Hamamatsu

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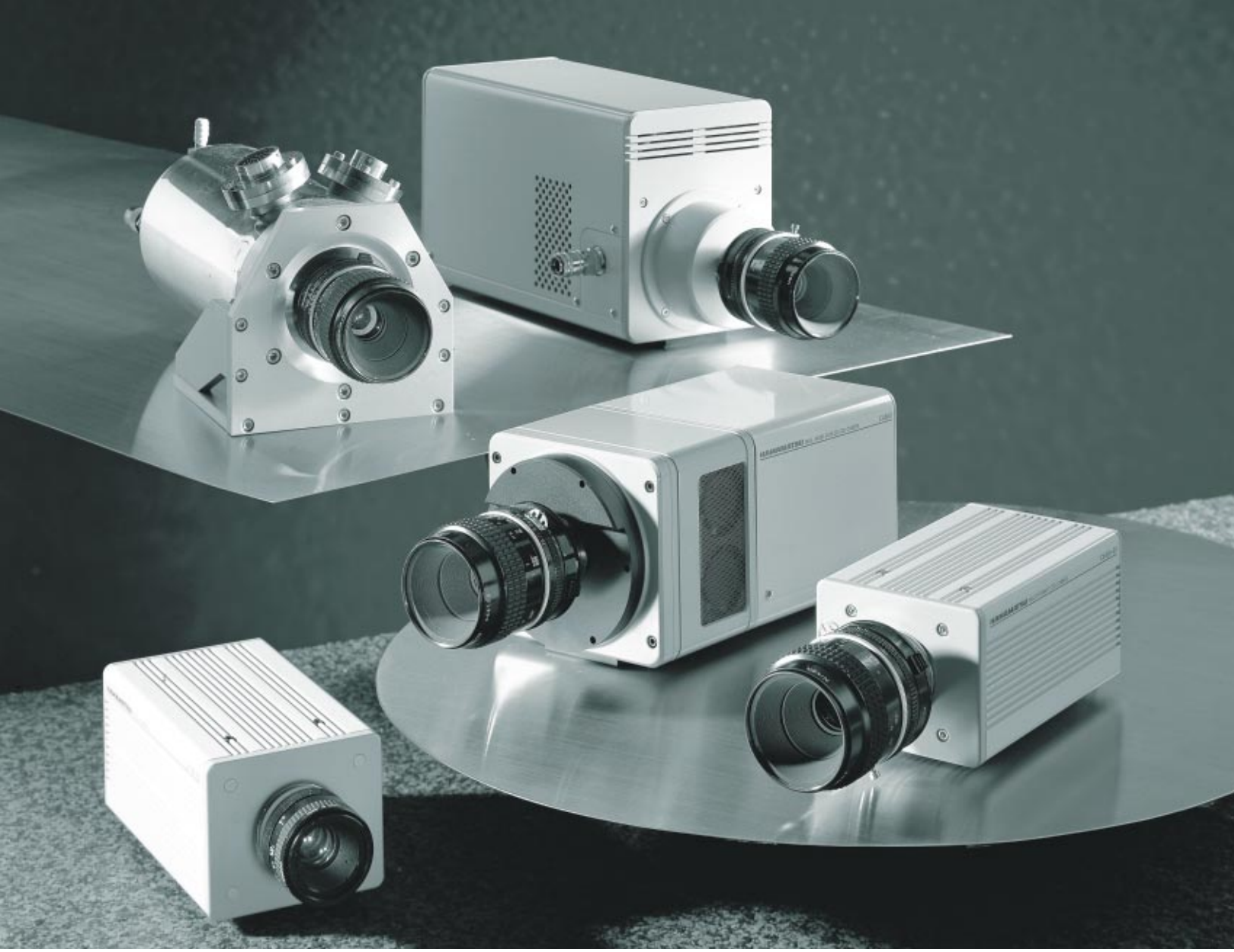
HAMAMATSU

System Products

Condensed Catalog

Digital CCD Camera/Realtime Image Processor/Streak Cameras/Optical Measurement Systems/Imaging and Analysis Systems



Working with optics technology, Hamamatsu is devoted to understanding and applying the concepts and mechanics involved in photonics (optical engineering).

As part of this work, the Systems Division at Hamamatsu has developed an extensive lineup of imaging and measurement devices incorporating television technology. These instruments are designed to cover the entire optical spectrum, from the visible range to infrared, ultraviolet, and X-ray ranges, as well as extremely faint light and ultra high-speed phenomena. The many products developed by the Systems Division are currently at work in diverse fields, including industrial applications as well as medical fields, scientific research and analysis, and space development.

This pamphlet presents a brief overview of products representative of those developed by the Systems Division at Hamamatsu.

Contents

High Resolution Digital B/W CCD Cameras: ORCA, ORCA Ⅱ

This is a monochrome cooled CCD camera which achieves high sensitivity, high resolution, and fast readout speed

The ORCA and ORCA Ⅱ are High Resolution Digital B/W CCD Cameras using a progressive scan interline CCD chip with no mechanical shutter. In addition to a high resolution of 1.3 million pixels, a wide dynamic range and a high sensitivity, these cameras serve a wide application range, down to low-light level imaging. Peltier cooling drastically reduces dark noise and minimizes thermal drift which makes this camera an ideal choice for demanding scientific and industrial applications.

▲ ORCA Ⅱ

Model	ORCA	ORCA Ⅱ	
		High-speed readout	High-precision readout
Effective no. of pixels	1280 (H) × 1024 (V) or 1024 (H) × 1024 (V)	1280 (H) × 1024 (V)	
Effective area	8.58 mm × 6.86 mm / 2/3-inch format		
Readout noise (r.m.s.)	8 to 12 electrons	10 electrons	3 to 5 electrons
Full well capacity	13000 electrons	16000 electrons	
binning		40000 electrons	
Cooling temperature	+5 °C	-40 °C to -50 °C	
Dark current	1 electron/pixel/sec	0.001 electron/pixel/sec	
A/D converter	10 bit or 12 bit	12 bit	12 bit or 14 bit

High Resolution Digital Color CCD Camera: ORCA Ⅲf

This is a color digital camera featuring outstanding color reproducibility and high resolution

The ORCA Ⅲf is a High Resolution Digital Color CCD camera using a progressive scan interline CCD chip with rotary RGB evaporated filter. In addition to its high resolution of 1.3 million pixels, 10 bit or 12 bit digital output, wide dynamic range and high sensitivity, the ORCA Ⅲf color camera offers a high quality color image in real time.

Effective no. of pixels	1280 (H) × 1024 (V) or 1024 (H) × 1024 (V)	
Effective area	8.58 mm × 6.86 mm / 2/3-inch format	
Frame rate	Constant mode	RGB full color 3 Hz
	Auto mode	Depends upon exposure time
Readout noise	8 to 13 electrons r.m.s. typ.	
Full well capacity	13000 electrons	
Lens mount	F mount	

Single Chip High Resolution Digital Color Camera: ORCA Ⅲm

This compact, single-chip color digital camera boasts high sensitivity and high resolution

The ORCA Ⅲm is a newly developed High Resolution Digital Color Camera employing a progressive scan interline CCD chip with matrix filters. In addition to its high resolution of 1.3 milion pixels, a 10- or a 12-bit output, wide dynamic range and high sensitivity, the camera offers high-quality color images for various scientific applications.

Effective no. of pixels	1280 (H) × 1024 (V) or 1024 (H) × 1024 (V)
Effective area	8.58 mm × 6.86 mm / 2/3-inch format
Frame rate	9 Hz
Read out noise	13 electrons r.m.s. typ.
Full well capacity	13000 electrons
Lens mount	C-mount

High Performance Digital CCD Camera: C7300

In addition to high resolution, a partial reading function enables high-speed reading of 250 Hz

In addition to a high resolution of 1280 × 1024 pixels, this digital camera achieves high-speed reading of 13 Hz for full-pixel readout and 250 Hz (maximum speed) for partial readout. A random scan function makes it possible to select the segment reading position for individual frames.

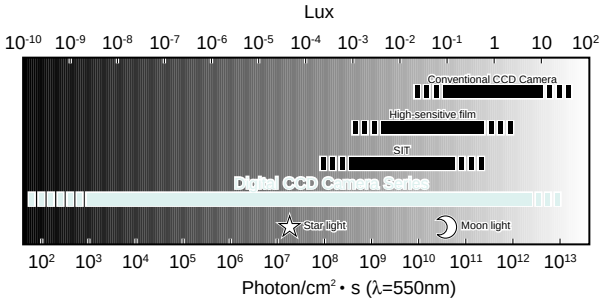
CCD	Progressive scan interline CCD	
Effective pixels	1280 (H) × 1024 (V)	
Readout speed:	Full-pixel readout	13 Hz
	Partial readout	250 Hz (max. speed)
Random access function	Up to 8 areas can be set	
A/D converter	8/10/12 bit	
Exposure time	100 µs to 1 second	

Digital CCD Camera: C4880 Series

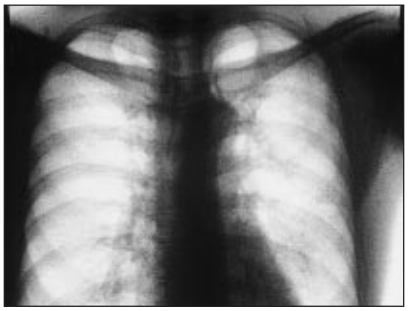
This digital camera achieves high sensitivity, high resolution, and a wide dynamic range in a broad spectrum of applications

The HAMAMATSU Digital CCD Camera Series provides a full lineup of more than 20 different models, designed to cover a diverse range of applications.
With the digital CCD cameras in this series, CCD elements for various types of scientific measurements are cooled using Peltier elements and other means, and the series features low noise characteristics and high sensitivity. In addition, analog output signals from the CCD are converted to digital signals (16-bit parallel signals) in the camera controller before being output. Because analog/digital conversion is carried out in the camera controller, problems which arose with conventional systems, such as deterioration of the S/N ratio because of signal transmission, and the S/N ratio being affected by the power supply environment on the signal reception side, have been eliminated.
Signals output from the camera controller can be transferred as video signals to a computer, using a frame grabber board with a digital input jack. This enables various types of image processing to be carried out, using the appropriate image processing software.

