Heavy Oil Recovery
Current Project Status

Outline

Detection Sensor development

- Proof of Concept Results
- Prototype Phases Results

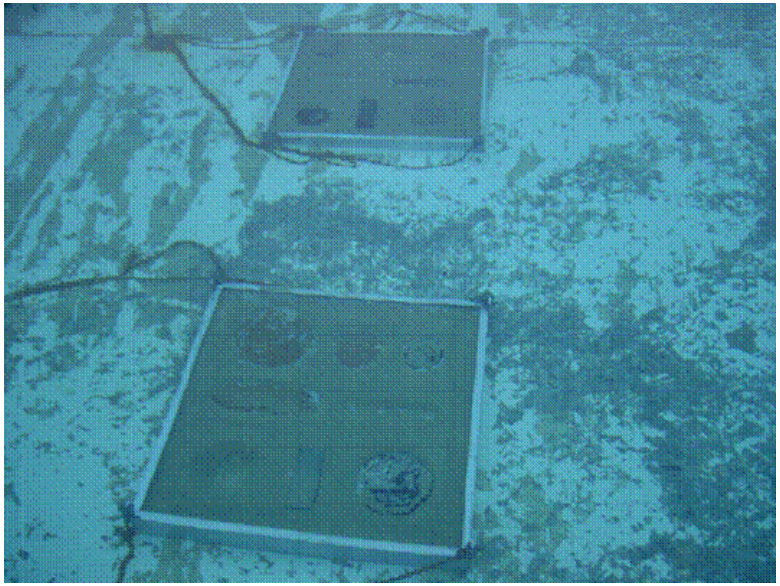
Recovery System Development

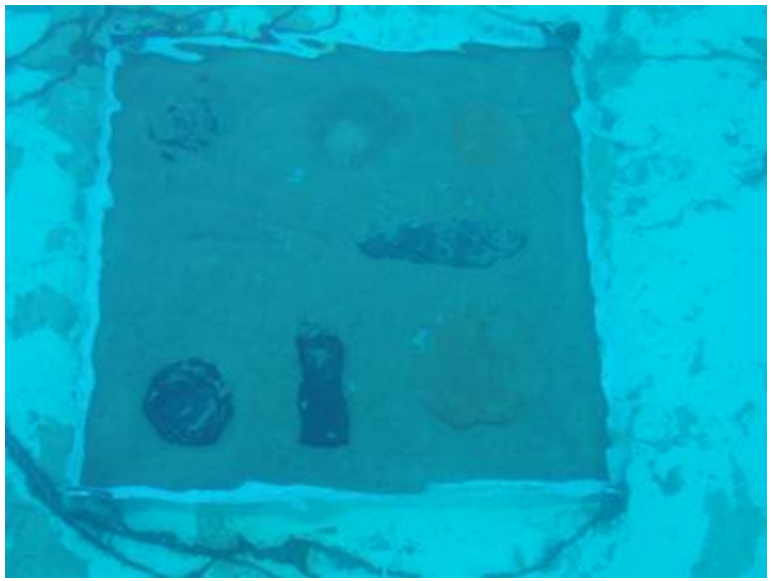
- Past History
- Design Phase
- Prototype Build Phase

Proof of Concept (POC) Target Trays

Setup:

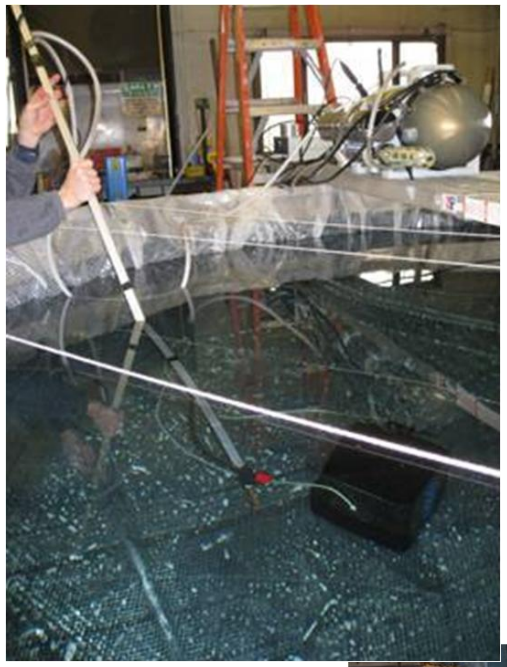
- **Two 8 foot by 8-foot trays**
- **Targets**
  - Two oils and roofing tar (asphalt)
  - 1-2 feet in diameter
  - 2-4 inches deep
- **Construction Sand**





