ❻				1.0				
C4880-81	Fast Scan Multi Format Cooled CCD Camera	High-speed fluorescence imageing and calcium-ion imaging	Maximum frame rate of up to approximately 500 frames/sec	300 to 900	656 × 434 ❻					70	Conforms to RS–232C	Dedicated Digital I/F (Conforms to RS–442)	
C2400-08	SIT Camera	Real-time fluorescence observation, Calcium-ion imaging	High resolution (500TV lines of horizontal center resolution)	400 to 850	500	± 3.0	20	7		48	–	–	C mount
C2400-89V	Proximity ICCD Camera		Proximity ICCD eliminates image distortion and low lag, Ultraviolet sensitivity	180 to 650	420			–		56	RS–232C		
C2400-89				180 to 850									
C2400-87V	ICCD Camera		High-sensitivity, Suitable for observation of rapid kinetic change by low lag and no distortion	350 to 650	450		–	3		52			
C2400-87				350 to 800									
C2400-97V				350 to 650									
C24000-97V				350 to 800									
C2400-35	PI-CCD Camera	Chemiluminescence, Bioluminescence (Photon counting imaging is possible)	High spatial resolution, Low geometric distortion, ❹	360 to 650	370	± 1.0		–		–			
C2400-47	VIM Camera		High efficiency photon counting rate ❹	280 to 650	300			3		–			
C2400-01	Chalnicon	Phase contrast, Differential interference contrast microscopy	General microscopic observation	400 to 700	700		10	20	0.95	50	–	–	
C2400-02	Silicon Vidicon		Visible to near infrared(1100nm)	400 to 1050	600		10	12	1.0	50			
C2400-03	Infrared Vidicon		Visible to infrared(1800nm)	400 to 1800	600	± 2.0	20	60	0.6	46			
C2400-05	UV Chalnicon		UV(200nm) to visible	200 to 750	700		10	20	0.95	50			
C2400-06	Saticon		Observation of bright and fast moving object	400 to 700	750	± 1.0	10	3	0.95	50			
C2400-07	Newvicon		General microscopic observation	400 to 800	700		10	20		50			
C2400-75	CCD Camera (1/2")		Compact and light weight, Observation of bright and fast moving objects	400 to 920 ❶	570	–	–	–	1.0	56 (54)	RS–232C		
C2400-77	CCD Camera (2/3")		Compact and light weight, Observation of bright and fast moving objects	400 to 920 ❶	570					52 (50)			
C2400-79	IR-CCD Camera (2/3")		Compact and light weight, Observation of NIR image	400 to 1200	570					57			

❶ Values when the infrared cut filter is removed.
❷ Corrected by optional shading corrector.
❸ After 50 ms
❹ Photocounting imaging requires optional image processor.
❺ Values inside ( ) are for CCIR.
❻ Valuse are image pixels of CCD not real resolution.

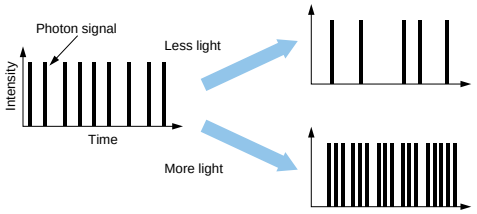
[Sensitivity Comparison chart]

