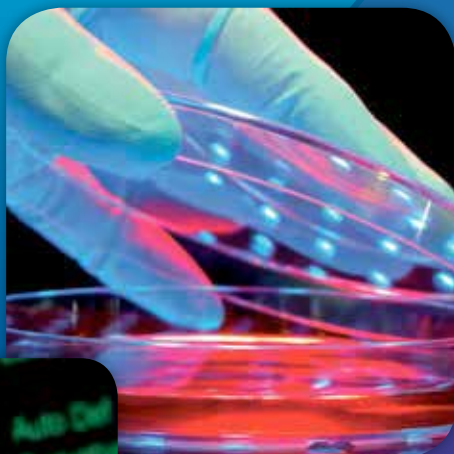


# AVANTES

*enlightening spectroscopy*



Short Form Catalog  
Based on Catalog IX

Dear customer,

After being over 20 years in this industry I am still excited and proud to present to you an overview of our latest / best products. In this edition we show you our instruments 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 over 2 decades 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 is located in the Netherlands. The company also operates direct offices from China, United Kingdom, Germany and North America. In addition, Avantes has a growing worldwide distribution network of more than 40 qualified distributors to meet our customer's needs worldwide.

In this catalog you will find a compact overview of our products. All detailed information like technical data and ordering info can be found on our website. As we are continuously improving our products and introduce new instruments regularly we recommend

to check the digital version of the extended and up to date version of this catalog at [www.avantes.com](http://www.avantes.com)

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



Benno Oderkerk

CEO and founder Avantes

#### OUR MISSION

We provide state of the art, innovative measuring equipment that helps mankind live longer, healthier, 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 of each Avantes employee.

#### VISION

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

This catalog contains information & product data based on Catalog IX

#### Technical Data) Disclaimer and Copyright.

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# Introduction spectroscopy

## Spectroscopy measurements

Optical spectroscopy is a technique for measuring light intensity in the UV-, VIS- and IR-regions of the electromagnetic spectrum. Spectroscopic measurements are being used in many different applications, such as color measurement, concentration determination of chemical components or electromagnetic radiation analysis.

What a spectrometer does is accurately measure the brightness of all the colors in the spectrum and present that as a graph on the computer screen, sorted from short to long wavelengths. Just like with a rainbow, a spectrometer separates the many different light waves present in white light, this makes the different colors visible. And makes sure that the light can be measured accurately.

Spectrometers can see UV and IR light as well, they see more than meets the eye and can also discriminate between far more colors than the human eye can, even if the light is very faint or fast.

To put it in technical terms: spectral range, spectral resolution, sensitivity and speed exceed the eye's capabilities and it gives off very reproducible quantitative numbers, something that the eye cannot do at all.

Spectrometers can be flexibly configured to be optimized for each of these parameters: especially suited for UV, visible light or IR, very bright or very faint light, or suited for harsh conditions.

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.

Most Avantes spectrometers are based on the compact Czerny-Turner design, whose principal components are a slit, a collimating mirror, an optical grating, a focusing mirror and an electronic detector linked to customized electronics and computer software. Light is shone into the spectrometer using a glass fiber that picks up the light from the application that it is used for, usually with some additional optics. Avantes has a special capability to build these pickup units.

It can of course be any kind of light: directly coming from a lamp or other source, reflected off your car or clothing or skin, scattered from milk or smoke or the blue sky; the possibilities are infinite.

## And then there was light...

*Light is more than meets the eye. What we perceive as white light is actually an array of different colored light. These colors become visible in, for example, a rainbow. A rainbow occurs when sunlight hits raindrops, which therefore separates the colors into a vivid arc. When a rainbow is viewed with a dark backdrop the colors become even more enhanced and vivid.*

*An isolation of a short piece of the rainbow, from violet to red as shown in the picture, is called a spectrum. Each color corresponds to their own wavelength of light. For example blue light has short wavelengths (400 nanometers) and red has longer wavelengths (700 nanometers). A nanometer is equal to one billionth of a meter.*

*There is also light that the human eye can not perceive, because the wavelengths are either too short or too long. The light with very short wavelengths is called ultraviolet or UV. This is the light that is harmful for the human skin and can cause welding arc eyes. Beyond the other end of the spectrum there is light with very long waves, this light is called infrared or IR. This light is, just like the UV light, invisible for the human eye, but can be perceived as warmth.*





## What can we learn from spectroscopy?

But why would one want to measure spectra in the first place? Because it tells you the identity of the substance that the light has traveled through.

The heart of the matter is that light that is emitted or scattered, transmitted or reflected by something, carries information about its properties and conditions such as chemical and physical composition, temperature, density, and many more parameters. Each material has its own unique spectrum, a personal signature, that allows recognition and measurement even in a clogged environment.

This is why spectroscopy is a very versatile method for investigating the characteristics of many different things. Another plus is that a spectrometer does not need to make contact to measure and can be used from large distances, because it measures light. A spectrometer can measure everything from solids to fluids to gasses.

Therefore we find spectrometry applications in a wide array of interest. Some examples of applications are:

- Environmental applications such as gas sensing / water quality
- Medical applications such as oxygen-level measurement in blood, condition of human skin
- Food & Agriculture such as fruit-sorting, or quality measurement during harvesting
- Petrochemical and automotive industry
- Thickness of thin layers
- Pharmaceutical industry
- Petrochemical and automotive industry
- Textiles and papers
- Solar
- Semiconductor

And the list goes on and on...

To mention all the possible applications would simply be too much, so if you haven't seen your application listed, please contact us, to share your story. We love to hear from you.



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## Spectrometer platforms



### 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 2048, 2048L and 3648 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 for adequate volumes needed. Therefore the CompactLine is especially suited for OEM users wanting to integrate a spectrometer into their instrument.

### 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-128 and AvaSpec-FAST-series), high-resolution instruments for demanding measurements like atomic emission (AvaSpec-ULS3648) and versatile instruments for common applications such as irradiance and absorbance chemistry (AvaSpec-ULS2048 & AvaSpec-ULS2048L). This instrument line offers an array of solutions for varied uses, while providing excellent price-to-performance ratios.

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 standalone, 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 customer's existing system.



### 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 three feature high-performance thermoelectrically cooled detectors. The other models are based on standard CCDs, upgraded to high-performance instruments as a result of Avantes' unique and recently improved 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.

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 up till 2500 nm. 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-NIR256-1.7 features an uncooled 256 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.

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

In the following section of the catalogue you will find a selection of our spectrometers.

In this compact version the information is limited/ comprised. This catalog contains information & product data based on Catalog IX which is available on [www.avantes.com](http://www.avantes.com)

All our spectrometers offer features like:

- Choices of multiple gratings offering tailoring the spectrometer to your needs
- A 16 bit Analogue to Digital converter for optimal analysis of your measurement.
- USB2 communication interface with your PC (or even USB3 and Ethernet).
- Large number of analogue and digital in- and outputs for direct and quick interfacing to your application.
- Available as OEM module



# AvaSpec Pre-configured Fiber-optic Spectrometers (In stock, ready to ship)



For customers with urgent needs and general flexibility in their specifications, Avantes offers a variety of pre-configured spectrometers, which are ready to ship. Four of the instruments are configured for UV-VIS-NIR measurements (200-1100 nm),

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

Of course a USB2-cable and an extensive manual are included. These spectrometers are off the shelf and ready to ship.

## Technical Data

| Name                 | AvaSpec-<br>ULS3648-<br>USB2-UA-25                                                                               | AvaSpec-<br>ULS2048-<br>USB2-UA-50                                                                        | AvaSpec-<br>ULS2048L-<br>USB2-UA-RS               | AvaSpec-<br>ULS2048-<br>USB2-VA-50                     | AvaSpec-<br>ULS2048L-<br>USB2-BB-50 | AvaSpec-<br>ULS2048XL-<br>USB2-UA-50                                                                           |
|----------------------|------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|---------------------------------------------------|--------------------------------------------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------|
| Uses                 | UV/VIS/NIR                                                                                                       |                                                                                                           |                                                   | VIS/NIR                                                | VIS                                 | UV/VIS/NIR                                                                                                     |
| Range                | 200-1100 nm                                                                                                      |                                                                                                           |                                                   | 360-1100 nm                                            | 360-880 nm                          | 200-1160 nm                                                                                                    |
| Slit/Connector       | 25 µm<br>SMA-905<br>connector                                                                                    | 50 µm<br>SMA-905<br>connector                                                                             | 25 µm<br>SMA-905<br>Replaceable Slit<br>connector | 50 µm<br>SMA-905<br>connector                          |                                     |                                                                                                                |
| Resolution<br>(FWHM) | 1.4 nm                                                                                                           | 2.4 nm                                                                                                    | 1.4 nm                                            | 2.4 nm                                                 | 1.2 nm                              | 2.4 nm                                                                                                         |
| A/D Converter        | 16-bit                                                                                                           |                                                                                                           |                                                   |                                                        |                                     |                                                                                                                |
| Interface            | USB 2.0                                                                                                          |                                                                                                           |                                                   |                                                        |                                     |                                                                                                                |
| Included options     | Deep-UV Coating<br>Order-sorting coa-<br>ting                                                                    | Detector collection lens<br>Deep-UV Coating<br>Order-sorting<br>coating                                   |                                                   | Detector collection lens<br>Order-sorting coating      |                                     |                                                                                                                |
| Applications         | High-resolution<br>measurements<br>from high intensity<br>sources (lasers,<br>powerful light<br>sources, plasma) | Highly versatile broadband<br>spectrometer.<br>Ideal for absorbance,<br>emission, irradiance measurements |                                                   | Color measurements, visible irradiance<br>measurements |                                     | Highly sensitivity<br>applications such<br>as fluorescence or<br>irradiance from very<br>low intensity sources |
| AvaSoft-Full         | Included                                                                                                         |                                                                                                           |                                                   |                                                        |                                     |                                                                                                                |

## Ordering Information

|                                     |                                                                                                                                                                                                                                                                         |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>AvaSpec-ULS3648-USB2-UA-25</b>   | <ul style="list-style-type: none"> <li>UV/VIS/NIR spectrometer, 3648 pixel CCD detector, grating UA (200-1100 nm), slit-25, OSC-UA, DUV3648, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.</li> </ul>                                      |
| <b>AvaSpec-ULS2048-USB2-UA-50</b>   | <ul style="list-style-type: none"> <li>UV/VIS/NIR spectrometer, 2048 pixel CCD detector, grating UA (200-1100 nm), slit-50, OSC-UA, DCL-UV/VIS, DUV400, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.</li> </ul>                           |
| <b>AvaSpec-ULS2048L-USB2-UA-RS</b>  | <ul style="list-style-type: none"> <li>UV/VIS/NIR spectrometer, 2048 large pixel CCD detector, grating UA (200-1100 nm), slit-25-RS, OSC, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full, including SLIT-KIT-SMA.</li> </ul> |
| <b>AvaSpec-ULS2048-USB2-VA-50</b>   | <ul style="list-style-type: none"> <li>VIS/NIR spectrometer, 2048 pixel CCD detector, grating VA (360-1100 nm), slit-50, OSC, DCL-UV/VIS, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.</li> </ul>                                         |
| <b>AvaSpec-ULS2048L-USB2-BB-50</b>  | <ul style="list-style-type: none"> <li>VIS spectrometer, 2048 large pixel CCD detector, grating BB (360-880 nm), slit-50, OSC, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.</li> </ul>                                    |
| <b>AvaSpec-ULS2048XL-USB2-UA-50</b> | <ul style="list-style-type: none"> <li>UV/VIS/NIR spectrometer, 2048 pixel backthinned CCD detector, grating UA (200-1150 nm), slit-50, OSC-UA, DCL-UV/VIS-200, USB2 high-speed interface, including USB interface cable and AvaSoft-Full.</li> </ul>                   |

All preconfigured spectrometers are equipped with AvaSoft-Full and ready to use.



# CompactLine AvaSpec-Mini: 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 of 2000:1, stray-light levels lower than 0.17% and weighs only 174 grams. Easy to take anywhere you like.

The AvaSpec-Mini finds its way into many areas of research, such as light analysis, chemical research and Raman spectroscopy. Or use it as a tiny OEM-spectrometer in your application. The possibilities are endless.

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



## Technical Data

| Name               | AvaSpec-Mini 2048                                           | AvaSpec-Mini 2048L                         | AvaSpec-Mini 3648                     |
|--------------------|-------------------------------------------------------------|--------------------------------------------|---------------------------------------|
| Wavelength range   | 220-1000 nm                                                 |                                            |                                       |
| Sensitivity        | Similar to ULS2048 (no DCL)                                 | Similar to ULS2048 (no DCL)                | Similar to ULS3648 (no DCL)           |
| Detector           | Sony CCD linear array, 2048 pixels                          | Sony CCD linear array, 2048 (Large) pixels | Toshiba CCD linear array, 3648 pixels |
| Signal/Noise       | 200:1                                                       | 300:1                                      | 350:1                                 |
| Integration time   | 1.05ms - 10 minutes                                         |                                            | 10µs - 10 minutes                     |
| I/O                | 6 bidirectional programmable I/O; 2 analog out; 2 analog in |                                            |                                       |
| Dimensions, weight | 95 x 68 x 20 mm, 174 grams                                  |                                            |                                       |

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

| Grating (lines/mm) | Slit size (µm) |           |           |      |      |       |
|--------------------|----------------|-----------|-----------|------|------|-------|
|                    | 10             | 25        | 50        | 100  | 200  | 500   |
| <b>2048 (L)</b>    |                |           |           |      |      |       |
| <b>600</b>         | 0.40-0.53      | 0.70      | 1.20      | 2.40 | 4.60 | 10.80 |
| <b>1800</b>        | 0.10-0.18      | 0.20-0.29 | 0.34-0.42 | 0.80 | 1.60 | 3.60  |
| <b>3648</b>        |                |           |           |      |      |       |
| <b>600</b>         | 0.30-0.36      | 0.58-0.60 | 1.17      | 2.20 | 4.50 | 10.00 |
| <b>1800</b>        | 0.09-0.11      | 0.18      | 0.36-0.40 | 0.78 | 1.50 | 3.70  |

\* Typical values. Small deviations are possible.

- Small/ Compact size
- UV, VIS and NIR version
- OEM
- Preconfigured versions for non-OEM

## NEW EVO Series: StarLine AvaSpec-ULS2048L-EVO Spectrometer

### EVO series: AvaSpec-ULS2048L



The first instrument in our new EVO series: the AvaSpec-ULS2048L-EVO. Using the new electronics board AS 7010 this spectrometer has all the advantages of the current AvaSpec-ULS2048L-USB2 and offers USB3.0 communication as well, which means 10x higher speed compared to USB2.

Unique is the 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.

This unique, first to the market combination enables you to create high speed multichannels systems, perfectly suited for most industrial applications.

Options include a deep-UV detector coating, for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2<sup>nd</sup> order effects. Furthermore, the AvaSpec-2048L 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.

### Technical Data

|                           |                                                                                                     |
|---------------------------|-----------------------------------------------------------------------------------------------------|
| <b>Wavelength range</b>   | 200-1100 nm                                                                                         |
| <b>Resolution</b>         | 0.06 –20 nm, depending on configuration                                                             |
| <b>Sensitivity</b>        | 470,000 counts/μW per ms integration time                                                           |
| <b>Detector</b>           | CCD linear array, 2048 pixels                                                                       |
| <b>Signal/Noise</b>       | 300:1                                                                                               |
| <b>Integration time</b>   | 1.11 ms – 10 minutes                                                                                |
| <b>Digital IO</b>         | HD-26 connector, 2 Analog in, 2 Analog out, 13 Digital bidirectional, trigger, sync., strobe, laser |
| <b>Power supply</b>       | Default USB3 power, 500 mA<br>Or 12VDC, 300 mA                                                      |
| <b>Dimensions, weight</b> | 177 x 127 x 44,5 mm (1 channel), 1135 grams                                                         |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048L-EVO

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

#### AvaSpec-ULS2048L-EVO

- USB3
- Gigabit-Ethernet
- Latest technology
- Replaceable Slit option

# AvaSpec-ULS2048 StarLine

## Versatile Fiber-optic Spectrometer

### AvaSpec-ULS2048



The workhorse of our spectrometer line-up, the AvaSpec-ULS2048. Used in many applications in the UV/VIS-range, it is particularly useful in time-critical situations thanks to its exceptional response speed.