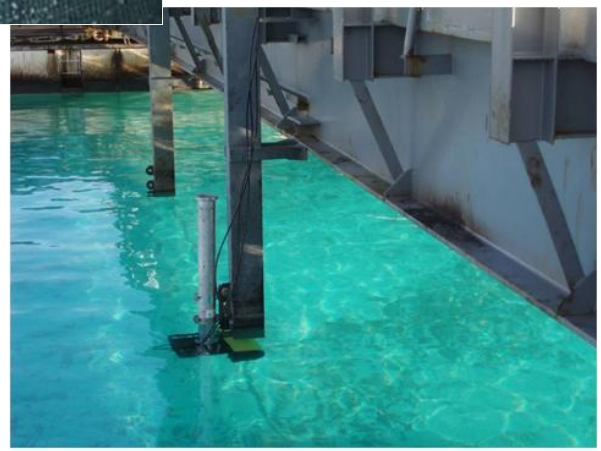
Pictures of Systems

WHOI



EIC

RESON



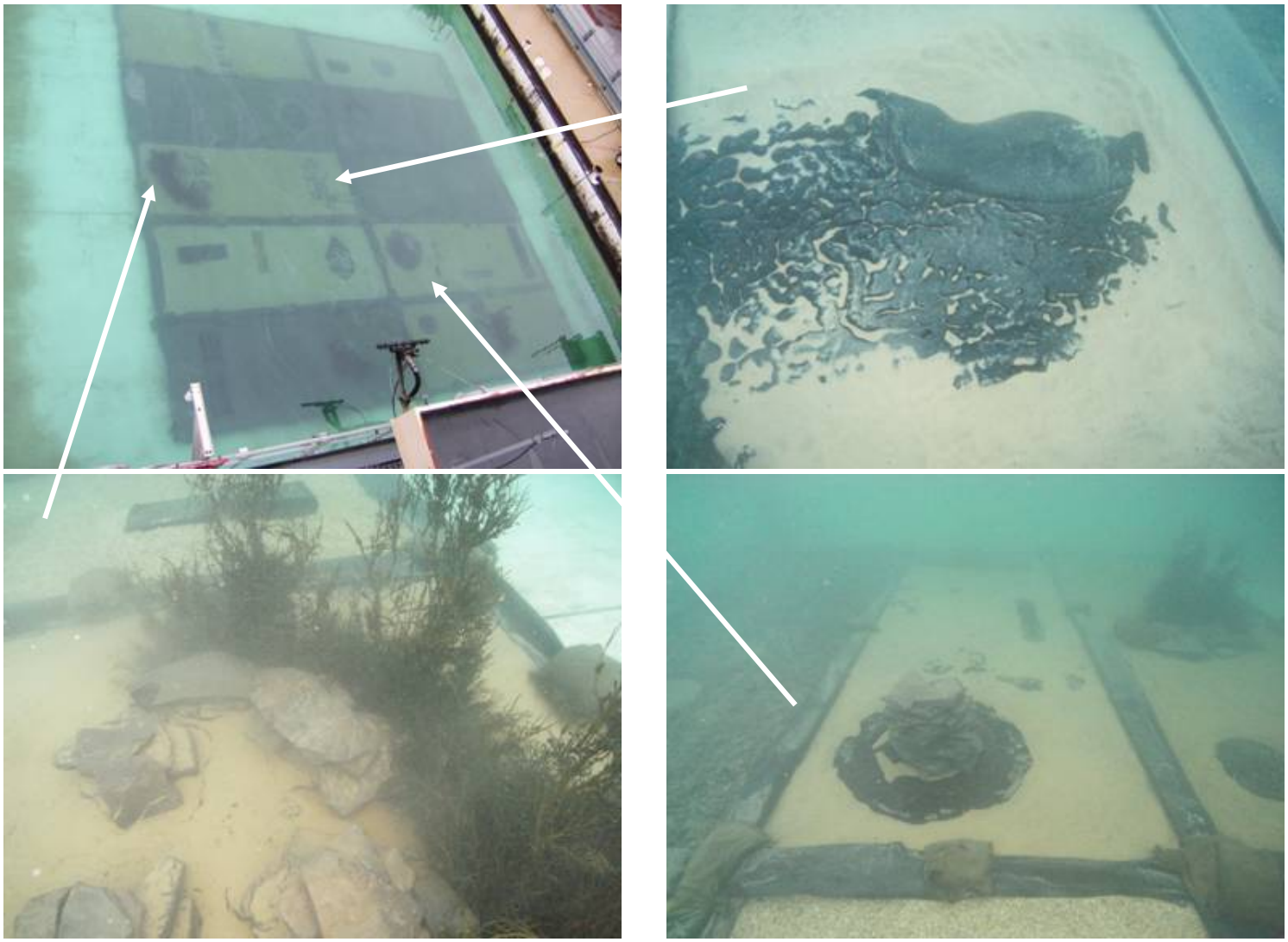
SAIC

Results of POC tests

Requirement	RESON	SAIC	EIC	WHOI
Identification of heavy oil on sea floor (80% certainty)	X	x	X	x
Ability to detect oil on the sea floor from at least 1 meter away	X	x	X	
Georeference oil locations	x	X	X	X
Real time data	x	X	X	X
Operate in fresh and sea water conditions equally well	X	X	X	X
Operate up to 100 feet	X	X	X	X

- **SAIC overloaded by reflection of light off tank walls**
- **WHOI has limited capability**
- **RESON and EIC selected for prototype development**

Prototype Test Layout



Other Systems

EIC

Coda Octopus

Biosonics

SRI Int

Prototype Test Results

Requirement	RESON	EIC	BioSonics	CodaOctopus
Identification of heavy oil on sea floor (80% certainty)	X	X	x	x
Ability to detect oil on the sea floor from at least 1 meter away	X	X	X	X
Geo-referenced to within 1 meter	x	x	x	x
Real time data	x	X	X	x
Able to provide data for all sea floor conditions	x	X	X	x
Search a one square mile area in a 12-hour shift	X	x	x	X
Water currents of up to 1.5 knots	X	X	X	X
Operate in up to 5 foot seas	X	X	X	X
Operable during the day and night	X	X	X	X
Able to be set up within 6 hours	X	X	X	X
Easily deployable and transportable	X	X	X	X
Capable of being deployed from a vessel of opportunity and a variety of other platforms	X	X	x	x

Detection Results

Methods were successful in detecting oil in benign environment

No one method that can cover 100% of area with no false alarms

Resolution of results still an issue

- Easier if oil stays together
- Random hits need to be correlated

Use of techniques in turbid water and very soft bottom also an issue

Megator Pump (attempted recovery)

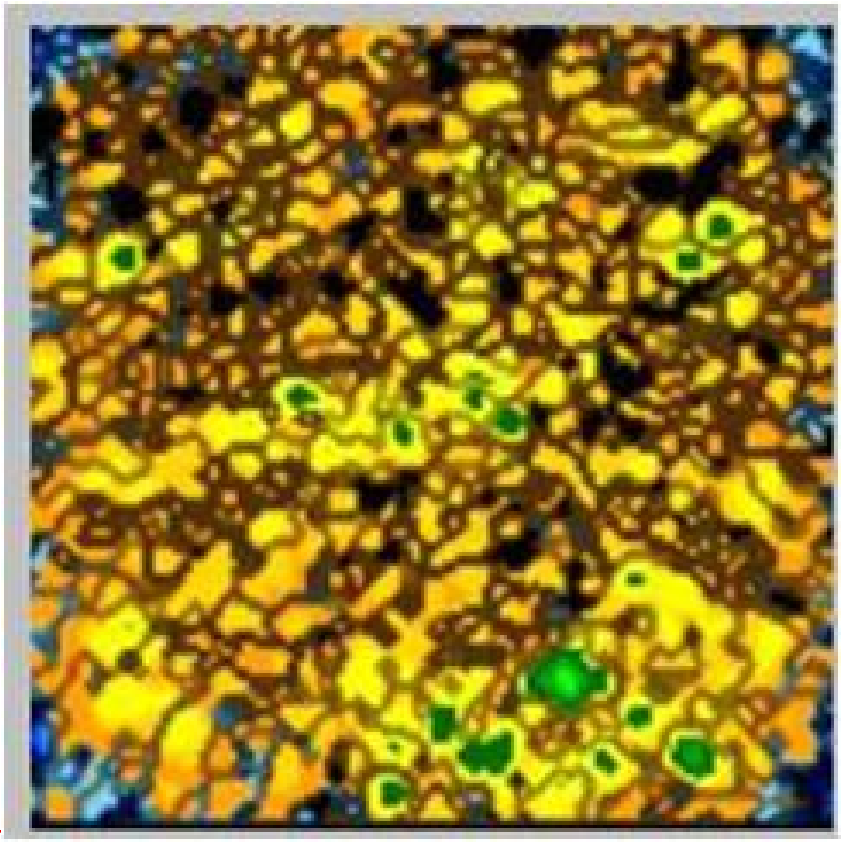
Pump & Nozzle

In Action

	NO 6 Fuel	Tesoro Slurry	Sundex 8600
Density (g/ml @ 1C)	1.083	1.0626	1.071
Viscosity (cP @ 30.5F, -.8C))	700,000	80,000	550,000

Tests in Gulf - inconclusive

EIC and CodaOctopus Mounted



Acoustic Data

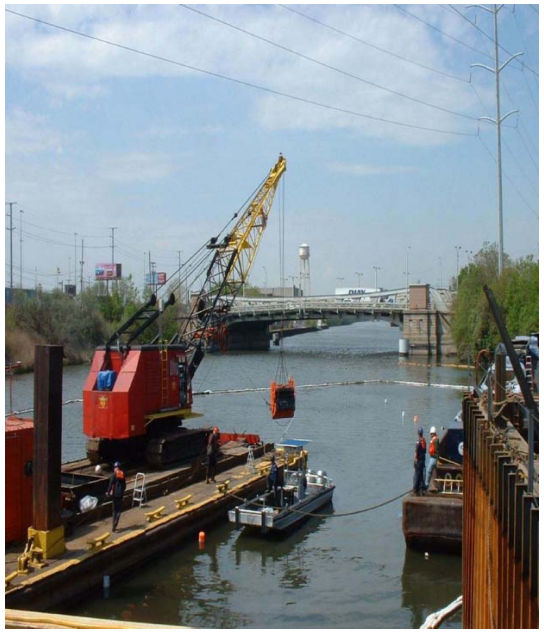
Submerged Oil Recovery Issues

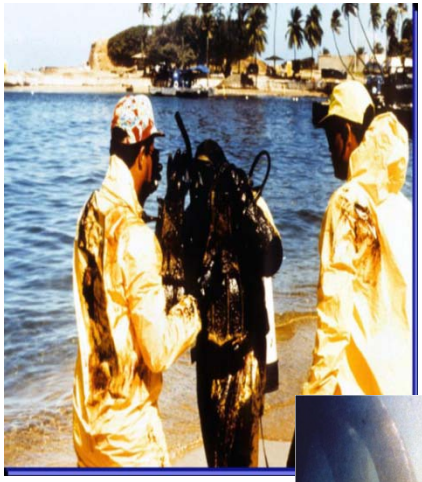
Little change since National Academy of Science Report in 1999

- **Provided recommendations for containment and recovery of submerged oil**
  - Ideas have been used in few actual spills
  - Most surface-based techniques (dredging using pumps or mechanical) have limited control so additional damage is usually caused
  - Current procedure relies on visual detection and recovery with use of divers
  - Method limited by visibility and diver capability limits for time and depth.
  - Response also limited by lack of knowledge about submerged oil behavior
  - Recovery also limited by inefficient collection that includes a large amount of silt and water along with oil
    - Requires large decanting/separation effort that may have floating and non-floating oil.

