HAMAMATSU

PHOTON IS OUR BUSINESS

NEWS 2017 02

Cover Story

Rich data that provides new insights

ORCA-Flash4.0 LT +
Scientific CMOS camera

W-VIEW GEMINI-2C
Image splitting optics

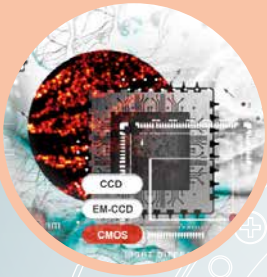
ORCA Spark
Digital CMOS camera

ImagEM X2
EM-CCD camera

ORCA-Flash4.0 V3
Scientific CMOS camera

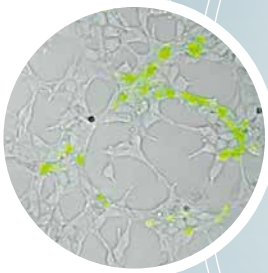
Live cell imaging
How does the brain work?

Super-resolution microscopy
New technology, new insights?



Micro- and nano-scale events
How do cells grow?

In vivo & in vitro
Is there a correlation between in vitro and in vivo performance?



Life in 4 dimensions
How can we enable faster 3D imaging?

Cellular voltage
Is there a better way to measure voltage at the cell membrane?

Maximum intensity projections
How can we shape the illumination to reveal the most information?

Cover Story

We are delighted to introduce Hamamatsu's newly updated Life Science Camera Community

Our community contains not only product information, latest news and events but also a wealth of information on the various imaging techniques such as live cell imaging, super-resolution and much more.

The Living Image is a site dedicated to celebrating life science imaging, brought to you by Hamamatsu. At the Living Image we present exciting research stories at the forefront of microscopy and imaging, highlighting the advances each work makes to biology and discussing technologies that make the work possible.

Find out about lightsheet microscopy and zebrafish brains, super-resolution microscopy at very high speeds, new insight into bacterial cell division, an innovative in vivo GPCR screening assay, and voltage measurements to visualize cellular excitation.

Explore our resources pages which offer insightful information about the technology behind the imaging. There you'll also find our Journal Club which provides in-depth details on imaging topics ranging from understanding which camera technology is likely to work for you to considerations on matching microscope optics to your experimental question.

www.hamamatsucameras.com

Cover Story

Live cell imaging

How does the brain work?

How does a collection of individual neurons coordinate to make a muscle move and understand what a scent means all in the same few milliseconds of time?

Scientists have been searching for answers to this question for decades, building up a complete picture from isolated bits and pieces of in vitro and tissue culture systems, stained tissue, and functional imaging technologies such as MRI.

Super-resolution microscopy

New technology, new insights?

Cell signaling and clathrin-mediated endocytosis. Lipid rafts and molecular motion within the membrane. Movement of organelles within a cell and cell division. Protein organization and co-localization. Virus entry. Many of cell and molecular biology's most critical events are occurring in the mid- to low- nanometer scale, which has hampered direct study through microscopy.

Micro- and nanoscale events

How do cells grow?

As a cell increases in size during progression of the cell cycle, how is new material added to the cell wall or the plasma membrane? Does growth occur evenly across the cell or are there specific zones where new components are deposited? Is there a pattern to addition? How is turgor pressure maintained? These are fundamental questions about the biology of a cell – as fundamental as DNA replication – but many of the molecular details remain unclear.

In vivo & in vitro

Is there a correlation between in vitro and in vivo performance?

In vitro cell culture has been a powerful tool for shedding light on cellular processes, but behavior in vivo – in the context of the cell's native environment within the living organism – can be quite different. This difference is one of the many factors that can plague high-throughput drug screening efforts, as candidate compounds that perform well in vitro can show little to no activity in vivo.

Life in 4 dimensions

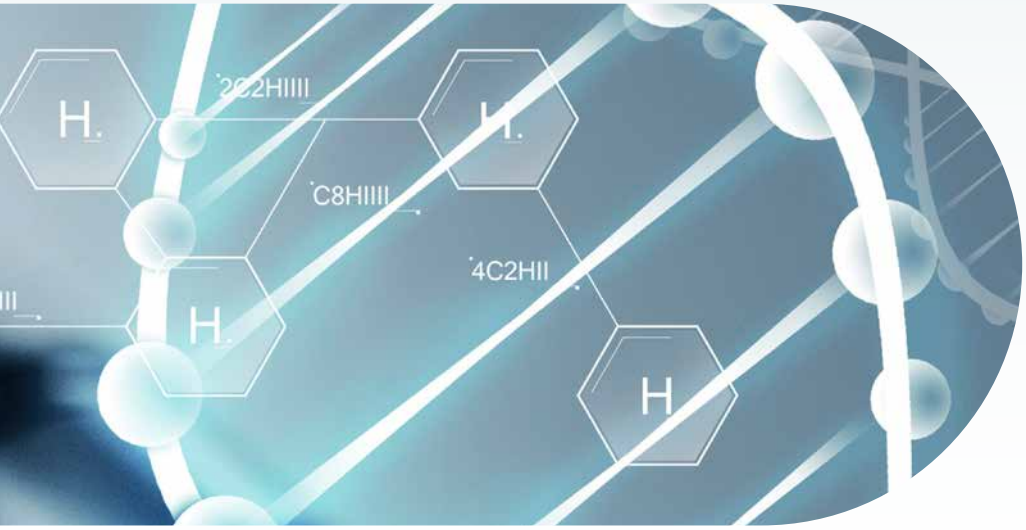
How can we enable faster 3D imaging?

From understanding how molecules shift and reorient as cells divide to capturing the complex, coordinated events that occur within neural assemblies inside a living brain, how can we truly understand biological processes unless we can watch them unfold at high-resolution in three dimensional space?

Cellular voltage

Is there a better way to measure voltage at the cell membrane?

Whether for basic research or drug discovery, precise measurement of voltage changes at the cell membrane is essential for understanding function, pathology, and potential therapeutic effects in electrically active cells. Ideal techniques for studying cellular voltage changes provide millivolt sensitivity and millisecond response times, preferably at subcellular resolutions.



Maximum intensity projections

How can we shape the illumination to reveal the most information?

Imagine capturing images of your living biological sample with excellent contrast, high x, y and z (axial) resolution and large field-of-view (FOV) with limited sample cellular damage from light exposure. Suddenly, probing inquiries into cellular development, morphology and behavior are within reach. Light-sheet microscopy is the powerful tool that enables this approach.

Digital CMOS Board Level Camera

High resolution scientific imaging with 12 megapixels

The core of the C13949-50U camera is the scientific image sensor, an advanced CMOS detector that simultaneously achieves high resolution, fast readout speeds and low noise.

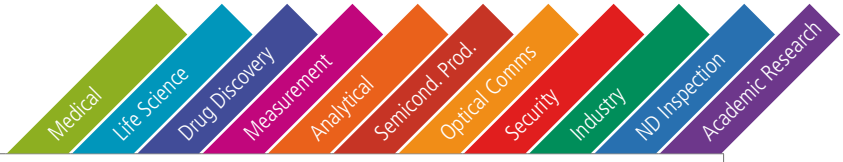
HIGH RESOLUTION
4,096 x 3,008
12 megapixels

READOUT NOISE
2.3 electrons
(typ.)

FRAME RATE
15 frames/s
(Full resolution)

See page 31 to find out more about our new Digital CMOS Board Level Camera.

Content



R&D Interview

An innovative step to expand X-ray inspection applications

A sealed type MFX with a transmission target is now on the scene!

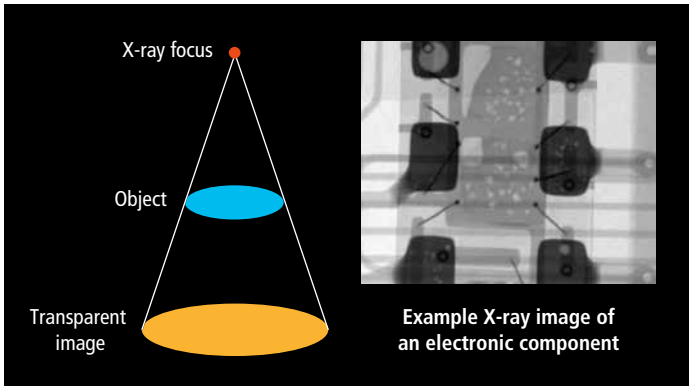
X-ray inspection is a technique that provides information about the internal structure of objects such as semiconductor devices, which cannot be seen from the outside. Its accuracy depends on the MFX or microfocus X-ray source used to generate X-rays. We have just unveiled a new model MFX that combines the advantages of the "open type" having high accuracy and a "sealed type" offering easy maintenance. This new model is a sealed type MFX using a "transmission target" which has been difficult to install in sealed types up till now. It delivers high resolution, high magnification, and a wide radiation angle, making it an ideal replacement for the "open type" currently ranked as a high-performance MFX model.

We talked to members of the project that achieved a plan spanning more than 10 years to develop this new model spawned by expectations on the market. Now let's hear about the background and groundwork leading to completion of this project.

Sealed type MFX with world's highest level of performance

First of all, we want to ask you, what exactly is an MFX or microfocus X-ray source?

Yagi: The MFX is an X-ray source that generates X-rays by focusing electrons through an electron lens to strike a very small area on a metal target in a vacuum. Since X-rays are then emitted from the focal spot on the metal target, the smaller the focal spot, the clearer and sharper the acquired X-ray image even when magnified geometrically. For example, the photo on the bottom is the X-ray image of an electronic component showing the internal structure down to the micrometer scale.



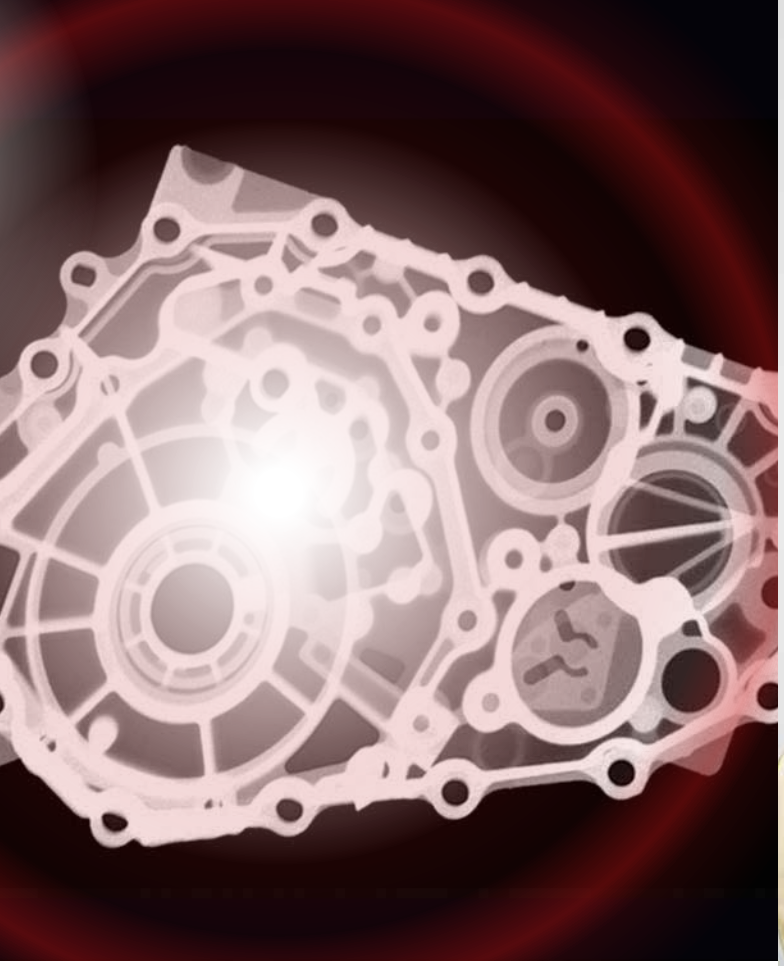
Example X-ray image of an electronic component

Suzuki: The MFX is available in two types. One is the sealed type while the other is an open type. The sealed type uses a vacuum tube called an X-ray tube, while the open type creates a vacuum state by a combination of a metal container and vacuum pumps. The sealed type is compact and lightweight allowing easy maintenance and lower power consumption. In contrast, the open type is large and requires regular maintenance yet has a replaceable cathode. Using the high precision cathodes gives more precise images.

Can you please explain what a transmission target is?

Tanaka: As mentioned earlier, the MFX generates X-rays by making electrons strike the metal target. There are two metal target structures where electrons collide. One is the transmission target and the other is the reflection target. The transmission target can form a small X-ray focal spot compared to the reflection target. The smaller the X-ray focal spot, the higher the resolution will be. So, as you might guess, this means that an open type MFX having a transmission target can acquire high precision images.