For general purposes, the AvaSpec-ULS2048 is the choice of many of our most demanding customers.

Options include deep-UV detector coating for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filters to reduce 2<sup>nd</sup>

order effects. Furthermore, the AvaSpec-ULS2048 is available with a wide range of slit sizes, gratings and fiber-optic entrance connectors.

The AvaSpec-ULS2048 is also available in dual or multi-channel versions (up to 10 spectrometers in a 19" rack), where all spectra are taken simultaneously.

Connection with your PC is done via USB2-connection, delivering a scan every 1.8 milliseconds. Integration time can be as short as 1.05 milliseconds up to a maximum of 10 minutes.

### Technical Data

|                           |                                                      |
|---------------------------|------------------------------------------------------|
| <b>Wavelength range</b>   | 200-1100 nm                                          |
| <b>Resolution</b>         | 0.05 – 20 nm, depending on configuration (see table) |
| <b>Sensitivity</b>        | 310,000 counts/μW per ms integration time            |
| <b>Detector</b>           | CCD linear array, 2048 pixels                        |
| <b>Signal/Noise</b>       | 200:1                                                |
| <b>Integration time</b>   | 1.05 ms – 10 minutes                                 |
| <b>Dimensions, weight</b> | 175 x 110 x 44 mm (1 channel), 716 grams             |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048

| Grating (lines/mm) | Slit size (μm) |              |            |      |      |      |
|--------------------|----------------|--------------|------------|------|------|------|
|                    | 10             | 25           | 50         | 100  | 200  | 500  |
| <b>300</b>         | 0.80 – 0.90*   | 1.10-1.20*   | 2.30       | 4.60 | 9.00 | 20.0 |
| <b>600</b>         | 0.40 – 0.50*   | 0.63         | 1.15       | 2.31 | 4.50 | 10.0 |
| <b>830</b>         | 0.28           | 0.40         | 0.80       | 1.60 | 3.20 | 8.0  |
| <b>1200</b>        | 0.18 – 0.22*   | 0.29         | 0.61       | 1.18 | 2.20 | 5.4  |
| <b>1800</b>        | 0.10 – 0.16*   | 0.19         | 0.35-0.42* | 0.80 | 1.60 | 3.6  |
| <b>2400</b>        | 0.08 – 0.11*   | 0.10 – 0.15* | 0.28       | 0.55 | 1.10 | 2.7  |
| <b>3600</b>        | 0.05 – 0.08*   | 0.10         | 0.18       | 0.38 | 0.75 | 1.8  |

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

- Excellent timing characteristics
- UV/VIS/NIR
- Configurable
- Low straylight
- Replaceable Slit option

# AvaSpec-ULS2048L StarLine Versatile Fiber-optic Spectrometer

## AvaSpec-ULS2048L



A close cousin to the AvaSpec-ULS2048 but with larger pixels, is the AvaSpec-ULS2048L. It provides enhanced sensitivity at an affordable price. The AvaSpec-ULS2048L has pixels that are almost four times higher than those in the AvaSpec-ULS2048. It gives you a better signal to noise ratio and 40% less dark noise.

Options include a deep-UV detector coating, for better performance in the deep-UV-range, a detector collection lens to enhance sensitivity in the 200-1100 nm range and order-sorting filter to reduce 2<sup>nd</sup> order effects. Furthermore, the AvaSpec-ULS2048L is available with a wide range of

slit sizes, gratings and fiber-optic entrance connectors.

The AvaSpec-2048L is also available in dual or multi-channel versions (up to 10 spectrometers), where all spectra are taken simultaneously.

Connection to your PC is handled via USB2-connection, delivering a scan every 1.8 milliseconds. Integration time can be as short as 1.05 milliseconds up to a maximum of 10 minutes. It comes complete with AvaSoft-Basic software, USB cable and an extensive manual, including a quick start guide in four languages.

### Technical Data

|                           |                                                     |
|---------------------------|-----------------------------------------------------|
| <b>Wavelength range</b>   | 200-1100 nm                                         |
| <b>Resolution</b>         | 0.06 –20 nm, depending on configuration (see table) |
| <b>Sensitivity</b>        | 470,000 counts/μW per ms integration time           |
| <b>Detector</b>           | CCD linear array, 2048 pixels, large pixel          |
| <b>Signal/Noise</b>       | 300:1                                               |
| <b>Integration time</b>   | 1.05 ms – 10 minutes                                |
| <b>Dimensions, weight</b> | 175 x 110 x 44 mm (1 channel), 716 grams            |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048L

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

- High Sensitivity
- General purpose
- Replaceable Slit option



# AvaSpec-ULS3648 StarLine High-resolution Fiber-optic Spectrometer

Are you looking for a high-resolution? Then take a look at the AvaSpec-ULS3648. Featuring an electronic shutter, it can support integration times as short as 10 microseconds, making it also ideal for CW laser measurements.

Options include order-sorting filters to prevent 2<sup>nd</sup> order effects, deep-UV detector coating for better sensitivity in the deep-UV-range, and a detector collection lens to enhance overall sensitivity. Also, a wide range of slit sizes down to 5µm, gratings and fiber-optic entrance connectors are available.

Configurations with two to ten channel spectrometers are available. These give you the possibility for multiple simultaneous readouts or higher optical resolution in which several spectrometers are arrayed with each covering a short range with high-resolution. For more information, see pages 62 and 63.

The connection to your computer is done through USB2 at 480 Mbps. This translates into 3.7 ms per scan data transfer speed. Of course it's supplied with AvaSoft-Basic, USB cable and an extensive manual, including a quick start guide in four languages.

## AvaSpec-ULS3648



### Technical Data

|                           |                                                     |
|---------------------------|-----------------------------------------------------|
| <b>Wavelength range</b>   | 200 - 1100 nm                                       |
| <b>Resolution</b>         | 0.05 -20 nm, depending on configuration (see table) |
| <b>Sensitivity</b>        | 160,000 counts/µW per ms integration time           |
| <b>Detector</b>           | CCD linear array, 3648 pixels                       |
| <b>Signal/Noise</b>       | 350:1                                               |
| <b>Integration time</b>   | 10 µs - 10 minutes                                  |
| <b>Dimensions, weight</b> | 175 x 110 x 44 mm (1 channel), 716 grams            |

### Resolution table (FWHM in nm) for AvaSpec-ULS3648

| Grating (lines/mm) | Slit size (µm) |              |            |            |      |      |
|--------------------|----------------|--------------|------------|------------|------|------|
|                    | 10             | 25           | 50         | 100        | 200  | 500  |
| <b>300</b>         | 0.60 - 0.70*   | 1.10-1.30*   | 2.20-2.40* | 4.60       | 9.00 | 20.0 |
| <b>600</b>         | 0.30 - 0.36*   | 0.58-0.68*   | 1.17       | 2.20       | 4.50 | 10.0 |
| <b>830</b>         | 0.25           | 0.48         | 0.93       | 1.70       | 3.40 | 8.0  |
| <b>1200</b>        | 0.14 - 0.18*   | 0.30         | 0.62       | 1.08       | 2.20 | 5.0  |
| <b>1800</b>        | 0.09 - 0.11*   | 0.18         | 0.36-0.40* | 0.78       | 1.50 | 3.7  |
| <b>2400</b>        | 0.07 - 0.09*   | 0.13 - 0.15* | 0.26-0.32* | 0.52-0.64* | 1.10 | 2.7  |
| <b>3600</b>        | 0.05 - 0.06*   | 0.10         | 0.19       | 0.40       | 0.80 | 2.0  |

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

- For High Resolution applications
- Short integration times
- Replaceable Slit option

## 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 only available on ULS Ultra-low Stray-light AvaSpecs and the NIR256-1.7 spectrometer. The slit sets contain 25, 50, 100 and 200  $\mu\text{m}$  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

|                            |                                                        |
|----------------------------|--------------------------------------------------------|
| <b>Slit set connectors</b> | SMA-905 or FC/PC                                       |
| <b>Slit sizes</b>          | 25, 50, 100, 200 $\mu\text{m}$ (width) x 1 mm (height) |
| <b>Material</b>            | Stainless steel                                        |
| <b>Fixing screws</b>       | Torx (included)                                        |



### 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 and 200  $\mu\text{m}$ . Also included in the kit are the tools to easily change the slit in the spectrometer.

The Slit Kit is available in SMA and FC/PC versions. Both kits can be used on any spectrometer with the replaceable slit option installed.

Don't forget to order  
a fiber cable

# AvaSpec-ULS2048XL SensLine

## High UV- and NIR-sensitivity back-thinned CCD Spectrometer

Combining exceptional quantum efficiency with high-speed is the value proposition of the AvaSpec-ULS2048XL spectrometer. Unlike many back-thinned CCD spectrometers, which have two dimensional arrays, the ULS2048XL 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 2<sup>nd</sup> order effects and purge ports for deep-UV measurements.

The AvaSpec-ULS2048XL 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 is also available in dual or multi-channel versions (up to 10 spectrometers), where all spectra are acquired simultaneously.

Connection to your PC is handled via a USB2-connection, delivering a scan every 2 milliseconds. The instrument comes complete with AvaSoft-basic software, USB cable and an extensive manual, including a quick start guide in four languages.

### AvaSpec-ULS2048XL



### Technical Data

|                           |                                                      |
|---------------------------|------------------------------------------------------|
| <b>Wavelength range</b>   | 200 - 1160 nm                                        |
| <b>Resolution</b>         | 0.09 - 20 nm, depending on configuration (see table) |
| <b>Sensitivity</b>        | 460,000 counts/μW per ms int. time                   |
| <b>Detector</b>           | Back-thinned CCD image sensor 2048 pixels            |
| <b>Signal/Noise</b>       | 450:1                                                |
| <b>Integration time</b>   | 2 μs - 20 seconds                                    |
| <b>Dimensions, weight</b> | 175 x 110 x 44 mm (1 channel), 855 grams             |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048XL

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

- Backthinned detector with good UV and NIR response
- Short integration times possible
- Good timing characteristics

# AvaSpec-ULS2048LTEC SensLine

## Thermo-Electric Cooled

## Fiber-optic Spectrometer

### AvaSpec-ULS2048LTEC



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

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

### Technical Data

|                                                                 |                                                     |
|-----------------------------------------------------------------|-----------------------------------------------------|
| <b>Wavelength range</b>                                         | 200-1100 nm                                         |
| <b>Resolution</b>                                               | 0.06 –20 nm, depending on configuration (see table) |
| <b>Sensitivity</b>                                              | 470,000 counts/μW per ms integration time           |
| <b>Detector</b>                                                 | CCD linear array, 2048 pixels                       |
| <b>Temperature cooled CCD</b>                                   | Max. ΔT = -35 °C versus ambient                     |
| <b>3-stage Peltier cooling internal Power supply @ ΔT=-35°C</b> | 5VDC, 3.0A                                          |
| <b>Signal/Noise</b>                                             | 300:1                                               |
| <b>Integration time</b>                                         | 1.11 ms – 10 minutes                                |
| <b>Dimensions, weight</b>                                       | 250 x 179 x 144 mm, 3.6 kg                          |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048LTEC

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

- High performance
- TE-Cooled
- Long integration times possible
- For low light applications



# AvaSpec-ULS2048x64TEC SensLine Thermo-Electric Cooled Fiber-optic Spectrometer

The AvaSpec-ULS2048x64TEC spectrometer is one of the newest spectrometers in the SensLine.

This instrument enhances the Sensline series. With a cooled, backthinned detector. The backthinned 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 500 seconds with low noise values.

The instrument features our re-designed three-stage Peltier cooling device integrated into our exclusive ultra-low stray-light optical bench, which can reduce the temperature of the CCD chip by -35 °C against ambient, improving the dark baseline and PRNU level by a significant factor. The detector cooling also reduces the dark

noise by a factor of 2-3.

The AvaSpec-ULS2048x64TEC-USB2 uses a special low noise version of the 2048x64 detector. All the features mentioned above make this instrument ideally suited for measuring low light applications like for instance fluorescence.

Optimal flexibility is guaranteed with the (optional) replaceable slit making the instrument suitable for different kind of applications.

The above mentioned make the AvaSpec-ULS2048x64TEC 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.

The AvaSpec-ULS3648TEC can be delivered as 1- or 2-channel instrument and has all the standard options, gratings and specifications of the standard AvaSpec-ULS3648.

## AvaSpec-ULS 2048x64TEC



The AvaSpec-ULS3648TEC is built into a newly designed housing with an integrated temperature regulator, USB2 high-speed communication, dual cooling fans and an integrated power supply.

### Technical Data

|                               |                                                        |
|-------------------------------|--------------------------------------------------------|
| <b>Wavelength range</b>       | 200-1160 nm                                            |
| <b>Resolution</b>             | 0.09 –20 nm, depending on configuration (see table)    |
| <b>Sensitivity</b>            | 300,000 counts/μW per ms integration time              |
| <b>Detector</b>               | Backthinned CCD, 2048x64 pixels, Low Noise             |
| <b>Temperature cooled CCD</b> | Max. ΔT = -35 °C versus ambient. Optimal setting: 5 °C |
| <b>Signal/Noise</b>           | 550:1                                                  |
| <b>Integration time</b>       | 9.7 ms – 500s                                          |
| <b>Dimensions, weight</b>     | 250 x 179 x 144 mm, 3.6 kg                             |

### Resolution table (FWHM in nm) for AvaSpec-ULS2048x64TEC

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

- TE-Cooled
- Backthinned detector with good NIR response
- Low noise
- For fluorescence and Raman applications

# AvaSpec-HS2048XL SensLine

## High UV and NIR sensitivity back-thinned CCD Spectrometer

### AvaSpec-HS2048XL



For high sensitivity applications where high resolution is not of paramount concern, the AvaSpec-HS2048XL 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 available. 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.

### Technical Data

|                                             |                                                                                                    |
|---------------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Optical Bench</b>                        | High-sensitivity asymmetrical design, 37.5 mm focal length; NA – 0.22, f/2.27                      |
| <b>Wavelength range</b>                     | 200 - 1160 nm                                                                                      |
| <b>Resolution</b>                           | 1 - 10 nm, depending on configuration (see table)                                                  |
| <b>Stray-light</b>                          | < 1 %                                                                                              |
| <b>Sensitivity</b>                          | 1,100,000 counts/μW per ms int. time                                                               |
| <b>UV Quantum efficiency</b>                | 60% 200-250 nm 78% 550- 750 nm                                                                     |
| <b>Detector</b>                             | Back-thinned CCD image sensor 2048 pixels                                                          |
| <b>Signal/Noise</b>                         | 450:1                                                                                              |
| <b>AD converter</b>                         | 16-bit, 1 MHz                                                                                      |
| <b>Integration time</b>                     | 2 μs – 600 seconds                                                                                 |
| <b>Interface</b>                            | USB 2.0 high-speed, 480 Mbps<br>RS-232, 115.200 bps                                                |
| <b>Sample speed with on-board averaging</b> | 2.09 ms /scan                                                                                      |
| <b>Data transfer speed</b>                  | 2.09 ms /scan (USB2)<br>432 ms / scan (RS-232)                                                     |
| <b>Digital IO</b>                           | HD-26 connector, 2 Analog in, 2 Analog out, 3 Digital in, 12 Digital out, trigger, synchronization |
| <b>Power supply</b>                         | Default USB power, 450 mA. or with SPU2 external 12VDC, 200 mA                                     |
| <b>Dimensions, weight</b>                   | 175 x 165 x 85 mm, 1,950 kg                                                                        |

# AvaSpec-NIR256/512-1.7(TEC)

## NIRLine Near-Infrared Fiber-optic Spectrometer

For measurements in the near infrared range out to 1.7  $\mu\text{m}$ , Avantes offers three spectrometer configurations. The AvaSpec-NIR256-1.7 is the most economical in the NIR-range of spectrometers made by Avantes, but offers exceptional performance specifications such as a sample speed of only 1.06 ms/scan and integration times as fast as 10  $\mu\text{s}$ . This instrument is also available in RS-version meaning you can easily change the slit in a matter of seconds.