Examples of Recovery (pictures from NOAA)

Clamshell





Berman Spill

DBL-152

Other Examples of Equipment (from D Usher)

Coated Hose

Decanting

Pumps

Recovery Specifications

- Presence of heavy oil on the sea floor identified with 80% certainty
- Oil location geo-referenced to within 5 meters in accuracy
- Minimal dispersion of oil or bottom material into the water column
- Provides recovery for all sea floor conditions
- Operates in fresh and sea water conditions
- Operates in water depths of up to 200 feet
- Easy to operate and requires minimal training and maintenance

Recovery Specifications (cont'd)

- Easily de-contaminated and durable
- Operates in water currents at the surface of up to 1.5 knots
- Deploys and operates in up to 5 foot seas
- Operable during the day and night
- Sets up within 12 hours of arriving on site
- Viscosity – Operates in the range of 2000-100,000 cSt
- Includes a decanting system that can handle the heavy or refloating oil
- Process to complete "polishing" the resultant water for disposal
- Minimal impacts to benthic resources

Project process

BAA Released June 2009

- Phase I: System Design
  - 10-12 months
- Phase II: Prototype Development
  - 10-12 months (tests in 2011)

Proposals Accepted August 2009

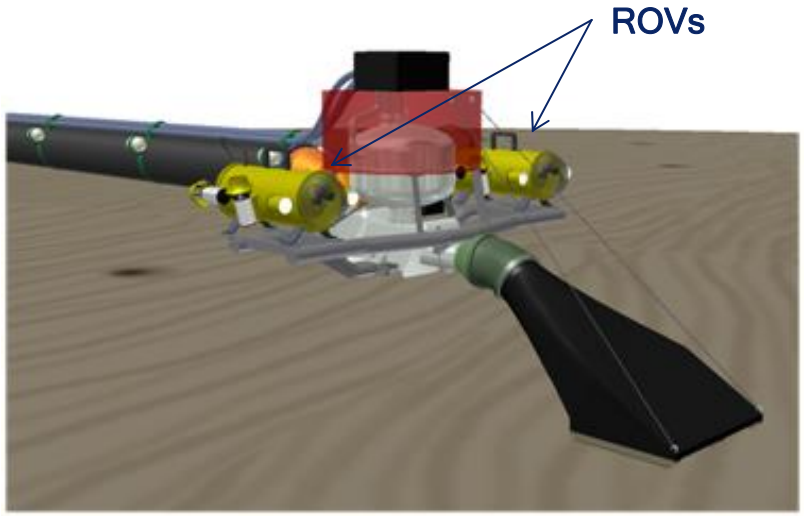
- 6 proposals
- 3 awards
  - Alion Corp (working with Jacqui Michel of RPI)
  - Marine Pollution Control (based on manned submersible)
  - Oil Stop (working with Tornado Motion Technologies)

Final Reports Reviewed November 2010

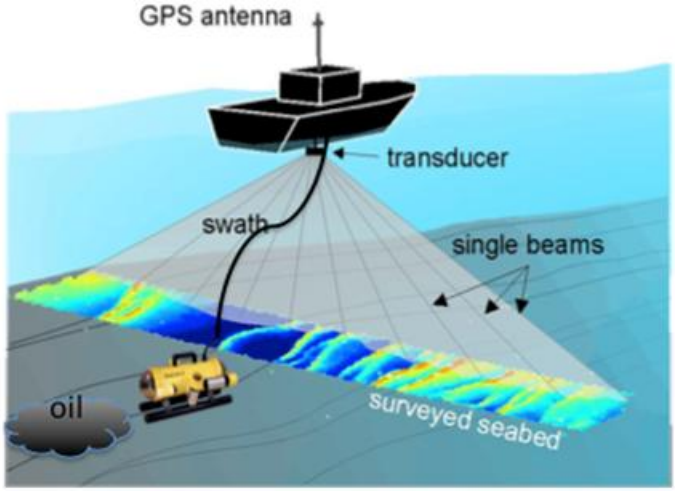
- Anticipate contact awards for all 3 in January 2011 for prototypes

Alion

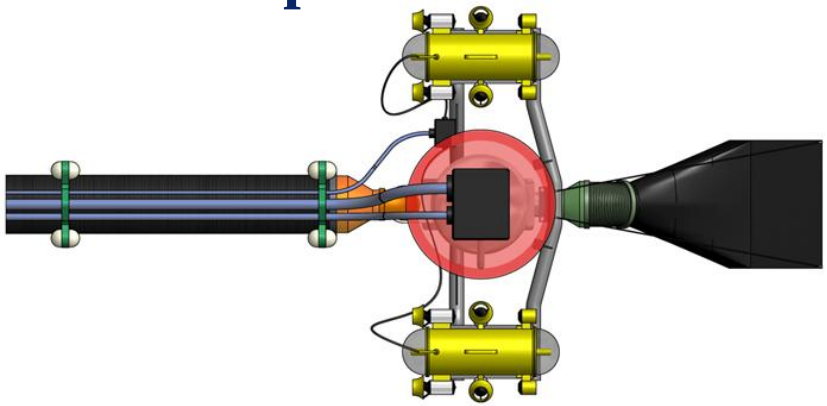
- **Lightweight system based on Remotely Operated Vehicles (ROV)**
- **Uses SONAR for detect**
- **Least developed concept**



Concept of Operations



Top View



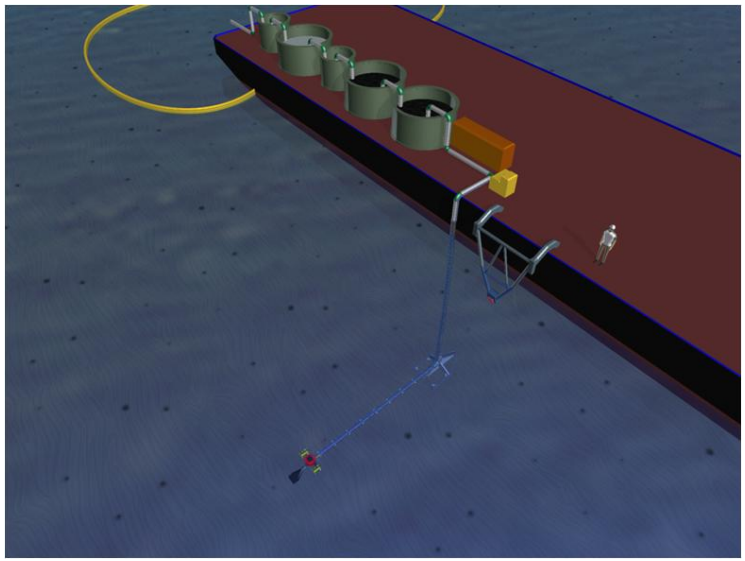
Alion - Trade-Offs

ROVs

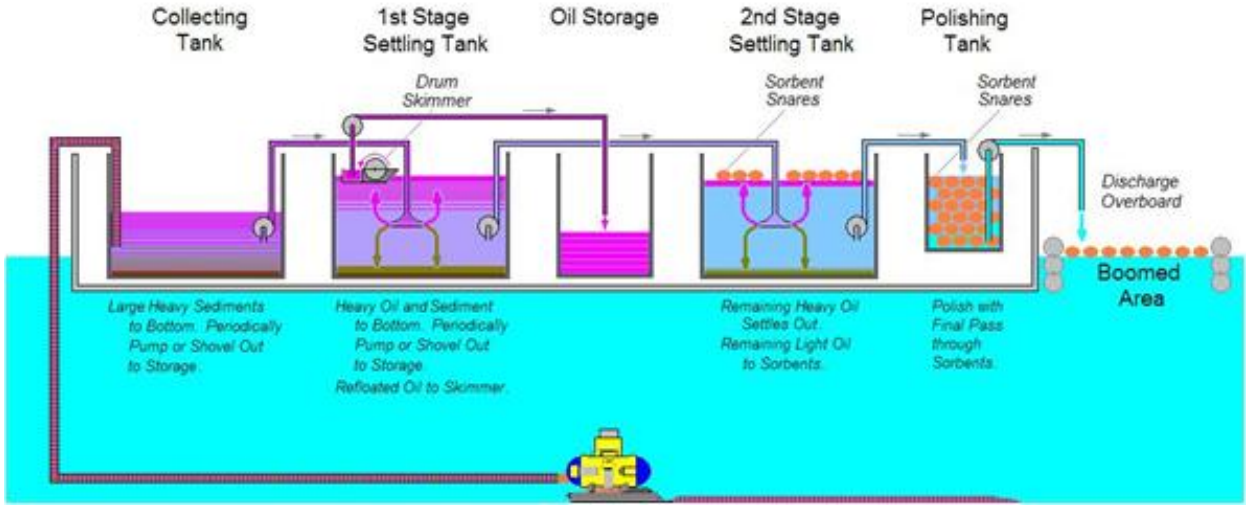
Pumps

Alion- Other Issues

Alternative Concept (on barge)

