LASER PRODUCTS

Specialise Instruments

INTELLIGENT SOLUTIONS

Specialise Instruments Marketing Company,
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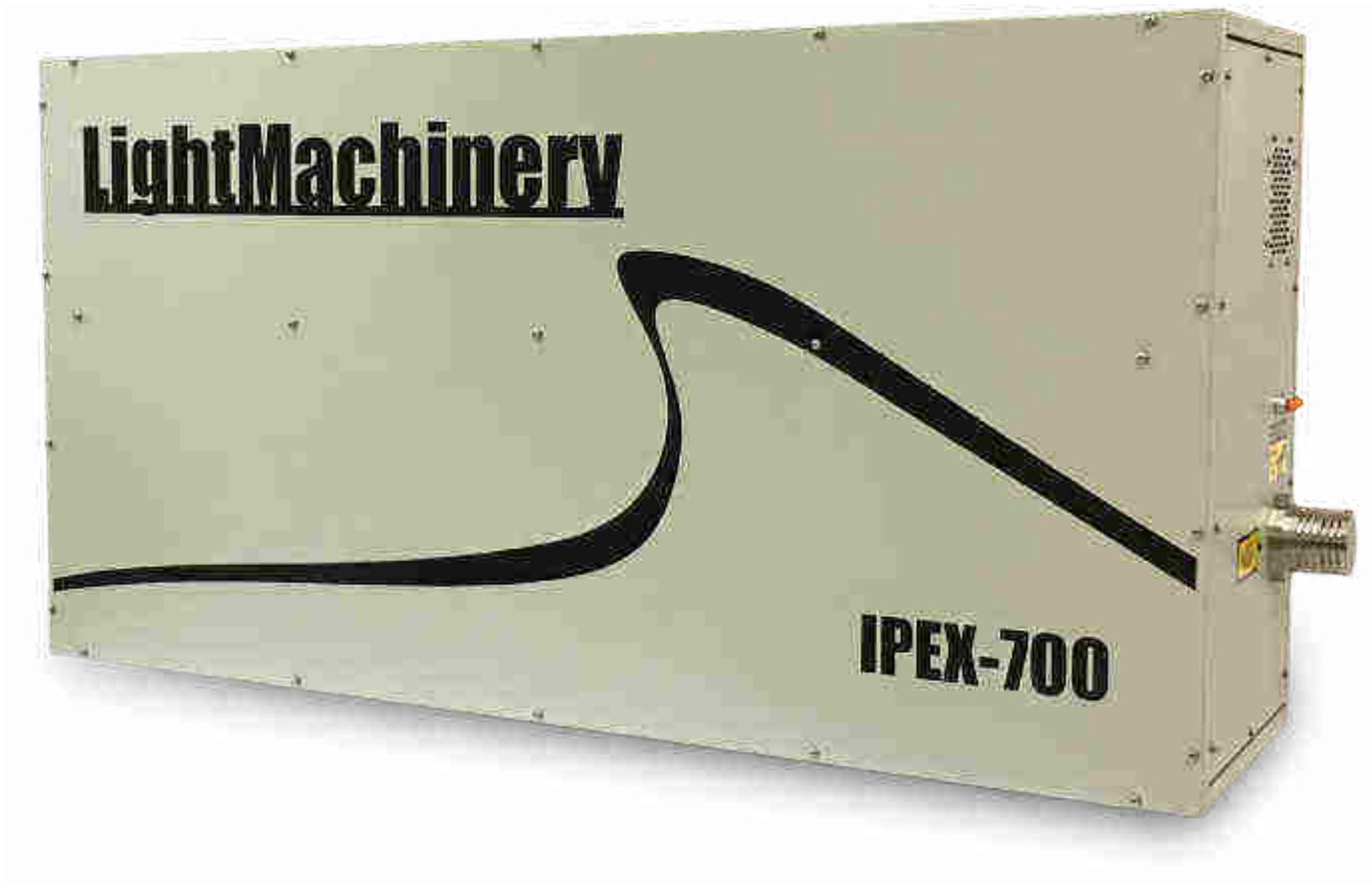
Kanjurmarg (W).Mumbai – 400 078.
Tel: 91-022-68551200 -Extn - 213.
Web: www.simc.co.in

LightMachinery
Excellence in Lasers and Optics



IPEX-700

A better excimer laser

- **Medium-power excimer lasers** for Industrial, R&D and Scientific applications (including Pulsed Laser Deposition), based on LightMachinery's best-selling high-power Ipex-800 Series industrial excimer lasers
- Now with **exciPure™** technology for ultimate gas lifetimes and lowest cost of operation
- Simple, direct control from a new-generation tablet-based user interface
- User-convenient features, optional air-cooling to 25 Hz, single-phase electrical power, small footprint, single-sided service access, **EasyClean™** automated optics seals to retain gas fill and reduce downtime during optics maintenance
- Excellent beam uniformity, pulse-to-pulse energy stability and short pulse duration
- High-stability optics mounts for ultimate beam pointing accuracy & optional high-brightness optics for applications requiring low beam divergence

LightMachinery
Excellence in Lasers and Optics

IPEX™-740 / 760 Series Excimer Lasers for Industrial & Scientific Applications

IPEX-700 Series lasers are designed for medium-power industrial processing and scientific applications. They deliver versatile performance combined with state-of-the-art industrial reliability.

exciPure™ technology, introduced in 2016, combines improved materials, a new dual-stage filter that removes both particulate and gaseous contaminants, and an improved stabilization algorithm. It represents the greatest improvement in excimer gas lifetime and reduction in operating costs in a generation.

EasyClean™ automated valves filled to the optics ports allow the laser chamber to be sealed and the gas fill to be retained while resonator optics are removed for cleaning and maintenance.

Simple to use

- Advanced tablet-based operator interface
- Optional air cooled operation to 25 Hz
- Premix or individual gas cylinders
- Single phase electrical power
- Integral oil-free vacuum pump
- Single-sided service access and economical to operate

IPEX-700 lasers combine the benefits of high performance with the lowest total cost of ownership and best uptime in the market today.

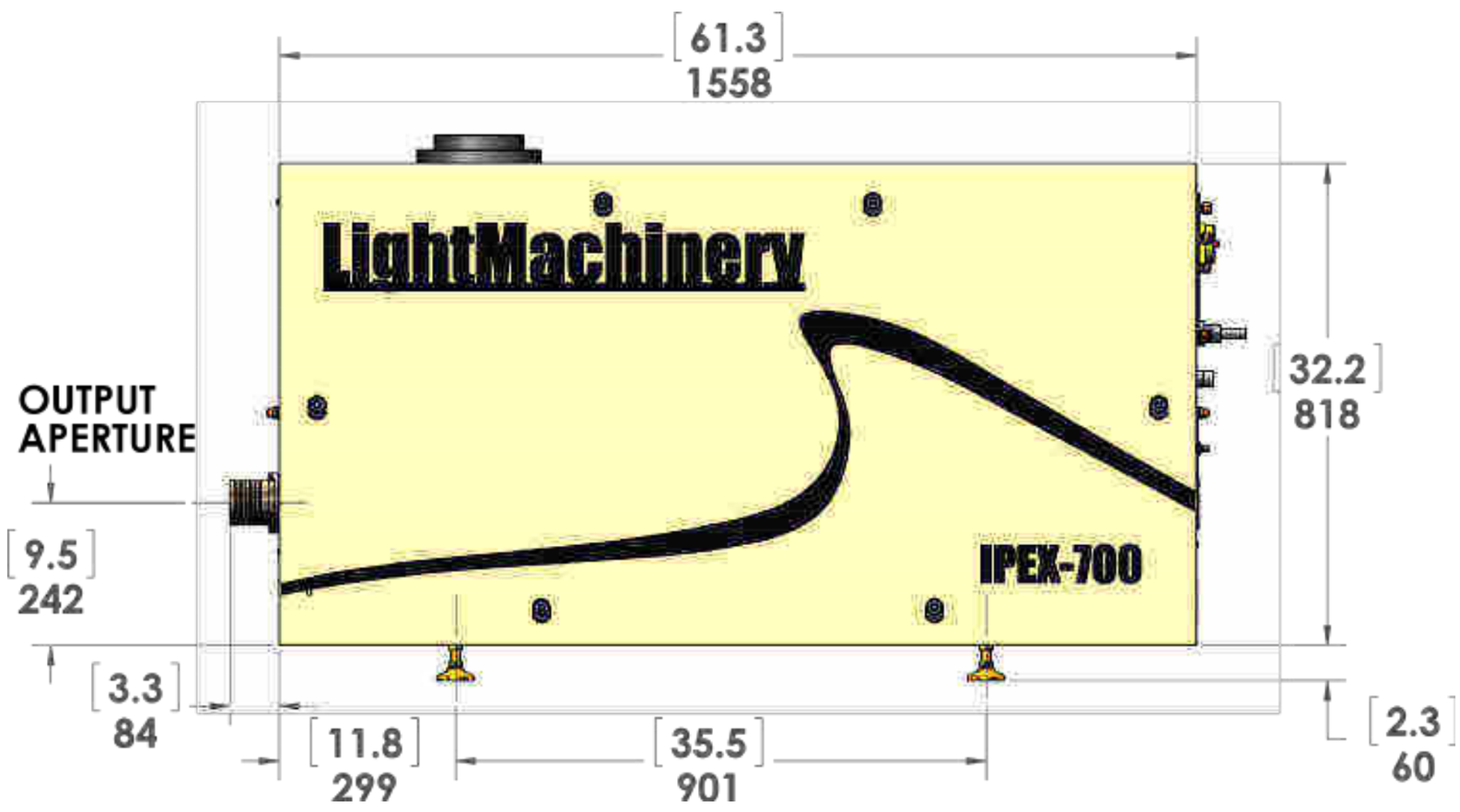
Optical Beam Delivery Systems

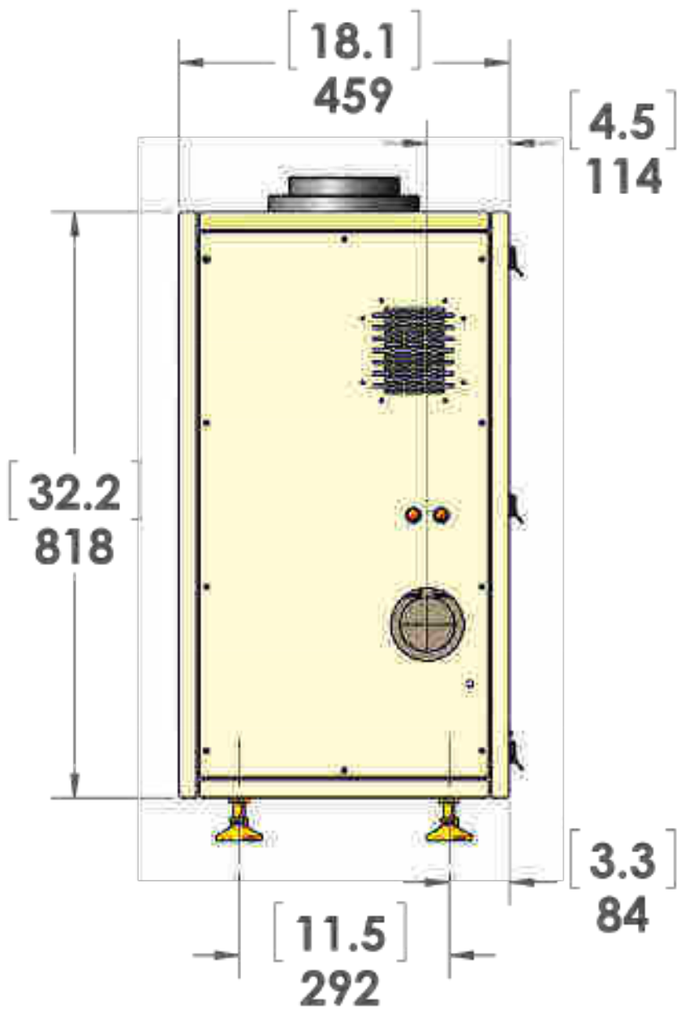
LightMachinery is more than just a laser supplier. With our optical design expertise and together with our integration partners, we can offer complete laser / beam delivery / processing systems for many requirements, including those of PLD customers.

Facilities

Electrical Power Single-phase, 200 – 240 V 50 / 60 Hz	**Cooling** Optional air cooling up to 25 Hz repetition rates Water cooling at higher repetition rates
Laser Gas Premix or individual gas cylinders Consult LightMachinery for details	**Weight (net)** 295 kg / 650 lbs.

Dimensions





LightMachinery
Excellence in Lasers and Optics

Specifications

	Series	ArF	KrF	XeCl	XeF
Wavelength (nm)		193	248	308	351
Maximum Pulse Energy (mJ) at low repetition rates	IPEX- 740	230	475	300	275
	IPEX- 760	250	700	600	350
Stabilised Pulse Energy (mJ) at maximum repetition rates	IPEX- 740	150	400	250	225
	IPEX- 760	200	600	500	300
Stabilised Average Power (W)	IPEX- 746	15	40	25	22
	IPEX- 744	7.5	20	12	11
	IPEX- 742	3.7	10	6.0	5.5
	IPEX- 766	10	30	25	15
	IPEX- 764	6.0	18	10	9.0
	IPEX- 762	3.0	9.0	5.0	4.5
Maximum Repetition Rate (pps)	IPEX- 746	100	100	100	100
	IPEX- 744	50	50	50	50
	IPEX- 742	25	25	25	25
	IPEX- 766	50	50	50	50
	IPEX- 764	30	30	20	30
	IPEX- 762	15	15	10	15
Pulse Duration (ns) (FWHM)		12-20			
Energy Stability, 1 Sigma (%) (KrF)		1			
Beam Dimensions (mm) (V x H) (nominal)	IPEX- 740	12 x 26			
	IPEX- 760	12 x 28			
Beam Divergence (mrad) (V x H) (nominal) *	IPEX- 740	1 x 3			
	IPEX- 760	1 x 3			

**With standard resonator optics. Can be reduced to ~250 µrad with High Brightness Unstable Resonator Optics*

Specifications are subject to change. Please consult LightMachinery for latest information

For further technical and sales information, please visit our website or contact:

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(613) 749-4895

LightMachinery
Excellence in Lasers and Optics

HyperFine HF Series Spectrometers

compact, sub picometer resolution

The HyperFine HF series of spectrometers are based on LightMachinery's patented fluid jet polishing technology. Designed for measuring hyperfine spectra and subtle spectral shifts, the HyperFine spectrometer from LightMachinery is a compact spectrometer capable of **1 picometer resolution**.

It is ideal for measuring fine features in plasmas, pulsed laser characterization and for measuring the small spectral shifts from Brillouin or Raman scattering. Simple PC based software allows the user to review spectra in real time and save or export for more analysis. LabView drivers enable the HF series to be integrated into automated experimental setups.

Features

- FAST, No moving parts (single shot spectrum analysis)
- Sub picometer resolution
- Fiber optic input
- Quick data acquisition and export
- Simple USB interface
- LabView Drivers

Benefits

- Fast acquisition (>10Hz)
- Compact
- Can resolve hyper fine spectra below 1 picometer
- Ultra-reliable
- Large range-over-resolution ratio (>10000)
- LightMachinery's legendary customer support

Light source characterization

- Lasers of all types
- Single shot pulsed laser spectrum
- Super luminescent diodes
- Gas discharge lamps, etc

Passive components characterization

- Notch filters
- Etalons
- Fiber Bragg gratings, etc

Spectroscopy

- Plasma spectroscopy
- High-precision gas spectroscopy
- Brillouin spectroscopy
- Femtosecond comb fingerprinting spectroscopy
- Spectral-domain optical coherence tomography
- Solar spectroscopy

Form Factors:

- A: 10 x 24 x 6 inches
- B: 22 x 13 x 6 inches
- C: 8 x 8 x 5 inches
- D: 28 x 15 x 6 inches

Part Number	Form Factor	Total Range (nm) with manual grating rotation	Simultaneous Range (nm) without grating rotation	Resolution (pm)	Resolution (1/cm)
HF-8993-1	A	270 - 330	12	<2.5	0.3
HF-8993-2	A	270 - 330	25	<5	0.6
HF-11457	C	250 - 320	50	<15	1.7
HF-11458	C	280 - 360	80	<15	1.7
HF-9340	C	fixed grating	350 - 450	<25	1.5
HF-9332	C	fixed grating	450 - 650	<30	0.9
HF-8989-1	A	400 - 500	15	1.0	0.05
HF-8989-2	B	500 - 600	15	1.0	0.03
HF-8989-2e	B	525 - 640	15	1.0	0.03
HF-8988*	A	500 - 550	15	15	0.55
HF-8989-3	A	600 - 700	15	1.0	0.02
HF-9353	C	fixed grating	700 - 1050	<30	0.4
HF-8995-1	B	700 - 900	25	2.0	0.03
HF-8995-1-0.5	D	700 - 900	6	<1	0.01
HF-8991-3	A	800 - 1000	20	2.0	0.02
HF-8995-2	A	900 - 1100	20	2.0	0.02

OPOTEK

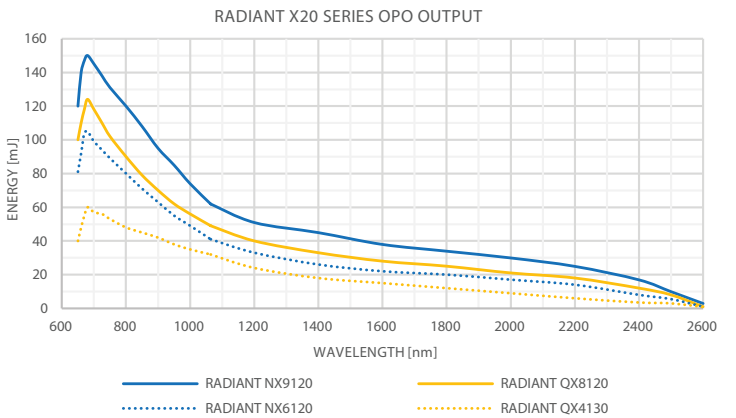
RADIANT X

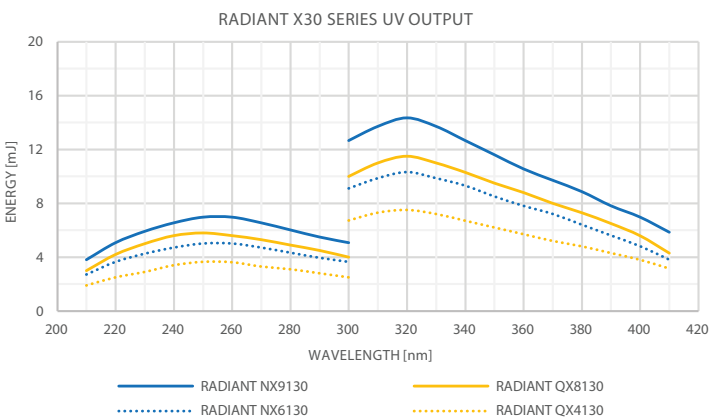
TUNABLE LASER SYSTEM

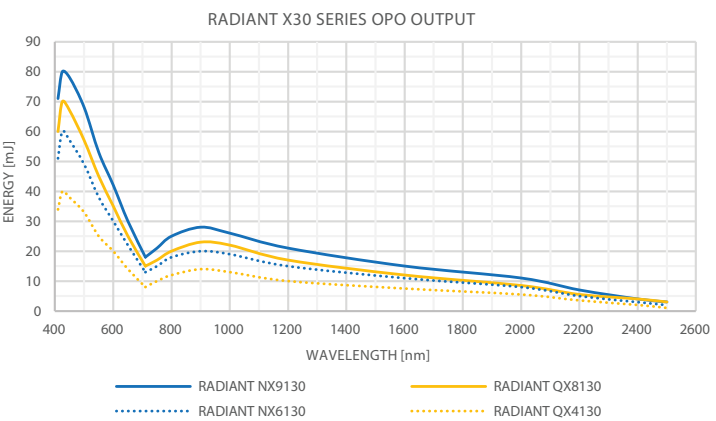
The next generation of RADIANT tunable laser systems has arrived! With the assistance of our loyal customers, OPOTEK has redesigned the versatile RADIANT tunable laser system with an increase of up to 50% output energy per pulse in a 12% smaller package. The RADIANT X is light-sealed and fully motorized so that all tunable wavlengths are accessible from a single port.

Required installations are now a thing of the past. The RADIANT X is designed to withstand the rigors of shipping. With an external alignment verification that takes minutes for any user to perform, the RADIANT X can be operational the same day it is received.

New to the list of features for the RADIANT X tunable laser system is an easy mount solution for users looking to integrate the RADIANT X into a larger OEM system.





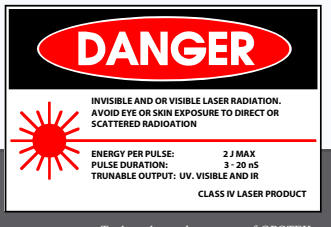


RADIANT X SERIES SPECIFICATIONS

	RADIANT QX4120	RADIANT QX8120	RADIANT NX6120	RADIANT NX9120	RADIANT QX4130	RADIANT QX8130	RADIANT NX6130	RADIANT NX9130
WAVELENGTH RANGE (nm)								
SIGNAL	650-1064				410-710			
IDLER	1064-2600				710-2500			
UV (optional)	---				210-410			
OPO CHARACTERISTICS								
PEAK OPO ENERGY [mJ]	60	120	100	150	40	70	60	80
PULSE TO PULSE STABILITY (RMS % @ PEAK OPO WL)	2				2			
PUMP LASER RESIDUAL ENERGY [mJ]	40 - 50 at 532 nm	80 - 100 at 532 nm	70 - 80 at 532 nm	100 - 120 at 532 nm	30 - 60 at 355 nm	40 - 80 at 355 nm	50 - 70 at 355 nm	60 - 100 at 355 nm
LINEWIDTH (cm^{-1})	4-7				4-7			
TUNING RESOLUTION (cm^{-1})	<1				<1			
PULSE DURATION (ns)	6	6	8	8	6	6	7	7
BEAM DIAMETER (mm)	6.5	9	7	8	6.5	9	7	8
BEAM DIVERGENCE (mrad)	<2				<1.5			
SIGNAL POLARIZATION	Horizontal				Horizontal			
IDLER POLARIZATION	Vertical				Vertical			
PUMP LASER								
PUMP WAVELENGTH (nm)	532				355			
PUMP ENERGY (mJ)	150	400	270	420	110	200	140	210
PULSE DURATION (ns)	6	6	8	8	6	6	7	7
BEAM DIVERGENCE (mrad)	<1				<1			
PULSE TO PULSE STABILITY (%)	<4				<6			
PULSE REPETITION RATE (Hz)	20	10	10	10	20	10	10	10
DIMENSIONS (L x W x H) [inches (cm)]								
LASER HEAD	29.0x16.0x10.0 (73.7x40.7x25.4)				29.0x16.0x10.0 (73.7x40.7x25.4)			
CONTROL ELECTRONICS BOX	11.5x10.3x3.8 (29.2x26.2x9.7)				11.5x10.3x3.8 (29.2x26.2x9.7)			
UMBILICAL LENGTH (m)	2.5				2.5			
PUMP LASER POWER SUPPLY	11.1x19.9x20.2 (28.3x50.7x51.3)	11.1x19.9x20.2 (28.3x50.7x51.3)	22.3x23.2x11.6 (56.8x59.0x29.6)	22.3x23.2x11.6 (56.8x59.0x29.6)	11.1x19.9x20.2 (28.3x50.7x51.3)	11.1x19.9x20.2 (28.3x50.7x51.3)	22.3x23.2x11.6 (56.8x59.0x29.6)	22.3x23.2x11.6 (56.8x59.0x29.6)
LASER HEAD WEIGHT [lbs (kg)]	100 (45.4)				100 (45.4)			
PUMP LASER POWER SUPPLY WEIGHT [lbs (kg)]	59.5 (27)	59.5 (27)	65 (29.5)	65 (29.5)	59.5 (27)	59.5 (27)	65 (29.5)	65 (29.5)
OPERATING REQUIREMENTS								
COOLANT SYSTEM	Distilled water				Distilled water			
ROOM TEMPERATURE (°C)	18-28				18-28			
ENVIRONMENT CONDITIONS	Pollution degree 2 or better				Pollution degree 2 or better			
POWER REQUIREMENTS	100-240 VAC, 50Hz/60Hz				100-240 VAC, 50Hz/60Hz			

OPOTEK

All specifications are subject to change due to ongoing product improvements.
All tuning curves represent nominal values.
All dimensions approximate in inches (centimeters)



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OPOTEK

OPOLETTE
SERIES

World's smallest OPO tunable laser system

UV • VIS • NIR • MIR

The Opolette tunable laser series utilizes optical parametric oscillator (OPO) technology to generate wavelengths over a broad range in the UV, VIS, NIR and MIR. Designed for portability, the entire laserhead fits into a compact footprint and ships hermetically sealed to protect from the environment.

Requiring no installation, the system includes verification hardware to check alignment after shipping or relocation. All tunable beams exit the system from the same port resulting in one beam path to the end-user's application. Wavelength tuning is motorized and computer controlled.

OPOTEK.COM • 760.929.0770

OPOLETTE HE 355 LD

Tuning Range Output: UV, VIS, NIR
Application: Spectroscopy

FEATURES

- Hermetically sealed, light-weight, compact tunable laser system
- Integrated pump laser with quick connect cables
- End-user replaceable flashlamp (50 million shot lifetime) and DI cartridge
- All tunable wavelengths output from a single port
- Alignment verification
- Computer controlled tuning via control software/software development kit (SDK)
- Flashlamp and/or Q-Switch external triggering
- Temperature controlled, motorized Harmonic(s) (MH)
- Real-time wavelength monitoring (WM)
- Harmonic Auto-Optimization (HAO)
- Access to residual beams
- Warranty: One year on pump laser, all optics and crystals, mechanics, and electronics. Includes all options except fibers.

OPTIONS

Protective Hard Shell Cases (PHSC)
Includes two protective hard cases with custom foam padding.

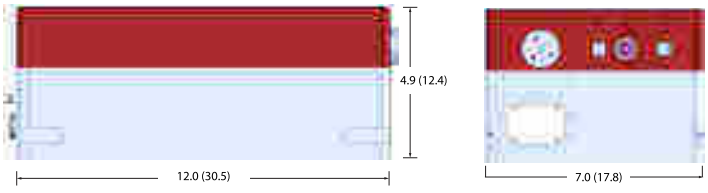
Extended UV Tuning Range (UV)
Extends tuning range to 210 – 410 nm. Decreases OPO by about 20%

External Motorized Variable Attenuator (eMVA)
End-user installable/removable. Reduces max OPO by 10-15% when installed. Computer controlled. Can only be used with visible and near-infrared wavelengths.

Fiber Delivery Kit (FD)
Can be optimized for either ultra-violet (UV), visible (VIS), or near-infrared (NIR) tuning ranges.
Externally mounted fiber delivery kit includes mounts, coupling lens and fiber. Fiber specifications: 2.5 m long, 1 mm diameter core, NA = 0.22

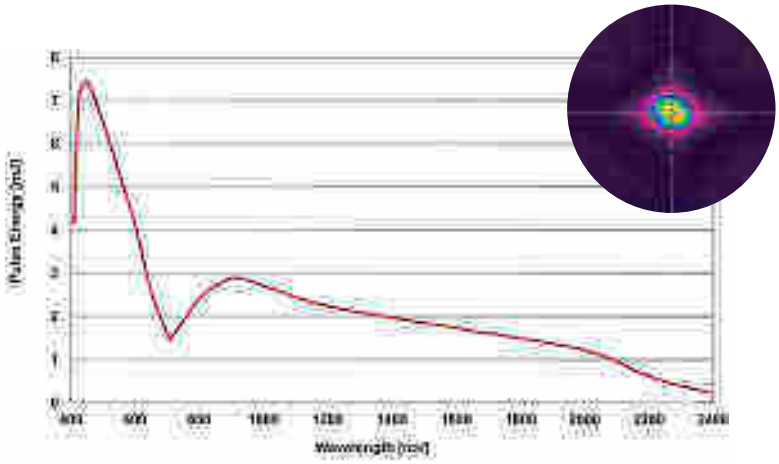
Extended Warranty (EXW)
Extends full system warranty for one additional year, for a total of two years. Includes all options except for fibers.

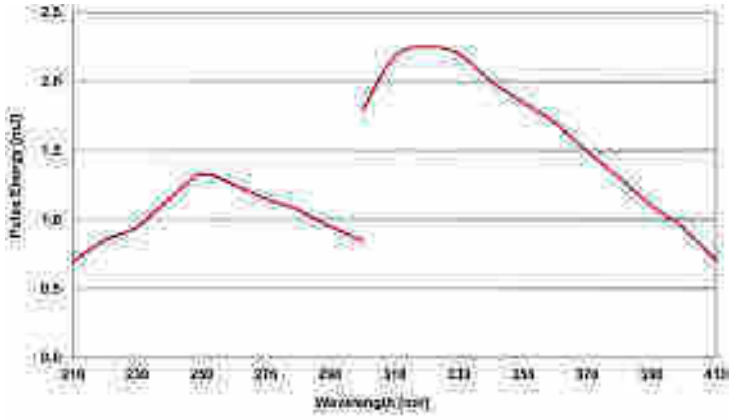
DIMENSIONS (532 LD, 355 LD, 2731, 3034)



All dimensions approximate in inches (centimeters)

Typical far field beam profile at 450 nm shown in insert.



