RESPONSE OF OCTAGON TO FERMILAB NEUTRINOS

V.J. Stenger
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I have run the Hawaii DUMAND Monte Carlo program DUMC on low energy neutrinos that would come from Fermilab if the proposal outlined in HDC-11-89 is approved.

This has been done in several stages, which give consistent results. In all cases, the muons from the neutrinos are assumed to point back at Fermilab, with a zenith angle of 119.5^o at the array.

1) First I simply generated 20 GeV muons and passed them through the array using existing algorithms. The muons were generated to start uniformly distributed on the end surface and parallel to the axis of a cylinder of radius 156.32 m and length the same. The cylinder's axis points to Fermilab and the other end is at the center of the array. (Don't worry about these details, since this was just the first run and I include it here because it shows consistent results). The result was an effective area for fully reconstructed muons of 16,700 m^2. The mean pointing error was 4.2^o and the median error 1.0^o. Since the range of a 20 GeV muon is about 68 m, we can estimate the effective volume of the array to be (68)(16,700) = 1.13x10^6 m^3.

2) Next I generated neutrino interactions uniformly within a vertical cylinder that was larger than the array by 30 m in radius and length: radius = 82.26 m, length = 260 m. A uniform Bjorken y distribution was generated, so Emu = (1-y)Enu. In this case, a fixed Enu = 20 GeV was used. The effective volume for fully reconstructed events was 1.08x10^6 m^3. The mean pointing error was 5.1^o and the median 2.0^o.

3) Next I generated the neutrino energy according to the spectrum in HDC-11-89 (or at least, the one provided to me by J. Learned). The results

were an effective volume for fully reconstructed events of 1.00×10^6 m^3, mean pointing error 4.7°, median 2.2°.

4) Finally I generated light from hadron cascade of energy Enu−Emu and added that to the light pool. The results were identical to 3) above, with no addition triggers resulting.

Conclusion

The effective volume of the Octagon array to neutrinos from Fermilab with energies in the range of 20 GeV will be about 10^6 m^3. This is about half the enclosed volume, so I conclude that the detection efficiency will be about 50%. Learned and Peterson assumed 100% in HDC−11−89. Detection is limited to the muon, with the hadron shower adding nothing to the detectability of the event with the tight muon trigger used.

My conclusions are very insensitive to the actual spectrum and method of analysis, and so should be fairly robust (to use a currently fashionable word). However it does assume the same, rather stringent, trigger conditions as for throughgoing very high energy muons, namely a minimum of 10 optical modules and 3 strings for the final fit. This is needed, in that case, to reduce the background of false triggers from a random background taken to be 100 KHz per tube.

If the time structure of the Fermilab beam were used to generate a tighter gate, the background could be significantly reduced and a looser requirement on the number of modules could be applied. However, it should be recognized that fewer modules will result in a poorer fit, so this may not be desirable.