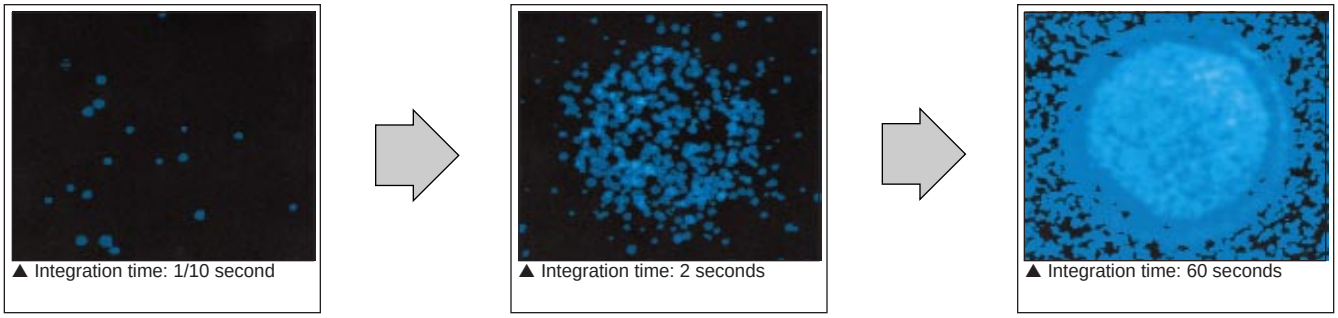


① Depends on charge integration time on CCD.
② Analog contrast enhanced imaging
③ Photon counting imaging (required image processor)

[Photon Counting Imaging] (using ARGUS-20 image processor)

Photon counting imaging is a technique for the visualization of light levels too low to be imaged using ordinary high sensitivity video cameras. At extremely low levels, the photon flux per unit area becomes so low that the scene being imaged no longer appears continuous.
Instead, it is represented by individual photons which are both temporally and spatially distinct from one another. Viewed on a monitor, such an image appears as scintillating points of light, each point representing a single detect photon. By accumulating these detected photons in a digital processor over time, an image can be acquired. In contrast to conventional cameras where the signal at each image point is assigned an intensity value, in photon counting imaging the amplitude of the signal carries no significance. The objective is to simply detect the presence of a signal (photon) and counting these with respect to their position over time.





▲ Integration time: 1/10 second

▲ Integration time: 2 seconds

▲ Integration time: 60 seconds

Glossary of Terms

● Resolution
The resolution is a measure of the maximum ability of a video camera to delineate picture details. It is expressed as the maximum number of TV lines that can be discerned when a white/black stripe pattern is viewed by the camera. The white/black lines are counted separately.

● S/N ratio
A comparison of the video signal component and the noise component that is mixed in. S/N ratio is usually shown in dB.

● Shading
Non-uniformity of video output signal when a video camera views a uniform source. It is expressed as the difference between the brightest and darkest signals divided by the brightest signal and multiplied by 100%. Shading is mainly caused by non-uniform sensitivity of an image tube surface.

● Lag
A phenomenon caused when some of the output signal lingers even after the incident light was interrupted. For video cameras, this means output signal delay in response to the change of incident light.

● Gamma characteristic
This is the relationship between the signal output and the incident light. On a logarithmic graph, the former is shown on the vertical axis and the latter on the horizontal axis; the gamma characteristic is the slope (tangent) of the resulting straight line.

● Geometric distortion
This is the difference (distortion) between the subject and the image of the subject shown on the screen. Expressed as a percentage to the vertical height of the screen.

