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UNIVERSITÉ LAVAL

Developing the Oscillating Hydrofoils Hydrokinetic Turbine

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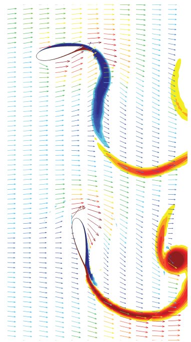
Numerical Simulations (CFD)

Using high-end Navier-Stokes Computational Fluid Dynamics simulations (CFD) running on supercomputers in order:

To optimize

→ geometry
→ motion amplitudes
→ oscillation frequency
→ multiple-foils spatial arrangement

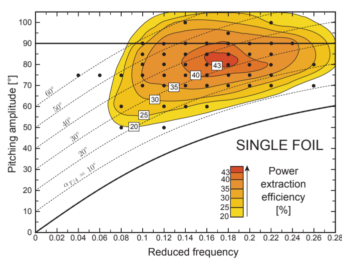
for maximum performance in power extraction.



Velocity vectors and vorticity field around two oscillating hydrofoils in a parallel spatial configuration (2D URANS).

To identify

zones of high performance in relevant parametric spaces.

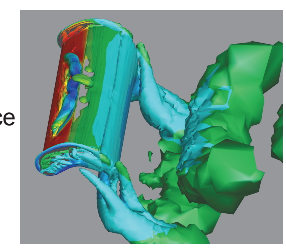


To quantify

the effect of

→ foil aspect ratio (3D)
→ flow misalignment
→ free-stream turbulence
→ free surface proximity

on extracted power.



Pressure-colored isosurface of λ_2 vortex criterion around one oscillating hydrofoil (3D URANS).

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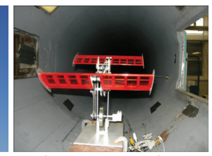
Prototype Testing

Building small-scale prototypes operating in air or water in order:

To design

efficient and reliable mechanism for the hydrofoils actuators and the power transmission.

Éolo prototype, parallel configuration, operating in air.



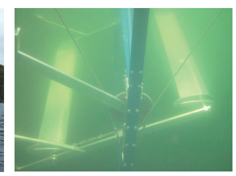
PTAO prototype, tandem configuration, operating in air.

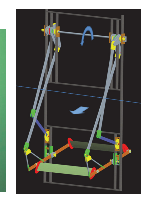
MAO prototype, single foil, operating in water canal.

To measure

the actual power extracted from a complete turbine with multiple foils

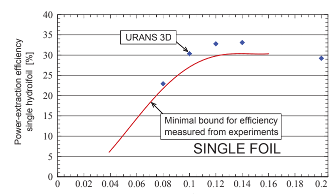
→ first-generation HAO prototype (2009): two foils in a tandem configuration





To validate

the results predicted from the numerical simulations

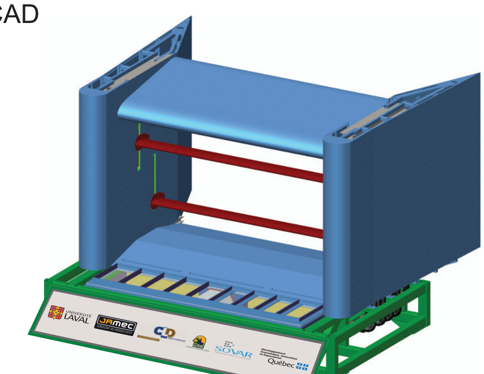


Second-generation HAO hydrokinetic turbine

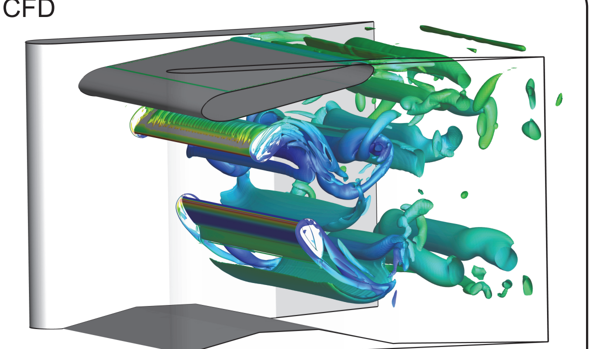
→ http://hydrolienne.fsg.ulaval.ca/en ←

- Smoothed-out power output through the use of phase-shifted hydrofoil motions → makes the turbine self-starting
  → facilitates grid integration
- Lean design where the hydrofoils are the only moving parts through the water flow.
- Compact and robust mechanisms based on low-pressure water hydraulics.

CAD



CFD



URANS simulation, Q-criterion iso-surfaces colored by pressure

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