NDSF Facility Update

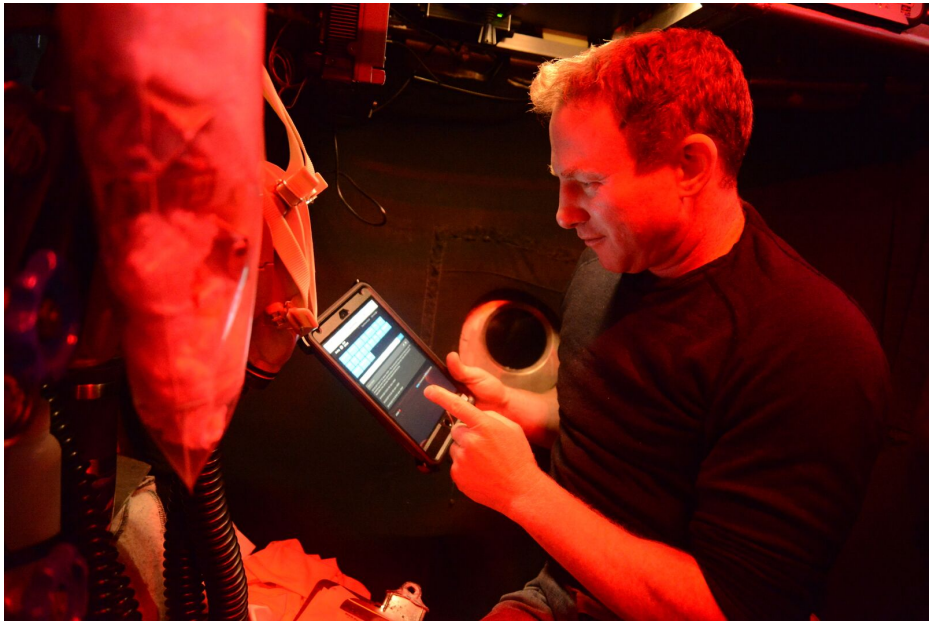
Facility Update

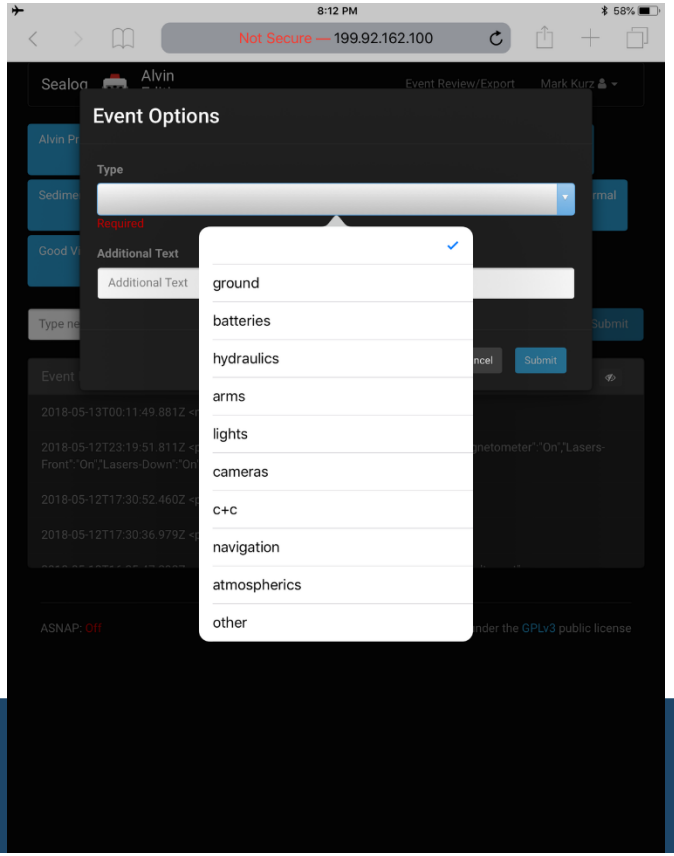
NDSF NATIONAL DEEP SUBMERGENCE FACILITY

New NDSF Event logging system

~ Sealog/Seaplay

- Development of Event Logging for Alvin (Sealog)
- Replacement/Augmentation of Jason Event Logger
- Replacement/Migration of Frame Grabber/Virtual Van

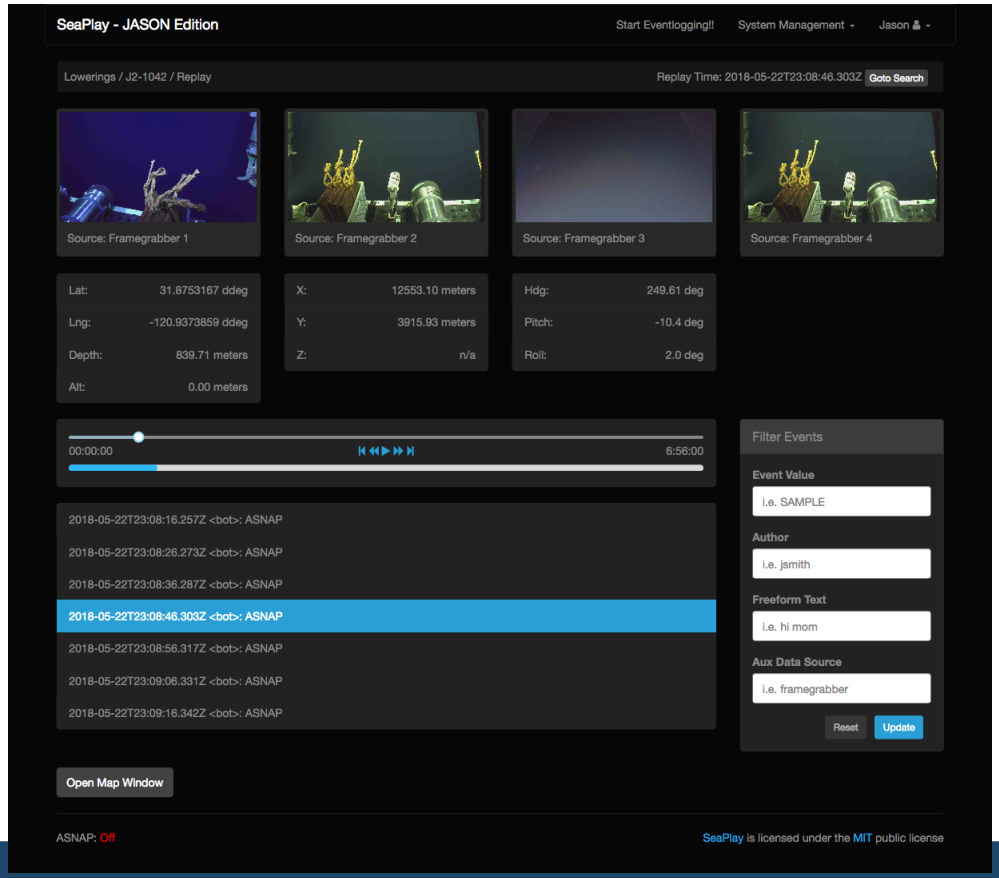




Sealog/Seaplay

- Development of Event Replay and Analysis (Seaplay)
- Standalone for Alvin, integrated for Jason

- Similar to FG/VV, includes search and integrated metadata.
- Easier updates/edits and integration of non-realtime data



Sealog/Seaplay

- Features:
  - Single source event server (both templates and logs)
  - Open Source/Cross Vehicle (SOI contributions)
- Status: Prototypes in service
  - All the Alvin and Jason cruises in 2018 operated with the Sealog/Seaplay prototype in parallel with current Frame Grab and Virtual Van systems.
- Future:
  - Move to routine operations
  - Incorporation of user feedback
  - Development of new capabilities using the RESTful API
  - Extension to other vehicles (NDSF, other)
  - Data (logged events) integration with larger databases

Alvin updates: Staffing

- Alvin Pilots
  - Danik Forsman – Qualified pilot in September
  - Todd Litke and Drew Bewley completing pilot qualifications in 2019
- New Alvin mechanic
  - Nick O'Sadcia - joined full time in 2018
- Ops crew
  - Team is fully qualified on all watch-stations
  - 2-MATE interns on engineering and Kurz cruise
  - Defining role of new Alvin data tech/ET
- SE&OG staff
  - Rick Sanger beginning PIT training
  - Two week dedicated systems and operations focused training session for Ops team

