

AVANTES

MEMBER OF THE NYNOMIC GROUP

Spectrometers | Light Sources | Fiber Optics | Software | Accessories

Enlightening Spectroscopy

Catalog XI

INTRODUCTION

Dear customer,

After being in this industry for over 25 years, I am still excited and proud to present to you our new catalog. In this edition, we showcase all of our instruments and accessories for fiber-optic spectroscopy.

As the leading innovator in the development and application of miniature spectrometers we continue to develop and introduce new instruments. Avantes' instruments and accessories are also integrated into many OEM applications in many industries and markets throughout the world. With a quarter of a century of experience in fiber optic spectroscopy and thousands of instruments in the field, Avantes is eager to help our customers with Enlightening Spectroscopy.

Avantes works with customers in a variety of markets, including chemical, (bio)medical, environmental, glass & coating, life-science, chemistry, lighting semiconductor, agricultural and food processing technology. Additionally, Avantes works with research organizations and universities, aiding in

developing research and teaching opportunities.

Our OEM program is designed to work with our customers to identify needs and customize an Avantes' spectroscopy solution based on our customer's needs and Avantes technical knowledge and experience. Avantes' continued growth is based upon a commitment to providing exceptional technology and superb customer satisfaction.

Avantes engineering, manufacturing, sales and service headquarters are located in the Netherlands.

The company also operates direct offices in China and North America. In addition, Avantes has a growing worldwide distribution network of more than 40 qualified distributors to meet our customers' needs worldwide.

In this catalog you will find a complete and detailed overview of our products. As we are continuously improving our products and introduce new instruments regularly we recommend to check the digital version on our website for an up-to-date version of this catalog.

We are looking forward to building up a long term relationship with you.



Benno Oderkerk

CEO and founder of Avantes

OUR MISSION

We provide state-of-the-art, innovative measuring equipment that helps mankind live longer, healthier lives, and saving the planet for generations to come.

VALUES

Avantes is the innovative, trusted leader in high-quality and customer oriented optical instruments and solutions.

We achieve this through service oriented thinking and acting, encouraging and motivating each other with a positive, critical and professional attitude.

VISION

To enrich the lives of mankind in the world we live in.

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NEW IN THIS CATALOG

AvaSpec-Mini-NIR256-1.7

Our latest addition to our popular CompactLine Mini-series: the AvaSpec-Mini-NIR! This compact, versatile near-infrared spectrometer operates in a 900-1750 nm range and is suitable for various applications, including food analysis and recycling.

Find out more on page ..



AvaSpec-ULS2048x64TEC-EVO

Updated and improved: this spectrometer has a thermoelectrically cooled, back-thinned detector that enables long integration times with low noise levels. The cooling of this spectrometer can reduce the temperature of the CCD chip to -30°C against ambient.

Find out more on page ..

AvaSpec-ULS2048x64-EVO

More cost effective than the cooled version but with the same pixel count, the AvaSpec-ULS2048x64-EVO is a great choice for applications that require integration times lower than 2 seconds. This uncooled spectrometer has an established track record in various DOAS applications.

Find out more on page ..



Direct-Attach Shutter

This remote-controlled shutter, positioned between the spectrometer entrance and the input fiber, is the ideal accessory to quickly and automatically take dark measurements without having to cover the sensor, switch off your light source or perform other manual actions.

Find out more on page ..

Spectrometers

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A close-up photograph of a female scientist with brown hair, wearing safety glasses and a white lab coat. She is looking intently through a rack of ten test tubes. Each test tube contains a yellow liquid. The background is a soft, out-of-focus laboratory setting. The word 'Spectrometers' is written vertically in a purple font on the left side of the image.

Spectrometers

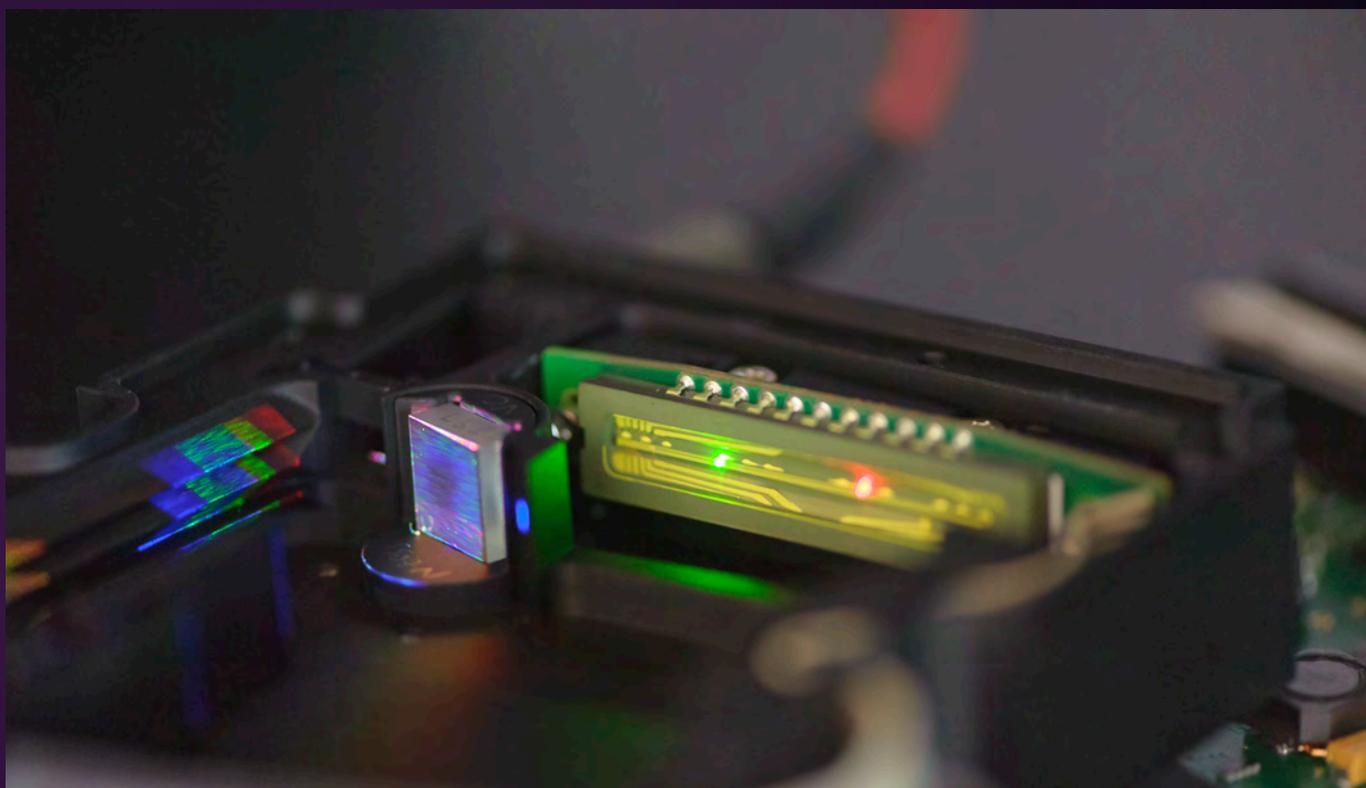
INTRODUCTION

A spectroscopic instrument or spectrometer generally consists of entrance slit, collimator, a dispersive element, such as a grating or prism, focusing optics and detector. In a monochromator system there is normally also an exit slit, and only a narrow portion of the spectrum is projected on a one-element detector. In monochromators the entrance and exit slits are in a fixed position and can be changed in width. Rotating the grating scans the spectrum.

The development of micro-electronics during the 90's in the field of multi-element optical detectors, such as Charged Coupled Devices (CCD) arrays and complementary metal-oxide semiconductor (CMOS), enabled the production of low cost scanners, CCD cameras, etc. These same CCD and CMOS detectors are now used in the Avantes AvaSpec line of spectrometers, enabling fast scanning of the spectrum, without the need for a moving grating.

Thanks to the need for fiber-optics in the communication technology, low absorption silica fibers have been developed. Similar fibers can be used as measurement fibers to transport light from the sample to the optical bench of the spectrometer. The easy coupling of fibers allows a modular build-up of a system that consists of light source, sampling accessories and fiber-optic spectrometer. Furthermore fiber-optic enable the introduction of sampling into harsh and difficult to access environments.

The modularity, flexibility and speed of measurement made possible by fiber-optic spectrometers have resulted in wide adoption of this technology in a variety of industries.



Three years
limited warranty on
all Avantes spectrometers,
light sources and accessories

Optical Bench Design



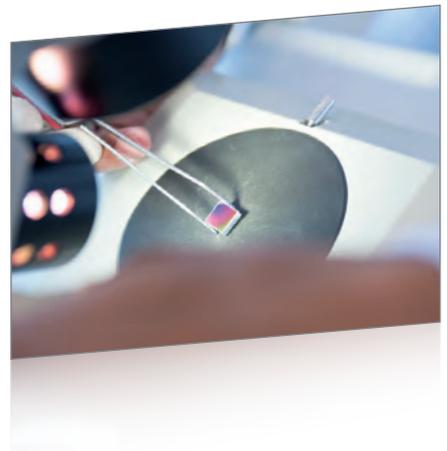
Avaspec-ULS Optical Bench Design: Symmetrical Czerny-Turner

- | | |
|------------------------|--------------------|
| 1. Detector | 7. Focusing mirror |
| 2. SMA Connector | 8. CPC light traps |
| 3. Grating | 9. CPC light traps |
| 4. Slit, mode stripper | 10. DCL-UV/VIS |
| 5. 2nd mode stripper | 11. OSC-filter |
| 6. Collimating mirror | |

The heart of most AvaSpec fiber-optic spectrometers is an optical bench with 37.5, 50, 75 or 100 mm focal length, developed in a symmetrical Czerny-Turner design. Light enters the optical bench through a standard SMA-905 connector and is collimated by a spherical mirror. A plain grating diffracts the collimated light; a second spherical mirror focuses the resulting diffracted light. An image of the spectrum is projected onto a 1-dimensional linear detector array.

Avantes AvaSpec-HS2048XL high-sensitivity spectrometers have a revolutionary optical bench design with multiple toroid mirrors which ensure that the full numerical aperture of the fiber entrance will be projected on the backthinned CCD array.

All of our optical benches have a number of components installed inside, allowing a wide variety of different configurations, depending on the intended application. The choice of these components such as the diffraction grating, entrance slit, order-sorting filter, and detector have a strong influence on system specifications such as sensitivity, resolution, bandwidth and stray-light. Each of these specifications will be discussed in detail in the following paragraphs.



How to configure a spectrometer for your application

The modular AvaSpec line of instruments provides you with a number of configuration options to optimize the optical and spectroscopic performance of your instrument for your application.

This section provides you some guidance on how to choose the right grating, slit, detector and other configuration options, to be installed in your AvaSpec.

Wavelength Range

In the determination of the optimal configuration of a spectrometer system the wave-

length range is key parameter that defines the appropriate grating choice.

If you are looking for a wide (broadband) wavelength range, we recommend the use of a 300 lines/mm grating. For lesser range (approximately 500 nm) but higher resolution, you might consider a 600 lines/mm. Higher lines/mm gratings (1200, 1800, 2400, 3600) provide higher resolution for applications that require this (see Grating selection table in the spectrometer product section). Broadband gratings provide the greatest flexibility but may not provide the best performance for specific

applications. Contact an Avantes Sales Engineer or representative for a recommended grating configuration.

Detector Choice

The choice of your wavelength range along with the demands of your measurement speed and accuracy often suggests the appropriate detector for your application.

Avantes offers a variety of different detector types, each with different sensitivity curves (see Figure 3a and 3b on page 20).

The AvaSpec instrument line is divided into multiple groups based on general requirements. The AvaSpec-Starline is comprised of general purpose UV/VIS instruments with low-cost CCD or CMOS detectors. The AvaSpec Sensline is comprised of higher performance back-thinned CCDs and thermo-electrically cooled CCD UV/VIS instruments. These instruments are particularly better in the UV and NIR range, compared to standard CCD and CMOS detectors. The AvaSpec NIRLine is comprised of instruments with InGaAs arrays for longer wavelength measurements, ranging from 900-2500 nm. For applications where the size of the instrument is a critical factor, Avantes offers the CompactLine with spectrometers that have a small form factor.

For high-speed applications, the 2048 pixel CMOS detectors in the AvaSpec-ULS2048CL from the StarLine are normally the best options. For low-light level applications such as fluorescence and Raman, the SensLine instruments may be the most appropriate. The AvaSpec NIRLine features 6 different InGaAs detectors for various applications.

The modularity and inter-compatibility of the AvaSpec line also make it possible to combine two or more detectors in a single instrument enclosure to provide optimal performance over a broad wavelength range. For example, an AvaSpec StarLine (UV/VIS) spectrometer can be combined with a NIRLine spectrometer to enable measurements from 200-2500 nm in a single instrument.

Optical Resolution & Slit size

If high optical resolution is required, you may want to consider a grating with higher lines/mm (1200, 1800, 2400, 3600), thus limiting the range of the instrument to a more narrow range. Additionally, it is advisable to consider a detector with 2048 or 4096 pixels and a small slit (10 or 5 μm). For the best resolution with all other criteria of lesser importance, the AvaSpec-4096CL with a 5 micron slit is optimal.

Slit size is a key factor in determining both resolution and throughput of the optical bench. It is important to balance your need for resolution with the need for sensitivity and throughput of the optical bench. If resolution is optimized without considering the need for throughput, you may not have adequate light to get a stable measurement. As previously mentioned, for optimal resolution our smallest slit (5 microns) is recommended. If your application does

not require the highest possible resolution and is not one that has an excess of light (laser measurement for example), we recommend that you consider as larger slit to maximize throughput into the optical bench.

The AvaSpec-RS with replaceable slit makes your spectrometer a versatile instrument for both high-resolution and high-sensitivity measurements.

Sensitivity

When considering sensitivity, it is very important to distinguish between photometric sensitivity (How much light do I need for a detectable signal?) and chemometric sensitivity (What absorbance difference level can still be detected?)

a. Photometric Sensitivity

For the best photometric sensitivity a combination of a high-throughput optical bench and a high quantum-efficiency (QE) detector is recommended. The instruments in the AvaSpec SensLine are specifically optimized for photometric sensitivity.

For example fluorescence applications require high photometric sensitivity. Avantes AvaSpec-HS2048XL is the highest performance instrument we offer for this application. For Raman applications, where the combination of resolution and sensitivity is required, we commonly recommend our AvaSpec-HERO with TEC cooling. To further enhance photometric sensitivity, we recommend the use of a detector collection lens (DCL-UV/VIS or DCL-UV/VIS-200), which is a cylindrical lens with focuses light from larger core fiber-optics and bundles down onto the smaller detector pixels.

For additional photometric sensitivity, a larger slit and a 300 line/mm grating to minimize light dispersion are available. Some more demanding applications also require thermo-electric cooling of the CCD detector (see product section AvaSpec-ULS2048LTEC and AvaSpec-HERO) to minimize noise and increase dynamic range at long integration times (up to 60 seconds).

For our detector types the photometric sensitivity is given in Table 4 (page 19) and Table 5 (page 21), the spectral sensitivity for each detector is depicted in Figures 3a and 3b.

b. Chemometric Sensitivity

To detect drastical different absorbance values, close to each other with maximum sensitivity, you need high Signal to Noise (S/N) performance. The detectors with best S/N performance are again in

the AvaSpec SensLine series spectrometers



with the AvaSpec-HERO at the top of the line. The S/N performance can also be enhanced by averaging multiple spectra. The square root of the number of averages translates to the improvement in signal to noise.

Timing and Speed

The data capture process is inherently faster with linear detector arrays and no moving parts as compared with a monochromator design, however, there are optimal detectors for each application. For high-speed applications such as measurements involving pulsed lasers and light sources, we recommend the AvaSpec-ULS2048CL-EVO spectrometers.

These instruments support high-speed data acquisition with the capability of starting an acquisition as fast as within 1.3 microseconds of receiving an external trigger. Since data transfer time is critical for these applications, Avantes' unique Store-to-RAM mode enables on board storage of up to 5000 spectra to the instrument RAM buffer.

The above parameters are the most important in choosing the right spectrometer configuration. Please contact our application engineers to optimize and fine-tune the system to your needs. Table 1 on the next page provides a quick reference guide for spectrometer selection for many common applications. The system recommendations in this table are for simple configurations of mostly single channel spectrometers. For more elaborate explanations of specific explanations, see the applications section at the back of the catalog.

Table 1 Quick Reference Guide for Spectrometer Configuration

Application	AvaSpec-type	Grating	WL range (nm)	Coating	Slit (μm)	FWHM Resolution (nm)	DCL	OSF	OSC
Biomedical	ULS2048CL	NB	500-1000	-	50	1.2	-	475	-
Chemometry	ULS2048CL	UA	200-1100	-	50	2.3	-	-	OSC-UA
Color	ULS2048CL	BB	360-780	-	200	4.5	X/-	-	-
Fluorescence	ULS2048x64TEC ULS2048XL	VA, VB, UB	350-1100, 300-800	-	200	9.2 4.6	X	305	OSC
	HS2048XL	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
Fruit-sugar	ULS2048CL	IA	800-1100	-	50	6.4	X	600	-
Gemology	ULS2048	VA	350-1100	-	25	1.2	X	-	OSC
High-resolution	ULS2048CL	VD	600-700	-	10	0.12	-	550	-
	ULS4096CL	VD	600-700	-	10	0.05	-	550	-
High UV/NIR-Sensitivity	HS2048XL	HS-500-0.33	200-1160	-	200	10.0	-	-	OSC
Irradiance	ULS2048CL	UA	200-1100	DUV	50	2.3	X/-	-	OSC-UA
Laserdiode	ULS4096CL	NC	700-800	-	10	0.18	-	600	-
LED	ULS2048CL	VA	350-1100	-	25	1.2	X/-	-	OSC
LIBS	ULS4096CL	D,E,F	200-900	DUV	10	0.09	-	-	-
Raman	ULS2048LTEC ULS2048x64TEC	NC	780-930	-	25	0.3	X	600	-
	ULS2048XL	VA	300-1100	-	50	2.5	-	305	OSC
Thin Films	ULS2048CL	UA	200-1100	DUV	100	4.6	X	-	OSC-UA
UV/VIS/NIR	ULS2048CL	UA	200-1100	DUV	25	1.2	X/-	-	OSC-UA
	ULS2048XL	UA	200-1100	-	25	1.5	-	-	OSC-UA
NIR	NIR512-1.7TEC	NIR200-1.5	1000-1750	-	25	6.0	-	1000	-
	NIR256-2.5TEC	NIR100-2.5	1000-2500	-	50	15.0	-	1000	OSC-NIR

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

How to choose the right grating

A diffraction grating is an optical element that separates incident polychromatic radiation into its constituent wavelengths. A grating consists of series of equally spaced parallel grooves formed in a reflective coating deposited on a suitable substrate. The way in which the grooves are formed separates gratings in two types, holo-graphic and ruled.

The ruled gratings are physically formed onto a reflective surface with a diamond on a ruling machine. Gratings produced from laser constructed interference patterns and a photolithographic process are known as holographic gratings.

Avantes AvaSpec spectrometers come with a permanently installed grating that must be specified by the user. Additionally, the user needs to indicate what wavelength range needs to reach the detector. Sometimes the specified usable range of a grating is larger than the range that can be projected on the detector. In order to cover a broader range, a dual or multi-channel spectrometer can be chosen. In this configuration each channel may have different gratings covering a segment of the range of interest.

In addition to broader range, a dual or multi-channel spectrometer also affords higher resolution for each channel. For each spectrometer type a grating selection table is shown in the spectrometer platform section.

Table 2 illustrates how to read the grating selection table. The spectral range to select in Table 2 depends on the starting wavelength of the grating and the number of lines/mm; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

In Figure 2, grating efficiency curves are shown. When looking at the grating efficiency curves, please realize that the total system efficiency will be a combination of fiber transmission, grating and mirror efficiency, detector quantum efficiency and coating sensitivities. The dual-blazed grating is a 300 lines/mm broadband grating (covering 200-1100 nm) that has optimized efficiency in both UV and NIR.

Different diffraction gratings

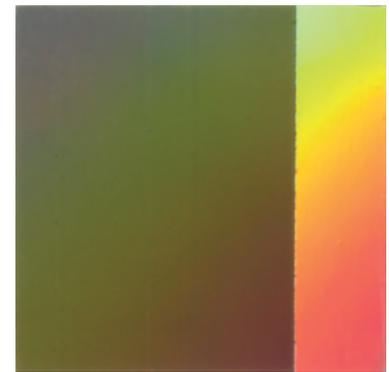
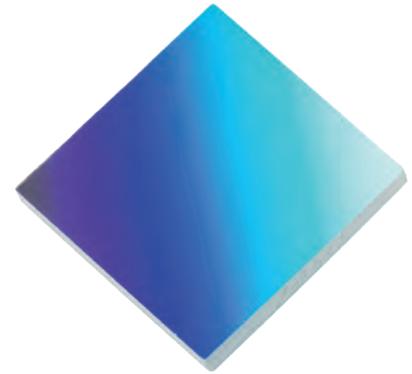


Table 2 Example of Spectral Range and Gratings

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100	900	300	300	UA
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	220-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
		800			VA

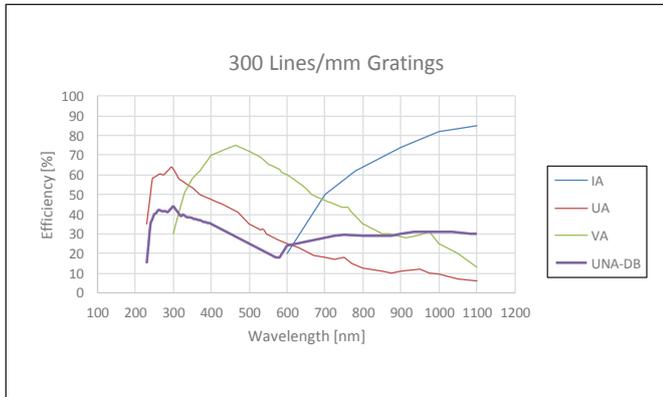
Please select Spectral range bandwidth from the useable Wavelength range, for example: grating UE (200-315 nm)
* the spectral range depends on the starting wavelength of the grating; the higher the wavelength, the smaller the range. For example: Grating UE (510-580 nm)

The order code is defined by 2 letters: the first is the Blaze (U= 250/300 nm or UV for holographic, B=400 nm, V=500 nm or VIS for holographic, N=750 nm, I=1000 nm) and the second the nr of lines/mm (Z=150, A=300, B=600, C=1200, D=1800, E=2400, F=3600 lines/mm)

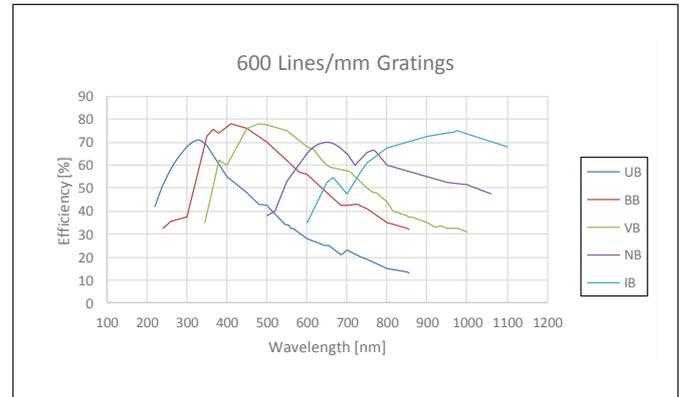
For newer types a different nomenclature is used stating the product line, lines/mm and blaze.

Figure 2 Grating Efficiency Curves

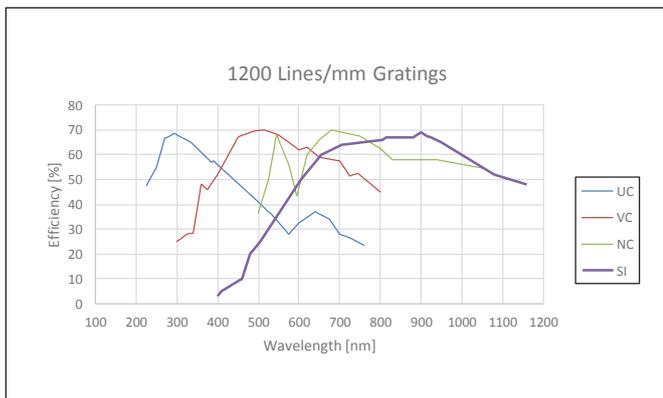
300 lines/mm gratings



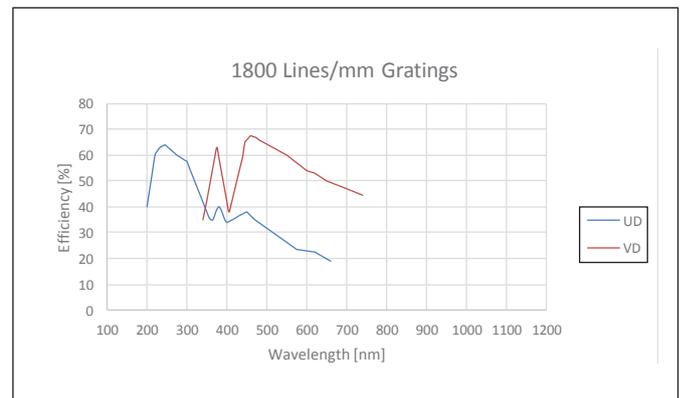
600 lines/mm gratings



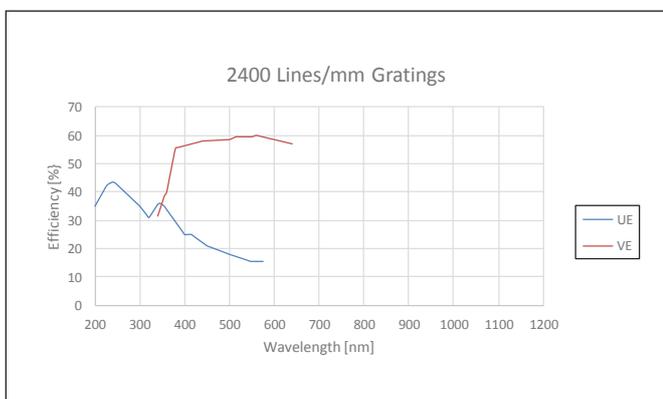
830 & 1200 lines/mm gratings



1800 lines/mm gratings



2400 lines/mm gratings



3600 lines/mm grating

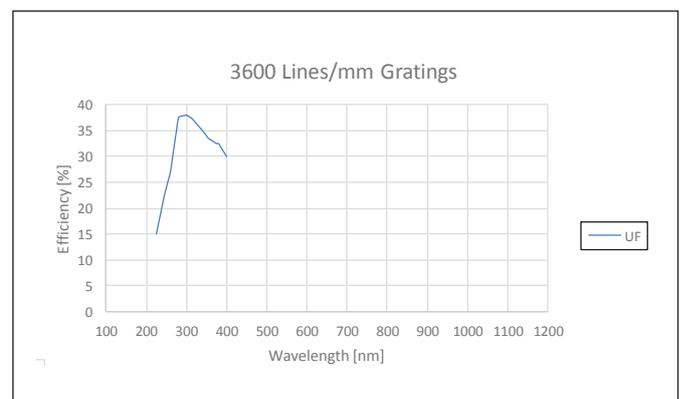
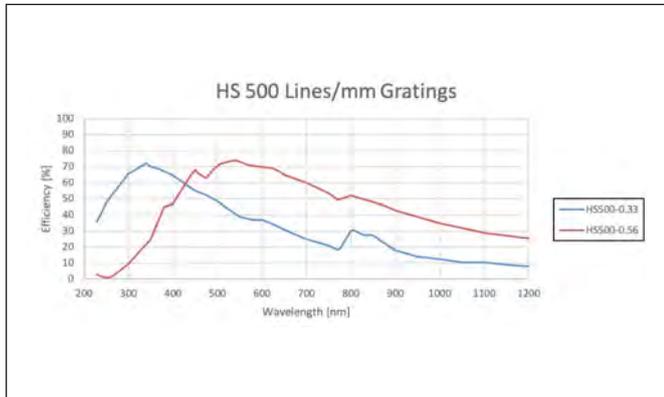


Figure 2 Grating Efficiency Curves

HS 500 lines/mm gratings



HS 600 lines/mm gratings



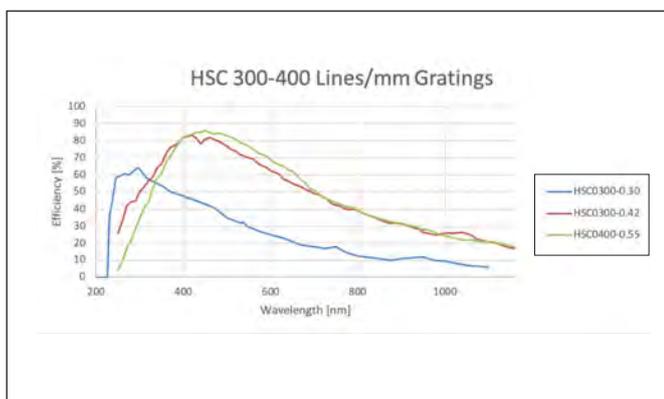
HS 830-1000 lines/mm gratings



HS 1200 lines/mm gratings



HSC 300-400 lines/mm gratings



HSC 600-830 lines/mm gratings

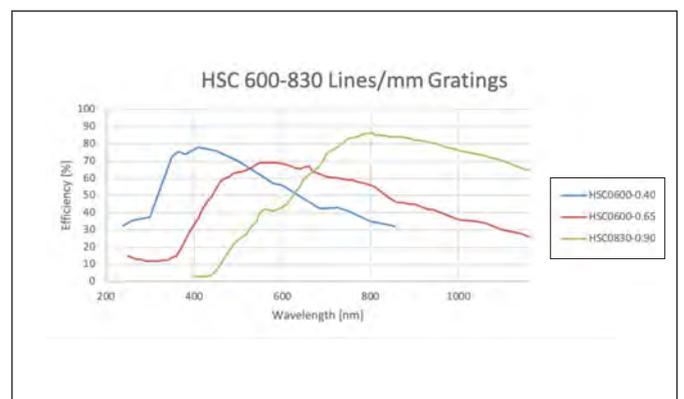
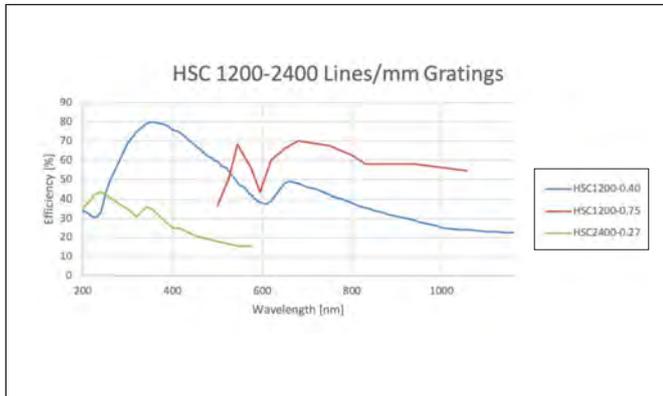
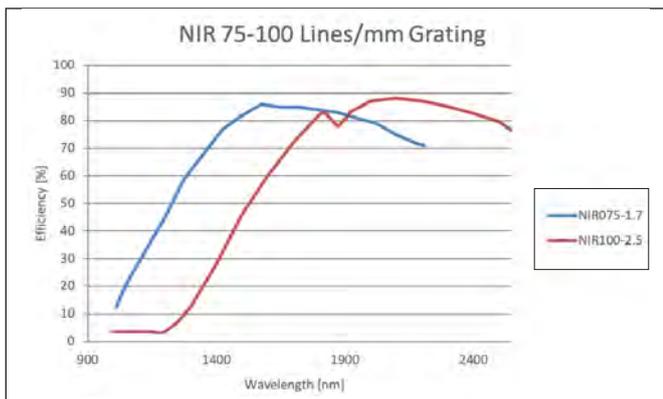


Figure 2 Grating Efficiency Curves

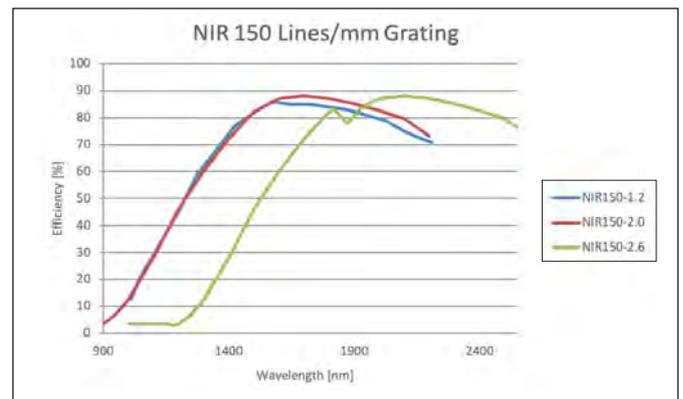
HSC 1200-2400 lines/mm gratings



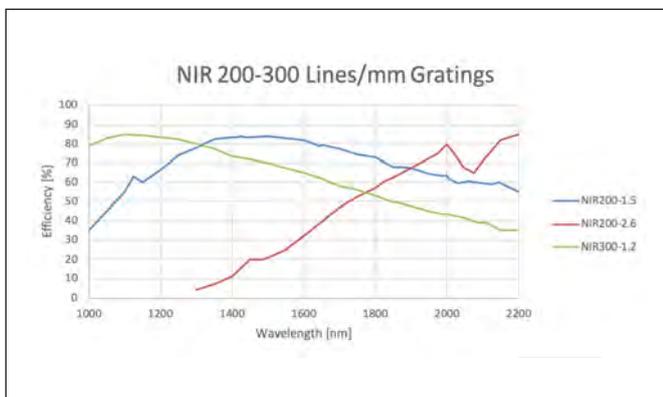
NIR 75-100 lines/mm gratings



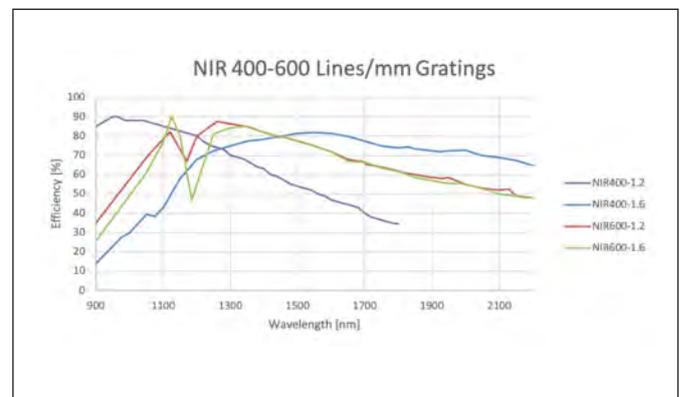
NIR 150 lines/mm gratings



NIR 200-300 lines/mm gratings



NIR 400-600 lines/mm gratings



How to select optimal optical resolution

Installed Slit in SMA Adapter



The optical resolution is defined as the minimum difference in wavelength that can be separated by the spectrometer. For separation of two spectral lines it is necessary to project them at least two array-pixels apart.

Because the grating determines how far different wavelengths are separated (dispersed) at the detector array, it is an important variable for the resolution. The other important parameter is the width of the light beam entering the spectrometer. This is basically the installed fixed entrance slit in the spectrometer, or the fiber core when no slit is installed.

For AvaSpec spectrometers the available slit widths are 5, 10, 25, 50, 100, or 200 μm wide x 1000 μm high, or 500 μm wide x 2000 μm high. The slit image on the detector array for a given wavelength will cover a number of pixels. For two spectral lines to be separated, it is necessary that they are dispersed over at least this image size plus one pixel. When large core fibers are used the resolution can be improved by a slit of smaller size than the fiber core. This effectively reduces the width of the light beam entering the spectrometer optical bench.

The influence of the chosen grating and the effective width of the light beam (fiber core or entrance slit) are shown in the tables provided for each AvaSpec spectrometer instrument.

In Table 3 the typical resolution can be found for the AvaSpec-ULS2048CL. Please note that for the higher lines/mm gratings the pixel dispersion varies along the wave-

length range and improves towards the longer wavelengths.

The resolution in this table is defined as Full Width Half Maximum (FWHM), which is defined as the width in nm of the peak at 50% of the maximum intensity.

For larger pixel-height detectors (3648, 2048L, 2048CL, 2048XL, 4096CL) in combination with thick fibers (>200 μm) and a larger grating angle the actual FWHM value can be 10-20% higher than the value in the table. For best resolution small core diameter fibers are recommended.

All data in the resolution tables are based on averages of actual measured data (with 200 μm fibers) of our Quality Control System during the production process. A typical standard deviation of 10-25%, depending on the slit diameter and the grating should be taken into account. For 10 μm slits the typical standard deviation is somewhat higher, which is inherent to the laws of physics. The peak may fall exactly within one pixel, but may cover 2 pixels causing, a lower measured resolution.

The replaceable slit feature is available on all ULS and NIR spectrometers. The spectrometers come with one installed slit and a slit kit which includes 3 other slit sizes, so you can opt for higher resolution (25 μm slit) or higher throughput (200 μm slit) or somewhere in between (50 or 100 μm slits).

Resolution Table (FWHM in nm) for AvaSpec-ULS2048CL-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Detector arrays

The AvaSpec line of spectrometers can be equipped with several types of detector arrays. Presently we offer silicon-based CCDs, back-thinned CCDs, and CMOS Arrays for the 200-1100 nm range. A complete overview of each is given in the next section "Sensitivity" in Table 4. For the NIR range (1000-2500 nm) InGaAs arrays are implemented.

All detectors are tested in incoming goods inspection, before they are used in our instruments. Avantes offers full traceability on following detector specifications:

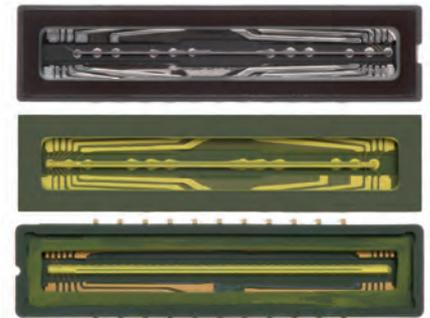
- Dark noise
- Signal to noise
- Photo Response Non-Uniformity
- Hot pixels

StarLine and CompactLine CMOS Detectors (2048CL/4096CL)

Both CCD (charge-coupled device) and CMOS (complementary metal-oxide semiconductor) detectors start at the same point – they convert light into electrons, only with different technologies. In the last years CMOS sensors has improved up to a point where they reach near parity with CCD devices.

Looking to the future the CMOS detectors seem to definitely take over the standard CCD technology in general purpose spectrometers. In general the CMOS detectors have a good UV response (without the need of using UV enhancement coatings) and a higher response in the NIR region.

The overall sensitivity tends to be somewhat lower than with the CCD technology.



SensLine Back-thinned CCD Detectors (2048XL/2048x64/1024x58)

For applications requiring high quantum efficiency in the UV (200-350 nm) and NIR (900-1160 nm) range, combined with good S/N and a wide dynamic-range, back-thinned CCD detectors are the right choice.

Avantes offers cooled and uncooled versions. In case of a 2D-detection the vertical pixels are binned, giving effectively one high pixel to increase sensitivity.

- + Advantage of the back-thinned CCD detector is the good UV and NIR sensitivity, combined with good S/N and dynamic range.
- Disadvantage is the relatively higher cost.



NIRLine InGaAs linear image sensors

(AvaSpec-NIR256/512)



The InGaAs linear image sensors deliver high-sensitivity in the NIR wavelength range. The detector consists of a charge-amplifier array with CMOS transistors, a shift-register and timing generator. For InGaAs detectors the dynamic range is limited by the dark noise. For ranges up to 1.75 μm no cooling is required and these detectors are available in both 256 and 512 pixels. Detectors for the extended range $>2.5 \mu\text{m}$ all have 2-stage TE-cooling to reduce dark noise and are available in 256 and 512 pixel versions.

6 versions of detectors are available:

- 256/512 pixel non-cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel 2-stage cooled Extended InGaAs detector for the 1000-2500 nm range

Sensitivity



The sensitivity of a detector pixel at a certain wavelength is defined as the detector electrical output per unit of radiation energy (photons) incident to that pixel. With a given A/D converter this can be expressed as the number of counts per mJ of incident radiation.

The relation between light energy entering the optical bench and the amount hitting a single detector pixel depends on the optical bench configuration. The efficiency curve of the grating used, the size of the input fiber or slit, the mirror performance and the use of a Detector Collection Lens are the main parameters. With a given set-up it is possible to do measurements over about 6-7 decades of irradiance levels. Some standard detector specifications can be found in Table 4 detector specifications. Optionally, a cylindrical detector collection lens (DCL) can be mounted directly on the detector array.

The DCL-UV/VIS-200 can be used for our spectrometers with larger pixel heights to have a better vertical distribution of light focusing on the detector and is primarily for fiber diameters larger than 200 μm and round- to-linear assemblies.

Our SensLine has the most sensitive detectors out of all of our instrument lines, as it includes back-thinned and thermoelectrically cooled detectors.

In Table 4 the UV/VIS detectors are depicted with their specifications, please find below some additional information on how those specifications are determined.

Pixel Well Depth (electrons)

This value is specified by the detector supplier and defines how many electrons can fit in a pixel well before it is saturated, this value determines the best reachable Signal to Noise ($=\sqrt{\text{Pixel well depth}}$).

Sensitivity in Photons/count @ 600 nm

The number of Photons of 600 nm that are needed to generate one count of signal on a 16-bit AD converter, the lower this number is, the better is the sensitivity of the detector.

The calculation of the number of Photons/count is $(\text{Pixel Well depth in electrons})/16\text{-bit AD}/\text{Quantum Efficiency @ 600 nm}$.

Sensitivity in counts/ μW per ms integration time

Sensitivity here is for the detector types currently used in the UV/VIS AvaSpec spectrometers as output in counts per ms integration time for a 16-bit AD converter. To compare the different detector arrays we have them all built up with an optical bench with UA 300 lines/mm grating covering 200-1100 nm, DCL if applicable, and 50 μm slit.

The measurement setup for 350-1100 nm has a 600 μm fiber connected to an AvaSpere-50-LS-HAL, equivalent to an optical power of 1.14 μW .

For the UV/VIS measurement at 220-1100 nm we connected the 600 μm fiber to an AvaLight-DHS through a CC-VIS/NIR diffuser, equivalent to 2.7 μW power.

Peak Wavelength and QE @ peak

The peak wavelength is provided by the detector supplier as well as the Quantum Efficiency, defined as the number of electrons generated by one photon.

Signal/Noise

Signal/Noise is measured for every detector at Avantes' Quality Control Inspection and defined as the illuminated maximum Signal/Noise in Root Mean Square for the shortest integration time. The RMS is calculated over 100 scans.

Dark Noise

Dark noise is measured for every detector at Avantes' Quality Control Inspection and defined as the non-illuminated noise in

Root Mean Square for the shortest integration time. The RMS is calculated over 100 scans.

Dynamic Range

The dynamic range is defined as the (maximum signal level- baseline dark level)/dark noise RMS.

Photo Response Non-Uniformity

Photo Response Non-Uniformity is defined as the max difference between output of pixels when uniformly illuminated, divided by average signal of those pixels. PRNU is measured for every detector at Avantes' Quality Control Inspection.

Frequency

The frequency is the clock frequency at which the data pixels are clocked out through the AD-converter.

Table 4 Detector Specifications (based on a 16-bit AD converter)

	StarLine			SensLine			
Detector	HAM-2048CL	HAM-4096CL	SONY-2048L	HAM-2048XL	HAM-2048x64TEC	HAM-2048x64	HAM-1024x58
Type	CMOS linear array	CMOS linear array	CCD linear array	Back-thinned CCD array	Cooled Back-thinned CCD array	Back-thinned CCD array	Cooled Back-thinned CCD array
# Pixels, pitch	2048, 14 µm	4096, 7 µm	2048, 14 µm	2048, 14 µm	2048, 14 µm	2048, 14 µm	1024 x 58, 24 µm
Pixel width x height (µm)	14 x 200	7 x 200	14 x 200	14 x 500	14 x 14 (total height 0.9 mm)	14 x 14 (total height 0.9 mm)	24 x 24 (total height 1.4 mm)
Pixel well depth (electrons)	80,000	80,000	90,000	200,000	300,000	200,000	1,000,000
Sensitivity Photons/ count @600 nm	2	2	2	4	6	4	16
Sensitivity in counts/µW per ms integration time	375,000 (AvaSpec-ULS2048CL)	218,000 (AvaSpec-ULS4096CL)	470,000 (AvaSpec-ULS2048L)	460,000 (AvaSpec-ULS2048XL)	300,000 (AvaSpec-ULS2048x64TEC)	650,000 (AvaSpec-ULS2048x64)	445,000 (AvaSpec-HERO)
Peak wavelength	700 nm	700 nm	450 nm	650 nm	600 nm	600 nm	650 nm
QE (%) @ peak	80%	80%	40%	78%	78%	78%	92%
Signal/Noise	300:1	335:1	300:1	525:1	550:1	450:1	1200:1
Dark noise (counts RMS)	16	16	20	5	5	11.5	2
Dynamic Range	4000	4000	3300	13,700	19,000	1600	40,000
PRNU*	± 5%	± 5%	± 5%	± 3%	± 3%	± 3%	± 3%
Wavelength range (nm)	200-1100	200-1100	200-1100	200-1160	200-1160	200-1160	200-1160
Frequency	6 MHz	6 MHz	2 MHz	1 MHz	500 kHz	1.33 MHz	250 kHz

* Photo-Responsive Non-Uniformity

Figure 3a Sensitivity Curve StarLine

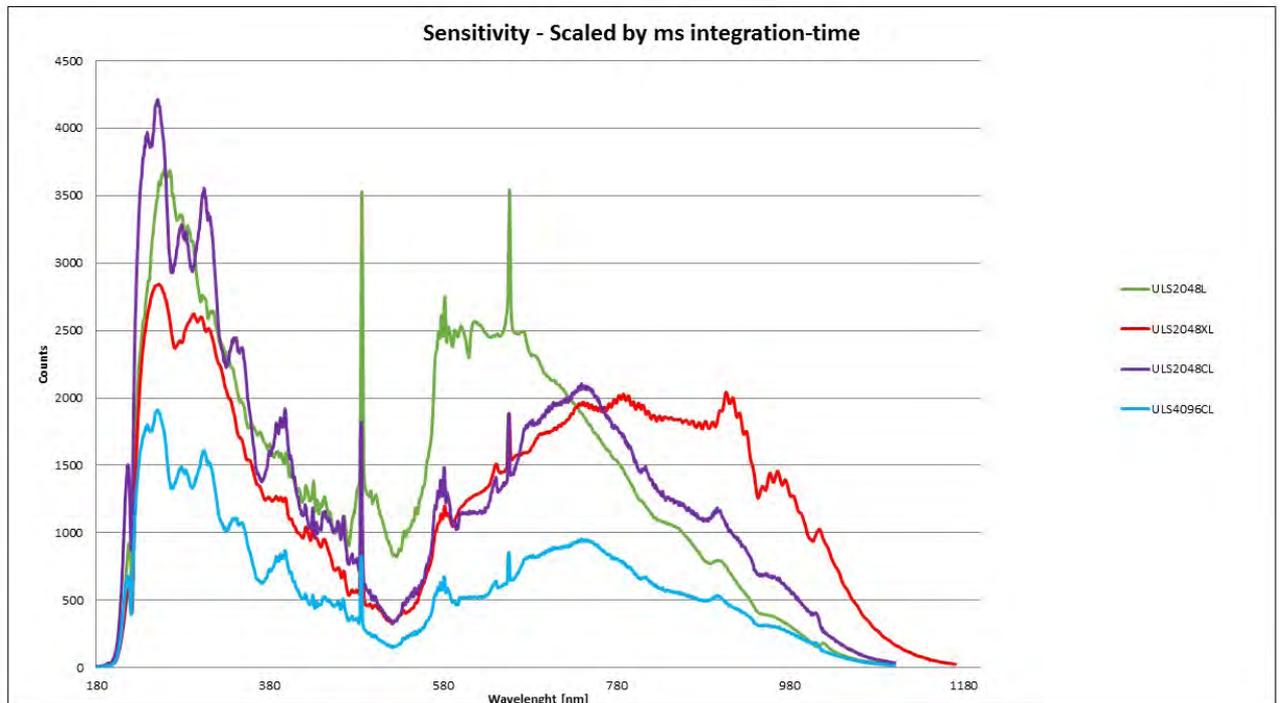
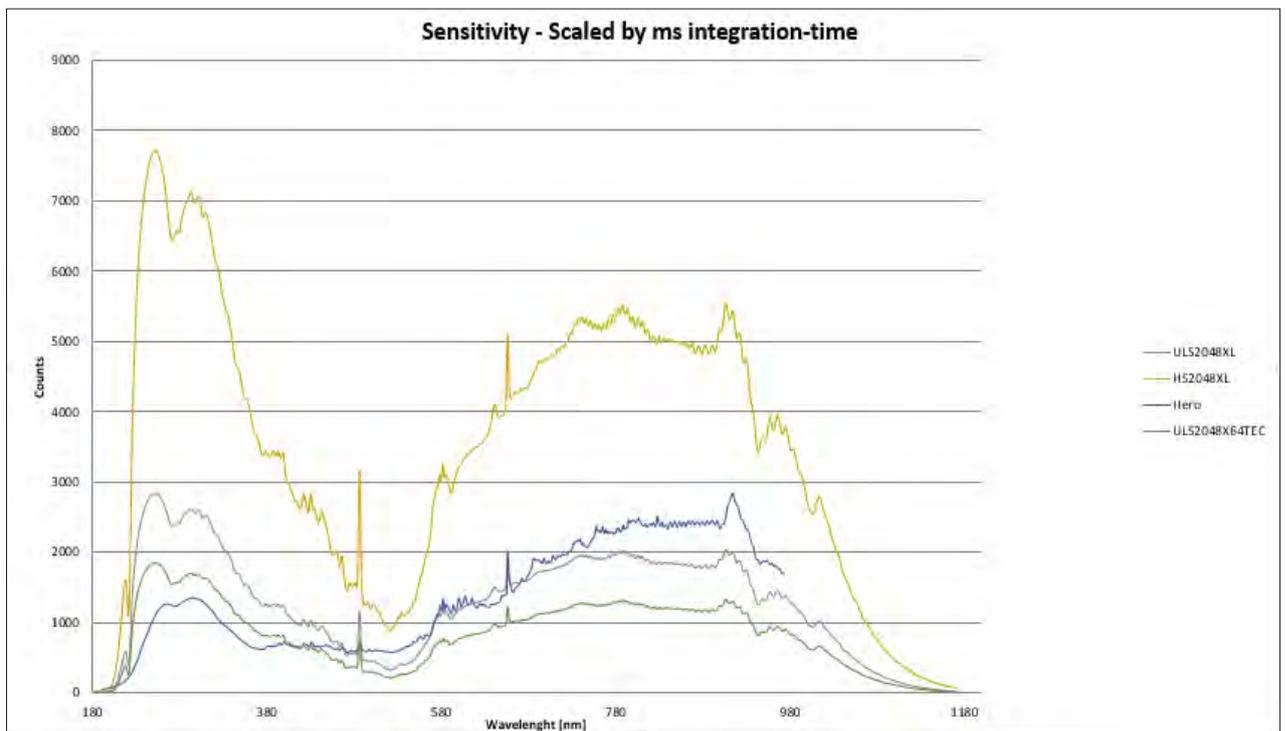


Figure 3b Sensitivity Curve SensLine



In Table 5 the specifications for the NIR spectrometers are given.

Sensitivity

For NIR detectors 2 different modes are available, the default setting is for high-sensitivity mode (HS), this means more signal at a shorter integration time.

The other mode of operation is low-noise (LN), this means a better S/N performance. Sensitivity, S/N, dark noise and Dynamic Range are given as HS and LN values.

Table 5 Detector Specifications (AvaSpec-NIR Models)

Detector	NIRLine					
	HAM-256-1.7	HAM-512-1.7	SU-256-1.7	SU-512-1.7	HAM-256-2.5	HAM-512-2.5
Type	Linear InGaAs array	Linear InGaAs array	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling
# Pixels, pitch	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm
pixel width x height (µm)	50 x 500	25 x 500	50 x 500	25 x 500	50 x 250	25 x 250
Sensitivity HS in counts/µW per ms	8,200,000 (integral 1000-1750 nm)	3,880,000 (integral 1000-170 nm)	4,800,000 (integral 1000-1750 nm)	2,500,000 (integral 1000-1750 nm)	990,000 (integral 1000-2500 nm)	480,000 (integral 1000-2500 nm)
Signal/Noise (HS)	1900:1	1900:1	1900:1	1900:1	1800:1	1900:1
Dark noise HS (counts RMS)	16	16	16	16	16	15
Dynamic Range HS	6000	6000	4900	4900	3500	4300
Sensitivity LN in counts/µW per ms	469,000 (integral 1000-1750 nm)	222,000 (integral 1000-1750 nm)	160,000 (integral 1000-1750 nm)	83,000 (integral 1000-1750 nm)	55,000 (integral 1000-2500 nm)	26,600 (integral 1000-2500 nm)
Signal/Noise (LN)	5000:1	5000:1	5000:1	5000:1	4000:1	3700:1
Dark noise LN (counts RMS)	12	12	12	12	12	13
Dynamic Range LN	9000	9000	7600	7600	4500	5100
Peak wavelength	1550 nm	1550 nm	1500 nm	1500 nm	2300 nm	2300 nm
QE (%) @ peak	90%	90%	70%	70%	65%	65%
PNRU**	±5%	±5%	10%	10%	±5%	±5%
Defective pixels (max)	0	0	0	0	12	26
Wavelength range (nm)	900-1750	900-1750	900-1750	900-1750	1000-2500	1000-2500
Frequency	500 kHz	500 kHz	1.2 MHz	1.2 MHz	500 kHz	500 kHz

** Photo-Response Non-Uniformity

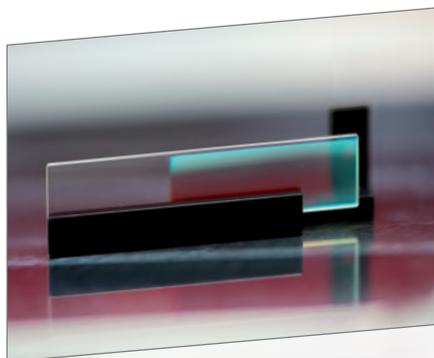
Add flexibility to your spectrometer with the Replaceable Slit (-RS) option

Stray light and second-order effects

Stray-light is radiation of undesired wavelengths that activates a signal at a detector element. Sources of stray-light can be:

- Ambient light
- Scattering light from imperfect optical components, or reflections of non-optical components
- Order overlap

Order-Sorting Window in holder



Avantes symmetrical Czerny-Turner optical bench designs favor stray-light rejection relative to crossed designs. Additionally, Avantes Ultra-Low Stray-light (AvaSpec-ULS) spectrometers have a number of internal measures to reduce stray-light from zero order and backscattering.

When working at the detection limit of the spectrometer system, the stray-light level from the optical bench, grating and focusing mirrors will determine the ultimate limit of detection. Most gratings used are holographic gratings, known for their low level of stray-light. Stray-light measurements are conducted using a halogen light source and long-pass or band-pass filters.

Typical stray-light performance for the AvaSpec-ULS and a B-type grating is <0.06% at 250-500 nm. Second order effects, which can play an important role for gratings with low groove frequency, and therefore a wide wavelength range, are usually caused by the 2nd order diffracted beam of the grating. The effects of these higher orders sometimes need to be addressed using filtering. The strategy is to limit the light to the region of the spectra, where order overlap is not possible.

Second order effects can be filtered out, using a permanently installed long-pass optical filter in the SMA entrance connector or an order-sorting coating on a window in front of the detector. The order-

sorting coatings on the window typically have one long-pass filter (600 nm) or 2 long-pass filters (350 nm and 600 nm), depending on the type and range of the selected grating. In the broadband ULS configurations, Linear Variable Filters are used for even better suppression of the second order effects.

