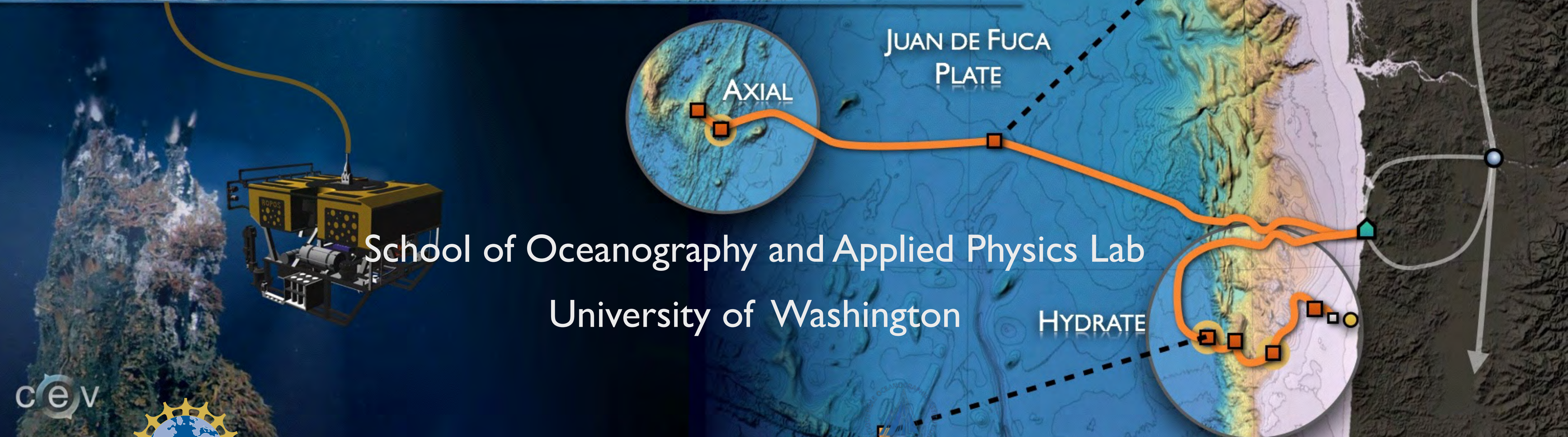


Regional Cabled Array

Deb Kelley and Cabled Array Team



School of Oceanography and Applied Physics Lab
University of Washington

ce v



REGIONAL CABLED ARRAY

▶ Changes in RCA in 2.0

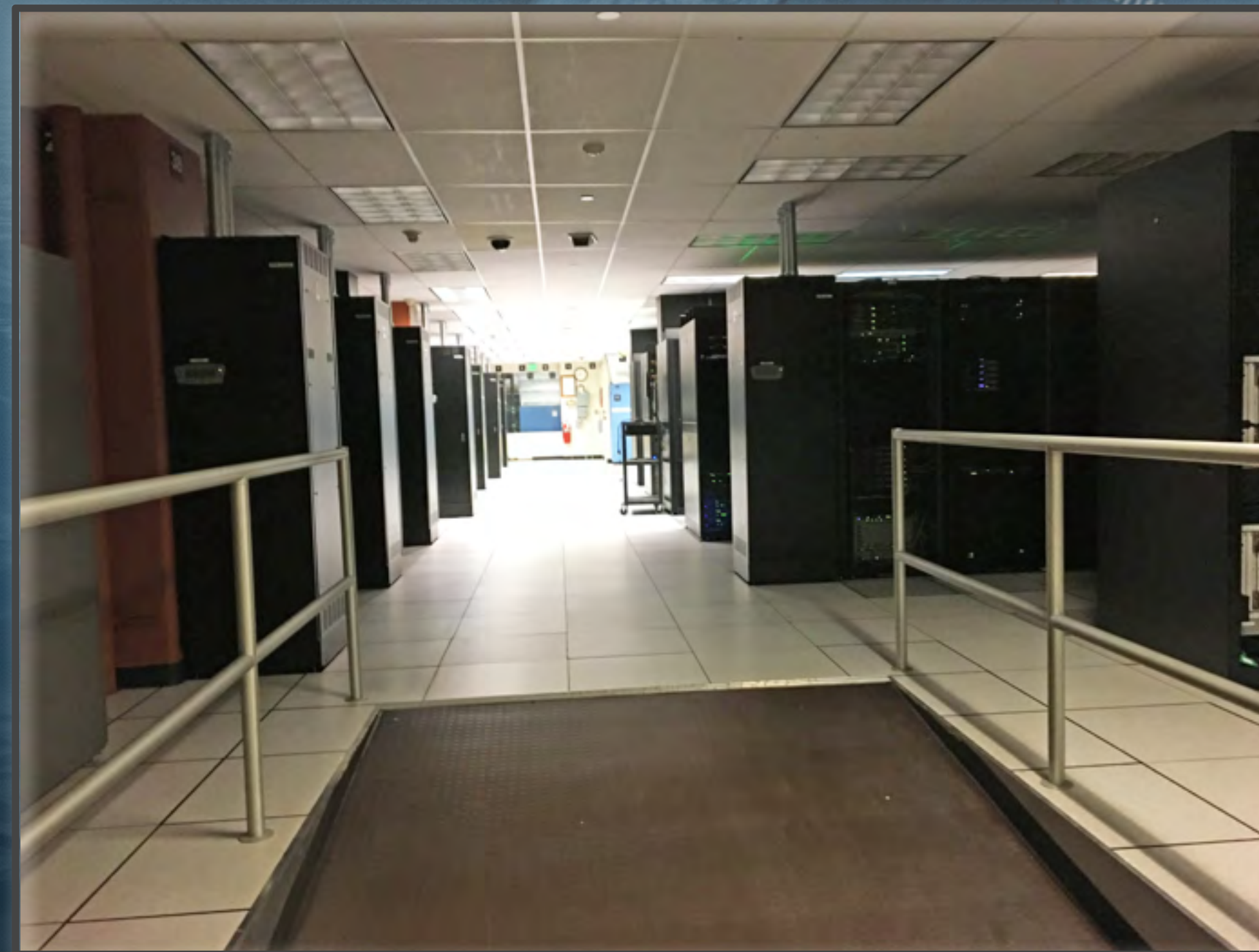
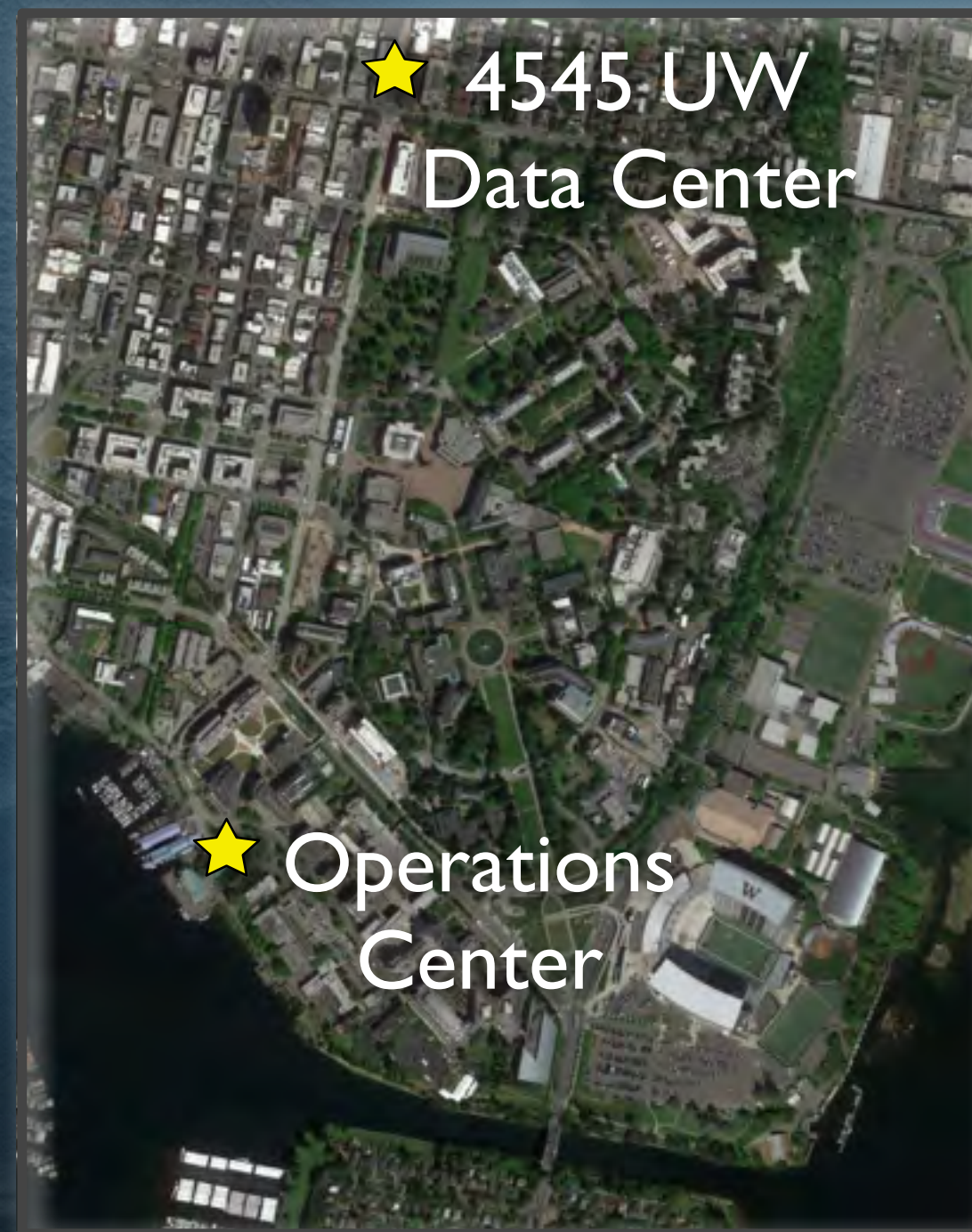


Cabled Array students 2018
Leg 1

- ▶ Took over management of terrestrial west coast infrastructure in partnership with Pacific Northwest GigaPop
- ▶ UW now responsible for port agent drivers and data parsers
- ▶ Port agent drivers and data parsers will be moved to the Shore Station
- ▶ Data Positions Formalized, Advertised and Hired 1.5 FTE's
 - ▶ End-to-end process formalized and implemented for calibration, instrument metadata, data evaluation (Orest)
- ▶ Operations - 2018 field season and infrastructure status
- ▶ Operations - PI instruments
- ▶ Outreach
- ▶ Operations - 2019 and issues

NW GigaPop-UW Partnership Operates and Maintains West Coast Cabled Array Network Including Backhaul

Portland Pittock Building now a passthrough - all CI servers moved to UW IT Data Center
4545 Building - 5 minutes from Cabled Array Operations Center - efficient "remote hands"

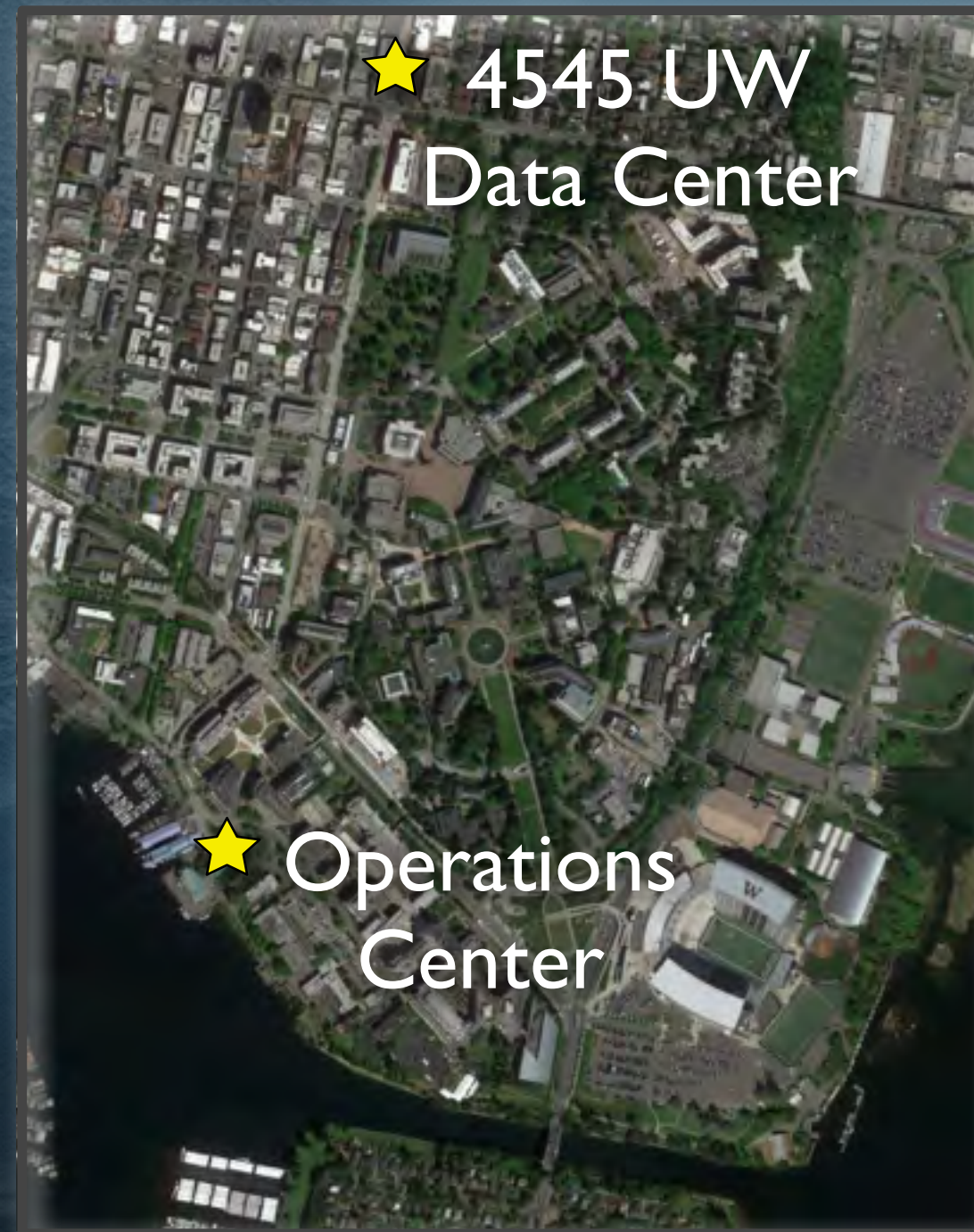


4545 Data Center - Great facility at low cost!:

- ▶ 11,800 ft² of raised floor space; 290 cabinets of which 220 are occupied - entire additional open area for future expansion.
- ▶ Current power 500 kW with ~ 342 kW utilized. Cooling capacity for 686 kW worth of equipment and generator capacity for 2000 kW.

