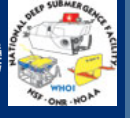




# NDSF 2016 Operator's Report Announcements



## People

- Kerry Strom
- Anthony Tarantino
- Danik Forsman & Drew Bewley
- Ian Vaughn

## NDSF Vehicle Highlights

- *Alvin*
- *Jason*
- *Sentry*

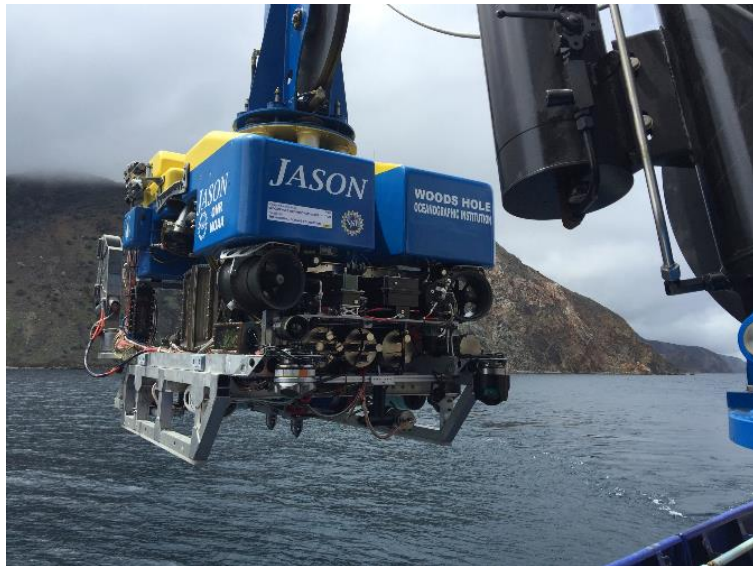
## Related Activities

- R/V *Neil Armstrong* SVCs
- NLF Projects





# Jason Upgrade



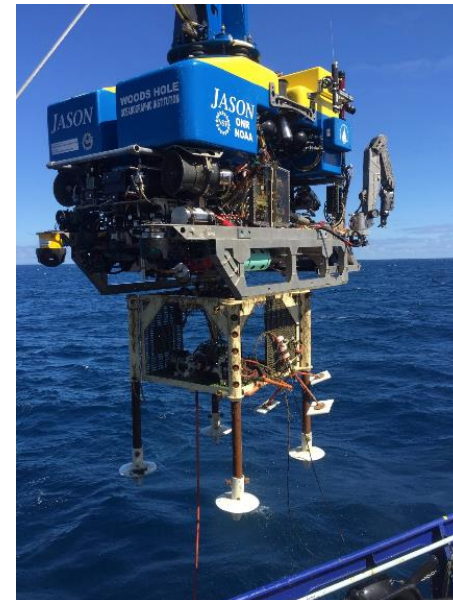
## OBJECTIVE:

Modifications to enable routine operation and maintenance of OOI/RSN components, including heavy lift and cable laying

INVESTMENT: \$2.4 million

## HIGHLIGHTS:

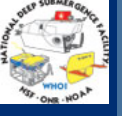
- Increased payload to 4,000 lb
- Hydraulic latch system
- New crane and docking head
- Increased science payload