The AvaSpec-NIR256/512-1.7 TEC spectrometers can be operated in two distinct gain-setting modes, the high-sensitivity

mode (HS, default) and the low-noise (LN) mode. Setting of the different gain modes can be done via a software option.

All NIR-1.7 instruments are available with a choice of four different gratings, making it possible to choose the bandwidth fitting your application. Digital and analog I/O ports enable external triggering and control over the shutter and pulsed light sources from the Avantes line of products. The uncooled AvaSpec-NIR256-1.7 is USB2 powered, while the TEC cooled instruments require external power.

### AvaSpec-NIR256-1.7TEC



### Technical Data

| Spectrometer                                    | AvaSpec-NIR256-1.7                                                    | AvaSpec-NIR256-1.7TEC                                                           | AvaSpec-NIR512-1.7TEC                                                           |
|-------------------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------------|---------------------------------------------------------------------------------|
| Wavelength range                                | 900 - 1750 nm                                                         |                                                                                 |                                                                                 |
| Resolution (slit & grating dependent)           | 2.0 - 50 nm                                                           |                                                                                 | 1.5 - 50 nm                                                                     |
| Sensitivity HS in counts / $\mu\text{W}$ per ms | 1,300,000<br>(integral 1000-1750 nm)                                  | 2,770,000<br>(integral 1000-1750 nm)                                            | 1,385,000<br>(integral 1000-1750 nm)                                            |
| Signal/Noise HS                                 | 2000:1                                                                | 1700:1                                                                          | 1700:1                                                                          |
| Integration time HS                             | 10 $\mu\text{s}$ - 750 ms                                             | 20 $\mu\text{s}$ - 1 second                                                     | 20 $\mu\text{s}$ - 1 second                                                     |
| Sensitivity LN in counts / $\mu\text{W}$ per ms | 74,000<br>(integral 1000-1750 nm)                                     | 96,000<br>(integral 1000-1750 nm)                                               | 48,000<br>(integral 1000-1750 nm)                                               |
| Signal/Noise LN                                 | 6000:1                                                                | 3600:1                                                                          | 3600:1                                                                          |
| Integration time LN                             | 10 $\mu\text{s}$ - 8 seconds                                          | 20 $\mu\text{s}$ - 35 seconds                                                   | 20 $\mu\text{s}$ - 35 seconds                                                   |
| Detector                                        | InGaAs linear array, 256 pixels, 50 $\mu\text{m}$ x 500 $\mu\text{m}$ | TE-cooled InGaAs linear array, 256 pixels, 50 $\mu\text{m}$ x 500 $\mu\text{m}$ | TE-cooled InGaAs linear array, 512 pixels, 25 $\mu\text{m}$ x 500 $\mu\text{m}$ |
| Dimensions, weight                              | 175 x 165 x 85 mm, 2.2 kg                                             | 244 x 144 x 254 mm, 5.1 kg                                                      |                                                                                 |

### Resolution table (FWHM in nm) for AvaSpec-NIR256/512-1.7

| Grating (lines/mm) | Slit size ( $\mu\text{m}$ ) |    |     |     |     |
|--------------------|-----------------------------|----|-----|-----|-----|
|                    | 25*                         | 50 | 100 | 200 | 500 |
| 200                | 5                           | 6  | 12  | 24  | 50  |
| 400                | 2.5                         | 3  | 6   | 12  | 25  |
| 600                | n.a.                        | 2  | 4   | 8   | 18  |

\* only for AvaSpec-NIR512TEC

- Cooled and uncooled version
- 512 pixels for high resolution
- Determine watercontent
- Agriculture applications

## AvaSpec-NIR256-2.5-HSC

### NIRLine Near-infrared Fiber Optic Spectrometer



Avantes offers a wide range of NIR spectrometers. The 2.x-series extended InGaAs instruments feature 256 or 512 pixel detectors and are available in configurations enabling measurements up to 2000, 2200 and 2500 nm. The -HSC is the improved version of the AvaSpec-NIR2.5TEC and offers improved sensitivity, less weight and less size. It is based on a 100mm optical bench with a NA of 0.13 offering optimal balance between resolution and sensitivity.

A range of gratings are available offering the possibility to tailor the instrument for optimal performance in your application.

Also available on the -HSC is the user selectable 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 low-light conditions. Analog and digital IO ports enable external triggering and control of shuttered and pulsed light sources from the AvaLight series of illumination sources.

The instrument features a dual stage thermo-electrical Peltier-cooled InGaAs detector, especially designed for measuring in the NIR range. Connection to the computer is managed through the USB2.0 interface. Data is transferred in 1.1 ms. All instruments are supplied with AvaSoft-Basic, a manual and USB/power cables.

The instrument is equipped with a replaceable slit which offers you great flexibility for your experiment.

#### Technical Data

|                                                                           |                                                        |
|---------------------------------------------------------------------------|--------------------------------------------------------|
| <b>Wavelength Range</b>                                                   | 1000 - 2500 nm                                         |
| <b>Resolution (slit &amp; grating dependent)</b>                          | 4.8-77 nm                                              |
| <b>Sensitivity HS in counts / <math>\mu</math>W per ms (1000-2500 nm)</b> | 995,000                                                |
| <b>Signal/Noise HS</b>                                                    | 1400:1                                                 |
| <b>Integration time HS</b>                                                | 10 $\mu$ s -5ms                                        |
| <b>Sensitivity LN in counts / <math>\mu</math>W per ms (1000-2500nm)</b>  | 57,500                                                 |
| <b>Signal/Noise LN</b>                                                    | 3685:1                                                 |
| <b>Integration time LN</b>                                                | 10 $\mu$ s -100ms                                      |
| <b>Detector</b>                                                           | InGaAs linear array with 2-stage TE-cooling, 256 pixel |
| <b>Cooling</b>                                                            | 45 °C versus ambient                                   |
| <b>Dimensions, weight</b>                                                 | 185 x 145 x 185 mm, 3.5 kg.                            |

#### Resolution table (FWMH in nm) for AvaSpec-NIR256-2.5-HSC

| Grating (lines/mm) | Slit size ( $\mu$ m) |      |      |      |
|--------------------|----------------------|------|------|------|
|                    | 50                   | 100  | 200  | 500  |
| <b>75</b>          | 12.1                 | 15.7 | 30.8 | 77.0 |
| <b>100</b>         | 9.5                  | 12.4 | 21.0 | 52.5 |
| <b>150</b>         | 6.4                  | 8.3  | 14.0 | 35.0 |
| <b>200</b>         | 4.8                  | 6.1  | 10.6 | 26.5 |

- Excellent NIR performance
- Cooled
- High sensitivity
- Replaceable Slit
- Agriculture / Semicon / Plastics

# 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 optimal performance we provide you a Raman bundle you 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.

All 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.

## 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

*Based on an uncooled spectrometer this is the entry bundle for reasonable strong signals*

- Range : 150 cm<sup>-1</sup> - 3600 cm<sup>-1</sup>
- Resolution: 6 cm<sup>-1</sup>
- 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

*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<sup>-1</sup> - 3600 cm<sup>-1</sup>
- Resolution: 6 cm<sup>-1</sup>
- 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-C

*For the most demanding applications. The spectrometer used in this bundle makes use of a cooled spectrometer with a special low-noise Back-Thinned detector. Back thinned detectors have much better sensitivity in the NIR range (800-1160nm) in comparison to standard Si-detectors.*

- Range : 150 cm<sup>-1</sup> - 3600 cm<sup>-1</sup>
- Resolution: 6 cm<sup>-1</sup>
- AvaSpec-ULS2048x64TEC-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)

## 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.

For very weak signals (possibly together with fluorescence background) the Ava-Raman-C is recommended. Thanks to Higher quantum efficiency in NIR and better signal /noise performance.

- Analysis of liquids, powders, tablets, gels
- Measurements through transparent and semi-transparent packages



# AvaRaman Fiber-optic Raman System



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, 633 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.

AvaRaman-TEC series spectrometers have a three-stage Peltier cooling systems,

which provides  $\Delta T$  down to  $-30^{\circ}\text{C}$  cooling to ambient for superior dark noise reduction, keeping the detector at a steady  $5^{\circ}\text{C}$ . Thanks to the PID controller, this temperature is stable within a  $0.1^{\circ}\text{C}$  bandwidth. 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-Raman and Panorama-Pro, please contact us for more information.

## Technical Data

|                              | AvaRaman-532TEC                                                                  | AvaRaman-785TEC                                                                       |
|------------------------------|----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------|
|                              | Cooled                                                                           | Cooled                                                                                |
| <b>Signal to noise Ratio</b> | 200:1 for Benzene                                                                | 300:1 for Benzene                                                                     |
| <b>Resolution*</b>           | $\pm 6 \text{ cm}^{-1}$                                                          | $\pm 6 \text{ cm}^{-1}$                                                               |
| <b>Spectrometer</b>          | AvaSpec-ULS2048L-TEC with grating NC (535-752 nm), slit-25, DCL-UV/VIS TE-cooled | AvaSpec-ULS2048L-TEC with grating SI (785-1080 nm), slit-25, DCL-UV/VIS-200 TE-cooled |
| <b>Raman Shift</b>           | 100-5400 $\text{cm}^{-1}$                                                        | 100-3500 $\text{cm}^{-1}$                                                             |
| <b>Laser output</b>          | 532 nm, 50 mW                                                                    | 785 nm, 500 mW, Class 3b                                                              |
| <b>Laser Wavelength</b>      | 532 nm                                                                           | 785 nm                                                                                |
| <b>Dimensions housing</b>    | 240 (L) x 140 (W) x 250 (H) mm                                                   |                                                                                       |

## AvaRaman probes



AvaRaman-PRB-XXX  
3/8" SS focusing probe with a 200  $\mu\text{m}$  excitation fiber and 400  $\mu\text{m}$  read fiber. Multiple focal lengths available (5 mm, 7.5 mm (standard), 10 mm). It can withstand  $80^{\circ}\text{C}$ . Manual shutter included, 1.5 m fibers.  
Specify XXX=excitation wavelength



AvaRaman-PRB-FP-XXX  
1/2" SS focusing probe with a 200  $\mu\text{m}$  excitation fiber and 400  $\mu\text{m}$  read fiber. Multiple focal lengths available (5 mm (standard), 7.5 mm, 10 mm). It can withstand  $80^{\circ}\text{C}$ .  
Specify XXX=excitation wavelength



AvaRaman-PRB-FIP-XXX  
5/8" SS immersible focusing probe for in-situ measurements with a 200  $\mu\text{m}$  excitation fiber and 400  $\mu\text{m}$  read fiber. It can withstand  $200^{\circ}\text{C}$ .  
Specify XXX=excitation wavelength



AvaRaman-PRB-FC-XXX  
3/8" SS immersible process probe for in-situ measurements with a 200  $\mu\text{m}$  excitation fiber and 400  $\mu\text{m}$  read fiber. It can withstand  $500^{\circ}\text{C}$  and 3000psi, the probe optics provide complete background filtering.  
Specify XXX=excitation wavelength

\* typical resolution: higher resolution possible on request

# AvaSpec Multi-Channel Spectrometer

Do you need more precise measurements over a broad range? Or multiple measurements at the same moment for process control? The unique 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.

These can be any from the Avantes catalog, starting with the robust and versatile UV/visible AvaSpec-ULS2048 up to the TEC cooled AvaSpec-NIR2.5 near infrared spectrometer.

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.

All channels are connected to the computer through one single USB 2.0-cable.

In general, Avantes multichannel spectrometers are frequently used for applications where high resolution with a broad range is needed in combination with synchronized measurements, such as plasma and LIBS configurations. In AvaSoft, all spectrometer channels can be combined into one graph, making one virtual spectrometer.

#### Benefits:

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



## 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 |

## OEM Capabilities

All our spectrometers are available as an OEM module.

For more information see page 65 or go to [www.avantes.com/oem](http://www.avantes.com/oem) or just contact us!

### Multi-Channel Spectrometers

- Flexible
- Custom made
- Unique

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 XP up to Windows 10. Since the initial version of AvaSoft in 1996, a major upgrade has been released at least once a year, featuring new options and possibilities.

- 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 and real-time export to Excel.
- AvaSoft-All, which includes AvaSoft-Full and all add-on application modules in one package.
- Stand-alone AvaSoft packages for pre-configured systems, such as AvaSoft-Raman for our Raman line of systems and AvaSoft-ThinfilM for measurements with the AvaThinfilM system.
- Our user friendly Dynamic Link Library (DLL) interface packages with support for basic spectrometer control, color measurements and irradiance measurements.



A person in silhouette is standing on a platform, adjusting a light source mounted on a rig. The background shows a body of water and a bright sun setting or rising, creating a strong backlight effect. The image is overlaid with a green gradient on the left side.

# 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                 |
|-------------------------------|-------------------|-------------------------------|------------|-------------------------|
| <b>Color / VIS / NIR</b>      | 360-2500 nm       | Tungsten Halogen              | Continuous | AvaLight-HAL(-S)-MINI   |
| <b>DUV</b>                    | 190-400 nm        | Deuterium                     | Continuous | AvaLight-D-S-DUV        |
| <b>UV</b>                     | 215-400 nm        | Deuterium                     | Continuous | AvaLight-D-S            |
| <b>UV/VIS/NIR refl./abs</b>   | 215-2500 nm       | Deuterium/Halogen             | Continuous | AvaLight-DH-S-(BAL)     |
| <b>UV/VIS/NIR absorption</b>  | 200-2500 nm       | Deuterium/Halogen             | Continuous | AvaLight-DHc            |
| <b>UV/VIS</b>                 | 200-1000 nm       | Xenon                         | Pulsed     | AvaLight-XE             |
| <b>Fluorescence</b>           | Multiple possible | LED                           | Continuous | AvaLight-LED            |
| <b>Wavelength Calibration</b> | 253-1704 nm       | Mercury-Argon<br>Neon / Argon | Continuous | AvaLight-CAL            |
|                               | 200-700 nm        | Zinc/Cadmium                  | Continuous | AvaLight-CAL-CAD/Zinc   |
| <b>Irradiance Calibration</b> | 360-2500 nm       | Tungsten Halogen              | Continuous | AvaLight-HAL-CAL-MINI   |
|                               | 200-1100 nm       | Deuterium/Halogen             | Continuous | AvaLight-DH-(BAL)-CAL   |
| <b>Radiance Calibration</b>   | 360-2500 nm       | Tungsten Halogen              | Continuous | AvaSphere-50-LS-HAL-CAL |

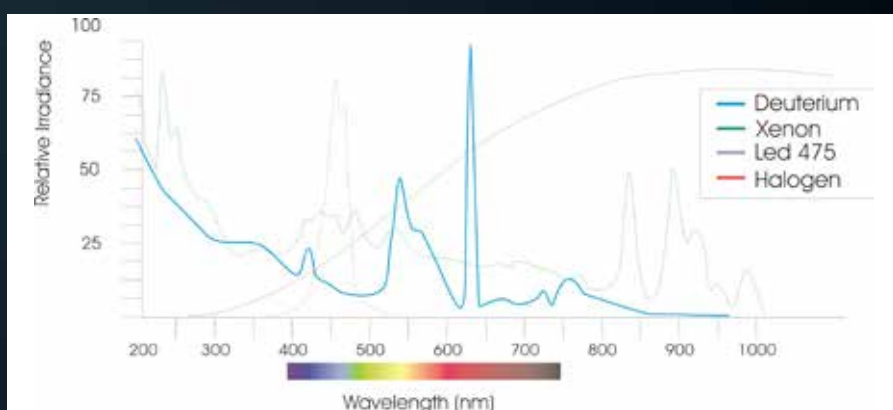


Figure 7 spectral distribution of different Light Sources

## 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
- Low cost
- 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).

