HighFinesse
Laser and Electronic Systems

Ångstrom

Wavelength Meter

Sensitive and compact device with a large spectral range for high speed measurements of pulsed and continuous lasers

The sturdiness of our design has been proven even under extreme conditions such as freefall dropping experiments or in air-borne applications (LIDAR). The absence of movable parts ensures our most valued advantages, e.g. high-speed measurements of pulsed and continuous lasers.

— Picture courtesy: DLR Institute of Atmospheric Physics

The HighFinesse/Ångstrom wavelength meters are the unsurpassed high-end instruments for wavelength measurement of pulsed or continuous laser sources. They deliver the superb absolute and relative accuracy required by cutting edge scientific research, as well as industrial and medical applications. The unmatched precision of the WS8 series and all of our other wavelength meters is achieved by using non-moving Fizeau interferometers in a unique geometric configuration. To allow even higher stability and precision, temperature and pressure effects are compensated*.

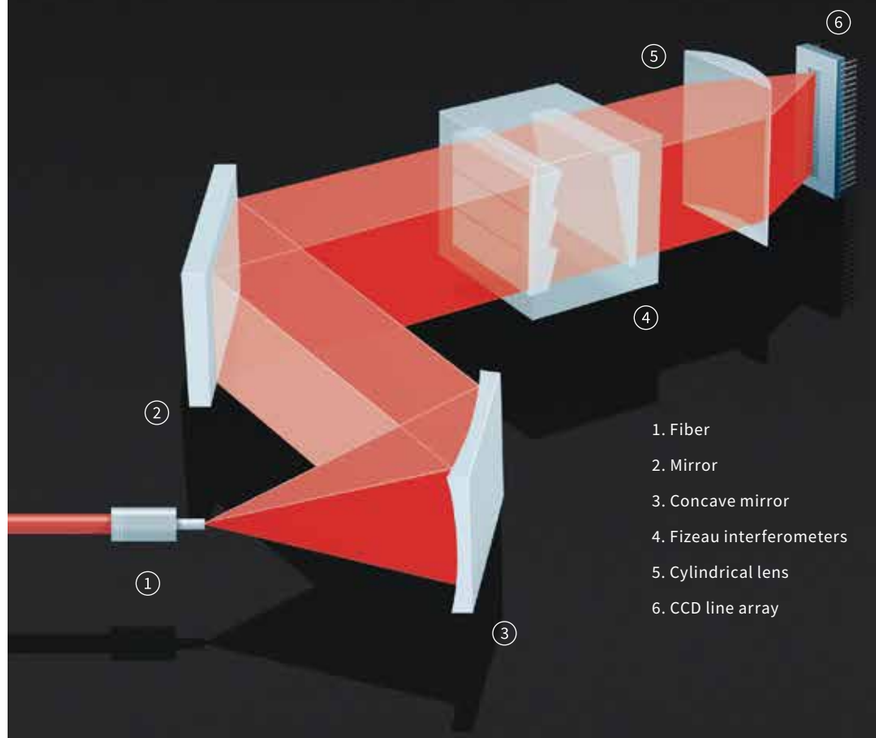
The wavelength meters are connected to the PC via a USB interface and are ready for use as soon as the software delivered with the device is installed. A compact, thermally insulated housing holds the optical elements as well as the electronics. The design enables the integration of additional options, allowing customized solutions to specific applications even years after purchase.

Enter a new world of accuracy!

*For more details, please consult our website

Fizeau based interferometers

The optical unit consists of Fizeau-based interferometers which are read out by photodiode arrays. We achieve remarkable high accuracy and stability by using exclusive, non-moving optics.



The light is coupled into the device via a fiber and then collimated by a mirror, before entering the solid-state Fizeau-interferometers. The interference pattern is imaged by a cylindrical lens onto CCD photodiode arrays. This recorded pattern is transferred to your computer via a high-speed USB connection which allows data acquisition rates of up to 76 kHz.

The software fits and compares the pattern to a previously recorded calibration to calculate the wavelength. One significant advantage of our Fizeau-based wavelength meters, compared with other available instruments, is the absence of mechanical moving parts. This ensures the high reliability of accuracies up to 2 MHz (absolute) and ensures the outstanding robustness HighFinesse wavelength meters are noted for. The design enables the precise measurement of not only continuous lasers, but also pulsed laser sources, which broadens the application range even further.