Suzuki: However, the transmission target usually requires a large electron lens with an electromagnetic focusing coil to achieve features such as a wide radiation angle, high magnification, and high resolution. This is one reason why open type MFXs using a transmission target have to be a large size.



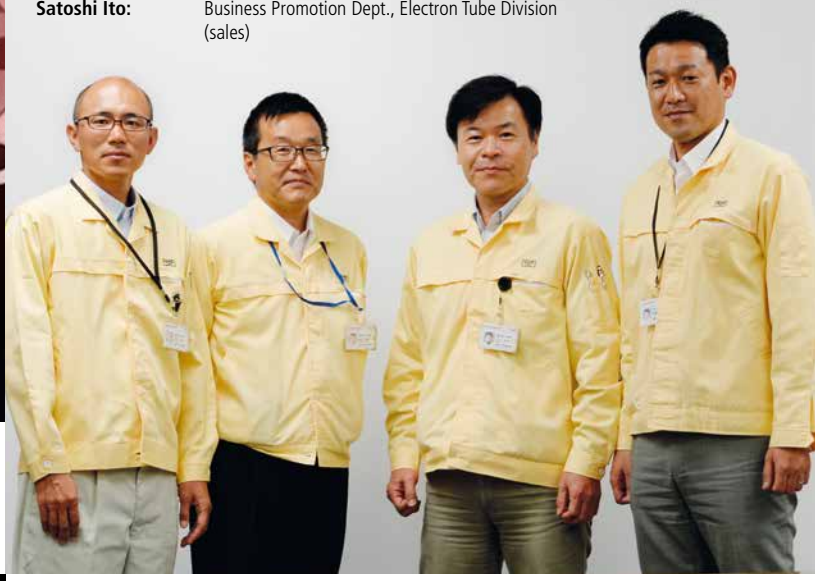
Interviewees (from the left)

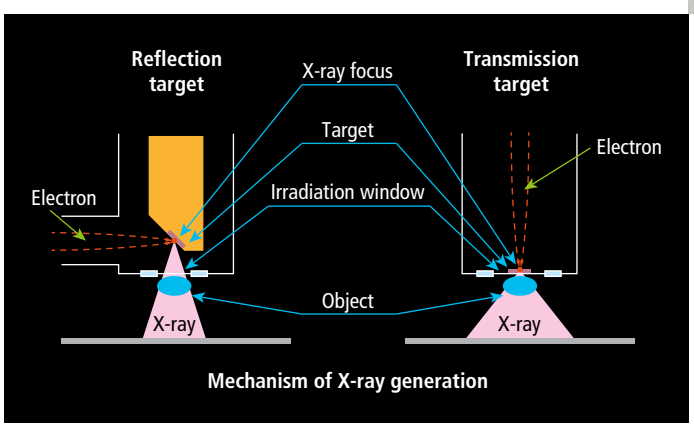
Kazutaka Suzuki: Manuf. #5, Electron Tube Division (main development of MFX)

Motofumi Tanaka: Manuf. #5, Electron Tube Division (development of sealed type MFX)

Chihiro Yagi: Manuf. #5, Electron Tube Division (general management in development of MFX)

Satoshi Ito: Business Promotion Dept., Electron Tube Division (sales)





Mechanism of X-ray generation

Ito: That large size is what makes it difficult for conventional technology to use a transmission target in a sealed type MFX.

Tanaka: The new model sealed type MFX we just developed succeeds in using a transmission target that makes the X-ray focal spot smaller, while still being compact, lightweight, and having easy maintenance. This means the new sealed type MFX delivers high resolution, high magnification, and a wide radiation angle equivalent to those of the open type MFX which is ranked as a high performance model.

Yagi: The open type MFX and the conventional sealed type MFX each have advantages and disadvantages. Our newly developed sealed type MFX is a hybrid model that combines the advantages of both types. We feel proud that our new sealed type MFX has the world's highest level of performance among similar type products from rivals.

Success! We downsized the electron lens by applying our advanced power supply technology

We have heard that installing a transmission target in a sealed type MFX was a tough task. What were the keys to solving this problem?

Suzuki: By applying power supply technology we have amassed over the years, we succeeded in developing a high voltage power supply that accurately controls the electric field generated between electrodes assembled for the electron lens. This allowed mounting a smaller-sized electrostatic focusing electron lens in a sealed type MFX instead of having to use a large-sized electromagnetic focusing electron lens.

Tanaka: Since we design and manufacture both sealed type and open type MFXs, we are familiar with the technical makeup of both types. I think this is one factor that led to our success.

Ito: In terms of sales, we estimate our sealed type MFX accounts for 70 to 80 % of the overall market share and our open type MFX accounts for some 10 % of the overall market share. So our sealed type MFX now has an overwhelming advantage in market sales. This increased market share results from the reliability, quality, and easy maintenance our high voltage power supplies offer.

Yagi: The sealed type MFX is easy to maintain and provides long-term operation and so now has a firm position as a general-purpose MFX

essential for in-line inspections. The increasing demand for 100 percent testing of smartphone components and batteries has tremendously boosted the need for making X-ray inspections. The advent of our new sealed type MFX will minimize the difference in performance between the sealed type and open type, so we can now expect dramatic new transitions in the X-ray inspection market.

When did you first get the idea to utilize the advantages of both sealed and open types?

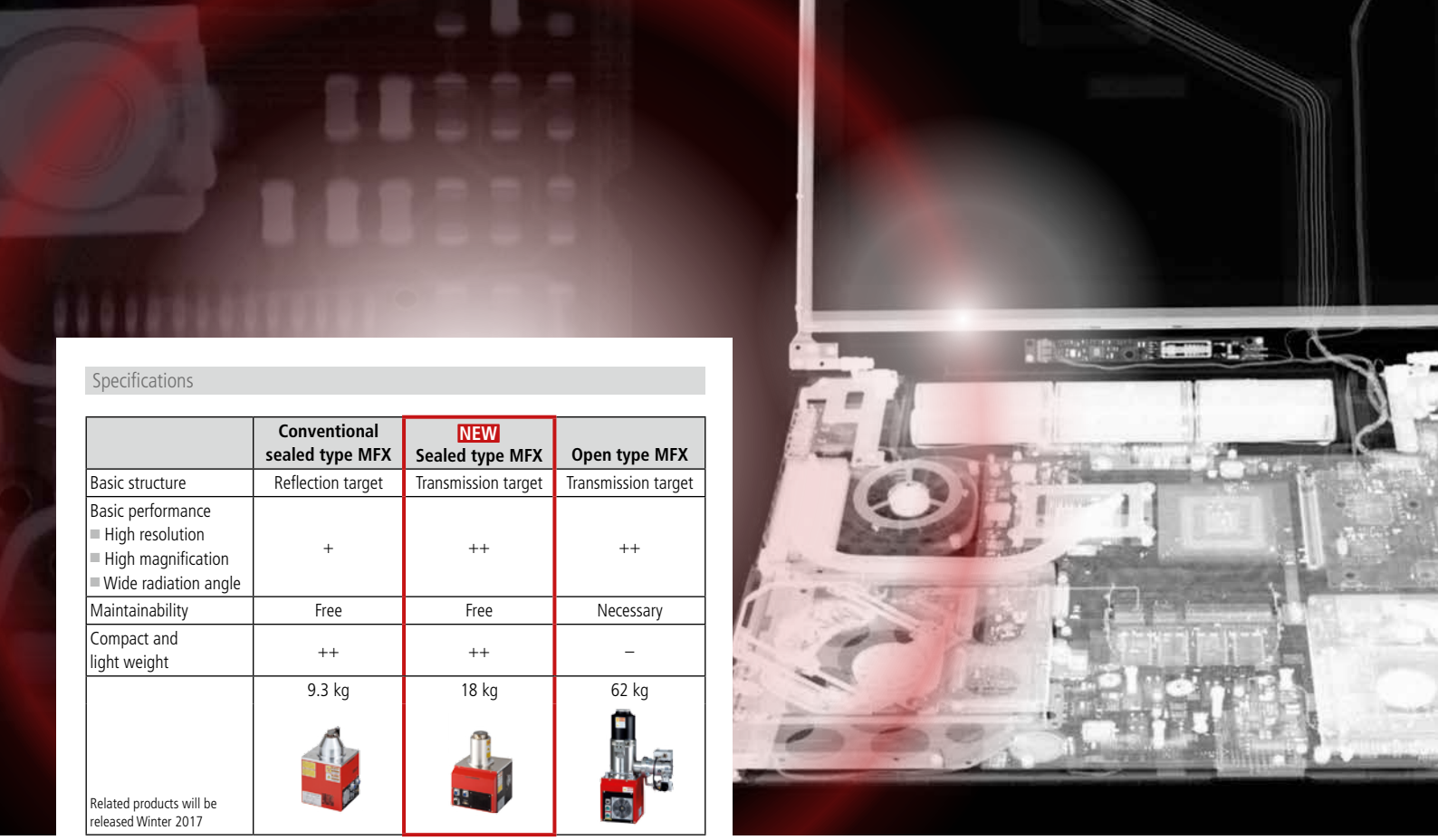
Ito: Sales of our MFX series started in 1993. Since then we have worked hard to develop both the sealed type and open type. Around 2003, we began studies on developing a model that merges the advantages of both types. But the technical hurdles to develop it were quite high and it took us many years to make that concept a reality.

Suzuki: It was very difficult to develop high-voltage power supplies for the MFX. In order of difficulty, the thorniest problem was developing a hybrid type power supply for the new sealed type MFX; followed by high-voltage power supplies for the conventional sealed type MFX; and then those for the open type MFX. One reason that made these tasks so difficult was that the open type and sealed type each use a different voltage application method.

Tanaka: On the open type MFX, the high-voltage power supply could be designed separately from the focus adjustment circuit. However, the new model was based on the idea of integrating the high-voltage power supply and focus adjustment circuit into the same compact unit. In that case, the high-voltage power supply and the focus adjustment circuit mutually affect each other, so finding an optimal balance was a real struggle.

Yagi: We have a proven track record in power supply technology that has allowed us to meet customers' demands for 80 to 300 kV. I do believe that this background is what helped us overcome these tough technical problems.

Suzuki: Besides designing a power supply, we also faced new challenges with the X-ray tubes and targets. Specifically, we had to substantially change the design concept, because the X-ray tube for the new model requires a high voltage with a polarity opposite the voltage applied to the conventional sealed type. A thermal problem also arose from the target where electrons strike to generate X-rays, because it was essential to focus the electrons onto a smaller focal spot on the target. So how to avoid this thermal effect within a vacuum was another serious challenge.



Specifications

	Conventional sealed type MFX	NEW Sealed type MFX	Open type MFX
Basic structure	Reflection target	Transmission target	Transmission target
Basic performance ■ High resolution ■ High magnification ■ Wide radiation angle	+	++	++
Maintainability	Free	Free	Necessary
Compact and light weight	++	++	–
Related products will be released Winter 2017	9.3 kg	18 kg	62 kg

Highly compatible with in-line inspection needs for electronic components

Have you had an opportunity to hear customer opinions or suggestions at the development stage?

Ito: There were a lot of demands from customers for a new model which integrates the advantages of the sealed type and open type. We also had customers saying: "I want to try it out right away!" even though it was still under development. So before releasing the new model, we asked customers more often than usual to evaluate the prototype and give us as much feedback as possible to reflect their needs in the final product.

Tanaka: Customer usage varies according to their applications. So at the prototype evaluation stage, we had a wide range of customers telling us what they really need and then we finally finished crafting a product that met the greatest common customer needs.

Are there challenges still remaining even for the new model?

Suzuki: We already have requests for a sealed type model that will operate on a much higher voltage and create a much smaller focal spot. This means that customers are still eager to acquire more detailed and clearer images.

Yagi: Most requests from customers are for in-line inspection applications. When using a sealed type MFX for in-line inspections, it must provide stable operation for long periods of time. However, the target is more likely to be damaged when the focal spot on the target is made even smaller. So, we will now work to achieve a smaller focal spot and a longer operation time, which are mutually opposing factors.

Ito: Recently, 100 % inspections are becoming the standard for electronic components such as in smartphones. This trend is also increasing the demands for X-ray non-destructive in-line inspections. We will make continuous efforts to meet customer needs to further expand the market for our new model.

Finally, any message to the readers?

Ito: The new sealed type MFX is a product we developed through a cluster of advanced technologies fostered over many years. Among these, vacuum tube technology essential for development of the sealed type MFX is the true strength of our company. I think our company mission is to provide high-end performance products at reasonable prices.

