A Drifting Acoustic Instrumentation SYsytem (DAISY)

DE-EE0007823

Marine and Hydrokinetics Program

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University of Washington

Project Overview

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Project Summary

- Develop and demonstrate a modular, drifting acoustic measurement system for use in energetic waves and currents.
- Minimize contamination from flow-noise (caused by relative motion between the hydrophone and water) and self-noise (caused by mechanical or electrical components).
- Develop a method to localize sound by using multiple DAISYs to attribute emissions to specific sources.

Project Objective & Impact

- Acoustic monitoring is required for most marine energy projects. Standardized measurement approaches are now described in IEC Technical Specification 62600-40.
- To retire acoustic risk, cost-effective, high-fidelity measurements of underwater sounds in marine energy environments are required.
- Acoustic localization is required to objectively attribute emissions to a specific source and avoid conflating sound from marine energy converters with other ambient or anthropogenic sources.

Project Information

Project Principal Investigator(s)

Brian Polagye

WPTO Lead

Dana McCoskey
Corey Vezina

Project Partners/Subs

None

Project Duration

- December 1, 2016
- December 31, 2020

Alignment with the Program

Marine and Hydrokinetics (MHK) Program Strategic Approaches

Data Sharing and Analysis

- Foundational and Crosscutting R&D
- Technology-Specific Design and Validation
- Reducing Barriers to Testing

Alignment with the MHK Program

Reducing Barriers to Testing

- Enable access to world-class testing facilities that help accelerate the pace of technology development
- Work with agencies and other groups to ensure that existing data is well-utilized and identify potential improvements to regulatory processes and requirements
- **Support additional scientific research as needed, focused on retiring or mitigating environmental risks and reducing costs and complexity of environmental monitoring**
- Engage in relevant coastal planning processes to ensure that MHK development interests are equitably considered

The DAISY supports acoustic risk retirement by complying with the International Electrotechnical Commission (IEC) 62600-40 technical specification for acoustic characterization.

The DAISY research and development addresses the existing technological gaps that inhibit identification of sound originating from marine energy converters.

Project Budget

Total Project Budget – Award Information		
DOE	Cost-share	Total
$750k	$85k	$835k

FY17	FY18	FY19 (Q1 & Q2 Only)	Total Actual Costs FY17–FY19 Q1 & Q2 (October 2016 – March 2019)
Costed	Costed	Costed	Total
$145k	$250k	$107k	$501k

- R&D change to reduce cost and increase functionality: Switch from commercially-available recording hydrophone system (OceanSonics icListen HF) to board-level integration of HTI 99-UHF
  - Extended duration for Budget Period 2
  - Overall system cost reduction and greater integration flexibility
  - Uses US-sourced hydrophones

