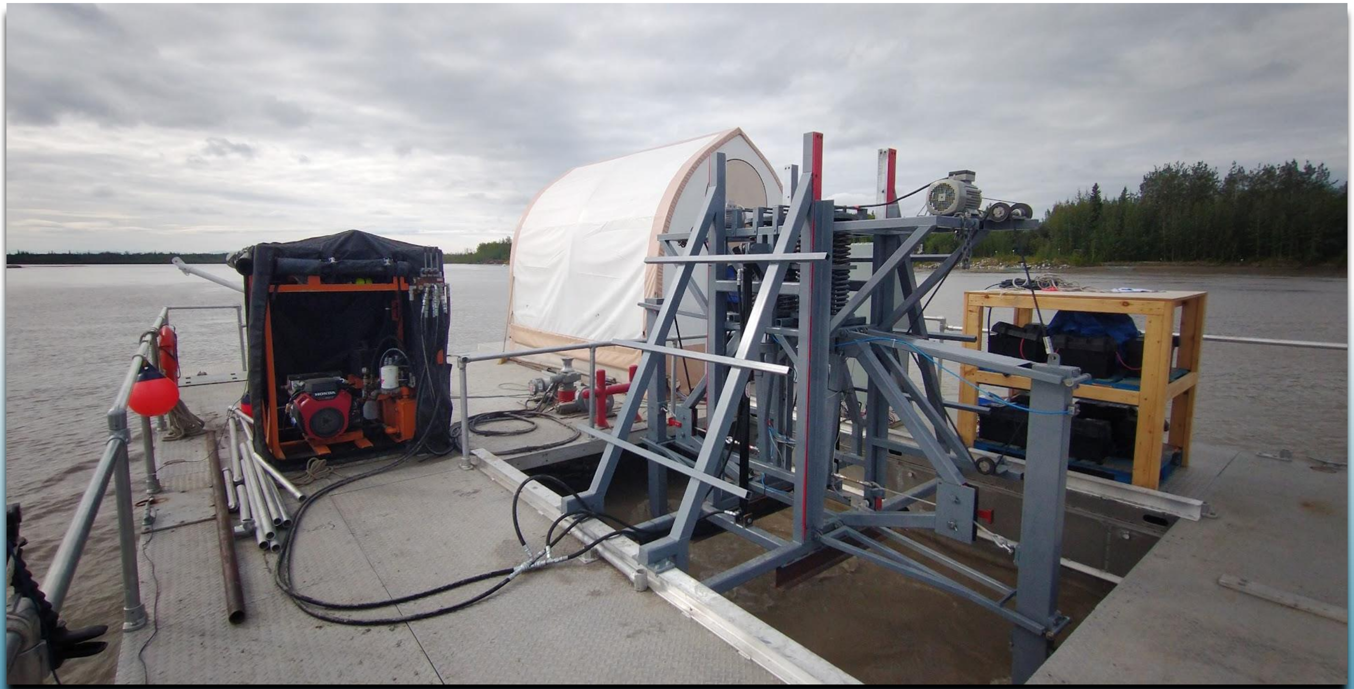
Field Testing of Water Horse Current Energy Converter

Marine Energy Technical Symposium, 14 September 2022

Ben Loeffler, Alaska Center for Energy and Power at UAF, bhloeffler@alaska.edu



PMEC Pacific Marine Energy Center

University of Alaska Fairbanks

Oregon State University

University of Washington

Acknowledgements

Water Horse material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Water Power Technologies Office Award Number DE-EE0008389.

