**Progress Report
Study of Electron-Positron Interactions**

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I. Introduction

For the past seven years, this group has been interested in the study of tests of the Standard Model of Electroweak interactions. The program has centered about the AMY experiment which examines the nature of the final state products produced in electron-positron collisions in the center of mass energy range near 60 GeV. Results of these measurements have shown a remarkable consistency with the predictions of the minimal model of 3 quark and lepton generations and single charged and neutral intermediate bosons. No new particles or excited states have been observed nor has any evidence for departures in cross sections or angular asymmetries from expectations been observed. These conclusions have been even more firmly established by the higher energy results from the LEP and SLC colliders at center of mass energies of about 90 GeV.

The Virginia Tech part of the AMY collaboration is in the process of analyzing data accumulated up to the end of July, 1990 and expects to have completed a number of theses during the forthcoming year. A portion of the effort will begin to address new areas of investigation related in part to our continuing interest in the subject of electroweak interactions. It is clear that the extension of our past endeavours to higher center of mass energies using electron beams will not be possible in the reasonably near future inasmuch as no electron type colliders beyond LEP are envisioned. Our focus is shifting to the other particle which probes the electroweak interactions; namely the neutrino.

There are a number of reasons why the cosmic rays may be a reasonable source for the study of neutrino interactions. First, energies of cosmic ray particles are known to extend to at least 10^{20} eV, which corresponds to center of mass energies of about 10^6 GeV, far beyond present ranges of laboratory study. Second, results emerging from experiments which study the emission of neutrinos from the sun give a hint that the neutrino may have

properties other than that of a point and massless particle. This introduces the possibility that neutrinos will at some energy interact with a substantially higher probability than extrapolations from present day measurements predict.

The relative merit of attempting to observe neutrinos from point sources versus observing neutrinos generally is not easy to predict. The improved ability to interpret is offset by the probably episodic nature of the emission and irreproducibility of the results. In this phase of development, it is best to be sensitive to both sources of neutrinos.

As a second phase of our program at Virginia Tech, we are studying the feasibility of detecting cosmic ray neutrinos in a proposed experiment which we have called NOVA. The results of the test setup will be instrumental in developing an optimum design.

A third program we are involved in is the MEGA experiment at Los Alamos, an experiment to place a limit on the rate of muon decay to electron plus photon which is forbidden by the Standard Model.

II. REPORT ON THE AMY EXPERIMENT

A. AMY STATUS

The AMY experiment at TRISTAN continues to study the physics of electron-positron collisions at center of mass energies between 50 and 64 GeV. In this energy range, the electroweak cross section has a local minimum of ~ 100 pb as the falling QED amplitude becomes comparable to the rising weak amplitude near the Z^0 pole. Thus, the AMY experiment can make sensitive comparisons with the predictions of the Standard Model of the electroweak interaction.

In the summer and fall of 1989, the endcap regions of AMY were reinstrumented with new endcap shower counters (ESC) covering $0.799 \leq \cos \theta \leq 0.982$ and small angle counters (SAC) covering $0.982 \leq \cos \theta \leq 0.9994$. These detectors have substantially improved AMY's solid angle coverage and its energy and angular resolutions in the forward region: the ESC energy resolution for 32 GeV electrons is 8.4% and the angular resolution are $\sigma_\theta = 2.4$ mrad and $\sigma_\phi = 8.0$ mrad.

Testing of the rebuilt synchrotron X-ray detector (XRD) continued in 1990. This detector, sandwiched between the central drift chamber (CDC) and the barrel calorimeter (SHC), is to distinguish electrons from other charged particles such as pions by the presence or absence of associated synchrotron radiation as the particles are bent in the 3 Tesla magnetic field of AMY. Based on a very preliminary analysis of isolated muons and electrons, the XRD has a muon misidentification probability of 6.2% and an electron identification efficiency of 44%. Improvement will require a better knowledge of the charged particle position as it passes through the XRD; most of the work is going into understanding the position resolution.

