NDSF Facility Update

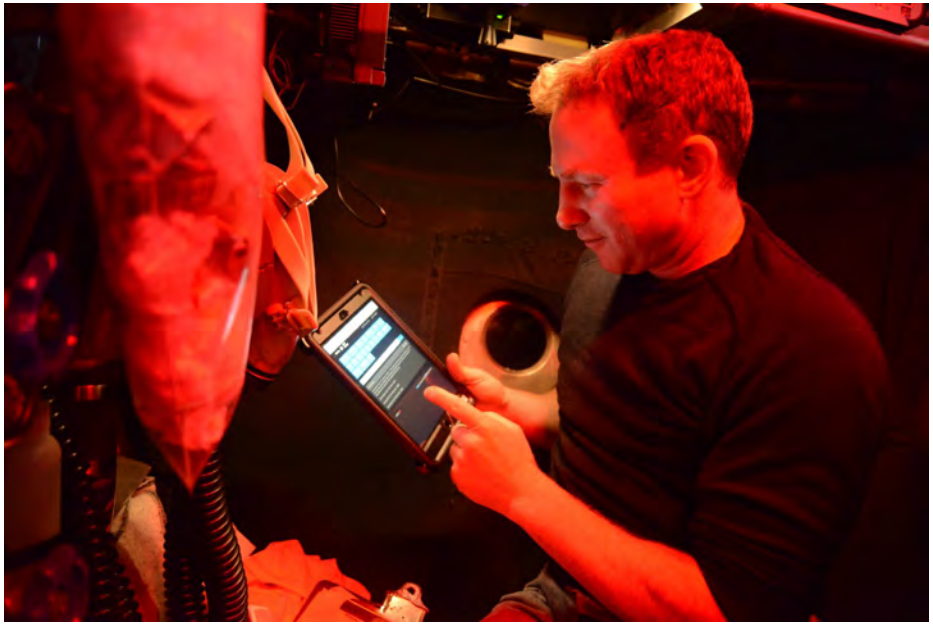
Facility Update

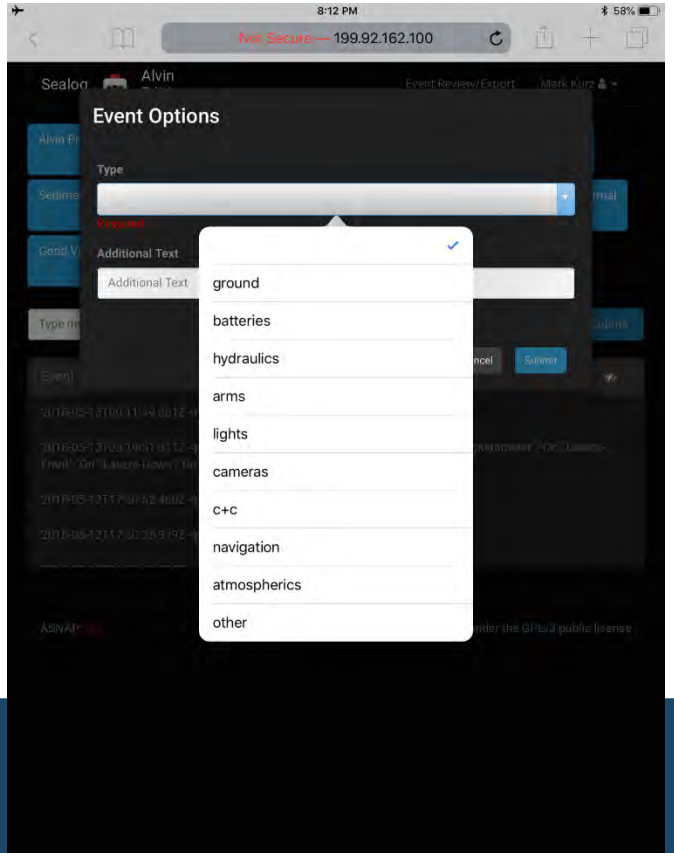
NDSF NATIONAL DEEP SUBMERGENCE FACILITY

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

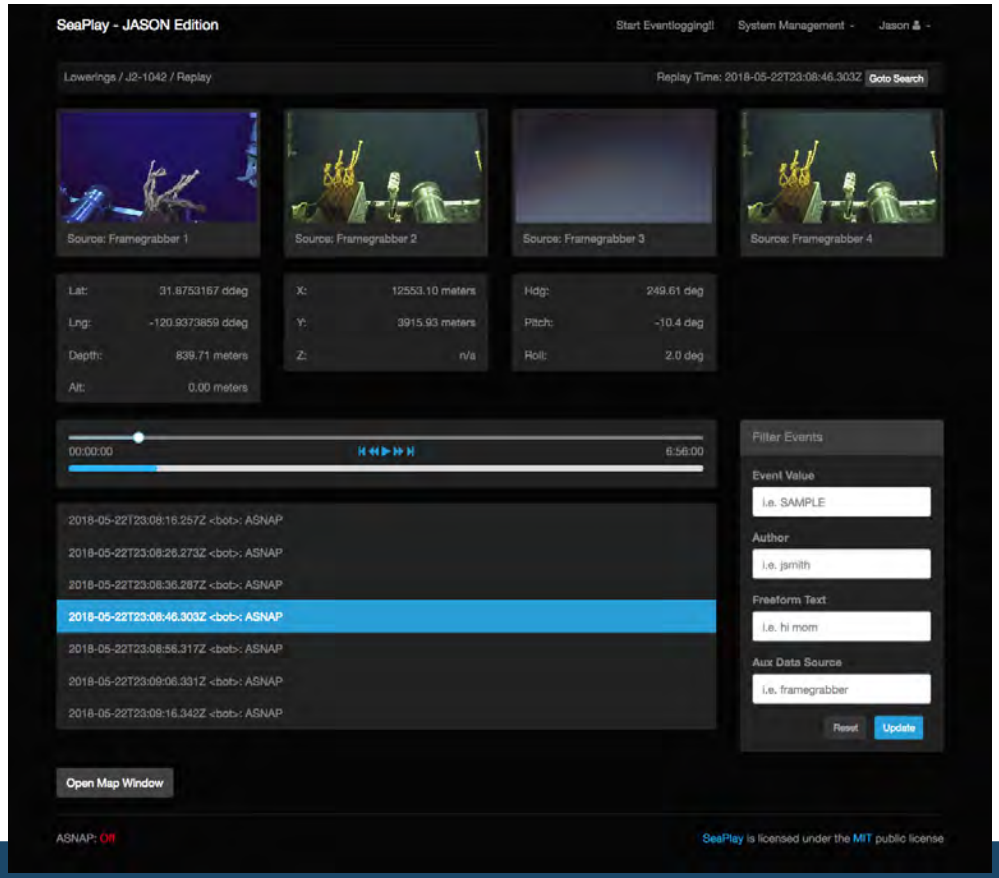




Sealog/Seaplay

- 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
  - One Alvin cruise (plus engineering cruise)
  - One Jason engineering cruise (currently being deployed for science ops)
- 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

Improving NDSF Data accessibility/usability

- Meta data QA

  Establishing vehicle Metadata QA protocol at NDSF that will streamline access to NDSF data through large database, e.g. MGDS/IEDA

