Wavelight Technologies

# SPECTRAL INSTRUMENTS

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**Wavelight Technologies** has been developing and manufacturing advanced laser and spectral systems for various industrial, medical, and scientific applications. With a focus on precision and innovation, the company handles the full cycle of operations — from applied research and product development to production, quality control, and international distribution. Our products are successfully used in more than 30 countries worldwide.

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# MONOCHROMATORS SPECTROGRAPHS

# MONOCHROMATOR
# **WM100**


> The WM100 is a compact, high-intensity shortfocus monochromator that operates in the 200-1200 nm spectral range.

The WM100 monochromator comprises a turret with two diffraction gratings produced by Edmund Optics, USA. Spectrum scanning and diffraction gratings switching are computer controlled. Entrance and exit slits are changeable; they are mounted on two six-position discs. Each disc contains six spectral slits pre-aligned by the manufacturer. To change the slit width you just need to manually rotate the knob moving it to one of its six fixed positions. Indicators on the WM100 housing show the widths of entrance and exit slits, and the software allows calculating the spectral width of the selected wavelength.

Being a scanning monochromator, the WM100 does not have a flat output field, and therefore it cannot be used as a spectrograph with a multi-channel detector installed at the output port. The WM100 supply set contains two optical fiber adapters and two fused silica condensers. The condensers and fiber adapters can be installed at the entrance and/or exit slit. The condenser is used to focus light onto the monochromator's entrance slit as well as focus light coming from the monochromator onto the sample. Fiber adapters allow light to be transferred to/from the monochromator using optical fibers (SMA-905 connectors).

## OPTICS & ACCESSORIES

The WM100 Vmonochromator has a wide range of options and accessories that provide efficient light collecting from the sample located at a finite distance and at infinity, delivering light to the monochromator with and without an optical fiber.

### Features

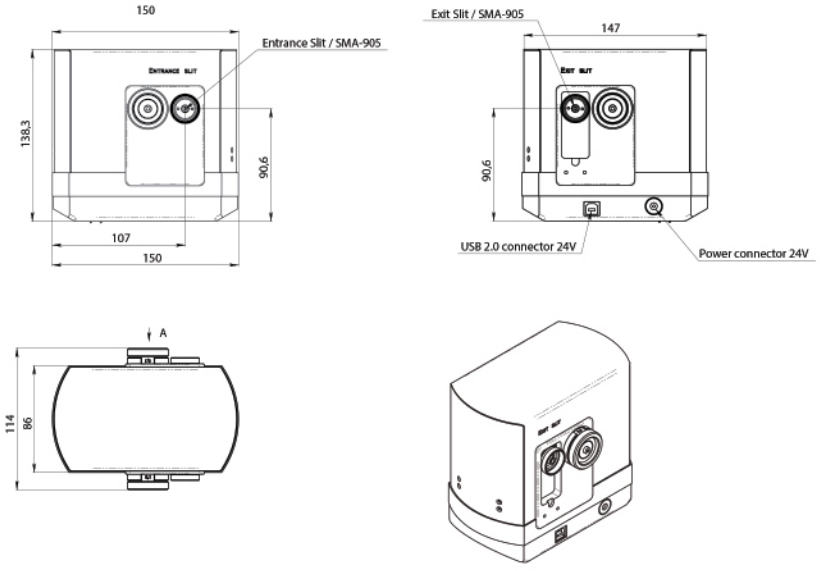
- Extremely high aperture f/2,9
- Quick slit changing
- Compact size and light weight
- Aperture Matching Adapters
- Optical fibers
- Cassegrain Objectives
- Condensers

### Application

- As an efficient spectral selection instrument for the investigation of detectors and light sources
- As a narrow-band tunable filter for broadband fluorescence excitation sources
- As an order separator in spectral instruments containing Echelle diffraction gratings
- In other research and analytical equipment operating in the UV, visible and NIR spectral ranges
- For spectroscopic education in colleges and universities

## Specifications

| | | |
|---|---|---|
| Spectral range, nm | 200 - 1200 | |
| Focal length of the collimator and camera lenses, mm | 44,2 | |
| Aperture ratio | f/2,9 | |
| Diffraction gratings | | |
| Grating dimensions, mm | 25 x 25 x 6 | |
| Grooves/mm | 1200 | 600 |
| Blaze wavelength, nm | 300 | 500 |
| Reciprocal linear dispersion (average), nm/mm | 18,7 | 34,7 |
| Spectral range, nm | 200 - 600 | 600 - 1200 |
| Wavelength of automatic change of grating, nm | 600 (program controlled) | |
| Tuning step by angle, deg | 0,01875 | |
| Tuning step by spectrum, nm | 0,125 | 0,25 |
| Wavelength position accuracy, nm | ± 1,0 | ± 1,5 |
| Wavelength repeatability, nm | ± 0,25 | ± 0,5 |
| Scanning speed, nm/s | 200 | 400 |
| Wavelength switching time, s | | |
| minimal | 0,001 | |
| maximum | 38,4 | |
| Entrance/exit slits (changeable) | | |
| Slit width, mm | 0,02; 0,05; 0,1; 0,25; 0,5; 1,0 | |
| Slit height, mm | 3,0 | |
| Spectral range chosen by ML44 of entrance and exit slits width(average), nm | | |
| 20 µm | 0,35 | 0,7 |
| 50 µm | 0,9 | 1,8 |
| 100 µm | 1,8 | 3,5 |
| 250 µm | 4,5 | 8,9 |
| 500 µm | 9,0 | 17,7 |
| 1000 µm | 18,0 | 35,5 |
| Optical input/output | - Optical fiber adapter SMA-905<br>- Condenser F=16 mm | |
| PC connection | USB | |
| Dimensions, mm | 138,5 x 114 x 147 | |
| Weight, kg | 2,1 | |




WM100 Dimensions

# MONOCHROMATOR/SPECTROGRAPH **WM200**


> The WM200 is a compact, short-focus & multifunctional instrument that offers a unique combination of performance specifications. It is equipped with all the essential options for large-sized monochromators and spectrographs.

## Features

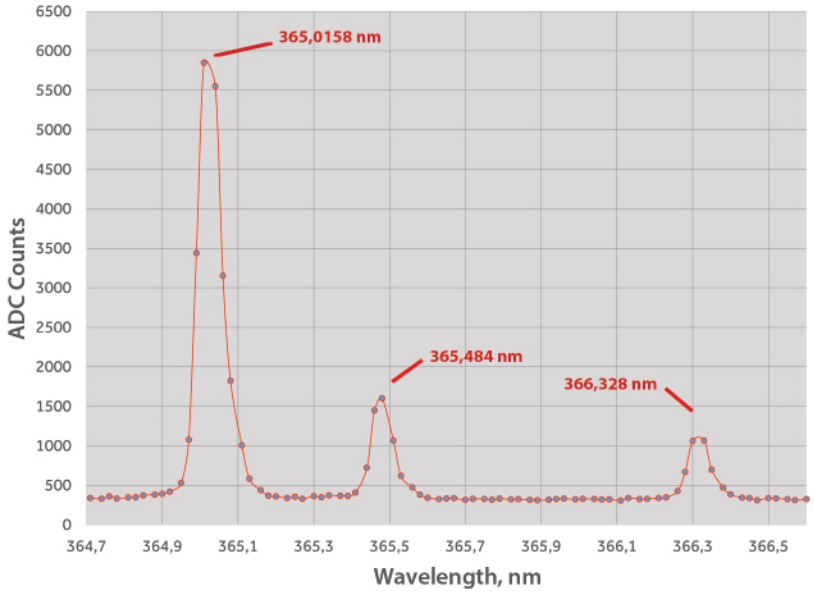
High aperture ratio (f/3,6) of the WM200 allows it to be used for a wide range of applications, including fluorescence, reflectance, and transmission measurements from the UV to IR spectral range, as well as analysis of light sources and multi-channel spectroscopy. Low level of stray light, due to the high quality of the optical scheme and the careful engineering of the instrument housing, provides an optimum signal-to-noise ratio. Up to three diffraction gratings mounted on the automated turret cover a wide spectral range with the use of just one compact device. Both output ports of the WM200 provide fully functional flat fields of 30x10 mm, allowing you to connect either two exit slits, an exit slit and a multichannel detector, or two detectors concurrently.

The high degree of automation in the WM200 system allows for scanning and changing of diffraction gratings, order separating filters, adjusting the entrance slit width, and automated background subtraction through shutter control. Both exit slits of the WM200 are equipped with precise mechanisms for slit focusing. These precise and easy-to-use mechanisms are provided by the detector adapters. wavelight technologies software enables automated control of the WM200 and its detector. It allows stitching spectra obtained by several diffraction gratings in order to get a panoramic spectrum. Many possibilities of spectra processing and analysis are provided as well. SDK, DLL program modules and/or LabVIEW drivers are supplied with the WM200 for controlling the instrument via the customised software or LabView.

## Application

- Fluorescence and Raman Spectroscopy
- Absorbance, Transmission and Reflectance measurements from the UV to IR spectral range
- Multichannel Spectroscopy
- As a spectral selection device for user with a streak-camera

# WM200 ADVANTAGES




Mercury lamp lines (365,0158 nm, 365,484 nm, 366,328 nm) registered by WM200 (diffraction grating 1800 gr/mm) demonstrate high optical quality of the instrument

The scanning monochromator/spectrograph WN200 is made according to an asymmetric Cherny-Turner scheme with a focal length of 142 mm. The WM200 output ports may hold either two exit slits, or one exit slit and a detector, or two detectors simultaneously. Direct (axial) and lateral (radial) output ports operate alternately. Switching between the output ports is effected manually with the Port Switcher located at the upper cover of the instrument. The switcher moves the folding mirror, which directs light to the lateral (radial) output port. If the switcher is off, light goes to the direct (axial) output port. The large flat field on the output of the WM200 30x10 mm ensures a wide simultaneous spectral range and the ability to automatically stitch together several scanned spectra.

## OPTICS & ACCESSORIES

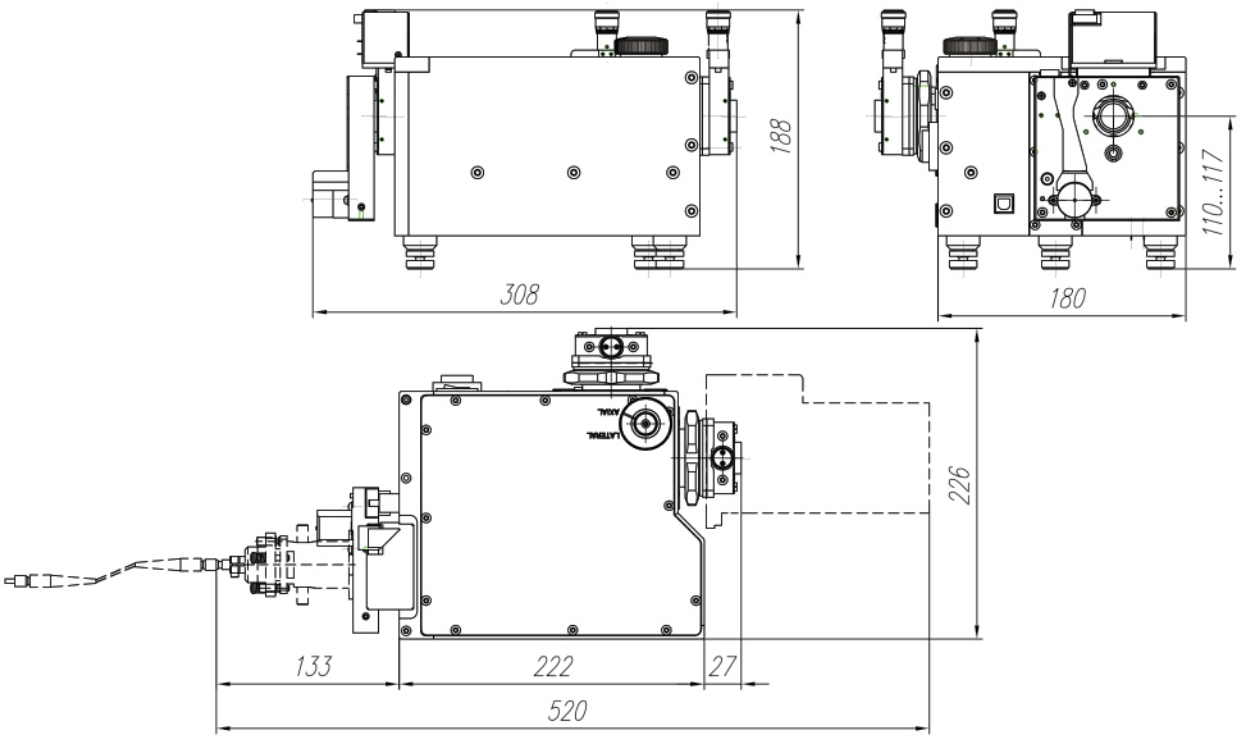
The WM200 monochromator/spectrograph has a wide range of options and accessories that provide efficient light collecting from the sample located at a finite distance and at infinity, delivering light to the monochromator with and without an optical fiber, effective aperture matching of the optical fiber and monochromator.