NW GigaPop-UW Partnership Operates and Maintains West Coast Cabled Array Network Including Backhaul

Transition to UW is complete. UW now responsible for port agents and data parsers



- ▶ Port Agents and Logs: Software that “listens” to cabled instruments and places data in a message queue to be uFrame ingested. Logs contain configuration information in the data e.g., instrument and server IP addresses, port numbers etc
- ▶ Data parsers: Parse the raw data into L0 science and engineering data products

REGIONAL CABLED ARRAY

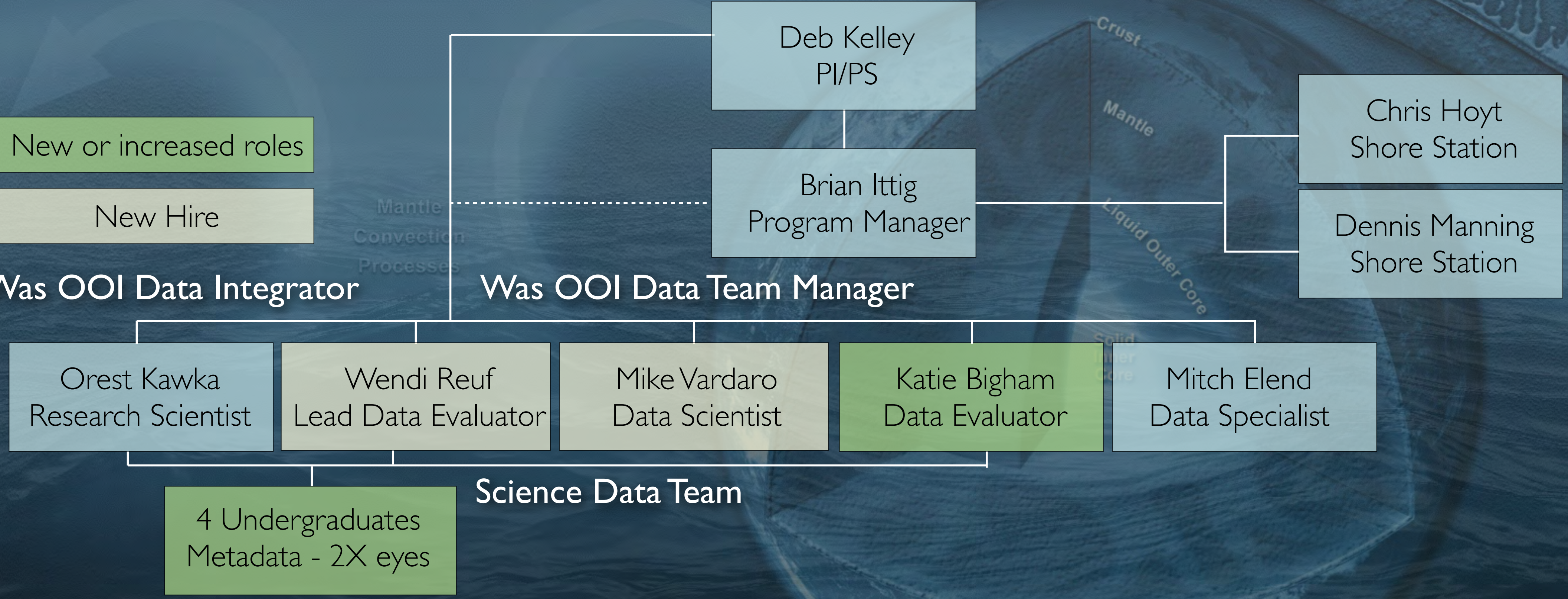
Data and Network Personnel Changes

New or increased roles

New Hire

Was OOI Data Integrator

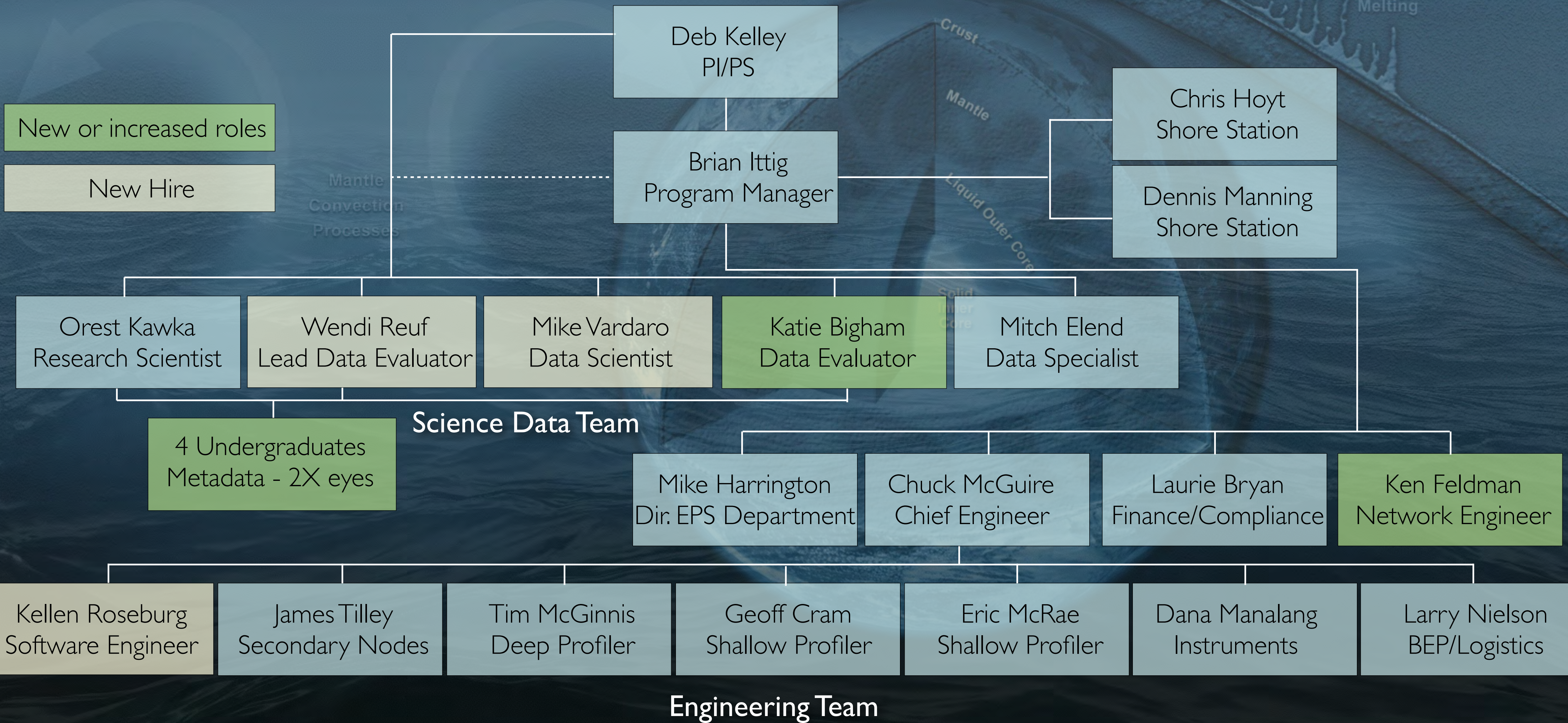
Was OOI Data Team Manager



4 Undergraduates
Metadata - 2X eyes

REGIONAL CABLED ARRAY

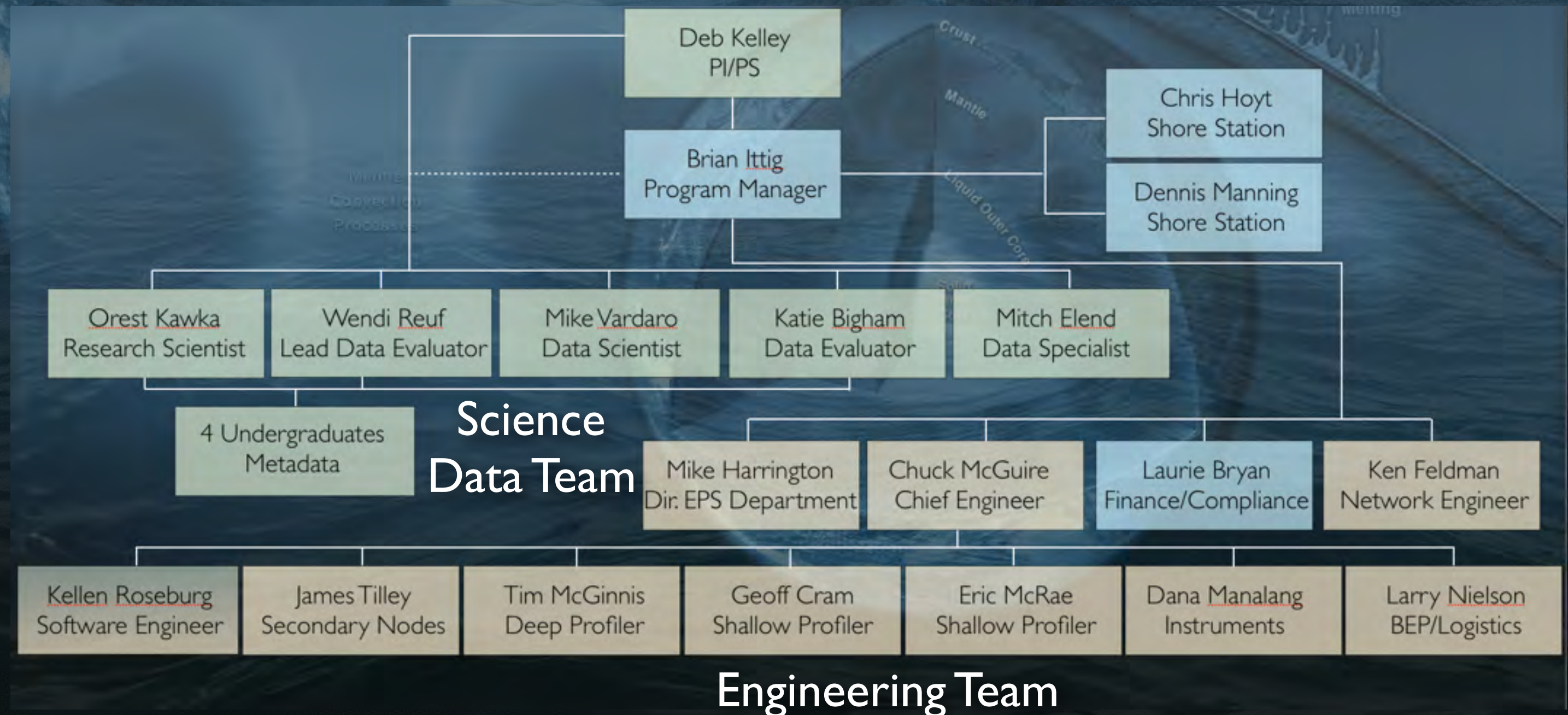
Data and Network Personnel Changes



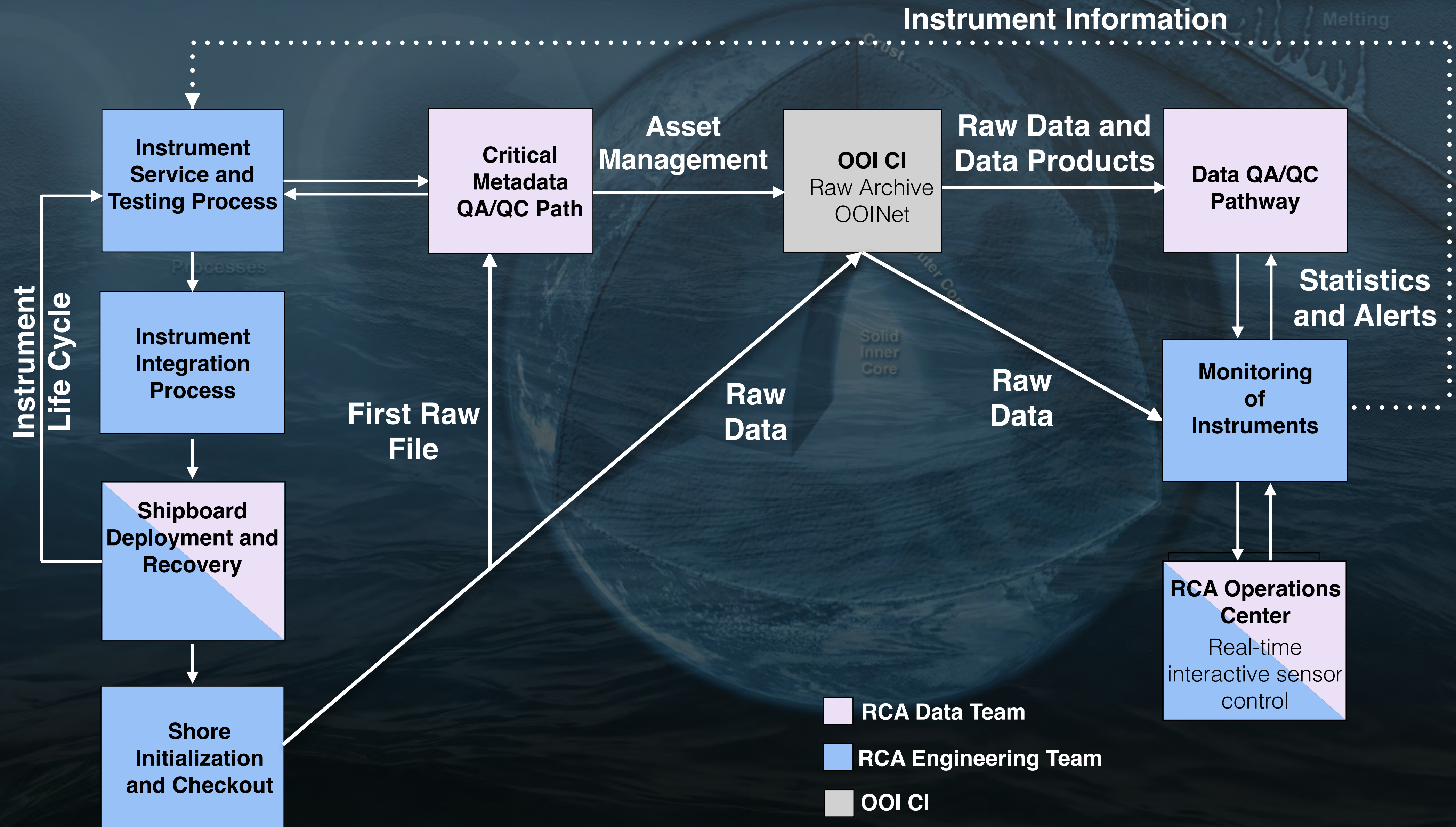
Cabled Array

How We Operate

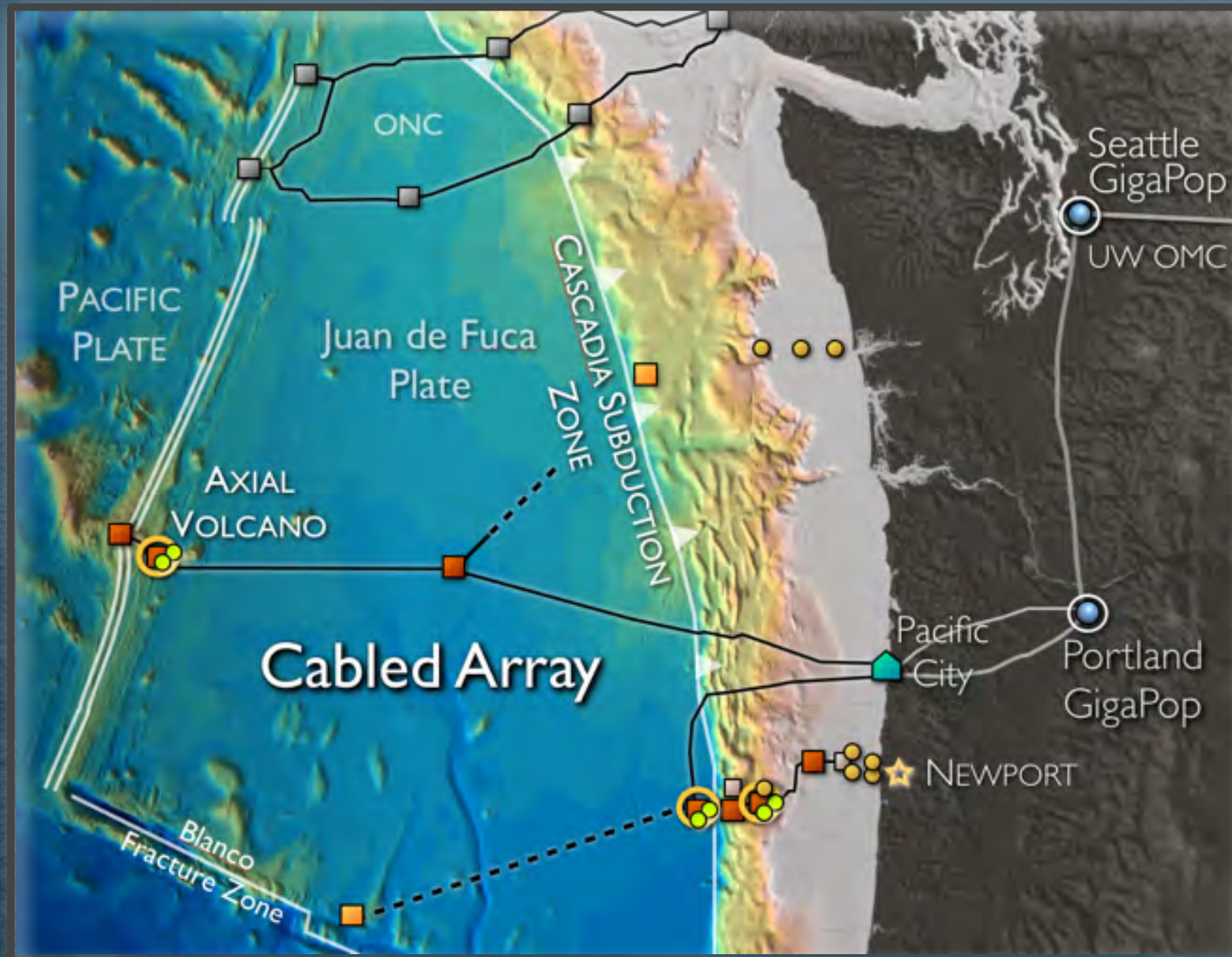
- ▶ PI-PM-Finance: Talk Daily
- ▶ PM-Finance-Engineering: Talk Daily to Weekly
- ▶ Data Team Talk Daily
- ▶ Weekly Meeting Data-Engineering Instrument: Metadata, Evaluation - Are Instruments Working? (Orest will expand)
- ▶ Weekly Meeting Control Account Managers: Refurb Status and Budgets
- ▶ Monthly All Hands Meeting
- ▶ Several Precruise Meetings