In Table 6, a wide range of optical filters for installation in the optical bench can be found. The filter types that are 3 mm thick give a much better 2nd order reduction than the 1 mm filters. The use of following long-pass filters is recommended: OSF-475 for grating NB and NC, OSF-515 / 550 for grating NB and OSF-600 for grating IB. For backthinned detectors, such as the 2048XL and 1024x58/122 we recommend an OSF-305 Filter, when the starting wavelength is 300 nm and higher.

Table 6 Filters installed in AvaSpec spectrometer series

OSF-XXX	Permanently installed order-sorting filter @ XXX nm (XXX= 305, 395, 475, 515, 550, 600, 850)
OSC	Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings
OSC-UA	Order-sorting coating with 350 and 600 nm long-pass filter for UA/VA gratings. Linear Variable Filter for ULS benches
OSC-UB	Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
OSC-UC	Order-sorting coating with 300 nm long-pass filter for UC gratings
OSC-HS500	Order-sorting coating with 350 and 600 nm long-pass filter for HS500 gratings in AvaSpec-HS
OSC-HS900	Order-sorting coating with 600 nm long-pass filter for HS900 gratings in AvaSpec-HS
OSC-HS1000	Order-sorting coating with 350 nm long-pass filter for HS1000 gratings in AvaSpec-HS
OSC-HSC300	Order-sorting coating for use with grating HSC0300-xx
OSC-HSC600	Order-sorting coating for use with grating HSC0600-xx
OSC-NIR	Order-sorting coating with 1400 nm long-pass filter for NIR100-2.5 and NIR150-2.0 gratings in AvaSpec-NIR256/512-2.5TEC

Spectrometer Platforms

AvaSpec StarLine

The AvaSpec StarLine family of instruments comprises high-performance spectrometers which exceed the demands of most general spectroscopy applications. The StarLine includes high-speed instruments for process control (AvaSpec-ULS2048CL-EVO), high-resolution instruments for demanding measurements like atomic emission (AvaSpec-ULS4096CL-EVO) and versatile instruments for common applications such as irradiance and absorbance chemistry (also AvaSpec-ULS2048CL-EVO). This instrument line offers an array of solutions for varied uses, while providing excellent price-to-performance ratios.

The AvaSpec-ULS2048CL/4096CL are based on CMOS arrays can measure wavelengths from 200-1100 nm. The AvaSpec-FAST series of instruments is specially designed for high-speed acquisitions such as pulsed light source and laser measurements.

Instruments in the AvaSpec StarLine family are designed to perform in a variety of applications such as:

- Reflection and transmission measurements for optics, coatings and color measurement
- Irradiance and emission measurements for environmental, light characterization, and optical emission spectroscopy



- High-speed measurements for process control, LIBS or laser/pulsed source characterization
- Absorbance chemistry

AvaSpec StarLine instruments are fully integrated with Avantes' modular platform, allowing them to function stand-alone, or as multi-channel instruments. These products are fully compatible with other AvaSpec instruments in our AvaSpec SensLine and NIRLine. The entire AvaSpec StarLine is available as an individual lab instrument as an OEM module for integration into a customers' existing system.

The StarLine instruments are available with our standard ultra-low stray-light (ULS) optical bench (75 mm focal length). The AvaSpec StarLine instruments are also available with a number of premium options such as irradiance/intensity calibration and non-linearity calibration.



AvaSpec CompactLine

In cases where size matters, the AvaSpec CompactLine family offers spectrometers with the smallest form factor. This enables easier integration of our spectrometers into machines or handheld devices.

The AvaSpec CompactLine is based on the 2048CL, 4096CL models of the StarLine. Squeezing the size down hardly compromises the performance of the instruments, but limits the customer a bit in the configurations possible.

Customization is possible when adequate volumes are needed. Therefore the CompactLine is especially well suited for OEM users wanting to integrate a spectrometer into their instrument.

The latest addition to our CompactLine is the AvaSpec-Mini-NIR. With this instrument it is now possible to measure up to 1700 nm in the same small form factor!

For external triggering Avantes offers the AvaTrigger, featuring optical triggering, external TTL or manually through the pushbutton.

AvaSpec SensLine

The AvaSpec SensLine family of products is Avantes' response to customers who require higher performance for demanding spectroscopy applications such as fluorescence, luminescence and Raman. The AvaSpec SensLine product line includes several high-sensitivity, low-noise spectrometers. Some of the instruments are based on back-thinned detector technology, of which some feature high-performance thermoelectrically cooled detectors. The other models are based on standard CCDs, upgraded to high-performing instruments as a result of Avantes' unique detector cooling technology. The back-thinned CCD detectors featured in the AvaSpec SensLine product family are high quantum efficiency detectors with excellent response in the UV, VIS and NIR from 200-1160 nm.

AvaSpec SensLine instruments are fully integrated with Avantes' modular platform, allowing them to function as stand-alone, or as multi-channel instruments. These products are fully compatible with other AvaSpec instruments in our AvaSpec

StarLine and AvaSpec NIRLine product families. The entire AvaSpec SensLine is available as a lab instrument or an OEM module for integration into a customers' existing system.

Avantes' innovative ultra-low stray-light (ULS), revolutionary High-Sensitivity (HS) and the optimal compromise (HSC) optical benches are the core optical technologies in the AvaSpec SensLine. These highly stable optical benches combined with our high-performance electronics board deliver high-performance instruments at affordable prices.

All members of the AvaSpec SensLine are designed to provide performance features such as:

- High-stability
- High-sensitivity
- High-speed acquisition
- Low-noise



AvaSpec NIRLine

The AvaSpec NIRLine instruments are high-performance, near-infrared spectrometers that are optimized for the demands of measuring long wavelengths. This line provides leading-edge performance for dispersive NIR instruments with toroidal focusing mirrors and dynamic dark correction for enhanced stability. The NIRLine is comprised of both thermo-electrically cooled and un-cooled instruments. AvaSpec-NIR256/512-1.7 features an uncooled 256 or 512 pixel InGaAs detector. All other instruments in the NIRLine have thermo-electric, peltier-cooled InGaAs detectors which support cooling down to -25°C against ambient.

AvaSpec NIRLine instruments are fully compatible with our AvaSpec StarLine and SensLine spectrometers. Avantes' AvaSpec NIRLine instruments are available as laboratory instruments or OEM modules.

AvaSpec NIRLine instruments are available with a number of premium options such as irradiance/intensity calibration and non-linearity calibration.

The AvaSpec NIRLine instruments are designed to perform in a variety of applications such as:

- Moisture content measurement of liquids, solids and powders for inline and quality control purposes
- Quantitative and qualitative measurement of volatile organics such as ethanol, and methanol
- Plastic characterization and material identification
- Irradiance measurements, such as solar monitoring
- Qualitative measurements of feed and food

For the latest information,
go to www.avantes.com

Preconfigured Spectrometers (In Stock)

For customers with urgent needs and general flexibility in their specifications, Avantes offers a variety of preconfigured spectrometers. We keep these spectrometers in stock so they are readily available, which makes for a significant decrease in shipping time.

Out of the seven available models, five are configured to be used for measurements in the UV-VIS-NIR range (200 to 1100 nm), one

for the VIS-NIR range (360 to 1100 nm), and one just for the visible range (360 to 880 nm).

Several models are equipped with a replaceable slit (RS). All preconfigured spectrometers are available at discount pricing and include an upgrade to AvaSoft-Full. The full specifications are listed below.



Technical Data

Name	AvaSpec-ULS2048L-USB2-UA-RS	AvaSpec-ULS2048CL-EVO-RS-UA	AvaSpec-ULS2048XL-EVO-RS-UA	AvaSpec-ULS4096CL-EVO-UA-10	AvaSpec-ULS2048CL-EVO-UA-50	AvaSpec-ULS2048CL-EVO-VA-50	AvaSpec-ULS2048CL-EVO-RS-BB
Uses	UV/VIS/NIR					VIS/NIR	VIS
Range	200 - 1100 nm	200 - 1160 nm	200 - 1100 nm		360 - 1100 nm	360 - 880 nm	
Slit/Connector	25 µm/SMA-RS			10 µm SMA-905	50 µm/SMA-905		25 µm/SMA-RS
Resolution (FWHM)	1.4 nm			0.5-0.7 nm	2.5 nm		0.7 nm
A/D Converter	16 bit						
Interface	USB 2.0	USB 3.0/ETH					
Included options	Detector collecting lens, deep-UV coating, order-sorting coating, slit kit SMA	Detector collecting lens, order-sorting coating, slit kit SMA		Detector collecting lens, order sorting coating, slit			Detector collecting lens, order-sorting coating, slit kit SMA
Applications	Absorbance, emission, irradiance measurements	High-sensitivity applications (fluorescence, irradiance from very low intensity sources)		High-resolution measurements from high-intensity sources (lasers, powerful light sources, plasma)	Absorbance, emission, irradiance measurements	Color measurements, visible irradiance measurements	
AvaSoft-Full	Included						

Ordering Information

AvaSpec-ULS2048L-USB2-UA-RS	Ultra-low stray light fiber optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x200 μm CCD detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, DUV, USB2 powered, USB2 high speed interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 μm in box).
AvaSpec-ULS2048CL-EVO-RS-UA	Ultra-low stray light fiber optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x200 μm CMOS detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 μm in box).
AvaSpec-ULS2048XL-EVO-RS-UA	Ultra-low stray light fiber optic UV/VIS/NIR spectrometer with replaceable slit, 2048 pixel/14x500 μm back thinned CCD detector, grating UA (200-1100 nm), DCL-UV/VIS-200, OSC-UA, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 μm in box).
AvaSpec-ULS4069CL-EVO-UA-10	Ultra-low stray light fiber optic UV/VIS/NIR spectrometer, 4069 pixel CMOS detector, slit 10, grating UA (200-1100 nm), OSC-UA, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-UA-50	Ultra-low stray light fiber optic UV/VIS/NIR spectrometer, 2048 pixel CMOS detector, grating UA (200-1100 nm), slit 50, OSC-UA, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-VA-50	Ultra-low stray light fiber optic VIS/NIR spectrometer, 2048 pixel CMOS detector, grating VA (360-1100 nm), slit 50, OSC, DCL-UV/VIS-200, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full.
AvaSpec-ULS2048CL-EVO-RS-BB	Ultra-low stray light fiber optic VIS spectrometer, 2048 pixel CMOS detector, grating BB (360-880 nm), OSF-305, OSC, USB3 powered, high speed USB3 and ETH interface. Includes AvaSoft-Full and slit kit SMA (slit 25-RS preinstalled; 50, 100 and 200 μm in box).

AvaSpec-Mini2048CL

Small and Powerful OEM Spectrometer

Looking for a very small spectrometer with a resolution of up to 0.1 nm? Then the AvaSpec-Mini is an ideal choice. It's only the size of a deck of cards, yet delivers a dynamic range better than 3000:1, stray-light levels lower than 0.2% and weighs only 175 grams. Easy to take anywhere you like.

The AvaSpec-Mini2048CL is produced with the latest automated production technology, providing excellent unit-to-unit reproducibility and temperature stability.

These are key parameters for OEM customers for reliable integration into their products.

Many areas of research can be covered with this device, such as light analysis, chemical research and Raman spectroscopy. The possibilities are endless.

Of course, the AvaSpec-Mini works seamlessly with Avantes spectroscopy software and the Windows and Linux libraries.



Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	200 - 1100 nm
Stray light	0.2 - 1%
Sensitivity	337.500
Detector	HAM S11639 , CMOS linear array, 2048 pixels (14x200 µm)
Signal/noise	330:1
Dynamic range	3300
Dark noise	16 cnts
AD converter	16-bit, 6 MHz
Integration time	30 µs - 40 s
Interface	USB 2.0 (480 Mbps) / pigtailed (40 cm) USB-A
Sample speed with on-board averaging	3.0 ms/scan
Data transfer speed	4.6 ms/scan
I/O	5 bidirectional programmable I/O; 1 analog out; 1 analog in, 1x5V
Dimensions, weight	95 x 68 x 20 mm, 175 grams
Power supply	Default USB power, 500 mA
Temperature range	0-55°C

Grating selection table for AvaSpec-Mini*

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
2048CL					
UV	200-400	167	1800	250	MN 1800-0.25
VIS	330-900	530	600	500	MN 600-0.50
NIR	550-1100	520	600	1000	MN 600-1.00
UV/VIS/NIR	200-1100	900	300	300	MN 300-0.30
VIS/NIR	360-1100	720	300	500	MN 300-0.50

* Other gratings are available on request.

Resolution table (FWHM in nm) for AvaSpec-Mini*

Grating (lines/mm)	Slit size (µm)					
	10	25	50	100	200	500
	2048 CL					
300	1.00	1.30	2.40	4.80	9.20	22.00
600	0.40-0.53	0.70	1.20	2.40	4.60	11.00
1800	0.10-0.18	0.22	0.34-0.42	0.80	1.60	3.60

* Typical values. Small deviations are possible.

Ordering information

AvaSpec-Mini2048CL

- Mini Fiber-optic Spectrometer, 75 mm focal length, 2048 pixel CMOS detector, USB 2 powered interface, including DCL

Specify grating, wavelength range and options. Other gratings are available on request.

Options

- SLIT-XX** • Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 µm (5 µm possible on request)
- OSC** • Order sorting coating for grating MN 600-0.50, recommended with OSF-305
- OSC-UA** • Order sorting coating for grating MN 300-0.30
- OSC-VA** • Order sorting coating for grating MN 300-0.50, recommended with OSF-305
- OSF-YYY** • Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 457, 515, 550 or 600 nm, depends on range

For non-OEM users a set of preconfigured models are available

AvaSpec-Mini4096CL

Small and powerful OEM spectrometer

This first-to-the-market, 4096 pixel CMOS array miniature spectrometer is the perfect combination of small size and high resolution (up to 0.09 nm)!

It's only the size of a deck of cards, yet delivers a dynamic range better than 3000:1, stray-light levels lower than 0.2% and weighs only 175 grams. Easy to take anywhere you like.

The AvaSpec-Mini4096CL is produced with the latest automated production technology, providing excellent unit-

to-unit reproducibility and temperature stability. These are key parameters for OEM customers for reliable integration into their products.

Many areas of research can be covered with this device, such as light analysis, chemical research and Raman spectroscopy. The possibilities are endless.

Of course, the AvaSpec-Mini works seamlessly with Avantes spectroscopy software and the Windows and Linux libraries.



Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	200 - 1100 nm
Stray light	0.2 - 1%
Sensitivity	261.000
Detector	HAM S13496 , CMOS linear array, 4096 pixels (7x200µm)
Signal/noise	300:1
Dynamic range	3300
Dark noise	16 cnts
AD converter	16-bit, 6 MHz
Integration time	30 µs - 50 s
Interface	USB 2.0 (480 Mbps) / pigtailed (40 cm) USB-A
Sample speed with on-board averaging	6.5 ms/scan
Data transfer speed	8.9 ms/scan
I/O	5 bidirectional programmable I/O; 1 analog out; 1 analog in, 1x5V
Dimensions, weight	95 x 68 x 20 mm, 175 grams
Power supply	Default USB power, 500 mA
Temperature range	0-55°C

Grating selection table for AvaSpec-Mini

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
4096CL					
UV	200-400	170	1800	250	MN 1800-0.25
VIS	330-900	535	600	500	MN 600-0.50
NIR	550-1100	525	600	1000	MN 600-1.00
UV/VIS/NIR	200-1100	900	300	300	MN 300-0.30
VIS/NIR	360-1100	720	300	500	MN 300-0.50

* Other gratings are available on request.

Resolution table (FWHM in nm) for AvaSpec-Mini*

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
	4096CL					
300	0.50-0.70	1.20-1.30	2.17	4.60	9.00	20.00
600	0.30-0.36	0.58-0.68	1.17	2.20	4.50	10.00
1800	0.09-0.11	0.18	0.36-0.40	0.78	1.50	3.70

* Typical values. Small deviations are possible.

Ordering Information

AvaSpec-Mini4096CL

- Mini Fiber-optic Spectrometer, 75 mm focal length, 4096 pixel CMOS detector, USB 2 powered interface, including DCL

Specify grating, wavelength range and options. Other gratings are available on request.

Options

- SLIT-XX** • Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm (5 μm possible on request)
- OSC** • Order sorting coating for grating MN 600-0.50, recommended with OSF-305
- OSC-UA** • Order sorting coating for grating MN 300-0.30
- OSC-VA** • Order sorting coating for grating MN 300-0.50, recommended with OSF-305
- OSF-YYY** • Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 457, 515, 550 or 600 nm, depends on range

For non-OEM users a set of preconfigured models are available

AvaSpec-Mini-NIR

Small and Powerful OEM NIR Spectrometer

AvaSpec-Mini-NIR256-1.7



The latest addition to our CompactLine: the AvaSpec-Mini-NIR!

The AvaSpec-Mini-NIR is a compact near-infrared spectrometer, based on a combination of our popular AvaSpec-NIR256-1.7 and Mini-series.

This NIR spectrometer might not be as sensitive as our bigger NIR spectrometers, but this loss in sensitivity is greatly compensated by its size and robustness.

Like our other CompactLine spectrometers, this device is only the size of a deck of cards

and USB powered, which makes it easy to integrate into other devices, including but not limited to OEM handheld applications.

This versatile miniature near-infrared spectrometer is well suited for various applications, including food analysis and recycling.

Of course, the AvaSpec-Mini-NIR works seamlessly with our AvaSoft software and the Windows and Linux libraries we have available.

Technical Data

Optical bench	Symmetrical Czerny-Turner, 75 mm focal length, MK II
Wavelength range	900-1750 nm
Stray light	1%
Sensitivity HS in counts/μW per ms	665,000 (integral 1000-1750 nm)
Dynamic range HS	4750:1
Integration time HS	10 μ s – 300 ms
Signal/noise HS	1900:1
Dark noise HS	14 counts
Sensitivity LN in counts/μW per ms	38,000 (integral 1000-1750 nm)
Dynamic range LN	7500:1
Integration time LN	10 μ s – 5 seconds
Signal/noise LN	5000:1
Dark noise LN	9 counts
Detector	InGaAs array, 256 pixels
AD converter	16-bit, 500 kHz
Interface	USB2.0 (480 Mbps)/pigtailed (40 cm) USB-A
Sample speed with store to RAM	0.53 ms/scan
Data transfer speed	1.2 ms/scan
I/O	5 bidirectional programmable I/O: 1 analog out, 1 analog in, 1 x 5V
Power supply	Default USB power, 500 mA
Dimensions, weight	95 x 68 x 20 mm, 185 g
Temperature range	0-55°C

Grating selection table for AvaSpec-Mini-NIR

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	900-1750	725	200	1550	NIR200-1.6
NIR	900-1495	330-320	400	1210	NIR400-1.2
NIR	1250-1700	315-310	400	1600	NIR400-1.6
NIR	900-1450	210-195	600	1280	NIR600-1.3
NIR	1350-1735	185-170	600	1669	NIR600-1.7

Resolution table (FWHM in nm) for AvaSpec-Mini-NIR*

Grating (lines/mm)	Slit size (μm)			
	50	100	200	500
200	6	12	24	50
400	3	6	12	25
600	2	4	8	18

* Typical values. Small deviations are possible.

Ordering information

AvaSpec-Mini-NIR256-1.7

- Miniature NIR fiber-optic spectrometer, 75 mm focal length, 256 pixel InGaAs detector, USB2 powered interface

Specify grating, wavelength range and options. Other gratings are possible on request.

Options

SLIT-XX

- Slit size, please specify XX = 50, 100, 200 or 500 μm

For non-OEM users, a preconfigured model will be available upon release

EVO Series, with CMOS detector: StarLine AvaSpec-ULS2048CL-EVO Spectrometer

Using CMOS technology instead of the conventional CCD technology, this spectrometer offers you the latest technology.

New technologies like CMOS have evolved and become a suitable alternative.

In combination with our latest AS-7010 electronics it offers you a versatile device including USB3.0 communication with 10x higher speed compared to USB2, and a second communication port which offers Gigabit Ethernet for integration in your company network and possibility for long distance communication.

Besides the high speed communication options, the EVO also offers a fast microprocessor and 50x more memory which can help you to store more spectra onboard and realise more functionality.

Options include a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2nd order effects. Furthermore, the AvaSpec-2048CL is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors. It comes complete with AvaSoft-Basic software, USB cable and an extensive manual.

The AvaSpec-ULS2048CL-EVO is also available as OEM unit, Bench only or Rackmount version.

AvaSpec-ULS2048CL



Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.06 –20 nm, depending on configuration (see table)
Stray-light	0.19-1.0%, depending on the grating
Sensitivity	375,000 counts/μW per ms integration time
Detector	CMOS linear Image Sensor
Signal/Noise	300:1
AD converter	16-bit, 6 MHz
Integration time	9 μs – 59s
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	0.38 ms /scan
Data transfer speed	0.38 ms/scan (USB3), 1.0 ms (ETH)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	Default USB3 power, 500 mA Or 12VDC, 300 mA

Ordering Information

AvaSpec-ULS2048CL-EVO

- Fiber-optic Spectrometer, 75 mm AvaBench, 2048 pixel CMOS detector 14 x 200 μm, USB powered, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable.
Specify grating, wavelength range and options.

Grating Selection Table for AvaSpec-ULS2048CL-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	891**	300	300	UA
UV/VIS/NIR	200-1100**	891**	300	300/1000	UNA-DB
UV/VIS	200-850	515	600	300	UB
UV	200-750	247-218*	1200	250	UC
UV	200-650	163-143*	1800	UV	UD
UV	200-580	113-69*	2400	UV	UE
UV	200-400	69-45*	3600	UV	UF
UV/VIS	250-850	515	600	400	BB
VIS/NIR	300-1100**	792**	300	500	VA
VIS	360-1000	495	600	500	VB
VIS	300-800	247-218*	1200	500	VC
VIS	350-750	142-89*	1800	500	VD
VIS	350-640	74-49*	2400	VIS	VE
NIR	500-1050	495	600	750	NB
NIR	500-1050	218-148*	1200	750	NC
NIR	600-1100	346-297	830	800	SI
NIR	600-1100**	495**	300	1000	IA
NIR	600-1100	495	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS2048CL-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Options

-RS	• Replaceable slit
DCL-UV/VIS-200	• Quartz Detector Collection Lens (200-1100 nm)
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=25, 50, 100, 200 or 500 μm. Only in combination with AvaSpec-ULS2048CL-EVO-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings, recommended with OSF-305
OSC-UA	• Order-sorting coating Linear Variable Filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

EVO Series, with 4k CMOS detector: StarLine AvaSpec-ULS4096CL-EVO

Another new member in our EVO series: the AvaSpec-ULS4096CL-EVO. Using CMOS technology instead of the conventional CCD technology, this spectrometer offers you the latest technology; ready for the next decade. The dominant position of CCD detectors in the spectrometer field is fading and new technologies like CMOS have evolved and become a suitable alternative. The AvaSpec-ULS4096CL-EVO offers you this latest technology ensuring a spectrometer platform for the coming years. In combination with our latest AS-7010 electronics it offers you a versatile device including USB3.0 Communication with 10x higher speed compared to USB2, and a second communication port which offers Gigabit Ethernet for integration in your company network and possibility for long distance communication at an affordable price.

Besides the high speed communication options, the EVO also offers a fast microprocessor and 50x more memory which can help you to store more spectra onboard and realise more functionality.

Options include a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2nd order effects. Furthermore, the AvaSpec-4096CL is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors.

It comes complete with AvaSoft-Basic software, USB cable and an extensive manual.

The AvaSpec-ULS4096CL-EVO is also available as OEM unit, Bench only or Rackmount version.

With the 4096 pixels these spectrometers are tailored for high resolution applications like Plasma and LIBS.

AvaSpec-ULS4096CL



Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.05 -20 nm, depending on configuration (see table)
Stray-light	0.19-1.0%, depending on the grating
Sensitivity	218.000 counts/μW per ms integration time
Detector	CMOS linear Image Sensor
Signal/Noise	335:1
AD converter	16-bit, 6 MHz
Integration time	9 μs - 40s
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	0.70 ms /scan
Data transfer speed	0.70 ms/scan (USB3), 1.31 ms (ETH)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	Default USB3 power, 532 mA Or 12VDC, 300 mA
Dimensions, weight	177 x 127 x 44,5 mm (1 channel), 1155 grams

EVolutionary spectroscopy:

- Speed
- Network integration
- Multi-channel benefits

Grating Selection Table for AvaSpec-ULS4096CL-EVO

Use	Usable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	891**	300	300	UA
UV/VIS/NIR	200-1100**	891**	300	300/1000	UNA-DB
UV-VIS	200-850	515	600	300	UB
UV	200-750	247-218*	1200	250	UC
UV	200-650	163-143*	1800	UV	UD
UV	200-580	113-69*	2400	UV	UE
UV	200-400	69-45*	3600	UV	UF
UV/VIS	250-850	515	600	400	BB
VIS/NIR	300-1100**	792**	300	500	VA
VIS	360-1000	495	600	500	VB
VIS	300-800	247-218*	1200	500	VC
VIS	350-750	142-89*	1800	500	VD
VIS	350-640	74-49*	2400	VIS	VE
NIR	500-1050	495	600	750	NB
NIR	500-1050	218-148*	1200	750	NC
NIR	600-1100	346-297	830	800	SI
NIR	600-1100**	495**	300	1000	IA
NIR	600-1100	495	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 4096 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS4096CL-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	0.50-0.70	1.20-1.30*	2.17	4.6	9.00	20.0
600	0.30-0.36*	0.58-0.60	1.17	2.20	4.5	10.0
830	0.25	0.48	0.93	1.7	3.4	8.0
1200	0.14-0.18*	0.30	0.62	1.08	2.2	5.0
1800	0.09-0.11*	0.18	0.36-0.40*	0.78	1.5	3.7
2400	0.07-0.09*	0.13-0.15*	0.26-0.32*	0.40-0.64*	1.1	2.7
3600	0.05-0.06*	0.10	0.19	0.4	0.8	2.0

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

**expected resolution gain with a 5 micrometer slit will be a factor 0.8

Ordering Information

AvaSpec-ULS4096CL-EVO

- Fiber-optic Spectrometer, 75 mm AvaBench, 4096 pixel CMOS detector 7 x 200 μm, USB powered, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable.
Specify grating, wavelength range and options.

PS-12V/1.0A

- External power supply, needed for operation in ETH mode or with USB2 ports.

Options

-RS	<ul style="list-style-type: none">• Replaceable slit
DCL-UV/VIS-200	<ul style="list-style-type: none">• Quartz Detector Collection Lens (200-1100 nm)
SLIT-XX	<ul style="list-style-type: none">• Slit size, please specify XX = 5, 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	<ul style="list-style-type: none">• Replaceable slit with SMA connector , specify slit size XX=25, 50, 100 or 200 μm. Only in combination with AvaSpec-ULS4096CL-EVO-RS
SLIT-XX-RS-FCPC	<ul style="list-style-type: none">• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	<ul style="list-style-type: none">• Order-sorting filter for reduction of 2nd order effects please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	<ul style="list-style-type: none">• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings, recommended with OSF-305
OSC-UA	<ul style="list-style-type: none">• Order-sorting coating with Linear Variable Filter for UA, VA gratings
OSC-UB	<ul style="list-style-type: none">• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	<ul style="list-style-type: none">• FC/PC fiber-optic connector

Using **CMOS technology** instead of conventional CCD technology, this spectrometer offers you the latest technology, ready for the next decade!

AvaSpec-Fast StarLine Ultra-fast Spectrometer for High-speed Applications

AvaSpec-Fast



For ultra-fast spectral acquisition the AvaSpec-Fast offers the best solution. Up to 5637 spectra can be stored at 0.20 ms per scan using Avantes unique store-to-RAM functionality. Depending on the configuration chosen, between 1254 and 5637, spectra can be stored during one burst.

The AvaSpec-FAST series is available in five different configurations; the difference being the number of active pixels. More pixels provide higher resolution or more bandwidth, but slower minimum integration time. For all models, start/stop pixels can be set in our software to increase the number of scans stored on board over a shorter wavelength range.

The AvaSpec-FAST can be configured in CR or SS mode. CR, or continuous run mode, means a single external trigger (through the DB26-connector) results in a customer-set number of scans automatically to be measured. SS-mode, for single scan, means a single spectrum is acquired at every external trigger. CR or SS mode must be specified at the time of order.

Possible configurations are single or dual channel, desktop or Rack-mounted. The instrument is available with all the options and gratings of the AvaSpec-ULS2048. The AvaSpec Fast series is based on the AvaSpec-ULS2048. Optional it can also be based upon the AvaSpec-ULS2048L.

Technical Data

FAST Series Model	Min Integration Time	Pixels	Max. Frequency (Hz) in CR-Store to RAM	Max amount of spectra Store to RAM
AvaSpec-ULS350F-USB2	0.20 ms	350	5000	5637
AvaSpec-ULS750F-USB2	0.40 ms	750	2500	2716
AvaSpec-ULS950F-USB2	0.50 ms	950	2000	2157
AvaSpec-ULS1350F-USB2	0.70 ms	1350	1400	1528
AvaSpec-ULS1650F-USB2	0.85 ms	1650	1100	1254

Grating Selection Table for AvaSpec-FAST

Grating	Lines/mm	Spectral range AvaSpec-ULS350F (nm)	Spectral range AvaSpec-ULS750F (nm)	Spectral range AvaSpec-ULS950F (nm)	Spectral range AvaSpec-ULS1350F (nm)	Spectral range AvaSpec-ULS1650F (nm)
Z	150	400	850	900	n.a.	n.a.
A	300	190	400	520	750	900
B	600	90	200	250	360	450
C	1200	45	100	120	180	210
D	1800	30	60	80	110	140
E	2400	20	45	50	80	100
F	3600	10	27	30	50	60

Ordering Information

AvaSpec-ULS350F-USB2	<ul style="list-style-type: none"> Ultra-fast Fiber-optic Spectrometer, 75 mm low stray-light AvaBench, 350 pixel CCD detector, USB/RS-232 interface, incl. AvaSoft-Basic, USB2 cable. Specify grating, wavelength range and options
AvaSpec-ULS750F-USB2	<ul style="list-style-type: none"> As AvaSpec-ULS350F-USB2, but 750 pixel CCD detector
AvaSpec-ULS950F-USB2	<ul style="list-style-type: none"> As AvaSpec-ULS350F-USB2, but 950 pixel CCD detector
AvaSpec-ULS1350F-USB2	<ul style="list-style-type: none"> As AvaSpec-ULS350F-USB2, but 1350 pixel CCD detector
AvaSpec-ULS1650F-USB2	<ul style="list-style-type: none"> As AvaSpec-ULS350F-USB2, but 1650 pixel CCD detector

Options

- See AvaSpec-ULS2048-USB2

AvaSpec-RS Replaceable-Slit Spectrometer

AvaSpec-RS

For most customers the choice between throughput and resolution is not an easy one. Avantes now offers the possibility for end-users to easily replace a slit through the introduction of our replaceable-slit feature. The replaceable slit option is available on ULS Ultra-low Stray-light AvaSpecs. On our AvaSpec-HERO & NIR spectrometers this is standard. The slit sets contain 25, 50, 100 and 200 μm slits along with a screwdriver tool to

facilitate the change. Slit kits are available with SMA-905 connector, as well as FC/PC connectors. Slit sets can be ordered separately for the -RS spectrometer.

No recalibration of the spectrometer is needed when changing slit because of the high-precision slit positioning.



Technical Data

Slit set connectors	SMA-905 or FC/PC
Slit sizes	25, 50, 100, 200 or 500 μm (width) x 1 mm (height)
Material	Stainless steel
Fixing screws	Torx (included)

Ordering Information

-RS	<ul style="list-style-type: none"> Replaceable slit, to be added to the product code of the AvaSpec-ULS
SLIT-XX-RS	<ul style="list-style-type: none"> Replaceable slit with SMA connector. Specify slit size XX=25, 50, 100, 200 or 500 μm, in combination with AvaSpec-ULS-RS spectrometers
SLIT-XX-RS-FCPC	<ul style="list-style-type: none"> as SLIT-XX-RS, but with FC/PC connector

Slit Kit

To fully utilize your AvaSpec-RS series spectrometer with replaceable slit, the Slit Kit is available. It features a complete set with four slits, of 25, 50, 100, 200 and 500 μm . Also included in the kit are the tools to easily change the slit in the spectrometer.

The Slit Kit is available in SMA (choice of 4 SMA slits), SMA/FCPC (combination of 2 SMA and 2 FCPC slits) and FC/PC (choice of 4 FCPC and/or SMA slits) versions.

All kits can be used on any spectrometer with the replaceable slit option installed. Slit sizes 5 and 10 μm cannot be included in the kit, but can be ordered as a separate item (recalibration of spectrometer recommended).



Ordering Information

SLITKIT-SMA	<ul style="list-style-type: none"> Slit kit containing of 4 SMA replaceable slits. Choice of 25, 50, 100, 200 and 500 μm slits (any combination), and the tools to replace the slit
SLITKIT-SMA/FCPC	<ul style="list-style-type: none"> Slit kit containing of 2 SMA and 2 FCPC replaceable slits.. Choice of 25, 50, 100, 200 and 500 μm slits (any combination), and the tools to replace the slit
SLITKIT-FCPC	<ul style="list-style-type: none"> Slit kit containing of 4 replaceable slits (FCPC and/or SMA). Choice of 25, 50, 100, 200 and 500 μm slits (any combination), and the tools to replace the slit.

Don't forget to order a fiber cable

AvaSpec-ULS2048XL-EVO SensLine High UV and NIR Sensitivity Back-thinned CCD Spectrometer

AvaSpec-ULS2048XL-EVO



Combining exceptional quantum efficiency with high-speed is the value proposition of the AvaSpec-ULS2048XL-EVO spectrometer. Unlike many back-thinned CCD spectrometers, which have two dimensional arrays, the ULS2048XL-EVO has large monolithic pixels of 14x500 microns with exceptional efficiency in the UV, from 200-400 nm, and the NIR, from 950-1160 nm. The instrument also has an electronic shutter, which enables integration times as low as 2 microseconds. To further enhance sensitivity, a detector collection lens is available which improves sensitivity up to 60% when combined with larger core fibers.

Options include order-sorting filter, to reduce 2nd order effects and purge ports for deep-UV measurements. The AvaSpec-ULS2048XL-EVO comes with a wide range of slit sizes, gratings and may be configured with SMA or FC/PC fiber-optic entrance connectors.

The AvaSpec-ULS2048XL-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Connection to your PC is handled via a USB3-connection or Ethernet, delivering a scan every 2 milliseconds. The instrument comes complete with AvaSoft-basic software, USB cable and an extensive manual.

Technical Data

Optical Bench	ULS, Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200 - 1160 nm
Resolution	0.09 -20 nm, depending on configuration (see table)
Stray-light	< 0.5%
Sensitivity	460,000 counts/ μ W per ms int. time
UV Quantum efficiency	60% (200-300 nm)
Detector	Back-thinned CCD image sensor 2048 pixels
Signal/Noise	525:1
AD converter	16-bit, 1 MHz
Integration time	2 μ s - 20 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with store to RAM	2.44 ms /scan
Readout Noise	9.8 cnt RMS
Dark Noise	4.5 cnt RMS
Dynamic Range	13.700
Data transfer speed	2.44 ms /scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 700 mA. Or external 12VDC, 360 mA
Dimensions, weight	175 x 127 x 44,5 mm (1 channel), 1180 grams

Grating Selection Table for AvaSpec-ULS2048XL-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160**	960**	300	300	UA
UV/VIS/NIR	200-1160**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1160**	860**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-100*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1160**	560**	300	1000	IA
NIR	600-1160	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS2048XL-EVO

Grating (lines/mm)	Slit size (µm)					
	10	25	50	100	200	500
300	1.40	1.50	2.5	4.8	9.2	21.3
600	0.70 - 0.80*	0.75-0.85*	1.2	2.4	4.6	10.8
830	0.42 - 0.48*	0.50-0.58*	0.93	1.7	3.4	8.5
1200	0.25 - 0.31*	0.37 - 0.43*	0.52-0.66*	1.1	2.3	5.4
1800	0.17 - 0.21*	0.26 - 0.32*	0.34-0.42*	0.8	1.6	3.6
2400	0.12 - 0.18*	0.18 - 0.24*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.09 - 0.12*	0.11 - 0.15*	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048XL-EVO

PS-12V / 1.0A

- Ultra-low Stray-light Fiber-optic Spectrometer, 75 mm AvaBench, 2048 large 500 µm pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable.
Specify grating, wavelength range and options
- External power supply, needed for use in ETH mode

Why is the XL so sensitive?
We're using back-illuminated detectors.
They have the electronics on the backside of the detector,
allowing more light to be caught by the front side.

Options

-RS	• Replaceable slit
DCL-UV/VIS-200	• Quartz Detector Collection Lens (200-1100 nm)
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector , specify slit size XX=25, 50, 100, 200 or 500 μm . Only in combination with AvaSpec-ULS2048XL-EVO-RS
SLIT-XX-RS-FCPC	• as SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, 1 mm thick, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings, recommended with OSF-305
OSC-UA	• Order-sorting coating Linear Variable Filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

AvaSpec-HERO SensLine

The AvaSpec-HERO is the top of the line spectrometer!
Based on our High Sensitivity Compact (HSC) optical bench (f=100mm; NA=0.13) and a 1024x58 backthinned CCD detector, it offers the best of both worlds: high sensitivity and resolution!

The instrument is equipped with thermo-electric cooling, enabling long integration times in low light applications. In conjunction with our AS7010 electronics, including a high-end AD converter, noise is kept to a minimum, which offers you an excellent Signal to Noise and Dynamic Range performance.

A selection of gratings and slits offers you the flexibility of configuring the instrument for a wide range of applications in the 200-1160 nm range.

From low light fluorescence applications to demanding Raman applications, the AvaSpec-HERO is your ideal companion.

With the high-speed USB3.0 and Gigabit Ethernet communication interface, the connection to your computer is fast and simple.

Of course the digital IO ports enabling external triggering, control of shutters, and pulsed light sources from the Avantes line of instruments are available as well.

The Avaspec-HERO is standard equipped for use with replaceable slits, offering optimal flexibility for a variety of applications. The combination of all the above makes the AvaSpec-HERO your ideal companion for all your spectroscopic measurements.

AvaSpec-HERO



Technical Data

Optical Bench	HSC Symmetrical Czerny-Turner, 100 mm focal length, NA: 0.13
Wavelength range	200-1160 nm
Resolution	0.2-7 nm, depending on configuration (see table)
Stray-light	0.5%, depending on the grating
Sensitivity	445,000 counts/ μ W per ms integration time
Detector	CCD array image sensor with one stage TE Cooled, 1024 pixels
Temperature cooled CCD	Max. $\Delta T = 30$ °C versus ambient
Signal/Noise	1200:1
Dynamic Range	40.000
AD converter	16-bit, 250 kHz
Integration time	5.2 ms- 60 sec
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital bidirectional, trigger, sync., strobe, laser.
Sample speed with on-board averaging	5.2 ms/scan
Data transfer speed	5.2 ms/scan (USB3 and ETH)
Power supply	12VDC, 1.5A
Dimensions, weight	185 x 161 x 185mm, 3500 grams

The new AvaSpec-HERO is the answer for those who are in need of high resolution and high sensitivity!

Grating Selection Table for AvaSpec-HSC1024x58TEC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160	770-760*	300	300	HSC0300-0.30
UV/VIS/NIR	250-1160	770-760*	300	420	HSC0300-0.42
VIS/NIR	250-1160	577-553	400	550	HSC0400-0.55
UV/VIS	250-850	373-340*	600	400	HSC0600-0.40
VIS/NIR	250-1160	373-340*	600	650	HSC0600-0.65
VIS/NIR	500-1160	268-220*	830	900	HSC0830-0.90
UV/VIS	200-1160	182-130*	1200	400	HSC1200-0.40
VIS/NIR	500-1050	182-130*	1200	750	HSC1200-0.75
UV/VIS	200-580	84-61*	2400	270	HSC2400-0.27

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

Resolution Table (FWHM in nm) for AvaSpec-HSC1024x58TEC-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.70	1.80	2.30	3.40	6.50	14.0
400	1.30	1.45	1.60	2.60	5.10	12.0
600	0.75	0.85	1.10	1.70	3.40	7.50
830	0.50	0.60	0.70	1.25	2.30	5.00
1200	0.32	0.40	0.48	0.80	1.45	3.50
2400	0.17	0.30	0.36	0.50	0.80	1.75

* Above values are average values. Due to optical properties resolution will be better in the lower wavelengths than in the higher wavelength range.

Ordering Information

AvaSpec-HSC1024x58TEC-EVO

- AvaSpec-HERO; High sensitivity fiber optic spectrometer, HSC 100mm bench design, 1024x58 pixel back illum TE cooled CCD detector, high-speed USB 3.0 and ETH interface, including AvaSoft-Basic, USB interface cable, specify grating, wavelength range and options

Options

SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX=10, 25, 50, 100, 200 or 500 μm.
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
SLITKIT-SMA	• Slit kit containing 25, 50, 100, 200 or 500 μm slits, and the tools to replace the slit. SMA-connectors
SLITKIT-FCPC	• As SLITKIT-SMA, but with FC/PC connectors
OSF-YYY-3	• Order sorting filter for reduction of 2nd order effects, 3 mm thick, please specify YYY= 305, 395, 475, 515, 550, 600 nm
OSC-HSC300	• Order sorting coating for use with grating HSC0300-xx
OSC-HSC600	• Order sorting coating for use with grating HSC0600-xx and HSC0400-xx

AvaSpec-ULS2048x64TEC-EVO SensLine Thermoelectrically Cooled Fiber-Optic Spectrometer

The AvaSpec-ULS2048x64TEC-EVO is an updated version of our AvaSpec-ULS2048x64TEC spectrometer, with improved electronics and cooling.

This instrument enhances the Sensline series with its cooled, back-thinned detector. The back-thinned detector has good sensitivity in the UV and IR region. The 64 pixelheight (0.89 mm) enables catching as many photons as possible while the cooling enables long integration times up to 120 seconds with low-noise levels.

The instrument features Peltier cooling device integrated into our exclusive ultra-low stray light optical bench, which can reduce the temperature of the CCD chip to -30°C against ambient, improving the dark baseline and PRNU level significantly. The detector cooling also reduces the dark noise by a factor of 2-3.

The AvaSpec-ULS2048x64TEC-EVO uses a special low-noise version of the 2048x64 detector with integrated cooling.

All the features mentioned above make this instrument ideally suited for measuring low-light applications, such as fluorescence or low-light Raman measurements.

Optimal flexibility is guaranteed with the replaceable slit, making the instrument suitable for various kinds of applications.

The above mentioned qualities make the AvaSpec-ULS2048x64TEC-EVO an excellent choice for low light-level applications, such as fluorescence and Raman measurements, where integration times of more than 5 seconds may be needed.

AvaSpec-ULS2048x64TEC-EVO



Technical Data

Optical bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1160 nm
Resolution	0.09 -20 nm, depending on configuration (see table)
Stray light	<1%, depending on the grating
Sensitivity	300,000 counts/μW per ms integration time
Detector	Backthinned CCD, 2048x64 pixels, low noise, integrated cooling
Temperature-cooled CCD	Max. ΔT = -30°C versus ambient. Optimal setting: 5°C
Signal/noise	550:1
AD converter	16-bit, 500 KHz
Dynamic range	19,000
Dark noise	5 cnts
Integration time	9.7 ms-120 s
Interface	USB 3.0 high speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	9.7 ms/scan
Data transfer speed	9.7 ms/scan (USB3) 9.7 ms/scan (ETH)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	12 VDC, 1.5 A
Operating temperature	0-40°C
Cooling	30°C versus ambient
Dimensions, weight	185 x 145 x 185 mm, 3500 grams

Grating Selection Table for AvaSpec-ULS2048x64TEC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160**	960**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1160**	860**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1160**	560**	300	1000	IA
NIR	600-1160	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS2048x64TEC

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.40	1.50	2.5	4.8	9.2	21.3
600	0.70-0.80*	0.75-0.85*	1.2	2.4	4.6	10.8
830	0.42-0.48*	0.50-0.58*	0.93	1.7	3.4	8.5
1200	0.25-0.31*	0.37-0.43*	0.52-0.66*	1.1	2.3	5.4
1800	0.17-0.21*	0.26-0.32*	0.34-0.42*	0.8	1.6	3.6
2400	0.12-0.18*	0.18-0.24*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.09-0.12*	0.11-0.15*	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

AvaSpec-ULS2048x64TEC-EVO

Thermoelectrically cooled fiber-optic spectrometer, 75 mm ultra-low stray light AvaBench, 2048x64 pixel, TE-cooled and regulated low-noise CCD detector, USB3/ETH high-speed interface and replaceable slit, incl. AvaSoft-Basic, USB cable, desktop housing. Specify grating, wavelength range and options

Options

DCL-UV/VIS-200	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX-RS	• Replaceable slit with SMA connector. Specify slit size XX= 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of 2 nd order effects, 1 mm thick, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings, recommended with OSF-305
OSC-UA	• Order-sorting coating with linear variable filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings

AvaSpec-HS2048XL-EVO SensLine High UV and NIR Sensitivity Back-thinned CCD Spectrometer

For high sensitivity applications where high resolution is not of paramount concern, the AvaSpec-HS2048XL-EVO is an exceptional instrument. Featuring Avantes' HS optical bench which has a full 0.22 numerical aperture for superior throughput, the AvaSpec-HS2048XL has a back-thinned CCD detector with 2048 pixels measuring 14X500 microns.

Unlike many back-thinned CCD spectrometers, which have two dimensional arrays the HS2048XL has large monolithic pixels with exceptional efficiency in the UV, from 200-400 nm, and the NIR, from 950-1160 nm, while retaining sensitivity in the visible range. The unique optical design features torroid collimating and focusing mirrors to control image magnification and enhance efficiency. The instrument also features an electronic shutter, which enables integration times as low as 2 microseconds.

For configurations, which require second order filtering, order-sorting filters are avail-

able. The AvaSpec-HS2048XL is available with a wide range of slit sizes, gratings and may be configured with SMA or FC/ PC fiber-optic entrance connectors.

The AvaSpec-HS2048XL-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

AvaSpec-HS2048XL-EVO



Technical Data

Optical Bench	High-sensitivity asymmetrical design, 37.5 mm focal length; NA - 0.22, f/2.27
Wavelength range	200 - 1160 nm
Resolution	1 - 20 nm, depending on configuration (see table)
Stray-light	< 1 %
Sensitivity	1,250,000 counts/ μ W per ms int. time
UV Quantum efficiency	60% (200-300 nm)
Detector	Back-thinned CCD image sensor 2048 pixels
Signal/Noise	525:1
AD converter	16-bit, 1 MHz
Integration time	2 μ s - 600 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet, 1 Gbps
Sample speed with on-board averaging	2.44 ms /scan
Dynamic Range	14.900
Data transfer speed	2.44 ms /scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 700 mA. or external 12VDC, 360 mA
Dimensions, weight	175 x 165 x 85 mm, 1,950 kg

Grating Selection Table for AvaSpec-HS2048XL-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160	900	500	330	HS500-0.33
UV/VIS	200-660	440	1000	250	HS1000-0.25
UV	200-850	520	600	300	HS600-0.30
UV/VIS	200-850	520	600	400	HS600-0.40
UV/VIS	300-1160	860	500	560	HS500-0.56
VIS	360-1000	500	600	500	HS600-0.50
NIR	500-1050	500	600	750	HS600-0.75
VIS	350-850	460	900	550	HS900-0.55
VIS	400-722	322	1200	500	HS1200-0.5
NIR	600-1160	500	600	1000	HS600-1.0
NIR	600-1160	350	830	900	HS830-0.9
NIR	750-990	240	1200	1000	HS1200-1.0

Resolution Table (FWHM in nm) for AvaSpec-HS2048XL-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
500	2.6	4.5	5.5	6.5	10.0	22.0
600	2.2	3.8	4.5	5.5	7.5	18.0
830*	2.1	3.6	4.0	5.0	7.0	15.0
900*	2.0	3.5	3.8	4.8	6.8	14.5
1000*	1.9	3.3	3.6	4.6	6.6	14.0
1200*	1.8	3.0	3.3	4.3	6.2	13.5

* theoretical values

Ordering Information

AvaSpec-HS2048XL-EVO

- High-sensitivity fiber-optic Spectrometer, 2048 large 500 μm pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

PS-12V/1.0A

- External power supply, needed for use in ETH mode

Options

SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 μm
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, 1 mm thick, please specify YYY= 305, 385, 475, 515, 550 or 600 nm
OSC-HS500	• Order-sorting coating with 350 and 600 nm long-pass filter for HS500 gratings in AvaSpec-HS
OSC-HS600	• Order-sorting coating with 350 and 600 nm long-pass filter for HS600 gratings in AvaSpec-HS
OSC-HS900	• Order-sorting coating with 600 nm long-pass filter for HS900 gratings in AvaSpec-HS
OSC-HS1000	• Order-sorting coating with 350 nm long-pass filter for HS1000 gratings in AvaSpec-HS
FCPC	• FC/PC fiber optic connector

The AvaSpec-HS2048XL-EVO is ideally suited for diffuse reflection measurements (UV, VIS, NIR) and fluorescence.

AvaSpec-ULS2048x64-EVO SensLine High UV and NIR Sensitivity Spectrometer

Alongside the cooled AvaSpec-ULS2048x64TEC-EVO with low-noise detector, Avantes also offers the more cost-effective, uncooled AvaSpec-ULS2048x64-EVO. With its standard 2048x64 backthinned detector, this spectrometer is perfect for less demanding applications in the UV and NIR range.

For applications that require integration times lower than 2 seconds, the cooling option is often not needed. For example, this uncooled AvaSpec-ULS2048x64-EVO has an established track record in various DOAS applications all over the world because of its high UV response and 0.9 mm detector height that enables detecting the wavelengths of interest.

Options include an order-sorting filter, to reduce second-order effects and purge ports for deep-UV measurements. The AvaSpec-ULS2048x64-EVO comes with a wide range of slit sizes, gratings and can be configured with SMA or FC/PC fiber-optic entrance connectors.

The AvaSpec-ULS2048x64-EVO uses the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Connection to your PC is handled via USB3-connection or Ethernet, delivering a scan every 2 milliseconds. The instrument comes complete with AvaSoft-basic software, USB cable and an extensive manual.

AvaSpec-ULS2048x64-EVO



Technical Data

Optical bench	ULS, Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1160 nm
Resolution	0.09-20 nm, depending on configuration (see table)
Stray light	< 1%, depending on the grating
Sensitivity	650,000 counts/ μ W per ms int. time
Detector	Back-thinned CCD image sensor 2048x64 pixels (height: 0.89 mm)
Signal/noise	450:1
AD converter	16-bit, 1.33 MHz
Integration time	2.4 ms-25 seconds
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps
Sample speed with on-board averaging	2.4 ms/scan
Readout noise	7.5 cnt RMS
Dark noise	11.5 cnt RMS
Dynamic range	6100
Data transfer speed	2.4 ms/scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser
Power supply	Default USB power, 885 mA. Or external 12VDC, 420 mA
Dimensions, weight	177 x 127 x 44,5 mm (1 channel), 1180 grams

Grating Selection Table for AvaSpec-ULS2048x64-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1160**	960**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1160**	860**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-100*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1160	350-300	830	800	SI
NIR	600-1160**	560**	300	1000	IA
NIR	600-1160	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS2048x64-EVO

Grating (lines/mm)	Slit size (μm)					
	10	25	50	100	200	500
300	1.40	1.50	2.5	4.8	9.2	21.3
600	0.70 - 0.80*	0.75-0.85*	1.2	2.4	4.6	10.8
830	0.42 - 0.48*	0.50-0.58*	0.93	1.7	3.4	8.5
1200	0.25 - 0.31*	0.37 - 0.43*	0.52-0.66*	1.1	2.3	5.4
1800	0.17 - 0.21*	0.26 - 0.32*	0.34-0.42*	0.8	1.6	3.6
2400	0.12 - 0.18*	0.18 - 0.24*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.09 - 0.12*	0.11 - 0.15*	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

- AvaSpec-ULS2048x64-EVO**
- Ultra-low Stray-light Fiber-optic Spectrometer, 75 mm AvaBench, 2048x64 pixel back-thinned CCD detector, USB powered, high-speed USB3.0 and ETH interface, incl. AvaSoft-Basic, USB interface cable. Specify grating, wavelength range and options

Options

-RS	• Replaceable slit
DCL-UV/VIS-200	• Quartz detector collection lens (200 - 1100 nm)
SLIT-XX	• Slit size, please specify XX = 5, 10, 25, 50, 100, 200 or 500 μm
SLIT-XX-RS	• Replaceable slit with SMA connector, specify slit size XX = 25, 50, 100, 200 or 500 μm. Only available for AvaSpec-ULS2048CL-EVO-RS
SLIT-XX-RS-FCPC	• As SLIT-XX-RS, but with FC/PC connector
OSF-YYY	• Order-sorting filter for reduction of second-order effects please specify YYY = 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>305 nm) and VB gratings, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm linear variable filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber-optic connector

AvaSpec-ULS2048LTEC SensLine Thermo-Electric Cooled Fiber-optic Spectrometer

Long integration times in general are equivalent to higher dark noise. Avantes Thermo-Electric Cooled (TEC) spectro-meters systems overcome this problem

by cooling the detector. These instruments are equipped with triple stage cooling, keeping your detector at optimal 5 degrees Celsius (maximum -35°C difference from ambient temperature).

The detector cooling provides a significantly lower and more stable dark baseline and PRNU level. Dark noise is reduced by a factor of 2-3. This allows the ULS2048LTEC to be used in very low light conditions, such

as fluorescence and Raman measurements. If needed, integration times of more than 5 seconds are possible.

The AvaSpec-ULS2048LTEC has an integrated temperature regulator, USB2.0 high-speed interface and two cooling fans to actively ventilate the heat sink of the Peltier cooling elements. The spectrometer power supply is integrated into the housing.

