



quDIS

Interferometric distance measurement

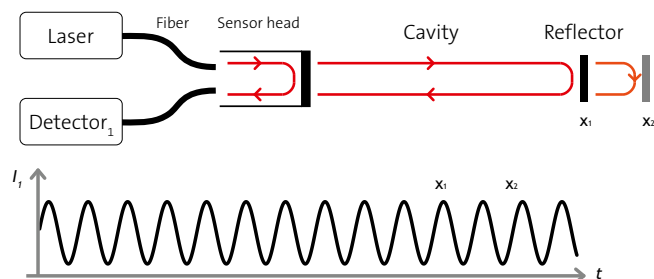


Interferometry - sub-nanometer accuracy

Interferometry is by far the best method when length measurement has to be performed with highest accuracy. The use of a stable laser and superposition of its coherent radiation allow the observation of interference phenomena. The detected signal gives the optical path length. In this way can sub-nanometer resolution and repeatability be achieved.

Superposition principle

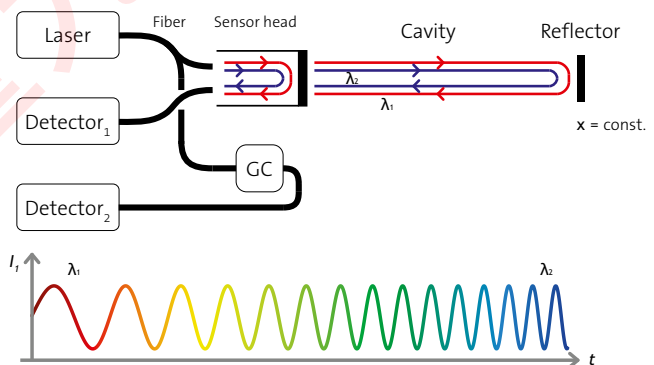
All kinds of interferometers make use of the same principle: A laser beam with high coherence length is split up and diverted into two different paths, one reference arm and one measurement arm. When the two beams are then superimposed, constructive and destructive interference can be observed.



The interferometer is inspired by a Fabry-Perot-Interferometer. Laser light is fiber coupled and at the end of the fiber 4% of the light is reflected to the detector. The rest passes the cavity, is reflected and also guided to the detector. The graph shows the interference signal of a constantly moved mirror.

Interference Spectroscopy - Frequency analysis and relative distances

Beside optical path length changes, modification of the laser wavelength also leads to signal modulations by interference. The pattern of the interference reveals a lot of information about the measured path. We name this feature "Interference Spectroscopy".



Tuning the wavelength also causes a similar interference pattern as moving the mirror. The absorption lines of a acetylene cell are used for precise wavelength control.

Relative length changes of the path can be determined simply by counting the interference maxima during the up and the down sweep of the wavelength. This method is not affected by contrast changes of the signal.

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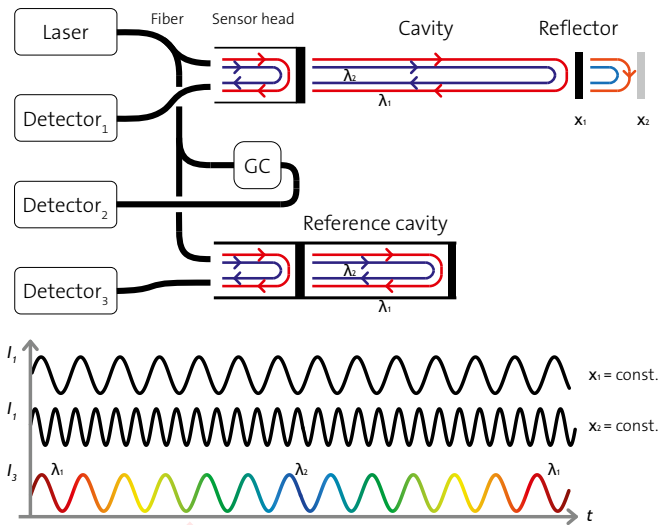


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Internal reference cavity - Laser stabilization and absolute distances

The use of the “Interference Spectroscopy” in combination with an internal reference enables absolute distance measurement by analyzing and comparing the two interference pattern. The signal of the measurement cavity depends both on the measurement path length and the controlled laser wavelength in combination. The reference signal depends only on the laser wavelength changes, as the optical path length of the reference cavity is constant.

Moreover, the “Interference Spectroscopy” paves the way for further analysis. In addition to position, velocity and acceleration also information on refractive index, reflectivity or surface tilts can be derived from the signals in real time.



The fiber-based set-up is completed by an internal reference cavity. The graph shows the signal of the internal reference with adjusted wavelength change in color and the two cavities in black. Analyzing the interference pattern, a lot of information is revealed about the measured cavity.

Key Features

- Signal stability < 0.05 nm
- Absolute distance measurement
- 0.1 ... 20 m working distance
- 25 kHz bandwidth
- 1 m/s target speed
- 3 sensor axes, multiple devices

Applications

- Interferometric distance measurement
- Vibration analysis
- Beam interrupt compensation
- Gap and edge measurement
- Environment analysis
- Quality control

quDIS Specifications

Interferometer	
Laser source	DFB laser (class1)
Laser power (class 1)	< 400 μ W
Wavelength (IR)	1 535 nm
Laser linewidth	<5 MHz
Sensor axes	3
Fiber input connectors	FC Narrow-Key-Slot Mating Sleeves
Synchronization	Multiple devices

Sensor	
Resolution	1 pm
Signal stability *1	< 0.05 nm
Signal stability, absolute distance *2	< 200 nm
Bandwidth *3	25 kHz
Working distance *4	0.1 ... 20 m
max. target velocity	1 m/s
Sensor heads	Vacuum, low temperature

*1: relative distance RMS@ 100Hz, 2s, 200mm *2: absolute distance RMS@ 100Hz, 200mm
 *3: @ 1000mm, distance dependent *4: sensor head dependent

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