  (*This is a collaborative effort between NDSF, working with summer guest student/research assistant, Sawyer Newman (Library Science, Simmon's College), and Vicki Ferrini at LDEO).

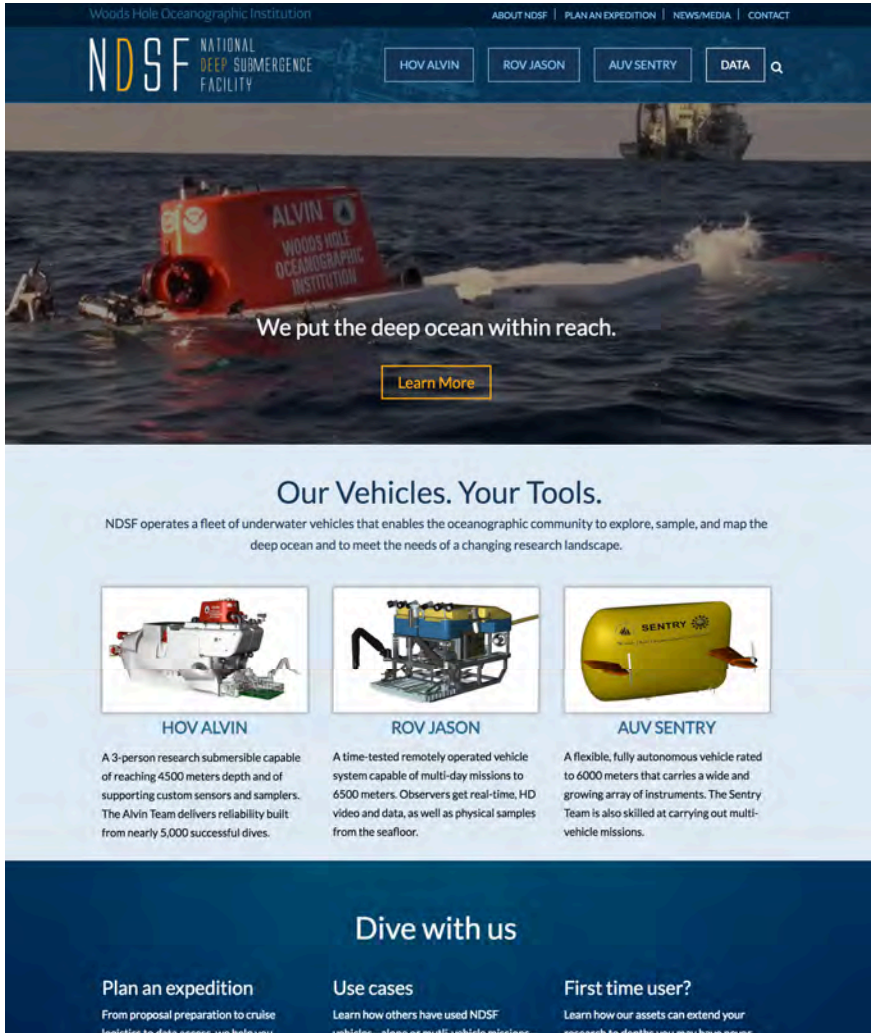
- Data Archive

  Re-assessing NDSF data archive protocol in collaboration with WHOI Data Library/Archive to best preserve NDSF data asset (including still images and videos) and ensure improved access to the data in near-future.

- *NEW* NDSF website.

  Building the new peer-to-peer NDSF website in collaboration with the WHOI Communications office that will provide most updated vehicle specs and dive metadata etc. for cruise planning and enhance the visibility of NDSF to (new) users.

