

Aeroacoustic wind tunnel experiments on static and dynamically oscillating aerofoils

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Societal impact of noise emissions from aero-components

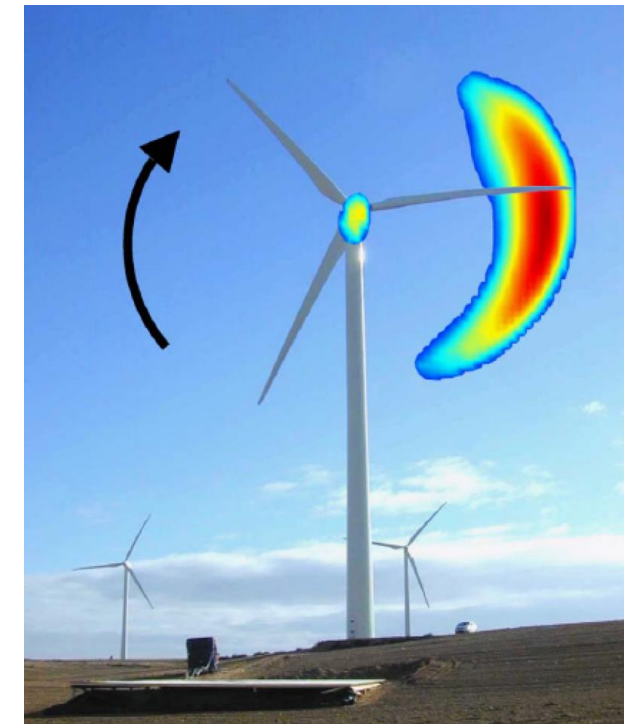
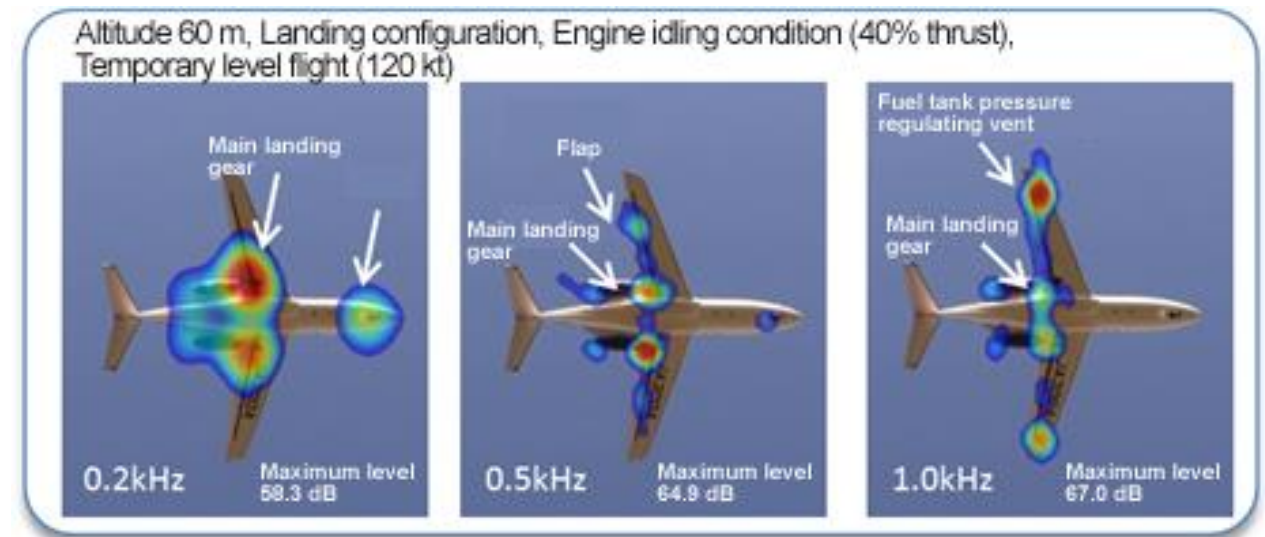
- Negative health effect of environmental noise
- Noise limiting regulations

Industrial relevance

- Aircraft in high-lift configuration during landing and take-off
- Wind turbines, propellers, rotors

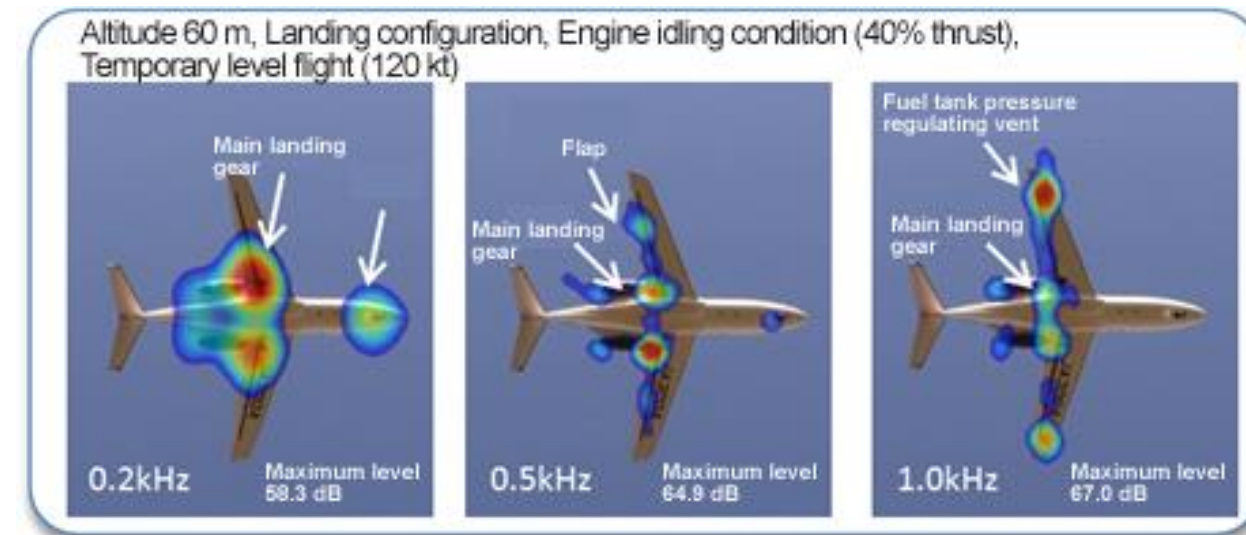


Reducing noise opens-up valuable commercial, societal, and financial opportunities



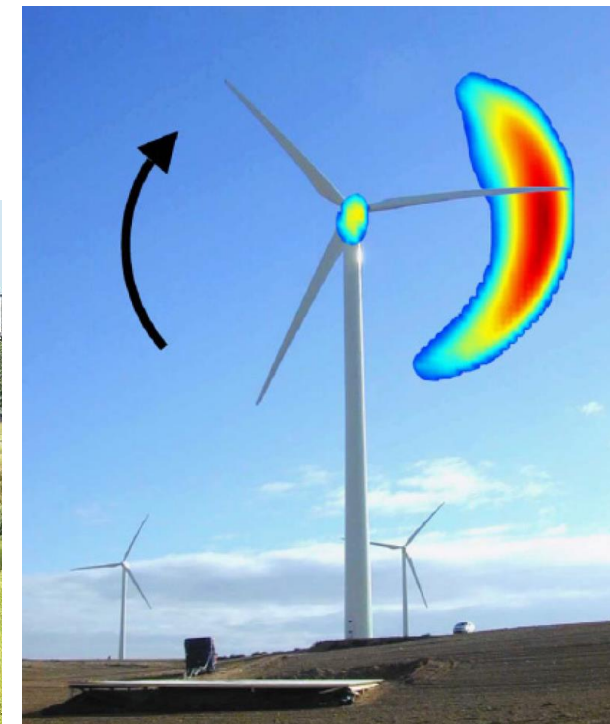
Extensive experimental test campaigns

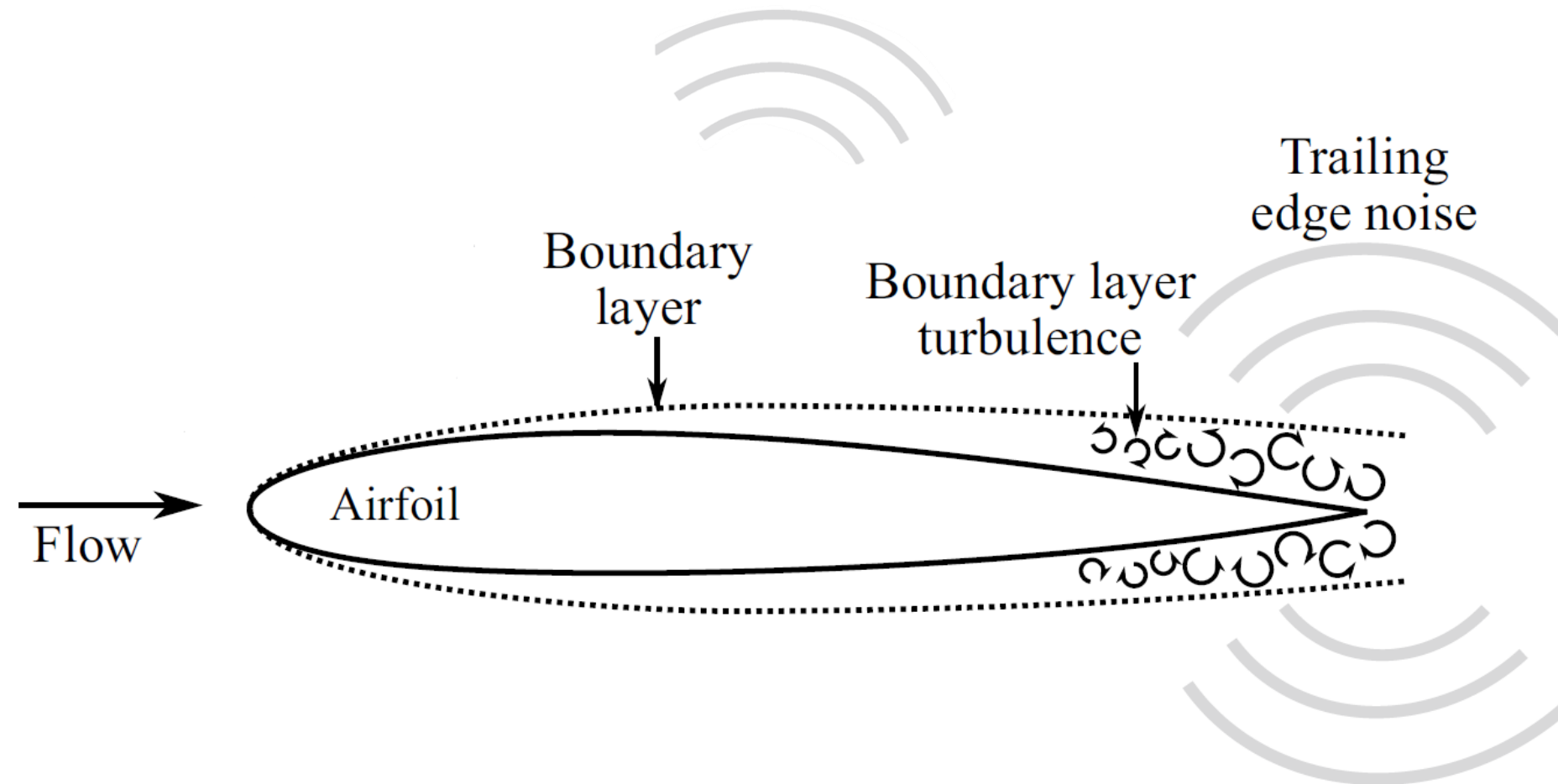
- Generating a broad, high-fidelity dataset of aerofoil self-noise and other aerodynamically generated noise
- Evaluating the effect of aerofoil shape on noise emissions
- Investigating noise mitigation strategies
- Make some data publicly accessible for wider use

