Fluorescence Spectrophotometer

FP-8000 series

UV/CD Division

JASCO Corp

Introduction of New Instruments

JASCO started in 1958 as a company manufacturing

IR dispersive spectrophotometers

Since then, several other instruments have been developed for commercial sales:

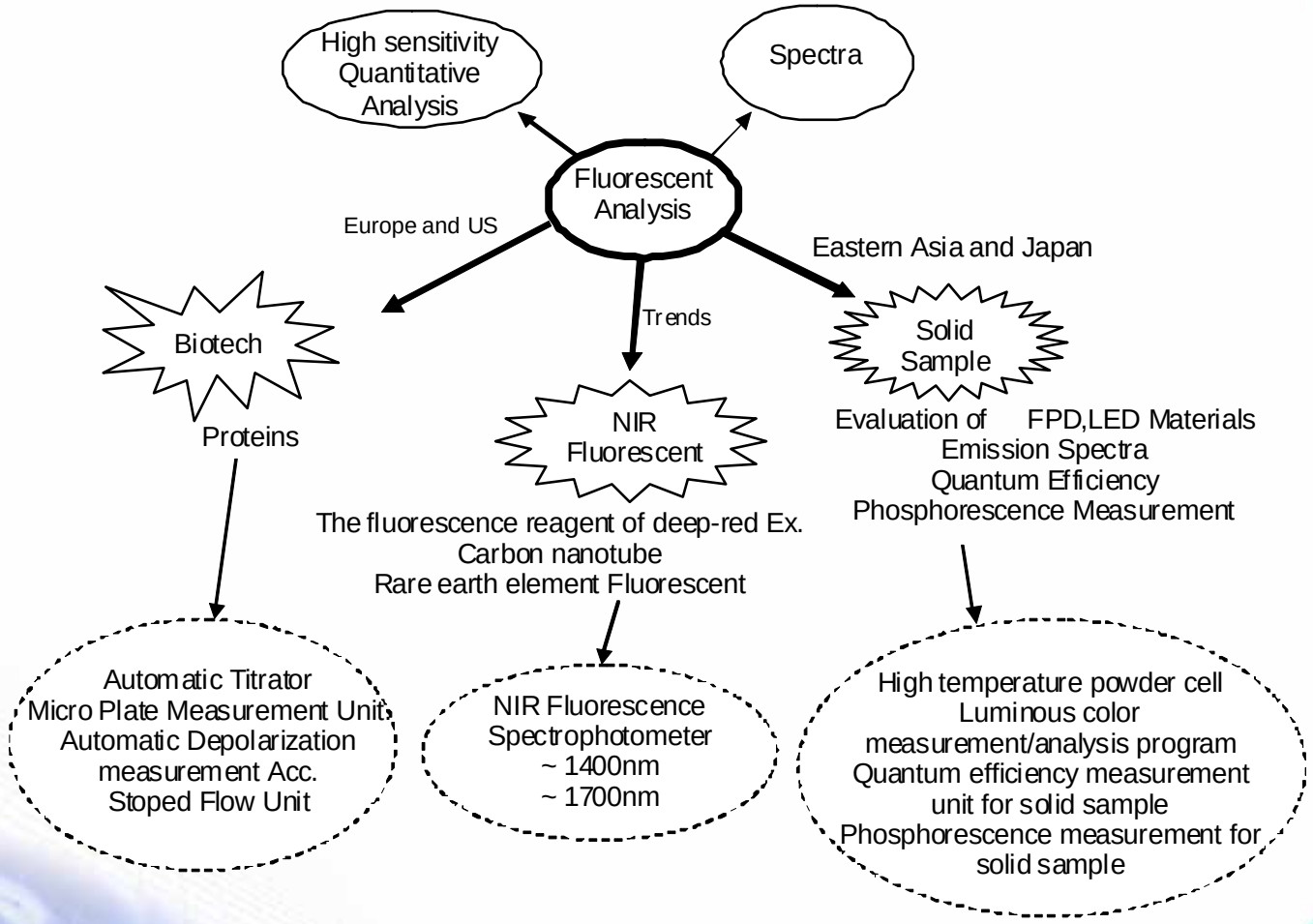
- **UV-Vis(1961)**
- **CD/ORD(1964)**
- **Polarimeter(1965)**
- **Spectrofluorometer(1967)**
- **Laser Raman(1969)**
- **HPLC(1972)**
- **Cell sorter/Flow cytometer(1982)**
- **SFC(1985)**
- **Cell fusion(1986)**
- **Gas permeability tester(1987)**
- **Ellipsometer(1989)**
- **NUVOM(1991)**
- **Ca ion analyzer(1991)**
- **Hi-SOR-CD(1998)**
- **SNOM(2000)**
- **VUV(2000)**

History of JASCO Spectrofluorometers

1967 FP-1
1968 FP-2
1969 FOM-1
1970 FP-3
1970 FL-10
1971 FOM-2
1972 FP-4
1975 FP-100

1976 FP-550
1976 SFP-3-1
1980 FP-550A
1985 FP-770
1989 FP-777
1996 FP-750
1997 FP-715
2000 FP-6600, 6500,
6300, 6200, 6100

Diverse Demands of the Market



Requirements for Life Science Applications

- Micro-sampling
- Automation (Auto-sampler, Micro-plate reader)
- Fluorescence depolarization (anisotropy)
- Auto-titration
- Stopped flow

Requirements for Advanced Materials Research

- Accurate quantum yield determination
- Accurate spectral correction
- Solid or powder samples
- Micro particle samples
- Luminous materials (White LED & …)
- Phosphorescence (Organic EL)
- Electric-field inducing Abs. (Organic EL)

Requirements for NIR Fluorescence Mesurements

- Carbon nano-tube analysis
  - Chirality determination of CNT
- NIR & deep red fluorescent dye
  - High sensitivity measurement in crude sample

Improvement Requests For Next FP Series

- Improvement of noise to signal ratio
- A precise excitation light monitor
- Improvement in user-friendliness
  - Suppression high-order diffraction light
  - Basic and advanced parameters setup
  - Simple and accurate spectrum correction
- Enhanced accessories

Development Objectives

- 4 models: The successors of FP8200/8300/8500/8600.
- The fundamental performance of each model's monochromator will be improved.
- High speed excitation shutter.
- Auto gain ~ Expand dynamic range.
- Spectra Manager 2/CFR, Automatic accessories recognition, USB2.0 for data communication.
- Enhanced accessories.
- iRM with color LCD

Instrument Outline

- ➢Series products by function, performance & applications
- ➢Enhancements for performance, S/N, speed, dynamic range, etc.
- ➢Improvement in optics and signal processing
- ➢Artifact free spectra by higher-order diffraction cut-filters, accurate Excitation monitoring, etc.
- ➢Instrument appearance

FP-8000 series line

FP-8200 High performance routine model

- Wide dynamic range over 6 orders of magnitude fluorescence emission
- Spectra free from higher order diffraction light (option)

FP-8300 Enhanced model for Bio-science

- Updated application systems for Bio-analysis applications (Microplate reader, Stopped flow , Fluorescence depolarization, Titration)
- Wide dynamic range over 6 orders of magnitude
- Spectra free from higher order diffraction light (standard)
- Expansion to materials analysis (Phosphorescence, Integrating sphere)

FP-8500 Evolved for advanced materials evaluation

- Highest sensitivity
- Highest scan speed
- Wide dynamic range over 6.5 orders of magnitude
- Spectra free from higher order diffraction light (standard)

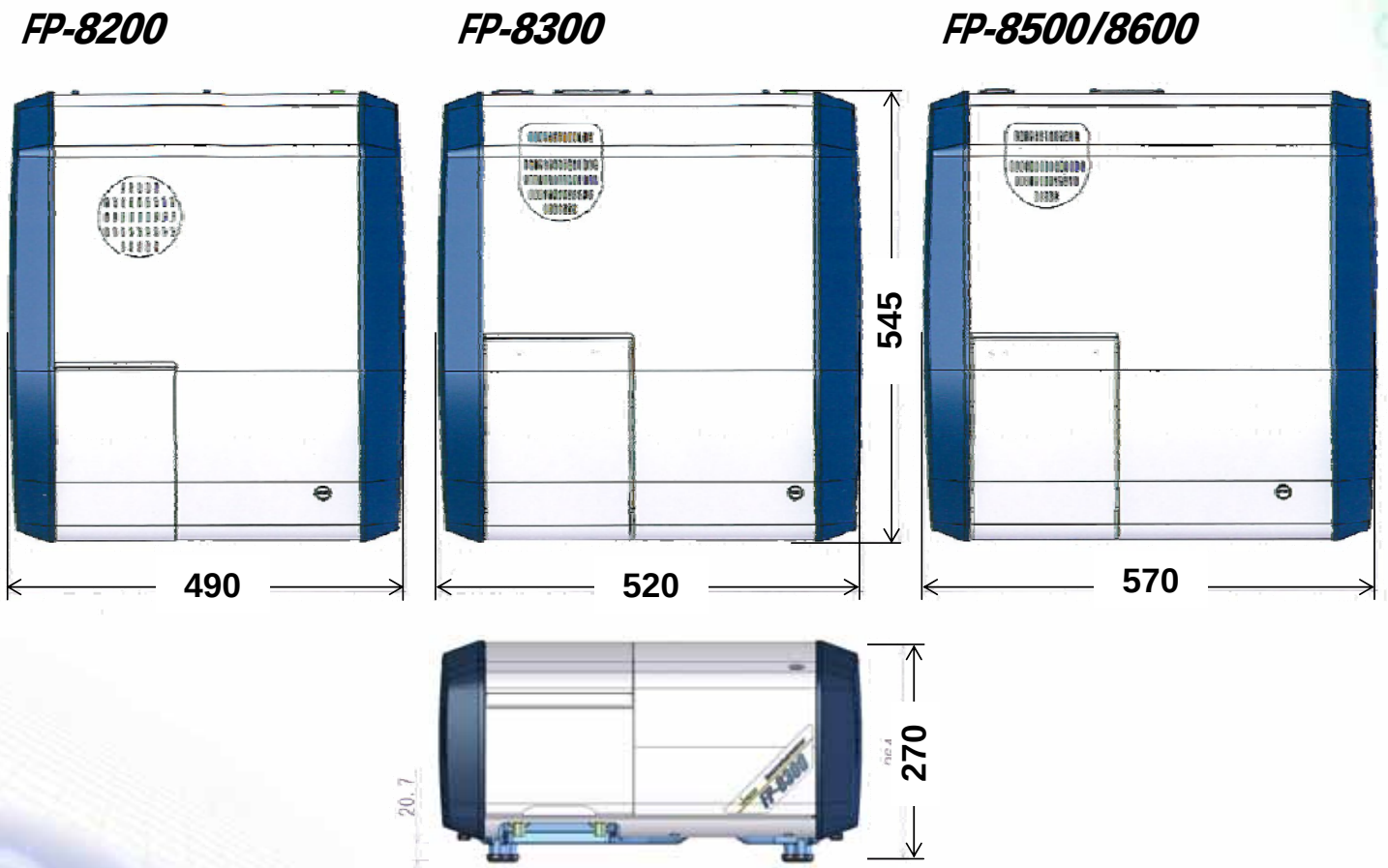
FP-8600 For evaluation of new technology materials

- Covering NIR region
- Highest scan speed
- Spectra free from higher order diffraction light (standard)

Updated Appearance – Contemporary Design

FP-8500

Instrument Dimensions



New Functions and Features

• High S/N	*FP-8200/8300/8500/8600*
• Wide dynamic range	*FP-8200/8300/8500/8600*
• High scan speed	*FP-8200/8300/8500/8600*
• Improved wavelength resolution	*FP-8200/8300*
• Higher order diffraction cut filter	*FP-8200/8300/8500/8600*
• Improved NIR performance	*FP-8600*
• Improved spectral correction	*FP-8200/8300/8500/8600*
• Enhanced phosphorescence	*FP-8300/8500/8600*
• Non-contact IQ accessory	*FP-8200/8300/8500/8600*
• USB communication	*FP-8200/8300/8500/8600*
• Spectra Manager II & CFR	*FP-8200/8300/8500/8600*
• iRM-900	*FP-8200/8300*
• Updated accessories	*FP-8200/8300/8500/8600*

Feature 1: Improvement in S/N

The most important feature in Fluorescence

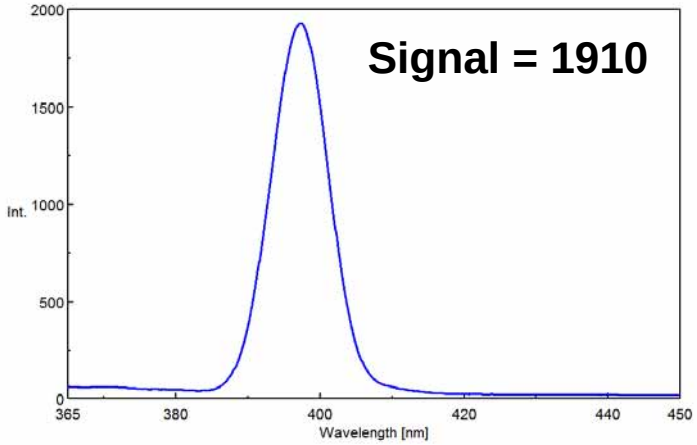
FP-8000

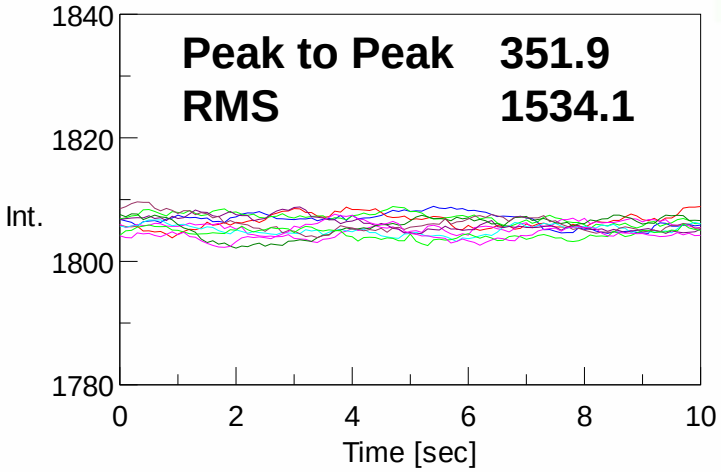
FP-8200	1:380 (SBW=5nm)
FP-8300	1:680 (SBW=5nm)
FP-8500	1:1200 p-p (SBW=5nm)
FP-8600	1:600 (EM SBW=10nm)

Feature 1: Improvement in S/N

Water Raman [Peak Signal]/[Peak Noise], Ex 350nm

FP-8500: >1200 (RMS), >300 (p-p)



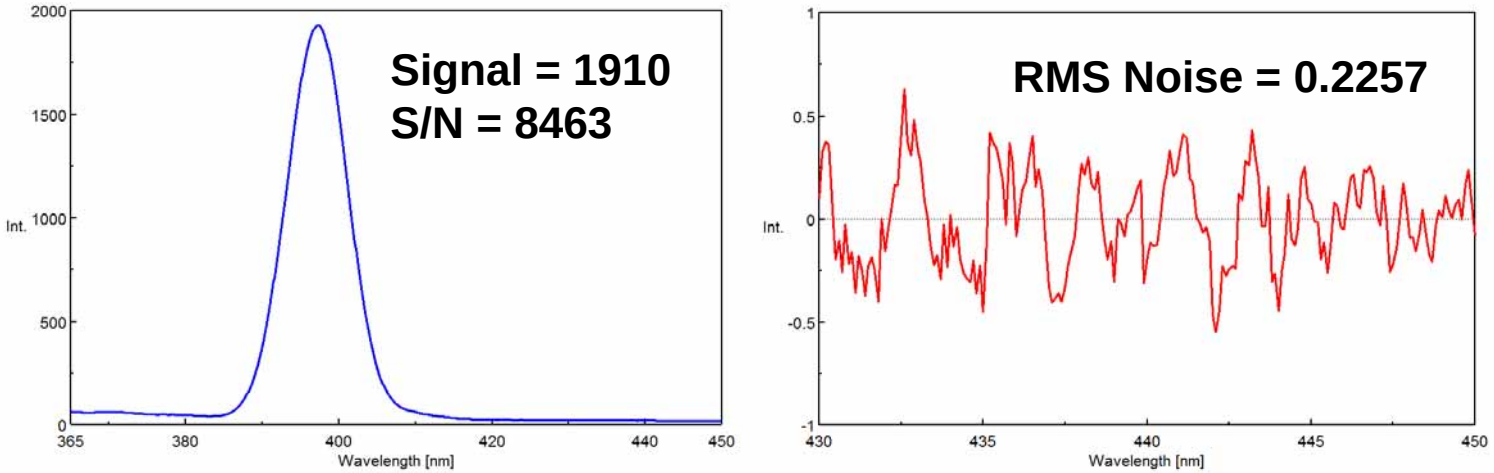


- Advanced AD enables rapid sampling at the rate 0.2μsec for emission data, and new high speed signal processing by FPGA contributes to considerable improvement of the efficiency for signal acquisition
- P-P S/N is calculated according to JIS K0120

Feature 1: Improvement in S/N

Water Raman [Peak Signal]/[Baseline Noise], Ex 350nm

FP-8500: >5000 (RMS)



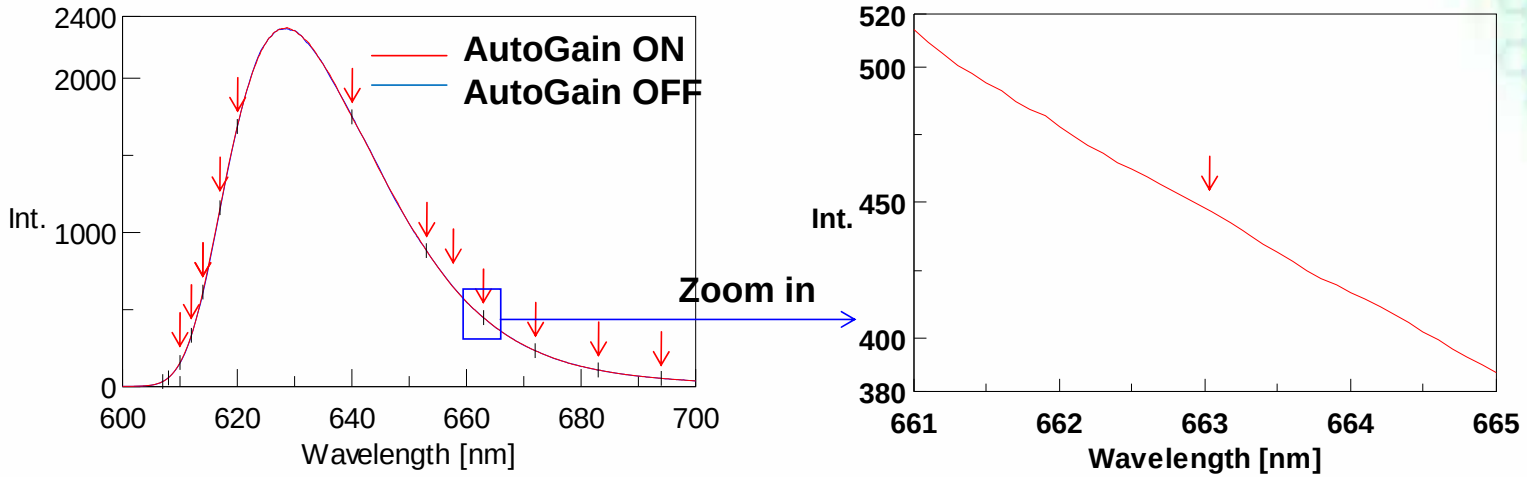
- S/N ratio at baseline is much larger than at the Raman peak.
- Noise evaluated at baseline(450nm) is much smaller than at the Raman peak.
- Noise is roughly proportional to signal intensity.