AvaSpec-ULS2048LTEC



Technical Data

Optical Bench	ULS Symmetrical Czerny-Turner, 75 mm focal length
Wavelength range	200-1100 nm
Resolution	0.06 -20 nm, depending on configuration (see table)
Stray-light	0.04-0.1%, depending on the grating
Sensitivity	470,000 counts/μW per ms integration time
Detector	CCD linear array, 2048 pixels
Temperature cooled CCD	Max. ΔT = -30°C versus ambient (optimal setting: 5°C)
Time to stabilize	4 minutes
Dark baseline improvement @ ΔT=-35°C and it>5 sec	> Factor 6
PRNU improvement @ ΔT=-35°C and it>5 sec	> Factor 8
3-stage Peltier cooling internal Power supply @ ΔT=-35°C	5VDC, 3.0A
Signal/Noise	300:1
AD converter	16-bit, 2 MHz
Integration time	1.11 ms - 10 minutes
Interface	USB 2.0 high-speed, 480 Mbps RS-232, 115.200 bps
Sample speed with store to RAM	1.1 ms /scan
Data transfer speed	1.8 ms /scan (USB2) 430 ms/scan (RS-232)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, sync.
Power supply	100-240 VAC, 50W
Dimensions, weight	250 x 179 x 144 mm, 3.6 kg

Our TEC-spectrometers are kept at a steady 5°C for maximum precision

Grating Selection Table for AvaSpec-ULS2048LTEC

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
UV/VIS/NIR	200-1100**	900**	300	300	UA
UV/VIS/NIR	200-1100**	900**	300	300/1000	UNA-DB
UV/VIS	200-850	520	600	300	UB
UV	200-750	250-220*	1200	250	UC
UV	200-650	165-145*	1800	UV	UD
UV	200-580	115-70*	2400	UV	UE
UV	200-400	70-45*	3600	UV	UF
UV/VIS	250-850	520	600	400	BB
VIS/NIR	300-1100**	800**	300	500	VA
VIS	360-1000	500	600	500	VB
VIS	300-800	250-200*	1200	500	VC
VIS	350-750	145-90*	1800	500	VD
VIS	350-640	75-50*	2400	VIS	VE
NIR	500-1050	500	600	750	NB
NIR	500-1050	220-150*	1200	750	NC
NIR	600-1100	350-300	830	800	SI
NIR	600-1100**	500**	300	1000	IA
NIR	600-1100	500	600	1000	IB

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

** please note that not all 2048 pixels will be used for the useable range

Resolution Table (FWHM in nm) for AvaSpec-ULS2048LTEC

Grating (lines/mm)	Slit size (µm)					
	10	25	50	100	200	500
300	1.0	1.4	2.5	4.8	9.2	21.3
600	0.40-0.53*	0.7	1.2	2.4	4.6	10.8
830	0.32	0.48	0.93	1.7	3.4	8.5
1200	0.20-0.28*	0.27-0.38*	0.52-0.66*	1.1	2.3	5.4
1800	0.10-0.18*	0.20-0.29*	0.34-0.42*	0.8	1.6	3.6
2400	0.09-0.13*	0.13-0.17*	0.26-0.34*	0.44-0.64*	1.1	2.7
3600	0.06-0.08*	0.10	0.19	0.4	0.8	1.8

* depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the better the resolution

Ordering Information

- AvaSpec-ULS2048LTEC-USB2**
- Thermo-Electric Cooled Fiber-optic Spectrometer, 75 mm Ultra-Low Stray-light AvaBench, 2048L pixel 3-stage TE-cooled and regulated CCD detector, USB2 high-speed interface, incl. AvaSoft-Basic, USB cable, desktop housing.
 - Specify grating, wavelength range and options

Options

DUV	• Deep-UV detector coating >150 nm
DCL-UV/VIS-200	• Detector Collection Lens to enhance sensitivity, Quartz, 200-1100 nm
SLIT-XX	• Slit size, please specify XX = 10, 25, 50, 100, 200 or 500 µm
OSF-YYY	• Order-sorting filter for reduction of 2nd order effects, please specify YYY= 305, 395, 475, 515, 550 or 600 nm
OSC	• Order-sorting coating with 600 nm long-pass filter for BB (>350 nm) and VB gratings, recommended with OSF-305
OSC-UA	• Order-sorting coating with 350 and 600 nm long-pass filter for UA, VA gratings
OSC-UB	• Order-sorting coating with 350 and 600 nm long-pass filter for UB or BB (<350 nm) gratings
-FCPC	• FC/PC fiber optic connector
-RS	• Replaceable slit (recommended)

AvaSpec-NIR256/512-1.7-EVO

NIRLine Near-Infrared Fiber-optic Spectrometer

For measurements in the near infrared range out to 1.7 μm , Avantes offers a new series of uncooled spectrometer configurations. The AvaSpec-NIR256-1.7-EVO and the AvaSpec-NIR512-1.7-EVO offer the same high sensitivity optical bench with the next generation of electronics. Both instruments deliver the same exceptional performance specifications such as a sample speed of only 0.53 ms/scan and integration times as fast as 20 μs , as the Avantes instruments you have come to trust.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

The AvaSpec-NIR256/512-1.7-EVO spectrometers pair the same trusted InGaAs array detectors with our ultra low-noise electronics board featuring USB3 and Giga-Ethernet connection port. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed lightsources and choose from two distinct software-controlled gain-setting modes, high-sensitivity mode (HS, default) and the low-noise (LN) mode.

These affordable uncooled instruments are USB powered and are available with a choice of four gratings and replaceable slits to match the bandwidth and requirements fitting your application.

AvaSpec-NIR256-1.7-EVO



Technical Data

Spectrometer	AvaSpec-NIR256-1.7-EVO	AvaSpec-NIR512-1.7-EVO
Optical Bench	Symmetrical Czerny-Turner, 50 mm focal length,	
Wavelength range	900-1750 nm	
Resolution (slit & grating dependent)	2-50 nm	
Stray-light	<1%	
Sensitivity HS in counts /μW per ms	8,200,000 (integral 1000-1750 nm)	3,880,000 (integral 1000-1750 nm)
Dynamic Range HS	6000:1	
Integration time HS	10 μs -500 ms	
Signal/Noise HS	1900:1	
Sensitivity LN in counts /μW per ms	469,000 (integral 1000-1750 nm)	222,000 (integral 1000-1750 nm)
Dynamic Range LN	9000:1	
Integration time LN	10 μs -10 s	
Signal/Noise LN	5000:1	
Detector	InGaAs linear array, 256 pixels, 50 μm x 500 μm	InGaAs linear array, 512 pixels, 25 μm x 500 μm
AD converter	16-bit, 500 kHz	16-bit, 500 kHz
Interface	USB3.0 high speed, 5 Gbps, Gigabit Ethernet 1 Gbps	
Sample speed with store to RAM	0.53 ms/scan	
Data transfer speed	0.53 ms/scan (USB3)	
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital IO bi-directional, trigger, synchronization, strobe, laser	
Power supply	Default USB power, 600 mA or external 12VDC, 320mA (4W)	
Dimensions, weight	185 x 100 x 184 mm, 2.7 kg	

Grating Selection Table for AvaSpec-NIR256/512-1.7-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
		256/512			
NIR	900-1750	850	200	1500	NIR200-1.5
NIR	1000-1700	340	400	1600	NIR400-1.6
NIR	900-1400	200	600	1200	NIR600-1.2
NIR	1300-1600	152	600	1600	NIR600-1.6

Resolution Table (FWHM in nm) for AvaSpec-NIR256/512-1.7-EVO

Grating (lines/mm)	Slit size (μm)				
	25*	50	100	200	500
200	6	8	12	22	50
400	2.5	3	6	12	25
600	n.a.	2	4	8	18

* only for AvaSpec-NIR512

Ordering Information

AvaSpec-NIR256-1.7-EVO	<ul style="list-style-type: none"> Fiber-optic Spectrometer, 50 mm AvaBench, 256 pixel InGaAs detector, high-speed USB3 and ETH interface, with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
AvaSpec-NIR512-1.7-EVO	<ul style="list-style-type: none"> Fiber-optic Spectrometer, 50 mm AvaBench, 512 pixel InGaAs detector, high-speed USB3 and ETH interface, with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit
PS-12V/1.0A	<ul style="list-style-type: none"> External power supply, needed for operation in ETH mode

Options

SLIT-XX-RS	<ul style="list-style-type: none"> Replaceable slit with SMA connector, specify slit size XX=25*, 50, 100 or 200 μm
SLIT-XX-RS-FCPC	<ul style="list-style-type: none"> as SLIT-XX-RS, but with FC/PC connector

* only for AvaSpec-NIR512

Did you know the AvaSpec-NIR256-1.7-EVO has a little brother? Our new AvaSpec-Mini-NIR uses the same detector as the AvaSpec-NIR256-1.7-EVO, but in a much smaller package! This makes the AvaSpec-Mini-NIR perfect for OEM use and integration into handheld devices. Check it out on page 31!

AvaSpec-NIR256/512-1.7-HSC-EVO NIRLine Cooled Near-Infrared Fiber-optic Spectrometer

For measurements in the near infrared range out to 1.7 μm , Avantes offers a new series of cooled spectrometer configurations. The AvaSpec-NIR256-1.7-HSC-EVO and the AvaSpec-NIR512-1.7-HSC-EVO offer the high sensitivity 100mm optical bench (HSC) with the next generation of electronics (EVO). Both instruments deliver exceptional performance specifications such as a high sample speed and integration times as fast as 20 μs , as the Avantes instruments you have come to trust.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

The AvaSpec-NIR256/512-1.7-HSC-EVO spectrometers pair the same trusted InGaAs

array detectors with our ultra low-noise electronics board featuring USB3 and Giga-Ethernet connection port. The instruments are standard equipped with a Replaceable Slit. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed lightsources and choose from two distinct software-controlled gain-setting modes, high-sensitivity mode (HS, default) and the low-noise (LN) mode.

Cooling ensures optimal noise condition even at longer integration times. All NIR-1.7 instruments are available with a choice of four different gratings, making it possible to choose the bandwidth fitting your application.

AvaSpec-NIR256-1.7-HSC-EVO



Technical Data

Spectrometer	AvaSpec-NIR256-1.7-HSC-EVO	AvaSpec-NIR512-1.7-HSC-EVO
Optical Bench	Symmetrical Czerny-Turner, 100 mm focal length, 1 stage TE-cooled	
Wavelength range	900-1750 nm	
Resolution (slit & grating dependent)	1.9-32 nm	1.7-32 nm
Stray-light	<1%	
Sensitivity HS in counts / μW per ms	4.800.000 (integral 1000-1750 nm)	2.500.000 (integral 1000-1750 nm)
Dynamic Range HS	4900:1	
Signal/Noise HS	1900:1	
Integration time HS	20 μs -500ms	
Sensitivity LN in counts / μW per ms	160.000 (integral 1000-1750 nm)	83.000 (integral 1000-1750 nm)
Dynamic Range LN	7600:1	
Signal/Noise LN	5000:1	
Integration time LN	20 μs -20 s	
Detector	TE-cooled InGaAs linear array, 256 pixels, 50 μm x 500 μm	TE-cooled InGaAs linear array, 512 pixels, 25 μm x 500 μm
AD converter	16-bit, 1,2 MHz	
Interface	USB3.0 high speed, 5 Gbps, Gigabit Ethernet 1 Gbps	
Sample speed with store to RAM	0.13 ms/scan	0.24 ms/scan
Data transfer speed	0.4 ms/scan (USB3)	0.53 ms/scan (USB3)
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital IO bi-directional, trigger, synchronization, strobe, laser	
Power supply	12VDC, 12W	
Operating temperature	0-40°C	
Cooling	25°C versus ambient	
Dimensions, weight	185 x 160 x 184 mm, 3.6 kg	

Grating Selection Table for AvaSpec-NIR256/512-1.7-HSC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
		256/512			
NIR	900-1700	800	150	1250	NIR150-1.2
NIR	900-1700	380-310*	300	1200	NIR300-1.2
NIR	900-1700	262-230*	400	1200	NIR400-1.2
NIR	960-1700	262-230*	400	1600	NIR400-1.6

*depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

Resolution Table (FWHM in nm) for AvaSpec-NIR256/512-1.7 HSC- EVO

Grating (lines/mm)	Slit size (μm)				
	25*	50	100	200	500
150	4.0	5.7	7.0	12.8	32
300	1.8	2.3	3.0	4.0	10
400	1.7	1.9	2.5	3.3	8.3

* only for AvaSpec-NIR512

Ordering Information

AvaSpec-NIR256-1.7-HSC-EVO

- Fiber-optic Spectrometer, 100 mm AvaBench, 256 pixel InGaAs detector with 1-stage TE cooling, high-speed USB3 and ETH interface with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit.

AvaSpec-NIR512-1.7-HSC-EVO

- Fiber-optic Spectrometer, 100 mm AvaBench, 512 pixel InGaAs detector with 1-stage TE cooling, high-speed USB3 and ETH interface with replaceable slit, incl. AvaSoft-Basic, USB interface cable, OSF-850/1000-3. Specify grating, wavelength range and slit.

Options

SLIT-XX-RS

- Replaceable slit with SMA connector, specify slit size XX=25*, 50, 100, 200 or 500 μm

SLIT-XX-RS-FCPC

- as SLIT-XX-RS, but with FC/PC connector

* only for AvaSpec-NIR512

For external triggering Avantes offers the AvaTrigger featuring optical triggering, external TTL or manually through the pushbutton.

AvaSpec-NIR256/512-2.5-HSC-EVO

NIRLine Near-infrared Fiber Optic Spectrometer

AvaSpec-NIR256-2.5-HSC-EVO



The new and improved versions of our NIR spectrometers offer more sensitivity, less weight and less size. They are based on a 100mm optical bench with a NA of 0.13 offering optimal balance between resolution and sensitivity.

The 2.5-HSC series feature 256 or 512 pixel InGaAs detectors and are available in multiple configurations. These instruments are perfect for grain, corn, wheat, soya, polymers but also for medical uses, process monitoring and other analysis. The 256 pixel detectors offer best sensitivity for most applications.

For applications where resolution is key, or more datapoints for modelling is required, the 512 pixel detector will be the best choice.

Also available on the -HSC is the userselectable gain setting mode: LN(low-noise, standard setting), which gives you a longer integration time and higher signal to noise ratio, or HS (high-sensitivity) for measuring in lowlight conditions. Analog and digital IO ports enable external triggering and control of shuttered and pulsed light sources from the AvaLight series.

The EVO instruments use the AS7010 electronics board offering USB3 (10 times faster than USB2), Gigabit Ethernet and better signal processing.

Technical Data

Spectrometer platform	AvaSpec-NIR256-2.5-HSC-EVO	AvaSpec-NIR512-2.5-HSC-EVO
Optical Bench	TE-cooled Symmetrical Czerny Turner, 100 mm focal length	
Wavelength Range	1000-2500 nm	
Resolution (slit & grating dependent)	4.4-85.0 nm	2.6-85.0 nm
Pixel Dispersion (with NIR 075-1.7 grating)	6.2 nm	3.1 nm
Stray-light	<1.0%	
Sensitivity HS in counts / μ W per ms (1000-2500 nm)	990,000	480,000
Signal/Noise HS	1800:1	1900:1
Integration time HS	10 μ s-5 ms	
Sensitivity LN in counts / μ W per ms (1000-2500nm)	55,000	26,600
Signal/Noise LN	4000:1	3700:1
Integration time LN	10 μ s-100 ms	
Detector	inGaAs linear array with 2-stage TE-cooling, 256 pixel	inGaAs linear array with 2-stage TE-cooling, 512 pixel
Pixel size (WxH)	50 x 250 μ m	25 x 250 μ m
AD converter	16 bit, 500kHz	
Interface	USB 3.0 high-speed, 5 Gbps Gigabit Ethernet 1 Gbps	
Sample speed with on-board averaging	0.54 ms/scan (USB3)	
Data transfer speed	1.11 ms/scan (USB3)	
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bi-directional, trigger, sync, strobe, laser	
Power supply	12 V, 40W	
Operating Temperature range	0-40°C	
Cooling	45°C versus ambient	
Dimensions, weight	185 x 145 x 185 mm, 3.5 kg	

Grating Selection Table for AvaSpec-NIR 256/512-2.5-HSC-EVO

Use	Useable range (nm)	Spectral range (nm)	Lines/mm	Blaze (nm)	Order code
NIR	1000-2500	1500	75	1700	NIR075-1.7
NIR	1350-2500	1173-1150*	100	2500	NIR100-2.5
NIR	1000-2500	750-660*	150	2000	NIR150-2.0
NIR	1000-2500	815-700*	150	2600	NIR150-2.6
NIR	1000-2500	574-530*	200	1500	NIR200-1.5

*Depends on the starting wavelength of the grating; the higher the wavelength, the bigger the dispersion and the smaller the range to select.

Resolution Table (FWMH in nm) for AvaSpec-NIR256/512-2.5-HSC-EVO

Grating (lines/mm)	Slit size (μm)				
	25*	50	100	200	500
75	8.9	12.9	16.0	33.9	84.5
100	7.2	9.5	12.0	20.0	50.0
150	4.0	5.7	7.0	12.8	32.0
200	2.6	4.4	5.2	9.3	23.3

* Only for AvaSpec-NIR 512

Ordering Information

AvaSpec-NIR256-2.5-HSC-EVO

- NIR Spectrometer, 100 mm Avabench, 256 pixel InGaAs detector 2stage TEC, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB cable, specify OSF-1000, NIR grating and wavelength range and Slit-xx-RS

AvaSpec-NIR512-2.5-HSC-EVO

- NIR Spectrometer, 100 mm Avabench, 512 pixel InGaAs detector 2stage TEC, high-speed USB 3.0 and ETH interface, incl. AvaSoft-Basic, USB cable, specify OSF-1000, NIR grating and wavelength range and Slit-xx-RS

Options

- SLIT-XX-RS** • Slit size, please specify XX = 25, 50, 100, 200 or 500 μm

This instrument is perfect for grain, corn, wheat, soya and other analysis.

AvaSpec Dual-Channel Fiber-optic Spectrometer

AvaSpec-ULS2048CL-2-EVO



Sometimes a single channel spectrometer is not enough, for example when you want higher resolution or to do two redundant measurements at the same time. The AvaSpec dual channel spectrometers are designed specifically for this purpose. Each spectrometer can be configured independently. It is also possible to have different detector types in each channel.

Please contact one of our application specialists to configure the perfect solution for your application.

Technical Data

Connections	2 x USB2.0 or USB3.0/ETH 2 x DB26 2 x SMB (synch) 2 x power connector
Dimensions, weight	175 x 165 x 85 mm, 1800 grams

Ordering Information

AvaSpec-DDDD-2-USB2	<ul style="list-style-type: none"> Dual-channel AvaSpec-USB2 Fiber-optic Spectrometer with 2 channels with the same detector in one housing, including synchronization cable. For both channels specify Detector type DDDD (ULS2048/ULS3648/ULS2048L/2048XL), grating, wavelength range and options.
AvaSpec-MMMM/SSSS-2-USB2	<ul style="list-style-type: none"> Dual-channel AvaSpec-USB2 Fiber-optic Spectrometer with 2 channels with different detectors in one housing, including synchronization cable. For both channels specify Detector type MMMM and SSSS (ULS2048/ULS3648/ULS2048L/ULS2048XL), grating, wavelength range and options.
AvaSpec-EEEE-2-EVO	<ul style="list-style-type: none"> Dual-channel AvaSpec-EVO Fiber-optic Spectrometer with 2 channels with the same detector in one housing, including synchronization cable. For both channels specify Detector type EEEE (ULS2048CL/ULS4096CL), grating, wavelength range and options.

Pre-configured spectrometers can be shipped within 24 hours

AvaSpec Multi-Channel Spectrometer

Do you need more precise measurements over a broad range? Or multiple measurements at the same moment for process control? AvaSpec multi-channel spectrometers fulfill your every need. You can select from our range of spectrometer detectors, choose different slits or gratings: anything is possible.

Two enclosure options are available: the 9" desktop housing for up to 4 channels and the 19" rack-mountable which holds a maximum of 10 spectrometers. For our USB2 version all channels are connected to the computer through a single USB2-cable.

For the EVO series a USB3 and a Ethernet version is available.

The Ethernet version (ETH) supports standard 4 channels. With the additional hub installed, it can handle up to 10 channels.

Benefits:

- Combine up to 10 channels in one enclosure
- Any channel fully configurable to your needs
- Different integration times and averaging settings possible for each channel
- Ideal for process control

AVS-RACKMOUNT



Technical Data

Housing	Desktop	Rack-mount
Max nr. Channels	4	10 (UV/VIS)
Dimensions	315 x 235 x 135 mm (d x w x h)	315 x 445 x 135 mm

Ordering Information

AVS-DESKTOP-USB2	<ul style="list-style-type: none"> • Desktop for USB2 platform multichannel AvaSpec, incl. channel synchronization, USB2-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-RACKMOUNT-USB2	<ul style="list-style-type: none"> • 19" Rack-mount for USB2 platform multichannel AvaSpec, incl. channel synchronization, USB2-hub and 100-240VAC power supply, supports max. 10 Rack-mount spectrometer units.
AvaSpec-DDDD-USB2-RM	<ul style="list-style-type: none"> • Rack-mount Unit USB2 Fiber-optic Spectrometer, self powered high-speed USB2 interface, incl. AvaSoft-Basic software, USB cable and sync cable, specify detector type DDDD (ULS2048/ULS3648/ULS2048L/ULS2048XL/NIR256/512), grating, wavelength range and options. Desktop/Rack-mount needs to be ordered separately
AVS-DESKTOP-USB3	<ul style="list-style-type: none"> • Desktop for USB3 platform multichannel AvaSpec-EVO, incl. channel synchronization, USB3-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-DESKTOP-ETH	<ul style="list-style-type: none"> • Desktop for ETH platform multichannel AvaSpec-EVO, incl. channel synchronization, ETH-hub and 100-240VAC power supply, supports max. 4 Rack-mount spectrometer units.
AVS-RACKMOUNT-EVO-USB3	<ul style="list-style-type: none"> • 19" Rackmount for USB3 platform multichannel AvaSpec-EVO, including channel synchronization, USB3-hub, one DB26-IO connector and 100-240VAC power supply, supports max 10 rackmount unit spectrometer channels.
AVS-RACKMOUNT-EVO-ETH	<ul style="list-style-type: none"> • 19" Rackmount for ETH platform multichannel, including channel synchronization, 4 channel ETH-hub, one DB26-IO connector and 100-240VAC power supply, supports max. 10 rackmount unit spectrometer channels (needs AVS-RM-ADDON-5-10ETH).
AVS-RM-ADDON-5-10ETH	<ul style="list-style-type: none"> • Extra Industrial Hub for extension of AVS-RACKMOUNT-EVO-ETH to 5-10 channels
AvaSpec-EEEE-EVO-RM	<ul style="list-style-type: none"> • Rack-mount EVO Fiber-optic Spectrometer, incl. AvaSoft-Basic software, USB cable and sync cable, specify detector type EEEE (ULS2048CL/ULS4096CL/ULS2048L/ULS2048XL/NIR256/512), grating, wavelength range and options. Desktop/Rack-mount needs to be ordered separately

Synchronize all channels easily with internal sync cables

Avantes Raman Bundles

Raman Spectroscopy allows obtaining individual spectral 'fingerprints' of materials. Commonly used in chemistry, pharmaceutical and medical fields, to provide information by which molecules can be identified.

To offer our customers optimal performance for a reasonable price, Avantes joint forces with 2 partners to offer you a Raman Bundle consisting of a great spectrometer (3 different models), a unique Laser-Probe combination (785nm) supplying enhanced signals and an outstanding Software package to analyze the Raman spectra.

These 3 Bundles have in common:

For Excitation:

AvaLaser785 (incl.: 785 nm laser safety goggles). It has an ultra-high throughput integrated Raman probe. This novel device includes an integrated wavelength stabilized laser source with Raman filter packs, beam shaping optics and high efficiency Raman spectra collection optics.

Type of Measurements:

Raman techniques are used for many different materials. The Avantes bundles are really good for the use of powders and liquids. When strong signals are available (aromatic compounds, alcohol based liquids) in general Ava-Raman-A is useful to perform the measurement.

When weak Raman signals occur (Integration time longer than 5 seconds) the thermo-electric-cooled (TEC) spectrometer is recommended. This is added in the Ava-Raman-B.

If very weak signals possibly together with fluorescence background the Ava-Raman-D using our new AvaSpec-HERO is recommended (Higher quantum efficiency in NIR and better signal to noise performance).

For Analysis:

Panorama-Light: Panorama Light is a modular, high-end software platform for spectroscopic data evaluation. The application meets all requirements for a comprehensive spectroscopy working environment, offering:

- Measurement with an instrument
- 2D & 3D data visualization
- Searching in libraries
- Archiving in spectral libraries, including additional information

For Detection:

We offer state of the art spectrometers based on the Avantes Star- and SensLine spectrometers, tailored for optimal performance in the Raman range of interest.

AvaRaman Bundle



Ordering Information

AvaRaman-A

*For basic applications.
Based on an uncooled spectrometer this is the entry bundle for reasonable strong signals*

- Range : 150 cm⁻¹ - 3600 cm⁻¹
- Resolution: 6 cm⁻¹
- AvaSpec-ULS2048L-USB2 set for (788-1100nm), slit-25, DCL-UV/VIS200, FC-PC connector)
- Also including: AvaLaser785 (incl. probe), AvaRaman software: Panorama Light
Optional: Replaceable slit (add -RS)

AvaRaman-B

*For demanding applications.
Based on the cooled version of the spectrometer offered in the bundle Ava-Raman-A.
Cooling enables you to work with longer integration times, yet keeping the thermal noise limited.*

- Range : 150 cm⁻¹ - 3600 cm⁻¹
- Resolution: 6 cm⁻¹
- AvaSpec-ULS2048L-TEC-USB2 set for (788-1100nm), slit-25, DCL-UV/VIS200, FC-PC connector)
- Also including: AvaLaser785 (incl. probe)
AvaRaman software: Panorama Light
Optional: Replaceable slit (add -RS)

AvaRaman-D

*For the most challenging applications.
This bundle uses the AvaSpec-Hero for detection. The High end cooled back-thinned detector, low-noise electronics and optical bench with high Numerical Aperture, results in excellent Signal to Noise and Dynamic Range*

- Replaces AvaRaman-C
- Range : 100 cm⁻¹ - 3000 cm⁻¹
- Resolution: 10 cm⁻¹
- Spectrometer based on an AvaSpec-HS1024x58TEC-EVO set for (788-1020nm), slit-25, FC-PC connector, replaceable.
- Also including: AvaLaser785 (incl. probe)
AvaRaman software: Panorama Light

Options

Ava-Raman-SH-785 Bundle

Light tight cuvette holder for Use with Raman probe of AvaLaser785 used with the Ava-Raman A/B/D bundles.
Incl. adjustable gold coated mirror for signal collection

Ava-Raman-XYZ-785 Bundle

Manually Adjustable X-Y-Z Stage for use with Raman probe of AvaLaser785 used with the Ava-Raman A/B/D bundles

AvaRaman Fiber-optic Raman System

AvaRaman



Raman spectroscopy is especially useful for reaction monitoring, product identification, remote sensing and the characterization of highly scattering particulate matter in aqueous solutions. Based on the principle discovered by Prof. Chandrasekhara Venkata Raman, it measures the result of the inelastic scattering of photons.

Avantes uses the high-sensitivity AvaSpec spectrometers in combination with a 532 nm or 785 nm laser to give you the best result for your Raman measurements. The spectrometers are appropriately configured according to the wavelength of the laser.

Now the AvaSpec-HERO is integrated in a Raman system as well. Because of the lower dark noise (only 2 counts) you'll have a much better performance. The superior Signal to Noise ratio (800:1) is important when you're dealing with small signals, which is typically the case in raman. Also when small process changes need to be monitored in time, the HERO is superior as the small change process will lead to a small change in signal which can be clearly discriminated by the excellent SN ratio. The higher NA optical bench results in a better sensitivity (Twice as high as the ULS2048L). This will lead to

more photons impinging on the detector. Temperature control is very important in raman measurements to create stable results in time. Cooling to -10°C for lowest noise performance and very stable cooling control ($\pm 0.1^{\circ}\text{C}$ accuracy) is delivering accurate and reproducible results. This all together provides you with a combination that is suitable for the more demanding applications (low light, better signal to noise, low noise ratio).

All AvaRaman systems are equipped with cooling systems. Cooling the detector down to -35°C cooling versus ambient, reduces the noise figures by a factor 2-3, enabling the usage of longer integration times to enhance the detection of small signals. All AvaRaman systems are delivered with special AvaSoft-Raman software. Complementary Panorama-Pro software is available for Raman interpretation and functional group assignment.

A selection of different probes is available to select the right one for your application. For more information on our software solutions including AvaSoft-FULL/Raman and Panorama-Pro, please check the software pages on the website.

Technical Data

	AvaRaman-532TEC	AvaRaman-532HERO-EVO	AvaRaman-785TEC
	Cooled	Cooled	Cooled
Signal to noise Ratio	200:1 for Benzene	800:1 for Benzene	300:1 for Benzene
Resolution*	10 cm^{-1}	10 cm^{-1}	7 cm^{-1}
Spectrometer	AvaSpec-ULS2048L-TEC with grating NC (535-752 nm), slit-25, DCL-UV/VIS TE-cooled	AvaSpec-HERO with HSC1200-0.75 (535-660nm), slit-25-FCPC, TE-cooled, Standard: replaceable slit	AvaSpec-ULS2048L-TEC with grating SI (785-1080 nm), slit-25, DCL-UV/VIS-200 TE-cooled
Raman Shift	100-5400 cm^{-1}	100-3650 cm^{-1}	100-3500 cm^{-1}
Laser output	532 nm, 50 mW	532 nm, 50 mW	785 nm, 500 mW, Class 3b
Laser Wavelength	532 nm	532 nm	785 nm
Laser Bandwidth	< 0.1 nm	< 0.1 nm	< 0.2 nm

* typical resolution: higher resolution possible on request

Pre-configured spectrometers can be shipped within 24 hours



AvaRaman Probes



AvaRaman-PRB-XXX

3/8" SS low-cost focusing probe with a 200 μm excitation fiber and 400 μm read fiber. Multiple focal lengths available (5 mm, 7.5 mm (standard), 10 mm). It can withstand 80°C. Manual shutter included, 1.5 m fibers. Specify XXX=excitation wavelength, laser and spectrometer connection type.

AvaRaman-PRB-FP-XXX

1/2" SS focusing probe with a 200 μm excitation fiber and 400 μm read fiber. Multiple focal lengths available (5 mm (standard), 7.5 mm, 10 mm). It can withstand 80°C. Specify XXX=excitation wavelength, laser and spectrometer connection type.

AvaRaman-PRB-FIP-XXX

5/8" SS immersible focusing probe for in-situ measurements with a 200 μm excitation fiber and 400 μm read fiber. It can withstand 200°C. Specify XXX=excitation wavelength, laser and spectrometer connection type.

AvaRaman-PRB-FC-XXX

3/8" SS immersible process probe for in-situ measurements with a 200 μm excitation fiber and 400 μm read fiber. It can withstand 500°C and 3000psi. Specify XXX=excitation wavelength, laser and spectrometer connection type.

Ordering Information

Consisting of following elements:

- Solid state 50 mW laser 532 nm, FWHM 0.1 nm, FC/PC connector
- TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 1200 lines/mm grating set 535-752 nm, 25 μm slit (SMA), DCL-UV/VIS-200
- AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-532 laser safety goggles

AvaRaman-532TEC-USB2

Consisting of following elements:

- Solid state 50 mW laser 532 nm, FWHM 0.1 nm, FC/PC Connector
- TE-cooled AvaSpec-HERO Spectrometer with 1200 lines/mm grating set for 535-660 nm, 25 μm slit (FC/PC) (replaceable)
- AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-532 laser safety goggles

AvaRaman-532HERO-EVO

Consisting of following elements:

- Solid state 500 mW laser 785 nm, FWHM 0.2 nm, FC/PC connector
- TE-cooled AvaSpec-ULS2048L-TEC-USB2 Spectrometer with 830 lines/mm grating set 785-1080 nm, 25 μm slit (SMA), DCL-UV/VIS-200
- AvaSoft-Raman software for the AvaRaman system, AvaRaman-GL-785 laser safety goggles

AvaRaman-785TEC-USB2

Other Accessories

AvaRaman-SH-3/8"

- Rugged cuvette holder for secure positioning of 3/8" Raman probes

AvaRaman-SH-1/2"

- Rugged cuvette holder for secure positioning of 1/2" Raman probes

AvaRaman-Calibrationtile

- PTFE White tile in holder for 3/8" Raman probe

AvaSpec Services and Calibrations

Wavelength Calibration

All AvaSpec spectrometers come standard with a wavelength calibration and coefficients, to calculate wavelength from pixel number. This information is installed on-board, on the AvaSpec's EEPROM.

Under normal conditions the wavelength calibration does not need to be redone, since the spectrometers have no moving elements inside. If a wavelength shift is measured versus the original wavelength calibration, the spectrometer can be recalibrated by the end-user, using the Avalight-CAL and the auto-calibration software routine in AvaSoft-Full.

As an option the spectrometer can also be returned to Avantes for recalibration, (Spectral-cal-service). Before returning the spectrometer an RMA authorization number needs to be obtained.

Non-linearity Calibration

Most detectors of the AvaSpec spectrometers have a good linear behavior in their detector response, which means that there is a better than 95% correlation between raw signal in A/D counts and the light intensity at the spectrometer entrance.

However for some applications, which require a wide dynamic range, such as highly absorbing substances or low light level applications, combined with a need for high accuracy, a non-linearity calibration of the detector is recommended. This NL-calibration is performed on the detector array and the output signal is linearized to better than 99%. A complete calibration report and the calculated NL calibration coefficients are delivered with the spectrometer. For irradiance calibrations the NL-calibration is automatically included.



Irradiance Calibration

Applications that use spectrometers to measure the light energy of radiant sources require an irradiance-calibrated spectrometer. For all AvaSpec spectrometers irradiance NIST traceable calibrations can be offered. Irradiance calibrations ($\mu\text{W}/\text{cm}^2$) are normally performed on a system with a fiber-optic cable and a cosine corrector or integrating sphere.

The irradiance calibrations can be performed over 3 different wavelength ranges, UV (200-400 nm), VIS (360-1100 nm) and NIR (1100-2500 nm). All systems are calibrated against a NIST traceable

irradiance calibration standard and come with a complete report and calibration files, which are stored on the EEPROM of the spectrometer and can be loaded directly into the AvaSoft-IRRAD software module to obtain irradiance parametric measurements.

More information on irradiance can be found in the software section (AvaSoft-IRRAD) and the section Applications - Irradiance Measurements.

As an alternative to Avantes irradiance calibration services, irradiance calibrated light sources, such as AvaLight-DHS-CAL and AvaLight-HAL-CAL-Mini are available to perform your own irradiance field calibration.

Ordering Information

Spectral-cal-service	• Spectral calibration service for an AvaSpec, incl. calibration sheet
NL-calibration	• Non-linearity calibration service (per channel)
IRRAD-CAL-UV	• Irradiance calibration service UV range (200-400 nm) per channel, FC/PC connector recommended, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and presolarized fibers (PRESOL)
IRRAD-CAL-VIS	• Irradiance calibration service VIS range (360-1100 nm) per channel, incl. NL-calibration, needs AvaSoft-Full and AvaSoft-IRRAD
IRRAD-CAL-NIR	• Irradiance calibration service NIR range (1100-2400 nm) per channel, incl. NL-calibration, needs AvaSoft-Full and AvaSoft-IRRAD
IRRAD-CAL-UV/VIS	• Irradiance calibration service UV/VIS range (200-1100 nm) per channel, FC/PC connector recommended, incl. NL-calibration, needs AvaSoft-Full, AvaSoft-IRRAD and presolarized fibers (PRESOL) (calibration standardly performed without stray-light correction algorithm if applicable)

OEM Spectrometer: AS-5216 Microprocessor Board

The AS-5216 microprocessor board provides both flexibility and ease of integration. It features high-speed USB 2.0 communication and can be used in combination with the following detectors:

- Sony ILX554B and ILX511B
- Toshiba 1304
- Hamamatsu S11155/S7031 and G92xx series with/without TEC
- Sensors Unlimited 256 and 512

The board is equipped with an HD26 digital I/O connector with 13 programmable I/O port (3 digital in, 10 digital out), 2 analog out ports and 2 analog in ports. One digital out port is generally used to control the flash rate of

an AvaLight-XE pulsed Xenon light source, another digital out it used to control external TTL-shutter devices and a third is reserved for external control for flashing a laser source in LIBS applications. A digital in may be used for external hardware triggering.

A maximum of 127 AS-5216s can be coupled and synchronized through the USB 2.0 interface. This means easy and simultaneous sampling of 2-127 channels. The AS-5216 board can be synchronized with other AS-5216 boards to control the simultaneous data-sampling of multiple channels, all connected to USB2.0 high-speed interface. On-board signal processing allows data reduction to speed up scan transfer time.

Data reduction can be achieved by defining a start and stop pixel and On-Board Averaging.

This board is compatible with the extensive AvaSpec-DLL software development kit, enabling full control over the spectrometer in customer-designed software.



Technical Data

Microprocessor	Coldfire® 5216, 32-bit, 64 MHz	
Memory	512 KB Flash Memory, 64KB RAM	
A/D converter	16-bit, 2 channels for video signal	
Integration time	2 µs - 10 minutes (detector dependent)	
Data Transfer speed	1.8 ms/scan for Sony ILX554 2048 pixels, 2 MHz	
	1.8 ms /scan for Sony ILX511 2048 pixels, 2 MHz	
	1.1 ms/scan for TAOS 1401 2 MHz	
	3.7 ms /scan for Toshiba TCD1304, 1 MHz	
	2.09 ms/scan for Hamamatsu S11155, 1 MHz	
	5.22 ms/scan for Hamamatsu S7031, 250 kHz	
USB interface	2.0 high-speed, 480 Mbps	
	RS-232 interface	Baudrate 115200 bps, HD-26 female connector
	Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization
Power supply	Default USB power, 350 mA 12 VDC, reverse polarity protection, 150 mA	
Temperature range	0- 55 °C	

Ordering Information

- | | |
|----------------|---|
| AS-5216 | • Microprocessor board 16-bit AD and USB2.0/RS-232 interface.
Specify detector type, see below |
|----------------|---|

Detector Types

- ILX	for Sony ILX554B detectors (AvaSpec-ULS2048-USB2)
-ILX511	for Sony ILX511B detectors (AvaSpec-ULS2048L-USB2)
- TOS3648	for Toshiba 1304 detectors (AvaSpec-3648-USB2)
- HAM2048XL	for Hamamatsu S11155 detectors (AvaSpec-ULS2048XL-USB2), extra pcb incl.
HAM1024x58	for Hamamatsu S7031 detectors (AvaSpec-HS1024x58/122-USB2), extra pcb incl.
- NIR256/512	Hamamatsu G92xx series InGaAs NIR detectors (AvaSpec-NIR256/512-1.7)
- NIR256/512TEC	Hamamatsu G92xx series with TEC InGaAs NIR detectors (AvaSpec-NIR256/512-2.5-HSC-EVO), extra pcb incl.
-NIRSU256/512	Sensors Unlimited 256/512 InGaAs NIR detectors (AvaSpec-NIR256/512-1.7-HSC-EVO)

OEM Spectrometer: AS-7010 Microprocessor board



The AS-7010 is the all new electronic platform and the base for Avantes' future spectrometer models.

It is equipped with a powerful Xilinx Zynq 7010 microprocessor. It combines the software programmability of a Processor with the hardware programmability of an FPGA, resulting in unrivalled levels of system performance and flexibility. The generous 100 Mpixel memory enables onboard storage of spectra and custom programming. Equipped with 2 different AD converters optimal performance for each detector type is assured.

The As-7010 comes with the ability of 2 communication ports: High Speed USB3.0 and GigaEthernet.

Also on board is the HD26 digital I/O connector with 13 programmable digital I/O ports, 2 analog out ports and 2 analog in ports. The connector is compatible with the AS-5216 I/O connector.

Technical Data

Microprocessor	Xilinx Zynq 7010
Memory	100 Mpixel
A/D converter	16-bit, 2 channels for video signal / 16-bit, high end - low noise (detector dependent)
Integration time	2 μ s - 10 minutes (detector dependent)
USB interface	3.0 high-speed, 5 Gbps
ETHERnet interface	Giga Ethernet, 1 Gbps
Digital IO	HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, synchronization, strobe, laser
Power supply	Default USB3.0 power, 500 mA 12 VDC, reverse polarity protection, 300 mA
Temperature range	0- 55 °C
Dimensions, weight	162,5 x 100 mm, 97 grams

Ordering Information

AS-7010	<ul style="list-style-type: none"> Microprocessor board 16-bit AD and USB3.0/Ethernet interface. Specify detector type, see below
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Detector Types

- ILX511	for Sony ILX511B detectors (AvaSpec-ULS2048L-EVO)
- HAM11639	for Hamamatsu S11639 CMOS detectors (AvaSpec-ULS2048CL-EVO)
- HAM13496	for Hamamatsu S13496 CMOS detectors (AvaSpec-ULS4096CL-EVO)
- HAM2048XL	for Hamamatsu S11155 detectors (AvaSpec-ULS/HS2048XL-EVO), extra pcb incl.
- HAM1024x58	for Hamamatsu S7031 detectors (AvaSpec-HERO), extra pcb incl.
- HAM2048x64	for Hamamatsu 11071 or 11850 (AvaSpec-ULS2048x64(TEC)-EVO), extra pcb incl.
- NIR	for InGaAs NIR detectors (Specify model), extra pcb incl.

OEM spectrometer: AvaBench Optical Bench

AvaSpec optical benches are available with or without one of our electronics boards for integration into customer's systems. Avantes has developed four types of UV/VIS optical benches, especially for OEM customers. The optical benches AvaBench-75-ULS (used in both StarLine and SensLine), AvaBench-75-ULSTEC (SensLine) and AvaBench-37.5-HS and AvaBench-100-HSC (SensLine) are Czerny-Turner designs with fiber-optic entrance connectors (Standard SMA, others possible), collimating and focusing mirrors and a diffraction grating. A choice of different gratings with different dispersions and blaze angles enable applications in the 200-1100 nm range. The newly designed high numerical aperture AvaBench-37.5-HS has full mechanical compatibility for mounting holes with the AvaBench-75-ULS, so for OEM customers it is easy to upgrade to a higher-throughput optical bench.

Wavelength ranges, resolution tables, detector specifications and AvaBench options can be found in the instrument page corresponding to each spectrometer type. In the table below the detailed key specifications can be found. All AvaBench optical benches are fully compatible with Avantes electronics board or may be interfaced to customer specific electronics. Video output is handled through a separate mini-coax cable.

AvaBench-75-ULS



Technical Data

	AvaBench-75-ULS	AvaBench-75-MN	AvaBench-75-ULSTEC	AvaBench-37.5-HS	AvaBench-100-HSC
Implemented in	AvaSpec-ULS2048/3648/2048L/2048CL/4096CL/2048XL/2048x64(TEC)	AvaSpec-Mini2048CL/4096CL	AvaSpec-ULS2048LTEC	AvaSpec-HS1024x58/2048XL	AvaSpec-HERO
Focal length	75 mm	75 mm	75 mm	37.5 mm asym.	100 mm
Numerical aperture	0.07	0.07	0.07	0.22	0.13
Wavelength range	200-1160 nm	200-1100 nm	200-1100 nm	200-1160 nm	200-1160 nm
Resolution (FWHM)	0.05-20 nm	0.05-20 nm	0.05-20 nm	1.2-20 nm	0.18-5.50 nm
Stray-light	0.04-0.1%	0.2-1%	0.04-0.1%	<1%	<1%
Gratings	Different	Different	Different	Different	Different
Slits	10, 25, 50, 100, 250, 500 μm	10, 25, 50, 100, 250, 500 μm	10, 25, 50, 100, 250, 500 μm	25, 50, 100, 200, 500 μm	25, 50, 100, 250, 500 μm
Detector	SONY 2048(L) / TOSHIBA 3648 /HAM 2048CL/4096CL/2048XL/2048x64	HAM 2048CL/4096CL	SONY 2048L	HAM 2048XL	HAM 1024x58
Detector lens	UV/VIS	UV/VIS-200	UV/VIS-200	n.a.	n.a.
Order-sorting filter	See options	See options	See options	See options	See options
Dimensions, weight	120 x 91 x 21 mm, 350 gr.	95 x 68 x 20 mm, 175 gr	120 x 91 x 62 mm, 760 gr.	95 x 152 x 42 mm, 722 gr	120 x 125 x 109 mm, 1500 gr

Download the latest software for your AvaSpec at www.avantes.com

Ordering Information

AvaBench-75-ULS2048-U2	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS3648-U2	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 3648 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048L-U2/U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048CL-U2/U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-ULS4096CL-U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 4096 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048XL-U2/U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048XL pixel back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048x64-U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048x64 pixel back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048x64TEC-U3	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, 2048x64 pixel back-thinned cooled CCD detector. Specify grating, wavelength range and options.
AvaBench-75-MN2048CL-U3	<ul style="list-style-type: none"> • OEM miniature optical bench, 75 mm focal length, 2048 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-MN4096CL-U3	<ul style="list-style-type: none"> • OEM miniature optical bench, 75 mm focal length, 4096 pixel CMOS detector. Specify grating, wavelength range and options.
AvaBench-75-ULS2048LTEC-U2	<ul style="list-style-type: none"> • OEM ultra-low stray-light optical bench, 75 mm focal length, TE-cooled 2048 large pixel detector. Specify grating, wavelength range and options.
AvaBench-37.5-HS2048XL-U2/U3	<ul style="list-style-type: none"> • OEM High-sensitivity optical bench, 37.5 mm focal length, 2048XL pixel back-thinned CCD detector. Specify grating, wavelength range and options.
AvaBench-100-HSC 1024x58TEC-U3	<ul style="list-style-type: none"> • OEM High-sensitivity optical bench, 100 mm focal length, 1024x58 pixel TE-cooled back-thinned CCD detector. Specify grating, wavelength range and options.

The grating can only be changed by Avantes.
Therefore, choose your grating wisely.
Our application specialists are available to support you with your choice.
In general, a higher resolution means a lower bandwidth.
By combining multiple spectrometers
in our AvaSpec-Dual or rack-mountable versions,
you can create one virtual spectrometer with high-resolution
and high bandwidth.

OEM spectrometer: AvaBench NIR Optical Bench

For OEM applications in the NIR range, Avantes offers our line of AvaBench NIR optical benches.

The AvaBench-50 optical bench is available in the 1000-1750 nm range for uncooled detectors.

The AvaBench-100TEC is developed for the NIR range from 1000-2500 nm with thermoelectric cooling. The AvaBench-100TEC supports two different TE-cooled detectors with 256 pixels and two TE-cooled detectors with 512 pixels. The 100 mm focal length optical bench provides the optimal balance between optical throughput and resolution. To keep the size as compact as possible, this bench features a unique folding mirror. New in the NIR line of optical benches is the AvaBench-75-MN, offering a unique small form factor in the NIR range.

All AvaBench NIR optical benches have symmetrical Czerny-Turner designs with a fiber-

optic entrance connector (standard SMA, other options available), collimating and a special designed focusing mirror and diffraction grating. A choice of different NIR gratings can be selected for all models.

Wavelength ranges, resolution tables, detector specifications and AvaBench options can be found on the pages corresponding to each spectrometer type.

In the table below, the key specifications of the NIR optical benches are listed.

The NIR AvaBenches are fully compatible with Avantes electronic boards or may be interfaced to customer specific electronics. The NIR optical benches have a separate video output through a mini-coax cable. The TEC NIR benches have a heatsink and additional electrical connections for both temperature sensor and power for the 2-stage Peltier cooling.

AvaBench-50



Technical Data

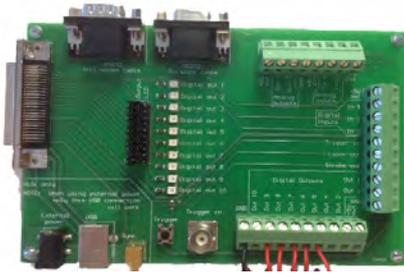
	AvaBench-50	AvaBench-75-MN	AvaBench-100TEC
Implemented in	AvaSpec-NIR256-1.7	AvaSpec-Mini-NIR	AvaSpec-NIR256-1.7TEC AvaSpec-NIR512-1.7TEC AvaSpec-NIR256-2.5-HSC-EVO AvaSpec-NIR512-2.5-HSC-EVO
Focal length	50 mm	75 mm	100 mm
Numerical aperture	0.24	0.07	0.14
Wavelength range	1000-1750 nm	900-1750 nm	1000-2500 nm
Resolution (FWHM)	2-50 nm	2-50 nm	1.5-90 nm
Stray-light	< 1%	< 1%	< 0.5%
Gratings	different	different	different
Slits	50, 100, 200, 500 μm	50, 100, 200, 500 μm	25, 50, 100, 250, 500 μm
Detector	HAM-NIR256-1.7	HAM-NIR256-1.7	SU-NIR256/512-1.7 HAM-NIR256-2.5 HAM-NIR512-2.5
TE Cooling	No	No	Yes
Order-sorting filter	OSF-850-3/OSF-1000-3	OSF-850-3/OSF-1000-3	OSF-1000-3 and OSC-NIR
Dimensions, weight	100 x 130 x 40 mm, 875 gr.	95 x 68 x 20 mm, 175 gr	185 x 145 x 185 mm, 3.5 kg.

Ordering Information

AvaBench-50-NIR256-1.7	<ul style="list-style-type: none"> OEM optical bench, 50 mm focal length, 256 pixel InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-Mini-NIR256-1.7	<ul style="list-style-type: none"> OEM optical bench, 75 mm focal length, 256 pixel InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR256-1.7TEC	<ul style="list-style-type: none"> OEM optical bench, 100 mm focal length, 256 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR512-1.7TEC	<ul style="list-style-type: none"> OEM optical bench, 100 mm focal length, 512 pixel TE-cooled InGaAs detector. Specify grating, wavelength range and slit, OSF-850-3 or OSF-1000-3.
AvaBench-100-NIR256-2.5TEC	<ul style="list-style-type: none"> OEM optical bench, 100 mm focal length, 256 pixel TE-cooled InGaAs detector 2.5 μm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.
AvaBench-100-NIR512-2.5TEC	<ul style="list-style-type: none"> OEM optical bench, 100 mm focal length, 512 pixel TE-cooled InGaAs detector 2.5 μm. Specify grating, wavelength range and slit, OSF-1000-3, OSC-NIR.

Developer kits for easy IO access

Printed circuit board for AS5216 boards



Avantes Spectrometers feature great flexibility offering multiple Input / Output connections. These IO can be used with Avasoft 8 (Time Series) or with customized applications. The DEVKITs are intended to make life easier in the development-stage. Instead of fabricating or soldering a cable with the right connections now it is easy to connect using the screw terminals.

The AVS-DEVKIT-AS(C)5216 contains the PCB-IO-EXT-BES Printed Circuit Board. This board has several screw terminals for easy connectivity to the IO points, a BNC con-

necter for the input trigger as well a push button for manual control. All outputs have a LED indicating their status (selectable with jumpers). Furthermore RS232 connectors are provided. For the ASC version a power, USB and SYNC connector are on the PCB. The PCB-IO-EXT-BES will be connected to the AvaSpec-ULS or AvaSpec-ULSi IO Connector with an interface cable.

Since the AS7010 and the AS5216 electronic boards share the same IO connections, the AVS-DEVKIT-AS5216 can also be used in combination with the AS7010.

Ordering Information

AVS-DEVKIT-AS5216

- Developer Kit consisting of: PCB-IO-EXT-BES Printed Circuit Board for connection to Avantes Spectrometers with AS5216 or AS7010 electronics boards, to easily control and connect signals to the IO connector. IC-IOEXT-DB26 connection cable to connect the board to DB26 connector.

Service-Mini-MKII-IO

- Service part: Set of mating connectors and wires for AvaSpec-MINI MKII IO connectors.(3 connectors/ 30 wires)
This set consists:
3 x mating connector Wurth WTB series 665 010 113 322 and
30 x 150mm precrimped cable Wurth WTB series 665 010 130 115

The Developer Kit makes life easier in the development-stage. Connecting the screw terminals will enable you to get your application up and running in no-time!

OEM Spectrometer: Enclosures

For OEM (Original Equipment Manufacturer) customers, Avantes offers a line of enclosures for their spectrometers. There are multiple enclosures available for different combinations of AvaBenchs and circuit boards.



Ordering Information

- | | |
|-------------------------------|---|
| AVS-HOUSING | • Aluminum housing to fit AvaBench-75 and AS-5216 board. |
| AVS-HOUSING-EVO-ULS | • Aluminum housing to fit AvaBench-75 and AS-7010 board. |
| AVS-HOUSING-DUAL | • Dual-channel aluminum housing to fit two AvaBench-75 and AS-5216/7010 boards. |
| AVS-HOUSING-EVO-HSC | • Aluminum housing to fit AvaBench-100 and AS-7010 board. |
| AVS-HOUSING-IND | • Neutral black aluminum housing to fit AvaBench-75 and AS-5216/7010 board with mounting ears |
| AVS-HOUSING-DUAL-IND | • Dual-channel neutral black aluminum housing to fit 2 AvaBench-75 and 2 AS-5216/7010 boards with mounting ears |
| AVS-HOUSING-HSC-OEM | • Stainless steel housing to fit AvaBench-100 and AS-7010 board. |
| AVS-HOUSING-NIR1.7-OEM | • Stainless steel housing to fit AvaBench-50 and AS-7010 board, with mounting ears. |

AvaSpec Spectrometer Interface Cables

Avantes offers a wide range of cables to connect your AvaSpec spectrometer to an AvaLight series light source or one of our many accessories (Fiber-optic switches, AvaTrigger, etc).

In the table below, the cable options for your light source or accessory application can be found. Please note that the cables generally are 2 meters long, but custom lengths are available on request.

Interface cables



USB2/EVO platform spectrometers (DB26 / SMB connector)

Connect to	Product code	Description
RS-232	IC-DB26/DB9-2	Interface cable AvaSpec-USB2 platform DB26 male to RS232 DB9 female cable, 2 m
AvaLight-S / AvaLight-XE	IC-DB26-2	Interface cable AvaSpec-USB2/EVO platform to DB15 for AvaLight-S with shutter for auto-save dark/ lamp off, AvaLight-XE control
BNC-Ext. hardware trigger	IC-DB26-EXTRIG-BNC-2	Interface cable AvaSpec-USB2/EVO platform to BNC plug External trigger, 2 m
External Hardware Trigger	IC-Extrig-USB2	Interface cable AvaSpec-USB2/EVO to External trigger pushbutton, 2 m
RS-232 Avalight-S / Avalight-XE	IC-DB26/DB9/DB15-2	Interface Y cable AvaSpec-USB2 platform to RS-232 (DB9) and Avalight-S (DB15) with shutter for auto save dark/ lamp off, AvaLight-XE control
Avalight-S / Avalight-XE External Hardware Trigger	IC-DB26-Extrig-USB2	Interface Y-cable AvaSpec-USB2/EVO to External trigger pushbutton and Avalight-S with shutter, 2 m
Other spectrometer	IC-COAX-SMB-0.25	Synchronization coax cable with 2 SMB connectors 0.25 m for AvaSpec-USB2/EVO platform

Software



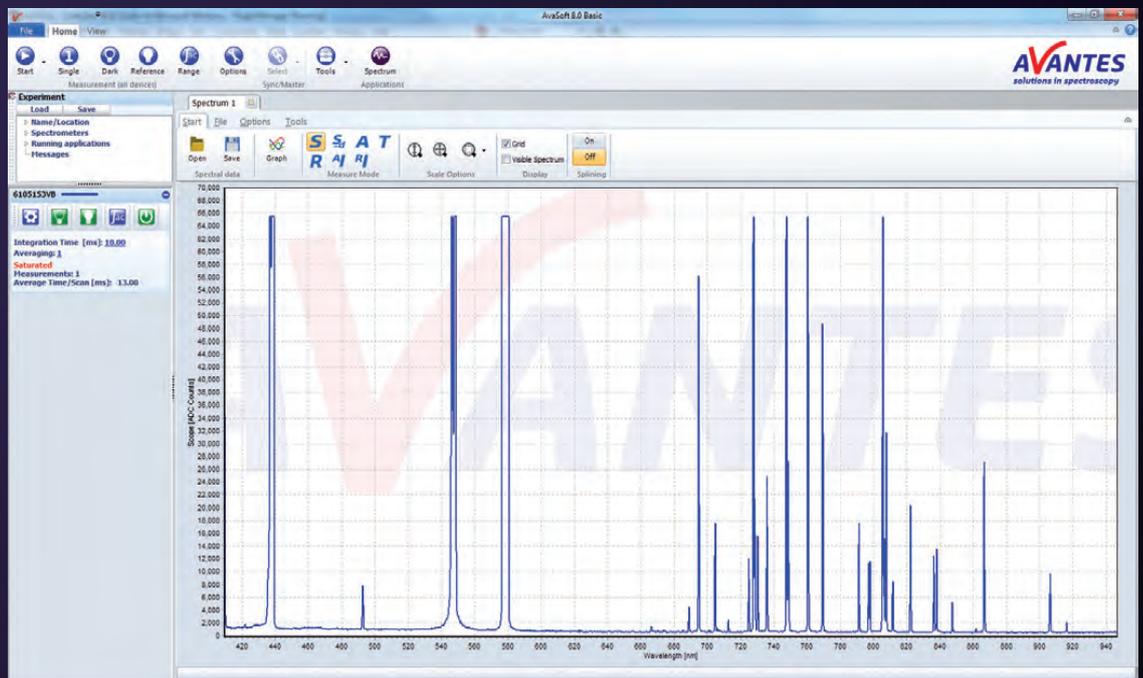
INTRODUCTION

AvaSoft is a software package that can be used to control all Avantes spectrometers and a wide range of accessories. The latest version can be used with Windows. Since the initial version of AvaSoft in 1996, a major upgrade has been released at least once a year, featuring new options and possibilities.

Our state of the art modular software is available as a scalable platform:

- AvaSoft-Basic: Everything needed for basic measurements and controlling your AvaSpec series spectrometer, including basic data acquisition. Basic allows you to save and display data in the following modes: scope, transmission, absorption and relative irradiance.
- AvaSoft-Full: Includes all possibilities of AvaSoft-Basic and adds many other options, such as history channel functions, auto-calibration procedures and external triggering.
- Application add-on modules for AvaSoft-Full enable special measurement procedures: color measurements, absolute irradiance, chemometrics, process control.
- AvaSoft-All, which includes AvaSoft-Full and all add-on application modules in one package.
- Dynamic Link Library (DLL) interface packages with support for basic spectrometer control, color measurements and irradiance measurements.

