Project Title: Eye-In-The-Sea

Sanctuary: Monterey Bay National Marine Sanctuary

Project Coordinator:
Edith Widder, MBARI Adjunct
Erica Raymond
Ocean Research and Conservation Association
Duerr Laboratory for Marine Conservation
1420 Seaway Drive, 2nd Floor
Fort Pierce, FL 34949

Project Abstract/Objectives: Eye-in-the-Sea (EITS) is a relatively unobtrusive deep-sea camera system designed for either autonomous or cabled use. Autonomous versions of EITS have been deployed routinely in the Sanctuary for the past several years (see MBARI project #900432 in previously submitted reports). The latest version of the EITS is being designed for use on MBARI's cabled observatory, MARS, to provide real-time, continuous *in-situ* measurements of marine activity, record spontaneous bioluminescence activity, carryout photobehavior experiments, document the pattern of succession at food drops and monitor sediment accumulation and scouring at the node. EITS uses far-red illumination in combination with a low-light video camera to unobtrusively record the activity of deep-sea organisms.

Intended Use of Results: Results are intended to further the understanding of deep-sea organisms and their behavior. These results will be published in appropriate scientific journals and presented at conferences, as appropriate.

Methods:

MBARI's R/V *Point Lobos* and ROV *Ventana* will be used to deploy the instrument as well as connect it to the MARS cable system. The MARS node will be located in the trawl resistant frame at 36.712333, -122.186833 (see map included in this packet). The instrumentation for this project will be deployed at a location within the 4-kilometer radius around the node, although the exact deployment site has not yet been determined.

Two far-red and two white illuminators are mounted on the top of EITS's square flame (see Figure 1 below and the attached illustration from the New York Times). Far-red light is dimly visible to the human eye, but nearly invisible to deep-sea dwellers that are adapted to see primarily blue light. Having two separate illuminators on EITS allows us to test animals' behavior in response to different wavelengths of light.

To attract animals to the EITS, we will use both bait and an electronic jellyfish (e-jelly). The e-jelly was designed to imitate the bioluminescent burglar alarm display of the common deep-sea jellyfish Atolla, and consists of a ring of blue LEDs. Additionally, a mechanical form of bait intended to mimic a struggling fish is under development for use

on EITS. Bioluminescent activity will be recorded using a very sensitive light detector called a photomultiplier tube (PMT). PMT signals above a user-defined ambient threshold will flag the corresponding video segment. Bioluminescent sources will later be characterized from these video clips. A hydrophone mounted to the frame will allow us to record noise emitted by periodic visits from research vehicles, changes in ambient noise, and sounds from animal activity. In addition to recording biological data and acoustics, we will also be able to consistently collect physical data from EITS's CTD and current meter. EITS will be equipped with an anti-biofouling system designed to pump jets of seawater onto the camera housing's viewport, which will greatly decrease visual impairment due to sedimentation. The EITS can be programmed to turn on its camera and peripherals (illuminators, PMT, hydrophone, e-jelly, CTD, current meter, and anti-biofouling system) and record video at regular intervals. The system's control and data storage will be housed on shore at MBARI.

Moored EITS will be deployed near the MARS observatory during February 2008. The base, weighing approximately 155 lbs, is deployed first, and functions as a separated anchor, such that the instrument can be removed for servicing without the need for anchor removal. There is a parking position located on the base to hold the ODI Nautilus connector harness, which is connected to the MARS node while the EITS is topside. Once deployed, the EITS frame is locked onto its base and its three leaves are opened. These leaves are used for bait deployments and ancillary instrument mounting (see attached drawings for dimensions). A single bait drop of locally occurring fish carcasses is planned for March 2008. Total length of deployment will be up to 6 months.

Collections: No specimens will be collected for this project.

Schedule: As stated above, the EITS will be deployed during February 2008. The system will be deployed for up to 6 months.

Publications and Reports: Results from the EITS deployment will be published in relevant peer-reviewed journals, such as *Deep-Sea Research,* and presented at national and international conferences. Reports for NSF and MBARI will also be generated as part of this study.

Data and Other Materials: Collections of EITS footage will be packaged onto DVDs and sent on a requested basis to schools. In addition to EITS video, each DVD will contain a look-up key of common deep-sea species of Monterey Bay, three teaching modules on the deep sea (including known video footage) and a formatted Excel spreadsheet for data entry, all of which will also be available through MBARI's *Education and Research: Testing Hypotheses* (EARTH) website link. Students will be expected to observe the footage, noting presence and absence of species, number of animals present and specific behavioral traits, including any exceptional sounds. Information about the e-jelly mode, number and color of the illuminators, and bait type will be provided in the Excel spreadsheet. The program will also maintain its own interactive website through Ocean Research & Conservation Assoc. (ORCA) and

MBARI. The interactive website will allow teachers to post student collected data and observations, and this will encourage communication among participating schools and scientists.

Qualifications: Edith Widder is a biologist and deep-sea explorer who combines expertise in oceanographic research and technological innovation with commitment to reversing the worldwide trend of marine ecosystem degradation. A specialist in bioluminescence (the light chemically produced by many ocean organisms), she has been a leader in helping to design and invent new submersible instrumentation, and equipment to enable unobtrusive deep-sea observation of environments. Working with engineers, she has built a number of unique devices that enable scientists to see the ocean in new ways, including **HIDEX**, a bathyphotometer that measures how much bioluminescence there is in the ocean, and **LoLAR**, the most sensitive deep-sea light meter. Most recently, Widder helped to design a remotely operated camera system, known as **Eye in the Sea (EITS)**, which, when deployed on the sea floor, automatically detects and measures the bioluminescence given off by nearby organisms. EITS has produced footage of rare sharks, jellyfish, and squid in their natural habitats. In 2005, Widder left her post at the Harbor Branch Oceanographic Institution to help establish and lead a new organization, the Ocean Research & Conservation Association (see http://www.oceanrecon.org/home.htm). A key effort of the institution is the development of state-of-the-art sensors and technological systems for evaluating water quality and ecosystem health. While translating complex scientific issues into engineerable solutions, Dr. Widder is fostering greater understanding of ocean life as a means to better, more informed ocean stewardship.

Edith Widder received a B.A. (1973) from Tufts University and an M.A. (1977) and Ph.D. (1982) from the University of California, Santa Barbara. She was a senior scientist and director of the Bioluminescence Department at Harbor Branch Oceanographic Institution in Ft. Pierce, Florida (1989-2005), prior to co-founding and directing the Ocean Research & Conservation Association, also in Ft. Pierce. She holds adjunct appointments at Johns Hopkins University, Monterey Bay Aquarium Research Institute, Florida Atlantic University, Florida Institute of Technology, and Bigelow Laboratory for Ocean Scientists.

Her CV is attached.

Erika Raymond will be a postdoctoral researcher at MBARI and a project manager for the EITS study. Her CV is attached.

Environmental Impacts: The EITS will have very minor impacts to the seafloor while it is deployed. All equipment will be recovered at the end of the experiment and the seafloor should return to its previous condition rapidly.