Conducting Deep-Dives into Metadata and Each Instrument Comprehensive End-to-End Instrument and Data QA/QC



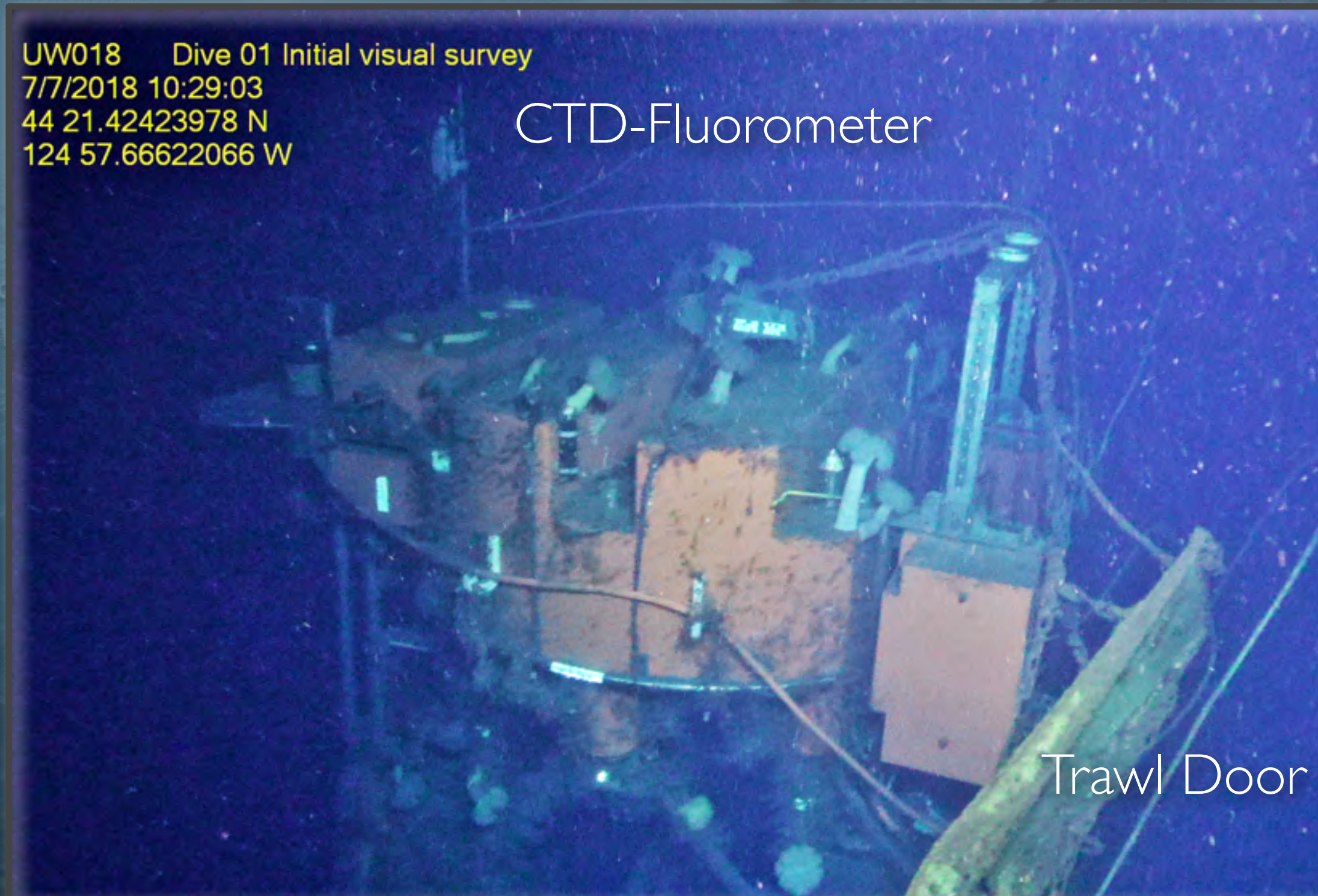
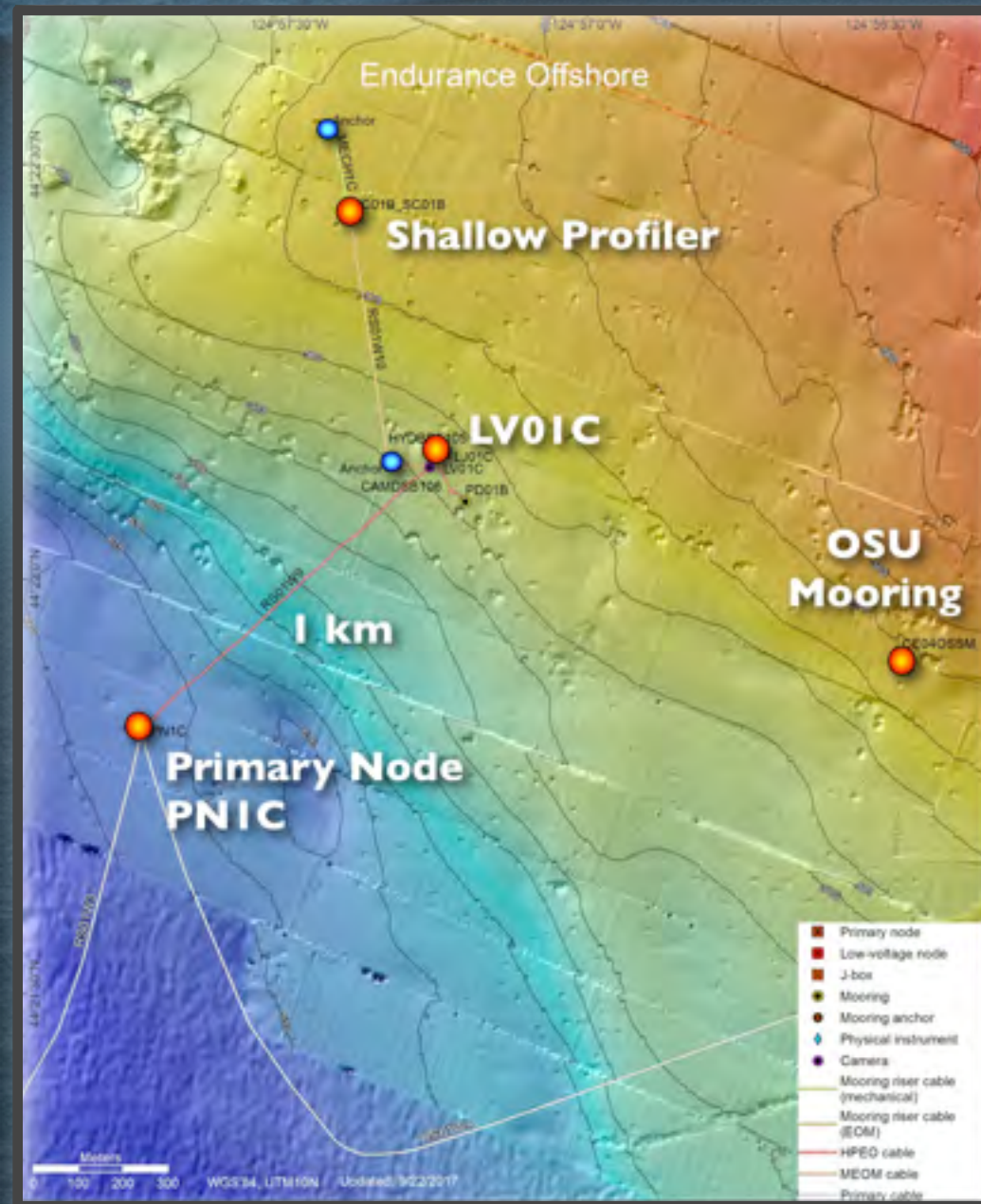
Regional Cabled Array - Field Operations 2018



- ▶ 4th Operations and Maintenance Cruise 47 days, 6/19 to 8/5
- ▶ R/V *Revelle* and ROV *Jason* - 58 dives
 - ▶ Turned 5 Junction Boxes
 - ▶ 3 Shallow Profiler Platform Assemblies, 3 Shallow Profiler Science Pods (Axial Platforms Recovered)
 - ▶ First time reinstallation of complete 2-legged Shallow Profile Mooring - Endurance Offshore
 - ▶ 2 Benthic Experiment Platforms
 - ▶ 84 CORE instruments turned-installed
 - ▶ 11 Installations of new PI instruments/Platforms & Turning of 2
 - ▶ 3 Deep Profiler moorings
 - ▶ 15 verification CTDs plus Jason Niskins and gas-tights
 - ▶ Recovery of *Jason* elevator dropped last year (2 instruments)
- ▶ VISIONS' 18 - 23 undergraduate and graduate students: UW, Grays Harbor, Queens College NY, Chico - California State
 - ▶ USA, Taiwan, Malaysia, Argentina

REGIONAL CABLED ARRAY: SHALLOW PROFILER TRAWL

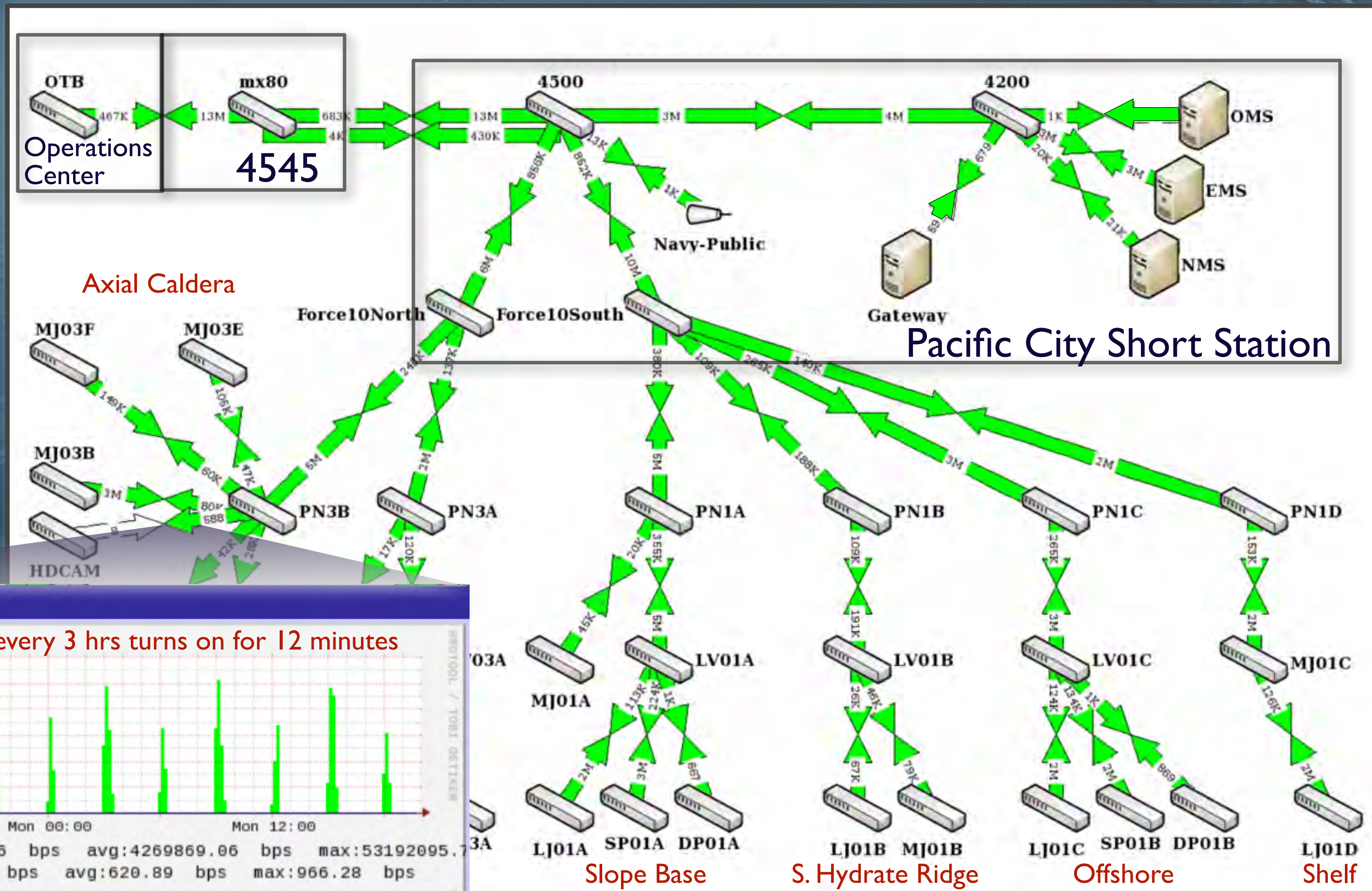
- ▶ 200 m platform was pulled down to 400 m, then rose to 100 m before communications lost - ended up by PNIC (anchor by LV01C “bounced” northward, big divots in seafloor)



- ▶ Recovered 7/7/2018 in <24 hrs by Pelagic Services (Ed Cassano, Odyssey ROV)
- ▶ 400 ft of next attached, 1 trawl door
- ▶ Reinstalled during Leg 3, operational

