HAMAMATSU
PHOTON IS OUR BUSINESS
NEWS 2016 02

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Cover Story

At Hamamatsu Photonics, we believe that photonics technology can provide the means to overcome many of the challenges in areas such as healthcare, energy and the environment.

In this issue of the Hamamatsu News, you can read the interview with our research and development teams and you can see how they are working to develop new photonic devices for Environmental applications, specifically in the field of gas analysis in the mid-infrared region.
You can also read how Hamamatsu, at the 1st International Symposium on Advanced Photonics, brought together leading scientists from around the world to share the latest research on the topic of "Quantum many-body science and technology".

These are just some of the ways in which Hamamatsu Photonics, through fundamental scientific research in light and the development of new related technologies, is contributing to the creation of industries that will help enhance society.

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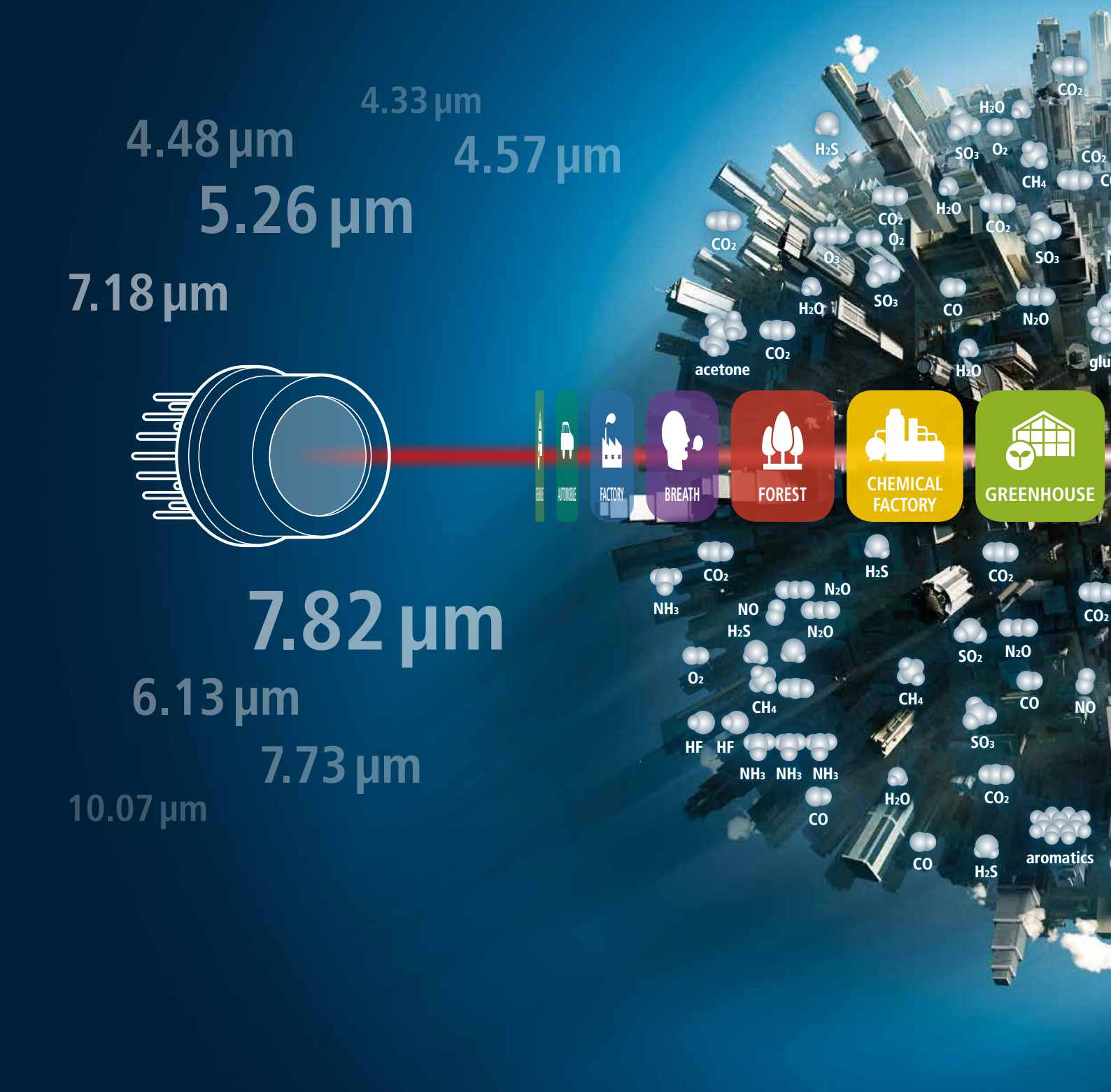
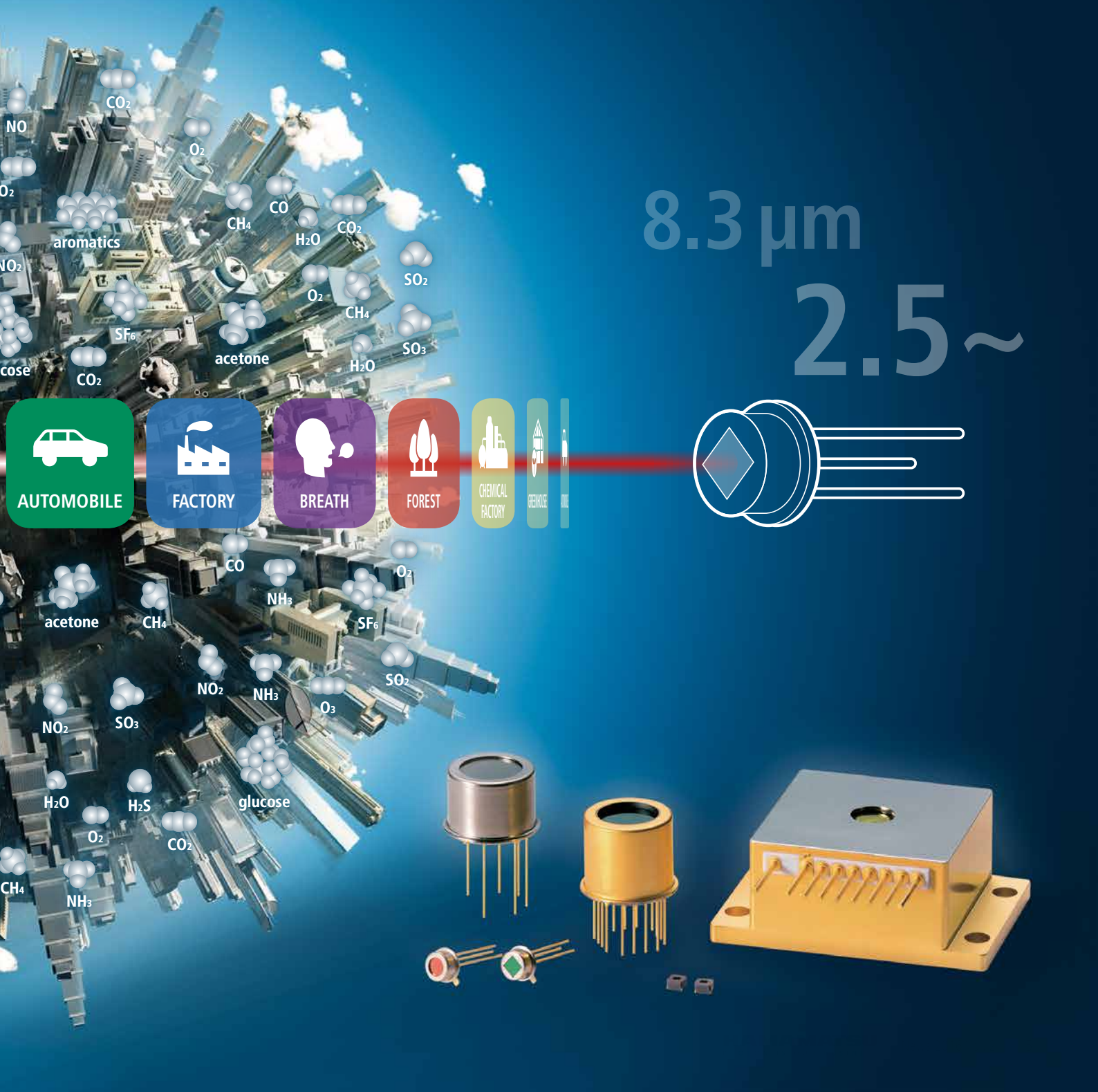
A wide lineup of light emitters and light sensors to support development of mid-infrared measuring instruments

Devices for gas analysis applications

Quantum cascade laser (QCL) × Indium arsenide antimonide InAsSb photovoltaic detector



Optical measurement of gases, atoms, and molecules such as NOx (nitrogen oxide) and SOx (sulfur oxide) having absorption characteristics in the mid-infrared spectral range from 3 µm to 10 µm is the focus of a lot of recent attention. Many equipment manufacturers are now designing products that focus on this mid-infrared spectral region. To meet the needs of these manufacturers, Hamamatsu Photonics is developing and producing in-house the light-sensing and light-emitting devices needed for making mid-infrared measurements. Hamamatsu Photonics offers these light-sensing and light-emitting devices in sets for particular applications. There are very few manufacturers in the world that can produce such devices. We talked to members in charge of developing those devices to ask about the background sales and engineering strategies.



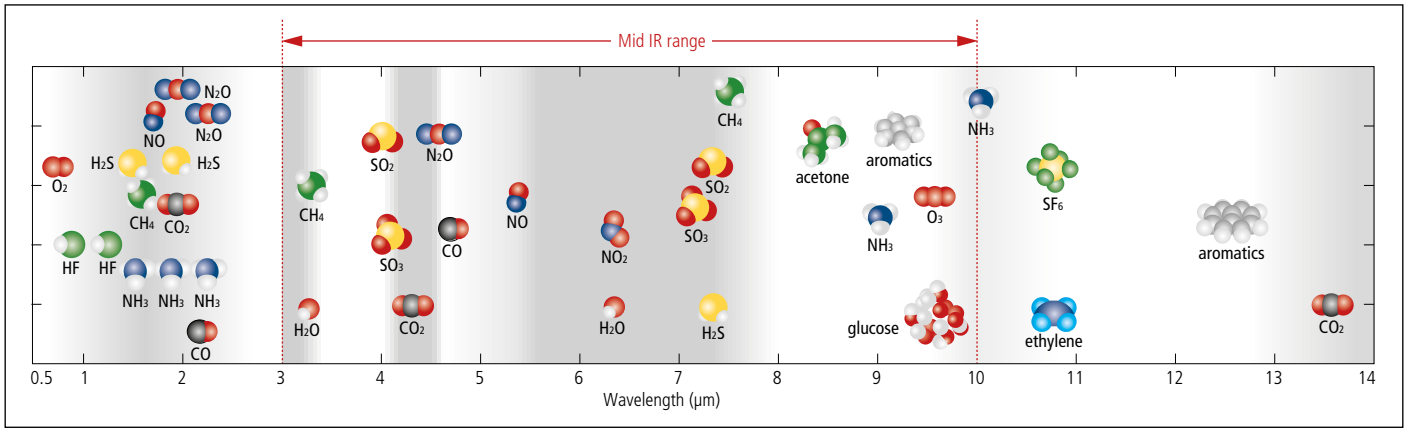


Figure 1: Absorption wavelengths of gases
Hamamatsu provides light sources used to measure gases that absorb light in the mid-infrared range (3 μm to 10 μm).

Technical process to provide both light sensors and light emitters needed for gas analysis

What are the special features offered by optical measurements in the mid-infrared range?

Oishi: Techniques such as gas chromatography and mass spectrometry are used for making gas measurements and these involve obtaining a sample of the target gas and measuring it inside a measuring instrument. However, the optical measurement using a laser offers the advantage that you can make measurements by directly applying the laser to the target gas. That means you don't have to bring the test object into a laboratory, so you can make measurements in the field or right on the production line at the worksite. This vastly broadens the possible applications.

Sugiyama: Here at Hamamatsu Photonics we have provided lasers used to measure gases in the mid-infrared spectral range. Gases we can now measure in the wavelength range of about 3 μm to 10 μm include methane gas, carbon dioxide, carbon monoxide, sulfur oxide and nitrogen oxide, and so on. (See Figure 1)

Did you face any challenges in developing light sensors and light emitters for the mid-infrared range?

Sugiyama: Well, the reason why we were interested in the gas molecules in the mid-infrared region is that many gases or gas molecules strongly absorb the mid-infrared light. This is advantageous to make measurements.

Iida: On the other hand, the background light that may enter the detector becomes brighter in the mid-infrared range, so light other than what you want to detect is also sensed. This becomes a noise component and causes problems in light detection. Moreover, in this wavelength range, manufacturing an ideal light sensor with sufficiently high sensitivity is very difficult. This makes it essential to enhance the light emitter performance as well as to increase the mid-infrared sensitivity of the light sensor. Parallel development that boosts the performance of both devices is where one sees the true value of Hamamatsu Photonics.

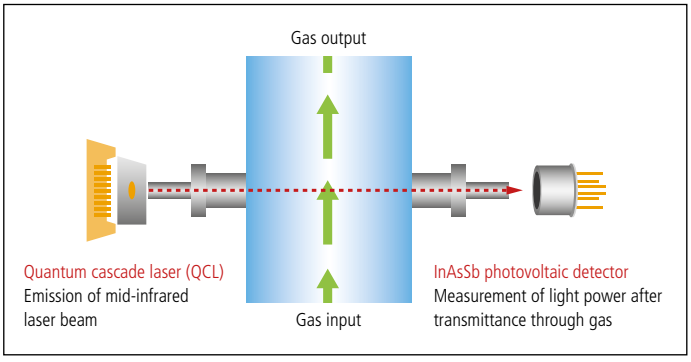


Figure 2: Schematic diagram of trace gas analysis using a light emitter (QCL) and light sensor (InAsSb photovoltaic detector)

Oishi: In new product development by an equipment manufacturer, it's very important to increase the accuracy in the initial development stage. Attaining an optimal state of light sensor and light emitter performance is the quickest road to increasing the accuracy. Our company understands how to do this for both devices, so we can help equipment manufacturers obtain the desired accuracy.

Why does only Hamamatsu Photonics offer sets consisting of both light sensor and light emitter?

