CANADIAN ACADEMY OF ENGINEERING OCEANS SEMINAR

Marine pollution and oil spill response:

Memorial's physical location inspires its researchers to lead critical marine and ocean-related research.

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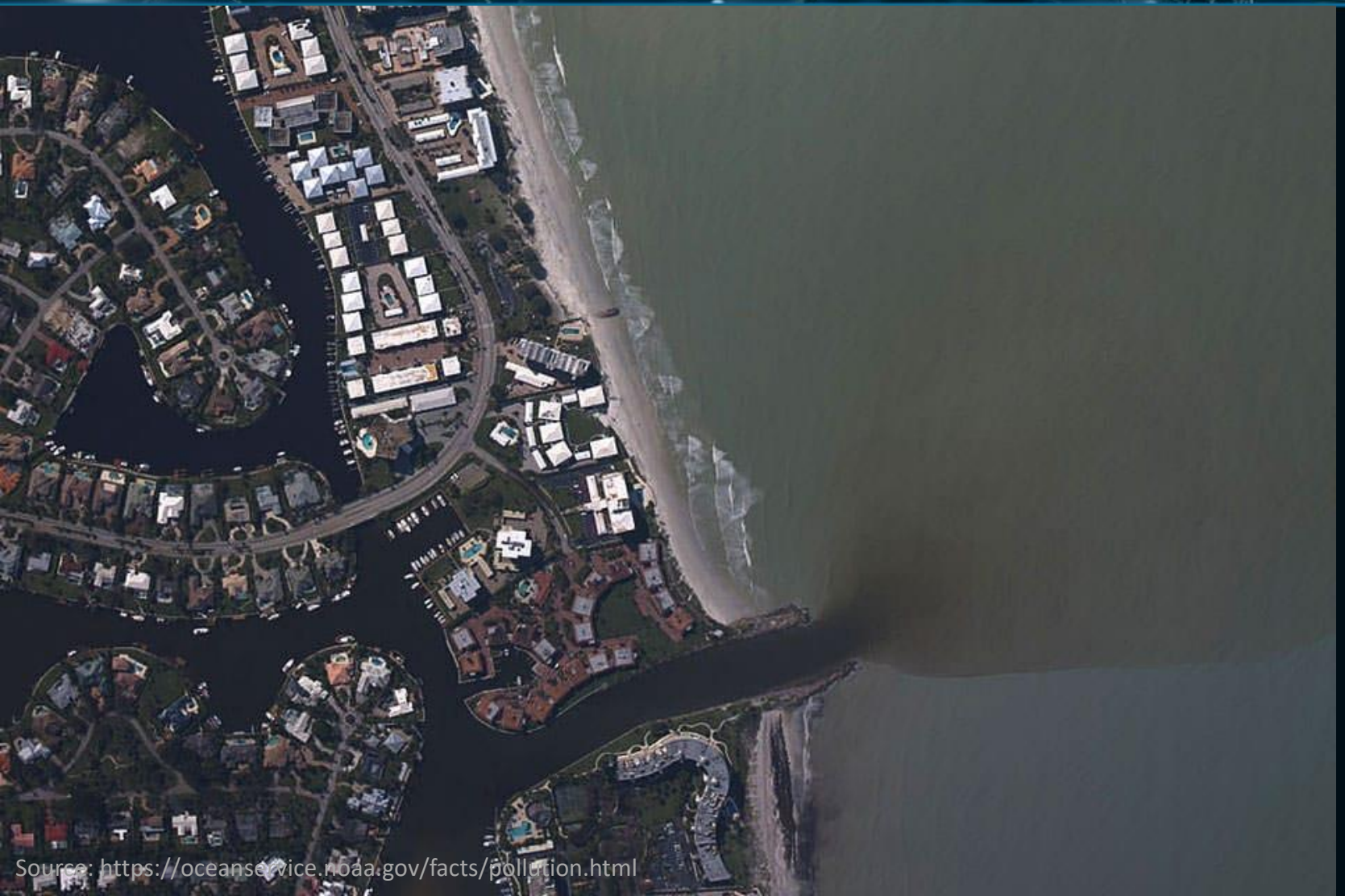
Memorial University
Newfoundland and Labrador's University
March 2021

Slide credits include: Jimin Hwang; Jeff Green


A PLACE &
PEOPLE SHAPED
BY COLD WATER,
WIND & ICE.
Canada
GEORGE R. PEARKES
MEMORIAL UNIVERSITY
NEWFOUNDLAND AND LABRADOR'S UNIVERSITY

Background



Most ocean pollution begins on land

-National Oceanic and Atmospheric Administration (NOAA)-

Source: https://oceanservice.noaa.gov/facts/pollution.html

Background

Source: https://www.marineconservation.org.au/ocean-plastic-pollution/

Marine life is facing constant threats and dangers:

Plastics

-Australian Marine Conservation Society-

Background

Source: https://phys.org/news/2010-06-oil-bp-nautical-miles.html

Oil spills

BP

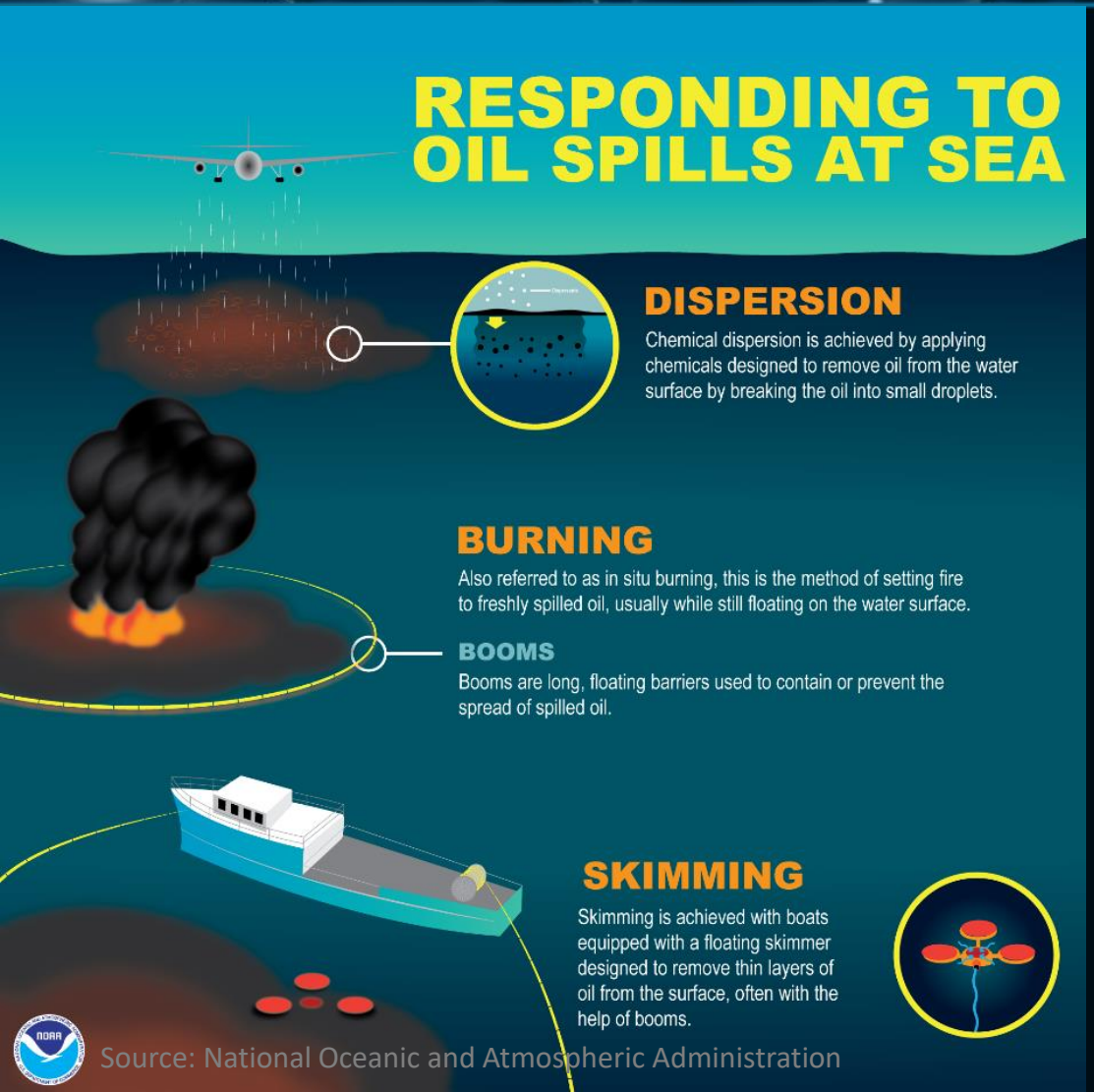
Gulf of Mexico

April 2010

Spilled amount:

4.9 million barrels

When oil spills happen …



Oil Spill Response Guideline

CRITICAL RESEARCH

Projects at Memorial University, funded under
Fisheries and Oceans Canada's
Multi-Partner Research Initiative (MPRI) on oil spill response:

- *Technical effectiveness of using dispersants*
- *Improved adsorption technologies*
- *Interactions between oil, dispersants and particles*
- *Improved decanting and oily waste management*
- *Delineation using Autonomous Underwater Vehicles*

MPRI - $45.5 million in federal funding to focus on enhancing oil spill response measures ($5.5 million at Memorial) – part of Oceans Protection Plan

MEMORIAL UNIVERSITY

WORLD-CLASS RESEARCH FACILITIES

Autonomous Ocean Systems Centre (AOSCENT)
CREAIT Network

MEMORIAL UNIVERSITY

TEAM

- Researchers from Canada, Australia, UK, United States, China
- *Memorial:* Neil Bose, Ting Zou, Bo Thanyamanta, Yaomei Wang, Xi Chen, Gina Millar, Craig Bulger, Work Term students
- *Dalhousie:* Douglas Wallace, Aly Chua, Mae Seto, Haibo Niu
- *CSIRO Energy:* Xiubin Qi
- *Univ of Tasmania:* Jimin Hwang, Eonjoo Kim
- *Univ of Southampton:* Mario Brito
- *Sun Yat-sen Univ, Zhuhai:* Shuangshuang Fan