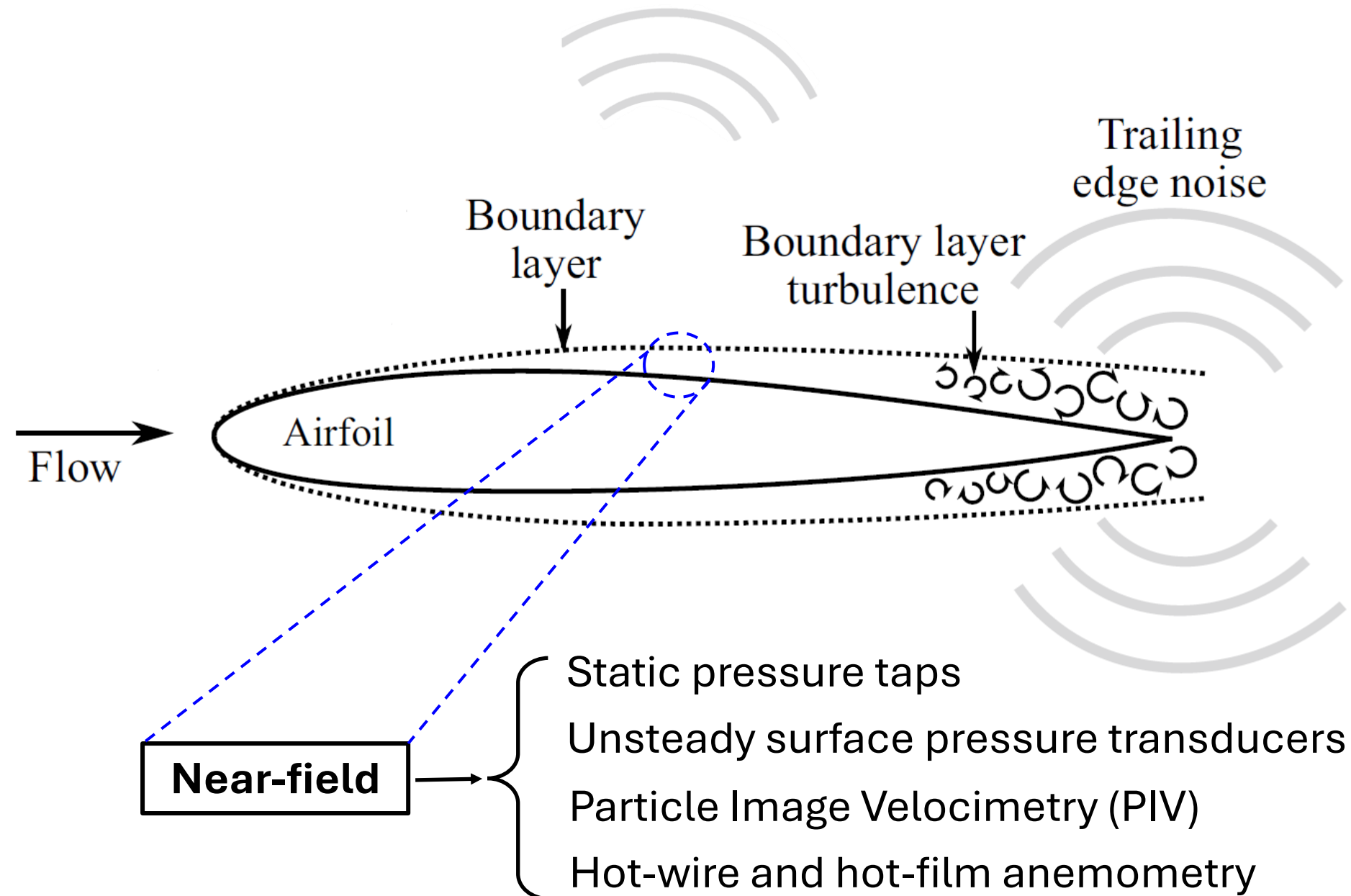


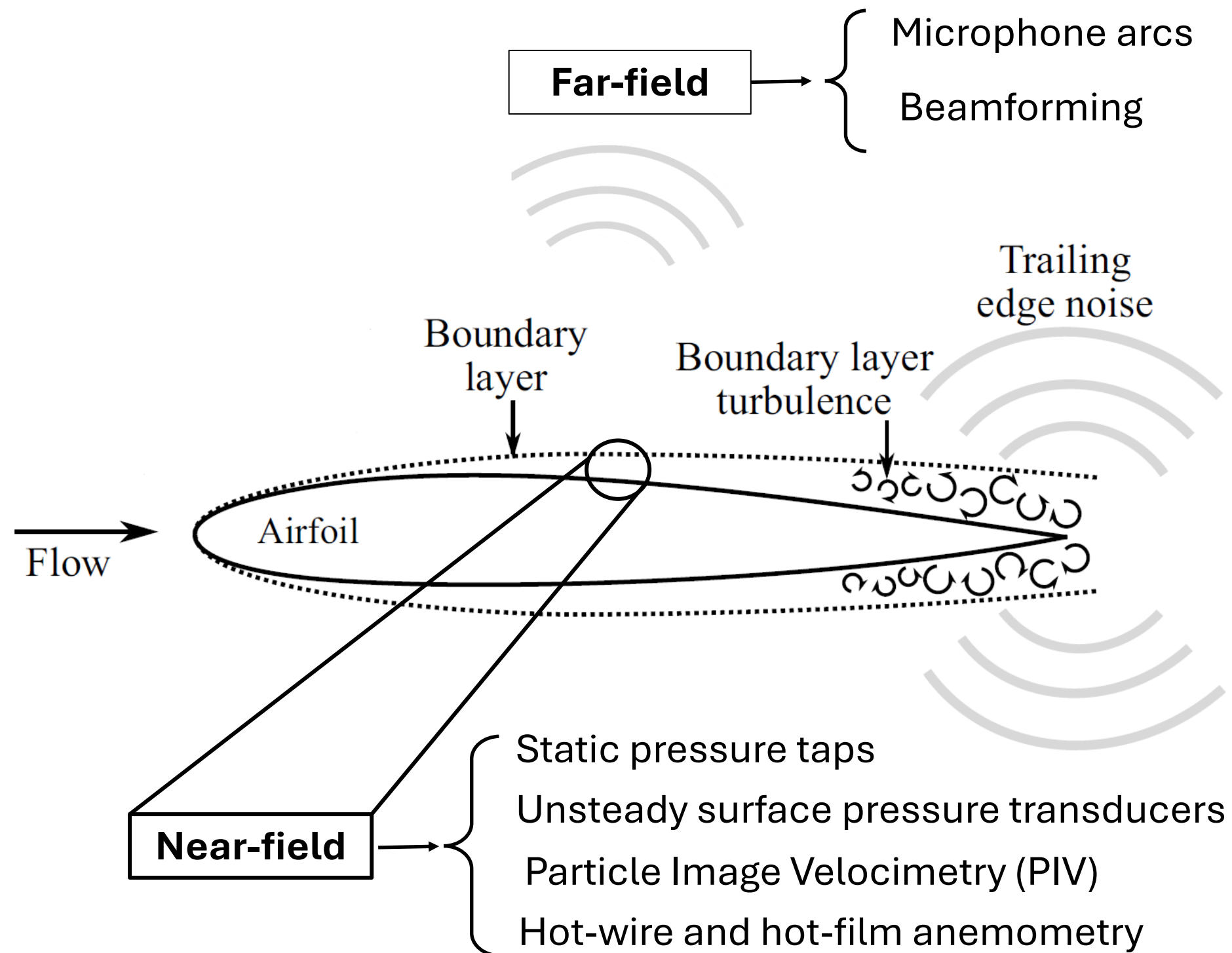
Topics included:

- Aeroacoustics of static aerofoils
- Aeroacoustics of dynamically oscillating aerofoils
- High lifting devices







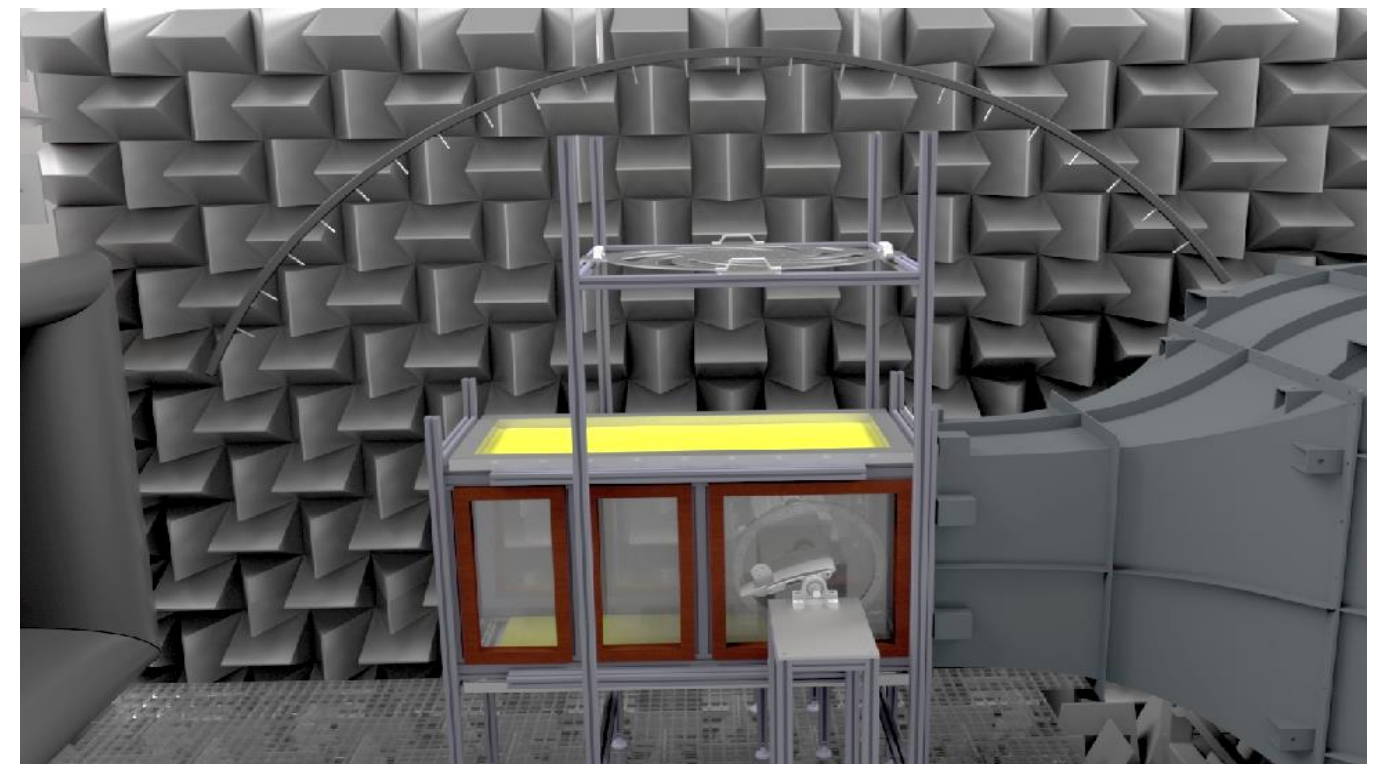
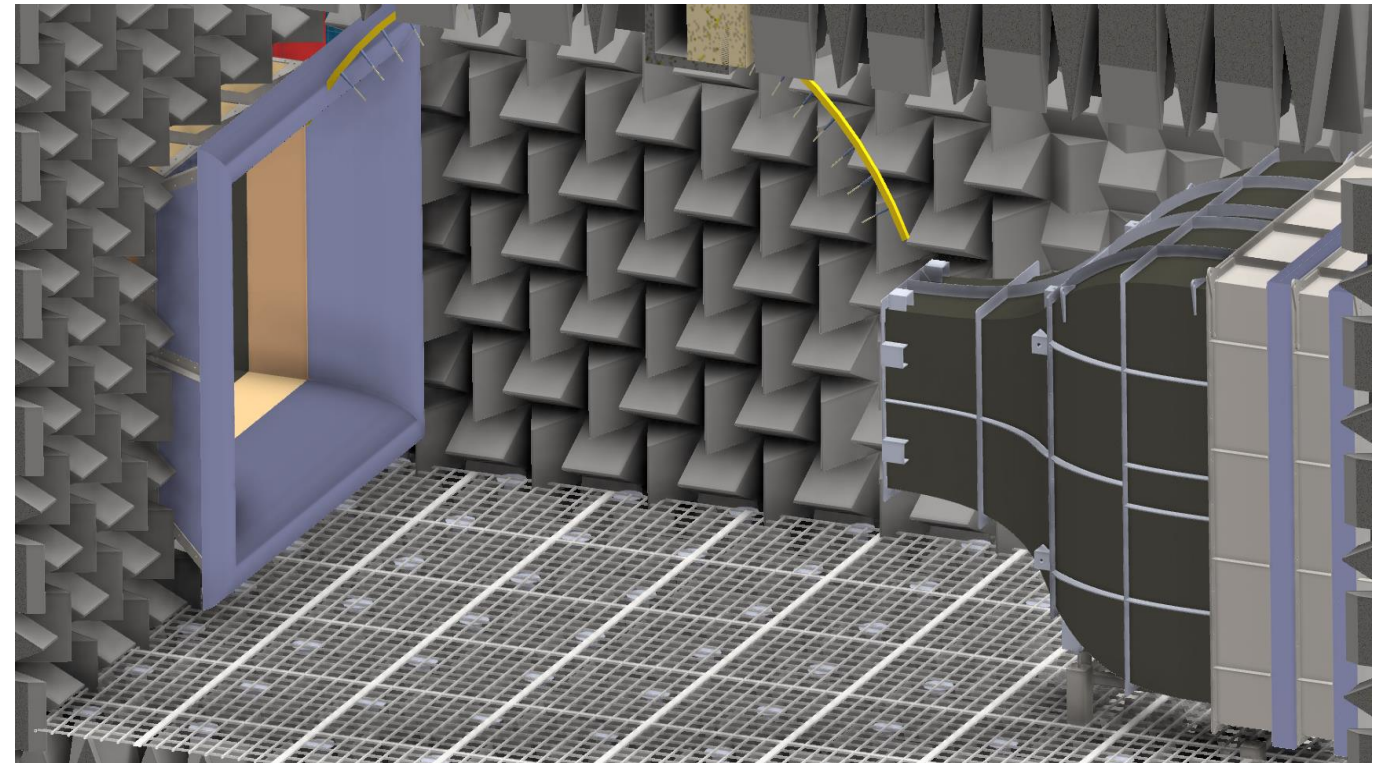