Specification Comparisons of All Cameras

Model	Pickup device	Sync. System	Effective number of scanning lines	Inter-lace ratio	Aspect ratio (hori-zontal : vertical)	Cell size (μm)	Effective number of pixels	Effective scanned area (mm)	Image memory		A/D con-verter
									High resolution mode	Standard resolution mode	
C5810-01	1/2-inch Interline type 3-chip CCD	NTSC	483	2:1	4:3	8.4 × 9.8	756(H) × 485(V)	6.3(H) × 4.7(V)	1024(H) × 483(V) × 8bit(D) × 2	640(H) × 483(V) × 8bit(D) × 2	8bit
C5810-11		PAL	573			8.6 × 8.3	739(H) × 575(V)		992(H) × 509(V) × 8bit(D) × 2	739(H) × 509(V) × 8bit(D) × 2	
C2400-75i + ARGUS-20	1/2-inch Interline type CCD	EIA	483			8.4 × 9.8	756(H) × 485(V)	6.3(H) × 4.7(V)	1024(H) × 483(V) × 16bit(D) × 2	640(H) × 483(V) × 16bit(D) × 2	
		CCIR	573			8.6 × 8.3	739(H) × 575(V)		1024(H) × 509(V) × 16bit(D) × 2	640(H) × 509(V) × 16bit(D) × 2	
C5985, -02	1/2-inch Interline type CCD	EIA	483			8.4 × 9.8	756(H) × 485(V)	6.3(H) × 4.7(V)	756(H) × 483(V) × 8bit(D) × 2		
C5985-10, -12		CCIR	573			8.6 × 8.3	739(H) × 575(V)		739(H) × 509(V) × 8bit(D) × 2		
ORCA-100	Progressive scan interline CCD	–		1:1		6.7 × 6.7	1280(H) × 1024(V)	8.56(H) × 6.86(V)	1280(H) × 1024(V) × 16bit(D)		10bit
C4880-10	Full frame transfer type CCD				1:1	12 × 12	1000(H) × 1018(V)	12.0(H) × 12.2(V)	1000(H) × 1018(V) × 16bit(D)		14bit
C4880-10											
C4880-30	Full frame transfer type CCD					24 × 24	512(H) × 512(V)	12.2(H) × 12.2(V)	512(H) × 512(V) × 16bit(D)		12bit
C4880-40	Progressive scan interline CCD				4:3	6.7 × 6.7	1280(H) × 1024(V)	8.56(H) × 6.86(V)	1280(H) × 1018(V) × 16bit(D)		14bit
C4880-81	Progressive scan interline CCD					9.9 × 9.9	659(H) × 494(V)	6.52(H) × 4.89(V)	659(H) × 494(V) × 16bit(D)		12bit/ 10bit *
C2400-08	Silicon intensified tube	EIA	487	2:1		–	–	12.7(H) × 9.5(V)	–		–
		CCIR	575								
C2400-89, 89V	Proximity type image intersifier	EIA	483				756(H) × 485(V)	12.8(H) × 9.6(V)			
		CCIR	573				739(H) × 575(V)				
C2400-87,-87V C2400-97,-97V	Inverter type image intensifier	EIA	483				756(H) × 485(V)	13.4(H) × 10.3(V)			
		CCIR	573				739(H) × 575(V)	13.0(H) × 10.1(V)			
C2400-35	Inverter type 1-stage MCP image intensifier	EIA	483				756(H) × 485(V)	12.7(H) × 9.5(V)			
		CCIR	573				739(H) × 575(V)				
C2400-47	Inverter type 2-stage MCP image intensifier	EIA	483				756(H) × 485(V)	13.4(H) × 10.3(V)			
		CCIR	573				739(H) × 575(V)	13.0(H) × 10.1(V)			
C2400-01	Chalnicon Tube	EIA	487		4:3	–	–	12.7(H) × 9.5(V)			
		CCIR	575								
C2400-02	Silicon Vidicon Tube	EIA	478								
		CCIR	575								
C2400-03	Infrared Vidicon Tube	EIA	487								
		CCIR	575								
C2400-05	UV Chalnicon Tube	EIA	487								
		CCIR	575								
C2400-06	Saticon Tube	EIA	487								
		CCIR	575								
C2400-07	Newvicon Tube	EIA	487								
		CCIR	575								
C2400-75	1/2-inch interline type CCD	EIA	483			8.4 × 9.8	756(H) × 485(V)	6.3(H) × 4.7(V)			
		CCIR	573			8.6 × 8.3	739(H) × 575(V)				
C2400-77	2/3-inch interline type CCD	EIA	483			11.0 × 13.0	756(H) × 485(V)	8.3(H) × 6.3(V)			
		CCIR	573			11.0 × 11.0	739(H) × 575	8.1(H) × 6.3(V)			
C2400-79	2/3-inch frame transfer type CCD	EIA	483			8.8 × 6.6	754(H) × 484	8.8(H) × 6.6(V)			

