Remotely Operated Vehicles
Deep Discoverer and *Seirios*

Remotely operated vehicles (ROV) *Deep Discoverer* and *Seirios* operate as a two-body system off NOAA Ship *Okeanos Explorer*. The system is owned by NOAA Ocean Exploration and developed, maintained, and operated by a team of engineers at the Global Foundation for Ocean Exploration. It's capable of exploring to depths as great as 6,000 meters, offering a wide range of surveying and sampling capabilities for exploring the deep ocean. The pair has completed over 400 dives together in the Pacific and Atlantic basins.

Scientific Instrument Support

- Flexible telemetry and power system with spare gigabit Ethernet, high-speed serial, and fiber-optic connections available for equipment
- Switched power at various typical subsea voltages

Configuration

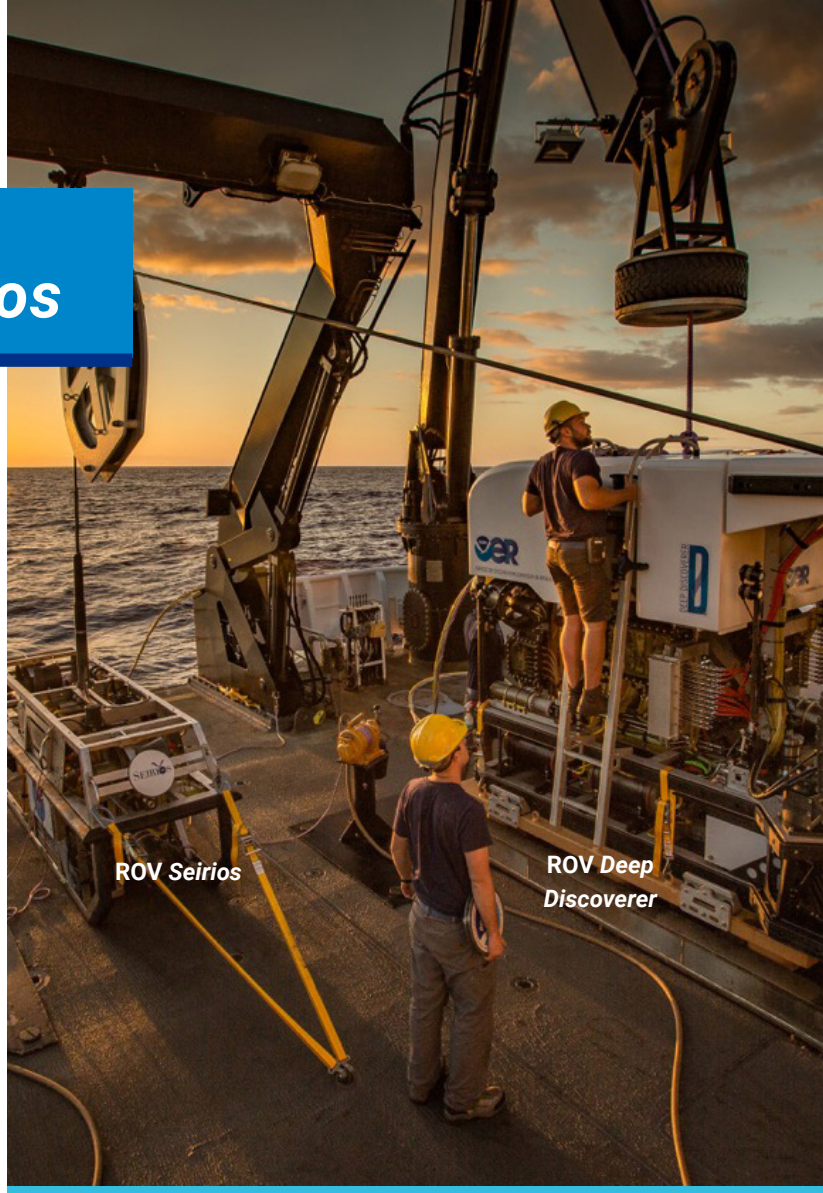
A 9,000-meter-long, 1.7-centimeter-wide electro-optical cable connects the system to the ship, providing power to the ROVs as well as a pathway for data transfer between the vehicles and the ship. The camera sled *Seirios* is directly tethered to the ship via this cable and is attached to *Deep Discoverer* via a 33-meter-long electro-optical neutral buoyancy cable.

This configuration allows *Seirios* to absorb the heave from the ship while keeping *Deep Discoverer* stable as it explores the ocean floor. The lights and cameras on *Seirios* give the ROV pilots a bird's eye view of *Deep Discoverer* and surrounding areas, literally shedding light on a dive site's features and inhabitants.

