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Influence of span-wise coherence on the acoustic radiation in a cylinder wake

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Abstract

The aim of this study is to detect and visualise the influence of span-wise coherence on propagating sound waves emanating from a flow around circular cylinders with span-wise variations of the local radius. Synchronous particle image velocimetry (PIV) and microphone measurements are performed in a circular wind tunnel with a nozzle size of 0.4 m × 0.4 m at a maximum flow speed of $U_\infty = 43\,\mathrm{m\,s^{-1}}$. The test section is surrounded by a full anechoic chamber of approximately 9 m × 9 m × 5 m.
The two components (2C) of the velocity field data are acquired in selected vertical two-dimensional planes (2D) using 2C2D-PIV around the cylinder mid-span. All three velocity components (3C) are acquired using stereoscopic or 3C2D-PIV in a horizontal span- and flow-wise oriented plane in the near wake of the cylinder. The pressure measurements are conducted with 4 microphones (Type:1/4 40BF; G.R.A.S.) in the far field outside the flow to avoid unwanted influences on the flow field and vice versa. The microphones are installed above the cylinder and are distributed in a horizontal line at the mid-span of the cylinders in flow direction to take into account the directivity of the sound emission. The vertical positions were approximately 1.8 m (120 d) above the cylinder and the distance between the microphones was about 0.3 m (20 d). A multi-analyzer (Type: DEWE3; Dewetron) simultaneously records the microphone-signals, the camera trigger, the q-switch of the laser and three components of the forces acting on the cylinders with a sampling frequency of $f_s = 100\,\mathrm{kHz}$ and a dynamic range of 24 bit. Cylinders with different span-wise variations are investigated as illustrated in fig. 1. The geometric parameters of the cylinders are selected such

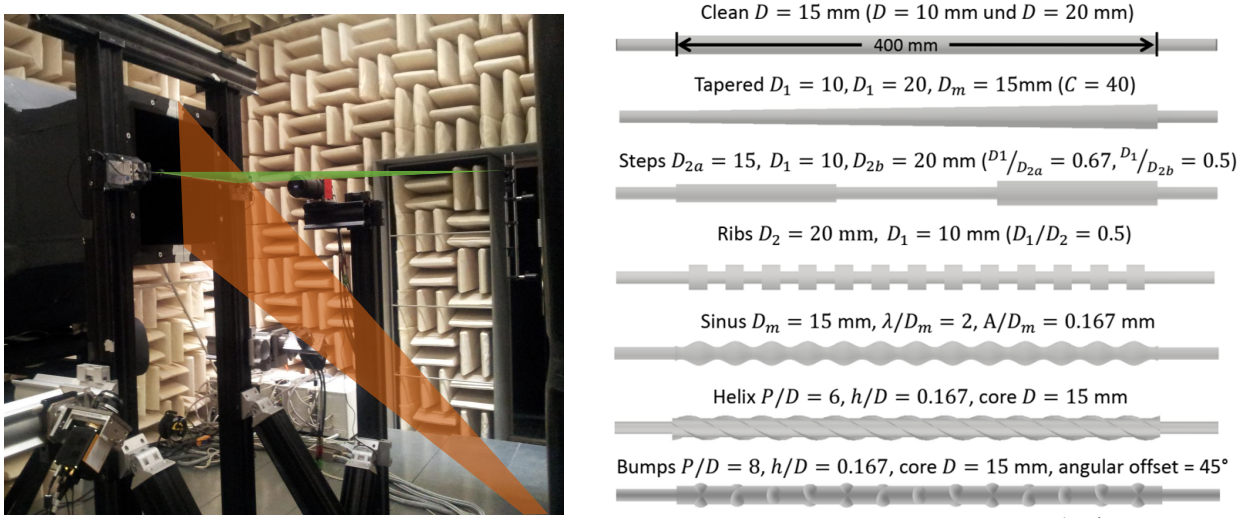

Figure 1: Experimental setup with indicated light sheets for the 2C2D-PIV (orange) and 3C2D-PIV (green) (left); and the different cylinders tested (right).