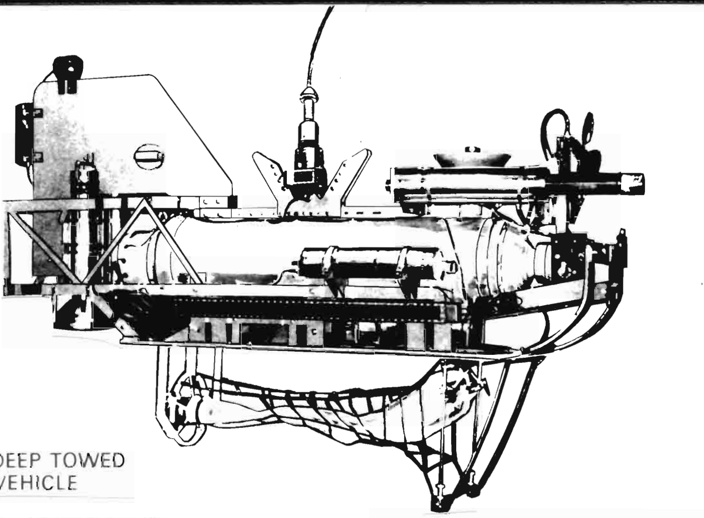
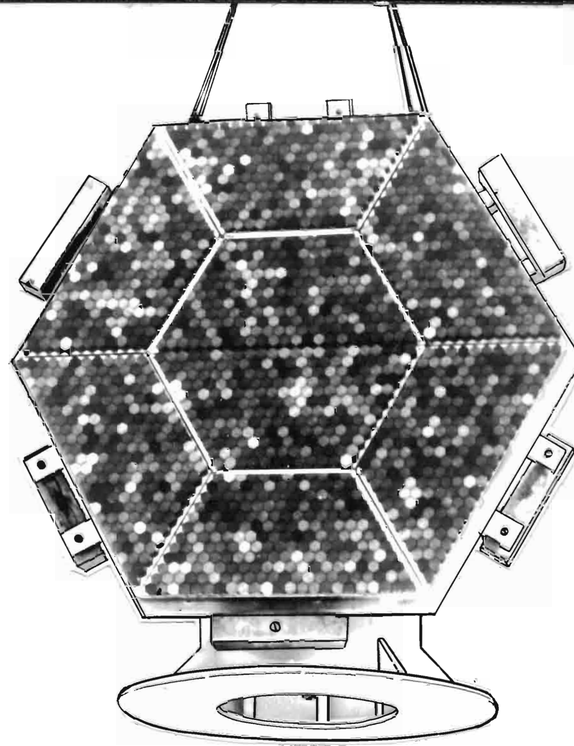
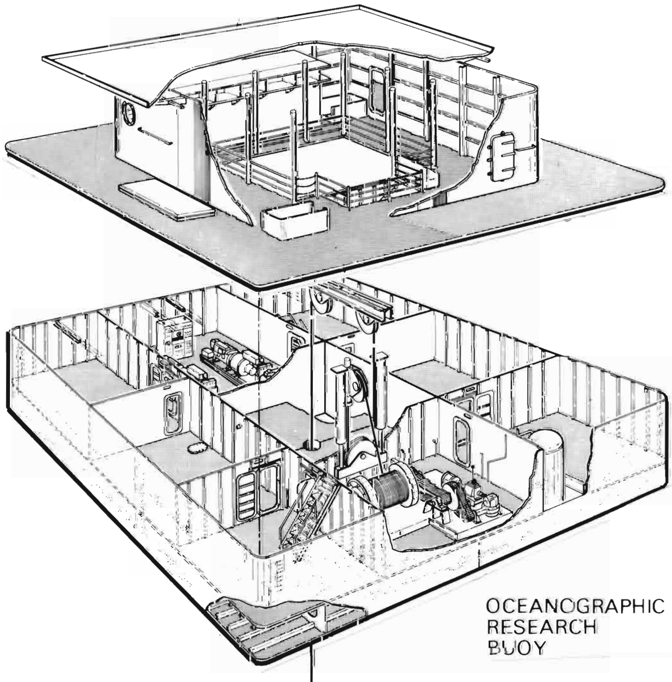
PLATFORMS & DEVICES of the MARINE PHYSICAL LABORATORY