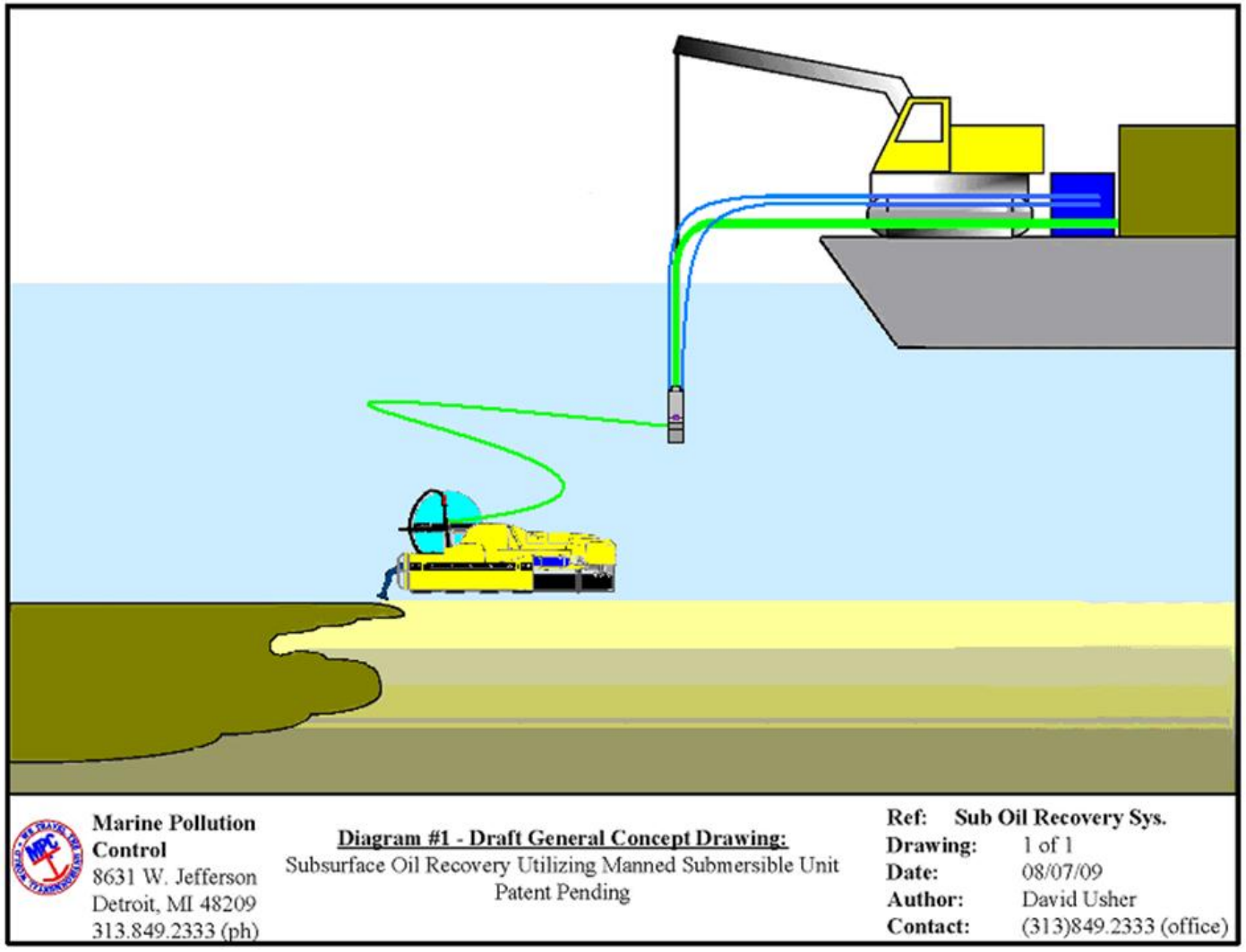


Decanting/Separation Design

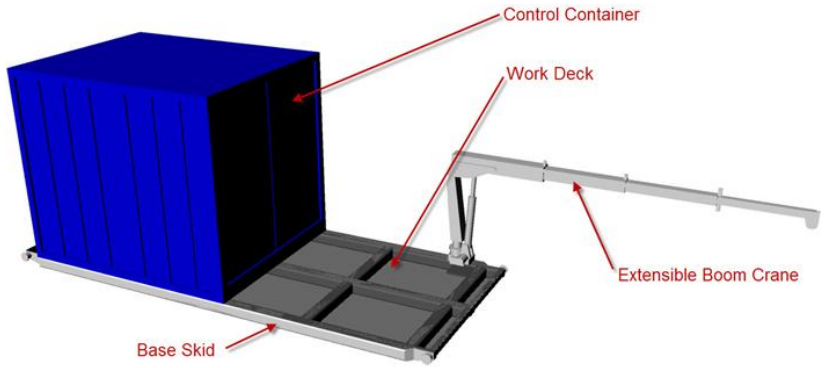


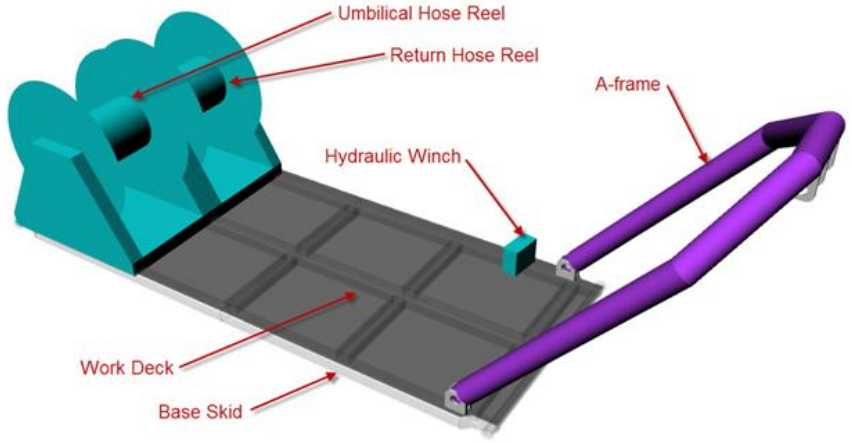
Marine Pollution Control

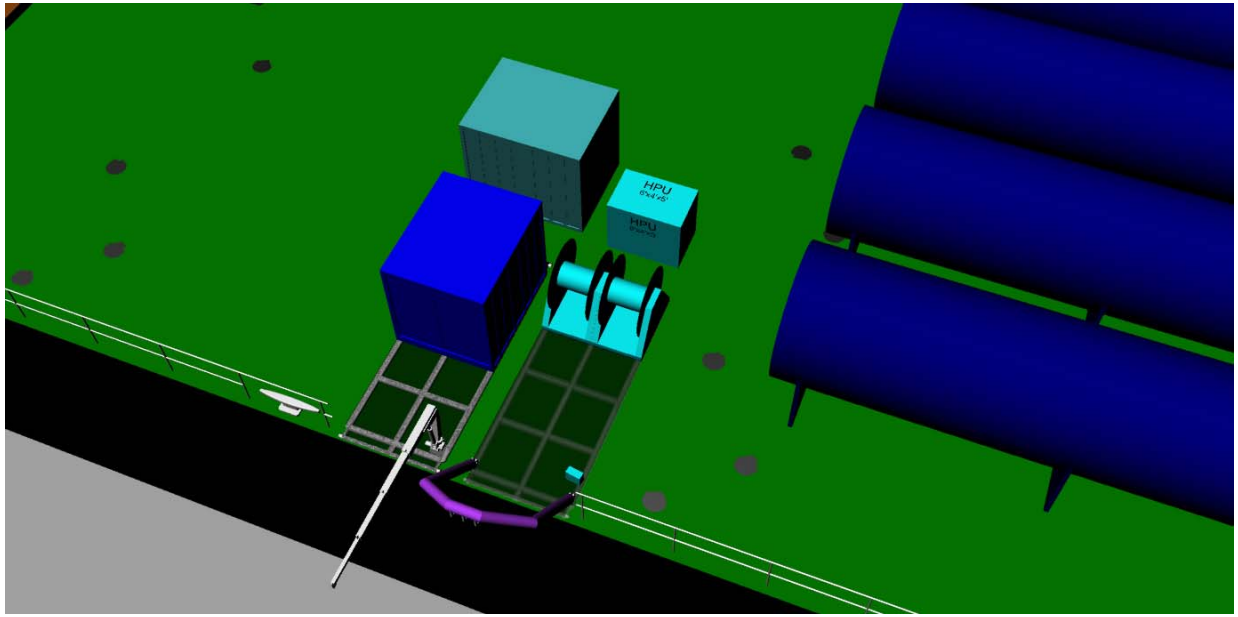
- **Based on existing manned submersible**
- **Uses sonar, EIC and visual for detection**