# Early Career Scientist Cruise



## HIGHLIGHTS:

- 24 ECS participants
- 5 mentors
- 12 new *Alvin* divers
- Telepresence

## OBJECTIVE:

Provide opportunity for early career scientists to use *Alvin* and *Sentry*





# R/V Atlantis/NTSB – El Faro Flight Data Recorder Search



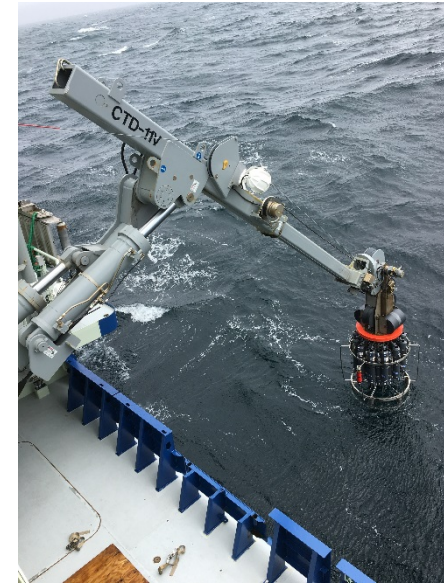




# R/V Neil Armstrong Science Year 1



- December – February – Detyens Shipyard, Charleston, SC
- Acoustic trials, AUTECH Range
- SVC 1 – Charleston - Charleston
- SVC 2 – Charleston - Norfolk
- SVC 3 – Norfolk – Woods Hole
- SVC 4/5/6 – Woods Hole – Woods Hole
- Acceptance into UNOLS May 4
- May-June – First science (OOI/Pioneer Array)
- July – OOI/CGSN Irminger Sea
- August – OSNAP, North Atlantic
- October – OOI/Pioneer Array
- Nov – February – Warranty Yard Period, Detyens





# Armstrong Science Verification Cruises



SVC	Scope	Participating Institutions	Port	Days
1	Moorings; ARGO floats	Duke; USC; WHOI	Charleston	7
2	Water sampling; SONAR	ECU; USGS	Charleston	11
3	OOI service; glider recovery	WHOI	Norfolk	8
4	ROV; AUV; OOI service; telepresence	WHOI; Michigan; URI; USGS	Woods Hole	8
5	Geophysics; geology	WHOI; Rice; USGS	Woods Hole	5
6	Biology; MOCNESS; trawls	WHOI; NOAA; UNH	Woods Hole	7
7	Coring		Woods Hole	TBD
8	<i>Jason</i> Training	WHOI	Woods Hole	TBD



# Armstrong Science Verification Cruises

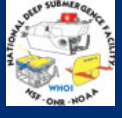


Good	Needs Improvement
Mooring recoveries Deck space and flexibility CTD overboarding system A-Frame Stationkeeping ROV and AUV ops Coring ops EK 80 USBL Interior space Auxiliary power Habitability	Crane sight lines Vehicle overboarding methodology Bulwarks Uncontaminated SW system Deck drainage Method for retrieving water samples “Wet” lab Network/email Telepresence ADCP interference Main lab “ergonomics”

*Key: Provide SSSG and crew training for the many complex systems*



# *NDSF 2016 Operator's Report* **Nereus Legacy Fund**

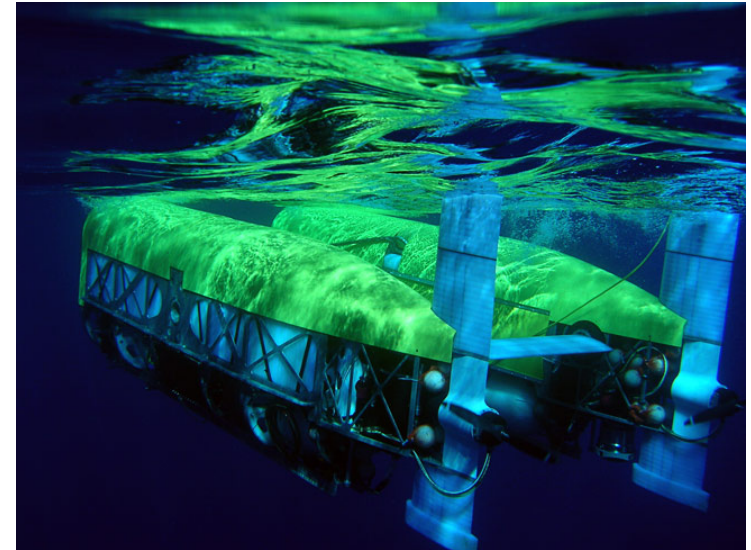


## **NLF Guiding Principles**

- Develop deep submergence technology with broad impact
- Enable new operational paradigms and open new realms to scientific enquiry
- Deliver deep submergence tools that enhance ocean science