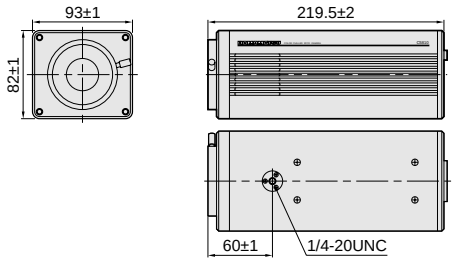
* 12bit : High-precision scan mode
10bit : Fast scan mode

Maximum Frame rate	Maximum Exposure time	Cooling method	Cooling temperature	Video output signal	Operating temperature	Operatine storage humidity	Line voltage	Power comsumption	Model
–	60sec	Peltier +Fan air radiation system	Cools the CCD element to 20 °C less than the ambient temperature	RGB + SYNC composite video, Y/C(S video	0 to 40°C	70 % max. (no conden-sation)	AC90 to 130V 50/60Hz	Approx. 80VA	**C5810-01**
							AC180 to 250V 50/60Hz		**C5810-11**
	Controled with ARGUS-20	–	–	Composite video signal 1 Vp-p/75ohm			AC100/117/220/ 240 V 50/60Hz	Approx. 200VA	**C2400-75i + ARGUS-20**
	300sec	Peltier +Fan air radiation system	Cools the CCD element to 10 °C less than the ambient temperature				AC90 to 130V 50/60Hz	Approx. 60VA	**C5985, -02**
							AC180 to 250V 50/60Hz		**C5985-10, -12**
18 frame/sec (with 2 × 2 binning)	10sec	Petier +Fan air radiation system	Cools the CCD element to 15 °C less than the ambient temperature	RS-422A/16 bit parallel output			AC 100/117 /220/ 240 V 50/60Hz	Approx. 70VA	**ORCA-100**
7 frame/sec (Fast scan mode)	–	Heretic vacuum sealed Paltier water-cooled	-40 °C					Approx. 220VA	**C4880-10**
	–	Heretic vacuum sealed Peltier air-cooled	-30 °C						**C4880-10**
2.3 frame/sec	–	Heretic vacuum sealed Paltier water-cooled	-40 °C to -50 °C					Approx. 220VA	**C4880-30**
5.4 frame/sec	–	Heretic vacuum sealed Peltier air-cooled	-40 °C to -50 °C					Approx. 200VA	**C4880-40**
See page 9	–	Peltier +Fan air radiation system	Cools the CCD element to 20 °C less than the ambient temperature					Approx. 115VA	**C4880-81**
• 30 frame/sec (EIA) • 25 frame/sec (CCIR)	–	–	–	Composite video signal				Approx. 80VA	**C2400-08**
								Approx. 30VA	**C2400-89, 89V**
								Approx. 50VA (C2400-97)	**C2400-87,-87V C2400-97,-97V**
									C2400-35
									C2400-47
								Approx. 80VA	**C2400-01**
									C2400-02
									C2400-03
									C2400-05
									C2400-06
									C2400-07
								Approx. 20VA	**C2400-75**
									C2400-77
									C2400-79

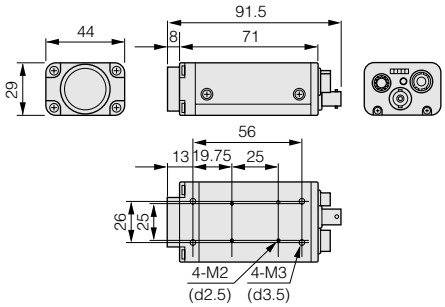
Dimensional Outline (unit: mm)