Marine Pollution Control
(control station and umbilical control concepts)







Components Available

Existing Submersible

Multi-degree of Freedom Robot Arm

Pump and debris control

Oil Stop

- Based on submersible dredge
- Uses visual for detection
- Weight reduction and increased depth capability needed

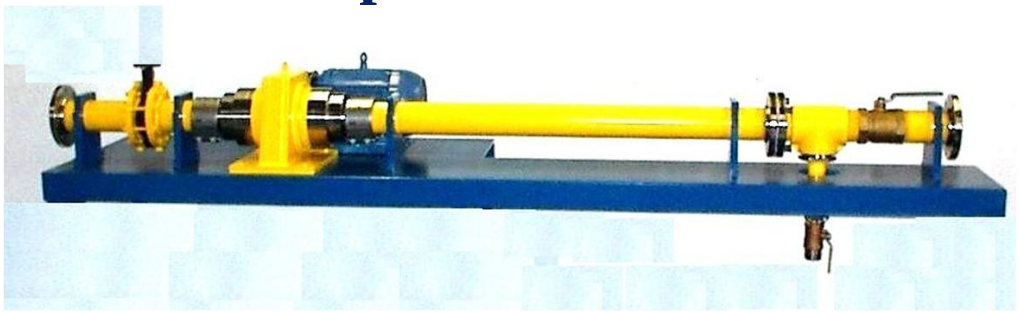
Eddy Pump

Existing Components

Typical frac tank

Conveyor Belt Skimmers

Voraxial Separator



Results

Systems selected as having unique capabilities

- One is lightweight
- One can get deeper and stay longer (manned submersible)
- One could handle harsh wind/wave conditions

Planned testing at Ohmsett in November, 2011

- Due to 8-foot depth, there is a limit to testing especially for submerged crawler and manned submersible
- Modifications to systems to compensate
- Considering full field tests in FY2012 without oil (location TBD)

Questions

Non-Attribution Policy

Opinions or assertions expressed in this paper are solely those of the author and do not necessarily represent the views of the U.S. Government. The use of manufacturer names and product names are included for descriptive purposes only and do not reflect endorsement by the author or the U. S. Coast Guard of any manufacturer or product.

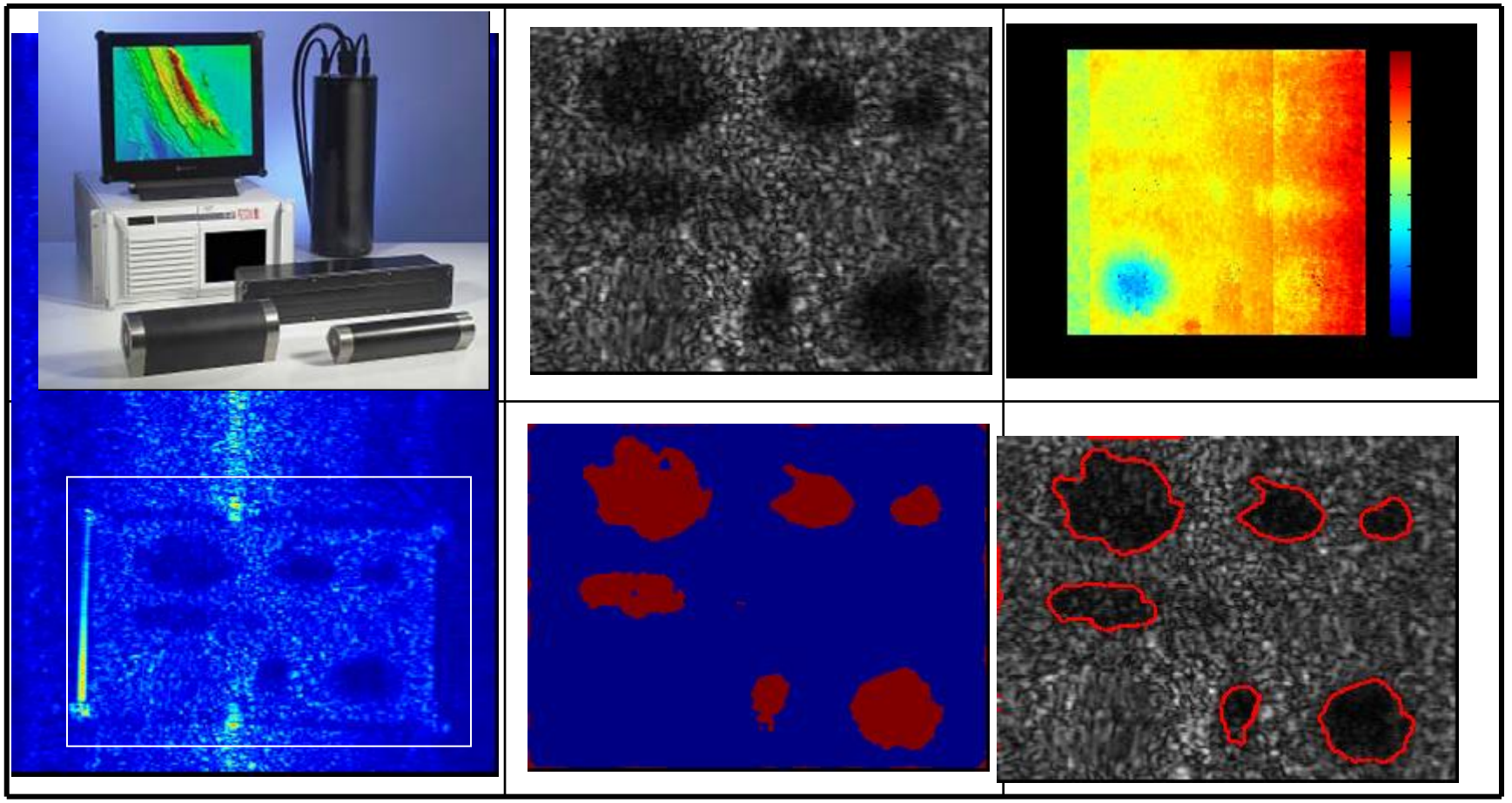
Backup Slides

Past Projects

Evaluation of Airborne Laser Fluorosensor

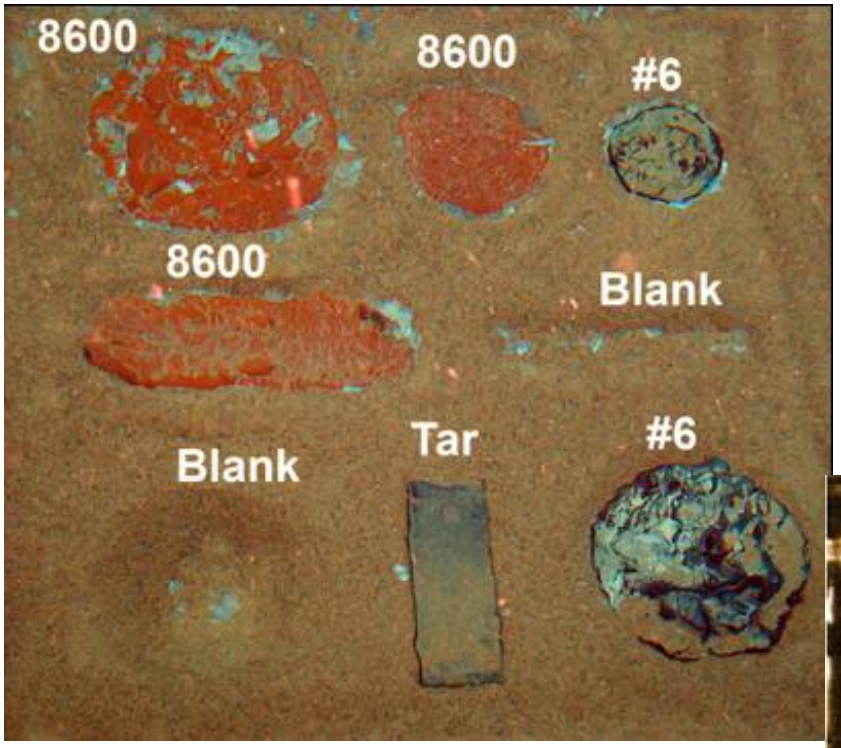
- **Literature Search Sensor Evaluation**
  - Including Infrared (IR), Ultraviolet(UV), Multispectral
  - Selected laser fluorometry (LF) for evaluation
- **Concept Testing – successful** (able to detect in 40 feet of clear water)
  - NASA
  - SESI
  - LDI³
- **Cost Benefit Analysis**
  - Opportunities Analysis – how many actual spills are there
  - Statistical Approach – how many spills could LF be used on
  - Scenario-Based Approach – using past spills to see if response would have changed with LF deployment
  - Implementation Costs for multiple options – strategic versus tactical
  - Result of Analysis - not enough benefit for costs