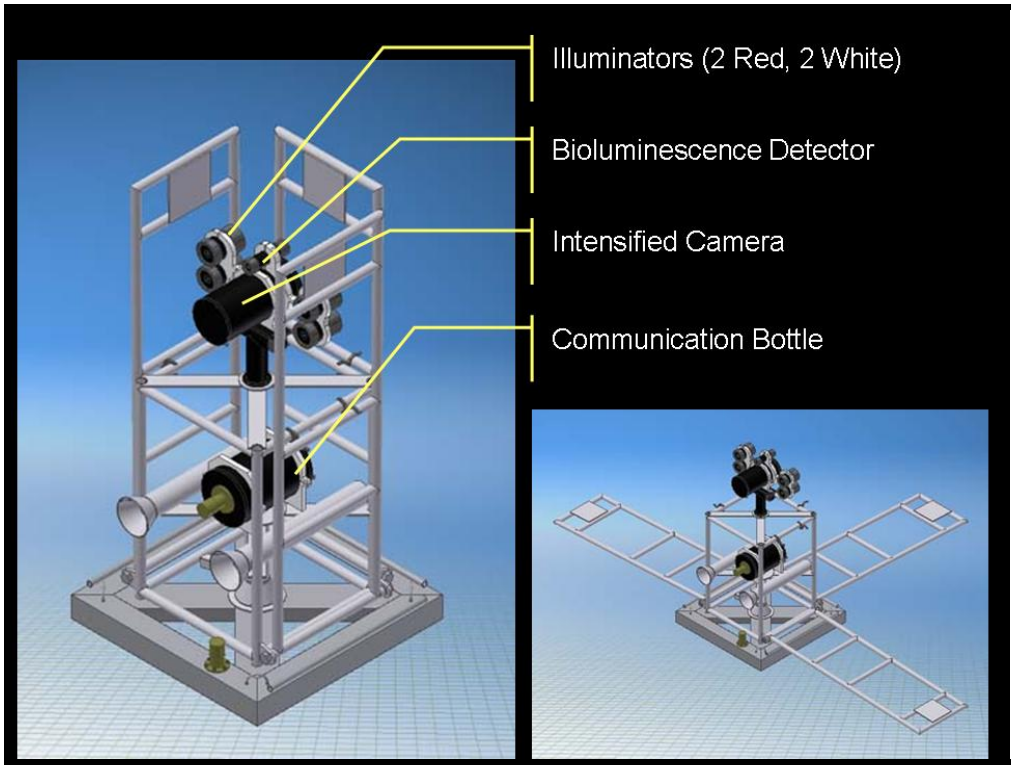

Figure 1. Ocean Recon's "Eye in the Sea," a center piece for educational outreach on MARS.

The New York Times

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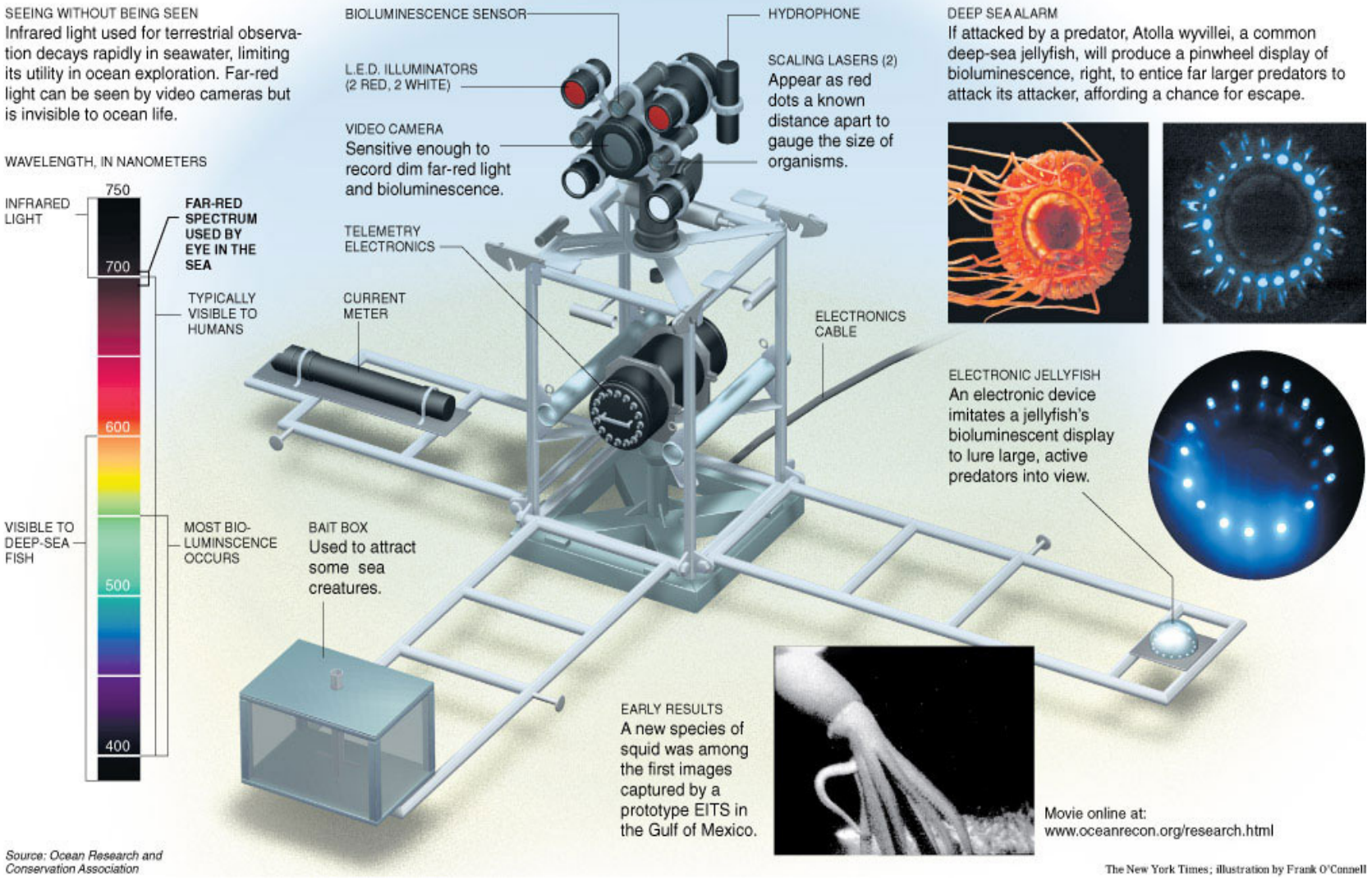
SCIENCE ILLUSTRATED

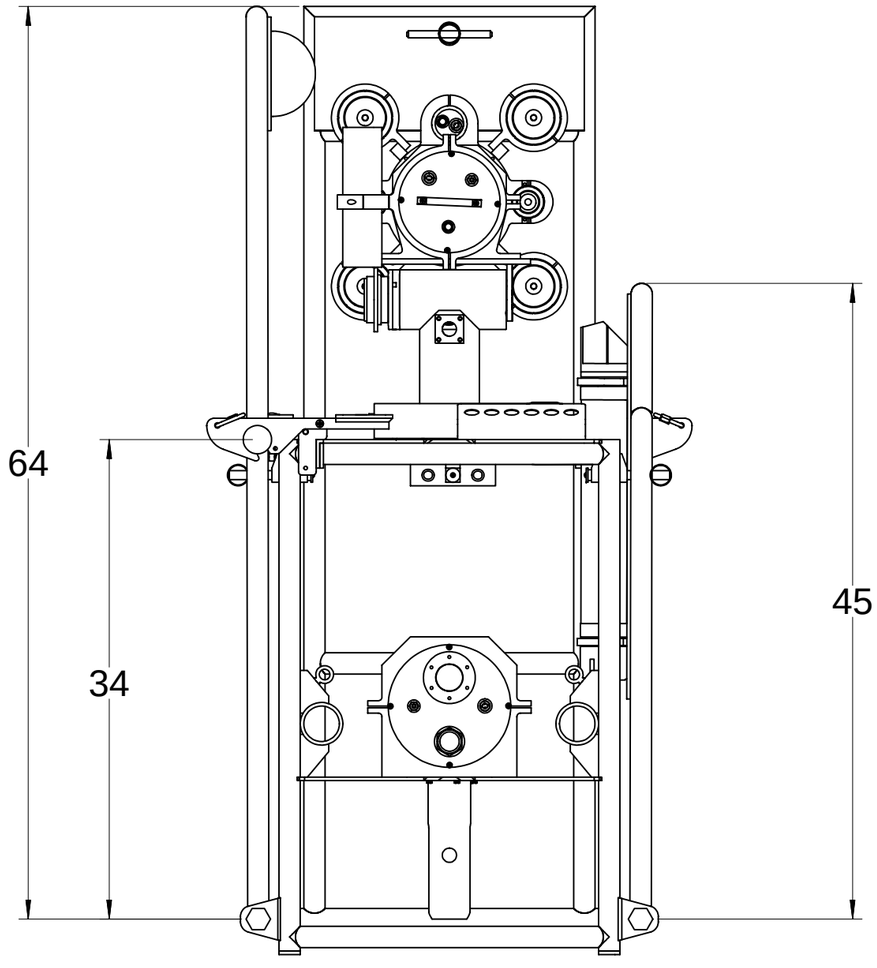
An Undersea Camera That Won't Scare Away Its Subjects

Undersea creatures can be very sensitive to light, complicating attempts to find and photograph them. Lights on vessels venturing into a world without sunlight drive species away, as can bright lights for video. Infrared light decays rapidly in seawater. But Edith A. Widder, a marine biologist at the Ocean Research and Conservation Association, has developed a system that uses a spectrum of light known as far red. Called Eye in the Sea, the system will be used starting in November 2007 as part of the Monterey Bay Aquarium Research Institute cabled observatory, a remotely controlled camera platform that can be lowered to the dark depths of the sea.

