

Quantaurus-QY[®] Plus

UV-NIR absolute PL quantum yield spectrometer C13534-11, -12

Easily extend functions with newly designed options.

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

1

New feature

Near-infrared
up to 1650 nm

2

New feature

Low quantum yield
of 1% or lower

3

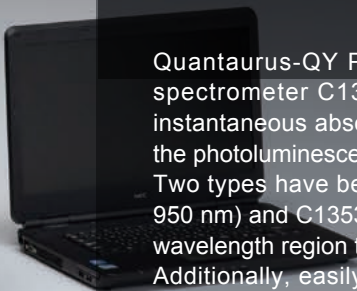
New feature

Upconversion
emission material

HAMAMATSU

PHOTON IS OUR BUSINESS

Quantaurus-QY[®] Plus



Quantaurus-QY Plus (UV-NIR absolute PL quantum yield spectrometer C13534-11, -12) is designed to measure the instantaneous absolute value of emission quantum yield using the photoluminescence method.

Two types have been made available, C13534-11 (300 nm to 950 nm) and C13534-12 (400 nm to 1100 nm), according to the wavelength region to be measured.

Additionally, easily extended functions using newly designed options allows measurements to be made in the near-infrared up to 1650 nm, at high sensitivity (evaluation of low quantum yield), and of upconverted emissions.

Additional options allow high-sensitivity, near-infrared, and upconverted measurements!

Principle of quantum yield measurement

Measurement of reference
(only for quartz cells)



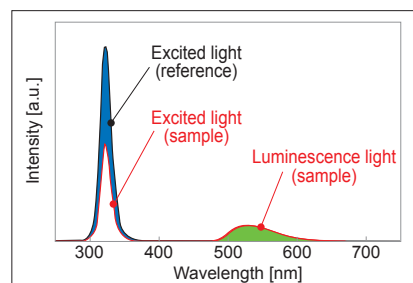
Measurement of sample
(quartz cells containing sample solution)



Calculation of
photoluminescence quantum yield

Photoluminescence
quantum yield

$$= \frac{\text{Number of photons emitted as photoluminescence from sample}}{\text{Number of photons absorbed by sample}}$$



▲ Excitation light on reference and sample and photoluminescence spectrum measurement example

Specifications

Type number	C13534-11	C13534-12
PL measurement wavelength range	300 nm to 950 nm	400 nm to 1100 nm
Monochromatic light source		
Light source	150 W xenon light source	
Excitation wavelength	250 nm to 850 nm	375 nm to 850 nm
Bandwidth	10 nm or less (FWHM)	
Excitation wavelength control	Automatic control	
Multichannel spectroscope		
Photo-detector	BT-CCD linear image sensor	
Measurement wavelength range	200 nm to 950 nm	350 nm to 1100 nm
Wavelength resolution	< 2 nm	< 2.5 nm
Number of photosensitive device channels	1024 ch	
Device cooling temperature	-15 °C	
AD resolution	16 bit	
Spectroscope optical arrangement	Czerny-Turner type	
Integrating sphere		
Material	Spectralon	
Size	3.3 inch	

System example with enhanced functions

1

New feature

Near-infrared

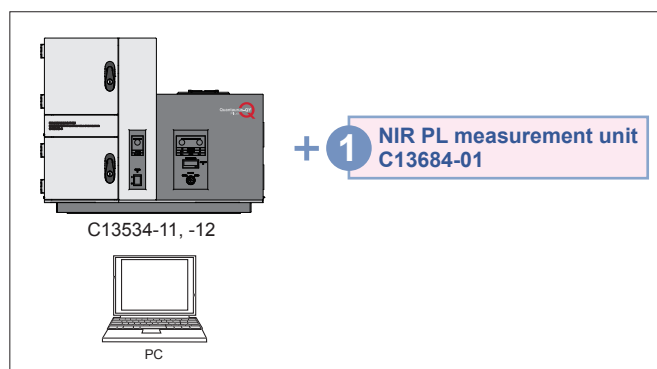
Absolute PL quantum yield spectrometer with extended NIR sensitivity C13534-31, -32
 Absolute measurement of quantum yield over a broad wavelength range up to 1650 nm is possible.

This system consists of the Quantaaurus-QY Plus (C13534-11,-12) with the addition of a supplementary unit: an NIR PL measurement unit.

