

Field Testing of Water Horse Current Energy Converter

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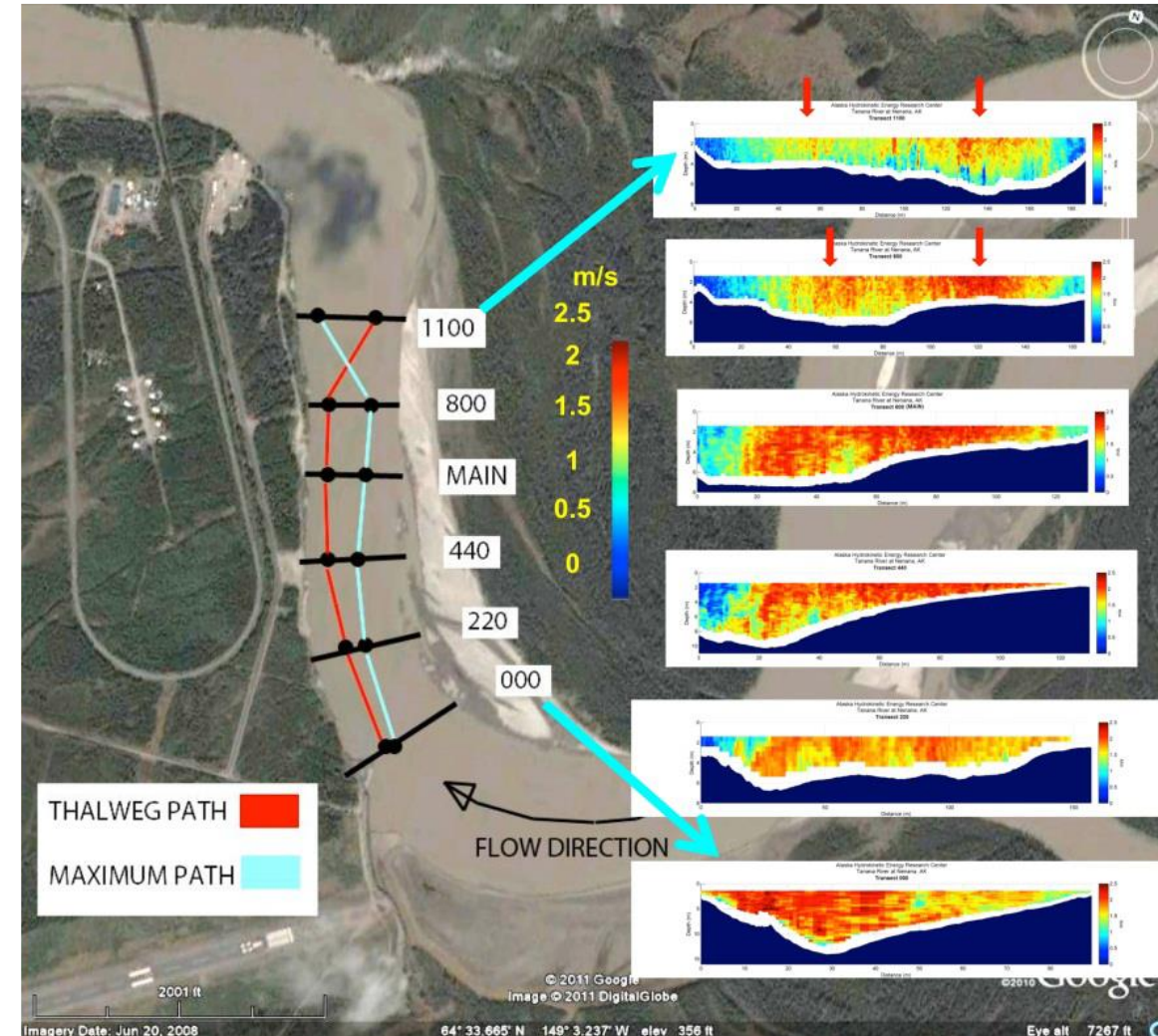
Prototype developed in consultation with Renerge, Inc. based on Renerge IP and R&D

Outline

- Test Site Overview
- Water Horse background
- Development highlights
- 2021 Field Testing
- Results
- Conclusions

