# Support for ISO TC43/SC3 To Develop Shallow Water Vessel Source Level Measurements Standard

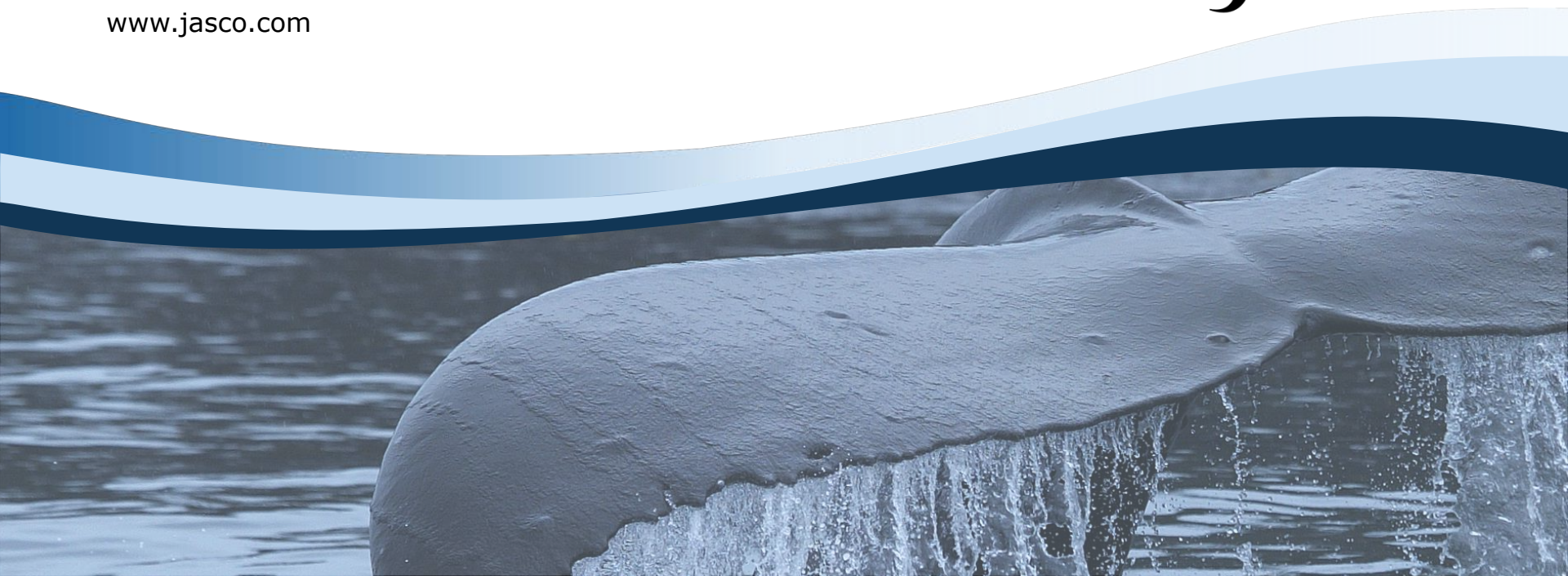
## Field Experiment Overview

Alex MacGillivray and Bruce Martin, JASCO Applied Sciences

CISMaRT Workshop 2020

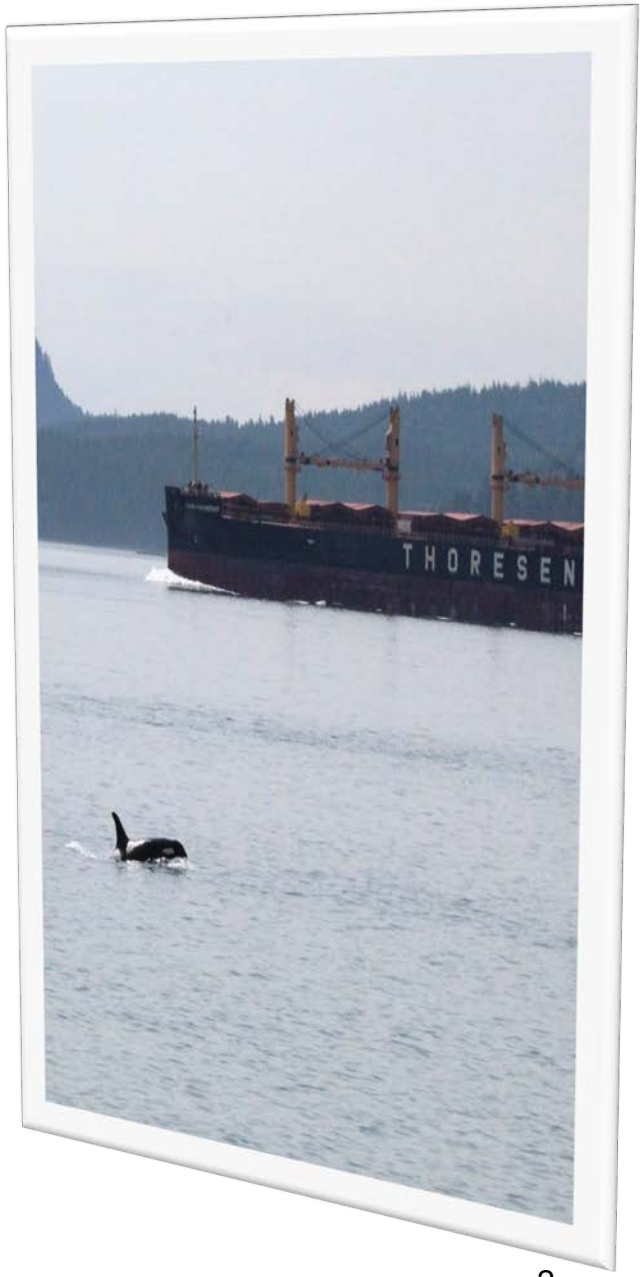
2020 Nov 25

www.jasco.com



# Project Overview

- Efforts to reduce vessel URN require standardized methods for obtaining accurate, repeatable SL measurements
  - Current ISO standards only applicable to deep water (> 200 m)
  - Separate standard needed to address unique issues with measuring SL in shallow water
- This project funded by Transport Canada to support ISO development of shallow-water URN measurement procedure (17208-3)