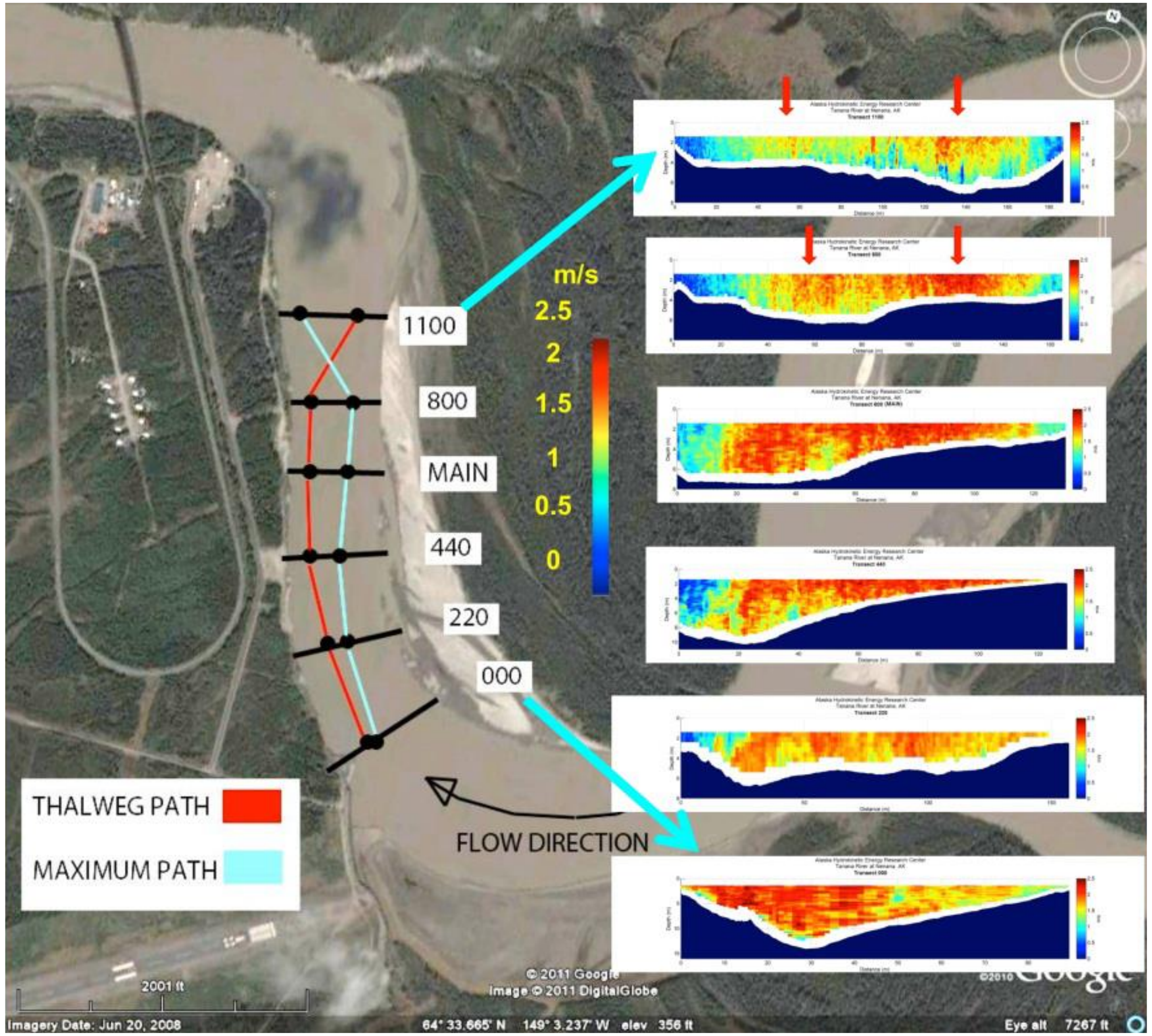
Prototype developed in consultation with Renerge, Inc. based on Renerge IP and R&D

Outline

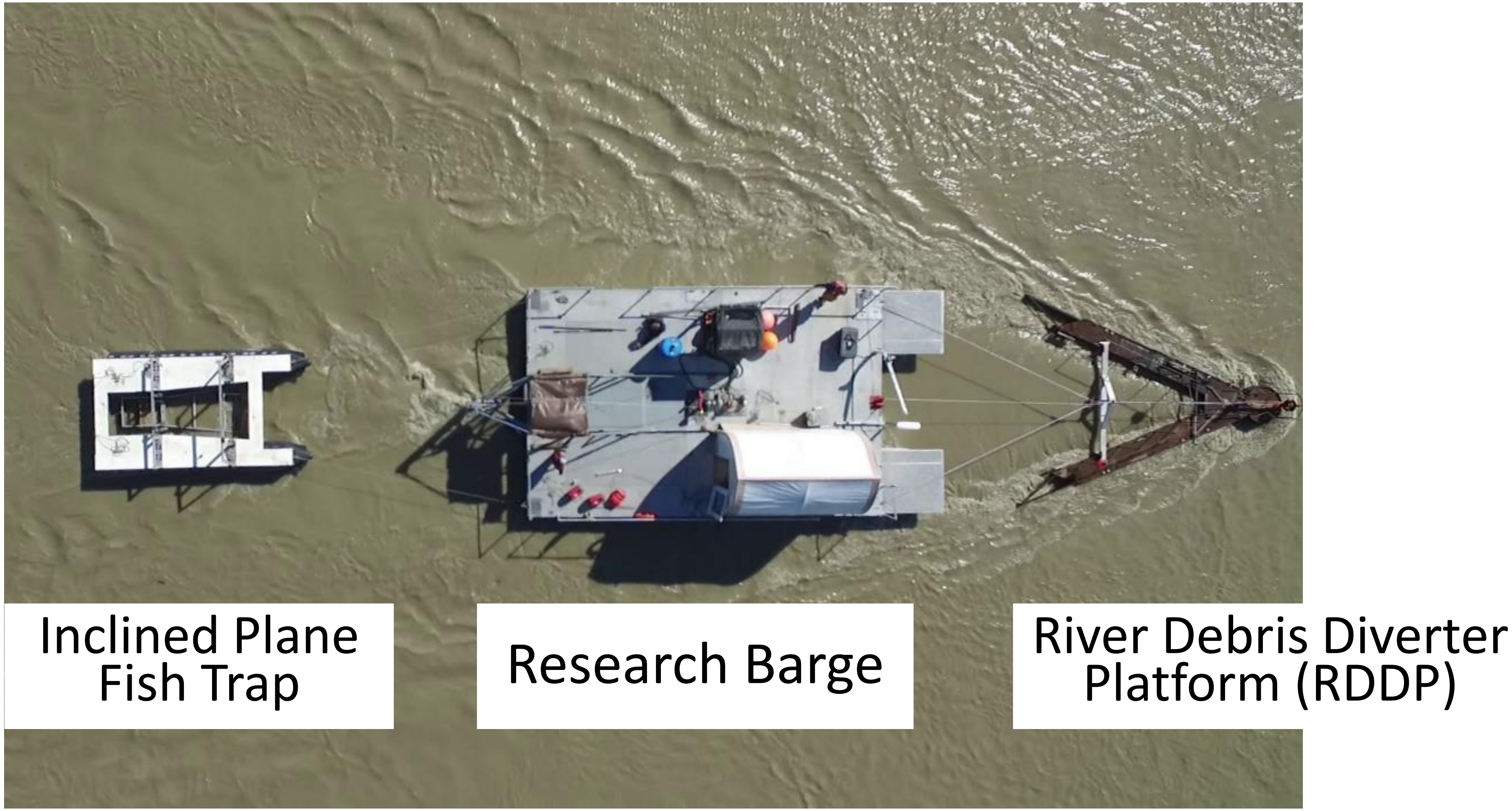
- Test Site Overview
- Water Horse background
- Development highlights
- 2021 Field Testing
- Results
- Conclusions

