Breakout Session: Shipboard USBL Systems

Uses, set-up, care and maintenance, calibration, and open discussion

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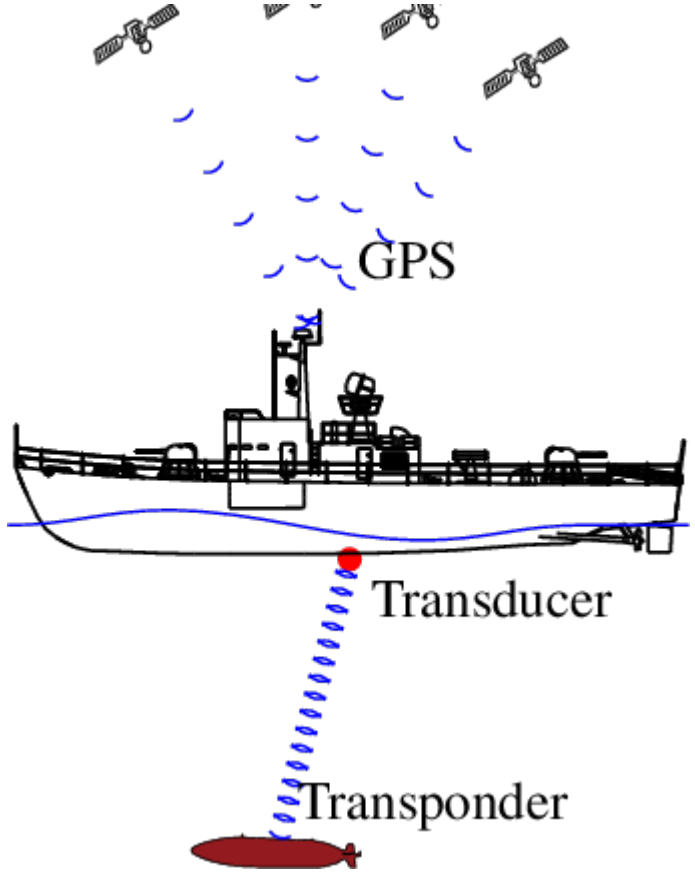
NDSF NATIONAL DEEP SUBMERGENCE FACILITY

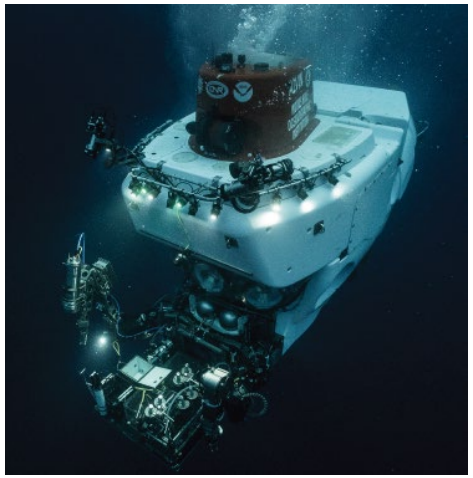
USBL – What is it?

- Ultra Short Base Line
  - Method of underwater acoustic positioning. A complete USBL system consists of a transceiver, which is mounted on a pole under a ship, and a transponder or responder on the seafloor, on a towfish, or on an ROV. A computer, or "topside unit", is used to calculate a position from the ranges and bearings measured by the transceiver.

- An acoustic pulse is transmitted by the transceiver and detected by the subsea transponder, which replies with its own acoustic pulse. This return pulse is detected by the shipboard transceiver. The time from the transmission of the initial acoustic pulse until the reply is detected is measured by the USBL system and is converted into a range.

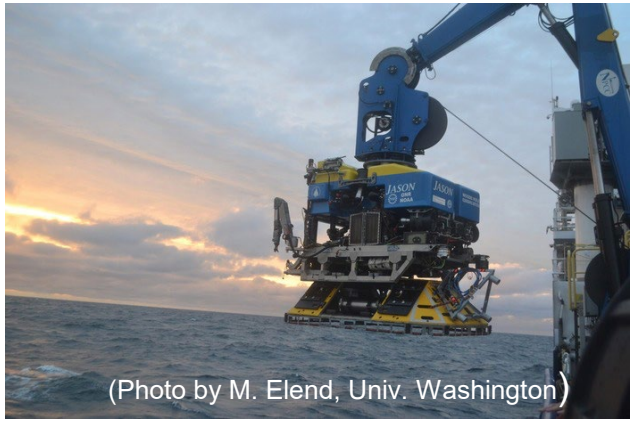


NDSF Vehicles



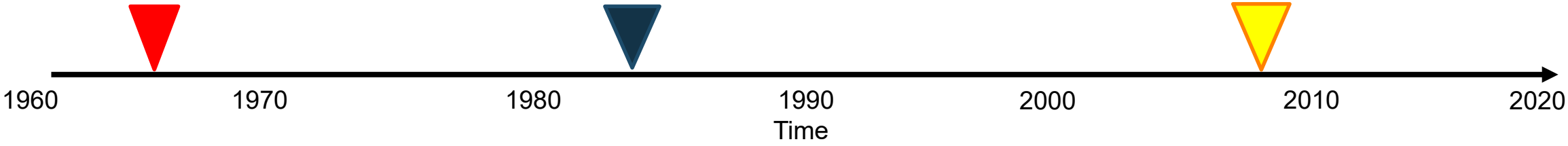
(Photos by Lu Lamar, WHOI)

The Woods Hole Oceanographic Institution operates three deep submergence vehicles as part of the NSF-funded National Deep Submergence Facility in support of the entire Oceanographic community.



