

# The Memorial Explorer

**Current developments for under-ice research**

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# Outline

## Overview

- MERLIN
- AUV
- Motivation

## CATCHY

- Project Cornerstone
- Design
- Testing
- Deployment

## Future

- REALM
- Antarctic

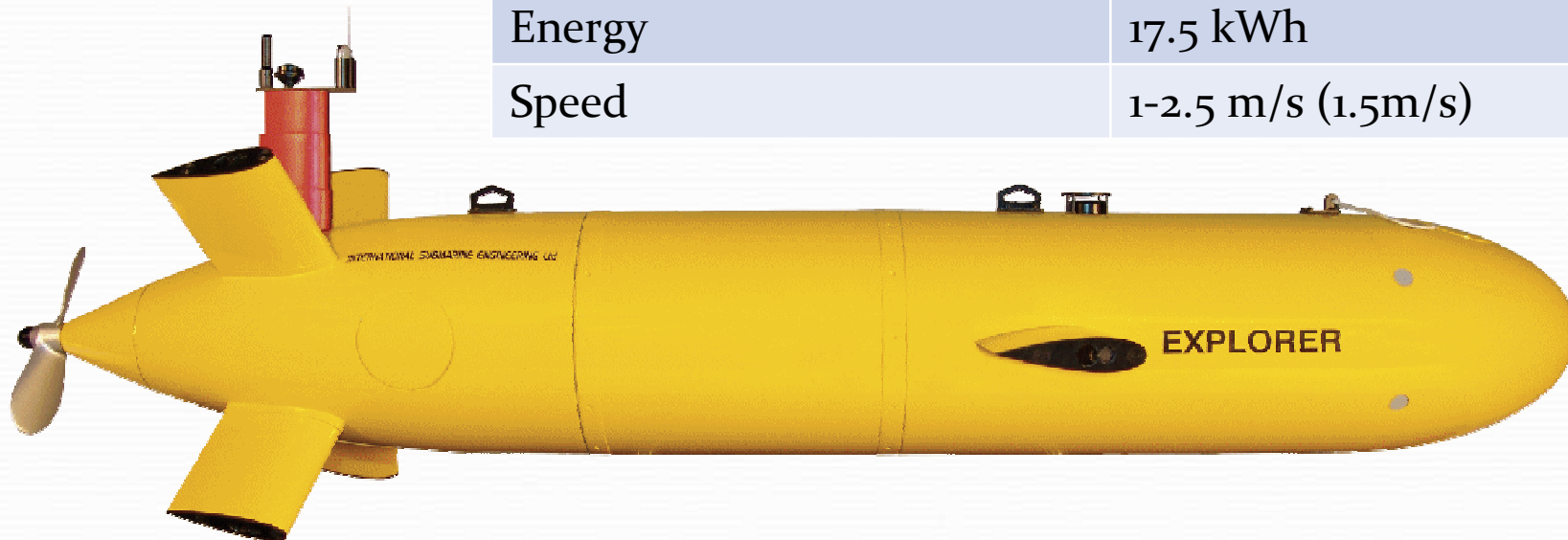
# Overview: MERLIN

- Marine Environmental Lab for Intelligent Vehicles
  - The lab is a node in Memorial University's CREAT Network.
- The mandate of the Network is to **facilitate** accessibility of higher value institutional research assets and **promote** new research partnerships.

# Overview: AUV

- International Submarine Engineering (ISE) Explorer

Length	4.5m
Diameter	0.68m
Depth Rating	3000m
Energy	17.5 kWh
Speed	1-2.5 m/s (1.5m/s)



# Overview: Motivation

- Development of AUV platform for under-ice research
  - Logistical and operational
  - Platform and equipment
  - Safety and risk mitigation
  - Mission control and situational awareness