Advisors:

- Lisa DiPinto, NOAA Office of Response and Restoration
- Robyn Conmy, Oil Research Program, USEPA
- Chris Kaminski/David Hopkin, International Submarine Engineering (ISE)
- Anthony Peach/Mike Cole, Fugro, St John’s
- Erin Fischell, WHOI

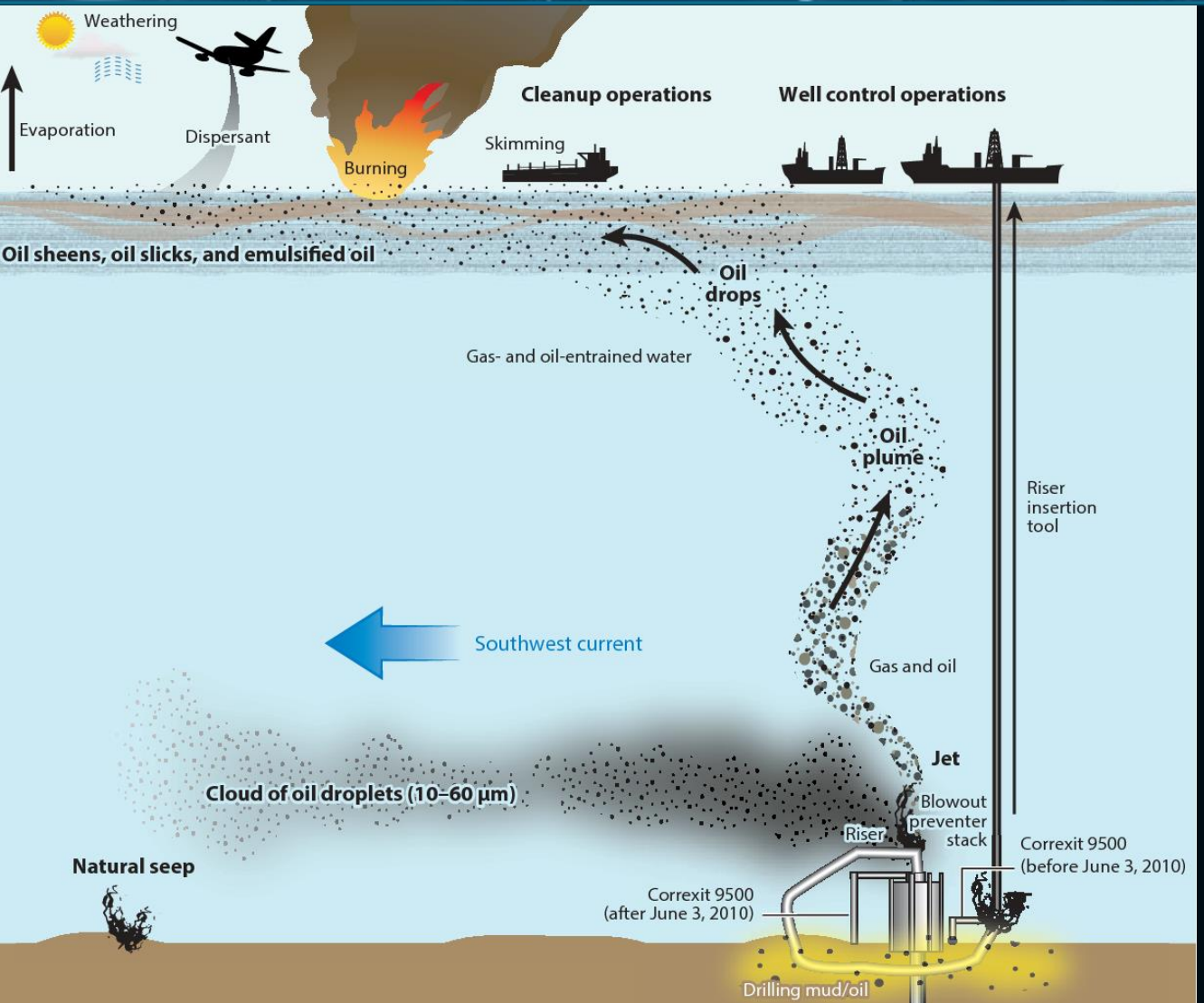
Four main tasks to respond to oil spills

- Step 1: Assessment
- Step 2: Monitoring
- Step 3: Response assistance
- Step 4: Reporting

1. Discontinuous plume
2. Dispersion
3. Physical, chemical and biological transformation

… extracts from “*Understanding oil spills and oil spill response*”
- by United States Environmental Protection Agency (EPA) -

Example



DWH Explosion

Gulf of Mexico

April 2010

Emulsification

Trapped at 1000 m depth

Reference: King, G. M., Kostka, J. E., Hazen, T. C., & Sobecky, P. A. (2015). Microbial responses to the Deepwater Horizon oil spill: from coastal wetlands to the deep sea. Annual review of marine science, 7, 377-401.