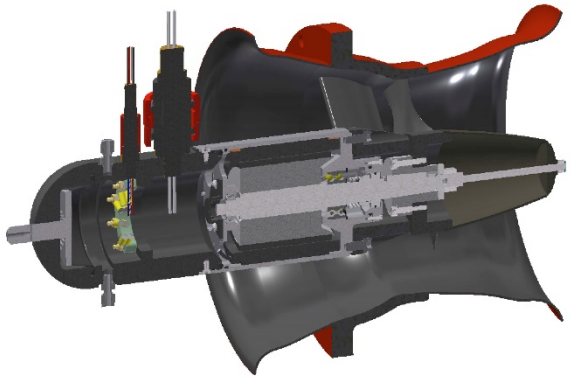
Alvin updates: New computers & Touch Interfaces

- New capacitive touch screen interfaces
- Full in-hull computer replacement
  - numerous software improvements to navigation and command/control
- Implementation of Event Logger
  - replaces 'Frame Grabber'
  - provides excellent interface for ACOMMs meta-data transfer to surface station
- Integration of new in-hull 4K video system in process
  - new 4K monitors, new camera controllers (X-box) and improved control interface software

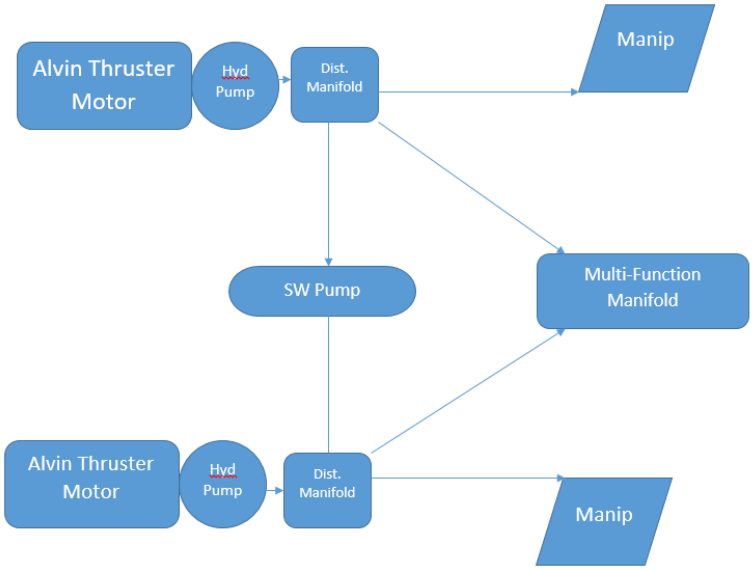
Ge-Chic capacitive touch screen

Alvin updates: New thruster and controllers

- successful test during 2018 engineering series
- two installed in August w/good performance and no problems
- remaining thruster installation in 2019
- 40% more thrust, improved efficiency (PCAR)
- motor power for new dual-hydraulic system in 2020

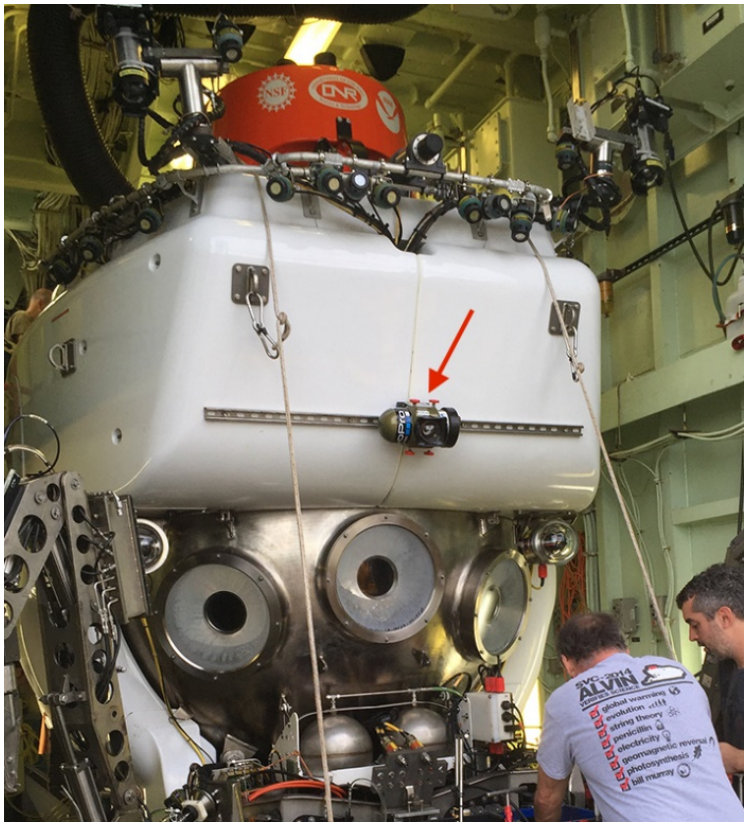


New Thruster Assembly



Alvin updates: Cameras

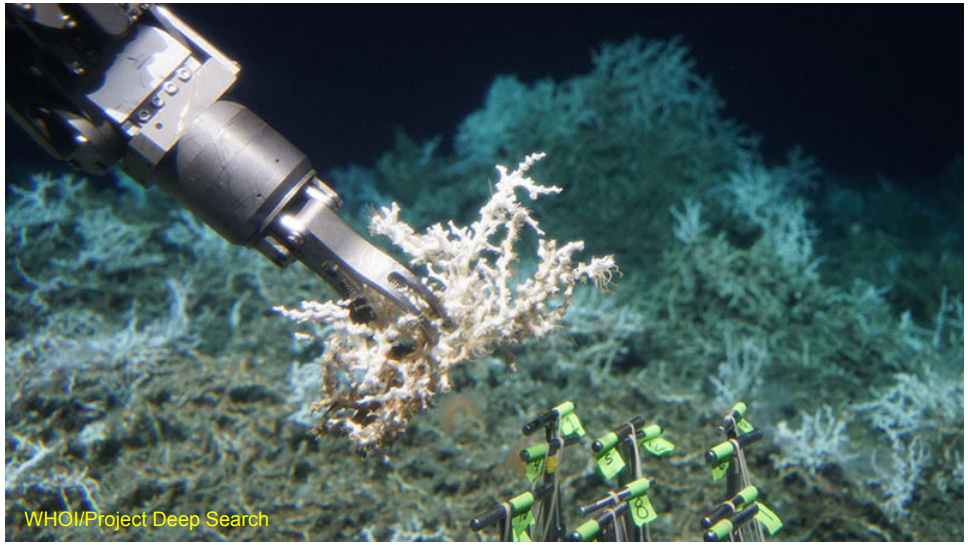
- **DSPL Apex 4K camera system testing**
  - **Installed since August 2018**
  - **Developing 4K data pipeline (PCAR)**



- **New cameras (PCAR)**
  - **DSPL HD wide angle cameras (2)**
  - **DSPL low-light camera (2)**
  - **MISO Go-Pro still camera**
  - **6500m PATZ camera – spare**
  - **continuing integration of new images into data pipeline (PCAR)**