Visit our website at www.avantes.com to download the latest version of the AvaSoft spectroscopy software free of charge. When no spectrometer is connected to the computer, AvaSoft will start in demo-mode, making it ideal to try out our software. In demo-mode, the software will work as AvaSoft-Full, making it possible to test spectrometer functions and display and analyze spectra offline.



AvaSoft-Basic Software

To facilitate the use of our AvaSpec series spectrometers, we provide our AvaSoft-Basic, free of charge. It features user-friendly controls, pull down menus and is mouse oriented. Mouse clicks control movements of a data cursor for instantaneous readout of wavelength, pixel and Y-axis magnitude. The multi-window and multi-monitor interface enables side by side comparison of measurements. Use mouse dragging for easy and fast zoom-in/out on both X and Y axes. An unlimited number of AvaSpec series spectrometers can be connected to the computer, either through USB or Ethernet.

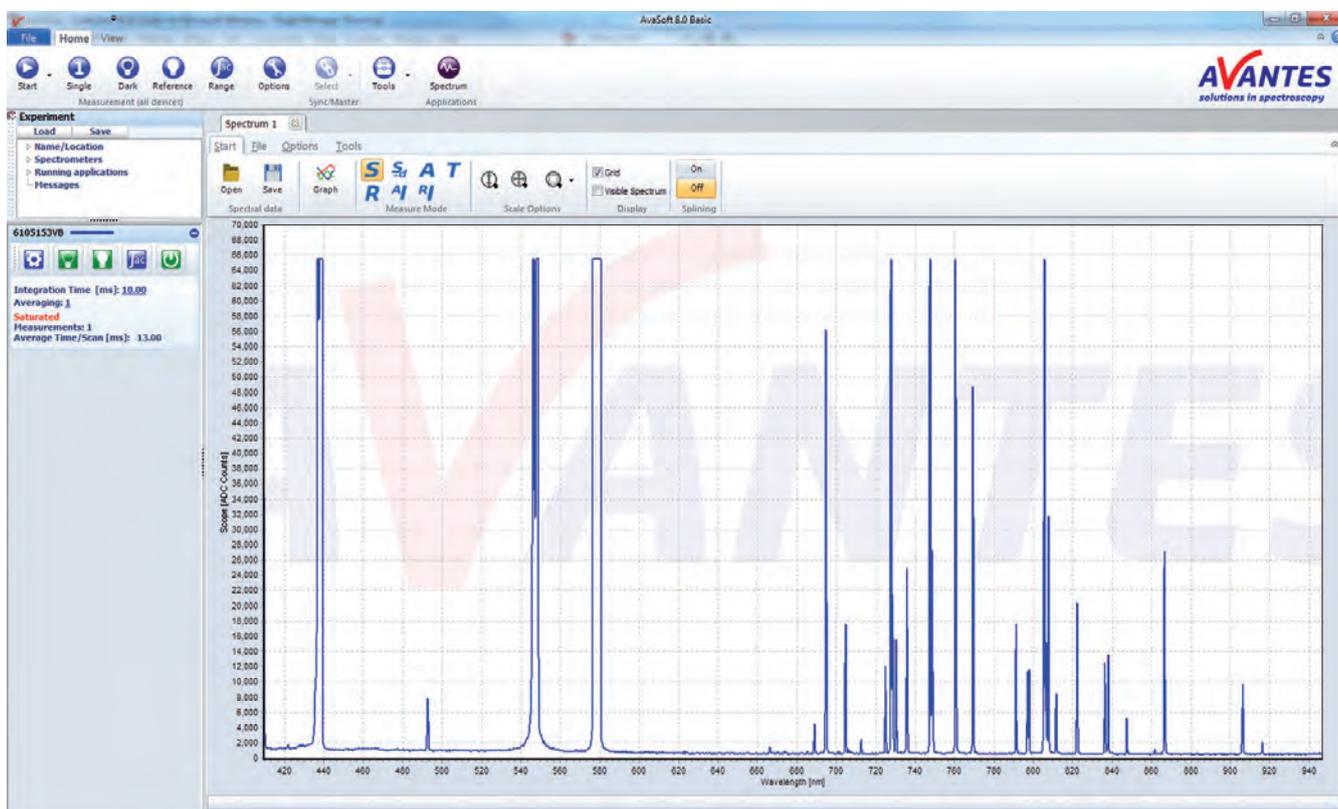
In the main window, controls for on-line/off-line spectral analysis are available. Software icons facilitate easy saving of reference, dark and experiment spectra. Additionally, changing the measurement units to absorbance, transmittance, irradiance or raw scope data can be done with one click of the mouse. Rescaling the Y-axis, setting the scale for X- and Y-axis and peak/valley searching are also available.

Instrument control and data collection parameters are user-definable, such as detector integration time, auto-dark cor-

rection, signal averaging and spectral smoothing. Saved graphics can be exported to ASCII and be exported into Excel and other data processing software.

Other options are a 3D display functionality and the option to save a graph directly as a PDF-file. File management features flexible file filters.

The latest version of AvaSoft-Basic can be downloaded from the Avantes website. Please contact us for upgrading to AvaSoft-Full or -All.



Ordering Information

- AvaSoft-Basic** • Free Basic Spectrometer software for Windows

For the latest information,
go to www.avantes.com

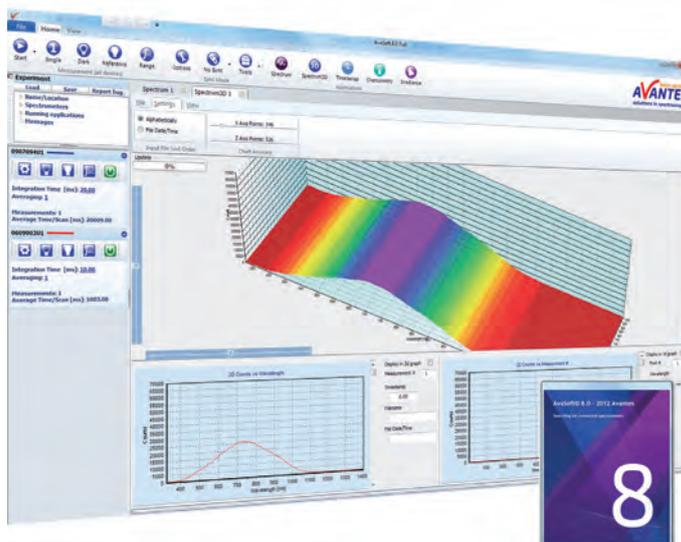
AvaSoft-Full and AvaSoft-All

AvaSoft-Full

The AvaSoft-Full version offers many more possibilities and options than AvaSoft-Basic. In the table below you can find the similarities and differences between the two versions.

AvaSoft-All

For the greatest flexibility, AvaSoft-All includes AvaSoft-Full and all application modules described in the subsequent pages. This means you can do color, irradiance, chemometry measurements, process control and real-time exporting to Excel all in one convenient software package.

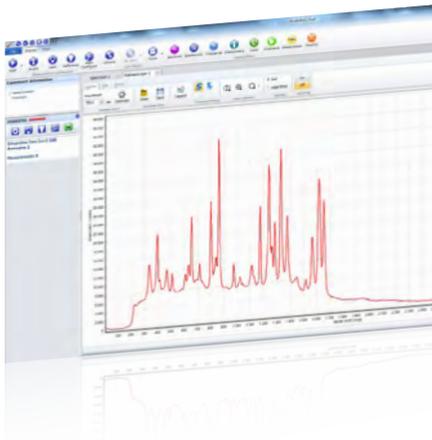


Comparison AvaSoft-Basic and AvaSoft-Full

	Basic	Full	All
Editable data collection parameters per channel, such as detector integration time, auto-dark correction, signal averaging, spline interpolation and spectral smoothing.	X	X	X
Display data in scope-, transmittance-, absorbance-, or relative irradiance mode. Multiple spectrometer channels are displayed in the same graph, optional grid display. 3D display for multiple spectra in time series.	X	X	X
Save spectra, and display online measurements against (multiple) saved spectra background. Print (multiple) spectra in color. Convert saved spectra to ASCII format in equidistance (nm) with start wavelength in nm. Automatic save spectra periodically (save a spectrum every x seconds).	X	X	X
Help menu option to find quickly a description about any AvaSoft topic.	X	X	X
Time Series, in which the output of user defined functions, integrals, peaks (intensity, wavelength) can be followed simultaneously against time. Functions can be entered in Visual-Basic script. Time series measurements can be saved/loaded and printed. Zoom- and panning functions can be applied to expand quickly an interesting part of the time series measurement to the full graph.		X	X
Auto Wavelength Calibration. In combination with a Mercury-Argon Light Source, a number of peaks can be detected automatically. These peaks are then compared with the wavelengths where they should have been detected, and a regression fit is performed to calculate the best wavelength calibration coefficients.		X	X
Correct for drift. Master and slave channels with similar range can be used to correct for changes in the light source.		X	X
Save live to file.		X	X
Store to RAM for ultrafast Data saving for a limited amount of scans.		X	X
External Trigger control to acquire spectral data only if a TTL signal is presented with optional integration time delay settings.		X	X
Convert spectra to other file formats		X	X
Merging spectra of multiple channels to one spectrum.		X	X
Full Width Half Max calculations, online or on saved spectra. Graphically displayed. Integral calculations, online or on saved spectra, graphically displayed.		X	X
Auto-configure integration time: AvaSoft searches for an optimal integration time.		X	X
Automatic Save Dark by TTL shutter.		X	X
LIBS application.		X	X
Thinfilm application.			X
Raman application.			X
Irrad application			X
Color application.			X

Ordering Information

- AvaSoft-Full** • Full version AvaSpec software for Microsoft Windows
- AvaSoft-All** • Full version AvaSpec software, including all applications



For online and offline reflective color measurements, AvaSoft-COL is the ideal companion. This application provides a precise way to perform color measurements using the basic principles and techniques defined by the International Commission on Illumination (CIE). The CIE 1976 L*a*b* color parameters are calculated, along with other parameters, like Hue, Chroma and X, Y, Z.

These parameters can be displayed in a CIELAB chart or in a graph versus time. Another possibility is saving the measured L*a*b* values to an online database and using one of the products from the database as a reference color. Color differences (ΔE_{Lab} , ΔL^* , Δa^* , or Δb^*) are made through comparing the measured L*a*b* values to the stored database values.

The color of an object can be expressed by the CIE 1976 (L*a*b*) color space. L* describes the brightness of the color. A positive value of a* describes the redness of the color, a negative a* the greenness. Similarly, yellowness is a positive b*, where blue is a negative b*. The L*a*b* values are derived from the CIE tristimulus values X, Y and Z of the sample (object) and the standard illuminant tristimulus values X_n , Y_n and Z_n .

The standard illuminant tristimulus values for X_n , Y_n and Z_n are constant and depend only on the type of standard illuminant that has been chosen.

The CIE tristimulus values X, Y and Z of the color of an object are obtained by multiplying the relative power P of a standard illuminant, the reflectance R (or the transmittance) of the object, and the 1931 or 1964 CIE standard observer functions x_n , y_n and z_n (2 and 10 degree angles). The integral of these products over all the wavelengths in the visible spectrum (380 to 780 nm with a 5 nm interval) gives the tristimulus values.

Ordering Information

AvaSoft-COL	• Color application add-on software, to be ordered with AvaSoft-Full
AvaSoft-All	• Full version AvaSpec software (includes AvaSoft-COL, -IRRAD, -Raman and, -ThinFilm)

Color chart

The color chart display features:

- Display in CIELAB chart, the actual sample color as well as the reference color with the corresponding ΔE_{Lab} , ΔL^* , Δa^* , or Δb^* values are displayed and saved as well.
- The settings for the LAB chart display can be changed, such as no graphical display of reference and sample color in order to speed up the measurements.
- The standard observer angle is selectable for 2° or 10°.
- The reference color can be saved to and loaded from a color database. The database contains, apart from all color parameters, a product ID and a display of the actual color. The database can be sorted alphabetically or in either value column.

Time series

The time series display has following features:

- Display in time series can be selected for any number of channels.
- For each channel a color parameter (L*, a*, b*, hue, C, X, Y, Z, ΔE_{Lab} , ΔL^* , Δa^* , or Δb^*) can be selected. For each channel a different reference color can be selected, enabling color sorting.
- For each channel the time axis can be set to a different scale, allowing simultaneous display of long time and short term monitoring of the same parameter.
- For each channel the actual measured color, as well as the reference color (if in ΔE_{Lab} , ΔL^* , Δa^* , or Δb^* mode) is displayed.
- The saved time series data can be displayed with extensive zooming and dragging options.

AvaSoft - Irradiance

Avantes spectrometers measure radiated optical energy, which can be quantified as a radiant flux, in energy per second (Watt) radiated from a source. The radiated optical energy can also be correlated with human vision (photometry), as defined in the CIE, to obtain a spectral luminous efficiency function to characterize the vision of an average human observer.

An Avantes irradiance calibrated spectrometer system can measure both radiometric as well as photometric quantities. Radiometric quantities are radiant energy (in Joule), Radiant power or flux (in Watt) or irradiance (Watt per cm²). Related photometric quantities are luminous flux (lumen) or illuminance (lux or lumen per m²).

The measured spectral distribution is used to calculate the above-mentioned parameters. An intensity calibrated light source such as those in Avantes' factory calibration laboratory or our field calibration lamps, the AvaLight-HAL-CAL or AvaLight-DH-CAL, with known energy output (in $\mu\text{Watt}/\text{cm}^2/\text{nm}$) are used as a reference. Calibrations can be performed at Avantes' factory laboratory or in the field and stored on the EEPROM of the spectrometer (or an independent file) for future usage. AvaSoft-IRRAD Software is required for either type of calibration.

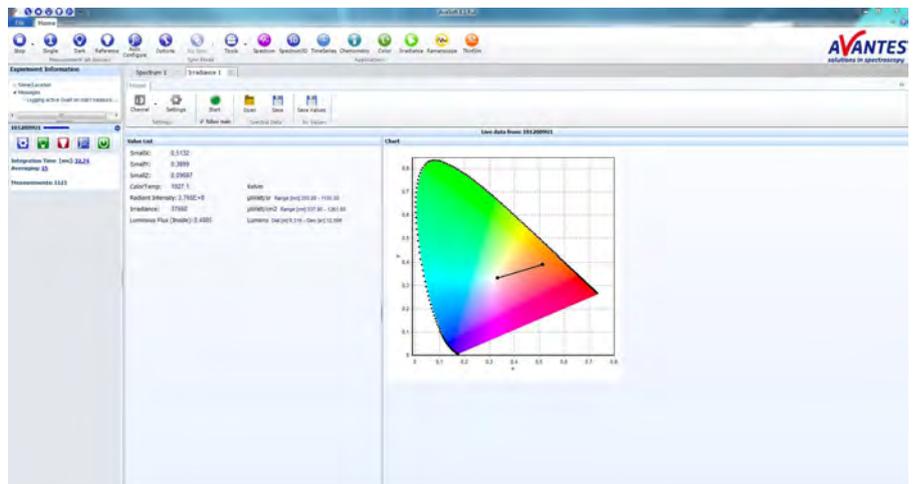
The color of light parameters can be expressed by the chromaticity coordinates x, y and z. These chromaticity coordinates are obtained by taking the ratios of the tristimulus values (X, Y and Z) to their sum. The tristimulus values X, Y and Z and the spectral irradiance are computed in a wavelength range from 380 nm to 780 nm, using a 1 nm interval. These parameters, as well as the coordinates u and v, and the color temperature of an external light source can be calculated and displayed in real-time in the AvaSoft-IRRAD module.

The CRI color-rendering index of a light source is also included in the AvaSoft IRRAD module. The color rendering index of a light source with a color temperature <5000K is a measure of how close a light source matches a perfect black body radiant. Additionally AvaSoft-IRRAD features a setting for auto-adjusting the integration time during a time sequence measure-

ment, so a large dynamic range can be achieved for applications that have both a very high light level and a very low light level, such as solar measurements.

AvaSoft-IRRAD enables two ways to display and save calculated output:

- Data can be displayed as spectral irradiance in $\mu\text{Watt}/\text{nm}$ versus wavelength. Additionally, the following output parameters can be displayed: radiometric quantities $\mu\text{Watt}/\text{cm}^2$, $\mu\text{Joule}/\text{cm}^2$, μWatt or μJoule , photometric quantities Lux or Lumen, color coordinates X, Y, Z, x, y, z, u, v, color rendering index and color temperature, and number of photons $\mu\text{Mol}/\text{s}\cdot\text{m}^2$, $\mu\text{Mol}/\text{m}^2$, $\mu\text{Mol}/\text{s}$ and μMol . The AvaSoft-IRRAD module also displays raw data in Scope mode as well as the X-Y Chromaticity diagram, including parameters, which are useful for LED measurements, such as: Dominant Wavelength, Purity, Central Wavelength, Peak Wavelength, Centroid, etc.
- In Time Measurement mode, any number of functions can be displayed simultaneously against time. For each function, a different radiometric, photometric, photon or color coordinate output parameter and/or wavelength range may be selected, as well as a different spectrometer channel.



Ordering Information

AvaSoft-IRRAD
AvaSoft-All
IRRAD-DLL

- Irradiance application add-on software, to be ordered with AvaSoft-Full
- Full version AvaSpec software (includes AvaSoft-COL, -IRRAD, -Raman and, -ThinFilm)
- 32-bit DLL for Irradiance/LED application

AvaSoft - Chemometry

The AvaSoft-CHEM module enables online concentration determination with a spectroscopy system. Lambert-Beer's law states there is a linear relationship between absorbance and concentration:

$$A = e * c * l$$

Where A is the absorbance (or extinction), e is the extinction coefficient of the compound to be measured, c is the concentration and l is the optical path length.

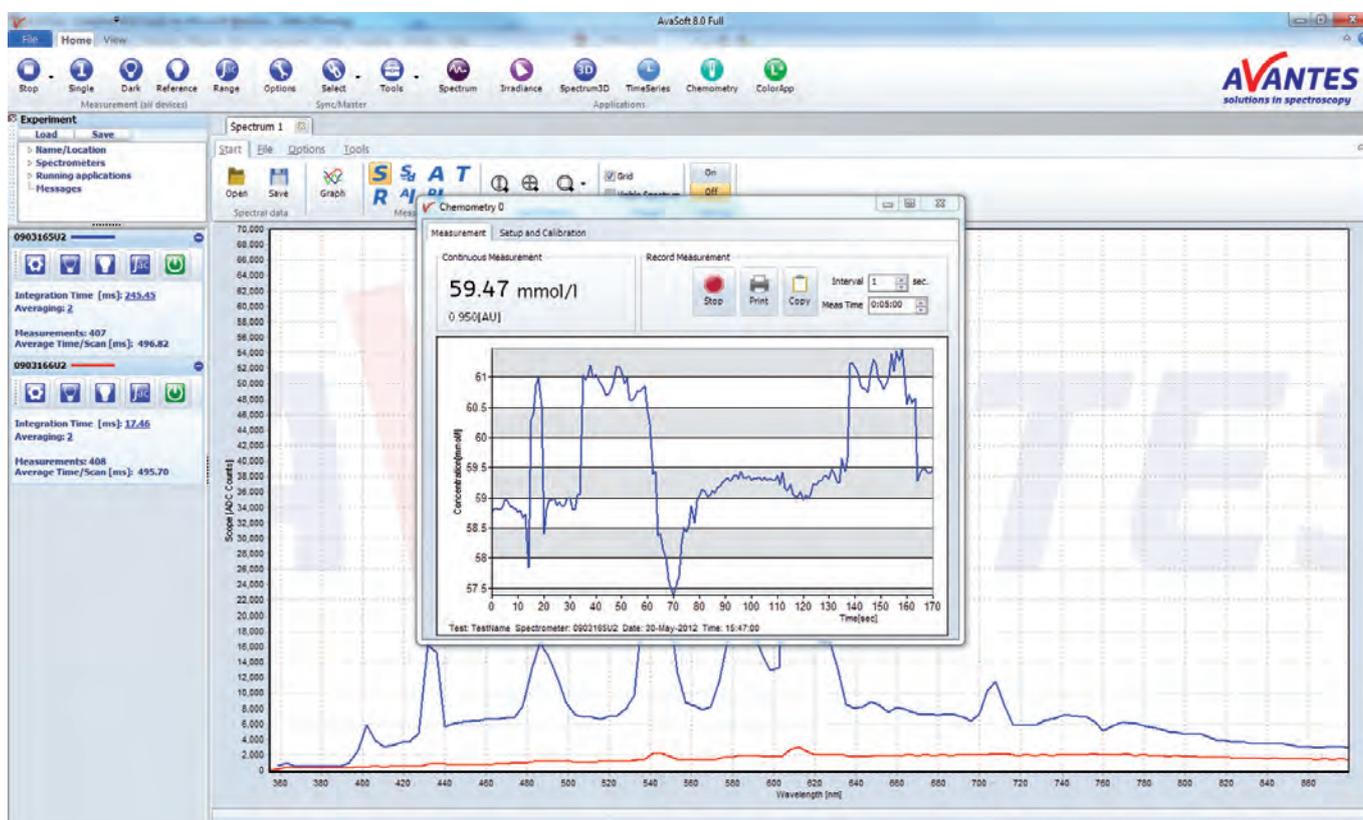
In practice this relation is only linear at reasonably low absorbance levels (less than 2 Au). To measure the absorbance, a few samples with known concentrations are needed. It is important to always measure the absorbance at the same wavelength and use more samples of different concentrations in order to provide a better chemometric model.

The absorbance values are used in AvaSoft-CHEM to create a linear (or second order - quadratic) calibration line. This calibration line is then used to measure the concentra-

tion of unknown samples or to measure the change in concentration over time.

AvaSoft-CHEM can display and save the calculated concentration in the following ways:

- Online display of concentration in a separate display window
- Up to eight history channel functions can be selected to display and save concentration values against time. This application can be combined with the Excel and Process-Control applications.



Ordering Information

AvaSoft-Full

- Chemometry application software for concentration measurements, included with AvaSoft-Full

Download the latest software for your AvaSpec series spectrometer at www.avantes.com

Raman Spectroscopy Software

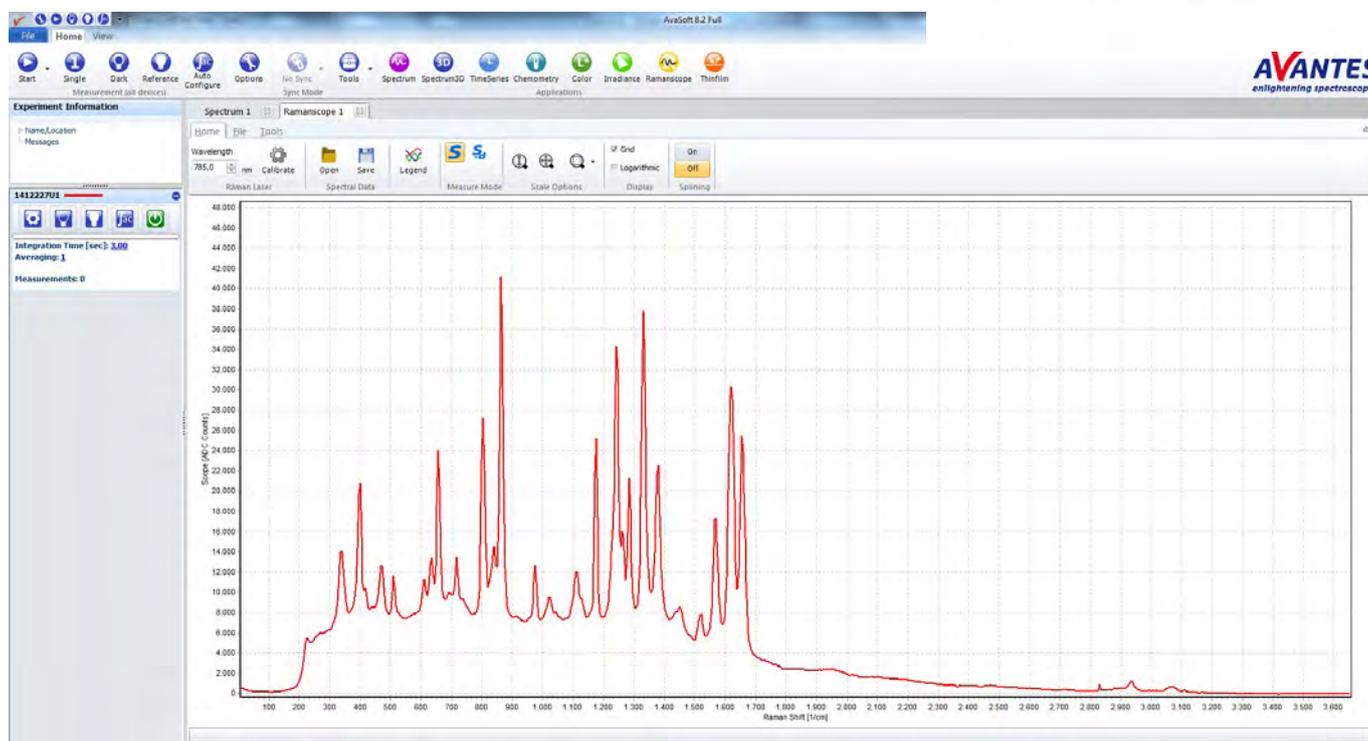
Included with the AvaRaman systems, AvaSoft-Raman enables full control over your Raman spectroscopy system.

In addition to most of the features available in AvaSoft-FULL, AvaSoft-Raman, which is a standalone application, also features:

- Display of the wavelength axis in cm^{-1}
- Auto calibration routines to determine the excitation laser peak (please note that an AvaRaman-Calibration tile is needed, sold separately)
- Integration time progress bar to indicate integration time status for longer spectral acquisitions
- View signal in normalized counts
- Software baseline correction for fluorescence suppression

AvaSoft-Raman also features history channel functions to monitor peak values or concentration versus time.

Process control and export to Excel add on modules are also available for online analyses and control.



Ordering Information

Avasoft-Raman

- Raman application add-on software, to be ordered with AvaSoft-Full

Avasoft-All

- Full version AvaSpec software (includes AvaSoft-COL, -IRRAD, -Raman and, -ThinFilm)

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

AvaSoft-ThinFilm

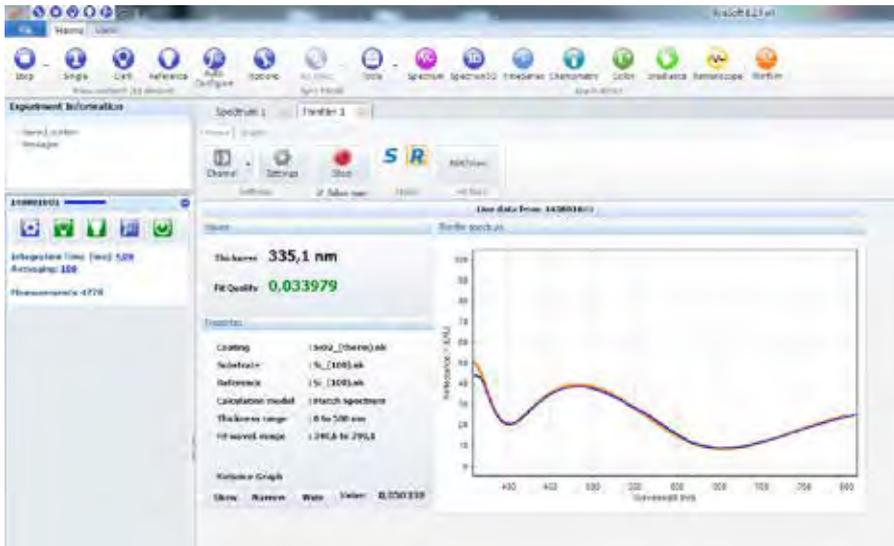
AvaSoft-ThinFilm software is a standalone package to control the system and conduct measurements on thin film coatings.

The software calculates a layer thickness from the reflection interference spectrum for optically transparent layers with known optical parameters. Two different methods for thin film calculations are implemented in the AvaSoft-ThinFilm software: the Fast Fourier Transform (FFT) and the best-fit

optimization algorithm (match spectrum). The FFT method determines the frequency of the interference pattern; this is mostly used for thick layers. The match spectrum optimization determines the best fit for various thickness calculations. Fitting parameters are adjustable for quality of fit monitoring and to speed up the data processing.

Included in the software is an extensive database of the optical constants “n” and “k” of substrates and coatings. The database includes substrate and coating materials used in important application fields, such as semiconductor and optical coatings.

Process-control and export to Excel add-ons modules are also available for AvaSoft-ThinFilm.



Ordering Information

AvaSoft-ThinFilm

• Thin film add-on software, to be ordered with AvaSoft-Full

AvaSoft-All

• Full version AvaSpec software (includes AvaSoft-COL, -IRRAD, -Raman and, -ThinFilm)

Panorama[®] Spectroscopy Software

Panorama[®] software is a sophisticated modular spectroscopy software application for demanding end users that require special analytical functions. The software enables manipulation of all 2D and 3D spectroscopic data with just a few mouse clicks. Manipulation operations can be undone and redone unlimited times with ease. Math operation history contains frequently used mathematical operations that are automatically stored and applied to subsequent data sets.

By adding the Security module all data manipulations are logged in an audit trail. This trail is attached to the manipulated object for full CFR 21 part 11 compliance. In the audit train window, changed control history of an object can be tracked. Software user permission levels may also be assigned.

The Panorama-Quantify module enables major multivariate analysis methods such as PLS-1, PLS-2, SIMPLS, MLR, PCA, PCR for sophisticated NIR spectroscopy analysis.

Some of the mathematical options included in the Panorama-Pro software are:

- ATR correct / multiplicative scatter corrections / standard normal variate correction
- Exponential functions
- Zapping / cutting
- Arithmetic calculation / spectrum arithmetic
- Noise statistics / user defined peak evaluation
- Detrending / stretch x-axis
- Data point manipulation
- Thickness correction / advanced two-point baseline correction
- Unit conversion for X- and Y-axis
- Converting of many known data formats
- Calculate polynomial fits

Available add-ons to Panorama-Pro are:

- A Search module, which includes a powerful library module that allows archiving and searching of spectroscopic data on libraries or on your own hard disk
- Reaction Monitoring module provides users with optimal support analyzing characteristic properties and features of spectroscopic data. This facilitates quantification and
- prediction of spectroscopic trends based on 2D and 3D data spectral.

Ordering Information

Panorama-Pro	• Spectroscopic Mathematic Data processing Software package, 2D/3D display
Panorama-Search	• Add-on to Panorama Pro, incl. library module & spectrum search module
Panorama-Quantify	• Add-on to Panorama Pro, incl. Multivariate Data Analysis with PLS, MLR
Panorama-Raman	• Add-on to Panorama Pro, incl. Raman Interpretation and functional group assignment
Panorama-Security	• Add-on to Panorama Pro, full 21 CFR part 11 compliance. Ideal for FDA/GXP regulated environments

Specline Analytical Software

To easily identify and analyze atoms, ions and molecules, Specline[®] analytical software offers an extensive database. It enables analysis of spectral data, imported directly from AvaSoft spectroscopy software along with other standard formats.

This unique database for atoms and molecules makes line identification fast and easy. To support you in analyzing and com-

paring the spectra, many evaluation functions are available including:

- Search algorithms for automatic peak finding in the spectra
- Identification of atoms, molecules and their ions using the included extensive database
- Data evaluation and smoothing, integral, scaling, peak value, calibration, arithmetic of spectra (+, -, *, /)
- Comparison of data: several spectra can be overlaid and compared, even when they have different file formats
- Search the periodic table for atoms and ions, wavelength and intensity range
- Data export to ASCII, binary and Excel (CSV) formats, graphical export to BMP, WMF and WPG formats

Ordering Information

AvaLIBS-Specline-A	• Spectroscopy software for peak finding and identifying spectral lines, complete version with database for atoms and ions
AvaLIBS-Specline-AM	• Spectroscopy software for peak finding and identifying spectral lines and molecular bands, complete version with data base for atoms, molecules and ions
AvaLIBS-Specline-AMS	• Spectroscopy software for peak finding and identifying spectral lines and molecular bands, complete version with data base for atoms, molecules, extended by many special molecules (e.g molecular hydrogen and polyatomic molecules)

Interface Packages and Libraries for Windows and Linux

AvaSpec-DLL Windows and Linux interface packages

Available in both Linux and Windows versions, the interface packages allow you to easily write custom software solutions for AvaSpec series spectrometers.

The Windows version, AvaSpec-DLL, is 32-bit software that works seamlessly under 64-bit versions of Windows in a mode called WoW64. The Windows version also includes a 64-bit version (AvaSpecx64.DLL) which can be used when a 64-bit programming environment is used.

The software can be used for the following actions:

- Establishing connections to one or more connected USB spectrometers, activation and deactivation.
- Setting and retrieving device hardware parameters from the spectrometer's EEPROM. This includes wavelength coefficients, gain and offset values and optional parameters that can be added. These include non-linearity calibration, irradiance calibration and others. Data collection parameters, such as integration time, averaging, smoothing and start/stop pixel can be stored to the EEPROM.
- Data acquisition and transferring of the spectra to your application
- Communicating with other devices by using TTL and/or analog output signals. The AvaSpec series spectrometers are equipped with a 26-pin digital I/O connector: 3 grounds, 1 digital-in (predefined for external hardware trigger), 3 programmable digital-in, 1 digital-out to control a pulsed light source (such as AvaLight-XE), 1 digital-out to synchronize a pulsed laser (e.g. for LIBS applications) and 10 programmable (TTL level with 6 outputs programmable with pulse width modulation – PWM) digital-out signals. 2 analog-out and 2 analog-in are included as well. The packages include options to control the TTLs of this external I/O connector. The hardware synchronization between the connected spectrometers can be software controlled. The packages also include a number of sample programs to give examples on how to write your programs. They are an excellent starting position.

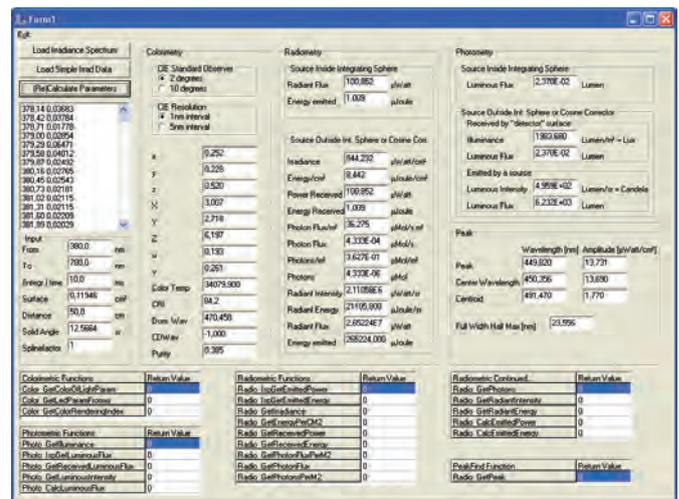
Example source codes in multiple languages are included. Please visit our website for the complete list. You can find them on the interface packages page in our software overview (www.avantes.com/products/software).

FOM-DLL Windows interface package for fiber-optic multiplexer

To facilitate writing custom software solutions for the fiber-optic multiplexer under Windows, the FOM-DLL has been developed. It runs under Windows and contains options to control the position of the multiplexer to one of the 16 positions, travel to the step motor's reference position and to request status information. Example source code in Visual C++, Delphi, C++ Builder and LabView demonstrate how to use the MUX-DLL is included in the package.

Irradiance-DLL

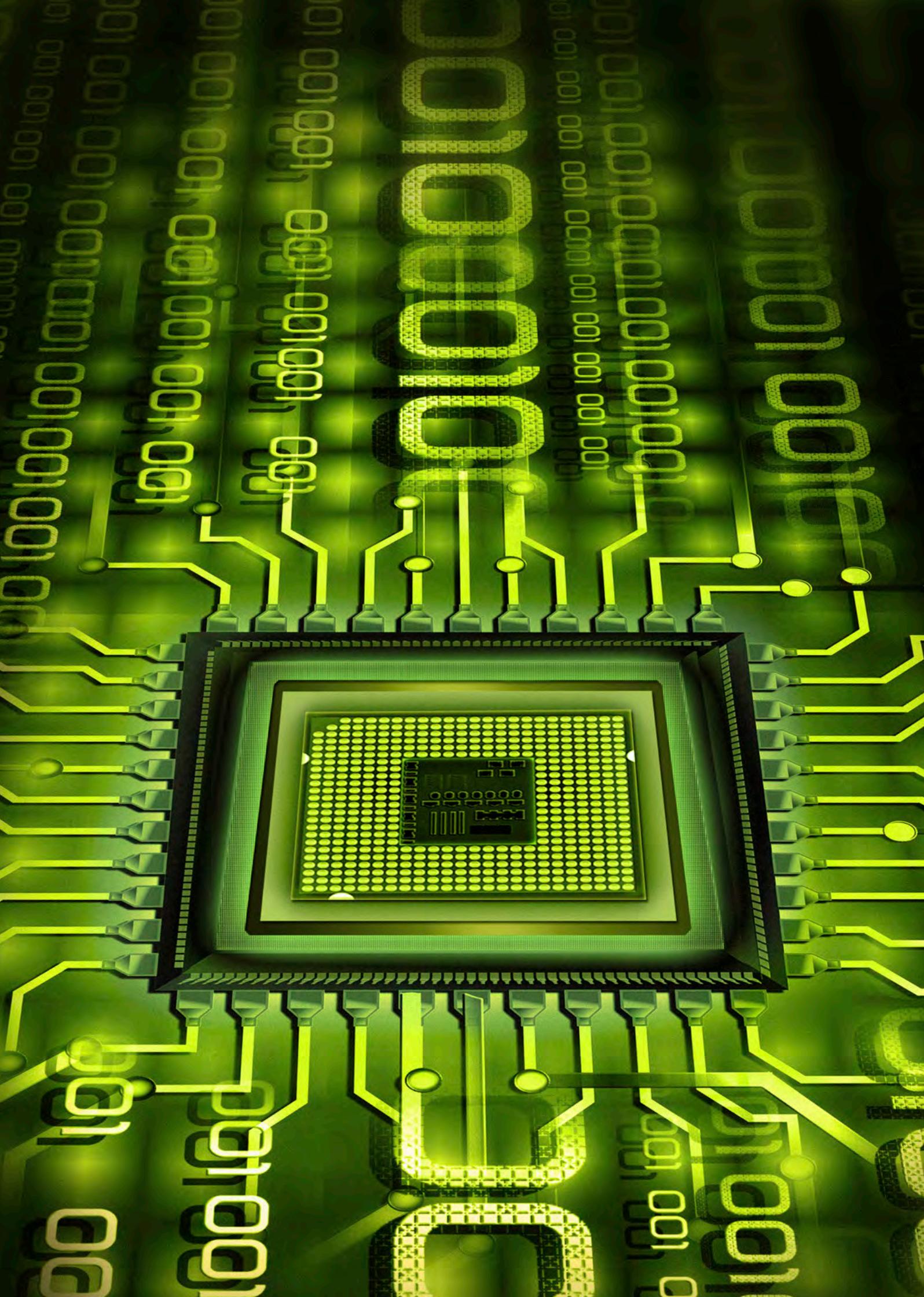
The Irradiance-DLL includes the possibility to calculate colorimetric, radiometric, photometric and peak parameters from an array of irradiance values ($\mu\text{W}/\text{nm}\cdot\text{cm}^2$) as well as the CRI. Example programs in C++ and Labview are included as well. It runs under Windows.



Ordering Information

AvaSpec-DLL	• Interface DLL package for AvaSpec-EVO platform for Windows
FOM-DLL	• Interface DLL package for Fiber-optic Multiplexer (FOM-UVIR400-1x16, FOM-UVIR400-4x4 and FOM-UVIR400-2x8) for Windows
IRRAD-DLL	• 32-bit DLL for Irradiance/LED application for Windows
LINUX-LIBRARY	• Linux interface package

We can also calibrate your AvaSpec series spectrometer



A person in silhouette is adjusting a light source on a rig against a sunset background. The scene is bathed in a warm, golden light from the setting sun, creating a silhouette effect on the person and the equipment. The person is standing on a platform, possibly a boat or a structure over water, and is reaching up to adjust a component of the rig. The rig consists of a vertical pole with various sensors and lights attached. The background shows a vast expanse of water and a clear sky with the sun low on the horizon. The overall mood is professional and technical, emphasizing the use of light sources in scientific or industrial applications.

Light Sources

INTRODUCTION

For applications such as transmission, absorption and reflection, illumination sources are needed. Avantes offers a wide range of different light sources, to suit your specific needs. An overview of the different options can be found on this page.

Tungsten Halogen light sources are mostly used to do measurements in the visible and NIR range. AvaLight Halogen sources provide a very stable output combined with long bulb lifetime. The high-stability enables their use in reflection and transmission configurations or as an irradiance calibration light source. Most importantly, the Halogen light's spectral output is a smooth black body curve which provides for maximized dynamic range.

Avantes Deuterium light sources are known for their stable output and are used for UV absorption or reflection measurements. These can also be used as irradiance calibration sources due to their high-stability. The standard AvaLight-DH-S mixes the Halogen light with the Deuterium light, thus producing a wide spectral range light source. The output spectrum of Deuterium light sources exhibits several peaks, with a prominent peak at 656 nm. The AvaLight-DH-S-BAL incorporates a dichroic beam splitter installed to minimize these peaks, providing a smooth spectrum from 200-2500 nm.

Our pulsed Xenon light source is used in applications where a long lifetime and high output power is needed, such as in fluorescence measurements. This is an affordable UV source, but the spectral output is not as smooth and continuous as the AvaLight Halogen and Deuterium light sources. LED light sources provide high power at a precise wavelength. A typical application for AvaLight-LED sources is fluorescence. They provide long lifetime, short warm-up time and high-stability.

For wavelength calibration Avantes offers a variety of sources including Argon, Mercury-Argon, Neon, Zinc and Cadmium. All Avantes spectrometers are factory wavelength calibrated and do not require recalibration as they have fixed slits and optics. For those customers who wish to do their own calibrations, the AvaLight-CAL light sources can be used for recalibration purposes. For auto-calibration AvaSoft-Full provides a calibration procedure to make this easy.

Table 8 Overview light sources

	Wavelength Range	Type	Principle	Product
Color / VIS / NIR	360-2500 nm	Tungsten Halogen	Continuous	AvaLight-HAL-S-MINI
DUV	190-400 nm	Deuterium	Continuous	AvaLight-D-S-DUV
UV	215-400 nm	Deuterium	Continuous	AvaLight-D-S
UV/VIS/NIR refl./abs	215-2500 nm	Deuterium/Halogen	Continuous	AvaLight-DH-S(-BAL)
UV/VIS/NIR absorption	200-2500 nm	Deuterium/Halogen	Continuous	AvaLight-DHc
UV/VIS	200-1000 nm	Xenon	Pulsed	AvaLight-XE(-HP)
Fluorescence	Multiple possible	LED	Continuous	AvaLight-LED
Wavelength Calibration	253-1704 nm	Mercury-Argon Neon / Argon	Continuous	AvaLight-CAL-MINI
	200-700 nm	Zinc/Cadmium	Continuous	AvaLight-CAL-CAD/Zinc
Irradiance Calibration	360-2500 nm	Tungsten Halogen	Continuous	AvaLight-HAL-CAL-MINI
	200-1100 nm	Deuterium/Halogen	Continuous	AvaLight-DH(-BAL)-CAL

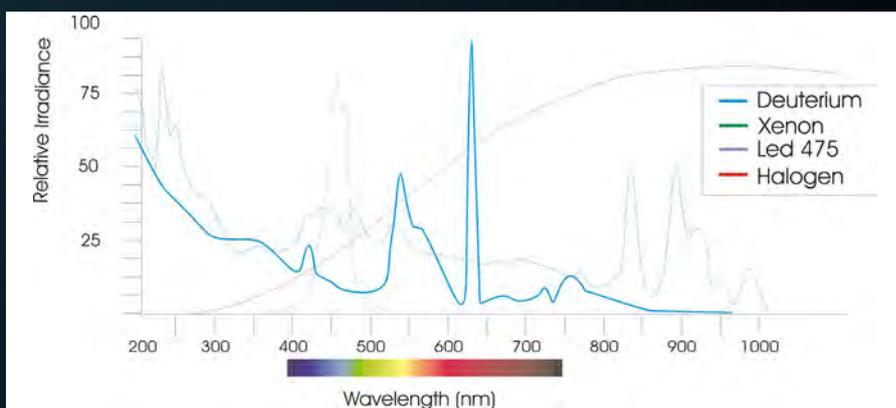


Figure 7 spectral distribution of different Light Sources

AvaLight-DHc Full-range Compact Light Source

AvaLight-DHc



Get the best out of two worlds with the AvaLight-DHc. It has both a deuterium light source and a halogen light source, providing you with adequate light between 200 and 2500 nm for nearly all absorbance chemistry applications. Deuterium emits light between 200 and 550 nm, where the halogen takes over up to 2500 nm. Coupling this lightsource to the rest of your spectroscopy system is easy with the SMA connector.

Optionally the AvaLight-DHc is available in a rack-mountable version, to be used in the 19" rack or the 9.5" desktop system.

- Combined Deuterium-Halogen
- Integrated TTL-shutter

A direct-attach cuvette holder CUV-DA (see section accessories) is available for fluorescence or absorbance measurements.

This light source is recommended in settings with large fiber cables or direct-attachment to a cuvette holder such as the CUV-DA, due to its relatively low output energy. The integrated TTL-shutter makes saving a dark measurement very simple in combination with AvaSoft (extra IC-DB26-2 needed).

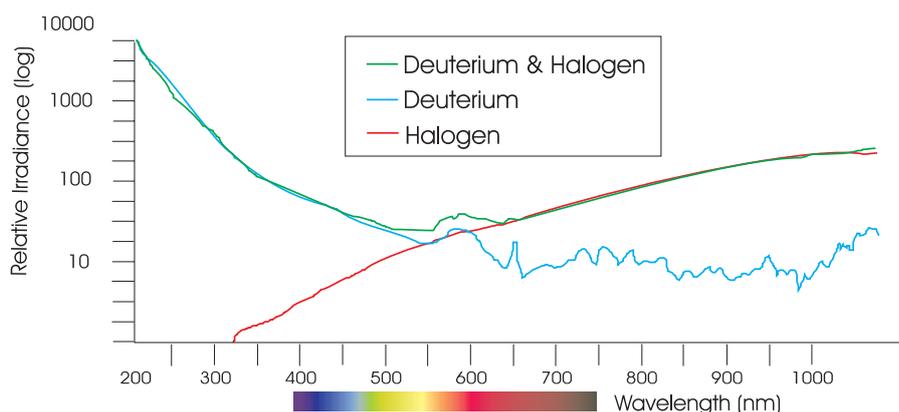


Figure 8 Spectral output of AvaLight-DHc

Technical Data

	Deuterium Light Source	Halogen Light Source
Wavelength Range	200 - 400 nm	400 - 2500 nm
Stability	< 1 mAU	< 1 mAU
Warm-up time	8 min	1 min
Drift	< 0.25% / h	< 0.25% / h
Optical Power in 600 μm fiber	0.2 μ Watt	7 μ Watt
Lamp Lifetime	1000 hours	2000 hours
Temp. Range	5°C - 35°C	
Power Supply	12VDC / 450 mA	
Dimensions, weight	175 x 110 x 44 mm, 570 g	
Lifetime shutter	1.000.000 cycles (typical)	

Ordering Information

AvaLight-DHc	• Compact Deuterium Halogen Light Source with TTL Shutter
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-DHc-TTL-shutter
AvaLight-DHc-RM	• Rackmount Compact Deuterium Halogen Light Source with TTL Shutter
AvaLight-DHc-B	• Compact Deuterium Halogen Replacement Bulb
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A for AvaLight-DHc



Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

AvaLight-HAL-S-MINI Tungsten-Halogen Light Source

AvaLight-HAL-S-MINI



From visible light to near infrared, that's where the AvaLight-HAL-S-Mini works best. It's a compact, stabilized halogen light source, with adjustable focusing of the fiber connection, maximizing output power at the desired wavelength. The light source also has adjustable output power to provide extra power or longer bulb life.

A filter-slot mounted on the front of the AvaLight-HAL-S-Mini accepts 1" round or 2" x 2" square filters, to block specific ranges of wavelengths or instantly lower the intensity.

The adjustable focus on the AvaLight-HAL-S-Mini helps you get the most out of your light source: it makes sure all possible power is transmitted through your optical fiber. Bulb replacement is easy and can be done in a matter of minutes.

Optionally a combined direct-attach cuvette holder and attenuator is available (CUV-ATT-DA-HAL). for attenuation you can use the Inline Filterholder, FH-INLINE or the Inline attenuator, ATT-INL.

The optical output can be controlled through a dongle at the backside or from your spectrometer. At low setting the lamp has a color temperature of 2700K but provides over 13000 hours of lifetime. The standard or medium setting changes the color temperature to 2850K and provides 50% more power with a bulb lifetime of 4000 hours. The high power setting gives a color temperature of 3000K, double power compared to the long-life setting and gives you up to 1000 hours of lifetime.

The AvaLight-HAL-S-Mini features an internal TTL-shutter, controllable from your AvaSpec spectrometer. This gives you the ability to use the auto-save dark option in AvaSoft spectroscopy software.

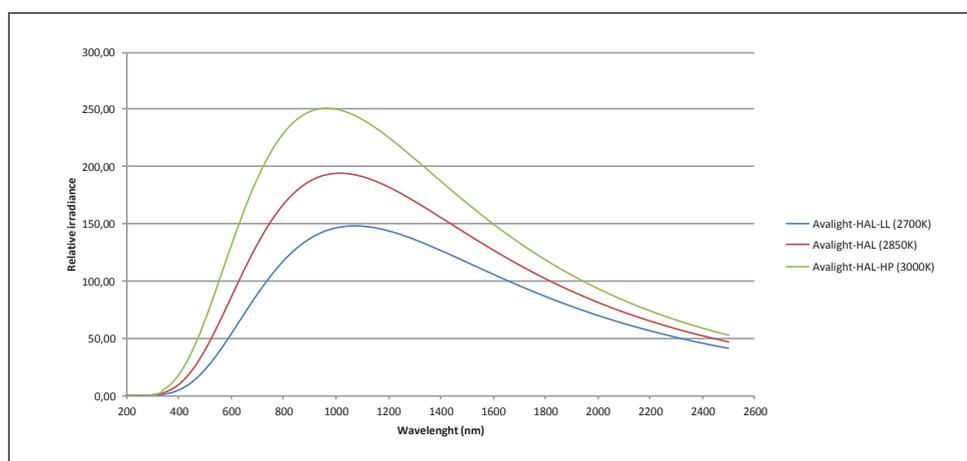


Figure 9 Spectral output of AvaLight-HAL-Mini

Technical Data

	AvaLight-HAL-S-Mini (standard)	AvaLight-HAL-S-Mini (long life)	AvaLight-HAL-S-Mini (high power)
Wavelength Range	360-2500 nm		
Stability	± 0.1%/ °C		
Time to stabilize	Ca. 10 min.		
Output to bulb	12.0 VDC/ 0.83A	11.3 VDC/ 0.8A	14.1 VDC/ 1.0A
Bulb Life	4000 hrs	> 13000 hrs	< 1000 hrs
Min. Optical power* 200 µm fiber	0.5 mWatt	0.35 mWatt	0.7 mWatt
Min. Optical power* 600 µm fiber	4.5 mWatt	3.2 mWatt	6 mWatt
Min. Optical power* 1000 µm fiber	10 mWatt	7 mWatt	14 mWatt
Bulb Color Temperature	2,850 K	2,730 K	3,000 K
Power requirement	12 VDC / 2.08A		
Temperature range	0-55 °C		
Dimensions, weight	150 x 78 x 37 mm, 510 grams		
Lifetime shutter	1,000,000 cycles (typical)		

* Optical power measured from 350-1100nm

Separate Filters

GL-WG305-3	Separate 50 x 50 x 3 mm long-pass filter > 305 nm
GL-KG3-3	Separate 50 x 50 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-3	Separate 50 x 50 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG395-3	Separate 50 x 50 x 3 mm long-pass filter > 395 nm
GL-GG475-3	Separate 50 x 50 x 3 mm long-pass filter > 475 nm
GL-OG515-3	Separate 50 x 50 x 3 mm long-pass filter > 515 nm
GL-OG550-3	Separate 50 x 50 x 3 mm long-pass filter > 550 nm
GL-NG9-1	Separate 50 x 50 x 1 mm Neutral Density filter (transmission 10%, 400-1100 nm)
GL-NG9-2	Separate 50 x 50 x 2 mm Neutral Density filter (transmission 1%, 400-1100 nm)
GL-NG9-3	Separate 50 x 50 x 3 mm Neutral Density filter (transmission 0.1%, 400-1100 nm)

More filter types available, please contact us for ordering information

Ordering Information

AvaLight-HAL-S-Mini	• 10W Tungsten Halogen lamp, fan cooled, incl. TTL shutter, needs extra PS-12V/2.08A power supply
AvaLight-HAL-S-RM	• Rack-mounted version of AvaLight-HAL-S-Mini
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-HAL-(S)-Mini for shutter and power setting
AvaLight-HAL-B-Mini	• 10W Tungsten Halogen Replacement bulb for AvaLight-HAL-(S)-Mini
PS-12V/2.08A	• Power supply 100-240VAC/12VDC, 2.08A, necessary for AvaLight-HAL-Mini
DONGLE-Mini-H	• Dongle for high power setting
DONGLE-Mini-L	• Dongle for long life setting

AvaLight-DH-S Deuterium-Halogen Light Source

AvaLight-DH-S



In need of more power than the AvaLight-DHc? The AvaLight-DH-S is Avantes' most powerful deuterium halogen source. Like the DHc it is also a combined deuterium and halogen light source, capable of transmitting light in the UV/VIS/NIR-range, but has 35 times more halogen output and up to 300 times more deuterium power. The source has a prominent 656 nm deuterium peak which can limit dynamic range (see AvaLight-DH-S-BAL as an alternative). It includes a focusing lens assembly, to fully utilize the possibilities and size of your fiber.

The AvaLight-D-S is a deuterium light source only, making it a great option for measurements in the UV range, 190-400 nm. The AvaLight-D-S-DUV version starts even lower at 175 nm, for your deep-UV experiments. This version also offers twice the intensity at 200nm.

The output of the AvaLight-DH-S is optimized for fibers or bundles up to 600 micrometers. For larger fibers the focal point is manually adjustable to optimize the light coupling into your fiber.

The AvaLight-D(H)-S features an integrated TTL-shutter and filter holder for filters of up to 50x50x5.0 mm.

- Combined Deuterium-Halogen
- UV-VIS-NIR
- Deep-UV optional
- Powerful

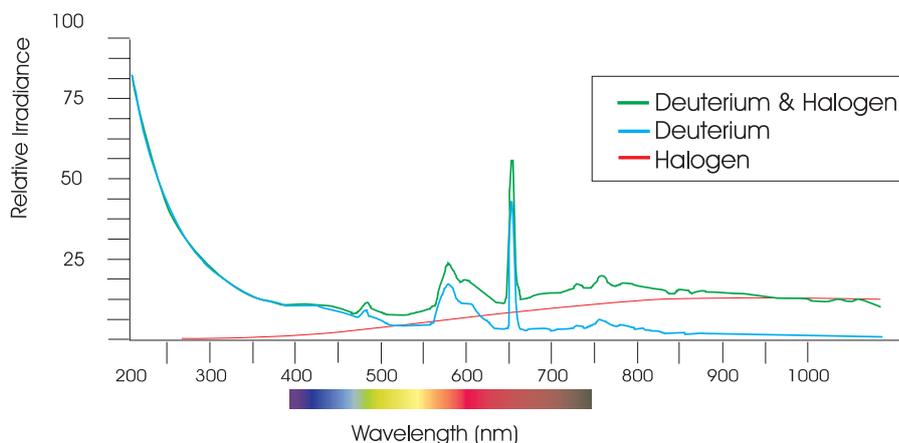


Figure 10 Spectral output AvaLight-DH-S

Technical Data

	Deuterium (Deep-UV) Long life	Deuterium (Standard) Long life	Halogen
Wavelength Range	175-400 nm	190-400 nm	360-2500 nm
Warm-up Time	30 min.		20 min.
Lamp Power	78W / 0.75A		5W /0.5A
Lamp Lifetime	2000 h		1000 h
Noise (AU)	2x 10 ⁻⁵		10 ⁻⁴
Max. drift	± 0.5%/h		±0.1%/h
Color Temperature	-	-	3000 K
Optical Power* in 200µm fiber	11 µW	11 µW	43 µW
Optical Power* in 600µm fiber	72 µW	72 µW	239 µW
Optical Power* in 1000µm fiber	206 µW	206 µW	354 µW
Power consumption	90 Watt (190Watt for heating D-Lamp 4-5 sec.)		
Power Requirements	100-240VAC 50/60 Hz		
Dimensions / Weight	315 x 165 x 140 mm / ca 5 kg.		
Lifetime shutter	1,000,000 cycles (typical)		

* total power for the specified wavelength range

For a table of separate 50x50 mm filters to install in AvaLight-D(H)-S see AvaLight-HAL.