TRISTAN achieved a center of mass energy of 64 GeV in late 1989; 1.5 pb^{-1} of data were

recorded by AMY at this energy. The energy was reduced to 58 GeV for the February--July 1990 run to maximize the luminosity of TRISTAN. About 27 pb^{-1} of data were recorded by AMY in this period. The lifetime integrated luminosity of AMY now stands at 60 pb^{-1} .

B. PHYSICS RESULTS

The AMY collaborators continue to be active in extracting useful results from the limited data sample. A complete list of new publications since the last progress report appears in the Bibliography; new contributed papers are listed in the Conference Submitted Papers section. Some of the results are summarized below.

1. Comparison of Quark and Gluon Jets: In contrast with the data taken at lower center of masses energies at PEP and PETRA, we see distinct differences in the properties of hadronic jets produced from quark and gluon parents. These differences are apparent, for instance, in the higher concentration of energy near the jet axis for quark-induced jets.

2. Multihadron Event Properties: Comparison of multihadronic events in the TRISTAN energy range with the predictions of the LUND 6.2, LUND 6.3 and HERWIG phenomenological models of $e^+e^- \rightarrow \text{hadrons}$ shows that the LUND 6.3 model best reproduces all of the event shape distributions measured by AMY.

3. Forward-Backward Asymmetry in $e^+e^- \rightarrow b\bar{b}$ and $e^+e^- \rightarrow \text{hadron jets}$: The Standard Model predictions of a forward-backward asymmetry in these processes is confirmed in measurements of hadronic event production in AMY.

4. Measurements of Hadronic R : We see no evidence for production of new quark flavors beyond the five known to date. However, the value of R , the ratio of the hadronic cross section to the lowest-order QED prediction for dimuon production, is still higher than expected from the Standard Model prediction with $M_Z = 91 \text{ GeV}$ and $\sin^2 \theta_W = 0.231$.

The reason for this discrepancy is not known.

5. Observation of Anomalous Production of Muon Pairs in 4-lepton Final States: We see an excess over the QED prediction of $e^+e^- \rightarrow e^+e^-\mu^+\mu^-$ when all four final-state leptons are seen in AMY. We observe 7 events and expect 1.9. The statistical probability of such an excess is 0.34%. No such excess appears in the untagged or single-tagged four-lepton data samples, or in the double-tagged $e^+e^- \rightarrow e^+e^-\mu^+\mu^-$. All of the dimuon pairs have invariant mass below $1 \text{ GeV}/c^2$; any possible excess in the double-tagged 4-electron signal in this mass range cannot be distinguished from the high radiative-Bhabha background. All of the dimuon pairs emerge along the direction of the original positron beam. The reason for the excess is unknown.

6. New Particle Searches: We have ruled out production of fourth-generation quarks and leptons, non-minimal Higgs bosons, various supersymmetric particles, leptoquarks and colored leptons in the TRISTAN energy region. From the non-observation of these processes, we have set limits on new particle masses and/or couplings. In general, these limits have been superseded by the latest results from the LEP colliding beam accelerator.

C. OPERATIONS OF THE VIRGINIA TECH GROUP

The Virginia Tech group continues to be active in all aspects of the AMY experiment. Our main responsibilities are in the operation of the barrel calorimeter and in data analysis.

1. Calorimeter Operation

The Virginia Tech group continued its responsibility for day-to-day operation and maintenance of the AMY barrel calorimeter. This includes routine maintenance of the hardware as well as software calibration of the detector response. As a result of the installation of redesigned iron pole tips in conjunction with the ESC and SAC, the magnetic field in the shower counter region was affected. Also, in an attempt to prevent further loss of wires

after the tremendous repair effort in Summer 1989, the high voltages on the wires were reduced by 50 Volts. Thus, a large effort has been expended in recalibrating the detector response in the presence of the modified magnetic field and with the lower wire voltage. With the repair of the shower counter and the recalibration effort, the detector resolutions have recovered to the levels that were achieved before the burning of $\sim 20\%$ of the SHC wires (discussed in the last progress report).