Alvin updates: Cameras

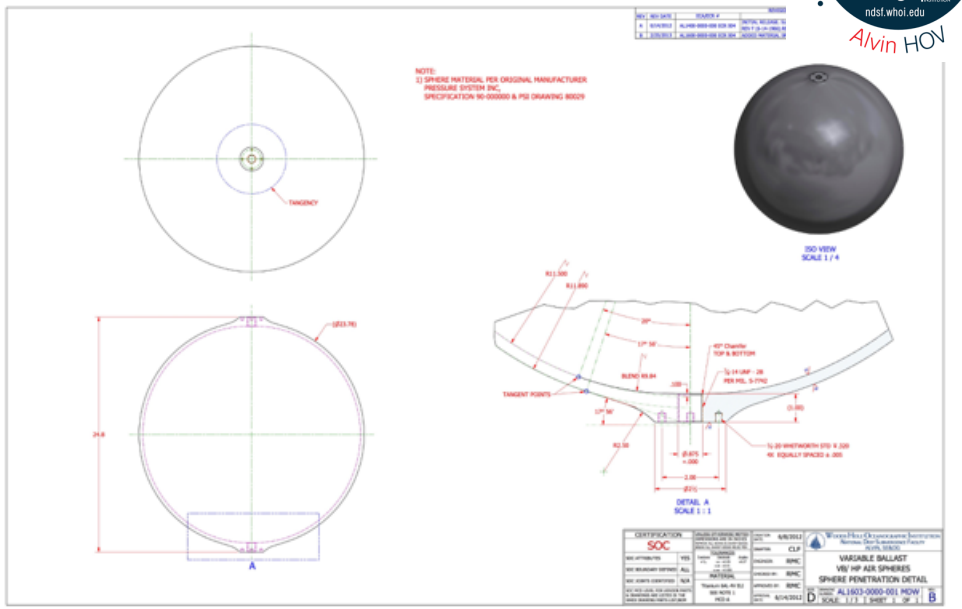
- **New spare PATZ camera**
- **New in-hull mirror-less camera**
  - Sony Alpha 7Sii
  - 20-70mm wide-zoom lens

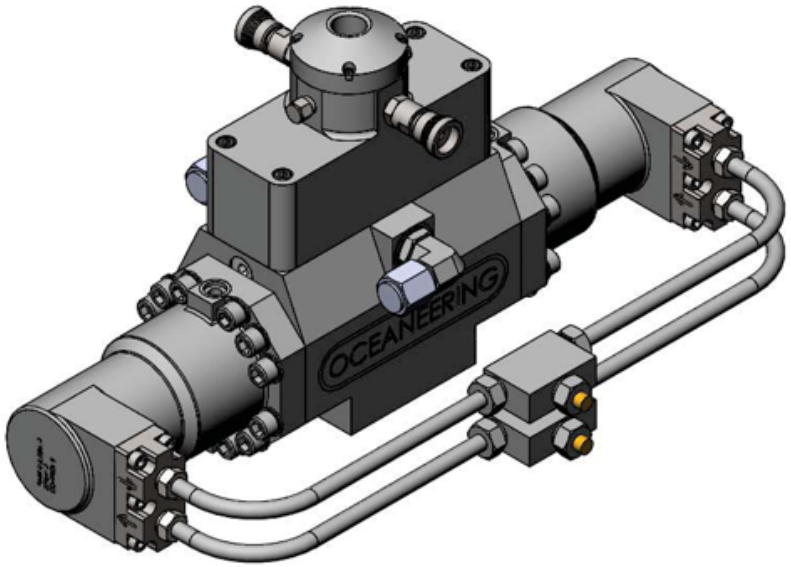


- 4K video capable
- superb low-light imaging
- augments existing suite of cameras
- widely used by video/still professionals

Alvin updates: VB system updates

- **VB-HP Air Spheres**
  - New 6500m ballast spheres
  - manufacture and procurement underway





New duplex seawater pump

- hydraulically powered seawater pump – joint WHOI/Oceaneering design
- significant improvements to system for 6500 meters

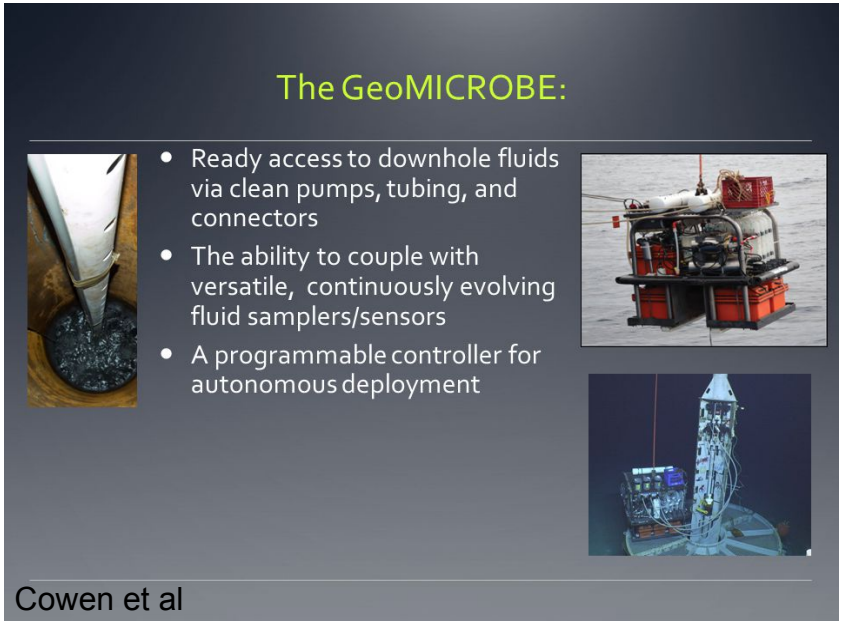
Concept for deployed science module

- **PREMISE:** bottom-time is a precious commodity for deep sea science
  - Decoupling vehicles from long term sampling/monitoring enables completion of additional science activities during bottom time
  - Parallel science activities can maximize use of vehicles' strengths (manipulation, sampling, maneuverability, sensing, observing)
  - Reduces time spent managing stationary sampling/monitoring
  - Previous work by **J. Cowen**, **B. Glazer**, **C. Cary, S. Williamson,** and others has shown value of deployable samplers to enable independent sampling during dive time
    - **Geo-MICROBE Sled**
    - **LVWS (Large Volume Water Sampler)**

Dr. James Cowen

Concept for deployed science module

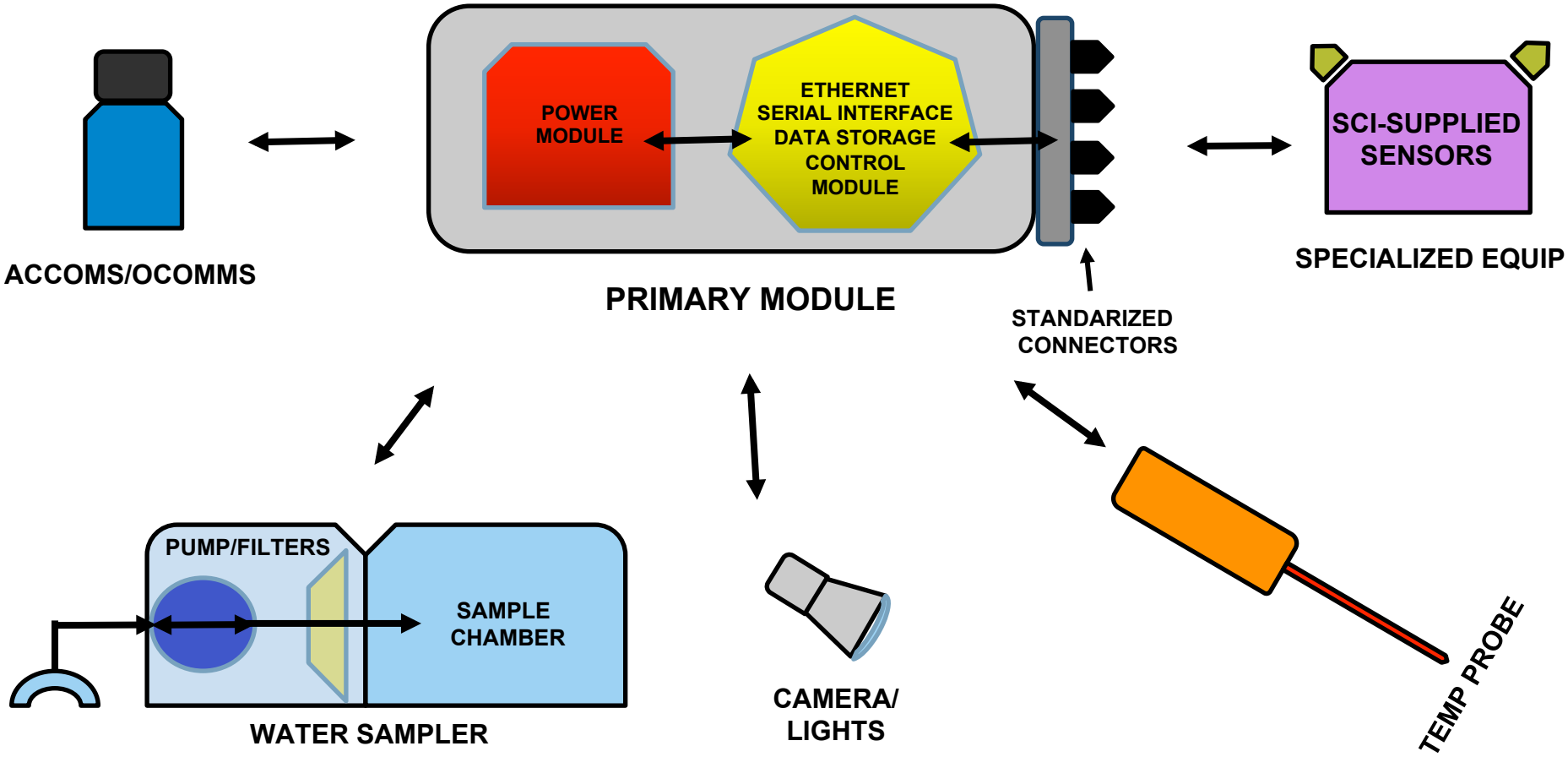
- Development of an advanced de-coupled sampling tool for community use
- Alvin engineers are defining the list of system/module requirements
- Versatile, 'primary' interface module
- Sized for use on elevators, sleds, baskets etc with a range of capabilities - pump/filter control, sensor interfaces, serial data, temperature etc