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

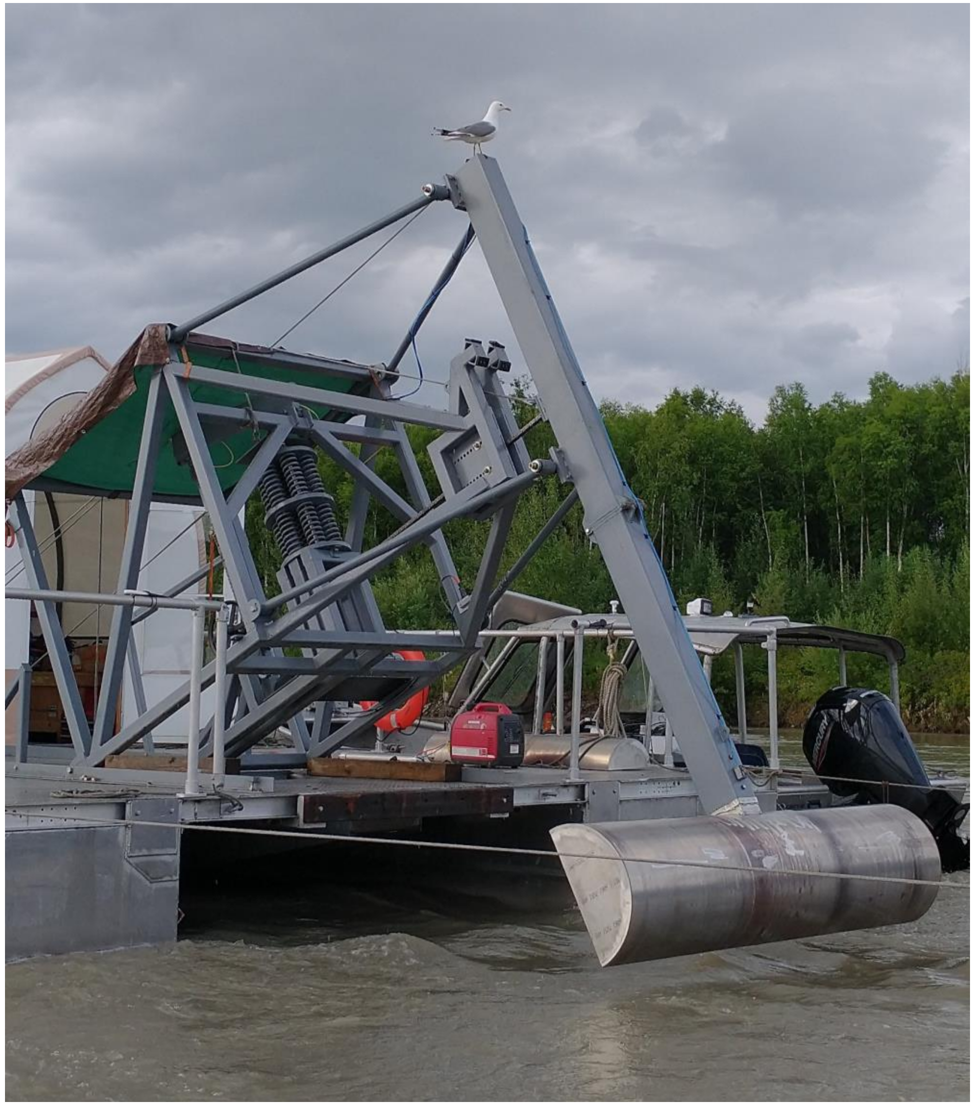


Tanana River Test Site - Infrastructure



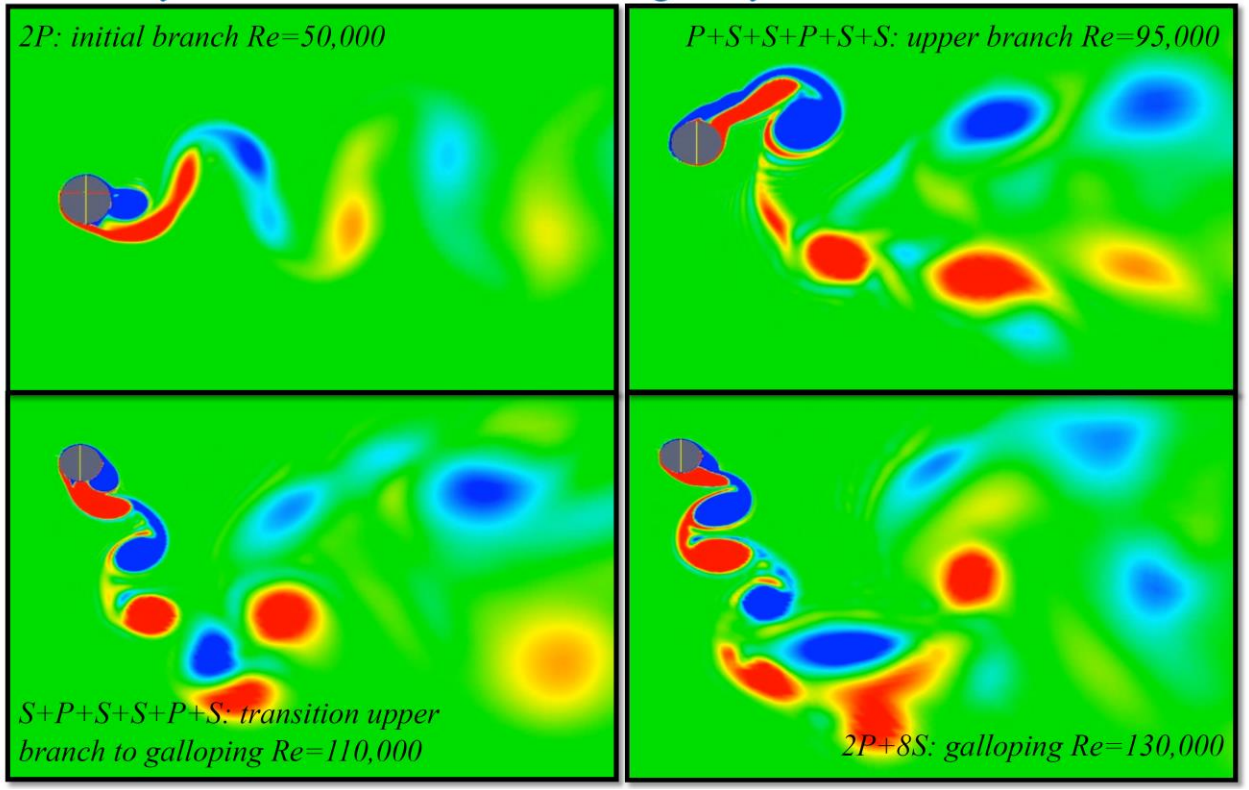
Water Horse – Prototype 1 (2020)