Camera Head

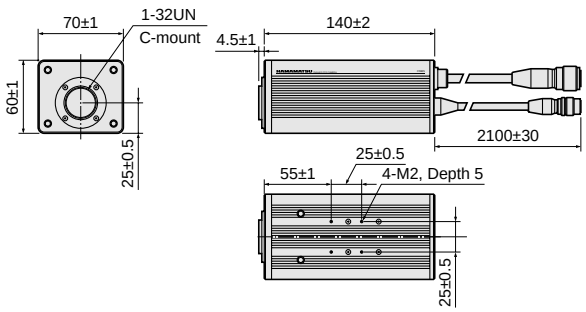
• C5810 (approx. 1.6 kg)



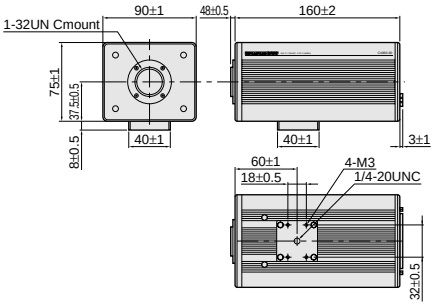
• C2400-75, -75i (approx. 140g)



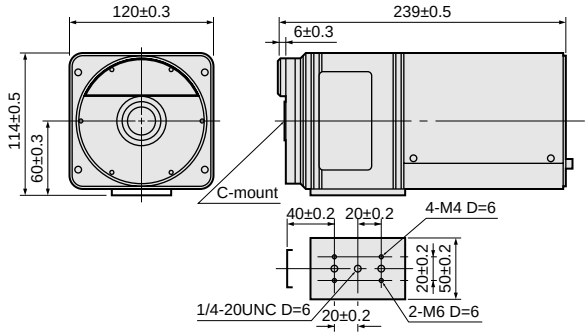
• C5985 (approx. 1.2 kg)



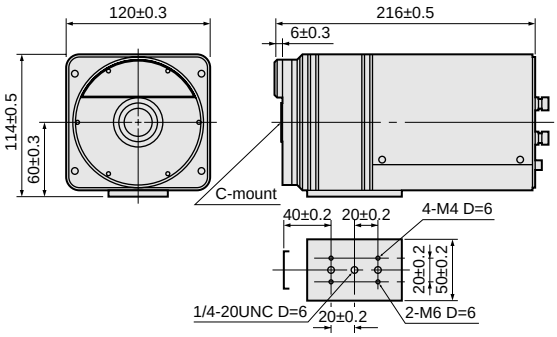
• ORCA-100 (approx. 1.3 kg)



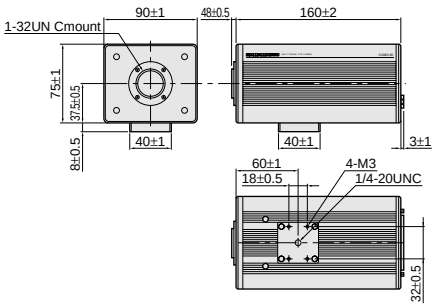
• C4880-07, -97 (approx. 2.5 kg)



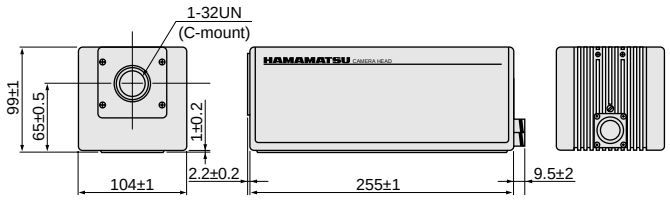
• C4880-17, -71 (approx. 2.5 kg)



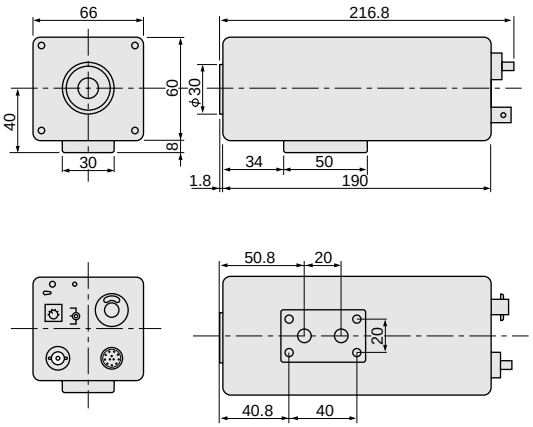
• C4880-81 (approx. 1.3 kg)