# CATCHY

Canadian AUV Through-ice Capture and Hold System

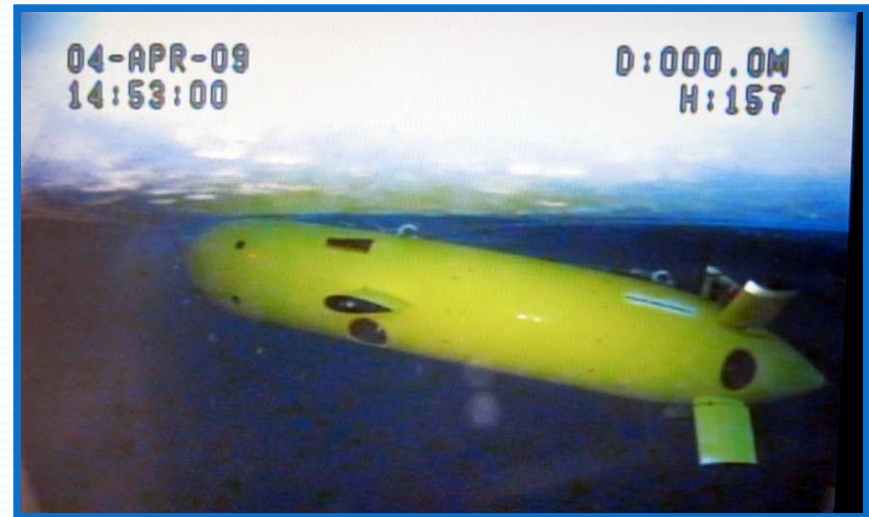
- Designed in support of Canada's AUV survey missions for the upcoming UNCLOS bid
  - Project CORNERSTONE
- AUVs will map bathymetry under-ice to determine extent of continental shelf

# CATCHY: Design

- Scenario
  - Launch from base camp
    - AUV sized hole
  - **Docking at remote site**
    - non-retrieval
    - data upload
    - INU alignment
    - battery charging
  - Several remote dockings to extend under-ice time
  - Recovery at base camp

# CATCHY: Design

- Constraints
  - Deployable through 60 cm<sup>2</sup> hole
  - Adaptable
    - Ice thickness
    - Currents
  - Portable
    - Helicopter
    - Skidoo
  - Robust (Simple)
  - ROV assisted