Conventional apparatus for measuring quantum yield could only measure the wavelength range up to 1100 nm because of the sensitivity of the sensors. With this system, absolute measurement of the quantum yield is possible over a wide wavelength range up to 1650 nm with the addition of the NIR PL measurement unit, equipped with an InGaAs line sensor sensitive in the near-infrared.

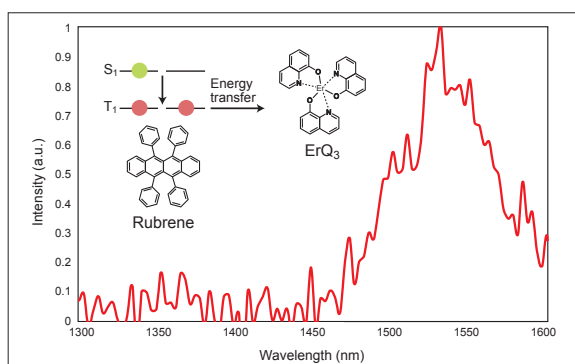
1 NIR PL measurement unit C13684-01

A multichannel detector for measurement in the near-infrared (900 nm to 1650 nm). Sensitivity calibration data is included.



NIR emission using singlet fission process

Singlet fission is the process that two lowest triplet states (T_1) are produced with interaction between the lowest singlet state (S_1) and neighboring ground state molecules.



Mechanism of singlet fission in a rubrene film

NIR emission spectrum of 2 mol% ErQ₃: rubrene film measured at excitation wavelength of 515 nm. Emission peak was 1.53 μ m. NIR emission from ErQ₃ was observed after energy transfer from the lowest triplet state of rubrene which was produced with singlet fission process. PL quantum yield of 0.007 was obtained.

Courtesy of Prof. Chihaya Adachi and Hajime Nakanotani,
 Center for Organic Photonics and Electronics Research, Kyushu University
 R. Nagata, H. Nakanotani, William J. Potscavage Jr., and C. Adachi,
Adv. Mater., **2018**, 1801484

Specifications

Type number	C13534-31	C13534-32
PL measurement wavelength range	300 nm to 1650 nm	400 nm to 1650 nm
Monochromatic light source		
Light source	150 W xenon light source	
Excitation wavelength	250 nm to 850 nm	375 nm to 850 nm
Bandwidth	10 nm or less (FWHM)	
Excitation wavelength control	Automatic control	
Multichannel spectroscope		
Photo-detector	BT-CCD linear image sensor	
Measurement wavelength range	300 nm to 950 nm	400 nm to 1100 nm
Wavelength resolution	< 2 nm	< 2.5 nm
Number of photosensitive device channels	1024 ch	
Multichannel spectroscope for C13684-01		
Photo-detector	InGaAs linear image sensor	
Measurement wavelength range	900 nm to 1650 nm	
Wavelength resolution	< 9 nm	
Number of photosensitive device channels	256 ch	
Integrating sphere		
Material	Spectralon	
Size	3.3 inch	

System example with enhanced functions

2

New feature

High sensitivity

Absolute PL quantum yield spectrometer with high sensitivity in UV-NIR C13534-33, -34

Evaluation of low quantum yield of 1% or less is possible. Shows its strength for measurements in the near-infrared region.

This system consists of the Quantaaurus-QY Plus (C13534-11,-12) with the addition of supplementary units: an NIR PL measurement unit, a high power Xe lamp unit and a filter unit.

With the apparatus used for measuring the absolute PL quantum yield in the past, it was often fundamentally difficult to evaluate low quantum yield (for example, 1% or less). This system has made it possible to evaluate a low quantum yield of 1% or less through the use of a high-output xenon lamp as an excitation source. It is particularly effective in extending the measurement wavelength range to the near-infrared region.

1 NIR PL measurement unit C13684-01

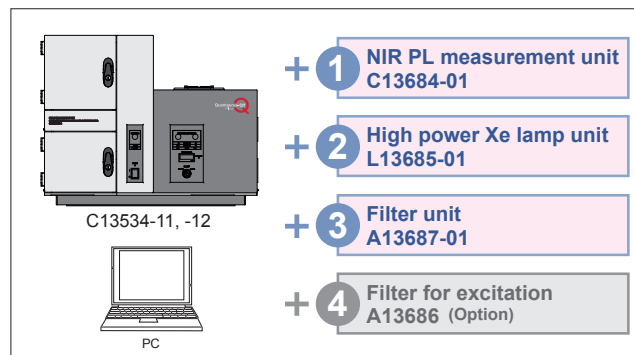
A multichannel detector for measurement in the near-infrared (900 nm to 1650 nm). Sensitivity calibration data is included.