Feature 2: Expansion of Dynamic Range

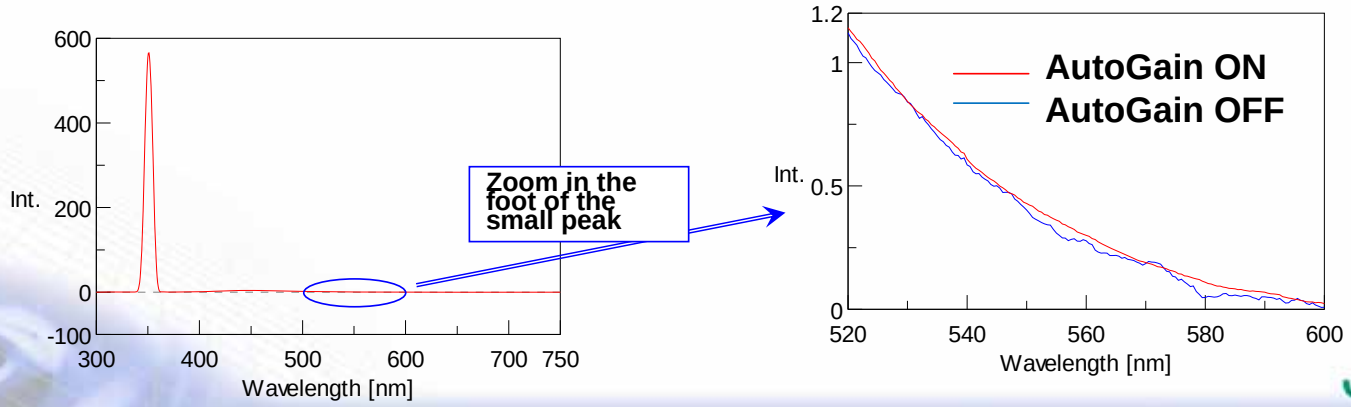
New
Auto-Gain & Auto-SCS

which provides a remarkable expansion of fluorescence dynamic range

Feature 2: Expansion of Dynamic Range



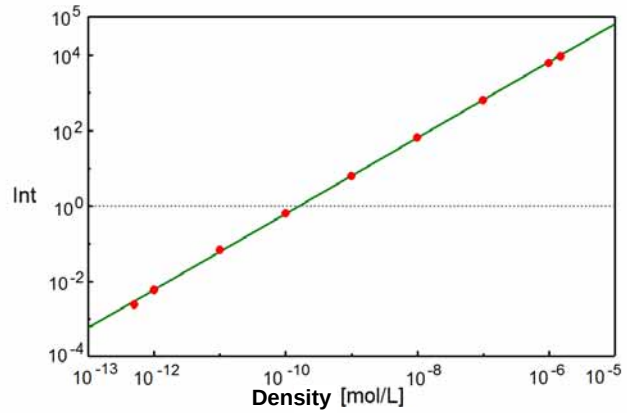
A single spectrum collection can provide reliable acquisition of a very small peak together with a coexisting large peak. This feature is very useful for the determination of fluorescence quantum yield.



Feature 2: Expansion of Dynamic Range

Auto-SCS allows measurement from sub-picomol. to micro-mol, without manually changing the instrument "Sensitivity" setting.

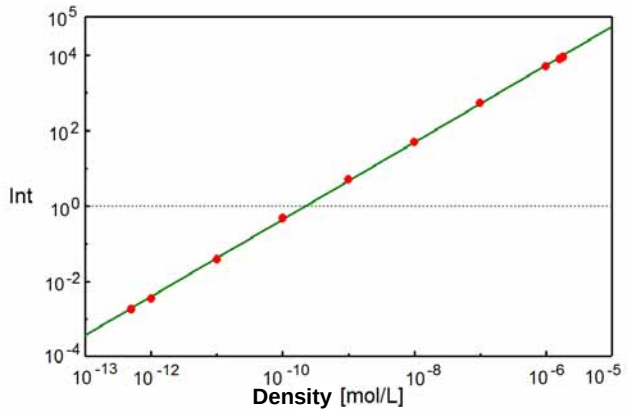
FP-8200 **Fluorescein**



$5 \times 10^{-13} \sim 1.5 \times 10^{-6}$ mol/L
Linearity over 6 orders of magnitude

log(Y) = A ×log(X) + B
A = 1.007
B = 9.850
C.C. = 0.9999
Std.Err. = 3.469E-008

FP-8500 **Fluorescein**

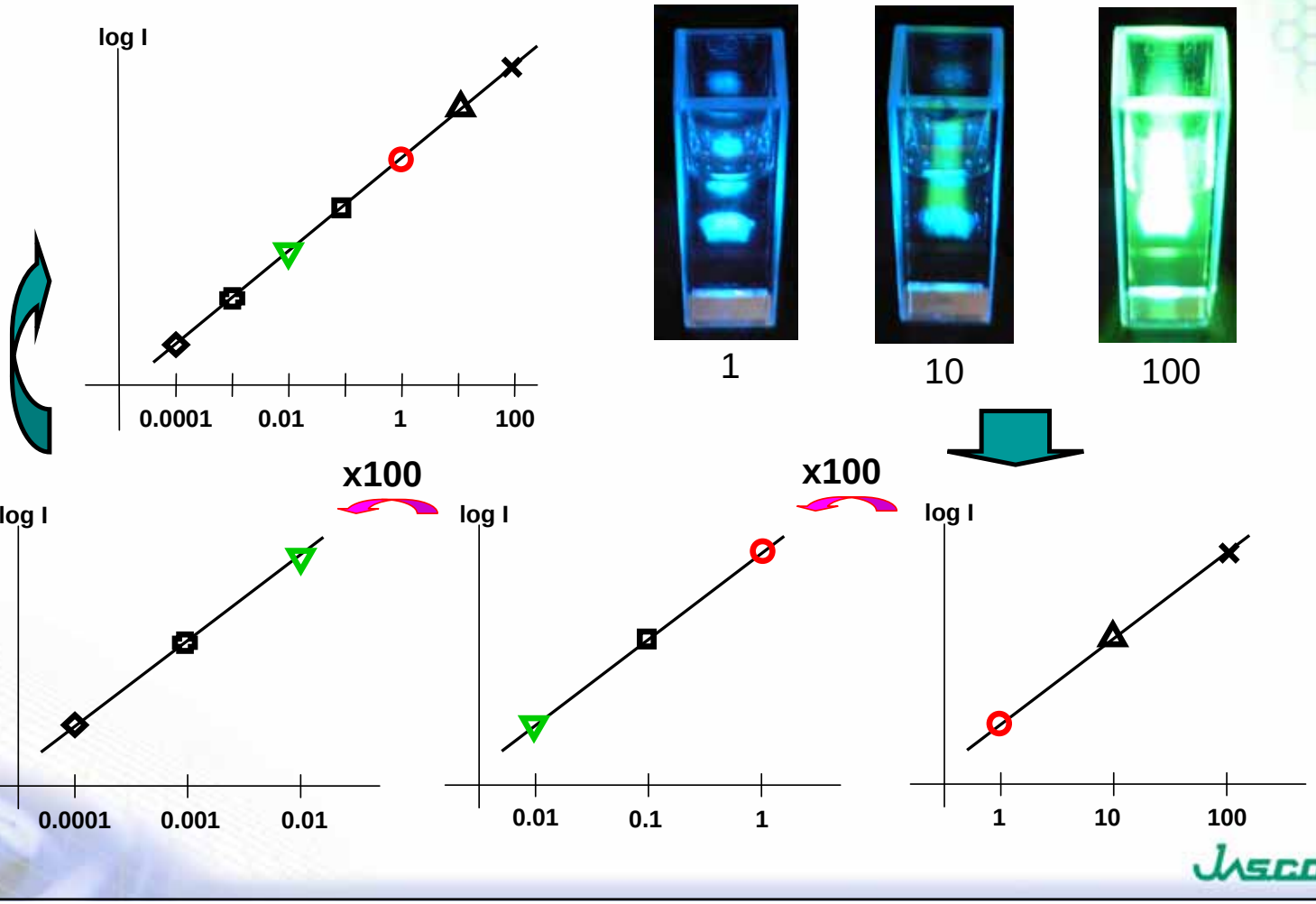


$5 \times 10^{-13} \sim 1.8 \times 10^{-6}$ mol/L
Linearity over 6.5 orders of magnitude

log(Y) = A ×log(X) + B
A = 1.023
B = 9.855
C.C. = 0.9999
Std.Err.= 5.585E-008

Feature 2: Expansion of Dynamic Range

Several steps is needed to cover 6 orders in previous model.



Feature 3: Improvement in Scan Speed

FP-8000

FP-8200	20000nm/min
FP-8300	20000nm/min
FP-8500	60000nm/min
FP-8600	Ex:60000nm/min
	Em:120000nm/min

Advanced sine-bar driving screw and new monochromator motor drive results in a much faster scan speed for all instruments.

Feature 4: Improvement in Wavelength Resolution

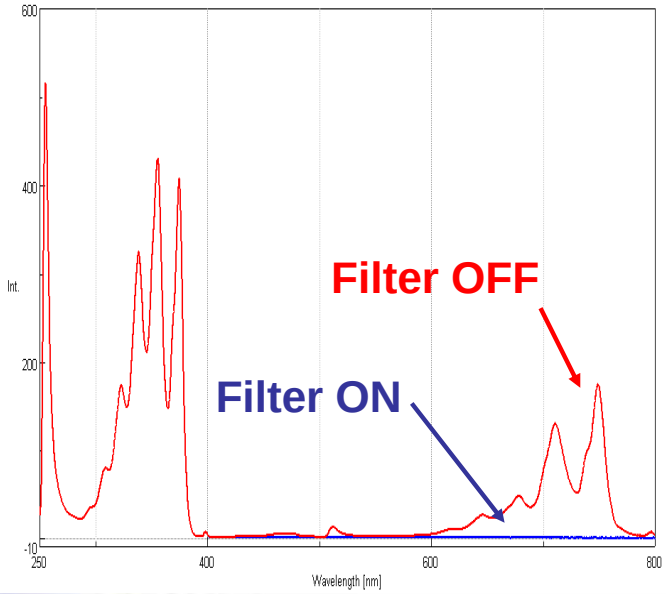
FP-8000

FP-8200	2.5nm
FP-8300/8500	1nm

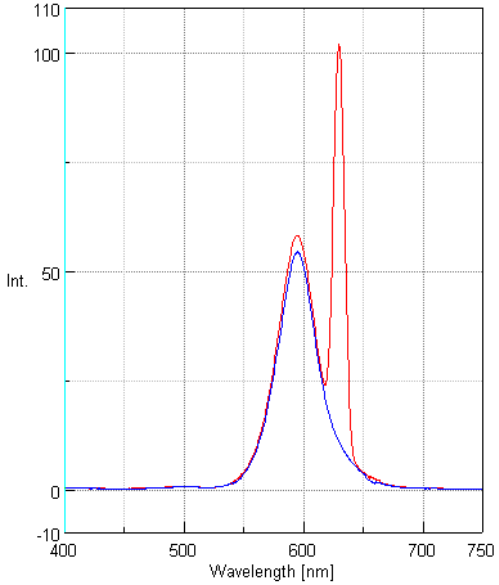
Feature 5: Higher Order Diffraction Cut Filters

Fluorescence instruments have always suffered from higher order diffraction effects.

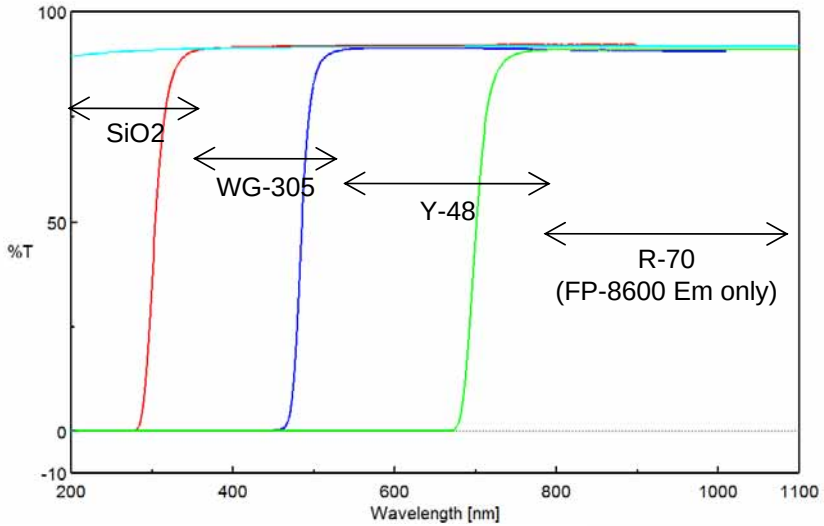
Ex spectrum of anthracene

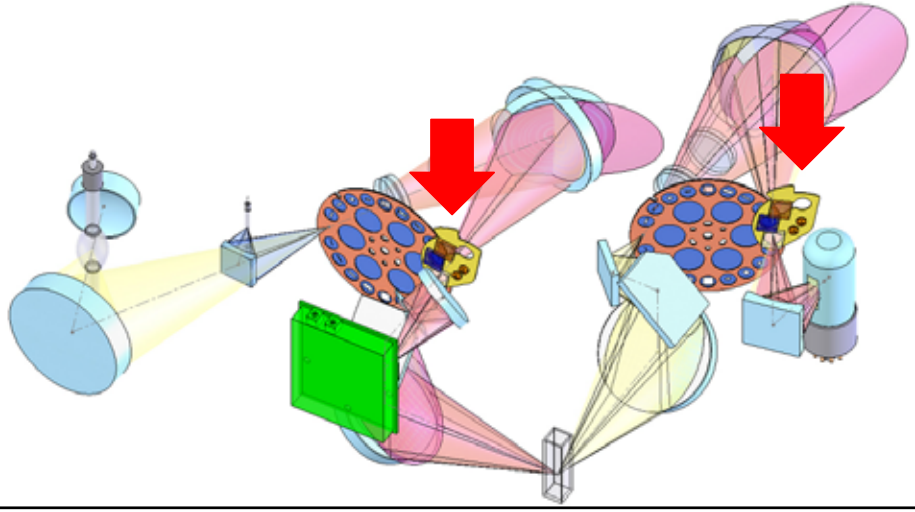


Em Spectrum of Orange plate



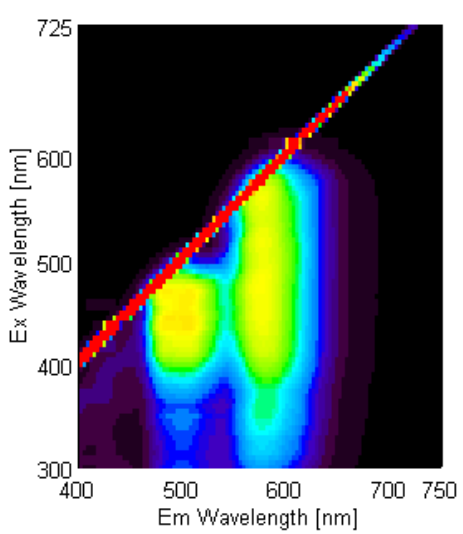
Feature 5: Higher Order Diffraction Cut Filters

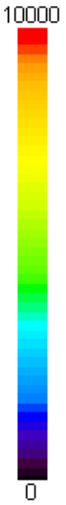




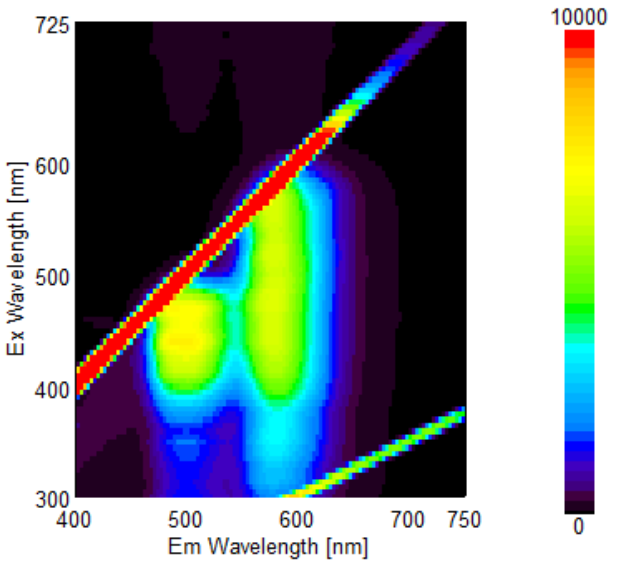
Feature 5: Higher Order Diffraction Cut Filter

with cut filters





without cut filters



The new ‘cut filter’ capability removes peaks originating from higher order diffracted light to provide simple, reliable spectral acquisition and analysis. This system works quite well for 3D fluorescence measurements to reveal peaks usually hidden by the high order diffraction peak.
The cut filter method also works quite well for quantum yield determination by providing measurements of accurate spectra.