We have had one faculty member, one Research Associate, and one U.S. graduate student supported by the contract in continual residence at KEK during the data taking periods from November 1989 to July 1990.

2. Data Analysis

Analysis of data by the Virginia Tech group is now carried out primarily at Virginia Tech, with a small fraction (primarily event selection) still done using the KEK computers.

Our students take advantage of the ability to use the KEK FACOM mainframes, the Virginia Tech AMY VAXCluster, and the Virginia Tech Institute of High Energy Physics Convex minisupercomputer in their studies. All of the programs for event generation, simulation and analysis are maintained on all three computer systems. This gives us the flexibility to balance our computing needs with the loads on all three systems; in particular, it significantly lessens our dependence on the over-subscribed KEK computers.

Four Virginia Tech students are presently working on their theses from the AMY experiment. They are Kangping Hu ("Search for Monochromatic Gamma Rays and π^0 "), Anzhi Lai (" $e^+e^- \rightarrow e^+e^-$ "), Mark Mattson ("Study of Multiquark Jet Production") and Kevin Sterner ("Search for Supersymmetric Particles"). All have resided at KEK for varying periods in 1989-1990, familiarizing themselves with the AMY detector, providing assistance in running the experiment, and discussing their data analysis with the other

members of the AMY group.

Research Associate E. Low left in late 1990 to take a position at the University of Pennsylvania. Her duties at KEK of calorimeter maintenance and operation and of detector calibration will be assumed by Professor S. Schnetzer of Rutgers University and other AMY collaborators at KEK, one of whom (Z.P. Mao) will be partially supported by our grant.

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Y.H. Ho *et al*, Observation of Anomalous Production of Muon Pairs in e^+e^- Annihilation into Four-Lepton Final States, submitted to Phys. Lett. B.

J. Smith *et al*, Mass Limits of Charged Higgs at Large $\tan \beta$ from e^+e^- Annihilations at $\sqrt{s} = 50-61.4$ GeV, submitted to Phys. Rev. D.

H.W. Zheng *et al*, Charged Hadron Multiplicities in e^+e^- Annihilations at $\sqrt{s} = 50$ to 61.4 GeV, submitted to Phys. Rev. D.

Y. Sakai *et al*, Search for Charged Heavy Leptons with Arbitrary Neutrino Masses in e^+e^- Annihilations at $\sqrt{s} = 50-60.8$ GeV, submitted to Intl. Journal of Modern Physics.

Conference Submitted Papers

Recent Results at TRISTAN, submitted to Les Rencontres de Physique de la Vallée D'Aoste, La Thuile, Italy (March 1990).

Bose-Einstein Correlations in Pion Production at TRISTAN, submitted to 25th Intl. Conference on High Energy Physics, Singapore (August 1990).

Measurement of the $e^+e^- \rightarrow b\bar{b}$ Cross Section and Forward-Backward Charge Asymmetry at a Center-of-Mass Energy of 57.2 GeV, submitted to 25th Intl. Conference on High Energy Physics, Singapore (August 1990).

Measurement of Heavy Quark Fragmentation at TRISTAN, submitted to 25th Intl. Conference on High Energy Physics, Singapore (August 1990).

Test of the Next-to-Leading-Logarithm QCD Approximation using AMY Data, submitted to 25th Intl. Conference on High Energy Physics, Singapore (August 1990).

Search for Charged Higgs Particles with AMY, submitted to 25th Intl. Conference on High Energy Physics, Singapore (August 1990).

III. Progress on NOVA Experiment

The following is a brief summary of NOVA progress; a more detailed description is given in Appendix A.