- Order Separating Filters Wheel
- Aperture Matching Adapters
- Light-collecting Condensers
- Crossed Entrance Slit (optionally installed instead of the Standard Entrance Slit)
- Optical Fibers
- Adapters for attaching CCD detectors
- CCD detectors
- Cassegrain Objectives

## Specifications

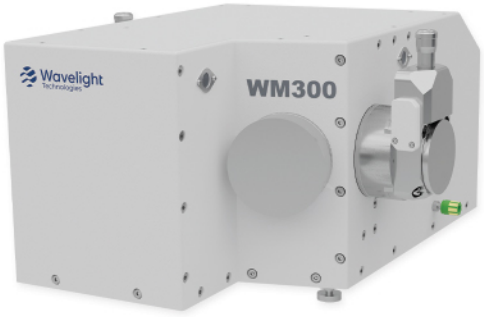
| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Optical scheme | Optimized Czerny-Turner with one optical input and two outputs | | | | | | | | | |
| Spectral range | Typical 190 - 3600 nm; extended up to 15 µm at your request | | | | | | | | | |
| Aperture ratio | f/3,6 | | | | | | | | | |
| Focal length, mm | 142 | | | | | | | | | |
| Flat field, mm | 30 x 10 | | | | | | | | | |
| Diffraction gratings | 40 x 40 x 10 mm; Turret with 3 gratings from the list below1) | | | | | | | | | |
| Grooves/mm[1)] | 1800 | 1200 | 900 | 600 | 600 | 400 | 300 | 200 | 100 | 100 |
| Blaze wavelength | 270 | 400 | 600 | 750 | 1000 | 800 | 1500 | 1500 | 2000 | 500 |
| Reciprocal linear dispersion (average) nm/mm | 3,2 | 4,9 | 6,4 | 9,8 | 9,4 | 15,2 | 20,1 | 30,4 | 63,0 | 68,0 |
| Spectral range [2)], nm | 190 - 540 | 265 - 800 | 400 - 1200 | 500 - 1500 | 660 - 2000 | 530 - 1600 | 1000 - 3000 | 1000 - 3000 | 1330 - 4000 | 330 - 1000 |
| Multi-channel detector concurrent registration spectral range (average), nm | 81[3)] | 126[3)] | 165[3)] | 250[3)] | 120[4)] | 194[4)] | 257[4)] | 388[4)] | 800[4)] | 870[4)] |
| Spectral resolution (average), nm | 0,2[3)] 0,13[5)] | 0,3[3)] 0,2[5)] | 0,4[3)] 0,27[5)] | 0,6[3)] | 0,6[4)] | 0,95[4)] | 1,25[4)] | 1,9[4)] | 3,8[4)] | 4,2[4)] |
| Entrance slit | Software-controlled adjustment from 0 to 3 mm, 10 mm height | | | | | | | | | |
| Exit slits | Micrometer-driven from 0 to 3 mm, 10 mm height | | | | | | | | | |
| Integrated shutter | Software-controlled, serves for dark signal measuring | | | | | | | | | |
| PC connection | Full-Speed USB interface | | | | | | | | | |
| Dimensions and weight | 308 x 226 x 188 mm, 8 kg | | | | | | | | | |

1) Diffraction gratings with an alternate number of grooves per mm/blaze wavelength can be used upon your request .
2) Wavelength range with diffraction efficiency higher than 40%.
3) For the detector with 25 µm pixel size and 25,6 mm of active area.
4) For the detector with 25 µm pixel size and 12,8 mm of active area.
5) For the detector with 8 µm pixel size and 29,1 mm of active area.




WM200 dimensions

# MONOCHROMATOR/SPECTROGRAPH **WM300**

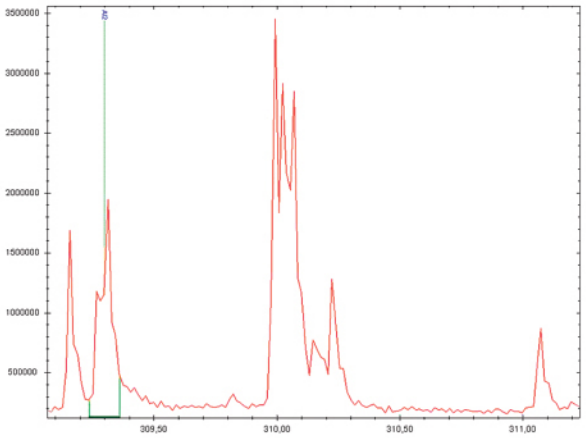



The WN300 is a universal automated light-intensive monochromator/spectrograph with a focal length of 284 mm and a 30x10 mm flat field, offering high quality of lines and a low level of stray light.

## Features

High aperture ratio (f/3,8), low level of stray light and high line quality allow for the successful use of the WN300 in a wide range of spectral analysis tasks. Two output ports allow connecting to the WN300 two exit slits, exit slit/detector or two detectors concurrently. WN300 is completely automated. Spectrum scanning and changing of diffraction gratings, order separating filters, slit width adjustment and output port selection are performed automatically and controlled via the easy-to-use software. An automatic shutter provides for automatic background (dark signal) subtraction, along with detector protection against excessive illumination from the light source.

The M266 detector adapters have the ability to conveniently adjust the detector's focus. The wavelight technologies provides automated control over the monochromator WM300 and its detectors. It allows stitching spectra obtained by several diffraction gratings in order to get a panoramic spectrum. Many possibilities of spectra processing and analysis are provided as well. SDK, DLL program modules and/or LabVIEW drivers are supplied with the WM300 for controlling the instrument via the customised software or LabView.




Fe quadruplet (spectral lines 309,9897 nm, 309,9971 nm, 310,0304 nm, 310,0666 nm). The spectrum was acquired with spark excitation using the WM300 with 1800 grooves/mm grating. The possibility of resolving at least 3 peaks demonstrates high optical quality of the instrument.

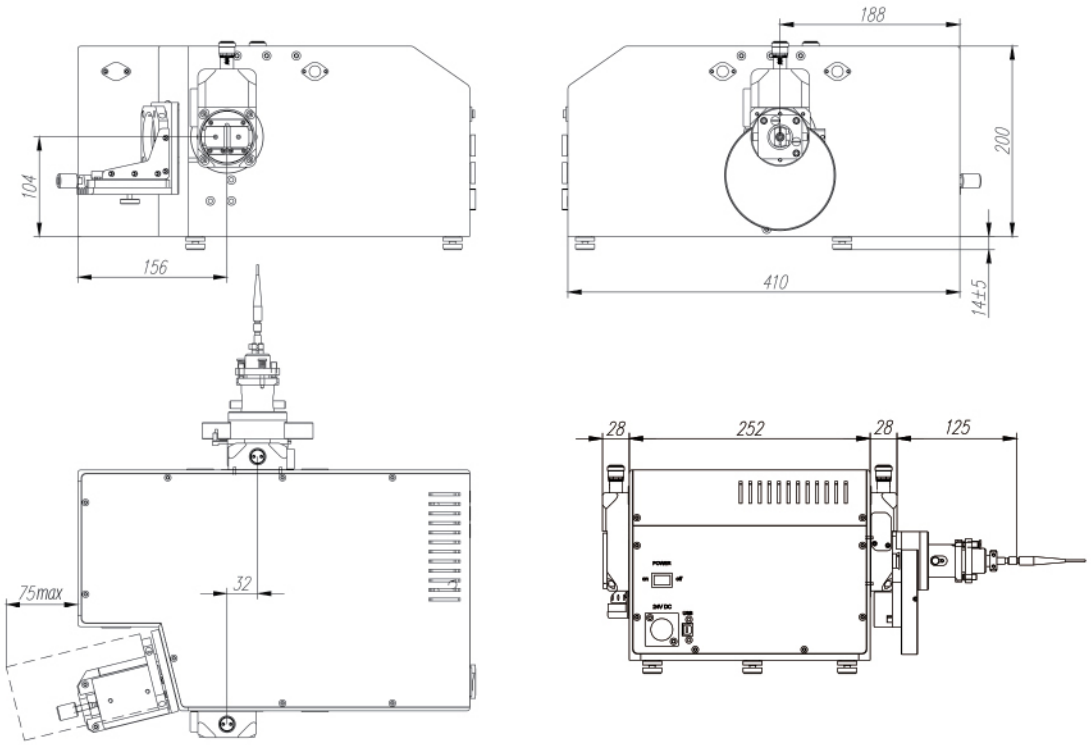
# WM300 ADVANTAGES

The standard optics include spherical and flat mirrors with an Al+$MgF_2$ coating that has been optimized for high ultraviolet efficiency. Additionally, the device may include optics with an Al+$SiO_2$ or gold coating, which provides high efficiency in the infrared spectrum. Direct (axial) and lateral (radial) output ports operate alternately. Switching between the output ports is effected by the software with the use of the swinging mirror, which in its operating position directs light to the lateral (radial) output port. The instrument is also available with one output (axial) port. If the radial output port is not used, it is plugged.

## OPTICS & ACCESSORIES

The WM300 monochromator/spectrograph has a wide range of options and accessories that provide efficient light collecting from the sample located at a finite distance and at infinity, delivering light to the monochromator with and without an optical fiber, effective aperture matching of the optical fiber and monochromator.

- Order-Separating Filters Wheel
- Aperture Matching Adapters
- Light-collecting Condensers
- Crossed Entrance Slit (optionally installed instead of the Standard Entrance Slit)
- Optical Fibers
- Adapters for attaching CCD detectors
- CCD detectors
- Cassegrain Objectives




WM300 Dimensions

## Specifications

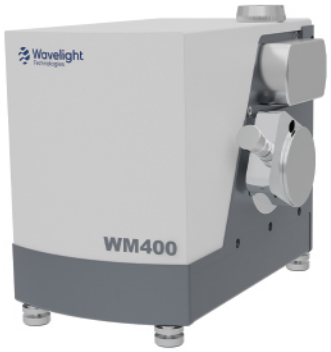
| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Optical scheme | Optimized Czerny-Turner with one optical input and two outputs | | | | | | | | |
| Spectral range | Typical 190 – 3600 nm<br>Extended up to 40 µm at your request | | | | | | | | |
| Aperture ratio | 1:3,8 | | | | | | | | |
| Focal length, mm | 284 | | | | | | | | |
| Flat field, mm | 30 x 10 | | | | | | | | |
| Diffraction gratings | 50 x 50 x 10 mm, one grating or turret with 4 gratings from the list below [1] | | | | | | | | |
| Grooves/mm[1] | 2400 | 1800 | 1200 | 600 | | 400 | | 300 | |
| Reciprocal linear dispersion (average), nm/mm | 1,58 | 2,12 | 3,18 | 6,37 | 6,32 | 9,6 | 9,41 | 12,75 | 12,64 |
| Blaze wavelength, nm | 225 | 270 | 400 | 750 | 1000 | 800 | 1700 | 1500 | 2000 |
| Spectral range [3], nm | 190 - 450 | 190 - 540 | 265 - 800 | 500 - 1500 | 660 - 1800 | 530 - 1600 | 1130 - 2600 | 1000 - 3000 | 1330 - 3600 |
| Multi-channel detector concurrent registration spectral range (average), nm | 38 [4] | 51 [4] | 76 [4] | 150 [4] | 80 [5] | 230 [4] | 120 [5] | 160 [5] | 160 [5] |
| Spectral resolution, nm | <0,1 [4] | <0,15 [4] | <0,22 [4] | <0,45 [4] | <0,45 [5] | <0,7 [4] | <0,7 [5] | <0,94 [5] | <0,94 [5] |
| Wavelength position accuracy, nm | ± 0,15 | ± 0,217 | ± 0,32 | ± 0,65 | | ± 1,00 | | ± 1,34 | |
| Wavelength repeatability, nm | ± 0,113 | ± 0,167 | ± 0,245 | ± 0,50 | | ± 0,775 | | ± 1,04 | |
| Diffraction grating rotation step, nm | 0,007 | 0,009 | 0,013 | 0,026 | | 0,04 | | 0,05 | |
| Scanning speed, nm/s | 12,5 | 16,7 | 25,0 | 50,0 | | 75,0 | | 100,0 | |
| Entrance/Exit slits | Automatic and manual adjustment | | | | | | | | |
| Slit width, mm | 0 - 2 | | | | | | | | |
| Slit height, mm | 12 | | | | | | | | |
| Parallelism, µm | ± 1 | | | | | | | | |
| Micrometer reading accuracy, µm | ± 1 | | | | | | | | |
| Step size, µm | 0,001953125 | | | | | | | | |
| Precision, µm | ±1 | | | | | | | | |
| Filter wheel | Automatic switching | | | | | | | | |
| Max. number of filters | 6 | | | | | | | | |
| Standard number of filters | 5 | | | | | | | | |
| Filter size, mm | 20 | | | | | | | | |
| Optical diameter, mm | 16 | | | | | | | | |
| Integrated shutter | Software-controlled, serves for dark signal measuring | | | | | | | | |
| PC connection | High-Speed USB | | | | | | | | |
| Dimensions, weight | 410 x 252 x 213 mm, 23,5 kg | | | | | | | | |

1) Diffraction gratings with an alternate number of grooves per mm/blaze wavelength can be used upon your request.
2) Reciprocal linear dispersion is indicated for blaze wavelength.
3) Wavelength range for which diffraction efficiency exceeds 40%.
4) For the detector with 24 µm pixel size and 24,5 mm length of active area.
5) For the detector with 25 µm pixel size and 12,8 mm length of active area.