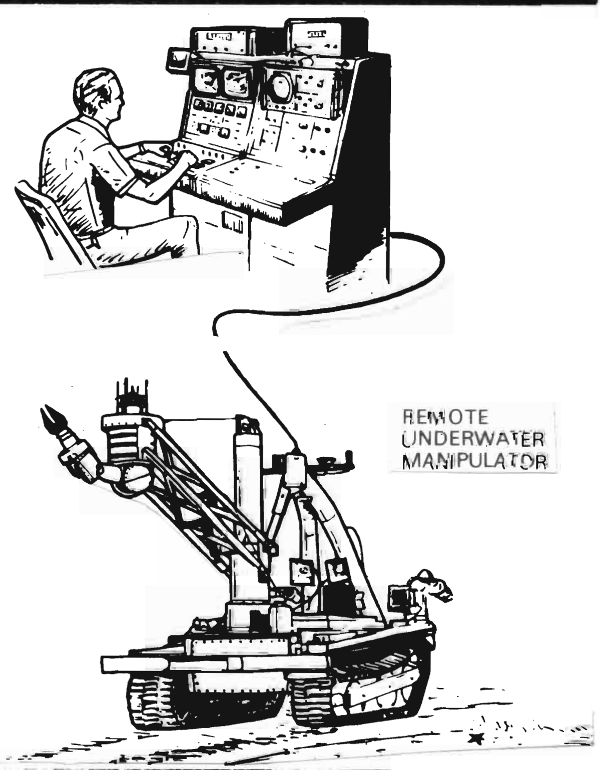
DEEP TOWED VEHICLE



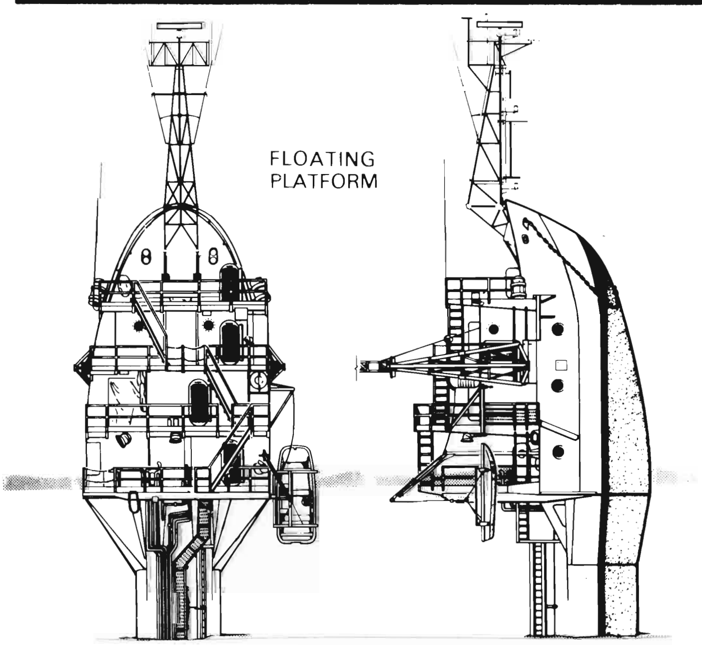
DOPPLER SONAR



OCEANOGRAPHIC RESEARCH BUOY



REMOTE UNDERWATER MANIPULATOR



FLOATING PLATFORM

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PLATFORMS AND DEVICES OF THE MARINE PHYSICAL LABORATORY OF THE SCRIPPS INSTITUTION OF OCEANOGRAPHY UNIVERSITY OF CALIFORNIA, SAN DIEGO

The Marine Physical Laboratory is one of the research laboratories of the Scripps Institution of Oceanography, an institution of the larger University of California, San Diego campus. Headquarters for the laboratory are located within the Naval Ocean Systems Center compound on Point Loma. Some of the staff conduct their research programs on the La Jolla campus of the University.

The Marine Physical Laboratory, since its origin in 1946, has maintained a research program which has been continuously directed toward increased understanding of the generation, propagation and detection of energy in the ocean and surrounding media. A simplified overview of the laboratory program would divide Ocean Acoustic Environment, Marine Physics/Geophysics, Signal Processing, Ocean Technology, and Advisory and Exploratory functions of the staff. Ocean acoustic research includes long-range studies of propagation paths and noise distributions in the open ocean and short-range investigations of scattering from nearby biological and physical reflectors. Marine physics and geophysics span the measurement of acoustic properties of the earth's crust to the investigation of fine-scale topography and water motions using advanced sonar equipment. Signal processing theoretical studies are augmented by hardware development and practical ocean experiments. Ocean Technology efforts at the laboratory have developed a variety of research platforms, tools and techniques for use in the program. Over and above their research, members of the laboratory participate in many ways in the planning of Navy and University long-range programs, and in the educational activities of the University of California, San Diego.