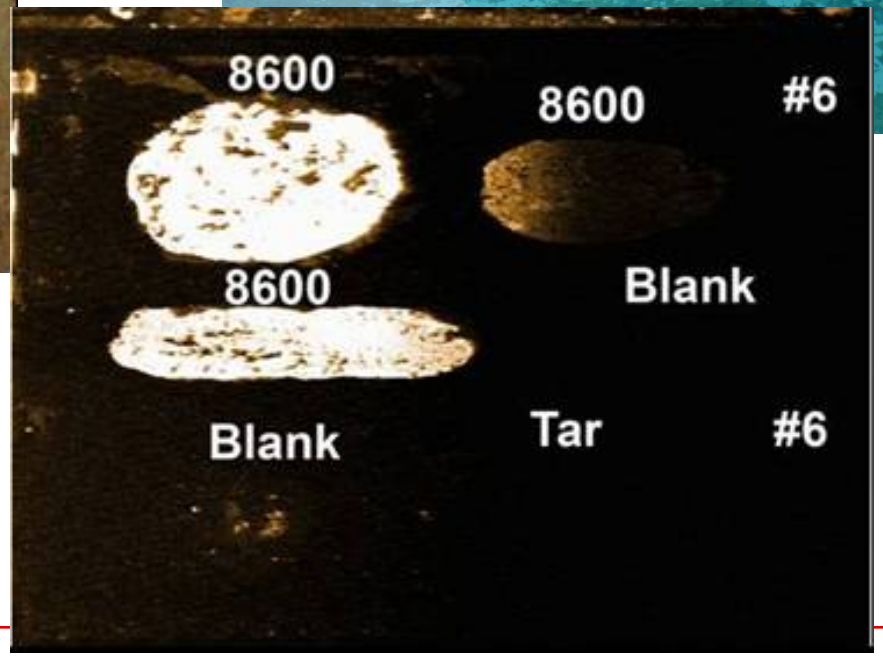
Tray B using RESON Multi-Beam Sonar (based on target strength analysis)



Eight-Inch Target Tray (B) RESON Data with Sonar on Top of Tray (Left Figure: raw data, Top Center: zoomed raw data for bottom tray, Top Right: echo sounder data on same area, Bottom Center: automated detections results, Bottom Right: automated detection overlaid on raw data)

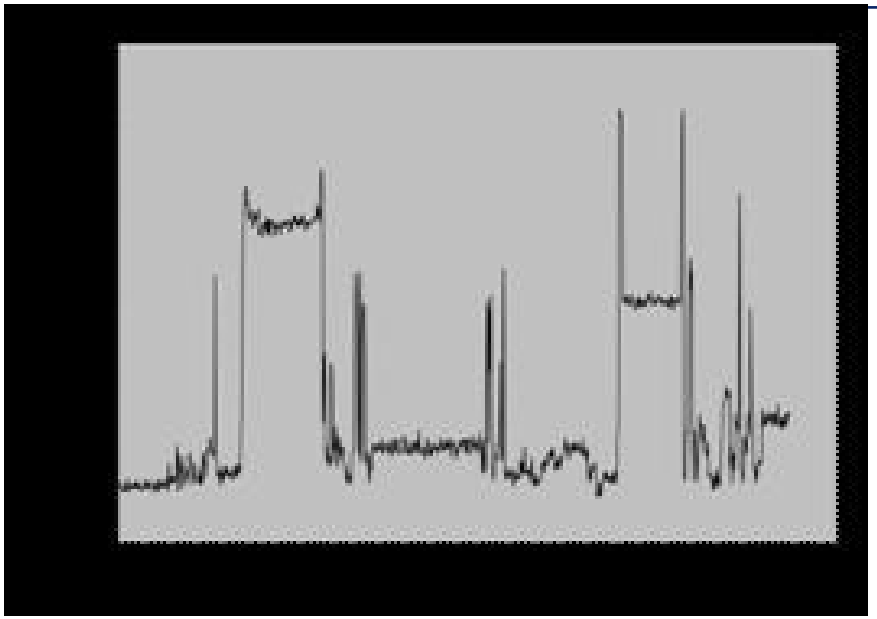
SAIC Laser Fluorescence System
(based on oil fluorescence return)

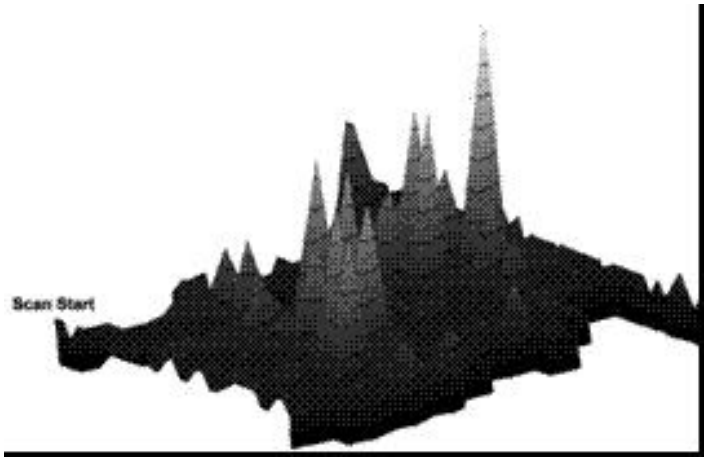




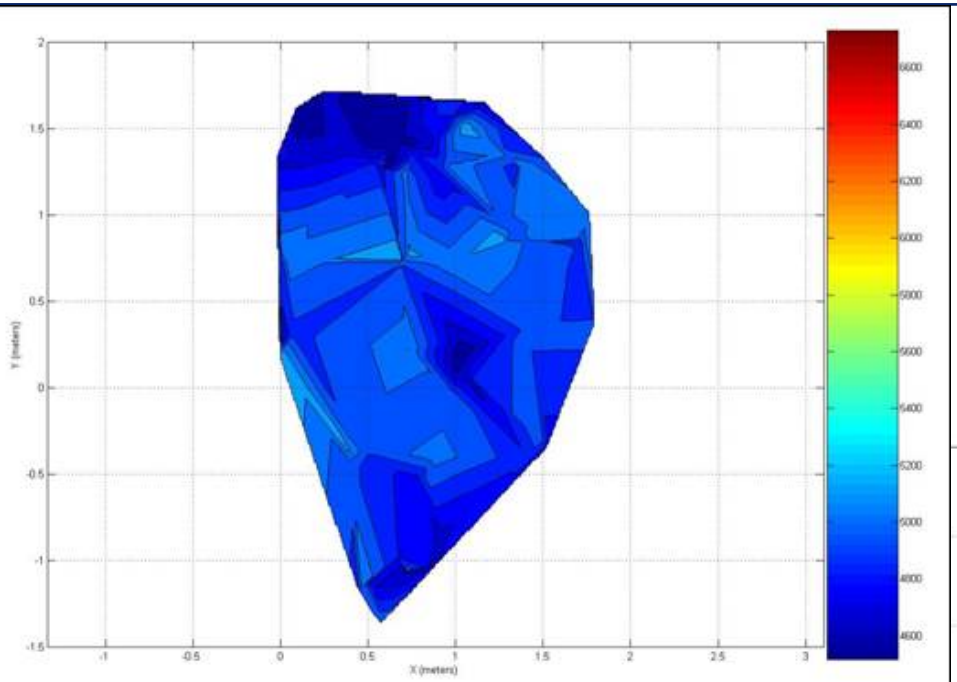
Visual **Fluorescence**

EIC Fluorescence Polarization
(additional processing for better signal)