## Application

- Fluorescence and Raman Spectroscopy
- Absorbance, Transmission and Reflectance measurements from the UV to IR spectral range
- Multichannel Spectroscopy
- Analytical tasks from the UV to IR spectral range

# ADDITIVE/SUBTRACTIVE MONOCHROMATOR **WM400**




> The WM400 is a compact, double monochromator that offers enhanced functionality and a low level of stray light. The main feature of the WM400 is ability to operate in both addition and subtraction modes. This "two-in-one" instrument can provide both modes without the need for additional alignment or calibration. Addition and Subtraction modes can be switched manually by using a selector knob located at the top of the monochromator.

In the Dispersion Addition Mode, the WM400 has an effective focal length of 260 mm. Extremely low level of stray light is achieved due to an intermediate slit and a precisely calculated optical design. In the Dispersion Subtraction Mode, the WM400 serves as a tunable low-light filter with a bandpass that can be selected by the user. The central wavelength is set by the computer by synchronous turning of two identical diffraction gratings. As a scanning monochromator, the WM400 does not generate a flat output field, therefore it cannot be used as a spectrograph with a multichannel detector attached to the output port. The software allows calculating the line width in both Dispersion Addition and Subtraction modes, depending on the widths of the entrance, intermediate, and output slits that are set.

The WM400 features manual control for the entrance, intermediate, nd output slits, as well as smooth micrometric adjustment of the opening width. The entrance and exit slits are positioned at a 66-degree angle to the vertical, and special holder can be provided upon request to ensure the vertical position of the slits. The WM400 features a wide range of high-quality ruled diffraction gratings. In order to achieve perfect dispersion compensation in the subtraction mode (zero dispersion), the manufacturer ensures that the diffraction gratings for both halves of the monochromator are exact replicas produced from the same matrix. Both the WM400 gratings are positioned on the same axis and driven by the same step motor, ensuring complete synchronization in their rotation and high accuracy in wavelength setting. The WM400 gratings are controlled by a computer via the USB interface. The WM400 software allows users to make real-time adjustments to the calibration. The software also allows you to calculate the spectral line width produced by the monochromator, using modes of Dispersion Addition and Subtraction, depending on the set widths of the entrance, intermediate, and output slits. If necessary, you can attach your own detector to the slit or purchase a highly sensitive PMT offered by .

## Features

- Double monochromator for excellent stray light rejection
- Dispersion Subtraction & Addition Modes
- High Aperture ratio
- Compact & Cost-efficient

# WM400 ADVANTAGES

The main advantage of the WM400 monochromator is its multifunctionality, as it can operate in both Addition and Subtraction modes without the need for additional adjustments or manual replacement of optical elements. This unique property was achieved by introducing a switchable optical coupling system consisting of two single monochromators into the optical scheme of a double monochromator. In the Dispersion Subtraction mode, the monochromators are paired using two flat mirrors with an intermediate slit between them. When the WM400 is switched to the dispersion addition mode, one of the flat mirrors is replaced with a "roof", which is a reflector made from two mirrors forming a 90° dihedral angle. The effect of this replacement is similar to the classical approach, when changing the mode from the Dispersion Addition to the Subtraction. This is a "flip" in the optical scheme of the 2nd monochromator, relative to the 1st one. The main difference between the two approaches is that, with the standard method, there is a complete redesign of the device. Whereas, the WM400 requires the use of only a two-position switch within the overall design. This allows for multi-functionality, without compromising structural integrity or the compactness of the instrument. All optical elements of the WM400 have been carefully designed by the manufacturer and require no additional adjustments when switching between operating modes or when replacing a set of gratings.

## OPTICS & ACCESSORIES

The input and output slits of the WM400 are positioned at an angle of 66° to the vertical. If the specific requirements of your application require vertical slits, the device can be equipped with a special holder to ensure the inclined position of the monochromator housing and vertical positioning of the slits. Optionally, a holder can be supplied that ensures the horizontal positioning of the WM400 slits. The WM400 supply set includes a viewing unit Sight, which is used to check the current monochromator calibration. The Sight has an achromatic objective that is placed on the entrance slit and is used to visually observe the positions of known spectral lines relative to the center of the exit slit. The spectral range of the Sight operation is 200-2000 nm.

The AFA adapter consists of two achromatic lenses and a SMA-905 connector, and is designed to match the apertures for fiber input/output of radiation into the monochromator. The spectral range of operation is 200-2000 nm. The AFA is installed on the input and/or output slits of the WM400 , and allows for minimizing radiation loss during fiber input/output, as well as reducing level of stray light by adjusting the aperture.

The WM400 monochromator has a wide range of options and accessories that provide efficient light collecting from the sample located at a finite distance and at infinity, delivering light to the monochromator with and without an optical fiber, effective aperture matching of the optical fiber and monochromator.

- Aperture Matching Adapters
- Light-collecting Condensers
- Optical fibers
- Cassegrain Objectives
- Holders to ensure the vertical position of the slits
- PMT and detector adapters

## Specifications

| | | | |
|---|---|---|---|
| **Optical scheme** | Modified Czerny-Turner double monochromator supplemented by an optical matching unit providing either additive or subtractive dispersion | | |
| **The 1st monochromator focal length:** | | | |
| Collimating mirror, mm | 130 | | |
| Focusing mirror, mm | 142 | | |
| **The 2 nd monochromator focal length:** | | | |
| Collimating mirror, mm | 142 | | |
| Focusing mirror, mm | 130 | | |
| **Ports** | 1 input, 1 output | | |
| **Aperture ratio** | 1:4,5 | | |
| **Entrance & Exit slits** | Micrometric | | |
| Slit width, mm | Adjustable from 0 to 2,0 | | |
| Slit height, mm | 12 | | |
| Parallelism, μm | ± 1 | | |
| Micrometer reading accuracy, μm | ± 1 | | |
| **Intermediate slit** | Micrometric | | |
| Slit width, mm | Adjustable from 0 to 5,0 | | |
| Slit height, mm | 12 | | |
| Parallelism, μm | ± 1 | | |
| Micrometer reading accuracy, μm | ± 1 | | |
| **Diffraction gratings** [1] | Interchangeable one pair is supplied with instrument; other pair is an option | | |
| Grooves/mm | 1200 | 600 | 300 |
| Grating dimensions, mm | 25 x 25 x 8 | 25 x 25 x 8 | 25 x 25 x 8 |
| Blaze wavelength, nm | 280 | 600 | 1500 |
| Preferable spectral range, nm 2) | 190 - 650 | 385 -1300 | 770-2600 |
| Mechanical range, nm | 0 - 760 | 0 - 1500 | 0-3000 |
| **Wavelength** | | | |
| Reciprocal linear dispersion (average) of the 1st monochromator, nm/mm | 5,8 | 11,6 | 23,2 |
| Wavelength position accuracy, nm | ± 0, 15 | ± 0,25 | ± 0,5 |
| Wavelength repeatability, nm | ± 0,05 | ± 0,1 | ± 0,2 |
| Wavelength step size, nm | 0,01 | 0,02 | 0,04 |
| Wavelength scan speed, nm/s | 19 | 38 | 76 |
| Wavelength resolution, nm | 0,07 | 0,14 | 0,28 |
| **Dispersion addition mode** | | | |
| Reciprocal linear dispersion (average), nm/mm | 3,0 | 6,0 | 12,0 |
| Width of the selected spectral range, nm | 0,2 - 6,0 | 0,4 - 12,0 | 0,8 - 24,0 |
| **Dispersion subtraction mode** | | | |
| Reciprocal linear dispersion, nm/mm | 0 | 0 | 0 |
| Width of the selected spectral range, nm | 0,2 - 40,0 | 0,4 - 80,0 | 0,8 - 160,0 |
| Width of 25 μm entrance slit image, μm | | | |
| with 2,5 mm intermediate slit | 32 | 32 | 32 |
| with 5,0 mm intermediate slit | 43 | 43 | 43 |
| Stray Light | $10^{-9}$ | | |
| PC connection | Full Speed USB | | |
| Electrical service requirement | Single phase main 85-264; 47-63 Hz | | |
| Dimensions, mm | 265 x 195 x 210 | | |
| Weight, kg | 8 | | |

1) Upon request, diffraction gratings with customized groove densities and blaze wavelengths can be provided.
2) The usable wavelength range includes wavelengths where the grating efficiency exceeds 30%.

# MONOCHROMATOR/SPECTROGRAPH **WM500**


The WM500 is a long-focal automated monochromator/spectrograph that is characterized with a high line quality and low level of stray light.

## Features

High aperture ratio (f/6,7), low level of stray light and perfect line quality enable successful use of the WM500 in a wide range of applications. Two input and two output ports can be completed with the full set of accessories produced by wavelight technologeis: standard and crossed entrance slits, order separating filter wheels, aperture matching systems and optical fibers, CCD detectors and adapters for them. Fully automated control. Spectrum scanning and changing of diffraction gratings, order separating filters, slit width adjustment and output port selection are performed automatically and controlled via the easy-to-use software. An automatic shutter provides for automatic background (dark signal) subtraction, along with detector protection against excessive illumination from the light source.

The WM500 two output slits feature precise slit focusing units. The WM500 detector adapters feature the ability for fine focus adjustment. wavetechnologies. software provides automated control over the monochromator WM500 and its detectors. It allows stitching spectra obtained by several diffraction gratings in order to get a panoramic spectrum. Many possibilities of spectra processing and analysis are provided as well. SDK, DLL program modules and/or LabVIEW drivers are supplied with the WM500 for controlling the instrument via the customised software or LabView.

## Application

- Fluorescence and Raman Spectroscopy
- Absorbance, Transmission and Reflectance measurements from the UV to IR spectral range
- Multichannel Spectroscopy
- Analytical tasks from the UV to IR spectral range

## OPTICS & ACCESSORIES

The WM500 monochromator/spectrograph has a wide range of options and accessories that provide efficient light collecting from the sample located at a finite distance and at infinity, delivering light to the monochromator with and without an optical fiber, effective aperture matching of the optical fiber and monochromator.

- Order Separating Filters Wheel
- Aperture Matching Adapters
- Light-collecting Condensers
- Crossed Entrance Slit (optionally installed instead of the Standard Entrance Slit)
- Optical Fibers
- Adapters for attaching CCD detectors
- CCD detectors
- Cassegrain Objectives

## Specifications

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Optical scheme | Optimized Czerny-Turner with two inputs and two outputs | | | | | | | | |
| Spectral range | Typical 190 - 4500 nm | | | | | | | | |
| Aperture ratio | 1:6,7 | | | | | | | | |
| Focal length, mm | 522 | | | | | | | | |
| Flat field, mm | 30 x 10 | | | | | | | | |
| Diffraction gratings | 70 x 70 x 10 mm, one grating or a turret with 4 gratings from the list below [1] | | | | | | | | |
| Grooves/mm | 2400 | 1800 | 1200 | 600 | | 400 | | 300 | |
| Reciprocal linear dispersion (average) [2], nm/mm | 0,66 | 1,0 | 1,4 | 2,8 | 2,6 | 4,37 | 3,68 | 5,56 | 5,16 |
| Blaze wavelength, nm | 225 | 270 | 400 | 750 | 1000 | 800 | 1700 | 1500 | 2000 |
| Spectral range [3], nm | 190 - 500 | 190 - 600 | 260 - 900 | 480 - 1680 | 648 - 2250 | 515 - 1800 | 1095 - 3825 | 965 - 3375 | 1290 - 4500 |
| Mechanical range for axial port, nm | 0 - 640 | 0 - 850 | 0 - 1280 | 0 - 2560 | 0 - 2560 | 0 - 3840 | 0 - 3840 | 0 - 5120 | 0 - 5120 |
| Multi-channel detector concurrent registration spectral range (average) [4], nm | 17 | 25 | 38 | 78 | 70 | 123 | 96 | 155 | 140 |
| Spectral resolution (average) [4], nm | <0,016 | <0,022 | <0,035 | <0,07 | <0,06 | <0,1 | <0,09 | <0,14 | <0,13 |
| Wavelength position accuracy, nm | ± 0,026 | ± 0,037 | ± 0,057 | ± 0,12 | | ± 0,17 | | ± 0,23 | |
| Wavelength repeatability, nm | ± 0,021 | ± 0,030 | ± 0,046 | ± 0,095 | | ± 0,135 | | ± 0,185 | |
| Scanning speed, nm/s | 12,5 | 16,7 | 25,0 | 50,0 | | 75,0 | | 100,0 | |
| Entrance/exit slits | Automatic and manual adjustment | | | | | | | | |
| Slit width, mm | 0-2 | | | | | | | | |
| Slit height, mm | 12 | | | | | | | | |
| Parallelism, µm | ± 1 | | | | | | | | |
| Micrometer reading accuracy, µm | ± 1 | | | | | | | | |
| Step size, µm | 0,001953125 | | | | | | | | |
| Precision, µm | ± 1 | | | | | | | | |
| Filter wheel | Automatic switching | | | | | | | | |
| Max. number of filters | 8 | | | | | | | | |
| Standard number of filters | 5 | | | | | | | | |
| Filter size, mm | 20 | | | | | | | | |
| Optical diameter, mm | 16 | | | | | | | | |
| Integrated shutter | Computer controlled, serves for dark signal measuring | | | | | | | | |
| PC connection | High-Speed USB | | | | | | | | |

1) Diffraction gratings with an alternate number of grooves per mm/blaze wavelength can be used upon your request.
2) Reciprocal linear dispersion is indicated for blaze wavelength.
3) Wavelength range for which diffraction efficiency exceeds 40%.
4) For detector with 8 µm pixel size and 29,1 mm length of active area.