Wind Tunnel facilities

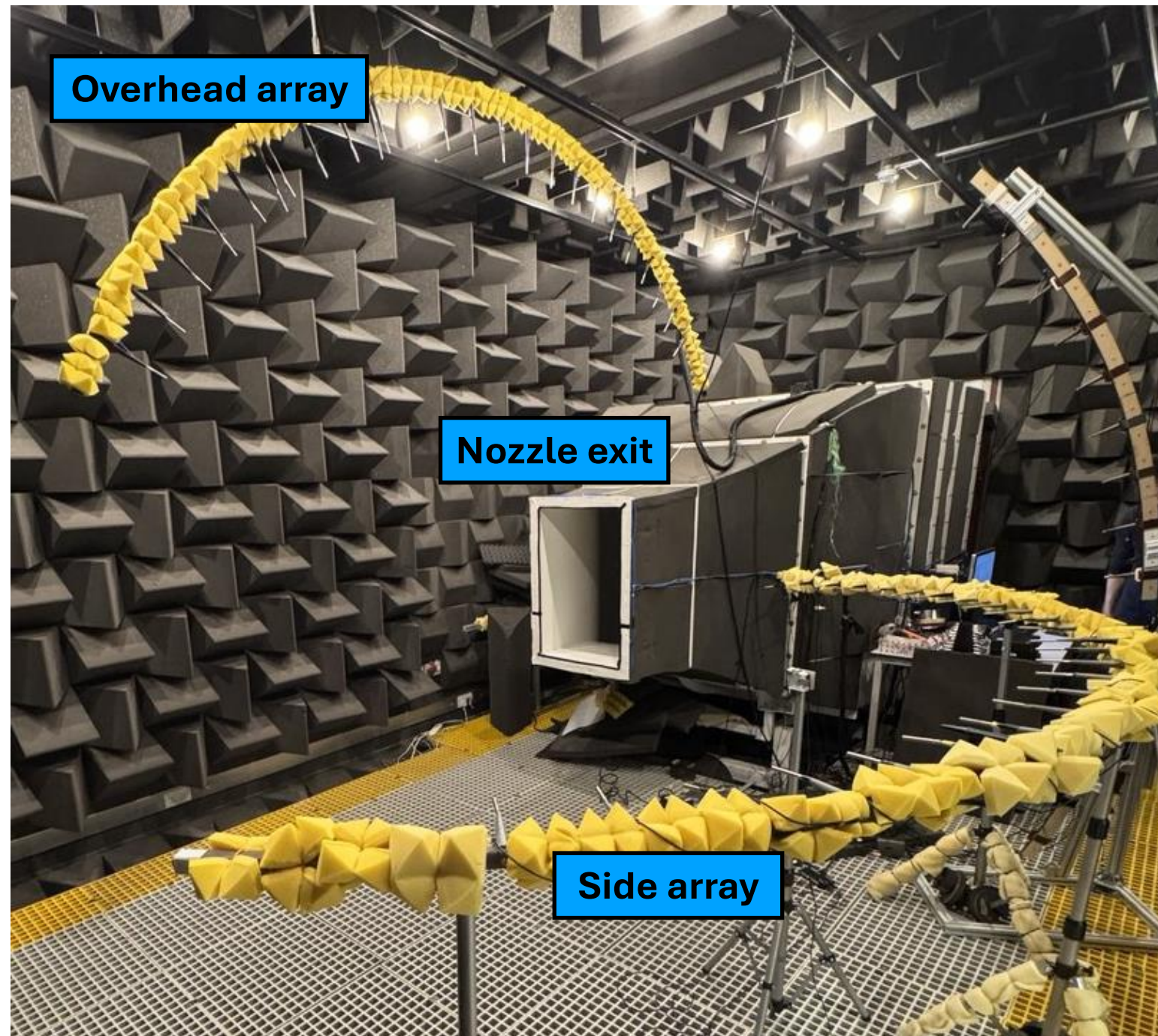
- National aeroacoustics wind tunnel facility (AA tunnel)
- Low turbulence tunnel

Experimental techniques

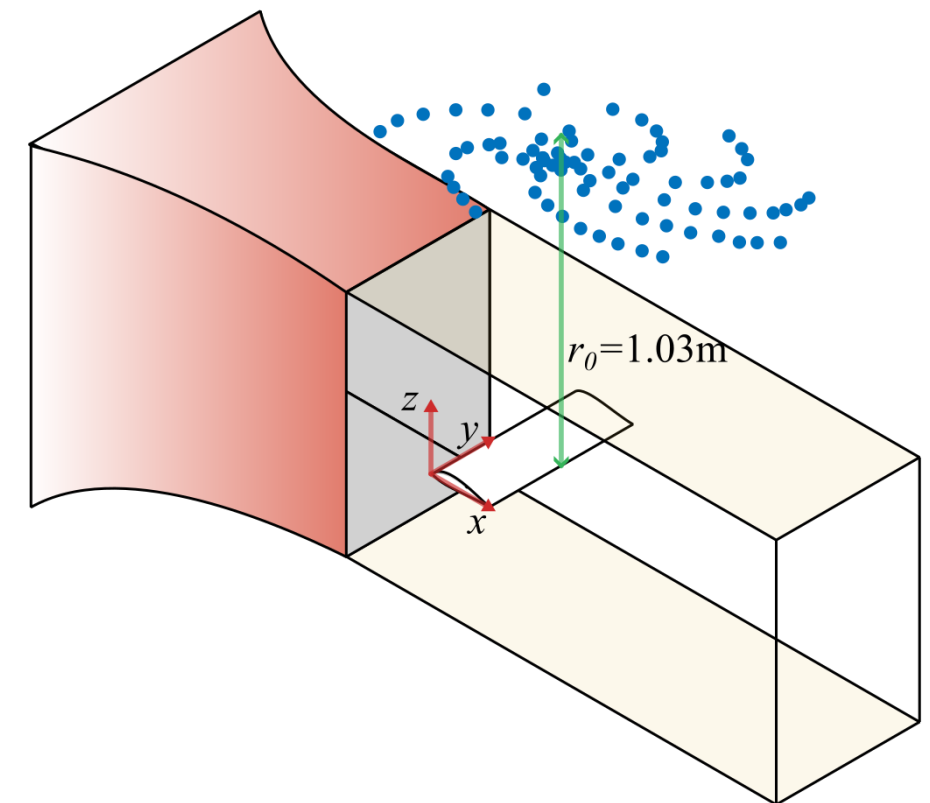
- Static pressure measurements
- Dynamic pressure transducers
 - ✓ Direct Sensing
 - ✓ Remote Sensing
- Far-field microphone arcs
- Particle Image velocimetry (PIV)
- Hot-wire measurements



Far-field microphone arrays

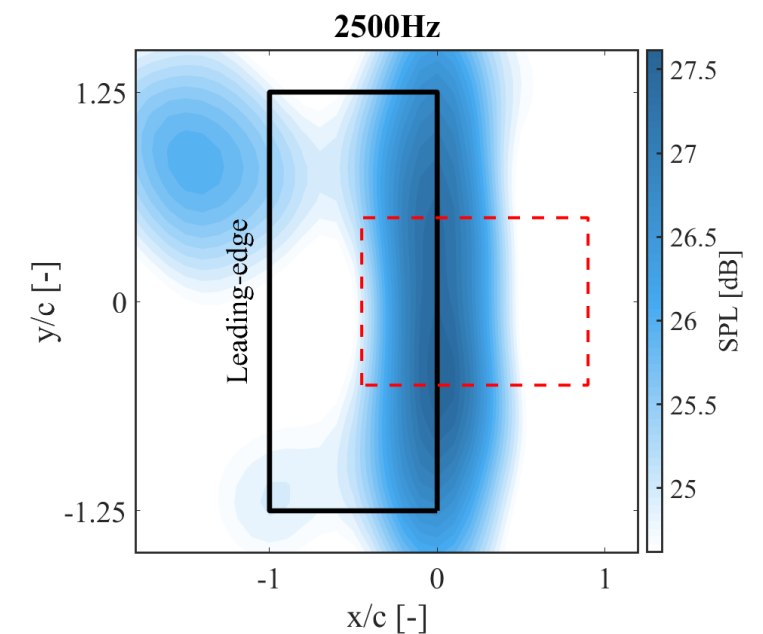
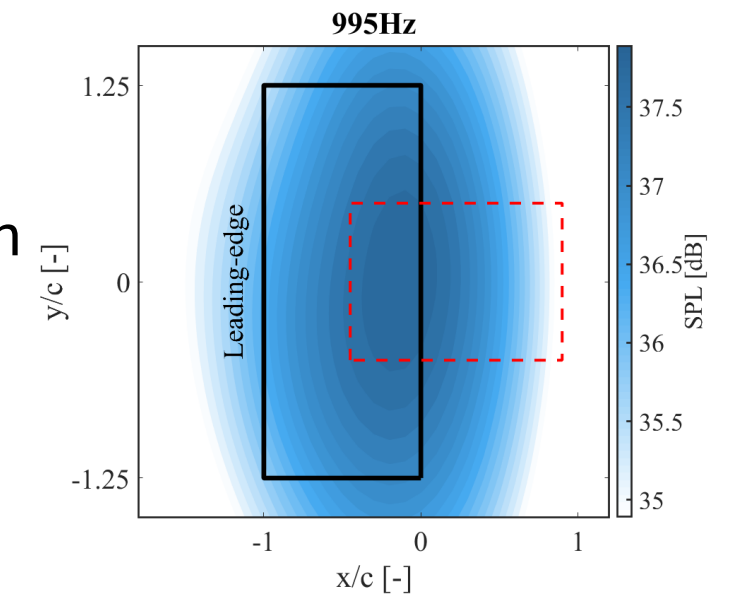
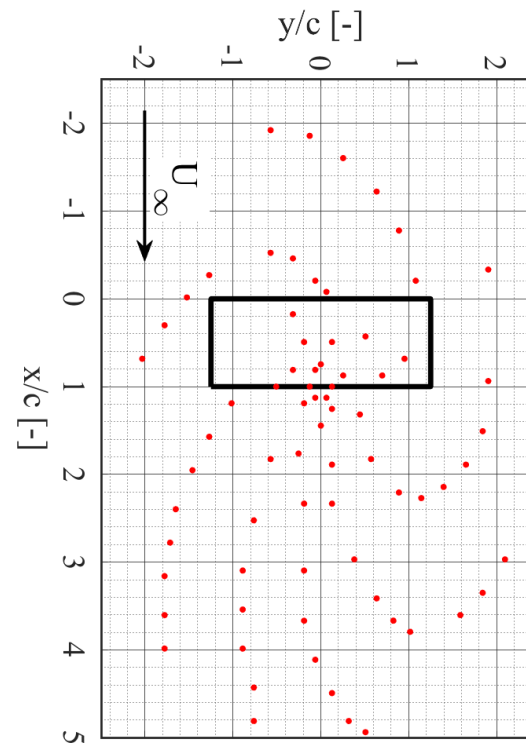
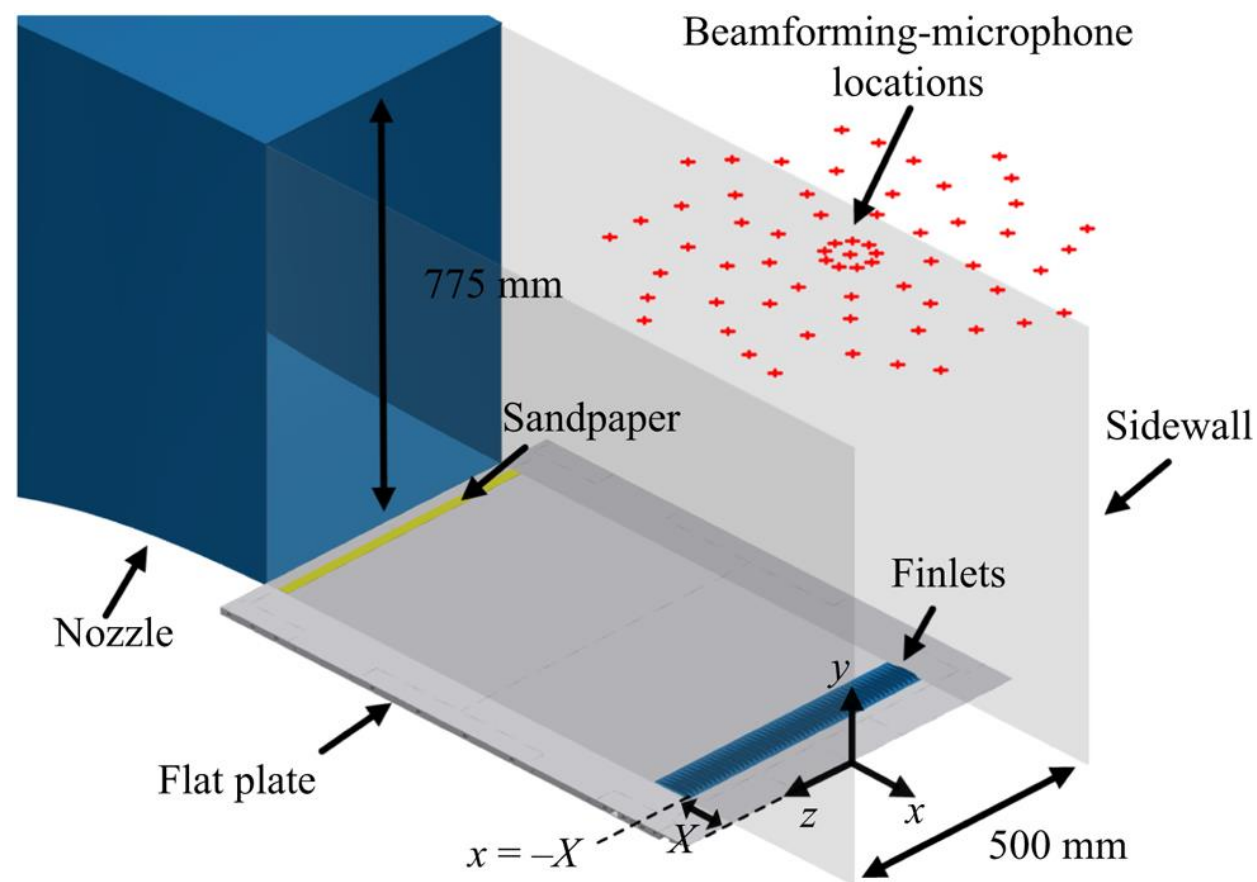