A new online presence for NDSF



- Modern, visual design with mobile compatibility in Word Press environment to enable easy updating and back-end access
- User-centric focus with emphasis on reaching out to new users and multi-vehicle users
- New, updated, and streamlined content
- Greater consistency in information from each vehicle group
- Easier access to data

Jason update: staffing

- New contractors
  - Summer Farrel, experienced OET ROV operator, mechanical
  - Jim Convery, experienced oil field ROV operator, mechanical
- Ben Tradd EL and RCA Project Manger
- Lead assigned for each expedition (pcar 2018)

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

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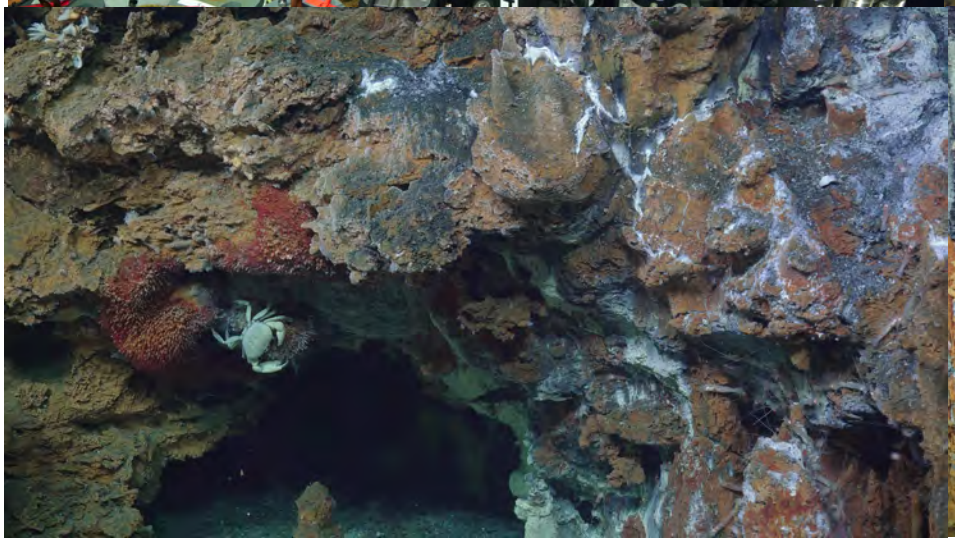
Jason system upgrades – 4K Camera

- 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 res 4 k recorded in highlights and HD 24/7
- Stills in full res 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)

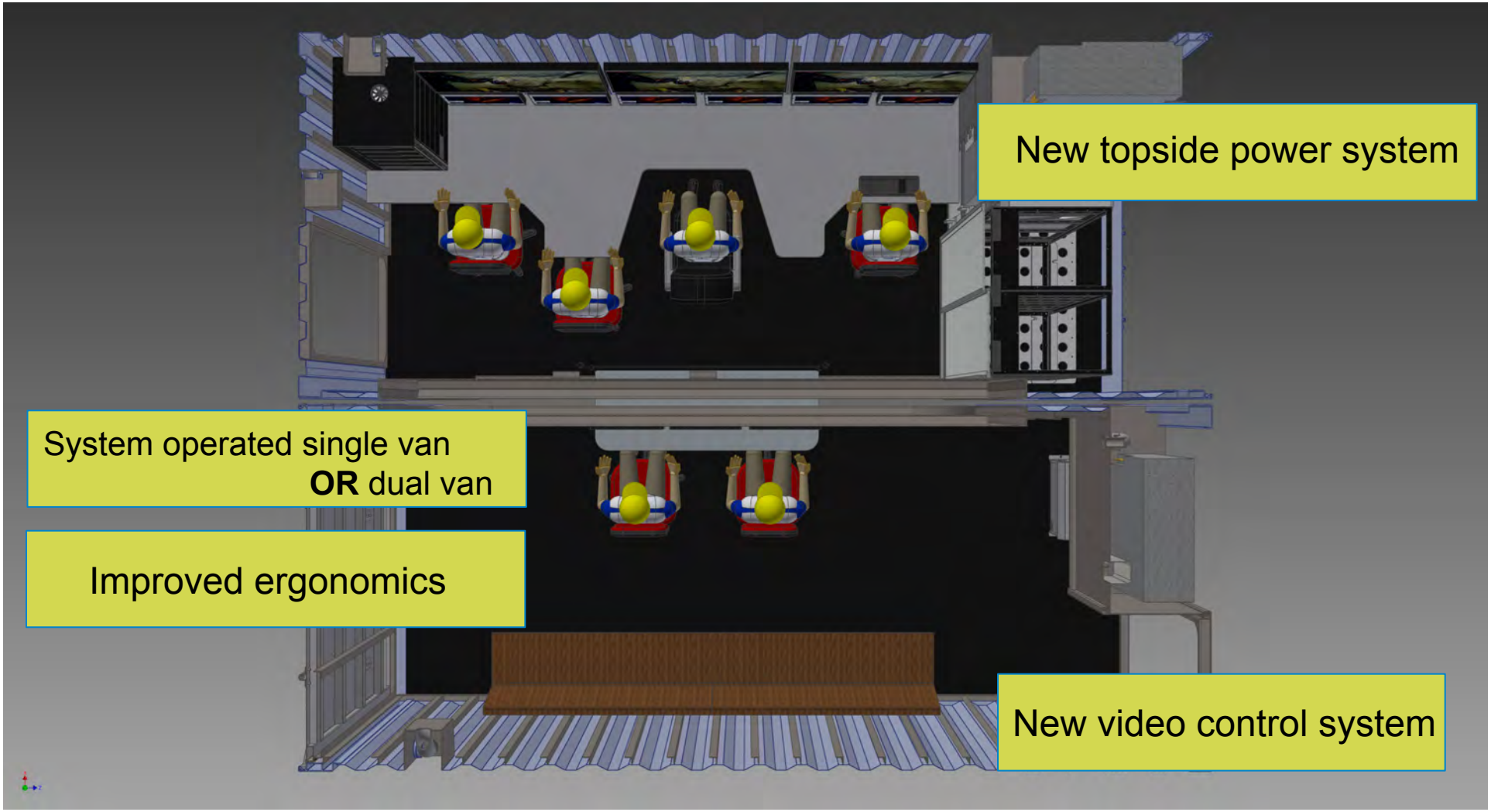
Sulis Stills



Sulis 4K video

New 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.