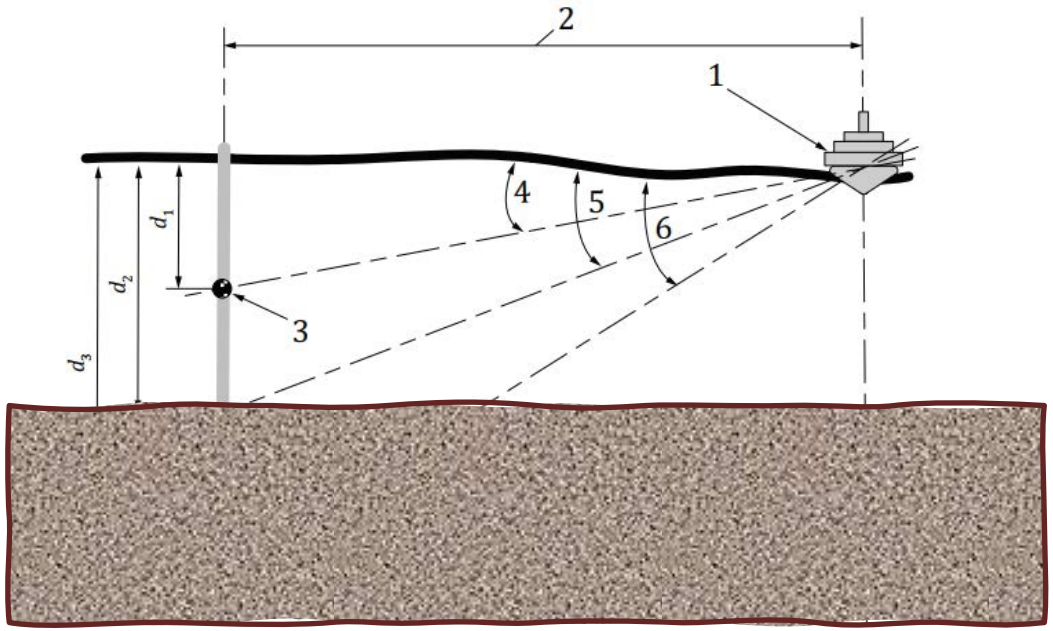
# Project Overview cont'd

- Objective: Conduct systematic field experiments to address knowledge gaps:
  - how to account for influence of seabed on SL measurement?
  - what is preferred hydrophone geometry and minimum depth?
  - what are associated uncertainties?
- Field experiments conducted in partnership with BC Ferries:
  - *BCF sailings provide ideal ships of opportunity for obtaining large, systematic URN dataset*

# Motivation

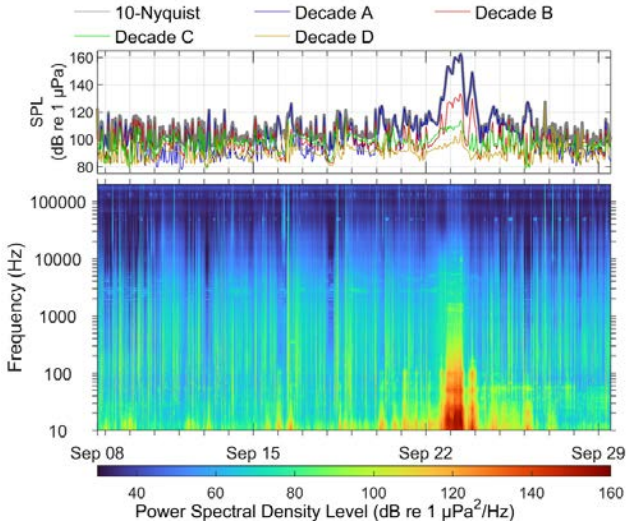
- Existing ISO source level measurement standards are only strictly applicable to deep water case
  - 17208-1:2016 (RNL)
  - 17208-2:2019 (SL)
- Sound reflected from seabed affects measured URN in shallow water
- Hydrophone geometry needs to be adjusted for shallow water

*What combination of measurement geometries and data analysis methods produce vessel URN estimates in shallow water similar to those obtained by following ISO 17208-1/-2?*