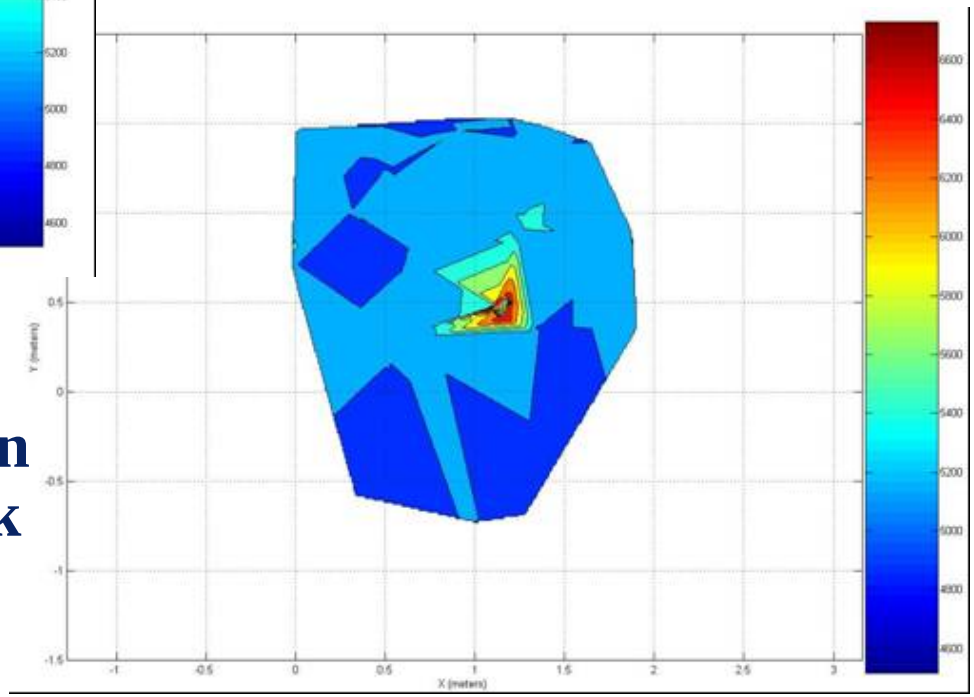


WHOI Results for Indoor Tank

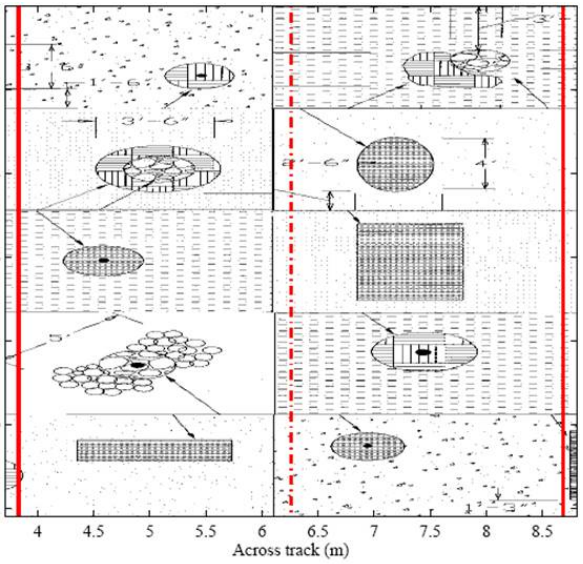


No Oil Present

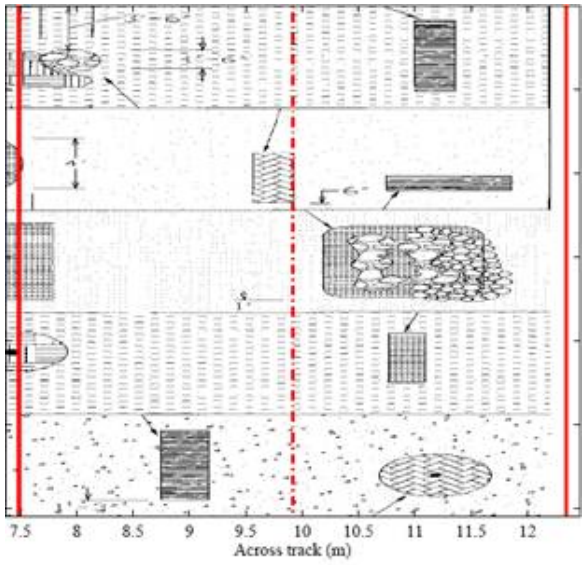
Oil in Tank



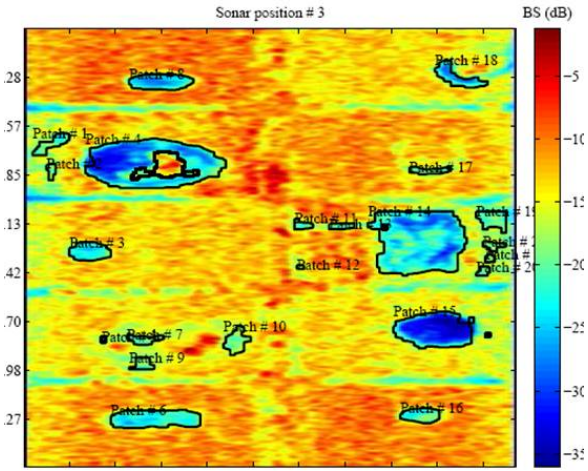
RESON Results

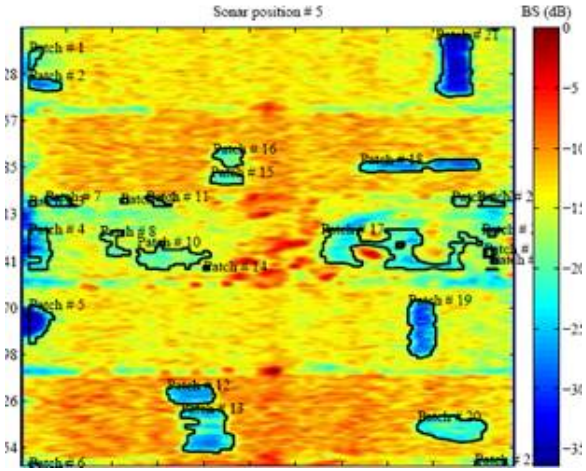


(a) Sketch of the survey area.



(a) Sketch of the survey area.