- 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

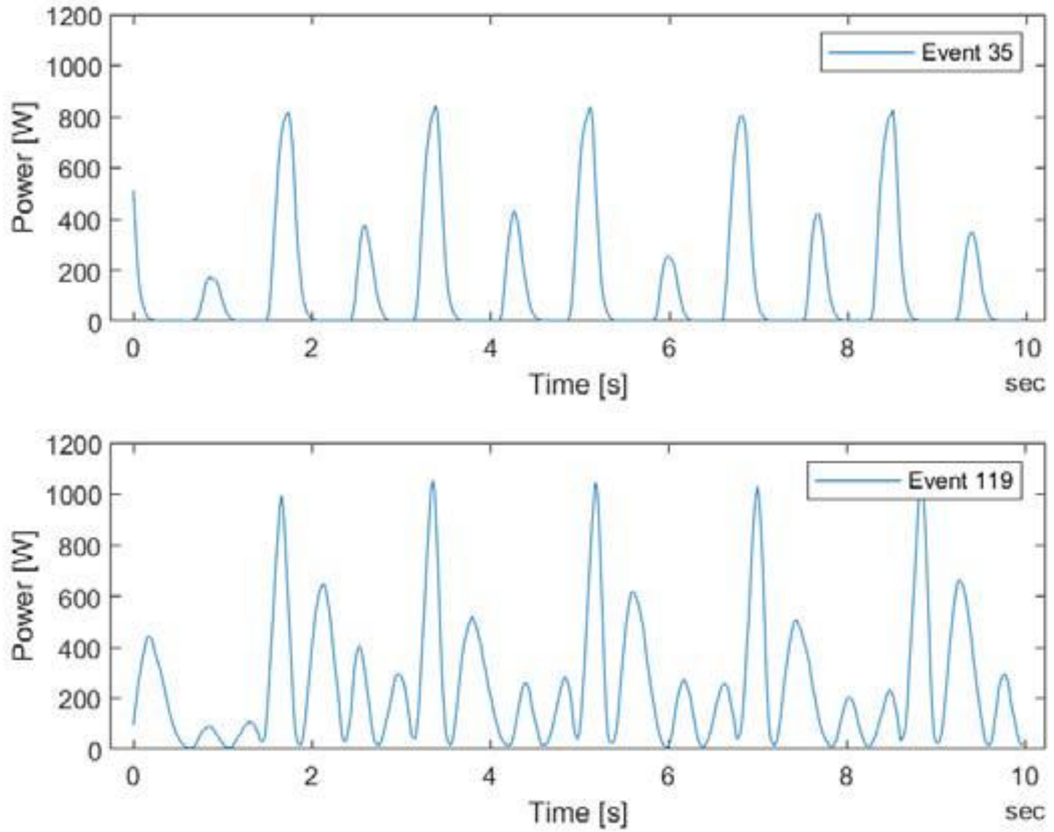


M. M. Bernitsas, “The VIVACE Converter,” 2011.

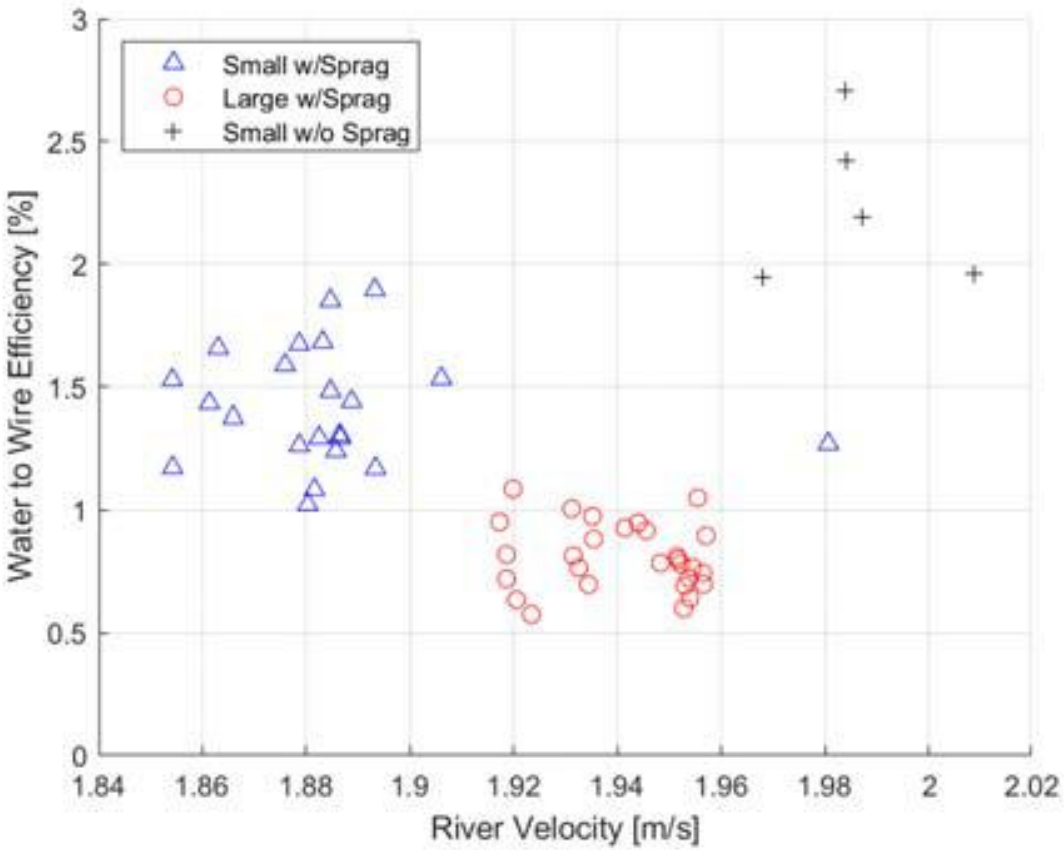
Water Horse Video