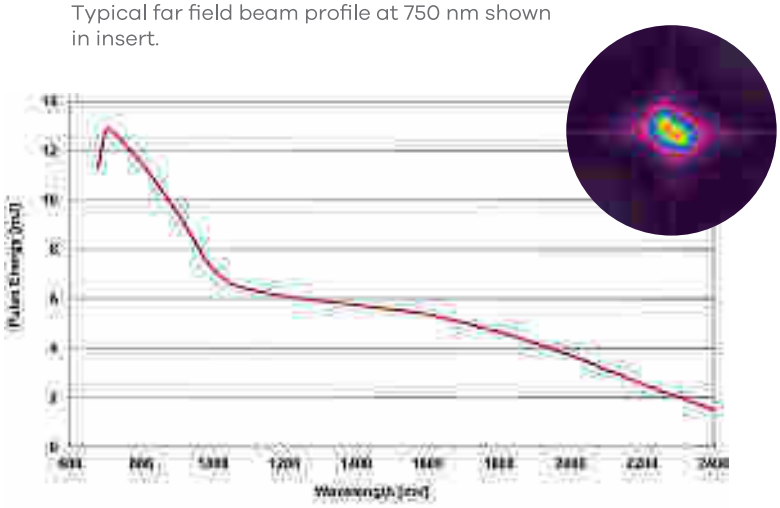


Extend the tuning range with UV tuning (210-410nm).

OPOLETTE HE 532 LD

Tuning Range Output: NIR
Application: Photoacoustic Imaging

Typical far field beam profile at 750 nm shown in insert.



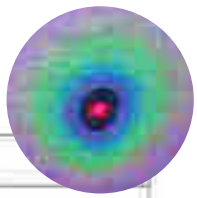
OPOLETTE HE 2731/3034

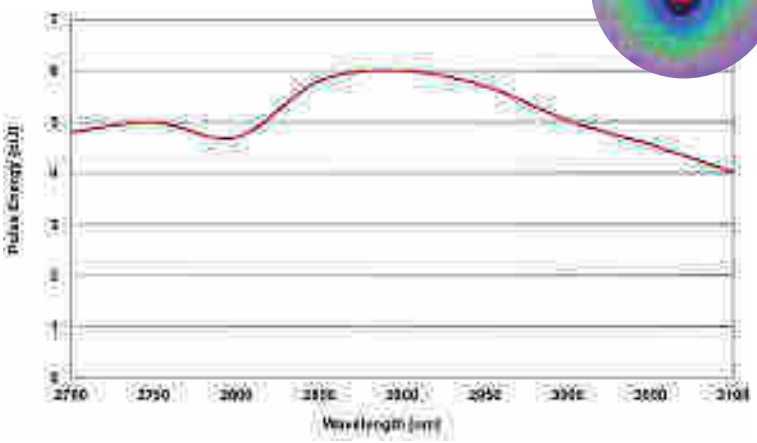
Tuning Range Output: MIR
Application: Mass Spectrometry

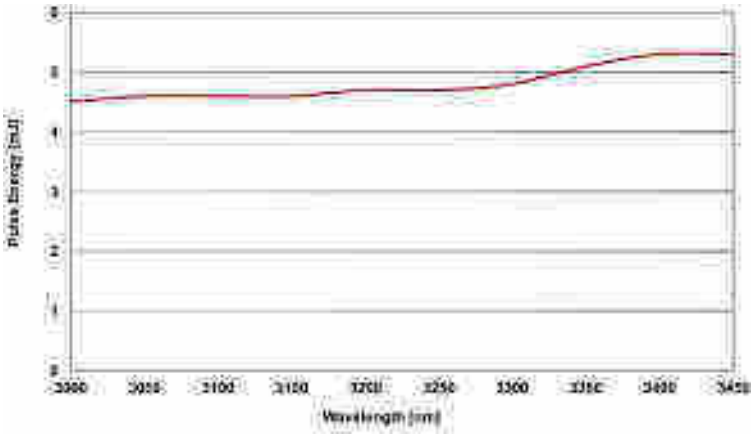
FEATURES

- Hermetically sealed, light-weight, compact tunable laser system
- Integrated pump laser with quick connect cables
- End-user replaceable flashlamp (50 million shot lifetime) and DI cartridge
- All tunable wavelengths output from a single port
- Alignment verification
- Integrated alignment diode laser for OPO beam path identification
- Computer controlled tuning via control software/software development kit (SDK)
- Flashlamp and/or Q-Switch external triggering
- Access to residual beams
- Warranty: One year on pump laser, all optics and crystals, mechanics, and electronics. Includes all options except fibers.

Picture shows MIR OPO beam heating a liquid crystal sheet with built-in guidance laser overlapping the center area.







OPTIONS

Protective Hard Shell Cases (PHSC)
Includes two protective hard cases with custom foam padding.

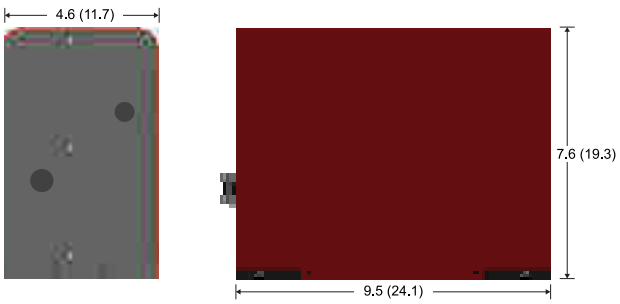
External Motorized Variable Attenuator (eMVA)
End-user installable/removable. Reduces max OPO by 10-15% when installed. Computer controlled. Can only be used with visible and near-infrared wavelengths.

Fiber Delivery Kit (FD)
Can be optimized for either ultra-violet (UV), visible (VIS), or near-infrared (NIR) tuning ranges.
Externally mounted fiber delivery kit includes mounts, coupling lens, and fiber. Fiber specifications: 2.5 m long, 1 mm diameter core, NA = 0.22

Harmonic Generation (HG)
355 nm generated from residual 1064 nm.

Extended Warranty (EXW)
Extends full system warranty for one additional year, for a total of two years. Includes all options except for fibers.

DIMENSIONS (2940)

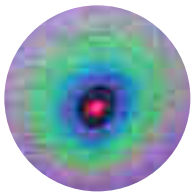


All dimensions approximate in inches (centimeters)

OPOLETTE HE 2940

Application: Mass Spectrometry

Fixed Wavelength: 2940 nm
and Peak OPO Energy: 6 mJ



Picture shows MIR OPO beam heating a liquid crystal sheet with built-in guidance laser overlapping the center area.

OPOLETTE SERIES SPECIFICATIONS

Product	HE 532 LD	HE 355 LD	HE 2940	HE 2731	HE 3034
Wavelength range (nm)	650 - 2400	410 - 2400	2940	2700 - 3100	3000 - 3450
Signal	650 - 1064	410 - 710	---	---	---
Idler	1064 - 2400	710 - 2400	2940	2700 - 3100	3000 - 3450
Output pulse energy					
Peak OPO Energy (mJ)	12.5	9	6	6	5
Pulse to Pulse Stability (RMS % at Peak OPO WL)	2	2	2	2	2
Pump laser residual energy (mJ)	20 - 25 at 532 nm	15 - 20 at 355 nm	40 at 1064 nm	40 - 45 at 1064 nm	40 - 45 at 1064 nm
Linewidth (cm^{-1})	4 - 7	4 - 7	3 - 4	3 - 4	3 - 4
Tuning Resolution (cm^{-1})					
Signal	< 1	< 1	< 1	< 1	< 1
Idler	< 1	< 1	< 1	< 1	< 1
Pulse Duration (ns)	7	7	7	7	7
Beam Diameter (mm)	4	4	4	4	4
Beam Divergence (mrad)	< 2	< 2	<10 on x-axis, <5 on y-axis	<10 on x-axis, <5 on y-axis	<10 on x-axis, <5 on y-axis
Polarization					
Signal Beam	Horizontal	Horizontal	---	---	---
Idler Beam	Vertical	Vertical	Vertical	Vertical	Vertical
Pump Laser					
Pump Wavelength (nm)	532	355	1064	1064	1064
Max pump pulse energy (mJ)	55	35	100	100	100
Pulse Duration (ns)	7	7	7	7	7
Beam Divergence (mrad)	< 3	< 3	< 3	< 3	< 3
Pulse to Pulse Stability (RMS %)	< 2	< 2	< 2	< 2	< 2
Pulse Repetition Rate (Hz)	20	20	20	20	20
Physical Characteristics: LxWxH - inches (cm)					
Laser Head	12 x 7 x 4.9 (30.5 x 17.8 x 12.4)	12 x 7 x 4.9 (30.5 x 17.8 x 12.4)	9.5 x 4.6 x 7.6 (24.1 x 11.7 x 19.3)	12 x 7 x 4.9 (30.5 x 17.8 x 12.4)	12 x 7 x 4.9 (30.5 x 17.8 x 12.4)
Control Electric Box	11.5 x 10.3 x 3.8 (29.2 x 26.2 x 9.7)	11.5 x 10.3 x 3.8 (29.2 x 26.2 x 9.7)	---	11.5 x 10.3 x 3.8 (29.2 x 26.2 x 9.7)	11.5 x 10.3 x 3.8 (29.2 x 26.2 x 9.7)
Umbilical Length: (m)	2.5	2.5	2.5	2.5	2.5
Pump laser power supply size	17.2 x 5.3 x 14.2 (43.5 x 13.3 x 36)	17.2 x 5.3 x 14.2 (43.5 x 13.3 x 36)	17.2 x 5.3 x 14.2 (43.5 x 13.3 x 36)	17.2 x 5.3 x 14.2 (43.5 x 13.3 x 36)	17.2 x 5.3 x 14.2 (43.5 x 13.3 x 36)
Laser Head weight: lbs (kg)	25 (11)	25 (11)	10 (4.5)	25 (11)	25 (11)
Control Electric Box weight: lbs (kg)	5 (2.3)	5 (2.3)	---	5 (2.3)	5 (2.3)
Pump laser power supply weight: lbs (kg)	31 (14)	31 (14)	31 (14)	31 (14)	31 (14)
Operating Requirements					
Coolant system	Distilled water	Distilled water	Distilled water	Distilled water	Distilled water
Room Temperature (°C)	18 - 28	18 - 28	18 - 28	18 - 28	18 - 28
Environment Conditions	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better
Power Requirements	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz

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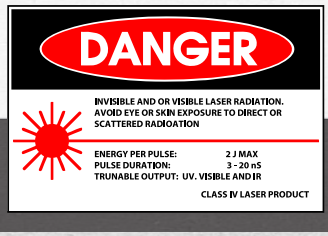
All specifications are subject to change due to ongoing product improvements.
All tuning cures represent nominal values.
All dimensions approximate in inches (centimeters)



2233 Faraday Avenue Suite E | Carlsbad California CA USA 92008
760.929.0770 | www.opotek.com | opo@opotek.com

OPOTEK

PHOCUS
SERIES

Tunable Laser System for Photoacoustic Imaging

Based on the Ring-Cavity optical parametric oscillator (OPO) technology, the Phocus series represents the optimal light source for photoacoustic imaging applications that require high pulse energies and NIR wavelengths for deep penetration of biological tissue. A customizable, safety-interlocked fiber bundle delivers light from the system to the instrumentation and prevents system operation without fiber attachment.

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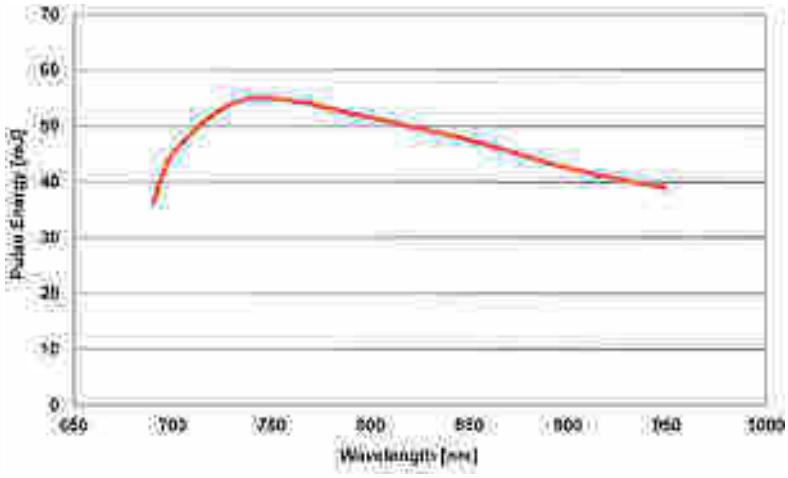
INLINE

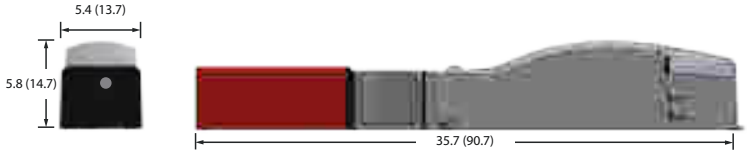
Tuning Range Output: NIR
Application: Photoacoustic Imaging

FEATURES

- Fully integrated tunable laser system with quick connect cables
- Motorized, hermetically sealed, harmonic/OPO modules
- End-user replaceable flashlamp (100 million shot lifetime) and DI cartridge
- All tunable wavelengths output from a single port
- Computer controlled tuning via control software/software development kit (SDK)
- Flashlamp and/or Q-Switch external triggering
- Temperature controlled, motorized Harmonic(s) (MH)
- Real-time pulse energy monitoring and logging for data normalization (EM)
- Harmonic Auto-Optimization (HAO)
- Flashlamp and/or Q-Switch external triggering
- Warranty: Two years on pump laser, one year on all optics and crystals, mechanics, and electronics. Includes all options except fibers.



DIMENSIONS



All dimensions approximate in inches (centimeters)

OPTIONS

High Energy Fiber Bundle (FBHE): Benchtop.
Can be optimized for either visible (VIS) or near-infrared (NIR) tuning ranges. Externally mounted fiber bundle delivery kit includes, mounts, coupling lens, and fiber bundle. Fiber bundle specifications: 2.0 m long, 3.5 or 5 mm input and output diameter, NA = 0.37.

Energy Meter (EM): Inline and Benchtop.
Real-time pulse energy monitoring, logging for data normalization. Reduces OPO energy by 8%.

IDLER Access (ID): Benchtop.
Extends tuning range to include 740 – 1200 nm
Decreases SIGNAL performance by 10%

Fast Tuning OPO (FT): Inline and Benchtop.
Tunes the OPO to any SIGNAL (or IDLER) wavelength per shot fired.

Fiber Bundle Access to Residual 1064nm Output (1B): Benchtop.

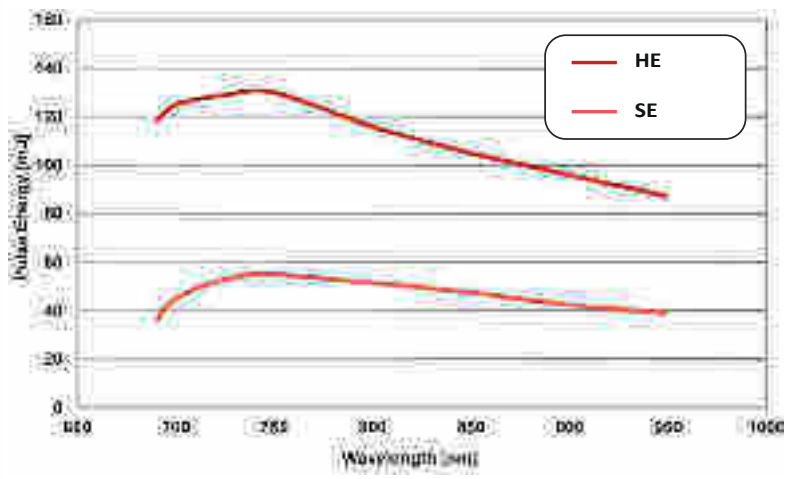
Fiber Bundle Access to Residual 532nm Output (2B): Benchtop.

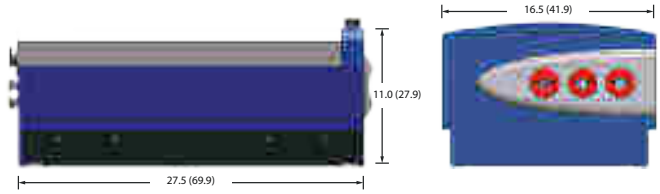
Wavemeter (WM): Inline and Benchtop.
Integrated wavemeter for real-time wavelength monitoring

Extended Warranty (EXW): Inline and Benchtop.
Extends full system warranty for one additional year, for a total of two years. Includes all options except for fibers.

BENCHTOP SE/HE

Tuning Range Output: VIS, NIR
Application: Photoacoustic Imaging





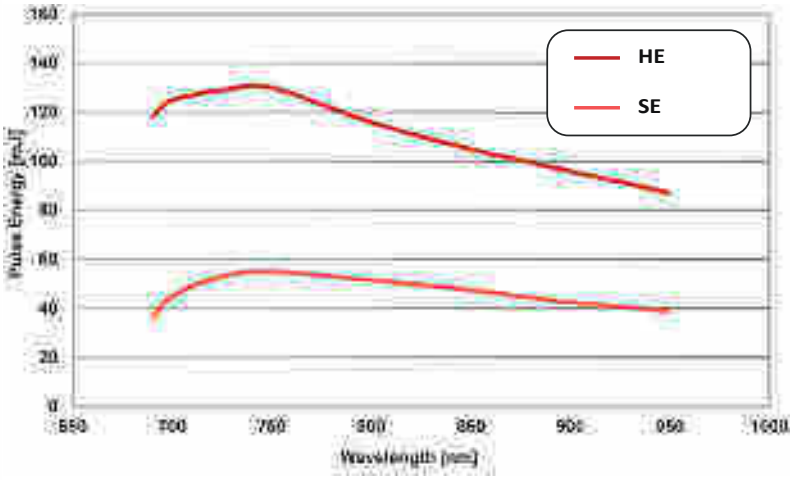
All dimensions approximate in inches (centimeters)

MOBILE SE/HE

Output Tuning Range: VIS, NIR
Application: Photoacoustic Imaging

FEATURES

- Vibration isolated, fully integrated, light sealed transportable cart with shock-absorbing casters
- Motorized, hermetically sealed, harmonic/OPO modules
- End-user replaceable flashlamp (100 million shot lifetime) and DI cartridge
- All tunable wavelengths output from a single port
- Interlocked fiber bundle output, includes fiber bundle (FB)
- Computer controlled tuning via control software/software development kit (SDK)
- Flashlamp and/or Q-Switch external triggering
- Temperature controlled, motorized Harmonic(s) (MH)
- Harmonic Auto-Optimization (HAO)
- Warranty: Two years on pump laser, one year on all optics and crystals, mechanics, and electronics. Includes all options except fibers.



OPTIONS

Motorized Variable Attenuator (MVA)
End-user installable/removable. Reduces max OPO by 10-15% when installed. Computer controlled. Can only be used with visible and near-infrared wavelengths

High Energy Fiber Bundle (FBHE)
Can be optimized for either visible (VIS) or near-infrared (NIR) tuning ranges.
Externally mounted fiber bundle delivery kit includes, mounts, coupling lens, and fiber bundle. Fiber bundle specifications: 2.0 m long, 3.5 or 5 mm input and output diameter, NA = 0.37.

Fast Tuning OPO (FT)
Tunes the OPO to any SIGNAL (or IDLER) wavelength per shot fired.

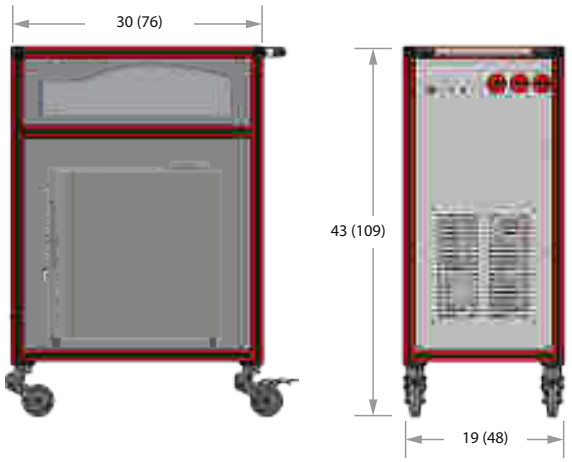
Fiber Bundle Access to Residual 1064nm Output (1B)

Fiber Bundle Access to Residual 532nm Output (2B).

Wavemeter (WM)
ntegrated wavemeter for real-time wavelength monitoring

Extended Warranty (EXW)
Extends full system warranty for one additional year, for a total of two years. Includes all options except for fibers.

DIMENSIONS



All dimensions approximate in inches (centimeters)

PHOCUS SERIES SPECIFICATIONS

Product Name	Inline	SE Benchtop	HE Benchtop	SE Mobile	HE Mobile
Beam Delivery	free space	fiber delivery	fiber delivery	fiber delivery	fiber delivery
Wavelength range (nm)	690 - 950	690 - 950, 1200 - 2400	690 - 950, 1200 - 2400	690 - 950, 1200 - 2400	690 - 950, 1200 - 2400
Signal	690 - 950	690 - 950	690 - 950	690 - 950	690 - 950
Idler	1200 - 2600	1200 - 2600	1200 - 2600	1200 - 2600	1200 - 2600
Output pulse energy					
Peak OPO energy (mJ)	55	60	150	60	150
Pump laser residual energy (mJ)		20 - 40	70 - 100	20 - 40	70 - 100
Pulse Duration (ns)	5	5	5	5	5
Beam Diameter (mm)	6.5	6.5	9	6.5	9
Beam Divergence (mrad)	< 10	< 10	< 10	< 10	< 10
Polarization					
Signal Beam	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Idler Beam	Horizontal	Horizontal	Horizontal	Horizontal	Horizontal
Pump Laser					
Pump Wavelength (nm)	532	532	532	532	532
Max pump pulse energy (mJ)	150	150	360 - 400	150	360 - 400
Pulse Duration (ns)	6	6	6	6	6
Beam Divergence (mrad)	< 0.5	< 0.5	< 0.5	< 0.5	< 0.5
Pulse Pulse Stability (%)	< 3	< 2	< 2	< 2	< 2
Pulse Repetition Rate (Hz)	20	20	10	20	10
Physical Characteristics					
Unit Size (WxLxH) (mm)	137 x 907 x 147	419 x 699 x 279	483 x 762 x 1092	483 x 762 x 1092	483 x 762 x 1092
Power Supply Size (mm)	262 x 292 x 97	integrated	integrated	integrated	integrated
Umbilical Length (m)	2.5	2.5	2.5	integrated	integrated
Pump laser power supply size (mm)	283 x 507 x 513	283 x 507 x 513	283 x 507 x 513	integrated	integrated
Operating Requirements					
Coolant system	Distilled water	Distilled water	Distilled water	Distilled water	Distilled water
Room Temperature (°C)	18 - 28	18 - 28	18 - 28	18 - 28	18 - 28
Environment Conditions	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better	Pollution degree 2 or better
Power Requirements	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz	100 - 240 VAC, 50Hz/60Hz

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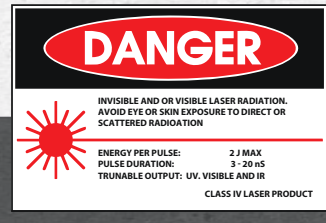

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High Power CW 532 nm DPSS Lasers
Sprout-H Series

Features
- Compact laser head with Seal™ enclosure for long lifetime
- LockT™ optics mounting for permanent laser head alignment
- Long lifetime pump diode pack integrated inside laser head
- Low noise option <0.02% rms with Noise Elimination Technology
- Excellent long-term power stability <0.5% rms over 24 hours
- Closed-loop, purpose-built TEC chiller integrated in power supply
- Disconnectable, 3 meter long control cable
- 5, 6, 8, 10, 12, 15, 18 and 20 W versions

Applications
- Pumping Ti:Sapphire lasers: ultrafast & continuous-wave
- Pumping dye lasers
- Flow visualization, PIV
- Flow cytometry
- Spectroscopy

Patented

Sprout™ is a compact, diode-pumped solid-state (DPSS) laser providing high-power, continuous-wave (CW) power at 532nm in a near- perfect TEM_{00} mode with extremely low optical noise and excellent long-term stability. Sprout™ is truly a next-generation laser designed and manufactured using many years of experience to provide a sealed, turn-key source of collimated green light with high spectral purity.

A number of key technologies enable Sprout™ to guarantee this performance. Seal™ technology keeps all dirt, dust and moisture out of the laser head to provide years of uninterrupted usage without need for cleaning or maintenance. LockT™ technology locks all laser head optics permanently in perfect alignment. Finally, for those applications requiring near-zero optical noise, Noise Elimination Technology (NET™) is the solution.

The laser head is a monolithic 3-dimensional design for ruggedness and compactness to minimize the space consumed in your lab or instrument. The pump diode package, integrated inside the laser head, has a typical mean time to failure (MTTF) of more than 50,000 hours to minimize cost-of-ownership. Locating the pump diode in the laser head rather than the power supply eliminates the fiber optic delivery cable.

A 3 meter long, flexible, disconnectable control cable connects the laser head to the power supply. The power supply, with touch-screen control, also contains an integrated TEC-based chiller purpose-built for this application to provide increased reliability and reduced overall system footprint. Additional features include automatic laser power control and USB, RS-232 and Ethernet interfaces for external monitoring, control and remote service.

Sprout™ is a state-of-the-art laser designed for today's integrated solutions. It combines superb performance and tremendous value for today's market.

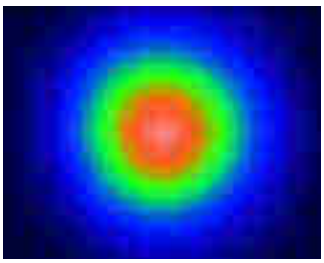
LIGHTHOUSE PHOTONICS

sprout

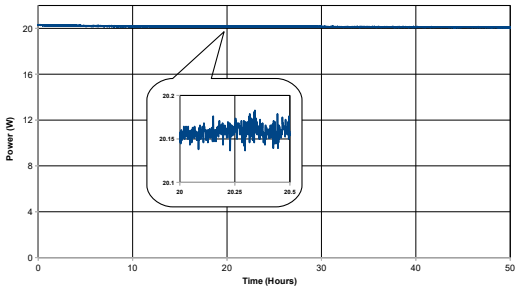
Laser Output Characteristics[1,8]	H-5W	H-6W	H-8W	H-10W	H-12W	H-15W	H-18W	H-20W
Average Output Power	> 5 W	> 6 W	> 8 W	> 10 W	> 12 W	> 15 W	> 18 W	> 20 W
Wavelength	532 nm							
Spectral Purity[2]	> 99.9 %							
Spatial Mode	TEMoo							
Beam Quality (M^2)	1.0 - 1.1							
Beam Ellipticity	< 1.0 : 1.1							
Beam Diameter[3]	2.3 mm ± 10%							
Beam Divergence[4]	< 0.5 mrad							
Pointing Stability[5]	< 2 µrad/°C							
Power Stability[6]	< ± 0.25 % rms							
Noise[7]	Standard version: < 0.1 % rms Low noise (NET) version: < 0.02 % rms							
Polarization	> 100:1 vertical Horizontal polarization option available							
Power Requirements								
Operating Voltage	100-240 VAC, 50 Hz / 60 Hz							
Power Consumption	5W-12W versions: 600 W max, 350 W typical 15W-20W versions: 1000 W max, 600 W typical							
Cooling Requirements								
Laser Head	Closed-loop TEC chiller built into separate compartment in power supply chassis							
Power Supply	Air-cooled							
Environmental Specifications								
Operating Temperature	64-90°F (18-32°C)							
Relative Humidity	8-85%, non-condensing							
Laser Head - Physical								
Dimensions (Height x Width x Length)	5W-12W versions: 2.7 x 5.3 x 9.4 inches (69 x 135 x 240 mm) 15W-20W versions: 2.7 x 5.3 x 16.8 inches (69 x 135 x 425 mm)							
Weight	5W-12W versions: 9.2 lbs (4.2 kg) 15W-20W versions: 16.7 lbs (7.6 kg)							
Cable Length	10 ft (3 m) 16 ft (5 m) option available for 5W-12W versions							
Power Supply-Cooler - Physical								
Dimensions (Height x Width x Depth)	13.6 x 15.7 x 18.9 inches (345 x 398 x 480 mm)							
Weight	5W-12W versions: approx. 70 lbs (32 kg), including cable 15W-20W versions: approx. 77 lbs (35 kg), including cable							

Notes:
1. All performance specifications are guaranteed at specified power
2. Output power at 532 nm compared to output power at 1064 nm
3. $1/e^2$, measured at the output port of the laser head
4. Full angle ($1/e^2$), measured at the output port of the laser head
5. Measured at far-field x and y positions after a 30 minute warm-up and over a 20°C to 30°C temperature range
6. Measured over a 24 hour period after a 15 minute warm-up
7. Measured from 10 Hz to 10 MHz
8. Lighthouse Photonics is continually improving the performance of its products. Specifications subject to change without notice.