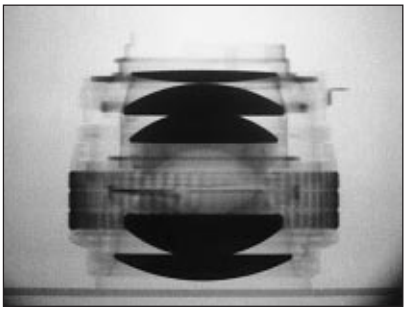
[Sensitivity]



Model	Imaging Device	A/D converter (bit)	Cooling method	Features							
				Long-term exposure	Wide dynamic range	High sensitivity	Low noise	UV sensitivity	IR sensitivity	High resolution	Frame rate
C4880-10	TC-215	12,14	Hermetic vacuum sealed water-cooling	◎	○	◎		◎	○	◎	◎
			Hermetic vacuum sealed air-cooling	○							
			LN2 cooling	◎							
C4880-20	S5466	12,14,16	Hermetic vacuum sealed water-cooling	◎	◎				○		◎
			Hermetic vacuum sealed air-cooling	○							
C4880-21	S7170	12,14,16	Hermetic vacuum sealed water-cooling	◎	◎	◎	○	◎	◎		◎
			Hermetic vacuum sealed air-cooling	○							
C4880-30	SI502A	12,14,16	Hermetic vacuum sealed water-cooling	◎	◎	◎	○	○	◎		○
			Hermetic vacuum sealed air-cooling	○							
			LN2 cooling	◎							
C4880-31	SI003A	12,14,16	Hermetic vacuum sealed water-cooling	○	◎	○		○	◎	◎	
			LN2 cooling	◎							
C4880-91 -92	S5466	12	Air-cooling (Intensified head)	Gate (100ns~)		◎					
				Gate (5ns~)							
C4880-80	ICX-074	12,14	Air-cooling	○			○	○			◎



▲ X-ray fluoroscopy image of chest. Diagnosis can be made much faster than by the conventional film method.
(Photo courtesy of Dr. Katakura, Tohoku Medical University Technical College)



▲ Image transmitted through the lens on a neutron scintillator. The resulting image shows no distortion and the wide dynamic range is maintained
(Photo courtesy of Rikkyo University Atomic Power Laboratory, Japan Atomic Research Laboratory)

▲ Observation of M51 nabula

Standard CCD Camera Series

These are high-sensitivity, high-resolution video cameras employing a solid state CCD

Type	Model ①	Features
B/W camera	C5403, -01	1/3" CCD type/High-sensitivity, high-resolution type
	C5405, -01	1/2" CCD type/High-sensitivity, high-resolution type
	C3077, -70, -71	2/3" CCD type/High-sensitivity, high-resolution type
	C7500-10, -11	1/2" CCD type /NIR-CCD type
Color camera	C6157, -01	1/3" 3CCD models
	C4200, -01	2/3" single-CCD models

①Two models are available, depending on the number of pixels.

▲ C5405

B/W Chilled CCD Camera: C5985 Series

High sensitivity (more than 1000 times that of our standard CCD camera), 1/2" CCD type

The B/W Chilled CCD Cameras C5985 Series are high-sensitive, B/W CCD cameras developed for observation under low illumination and for monitoring and measurement under faint light conditions, which are difficult to achieve with conventional B/W CCD cameras.

Model	C5985	C5985-02	C5985-10	C5985-12
Pickup device	1/2-inch interline-type CCD			
Video signal system	EIA		CCIR	
Effective number of pixels	756 × 485		739 × 575	
Spectral response	400 to 700 nm	300 to 1000 nm	400 to 700 nm	300 to 1000 nm
Lens mount	C mount			
Min. acquisition illumination intensity	2.5×10^{-4} Lux min. (exposure time 30 secs)			
Exposure time	1/10,000 sec to 300 secs (automatic exposure time adjustment mode provided)			
Image memory	756 (H) × 483 (V) × 8 bit (D)		739 (H) × 509 (V) × 8 bit (D)	

Color Chilled 3-chip CCD Camera: C5810 Series

High sensitivity (more than 1000 times that of our standard CCD camera), 1/2" 3 CCD type

The C5810 Series are high-sensitivity, color 3-chip CCD cameras 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.

Model		C5810-01	C5810-11
Pick up device		1/2-inch interline 3-chip CCD	
Video signal system		NTSC	PAL
Effective number of pixels		756 × 485	739 × 575
Image output		RGB+SYNC, composite video, Y/C (S video)	
Lens mount		1/2-inch bayonet mount (Flange back 38 mm)	
Exposure time		1/10000 to 60 sec (Automatic exposure time adjustment mode provided)	
Image memory	High resolution mode	1020(H) × 483(V) × 8 bit(D)	992(H) × 509(V) × 8 bit(D)
	Standard resolution mode	640(H) × 483(V) × 8 bit(D)	739(H) × 509(V) × 8 bit(D)

EB-CCD Cameras: C7190-10, -20

High-sensitivity cameras use a new method to achieve high amplification gain by bombarding CCD surface with accelerated electrons

These high-sensitivity cameras combine a revolutionary new concept with advanced technology, achieving a high amplification gain by bombarding the CCD surface with electrons accelerated using an applied voltage. Uniformly high sensitivity and an outstanding S/N are just two of the many advantages.

Model	C7190-10	C7190-20
CCD	FFT-CCD	FT-CCD
Effective no. of pixels	512 (H) × 512 (V)	640 (H) × 480 (V)
Readout speed	0.5 Hz/7 Hz	30 Hz/60 Hz
Gain	to 600 times	600 to 700 times
Gate time	1 ms	—
Cooling temperature	-25°C	—

▲ C7190-20 (Video rate type)

❸ *X-ray Cameras*

X-ray CCD Camera: C6086 Series

The C6086 X-ray CCD camera was specifically developed for X-ray observation. A CCD coupled with X-ray scintilator is used for detection. The C6086 realizes small size, light weight and high resolution.

Item	C6086-01,-02	C6086-11,-12	C6086-21,-22
Effective sensitive area	8.8 × 6.6mm (2/3-inch)	20 × 15mm (1.5-inch)	32.5 × 24.4mm (2.5-inch)
Resolution	25 µm min	43 µm min	62 µm min
Contrast enhancement	available	available	available

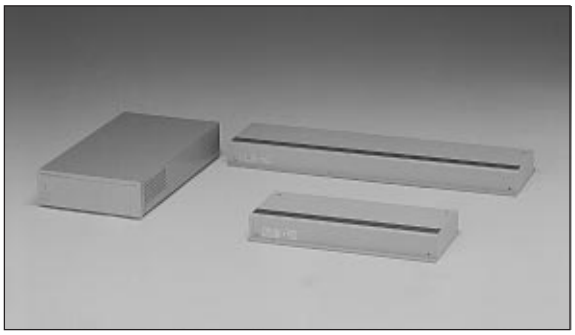
X-ray Line Sensor Camera: C7390 Series

X-ray images of inspection targets supplied on transport mechanism such as belt conveyor captured at high sensitivity and high resolution

This camera enables non-contact, non-destructive inspection of the interiors of product packages. Ideal for wide-range X-ray inspection of the interiors of packages containing items such as foodstuffs and electronic parts. A thin-type sensor head is used, enabling installation within the conveyor.

Detection method	Scintillator method
X-ray sensitivity range	Approx. 40 to 160 keV
Inspection resolution (horizontal)	Sensor element pitch 0.4 mm
Detection width	256 or 512 mm *
Line speeds supported	4 to 40 m/min. (with square pixels)
A/D conversion	12 bit

* For other detection widths, please consult HAMAMATSU.



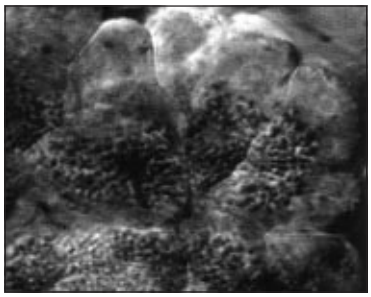
High-performance, Multi function Camera: C2400 Series

High-performance cameras developed for use in industrial and biomedical fields, these employ contrast enhancement circuits

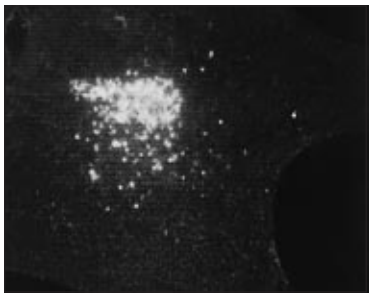
The video cameras in this series are high-performance cameras emphasizing ease of use. Developed for use in industrial and biomedical fields, they employ contrast enhancement circuits, so that low-contrast images can be converted to sharply detailed images.
In addition to recording images on a VTR or VCR, image processing and analysis can be carried out using these in combination with image processing devices and measuring instruments.

● Biomedical applications

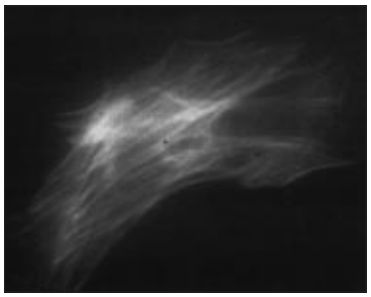
● Rat pancreas acinus cell (Measured with C2400-77)
(photo courtesy of Dr.Sakurai, Photon Medical Research Center of Hamamatsu University School of medicine, Japan)



● Observation of virus-infected cell using fluorescent antibody technique Measured with C2400-08 (photo courtesy of Dr. T. Bäahi, University Zürich, Switzerland)

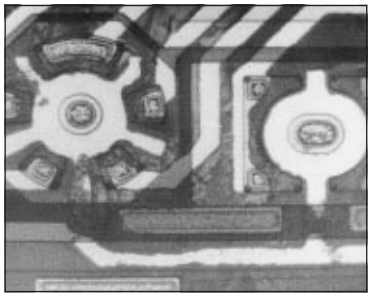


● Fluorescence image of stained actin Measured with C2400-87



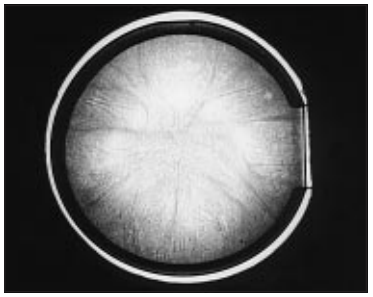
● Industrial applications

● IC Internal Inspection



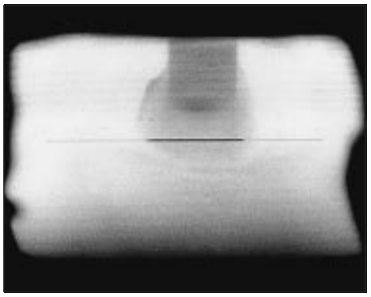
▲ (Measured with C2400-03)

● Wafer Inspection



▲ (Measured with C2400-03)

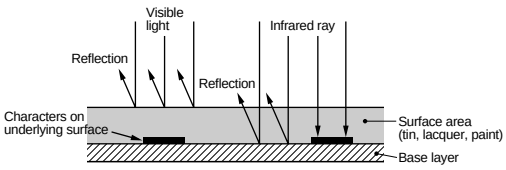
● Width Analysis



▲ Used in combination with the Width Analyzer to measure the width of a crystal inside a furnace

● IR Reflectography (C2400-03)

Infrared ray transmission



● Observation example of a painted column (Amidado in the Hokaji Temple, Kyoto)

▲ Film Photo (visible light)

▲ Observation by IR Video Camera

Near Infrared CCD Camera System: C7500-60,61

A new 1/2 inch interline CCD with high sensitivity in the near-infrared region

Near Infrared CCD Camera System (C7500-60,-61) consists of a new 1/2-inch interline CCD with high sensitivity in the near-infrared region and a multifunction camera controller.