Autonomous underwater vehicle (AUV)

- Expanded application of underwater robotics
- Increased demand for high level of autonomy

THREE MAIN SUB-PROJECTS

1. Adaptive sampling of maritime environment features and sensor capability using an Autonomous Underwater Vehicle (AUV) – ISE Explorer.
2. Multi-vehicle cooperation in defining the boundary and diffusion of an oil spill – glider AUVs.
3. Assessment of different AUV platforms and specification of a rapidly-deployable AUV for oil spill delineation – micro AUVs and Long Range AUVs.

Methodology

Backseat Driver

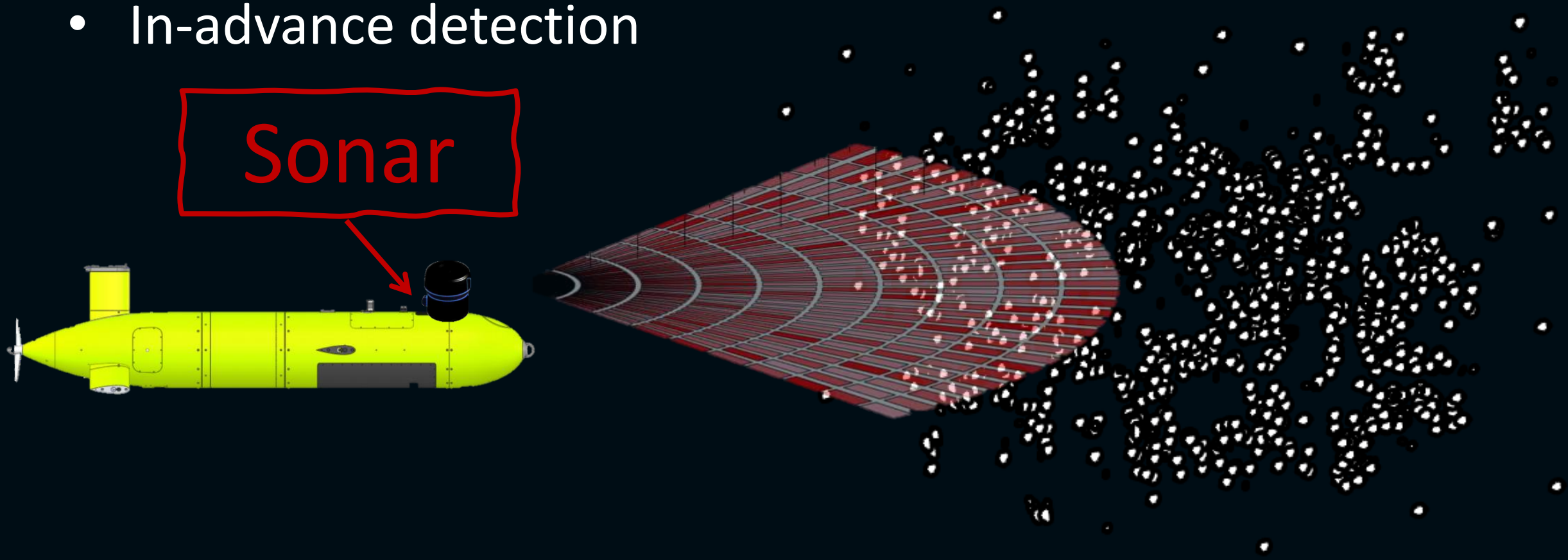
- Independent decisions
- Generate commands
- Indirect driver
- Real-time requirement