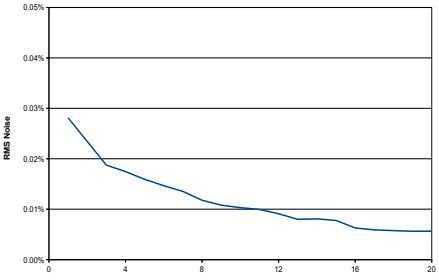
LIGHTHOUSE PHOTONICS



Typical Far-field beam profile



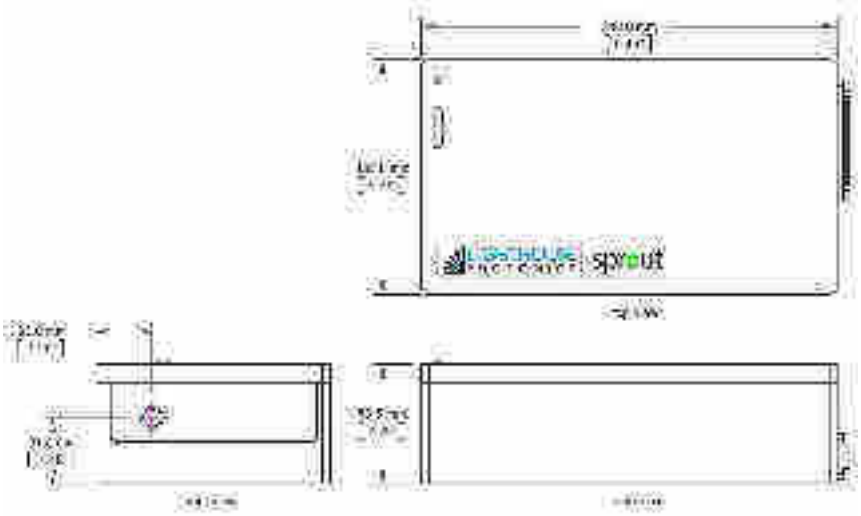
Power stability <0.1% rms
over >24 hours



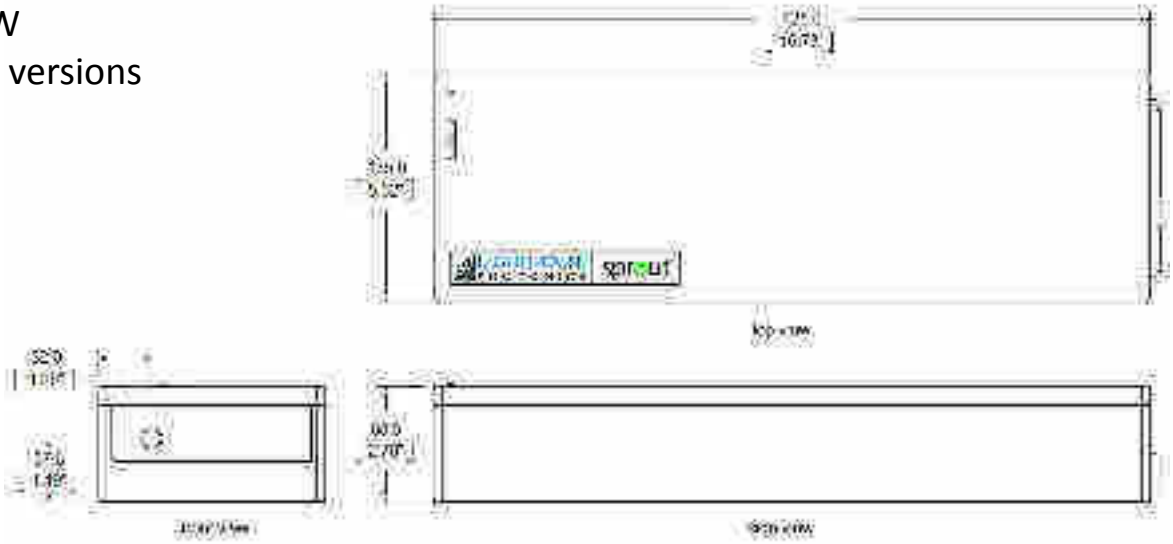
Optical noise <0.02% rms
for NET™ version

Laser Head Dimensions

5W, 6W, 8W, 10W,
and 12W versions

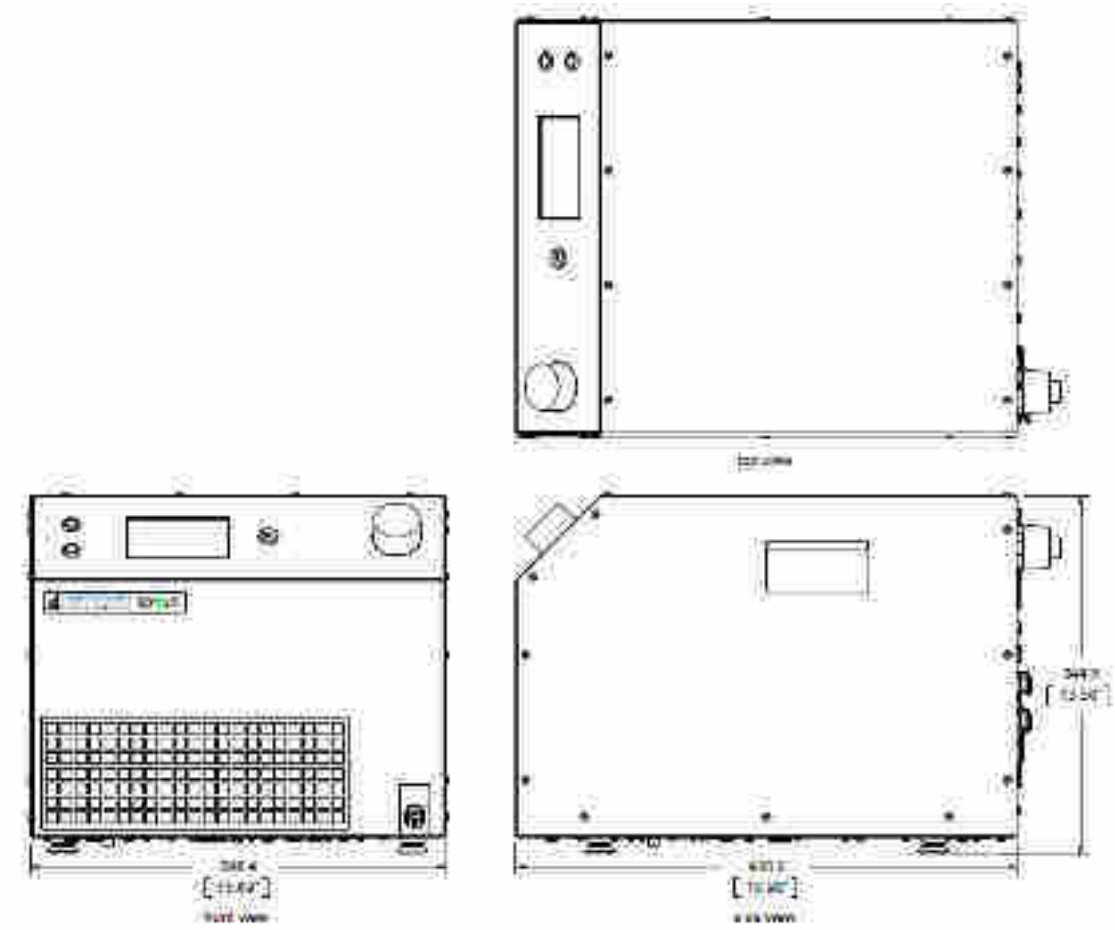


15W, 18W
and 20W versions



sprout

Power Supply - Cooler Dimensions



For more information go to: **www.lighthousephotonics.com**

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LIGHTHOUSE PHOTONICS

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High Power CW 532 nm DPSS Lasers
Sprout-Solo Series

Features
- Single longitudinal mode (single frequency) output
- Compact laser head with Seal™ enclosure for long lifetime
- LockT™ optics mounting for permanent laser alignment
- Long lifetime pump diode pack fiber-coupled to laser head
- Ultra low noise option <0.02% rms with Noise Elimination Technology
- Excellent long-term power stability <0.5% rms over 24 hours
- Fast warm-up time < 15 minutes for mode-hop free operation
- Closed-loop, purpose-built TEC chiller integrated in power supply
- 5, 6, 8, and 10 W versions

Applications
- Holography
- Interferometry
- Raman spectroscopy
- Atom trapping, optical lattices
- Pumping Ti:Sapphire & dye lasers

Patent Pending

Sprout™ is a compact, diode-pumped solid-state (DPSS) laser providing high-power, continuous-wave (CW) power at 532nm in a near- perfect TEM_{00} mode with extremely low optical noise and excellent long-term stability. Sprout™ is truly a next-generation laser designed and manufactured using many years of experience to provide a sealed, turn-key source of collimated green light with high spectral purity.

A number of key technologies enable Sprout™ to guarantee this performance. Seal™ technology keeps all dirt, dust and moisture out of the laser head to provide years of uninterrupted usage without need for cleaning or maintenance. LockT™ technology locks all laser head optics permanently in perfect alignment. Finally, for those applications requiring near-zero optical noise, Noise Elimination Technology (NET™) is the solution.

The laser head is a monolithic 3-dimensional design for ruggedness and compactness to minimize the space consumed in your lab or instrument. The fiber-coupled pump diode package, contained in the power supply, has a typical mean time to failure (MTTF) of more than 50,000 hours to minimize cost-of-ownership. The power supply also contains an integrated thermo-electrically-cooled (TEC) chiller. The chiller is designed specifically for this application to provide increased reliability and reduced overall system footprint. Additional features include automatic laser power stabilization and USB, RS-232 and Ethernet interfaces for external monitoring, control and remote service.

Sprout™ is a state-of-the-art laser designed for today's applications. It combines superb performance and tremendous value for today's market.

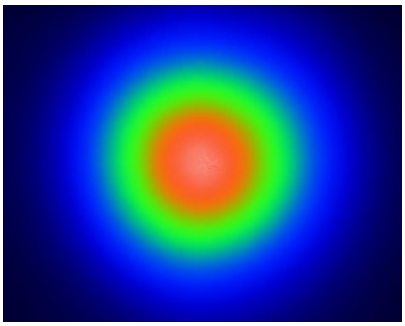
LIGHTHOUSE PHOTONICS

sprout™

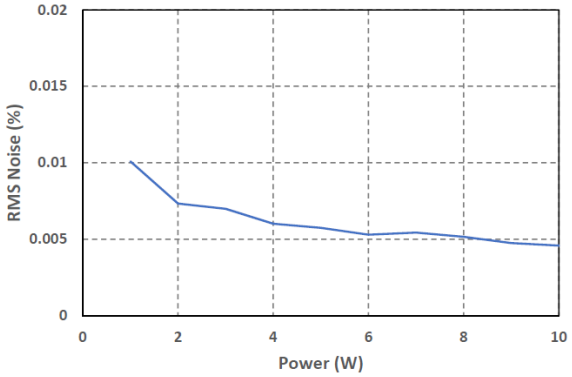
Laser Output Characteristics[1,11]	Solo-5W	Solo-6W	Solo-8W	Solo-10W
Average Output Power	> 5 W	> 6 W	> 8 W	> 10 W
Wavelength	532 nm			
Linewidth[2]	< 2 MHz			
Coherence Length	> 30 m			
Spectral Purity[3]	> 99.9 %			
Spatial Mode	TEMoo			
Beam Quality (M^2)	1.0 - 1.1			
Beam Ellipticity	< 1.0 : 1.1			
Beam Diameter[4]	2.3 mm ± 10%			
Beam Divergence[5]	< 0.5 mrad			
Pointing Stability[6]	< 2 µrad/°C			
Power Stability[7]	< ± 0.25 % rms			
Warm-up Time (mode-hop free)[8]	< 15 minutes			
Noise[9]	Standard version: < 0.1 % rms Low noise (NET) version: < 0.02 % rms			
Polarization	> 100:1 vertical Horizontal polarization option available			
PZT Input Voltage[10]	0 to +100 V/channel			
PZT Tuning Range[10]	> 8.2 GHz			
PZT Bandwidth[10]	DC to 20 kHz			
Power Requirements				
Operating Voltage, Frequency	100 to 240 VAC, 50 Hz / 60 Hz			
Power Consumption	700 W max, 400 W typical			
Cooling Requirements				
Laser Head	Closed-loop chiller in Power Supply - Cooler			
Power Supply (in Power Supply - Cooler)	Air-cooled			
Environmental Specifications				
Operating Temperature	64 to 90°F (18 to 32°C)			
Relative Humidity	8 to 85%, non-condensing			
Laser Head - Physical				
Dimensions (Height x Width x Length)	2.7 x 5.3 x 12.6 inches (69 x 135 x 320 mm)			
Weight	approx. 16 lbs (7.3 kg)			
Cable Length	10 ft (3 m)			
Power Supply-Cooler - Physical				
Dimensions (Height x Width x Depth)	13.6 x 15.7 x 18.9 inches (345 x 398 x 480 mm)			
Weight	approx. 70 lbs (32 kg)			

Notes:
1. All performance specifications are guaranteed at maximum specified power
2. Measured over 50 msec with a thermally-stabilized reference etalon
3. Output power at 532 nm compared to output power at 1064 nm
4. $1/e^2$, measured at the output port of the laser head
5. Full angle ($1/e^2$), measured at the output port of the laser head
6. Measured at far-field x and y positions after a 30 minute warm-up and over a 20°C to 30°C temperature range
7. Measured over a 24 hour period after a 15 minute warm-up
8. Measured at an environmental temperature of 23°C ± 3°C
9. Measured from 10 Hz to 10 MHz
10. PZT optional
11. Lighthouse Photonics is continually improving the performance of its products. Specifications subject to change without notice.

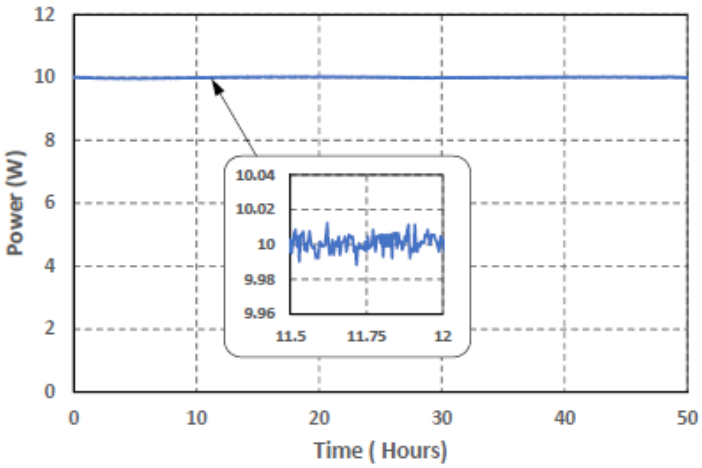
LIGHTHOUSE PHOTONICS



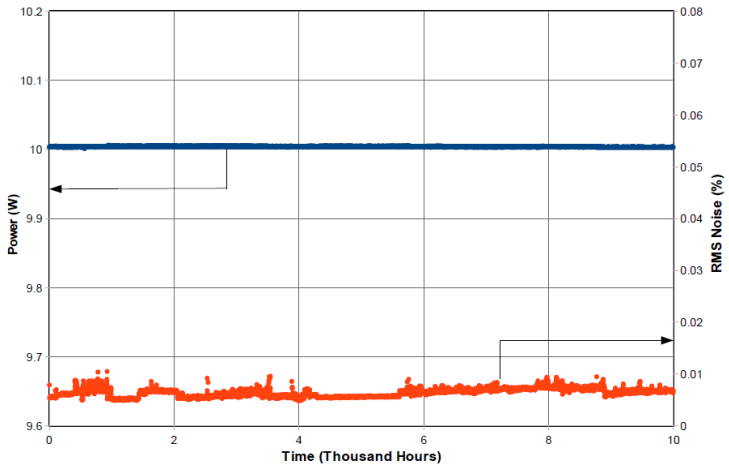
Typical Far-field beam profile



Optical noise <0.02% rms
for NET™ version



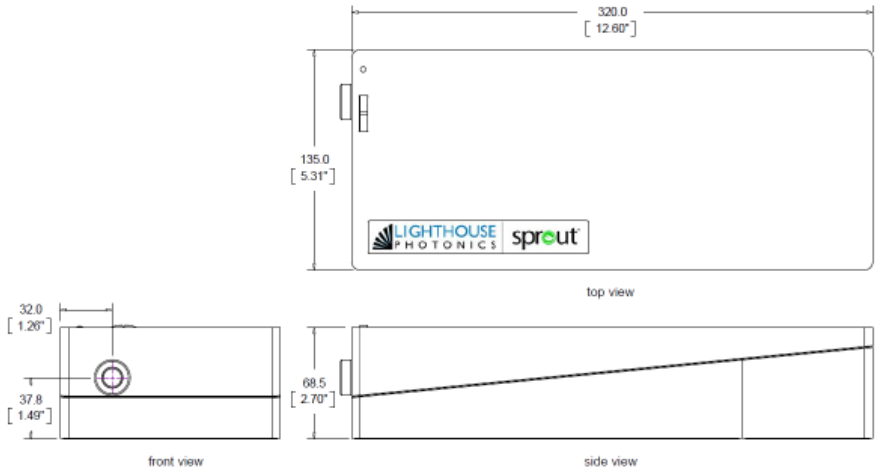
Power stability <0.2% rms
over >24 hours



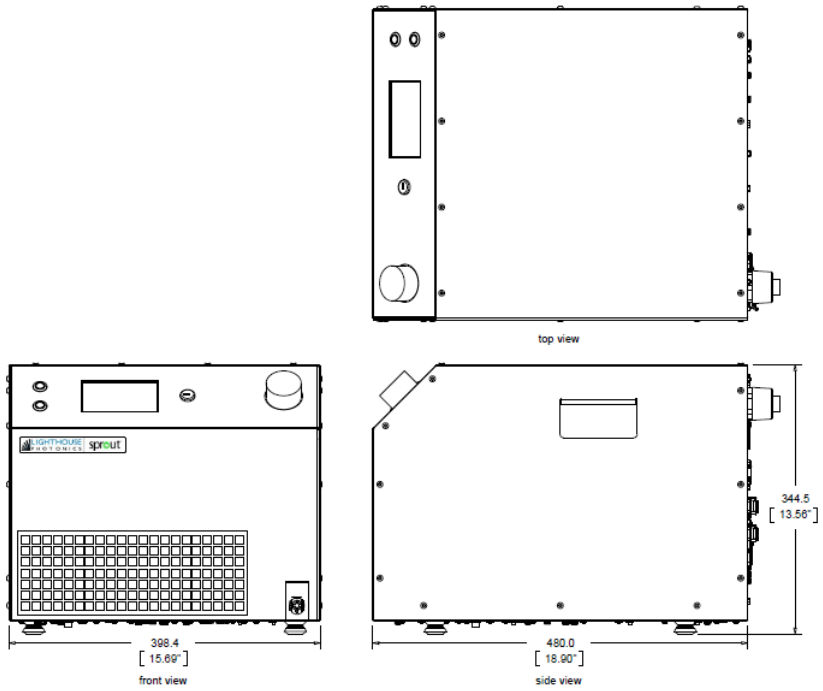
10,000 hour test data for
output power & rms noise

sprout™

Laser Head Dimensions



Power Supply - Cooler Dimensions



For more information go to: **www.lighthousephotonics.com**

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efax: 408-773-6240
e-mail: info@lighthousephotonics.com

LIGHTHOUSE PHOTONICS

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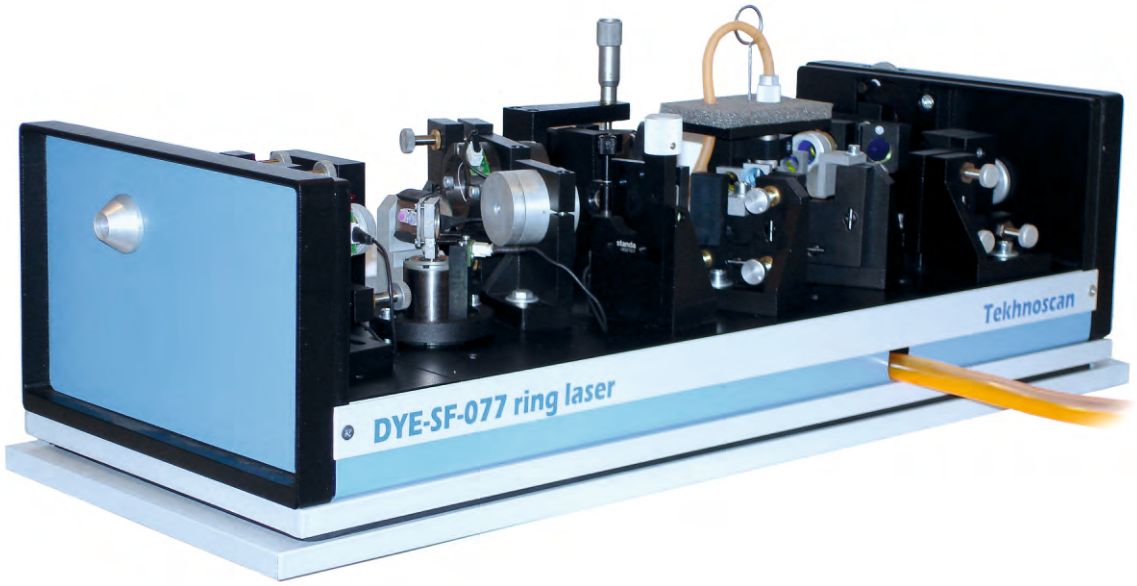
No. 2019-10-01

DYE-SF-077

CW Frequency-Stabilised Dye Laser



1 **NARROWEST LINEWIDTH**

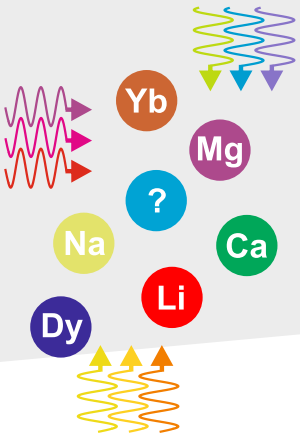
2 **ULTRA-STABLE**

3 **AUTOMATED WAVELENGTH SETTING OPTION**

4 **FREQUENCY DOUBLER AVAILABLE**

DYE-SF-077 laser is the first representative of the new contemporary generation of dye lasers that offer to the user virtually the same level of convenience and simplicity of operation as with a solid-state tuneable laser. Similarity of this laser to a solid-state one is emphasized by the fact that DYE-SF-077 laser can be optionally shipped in the combined configuration which allows its operation as a Ti:Sapphire laser (TIS-SF-777). Laser model DYE-SF-077 features exceptionally narrow generation line width, which amounts to less than 100 kHz/sec. DYE-SF-077 laser sets new standard for generation line width of commercial CW single-frequency dye lasers.

Upon customer's order, DYE-SF-077 laser may be equipped with a USB compatible interface for a desktop or a laptop connection used to remotely scan the generation line of the laser and to perform multi-channel data acquisition. DYE-SF-077 laser also may be shipped together with an atom cell and a system for reduction of long-term generation line drift. Besides, laser DYE-SF-077 in combination with highly-efficient resonant frequency doubler FD-SF-07 delivers several hundreds milliwatts of narrow-band UV radiation within the 285–350-nm range.



TekhnoScan LASER SYSTEMS

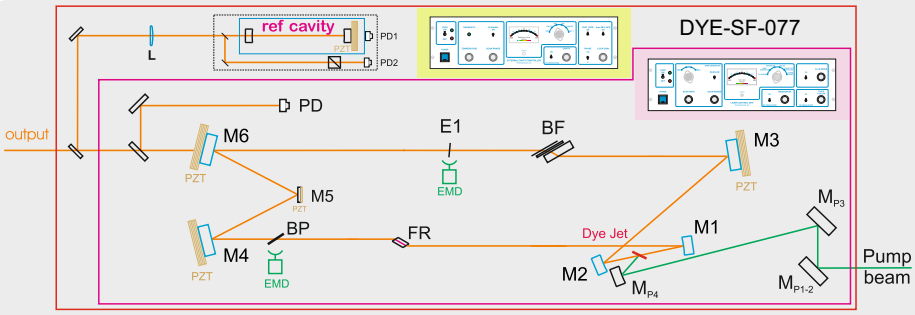
Photonics of High Technologies®

Features

- Rigid laser base-plate with three invar rods in a volumetric cinfiguration
- Absolute frequency stabilisation to atomic/molecular reference line available
- Automated absolute high-precision wavelength setting option
- Single solid etalon
- Auto-Relock function

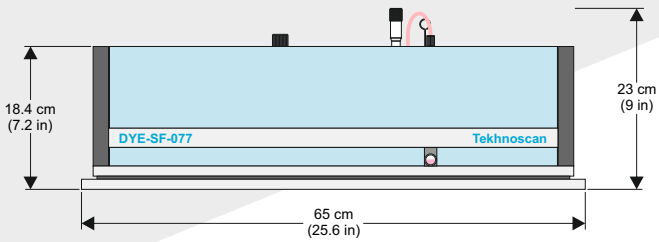
Applications

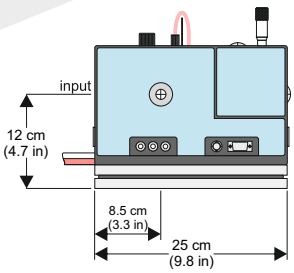
- Cooling, BEC and manipulating atoms
- High-resolution spectroscopy
- Tasks requiring low amplitude noise
- Doubling, Raman & parametric conversion
- Isotope separation
- Nanoscience research

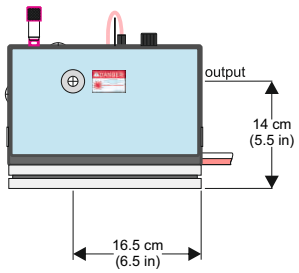


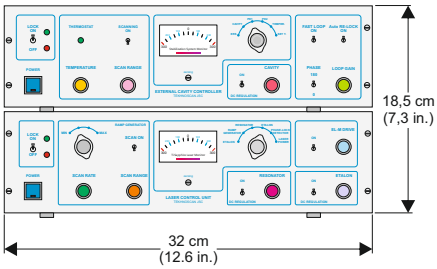
Laser Specifications

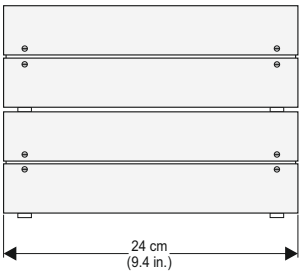
	DYE-SF-07	DYE-SF-077
Line width, over 1 s rms	**< 10 MHz**	**< 100 kHz**
Line width, over 0,1 s rms	**< 1 MHz**	**< 10 kHz**
Output, W (6 W pump)	**> 1**	
Wavelength range, nm	**550-700**	
Smooth scanning, GHz	**6-35**	

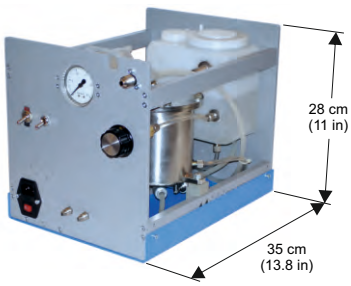




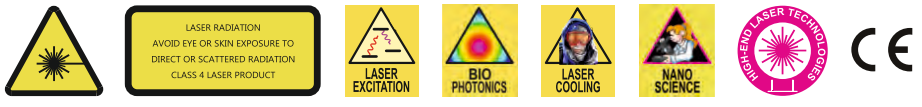








Information and specifications contained herein are deemed to be reliable and accurate as of the publication date. Tekhnoscan reserves the right to change these specifications at any time without notice.



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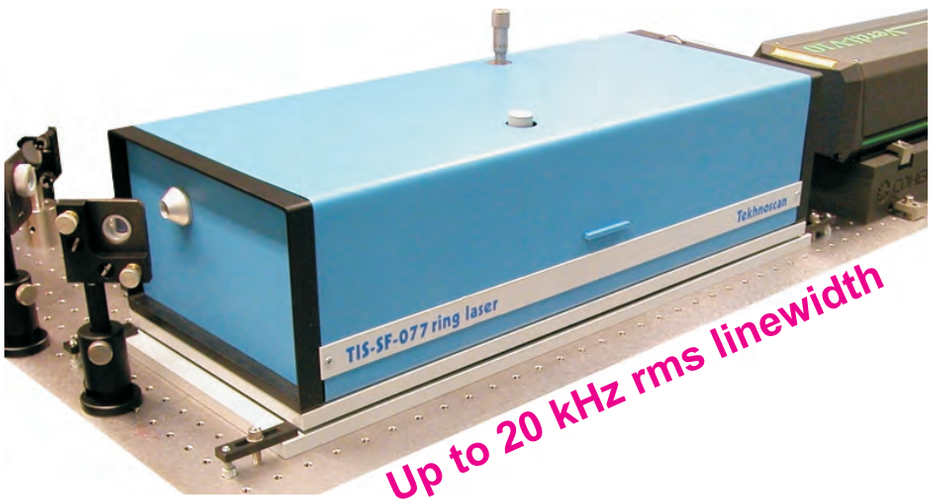
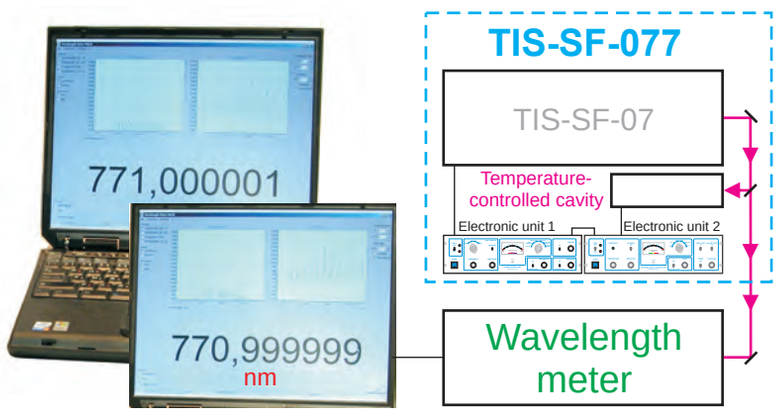
Frequency-stabilised CW single-frequency ring Ti:Sapphire laser, model TIS-SF-077



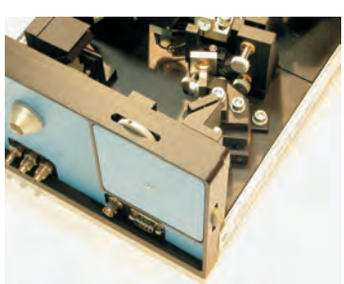


Tekhnoscan presents a new frequency-stabilised CW single-frequency ring Ti:Sapphire laser, model TIS-SF-077, designed for researches in atom cooling and super-fine resolution spectrometry

Ti:Sapphire laser, model TIS-SF-077, is a further development of model TIS-SF-07; it now includes a system of frequency stabilisation on the basis of a thermo-stabilised interferometer and a fast electronic driver; the thermo-stabilised interferometer comes as a separate module installed beside the laser itself

Convenient multi-function electronic control units

CW single-frequency Ti:Sapphire laser with frequency stabilisation, model TIS-SF-077, opens up new horizons in super-fine wavelength-selective action on objects of investigation. The output linewidth of this laser does not exceed 50 kHz rms and may be further reduced (up to 20 kHz rms) upon a custom order. Laser TIS-SF-077 features exceptionally low generation line drift: less than 40 MHz/hour. This remarkably small figure is guaranteed by a superb thermal isolation and stabilization of the reference interferometer and its special design. The working wavelength range of this laser spans 700-1050 nm and can be further extended into the 350-525-nm range with the help of efficient frequency doubler FD-SF-07 offered by Tekhnoscan.



superfine-precision adjustments of the pump beam, which allow the user to restore quickly the laser generation parameters when the pump beam changes position; for the convenience of use these controls are accessible from the front flange of the laser without opening the case cover

TekhnoScan LASER SYSTEMS

Advanced Realized Photonics Ideas

STANFORD
COMPUTER
OPTICS

Superior imaging intensified CCD cameras

4 Picos

Ultra high speed ICCD camera

200ps highest shutter speed
Best imaging quality
Single photon detection
Compact and light design

www.stanfordcomputeroptics.com

STANFORD
COMPUTER
OPTICS

4 Picos ICCD camera

Ultra high speed intensified CCD camera

Based on more than 25 years of experience in the field of high speed intensified imaging, Stanford Computer Opitcs, is developing pioneering, ultra fast-gated intensified CCD (ICCD) cameras. The 4 Picos ICCD camera includes cutting-edge electronics and provides ultra high shutter speeds with sub-nanosecond gating time down to 200ps.