Management and Technical Approach

Planned

Actual

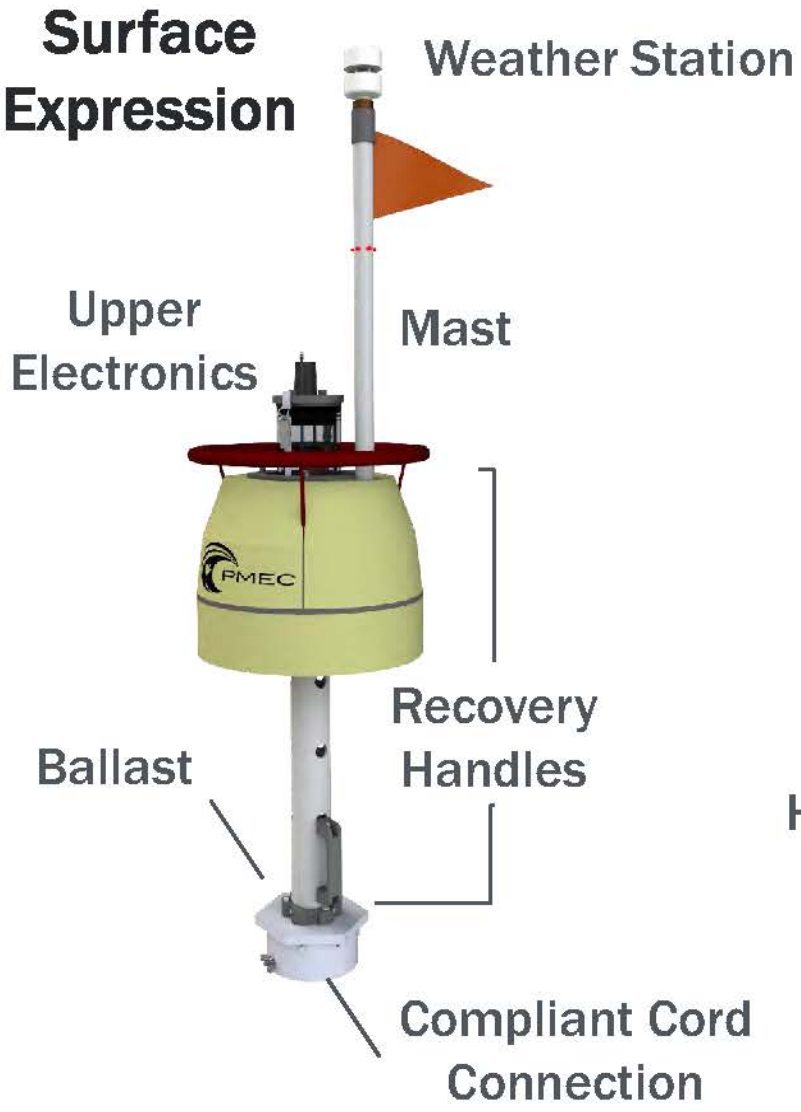
Management and Technical Approach

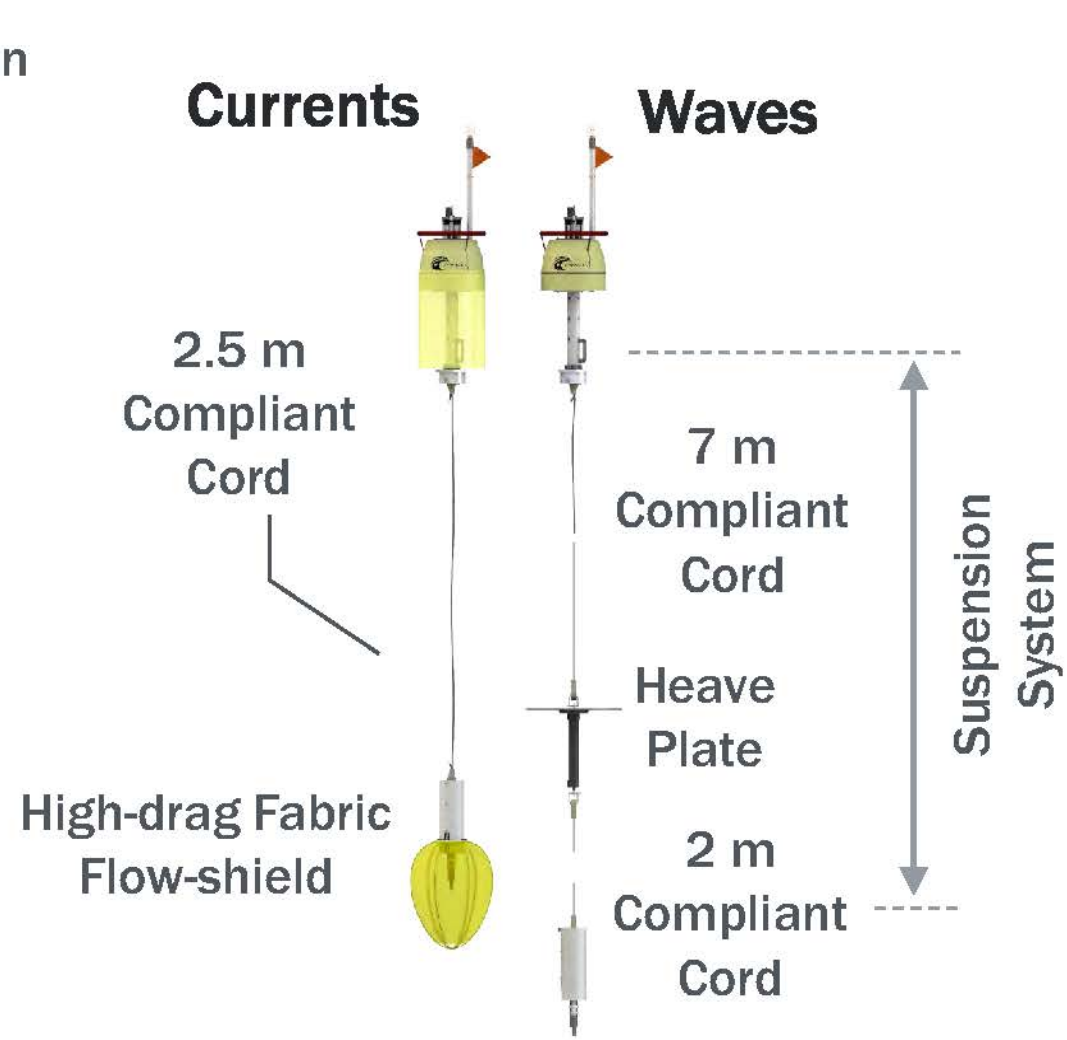
- **Success Factors**
  - *Technical*: Minimize flow-noise and self-noise in recordings
  - *Market*: Meet and exceed IEC 62600-40 technical specification
  - *Business*: Minimize product cost (equipment and operations)
- **Challenges**
  - *Equipment cost*: COTS hydrophone acquisition system > 75% of total system cost
  - *Hydrophone acquisition system development*: Relatively complicated board-level electronics design required to minimize high-frequency (> 10 kHz) noise
  - *Low-frequency self-noise and flow-noise suppression*: Competing design requirements to minimize self-noise and flow-noise at low frequencies (< 20 Hz) while minimizing cost and operational complexity

End-User Engagement and Dissemination Strategy

- **Alignment with IEC 62600-40**
  - PI was Convener of IEC 62600-40 (transitioning to IEC ad hoc group to monitor implementation)
  - DAISY compliant with technical specification
  - DAISY capabilities should address gaps identified by specification
- **Presentations**
  - European Wave and Tidal Energy Conference (2017)
  - Marine Energy Technology Symposium (2018)
  - Environmental Interactions of Marine Renewables (2018)
  - Acoustical Society of America (2018)
- **Publications**
  - Planned archival publication on system development and performance

Technical Accomplishments





Technical Accomplishments (Cont.)