Frontseat Driver

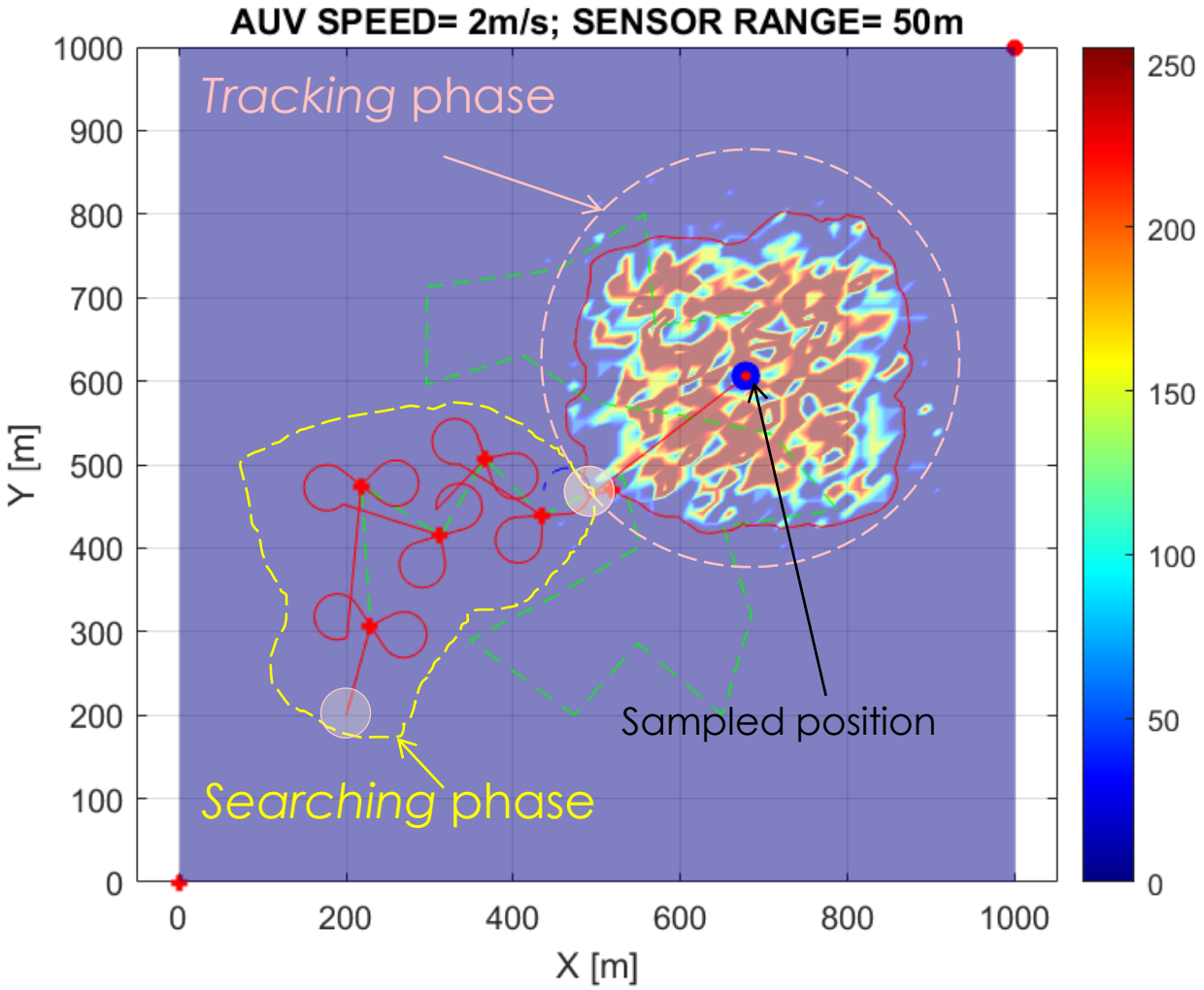
- Pre-defined instruction
- Vehicle motion control
- Direct driver
- Vulnerable to chained system failure