Ordering Information

AvaLight-D-S	• Deuterium light source, 190-400 nm, incl. TTL shutter, -SR fibers needed
AvaLight-DH-S	• Deuterium-Halogen light source, 190-2500 nm, incl. TTL shutter, -SR fibers needed
AvaLight-D-S-DUV	• Deep-UV deuterium light source, 175-400 nm , TTL shutter, -SR fibers needed, 2000h
AvaLight-DH-S-DUV	• Deep-UV deuterium-halogen light source, 175-2500 nm , TTL shutter, -SR fibers needed
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-D(H)S-BAL
AvaLight-D-B	• Replacement deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-D-B-DUV	• Replacement deep-UV deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-DH-B	• Replacement halogen bulb for AvaLight-DH-BAL light source
CUV-DA-DHS	• Direct-attach cuvette holder for AvaLight-D(H)S-BAL

AvaLight-DH-S-BAL Balanced Power

AvaLight-DH-S-BAL



The AvaLight-DH-S is a powerful deuterium halogen source, but like any unbalanced deuterium halogen source it does have a very dominant alpha peak at 656 nm. This is why Avantes developed the DH-S-BAL, in which this peak is drastically reduced by a dichroic filter. This means less power, but an increase in the dynamic range of a factor 20. A comparison spectrum, which is taken with a standard AvaSpec-ULS2048CL, is shown on the next page.

The light source delivers a continuous spectrum with high efficiency. The highest stability is in the ultraviolet, visible and near infrared range, from 215 to 2500 nm. An integrated TTL-shutter and filter holder for filters of up to 50x50x5.0 mm are included. The TTL-shutter can be controlled from any AvaSpec spectrometer, which means the auto-save dark-option in AvaSoft software can be used (please note: IC-DB26-2 cable needed).

Connection to the fiber is done through an SMA-905 connector, which features an adjustable focusing lens assembly. This ensures you getting the maximum possible power into your fiber. For all deuterium light sources solarization resistant fibers are recommended. The output of the AvaLight-DH-S-BAL is optimized for fibers or bundles up to 600 μm .

The filter holder can be easily replaced by a direct-attach cuvette holder CUV-DA-DHS (see section accessories) useful for fluorescence or absorbance measurements.

- Balanced light source
- Wide spectrum: 215-2500 nm
- Integrated TTL shutter
- High efficiency
- Increased dynamic range

Technical Data

	Balanced Deuterium (Standard)	Balanced Halogen Lamp
Wavelength Range	215-500 nm	500-2500 nm
Warm-up Time	30 min.	20 min.
Lamp Power	78 W / 0.75 A	5 W / 0.5 A
Lamp Lifetime	2000 hrs	1000 hrs
Noise (AU)	2×10^{-5}	10^{-4}
Max. drift	$\pm 0.5\%/hr$	$\pm 0.1\%/hr$
Color Temperature	-	3000 K
Optical Power in 200 μm fiber	6 μW	17 μW
Optical Power in 600 μm fiber	33 μW	160 μW
Optical Power in 1000 μm fiber	90 μW	448 μW
Power consumption	90 Watt (190 Watt for heating D-Lamp 4-5 sec.)	
Power Requirements	100-240VAC 50/60 Hz	
Dimensions / Weight	315 x 165 x 140 mm / ca 5 kg.	
Lifetime shutter	1,000,000 cycles (typical)	

For a table of separate 50x50 mm filters to install in AvaLight-D(H)-S see AvaLight-HAL.

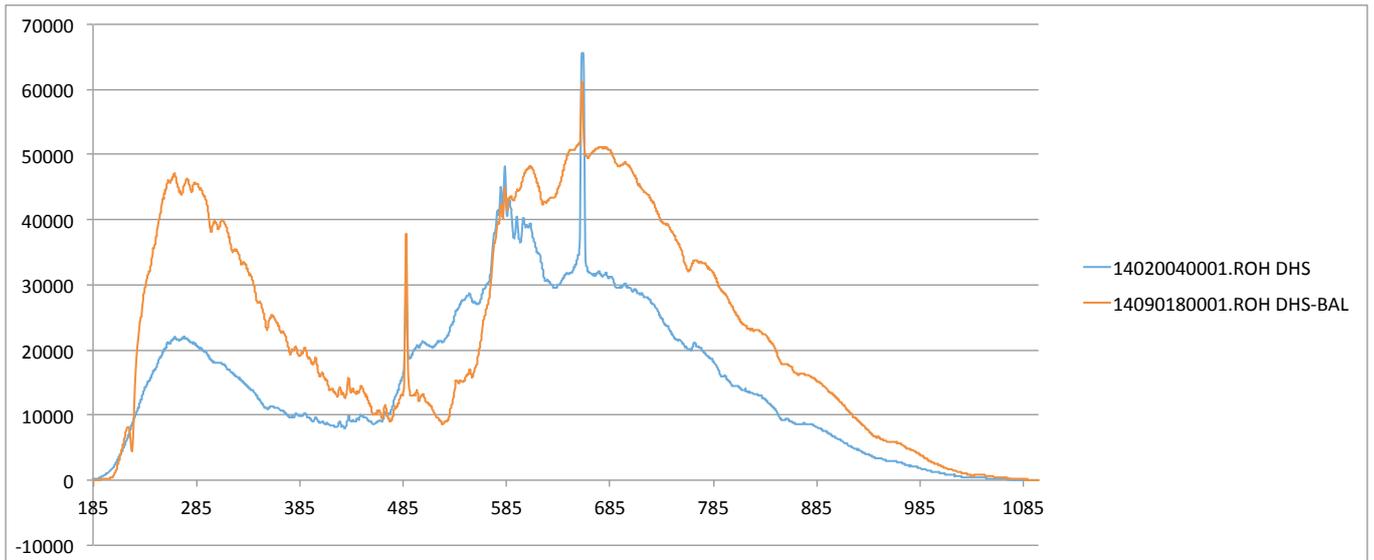


Figure 11 Spectral output AvaLight-DH-S-BAL (red) vs. AvaLight-DH-S (blue). (RAW data)

Ordering Information

AvaLight-D-S-BAL	• Balanced Deuterium light source, 215-500nm, incl. TTL shutter, -SR fibers needed
AvaLight-DH-S-BAL	• Balanced Deuterium-Halogen light source, 215-2500 nm, incl. TTL shutter, -SR fibers needed
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-D(H)S-BAL
AvaLight-D-B	• Replacement deuterium bulb for AvaLight-D/AvaLight DH-BAL light source
AvaLight-DH-B	• Replacement halogen bulb for AvaLight-DH-BAL light source
CUV-DA-DHS	• Direct-attach cuvette holder for AvaLight-D(H)S-BAL

Add flexibility
to your spectrometer with
the Replaceable Slit (-RS) option

AvaLight-XE Pulsed Xenon

AvaLight-XE



Perfect for ultraviolet applications like fluorescence, the AvaLight-XE is a pulsed xenon light source. When connected to your AvaSpec spectrometer through the IC-DB26-2 cable (sold separately), the flashes are synchronized with the data collected by the spectrometer. In AvaSoft the number of flashes per scan can be selected.

With a special DUV bulb the AvaLight-XE can be used for deep ultraviolet application (below 200 nm). A special direct-attach cuvette holder is available for your fluorescence applications. For transmission measurements, the AvaLight-XE can be used in conjunction with the CUV-ATT-DA which has an iris attenuator to limit the light output and to avoid saturation.

- Pulsed light source
- Perfect for fluorescence
- Cuvette holder available
- Long lifetime

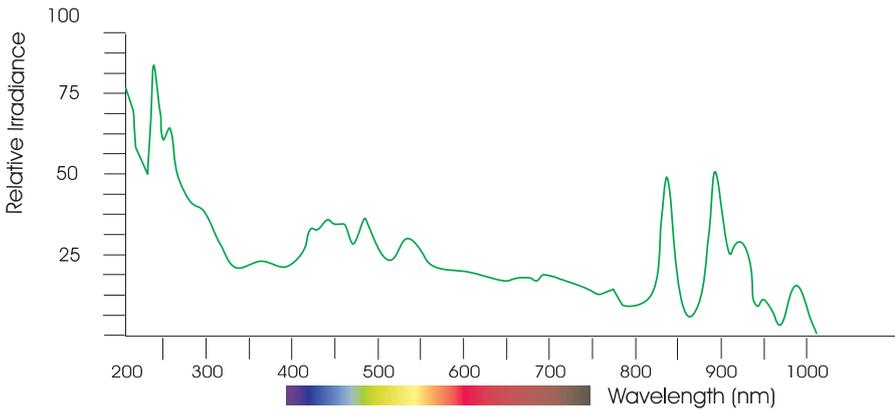


Figure 12 Spectral output of the AvaLight-XE

Technical Data

Spectral Output	200 nm to 1000 nm
Total Optical Power output	39 μ J per pulse (average 66 mW)
Optical Power in 200 μm fiber	0.66 μ J per pulse (average 20 μ W)
Optical Power in 600 μm fiber	3.2 μ J per pulse (average 320 μ W)
Optical Power in 1000 μm fiber	7.4 μ J per pulse (average 744 μ W)
Synchronization Input	15 pin sub-D connector, TTL level
Pulse Duration	5 μ s (at 1/3 height)
Pulse delay	6 μ s
Pulse rate (max.)	100 Hz
Bulb Life	min. 10 ⁹ pulses
Connector	SMA-905 connector
Power requirement	12 VDC/550 mA
Dimensions, weight	175 x 110 x 44 mm, 540 grams

Ordering Information

AvaLight-XE	• Xenon Light Source (200-1000 nm), needs interface cable and power supply
AvaLight-XE-DUV	• DUV (160-1000 nm) version of the AvaLight-XE, needs interface cable and power supply
AvaLight-XE-B	• Spare bulb for the AvaLight-XE (200-1000 nm)
AvaLight-XE-B-DUV	• Spare bulb for the AvaLight-XE-DUV (160-1000 nm)
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-XE
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
ATT-DA	• Direct-attach attenuator for AvaLight-DHc/XE/LED
CUV-ATT-DA	• Direct-attach cuvette holder and attenuator for AvaLight-DHc/XE/LED
PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A for AvaLight-XE

AvaLight-XE High Power Pulsed Xenon

Perfect for ultraviolet applications like fluorescence, the AvaLight-XE-HP is a pulsed xenon light source. When connected to your AvaSpec spectrometer through the Y-cable, the flashes are synchronized with the data collected by the spectrometer. In AvaSoft the number of flashes per scan can be selected.

Compared to the AvaLight-XE (2W), the XE-HP can provide significant more power. The AvaLight-XE-HP comes in a compact housing and is ideal for OEM integration.

AvaLight-XE-HP



Technical Data

Spectral Output	200 nm to 1000 nm
Total Optical Power output	max 6W / 39mJ per flash
Synchronization Input	9 pin sub-D connector, TTL level
Pulse rate (max.)	150 Hz
Long Life	1,0 x 10 ⁹ flashes
Connector	SMA-905 connector
Power requirement	11 -28 VDC/2.08A
Dimensions, weight	98 x 44 x 35 mm, 192 grams

Ordering Information

AvaLight-XE-HP	<ul style="list-style-type: none">• 6W Xenon Light Source (200-1000 nm), with Y-cable for power and trigger connection. Needs extra PS-12V/2.08A power supply
PS-12V/2.08A	<ul style="list-style-type: none">• Power supply 100-240VAC/12VDC, 2.08A for AvaLight-XE-HP

AvaLight-HAL-CAL-Mini and AvaLight-DH-CAL Calibrated Light Sources

AvaLight-HAL-CAL-Mini



Calibrating your spectrometer has never been easier: the AvaLight-HAL-CAL-Mini and Avalight-DH-CAL are NIST traceable calibrated light sources which measure absolute spectral intensity.

The AvaLight-HAL-CAL-Mini is a compact, affordable light source. It is calibrated for the visible range (350-1095 nm). Optionally, an extended calibration for the near-infrared spectral range (1100-2500 nm) can be ordered. It has a built-in diffuser, a cosine corrector with SMA adapter and comes with a calibration file in ASCII format. Calibration can be done using the AvaSoft software.

The AvaLight-HAL-CAL-ISPxx-Mini is a special version of the Avalight-HAL-CAL-Mini, which enables coupling any of Avantes' AvaSphere-xx-IRRAD integrating spheres to the lightsource (xx=30, 50 or 80) for calibration. This source is supplied with a special bottom plate to stabilize the AvaSphere. The Avalight-HAL-CAL-Mini and Avalight-HAL-CAL-ISPxx-Mini include a power supply.

- Field calibration
- Visible and optional NIR range
- Built-in diffuser
- Versatile

AvaLight-DH-CAL



For calibrations in the ultraviolet and visible range (200-1099 nm), the AvaLight-DH-CAL is the best solution. This source can be used with all AvaSpec spectrometers to calibrate for absolute spectral intensity. It is supplied with a built-in diffuser, a cosine corrector (CC-VIS/NIR) with SMA adapter and the calibration files in ASCII format.

Two calibration files are included: one for irradiance calibration over the full range (200-1099 nm) and one over the visible and near infrared range (350-1099 nm). For the first file, both the deuterium and the halogen bulb should be used during calibration. The second file is to be used with only the halogen light. The halogen only spectrum provides a smoother black body calibration spectrum for the longer wavelengths.

For a more balanced spectrum across the 200-1100 nm range, Avantes offers the AvaLight-DH-BAL-CAL. For ultraviolet range calibration only (200-400 nm), the AvaLight-D-CAL is the right choice.

The calibration files can be imported in the AvaSoft-IRRAD application software, for intensity calibration which turns your spectrometer into a spectroradiometer.

The AvaLight-DH-CAL-ISPxx is a special version of these calibrated light sources, meant to facilitate coupling of the AvaSphere-xx-IRRAD integrating spheres to the light source. (xx is 30, 50 or 80).

- Flexible calibration
- Ultraviolet and visible range
- Built-in diffuser and cosine corrector

Technical Data

	AvaLight-HAL-CAL-Mini	AvaLight-DH-(BAL)-CAL
Calibration use	Irradiance $\mu\text{W cm}^{-2} \text{ nm}^{-1}$	Irradiance $\mu\text{W cm}^{-2} \text{ nm}^{-1}$
Calibrated surface	CC-VIS/NIR or AvaSphere	CC-VIS/NIR or AvaSphere
Wavelength Range	350-1095 nm / 1100-2500 nm*	200-1099 nm
Calibration Repeatability	$\pm 0.5 \%$	$\pm 1.0\%$
Calibration Relative Uncertainty to NIST standard	$\pm 5.0\%$ (350-1100 nm) $\pm 3.5\%$ (1100-1950 nm) $\pm 5.0\%$ (1950-2500 nm)	$\pm 10\%$ (200-240 nm) $\pm 9\%$ (240-350 nm) $\pm 10\%$ (350-400 nm) $\pm 9.5\%$ (400-1100 nm)
Calibration valid for	60 hrs	60 hrs
Warm-up Time	Ca. 15 min.	Ca. 30 min.
Bulb Output	$170 \mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@800 nm)	$80 \mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@215 nm) $5 \mu\text{W cm}^{-2} \text{ nm}^{-1}$ (@800 nm)
Power requirement	12 V / 2.08A	100-240 VAC
Dimensions	150 x 78 x 37 mm	315 x 165 x 140 mm

* optional extended range NIR calibration

Ordering Information

AvaLight-HAL-CAL-Mini	• NIST traceable Halogen Lamp with CC- VIS/NIR diffuser, incl. PS-12V/2.08A
AvaLight-HAL-CAL-ISP30-Mini	• NIST traceable Halogen Lamp for use with AvaSphere-30-IRRAD, incl. PS-12V/2.08A and special sphere holder bottom plate
AvaLight-HAL-CAL-ISP50-Mini	• As AvaLight-HAL-CAL-ISP30-Mini for use with AvaSphere-50-IRRAD
AvaLight-HAL-CAL-ISP80-Mini	• As AvaLight-HAL-CAL-ISP30-Mini for use with AvaSphere-80-IRRAD
HL-Recal	• AvaLight-HAL-CAL recalibration service 350-1095 nm
HL-Recal-NIR	• AvaLight-HAL-CAL extended or recalibration service 1100-2500 nm
AvaLight-D-CAL	• NIST traceable UV Deuterium Lamp with CC-VIS/NIR diffuser, -SR fibers recommended
AvaLight-DH-CAL	• NIST traceable UV/VIS Deuterium/Halogen Lamp with CC-VIS/NIR diffuser, -SR fibers recommended
AvaLight-DH-BAL-CAL	• As AvaLight-DH-CAL, but balanced UV/VIS Deuterium/Halogen
AvaLight-DH-CAL-ISP30	• NIST traceable UV/VIS Deuterium/Halogen Lamp for use with AvaSphere-30-IRRAD, incl. special sphere holder bottom plate, -SR fibers recommended
AvaLight-DH-CAL-ISP50	• As AvaLight-DH-CAL-ISP30 for use with AvaSphere-50-IRRAD
AvaLight-DH-CAL-ISP80	• As AvaLight-DH-CAL-ISP30 for use with AvaSphere-80-IRRAD
DH-Recal	• AvaLight-DH-CAL recalibration service 200-1099 nm
AvaSoft-IRRAD	• Irradiance add-on software, to be ordered with AvaSoft-Full

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

AvaLight-CAL Spectral Calibration Source

AvaLight-CAL-Mini



The AvaLight-CAL-xxx is a spectral calibration lamp. It's available in Mercury-Argon (253.6-922.5 nm), Neon (337-1084.5 nm), Argon (696.5-1704 nm) Zinc (202.5-636.2 nm) and Cadmium (214.4-643.8 nm) versions. The major lines including their relative intensity and structures are shown below.

The standard SMA-905 connector supplies an easy connection between the lamp and optical fibers, making the AvaLight-CAL-xxx a low cost wavelength calibration system for any fiber-optic spectrometer. AvaSoft-Full spectroscopy software includes an automatic recalibration procedure.

The AvaLight-CAL-Mini, AvaLight-CAL-AR-Mini, AvaLight-CAL-Neon-Mini all come in the Mini-housing. They are equipped with a connector at the rear enabling to switch the unit on/off remotely with a TTL signal.

The AvaLight-CAL can also be delivered in rack-mountable version, to be integrated in Avantes 19" Rack-mount or the 9.5" desk-top housing. The PS-12V/1.0A power supply should be ordered separately.

- Calibration light source
- Available in a variety of wavelength ranges (UV to NIR)

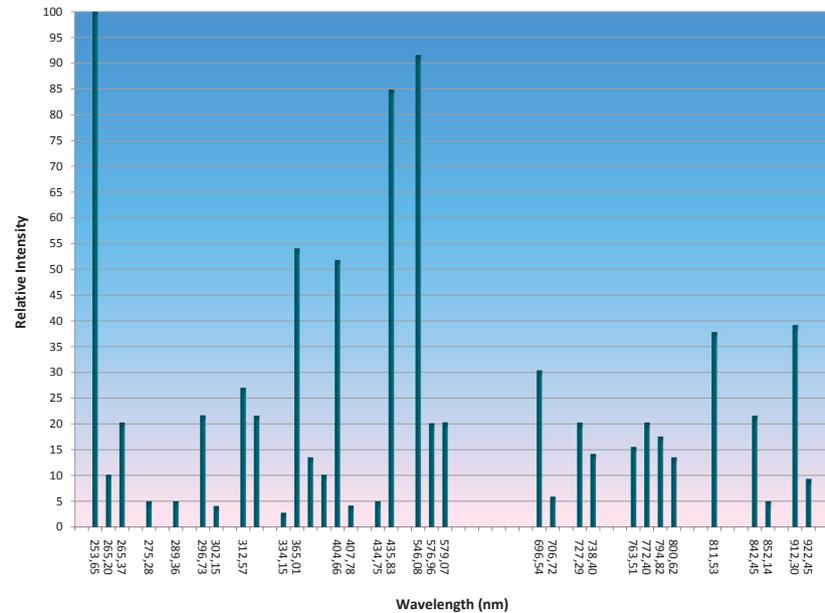


Figure 14 Spectral lines AvaLight-CAL-Mini

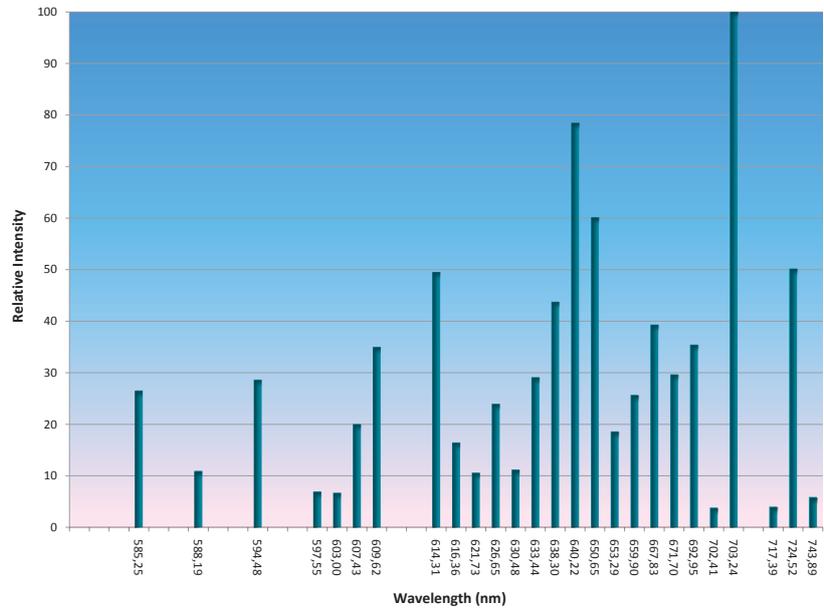


Figure 15 Spectral lines AvaLight-CAL-Neon-Mini

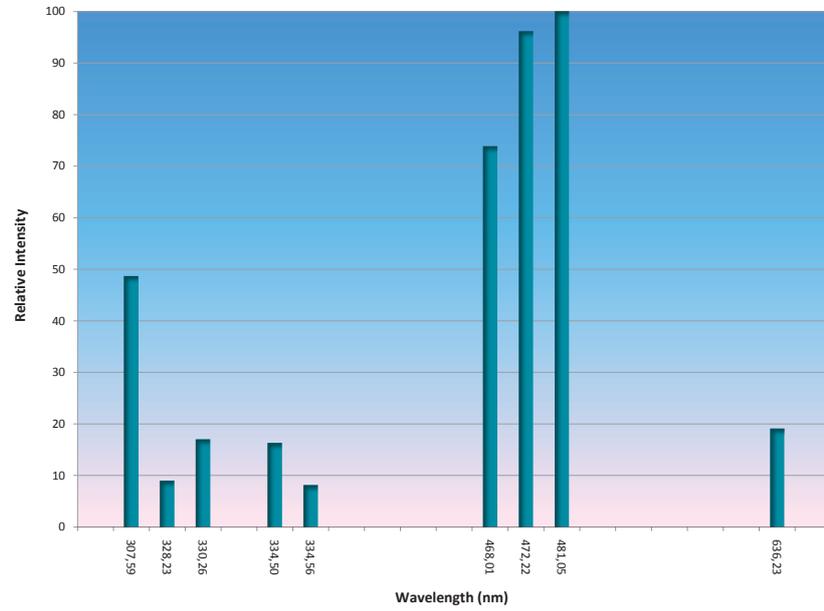


Figure 16 Spectral lines AvaLight-CAL-Zinc

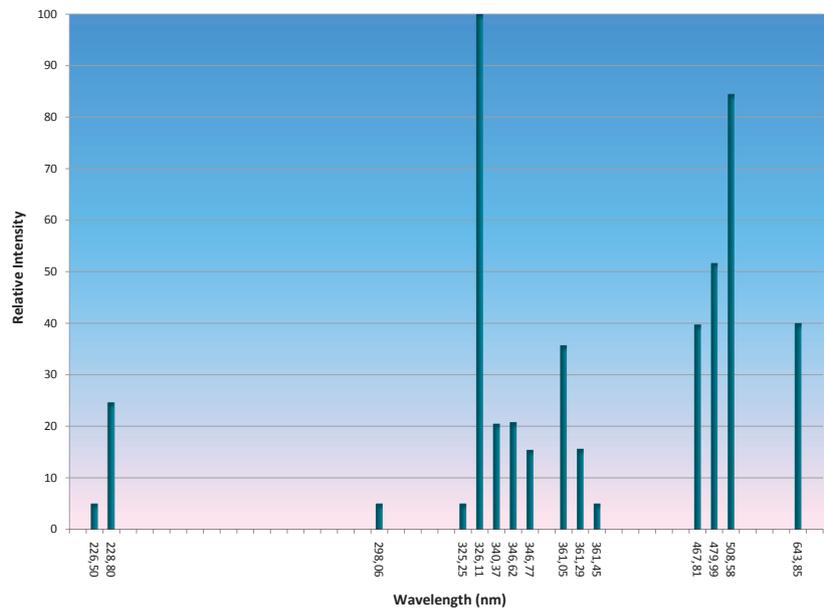
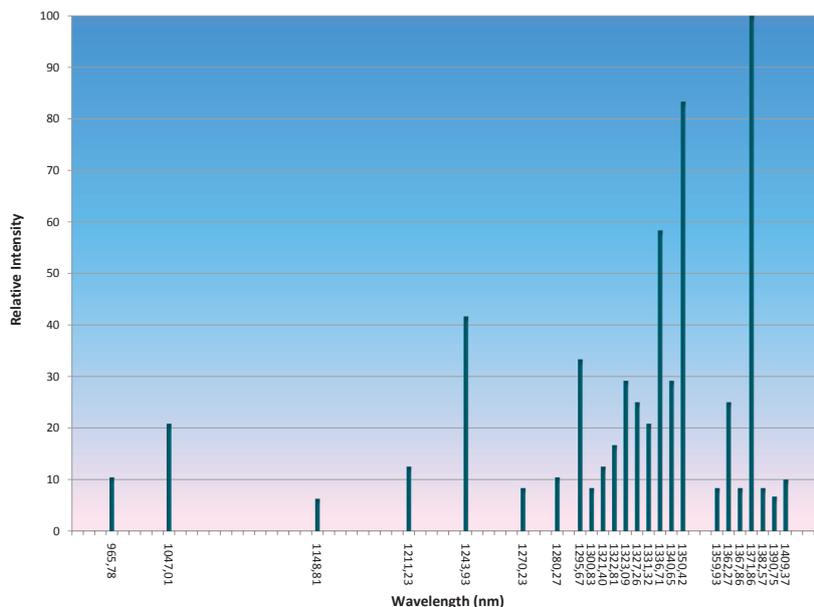


Figure 17 Spectral lines AvaLight-CAL-CAD



AvaLight-HPLED High-power Light Sources for Fluorescence Applications

The AvaLight-HPLED is a compact, affordable LED light source meant for fluorescence applications. This high-power version was made for more demanding applications compared to our regular LED light source.

The AvaLight-HPLED light sources produce continuous or pulsed spectral output at different wavelengths. All sources have an SMA-905 connector to connect fiber optics and come with a 5V/1.6A power supply.

This high-power LED light source can be used as a DC source or pulsed with a programmable Pulse Width Modulation (PWM), supplied by an AvaSpec-USB2 or EVO spectrometer (IC-DB26-2 cable needed).

Benefits of the AvaLight-HPLED:

- Compact
- High power levels
- Fluorescence excitation
- Several excitation wavelengths

AvaLight-HPLED



Technical Data for AvaLight-HPLED

	AvaLight-HPLED-385	AvaLight-HPLED-405	AvaLight-HPLED-470	AvaLight-HPLED-530	AvaLight-HPLED-625	AvaLight-HPLED-White
Peak wavelength	385 nm	405 nm	470 nm	530 nm	625 nm	N.A.
FWHM (nm)	15 nm	15 nm	25 nm	35 nm	25 nm	N.A.
Optical power 600 μm fiber	3.4 mWatt					
Connector	SMA-905					
Power supply	5V, 500 mA					
Dimensions, weight	150 x 78 x 37 mm, 420 grams					

Ordering Information

AvaLight-HPLED-XXX

- High-power light-emitting diode light source, specify wavelength XXX = 385, 405, 470, 530, 625, White. Includes 5V/1.6A power supply

IC-DB26-2

- Interface cable AvaSpec-USB2/EVO platform to AvaLight-HPLED for PWM

AvaLight-LED Light Source for Fluorescence Applications

AvaLight-LED



The AvaLight-LED is a compact, low-cost light source meant for fluorescence applications. It produces continuous or pulsed spectral output at different wavelengths. Some standard excitation wavelengths are shown in the table on this page, but other wavelengths are available upon request. The sources have an SMA-905 connector to couple to fiber-optics. Please note that the power supply (PS-12V/1.0A) has to be ordered separately.

The AvaLight-LED can be used as a DC source or pulsed with a programmable Pulse Width Modulation (PWM), supplied by an AvaSpec-USB2 spectrometer (IC-DB26-2 cable needed).

The CUV-DA is a cuvette cell holder that has an integrated LED for direct illumination of the cell. This provides greater excitation energy for fluorophores with low quantum efficiency.

Other accessories include the CUV-FL and CUV-ALL cuvette holders and the FCR-UV fluorescence probes. They can be found in the accessories and fiber-optics chapters of this catalog. At the end of the catalog, an example fluorescence setup can be found.

- Fluorescence excitation
- Compact
- Flexible excitation wavelength

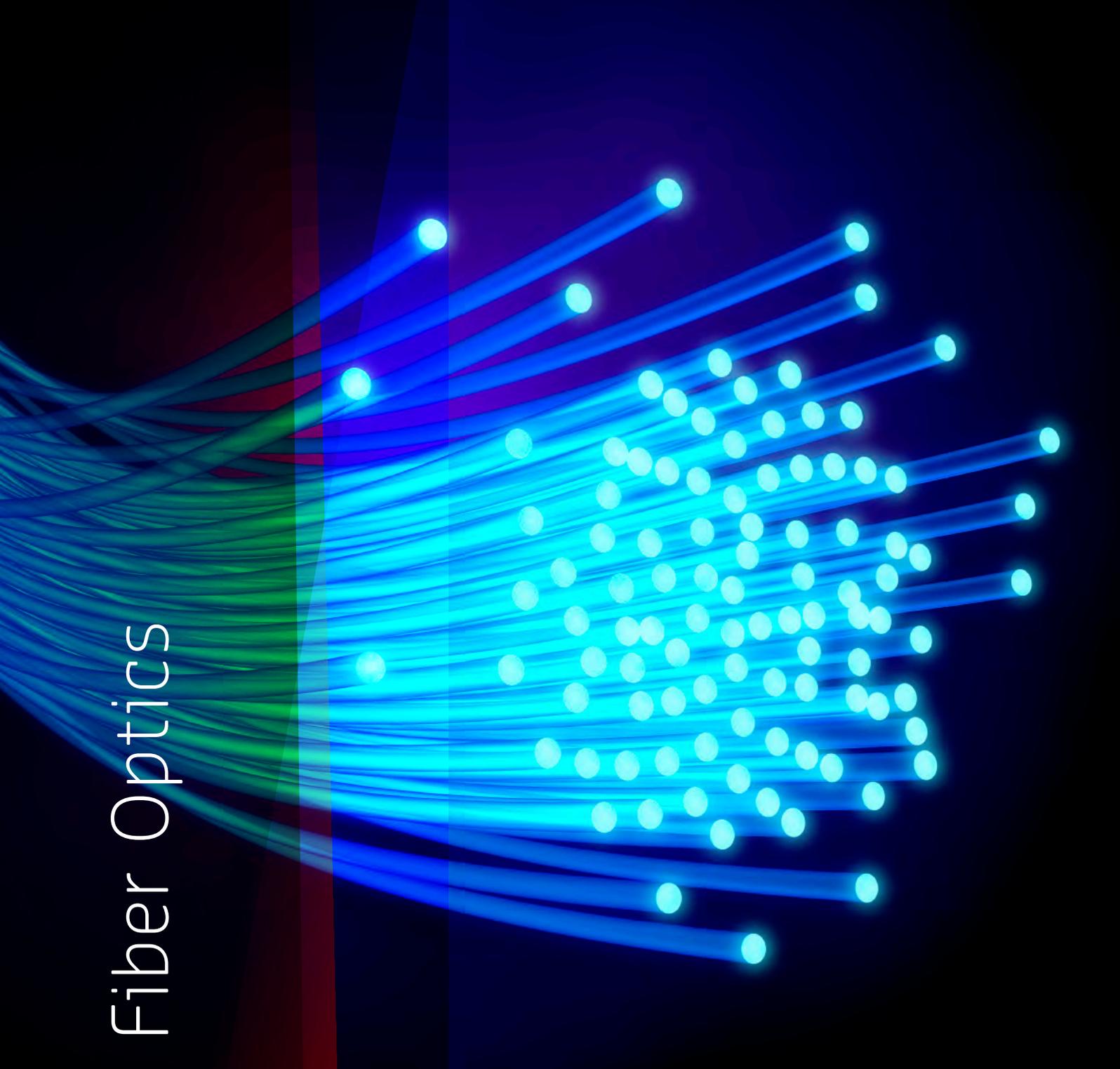
Technical Data

	AvaLight-LED 355/380	AvaLight-LED 400/410/430	AvaLight-LED 450/470/490	AvaLight-LED 530/590/780
Spectral Range*	355/380 nm	400/410/430 nm	450/470/490 nm	530/590/780 nm
FWHM (nm)	15 nm	11 nm	30 nm	30 nm
Optical power 600 μm fiber	10 μWatt	25 μWatt	25 μWatt	25 μWatt
Connector	SMA-905			
Power supply	12 VDC, 40 mA			
Dimensions, weight	175 x 110 x 44 mm, 480 grams			

* other wavelengths available on request

Ordering Information

AvaLight-LED-XXX	• Light Emitting Diode Lightsource, specify wavelength XXX
AvaLight-LED-XXX-RM	• Rackmount version of the Light Emitting Diode Lightsource, specify wavelength XXX
AvaLight-LED-CON	• LED lightsource control unit with electrical connector to LED, needs extra PS-12V/1.0A and interface cable.
CUV-LED-XXX	• LED holder for Cuvette, specify LED wavelength XXX.
CUV-DA	• Direct-attach cuvette holder for AvaLight-DHc/XE/LED
IC-DB26-2	• Interface cable AvaSpec-USB2/EVO platform to AvaLight-LED for PWM
PS-12V/1.0A	• Power supply 100-240 VAC/12VDC, 1.0 A for AvaLight-LED



Fiber Optics

INTRODUCTION

The use of fiber-optics as light guidance allows a great modularity and flexibility in the setup of an optical measurement system. Optical fibers can be made of many materials, such as plastic, glasses and silicates (SiO_2). For high quality fiber-optics, as used in spectroscopic applications, synthetic fused silica (amorphous silicon dioxide) is used, that can be intentionally doped with trace elements to adjust the optical properties of the glass.

The basic principle of light transport through an optical fiber is total internal reflection. This means that the light within the numerical aperture of a fiber (NA = input acceptance cone) will be reflected and transported through the fiber. The size of the numerical aperture depends on the materials used for core and cladding.

Two basic types of silica fibers can be distinguished; single-mode and multi-mode fibers, depending on the propagation state of the light, traveling down the fiber. For most spectroscopic applications multi-mode fibers are used. Multi-mode fibers can be divided into 2 subcategories, step-index and graded-index. A relatively large core and high NA allow light to be easily coupled into the fiber, which allows the use of relatively inexpensive termination techniques. Step-index fibers are mainly used in spectroscopic applications.

Graded-index multimode fibers have a refractive index gradually decreasing from the core out through the cladding. Since the light travels faster in material with lower refractive index, the modal dispersion (amount of pulse-spreading) will be less.

These graded-index fibers are mainly used in telecommunication application, where dispersion at long distance (2-15 km) plays an important role.

Product codes

For example FC-20UVIR200-3-BX

A product code is designed as follows:

Type of Product	Number of fibers	Wavelength	Fiber core diameter	Overall Length	Jacketing	Other options
FC = standard fiber cable FCB = bifurcated fiber FCR = fiber reflection probe FDP = fiber dip probe	almost any number possible	UV = 200-800 nm IR = 350-2500 nm UVIR = 200-2500 nm	8 μm* 50 μm** 100 μm*** 200 μm*** 400 μm*** 600 μm*** 800 μm** 1000 μm**	in meters	BX = stainless steel ME = chrome-plated brass MS = metall silicone	HT= high temperature on request: HTX= extreme high temperature PK= PEEK HY= Hastelloy®

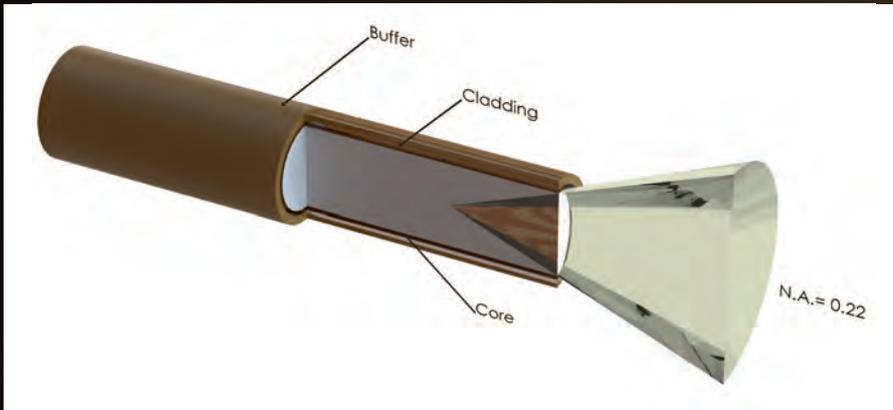
* Only for IR fibers

** Only for UV or IR fibers

*** Only for UVIR fibers



FIBER-OPTIC DESIGN



Core

For spectroscopic applications, generally, multi-mode step index silica fibers are used. These range in core thickness from 50 to 1000 microns. The core is made out of pure silica. Other fiber cores with much higher absorption are made out of certain glass types or plastics. These are not offered in this catalog.

First a distinction is made between silica with high or low OH content. Silica fibers with high OH (600-1000 PPM) are used in the UV/VIS wavelength range because of the low absorption in the UV. They are

referred to as UV/VIS fibers. For Deep-UV applications (below 230 nm) special solarization resistant fibers can be used.

The water content causes strong absorption peaks in the NIR wavelength range.

In order to get good fibers for the NIR range, the "water" is removed from the silica. This results in low OH fibers (<2 PPM) with low absorption in the NIR.

They are referred to as VIS/NIR fibers.

Best of both worlds are the so-called broadband fibers, which can be used for the UV-NIR range (200-2500 nm), the product code for these fibers is UVIR.

Avantes has standardized on this broadband type of fiber.

Cladding

In order to get the light guiding effect the core is cladded with a lower index of refraction material. For the highest quality fibers with the lowest absorption this is a fluorine-doped silica, the so-called silica-silica or all-silica fibers with a numerical aperture (NA) of 0.22.

Buffers

Without further protection fibers would easily break, because of small scratches or other irregularities on the surface. Therefore a next layer, the buffer, is added. This buffer also determines under what circumstances the fiber can be used. Temperature range, radiation, vacuum, chemical environment and bending are factors to be considered.

Polyimide buffers offer a wide temperature range (-190 to 400°C) and superior solvent

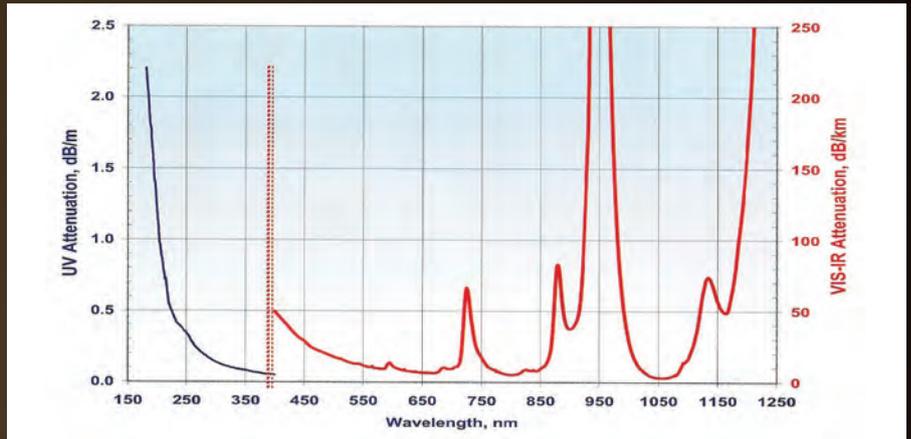
resistance. Also, this material is non-flammable.

Drawbacks are sensitivity to micro bending and the difficulty to remove it.

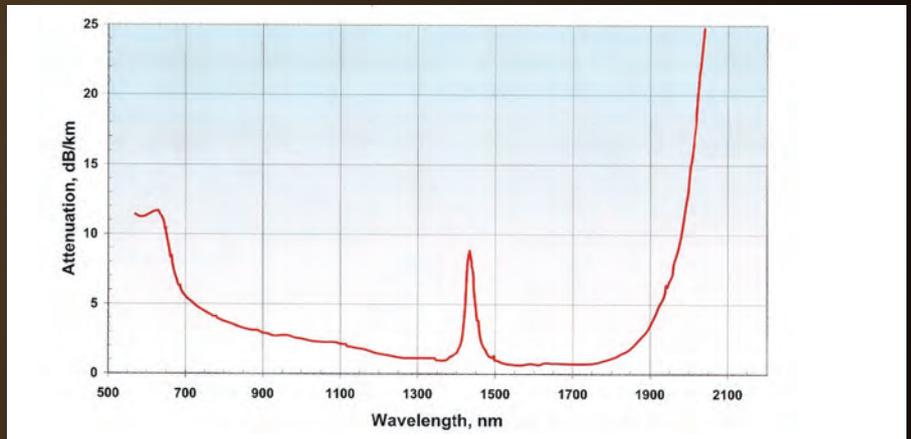


Technical Data

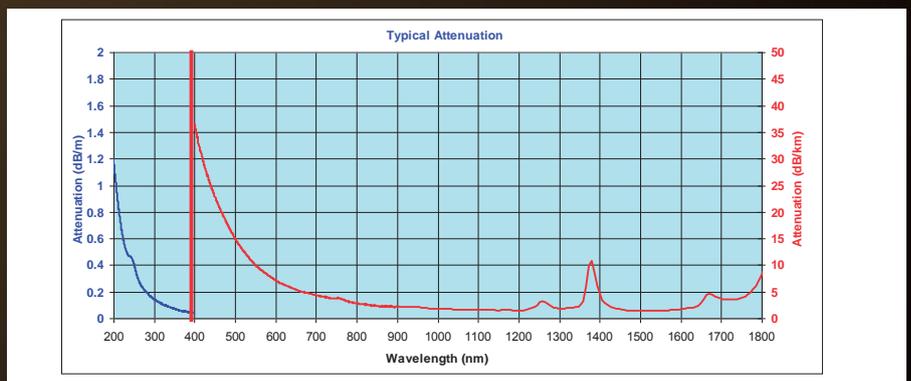
Fiber Material	Standard
Temperature Range	-190 °C to +400°C
Fiber type	Step index Multimode
Core Numerical Aperture	0.22 ± 0.02
Buffer	Polyimide
Available Diameters	50/100/200/400/600/800/1000 μm
Laser damage resistant core	1,3 kW/mm ² CW at 1060 nm, up to 10 J, pulsed
Bend radius	momentary 100 x clad radius long term 600 x clad radius



Transmission UV/VIS fibers



Transmission VIS/NIR fibers



Transmission UV/VIS/NIR broadband

Solarization Resistant Fibers for Deep-UV applications

Most spectroscopic applications with fiber-optics have been restricted to wavelength ranges above 230 nm, because standard silica fibers with an undoped core and fluorine doped cladding are frequently damaged by exposure to deep-UV light (below 230 nm). This solarization effect is induced by the formation of "color centers" with an absorbance band of 214 nm. These color centers are formed when impurities (like Cl) exist in the core

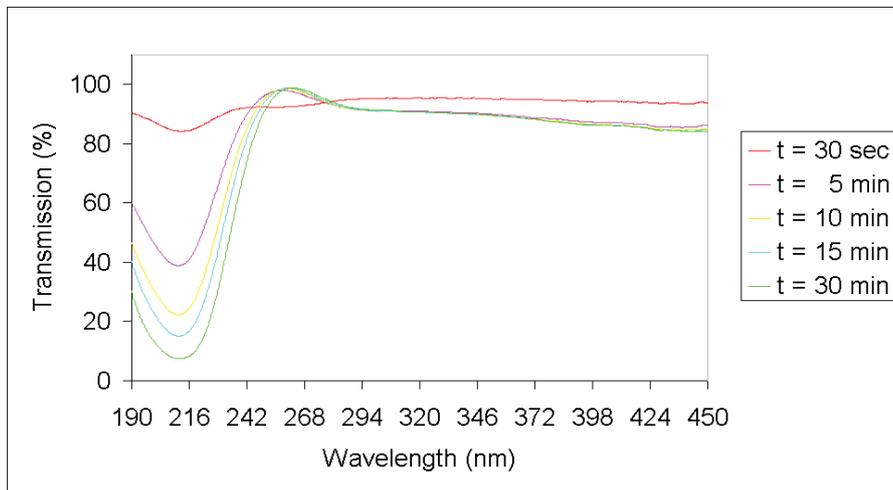
fiber material and form unbound electron pairs on the Si atom, which are affected by the deep-UV radiation.

For this purpose, solarization resistant fibers, which were hydrogen loaded, were developed. The broadband fibers Avantes uses are Solarization Resistant. This means that these fibers provide long-term stability at 30-40% transmission (for 215 nm). Small degradation of the transmis-

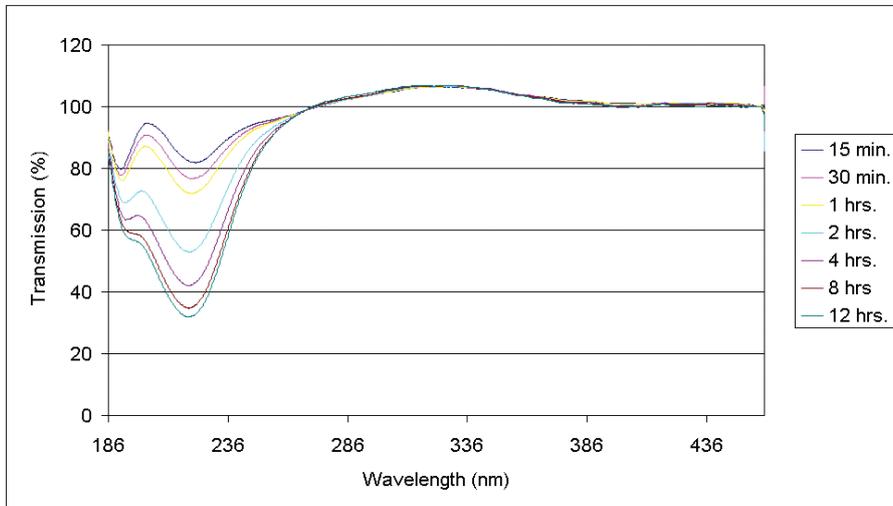
sion can still take place.

First couple of hours of these fibers show a high drop in transmission (100% to 40%). In order to have a stable transmission from the start one can order the PRESOL option. When PRESOL is ordered with a fiber or probe Avantes pre-solarized the product for an 10-hrs period, to have a constant transmission of 30-40% @ 215 nm.

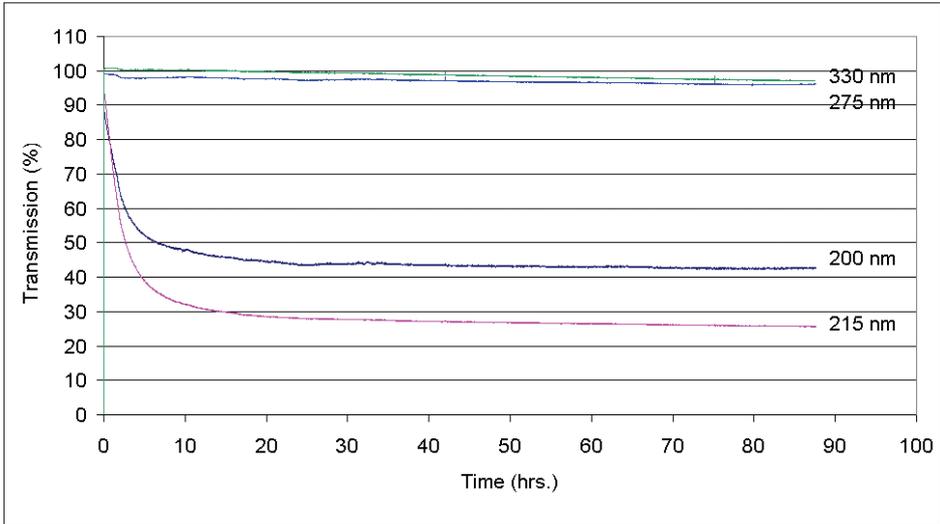
Solarization UV



Solarization UVIR

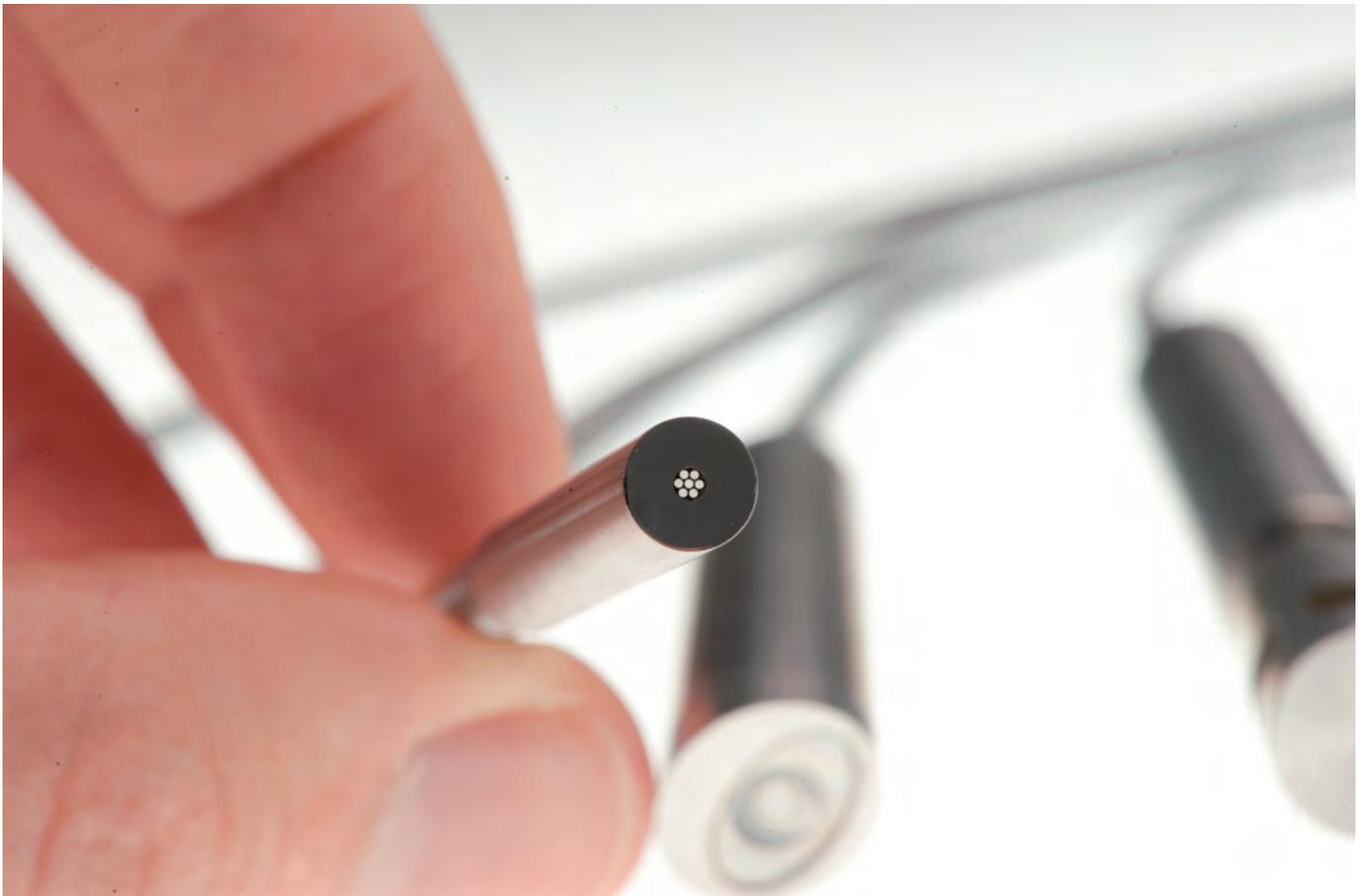


Solarization UVIR



Ordering Information

- PRESOL** • Presolarization of UVIR fiber



Fiber-optic Jacketing

For different applications Avantes offers different jacketing material. Standard fiber-optic cables and bifurcated cables are protected by a Kevlar reinforced polypropylene inner tubing with PVC red outer jacket. All of our standard reflection probes are protected by a flexible stainless steel jacket with interlocking profile (BX) or a

chrome-plated brass outer jacket, with hooked profile (ME) for optimal strain relief with silicon or PTFE inner tubing. For waterproof and some medical applications stainless steel spiral jacketing with glassilk and gray outer silicon rubber coating can be provided. Inside this jacket silicon or PTFE inner tubing is used as well. For

heavy industrial environments we advise the metal stainless steel (-BX) jacketing. It features a tensile strength of 950N. Some specifics on the jacketing can be found in the following technical information.

Contact us if you have any special conditions requirements.

Technical Data

Jacketing material	Kevlar reinforced PVC	Chrome plated brass (ME)	Stainless Steel (BX)	Silicon coated stainless steel (MS)
Inner Tubing	Polypropylene	Silicon/PTFE	Silicon/PTFE	Silicon/PTFE
Outer dimensions	3.8 mm	5.0 mm	6.0 mm	5.8 mm
Min. bending radius	18 mm	18 mm	35 mm	18 mm
Temperature Range	-20°C to +65°C	-65°C to +250°C	-65°C to +250°C	-60°C to +180°C
Tensile Strength	150 N	350 N	950 N	70 N
Application	Standard	Industrial	Heavy Industrial	Waterproof IP67

Ordering Information

- ME** • flexible chrome-plated brass outer jacket, with hooked profile
- BX** • Heavy industrial stainless steel jacket, with fully interlocking profile
- MS** • stainless steel spiral jacket with glassilk and gray outer silicon rubber coating

Standard



-MS



-ME



-BX



Fiber-optic Probe Properties

Avantes offers a broad standardized product range of fiber optics as described in this catalogue. For special cases Avantes also offers modification to this fiber-optic cables and probes to customers request. Most materials we use in our fiber-optic assemblies can be replaced with others to improve specific chemical or thermal resistance or to enhance vacuum or pressure properties. Please contact our fiber design engineers with your specific request.