A. Background

The NOVA activity is oriented towards answering important astrophysical and ultra high energy particle physics questions related to neutrinos. Specifically, it has the goal of addressing the following physics issues:

1. Can the neutral radiation reported to have been detected by extensive air shower arrays from the direction of CYGNUS X-3 be neutrinos?
2. Can the muons reported to have been detected by underground detectors from CYGNUS X-3 be due to neutral particles with interaction cross sections between those of photons and conventional standard model neutrinos?
3. What limits can be placed upon fluxes and cross sections of neutrinos incident upon the earth from non-specific sources?

Because the processes being studied are expected to be rare, the experiment must have the dual features of rejecting effectively conventional backgrounds from cosmic ray proton and photon interactions in the upper levels of the earth's atmosphere, and enhancing the probability of detecting neutrinos and other weakly interacting particles. The concept involves the setting up of an extensive array of scintillators and drift chambers located on a mountain side so as to detect particles moving almost parallel to the earth's surface. The atmosphere depth presented to the experimental geometry will serve as attenuating shields for backgrounds and target material for weakly interacting particles. With the aid of excellent timing from the scintillators and position resolution from the drift chambers, angular resolutions of the order of 10 mradians for direction resolution are anticipated in

the search for radiation from point sources.

To demonstrate the soundness of the proposed experiment, a small part of our group has been involved in conducting a feasibility study. The goals of the study are the following:

1. Measure the angular distributions of single cosmic rays in the zenith angular interval of 75 deg to 105 deg.
2. Measure the angular distributions of multiple particle events in the above interval.
3. Study the relative composition of soft and hard components as a function of zenith angle.
4. Study the time variations in signals as a function of direction and trigger type.
5. Utilize the measurements of trigger rates with varying parameters such as detector separations, particle multiplicity, shielding, etc. in optimizing the design of an extensive array.
6. Perform extensive Monte Carlo simulations utilizing the Convex 210 computer of proton and neutrino interactions in the horizontal atmosphere and earth's crust to determine optimal design characteristics of the array.

B. Apparatus Acquisition

During the past several months, the group has been busy acquiring equipment from various sources to conduct the study. The following is a summary of those efforts:

1. From Professor L. Mo at Virginia Tech, sixteen $\frac{1}{2}m \times 1m$ scintillation counters.
2. From Professor B. Richter at SLAC, about $30m^2$ of scintillators.
3. From Professor B. Blumenfeld at Johns Hopkins, ten $\frac{1}{3}m \times 5.3m$ 4 cell drift chambers.
4. From T. Kirk at Argonne, about $20m^2$ of scintillator and assorted electronics and power supplies.
5. From Professor T. O'Halloran at Illinois and Wonyong Lee at Columbia, about $42m^2$ of 4 cell drift chambers. We are proposing to acquire another $3000m^2$ of drift chambers

from these groups by year's end.

In addition to these acquisitions, we intend to supplement the supply of scintillators and electronics from our involvement in the AMY experiment when that equipment becomes available, hopefully by early 1992. Summarizing, almost all of the equipment being used for the feasibility study consists of equipment used previously in high energy physics experiment funded by the federal agencies. Equipment expenditures have been modest and for items of general laboratory usage.

C. NOVA Personnel

During the past several months, the following personnel have been involved with the NOVA feasibility study.

PhD's

Dr. Norman Morgan	full time
Prof. A. Abashian	25% time
Prof. K. Gotow	10% time
Prof. L. Piilonen	15% time

Graduate Student

Y.D. Zheng	50% time
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Undergraduate Students

T. Duty (Academic Year)	30% time
E. Leckner (Summer)	100% time
P. Shifler (Summer)	100% time

As seen, the feasibility study is being staffed with a very minimal effort. The group is, however, enthusiastic about the project and dedicated to demonstrating the soundness of the proposed experiment.