Primary support for the laboratory comes from the U.S Navy. The basic support from 1946 to 1958 was provided through the Bureau of Ships (now Naval Ship Systems Command). Since 1958 primary support has been received through the Office of Naval Research and since 1978, additionally through the Naval Oceanographic Research & Development Activity; this primary support has been augmented by other branches of the Navy for special projects. The National Science Foundation also provides grants for specific research investigations.

The first director of the Marine Physical Laboratory was Dr. Carl Eckart, who served from 1946 to 1952. He was succeeded in 1952 by Sir Charles S. Wright, in 1955 by Dr. A. B. Focke followed in 1958 by Dr. F. N. Spiess, and in 1981 by Dr. K. M. Watson.

The present staff of the laboratory numbers about 80, of which 12 are senior academic, 12 junior academic, 15 engineering, 29 technical, and 10 administrative and staff members.

In pursuit of the understanding of the ocean under the broad charter of the laboratory, the staff members have developed a number of specialized platforms and devices to carry their research instruments on and in the ocean. Some of these are described below to illustrate the length to which one must go to unlock the secrets of the sea.

FLIP *(Floating Instrument Platform)* - FLIP is an unusual vessel developed under the sponsorship of the U.S. Navy's Office of Naval Research to fulfill a need for an extremely stable and yet mobile platform from which accurate acoustical measurements could be made at sea. FLIP was constructed with about 700 tons of steel and concrete ballast. It is not self-propelled, and must be towed.

FLIP, which has an overall length of 108 meters, is towed in the horizontal position to the area where scientific operations are to be carried out. Upon arrival on station the tow line is cast off and ballast tanks distributed throughout the after 84 meters of the vessel are flooded. In about 20 minutes the vessel is completely vertical with approximately 17 meters of prow pointed skyward and the remaining 91 meters of vessel under water.

FLIP's stability, 91 meter draft, and low acoustic noise levels have made it uniquely suitable for a wide variety of research experiments. Research conducted on FLIP has included studies of temperature variations, wave generation, turbulence and thermal structure, wave amplitude and directionality, long-range sound propagation, sound attenuation and scattering, and ambient noise intensity and direction. Scientists from many other universities and government laboratories have participated in research conducted with FLIP. It has remained at sea for as long as 45 days with 35 consecutive days in the vertical position: the longest when it was in the Gulf of Alaska, 1800 miles from home. In over 20 years of service FLIP has spent over 1000 days at sea in both the Atlantic and Pacific Ocean, and has completed the transition from horizontal to vertical and return over 200 times.

Deep Tow Vehicle - The DEEP TOW system was designed to study the details of sea floor topography and related characteristics. It consists of an instrumented vehicle, commonly called a FISH, towed by a research ship with a five-mile length of electro-mechanical cable. A network of bottom-mounted acoustic transponders is used to provide precise navigational information.

The unmanned vehicle consists mainly of a pressure case which houses and protects the electronics unit from the sea pressure down to depths as great as 7300 meters. The following instrument sensors are mounted in various locations on the outside of this case: A precision downward-looking echo sounder which, combined with the upward-looking echo sounder or a precision pressure gauge, gives a detailed profile of the depth of the ocean bottom under the vehicle, right and left side-looking sonars, bottom penetration sonar, an acoustic ranging transducer, proton magnetometer, temperature sensor, conductivity element, a camera and strobe light system, slow scan television system, and an obstacle avoidance sonar system. The ship's laboratory contains the vehicle sensor control rack, the power supplies, the data recorders, and other instruments related to the survey. A computer is used for rapid navigational computation and data logging. The ranges from the transponders are fed into the computer and the positions are automatically marked on the plotter.

The DEEP TOW system is a powerful research tool for studying the geology of the sea floor and thereby its influence on acoustic and magnetic systems. By virtue of its complex of instruments and the precision of its acoustic transponder navigation system, magnetic, topographic, sub-surface sediment, and photographic data may be closely correlated to identify features of special interest and to obtain a much more complete general understanding of the processes of formation of the sea floor structure than has been possible with the isolated random observations of the past. Additional instrumentation has been developed to acquire chemical and biological samples at great depths using the DEEP TOW system.

