Good Practice In Interferometry

PRECISION-OPTICAL ENGINEERING

IF 006

Application Note

By measuring the distortions in a wavefront interacting with a test piece compared to a reference beam, aberrations in optical systems, badly manufactured optical components and inhomogeneities in materials can be identified. The interference between the test beam and the reference beam yields information related to surface form errors or optical waveform distortion errors. Although PC-based software is available to automate the fringe analysis and measurement processes, good practice in measurement methodology is still essential. Interferometric measurements can vary from comparative tests applying visual assessment (generally used for relatively low accuracy results) to a calculation of the complete geometrical properties of an optical system. Commonly required measurements, however, are those of form error both for flat and spherical optics. Since all measurements are based on analysis of fringe patterns, attention to detail in their generation and stability is of paramount importance.

Reference optics

The quality of results obtained depends on the quality of the interferometer and the reference optics used. A high quality reference optic is essential as a beam splitter. Most software allows the subtraction of errors due to the reference components from the measured wavefront which relaxes the requirements for component accuracy. However, it is never completely certain that the same part of a reference component is being used, particularly if a wedged or decentred optical component has been inserted for measurement.

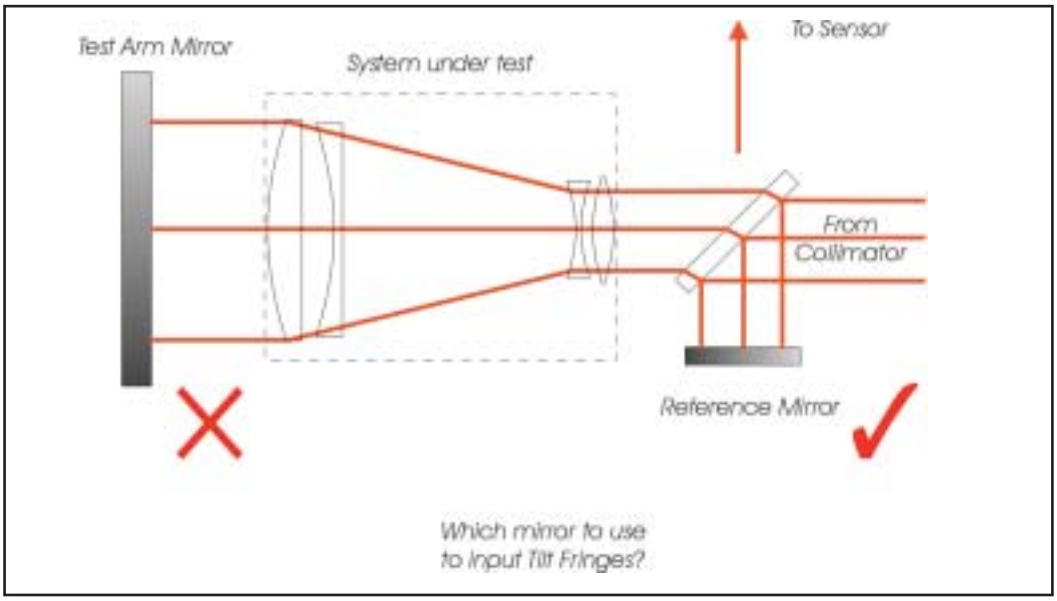
Vibration effects

All optical components should be mounted on a vibration-isolated optical bench for the best results. This is less critical for low accuracy comparative tests, but is absolutely essential for high accuracy phase shift analysis during which individual snapshots can be affected by vibration. During a statistical run of measurements, it is possible to see the effects on the results by the operation of plant machinery nearby, or the cutting-in of air conditioners. Air turbulence itself, which could arise from air conditioners or forced convection in an open room, or the proximity of heat generating electronic equipment, cannot be eliminated by anti-vibration systems. If critical measurements including long path lengths are to be made, it is often necessary to shield the equipment from sources of air convection.

Optical alignment

The test beam and reference beam must follow an identical path inside the interferometer and the test beam must retrace its path accurately. Internal instrument alignment procedures as stipulated by the manufacturer must be followed and external optical components including the test piece and reference optics must also be carefully aligned along the optical axis of the interferometer. It is important that the test beam accurately retraces its path through the optical system under test after reflection from the return mirror. This is especially so in complicated systems which may have rapidly varying aspheric surfaces or discontinuous diffractive optics. For this reason it is best to introduce tilt fringes by tilting the reference mirror rather than the return mirror in the test arm, as shown in the figure (overleaf).

PRECISION-OPTICAL ENGINEERING
Wilbury Way, Hitchin, Hertfordshire, SG4 0TP, United Kingdom.
Tel: +44 (0) 1462 440328 Fax: +44 (0) 1462 440329
E-mail: sales@p-oe.co.uk Web: www.p-oe.co.uk
P-OE is a business centre of MBDA UK Limited



Accurate focusing of the optical pupil is also important, particularly at wavelengths in the infra-red, to avoid erroneous interpretation of results. Diffracted light will also interfere with the reference beam so the optical aperture of the system under test should be focused onto the camera sensitive surface. Diffraction effects arising from double pass configurations may be cured by imaging the optical pupil onto the interferometer camera both directly, and via the reference mirror or sphere. Optical components are usually defined to have a clear aperture over which the wavefront is controlled. If the system under test has a larger physical diameter than the used aperture then it may be measured over the larger aperture and then masked in software to the used aperture to keep the effects of diffraction away from the pupil zone analysed.

Pupil matching

When performing a measurement, as much of the interferometer's pupil as possible should be used, to maximise the number of data points in the measurement data. An optical zoom system or other aperture adapter is essential to provide such pupil matching. Electronic zoom simply enlarges both the image and pixels without giving any more data.

PRECISION-OPTICAL ENGINEERING

Wilbury Way, Hitchin, Hertfordshire, SG4 0TP, United Kingdom.

Tel: +44 (0) 1462 440328 Fax: +44 (0) 1462 440329

E-mail: sales@p-oe.co.uk Web: www.p-oe.co.uk

P-OE is a business centre of MBDA UK Limited