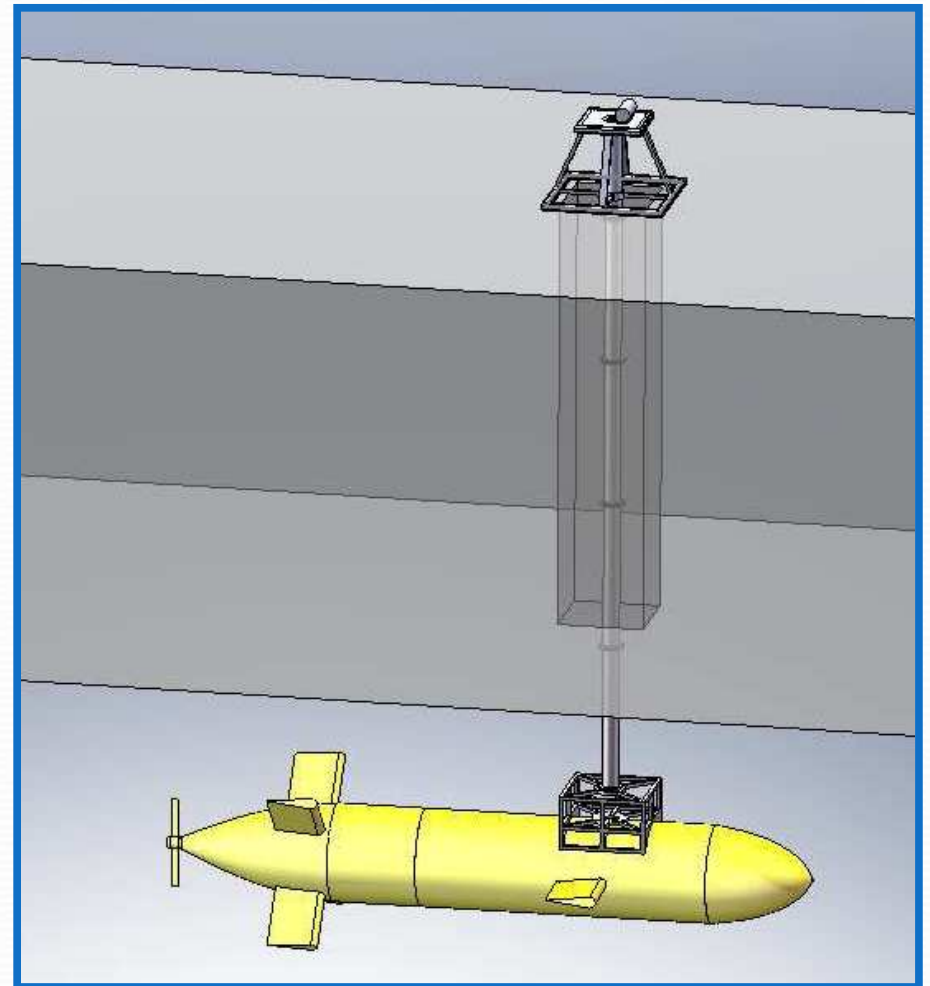




# CATCHY: Design

- Features

- Capture of AUV at end of mission
- Secure retention of AUV
- Full rotation of AUV
  - INU Alignment
- Support under-ice charging and data upload
- Release of AUV for next mission



