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Passive vibration damping of hydrofoils using resonant piezoelectric shunts

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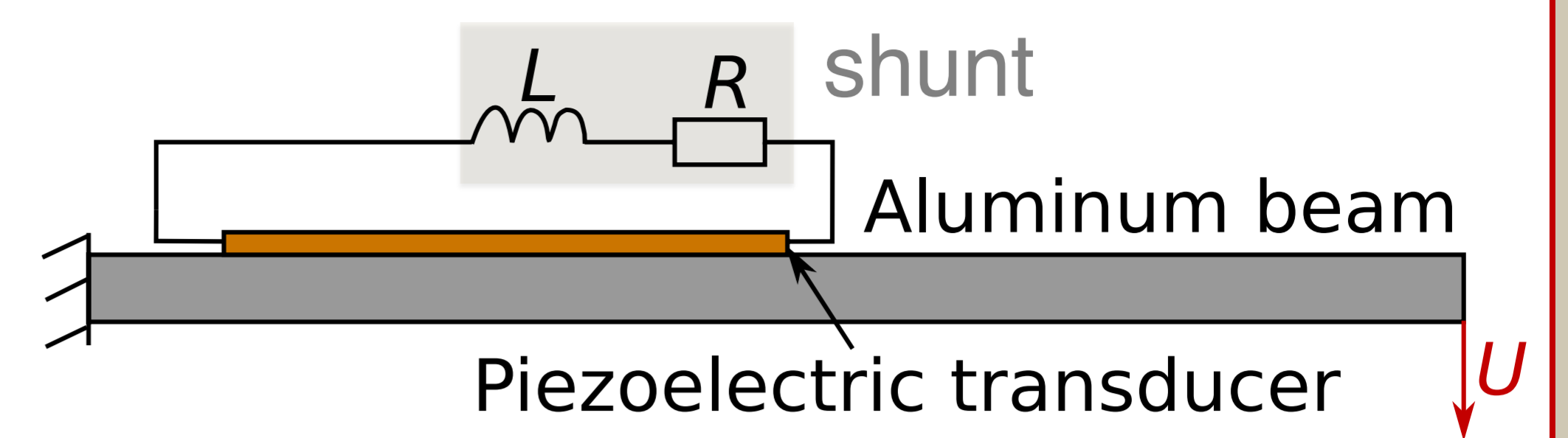
Introduction



Marine lifting surfaces

Flow-induced vibrations

Shorter life cycle
Poor acoustic performances



Objective: Vibration damping under hydrodynamic flows using a resonant piezoelectric shunt

Methodology

Still water (excitation by piezoelectric patches)

