Digital Holographic Particle Image Velocimetry

T.A. Ooms, V.S.S. Chan, J. Westerweel & J.J.M. Braat*

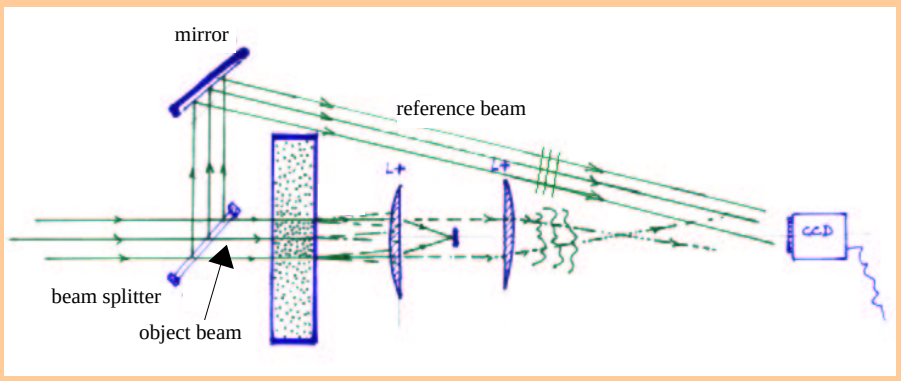
Laboratory for Aero&Hydrodynamics, *Optics Research Group, Delft University of Technology
Leeghwaterstraat 21, 2628 CA Delft, The Netherlands
www.ahd.tudelft.nl
contact: t.a.ooms@wbmt.tudelft.nl

1. Motivation

To avoid the time-consuming steps of conventional optical holography, we are experimentally studying the possibilities of digital holographic particle image velocimetry (HPIV).

2. Experimental setup

A tank containing suspended particles with fixed positions is illuminated with a collimated highly-coherent laser beam. The light scattered from the particles is separated from the bright unscattered beam with an optical Fourier filter. The remaining scattered light interferes with the reference beam to form a hologram on the CCD.



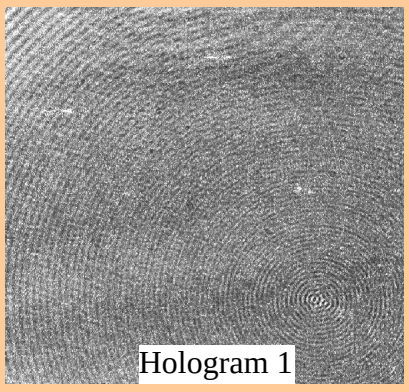
The scattered light from a particle is well delocalized in the hologram.

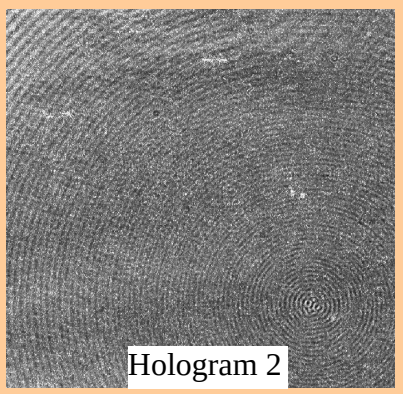
3. Hologram reconstruction

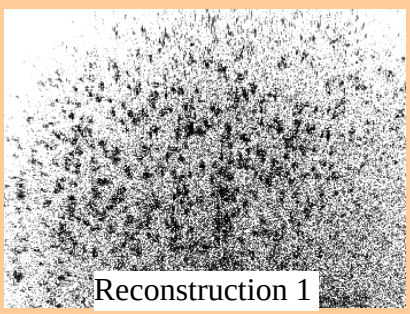
Reconstruction is performed numerically using a combination of quadratic-phase-exponential terms and a fast-Fourier-transform.

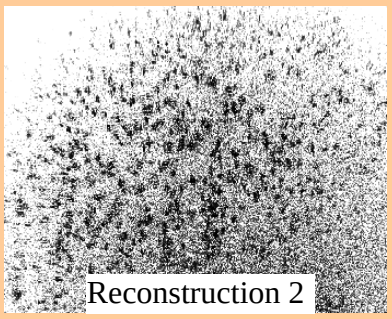
4. Preliminary results

To verify that the reconstructed image is indeed showing the suspended particles, the tank was shifted, and the experiment repeated.

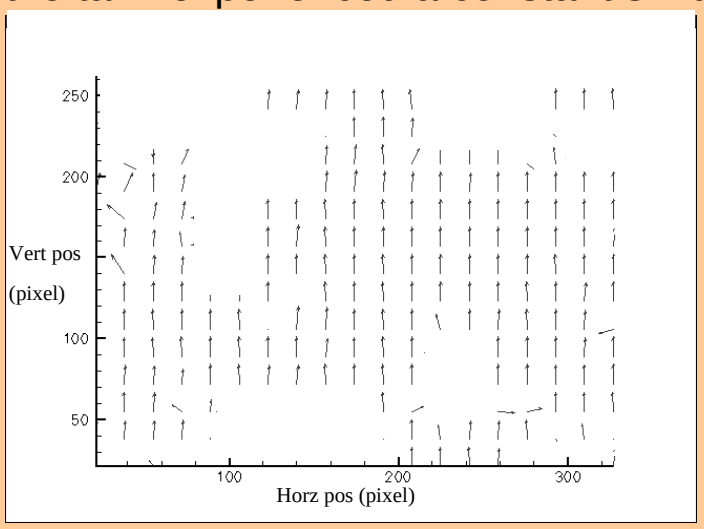






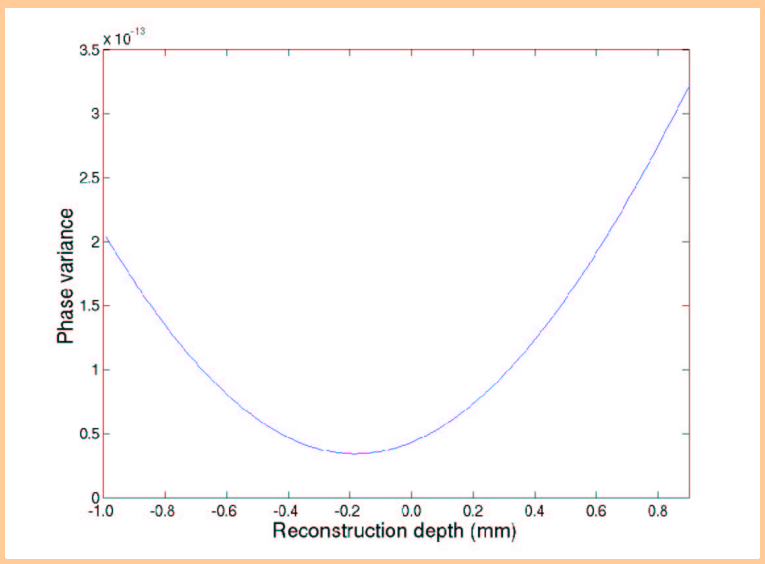


Analysis with PIV software confirms that the tank experienced a constant shift:



5. Future plans

The depth of focus in the reconstruction is being improved a factor 100, using multi-pass viewing and the complex amplitude of the reconstructed wave:



To apply digital holography in the study of fluid dynamics, the particles will be suspended in a fluid, instead of a solid, requiring imaging of dynamic particles.