In the following paragraphs some of the most essential technical parameters are listed for the materials we use.

Thermal Resistance

The thermal resistance of a fiber-optic assembly depends on some of the materials used:

1. Fiber: the standard fiber design has a polyimide buffer, covering a wide thermal range -190 to 400 °C.
2. Jacketing: the standard jacketing is PVC based and has a small temperature range (-20°C to 65°C), for higher temperatures a flexible metal jacketing (-BX/ME) with silicone inner tubing (up to 250°C) or stainless steel tubing (not flexible, to 750°C) is recommended.

3. Probe ends: connectors and ferrules are standard made of metal and have a wide temperature range. For special plastics, like PVC, PEEK and Teflon a limited temperature range is applicable.

4. Bonding epoxy: the standard epoxy used is a heat curing bonding epoxy with a temperature range of -60°C to 175°C. The curing temperature is standard 100 °C, for high temperature ranges (order code -HT), the curing temperature is 200°C. For the HTX (extreme high temperature) fibers and probes ceramic solution are available to realize a process that can withstand temperatures up to 500°C.

Technical Data

Temperature range	Fiber	Jacketing	Probe end	Bonding
-20°C to +65°C	Standard Polyimide	Standard PVC	Standard metal/ PVC/PEEK	Standard Epoxy
-30°C to +100°C	Standard Polyimide	Metal (-BX/ME) or silicone (-MS)	Standard metal/ PEEK	Standard Epoxy
-60°C to +200°C (HT)	Standard Polyimide	Metal (-BX/ME) or silicone (-MS)	Standard metal/ PEEK	High temperature curing epoxy

Ordering Information

- HT • High Temperature version (up to 200°C)

All fibers
are available with SMA,
ST and/or FC/PC connectors

Chemical resistance

The chemical resistance of a fiber-optic assembly depends on some of the materials used:

1. Fiber, the standard fiber design has a polyimide buffer, which normally will not be in contact with the sample; the quartz core provides good resistance against most solvents.
2. Jacketing, the standard jacketing is PVC based and has a relative good chemical resistance. The -BX stainless steel and -ME chrome plated brass jacketing also have a good chemical resistance, but are not waterproof. The Silicone metal jacketing (-MS) is recommended for waterproof environment, biomedical applications, etc. The PEEK and PTFE jacketing have the best chemical resistance.
3. Probe ends, connectors and ferrules are standard made of stainless steel (316)

and are not very well suitable in corrosive environment. For most corrosive environments PEEK or Hastelloy® C276 are recommended.

4. Bonding, the standard heat-curing two-component epoxy used is resistant to water, inorganic acids and salts, alkalis and many aggressive organic solvents and most petrochemical products, and an extended range of organic and inorganic environments.

The table below gives a summary for the chemical resistance for most materials used. It has been drawn up on the basis of relevant sources in accordance with the state of the art; no claim to completeness. The data constitutes recommendations only, for which no liability can be accepted. Please contact us if you have any doubt about the materials to use for your application.

Technical Data

Chemical environment	Fiber	Jacketing	Probe end	Epoxy	
Acids weak	Standard Polyimide	-BX/ME -MS -PEEK -PVC	± + + +	St. steel 316 PEEK Hastelloy® C276	- + + +
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	- ± + ±	St. steel 316 PEEK Hastelloy® C276	- + + +
Acids strong	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
Bases weak	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
Bases strong	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
Aromatic carbons	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ + + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ ± + +	St. steel 316 PEEK Hastelloy® C276	+ + + +
Alcohols	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ - + -	St. steel 316 PEEK Hastelloy® C276	+ + + ±
	Standard Polyimide	-BX/ME -MS -PEEK -PVC	+ - + -	St. steel 316 PEEK Hastelloy® C276	+ + + ±

+ = good resistance
± = conditional resistant
- = not resistant

Options

- PK • PEEK Probe material replaces Stainless Steel
- HY • Hastelloy® C276 Probe material replaces Stainless Steel

Fiber-optic Connectors

SMA Connectors

We supply all of our standard fiber-optic cables, bundles and probes with SMA-905 connectors that easily fit into our complete range of spectrometers, light sources and accessories.

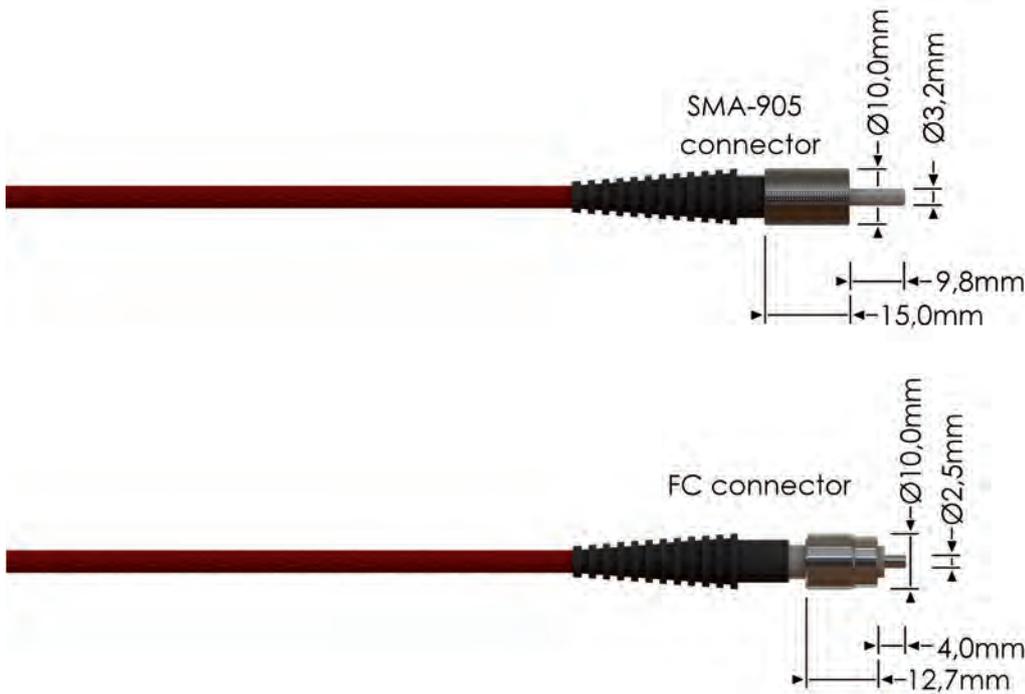
The SMA-905 connectors are screw-fitted and can be rotated over 360 degrees. The typical insertion loss for the connectors is 0.5 dB. The maximum filling diameter for bundles is 2.46 mm

FC/PC Connectors

Optional FC/PC-connectors can be mounted to our fiber-optic products. The multi-mode FC/PC connectors have an extremely low insertion loss of < 0.2 dB. The FC/PC connector cannot rotate, always mounts into the same fixed position and therefore has a high reproducibility.

Ordering Information

- FC/PC • FC/PC connector instead of standard SMA



Fiber-optic Cables

Avantes offers a wide range of fiber-optic cables, which can be made in a variety of lengths and configurations to meet your needs. For common applications, a 2 meter length is sufficient. For this reason it is our standard fiber length.

Avantes offers SMA-905 or FC/PC connectors and these can be the same or different on both ends. For some applications, special round to linear fiber cables are recommended in which a bundle of fibers configured in a round pattern on one end and a linear array on the other end. The linear array (typically 1 mm in height) is aligned with the slit height of the spectrometer which is also 1 mm. This fiber configuration provides maximized light throughput for applications requiring high-sensitivity.

Fiber-optic cable types and diameters are recommended based upon the wavelength range being measured and the sensitivity required for a measurement. In general different fibertypes can be classified. For the UV range high OH UV/VIS fiber is used. For customers working below 240 nm in the UV, special high OH UV/VIS fiber called solarization resistant fiber (SR) is available. For longer wavelengths low OH VIS/NIR fiber is recommended. Best of both worlds can be achieved with our broadband fiber, which is our standard. This gives you the combined performance of the UV, UV-SR and IR fibers.

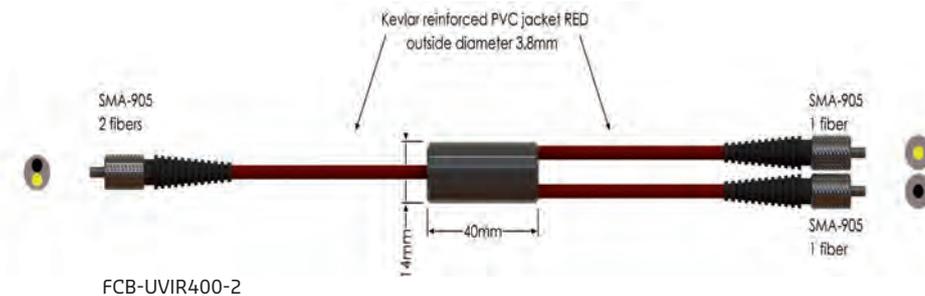
Avantes also offers a variety of jacketing options including Kevlar reinforced PVC sleeving with PTFE inner tubing (standard), chrome plated brass monocoil, stainless

steel BX, silicone coated stainless steel monocoil and other special jacketings upon request. For applications requiring high temperature resistance, special high temperature epoxy (HT) is available and should be specified at the time of order.

Recommended wavelengths for different cables:

200-2500 nm: UV/VIS/NIR (UVIR)
UV/IR available in core sizes 100, 200, 400, 600 μm

200-800 nm: Solarization resistant (-SR)
250-800 nm: UV/VIS (UV)
350-2500 nm: VIS/NIR (IR)



FCB-UVIR400-2

Ordering Information

FC-IR008-2 or -1	• Cable with 8 μm Fiber, 2 or 1m length, SMA terminations
FC-xx050-2 or -1*	• Cable with 50 μm Fiber, 2 or 1m length, SMA terminations
FC-UVIR100-2 or -1	• Cable with 100 μm Fiber, 2 or 1m length, SMA terminations
FC-UVIR200-2 or -1	• Cable with 200 μm Fiber, 2 or 1m length, SMA terminations
FC-UVIR400-2 or -1	• Cable with 400 μm Fiber, 2 or 1 m length, SMA terminations
FC-UVIR600-2 or -1	• Cable with 600 μm Fiber, 2 or 1m length, SMA terminations
FC-xx800-2 or -1*	• Cable with 800 μm Fiber, 2 or 1m length, SMA terminations
FC-xx1000-2 or 1*	• Cable with 1000 μm Fiber, 2 or 1m length, SMA terminations
FCB-xx050-2 or 1*	• Bifurcated cable 2x50 μm , 2 or 1m length, SMA terminations
FCB-UVIR100-2 or 1	• Bifurcated cable 2x100 μm , 2 or 1m length, SMA terminations
FCB-UVIR200-2 or 1	• Bifurcated cable 2x200 μm , 2 or 1m length, SMA terminations
FCB-UVIR400-2 or 1	• Bifurcated cable 2x400 μm , 2 or 1m length, SMA terminations
FCB-UVIR600-2 or 1	• Bifurcated cable 2x600 μm , 2 or 1m length, SMA terminations

Other lengths and fiber types are available.

*Specify xx = UV for UV/VIS fiber cables, IR for VIS/NIR

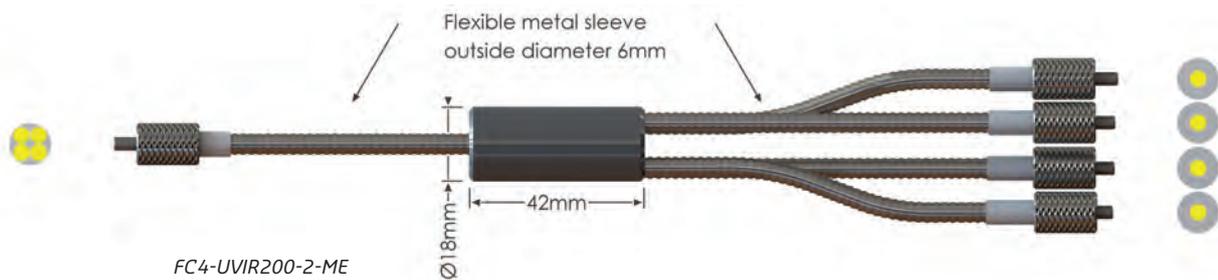
Multi-furcated Fiber-optic Cables

Simultaneous multi-point measurements and Avantes multi-channel spectro-meters, require multi-furcated fiber-optic cables. These assemblies can function as a combiner or splitter of light as they have multiple legs on one side which converge into a single connector on the opposite side. Avantes offers virtually any combination possible, which can be adapted to your requirements.

Typical setups that require multi-furcated cables are:

- One sampling point such as an integrating sphere, cosine corrector or collimating lens being measured with several spectrometers (individual AvaSpecs or Multi-channel).
- Multiple illumination fibers splitting out from one light source to different sampling points.

Various types of connectors, jacketings and fiber sizes are available for these multi-furcated fiber cables. Contact us to configure and quote you on your specific needs.



Ordering Information

FC4-UVIR200-2	• Four-furcated cable, 4x200 μm broadband fibers , all legs SMA terminated, total 2 m long, splitting point in the middle
FC4-UVIR400-2	• As FC4-UVIR200-2, but with 4x400 μm broadband fibers
FC4-UVIR600-2	• As FC4-UVIR200-2, but with 4x600 μm broadband fibers
FC5-UVIR200-2	• Five-furcated cable, 5x200 μm broadband fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC5-UVIR400-2	• As FC5-UVIR200-2, but with 5x400 μm broadband fibers
FC6-UVIR200-2	• Six-furcated cable, 6x200 μm broadband fibers, all legs SMA terminated, total 2 m long, splitting point in the middle
FC6-UVIR400-2	• As FC6-UVIR200-2, but with 6x400 μm broadband fibers
FC8-UVIR200-2	• Eight-furcated cable, 8x200 μm broadband fibers , all legs SMA terminated, total 2 m long, splitting point in the middle
FC8-UVIR400-2	• As FC8-UVIR200-2, but with 8x400 μm broadband fibers

Other lengths available on request

Reflection Probes (Standard)



To obtain spectral information of the diffuse, or specular materials, reflection probes are used. The light from a light source is sent through six illumination fibers to the sample and the reflection is measured by a 7th fiber in the center of the reflection probe tip. The 7th fiber is coupled to a spectrometer configured to the appropriate wavelength range of interest. More illumination fibers can be added to get more energy from the light source and therefore increase the reflection signal level.

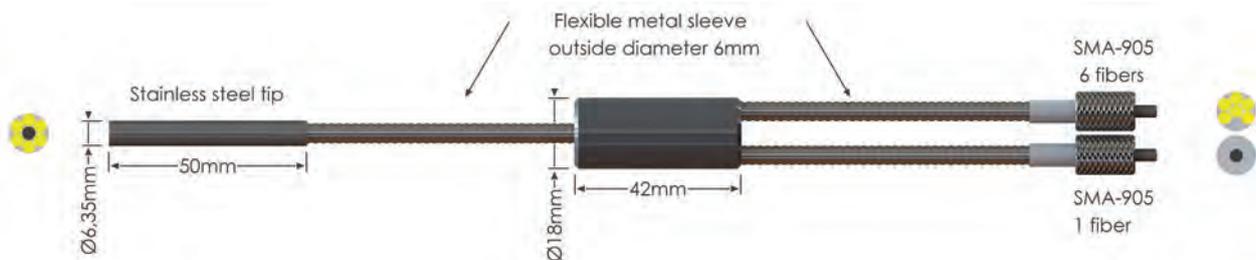
For measurements under an angle of 90°,

the FCR-90-Option was developed. It's a special adapter with a mirror positioned at 45° and can be easily mounted on the tip of Avantes standard reflection probes.

The FCR-COL is an adjustable UV/VIS/ NIR collimating and focusing lens which enables focusing the measurement spot at an extended distance.

Technical Data

Fibers	7 fibers 200 mm or 400 mm core, 6 light-fibers, 1 read fiber, N.A.= 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter. Optionally -PK for PEEK or -HY for Hastelloy® C276 (on request)
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, O.D. 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200 °C)
Pressure	Probe head 50 bar @ 25 °C
Bending	Minimum bend radius: Short term (few seconds) 20-40 mm, long term: 120 -240 mm



Ordering Information

FCR-7UVIR200-2-BX/ME*	• Reflection probe, 7 x 200 µm broadband fibers, 2 m length, SMA term.
FCR-7UVIR400-2-BX/ME*	• Reflection probe, 7 x 400 µm broadband fibers, 2 m length, SMA term.
FCR-90-Option	• 90° Reflection add-on reflector for use with all 1/4" reflection probes
FCR-COL	• Adjustable UV/VIS/NIR Collimating/focusing lens for FCR probes

* please specify jacket material

Options

-HT	• High Temperature version (up to 200°C)
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Reflection Probes with Multiple Legs

For some measurements, a reflection probe is needed that can be coupled to two spectrometers and a light source. A good example is a reflection measurement in the UV/VIS and NIR range. For these situations, Avantes offers our reflection probes with multiple legs.

The light from a light source is coupled into a fiber bundle, consisting out of 17

illumination fibers which transport the light to the end of the probe. The reflected light is uniformly reflected into the two read fibers, each of which is connected to a spectrometer.

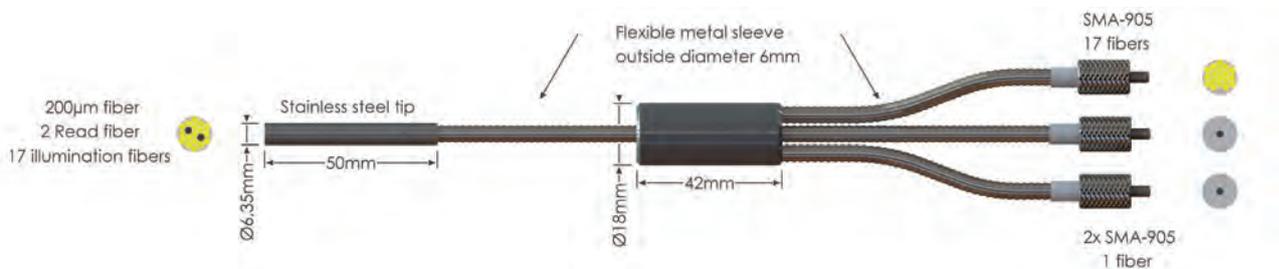
For measurements under a 90° angle, the FCR-90-Option has been developed. It is an adapter with a mirror mounted at 45° and can be easily mounted to the tip of these

reflection probes.

To accurately focus a small measurement spot from a higher distance, the FCR-COL adjustable US/VIS/NIR collimating/focusing lens is available and can be mounted to the tip of these probes.

Technical Data

Fibers	19 fibers 200 µm core, 17 light-fibers, 2 read fibers in 2 separate legs, N.A.= 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (3x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter. Optionally -PK for PEEK or -HY for Hastelloy® C276 (on request)
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 50 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-19UVIR200-2-BX/ME*	• Reflection probe UV/VIS/NIR, 17 x 200 µm UV/VIS/NIR illumination fibers, 2 read UV/VIS/NIR fibers in separate legs, 2 m length, 3 SMA term.
FCR-90-Option	• 90° Reflection add-on reflector for use with all 1/4" reflection probes
FCR-COL	• Adjustable UV/VIS/NIR Collimating/focusing lens FCR probes

* please specify jacket material

Options

-HT	• High Temperature version (up to 200°C)
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Reflection Probes with Reference

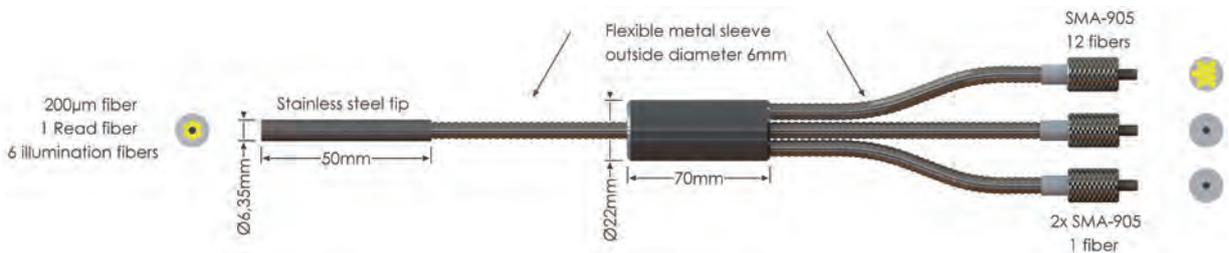
In order to correct fluctuations and drift from your light source, periodic referencing is required. To facilitate this, Avantes offers this series of reflection probes with a self-referencing feature. The light coming from the light source is bundled into 12 fibers, which are split into two 6 fiber

bundles. One of these bundles is carried to the probe end for sample measurements and the other bundle of 6 are directed to a white reflection tile built into the probe to provide a light source reference. This reference leg is connected to a slave spectrometer channel dedicated to light source

referencing or may be routed to a single channel via a fiber-optic (contact a Sales Engineer about this special configuration). On the measurement side the probe end has a 7th fiber which reflects light back to the master spectrometer channel.

Technical Data

Fibers	14 fibers 200 µm core, 12 light-fibers, 2 x 1 read fiber, N.A.= 0.22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (3x)
Probe end	Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter . Optionally -PK for PEEK or -HY for Hastelloy® C276 (on request).
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 50 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-14UVIR200-2-REF-BX/ME*

- Reflection probe with reference, 14 x 200 µm broadband fibers, 2 m length, SMA term.

* please specify jacket material

Options

- HT • High Temperature version (up to 200°C)

Reflection Probes with Small Tips

For some medical and semiconductor applications, a (very) small tip is desired to do reflectance measurements. Avantes offers two standard diameters of small tip reflection probes, 1.5 and 2.5 mm and each tip is normally 100 mm long.

The probe is configured with an illumination leg with six 200 µm fiber cables which connects to a fiber coupled light source

and a single 200 µm read fiber cable to measure the reflection via connection to a spectrometer.

A special angled fiber holder (AFH-15) is available for the 1.5 mm diameter reflection probe. This device enables reflection measurements under angles of 15, 30, 45, 60, 75 and 90 degrees. For more information, see 'Reflection probe holders'.



Technical Data

Fibers	7 fibers 200 µm core, 6 light-fibers, 1 read fiber, N.A.= 0,22. Standard 2 m length, splitting point in the middle.
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel cylinder, 100 mm long x 1.5 or 2.5 mm diameter.
Jacketing	The optical fibers are protected by a Kevlar reinforced PTFE jacket with PVC sleeving. OD: 3.8 mm
Temperature	-20°C to 65°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

- FCR-7UVIR200-2-1.5x100** • Reflection probe, 1.5 mm tip, UV/VIS, 7 x 200 µm broadband fibers, 100 mm long, 2 m length, SMA
- FCR-7UVIR200-2-2.5x100** • Reflection probe, 2.5 mm tip, UV/VIS, 7 x 200 µm broadband fibers, 100 mm long, 2 m length, SMA

For diffuse or specular reflection measurements, take a look at the RPH-1 reflection probe holder

Reflection Probes for Powders and Thick Fluids



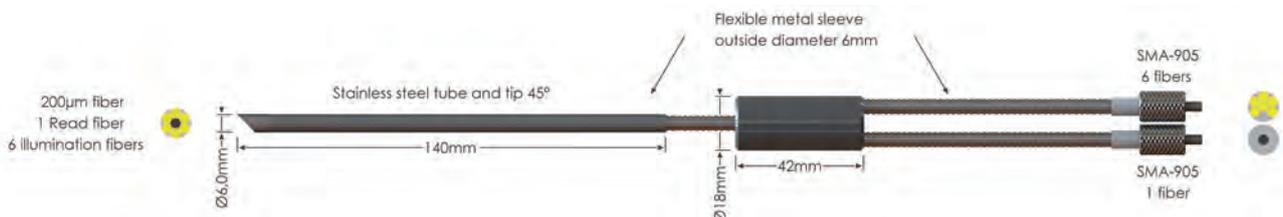
For effective measurement of reflection in powders and thick fluids, Avantes offers this specially designed series of reflection probes. The probes allow the user to simply dip the probe into the powder or thick fluids to do the measurements.

The illumination leg of the probe is connected to a light source and carries light

to the sample via a bundle of six fibers. At the probe tip, a 45 degree fused silica window illuminates the sample and collects the indirect reflections which are carried by a single fiber to the spectrometer. The 45 degree angle of the probe prevents the measurements of direct back reflection from the window, thus improving the dynamic range of your measurement.

Technical Data

Fibers	7 fibers 200 μm core, 6 light-fibers, 1 read fiber, N.A.= 0.22. Standard 2 meter length
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe end	Stainless steel 316 cylinder, 140 mm long x 6.0 mm diameter. The probe end contains a 5 mm diam. x 1 mm thick fused silica window. Waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276 (on request).
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, O.D. 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FCR-7UVIR200-2-45-BX/ME* • Reflection probe for powders and turbid fluids

* please specify jacket material

Options

-HT • High Temperature version (up to 200°C)

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

1/2" Industrial Reflection Probes for Powders and Thick Fluids

For industrial applications that need reflection measured in thick liquids or powders, this probe is the ideal choice. The stainless steel cylinder and probe end make it withstand extreme situations. The tip is exchangeable and waterproof. Optionally PEEK or Hastelloy® C276 can be used as tip material.

The light enters from the light source through six bundled fibers to the probe end, where it lights the material to be analyzed through a sapphire window angled at 45 degrees. This angle prevents any light to be reflected from the window. The light is selectively reflected through the seventh fiber in de probe. This fiber leads to the connected spectrometer.



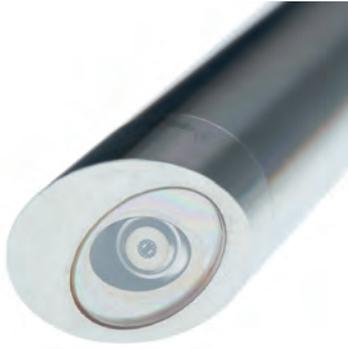
Technical Data

Fibers	7 fibers 200 µm core, 6 light-fibers, 1 read fiber, N.A.= 0.22, standard 2 meter length
Wavelength Range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Probe End	Stainless steel cylinder, 120 mm long x 12.7 mm (1/2") diameter. The probe end contains a ca. 10 mm diam. x 1 mm thick sapphire window. The probe tip is exchangeable and waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-40 °C to 100 °C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm

Ordering Information

FCR-7UVIR200-2-45-IND	• 1/2" Reflection probe for powders and turbid fluids
FCR-TIP45	• 1/2" Replacement tip with sapphire window for UV/VIS/NIR

1/2" Industrial Fluorescence Probes

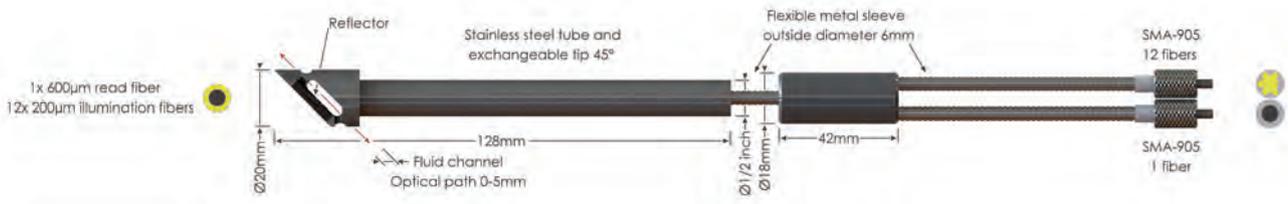


For effective measurement of fluorescence, Avantes offers this specially designed reflection probe. It features 12 excitation fibers of 200 μm around a 600 μm read fiber, which transports the fluorescence signal back to the spectrometer.

To turn the 45° reflection probe into a fluorescence probe, a special reflector accessory, FCR-FLTIP-IND, is attached to the probe end. It prevents ambient light to enter the probe and backscatters the excitation light. This increases the typically low fluorescence signal. The fluid channel path can be varied between 0 and 5 mm.

Technical Data

Fibers Illumination	12 fibers of 200 μm , UV/VIS
Fibers Detection	1 fiber 600 μm
Wavelength Range	200-2500 nm (UV/VIS/NIR)
Connector	2 x SMA-905
Probe End	Stainless steel 316 cylinder, 128 mm long x 12,7 mm (1/2") diameter. The probe end contains a ca. 10 mm diameter x 1 mm thick sapphire window with anti-reflection coating. The probe tip is exchangeable and waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276
Fluorescence Accessory	See drawing below
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (BX, O.D. 6.0 mm) or chrome plated brass (ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve. Optionally a waterproof, steel reinforced, silicon jacket can be provided
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 60 mm, long term: 360 mm



Ordering Information

FCR-UVIR200/600-2-IND	• 1/2" Reflection Probe for fluorescence applications
FCR-FLTIP-IND	• Fluorescence Reflector Accessory for 1/2" FCR-UVIR200/600-2-IND probes

Options

-HT	• High Temperature version (up to 200°C)
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All our broadband fibers are polarization resistant fibers

Mini Transmission Dip Probes

For absorption measurements in miniaturized centrifuge tubes or vessels, Avantes offers the mini transmission dip probe. It features a miniaturized tip which is 130 mm long and 3.2 mm in diameter.

The mini transmission dip probe has a fixed 5 or 10 mm optical path length. It is available in a UV/VIS/NIR (200-2500 nm) version. The probe features Avantes ME, chrome plated brass, jacketing.

Optionally the probe can be configured with a longer stainless steel or Hastelloy® tip, and/or other jacketing options. The probe has two SMA connectors (FC/PC also available) for convenient coupling to the Avantes line of spectrometers and light sources.

Please contact us for special requirements.



Technical Data

Fibers	1 illumination and 1 detection fiber, both 200 μm, standard 2 meters length
Wavelength Range	200-2500 nm (UV/VIS/NIR)
Connectors	2 x SMA-905
Probe End	Stainless steel 316 cylinder, 130 mm long x 3.2 mm (1/8") diameter. The probe end contains 5 mm physical, 10 mm optical path, or a 2.5 mm physical gap (5 mm optical path). Optionally -HY for Hastelloy® C276
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-40 °C to 100 °C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

FDP-2UVIR200-2-2.5-mini	• 1/8" Mini Dip Probe, 2.5 mm path length (optical 5 mm), 2 m length
FDP-2UVIR200-2-5-mini	• 1/8" Mini Dip Probe, 5 mm path length (optical 10 mm), 2 m length

Options

-BX	• Stainless steel jacket
-HT	• High Temperature version (up to 200°C)

Transmission Dip Probes

For online and inline absorbance measurements in fluids, transmission dip probes are used. When dipping or permanently mounting the probe end into the fluid, absorbance can be measured.

A standard SMA-905 connector is used to couple light into a fiber bundle, typically consisting out of six fibers (other configurations available upon request). The light

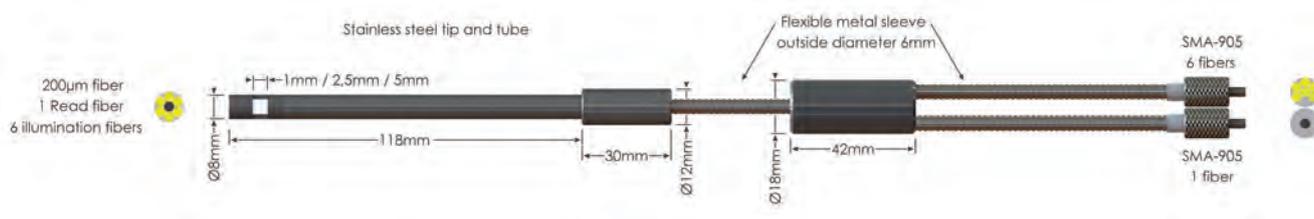
is transmitted to the probe end, where it crosses the predetermined gap and is then reflected against a diffuse white reflective material back onto the receiving read fiber, which is coupled, to a spectrometer on the second leg of the probe.

The read fiber is placed in the center of the illumination fiber bundle to provide the best collection efficiency for the probe.

Both bundles are housed in flexible stainless steel jacketing and the probe tip is also made of stainless steel. At the mid-point of the assembly a ferrule is used to split the fibers into their respective legs (illumination and read) which are terminated in SMA-905 connectors.

Technical Data

Fibers	6 illumination fibers, 1 detection fiber, all 200 μm , standard 2 meters
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Tips	Replacement tips are available with 1, 2.5 and 5 mm spacing, i.e. an optical path of 2,5 and 10 mm and contain a 5 mm diam. x 1 mm thick fused silica window
Probe end	Stainless steel 316 cylinder, 100 mm long x 8,0 mm diameter. Waterproof.
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. The jacketing also gives stress relieve.
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

- FDP-7UVIR200-2-yy** • Transmission Dip Probe, yy (1, 2.5, 5 mm) gap, 2 m length, SMA term.
- FDP-TIP-yy** • Replacement tips, 1 mm, 2.5 mm, 5 mm gap for probe (fill in gap length for yy, note optical path =2*yy)

Options

- BX** • Stainless steel jacket
- HT** • High Temperature version (up to 200°C)

Transmission Dip Probes with Variable Path Length

For more flexibility during absorbance measurements in fluids, this fiber-optic probe features a variable and adjustable path length. The gap between the fiber and the diffuser can be set anywhere between 0.25 and 10 mm.

A standard SMA-905 connector is used to couple light into a fiber bundle, typically consisting out of six fibers (other configurations available upon request). The light is transmitted to the probe end, where it crosses the predetermined gap and is then reflected against a diffuse white reflective material back onto the receiving read fiber which is coupled to a spectrometer on the second leg of the probe.

The read fiber is placed in the center of the illumination fiber bundle to provide the best collection efficiency for the probe. Both bundles are housed in flexible stainless steel jacketing and the probe tip is also made of stainless steel. At the mid-point of the assembly a ferrule is used to split the fibers into their respective legs (illumination or read) which are terminated in SMA-905 connectors.



Technical Data

Fibers	6 illumination fibers, 1 detection fiber, all 200 μm , standard 2 meters
Wavelength range	200-2500 nm (UV/VIS/NIR)
Connectors	SMA-905 connectors (2x)
Optical Path	0.25 - 10 mm physical gap, i.e. an optical path of 0.5-20 mm
Probe end	Stainless steel 316, 150-160 mm long x 12,7 mm ($\frac{1}{2}$ ") diameter. Waterproof.
Jacketing	The optical fibers are protected by a silicon inner tube and a flexible stainless steel (optional BX, O.D. 6.0 mm) or chrome plated brass (standard ME, 5.0 mm) outer jacket. Optionally a waterproof, steel reinforced, silicon tubing can be provided (-MS)
Temperature	-30°C to 100°C. (-HT version 200°C)
Pressure	Probe head 10 bar @ 25°C
Bending	Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm



Ordering Information

- | | |
|---------------------------|---|
| FDP-7UVIR200-2-VAR | • Transmission Dip Probe in stainless steel with variable tip length, 2 m length, SMA term. |
| FDP-TIP-VAR | • Replacement Stainless Steel tip for Transmission dip probe with variable tip length |

Options

- | | |
|------------|--|
| -BX | • Stainless steel jacket |
| -HT | • High Temperature version (up to 200°C) |

Custom Fiber Assemblies and Probes



For some applications a very specific fiber or probe is needed. Avantes has almost 20 years of experience in designing the custom probes for unique applications. Avantes has significant expertise in designing fiber-optics for high temperature (HTX), high pressure (HP), vacuum and other difficult conditions. Avantes wide variety of standard and custom materials can be configured to provide a fiber assembly which can meet the challenges of your environment.

On the left are some examples of our special designs. Please contact us to discuss your needs.



High temperature UV/VIS/NIR probe with gas connection

The universities of Bochum (Germany) and Utrecht (The Netherlands) approached us with a problem doing high temperature measurements at low pressure of dehydrogenation of propane: an ideal situation for the creation of cokes. Therefore every time the probe was contaminated with coke residue on the tip, meaning they could only do a single test after which they had to replace the probe.

Avantes responded by designing this high temperature probe. It's resistant to temperatures of 700 degrees centigrade or more and features a connection for gas insertion into the probe. So far, during one test the probe was used over 150 hours continuously, with temperatures of 550-600 degrees. The gas used was nitrogen. The result was a clean tip, re-usable probe and very happy customers.

Chemical resistant reflection probe

In chemical environments, standard reflection probes have a huge disadvantage: many chemicals interfere with the glue used to construct the probes. This version eliminates this disadvantage: all connections are mechanical, sapphire windows and o-rings are used. The material used is stainless steel 310, which is chemical resistant as well.

A reflection probe is inserted into the back of this probe: it serves as a protective sleeve. The path length is variable and up to 30 mm.

Collimating Lenses

To convert divergent beams of light into a parallel beam, a collimating lens is needed. Avantes collimating lenses are optimized for the UV/VIS/NIR range (200-2500 nm) and have anodized aluminum housings.

The COL-UV/VIS and COL-90-UV/VIS have a 6 mm diameter lens with a confocal length of 8.7 mm. The COL-90-UV/VIS is used when a 90-degree exit angle is needed. The focal point for the COL-UV/VIS and COL-90-UV/VIS can be adjusted. The COL-

UV/VIS can also be ordered with an FC/PC connector.

The COL-UV/VIS-25 is the big brother of the COL-UV/VIS. It has a lens diameter of 25 mm and a confocal length of 50 mm. This larger collimating lens is suitable for collection of light in free space.

COL-UV/VIS



COL-90-UV/VIS



Technical Data

	COL-UV/VIS	COL-90-UV/VIS	COL-UV/VIS-25
Lens Diameter	6 mm		25 mm
Lens confocal length	8.7 mm		50 mm
Lens Material	UV grade Fused Silica		
Wavelength range	200-2500 nm		
Fiber connection	SMA-905, UNS 1/4" (standard, FC/PC also possible)		
Mirror reflectivity	n.a.	>90% (200-1100 nm)	n.a.
Housing Material	Aluminum black anodized		
Thread	UNF 3/8"-24		n.a.
Temperature range	-30°C to 100°C (-HT version 200°C)		

Ordering Information

COL-UV/VIS	• Collimating lens for UV/VIS/NIR, incl. SMA adapter and adj. focus
COL-UV/VIS-FCPC	• Collimating lens for UV/VIS/NIR, incl. FC/PC adapter, adj. focus
COL-90-UV/VIS	• Collimating lens under 90 degrees for UV/VIS/NIR, incl. SMA adapter
COL-UV/VIS-25	• Collimating lens 25 mm for UV/VIS/NIR, incl. SMA adapter and adj. focus

A collimating lens
can be used to collect
more light into a fiber cable

Cosine correctors

CC-VIS/NIR



To collect light from a 180° angle, cosine correctors are used. This eliminates optical interface problems associated with the light collection sampling geometry inherent to other sampling devices such as bare fiber-optics, collimating lenses or integrating spheres.

Avantes offers four different models of cosine correctors: The CC-UV/VIS and CC-VIS/NIR have a 3.9 mm active area, and dimensions of 18 mm (L) X 6.5 mm (OD). The CC-UV/VIS is made of Teflon which is especially suited for measurements in the 200-800 nm range, whereas the CC-VIS/NIR covers the full UV/VIS/NIR range of 200-2500 nm and is made of Radin Quartz.

The CC-UV/VIS/NIR-8MM works as the CC-VIS/NIR, but has an active area of 8.0 mm and dimensions of 29 mm (L) X 12 mm (OD). The specialized CC-UV/VIS/NIR-5.0 has a 20 mm active area is used for solar measurement applications requiring a 5° angular field of view has a 20 mm active area and is much larger than the other cosine correctors measuring 317 mm (L) X 38 mm (OD).

Technical Data

	CC-UV/VIS	CC-VIS/NIR	CC-UV/VIS/NIR-8MM	CC-UV/VIS/NIR-5.0
Active area	3.9 mm	3.9 mm	8.0 mm	20.0 mm
Diffusing material	Teflon (200-800 nm), ca. 1 mm thick	Radin Quartz (200-2500 nm), ca. 1.5 mm thick		
Dimensions	6.5 mm diameter, 18 mm long		12 mm diameter, 29 mm long	38 mm diameter, 317 mm long
Sampling geometry	Accepts light at/from 180° FOV			Accepts light at 5° FOV
Connector	SMA-905			
Temperature	-30 °C to +100 °C			

Ordering Information

CC-UV/VIS	• Cosine Corrector for UV/VIS, incl. SMA adapter
CC-VIS/NIR	• Cosine Corrector for UV/VIS/NIR, incl. SMA adapter
CC-UV/VIS/NIR-8MM	• Cosine Corrector for UV/VIS/NIR, 8 mm area, incl. SMA adapter
CC-UV/VIS/NIR-5.0	• Cosine Corrector for UV/VIS/NIR, 5.0° FOV, incl. SMA adapter

A cosine corrector collects light from an angle of 180°, ideal in situations with scattered light

Vacuum Feedthroughs

These feedthroughs are designed for the use with fiber-optics in vacuum chambers, such as for plasma and coating deposition monitoring. They can be used in chambers with wall thicknesses of 5-40 mm and vacuum levels up to 10^{-7} millibar.

The feedthrough assembly consists of an M12 housing with Viton® O-ring and two SMA fiber-optic interconnects to allow easy coupling to fiber-optic cables and probes. In order to connect these assemblies to fiber-optic cables inside/outside the chamber, two extra SMA fiber

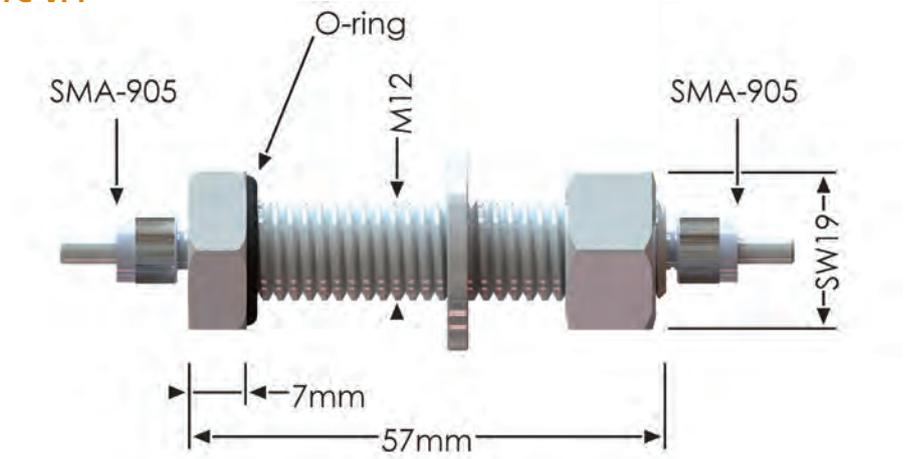
interconnects (ME-FI-SM-MM) should be ordered separately.

The vacuum feedthrough can be delivered for all fiber diameters, from 50µm up to 1000 µm for UV/VIS/NIR.

A high temperature version of the vacuum feedthrough(-HT) is also available enabling the device to withstand temperatures up to 200°C.



FC-VFT



Technical Data

Fibers	1 fiber, diameter 50 µm, 100 µm, 200 µm, 400 µm, 600 µm, 800 µm or 1000 µm
Wavelength range	200-800 nm (UV/VIS), 350-2500 (VIS/NIR) or 200-2500 nm (UV/VIS/NIR)
Connectors	Standard SMA-905 connectors (2x)
Wall thickness of vacuum chamber	5-40 mm
Vacuum	Max. 10^{-7} mbar
Temperature	-40°C to 100°C (-HT version 200°C)

Ordering Information

FC-VFT-xx50	• Vacuum feedthrough for 50 µm fibers, incl. SMA adapter, needs 2 extra SMA interconnects
FC-VFT-UVIR100	• As FC-VFT-xx50, for 100 µm broadband fibers
FC-VFT-UVIR200	• As FC-VFT-xx50, for 200 µm broadband fibers
FC-VFT-UVIR400	• As FC-VFT-xx50, for 400 µm broadband fibers
FC-VFT-UVIR600	• As FC-VFT-xx50, for 600 µm broadband fibers
FC-VFT-xx800	• As FC-VFT-xx50, for 800 µm fibers
FC-VFT-xx1000	• As FC-VFT-xx50, for 1000 µm fibers
ME-FI-SM-MM	• SMA fiber interconnect, 2 pieces needed for each vacuum feedthrough

Specify xx = UV for UV/VIS fiber cables, IR for VIS/NIR

Options

-HT	• High Temperature version (up to 200°C)
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Fiber-optic Homogenizers

MMA-UV/VIS-SMA Homogenizer



When connecting a multi-furcated fiber to a spectrometer or light source, light entering/exiting each of the fiber legs may or may not be uniform, so a fiber-optic homogenizer can be used to mix the signals to provide more uniform signal.

The compact MMA-UV/VIS-SMA fiber-optic homogenizer is made of anodized aluminum and has female SMA-905 connectors on both ends. Internally, a highly transmissive Suprasil-Rod with a diameter of 1 or

3 mm transmits the light from one end to the other (from bundle to single fiber) and perfectly mixes the modes.

The fiber-optic homogenizer can also be used as a mode stripper.

Technical data

Wavelength Range	200-2000 nm
Optical Rod Diameter Stabdurchmesser	3 mm or 1 mm
Lens Material	Suprasil 1
Housing Material I	Aluminum anodized
Fiber Connection	SMA-905, UNS 1/4"
Dimensions	Length 47.5 mm, Diameter 14 mm
Temperature	-30 °C to +100 °C

Ordering Information

MMA1-UV/VIS-SMA	• Homogenizer / Modestripper 1 mm UV/VIS diameter for SMA Connectors
MMA3-UV/VIS-SMA	• Homogenizer / Modestripper 3 mm UV/VIS diameter for SMA Connectors

Fiber Microscope Adapters



To easily mount an Avantes fiber-optic spectrometer to a microscope, a C-mount adapter is available. It connects to an SMA or FC/PC fiber-optic cable and features an outside diameter

of 38 mm, 35 mm long to slide inside the tube of a microscope. A special adapter with C-mount 1 inch-32 thread is available as AVS-MFA-SMA to screw onto a microscope.

Technical Data

	AVS-MFA-SMA	AVS-CMOUNT-SMA	AVS-CMOUNT-FCPC
Fiber-optic connection	SMA	SMA	FC/PC
Microscope mount	1 inch-32 Cmount thread	38 mm diameter	38 mm diameter
Material	Black anodized aluminum		

Ordering Information

AVS-MFA-SMA	• C-mount adapter for Olympus, SMA connector
AVS-CMOUNT-SMA	• C-mount adapter, SMA connector
AVS-CMOUNT-FCPC	• C-mount adapter, FC/PC connector

Reflection Probe Holders

RPH-1 Reflection Probe Holder

The RPH-1 is to be used with our standard reflection probes, which are 6.5 mm in diameter. The holder enables positioning of the probe tip in two angles: 45 degrees for diffuse reflection measurements and 90 degrees (normal to sample) for specular reflection. This assembly is mostly used to facilitate color measurements.

A setscrew is included to mount the probe into position. The RPH-1 is a small device, measuring only 60 by 30 by 30 millimeters. It's made of black anodized aluminum.



AFH-15 Angled Fiber Holder

To do an angled measurement with a small 1.5 mm reflection probe or 1.5 mm stainless steel ferrule terminated fibers, the AFH-15 is the ideal accessory. Offering angles including 15°, 30°, 45°, 60°, 75° and 90°, reflection measurements with differing incident and collection angle can be easily

made with multiple, separate fibers for illumination and detection.

All 11 holes have a diameter of 1.6 mm and are equipped with a setscrew to mount the probes or fibers into position. The AFH-15 is made of black anodized aluminum.



AFH-Ocular

Measurements on a small spot (less than 0.5 mm) can be challenging but the AFH-Ocular makes the job easier. The ocular enables visual location of the measurement spot on your sample. The holder is used in conjunction with our miniaturized reflection probe (FCR-7UV100-2-1x25) which has 7 x 100 µm fibers in a 6 around

1 configuration and the tip is 1 mm in diameter x 25 mm long.

Please note that a black cover over the ocular (not included) should be used during measuring to prevent ambient light from reaching the measurement spot.



Ordering Information

RPH-1	• Reflection probe holder for 45/90 degree mounting of 6.5 mm reflection probes
AFH-15	• Angled fiber probe holder for measuring under different angles, needs 1.5 mm ferrule terminated fibers.
FC-UVIR200-2-1.5x40	• Fiber cable, 200 µm UVIR fiber, 2 m long, one end with SMA connector, other end with stainless steel ferrule, OD=1.5 mm x 40 mm length.
AFH-Ocular	• Angled fiber probe holder for precise measurements under 45 degrees incl. Ocular
FCR-7UVIR100-2-1x25	• Reflection probe with 7x100 µm UVIR fibers to 1x25 mm stainless steel ferrule, 2 meter long with PVC/Kevlar protection sleeve and 2 SMA connectors

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

T/R Stages for Transmission and Reflection



This transmission and reflection stage is the ideal companion to make it easier to perform reflection and transmission measurements. The TR-Stage is a great accessory to perform and create multiple measurement set-ups.

The TR-stage consists of 3 different elements:

- The top plate can hold a COL-UV/VIS (included) or a 6.35 mm reflection probe. It also has a cover to shield against ambient light.

- The middle plate is intended to place the sample on.

- The bottom plate can be used to mount or position a COL-UV/VIS, AvaSphere-xx-IRRAD (xx= 30 or 50) or WS-2 Reference tile. With an additional plate, the TR-LSHAL-Holder, it can be used in combination with the AvaSphere-50-LS-HAL-12V as well (not included).

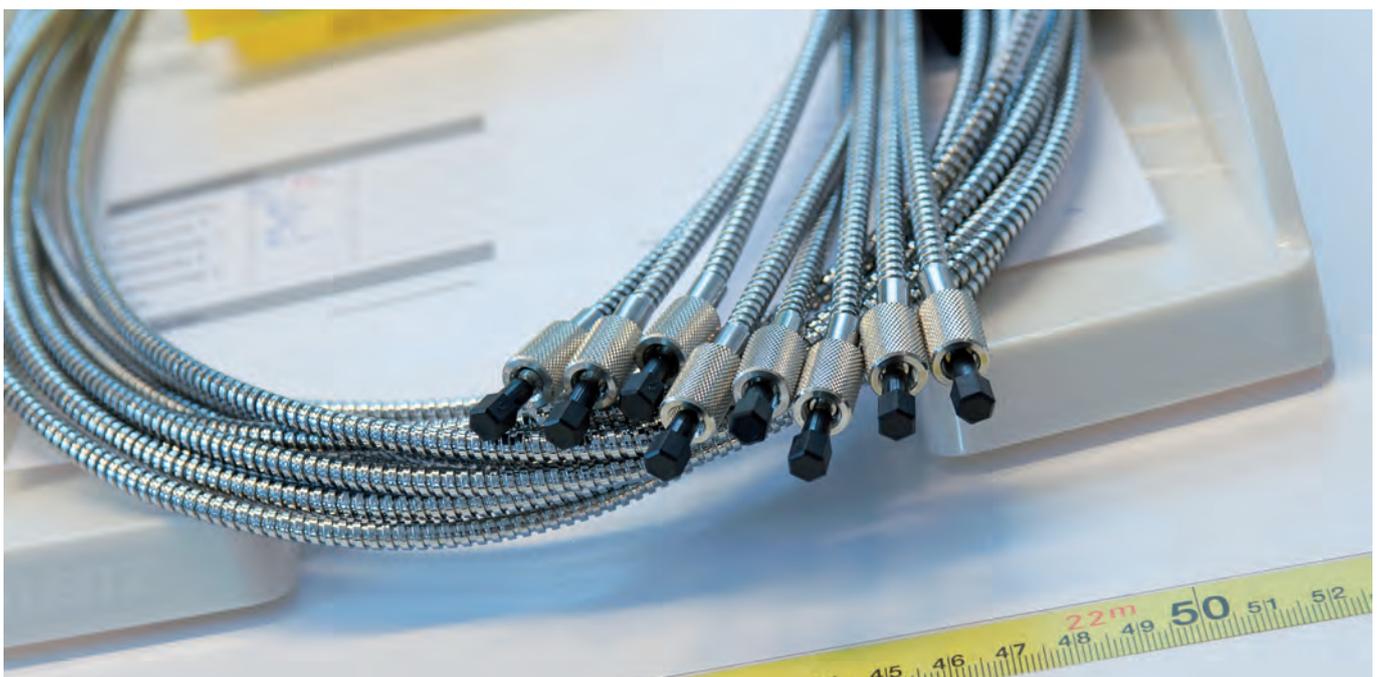
Ordering Information

TR-Stage

- Transmission stage for use with 30/50 mm Avasphere, WS-2 reference tile, COL-UV/VIS or 6.35mm probe.

TR-LSHAL-Holder

- Additional AvaSphere-50-LS-HAL-12V holder for TR-Stage



Fiber Interconnects

To connect one fiber to another, a fiber interconnect is needed. They can be useful for coupling patch cords to fiber-optic probes and other devices, or for any multiple-fiber application where coupling of standard optical fibers and accessories is preferable to creating costly and complex fiber-optic assemblies.

Bulkheads

Avantes bulkhead adaptors for TO-5 and TO-18 packages are ideal for coupling an LED to a fiber-optic cable: the back side has space for an LED.

ME-FI-SM-MM SMA interconnect



ME-FI-FC/PC-MM FC/PC interconnect



ME-SM-BC SMA Bulkhead



ME-FCPC-BC FC/PC Bulkhead



Ordering Information

ME-FI-SM-MM	• SMA Fiber interconnect, panel mountable
ME-FI-FCPC-MM	• FC/PC Fiber interconnect, panel mountable
ME-SM-BC	• SMA bulkhead adapter to TO-18
ME-SM-BC-S	• SMA bulkhead adapter to TO-5
ME-FCPC-BC	• FC/PC Bulkhead adapter



Accessories

1000

INTRODUCTION

To facilitate easier and more accurate measurements during an experiment, Avantes offers a wide selection of high quality accessories. From integrating spheres to cuvette holders, filter holders and fiber-optic multiplexers Avantes has you covered for your fiber-optic accessory needs.

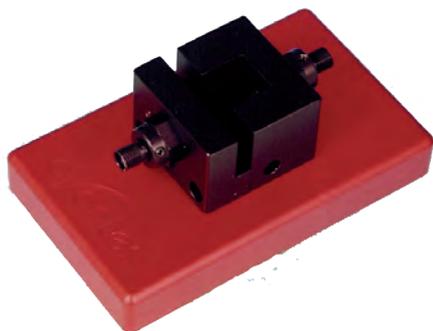
Avantes Accessories can be divided into several categories:

- USB to ethernet converter
- Cuvette holders. They are available in five different categories
 - 10 mm optical path, for UV/VIS/NIR absorbance measurements
 - 10 mm optical path, for UV/VIS fluorescence measurements
 - 10 mm optical path, for dual channel spectroscopy and fluorescence measurements
 - Variable length, from 10 to 100 mm for low absorption measurements
 - Direct-attached cuvette holders.
- Integrating spheres, available in three types:
 - Irradiance, for measuring radiometric and photometric quantities of LEDs and other light sources
 - Reflection, for measuring color parameters of object surfaces, such as L, a, b, hue, chromaticity
 - Reflection spheres with integrated light sources
- AvaTrigger external triggerbox device
- Inline or direct-attached filter holders and TTL-controlled shutters
- Inline or direct-attached fiber-optic attenuator
- Fiber-optic multiplexer, 1x16, 2x8 or 4x4 channels
- Optical table mounts for collimating lenses, as presented under fiber-optic accessories
- Flow cells for different types of applications:
 - Inline absorption measurements and process control 1/2" and 1/4" with 5 or 10 mm path length
 - Micro-flow cells for low volume, high pressure and HPLC applications
 - Long path flow cells for very low absorption measurements
- White and specular reflection tiles/standards to be used as a reference material for reflection measurements, such as color applications
- Power adapters and battery packs



Cuvette Sample Holders

CUV-UV/VIS



The CUV-UV/VIS, CUV-FL-UV/VIS and CUV-ALL-UV/VIS are especially designed for absorption and fluorescence measurements and should be used with standard 10x10 mm cuvettes. For non-standard cuvettes, adjustable ball-detents ensure repeatable placement and measurements at the same location. All cuvette holders have a 5 mm wide slit to hold filters and a cover to prevent ambient light from entering the light path.