# MONOCHROMATOR/SPECTROGRAPH **WM600**

Monochromator/spectrograph WM600 is available for order in the double-dispersive scheme modification – **Double WM300**. In such a case, the output slit of the 1st WM300 becomes the entrance slit of the 2nd WM300. Due to the longer focal length and dispersion addition, the twice-better spectral resolution and lower level of stray light are achieved. A spectral slit with blackened blades can be supplied upon your request.

## Specifications

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Optical scheme | Optimized Czerny-Turner with one input and two outputs | | | | | | | | |
| Spectral range | Typical 190 – 3600 nm, Extended up to 40 µm (upon request) | | | | | | | | |
| Aperture ratio | 1:3,8 | | | | | | | | |
| Focal length, mm | 568 | | | | | | | | |
| Lateral port flat field of the 1st M266, mm | 30 x 10 | | | | | | | | |
| Lateral port flat field of the 2nd M266, mm | 6 x 10 | | | | | | | | |
| Diffraction gratings | 50x50x10 mm, one grating or a turret with 4 gratings from the list below 1) | | | | | | | | |
| Grooves/mm [1] | 2400 | 1800 | 1200 | 600 | | 400 | | 300 | |
| Reciprocal linear dispersion (average), nm/mm [2] | 0,79 | 1,06 | 1,59 | 3,19 | 3,16 | 4,8 | 4,7 | 6,37 | 6,32 |
| Blaze wavelength, nm | 225 | 270 | 400 | 750 | 1000 | 800 | 1700 | 1500 | 2000 |
| Spectral range, nm [3] | 190 - 450 | 190 - 540 | 265 - 800 | 500 - 1500 | 660 - 1800 | 530 - 1600 | 1130 - 2600 | 1000 - 3000 | 1330 - 3600 |
| Multi-channel detector concurrent registration spectral range on the output of the 2nd M266 (average), nm | 3,8 [4] | 5,2 [4] | 7,6 [4] | 15,0 [4] | 8,0 [5] | 23,0 [4] | 12,0 [5] | 16,0 [5] | 16,0 5) |
| Spectral resolution on the output of the 2nd M266, nm | <0,05 [4] | <0,075 [4] | <0,11 [4] | <0,22 [4] | <0,22 [5] | <0,35 [4] | <0,35 [5] | <0,47 [5] | <0,47 [5] |
| Entrance/exit slits | Refer to M266 specifications | | | | | | | | |
| Intermediate slit width, mm | 5 | | | | | | | | |
| Filter wheel | Refer to M266 specifications | | | | | | | | |
| Integrated shutter | Computer controlled, serves for dark signal measuring | | | | | | | | |
| PC connection | High-Speed USB | | | | | | | | |

1) Diffraction gratings with an alternate number of grooves per mm/blaze wavelength can be used upon your request.
2) Reciprocal linear dispersion is indicated for blaze wavelength.
3) Wavelength range for which diffraction efficiency exceeds 40%.
4) For the detector with 24 µm pixel size and 24,5 mm length of active area.
5) For the detector with 25 µm pixel size and 12,8 mm length of active area.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# SPECTROMETERS

# SPECTROMETER
# **WS100**


The WS100 compact spectrometer is an essential instrument for any scientific laboratory. It is also useful for demonstration purposes and for learning the basics of spectroscopy. In addition, it can be used in the manufacturing process of instrument-making companies. For many years, WS100 has been an excellent addition to the tunable laser systems offered by wavelight technologies.

The use of an original concave diffraction grating makes the WS100 a unique instrument that provides high resolution of 1 nm within an extremely wide spectral range, from 190 to 1100 nm.

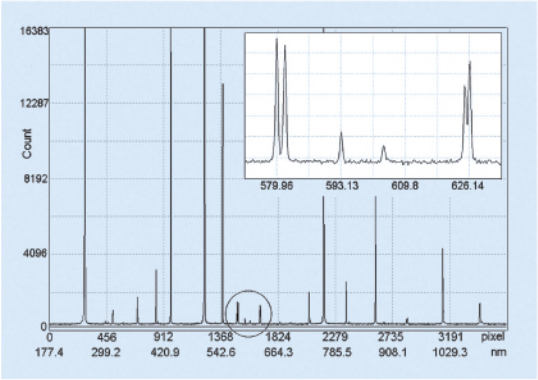
The WS100 spectrometer is convenient and easy to use: it is calibrated by the manufacturer, does not contain any movable parts, is controlled and powered from the computer via the Full-Speed USB interface. The WS100 can be triggered from your light source with standard TTL trigger pulses via the BNC-58 connector. The WS100 is also able to produce TTL trigger pulses.

## Features

- Extremely wide range – 190 to 1100 nm –covered with the use of one diffraction grating
- Combination of compact design and high resolution
- Friendly interface compatible with Windows 8/11
- No external power requirements

## Application

- Laser wavelength control
- Plasma control
- Analysis of any light source within 190-1100 nm spectral range
- For spectroscopy education
- Measuring schemes implementation




Mercury spectrum acquired with the WS100-3648T

# WS100 ADVANTAGES

Specific features of the WS100 spectrometer depend on the chosen detection system type. Toshiba linear image sensor TCD 1304 installed in the WS100-3648T features high sensitivity. The large number of relatively narrow pixels ensures high resolution and accurate wavelength determination. However, when recording wide-band spectra with the WS100-3648T, spectrum modulation is observed, limiting their application in spectrometry.

The software allows the user to perform calibration of the WS100 spectral sensitivity in a selected spectral range. Factory calibration of the WS100 spectral sensitivity is not provided. The S13496 and S11639-01 sensors installed in the WS100 demonstrate excellent linearity, wide dynamic range and absence of spectrum modulation.

## Specifications

| | | | |
|---|---|---|---|
| Diffraction grating, grooves/mm | 300 | | |
| Reciprocal dispersion (average), nm/mm | 33,28 | | |
| Aperture ratio | 1:6,0 | | |
| Focal length, mm | 99 | | |
| Spectral range, nm | 190 - 1100 | 190 - 1100 | 200 - 1100 |
| Spectral resolution (average), nm | 1,0 | 1,0 | 1,5 |
| Image sensor model | CCD TCD1304 Toshiba 3648 pixels | CMOS S13496 Hamamatsu 4096 pixels | CMOS S11639-01 Hamamatsu 2048 pixels |
| Pixel size, µm | 8 x 200 | 7 x 200 | 14 x 200 |
| Active area, mm | 29,184 | 28,672 | 28,672 |
| Min. exposure time, ms | 7,4 | 0,018 | 0,018 |
| Max. exposure time, not less, s 1) | 3 | 5 | 5 |
| Antiblooming 2) | No | Yes | Yes |
| Photo response non-uniformity, % 3) | ± 5 % | ± 2 % | ± 2 % |
| Dynamic range | 2000 : 1 | 5000:1 | 5000:1 |
| Photo sensitivity, V/lx×s | 160 | 650 | 1300 |
| RMS read noise, ADC counts | <8 | < 4 | < 4 |
| Data rate (max), kHz | 500 | 3000 | 3000 |
| ADC number of bits | 16 bits, 65536 counts | | |
| Triggering | Internal / External | | |
| External trigger pulse requirements | BNC-58 connector, positive polarity, 3-15 VDC amplitude, 5-20 µs pulse duration FWHM | | |
| Trigger pulses parameters | Positive polarity, 4-5 VDC amplitude, 10 µs pulse duration FWHM | | |
| PC connection | Full-Speed USB | | |
| Optical input | Direct radiation input to the entrance slit | | |
| Dimensions, mm | 66 x 86 x 146 | | |
| Weight, kg | 0,75 | | |

1) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25 °C ambient.
2) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
3) Signal level reaches 50% of dynamic range.

The standard WS100 supply set includes: control USB-cable, direct and reverse triggering cables. Due to input slit presence the WS100 allows operation with or without optical fiber.

Upon your request, the WS100 may be supplied with a dielectric filter separating high spectrum orders We recommend this filter for operation with broadband spectra.

# IR-SPECTROMETER
# **WS200-IR**


> The compact high-sensitive spectrometer WS200-IR contains a non-cooled linear InGaAs image sensor, and is recommended for any spectroscopic applications in the IR spectral range such as fluorescence, reflectance, transmittance, photometric measurements and other researches, that do not require long-time signal storage.

The high-aperture optical scheme of the WS200-IR does not have any moving parts. The monolithic housing of WS200-IR ensures long-time measurement stability. The WS200-IR spectrometer is easy and convenient to use: it is calibrated by the manufacturer, is controlled and powered from the PC via the Full-Speed USB interface.

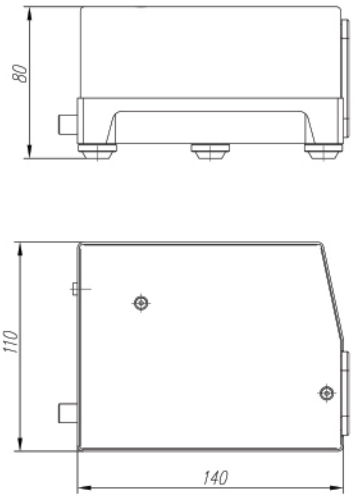
Light input using quartz optical fiber provides flexibility in instrument arrangement. The spectrometer has a fixed-width entrance slit and can be used without optical fiber.

## Application

- Laser radiation registration
- Analysis of any light sources within range 780-1700 nm

## Features

- High-sensitivity non-cooled InGaAs detector
- Compact monolithic housing for optimum stability
- Diffraction gratings, spectral ranges and resolutions tailored to your requirements
- User-friendly interface compatible with Windows 8/11




WS200-IR Dimensions

## Specifications

| SPECTROMETER MODEL | WS200-IR |
|---|---|
| Spectral range, nm | 780 – 1700 |
| Focal length, mm | 87,7 |
| Aperture ratio | 1:7,7 |
| Entrance slit | 0,020 x 3 |
| Spectral resolution | Depends on chosen diffraction grating (see table below) |
| Image sensor model | G9204-512DA |
| Number of pixels | 512 |
| Pixel size, µm | 25 x 500 |
| Active area, mm | 12,8 x 0,5 |
| Max. spectral sensitivity , nm | 1550 |
| Antiblooming [1] | No |
| ADC number of bits | 16 bits, 125 kHz |
| RMS read noise, ADC counts | < 6 |
| Dynamic range | ~ 12000 : 1 |
| Min. exposure time, ms | 12 |
| Max. exposure time, s | 2 [2] |
| Frame processing time in the binning mode, ms | 4,1 |
| Thermoelectric cooling | No |
| Operating temperature, °C | 10 – 30 |
| PC connection | Full Speed USB |
| Triggering | Internal / External |
| External trigger pulse requirements | BNC-58 connector, positive polarity, 3-15 VDC amplitude, 5-20 µs pulse duration FWHM |
| Trigger pulses parameters | Positive polarity, 4-5 VDC amplitude, 20 µs pulse duration FWHM |
| Optical input | - Direct radiation input to the entrance slit<br>- Optical fiber: 0,6 mm diameter, 1m length, SMA-905 connector (optional) |
| Dimensions, mm | 142 x 110 x 80 |
| Weight, kg | 1,2 |

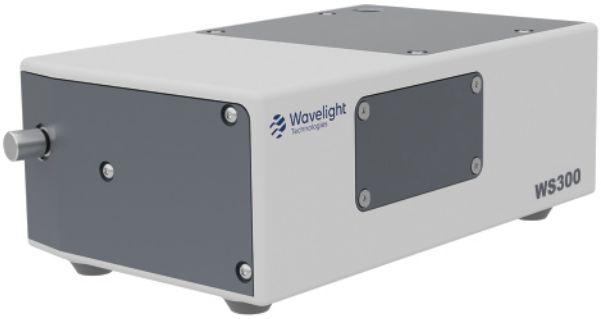
1) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
2) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.

When placing an order, you need to choose the diffraction grating number of grooves (i.e., the spectral resolution of your instrument), as well as the spectral range of operation. For your convenience, the table below shows the average values of the dispersion, spectral resolution, and the multi-channel detector concurrent registration spectral range.

| Diffraction gratings, grooves/mm | 150 | 200 | 300 | 400 | 600 |
|---|---|---|---|---|---|
| Spectral range, nm | 780 - 1700 | | | | |
| Multi-channel detector concurrent registration spectral range (average), nm | 950 | 710 | 464 | 320 | 210 |
| Reciprocal dispersion (average), nm/mm | 74,5 | 55,5 | 36,3 | 26,5 | 16,6 |
| Spectral resolution (average), nm | 4,6 | 3,4 | 2,3 | 1,7 | 1,0 |

EXAMPLE: If you are interested in the 200 grooves/mm grating (average spectral resolution of 3,4 nm), you need to choose the location of the 710 nm concurrent registration within the possible diffraction grating spectral range of the 780-1700 nm. For example: WS200-IR spectrometer operating in the 990-1700 nm range with 3,4 nm resolution.

# SPECTROMETER
# **WS300**




> The WS300 spectrometer is designed to measure the spectral composition of CW and pulsed light sources radiation. With its relatively low aperture ratio and high spectral resolution, it is ideal for use in monitoring the wavelength of lasers, diodes, and other sources that emit a powerful optical signal.

The construction and design of the optical scheme of the WS300 dual-channel spectrometer provides for the possibility of installing any two diffraction gratings from the WS300 specifications. The WS300 model allows alternate recording of spectral data from both channels, providing flexibility for various applications.