New topside power system
System operated single van
OR dual van
Improved ergonomics
New video control system

New Control Vans

Jason Maintenance Summary

- Developed 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
- 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)

Collaborations

- WHOI has a partnership with OET that we' re 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)

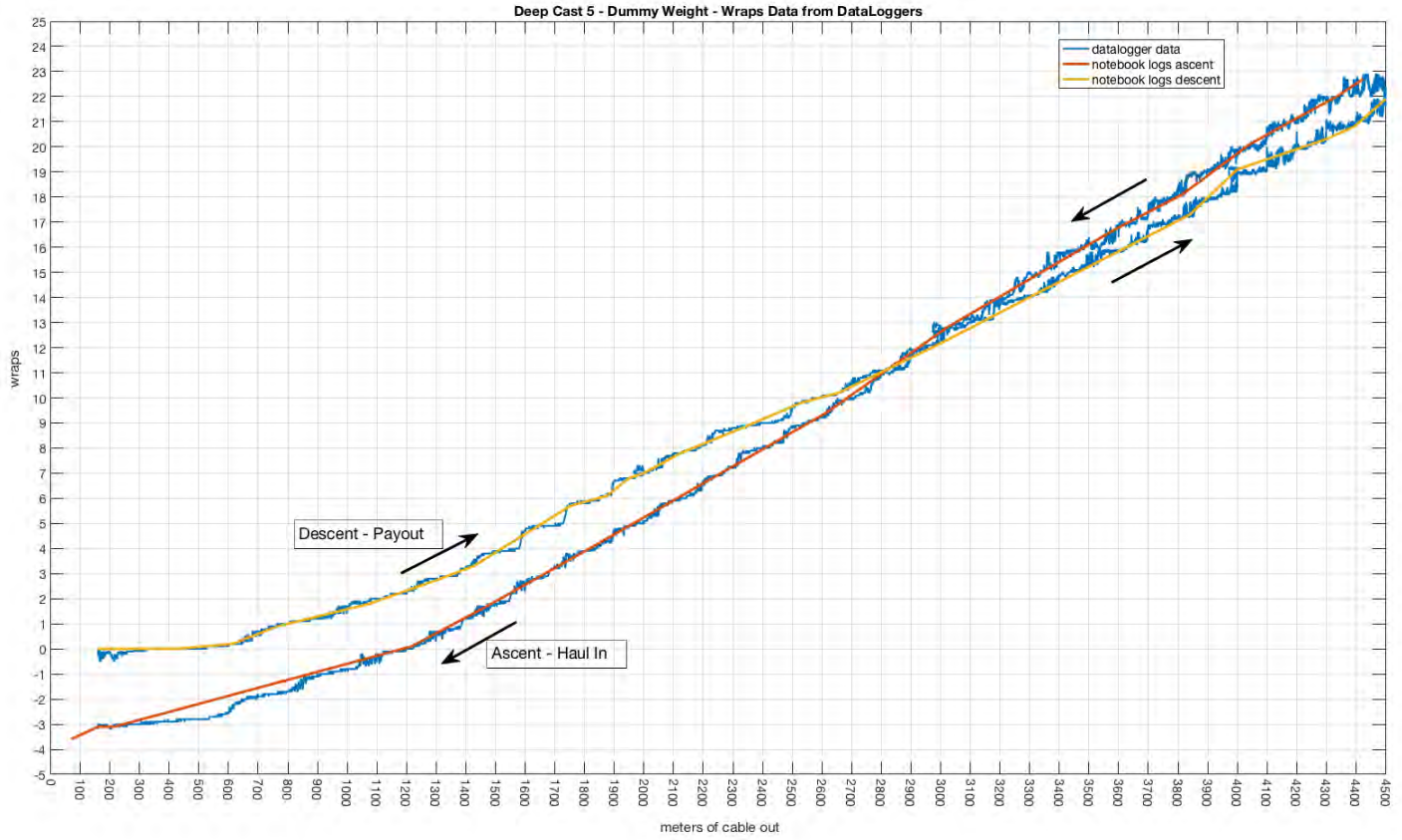
Cable Torque Workshop

- 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

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

Dummy weight cast 5



- Characterization curve, used to determine turns at depth.

JASON engineering cruise
– Jason 1-body System Operation Procedures

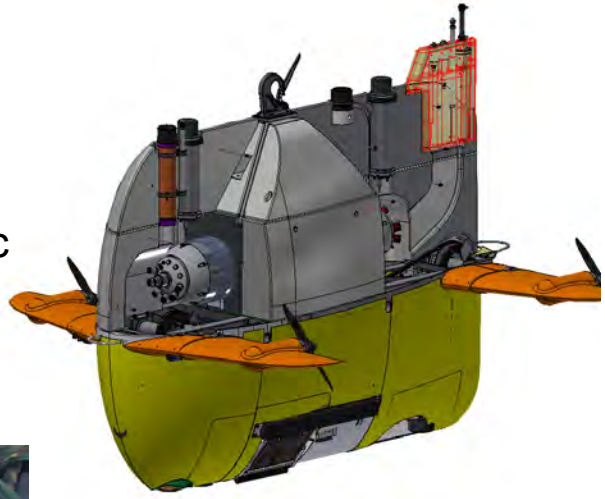
- Use characterization curve to turn in wraps for target depth on descent, turn wraps out on ascent.
- Wrap counter always 0 at the surface.
- Allow torque to spin out while in the air on recovery
- Use e log to track turns
- Dynamic donut to maintain a tight 'S'
  - SR 130m +/- 3m
- At start of dive 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

- All cruise planning and execution of the cruises, as well as routine maintenance functions now managed by Sentry Ops Manager, Sean Kelley
- Masako Tominaga now heavily involved in formalized pre-cruise planning and follow-up processes
- Manyu Belani new mechanical engineer started in January 2018
- Laura Lindzey starts as new software engineer in September 2018.