The CUV-UV/VIS features two COL-UV/VIS collimating lenses with adjustable focus to maximize light throughput.

The CUV-FL-UV/VIS has the same specifications, but the collimating lenses are placed under an angle of 90 degrees for fluorescence measurements (to isolate excitation from emission wavelengths).

The other two ports on the CUV-FL-UV/VIS have SiO₂ coated aluminum mirrors (CUV-FL-MIRROR) to enhance the excitation and fluorescence signals.

The CUV-ALL-UV/VIS features four collimating lenses, all COL-UV/VIS, in two optical paths.

CUV-ALL-UV/VIS



For UV measurement Avantes offers quartz cuvettes. The CUV-10-2 has two optical windows for absorption measurements. The CUV-10-4 features four optical windows, ideal for fluorescence with the CUV-FL-UV/VIS or dual path measurements with the CUV-ALL-UV/VIS.

Technical Data

	CUV-UV/VIS	CUV-FL-UV/VIS	CUV-ALL-UV/VIS
Cuvette Dimensions	10 x 10 mm (lightpath)		
Fiber connection	2 x COL-UV/VIS, SMA	2 x COL-UV/VIS, SMA, 2 mirrors	4 x COL-UV/VIS, SMA
Filter slot	Max 5 mm wide		
Overall dimensions	100 x 60 x 40 mm	100 x 100 x 40 mm	
Cover	Black anodized aluminum with black PE insert, 45 x 45 x 80 mm		

Ordering Information

CUV-UV/VIS	• Cuvette Holder, 10 mm path, incl. 2 UV/VIS/NIR lenses and cover
CUV-FL-UV/VIS	• Fluorescence Cuvette Holder, 10 mm path, incl. 2 UV/VIS/NIR lenses under 90°, 2 x SiO ₂ coated aluminum mirrors and cover
CUV-ALL-UV/VIS	• Cuvette Holder 10 mm path, 2 beams, 4 x UV/VIS/NIR lenses and cover
CUV-FL-MIRROR	• SiO ₂ coated aluminum mirror
CUV-10-2	• Quartz Cuvette 10 mm, 2 windows, 3.5 ml
CUV-10-4	• Quartz Cuvette 10 mm, 4 windows, 3.8 ml

Temperature Controlled Cuvette Holders

For extra stability during demanding measurements such as fluorescence, Avantes offers the CUV-UV/VIS-TC, a temperature controlled cuvette holder. The temperature can be set anywhere between -30°C and +105°C with an accuracy of 0.05°C.

Other features include magnetic stirring, slit attenuation kit and fused-silica lens systems with SMA fiber-optic connectors. It can be combined with any AvaLight light source or AvaSpec spectrometer to create a powerful measurement system.

The CUV-UV/VIS-TC is available in fluorescence, absorption or combined fluorescence/absorption configurations. A special direct-

attached fluorescence configuration is available for coupling the Avalight-XE pulsed Xenon source for maximized fluorescence excitation energy.

Application areas enabled by the CUV-UV/VIS-TC series include DNA melting and annealing, protein thermodynamics, fluorophore characterization, enzyme kinetics and online thermocycling of biological particles.

CUV-UV/VIS-TC



Technical Data

Cuvette Dimensions	10 x 10 mm (lightpath)
Fiber connection	2 x COL-UV/VIS, SMA, 2 mirrors
Temperature control (Peltier)	-30°C to +105°C
TE control accuracy	± 0.05 °C
Stirring	Variable speed magnetic stirring
Overall dimensions	100 x 100 x 40 mm
Control unit	TE controller unit and circulation pump

Ordering Information

CUV-UV/VIS-TC-ABS	<ul style="list-style-type: none"> Temperature controlled cuvette holder absorbance Kit, includes sample compartment, Temperature-Controller, two QIL-UV imaging lenses, BATH 100 submersible pump, QSLITS optical slits, cover with access cap, tubing, cables and a stir bar
CUV-UV/VIS-TC-FL	<ul style="list-style-type: none"> Temperature controlled cuvette holder fluorescence Kit, same as CUV-UV/VIS-TC-ABS but with two QIL-UV imaging lens assemblies and two QMP mirror plugs
CUV-UV/VIS-TC-ABS/FL	<ul style="list-style-type: none"> Temperature controlled cuvette holder fluorescence & absorbance kit, same as CUV-UV/VIS-TC-ABS, but with two QIL-UV imaging lens assemblies, two QCL-UV collimating lens assemblies, and two QMP mirror plugs
CUV-UV/VIS-TC-AVXE	<ul style="list-style-type: none"> Base plate and support with AR-coated fused silica lens pair for excitation using the Avalight-XE pulsed Xe light sources

Accessories

CUV-TC-QCL-UV	<ul style="list-style-type: none"> Extra AR-coated UV/VIS collimating lens for CUV-UV/VIS-TC
CUV-TC-QIL-UV	<ul style="list-style-type: none"> Extra AR-coated UV/VIS imaging lens for CUV-UV/VIS-TC
CUV-TC-QMP	<ul style="list-style-type: none"> Spherical mirror plate with steering plate for CUV-UV/VIS-TC
CUV-TC-QFH	<ul style="list-style-type: none"> Filter holder for CUV-UV/VIS-TC
CUV-10-4	<ul style="list-style-type: none"> Quartz Cuvette 10 mm, 4 windows, 3.8 ml

Direct-attach Accessories

CUV-DA



Avantes offers a wide range of high quality direct-attach accessories, such as cuvette holders, filter holders and attenuators for the AvaLight series of light sources. In the table below an overview of direct-attach accessories for each light source can be found. For more information, please take a look at the following pages.

The last column is a combination of the attenuator, the cuvette holder and the filter holder in one easy to attach device.

CUV-ATT-DA



Ordering Information

Coupling to	Mounting	Round 1/2" Filter Holder	Cuvette Holder	Attenuator	Cuvette/ Filter Holder/ Attenuator
AvaLight-HAL-Mini	UNS thread	FH-DA-HAL-Mini	CUV-DA-HAL-Mini	ATT-DA-HAL-Mini	CUV-ATT-DA-HAL-Mini
AvaLight-DHS	Front plate	n/a	CUV-DA-DHS	n/a	n/a
AvaLight-DHc					
AvaLight-XE	SMA thread	FH-DA	CUV-DA	ATT-DA	CUV-ATT-DA
AvaLight-LED					
Fiber-optic	fiber	FH-INLINE	CUV-UV/VIS	ATT-INL-EXT	n/a

Direct-attach Variable In-line Filter Holder

As part of the wide range of direct-attach accessories, Avantes offers the FH-DA series of filter holders. They can hold 0.5 inch filters of 1-8 mm thick.

The filter holders are equipped with a quartz collimating lens for the UV/VIS/NIR range. Avantes offers a wide range of round 12 mm filters.

The FH-DA is available in two versions: the FH-DA for the Avalight-XE, Avalight-DHc and Avalight-LED. The FH-DA-HAL is designed to work seamlessly with the Avalight-HAL.

FH-DA



Technical Data

	FH-DA	FH-DA-HAL-Mini
Wavelength range	200-2500 nm	
Filter Dimensions	Round, 13 mm diameter, 1-8 mm thick	
Fiber connection	SMA-905 connector	
Light source	Avalight-DHc/XE/LED	Avalight-HAL-Mini
Light source mounting	SMA-905 thread	UNS thread (remove COL-UV/VIS)
Material	Black anodized aluminum	

Separate Round Filters

GL-WG305-12	Separate 12 x 3 mm long-pass filter > 305 nm
GL-KG3-12	Separate 12 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-12	Separate 12 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG395-12	Separate 12 x 3 mm long-pass filter > 395 nm
GL-GG475-12	Separate 12 x 3 mm long-pass filter > 475 nm
GL-OG515-12	Separate 12 x 3 mm long-pass filter > 515 nm
GL-OG550-12	Separate 12 x 3 mm long-pass filter > 550 nm
GL-NG9-1-12	Separate 12 x 1 mm Neutral Density filter, (transmission 10%, 400-1100 nm)
GL-NG9-2-12	Separate 12 x 2 mm Neutral Density filter, (transmission 1%, 400-1100 nm)
GL-NG9-3-12	Separate 12 x 3 mm Neutral Density filter, (transmission 0.1%, 400-1100 nm)

Ordering Information

FH-DA	<ul style="list-style-type: none"> • Direct-attach Filter Holder for 12 mm diameter filters, 1-8 mm thick, incl. one UV/VIS collimating lens.
FH-DA-HAL-Mini	<ul style="list-style-type: none"> • As FH-DA, meant for the Avalight-HAL-Mini light source.

For the latest information,
go to www.avantes.com

CUV Direct-attach Cuvette Holders

CUV-DA



To mount a cuvette holder directly to your light source, Avantes offers a range of direct-attached cuvette holders. The CUV-DA connects to the AvaLight-DHc, -XE and -(HP) LED light sources, the CUV-DA-DHS to the AvaLight-DHS and AvaLight-DHS-BAL and the CUV-DA-HAL to the AvaLight-HAL. These devices can be used for either absorbance or fluorescence measurements.

All CUV-DA cuvette holders feature two 90-degree and one 180-degree threads that allow the COL-UV/VIS collimating lens to be connected for absorbance or fluorescence setups. Each of CUV-DA

series cuvette holders includes two SiO₂ aluminum mirrors to further enhance fluorescence signals. These are mounted at 90 degrees to the excitation source and emission output. The CUV-DA has a 5 mm wide filter slot.

For the AvaLight-HAL and the AvaLight-DHS the direct-attached cuvette holders can be mounted directly on the front panel of the light source by removing the standard filter holder.

Technical Data

	CUV-DA			CUV-DA-DHS	CUV-DA-HAL-Mini
Lightsource	AvaLight-DHc	AvaLight-(HP)LED	AvaLight-XE	AvaLight-DH-S	AvaLight-HAL-Mini
Wavelength range	200-2500 nm				
Cuvette Dimensions	10 x 10 mm (lightpath)				
Light source connection	SMA thread incl col. lens			Mounting plate	UNS-thread (remove COL-UV/VIS)
Fiber connection	1 x COL-UV/VIS, SMA-905 connectors				
Fluorescence mirrors	2 x SiO ₂ coated aluminum mirrors				
Filter slit	Max. 5 mm wide				n.a.

Ordering Information

CUV-DA	<ul style="list-style-type: none"> Direct-attach 10 mm cuvette holder for AvaLight-DHc/XE/LED, incl. COL-UV/VIS lens and 2 mirrors
CUV-DA-DHS	<ul style="list-style-type: none"> Direct-attach 10 mm cuvette holder for AvaLight-D(H)-S, incl. COL-UV/VIS lens and 2 mirrors
CUV-DA-HAL-Mini	<ul style="list-style-type: none"> Direct-attach 10 mm cuvette holder for AvaLight-HAL(S)-Mini, incl. COL-UV/VIS lens and 2 mirrors
CUV-FL-MIRROR	<ul style="list-style-type: none"> SiO₂ coated aluminum mirror
CUV-10-4	<ul style="list-style-type: none"> Quartz Cuvette 10 mm, 4 windows, 3.8 ml
CUV-COVER-DA	<ul style="list-style-type: none"> Cover for CUV-DA and CUV-DA-HAL-Mini

Direct-attach Fiber-optic Attenuators

When light intensity has to be reduced, the direct-attached attenuator is a great choice with your AvaLight series light sources. The attenuator helps in situations where detector saturation is an issue. It is attached to the light source and has a SMA connector to couple to other measurement devices and your spectrometer.

The attenuation can be set from 0-100%, which can be fixed with a set screws. It is supplied with a UV/VIS/NIR collimating lens. The ATT-DA series attenuators come in two

versions: the ATT-DA is meant to be used with the AvaLight-DHc, the AvaLight-XE and AvaLight-LED. The ATT-DA-HAL is meant to be used with an AvaLight-HAL light source.

ATT-DA



Technical Data

	ATT-DA	ATT-DA-HAL-Mini
Wavelength range	200-2500 nm	
Attenuation	0-100%	
Iris aperture	0.0 - 12.0 mm	
Iris construction	2 x 5 leaves	
Fiber connection	SMA-905 connector	
Light source	AvaLight-DHc/XE/LED	AvaLight-HAL-Mini
Light source mounting	SMA-905 thread	UNS-thread (remove COL-UV/VIS)
Material	Black anodized aluminum	
Dimensions	27 mm round x 49 mm	37 x 41 x 57 mm

Ordering Information

ATT-DA	• Direct-attach Fiber-optic Attenuator, 0-100%, SMA connector
ATT-DA-HAL-Mini	• As ATT-DA, for AvaLight-HAL-Mini

Did you know
Avantes is specialized
in custom made
fiber-optic cables?

Cuvette Holders with Attenuator and Filter Holder

CUV-ATT-DA



Have the most flexible setup with the combined cuvette holder, attenuator and filter holder. You can control the light throughput from 0-100%, which can be fixed with a set screw. Use the cuvette holder for any cuvette up to 10x10 mm and add half inch diameter (12-13 mm) filters of 1-8 mm thick.

The combined direct-attached accessory is available in two versions: the CUV-ATT-DA is used with the AvaLight-DHc (Deuterium and Halogen), AvaLight-XE (Xenon) and AvaLight-LED. The CUV-ATT-DA-HAL is meant for the AvaLight-HAL (Halogen) light source.

Technical Data

	CUV-ATT-DA	CUV-ATT-DA-HAL-Mini
Wavelength range	200-2500 nm	
Cuvette Dimensions	10 x 10 mm (lightpath)	
Attenuation	0-100%	
Filter slit	Max 5 mm wide	
Fiber connection	SMA-905 connector	
Fluorescence mirrors	2 x SiO ₂ coated aluminum mirrors	
Light source	AvaLight-DHc/XE/LED	AvaLight-HAL-Mini
Light source mounting	SMA-905 thread	UNS-thread (remove COL-UV/VIS)
Material	Black anodized aluminum	

Ordering Information

CUV-ATT-DA	<ul style="list-style-type: none"> • Combined direct-attach Fiber-optic Attenuator, Filter Holder and Cuvette Holder, SMA connector
CUV-ATT-DA-HAL-Mini	<ul style="list-style-type: none"> • As CUV-ATT-DA, but for AvaLight-HAL-Mini light source
CUV-COVER-DA	<ul style="list-style-type: none"> • Cover for DA cuvette holders



Variable In-line Filter Holders

When an in-line filter is needed, Avantes offers two types of in-line filter holders: the FH-INLINE-1" and the FH-INLINE. The FH-INLINE-1" is designed to hold one inch filters from 1-60 mm thick. The FH-INLINE is designed for 1/2" or 12-13 mm filters of 1-8 mm thick.

Both in-line filter holders come with two quartz collimating lenses for the UV/VIS/NIR range. Avantes offers a wide range of round 12 mm filters (for FH-INLINE). For more specifications please see the table below.

FH-INLINE-1"



FH-INLINE



Technical Data

	FH-INLINE	FH-INLINE-1"
Wavelength range	200-2500 nm	
Filter Dimensions	Round, 12-13 mm diameter, 1-8 mm thick	Round, max 1 inch (25.4 mm) diameter, 1-60 mm thick
Fiber connection	2 SMA-905 connectors	
Material	Black anodized aluminum	
Dimensions	round 20 x 50 mm	81 x 41 x 51 mm

Separate Round Filters

GL-WG305-12	Separate 12 x 3 mm long-pass filter > 305 nm
GL-KG3-12	Separate 12 x 3 mm band-pass filter, transparent > 325 nm and < 700 nm
GL-BG28-12	Separate 12 x 3 mm band-pass filter, transparent > 360 nm and < 500 nm
GL-GG395-12	Separate 12 x 3 mm long-pass filter > 395 nm
GL-GG475-12	Separate 12 x 3 mm long-pass filter > 475 nm
GL-OG515-12	Separate 12 x 3 mm long-pass filter > 515 nm
GL-OG550-12	Separate 12 x 3 mm long-pass filter > 550 nm
GL-NG9-1-12	Separate 12 x 1 mm Neutral Density filter, (transmission 10%, 400-1100 nm)
GL-NG9-2-12	Separate 12 x 2 mm Neutral Density filter, (transmission 1%, 400-1100 nm)
GL-NG9-3-12	Separate 12 x 3 mm Neutral Density filter, (transmission 0.1%, 400-1100 nm)

Ordering Information

FH-INLINE	<ul style="list-style-type: none"> In-line Filter Holder for 12-13 mm diameter filters 1-8 mm thick, incl. UV/VIS collimating lenses and SMA connectors
FH-INLINE-1"	<ul style="list-style-type: none"> Inline filterholder for 1" filters, max 60 mm optical path, incl 2 collimating lenses and SMA connectors.

In-line Fiber-optic Attenuators

ATT-INL-EXT



For all UV-VIS-NIR applications and ATT-INL-EXT setups where light intensity has to be reduced, Avantes offers the inline fiber-optic attenuator (ATT-INL-EXT) and the direct attached fiber-optic attenuator (ATTDA). This device is an iris attenuator which controls light throughput to avoid detector saturation. The ATT-INL-EXT is coupled between two SMA terminated fiber-optic cables, whereas the ATT-DA can

be connected directly to the light source. Both devices consist of two UV/VIS/NIR collimating lenses mounted on either side of an adjustable iris. The attenuation can be set from 0-100% and can be fixed with a set screw.

Technical Data

Wavelength range	200-2500 nm
Attenuation	0-100%
Iris aperture	0.0 - 12.0 mm
Iris construction	2 x 5 leaves
Fiber connection	2 SMA-905 connectors, incl. 2 COL-UV/VIS collimating lenses
Material	Black anodized aluminum
Dimensions	60 x Ø 25 mm

Ordering Information

ATT-INL-EXT • In-line Fiber-optic Attenuator, 0-100%, SMA connectors

Variable Pathlength Cuvette Holders

CUV-VAR-UV/VIS



For low absorption measurements and flow cell cuvettes, the CUV-VAR-UV/VIS cuvette holder is the ideal solution.

It features a variable, adjustable path length, ranging from 10-160 mm, ensuring maximum flexibility. It can be used as a standard cuvette holder with a 10 mm path length, as a filter holder with 2 mm path length or any path length up to 160 mm.

This item is equipped with two COL-UV/VIS collimating lenses to support applications in the 200-2500 nm wavelength range.

Technical Data

Base Dimensions (L x W x H)	200 x 80 x 25 mm
Fiber connection	2 x COL-UV/VIS, SMA connectors
Optical path	10-160 mm
Cuvette holder insert	Minimal optical path 10 mm.
Focal height	15 mm from base plate
Overall dimensions (L x W x H)	200 x 96 x 62 mm

Ordering Information

CUV-VAR-UV/VIS • Cuvette Holder with variable 10-160 mm path, incl. 2 COL-UV/VIS collimating lenses

Integrating Spheres

An integrating sphere works as a light collector. The light collected can be used as a diffuse illumination or measurement source. The basic principle is that light enters the sphere through the sample port, goes through multiple reflections on the highly reflective, Lambertian surface of the sphere and is scattered uniformly around the interior of the sphere. Behind a baffled port inside the sphere which is independent of the angular properties of the sample port, a fiber-optic cable collects a homogenized light signal and carries it to the spectrometer. The baffle is very significant as it prevents first reflections from entering the detection fiber.

The AvaSphere series integrating spheres are available with active diameters of 30, 50 and 80 mm and an SMA port at 90 degrees for collecting the irradiance and reflection signals. The reflection spheres feature an additional SMA-connector port at 8 degrees from normal (from sample port) for direct illumination. This port couples external light into the sphere through a fiber-optic cable connected to a COL-UV/VIS collimating lens. The sample port diameters are 6 mm for the AvaSphere-30, 10 mm for the AvaSphere-50 and 15 mm for the AvaSphere-80.

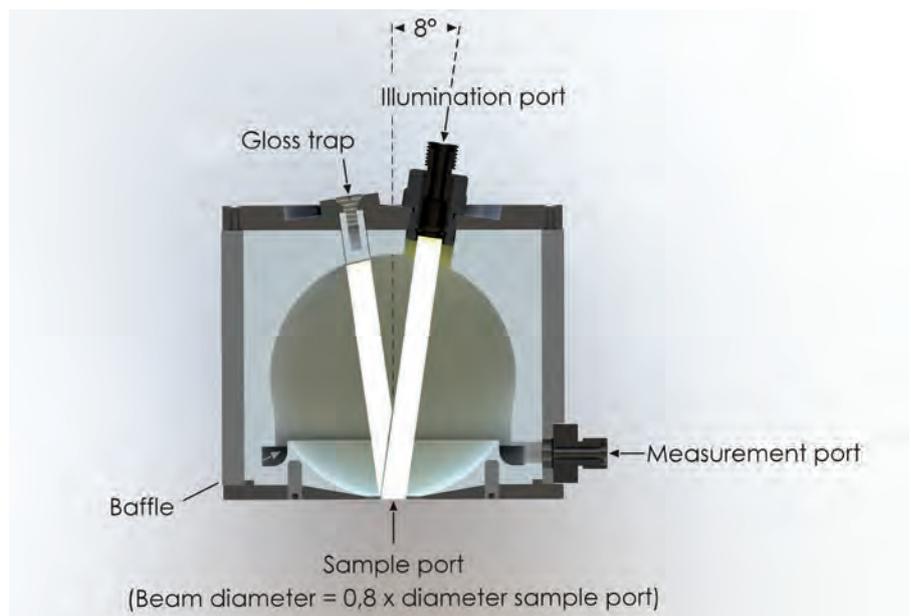
All sample ports are knife-edge, ensuring a near 180 degree field of view of the sample port. The irradiance version of the integrating sphere can be used for measurements of light sources, such as lasers, LEDs and incandescent sources.

For irradiance measurements of 5 mm cylindrical LEDs, a special adapter is available for the AvaSphere-50/80-IRRAD. This adapter ensures correct and reproducible positioning of the LEDs inside the sphere.

The AvaSphere reflection version is used for the measurement of total integrated reflectance of a surface, as well as for color measurements and fluorescence spectroscopy on solids/powders. The principle of measurement is based on direct illumination and indirect reflection. The AvaSphere-50-LS-HAL with internal light source can be used as a uniform source and is available with an intensity calibration file.

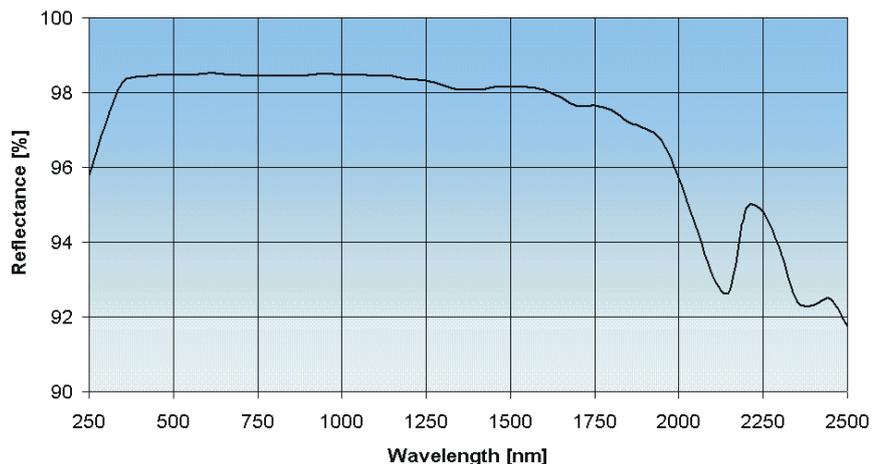
The inside of the integrating spheres is made of a highly reflective diffuse PTFE material. This provides over 96% reflectance over a wide wavelength range of 250-2500 nm. For the AvaSphere-50-REFL a special black gloss-trap is available to exclude specular reflection in the measurement. Please order this option when ordering the sphere. In case specular reflection needs to be included, a white reflective part, which is standard on all AvaSphere-50-REFL, can be mounted in the position of the gloss-trap.

AvaSphere-30-REFL



Reflection Integrating Sphere Drawing for AvaSphere-50-REFL

Reflectance Factor ODM



Reflection Curve AvaSphere

Technical Data

	AvaSphere-30	AvaSphere-50	AvaSphere-80
Internal diameter (mm)	30	50	80
Sample port diameter (mm)	6	10	15
External Dimensions	59.5 mm diameter 40 mm height	69.5 mm diameter 60 mm height	109 mm diameter 95 mm height

Ordering Information

AvaSphere-30-IRRAD	• Integrating Sphere 30 mm for light measurements (250-2500 nm), Sample-port 6 mm
AvaSphere-50-IRRAD	• Integrating Sphere 50 mm, Sample-port 10 mm
AvaSphere-80-IRRAD	• Integrating Sphere 80 mm, Sample-port 15 mm
AvaSphere-30-REFL	• Integrating Sphere 30 mm for reflection (250-2500 nm), Sample-port 6 mm, 2 SMA port
AvaSphere-50-REFL	• Integrating Sphere 50 mm for reflection, Sample-port 10 mm
AvaSphere-80-REFL	• Integrating Sphere 80 mm for reflection, Sample-port 15 mm
AvaSphere-50-LS-HAL-12V	• Integrating Sphere 50 mm for reflection, built-in halogen light source, sample-port 10 mm
AvaSphere-LED-ADR	• Cylindrical Adapter to hold 3, 5, 8 mm LED's inside the AvaSphere-50-IRRAD
AvaSphere-LED-ADR-80	• As AvaSphere-LED-ADR, but for AvaSphere-80-IRRAD
AvaSphere-GT50	• Optional Gloss-trap for AvaSphere-50-REFL, coated with black absorbing material. Only in combination with AvaSphere-50-REFL.
AvaSphere-GT50-W	• Gloss-trap coated with white material to include specular reflection. Standard included in AvaSphere-50-REFL.
AvaSphere-50-HOLD	• WS-2 (-GEM) Tile holder for AvaSphere-50-REFL/LS-HAL-12V
AvaSphere-COL-PLUG-W	• Optional replacement for collimating lens on top of AvaSphere-50-REFL to realise IRRAD functionality.

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

Integrating Spheres with Internal Halogen Light Source

Providing up to 160 times more light on your sample for a reflection measurement relative to our standard reflectance integrating sphere, the AvaSphere-50-LS-HAL-12V is a valuable instrument for reflection applications. It is a combination of an integrating sphere and a halogen light source. The sphere provides diffused halogen light on your sample without the losses associated with fiber-optic coupling. It has a direct collimated SMA-port for collection of the reflection signal with any of our AvaSpec spectrometers.

It's mostly useful for dark or low reflecting materials and NIR spectral measurements

where signal strength can be limited. It is also very useful for measuring gem stones. In the application section of this catalog a complete gemology setup can be found.

The AvaSphere-50-LS-HAL-12V has an internal diameter of 50 mm, a sample port of 10 mm and an SMA terminated reference port. The 5W halogen lamp is stabilized and cooled with forced airflow. A 12V power supply is included.

The switch line makes it possible to remotely switch the lightsource on/off with a TTL signal.

AvaSphere-50-LS-HAL-12V



Technical Data

Wavelength range	360-2500 nm
Internal diameter	50 mm
Sample port diameter	10 mm
Color temperature	2850 K
Stability/Drift	< 0.1% / h
Bulb life	4.000 hrs
Power requirement	12VDC, 1A

Ordering Information

AvaSphere-50-LS-HAL-12V	• Integrating sphere 50 mm for reflection (360-2500 nm), including 5W halogen lightsource, sample port 10 mm diam., 2 SMA ports (reflection and reference) and 12V power supply.
AvaLight-HAL-B-5W	• Replacement 5W halogen bulb for AvaSphere-50-LS-HAL-12V
IC-DB26-AvaSphere-0,5	• Interface cable to control switchline with AvaSpec
AvaSphere-50-HOLD	• WS-2(-GEM) tile holder for AvaSphere-50-LS-HAL-12V for gemology applications

Pre-configured spectrometers can be shipped within 24 hours

Large Integrating Spheres

For measurement of high powered LEDs and sources, Avantes offers the AvaSphere-100, -150 and -200. The number corresponds with the internal diameter of the spheres in millimeters.

The 100, 150 and 200 models come with three ports: at 0, 90 degrees and NP. The port of your choice is fitted with a baffled SMA-905 connector, please specify when ordering. Either of the other two ports can be used for illumination or sampling. The default sample port sizes are typically 25% of the sphere's diameter. Port plugs or reducers are available on request.

All spheres can be attached to spectrometers via fiber-optic cables and the entire system can be irradiance calibrated to measure total flux of a lamp under test.



Technical Data

	AvaSphere-100	AvaSphere-150	AvaSphere-200
Wavelength range	400-1100 nm	400-1100 nm	400-1100 nm
Internal diameter	102 mm	152 mm	203 mm
Port diameters	25.4 mm	38.1 mm	50.8 mm
Port Reducers	10 mm	10 mm	10 mm
External Dimensions	118 mm	168 mm	218 mm

Ordering Information

AvaSphere-100	• Integrating Sphere, 100 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-100-SMA	• Additional SMA port for the AvaSphere-100
AvaSphere-100-PR10	• Port reducer for the AvaSphere-100 to 10 mm
AvaSphere-100-PP	• Port plug for unused ports for the AvaSphere-100
AvaSphere-150	• Integrating Sphere, 150 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-150-SMA	• Additional SMA port for the AvaSphere-150
AvaSphere-150-PR10	• Port reducer for the AvaSphere-150 to 10 mm
AvaSphere-150-PP	• Port plug for unused ports for the AvaSphere-150
AvaSphere-200	• Integrating Sphere, 200 mm, 3 ports (0,90,NP), 1 baffled SMA port, incl. Postmount
AvaSphere-200-SMA	• Additional SMA port for the AvaSphere-200
AvaSphere-200-PR10	• Port reducer for the AvaSphere-200 to 10 mm
AvaSphere-200-PP	• Port plug for unused ports for the AvaSphere-200

For the latest information,
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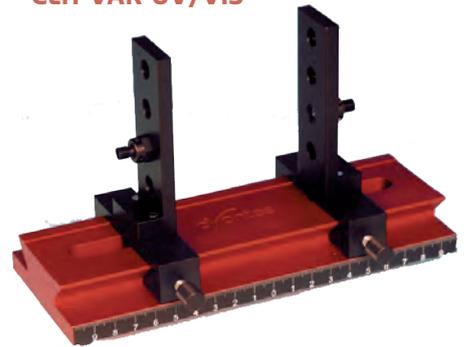
Variable Collimating Lens Holders

For transmission measurements of samples of various sizes and thicknesses, the variable collimating lens holder is the perfect tool. The vertical bars can be adjusted to samples up to 160 mm thick. The base is made of anodized aluminum and features adjustable mount bars. Each bar has four 3/8"-24 threaded holes for COL-UV/VIS collimating

lenses. Adjusting the bars is easy, simply loosen the screws and slide.

Two COL-UV/VIS collimating lenses are included with the variable collimating lens holder.

CLH-VAR-UV/VIS



Technical Data

	Base	Mounting bars
Dimensions	200 x 80 x 25 mm, total height 120 mm	35 x 7 mm thick
Threads	n.a.	4 holes 3/8"-24, 20 mm apart
Collimating Lenses	n.a.	2 COL-UV/VIS

Ordering Information

CLH-VAR-UV/VIS	• Variable Collimating Lens Holder, including 2 COL-UV/VIS lenses
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Download the latest software for your AvaSpec at www.avantes.com

AvaTripod

AvaTripod



The AvaTripod is a flexible and versatile accessory, which is useable in various applications.

The top of the tripod has an attachment head which features two holes; one measuring 6.8 mm in diameter to hold the barrel of a cosine corrector (CC-UV/VIS) or a reflection probe and a setscrew to hold the probe or cosine corrector in place.

The second hole is a 3/8"-24 threaded hole for a COL-UV/VIS collimating lens.

The head can be fixed at any position, at any angle with an adjustable height of 200-300 mm.

Technical Data

Dimensions	250 x 250 x 300 mm Max 75 x 75 x 200 mm (folded)
Threads	1 hole 3/8"-24 for COL-UV/VIS collimating lens 1 hole 6.8 mm diameter with setscrew for FCR probes and cosine correctors
Height adjustment	200-300 mm

Ordering Information

- AvaTripod**
- Tripod with COL-UV/VIS thread and 6.8 mm hole for FCR and CC-UV/VIS

AvaTrigger External Trigger Box

AvaTrigger



We made it smaller and more sensitive... Introducing the new AvaTrigger. Designed for use with any AvaSpec-USB2 spectrometer, it enables two different external triggering methods: optical and manual.

The optical trigger is useful for measuring pulsed light sources, such as solar simulations. Your Avantes spectrometer can start integrating within 1.5 microseconds after receiving the signal from the AvaTrigger. Alternatively, you can specify a delay time if you are interested in measuring spectral output against time (temporal stability). The AvaTrigger has an SMA-905 connector

to easily couple with any accessory or light source from Avantes' extensive line-up.

The sensitivity of the optotrigger can be adjusted by a potentiometer at the front. A green indicator LED on the front panel of the AvaTrigger shows a short pulse when a TTL pulse is sent to your spectrometer.

The IC-DB26-2 interface cable required to connect the AvaTrigger with your Avantes spectrometer is included in the box.

Technical Data

Trigger Input	Opto	Pushbutton
Internal Delay time to TTL output	Ca. 300 ns*	20 µsec
Minimal pulse duration Trigger in	10 µsec	
Power consumption	5 mA @ 5VDC (internal)	
IO connector to AvaSpec	Pin 3 (5VDC), Pin 4 (hardware trigger to AvaSpec), pin 8 (enable trigger), pin 10 GND	
Dimensions	75 x 78 x 37 mm	
Weight	260 g	

*depending on the slew rate of the light source

Ordering Information

- AvaTrigger-USB2**
- External trigger source for all AvaSpec-USB2/EVO spectrometers, incl. IC-DB26-2

Fiber-Optic Switch (FOS-2-INL)

Avantes' fiber-optic switch (FOS) is the ideal accessory to correct light source drift.

This FOS is operated electronically via TTL signals from an external source or one of our AvaSpec spectrometers. TTL signals can be provided either by an external device or by an AvaSpec spectrometer connected via an interface cable (IC-DB-xxx, see ordering information below).

The FOS is coupled in the optical paths between SMA-terminated fibers and features four COL-UV/VIS collimating lenses (UV/VIS/NIR).

Both light paths can be controlled independently via the two TTL signals.

The industrial-graded shutter motors inside support heavy usage of the instrument. With its 5 million cycles, 24/7 operation is supported in most cases.

To operate the FOS, a PS-12V/2.08A power supply and interface cable are required (ordered separately).

FOS-2-INL



Technical Data

Wavelength range	200 - 2500 nm
Fiber connection	4 SMA-905 connectors, incl. 4 COL-UV/VIS collimating lenses
Shutter frequency	Max. 5 Hz
Shutter delay	15 ms
Shutter attenuation	-1.0 dB*
Material	Black anodized aluminum
Dimensions	34 x 58 x 45 mm
Lifetime shutter	5,000,000 cycles (typical)
Power	12V DC/500 mA

*Attenuation is measured using 600 µm core fibers.

Ordering Information

FOS-2-INL	• In-line fiber-optic switch, 2 independently controlled optical paths. Includes 4 COL-UV/VIS collimating lenses. Needs 12V powersupply and interface cable (not included)
IC-DB26-FOS-SHUTTER-0.6	• Interface cable from AvaSpec-EVO platform to FOS, 0.6 m
IC-DB26-FOS-SHUTTER-2.0	• Interface cable from AvaSpec-EVO platform to FOS, 2 m
PS-12V/2.08A	• Power supply 12V DC, 2.08A, necessary to operate FOS

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light sources and accessories

Direct-Attach Shutter

DA-Shutter



For accurate results during a transmission, absorption, reflection, irradiance or color measurement at different integration times, a good dark measurement is necessary. Taking this dark measurement often leads to having to undertake manual actions, like covering the sensor or switching off the light. This might prove to be problematic with certain applications because of the time and place or operator restraints.

Our solution: a remote-controlled shutter, positioned between the spectrometer entrance and the input fiber.

Avantes' direct-attach shutter is the ideal accessory to facilitate automatic shuttering of a spectrometer. This shutter is operated via TTL pulses from either an external source or an AvaSpec spectrometer through a cable

(IC-DB26-AS-SHUTTER-0.6, to be ordered separately).

The DA-Shutter switch unit is directly attached to the spectrometer's SMA input connector. The fiber that is normally connected to the spectrometer is then connected to the DA-Shutter. This switch unit, as well as the power source and TTL control signal, is connected to the control box.

The industrial-graded shutter motor used inside will support heavy usage of the instrument. With its 5,000,000 cycles, 24/7 operation is supported in most cases.

To operate the DA-Shutter, a PS-12V/2.08A 12 volt DC power adapter is required (to be ordered separately).

Technical Data

Wavelength range	200-2500 nm
Fiber connection	SMA-905 connector
Spectrometer connection	SMA-905 connector (female)
Shutter frequency	Max. 5 Hz
Shutter delay	15 ms
Attenuation/amplification DA-Shutter	+0.6 dB (AvaSpec HSC/HERO), -1.5 dB (AvaSpec HSC/NIR)*, +0.6 dB (AvaSpec-ULS/Mini)
Material	Black anodized aluminum
Dimensions switch unit (DxH)	30 x 38 mm
Dimensions control box (HxLxW)	28 x 58 x 45 mm
Power	12V DC/500 mA
Lifetime shutter	5,000,000 cycles (typical)

*Attenuation is measured using 600 μ m core fibers

Ordering Information

DA-Shutter	• Direct-attach shutter, one optical path, including control box. Needs 12V power supply and interface cable (not included)
IC-DB26-DA-AS-SHUTTER-0.6	• Interface cable for AvaSpec-EVO platform to DA-Shutter, 0.6 m
IC-DB26-DA-AS-SHUTTER-2	• Interface cable for AvaSpec-EVO platform to DA-Shutter, 2 m
PS-12V/2.08A	• Power supply 12 VDC, 2.08 A, necessary for DA-Shutter

Fiber-optic Multiplexer (FOM)

To configure systems which enable a single light source and spectrometer to make multi-point serial measurements, Avantes offers the FOM fiber-optic multiplexer. The device is available in three different configurations: 1 input to 16 outputs, 2 inputs to 8 outputs or 4 inputs to 4 outputs. The FOM consists of a precisely controlled stepper motor and a rotary block. The optical path is coupled through multiple COL-UV/VIS collimating lenses.

The fiber-optic multiplexer is controlled via a USB-connection to a PC. The FOM software enables full control over the

switching order, switching time and delay time and operates as a stand-alone unit. To integrate the FOM with AvaSpec spectrometers and your own devices the FOM-DLL software development kit is available and should be ordered separately.

Applications for the FOM include process control, where multiple locations need to be measured with multiple probes, all with one spectrometer and/or light source.

FOM-UVIR400-2x8



Technical Data

	FOM-UVIR400-1x16	FOM-UVIR400-2x8	FOM-UVIR400-4x4
Multiplex Channels	1 x 16	2 x 8	4 x 4
Optical Throughput	> 60 % (based on 400 µm fibers)		
Wavelength Range	200-2500 nm (UV/VIS/NIR)		
Fibers	Standard max. 400 µm, different dimensions available on request		
Connectors	All SMA-905		
Optical Repeatability	> 99%		
Switching Time	< 60 ms between adjacent positions		
Interface	USB 2.0		
Power Requirement	100-230 VAC, 60VA		
Dimensions	244 x 144 x 354 mm		

Ordering Information

FOM-UVIR400-1x16	• Fiber-optic Multiplexer, 1 x 16 channels, 400 µm fibers
FOM-UVIR400-2x8	• Fiber-optic Multiplexer, 2 x 8 channels, 400 µm fibers
FOM-UVIR400-4x4	• Fiber-optic Multiplexer, 4 x 4 channels, 400 µm fibers

Options

FOM-DLL	• Interface DLL package for Fiber-optic Multiplexer (FOM-UVIR400-1x16 and FOM-UVIR400-2x8, and FOM-UVIR400-4x4) for Windows
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Direct-attach Beam Splitter/Combiner



The Beam Splitter gives you a flexible option for using dual light sources or spectrometers. The small size of the beam splitter allows it to directly mount to the front of any AvaSpec spectrometer or AvaLight lightsource, eliminating the fiber interface. Another advantage is that your existing

systems can be easily upgraded to a two channel system. Being highly adaptable, the Beam Splitter enables easy measurement of two different applications at the same time (for example a fluorescence and a absorption measurement).

Technical Data

Wavelength range	250-2000nm
Throughput	Ca. 25%
Temperature range	0-40 C
Switching time open	15 ms
Switching time close	30 ms
Maximum frequency	10 Hz
Power supply	5VDC, 0.3A (max power 1.5W)
Fiber connection	SMA-905 connector
Material mechanical	Black anodized aluminum
Material optical	UV Fused silica
Dimensions (LxWxH)	44 x 34 x 63 mm *
Weight	184 grams
	* Exclusive COL-UV/VIS and I/O connector

Ordering Information

BSC-DA	<ul style="list-style-type: none"> • Direct-Attach Beam Splitter / Combiner, includes IC-DB26-BEAM-0.6 (0.6 m interface cable), needs extra PS-5V / 1.1 A power supply
IC-DB26-BEAM-2	<ul style="list-style-type: none"> • Interface cable (2 meters long)

In-Line Flow Cells

For in-line absorbance or fluorescence measurements, Avantes offers the in-line flow cells. They are available for tubing diameters of 1/4, 1/2 and 1 inch. The flow cells consist of Swagelok union cross tube fittings and two UV/VIS/NIR collimating lenses.

The optical path depends on the size of the flow cell: the 1/4" version has an optical path of 5 mm, the 1/2" of 10 mm and the 1" version 20 mm. They feature SMA-905 connectors for easy coupling to any of our wide range of fiber-optic cables or bundles

All flow cells come with variable focusing to optimize light throughput over the spectral range.

All flow cells are also available in high temperature configurations (up to 200°C). Special flow cells for gasses and liquids are also available and are designed to withstand pressures up to 100 bar.



Technical Data

	1/4" flow cell	1/2" flow cell	1" flow cell
Optical path	5 mm	10 mm	20 mm
Sample volume	62 µl	124 µl	248 µl
Wavelength range	200-2500 nm		
Fiber connection	2 x SMA-905 connectors		
Collimating optics	Plano Convex, focal length 8.7 mm		
Max. Temperature	80°C (HT version till 200°C available on request)		
Max. Pressure	10 bar (Special Gasflowcell up to 100 bar)		
Material	Stainless steel for the fitting, black anodized aluminum for the SMA-905 connectors		
Overall dimensions	55 x 45 x 15 mm	72 x 50 x 22 mm	98 x 60 x 38 mm

Ordering Information

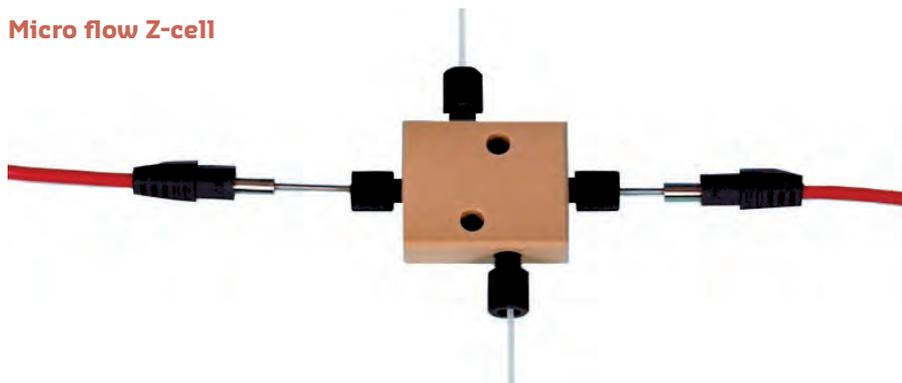
Flowcell-1/4"	• Flow cell 1/4" with variable SMA adapter, 5 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1/2"	• Flow cell 1/2" with variable SMA adapter, 10 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1"	• Flow cell 1" with variable SMA adapter, 20 mm path length, incl. 2 UV/VIS/NIR lenses
Flowcell-1/4"-FL	• Fluorescence Flow cell 1/4" with 2 SMA adapters, incl. 1 UV/VIS/NIR lens
Flowcell-1/4"-5-HPHT	• Flow cell for gasses and liquids, 1/4", 5 mm optical path length with SMA adapter, including 2 UV/VIS/NIR lenses, high pressure 100 bar, high temp 200°C.
Flowcell-1/4"-50-HPHT	• Flow cell for gasses and liquids, 1/4", 50 mm optical path length with SMA adapter, including 2 UV/VIS/NIR lenses, high pressure 100 bar, high temp 200°C.

Option

-HT	• High temperatures up to 200°C
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Micro Flow Cells

Micro flow Z-cell



For in-line measurements of low liquid volumes, Avantes offers our micro flow cells. The micro flow cells feature a Z-design and can easily be coupled to 1.5 mm PTFE tubing with 0.5 mm inner diameter. Typically these are used for absorption measurements and HPLC applications. Two special fiber-optic cables (FC part number terminating in FIA) are required for coupling with these micro flow cells. The special fiber-optic cable is the window for these flow cells.

Technical Data

Flow Cell Type	Micro flow Z-cell -10	Micro flow cell -1.5
Wavelength Range	200-2500 nm	
Optical path length	10 mm	1.5 mm
Sample volume	18 µl	3 µl
Tubing OD connection	1.5 mm (1/16")	
Pressure rating	10 bar	
Fiber-optic coupling	1.6 mm ferrule	
Dimensions / material	32 x 38 x 13 mm / PEEK	

Ordering Information

FLOWCELL-Z-10	• Flow Z cell with 10 mm optical path
FLOWCELL-1.5	• Flow Z cell with 1.5 mm optical path
FC-UVIR400-1-FIA-SR	• Fiber cable 400 µm, UV/VIS, sol. Resistant for Flow Z cell 10/1.5

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light sources and accessories

Reference Tiles

For diffuse reflection measurements, Avantes offers the WS-2 reference tile. For specular reflection measurements, the RS-2 is available.

The WS-2 reference tile is made out of a white diffuse PTFE based material, which is considered the highest grade reference material for diffuse reflectance. It is mostly used in colorimetric application where a reference signal has to be obtained during a reflection measurement.

The PTFE material is high purity and processed using exacting standards to an amorphous structure, so the tile reflects light from 350-1800 nm at circa 98% and from 250-2500 nm at more than 92%. The material offers long term stability, even in UV applications. The plastic is hydrophobic and chemically inert, so it is cleanable.

For gemology applications, the WS-2 is used in combination with a reflection integrating sphere. The gemstone is put on the middle of the tile with the integrating sphere over it.

The special WS-2-GEM is designed to facilitate holding and cooling a gemstone with liquid nitrogen, as it features a cavity and hole in the middle of the tile.

The WS-2-CAL is a NIST traceable calibrated white reference tile which includes an electronic calibration file covering 250-2500 nm.

The RS-2 is a mirror tile which can be used as a reference standard for specular reflection measurements.

The RS-2-CAL is a calibrated mirror tile which includes a NIST traceable calibration file, which is created using an 8° absolute specular reflectance measurement over the wavelength range from 250-2500 nm.

We also have black and grey reference tiles available. These tiles are perfect for reflectance measurements. For more information on these tiles, please look at the ordering information on the next page.

As with most Avantes products, these accessories can be delivered in a custom design. Contact us for more information.

WS-2 and WS-2-GEM



RS-2

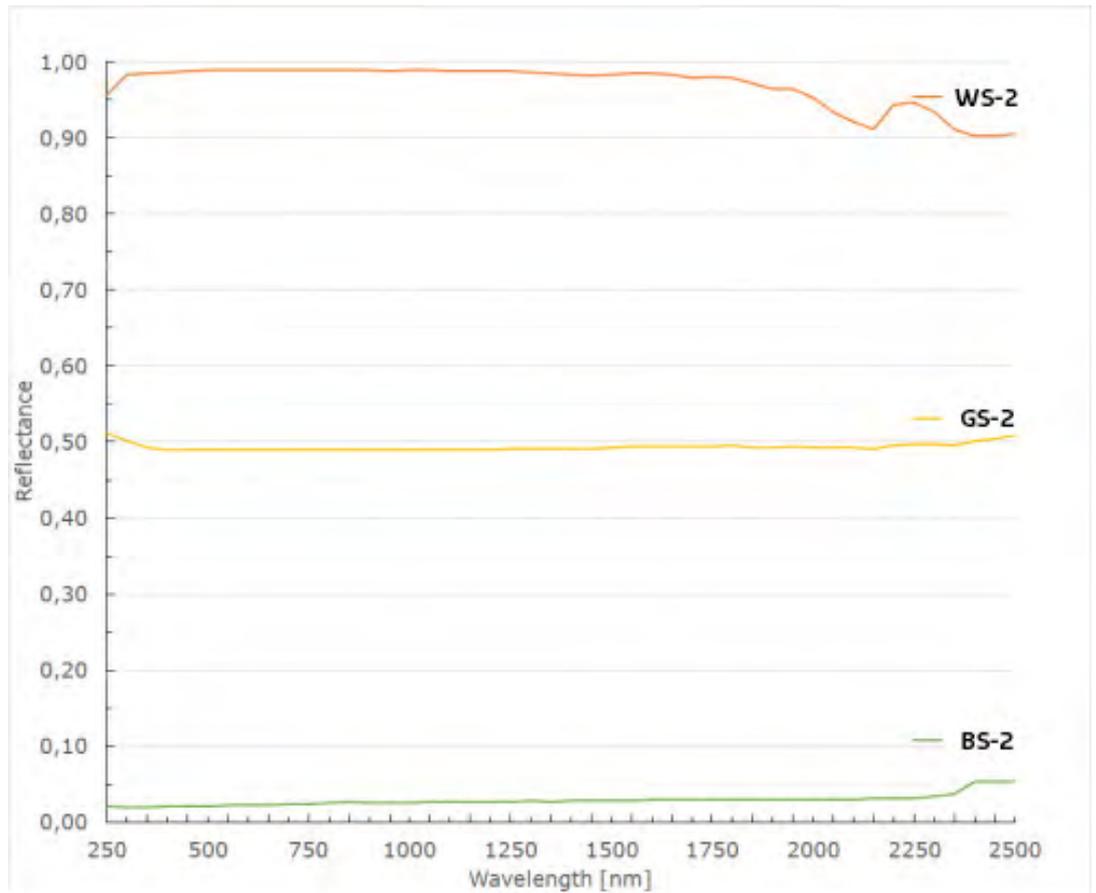


Technical Data

	WS-2	RS-2
Material	Diffuse PTFE material	BK7 with Al+MgF ₂ coating
Max. temperature	280°C	80°C
Dimensions tile	32 mm diameter / 10 mm thick	32 mm diameter / 1 mm thick
Housing	38 mm diameter, black PVC, cover red anodized	

For the latest information,
go to www.avantes.com

Reflectance Curves Reference Tiles



Ordering Information

WS-2	• White reference tile
WS-2-GEM	• White reference tile with cone, specially for Gemstone measurement
WS-2-CAL	• NIST traceable calibrated white reference tile with 8° hemispherical calibration, 250-2500nm
RS-2	• Specular Reflectance standard with Al+MgF ₂ , 250-2500 nm
RS-2-CAL	• NIST traceable calibrated Specular Reflectance standard with Al+MgF ₂ , 250-2500 nm
BS-2	• Black reference tile for reflectance measurements. Diffuse, 2%
GS-2	• Grey reference tile for reflectance measurements. Diffuse 50%

12 and 24 Volts Power Adapters for Spectrometer and Light Sources

Most AvaSpec spectrometers are USB powered, but some users prefer to externally power their instrument. Avantes PS-12V and PS-24V can be used to connect your AvaSpec spectrometer and AvaLight light sources to any 100-240V power connection.

The PS-12V has a maximum output of 1.0A and is used with all AvaSpec spectrometers and most light sources and accessories. The PS-24V is to be used with the AvaLight-HAL halogen light source and the FOS-inline

fiber-optic switch.

All power supplies are equipped with automatic thermal and overload cut-off circuitry. Please specify on the order which plug should be delivered based upon your geography: Euro, UK, USA or Australian plugs are available.

PS-12V Power adapter



Technical Data

	PS-12V/1.0A	PS-24V/1.25A
Power Input	100-240 VAC ± 10%/ 47-63 Hz	
Power consumption	400 mA	700 mA
Power Output	12 VDC ± 5%, depending on load	24 VDC ± 5%, depending on load
Output current (max.)	1.0 A	1.25 A
DC -Connector	5.5 mm OD, 2.1 mm ID, 11.5 mm long	3.5 mm OD, 1.3 mm ID, 10 mm long
Dimensions	92 mm x 40 mm x 28 mm	105 mm x 68 mm x 39 mm
Operating Temperature	0 - 45°C	
Cable length	2.0 m	

Ordering Information

PS-12V/1.0A	• Power supply 100-240VAC/12VDC, 1.0A
PS-24V/1.25A	• Power supply 100-240VAC/24VDC, 1.25A for FOS
PS-12V/1.1mm	• Power supply 100-240VAC/12VDC, 1.0A for AvaSpec-Mini
PS-12V/2.08A	• Power supply 100-240VAC/12VDC, for AvaLight-HAL-Mini

Euro plug standard, special power plug specify

-UK	• UK plug
-US	• USA plug

Did you know
Avantes is specialized
in custom made
fiber-optic cables?



Applications

INTRODUCTION

On the following pages we have listed some examples of the wide variety of solutions Avantes spectrometers are used for. From air pollution monitoring to measuring light effects on the biological clock of different organisms. And from LED measurements to real-time monitoring fertilizer concentration on crops.

Furthermore a number of example setups have been listed. LED, Irradiance, Thin Film and Color measurements are just some of the many possibilities. But the Avantes Spectrometers can be used in many more applications. Contact an application engineer to discuss your situation and the perfect spectroscopy solution for your needs.

Some of the markets our spectrometers are used in:

- Agriculture
- Astronomy
- Automobile industry
- Biology
- Biotechnology
- Chemistry
- Coating industry
- Colorimetry
- Construction
- Cosmetics
- Dairy industry
- Dental
- Dermatology
- Environmental
- Film industry
- Food
- Gas chromatography
- Gemology
- LCD industry
- Light industry
- Meteorology
- Medical
- Nanotechnology
- Narcotics
- Nuclear industry
- Optical filters
- Painting industry
- Paper industry
- Particle size analysis
- Pharmaceutical
- Photovoltaic industry
- Plasma etching
- Printing industry
- Pyrometry
- Radiometry
- Semiconductor industry
- Solar spectrum measurements
- Space research
- Sun glasses industry
- Textile industry

Avantes Spectrometers: Versatility Worldwide

Finding fires with AvaSpec



Developed in Portugal, the Forest Fire Finder is an advanced fire detection and tracking system. The system consists of an individual or a series of towers which feature telescopic optics to measure spectra over forested areas. The system features an AvaSpec-ULS2048-USB2 spectrometer, a video camera, weather station, telescope, processing/controlling unit and communications unit. The telescope and the video camera scan the horizon non-stop, at an angle of 320 degrees. The telescope is connected to the spectrometer by means of a fiber and can collect spectra up to 15km away. These spectra are then processed and analyzed. The video camera takes pictures at pre-set intervals and can also be used to send real-time video. It is aligned with the telescope, to ensure what is measured.

Should the system detect a forest fire, automatically alerts are sent out through SMS, IP, GSM, etc. The alert contains needed information, such as fire location, detection time, weather conditions and an image of the detected fire. The weather conditions include wind speed and direction, temperature and humidity.

Environmental preservation in China has been closely examined in recent times, and there is increasing concern about reducing environmental pollution.

Industrial gas emissions have contributed enormously to the air pollution and must be monitored continuously. In China there are several companies which develop and manufacture CEMS (Continuous Emission Monitoring System). CEMS is used to do the air pollution measurement. These systems monitor the concentration of industrial gases and suspended particles emitted from air pollution sources.

UV spectrometers are integrated to the CEMS used for calculating the absorption of SO_x/NO_x. Over 200 CEMS systems do have 'Avaspec inside' and we expect this to be multiple in the future.

These AvaSpec spectrometers have high demands regarding stray-light, optical resolution, stability and sensitivity.

The AvaSpecULS2048x16 has proven to be a very good choice for this application. This is because this device has a very high quantum efficiency and SNR(500:1) in the UV range, besides it has a lower stray light.

