



**HAL**  
open science

# Hydrofoil flow induced vibration mitigation by passive resonant piezoelectric shunt

Yann Watine, Boris Lossouarn, Céline Gabillet, Jacques-André Astolfi,  
Jean-François Deü

► **To cite this version:**

Yann Watine, Boris Lossouarn, Céline Gabillet, Jacques-André Astolfi, Jean-François Deü. Hydrofoil flow induced vibration mitigation by passive resonant piezoelectric shunt. 31th International Conference on Adaptive Structures and Technologies, ICAST2021, Oct 2021, Virtual conference, Switzerland. hal-03445667

**HAL Id: hal-03445667**

**<https://hal.science/hal-03445667v1>**

Submitted on 24 Nov 2021

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## Context

Hydrofoils are subjected to flow induced vibrations

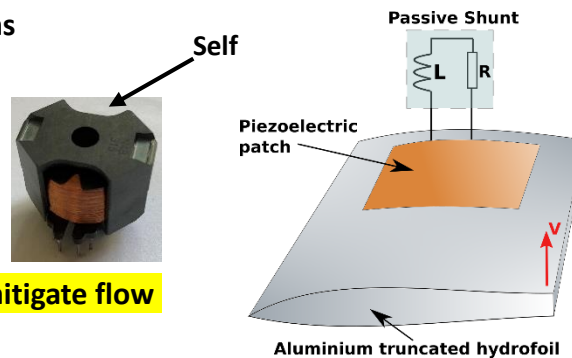
⇒ Structural fatigue + acoustic noise

If vortex shedding frequency = natural frequency

⇒ Resonance

⇒ High amplitude vibrations

**Objective: Use a resonant piezoelectric shunt to mitigate flow induced vibration at resonance**



## Methodology

**Hydrodynamic tunnel:**

$U_0 = 3.0$  to  $5.5$  m/s

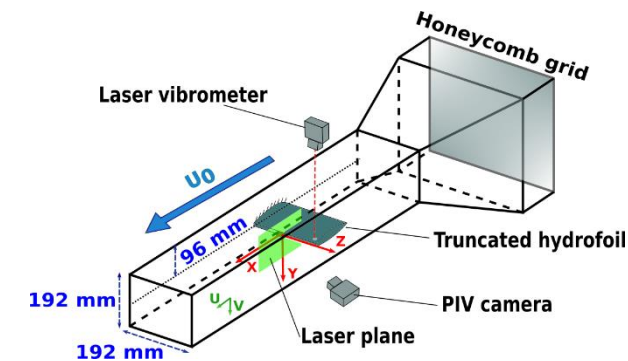
$Re = 2.40 \times 10^5$  to  $4.40 \times 10^5$

Incidence =  $0^\circ$

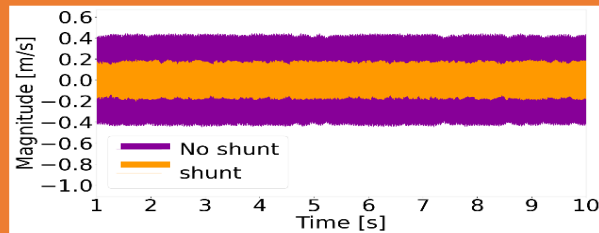
**Laser Vibrometry + TR-PIV**

**Shunt tuning:**

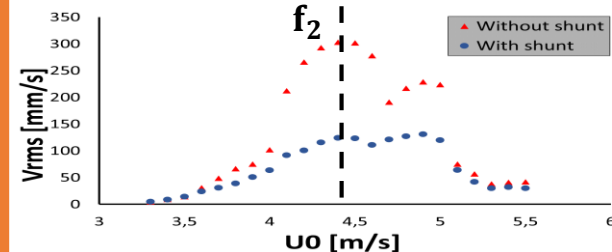
At the twisting mode frequency ( $f_2 = 282$  Hz)



## Vibration mitigation



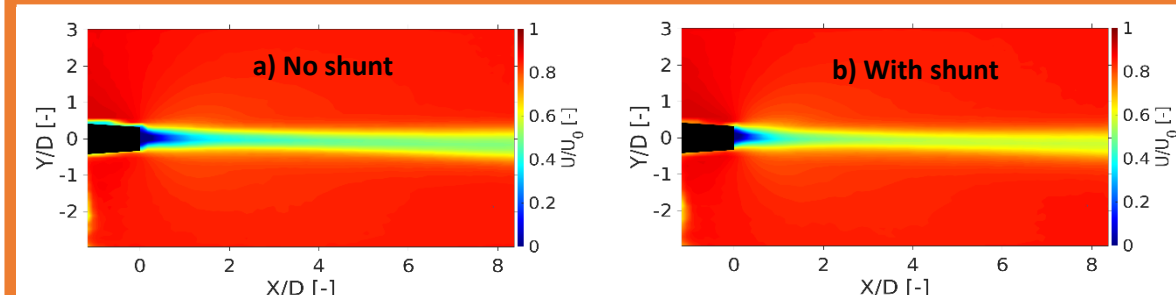
Vibration velocity signal at  $U_0 = 4.4$  m/s



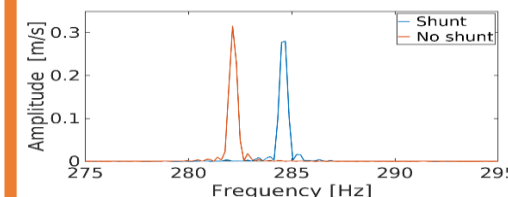
Vrms of vibration signal at various flow velocities.

- ⇒ 16 dB vibration reduction at zero flow velocity
- ⇒ High vibration level reduction at resonance (50 % on  $V_{rms}$ )
- ⇒ Twisting mode resonance observed at  $U_0 = 4.4$  m/s
- ⇒ Impact of the shunt from 4.0 to 5.0 m/s

## Impact on the wake at twisting resonance, $U_0 = 4.4$ m/s



(x,y) distribution of averaged  $U$  velocity component with (b) and without (a) shunt.



Spectrum of fluctuating  $v$  velocity downstream the trailing edge

- ⇒ Decrease of the thickness of the wake
- ⇒ Decrease of velocity fluctuation magnitude
- ⇒ Slight modification of the vortex shedding frequency

## Further work

- ⇒ Study in detail the impact of vibration mitigation on the wake dynamics.
- ⇒ Optimise de shunt design for optimal mitigation.

## References

- L. Pernod, B. Lossouarn, J.-A. Astolfi, J.-F. Deü, Vibration damping of marine lifting surfaces with resonant piezoelectric shunts, JSV, 2021
- Y. Watine, C. Gabillet, J.-A. Astolfi, L. Pernod, B. Lossouarn, J.-F. Deü. Vortex Induced Vibrations Analysis of a Cantilevered Blunt Plate by Proper Orthogonal Decomposition of TR-PIV and Structural Modal Analysis. Proc. ASME-FEDSM 2020