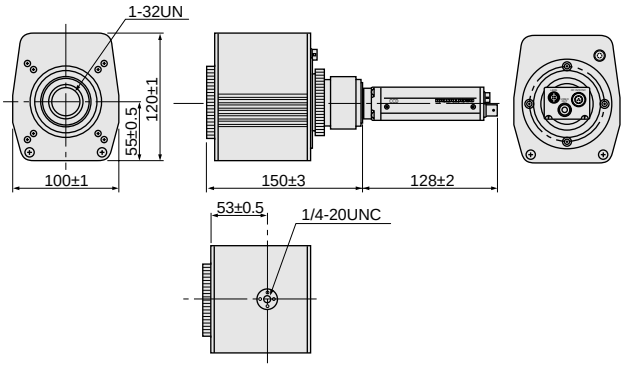
● C2400-08 (approx. 3kg)



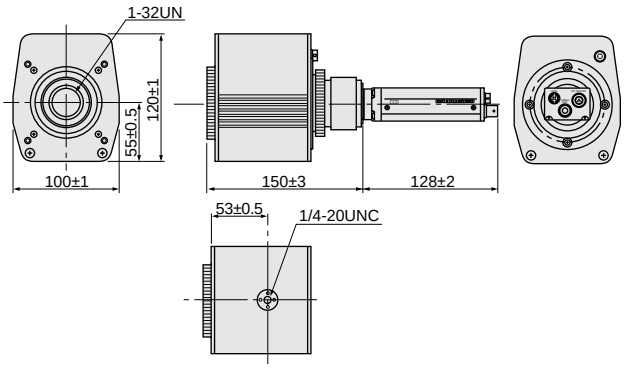
● C2400-89 (approx. 950g)



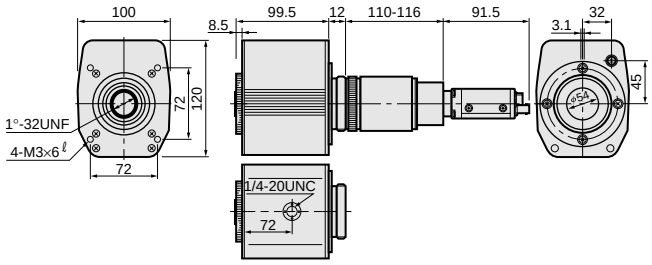
● C2400-87, -97 (approx. 2kg)



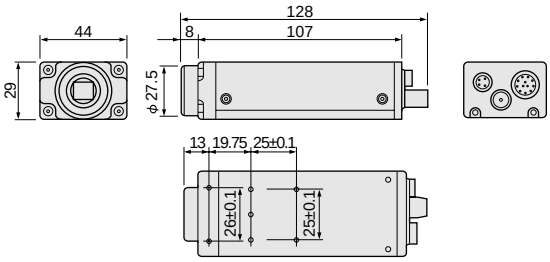
● C2400-47 (approx. 3kg)



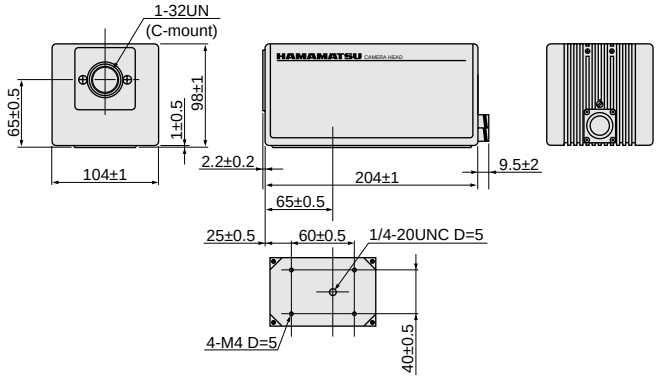
● C2400-35 (approx. 5.5kg)