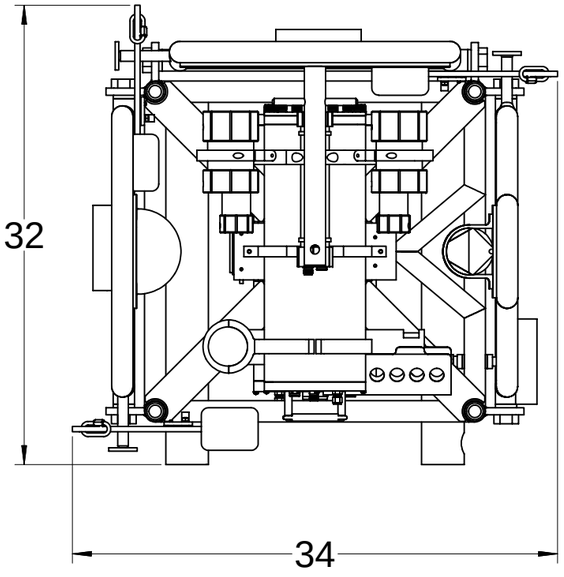
ANGELA M. H. SCHUSTER



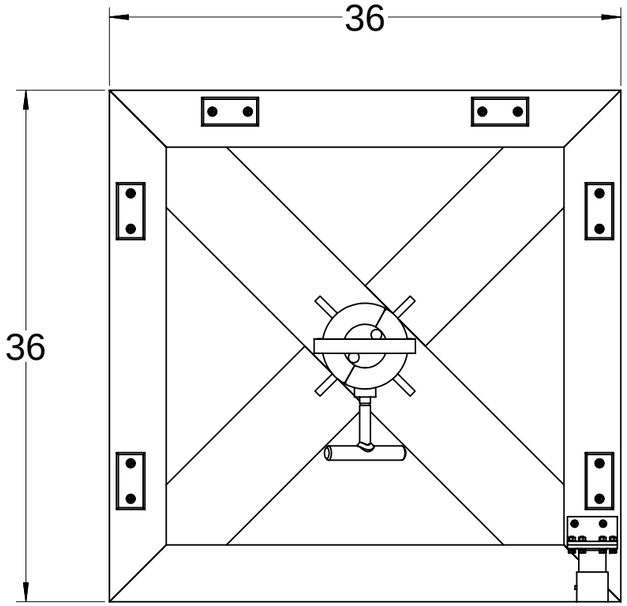
EITS Frame
Side View

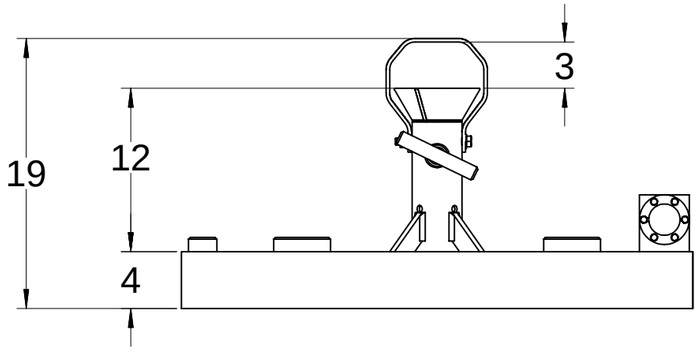


EITS Frame
Top View



Anchor
In Air Weight: approx. 155 lbs.





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			PROJECT MANAGER: L Frey		
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HARBOR BRANCH
OCEANOGRAPHIC INSTITUTION, INC.

PROJECT Eye In The Sea - MARS

TITLE
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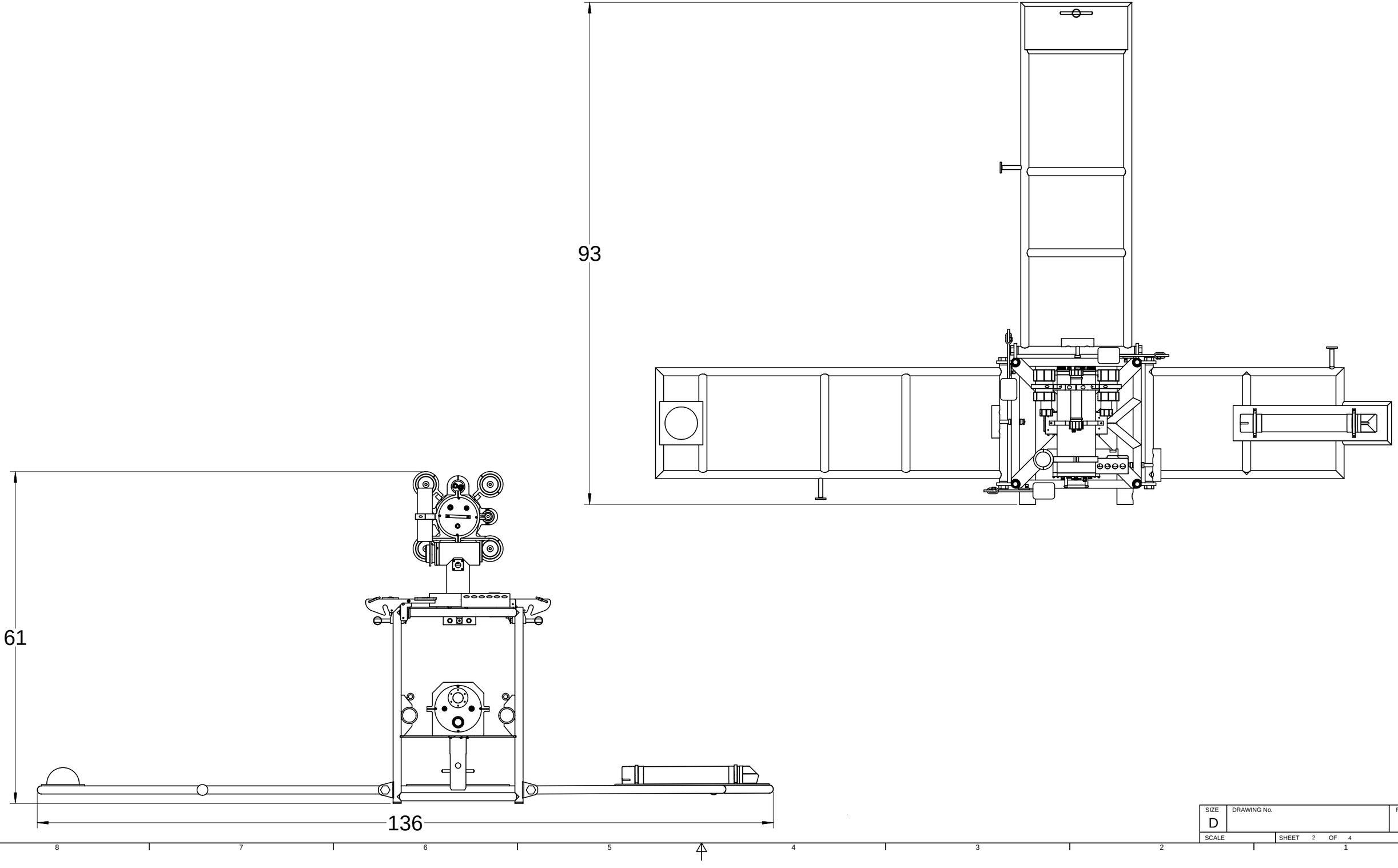