Tanana River Test Site – Overview

- Located in Nenana, AK (55 highway miles SW of Fairbanks)
- Open water May to October
- Velocity 1.3 to 3.0 m/s
- Depth ~ 6m (20 ft)
- Fully Permitted
- <http://acep.uaf.edu/facilities/tanana-river-hydrokinetic-test-site.aspx>



Tanana River Test Site - Infrastructure



Inclined Plane
Fish Trap

Research Barge

River Debris Diverter
Platform (RDDP)



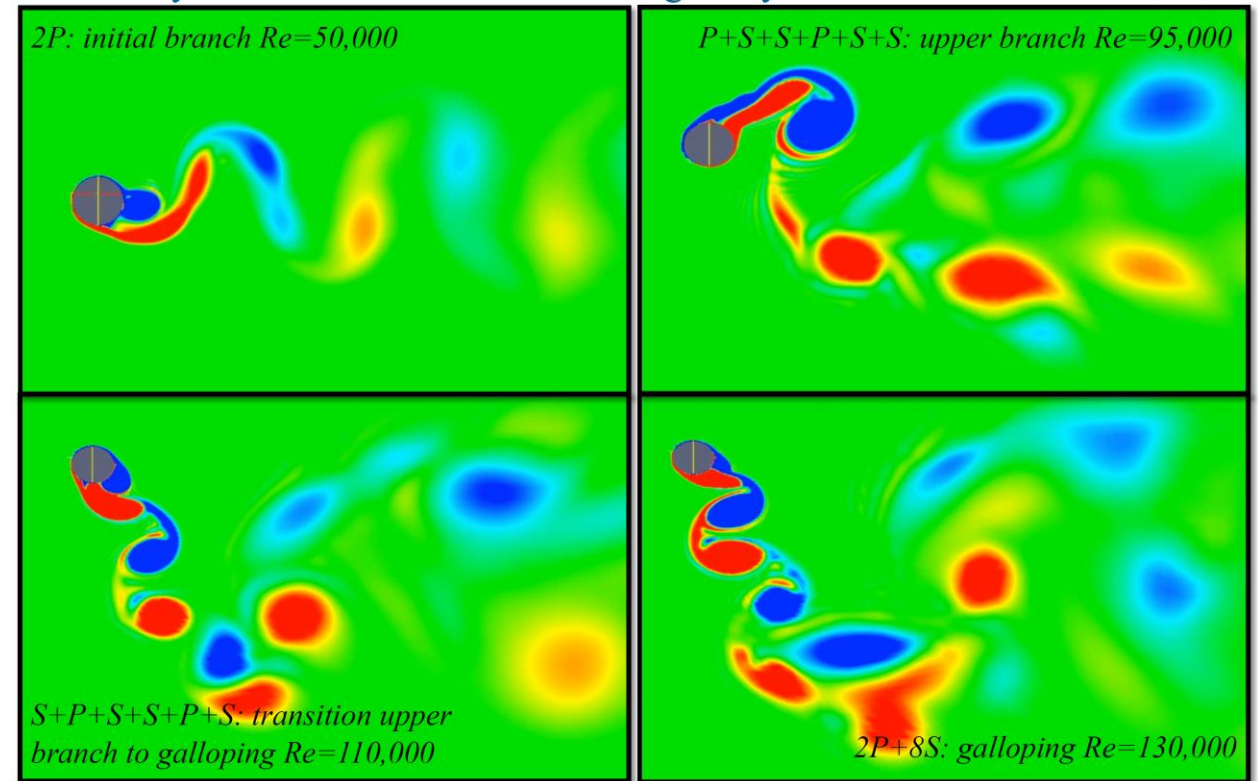
Water Horse – Prototype 1 (2020)

- DOE WPTO Funding
- Renerge, Inc IP
- Low-cost and robust vs low efficiency



Water Horse - Galloping Current Energy System

- Bluff body vortex shedding changes with Reynold, $Re = \frac{\rho v L}{\mu}$
- Shedding frequency per Strouhal, $St = \frac{fL}{v} \cong 0.2$
- VIVACE research at University of Michigan
- Cannot constrain frequency or amplitude



