Deep seafloor cable observation technologies towards future ocean bottom neutrino detector experiment.

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Long-term neutrino observation at the bottom of deep ocean will open the window to investigate the neutrino source in deep earth’ s interior by escaping from the effect of sources in continental crust and those from anti-neutrinos from reactors. Ocean Bottom neutrino Detector (OBD) was first conceived in University of Hawaii to realize such a geoneutrino observation in the ocean floor in 2005, though only conceptual study and preliminary tests were conducted, and its feasibility is yet remain very uncertain. We now formed a joint research group with collaborators with background of deep seafloor cabled observation network development (such as off-Japan coast DONET seafloor cabled network for earthquake and Tsunami monitoring) and geoneutrino detector in Kamioka (KamLAND), trying to establish a new OBD concept and put it into practice in the future.
From our initial preliminary study of new OBD concept, three stage plans are suggested to develop matured scientific ocean bottom detector with scintillator volume of 10-50 k tons as the third and final stage. The first step is 1-10 tons OBD to demonstrate element technologies for OBD systems. The second stage 1.5 k tons OBD is aiming the first detector to achieve estimation of mantle geo-neutrinos from 3 years observation expecting 8.5 geo-neutrino events a year.
To facilitate long-term multi-year continuous observation in near the deep seafloor, necessitated from the small number of the mantle geo-neutrino events a year, we consider a seafloor cable connection as an indispensable part of the OBD system. There are existing cable technologies designed for long-term observation for earthquake and Tsunamis (DONET: Dense Ocean-floor Network for Earthquake and Tsunamis). In DONET, seafloor sensors distributed in 100 km+ wide area are linked to a submarine cable, which feeds electric power and precision time reference to each seafloor sensors. The cable also supports two-way high-speed communication to each sensor for command and data link. Power distribution is one of key important technical features in seafloor cable network if multiple stations are to share the same submarine cable. In DONET, each 8 sensors can receive up to 45 W power distributed from the Node equipment, which receives 500 W power from the submarine cable. In recent development, we developed a new Node equipment to accommodate more power hangry sensors, which can deliver each 250 W power to four individual sensors. In the current estimation, 1.5 tons OBD will need a lot more power than that, although low power PMT driver and ADC development would make the power demand closer to the ~ 10kVA limit of power feeding by telecom standard land equipment, if the OBD receives all power without any power distribution mechanism. In the new Node equipment, users can connect to seafloor sensors via a fiber optic link which can give 1 Gbps speed and very high precision time synchronization, which would support communication needs for OBD system.
We are currently planning for seafloor experiment of a 1-10 tons class OBD to demonstrate technical elements for the first stage. Primary candidate site for such demonstration experiment is 1100 m deep seafloor in Sagami Bay, Japan, where submarine cable connection is available to that deep seafloor. The technical elements to be demonstrated include PMT detector package that functions at high ambient pressure (10~60 MPa) in deep seafloor, high performance liquid scintillator in low temperature and high ambient pressure, as well as reliable and low power data acquisition and telemetry system which support OBD operation for many years. With the demonstration OBD in the deep seafloor, we also expect to obtain in-situ seafloor environmental information necessary to design a larger scale OBD, such as the flux of neutron and muon in deep sea as well as radioactive material concentration in deep seawater. For the

planned 1-10 tons class detector, we also estimated the level of expected neutron background for different structure of the detector vessel.