Another key benefit is the simplicity of our wavelength meters. Simply connect the USB cable and run the program supplied. That’s all it takes!

Up until now our multichannel switches have always been limited in either the wavelength range for single mode switches, or accuracy for multimode switches. Our new PCF switches solve this problem. Using endlessly single mode photonic-crystal-fibers (PCF) allows us to produce a switch that offers single mode operation for all wavelengths. Using the PCF switch it is possible to switch between light-sources at any wavelength within the device's measurement range and maintain the full accuracy. Combining the PCF switch with other options such as PID control opens new possibilities.

Sold exclusively with the WS8 the PCF switches are available in two-channel (standard), four-channel, and eight-channel configurations.

The HighFinesse/Ångstrom WS8 wavelength meter and PCF switch: enter a new world of accuracy!

Technical Data

		Unit	WS5	WS6-600	WS6-200	WS7-60	WS8-30	WS8-10	WS8-2
Measurement range	Standard (330 – 1180 nm)		■	■	■	■	■	■	■
	UV-I (248 – 1180 nm)		■	■	■	■	■	■	▢
	UV-II (192 – 800 nm)		■	■	■	■	▢	▢	▢
	VIS / IR (330 – 1750 nm) [17]		■	■	■	▢	▢	▢	▢
	VIS / IR-II (500 – 2250 nm) [17]		■	■	■	▢	▢	▢	▢
	IR-I (630 – 1750 nm)		■	■	■	■	■	■	▢
	IR-II (1000 – 2250 nm)		■	■	■	■	■	▢	▢
	IR-III (1400 – 11000 nm)		■	▢	■	▢	▢	▢	▢
Absolute accuracy [1]	192 – 330 nm [2]	pm	3	0.6	0.4	0.2	0.1	0.1	–
	330 – 420 nm	pm	2	0.3	0.2	0.04	0.02	0.01	0.01
	420 – 1100 nm	MHz	3000	600	200	60	30	10 [3]	2 [4]
	1100 – 2250 nm	MHz	2000	400	150	40	20	10 [3]	–
	1400 – 11000 nm	MHz	3000	–	200	–	–	–	–
Quick coupling accuracy (with multi mode fiber)		MHz	3000	600	600 [5]	150	100	100	100
Wavelength deviation sensitivity/Measurement resolution [6]		MHz	500	20	4	2	1	0.4	0.2 [19]
Linewidth option	Accuracy [7]	MHz	2000	500	400	200	100	100	100
Measurement speed [8]		Hz	950 (IR: 1800, IR-III: 100)	950 (IR: 1800)	500 (IR: 1800, IR-III: 100)	500	500	500	500
Required input energy and power [9]	Standard	µJ (or µW)	0.02 – 15	0.02 – 15	0.02 – 15	0.02 – 15	0.02 – 15	0.08 – 60	0.08 – 60
	UV-I	µJ (or µW)	0.02 – 10	0.02 – 10	0.02 – 10	0.02 – 10	0.02 – 10	–	–
	UV-II	µJ (or µW)	0.02 – 200	0.02 – 200	0.02 – 200	0.04 – 400	–	–	–
	IR-I	µJ (or µW)	2 – 200	2 – 200	2 – 200	2 – 200	2 – 200	8 – 800	–
	IR-II [10]	µJ (or µW)	2 – 80	2 – 80	2 – 80	2 – 80	–	–	–
	IR-III	mW	1	–	1	–	–	–	–
FSR of the Fizeau interferometers (Fine/wide mode) [11]		GHz	100	16/100 [12]	16/100 [13]	8/32	4/32	2/20	2/20
Calibration [18]			Built-in calibration [14]			Built-in calibration [15]	Stabilized HeNe laser or any other well known laser source Δν < 5 MHz	SLR-780 or any other well known laser source Δν < 2 MHz	I2 stabilized HeNe or any well known laser source Δν < 1 MHz
Recommended calibration period			≤ 1 month			≤ 14 days	≤ 10 hours	≤ 1 hour	≤ 2 minutes
Warm-up time			No warm-up time under constant ambient conditions [16]					> 30 minutes	
Dimensions L × W × H		mm	360 × 120 × 120	360 × 120 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120
Weight		kg	2.8	2.8	5.5 [18]	5.9	6.1	6.4	6.4
Interface			High-speed USB 2.0 connection						
Power supply			Power consumption < 2.3 W, power provided directly via USB cable IR-II, IR-III: external power supply included; IR-I, WS7 and WS8 external power supply only						