More detailed information

High performance and reliable electronics
The 4 Picos ICCD camera is equipped with high resolution image intensifier which provide highest temporal resolution available and excellent sensitivity down to single photons. With quality CCD sensors and high resolution image intensifier the 4 Picos ICCD cameras provide exceptional performance and superior image quality. Long-lasting and reliable electronics ensure trouble-free and undisturbed intensified imaging experience.

Down to 200ps flat top, true optical gating time
In-house developed, custom-built electronics provide extreme low jitter and low propagation delay. The flat top, true optical gating time of down to 200ps is still unique and unrivaled. The extreme low jitter of 10ps and highest accuracy in gate and delay time control of 10ps resolution provides unique capabilities for time resolved measurements.

Unique ICCD camera with picosecond resolution The adjustable MCP voltage, multiple trigger options and various operation modes make the 4 Picos most flexible and versatile intensified CCD camera. Optionally, the 4 Picos ICCD camera can be equipped with up to 2MHz (on request 5MHz) continuous photocathode gating repetition rate and increased signal amplification using a V-stacked double multi-channel plate (MCP) image intensifier.

Images cover & backside:
A water droplet transformed into the plasma state by a focused Laser beam. The plasma development induce a fast expansion with strong dynamics. The images show the plasma development within the first 40ns after the Laser pulse. The images show a area of 1mm by 1mm and are taken with exposure time of 200ps. Figures reprinted with permission from Fraunhofer ILT, Aachen, Germany.

Highlights

Standard features and benefits

- Shortest shutter time 200ps
- Gating time from 200ps .. DC
- Internal delay times: 0 .. 80s
- Highly accurate timing control with step size of 10ps
- Extreme low jitter: 10ps
- High resolution image intensifiers with optical system resolution of >60lp/mm
- Spectral sensitivity from UV to red (depends on type of image intensifier)
- Brilliant sensitivity providing single photon detection
- Adjustable MCP voltage for 50db dynamic range in signal amplification
- Multiple exposure operation with up to 3.3MHz (burst mode) and 200kHz (continuous) optical shutter repetition rate
- Customized f/0.8 distortion free lens coupling between image intensifier and CCD
- High dynamic range up to 14bit resolution
- Multiple trigger options: 3x input; 3x output
- USB 2.0 (standard) USB 3.0 (optional) output
- Remote interface for real time camera control
- Compact and light system design
- 4 Spec E software

Optional features

- Nikon F-Mount Adapter
- Two discrete images with double frame mode (fast interframing time 500ns) with P46 phosphor, only
- High photocathode gating repetition rate up to 2MHz continuous; on request up to 5MHz available
- Adapters for various spectrometer
- Vacuum flange for UHV connection

Fastest optical gating down to 0.2ns

Superior image quality by customized lens coupling

High system sensitivity with single photon detection

Long-lasting electronics (24 months warranty)

Compact and light design

Best performance CCD sensors

High resolution, high dynamic range imaging sensors

The 4 Picos ICCD camera features high resolution intensified imaging for sharpest images with 0.2ns true optical gating. The 4 Picos camera provides highest sensitivity with new Gen II high Quantum Efficiency photocathodes and provides the best intensified image quality through customized lens coupling without compromising vignetting, distortion and coupling efficiency. All CCD sensors are front-illuminated types and provide best image quality with low noise and high fill factor.

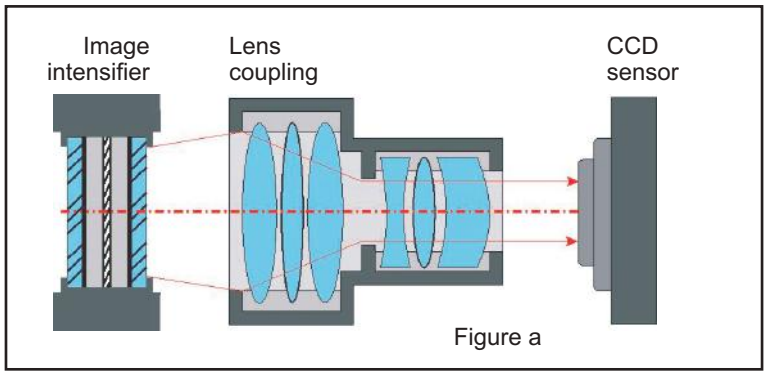


Figure a: Schematic sketch of the lens coupled intensified CCD camera. The appropriate coupling lens images the phosphor screen of the image intensifier to the CCD sensor.

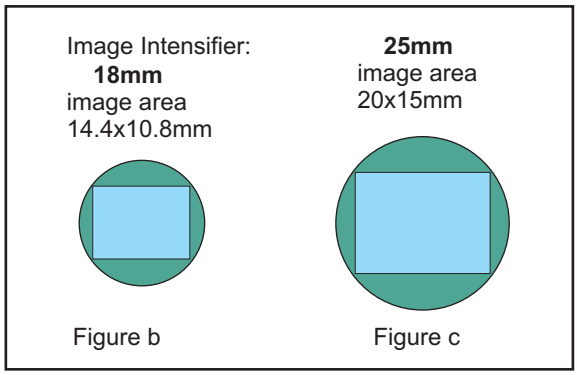


Figure b and c: Lens coupling provides full coverage of the CCD sensor (no dark corners) and highest image resolution.

Automatic continuous cleans
The CCD sensor is automatically cleared before triggering at trigger frequencies below 4Hz. This ensures the best and most efficient reduction of CCD sensor background noise.

High fill factor
The interline CCD sensor provide highest fill factors using micro lens arrays on top of the active pixels.

High dynamic range
The CCD sensor provides up to 14bit dynamic range. Furthermore, the CCD sensor gain can be adjusted from 0 to 20db. In combination this results to 17bit dynamic range of the CCD sensor.

CCD sensor options

Parameter	High resolution HR CCD sensor	Standard resolution SR CCD sensor
Resolution	1360x1024	780x580
Pixel size [µm]	4.7x4.7	8.3x8.3
Camera interface	USB 2.0	USB 2.0
Binning options	full frame, 2 (2x2binning), ROI (region of interest)	
Dynamic range	12 or 14 bit	12 or 14 bitt
Video gain [dB]	full and ROI: 0..20db; 2x2: 0..25db	
Chip readout	Correlated double sampling, dark current corrected	

Time settings

Superior timing control with on-board delay generator

The **on-board digital** delay generator provides accurate timing control of the photocathode gating. All true flat top optical gating times are measured in single shot measurements. These measurements do not include the positive influence of signal jitter in integrating measurements.

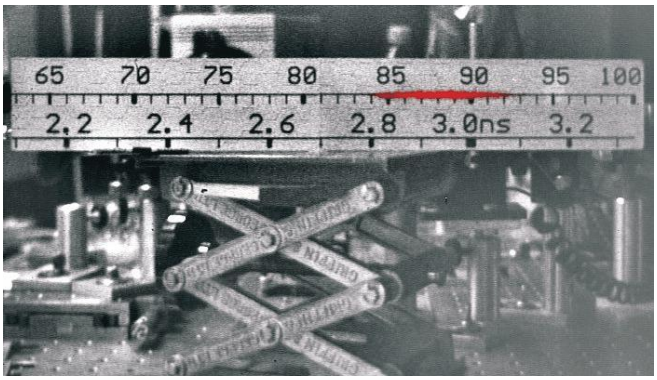
Time settings

Parameter	4 Picos
Gate time [step size]	200ps … 80s [10ps]
Delay time [step size]	10ps … 80s [10ps]
Jitter	<10ps
Minimal dead time between multiple exposures	300ns
Minimal interframing time (optional double frame mode*)	500ns
Trigger propagation delay	internal gate pulse: 60-65ns external gate pulse: 30-35ns

** image intensifiers with P46 phosphor screen*

4 Picos ICCD camera captures the motion of light

The ultra high speed shutter system of the 4 Picos ICCD camera provides shortest gating times down to 200ps flat top at single shot measurements. This feature is unique and enables trapping the motion of light.



The image shows the distance a femtosecond laser pulse moved along a ruler while the shutter of the 4 Picos camera was open. This distance is a direct measure of the flat top, single shot gating time.

Direct measurement of the gating time.
For the direct measurement of the gating time the 4 Picos ICCD camera is placed perpendicular to a ruler which is pointing in the propagation direction of a femtosecond laser. The width of a fs laser pulse is a fraction of a millimeter and it is moving with the speed of light. Thus the measured distance which the laser pulse travels while the shutter of the 4 Picos camera is open indicates directly the single shot gating time.

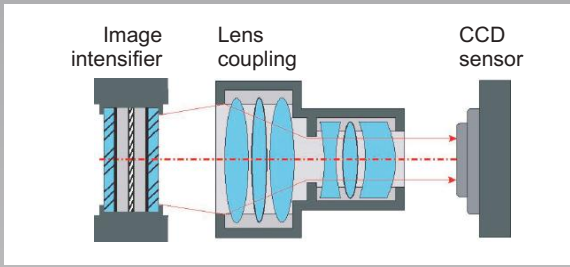
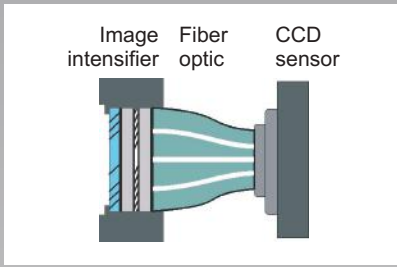
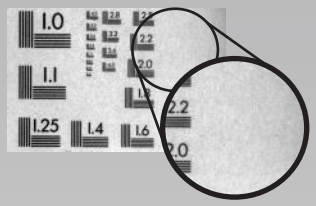
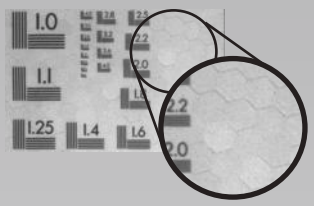
Direct measurement versus FWHM specifications
All ICCD cameras from Stanford Computer Optics are indicated with the minimum single shot gating time. In contrast to this direct measurement of the gating time most competing ICCD cameras are stated using FWHM (Full Width Half Maximum) specifications for the shortest gating time. The FWHM specification is determined by integrating a series of laser pulses. Due to the jitter of the camera and the light source the accumulated signal is similar to a Gaussian curve. Hence the specified FWHM gating times are faking shorter times and ignoring the long tails. However, especially these long tails are causing blurred and fuzzy images.

Lens coupling system

The lens coupled ICCD cameras provide superior image quality.

All 4 Picos ICCD cameras are equipped with the in-house developed, customized f/0.8 lens coupling system. It provides superior imaging quality without compromising distortion, resolution and vignetting. In contrast to other claims the lens coupled ICCD camera systems provides single photon detection and high S/N ratio at low light environment. The stray light is reduced using convenient anti-reflex coatings which results in magnificent optical contrast. Furthermore, in combination with the adjustable MCP voltage it proves high dynamic range, large linearity and ensures a great life span of the imaging system.

Coupling image intensifier CCD sensor comparison

Parameter	F/0.8 lens coupled ICCD camera	Fiber-optic coupled ICCD camera
		
Example		
Advantages	+ excellent coupling efficiency by F/0.8 lens + superior image quality highest modulation transfer function (cut off @ 180lp/mm) **NO honeycomb pattern** **NO vignetting** **NO distortion** (<0.03%) + cost efficient + variable setup (e.g. easy repair and replacement of each single component, especially image intensifier)	+ good coupling efficiency + compact design
Disadvantages	- stretched design	- poor image quality lower modulation transfer function distortion > 3% **CLEARLY visible honeycomb pattern** - cost intensive - fixed structure e.g. no repair or replacement

In summary the fiber-coupled ICCD camera systems provide lower image quality and less flexibility in combination and maintenance. Whereas the often claimed much better coupling efficiency diminish after taking into account the coupling loss, the core-cladding-ratio of the fibers and the significant loss of the fiber optic due to diameter reduction. On the other hand the customized F/0.8 lens coupling system provides best intensified image quality, high flexibility and excellent coupling efficiency.

4 Picos family

Customize the optimum 4 Picos ICCD camera for your application

The 4 Picos ICCD camera enables the customization to the requirement and needs of your experiment. This guarantees best performance in combination with superior intensified imaging. Please follow the indicated four step process to get the best and most suiting ICCD camera for your application.

Customize the 4 Picos camera in 4 steps:

1. Select the minimum gating time
2. Select the optimum image intensifier
3. Choose the ideal CCD sensor
4. Pick the required accessories

1. Minimum gate time

If the preferred minimum gate time is 200ps the 4 Picos is the “camera of your choice”.

For min gate time in the nano-second regime please see our 4 Quik E ICCD camera.

2. Image intensifier

2.1. Photocathode
- UV high QE
- optional: blue high QE green high QE, red high QE (see details on next page)
- input window: quartz or MgF2 on request

2.2. Multi-channel plate (MCP)
- single or
- dual stage (optional)

2.3. Phosphor screen
- P43 standard
- P46 optional (requested for 500ns fast dual frame mode)

3. CCD sensor

3.1. Digital output
- standard: USB 2.0
- optional: USB 3.0 (2019)

3.1. Resolution of CCD sensor
- standard resolution: 780 x 580 pixel
- high resolution: 1360 x 1024 pixel

3.2. Dynamic range of CCD sensor
- 12bit or
- 14bit

Please contact our sales team to get assistance and further details to these options.

4. Selection of optional accessories and adapters

Item-No.	Name of product	Description
LMA-...	lens mount adapter	selection of adapter for various lens mount systems (e.g. F-mount, EOS) providing full aperture and reduced stray light by black anodized aluminum
SGA-...	spectrograph adapter	selection of adapter for all common spectrograph manufacturer e.g. Acton, Horiba and Jobin Yvon, others on request
VF	vacuum flange	customized flange to connect the ICCD camera to any vacuum tube
SMB-BNC	SMB-BNC	SMB - BNC adapter cables in any length
IOL-...	input objective lens	various input objective lenses e.g. Pentax UV lens 25mm, F2.8-16; Pentax UV lens 78mm, F3.8-16F3.8-1, others on request

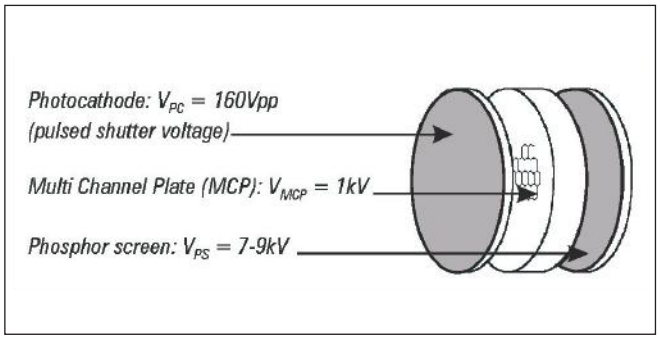
High performance image intensifier

Guidance to make the right choices in order to get the most suitable image intensifier.

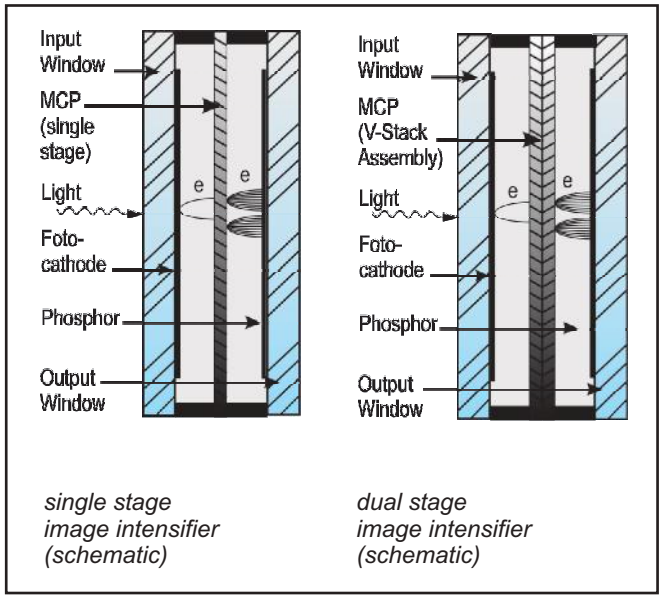
The image intensifier is a key component of each ICCD camera. This section deals with the fundamental characteristics of image intensifiers and their options.
Different applications of ICCD cameras have different demands and requirements on the camera and thus on the image intensifier.

Following questions need to be addressed

- What are the spectral characteristics of the illumination?
  → Does determine the suitable photocathode.
- How fast need to be the shutter/shortest gating time?
  → Highest shutter speed does have some constrains to e.g. size of the image intensifier.
- How much light is there?
  → Dual stage MCP's have better performance at low light environments but less .
- High speed or low light imaging?
  → Does determine the suitable phosphor screen.



New: Gen II High QE photo cathodes
The new Gen II high Quantum Efficiency photo cathodes are providing the best spectral responsibility performance....



single stage image intensifier (schematic)

dual stage image intensifier (schematic)

First the incoming photon releases an electron in the photocathode, second the electron is accelerated and amplified to an electron avalanche within the multi-channel plate (MCP), third the accelerated electrons are converted into photons by the phosphor screen.

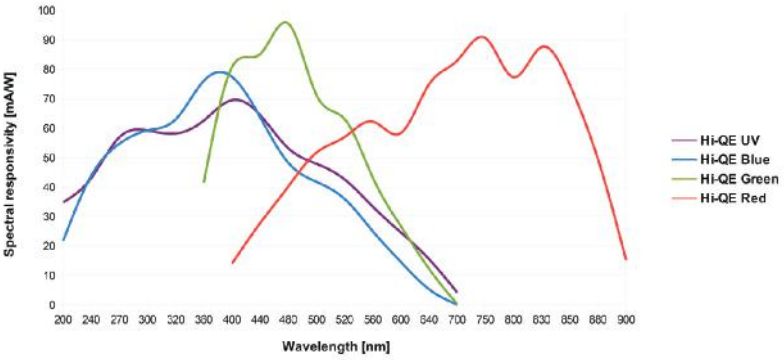
Photocathodes

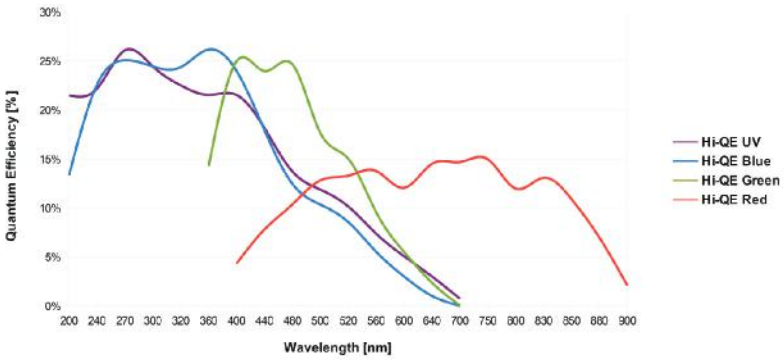
	Type	Spectral range
Standard	UV High QE	approx. 180 - 700nm
Optional	UV High QE MgF2	approx. 110 - 700nm
	Blue High QE	approx. 200 - 700nm
	Green High QE	approx. 360 - 700nm
	Red High QE	approx. 400 - 900nm

Image intensifier specifications

Shutter speed
The shutter speed is limited by the speed of light since any electromagnetic signal does not travel faster.

Input window
The standard input window is made of quartz. This limits the UV spectral range below 165nm. The optional Magnesium Fluoride (MgF2) window enables measurements down to 110nm.





Photocathode
Photocathodes define the sensitivity and the spectral response of the image intensifier.

Phosphor screen
There are three important considerations in choosing a luminous (phosphor) output screen.

1. spectral emission range
2. efficiency
3. phosphor decay time

The P43 phosphor screen has a higher efficiency, however, a longer decay time. For fast applications e.g. double frame mode with interframing time of 500ns the P46 phosphor screen is neccessary to avoid gost images from the previous exposure.

Multi-channel-plate (MCP)
Image intensifiers can be equipped with single or double stage MCP's. The single stage MCP features excellent signal gain and fits most applications of the ultra high speed ICCD cameras.

The V-stacked double MCP's are especially used for extreme low light environments. The increased electron multiplication provide single photon detection with increased signal to noise ratio and reduced ion feedback noise. Therefore, the double MCP is mainly used for long exposure measurements and extreme low light applications

Upper graph: Spectral responsitivity [mAW]
Lower graph: Quantum Efficiency [%]

Phosphor screen

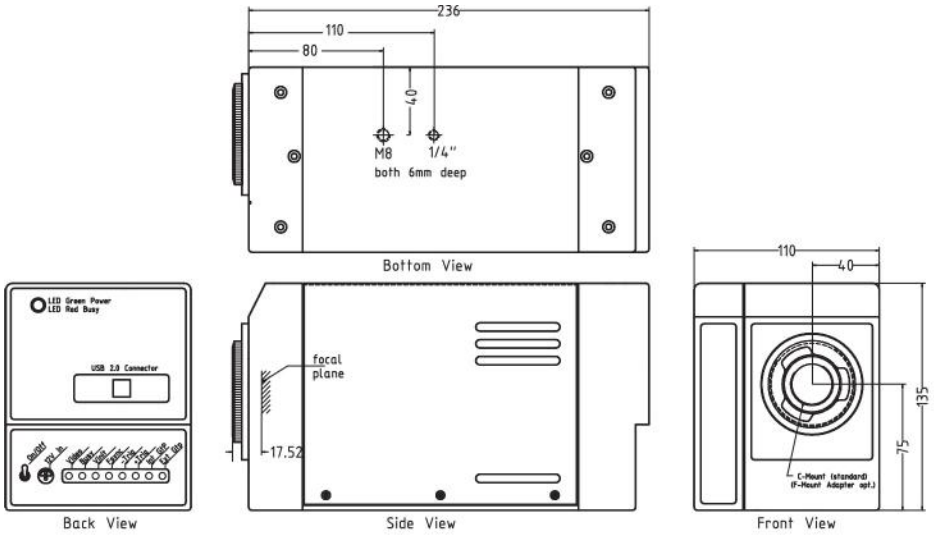
Type	Composition	Efficiency	Decay time		Emission spectral range
			90% to 10%	10% to 1%	
P43	Gd_2O_2S:Tb	185 ph/e @6kV	1.5ms	3.3ms	360 - 680nm
P46	$Y_3Al_5O_{12}$:Ce	90 ph/e @6kV	0.2µs	10µs	490 - 620nm

Micro-channel-plate (MCP)

Type	Electron multiplication	S/N ratio	Notice
Single stage	up to 10^3	very good	best image quality
Double stage	up to 10^6	excellent	highest sensitivity

Dimensions

Compact and light design



Mechanical and environmental data

Parameter	Description
Camera weight (all in one)	3kg / 6.6lb
Camera dimensions without lens	248 x 110 x 135mm (l x w x h)
Camera mount	1/2" and M8 mounting holes
Operating humidity	25..95%, non condensing
Operating temperature	0°C 50°C / 32°F 122°F
Performance specification	10°C 40°C / 50°F 104°F
Operating limits	-10°C 50°C / 14°F 122°F
Shock and vibration	60g accel. shock, 7g Vibration (11 200Hz), excludes MCP in direct frontal impact
Voltage	90..260VAC

Extended warranty on all products from Stanford Computer Optics

2 years
on mechanics and electronics
Stanford Computer Optics Inc. warrants all new products to be free from defects in materials and workmanship for 24 months from the date of dispatch.

1 year on image intensifier
Image intensifiers are subject to the original manufacturer's warranty conditions. It comprises a warranty of 12 months. In case of any defect the Paul Hoess KG or Stanford Computer Optics Inc. will assist for repair or replacement.

Warranty restriction
Warranties do not cover normal wear, misuse, negligence or accident. They do not apply to goods which have been misused, altered, inadequately maintained, stored incorrectly, or negligently installed or serviced.

Applications

4 Picos ICCD camera provides user-friendly intensified imaging for numerous, different applications

Fluorescence lifetime imaging microscopy (FLIM)
e.g. by S. Cheng from the Texas A&M University, United States: Optics Letters, Vol. 38, Issue 9, 2013 and Y. Sun from the University of California-Davis, United States: Optics Letters, Vol. 34, Issue 13, 2009

Fluorescence resonance energy transfer (FRET)
e.g. by A. L. Rusanov from the Russian Academy of Sciences, Russian Federation: J. Biophotonics, Vol. 3, Issue 12, 2010

Fusion reaction diagnostic
e.g. by E. J. Lerner et al., from the Lawrenceville Plasma Physics, Inc., United States: Phys. Plasmas, Vol. 19, Issue 3, 2012

The 4 Picos ICCD camera integrated at the experimental setup of the dense plasma focus with the from the backside facing the window of the vacuum chamber. Figure reprinted with permission of the Lawrenceville Plasma Physics, Inc (2012).

Thomson scattering
e.g. by E. R. Kieft from the Eindhoven University of Technology, The Netherlands: Rev. Sci. Instrum., Vol. 76, Issue 5, 2005

Synchrotron beam diagnostic
e.g. by J. C. Bergstrom from the Canadian Light Source, Canada: Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Vol. 562, Issue 1, 2006

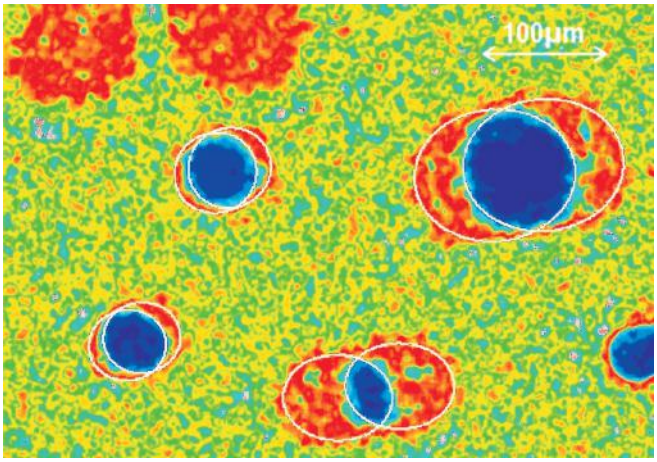
Gated viewing 3D laser radar
e.g. by J.F. Andersen from the Danisch Defense Reasearch Establishment, Denmark: Applied Optics, Vol. 45, Issue 24, 2006

Photoluminescence
e.g. by S. I. Hintschich from the University of Durham, United Kingdom: Journal of Chemical Physics, Vol. 119, Issue 22, 2003

Light intensity measurements over 11 orders of magnitude
e.g. by C. Rothe from the University of Durham, United Kingdom: Phys. Rev. Lett., Vol 96, Issue 16, 2006

Plasma expansion dynamics
e.g. by C. Janzen from the Fraunhofer-Institut für Lasertechnik (ILT), Germany: Spectrochimica Acta Part B: Atomic Spectroscopy, Vol 60, Issues 78, 2005

Spray analysis
e.g. by T. Streibl from the Universität der Bundeswehr, Germany: Proc. SPIE 4308, High-Speed Imaging and Sequence Analysis III, 45, 2001



The image shows particles imaged with dual laser illumination under a certain angle. The separation of the shades is a direct measure of the particles position within the viewing direction. Using this information the particle size and shape can be directly analyzed by the particles shades. Figure reprinted with permission of Universität der Bundeswehr, Munich.