D. Feasibility Test Setup

The idea behind the feasibility test is to study the behaviour of cosmic rays moving in directions close to zenith angles near 90 deg. We have set up in the Physics Building at Virginia Tech in the renovated room previously used as the reactor vault. The room is a

45' $\times$ 45' two storied room with crane coverage and with walls of concrete between about 1' and 3' thick. The setup is shown in Figure 1. On the wall which faces northwesterly (West (W) wall), sixteen $\frac{1}{2}m \times 1m$ scintillators arranged in 4 groups of 4 are affixed. On the opposite wall (East (E) wall), six $\frac{1}{2}m \times 1m$ scintillators are affixed.

A third bank (M) of five scintillators, each $\frac{1}{5}m \times 3.5m$ is situated about $1\frac{1}{2}m$ west of the east bank. To define a region of angular acceptance of $\Delta\theta$ (zenith) = 4 deg and $\Delta\phi$ = 10 deg (azimuth), a broad three fold coincidence E, M and W_θ counters is required. Because of the differences in vertical heights of the W bank (4m) and the other banks (1m), particles moving from west to east may have zenith angles between 75 deg and 90 deg while single tracks moving from east to west may have zenith angles between 105 deg and 90 deg.

E. Data Analysis

For any trigger, the differential in transit time between the west and east planes is recorded as well as the time of day for each event. For each run of about 20,000 triggers, a time delay curve is made as shown for example in Figure 2. We see two narrow peaks at $\pm 45nsec$ corresponding to single particles moving in the two opposite directions. In addition, a broad peak centered at $0nsec$ is observed which corresponds to the detection of a cosmic ray shower with probably three different particles striking the E, W, and M planes.

The angular distribution of the cosmic rays is shown in Figure 3. For angles less than 90 deg, the data exhibits a $\cos^2 \theta$ distribution as expected. For angles beyond 90 deg, the distribution appears to be essentially flat. The solid curve is a $\cos^2 \theta$ dependence normalized to the cosmic ray flux reported at $\theta = 0$ degrees from the particle databook together with a constant angular independent background as determined from the measurements for $\theta > 90$ deg. The fit is remarkably good.

Naively, one might believe that the events beyond 90 deg are particles emerging from beneath the floor's surface. There is, however, an alternative explanation which is that these are not single track events but are instead horizontal showers of perhaps several particles moving at angles less than 90 degrees. Under these circumstances, the events might actually be one particle in E and M banks with another track in the W bank. The narrow wave front for the shower still insures the same timing as for a single track.

If the events at 90 deg and beyond do consist of multiple particles, then perhaps the rates would be affected by absorbing material. Measurements indeed show a sensitivity to 8cm of lead absorber placed between the W and M planes as shown in Figure 4. Further studies of these horizontal showers are continuing with the inclusion of drift chambers between M and E and ADC's which together will record the directions and numbers of particles for a given trigger.

The times of arrival during the day is shown for a typical 24 hour run in Figure 5. If there were a point source, it might manifest itself as an increased number of events sometime during the day. The statistics are too meager to expect to see any sources at this time.

For angles near 90 deg, the trigger rate in either the EW or WE directions are of the order of $10^{-2} Hz$. If we were to extrapolate these results to a detector 200 times as large and with acceptance angles of $\Delta\theta = 20$ and $\Delta\phi = 90^\circ$, the trigger rate would approach $10 Hz$, a rate close to what we consider to be acceptable. Further studies should determine the optimum trigger requirements at each station

Our preliminary conclusions based upon the data acquired to date are the following:

1. Background rates for zenith angles close to 90° are low. Accidental coincidences of vertically descending showers can be managed through time of flight techniques
2. Clear signals of single particles traveling at large zenith angles are easily measurable.

The rates are low and easily manageable with our on-line computer.

3. Particles at very large zenith angles often are accompanied by other particles. This introduces the possibility of requiring more than one particle at a station as a further means of reducing the effects of vertically descending showers.