Cabled Array Operational Status

Operations Management System Weathermap: Live Status Network Traffic

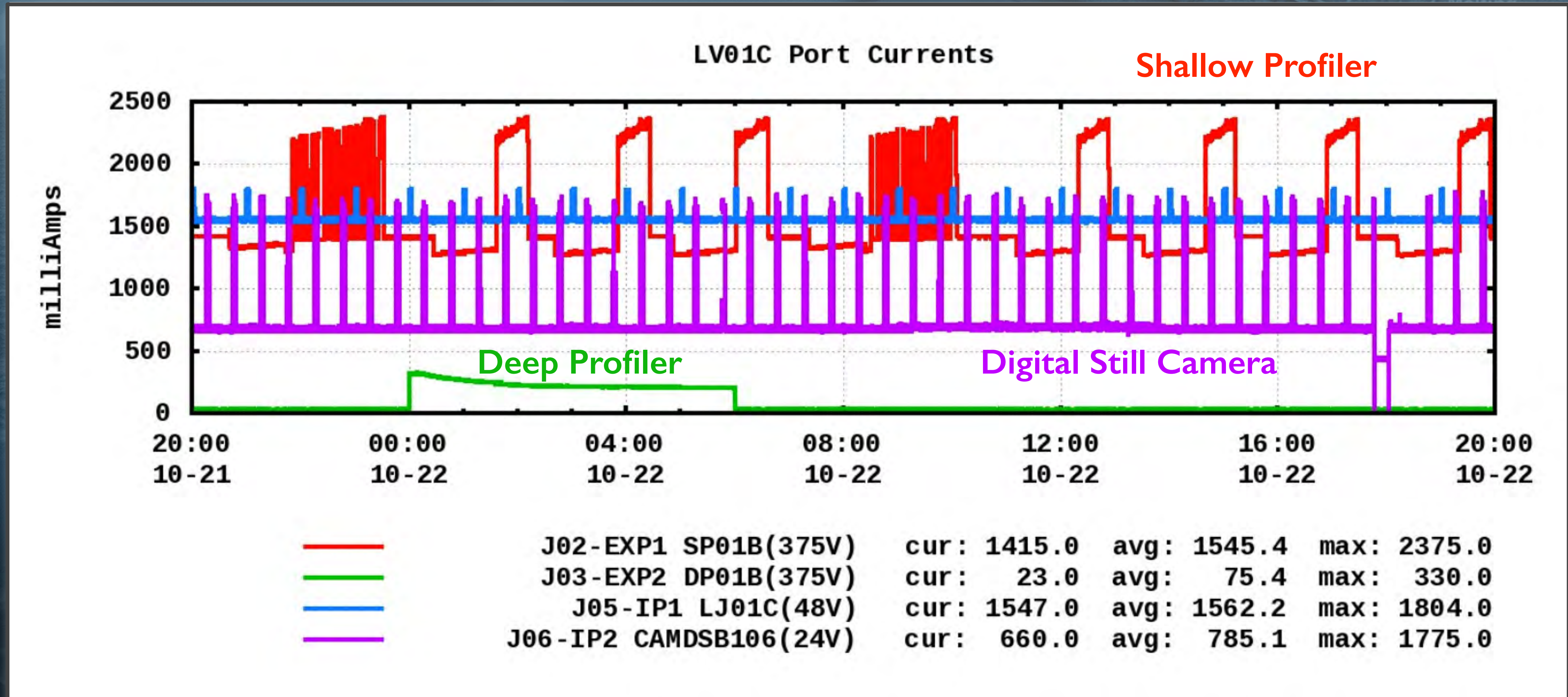


Rapid, easy way to determine infrastructure status

▶ Hovering on any connection provides live update

Cabled Array Operational Status: October 22, 1240 Pacific

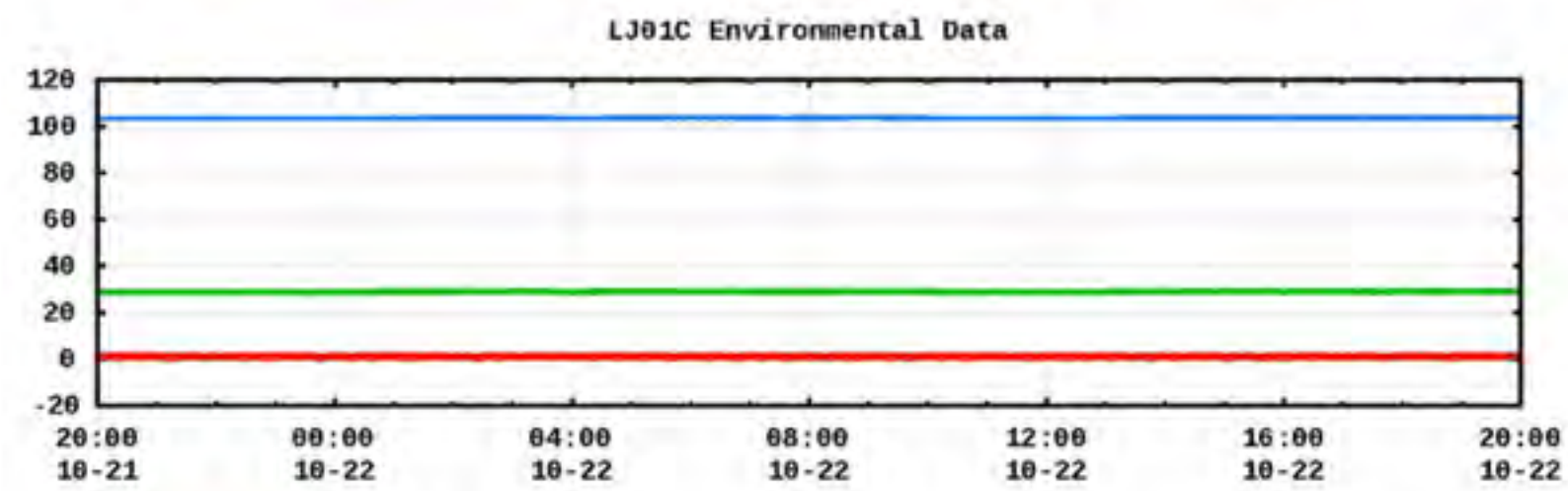
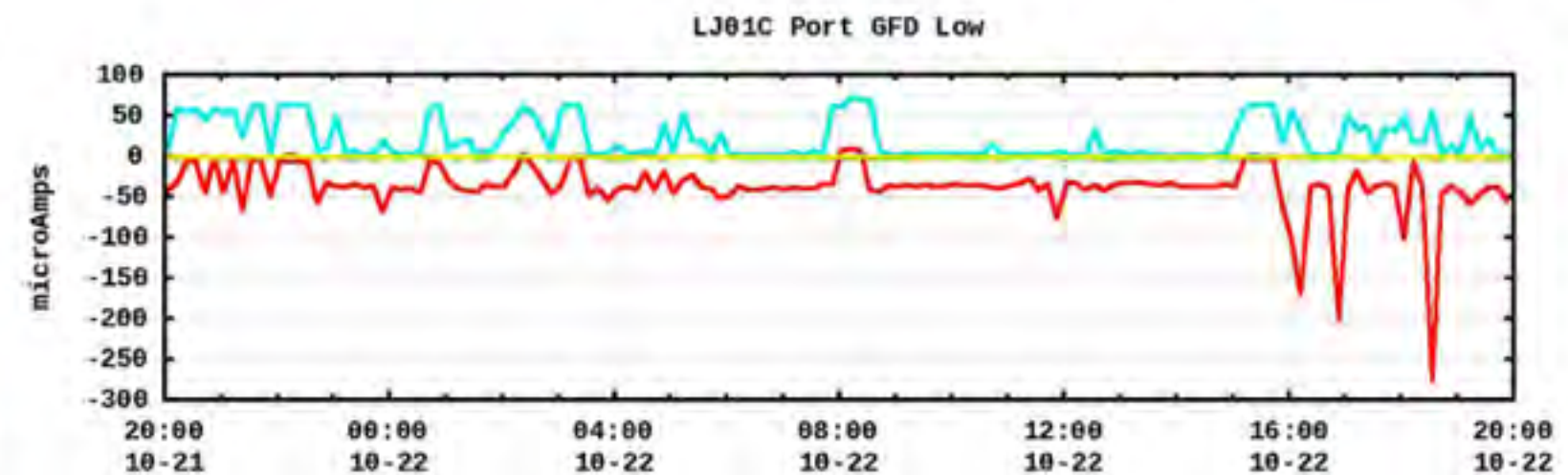
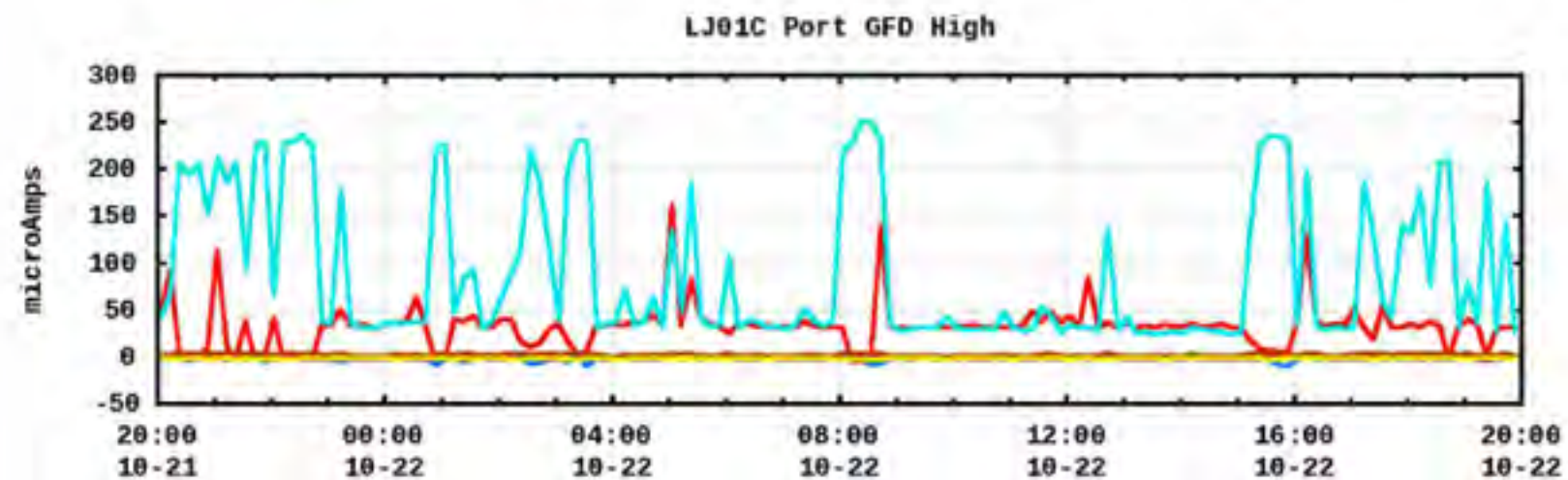
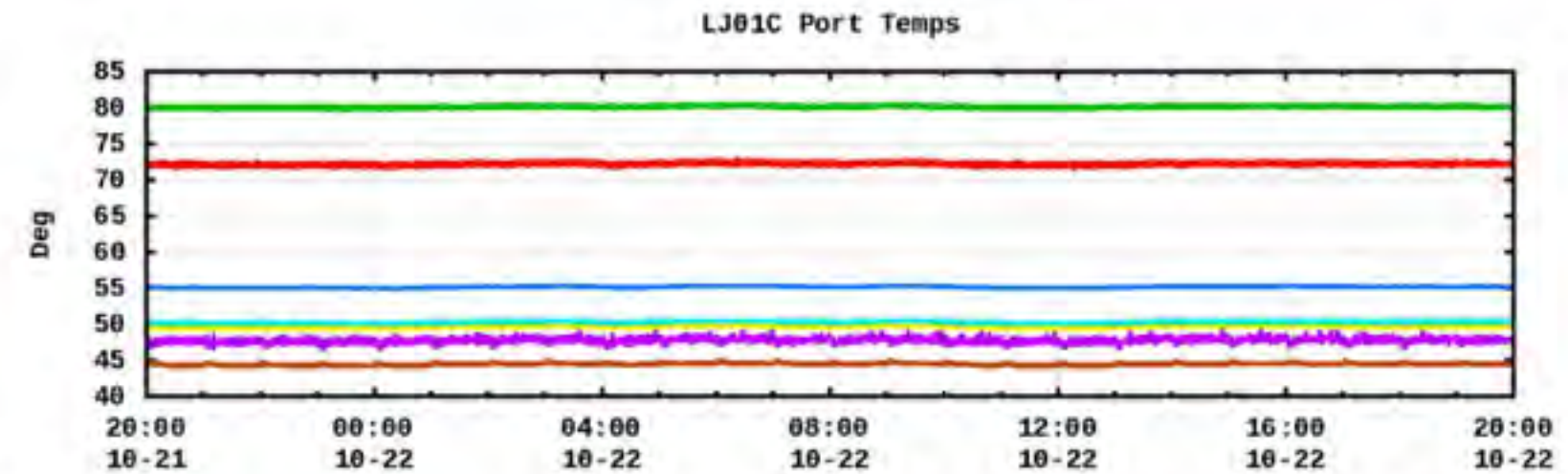
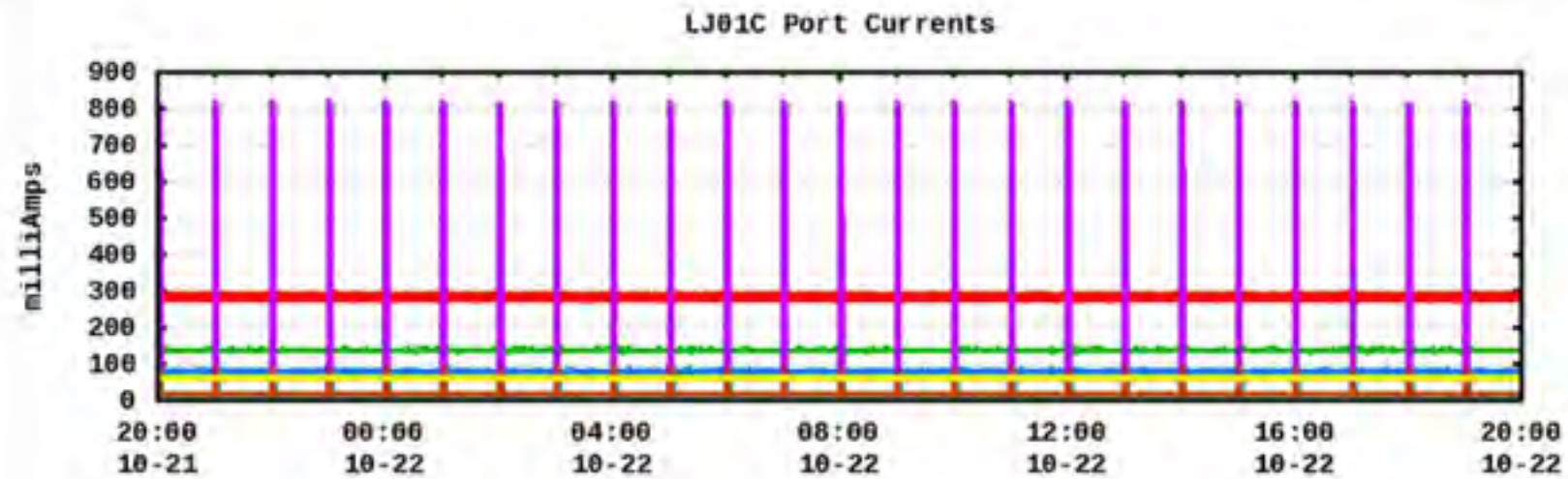
Operations Management System: Live Status Drill Down to Site



Cabled Array Operational Status: October 22, 1321 Pacific

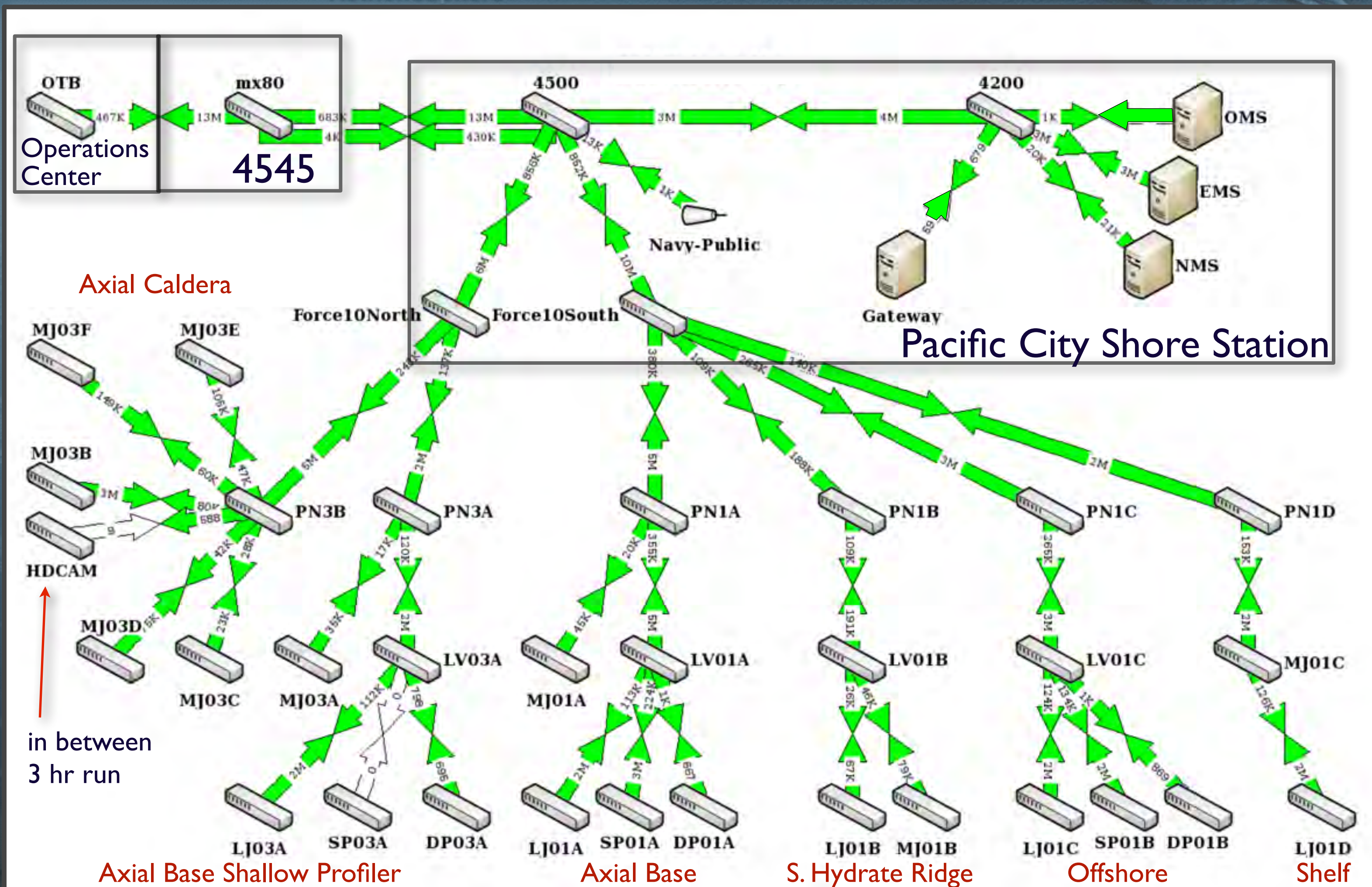
Operations Management System: Live Status Drill Down to Instrument