DOAS (Differential optical absorption spectroscopy) is one of the techniques which is used in these systems.

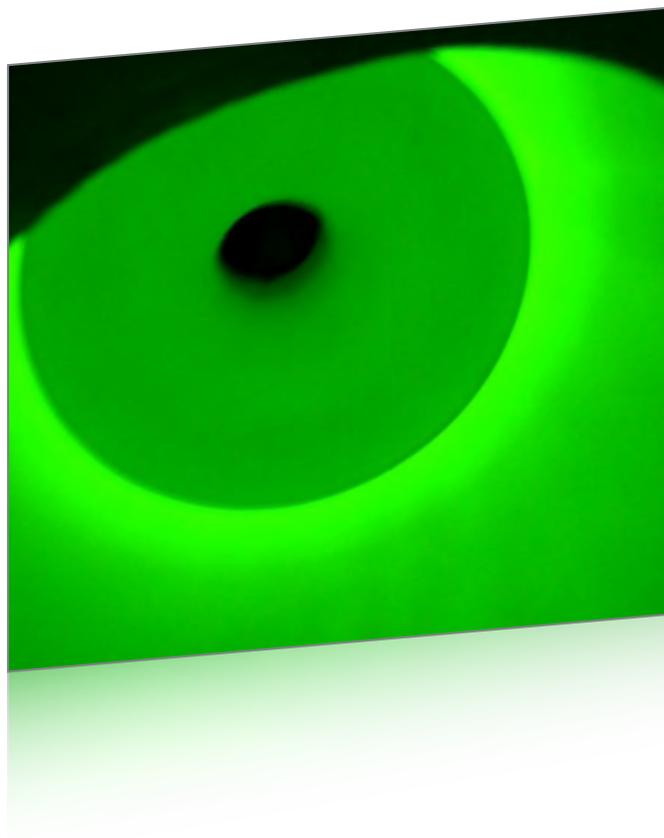
Application Note: CEMS Continuous Emission Monitoring Systems



Application Note: Light Effects on the Biological Clock

Most organisms have a circadian clock which has evolved as a consequence of the rotation of the earth around its axis. The circadian clock resides in the suprachiasmatic nucleus and generates rhythms of about 24 hours. The suprachiasmatic nucleus adapts to daily changes in its environment. Light is the main synchronizer of the biological clock to the external light-dark cycle and is detected by ocular photoreceptors in the retina. Light information is then sent to the suprachiasmatic nucleus via the optic tract. In the suprachiasmatic nucleus light information leads to an enhancement in electrical activity of the neurons.

To determine the effects of light on the circadian clock in mice, in vivo electrophysiological recordings of neurons of the circadian clock were performed. Mice were exposed to three different wavelengths of light using monochromatic LEDs. The wavelengths of light used were UV (λ max 365 nm), blue (λ max 467 nm) and green (λ max 505 nm). During light exposure the extracellular activity of a group of neurons of the suprachiasmatic nucleus were recorded.



Integration of Avantes Spectrometers in Multi-element LIBS Analysers



The Laser Induced Breakdown Spectroscopy (LIBS) gives information about the elemental composition within a small spot on a sample surface and, in addition, even low Z elements can be measured with good sensitivity. With the LIBS Software Suite (LSS) calibration (univariate or multivariate, PLS) and classification (PCA, NN) models for a wide range of analysis tasks can be created. The calibration models can be used for offline and online measurement. The SECOPTA GmbH in Berlin, Germany has integrated Avantes spectrometers in different FiberLIBS and MopaLIBS element analysers for industrial and laboratory applications.

To measure and apply the appropriate levels of fertilization on crops can be a time consuming activity. This is what the Yara system was designed to facilitate. Featuring a dual channel AvaSpec series spectrometer, fiber-optics and processing electronics mounted in a blue box on top of a tractor, the system makes real-time measurements of the optical appearance of crops and intelligently applies fertilizers accordingly.

Relevant for the fertilization is the level of nitrogen in a crop, which is measured by means of reflection spectroscopy. In the visible range (380-740 nm) the reflection is an indication of the leaf chlorophyll content, in the NIR range (700-1000 nm) reflectance is mainly affected by the crop's biomass.

Included with the Yara system is a terminal for real-time monitoring. A special viewing geometry and integrated irradiance correction guarantees accurate measurements. The system logs crop and GPS data on a on-board data card.

Monitoring Fertilizer Concentration on the Go



Testing Leakage of Cooling Water of (Nuclear) Power Plants



In Japan there are many (nuclear) power plants and they are all build on a rocky based bottom. These rocks also have underground water streams, in case of an earthquake (not unrealistic in JAPAN) radioactive cooling water might leak through the rocks into these clear water streams and spread the radio- active radiation on to a greater area, which will be extremely dangerous for environment and all living creatures.

The idea is to drill several deep holes in a specific area around the power plant (aprox. 50 m deep) and measure fluorescence in the underground water stream. To the cooling water used in the coolwater system of the power plant a tracer is added, this tracer will cause a strong fluorescence signal when measured with the AVANTES system in a 50 meters deep well. When in case of an earthquake cooling water would leak it can be traced within a reasonable time as the distance from detection well to power plant is short.

For a company in Japan we developed a special flow cell with an integrated LED 480 nm, an AvaSpec with a backthinned detector (VB grating and SLIT 200) will detect the fluorescence in the control room. A 50 m powercable and a 50 m fiber was part of the solution as well.

High Dynamic-Range Time Intensity Measurement of Intense Femtosecond Laser Pulses

Ultrafast lasers are now broadly used in many research fields such as high intensity laser-matter interaction, femtochemistry, THz generation or time-resolved spectroscopy.

Characterization of femtosecond laser pulses has always been a difficult task, but with a new technique called Self-Referenced Spectral Interferometry, invented and patented by Fastlite (Paris, France), researchers can perform single-shot, calibration-free measurements with a simple and compact setup.

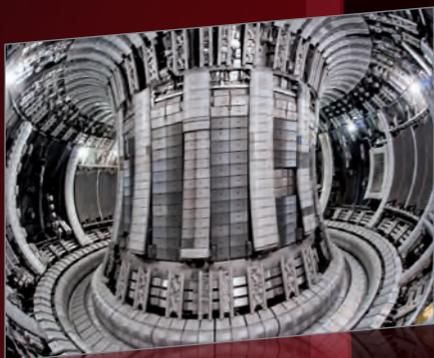
The Wizzler system, which includes an AvaSpec-2048L spectrometer, provides spectral intensity, spectral phase and coherent contrast measurements with an unprecedented dynamic range over 40dB, and is now becoming the reference tool in the field of femtosecond pulse measurements.

The included spectrometer covers a bandwidth ranging from 650 to 1080 nm and matches the full spectral bandwidth covered by the widely used Ti:Sapphire lasers. The hardware trigger allows single-shot acquisition up to 1kHz.



Plasma-Surface Interaction Measured by Avantes

Just a small town in the English countryside, but it hosts a research facility that might change the world as we know it. The Joint European Torus, based in Oxfordshire, researches how to use fusion energy in daily life. Fusion offers the promise of energy that is environmental friendly, safe and available in almost unlimited quantities. Avantes spectrometers are used at the facility to measure changes during these plasma experiments.

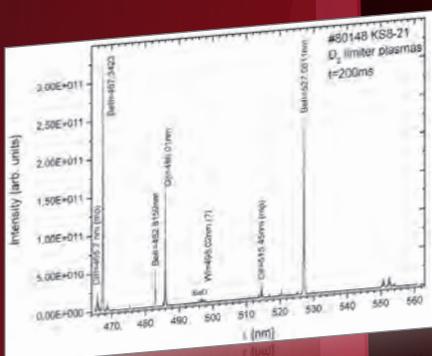


Deputy leader Dr. Sebastijan Brezinsek of the JET-EFDA task force E2 is responsible for all spectrometers used at both the English and German facilities. When upgrading the torus, new miniature spectrometers were also needed. Mr. Brezinsek explains their choice:

"we used a European Tender and the Avantes spectrometers offered the best quality for the best price. They are used to measure changes in the internal environment of the torus over time and they run 24 hours per day, for several years to come. This way we can measure the influence of the plasma on the internal environment of the torus. So far the quality of Avantes has proven itself."

To prevent any influence from radiation, fiber cables guide the light to a facility 100 meters away from the torus building. There the 53 Avantes spectrometers work non-stop. For this application Avantes had to develop special systems, or as Klaas Otten, Avantes' technical sales manager, puts it:

"we are used to design custom made spectrometers for different applications. The systems used at JET-EFDA have special casing and low-noise detectors, to prevent any distortion. This system asked for individually triggered spectrometers, with fast data acquisition. Plasma is a fast changing substance and therefore fast repetition rate was one of the key requirements."



Avantes supplies their spectrometers with high-performance measurement software, AvaSoft. For JET-EFDA, the DLL-package was used to control the instruments. According to Mr. Brezinsek:

"all our measurement systems connect to one central software solution, therefore we decided to use Avantes' DLL-files. This way we can combine all information into one view, thus enhancing the quality of our work." He concludes: "Thanks to Avantes, we can do our work better, faster and deliver better results. In France we are building a torus that should supply five times the energy we put into the system. This will really be the future of power supply in the world and Avantes helps to make it possible!"

Color Measurements

The human eye has a spectral sensitivity that peaks at around 555 nm, which means that the color green gives an impression of higher brightness than other colors. At 490 nm the sensitivity is only 20% compared to the sensitivity at 555 nm. Furthermore, the human eye can only distinguish about 10 million different colors which is actually quite limited relative to the needs of color measurement applications. Spectrometers are designed to measure exact wavelengths, and are therefore ideal for color measurements.

Visible light has a wavelength range of 390-750 nm, so generally color measurement systems are configured to cover the range from 380-780 nm with a spectral resolution of around 5 nm (FWHM).

To facilitate reflective color measurements a reflection probe or integrating sphere is typically required. In either case, a white continuous light source illuminates the surface to be measured and a white reflective



standard tile is needed for calibration. Color measurements may be applied to a variety of industrial applications such as color of textile, paper, fruit, wine, and bird feathers. Avantes has developed a variety of custom probes to meet the specific demands of the

color measurement application. Color measurements are manifested in the L*a*b* color model which includes parameters for brightness and hue.

Color Measurement of Small Areas



This bundle features an AvaSpec-ULS2048CL-EVO spectrometer that is tuned for visible light, which makes it ideal for color measurements. An illuminant A halogen light source for illumination and a reflection probe (with reflection probe holder) are included as well.

Typical applications:

- In-line reproducibility
- Analysing small spots & lines

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating BB (360-780nm) 200 μm slit AvaSoft-Full & AvaSoft-Color
Light source	AvaLight-HAL-S-Mini	PS-12V/2.08A
Fiber optics	FCR-7UVIR200-2 RPH reflection probe holder	
Included	WS-2 white reflection tile	

Color Measurement of Surfaces



To measure color, wide angle diffused light from a sample is analyzed. This bundle includes a handheld 50 mm integrating sphere and a compact spectrometer. With this bundle, your measurements are free of the gloss-specular component. The measurement optics are placed under a 8° angle (D/8 SPIN).

Typical applications:

- Rough surfaces
- Textile and printed paper
- Fruits

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating BB (360-780nm) 100 μm slit AvaSoft-Full & AvaSoft-Color
Light source	AvaSphere-50-LS-HAL-12V	
Fiber optics	FC-UVIR200-2-ME	
Included	WS-2 white reflection tile	

UV/VIS absorbance measurements

The absorbance (also called optical density) of a material is a logarithmic ratio of the radiation falling upon a material, to the radiation transmitted through a material. UV/VIS absorbance measurements encompass a wide variety of chemical and biochemical applications which involve many areas of research and industrial end uses. UV/VIS absorbance can be applied qualitatively and quantitatively in spectroscopic measurement applications ranging from blood parameters to chemical concentrations in process and reaction monitoring. Fiber-optic spectrometers offer a tremendous value proposition for UV/VIS measurements because of their relatively low cost, small size and ability to be introduced in harsh environments through the fiber interface. Combined with a fiber-optic transmission dip probe, inline flow cells or the more traditional cuvette cell, a fiber-optic spectrometer can accurately and

repeatably measure over the range from 200-1100 nm.

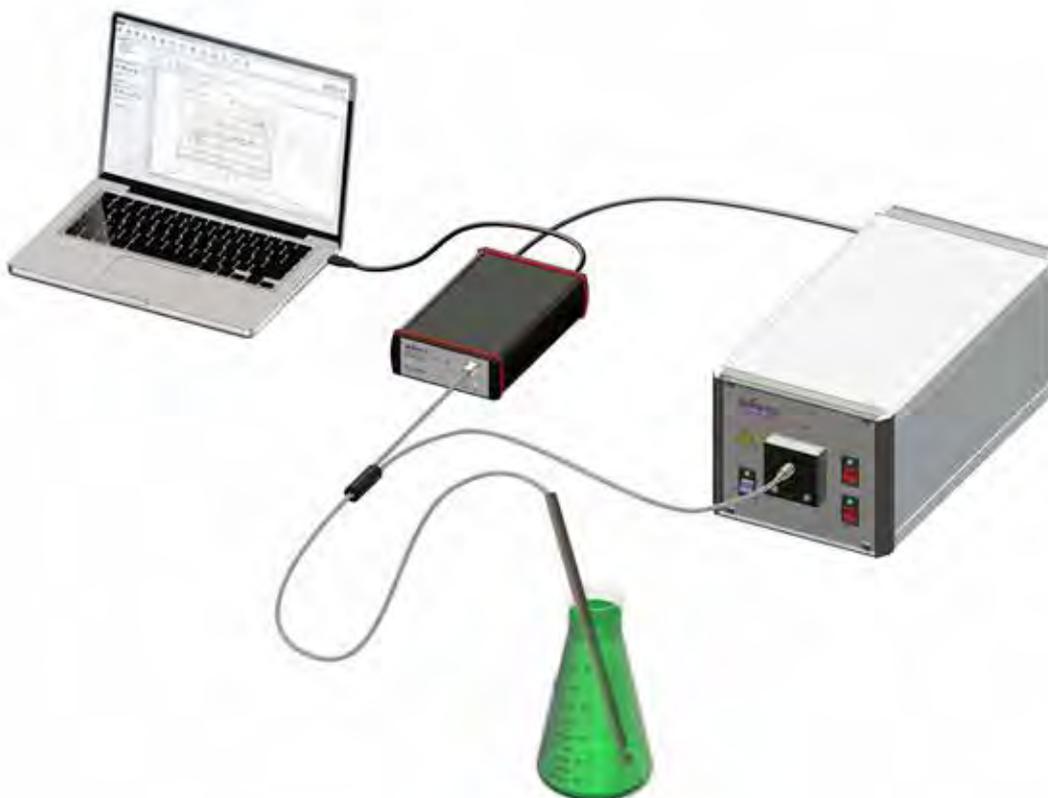
Small Instruments Come of Age

Scientists who are largely familiar with more traditional bench top spectrophotometers may have the perception that fiber-optic instruments cannot provide the resolution or stray-light rejection required for more demanding applications. In fact, fiber-optic spectrometer technology has come a long way and Avantes' instruments are on the leading edge for this technology. Our instruments are capable of measuring at resolutions as high as 0.05 nm in the UV. In terms of stray-light rejection, Avantes has developed a special optical bench called the ultra-low stray-light (ULS) optical bench to provide optimal performance for our customers. AvaSpec ULS spectrometers have stray-light levels as low as 0.04%. Typically UV/VIS absorbance systems

consist of a spectrometer, stabilized light source and fiber-optics, which are connected to some form of sampling accessory (probe or cuvette cell). Single fiber-optic spectrometers can be configured for broadband measurements (200-1100 nm) or narrow band (any range from 200-1100 nm) depending upon the desired wavelength range and resolution. Avantes UV/VIS instruments are also fully compatible with our AvaSpec NIRLine spectrometers, which enable spectroscopic measurements out to 2500 nm.

Common System Configurations

Avantes modular platform enables users to configure systems in a variety of ways and also allows the flexibility of changing the system configuration later to provide additional functionality. The typical UV/VIS absorbance system consists of an AvaSpec spectrometer, AvaLight fiber-optic light source, fiber cables



and a cuvette cell holder. To the left this system configuration is shown with a cuvette cell holder above with a dip probe configuration below.

Our affordable AvaSpec-ULS2048-USB2 and AvaSpec-ULS2048L-USB2 provide excellent resolution (1.0 nm FWHM) over the entire range from 200-1100 nm, or higher resolution for a shorter-range configuration. For higher resolution (0.6 nm FWHM from 200-1100 nm) the AvaSpec-ULS3648-USB2 is recommended. Customers that demand higher signal-to-noise performance and higher sensitivity in the UV or NIR should consider Avantes SensLine instruments. The AvaSpec-ULS2048XL has a high-performance back-thinned CCD detector and the AvaSpec-HS1024X58/122-TEC is Avantes' highest sensitivity spectrometer with a thermo-electrically cooled CCD detector and a high numerical aperture optical bench. Any of Avantes' instruments can be combined with our AvaLight-DHS-BAL

deuterium halogen source and a CUV-UV/VIS cuvette cell holder. The CUV-DA-DHS is a nice alternative, which enables directly coupling of the cuvette cell holder to the front plate of the light source to minimize the use of fiber-optics. This same system configuration can be integrated into a single housing (AVS-Desktop) to provide an integrated spectrophotometer module with a common power supply for the light source and spectro-meter.

Fiber-optics

One of the key value propositions to fiber-optic instruments is the ease with which measurements can be made inline or in-process using a fiber-optic probe or accessory. Avantes offers a variety of sizes and configurations of fiber-optic transmission dip probes, which include special configurations for measurements in high temperatures (up to 500 °C), high pressure or vacuum. Also available are fiber-optic flow cells for standard and micro-fluidic applications.

Instrument Control Software

Avantes proprietary AvaSoft software is a Windows-based 32- and 64-bit compatible software package which enables full instrument control and includes a basic chemistry add-on module (AvaSoft-Chem). For customers requiring more sophisticated analytical software, which enables model development and multi-variate analysis, Avantes instruments are fully compatible with Panorama-Pro software from LabCognition.

UV/VIS/NIR Absorbance



Designed for broadband measurements, this UV/VIS/NIR absorbance bundle features a high-power deuterium halogen light source with integrated shutter and a variable dip probe. A versatile bundle to measure absorbance in most situations.

Typical applications:

- Colorization of fluids
- In-line measurements
- Color of liquids in test tubes and flasks

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating UA (200-1100nm) 25 µm slit, DCL-UV/VIS-200 OSC-UA Order Sorting Filter AvaSoft-Full
Light source	AvaLight-DH-S-BAL	
Fiber optics	FDP-7UVIR200-VAR	

Irradiance Measurements

Radiometry deals with the measurement of all optical radiation inclusive of the visible portion of this radiant energy. Irradiance is a parameter of radiometry. It describes the amount of radiant power impinging upon a surface per unit area. Irradiance measurements can be done in the UV, VIS and NIR wavelength ranges.

Avantes works with a variety of irradiance applications ranging from pulsed solar simulator characterization to free space measurements of radiant sources such as street lights. The AvaSpec line of instruments provides exceptional resolution and stray-light rejection to ensure the accuracy of these measurements. Typical system configurations involve one or more spectrometers configured for the appropriate range 200-400 nm for UV irradiance, 360-1100 nm for VIS irradiance and 1100-2500 nm for NIR irradiance. While broadband

configurations covering 200-1100 nm are feasible with one spectrometer, optimal performance is achieved with dedicated UV (200-400 nm), VIS/NIR (400-1100 nm) channels.

The spectrometer or group of spectrometers is connected via fiber-optic cable to a diffuser with a known surface area and the entire system is calibrated against a NIST traceable source for irradiance. Avantes offers a variety of cosine diffusers and integrating spheres for irradiance applications. The calibrated system is shipped as an integrated system (connected together) and should remain in this configuration in order to ensure the integrity of the calibration. FC/PC connectors are recommended in lieu of the standard SMA, which enable repeatable disconnection and re-insertion of the fiber-optics, so the system may be disconnected for transportation.

Customers that wish to conduct their calibrations may consider one of Avantes' intensity calibration sources. The AvaLight-HAL-CAL is available for VIS/NIR wavelengths (360-2500 nm) and the AvaLight-DH-CAL is available for UV/VIS wavelengths (200-1100 nm).

The Avantes AvaSoft-IRRAD software module enables irradiance parameter measurements such as radiometric quantities - $\mu\text{Watt}/\text{cm}^2$, $\mu\text{Joule}/\text{cm}^2$, μWatt or μJoule , photometric quantities Lux or Lumen, color coordinates X, Y, Z, x, y, z, u, v, color rendering index and color temperature, and number of photons $\mu\text{Mol}/\text{s}\cdot\text{m}^2$, $\mu\text{Mol}/\text{m}^2$, $\mu\text{Mol}/\text{s}$ and μMol . AvaSoft-IRRAD software also facilitates the performance of irradiance intensity calibrations.



Irradiance/Spectroradiometry



Irradiance means measuring how much light reaches a specific place. In this bundle, a cosine corrector is included to collect light from a 180 degree angle, so the measurements are precise. The comprehensive AvaSoft-Irrad software makes it possible to perform fully calibrated, traceable radiometric and photometric measurements.

Typical applications:

- Solar lighting
- Environmental & general lighting

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating UA (200-1100nm) 25 µm FC/PC slit, DLC-UV/VIS-200 OSC-UA Order Sorting Filter AvaSoft-Full & AvaSoft-Irrad Irrad-CAL-UV/VIS
Fiber optics	FC-UVIR200-2-ME-FC/SMA	
Included	CC-VIS/NIR	

Download the latest
software for your AvaSpec
at www.avantes.com

LED measurements

The measurement of LEDs presents unique application requirements for which Avantes has the appropriate instrumentation and applications experience to assist our customers in configuring a system. Avantes' many years of working with LED application has prompted us to develop a variety of system configurations that meets most LED metrology requirements. Light Emitting Diodes can be measured in a wide variety of colors and brightness. Accurate measurement of the LEDs therefore is essential. This can be done in two ways: photometry and radiometry.

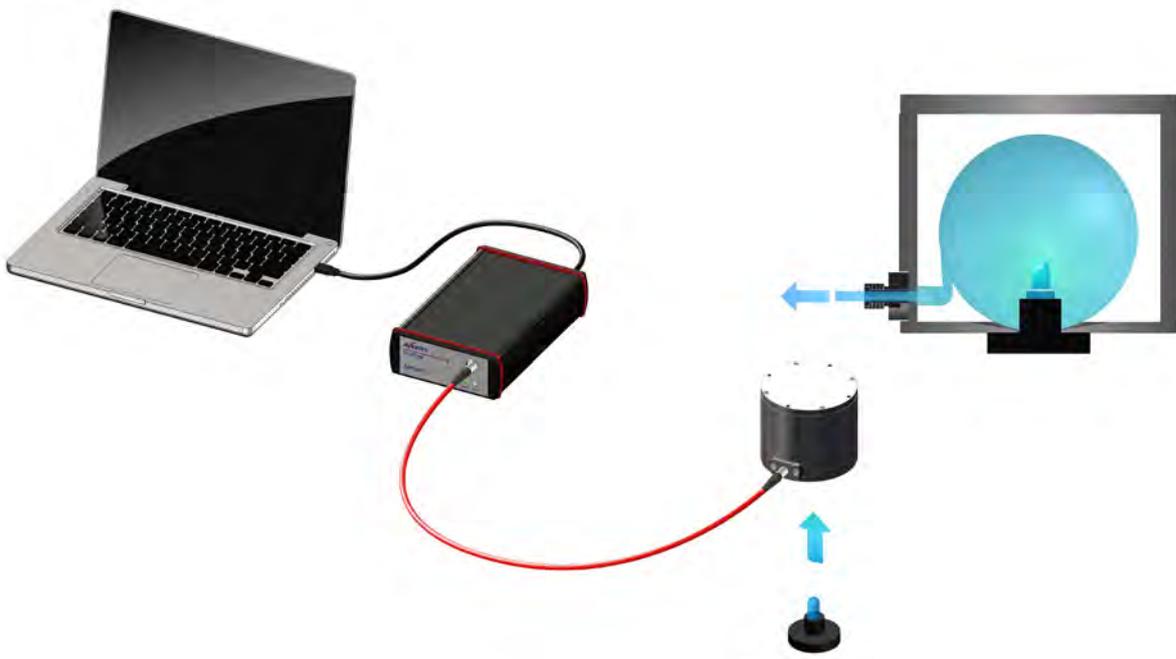
Photometry relates to visible radiation alone, just as the response of the human eye. Radiometry goes beyond these limitations. In both photometry and radiometry, the LED can be characterized in emitted power or in intensity. Emitted power is all the power (flux) emitted from the LED in lumens or Watts, collected and measured without regards to the direction of the

flux. The intensity is the ratio of the flux, leaving the source and propagating in the element of solid angle containing the given direction, and is expressed in candelas.

For basic measurements of photopic parameters and irradiance (excluding flux) a system is typically configured with the AvaSpec-ULS2048-USB2-FCPC spectrometers, a 25 or 50 μm slit and 300 line/mm grating covering the range from 360-1100 nm and provides 1.4 -2.4 nm full width half maximum (FWHM) resolution. A 2 meter fiber-optic cable (FC-UV200-2-FC-SMA) is mated to the instrument and terminated in a cosine function diffuser (CC-UV/VIS/NIR) which has 3.9 mm diameter surface area. The entire system is irradiance calibrated with an NIST source over the specified wavelength range for spectral irradi-

ance ($\mu\text{W}/\text{cm}^2/\text{nm}$). This calibrated system can be operated using Avantes proprietary AvaSoft-IRRAD software which provides the following parameters: X, Y, Z, x, y, z, u, v, CRI, Color Temperature, Dominant Wavelength, Complementary Dominant Wavelength, FWHM, Centroid, Peak Wavelength & Purity. Additionally raw data in scope mode is displayed, as well as the X-Y chroma-ticity diagram. Optionally, the system can be configured with longer fiber lengths and the AvaTripod to hold the diffuser in place during measurement. The system can be controlled via Avantes dynamic linking library (DLL) interface through LabView, C#, C++ and a number of other programming environments.

For flux measurements the entire LED must be inserted into the port of an integrating sphere. Avantes offers a complete line of integrating spheres ranging from 30-200 mm (internal diameter).



For system calibrations, Avantes offers the AvaLight-HAL-CAL calibration sources which are offered in configurations that are compatible with cosine diffusers and small integrating spheres (30, 50, 80 mm). Avantes also offers two system configurations to enable the CIE Average LED Intensity (ALI) measurements which are specified in the CIE Publication No. 127. AvaSPEC-IRRAD-ILEDA and AvaSpec-IRRAD-ILEDB correspond to the condition A (316

mm measurement distance) and condition B (100 mm measurement distance) standards, respectively. The system is typically based upon the AvaSpec-ULS2048-USB2-FCPC spectrometers which are configured with a 25 or 50 μm slit and 300 line/mm grating covering the range from 360-1100 nm and provide 1.4-2.4 nm (FWHM) resolution. A fiber-optic cable (FC-UV200-2) is mated to the instrument and terminated in our AvaSphere-IRRAD-30 integrating sphere

which couples with the corresponding ILED-TUBE-A or ILED-TUBE-B. The system is irradiance calibrated with a NIST source over the specified wavelength range for spectral irradiance ($\mu\text{W}/\text{cm}^2/\text{nm}$). The ILED TUBE-A or ILED-TUBE-B is coupled with the AvaLED-Holder-5 mm (LED holder for 5 mm/T1 $\frac{3}{4}$ LEDs) which is coupled with a current stabilized power supply.

LED Light Measurements



More and more countries are banning incandescent lamps from being sold, hugely boosting LED sales. Avantes offers the necessary tools for the photometric and radiometric measurement of LED lights. The spectrometer in this bundle is irradiance calibrated in order to obtain absolute values.

Typical applications:

- Irradiance
- Illuminance
- Radiometric & photometric flux
- Luminous intensity
- Color coordinates

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating VA (350-1000nm) 25 μm FC/PC slit, DLC-UV/VIS-200, OSC AvaSoft-Full & AvaSoft-Irrad Factory-calibrated system for irradiance IRRAD-CAL-VIS
Fiber optics	FC-UVIR600-2-ME-FC/SMA	
Included	AvaSphere-50-IRRAD AvaSphere LED adapter	

For the latest information,
go to www.avantes.com

Thin Film Metrology

Optical thickness of a coating is determined by white light interference and the pattern is translated into optical thickness through mathematical calculations.

Thin film metrology involves the use of these mathematical calculations to the presence and thickness of coatings which have been deposited on a substrate material using a variety of processes. The techniques available for this measurement range from profilometry to ellipsometry, spectroscopic reflectometry and x-ray analysis. Avantes instruments and fiber-optic sampling tools enable spectroscopic reflectometry measurements to support applications in a variety of industries from semiconductor to solar and optical coating measurements. Avantes thin film solutions provide measurement systems for single and multi-layer thin films on a number of substrates.

Thin Film Quality Control

Thin film deposition processes require regular monitoring and quality control particularly as new recipes are implemented

and optimized in a coating facility. Typical applications require regular quality control inspection during the initial phases requiring a high-speed offline measurement system to validate film thickness. Avantes thin film solutions enable high-speed spot measurements which can facilitate thin film presence and thickness validation.

Thin Film Reflectometry

Spectroscopic reflectometry involves illuminating samples with a white light (typically tungsten halogen or deuterium-halogen) at an incident angle which is normal to the sample and then measuring the reflectance and interference from the same geometry. Depending upon the nature of the coating ultra-violet, visible or near infrared wavelength measurements may be necessary to obtain an optimum fitting of the measured curve relative to the theoretical reflectance curve. The theoretical curve is developed from a database of optical constants (n and k). The "n" value is the refractive index and "k" is the extinction coefficient. The sampling process initially involves measuring a reference uncoated substrate followed by

the sample measurement using the same conditions. Characteristics about the substrate (thickness and material) are inputs for the software along with characteristics of the thin film layers (material, thickness). Reflectance spectra are captured and analyzed by software algorithms which compare the measured data to theoretical calculated values derived from the database of optical constants. The software provides a calculated thickness value along with a measure of goodness of fit relative to the theoretical curve.



Single-layer Thin Film Metrology

Avantes' single-layer thin film metrology system consists of our AvaSpec-ULS2048CL-EVO fiber-optic spectrometer, AvaLight-DHc/deuterium-halogen light source or AvaLight-HAL tungsten halogen light source, the FCR-7UV200-2-ME (optional FCR-7UV400-2-ME for higher throughput) fiber-optic reflection probe and our Thin Film Stage. The software that drives the single layer system is Avantes' AvaSoft-ThinFilm which is a 32 or 64-bit application which supports single layer measurements of thin films ranging from 10 nm-50 µm with 1 nm resolution. AvaSoft-ThinFilm supports UV/VIS and NIR wavelength measurements from 200-1100 nm. The system is available with an optional

thin film standard which provides samples of uncoated and coated substrates for validation purposes. For most specular surface UV measurements, the AvaLight-DHc compact deuterium halogen source is adequate, but for more diffuse coated surfaces, the higher power AvaLight-DH-S is recommended.

Thin Film



This bundle was especially designed for single layer thin film measurements, with a light source, a reflection probe and a stage and standard included. The setup can measure thin films ranging from 10 nm up to 50 µm with a resolution of 1 nm and supports UV, VIS and NIR measurements from 200 up to 1100 nm.

Typical applications:

- Semi-conductor industry
- Solar panels
- Coating

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating UA (200-1100nm) 100 µm slit, DCL-UV/VIS-200 OSC-UA AvaSoft-ThinFilm
Light source	AvaLight-DHc	PS-12V/1.0A
Fiber optics	FCR-7UVIR200-2-ME	
Included	ThinFilm stage & standard	

Monitoring Coating Processes in Vacuum Chambers

Layer thickness, composition, surface finish, light transmission, reflectance, polarization ability: these are some of the important parameters that need to be monitored during coating processes. They all are facilitated by spectroscopy and spectroscopic interferometry. Fiber-optics provide a versatile tool to measure in remote vacuum and clean room chambers.

The illumination and detection can be organized at different fiber positions relative to the coating: to allow specular reflection, diffuse reflection, transmission, polarization, interference, fluorescence and even Raman scattering to be measured. Fiber-optics can

be arranged to either monitor several positions or to measure at different spatial positions or masking conditions simultaneously.

For on-line production environments, several fiber-optic sensors can be placed to monitor a production run. Ionic sources, such as plasma sources, can be monitored for spectral emission to confirm their conditional efficiency during the operating process.

A typical application for a vacuum chamber system is monitoring an on-line coating process on a web. For this type of system a vacuum feed-through is used to transfer light into the vacuum area and then passes

to the reflectance probe. The reflected light is passed through another vacuum feed-through to a spectrometer, AvaSpec-ULS2048-USB2 or SensLine instrument. The reflectance probe can be easily disconnected using the SMA interconnects. To compensate for fluctuations in the light source, a second channel can be added for light source reference measurements.



Vacuum



Two vacuum feed-throughs are included in this bundle: one with a 200 μm fiber cable and one with a 600 μm diameter. The needed reflection probe and a deuterium halogen light source are included as well.

Typical applications:

- Coating
- Plasma

... and many more

Spectrometer	AvaSpec-ULS2048CL-EVO Grating UA (200-1100 nm), 50 μm slit, DCL-UV/VIS-200, OSC-UA
Software	AvaSoft-Full and ALL
Lightsource	AvaLight-DH-S-BAL
Fiber-optics	FCR-7UVIR200-2-ME FC-UVIR600-2-ME and FC-UVIR200-2-ME
Vacuum Feedthrough	FC-VFT-UVIR200 and FC-VFT-UVIR600

Plasma Measurements



Plasmas are known for many emission peaks, located closely together. To separate these peaks, Avantes has developed multi-channel spectrometers, featuring much higher resolution than a stand-alone device. For plasma monitoring, Avantes has developed two bundles, with everything you need to measure plasma.

Typical applications:

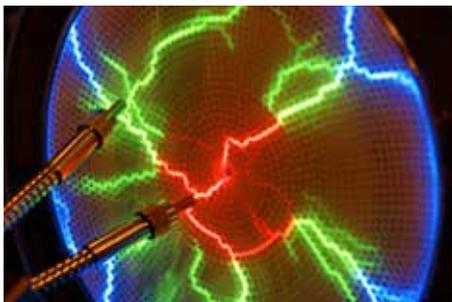
- Semi-conductor
- Solar cells
- Razor blades
- Fusion reactors
- Glass & coatings

High-resolution Plasma Measurement

This 200 to 960 nm quad-channel spectrometer boasts an optical resolution of 0.22-0.28 nm, four times better than a standard AvaSpec-ULS2048CL-EVO covering the same range. In AvaSoft Spectroscopy Software, the four channels are combined as if you were working with only one spectrometer.

Spectrometers	4-channel desktop housing 4 x AvaSpec-ULS2048CL-EVO	Gratings: <ul style="list-style-type: none"> • UC (200-450nm), 0.28 nm • UC (450-680nm), 0.26 nm • NC (660-830nm), 0.24 nm • NC (820-960nm), 0.22 nm <p>All channels with 10 µm slit, DCL-UV/VIS-200 OSF-600 order sorting filter (where needed)</p>
Fiber Optics	FC4-UVIR400-2-ME	
Software	AvaSoft-Full SPECline-A	

Extreme High-resolution Plasma Measurement



For even higher resolution than the above-mentioned quad-channel spectrometer, this version features eight channels, with an optical resolution of up to 0.09 nm. The wavelength range is 200-930 nm, which means it detects from ultraviolet, through

visible, up to near infrared light.

The system is delivered in a 19" rackmountable enclosure.

Spectrometers	8-channel 19" rackmountable enclosure 8 x AvaSpec-ULS2048CL-EVO	Gratings: <ul style="list-style-type: none"> • UE (200-300 nm), 0.13 nm • UE (300-390 nm), 0.12 nm • UE (380-460 nm), 0.11 nm • UE (460-530 nm), 0.10 nm • VE (530-588 nm), 0.09 nm • VE (570-620 nm), 0.09 nm • NC (620-780 nm), 0.24 nm • NC (780-930 nm), 0.22 nm <p>All channels with 10 µm slit, DCL-UV/VIS-200 OSF-600 order sorting filter (where needed)</p>
Fiber Optics	FC8-UVIR400-2-ME	
Software	AvaSoft-Full SPECline-A	

Gemology Measurements

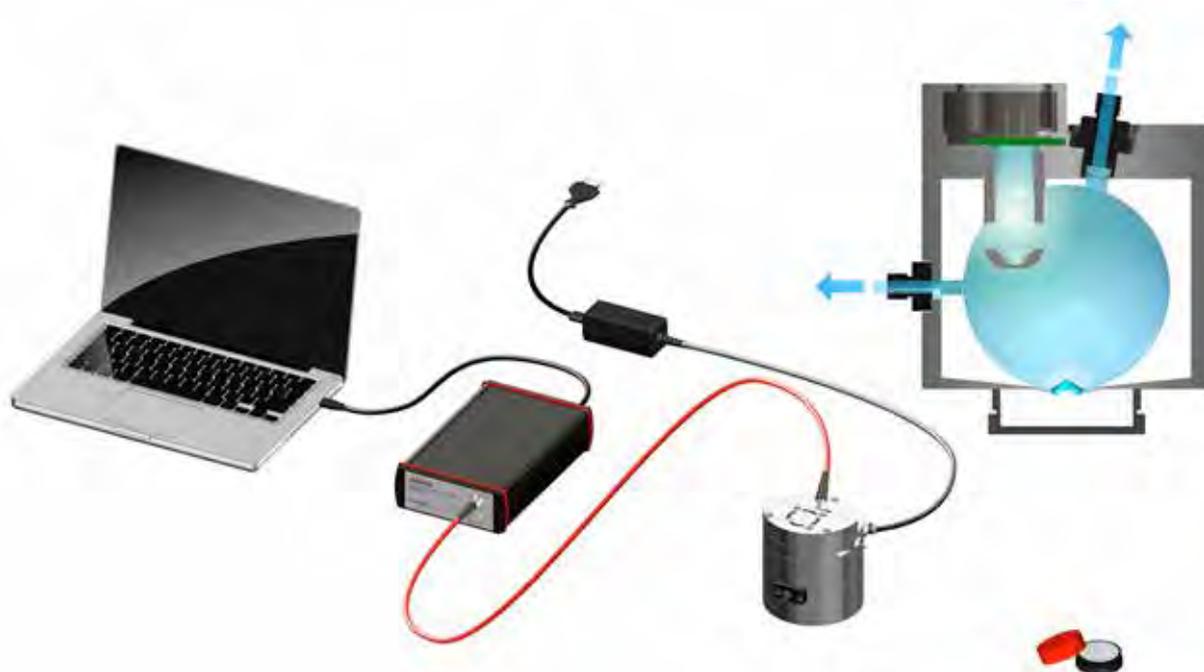
The measurement needs of the Gemology industry are demanding for a series of reasons. Chief among these can be low signal measurement and the need for rapid measurement systems to handle the volume of gemstones measured. Avantes offers basic measurement tools as well as advanced systems to meet various gemological requirements. Measurements can be accomplished with fairly simple systems using either integrating spheres or reflection probes up to photoluminescence systems requiring lasers and TE-cooled spectrometers.

Basic Gemology Measurement

Gemologists often have two basic questions, "What are the characteristics of the stone I'm asked to measure?", and "Are these characteristics natural?" This is because the industry has developed multiple methods to "enhance" stones to improve color and hide imperfections. Methods employed include heat treating, irradiating, resin filling, laser drilling and even simple surface medications such as petroleum product treatments.

A typical basis system consists of an AvaSpec-ULS2048-USB2 spectrometer, a WS-2-GEM, white reference tile for gemol-

ogy, and either an FCR-7UV200-2-BX fiber-optic reflection probe and AvaLight-HAL halogen light source or an AvaSphere-50-LS-HAL, reflection integrating sphere with Halogen illumination included. Although there are a number of possible applications, the measurement of the main chromium peaks (692.8 nm & 694.2 nm) in rubies or the determination of diamond types Ia or Ib status are frequently performed with this setup. Type Ia or colorless diamonds show strong nitrogen absorption peaks at 415 nm and 478 nm, whereas type Ib, yellow diamonds have wider distribution of nitrogen atoms eliminating these



peaks. Other useful peaks are at 592 nm and 741 nm, peaks which indicate artificial coloring has occurred.

Advanced Gemology Measurements

Various entities report the use of photoluminescence systems to detect gemstone characteristics. This technique most often makes use of a laser excitation source, sample chamber, and detection system. The laser wavelength depends on the feature(s) being sought. Most often, the chamber will

include provisions for cryogenic cooling. The detection system can range from simple cameras to photomultiplier tubes. Avantes has provided systems with various lasers as well as the AvaSpec-ULS2048LTEC-USB (thermoelectrically cooled) spectrometer. An AvaRaman-Probe, fiber-optic Raman probe, is required as well to filter the excitation source out of the measured data.

One example of the usefulness of this technique is the detection of high-pres-

sure, high-temperature treatment (HPHT). HPHT is sometimes used to improve diamond color, for instance turning brown diamonds into green or yellow diamonds. Since many regulatory agencies require that all such treatments be disclosed, the chief concern is that stones could be misrepresented as natural or untreated stones. HPHT can be detected with an Avantes high-performance photoluminescence system as it leaves a trace peak at 694 nm.

Gemology



In gemology, there are two basic questions: “what are the characteristics of the stone I’m measuring?” and “are these characteristics natural?” The easy way to answer these questions is with the gemology bundle. This bundle includes a sphere and a special gemology white reference tile to quickly categorize

and validate gems. Typical applications:

- Color
- Natural or artificial
- Artificial coloring

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating VA (360-1000nm) 25 µm slit, DCL-UV/VIS-200, OSC AvaSoft-Full
Fiber optics	FC-UVIR600-2	
accessories	AvaSphere-50-LS-HAL-12V AvaSphere-50-HOLD WS-2-GEM	PS-12V/1.25A

Three years
limited warranty on all
Avantes spectrometers,
light sources and accessories

Fluorescence Measurements

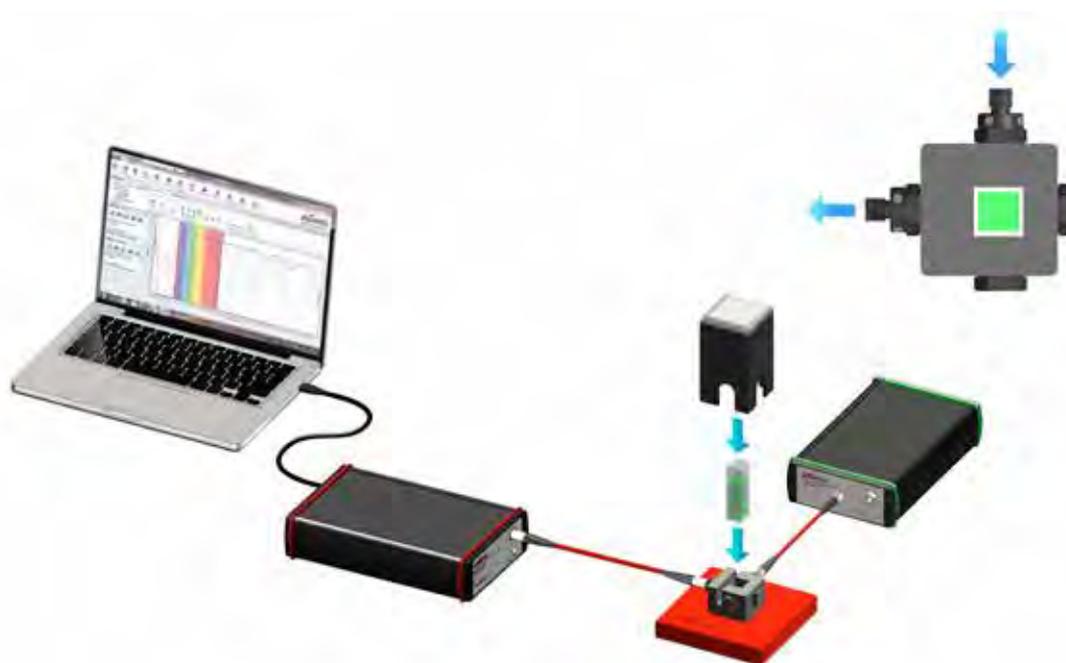
Fluorescence spectroscopy, also known as fluorometry or spectrofluorometry, is a type of electromagnetic spectroscopy, which analyzes fluorescence from a sample. It involves using a beam of light that excites the electrons in molecules of certain compounds and causes them to emit light; typically, but not necessarily, visible light. It is a useful technique in many biological (chlorophyll and carotenoid), biochemical (fluorescence diagnosis of malignancies) and environmental applications. For most fluorescence applications the amount of fluorescence energy emitted is only 3% of the amount of excitation light energy. Fluorescence light has a lower energy (higher wavelength) than the excitation energy and is usually scattered light. This means it emits energy in all directions.

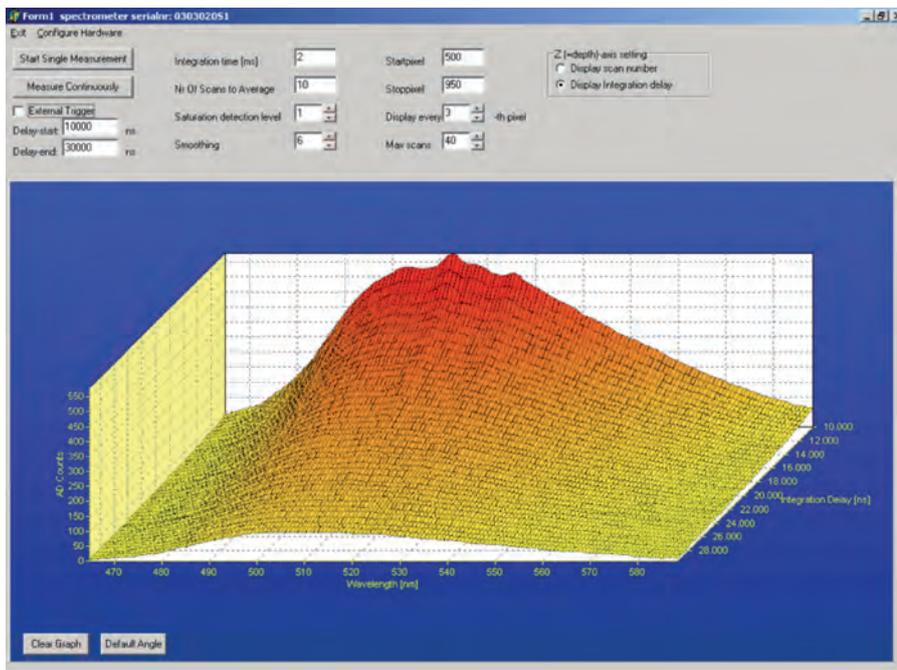
For optimal performance assuming the time acquisition window is not limited, Avantes recommends our AvaSpec-ULS2048LTEC spectrometer for this application, since it can support long integration times often exceeding 5 seconds. When higher-speed acquisition is required, Avantes recommends the AvaSpec-HS2048XL-EVO back-thinned CCD spectrometer. For maximal sensitivity the top model of the SensLine, AvaSpec-HS1024x122-USB2 spectrometer is recommended.

When configuring the measurement setup, preventing excitation light from entering the spectrometer is an important issue.

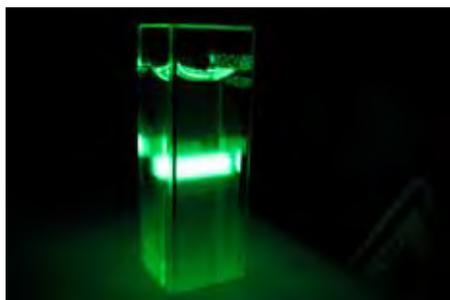
Possible methods to accomplish this, where one does not exclude the other, include:

- Make use of an AvaLight-LED light source which typically has a narrow bandwidth enabling the limitation of excitation to shorter wavelengths that are not part of the emission spectrum
- Use a broadband light source such as the AvaLight-HAL for high output in combination with an (interference) band-pass or low-pass filter.
- Make sure the optical path for excitation light and fluorescence are perpendicular. This means the excitation light will not enter the receiving fiber (use the CUV-UV/VIS-FL or the CUV-DA)
- Use the fluorescence decay time to separate excitation energy from the integration time start pulse. Use a pulsed light source to accomplish this (pulsed laser or AvaLight-XE Xenon flash)





Fluorescence



In spectroscopy fluorescence is one of the more challenging setups, due to the low fluorescent emission (about 3% of the excitation energy). The AvaSpec-HS2048XL-EVO gives the highest sensitivity and the AvaLight-HPLED series provides excitation at the requested wavelength.

- Dyes identification
- Fluorescent lamps
- Diagnosis of malignancies
- Fluorescent labeling

Typical applications:

Spectrometer	AvaSpec-HS2048XL-EVO	Grating HS500-0.33 (350-1100 nm) 200 µm slit, OSC-HS500 AvaSoft-Full
Light source	AvaLight-HPLEDxxx	PS-12V/1.0A
Fiber optics	FCR-UVIR200/600-2-IND FCR-FLTIP-IND	

Pre-configured spectrometers can be shipped within 24 hours

Biomedical Applications

Avantes has extensive experience in the biomedical industry. Over the years, we have supported the development of both non-invasive and invasive spectrometry solutions for tissue and blood parameter measurements.

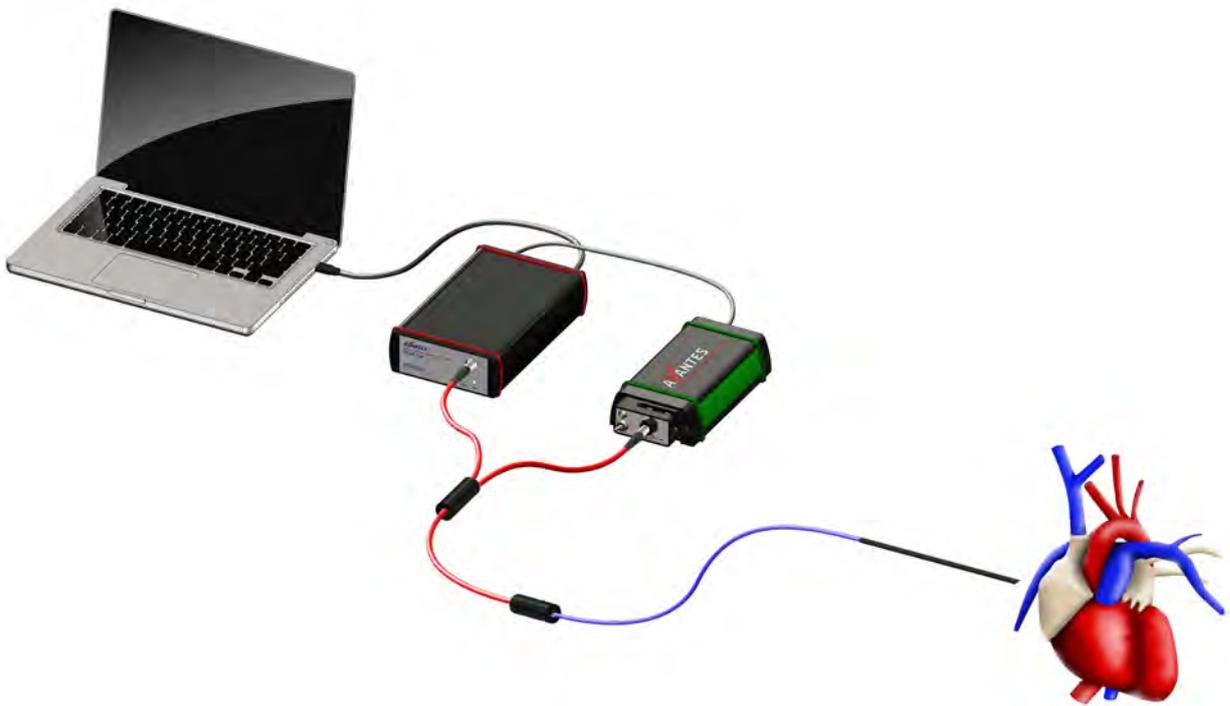
Some of the important medical indicators which Avantes has worked with include oxygen, hemoglobin, cytochrome and water concentration measurements in tissues and in the venous system. The AvaSpec-ULS2048-USB2 and our SensLine instruments are frequently recommended for these applications. The AvaLight-HAL tungsten halogen light source provides an excellent, high-stability VIS/NIR source for biomedical applications involving reflection

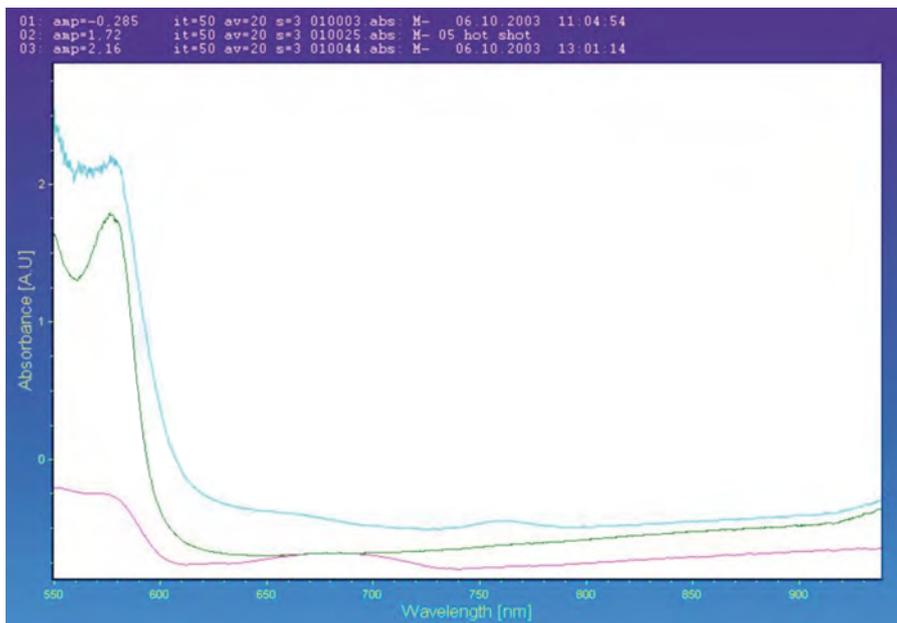
measurements. Avantes worked successfully with many customers to enable continuous measurements of oxygen saturation, concentration of total, oxygenated and deoxygenated hemoglobin.

Some examples of implementations of Avantes solutions:

- Angiology / Pharmacology - Monitoring of the oxygen saturation after the application of vaso-active substances. Oxygen changes caused by Reynaud syndrome and microcirculation diseases in tissue.
- Dermatology - Detection of local -regional perfusion diseases, recurrence of melanomas.
- Diabetology - Micro-angiopathy, early detection of Endotheld dysfunction and ulceration.

- Cardio surgery - Oxygen consumption of the heart muscle during and after bypass operations.
- Neurosurgery / Oncology - Quantifying of oxygen consumption of (brain) tumors before/after radiation or operations.
- Peditry / Gynecology - monitoring of oxygen concentration of critically ill newborns during birth.
- Plastic surgery / Transplantation medicine - Monitoring of transplanted and re-implanted tissues, bones or organs
- Accident surgery - Characterization of burned or frozen skin tissues.





Biomedical



Spectroscopy helps achieve the goal of realizing non-invasive measurement devices. This bundle non-invasively measures concentrations of unknown samples or changes in concentration over time. This bundle is meant for R&D usage.

Typical applications:

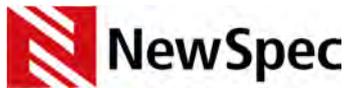
- Oxygen in blood
- Hemoglobin
- Microvascular circulation

Spectrometer	AvaSpec-ULS2048CL-EVO	Grating NB (500-1000nm) 50 µm slit, OSF-475 AvaSoft-Full and AvaSoft-Chem
Light source	AvaLight-HAL-S-Mini	PS-12V/2.08A
Fiber optics	FCR-7UVIR200-2-MS-PK-S	
Included	WS-2	

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Avantes is specialized
in custom made
fiber-optic cables?

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