Yagi: There is a growing trend toward combining AXI (automated X-ray inspection) with AOI (automated optical inspection). AOI can only see the surface of objects, while AXI can see the inside (structure) of objects so that applying both inspection processes will give more accurate and streamlined results. We expect our new sealed type MFX will help expand the field of X-ray inspection applications even further.

See page 25 to find out more about our new sealed type MFX.

Company News

The United Nations Global Compact

Hamamatsu Photonics K.K. has signed the United Nations Global Compact proposed by the United Nations and become a registered participant on August 18, 2017.

The United Nations Global Compact is a voluntary initiative of the United Nations to encourage companies and organizations to engage in the establishment of a global framework to achieve sustainable growth and act as good members of society by demonstrating responsible and creative leadership. Participants support the Ten Principles in four areas of human rights, labour, environment and anti-corruption and make continuous efforts to achieve sustainable development.

The 10 principles
This initiative proposes 10 principles that registered companies respect and support to help create a sustainable world.

Hamamatsu will continue to grow further, making every member of our organization ever more able to contribute to the betterment of society by creating new industries with photonics technology.

A strong message from Hamamatsu Photonics:
We as a global company uphold the following principles of the United Nations Global Compact and contribute to sustainable growth of society.

Principle 1
Businesses should support and respect the protection of internationally proclaimed human rights; and

Principle 2
make sure that they are not complicit in human rights abuses.

Principle 3
Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;

Principle 4
the elimination of all forms of forced and compulsory labour;

Principle 5
the effective abolition of child labour; and

Principle 6
the elimination of discrimination in employment and occupation.

TECHNOLOGY DAYS 2017

Chasing Photons in X-ray and Infrared

We are delighted to announce the 4th Hamamatsu Photonics Technology Days; a series of free-of-charge, one-day events held across Europe. We are delighted to have secured the following leading experts:

- **Dr. Jose Pozo,** PhD, EPIC
  Technology and Business Trends in Photonics in Europe
- **Prof. Dr. Markus Sigrist,**
  Institute for Quantum Electronics, ETH Zurich
  Sensing by Infrared Laser Spectroscopy
- **Prof. Dr. Peter Seitz,**
  Hamamatsu Photonics Europe, ETH Zurich, EPFL
  X-rays – See further than with VIS-NIR
- **Dr. Dieter Renker,** CERN / PSI / TU Munich
  Latest developments in SiPM / MPPCs

Principle 7
Businesses should support a precautionary approach to environmental challenges;

Principle 8
undertake initiatives to promote environmental responsibility; and

Principle 9
encourage the development and diffusion of environmentally friendly technologies.

Principle 10
Businesses should work against corruption in all its forms, including extortion and bribery.

http://www.hamamatsu.com/jp/en/news/csr/20170828000000.html

For further information, please refer to the following website
www.unglobalcompact.org/what-is-gc (En)
www.unglobalcompact.org/what-is-gc (Fr)

Application Report

FISHing of gut microbiota with the NanoZoomer S60

Risson A., Tamellini A., Darnaud M.

BIOASTER, a new model for technology innovation in microbiology

The BIOASTER Technology Research Institute (TRI) was created in April 2012 by the Institut Pasteur and Lyonbiopole health competitiveness cluster, following the initiative of the French Government through the "Investissements d'Avenir" Program.

BIOASTER is leading collaborative projects that bring together academics, start-ups, SMEs and industrial groups, and is developing a unique technological and innovative model in order to overcome technological bottlenecks and explore new avenues applied to microbiology in health and diseases. In this context, the Preclinical Models & Imaging Unit tested the Hamamatsu NanoZoomer S60 with its fluorescence module, to evaluate its relevance for bacteria imaging in relation to the study of host-microbiota and microbes-microbes interactions.

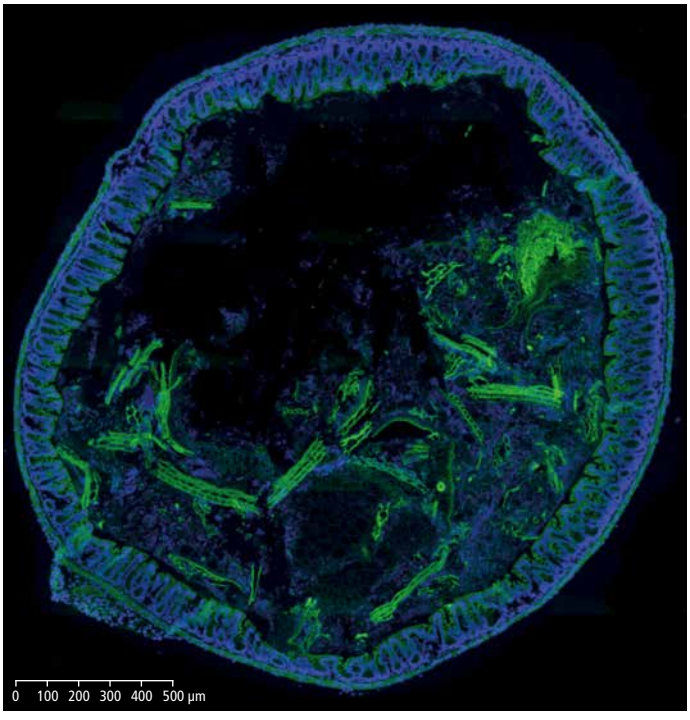


Figure 1: Whole mouse colon section stained with DAPI (blue) showing high level of green autofluorescence from the gut epithelium and lumen, which can be a limitation for imaging samples with green channel (FITC). 20x objective, 4x view.

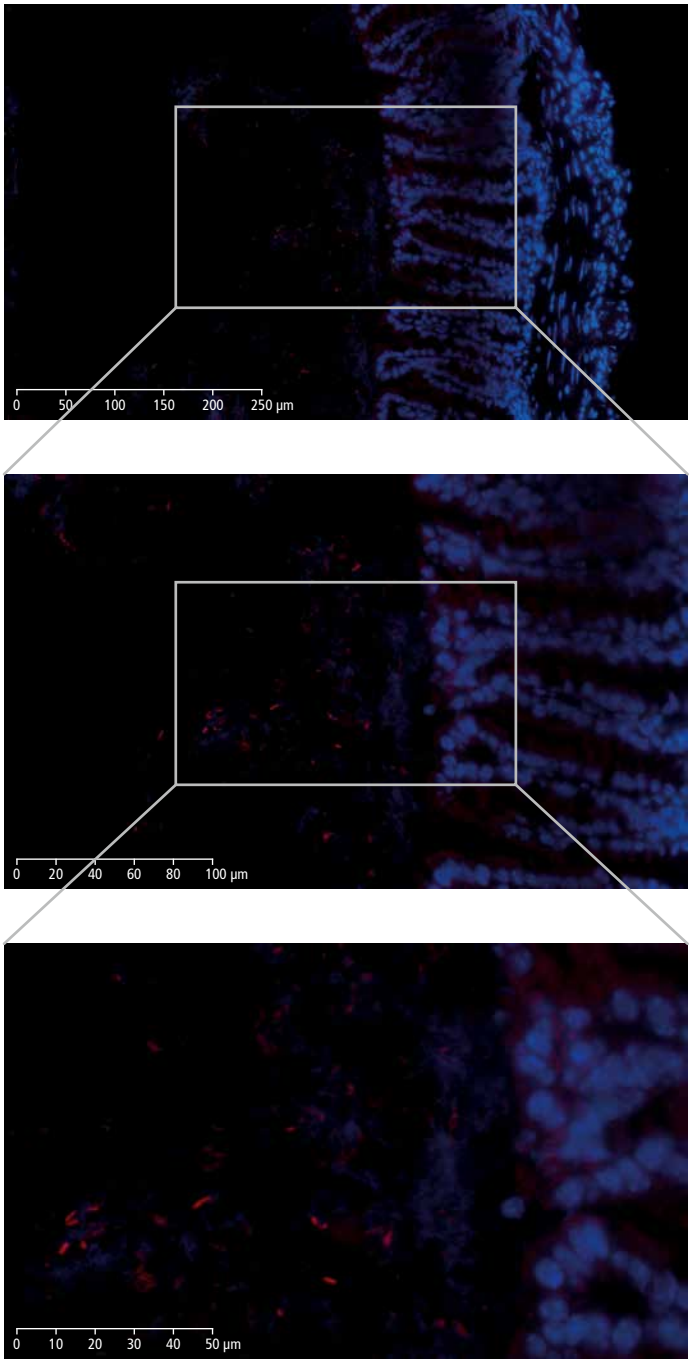


Figure 2: Mouse colon section showing epithelial cell nuclei stained with DAPI (blue) and Lactobacilli distribution within the lumen, detected by the FISH probe LGC0355 labeled with the fluorophore CY5 (red). 20x objective (above), magnification to 40x (middle) and additional numerical zoom to 80x (below).

Bringing the gut microbiota into focus

Histological processing can alter tissues so several sections are often placed on the same microscopy slide in order to maximize the acquisition of views. One great advantage of the NanoZoomer is its capacity to scan the whole microscopy slide with the possibility afterwards to zoom anywhere within the scanned image to look just as well at a whole tissue section (Figure 1) as at a specific subcellular site (Figure 3).

In addition to high quality magnification, the NanoZoomer offers two essential features, an automated focus with the possibility to delete or add manually focus check points on the epithelium, and Z-stacking for samples with 3D structures such as bacteria. We found that 0.5 µm z-steps travelling from -0.5 µm (below focus point) to +1.5 µm (above focus point) were optimal for mouse colon sections of 4 µm.

Another great value of the NanoZoomer is the possibility to detect 6 different fluorescent probes or more, optimize individual intensity and potentially modify colors to improve clarity, allowing for co-staining of different targets, but it also makes it possible to overcome some limitations due to the green autofluorescence of the intestinal epithelium (1) and lumen, which might mask bacteria specific signals (Figure 1).

Imaging of Lactobacilli detected by specific fluorescent in situ hybridization (FISH) in mouse colon sections

Increased evidence that gut microbiota is a key factor in human health and diseases opens a new golden age in microbiology. From pathologies to phenotypical features, its range of action holds promises which have to be unveiled in the near future. However, the gut microbiota is an ecosystem that has proved itself to be a lot more complicated than what was expected. As a result, the development of simplified models, but conserving the key features of original models, is of high necessity in enabling scientists to study the causal link between microbiota changes and the host response (2, 3).

In the context of an internal innovation project at BIOASTER which aimed to establish such a gnotobiotic mouse model, we set up FISH imaging activities in order to highlight host-microbiota and microbes-microbes interactions. Hereinafter, we show images of a mouse colon section stained with the FISH probe LGC0355 targeting Lactobacilli, Firmicutes (Figure 2), which are among the most common bacteria in the mouse gut, but also in the intestine of humans and widely used as probiotics.

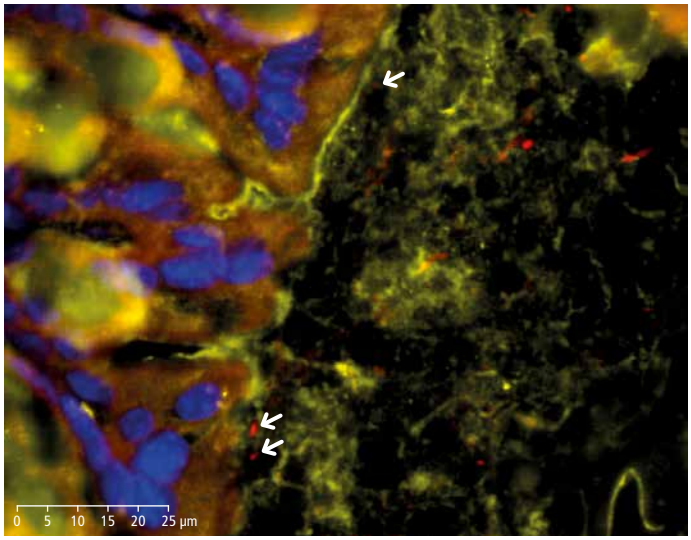


Figure 3: IF staining of Muc2 secreted by Goblet cells (orange, TxRed) in mouse colon section showing the adhesion of Lactobacilli (red, CY5) to host surfaces (epithelial cell nuclei stained with DAPI, blue) through mucus-microbe interactions (arrows). 20x objective, 80x view.

Combining immunofluorescence (IF) and bacterial FISH to highlight the intestinal barrier

Next, we additionally stained the mucosal barrier in order to inspect the border between the intestinal epithelium and the microbes (Figure 3). The mucus secreted by Goblet cells protects the epithelial cells against damage, but also accommodates Lactobacilli which have adhesion properties on mucins, allowing suitable interaction with the host to confer health benefits (4).