- [Summary](#)
- [System Power](#)
- [Primary Node Ports](#)
- [Primary Node Env Year](#)
- [Primary Node Optical](#)
- [Network Map](#)
- [Instrument Staus](#)
- [Endurance Staus](#)
- [OMS Alarms](#)
- [Profiler Summary](#)
- [Sec Node Stats \(y\) \(w\)](#)
- [MJ03A \(d\) \(w\) \(m\) \(y\)](#)
- [LV03A \(d\) \(w\) \(m\) \(y\)](#)
- [LJ03A \(d\) \(w\) \(m\) \(y\)](#)
- [MJ03B \(d\) \(w\) \(m\) \(y\)](#)
- [MJ03C \(d\) \(w\) \(m\) \(y\)](#)
- [MJ03D \(d\) \(w\) \(m\) \(y\)](#)
- [MJ03E \(d\) \(w\) \(m\) \(y\)](#)
- [MJ03F \(d\) \(w\) \(m\) \(y\)](#)
- [MJ01A \(d\) \(w\) \(m\) \(y\)](#)
- [LV01A \(d\) \(w\) \(m\) \(y\)](#)
- [LJ01A \(d\) \(w\) \(m\) \(y\)](#)
- [LV01B \(d\) \(w\) \(m\) \(y\)](#)
- [LJ01B \(d\) \(w\) \(m\) \(y\)](#)
- [MJ01B \(d\) \(w\) \(m\) \(y\)](#)
- [LV01C \(d\) \(w\) \(m\) \(y\)](#)
- [LJ01C \(d\) \(w\) \(m\) \(y\)](#)
- [MJ01C \(d\) \(w\) \(m\) \(y\)](#)
- [LJ01D \(d\) \(w\) \(m\) \(y\)](#)
- [PC01A \(d\) \(w\) \(m\) \(y\)](#)
- [SC01A \(d\) \(w\) \(m\) \(y\)](#)
- [SF01A \(d\) \(w\) \(m\) \(y\)](#)
- [PC01B \(d\) \(w\) \(m\) \(y\)](#)
- [SC01B \(d\) \(w\) \(m\) \(y\)](#)
- [SF01B \(d\) \(w\) \(m\) \(y\)](#)
- [PC03A \(d\) \(w\) \(m\) \(y\)](#)
- [SC03A \(d\) \(w\) \(m\) \(y\)](#)
- [SF03A \(d\) \(w\) \(m\) \(y\)](#)
- [SC01A Slope Base Winch](#)
- [SC01B Endurance Winch](#)
- [SC03A Axial Base Winch](#)
- [PD01A Slope Base DP](#)
- [PD01B Endurance DP](#)
- [PD03A Axial Base DP](#)
- [HDCam](#)



Cabled Array Operational Status: October 22, 1240 Pacific

Primary Nodes and Junction Boxes 100% Operational

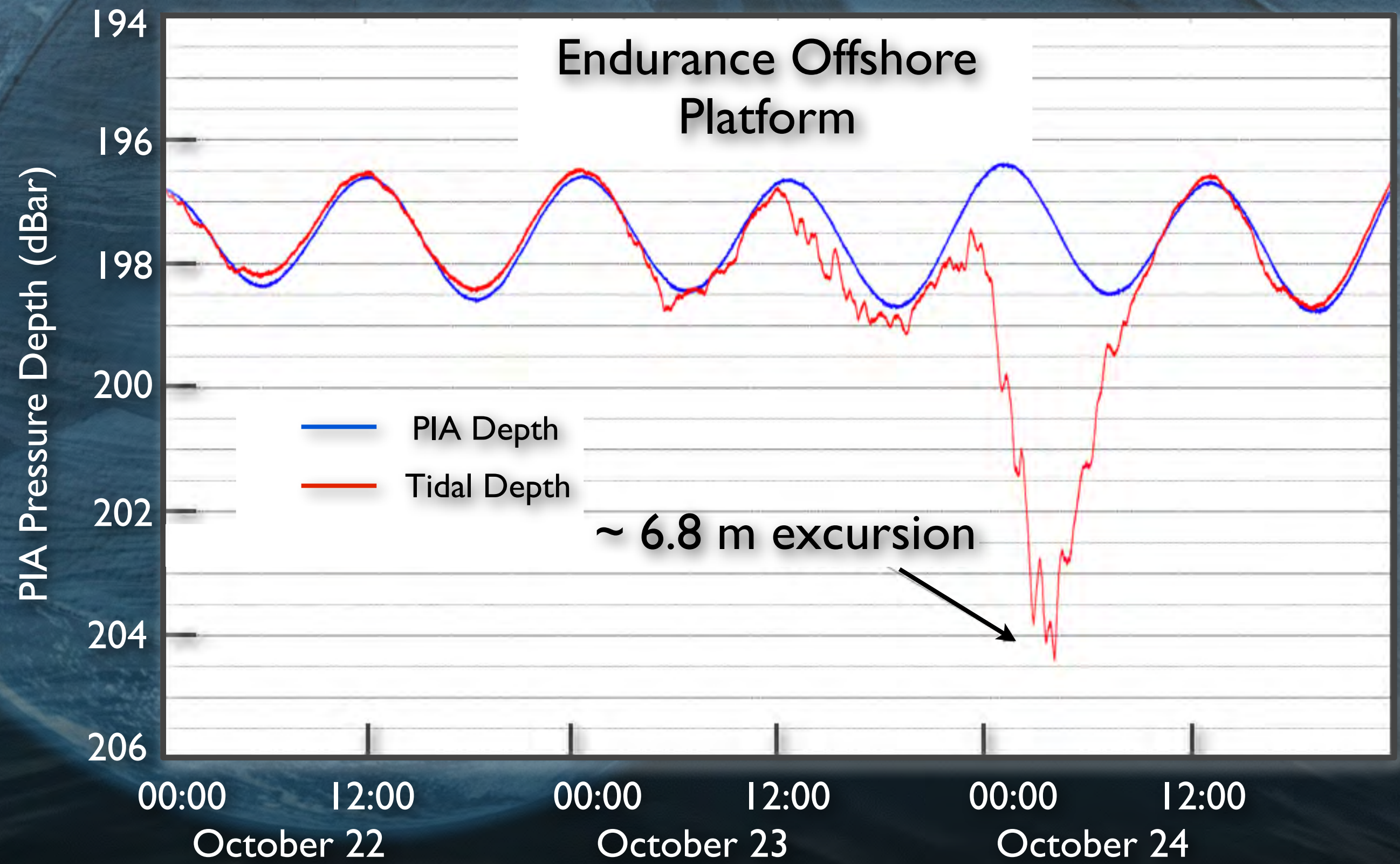
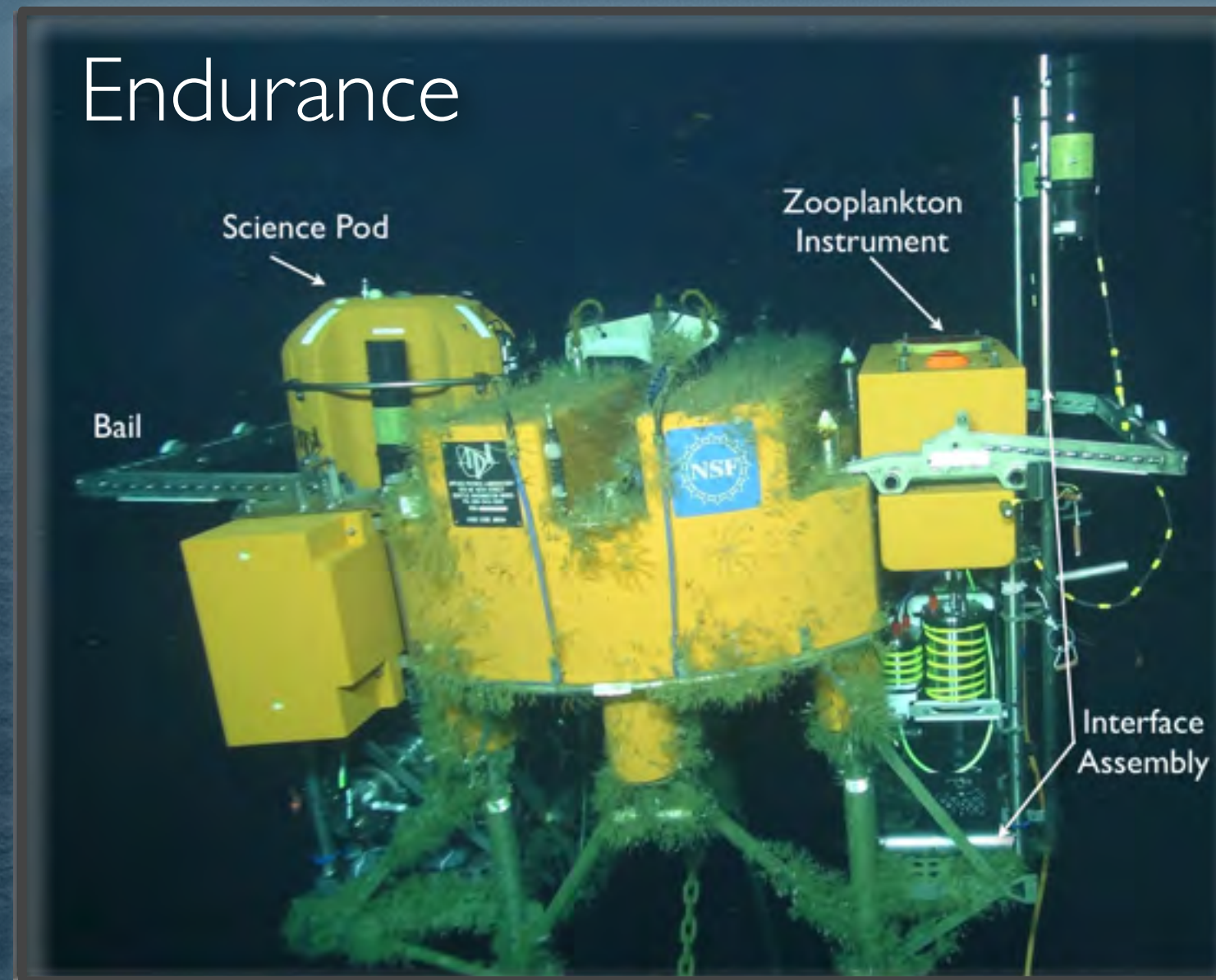


All Primary Nodes and 18 Junction Boxes Operational

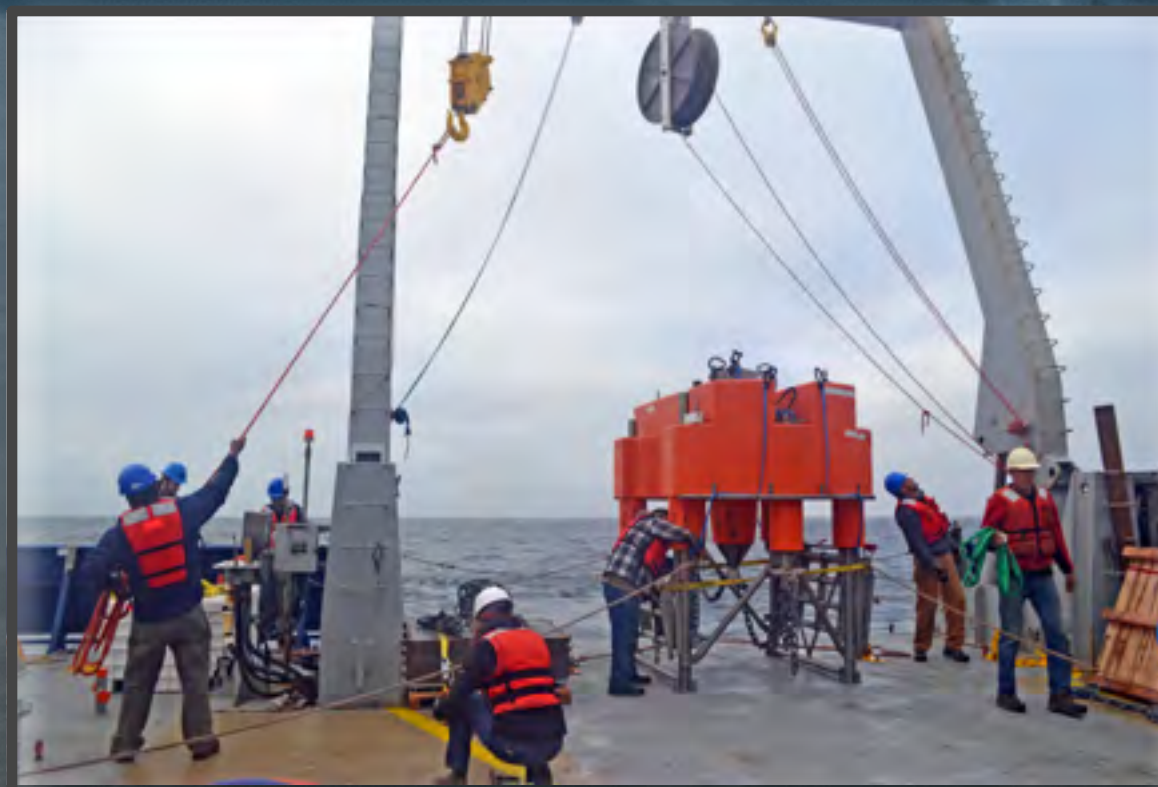
Cabled Array Operational Status: October 25, | 13 | Pacific

Shallow Profilers >>30,000 profiles since 2015

- ▶ Slope Base: 100% Operational
- ▶ Endurance Offshore: 100% operational, First installation of a 2-legged mooring; GAF Connector Implemented



Recovered trawled platform 2017



New platform going in Cabled Array 2018

- ▶ October 24, 2018~ 6.8 m blow down of 12,000 lb, 12 ft across platform
- ▶ September 26-27, 2015~ 6.4 m blow down of

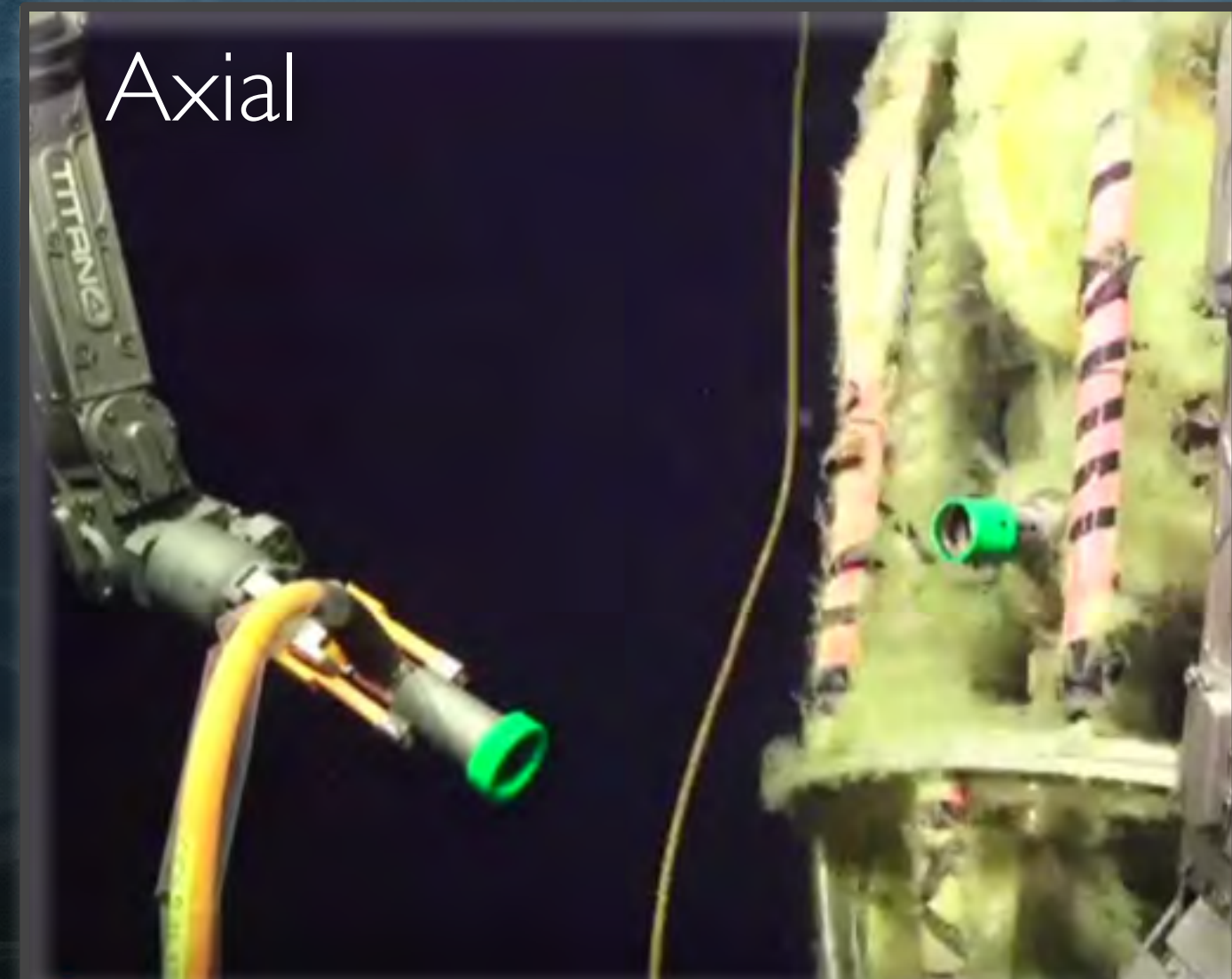
Cabled Array Operational Status: October 25, 1131 Pacific

Shallow Profilers >>30,000 profiles since 2015

- ▶ Slope Base: 100% Operational
- ▶ Endurance Offshore: 100% operational, First installation of a 2-legged mooring; GAF Connector Implemented



Teledyne ODI Gross Alignment Funnel (GAF) : Optimize ROV mating efficiency. Purchased a few for critical connections.