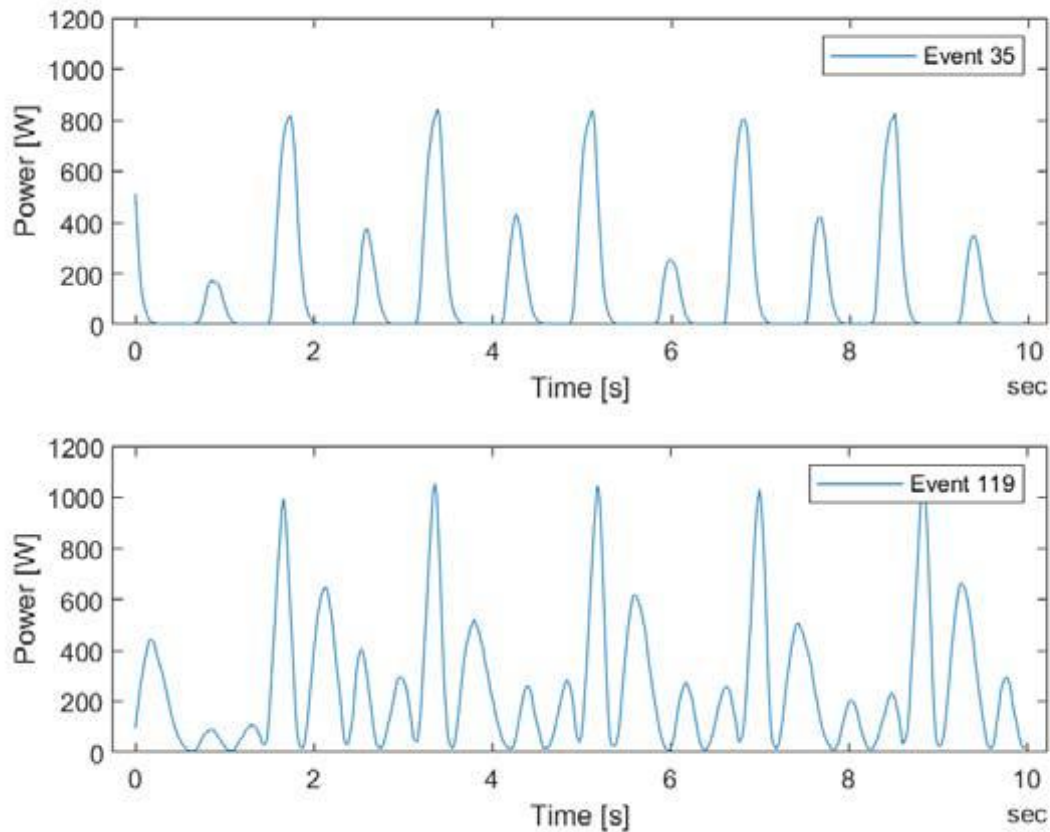
M. M. Bernitsas, "The VIVACE Converter," 2011.