(Photo by M. Elend, Univ. Washington)

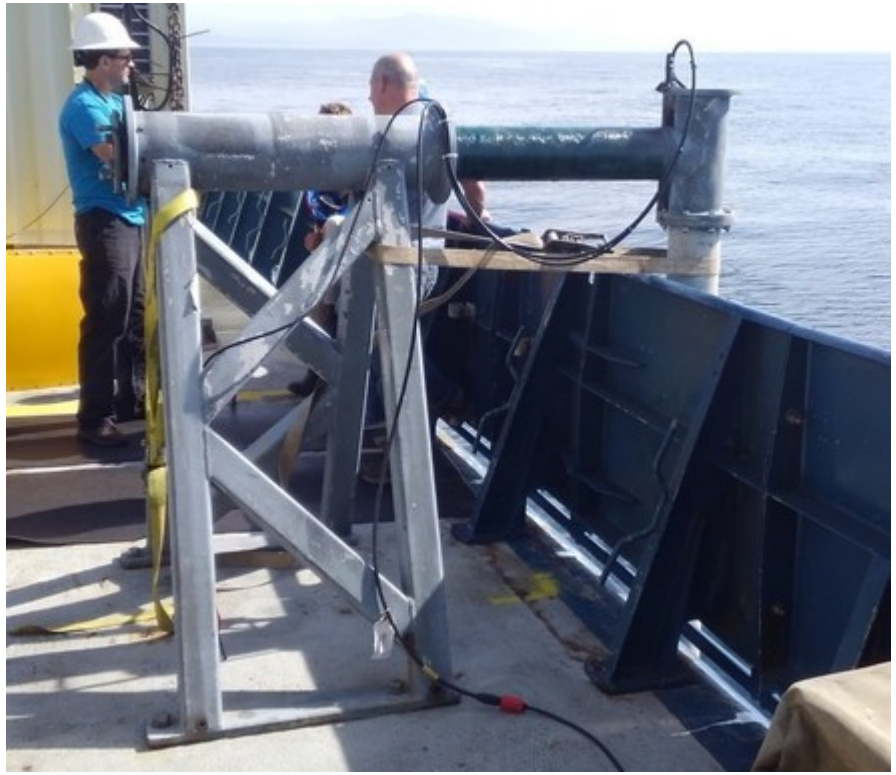
(Photos by Lu Lamar, WHOI)

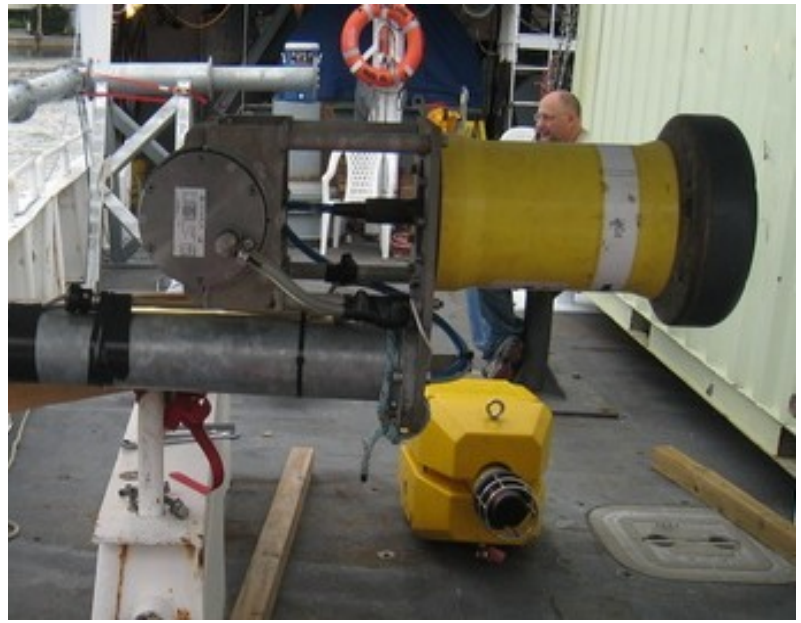


USBL – What are the parts?