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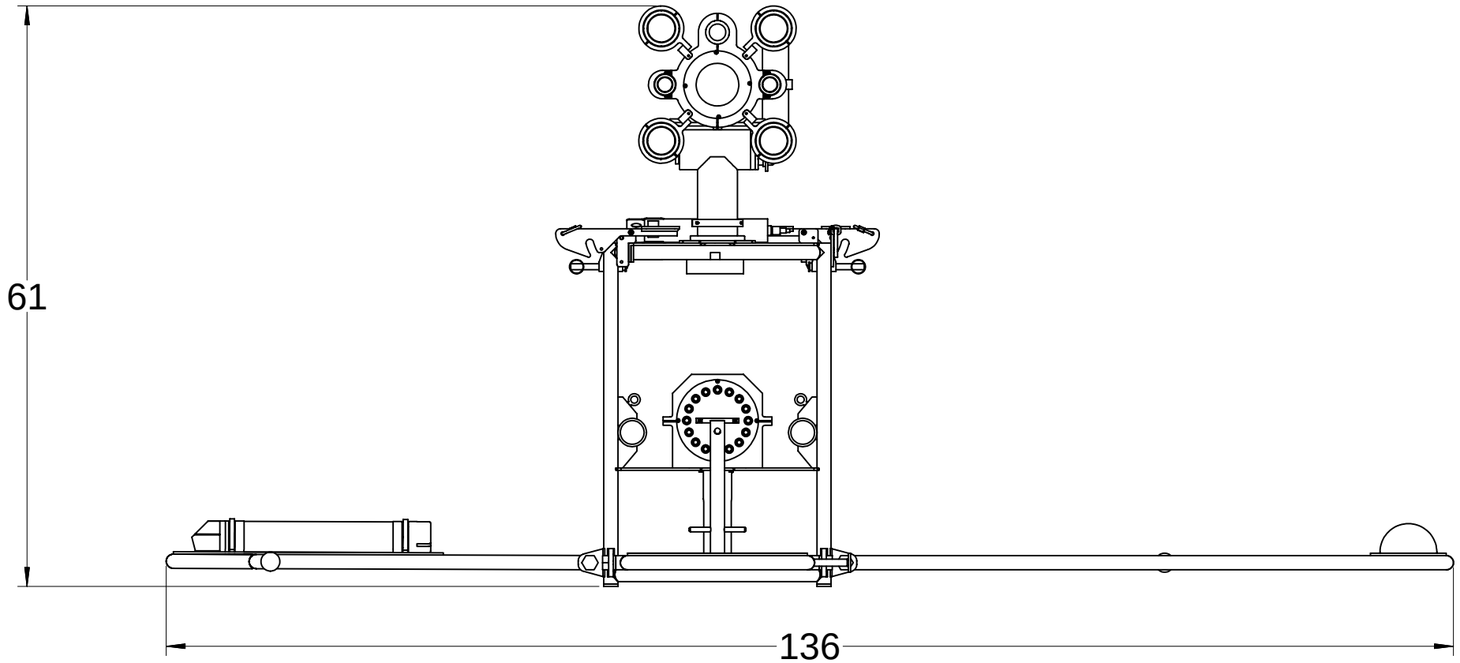

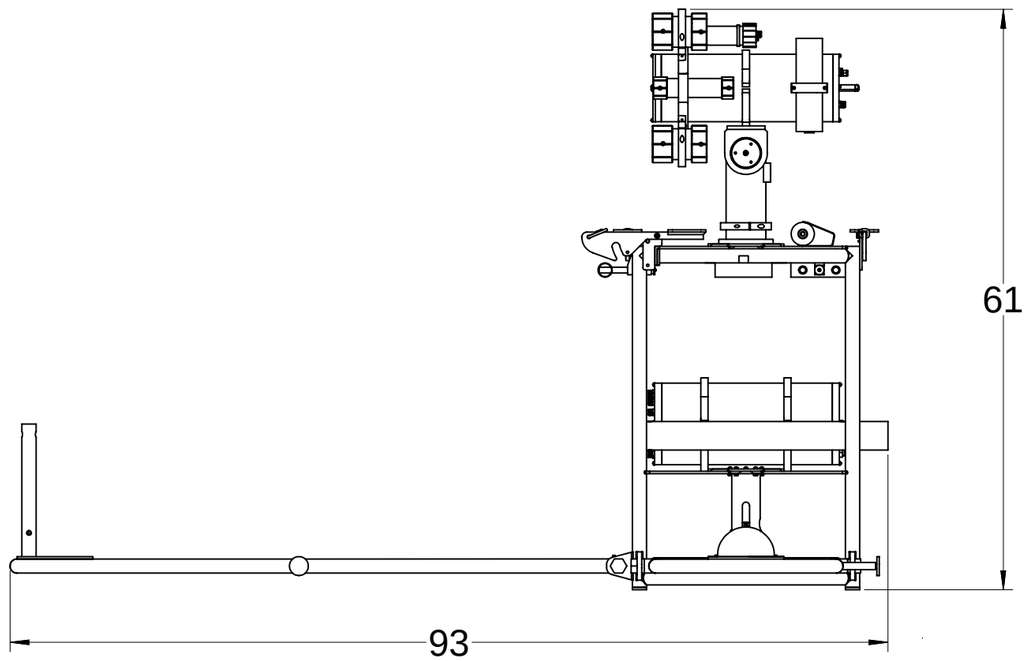

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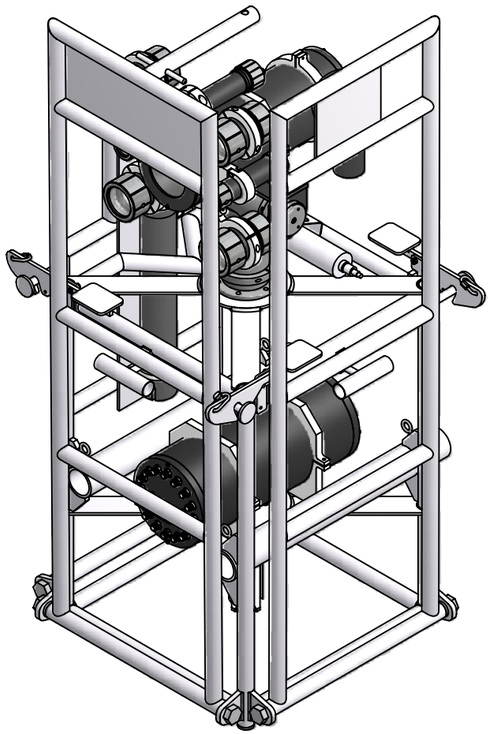

