NACA63018 airfoil in Kevlar-walled wind tunnel – aeroacoustic microphone array measurements

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This dataset[1] consists of acoustic measurements conducted in an aeroacoustic wind tunnel (Poul la Cour Tunnel, PLCT (https://www.plct.dk)) with Kevlar side walls using a microphone array.

Overview

The Poul La Cour Wind Tunnel has a closed loop airline (Figure 1). The airline is 66 m long and 27 m

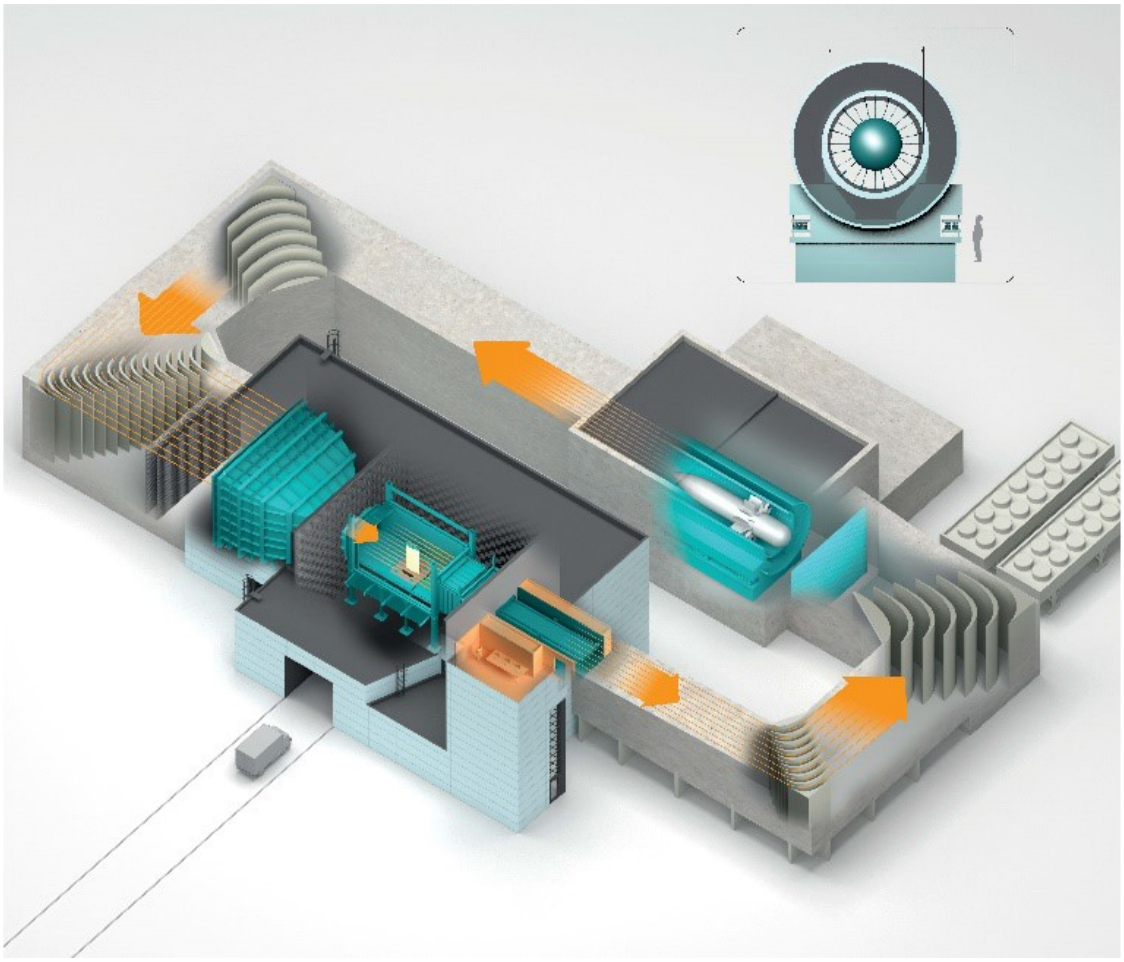

Figure 1: The Poul La Cour Wind Tunnel.