2 High power Xe lamp unit L13685-01

This excitation light source is used for evaluating low quantum yields with high sensitivity. Used in combination with the A13686 excitation filter.

3 Filter unit A13687-01

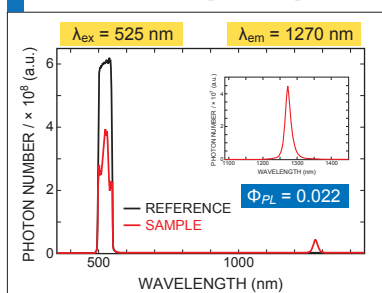
This bandpass filter is used in combination with the L13685-01 high-output xenon lamp unit. It can be selected in accordance with the excitation wavelength to be used.



4 Filter for excitation A13686 (Option)

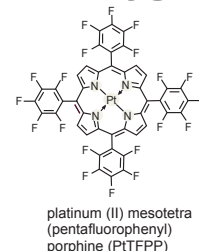
This dimmer filter is for use with the L13685-01 high power xenon lamp unit. Sensitivity calibration data is included.

Absolute phosphorescence quantum yield of singlet molecular oxygen



This is an example of the Photoluminescence quantum yield measurement of singlet oxygen using platinum (II) mesotetra (pentafluorophenyl) porphine (PtTFPP) solution as a sensitizer. We successfully expanded the wavelength region for the measurements to a 400 nm to 1650 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: 1270 nm), and obtained 0.022 as the absolute photoluminescence quantum yield for singlet oxygen.



Courtesy of Prof. Tobita and Prof. Okutsu, 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)

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

Specifications

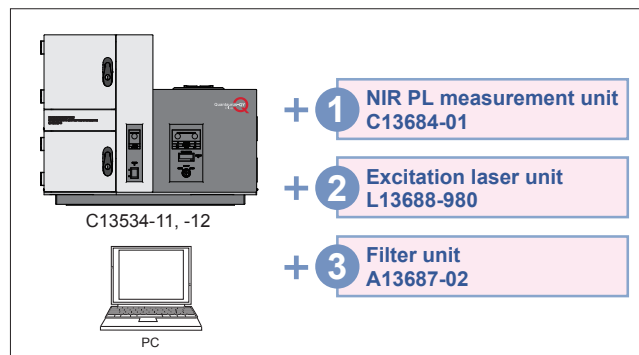
Type number	C13534-33	C13534-34
PL measurement wavelength range	300 nm to 1650 nm	400 nm to 1650 nm
Monochromatic light source		
Light source	150 W xenon light source	
Excitation wavelength	250 nm to 850 nm	375 nm to 850 nm
Bandwidth	10 nm or less (FWHM)	
Excitation wavelength control	Automatic control	
Excitation light source for high sensitivity		
Light source	High power xenon light source(150 W)	
Radiant wavelength range	ca. 300 nm to 800 nm	ca. 375 nm to 800 nm
Excitation wavelength	Choice from 375 nm, 400 nm, 475 nm, 525 nm	
Bandwidth	Approx. 50 nm	
Multichannel spectroscopy for C13534-11/-12		
Photo-detector	BT-CCD linear image sensor	
Measurement wavelength range	300 nm to 950 nm	400 nm to 1100 nm
Multichannel spectroscopy for C13684-01		
Photo-detector	InGaAs linear image sensor	
Measurement wavelength range	900 nm to 1650 nm	
Integrating sphere		
Material	Spectralon	
Size	3.3 inch	
Filter unit		
Filter type	ND filter	

Upconversion

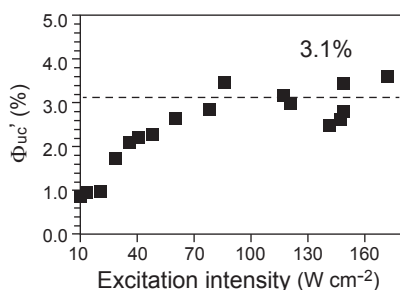
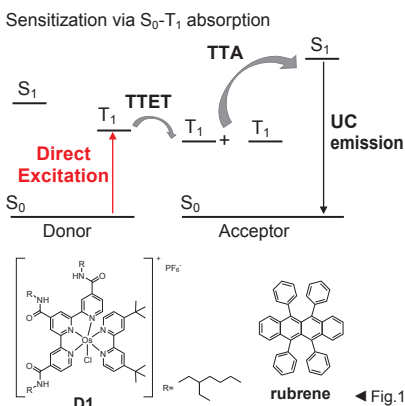
Absolute PL quantum yield spectrometer for upconversion in UV-NIR C13534-35, -36
 Absolute quantum yield measurement of upconverted emission is possible.