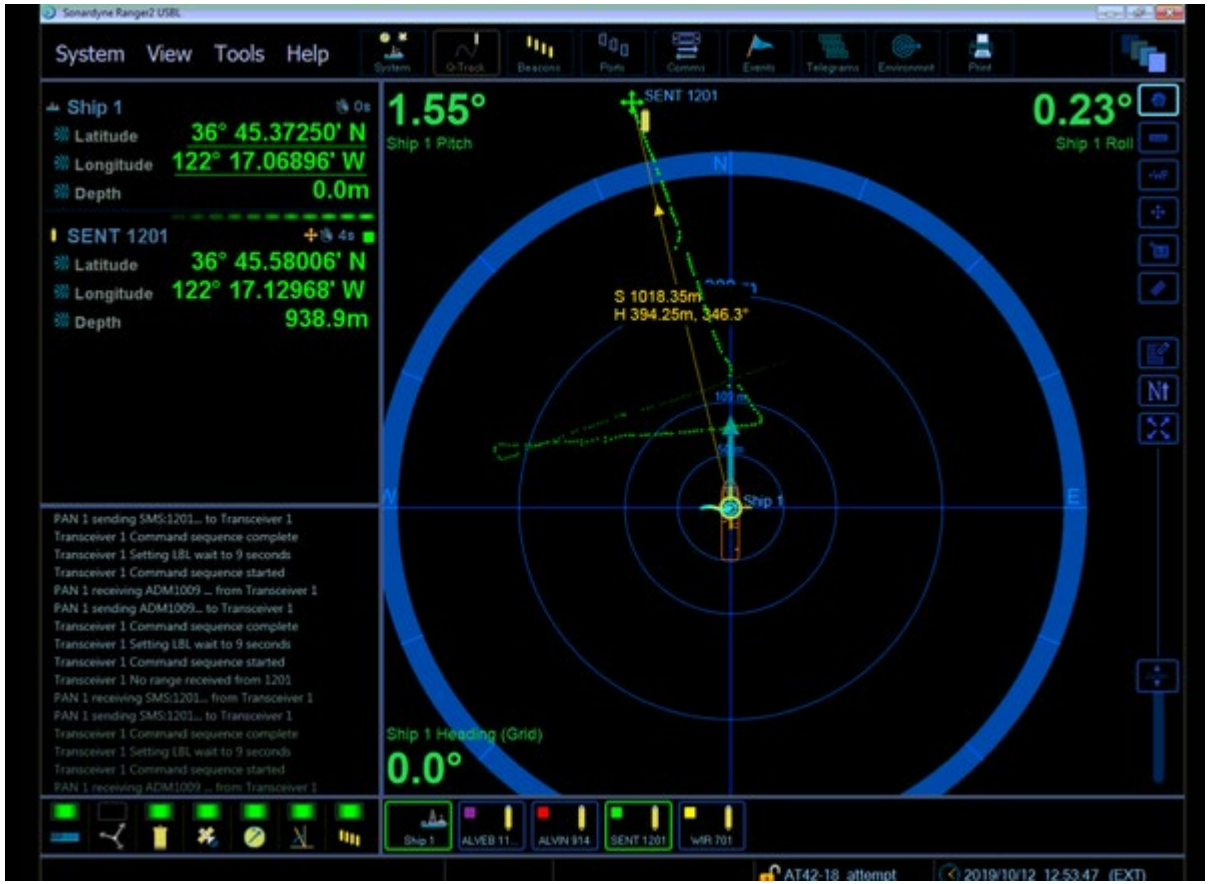
- Computer -- GUI for control/Processes data input
- NCU -- Data feeds input and output
- GPS -- position data
- Pitch Roll heading Sensor
- Transceiver -- Transducers for transmit and receive

USBL Pole





NDSF Navigation with USBL



- USBL is used within the NDSF facility for range, bearing, and acoustic communications with the three vehicles in the facility (Alvin/Jason/Sentry). NDSF moved to USBL ~ 2009 moving away from LBL transponder nets. This significantly reduced setup time once on station, removing the need to deploy and survey LBL transponders.

- USBL Navigation is required for every cruise we conduct, each vehicle owns and maintains USBL hardware that travels with the System.

USBL Use By Vehicle

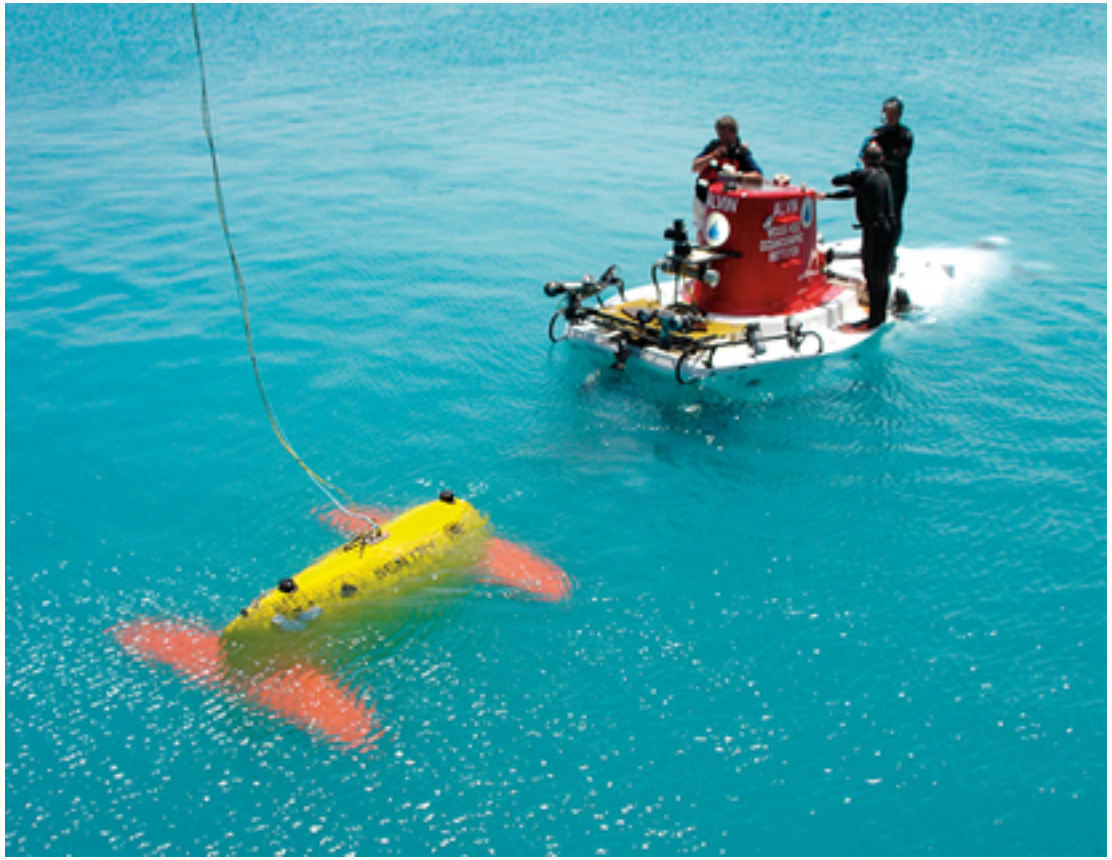
Vehicle	ALVIN	JASON ☐Stuff here	SENTRY
System	Sonardyne Ranger2 (embedded in R/V Atlantis)	Sonardyne Ranger2 (Fly away system)	Sonardyne Ranger2 (Fly away system)
Tracking	Yes	Yes	Yes
SMS (acoustic modem)	Yes 1. Elevator release 2. Position to Alvin	Yes 1. Elevator Release 2. Wire turn counter	Yes 1. Vehicle Real time Data 2. Control and configuration of mission in Real time