## **NLF Project criteria**

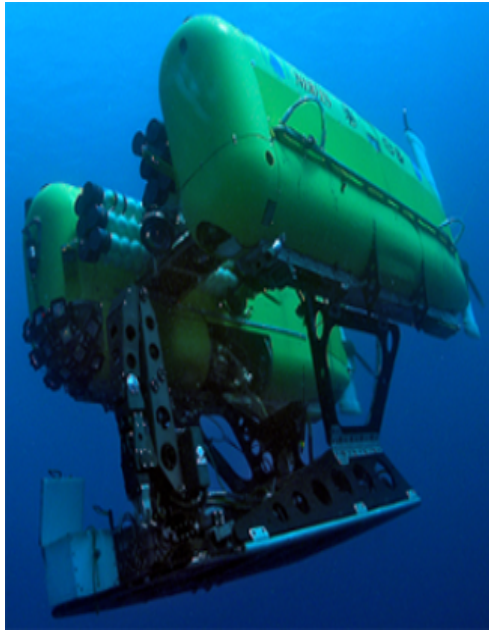
- Benefit a wide range of DSV users
- Provide synergistic opportunities (material or otherwise) between vehicles
- Provide leveraging opportunities for future growth
- Provide mechanism to continue development of forward-looking tools for deep submergence science





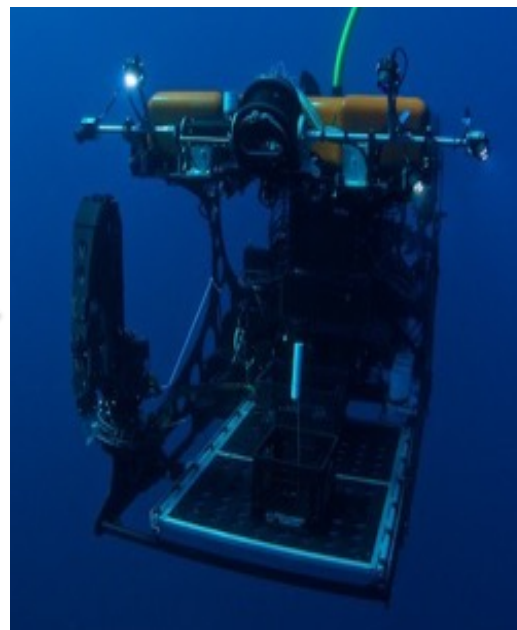


# Generations of the *Nereus* Family



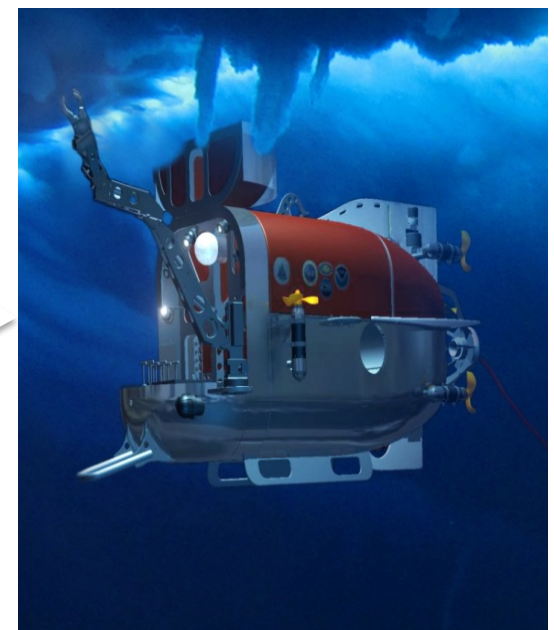
***Nereus*  
Hybrid ROV**

Pioneered novel solutions to challenges for exploring hadal depths with light fiber tether



***Nereid* Hybrid  
Tether ROV**

Pushing the limits of conventional cable/tether



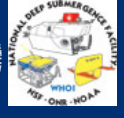
***Nereid* Under Ice  
Hybrid ROV**

Robust light fiber tether revisions and smart autonomous situational awareness



# NDSF 2016 Operator's Report

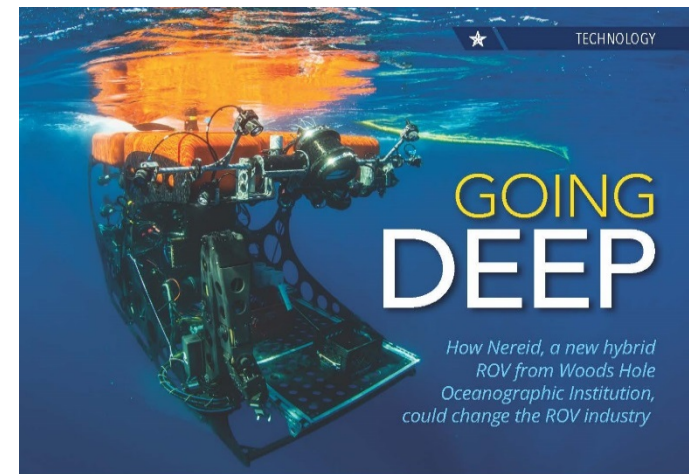
## Nereus Legacy Fund



Project	Investment	Investigator	Objective
Nereid Hybrid Tether	\$182,668	Bowen	Complete lift tether development; sea trial vehicle and ready for operations