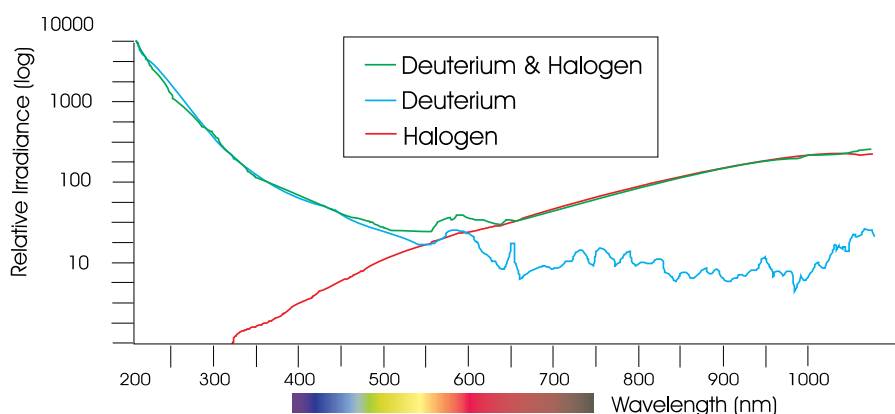


Figure 8 Spectral output of AvaLight-DHc

#### Technical Data

|                                                     | Deuterium Light Source     | Halogen Light Source |
|-----------------------------------------------------|----------------------------|----------------------|
| <b>Wavelength Range</b>                             | 200 - 400 nm               | 400 - 2500 nm        |
| <b>Optical Power in 600 <math>\mu</math>m fiber</b> | 0.2 $\mu$ Watt             | 7 $\mu$ Watt         |
| <b>Lamp Lifetime</b>                                | 1000 hours                 | 2000 hours           |
| <b>Power Supply</b>                                 | 12VDC / 450 mA             |                      |
| <b>Dimensions</b>                                   | 175 x 110 x 44 mm          |                      |
| <b>Lifetime shutter</b>                             | 1.000.000 cycles (typical) |                      |

# AvaLight-HAL-(S)-MINI

## Tungsten-Halogen Light Source

From visible light to near infrared, that's where the AvaLight-HAL-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-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-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-INL, 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.

### AvaLight-HAL-S-MINI

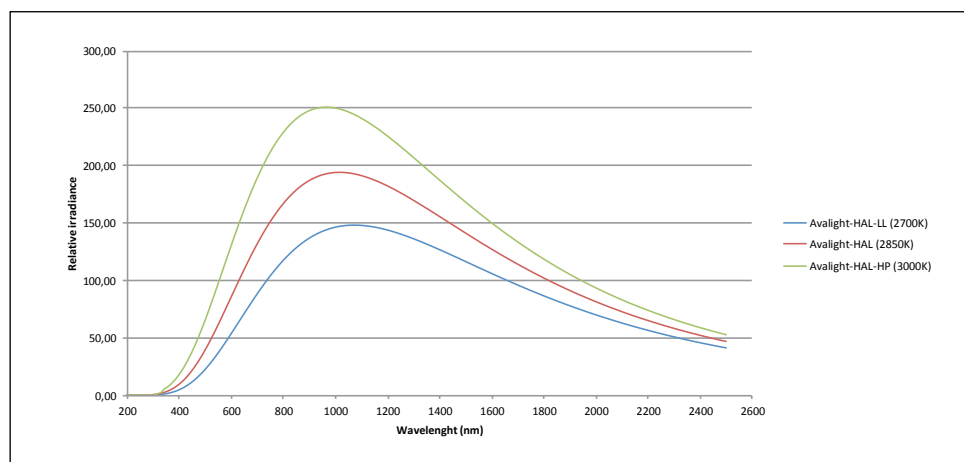


Figure 9 Spectral output of AvaLight-HAL-Mini

### Technical Data

|                                         | AvaLight-HAL-(S)-Mini (standard) | AvaLight-HAL-(S)-Mini (long life) | AvaLight-HAL-(S)-Mini (high power) |
|-----------------------------------------|----------------------------------|-----------------------------------|------------------------------------|
| <b>Wavelength Range</b>                 | 360-2500 nm                      |                                   |                                    |
| <b>Bulb Life</b>                        | 4000 hrs                         | > 13000 hrs                       | < 1000 hrs                         |
| <b>Min. Optical power* 600 µm fiber</b> | 4.5 mWatt                        | 3.2 mWatt                         | 6 mWatt                            |
| <b>Bulb Color Temperature</b>           | 2,850 K                          | 2,730 K                           | 3,000 K                            |
| <b>Power requirement</b>                | 12 VDC / 1.5A                    |                                   |                                    |
| <b>Dimensions, weight</b>               | 150 x 78 x 37 mm, 510 grams      |                                   |                                    |
| <b>Lifetime shutter</b>                 | 1,000,000 cycles (typical)       |                                   |                                    |

\* Optical power measured from 350-1100nm

## 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,

and an increase in the dynamic range of a factor 20.

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 deu-

terium light sources solarization resistant fibers (-SR) are recommended (see the fiber-optic section of this catalog). The output of the AvaLight-DH-S-BAL is optimized for fibers or bundles up to 600  $\mu\text{m}$ .

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

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 Deuterium (Standard) | Balanced Halogen Lamp |
|------------------------------------------------------------|-------------------------------|-----------------------|
| <b>Wavelength Range</b>                                    | 215-500 nm                    | 500-2500 nm           |
| <b>Lamp Lifetime</b>                                       | 2000 hrs                      | 1000 hrs              |
| <b>Color Temperature</b>                                   | -                             | 3000 K                |
| <b>Optical Power in 600 <math>\mu\text{m}</math> fiber</b> | 33 $\mu\text{W}$              | 160 $\mu\text{W}$     |
| <b>Power Requirements</b>                                  | 100-240VAC 50/60 Hz           |                       |
| <b>Dimensions / Weight</b>                                 | 315 x 165 x 140 mm / ca 5 kg. |                       |
| <b>Lifetime shutter</b>                                    | 1,000,000 cycles (typical)    |                       |

## AvaLight-XE Pulsed Xenon

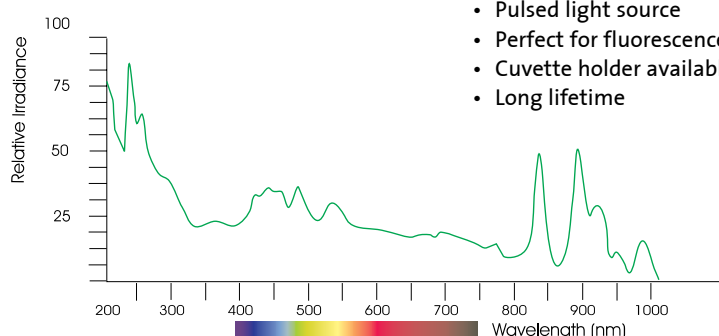
### AvaLight-XE



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



## Technical Data

|                                                     |                                             |
|-----------------------------------------------------|---------------------------------------------|
| <b>Spectral Output</b>                              | 200 nm to 1000 nm                           |
| <b>Optical Power in 600 <math>\mu</math>m fiber</b> | 3.2 $\mu$ J per pulse (average 320 $\mu$ W) |
| <b>Pulse rate (max.)</b>                            | 100 Hz                                      |
| <b>Bulb Life</b>                                    | min. 10 <sup>9</sup> pulses                 |
| <b>Power requirement</b>                            | 12 VDC/550 mA                               |
| <b>Dimensions, weight</b>                           | 175 x 110 x 44 mm, 540 grams                |

# AvaLight-LED Light Source for fluorescence applications

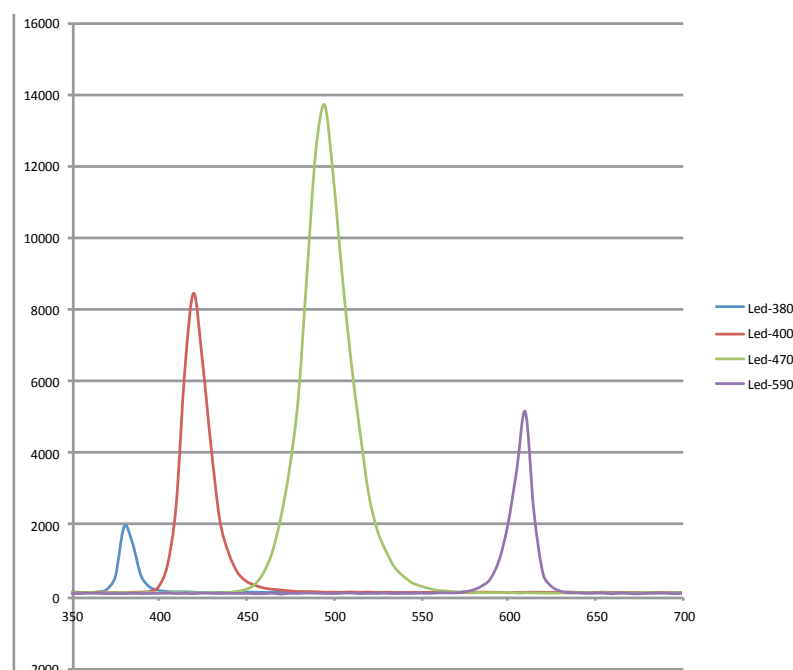
The AvaLight-LED is a compact, light source meant for fluorescence applications. It produces continuous or pulsed spectral output at different wavelengths. Some standard excitation wavelengths are shown in the table on this page, but other wavelengths are available upon request. The sources have an SMA-905 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).

- Low cost fluorescence excitation
- Compact
- Flexible excitation wavelength

## AvaLight-LED



## Technical Data

|                                                  | AvaLight-LED<br>355/380      | AvaLight-LED<br>400/410/430 | AvaLight-LED<br>450/470/490 | AvaLight-LED<br>530/590/780 |
|--------------------------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|
| <b>Spectral Range*</b>                           | 355/380 nm                   | 400/410/430 nm              | 450/470/490 nm              | 530/590/780 nm              |
| <b>FWHM (nm)</b>                                 | 15 nm                        | 11 nm                       | 30 nm                       | 30 nm                       |
| <b>Optical power 600 <math>\mu</math>m fiber</b> | 10 $\mu$ Watt                | 25 $\mu$ Watt               | 25 $\mu$ Watt               | 25 $\mu$ Watt               |
| <b>Power supply</b>                              | 12 VDC, 40 mA                |                             |                             |                             |
| <b>Dimensions, weight</b>                        | 175 x 110 x 44 mm, 480 grams |                             |                             |                             |

\* other wavelengths available on request



# 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 ( $\text{SiO}_2$ ). 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 ( $\text{NA}$  = 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  $\text{NA}$  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-20UV200-3-BX-SR

A product code is designed as follows:

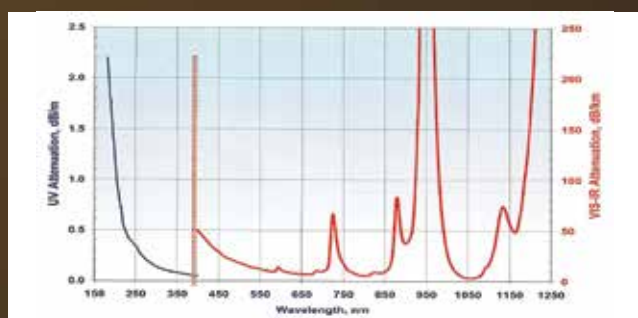
| Type of Product                                                                                              | Number of fibers           | Wavelength                                                | Fiber core diameter                                                                                                                                                                 | Overall Length | Jacketing                                                                              | Other options                                                                                                      |
|--------------------------------------------------------------------------------------------------------------|----------------------------|-----------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------|
| FC = standard fiber cable<br>FCB = bifurcated fiber<br>FCR = fiber reflection probe<br>FDP = fiber dip probe | almost any number possible | UV = 200-800 nm<br>IR = 350-2500 nm<br>UVIR = 250-2500 nm | 8 $\mu\text{m}^*$<br>50 $\mu\text{m}^{**}$<br>100 $\mu\text{m}$<br>200 $\mu\text{m}$<br>400 $\mu\text{m}$<br>600 $\mu\text{m}$<br>800 $\mu\text{m}^{**}$<br>1000 $\mu\text{m}^{**}$ | in meters      | BX = stainless steel<br>ME = chrome-plated brass<br>MS = metall silicone<br>FX = fixed | SR = solarization resistant<br>HT= high temperature<br>HTX= extreme high temperature<br>PK= PEEK<br>HY= Hastelloy® |

\*Only for IR fibers

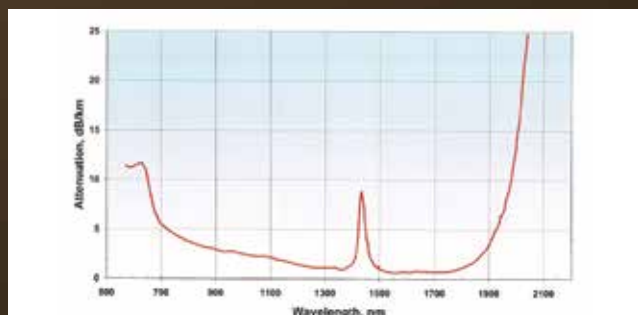
\*\* Only for UV or IR fibers

#### Technical Data

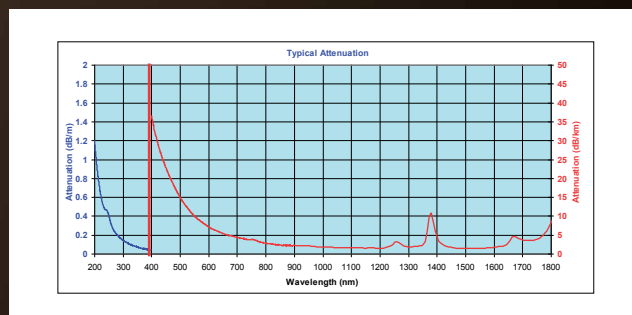
|                                    |                                                            |
|------------------------------------|------------------------------------------------------------|
| <b>Fiber Material</b>              | Standard                                                   |
| <b>Temperature Range</b>           | -190 °C to +400°C                                          |
| <b>Fiber type</b>                  | Step index Multimode                                       |
| <b>Core Numerical Aperture</b>     | 0.22 $\pm$ 0.02                                            |
| <b>Buffer</b>                      | Polyimide                                                  |
| <b>Available Diameters</b>         | 50/100/200/400/600/800/1000 $\mu\text{m}$                  |
| <b>Laser damage resistant core</b> | 1,3 kW/mm <sup>2</sup> CW at 1060 nm, up to 10 J, pulsed   |
| <b>Bend radius</b>                 | momentary 100 x clad radius<br>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

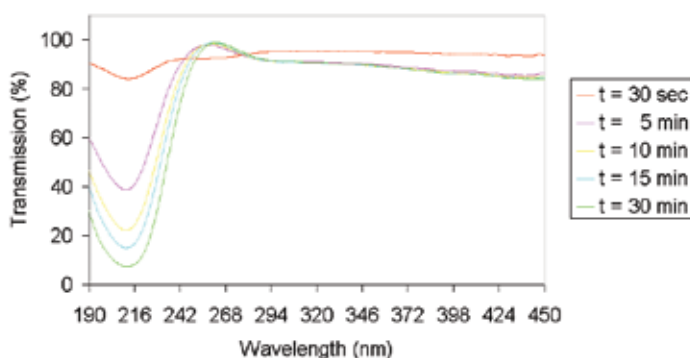
atom, which are affected by the deep-UV radiation.