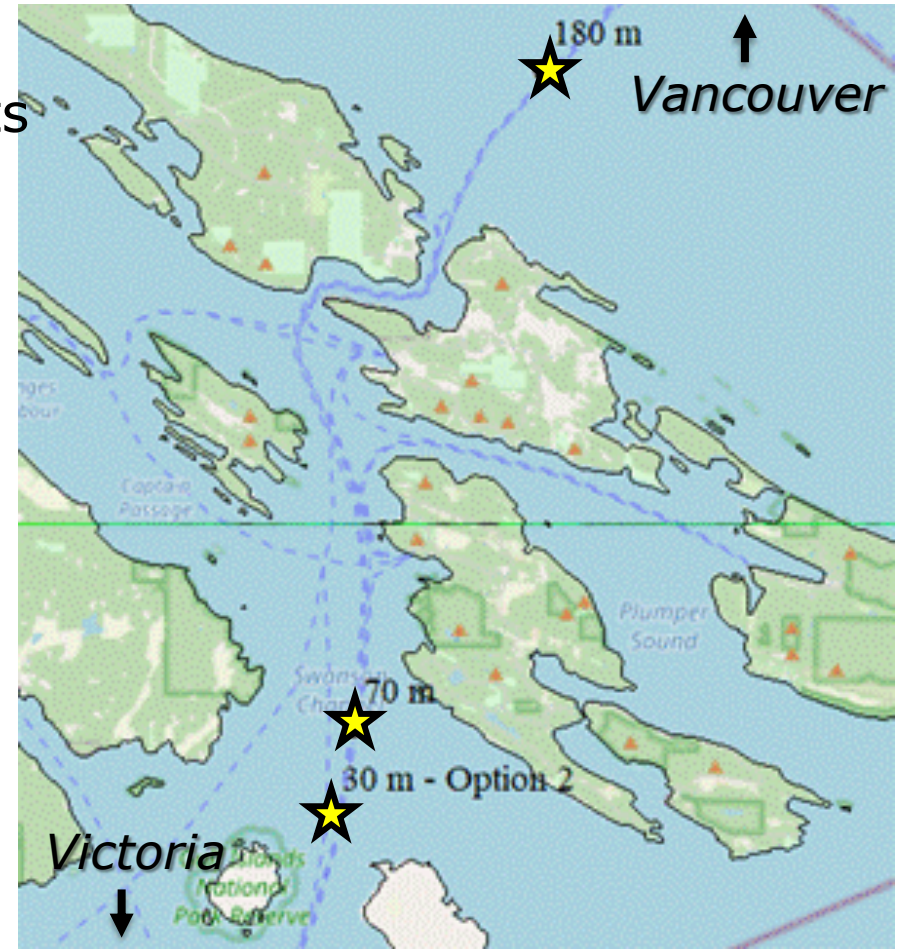
# Progress To Date

1. August 2020: Completed consultation with ISO URN working group:
   - JASCO delivered whitepaper on vessel URN measurement in shallow water
   - Experimental plan incorporated feedback from members of ISO working group (TC 43/SC 3/WG 1)
2. September 2020: Completed field tests of hydrophone arrays:
   - Prototype arrays deployed near Halifax harbour approach for 3 weeks
   - Trial data being analyzed, used to refine mooring design
3. November 2020: Delivered spring 2021 field trials plan
   - Subject of this presentation



# Spring 2021 Field Trials

- Dates: 3/May-23/Jul 2021
  - roughly 12 weeks sampling
- Systematic URN measurements of BCF vessels sailing between Swartz Bay & Tsawassen
- Continuous vessel URN sampling at 3 locations
  - shallow (30 m)
  - intermediate (70 m)
  - deep (180 m)
- Hydrophone arrays to be deployed at each location
- Vessel tracks recorded using AIS
- Periodic CTD sampling



# Source Vessels

## Vessel Classes

Spirit Class:
- 167 m
- Twin-screw, Single Ended
- 1572 possible measurements


Coastal Class:
- 160 m
- Single-screw, Double Ended
- 416 possible measurements


Queen of New Westminster:
- 130 m
- Twin-screw, Single Ended
- 416 possible measurements