Modal analysis
→ ω_{oc} and ω_{sc}

$$k_c = \sqrt{\frac{\omega_{oc}^2 - \omega_{sc}^2}{\omega_{sc}^2}}$$

Resonant shunt design

$$L = \frac{1}{C\omega_{oc}^2}$$

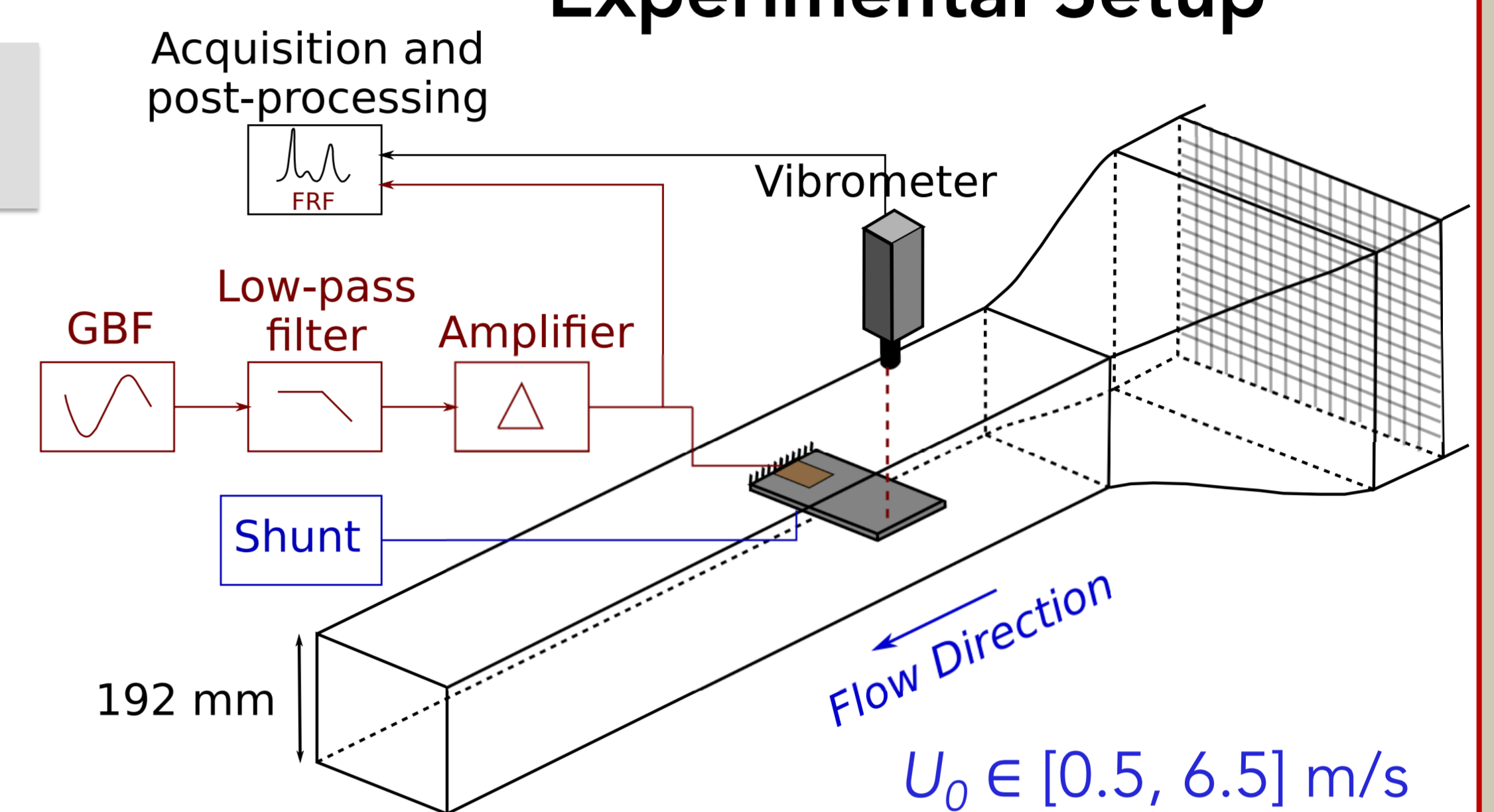
$$R = \sqrt{\frac{3}{2}} \frac{k_c}{C\omega_{oc}}$$