Not long ago, solarization resistant fibers, which were hydrogen loaded, were developed (UVI). The drawback of these fibers is the limitation on smaller fiber diameters and limited lifetime, caused by the H<sub>2</sub> outgassing from the fiber. Recently, with the availability of a modified core preform, a new fiber became available (UVM). This fiber provides long-term sta-

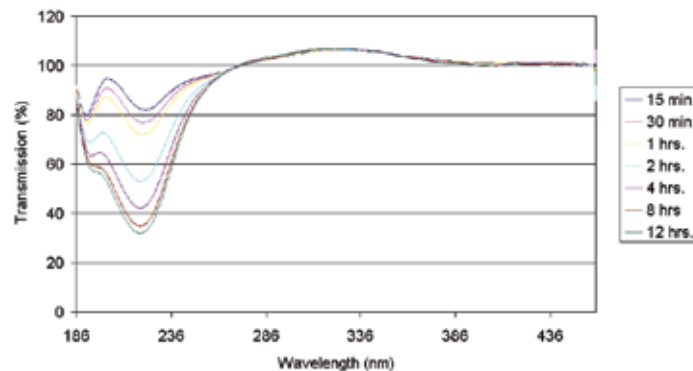
bility at 30-40% transmission (for 215 nm).

All UV/VIS fiber-optic probes, cables and bundles with core diameters of 100  $\mu\text{m}$ , 200  $\mu\text{m}$ , 400  $\mu\text{m}$ , 600  $\mu\text{m}$ , 800  $\mu\text{m}$  and 1000  $\mu\text{m}$  can be delivered with solarization resistant fibers. All assemblies, made by Avantes, are pre-solarized for an 8-hrs period, to have a constant transmission of 30-40% @ 215 nm.

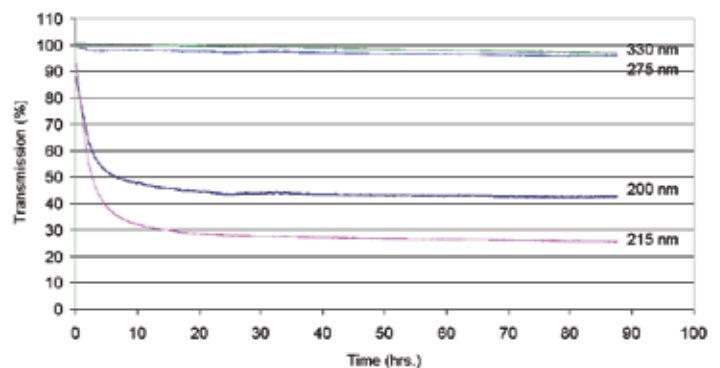
Solarisation normal UV400



Solarization UVM100



Solarisation 100 micron UVM 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

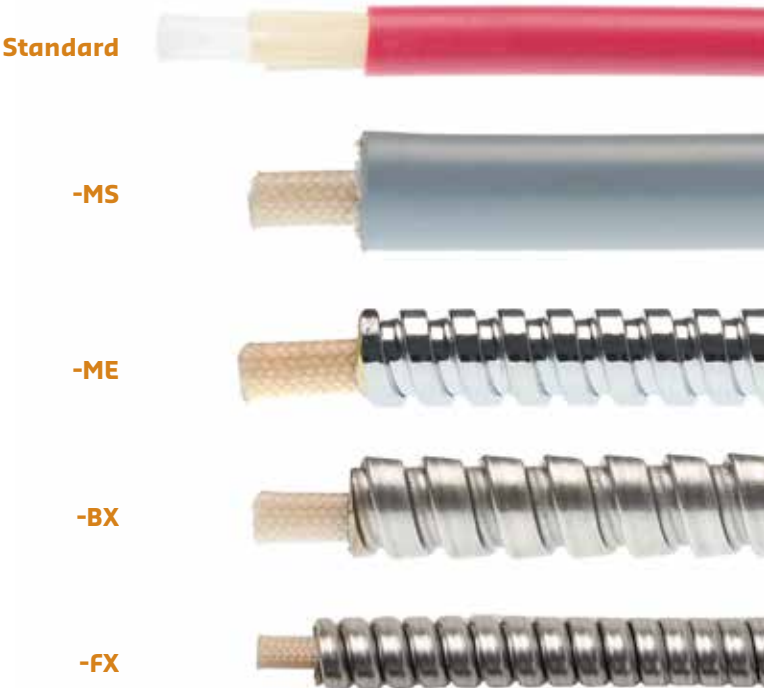
hooked profile (ME) for optimal strain relief with silicon or PTFE inner tubing. For waterproof and some medical applications stainless steel spiral jacketing with glassilk and gray outer silicon rubber coating can be provided. Inside this jacket silicon or PTFE inner tubing is used as well. For heavy industrial environments we advise the metal stainless steel (-BX) jacketing.

It features a tensile strength of 950N. For special cases we can offer our form holding jacketing (FX). Some specifics on the jacketing can be found in the following technical information.

Contact us if you have any special conditions requirements.

## Technical Data

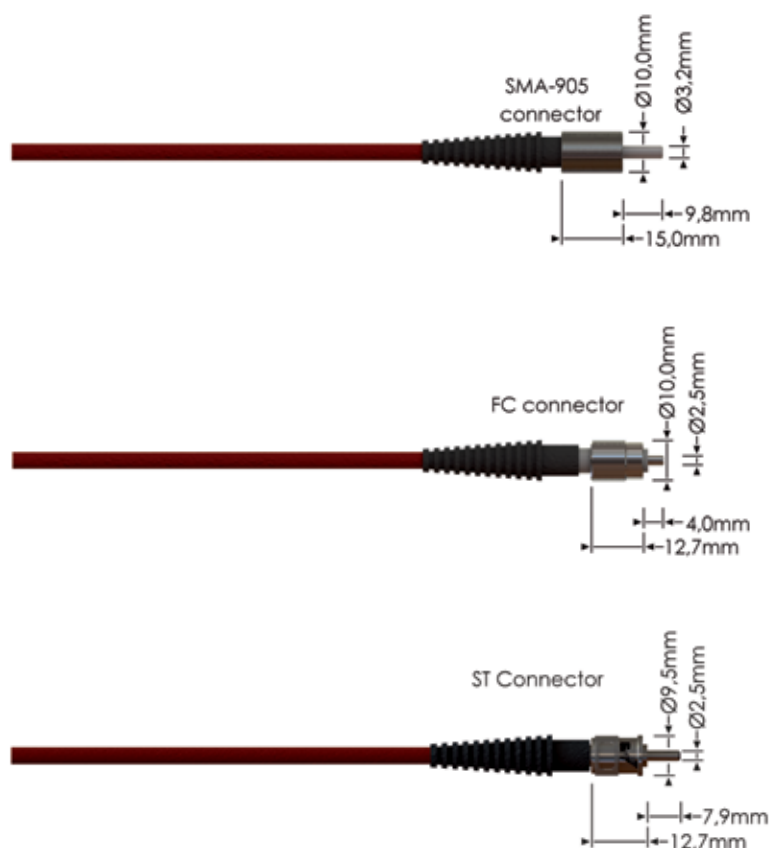
| Jacketing material  | Kevlar reinforced PVC | Chrome plated brass (ME) | Stainless Steel (BX) | Silicon coated stainless steel (MS) | Stainless Steel (FX) |
|---------------------|-----------------------|--------------------------|----------------------|-------------------------------------|----------------------|
| Inner Tubing        | Polypropylene         | Silicon/PTFE             | Silicon/PTFE         | Silicon/PTFE                        | Steel/Copper         |
| Outer dimensions    | 3.8 mm                | 5.0 mm                   | 6.0 mm               | 5.8 mm                              | 6.1 mm               |
| Min. bending radius | 18 mm                 | 18 mm                    | 35 mm                | 18 mm                               | 35 mm                |
| Temperature Range   | -20°C to +65°C        | -65°C to +250°C          | -65°C to +250°C      | -60°C to +180°C                     | -65°C to +250°C      |
| Tensile Strength    | 150 N                 | 350 N                    | 950 N                | 70 N                                | n.a.                 |
| Application         | Standard              | Industrial               | Heavy Industrial     | Waterproof IP67                     | Industrial           |



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



## 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 multimode 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.

### ST connectors

Optional ST-connectors can be mounted to our fiber-optic products.

ST-connectors easily mount with their bayonet type of fitting, and can therefore not rotate, i.e. they mount in a fixed position. The maximum filling diameter is 1.5 mm, typical insertion loss is 0.3 dB.

## 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. For the UV range high OH UV/VIS fiber is recommended. For customers working below 240 nm in the UV, special high OH UV/VIS fiber called solarization resistant fiber (SR) is recommended. For longer wavelengths low OH VIS/NIR fiber is recommended. Best of both worlds can be achieved with our broadband fiber. This gives you the combined performance of the UV 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

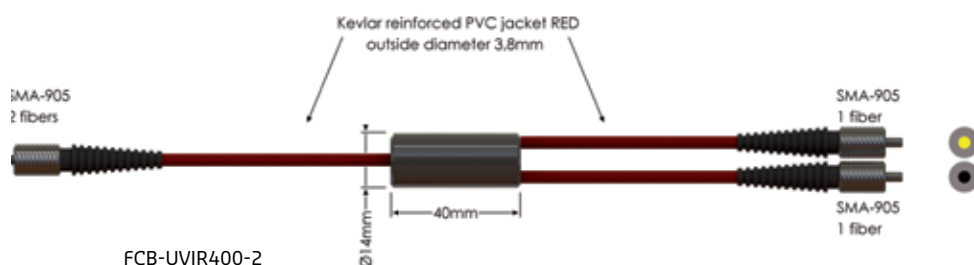
request.

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:

- 180-800 nm: Solarization resistant (-SR)
- 200-800 nm: UV/VIS (UV)
- 350-2500 nm: VIS/NIR (IR)
- 250-2500 nm: UV/VIS/NIR (UVIR)
- UV/IR available in core sizes 200, 400, 600  $\mu\text{m}$

Note: UVIR available in core sizes 200, 400 and 600 micron.





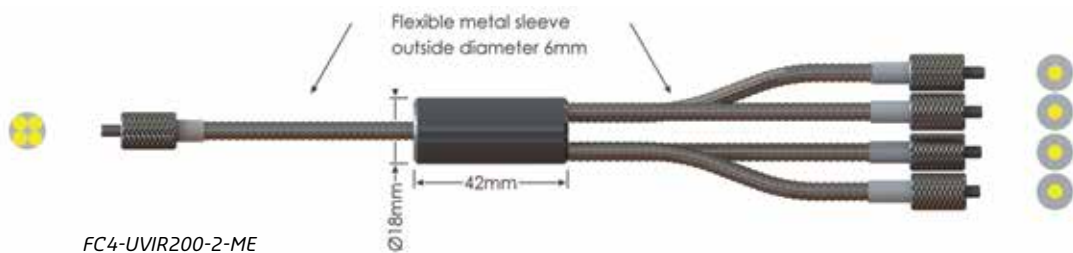
# Multi-furcated Fiber-optic Cables

Simultaneous multi-point measurements and Avantes multi-channel spectrometers, require multi-furcated fiber-optic cables. These assemblies can function as a combiner or splitter of light as they have multiple legs on 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.
- All 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.



## 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 7<sup>th</sup> fiber in the center of the reflection probe tip. The 7<sup>th</sup> 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

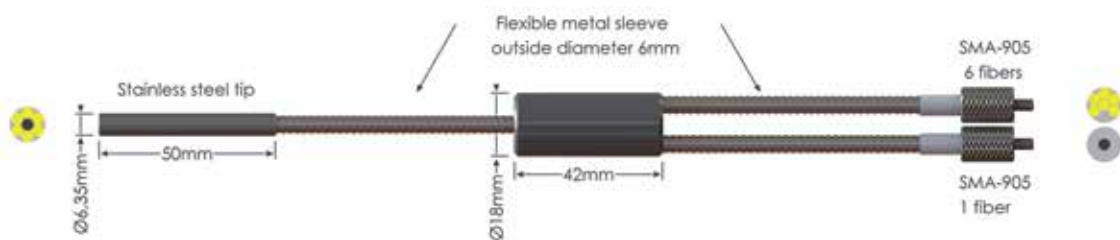
level. For measurements under an angle of 90°, the FCR-90-Option was developed. It's a special adapter with a mirror positioned at 45° and can be easily mounted on the tip of Avantes standard reflection probes.

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

|                         |                                                                                                                                                                                                           |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fibers</b>           | 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.                                                                             |
| <b>Wavelength range</b> | 200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)                                                                                                                                    |
| <b>Connectors</b>       | SMA-905 connectors (2x)                                                                                                                                                                                   |
| <b>Probe end</b>        | Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter. Optionally -PK for PEEK or -HY for Hastelloy® C276                                                                                           |
| <b>Jacketing</b>        | 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. |
| <b>Temperature</b>      | -30°C to 100°C. (-HT version 200 °C, -HTX version 500 °C)                                                                                                                                                 |
| <b>Pressure</b>         | Probe head 50 bar @ 25 °C                                                                                                                                                                                 |
| <b>Bending</b>          | Minimum bend radius: Short term (few seconds) 20-40 mm, long term: 120 -240 mm                                                                                                                            |



## Reflection Probes with Reference

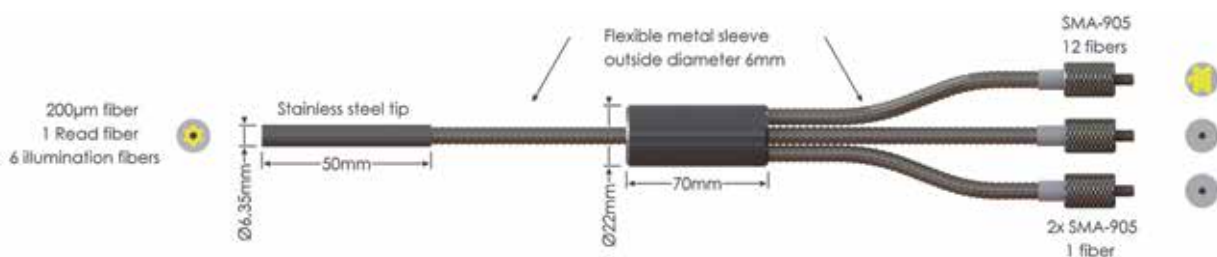
In order to correct fluctuations and drift from your light source, periodic referencing is required. To facilitate this, Avantes offers this series of reflection probes with a self-referencing feature. The light coming from the light source is bundled into 12 fibers, which are split into two 6 fiber

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 7<sup>th</sup> fiber which reflects light back to the master spectrometer channel.

### Technical Data

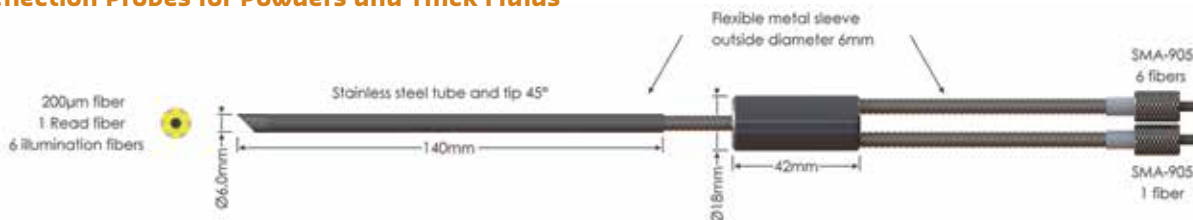
|                         |                                                                                                                                                                                                      |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fibers</b>           | 14 fibers 200 $\mu$ m core, 12 light-fibers, 2 x 1 read fiber, N.A.= 0.22. Standard 2 m length, splitting point in the middle.                                                                       |
| <b>Wavelength range</b> | 200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)                                                                                                                               |
| <b>Connectors</b>       | SMA-905 connectors (3x)                                                                                                                                                                              |
| <b>Probe end</b>        | Stainless steel 316 cylinder, 50 mm long x 6.35 mm diameter . Optionally -PK for PEEK or -HY for Hastelloy® C276.                                                                                    |
| <b>Jacketing</b>        | 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. |
| <b>Temperature</b>      | -30°C to 100°C. (-HT version 200°C, -HTX version 500°C)                                                                                                                                              |
| <b>Pressure</b>         | Probe head 50 bar @ 25°C                                                                                                                                                                             |
| <b>Bending</b>          | Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm                                                                                                                               |



### Reflection Probes with Small Tips



### Reflection Probes for Powders and Thick Fluids



Avantes offers a wide variety of reflection probes. For details go to [www.avantes.com](http://www.avantes.com)

## 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.

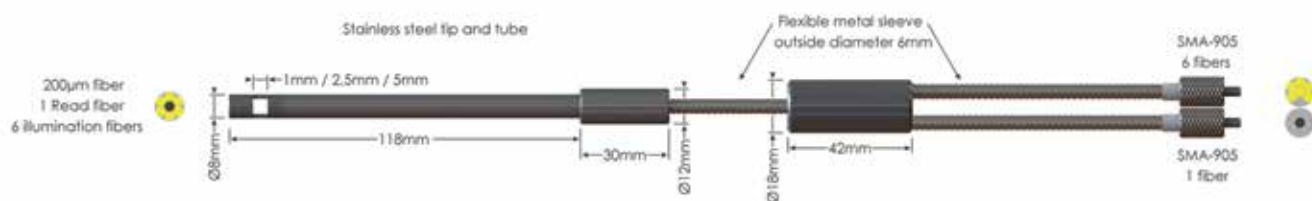
The read fiber is placed in the center of the illumination fiber bundle to provide the best collection efficiency for the probe. Both bundles are housed in flexible stainless steel jacketing and the probe tip is also

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.