## Status

- Destructive testing, dockside testing and sea trials completed in Q3 2016
- Concept of operations developed and being implemented
- Transitioning to operations
- Interest from industry



By Louise Murray

A new class of 2,500-meter capable hybrid ROV/AUV from Woods Hole Oceanographic Institution (WHOI) paves the way for a sea of change in ROV shipping requirements, lowering costs and extending mission capability. *Nereid HTT* was developed for deep-sea scientific and filming missions and WHOI is actively seeking partners who can apply these new technologies to a range of emerging applications. Operating a conventional light work class Remotely Operated Vehicle (ROV) commercially in the Oil and Gas sector currently costs around \$65,000 per day in the North Sea, and \$35,000 per day in the Gulf of Mexico, including the dynamic positioning (DP) support vessel, crew and a redundant second ROV. The latest technologies developed for cutting-edge submersibles developed at WHOI may one day radically change those economics. The hybrid vehicle, *Nereid*, is both an ROV and an Autonomous Underwater Vehicle (AUV) and is best thought of as capable of operating on a spectrum anywhere between these two traditional classifications. Its inventor, Andy Bowen, principal developer and engineer on the project, has a 30-year history at WHOI working with ground-breaking robotic submersibles—he developed the *Nereus*, an 11-kilometer-capable hybrid ROV.

"We had to solve a lot of difficult problems to operate the *Nereus* at 11 kilometers," says Bowen. For example a lightweight tether cable was an operational necessity since traditional ROV solutions would have resulted in a massive and very costly system. "Other technologies that we have implemented on *Nereid* include the large amounts of rechargeable energy that can be stored aboard the vehicle, a refined manipulator design coupled with a power-efficient hydraulic power unit, and highly efficient and effective electric propulsion, lighting and control systems," he explains. Taken separately, these are all incremental advances in design, but when combined with the powerful software embedded in the *Nereid HTT*, are transformational. One of the most advanced, versatile and cost-effective unmanned submersibles in the world, *Nereid HTT* was on an engineering cruise for the first time to 2,500 meters off the coast of Panama in August 2016. During these trials, the *Nereid* vehicle was operated with a lightweight reusable tether and via a WHOI optical modem as a tetherless ROV. Many of the innovative technologies seen in *Nereid* impact on the shipping end of ROV support and have the capacity to completely change the economics of deep-sea ROV operations. The acoustic, optical and expendable tethering system is unique, and the innovative reusable tether cable is in the final stages of a U.S. Patent office application. The tether diminishes the need for a DP capability in the support ship, opening up deep-sea ROV operations to a more diverse set of vessels. When operating with the lightweight reusable tether, the vehicle is deployed from a small electric winch, rather than a much larger winch and associated tether management system. Bowen estimates that the size and weight of the winch and cable are reduced by as much as 40% when compared to other deep-sea light work class ROVs. A large contribution to that reduction is the fact that the vehicle is battery-powered so the tether need not carry power to the vehicle, reducing its diameter. Battery power also does away with the requirement

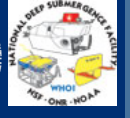
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# NDSF 2016 Operator's Report

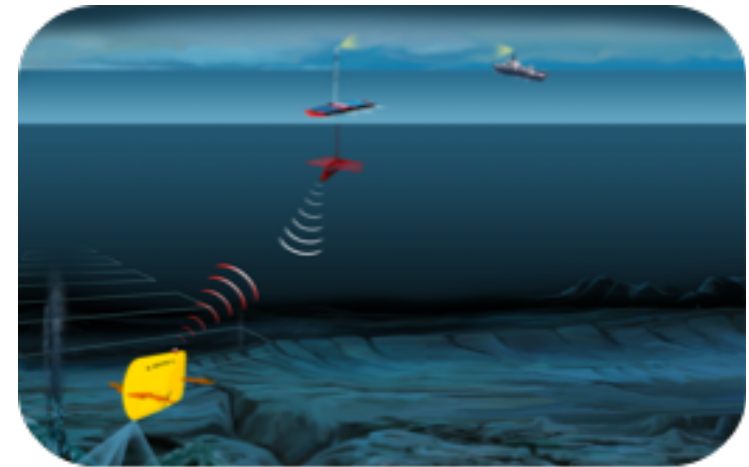
## Nereus Legacy Fund



Project	Investment	Investigator	Objective
<i>Sentry</i> ASV Tender	\$177,024	Kaiser	Develop capability to autonomously monitor and control <i>Sentry</i> using an ASV