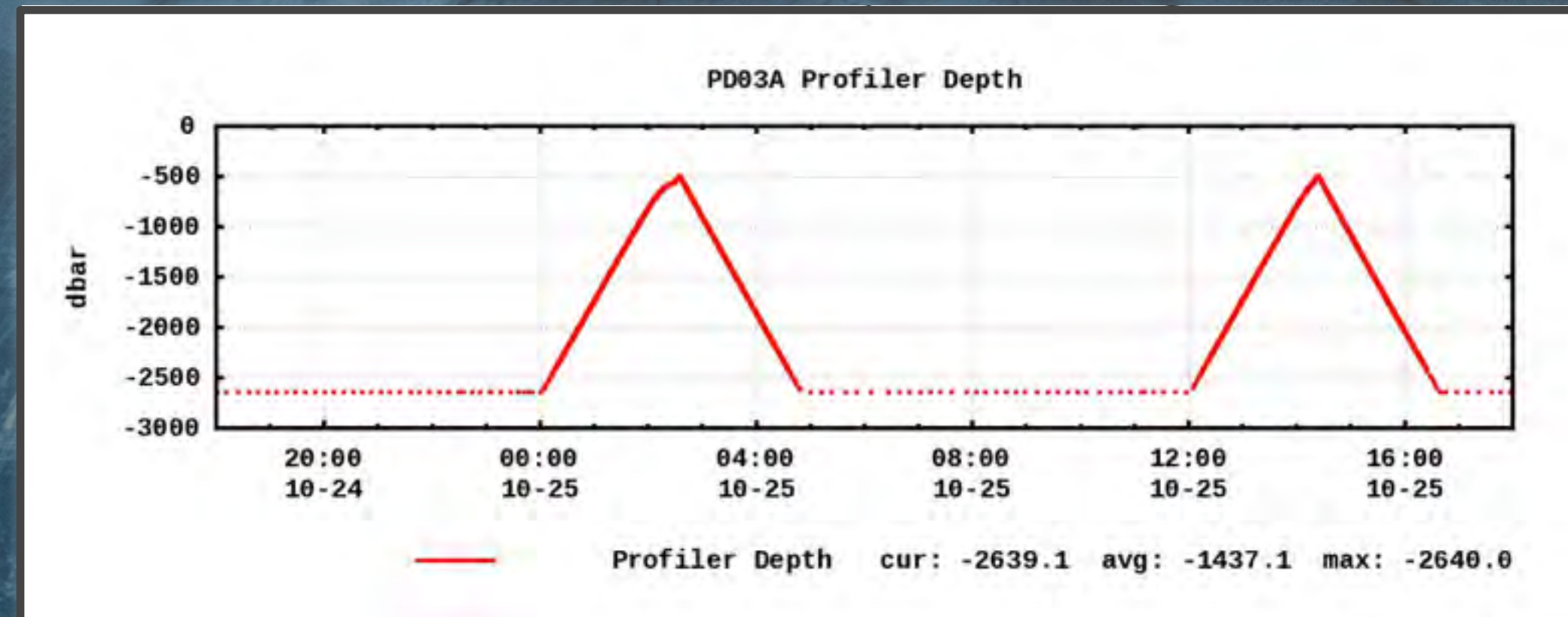


- ▶ Axial Base: Main wetmate connector providing power and bandwidth damaged during ROV connection either last or this year; both PIA and Winched Science Pod Removed
 - ▶ “Fix” options discussed later

Cabled Array Operational Status: October 25, 1131 Pacific

Deep Profilers

▶ Axial - 100% operational

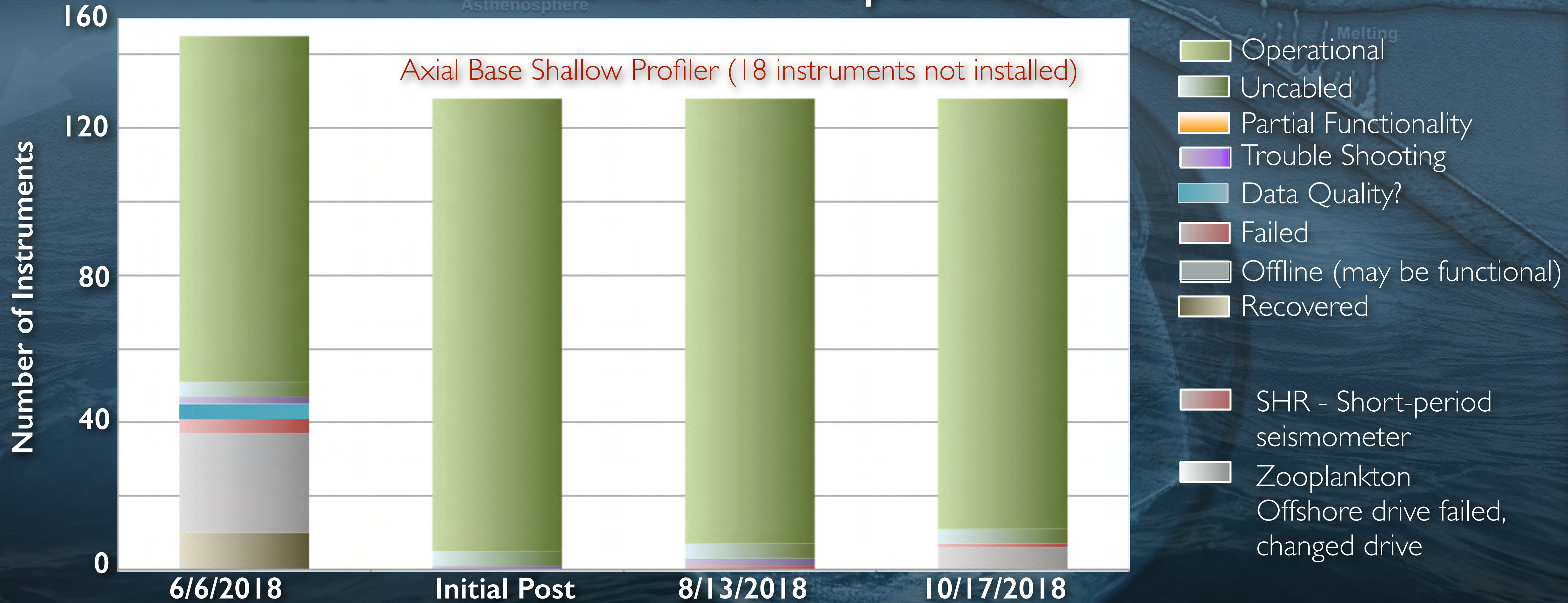


Niskin Verification Sample

- ▶ Offshore Deep Profiler - all instruments working, but vehicle is heavy currently travels 1 m out of dock
- ▶ Slope Base - Vehicle gets stuck in dock - high currents
- ▶ Investigating why data are not in CI

Cabled Array Operational Status

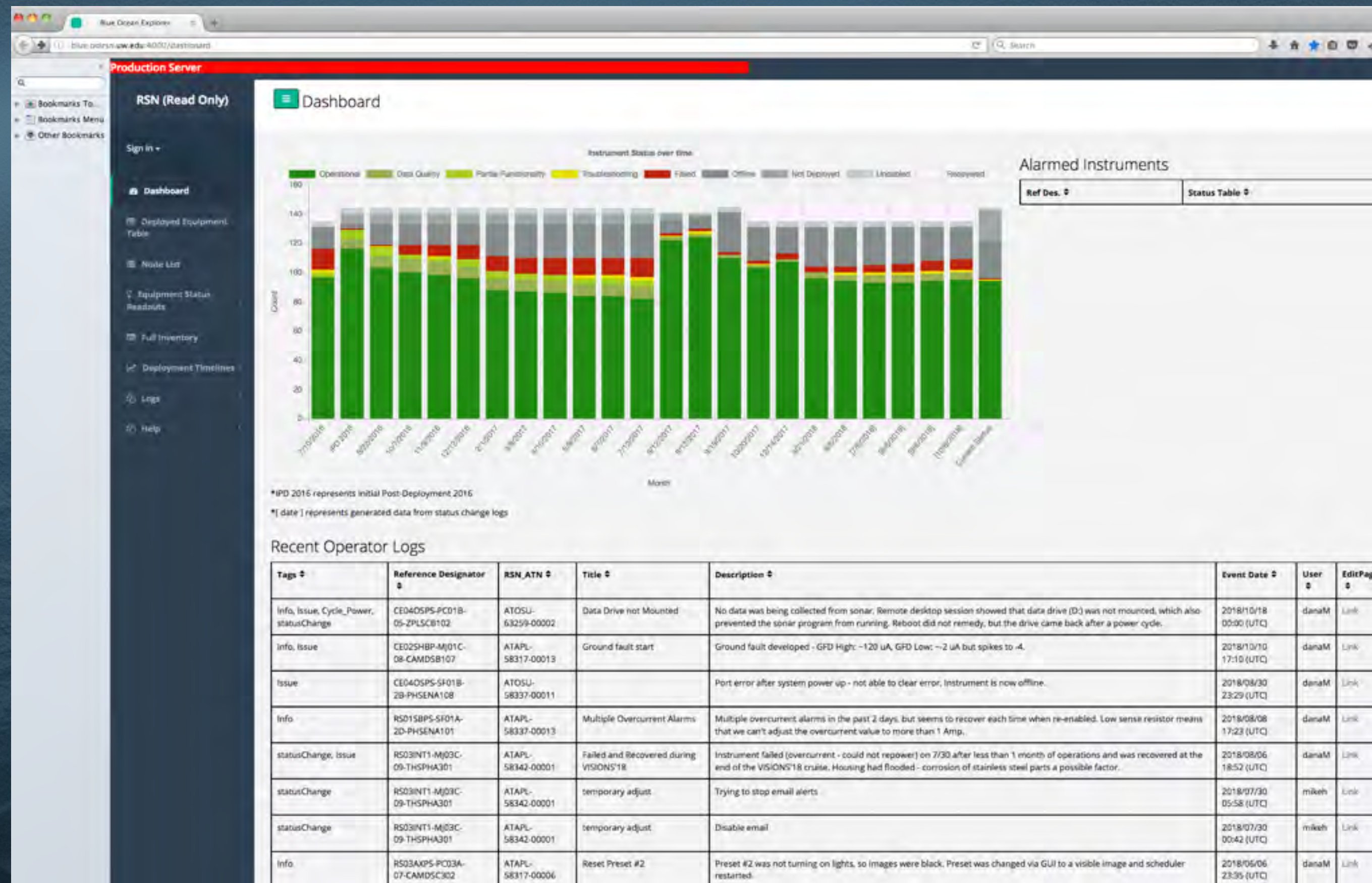
Cabled Instruments - 95% Operational



	6/6/2018	Initial Post Cruise	8/13/2018	10/17/2018
Operational	98	127	125	121
Failed	4	0	1	1
Offline	27	0	0	6

*Phasing Kongsberg cameras out to SubC- will replace on shallow profiler platforms 2019 cruise

Cabled Array Operational Status: Blue Ocean Explorer



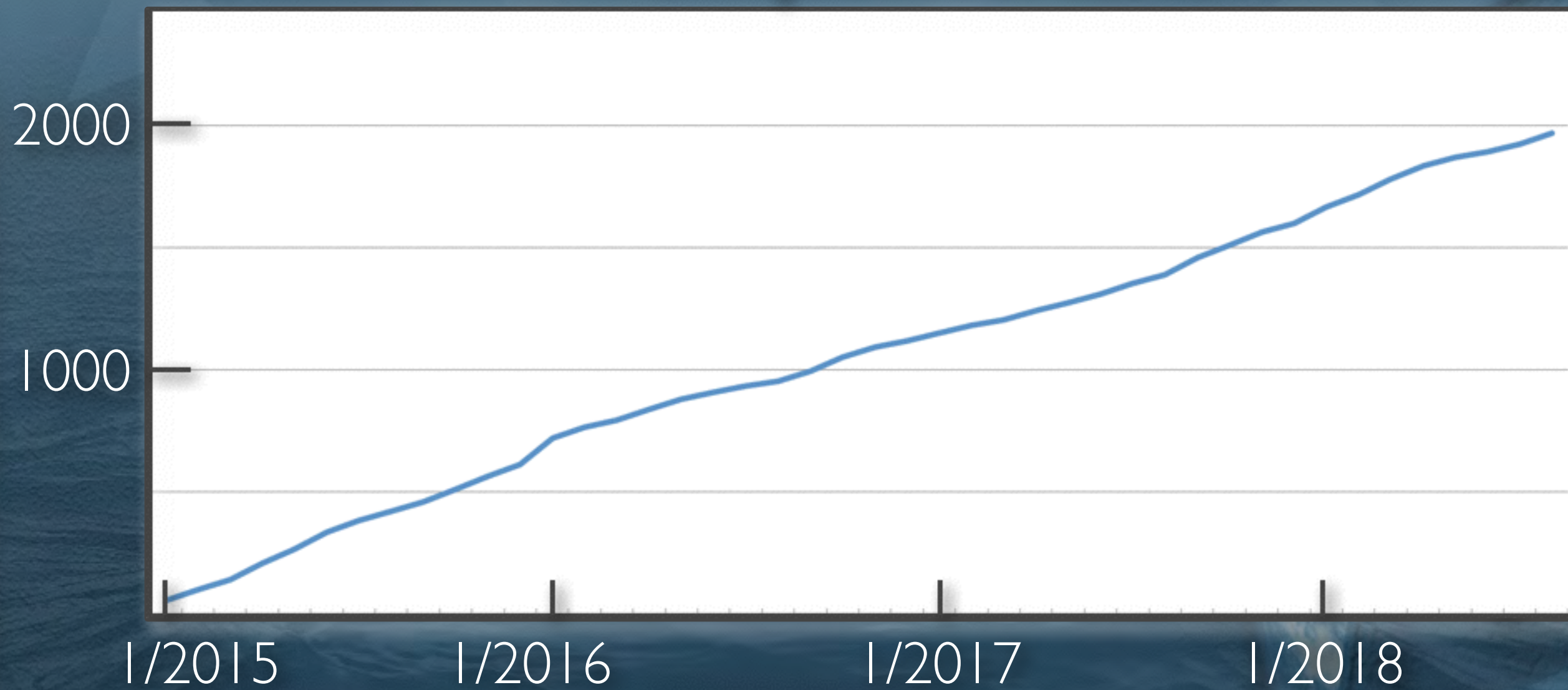
Very close to operational - integrated operational status, assets, issues etc

- ▶ Deployment Equipment Table
- ▶ 18 Junction Boxes - status, alarms
- ▶ Equipment Status Readouts
 - ▶ Weathermap
 - ▶ Status Plots
 - ▶ Blue Reports: Issue description & resolution
- ▶ Full Inventory
 - ▶ Equipment type (instrument, cable)
 - ▶ Description (ADCP-75 kHz)
 - ▶ Manufacturers Serial #
 - ▶ Cabled Array Serial #
 - ▶ Action
- ▶ Deployment Timelines
- ▶ Logs
 - ▶ Equipment Transfer logs (depot, seafloor)
 - ▶ Operator
 - ▶ User Action Log

