Three Tests to Assess Interferometer Performance

This technical note gives three test recipes to assess interferometer performance

How good is your interferometer? Has a system's performance degraded since last year? How does one system compare to another? Do annual "calibrations" indicate actual performance? These are important questions to answer.

Manufacturers specify a narrow set of performance parameters, promised at delivery. Advanced tests are undefined, or require special tools, and are of uncertain utility. Historically measurement repeatability was the canonical performance parameter. Today with vibration tolerant data acquisition and 12-bit cameras measurement repeatability is "in the noise" compared to other error sources like air turbulence or reference surface accuracy. Further repeatability as defined on the specification sheet in the footnotes barely resembles normal usage. The test is defined with many averages of nulled, extremely short plano cavities, unlike daily usage where most measurements have no averaging and much longer cavities. So what matters?

Here are three simple tests to assess the limits of any interferometer.

Image Resolution:

Indicates how well an interferometer will image features on the surface, including mid-spatial frequencies

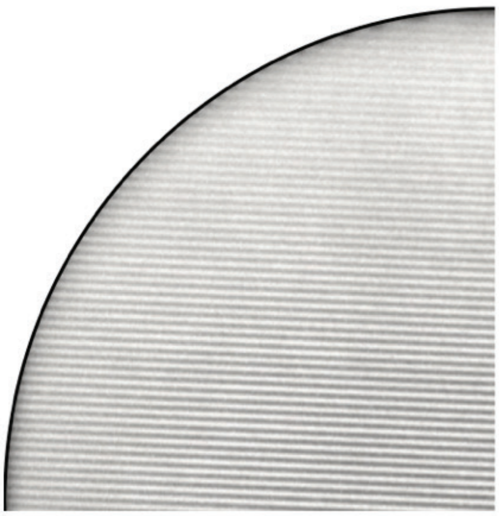
Remove all reference optics. Place a white card printed target on your computer printer with straight lines spaced at 1line/mm and place it approximately 200 mm from the aperture. Shine a bright lamp on the card, observe the image in the data acquisition (view) camera, and focus on the card.

Observe the sharpness and limits of resolution. Especially look at the edges of the field of view. Do the lines look uniform? Note the images to the right, the resolution is different for horizontal and vertical lines with both losing contrast at the edge perpendicular to the line direction.

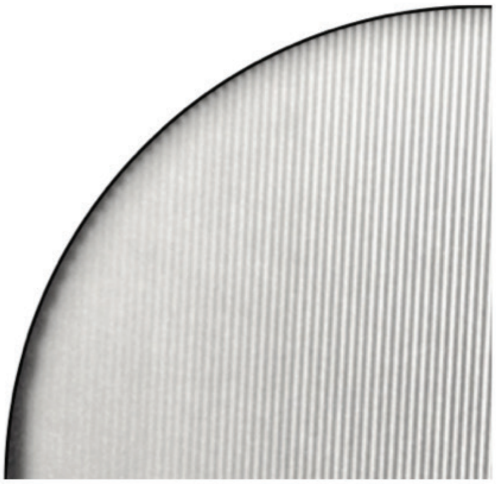
If a system has poor imaging qualities it will not have good phase imaging qualities, or Instrument Transfer Function (ITF). The ITF test measures ~100nm tall features with various spatial frequencies to determine the phase resolution limit. There is industry disagreement regarding the best step height and target structure for ITF and discussion as to whether ITF is a valid parameter. Simply testing the image quality is a good start and instructive as shown at right.

A high-quality image is also important achieve a sharp focus that minimizes edge diffraction. Edge diffraction, if not minimized by a sharp focus, distorts the surface's edge.

An annual image resolution test assures nothing has changed.



Horizontal 1line/mm Target



Vertical 1line/mm Target

Wavefront Error at Maximum Measurable Fringes:

Indicates the measurement accuracy of parts measured off null. Supports rapid convergence to final figure of CNC machined optics, speeding part production, and the accurate measurement of non-spherical parts.