Water Horse Results - 2021

Electrical Output Power Signal

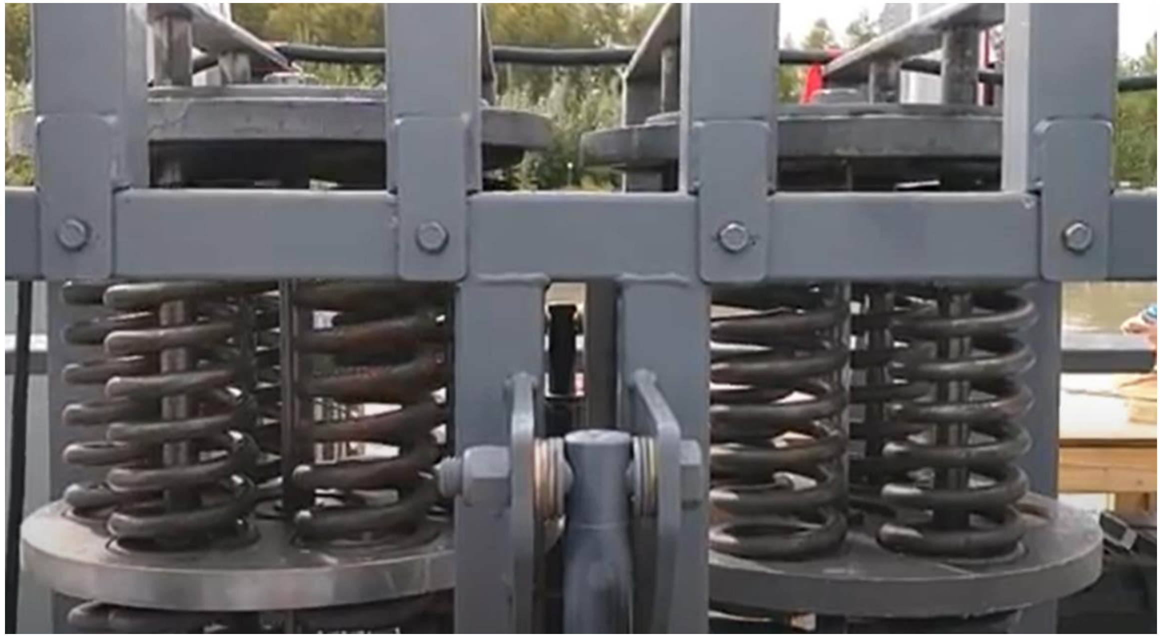


Water-to-wire Efficiency

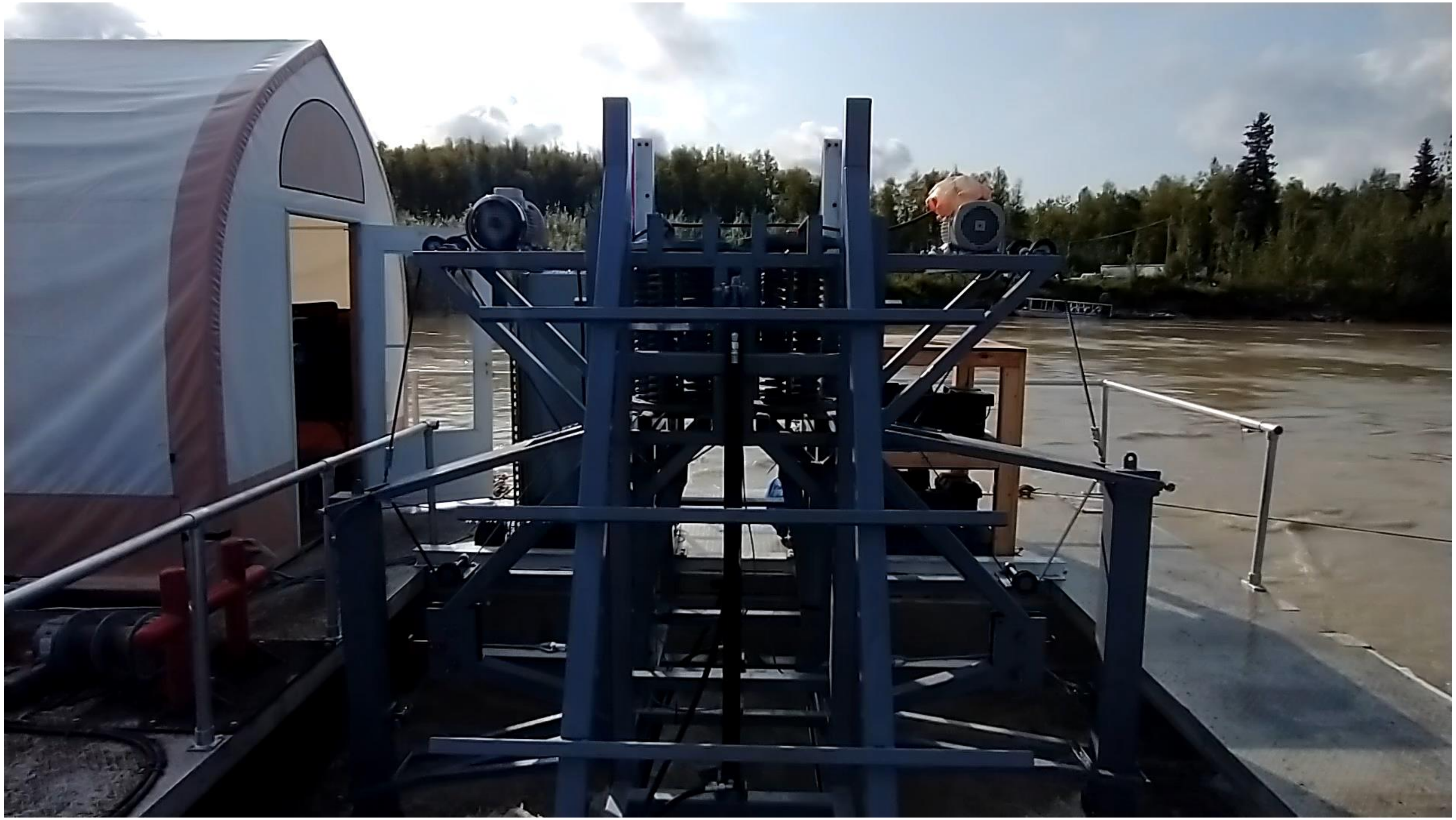


System improvements