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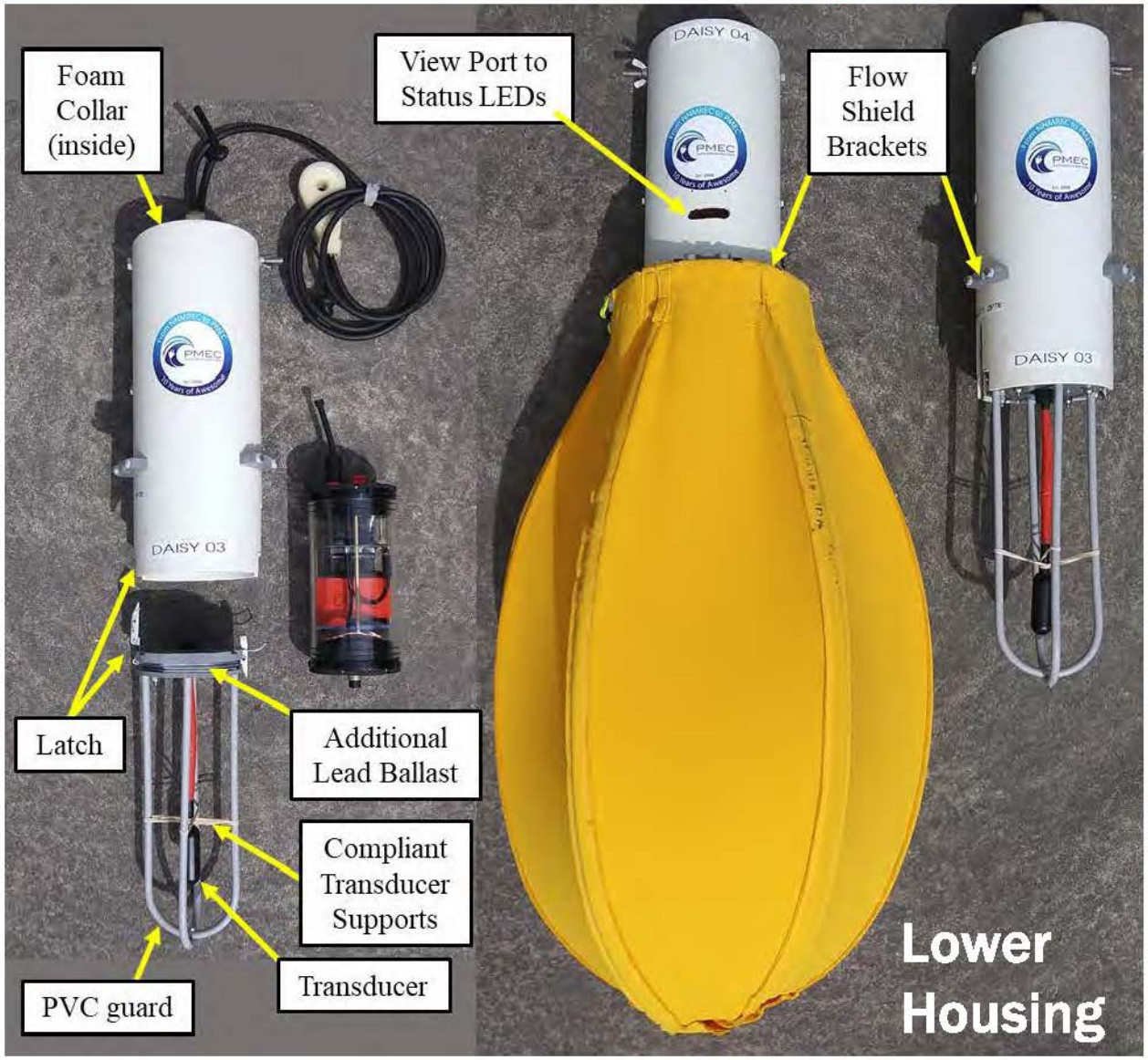