IRIS USER INFORMATION: SEISMIC DATA

Users continue to increase

Unique Addresses

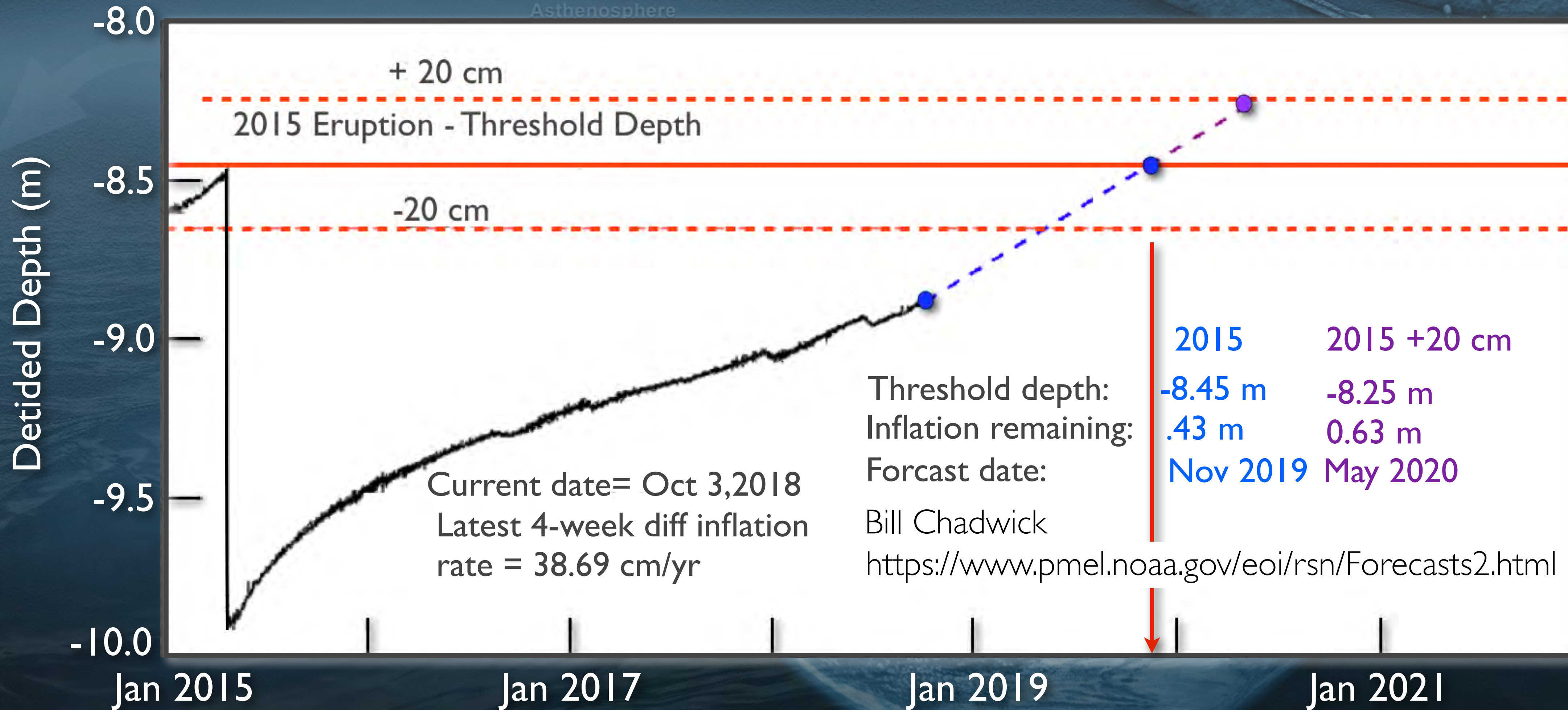


Repeat Customers



- ▶ Total Gigabytes Downloaded = 13,136.8
- ▶ User base continues to increase ~ 500 repeat customers
- ▶ Project Eddie Environmental Data-Driven Inquiry and Exploration
- ▶ Request to NSF to incorporate Cabled Array data into ShakeAlert
- Early Warning System for West Coast

When will Axial Seamount Erupt?



Only submarine volcano where eruptive predictions may be rigorously tested
70% of volcanism on Earth occurs along mid-ocean ridges - Axial is on one

Expansion of Cabled Array - PI Instruments

PI Instruments Now On Cabled Array

- ▶ 2017: Chadwick (OSU-NSF) Bottom Pressure Tilt and CTD - ASHES -2018-2019
- ▶ 2018: Bemis (Rutgers-NSF) COVIS Flow Imaging Sonar - ASHES
3 uncabled thermistor array 2018-2020
- ▶ 2018: Sasagawa and Zumberge (UCSD-NSF) Self Calibrating Pressure Instrument - Central Caldera 2018-2019?
- ▶ 2018: Wilcock (UW-NSF) Flipping Tilt Meter Central Caldera -2018-2020
- ▶ 2018: Breedlove (ONR) Vent Energy Harvester (platform) 2018-2020



BOTPT



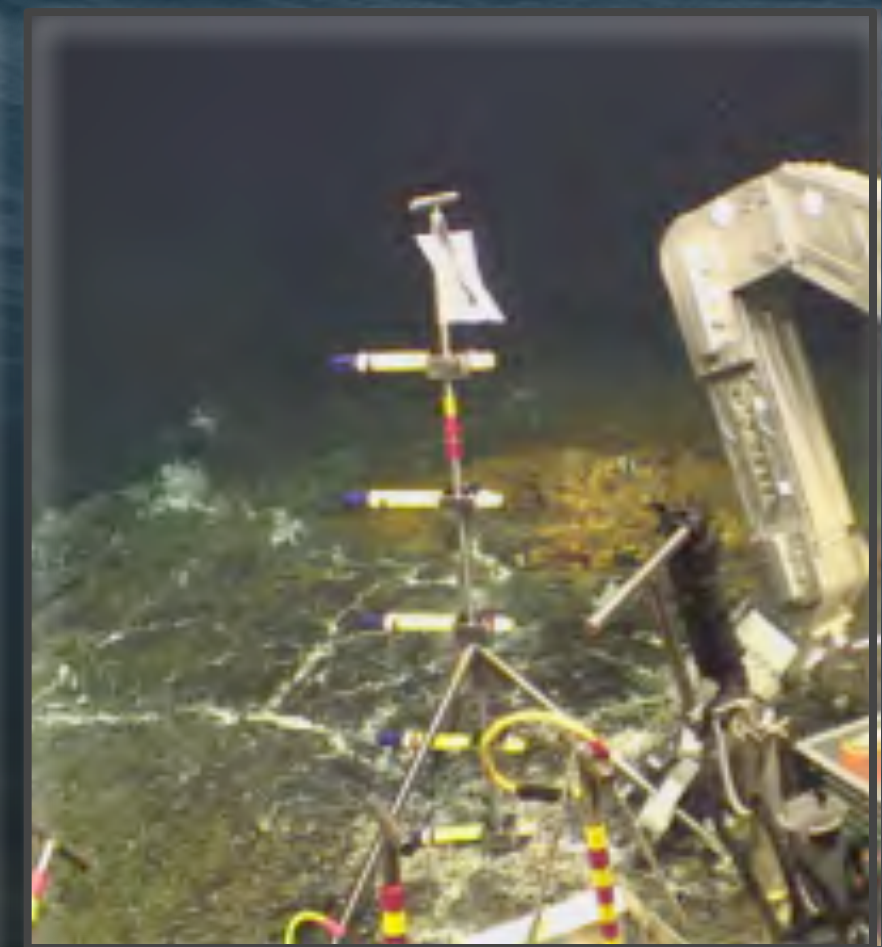
COVIS



Self Calibrating

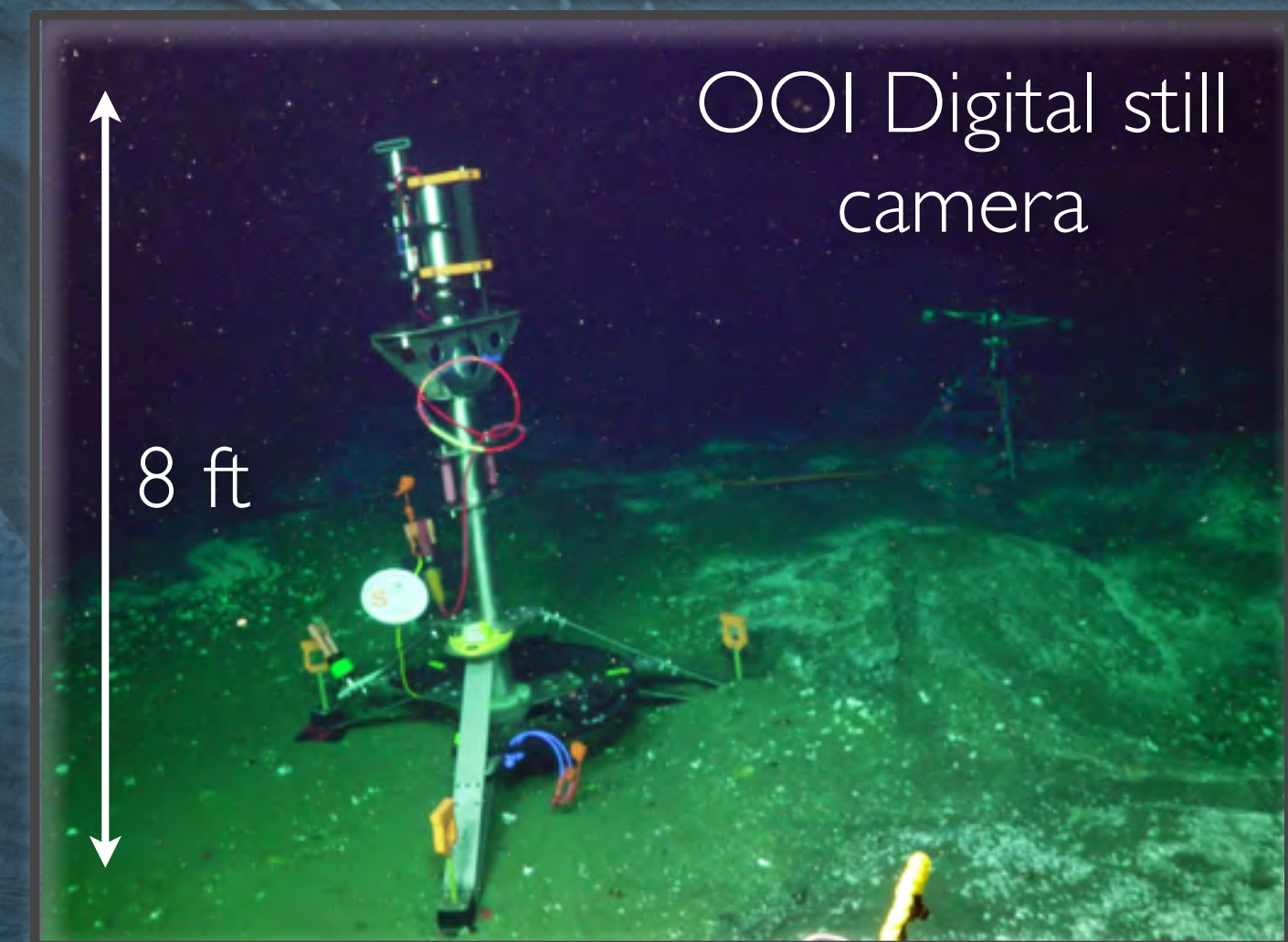
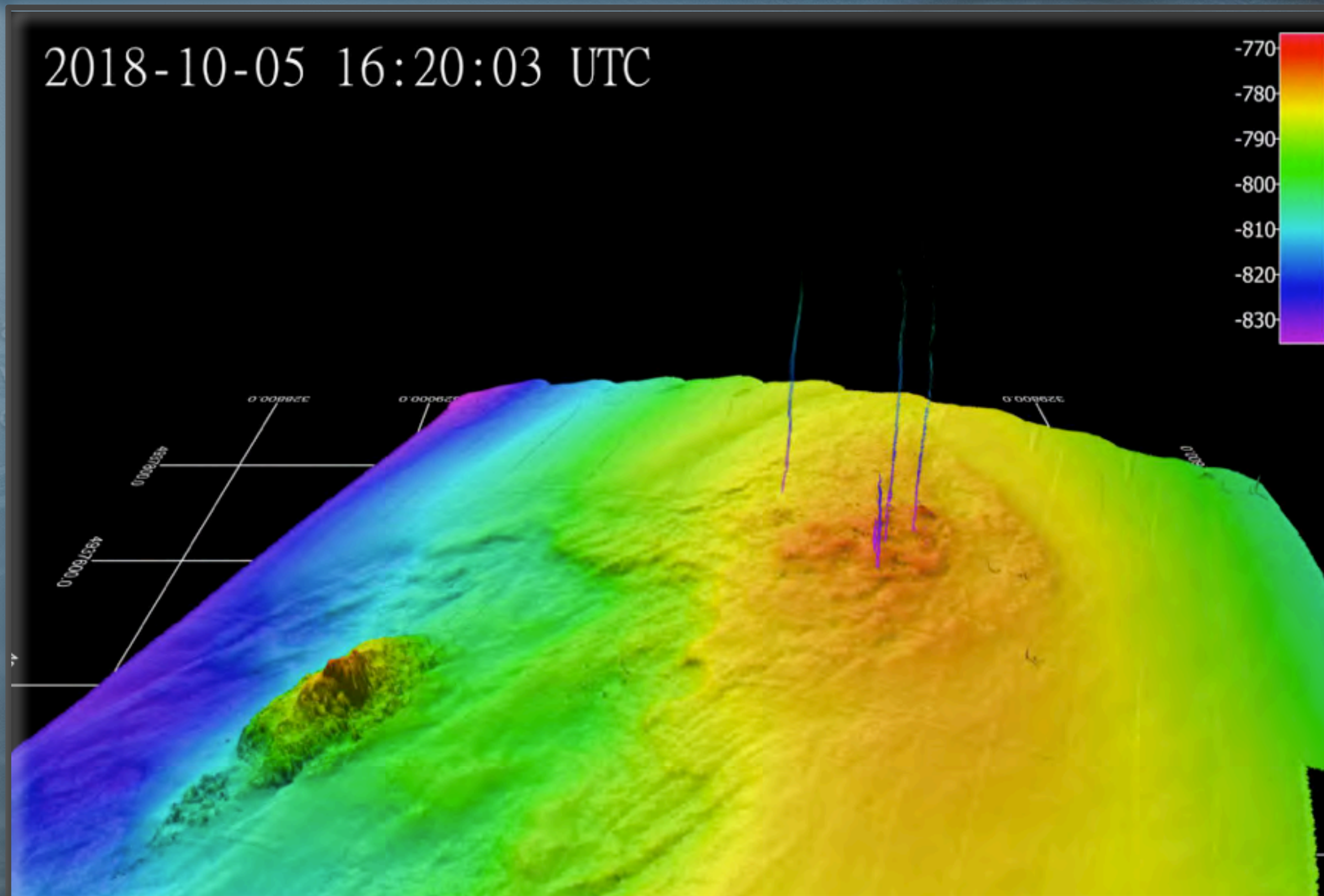


Flipper



Thermistor Arrays

Quantifying Gas Emissions at Southern Hydrate Ridge - 3 yrs⁺ (MARUM; Y. Marcon and G. Bohrmann)



Centimeter resolution



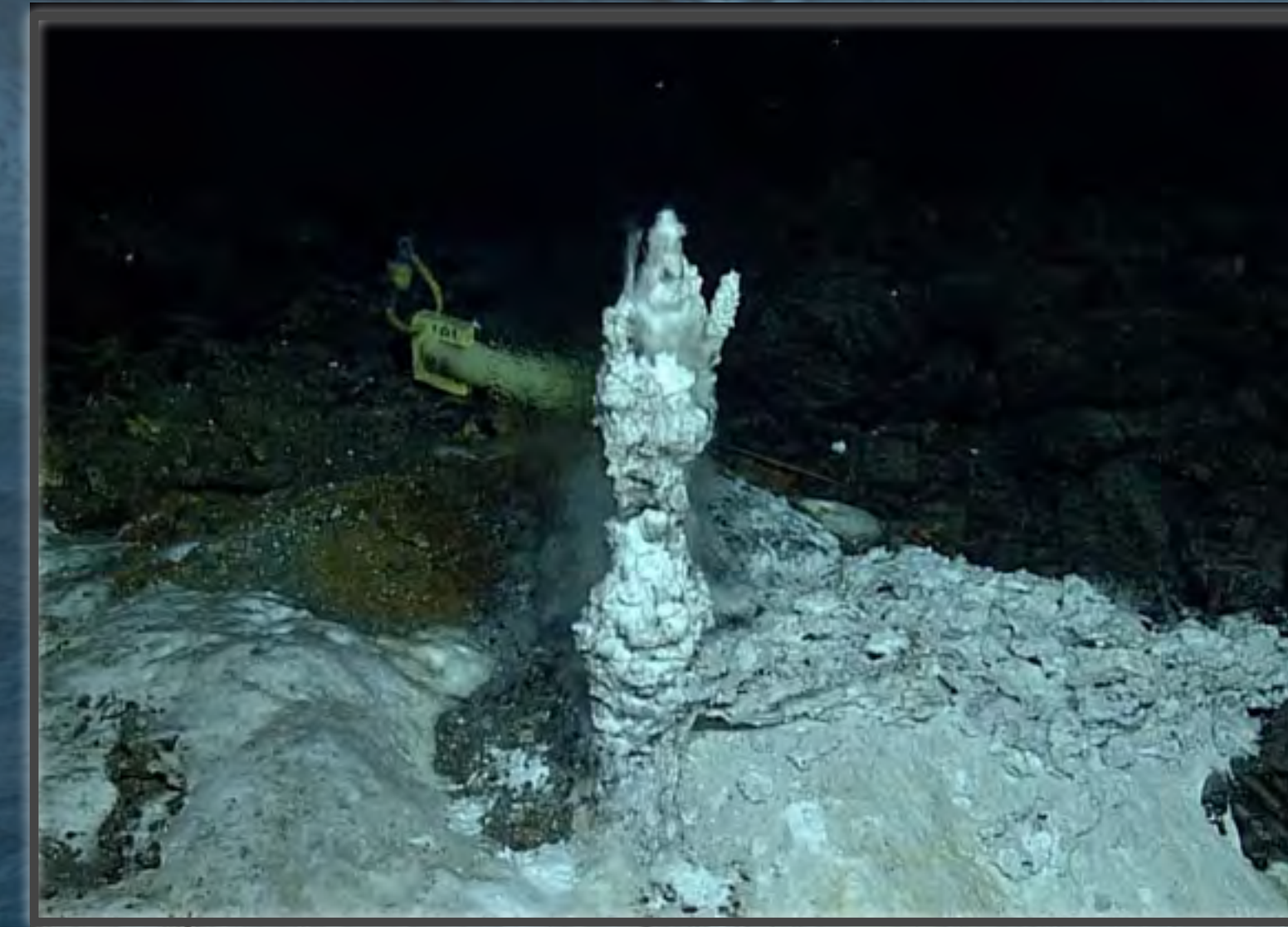
Sampling bubbles - hydrate

Multibeam sonar, ~ 250 m range, every 2 hrs for ~ 12 minutes. Buffered, large files.

