# Dumand II (Deep Underwater Muon and Neutrino Detector). Ocean deployment is underway.

Presented by
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**Abstract**

*The first stage of Dumand II, a particle detector for astronomy with a sensitive area of 3100 $m^2$, comprised of an array of 72 38-cm photomultipliers is being deployed in the Pacific at a depth of 4800m. It will be capable of detecting astronomical point sources of TeV neutrinos which exceed a flux of $8*10^{-10}$ $cm^{-2}$ $s^{-1}$. Spatially unresolved TeV neutrinos such as the integral flux from Active Galactic Nuclei can be detected to the level of $10^{-14}$ $cm^{-2}s^{-1}$. Models of AGN's extrapolated from observed Gamma fluxes predict neutrino flux levels of this level and should produce about 50 events per year in the first stage. For muons above 3 TeV, the effective detection sensitivity will exceed that of any previous detector. The full Dumand II detector will have a sensitive area of 20000 $m^2$.*

## Introduction.

In this conference we have been reminded that in spite of the success of the Standard Model of Particles, we still have many oustanding basic puzzles of nature. Professor Veltman[1], in his talk at the conference opening, emphasized our lack of knowledge of the source of energy of quasars and the source of the flattened velocity-radius curves of the stars in a galaxy. He suggested that these puzzles may well be the key to new and deep insights. It would serve us well to make measurements of the primary processes of these astrophysical objects. Fluxes of ultra high energy hadrons and photons have been detected that presumably are emitted by astrophysical source. It is natural to assume that the sources would emit approximately the same energy in fluxes of neutrinos. Imaging by ultra high energy photons have given hints of the sources. Our premise is that imaging the astrophysical sources by their neutrino emissions will yield insights as to the location of the sources and to the physical processes which give rise to the ultra high energy emissions. We note that the imaging of the sun and SN1987A by neutrinos have consolidated our understanding of the energy sources for these objects by measuring the direct neutrino emissions of the primary processes.

figure 1.

### The Dumand Array.

Figure 1 is a sketch of the to be completed Dumand II Array. The dimensions of this array can best be illustrated by comparing this with the Eiffel tower which has probably made an indelible impressions on all the attendees here. The Dumand II is an instrumented column of water which would envelope the Eiffel Tower both in height and the width of the base. Charged particles produced by impinging neutrinos would be detected by their cherenkov light emission. We will be able to measure the energy and direction of the charged particles with the array of photomultiplier tubes. This will imply the neutrino direction to an angle of 1 degree. The large size of the array is dictated by the low specific detection efficiency of neutrinos.. We note that even the primary stage of the 3 strings will be the largest astrophysical detector.

Dumand II[2] will be an array of 216 optical modules deployed in nine vertical strings moored to the ocean floor that will be placed in an octagonal configuration of 100 m diameter with one string in the center. The array will be moored at the ocean floor (depth 4800m) 25 km from the island of Hawaii. Data-taking is expected to begin in late 1993 after the first three strings with 72 optical modules are deployed.

### Summary of the status of Dumand II construction.

Like the construction period of the Eiffel tower, Dumand II is taking about 3 years to prefabricate the parts which will then be assembled *in-situ* in about 2 years. The design of Dumand II [3] is complete and components for the first three strings are currently being assembled and tested. Optical modules from Japan and Europe are being shipped to Hawaii for final testing and incorporation in the strings. The underwater portion of the data acquisition systems being made in the US. laboratories are being tested in ensemble.

The optical and power shore cable is being prepared for laying from the site to the shore station. The shore cable is attached to a Junction box which serves as the center for communicating signals and distributing power to the array.

At the same time, Dumand II crews have been preparing the site and testing the underwater assembly operations. The site has been prepared by the placement of markers (acoustical transponders) which have been surveyed to geocentric coordinates. The suitability of the site has been surveyed by acoustical means, film camera and video recordings; but we have also cruised the area in a manned submarine, the USN's Sea Cliff, to be assured that the site is fairly flat and free of any features that would interfere with a successful deployment and operation. We have verified the exceptional clarity of the water. The bottom is ideal for anchoring the moorings and for siting the junction box.

### Deployment Schedule

Final assembly and testing operations are now on going in Hawaii. We have scheduled a ship (RV Independence) for the deployment of the first string, the junction box and the shore cable in October of this year. The other two strings will be deployed shortly thereafter.

### Capabilities of the 3-string array in the initial deployment

The capabilities of the full Dumand II array has been reviewed in many reports[4]. Here I will summarize some of the expected observations of the 3-string array. Monte Carlo simulations of the response of the 3-string array (Triad) will have an effective detection area for muons above 3 TeV that exceed previous and existing underground detectors. The median pointing accuracy at this energy will be about 3 degrees. Thus the Triad will be able to search for astronomical sources of very high energy neutrinos at a greater level of sensitivity than has so far been achieved in other experiments. Our designed trigger while keeping the trigger rate at a reasonable level has the unintneded consequence of a strong energy dependence. For 10 TeV muons, the effective area will be 3100 $m^2$ and scales roughly with log(energy). Using the neutrino fluxes calculated by several authors for Active Galactic Nuclei (AGN's), the following table of projected event rates is obtained:

| **Model[5]** | **Event Rate ($year^{-1}$)** |
|---|---|
| Biermann | 72 |
| Stecker et al | 97 |
| Sikora and Begeleman | 71 |
| Protheroe and Szabo | 21 |