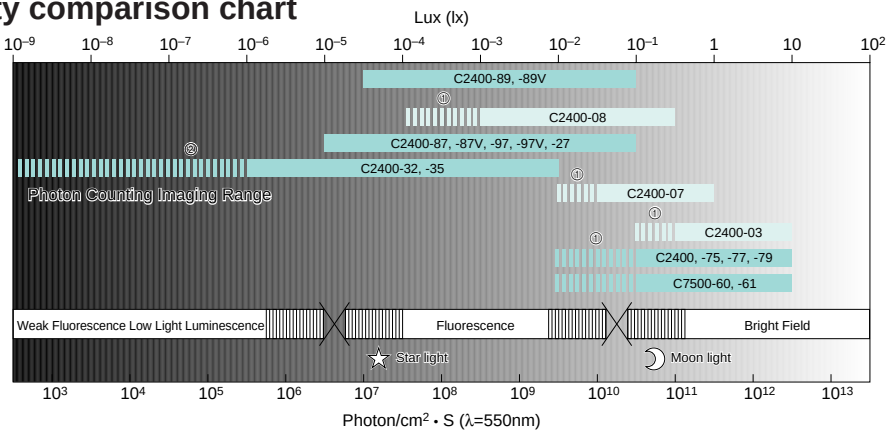
	C7500-60	C7500-61
Pickup device	1/2-inch interline CCD	
Video signal System	EIA	CCIR
Effective number of Pixels (H) × (V)	756 × 485	739 × 575
Contrast enhancement	Yes	

● Specification comparison list

Model	Product Name	Biological Application	Industrial Application	Features	Spectral response Typ.(nm)	Horizontal Center Resolution Typ. (TV lines)	Gemetric Distor-tion Max (% within in-scribed circle)	Shad-ing Max. (% within in-scribed circle)	Lag Typ. (%)	Gamma Typ.	S/N Min CB (p–p/r.m.s) ①
C2400-08	SIT Camera	Real-time fluorescence observation, Calcium-ion imaging	Real-time observation of Weak light	High-resolution	400 to 850	500	± 3.0	20	7	1.0	48
C2400-89V	Proximity ICCD Camera			Proximity ICCD eliminates image distortion and low lag, Ultraviolet sensitivity	180 to 650	420	± 1.0	–	–		56
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						
C2400-97					350 to 800						
C2400-27	GenIV ICCD Camera			High-resolution High-sensitivity	400 to 900	550					60
C2400-32 -35	PI-CCD Camera	Chemiluminescence, Bioluminescence (Photon counting imaging is possible)	—	High spatial resolution, Low geometric distortion	360 to 650	370			–		(58)
C2400-03	Infrared Vidicon	Phase contrast, Differential interference contrast microscopy	• Online control • Video Measuring • Width analysis • IC internal Inspection (C2400-03, C2400-79) • Wafer Inspection (C2400-03) • IR-Reflectgraphy (C2400-03)	Visible to infrared	400 to 1800	600	± 2.0	20	60	0.6	46
C2400-07	Newvicon			General microscopic observation	400 to 800	700	±1.0	10	20	1.0	50
C2400-75	CCD Camera (1/2")			Compact and light weight, Observation of bright and fast moving objects	400 to 920	570	–	–	–	1.0	56 (54)
C2400-77	CCD Camera (2/3")										52 (50)
C2400-79 ②	NIR-CCD Camera (2/3")			Compact and light weight, Observation of NIR image	400 to 1200						57
C7500-60 -61	NIR-CCD Camera (1/2")				300 to 1200						56 (54)

① Value inside ( ) are CCIR.
② The Video Signal System of C2400-79 is EIA only.

● Sensitivity comparison chart



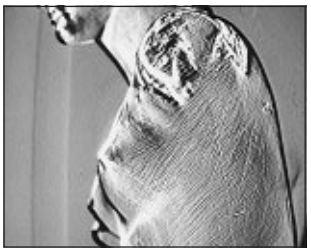
① Analog contrast enhanced imaging
② Photon counting imaging (required image processor)

Super Eye: C2847

A video camera that uses real-time image processing for high-level identification of objects

This image-enhancing video camera is equipped with an imaging tube that has a wide dynamic range and offers real-time differential processing, combined with brightness compression processing, all in a single unit. Using this camera, clearly detailed images can be produced of objects with extremely faint contrast that cannot be distinguished with the human eye.

▲ Original image



▲ Image captured by Super Eye

❺ *FA Measurement System*

Real-Time Image Processor: ARGUS-20

Image measurement with high resolution of 1,024 horizontal pixels and simple mouse operation

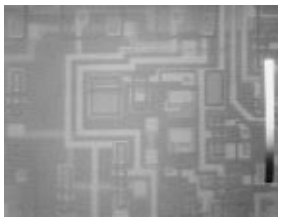
This is an image processor which achieves a high resolution of 1,024 horizontal pixels. A broad range of image processing functions and measurement functions are provided, including image subtraction, accumulation, and recursive filters. A mouse is used, making operation easy. In addition, a superimpose function enables superimposed displays of illuminated images, emissions, and fluorescence emissions, making it possible to identify fluorescence positions and other elements.

● Specifications

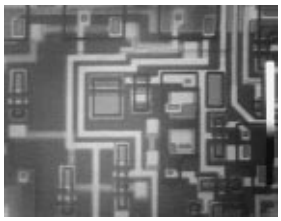
Synch method			EIA (USA)	CCIR (Europe)
Input signal	H.scanning frequency		15.734 kHz	15.625 kHz
	V.scanning frequency		59.94 Hz	50.00 Hz
	Total number of scanning lines		525	625
	Number of effective scanning lines		483	509
	Interlace ratio		2:1	
	Aspect ratio of screen		4:3	
	Signals		Composite 1.0Vp-p/75	
Aspect ratio of pixel			2:3 (High-resolution mode) 1:1 (Normal- resolution mode)	
Output signal	For monitor		Composite 1.0Vp-p/75	
	For VTR or VCR		Composite 1.0Vp-p/75	
RGB output	RGB signal		0.7Vp-p/75 positive	
	HD,VD,Sync signal		2.0Vp-p/75 negative	
A/D,D/A converter			8 bit approx. 20MHz sampling	
Image memory	Main memory	High-resolution mode	1024 (H) × 483 (V) × 16 bit	1024 (H) × 509 (V) × 16 bit
		Normal-resolution mode	640 (H) × 483 (V) × 16 bit	640 (H) × 509 (V) × 16 bit
	Sub memory	High-resolution mode	1024 (H) × 483 (V) × 16 bit	1024 (H) × 509 (V) × 16 bit
		Normal-resolution mode	640 (H) × 483 (V) × 16 bit	640 (H) × 509 (V) × 16 bit
	Graphic memory	High-resolution mode	1024 (H) × 483 (V) × 4 planes	1024 (H) × 509 (V) × 4 planes
		Normal-resolution mode	640 (H) × 483 (V) × 4 planes	640 (H) × 509 (V) × 4 planes
Operating temperature			0°C to +40°C	
Storage temperature			–10°C to +50°C	
Operating and storage humidity			90% or less (non-condensation)	
Line voltage			100/117/220/240 VAC 50/60Hz	
Power consumption			Approx. 200 VA	

● Functions and Application Example

● **Enhancement:** Allows interactive enhancement, suppression or isolation of selected intensity levels on the image. Fourteen different enhancement modes are available, of which any three can be selected for display on the main menu.



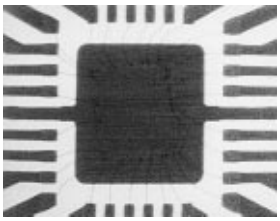
▲ Original image



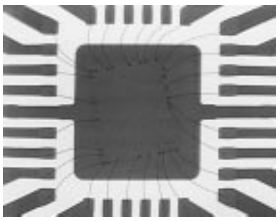
▲ With contrast enhancement

IR Image of IC chip's internal layer

● **Image Accumulation:** Integrates multiple images of a stationary sample to produce a clear, well-defined final image.



▲ Original image



▲ Accumulated image

X-ray Image of an IC chip

● **Superimposition:** Superimposes a real-time image over stored image. Can be used to superimpose a color image over a black-and-white image, or to merge two color images.

▲ Standard illumination image

▲ Fluorescent image of oil excited by UV ray.

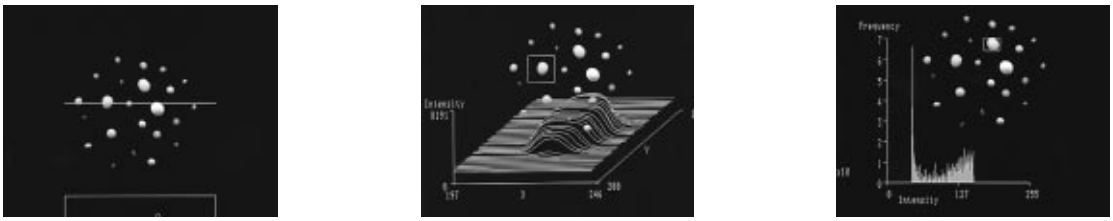
▲ Superimposed image

Fluorescence image of oil stiched on metal

● **Profile:** Displays a profile of the intensity levels along a straight line through the image.

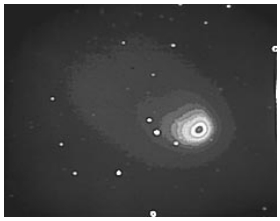
● **3D:** Displays a three-dimensional profile of the intensity levels within a user-defined window.

● **Histogram:** Displays histogram of intensity levels within a user-defined window.

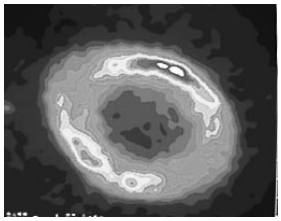


Fluorescence image of micro oil particle

● **Pseudo-color Display:** Generates a pseudo-color display. Can display either a single color or multiple colors representing different intensities on the image.



