July, 19, 2017

Notes from the Ocean Bottom Detector (OBD) 1-day meeting on board the Chikyu:

Some 25 ocean engineers, particle physicist and geoscientists from JAMSTEC, Tohoku University, and other institutions met for the first time to discuss the development of an Ocean Bottom Detector (OBD) that would produce geoneutrino images of the Earth's deep interior. The 9 July meeting, hosted by on board Chikyu, included Chikyu tour, a series of presentations on the current science and technology followed by presentations and discussions on developing and testing a prototype (a ∼10 ton detector) instrument and a technology demonstration detector that could establish the mantle flux of geoneutrinos.

Discussion points included the following:

Site Location

- near shore location (i.e., 300km or less) to resupply the Chikyu and its crew
- optimize location by using insights from existing site surveys
- seek possible compatibility with Moho drilling site
- consider using existing underwater cabling (e.g. 45 W/interface in DONET1 case)
- North Arch of Hawaii suggested as a surveyed, non-continental, near shore location for OBD

Communications with and Powering the detector

- understand limitations of current technology for delivering power to the detector
- supplying power from Chikyu, which can produce 30 MW, needs to be discussed even if 100 kW level
- addressing the importance of data transfer needs (e.g. ∼350 GB/day in KamLAND case) and detector stability check needs (should be much smaller than full data) from detector to shore

Purifications systems (*LS* and water)

- *Liquid Scintillator* (*LS*) purification process is a power intensive concern. Where? When?
- need to have water purification system for muon veto area on vessel and circulate?
- can oil be substituted for muon veto layer?

Needs for Design Detector

- Categories of phases; 1. deployment, 2. measurement, 3. maintenance and recovery

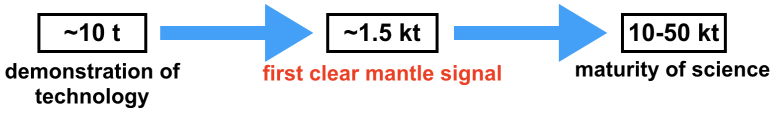
Prototype detector

- design and test a ∼10 ton, deep water detector
- goals: to address technology challenges
- critically evaluate performance of
  - light transmission of *LS* at ocean bottom environment
  - stability of *PhotoMultiplier Tube* (*PMT*) at ocean bottom pressures
  - pressure compensation device for *LS* and *PMT* housing
  - communications and power connections and performance
- understand power demands on system

Identified immediate action items

- submission (early August) of an abstract and poster presentation for the 7th Neutrino Geoscience meeting, 21-23 October 2019 in Prague, Czech Republic
- session submission (open early September early October) for joint JpGU-AGU meeting May 2020; session topic should multidisciplinary and session organizers should include JpGU and AGU conveners. Working title: Exploring the Earth's interior using cutting edge science and technology
- establish (immediately) a working group (5-10 people) diversity of members including disciplinary (engineering, physics and geology) and institutional (JAMSTEC, Tohoku U, other) considerations

Potential Strategy



OBD Working group

Members:
JAMSTEC: Kenta Ueki, Natsue Abe, Masanori Kyo, Noriaki Sakurai, Eiichiro Araki, Takashi Kasaya, Hiroshi Yoshida
Tohoku University: Hiroko Watanabe, Kunio Inoue, Bill McDonough

Agenda: set goals and working timelines for realization and deployment of 1.5 kton ocean bottom detector (OBD), with the long-term goal of building a 10 to 50 kton detector for applications in geology, physics, astroparticle physics, and more.

Potential schedule:

for NGS 2019

- establish several kinds of detector deployment and operation idea and develop list of pros and cons

year 1: laboratory tests for ∼10 ton prototype detector

- establish a cost estimate and funding profile for designing and testing a ∼10 ton prototype detector
- research and develop beyond the >10 year old Hanohano engineering report
- laboratory tests and simulations of a prototype detector
- design a ∼10 ton prototype detector, complete with the following components
  filled with *LS* (e.g., LAB) and calibration source
  inner framework complete with *PMT* array and associated electronics
  pressure compensation device to accommodate *LS* volume change
  2 outside muon sensing *PMTs* in benthos spheres
  externally deployed, gamma ray detector (e.g., HPGe or NaI)
- reporting performance and problems encountered with prototype testing
- evaluation of potential deployment sites - develop list of pros and cons

year 2: developments of ∼10 ton prototype detector

- nautical application for ∼10 ton prototype detector test under the sea (April - July)
- establish a cost estimate and funding profile for designing and constructing a ∼10 ton prototype detector
- construction of ∼10 ton prototype detector

year 3: field test of ∼10 ton prototype detector, and starting study of 1.5 kt detector

- field test the prototype detector under these possible conditions
  4 km water depth, offshore Japan, preferable with communications and power to land
  1-2 months deployment
  technology agenda: way to deploy and recover the detector, power supply, data transfer, detector calibration
  science agenda: environment measurement for future detector (muon flux, neutron flux, density of sea water, radioactivity (U, Th, K), etc)
- reporting performance and problems encountered with prototype testing
- identify and begin collaborations with international partners
- evaluation of potential deployment sites of 1.5 kton detector- develop list of pros and cons
- establish a cost estimate and funding profile for designing and testing a 1.5 kton detector

beyond

- design of a 1.5 kton detector
- design *port-to-site* transport (and return) and deployment details for the 1.5 kton detector
- laboratory tests
- deployment of 1.5 kton detector
  4 km water depth
  3+ year deployment
  science agenda: determining the mantle's geoneutrino flux to ±25%
- report mantle's geoneutrino flux and transform the discussion on the power driving the Earth's engine