In conclusion, the NanoZoomer S60 provides high quality fluorescence imaging of gut microbiota comparable to confocal microscopy, with improved reproducibility and time management thanks to automated scanning and a proper slide capacity. On top of that, the same equipment allows brightfield imaging, and easy-to-use software offers full options analysis, including interactive data sharing with collaborators.

For further information see:

[1] Monici M. (2005) "Cell and tissue autofluorescence research and diagnostic applications." Biotechnol Annu Rev 11, 227.

[2] Stappenbeck TS, Virgin HW. (2016) "Accounting for reciprocal host-microbiome interactions in experimental science." Nature 534, 191.

[3] Martin R, Bermudez-Humaran LG, Langella P. (2016) "Gnotobiotic Rodents: An In Vivo Model for the study of Microbe-Microbe Interactions." Front. Microbiol. 7, 409.

[4] Van Tassell ML, Miller MJ. (2011) "Lactobacillus Adhesion to Mucus." Nutrients 3, 613.

InGaAs Linear Image Sensors G13913-128FB/-256FG

NEW

Near infrared image sensors for portable analytical instruments

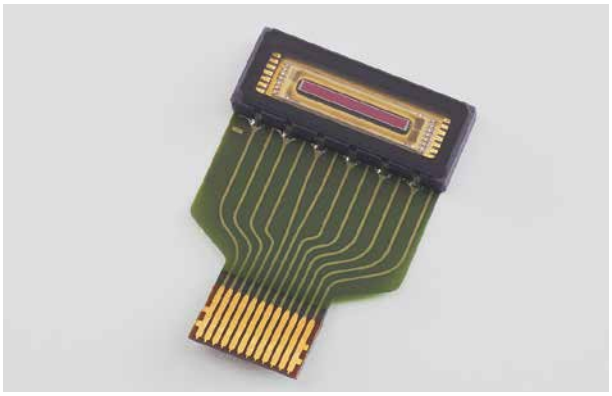
The compact and low-cost near infrared linear image sensors are designed for portable analytical instruments. They consume less current than the previous product (DIP package products: G11620 series). Further, because they employ a compact LCC package with a flexible board, they are suitable for integration into compact thin devices.

Features

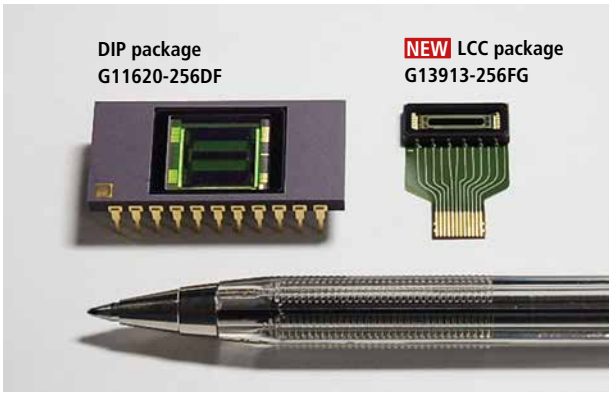
- Compact (with flexible board)
- 3.3 V drive
- Low current consumption: 15 mA (G13913-128FB)
- Low cost
- 128 pixels (50 x 250 µm/pixel): G13913-128FB
- 256 pixels (25 x 250 µm/pixel): G13913-256FG

Applications

- Portable analytical instruments



G13913-128FB/-256FG

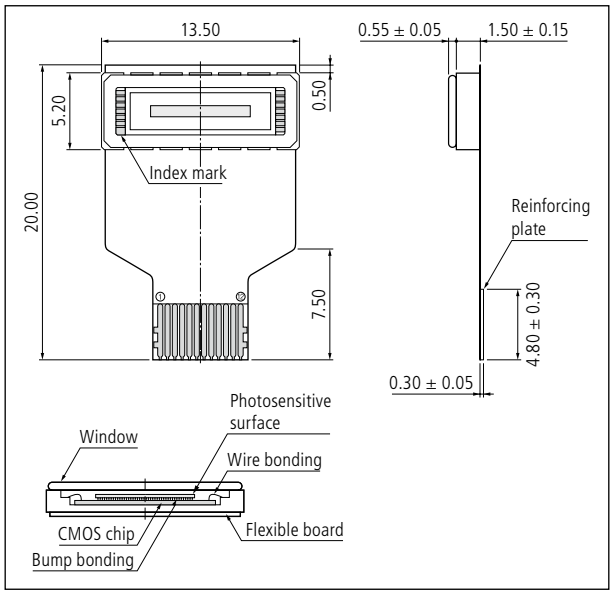


Specifications (Comparison with the DIP package product)

Parameter	NEW LCC package G13913-256FG	DIP package G11620-256DF	Unit
Spectral response range	0.95 to 1.7		µm
Number of pixels	256	256	pixels
Pixel size (H x V)	25 x 250	25 x 500	µm
Supply voltage	3.3	5	V
Consumption current	20	50	mA
Readout noise*1	150	200	µV rms
Saturation output voltage	2.2	2.8	V
Dark current*1	±1	±0.5	pA
Package size	13.5 x 5.2 x 2.05	31.8 x 15.1 x 3.0	mm

*1 CE = 16 nV/e⁻, t = 10 ms

Dimensional outline (Unit: mm)



NEW

Infrared LED
L13072-0120P, L13895-0145P, L12509-0155P

Near infrared LEDs in low-cost bullet-shaped packages suitable for near infrared lighting

These high output near infrared LEDs have a peak emission wavelength at 1 µm or higher. Highly reliable metal packages and packages with lens are available in addition to the low-cost bullet-shaped packages.

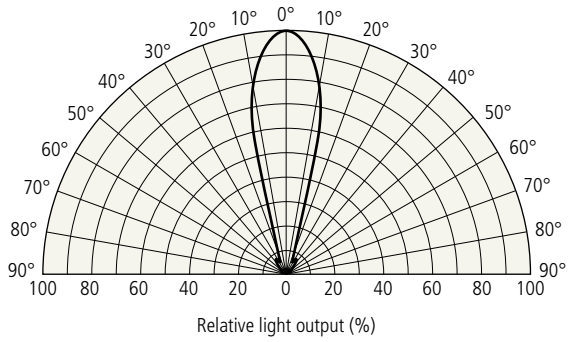
L13072-0120P, L13895-0145P, L12509-0155P

Specifications

Type No.	Peak emission wavelength (µm)	Spectral half width (nm)	Radiant flux (mW)	Forward voltage (V)	Cutoff frequency (MHz)
L13072-0120P	1.2	80	5	1.1	15
L13895-0145P	1.45	120	5	0.9	10
L12509-0155P	1.55	120	3.8	0.8	15

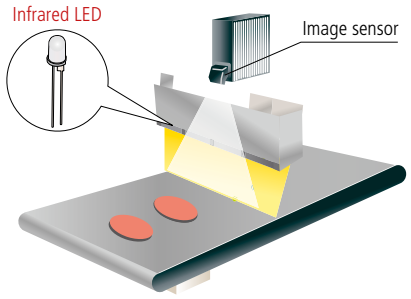
* Measurement condition: I_F = 50 mA

Directivity (Typ. Ta = 25 deg. C.)



Application example (Lighting for infrared cameras)

Infrared LEDs with large output are used as light sources for infrared camera imaging. These LEDs are arranged around the camera.



LCOS-SLM Modules
X11840/X13268/X13139 Series

NEW

LCOS-SLM for high-power lasers

Heat radiation type LCOS-SLM (Liquid Crystal on Silicon – Spatial Light Modulator) suitable for high-power laser processing was added to the current lineup. The incorporation of a water-cooled heatsink along with an elaborately designed mirror that improves reflectance suppresses temperature increase to less than one-tenth that of the previous product while providing high light resistance performance.

Differences from previous type

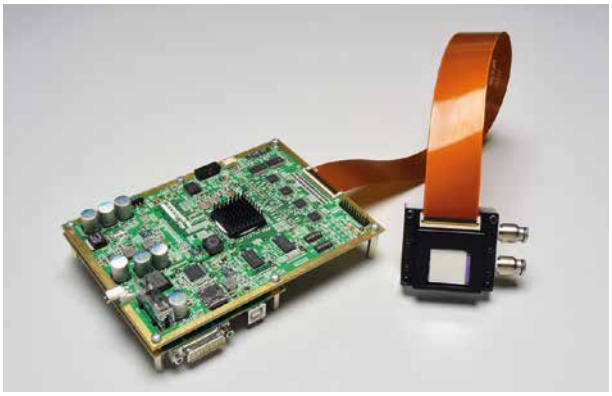
The power handling capability has been improved from 40 W/cm^2 to 210 W/cm^2 or more. They are expected to be used for laser processing applications such as laser marking with high-power lasers with 100 W class.

Features

- Incorporation of a water-cooled heatsink to improve heat radiation efficiency
- Improved mirror reflectivity to suppress heat generation
- World's highest light resistance performance based on design utilizing unique Hamamatsu know-how

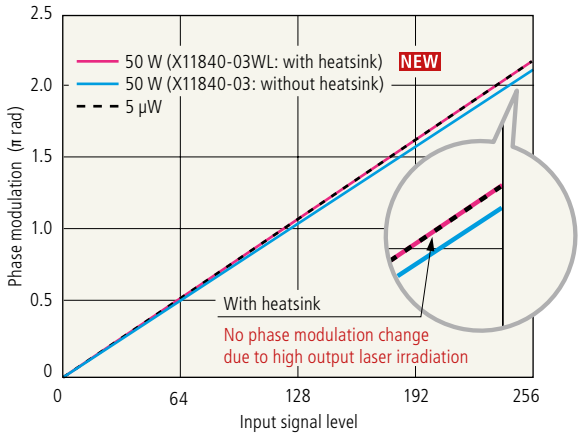
Specifications

Parameter	X11840-03WL/-03WR X11840-04WL/-04WR	X13268-03WL/-03WR X13268-04WL/-04WR	X13139-03WL/-03WR X13139-04WL/-04WR	Unit
Number of pixels	792 x 600		1,272 x 1,024	pixels
Pixel pitch	20	12.5	12.5	µm
Effective area size	15.8 x 12	9.9 x 7.5	15.9 x 12.8	mm
Fill factor	98	96	96	%
Interface	Digital Video Interface (DVI-D)			-



X11840/X13268/X13139 series

Laser irradiation test result



Laser test conditions
Wavelength: 1,030 nm
Beam diameter: φ5.5 mm
Irradiation level: Average output = 50 W, per unit area = 210 W/cm^2

Improved light resistance

A water-cooled heatsink was installed in the LCOS head section to improve light resistance. The heatsink suppresses the temperature increase caused by laser irradiation.

NEW

CMOS Area Image Sensors S11680-71-02/-82-02

Image sensors with a USB cable

These CMOS area image sensors have 1.5 megapixels (1,000 x 1,500), each of which is 20 x 20 µm in size. They have a built-in photodiode that detects light irradiation. The type with a fiber optics plate (FOP) has a flat surface, which is suitable for bonding optical components. These products are sensitive to visible light, but X-ray imaging becomes possible by mounting scintillators on pixels.

Features

- Thin package: 21.8 x 35.4 x 1.5[t] mm (S11680-71-02)
- Built-in photodiode that detects light irradiation
- USB 2.0 interface

Applications

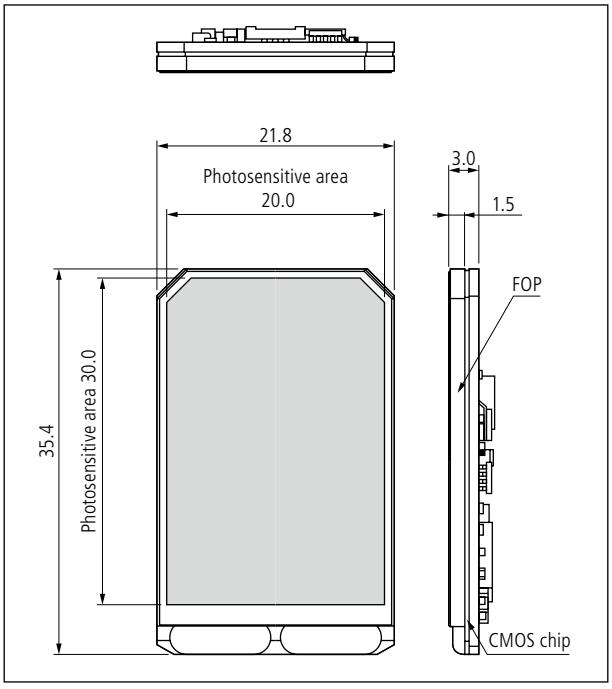
- Scientific analysis
- Scintillator evaluation
- Non-destructive X-ray inspection (Additional scintillator is required.)