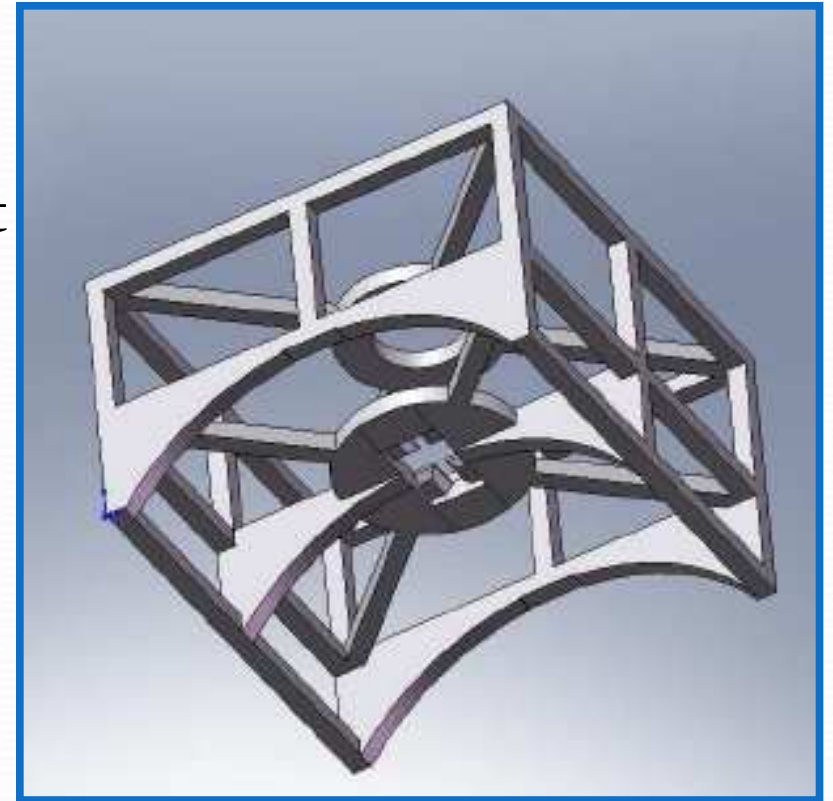
# CATCHY: Design



IOT AUV Workshop 2010 - October, 2010

# CATCHY: Design

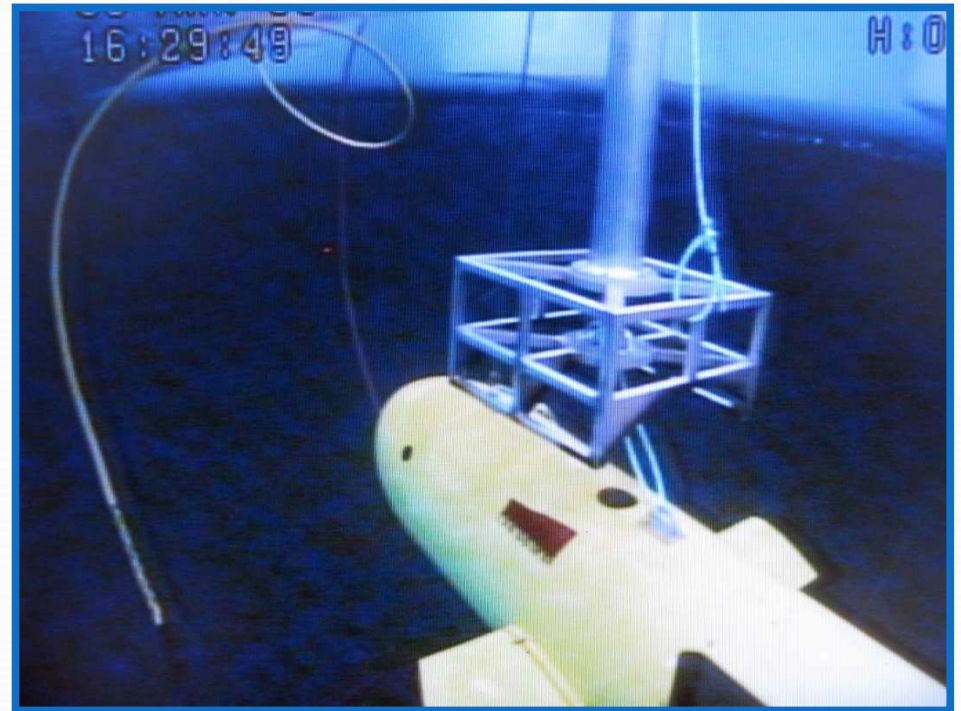
- Cradle
  - keyed to AUV lifting lug
  - Curved surface allows alignment of AUV
- Topside secures to ice
  - Mountable capstan
- Shaft consists of individual sections
  - Expandable by 1m lengths