▲ Bradfield comet



▲ Ring nebla

● **CCD On-Chip Integration:** CCD camera integrates electron charged by each CCD element, enabling extended exposure time giving greatly enhanced sensitivity (requires use of the C2400-75i CCD camera).

▲ Original image

▲ With 1 second on-chip integration

Image of dark lit area

Video Measuring Unit: C3160 Series

A high-precision, real-time image measuring system which can be used in a wide range of fields, including FA and LA

This is a system which can be used in combination with a variety of video cameras such as CCD cameras, for non-contact measurement of objects. Since image is input through a video camera, the system can be used with almost any size of target, from buildings and bridges to IC patterns under a microscope. Hamamatsu provides a full range of CCD and other video cameras to meet any application, allowing the user to select the appropriate features, such as high sensitivity, cameras for ultraviolet, infrared, or X-ray use, and many others. The optimum camera can thus be chosen based on the target being measured and the environmental conditions.
Functions such as addition and averaging of the data, elimination of irregular data, judgments based on standard data, and conversion to actual-size are all possible. In addition, a standard GP-IB interface is provided for easy external control.

Product name/model	Measurement items
Width Analyzer C3161	Dimensions (width/length), 1-dimensional displacement (position)
X-Y Tracker C3162	2-dimensional displacement (position), automatic tracking of moving objects
Area Analyzer C3163	Surface area
Percept Scope C3160	All of the above measurement items

3-Dimensional Shape Measurement Unit: C6648

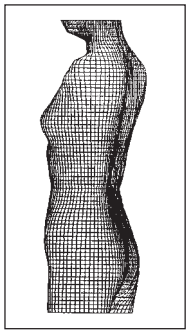
Fast, accurate measurement of 3-dimensional subjects such as people and objects, with no contact

With an infrared LED and a semiconductor position sensing detector (PSD), triangulation is used for rapid, non-contact measurement of three-dimensional shapes of target objects.

- **Applications involving human body measurement (BL scanners)**

This system measures 3-dimensional shapes of the human body, by positioning multiple distance sensors around the person being measured and scanning from top to bottom. A single scan reads 192 points in the horizontal direction and 340 points in the vertical direction, in only 10 seconds.
Possible applications include medical treatment, apparel design, and fields involving aesthetics.

▲ BL scanner



▲ Example of measurement output

Measurement range:	Height	2000 mm
	Width	830 mm
	Thickness	500 mm
Measurement time		Approx. 10 seconds
Measurement precision (at 500 mm from sensor)		± 1 mm
Measurement pitch		Horizontal: Approx. 8 mm/Vertical: Approx. 5 mm
Dimensions/weight		1625 (W) × 2600 (H) × 1715 (D) mm / Approx. 390 kg

Position Sensor: C5949

Light spot position measurement unit with no wiring between controller and LED target

This is a light spot position measurement unit which uses a PSD and an infrared LED. The LED target is attached to the subject and the position of the emitting point is changed (up to 7 points can be measured), enabling real-time measurement (standard 300 Hz). The sensor head is equipped with an internal infrared filter and a background light elimination circuit, to enable accurate measurements unaffected by background light. Also, an LED driver is used, eliminating the need for wiring between the controller and the LED target.

No. of measurement points	Up to 7 points
Response frequency	Standard 300 Hz
Resolution	1/5000

Position Sensor: C7339

Light spot position measurement device (for 1-point measurement) using a semiconductor position sensing detector (PSD)

This device measures two-dimensional light spot positions (for 1-spot measurement). A semiconductor position sensing detector (PSD) made by HAMAMATSU is used as the sensing detector, ensuring a fast response speed and high resolution. Positions can be measured directly laser beams.

Useful photocathode size	10 × 10 mm
Spectral response characteristic	320 to 1100 nm
Resolution	1/5000
Position detection error (center area)	±1.0%

Optics and Cameras for Optical Beam Measurement

Dedicated optics/camera enables various types of optical beam measurement when used in combination with the LEPAS-11

This is a dedicated optics system and camera which enables measurement of various types of optical beams when used in combination with the LEPAS-11 Laser Beam Profiler.
An extensive product lineup encompasses all lasers from ultraviolet to infrared. Various types of laser beam measurement are available, including FFP, NFP, and astigmatic difference measurement.

● Optics

FFP optics A3267-05, -06, -07, -11	Measurement angle range: ±30° to ±60°
High-resolution FFP optics A3267-08 and others	Resolution: 0.1 mrad Measurement angle range: ±15 mrad
NFP optics A4859-01	Beam expansion ratio: 500 × (up to 1000 × available as an option)
Lateral optics A6216	Incident NA: Approx. 0.35
Expanding optics A6501	Beam expansion ratio: 50 ×
FOP screen optics A6502	Measurement surface area: ϕ 65 mm
Optics for excimer lasers A5997	Wavelength range: 190 to 400 nm
Optics for processed YAG lasers A6503-01 and others	Beam intensity attenuation: 6 digits max.
M2 measurement optics A7681	Measurement precision 5% (at M2 = 1, with beam diameter of ϕ 10 mm)

● Cameras

Interference fringe free visible range detector C5948	Interference-free Wavelength range: 400 to 1100 nm
Visible range camera C3077	Wavelength range: 400 to 1100 nm
Near infrared range camera C5840	Wavelength range: 400 to 1650 nm
Infrared visicon camera C2400-03	Wavelength range: 400 to 1800 nm

Laser Beam Profiler: LEPAS®-11

High-performance frame grabber board and dedicated software enable high-precision laser beam analysis using a personal computer

The Laser Beam Profiler LEPAS-11 is a new type of laser beam profiler which combines a high-performance frame grabber board and dedicated software (supported by Windows®) with a personal computer (IBM PC-AT or compatible) for high-speed, high-performance, and low-cost profiling.
Various types of optical beam parameters can be measured and analyzed simply by connecting camera output to the LEPAS-11. Images can be saved in TIFF format and analysis results in text format, making it easy to process data using commercial application software.

▲ Example showing combination with FFP optics

Image acquisition speed	30 frames/sec max.
Video A/D	10 bit
Frame memory	640 (H) × 480 (V) pixels × 16 bit
Image acquisition	Accumulation, subtraction
Real-time monitoring	Peak intensity, peak coordinates, FWHM, XY profile
Beam parameter analysis	FWHM, 1/e width, $1/e^2$ width, any desired width, Gauss fit width, peak intensity, peak coordinates, center of gravity coordinates, surface area, relative energy, average intensity, scattering, beam inclination, long diameter/short diameter

Streak Camera Series

Supports all kinds of high-speed optical measurements down to the sub-ps domain, from X-ray to the IR range

The streak camera series by Hamamatsu provides a full lineup of products that enable the user to select the optimum camera for the application, based on factors such as temporal resolution, wavelength sensitivity, and sweep method.

Model	Temporal resolution *	Features
C2830	Within 10 ps (with fast sweep)	Inexpensive model with a time resolution of 10 ps.
	Within 100 ps (with slow sweep)	
C5680*	Within 2 ps (with fast sweep)	General-purpose model with three types of sweep operation. Spectral response from X-ray to near infrared by selecting appropriate streak tube.
	Within 2 ps (with synchroscan)	
	Within 50 ps (with slow sweep)	
FESCA-200	200 fs	Used in the femtosecond range.
C4575-01	Within 2 ps	For X-ray use (10 eV to 10 KeV).

* Fast sweep, slow sweep, and synchroscan are enabled by changing the plug-in unit.

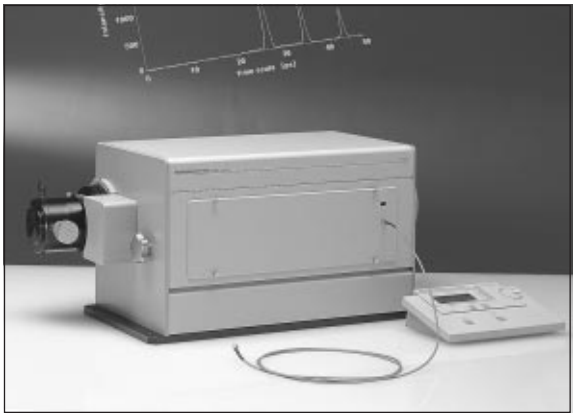
▲ C5680

Synchroscan FESCA: C6860

High-repetition sweep of 75 to 100 MHz and superb time resolution in femtosecond range achieved

This streak camera boasts synchroscanning (75 to 100 MHz) and a time resolution of 500 fs. Captured images can be accumulated, enabling a wide dynamic range and making it possible to measure optical phenomena under extremely faint light conditions and in the near infrared region.

Spectral sensitivity		200 to 850 nm (S-20)
		300 to 1600 nm (S-1)
Synchroscan:	Time resolution	500 fs max. (fastest speed range)
	Repetition frequency	5 to 100 MHz
	Dynamic range	1:1000
Low-speed single sweep:	Time resolution	50 ps max. (fastest speed range)
	Sweep time range	5 ns to 1 ms



Framing Streak Camera: C4187

A high-speed framing streak camera with a exposure time of 50 ns and ultra high-speed framing of 3 million frames per second

This is an ultra high-speed framing camera with a exposure time of 50 ns, a frame rate of 3 million frames per second, and continuous imaging of up to 8 frames. A dedicated readout system enables in sitn image and data analysis in real-time. In addition, this camera can also be used as a streak camera by changing the plug-in module.

Exposure time	50 ns to 1 ms (continuously variable)
Frame rate	100 frames/second to 3 million frames/second (continuously variable)
Frame interval	10 ms to 300 ns
No. of frames	1, 2, 4, 8 (switchable)
Resolution (at center of phosphor screen)	13 ℓp /mm

▲ C4187 and dedicated readout system

Picosecond Photodetector: C4258 Series

Ideal for pulsed light monitoring of mode synchronous pulsed lasers and semiconductor lasers in the visible and near infrared regions

This is a compact optical detector with a high-speed response, in which the light-receiving element, high-frequency circuit, and power supply have been integrated in a single unit. Connecting the C4258 to an oscilloscope enables easy observation of optical phenomena in the picosecond region.

Sensitive wavelength range:	C4258	0.4 to 0.87 µm
	C4258-01	0.6 to 1.65 µm
Sensitivity:	C4258	1 mV/mW (at 0.6 µm)
	C4258-01	3 mV/mW (at 1.3 µm)
Photocathode surface		0.2 mm × 0.2 mm
Rise time		50 ps
FWHM		60 ps
Low-frequency cutoff frequency		100 kHz

Stabilized Picosecond Light Pulser: PLP-02

Ultra-short light sources with pulse widths of 50 ps or less

The Hamamatsu Picosecond Light Pulser, model PLP-02, is an ultra-short pulsed light source using laser diode. The PLP-02 can offer superb performance with the pulse width less than 50 ps and maximum repetition frequency of 2 MHz.