Sentry update: mechanical and electrical

- Replaced all salvaged SeaCliff foam. Gained approximately 50lbs of payload and eliminated potential failure problems. (PCAR 2016).
- New wing servo design underway. Largest remaining mechanical failure on vehicle
  - Direct Drive and high reliability (PCAR Multiple)
  - Smaller and lighter
- 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



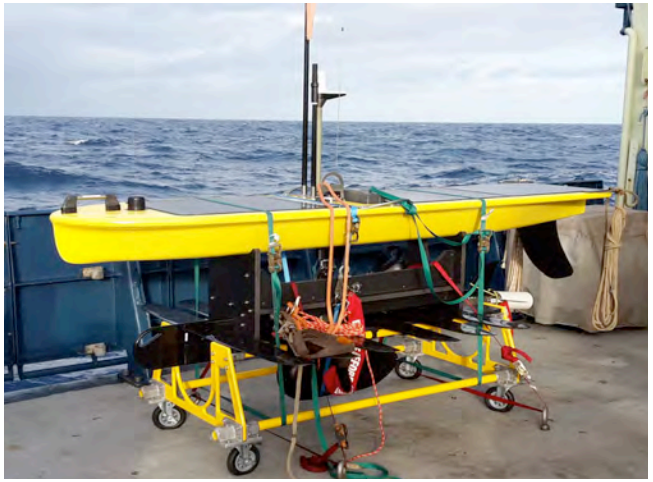
Sentry update: Data and reporting

- Renewed our Sonarwiz license and rolled out a sidescan processing training program (PCAR 2017)
- Converted existing data pipeline to be compatible with ROS
- Remaining 2018 initiatives include:
  - Experimenting with Quimera for Multibeam processing
  - 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. 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)
- Updating User's Guide (PCAR multiple)

Sentry update: Operational capabilities

- Improved ship use efficiency
  - Wave Glider – see later presentation (PCAR 2015 and others)
  - Deck Box – will make launching with other assets in the water much easier – online now
  - Navigation grade GPS and Surface Drive – Allows us to recover to the ship from long distances on the surface without moving the ship if other assets are in the water – online 2019
  - Concurrent Sentry/Alvin Operations – described in ops highlights



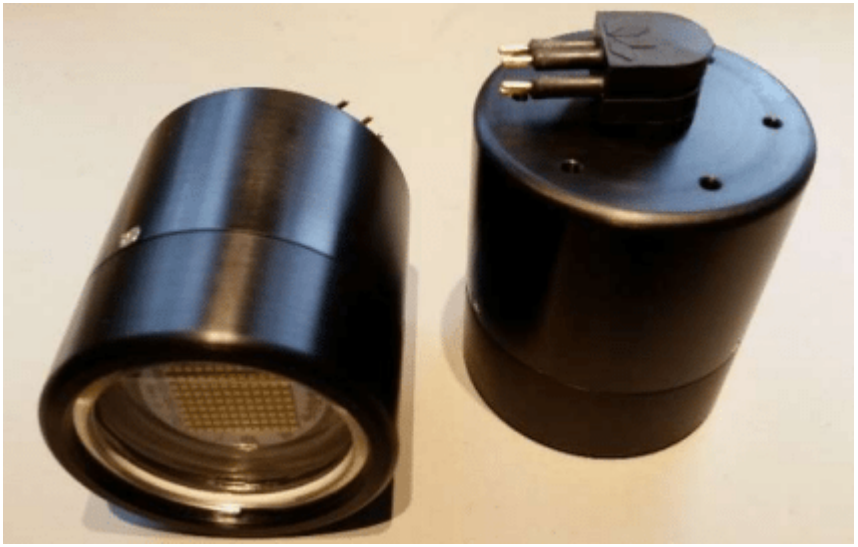
Sentry update: Major Command and Control

Undertaking 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: leverages HUGE open source robotics community
  - makes adding new science capabilities much easier and more streamlined including a much better simulation environment for faster development.
  - more maintainable (addresses c. 2014 – 2016 PCAR feedback about new flight modes and bottom following)
- Basic Vehicle control online and tested during engineering cruise and validated by 2018-Kurz cruise
- Additional conversion in 2018 and 2019.
- Underwater ROS workshop at WHOI October 31 – November 1, 2018 – WHOI will open source most of this code

Sentry update: Sensing

- Adding fill flashes to camera system improve lighting (PCAR 2017)
  - Should greatly improve the performance of mosaicking pipelines and potentially allow that as a capability (PCAR multiple)
- Reson is now quite old, continues to be unreliable, and needs replacement soon (PCAR multiple). See later presentation



Sentry update: Synergistic Activities

Lots of other funded work is feeding new capabilities directly into Sentry

- NOAA – OER
  - Acoustic image transfer
  - Automated chemical anomaly detection
  - On vehicle machine learning for image classification
- WHOI Internal
  - Nereus Legacy Fund – ASV (Autonomous Surface Vehicle) Development
  - Ocean Institutes – Automated map generation on vehicle
  - Interdisciplinary award – Geodetic target detection and movement tracking
- ONR
  - Terrain relative navigation (still in contracting process)
  - Micro-modem based LBL system
  - New battery technology
- Ocean Twilight Zone (private donors)
  - Midwater mission capabilities
  - Iso-X surface following capabilities

Alvin updates: Staffing

- New Alvin Expedition Leader
  - Todd Litke - First cruise (Kurz) acting as solo EL
- Ryan Dahlberg
  - newest Alvin ET
- Ops crew
  - completed majority of watch station qualifications
- Forsman & Litke
  - expected Pilot qualification – Fall 2018, early 2019


Image by Lu Lamar

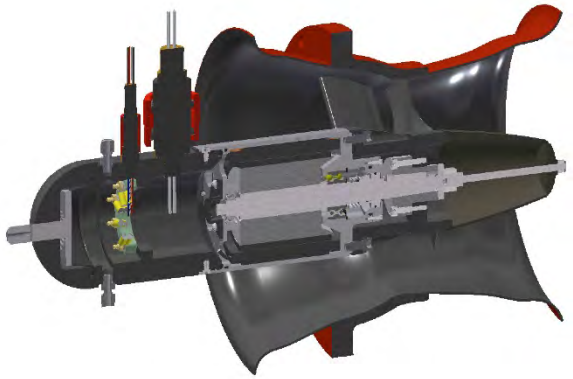
Alvin updates: New computers & Touch Interfaces