Beamforming arrays



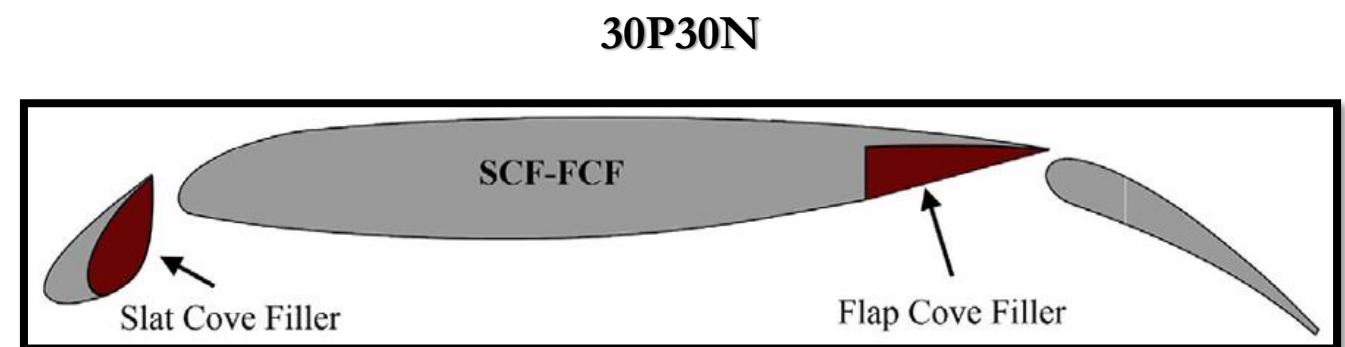
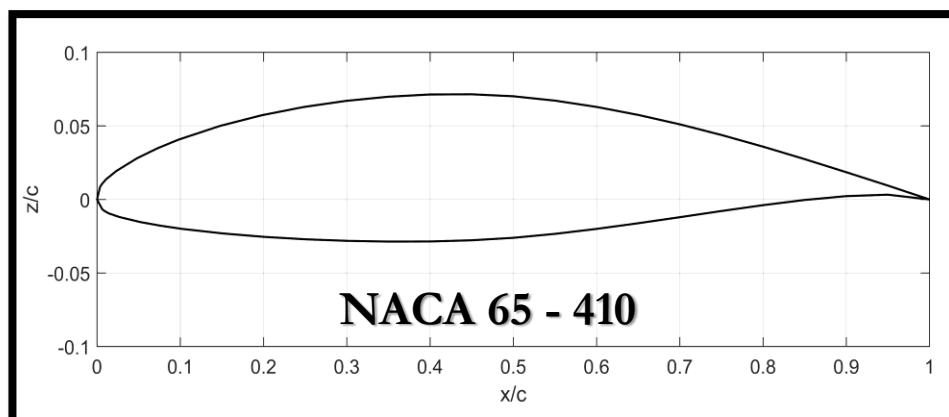
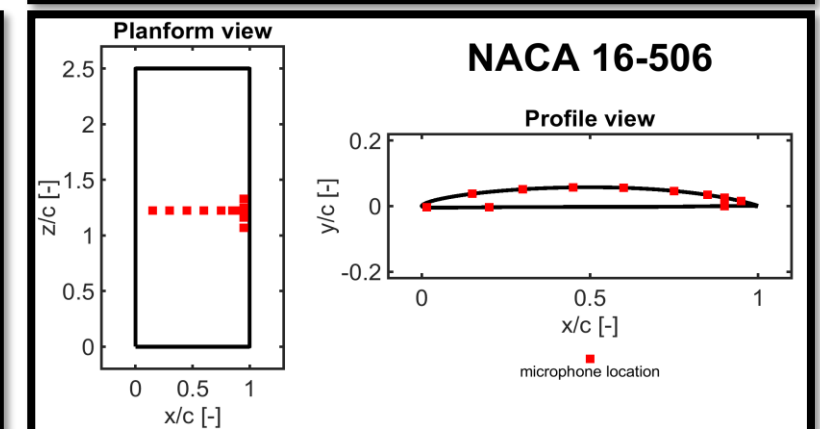
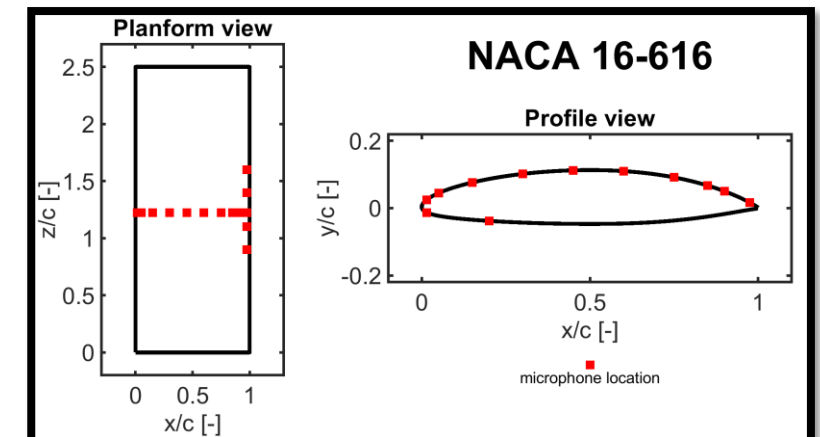
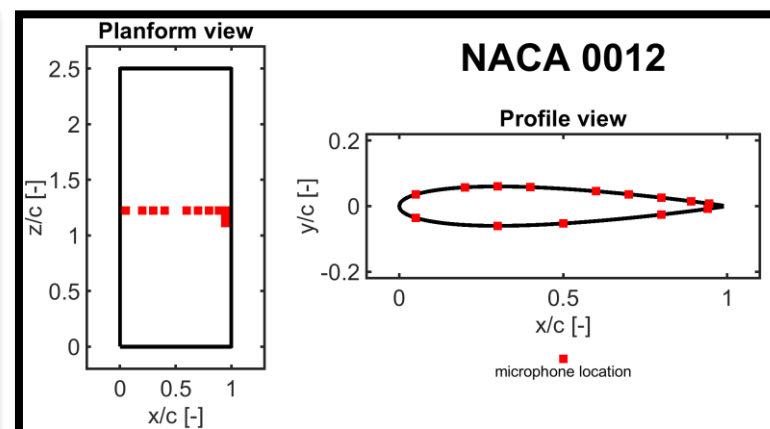
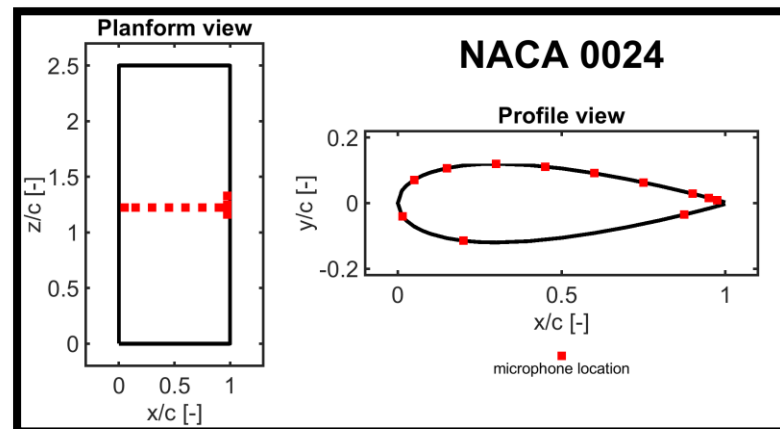
Beamforming

- 80 microphone **elliptic** spiral array (0.8m by 1.4m)
- 73 microphone **circular** array (0.8m diameter)
- Source power integration technique applied to delay-and-sum beamforming maps

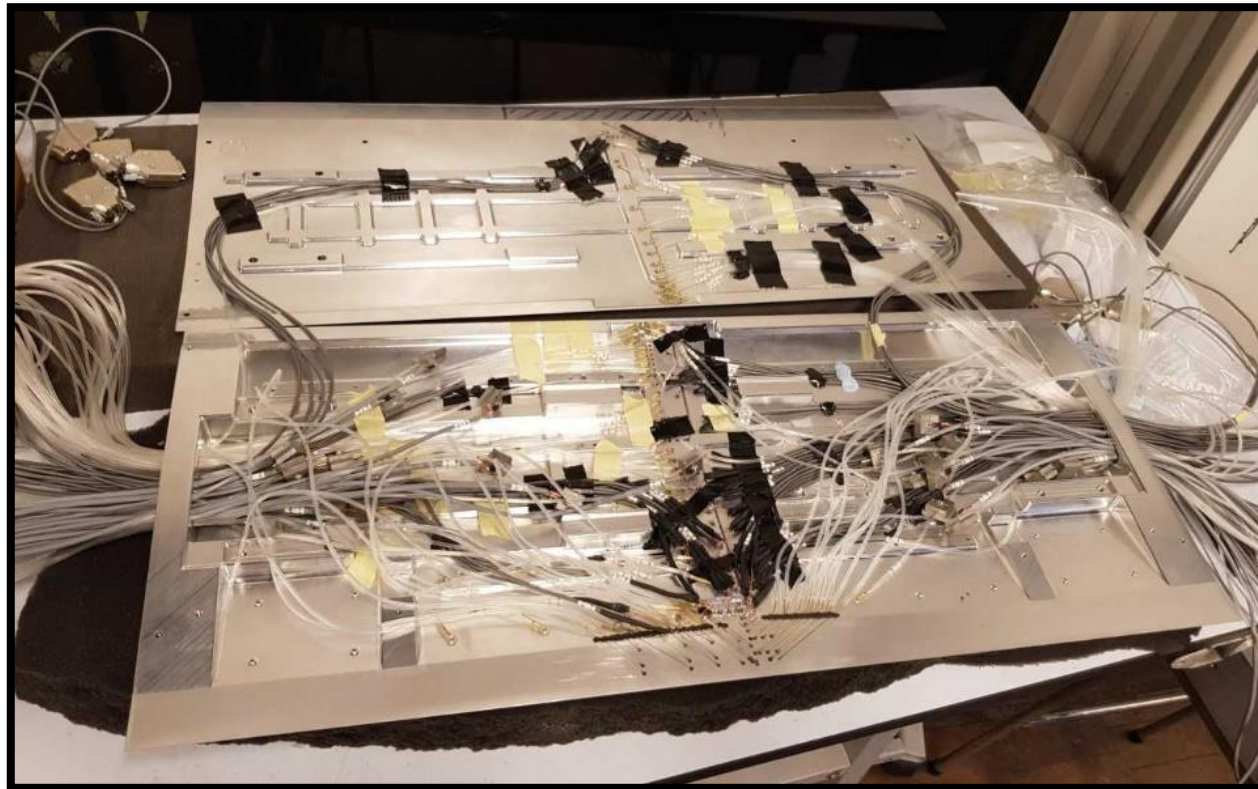


Aerofoils

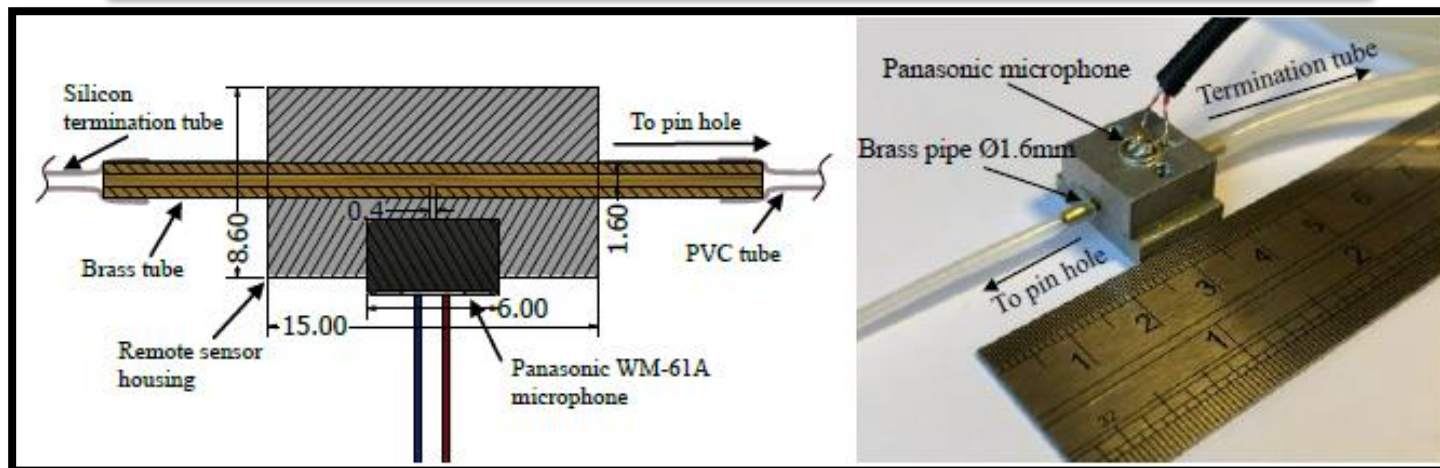
- NACA 16-616, NACA 16-506, NACA 0024, NACA 0012
- 3D printed/manufactured (AL)
- Various chord sizes such as $c = 0.2 - 0.3$ m, and span $L = 0.5 - 0.7$ m