- 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

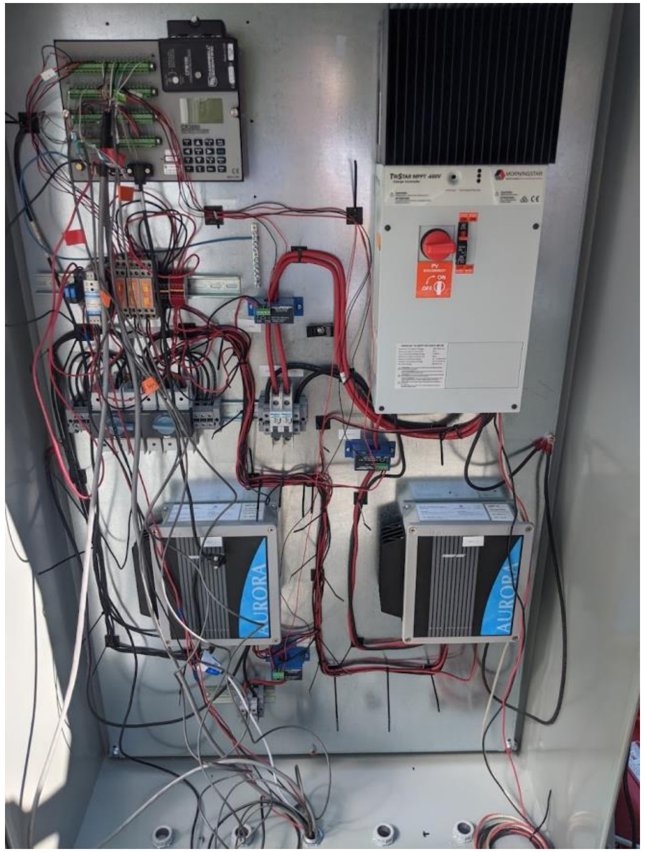


Dual Oscillator Video

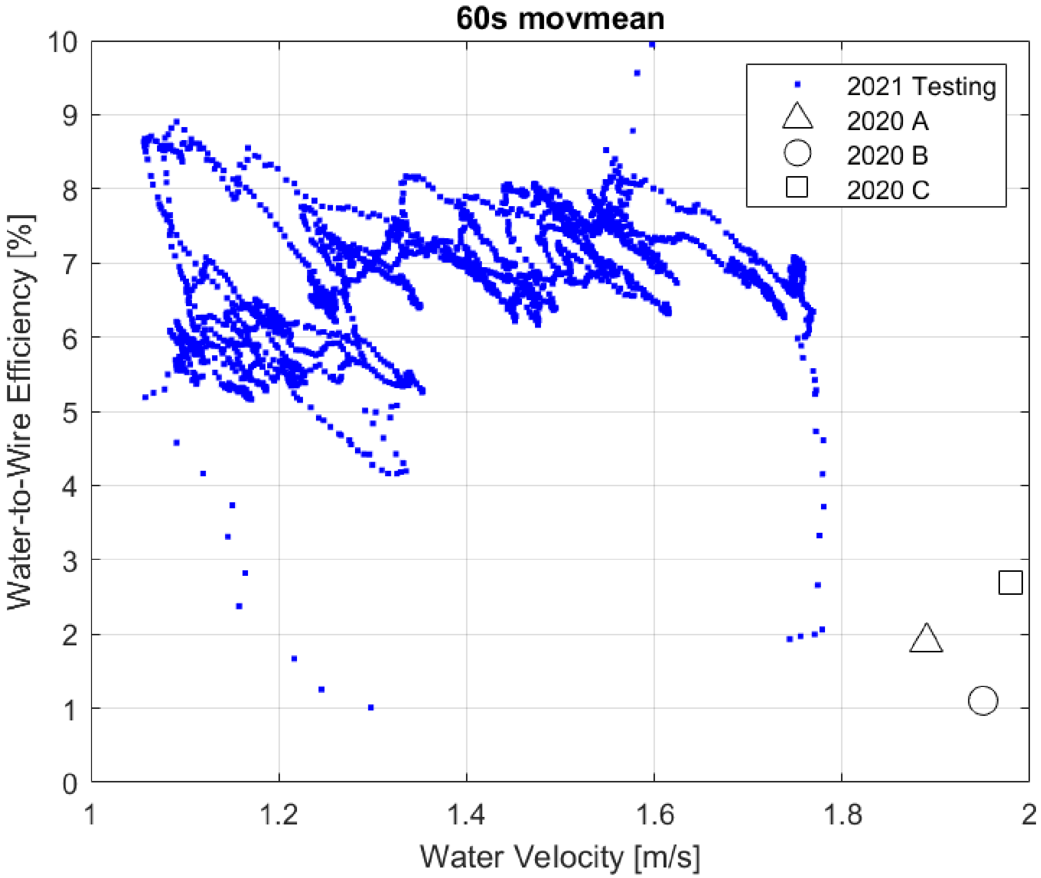


Water Horse Results - 2022

Electrical Output Power Signal

