



(P/N BG-1000)

FLOW MEASUREMENTS AROUND A FLEXIBLE SPHERE USING SOAP BUBBLES AS TRACER BUBBLE GENERATOR BG-1000

APPLICATION NOTE PIV-025 (A4)

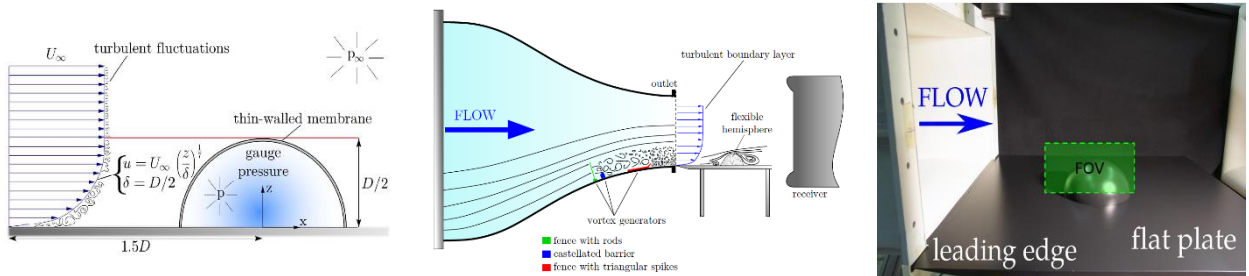
BUBBLES FOR VELOCIMETRY

Flexible Hemisphere in Turbulent Boundary Layer

Flow fields around spherically shaped bluff bodies (such as domed structures) in turbulent boundary layers exhibit complex flow pattern with an upstream horseshoe vortex and a recirculation area with trailing vortices in the wake region. The present application note aims to show the capabilities of soap bubbles used as tracer for PIV 2D2C to follow these structures.

Experimental Setup

The tests were conducted in the wind tunnel facility of the Department of Fluid Mechanics at HSU Hamburg in Germany. Velocity fields of $120 \text{ mm} \times 200 \text{ mm}$, around a flexible hemisphere with a diameter of 150 mm , were measured using a PIV 2D2C system composed of a high-resolution CCD PowerView™ Camera 8MP (P/N 630092) synchronized to a pulsed Nd-YAG laser delivering 200 mJ/pulse . The bubble generator (P/N BG-1000) was used for seeding the air flow. A set of 200 pair of images were captured at a frequency of 3 Hz .



With courtesy of PFS (HSU Hamburg)

Figure 1. Experimental Setup



The bubble generator was delivering bubbles with an average diameter of 15 μm , a Stokes number of 0.12 and a concentration of 10^7 bubbles/sec. An example of a raw image captured with the PIV system is shown below.

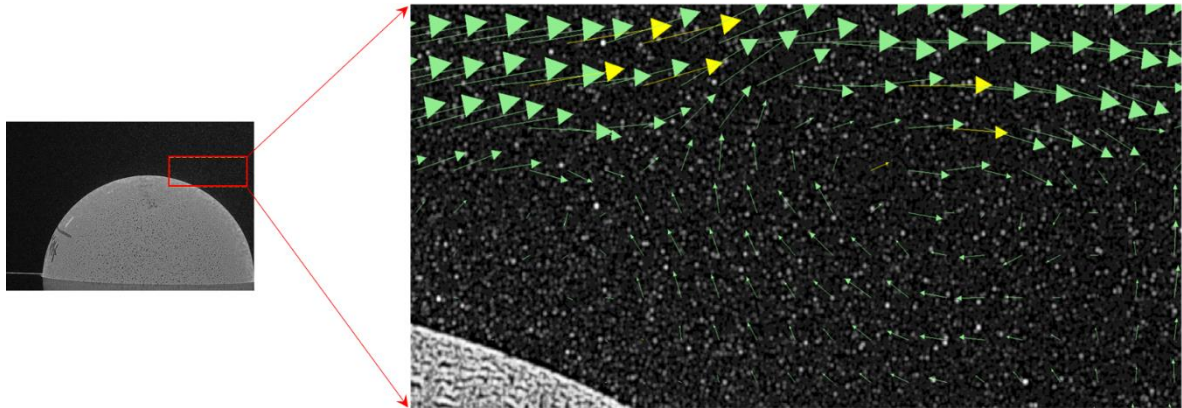


Figure 2. Soap Bubbles as Seen by the PIV Camera

Results

The processing was done using Insight 4G™ software v. 11 to calculate velocity fields with a spatial resolution of 2 mm and 1 mm resp. in x and y directions (i.e. $\sim 10,000$ vectors/field) and a standard uncertainty less than 3%.