This system consists of the Quantaurus-QY Plus (C13534-11,-12) with the addition of supplementary units: an NIR PL measurement unit, an excitation laser unit and a filter unit. With upconverted emission, the measurement of absolute quantum yield has always been a problem due to low luminous efficiency or to the need for a laser as a light source for excitation. This system has made it possible to measure the absolute quantum yield of the upconverted emission by utilizing an excitation laser as the light source.

- 1 **NIR PL measurement unit C13684-01**
 A multichannel detector for measurement in the near-infrared (900 nm to 1650 nm). Sensitivity calibration data is included.
- 2 **Excitation laser unit L13688-980**
 This excitation light source (980 nm) is used for upconversion measurement. It includes an optical system for laser mount.
- 3 **Filter unit A13687-02**
 This dimmer filter (980 nm) is used for upconversion measurement. Sensitivity calibration data is included.



Emission quantum yield for triplet-triplet annihilation based-upconversion



▲ Fig.2 Absolute UC quantum yield of D1-rubrene in PVA film as a function of excitation intensity (excited at 730 nm).

Photon upconversion is a process for converting lower energy light into higher energy light. Particularly, Triplet-triplet annihilation upconversion (TTA-UC) has a great amount of attention as one of those techniques which efficiently utilize weak light.

In this work, a high UC quantum yield was obtained by employing a donor with direct $S_0 \rightarrow T_1$ absorption in the NIR region.

◀ Fig.1. Energy diagram of TTA-based UC utilizing $S_0 \rightarrow T_1$ absorption of donor. TTET : Triplet-triplet energy transfer

Courtesy of Prof. Kimizuka and Prof. Yanai, Department of Chemistry and Biochemistry, Center for Molecular Systems (CMS), Kyushu University

S. Amemori, Y. Sasaki, N. Yanai, and N. Kimizuka, *J. Am. Chem. Soc.*, **138**, 8702 (2016)

Specifications

Type number	C13534-35	C13534-36
PL measurement wavelength range	300 nm to 1650 nm	400 nm to 1650 nm
Monochromatic light source		
Light source	150 W xenon light source	
Excitation wavelength	250 nm to 850 nm	375 nm to 850 nm
Bandwidth	10 nm or less (FWHM)	
Excitation wavelength control	Automatic control	
Excitation lightsource for upconversion		
Light source	CW laser diode	
Output wavelength	980 nm	
Maximum output power	1 W	
Multichannel spectroscopy for C13534-11/-12		
Photo-detector	BT-CCD linear image sensor	
Measurement wavelength range	300 nm to 950 nm	400 nm to 1100 nm
Multichannel spectroscopy for C13684-01		
Photo-detector	InGaAs linear image sensor	
Measurement wavelength range	900 nm to 1650 nm	
Integrating sphere		
Material	Spectralon	
Size	3.3 inch	
Filter unit		
Filter type	ND filter, shortpass filter	

Features

Measure the emission in NIR

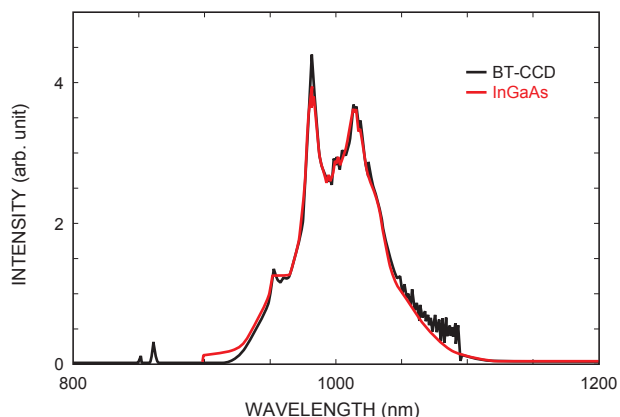
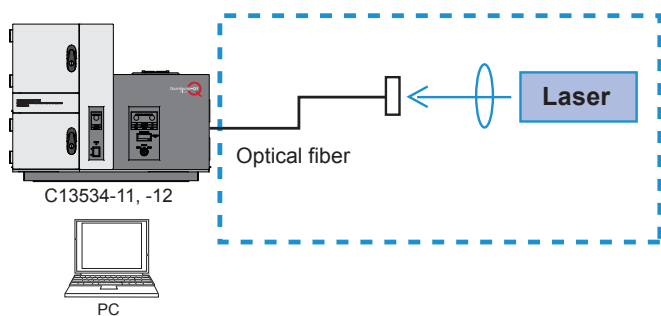


Figure. Emission spectra of $Y_2O_2S: Yb, Er$ measured using BT-CCD and InGaAs linear image sensors.