USBL importance to our operations

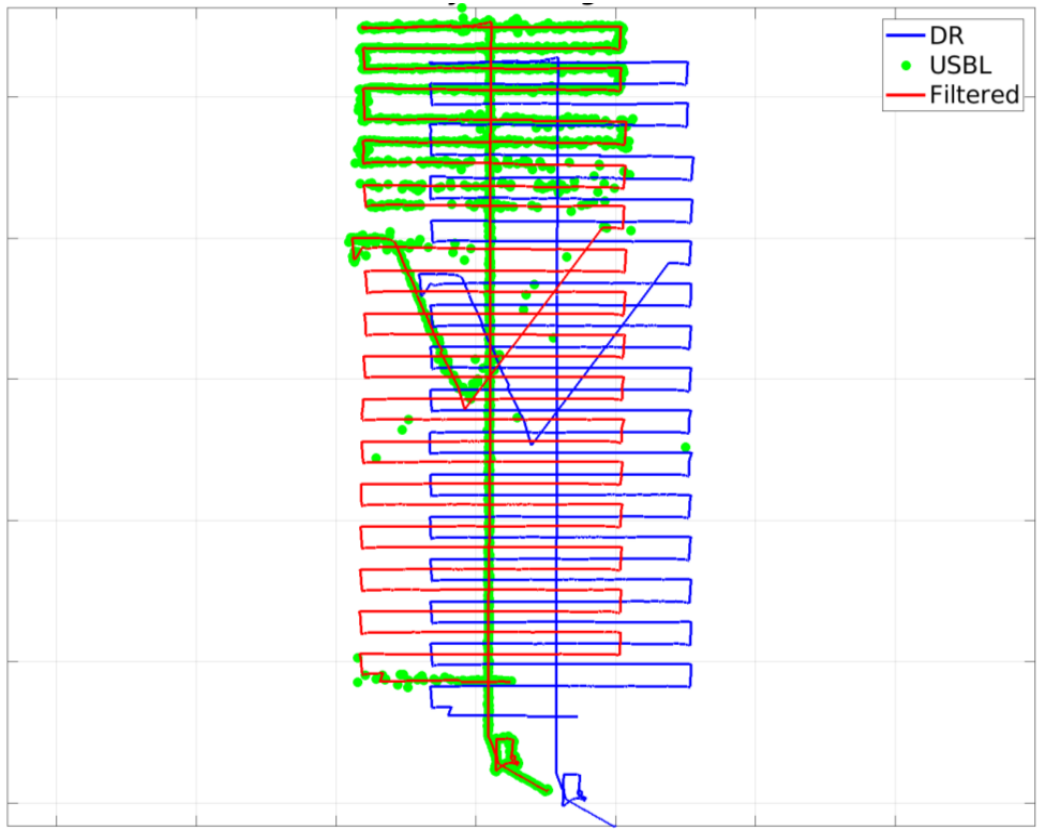
- Provides real time navigation for our vehicles. Accurate navigation and tracking is critical to deep ocean sciences providing the most accurate position for the location of collected samples.