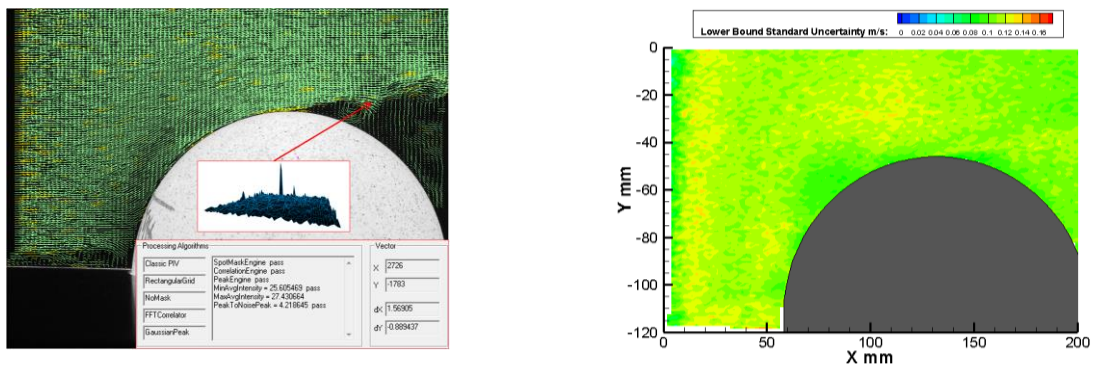


Image Preprocessing: Subtraction of average intensity image

Velocity processing: Iterative FFT cross-correlation - Initial/Final spot areas respect. of 128pxx64px & 64pxx32px with 50% overlap

Vectors post processing: Local vector validation/replacement based on Median test using the 5x5 neighborhood measured vectors.

Figure 3. Instantaneous velocity vector field as processed by Insight 4G Software

The main turbulent structures of the flow mentioned before were detected as shown by the streamlines and the contours of vorticity and λ_2 criterion shown below.

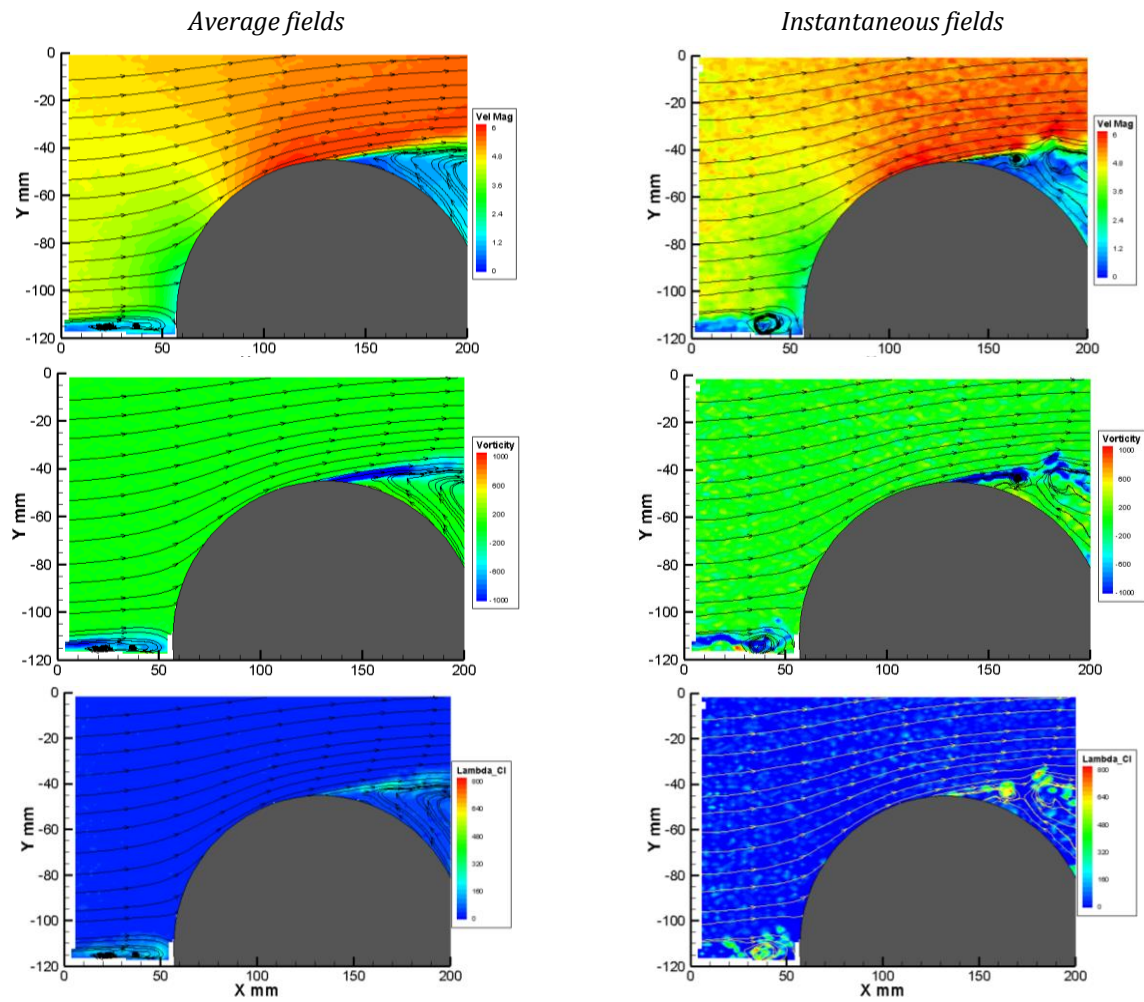


Figure 4. Contours of Velocity Magnitude, Vorticity and λ_2 Criterion

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