VOLUMETRIC SIZING AND VELOCITY IMAGING USING V3V-FLEX

APPLICATION NOTE V3V-FLEX-013 (US)

Introduction

A study was conducted using a TSI V3V-Flex™ camera and illumination system to investigate the flow around a droplet falling through air. The experimental setup was designed to mimic falling raindrops and the continuous phase around them. Of particular interest was to capture the size and velocity of the falling raindrops, as well as the velocity of the surrounding flow field, simultaneously, without the use of backlighting. In other words, the same source of illumination was used for both the raindrop and the seeding contained in the continuous phase. This is a challenging measurement due to the nature of the two phases (water and air) of interest.

Experimental Setup

The experimental setup consisted of three high speed cameras (TSI Model #630083-6GB) with pixel resolution of 1280 x 800 pixels and frame rates up to 3200 fps, and a dual head YLF laser operating at 30 mJ/pulse at 1 kHz (TSI Model #YLF30-3000-CON). The laser and cameras were synchronized with a Model 610036 synchronizer, and the data was processed with INSIGHT V3V™ 4G software.

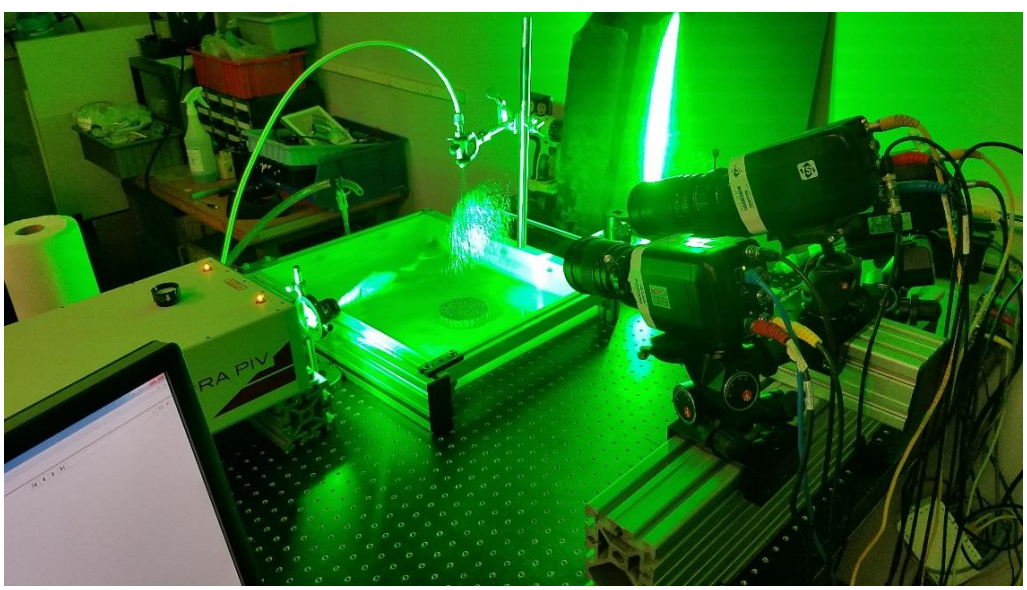

Figure 1. The experimental setup showing the layout of the cameras, laser, and spray.

Figure 2. A view looking through the illumination volume clearly showing the simulated raindrops and seed particles.

The images were pre-processed in two different ways in order to analyze the two phases separately. A portion of the original image can be seen in Figure 3.

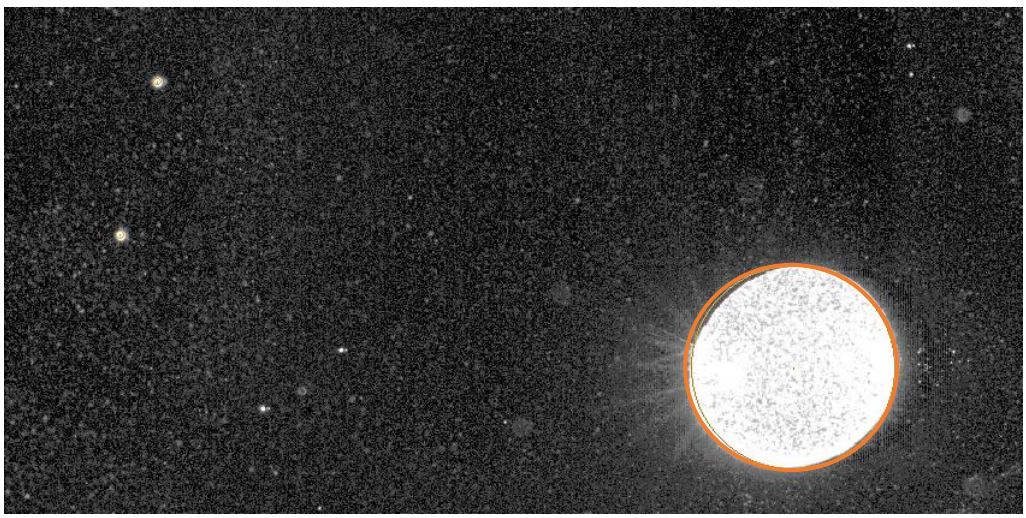

Figure 3. A portion of a raw image, showing the low intensity of the seeded continuous phase, and the location of a large raindrop, as well as several smaller raindrops (circled in orange).