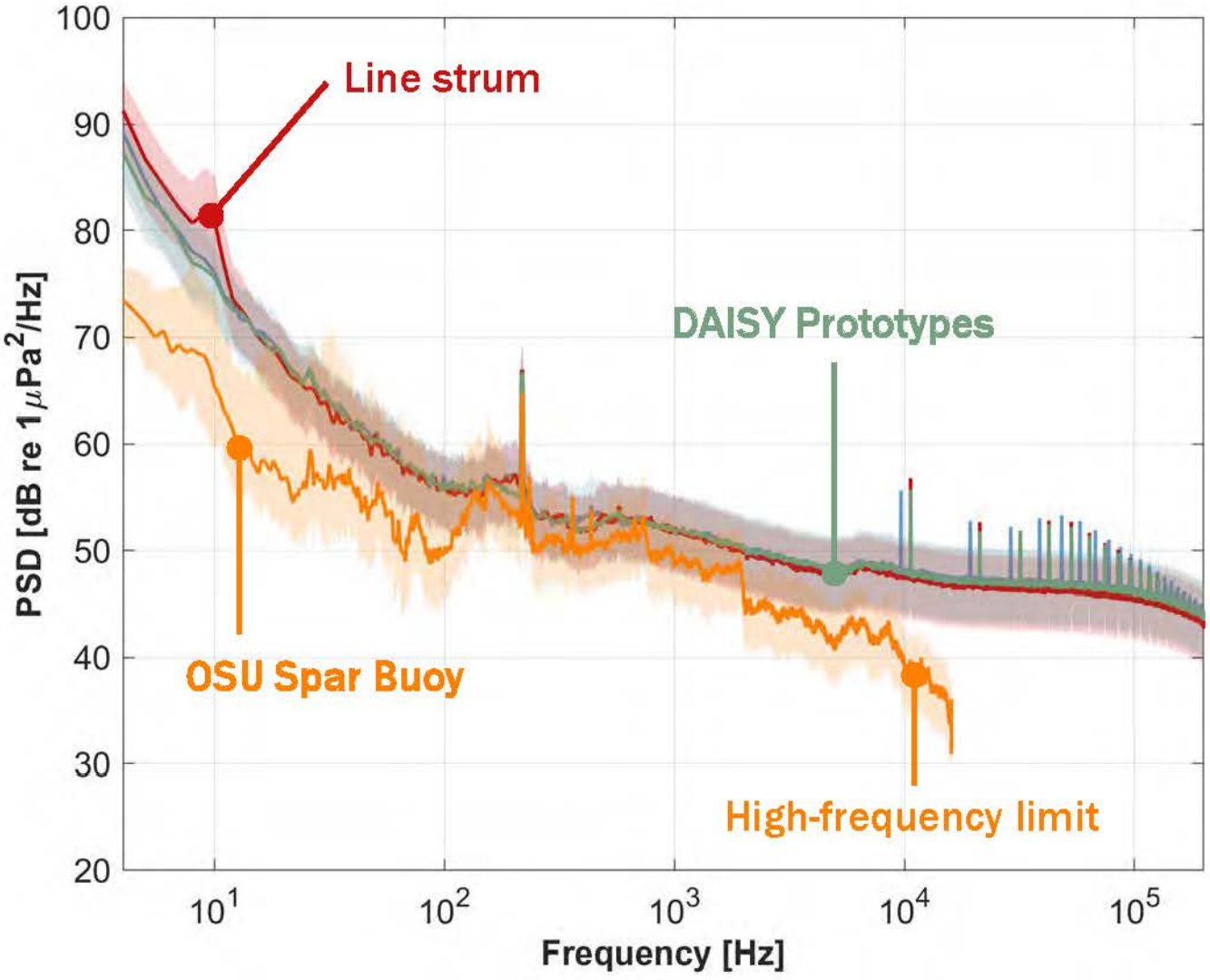
- **Flow shield**
  - Quiescent pocket around hydrophone in currents
  - Tear-resistant "ripstop" fabric
  - Fabric layers (hydrophobic / hydrophilic) suppress air bubble formation
  - Spring steel for structure and durability

Technical Accomplishments (Cont.)

Credit: Dana McCoskey, US Department of Energy

Technical Accomplishments (Cont.)

