# SUMMARY OF NEUTRINO PROPOSALS

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## ABSTRACT

The first eleven neutrino proposals submitted to NAL are summarized.

The purpose of this note is to summarize and catalogue the neutrino proposals as of this date, making possible a rapid introduction to this immense subject. No judgment of the relative merits of individual proposals is intended, nor is this review in any sense a substitute for the original documents, which should be consulted for accuracy and interpretation, as well as for technical detail.

The first eleven neutrino proposals are listed in Table I with the target material, neutrino energy, proton energy, and total number of protons requested. The next two columns indicate whether pion-kaon focusing should distinguish meson charge, thereby separating neutrinos from antineutrinos. The last column indicates the physics topics emphasized in each proposal where various letters are associated with particular topics in the key below. There is considerable arbitrariness in the table, particularly in the proton energy assumed, the range of neutrino energies considered accessible, and, most of all, in the physics explicitly proposed. For example, people rarely attempted to list all of the interactions they might have studied, while some of the interactions that were named would clearly be done better by other techniques emphasizing these areas.

Certain generalizations may be helpful at this point. First, the proposals seem to fall naturally into five groups:

1. Bubble chamber with $H_2$ or $D_2$,
2. Bubble chamber with $H_2$ or $D_2$ surrounded by Ne,
3. Bubble chamber with Ne,
4. Hybrid consisting of $H_2$ or $D_2$ bubble chamber with auxiliary counters and chambers,
5. Counters and spark chambers.

A second generalization is that the bubble-chamber or hybrid proposals--essentially proposals or parts thereof using $H_2$ or $D_2$--are aimed at somewhat lower energies than the counter proposals in which massive high-Z targets compensate for the

low-neutrino intensity expected at high energies. Furthermore, the effectiveness of the calorimeters described in the counter proposals is lower in the low-energy region than at high energies, the angular acceptances are smaller for complete event analysis, and the physics emphasized by the counter and bubble-chamber experiments is rather different, as indicated in the last column of the table.

Third, since the neutrino energy spectrum is broad, the neutrino flux is known for a particular interaction only when the total energy, including neutron and neutral-pion components, is measured. (Proposal 21 is exceptional in that a neutrino beam with narrow energy band is used.) Total cross sections, deep-inelastic cross sections, and other channels involving neutrals thus require detectors that are thick in radiation and collision lengths.

In short, the counter proposals have emphasized total cross sections, deep inelastic scattering, and the $W^{\pm}$ search at high energy, while the bubble-chamber proposals have concentrated on specific (generally 3c) reactions at lower energies: elastic form factors, single pion production, hyperon production, polarization, and the Adler tests. The hybrid proposal combines massive detectors with the bubble-chamber target but is rate-limited by the choice of $H_2$ and $D_2$ to neutrino energies below about 120 GeV.

Table I. Summary of Neutrino Proposals.

| | Number | Target | $E_\nu$(GeV) | $E_p$(GeV) | $N_p(10^{19})$ | Focus | Charge Sep. | Proposed Physics Emphasis |
|---|---|---|---|---|---|---|---|---|
| BC | 20$\nu$ | $D_2$ | 0-75<br>0-120 | 200<br>500 | 0.75<br>0.25 | yes | yes | A |
| BC | 31$\bar{\nu}$ | $H_2$ | 0-100 | 500 | 1 | yes | yes | ABDEIJG |
| BC | 45$\nu$ | $H_2$ | 5-50 | 200 | 0.2 | yes | yes | BCDFIJKMN |
| BC | 42$\nu$ | $D_2$+Ne (TST) | 8 | 200 | 0.05 | yes | yes | ABDEFGI |
| BC | 44$\nu$ | $D_2$+Ne (TST) | 0-75<br>0-170 | 200<br>500 | 0.5 | yes | yes | ABCDFGIKMN |
| BC | 53$\nu$ | $D_2$+Ne+Pb | 0-75<br>0-170 | 200<br>500 | 2 | yes | yes<br>(no) | ABDEFGHILM |
| BC | 28$\nu$ | Ne | 0-150 | 200 | 2 | yes<br>(no) | yes<br>(no) | FGHJKLN |
| Hy | 9$\nu$, $\bar{\nu}$ | $H_2$($D_2$) | 15-75<br>15-120 | 200<br>500 | 2(2)<br>2 | yes | yes | AGIJL |
| C | 1$\nu$ | $H_2$, Pb | 10-150<br>10-300 | 200<br>500 | 4 | yes | yes<br>(no) | IHLGN |
| C | 21$\nu$ | Fe | 300±18 | 400 | 0.2 | yes | yes | GILN |
| C | 38$\nu$ | $H_2$, Al<br>Fe, U | 20-150<br>20-300 | 200<br>500 | 0.2 | yes | yes | IHLGN |

BC = Bubble Chamber, Hy = Hybrid, C = Counters and Spark Chambers
(no) indicates focusing or charge separation optional; (TST) = Track-Sensitive Target
Physics Designation:

A. $\nu$ elastic form factors
B. 1-pion production (Adler test)
C. vector-meson production
D. hyperon production $\Delta S = 1$, $\Delta S = 0$ (associated production)
E. polarization
F. $d^2\sigma/d\nu dq^2$ at small $q^2$ (Adler test)
G. total cross sections
H. four-Fermion interactions
I. $W^\pm$ search
J. ($\nu$-$\bar{\nu}$) comparison
K. neutral-current interactions
L. deep-inelastic scattering
M. inverse muon decay
N. miscellaneous: heavy-lepton search, monopole search, A dependence.