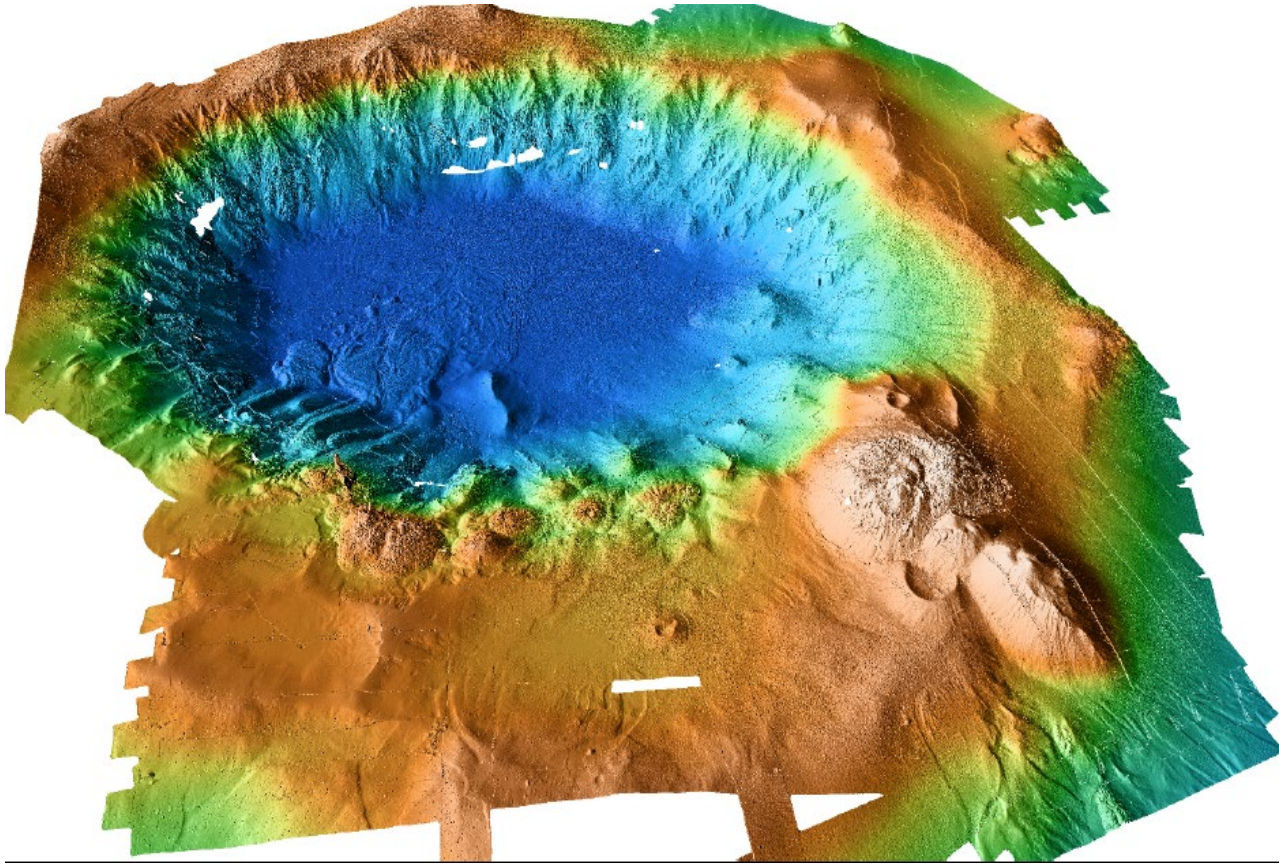
- Each recovery of the vehicles requires accurate navigation to ensure the safety of the vehicles as well as the safety of the passengers inside HOV Alvin.

- Multibeam Mapping requires accurate navigation to tie the multibeam data to the location of the vehicle.



USBL Importance (cont.)





USBL Use Cases – R/V Atlantis (AGOR-25)

- Embedded System

- Uses 'trackpoint' pole, mounted mid ship. Operated by Engineers for deployment and recovery.

- Sonardyne Ranger computer and NCU are on the bridge in toplab

- P/R/H from ships PHINS

- Transceiver head in sea chest (hard to access)

- Gate valve limits the size of the transceiver head.

- Integration requires bridging networks.

USBL Use Cases – Pisces

- First installation used over the side pole in place of centerboard.
- Bolt pattern did not match pole footprint – welded to the deck
- Following year, installed cables and fabricated brackets for the centerboard.
- Permanent wiring was installed by contractor
- Used our sonardyne gear on centerboard
- Ranger computer and NCU secured in lab, inside travel case
- Centerboard was ideal for the science mission operating in currents of 4knots in the gulf stream

USBL Use Cases – Endeavor

USBL Use Cases – Atlantic Explorer

- Used existing moon pool/tower on the ship
- Fabricated brackets for the head and transducers
- Installed during the mob
- Mobile rack with the sonardyne system mounted in the lab
- Limited depth below the hull with moon pool setup.
- Large enough for full size transceiver head

USBL Cruise planning

- Communications well ahead of time

- Calibration (when was the last one what did it look like)

- Do we need to plan a calibration for the cruise?
- What is a good calibration?

- How can our group tie into the existing system?
  Network, control of the GUI?

- What will be required during the mobilization?

- Job File – what exists, is it relevant?

- Who will run the deck ops for deployment?

