CONF-8310237--3

12/20/83

BNL--34144

DE84 006540

A Monopole Search Using an Accelerator Detector

Japan/USA Neutrino Collaboration[1]

Presented by P.L. Connolly, Brookhaven National Laboratory

at the Monopole '83 Conference

University of Michigan, Ann Arbor, MI Oct. 6-9

[1] L.A. Ahrens, S.H. Aronson, P.L. Connolly, T.E. Erickson, B.G. Gibbard, M. Montag, M.J. Murtagh, S.J. Murtagh, S. Terada, A.M. Thorndike, W.G. Walker, P.J. Wanderer, D.H. White (BNL); J.L. Callas, D. Cutts, R.S. Dulude, B.W. Hughlock, R.E. Lanou, J .T. Massimo, T. Shinkawa (Brown); K. Amako and S. Kabe (KEK); Y. Nagashima, Y. Suzuki, S. Tatsumi (Osaka); K. Abe, E.W. Beier, D.C. Doughty, L.S. Durkin, R.S. Galik, S.M. Heagy, M. Hurley, A.K. Mann, F.M. Newcomer, R. Van Berg, H.H. Williams, T. York (Penn); P. Clarke, D. Hedin, M.D. Marx, E. Stern (SUNY/SB); T. Miyachi, (Tokyo)

A Monopole Search Using an Accelerator Detector

Japan/USA Neutrino Collaboration

Presented by P.L. Connolly, Brookhaven National Laboratory

A neutrino detector at the Brookhaven AGS has been used to investigate the feasibility of using an already constructed apparatus for GUT monopole searches. A flux limit (90%CL) of 5.2×10^{-12} cm^{-2} sec^{-1} str^{-1} was found. The limitations of such an approach are discussed.

This collaboration is primarily interested in the elastic scattering of ν ($\bar{\nu}$) on electrons and protons and the design of the apparatus is determined by these goals. The main part of the detector consists of 112 identical modules. Each module consists of a plane of liquid scintillator cells for event time, and 2 planes of proportional drift tubes for xy position measurement. In addition there is a gamma catcher for downstream electromagnetic shower measurement and a muon spectrometer for normalization and beam studies.

The apparatus is read out by 4 PDP LSI-11/3 linked to a PDP 11-34. Further apparatus details and early results can be found in a recent publication.[1]

---

[1] L.A. Ahrens, S.H. Aronson, P.L. Connolly, T.E. Erickson, B.G. Gibbard, M. Montag, M.J. Murtagh, S.J. Murtagh, S. Terada, A.M. Thorndike, W.G. Walker, P.J. Wanderer, D.H. White (BNL); J.L. Callas, D. Cutts, R.S. Dulude, B.W. Hughlock, R.E. Lanou, J .T. Massimo, T. Shinkawa (Brown); K. Amako and S. Kabe (KEK); Y. Nagashima, Y. Suzuki, S. Tatsumi (Osaka); K. Abe, E.W. Beier, D.C. Doughty, L.S. Durkin, R.S. Galik, S.M. Heagy, M. Hurley, A.K. Mann, F.M. Newcomer, R. Van Berg, H.H. Williams, T. York (Penn); P. Clarke, D. Hedin, M.D. Marx, E. Stern (SUNY/SB); T. Miyachi, (Tokyo), Measurement of the Cross Section of $\nu_\mu + e^- \rightarrow \nu_\mu + e^-$, Phys. Rev. Lett. 51, 1514 (1983).

Only the liquid scintillator planes are used in this study. The scintillator is a mixture of NE235A and mineral oil enclosed in extruded acrylic tubes 7.9 cm deep and 25 cm high. Sixteen of these cells are assembled in a vertical wall with an active area of 4.22 x 4.09 m^2. The horizontal distance between scintillator planes is 17 cm. The overall size is comparable to existing dedicated monopole detectors. Each cell is viewed at each end by a 2" Amperex 2212A phototube. Discriminator thresholds were set so that the apparatus is sensitive to 1/3 x min. ionizing particle. Times are measured with an accuracy of a few ns.

For neutrino beam running, the apparatus is run in a completely triggerless mode. A gate (10 μs) is opened slightly before arrival of the neutrino beam and all detector elements with data above threshold are read out at the end of the gate. There are a large set of calibration and monitoring routines which can be run in the period between beam pulses. One of these is called by us the Horizontal Cosmic Ray (HCR) trigger. In this mode the calorimeter planes are divided into groups of 4 successive planes. In each group, at least 3 of the 4 planes must have a cell in which both PMT tubes fired in coincidence (150 ns.). Super groups of 8, 12, 16 etc. planes can be formed. A gate is opened and if the required trigger is found in time coincidence the data are read out. If the trigger is not satisfied another gate is automatically initiated. This HCR trigger is normally satisfied by single relativistic cosmic ray muons moving in a direction roughly parallel to the neutrino beam direction. On-line analysis of the read out (PDT's included) from this trigger provides a very useful monitor of the efficiency and performance of the detector.

We have modified this trigger (using a super group of 32 planes) to search for low velocity ($\beta < .2$) penetrating particles. To allow for traversal of slow particles, the gate width was increased to 40 μs and the signals from each plane were latched so that the overall coincidence could be triggered. A veto circuit was included to exclude triggers caused by a single fast particle traversing the super group.

The trigger rate was then dominated by two (or more) independent fast muons. If there were but two fast muons, one of them must have traversed at least 1/2 of the required range. A routine was inserted into the 11/34 program which histogrammed the times of the individual hits. If the number of hits in a single bin exceeded that expected from a particle traversing 1/2 of the super group, the trigger was rejected. No dead time was caused by this routine.

Surviving triggers were written to tape for off-line analysis. Most of these were cases in which the time of arrival was such that the times were histogrammed into 2 adjacent bins and so evaded the on-line software filter. The off-line program required an explanation for each trigger in terms of known phenomenon. i.e. The 32 planes were hit by a small number of tracks each of which had a narrow time width. Any event which did not satisfy this criterion was examined in detail. Most of these were triggers in which most of the planes were hit by a few fast tracks and the remainder of the trigger requirement was satisfied by noise. No interesting candidates were found.

We find a flux limit (90% Confidence Level) of

. $\Omega = 14.5\ m^2$ str

. $t = 3 \times 10^6$ sec

. $F < 5.2 \times 10^{-12}\ cm^{-2}\ str^{-1}\ sec^{-1}$

in the velocity range $10^{-3} \leq \beta \leq .2$

We have shown that a large accelerator detector can be operated for a monopole search. The lower velocity limit in this study was constrained by the gate width which could be readily extended. Using all the apparatus could contribute an additional factor of ≈3 but a major limitation is the small solid angle. We are currently investigating methods to make the detector effectively isotropic.

This research has been supported in part by the U.S. Dept. of Energy under Contract No. DE-AC02-76CH00016.