Methodology

- Target of interest – undissolvable substances
- In-advance detection

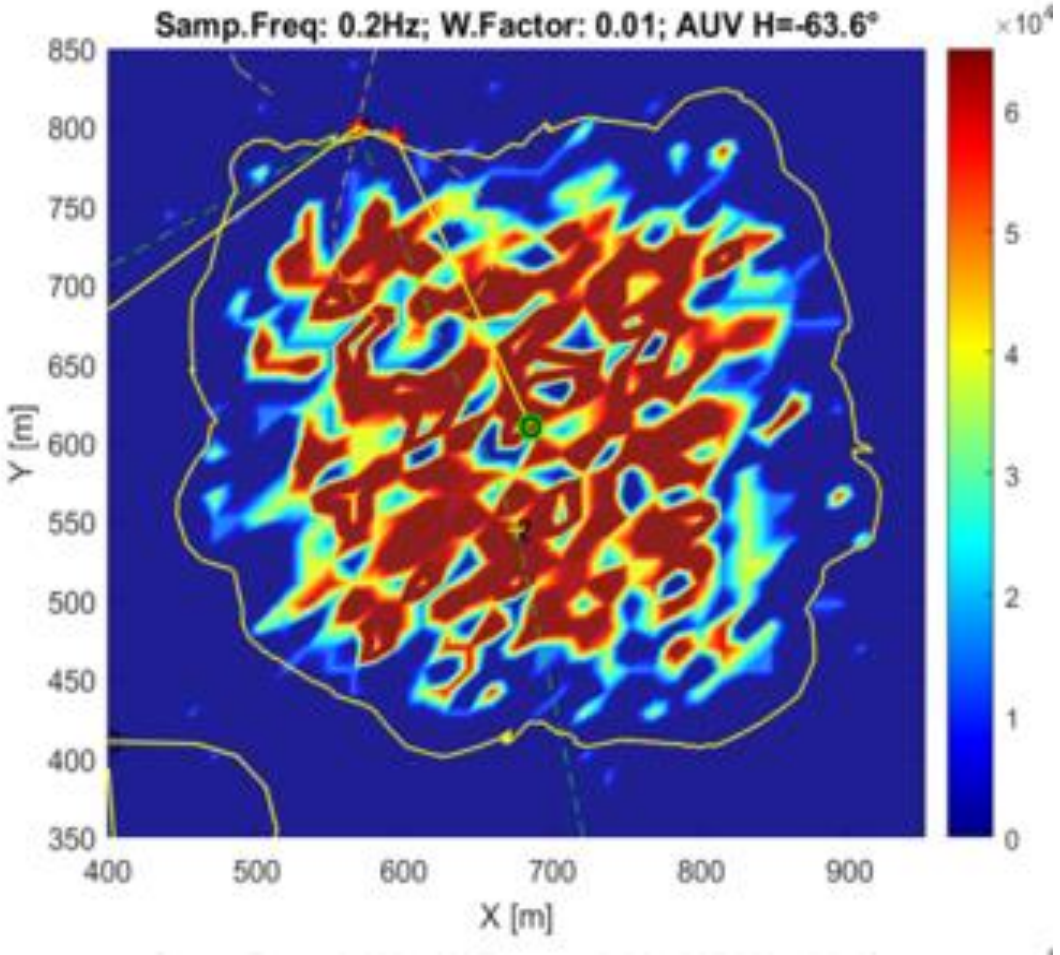


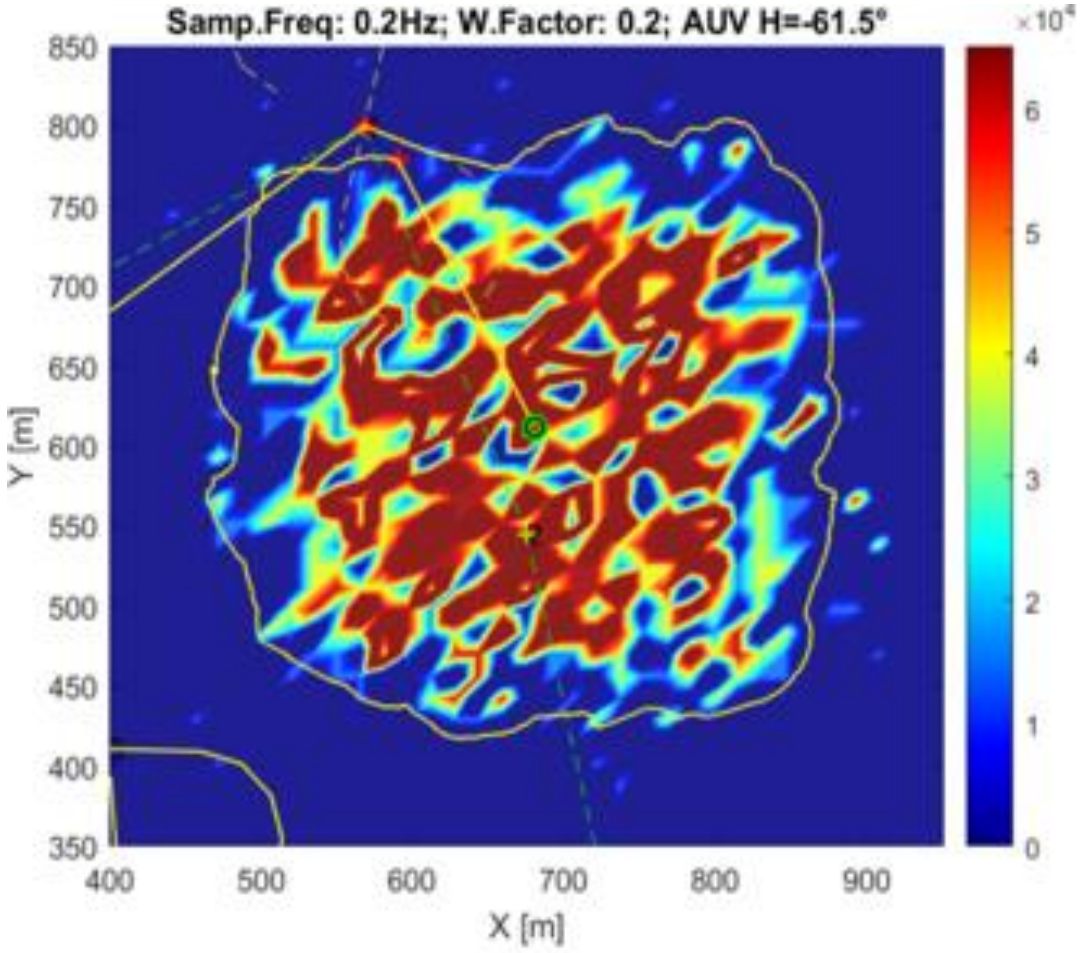
SIMULATION RESULTS (OVERALL)