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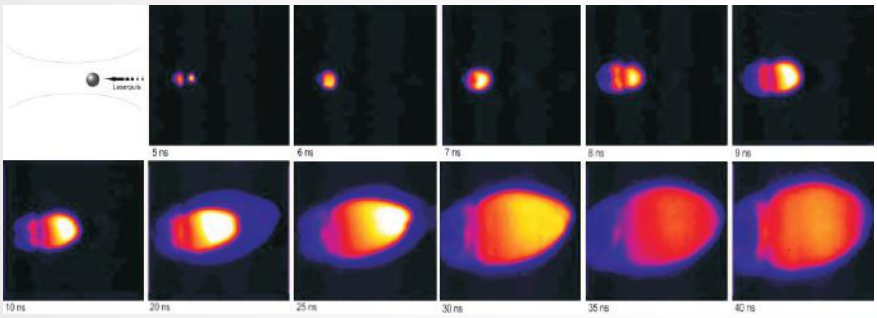
Superior imaging intensified CCD cameras

4 Picos

Ultra high speed ICCD camera



200ps highest speed shutter

Best imaging quality

Single photon detection

Compact and light design

Contact

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Superior imaging intensified CCD cameras

4 Quik E

High speed ICCD camera

1.2ns highest shutter speed
Best imaging quality
Single photon detection
Compact and light design

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4 Quik E ICCD camera

High speed intensified CCD camera

Based on more than 25 years of experience in the field of high speed intensified imaging, Stanford Computer Opitcs, is developing pioneering, fast-gated intensified CCD (ICCD) cameras. The 4 Quik E ICCD camera sets new standards of reliable and outstanding, nanosecond resolved imaging and spectroscopy.

More detailed information

Down to 1.2ns flat top, optical gating time
The 4 Quik E ICCD camera is equipped with high resolution image intensifier which provide excellent temporal resolution and highest sensitivity down to single photon. Equipped with a high resolution CCD sensor the 4 Quik E camera provides exceptional performance and superior image quality. Long-lasting and reliable electronics ensure trouble-free and undisturbed intensified imaging experience.

High performance and reliable electronics
In-house developed, custom-built electronics provide extreme low jitter, low intrinsic delay, excellent timing control with 0.1ns accuracy and flat top, true optical gating time of down to 1.2ns. The adjustable MCP voltage, multiple trigger options and various operation modes make the 4 Quik E most flexible and versatile intensified CCD camera for any scientific or industrial application.

Multi-purpose camera with nanosecond resolution
Optionally, the 4 Quik E ICCD camera can be equipped with up to 2MHz (on request 5MHz) continuous photocathode gating repetition rate and and increased signal amplification using a V-stacked double multi-channel plate (MCP) image intensifier.

Images cover & backside: Positive streamer discharge in pure argon imaged with the 4 Quik E camera. Reprinted figure with permission from U. Ebert et al., 2011 Nonlinearity 24 C1. Copyright (2011) by IOP Publishing Ltd. The figure was published originally in figure 7 of S. Nijdam et al., 2010 J. Phys. D: Appl. Phys. 43 145204.

Highlights

Standard features and benefits

- Shortest shutter time 1.2ns
- Gating time from 1.2ns .. DC
- Internal delay times: 0 .. 80s
- Highly accurate timing control with step size of 0.1ns
- Extreme low jitter: 20ps
- High resolution image intensifiers with optical system resolution of >60lp/mm
- Spectral sensitivity from UV to red (depends on type of image intensifier)
- Brilliant sensitivity providing single photon detection
- Adjustable MCP voltage for 50db dynamic range in signal amplification
- Multiple exposure operation with up to 3.3MHz (burst mode) and 200kHz (continuous) optical shutter repetition rate
- Customized f/0.8 distortion free lens coupling between image intensifier and CCD
- High dynamic range up to 14bit resolution
- Multiple trigger options: 3x input; 3x output
- USB 2.0 (standard), USB 3.0 (optional) output
- Remote interface for real time camera control
- Compact and light system design
- 4 Spec E software

Optional features

- Nikon F-Mount Adapter
- Two discrete images with double frame mode (interframing time 500ns) with P46 posphor
- High photocathode gating repetition rate up to 2MHz continuous; on request up to 5MHz available
- Adapters for various spectrometer
- Vacuum flange for UHV connection

Fastest optical gating down to 1.2ns

Superior image quality by customized lens coupling

High system sensitivity with single photon detection

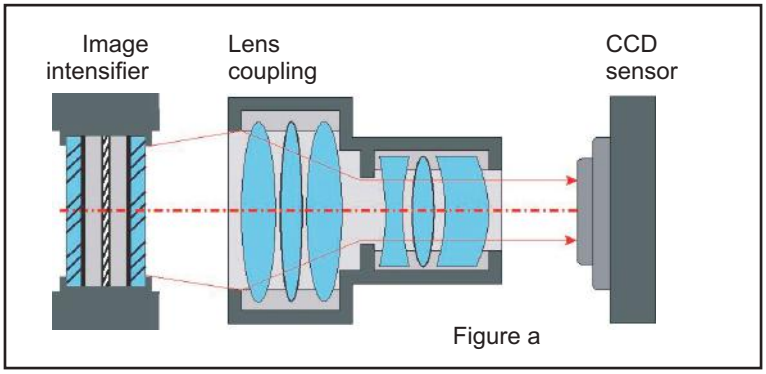
Long-lasting electronics (24 months warranty)

Compact and light design

Best performance CCD sensors

High resolution, high dynamic range imaging sensors

The 4 Quik E ICCD camera features high resolution intensified imaging for sharpest images with 1.2ns true optical gating. The 4 Quik E camera provides highest sensitivity with Gen II photocathodes and provides the best intensified image quality through customized lens coupling without compromising vignetting, distortion and coupling efficiency. All CCD sensors are front-illuminated types and provide best image quality with low noise and high fill factor.



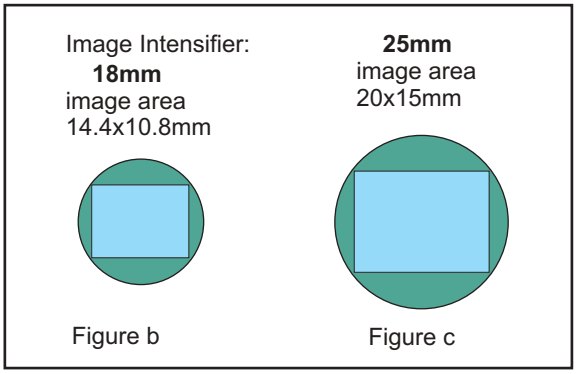


Figure a: Schematic sketch of the lens coupled intensified CCD camera. The appropriate coupling lens images the phosphor screen of the image intensifier to the CCD sensor.

Figure b and c: Lens coupling provides full coverage of the CCD sensor (no dark corners) and highest image resolution.

Automatic continuous cleans
The CCD sensor is automatically cleared before triggering at trigger frequencies below 4Hz. This ensures the best and most efficient reduction of CCD sensor background noise.

High dynamic range
The CCD sensor provides up to 14bit dynamic range. Furthermore, the CCD sensor gain can be adjusted from 0 to 20db. In combination this results in 17bit dynamic range of the CCD sensor.

High fill factor
The interline CCD sensor provide highest fill factors using micro lens arrays on top of the active pixels.

CCD sensor cooling
Only measurements with very long exposure times need active cooling to increase S/N ratio. On request a regulated Peltier cooling ensures a cooled operation of the CCD sensor. This total encapsulated cooling system does not causes condensation and does not need vacuum or nitrogen atmosphere.

CCD sensor options

Parameter	High resolution HR CCD sensor	Standard resolution SR CCD sensor
Resolution	1360x1024	780x580
Pixel size [µm]	4.7x4.7	8.3x8.3
Camera interface	USB 2.0	USB 2.0
Binning options	full frame, 2 (2x2binning), ROI (region of interest)	
Dynamic range	12 or 14 bit	12 or 14 bitt
Video gain [dB]	full and ROI: 0..20db; 2x2: 0..25db	
Chip readout	Correlated double sampling, dark current corrected	

Time settings

Superior timing control with on-board delay generator

The **on-board digital** delay generator provides accurate timing control of the photocathode gating. All true flat top optical gating times are measured in single shot measurements. These measurements do not include the positive influence of signal jitter in integrating measurements.

Time settings

Parameter	4 Quik E
Gate time [step size]	1.2ns … 80s [100ps]
Delay time [step size]	0.1ns … 80s [100ps]
Jitter	0.02ns
Minimal dead time between multiple exposures	300ns
Minimal interframing time (optional double frame mode*)	500ns
Trigger propagation delay	internal gate pulse: 60-65ns external gate pulse: 30-35ns

** image intensifiers with P46 phosphor screen*

Operation modes

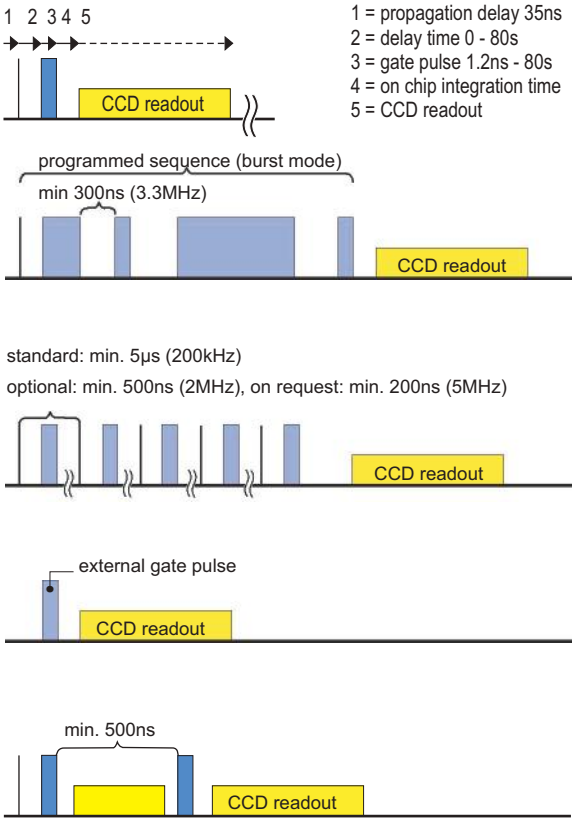
Single frame mode
The standard operational mode of our ICCD cameras allows the independent control of photocathode gating and CCD sensor.

Integrate-on-chip: Programmed sequence (burst mode)
Any time sequence consisting of multiple gate and delay times can be applied to the photocathode. The minimum delay time is 300ns corresponding to 3.3MHz gate repetition rate.

Integrate-on-chip: Multiple triggering (continuous)
This mode enables a continuous photocathode gating series on individual trigger signals with a predefined delay and gating time. The camera provides by default 200kHz, optionally 2MHz and on request 5MHz repetition rate. This mode is used e.g. for synchronization with high repetition rate lasers.

External gate control
Allows the direct control of the photocathode gating via an external TTL pulse and provides the shortest delay between external trigger and photocathode gating.

Optional: Double frame mode
Image intensifiers with P46 phosphor screen allow to capture two seperate full-size, full-resolution images with a interframing delay as short as 500ns. This mode is applied e.g. Particle Imaging Velocimetry (PIV) or particle size analysis.

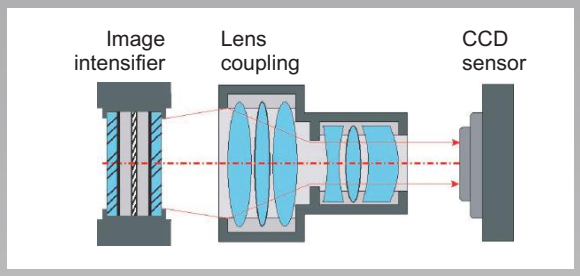
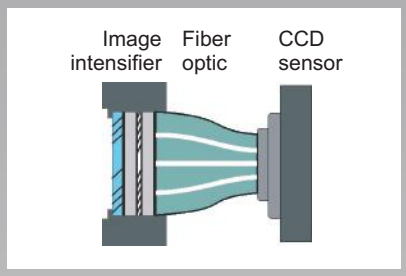
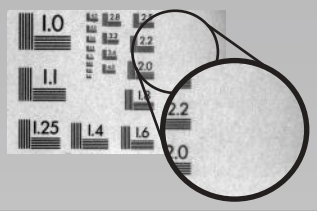
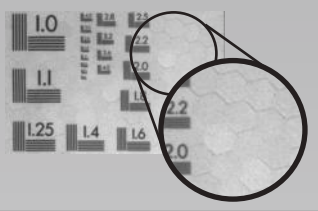


Lens coupling system

The lens coupled ICCD cameras provide superior image quality.

All 4 Quik E ICCD cameras are equipped with the in-house developed, customized f/0.8 lens coupling system. It provides superior imaging quality without compromising distortion, resolution and vignetting. In contrast to other claims the lens coupled ICCD camera systems provides single photon detection and high S/N ratio at low light environment. The stray light is reduced using convenient anti-reflex coatings which results in magnificent optical contrast. Furthermore, in combination with the adjustable MCP voltage it proves high dynamic range, large linearity and ensures a great life span of the imaging system.

Coupling image intensifier CCD sensor comparison

Parameter	F/0.8 lens coupled ICCD camera	Fiber-optic coupled ICCD camera
		
Example		
Advantages	+ excellent coupling efficiency by F/0.8 lens + superior image quality highest modulation transfer function (cut off @ 180lp/mm) **NO honeycomb pattern** **NO vignetting** **NO distortion** (<0.03%) + cost efficient + variable setup (e.g. easy repair and replacement of each single component, especially image intensifier)	+ good coupling efficiency + compact design
Disadvantages	- stretched design	- poor image quality lower modulation transfer function distortion > 3% **CLEARLY visible honeycomb pattern** - cost intensive - fixed structure e.g. no repair or replacement

In summary the fiber-coupled ICCD camera systems provide lower image quality and less flexibility in combination and maintenance. Whereas the often claimed much better coupling efficiency diminish after taking into account the coupling loss, the core-cladding-ratio of the fibers and the significant loss of the fiber optic due to diameter reduction. On the other hand the customized F/0.8 lens coupling system provides best intensified image quality, high flexibility and excellent coupling efficiency.

4 Quik E family

Customize the optimum 4 Quik E ICCD camera for your application

The 4 Quik E ICCD camera enables the customization to the requirement and needs of your experiment. This guarantees best performance in combination with superior intensified imaging. Please follow the indicated four step process to get the best and most suiting ICCD camera for your application.

Customize the 4 Quik E camera in 4 steps:

1. Select the minimum gating time
2. Select the optimum image intensifier
3. Choose the ideal CCD sensor
4. Pick the required accessories

1. Minimum gate time

If the preferred minimum gate time is 1.2ns the 4 Quik E is the camera of your choice.

For shorter times please see our 4 Picos ICCD camera with min. gate time down to 200ps.

2. Image intensifier

2.1. Photocathode
- UV high QE
- optional: blue high QE green high QE, red high QE (see details on next page)
- input window: quartz or MgF2 on request

2.2. Multi-channel plate (MCP)
- single or
- dual stage (optional)

2.3. Phosphor screen
- P43 standard
- P46 optional (requested for 500ns fast dual frame mode)

3. CCD sensor

3.1. Digital output
- standard: USB 2.0
- optional: USB 3.0 (2019)

3.1. Resolution of CCD sensor
- standard resolution: 780 x 580 pixel
- high resolution: 1360 x 1024 pixel

3.2. Dynamic range of CCD sensor
- 12bit or
- 14bit

Please contact our sales team to get assistance and further details to these options.

4. Selection of optional accessories and adapters

Item-No.	Name of product	Description
LMA-...	lens mount adapter	selection of adapter for various lens mount systems (e.g. F-mount, EOS) providing full aperture and reduced stray light by black anodized aluminum
SGA-...	spectrograph adapter	selection of adapter for all common spectrograph manufacturer e.g. Acton, Horiba and Jobin Yvon, others on request
VF	vacuum flange	customized flange to connect the ICCD camera to any vacuum tube
SMB-BNC	SMB-BNC	SMB - BNC adapter cables in any length
IOL-...	input objective lens	various input objective lenses e.g. Pentax UV lens 25mm, F2.8-16; Pentax UV lens 78mm, F3.8-16F3.8-1, others on request

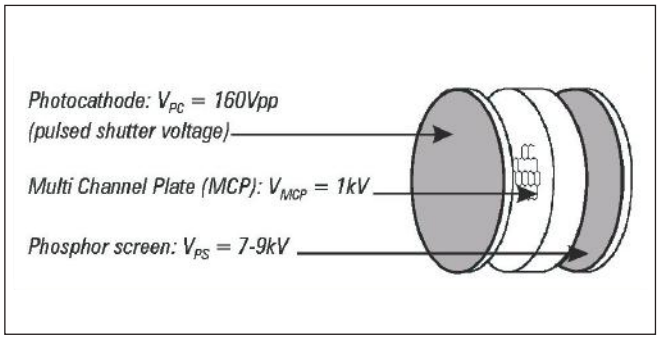
High performance image intensifier

Guidance to make the right choices in order to get the most suitable image intensifier.

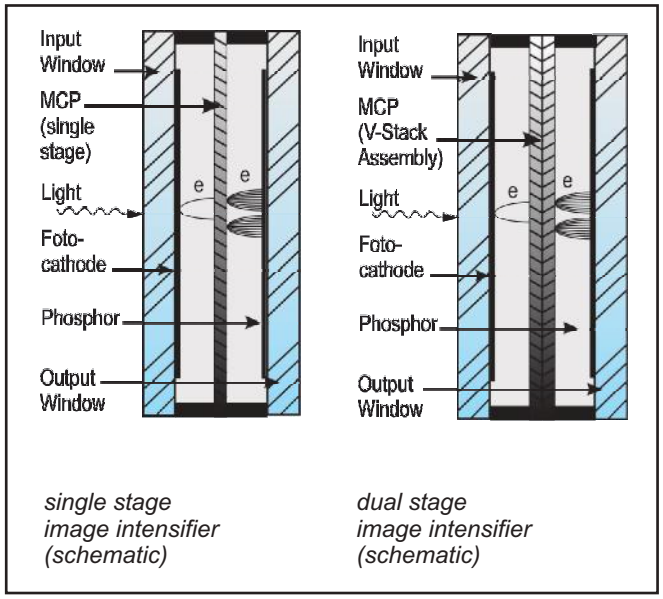
The image intensifier is a key component of each ICCD camera. This section deals with the fundamental characteristics of image intensifiers and their options.
Different applications of ICCD cameras have different demands and requirements on the camera and thus on the image intensifier.

Following questions need to be addressed

- What are the spectral characteristics of the illumination?
  → Does determine the suitable photocathode.
- How fast need to be the shutter/shortest gating time?
  → Highest shutter speed does have some constrains to e.g. size of the image intensifier.
- How much light is there?
  → Dual stage MCP's have better performance at low light environments but less .
- High speed or low light imaging?
  → Does determine the suitable phosphor screen.



New: Gen II High QE photo cathodes
The new Gen II high Quantum Efficiency photo cathodes are providing the best spectral responsibility performance....



single stage image intensifier (schematic)

dual stage image intensifier (schematic)

First the incoming photon releases an electron in the photocathode, second the electron is accelerated and amplified to an electron avalanche within the multi-channel plate (MCP), third the accelerated electrons are converted into photons by the phosphor screen.

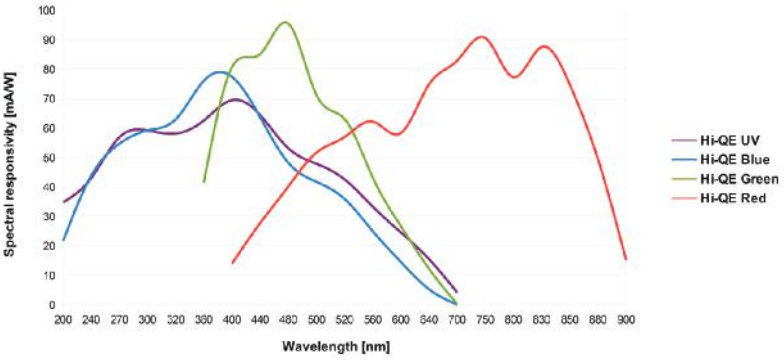
Photocathodes

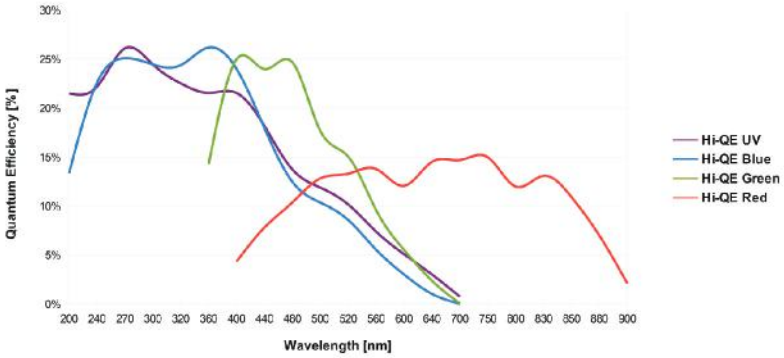
	Type	Spectral range
Standard	UV High QE	approx. 180 - 700nm
Optional	UV High QE MgF2	approx. 110 - 700nm
	Blue High QE	approx. 200 - 700nm
	Green High QE	approx. 360 - 700nm
	Red High QE	approx. 400 - 900nm

Image intensifier specifications

Shutter speed
The shutter speed is limited by the speed of light since any electromagnetic signal does not travel faster.

Input window
The standard input window is made of quartz. This limits the UV spectral range below 165nm. The optional Magnesium Fluoride (MgF2) window enables measurements down to 110nm.





Photocathode
Photocathodes define the sensitivity and the spectral response of the image intensifier.

Phosphor screen
There are three important considerations in choosing a luminous (phosphor) output screen.

1. spectral emission range
2. efficiency
3. phosphor decay time

The P43 phosphor screen has a higher efficiency, however, a longer decay time. For fast applications e.g. double frame mode with interframing time of 500ns the P46 phosphor screen is neccessary to avoid gost images from the previous exposure.

Multi-channel-plate (MCP)
Image intensifiers can be equipped with single or double stage MCP's. The single stage MCP features excellent signal gain and fits most applications of the ultra high speed ICCD cameras.

The V-stacked double MCP's are especially used for extreme low light environments. The increased electron multiplication provide single photon detection with increased signal to noise ratio and reduced ion feedback noise. Therefore, the double MCP is mainly used for long exposure measurements and extreme low light applications

Upper graph: Spectral responsitivity [mAW]
Lower graph: Quantum Efficiency [%]

Phosphor screen

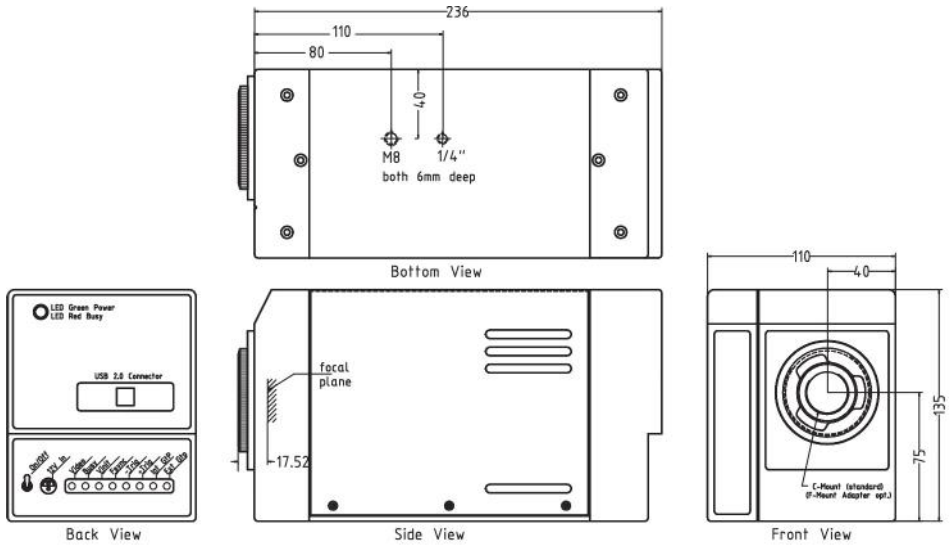
Type	Composition	Efficiency	Decay time		Emission spectral range
			90% to 10%	10% to 1%	
P43	Gd_2O_2S:Tb	185 ph/e @6kV	1.5ms	3.3ms	360 - 680nm
P46	$Y_3Al_5O_{12}$:Ce	90 ph/e @6kV	0.2µs	10µs	490 - 620nm

Micro-channel-plate (MCP)

Type	Electron multiplication	S/N ratio	Notice
Single stage	up to 10^3	very good	best image quality
Double stage	up to 10^6	excellent	highest sensitivity

Dimensions

Compact and light design



Mechanical and environmental data

Parameter	Description
Camera weight (all in one)	3kg / 6.6lb
Camera dimensions without lens	248 x 110 x 135mm (l x w x h)
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Operating humidity	25..95%, non condensing
Operating temperature	0°C 50°C / 32°F 122°F
Performance specification	10°C 40°C / 50°F 104°F
Operating limits	-10°C 50°C / 14°F 122°F
Shock and vibration	60g accel. shock, 7g Vibration (11 200Hz), excludes MCP in direct frontal impact
Voltage	90..260VAC

Extended warranty on all products from Stanford Computer Optics

2 years
on mechanics and electronics
Stanford Computer Optics Inc. warrants all new products to be free from defects in materials and workmanship for 24 months from the date of dispatch.

1 year on image intensifier
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Applications

4 Quik E ICCD camera provides user-friendly intensified imaging for numerous, different applications

Hyper-Rayleigh measurements
e.g. by M. R. Beaudin from the Carleton UniVersity, Canada: Chem. Mater.,18,1079-1084, 2006

Combustion imaging
e.g. by I.Y. Ohm from the Seoul National University, South Korea: International Journal of Automotive Technology, Vol. 12, Issue 5, 2012

Electrical breakdown measurements
e.g. by K. Schoenbach from the Old Dominion University, United States:
Plasma Sources Sci. Technol., Vol. 17, Issue 2, 2008

Fluorescence spectroscopy
e.g. by S.E. Saari from the Tampere University of Technology, Finland:
Atmospheric Environment, Vol. 71, 2013

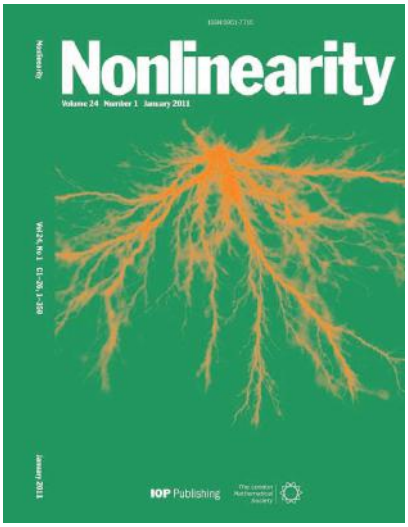
Spray and flow imaging
e.g. by H. K. Suh from the Hanyang University, South Korea: Atomization and Sprays, Vol. 17, Issue 7, 2007

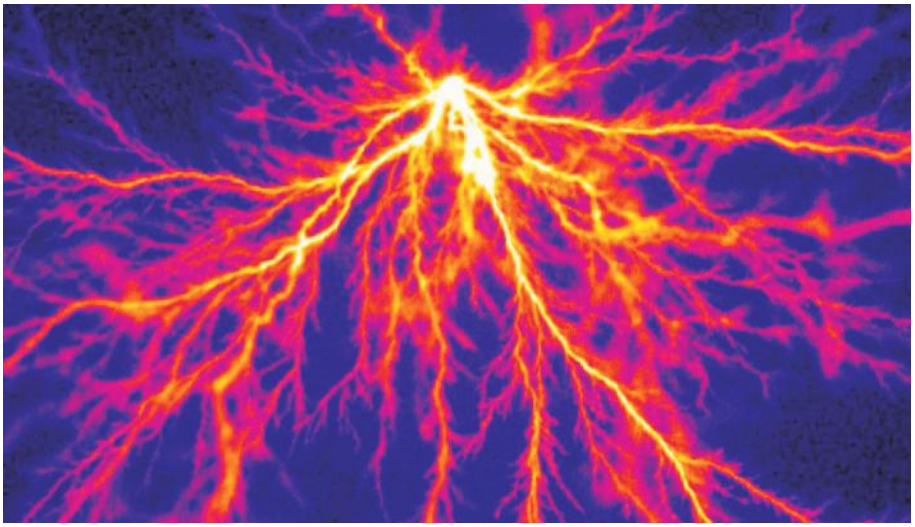
Laser induced breakdown spectroscopy (LIBS)
e.g. by S. T. Järvinen from the Tampere University of Technology, Finland: Spectrochimica Acta Part B: Atomic Spectroscopy , Vol. 86, 2013

Raleigh scattering
e.g. by J. Campo from the University of Antwerp, Belgium:
Optics Express, Vol. 17, Issue 6, 2009

Time-resolved optical emission spectroscopy
e.g. by R. M. van der Horst from the Eindhoven University of Technology, The Netherlands:
J. Phys. D: Appl. Phys., Vol. 45, Issue 34, 2012

Streamer discharge research
e.g. by U. Ebert from the CWI Amsterdam, The Netherlands: Nonlinearity, Vol. 24, Issue 1, 2011





Feather-like structures in a positive streamer discharge in pure argon at room temperature and atmospheric pressure. The image is recorded with the 4 Quik E ICCD camera and represents about 40mm of the discharge gap with the electrode tip in the top center. The blurred structures are out of focus.

Reprinted figure with permission from U. Ebert et al., 2011 Nonlinearity 24 C1. Copyright (2011) by IOP Publishing Ltd. The figure appeared also on the cover of Nonlinearity Vol. 24 (2011) and was published originally in figure 7 of S. Nijdam et al., 2010 J. Phys. D: Appl. Phys. 43 145204.