- Three new touch screen interface monitors
- 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

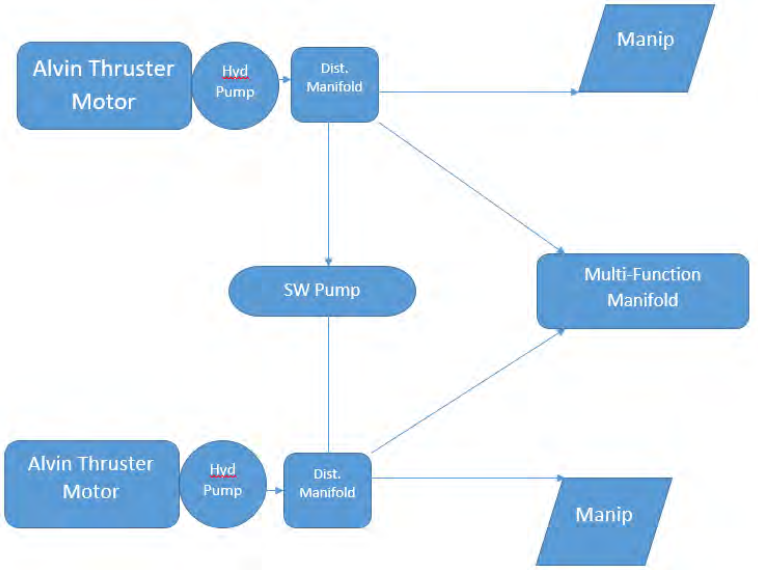
Ge-Chic capacitive touch screen

Alvin updates: New thruster and controllers

- Successful test during engineering series
- Progressive install in 2018-2019
- 40% additional thrust
- Improved efficiency
- Thruster motors will power updated dual-schilling manipulator hydraulic system

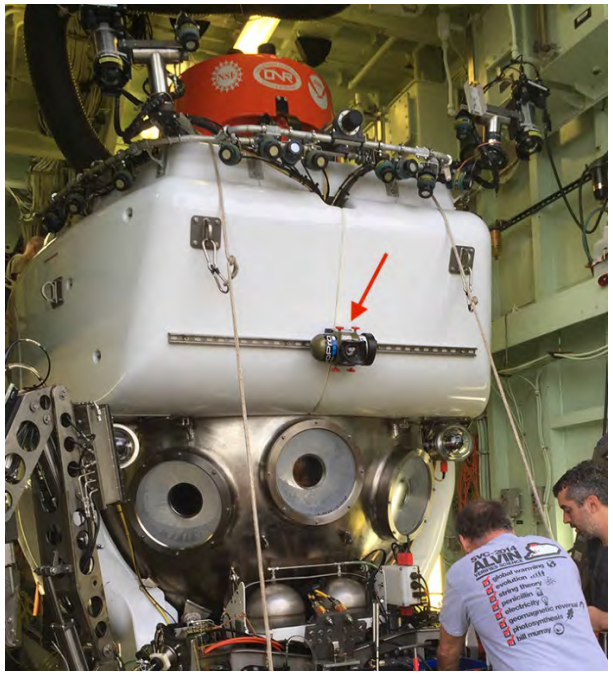


New Thruster Assembly



Alvin updates: Cameras

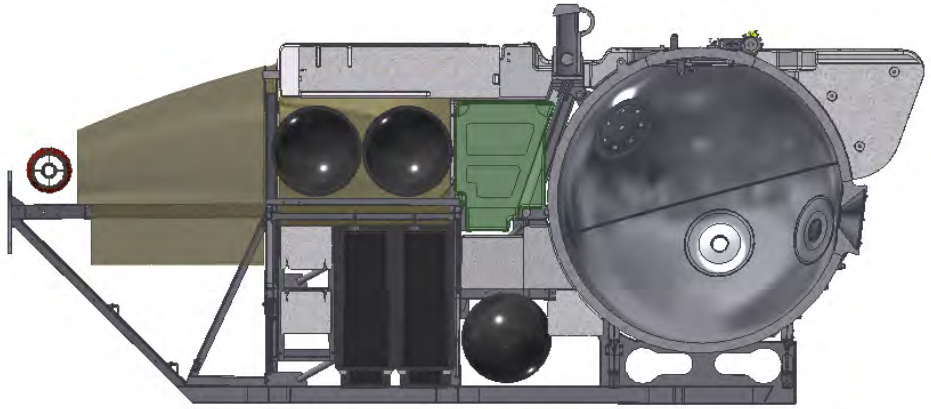
- **DSPL Apex 4K camera system testing**
  - **installation for use August – December 2018**



- **Completed Installation of new cameras**
  - **DSPL HD wide angle camera**
  - **DSPL low-light camera**
  - **MISO Go-Pro still camera**

Alvin updates: VB system updates

- **VB-HP Air Spheres**
  - **design completion and procurement of new ballast spheres**
  - **improved ballasting for 6500 meters**



- **Seawater Pump**
  - **hydraulically powered seawater pump procurement underway**
  - **significant improvements to system for 6500 meters**