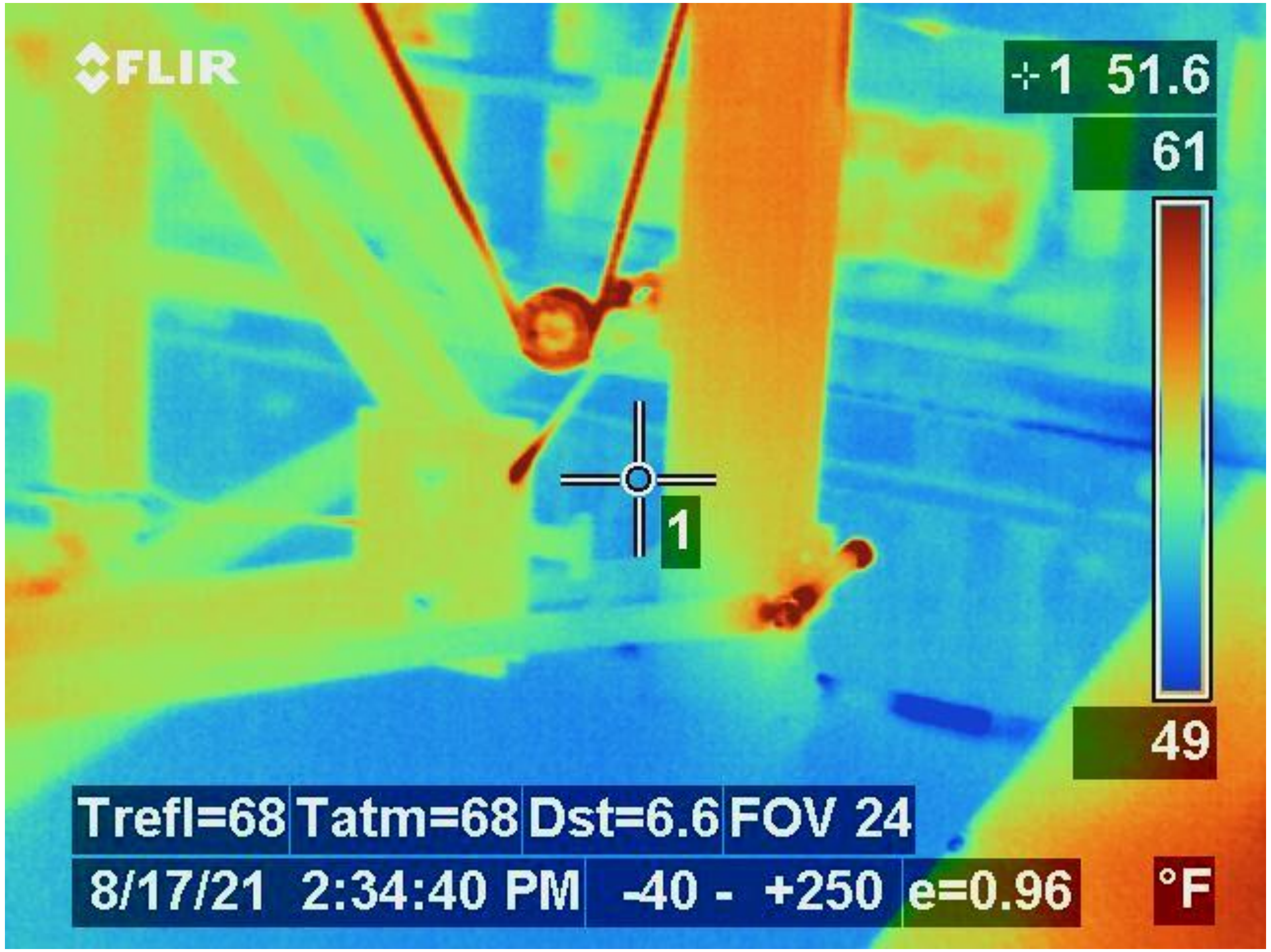


Water-to-wire Efficiency



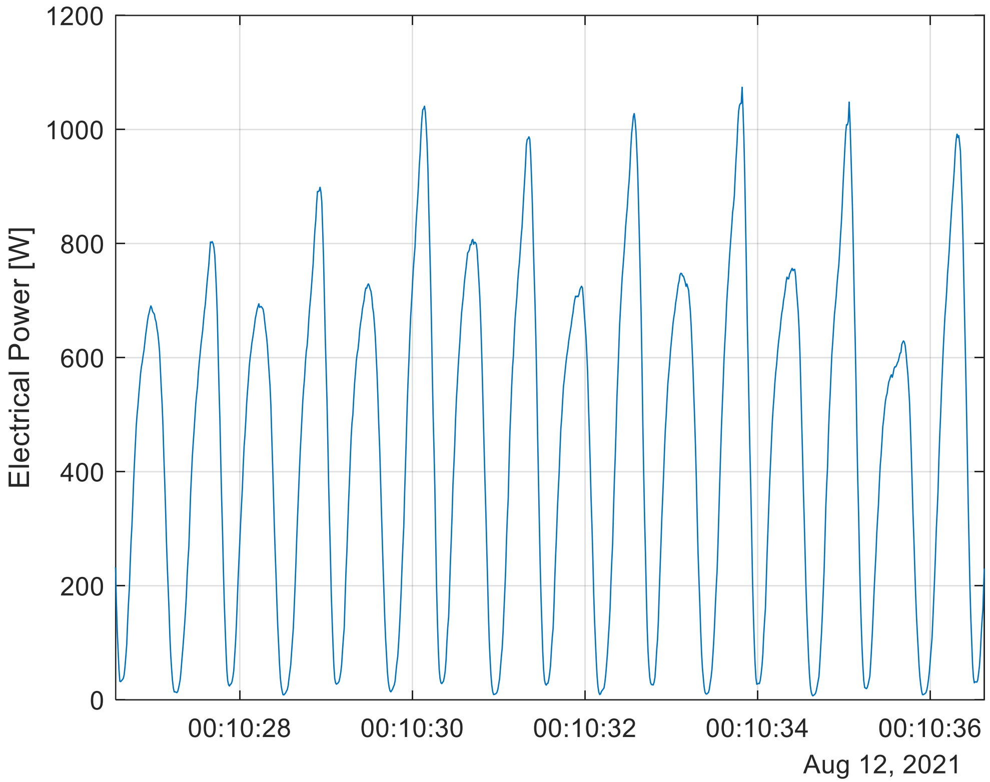
Dual Oscillator Qualitative Results

- 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



PMEC Pacific Marine Energy Center
UAF University of Alaska Fairbanks
ACEP Alaska Center for Energy and Power

Questions?

Ben Loeffler
Alaska Center for Energy and Power
at UAF
bhloeffler@alaska.edu