Using the image pre-processing routines available in INSIGHT V3V 4G software, the raindrops were masked from the image, and the continuous phase was accentuated. The results can be seen in Figure 4.

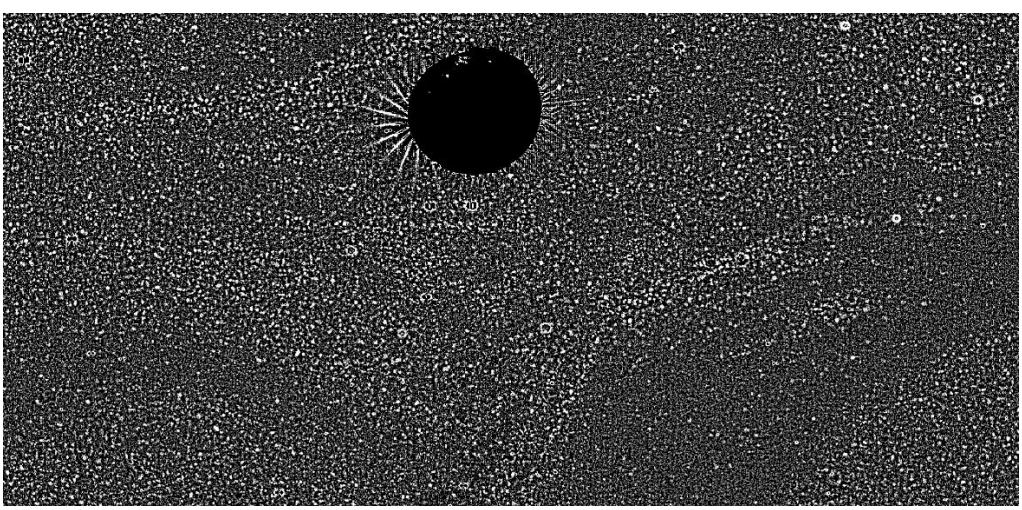

Figure 4. A portion of the pre-processed image with the rain drop removed and accentuating the seed particles which are used for tracking the continuous phase.

The resulting particle images were then processed using the Lagrangian particle tracking algorithms within INSIGHT V3V 4G software to determine the location, velocity, tracks, and particle sizes.

Results

The continuous phase and the dispersed phase (raindrops) were tracked using different algorithmic processing routines on the same images, then the final results were merged to display the results of both phases together at single instants in time.

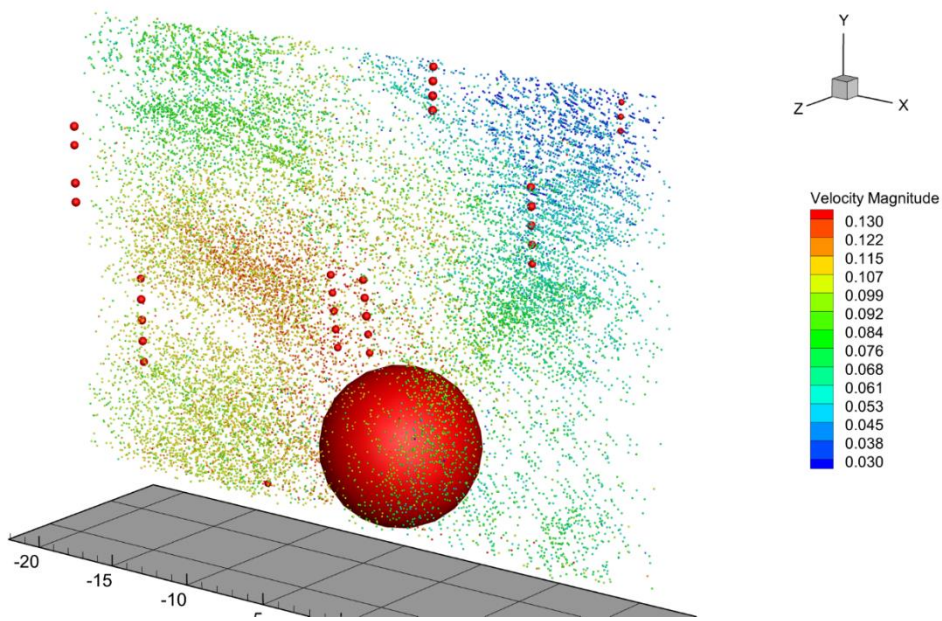

Figure 5. Velocity field showing the size, velocity and tracks of the raindrops and the surrounding flow field. Raindrops have higher velocity, so are generally red. The size of the particle corresponds to the measured diameter. A very large raindrop is seen exiting the bottom of the measurement volume.

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