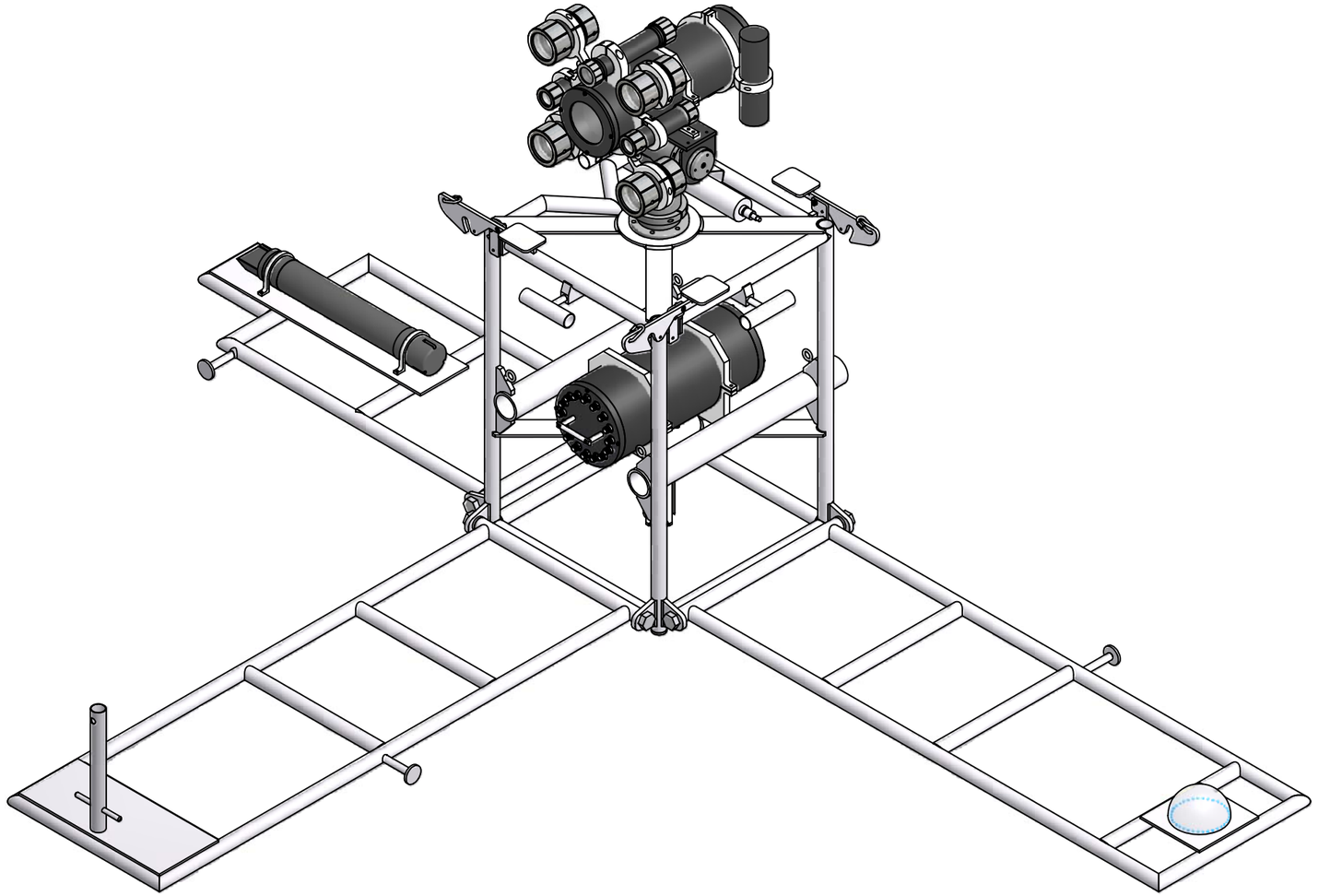

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CURRICULUM VITAE
Edith A. Widder

President and Senior Scientist
Ocean Research & Conservation Association
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Fort Pierce, Florida 34949
(772) 467 1600
E-mail: ewidder@oceanrecon.org

AREAS OF EXPERTISE:

Photophysiology and photoecology of marine organisms with emphasis on bioluminescence and vision. Instrumentation development and utilization of research submersibles for oceanic *in situ* light measurements. Development of bioluminescence measurements as a tool for mapping organism distribution patterns. Radiometric calibration. Certified research pilot for single-person submersibles: *Wasp*, *Deep Rover*, and *Deep Worker*.

EDUCATION:

1973 B.S. - *Magna cum laude* - Biology, Tufts University, Medford, Massachusetts
1977 M.S. - Biochemistry, University of California, Santa Barbara
1979 Experimental Neurobiology, Catalina Marine Science Center (Summer Program)
1982 Ph.D.- Neurobiology, University of California, Santa Barbara
1984 Certification: Scientific Research Pilot for Atmospheric Diving System Submersibles

ACADEMIC POSITIONS:

President and senior scientist, **Ocean Research & Conservation Assoc.** (2005-present)
Senior scientist and principal investigator, **Harbor Branch Oceanogr. Inst.** (1993-2005)
Adjunct Senior Research Scientist, **Bigelow Laboratory for Ocean Sciences** (2005-present)
Adjunct Research Professor, Earth and Planetary Sciences Dept, **Johns Hopkins Univ**. (2000-present)
Distinguished Scientist Adjunct, **Monterey Bay Aquarium Research Institute** (1998-present)
Professor of Biological Sciences, **Florida Institute of Technology** (1991-present)
Affiliate Professor, Dept of Biological Science, **Florida Atlantic University** (2000-present)
Acting Division Director, **Harbor Branch Oceanogr. Inst.** (1993-1994)
Associate scientist and principal investigator, **Harbor Branch Oceanogr. Inst.** (1991-93)
Assistant scientist and principal investigator, **Harbor Branch Oceanogr. Inst.** (1989-91)
Scientific consultant for **Dynamics Technology**, Inc., Los Angeles (1987-89)
Assistant research biologist and co-principal investigator, **UC Santa Barbara**, Marine Science Inst. and Neuroscience Research Inst. (1985-89)
Postdoctoral research biologist, ONR bioluminescence program. **UC Santa Barbara** (1983-85)
Associate researcher, ONR bioluminescence program, **UC Santa Barbara** (1977-83)
Ph.D. dissertation research, **UC Santa Barbara** (1977-82)
Research associate NIH resource lab in electron probe microanalysis. **Harvard Medical School.** (1973-75)
Laboratory assistant in phycology. Field Station of Environmental Sciences of the **University of Massachusetts.** (1968-69)

AWARDS SUMMARY:

Since 1984 over $12,000,000 in externally funded support including over **$7,000,000 from U.S. Navy** agencies (ONR, NORDA, NOARL, NRL), over **$3,000,000 from the National Science Foundation** and over **$1,000,000 from the National Oceanographic and Atmospheric Administration**.

PROFESSIONAL SOCIETIES:

American Academy of Underwater Sciences
American Association for the Advancement of Science
American Society of Limnology and Oceanography
Society of Photo-Optical and Instrumentation Engineers
International Society for Bioluminescence and Chemiluminescence, Councilor
Marine Technology Society, Editorial Board Member
Explorers Club

RESEARCH EXPEDITIONS :

59 research expeditions, 22 as chief scientist and 13 as co-chief scientist, including to the Gulf of Mexico, Bahamas, Gulf of Maine, western Mediterranean, Canary Islands and off the NW coast of Africa, as part of the first US oceanographic expedition into Cuban waters since Castro took power, to the Sea of Cortez, trans-Atlantic, trans-Pacific and off California. Over 250 dives in deep-diving submersibles.

PUBLICATIONS:

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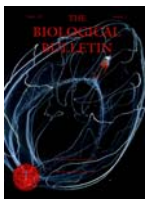

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Widder, E. A., Caimi, F. M., Taylor, L. D. and Tusting, R. F. (1992) Design and development of an autocalibrating radiometer for deep sea biooptical studies. **Oceanic Engineering Society of the IEEE, OCEANS '92,** Mastering the Oceans through technology. 1:525-530. New York.

Bowlby, M.R., E.A. Widder, and J.F. Case. (1991) Disparate forms of bioluminescence from the amphipods *Cyphocaris faurei. Scina crassicornis* and *S. borealis.* **Mar. Biol.** 108:247-253.

Widder, E.A., (1991) Midwater bioluminescence assessment in the West Alboran Gyre (Mediterranean Sea). **HBOI MP #126**.

Hollman, R., D.M. Lavoie, and E.A. Widder. (1991) Executive Summary Western Alboran Sea Assessments: April 1991. **Naval Oceanographic and Atmospheric Research Laboratory. Technical Note 270.**

Bowlby, M.R., E.A. Widder, and J.F. Case. (1990) Patterns of stimulated bioluminescence in two Pyrosomes (Tunicata: Pyrosomatidae). **Biol. Bull.** 179: 340-350.

Huber, M.E., A.C. Arneson and E.A. Widder. (1989) Extremely blue bioluminescence in the polychaete Polycirrus (Terebillidea). **Bull. of Mar. Science** 44:1236-1239.