Hydrodynamic flows

Hyp: identical ω_{oc} and ω_{sc}

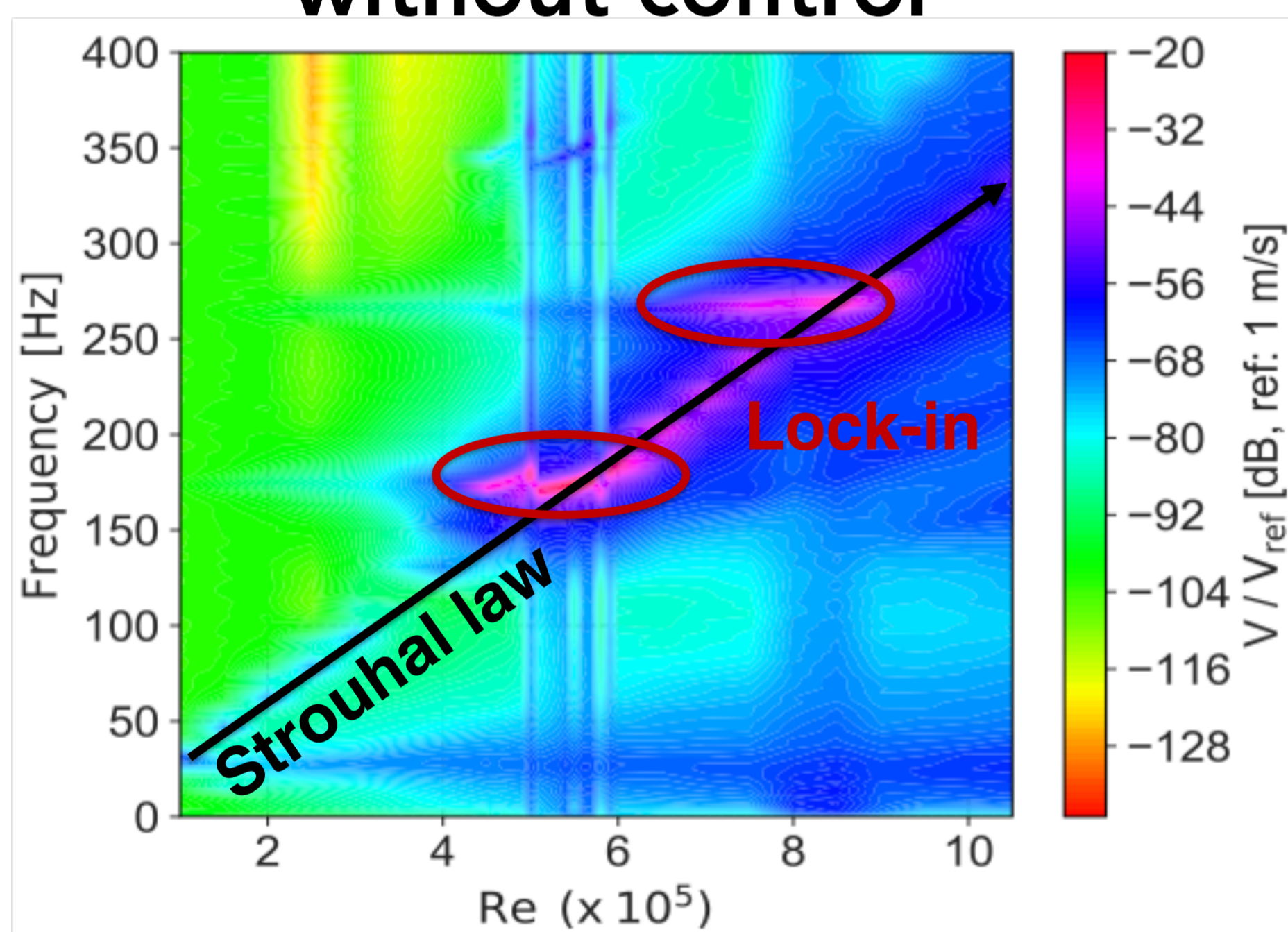
→ Identical shunt parameters

