Application Note

The PicoMove™ system is an ultra-stable interferometer based on a monolithic integrated optical circuit on glass. In conjunction with a reflective target, the very high stability of the optical head allows for displacement measurements with a sub-nanometer resolution (10 pm demonstrated in controlled environment). Figure 1 (left) details the measurement principle of the PicoMove interferometer, based on a Michelson-like architecture.

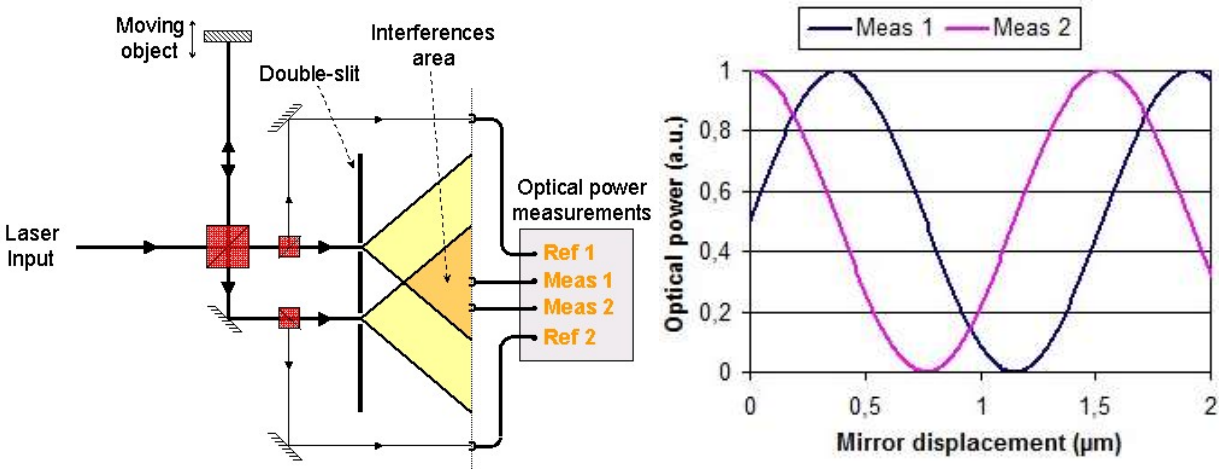

Figure 1: (left) PicoMove interferometer principle. (right) Fringes produced from a mirror displacement.

A laser beam is split into two arms: a reference arm with a constant length and a measurement arm that is reflected on the moving object. The length of this latter arm varies with the position of the device under test. Interferences are generated within a multimode area on the optical chip. The fringes are extracted at two predetermined positions in the interference area, such that a precise π/2 phase offset is fixed between the two measurement signals. Figure 1 (right) illustrates the signal variation on the measurement ports (Meas1 and Meas2) due to a displacement of the reflective object. This two signals in quadrature allow for the evaluation of both the amplitude and the direction of the displacement, while the two reference signal (Ref1 and Ref2) enable the tracking and correction of optical power variations originating either from the laser source or from the moving arm.

All the optical functions described in Figure 1 are monolithically integrated on a compact glass chip thanks to Teem Photonics' proprietary ion-exchange technology (**ioNext**). The optical head chip is then offered in OEM version (with optical fibers attached) for direct integration into the customer's system, or packaged in the casings shown in Figure 2:

- PicoMove: standard version, high resolution, highest stability.
- PicoMove-IS: compact version, designed for short working distances (< 1 cm).
- PicoMove-UHV: high resolution, ultra-compact and ultra-high vacuum (UHV) compatible.

Custom versions are also offered by Teem Photonics, e.g. designed for longer working distances or including several interferometers on the same chip and/or in a single packaging. Moreover, Teem Photonics can provide several kind of reflective mirrors to be attached on the target.

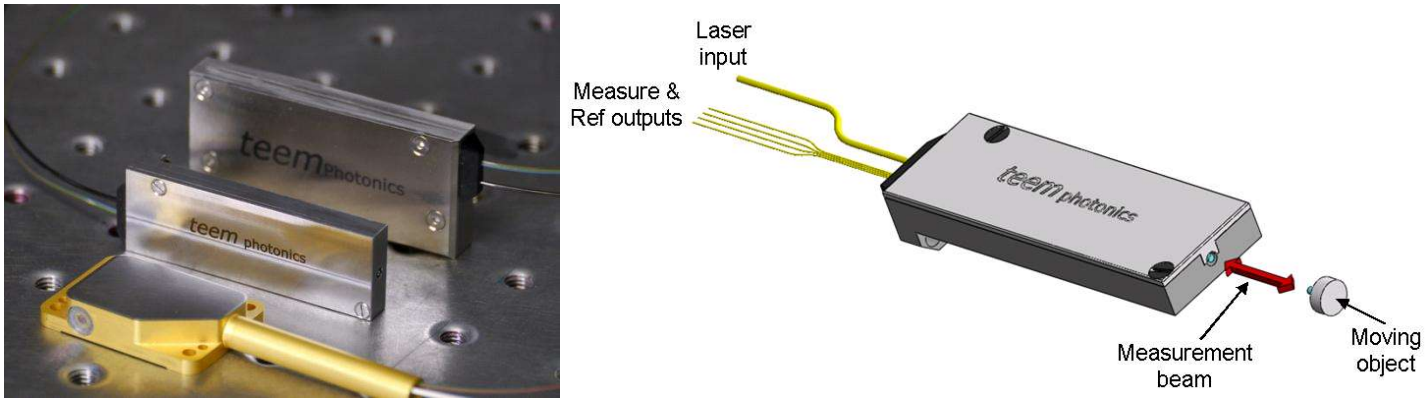

Figure 2: (left) PicoMove optical head casings in UHV version (left), IS version (center) and standard version (right). (right) Measurement principle of a PicoMove-IS version.

The PicoMove optical head is designed to function with a highly coherent laser source centered around 1550 nm. The laser itself is not provided by Teem Photonics. The wavelength stability and long-coherence length of the laser are key towards high-resolution (sub-nm) measurements with the PicoMove system. Our suggestion for the laser is the Orion™ laser module from Rio Inc. (http://www.rio-inc.com). For applications at short working distance (< 1 cm) and requiring a moderate displacement resolution (> 1 nm), the use of a standard distributed feedback laser (DFB) or external cavity laser (ECL) can be considered.

From the signal acquisition point of view, Teem offers the PicoMove Detection Module (PMDM, shown in Figure 3) that embeds the optical-to-electrical conversion electronics, as well as optical input connectors that guarantee the highest performance of the optical head. The module needs a +5/-5V power supply and offers an analog electrical output featuring a 500 kHz bandwidth on its four SMB output ports. Higher bandwidth (up to 35 MHz) for high speed measurements (up to meters/s) are offered on demand.

Figure 3: Front panel of the PicoMove Detection Module.