SmartAnswer – Flow-acoustic interaction of innovative materials

M.E. D'Elia[1], Y. Aurégan[2]

[1]PhD Candidate, [2]Director of Research, Acoustics Laboratory of the Université du Mans (LAUM)

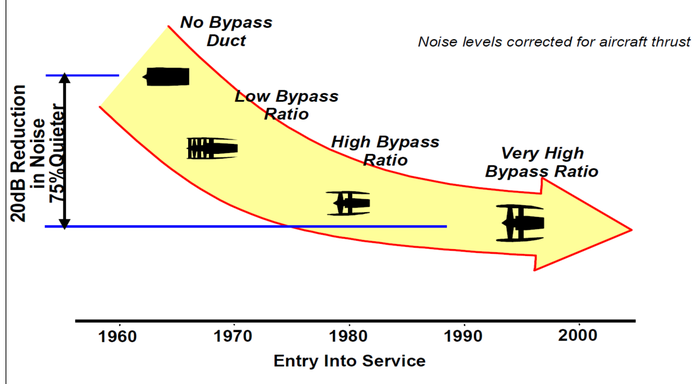
Smart Mitigation of flow-induced Acoustic Radiation and Transmission for reduced Aircraft, surface traNSport, Workplaces and wind enERgy noise

Host institution: LAUM

Partnership: cnrs

Motivation

In future aviation engines, bypass ratios are going to increase, allowing less and less space for sound absorption materials, while lower noise limits are being implemented.



Aircraft noise

Acoustic liners in airplane engine

For these reasons, there is a strong interest in subwavelength solutions [1], i.e. materials which can absorb wavelengths much larger then their inner thickness

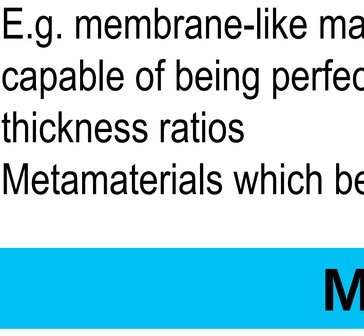
- E.g. membrane-like materials and/or vibrating element which are capable of being perfect absorber at very high wavelength-over-thickness ratios
- Metamaterials which better behave in presence of a grazing flow

Main Objective

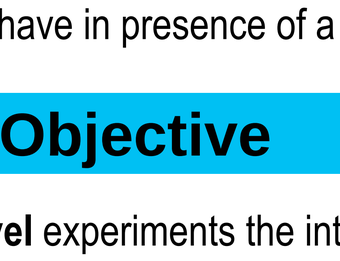
To better understand through **novel** experiments the interaction between grazing flows and innovative materials or metamaterials.
To develop, from this acquired knowledge, new type of materials which could enhance their performance in presence of a grazing flow [2].

Methodology

Experimental Approach



Optical techniques (LDV, PIV)
to measure directly the acoustic velocity in the flow-field



$f_D = f_{s1} - f_{s2}$

$V = \lambda_0(\underline{i}_{s2} - \underline{i}_{s1}) * f_D$

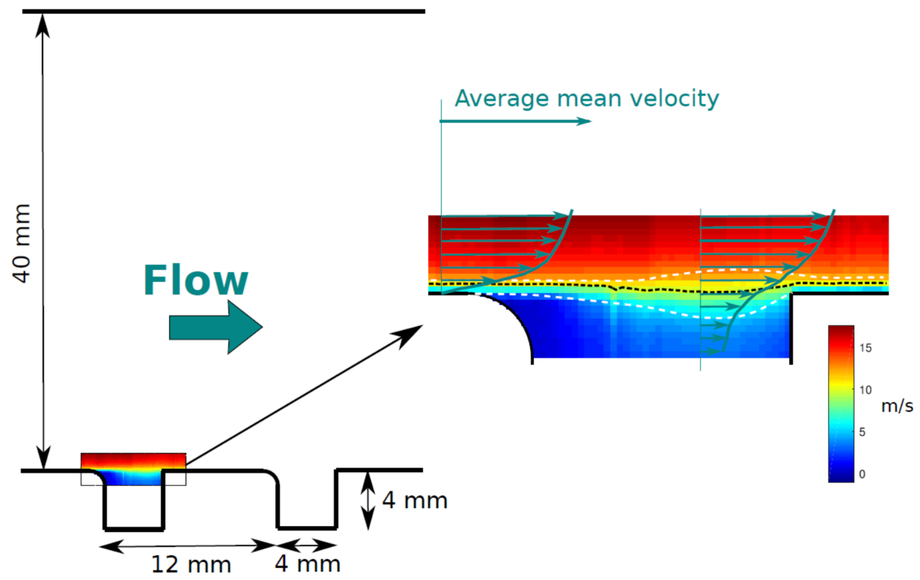
Modeling

- Physical (simple) models of the materials and technologies developed throughout the PhD program
- Numerical investigation to better isolate the acoustic and hydrodynamic components of aero-acoustic interactions