Excitation light : Visible (Measured with BT-CCD)
 BT-CCD linear image sensor (350 nm to 1100 nm)
 InGaAs linear image sensor (900 nm to 1650 nm)

Courtesy of Prof. Tobita and Prof. Okutsu, H. Hasebe, K. Suzuki, H. Horiuchi, T. Yoshihara, *Anal. Chem.*, **87**, 2360 (2015).

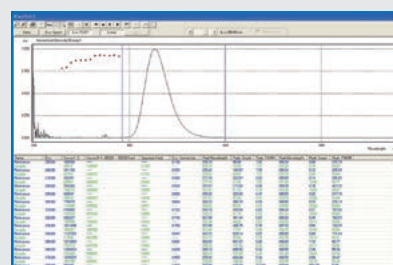
Flexibility to laser combination



If you look for the option to use your own laser, please contact Hamamatsu, The laser should be guided to the system through the optical fiber, and then appropriate filters are required.

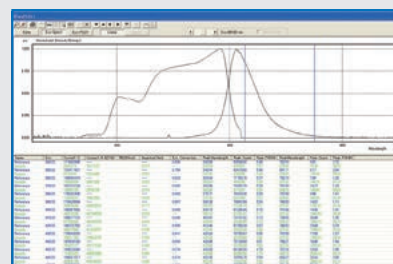
Data Analysis software

Autoscan of excitation wavelength



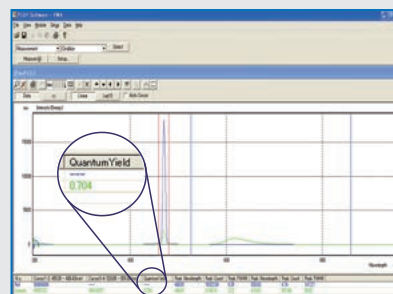
This screen shows the dependence of PL quantum yield on excitation wavelength. The excitation light through a motorized monochromator helps easily to measure wavelength dependence of the sample's PL quantum yield.

PL excitation spectrum



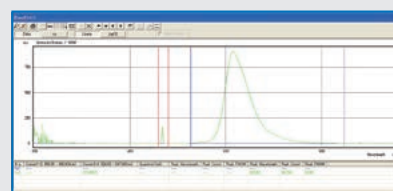
Excitation spectra produced from a sample can be measured by using an excitation light through motorized. The PL excitation spectrum in an emission wavelength range is easily obtained by selecting the range with two cursor lines.

PL quantum yield measurement



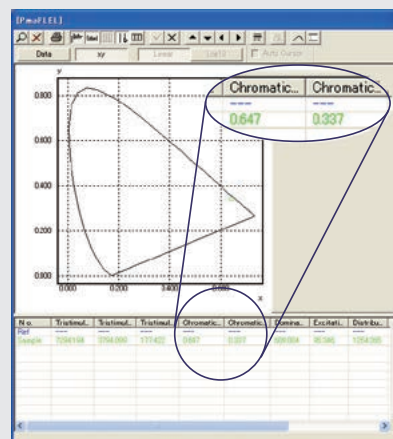
This is a basic screen for quantum yield measurements. The luminescence quantum yield is automatically calculated after measurement. Excitation and emission bands are defined by adjusting the cursors. The value of the quantum yield is displayed in the table below the spectrum next to emission intensities, peak wavelength, peak counts, and peak band (FWHM).

PL spectrum



A PL spectrum is displayed after subtracting the excitation light from it. The spectrum emitted from a sample during measurement of PL quantum yield usually contains excitation light components that were not absorbed by the sample. Subtracting this excitation light allows displaying just the light spectrum emitted from the sample itself.

x-y coordinates



Besides displaying PL spectra and calculating quantum yields, the software also includes a function for color coordinates. Besides the chromaticity coordinates (x, y) of the measured sample, the three stimulus values (X, Y, Z) are displayed.

