LARGE-SCALE VOLUMETRIC V3V™ MEASUREMENTS IN A WIND TUNNEL

APPLICATION NOTE V3V-FLEX-006 (A4)

Introduction

Large-scale volumetric velocity measurements were made in a wind tunnel using a Volumetric V3V™ system from TSI® Incorporated. A bubble generator was used to create micro-bubbles suitable as tracers for seeding the flow. The freestream flow velocity of the tunnel was measured. This allowed a quantification of the stability and turbulence intensity of the wind tunnel.

Experimental Setup

The experiments were run in the closed-return wind tunnel at the University of Minnesota—Department of Aerospace Engineering. The wind tunnel has a cross section at the measurement region of 1 m × 1.25 m and a maximum flow speed of 38 m/s. The flow is driven by a 100 HP frequency controlled variable speed motor with a P-38 feathering propeller.

A Volumetric V3V™ system with four 4MP cameras operating at 800 Hz were aligned on a measuring volume illuminated by a 30 mJ/pulse dual-head Nd:YLF laser positioned on top of the wind tunnel, with a mirror directing the illumination down into the test section through a window on the top of the tunnel. Light sheet optics were used to generate an illumination volume. A photo of the experimental setup can be seen in fig. 1. A model# 610036 synchronizer timing device coordinated the laser pulses and camera image capture, and the data was processed with INSIGHT V3V™-4G software.

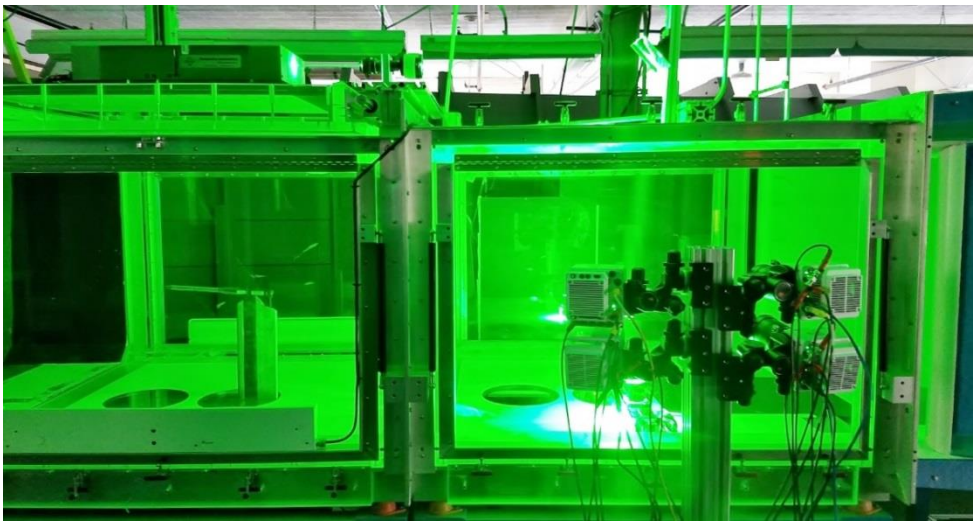

Fig. 1. The experimental setup showing the layout of the cameras, laser, and experimental test section

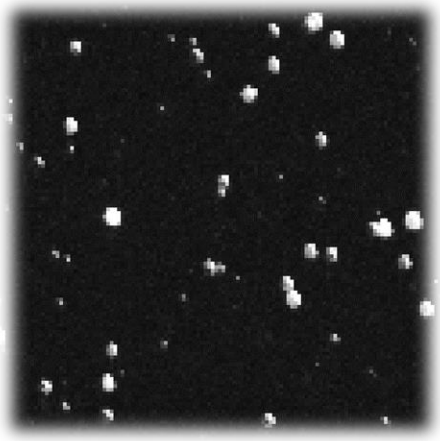

Fig. 2. Zoomed in view of the bubble images (128 x 128 pixels)

The bubbles were fed into the wind tunnel downstream of the test section and recirculated through the tunnel eventually arriving at the test section well mixed. The bubble mean diameter is 15 microns, and produced particle images on the order of 9 to 25 total pixels (fig. 2), depending on the magnification.

Results

Several configurations were run with different resultant measurement volumes. The first volume was 130 mm x 75 mm x 50 mm. An instantaneous result of this measurement can be seen in fig. 3.