- Will employ ACOMMS/optical modems for sampling monitoring, control & status reporting (to topside, in-hull)
- Use of camera provides option for sample imaging for review post-sampling, or real-time via modem
- Leverage off of existing technologies

Concept for deployed science module

- **Primary Module** provides interface for existing sensors and equipment



Jason update: staffing

- New contractors
  - **Summer Ferrel**, experienced OET ROV operator, mechanical
  - **Jim Convery**, experienced oil field ROV operator, mechanical
- **Ben Tradd** EL and RCA Project Manger

- Section leads assigned for each expedition (pcar 2018)

Jason system upgrades

- Long term plan for Reson replacement across NDSF is being researched (pcar 2018)
- Considered building simulator for pilot training, but have opted to send pilots to Schilling Robotics for ROV simulator and manipulator training (pcar 2018)
- Developing elevator tracking to prevent loss if weather prevents immediate recovery (pcar 2018)
  - Elevator pre-dive checklist
  - Will review weather limits for elevator ops with PI's
  - Developing user manual for Jason users, will include weather limits for Jason and elevators

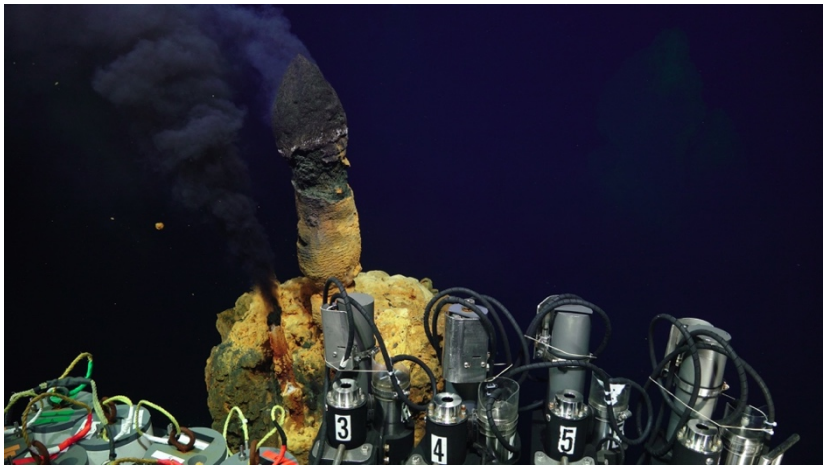
Jason system upgrades

- Development of new thruster motor and controller underway
  - Existing motors reaching end of life
  - Controller reached end of life years ago, WHOI has enough spares for several years
  - Suitable in house design for both being developed based on new Alvin motors
  - Will seek funds in 2019 to complete
- Tool van approaching end of life
  - Will seek funds in 2019 budget to build replacement
- SeaLog system is replacing VirtualVan
  - Details addressed elsewhere, refinements are continuing (pcar 2018)

Jason system upgrades – 4K Camera

- Subsea Sulis Z70 4 k
- Provides both stills and video in one camera (pcar 2018)
  - Faster still storage in still mode
  - Possible to capture stills in video mode with delay
- Full resolution 4 k recorded in highlights and HD 24/7
- Stills in full resolution to separate hard drive
- Redesigned GUI with P&T control integral (pcar 2018)
- Replaces Super Scorpio (pcars 2017)
- Connector oil leak on demo unit replaced by Jason connector on final unit (pcar 2018)