Experimental Setup

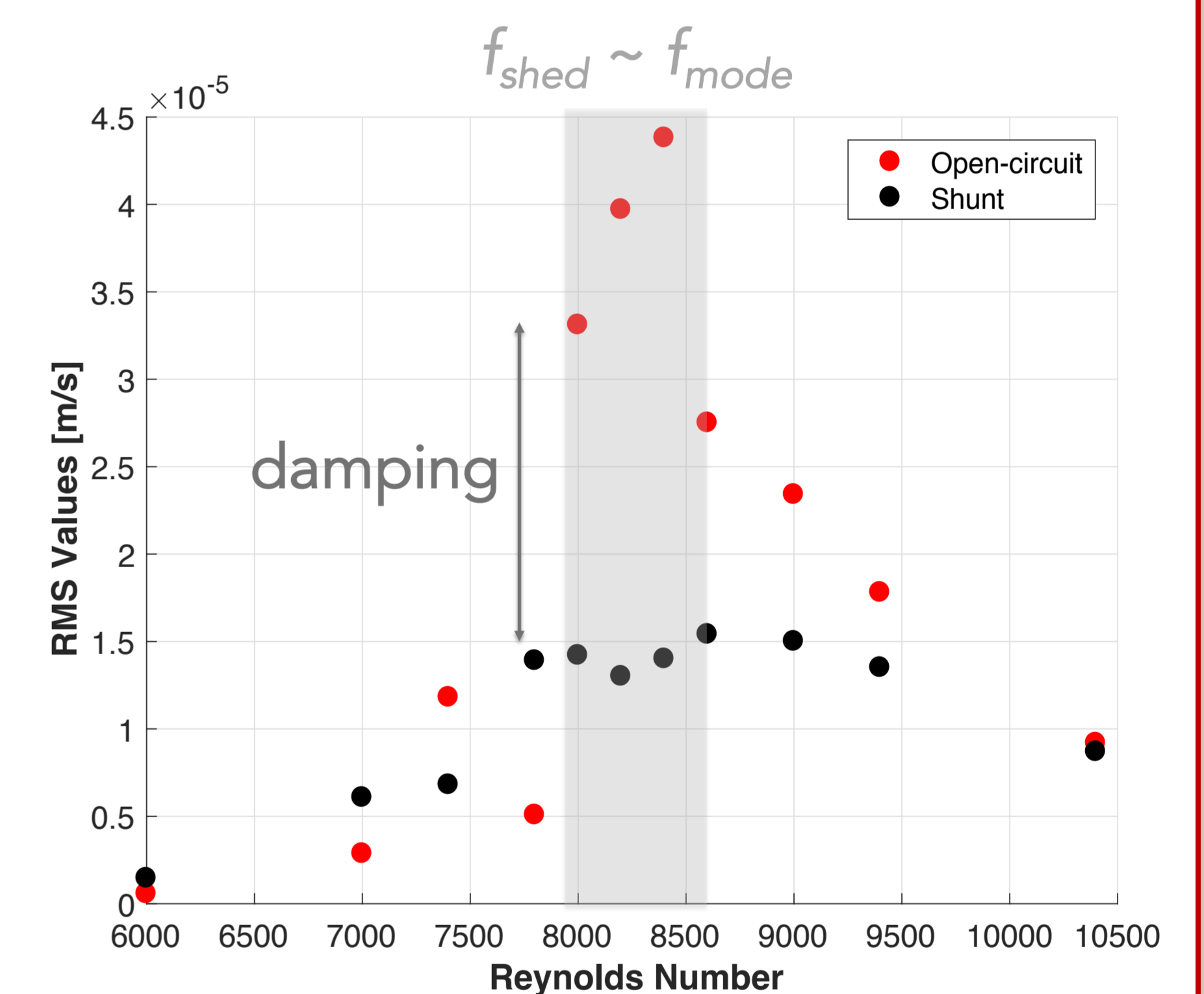
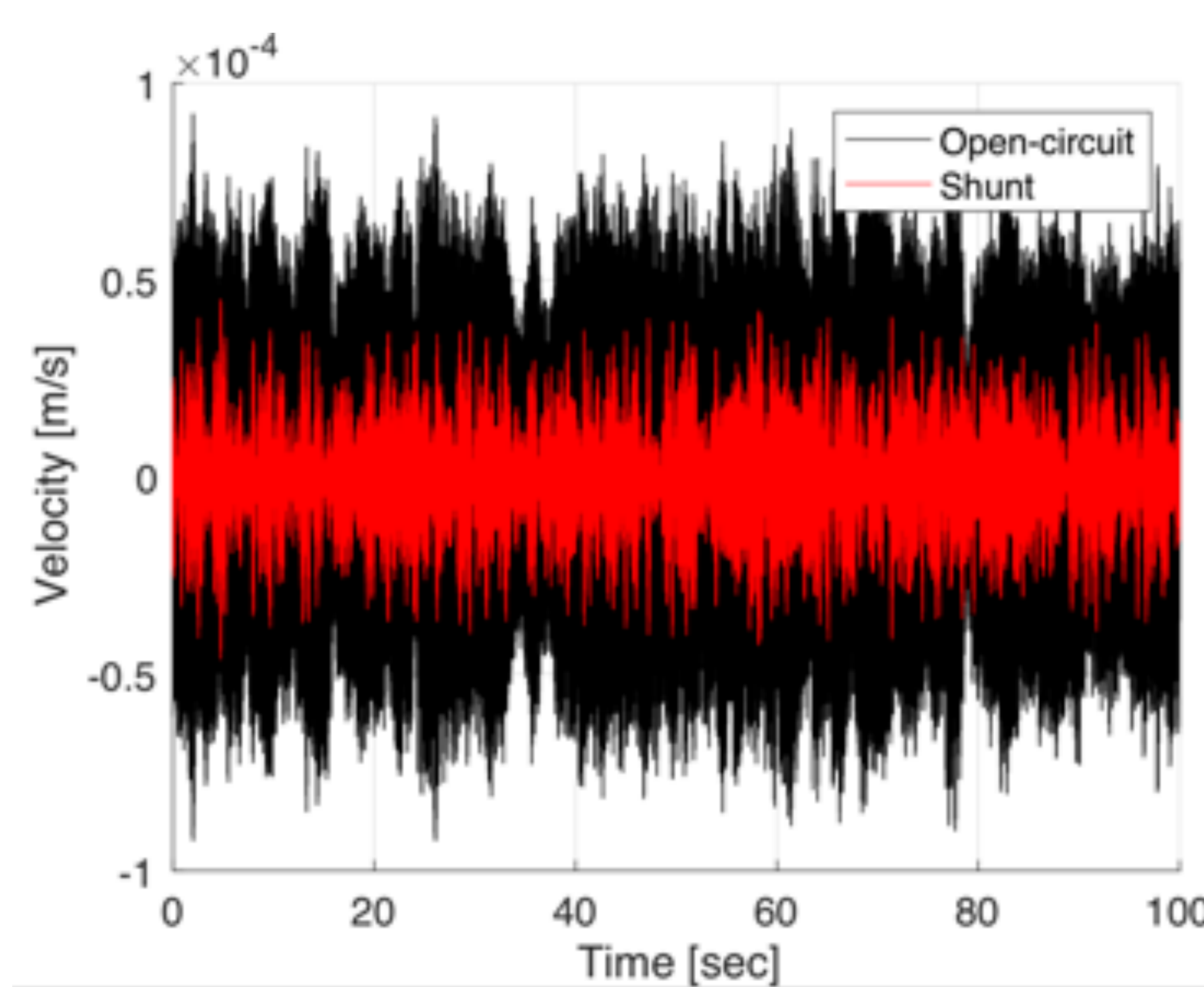