# CATCHY: Design

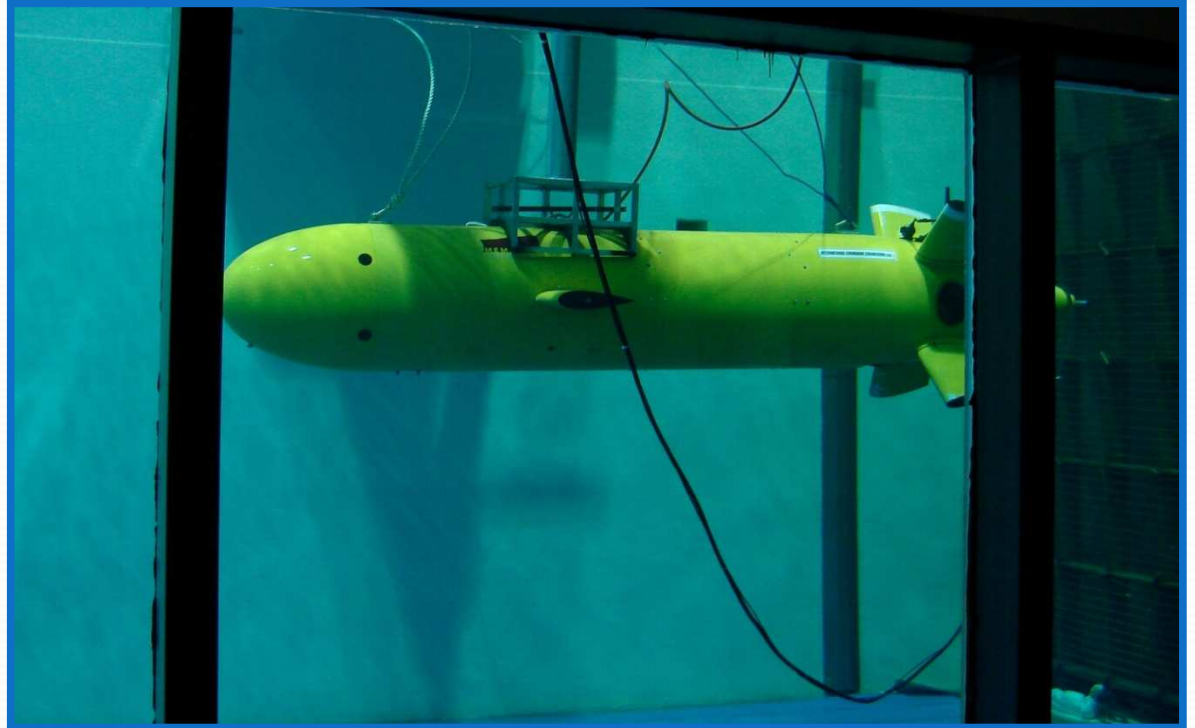
- Operation

- AUV lies under ice
- Line passed through shaft is brought to AUV by ROV
- Line returned to hole by ROV
- Line passed back through shaft
- AUV ballasted heavy
- Tension applied to pull AUV into basket



# CATCHY: Testing

- Testing – Marine Institute Flume Tank
  - Functionality
    - Retention
    - Rotation
    - Capture
    - Release
  - Currents
    - 0 to 1 m/s
    - 0 to 90°



# CATCHY: Testing

- Results – Marine Institute Flume Tank

TABLE I  
MI TEST RESULTS

Test	Successful Currents (m/s)
Retention nose-in	0.0 to 1.0
Retention broadside	0.0 to 1.0
Rotation	0.0 to 1.0
Capture nose-in	0.0 to 1.0
Capture broadside	0.0 to 0.2
Release nose-in	0.0 to 1.0
Release broadside	0.0 to 1.0

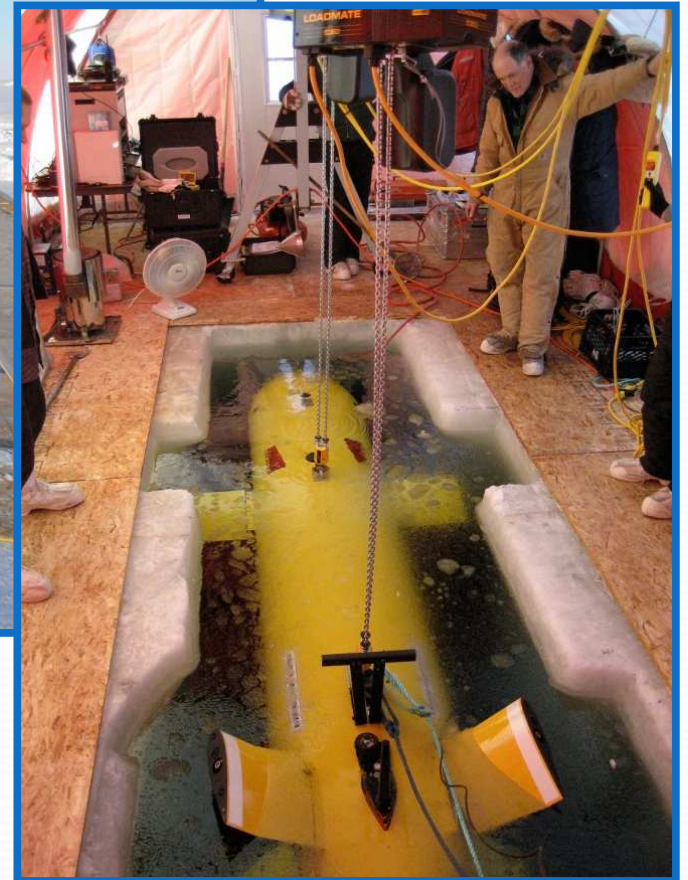


# CATCHY: Deployment

- On Ice Field Trials
  - Spring 2009
- Alert, Nunavut
  - Base camp setup
    - Template to mimic remote camp
  - Full capture operations
    - ROV assisted
  - INU alignment
    - In AUV