## Number of scheduled sailings

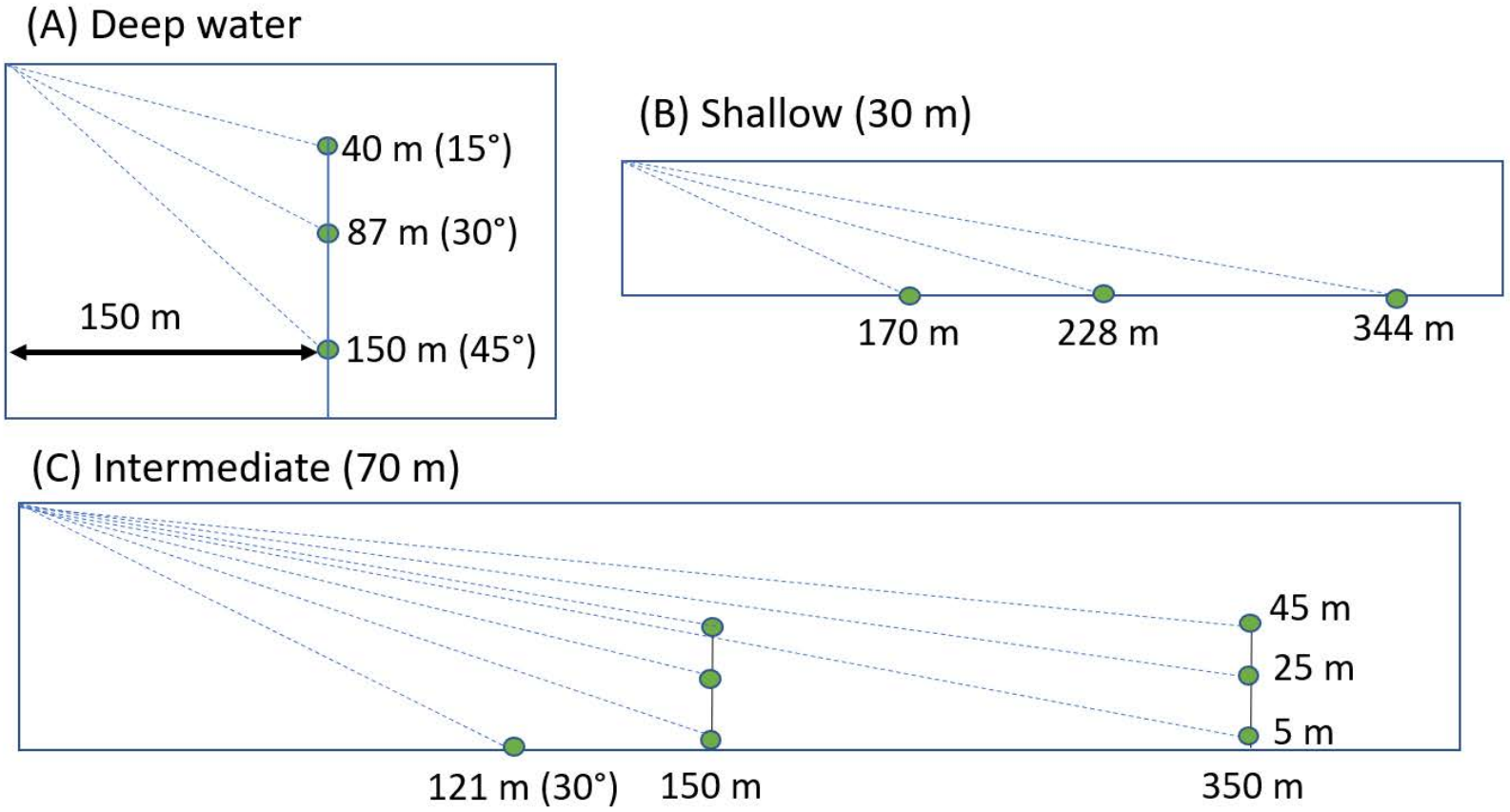
| Vessel | May | June | July | Total round trips |
|---|---|---|---|---|
| #1 Swartz Bay | 124 | 120 | 124 | 368 |
| #2 Swartz Bay | 75 | 93 | 119 | 287 |
| #1 Tsawwassen | 124 | 120 | 124 | 368 |
| #2 Tsawwassen | 39 | 50 | 119 | 208 |
| **Total number of sailings (round trip)** | **362** | **383** | **486** | **1231** |

# Non-Acoustic Vessel Data

- Every two weeks, BCF will provide data download from vessel management system (sampled at least once per minute):
  - GPS location
  - Speed & heading
  - Handle position
- BCF will also provide the following data for each voyage:
  - Number of vehicles aboard
  - Departure time, arrival time
  - Fore/aft draft (trim)