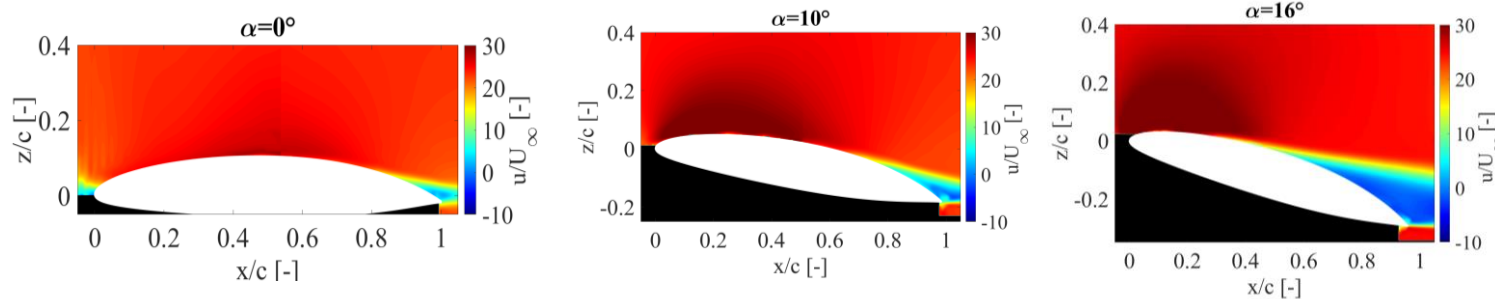
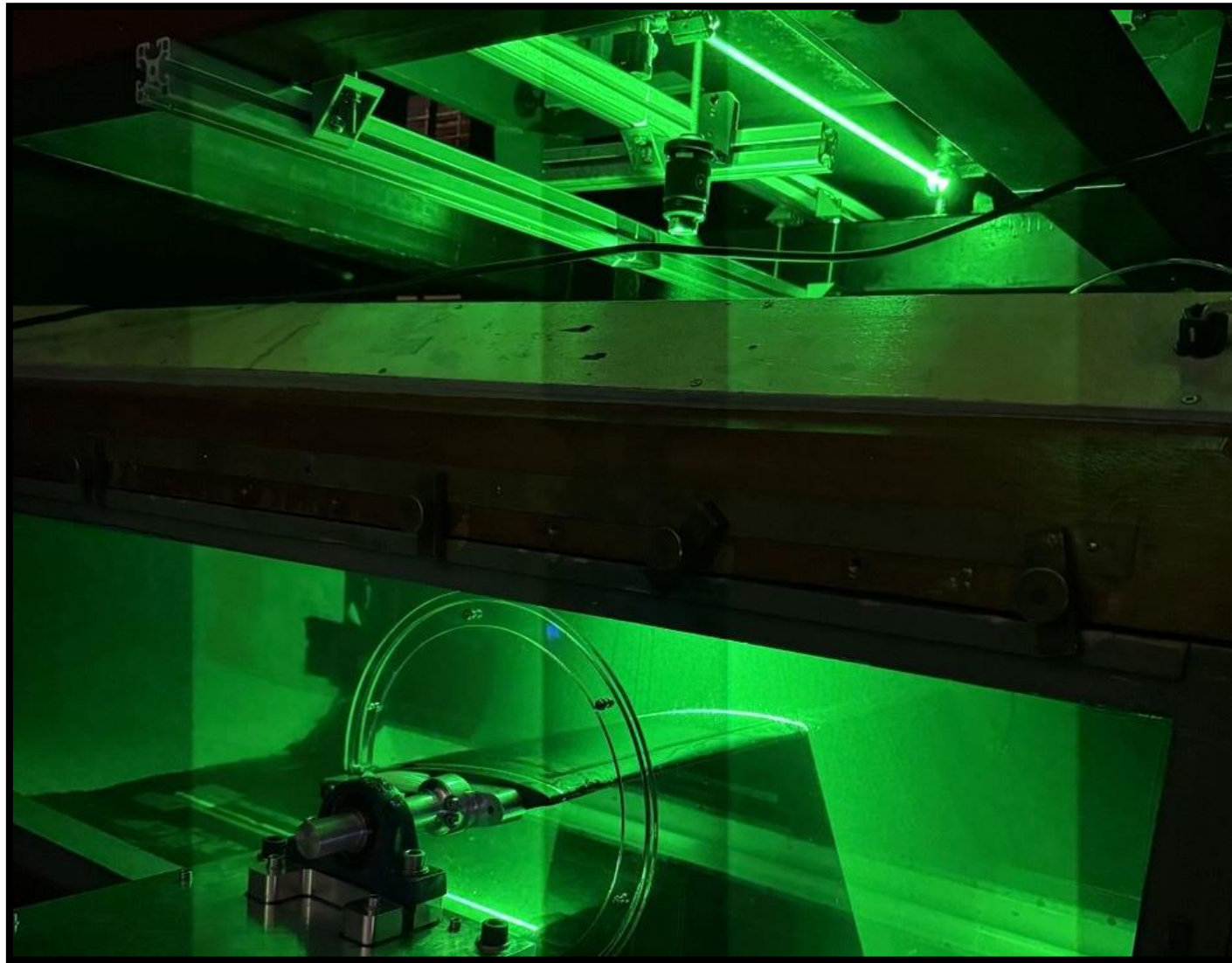
Near-field microphones and pressure transducers



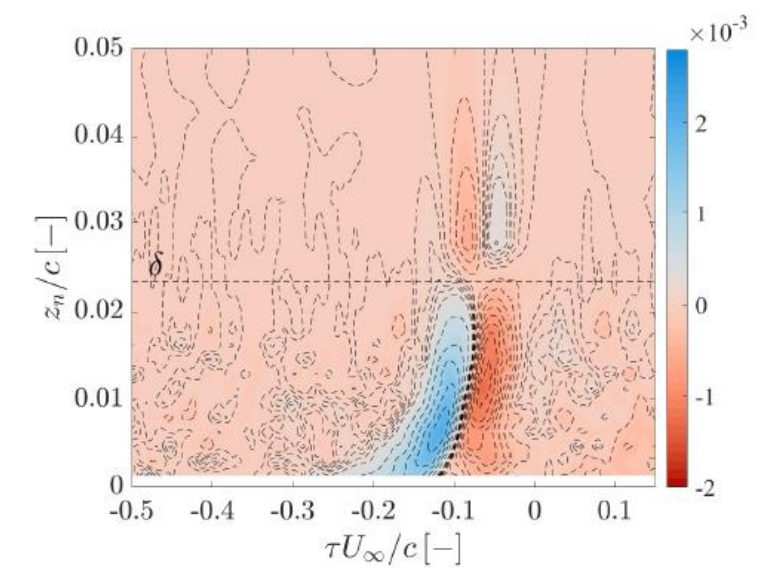
Direct and remote sensing techniques



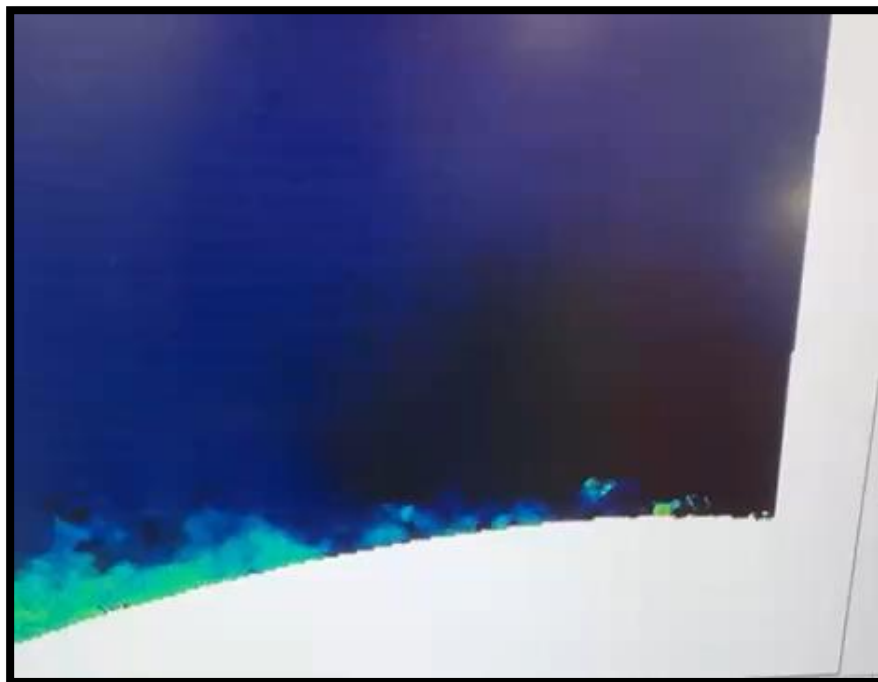
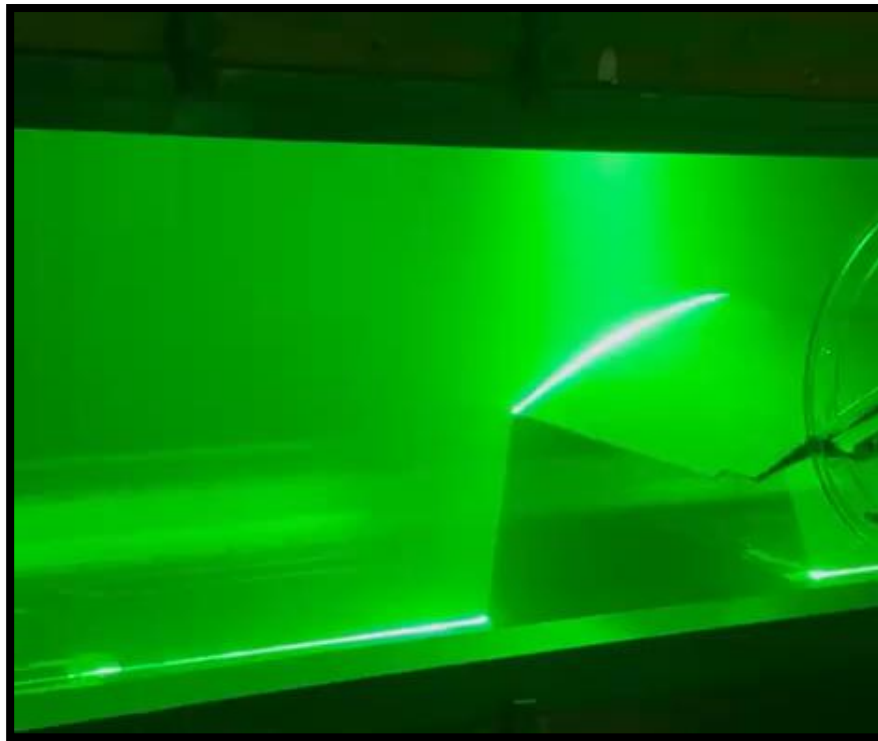
PIV



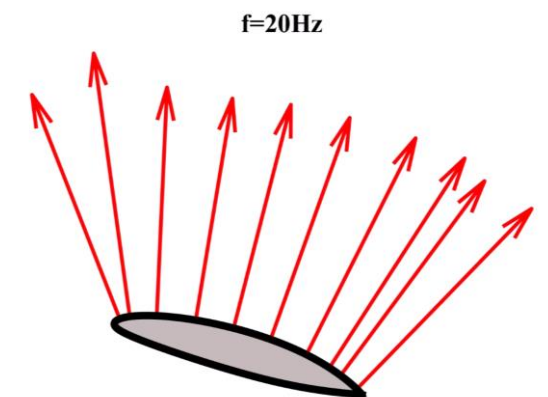
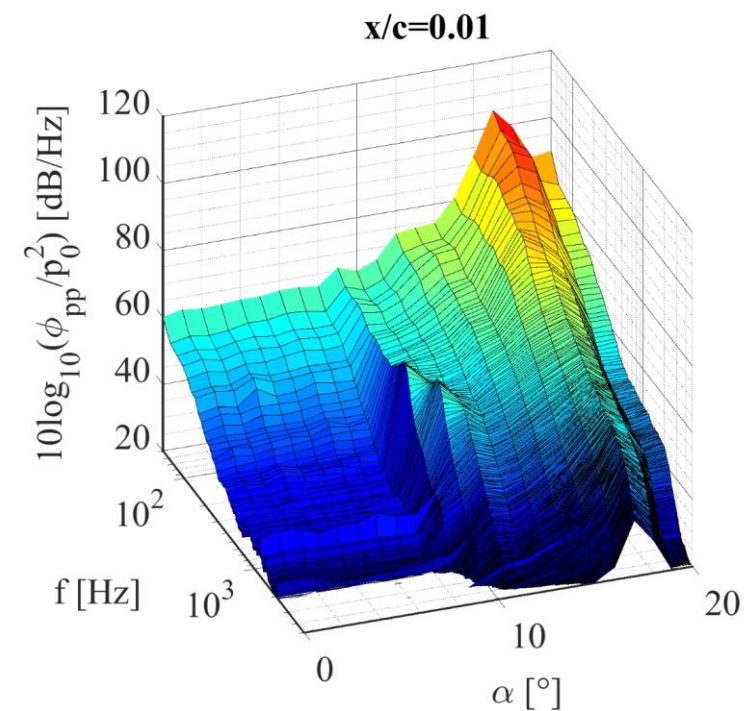
Hot-wire anemometry



