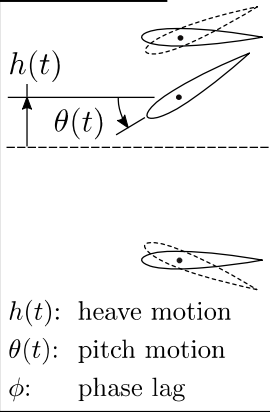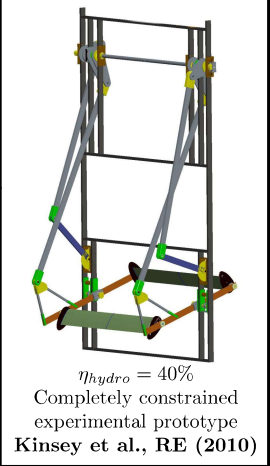# The fully-passive flapping-foil, a simple and highly efficient alternative as a hydrokinetic turbine

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Context

- When the heaving and pitching motions are constrained :
  - ➜ High energy extraction efficiency demonstrated numerically and experimentally

- Problem with complex mechanism :
  - ➜ Loss of energy & reliability

- Solution :
  - ➜ Simplify the mechanism by freeing both degrees of freedom

$h(t)$: heave motion
$\theta(t)$: pitch motion
ϕ: phase lag

$\eta_{hydro} = 40\%$
Completely constrained experimental prototype
Kinsey et al., RE (2010)

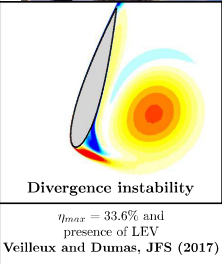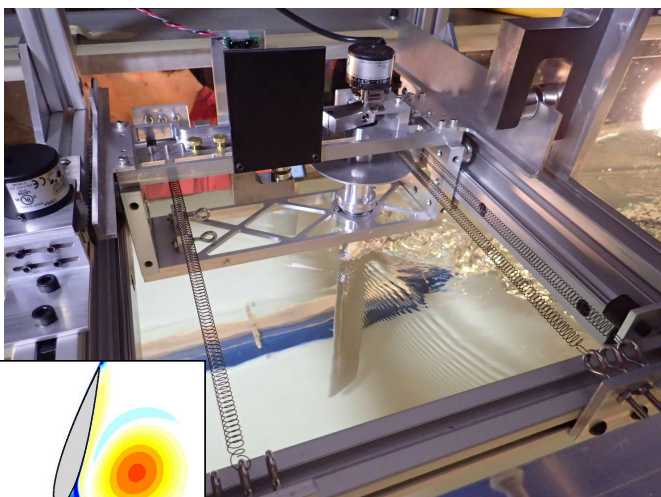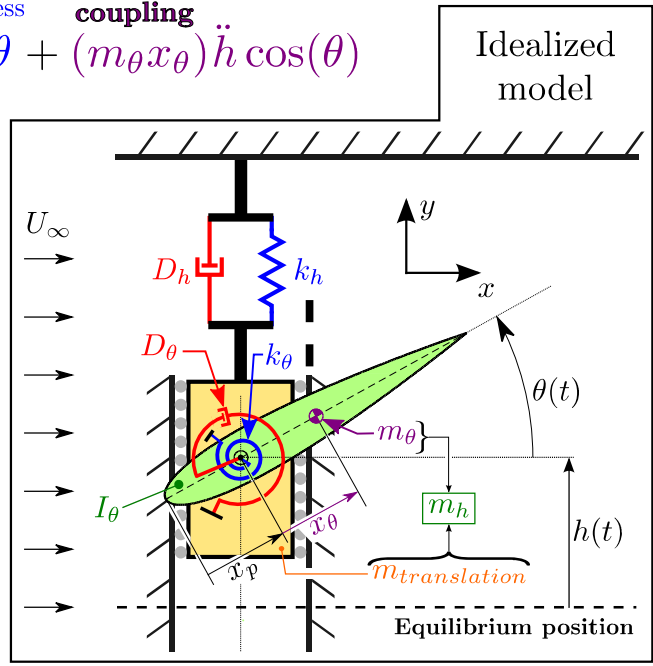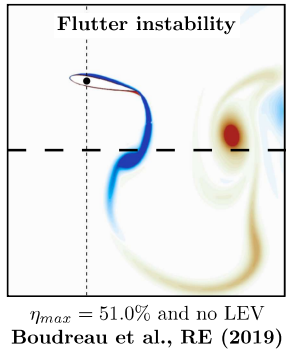## Fully-passive concept

Dynamic equations governing the motion of the foil

Heaving : $$F_y = m_h\ddot{h} + D_h\dot{h} + k_h h + (m_\theta x_\theta)(\ddot{\theta}\cos(\theta) + (\dot{\theta})^2 \sin(\theta))$$

$\quad\quad$ Inertia $\quad$ Viscous damping $\quad$ Spring stiffness $\quad$ **Dynamic coupling**

Pitching : $$M = I_\theta\ddot{\theta} + D_\theta\dot{\theta} + k_\theta\theta + (m_\theta x_\theta)\ddot{h}\cos(\theta)$$

What has been done so far?

- 2D simulations with clean inflow conditions

- Experimental demonstrations

Flutter instability

$\eta_{max} = 51.0\%$ and no LEV
Boudreau et al., RE (2019)

Idealized model

Divergence instability

$\eta_{max} = 33.6\%$ and presence of LEV
Veilleux and Dumas, JFS (2017)

$(\eta_{max} = 31.0\%)$ - Experimental setup of the fully passive hydrokinetic turbine in a channel at the University of Victoria
Boudreau et al., JFS (2018)

My M.Sc. project

What is next to investigate?
Validate the concept by including:

- 3D effects

- Confinement effects

- Perturbed inflow conditions (shear flow, turbulence)