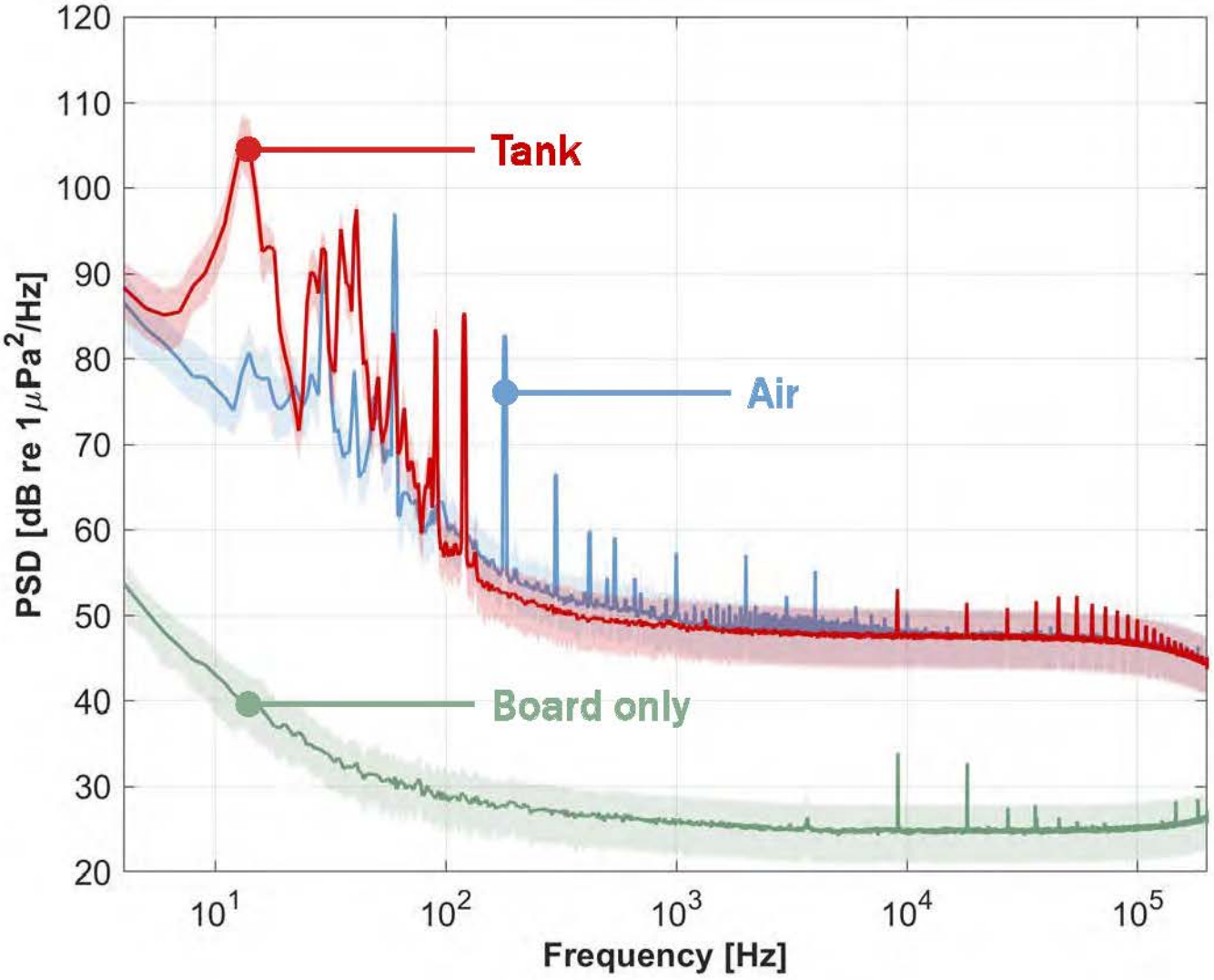
Quiescent Comparison: DAISY and OSU Spar Buoy



- **Consistent performance for DAISY 01, DAISY 02, and DAISY 03, but…**
  - High-frequency (> 10 kHz) artifacts
  - Intermittent line strum at low-frequency (< 10 Hz)
  - Poor agreement with OSU spar buoy at most frequencies

Technical Accomplishments (Cont.)