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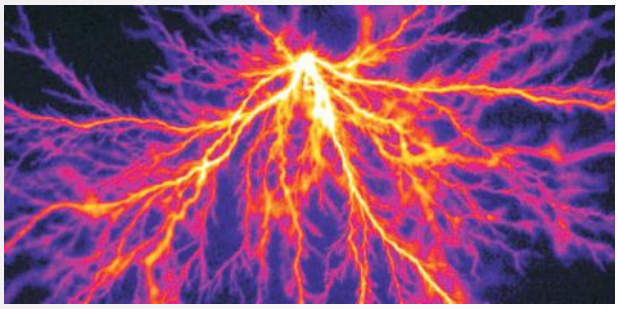
4 Quik E

High speed ICCD camera



1.2ns high shutter speed

Best imaging quality

Single photon detection

Compact and light design

Contact

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UNIKLASERS

SINGLE FREQUENCY DPSS

Product Range

2021

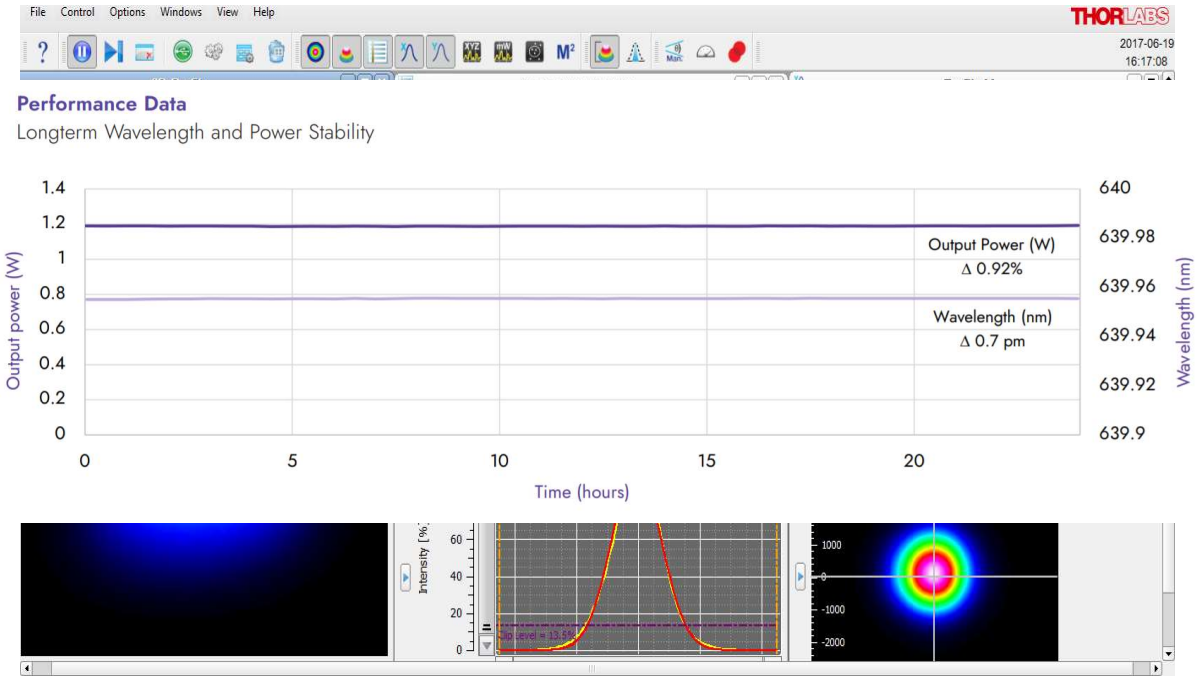
UNIKLASERS
SINGLE FREQUENCY DPSS

Solo 640 Laser Series

Power Specifications	
High Output Power	Up to 1 W
High Power Stability	< 2% over 8 hrs
Low Noise	< 0.1% RMS

Spectral Specifications	
Narrow Linewidth	< 500 kHz
High Spectral Stability	±1 pm over 8 hrs
High Coherence Length	> 100 m

Beam Specifications	
Small Beam Diameter	0.8 – 1.2 mm
Low Beam Divergence	< 1 mrad *diff ltd
High Pointing Stability	< 5 µrad/ºC



Holography Raman Brillouin Interferometry Photoluminescence Microscopy

UNIKLASERS
SINGLE FREQUENCY DPSS

Duetto 532 Laser Series

Power Specifications	
High Output Power	Up to 1 W
High Power Stability	< 2% over 8 hrs
Low Noise	< 0.1% RMS

Spectral Specifications	
Narrow Linewidth	< 500 kHz
High Spectral Stability	±1 pm over 8 hrs
High Coherence Length	> 100 m

Beam Specifications	
Small Beam Diameter	0.7 – 1.2 mm
Low Beam Divergence	< 1 mrad *diff ltd
High Pointing Stability	< 5 µrad/ºC

Holography Raman Brillouin Interferometry Photoluminescence Microscopy

UNIKLASERS
SINGLE FREQUENCY DPSS

Solo 1064 Laser Series

Power Specifications	
High Output Power	Up to 2 W
High Power Stability	< 2% over 8 hrs
Low Noise	< 0.1% RMS

Spectral Specifications	
Narrow Linewidth	< 500 kHz
High Spectral Stability	±1 pm over 8 hrs
High Coherence Length	> 100 m

Beam Specifications	
Small Beam Diameter	0.8 – 1.2 mm
Low Beam Divergence	< 1 mrad *diff ltd
High Pointing Stability	< 5 µrad/ºC

Flow Cytometry

Raman

Brillouin

Interferometry

Optical Manipulation

Heterodyning

Microscopy

UNIKLASERS
SINGLE FREQUENCY DPSS

Duetto 349 Laser Series

Power Specifications	
High Output Power	50 mW
High Power Stability	< 2% over 8 hrs
Low Noise	< 0.1% RMS

Spectral Specifications	
Narrow Linewidth	< 500 kHz
High Power Stability	±1 pm over 8 hrs
High Coherence Length	> 100 m

Beam Specifications	
Small Beam Diameter	0.8 – 1.2 mm
Low Beam Divergence	< 2 mrad *diff ltd
High Pointing Stability	< 5 µrad/ºC

Biomedical

Flow Cytometry

Diffraction Gratings

Lithography

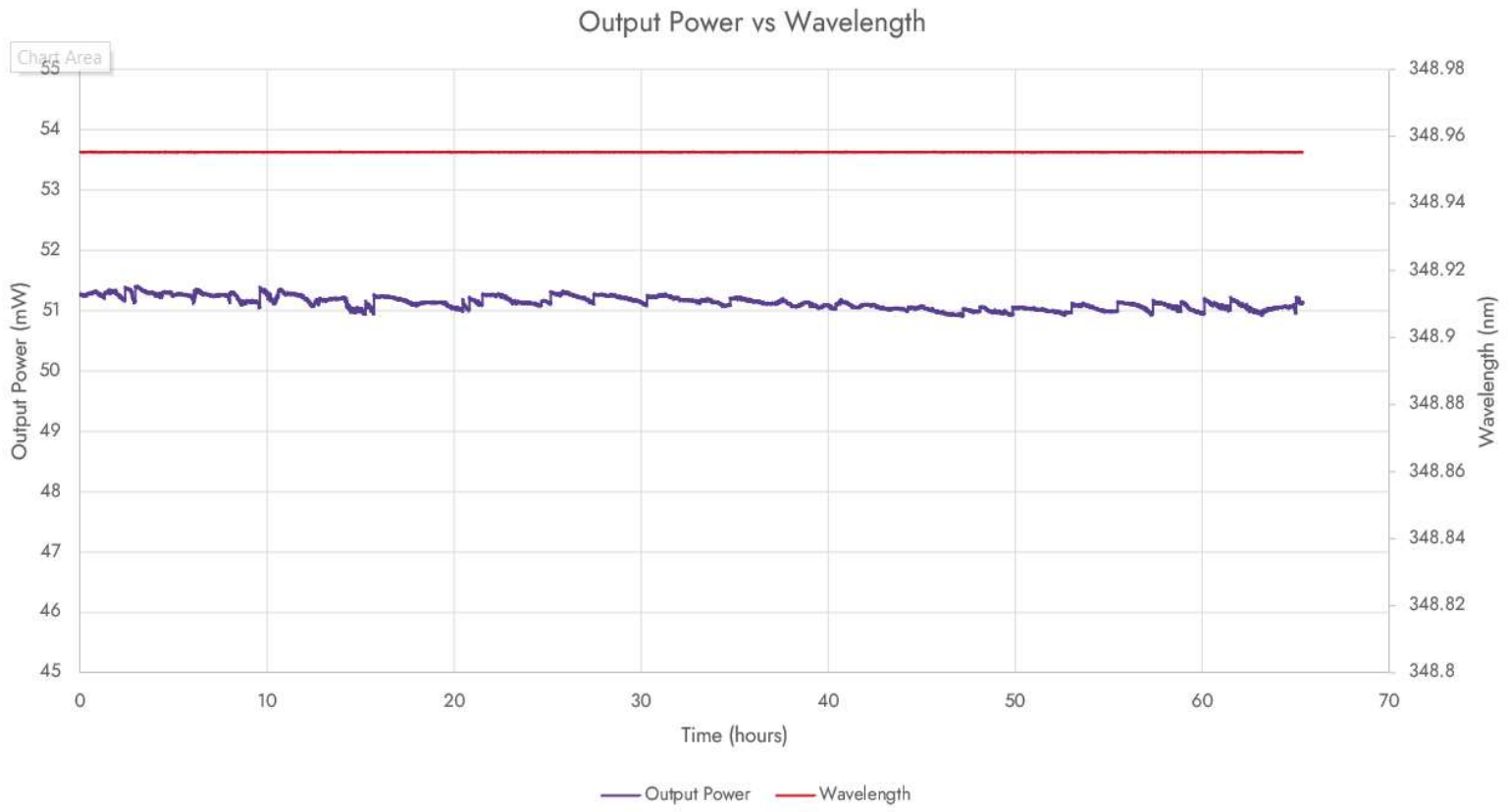
Semiconductors

Wafer Inspection

Photoluminescence

Raman

Performance Data



3. Products and Applications

3. Products and Applications

Spectral Products

(1) Main product line: UV-VIS

200nm — 1,100nm

USB

Normal Resolution
> 0.7 ~ 1.0 nm

High SNR

	Detector Type	Pixel #	Dark Noise RMS	SNR
SM245	CCD	2048	< 35	> 250 : 1
SM642	Non-TE-Cooled Backthinned	2048	< 7	> 450 : 1
SM303	TE-Cooled Backthinned	1024	< 2	> 1000 : 1

High Resolution
0.2 ~ 0.5 nm

	Detector Type	Pixel #	Dark Noise RMS	SNR
SM445	CCD	3648	< 35	> 250 : 1
SM642 - HRS	Non-TE-Cooled Backthinned	2048	< 7	> 450 : 1
SM303 - HRS	TE-Cooled Backthinned	1024	< 2	> 1000 : 1

Ethernet + On-Board Memory

NEW!

SM245N

SM445N

SM642N

Coming Soon!

SM303N

Advantage : Customized spectroscopy sensor with rapid wavelength range/SNR/light resolution according to customer's purpose and application

3. Products and Applications

Spectral Products

(1) Main product line:

NIR | Mid-IR

900nm — 2.500nm — 5,000nm

USB

NIR

SM304

Detector Type	Pixel #	Spectral Range (um)
InGaAs	512	0.9 – 1.7
Extended InGaAs	256	0.9 – 2.05
Extended InGaAs	512	0.9 – 2.2
Extended InGaAs	256	0.9 – 2.5
Extended InGaAs	512	0.9 – 2.5

Mid-IR

SM301

Detector Type	Pixel #	Spectral Range (um)
PbS	256	1.0 – 3.0
PbSe	256	1.5 – 5.0

Ethernet + On-Board Memory

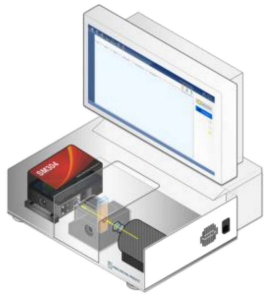
SM304N

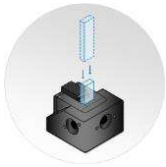
Coming Soon!

System

Realtime NIR Spectrophotometer

Coming Soon!





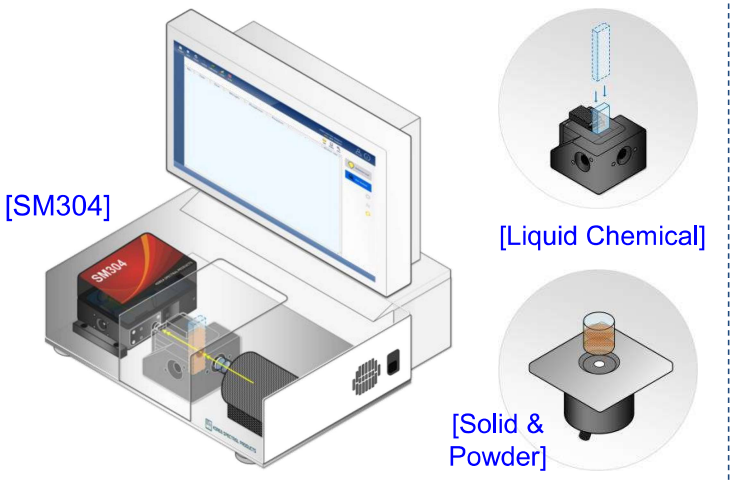
[Liquid Chemical]

[Solid & Powder]

3. Products and Applications

(2) Assembled system (Spectrophotometer systems)

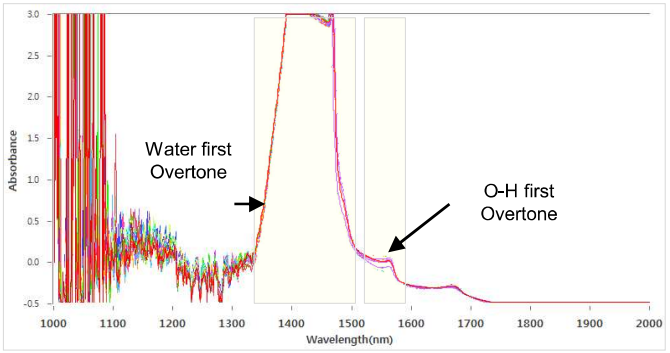
Analytical System : UV-Vis & NIR Spectrophotometers



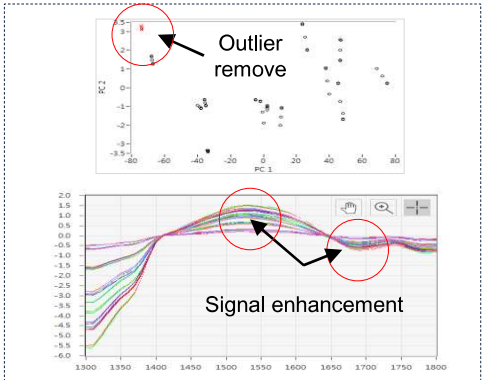
Near-Infrared Spectrophotometer

UV- VIS Spectrophotometer

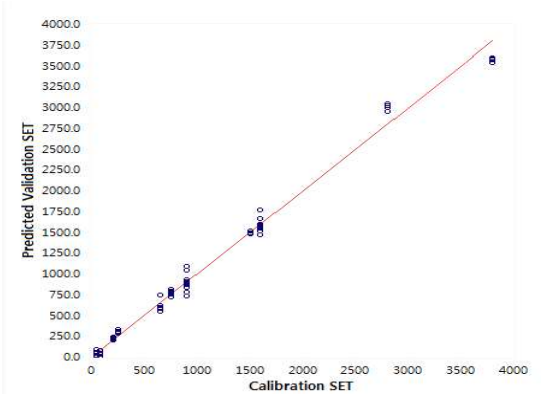
- Quantitative analysis of Liquid Chemical & Powder Samples with Machine Learning / CHEMOMETRICS-based Technology (concentration and content)



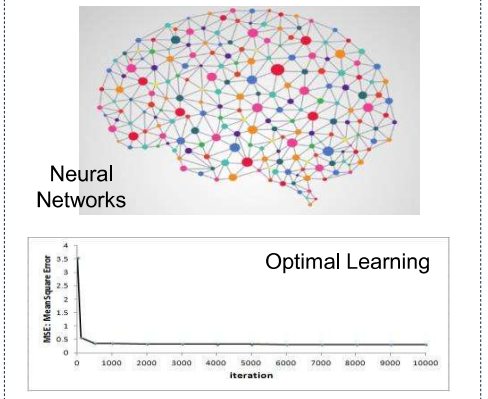
[NIR Spectrum of Liquid Chemical (H_2O, H_3PO_4 etc.)]



[Data Preprocessing]



[Predicted H_2O Concentration (ppm)]



[ANN Model for Regression]

3. Products and Applications

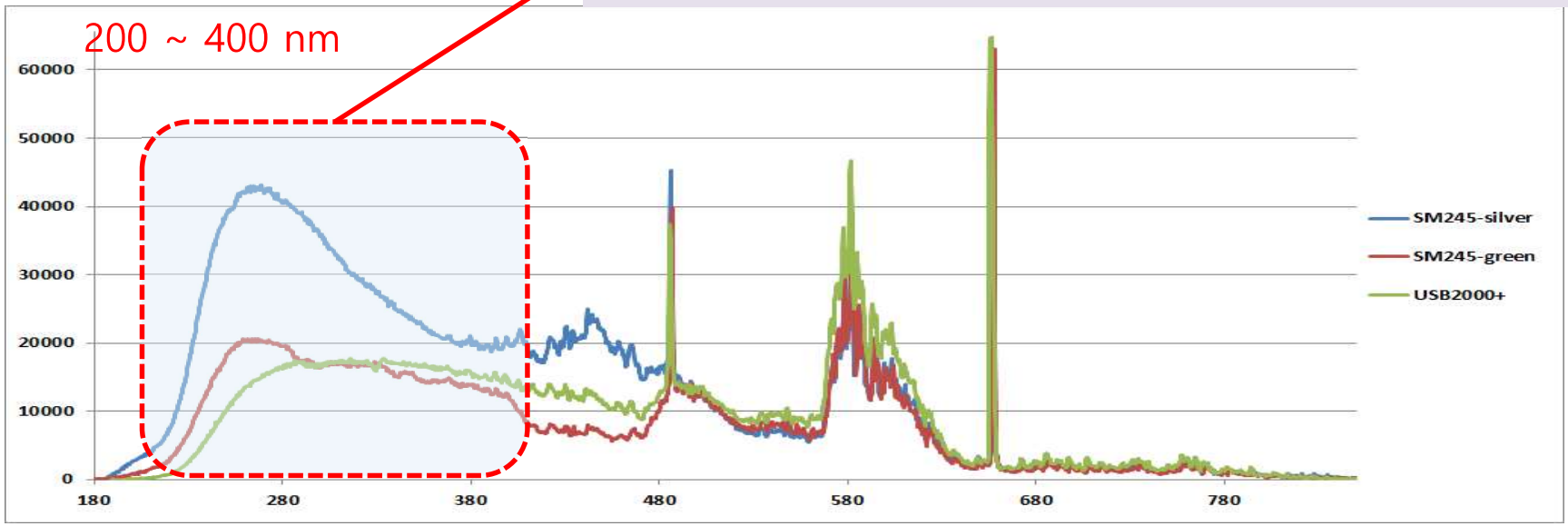
(3) High sensitivity deep UV phosphor coating for regular CCD

High Deep UV Enhanced Spectrometer(OES)

- X2 UV Enhancement than general UV enhanced OES
- High SNR of OES Spectrum

Twice the sensitivity of third-party OES sensors: high measurement accuracy

Main peak of Si / N_2 / OH / Cl / SiCl etc

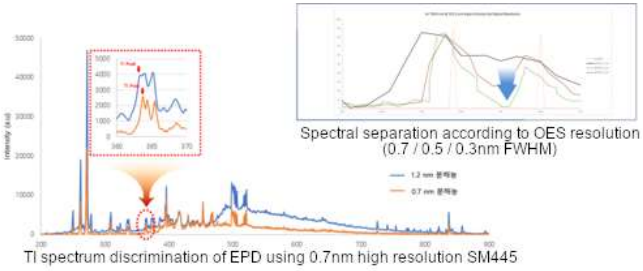


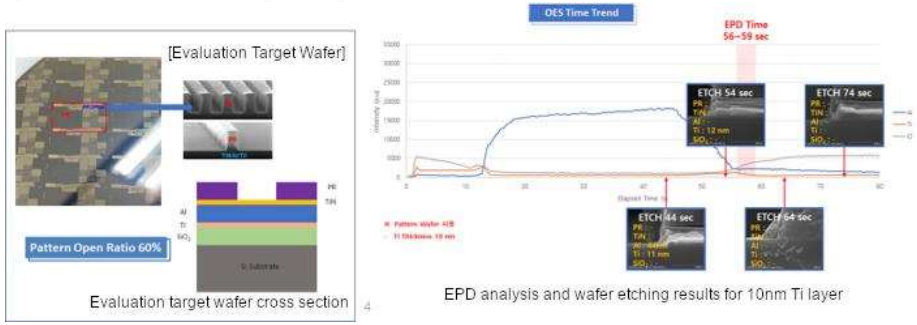
3. Products and Applications

(3) Higher resolution spectrometer solutions (1/2)

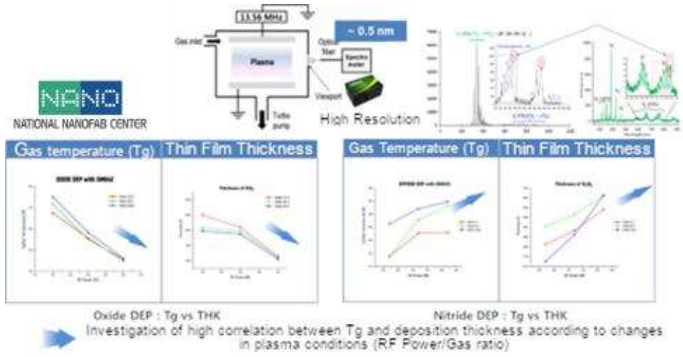
High Resolution Spectrometer

- Applied as a sensor for End Point Detection in Metal Etch processes, etc.
- Optimal end point recognition and process cost/time savings combined with a variety of statistical algorithms
- For spectroscopic electron temperature and gas temperature measurement / Raman spectroscopy in plasma chambers

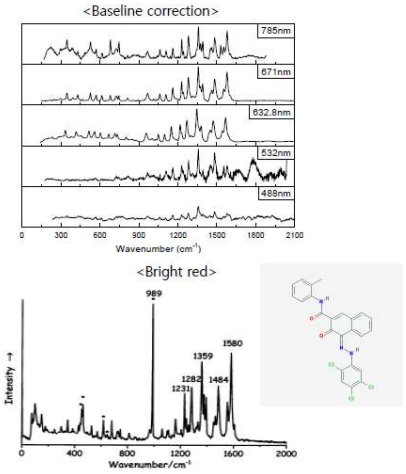




10 nm grade thin metal Film Etch EPD application example



Plasma electron/gas temperature measurement



Raman Spectral Analysis Example

SPECTRAL PRODUCTS

3. Products and Applications

(3) Higher resolution spectrometer solutions (2/2)

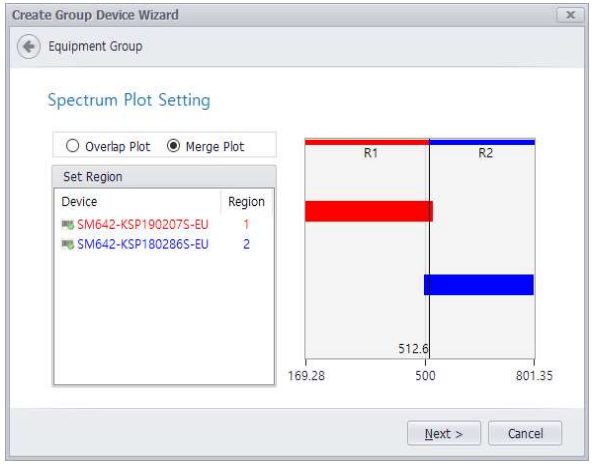
Multichannel Operation and Analysis

- Integrated analysis (Merge) of Multichannel USB and Ethernet Network with different wavelength bands

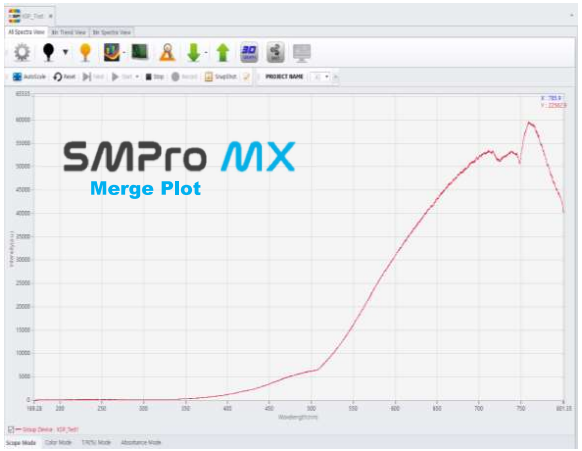
Built-in high-resolution spectrometer

	SM445 (TEAR-01)	SM445 (TEAR-02)
Feature	For high resolution, short-wave measurement	For high resolution, long wave measurement
Array Pixels	3648	
Wavelength area	350 – 640 nm	590 – 850 nm
Average Resolution	Max. 0.3 nm FWHM (<0.5 nm)	

2 Example of a channel embedded OES system and built-in high-resolution spectrometer specifications



Merge Plot Settings screen



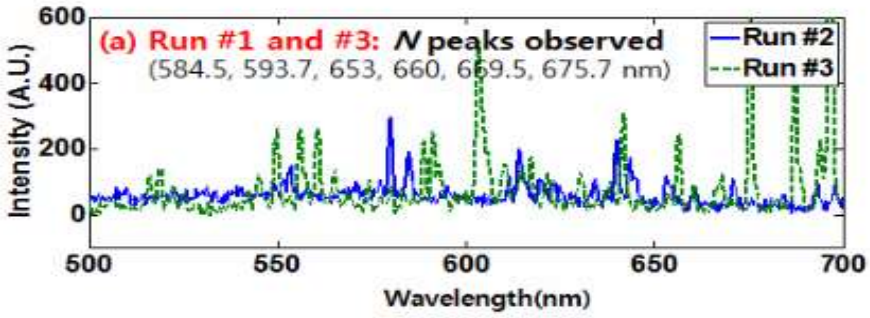
Outputs spectroscopy spectrum from different wavelength band spectrometers like a single spectrometer
(High resolution 350 – 850 nm Merge tungsten spectrum)

3. Products and Applications

(4) Spectrometer solutions for lower signal detection (1/2)

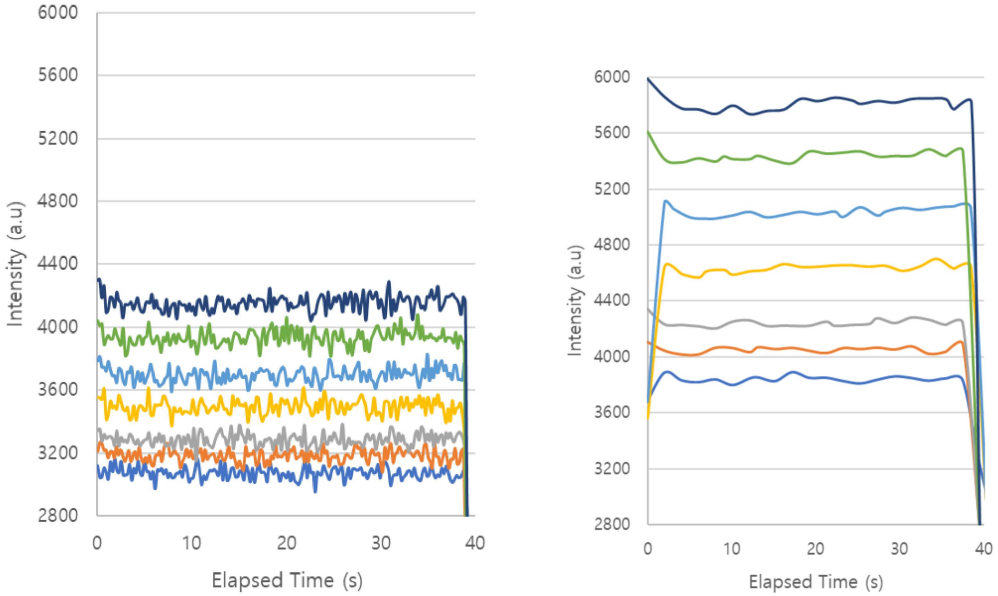
Low Spectrum Signal Detection and High Accuracy

- For luminescence signal analysis that requires high accuracy at very low spectral signals
- Strengthen customer competitiveness by replacing high-performance but expensive spectrometers from other vendors



Detection of Low Intensity Signal

Low SNR (High Noise) High SNR (Low Noise)



Example of signal discrimination according to spectroscopy Noise

3. Products and Applications

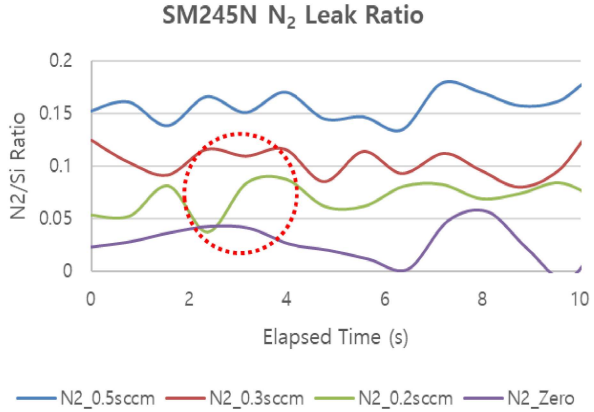
(4) Spectrometer solutions for lower signal detection (1/2)