Results

Flow-induced vibration without control



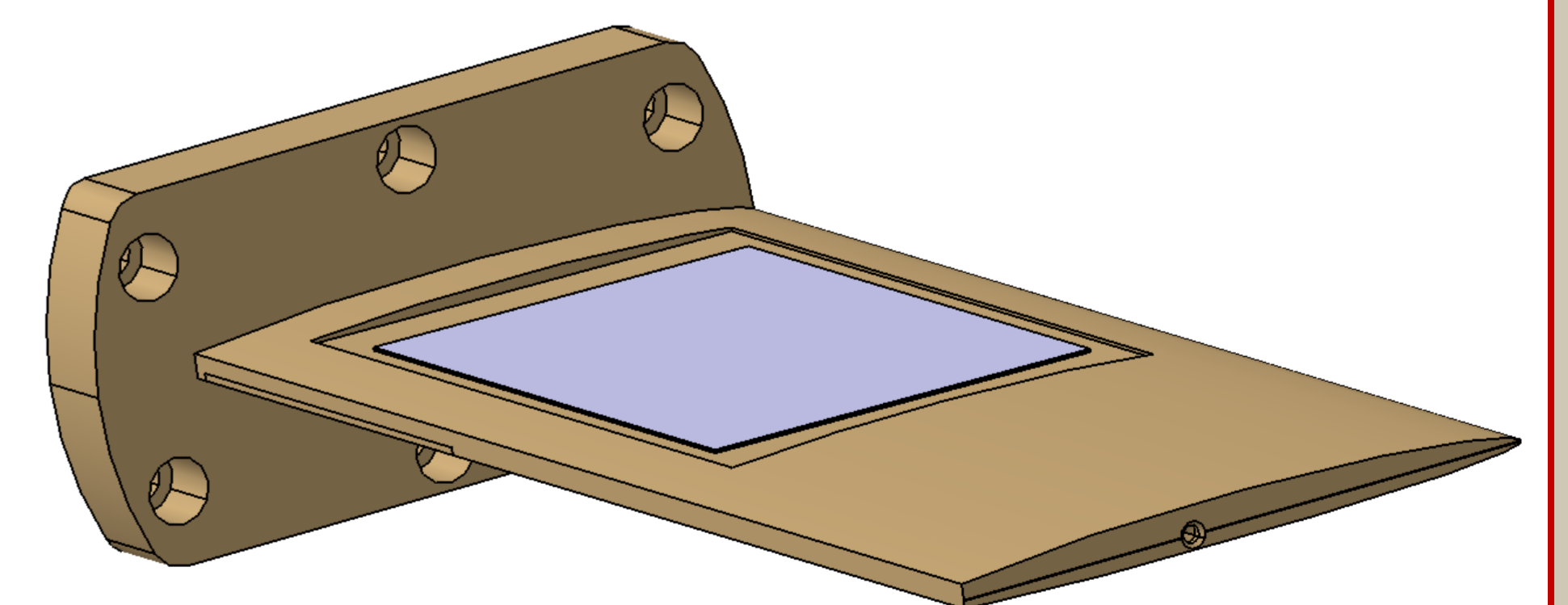
Vibrations with and without control under hydrodynamic flows



- Von Kármán vortex-shedding from trailing edge (Strouhal law) at frequency f_{shed}
- Strong coupling with 1st torsional mode and 2nd bending mode when $f_{shed} = f_{mode}$ → lock-in
- Vibration mitigation on 1st bending mode, in particular when f_{shed} close to $f_{bending1}$
- RMS values divided by ~3 at maximum vibration mitigation

Further work

- Vibration damping on the 1st torsional mode (most severe load case)
- More complex geometry: hydrofoil with a truncated trailing edge
- Numerical study and validation against experiments



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