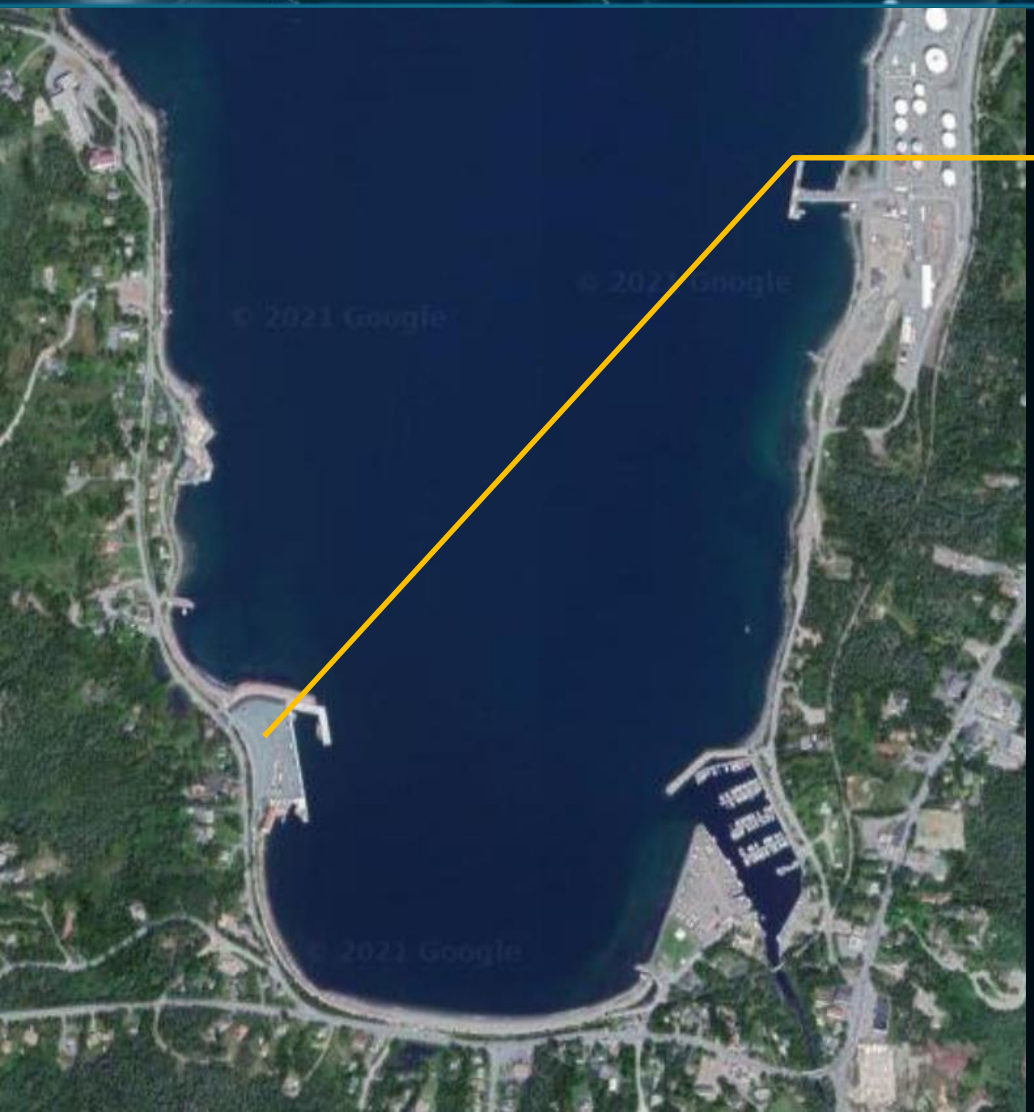
- 2-Phase delineation
  - ✓ Searching
    - ✓ Mode 1: Waypoint-visiting
    - ✓ Mode 2: Expanded search
  - ✓ Tracking
    - ✓ Mode 3: Tracking
    - ✓ Mode 4: Sampling

SIMULATION RESULTS (TRACKING)