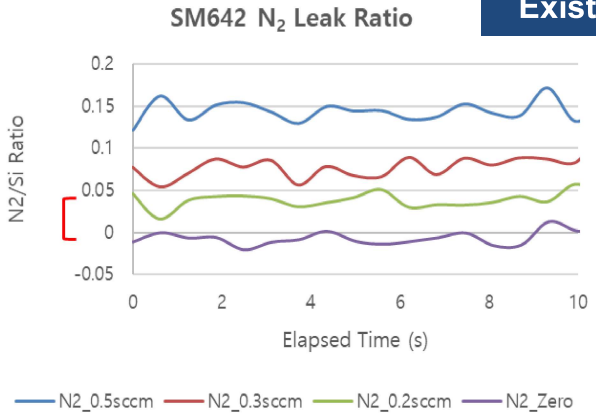
OES spectrometer for micro **leak** detection

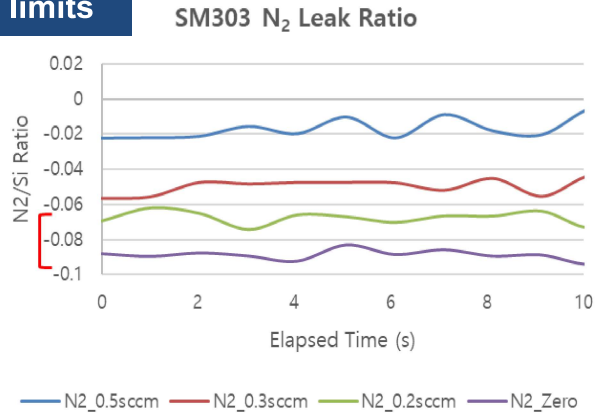
NEW! SM642F SM303F

As a network-based product
Coming soon

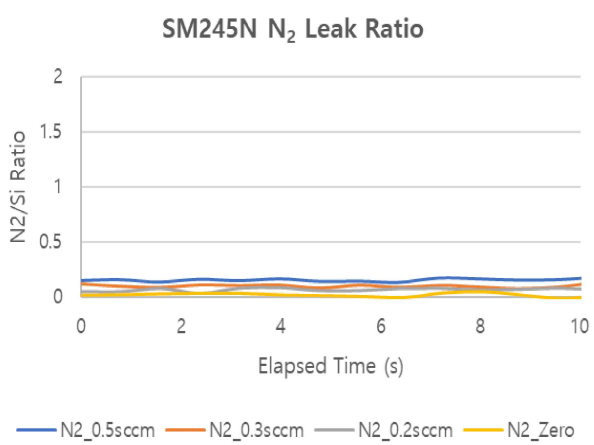
Existing limits

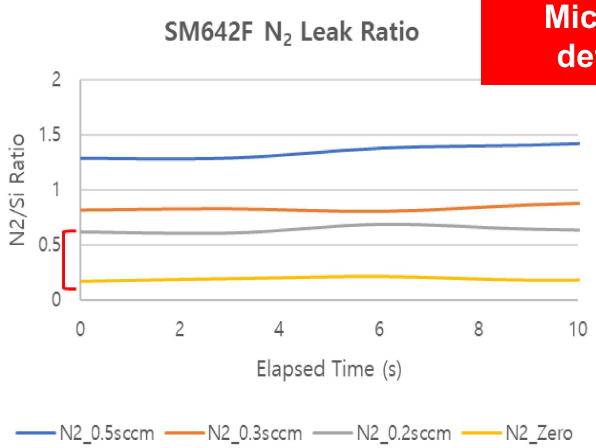


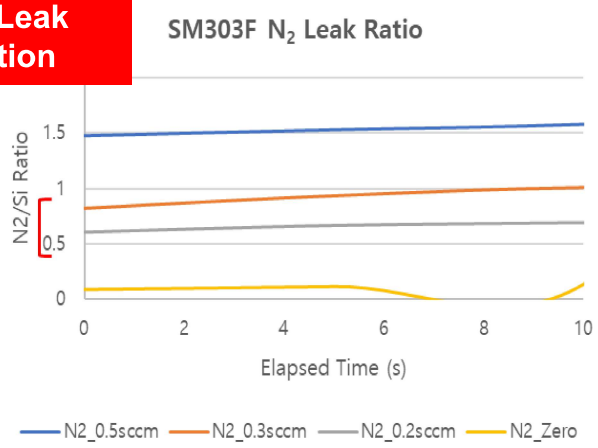




Micro Leak detection





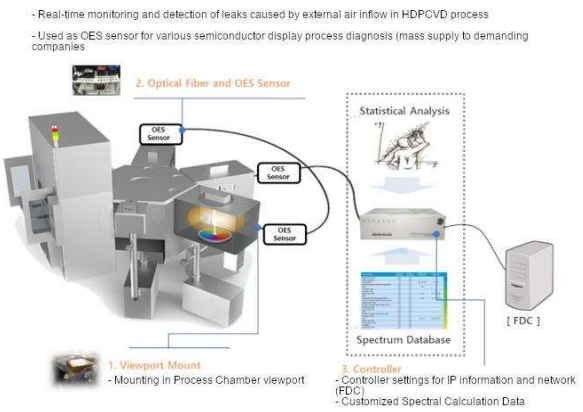


3. Products and Applications

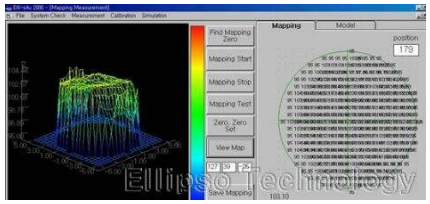
(5) Applications

Semiconductor Display Process Diagnostics

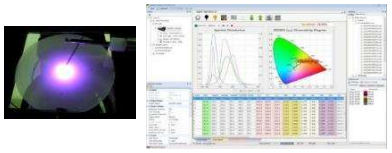
OES

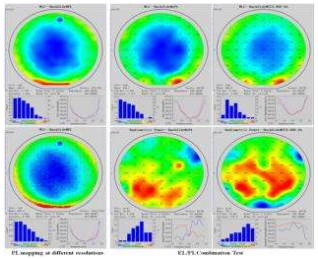


Ellipsometry

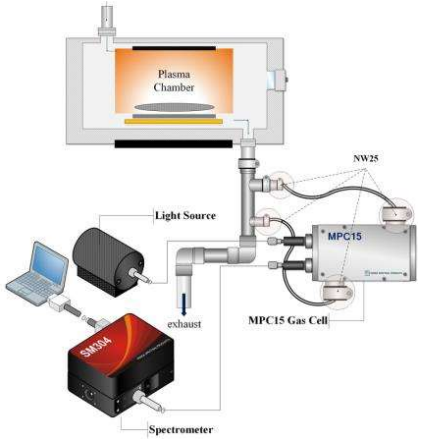


Colorimetry



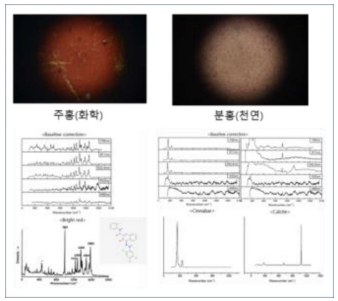


OAS

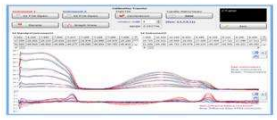


Environmental metrology and scientific analyzers

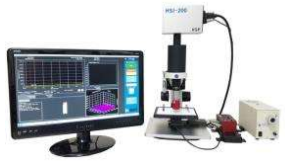
Raman / PL / EL

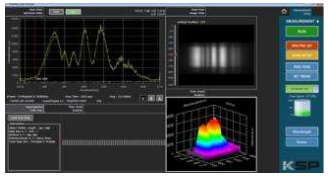


Spectrophotometry

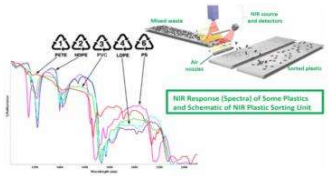


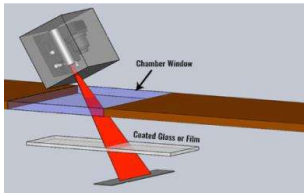
Hyperspectral Imaging





Material Analysis

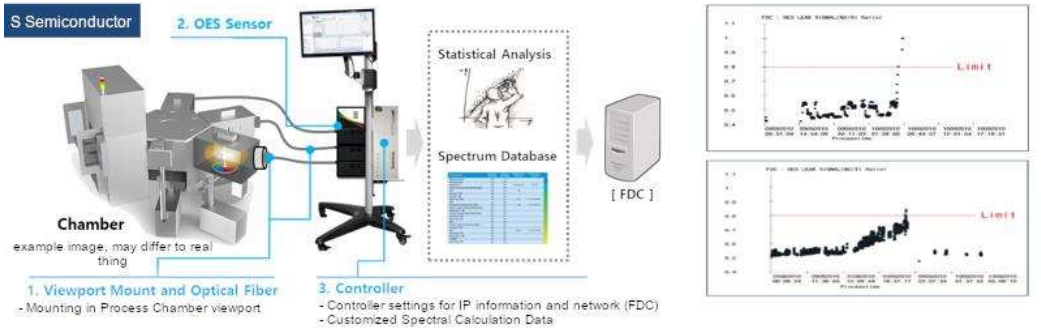




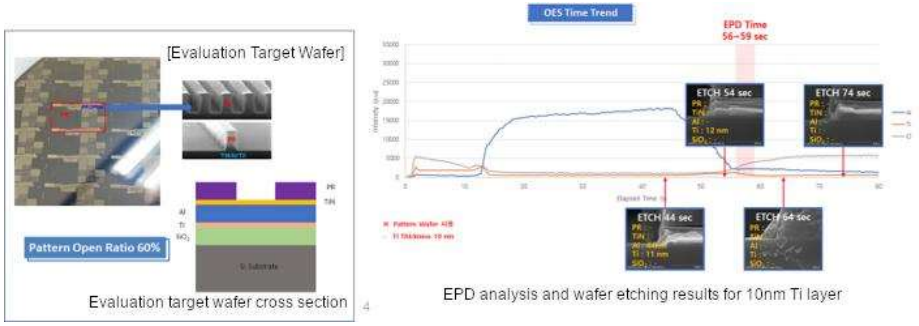
3. Products and Applications

(5) Applications – 1. OES (1/2)

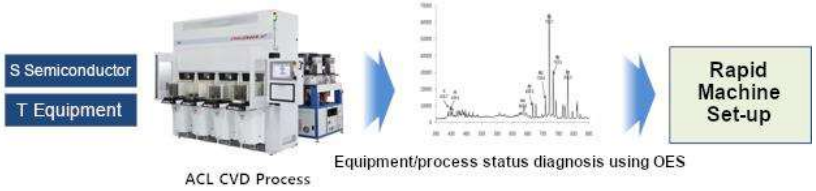
Leak Detection

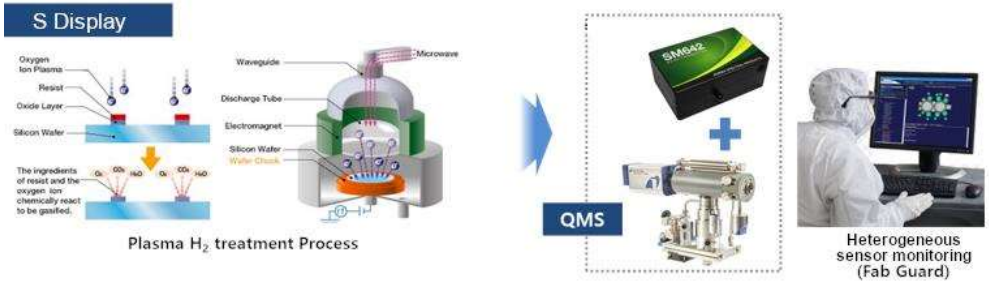


EPD of Thin Film Etch

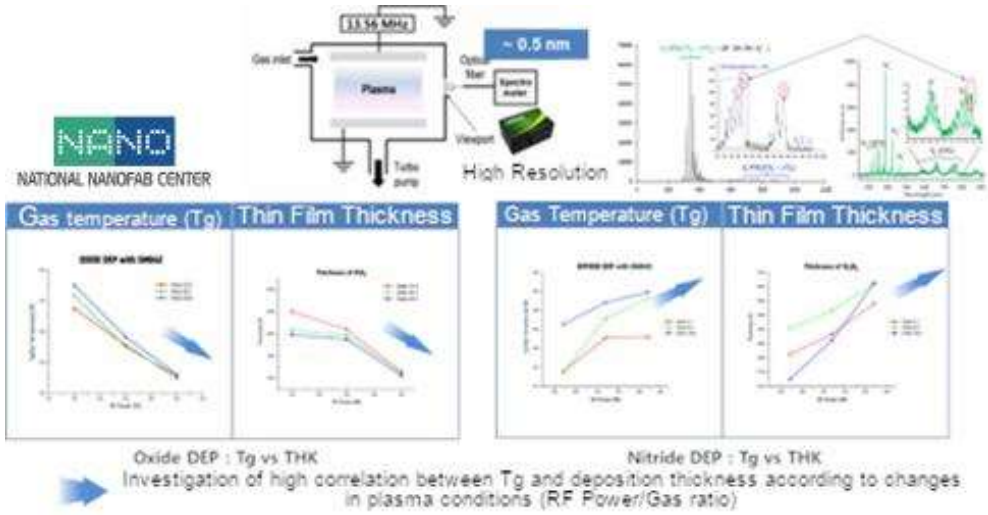


Advanced Process/Equipment Monitoring and Setup





Spectroscopic Electron/Gas Temperature Monitoring



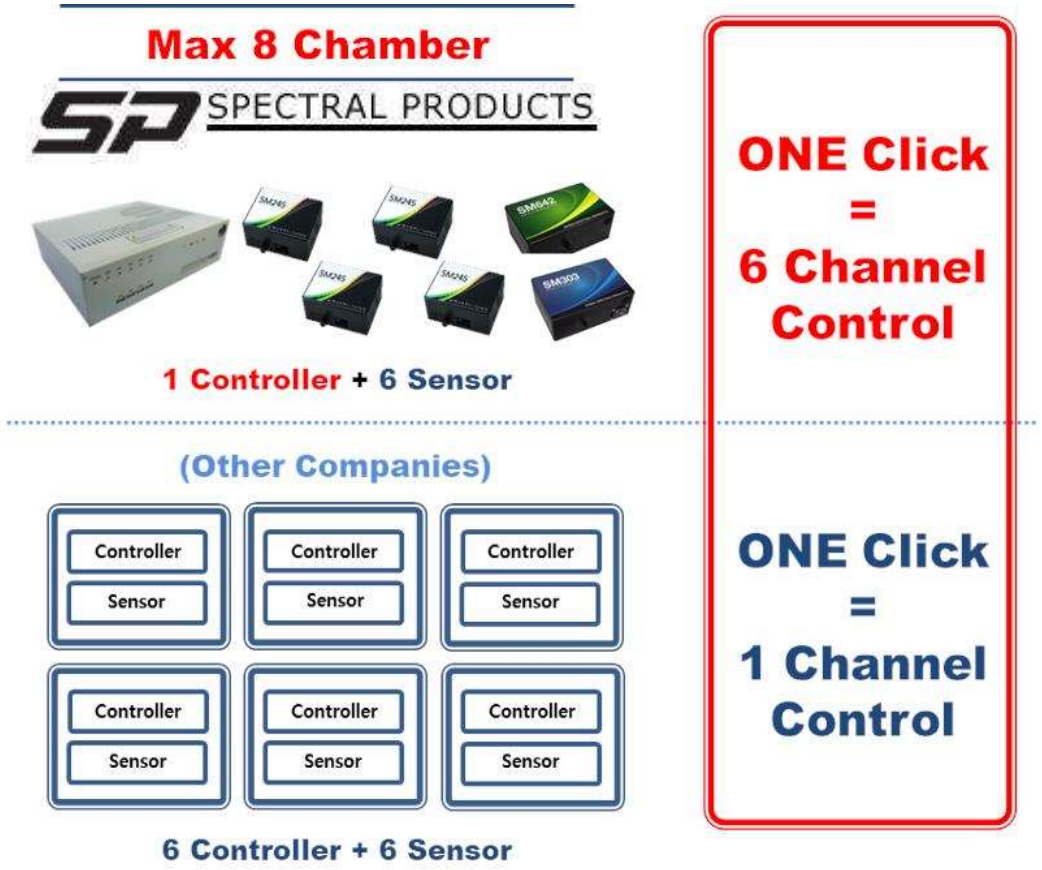
SPECTRAL PRODUCTS

(4) Applications – 1. OES (2/5)

Controller Based Multichannel Spectrometer(OES) System

- All of our spectrometers can operate up to 8 multichannel simultaneously with one controller, regardless of type

6 Chamber Example



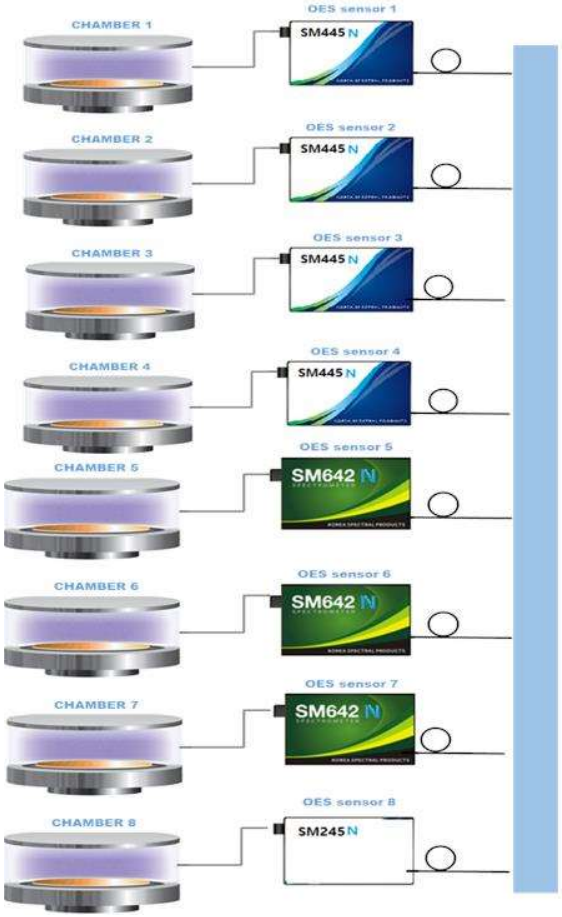
Spectral Products

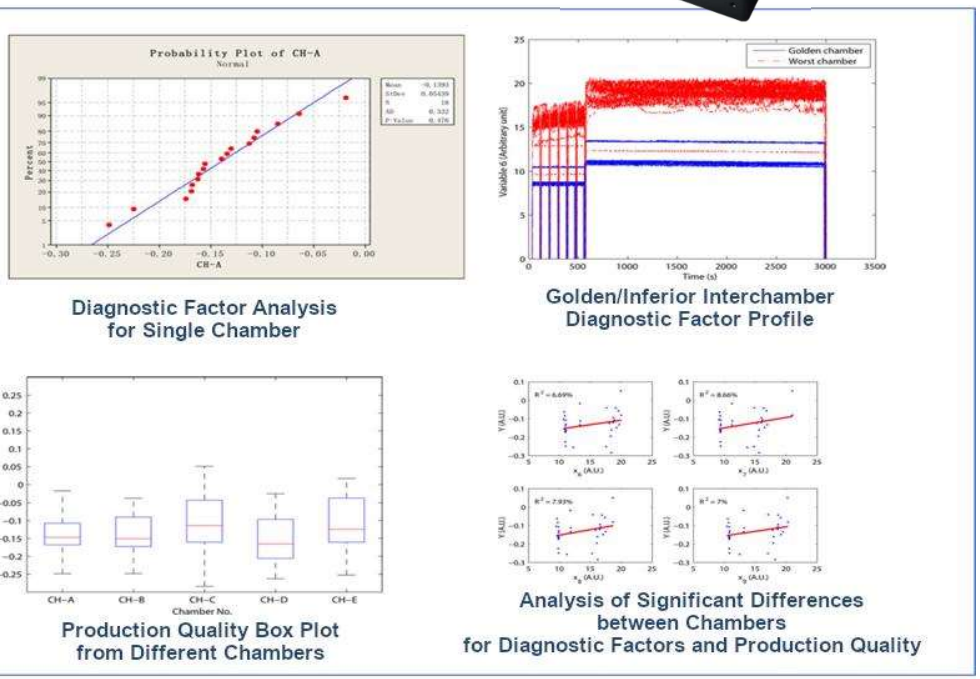
(4) Applications – 1. OES (3/5)

Network Based Multichannel Spectrometer(OES) System

Multichannel spectroscopy sensors based on network 34/7 controllers

Process monitoring and diagnostic factors self-calculation and delivery (modernization)
Provide high-quality information for machine-to-equipment tolerance and spread analysis





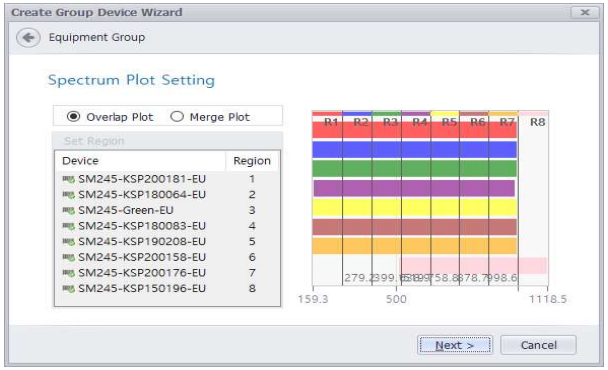
SPECTRAL PRODUCTS

(4) Applications – 1. OES (4/5)

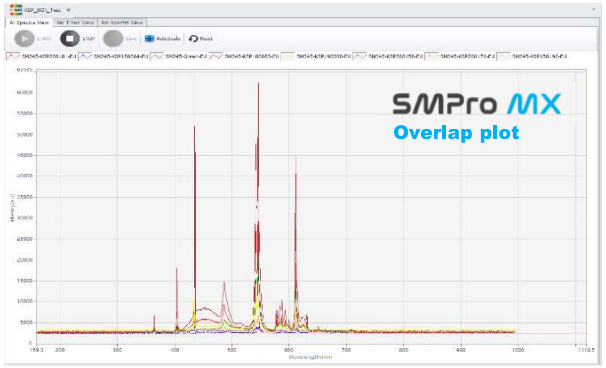
Multichannel Operation and Analysis

- Multi-windows & Overlap analysis of data from Multichannel USB and Ethernet Network spectrometers

8 Channel Ethernet Network spectrometer for simultaneous tungsten spectral measurement and multi-windows simultaneous analysis with one PC



Overlap Plot Settings Screen



Same wavelength band up to 8channel data simultaneous overlap output on a single graph

[Spectroscopy spectral output of different wavelength band spectrometers simultaneously]

Plasma Diagnostics in Semiconductor

1. Samsung Semiconductor : **Leak Detection**

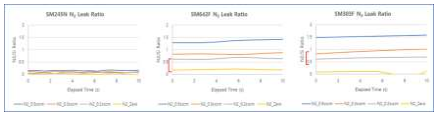
Controller

SM245-USB

2. Development and Customization : **Lower Leak Detection**

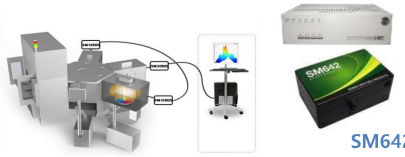
NEW!

SM642F SM303F



Evaluation Complete in Test Fab

3. Replacement old SM245-USB



Controller

SM642-USB

1. BOE, CSOT (Chinese Display) + SEMISYSCO

NEW!

Display Panel Plasma Etch EPD

SM303-2048

2. Sales Increased by growth of End User Market (Display Panel)

New End User : TIANMA (China)

NEW!

SM303F-2048

Upgrade Factor (V3.2)

(1) Power Stability

(2) GND/Earth Loop Stability

+ Testing SM245N

3. Expansion of Sales Volume with SEMISYSCO

(1) Change OEM : USB2000 to SM245N

(TCP/IP + Digital Potentiometer)

(2) New more Production Lines need SM303-2048

(BOE/CSOT in China)

1. Samsung Display + EL : **Realtime CVD Thickness Measure**

NEW!

SM245N

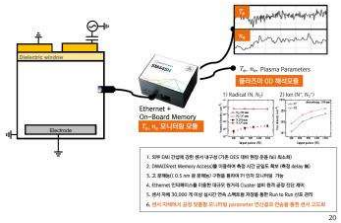
+ Testing SM642N

NEW!

2. Expansion of Sales Volume

(1) Confirmed : SAMSUNG Display (Supply to all PECVD facility)

(2) Waiting Evaluation Test : SK Hynix, SEMES, Equipment Companies



Report from KFE (2021.10)

(3) New Application : Plasma Dicing EPD (YESTI company)

1. Korea Fusion & Energy (KFE : National) : Electron Density etc

NEW!

SM445N

+ Upgrade : Internal Calculation for Machine Learning

Replacement : USB4000 to SM445N

Reporting to SEMI market from KFE

SPECTRAL PRODUCTS

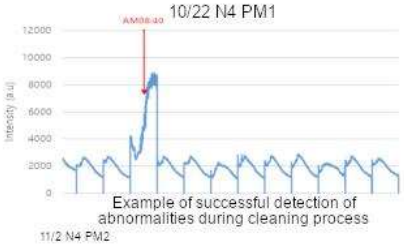
CONFIDENTIAL

3. Products and Applications

(4) Applications – 1. OES (5/5)

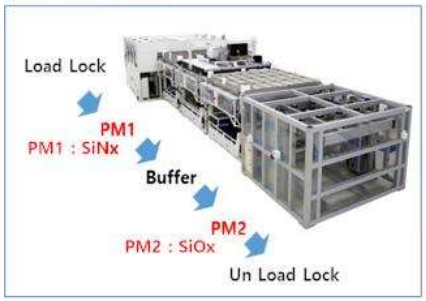
Plasma Cleaning Condition Monitoring (Vacuum)

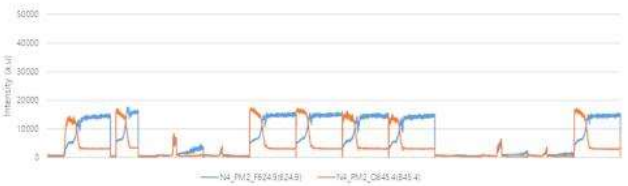
Cleaning condition
- NF_3 + Ar
- Power : 4,500-6,000 W



Example of successful detection of abnormalities during cleaning process

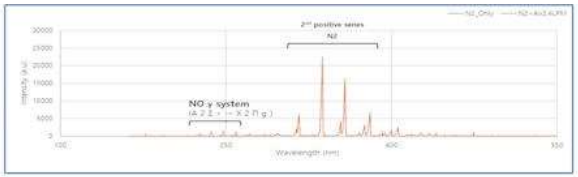
L Electronics





Take advantage of real-time cleaning process monitoring
(F and O radical EPD trend)

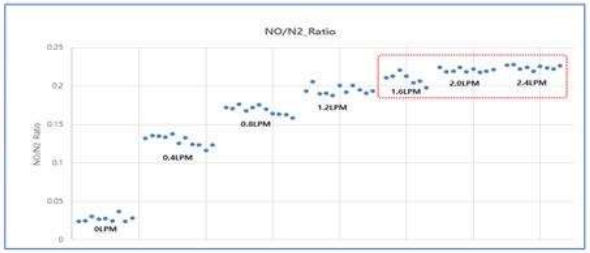
Plasma Cleaning Condition Monitoring (ATM)



Results of overpressure plasma diagnosis using OES

S Display

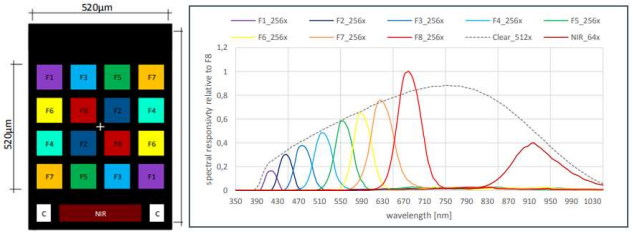
Rapid process/ equipment transfer from Mother Fab to overseas factories



Analysis of changes in plasma efficiency based on air infusion

Multispectral Detection System

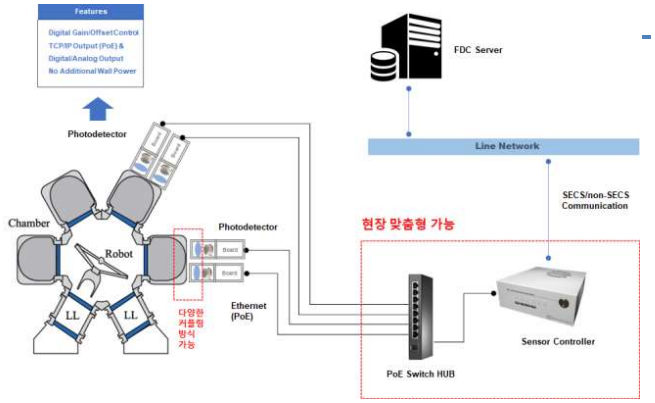
SAMSUNG Display : Multispectral Photodetectorfor EPD



Multispectral Photodetector
with PoE ethernet

Model : MPS7 (7-channel Ethernet)

SAMSUNG Display : Remote Plasma Cleaning EPD



- OEM Request
- All PECVD
in Samsung Display

SPECTRAL PRODUCTS

CONFIDENTIAL

3. Products and Applications

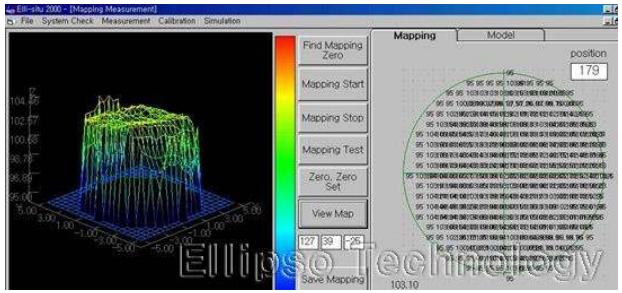
(4) Applications – 2. Ellipsometry

SE & SR(Spectroscopic Ellipsometer/Reflectometer)