Sugiyama: There are numerous challenges in developing both light emitters and light sensors, so there are very, very few manufacturers capable of taking up these challenges of dual development. For example, light emitter development requires developing laser light sources that are equal in number to the target gases for measurement at "1 wavelength for 1 component." This means large development costs and involves high risks in creating a new business.

Oishi: Viewed from a customer standpoint, purchasing the light emitters and light sensors from the same company offers huge advantages. For example, when equipment manufacturers are developing an optical measuring instrument, currently in most cases, they use the light sensors and light emitters procured from different manufacturers. However, in this case, if the measuring instrument they are manufacturing won't perform as expected, then it's difficult to determine whether the problem is caused by light emission or light detection. This becomes an obstacle in product development.

Ochiai: If the light emitters and the light sensors are produced by the same manufacturer, then it's easy to mutually evaluate both devices and in this way to boost performance of the measuring instrument. This advantage also contributes to shortening the customer's product development period. Laser absorption spectrometry using a QCL in the mid-infrared range is still a relatively new method and I think it will become a widespread method for selective gas measurement with high sensitivity and high resolution. Quantum cascade lasers (QCL) emitting a single wavelength of light and InAsSb photovoltaic detectors provide stable characteristics.

What kind of products do you have available for light emitters and for light sensors?

Sugiyama: Our flagship product for light emitters is the QCL. It originally started under Chairman Teruo Hiruma as an effort at our own expense to develop a light source for establishing breath analysis for cancer screening. Unfortunately, breath analysis testing for detecting cancer has still not been established as a technology. However, it has shown possibilities for detection of acetone, etc.

Iida: A typical light sensor for receiving light from the QCL is the InAsSb (indium arsenide antimonide) photovoltaic detector. We currently offer two types of sensors that cover the wavelength range from 2.5 µm to 8 µm.

What are the respective features or characteristics of the QCL and InAsSb photovoltaic detector?

Sugiyama: First let's talk about the QCL. A typical laser diode emits light at multiple wavelengths spanning several hundred nanometers and so the spectral range becomes wide. This causes measurement accuracy to drop because of interference by multiple gas absorption. The QCL employs a DFB (distributed feedback structure) that has a diffraction grating fabricated within the chip and allows laser emission at a single wavelength in an extremely narrow spectral range. However, DFB is extremely difficult to produce in large amounts and we initially had a very tough time trying to get a satisfactory yield rates for making good products.

Ochiai: Simultaneous with in-house development work to improve manufacturing technology for DFB structures to raise the yield rate of good products, we also proceeded with developing new products having an internal collimation lens. The light emitted from the laser chip broadens, so the products available until that time required the customers to design an optical system to change the shape of the light so that the laser light passes through the target object. To eliminate all that work, we incorporated a collimation lens into the package, so the customers no longer need to make this delicate optical alignment.

Was incorporating the collimation lens into the package a tough task?

Ochiai: In the case of a conventional QCL without a collimation lens, the customers had to align the optical axis on their own. Mid-infrared light is invisible and special optical materials are utilized, so design of the optical system requires a lot of time and effort. Placing the collimation lens outside the package does give the advantage that there is no limit on lens size making it easy to adapt for use along with the package. However, placing the lens inside the package requires high-precision alignment and clamping of the optical axis in an extremely limited space of the package. The effects from noise also have to be taken into account due to light reflection from the optical material.

R&D Interview

Sugiyama: The light emission point of a QCL is basically about 10 µm square which means the optical axis is aligned on a point about one-tenth the diameter of a hair, so this is no easy task. Moreover, even if collimated, just a tiny deviation of the lens axis during shipping will make it defective, so it has to be manufactured while taking its usage environment into account.

Are there some measurement tasks that only QCL can accomplish?

Ochiai: One example is isotope measurement. For instance in CO_2, there are carbon and oxygen isotopes that have respectively different mass numbers, and so each of them has their own different absorption wavelength. Even within the same CO_2, the isotope $^{13}CO_2$ will absorb light at a wavelength of 4.329 µm while $^{12}CO_2$ will absorb light at a wavelength of 4.328 µm. By finding the isotopic ratio, we can determine the gas emission source such as plants, soil, and combustion, as well as the generating factor. So this ability to measure isotopes can be called the true value of the QCL.

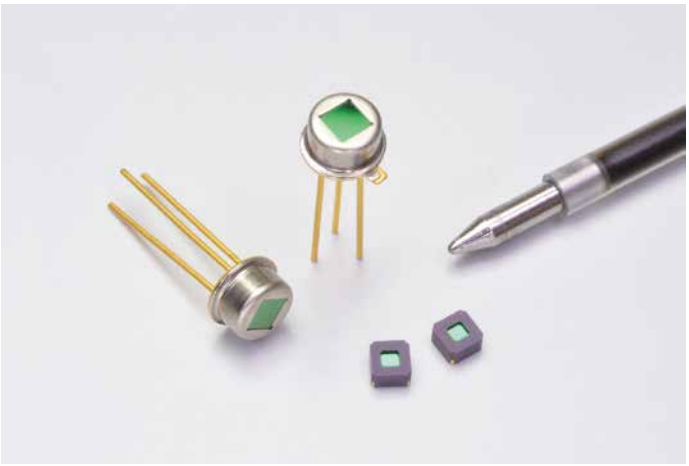
Could you also tell us about the InAsSb photovoltaic detector serving as the light sensor?

Asakura: The InAsSb photovoltaic detector is a compound semiconductor utilizing indium (In), arsenic (As), and antimony (Sb). The mercury cadmium telluride or MCT photoconductive detector and photovoltaic detector are widely used as conventional infrared detectors in the 3 µm to 10 µm range. However, the MCT detectors include mercury and cadmium which are prohibited under the RoHS directive on use of hazardous substances, so we newly developed the InAsSb detector that includes none of these hazardous substances.

Iida: Creating the InAsSb detector required developing new techniques for crystal growth and wafer process. This was necessary because we could not adapt the existing techniques directly to the fabrication of the InAsSb detector and had to newly develop optimal growth methods and process techniques to match the materials used. Film layers are formed by crystal growth on a wafer serving as the substrate. The quality of the crystal is a major factor that greatly affects the device characteristics, so we had to make a lot of modifications to obtain a high quality crystal. We finally achieved high sensitivity by applying new techniques to the wafer process and improving the device structure. Results from these efforts gave us new knowledge and skills for both crystal growth and wafer process.

Quantum cascade laser (QCL)

Asakura: MCT detectors exhibit large individual variations. However, the InAsSb photovoltaic detector offers advantages that it does not contain hazardous substances such as mercury and cadmium and also has highly stable characteristics and minimal variations between devices. The InAsSb photovoltaic detector is also good for mass production once the device specifications are settled.



InAsSb photovoltaic detector

A broad range of applications for measurements utilizing molecular absorption

How have customers reacted to these products?

Oishi: Our customers are now evaluating the QCL and InAsSb photovoltaic detector as a set of light emitter and sensor and are gradually confirming the device performance. The absorption wavelength range of the components contained in the gas is very narrow, so this demonstrates the strong points of QCL that emits light in a very narrow wavelength range. I think we can meet the needs of manufacturers who want to produce equipment having unique features.

Sugiyama: The main point about optical measurement is that it utilizes molecular absorption. This means that this method can be applied to measure not just gas but also to a variety of applications utilizing molecular absorption even in fluids and solids. For example, there are plenty of possibilities for applications in areas that utilize molecular absorption in moisture or cholesterol.

Please tell us about future directions for QCL and InAsSb photovoltaic detector.

Ochiai: The QCL we currently provide covers a wavelength range of 4 µm to 10 µm, and we are working to further extend the wavelength lineup. This means, of course, that we will also need a light sensor in the vicinity of 10 µm to use it together with a QCL as a pair.

Asakura: The InAsSb photovoltaic detector serving as the light sensor currently covers the wavelength range from 2.5 µm to 8 µm. Using the same technology for extending the wavelength range, we are planning to extend the sensitivity to 11 µm and 12 µm.

Oishi: Aiming at the long wavelength range around 10 µm, we will provide both light sensors and light emitters, and in the future plan, we will be developing modules consisting of a set of light sensor and light emitter. We welcome any inquiry for measurements that use mid-infrared light in this wavelength range.

Members (from the left)

Atsushi Sugiyama	*Development Center (in charge of QCL development)*
Takahide Ochiai	*Manuf. Group of Laser Group (in charge of QCL development)*
Satoru Oishi	*Business Planning & Development Dept. of Business Headquarters (in charge of sales)*
Masashi Asakura	*Solid State Division, Manuf. #1 (in charge of InAsSb photovoltaic detector development)*
Daisuke Iida	*Solid State Division, Manuf. #1 (in charge of InAsSb photovoltaic detector development)*

Hamamatsu brings together leading experts at the 1st International Symposium on Advanced Photonics

Hamamatsu, a center of fine-quality manufacturing, is aiming to become home to many companies involved in opto-research and opto-industry. The symposium was held at Lake Hamana, a short distance from the central part of Hamamatsu, where attendees enjoyed peaceful scenery and restful relaxation at Kanzanji Hot Springs.

Scientists share latest research outcomes in quantum many-body science and technology at the 1st International Symposium on Advanced Photonics in Hamamatsu

iSAP Hamamatsu was held in Hamamatsu, Japan on April 13 and 14, 2016. The topic of this year's conference, the first in a series, was "Quantum many-body science and technology". Researchers and scientists who are active at the forefront of photon quantum physics came together to present the latest available information on quantum simulations, cold atoms, quantum networks, quantum computing and other topics. Over 100 researchers and engineers from universities and corporate entities in Europe, the US and Asia enjoyed vigorous discussion both at and away from the event site, exchanging ideas and information.

Scientists are delving into quantum mechanics, the field of laws that govern the micro-world around us using light, in an effort to understand the mechanisms that drive our world at the atomic and molecular level. Through fundamental scientific research in light and the development of new related technologies, Hamamatsu Photonics is contributing to the creation of industries that will help enhance society.

For detailed information about iSAP Hamamatsu
http://www.isap-hamamatsu.org/

Sponsored by Research Foundation for Opto-Science and Technology, with cooperation from Hamamatsu Photonics K.K.

Hamamatsu to construct new building to increase manufacturing capacity of opto-semiconductors

Hamamatsu, Japan – April 4, 2016 – Hamamatsu Photonics K.K. has announced the construction of a new building no. 1 at its Shingai Factory to increase its manufacturing capacity of opto-semiconductor components. The new building will be used for post-processing steps (assembly and inspection) that will result from sales growth.

On April 5, a groundbreaking ceremony will be held on the site of the new building in Hamamatsu City. Construction is scheduled for completion in March 2017.

Shingai Factory new building no. 1 (exterior rendition)

Hamamatsu Photonics – Inspiring the next generation of scientists

Hamamatsu Photonics is reaching out to young students to both inspire and increase their interest in science and, more importantly, to encourage them to study science and attract them to a future career in the Photonics Industry.

As part of the outreach, Hamamatsu Photonics UK presented 13 schools from the Hertfordshire area with free laser kits which contained lasers, light emitting diodes, mirrors and diffraction gratings and these kits demonstrate how photons behave.

Craige Palmer and Chantelle Withey presented the kits to the school teachers and as part of the event, also gave them hands-on training. The teachers were very enthusiastic and were eager to take the kits back to the classroom to let the students try them.

It is very important to outreach to students and encourage more people to be interested in science, as there is a real shortage of science graduates. Our Company believes that this is just one way in which we can support this.

Company News

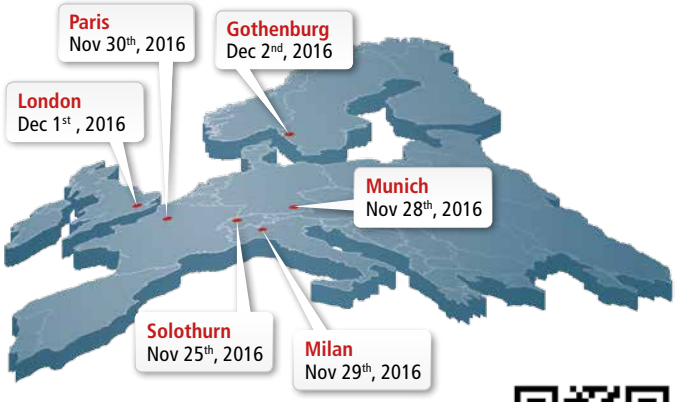
SOLOTHURN MUNICH MILAN PARIS LONDON GOTHENBURG

From a single chip to a custom-made scientific camera

At the 3rd Hamamatsu Technology Days event we will explain how we can provide you with customised opto-electronic solutions, tailored to meet the needs of your system design. From a simple single device to a complex camera module; we provide all building blocks necessary to help you achieve the optimum results.

Save the date and learn more about the following topics:

- Packaging of Opto-Semiconductors
- Photo-ASIC / IC in CMOS
- MCM - Multichip Modules
- MOEMS Modules
- Board Level Optical Modules
- OEM Camera Solutions



More informations at:
www.technology-days.com

DECTRIS EIGER Detectors in the fight against Zika virus

Baden, August 2016: The leading scientific journal Nature published in its latest issue a breakthrough on the quest towards a vaccine against Zika virus. The article describes atomic structures of a surface protein of Zika virus in complexes with neutralizing antibodies derived from Dengue patients. These antibodies act against Dengue, a tropical infectious disease, as well as against Zika. Scientists at Institut Pasteur determined the structures with PILATUS and EIGER X-ray detectors made by the Swiss manufacturer DECTRIS and installed at Synchrotron SOLEIL.

The determination of the structure of the Zika protein is already the second big success for EIGER detectors this year. In May, Japanese researchers published the structure of a CRISPR-Cpf1 complex based on data collected with EIGER. CRISPR shows great potential for gene-editing based therapeutics for serious diseases. First studies on lung cancer patients are currently being conducted in China.

EIGER detectors are high-performance X-ray cameras that measure X-rays diffracted on crystals to make the determination of atomic structures of protein complexes possible.

For additional information, please contact Andreas Förster at andreas.foerster@dectris.com or refer to http://www.dectris.com.