The shutter is manually moved from one channel of the spectrometer to another, changing the spectral range, by simply turning a two-position switch.

## Application

- Raman spectroscopy, fluorescence measurements
- Applications requiring high sensitivity
- Analysis of any light sources within 190-1100 nm range
- Metrological applications

## Features

- Current model based on highly sensitive detectors
- Enhanced sensitivity in the UV-range
- Monolithic housing for optimum stability
- Internal light trap for stray light reduction

# Specifications

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Optical scheme | Czerny-Turner | | | | | | | |
| Focal length, mm | 150 | | | | | | | |
| Aperture ratio | 1:12,0 | | | | | | | |
| Entrance slit (width x height), μm | 20 x 3000 | | | | | | | |
| Diffraction gratings | One from the list below | | | | | | | |
| Grooves/mm | 200 | 300 | 400 | 600 | 1200 | 1800 | 1800-II [1] | 1800-III [2] |
| Reciprocal dispersion (average), nm/mm | 33,15 | 21,5 | 16,2 | 10,5 | 4,7 | 3,0 | 1,3 | 0,8 |
| Spectral resolution (average), nm | 0,66 | 0,44 | 0,32 | 0,21 | 0,10 | 0,06 | 0,025 | 0,015 |
| Spectral range, nm | 200 - 1100 | 200 - 1100 | 200 - 1100 | 200 - 1100 | 200 - 1100 | 200 - 800 | 200 - 450 | 200 - 300 |
| Multi-channel detector concurrent registration spectral range (average), nm [3] | 920 | 620 | 460 | 300 | 135 | 85 | 38 | 23 |
| Optical input | - Direct radiation input to the entrance slit<br>- Optical fiber [4]: 0,6 (0,4) mm diameter, 1 m length, SMA-905 connector | | | | | | | |
| Dimensions, mm | 113 x 190 x 72,5 | | | | | | | |
| Weight, kg | 2,6 | | | | | | | |

1) The second diffraction order.
2) The third diffraction order.
3) For linear image sensor TCD1304 and single-channel S150
4) Optional.

| Linear image sensor model | Toshiba TCD 1304 | S13496 Hamamatsu | S11639-01 Hamamatsu |
|---|---|---|---|
| Number of pixels | 3648 | 4096 | 2048 |
| Pixel size, mm [2] | 0,008 x 0,2 | 0,007 x 0,2 | 0,014 x 0,2 |
| Active area, mm | 29,18 | 28,67 | 28,67 |
| Spectral range, nm | 200 - 1100 | 200 - 1100 | 200 - 1100 |
| Photosensitivity, V/lx×s | 160 | 650 | 1300 |
| Antiblooming [1] | No | Yes | Yes |
| Min. exposure time, ms | 7,4 | 0,018 | 0,018 |
| Max. exposure time, s [2] | 3 | 5 | 5 |
| Dynamic range | 2000 : 1 | 5000 : 1 | 5000 : 1 |
| ADC number of bits | 16 bits<br>65536 counts | 16 bits<br>65536 counts | 16 bits<br>65536 counts |
| RMS read noise, ADC counts | <8 | <4 | <4 |
| Shutter | Optional | Optional | Optional |
| PC connection | Full-Speed USB | Full-Speed USB | Full-Speed USB |
| Triggering | IN/OUT | IN/OUT | IN/OUT |

1) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
2) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.

# SPECTROMETER
# **WS400**


The compact high-sensitivity spectrometer WS400 is developed for low light intensity applications such as measurements of Raman scattering, fluorescence, etc., which require especially high sensitivity or enhanced specifications in the UV spectral range.

The high-aperture optical bench of the WS400 has no moving parts and minimises the number of reflective surfaces. The WS400 features a monolithic housing, thus ensuring long-time measurement stability. The housing has internal fins: light traps that allow reducing stray light – a typical problem of compact short-focal length instruments. The WS400 may contain as a detector either one of two non-cooled Hamamatsu back-thinned CCD-arrays without a charge-storage section (back-thinned FFT CCD), operating in the binning mode. Both arrays have wide spectral range and excellent sensitivity in the UV-range. These two arrays differ in quantum efficiency, data reading rate, dynamic range, and in pixel active area size.

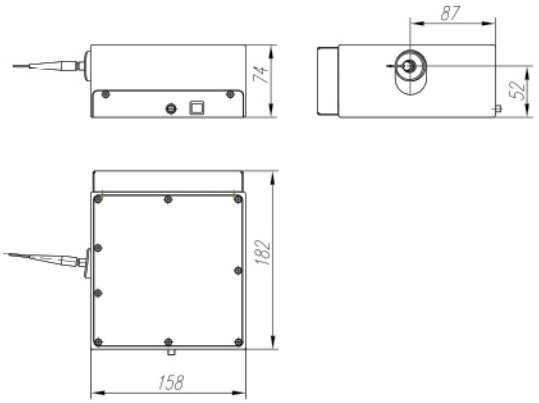
The detector based on the S7030-1006 CCD-array is more sensitive, has lower noise, better dynamic range and uniformity. The detector based on the S10420-1106-01 array is faster, has anti-blooming and, since it has a greater number of pixels and smaller pixel size, ensures better spectral resolution than the S7030-1006. Upon your request, WS400 may be supplied with an order separating filter installed. We recommend this option for operation with broadband spectra.

## Application

- Raman scattering, fluorescence measurements
- Application with high sensitivity requirement
- Analysis of any light source in the 190-1100 nm spectral range

## Features

- Up-to-date model based on back-thinned arrays for operation with low signals
- Enhanced UV sensitivity
- Monolithic housing for optimum stability
- Internal light trap for reducing stray light




WS400 Dimensions

# SPECTROMETER
# WS400

| | | | |
|---|---|---|---|
| Spectral range, nm | 190 - 1100 | | |
| Focal length, mm | 125 | | |
| Aperture ratio | 1:3,9 | | |
| Entrance slit | Fixed width: 14 µm, 30 µm and 50 µm | | |
| Spectral resolution | Depends on selected diffraction grating (see table below) | | |
| Image sensor model | S10420 -1106 - 01 Hamamatsu | S16010 -1106 Hamamatsu | S7030 - 1006 Hamamatsu |
| Number of pixels | 2068 x 70 | | 1024 x 64 |
| Number of active pixels | 2048 x 64 | | 1024 x 58 |
| Pixel size, µm | 14 x 14 | | 24 x 24 |
| Active area, mm | 28,672 x 0,896 | | 24,6 x 1,4 |
| Max. spectral sensitivity, nm | 500 | 700 | 650 |
| Max. quantum efficiency, % | >75 | | >90 |
| Sensitivity non-uniformity [1],% | ± 3 | | ± 3 |
| Antiblooming [2] | Yes | | No |
| ADC number of bits | 16 bits, 250 kHz | | 16 bits, 125 kHz |
| RMS read noise, ADC counts | <4 | | <2 |
| Dynamic range | ~ 16000 : 1 | | ~ 33 000 : 1 |
| Exposure time, s | 0,0083 - 10 [3] | | 0,0082 - 2 [3] |
| Frame processing time in the binning mode, ms | 9,39 | | 9,12 |
| Thermoelectric cooling | No | | |
| Operating temperature, °C | 10 – 30 | | |
| PC connection | Full Speed USB | | |
| Triggering | Internal / External | | |
| Optical input | - Direct radiation input to the entrance slit<br>- Optical fiber [4]: 0,6 (0,4) mm diameter, 1m length, SMA-905 connector | | |
| Dimensions, weight | 158 x 182 x 74 mm; 2,2 kg | | |

1) Signal level ≥ 50% of saturation.
2) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
3) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.
4) As an option.

At the time of placing your order you should choose grating grooves density (i.e. spectral resolution of your instrument), as well as the spectral range for operation. For your convenience, the table below lists the average values of grating dispersion, spectral resolution and multichannel array bandpass (average).

| Diffraction gratings, grooves/mm | 1800 | 1200 | 900 | 600 | 400 | 300 | 200 |
|---|---|---|---|---|---|---|---|
| Spectral range, nm | 190 - 600 | 190 - 900 | 190 - 1100 | 190 - 1100 | 190 - 1100 | 190 - 1100 | 190 - 1100 |
| Multi-channel detector concurrent registration spectral range (average), nm | 105 [2]<br>92 [3] | 170 [2]<br>145 [3] | 230 [2]<br>200 [3] | 350 [2]<br>300 [3] | 540 [2]<br>460 [3] | 720 [2]<br>620 [3] | 1000 [2]<br>920 [3] |
| Reciprocal dispersion (average), nm/mm | 3,8 | 6,0 | 8,2 | 12,5 | 19,0 | 25,4 | 38,0 |
| Spectral resolution (average), nm [1] | 0,16 [2]<br>0,22 [3] | 0,25 [2]<br>0,36 [3] | 0,34 [2]<br>0,5 [3] | 0,5 [2]<br>0,75 [3] | 0,8 [2]<br>1,1 [3] | 1,0 [2]<br>1,5 [3] | 1,6 [2]<br>2,3 [3] |

1) For 300 nm wavelength.
2) For SC125 spectrometer with S10420-1106-01 and S16010-1106 image sensors.
3) For SC125 spectrometer with S7030-1006 image sensors.

EXAMPLE: Let's say you are interested in a 1200 gr/mm grating and a detector based on the S10420-1106-01 sensor (average spectral resolution of 0,25 nm). You need to select the location of the 170 nm concurrent registration within the possible diffraction grating spectral range of the 190-900 nm. For example, the WS400 spectrometer with the S10420-1106-01 image sensor can operate in the range of 250-420 nm with a resolution of 0,25 nm.

# SPECTROMETER
# **WS500**


> High-aperture WS500 spectrometers were designed as an affordable alternative to scanning monochromators/ spectrographs with fixed gratings. Since the detectors are usually attached externally, WS500 spectrometers can accommodate any CCD or CMOS detector, including those cooled with TE or LN.

The WS500 series are available in two versions: the WS500 model containing one fixed diffraction grating and the WS510 model with a four-position manually switchable turret of diffraction gratings.

All the spectrometers are supplied with an eight-position manually switched filter wheel that contains three standard order separating filters, a UV silica two-lens condenser, and SMA-905 fiber adapter. With these accessories, users can select the most convenient method for delivering the analyzed radiation to the spectrometer, either using the optical fiber only or through the fiber, condenser, and order separating filters.

The standard WS500 optics comprise Al+$MgF_2$ coating optimized for high UV efficiency. Optionally the spectrometer may contain optics with Ag+$SiO_2$ or Au coating for high efficiency in the infrared spectral range. The WS510 specifications contain recommended combinations of diffraction gratings and multichannel detectors to meet the most common customer demands.

The WS500 can be triggered by your light source using standard TTL trigger pulses via the BNC-58 connector. It can also generate TTL trigger pulses itself. The spectral range and resolution (or grating grooves density) are selected when you place your order. To make it easier for you, the specifications list the average values of grating dispersion, spectral resolution, and multi-channel CCD detector concurrent registration spectral range for a certain grating. If you need more precise calculations for your spectrometer, please contact a wavelight technologies specialist.

## Features

- Wide choice of detectors to be installed, including cooled detectors
- Adapter manufacture for you detector
- High resolution - up to 0,06 nm
- High aperture ratio f/4,4
- Wide choice of methods to input radiation into the spectrometer

## Application

- Laser radiation registration
- Plasma monitoring
- Analysis of any light sources within 190-2560 nm* range

## Specifications

| | |
|---|---|
| Spectral range, nm | 150 |
| Aperture ratio | f/ 4,4 |
| Entrance slit | 0,016 x 3 [1] or 0,04 x 3 [2) 3)] or 0,08 x 3 |
| PC connection | Full-Speed or High-Speed USB |
| Dimensions, weight | (242 x 280 x 113) mm; 4,85 kg |

| WS500 SPECTROMETER | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diffraction gratings, grooves/mm | 300 | 400 | 600 | 1200 | 1800 | 100 | 50 |
| Spectral range, nm | 200 -1100 | 200 -1100 | 200 -1100 | 200 -1000 | 200 - 650 | 870 -1700 [2)] | 900 - 2560 [3)] |
| Multi-channel detector concurrent registration spectral range (average), nm | 620 [1)] | 460 [1)] | 300 [1)] | 130 [1)] | 80 [1)] | 830 [2)] | 1660 [3)] |
| Reciprocal dispersion (average), nm/mm | 21,3 | 15,8 | 10,2 | 4,0 | 3,0 | 65,0 | 131,0 |
| Spectral resolution (average), nm | 0,42 [1)] | 0,32 [1)] | 0,22 [1)] | 0,09 [1)] | 0,06 [1)] | 4,0 [2)] | 12,0 [3)] |

| WS510 SPECTROMETER | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Spectral range, nm | 200 -1100 | | | | 200 -1100 | | | | 870 -1700* | | | |
| Image sensor model | TCD1304 Toshiba | | | | S10420-1106-01 Hamamatsu | | | | G9212-512SB – G9214-512S Hamamatsu | | | |
| Pixel size & Active area | 29,1 mm, 3648 pixels 0,008 mm x 0,5 mm | | | | 28,672 x 0,896 mm, 2068 x 70 pixels, 14 x 14 µm | | | | 12,8 mm, 512 pixels, 0,025 mm x 0,5 mm (0,25 mm) | | | |
| Diffraction gratings, grooves/mm | 900 | 600 | 400 | 300 | 900 | 600 | 400 | 300 | 400 | 300 | 200 | 100 |
| Multi-channel detector concurrent registration spectral range (average), nm | 200 - 390 | 300 - 600 | 450 - 900 | 570 -1100 | 200 - 375 | 300 - 570 | 450 - 855 | 600 -1100 | 900 -1095 | 1065 -1330 | 1300 -1700 | 900 -1700 |
| Reciprocal dispersion (average), nm/mm | 7,0 | 10,5 | 15,8 | 21,1 | 7,0 | 10,5 | 15,8 | 21,1 | 15,5 | 20,9 | 31,7 | 65,0 |
| Spectral resolution (average), nm [1)] | 0,18 | 0,28 | 0,42 | 0,54 | 0,3 | 0,45 | 0,7 | 0,9 | 0,95 | 1,3 | 2,0 | 4,5 |

1) For a linear image sensor with 29,1 mm active area and 8 µm pixel size (TCD1304, Toshiba).
2) For a linear image sensor with 12,8 mm active area and 25 µm pixel size (G9214-512SB or G9212-512S, Hamamatsu)
3) For a linear image sensor with 12,8 mm active area and 50 µm pixel size (G9205-256W or G11478-256WB, Hamamatsu).