Water Horse Video

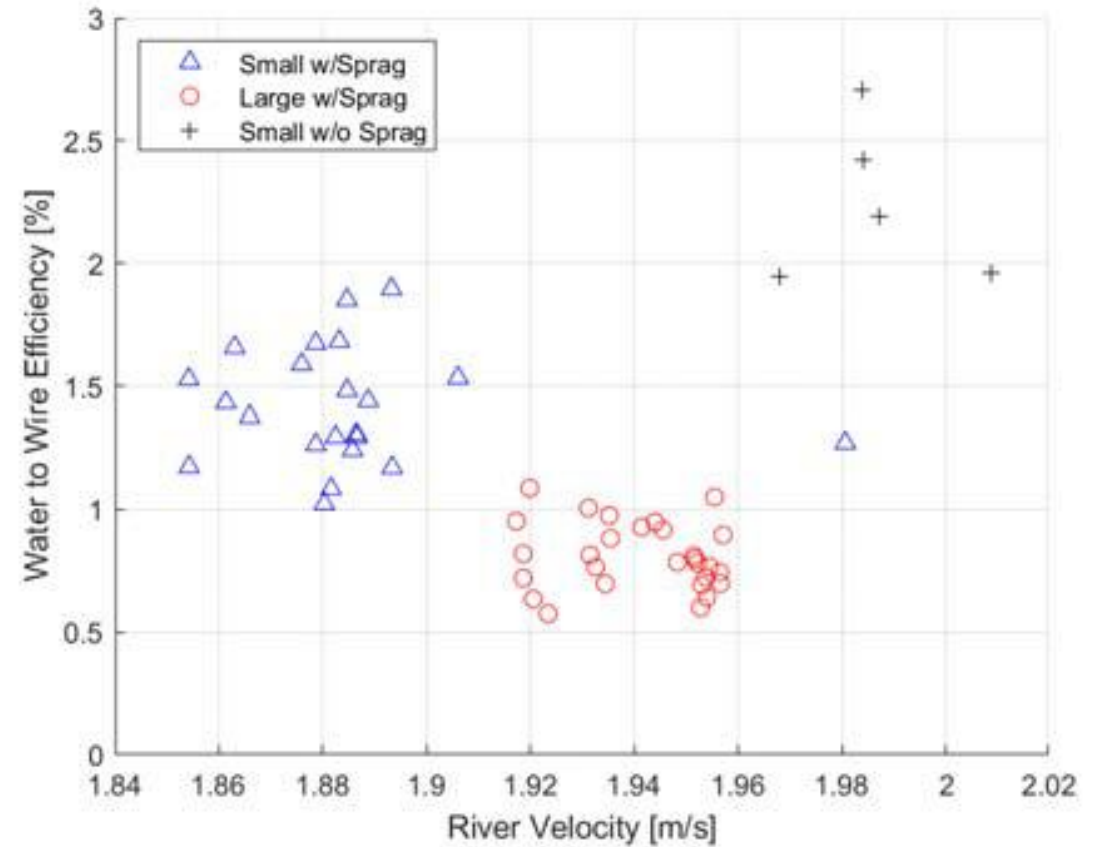


Water Horse Results - 2021

Electrical Output Power Signal

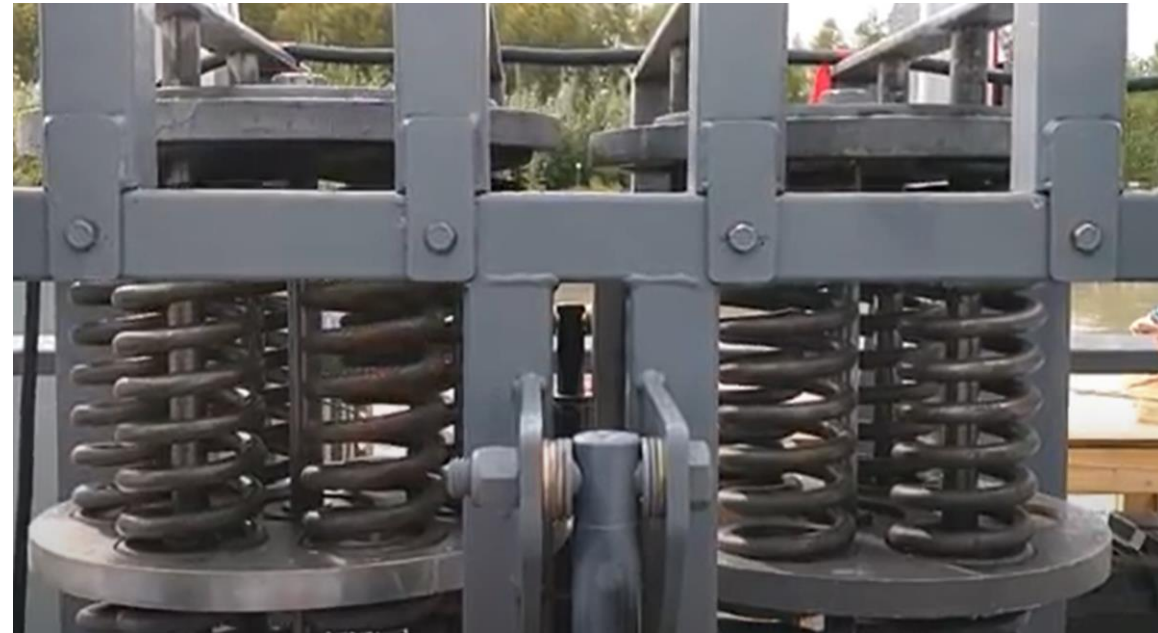


Water-to-wire Efficiency

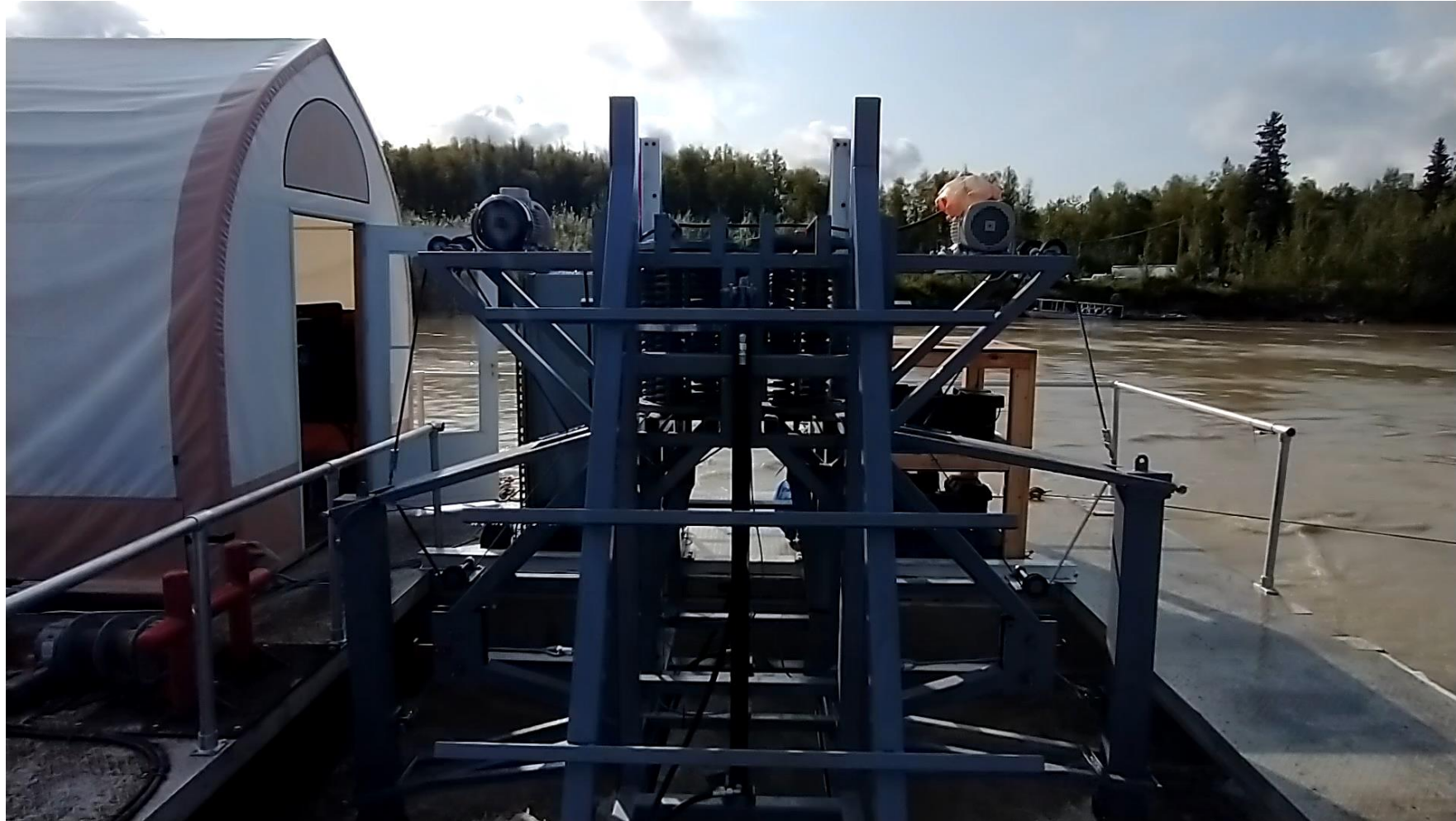


System improvements

- Bluff body size change
 - Increase oscillating frequency, away from barge frequency
- Simplified suspension
 - Lower cost and friction
- Spring rearrangement
 - Stable (tension) and compact
- Vertical deployment (still an issue)
- Improved PTO
 - Better coupling between generator and oscillator