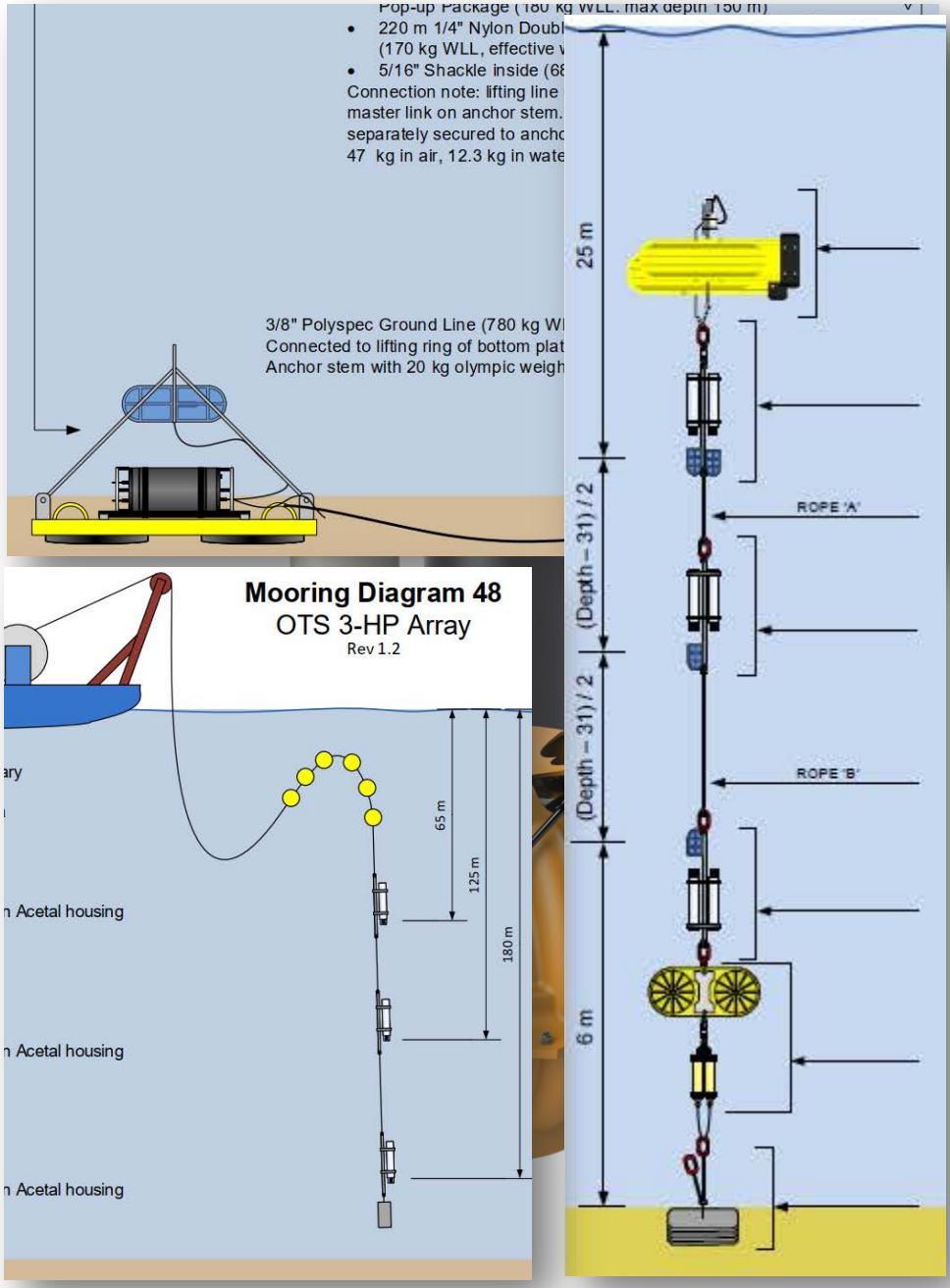
# Measurement Geometry

- Trialing multiple hydrophone geometries at 3 different sites:



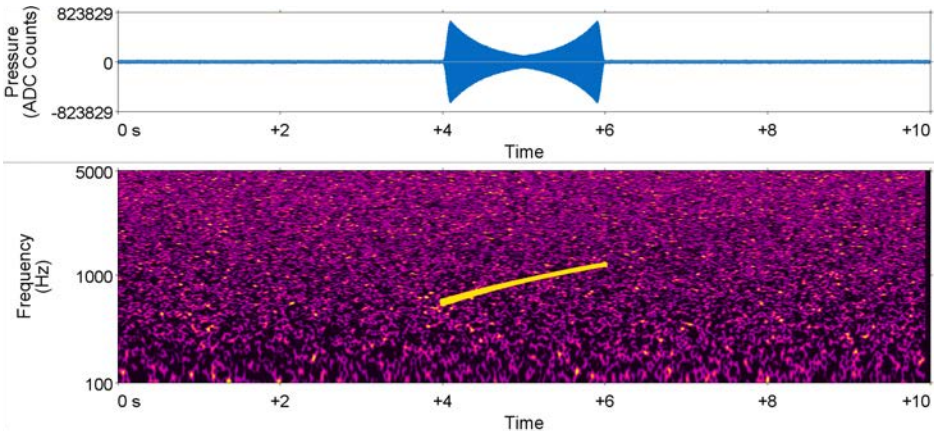
# Acoustic Sensors

- JASCO AMAR G4
  - 128 ksps recording
  - 24-bit resolution
  - GTI M-36 reference hydrophone
- Frequency range
  - 0.01-64 kHz
- Time period
  - 12 weeks endurance
- Three mooring configurations:
  - Bottom mounted (baseplate)
  - Moored vertical array
  - Drifting vertical array (3 days only)



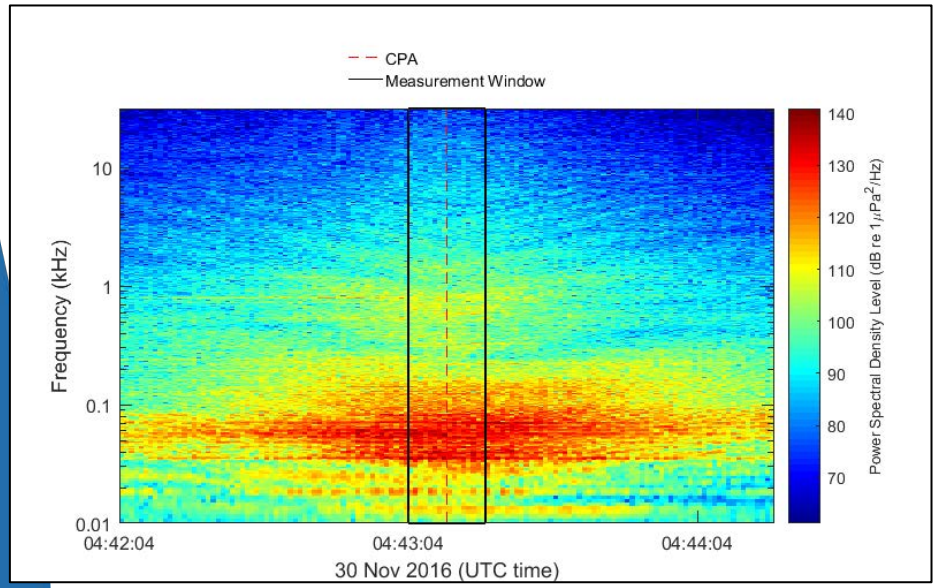
# Propagation Loss Experiments

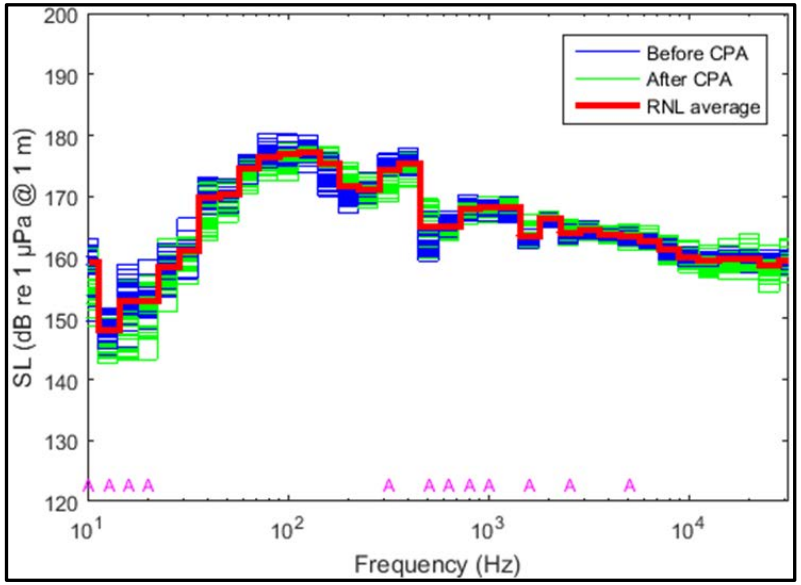
- Controlled sound source will be used to obtain calibrated sound propagation measurements
  - Resonant projector frequency of 900 Hz
  - Usable bandwidth of 500–1500 Hz
- Propagation loss will be measured directly between shallow source and receiver on seabed
- Measurements will be used to characterize seabed influence at all 3 measurement sites