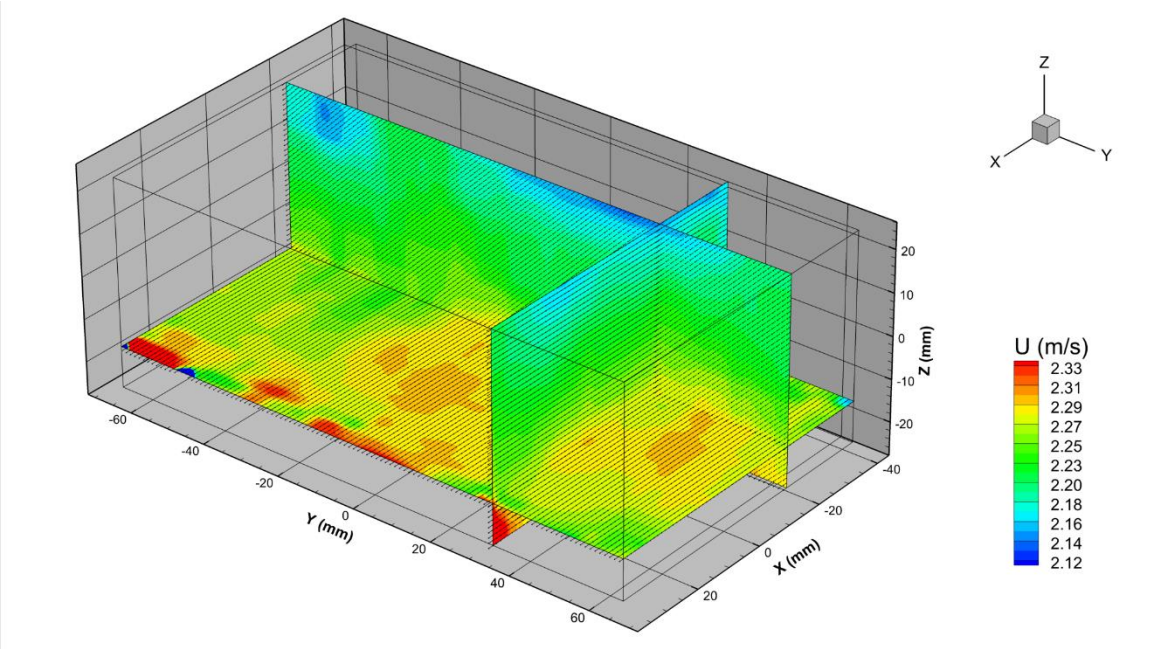

Fig. 3. Instantaneous streamwise velocity measured in a volume 13 × 7.5 × 5 cm^3

The second configuration resulted in a volume size of 200 mm x 70 mm x 12 mm. An instantaneous vector field can be seen in fig. 4.

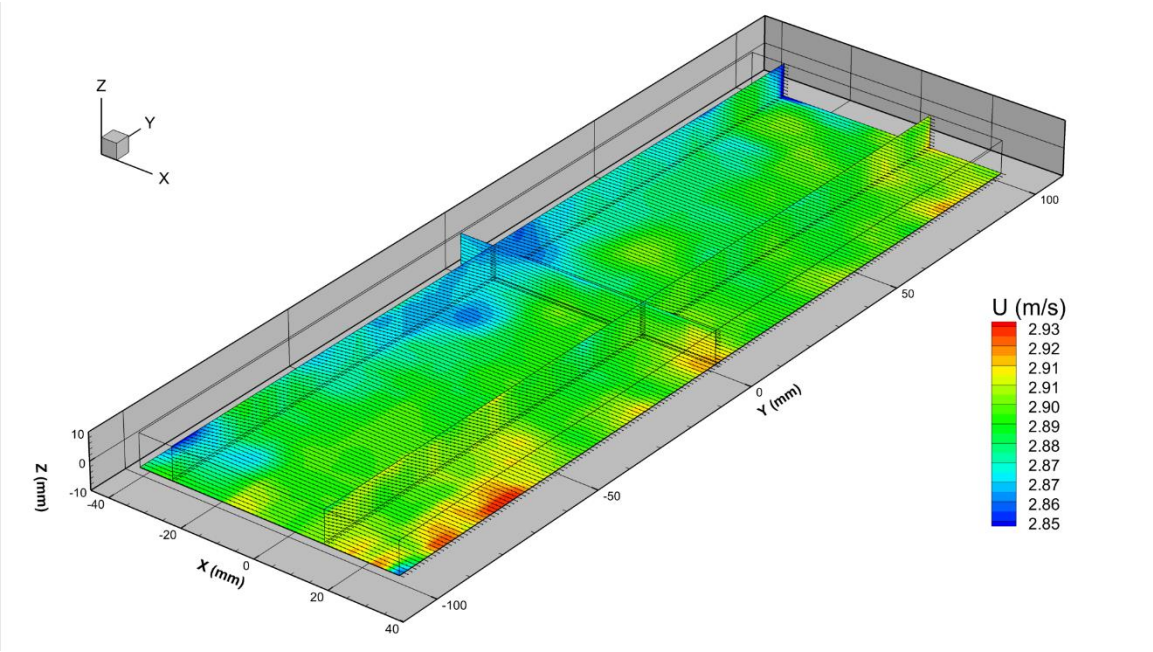

Fig. 4. Instantaneous stream-wise velocity measured in a volume 20 × 7× 1.2 cm^3

Conclusion

A Volumetric V3V™ system with a micro-bubble generator were used in order to measure large-scale volumetric velocity measurements assessing the freestream flow in a closed-return wind-tunnel. The particle images generated by the bubbles were well-suited for volumetric particle tracking, and an accurate assessment of the freestream velocity was determined.

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

USA	**Tel:** +1 800 680 1220	**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-006 Rev. B (5/11/2020) A4 Printed in U.S.A.