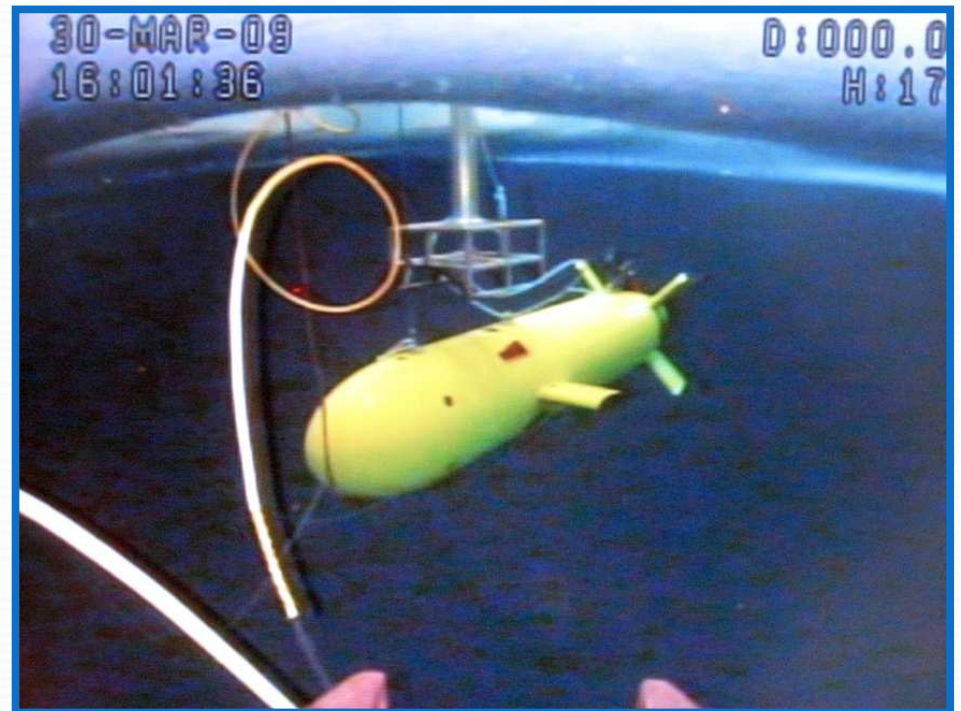
# CATCHY: Deployment





# CATCHY: Deployment

- Ice Trials - Results
- Capture
  - Assembly to capture successful
  - ROV in loop
  - Sufficient feedback and line management
  - Procedure works



# CATCHY: Deployment

- Ice Trials - Results
- INU Alignment
  - Controlled Rotation of AUV
  - Data indicates success for In AUV alignment at high latitude
    - 82.3N



# Future: ReALM

- AIF awarded for *Responsive AUV Localization and Mapping* project
- 4 year, \$4M project
  - \$2.1M from ACOA
  - \$1.9M contributions