ROV Jason - Sulis Stills Image Example

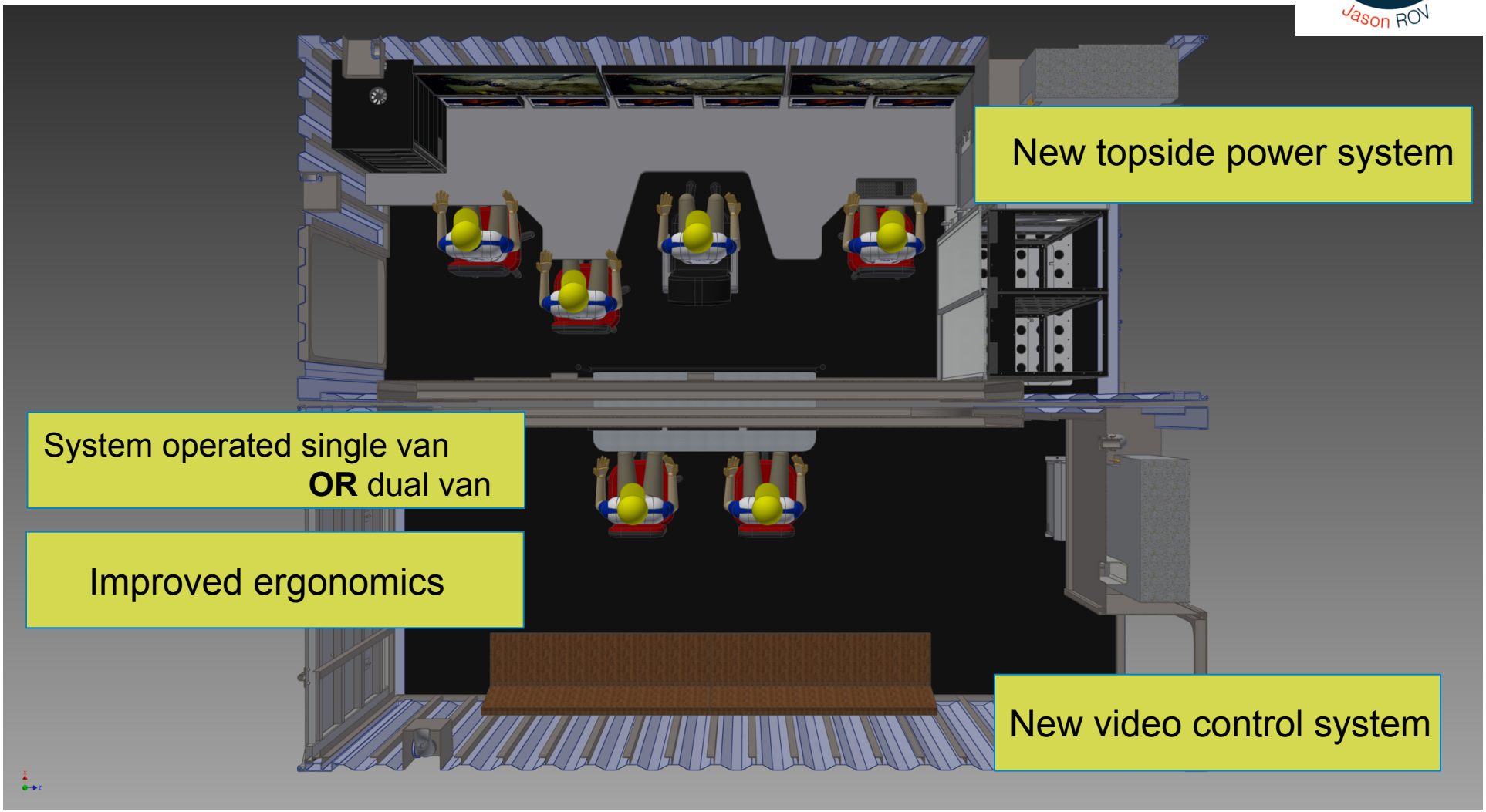


New ROV Jason Control Vans

- Excellent user feedback
- More viewable video real estate.
- Center 55” science screen quad view of multiple cameras at 1080p or one camera to 4K imagery.
- Video system upgraded to distribute and display 4k video imagery
- Integrated KVM system allows controlled access to any computers whether they be for science or ops at any station on the network. In the van or outside the van for when in single van ops.

ROV *Jason* New Control Vans

ROV *Jason* New Control Vans



Jason Maintenance Summary

- Developing alternate Atlantis layout to improve deck space (pcar 2018)
- Better tracking and record-keeping via a Computerized Maintenance Management System (CMMS) by *Fiix* (pcar 2017)
  - More regular maintenance following written procedures
  - More system inspections including spare manipulators (pcar 2018)
- Every cruise to have designated responsible OHS lead person (pcar 2017)
- Will work to have additional engineering support when swapping single to two body (pcar 2017)
- Improved supervision and work-flow gets imagery and data to science party ASAP (pcar 2017)
- Improved users website (pcar 2018)
- Developing user manual for control van systems (pcar 2018)

Collaborations with Science ROV service providers

- WHOI has a partnership with OET that we are expanding (Pcar 2017)
  - WHOI providing engineering services to develop a portable system to be used by OET, and WHOI
  - We've been providing operators to OET limited basis, will expand that effort for the portable system, and make it a two-way exchange.
- WHOI communicated with numerous operators, MBARI, ROPOS, SOC, NOC, and OET in the development of upgrade. Looking to expand collaborations to learn from others.
- Example cable workshop, future workshops forthcoming (pcar 2017)

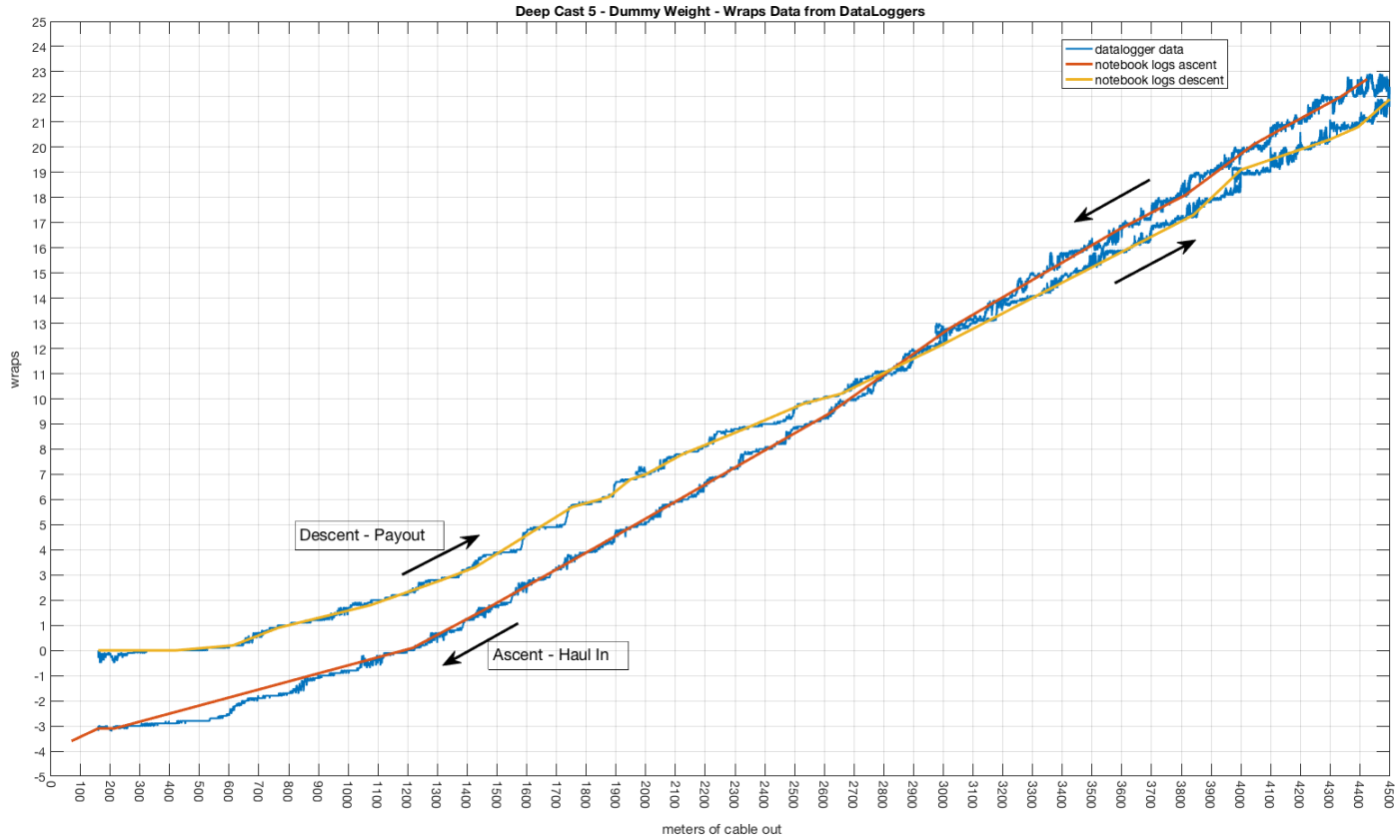
Science ROV Cable Torque Workshop

- Convened 1-1/2 day focused workshop (pcar 2017, 2018)
  - Broad group of ROV operator participants
    - Iframere, Jamstec, Nippon Marine Enterprises, Schmidt Ocean Institute, Ocean Exploration Trust, Marum, MBARI, WHOI, UW RCA, Woods Hole Marine Systems, Southampton National Oceanographic Center (UK)
  - Included Cable and cable modeling expert participants
    - Tension Member Technologies, Dynamic Systems Analysis
  - Share understanding of cable torque
  - Develop hockle mitigation procedures
  - Categorize the cable characteristics that contribute
  - Discuss strategy/testing to overcome the problems
  - Develop Engineering plans for test cruise

ROV *Jason* Engineering cruise - Objectives

- Refine Single body Jason operations
- Test Rapp ROV 4000 AHC electric winch
- Relax 0.842" Rochester A309441 EOM cable to 4500m with 2800 lb. dummy weight
- Test/develop dynamic donut display
- Test cable rotation sensor
- Develop procedures to prevent cable hockling
- Test new cameras on Jason

Engineering Cruise: *Results* - Dummy weight cast 5



- Characterization curve, used to determine turns at depth.

