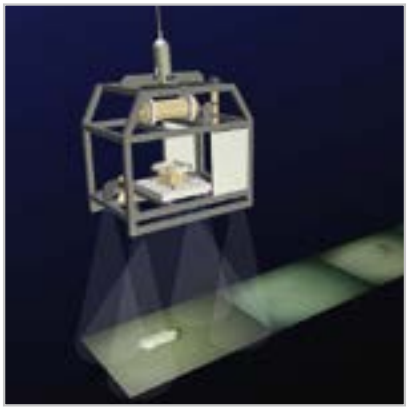
LASER COMPONENTS®

High-resolution Photos Taken in Absolute Darkness

5000 Meters below Sea Level

What are the effects of the current changes in the Arctic Ocean on the global ecosystem? Researchers from the Alfred Wegener Institute have been trying to get to the bottom of this issue. The most spectacular action they have taken thus far is currently the MOSAiC expedition. The research vessel Polarstern was frozen in the ice of the Arctic winter and is serving for one year as a base station for a variety of experiments. However, the scientists are also using high-tech equipment elsewhere in their work; for example, to non-invasively observe the sea floor.

At its underwater observatory "Hausgarten," the Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research has been observing the water, fauna, and (micro)flora in the Fram Strait since 1999. Both the warm, saline West Spitsbergen Current and the cold, low-salt East Greenland Current flow through the approximately 500 km wide strait. This makes it the Arctic Ocean's only deep-water connection to the system of the world's oceans, which is crucial for the exchange of oxygen and nutrients and an important variable in the global climate system



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The ocean floor observation system OFOS takes pictures 1.5 meters above the sea floor.

Autonomous Measuring Stations

Hausgarten now has twenty-one stations with free-fall devices that serve as observation platforms on the seabed. They cover depths of water between 250 meters and 5500 meters. In addition to the physical properties of sea water (temperature, salt content, and nutrient content), researchers there observe the Arctic microflora and fauna, among other things. During the ice-free summer months, additional equipment is used: a remote-controlled underwater vehicle takes specific samples at regular intervals, and experiments are carried out on site. Furthermore, an autonomous mini submarine traverses all vertical water layers to record the course and interaction of biochemical processes. At depths of up to 3000 meters, it is also used for large-scale observations on the seabed.

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Pictures from Depths of 5000 m

The most important research equipment at Hausgarten includes camera systems towed by ships, such as the ocean floor observation system (OFOS) and the ocean floor observation and bathymetry system (OFOBS). High-resolution images of the sea floor are captured using a vertically-downward-aligned digital SLR camera, a video camera, spotlights, and flash lamps. The OFOBS is also equipped with a sonar system. All these components are housed in such a way that they are able to withstand the enormous pressure load at water depths of up to 6000 meters. OFOS and OFOBS are lowered on a steel cable down to approx. 1.5 meters above the sea floor in order to not affect the structures being recorded. The cable also accommodates fiber optic cables for data and video transmission and a copper cable for the power supply. A research vessel pulls the structure weighing several tons through the area to be surveyed at 1 km/h. During this process, the video camera takes HD recordings of the seabed, while the single-frame camera provides a 23-megapixel snapshot every 30 seconds.

Lasers Used to Survey Deep-sea Objects

In order to use the data obtained from the cameras scientifically, the size of the surveyed objects must be recorded. This is done with the help of three powerful FLEXPOINT® dot laser modules mounted in an equilateral triangle around the single image camera. Each module has a distance of 50 cm to the other two modules. Thus, three red dots are visible on each image. The scientists determine the number of pixels between the dots and can thus estimate the actual size of the depicted objects. The use of three lasers also makes it possible to determine the size of an object on uneven ground because then the distances between the dots no longer form an exact equilateral triangle. The wavelength of 635 nm was chosen so that the laser dots on the images are optimally visible. A laser output of 50 mW ensures that they are not over-illuminated even when using strong headlights and flash lamps.

Size Matters

There are many reasons to want to determine the size of seafloor objects; for example, to find out whether a particular area is more likely to contain young or adult fish and crabs. If distances can be measured, the size of geological structures (black smokers, hydrothermal vents, mineral resources) can also be determined. Finally, size determination also helps with an unpleasant topic that is becoming increasingly important: It can be used to determine the amount of plastic waste deposited on the sea floor. This has meanwhile also taken on as similarly worrisome dimensions in the Fram Strait as in the deep-sea trenches off the Portuguese coast.

Autors

Dr. Autun Purser
Dr. Autun Purser is a scientist specialising in deep-sea ecology at the Alfred Wegener Institute in Bremerhaven. With the help of lasers, he was able to measure the deepest-existing octopod eggs ever observed as part of his current research.

Dipl.-Ing. (FH) Burkhard Sablotny
Burkhard Sablotny has been working in marine research since 1988 with a focus on deep-sea technology, twenty-four years of which he has spent at the Alfred Wegener Institute.

The Alfred Wegener Institute (AWI) Helmholtz Centre for Polar and Marine Research: www.awi.de

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Compact and Flexible Lasers

FLEXPOINT® modules are now used in various underwater missions. Not only are dot lasers used but MV modules for industrial image processing as well. Using remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs), they scan the sea floor and provide detailed 3D data on corals, shipwrecks, and offshore facilities. We also offer modules with wavelengths between 405 nm and 905 nm for other applications. The output power can be customized from a few micro-watts up to 100 mW.

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