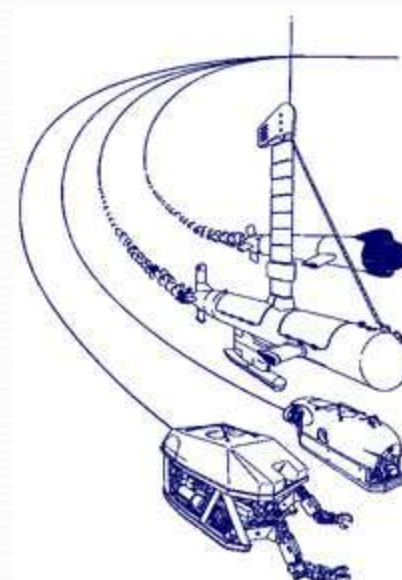


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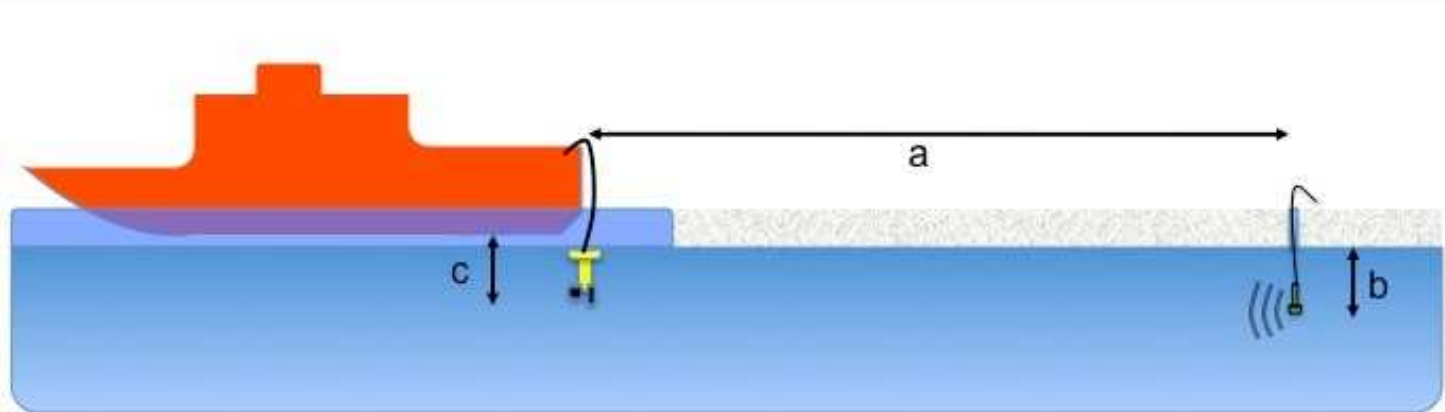
# Future: ReALM

- Qualitative Navigation
  - Vehicle navigation through an environment without the need for a single global coordinate system for landmarks
    - Under-ice return home capability
      - AUV position corrected relative to previously traversed path
  - Feature recognition
    - Real time sonar image registration and recognition
    - Relative path position from previously seen landmarks
    - Non-specific target based



# Future: ReALM

- Emergency AUV localization specifically designed for robustness in harsh environment operations
  - Utilizes one way signal transfer to increase likelihood of success
  - Novel localization algorithm to be implemented real time for a complete, mobile solution



# Future: ReALM

- Mobile Surface Control Computer
  - Existing surface unit is large and immobile
    - Not practical for remote or on-ice
  - Need for fully portable solution
    - Communication with AUV
      - Acoustics
      - Radio
    - Battery operation
      - or alternate power
    - Run ISE SCC software
    - Replaces 19" rack system



# Future: Antarctic

Australian Maritime  
College, UTAS



Australian Antarctic  
Division



MEMORIAL  
UNIVERSITY



Antarctic Climate and  
Ecosystems Cooperative  
Research Centre



Commonwealth  
Scientific and Industrial  
Research Organization

# Future: Antarctic

- Explorer AUV to be used to research the role of Antarctic sea-ice in climate change
  - Quantify size and shape of pressure ridge-keels
  - Improve understanding of links between sea-ice and ice algae and krill
  - Develop ice thickness mapping capabilities





# Future: Antarctic

- Under-ice sounding important data collection tool
- Developments are needed for greater acceptance of AUV technology for scientific missions
  - Adaptive mission planning
  - Situational awareness
  - Fault detection and diagnosis

# Discussion

- Many challenges still exist for AUV operations in remote ice-covered regions
- Developments in mission control are important for increased AUV use
- AUV offer many opportunities for science, especially when it comes to under-ice research

# Discussion

- Questions?