**Neutralizing antibodies bind to Zika virus envelope protein.
The dimeric Zika virus envelope protein is shown at the bottom (blue and cyan). Bound to it on the left is the antigen-binding fragment (Fab) of a neutralizing antibody crossreactive against dengue (heavy and light chain, brown and pale orange, respectively). The accession code for the structure is 5lcv.**

DECTRIS EIGER Detector

"Crucial for the excellent performance of our detector systems is the integral quality of each purchased part and fabrication step. With Hamamatsu as our main supplier of sensor wafers for the EIGER and PILATUS product series, we found an excellent partner willing to deliver with the stringent specifications required to guarantee lowest defect densities and best performance in our systems. Good customer relationship and the readiness for actions as put into practice by Hamamatsu guarantees us continuity and continuous improvement of sensor quality."

Silke Traut, M. Sc. Appl. Phys., Head of Micro- and Nano-Technology, DECTRIS

"The cornerstone for this fruitful relationship was laid in a small meeting at the PSI – Paul Schärer Institute, Villigen in Switzerland many years ago. Koei Yamamoto, Division Managing director of our Solid State Division, recognized the potential behind Christian Brönniman's thoughts immediately and engaged himself and his team accepted the challenge to realize the detectors needed. Many wafer runs later and after some setbacks, we became the supplier for the then newly founded start-up DECTRIS. We congratulate DECTRIS on this achievement and are proud to continue to develop with DECTRIS the next generation X-Ray Photon-counting Cameras for their future success."

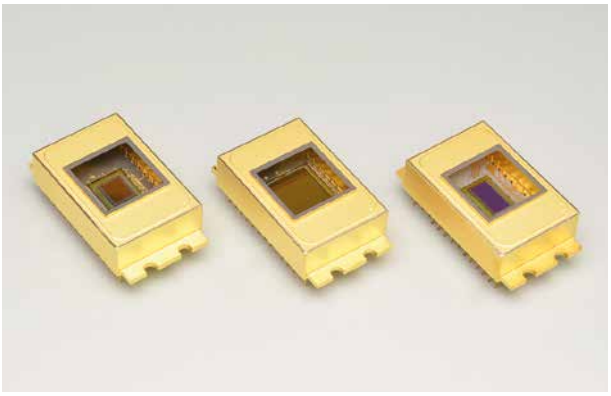
Marco Mayer, Area Manager Switzerland, HAMAMATSU Photonics Swiss Office

InGaAs Area Image Sensor G13393 Series, G13441-01

NEW

Two-dimensional image sensor for near infrared region

These are two-dimensional image sensors that have high sensitivity in the near infrared region. In addition to the previous 64 x 64 ch and 128 x 128 ch small package types, 192 x 96 ch type suitable for hyperspectral imaging, 320 x 256 ch type for general-purpose applications, and 640 x 512 ch type for high resolution imaging have been added to the lineup.



From left to right: G13393-0808W, G13393-0909W, G13441-01

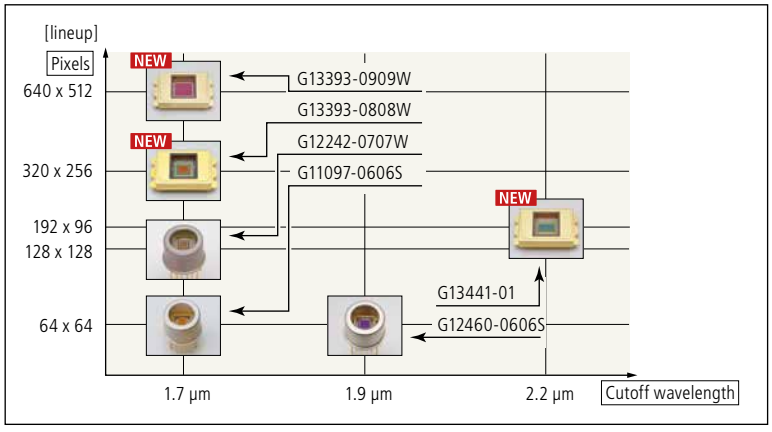
Features

- Spectral response range:
  - Up to 1.7 µm (G13393 series)
  - Up to 2.2 µm (G13441-01)
- High sensitivity
- Simple operation (built-in timing generator)

Applications

- Thermal image monitors
- Near infrared image detection
- Hyperspectral imaging
- Foreign object detection

Spectral response range: up to 1.7 µm (G13393 series) / up to 2.2 µm (G13441-01)



Specifications

Type no.	G11097-0606S	G12242-0707W	NEW G13393-0808W	NEW G13393-0909W	G12460-0606S	NEW G13441-01
Cutoff wavelength	1.7 µm				1.9 µm	2.2 µm
Number of pixels	64 x 64	128 x 128	320 x 256	640 x 512	64 x 64	192 x 96
Pixel pitch	50 µm	20 µm	20 µm	20 µm	50 µm	50 µm
ROIC	CTIA*1	SF*2	SF*2	SF*2	CTIA*1	CTIA*1
Frame rate max.	1,025 fps	258 fps	228 fps	62 fps	1,025 fps	867 fps
Cooling	One-stage TE-cooled	Two-stage TE-cooled	Two-stage TE-cooled	Two-stage TE-cooled	One-stage TE-cooled	Two-stage TE-cooled
Package	TO-8	TO-8	28L metal	28L metal	TO-8	28L metal

*1 CTIA (capacitive transimpedance amplifier) *2 SF (source follower amplifier)

CMOS Area Image Sensor S13101, S13102

NEW

Near infrared enhanced, APS*1 type

The S13101 and S13102 are APS type CMOS area image sensors that have high sensitivity in the near infrared region. Two pixel format types, SXGA and VGA, are available. They are an all-digital I/O type with built-in timing generator, bias generator, amplifier, and A/D converter. Rolling shutter readout or global shutter readout can be selected.

Differences from previous products

Compared to the previous products (S11661, S11662), random noise, dark output, and resolution have been drastically improved.

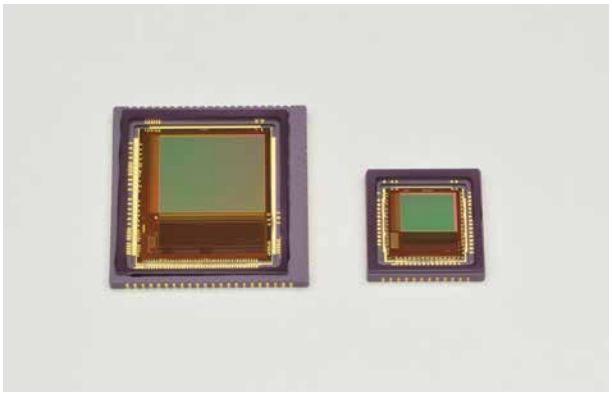
Features

- High sensitivity in near infrared region
- SPI communication function (partial readout, gain switching, frame start mode selection, etc.)
- Rolling shutter/global shutter readout
- Single 3.3 V power supply operation

Applications

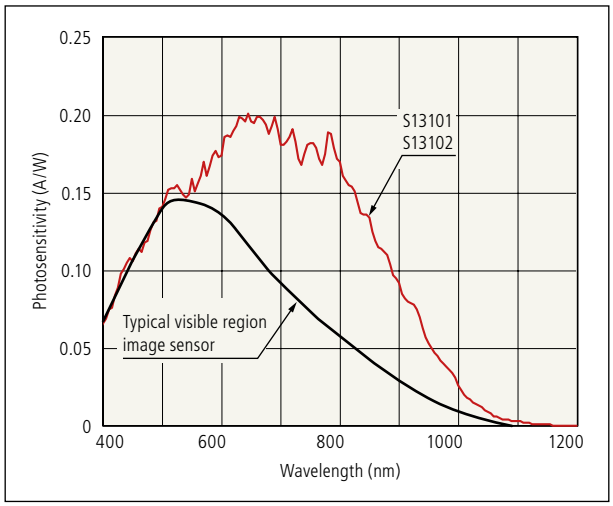
- Near infrared laser beam detection (position detection, pattern recognition)
- Near infrared image detection (wafer transmission image, vein authentication, etc.)

*1 Active Pixel Sensor



Left: S13101, right: S13102

Spectral response (typical example) (Ta = 25 deg. C.)



Specifications

Parameter	S13101	S13102	Unit
Number of effective pixels	1,280 x 1,024 (SXGA)	640 x 480 (VGA)	pixels
Image size (H × V)	9,472 x 7,578	4,736 x 3,552	mm
Pixel size (H × V)	7.4 x 7.4		µm
Spectral response range	400 to 1,000		nm
Frame rate max.	146	78	frames/s

CMOS Area Image Sensor S13103

NEW

Employs a function for high-speed readout of a small number of pixels

This is a CMOS area image sensor specifically designed for reading a small number of pixels at high speeds. A double-hold circuit was employed to enable high-speed readout of a small number of pixels.

Features

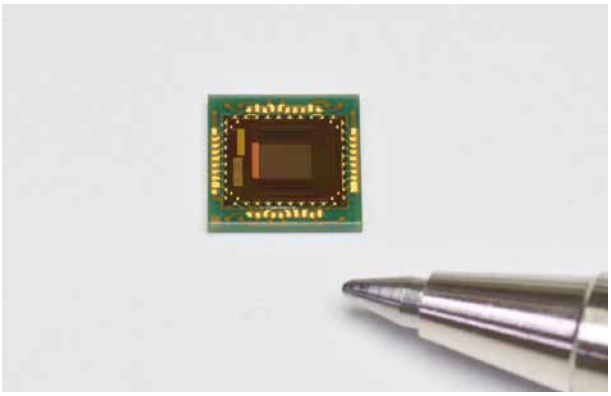
- High-speed readout of a small number of pixels
  - 6,890 frames/s (64 × 64 pixels)
  - 386 frames/s (320 × 240 pixels)
- SPI communication function (partial readout, gain switching, frame start mode selection, etc.)
- Global shutter readout
- Built-in partial readout and skip readout functions
- Single 3.3 V power supply operation

Applications

- Pattern recognition (barcode reader and the like)
- Position detection (displacement meter)

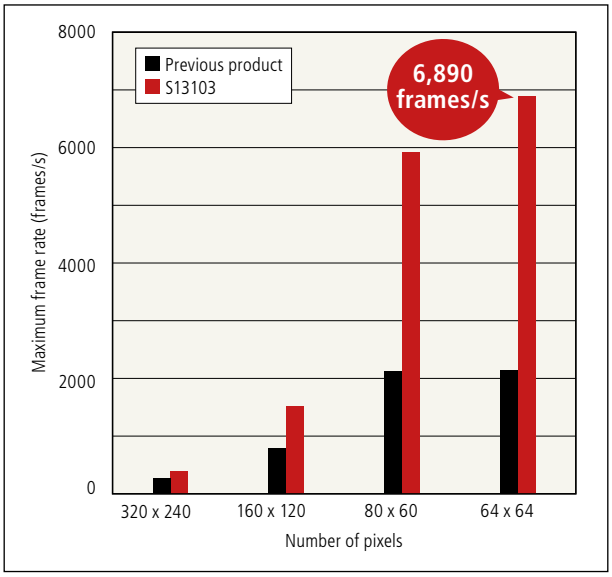
Specifications

Parameter	Specification	Unit
Number of effective pixels	320 x 240 (QVGA)	pixels
Image size (H × V)	2.368 x 1.776	mm
Pixel size (H × V)	7.4 x 7.4	μm
Spectral response range	400 to 1,000	nm



S13103

Maximum frame rate comparison (Data rate: 30 MHz)



InGaAs PIN Photodiode G13176 Series

NEW

Infrared detector employing surface mount type COB*1 package

The G13176 series is a near infrared detector available in a surface mount type COB package. Its size is drastically reduced compared to the previous metal package type. The small size makes this product suitable for integration into hand-held devices and mobile devices. Furthermore, the refined package resin has improved the reflow resistivity as compared to the previous product (G11777-003P).

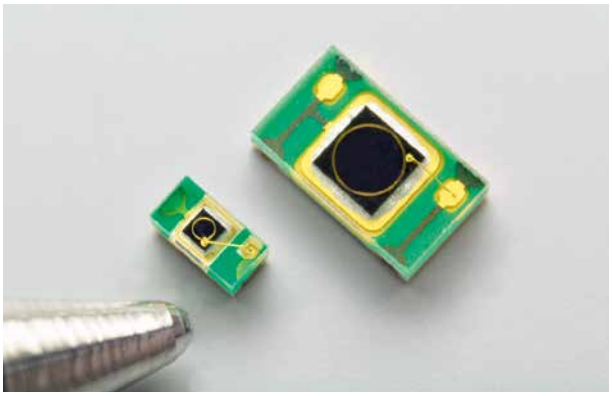
Features

- Small size COB package
- Surface mount type
- High sensitivity
- Low noise

Applications

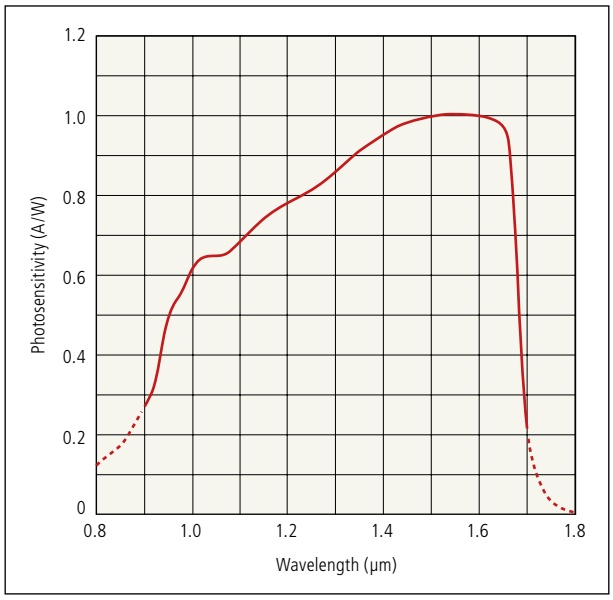
- Measurement
- Analysis
- Optical light level monitor

*1 chip on board



G13176 series

Spectral response (Typ. Ta = 25 deg. C., V_R = 0 V)



Specifications

Parameter	G13176-003P	G13176-010P	Unit
Photosensitive area	φ0.3	φ1.0	mm
Spectral response range	0.9 to 1.7		µm
Peak sensitivity wavelength	1.55		µm
Photosensitivity (λ = λp)	1		A/W
Dark current*2	0.1	0.8	nA
Cutoff frequency*3	600	60	MHz

*2 V_R = 5 V
*3 V_R = 5 V, R_L = 50 Ω

Infrared LED
L13141-0085K, L13142-0085K

NEW

Small light spot, high reliability LED

The L13141-0085K and L13142-0085K are current confinement type, small emission spot LEDs. The reliability of these products have improved from the previous products.