Specifications

Parameter	S11680-71-02	S11680-82-02	Unit
Image size	20 x 30		mm
Pixel size (H x V)	20 x 20		µm
Number of pixels	1,000 x 1,500		pixels
System gain	60		e^-/LSB
FOP	None	With FOP	-

S11680-71-02/-82-02

Dimensional outline S11680-82-02



Optics Modules C13398-01/-02

NEW

Absorbance measurement modules with built-in photodiode array, optical elements, current-to-voltage converter

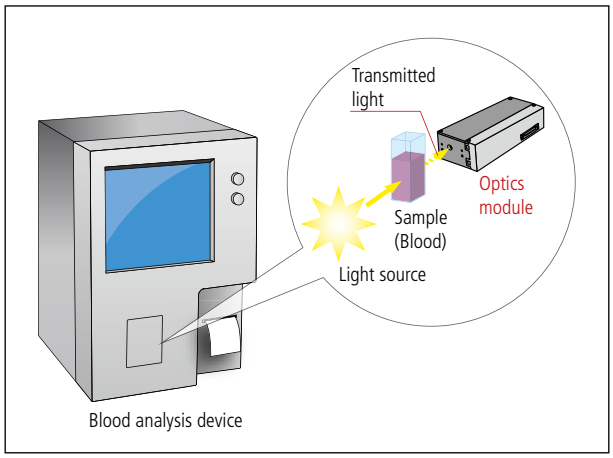
The C13398-01/-02 are optics modules for absorbance measurement featuring high blocking performance (OD > 4) and low noise. They are composed of Si photodiodes, beam splitters, filters, and a current-to-voltage conversion circuit. In combination with the dedicated evaluation circuit C13390 (sold separately), the analog output signals of each channel of the C13398 series can be converted into digital signals, and the results can be acquired into a PC. The C13398-01/-02 and C13390 can be driven by USB bus power.

Features

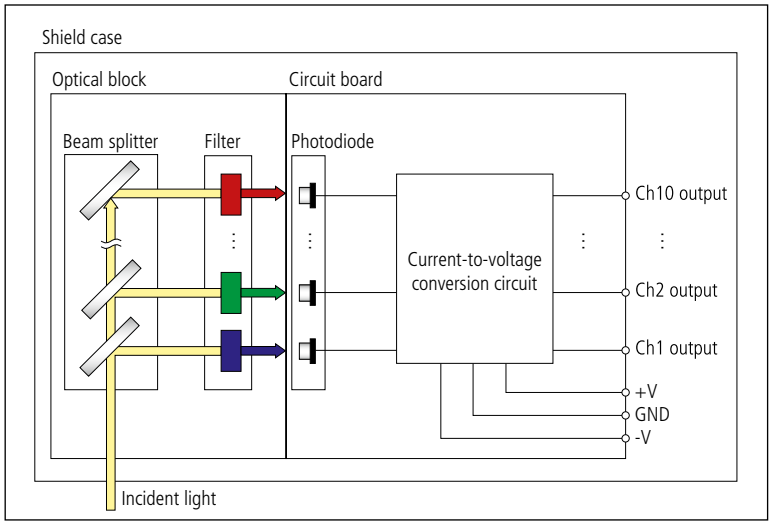
- Simultaneous detection of 10 wavelengths: C13398-01
  Simultaneous detection of 9 wavelengths of light and reference light: C13398-02
- High blocking characteristics: OD > 4
- A dedicated evaluation circuit C13390 is available (sold separately)
- Compact: 89 (W) x 26 (H) x 39 (D) mm
- Can be mounted on optical rod (M4)

C13398-01/-02

Application example (Blood analysis device)



Block diagram



Specifications

Parameter	C13398-01	C13398-02
Detector	Si photodiode	
Number of channels	10 ch	
Detection wavelength	340, 405, 450, 510, 546, 570, 600, 630, 660, 700 nm	340, 380, 405, 492, 510, 546, 578, 620, 690 nm, reference light
FWHM	10 nm	
Blocking OD	>4	
Conversion impedance	10^7 V/A	
Cutoff frequency (-3 dB)	1.6 kHz	
Maximum output amplitude	±9.8 V	
Output noise voltage (Dark state)	1 mVp-p	
Current consumption (Dark state)	±18 mA	
Supply voltage	±10 V	

Customization of detection wavelengths and conversion impedance is possible.

NEW

Multianode Photomultiplier Tube Assembly H13700

16 x 16 (256) channel multianode photomultiplier tube

Capable of observing single photon peaks on all channels

The H13700 is a successor model to the H9500 multianode photomultiplier tube assembly, and is capable of observing single photon peaks on all channels. The signal output connector of the H13700 differs from the H9500, but is easily connectable to PC boards.

Differences from previous model

Compared to the previous model (H9500), the collection efficiency*1 of the H13700 is improved from 65 % to 79 %, allowing observation of single photon peaks on all channels. Quantum efficiency is also increased from 24 % to 29 %.

Features

- Large sensitive area (Effective area ratio: 88 %)
- Wide effective photocathode size (48.5 mm x 48.5 mm)
- High-speed response (TTS: 380 ps)
- Capable of detecting and observing single photon peaks on all channels

Applications

- Academic research (RICH, colorimeter, gamma-ray telescope, etc.)
- Medical image diagnosis (PET, gamma camera, etc.)
- Radiation measurement

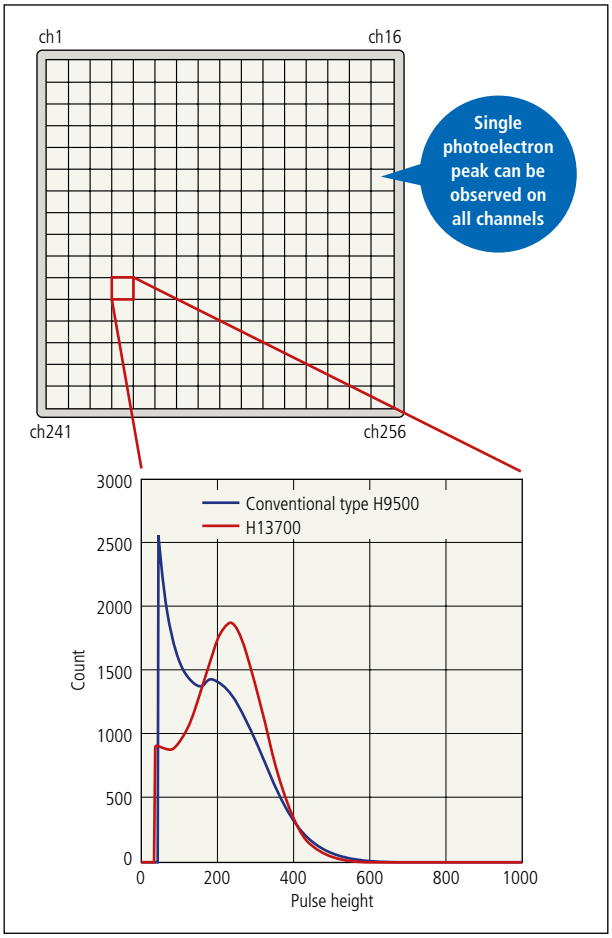
*1 Based on electron trajectory simulation.

Specifications

Parameter	H13700	H13700-03	Unit
Spectral response range	300 to 650	185 to 650	nm
Window material	Borosilicate glass	UV glass	-
Photocathode type	Bialkali		-
Effective area	48.5 x 48.5		mm
Anode type	16 x 16 matrix (256 ch)		-

H13700

H13700 vs. H9500



Photosensor Module H13229

NEW

Photomultiplier tube module usable in a vacuum or depressurized environment

The H13229 is a current-output photomultiplier tube module that consists of a TO-8 package photomultiplier tube, a high-voltage power supply circuit, and signal input/output pins.

Differences from previous model

The H13229 is the first photomultiplier tube module designed for use in a vacuum or depressurized environment.

Features

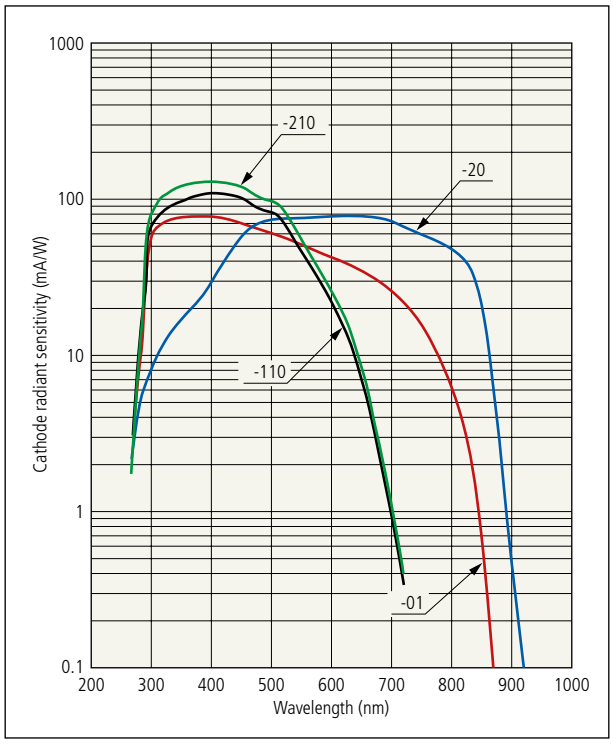
- Usable in a vacuum or depressurized environment
- Compact and lightweight
- Low power consumption
- Low outgassing

Application

- Low-level light measurement in a vacuum or depressurized environment

H13229

Spectral response (H13229 series)



Specifications

Parameter	Spectral response range	Peak wavelength	Unit
H13229-01	300 to 870	400	nm
H13229-110	300 to 700	400	nm
H13229-20	300 to 920	630	nm
H13229-210	300 to 700	400	nm

Specifications

Parameter	Specification	Unit
Input voltage	+3 to +5	V
Input current (at dark)	2.7	mA
Effective area	8 dia.	mm
Operational environment	Atmospheric to 0.01	Pa
Case material	Glass	-

NEW

Photon Counting Head H12775

Photon counting head incorporating a 1/2-inch head-on photomultiplier tube

The H12775 is a photon counting head incorporating a 1/2-inch head-on photomultiplier tube, a high-voltage power supply circuit, and a photon counting circuit. Photon counting measurements can be made by just supplying +5 V. The effective photosensitive area is 10 mm in diameter which is wider than that of photon counting heads using a TO-8 package photomultiplier tube.

Differences from previous model

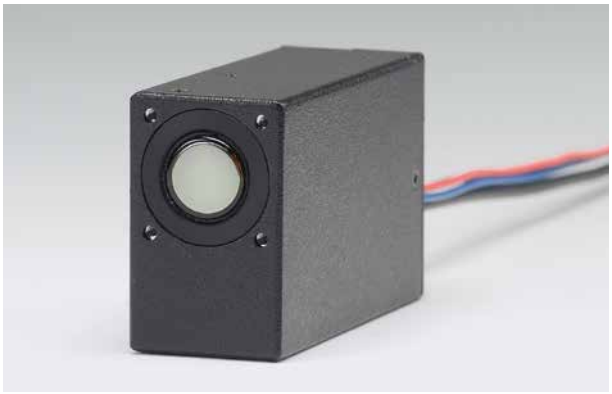
The H12775 is the first photon counting head that incorporates a 1/2-inch head-on photomultiplier tube.