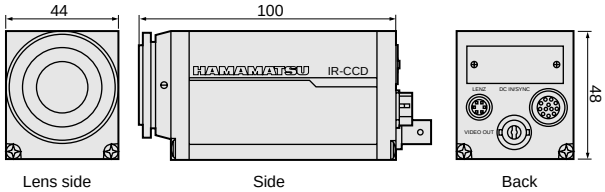
● C2400-77 (approx. 190g)



● C2400-01, -02, -03, -04, -05, -06, -07 (approx. 2kg)

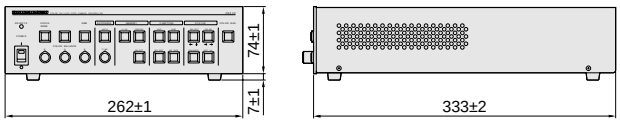


● C2400-79 (approx. 200g)

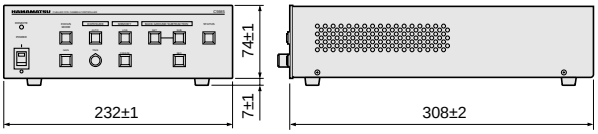


Camera Control Unit

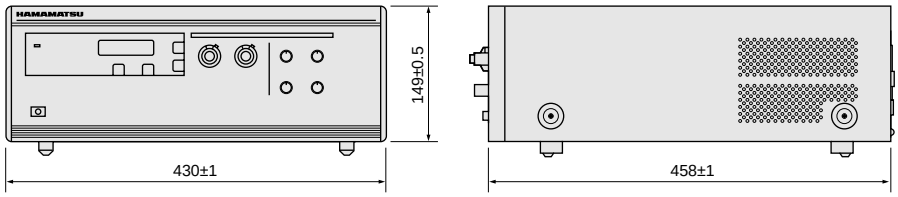
• C5810-01 (approx. 4 kg)



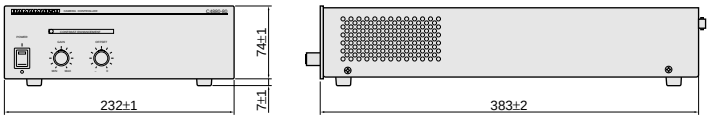
• C5985 (approx. 3.3 kg)



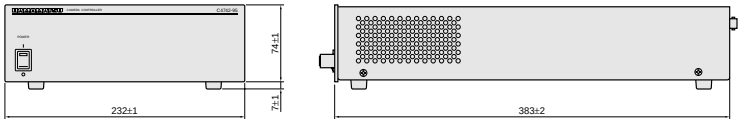
• C4880-Series (approx. 14 kg)



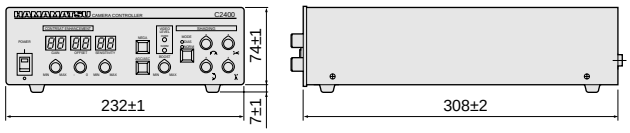
• C4880-81 (approx. 6.3 kg)



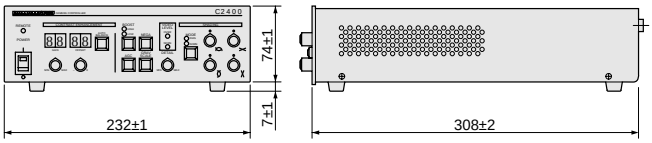
• C4742-95 (approx. 6.3 kg)