Features

- Reliability improved from the previous product
- Small light spot
- With microball lens: L13142-0085K

Applications

- Automatic control systems
- Optical switches
- Encoders

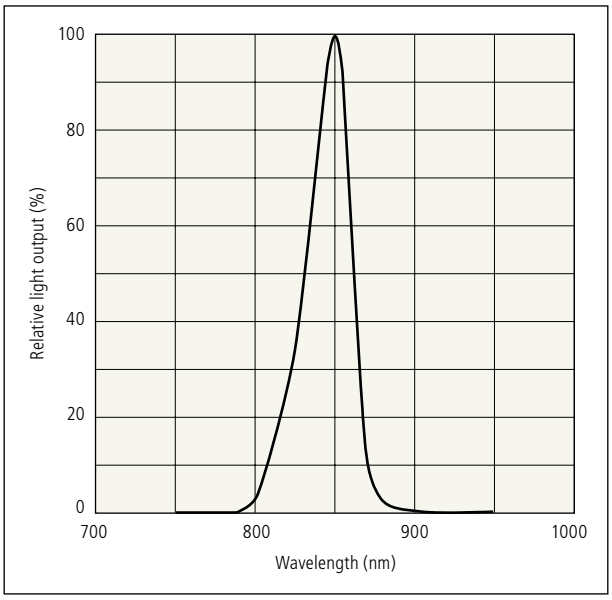
Left: L13141-0085K, right: L13142-0085K

Specifications

Parameter	L13141-0085K	L13142-0085K	Unit
Spot diameter*1	φ110	φ400	μm
Peak emission wavelength*1	850		nm
Spectral half width*1	30	35	nm
Radiant flux*1	2.8	3.0	mW
Cutoff frequency*2	25		MHz

*1 I_F = 50 mA
*2 I_F = 50 mA ± 10 mAp-p

Emission spectrum (Typ. Ta = 25 deg. C., I_F = 50 mA)



NEW

Infrared LED
L13072 Series, L12509 Series

For measuring gas and the like, near infrared LED

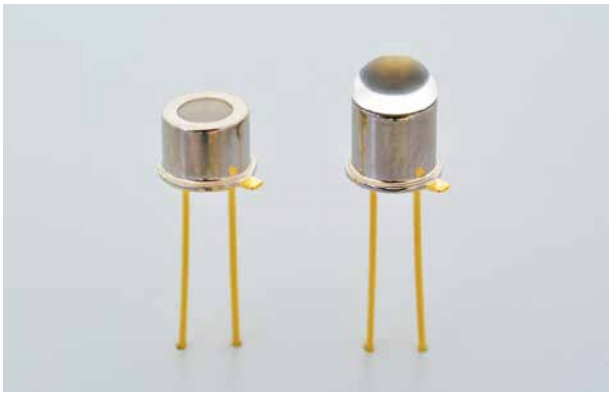
These near infrared LEDs used with InGaAs photodiodes are suitable for gas and other measurement applications. Two types with different peak emission wavelengths are available.

Features

- Peak emission wavelength:
  - 1.2 µm (L13072 series)
  - 1.55 µm (L12509 series)
- High radiant output power

Applications

- Gas measurement
- Analytical instruments



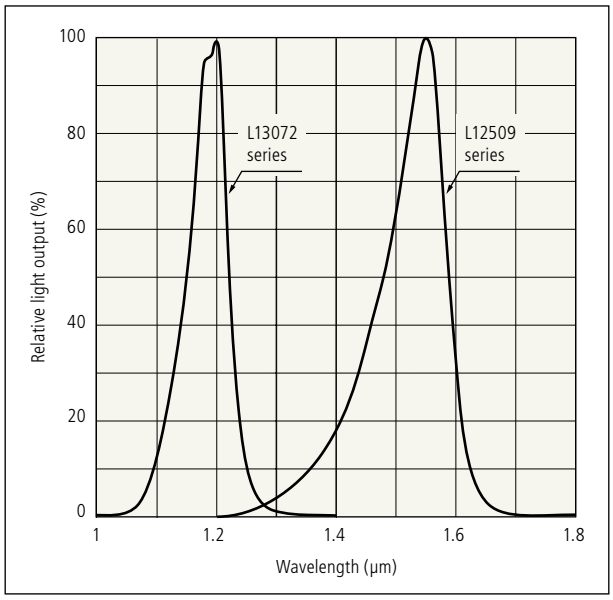
L13072 series, L12509 series

Specifications

Parameter	L13072		L12509		Unit
	-0120K	-0120L	-0155K	-0155L	
Package	TO-46				-
	Flat cap	With lens	Flat cap	With lens	
Peak emission wavelength*1	1.2		1.55		µm
Spectral half width*1	80		120		nm
Radiant flux*1	2.2	3.2	1.9	2.7	mW
Cutoff frequency*2	15		15		MHz

*1 I_F = 50 mA
*2 I_F = 50 mA ± 10 mAp-p

Emission spectrum (Typ. Ta = 25 deg. C., I_F = 50 mA)



Infrared LED
L13771-0330M, L13454-0390M

NEW

Measurement of gas and the like, mid-infrared LED

The L13771-0330M and L13454-0390M are mid-infrared LEDs with a peak emission wavelength in the 3 µm band that has been achieved using Hamamatsu unique crystal growth technology. These products are suitable for measuring CO_2 , CH_4 and other gases.

Features

- Peak emission wavelength:
  - 3.3 µm (L13771-0330M)
  - 3.9 µm (L13454-0390M)
- High radiant output power

Applications

- Gas measurement
- Analytical instruments

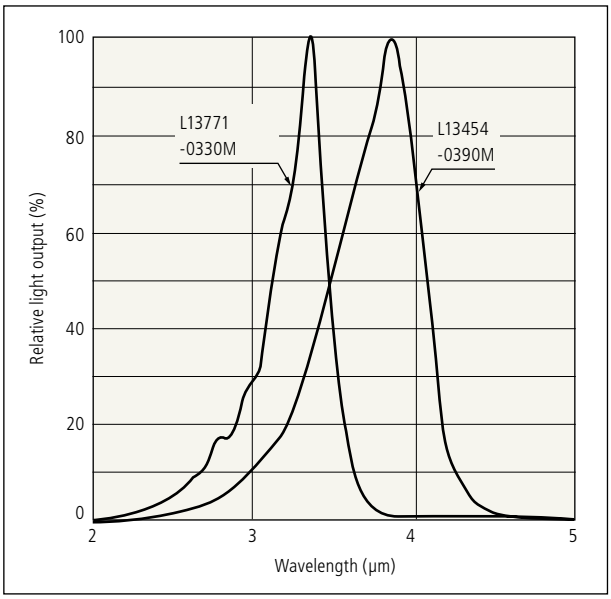
L13771-0330M, L13454-0390M

Specifications

Parameter	L13771-0330M	L13454-0390M	Unit
Peak emission wavelength*1	3.3	3.9	µm
Spectral half width*1	300	500	nm
Radiant flux*1	0.25	0.2	mW
Rise time*2	1	1	µs

*1 I_F = 50 mA, QCW mode (L13771-0330M)
I_F = 80 mA, QCW mode (L13454-0390M)
*2 10 to 90 %
Note: QCW mode: Quasi Continuous Wave mode

Emission spectrum (Typ. Ta = 25 deg. C.)



NEW

MEMS Mirror S12237-03P

Ultra-miniature, high performance Electromagnetically driven laser scanning MEMS mirror

The S12237-03P is an electromagnetically driven mirror that incorporates our unique Micro-Electro-Mechanical Systems (MEMS) technology. We achieved an ultraminiature scale by mounting the magnet beneath the mirror. Within a magnetic field generated by the magnet, electrical current flowing in the coil surrounding the mirror produces a Lorentz force based on Fleming's rule that drives the mirror. Hamamatsu MEMS mirrors offer a wide optical deflection angle and high mirror reflectivity as well as low power consumption.

Features

- Low current operation: 5 V max.
- Compact
- Wide optical deflection angle

Applications

- Laser scanner unit
- Optical switches

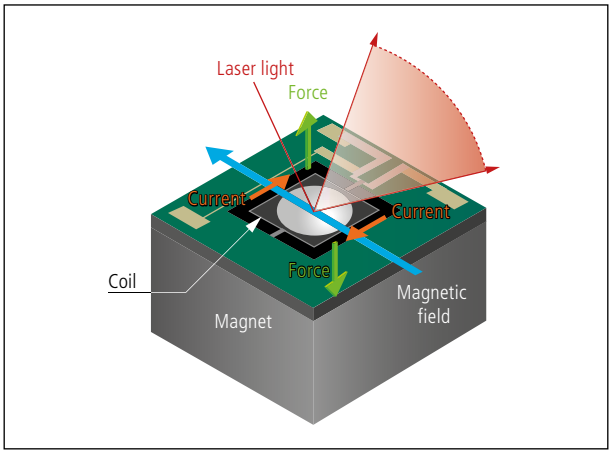
Specifications

Parameter	Specification	Unit
Operation mode	Linear mode	-
Mirror size	φ2.6	mm
Resonant frequency	530	Hz
Optical deflection angle*1	±15	degrees

*1 The optical deflection angle is twice the mechanical deflection angle.

S12237-03P

Structure and principle



In a MEMS mirror, a metallic coil is formed on a single-crystal silicon, a mirror is formed inside the coil through MEMS processing, and a magnet is arranged beneath the mirror. Within a magnetic field generated by the magnet, electrical current flowing in the coil surrounding the mirror produces a Lorentz force based on Fleming's rule that drives the mirror tilt angle in one dimension. The path of the laser light incident on the mirror surface is varied in this way to scan and project. Compared to the electrostatic or piezoelectric driven mirrors, electromagnetically driven MEMS mirrors are smaller, lower voltage driven, and lower power consuming.

High Speed Photomultiplier Tube R13478, R13449, R13408, R13089

NEW

Fast time response
Various sizes are available from 1 to 2 inches

Transit time spread (TTS) was reduced by optimizing the electron trajectories. A 25 mm (1 inch) diameter type was newly added to expand the product lineup. The overall length of the existing 28 mm (1-1/8 inch) and 38 mm (1.5 inch) types were shortened. These features help enhance equipment performance and also reduce the size and weight.

Features
- Fast time response
- Excellent time resolution
- Suitable for mass production

Applications
- Radiation monitor in security instrument
- Scintillation counting
- TOF-PET in nuclear medicine
- TOF counter in HEP experiment
- Optical communication

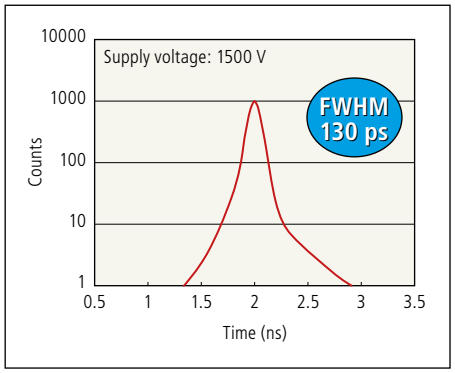
From left to right: R13478, R13449, R13408, R13089

Specifications

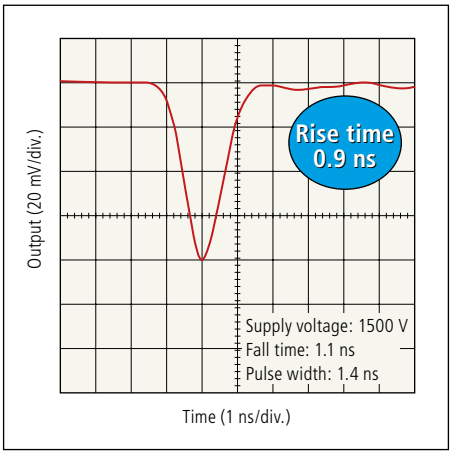
Parameter	R13478	R13449	R13408	R13089	Unit
Diameter	25 mm (1 inch)	28 mm (1-1/8 inch)	38 mm (1.5 inch)	51 mm (2 inch)	-
Spectral response range	300 to 650				nm
Photocathode type	Bialkali	Super bialkali, bialkali			-
Gain (typ.)*1	5.3×10^5			3.2×10^5	-
Supply voltage	1,500				V
Rise time (typ.)	0.9		1.2	2	ns
T.T.S. (FWHM) (typ.)	130	170	190	230	ps

*1 Supply voltage 1500 V, at 25 deg. C.

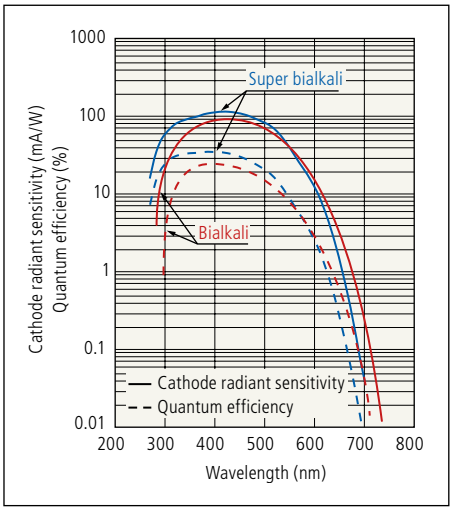
T.T.S. (R13478)



Output waveform (R13478, R13449)



Spectral response



NEW

High Speed Photosensor Module H13661

Suitable for high speed optical communication

PMT module containing a 1-1/8 inch head-on PMT and high-voltage power supply circuit.

