L.5: Development of a large beam liquid reference Fizeau interferometer

A large beam aperture liquid reference Fizeau interferometer (FI) with a beam aperture of 250 mm diameter was developed at Optical Design and Development laboratory (ODDL) in Advanced Lasers and Optics Division (ALOD) for measuring the flatness of optics up to 250 mm diameter. In optical workshops, FI is extensively used for non-contact testing of large diameter optical components like Nd:glass laser disks, glass windows etc. Though FI is not exactly common path interferometer, the interfering waves from the reference and test surfaces travel nearly same path through the interferometer system (from the reference surface), hence the measurement results are much less affected by the FI system aberrations and external mechanical vibrations.

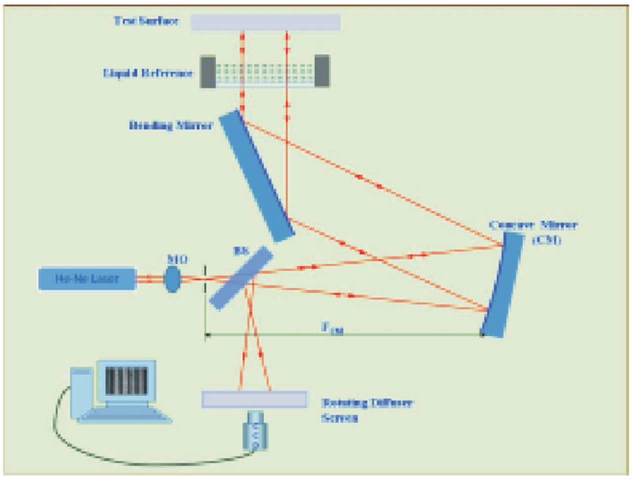

Fig. L.5.1: Schematic of the interferometer system

To develop such large aperture FI system, the collimating optics and the reference surface should be of very high optical quality. As shown in Fig.L.5.1, a concave mirror (f $\geq$2500 mm, Dia. $\geq$250 mm) at slightly off-axis configuration was used as the collimating optics. The advantage of using a high F-number mirror is that the residual wavefront aberrations introduced by the mirror at slightly off-axis will be negligible. Since the surface flatness of the test optics is measured relative to the flatness of the reference surface of the Fizeau cavity, a large dia. flat reference surface (at least of the order of $\lambda/10$, @$\lambda\geq$ 633nm) is required and the fabrication of such an accurate surface is highly challenging. It is well known that a liquid surface assumes the radius of the earth and a 500.0 mm diameter liquid surface will have a P-V deviation of $\lambda/100$. Hence, a liquid surface (liquid paraffin) of 275 mm diameter was used as a reference surface for testing of 250 mm diameter optics.

Phase shifting interferometry is most useful and accurate method for quantitative measurement of phase information of the test optics. The phase information can be converted to height variations and a 2-D surface form of the test optics can be obtained.

A cyclic path optical configuration was incorporated at the input beam to the concave mirror for the measurement of the surface form of the test optics using polarization phase shifting interferometry (PPSI). The advantage of PPSI technique is that the phase shifts between the interfering beams can be introduced outside the Fizeau cavity. Hence, the perturbations of the liquid surface due to mechanical vibrations during phase shifts can be minimized. The phase shifted interferograms were captured using CCD camera and Promise Software. The phase information was extracted using in-house developed 2-D phase unwrapping software.

The photograph of the developed system is shown in Fig.L.5.2. The interferometer was constructed on a vibration isolation table to isolate external mechanical vibrations. The collimation of the expanded beam was checked using an in-house fabricated 200.0 mm diameter wedge shear plate.

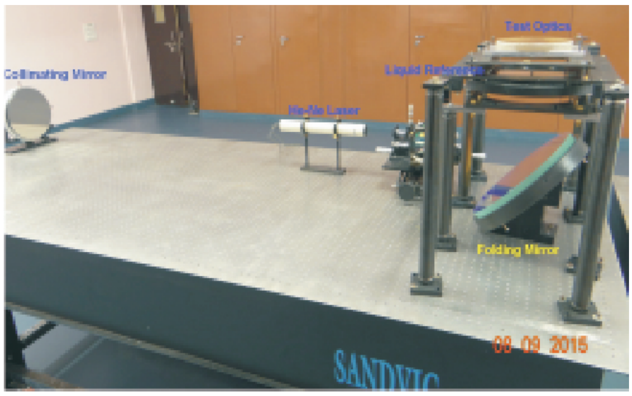

Fig. L.5.2: Photograph of the Liquid reference Fizeau interferometer

Using the present system, we measured the flatness of a 200 mm diameter BK-7 polished optical glass and cross checked the results using a Zygo interferometer to the form error of better than $\lambda/8$. For more details please refer to *S. Chatterjee et al., Appl. Opt. 55(2), (2016)*.

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