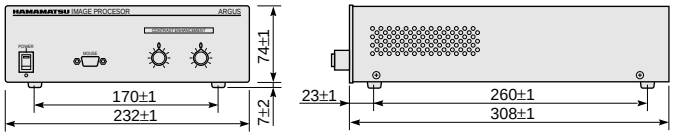
• C2400-01, -02, -03, -05, -06, -07, -08 (approx. 5kg)



• C2400-75, -77, -79 (approx. 4kg)



• ARGUS-20 (approx. 4.5kg)



HV Control Unit

• C2400-35, -47, -87, -87V, -89, -89V, -97, -97V (approx. 4kg)

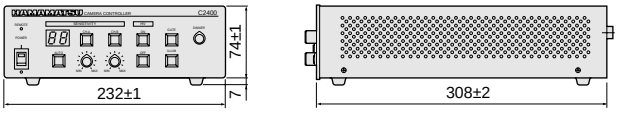


Image Processor

● ARGUS-20 Image Processors



- Image improvement and image processing functions are incorporated. By manipulating a mouse, the length and area of images can be measured and also number of particles can be counted for light measurements. Use with C2400 Series Cameras allow quantitative analysis and photon counting imaging.
- C-2400, -75i, -77, and C2400-89 camera heads can all be connected directly to the ARGUS-20.
  A separately available cable and software (option) are required for connection of the ARGUS-20 to a computer's SCSI interface.

Related Products

● Photodiode Array Unit (PDA) C5897



This is a 16 × 16 channel photodiode array unit used for optical measurement of membrane potential. Using this unit, absorption accompanying changes in potential and changes in extremely small volumes of light can be detected with high sensitivity. As many as 256 points can be sampled simultaneously, at an extremely fast sampling rate of 1 msec or less. (max, 0.5 msec)

Photo-sensitive device	PIN-type silicon photodiode (S4529)
Detection wavelength	400 to 1000 nm
No. of elements	256 channels (16 horizontal × 16 vertical channels)
Effective photo sensitive area of a element	0.95 mm × 0.95 mm (1.1 mm pitch)
Sampling rate	0.5 msec max.
A/D converter resolution	16 bits (1 : 65536)
Trigger input/output	1 input channel, 1 output channel
AUX input	Analog: 8 channels max. Digital: 8 channels max.
Mount	ENG mount and F mount
Power consumption	160VA (117V)/160VA (220V)

Related Catalogs

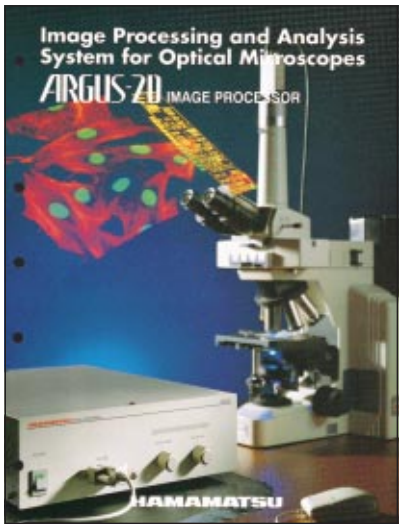
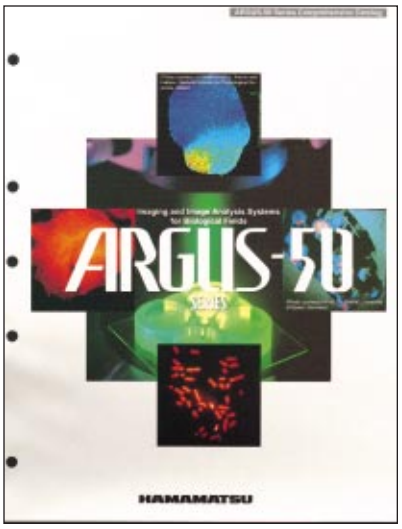


Image Processing and Analysis
System for Optical Microscopes
ARGUS-20 IMAGE PROCESSOR



Imaging and Image Analysis
Systems for Biological Fields
ARGUS-50 SERIES

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