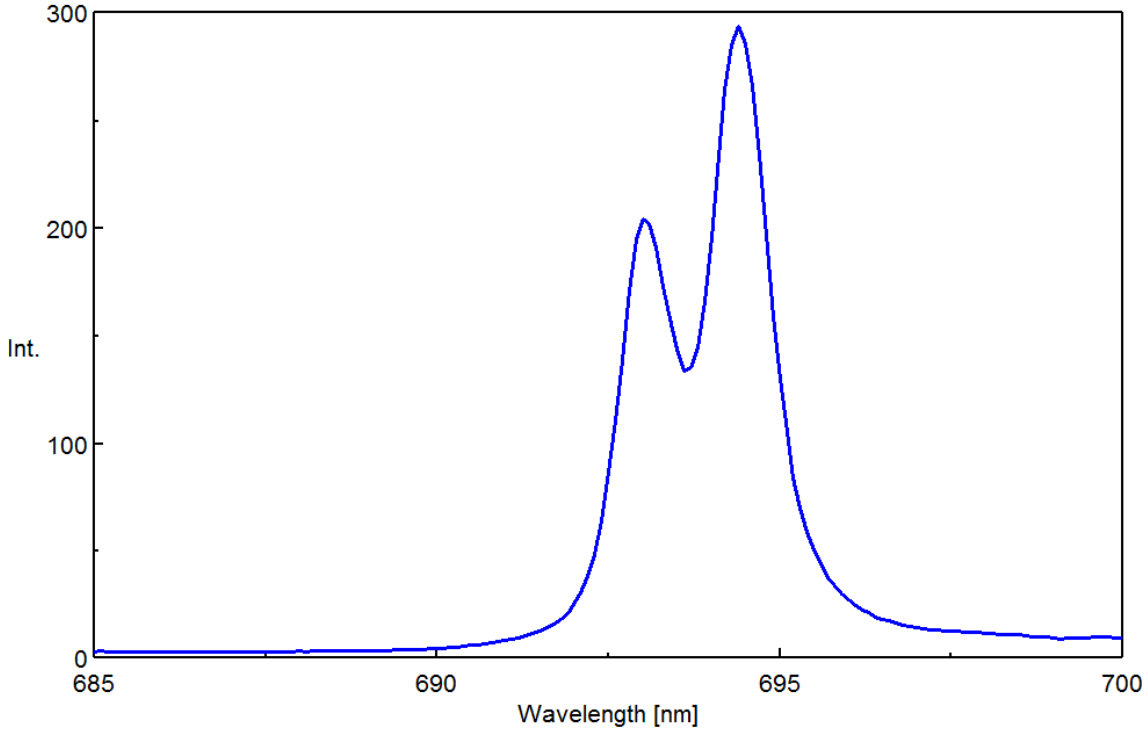
Feature 6: Improvements for Red Wavelengths

Rare-earth compounds, such as Eu, are often used in luminous materials such as LEDs which are evaluated by fluorescence in the deep red wavelengths.

To satisfy needs for these applications, the FP-8500/8600 instruments are equipped with a focus adjustment mechanism to maintain high wavelength resolution over a wide spectral range.

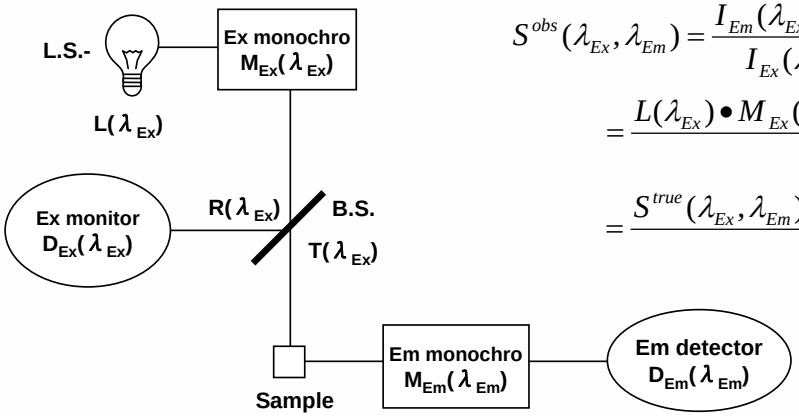
Feature 6: Improvements for Red Wavelengths

Em spectrum of a ruby



Feature 7: High Accuracy Spectrum Correction

The standard fluorescence spectral correction method was established long ago and described in many textbooks by using a Rhodamine B standard and a calibrated W light source. It is generally accepted that this spectral correction method may not provide the most accurate spectral correction, but it is abided by the inevitable that fluorescence spectrophotometers has such characteristics by its nature.



$$S^{obs}(\lambda_{Ex},\lambda_{Em}) = \frac{I_{Em}(\lambda_{Ex},\lambda_{Em})}{I_{Ex}(\lambda_{Ex})}$$

$$= \frac{L(\lambda_{Ex}) \bullet M_{Ex}(\lambda_{Ex}) \bullet T(\lambda_{Ex}) \bullet S^{true}(\lambda_{Ex},\lambda_{Em}) \bullet M_{Em}(\lambda_{Em}) \bullet D_{Em}(\lambda_{Em})}{L(\lambda_{Ex}) \bullet M_{Ex}(\lambda_{Ex}) \bullet R(\lambda_{Ex}) \bullet D_{Ex}(\lambda_{Ex})}$$

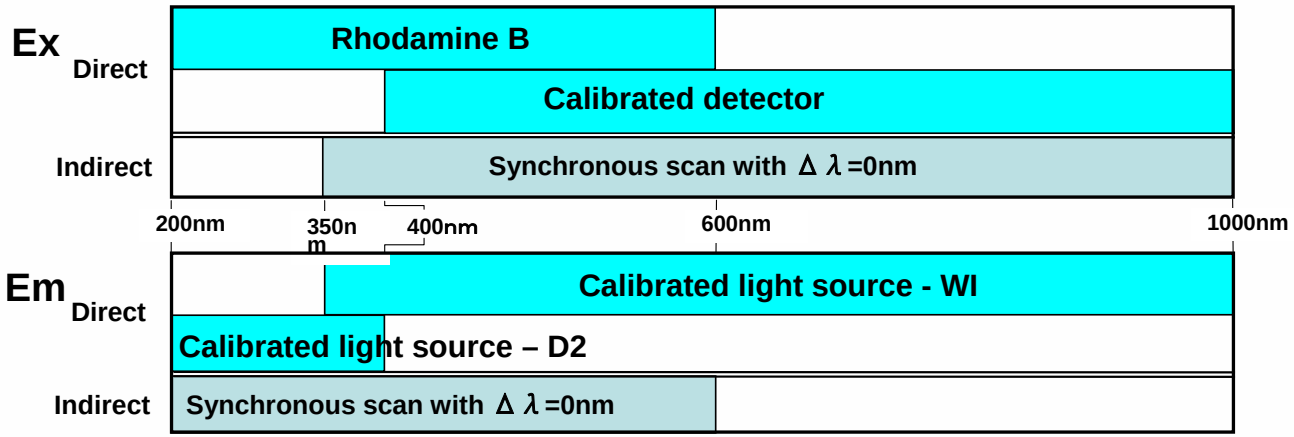
$$= \frac{S^{true}(\lambda_{Ex},\lambda_{Em}) \bullet T(\lambda_{Ex}) \bullet M_{Em}(\lambda_{Em}) \bullet D_{Em}(\lambda_{Em})}{R(\lambda_{Ex}) \bullet D_{Ex}(\lambda_{Ex})}$$

The evaluation of luminous compounds and determination of quantum yield for advanced materials research requires a more accurate spectral correction method. Jasco was determined to provide a more accurate spectral intensity correction method and the tools required for fluorescence correction.

Feature 7: High Accuracy Spectral Correction

To provide greater accuracy, Jasco developed a calibrated light source – D2 and a calibrated detector for the FP-8000 series, which will cover the full wavelength range with directly observed correction data.

FP-8000 Correction Method



Rhodamine B

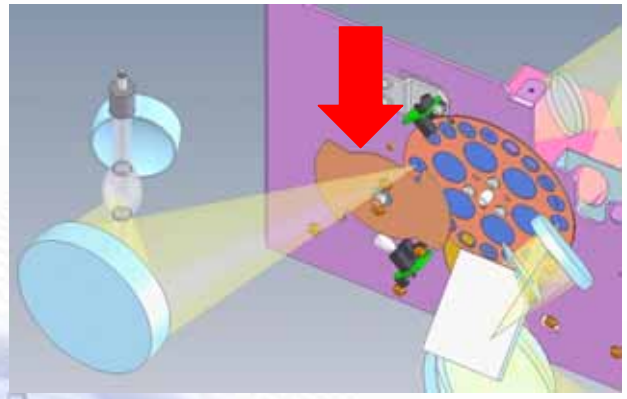
Calibrated light source – D2

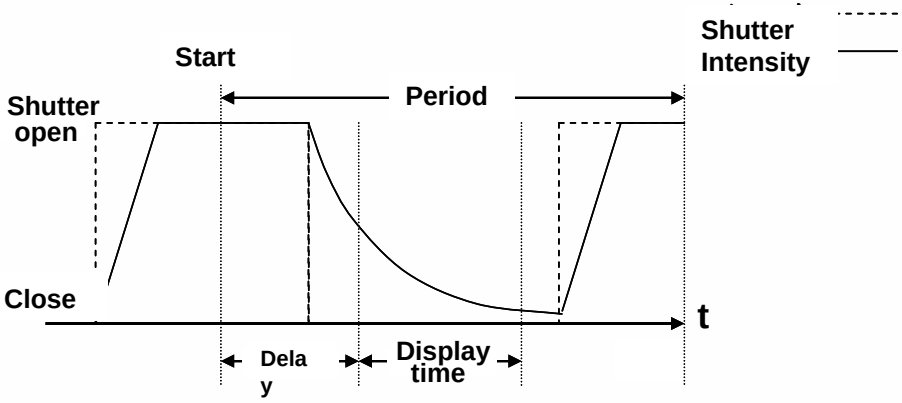
SID-844 Calibrated detector

Feature 8: Enhancements for Phosphorescence

Organic Electro-Luminescence (EL) is a new application for phosphorescent materials.
To analyze this specific type of sample, we developed a rotating chopper mechanism to enable measurements of phosphorescent materials with a lifetime shorter than 1 msec.

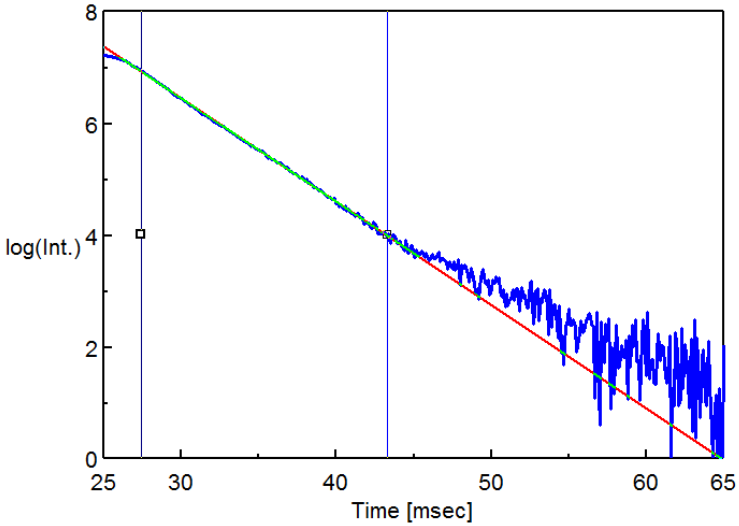
- Rotation frequency can be selected from 1200, 600, 300, 150 or 75 rpm
- Rotating chopper allows quick phosphorescence spectra measurement
- Expand phosphorescence measurements to many modes:
  ([Spectra], [Calibration]/[Analysis], [Fixed wavelength], [Time course], [Phosphorescence lifetime])





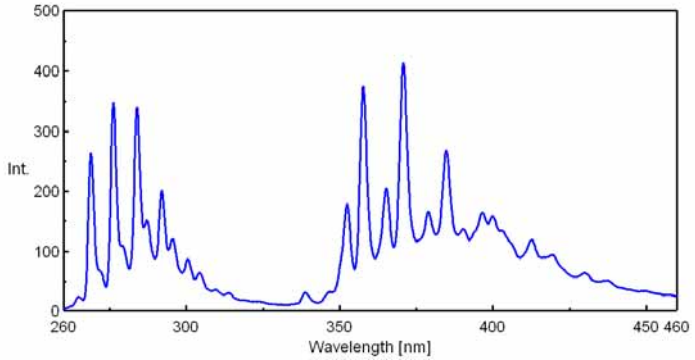
Feature 8: Enhancements for Phosphorescence

Phosphorescence lifetime of Benzophenone

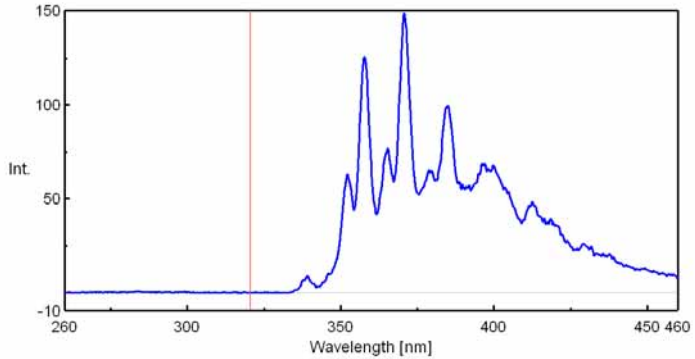


Range : 27.4 - 43.3 msec
Life time : 5.40 msec
Std. err. : 0.001799
Regression : Y = -0.185028 × X + 11.9925
C.C. : -0.9996

Fluorescence of benzene

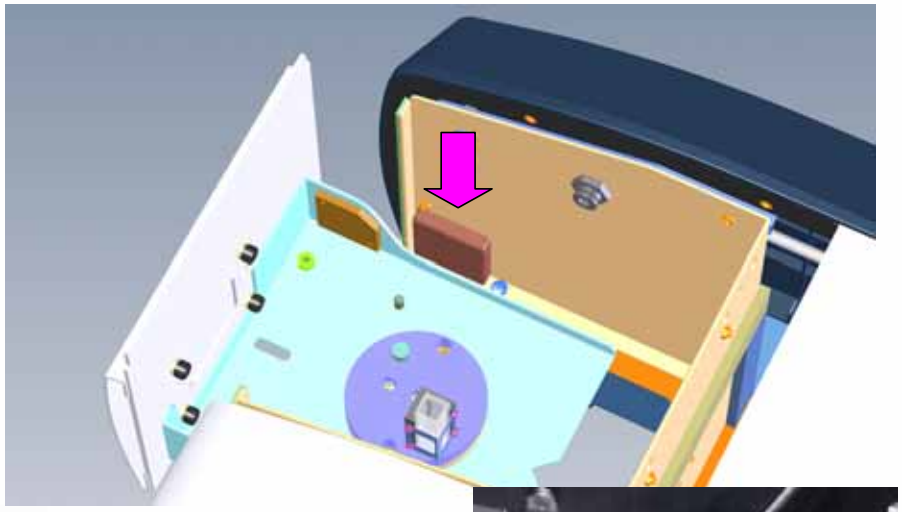


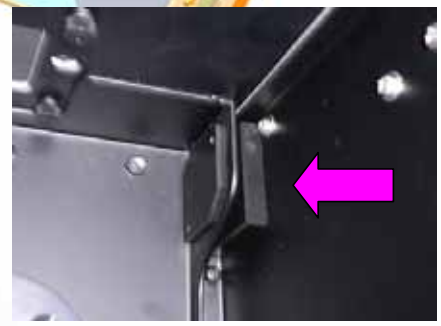
Phosphorescence of benzene

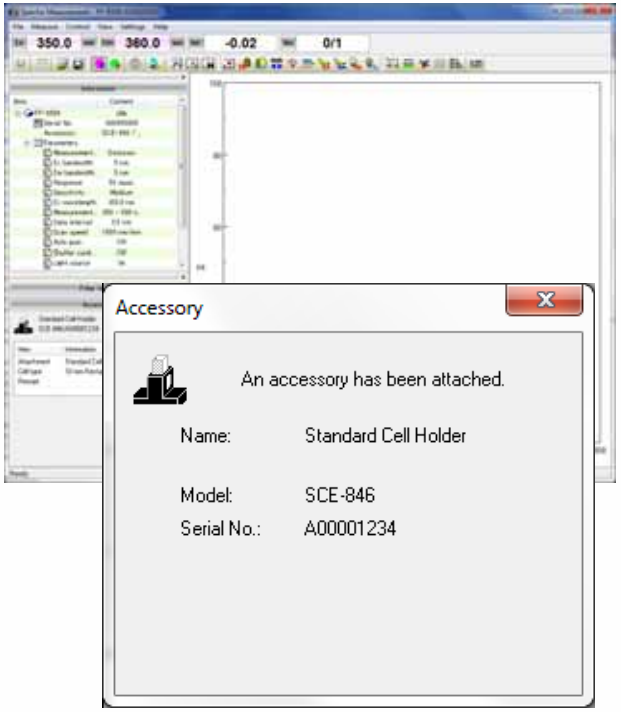


Feature 9: Non-contact IQ Accessories

Utilizing a non-contact type RFID tag

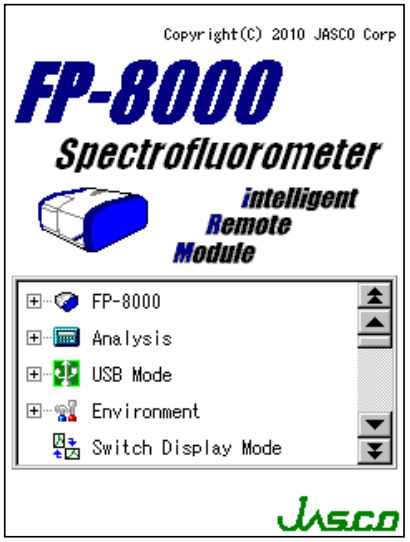






Feature 10: Other features

Spectra Manager Version2,
Spectra Manager CFR
(FP-8200/8300/8500/8600)



iRM-900
(FP-8200/8300)

USB connection

Introduction of Individual Models

FP-8500

Highest performance in the world
Enhanced for solid sample &
advanced materials analysis

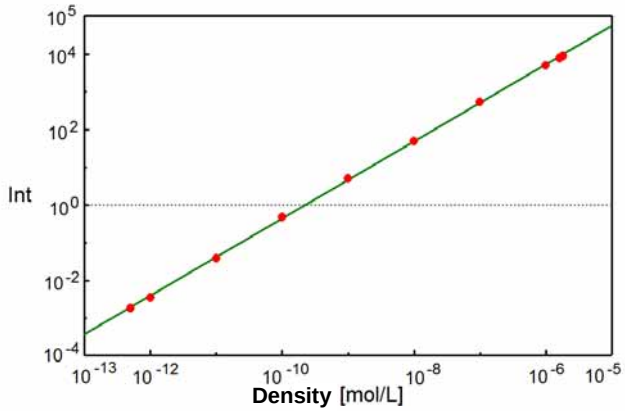
FP-8500

Evaluation of advanced materials: white LEDs, organic EL, etc., increased the requirements for fluorescence instruments.
To meet these applications, we have enhanced the spectral correction tools, integrating sphere, and other accessories together with basic functions and performance; the S/N, scan speed, dynamic range, and other enhancements.