** Past issues **

- Operator doesn't have a good understanding of the hardware

- Calibration Status is unknown

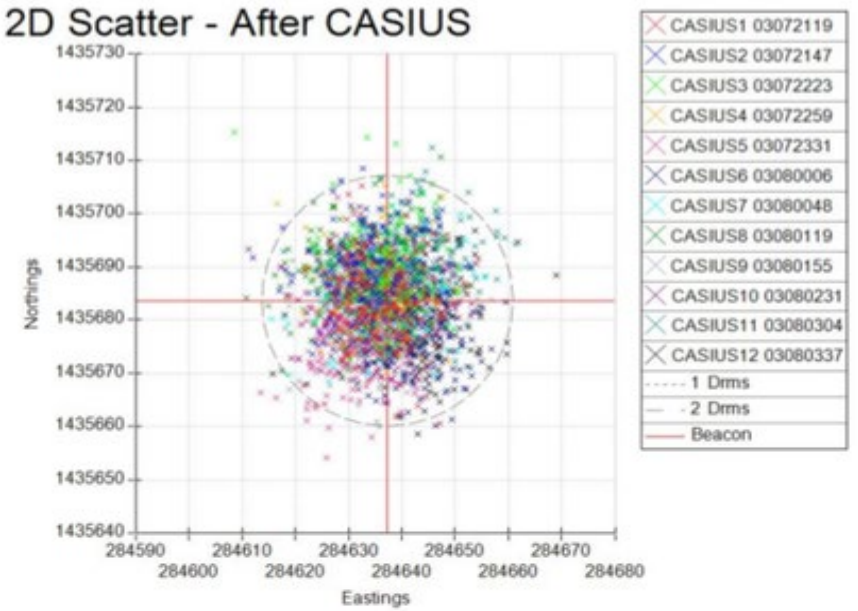
- Hardware has moved and calibration is now void

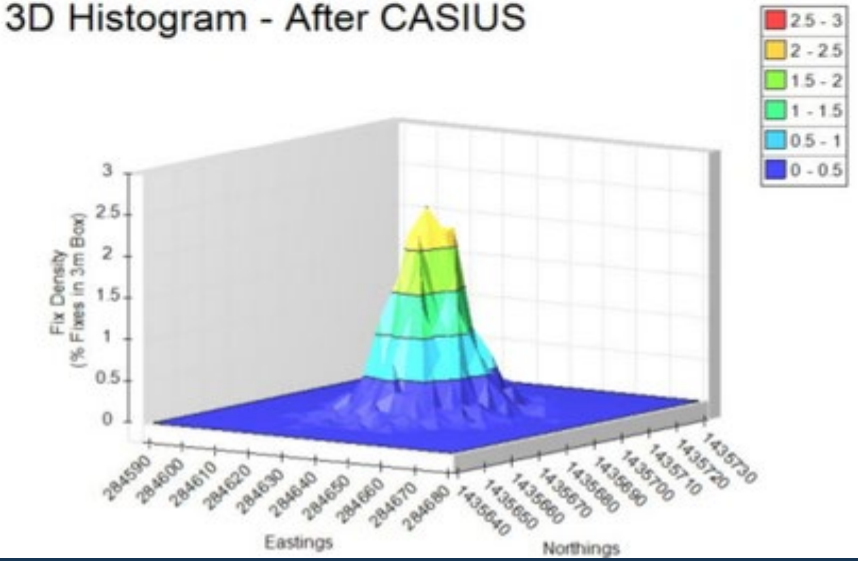
- System hasn't been used in a long time and status is ??

- Access to the computer requires significant work during the mob (Ethernet)

USBL - Calibration

USBL calibration tool CASIUS (Calibration of Attitude Sensors In USBL Systems) is Sonardyne's USBL calibration and verification tool integrated with the Ranger 2 software. The CASIUS calibration optimizes the performance and accuracy of Ultra-Short BaseLine (USBL) acoustic positioning systems by accurately calibrating the biases between the USBL transceiver(s) and the vessel's attitude and heading sensors.

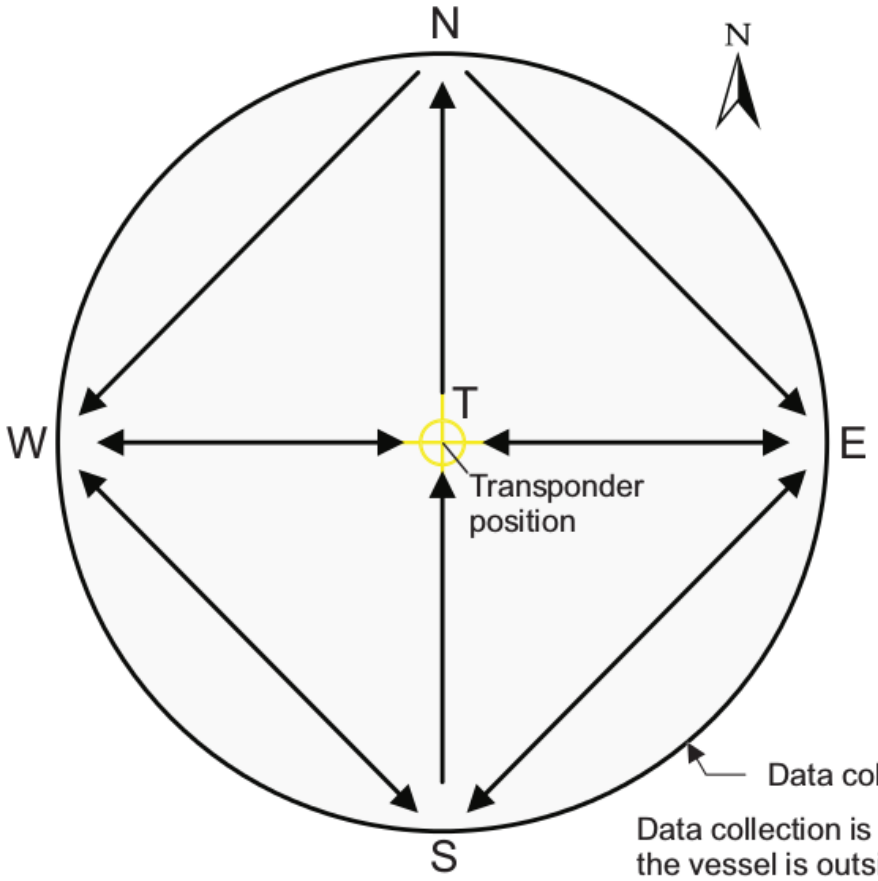




USBL – Calibration (cont.)