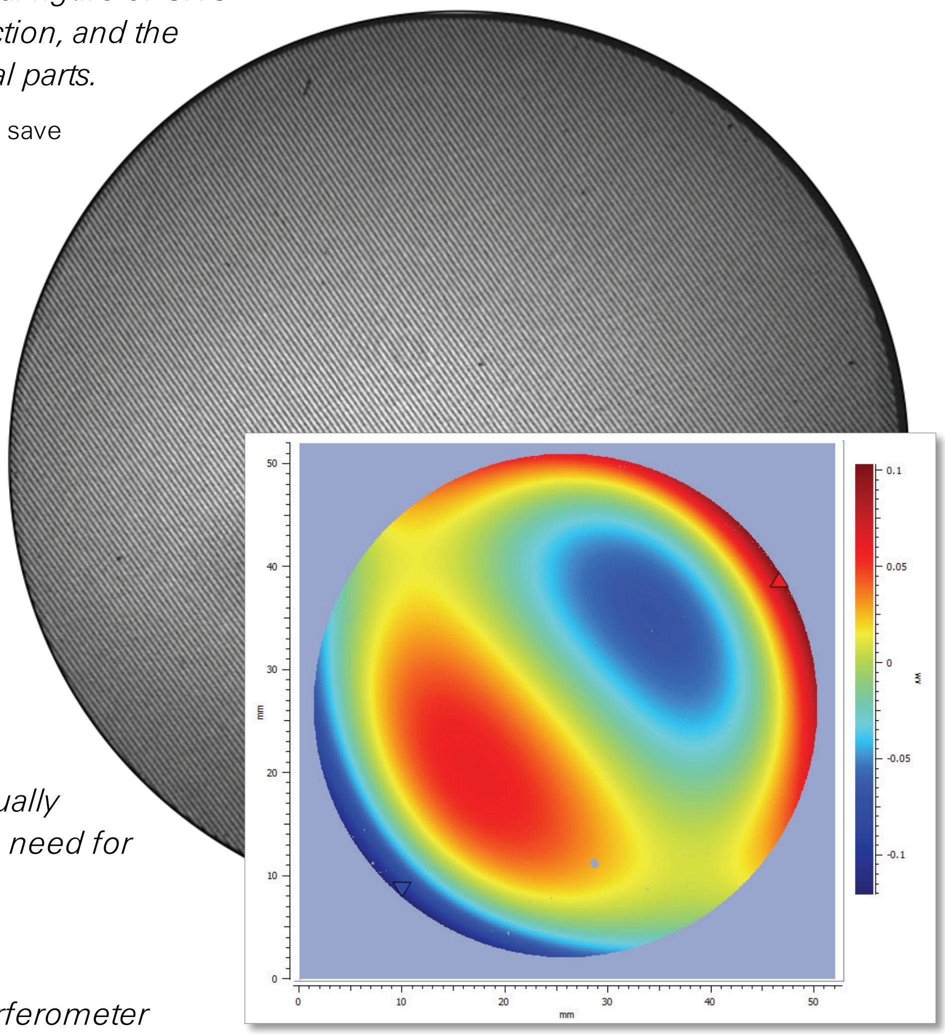
Null a flat cavity and take a measurement and save this REFERENCE result for later subtraction.

Tilt the fringes in one direction and continue measuring until the measurement starts to fail. Back up until the measurement succeeds and the fringes are maximized.

Subtract the REFERENCE result from this tilted data. The PV of the 36-Zernike terms in the PVr screen (in ÄPRE REVEAL) is the Wavefront Error (accuracy limit) at the Maximum Measurable Fringes or Maximum Slope

These errors are typically coma and third order spherical aberration and measure the error contribution due to slopes.

Record the PV error of the 36-Zernike terms and the map of the errors to annually track changes that indicate the possible need for service and repair



0.224 wave PV Error at
Max Fringe Tilt of 160 fringes

Maximum Measurable Fringes

Measures the maximum slope the interferometer can measure – Higher surface slope means further out of specification parts can be measured to start correcting sooner, thus converging faster saving time

Starting with the results of the previous test, simply record the maximum tilt measured. Also observe the fringe contrast as the fringe density increases, in some system the contrast decreases due to increased aberrations induced with tilt. Decreased fringe contrast indicates increased noise in the measurement lowering system accuracy.

Record the maximum tilt and the fringe contrast annually to track changes that indicate the possible need for service and repair

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