Widder, E.A., S.A. Bernstein, D.F. Bracher, J.F. Case, K.R. Reisenbichler, J.J. Torres and B.H. Robison. (1989) Bioluminescence in Monterey Submarine Canyon: image analysis of video recordings from a midwater submersible. **Mar. Biol.** 100:541-551.

Hiller-Adams, P., E.A. Widder, and J.F.Case. (1988) The visual pigments of four deep-sea crustacean species. **J. Comp. Physiol. A.** 163:63-72.

Widder, E.A., P. Hiller-Adams and J.F. Case. (1987) A multichannel microspectrophotometer for visual pigment investigations. **Vision Research** 27(7):1047-1055.

Latz, M.I., T.M. Frank, M.R. Bowlby, E.A. Widder and J.F. Case. (1987) Variability in flash characteristics of a bioluminescent copepod. **Biol. Bull.** 173:489-503.

Widder, E.A., M.I. Latz, and P.J. Herring. (1986) Temporal shifts in bioluminescence emission spectra from the deep-sea fish, *Searsia koefoedi.* **Photochem. Photobiol.** 44:97-101.

Denton, E.J., P.J. Herring, E.A. Widder, M.I. Latz and J.F. Case. (1985) The roles of filters in the photophores of oceanic animals and their relation to vision in the oceanic environment. **Proc. R. Soc. Lond. B** 225:63-97.

Widder, E.A., M.I. Latz, P.J. Herring, and J.F. Case. (1984) Far red bioluminescence from two deep-sea fishes. **Science** 225:512-514.

Frank, T.M., E.A. Widder, M.I. Latz and J.F. Case. (1984) Dietary maintenance of bioluminescence in a deep-sea mysid. **J. Exp. Biol.** 109:385-389.

Widder, E.A., M.I. Latz and J.F. Case. (1983) Marine bioluminescence spectra measured with an optical multichannel detection system. **Biol. Bull.** 165:791-810.

Widder, E.A. and J.F. Case. (1982) Distribution of subcellular bioluminescent sources in a dinoflagellate, *Pyrocystis fusiformis.* **Biol. Bull.** 162:423-448.

Widder, E.A. and J.F. Case. (1982) Luminescent microsource activity in bioluminescence of the dinoflagellate, *Pyrocystis fusiformis.* **J. Comp. Physiol.** 145:517-527.

Widder, E.A. (1982) Effector control in the bioluminescent dinoflagellate, *Pyrocystis fusiformis* (Murray) **Ph.D. Dissertation**, University of Califronia, Santa Barbara.

Widder, E.A. and J.F. Case. (1981) Two flash forms in the bioluminescent dinoflagellate, *Pyrocystis fusiformis.* **J. Comp. Physiol.** 143:43-52.

Widder, E.A. and J.F. Case. (1980) Bioluminescence excitation in a dinoflagellate. IN **Bioluminescence: Current Perspectives** (K.H. Nealson, ed.) Burgess Publishing Company, Minneapolis, pp. 125-132.

PATENTS HELD:

Co-holder of U.S. Patent # 5264906, awarded in 1993 for the HIDEX-BP (High Intake Defined Excitation Bathyphotometer) which is the standard in the U.S. Navy for the measurement of bioluminescence in the oceans.

Students and Postdocs Advised and Co-Advised:

Graduate Students:

Maura Jess, M.S. University of California Santa Barbara
Mark Bowlby, Ph.D. University of California Santa Barbara
Kathy Daumer, M.S. Florida Institute of Technology
Trevor Myslinski, M.S. Florida Institute of Technology
Jessie W. Davis, M.S. Florida Institute of Technology
Nicole McMullen, M.S. Florida Atlantic University
Erika Raymond, Ph.D. Candidate Johns Hopkins University
Karen Breitlow, M.S. Candidate Florida Atlantic University
Miranda Hoover, Ph.D. Candidate Florida Atlantic University

Post-docs:

Tamara Frank, HBOI Post Doc
Sönke Johnsen, HBOI Post Doc

EDUCATIONAL PRODUCTIONS:

1997 Educational web site on bioluminescence www.biolum.org produced in 1997. Winner of the National Science Teachers Association sciLINKS award in 2001.

1998 Author of The Bioluminescence Coloring Book. Harbor Branch Oceanographic Institution, Fort Pierce, Florida. Over 6000 sold.

2000 Wrote and produced Marine bioluminescence: Secret Lights in the Sea. 26 min educational video. Harbor Branch Oceanographic Institution, Fort Pierce, Florida. Winner of the 2001 Silver Reel Award in Media Excellence and the 2002 Silver CINDY (Cinema In Industry) Award from the International Association of Audio-Visual Communicators.

2003 National Geographic Virtual Teacher Workshop May 5 - 9, 2003: "Living Light in the Ocean" http://www.coexploration.org/ceo/ Over 3000 registrants (K-12 teachers).

2003-2008 Curator of 5000 sq ft traveling museum exhibit on bioluminescence. Glow: Living Lights is scheduled for a 5 year North American tour and will be seen by over 5 million viewers. http://www.glowexhibit.com/ Much of the imagery in this exhibit is from my library of stills and videos collected over the course of my career.

2004 Operation Deep Scope posted on NOAA's Ocean Explorer Explorations web page http://oceanexplorer.noaa.gov/explorations/04deepscope/welcome.html

2005 OceanAGE profile posted on NOAA website for web chat with video interview http://oceanexplorer.noaa.gov/edu/oceanage/welcome.html

2005 Operation Deep Scope II posted on NOAA's Ocean Explorer Explorations web page http://oceanexplorer.noaa.gov/explorations/05deepscope/welcome.html

Lucinda's Lamps: A Mermaid's Guide to Lights in the Sea (in development). Educational picture book: Ages 5-9. Written by Edith A. Widder.

Erika Heine Raymond

Ocean Research & Conservation Association
1420 Seaway Dr., Fort Pierce, Florida, 34949
erika@oceanrecon.org (772)321-5879

EDUCATION

In progress Ph.D., Oceanography, Johns Hopkins University, Baltimore, MD.
M.S., Biology, With Distinction, California Polytechnic State University, San Luis Obispo, CA.
B.S., Biology, California Polytechnic State University, San Luis Obispo, CA.

QUALIFICATIONS

- Cruise experience includes 26 research cruise efforts [9 as Chief Scientist], to 6 locations: Monterey Bay, Gulf of Maine, Gulf of Mexico, Gulf Stream, New Jersey Shelf and Florida Current
- Involvement in collaborative projects with Monterey Bay Aquarium and Research Institute, Harbor Branch Oceanographic Institution, Rutgers University, and Woods Hole Oceanographic Institution

AWARDS AND DISTINCTIONS

2005 Outstanding Student Poster Award, ASLO Summer Meeting, Santiago de Compostela, Spain.
2005 Field Research Grant, Johns Hopkins University, MD ($1,030)
2004 Field Research Grant, Johns Hopkins University, MD ($2,000)
2003 Field Research Grant, Johns Hopkins University, MD ($840)
2002 Field Research Grant, Johns Hopkins University, MD ($825)

EMPLOYMENT

2005 – Present **Research Assistant**, Ocean Research & Conservation Assoc., Ft. Pierce, FL.
2003 – Present **Laboratory Manager**, Dr. Edith Widder's laboratory, Harbor Branch Oceanographic Institution and Ocean Research & Conservation Assoc., Ft. Pierce, FL.
2003 – 2005 **Research Assistant**, Harbor Branch Oceanographic Institution, Ft. Pierce, FL.
1999 – 2001 **Research Assistant**, California Polytechnic State University, San Luis Obispo, CA.
1998 – 2000 **Laboratory Manager**, Seawater Lab, Diablo Canyon Nuclear Power Plant, San Luis Obispo County, CA.
1997 – 1998 **Research Technician**, Hopkins Marine Station, Pacific Grove, CA.