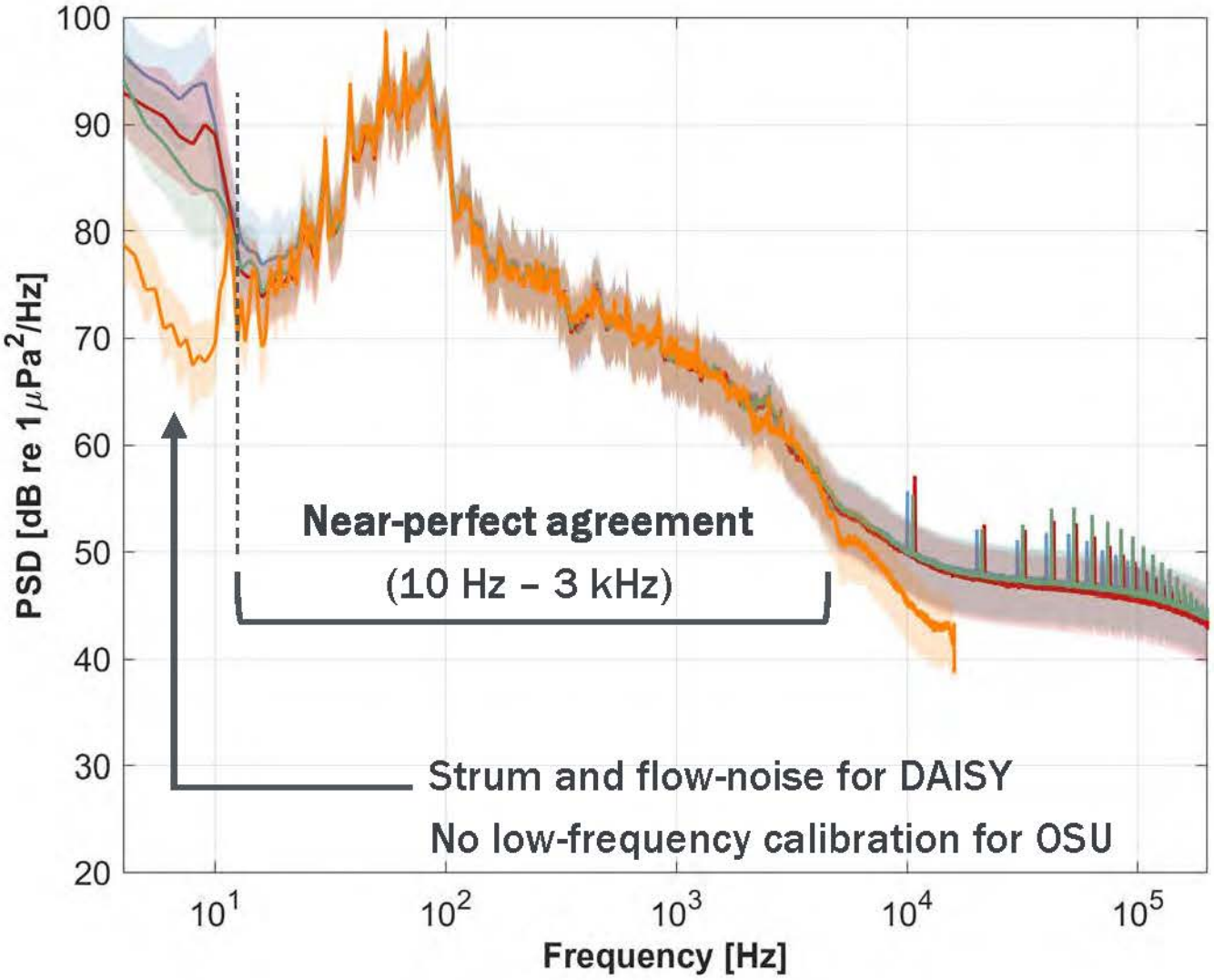
Noise Floor Identification



- Noise floor increases significantly when hydrophone attached
- Indicates source of noise is power supply to hydrophone (board modification)
- Noise floor at frequencies > 1 kHz in agreement with quiescent test data

Technical Accomplishments (Cont.)

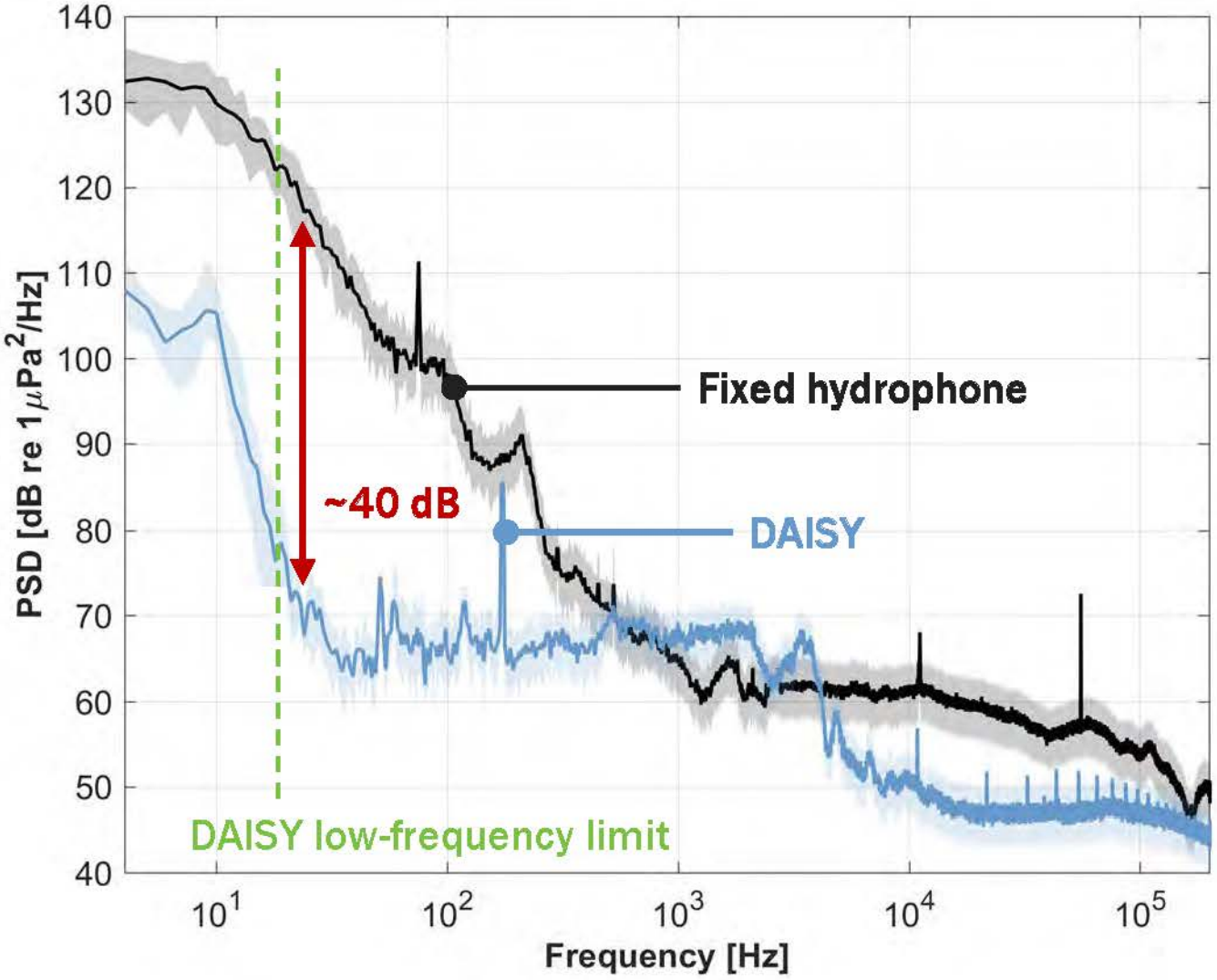
Clallam Bay Comparison: DAISY and OSU Spar Buoy