1) According to 3σ criterion, but never better than 20 % of the laser linewidth
2) With multi mode fiber
3) ± 200 nm around calibration wavelength (Outside of this range, the accuracy is 30 MHz)
4) ± 2 nm around calibration wavelength (Outside of this range, the accuracy is 10 MHz, note 3 also applies)
5) 200 MHz for WS6-200 IR-III
6) Standard deviation. WS6-200 and higher models require singlemode or PC fibers to reach this resolution.
7) Not better than 5 % of the linewidth.
8) Depending on PC hardware and settings. Highspeed models up to 50 kHz available
9) The CW power interpretation in [µW] compares to an exposure of 1s (generally the energy needs to be divided by the exposure time to obtain the required power)
10) µJ interpretation for pulsed lasers. CW signals need more power in [µW] since the exposure is limited at IR-II devices
11) Each device in each mode can measure lasers with a linewidth up to 30 % of the correspondig FSR
12) For IR devices: 32/32
13) For IR-I and IR-II devices: 16/16, for IR-III devices: 8/80
14) IR-III: external calibration source needed, e.g. SLR-1532
15) IR-devices: external calibration source needed, e.g. SLR-1532
16) IR-II: > 30 min. warm-up, or until ambient equilibrium
17) These devices have a decreased sensitivity by a factor of 4, compared to the VIS and IR rows in the required input fields, respectively
18) 2.8 for IR-I and IR-II
19) 100 kHz for special ranges on request

Upgrade options expand the capabilities of our wavelength meters to match individual requirements of cutting edge research and measurements.

MC In order to measure the frequencies of more than just one laser at a time, an opto-mechanical switch is used. The combination of our high-speed wavelength meters with one of the quickest fiber switches (MEMS) available allows up to eight channels to be measured almost simultaneously. Exposure time and other parameters can be defined independently for each light source. You can choose between singlemode or multimode fiber switches, depending on the required accuracy level of your measurements.

PID With the PID option it is possible to stabilize the frequency of a laser connected to the wavelength meter using a software based proportional-integral-derivative controller (PID controller). Unlike analog PID electronics, the PID option provides software based signal processing, allowing the laser to be stabilized to a specific user defined frequency or regulated with an arbitrary pattern. This makes it extremely useful in experiments where the laser frequency has to be actively regulated or varied to fit changing experimental conditions, such as laser cooling, atomic detection, trapping and spectroscopy. Combined with the MC option the wavelength meter can be used to stabilize multiple lasers simultaneously. The regulation speed and quality and absolute accuracy match the measurement speed, relative accuracy and absolute accuracy of the wavelength meter respectively. The measurement speed is not affected by the regulation.

TTL All wavelength meters detect and measure pulsed signals automatically. Additionally, this option allows the user to trigger pulsed measurements externally. The TTL option guarantees synchronization between pulsed excitation and measurement. It provides low-noise signals without parasitic parts when measuring pulsed signals with low duty cycles.

L The linewidth estimation of a singlemode laser source is performed by a special algorithm which eliminates the interferometer's instrument response function. The algorithm enables the estimation of the linewidth with an accuracy better than the tenth of the device FSR.

D The spectrometer option allows the analysis of emission spectra to an accuracy of 6 GHz, for laser sources with broad emission. The software automatically searches the spectral section where the laser emission line is located and displays it on the screen. In combination with the additional Fizeau interferometer array this allows wide range applications with a single device.

CAL Standard HighFinesse wavelength meters up to an absolute accuracy of 60 MHz feature auto-calibration via an integrated calibration source. This guarantees the accuracy and stability of measurements with our wavelength meters. For the higher accuracies we offer a variety of frequency stabilized, narrow linewidth, laser sources with up to ±10 kHz frequency stability for different applications.

HighFinesse/Ångstrom offers a number of highly specialized wavelength meters. Ultra-fast measurements, standalone devices, or customer specific modifications: we are always open to make your requirements possible!

Fastest Wavelength Meters

Our WS Fast series features ultra high speed measurement rates, the fastest commercially available!