F. Monte Carlo Simulations

Monte Carlo calculations have been underway for some time utilizing the Convex 210 super mini computer and the GEANT simulation program.

Our hope in the NOVA experiment is to detect neutrino interactions in the earth's atmosphere for θ near 90 deg and in the top layer of the earth's surface. Our primary backgrounds arise from protons interacting at the edge of the atmosphere several hundred kilometers away. For these distances, the backgrounds consist dominantly of very high energy muons, the electrons and photons having been absorbed by the approximately 1000 radiation lengths of atmosphere. Figures 6 and 7 show simulation results for energy vs density of muons due to $1PeV$ incident protons and transverse distance of muon density produced by $100TeV$ protons, respectively. On the average 10 and 60 muons, respectively, reach the earth's surface.

Figure 8 shows simulations for the case of $1PeV$ neutrinos interacting at distances of $30km$, assuming the Standard Model values for x and y distributions and neglecting muon bremsstrahlung. Clearly, neutrinos give rise to more muons, 133, than the background protons of the same energy.

These conclusions need to be modified, based upon the calculations of Stanev and Vankov¹ who have shown that muons of $10^{16}eV$ can radiate photons so as to have an average accompanying 10^5 electrons at any location along the muon's trajectory. For $E_\nu = 1PeV$, the charged current muon also has $E_\mu = 1PeV$ since $\langle \bar{y} \rangle \sim 0.03$ which

¹T. Stanev and H.P. Vankov, Phys. Rev. D40, 1472 (1989).

translates into 10^2 electrons accompanying that extremely energetic muon from the ν_μ interaction.

Muon bremsstrahlung introduces a further very important possibility for the NOVA experiment; namely the potential capability of observing the results of neutrinos interacting below the earth's surface. Figure 9 is from the paper of Stanev & Vankov and shows the effect of muon bremsstrahlung giving rise to upward going showers in the earth's atmosphere. If these numbers prove to give rise to substantial showers accompanying the muon, the detection area for NOVA experiment becomes the surface area of the array and not the detector area. This would mean that the capability of the NOVA experiment in terms of interaction volume and detection capability are comparable to DUMAND.

IV. THE MEGA EXPERIMENT

A. INTRODUCTION

The MEGA experiment² at the Clinton P. Anderson Meson Physics Facility (LAMPF) in Los Alamos, New Mexico will search for the rare decay $\mu^+ \rightarrow e^+ \gamma$ with an unprecedented sensitivity of one part in 10^{13} . This experiment, funded primarily by DOE and to a lesser degree by NSF, is being mounted by a group of physicists from 12 institutions: Los Alamos National Laboratory, Fermi National Accelerator Laboratory, Virginia Tech, University of Virginia, Princeton University, Yale University, Stanford University, University of Chicago, Texas A&M University, University of Houston, UCLA and Valparaiso University.

The family-number-nonconserving process $\mu^+ \rightarrow e^+ \gamma$ is forbidden by fiat in the Standard Model. Observation of this as-yet unseen decay would be the first clear indication of new physics beyond the Standard Model of the electroweak interaction. Several previous experiments have searched for the same or similar forbidden decays, and competing experiments are planned or being mounted at Brookhaven National Laboratory, TRIUMF and PSI (formerly SIN). MEGA is designed to be 500 times more sensitive to seeing $\mu^+ \rightarrow e^+ \gamma$ than the latest published limit set by the Crystal Box experiment³ at Los Alamos.

B. DETECTOR DESCRIPTION

The experiment consists of an electron detector inside a photon detector inside a large superconducting magnet (Figures 1 and 2). The magnetic field confines all charged decay products (electrons and positrons) to the central region of the apparatus that contains the electron detector's eight MWPCs and two scintillator barrels. Any photons are unaffected by the magnetic field and traverse the nearly massless electron arm MWPCs to the photon

²M. D. Cooper et al., "MEGA—Search for the Rare Decay $\mu \rightarrow e \gamma$," Proposal 969, Los Alamos Meson Physics Facility, July 1985.