- **Highest sensitivity**
  (>1200 RMS peak, >5000 RMS base)
- **Highest scan speed**
  (Max: 60,000 nm/min)
- **Dynamic range of 6.5 orders of magnitude**
- **Reduction of higher order diffraction peaks**

FP-8500

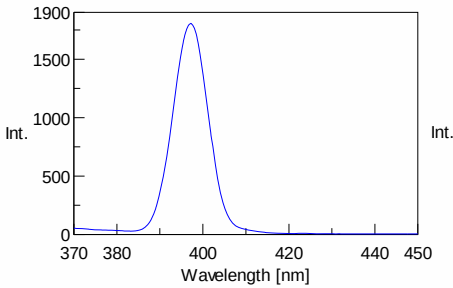
Wide dynamic range

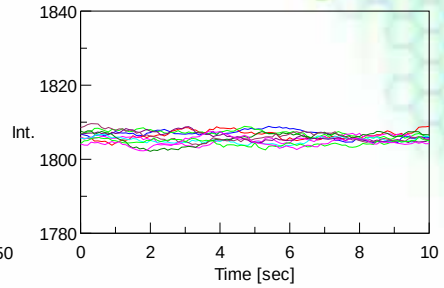


Linearity over 6.5 orders of magnitude
$5 \times 10^{-13} \sim 1.8 \times 10^{-6}$ mol/L of fluorescein

log(Y) = A ×log(X) + B
A = 1.023
B = 9.855
C.C. = 0.9999
Std.Err. = 5.585 E-008

Highest sensitivity

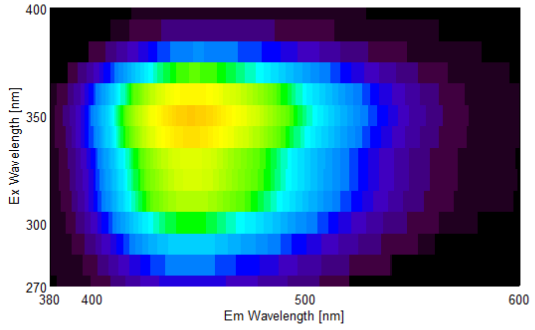




Peak to Peak	352
RMS (peak)	1534
RMS (base)	8463

Highest scan speed

Quinine sulfate



FP-8600

To meet new applications, such as carbon nano-tubes, NIR fluorescent dyes, up-conversion of fluorescence glasses, and other NIR fluorescent materials to be developed.

FP-8600

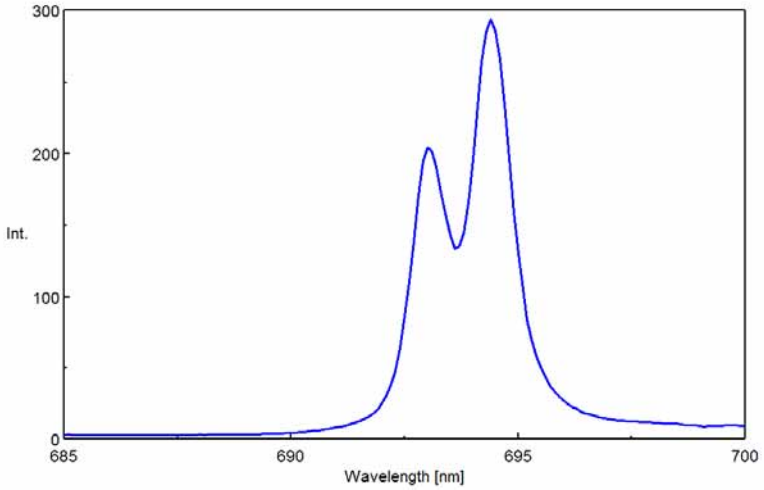
Carbon nano-tubes, NIR fluorescent dyes, up-conversion of fluorescent glasses.
New materials such as these will require NIR analysis.
We have enhanced the performance and functions to meet these applications.

- **NIR model for evaluation of new materials (Ex200nm～850nm, Em200nm～1010nm)**
- **Highest scan speed (Max: Ex 60,000 nm/min, Em 120,000 nm/min)**
- **Reduction of higher order diffraction peaks**

JASCO

FP-8600

Ruby



FP-8300

Targeted for Bio- and Life Science applications

FP-8300

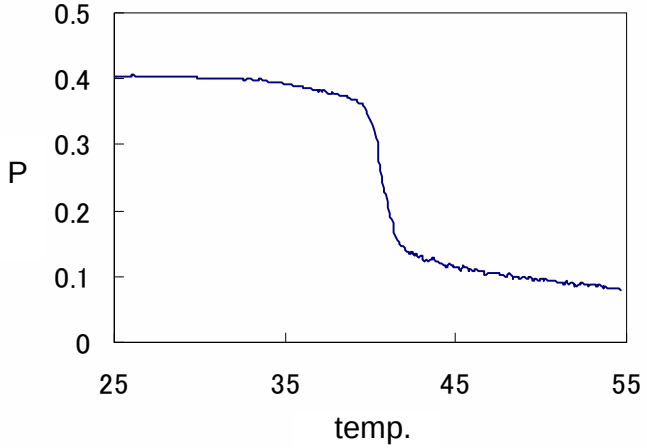
- Enhanced for Bio-applications
- Wide dynamic range
  over 6 orders of magnitude
- Reduction of higher order diffraction
- Expanded to solid samples
  (Phosphorescence, integrating sphere)
- High sensitivity (>680 RMS peak, >2800 RMS base)
- High speed (Max: 20,000 nm/min)

Bio-analysis is the most common application for fluorescence analysis. We have drastically improved the performance for the FP-8300, and developed enhanced accessories dedicated for these applications, such as the micro-plate reader, stopped flow, fluorescence anisotropy and auto-titration.

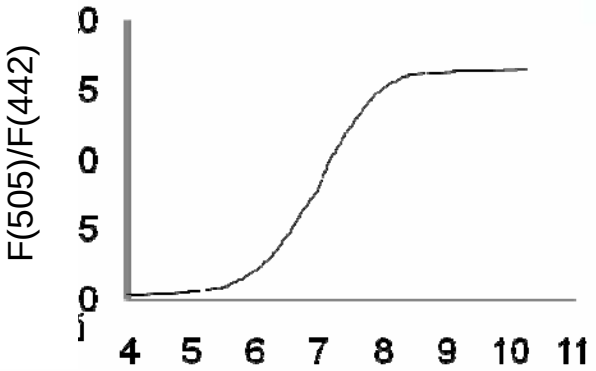
JASCO

FP-8300

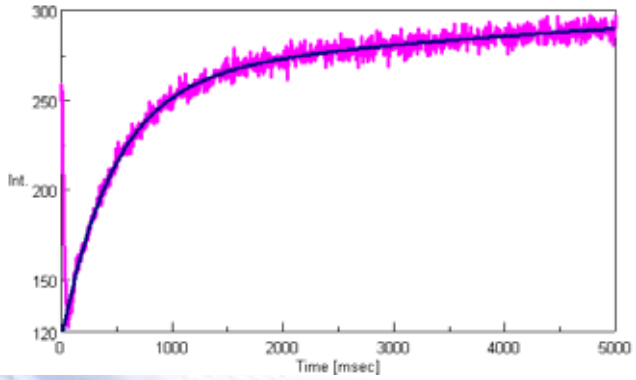
Fluorescence depolarization anisotropy



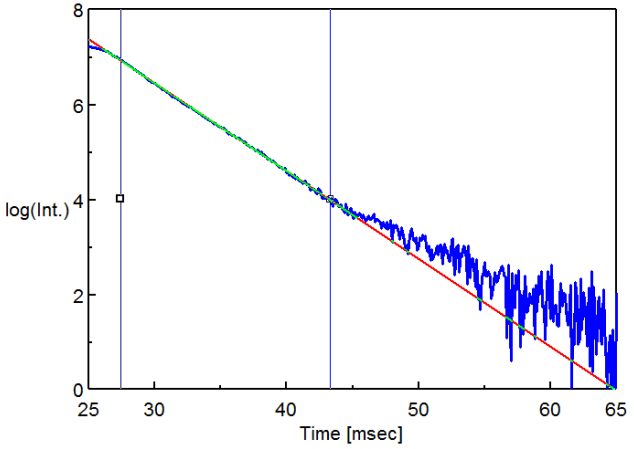
Auto-titration



Stopped flow



Phosphorescence



FP-8200

Routine fluorescence analysis

FP-8200

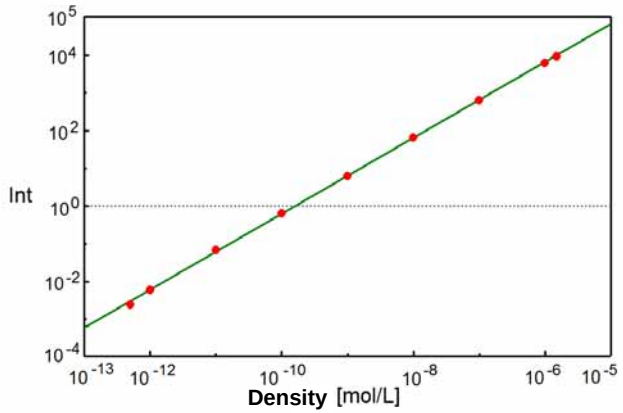
We have equipped the FP-8200, our routine model, with valuable capabilities, such as Auto Gain, Auto SCS and an optional cut-off filter assembly, for easy, quick, and reliable analyses. We have also improved the sensitivity, scan speed and resolution, among other items.

- **Wide dynamic range over 6 orders of magnitude**
- **Reduction of higher order diffraction peaks (option)**
- **High sensitivity (>380 RMS peak, >1600 RMS base)**
- **High speed (Max 20,000 nm/min)**

FP-8200

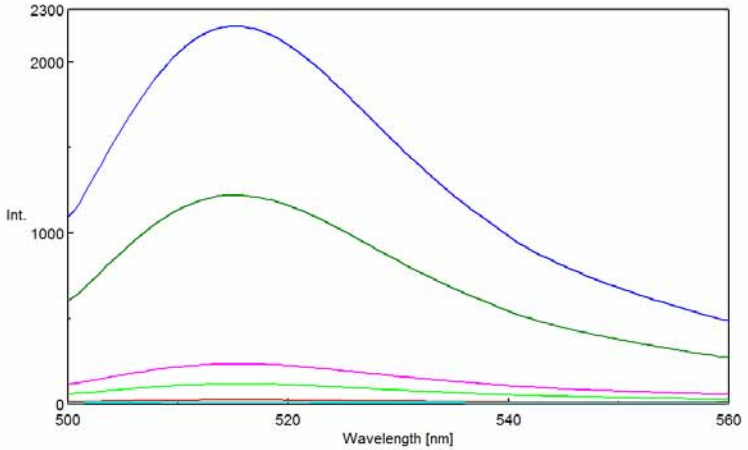
Wide dynamic range

Fluorescein



High sensitivity

Diluted fluorescein samples



Linearity over 6 orders of magnitude:
$5 \times 10^{-13} \sim 1.5 \times 10^{-6}$mol/L

log(Y) = A ×log(X) + B
A = 1.007
B = 9.850
C.C. = 0.99995
Std.Err. = 3.469E-008

- 1×10^{-10}mol/L
- 5×10^{-11}mol/L
- 1×10^{-11}mol/L
- 5×10^{-12}mol/L
- 1×10^{-12}mol/L
- 5×10^{-13}mol/L

Specifications

Model		FP-8200	FP-8300	FP-8500	FP-8600
Light source		150W Xe lamp with shielded lamp housing			
Photometric system		Photometric ratio system using monochromatic light to monitor the intensity output of Xe source			
Cut-off filter assembly for higher order diffration		Option	Standard		
Sensitivity[*1] (RMS)	Peak[*2]	380:1	680:1	1200:1	600:1
	Base[*3]	1600:1	2800:1	5000:1	2500:1
Wavelength range		Ex: Zero order , 200-750nm (Optionally -850 nm) Em: Zero order , 200-750nm (Optionally -900 nm)	Zero order , 200-750nm (Optionally -900 nm) on both Ex and Em	Zero order , 200-750nm (Optionally -850 nm) on both Ex and Em	Ex: Zero order , 200-850nm Em: Zero order , 200-1010nm
Spectral bandwidth		2.5-20nm on both Ex and Em	1-20nm on both Ex and Em	1-20, L5, L10nm on both Ex and Em	Ex: 1-20, L5, L10nm Em: 2-40, L10, L20nm
Wavelength scan speed		20-20000nm/min		10-60000nm/min	Ex: 10-60000nm/min Em: 20-120000nm/min
Resolution		2.5nm	1.0nm		Ex: 1.0nm Em: 2.0nm
Wavelength accuracy		±2.0nm	±1.5nm	±1.0nm	Ex: ±1.0nm Em: ±2.00nm
Gain		Hgih, Medium, Low, Very Low, Auto			
Auto Gain		Standard			
Start button		Standard			
Dimensions Net weight		490(W)×545(D)×270(H)mm 33.6kg	520(W)×545(D)×270(H)mm 36kg	570(W)×545(D)×270(H)mm 39kg	

[*1]: Minimum Signal to Noise ratio of Raman band of water, excitation 350nm, band width Ex 5nm Em 5nm (FP-8600: Ex 5nm Em 10nm), response 2s

[*2]: Noise is measured on the Raman peak

[*3]: Noise is measured on the baseline

Accessories

Important instrument interfaces for a variety of sample analyses requirements

Accessories for various volumes and shapes of samples

Model:	Name:	Available for:
FMH-801	3 mm micro cell jacket	FP-8200 / 8300 / 8500 / 8600
FMH-802	5 mm micro cell jacket	FP-8200 / 8300 / 8500 / 8600
FUV-803	Abs. measurement cell block	FP-8200 / 8300 / 8500 / 8600
FHM-804	High sensitivity cell block	FP-8200 / 8300 / 8500 / 8600
FSA-805	Cell block for triangular cell	FP-8200 / 8300 / 8500 / 8600
FSA-806	Cell block for rectangular cell	FP-8200 / 8300 / 8500 / 8600
FDA-808	Solid sample holding block	FP-8200 / 8300 / 8500 / 8600
FLH-809	Film holding block	FP-8200 / 8300 / 8500 / 8600
FPA-810	Powder sample cell block	FP-8200 / 8300 / 8500 / 8600


FMH-801/802


FUV-803


FHM-804


FSA-805


FSA-806


FDA-808


FLH-809


FPA-810

Accessories for various volumes and shapes of samples (2)

Model:		Name:	Available for:
SAF-850	New	One-drop measurement unit	FP-8200
SAF-851	New	One-drop measurement unit	FP-8300 / 8500 / 8600
CTS-855	New	Coumarin Measurement Unit	FP-8300 / 8500 / 8600
OBF-832		Optical fiber unit	FP-8300 / 8500 / 8600
EFA-833		Epi-fluorescence unit	FP-8300 / 8500 / 8600

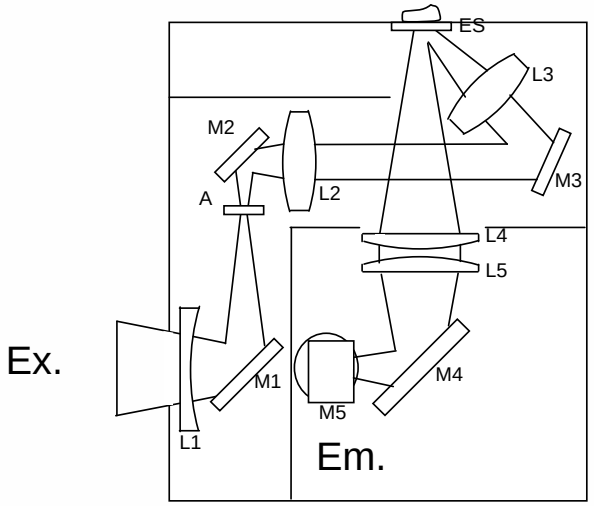

SAF-850


SAF-851


OBF-832


EFA-833

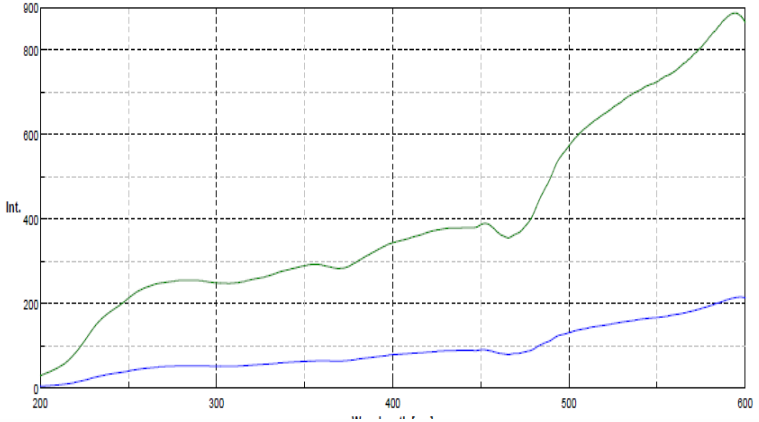
EFA-833 Epi-fluorescence Accessory



L1, L2, L3: **Lenses** 1、2、3
M1, M2, M3: **Mirrors:** 1, 2, 3
A: **Aperture**
ES: **Quartz window**
L4, L5: **Lenses** 4, 5
M4, M5: **Mirrors** 4, 5

Optics with mirrors and lenses improves Ex. light energy markedly, especially in far UV region.

Ex. intensity observed with Conc. RhodamineB



The EFA-833 provides approximately 20% greater Ex. intensity than the FDA-808.

Accessories for Temperature Control

Model:	Name:	Available for:
CTH-807	Water thermostatted cell block	FP-8200 / 8300 / 8500 / 8600
STR-811	Water thermostatted cell holder with stirrer	FP-8200
STR-812	Water thermostatted cell holder with stirrer	FP-8300 / 8500 / 8600
FCT-816	New Water thermostatted 4-position cell changer	FP-8200
FCT-817	New Water thermostatted 8-position cell changer	FP-8300 / 8500 / 8600

CTH-807

STR-811

STR-812

FCT-816

FCT-817

Accessories for Temperature Control

Model:	Name:	Available for:
EHC-813	Pettier thermostatted single cell holder (air-cooled)	FP-8300 / 8500 / 8600
ETC-814	Peltier thermostatted single cell holder (water-cooled)	FP-8200
ETC-815	Peltier thermostatted single cell holder (water-cooled)	FP-8300 / 8500 / 8600
PCT-818	Automatic 4-Position Peltier cell changer (water-cooled)	New FP-8300 / 8500 / 8600
PMU-830	Liq. N_2 cooling unit	FP-8300 / 8500 / 8600
CSH-831	New Cryostat holder	FP-8300 / 8500 / 8600
HPC-836	New High temperature powder cell unit	FP-8300 / 8500 / 8600

EHC-813

ETC-814

ETC-815

PCT-818

PMU-830

Temp. controller

CSH-831

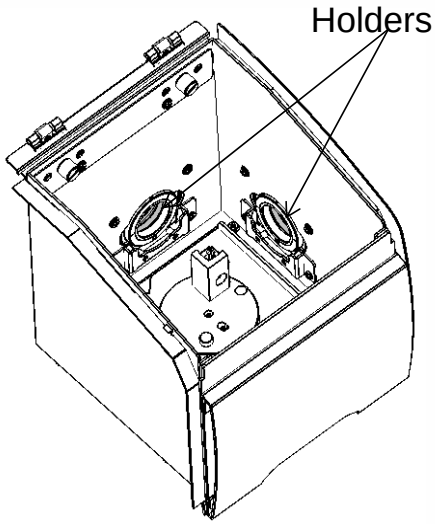
HPC-836

- **PCT-818 is adaptable to FP-8300**
- **CSH-831 is included in series**
- **HPC-836 is controllable from PC**

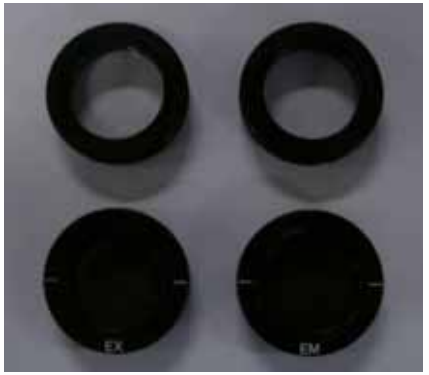
JASCO

Accessories: Automatic Polarizer

Model:	Name:	Available for:
FDP-837	New Automatic polarizer unit	FP-8300 / 8500 / 8600



Driving motor



Top : Quartz window
Bottom : Polarizer

We have separated the polarizer assembly from the system, and enhanced its flexibility, which allows the use of a thermostatted cell holder with a circulating bath instead of a dedicated Peltier cell holder. The new polarizer system is also for the FP-8300. This new accessory can also be applied to the fluorescence polarization measurement of solid samples.