Features

- High speed response
  - Up to 1.16 GHz cutoff frequency
  - 230 ps rise time
- Large effective area: 25 mm dia.
- Low power consumption
- Positive current output

Applications

- Optical communication
- LIDAR

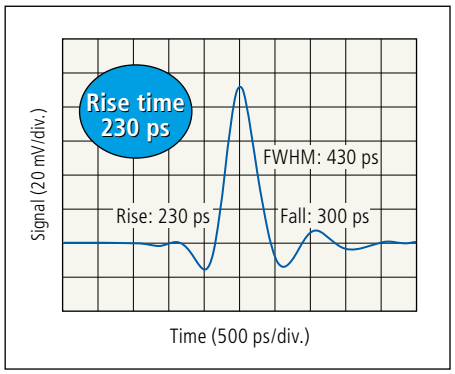
H13661

Specifications

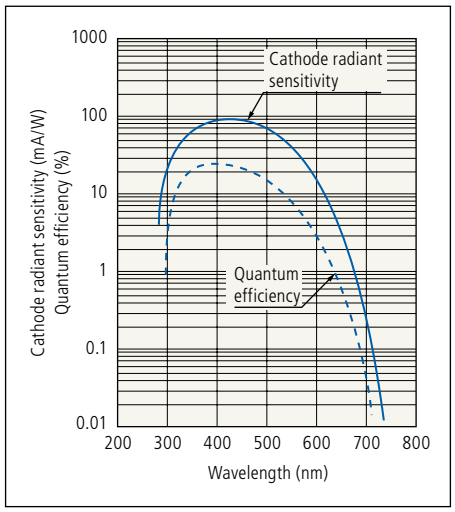
Parameter	Specifications	Unit
Spectral response range	300 to 650	nm
Effective area	φ25	mm
Input voltage	+4.8 to +5.5	V
Max. input current*1	6	mA
Max. output current	100	μA
Rise time*2	230	ps

*1 Input voltage +5.0 V, control voltage +2.2 V, operated in darkness
*2 Control voltage +2.2 V

Output waveform



Spectral response (typ.)



Photon Counting Head
H13197-40/42, H13198-40/42

NEW

GaAsP photocathode, built-in 16 ch linear multianode PMT

The H13197 series and H13198 series are photon counting heads using a 16-channel linear multianode PMT module with a GaAsP photocathode that has higher sensitivity than multialkali photocathodes in the visible light range or with a red-enhanced GaAsP photocathode that extends the sensitivity to longer wavelengths. These PMT modules use a newly developed electrode that improves collection efficiency and so enhances detection efficiency.

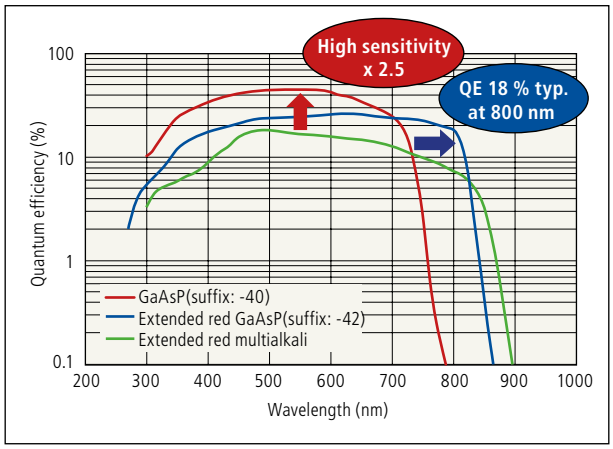
The H13198 series is basically identical to the H13197 series, except for the cooler attached to cool the photocathode to reduce dark count.

Features
- High sensitivity in visible range
- Reduced dark count due to cooling effect (H13198)

Applications
- Multi-wavelength fluorescence detection
- Laser scanning detection

Left: H13197, right: H13198
Fan and heat sink are sold separately.

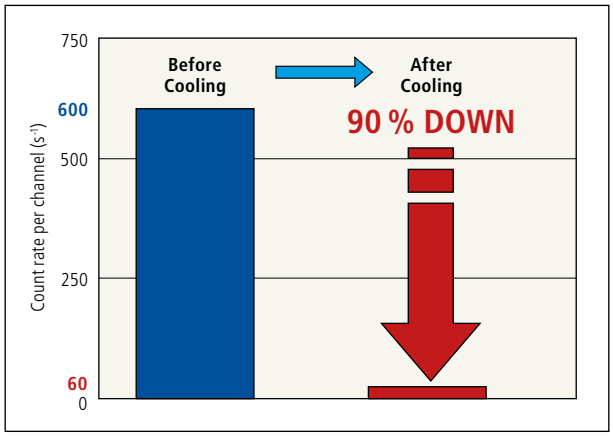
Quantum efficiency



Specifications

Parameter		H13197/H13198		Unit
		-40	-42	
Photocathode type		GaAsP	GaAsP Extended red	-
Spectral response range		300 to 720	300 to 870	nm
Quantum efficiency (typ.)	at 540 nm	45	25	%
	at 800 nm	-	18	
Gain (typ.)		1×10^6		-
Crosstalk (typ.)		2		%
Dark count / ch (typ.)	at 25 deg. C.	400	600	s^{-1}
	when cooled (H13198)	40	60	

Cooling function: Dark count (H13198-42)



NEW

Photon Detection Unit C13796

Makes it easy to measure low-light emission from living organisms, cells, and food

The C13796 is a photon detection unit designed to perform low-light measurements at single photon levels without a time-consuming measurement setup. All you need to do is prepare the sample you want to measure and a personal computer (PC). Select the desired accessories that match your application.

Compared to the previous model (C9692 series), the C13796 offers 3 times higher sensitivity and so allows accurate measurements with higher sensitivity.

Features

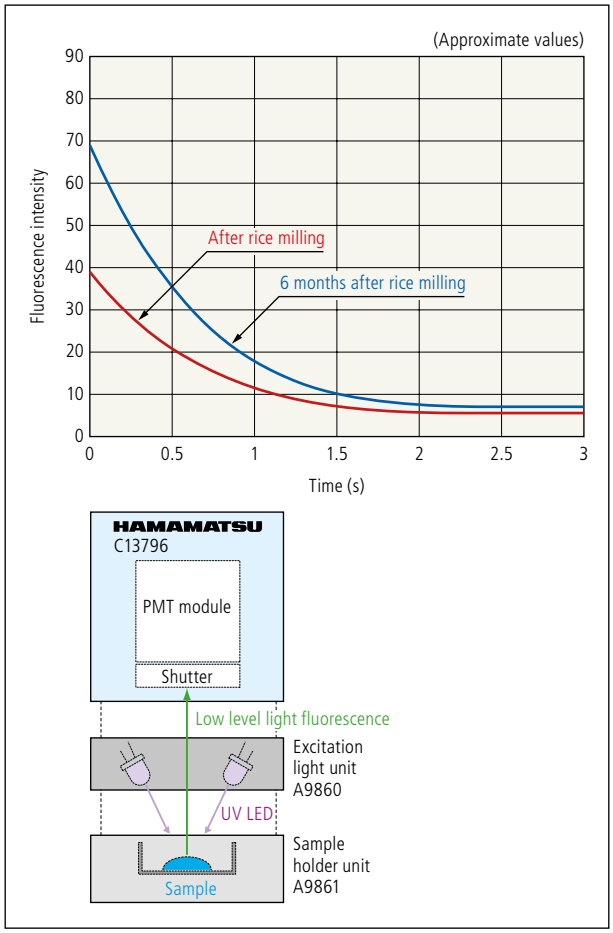
- Photon counting with high SN ratio
- USB interface
- Optical fiber (FC type) compatible (when using accessories)
- Built-in UV LED excitation light source (when using accessories)
- Reagent dispensing (when using accessories)

Applications

- Bioluminescence, chemiluminescence
- Food oxidation, antioxidant activity luminescence
- UV-excited (UV LED) delayed fluorescence
- ATP monitor using reagent

C13796+A9861 C13796+A11044 C13796+A10490+A9861

Measurement example: Oxidization on one polished rice grain



Specifications

Parameter	Specification	Unit
Detection method	Photon counting method	-
Spectral response range*1	300 to 650	nm
Maximum count rate	3 x 10^6	s^{-1}
Counter gate time	0.001 to 10 (1, 2, 5 steps)	s
Size (W x D x H)	100 x 100 x 99.5	mm

*1 300 nm to 850 nm type is also available.

Accessories

A9859	Optical fiber panel
A9859-01	Optical block panel
A9861	Sample holder block
A9860	Excitation light source
A10490	Dispenser unit
A11044	Microtube unit

High Speed Gated Image Intensifier Unit for High Speed Camera C10880-13C/F

NEW

No lighting required during imaging with high-speed framing camera

The C10880 series is capable of intensifying an optical image at a high gain. Attaching the C10880 series to the front of a high-speed camera compensates for the insufficient amount of light which usually occurs during imaging at high-speed frame rates. The C10880 series also offers a low image distortion that is nearly one half of the previous model C10880-03C/F (reduced from 4.4 % to 2.4 %) and so allows acquiring low distortion images.
The C10880-13C has a C-mount input port, while the C10880-13F has an F-mount input port.

Features

- High-speed gate operation: 10 ns or more
- Maximum repetition frequency: 200 kHz
- Built-in pulse generator
- Multi-exposure

Applications

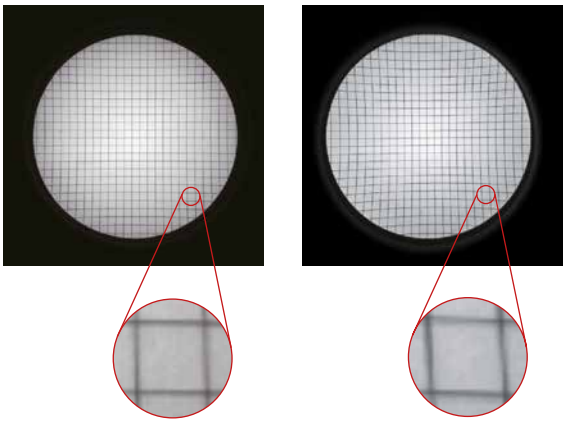
- Analysis of engine combustion state
- Analysis of plasma emission discharge
- Observation of flow of small particle, gas, liquid

Specifications

Parameter		Specifications	Unit
Spectral response range		185 to 900	nm
Effective photocathode area (min.)		φ24	mm
Phosphor screen	Material (front-stage I.I. / image booster)	P46	-
	Effective area (min.)	φ16	mm
Output window material		FOP	-

F mount type C mount type

Image distortion



Overall distortion at a position 80 % away from the center of the image

NEW

Flame Sensor UVTRON® R13192

Quickly detects a flame such as a small bonfire even at a distance of 100 meters ahead

The UVTRON® ultraviolet ON/OFF detector that makes use of the photoelectric effect of metal and the gas multiplication effect. It has a narrow spectral sensitivity of 185 nm to 260 nm, being completely insensitive to visible light. It does not require optical visible-cut filters, thus making it easy to use.

Features

- Detects weak UV light emitted from a flame
- Solar blind characteristics – sensitive only in the UV region
- Long-distance flame detection

Applications

- Fire alarm apparatus
- Arson watch monitor
- Discharge/spark detection

R13192

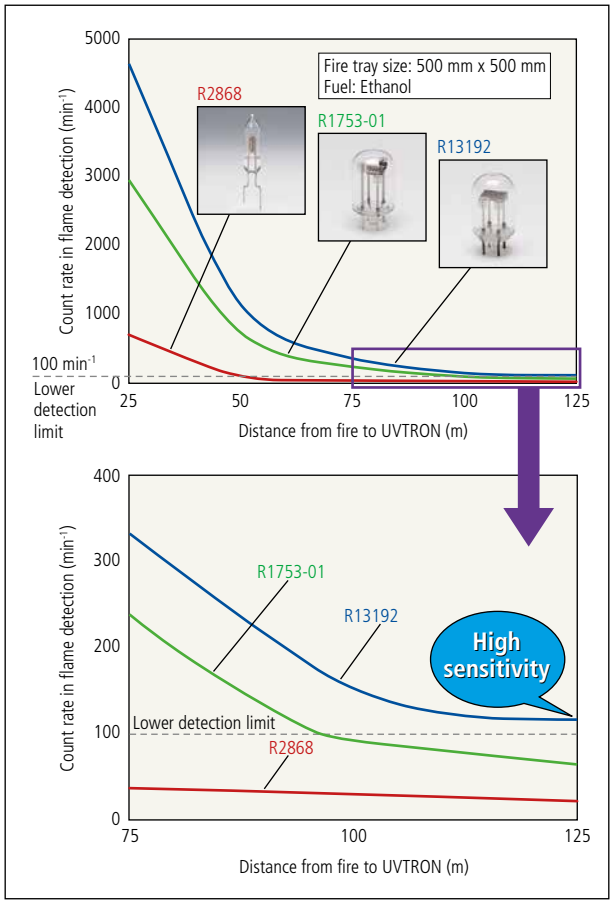
Specifications

Parameter	Specifications	Unit
Spectral response range	185 to 260	nm
Operation ambient temperature (maximum rating)	-20/+125	deg. C.
Recommended operating voltage	325±25	V
Sensitivity (typ.)*1	15,000	min^{-1}
Background (max.)*2	5	min^{-1}

*1 Count rate measured at 25 deg. C. using UV light at 200 nm wavelength and 10 pW/cm^2 power. Sensitivity varies depending on the wavelength of the incident UV light and the driving circuit.

*2 Measured under room lighting (approximately 500 lux) and recommended operating conditions. Background may increase due to external factors when used outdoors.

Sensitivity and distance from fire



Deep UV Light Source (UVCL) L12848-265

NEW

Mercury free and high output deep-UV light source

The L12848-265 is a mercury-free deep-UV light source that utilizes electron-beam excitation emission. Its compact body contains a lamp and a power supply, eliminating the need to design a housing and allowing easy assembly into equipment.