Selection table

Type No.	Product name	Near-infrared	High sensitivity	Upconversion	
				980 nm Laser	Other Laser
C13534-11/-12	Quantaurs-QY Plus	●	●	●	●
C13684-01	NIR PL measurement unit	●	option	●	●
L13688-980	Excitation laser unit	-	-	●	-
A13689-01	Laser mount	-	-	-	●
A13687-01	Filter unit	-	●	-	-
A13687-02	Filter unit	-	-	●	●
L13685-01	High power Xe lamp unit	-	●	-	-
A13686-375	Filter for excitation	-	option	-	-
A13686-400	Filter for excitation	-	option	-	-
A13686-475	Filter for excitation	-	option	-	-
A13686-525	Filter for excitation	-	option	-	-

Options

■ NIR PL measurement unit C13684-01

Multichannel detector for measurement in NIR range (900 to 1650 nm). Calibration data is included.

■ Laser mount A13689-01

A laser mount for an external laser module. It is possible to connect a laser module with fiber output (FC or SMA type).

■ Filter unit A13687-01

It contains ND filter used for measurement with L13685-01. Calibration data is included.



■ High power Xe lamp unit L13685-01

High power Xe lamp is used for measuring low PL quantum yield as an excitation light source by combination with A13688 series.



Sample holder

For solution

■ Sample holder for low temperature A11238-05 (Patented)

Optional sample holder which enables to measure PL quantum yield at 77 K with using liquid nitrogen.



For powder

■ Sample holder for temperature control A13924-02

This option allows setting the maximum temperature of powder samples up to 300 °C. Measurements can now be made in environments where phosphors for white LED are actually used. Temperature control range : RT to +300 °C.



■ Excitation laser unit L13688-980

Laser diode module (980 nm) used as an excitation light source for upconversion emission measurement. Fiber output laser (FC or SMA type) can be attached with the unit as an external light source.



■ Filter unit A13687-02

It contains ND and shortpass filters used for upconversion emission measurement with L13688-980. Calibration data are included.



■ Filter for excitation

A13686-375/ A13686-400/ A13686-475/ A13686-525

A filter for selecting excitation wavelength. It is used with L13685-01. Selection from 375 nm, 400 nm, 475 nm, 525 nm.

■ Controller for temperature control C13923-01

It is used to control temperature for A13924-02.

Sample case

For solution

■ Side-arm cell (3 sets) A10095-02

A three-piece set of cuvettes used for measurements of solution samples. The cuvettes are made of synthetic quartz which suppresses photoluminescence under UV light irradiation.

■ Sample tube for low temperature measurement (5 pcs) A10095-04

This is used to measure a sample solution at liquid nitrogen temperature.

For powder

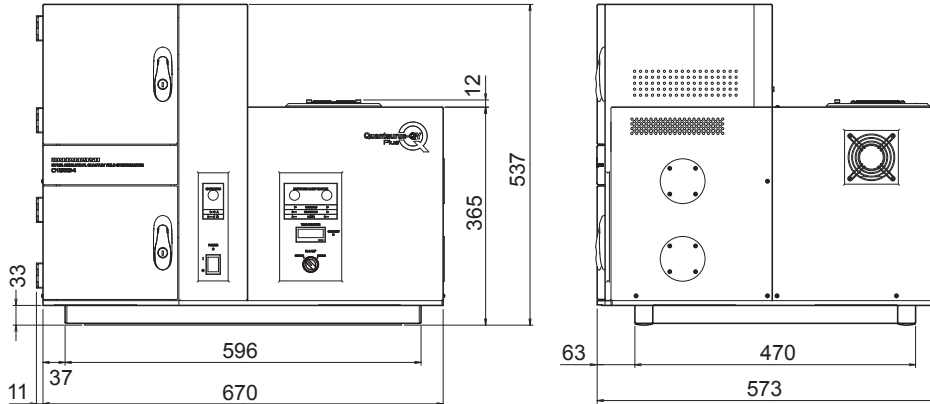
■ Laboratory dish without caps (5 sets) A10095-01

■ Laboratory dish with caps (5 sets) A10095-03

A five-piece set of petri dish used for measurements of solid samples such as powders and thin films. The petri dishes are made of synthetic quartz which suppresses photoluminescence under UV light irradiation.

Dimensional outlines / Related products

Dimensional outlines (Unit: mm) Weight: Approx. 60 kg



Related products Fluorescence Lifetime and Absolute PL Quantum Yield



Absolute PL quantum yield spectrometer C11347 series



Fluorescence lifetime spectrometer C11367 series



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