All Avantes fiber-optic probes can be customized to meet your specific requirements.

### Technical Data

|                         |                                                                                                                                                                                                                        |
|-------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fibers</b>           | 6 illumination fibers, 1 detection fiber, all 200 $\mu$ m, standard 2 meters                                                                                                                                           |
| <b>Wavelength range</b> | 200-800 nm (UV/VIS), 350-2500 (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)                                                                                                                                                    |
| <b>Connectors</b>       | SMA-905 connectors (2x)                                                                                                                                                                                                |
| <b>Tips</b>             | 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                                                           |
| <b>Probe end</b>        | Stainless steel 316 cylinder, 100 mm long x 8,0 mm diameter. Waterproof, Optionally -HY for Hastelloy® C276                                                                                                            |
| <b>Jacketing</b>        | 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. |
| <b>Temperature</b>      | -30°C to 100°C. (-HT version 200°C)                                                                                                                                                                                    |
| <b>Pressure</b>         | Probe head 10 bar @ 25°C                                                                                                                                                                                               |
| <b>Bending</b>          | Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm                                                                                                                                                 |



## 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.

All Avantes fiber-optic cables can be customized to meet your specific requirements.

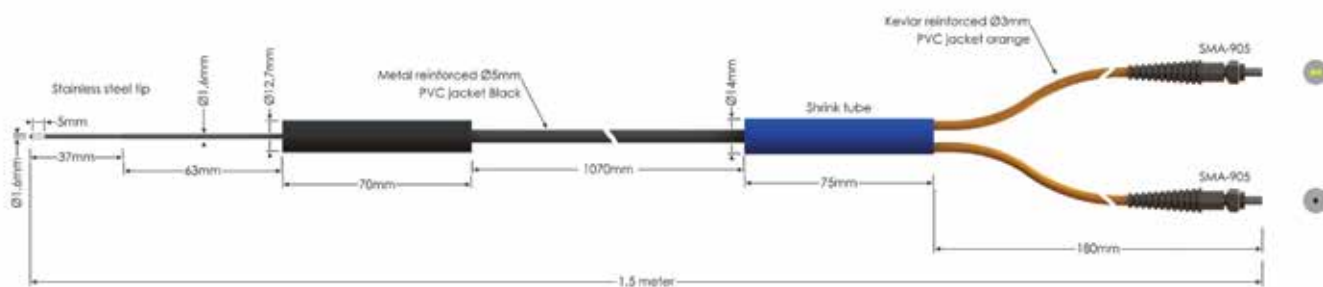


## Technical Data

|                         |                                                                                                                                                                                                                                                               |
|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Fibers</b>           | 6 illumination fibers, 1 detection fiber, all 200 $\mu$ m, standard 2 meters                                                                                                                                                                                  |
| <b>Wavelength range</b> | 200-800 nm (UV/VIS), 350-2500 nm (VIS/NIR) or 250-2500 nm (UV/VIS/NIR)                                                                                                                                                                                        |
| <b>Connectors</b>       | SMA-905 connectors (2x)                                                                                                                                                                                                                                       |
| <b>Optical Path</b>     | 0.25 - 10 mm physical gap, i.e. an optical path of 0.5-20 mm                                                                                                                                                                                                  |
| <b>Probe end</b>        | Stainless steel 316, 150-160 mm long x 12,7 mm ( $\frac{1}{2}$ ") diameter. Waterproof. Optionally -PK for PEEK or -HY for Hastelloy® C276                                                                                                                    |
| <b>Jacketing</b>        | 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) |
| <b>Temperature</b>      | -30°C to 100°C. (-HT version 200°C)                                                                                                                                                                                                                           |
| <b>Pressure</b>         | Probe head 10 bar @ 25°C                                                                                                                                                                                                                                      |
| <b>Bending</b>          | Minimum bend radius: Short term (few seconds) 20 mm, long term: 120 mm                                                                                                                                                                                        |



### Micro Transmission Dip Probes



### Mini Transmission Dip Probes



Avantes offers a wide variety of transmission dip probes. For details go to [www.avantes.com](http://www.avantes.com)

# Collimating lens

## 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



## 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)                |                    |               |

# Cosine correctors

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).

## CC-VIS/NIR



## Technical data

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





# Accessories

100

## INTRODUCTION

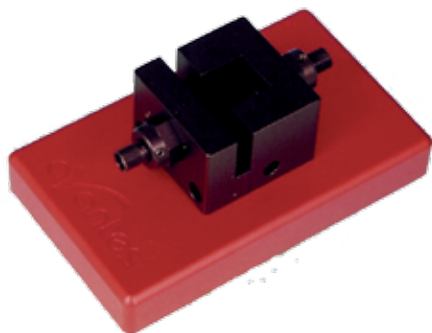
To facilitate easier and more accurate measurements during an experiment, Avantes offers a wide selection of high quality accessories. From integrating spheres to cuvette holders, filter holders and fiber-optic multiplexers Avantes has you covered for your fiber-optic accessory needs.

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





**CUV- UV/VIS****CUV-ALL-UV/VIS****Cuvette Dimensions****Fiber connection****Overall dimensions**

## Cuvette Sample Holders

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 SiO<sub>2</sub> 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.

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      |
|---------------------|--------------------------------|---------------------|
|                     | 10 x 10 mm                     |                     |
| 2 x COL-UV/VIS, SMA | 2 x COL-UV/VIS, SMA, 2 mirrors | 4 x COL-UV/VIS, SMA |
| 100 x 60 x 40 mm    | 100 x 100 x 40 mm              |                     |

## Direct-attach Accessories

**CUV-ATT-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 [www.avantes.com](http://www.avantes.com)

The last column is a combination of the attenuator, the cuvette holder and the filter holder in one easy to attach device.

**CUV-DA**

### Direct-attach accessories

|                          | Coupling to | Mounting    | Round 1/2" Filter Holder | Cuvette Holder  | Attenuator      | Cuvette/ Filter Holder/ Attenuator |
|--------------------------|-------------|-------------|--------------------------|-----------------|-----------------|------------------------------------|
| <b>AvaLight-HAL-Mini</b> |             | UNS thread  | FH-DA-HAL-Mini           | CUV-DA-HAL-Mini | ATT-DA-HAL-Mini | CUV-ATT-DA-HAL-Mini                |
| <b>AvaLight-DHS</b>      |             | Front plate | n/a                      | CUV-DA-DHS      | n/a             | n/a                                |
| <b>AvaLight-DHc</b>      |             |             |                          |                 |                 |                                    |
| <b>AvaLight-XE</b>       |             | SMA thread  | FH-DA                    | CUV-DA          | ATT-DA          | CUV-ATT-DA                         |
| <b>AvaLight-LED</b>      |             |             |                          |                 |                 |                                    |
| <b>Fiber-optic</b>       |             | fiber       | FH-INL                   | CUV-UV/VIS      | ATT-INL-EXT     | n/a                                |

# 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.

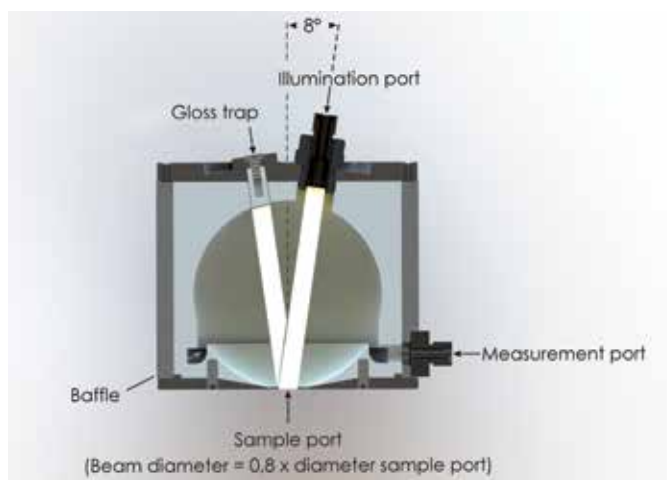
The AvaSphere reflection version is used for the measurement of total integrated reflectance of a surface, as well as for color measurements and fluorescence spectroscopy on solids/powders. The principle of measurement is based on direct illumination and indirect reflection. The AvaSphere-50-LS-HAL with internal light source can be used as a low-cost uniform source and is available with an intensity calibration file.

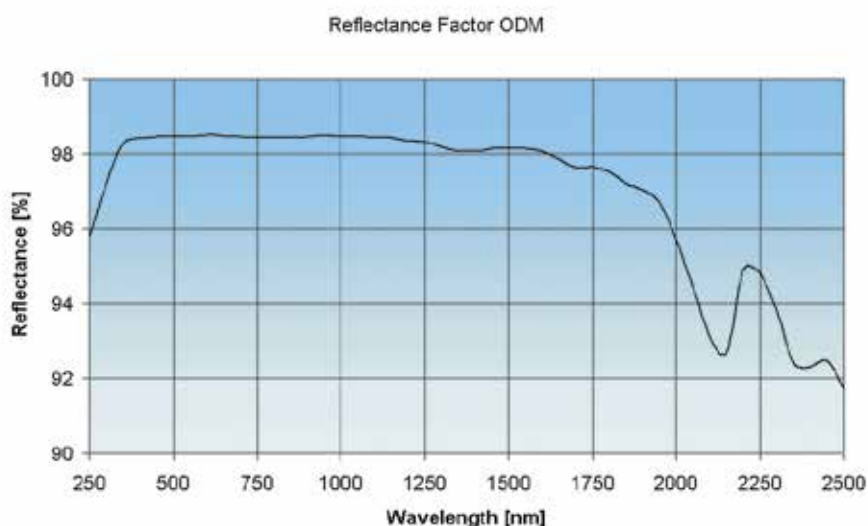
The inside of the integrating spheres is made of a highly reflective diffuse PTFE material. This provides over 96% reflectance over a wide wavelength range of 250-2500 nm. For the AvaSphere-50-REFL a special black gloss-trap is available to exclude specular reflection in the measurement. Please order 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 or 80-REFL





Reflection Curve AvaSphere

### Technical Data

|                                  | AvaSphere-30                     | AvaSphere-50                     | AvaSphere-80                    |
|----------------------------------|----------------------------------|----------------------------------|---------------------------------|
| <b>Internal diameter (mm)</b>    | 30                               | 50                               | 80                              |
| <b>Sample port diameter (mm)</b> | 6                                | 10                               | 15                              |
| <b>External Dimensions</b>       | 59.5 mm diameter<br>40 mm height | 69.5 mm diameter<br>60 mm height | 109 mm diameter<br>95 mm height |

## Integrating Sphere with internal halogen light source

### AvaSphere-50-LS-HAL-12V



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.

### Technical Data

|                             |                                |
|-----------------------------|--------------------------------|
| <b>Wavelength range</b>     | 360-2500 nm                    |
| <b>Internal diameter</b>    | 50 mm                          |
| <b>Sample port diameter</b> | 10 mm                          |
| <b>Color temperature</b>    | 2850 K                         |
| <b>Stability/Drift</b>      | < 0.1% / h                     |
| <b>Bulb life</b>            | 4.000 hrs                      |
| <b>Power requirement</b>    | 12VDC, 1A                      |
| <b>External Dimensions</b>  | 70 mm diameter, 82,5 mm height |



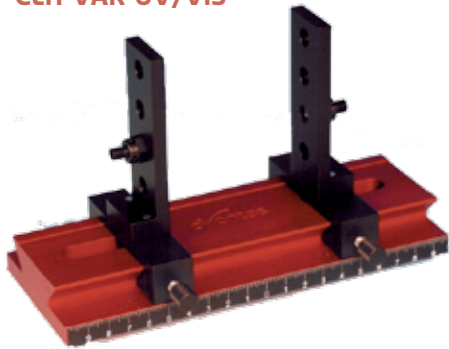
# Variable Collimating Lens Holder

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 col-

limating 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                 |

# AvaTrigger External trigger box

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.

AvaTrigger



### Technical Data

|                                   |                 |            |
|-----------------------------------|-----------------|------------|
| Trigger Input                     | Opto            | Pushbutton |
| Internal Delay time to TTL output | Ca. 300 ns*     | 20 µsec    |
| Minimal pulse duration Trigger in | 10 µsec         |            |
| Dimensions                        | 75 x 78 x 37 mm |            |
| Weight                            | 260 g           |            |

\*depending on the slew rate of the light source

**FOS-2-Inline**

## Fiber-optic Switch (FOS)

The fiber-optic switches (FOS) from Avantes are the ideal accessory to facilitate automatic shuttering of a spectrometer or to correct for light source drift. Automatic shuttering can be achieved with the FOS-1-Inline while light source drift correction requires the FOS-2-Inline. Both FOS designs can either be used automatically or operated electronically via a TTL pulse from an external source or AvaSpec spectrometer.

The FOS is coupled in the optical path between two SMA terminated fibers and features it two or four COL-UV/VIS collimating lenses (UV/VIS/NIR) and a filter holder for filters that are up to 5 mm thick. TTL signals can be provided by an external device or by an AvaSpec spectrometer connected through a cable (IC-DB26-2), ordered separately.

AvaSoft-Full spectroscopy software supports light source drift correction for a setup where one of the FOS-2-inline channels is connected to a reference measurement (such as a white tile, cuvette with blank) and the other channel is connected to the actual measurement. This provides for periodic switching to the reference channel and this updated reference data is used to correct the data measured at the sample channel.

A PS-24V/1.25A 24 volt DC power adapter is required for either of the FOS-series fiber-optic switches.

### Technical Data

|                            | FOS-1-inline                                                | FOS-2-inline                                                |
|----------------------------|-------------------------------------------------------------|-------------------------------------------------------------|
| <b>Wavelength range</b>    | 200-2500 nm                                                 |                                                             |
| <b>Fiber connection</b>    | 2 SMA-905 connectors, incl. 2 COL-UV/VIS collimating lenses | 4 SMA-905 connectors, incl. 4 COL-UV/VIS collimating lenses |
| <b>Filter slit</b>         | Max. 5 mm wide                                              |                                                             |
| <b>Shutter frequency</b>   | Max. 40 Hz                                                  |                                                             |
| <b>Shutter attenuation</b> | 60 dB                                                       |                                                             |
| <b>Dimensions</b>          | 130 x 65 x 65 mm                                            |                                                             |
| <b>Lifetime shutter</b>    | 1.000.000 cycles (typical)                                  |                                                             |

## In-Line Flow cells

**Flowcell-1/2"**

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 gas flow cells are also available and are designed to withstand pressures up to 200 bar.