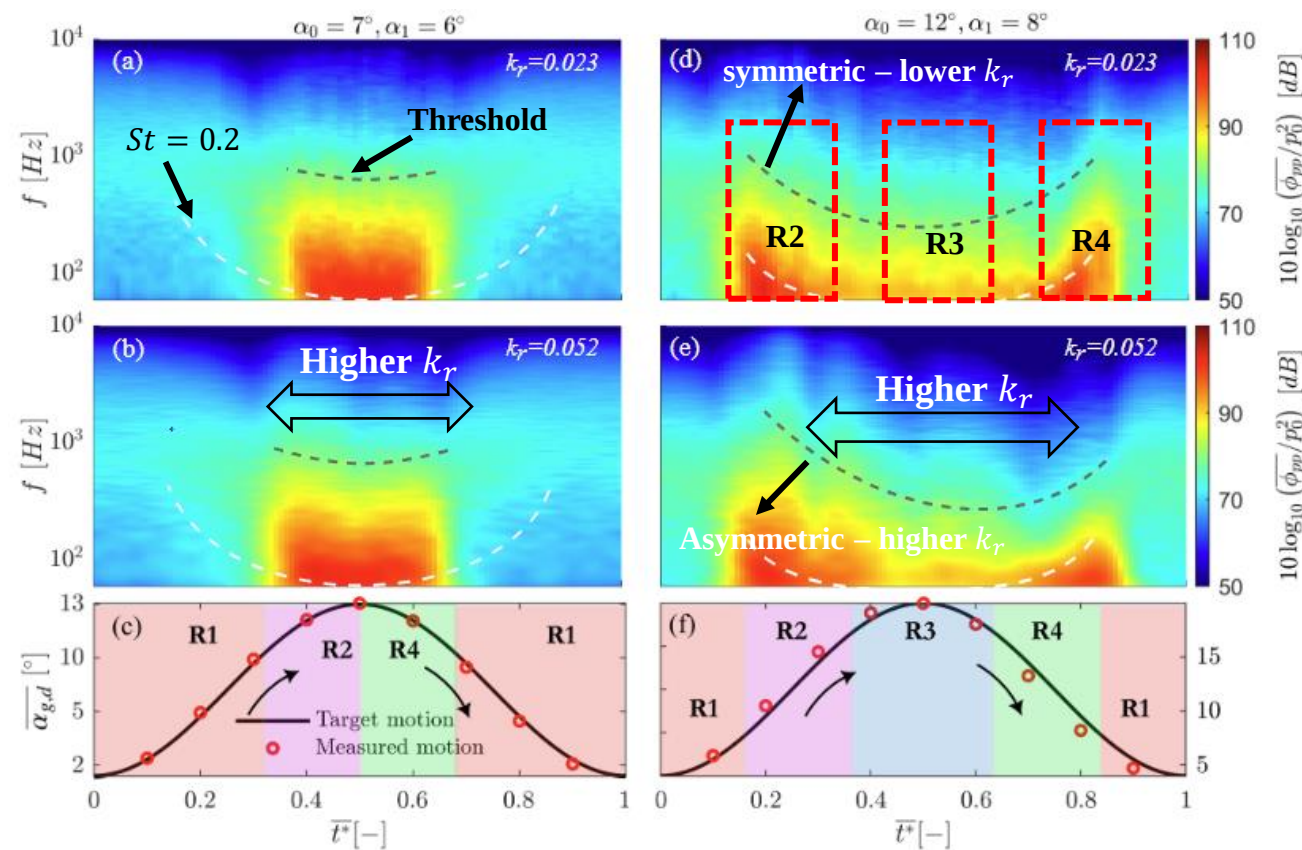
PIV



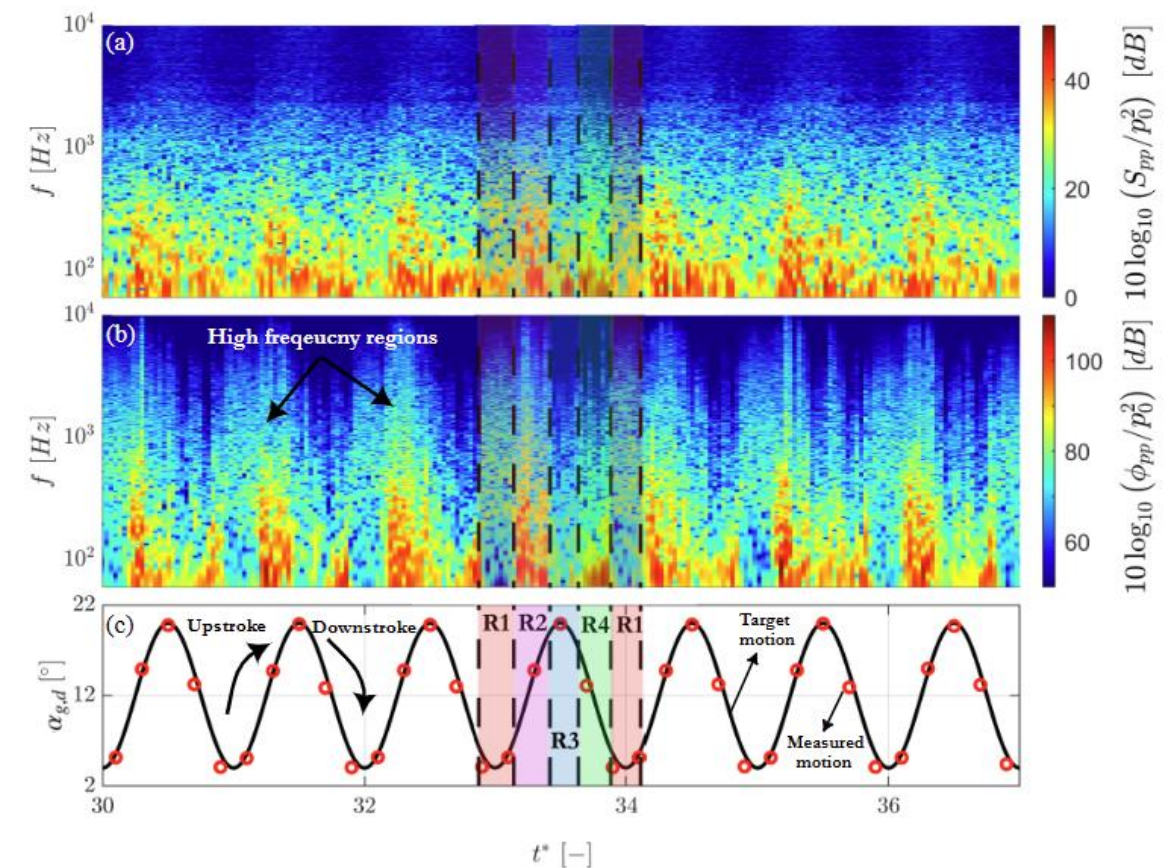
Surface measurements



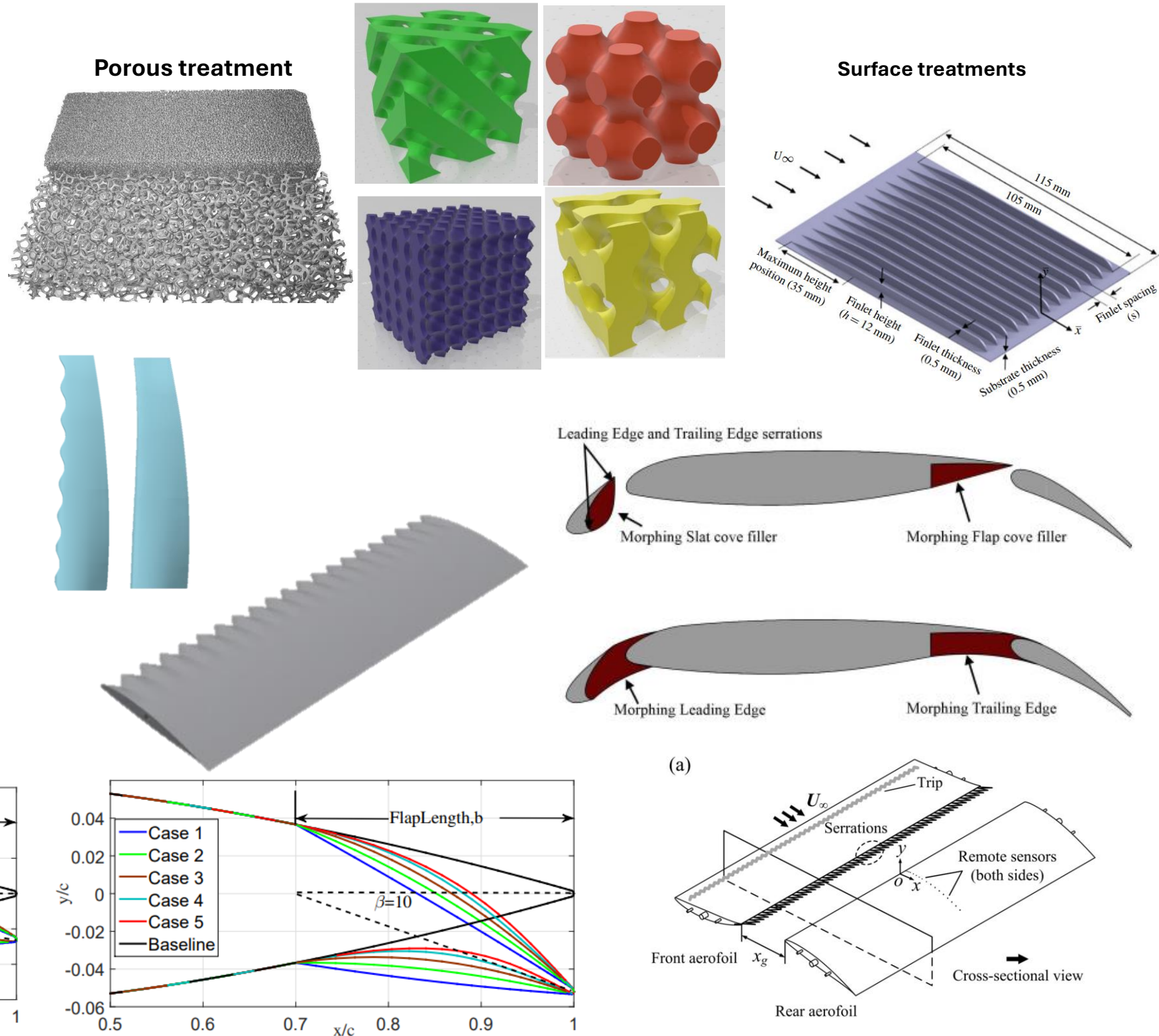
NACA 65-410 spectrogram phase averaging analysis



