



HighFinesse
Laser and Electronic Systems



Ångstrom



Wavelength Meter

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

Unrivaled precision



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.

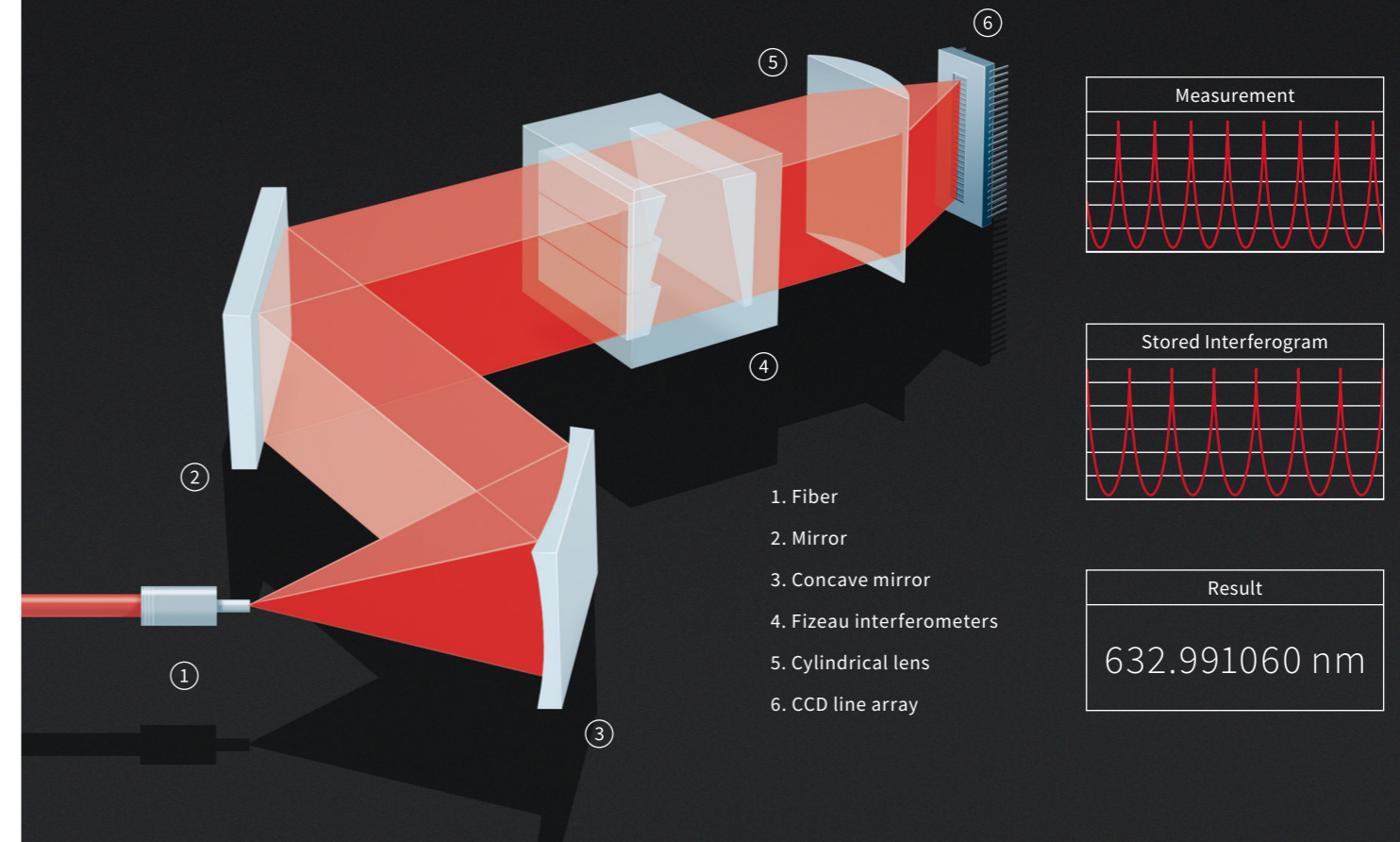
The wavelength meters are connected to the PC via a USB interface and are ready for use as soon as the software delivered with the instrument is installed. A compact, thermally insulated housing holds the optical elements as well as the electronics. The design enables the integration of additional options,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

Enter a new world of accuracy!



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 instrument 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 (Standard Series) or a Camera link connection (Fast Series) 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 instrument'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, four-channel, and eight-channel configurations.

Technical Data

Measurement range	UV-II (192 – 800 nm)
	UV-I (248 – 1180 nm)
	Standard (330 – 1180 nm)
	VIS / IR-I (330 – 1750 nm) ¹⁷⁾
	IR-I (630 – 1750 nm)
	VIS / IR-II (500 – 2250 nm) ¹⁷⁾
	IR-II (1000 – 2250 nm)
Absolute accuracy ¹⁾	IR-III (1400 – 11000 nm)
	192 – 330 nm ²⁾
	330 – 420 nm
	420 – 1100 nm
	1100 – 2250 nm
Quick coupling accuracy (with multi mode fiber)	1400 – 11000 nm
	Standard (VIS)
Required input energy and power ⁹⁾	UV-I
	UV-II
	IR-I
	IR-II ¹⁰⁾
	IR-III
FSR of the Fizeau interferometer s (Fine/wide mode) ¹¹⁾	
Calibration ¹⁸⁾	Built-in calibration ¹⁴⁾
	Built-in calibration ¹⁵⁾
Recommended calibration period	
Warm-up time	
Dimensions L × W × H	
Weight	
Interface	
Power supply	

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 photonic crystal fibers to reach this resolution.
 7) Not better than 20% of the linewidth.
 8) Depending on PC hardware and settings. Highspeed models up to 76 kHz available.