Accessories～Auto-sampler and Sipper

Model:	Name:	Available for:
SHP-819	Peristaltic sipper	FP-8200
SHP-820	Peristaltic sipper	FP-8300 / 8500 / 8600
QFS-821	New Vacuum sipper	FP-8200
QFS-822	Vacuum sipper	FP-8300 / 8500 / 8600
FSC-823	Micro flow cell holder	FP-8200
FSC-824	Micro flow cell holder	FP-8300 / 8500 / 8600
FMP-825	New Automatic microplate reader	FP-8300 / 8500 / 8600
ASU-800	Auto sampler unit	FP-8200 / 8300 / 8500 / 8600
ASP-849	Syringe pump unit	FP-8200 / 8300 / 8500 / 8600


SHP-819


QFS-821


FSC-823


FMP-825


ASU-800


ASP-849


SHP-820


QFS-822


FSC-824

- **New vacuum sipper was developed for FP-8200**
- **FMP-825 was modified**

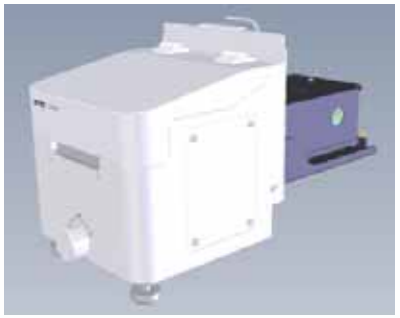
FMP-825 Automated Microplate Reader

Faster measurements are obtained by modifying the method for positioning of the micro-well plate and data acquisition.
We have also modified the temperature controller, and added as optional functions.

Accessories for Quantum Yield Determination

Model:	Name:	Available for:
ISF-834	60mmΦ Integrating sphere unit	New FP-8300 / 8500 / 8600
ILF-835	100mmΦ Integrating sphere unit	New FP-8300 / 8500 / 8600
ILFC-847	Cooled 100mmΦ Integrating sphere unit	New FP-8300 / 8500 / 8600

ISF-834



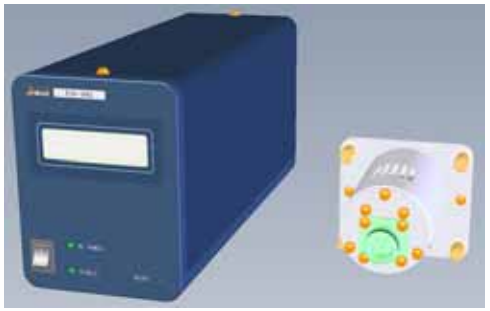
ILF-835

ILFC-847

•Adaptable to FP-8300

Accessories for Spectral Correction

Model:	Name:	Available for:
ESC-842	Calibrated light source – WI	FP-8200 / 8300 / 8500 / 8600
ESC-843	Calibrated light source – D2	FP-8200 / 8300 / 8500 / 8600
SID-844	Calibrated detector	FP-8200 / 8300 / 8500 / 8600



ESC-842

ESC-843

SID-844

- **ESC-842 is now available for the FP-8200 as corrected spectra are indispensable for publishing of research papers.**
- **The calibrated light source units were modified to fit the std. cell holder so the sources can be used directly for proper operation**
- **ESC-843 and SID-844 are newly developed spectral correction tools.**

Accessories for Kinetics and Reaction Analyses

Model:		Name:	Available for:
SFS-852 / 853/ 854	New	Stopped flow system	FP-8300 / 8500 / 8600
ATS-826	New	Automatic titration unit	FP-8200
ATS-827	New	Automatic titration unit	FP-8300 / 8500 / 8600
CSP-828		Lid with syringe port	FP-8200
CSP-829		Lid with syringe port	FP-8300 / 8500 /8600

Cell

SFS-852/853/854

ATS-826

ATS-827

CSP-828

CSP-829

Validation Accessories and Depolarizer

Model:	Name:	Available for:
VDK-840	New Validation kit 1	FP-8200 / 8300
VDK-841	New Validation kit 2	FP-8200 / 8300 / 8500 / 8600
FSP-838	New Depolarization plate	FP-8200 / 8300 / 8500 /8600

VDK-840

Testing kit for stray light and spectra correction. (FP-8500/8600 included as standard)

Constitution:
Rhodamine B (bottled, with pipet)
Triangle cell w/ PTFE stopper

VDK-841

Filter set (with certificate) for testing stray light

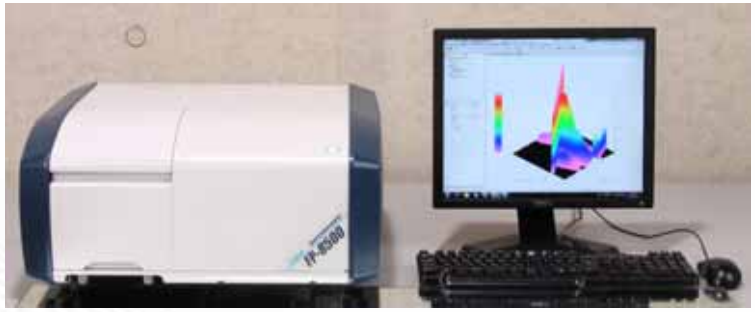
Constitution:
WG-305
L39
R60

FSP-838

System control/ Data processing

Spectra Manager Version 2/CFR

SM Ver2/CFR
with
numerous enhancements



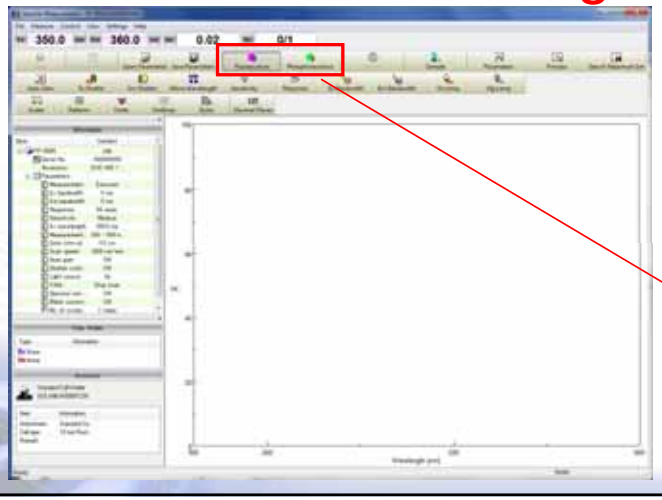
Standard Programs (DS measurement)

Name	Available for:	CFR
Spectrum measurement	2 / 3 / 5 / 6	Yes
Time course measurement	2 / 3 / 5 / 6	Yes
Quantitative calibration	2 / 3 / 5 / 6	Yes
Quantitative measurement	2 / 3 / 5 / 6	Yes
Fixed wavelength measurement	2 / 3 / 5 / 6	Yes
New! Abs measurement	2 / 3 / 5 / 6	Yes
Intensity monitor	2 / 3 / 5 / 6	Yes
Validation	2 / 3 / 5 / 6	Yes
Parallel time course	2 / 3 / 5 / 6	Yes
Phosphorescence lifetime	3 / 5 / 6	Yes
3D spectra measurement	2 / 3 / 5 / 6	Yes
Interval scan measurement	2 / 3 / 5 / 6	Yes
Spectral correction	2 / 3 / 5 / 6	Yes

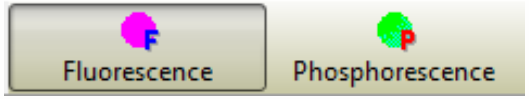
Std. programs (DS measurement)～Phosphorescence mode

These programs are provided with a 'phosphorescence mode'.

Name	Phosphorescence available for
Spectrum measurement	3 / 5 / 6
Time course	3 / 5 / 6
Quantitative calibration	3 / 5 / 6
Quantitative measurement	3 / 5 / 6
Fixed wavelength	3 / 5 / 6



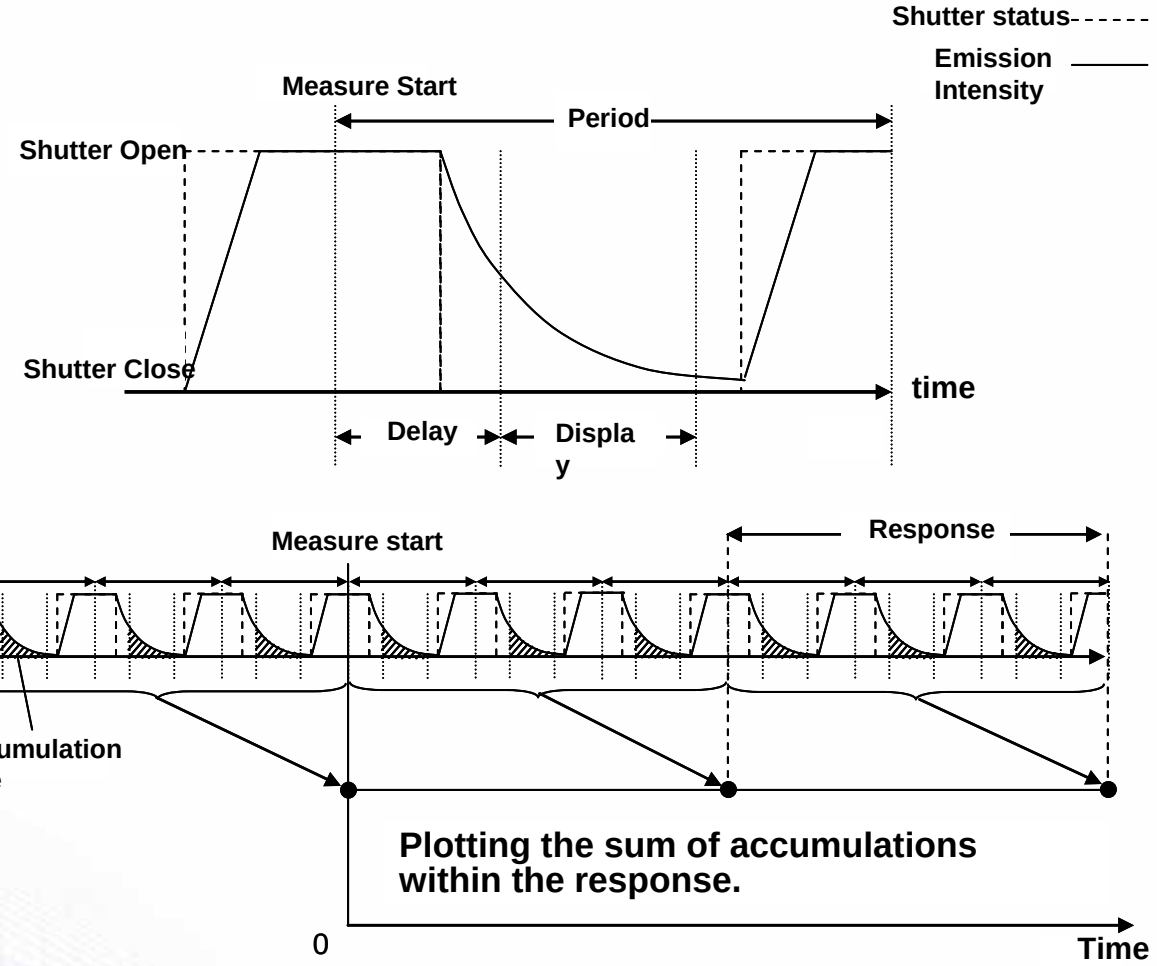
Phosphorescence time course measurement can be used for the evaluation of light-accumulating (phosphorescent) pigment, while phosphorescent assays are a more popular application for bio-science.



[Fluorescence mode]

[Phosphorescence mode]

Std. programs (DS measurement)～Phosphorescence mode



Std. programs (DS measurement)～Time course

FP-8200

- Data pitch: 0.01 sec～60 sec
- Max measure time: approx. 7 days (600,000 sec/10,000 min/167 hr)

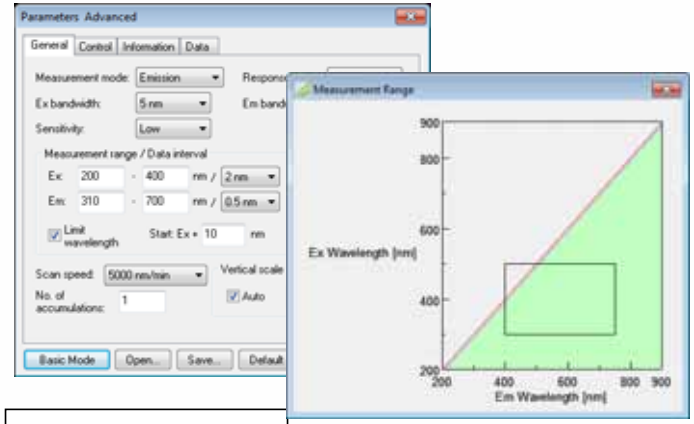
FP-8300/8500/8600

- [Fluorescence mode] & [Phosphorescence mode], are both available
- [Fluorescence mode]
- Data pitch: 0.05 msec ～60 min
- Unit of time: msec, sec, min
- Max measure time: 200 days (288,000 min/4,800hr)

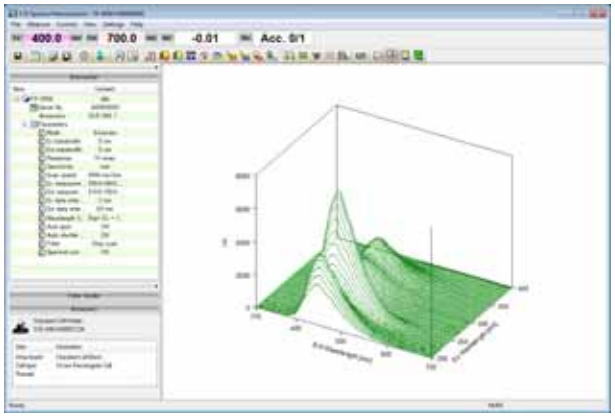
Light-accumulation (phosphorescent) pigments have a life time of minutes to hours. Lifetime can be determined by observing the emission time course data after shutting off the Ex. light.

Std. programs (DS measurement)～3D spectra

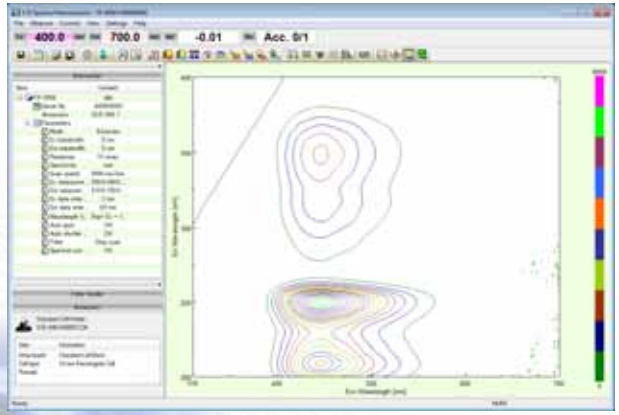
New Simpler parameter settings



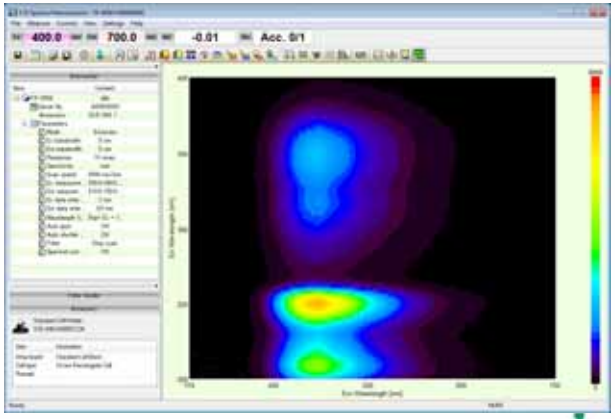
3D spectra



Contour map

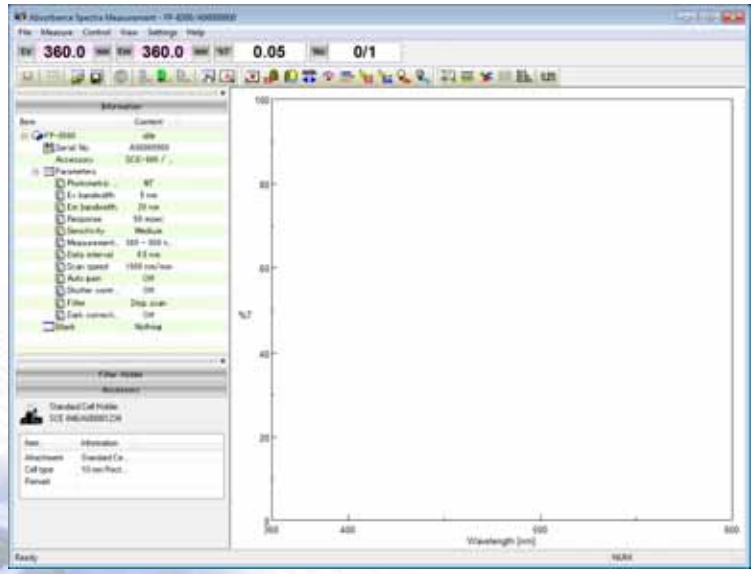


Color contour

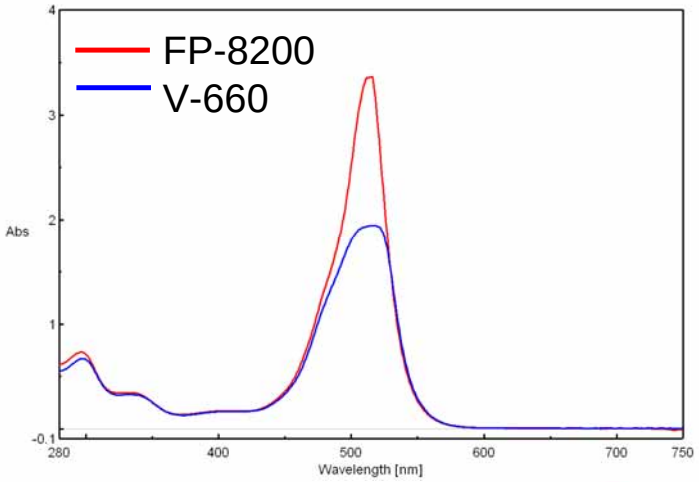


Std. programs (DS measurement)～Abs measurement

Many textbooks say “Fluorescence from samples may provide an artifact to the observed absorbance spectra” without any method for ‘correction’ of this interference.
The FP-8000 series offers a perfect absorbance measuring system: using the dual monochrometers, the higher order diffraction cut filter units for both incident and transmitted light and the use of the synchronized scanning mode with 0 nm wavelength difference.
It is now possible to observe accurate absorbance characteristics of organic EL compounds and other fluorescent samples.