JASON engineering cruise

– *Jason 1-body System Operation Procedures*

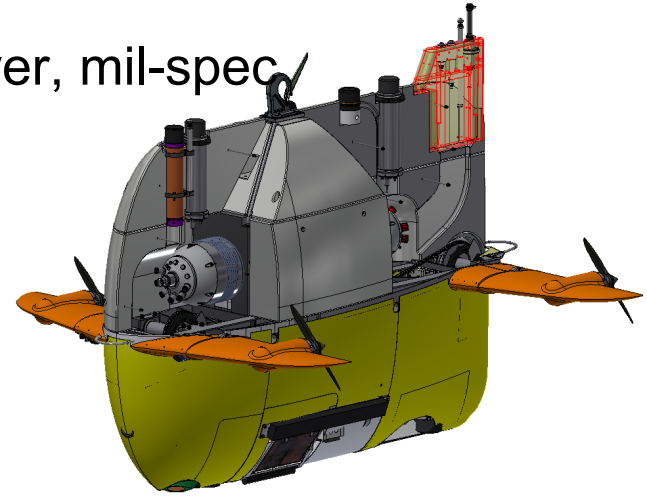
- Use characterization curve to turn in wraps for target depth on descent, turn wraps out on ascent.
- Wrap counter always 0 at the surface.
- Allow torque to spin out while in the air on recovery
- Use e log to track turns
- Dynamic donut to maintain a tight 'S'
  - SR 130m +/- 3m
- At start of dive relax 'S' to a SR of 120m +/- 3m turn rotation sensor torque out of the cable. Maintain tight 'S' at all other times.
- Periodic dummy weight casts to re-characterize the cable torque.

Sentry update: Staffing

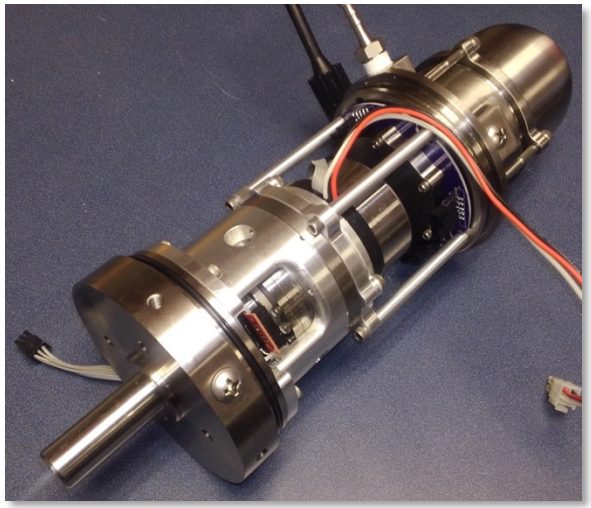
- **Sean Kelley** transitioning into program manager role
- **Justin Fujii** and **Mike Skowronski** training as expedition Leaders
- **Manyu Belani** (mechanical) and **Laura Lindzey** (software) joined Sentry ops., now up to speed on operations
- **Zac Berkowitz** continues to provide Software/Electrical support and excellent Expedition leader skills
- **Ian Vaughn** providing software support, leading ROS upgrade and future projects
- **Jennifer Vaccaro** coming up to speed as software operational support and engineering support
- **Kevin Kavanagh** continues to provide operations and logistics support for Sentry

Sentry update: mechanical and electrical

- Replaced all salvaged SeaCliff foam. Gained approximately 50lbs of payload and eliminated potential failure problems. (PCAR 2016).
- Thrusters upgraded to titanium body from aluminum, improving life expectancy
- New wing servo design completed and move to prototype hardware testing. Expecting increased reliability and position accuracy (PCAR Multiple) .
- New weather/leak/ground fault boards
  - Borrowing REMUS technology, tiny, low power, mil-spec
- New dorsal fin
  - Improves stability and drag
  - Efficient mounting of recovery aids



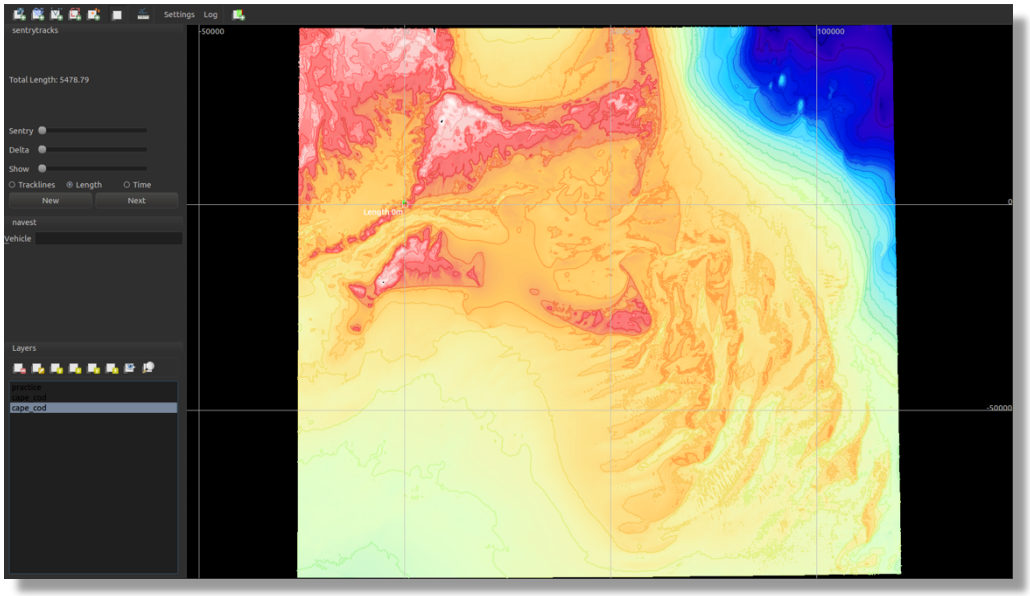
Sentry update: mechanical and electrical



- Arctic Ray strobes integrated
- Aft fin integrated into body
- Improved stability
- XR redesign and replacement
- Improved bottom following performance
- Improved surface communications with Sentry
- Supplement to OIS strobes currently installed
- Pioneer phased array DVL in process of integration
- Improved acoustic communications between Sentry and Ship
- Replacement of equipment that is end of life and cannot be spared

Sentry update: Software, Data and reporting

- Renewed our Sonarwiz license and rolled out a sidescan processing training program (PCAR 2017)
- Converted existing data pipeline to be compatible with ROS
- NavG navigation/tracking software nearly complete, tested fall 2018, will be used by all NDSF vehicles.

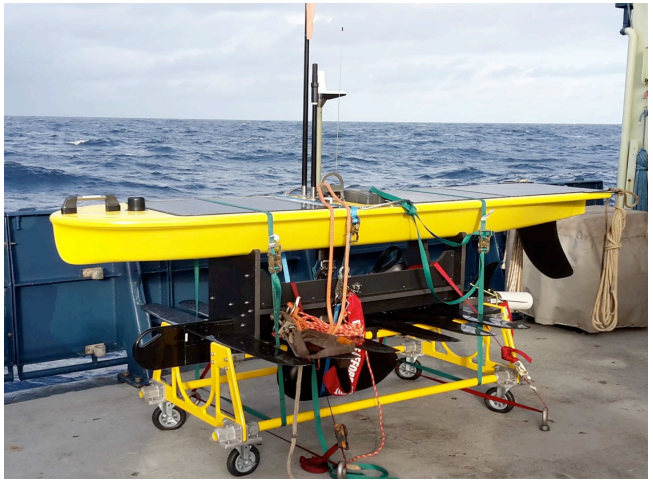


Sentry update: Software, Data and reporting

- Adding image metadata to photos (PCARs 2015, 2017)
  - Will soon update data structure and documentation for improved user clarity (PCAR 2018)
  - Beginning to create a library of data post processing training videos (PCAR2018). Currently available: multibeam and sidescan. Planned: magnetics, data organization, and sub-bottom profiler
  - Faster training for new NDSF staff
  - Fully accessible to the public via youtube
  - Will revisit the sub-bottom pipeline in 2019 (PCAR 2018)
- Sentry User Guide updates(PCAR multiple)

Sentry update: Operational capabilities

- Sentry specific pre-cruise meetings implemented (PCAR 2016)
- Wave Glider/Sentry operations (PCAR 2015 and others)
- Continues as a test platform for new technologies and sensors
  - High density multi-altitude chemical sensor surveys implemented
  - IUSBL
  - Whitcomb gyro
  - Franatec methane sensor
  - Anchoring implemented missions
- Surface Drive completion
- Reliability continues to increase
- Concurrent Sentry/Alvin operations – continue to improve procedure (PCAR2018)
- System Integration and operation onboard R/V Atlantic Explorer & R/V Falkor
- Plan to improve micro-modem/sub-bottom profiler operations scheme in 2019 (PCAR2018)



Sentry update: Major Command and Control

- A complete re-write of current on-vehicle control system (currently most code derived from a 1999 effort for J2)
- ROS (Robot Operating System) based: leveraging open source robotics community
  - New science capabilities much easier and more streamlined including a much better simulation environment for faster development.
  - Maintainable (addresses c. 2014 – 2016 PCAR feedback about new flight modes and bottom following)
- Basic Vehicle control online and tested during engineering cruise. Four science cruises have been completed following completion of project.
- Additional conversion in 2019 to include sonars outside of original scope .
- Underwater ROS workshop at WHOI October 31 – November 1, 2018 – source code was open source to entire community.