Features

- High output
- Mercury free
- Long life: 5,000 hours
- Easy assembly into equipment
- High luminous efficiency

Applications

- Sterilization
- Curing/bonding
- Environmental analysis
- Material resistance evaluation

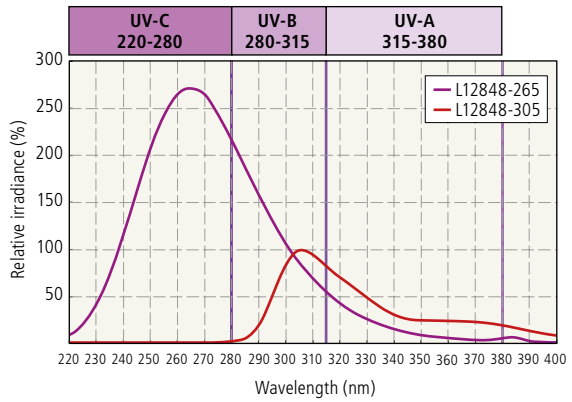
L12848-265

Specifications

Parameter		Specifications	Unit
Spectral distribution		220 to 350	nm
Peak wavelength		265	nm
Light output stability	Fluctuation (p-p) (max.)	0.3	%
	Drift (max.)	±3	%/h
Guaranteed life*1		5,000	h
Light-emitting point size		Approx. φ5	mm

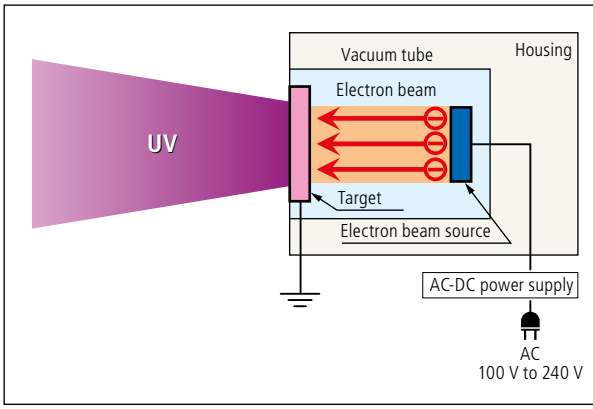
*1 Guaranteed life is defined as the time when light output falls below 50 % of the initial value or light output stability exceeds the guaranteed value.

Spectral distribution



This irradiance graph shows relative values when the maximum irradiance of L12848-305 is given as 100 %.

Internal structure



NEW

2 W Xenon Flash Lamp Module L13651/L13821 Series

Light source ideal for portable compact analytical instrument

The L13651 and L13821 series are 2 W xenon flash lamp modules integrated with a regulated drive power supply and a lamp trigger circuit. These lamp modules have the same performance as the conventional 2 W lamp modules but operate on either 12 V or 5 V.

Features

- High output
- High stability: 0.4 % CV (typ.)
- Preadjusted light-emitting point (L13651)
- Cylindrically stacked board type (L13821)

Applications

- Spectroscopic analysis
- Water quality and pollution analysis (TOC/TN, TP, etc.)
- Air pollution analysis (NOx, SOx, etc.)
- Blood analysis

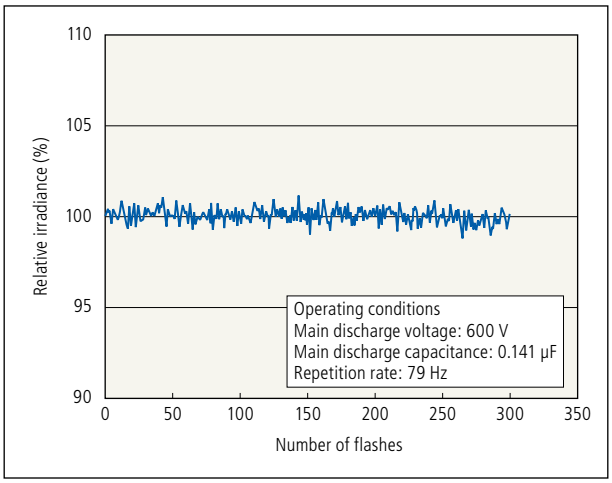
Specifications

Parameter		L13651/L13821				Unit
		-01	-02	-03	-04	
Spectral distribution		185 to 2,000				nm
Main discharge voltage variable range		400 to 600				V
Main discharge capacitance		0.141	0.094	0.047	0.02	µF
Maximum average input (continuous)	12 V operation	2				W
	5 V operation	2		1.5	1	W
Guaranteed life *1		$1x10^9$				flashes
Maximum repetition rate	12 V operation	177	266	532	1,250	Hz
	5 V operation			400	625	

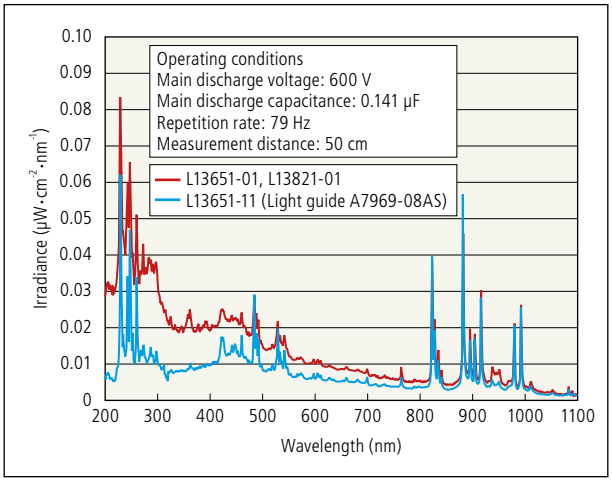
*1 Guaranteed life is defined as the time when the light output at 190 nm to 1100 nm in 2 W operation falls below 50 % of the initial value or light output stability exceeds 2.0 % CV.

Left: L13651, right: L13821

Light output stability (typ.) (L13651)



Spectral irradiance (typ.)



Capillary Lens J12432-01

NEW

Collimating optics for X-rays

Hamamatsu provides collimating optics for X-rays, which consist of a bundle of numerous hollow glass capillaries formed into a cylindrical shape with one end gently tapered.

These optical elements utilize total reflection of X-rays on the inner wall of each capillary to collimate X-rays emitted from an X-ray source.

Applications

- X-ray diffraction (XRD)

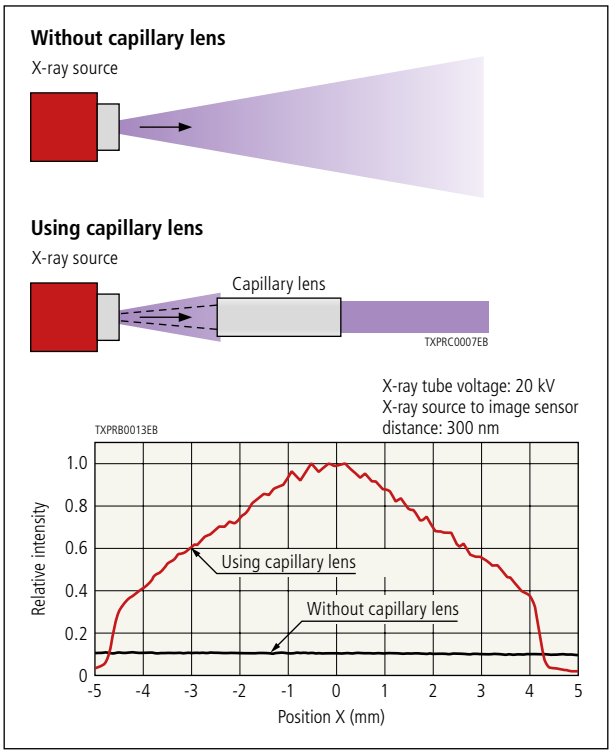
J12432-01

Specifications

Parameter	J12432-01	Unit
Operating X-ray energy (recommended)*1	5 to 20	keV
Input focal distance*1	50	mm
Parallel beam diameter	8	mm

*1 Distance from X-ray tube target to capillary lens input end.

X-ray collimating image



NEW

NanoZoomer S60 Digital Slide Scanner

Fluorescence imaging of whole tissue with high speed scanning

Features

- Handling of double size slides
- Capable of brightfield / fluorescence imaging
- Scanning and capturing the fluorescence image of whole tissue with high speed, sensitivity and image quality
- Automatically process up to 60 slides of regular size or 30 slides of double size

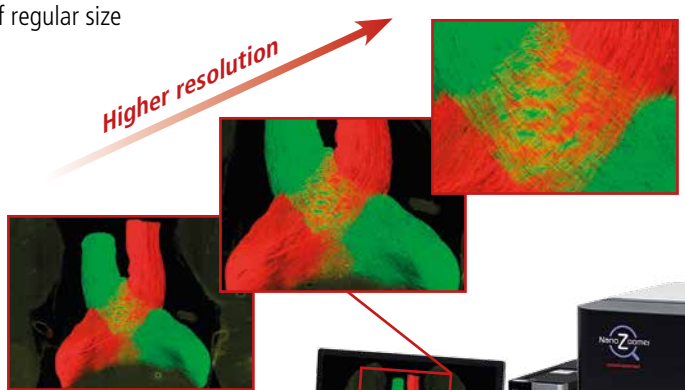


Image observation with a flexible zoom function like a microscope.

Additional accessories L13820-01, L13820-02, and L13820-03 are required for fluorescence scanning.

Quantaurus-QY Plus UV-NIR Absolute PL Quantum Yield Spectrometer

NEW

Easily extend functions with newly designed options

Quantaurus-QY Plus easily measures absolute PL quantum yield, which is difficult to measure using conventional technology.

New features

- For near-infrared up to 1,650 nm (C13534-31, -32)
- For low quantum yield of 1 % or lower (C13534-33, -34)
- For upconversion emission material (C13534-35, -36)

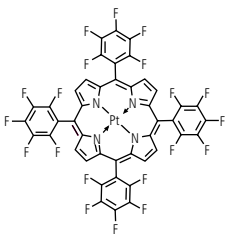
Features

- Measures absolute photoluminescence quantum yield of light-emitting materials (PL measurement)
- Utilizes an integrating sphere to measure all luminous flux
- Cooled, back-thinned CCD sensor allows measurements with ultra-high sensitivity and high S/N ratio
- Automatically controls the excitation wavelengths
- Wide selection of analysis functions
  - Photoluminescence quantum yield
  - Excitation wavelength dependence
  - Photoluminescence spectrum
- PL excitation spectrum

Singlet oxygen luminescence quantum yield

This is an example of the luminescence quantum yield measurement of singlet oxygen using platinum (II) mesotetra (pentafluorophenyl) porphine (PtTFPP) solution as a radiosensitizing agent. We successfully expanded the wavelength region for the measurements to a wide 400 nm to 1,650 nm range using a combination of BT-CCD and InGaAs line sensors.

As a result, we were able to simultaneously measure both the excitation light profile (center wavelength: 525 nm) and the singlet oxygen emission spectrum (peak wavelength: 1,270 nm), and obtained 0.022 as the absolute luminescence quantum yield for singlet oxygen.



platinum (II) mesotetra (pentafluorophenyl) porphine (PtTFPP)

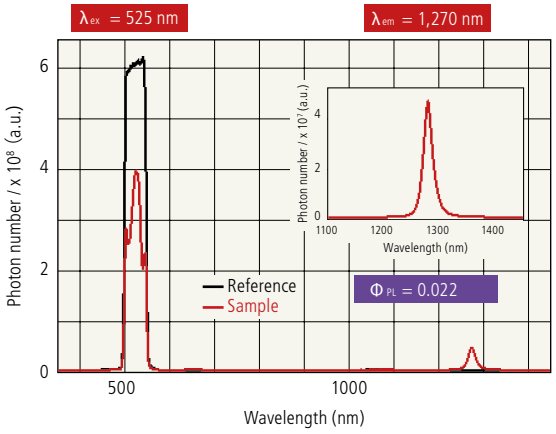
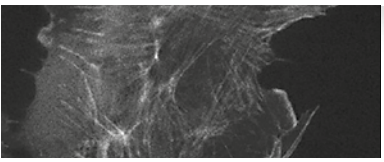


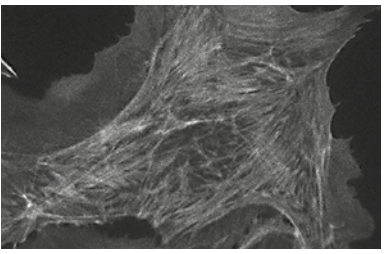
Fig.1 Excitation light profile and emission spectrum in the presence/absence of a chloroform solution of PtTFPP

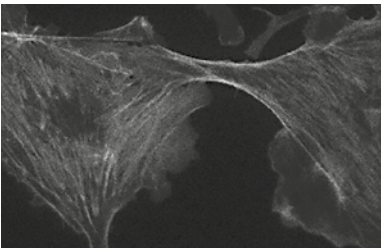
Courtesy of Tobita lab, Graduate School of Science and Technology, Gunma University
N. Hasebe, K. Suzuki, H. Horiuchi, H. Suzuki, T. Yoshihara, T. Okutsu, and S. Tobita, *Anal. Chem.*, 87, 2360 (2015)

NEW

ORCA-Flash4.0 V3



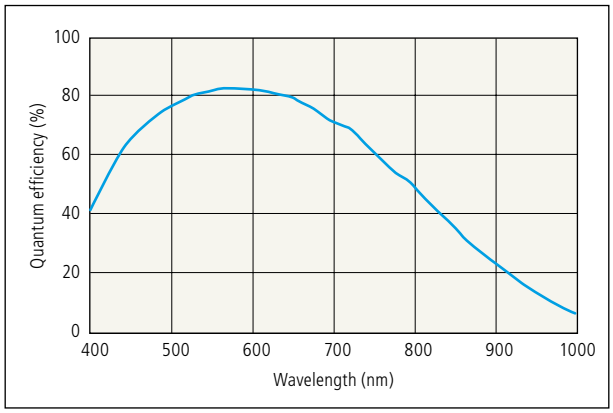




We've advanced our camera technology, so you can advance your science

Building on our extensive experience with high performance scientific cameras and advanced imaging applications, Hamamatsu introduces the new ORCA-Flash4.0 V3. This one camera expertly handles applications ranging from the acquisition of beautiful scientific images to experiments that demand detection, quantification and speed. With on-board FPGA processing enabling intelligent data reduction, highly refined in-camera, pixel-level calibrations, increased USB3.0 frame rates, purposeful and innovative triggering capabilities, patented lightsheet read out modes and individual camera noise characterization the ORCA-Flash4.0 V3 is the precision instrument for imaging.