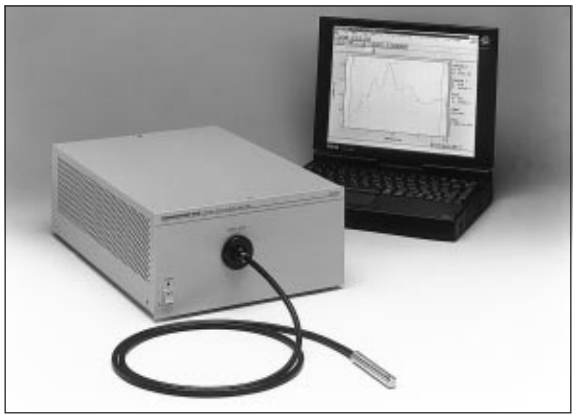
Pulse width:	50 ps or less
Emission wavelength (nm):	635, 650, 670, 780, 1300, 1550
High repetition frequency:	single shot up to 2 MHz

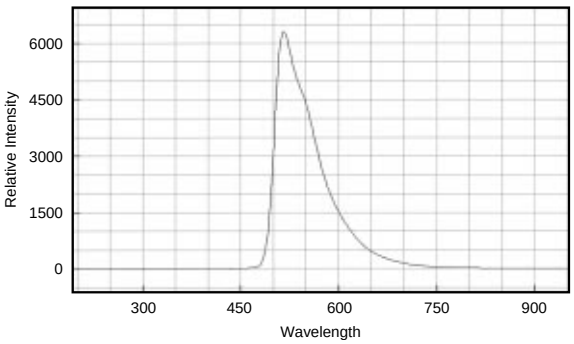
Photonic Multichannel Spectral Analyzer: PMA-11

A compact spectral analyzer combining a spectrograph and a high-sensitivity multichannel photodetector in one unit

This is a compact spectral analyzer combining a spectrograph and a high-sensitivity multichannel photodetector in a single unit. Light can be input easily using an optical fiber. The diffraction grating and the photo detector of the spectrograph are mechanically fixed, enabling high-level wavelength reproduction and longterm stability. The wavelength axis characteristics and spectral response characteristics have already been calibrated, so that spectral measurements can be carried out simply and accurately.

Model	C5965-3X	C5966-3X	C7473-36
Photodetector	MOS linear image sensor	CCD linear image sensor	Back thinned CCD linear image sensor
Simultaneous measurement wavelength range	X = 1	300 to 800 nm	200 to 950 nm
	X = 2	200 to 400 nm	
	X = 3	600 to 1000 nm	
Wavelength resolution	X = 1	< 3 nm (FWHM)	< 2 nm (FWHM)
	X = 2	< 1.5 nm (FWHM)	
	X = 3	< 2.5 nm (FWHM)	
Optical fiber length	1.5 m (standard)		
Light-receiving area of optical fiber	ϕ 1.0 mm		





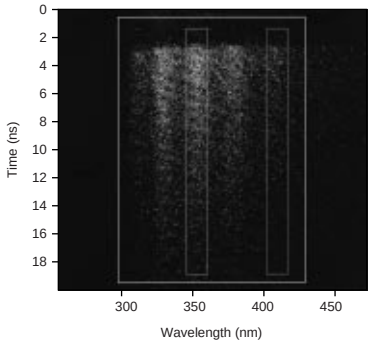
▲ Fluorescence spectra of fluorosein

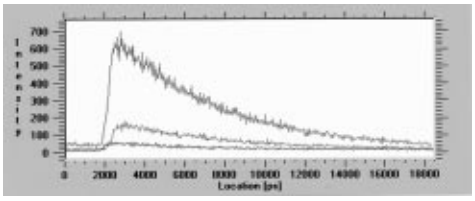
Picosecond Fluorescence Lifetime Measurement System: C4780

Fluorescence lifetime analysis with ultra-high sensitivity and 5 ps temporal resolution, using 2D photon counting method

This is a system which analyzes the fluorescence lifetime and time-resolved fluorescence spectrum simultaneously. A streak scope is employed in the detecting unit, enabling an extremely high level of sensitivity and a temporal resolution of 5 ps, using the 2-dimensional photon counting method.

Lifetime measurement range	Picosecond to millisecond
Wavelength range	200 to 850 nm, 400 to 900 nm, 300 to 1500 nm
Dynamic range	1 : 10^5 min.
Temporal resolution	Within 5 ps (de-convolution processing)
Detection method	2-dimensional photon counting





▲ The time-resolved fluorescence spectrum of an oxygen-saturated solution of anthracene in ethanol; excited by nitrogen laser; photon-counting integration of 30 seconds.

Camera Series for Videomicroscopy

Compact video cameras developed for use with optical microscopes. Living specimens displayed in clear detail

Image processing technology is highlighted among the foremost methods of biological research currently available to us. In addition to ion imaging using fluorescence probes and the FISH method, which are already established as general measurement methods, new technology is appearing on the stage, including GFP (Green Fluorescent Protein) blended protein technology, FRET (Fluorescence Resonance Energy Transfer), and other Cameleon methods. These image processing technologies, using devices with high sensitivity and high resolution, are playing an increasingly important role in research today.

Model	Detector	Features
• For fluorescence observation		
ORCA Ⅲm	Color 2/3-inch CCD	High-sensitivity, high-resolution color digital camera. CCD cooling enables high detection capability.
C5810	Color chilled 3CCD	High-sensitivity color camera. Ideal for imaging of multi-fluorescence stained samples and samples where imaging is difficult with an ordinary color camera.
C2400-75i	1/2-inch CCD	High-sensitivity CCD camera. High sensitivity is achieved by accumulating charges to the CCD for a given period of time. Can be used with fluorescence-stained samples, etc. For even higher sensitivity, chilled CCDs and cooled CCDs are available.
C5985	B/W chilled CCD	High-sensitivity monochrome camera. High sensitivity achieved by maximum exposure of 5 minutes.
ORCA ORCA Ⅱ	Cooled CCD	Digital camera with high sensitivity and resolution achieved by long exposure time, plus wide dynamic range. Used in broad range of applications such as FISH, blotting, Ca^{2+} measurement, and many others.
C2400-08	SIT	Enables detailed images of fluorescence just bright enough to be observed by the human eye. High resolution.
C2400-87 -97	I.I. + CCD	Even higher sensitivity than the C2400-08. Ideal for observation of specimens in which fluorescence intensity changes rapidly.
C2400-89	I.I. (proximity type) + CCD	Camera with sensitivity beyond that of the C2400-08. Chip integration enables sensitivity to be boosted even higher.
C2400-27	GenIV I.I + CCD	High resolution (550TV line), high sensitivity ICCD Camera
C7190-20	EB-CCD Camera	The newly-development Electron Bombardment CCD Camera.
C6790-81	HiSCA Camera	This is developed for High speed ratio imaging.

• For luminescence and extremely low light observation

C2400-32 -35	PI-CCD	Monitoring in fields too dark to be observed by the human eye, of fluorescence and faint luminescence using reagents.
ORCA Ⅱ	Cooled CCD	ORCA Ⅱ employs a hermetic vacuum-sealed head which can be cooled to –50 °C and guarantees maintenance-free operation.
C7190-10	EB-CCD	The newly-development Electron Bombardment CCD Camera.

• For bright field observation

C2400-75	1/2-inch CCD	Lighter and more compact than cameras with an imaging tube, this offers results free of after-images and distortion, and is ideal for observation of rapidly-moving specimens. Used in visible to near infrared regions, and for monitoring deep portions of fragments.
C7500-60 -61	1/2-inch CCD (NIR)	
C2400-77	2/3-inch CCD	
C2400-79	2/3-inch CCD (NIR)	

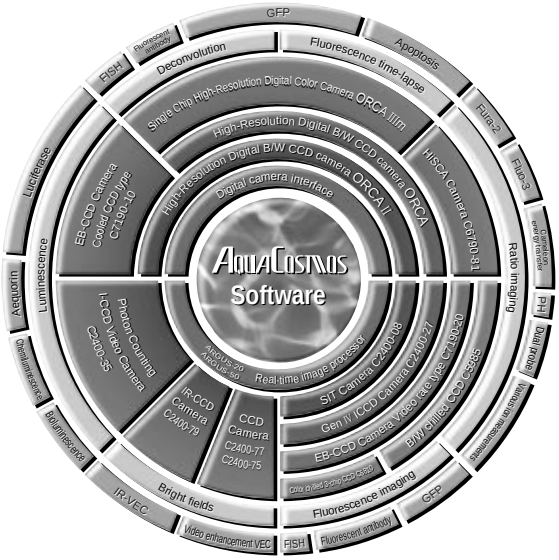
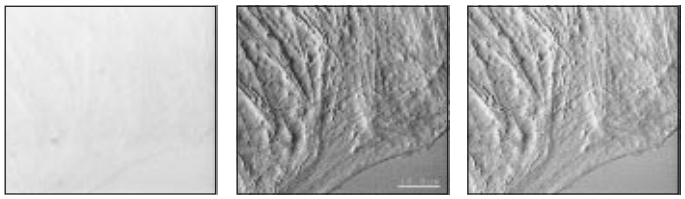


Image Processing and Analysis System for Optical Microscopes: ARGUS-20 Image Processor

Connect to a video camera for easy, high-quality observation and analysis using a microscope

This is an image processing and analysis system developed for observation using an optical microscope. Connecting the ARGUS-20 to a video camera designed for microscope realizes easy, high-quality image observation and quantitative analysis. In addition to a wide variety of realtime image processing functions, factors such as the diameter and surface area of the specimen, and the distance moved, can be measured manually and the actual dimensions displayed.

- **Examples of contrast enhancement and background subtraction (Specimen: Fibroblast)**



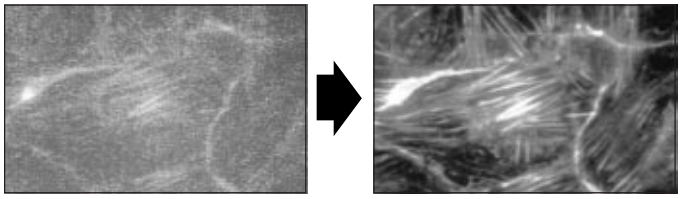
▲ Original image ▲ Contrast enhancement ▲ Background subtraction

ARGUS-20 with C2400-75i

It is sensitive enough to be used to view fluorescence images

The C2400-75i with on-chip integration has been specially designed for use with the ARGUS-20. It is sensitive enough to be used to view fluorescence images, while the system's high resolution and contrast enhancement enable you to view single microtubules in DIC images. You can even superimpose DIC and fluorescence images or two fluorecence images.