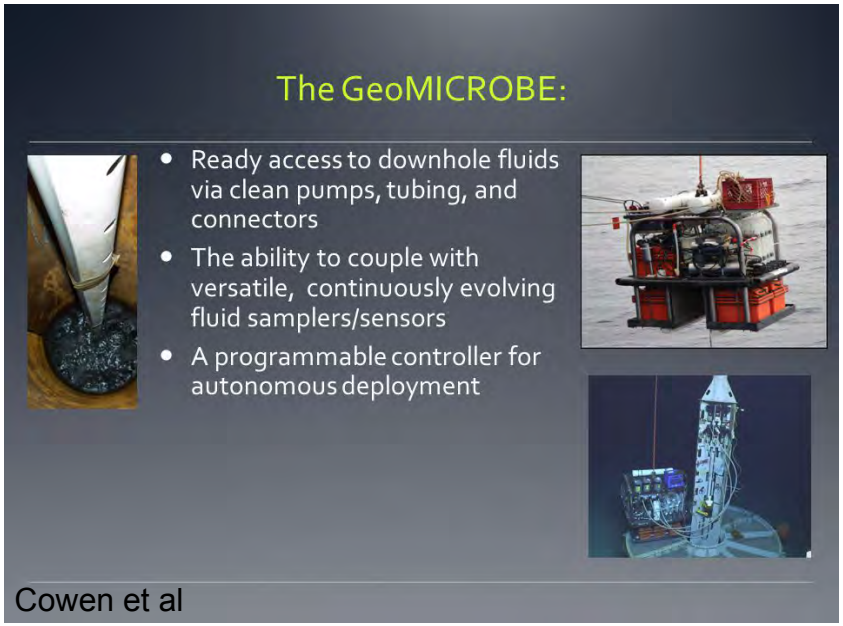
Concept for deployed science module

- **PREMISE:** bottom-time is precious for all vehicles (HOV, ROV, AUV)
  - 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

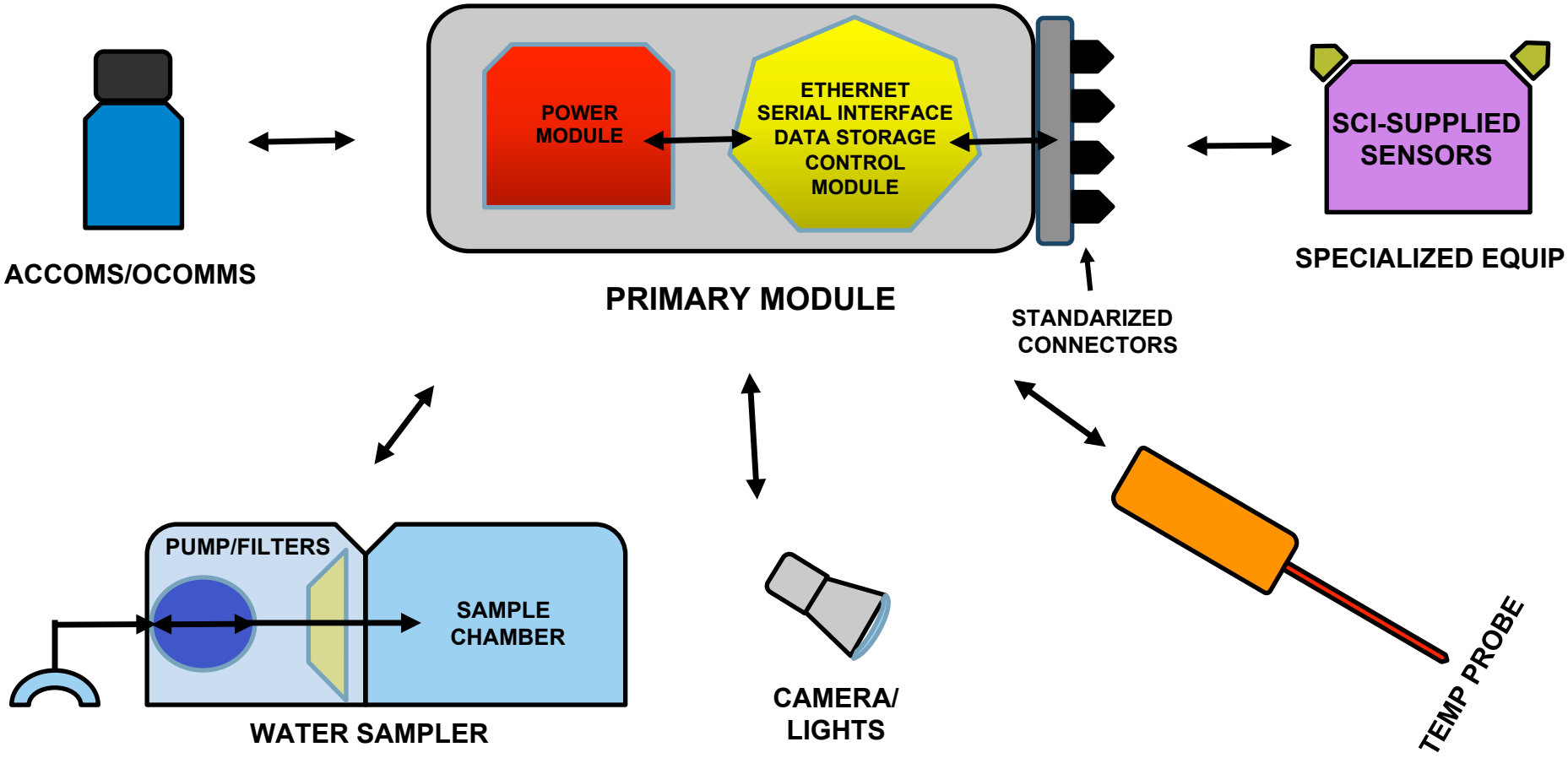
- Recommend development of an advanced de-coupled sampling tool for community use
- Uses a versatile, platform independent, 'primary module'
- Sized for use on elevators, sleds, baskets etc with a range of capabilities - pump/filter control, sensor interfaces, serial data, temperature etc



- Could 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

Concept for deployed science module

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



Engineering Cruise Results

- Conducted 5x 4500m dummy weight casts
  - Characterize and relax cable torque
  - Tested methodology, dynamic donut
  - Develop mitigation techniques
  - Tested VPN, Manufacturer able to log into system for troubleshooting
- Conducted 1x Jason dive to 4500m

JASON engineering cruise
- Dummy weight casts summary

Table 1. Wraps summary by cast. 0.843" EOM.