Abs. spectrum of Eosin B



Std. programs (DS measurement)～Spectral correction

- **Calibrated D_2 light source and a calibrated detector unit are new developments. They, together with Rhodamine B and the calibrated WI light source provide the ability to obtain correction data for the full wavelength range for both Ex. and Em. directly.**
- **These calibrated components are applicable to not only the std. cell holder but also the ISF-834 60mmΦ and ILF-835 100mmΦ I.S. units.**
- **The correction program has been modified to be able to operate Ex. and Em. separately.**

Ex \ Em	1	2.5	5	10	20
1	○	○	○	○	○
2.5	○	○	○	○	○
5	○	○	○	○	○
10	○	○	○	○	○
20	○	○	○	○	○

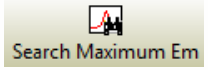
Previously, 50 spectra were required to cover all possible parameter settings.

Ex	
1	○
2.5	○
5	○
10	○
20	○
L5	○
L10	○

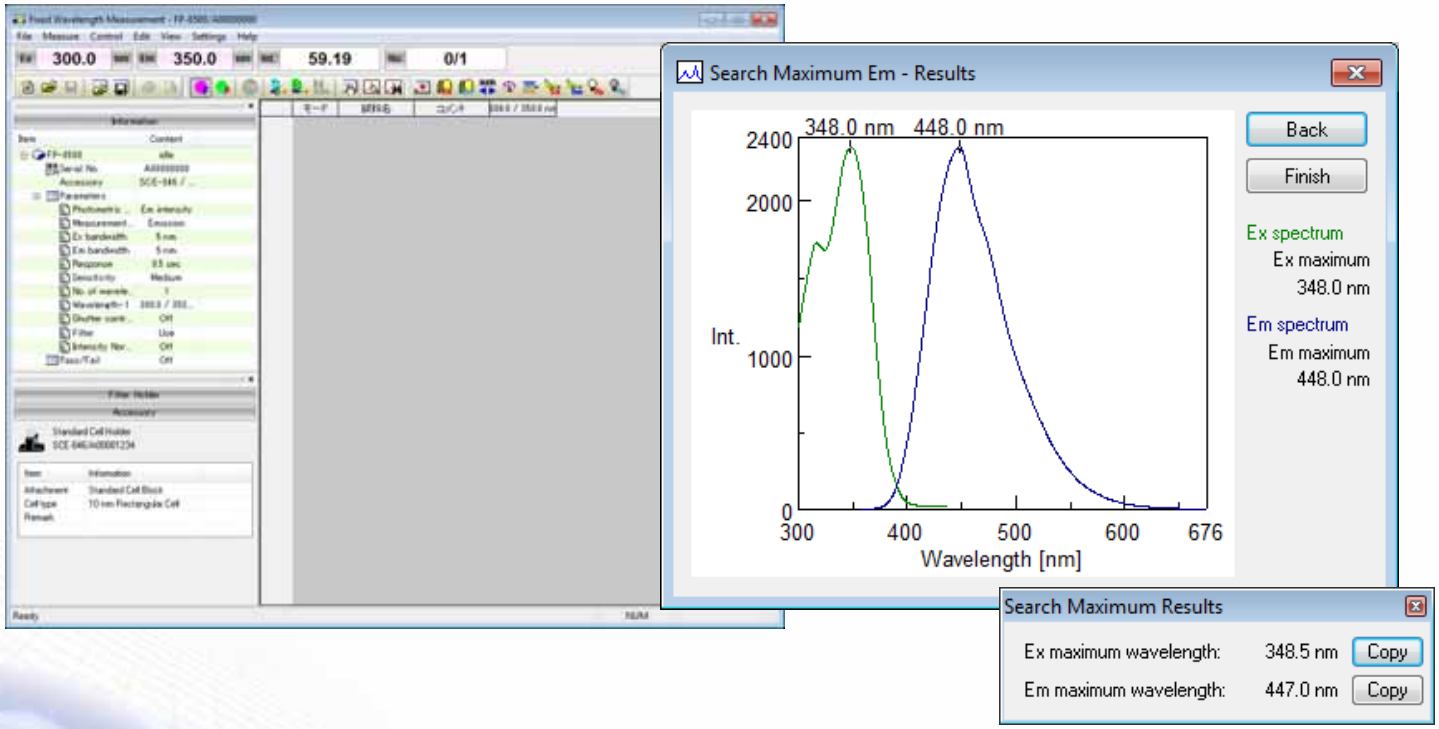
Em	
1	○
2.5	○
5	○
10	○
20	○
L5	○
L10	○

The correction system has been improved to reduce the requirements to 14 spectra.

Std. programs (DS measurement)～Peak search

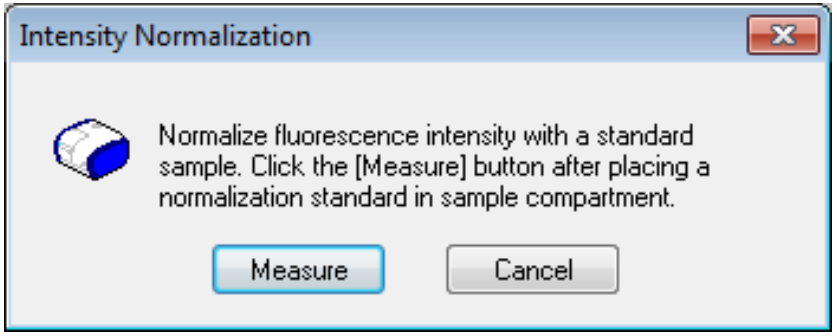
Peak search 

provides a rapid method to determine the Ex. and Em. peaks for an unknown fluorophore.
This function has been modified to be accessible from each software application, instead of an independent function. This enhances the ease of operation.



Std. programs (DS measurement)～'Single-point calibration'

The FP-8000 series is equipped with a new function which can calibrate the fluorescence intensity with the observed intensity of a single standard. This function eliminates the need to generate a working calibration curve at the beginning of every fluorescence assay.
For example, the regulation for the "testing method of chlorophylls" as an authorized testing method for water requires a calibration of the instrument by adjusting the fluorescence intensity of 1 mg/mL of fluorescein to 100.



Std. programs (DS analysis)

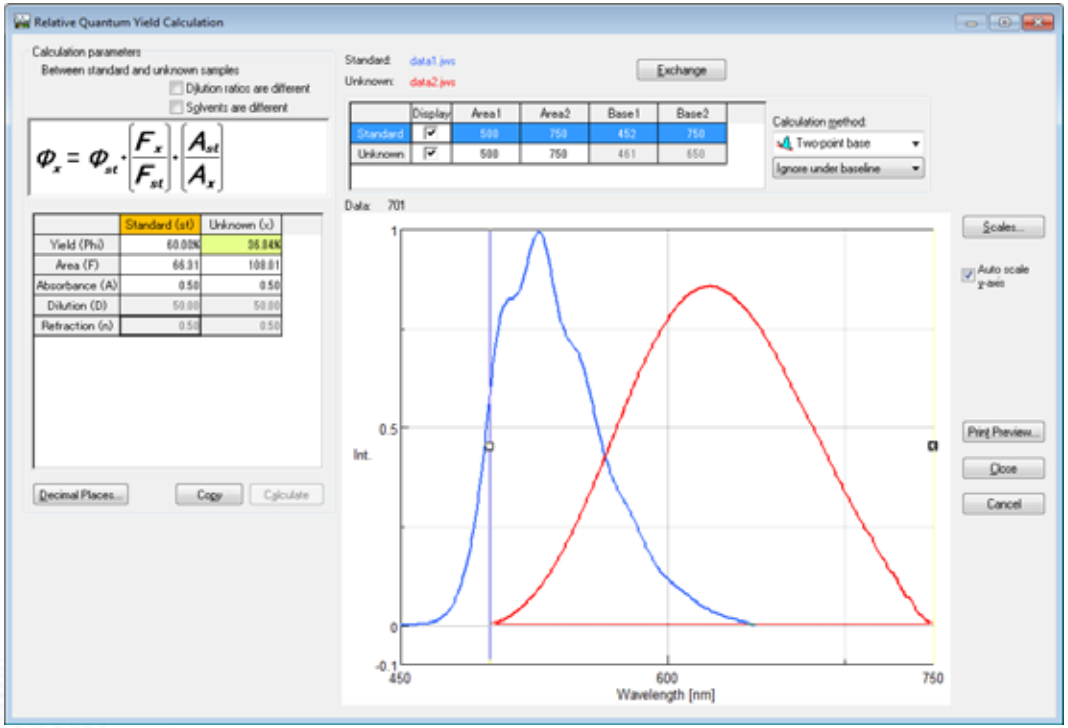
Name	Available for:	CFR
Spectrum analysis	2 / 3/ 5 / 6	Yes
Interval data analysis	2 / 3/ 5 / 6	Yes
JASCO Canvas	2 / 3/ 5 / 6	Yes

Programs in Spectrum analysis:

Name	Available for:	CFR
Phosphorescence lifetime	3 / 5/ 6	Yes
Spectral correction	2 / 3 / 5 / 6	Yes
New Relative quantum yield	2 / 3 / 5 / 6	No
Enzymatic reaction rate	2 / 3 / 5 / 6	Yes
New X unit conversion	2 / 3 / 5 / 6	Yes
New Y unit conversion	2 / 3 / 5 / 6	Yes
New Time axis offset	2 / 3 / 5 / 6	Yes
New Peak normalization	2 / 3 / 5 / 6	Yes

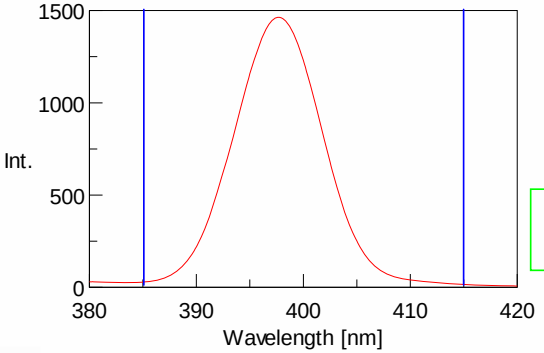
Std. programs (DS analysis) ～Relative quantum yeild

Quantum yield is proportional to the ratio of total emission when both fluorophore have the same total absorbance. A new program has been developed to determine the quantum yield of unknown samples by direct comparison with a standard sample having a known quantum yield.

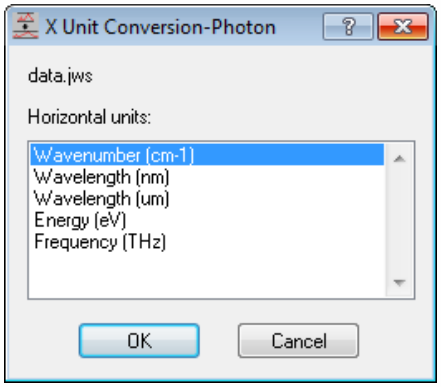


Std. programs (DS analysis) ～X unit conversion

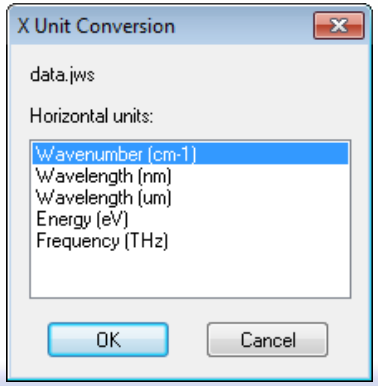
A new X unit conversion program has been added which does not distort the peak area. This conversion method is physically important when the ordinate has a dimension such as number of photons, energy, etc.

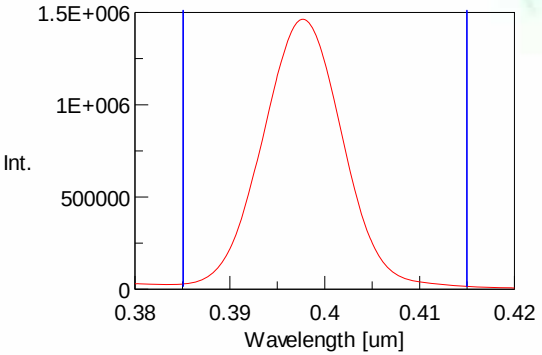


peak area: 13972.3
range: 385-415nm

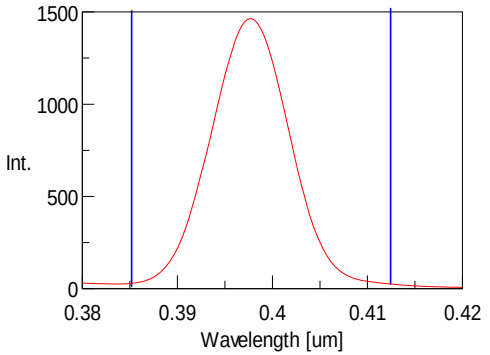


The example shows nm→μm, while nm→cm^{-1},eV are also common.





peak area: 13974.6
range: 0.385001-0.415006μm



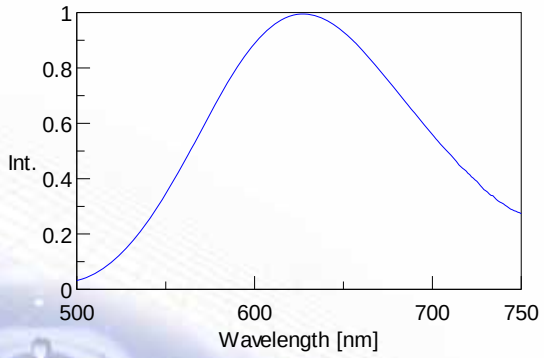
peak area: 13.9746
range: 0.385001-0.415006μm

Std. programs (DS analysis) ～Y unit conversion

A fluorescence photometer provides a spectrum with an ordinate value with the dimension of number of photons. While suited for quantum yield determination, the dimension of 'energy' is needed for color analysis of fluorescent emission. This new function provides such an ordinate conversion without changes to the dimensionless value of 'number of photons'.
For example, one photon has the energy of $e=h\nu$, so the sum of N photons is $E=N\cdot h\nu=N\cdot hc/\lambda$.

This function converts the ordinate by multiplying/dividing the factor of wavelength such that 1 μm is set to be 1.

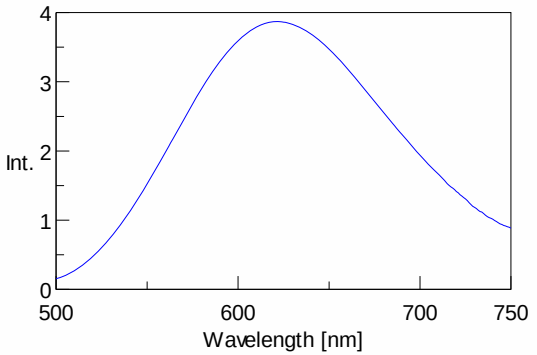
Int. (number of photons)



number of photons ⇔ energy

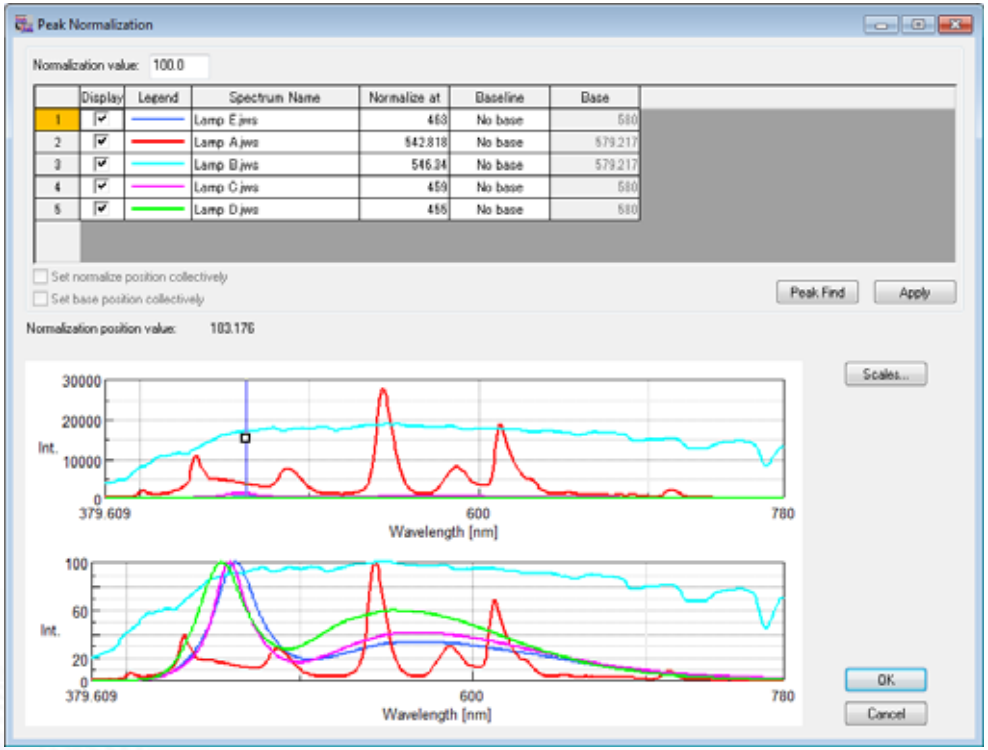
Correction factor for Ex. will be applied in case.