● Normal scanning (256 frames accumulation on frame memory) ● On-chip integration (10 sec integration)



▲ *f*-Actin of MDCK cell, fluorescence stained with fluorescein-phalloidin.

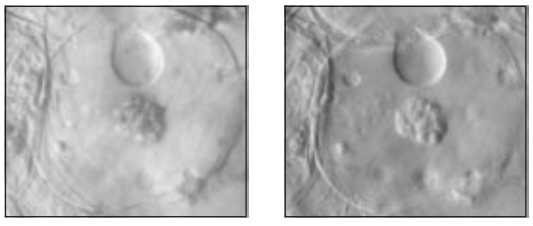
▲ ARGUS-20 with C2400-75i

ARGUS-20-PMDIC

The ARGUS-20-PMDIC is a newly developed extension of the Video Enhanced Contrast technique

Based on the well known ARGUS-20 image processor, this extension relies on video rate synchronization of contrast reversal and real time image subtraction to produce a unique video image. The result is an image that has automatic background subtraction and increased contrast in a single operation.
The addition of a single optical component, the Polarization Modulator, to a standard DIC microscope and the ARGUS-20-PMDIC hardware are all that are required.

Sample: Thick section of Jade Plant Root Tip (Genus Crassula)



▲ DIC Image ▲ PMDIC Image

▲ ARGUS-20 with C6489

AquaCosmos

Image Acquisition and Analysis System for Videomicroscopy

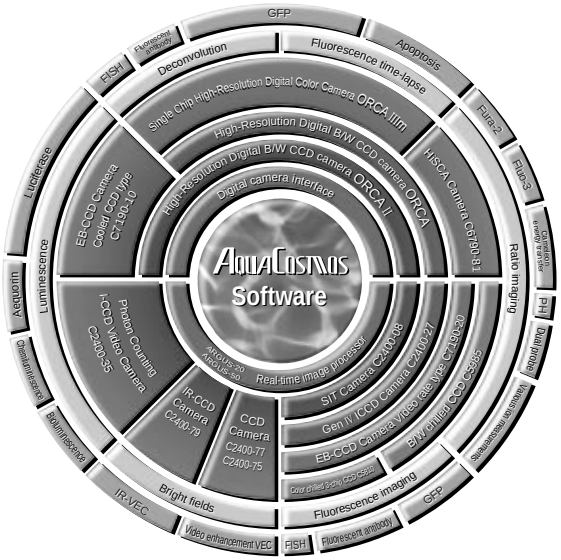
AquaCosmos is a next-generation image analysis system designed for use in biological fields. Renowned worldwide, it works hand-in-hand with a high-sensitivity digital cooled CCD camera and various types of imaging sensors designed by HAMAMATSU.

Can be connected to High-Resolution digital B/W CCD cameras.
A broad range of high-quality images, from luminescence to low light level fluorescence images, can be obtained.

Can be connected to a Single Chip High-Resolution digital color camera.
Fluorescence images and luminescence can be captured as high-quality, full-color digital images.

Can be connected to a variety of video cameras.
Image acquisition is possible from numerous types of cameras, including photon counting cameras, ICCD cameras, SIT cameras, and CCD cameras. Please feel free to consult HAMAMATSU concerning connections to your camera.

Can be connected to the newly-developed Electron Bombardment CCD camera (EB-CCD) and the Gen Ⅳ type of ICCD camera.
AquaCosmos can be connected to the EB-CCD camera, which is a next-generation high-sensitivity camera, as well as to the high-resolution Gen Ⅳ ICCD camera.



● Video enhancement microscope system

Using a differential interference (DIC) microscope and a CCD camera in combination, this system enables observation of living specimens, without using staining. Special image processing carried out in real time enables sharply clear observation of detailed subjects far surpassing the limits of the optical resolution of the microscope.
Phenomena such as microscopic cytoskeletons and exocytosis from secretory cells can be imaged. In addition, in-depth observation of tissue fragments and other subjects is also possible, using a near infrared CCD camera.

● Ratio imaging system

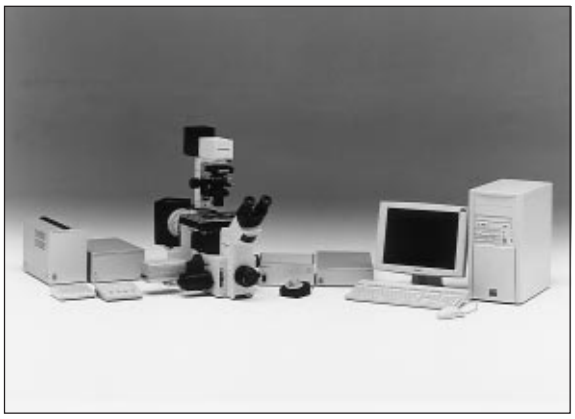
In this system, ratio imaging of fluorescence intensity is used to identify the dynamics of the various types of ion concentrations represented by the intra-cellular movements of calcium ions, both in two dimensions and as kinetic changes taking place over time. This system supports measurement using fluorescence probes for a variety of ratio methods.

● Luminescence image acqusition system

This system conducts luminescence imaging, using a photon counting I-CCD video camera (C2400-32/-35), EB-CCD Camera (C7190-10) and ORCA Ⅱ.
Applications include research such as gene expression analysis using luciferin-luciferase, blotting using emission kits, and the detection of active oxygen using emissions methods.

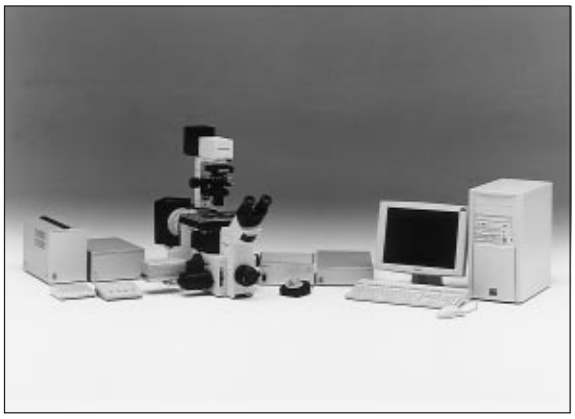
● B/W digital time-lapse recording system

The system can be configured in the ideal architecture to fit the application, such as measurement in which the excitation light shutter or transmitted illumination shutter is controlled, measurement in which switching of the excitation wavelength from the time lapse (XYT) of one wavelength is controlled, multi-wavelength fluorescence time-lapse measurement (XYλT) and four-dimensional time-lapse measurement (XYZT) that controls the Z focus, along with five-dimensional time-lapse measurement (XYλZT) which applies to the entire system.



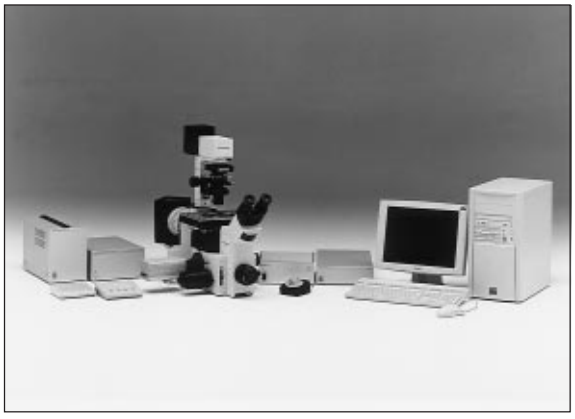
● Color digital time-lapse recording system

Using a color camera enables multi-layer fluorescence specimens and tissue-stained specimens to be captured in full color. The system can be upgraded to adopt the application, including adding time-lapse measurement (XYT) of color images in which the excitation light shutter or the transmitted illumination shutter is controlled, and 4-dimensional time-lapse measurement (XYZT) in which the Z-focus is controlled.



● Image deconvolution system

Attaching a Z-focus to the microscope and implementing control makes it possible to capture images while moving the position of the focal point. Because deconvolution software can be used to obtain sectioning images in sharp focus, free of optical bleeding from the image, excitation wavelengths can be used which were not available with laser confocal microscopes. In addition, because there is no need to use strong excitation light such as lasers, fading of the specimen can be suppressed, which allows high-quality images to be obtained.
Moreover, three-dimensional solid images can be obtained from sectioning images obtained in this manner.



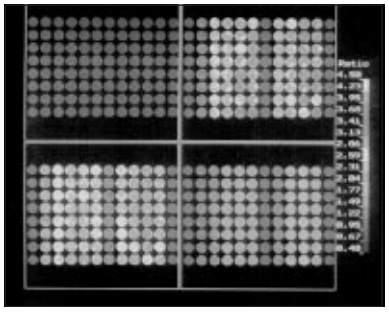
Fluorescence Drug Screening System: FDSS2000

Cell-based assay system featuring high sensitivity and wide dynamic range

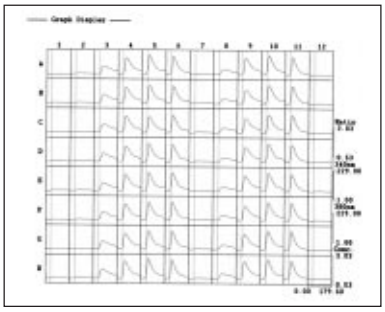
This is a cell-based assay system featuring high sensitivity and a wide dynamic range. A multi-dispenser unit enables simultaneous injection of samples into 96 wells.

Model	FDSS2000
Sensor	ICCD camera
Dynamic range	2-digit min.
96 multi-well injector	1
Injection range	10 to 200 µl
HTS	Manual installation

▲ FDSS2000



▲ Example of Fura-2 (FDSS2000)
A431 cell and adding Bradykinin
Data courtesy of KIRIN Brewery Co.,LTD
Pharmaceutical Research Laboratory



▲ Example of Fura-2 (FDSS2000)
(Measurement of temporal changes in fluorescence amount in each well)
A431 cell and adding Bradykinin
Data courtesy of KIRIN Brewery Co.,LTD
Pharmaceutical Research Laboratory

Infrared Oxygenation Monitor: NIRO®-300

Continuous, non-invasive measurement of tissue oxygenation using near infrared irradiation

Tissue is irradiated with a near infrared beam, and changes in the absorption rate are detected to measure changes in the oxygen concentration and the tissue oxygenation index (TOI). The measurement unit can be separated from the display unit and secured to poles and bars, to maximize efficiency in the setup of the equipment around the patient. Measurement can also be carried out in two locations simultaneously (optional).