Quantum efficiency



Features

- Calibrated for quantitative accuracy
- Flexibility for customized data control
- Patented tools for advanced imaging
- Focus on the relevant data
- Powerful triggering for synchronization

W-VIEW GEMINI-2C

NEW

Dual camera image splitting optics done right

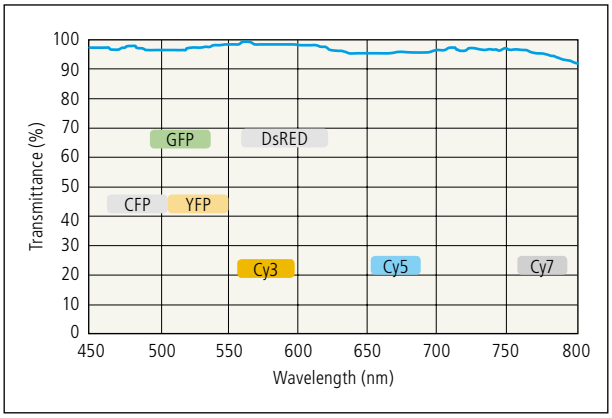
Dual channel optics are simple… in principle. In practice, designing a device that enables quick, stable alignment and delivers images with minimal distortions over a large field of view requires attention to detail. The W-VIEW GEMINI-2C gets the details right and more. Building on our imaging and optical experience, the W-VIEW GEMINI-2C is the first dual camera, dual channel system engineered with super resolution quality, while simultaneously offering versatility, expandability and ease of use. The W-VIEW GEMINI-2C turns a simple optical concept into an elegant and useful tool that can help maximize the information content of every image acquisition.

Features

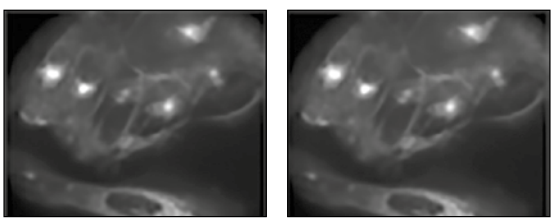
- Unrivaled optical quality provides superior images
  - Custom designed lenses optimized for fluorescent imaging
  - Wide field of view (20 mm for standard imaging, 12 mm for diffraction-limited imaging)
  - Ultra-low distortion (0.05 %), high spatial uniformity (98 %), high transmission (98 % @ 450-800 nm)
- Robust opto-mechanical design for ease of alignment and versatility
  - Dual channel x, y, z and rotational alignment
  - Standard filters and (dichroic) beamsplitters
  - Bypass and camera switching mode
  - C-mount compatibility
- Attention to detail enables advanced imaging applications
  - Lightsheet, single molecule imaging and super resolution microscopy
  - Tri-color and quad-color imaging
- Modular design supports expansion into engineered point spread function imaging

W-VIEW GEMINI-2C

W-VIEW GEMINI-2C Transmittance



W-VIEW GEMINI-2C Transmittance

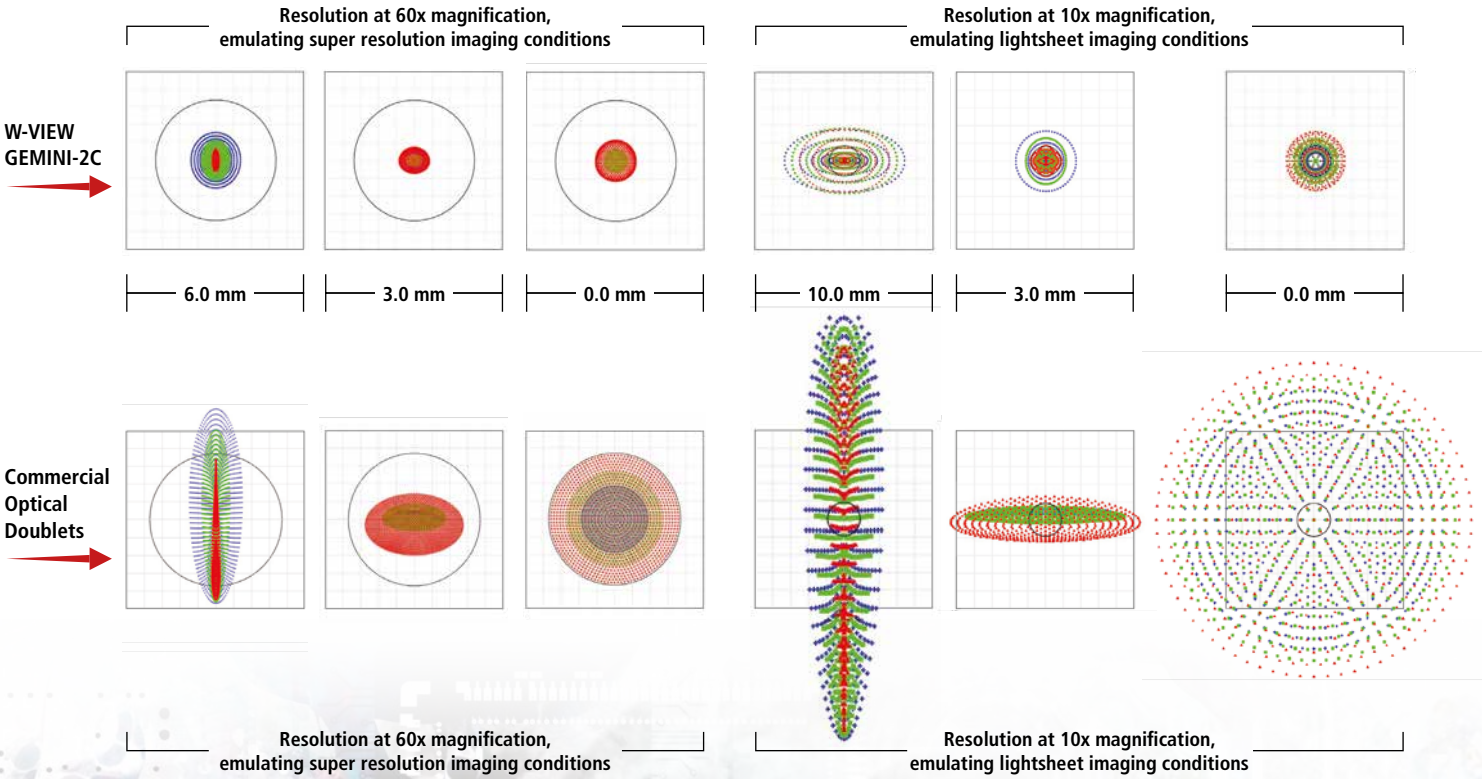


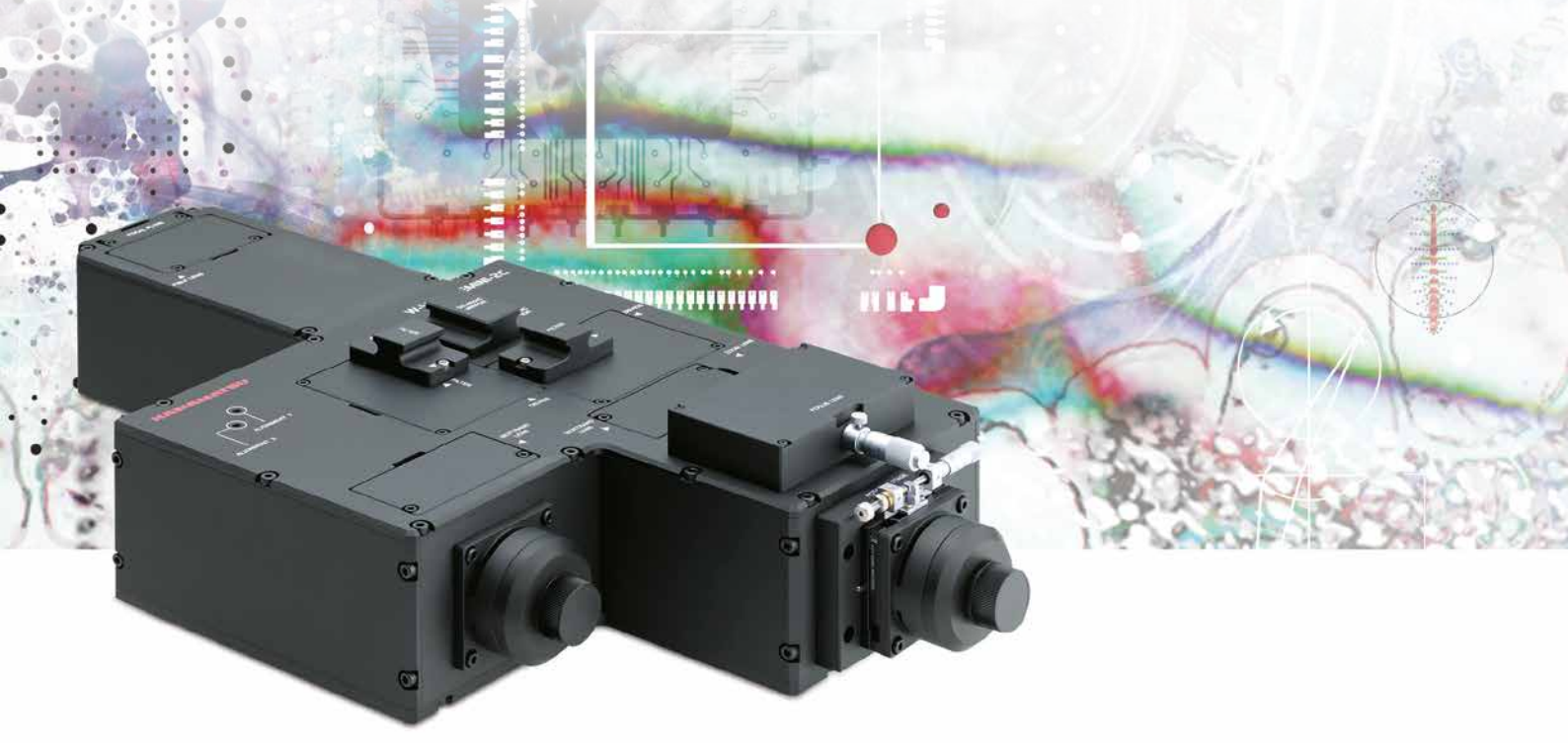
Reflected Image **Transmitted Image**

The orientation of the W-VIEW GEMINI-2C dual images are identical, not mirrored, making alignment intuitive and avoiding the extra step of inverting in software.

W-VIEW GEMINI-2C

W-VIEW GEMINI-2C for advanced imaging applications





CW Quantum Cascade Laser L12004-2190H-E

NEW

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

The lens integrated package for DFB-CW type QCL is sealed and collimated housing. The internal lens provides collimated output beam radiation. TEC (peltier) and thermistor for temperature stabilization of 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 conventional product

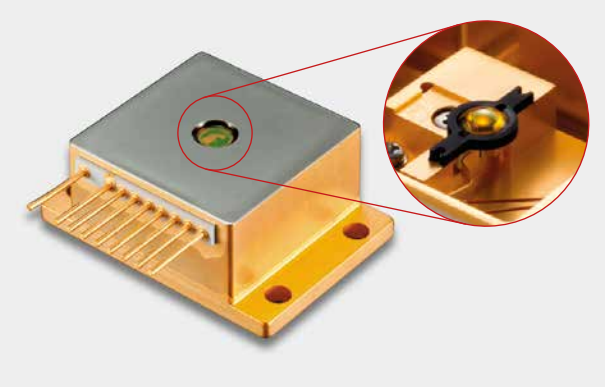
Contains a collimation lens with no change in package size.
Needs no additional collimation lens (A11331 sold separately).

Features

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

Application

- Trace gas analysis



L12004-2190H-E

Specifications (Top(qcl) = 20 deg.C.)

Wavelength	Operating temperature (QCL)*1		Line width*2	Tunable range*3	Output power	Threshold current	Side-mode suppression ratio (SMSR)
Typ.	Min.	Max.	Max.	Min.	Min.	Max.	Min.
4.57 µm*1	+10 deg. C.	+50 deg. C.	0.2 cm^{-1} *4	1.0 cm^{-1}	20 mW	1.0 A	25 dB*4
	Condition: K 2,190 cm^{-1} *6						

*1 Please contact a Hamamatsu sales office for the availability of the other wavelength above.
*2 This specifies the temperature range within which the target emission wavenumber (K) can be realized.
*3 Full-width half maximum
*4 This specifies the continuous tunable range (without mode hopping). The center wavenumber of the tuning range is the emission wavenumber (K).
*5 The figures are limited by the resolution and signal/noise ratio of the measuring instruments used.
*6 K: Emission wavenumber (cm^{-1})

NEW

Pulsed QCL Module
L14147-1278-01/-02

Mid-IR laser plug-in modules

The plug-and-play pulsed QCL module is a compact module containing a TO-8 can packaged pulsed DFB quantum cascade laser, pulse driver and TEC controller. The module can be easily and remotely controlled via Ethernet connection.

Difference from conventional product

Integrates a pulsed QCL, pulse driver, TEC controller, and control interface, all into the same housing.

Features

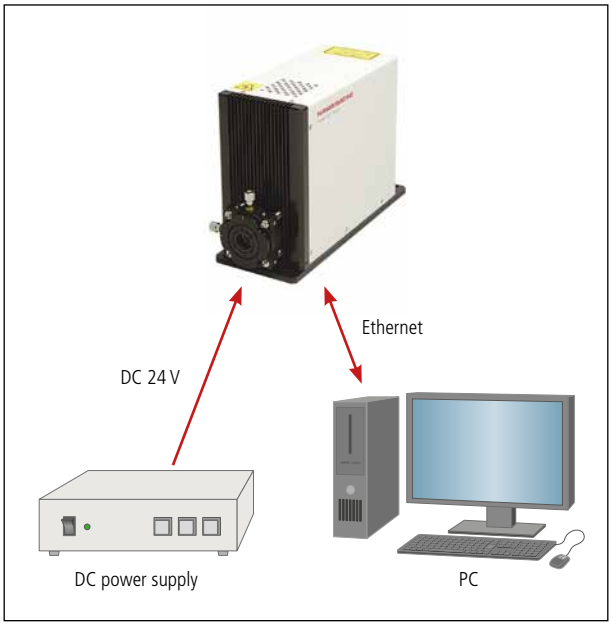
- Pulsed QCL (TO-8) L12017-1278T-C (7.82 µm, 100 mW) included
- Integrated pulse driver circuit and TEC controller
- Collimation lens available (L14147-1278-02)
- Use DC 24 V input
- Ethernet connection for software control
- Connect up to 4 units in parallel

Applications

- Continuous emission monitoring systems (CEMS)
- Environmental gas monitoring
- Infrared laser spectroscopy

L14147-1278-02

Connection example



Pulsed QCL lineup

Wavelengths other than 7.82 µm is available for selection from the below-mentioned pulsed QCL lineup table.