- Consistent performance for DAISY 01, DAISY 02, and DAISY 03
- Near-perfect agreement with OSU spar buoy at frequencies most relevant to wave converters

Technical Accomplishments (Cont.)

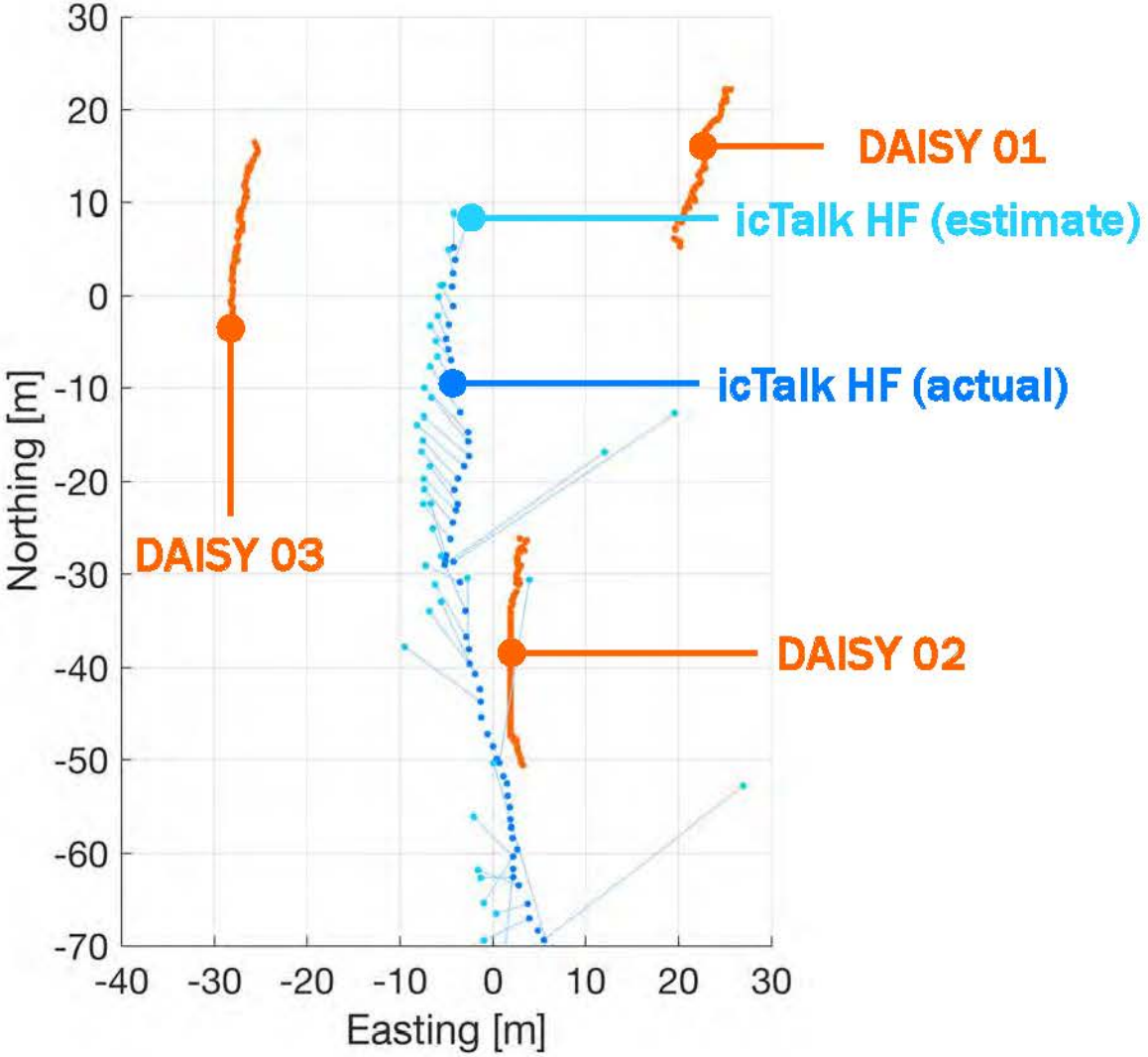
Sequim Bay Channel Comparison: DAISY and Fixed Hydrophone



- Flow shield suppresses flow-noise down to ~20 Hz (in 1.5 m/s flow)
- Other differences between fixed and drifting hydrophones likely explainable by depth variation between receivers

Technical Accomplishments (Cont.)