### Technical Data

|                           | 1/4" flow cell                                                                      | 1/2" flow cell  | 1" flow cell    |
|---------------------------|-------------------------------------------------------------------------------------|-----------------|-----------------|
| <b>Optical path</b>       | 5 mm                                                                                | 10 mm           | 20 mm           |
| <b>Sample volume</b>      | 62 µl                                                                               | 124 µl          | 248 µl          |
| <b>Wavelength range</b>   | 200-2500 nm                                                                         |                 |                 |
| <b>Fiber connection</b>   | 2 x SMA-905 connectors                                                              |                 |                 |
| <b>Max. Temperature</b>   | 80°C (HT version till 200°C available on request)                                   |                 |                 |
| <b>Max. Pressure</b>      | 10 bar (Special Gasflowcell up to 200 bar)                                          |                 |                 |
| <b>Material</b>           | Stainless steel for the fitting, black anodized aluminum for the SMA-905 connectors |                 |                 |
| <b>Overall dimensions</b> | 55 x 45 x 15 mm                                                                     | 72 x 50 x 22 mm | 98 x 60 x 38 mm |

# 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.

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



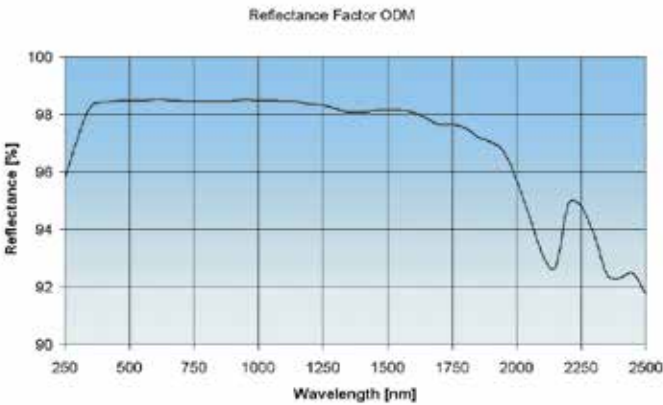
## RS-2



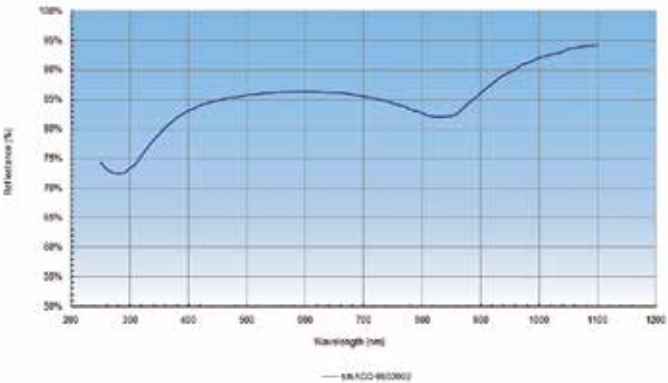
### Technical Data

|                  | WS-2                                          | RS-2                                 |
|------------------|-----------------------------------------------|--------------------------------------|
| Material         | Diffuse PTFE material                         | BK7 with Al+MgF <sub>2</sub> 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 |                                      |

WS-2 curve



RS-2 curve



For the latest information, go to [www.avantes.com](http://www.avantes.com)

## 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.**

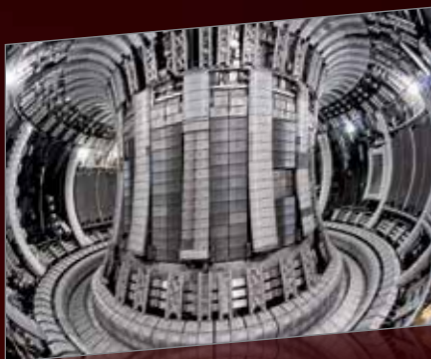
Furthermore a number of example setups have been listed. LED, Irradiance, Thin Film and Color measurements are just some of the many possibilities. But the Avantes Spectrometers can be used in many more applications. Contact an application engineer to discuss your situation and the perfect spectroscopy 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
- Scientific research
- Semiconductor industry
- Solar spectrum measurements
- Space research
- Sun glasses industry
- Textile industry



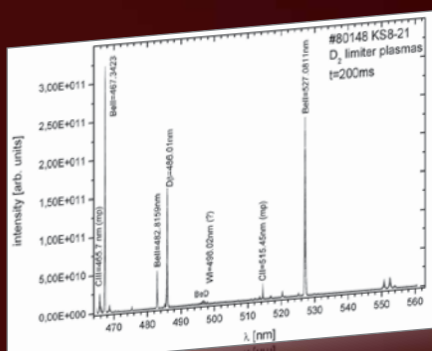
## Plasma-Surface Interaction Measured by Avantes



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 had 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!”



# 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.

## Application Note: CEMS Continuous Emission monitoring systems

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

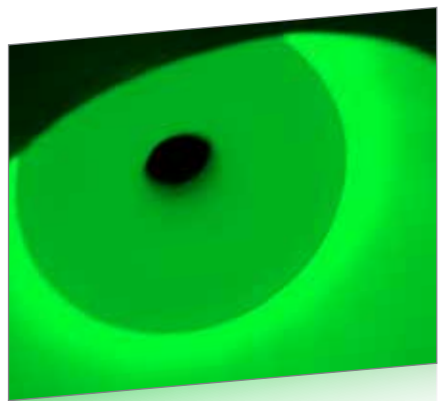
CEMS used for calculating the absorption of SO<sub>x</sub>/NO<sub>x</sub>. Over 200 CEMS systems do have 'Avaspec inside' and we expect this to be multiple in the future.

These AvaSpec spectrometers have high demands regarding straylight, 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:

### 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 ( $\lambda$  max 365 nm), blue ( $\lambda$  max 467 nm) and green ( $\lambda$  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.

## Monitoring fertilizer concentration on the go

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 or

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.



## Testing leakage of cooling water of (nuclear) power plant



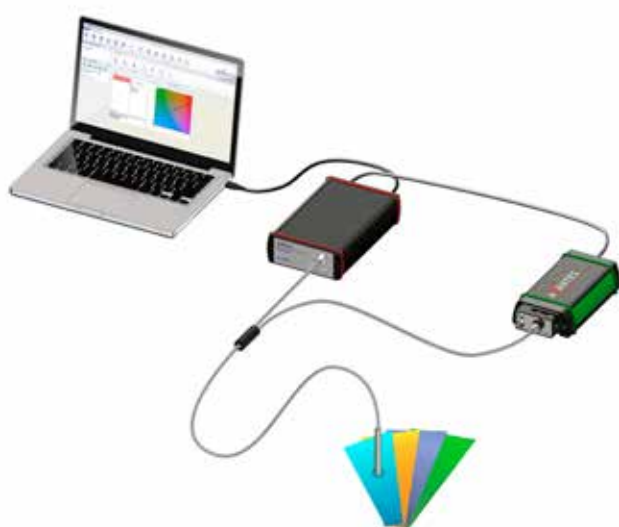
In Japan there are many (nuclear) power plants and they are all build on a rocky based bottom. These rocks also have underground water streams, in case of an earthquake (not unrealistic in JAPAN) radioactive cooling water might leak through the rocks into these clear water streams and spread the radio- 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 coolwa-

ter 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.

# Color measurements



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.

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

## Color measurement of small areas



Ideal for color measurements, this bundle features an AvaSpec-ULS2048 spectrometer, tuned for visible light. Furthermore a D65 halogen light source for illumination and a reflection probe together

with a reflection probe holder. Typical applications:

- In-line reproducibility
- Small spots & lines

... and many more

### Order information: AvaSpec-Color-A

|                     |                                                              |                                                                            |
|---------------------|--------------------------------------------------------------|----------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2                                         | Grating BB (360-780nm)<br>200 $\mu$ m slit<br>AvaSoft-Full & AvaSoft-Color |
| <b>Light source</b> | AvaLight-HAL-Mini                                            | PS-12V/2.08A                                                               |
| <b>Fiber optics</b> | FCR-7UV200-2 reflection probe<br>RPH reflection probe holder |                                                                            |
| <b>Included</b>     | WS-2 white reflection tile                                   |                                                                            |

## Color measurement of surfaces (total diffuse light)



Wide angle diffuse light from the sample is used to measure color. This uses a hand held 50 mm integrating sphere and a compact spectrometer. Measurement is 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

... and many more

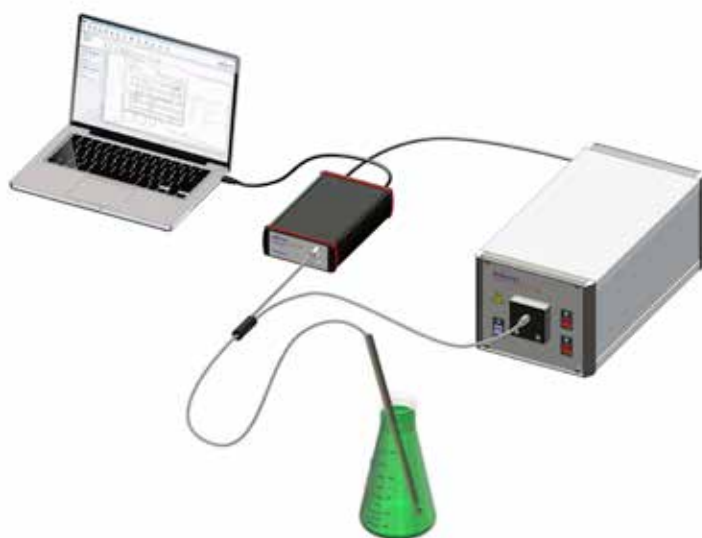
### Order information: AvaSpec-Color-B

|                     |                            |                                                                            |
|---------------------|----------------------------|----------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS3648-USB2       | Grating BB (360-780nm)<br>100 $\mu$ m slit<br>AvaSoft-Full & AvaSoft-Color |
| <b>Light source</b> | AvaSphere-50-LS-HAL        |                                                                            |
| <b>Fiber optics</b> | FC-UV200-2-ME              |                                                                            |
| <b>Included</b>     | 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 concentra-

tions 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.

## UV/VIS/NIR Absorbance



Designed for broadband measurements, this UV/VIS 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

... and many more

### Order information: Ava-Absorbance

|                     |                          |                                                                                                       |
|---------------------|--------------------------|-------------------------------------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2     | Grating UA (200-1100nm)<br>25 µm slit, DUV, DCL-UV/VIS<br>OSC-UA Order Sorting Filter<br>AvaSoft-Full |
| <b>Light source</b> | AvaLight-DH-S            |                                                                                                       |
| <b>Fiber optics</b> | FDP-7UV200-VAR Dip Probe |                                                                                                       |



## 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 -  $\mu\text{Watt}/\text{cm}^2$ ,  $\mu\text{Joule}/\text{cm}^2$ ,  $\mu\text{Watt}$  or  $\mu\text{Joule}$ , 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  $\mu\text{Mol}$ . AvaSoft-IRRAD software also facilitates the performance of irradiance intensity calibrations.



## Irradiance / Spectroradiometry



Irradiance means measuring how much light reaches a specific place. This is why a cosine corrector is included: it collects light from a 180 degree angle. The comprehensive AvaSoft-Irrad allows fully calibrated traceable radiometric and photometric measurements

Typical applications:

- Solar lighting
- Environmental & general lighting

... and many more

### Order information: Ava-IRRAD-A

|                     |                            |                                                                                                                                                      |
|---------------------|----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2 FC/PC | Grating UA (200-1100nm)<br>25 $\mu\text{m}$ slit, DUV, DLC-UV/VIS<br>OSC-UA Order Sorting Filter<br>AvaSoft-Full & AvaSoft-Irrad<br>Irrad-CAL-UV/VIS |
| <b>Fiber optics</b> | FC-UVIR200-2-ME-1FCPC      |                                                                                                                                                      |
| <b>Included</b>     | CC-VIS/NIR                 |                                                                                                                                                      |



# LED measurements

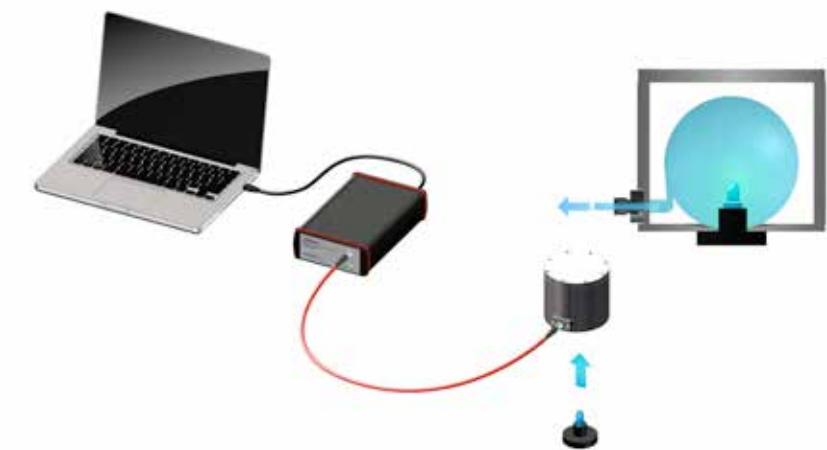
The measurement of LEDs presents unique application requirements for which Avantes has the appropriate instrumentation and applications experience to assist our customers in configuring a system. Avantes' many years of working with LED application has prompted us to develop a variety of system configurations 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 limita-

tions. 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  $\mu\text{m}$  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 irradiance ( $\mu\text{W}/\text{cm}^2/\text{nm}$ ). 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 chromaticity 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).



# LED light measurements



More and more countries ban incandescent lamps from being sold, hugely boosting LED sales. Avantes supplies the needed tools for photometric and radiometric measurements.

The spectrometer is irradiance calibrated to obtain absolute values.

Typical applications:

- Irradiance
- Illuminance
- Radiometric & photometric flux
- Luminous intensity
- Color coordinates

... and many more

## Order information: Ava-LED

|                     |                                             |                                                                                                                                                            |
|---------------------|---------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2 FC/PC                  | Grating VA (350-1000nm)<br>25 $\mu\text{m}$ slit, DLC-UV, OSC<br>AvaSoft-Full & AvaSoft-Irrad<br>Factory-calibrated system for irradiance<br>IRRAD-CAL-VIS |
| <b>Fiber optics</b> | FC-UVIR600-2-ME-1FCPC                       |                                                                                                                                                            |
| <b>Included</b>     | AvaSphere-50-IRRAD<br>AvaSphere LED adapter |                                                                                                                                                            |

# 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.

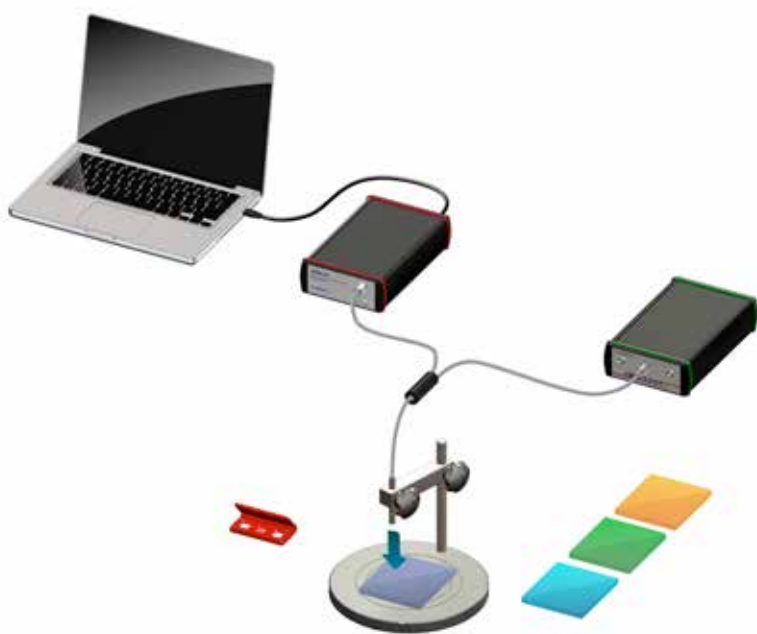
## Thin Film Quality Control

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.



## Thin Film



For single layer thin film measurements, this system provides the needed tools. It includes a reflection probe and a stage. It can measure thin films ranging from 10 nm to 50  $\mu\text{m}$  with a resolution of 1 nm. It supports UV/VIS and NIR measurements from 200 - 1100 nm.