Modifications of the WS500 infrared version are also available using the G9206-256WB sensor with a spectral range of up to 2,1 µm and the G11478-256WB sensor with a range of up to 2,56 µm.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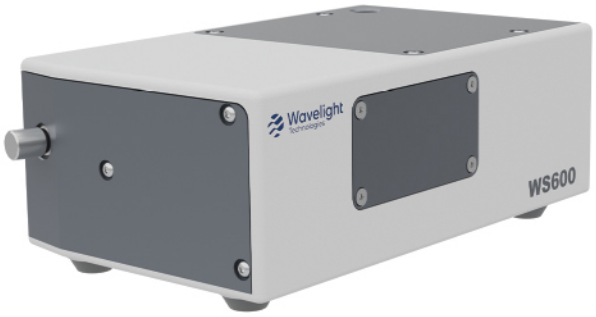
# SPECTROMETER
# HIGH-PRECISION WIDE-RANGE WAVELENGTH MEASURER

# HIGH-RESOLUTION WAVELENGTH METER **WS600**




> The WS600 is an ideal, low-cost, high-precision spectrometer for measuring laser wavelengths in a wide range of applications, including the alignment and testing of solid-state lasers, diode lasers, dye lasers, and OPOs

The WS600 optical scheme is based on an Echelle diffraction grating operating in high spectral orders, and a linear image sensor is used as a detector. The WS600 has no moving elements; powering and control are carried out by a computer via the Full-Speed USB interface. The WS600 can be triggered by a laser source using standard TTL-level signals. The WS600 allows for quick and easy measurement of the absolute wavelength value of both CW and pulsed lasers, with an outstanding precision of ±3 pm within a wide spectral range of 190 to 1100 nm, as well as detecting FWHM of the analyzed line. Apart from wavelength measuring the WS600 provides demonstration of analyzed spectra with resolution of 30 000 ($\lambda/\Delta\lambda_{FWHM}$) which comprises from 6 pm for the UV spectral range to 40 pm for the NIR. The WS600 also ensures real-time monitoring of the above values and spectra in the process of tuning the analyzed wavelength. The WS600 software WLMeter features a possibility to check the accuracy and, if necessary, correct it with any known wavelength guided to the WS600 : the laser with known wavelength, such as any He-Ne laser with wavelength of 632,816 nm or any other spectral line with certain constant wavelength value. WLMeter features another useful function «Lines Array» for monitoring and saving the central wavelength value over time.

In terms of wavelength resolution and accuracy, the WS600 is an alternative to a long-focus monochromator (with a focal length of more than 1000 mm), equipped with a suitable CCD. Unlike the monochromator, however, the WS600 does not have any moving elements and allows for real-time measurements without the need for scanning a diffraction grating. It is rigid, stable, and accurate, ensuring absolute reliability and offering a more affordable price point. The WS600 wavelength meter is not specifically designed for analysis of plasma emission and other complex spectra (see the SPECIFICATIONS: «Source linewidth requirement»). However, the WS600 can be applied in analysis of narrow spectral intervals within the spectral range of the Echelle order - from 0,5 nm in the UV range (190 nm) to 18 nm in the IR (1200 nm), which is preliminarily separated by a filter or monochromator. The laser beam is directed to the SHR entrance slit, either via a multimode optical fiber equipped with a diffuse attenuator (both of which are included in the supply set) or directly without any fibers.

## Features

- High accuracy ±3 pm and wide spectral range 190-1200 nm
- FWHM and spectral line monitoring and analysis
- deal for wavelength measurement of pulsed and CW lasers
- Fiber input; diffuse attenuator

Diffuse attenuator FA-3 contains two diffuse quartz glasses and SMA-905 connector. Axial adjustment of the fiber end relative to diffusive elements.

## Specifications

| | |
|---|---|
| Optical scheme | Czerny-Turner |
| Physical principle | Based on Echelle diffraction grating |
| Operating modes | CW & Pulsed |
| Spectral range, nm | 190-1100 |
| Wavelength detection accuracy, pm | ± 3 |
| Spectral resolution ($\lambda/\Delta\lambda_{FWHM}$) | 30000<br>(6 pm for λ=193 nm to 40 pm for λ =1200 nm – see Fig.[1]) |
| Source linewidth requirements, not abo | 125 cm $^{-1}$<br>(0,5 nm for λ =193 nm to 18 nm for λ = 1200 nm – see Fig.[2]) |
| Sensitivity | Less than 0,5 μW for 632,8 nm for min. exposure time of 7,3 ms |
| Mechanical moving parts | No |
| Calibration necessity | No (only calibration correction) |
| Line profile monitoring | Yes |
| Min. exposure time, ms | 7,3 |
| Optical input | - Direct radiation input to the entrance slit<br>- Optical fiber: 0,4 mm diameter, 1 m length, SMA-905 connector |
| PC connection | Full Speed USB |
| Triggering | External |
| Dimensions, mm | 113 x 190 x 72,5 |
| Weight, kg | 2,6 |

## RESOLUTION & SOURCE LINEWIDTH REQUIREMENTS

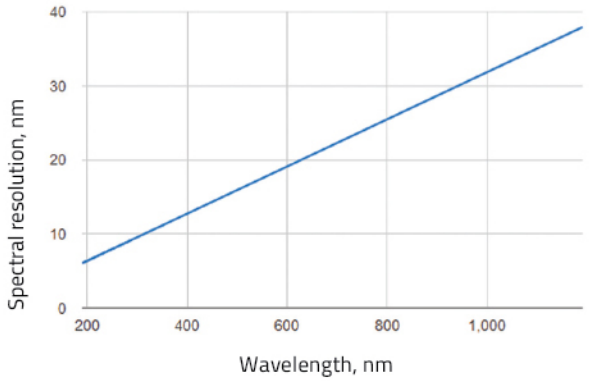



Fig. 1 Spectral resolution

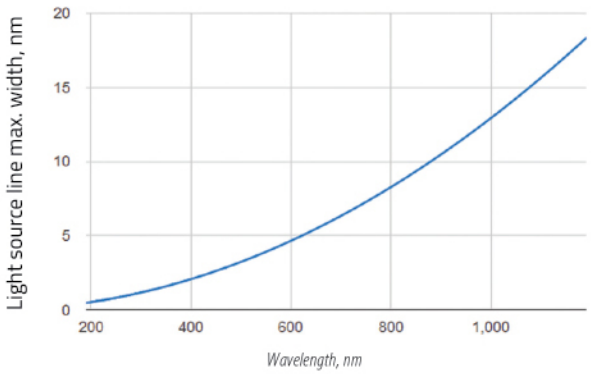
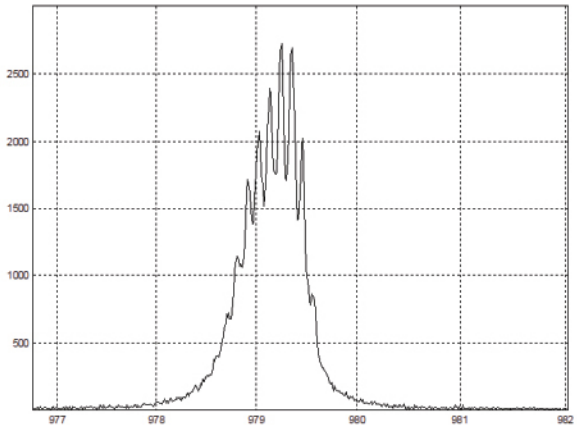



Fig. 2 Source linewidth requirements




OPO spectrum. $\lambda_{centr}$ = 979,169 nm, FWHM = 0,605 nm. It is possible to measure each separate peak.

# WAVELENGTH METER IN THE NEAR IR-RANGE **WS600-IR**


> The WS600-IR wavelength meter is an ideal instrument for measuring absolute wavelength value of pulse and CW lasers and diodes in the spectral range 600 -1800 nm with accuracy ± 15 pm, as well as detecting FWHM of the analyzed line.

The spectrometer has no moving elements and is powered and controlled by a computer via a Full-Speed USB connection. In the case of pulsed radiation, the WS600-IR can be triggered by your laser using a standard TTL-level synchronization output. The analyzed radiation is delivered to the entrance slit of the device via a multimode optical fiber with a diffuse attenuator (included in the supply set) or directly without the use of fibers. The software allows you to check the current measurement accuracy and, if necessary, adjust it using a He-Ne laser (632,816 nm) that is available. Optionally, the FA-546 interference filter module can also be used to adjust measurements using conventional fluorescent lamps that emit light at 546 nm, which are commonly found in laboratories.

The software also has a unique "Lines Array" function that tracks changes in the central wavelength over time while studying fastmoving processes. This function writes the array of results to a file for later processing. In terms of resolution and wavelength accuracy, the WS600-IR can be considered an alternative to a monochromator/spectrograph with a minimum focal length of 500 mm, equipped with an IR-detector. Unlike the long-focus monochromator, the WS600-IR does not contain moving parts, is monolithic, stable and accurate, offers absolute reliability, and is more affordable. The WS600-IR spectrometer is convenient in the process of setting up, adjusting, and testing laser systems that operate in the near-infrared spectral range.

## Features

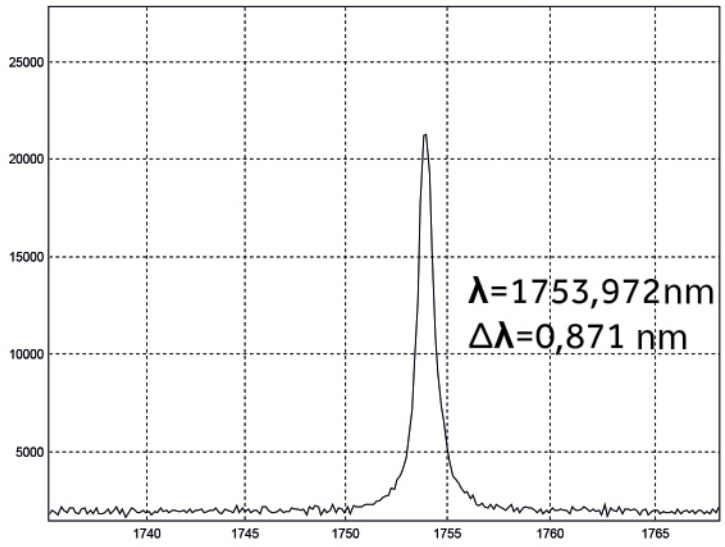
- Accuracy better than ±15 pm
- Spectral range 600-1800 nm
- Real-time Spectra & FWHM analysis
- Central wavelength continuous monitoring
- Ideal in wavelength control for CW and pulsed lasers
- Compact design; no moving elements
- No calibration needed
- Optical fiber input; diffuse attenuator
- Power from USB cable

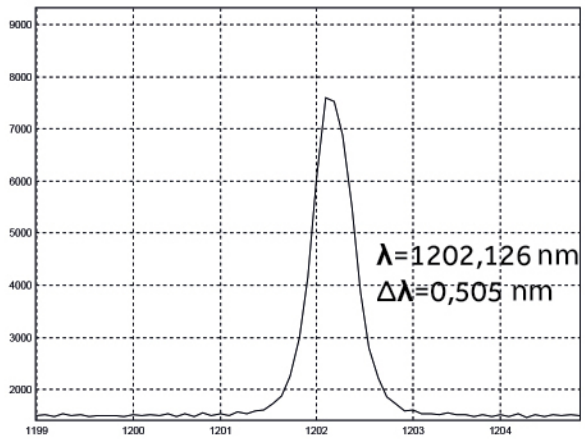
## Application

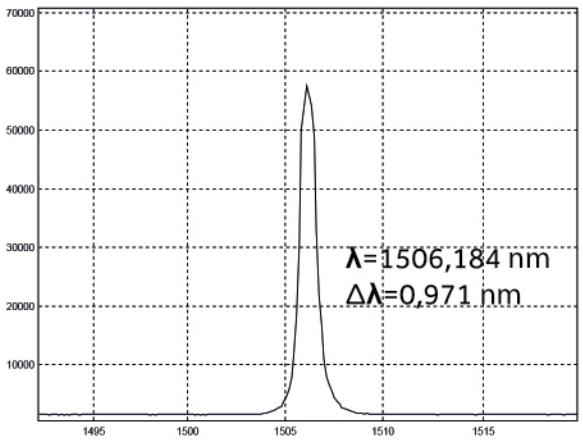
- Laser radiation registration
- Plasma analysis
- Analysis of any light sources within 600-1800 nm range