RESEARCH CRUISE EXPERIENCE

Sept. 2006	R/V *Pt. Lobos*- Monterey Bay, CA. Hydrophone experiments with Eye-in-the-Sea (EITS) autonomous deep-sea observatory. (3 days)
June 2006	R/V *Seward Johnson*-Miami Terrace, FL. EITS deployments to study the diel behavior of fishes on the Miami Terrace. PI for EITS experiments (10 days)
May 2006	R/V *Pt. Lobos*- Monterey Bay, CA. Hydrophone experiments with EITS. (4 days)
Fall 2005 – 2006	M/V *Thunderforce*- Ft. Pierce, FL. High Intake Defined Excitation BathyPhotometer (HIDEX-BP) experiments and plankton collection in the Florida Current. Chief Scientist (3 nights/ month)
Sept. 2005	R/V *Pt. Lobos*- Monterey Bay, CA. Red-light experiments with EITS. (4 days)
August 2005	R/V *Seaward Johnson*- NOAA OE, DeepScope II, Gulf of Mexico. EITS deployments at unique oases in the Gulf of Mexico to seek out new species and document species diversity. (2 weeks)
April 2005	R/V *Pt. Lobos*- Monterey Bay, CA. Red-light and novel bait experiments with EITS. (4 days)
Sept. 2004	R/V *Seward Johnson II*- Gulf of Maine. Deployment and testing of new HIDEX-BP. (1 week)
August 2004	R/V *Seward Johnson II*- NOAA OE, DeepScope, Gulf of Mexico. EITS deployments at unique oases in the Gulf of Mexico to seek out new species and document species diversity. (2 weeks)
July 2004	Puerto Mosquito, Vieques, Puerto Rico- Deployment of small bathyphotometer in bay for diel measurements of bioluminescence and temperature, and collection of phytoplankton samples for isolation and culturing. (12 days)
June 2004	R/V *Pt. Lobos*- Monterey Bay, CA. Deployment and testing of EITS ver. 2.0. (4 days)
August 2002	R/V *Seaward Johnson*- NOAA Ocean Exploration “Islands in the Stream”, Gulf Stream and Florida Current. Collected bioluminescent dinoflagellates for kinetic analysis and assisted with EITS deployments. (2 weeks)
July 2001	R/V *Endeavor* – Rutgers Tuckerton Field Station (LEO-15), Office of Naval Research Hyperspectral Coupled Ocean Dynamics Experiment (HyCODE). Deployment of HIDEX and CTD rosette for CTD/Bathyphotometer profiles. (2 weeks)
June 2001	R/V *Seward Johnson*- Gulf of Maine. Collection of animals with a midwater trawl net for vertical migration studies. (2 weeks)
Winter 2000	R/V *Point Sur* – Monterey Bay, CA. Assisted in operation of Bathyphotometer and Schindler trap profiles. (2 days)
Sept. 2000	R/V *Seward Johnson II*- Gulf of Maine. Collection of animals with a midwater trawl net for vertical migration studies. (2 weeks)
August 2000	R/V *Point Sur*, R/V *Shana Rae* and R/V *Pt. Lobos*. Monterey Bay Aquarium and Research Institute MOOS Upper- Water-Column Science Experiment (MUSE), Monterey Bay, CA. Operated bathyphotometer on ROV *Ventana* for horizontal transects. (1 night) Launch and recovery of Schindler trap, Niskin Bottle and profiling bathyphotometer, and identification, enumeration and HPLC pigment analysis of phytoplankton samples. (2 weeks)

Summer 2000	R/V *Walford* – Coastal predictive skill experiments focused on coastal upwelling and vertical structure of bioluminescence at Rutgers Tuckerton Field Station (LEO-15), NJ. Launch and recovery of optical package, Niskin Bottle and profiling bathyphotometer and identification, enumeration and HPLC pigment analysis of phytoplankton samples. (1 month)

LABORATORY EXPERIENCE

2003 – present	Calibration of optical equipment, maintenance of phytoplankton cultures, and development and maintenance of autonomous deep-sea observatory.
Summer 2000	Rutgers Tuckerton Field Station (LEO-15), NJ. Operated moored optical profiler and conducted HPLC and fluorometric measurements on filter samples.
1999 – 2001	Cal Poly, SLO, CA. Maintained phytoplankton cultures, performed HPLC and fluorometric measurements on filter samples, analyzed data using Excel and MATLAB, and identified phytoplankton species from local waters.
1997 – 1998	Hopkins Marine Station, Pacific Grove, CA. Genetic diversity studies in trout and salmon species. Performed DNA extractions and amplification, manual radioactive sequencing of mitochondrial DNA, Genescan analysis and statistical analysis of microsatellite data and operated an ABI automatic sequence.
1997	Cal Poly, Environmental Biotechnology Institute (EBI), SLO, CA. Unocal Avila Beach Bioremediation Project. Cultured bacterial communities from local soils, isolated colonies for FAME analysis and DNA sequencing, performed DNA extraction and PCR and DAPI staining of bacteria

TEACHING EXPERIENCE

2000	**Teaching Assistant**, Undergraduate Phycology, Spring, Cal Poly, SLO. Assisted in classroom and laboratory lectures, developed multiple laboratory units on the genetic sequencing of local algal species and organized class field trips.
2000	**Teaching Assistant**, Undergraduate Invertebrate Zoology, Winter, Cal Poly, SLO. Assisted in laboratory lectures.
1999	**Teaching Assistant**, Undergraduate Marine Biology, Fall, Cal Poly, SLO. Assisted in classroom and laboratory lectures and organized class field trips.
1999	**Laboratory Instructor**, Undergraduate General Biology Lab, Spring, Cal Poly, SLO. Lectured on general biology topics.
1999	**Laboratory Instructor**, Undergraduate General Biology Lab, Winter, Cal Poly, SLO. Lectured on general biology topics.
1998	**Laboratory Instructor**, Undergraduate General Biology Lab, Fall, Cal Poly, SLO. Lectured on general biology topics.
1997	**Teaching Assistant**, Undergraduate Cellular Biology, Spring, Cal Poly, SLO. Organized and presented weekly review sessions on lectured units.

PUBLICATIONS

Raymond, E.H. and E. A. Widder. Different behavioral responses of two deep-sea fishes to red, far-red and white light. (in press MEPS).

Raymond, E.H., T. Sutton and E. A. Widder. Diel behavior of fishes near the Miami Terrace, Florida. (in prep.)

Raymond, E.H., E. A. Widder and B.H. Robison. The sound and the flurry: acoustic signatures of underwater vehicles and associated animal behaviors around an unobtrusive baited camera. (in prep.)

Raymond, E. H., E. A. Widder, C. L., Frey, C. T. Cimaglia and M. Hoover. Assessment of bioluminescent sources and potential in a tidal inlet. (in prep.)

Moline M. A., M. J. Oliver, C. D. Mobley, L. Sundman, T. Bergmann, W. P. Bissett, J. Case, E. H. Raymond and O. M. E. Schofield. Bioluminescence in a complex coastal environment: Part I: Temporal dynamics of night-time water-leaving radiance. (submitted)

Widder E. A., E. H. Raymond, C.L. Frey and D.C. Smith. Eye-in-the-sea: A deep-sea observatory for unobtrusive exploration. (in prep.)

Moline, M. A., E. Heine, J. Case, C. Herren and O. Schofield. 2001. Spatial and temporal variability of bioluminescence potential in coastal regions. In: J. F. Case, P. J. Herring, S. H. D . Haddock, L. J. Kricka and P. E. Stanley, Eds., Bioluminescence and Chemiluminescence 2000. World Scientific Publishing Company, Singapore, p123-126.

Nielsen, J. L., E. L. Heine, C. A. Gan, and M. C. Fountain. 2000. Molecular analysis of population genetic structure and recolonization of Rainbow Trout following the Cantara spill. California Fish and Game 86(1):21-40.

Non-Refereed Abstracts and Presentations

Raymond, E. H., and E. A. Widder. Unobtrusive observations of deep-sea megafauna in the Gulf of Mexico. ASLO/AGU Ocean Sciences Meeting, Honolulu, HI. Feb. 2006.

Raymond, E. H. Unobtrusive observations in the deep sea. Florida Oceanographic Society, Stewart, FL. March 2006.