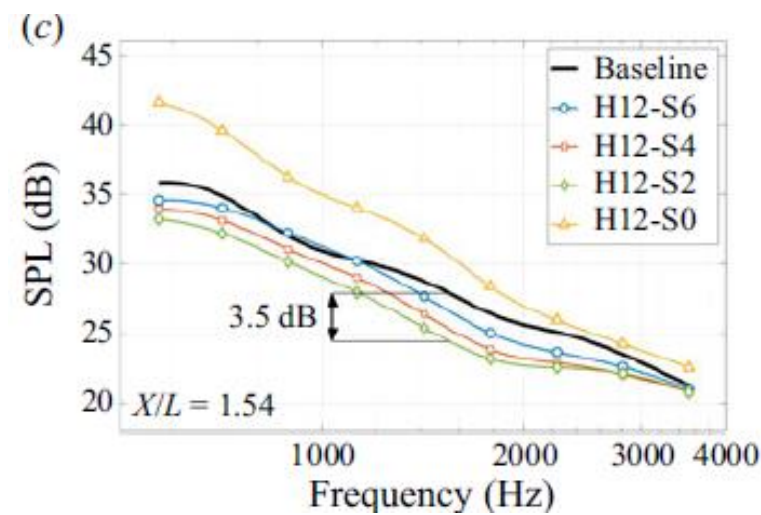
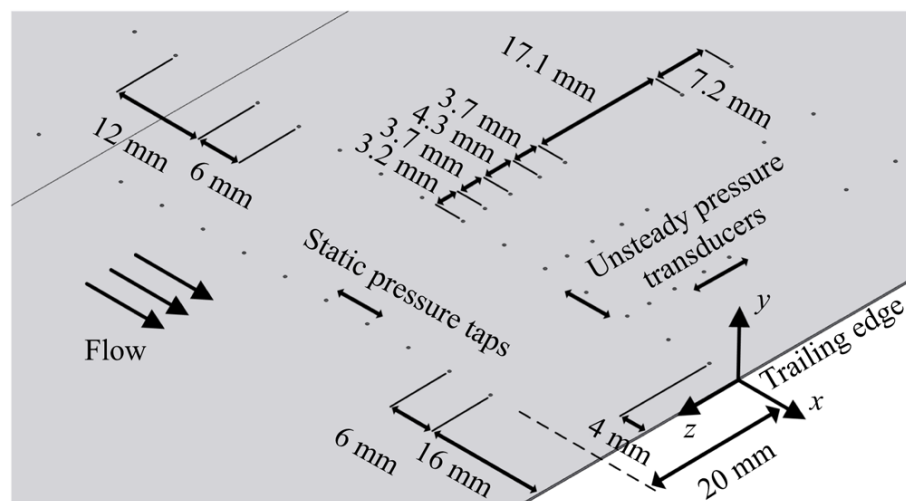
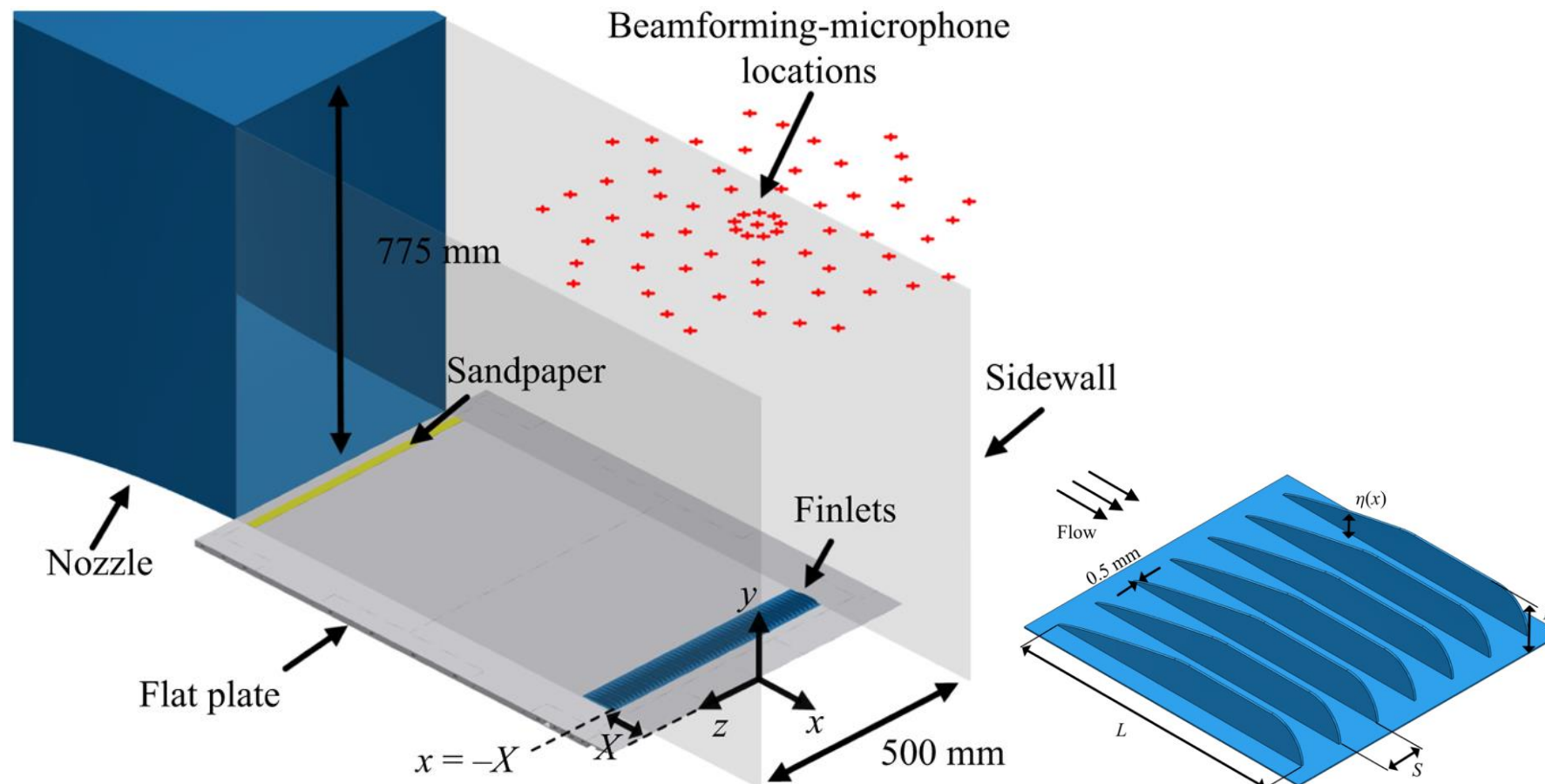
NACA 65-410 SFT analysis



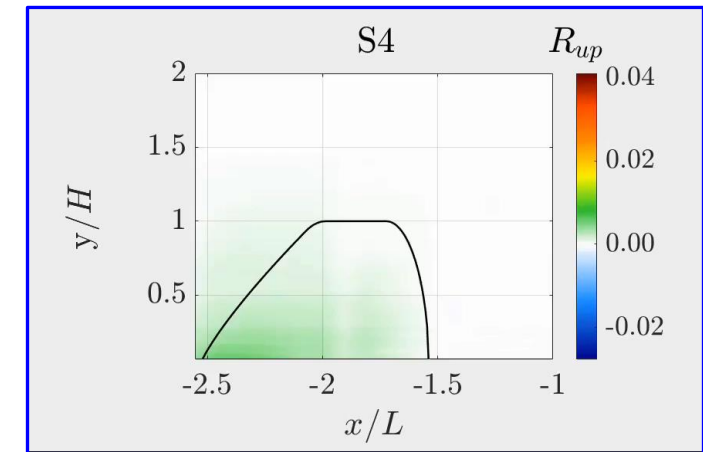
- Serrated aerofoils
- Porous treatments
- Morphing structures
- Surface treatments
- Flow suction
- Flow injection



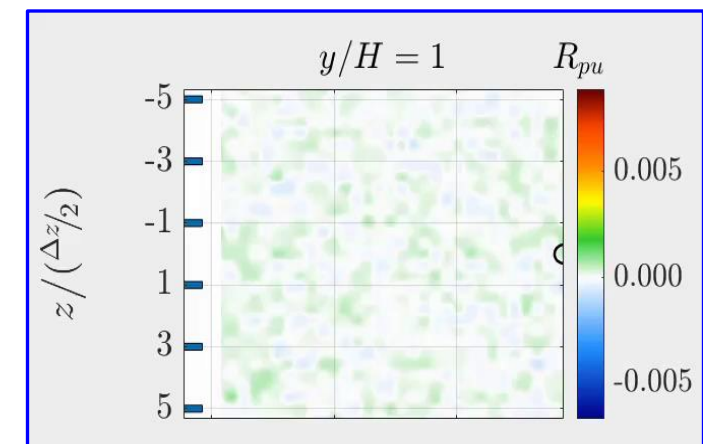
Noise control techniques



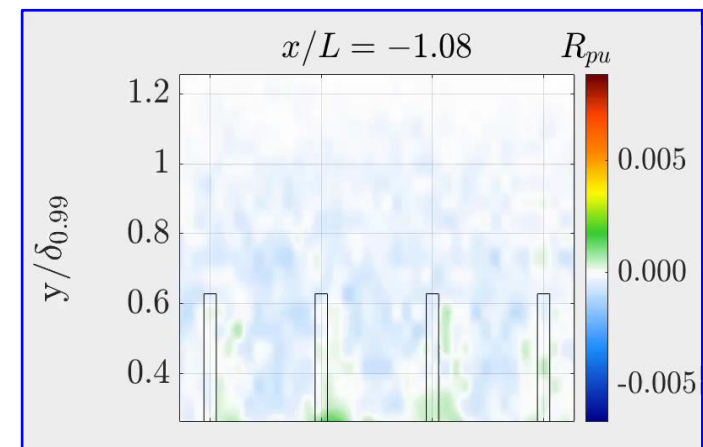
Within channel

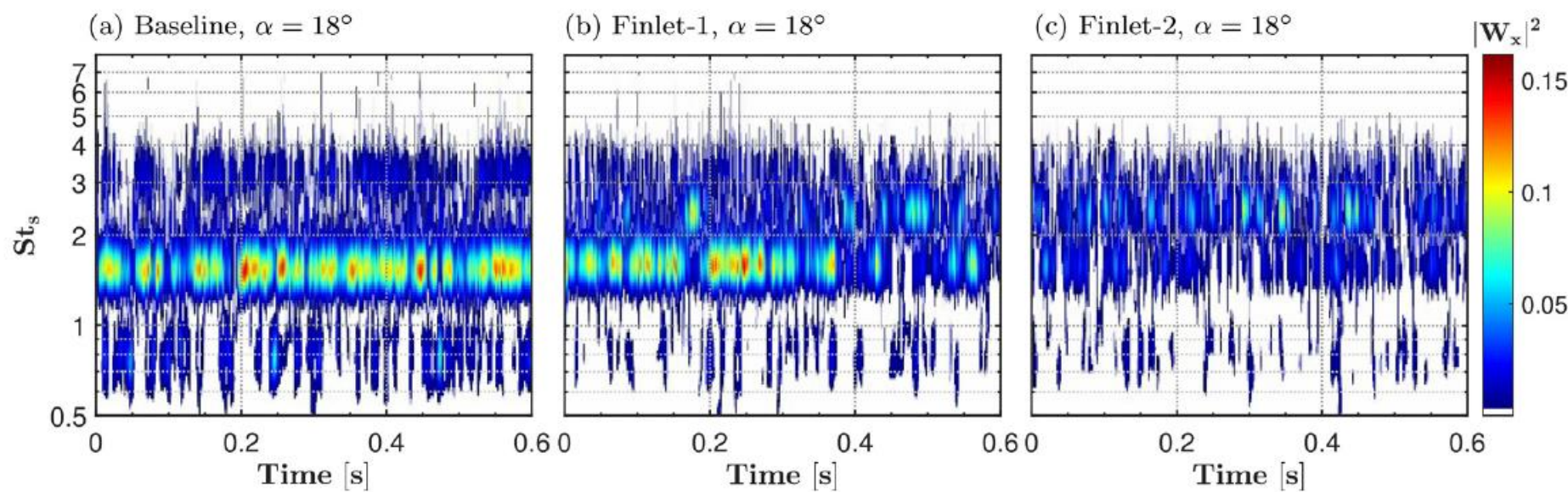
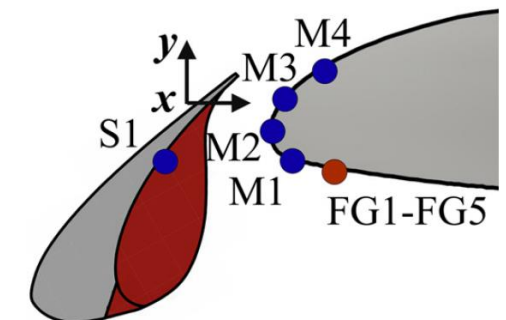
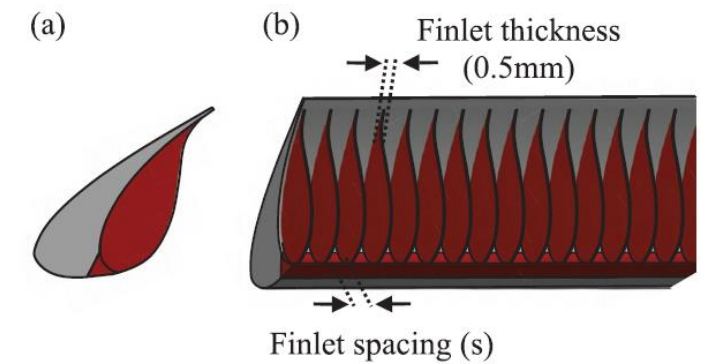
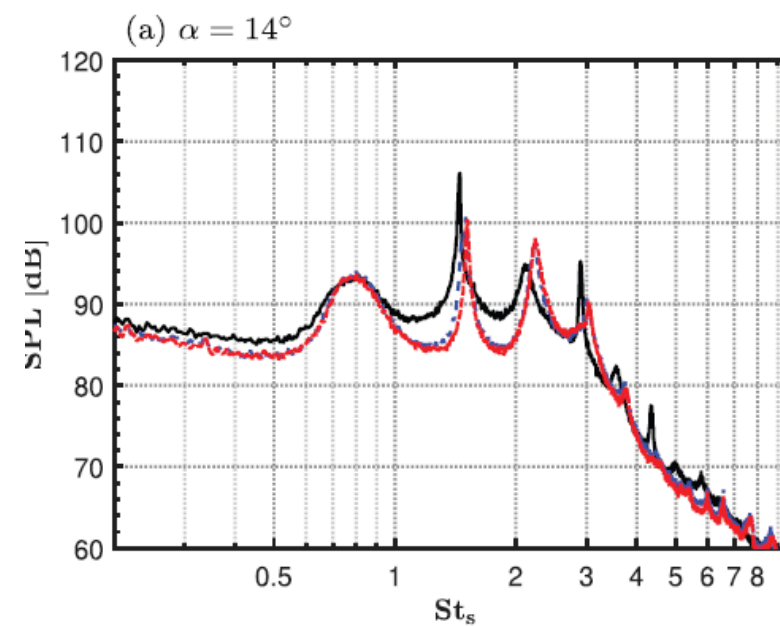
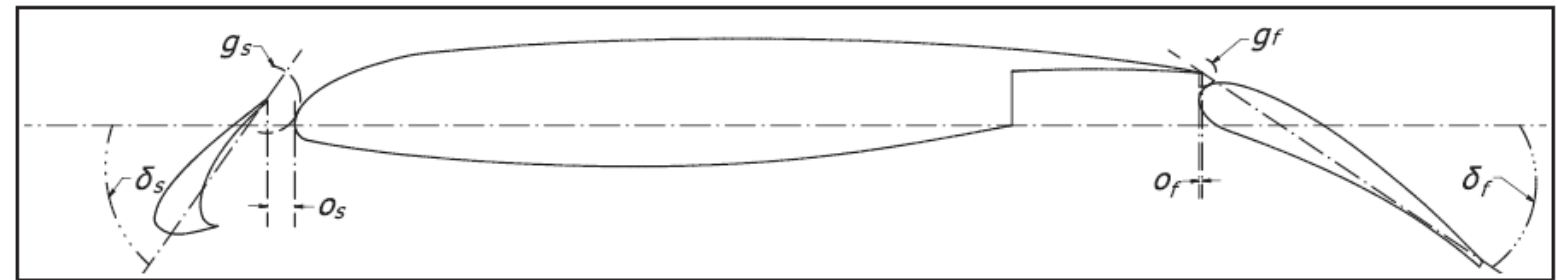
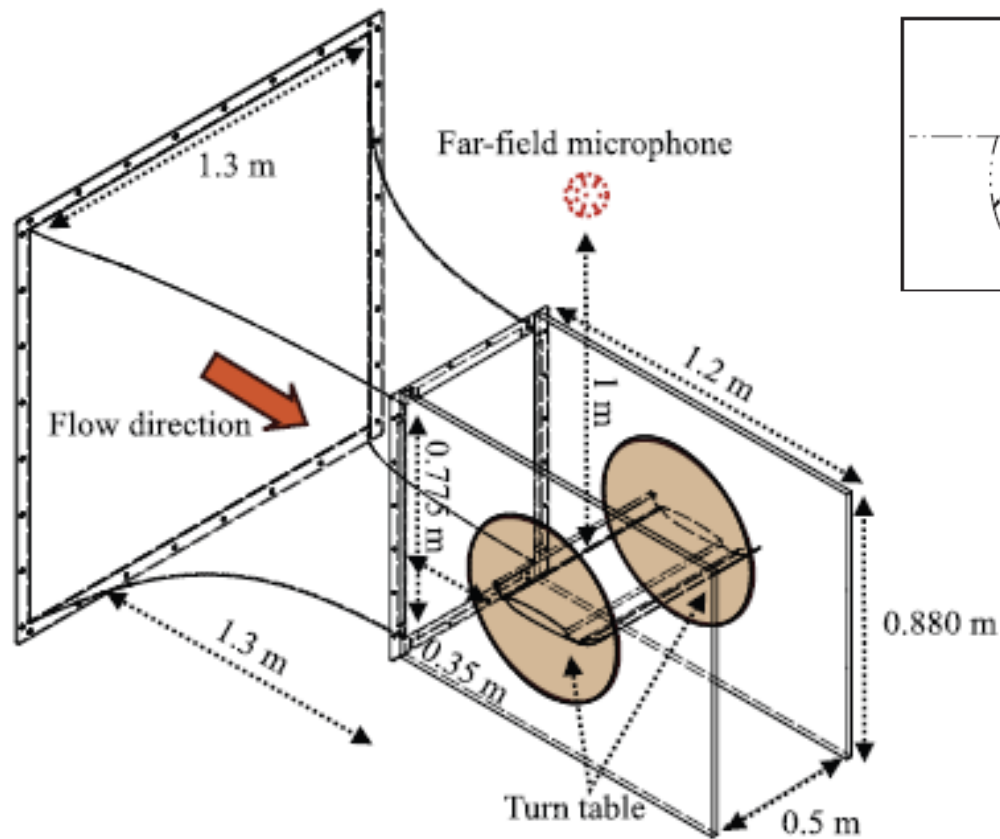