Cast	Surface	Deep	Surface		Diff Down	Diff Up		Diff Total	Max Depth
1	0	56	28.4		56	-27.6		28.4	4500
2	28.4	60.2	31.9		31.8	-28.3		3.5	4674
3	33.6	59.2	32.6		25.6	-26.6		-1	4691
5	0	22.7	-3.6		22.7	-26.3		-3.6	4500

+ wraps are CW looking down at the wire entering the water from the deck of the ship. Outer layer has a left-lay when observed from this vantage point.

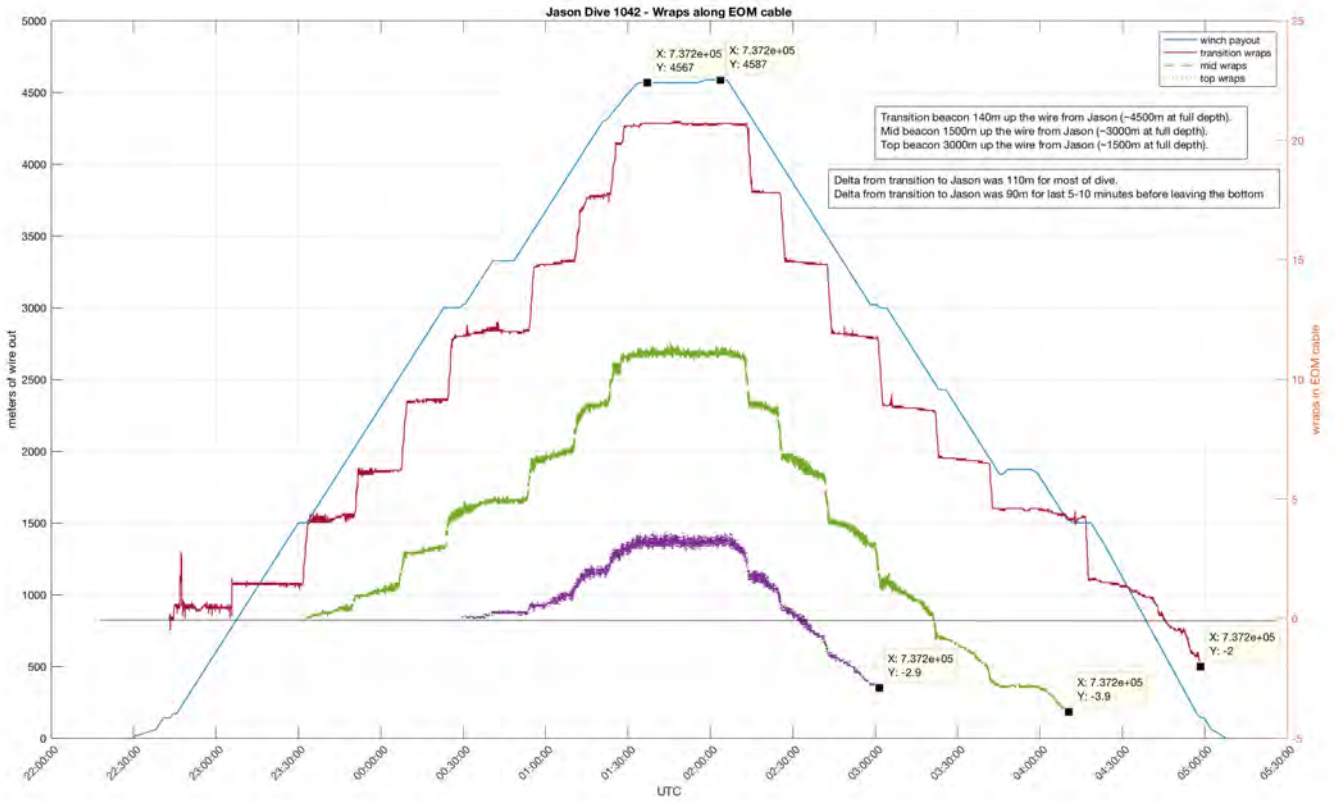
- Shows substantial improvement from cast 1 and gradual improvement on subsequent casts, but still relaxing as indicated by negative turns at surface.

JASON engineering cruise
- Dummy weight casts summary

Figure 1. Wraps curves by cast

Data collected from written logs during the dive, and corrected in post processing.

JASON Dive 1042



- Turned in 21 wraps on ascent and un turned 21 on ascent.

Dynamic Donut - definition

- Display SR and Δ_v and keep Δ_v near = SR, alert pilot when out of range (defined by Steinke simulations)
- As Δ_v deceases, Δ_{HMin} and Δ_{HMax} automatically increase
  - This tells the Jason pilots to either move Jason farther out on the donut, haul in cable, or move the ship, to keep Jason out of the donut hole
- Always keep Jason on the solid donut, out of the center donut hole and not beyond the solid donut
- Definitions
  - SR - Slant range from USBL beacon to Jason
  - Δ_v - USBL beacon to Jason vertical depth difference
  - Δ_H – Horizontal distance of USBL beacon to Jason
  - Δ_{Hmin} Minimum horizontal distance USBL to Jason
  - Δ_{Hmax} Maximum horizontal distance USBL to Jason
  - S – Shape of the cable defined by how tight the SR is, SR = 140m indicates no 'S' shape.
  - Loaded – Jason has a package attached to the latches and is heavy beyond available buoyancy, and the cable is vertical, Δ_v = SR
  - Unloaded – Jason does not have a package, is neutrally buoyant, and will utilize an 'S' curve in the cable

“Dynamic Donut”