▲ Example of bedside measurement

HAMAMATSU Semiconductor Failure Analysis System Series

Comparison of PHEMOS, THEMOS, µAMOS

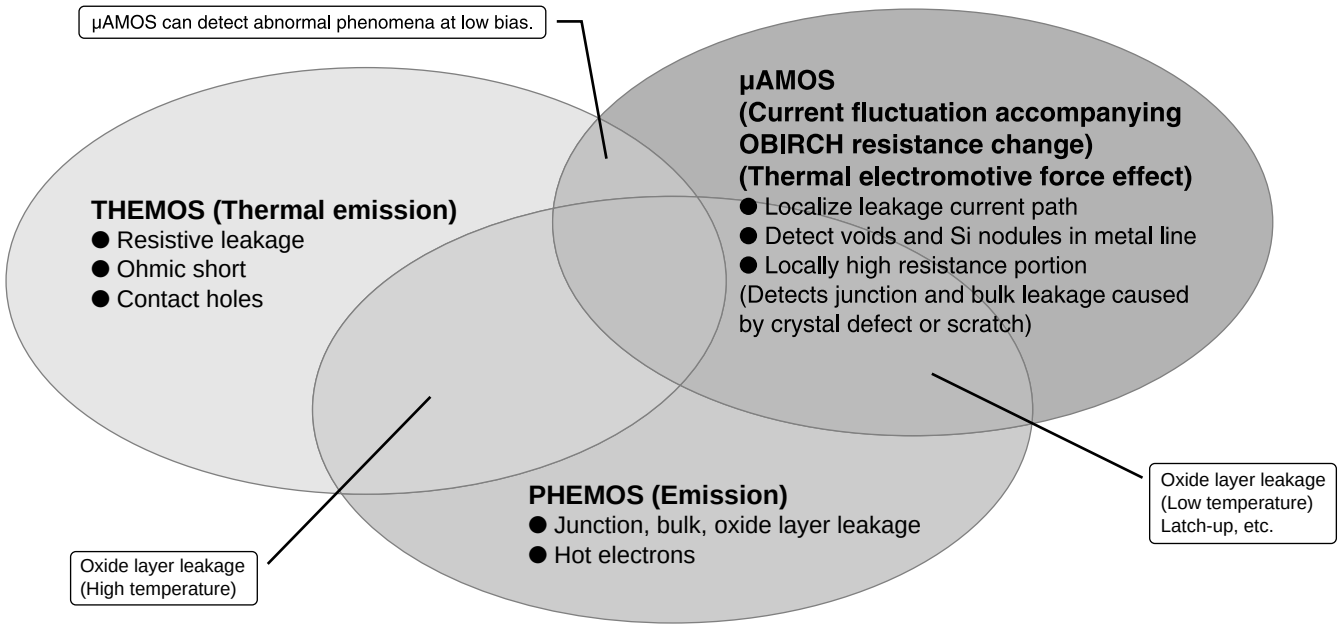
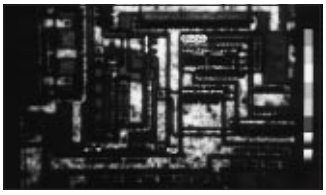


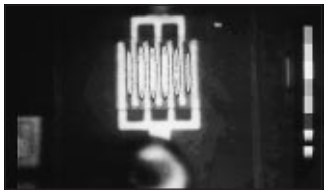
Photo Emission Microscope System: PHEMOS Series

Detection and quantitative analysis of positions of hot electrons, latchups, and other phenomena causing characteristic deterioration in VLSI chips, etc

This is an imaging and analysis system that uses a high-sensitivity video camera to detect extremely faint emissions caused by irregular phenomena occurring in semiconductor devices, such as ESD damage, leakage, hot carriers, and latchups. Extremely faint emissions from abnormal phenomena in the semiconductor device are detected in the dynamic state, and the positions are pinpointed.



▲ Example showing observation of emission from hot electrons in various FETs in an LSI chip



▲ Example showing observation of emission from recombination of minority carriers in bipolar transistor

▲ PHEMOS-200/C-CCD

Model	PHEMOS-75	PHEMOS-200/C-CCD	PHEMOS-200/II	PHEMOS-1000/C-CCD	PHEMOS-1000/II
Features	Micro-probing for packaged ICs, small chuck for diced wafer, flexible system	Compatible with commercial wafer probe station (optional), flexible system		Phemos-1000 incorporate a IR Confocal Laser Microscope to obtain high resolution, high dynamic range pattern image (Max 1024 × 1024).	
Detector	Dual Scan Mode Cooled CCD Camera	Dual Scan Mode Cooled CCD Camera	Photon Counting Camera	Dual Scan Mode Cooled CCD Camera	Photon Counting Camera
Packaged ICs	Yes				
Wafer	Possible (Die chip)	Yes			
Probing	Yes				
Eye piece	No	Yse (Binocular)			
Objective lens	5×, 20×, 100×				
Macro lens	0.8 (NA=0.25)	0.8 (NA=0.4)		0.8 (NA=0.4)/0.5 (NA=0.27)	
Max. field of view	15×15.27 mm (F.I.) or 15.36×15.36 (B.I.) mm	15×15.27 mm (F.I.) or 15.36×15.36 mm (B.I.)	12.5×11.6 mm	24×24.43 mm (F.I.) or 24.58×24.58 mm (B.I.)	20×18.56 mm
Back side detection	Optional		No	Yes	

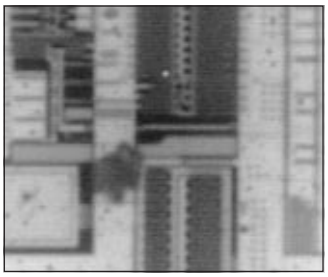
Thermal Emission Microscope System: THEMOS®-100

Locations of emissions caused by leaks in LSI and other semiconductor devices are detected as images, and positions pinpointed on circuits

These are thermal image analyzers designed to detect and analyze failure locations in semiconductor devices, using an infrared camera. Unlike conventional thermal analysis using liquid crystal methods, no thermal refining is needed, so thermal emissions can be detected quickly and at high sensitivity.

Model	THEMOS-100
Type	Wafer prober type
Features	Measurement of individual chips on wafers. Dedicated wafer-probe microscope provided.
Sensor	IR-CCD camera
Detection wavelength	3 to 5 µm
No. of pixels	801 × 512
Lens magnification	1×, 5×, 20×
Noise equivalent temperature difference	0.08°C

▲ THEMOS-100



▲ Front side observation of DRAM, using a 20× magnification lens.

▲ Backside observation of PLD, using a 20× magnification lens.

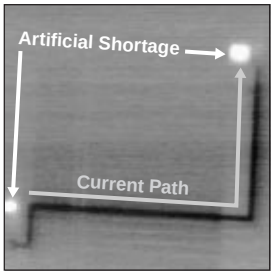
IR-OBIRCH Analysis System: µAMOS Series

New analysis system for detecting leakage wiring and wiring defects in LSI devices

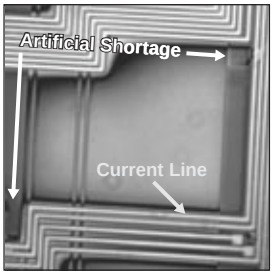
This is a semiconductor failure analysis device which uses a completely new method to pinpoint flaws in leakage current channels and wiring. The LSI circuit is irradiated with an infrared laser, and the resulting thermal emissions are used to detect changes in the current at high sensitivity. An OBIRCH (Optical Beam Induced Resistance Change) current image is displayed, synchronized to the scanned image of the laser.
This device enables leakage current channels to be pinpointed and resistance irregularities (via defects) in contact holes to be monitored.

Model	µAMOS-75	µAMOS-200
Type	Simplified probing type	Wafer prober type
Laser: Wavelength	1.3 µm	
Output	100 mW (standard), 500 mW (optional)	
Resolution	1024 × 1024, 512 × 512, 512 × 128	
Leakage current detection capability	50 µA (applied voltage 5 V, standard sample) 30 µA (applied voltage 3 V, standard sample) 20 µA (optional)	

▲ µAMOS-200



▲ OBIRCH Image



Objective lens: IR100X
Voltage: 4.8 V
Current: 1 mA

▲ Refractive Image (Backside observation)

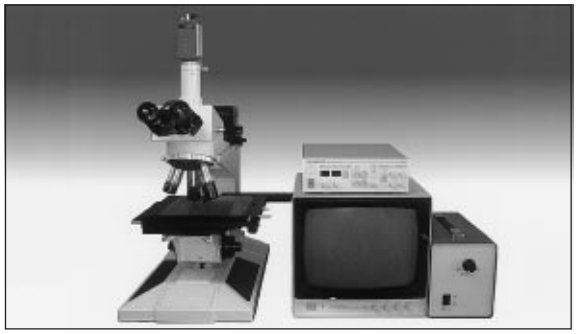
Infrared IC Internal Inspection System: C2955

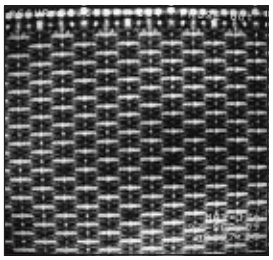
Tests electrodes, wire bonding, and dye bonding inside the IC

This is a testing system designed to inspect the IC internal defects, using an infrared microscope and an infrared vidicon camera. The infrared beam is passed through a silicon substrate and observed from the back, which enables non-invasive monitoring of interconnect network, wire bonding, and dye bonding, as well as the condition of the diffused zones.

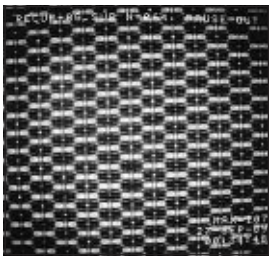
[100X Infrared Objective A3717]

This is a 100X lens designed specifically for the C2955.





▲ Memory IC pattern observed with standard 100X objective

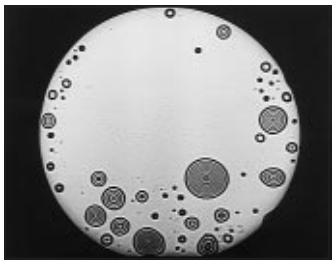


▲ Observation with the A3717 (same sample as at left)

Wafer Bonding Inspection System: C6145

Inspection system tests for voids in wafer bonding, using infrared light

This system is designed to inspect bonded wafers for voids, using infrared light transmission. In addition to voids, scratches and internal defects can also be monitored in real time, and displayed on the screen for visual inspection. Infrared lighting is used so that the entire surface of a large-diameter wafer can be inspected at one time.