Features

- Compact and lightweight
- Low power consumption
- Includes an excess light detection function

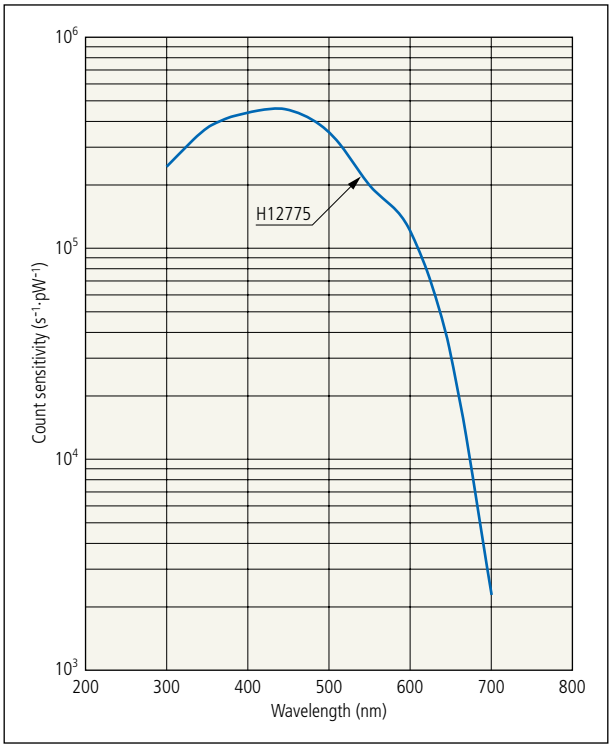
Applications

- Compact photometric equipment for the following fields:
  - Medical diagnosis
  - Biotechnology
  - Chemical analysis
  - Measurement



H12775

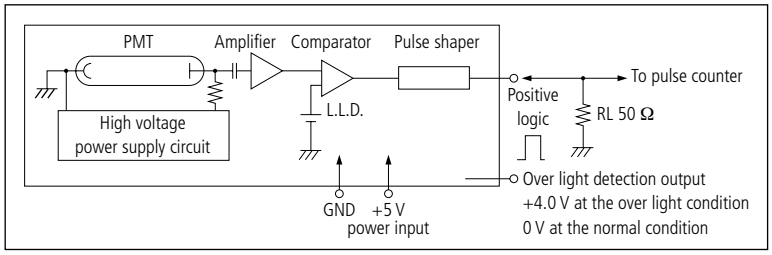
Count sensitivity



Specifications

Parameter	Specification	Unit
Spectral response range	300 to 650	nm
Input voltage	+5	V
Effective area	10 dia.	mm
Count linearity	5 x 10^6	s^{-1}
Output pulse height (50Ω load)	2.0	V
Pulse pair resolution	20	ns
Output pulse width	10	ns

Block diagram



MCP Assembly
F13446-11

NEW

Compact MCP assembly capable of floating operation in a range of ±5 kV

The F13446-11 is an MCP assembly with fast time response which is capable of time-of-flight (TOF) measurements. It operates with the high voltage electrode (MCP IN) at a voltage ranging from -5 kV to +5 kV, making it possible to select the optimal electric potential for positive ions, negative ions or electrons to be measured. The assembled MCP is robust and reliable, and exhibits low time jitter.

Differences from previous models

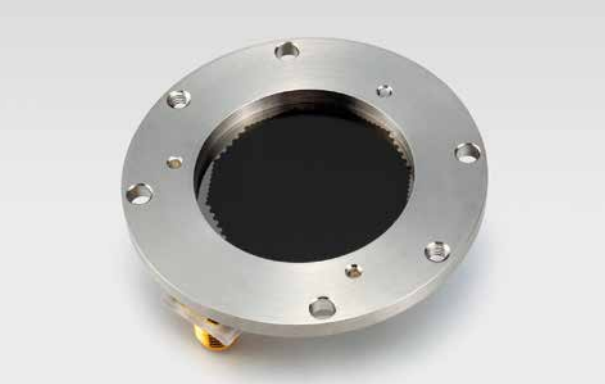
Unlike the previous compact MCP assembly F12395-11, the F13446-11 includes a coupling capacitor that allows setting the high voltage electrode at a voltage ranging from -5 kV to +5 kV.

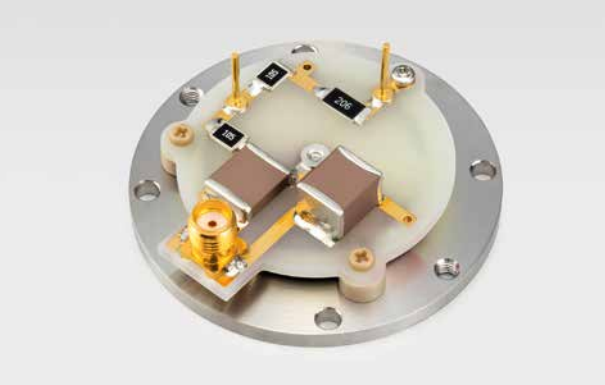
Features

- Floating operation with voltage of -5 kV to +5 kV applied to the high voltage electrode
- Effective area: 27 mm diameter
- Fast time response: 1.3 ns typical (FWHM)
- Using robust MCP
- Compact and thin profile

Applications

- TOF measurements
- Mass spectrometry
- Environmental measurements





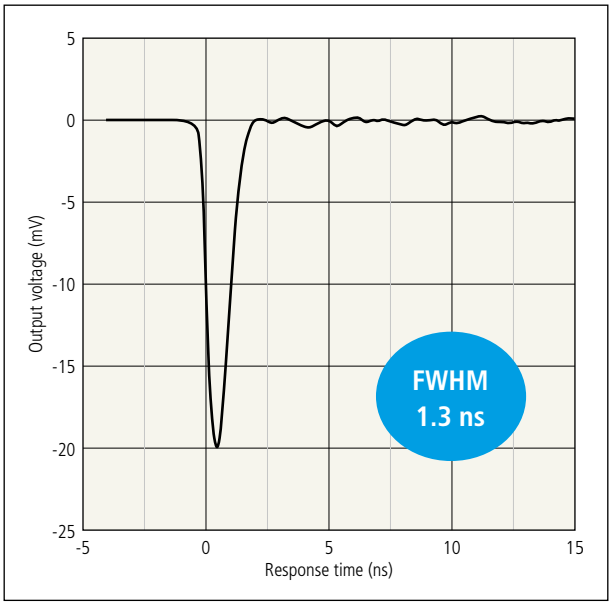
F13446-11

Specifications

Parameter	Specification	Unit
Effective area	27 dia.	mm
Gain (Min.)*1	1 x 10^6	-
Resistance (Typ.)*1	13.4 to 66.6	MΩ
Pulse width (Typ. FWHM)	1.3	ns
Setting voltage range	-5.0 to +5.0	kV
MCP channel diameter	12	μm
Bias angle	12	degree
Number of MCPs	2	-
Dark count (Max.)*1	3	s^{-1} cm^{-2}

*1 HV-BIAS 2.1 kV

Output waveform (Typ.)



NEW

110 kV Microfocus X-Ray Source L12531

Sealed type microfocus X-ray source with the world's highest level of performance

This new sealed type microfocus X-ray source uses a transmission target to achieve high resolution, high magnification, and wide radiation angle while still maintaining the advantages of the sealed type such as maintenance-free operation, a compact and lightweight design, and low power consumption. It offers the world's highest level of performance among sealed type X-ray sources.

Differences from previous models

Compared to previous models, this sealed type microfocus X-ray source has improved performance: about a 2-fold increase in test chart resolution and a maximum 7-fold increase in magnification. This will extend X-ray inspection applications to handle complex PC boards where advances in miniaturization, higher density, and multilayering never stop.

Features

- High resolution
- High magnification
- Wide radiation angle
- Maintenance free

Applications

- Non-destructive inspection
- X-ray CT
- Compatible samples
  - Electronic parts
  - PC boards
  - Plastic parts
  - Metal parts

Specifications

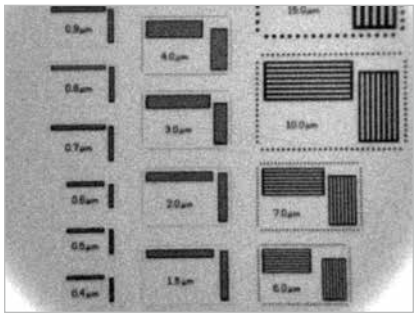
Parameter	Specification	Unit
X-ray tube voltage operation setting range	40 to 110	kV
X-ray tube current operation setting range	10 to 200	μA
Maximum output	16	W
Minimum resolution*1	2	μm
FOD (Focus to object distance)	Approx. 1	mm
X-ray beam angle*2	Approx. 120	degree
Dimensions	220 x 325.5 x 230	mm
Weight*3	Approx. 18	kg

*1 Measured by using JIMA RT RC-02B chart
*2 Reference value: With 50 % of maximum X-ray emission
*3 This weight includes the accessories of approx. 0.3 kg

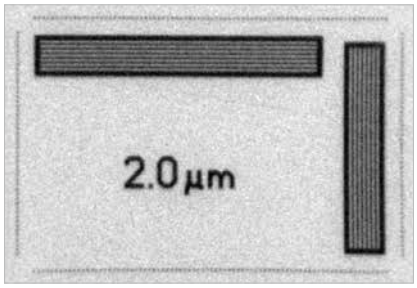
L12531

Comparison of magnification by resolution test chart

Conventional type (FOD: 7 mm)



L12531 (FOD: 1 mm)



Linear Irradiation Type UV-LED Unit LIGHTNINGCURE® LC-L5G/GC-113

NEW

Higher output power helps improve productivity

The LC-L5G/GC-113 series UV-LED light sources are ideal for UV ink drying/pinning (temporary drying) and UV curing/temporary curing. Compared to the previously available GC-77, the GC-113 series provides a higher light output of 10 W/cm^2 by using a compact air-cooling scheme and also offers a larger irradiation area while still having a mechanism to link multiple light sources. These features make the GC-113 series a good choice for applications where high UV power is required or workpieces are transported on high-speed conveyors.

LC-L5G/GC-113, L13343-1604-033/-2804-033/-3804-033

Differences from previous model

Compared to the previously available GC-77, the GC-113 series offers a higher light output and a larger irradiation area while still having a mechanism to link multiple light sources. This also makes the GC-113 series a good choice for applications requiring specifications that have not yet been met.

Features

- High output
- Compact size
- Fan air cooling
- Connectable or connected operation

Applications

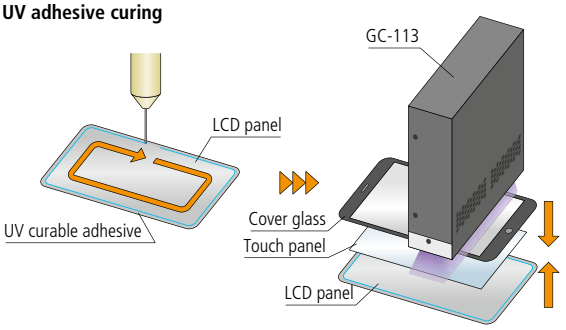
- UV ink drying/pinning (temporary drying)
- UV coating drying
- UV tape peeling
- UV adhesive curing/temporary curing
- Light source for fluorescence excitation and flaw inspections

Specifications

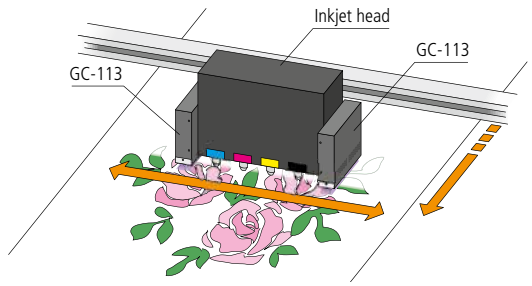
Parameter	Specification	Unit
Irradiation area	113 x 8	mm
UV irradiance (WD = 2 mm)	6 (at 365 nm) / 8 (at 385, 395 nm)	W/cm^2
UV irradiance (WD = 0 mm)	7.5 (at 365 nm) / 10 (at 385, 395 nm)	W/cm^2
Input voltage (DC)	48	V
Power consumption	260	W
Peak wavelength	365 / 385 / 395	nm
LED design life	20,000	h

Application examples

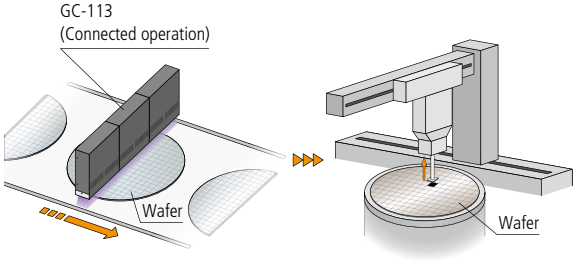
UV adhesive curing



UV ink drying



UV tape peeling



NEW

Linear Irradiation Type UV-LED Unit LIGHTNINGCURE® LC-L5G/GC-77S

Compact design allows installation in narrow spaces

The LC-L5G/GC-77S series UV-LED light sources are ideal for UV ink drying/pinning (temporary drying) and UV curing/temporary curing. Unlike the previously available GC-77, the new GC-77S series is designed to emit light perpendicular to its installation surface without sacrificing performance and functions. This means there is no need to provide vertical (height-wise) installation space, so the GC-77S can now be installed in locations where it was previously tough to mount. The GC-77S offers a high degree of design freedom making it flexible to meet the needs of various production processes.

Differences from previous model

Unlike the previously available GC-77, the GC-77S series is designed to emit light perpendicular to its installation surface without sacrificing performance and functions.