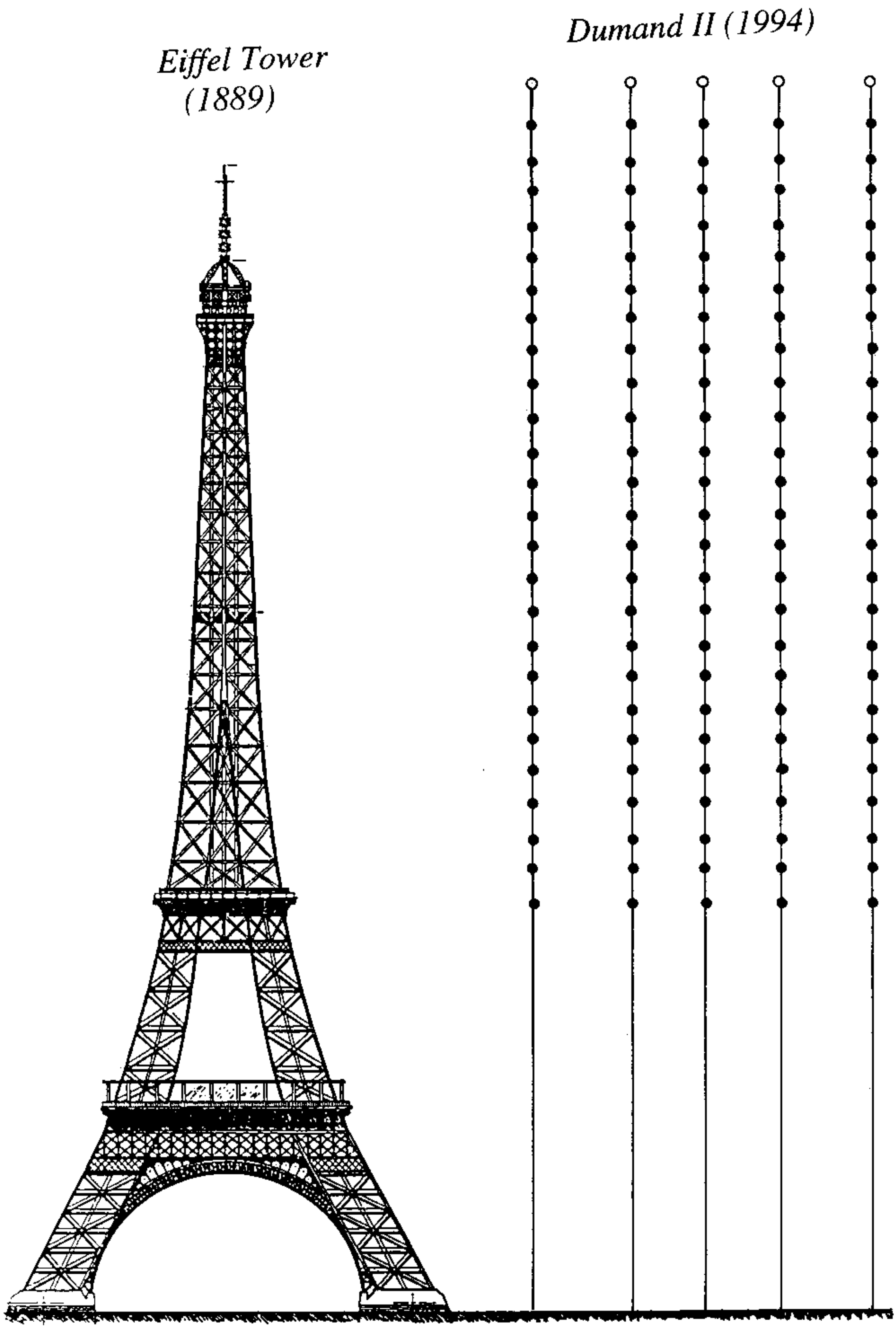
The rates calculated are the integral flux from all AGN's in the universe. Except for the Protheroe et al prediction, all models predict diffuse event rates which exceed the atmospheric background rates. Thus the triad will have substantial capability for discovery of UHE cascades and could provide the first evidence for diffuse AGN fluxes.

**Conclusions.**

The Dumand II construction has made great progress since the last report at the International Europhysics Conference on High Energy Physics. We hope that by the same time in the next meeting we will be able to report the actual data and with luck the beginning of high energy neutrino astronomy.

**References**

1. Veltman, Talk at EPS opening session.
2. Arthur Roberts, **Rev. Mod. Physics 64**, p 259 (1992).
3. A session is devoted to Dumand progress atthe **23rd International Cosmic Ray Conference at Calgary**, Canada, 19-23 July, 1993. The descriptions will appear in the proceedings of this conference.
4. V. J. Stenger, Proc. **2nd Nestor International Workshop,** 19-22 October, 1992, Pylos Greece, L. Resvanis, Ed.
5. Contributions from Biermann, Stecker etal , Sikora and Begelman, and Protheroe and Szabo are published in the proceedings of the **High Energy Neutrino Astronomy Conference** at the University of Hawaii, March,1992.


Eiffel Tower
(1889)
Dumand II (1994)