## Specifications

| | |
|---|---|
| Operating modes | CW & Pulsed (external triggering) |
| Spectral range, nm | 600 - 1800 |
| Wavelength detection accuracy, nm | ± 0,015 |
| Spectral resolution ($\lambda/\Delta\lambda_{FWHM}$) | 4 000 ($\Delta\lambda$FWHM from 0,15 nm for 600 nm to 0,48 nm for 1800 nm) |
| Source linewidth requirements, not above | ≤125 $cm^{-1}$ (from 4 nm for 600 nm to 40 nm for 1800 nm) |
| Optical input | - Direct radiation input to the entrance slit<br>- Optical fiber: 0,4 mm diameter, 1 m length, SMA-905 connector |
| Triggering | External |
| PC connection | Full Speed USB interface |
| Dimensions, mm | 142 x 110 x 80 |
| Weight, kg | 1,2 |




Optical parametric oscillator (OPO). Idler wave. Real-time measurements.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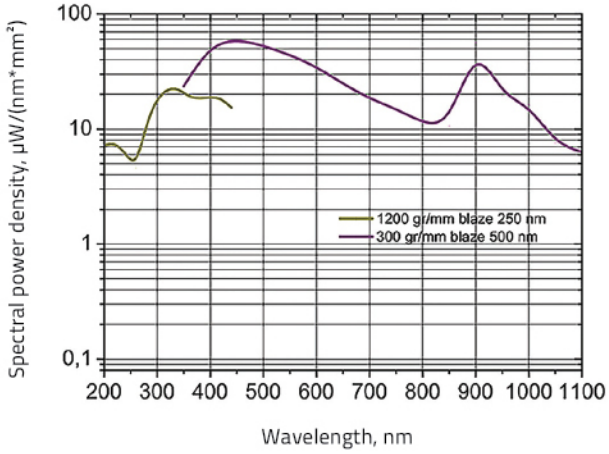
# TUNABLE LIGHT SOURCES

# TUNABLE LIGHT SOURCES
# **WL200 & WL300**


The WL200 & WL300 are powerful and efficient light sources, tunable in the 190-2500 nm spectral range with a stepless bandwidth adjustment.

The WL200 and WL300 are based on the new ultra-bright laser-driven light sources, XWS-65 and XWS-30, manufactured by the Troitsk Research and Development Center, and the proven wide-aperture automated monochromators, WM200 and WM300, produced by wavelight technologies.




The WM200 monochromator with 1200 grooves/mm diffraction grating, blaze at 250 nm and 300 grooves/mm blaze at 500 nm.

## Features

- Optical power – units of mW in a 6 nm spectral range
- Spectral power density up to 60 μW/(nm*mm2)
- Laser driven ultra-bright broadband light source XWS-65/XWS-30
- Optics for collimation, focusing, and inputting radiation into the fiber
- Automated monochromator M150 & M266

## Application

- Spectrometry and fluorimetry
- Metrology
- Photochemistry and photobiology
- Photovoltaics
- Microscopy, etc.

# WL200 & WL300 ADVANTAGES

Unique features such as high power density over a wide spectral range, including the UV-range from 190 nm, as well as long-term stability and a long lifetime, make XWS an essential and alternative instrument for metrological applications. Modern plasma laser-driven light source XWS-65 has undeniable advantages over gas-discharge lamps: spectral brightness and spatiotemporal stability are several times higher, as well as the lifetime is longer. The choice of a monochromator, such as the compact WM200 or the high-resolution WM300, allows you to optimize the optical power, spectral resolution, and degree of automation, as well as price range.

The WM300 monochromator is a fully automated instrument that contains up to 4 diffraction gratings. It has a focal length that is twice as long as the WM200 , which allows for twice the spectral resolution. Additionally, the slits can be opened twice as wide, increasing the optical output power four times compared to the WM200. The WM200 monochromator is a compact and wide-aperture instrument that can be supplied with 1, 2, or 3 diffraction gratings. Both monochromators can be supplied with either automated input and output slits or a set of fixed-width slits that can be manually changed. The spectral characteristics of the WL200 & WL300 tunable light sources depend on the chosen diffraction gratings.

## Specifications

| Tunable light source | WL200 | WL300 |
|---|---|---|
| Spectral range, nm | 190 - 2500 | |
| Monochromator model | WM200 | WM300 |
| Focal length, mm | 142 | 284 |
| Aperture ratio | 1:3,6 | 1:3,8 |
| Light source | XWS-65 | |
| Spot size on the monochromator entrance slit , µm | 500 | 500 |
| Optical output | - Direct radiation output through the output slit<br>- Fiber output (optional)<br>- Collimated radiation output using an achromatic adapter (optional) | |
| Max. output power | Up to 3 mW in a 6 nm spectral range<br>(depends on the monochromator model and chosen diffraction grating) | |
| Spectral power density | Up to 60 µW/(nm*mm$^2$) | |
| Output bandwidth (FWHM), nm | 1...180[1)] | 0,5...90[1)] |
| Wavelength repeatability, nm | 0,02 – 0,1 | |
| Scanning speed, nm/s | 16 - 300 | |
| Order separation filter wheel | - The automated 8-position filter wheel contains five absorbing filters for the 190 - 1620 nm spectral range<br>- Si filter for the 1000 – 2000 nm spectral range (optional; filter transmission up to 2500 nm) | |
| PC connection | USB | |
| Dimensions, mm | 458 x 292 x 220 | 530 x 490 x 250 |

1) Depends on the monochromator model, chosen diffraction gratings, and spectral slits width.

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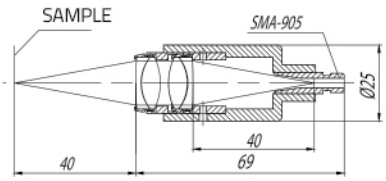
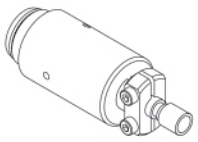
# ACCESSORIES

# LIGHT COLLECTING & FIBER COUPLING ACCESSORIES



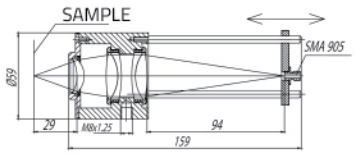



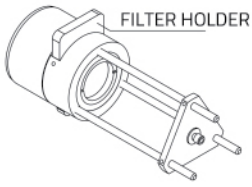
Wide-Range Achromatic Condenser PS-2

Designed to collect light from a sample over a wide spectral range and efficiently transmit it into an optical fiber or onto the entrance slit of a spectral instrument.

Consists of two achromatic, UV-transparent objectives.

Spectral range: ..... 200 - 2000 nm
Light collection angle ..... 22°
Front/back focal length ..... 38,5 mm



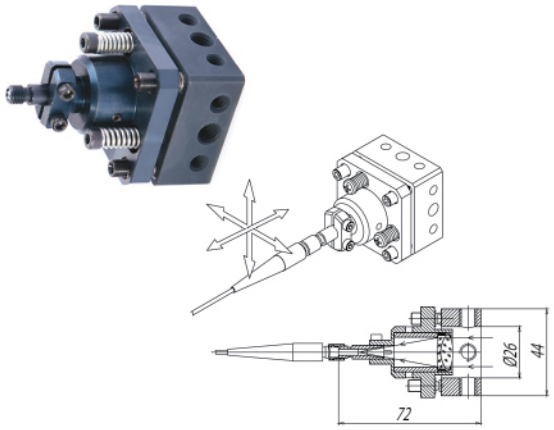

Wide-Aperture Achromatic Condenser PS-3

Designed to collect light from a sample over a wide spectral range and efficiently transmit it into an optical fiber or onto the entrance slit of a spectral instrument.

Consists of a meniscus and two achromatic objectives.

Spectral range:
Preferable ..... 400 - 1000 nm
Acceptable ..... 400 - 1700 nm
Light collection angle ..... 37°
Front focal length ..... 29,5 mm
Entrance aperture ratio ..... f/ 1,5
Back focal length ..... 100 mm
Exit aperture ratio ..... f/3,3

# LIGHT COLLECTING & FIBER COUPLING ACCESSORIES




Achromatic Fiber Adapter FA-1

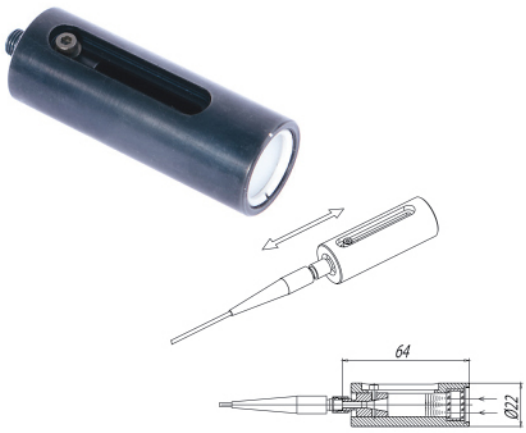
Contains a two-lens achromatic objective (diameter 15 mm, focal length 44,5 mm, 3D alignment).

Spectral range..... 200 - 2000 nm
Aperture ratio ..... f/3,0
Connector ..... SMA-905


Achromatic Fiber Adapter FA-2

Contains a two-lens achromatic objective (diameter 15 mm, focal length 44,5 mm, axial alignment)

Spectral range ..... 200 - 2000 nm
Aperture ratio ..... f/3,0
Connector ..... SMA-905




Diffuse Attenuator FA-3

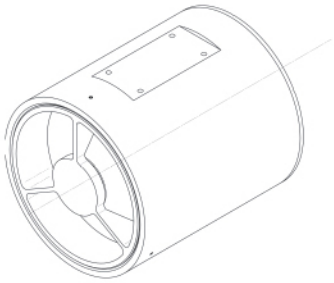
Contains two diffuse UV-silica substrates & SMA-905 connector.

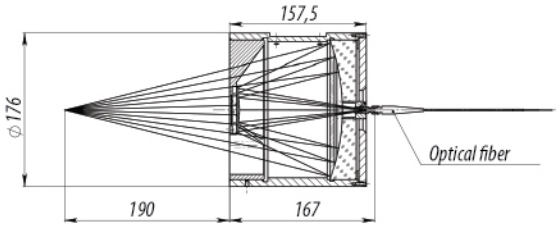
Axial adjustment of the fiber end relative to dispersing elements.

Spectral range ..... 200 - 2000 nm

Diffuse attenuator FA-3 is included into the standard set of supply of the wide-range Wavelength Meter SHR and SHR-IR.

# CASSEGRAIN OBJECTIVES

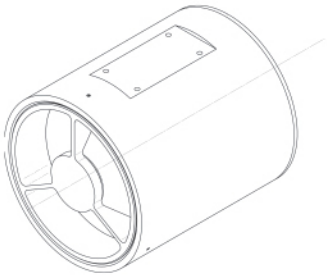


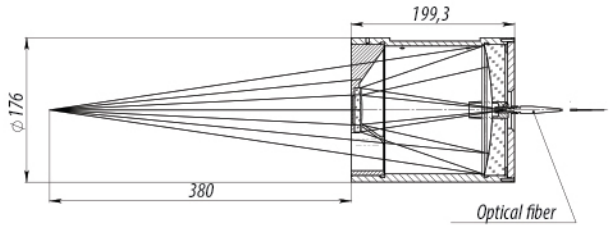



Cassegrain Objective CT-200

Designed to collect light from the objects located a distance of 190 mm from the objective housing. It contains a focusing mirror system. The objective is an achromatic and anastigmatic.

Spectral range..... 190 nm - 12 µm
Focal length..... 190 mm
Diameter..... 176 mm
Length ..... 167 mm
Connector..... SMA-905 (or another one according to your request)
Mirror coating .....Al+$MgF_2$ (or another one according to your request)



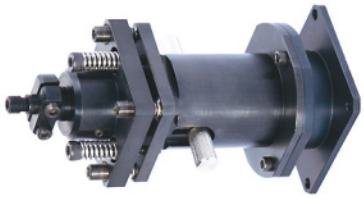


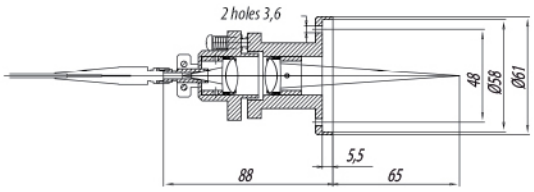

Cassegrain Objective CT-380

Designed to collect light from the objects located a distance of 380 mm from the objective housing. It contains a focusing mirror system. The objective is an achromatic and anastigmatic.

Spectral range..... 190 nm - 12 µm
Focal length..... 380 mm
Diameter..... 176 mm
Length ..... 236 mm
Connector..... SMA-905 (or another one according to your request)
Mirror coating .....Al+$MgF_2$ (or another one according to your request)

# APERTURE MATCHING ACCESSORIES



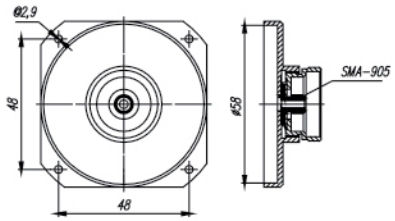



Achromatic fiber adapter AFA

Designed to match apertures of an optical fiber and monochromator in order to reduce stray light and optimize light throughput.