Features

- High output
- Small installation space
- Fan air cooling
- Narrow irradiation angle
- Connectable or connected operation
- Irradiation direction perpendicular to installation surface

Applications

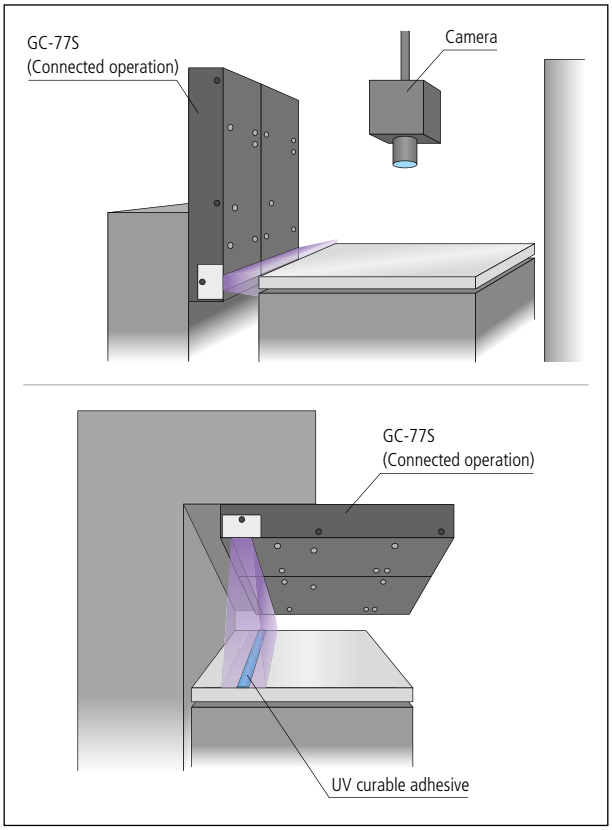
- UV ink drying/pinning (temporary drying)
- UV coating drying
- UV tape peeling
- UV adhesive curing/temporary curing
- Light source for fluorescence excitation and flaw inspections

Specifications

Parameter	Specification	Unit
Irradiation area	77 x 5	mm
UV irradiance (WD = 2 mm)	2	W/cm²
UV irradiance (WD = 0 mm)	2.5	W/cm²
Input voltage (DC)	48	V
Power consumption	45 (365 nm) / 40 (385, 395, 405 nm)	W
Peak wavelength	365 / 385 / 395 / 405	nm
LED design life	20,000	h

LC-L5G/GC-77S, L13343-1203-023/-2203-024/-3203-024/-4203-024

Installation examples



Digital Slide Scanner NanoZoomer S360 C13220-01

NEW

High throughput scanning of tissue slides with low operational workload

The NanoZoomer S360 is the latest high-throughput model, ideal for uses in hospitals and clinical laboratories, and has unique features: high throughput scanning of 82 slides/h, automatic scanning up to 360 slides, and reducing an operational workload by automated assistant for image quality check.

Features

- Scanning speed for 20x mode (15 mm x 15 mm): Approx. 30 s
- Scanning speed for 40x mode (15 mm x 15 mm): Approx. 30 s
- Throughput for 20x mode (15 mm x 15 mm): More than 82 slides/h (For the case of 5 focus points)
- Throughput for 40x mode (15 mm x 15 mm): More than 82 slides/h (For the case of 5 focus points)
- Slide loader (standard size slide): 360 slides (30 slides x 12 cassettes)

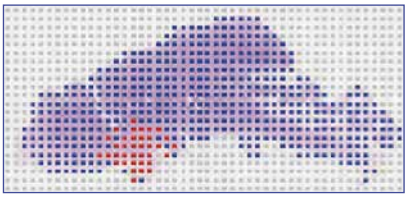
Specifications

Parameter		Specification	Unit
Scanning speed	20x mode (15 mm×15 mm)	Approx. 30	s
	40x mode (15 mm×15 mm)	Approx. 30	s
Throughput	20x mode (15 mm×15 mm)	More than 82*1	slides/h
	40x mode (15 mm×15 mm)	More than 82*1	slides/h
Objective lens		20x N.A. 0.75 User can select 20x or 40x mode at start of scanning	-
Compatible glass slides		26 x 76 (Thickness 0.9 to 1.2)	mm
Slide loader	Standard size slide	360 slides (30 slides x 12 cassettes)	-
Scanning resolution	20x mode	0.46	µm/pixel
	40x mode	0.23	µm/pixel
Focusing method		Pre-focus map	-
Z-stack feature		Yes	-
Image compression		JPEG compression	-
Power supply		AC 100 to AC 240	V
Power consumption (Scanner only)		Approx. 200	VA

*1 For the case of 5 focus points

NanoZoomer S360 C13220-01

Easy identification of areas in a slide that need to be visually checked



Blue colored: in-focus area

Red colored: out-of-focus area

The focus pass/fail results are superimposed and displayed over the entire tissue on a slide, and users can easily identify areas that need to be checked.

Cassette-based management of slide scan mode

Slide scan mode is independently manageable for each cassette labeled with a unique barcode. It is useful when different kinds of tissues or stains are included in one batch of scans.

NEW

Molecular Orientation Characteristic Measurement System C14234-11

The measurement result is comparable to simulation data

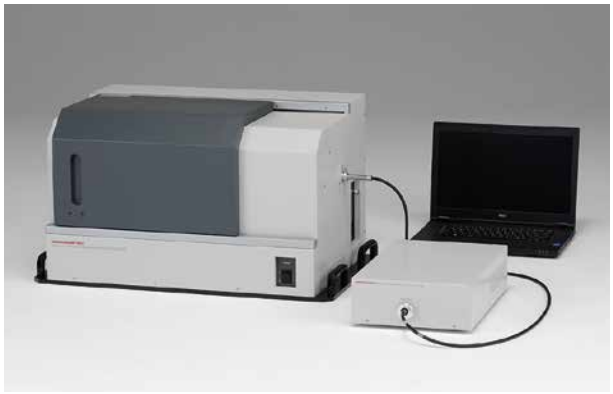
The C14234-11 is designed for measuring fluorescence spectra with multichannel analyzer PMA-12 and for angle dependency of P-polarized fluorescence with newly designed optics.

Features

- Measurement of angle dependency of PL intensity
- Comparison to the simulation results is possible
- Easy alignment of the optics and easy measurement
- Selectable excitation wavelength of LED light source unit (Options)
- Integrated shutter to prevent material degradation

Application

- Automatically measure the angle dependence of P-polarized light of fluorescence spectra



C14234-11

Specifications

Parameter	Specification	Unit
Angle range of measurement	–90° to 90° (the vertical direction of sample is 0°)	-
Excitation wavelength	365	nm
Emission wavelength	350 to 950	nm
Angle resolution	Approx. 3.5°	-
Sample size	□ 30 (using R20 mm lens)	mm

Comparison with the simulation

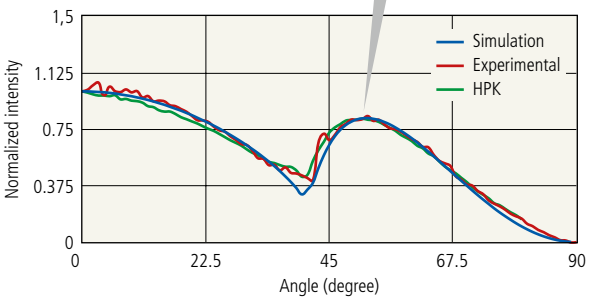
The molecular orientation pattern in the organic EL device is reflected in the photoluminescence (PL) emission pattern versus the detection angle. This PL emission pattern can be obtained by simulation from the molecular orientation pattern in the device.

In order to compare and confirm whether the sample has the characteristics as simulated, it is necessary to measure the PL emission pattern of the device.

For this measurement, adjustment of a complicated optical system is necessary, and researchers have required much time and labor. With the molecular orientation characteristic measurement system C14234-11, it is possible to accurately measure the PL emission pattern of the organic EL device simply by setting the sample.

Courtesy of Prof. Chihaya Adachi, Center for Organic Photonics and Electronics Research, Kyushu University and Prof. Takeshi Komino, Education Center for Global Leaders in Molecular Systems for Devices, Kyushu University

Angular dependent PL intensity data of a PL material measured by C14234-11 and the simulation.



X-ray TDI Camera C12300-321

NEW

Evolutional high speed scanning with TDI technology – bidirectional scanning operation is supported

The X-ray TDI camera is useful for in-line applications requiring high-speed operation, high sensitivity and high resolution with wider area.
With bidirectional scanning operation, it makes it possible to capture the objects effectively and improves the machine cycle time.

Features

- High speed readout (20 kHz)
- Bidirectional scanning operation
- Improved radiation hardness
- High S/N ratio with 12-bit output

Applications

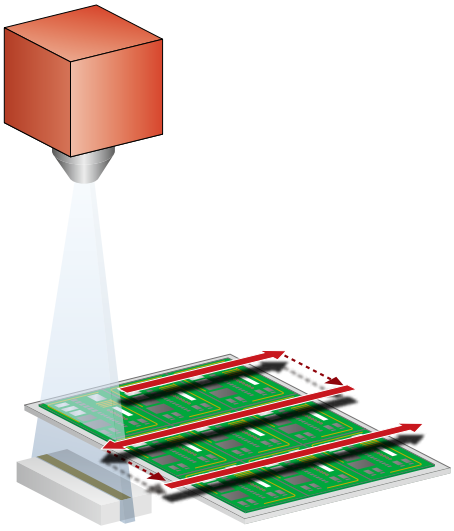
- Printed circuit board (PCB) inspection
- Surface-mounted component inspection
- Battery inspection

Bidirectional scanning operation is supported

C12300-321 enables the bidirectional scanning (inverse direction scanning) operation.

It is useful when the scanning direction is different in the same inspection system or the rescanning is needed for NG judgement.

Also the machine cycle time can be improved for large objects such as PCBs.



C12300-321

Specifications

Parameter		Specification	Unit
Effective X-ray tube voltage range		Approx. 25 to 130*1	kV
CCD pixel size		48 x 48	µm
Number of pixels		4,608 (H) x 150 (V)	-
X-ray sensitive area		221.1 (H) x 7.2 (V)	mm
Line speed		0.576 to 57.6	m/min
TDI line rate	1 x 1	Max. 20.0 kHz (57.6 m/min)	-
	Binning 2 x 2	Max. 15.0 kHz (86.4 m/min)	-

*1 Usable range of X-ray strength may vary depending on the tube current, the tube voltage and the distance.

NEW

Digital CMOS Board Level Camera C13949-50U

High resolution scientific imaging with 12 megapixels

The core of the C13949-50U camera is the scientific image sensor, an advanced CMOS detector that simultaneously achieves high resolution, fast readout speeds and low noise. With its small size, board-level design and simple, low-cost integration using USB 3.0, the C13949-50U is the ideal camera for OEM scientific imaging.