Sentry update: Sensing

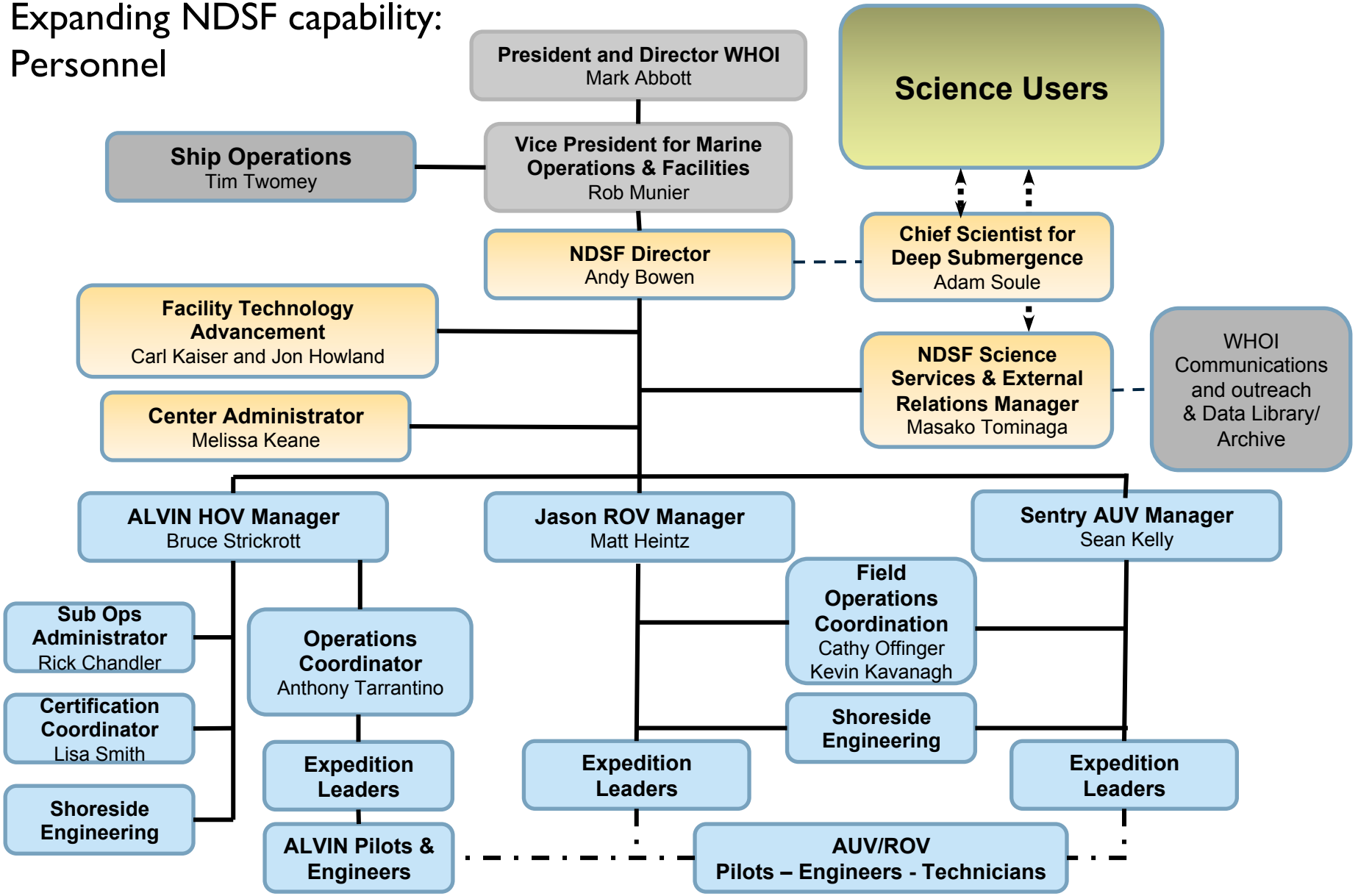
- Adding fill flashes to camera system improve lighting (PCAR 2017)
- Reson is now quite old, continues to be unreliable, and needs replacement soon (PCAR 2016/2017/2018). To be retired early 2019, replaced with EM2040.
- Seabird SBE03's temperature sensors integrated for Gregg cruise
- Nortek velocimeter integrated for Gregg cruise
- Franatec Methane sensor integrated Teske cruise
- Inverted USBL integrated for Kinsey/Whitcomb cruise
- Whitcomb gryo integrated for Kinsey/Whitcomb cruise

NDSF Facility Update

NDSF 2019 and onward

NDSF NATIONAL DEEP SUBMERGENCE FACILITY

Expanding NDSF capability: Personnel



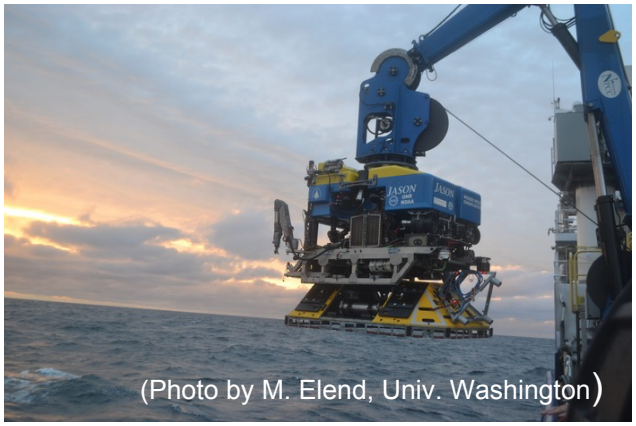
Expanding NDSF capability-2: Cross-Platform Technology

- *Integrating advanced, reliable technology:* Multibeam
- *Enhancing communication capability with submersible/vehicles:* NavG3.0 - and the scientific situational awareness it provides
- *Expanding science participation per dive:* Vehicle to ship communications (Sentry and Alvin both), and ultimately from ship to shore.
- *Unifying submersible/vehicle control software*: e.g. ROS
- *Serving for the era of Big Data*: On ship data storage, handling, and handoff - hardware and automation

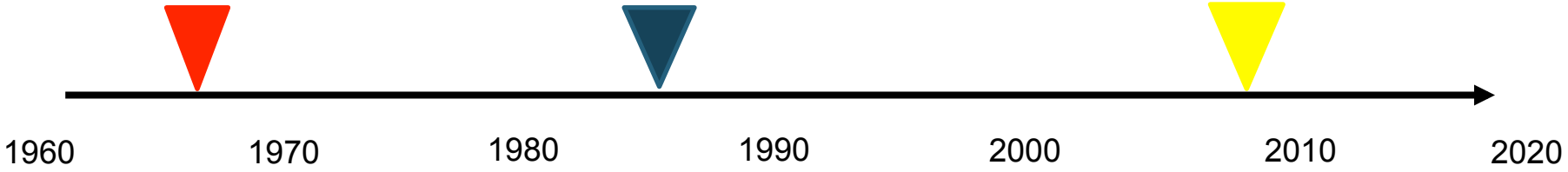
Expanding NDSF capability-3: Front-end user services

- *User support*: *Dive* planning pre-cruise meetings and follow ups
- *Visibility*: New NDSF Web-Presence and SNS feeds
- *Discoverability*: NDSF Dive Metadata

(Photos by Lu Lamar, WHOI)


(Photo by M. Elend, Univ. Washington)