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wide (furthest separated points of the airline tube, but neglecting the wind tunnel buildings). The air volume inside the airline is about 3875 m^3. The whole airline is built in concrete to achieve the largest possible damping of vibrations. The fan of the wind tunnel is driven by a 2.4 MW engine and has a diameter of 4.7 m. The fan was limited to 400 RPM or en engine power output of 1.8 MW. The fan can generate an air flow of up to 630 $m^3 s^{-1}$ at 400 RPM when a test object is placed in the tunnel. A settling chamber with honeycomb and 3 nets are positioned just before the nozzle contraction, which has a ratio of 9:1. The test section has a cross section of 2 x 3 m and is 9 m long. The top speed is 105 $m s^{-1}$ and the turbulence intensity is below 0.1 %. The test object is placed in a turntable with diameter of 1.355 m. Typical test objects are airfoil sections, an example of the measurement setup is shown in Figure 2.

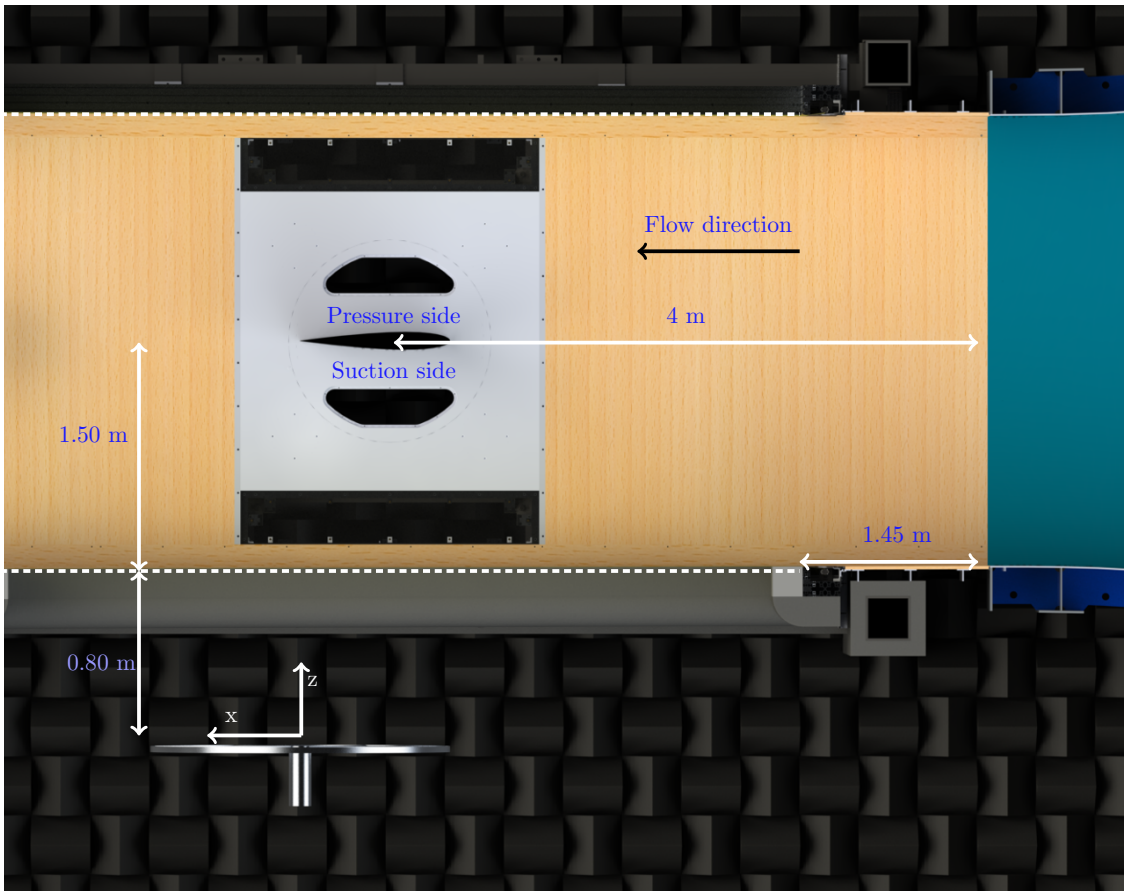

Figure 2: Airfoil placed in test section with Kevlar walls (dashed white lines). A microphone array is placed outside the test section, inside the anechoic chamber, centered about the trailing edge of the airfoil at mid span height.

The tunnel is equipped with acoustically transparent Kevlar walls in aero-acoustic configuration. The Kevlar walls are 6 m long and cover the part of the test section that begins 1 m downstream of the contraction. The test section is surrounded by an anechoic chamber. The acoustic field in the anechoic chamber was tested according to ISO 3745 standard. It is close to an ideal free field above frequencies of 125 Hz. The noise emitted from the airfoil is measured with a microphone array, which is placed in the anechoic chamber with a distance of 0.8 m from the Kevlar wall. It is centered above the trailing edge of the airfoil and its mid-span (Figure 3).
Acoustic measurements are conducted with a Brüel & Kjær 84 channel microphone array. The microphones are distributed pseudo-randomly in a circular plane with a diameter of 1.96 m. The array plane is placed parallel to the center plane of the test section. Measurements are post-processed by in-house software [1].