Features

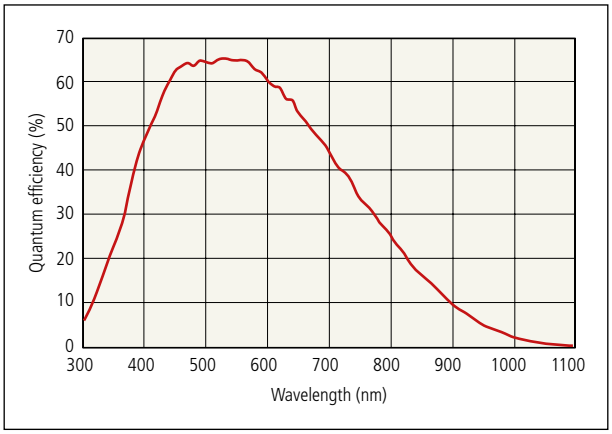
- Resolution: 12 megapixels (4,096 x 3,008)
- Readout noise: 2.3 electrons (typ.)
- Frame rate: 15 frames/s (full resolution)
- Global shutter

Applications

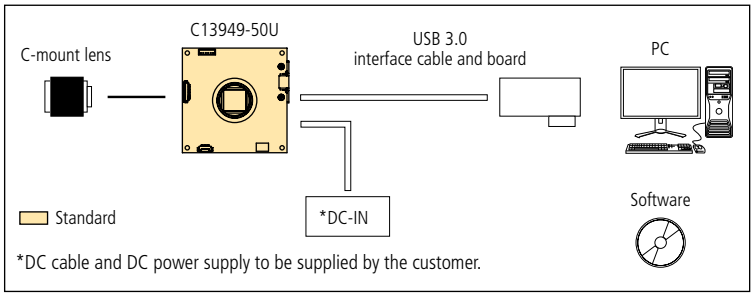
- Fluorescence imaging
- DNA sequencing
- CTC detection

C13949-50U

Spectral response



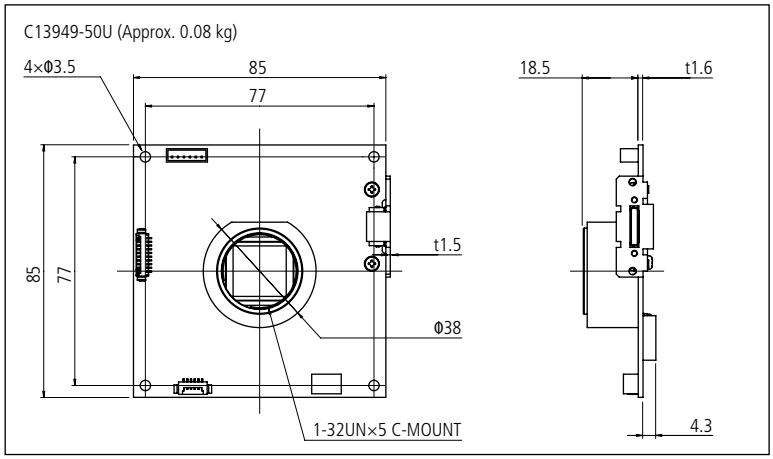
System configuration



Specifications

Parameter	Specification	Unit
Effective number of pixels	4,096 (H) × 3,008 (V)	-
Effective area	14.13 (H) × 10.37 (V)	mm
Frame rate (Internal trigger mode) Full resolution	15	frames/s
Readout noise (rms) typ.	2.3	e^-
Digital output	12	bit

Dimensional outline (Unit: mm)

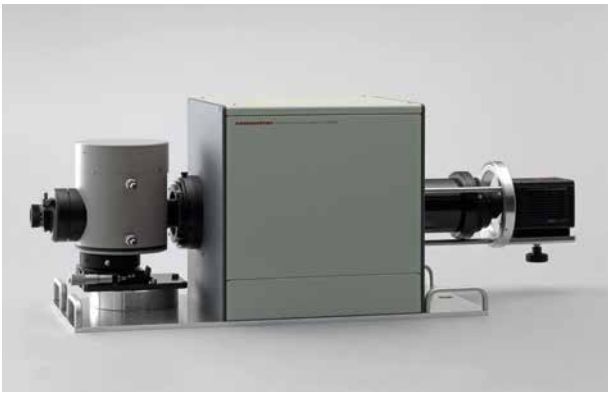


Femtosecond Streak Camera FESCA-100 C11853-01

NEW

FESCA-100, a new streak camera with the world's highest level of temporal resolution

The C11853-01 is an ultrafast streak camera with a temporal resolution of 100 femtoseconds (typ.). It is designed for use with single-shot or slow-repetitive phenomena.



FESCA-100 C11853-01

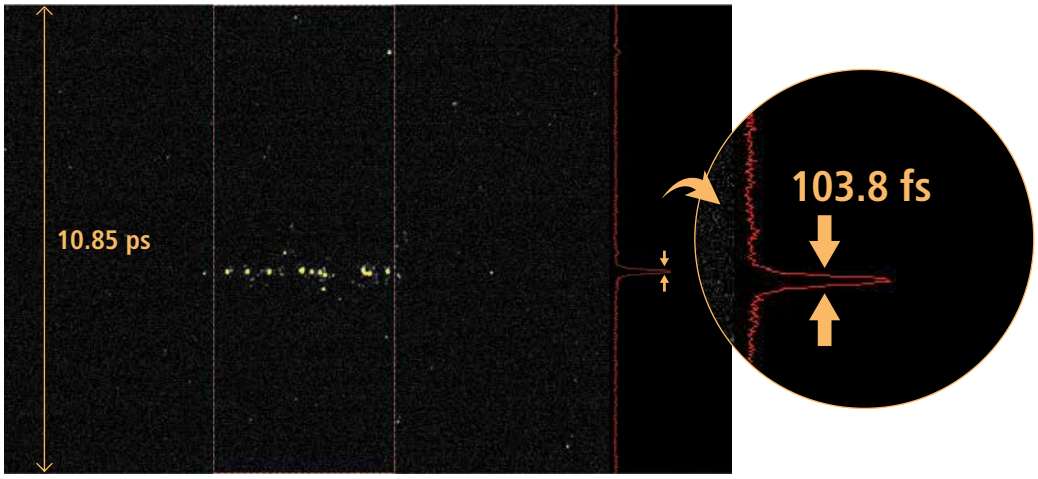
Features

- 100 femtosecond temporal resolution (typ.)
- Simultaneous measurement of light intensity on both the temporal and spatial axis
- Real time analysis is possible with the dedicated readout system

Applications

- Measurement of electron bunch for synchrotron and LINAC applications
- Analysis of the ultrastructure of laser waveform along optical waveguides
- Diagnosis of femtosecond lasers

Measurement of single ultrafast phenomena with high temporal resolution (100 femtoseconds)



Streak image and intensity profile of light pulse from Ti:Sapphire laser measured with the FESCA-100

NEW

CW Quantum Cascade Laser
L12004-2310H-E, L12005-1900H-E, L12006-1631H-E

Package with a built-in lens improves ease-of-use

The lens-integrated package for DFB-CW type QCL has a sealed and collimated housing. The internal lens provides collimated output beam radiation. TEC (peltier) and thermistor for temperature stabilization of the QCL-laser chip are inside the housing. The built-in lens makes the QCL easy to use, eliminating the need for beam alignment.

Difference from previous products

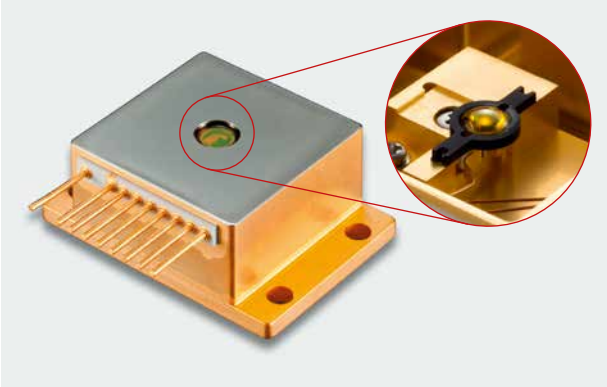
Contains a collimation lens with no change in package size.
Needs no additional collimation lens (A11331 sold separately).

Features

- Built-in aspherical collimation lens eliminates the need for optical alignment
- Light output: 20 mW (min.)
- Low-reflectivity lens and window

Application

- Trace gas analysis



L12004-2310H-E, L12005-1900H-E, L12006-1631H-E

DFB-CW QCL (built-in lens)

Type No.	Wavelength	Wavenumber	Target gas
L12004-2310H-E	4.33 µm	2,310 cm^{-1}	CO_2, CO_2 isotope
L12004-2190H-E	4.57 µm	2,190 cm^{-1}	N_2O, CO
L12005-1900H-E	5.26 µm	1,900 cm^{-1}	NO
L12006-1631H-E	6.13 µm	1,631 cm^{-1}	NO_2

DFB-CW QCL

Type No.	Wavelength	Wavenumber	Target gas
L12004-2310H-C	4.33 µm	2,310 cm^{-1}	CO_2, CO_2 isotope
L12004-2209H-C	4.53 µm	2,209 cm^{-1}	N_2O
L12004-2190H-C	4.57 µm	2,190 cm^{-1}	N_2O, CO
L12005-1900H-C	5.26 µm	1,900 cm^{-1}	NO
L12006-1631H-C	6.13 µm	1,631 cm^{-1}	NO_2
L12007-1392H-C	7.18 µm	1,392 cm^{-1}	SO_3
L12007-1354H-C	7.39 µm	1,354 cm^{-1}	SO_2
L12007-1294H-C	7.73 µm	1,294 cm^{-1}	CH_4

DFB-Pulsed QCL

Type No.	Wavelength	Wavenumber	Target gas
L12014-2231T-C	4.48 µm	2,231 cm^{-1}	N_2O, CO, CO_2
L12015-1901T-C	5.26 µm	1,901 cm^{-1}	NO
L12016-1630T-C	6.13 µm	1,630 cm^{-1}	NO_2
L12017-1278T-C	7.82 µm	1,278 cm^{-1}	CH_4, N_2O
L12020-0993T-C	10.07 µm	993 cm^{-1}	NH_3

Global Exhibitions 2017 and 2018

USA

November 2017

ISTFA
Nov 5-9 2017, Pasadena, CA

Neuroscience
Nov 11-15 2017, Washington, DC

Printed Electronics
Nov 16-17 2017, Santa Clara, CA

RSNA
Nov 26-Dec 1 2017, Chicago, IL

December 2017

Cell Biology
Dec 2-6 2017, Chicago, IL

BIOMEDevice
Dec 6-7 2017, San Jose, CA

January 2018

CES
Jan 9-12 2018, Las Vegas, NV

BIOS
Jan 27-28 2018, San Francisco, CA

Photonics West
Jan 30-Feb 1 2018, San Francisco, CA

February 2018

SLAS
Feb 3-7 2018, San Diego, CA

AADC (Advanced Autonomous Drive Conference)
Feb 13-14 2018, San Francisco, CA

Biophysical
Feb 17-21 2018, San Francisco, CA

Pittcon
Feb 26-March 1 2018, Orlando, FL

March 2018

USCAP
March 17-23 2018, Vancouver, BC US

April 2018

The Vision Show
April 10-12 2018, Boston, MA

AACR
April 14-18 2018, Chicago, IL

Defense & Commercial Sensing
April 15-19 2018, Orlando, FL

BIOMEDevice
April 18-19 2018, Boston, MA

May 2018

Radtech
May 7-9 2018, Rosemont, IL

CLEO
May 15-17 2018, San Jose, CA

Pathology Informatics Summit
May 21-24 2018, Pittsburgh, PA

June 2018

ASMS
June 3-7 2018, San Diego, CA

July 2018

Semicon West
July 9 2018, San Francisco, CA

Europe

November 2017

Compamed
Nov 13-16 2017, Düsseldorf, Germany

Inprint – Industrial Print Show
Nov 14-16 2017, Munich, Germany

Colloque RX et matière
Nov 14-17 2017, Lille, France

Carrefour Pathologie
Nov 20-23 2017, Paris, France

Diagnostics Boot Camp (with Visiopharm)
Nov 21-22 2017, London, UK

Nuovi Orientamenti in Sintesi Organica 2017
Nov 27 2017, Milano, Italy

GIANT Health Event
Nov 28-30 2017, London, UK

Digital Pathology Congress
Nov 30-Dec 1 2017, London, UK

December 2017

MIC Symposium
Dec 8 2017, Bern, Switzerland

Optogen
Dec 12-13 2017, Lecce, Italy

Agrifoodtech
Dec 13-14 2017, Brabanthallen 's-Hertogenbosch, NL

GIF 2017
Dec 14-16 2017, Perugia, Italy

January 2018

Quantitative BioImaging Conference
Jan 4-6 2018, Goettingen, Germany

Bamberger Morphologietage
Jan 12-14 2018, Bamberg, Germany

February 2018

Mobile World Congress
Feb 26-March 1 2018, Barcelona, Spain

ICON Europe
Feb 27-March 2 2018, Bielefeld, Germany

ECR
Feb 28-March 4 2018, Vienna, Austria

March 2018

Automaticon
March 20-23 2018, Warsaw, Poland

April 2018

Analytica
April 10-13 2018, Munich, Germany

A&T 2018
April 18-20 2018, Torino, Italy

May 2018

AKL
May 2-4 2018, Aachen, Germany

Optatec
May 15-17 2018, Frankfurt, Germany

TEC
May 17 2018, Warsaw, Poland

Technology HUB 2018
May 17-19 2018, Milano, Italy

SPS IPC Drives Italia 2018
May 22-24 2018, Parma, Italy

Pisa Meeting 2018
May 27-June 2 2018, La Biodola, Italy

Ipack Ima 2018
May 29-June 1 2018, Milano, Italy

June 2018

Neutrino
June 4-9 2018, Heidelberg, Germany

Achema
June 11-15 2018, Frankfurt, Germany

ConCar Expo
June 27-28 2018, Berlin, Germany

SLAS Europe
June 27-29 2018, Brussels, Belgium

Sensor und Test
June 26-28 2018, Nuremberg, Germany

August 2018

SINDEX
Aug 28-30 2018, Bern, Switzerland

September 2018

E 18
Sep 11-13 2018, Odense, Denmark

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