- ▶ Unprecedented 360° imaging of all methane plumes issuing from SHR! Also installed CTD-O₂ instrument
- ▶ 2019 4K video camera & refresh 1 sonar
- ▶ 2020 possible recovery cruise - funding at MARUM
- ▶ May request an extension

Expansion of Cabled Array - PI Instruments

- ▶ **ONR:** Reimers (OSU) Recovery of microbial battery OR Offshore, may install new instrument at SHR with Girguis - 2019...
- ▶ **NASA Exobiology:** J. Sobron (SETI Institute) In situ Vent Analyses Divebot for Exobiology Research (INVADER) 2018-2022 Field programs 2020, 2021, 2022 (perhaps 2023)
 - ▶ Platform with laser spectroscopic and imaging instruments, real-time visualization, validate operational strategies and adaptive sampling, signatures for life in extreme environments. Large, multi-year award
- ▶ **NSF:** Wilcock (UW) AOA Instrument - geodetic Axial first but goal is for Cascade Margin re margin deformation 2018-2020
- ▶ **Pending IODP:** Two IODP Preproposals for drilling with cork installations along OR Cabled Array line - SHR corked observatory



Cabled Array Issues and Implications 2018-2019

2018

- ▶ Axial Base Shallow Profiler Mooring main communication - power cable could not be plugged in

- ▶ Wetmate connector was damaged either in 2017 or this year during connector mating with Jason
- ▶ Two instrumented platforms removed and brought back to shore

2019

- ▶ Slope Base Deep Profiler Charger Failed and Endurance Offshore Deep Profilers not Completing Full Mission

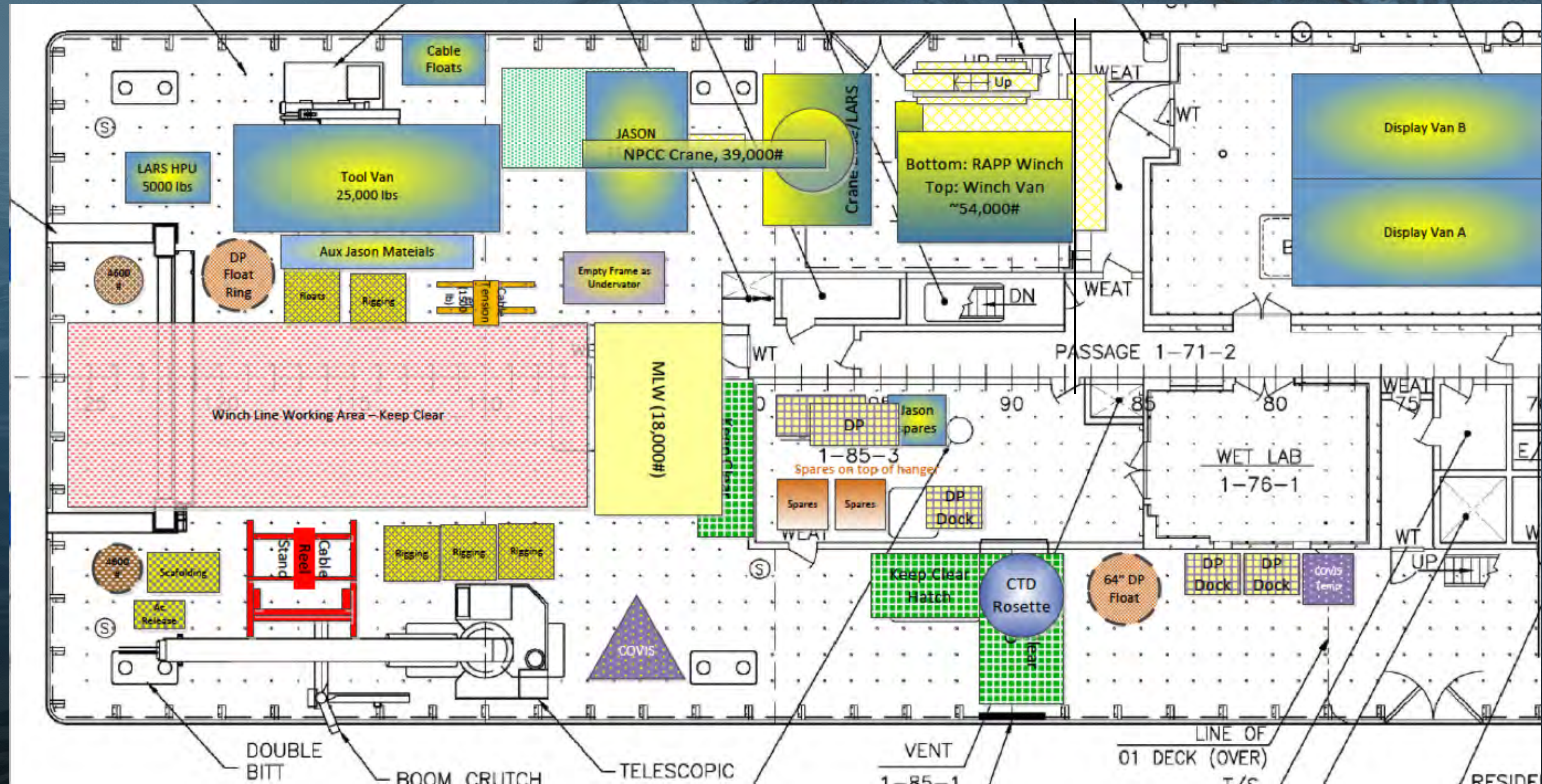
2019

- ▶ Maintenance Cruise onboard R/V *Atlantis* May 25-July 4 (one month earlier than normal), impact for Shallow and Deep Profiler moorings

- ▶ 2.5% PMO reduction request from each MIO to fund new CI hires
- ▶ To meet 2.5% cut (\$270K Cabled Array), proposed 3 days of *Atlantis* time will be removed from schedule if ECR approved
- ▶ Axial Shallow Profiler Mooring repair cannot be conducted on *Atlantis*:
 - Platform will not fit through A-frame and not enough deck space to accommodate winches
 - Therefore to complete in 2019, anticipated ~ \$600-700K needed to charter another ship/ROV; would require additional OOI program cuts; perhaps 1 leg raised onboard but high risk
- ▶ Unlikely Deep Profiler Moorings can be recovered/swapped on *Atlantis* - limited deck space requires medium lift winch placement at an angle to the A-frame, not clear wire angle will allow lift
- ▶ Due to limited deck space, likely will only have 1/2 control van - therefore no loggers in ROV control van, potential metadata impact

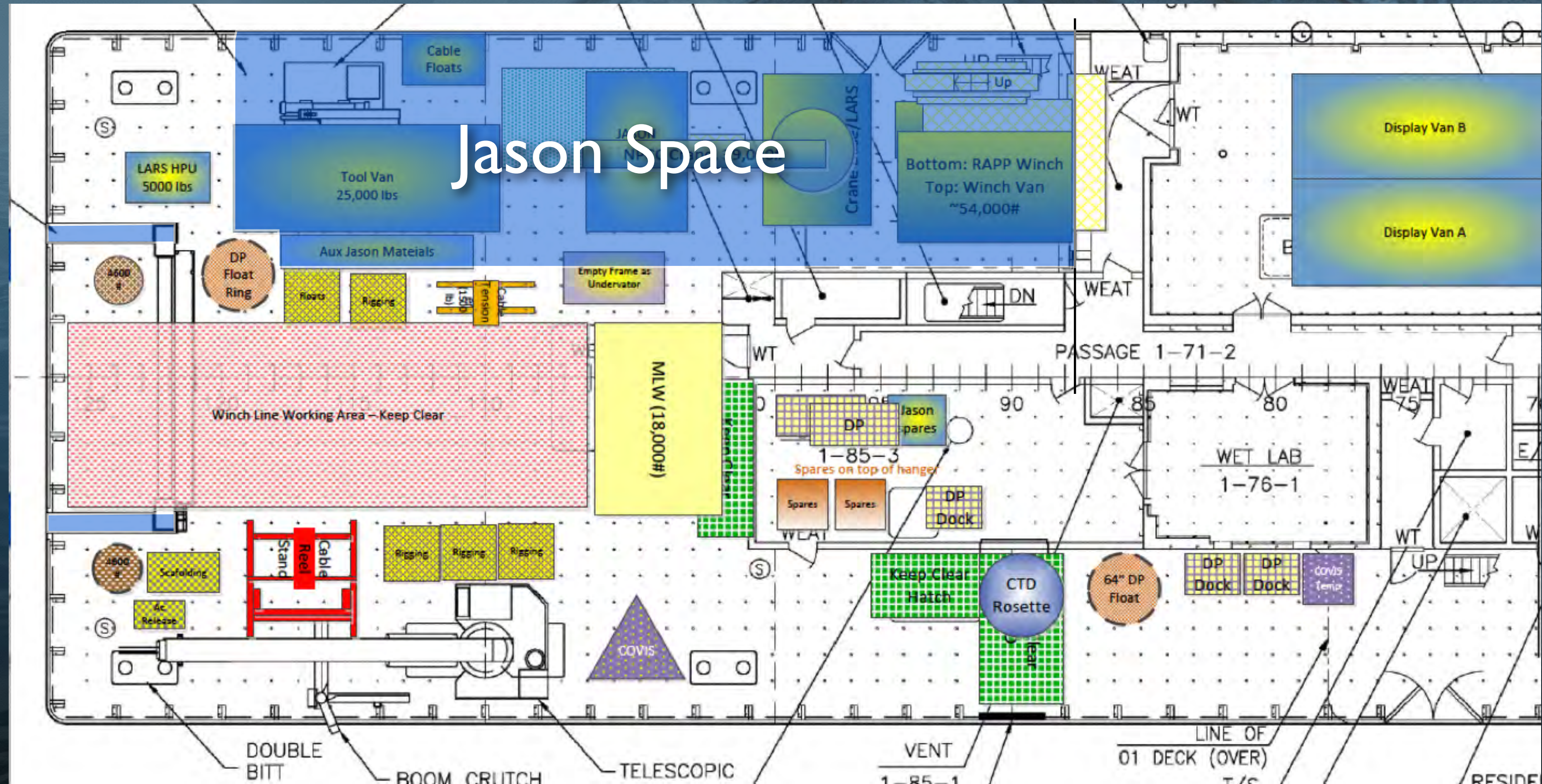
Cabled Array Deck Space Issues 2019

Revelle - Jason 2018 Deep Profiler Leg 4



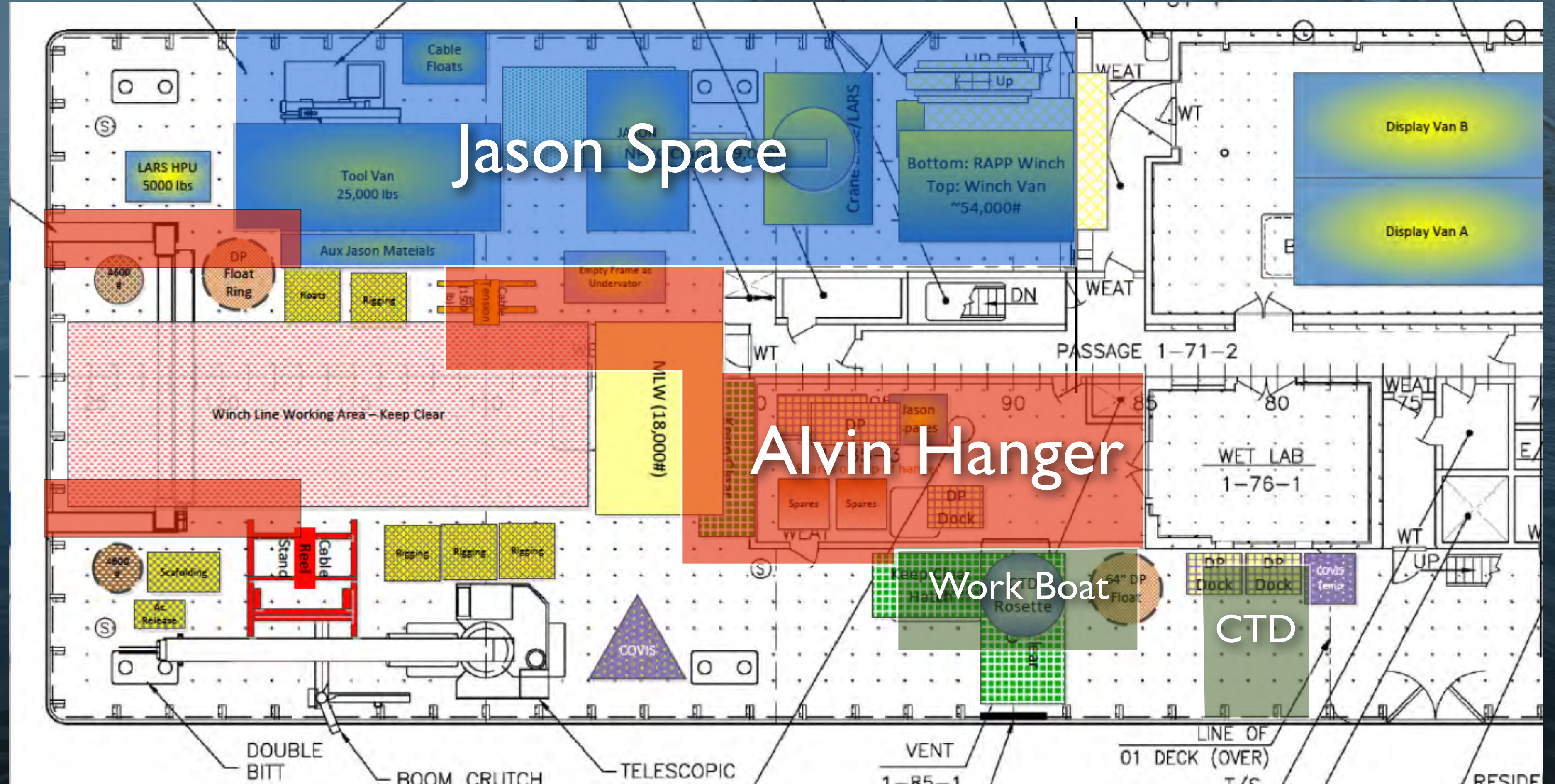
Cabled Array Operational Status: Blue Ocean Operational

Revelle - Jason 2018 Deep Profiler Leg 4



Cabled Array Operational Status: Blue Ocean Operational

Revelle



Cabled Array OUTREACH

- ▶ **CABLED ARRAY: UW VISIONS'18 PROGRAM** - 24 undergraduates from UW Seattle and Bothell, Grays Harbor College, Chico State - California, Queens College NY participated on 4 legs
- ▶ 5 senior thesis projects, 15 other projects:
 - ▶ Impact of seismic events on fluid flow at SHR (ADCP, seismometer data)
 - ▶ Temporal variation in nitrate across NE Pacific - Oregon Offshore to Axial
 - ▶ Impact of seismic events on fluid flow, hydrothermal venting and floc generation
 - ▶ Development on National Park-like map for Axial Seamount; video documentary on microbial blooms following the 2011 and 2015 eruption
 - ▶ 3D printed map of ASHES with printed instruments for classroom outreach, 3 D printed "working" Shallow Profiler Mooring
 - ▶ 30 minute and 4 minute engineering documentary- Shallow Profiler Mooring install