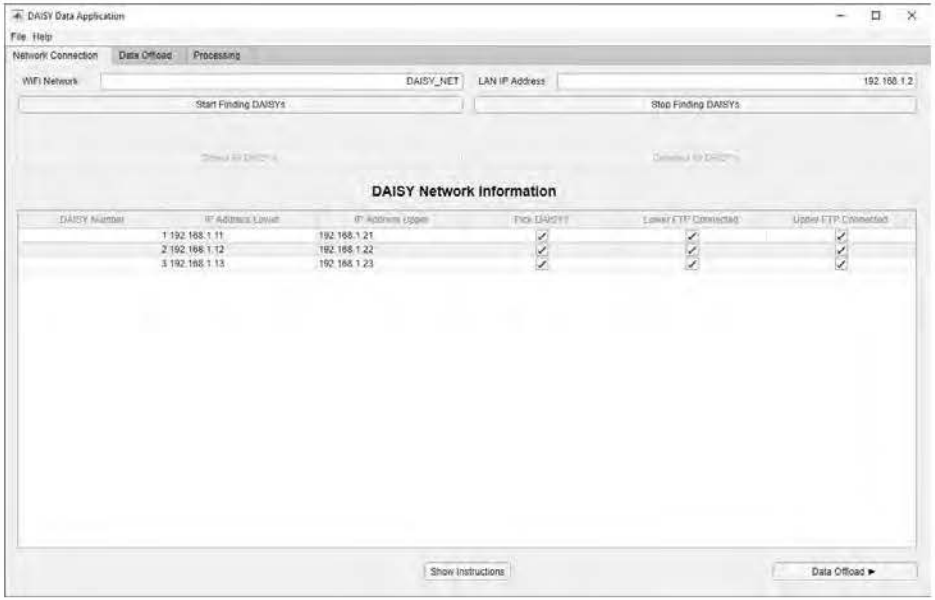
Localization: Sequim Bay

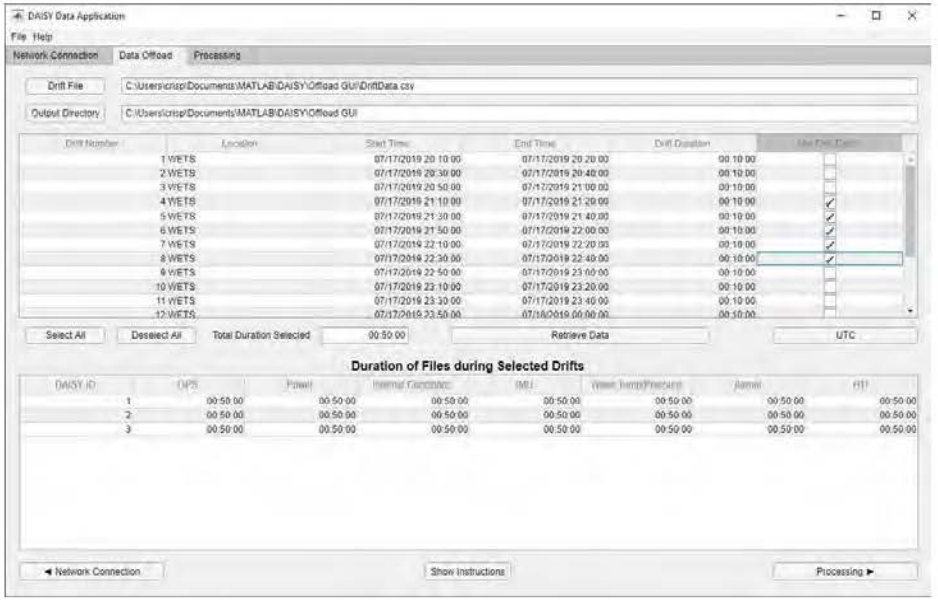


- **When source is inside array and the onset of received sound is well-defined, localization uncertainty < 10 m**
  - When source is outside array, localization accuracy degrades rapidly
  - When signal-to-noise ratio is low, accuracy degrades rapidly
  - When onset of received sound is ambiguous, accuracy degrades rapidly

Progress Since Project Summary Submittal

- Comparisons with shielded fixed hydrophone
- Development of offload software interface
  - User-friendly file management
  - Connects data to processing pipeline for rapid visualization





Progress Since Project Summary Submittal

Future Work

- **Board electronics revision**
  - Reduce high-frequency artifacts associated with current board
- **Deployment at WETS to localize sound sources**
  - Prototype DAISYs in use at WETS since 2015 - no observable strum in H_s > 2 m
  - Multiple, intermittent sound sources with high signal-to-noise ratio for localization (wave energy converter, moorings, marine mammals)

DAISY recovery during Fred. Olsen Lifesaver survey (Nov. 2018)