# Data Analysis: JASCO ShipSound

- Automated source level analysis system
  - Vessel position, speed, and course over ground tracked using AIS
- Calculates SPL and SL for each 1 second data window
- Averages over the *measurement window* defined by the vessel passing ±30° of closest point of approach (CPA)
- Decidecade band measurements are adjusted for background noise
- Analyst reviews every automated measurement





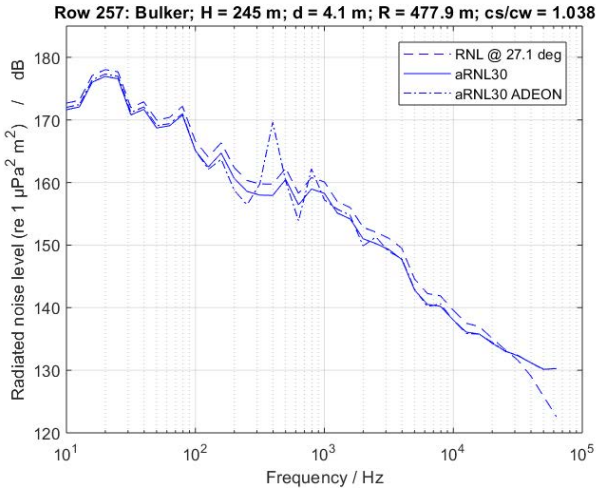

Research partnership with VFPA, Transport Canada, Ocean Networks Canada and JASCO Applied Sciences

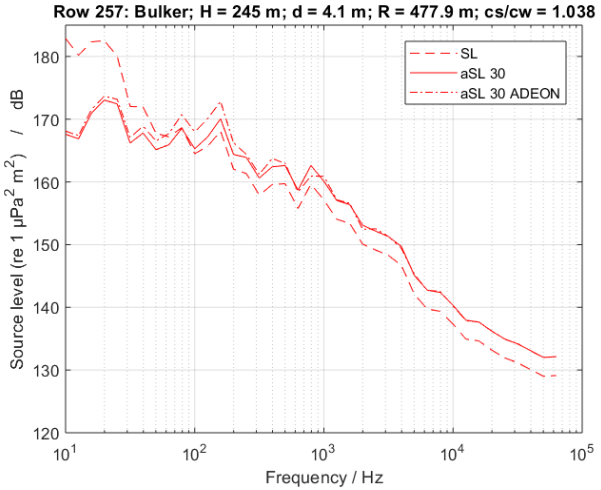
# Source Level Metrics

- We plan to evaluate four different source level metrics
- Radiated Noise Level (RNL)
  - Inverse square law (ISO 17208-1)
  - Not a true source level
- Source level (SL)
  - Monopole source level, including surface and seabed influence
  - Calculated using frequency dependent PL
- Adjusted RNL (aRNL)
  - RNL corrected for water depth ($H$), critical angle ($\psi$), and absorption ($\alpha$)

$$L'_{\mathrm{RN}} = L_{\mathrm{RN},30} + \Delta L_{H,\psi} + \Delta L_{\alpha}$$

- Adjusted Source Level (aSL)
  - Also referred to as "Dipole Source Level"
  - Calculated from SL using frequency-dependent correction factor
  - Robust to the choice of nominal source depth



# Questions?