Intermediate field measurement to characterize the wavefront of high power laser large optics

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ABSTRACT

The French Laser MégaJoule (LMJ) is a high power laser project, dedicated to fusion and plasma experiments. It will include 176 square beams involving thousands of large optical components. The wavefront performances of all those optics are critical to achieve the desired focal spot shape and limit the hot spots that could damage the components. The CEA has developed experimental methods to qualify precisely the quality of the large optical components manufactured for the project and measure the effect of various defects. For specific components (coated or parabola mirrors, lenses or gratings), classical techniques like interferometric setups may fail to measure the wavefront highest spatial frequencies (> 1 mm^{-1}). In order to improve the measurements, we have proposed characterization methods based upon a laser beam diffraction interpretation. They present limits and we need to improve the wavefront measurement for high spatial frequencies (> 1 mm^{-1}). We present in this paper the intermediate field measurement based upon the Talbot effect theory and the Fourier analysis of acquired intensity images. The technique consists in a double pass setup: a plane wave is transmitted through the component twice, to simplify the setup and improve the measurement. Then, intensity images are acquired at different distances with a CCD camera and lead to the wavefront power spectral density. We describe the experimental setup to measure the wavefront of large specific components. We show experimental results. Finally, we discuss about the advantages and the limits of such a method, and we compare it with our previous measurement methods.