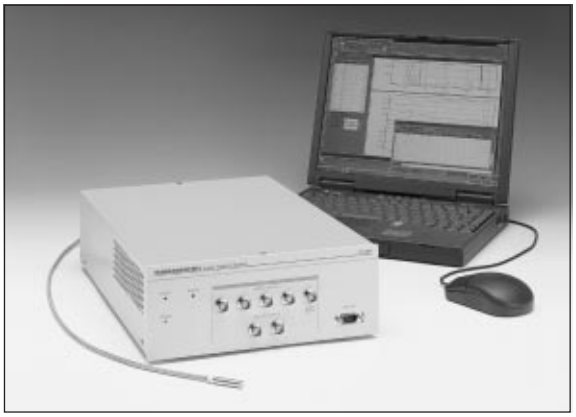


Void inspection ▶

Mutiband Plasma-Process Monitor: C7460

Plasma emissions are detected on multiple channels, in real time. Information management can be handled in a network format

This unit is designed for multi-channel, real-time detection of the optical plasma emissions created during semiconductor manufacturing processes using plasma, such as etching, sputtering, and CVD.
In addition to monitoring the plasma status, a variety of analysis functions can be used to detect the end of etching, optimize process conditions, estimate the type of plasma, and optimize the cleaning cycle. Moreover, an in-plant network designed for information management using an SAN (Sensor Actuator Network) makes it possible to use an Ethernet (TCP/IP) interface.



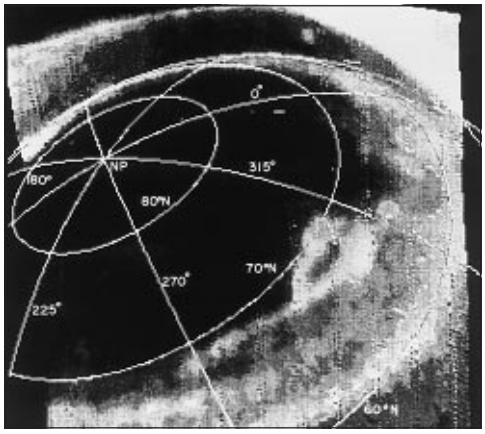
Measurement wavelength range	200 to 950 nm
Resolution:	Within 2 nm (FWHM of linear spectrum)
Interfaces (protocols)	Ethernet (TCP/IP)
	RS-232C (binary transmission)

⓬ Custom Tailored Systems

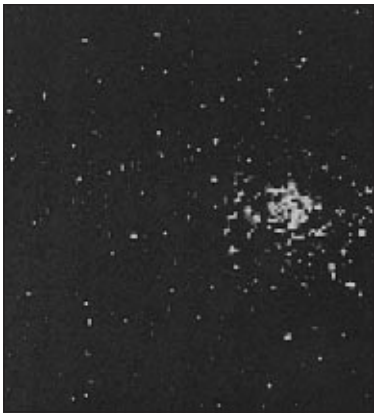
In addition to the standard products listed on the previous pages, Hamamatsu has developed and manufactures a wide range of products, custom tailored to fit the needs of the user, based on the target application and the environment in which the equipment is being used.

[Product Examples]

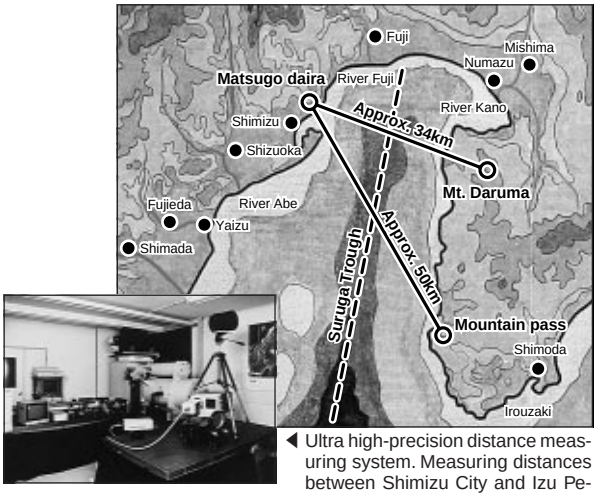
Product name	Content
Meadering and width anylysis system	System for measuring mendering and width of rolling lines on steel sheet or production lines on glass sheet
Ferrule eccentricity measuring systems	Systems for automatic measurement of eccentricity in ferrule connectors used in fiber-optic communications
Systems for measuring sizes of forged steel materials	Systems for measuring the diameters and shapes of forged steel materials
Rocket trajectory monitoring systems	Systems for monitoring rocket trajectories and obtaining flight data
Video camera systems for crystal pull-up control	Systems for measuring the width of single crystal pull-up (used to control pull-up speed)
Fuel rod dimension measuring systems	Systems for underwater measurement of external dimensions of nuclear fuel rods in nuclear power plants
Video camera systems for nuclear fusion reactors	Video camera systems for measuring reactor wall temperatures and impurities in reactors
Aurora imaging system	Systems for monitoring aurora phenomena in vacuum ultraviolet light (mounted on the satellite “Kyokko”)
Halley’s comet camera	Systems for monitoring the hydrogen corona of Halley’s comet in vacuum ultraviolet light (mounted on the Halley’s comet probe “Suisei”)
Ultra high-precision distance measurment	Precision distance measurement system using a laser and streak camera. Used for millimeter-unit measurements between Shimizu City and the Izu Peninsula, to foreknow earthquakes.



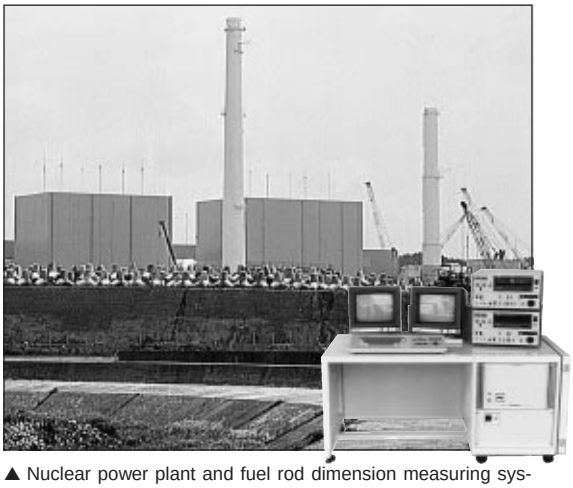
▲ Aurora captured by the aurora photographing system



▲ Hydrogen corona captured by the Halley’s comet imaging system



◀ Ultra high-precision distance measuring system. Measuring distances between Shimizu City and Izu Peninsula.



▲ Nuclear power plant and fuel rod dimension measuring system (Photo courtesy of Mitsubishi Heavy Industries Co., Ltd.)

[R & D 100 Award]

The R & D 100 Award is an award given on an annual basis for the best new products, technology, and materials developed that year, chosen as being the most outstanding and worthwhile of the year, by the “Research and Development” magazine issued in the U.S. The award, formerly called the I/R 100 Award, is given to a candidate selected by a screening committee from over 10,000 candidates every year after a multi-stage screening process. Hamamatsu has been awarded the R & D 100 Award four times, indicating the esteem in which our developmental and technological strength are held on a worldwide level.

- 1978: Awarded for the C1000 Computer Compatible Vidicon Camera computer use
- 1984: Awarded for the PIAS (Photon Counting Image Acquisition System)
- 1988: Awarded for the OOS-01 Sampling Optical Oscilloscope
- 1989: Awarded for the NIR-1000 (Non-Invasive Cerebral Oxygenetion Monitor)

▲ R&D 100 Award

[Top 10 Products]

Laser & Optronics, a U.S. publishing firm, awards prizes every year for the best 10 new products announced during the year (on a ranked basis). In 1989, Hamamatsu’s FESCA-500 was selected from among 40 candidates.

- 1989: Awarded for the FESCA-500 Femtosecond Streak Camera

[The 1990 Photonics Circle of Excellence Award]

Photonics Spectra, a U.S. publishing firm, awards 25 prizes every year for the best new products of the year. In 1990, Hamamatsu’s FESCA-500 was selected from among 120 candidates.

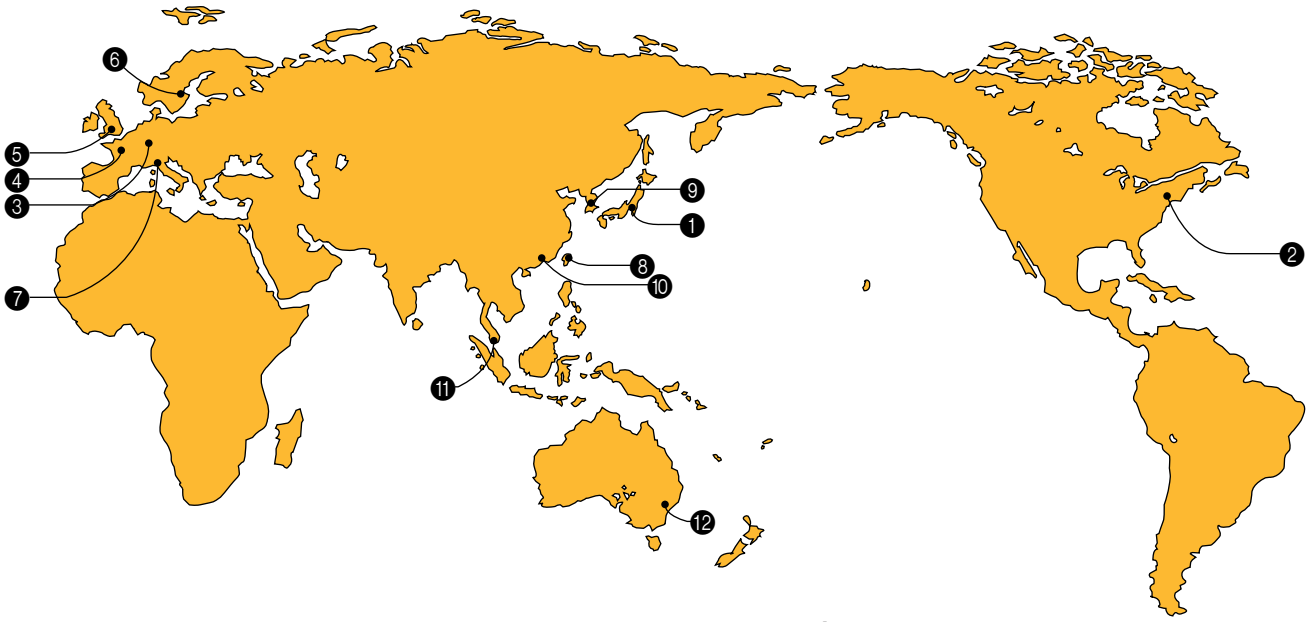
- 1990: Awarded for the FESCA-500 Femtosecond Streak Camera

Product Index

[C NUMBER]

[OTHERS]

SALES SUBSIDIARIES AND REPRESENTATIVES



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Cat. No. SSYS0002E03
SEP/99 CR
Printed in Japan (5000)