Type No.	Wavelength (typ.)*1	Unit
L12014-2231T-C	4.48	µm
L12015-1901T-C	5.26	
L12016-1630T-C	6.13	
L12017-1278T-C	7.82	
L12020-0993T-C	10.07	

*1 Please contact a Hamamatsu sales office for the availability of the other wavelengths above.

Pulsed Laser Diode
L12169-336-51, L11854-336-05

NEW

Delivers a peak light output of 100 W or more at 870 or 905 nm

The L12169-336-51 and the L11854-336-05 are multimode lasers that emit high-power pulsed light from the 360 µm x 10 µm emission area. Since the beam broadens to have a unimodal distribution and the near field pattern (NFP) is sharp, the L12169-336-51 and the L11854-336-05 are ideal as a light source for laser rangefinders and security/surveillance devices. The standard package is a 5.6 mm diameter CAN package, but other packages are also available upon request.

Difference from conventional product

- **L12169-336-51:** wide emission area and high peak light output of 100 W or more at 870 nm
- **L11854-336-05:** wide emission area and high peak light output of 100 W or more at 905 nm

Features

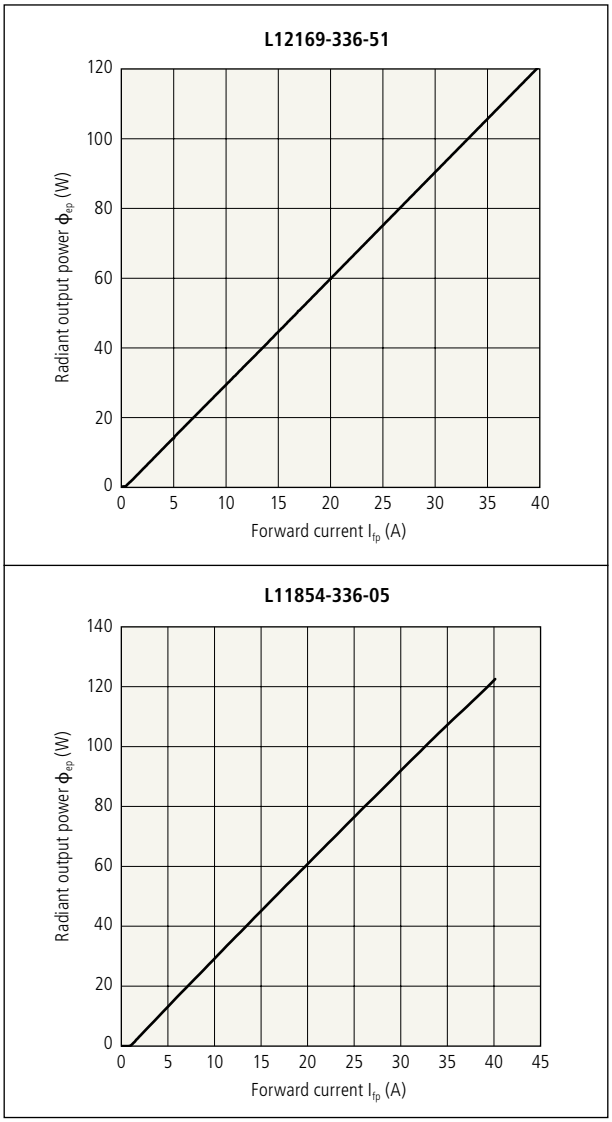
- Radiant peak output power: ≥100 W
- Peak emission wavelength
  - L12169-336-51: 870 nm
  - L11854-336-05: 905 nm
- Emitting area size: 360 µm × 10 µm

Applications

- Laser rangefinders
- Security
- Measuring instruments

L12169-336-51, L11854-336-05

Radiant output power vs. Forward current (typ.) ($T_{op(c)}$ = 25 deg. C.)

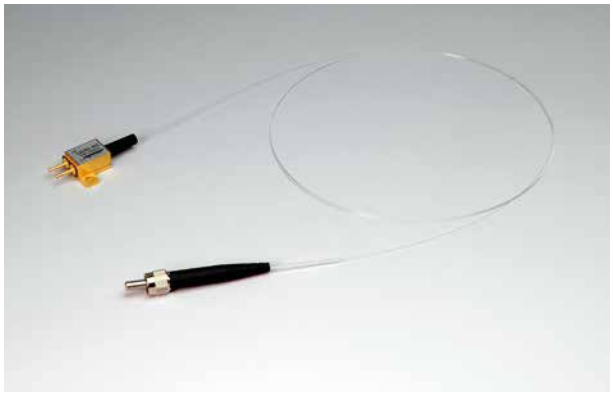


NEW

Fiber Output Laser Diode L13181-01S

Fiber output laser diode having high environmental durability

The L13181-01S is a fiber output laser diode with high optical output (10 W) and high conversion efficiency (55 %) achieved by our unique device structure. This LD is usable as a high-luminance light source in a wide range of fields, including material processing, pumping of fiber lasers and solid-state lasers, medical treatment, and chemical analysis.



L13181-01S

Difference from conventional product

SMA type connector

Features

- High output: 10 W
- High conversion efficiency: 55 % or more
- Pigtail (2 pin) with SMA

Applications

- Direct condensing processing
- Fiber laser and solid-state laser pumping
- Medical treatment
- Chemical analysis

Specifications

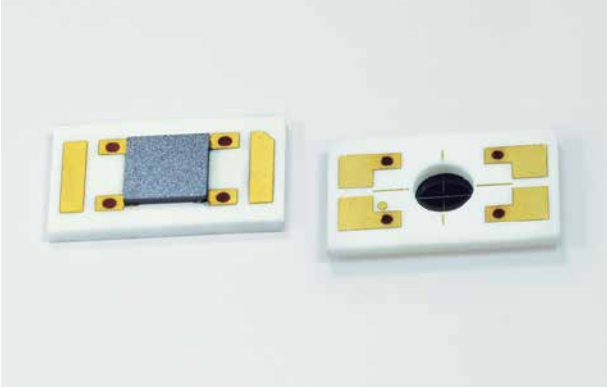
Parameter		Symbol	Value	Notes
LD	Output power at fiber exit end	ϕef	10 W	
	Operating current	I_{op}	11 A (typ.)	
	Operating voltage	V_{op}	<2 V	
	Emission wavelength	λc	915 nm ±10 nm	Contact Hamamatsu for other wavelengths.
Fiber	Guided wave longitudinal mode	-	Multimode	
	Core diameter	-	105 µm	MM-S105
	NA	-	0.15	Equivalent to 125-15A
	Jacket diameter	-	ϕ0.25 mm	Bare optical fiber

Terahertz Photoconductive Switch G12864-01/-02

NEW

Chip-carrier type terahertz photoconductive switch

The spectral region between light and electrical waves is known as terahertz (THz) region from the viewpoint of its frequency. This far-infrared spectral region has recently attracted considerable attention for its potential applications in spectroscopy, imaging, telecommunications, medical analysis, and so on. THz photoconductive switch (sometimes called a photoconductive antenna) G12864 series is able to emit and/or detect THz wave by illuminating an ultrafast pulse laser. Small element size (6 x 10 mm) helps easy installation in a system.



G12864-01/-02

Difference from conventional product

Allows flexible integration with the other components in user's system.

Applications

- Far-infrared spectroscopy
- Material analysis
- Nondestructive and non-contact inspection
- Structure inspection
- Security, etc.

Absolute maximum ratings

Parameter	Symbol	Value	Unit
Applied voltage	V_{op}	±10	V
Average input optical power*1, 2	P_{ave}	10	mW

*1 The beam diameter on the chip surface should be larger than 10 µm ($1/e^2$).
*2 Use a femtosecond laser with repetition rate from 50 MHz to 150 MHz.

NEW

SERS Detection Module C13560

World's smallest Raman spectrometer module

The Surface-Enhanced Raman Spectroscopy (SERS) detection module is a Raman OEM module that includes all the functions (excitation LD, polychromatic dispersion device, optical and control circuit systems) needed to perform Raman measurements. This module is an easy-to-use detection tool that utilizes a dedicated SERS substrate J13856, to facilitate simple screening applications such as POCT (Point of Care Testing). The module is also customizable to meet the customer's specific set of functional requirements for OEM type applications.

C13560

Difference from conventional product

One-twentieth (1/20) the weight and one-fortieth (1/40) the volume of previous model (C12710). Also low power consumption due to use of APS-CMOS linear image sensor.

Features

- Ultra-compact, lightweight, low power consumption Raman module with specialized, small SERS substrate

Applications

- Analytical chemistry, Environmental chemistry
- POCT, Active ingredient & contamination detection

Specifications

Parameter		Value
Light source	Wavelength	785 nm
	Output power	5 mW / 10 mW / 15 mW
	FWHM bandwidth	0.2 nm
Detecting section	Detector	APS-CMOS linear image sensor
	Range	400 cm^{-1} to 1,850 cm^{-1}
	Spectral resolution	10 cm^{-1}
Operation and equipment sections	Software	Operation software (source code disclosure)
	Interface	USB2.0
	Power consumption	Max. 0.9 W
Size (W × H × D)		80 mm × 60 mm × 12.5 mm*1
Weight		90 g*1

*1 The SERS substrate holder is excluded.

Global Exhibitions 2016 and 2017

USA

October 2016

NAPAC
Oct 9-14 2016, Chicago, IL

Autotech Council Science Fair
Oct 10 2016, Mountain View, CA

OSA Frontiers in Optics
Oct 19-20 2016, Rochester, NY

Pathology Visions
Oct 23-25 2016, San Diego, CA

November 2016

ISTFA
Nov 6-10 2016, Fort Worth, TX

Neuroscience
Nov 12-16 2016, San Diego, CA

Printed Electronics
Nov 16-17 2016, Santa Clara, CA

RSNA
Nov 29-Dec 4 2016, Chicago, IL

December 2016

ASCB Annual Meeting
Dec 3-7 2016, San Francisco, CA

BIOMEDevice
Dec 7-8 2016, San Jose CA

January 2017

Consumer Electronics Show
Jan 5-8 2017, Las Vegas, NV

BIOS
Jan 28-29 2017, San Francisco, CA

Photonics West
Jan 31-Feb 2 2017, San Francisco, CA

February 2017

SLAS International Conference
Feb 4-8 2017, Washington DC

March 2017

Pittcon
March 3-9 2017, Chicago, IL

June 2017

Sensors Expo
June 27-27 2017, San Jose CA

Europe

October 2016

Bondexpo
Oct 10-13 2016, Stuttgart, Germany

DSP Valley Smart Systems Industry Summit
Oct 11 2016, Flanders, Belgium

Photonex
Oct 12-13 2016, Coventry, England

ELRIG: Drug Discovery
Oct 13-14 2016, Liverpool, England

Sensors Day
Oct 14 2016, Cambridge, England

I FORUM 2016
Oct 11 2016, Paris, France

Belgian week of pathology
Oct 12-15 2016, Ghent, Belgium

Workshop on SoNDe application in neutron detection
Oct 17-19 2016, Freising, Germany

Oxford Biomedical Imaging Festival
Oct 18 2016, Oxford, England

FOGRA - Anwenderforum UV Druck
Oct 19-20 2016, Munich, Germany

Issues with Tissues
Oct 22 2016, London, England

SEMICON
Oct 25-27 2016, Grenoble, France

V Curso de Patologia Digital
Oct 26-28 2016, Porto, Portugal

NDT Russia
Oct 27-29 2016, Moscow, Russia

IEEE
Oct 29-Nov 6 2016, Strasbourg, France

November 2016

Congress Pathologie 2.0
Nov 2 2016, Utrecht, Netherlands

University of Hertfordshire STEM Careers Fair
Nov 2 2016, Hatfield, England

Optics & Photonics in Sweden (OPS)
Nov 2-3 2016, Linköping, Sweden

Carrefour Pathologie
Nov 7-10 2016, Paris, France

SSNET workshop
Nov 7-10 2016, Orsay, France

Electronica
Nov 8-11 2016, Munich, Germany

Vision
Nov 8-10 2016, Stuttgart, Germany

Sensors in Medicine
Nov 9-10 2016, London, England

3rd Joint Annual Meeting of the Swiss and Austrian Societies of Pathology
Nov 10-12 2016, Vienna, Austria

Diamond Light Source Monthly Supplier Exhib.
Nov 14 2016, Didcot, England

Forum de l'optique
Nov 17 2016, Palaiseau, France

Compamed
Nov 14-17 2016, Düsseldorf, Germany

InPrint 2016
Nov 15-17 2016, Milano, Italy

Advances in Cell Engineering, Imaging & Screening
Nov 17-18 2016, Louvain, Belgium

GANIL / SPIRAL 2
Nov 21-24 2016, Caen, France

BCCA
Nov 23-24 2016, Nottingham, England

Sensors in Food and Agriculture
Nov 29-30 2016, Cambridge, England

December 2016

4. Meeting "Imaging Structure and Function in the Zebrafish Brain"
Dec 1-4 2016, Martinsried, Germany

Digital Pathology Congress
Dec 1-2 2016, London, England

Eight Joint Ber II and Bessy II User Meeting
Dec 7-9 2016, Berlin, Germany

BioWin day
Dec 8 2016, Louvain, Belgium

AgriFoodTech
Dec 14-15 2016, Hertogenbosch, Netherlands

January 2017

Bamberger Morphologietage
Jan 13-15 2017, Bamberg, Germany

February 2017

7th Conference on Industrial Computed Tomography
Feb 7-9 2017, Louvain, Belgium

DGTHG
Feb 11-14 2017, Leipzig, Germany

Mobile World Congress
Feb 27-March 2 2017, Barcelona, Germany

Photonics
Feb 28-March 3 2017, Moscow, Russia

March 2017

ECR
March 1-5 2017, Vienna, Austria

Wearable Technology Show
March 7-8 2017, London, England

DPG Tagung
March 7-9 2017, Mainz, Germany

Elektronik
March 8-9 2017, Göteborg, Sweden

Automaticon
March 14-17 2017, Warsaw, Poland

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