Typical applications:

- Semi-conductor industry
- Solar panels
- Coating

... and many more

## Order information: Ava-ThinFilm

### Spectrometer

AvaSpec-ULS2048-USB2

Grating UA (200-1100nm)  
100  $\mu\text{m}$  slit, DCL-UV/VIS, DUV coating  
OSC-UA  
AvaSoft-ThinFilm

### Light source

AvaLight-DHc

PS-12V/1.0A

### Fiber optics

FCR-7UV200-2-ME reflection probe

### Included

ThinFilm stage & standard

# Plasma Measurements

Plasmas are known for many emission peaks, located closely together. To separate these peaks, Avantes has developed multichannel spectrometers, featuring much higher resolution than a stand-alone device. For plasma monitoring, Avantes has made two bundles, with everything you need to measure plasma.

Typical applications:

- Semi-conductor
- Solar cells
- Razor blades
- Fusion reactors
- Glass & coating

... and many more



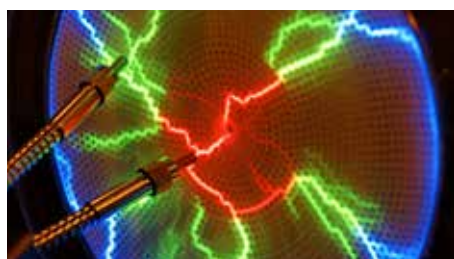
## High resolution Plasma measurement

This 200 to 1030nm quad-channel spectrometer boasts an optical resolution of 0.18-0.22 nm, four times better than a standard AvaSpec-ULS2048 covering the same range. In AvaSoft Spectroscopy Software, the four channels are combined as if you were working with only one spectrometer.

### Order information: Ava-Plasma-A

|                      |                                                                      |                                                                                                                                                                                                                                                                                                                       |
|----------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Spectrometers</b> | 4-channel desktop housing<br>4 x AvaSpec-ULS2048-USB2                | Gratings: <ul style="list-style-type: none"> <li>• UC (200-458nm), 0.18 nm</li> <li>• VC (455-683nm), 0.19 nm</li> <li>• NC (680-874nm), 0.20 nm</li> <li>• NC (870-1030nm), 0.22 nm</li> </ul> All channels with 10 µm slit,<br>DCL-UV/VIS detector collection lens &<br>OSF-600 order sorting filter (where needed) |
| <b>Fiber optics</b>  | FC4-UVIR400-2 multifurcated fiber                                    |                                                                                                                                                                                                                                                                                                                       |
| <b>Included</b>      | AvaSoft-Full spectroscopy software<br>SPECline-A analytical software |                                                                                                                                                                                                                                                                                                                       |

## 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 0.10 nm. The wavelength range is 200-1070 nm, which means it detects from ultraviolet, through visible, up to near infrared light.

The system is delivered in a 19" rackmountable enclosure.

### Order information: Ava-Plasma-B

|                      |                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|----------------------|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Spectrometers</b> | 8-channel 19" rackmountable enclosure<br>8 x AvaSpec-ULS2048-USB2    | Gratings: <ul style="list-style-type: none"> <li>• UE (200-320, 318-420 &amp; 417-505 nm), 0.10 nm</li> <li>• VE (500-565 nm), 0.10 nm</li> <li>• VD (565-670), 0.12 nm</li> <li>• VD (668-750 nm), 0.14 nm</li> <li>• NC (745-930 nm), 0.20 nm</li> <li>• NC (920-1070 nm), 0.22 nm</li> </ul> All channels with 10 µm slit,<br>DCL-UV/VIS detector collection lens &<br>OSF-600 order sorting filter (where needed) |
| <b>Fiber optics</b>  | FC8-UVIR400-2 multifurcated fiber                                    |                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Included</b>      | AvaSoft-Full spectroscopy software<br>SPECline-A analytical software |                                                                                                                                                                                                                                                                                                                                                                                                                       |

# 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

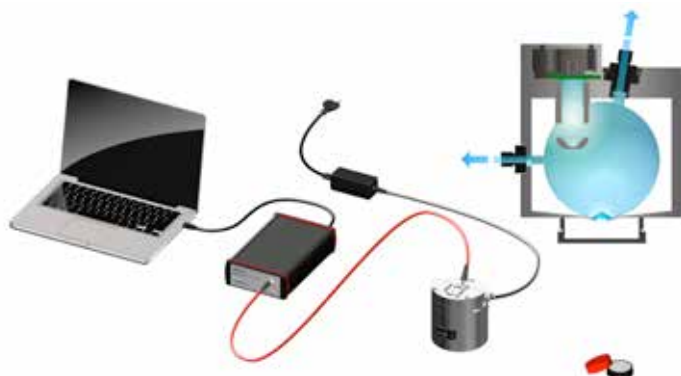
systems requiring lasers and TE-cooled spectrometers.

## 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 gemology, 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.



## Gemology



The easy way two answer two basic questions: "what are the characteristics of the stone I'm measuring?" and "are these characteristics natural?" is the Ava-GEM. It includes a sphere and a special gemology white reference tile to determine fast and without a doubt what your answers to the two questions will be.

Typical applications:

- Color
- Natural or artificial
- Artificial coloring

... and many more

### Order information: Ava-GEM

|                     |                                                      |                                                                        |
|---------------------|------------------------------------------------------|------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2                                 | Grating VA (360-1000nm)<br>25 µm slit, DCL-UV/VIS, OSC<br>AvaSoft-Full |
| <b>Fiber optics</b> | FC-UV600-2 reflection probe                          |                                                                        |
| <b>Included</b>     | AvaSphere-50-LS-HAL<br>AvaSphere-50-HOLD<br>WS-2-GEM | PS-24V/1.25A                                                           |

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

# 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.

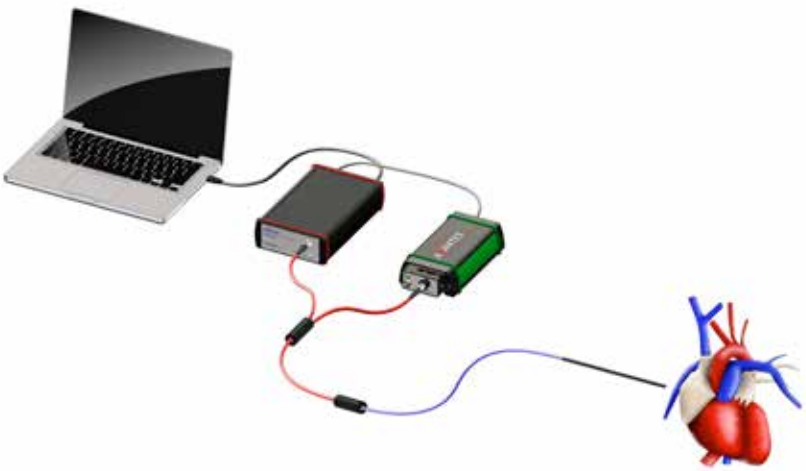
Some of the important medical indicators which Avantes has worked with include oxygen, hemoglobin, cytochrome and water concentration measurements in tissues and in the venous system. The AvaSpec-ULS2048-USB2 and our SensLine instruments are frequently recommended for these applications. The AvaLight-HAL 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:

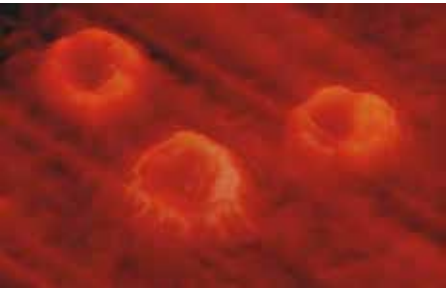
- Angiology / Pharmacology - Monitoring of the oxygen saturation after the application of vaso-active substances. Oxygen changes caused by Reynaud syndrome and microcirculation diseases in tissue.
- Dermatology - Detection of local -regional perfusion diseases, recurrence of melanomas.
- Diabetology - Micro-angiopathy, early detection of Endothel dysfunction and ulceration.

the heart muscle during and after bypass operations.

- Neurosurgery / Oncology - Quantifying of oxygen consumption of (brain) tumors before/after radiation or operations.
- Pediatrics / 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 achieving the goal of 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

... and many more

### Order information: Ava-Biomedical

|                     |                      |                                                                                 |
|---------------------|----------------------|---------------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048-USB2 | Grating NB (500-1000nm)<br>50 µm slit, OSF-475<br>AvaSoft-Full and AvaSoft-Chem |
| <b>Light source</b> | AvaLight-HAL-Mini    | Power supply                                                                    |
| <b>Fiber optics</b> | FCR-7IR200-2-MS-PK-S |                                                                                 |
| <b>Included</b>     | WS-2                 |                                                                                 |

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



## 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.

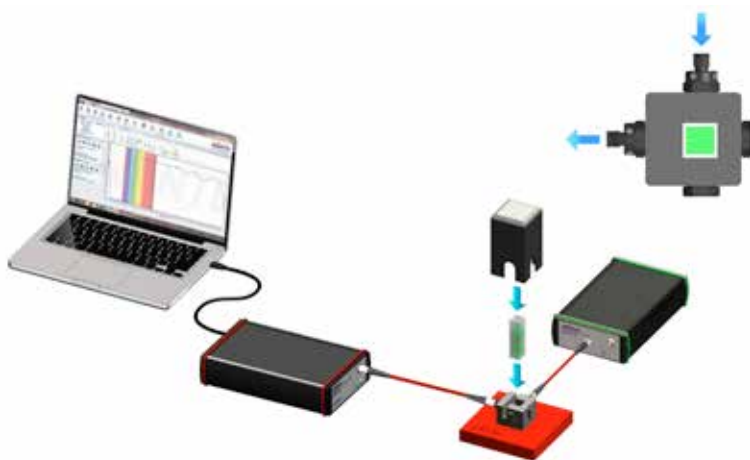
For optimal performance assuming the time acquisition window is not limited, Avantes recommends our AvaSpec-ULS2048L-TEC spectrometer for this application, since it can support long integration times often exceeding 5 seconds. When higher-speed acquisition is required, Avantes recommends the AvaSpec-

ULS2048XL back-thinned CCD spectrometer. For maximal sensitivity the top model of the SensLine, AvaSpec-HS1024x122-USB2 spectrometer is recommended.

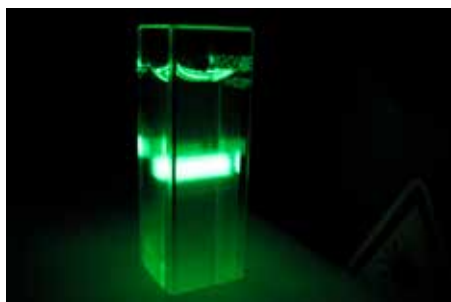
When configuring the measurement setup, preventing excitation light from entering the spectrometer is an important issue.

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-2048L gives the highest sensitivity and the AvaLight-LED series provides excitation at the requested wavelength.

Typical applications:

- Dyes identification
- Fluorescent lamps
- Diagnosis of malignancies
- Fluorescent labeling

... and many more

### Order information: Ava-Fluorescence

|                     |                                      |                                                                             |
|---------------------|--------------------------------------|-----------------------------------------------------------------------------|
| <b>Spectrometer</b> | AvaSpec-ULS2048L-USB2                | Grating VA (350-1000nm)<br>200 µm slit, DCL-UV/VIS-200, OSC<br>AvaSoft-Full |
| <b>Light source</b> | AvaLight-LEDxxx                      | Power supply                                                                |
| <b>Fiber optics</b> | FCR-UV200/600-2-IND<br>FCR-FLTIP-IND |                                                                             |

# Distributors

## Argentina



**LASEROPTICS SA**  
laser@laseroptics.com.ar

## Canada



**Delta Photonics**  
sales@deltaphotonics.com

## Germany North



**Avantes BV**  
FrankC@avantes.com

## Australia



**NewSpec Pty Ltd**  
andrew.richardson@newspec.com.au

## China



**Avantes China**  
henry\_zhang@avantes.com.cn

## Germany South



**Mountain Photonics GmbH**  
info@mphotronics.de

## Austria



**Laborchemie Gerätevertriebs GmbH**  
office@laborchemie.at

## Czech Republic, Slovak Republic



**Measurement Technic Moravia Ltd.**  
dusan.novotny@mt-m.eu

## Greece



**Optronics Technologies S.A.**  
optronics@optronics.gr

## Benelux



**Avantes BV**  
info@avantes.com

## Finland



**Senveco OY**  
juhani.tiainen@senveco.fi

## Hungary



**Joó Katalin Kereskedelmi és Szolgáltató Kft.**  
joo.katalin@invitel.hu

## Brazil



**MCI Photon Tech Ltda**  
mayara@mciphotontech.com.br

## France



**Optoprim**  
info@optoprim.com

## India



**New Age Instruments & Materials Pvt. Ltd.**  
Sales@Newagein.com

*Iran*

**Aryan Beris**  
Aryan@rayanchemie.com

*Korea*

**JinYoung Tech**  
jinyoungtech@gmail.com

*Romania*

**HISTERESIS SRL**  
constantin.sturza@histeresis.ro

*Israel*

**Rosh Electroptics Ltd.**  
mrubin@roshelop.co.il

*Latvia*

**SIA Doma**  
aldis.strods@domagroup.lv

*Russia (North-West)*

**LOKAMED Co. Ltd.**  
avantes@rambler.ru

*Italy*

**Laser Point Srl.**  
pellegrino@laserpoint.it

*Lithuania*

**VILDOMA, UAB**  
ginutis@vildoma.lt

*Singapore*

**EINST Technology Pte Ltd**  
sales@einstinc.com

*Italy*

**Optoprim Srl.**  
info@optoprim.it

*Malaysia*

**ASEPTEC SDN BHD**  
info@aseptec.com.my

*South Africa*

**Celtic Colour Consultants**  
avantes@celticcolour.co.za

*Japan*

**Phototechnica Corporation**  
tohyama@phototechnica.co.jp

*Poland*

**Spectro-lab**  
marcin.guz@spectro-lab.pl

*Spain*

**Instrumatic Española, S.A.**  
instrumatic@instrumatic.es

*Spain*



**ANTARES INSTRUMENTACIÓN,  
S.L.**  
ccarcedo@antaresinstrumentacion.com

*Taiwan*



**Protrustech Co., Ltd**  
sales@protrustech.com

*United Kingdom*



**Avantes (UK) Ltd.**  
infoUK@avantes.com

*Sweden*



**Aspect Photonics AB**  
inquiry@amstechnologies.com

*Thailand*



**Spectral Technology  
Instrument Co.,Ltd.**  
palakorn@spectralinstrument.com

*USA*



**Avantes Headquarters**  
infoUSA@avantes.com

*Switzerland*



**Instrumat SA**  
Francois.Maystre@instrumat.ch

*Turkey*



**Global Analytical Laboratory  
Equipment Ltd.**  
aksahin@globalanalitik.com.tr

*Taiwan*



**R&D Hi-Tech Corp**  
RND.Robin@msa.hinet.net

*Ukraine*



**TOV AVANTES**  
avantes@mksat.net

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**For product support or  
questions, contact us at:**

Avantes Headquarters  
Oude Apeldoornseweg 28  
7333 NS Apeldoorn  
The Netherlands  
Tel: +31 (0)313 670 170  
Fax: +31 (0)313 670 179  
[info@avantes.com](mailto:info@avantes.com)  
[www.avantes.com](http://www.avantes.com)

Avantes America  
9769 W. 119th Dr. Suite 4  
Broomfield, CO 80021  
Tollfree: +1 (866)678 4248  
Tel: +1 (303)410 8668  
Fax: +1 (303)410 8669  
[infoUSA@avantes.com](mailto:infoUSA@avantes.com)

Avantes China  
Room 1209-1210, ULO Park  
No. 601 apartment of Wangjing Yuan  
Chaoyang District, Beijing  
1000102 P.R. China  
Tel: +86 10 84574045  
Fax: +86 10 84574017  
[info@avantes.com.cn](mailto:info@avantes.com.cn)  
[www.avantes.com.cn](http://www.avantes.com.cn)



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