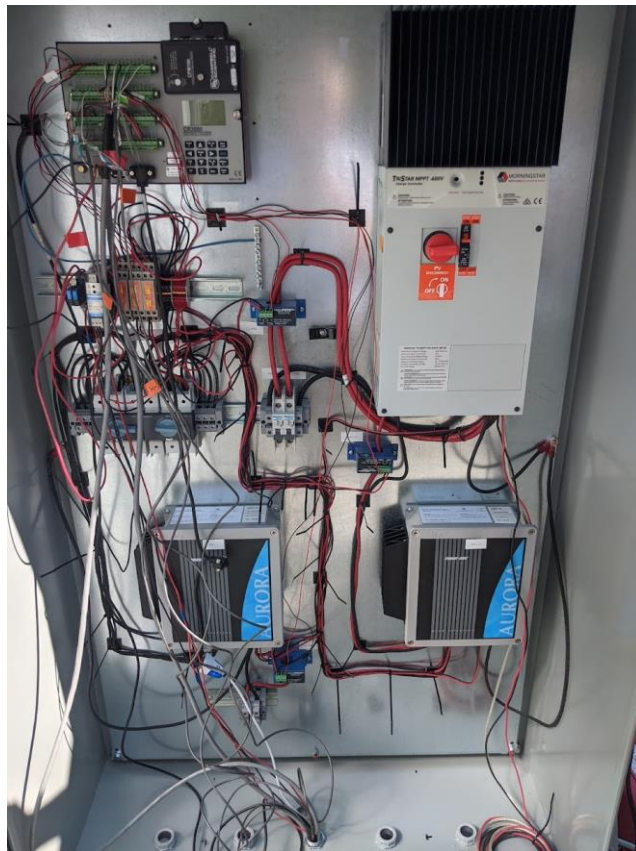


Dual Oscillator Video

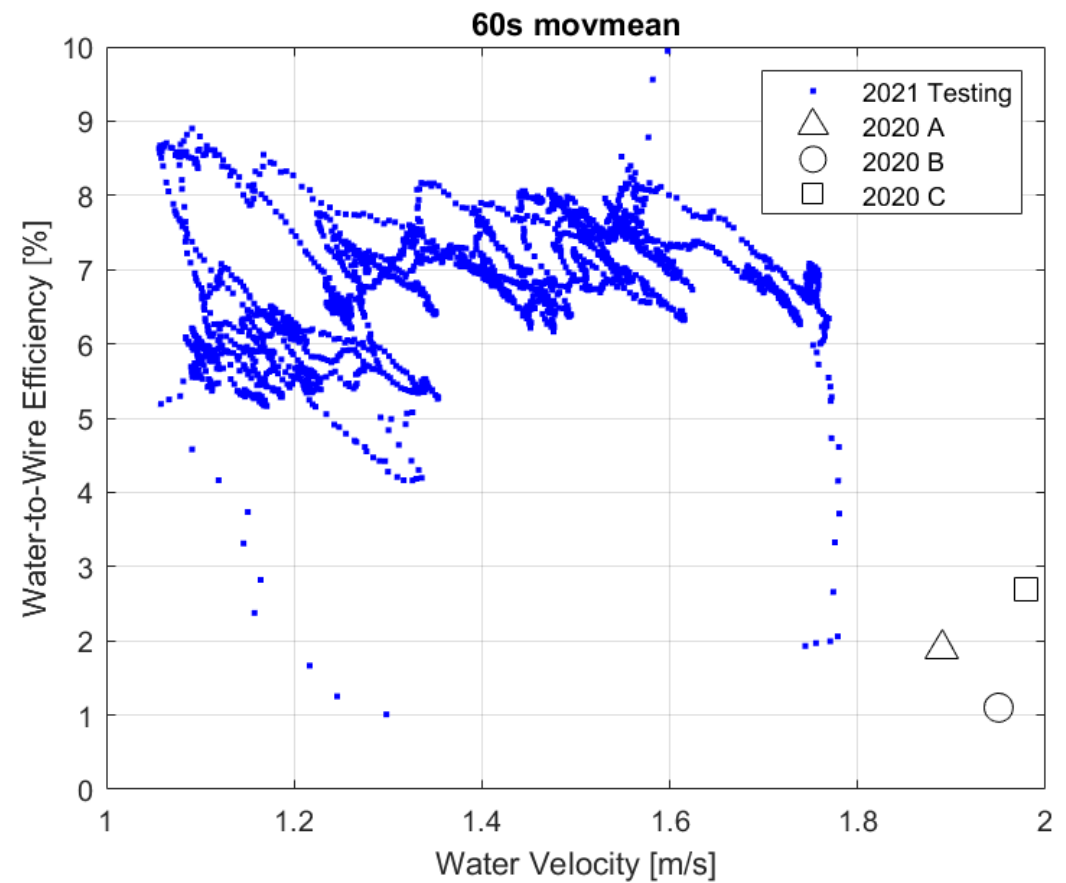


Water Horse Results - 2022

Electrical Output Power Signal

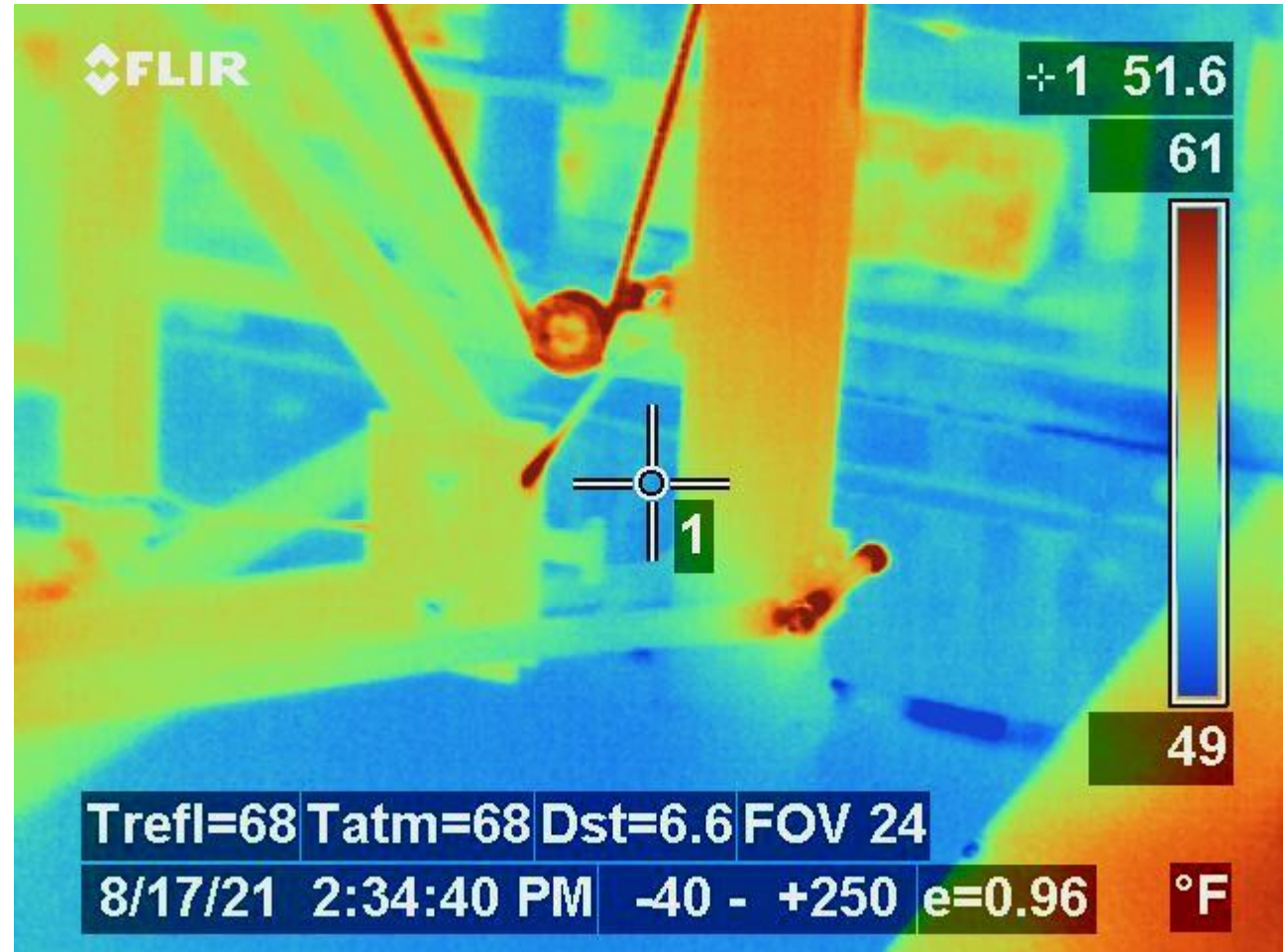


Water-to-wire Efficiency



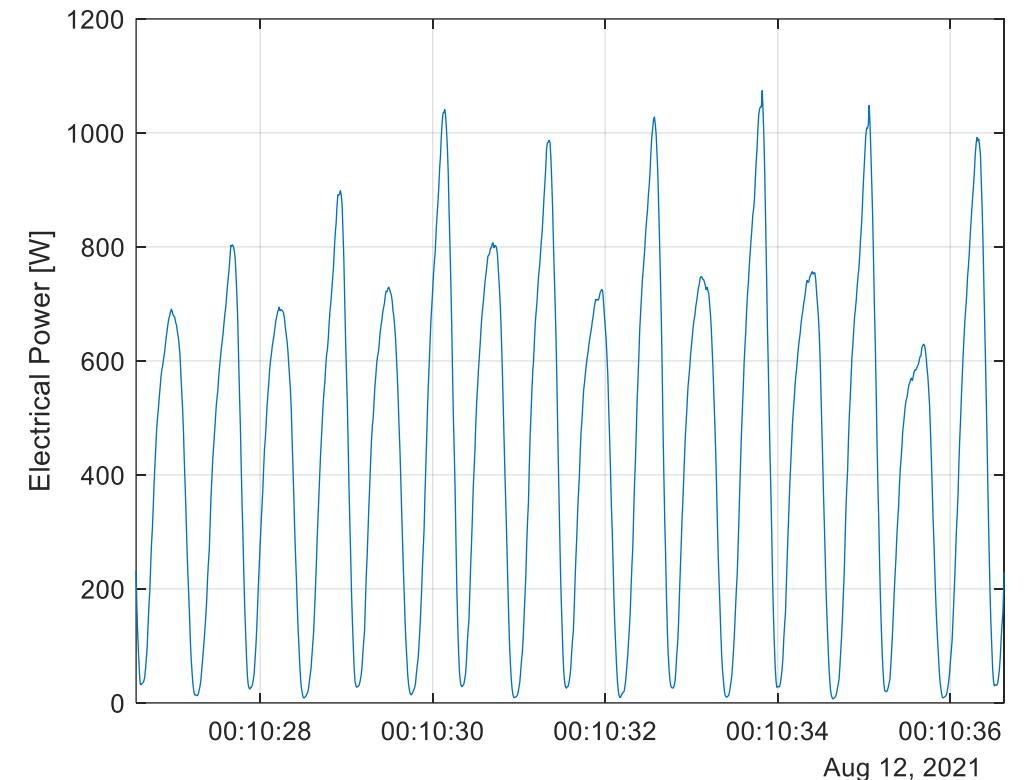
Dual Oscillator Qualitative Results

- System dependent on damping (electrical load)
- Realtime tuning may be needed to track river fluctuations
- Many moving parts (friction, wear, maintenance)



Conclusions

- Low Capacity Factor (4.1%)
 - Low efficiency despite improvements
 - Peak to average power (generator oversize)
- High structural requirement per unit power
 - Mechanical spring requirements
 - Cantilever design
- LCOE projected at \$4.38/kWh
- Publications in the works



Questions?

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