- *** Calibration Steps ***
- - Install equipment
- - Measure offsets
- - Launch Beacon
- - Plan Survey
- - Conduct Survey and Run CASIUS
- -(Refer to the Sonardyne Manual for instructions)

Figure 34 Manoeuvring pattern for a DP vessel



Leg	Hdg for DP
T – N	000
N – E	000
E – T	000
T – W	000
W – S	000
S – T	000
T – N	180
N – W	180
W – T	180
T – E	180
E – S	180

Data collection is turned off when the vessel is outside the data collection area

USBL – Calibration results (cont.)

Statistics:

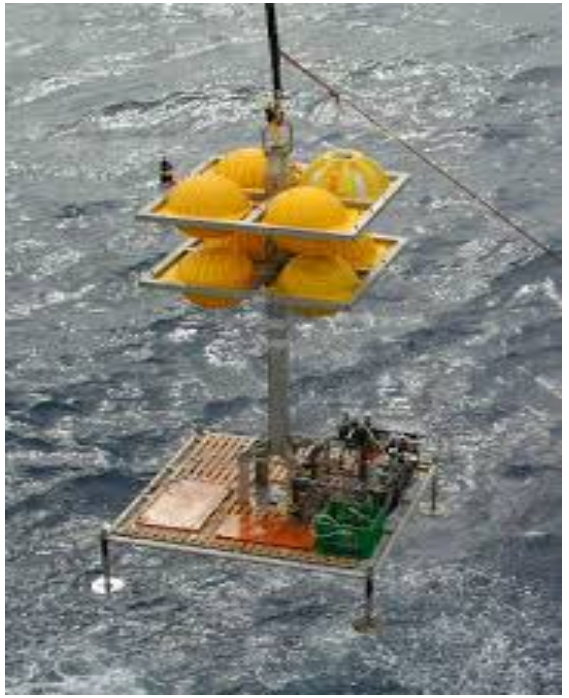
	Before CASIUS (distance)	After CASIUS (distance)	Before CASIUS (% depth)	After CASIUS (% depth)
39.4% Beacon Positions (1 sigma)	14.8m	7.9m	0.96	0.51
50.0% Beacon Positions (CEP)	17.8m	9.4m	1.16	0.61
63.2% Beacon Positions (1 Drms)	21.3m	11.2m	1.38	0.73
86.5% Beacon Positions (2 sigma)	27.6m	15.9m	1.79	1.03
98.2% Beacon Positions (2 Drms)	36.0m	23.6m	2.33	1.53

Cruise	**1 Sigma**	**2 Sigma**
2016 – Elf Faro (Atlantis)	7.9m	15.9m
2017 Nizinski (Pisces)	2.1m	4.6m
2018 Kinsey (Atlantis Explorer)	1.5m	3.3m
2014 Tominaga (Thompson)	9.9m	22.2m
2016 (Atlantis)	7.9m	14m
2011 (Atlantis)	3.6m	10.5m
2013 transit (Atlantis)	1.5m	5.4m