ORB *(Oceanographic Research Buoy)* - ORB, a 21 x 14 meter rectangular shaped vessel displacing approximately 330 tons, was developed by the Marine Physical Laboratory to serve projects at the laboratory which require the launch, retrieval, implantation or handling of large equipments or systems in the open ocean. In contrast to FLIP, ORB is designed to follow the sea surface as closely as possible, in order to simplify the task of placing and retrieving large objects in the ocean. The vessel has a center well of 9- by 6-meter area which can be opened to permit the lowering of equipment through it, using a cable-tensioning system to minimize vertical motions. The well doors when closed provide a dry work space and will safely support a weight of 12,000 kg. Loads up to 12 tons can be lowered to a maximum depth of 2,000 meters. ORB is 8 meters high from keel to upper deck. It has no means of self propulsion and must be towed to and from operating areas. In addition to laboratory work spaces and machinery space, ORB is equipped with complete living facilities for 20 people including five crew members.

ORB, during her first ten years of operation in support of over a dozen different projects, has been moored at over 20 sites ranging up to 400 km off the southern California coast and at depths from 30 to over 4,000 meters.

RUM *(Remote Underwater Manipulator)* - This series of seafloor work vehicles included RUM II, a remotely controlled, tracked vehicle which was developed under the sponsorship of the Office of Naval Research at the Marine Physical Laboratory for use as a research tool in sea floor technology experiments, and to establish design criteria for future sea floor technology systems. RUM III, which combines seafloor search and work capabilities, is in the development phase.

RUM II provided detailed information on vehicle trafficability, remote manipulation, navigation, cable telemetry systems, effect of ambient pressure on electronics, and environmental and mechanical design considerations. Design depth for the vehicle is 2,400 meters. Extensive operations have been carried out in a variety of locations of diverse bottom characteristics within 120 km radius from San Diego. Depth of operations has ranged from 30 to 1800 meters. Operational tasks carried out on the sea floor have included search and recovery, implantment of instruments, biological studies, vehicle trafficability studies, navigation exercises, collection of samples, and the measurement of the engineering properties of sea floor sediments. During operations, RUM was launched through the well on ORB and lowered to the sea floor. A pair of divers were used in the launch and recovery of the vehicle to connect and disconnect snubbing cables. Electrical power, telemetry for control and instrumentation, and signals for sonar, navigation aids and television were transmitted over the single coaxial umbilical cable connecting the RUM to ORB.

The vehicle was propelled by two independently controlled reversible 15.6 KW direct current motors, one driving each track. Other equipment included three television cameras, ten 500-watt quartz iodide lights, two 600-watt mercury vapor lights, color movie and still cameras, an obstacle avoidance scanning sonar with a 25-meter range, a high resolution search sonar with a 200-meter range, up- and down-looking depth sounders, a magnetic compass, listening hydrophones, acoustic transponder navigation system and a manipulator capable of exerting 22 kg of force in any direction.

Doppler Sonar - The accurate measurement of the oceanic water velocity field is a difficult task. Traditionally, currents are measured directly by discrete current meters which are suspended in the sea from moorings, or are inferred from the measurements of the oceanic density field. At the Marine Physical Laboratory, an alternative method has been developed, using Doppler Sonar. In this approach, high frequency sound is transmitted in a narrow beam. The sound scatters off the plankton drifting in the upper ocean. From the Doppler shift of the returning sound, the component of scatterer velocity parallel to the sonar beam can be deduced at many ranges.

After preliminary experimentation with existing sonars, a special purpose Doppler scattering sonar was developed. The sonar consists of a 1.5 m diameter array of 1680 individual transducers, each driven in uniform phase and power. The total array is driven at 32 KW peak power, between 65 and 90 kHz.

In preliminary tests the sonar was mounted near the bottom of FLIP and directed downward at a 45° angle from horizontal. Profiles of velocity were obtained down to a depth of 1.2 km and a range of 1.6 km. The information from the single sonar duplicates that from a linear array of 64 (one-component) conventional current meters. Following successful tests of the prototype a duplicate was constructed, as well as two smaller sonars. The complete four-sonar system has been mounted on FLIP and will be used to measure the horizontal and vertical variability in water velocity in the top kilometer of the sea. The initial use of the system will be to study the upper ocean internal wavefield. With time, emphasis will gradually shift to observations in the mixed layer and to air-sea interaction processes.

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