VOLUMETRIC V3V MEASURMENTS USING 12MP-330 CAMERAS

APPLICATION NOTE V3V-FLEX-007 (US)

Introduction

A study was conducted in the TSI closed return water channel with a test section of approximately 400 × 100 × 100 mm of the flow downstream of a rigid cylinder at *Re* = 1500. A time-resolved volumetric measurement system with three 12 megapixel cameras was used in order to provide both high-resolution as well as high frame rate volumetric measurements.

Experimental Setup

The experimental setup consisted of three 12MP-330 cameras (4096 × 3072 pixels) fitted with Scheimpflug mounts and 135mm lenses. The cameras were arranged in a linear array and focused on the measurement volume with a nominal magnification of 0.36. The incidence angle between the outermost cameras was approximately 41 degrees. The capture rate was 320 frames per second.

The seed particles were silver-coated hollow glass spheres (model# 10089-slvr) with mean diameter of 12 microns. A dual-head Nd:YLF Photonics pulsed laser was used as the illumination source which passed through a series of light sheet optics that created an illumination volume. The illuminating light then passed over a 45 degree turning mirror in order to direct the light upward through the measurement volume. The edges of the illumination volume were defined using a knife-edge beam block to precisely define the forward and rearward bounds of the measurement volume. The final measurement volume of the overlapped cameras was 68 × 44 × 32 mm.

The laser and cameras were synchronized with a model# 610036 timing box with timing precision of 250 ps. The calibration, image processing, and three-dimensional particle tracking was accomplished using INSIGHT V3V™-4G software.

An image of the experimental setup during data acquisition can be seen in fig. 1.

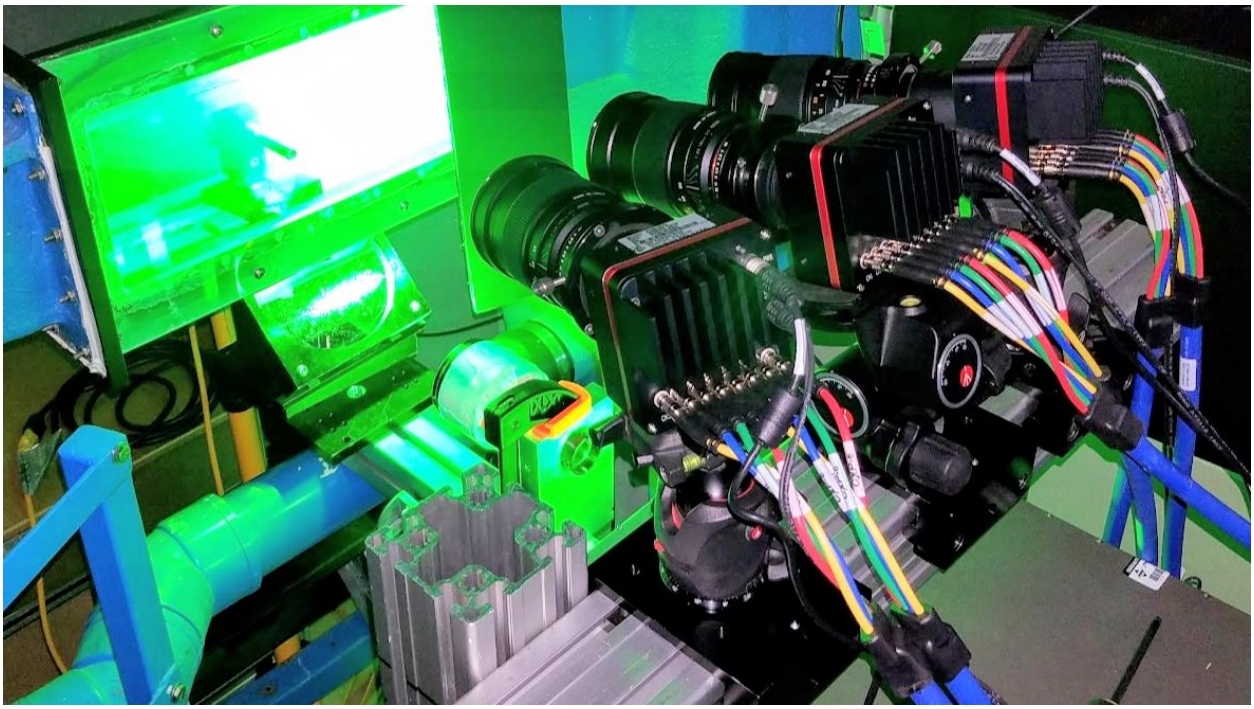

Fig. 1. The experimental setup showing the location of the three 12MP-330 cameras and the laser (underneath) projected upward through the measurement volume using a 45 degree mirror.

Figure 2 shows a sample image (left), and a 64 × 64 pixel spot on the image (right). Due to the large number of pixels and high magnification, each particle encompasses over 25 pixels, which allows the particle locations to be determined very accurately and contributes to the low uncertainty in the velocity measurement.

