

## Extension of the compressed interferometric particle sizing technique for three component velocity measurements

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The present contribution extends the presently planar advanced interferometric laser imaging Droplet sizing (ILIDS) with compression optics [1] to measure the third-velocity component of particles in two phase flows.

Two different methodologies are examined to measure the depth velocity, one employing just one camera and the other a two-camera stereoscopic arrangement. For the one-camera arrangement, the position of the droplet in the laser sheet can be determined by the size of the fringe pattern, since its size is dependant on the distance of the droplet from the imaging lens and the size of the receiving aperture. To correlate between the depth position and the fringe pattern length, a monodisperse droplet generator is traversed along the measurement volume and the particle fringe patterns length in various positions in space is used to interpolate a simple relationship function. In the stereoscopic arrangement system, the physical space is mapped in image space for both cameras by interpolating the nodes of a plain two-sided calibration plate in simple mapping model functions. Each particle is found in the two camera views by validating the particle size information and the position information that results from the calibration mapping models of each individual camera.

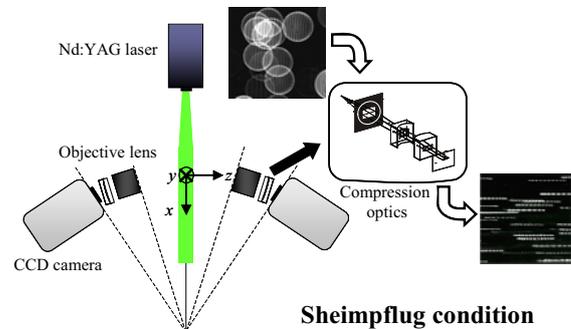
Fig. 1 shows the schematic of measurement system for the two-camera arrangement. It consists of two CCD cameras positioned on Scheimpflug mounts, objective lens with aperture mask and pair of cylindrical lenses. Since the fringe length at one side of the image is longer than that at the other side due to scattering angle, which is different than 90°, the Scheimpflug condition is applied. This condition allows for rotation of the field of view, making the plane imaged to be parallel to the central plane of the laser sheet instead of parallel to the imaging array. The same system was employed for the one-camera arrangement.

To validate the depth position calculation for both the aforementioned methodologies, a monodisperse droplet generator was positioned with a 75° inclination in respect to the horizontal axis. For the one-camera case, a simple second-order polynomial relation was fitted between the depth and the fringe length. The fringe pattern length changed from the one edge of the laser sheet to the other smoothly, but the resulting depth resolution was found to be low given the uncertainty fringe length pattern estimation. In addition, the inclination of the particle stream was found to be erroneous by 3.9%. For the stereoscopic case, this error was 1.5% (Fig. 2). For both cases, the droplet sizing error was 2.6% compared to the calculated theoretical size (Fig. 3). The stereoscopic arrangement was also applied to a spray.

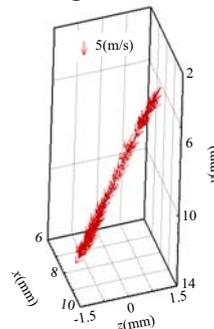
The results (Fig.4 and Fig. 5) showed that the method enables us to apply to the measurements of size and three-component velocity for the spray.

### References

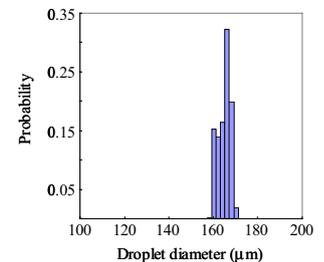
[1] Maeda *et al.* (2000), Meas. Sci. Technol., 11, L13-L18



**Fig. 1** Schematic of the measurement system

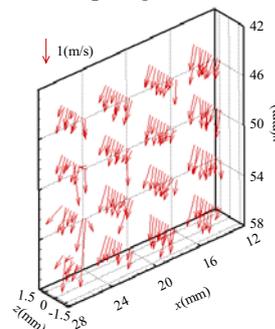


**Fig. 2** The instantaneous three components velocity of a 75° inclined monodisperse droplet generator

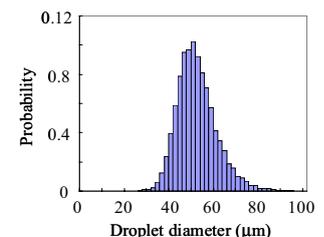


Mean diameter = 163.2 μm

**Fig. 3** Probability density function of the monodisperse droplet generator



**Fig. 4** The average three components velocity of the spray ( $d > 40 \mu\text{m}$ ).



**Fig. 5** Probability density function of the spray