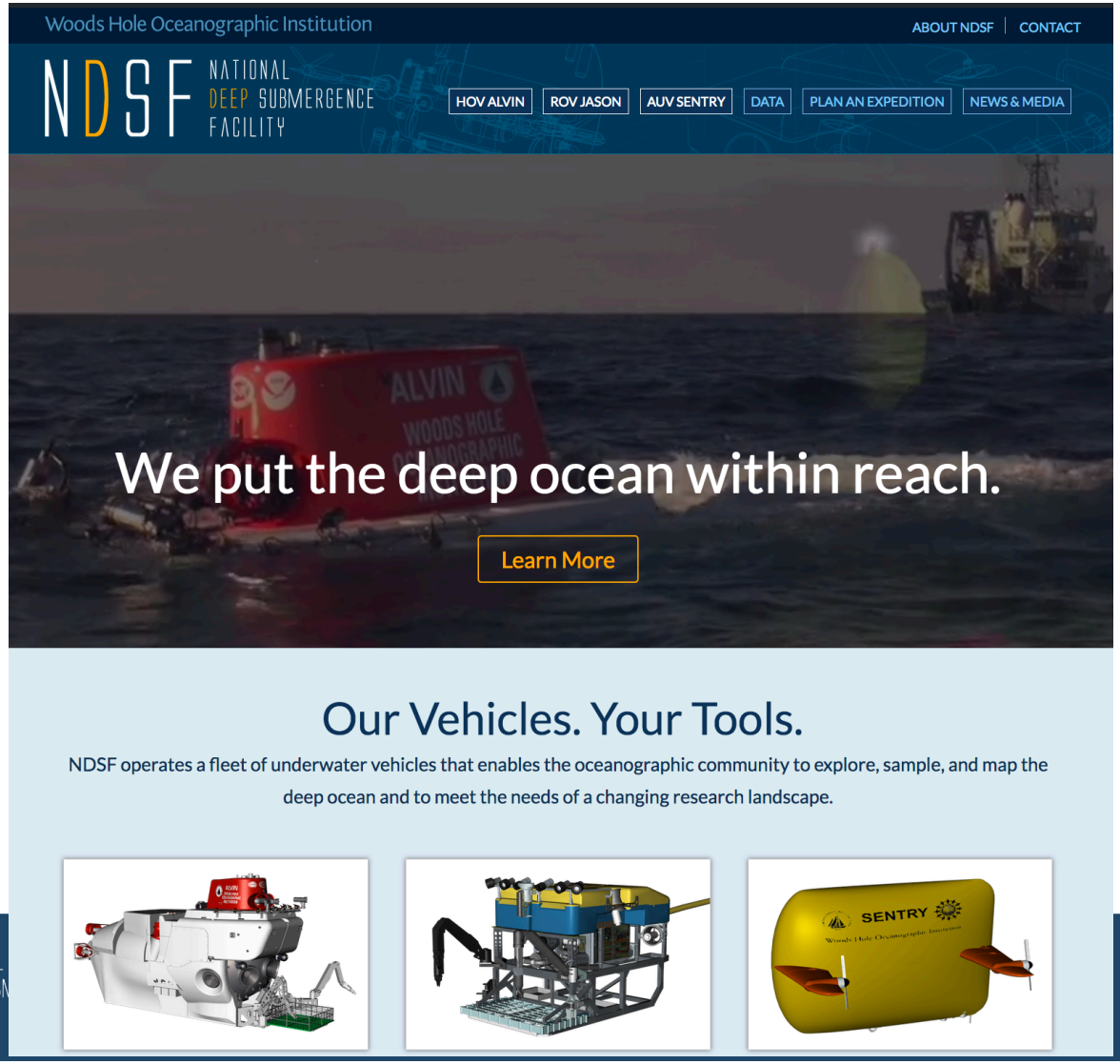
(Photos by Lu Lamar, WHOI)



A new online presence for NDSF

ndsf.whoi.edu

- Modern, visual design with mobile compatibility



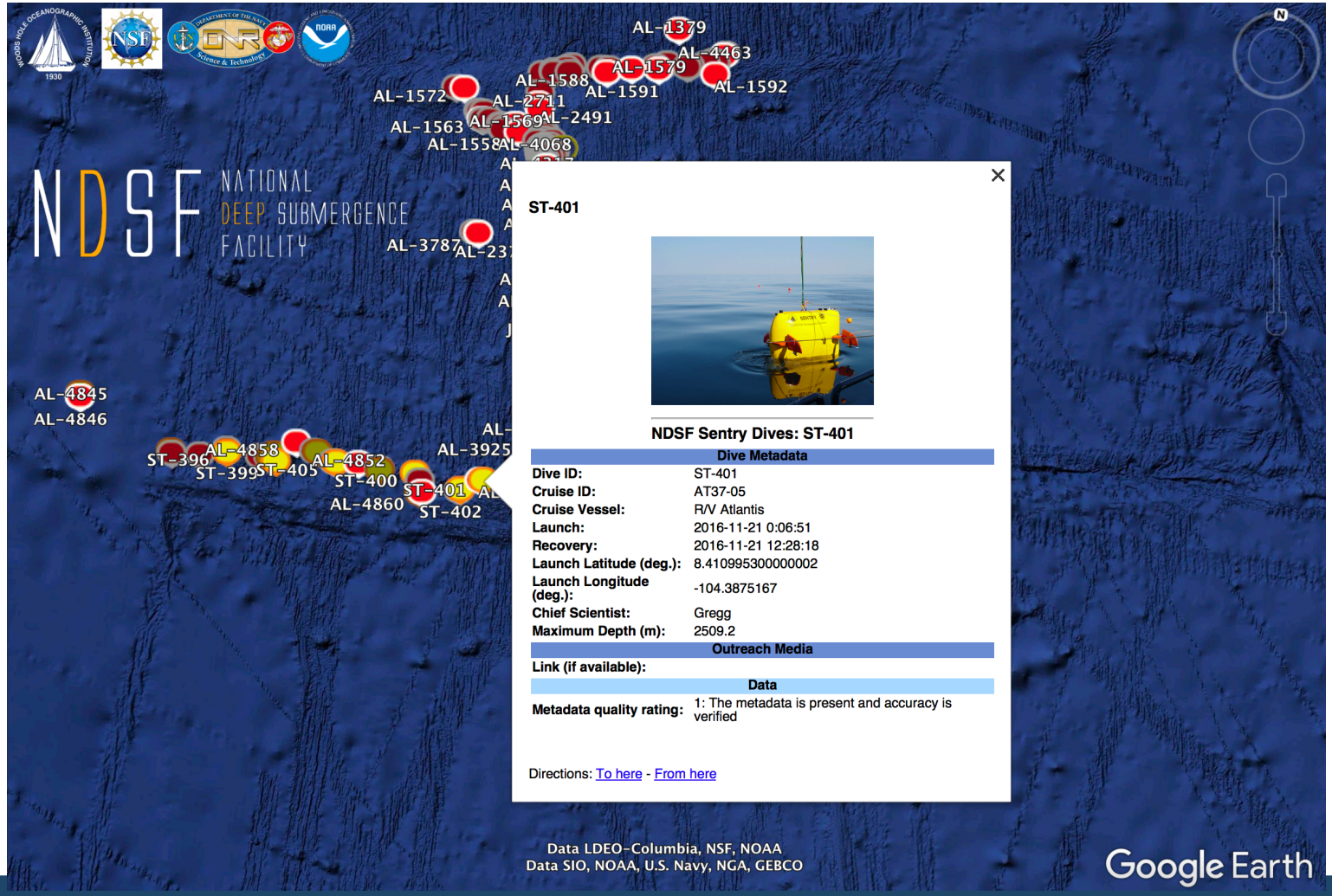
“We put the deep ocean within reach”

- User-centric focus with emphasis on reaching out to new users and multi-vehicle users
- Frequent update

- #HOVAlvin
- #ROVJason
- #AUVSentry
- #NDSF_WHOI

- e.g. @NSF_GEO

"We put the deep ocean data within reach"

https://ndsf.whoi.edu/data/

- User-centric focus with emphasis on reaching out to new users and multi-vehicle users
- Easier access to data