Int. (energy)



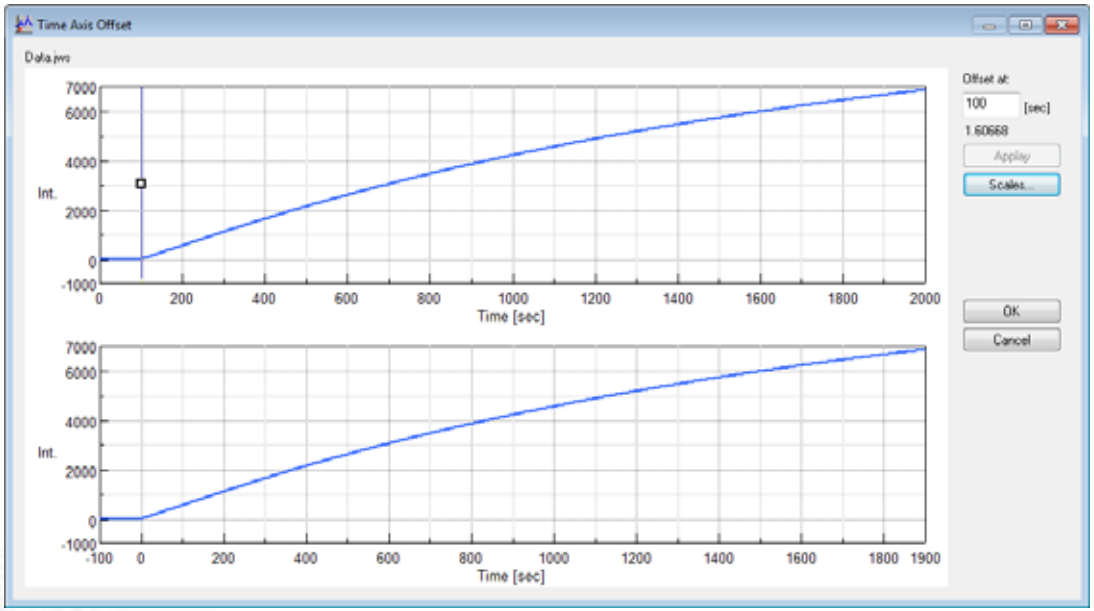
Std. programs (DS analysis) ～Peak normalization

This function normalizes the scales of multiple spectra for simplified shape comparison. This function is very useful for direct comparison of fluorescent dyes.



Std. programs (DS analysis) ～Time axis offset

This function provides an adjustment for setting of a proper “offset” to the time axis of a time course observation. It is valuable for kinetics analysis to compensate for the time lag from “measurement start” to “reaction start”.



Std. programs (Driver)

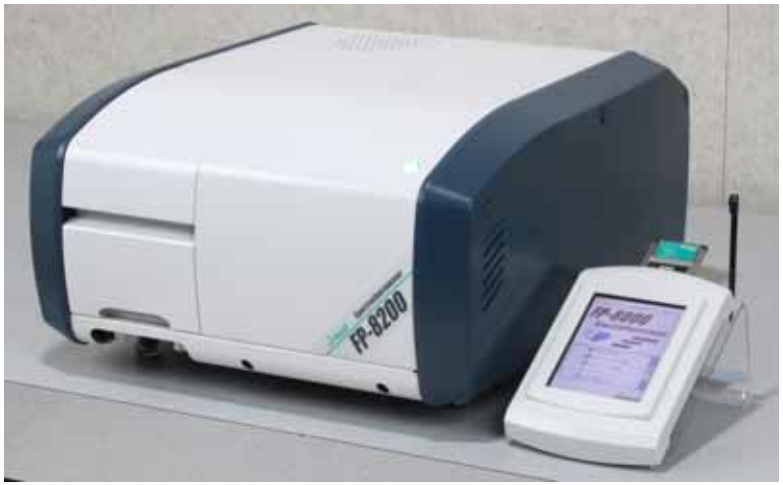
Name	Available for:
FP Control Driver	2 / 3 / 5 / 6
PAC-743 Temperature Controller Driver	2 / 3 / 5 / 6
Temperature Controller(ETC, EHC, PSC)	2 / 3 / 5 / 6
Driver for High Temperature Controller	3 / 5 / 6
Driver for AUS-800 Autosampler	2 / 3 / 5 / 6
Driver for AUS-605 Autosampler	2 / 3 / 5 / 6
Driver for Microplate Reader	3 / 5 / 6
Control driver for the rapid stopped-flow system	3 / 5 / 6
Driver for Automatic Titration Unit	2 / 3 / 5 / 6

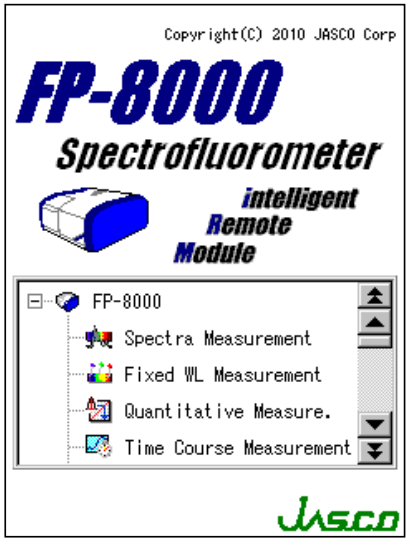
Optional programs～DS

Model	Name	Components	Available in	CFR
FWTS-872	Temperature interval	Temperature interval scan	2 / 3 / 5 / 6	Yes
FWTC-873	Dual-wavelength time course	Dual-wavelength time course Intracellular ionic concentration	2 / 3 / 5 / 6	Yes
FWTP-874	Temperature control – Melting	Temperature control/ramping DNA melting analysis Melting temperature calculation	2 / 3 / 5 / 6	Yes
VWKN-775	Kinetics analysis	Kinetics analysis	2 / 3 / 5 / 6	Yes
FWAP-875	Auto-depolarization	Auto-depolarization fixed W.L. Auto-depolarization time course Auto-depolarization temp. ctrl. New Auto-depolarization titration New Depolarization analysis	3 / 5 / 6	Yes
FWSF-877	Stopped flow	Stopped-flow measurement Reaction rate calculation Data accumulation	3 / 5 / 6	No
FWAT-876	Auto-titration	Automatic titration measurement	2 / 3 / 5 / 6	Yes
FWFC-878	Fluorescent object color	Fluorescent object color	3 / 5 / 6	No
FWLU-879	Luminous color	Luminous color meas./anal.	3 / 5 / 6	No
VWMC-883	Macro command	Macro command	2 / 3 / 5 / 6	No
FWQE-880	Quantum yield calculation	Quantum yield calculation	3 / 5 / 6	No

iRM-900

Modernized color LCD panel





Std. programs (iRM)

Measurement

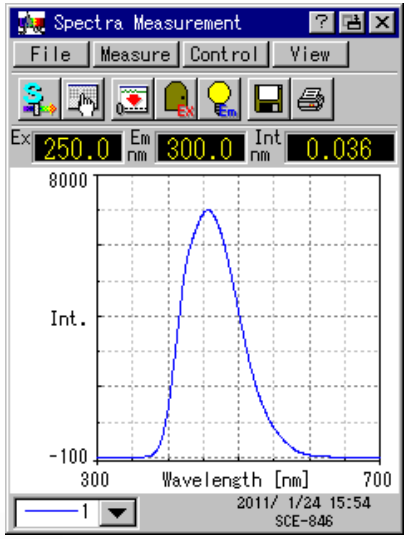
Name	Available in
Spectra	2 / 3
Time course	2 / 3
Quantitative meas.	2 / 3
Fixed wavelength	2 / 3
New Abs measurement	2 / 3
Intensity monitor	2 / 3
Peak search	2 / 3
Validation	2 / 3
New 3D spectra	2 / 3
New Spectral correction	2 / 3

Analysis

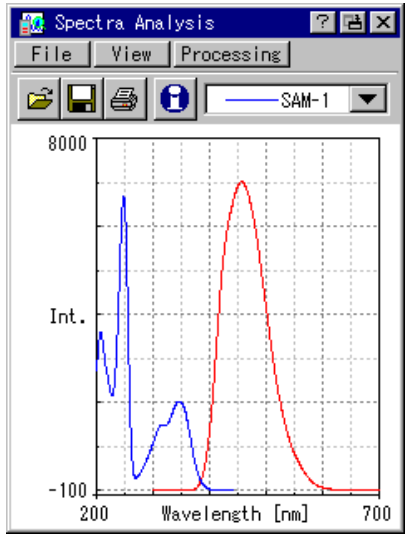
Name	Available in
New spectra analysis	2 / 3
New 3D spectra analysis	2 / 3

Std. programs (iRM)～for easier operation

- **Analysis separated from measurement with enhanced functions**
- **Two modes of parameter settings: basic and advanced modes**



Spectrum measurement



Spectrum analysis

Data processing:

- Baseline correction
- Smoothing
- Peak cut
- Deconvolution
- FFT filtering
- Interpolation, Cut
- Arithmetics
- Differential
- K-K (Kramers-Kronig)
- Peak picking
- Peak height/ratio
- Peak area/ratio
- Peak half-height width
- Specra difference
- X/Y unit conversion
- Comments editor
- Enzymatic reaction rate
- Spectra

Std. programs (iRM)～3D spectrum

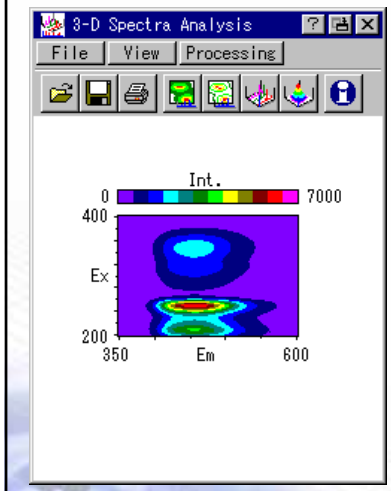
3D Spectra measurement

•Up to 50 spectra can be acquired as interval data (jwb)

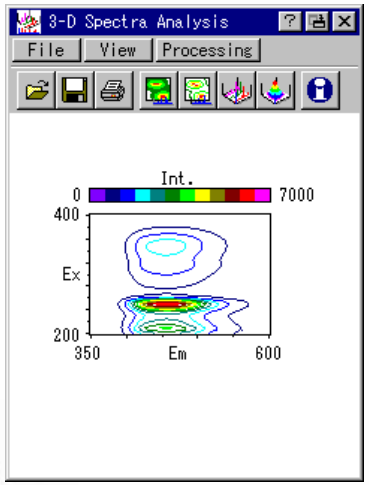
3D spectra analysis

•Display: Color contour / Contour / 3D / Color 3D
•Data processing: Smoothing / Baseline correction / Comment Editing
•Cross section, Peak search

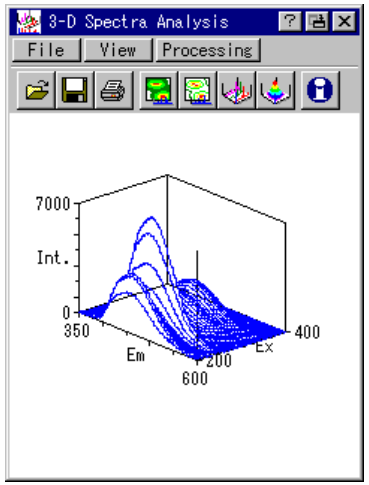
Color contour



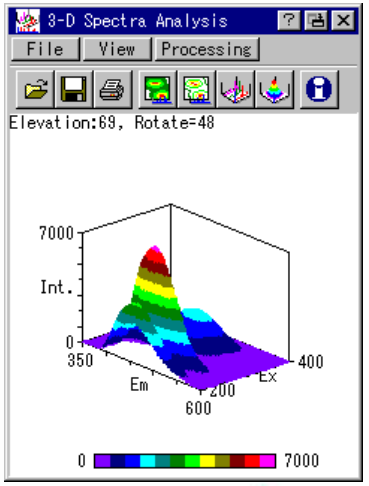
Contour



3D



Color 3D



Optional programs～iRM

Model	Name	Component	Available in
New FRTC-884	Dual-wavelength time course	Dual-wavelength time course	2 / 3
New FRTP-882	Temperature controlling・Melting	Temperature controlling	2 / 3
		DNA Melting analysis	2 / 3
FRKN-881	Kinetics	Parallel time course	2 / 3
		Kinetics analysis	
New FRAP-883	Auto-depolarization	Auto-depolarization fixed wavelength	3
		Auto-depolarization time course	
		Auto-depolarization temperature controlling	
		Depolarization analysis	
FRMC-885	Macro command	Macro command	2 / 3

Fluorescence Spectrophotometer

FP-8000 series

Application system

UV/CD Division

JASCO Corp.

Application system

- Optimal combination with accessory and program dedicated to specific application

Application systems

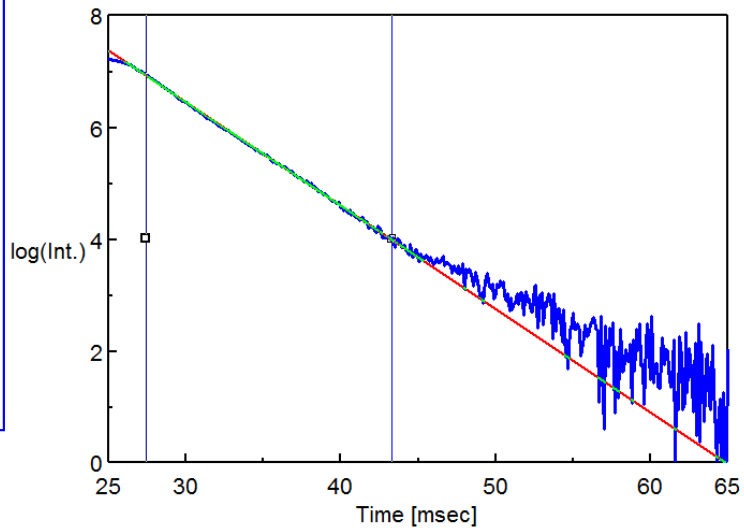
- Phosphorescence
- Fluorescence depolarization
- Fluorescence color
- Fluorescence quantum yield
- Phosphorescence quantum yield
- Auto measurement
- Stopped flow
- Auto titration
- One drop fluorescence
- Single perticcle fluorescence

Phosphorescence

Organic EL is a growing application for phosphorescence. For R&D research, a material is analyzed for a triplet emission, and then modifications are attempted to improve the quantum yield. By obtaining a more efficient excitation to the triplet state, energy losses are minimized and higher efficiency is obtained.
Phosphorescence assays are also increasingly popular for bioscience applications.

System:
- FP-8500 (8300, 8600)
- PMU-830 Liq. N_2 cooling unit

Lifetime of benzophenone



Range:	27.4 - 43.3 msec
Life time:	5.40 msec
Std.error:	0.00180
Regression:	Y = -0.1850 ×X + 11.99
C.C.:	-0.9996

JASCO

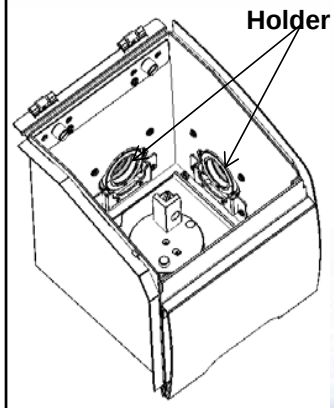
Auto depolarization measurements

Anisotropy is a well established method to study the mobility of a molecule, the molecular size, quality of binding to receptor, etc, by observing the depolarization of fluorescence from molecules excited by linear polarized light.

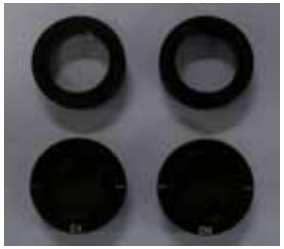
The polarizer drive unit is now a separate unit and can be combined with any cell holder of the customer's requirement.

Example system:

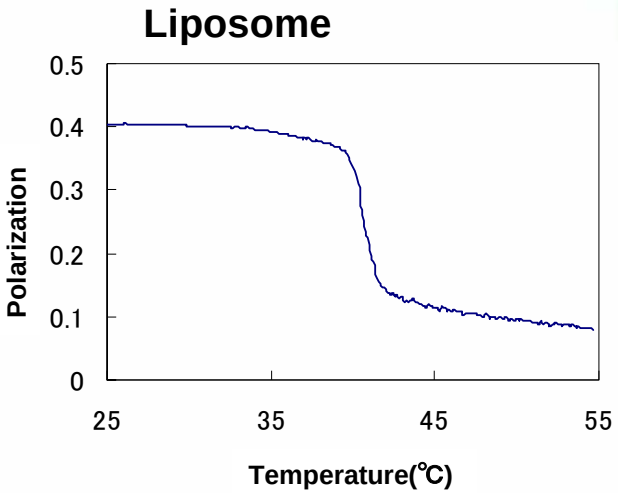
- **FP-8300 (8500)**
- **ETC-815 Peltier thermostatted cell holder**
- **FDP-837 Automatic polarizer**
- **FWAP-875 Auto-depolarization program**



Polarizer motor drive unit



Top: Quartz window
Bottom: Polarizer

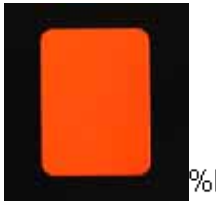


Fluorescent dye (DPH) was added to a liposome sample, then the fluorescence polarization was observed by changing the temperature. This experiment reveals a phase transition at approximately 40° C.

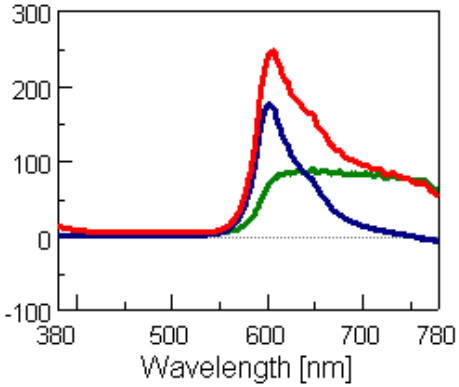
Color evaluation of fluorescent materials

Fluorescent materials are increasingly used for many objects, such as safety signs for superior visibility. ASTM established a testing method for luminescent color by using a fluorescence spectrophotometer. The standard method requires the measurement of the 3D spectra, calibration of the Ex. intensity to the standard D_{65} source, and accumulation of the Em. intensity for each wavelength for an intensity distribution. The object color calculation is then performed to obtain the chromaticity coordinates for the sample.