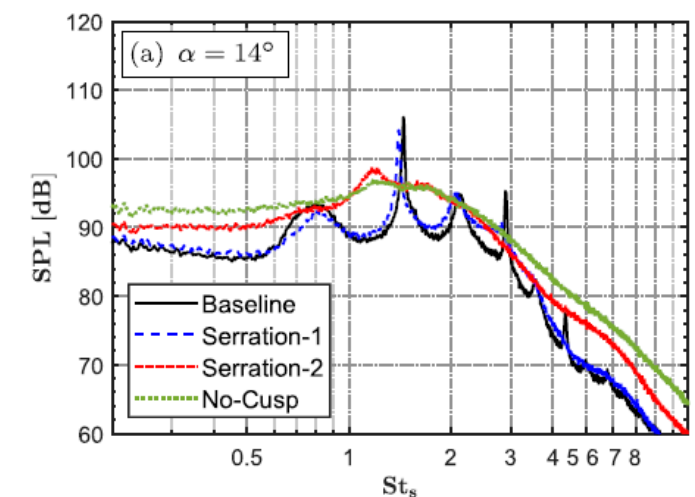
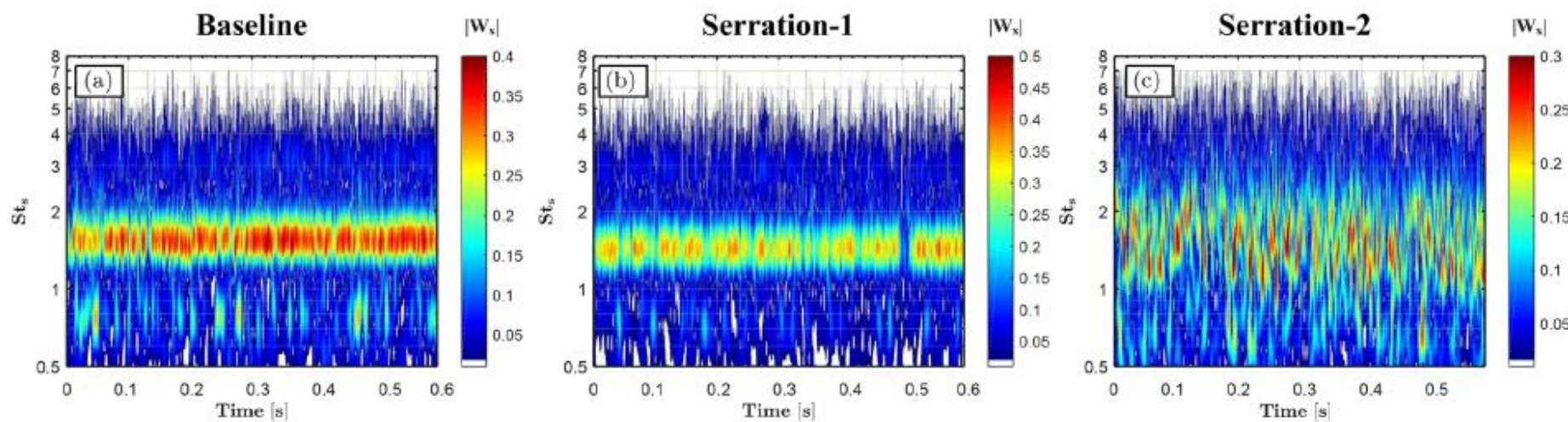
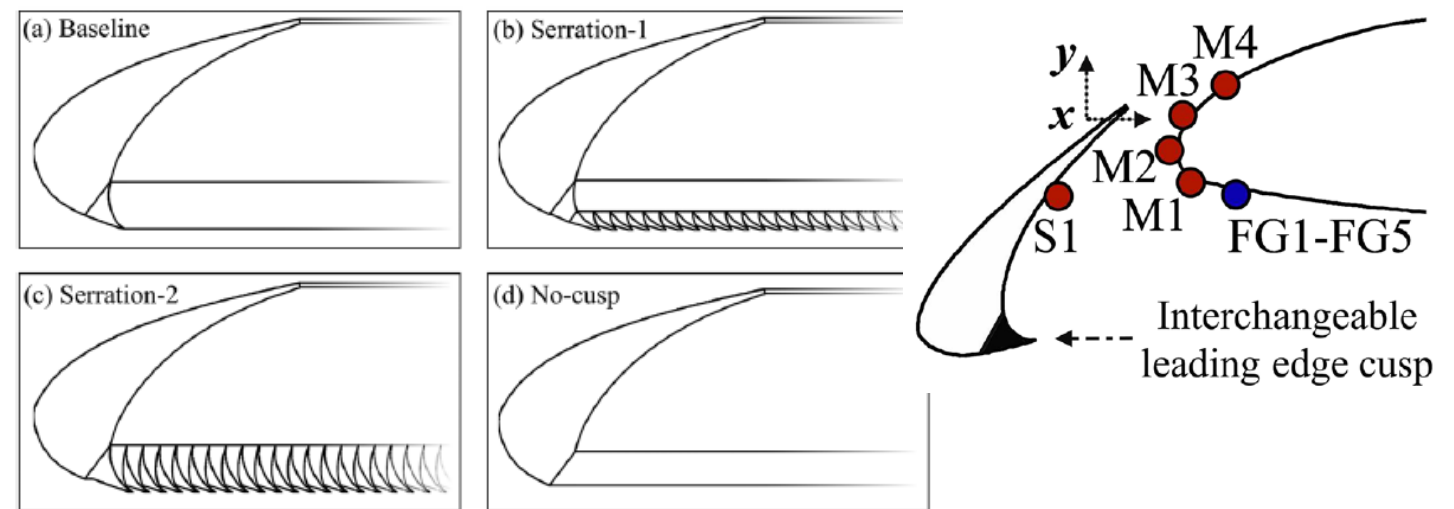
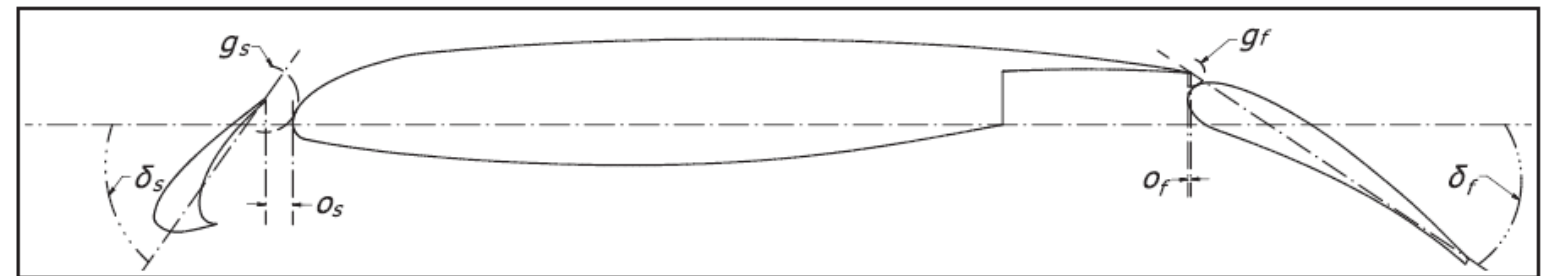
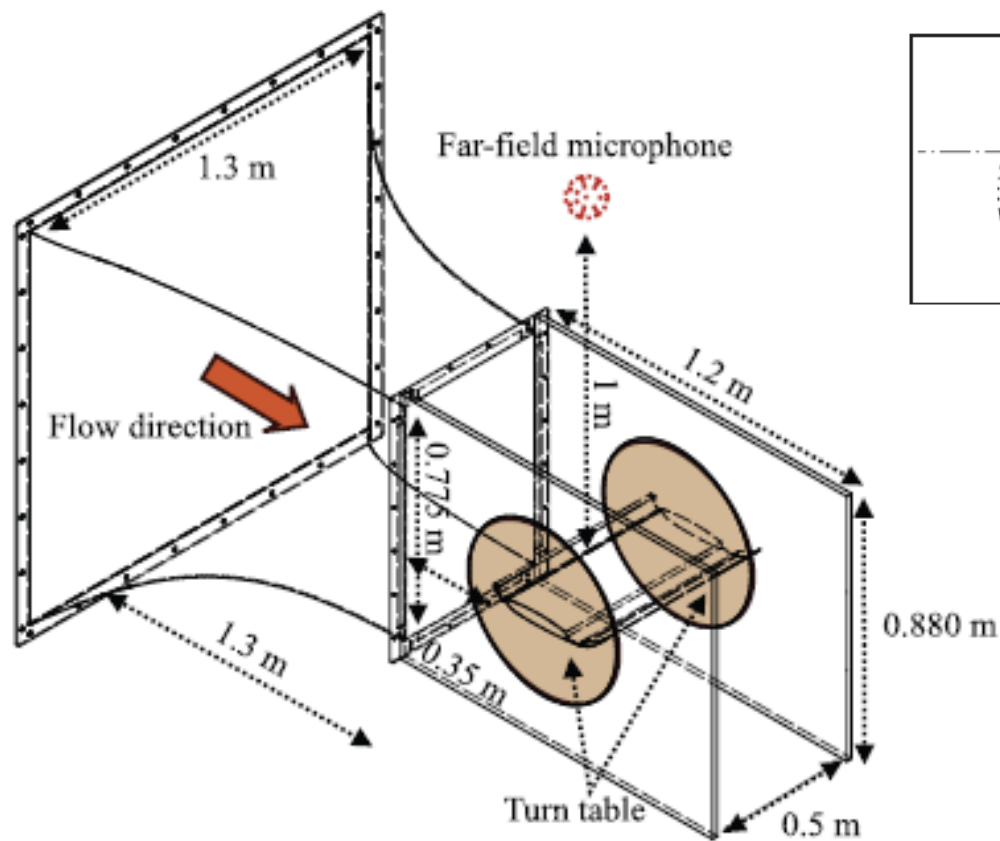
Top view



Front view







Aerofoil and high lifting devices studies at UOB

- Static aerofoil aeroacoustics
- Dynamically oscillating aerofoil aeroacoustics
- High lifting devices

Noise generation study and noise mitigation strategies

- Highly instrumented aerofoils
- Static and dynamic pressure sensors to capture near-field hydrodynamics
- Various microphone arc configurations to capture far-field noise spectra and the Overall Sound Pressure Levels (OSPLs)
- Hot wire and PIV

**Thank you for your kind
attention**



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