APPENDIX XV

DUMAND-Deep Underwater Muon and Neutrino Detection

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To- DESSC

From- John Learned
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For The DUMAND Collaboration

Date- May 24, 1995

Subject- Cooperative use of JASON for DUMAND installation and service

This memo contains a description of the DUMAND Neutrino Astronomy Project in brief terms, summarizes the status of already installed deep ocean facilities, and outlines our needs for deep submergence vehicles to install and maintain the laboratory which is located 25 km west of the Island of Hawaii at a depth of 4800 meters.

We respectfully request that DESSC consider the following-

1) DESSC endorsement of the cross disciplinary use of the JASON/MEDEA system for the DUMAND deep ocean operations is requested. The DUMAND System will need to be serviced by the ROV at a frequency of approximately once per year for order of one week, beyond a first year effort of several weeks for initial installation. We have already discussed minor modifications to JASON vehicle with the Deep Submergence Operations Group at Woods Hole Oceanographic (Mr. Andy Bowen - of the unmanned vehicles group has been the prime point of contact), in order to accomplish the tasks. These tasks are similar to those needed for almost any deep ocean terminal/laboratory. Funds required for any vehicle modifications or special components needed to carry out the DUMAND work would be provided by the DUMAND Project.

2) We ask the advice of DESSC on the best means for us to proceed to acquire needed facilities support, given that the DUMAND project is an approved and multiply reviewed project which is funded by the Dept. of Energy, which does not have deep submergence facilities like the Ocean Sciences Branch of NSF. The use of the JASON ROV for the DUMAND deployment and servicing is currently caught between agency and disciplinary forces, in kind of a Catch -22 situation. One line of argument in favor of shared, interagency use of facilities such as the deep submergence vehicles supported by NSF/ONR and NOAA is that DOE provides 'free' accelerator beam time to NSF-Physics researchers, so that in all fairness the DUMAND group (the only high energy physics project conducting experiments in the oceans), should have similar access to consideration for ship time and ROV allocations; from the NSF shared-use oceanographic facilities. To date, NSF-OCE facilities personnel have stated that DUMAND was not eligible for consideration for such ship time unless DOE paid the bill, or unless we had NSF funded collaborators (which we had in the past and did receive ship time for testing in previous years but our NSF collaborator has retired). (In passing I might mention that I have been unable to obtain a written policy which defines the rules.)

3) We have a deep ocean multiple use terminal already in place at depth, with high data rate capability, and it has capacity beyond our physics needs (due to built-in spare channels). We have considered the

route of soliciting ocean researchers to co-propose other ocean science activities which might be cost-effectively carried out with this unique asset (25 km West of the Big Island of Hawaii, and at 4.76 km depth in a subsidence basin).We would welcome shared-use of this potential deep ocean monitoring system for other oceanographic research and stand ready to collaborate with marine scientists in providing access to the DUMAND facility for their work. However, because of the urgent need to deploy the system (we are ready to perform tests for which JASON is needed as soon as possible in 1995) we do not feel that it is viable to wait for other oceanographic work to be attached to DUMAND so that it fits the mold of currently acceptable NSF-OCE facilities use.

4) We might also depend upon facilities potentially available from the USN in the Submarine Development Group One from San Diego. There are several problems with this however. First, it is a Navy facility and always at the command of flag officers who properly put the military concerns first, but who often care little about scientific missions (which do not contribute to their career advancement). Second, due to the decreasing funding of the military generally, the substantial amount of training time formerly available at little or no cost, must now be supported partially, For us in Hawaii this means paying unacceptably large transit costs (of order $250K), if we are the only user. Third, there is the systemic USN problem due to rotation of officers every two years, which means that long term experience is not accumulated (and historical documentation is not very good either). Fourth, we hear continuing rumors about the possible demise of the entire SubDevGrp1 operation. Thus, while we have had good relations with the SubDevGrp1 people, and there are some excellent people there now who have a really supportive attitude about science (particularly our liaison, Cmdr John Green), their use in the long run seems not a viable option.

We respectfully request that this memo be distributed to the DESSC membership and agency representatives; at the meeting and that the issue be discussed. If you require further information please do not hesitate to contact me by email or telephone at the addresses listed below. Thank you in advance for your consideration of this matter.

Sincerely,

(signed)

John G. Learned

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The DUMAND Project - Scientific Overview and Planning

Since the discovery of neutrinos in the 1950s, people have dreamed of viewing the universe in the 'light' of these particles, which must stream to us in vast numbers from astrophysical objects. Neutrinos are produced in essentially any place of high activity, from such nearby objects as galactic black holes and neutron stars, to the distant centers of the most luminous objects in the universe, the quasars. The neutrinos do not interact much with ordinary matter, and thus can flow freely from even the most dense objects, and will travel in straight lines to us (unlike charged cosmic rays which wander about due to the magnetic fields in the galaxy). Photons, the stuff of all astronomy until now, whether radio, light, or x-rays and gamma rays, do not escape from densely shrouded sources. The higher energy gamma rays are absorbed just in traversing the distance to quasars. But, while neutrinos will allow insight into the enigmatic engines of the universe, these neutrinos are exceedingly hard to catch, mostly going right on through the earth without a trace.