³R. D. Bolton et al., "Search for the Decay $\mu^+ \rightarrow e^+ \gamma$," Phys. Rev. Lett. **56**, 2641 (1986).

pair spectrometers where they have about 10% chance of being observed via $\gamma \rightarrow e^+e^-$.

The intrinsic resolution of the detector elements will allow us to reject all muon decays that do not result in exactly one positron back-to-back with one time-coincident photon in the final state (Table I).

A hardware trigger module continually monitors the pattern of hits in the photon pair spectrometers. Upon seeing a pattern indicative of a high energy photon, the raw data from the entire detector (about 700 words) is transferred to one of 32 computers for intermediate on-line analysis. Events that meet the loose kinematic requirements of this analysis are written on magnetic tape for more stringent off-line analysis. We expect to write about 2000 tapes of candidate events and to reject most, if not all, of these events in the off-line analysis as not being due to $\mu \rightarrow e\gamma$.

C. STATUS

The MEGA detector components are presently under construction and testing; the experiment will run in 1991-1992. Several technical challenges have been successfully addressed in designing both the electron arm MWPCs and the photon arm drift chambers. The innermost pair spectrometer of the photon arm underwent beam tests in the MEGA magnet during 1990. Several electron arm MWPCs have been built; four of these were tested with muon beams in the magnet in August-September 1990.

Detector construction will continue into 1991, with all of the electron arm and two pair spectrometers of the photon arm expected to be ready for physics data acquisition in the summer of 1991. The complete detector is expected to be ready in 1992.

Table 1
Parameters of $\mu \rightarrow e\gamma$ Experiments

Property	MEGA (ref. 1)	Crystal Box (ref. 2)
Fractional electron energy resolution	0.005	0.08
Fractional photon energy resolution	0.02	0.08
Photon-electron timing (ns)	0.5	1.1
Electron position resolution at the target (mm)	2.0	2.0
Electron angular resolution- including target scattering(deg)	0.6	1.3
Photon conversion point resolution (mm)	3	25
Electron-photon angle (deg)	0.6	8.0
Photon angle (deg)	10	--
Inefficiency of bremsstrahlung veto	0.2	0.5
Fractional solid angle times detection efficiency	0.1	0.2
Muon stopping rate (s^{-1})	3×10^7	5×10^5
Running time (s)	1.2×10^7	2×10^6
Branching ratio sensitivity	9×10^{-14}	4×10^{-11}
Number of background events with $\pm 2\sigma$ cuts	0.9	-50

All resolutions are FWHM

Elements Type	Number of Elements
Electron chamber planes	3
Electron chamber anode wires	1950
Electron chamber cathodes	3900
Electron timing scintillators	200
Bremsstrahlung veto scintillators	24
Photon MWPCs	10
Photon MWPC wires	3400
Photon drift chambers	10
Photon drift chamber anodes	2300
Photon drift chamber cathodes	4600
Photon scintillators	425
Photon scintillator PMTs	850
Primary trigger modules	5
Data memory modules	30
Microprocessors	32
6250 BPI tapes	2000

FEASIBILITY TEST SETUP

Fig 1

Display Curves
Friday, August 3, 1990 15:46

90°

Front Panel

Fig. 2

Fig. 3

Effect of 190 g/cm² Absorber

Fig. 4

85 DEGREES: WEST TO EAST

85 DEGREES: SHOWER

85 DEGREES: EAST TO WEST

Fig. 5

100 EVENTS OF 1PEV PROTON

Fig. 6

100 EVENTS OF 100.TEV PROTON

Fig. 7

100 EVENTS OF 1.PEV NEUTRINO WITH 90 DEG

Fig. 8

Fig. 9
 Stanev & Vankov, Phys. Rev. D40, 1472
 (1989).

Fig. 10

Fig. 11

END

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