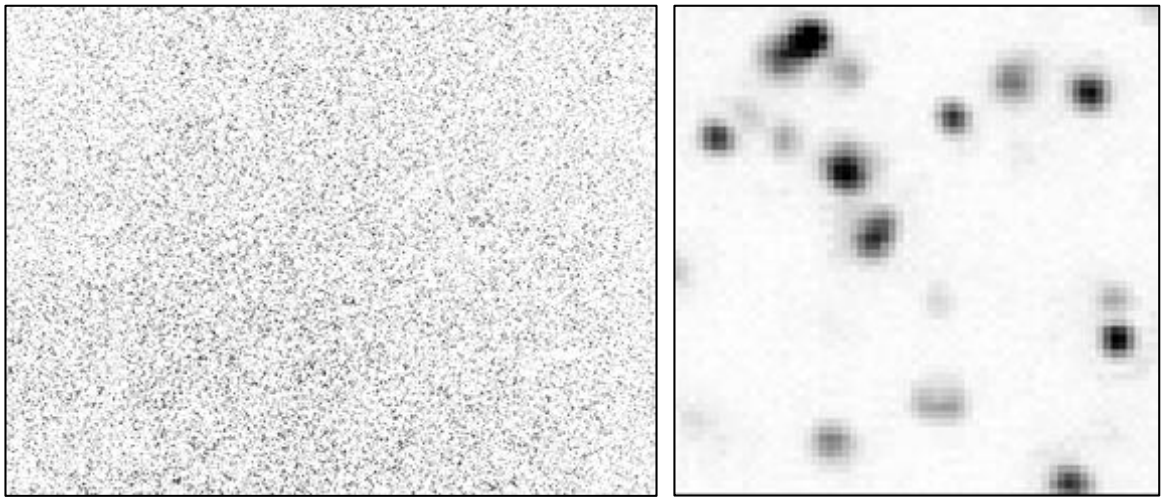

Fig. 2. A sample inverted image from one of the cameras (left), and a 64 × 64 pixel spot (right).

Results

A sample result of the 3D particle tracking can be seen in fig. 3. The particle tracks are colored by the velocity magnitude. The low-speed recirculation region downstream of the cylinder is clearly seen in blue. The vortex shedding is also apparent downstream.

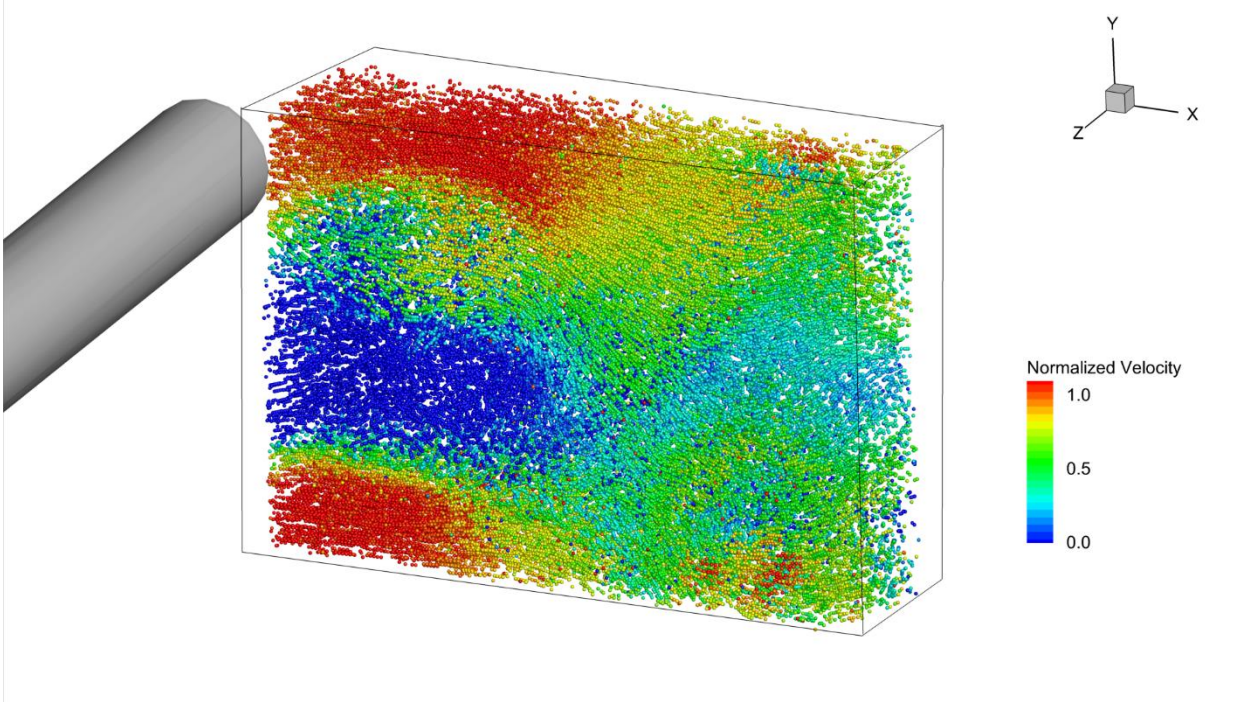

Fig. 3. Six consecutive realization of the particle flow field downstream of the cylinder. The particle color indicates velocity magnitude as shown.

Conclusion

The high-resolution 12MP cameras allowed for highly accurate particle positioning which contributed to the low uncertainty in the velocity measurement. The relatively high acquisition rate of 320 Hz allowed for time-resolved particle tracks to be determined. The V3V system used with 12MP-330 cameras is an excellent tool for high spatial resolution, high temporal resolution, and time-resolved data, especially suited for hydrodynamic and low-speed airflow measurements.

TSI and TSI logo are registered trademarks of TSI Incorporated.
INSIGHT V3V is a trademark of TSI Incorporated.

UNDERSTANDING, ACCELERATED

TSI Incorporated – Visit our website **www.tsi.com** for more information.

USA	**Tel:** +1 800 874 2811	**India**	**Tel:** +91 80 67877200
UK	**Tel:** +44 149 4 459200	**China**	**Tel:** +86 10 8219 7688
France	**Tel:** +33 1 41 19 21 99	**Singapore**	**Tel:** +65 6595 6388
Germany	**Tel:** +49 241 523030		

V3V-FLEX-007 Rev. A (6/20/2018) US ©2018 TSI Incorporated Printed in U.S.A.