Imaging Capabilities

Imaging is the main capability of the ROV system. There are 15 total video cameras between the two ROVs, including 10 high-definition cameras. *Deep Discoverer*'s primary camera can fully zoom in on a 7.6-centimeter-long organism from 3 meters away. Two lasers, located 10 centimeters apart, are used to determine the scale of objects in *Deep Discoverer*'s view.

46 LED lamps deliver more than 355,400 lumens of light, illuminating the otherwise dark ocean. *Deep Discoverer* has four specially fitted swing arms that allow pilots to maneuver light angles to hard-to-reach areas and to optimize camera views. Three LED light banks mounted on the back of *Seirios* are aimed forward and down to illuminate *Deep Discoverer* and the surrounding area from above.



Specification	*Deep Discoverer*	*Seirios*
Size (length, width, height)	3.2 meters, 2.0 meters, 2.6 meters	3.3 meters, 1.1 meters, 1.2 meters
Weight (in air)	4,400 kilograms	1,830 kilograms
Ascent/Descent Rate	30 meters/ minute	30 meters/ minute
Maximum Operating Depth	6,000 meters	6,000 meters
Propulsion	6 thrusters, 7.5 HP electric	2 thrusters, 7.5 HP electric

Lighting and Imaging

Deep Discoverer

- 28 Deep Sea Power and Light LED lamps (8 on swing arms)
- 3 high-definition Insite Pacific video cameras: Zeus Plus (tilt/18x optical zoom), its primary ROV camera, labeled ROVHD; Mini Zeus (pan/tilt); and Titan Plus (pan/tilt/zoom)
- 8 high-definition DeepSea Flexlink Multi SeaCams
- 1 custom packaged Canon R3 still camera with an RF24mm macro lens and high-definition video capability

Seirios

- 18 LED lamps
- 1 high-definition Insite Pacific Zeus Plus video camera with tilt capability, its primary camera, labeled CPHD
- 4 high-definition DeepSea Flexlink Multi SeaCams

Navigation

Deep Discoverer

- iXSea Phins fiber optical/inertial navigation system (0.05° heading accuracy)
- Nortek DVL 500 Doppler velocity log (DVL), 500 kilohertz, 6,000-meter operational depth
- Control software supports high-resolution navigation using DVL bottom lock and Phins heading reference with an accuracy of 0.1% of distance traveled
- TrackLink 10000HA ultra-short baseline (USBL) acoustic tracking system with positioning accuracy of 0.25° (26 meters at 6,000 meters depth)
- Tritech PA500 altimeter, 0.3-50-meter range
- Paroscientific 8B7000-I depth sensor
- Lord MicroStrain 3DM inertial motion unit (IMU)

Seirios

- TrackLink 10000HA USBL acoustic tracking system with positioning accuracy of 0.25° (26 meters at 6,000 meters depth)
- Tritech PA200 altimeter, 1-100-meter range
- Paroscientific 8B7000-I depth sensor
- Lord MicroStrain 3DM inertial motion unit (IMU)

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Sampling and Sensing Capabilities

Deep Discoverer is capable of collecting up to 11 biological and geological samples and 5 water samples for eDNA analysis during each dive. Both vehicles are outfitted with scientific sensors to collect additional information about the ocean and to help characterize the areas explored.

Sampling

Deep Discoverer

- 1 hydraulic force feedback seven-function Kraft Predator manipulator arm
- 1 hydraulic seven-function Schilling Orion manipulator arm
- 4 bio boxes
- 2 rock boxes, 1 with a lid
- 1 rotary suction sampler with 5 2.7-liter sample jars
- 5 1.7-liter individually triggered Niskin bottles
- ~10 kilograms of payload available for samples

Standard Sensors

- SeaBird SBE-911 Plus CTD (conductivity, temperature, and depth system) with dissolved oxygen, turbidity, and oxidation reduction potential sensors
- Tritech SeaKing DFS Dual frequency sector scan sonar, 200-meter range, 325 and 725 kilohertz
- Woods Hole Oceanographic Institution high-temperature probes, up to 400°C (*Deep Discoverer*)
- BlueView M900/2250 dual frequency multibeam sonar, 100-meter range, 15 hertz update rate, 130° field of view (*Deep Discoverer*)

Data Availability

Video, imagery, environmental data, and samples collected are available through the NOAA and partner archives. To access these data and products, visit: https://oceanexplorer.noaa.gov/data/access/access.html.