Readout rates can be up to 24 kHz in the 380 – 1050 nm and even up to 76 kHz in the 980 – 1650 nm wavelength range. Fast swept laser sources can be precisely characterized with these wavelength meters.

	WS6 VIS Fast	WS6 IR Fast
Measurement range	380 – 1050 nm (QE > 60%)	980 – 1650 nm (QE > 60%)
Absolute accuracy	600 MHz	400 MHz
Quick coupling accuracy	600 MHz	
Wavelength deviation sensitivity	100	
Live calculation speed [1]	3000 Hz	
Measurement rate	24000 Hz	76000 Hz
Minimum exposure time	41.6 µs	6 µs
Maximum exposure time [2]	3.3 ms	9 ms
Minimum required input energy and power	7 µW / 0.29 nJ @ 532 nm	1 mW / 6 nJ @ 1532 nm
Fizeau interferometers (FSR)	16 GHz / 100 GHz	
Calibration	Stabilized HeNe laser or any other well known laser source Δν < 150 MHz	
Recommended calibration period	1 month	
Warm-up time	30 min	
Dimensions	432 × 144 × 144 mm	
Weight	3.5 kg	
Interface	USB 2.0 and GbE	USB 2.0 and CL
Power supply	External 12 V	

1) Depends on PC and measurement mode 2) Depends on gain mode

OEM and customizations

While our standard housings are well suited for lab conditions there are cases where our devices are subjected to extreme conditions. For these instances we can work with the customer to design a housing suitable for their requirements. In the past these have included an increased protection from environmental influences and increased shock resistance. Contact us for user defined functions or OEM applications! The unmatched accuracy of our wavelength meters is used to actively stabilize the seed laser of a Laser Guide Star system (right). This guarantees that the yellow laser light is exactly on resonance with the atomic transition to enable the LGS to shine bright!

Picture courtesy: ESO/ Y. Beletsky

Standalone Wavelength Meter

HighFinesse/Ångstrom wavelength meters are also available in an industry standard 3U 19-inch case, allowing easy integration into existing rackmount systems. A standalone version allows full use of the device without the need for a connection to a PC. Measurements can be recorded directly onto the device internal storage or externally. They can be stored easily on USB flash drives, HDD/SSDs, or accessed the wavelength meter via SCPI client. This modification is available for all wavelength meter models (except FAST series).

Features

- Turnkey Wavelength Measurement
- Longterm Graph
- Relative Power Measurement
- Network: SCPI via Ethernet
- Linewidth Estimation (Option)
- External Trigger (Option)
- PID Laser Control (Option)
- Multichannel Switch (Option)

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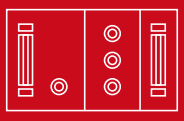
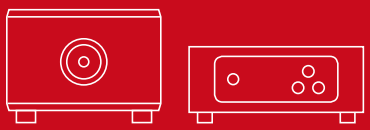
Spectrometer OSA

HighFinesse/Ångstrom optical spectrometers LSA and HDSA are designed to analyze the multi-line or broadband spectrum of light sources like cw and pulsed lasers, gas discharge lamps, super luminescence diodes, semiconductor laser diodes and LEDs. They are suitable to analyze the spectrum of telecom signals, resolve Fabry-Perot modes of a gain chip, and produce a spectral measurement of gas absorption.



Precision Current Sources

HighFinesse Precision Current Sources have been developed for experiments and quantum technologies in the areas of Cold atom physics and solid-state-physics. The linearly regulated BCS (Bipolar Current Source) and UCS (Unipolar Current Source) series deliver highly stable, low noise source currents for high precision magnetic field control. The current output is floating or is on a user defined potential. Ultrafast response to control signals and trigger functions, clear grounding, connection and signal isolation schemes make the integration of the current sources into complex experimental systems easy.



Linewidth Analyzer

HighFinesse Linewidth Analyzers (LWA) are specialized high-end devices for measuring and analyzing the spectral shape of various laser sources. Through the use of two measurement modes, the LWA can analyze both very narrow laser lines down to 100kHz as well as broader spectra up to 1GHz. They feature an extremely high resolution and accuracy in determining the linewidth of the respective laser source and its spectral lineshape. The LWAs are ideal for optimizing the stability of laser setups.

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