### Status

- Wave glider acquired
- Acoustic and iridium communications on-board systems nearly complete
- Software development to integrate navigation systems with *Sentry* to begin in Q1 2017
- Developing operational procedures
- Identifying cruise of opportunity in early 2018







# NDSF 2016 Operator's Report

## Nereus Legacy Fund



Project	Investment	Investigator	Objective
Engineering 6,500 m <i>Alvin</i>	\$405,606	Peters	Conduct engineering analyses necessary to develop a roadmap to 6,500 m

### Status

- Systems impacted by 6,500 m requirement identified
- Focus on power, variable ballast, life support, frame and hydraulics
- Begin work with NAVSEA in Q1 2017; their support is key
- Target design review in June 2017





# NDSF 2016 Operator's Report

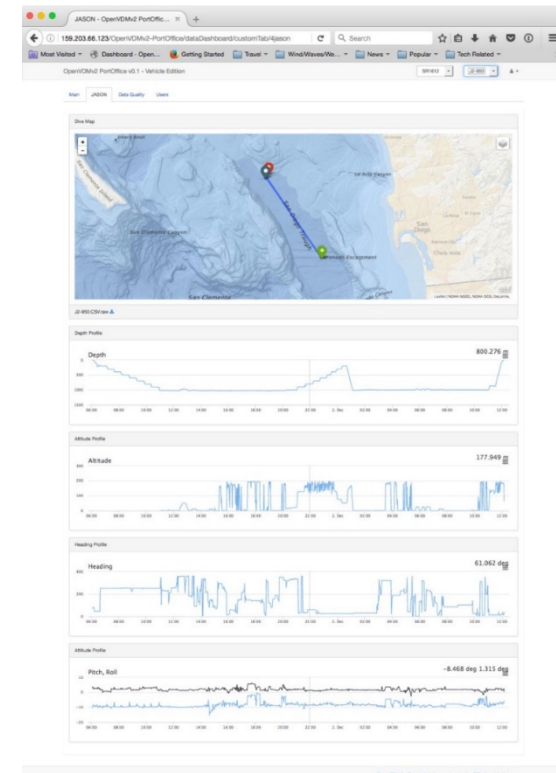
## Nereus Legacy Fund



Project	Investment	Investigator	Objective
Data Convergence & Telepresence	\$300,000	Howland	Develop a common automated data processing pipeline, data tracking and delivery system, determine benefits of telepresence-enabled on-shore data processing.

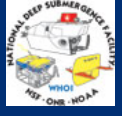
## Status

- Developing prototype NDSF data management tool using existing open source code
- Telepresence white paper in preparation; to be delivered in January
- Participated in *Sally Ride* SVC





# NDSF 2016 Operator's Report *Nereus* Legacy Fund



Project	Investment	Investigator	Objective
NUI Transition	\$823,923 + \$120,000	Jakuba	Transition NUI into a science-ready vehicle for routine high-latitude operations.

## Status

- Two 2016 field experiences (*Armstrong* SVC 4 and 87°N on *Polarstern*)
- Redesigned depressor
- Improved software and upgraded acommms
- Enhanced capabilities (manipulator, imaging, multibeam)
- Created O&M documentation







# NDSF 2016 Operator's Report

## Nereus Legacy Fund



Project	Investment	Investigator	Objective
Hadal Technology	Ph 1: \$100,000 Ph 2; \$800,000	Shank	Science driven vehicle technology development program to operate at full ocean depth

### Status

- Surveyed hadal science community; >75% of respondents want ROV capability
- Key desired capabilities include sampling, imaging and good navigation
- Plan for Phase II developed, with the goal to leverage existing resources and the Nereid family design
- Phase II funding pending