Calibration Beacon & Setup

- Transponder Ball

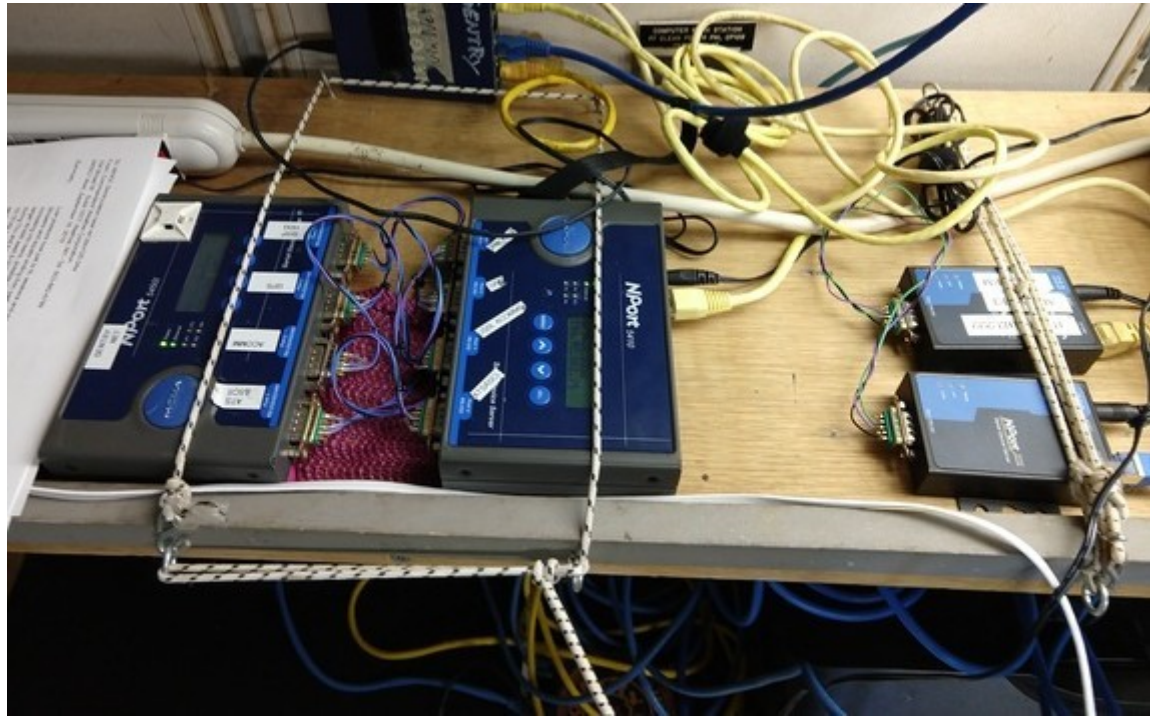
- Custom package



- Elevator

Data Feeds and Networking

- Bridging Networks
  - - whats the best method?
  - - Can we standardize?
  - - Each vehicle has an isolated network that requires the data feeds



USBL – Misc Notes

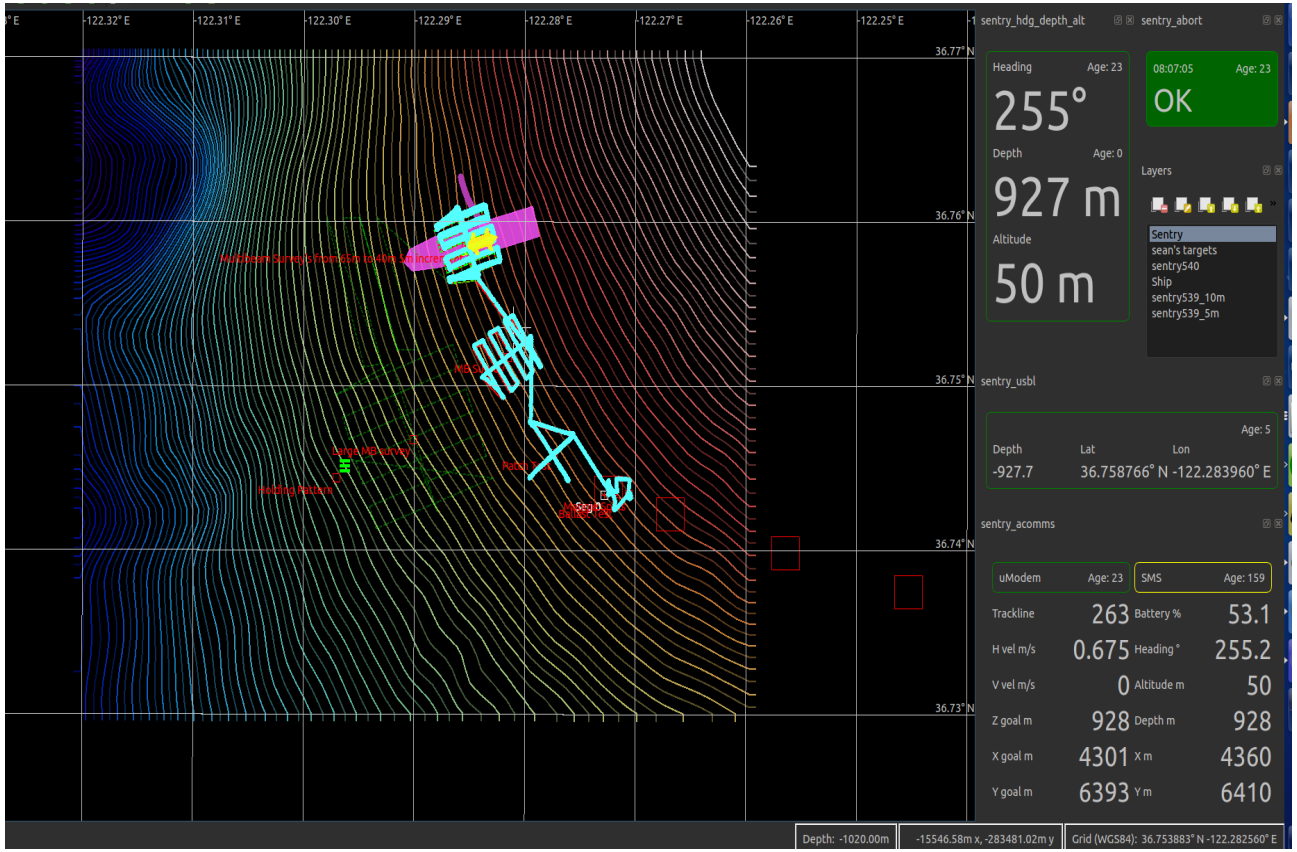
- Use simulation tool to test output beacon data feed.

- Update Sound Velocity Profile when required

- Always have issues when routing data feeds from/to system.

- Environment tab has a depth limit, anything past this depth will not be reported.

- SMS messaging can impact tracking and
- Freeze the transceiver head.



** Open Discussion **

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