Spectra of fluorescent sample under D_{65}



"Red" card

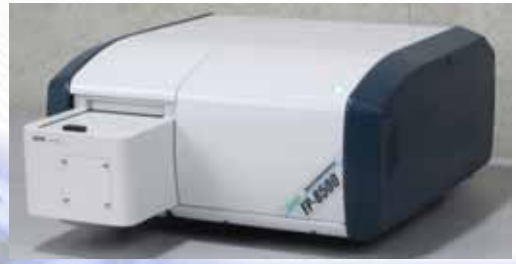


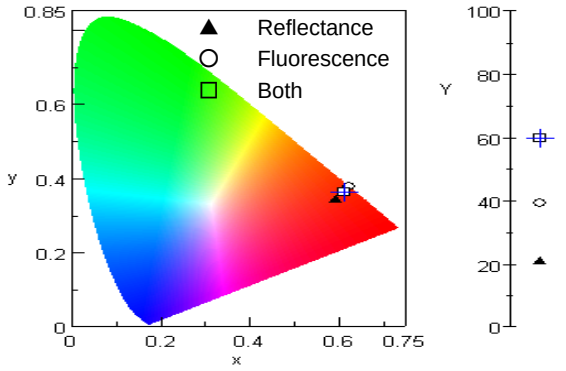
System

- FP-8500 (8300)

- ISF-834 60mm diam. I.S. accessory

- FWFC-878 Fluorescent object color program

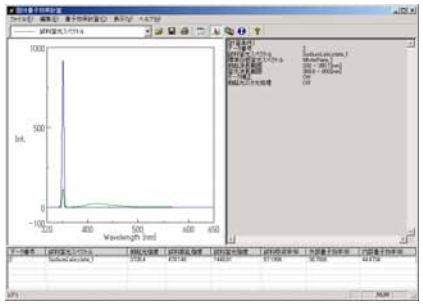


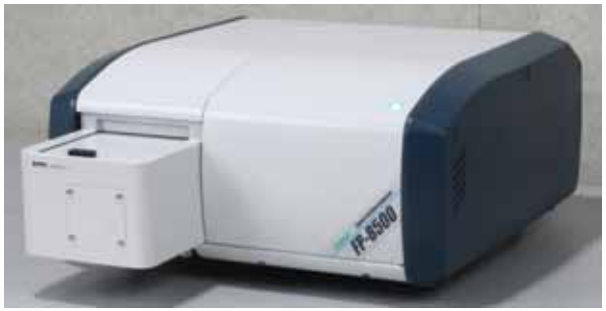


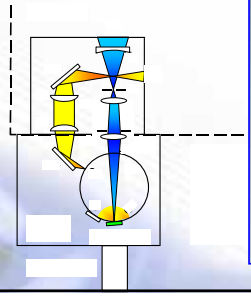
Fluorescence quantum yield determination

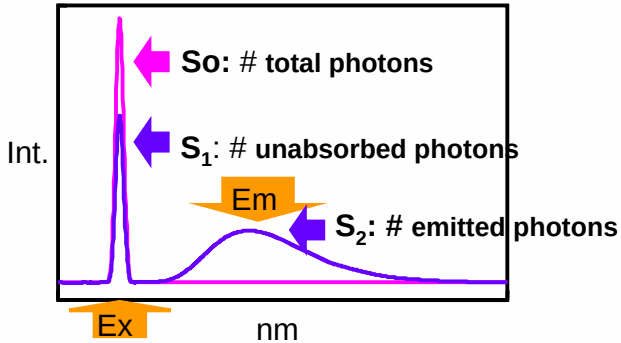
Fluorescent systems has been changed by the requirement from the evaluation of luminous materials used for white LED, etc. The FP-8000 series instruments provide numerous features for optimized analysis of these materials.

System
- **FP-8500 (8300)**
- **ISF-834 60mm diam. I.S. acc'y or ILF-835 100mm diam. I.S. acc'y**
- **FWQE-880 Quantum yield program**







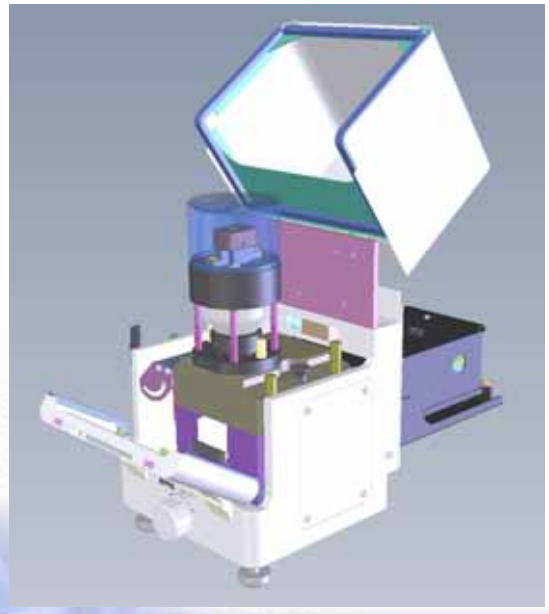


$$\Phi = \frac{\text{\# Emitted photons}}{\text{\# Absorbed photons}} = \frac{S_2}{S_0 - S_1}$$

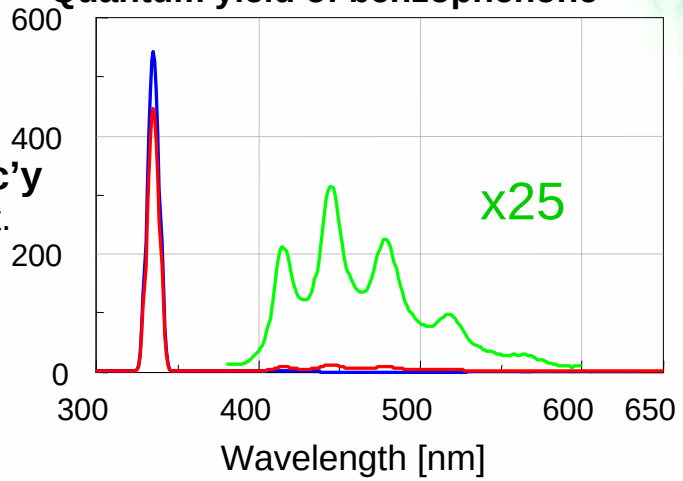
Phosphorescence quantum yield determination

An optimized accessory for phosphorescence quantum yield determination has been designed which includes a dewar with an integrating sphere.

System
- **FP-8500**
- **IFLC-847 Liq. N_2 cooled 100mm diam. I.S. acc'y**
- **FWQE-880 Quantum yield program**



Quantum yield of benzophenone



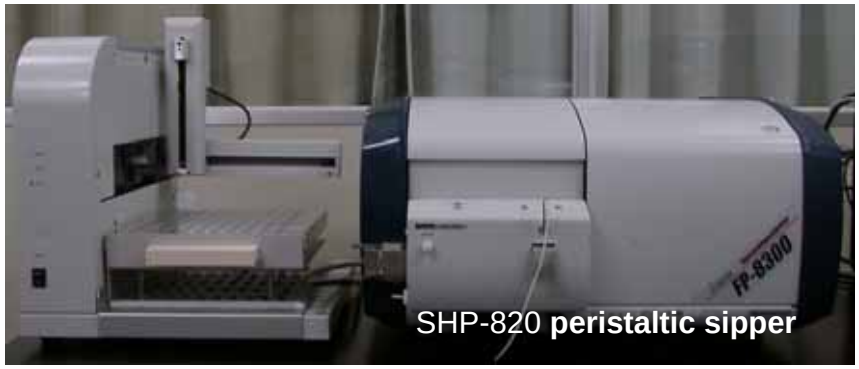
$$\Phi = \frac{819.276}{4954.31 - 4073.96} = 0.93$$

(Published spec. $\Phi > 0.8$)

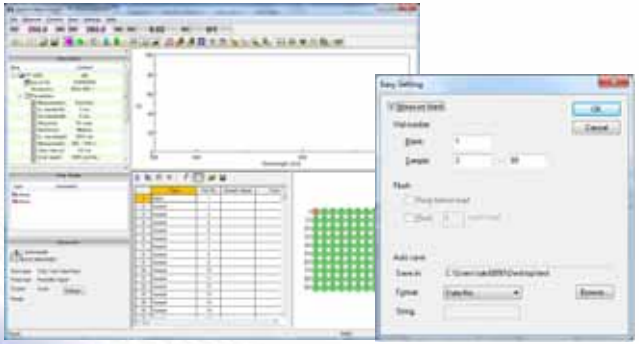
Exceeds the published specification by one figure in the precision.

Auto-sampler measurements

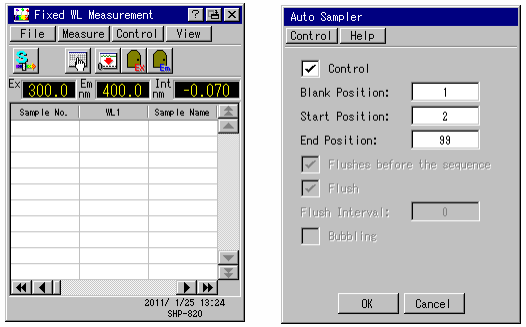
The standard measurement programs: [Spectrum Measurement], [Quantitative Analysis] and [Fixed Wavelength Measurement] for the PC or iRM includes an dedicated interface for automated measurements using an analysis sequence which can be modified by the user.
This software function is usable for all three auto-systems: peristaltic sipper, vacuum sipper, and flow cell holder + syringe pump.



SHP-820 **peristaltic sipper**



Spectra Manager [spectrum measurement]

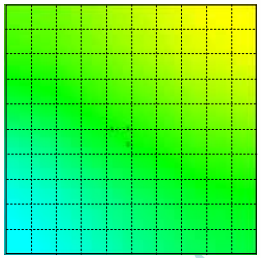


iRM [fixed wavelength measurement]

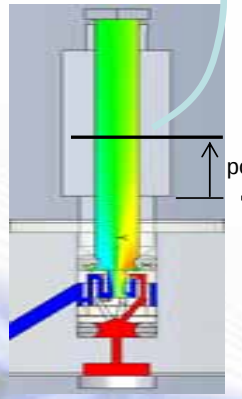
Stopped-flow experiments

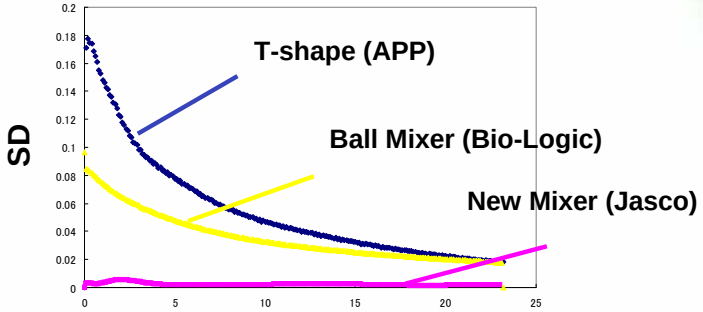
Stopped flow experiments are widely applied to the study of protein denaturation, enzyme reaction, and others. The combination of a rapid and sensitive fluorescence spectrophotometer and a stopped flow unit provides an optimized system.

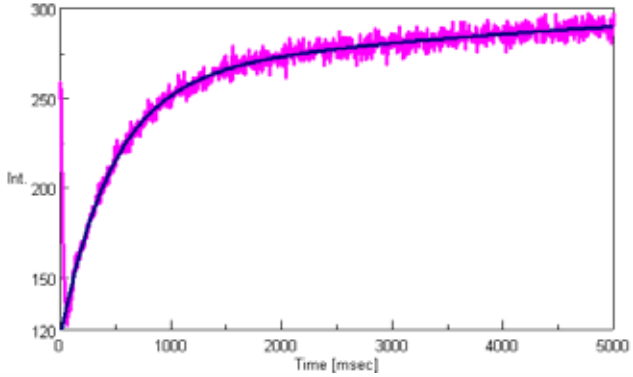
Mixing Efficiency



Calc. S.D.
of ratio







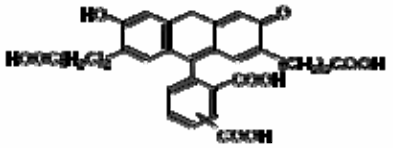
Denaturation of Cytochrome C (0.5mg/mL) by 0.1N sulfuric acid. Mixing ratio of 1:1.

Auto-titrator experiments

CD is widely used for protein denaturation studies using pH change or other denaturation compounds. Fluorescence can also be applied for these experiments.
JASCO offers a new integrated system incorporating an updated auto-titration unit and a dedicated program which will surpass competitive systems.

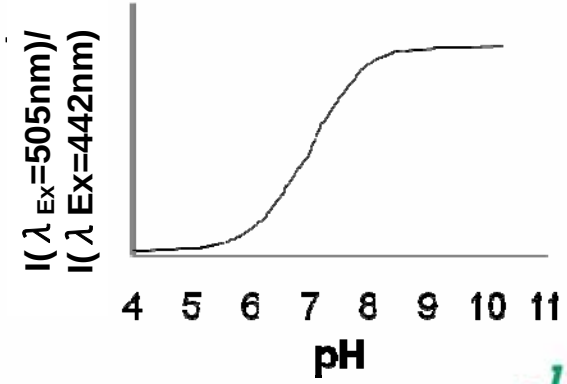
pH dependency of fluorescence intensity of BCECF

BCECF Fw:536.5



pH sensitive fluorescent dye
Ex λ : 505 nm
Em λ : 530 nm
Isosbestic point : 442 nm
pKa=6.98
Reagent: 0.005 N NaOH

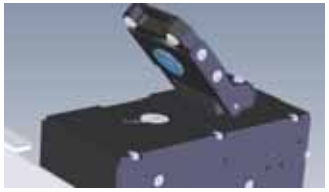
System
- FP-8300 (8200, 8500)
- STR-812 Water Thermostatted cell holder with stirrer
- ATS-827 Automatic titration unit
- FWAT-876 Automatic titration program



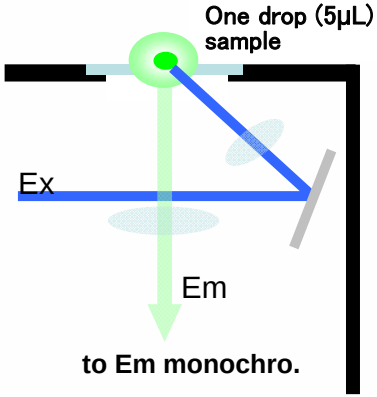
One drop measurement

"The smallest amount of samples possible" is an emerging requirement, especially for bio-science applications. The success of the "one-drop measurement" for the V-600 series has been extended to the FP-8000 series.

System
- FP-8200 (8300,8500,8600)
- SAF-850 One-drop meas. acc'y (SAF-851)

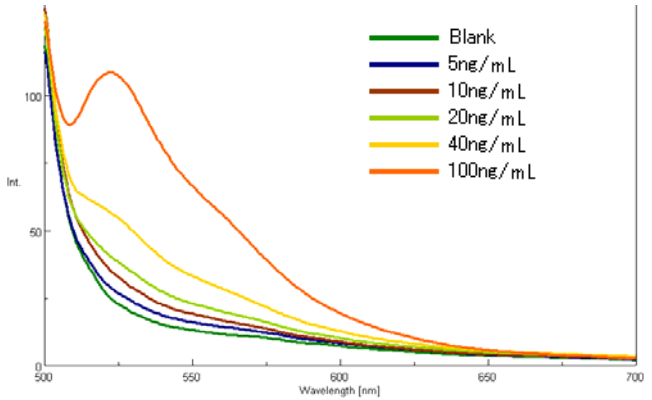


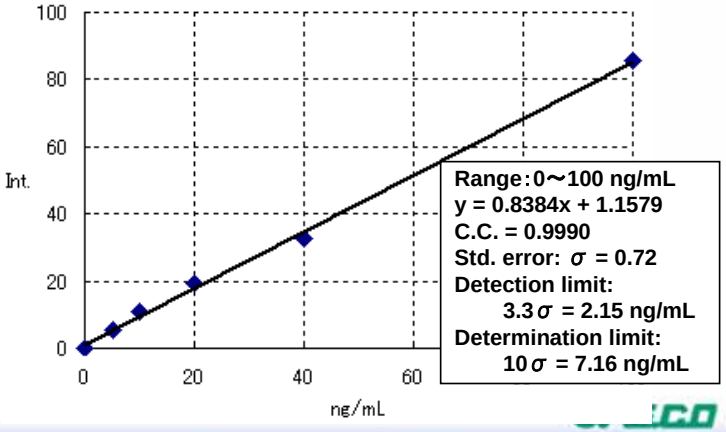
SAF-850



DNA labeled with PicoGeen

A λDNA sample was labeled with the fluorescent dye PicoGreen, which is a highly selective and sensitive label for the double strand DNA. The one drop experiment demonstrates more than 1000X higher sensitivity than the UV absorbance method.

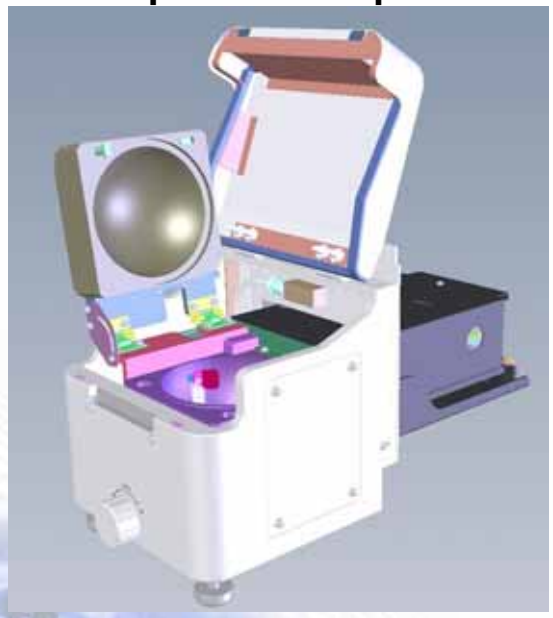


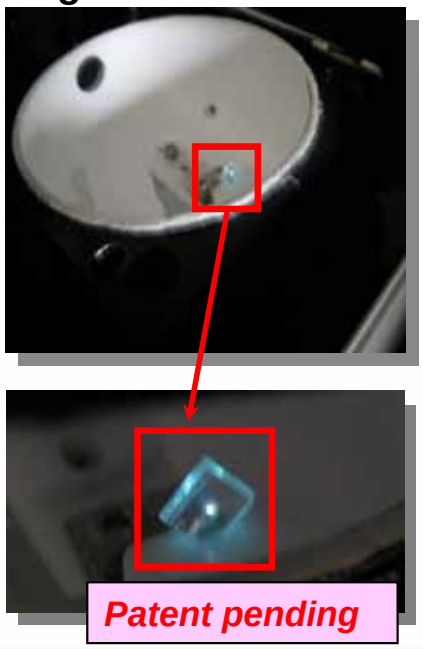


Single particle fluorescence

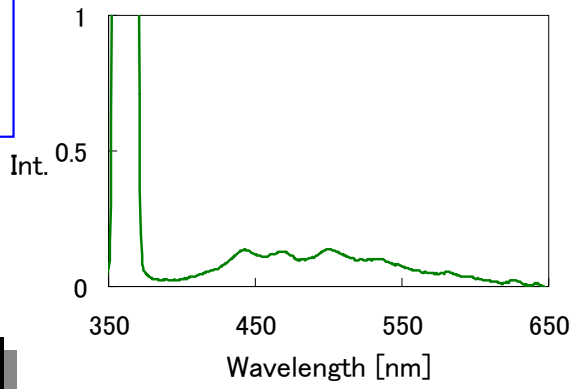
Several researchers have requested the ability to determine the fluorescence quantum yield of a single luminous particle of a sample ranging from 10-100 μm in size. The KBr plate method can provide the ability to perform such an experiment.

System
- **FP-8500**
- **ILF-835 100mm diam. I.S. acc'y**
- **KBr plate holder (custom)**
- **Optional KBr plate sampling tool**

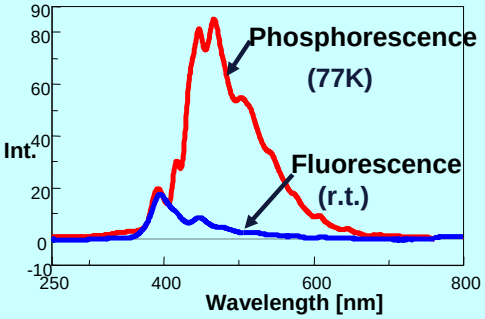




Fluorescence spectrum of one grain sample



Effectively usable for phosphorescence measurement



Thank you for attention!