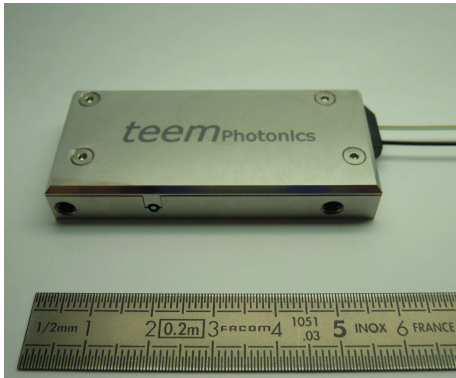


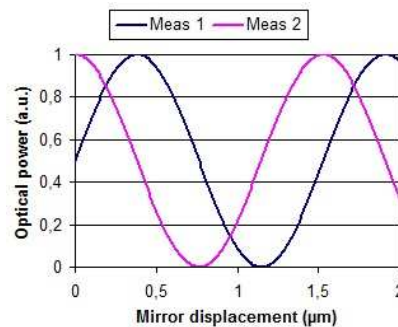
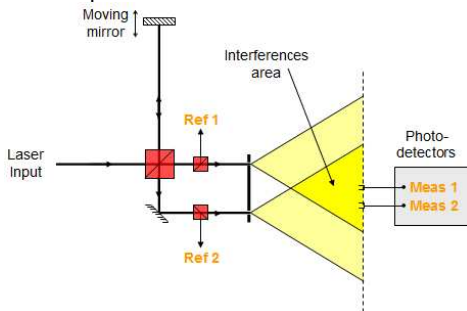
Integrated waveguide interferometer with picometric performances



With its flexible **Ion-Exchange technology** on glass substrate, Teem Photonics designs and realizes **Photonics Integrated Circuits (PICs)**, in which various optical functions are uniquely combined, to create **compact, stable, reliable, and high performances** optical sensors, such this interferometer*.
(*patented design)

Principle:

An interferences area is created thanks to a Michelson-like interferometer. Two $\pi/2$ -phase shifted optical ports allow determining both amplitude and direction of the mirror displacement.



Performances:

Operating wavelength	1530 – 1560 nm
Measurement beam divergence	< 10 mrad.
Interferences contrast	> 95% ⁽¹⁾
Measurement outputs phase shift	$\pi/2 \pm 0.05$ rad.
Optical path-length difference	< 0.1 mm ⁽²⁾
Displacement resolution	< 10 pm ⁽³⁾
Intrinsic noise	< 1pm/Hz ^{1/2} at 1Hz
Packaging dimensions	59 x 26 x 8.5 mm
Storage temperature	-40 to +85 °C

⁽¹⁾ for a mirror working distance < 20mm ; ⁽²⁾ for a mirror working distance of 1mm ; ⁽³⁾ for acquisition frequency in the 10Hz – 10kHz range

Typical applications:

- Measurement of sub-nanometer displacements
- High precision position sensor
- High precision vibration sensor
- High precision refractive index measurement

Features & benefits

Very high sensitivity

Exceptional displacement sensitivity and low intrinsic noise thanks to monolithic and very stable design

Temperature insensitive

Compact and monolithic integration, very low thermal expansion of both glass-chip and INVAR™ packaging

Monolithic integration

All optical functions integrated on a single wafer, very high stability of the measurement, insensible to vibration or shock

Remote electrical operation

No electrical parts in the sensor head. Laser source and detectors remotely placed through reliable fibre pigtailling

Eye-safe operation

1.55µm operating wavelength procure Eye safe conditions, compatibility with commercial Telecom sources

Visible wavelengths compatibility

Optical beam for alignment purpose available at visible wavelengths

Robust, stable, and highly reliable.

Intrinsically robust due to diffusion based process, glass based technology, no deposited layers, no etching.

Vacuum environment compatibility

Compatible with vacuum operation

Optional features

Plastic/Aluminium/Invar packaging

Four ports detection board with fibre-input and BNC-outputs available

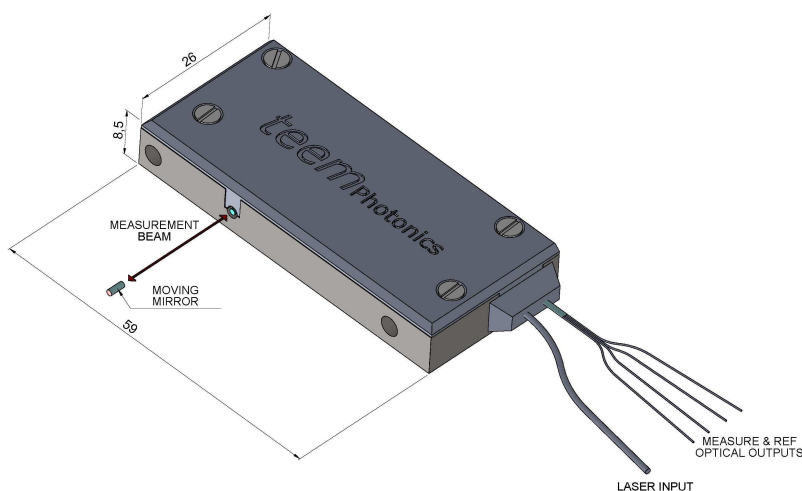
Optical integration:

All the optical functions are monolithically integrated on a compact glass chip thanks to Teem Photonics proprietary *ion-exchange technology*.

The optical chip integrates two power splitters, two tap couplers, and a 2x2 multimode interferometer area (replacing the beam splitter of the above scheme). All these functions are optically linked via singlemode low-loss waveguides.

The multimode interferometer area has been designed to create a perfect $\pi/2$ phase shift between the two output measurement waveguides (Meas1 and Meas2) in order to maximize the sensitivity of the displacement measurement. Taps allow evaluating optical powers in both input-arm and measurement-arm (Ref1 and Ref2). The splitters coupling-ratios have been selected to optimize the interferometer contrast.

Optical ports:



- ▶ One fibered input* (PM) for laser injection
- ▶ One collimated beam** to be reflected on the moving object (measurement arm)
- ▶ Four fibered outputs*:
 - two $\pi/2$ -phase shifted measurement ports to determine both amplitude and direction of the mirror displacement
 - two reference ports to optimize the interferences contrast

* These ports are reliably fibered to the glass chip with fibres array units

** The collimated beam is obtained by a selfoc lens

Packaging:

Our interferometer chip is protected by a compact package with dimensions as small as 59 x 26 x 8.5 mm. This package is standard made of aluminium-alloy, or made of INVAR™ for thermally sensitive applications. The measurement beam is perpendicular to the input and output fibres. Parallel design is feasible

Detection system:

The optical sensor head can be remotely installed thanks to low loss optical fibres. The detection system is available in two options. The first integrates four low-noise photo-detectors and their pre-amplifiers. The second integrates the photo-detectors and the amplifiers together with the laser source, the digital acquisition board, and the associated software. A USB link allows for connexion to a computer.