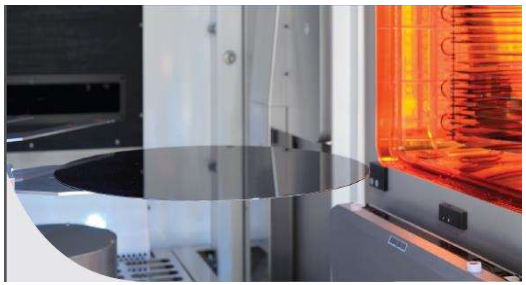
K

E

Customer SE with SM642



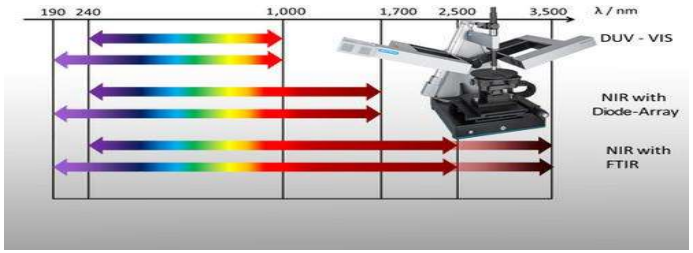
Thin film thickness 2D Profile example

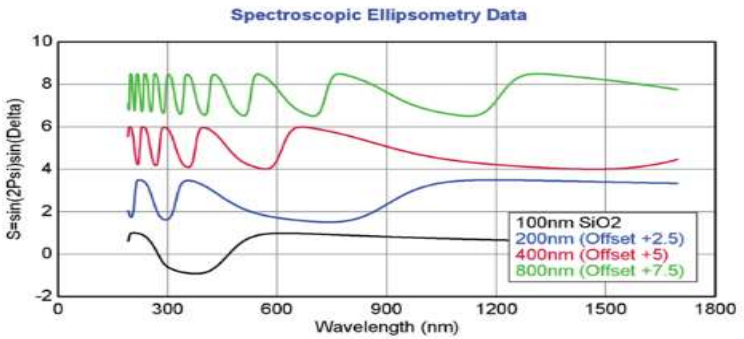


CM110 Monochromator & Inspection System

SE and SR sensor for High Thickness Film

Muller-Matrix Ellipsometer (KRISS)





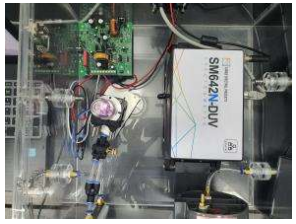
Up to 1,800 nm wavelength band
100 to 800 nm THK SiO2 Thin Film Thick Ellipsometric Data

SPECTRAL PRODUCTS

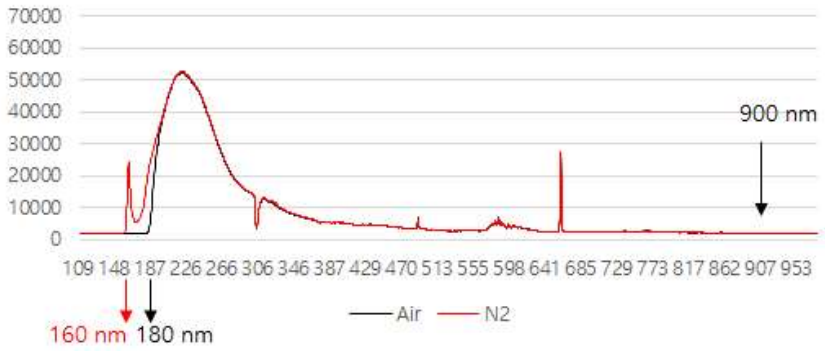
DUV Spectrometer for Ellipsometry

Request from AUROS Technology : DUV Spectrometer

SM642N-DUV



Evaluation in N2 purge Chamber



World First Wide Range DUV Spectrometer Developed
- Spectral Range : 160 – 900 nm in N2 purge

Ultra thin / thick film measurement OEM

AUROS Technology

- SE(Spectroscopic Ellipsometer) Inspection
- Compete with KLA Tencor
- OEM Request : SM642N-DUV + SM304N

Competitor : KLA Tencor Inspection System

SPECTRAL PRODUCTS

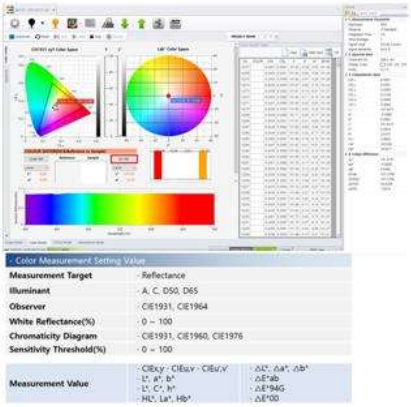
CONFIDENTIAL

3. Products and Applications

(4) Applications – 3. Colorimetry

Compact Color and Absorbance Measur

- Compact configuration for real-time reflection measurement to measure chromaticity
- Optical properties and change analysis of materials through permeability measurement



S/W for analyzing different colors

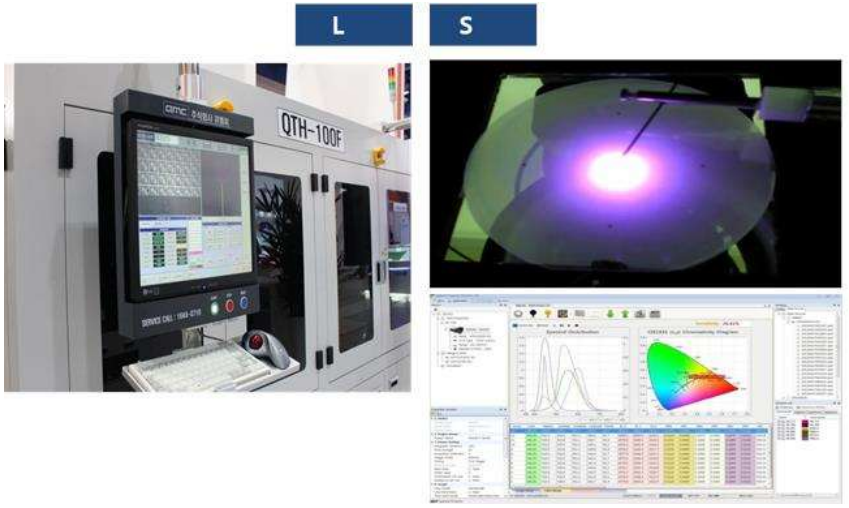
Configure reflection chromaticity measurements

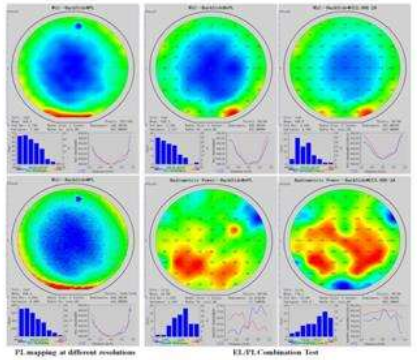
Transmission/absorbance measurement configuration

Various Measurement Accessories

LED/Display Tester for Photometry and Radiometry

- Tester equipment sensor for LED light characteristics transfer inspection used as Backlight for LCD display
- Photometry and radiometry inspection equipment sensors for a variety of light sources





Produced LED wafer-specific light characteristics spread analysis results

SPECTRAL PRODUCTS

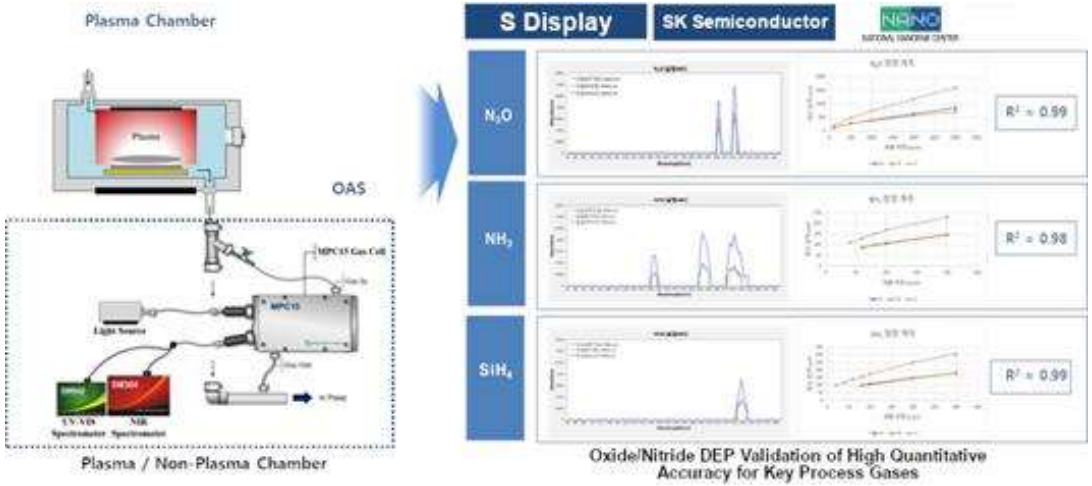
3. Products and Applications

Spectral Products

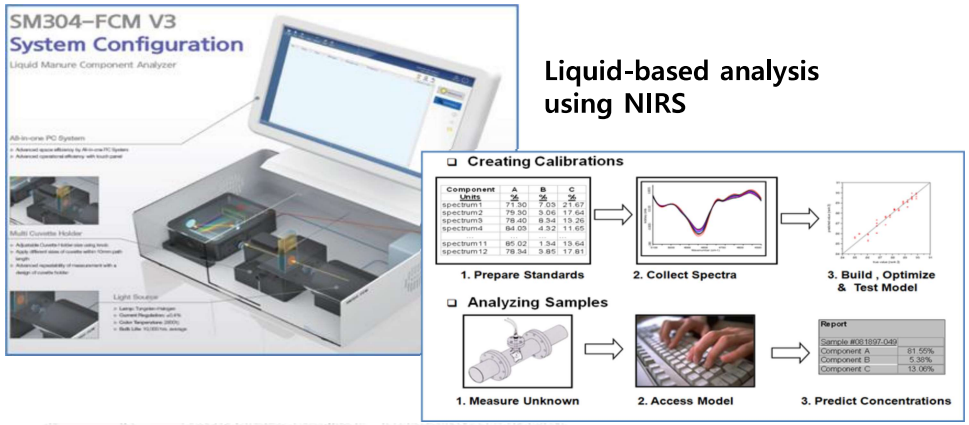
(4) Applications – 4. OAS & Spectrophotometry

ATM - Water Vapor Absorption Measurement

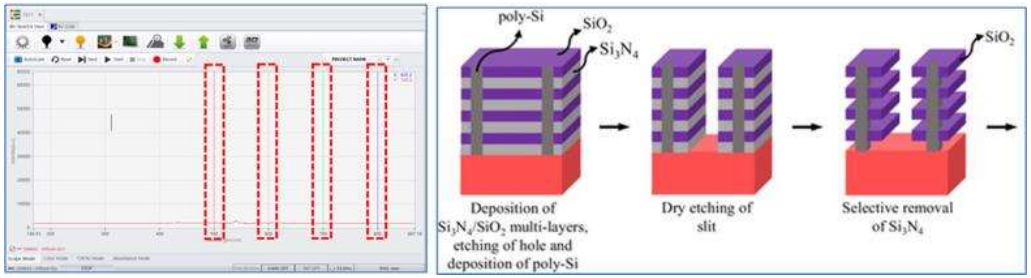
VAC - Exhaust Gas Absorption Monitoring



Liquid Chemical Absorption Measurement



Monitoring changes in wet chemical concentration through spectrum selection and analysis



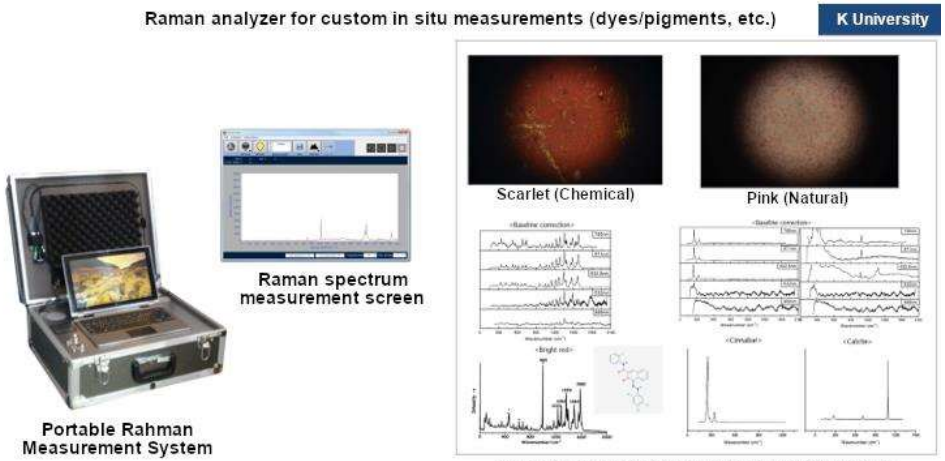
SPECTRAL PRODUCTS

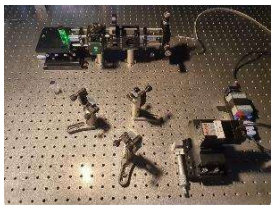
3. Products and Applications

Spectral Products

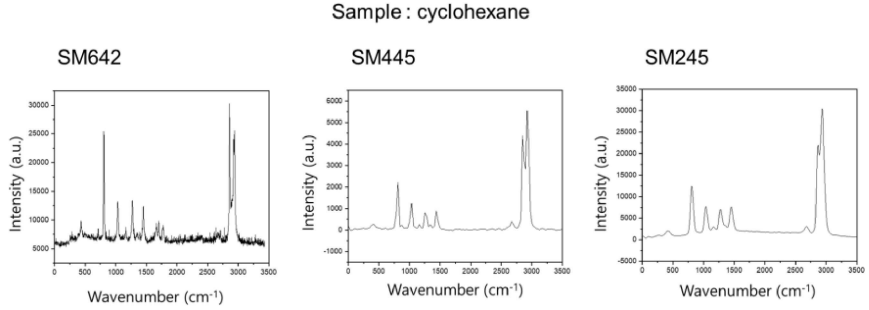
(4) Applications – 5. Raman & Infrared

Raman Spectrum Analysis



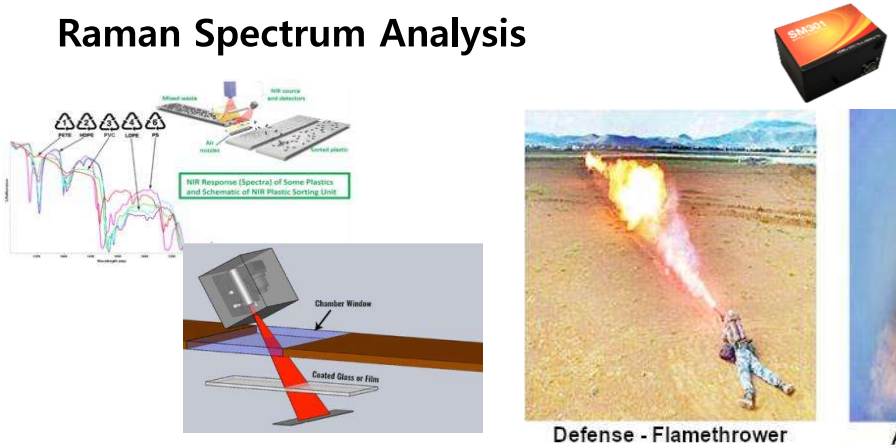


Raman Experimental Setup



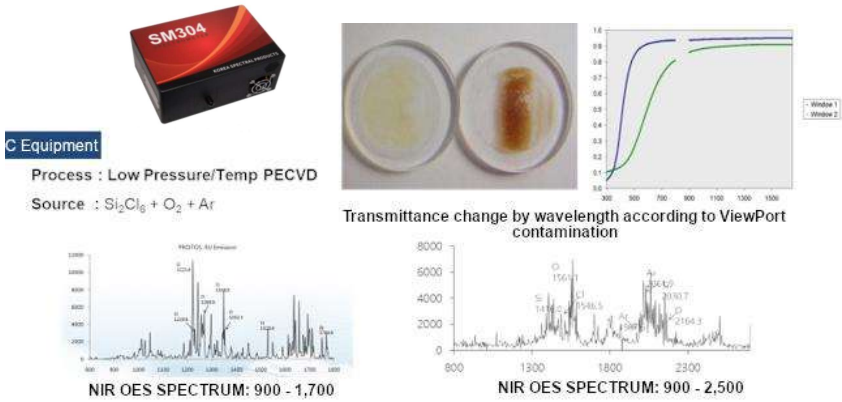
Raman Spectrum measurement results by spectrometer

Raman Spectrum Analysis



Defense - Flamethrower

Aerospace - Rocket Propulsion



Plasma measurement example using NIR OES

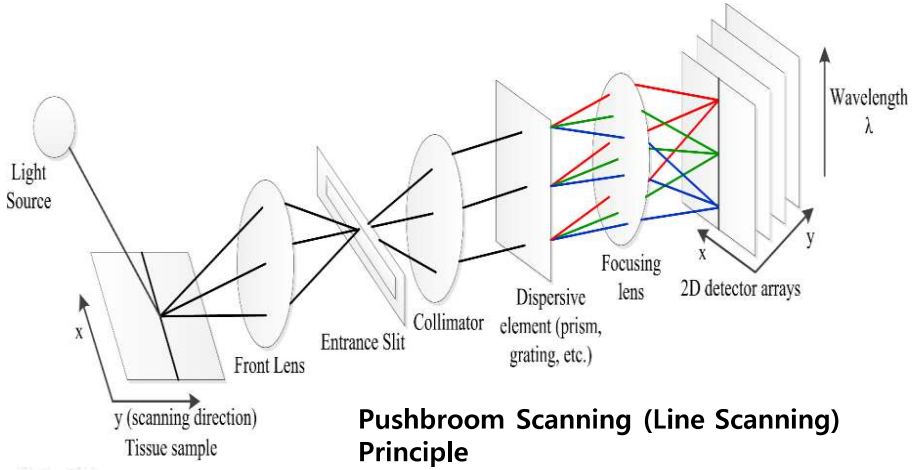
SPECTRAL PRODUCTS

3. Products and Applications

Spectral Products

(6) Applications – 6. Hyperspectral Imaging

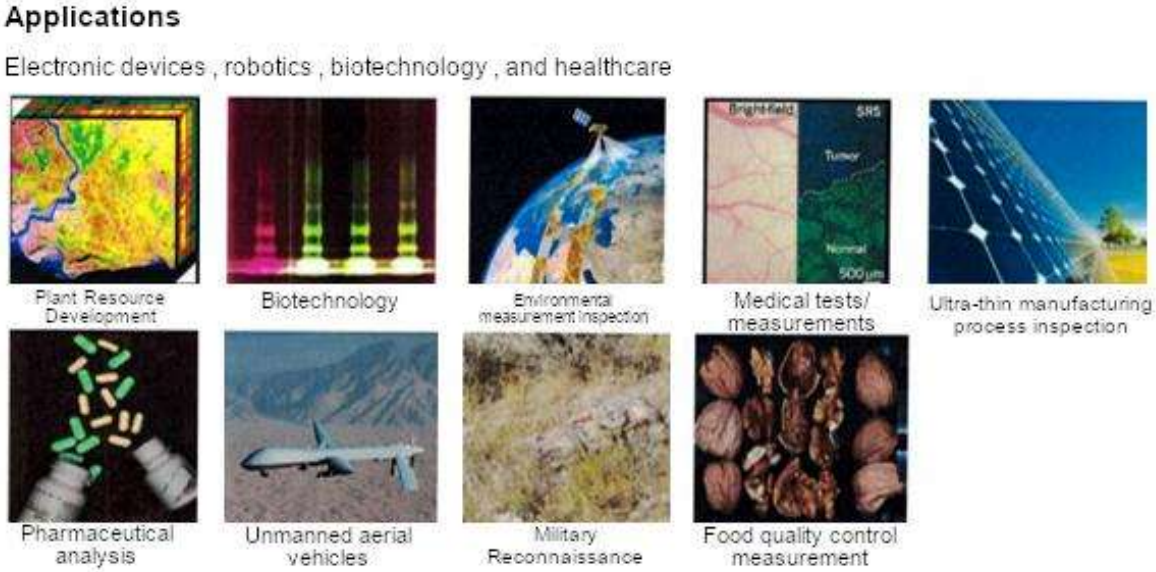
Imaging Spectrograph & Hyperspectral Imaging

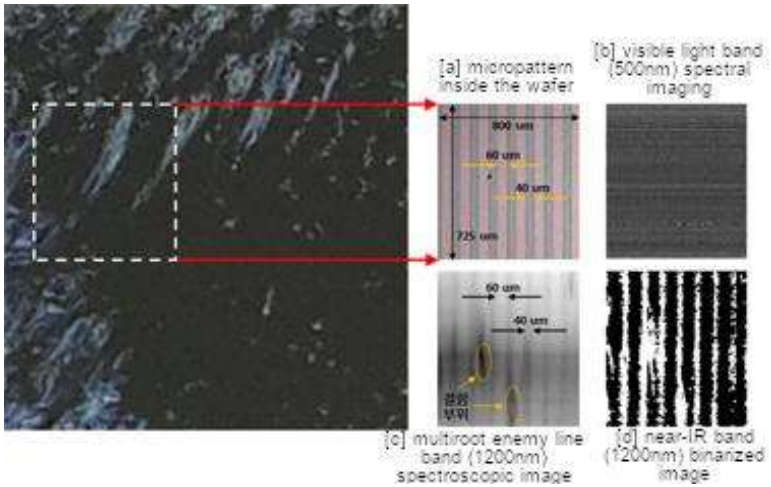


Pushbroom Scanning (Line Scanning) Principle

3D-IC Internal Defect Inspection

Microscope-based hyperspectral imaging device H/W and S/W





Example of 3D-IC internal defect detection through hyperspectral image analysis

Liquid Particle Counter (LPC) systems

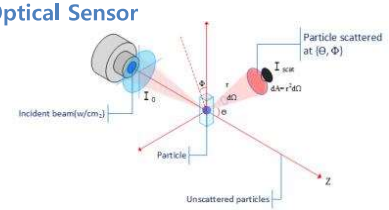
Development procedure

1. 1st development : Laboratory LPC System.

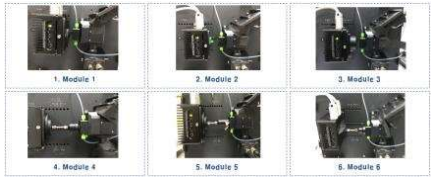
(1) Liquid Particle Counter (LPC)

Particle Detection Method : Light Scattering
Redirected light energy (Scattering)
Measurement of particles >0.15 micron

(2) Optical Sensor



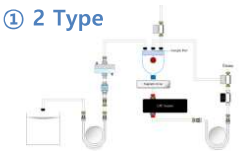
DPSS Laser (532nm), Flow Cell, Avalanche photodiode, Optics



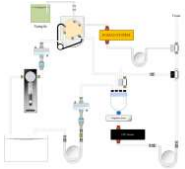
[Optical Module]

(3) Flow Control System (Liquid Flow & Control)

① 2 Type



[Manual Sampling]

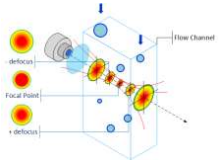


[Auto Sampling]

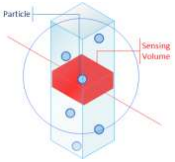
② Auto Dilution Technology

2. 2nd development : General Purpose LPC

(1) Optical Sensor Product Line-up

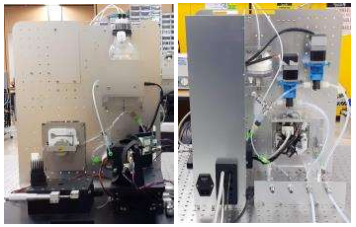


① SM-Micro
Range : 0.15 – 0.5μm
(Focused Beam Type)

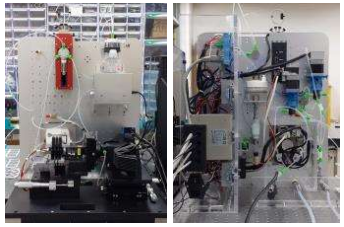


② SM-LB
Range : 0.5 – 5.0μm
(Line Beam Type)

(2) Flow Control System Line-up



[Manual Sampling]

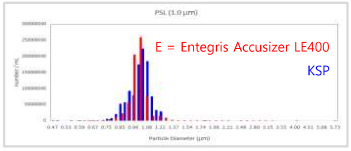


[Auto Sampling]

3. Calibration ISO 11171 & ISO 21501-2

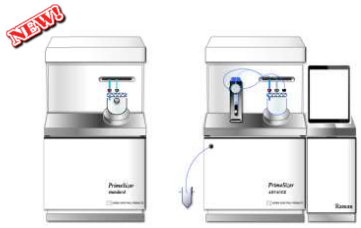
4. Comparison Testing

Manufacture : Rion (Japan), Entegris PSS (USA)



① Counting efficiency ② Size Resolution

5. demonstration instrument (Customer : DONGJIN SEMICHEM, in December)



Model Name : Primesizer

SM-LB 1st release (First Half of 2022)
SM-Micro 2nd release (Second Half of 2022)

6. Application

(1) SEMICONDUCTOR

① CMP Slurry QC (Large Particle Monitoring)

② CMP Process Filter TEST

(2) Food & Beverage

- Particle Size Distribution, "Mouth Feel"

(3) Pharmaceutical

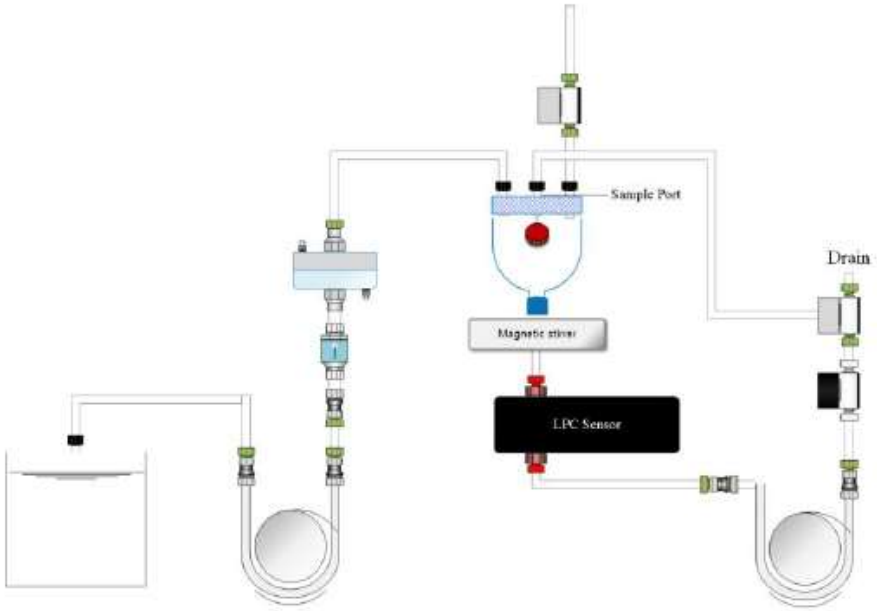
- Particle Size Distribution

CONFIDENTIAL

Liquid Particle Counter (LPC) systems

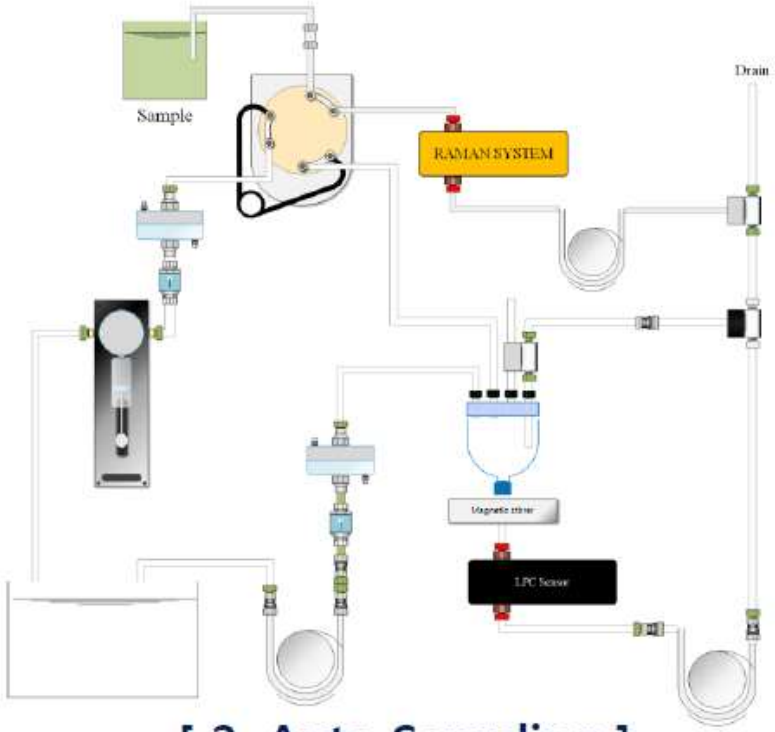
Two different Flow control systems

① LPC oriented Flow Control System



[1. Manual Sampling]

② Flow control System for Raman fusion type



[2. Auto Sampling]