Occasionally a neutrino (one in a million or so for the energies in question) will snatch a charge from a quark in the earth near a detector and become a charged particle. The electric charge then disturbs atoms along the path and radiates a wake of light, (called Cherenkov Radiation) as it travels at greater than the local speed of light (which in water is 3/4 of the speed in vacuum). Large photomultipliers can then

provide signals to trace the trajectory of such a particle, which travels kilometer distances and reveals the initial neutrino source direction to a degree or less. One can imagine a neutrino observatory such as we are building as a rotating all-sky (fish-eye lens) camera observing a faint image which will take months or years to develop.

There are many spinoffs to the neutrino detection program, including searches for the missing dark matter of the universe, study of the interactions of these particles at energies not assessable at human made accelerators, and even a plan to do earth tomography with neutrinos. Acoustic detection of neutrino induced particle cascades, which may be possible at the highest energies, will also be pursued in DUMAND.

The idea of carrying out neutrino astronomy from the depths of the ocean was conceived many years ago, owing to the unique nature of the benthic region.- phenomenal optical clarity, shielding, placidity, sparsely of biological activity (including human!), ready access from mid-ocean volcanic islands, and of course cost of material. Ocean is our shielding, target material, and detection medium. It took dearly a decade of activity, however, to;. examine the environment (it was found to be better than anticipated optically); study the backgrounds (bioluminescence having been a worry); develop the technology needed (in optical detectors, fiber optics, electronics, and overcoming a frustrating series of connector difficulties); and for physicists to gain the requisite operating and engineering experience in the deep ocean to design the reliable high technology equipment needed for an ocean laboratory for long term deployment.

The array under construction was approved in 1990, and will consist of eight moorings 450 m tall, placed in a 106 m diameter octagonal pattern, with one further instrument string in the center. Each instrument string consists of 24 optical detectors, each encased in a standard 17 inch glass instrument housing, plus 2 laser calibration devices, 5 hydrophones, a programmable pinger, environmental sensors, and a central electronics unit. Power at 350 VDC is delivered to a 12 port junction box, along with 12 single-rnode optical fibers, via a 30km armored cable to shore.

Near Future DUMAND Operations

This junction box has already been installed on a flat, barren bottom in the Kaho'olawe Deep (West of the Big Island of Hawaii), and successfully connected to a shore laboratory at Keahole Point, Hawaii. One instrument String was installed at the time of table laying, but this string failed soon due to a leak, and was recovered via acoustic release. The umbilical cable remaining from this initial string is now shorted (it was designed for a guillotined release) and must be removed prior to activation of the junction box; at present we are hoping that the ATV will be able to carry out this task (requiring about one half day of dive time) on the newly organized expedition of the Laney Chouest to Hawaii during June 1995.

We have developed a plan in concert with WHOI personnel, to employ the JASON cable and winch for sea trials of the reliability of the three moorings, prior to commitment to the deployment operations. These tests can employ a locally available ship, not needing DP capability. The DUMAND Project would provide the funding to cover the expenses for the winch costs including mobilization/demobilization and personnel for this work,

The first three moorings are ready for installation, though of course under continuous testing and improvement in our laboratory at UH while awaiting a ship for deployment and an ROV or DSV for connection. Deployment involves the use of a DP ship for placement of the mooring with several meter precision (an acoustic network is also in place) In the second step, an electro-optic connector must be dragged from the string base some 50 m to the junction box and plugged in. The connection operation was demonstrated to be workable (about 12 times) at the DUMAND site in 10/92 using the US Navy ATV with a mockup junction box and connector. JASON has practiced the connector removal operation in shallow water at WHOI in early 1995. JASON is the only available academic/civilian ROV in the US that is capable of carrying out these operations.

Summary of DUMAND's needs for joint operations with JASON,

1) Mooring tests from junction box as early as Summer/Fall, 1995.

2) Deployment and connection operations for three moorings during 1996.

3) Further activities for the deployment and connection of six more moorings in approximately 1997, plus ongoing maintenance at a frequency of order of once per year or less, for a period of less than five years.

Note that long range plans by a world consortium to build an array fifty times larger than DUMAND (a full cubic kilometer in size) are in formation at present for construction around the turn of the century. If carried out in Hawaii, this project would probably involve requiring an ROV and platform to be locally available for a significant fraction of time over some years, and certainly with direct funding of associated costs. Several options for that are under study, but we hope that the project can be carried out with oceanographic community involvement to our mutual benefit. Whatever we do would hopefully be carried out with significant involvement by WHOI and working within the scope of the DEESC.

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