Raymond, E. H. Spying on the deep sea: A new look at life in the dark depths. Smithsonian Marine Station, Ft. Pierce, FL. Feb. 2006.

Raymond, E. H. Eye-in-the-Sea: An unobtrusive platform for deep-sea observations. Florida State University, Tallahassee, FL. Nov. 2005.

Raymond, E. H., and E. A. Widder. Stealth matters: Opening an unobtrusive window in to the deep sea. ASLO Summer Meeting, Santiago de Compostela, Spain. June 2005.

Raymond, E. H. and E. A. Widder. Eye-in-the-Sea: A platform for unobtrusive *in-situ* observations of deep-sea nekton. ASLO Aquatic Sciences Meeting, Salt Lake City, UT. Feb. 2005.

Heine, E. L., C. M. Herren, E. A. Widder and M. A. Moline. Distribution of Bioluminescence across an Optical Front at LEO-15. ASLO/AGU Ocean Sciences Meeting, Honolulu, HI. Feb. 2002.

Haddock, S H ; Moline, M A ; Herren, C M ; Heine, E L ; Bellingham, J G ; Case, J F AUV-measured distribution of bioluminescence in a coastal environment. ASLO Aquatic Sciences Meeting, Albuquerque, NM. Feb. 2001.

Moline, M. A., J. Case, E. Heine, C. Herren and O Schofield. Spatial and temporal variability of bioluminescence potential in coastal regions. 11th International

Symposium on Bioluminescence and Chemiluminescence. Asilomar, CA. Sept. 2000.

EDUCATIONAL OUTREACH/ SERVICE

July 2006	Lecturer, EARTH Workshop, Tuckerton, NJ. http://www.mbari.org/earth/2006/DayTwo/EARTH_2006_EITS_web.pdf
Jan. 2006	Volunteer, Herron Island CoralWatch Workshop.
Nov. 2005	Judge, K-6 Science fair, Vero Beach, FL.
August 2005	NOAA's Ocean Explorer Explorations web page contribution. www.oceanexplorer.noaa.gov/explorations/05deepscope/logs/sep2/sep2.html
August 2004	NOAA's Ocean Explorer Explorations web page contribution. http://oceanexplorer.noaa.gov/explorations/04deepscope/logs/aug8/aug8.html
August 2003	Host, Evolving Communications Extreme Science Series, Dinoflagellate Bioluminescence Episode.
April 2001	Volunteer, Marine Science Promotional Video, Open House, Cal Poly, SLO.
Sept. 2000	Volunteer, 11th International Symposium on Bioluminescence and Chemiluminescence, Asilomar, CA.
April 2000	Touch Tank Volunteer, Open House, Cal Poly, SLO.
August 1999	Volunteer, Lizard Island Marine Station, Great Barrier Reef, Australia.

SOCIETY MEMBERSHIPS

Student member: American Society for Limnology and Oceanography (ASLO)

CERTIFICATIONS

SCUBA open water certification
First Aid & CPR
DAN oxygen administration

The MARS Ocean Observatory Testbed

MARS

General Information
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- MARS in the news
- Notice to Mariners
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Administration
- Contacts
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- Partners
- Permitting
- Meetings
- Presentations archive

Technical Information
- Invitation to researchers
- Site description
- Main science node
- How to interface
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- Extension capabilities

MARS science experiments
- Eye-in-the-Sea
- Benthic Rover
- Seafloor Seismometer
- Deep-Sea ESP
- ALOHA Mooring

Ocean Observatories
- JOI - Joint Oceanographic Institutions
- NEPTUNE Canada
- VENUS
- Hawaii Ocean Time Series
- Martha's Vineyard Cabled Observatory
- Coastal Ocean Observation Lab

Eye-in-the-Sea

Deep-sea creatures take center stage but stay out of the spotlight

The Eye in the Sea stands on the deck of the R/V Point Lobos following a short deployment in early 2006. The brown cylinder above the red battery box is the low light camera. At the top of the tripod, a far-red light source illuminates the scene in a color most animals can't see. In the background is ROV Ventana, the submersible that will connect Eye-in-the-Sea to the MARS observatory. Image: Kim Fulton-Bennett, ©2004 MBARI.

Look around on land, and you can see life everywhere. But it's a different story down in the deep ocean. There are still plenty of animals around, but deeper than about 200 m (660 feet) there's no light left to see them. Instead, light comes from the sea creatures themselves. More than 90 percent of them give off faint bluish flashes and glows, called bioluminescence, that seem unearthly to visitors from dry land.

What is bioluminescence?
It's the phenomenon of living creatures making their own light. Although we know the basic chemistry, we still don't know precisely why animals light up or even how many types of glowing creatures there are down in the depths. The Eye-in-the-Sea is helping us find out.

When looking around in the dark, it's natural to use a flashlight, and that's how most research in the deep sea is done: cruising in a submarine behind bright headlights. But it's not a great way to find shy creatures, which can dodge out of the way of the loud, glaring sub. By taking the opposite approach – sitting quietly and watching in the dark – the Eye-in-the-Sea lets creatures come to it.

How the Eye-in-the-Sea sees in the dark
The basic design is a very sensitive black-and-white video camera mounted on an aluminum tripod. The camera amplifies stray photons of light to create images we can see. The seafloor around MARS is so deep and dark that a nearby bioluminescent animal can light up the screen almost as if it were a cruise ship passing at night.

The camera is focused on a spot about 2 meters (6 feet) away and can see an area about 2 m wide. Extra illumination is provided by powerful red lights that are invisible to most sea creatures. The added light helps in identifying animals by making their non-luminescent parts visible.

Dr. Edith Widder and Ph.D. student Erika Raymond examine the Eye in the Sea before a brief deployment in Monterey Bay in spring 2006. Image: Kim Fulton-Bennett, ©2004 MBARI.

Widder, engineer Lee Frey, and Raymond cheer the first data returning from a successful deployment of the Eye-in-the-Sea. Image: Mark Richards.

The Eye-in-the-Sea can lure curious animals into view in one of two ways: by offering bait or by grabbing their attention using an electronic flashing jellyfish lure. Scientists plan to soon add a high-resolution color camera (with powerful flash) that they can trigger remotely when something interesting swims into view.

Why MARS?

The electrical power running day and night to the MARS observatory will solve the Eye-in-the-Sea's most nagging limitation: battery life. In the past, the Eye's power-hungry lights and equipment have curtailed its missions to a maximum of two days. That doesn't leave long for rare deep-water creatures to swim into view.

Previous missions captured only one or two creature snapshots per day. (The snapshots were often thrilling – the Eye's very first use of the electronic jellyfish captured images of a 2-m [6 feet] long squid completely new to science.) The Eye-in-the-Sea will stay at the MARS site for three to six months at a time, with cameras running 24 hours a day.The whole time, the MARS data link will bring the images to shore as they're taken, allowing scientists to watch, trigger experiments with the electronic jellyfish, or grab stills with the color camera as soon as they see something extraordinary.

Such long surveillance creates huge video archives to sift through. School children will have the chance to help the scientists cope with all the data, by watching the video and making a first pass at identifying the creatures they see. Lesson plans and activities are under development to help teachers take advantage of the Eye-in-the-Sea as a teaching tool.

Related Links

Dr. Edith Widder - inventor of Eye in the Sea
Ocean Research and Conservation Association

Eye-in-the Sea: An Innovative, Unobtrusive Camera System – NOAA Ocean Explorer
NOAA Operation Deep Scope 2005 – pictures, video clips, and

a daily log from a 2005 expedition to the bottom of the Gulf of Mexico
A marine bioluminescence primer for teachers. From *Bioscience Explained.*
The How and Why of Bioluminescence – Dr. Widder's educational site about bioluminescence
Popular Mechanics on Eye in the Sea's 2006 test run in Monterey Canyon
A short animation shows how Eye-in-the-Sea will arrive and start work at MARS [2 Mb Quicktime file courtesy Harbor Branch Oceanographic Institution]

Last updated: *Feb. 13, 2007*