Is mounted on the entrance slit of the M266 and MSA-130 monochromators or on the Filter Wheel.

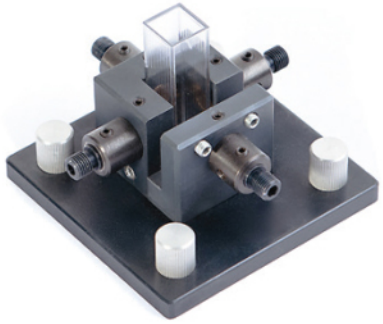
Spectral range ..... 200 - 2000 nm
Contains two achromatic objectives and SMA-905 connector.
Provides axial alignment of the fiber end and adjustment of the distance between objectives, which allows adjusting output aperture ratio within the range from f/3,5 to f/8,0.




Mechanical Fiber Adapter FA-4

Contains SMA-905 connector and four mounting holes for fixing on a monochromator input/output slit. Possibility of manual XY alignment of the fiber end relative to the monochromator slit.

# ACCESSORIES FOR LIQUID SAMPLES RESEARCH



Four-position cell holder FA-10

To measure absorption and fluorescence (at 90°) . Designed for a standard cell with 1 cm optical path length.
Spectral range .....200-2000 nm

Contains four collimating lenses and four standard SMA-905 connectors.
Possibility to install a filter up to 5 mm thick.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# DETECTORS

# MULTICHANNEL DETECTORS

Wavelight Technologies offers monochromator detectors based on the following image sensors manufactured by Toshiba and Hamamatsu:

| Sensor model | TCD1304 Toshiba | S13496 Hamamatsu | S11639-01 Hamamatsu |
|---|---|---|---|
| Number of pixels | 3648 | 4096 | 2048 |
| Pixel size, µm [2] | 8 x 200 | 7 x 200 | 14 x 200 |
| Active area, mm | 29,184 | 28,672 | 28,672 |
| Spectral range, nm | 200 – 1100 | 200 – 1000 | 200 – 1000 |
| Photosensitivity, V/lx*s | 160 | 650 | 1300 |
| Peak sensitivity wavelength, nm | 540 | 700 | 700 |
| Photoresponse non-uniformity [1], % | ±5 | ±2 | ±2 |
| Antiblooming [2] | No | Yes | Yes |
| ADC number of bits | 16 | 16 | 16 |
| RMS read noise, ADC counts | < 8 | < 4 | < 4 |
| Data rate (max), kHz | 500 | 3000 | 3000 |
| Dynamic range | 2000:1 | 5000:1 | 5000:1 |
| Min. readout time, ms | 7,4 | 1,366 | 0,683 |
| Min. exposure time, ms | 7,4 | 0,018 | 0,018 |
| Max. exposure time, not less, s [1] | 3 | 5 | 5 |
| Cooling temperature, °C | Non-cooled | Non-cooled | Non-cooled |
| Operating temperature, °C | 10 - 30 | 10 - 30 | 10 - 30 |
| PC connection | High-Speed USB | High-Speed USB | High-Speed USB |
| Triggering | IN/OUT | IN/OUT | IN/OUT |
| Dimensions, mm [3] | 66 x 86 x 32 | 66 x 86 x 32 | 66 x 86 x 32 |

1) At a signal level of 50% saturation.
2) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
3) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.

| Sensor model | S10420-1106-01 Hamamatsu | S16010-1106 Hamamatsu | S11850-1106-01 Hamamatsu | S10140-1109-01 Hamamatsu | S10141-1109S-01 Hamamatsu |
|---|---|---|---|---|---|
| Number of pixels | 2068 x 70 | 2068 x 70 | 2068 x 70 | 2068 x 512 | 2068 x 512 |
| Number of active pixels | 2048 x 64 | 2048 x 64 | 2048 x 64 | 2048 x 512 | 2048 x 512 |
| Pixel size, µm [2] | 14 x 14 | 14 x 14 | 14 x 14 | 12x12 | 12x12 |
| Active area, mm [2] | 28,672 x 0,896 | 28,672 x 0,896 | 28,672 x 0,896 | 24,576 x 6,072 | 24,576 x 6,072 |
| Spectral range, nm | 200 – 1100 | 200 – 1100 | 200 – 1100 | 200 – 1200 | 200 – 1200 |
| Peak sensitivity wavelength, nm | 500 | 700 | 600 | 640 | 640 |
| Quantum efficiency at peak sensitivity, % | >75 | >75 | >75 | >90 | >90 |
| Photoresponse non-uniformity, [1] % | ±3 | ±3 | ±3 | ±3 | ±3 |
| Antiblooming [2] | Yes | Yes | Yes | No | No |
| ADC number of bits | 16 | 16 | 16 | 16 | 16 |
| RMS read noise, ADC counts | <4 | <4 | <4 | <5 | <5 |
| Data rate (max), kHz | 250 | 250 | 250 | 250 | 250 |
| Frame processing time in the scanning mode, ms | 0,58 | 0,58 | 0,58 | 4,202 | 4,202 |
| Frame processing time in the binning mode, ms | 9,39 | 9,39 | 9,39 | 16,46 | 16,46 |
| Min. exposure time, ms | 8,272 | 8,272 | 8,272 | 8,272 | 8,272 |
| Max. exposure time, not less, s [1] | 5 | 5 | 40 | 2 | 60 |
| Cooling temperature, °C | Non-cooled | Non-cooled | 5 | Non-cooled | -10 |
| Operating temperature, °C | 10÷30 | 10÷30 | 10÷30 | 10÷30 | 10÷30 |
| PC connection | High Speed USB | High Speed USB | High Speed USB | High Speed USB | High Speed USB |
| Triggering | IN/OUT | IN/OUT | IN/OUT | IN/OUT | IN/OUT |
| Dimensions, mm [3] | 70 x 80 x 143 | 70 x 80 x 143 | 70 x 80 x 120 | 66 x 86 x 46 | 70 x 80 x 121 |

1) At a signal level of 50% saturation.
2) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
3) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.

| Sensor model | S7030-1006 | S7030-1007 | S7031-1006S | S7031-1007 |
|---|---|---|---|---|
| Number of pixels | 1024 x 64 | 1024 x 128 | 1024 x 64 | 1024 x 128 |
| Number of active pixels | 1024 x 58 | 1024 x 122 | 1024 x 58 | 1024 x 122 |
| Pixel size, $\mu m^2$ | 24 x 24 | 24 x 24 | 24 x 24 | 24 x 24 |
| Active area, $mm^2$ | 24,6 x 1,4 | 24,6 x 2,9 | 24,6 x 1,4 | 24,6 x 2,9 |
| Spectral range, nm | 200 – 1100 | 200 – 1100 | 200 – 1100 | 200 – 1100 |
| Peak sensitivity wavelength, nm | 650 | 650 | 650 | 650 |
| Quantum efficiency at peak sensitivity, % | >90 | >90 | >90 | >90 |
| Photoresponse non-uniformity, [1] % | ±3 | ±3 | ±3 | ±3 |
| Antiblooming [2] | No | No | No | No |
| ADC number of bits | 16 | 16 | 16 | 16 |
| RMS read noise, ADC counts | <2 | <2 | <2 | <2 |
| Data rate (max), kHz | 125 | 125 | 125 | 125 |
| Frame processing time in the scanning mode, ms | 0,54 | 1,07 | 0,54 | 1,07 |
| Frame processing time in the binning mode, ms | 9,12 | 9,89 | 9,12 | 9,89 |
| Min. exposure time, ms | 8,2 | 8,2 | 8,2 | 8,2 |
| Max. exposure time, not less, s [1] | 2 | 2 | 160 | 160 |
| Cooling temperature, °C | Non-cooled | Non-cooled | -10 | -10 |
| Operating temperature, °C | 10 - 30 | 10 - 30 | 10 - 30 | 10 - 30 |
| PC connection | High Speed USB | High Speed USB | High Speed USB | High Speed USB |
| Triggering | IN/OUT | IN/OUT | IN/OUT | IN/OUT |
| Dimensions, $mm^3$ | 66 x 86 x 47 | 66 x 86 x 47 | 70 x 80 x 121 | 70 x 80 x 121 |

1) At a signal level of 50% saturation.
2) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.
3) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25 °C ambient.

| Sensor model | G9212-512SB | G9214-512S | G9204-512DA | G11478-256WB | G9206-512WB |
|---|---|---|---|---|---|
| Number of pixels | 512 | 512 | 512 | 256 | 512 |
| Defective pixels [1] | ≤5 | ≤5 | No | ≤13 | ≤13 |
| Pixel size, μm[2] | 25 x 250 | 25 x 500 | 25 x 500 | 50x250 | 25x250 |
| Active area, mm[2] | 12,8 | 12,8 | 12,8 | 12,8 | 12,8 |
| Spectral range, nm | 0,9 – 1,67 | 0,9 – 1,67 | 0,9 – 1,7 | 0,9 – 2,6 | 0,7 – 2,25 |
| Peak sensitivity wavelength, μm | 1,55 | 1,55 | 1,55 | 2,3 | 1,95 |
| Photoresponse non-uniformity [1], % | ±5 | ±5 | ±5 | ±10 | ±10 |
| Antiblooming [3] | Yes | Yes | Yes | Yes | Yes |
| ADC number of bits | 16 | 16 | 16 | 16 | 16 |
| RMS read noise, ADC counts | <4 | <4 | <4 | <6 | <6 |
| Data rate (max), kHz | 125 | 125 | 125 | 125 | 125 |
| Min. readout time, ms | 4,1 | 4,1 | 4,1 | 2,05 | 2,05 |
| Exposure time step, μs | 16 | 16 | 16 | 16 | 16 |
| Min. exposure time, ms | 12 | 12 | 12 | 8 | 4,1 |
| Max. exposure time, not less, s [1] | 100 | 60 | 2 | 3,5 ms | 60 ms |
| Cooling temperature, °C | -10 | -10 | Non-cooled | -20 | -20 |
| Operating temperature, °C | 10 – 30 | 10 – 30 | 10 – 30 | 10-30 | 10-30 |
| PC connection | High Speed USB | High Speed USB | High Speed USB | High Speed USB | High Speed USB |
| Triggering | IN/OUT | IN/OUT | IN/OUT | IN/OUT | IN/OUT |
| Dimensions, mm[3] | 70 x 80 x 122 | 70 x 80 x 122 | 66 x 86 x 32 | 70 x 80 x 143 | 70 x 80 x 143 |

1) The total number of pixels with values of dark current, sensitivity nonlinearity, and readout noise exceeding the maximum, excluding the first and last pixel.t

2) At a signal level of 50% saturation.

3) Antiblooming is a sensor feature preventing charge overflow from exposed pixels to surrounding pixels.

4) Max. exposure time is the time when the dark signal constitutes 25% of the dynamic range at +25°C ambient.

5) All listed image sensors provide two operating modes: a wide dynamic range mode and a high sensitivity mode. The parameters presented are for the wide dynamic range mode.

# PHOTOMULTIPLIERS

Wavelight Technologies offers to equip monochromators and spectrographs with new generation photomultipliers series H11890 manufactured by Hamamatsu. H11890 is a photon counter, in a single metal casecontaining a phot omultiplier, a high-voltage power supply, a voltage divider circuit, a photon counting circuit and a USB interface. The photon counter is fully compatible with the software of spectrographs and monochromators produced by Wavelight Technologies . The H11890 series is available in 3 versions with three different photomultipliers, which makes it possible to use the detector for a variety of applications. The photon counting scheme is characterized by high linearity of counting and low noise.

| Model | | H11890-110 | H11890-210 | H11890-01 |
|---|---|---|---|---|
| Input voltage | | USB-power supply | | |
| Max. input current, mA | | 50 | | |
| Effective area, mm | | Ø 8 | | |
| Peak sensitivity wavelength, nm | | 400 | | |
| Spectral range, nm | | 230 - 700 | 230 - 700 | 230 - 870 |
| Readout sensitivity | 300 nm | $3,7 \times 10^5$ | $3,9 \times 10^5$ | $2,7 \times 10^5$ |
| | 400 nm | $4,9 \times 10^5$ | $6,1 \times 10^5$ | $3,6 \times 10^5$ |
| | 500 nm | $3,7 \times 10^5$ | $4,6 \times 10^5$ | $2,8 \times 10^5$ |
| | 600 nm | $1,1 \times 10^5$ | $1,3 \times 10^5$ | $2,0 \times 10^5$ |
| | 700 nm | $7,7 \times 10^3$ | $9,1 \times 10^3$ | $1,2 \times 10^5$ |
| | 800 nm | – | – | $3,0 \times 10^4$ |
| Readout linearity, $s^{-1}$ | | $5,0 \times 10^6$ | | |
| | | $2,0 \times 10^7$ | | |
| Dark current, $s^{-1}$ | Average | 50 | 50 | 600 |
| | Max. | 100 | 100 | 1000 |
| Readout time, ms | | 1 - 10000 | | |
| PC connection | | USB 2.0 | | |
| Operating temperature, °C | | +5...-40 | | |
| Weight, g | | 54 | | |

Photodiodes for the visible and infrared ranges, as well as power sources with ADC, are available upon request. We are also able to manufacture adapters to install your detectors in monochromators and spectrographs.

Wavelight
Technologies

Info@wavelight-tech.com
Dubai, U.A.E

www.wavelight-tech.com