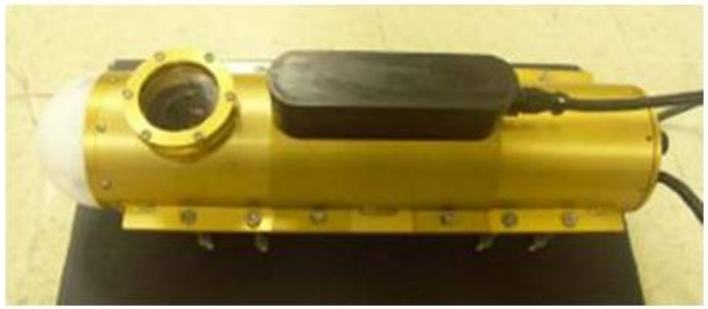


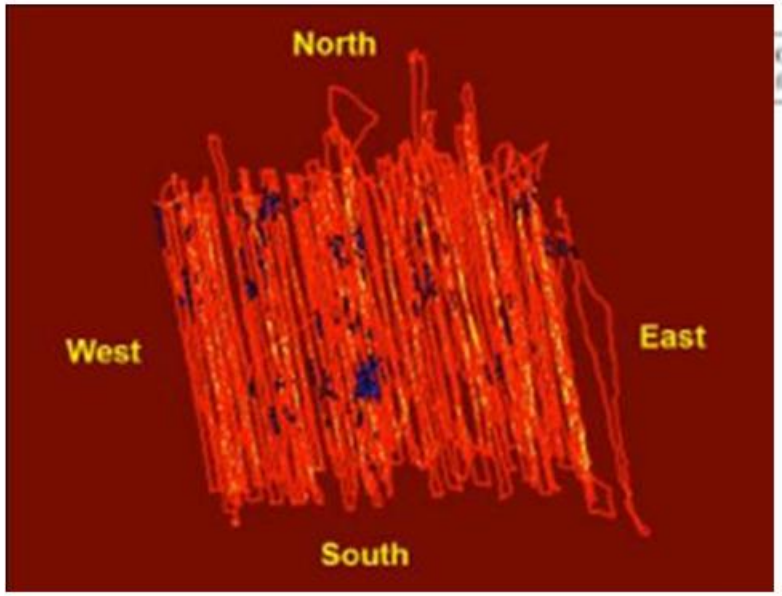


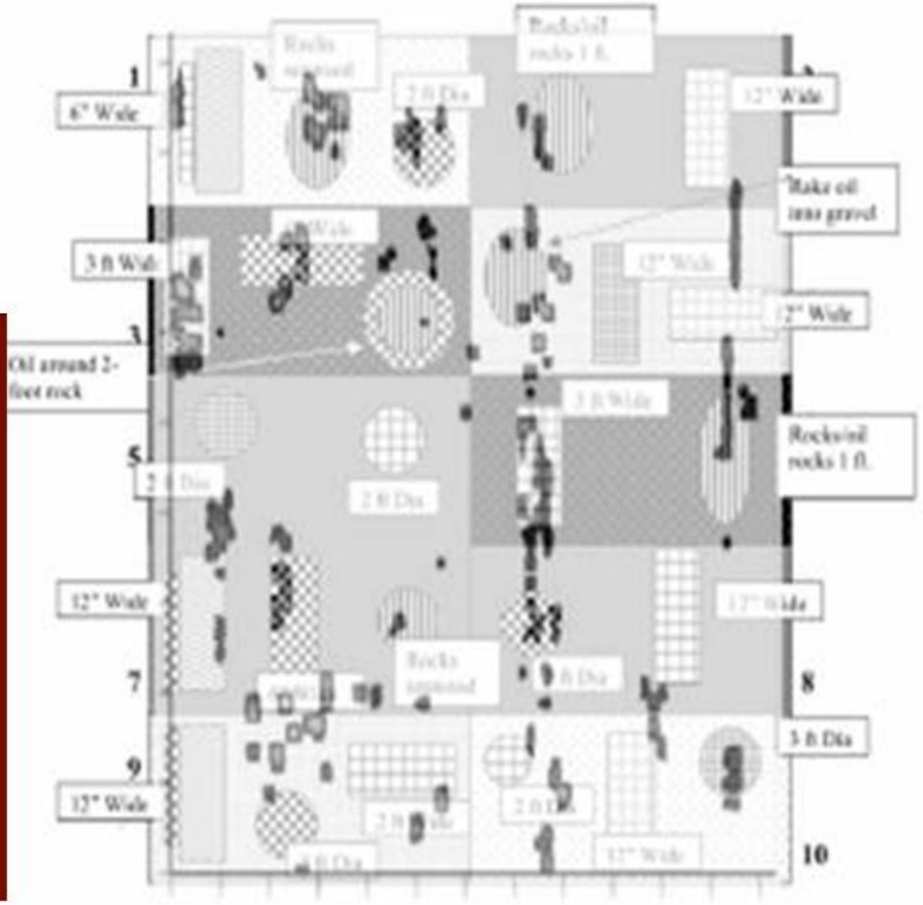
Using Area Detected as Measure:

Average Detection Rate of 87%
Average False Alarm Rate of 24%

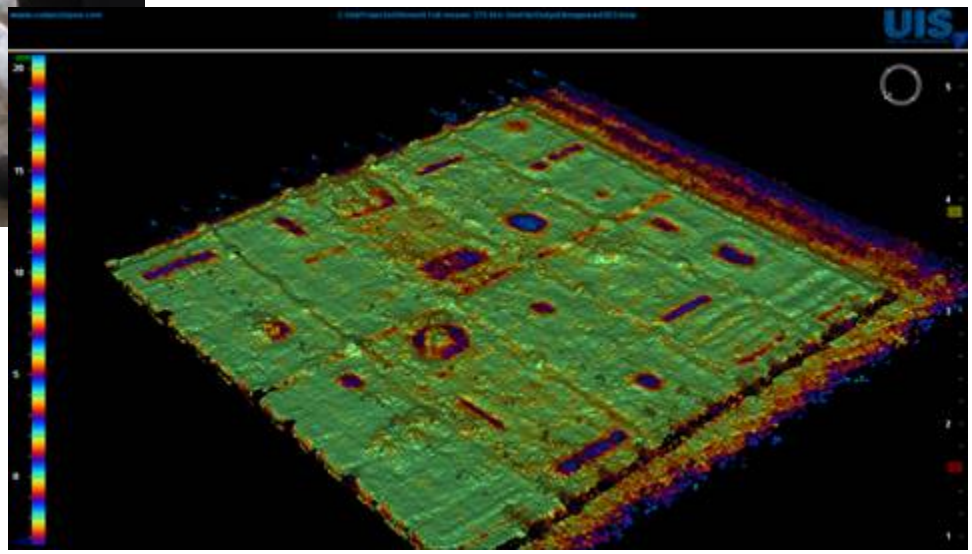
EIC Results (issues with GPS and light overload, added modulating laser)





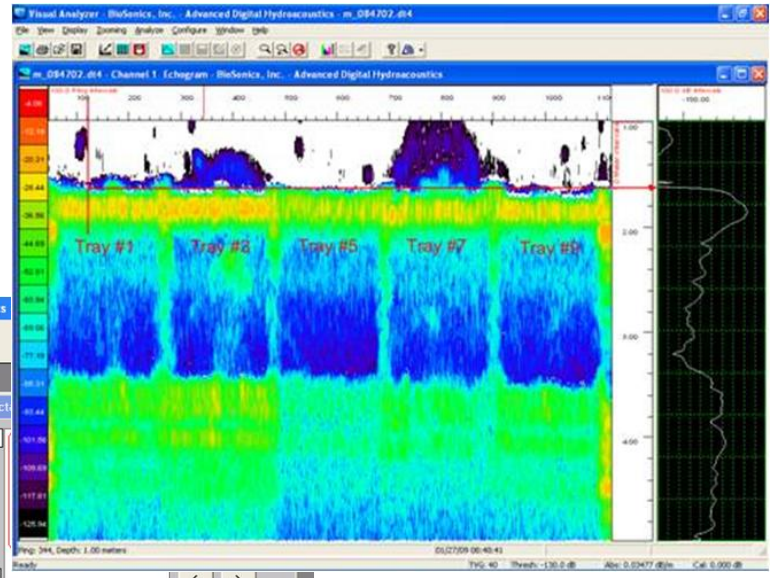


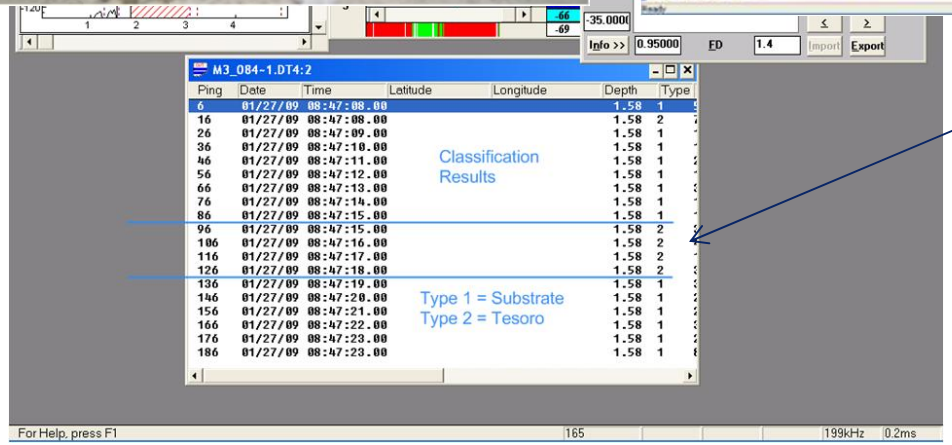
CodaOctopus (USCG sonar, system of opportunity)



Biosonics (system of opportunity)

Raw Data





Processed Data: Section showing unique substrate