Unit	WS5	WS6-600	WS6-200	WS7-60	WS8-30	WS8-10	WS8-2		
	■	■	■	■	□	□	□		
	■	■	■	■	■	■	□		
	■	■	■	■	■	■	■		
	■	■	■	□	□	□	□		
	□	□	□	■ ²²⁾	■	■	□		
	■	■	■	□	□	□	□		
	□	□	□	■	■ ²⁰⁾	□	□		
	■	□	■	□	□	□	□		
pm	3	0.6	0.4	0.2	0.1	0.1	-		
pm	2	0.3	0.2	0.04	0.02	0.01	0.01		
MHz	3000	600	200	60	30	10 ³⁾	2 ⁴⁾		
	2000	400	150	40	20	10 ³⁾	-		
MHz	3000	-	200	-	-	-	-		
	3000	600	600 ⁵⁾	150	100	100	100		
MHz	500	20	4 ²¹⁾	2	1	0.4	0.2 ¹⁹⁾		
MHz	2000	500	400	200	200	100	100		
Hz	950 (IR: 1500, IR-III: 100)	950 (IR: 1500) ⁸⁾	500 (IR: 1500, IR-III: 100) ⁸⁾	500	500	500	500		
	0.02 – 15	0.02 – 15	0.02 – 15	0.02 – 15	0.08 – 60	0.08 – 60	0.08 – 60		
μJ (or μW)	0.02 – 10	0.02 – 10	0.02 – 10	0.02 – 10	0.08 – 40	-	-		
	0.02 – 200	0.02 – 200	0.02 – 200	0.04 – 400	-	-	-		
	2 – 200	2 – 200	2 – 200	2 – 200	8 – 800	8 – 800	-		
mW	2 – 80	2 – 80	2 – 80	2 – 80	8 – 800	-	-		
	1	-	1	-	-	-	-		
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 Δv < 5 MHz	SLR-780 or any other well known laser source Δv < 2 MHz	I2 stabilized HeNe or any well known laser source Δv < 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		
mm	360 × 120 × 120	360 × 120 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120	360 × 200 × 120		
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; WS7-60 IR-I, WS8-30 IR-I, WS8-10 IR-I: external power supply included	

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 instruments.
 11) Each instrument in each mode can measure lasers with a linewidth up to 30% of the corresponding FSR.
 12) For IR instruments: 32/32.
 13) For IR-I and IR-II instruments: 16/16, for IR-III instruments: 8/80.
 14) IR-III: external calibration source needed, e.g. SLR-1532.
 15) IR and UV-II instruments: external calibration source needed, e.g. SLR-1532 or stabilized HeNe.

16) IR-II: > 30 min. warm-up, or until ambient equilibrium.
 17) These instruments have a decreased sensitivity by a factor of 4, compared to the Standard and IR ranges in the required input fields, respectively.
 18) 2.8 for IR-I and IR-II.
 19) 100 kHz for special ranges on request.
 20) Photonic crystal switches can be used up to 2000 nm. Please contact HighFinesse if you want to measure over 2000 nm.
 21) IR-III: 20 MHz.
 22) Measurement range WS7-60 IR-I: 530 – 1750 nm



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 instrument 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 instrument.

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.



Ultra-fast measurements, standalone instruments, 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.

	WS6-600 VIS Fast	WS6-200 IR Fast
Measurement range (QE > 60%)	380 – 1050 nm	980 – 1650 nm
Absolute accuracy	600 MHz	200 MHz
Quick coupling accuracy	600 MHz	600 MHz
Wavelength deviation sensitivity	20 MHz	4 MHz
Exposure Times ¹⁾	3 – 3300 μ s	6 – 9500 μ s
Measurement Rate	300 – 24000 Hz	100 – 76000 Hz
Live Calculation Speed ²⁾	24000 Hz	28000 Hz
Live Calculation Latency ²⁾	$\geq 33.6 - 0.7$ ms	$\geq 100.3 - 0.4$ ms
Minimum required input energy and power	100 μ W @ 3 μ s / 0.29 nJ @ 532 nm	1 mW @ 6 μ s / 6 nJ @ 1532 nm
Fizeau interferometers (FSR)	16 GHz / 100 GHz	16 GHz
Calibration	Stabilized HeNe laser or any other well known laser source	
	$\Delta v < 150$ MHz	$\Delta v < 40$ MHz
Recommended calibration period	1 month	
Warm-up time	30 min	
Dimensions	432 x 144 x 144 mm	
Weight	3.5 kg	
Interface	USB 2.0 and GbE	USB 2.0 and CL
Power supply	External 12 V (<9 W)	

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

OEM and customizations

While our standard housings are well suited for lab conditions there are cases where our instruments 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!



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 instrument without the need for a connection to a PC. Measurements can be recorded directly onto the instrument 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 instruments 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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