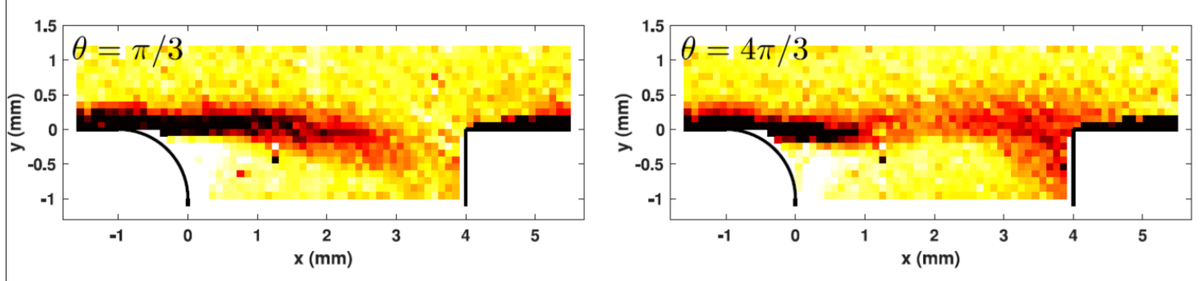
Results

- **LDV Measurements** of corrugated wall in presence of a grazing flow

The investigated corrugated wall

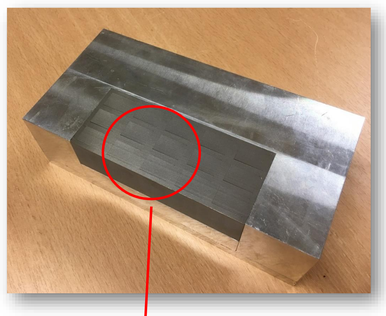


Measured mean horizontal velocity over a cavity. The black dashed line represent the line where the velocity is equal to the vortex convection velocity

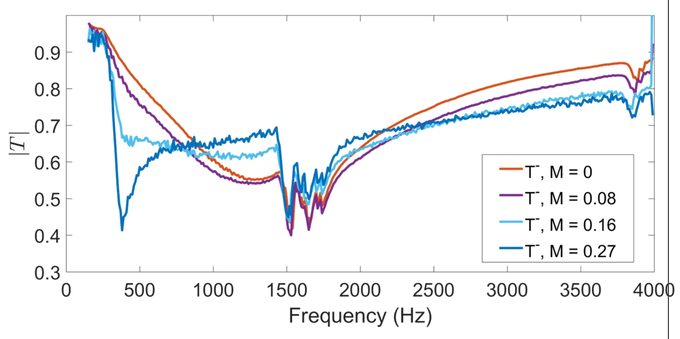


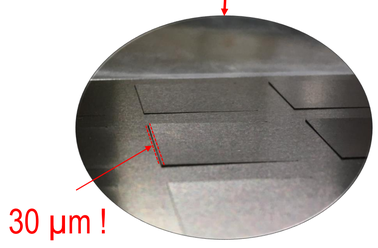
Sum of the mean vorticity and of the fluctuating vorticity when phase angle θ = π/3 and 4/3π

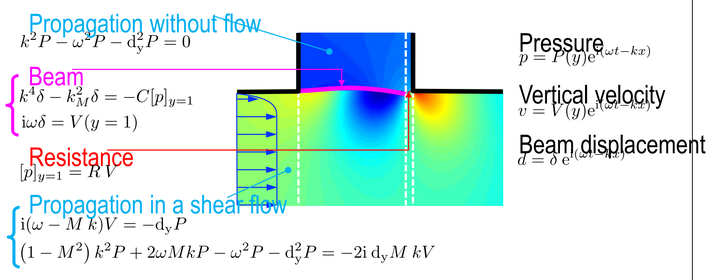
- **Acoustic Measurements** of Vibrating Beams



The investigated vibrating beam







References

[1] Yves Aurégan, Maud Leroux (2008). Experimental evidence of an instability over an impedance wall in a duct with flow. Journal of Sound and Vibration, 317(3–5), 432–439. https://doi.org/10.1016/j.jsv.2008.04.020

[2] Yves Aurégan (2018). Ultra-thin low frequency perfect sound absorber with high ratio of active area. Accepted for publication in Applied Physics Letters.

[3] Joachim Golliard, Yves Aurégan, and Thomas Humbert (2018). Acoustic propagation in pipes with corrugated treatment. AIAA-2018-3931 in 2018 AIAA/CEAS Aeroacoustics Conference. https://doi.org/10.2514/6.2018-3931

MARIE CURIE ACTIONS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Sklodowska-Curie grant agreement No 722401.