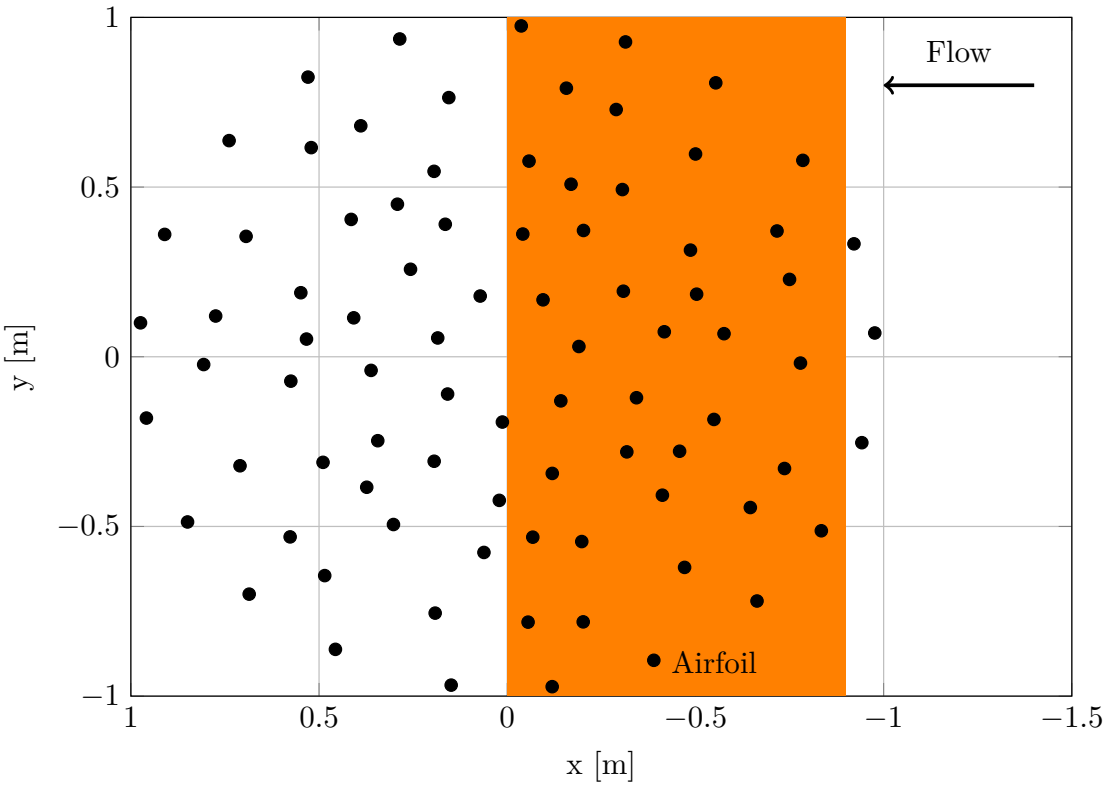

Figure 3: Microphone array

Dataset

The files in this dataset consist of microphone array measurements conducted in the setup described above. Both timeseries and frequency-domain data is provided in HDF5 fileformat using the AIAA Array Methods HDF5 File Definition. Each file consist of raw data and associated metadata that includes geometry setup, flow and ambient conditions. This is documented in the "AIAA Array Methods HDF5 File Definition" document.

Filename convention

The filename convention is:
`DTU_PLCT_NACA63018_[SURFACE]_[ADDON]_U0_[FLOWSPEED]_AoA_[AOA]_[SPECTRUMTYPE]_[CsmEss/TimeSeries].h5`.
For instance:
`DTU_PLCT_NACA63018_trip_5PS_5SS_U0_50_AoA_0_octave-12_CsmEss.h5`
means the NACA63018 airfoil with trip tape at 5% pressure side and 5% suction side, with no addons, at flow speed $U_0 = 50$m/s and angle of attack 0 degrees, and the dataset is the cross-spectral matrix (csm) in 1/12th octave bands. Note, the spectrum type is only stated for the CsmEss file.

References

[1] O. Lylloff, "Aeroacoustics.jl, a julia package for aeroacoustic measurements," 2020. v0.2.4.