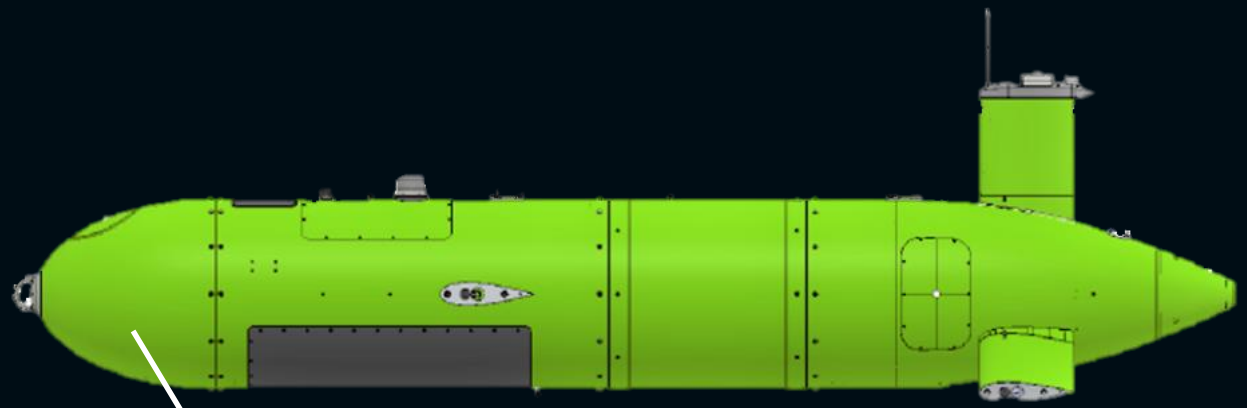




Field experiments



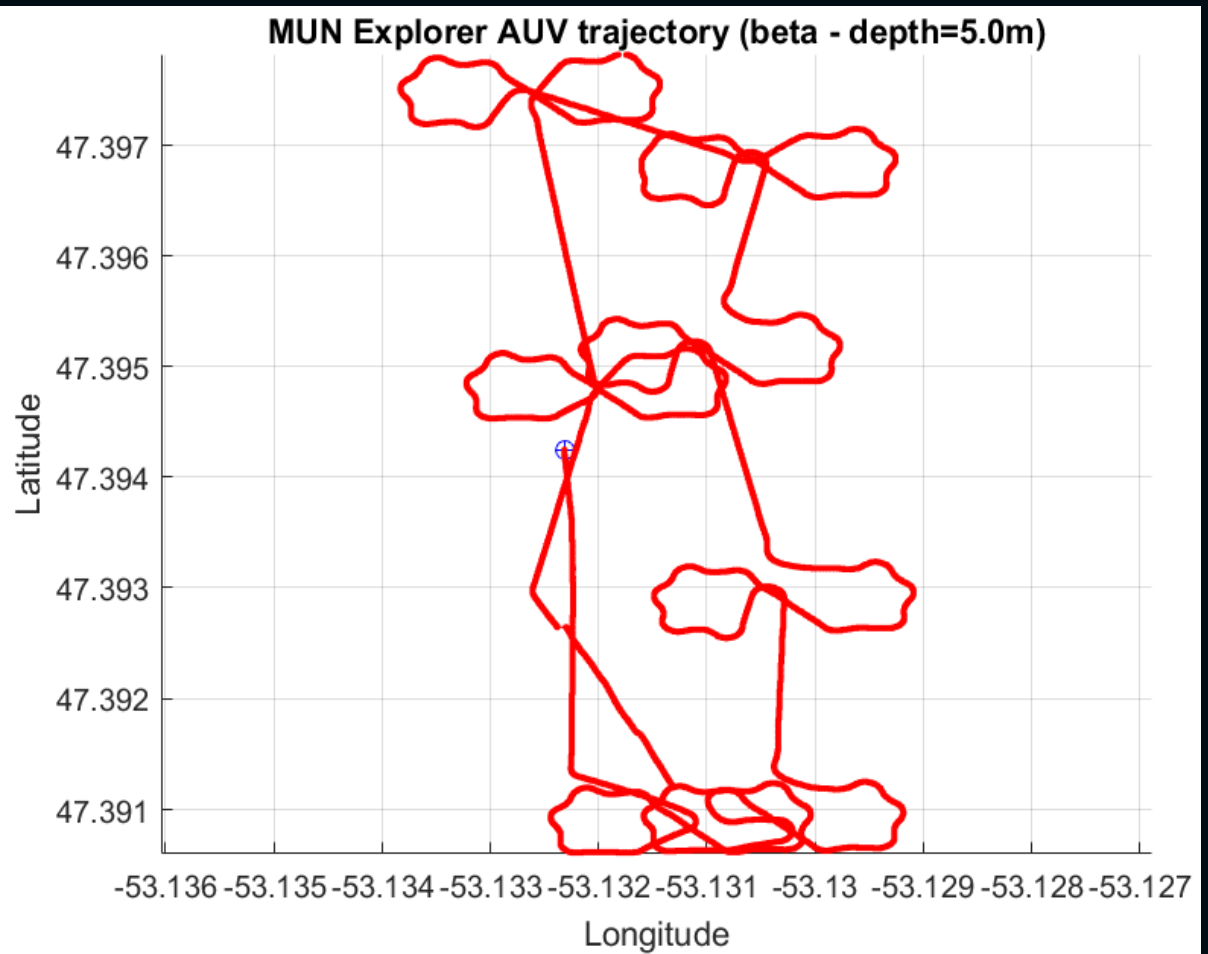
Marine base, Holyrood Bay, NL



ISE Explorer AUV

Experimental result

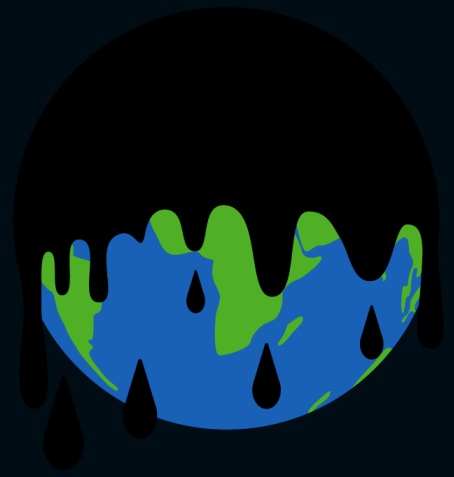
Mission: *beta*



- Depth = 0m (on surface)
- Overshooting occurred
- Conditional behaviour selection performance

Future work

- Field test
- Sensor: scanning sonar
- Various targets identification
  - Micro air bubbles
  - Streamers of sailcloth
  - Nets or ropes



THANK YOU

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