TRIMUON EVENTS AND THEIR INTERPRETATION

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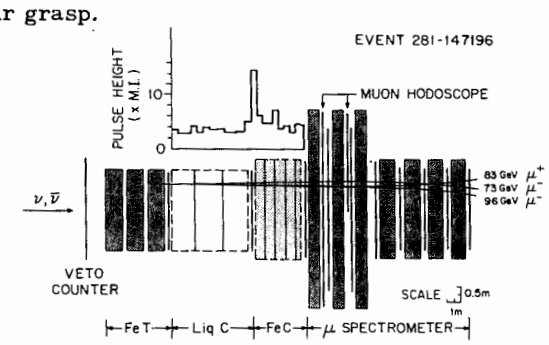
Neutrino experiments have always been an important part of the Fermilab program. One of the earliest results of Fermilab research was the observation of neutral currents independently of and almost simultaneously with CERN. In 1974, the first dimuons were observed. This was the first indication of charm and was reported at the London conference that summer. By now, approximately 5000 dimuon events have been observed. They occur in approximately 1% of all neutrino interactions.

Trimuon events have been produced in both Fermilab counter neutrino experiments (see Fermilab Report, April, 1977), the Caltech-Fermilab-Rockefeller collaboration (E21), and the Fermilab-Harvard-Pennsylvania-Rutgers-Wisconsin collaboration (E310). The rate of trimuon events is small, approximately 10^{-4} of the total neutrino interaction rate, and approximately 50 trimuon events have now been observed in the counter experiments. It is to be expected that they will be observed soon in bubble-chamber experiments. Two four-muon event candidates have also been recorded in the E310 experiment.

A number of mechanisms of trimuon production are possible. One likely and attractive possibility is the "flavor cascade," where new kinds of quarks decay in series. The discovery of the upsilon particle at Fermilab has made it likely that another quark, the b, exists. It is possible to envisage a t quark, paired with the b, decaying into the b, which in turn

decays into a charmed quark, which in turn decays into an s quark, with muons produced in each of these decays (dimuons, trimuons, and four-muon events). The flavor cascade is in accord with the bulk of the data, but has not been uniquely established. It is also possible to interpret some of the data in terms of parton-muon radiation or other, apparently less likely, possibilities, such as heavy lepton cascades. Several of the observed trimuons do not fit easily into any existing model and are perhaps a hint of something new, perhaps due to new leptons.

Neutrinos are a powerful tool for producing new phenomena, but the event rates become lower as the phenomena become more exotic. Neutrino experiments at Fermilab have been aided in exploring these new phenomena by significant increases in machine intensity. The number of protons on target for neutrino experiments has increased steadily, reaching more than 7×10^{18} in 1977. Higher beam energy is another direction in which accelerator improvements can be expected to make a substantial contribution to these studies. With the completion of the Energy Doubler an understanding of some of the phenomena which now appears to be tantalizingly close should come within our grasp.

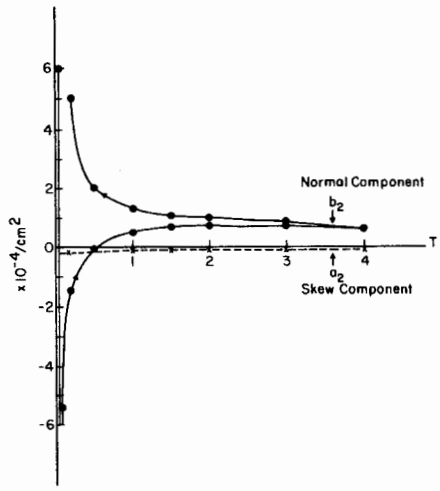


An unusual trimuon event superimposed on the Neuland detector in Lab C.

PROGRESS ON THE ENERGY DOUBLER/SAVER

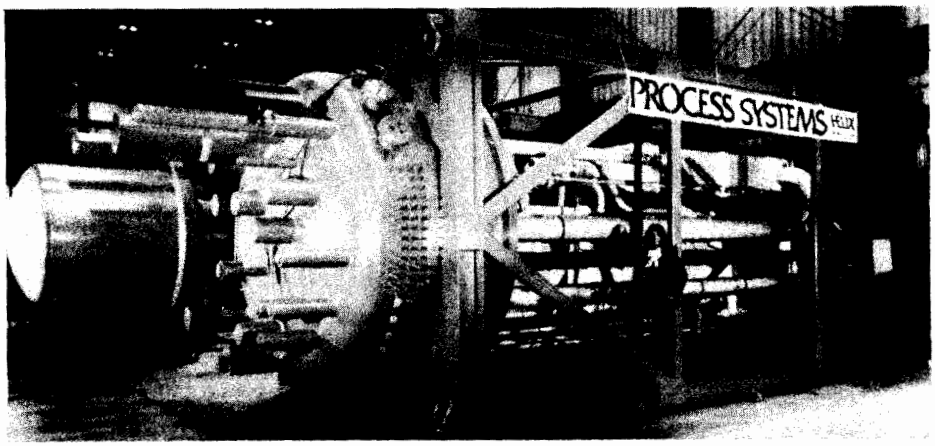
A significant advance has been made in fabrication techniques of Energy Doubler/Saver magnets. Motion of the coils during excitation had been somewhat of a problem, giving unacceptable field distortions. A new clamping-system design has been developed using more precise tooling and careful measurements to give a uniform preloading of the coil at cryogenic temperature. Several prototypes have been built and tested by measuring the change in arc length along the coil shell during excitation. This change has been reduced from approximately 20 mil in older designs to 4 mils, a result close to the "ideal" to be expected from motion of the collar itself. The new clamping system and a small, but important change in the width of the coils have combined to reduce the measured sextupole field in a dipole to within acceptably small limits, as is shown in the graph below.

The 8-magnet string just as assembled at the time of our last report in these pages (Oct. 1977) has been successfully operated. We are now modifying the energy-dumping scheme and connecting the system to a Main-Ring power supply for ramping tests.



Normal and skew sextupole components vs. magnetic field for magnet E22-52D.

Four Energy Doubler/Saver dipoles have been installed in A sector of Main Ring as part of the



The Central Helium Liquefier as it underwent final tests at the manufacturer.

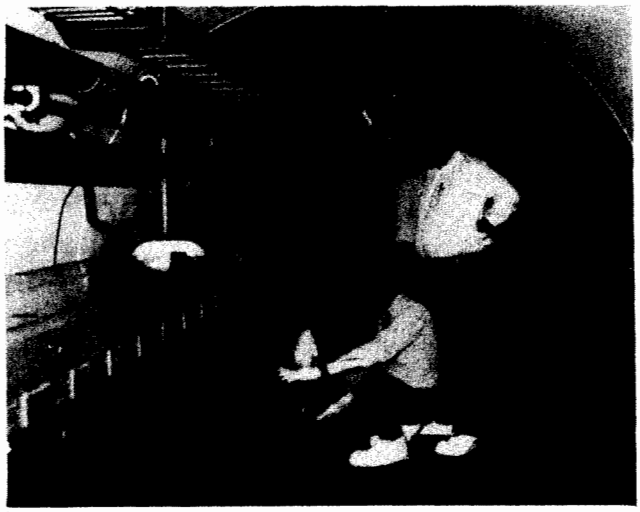
(Photo courtesy of Helix Technology Corporation)

Sector Test to be carried out over the next months. Several of the accompanying photographs show this work in progress in the tunnel. As part of the the Sector Test, a prototype satellite refrigerator has been installed in the new mini-Service Building at A1, shown on the cover of last month's Fermilab Report. Compressors have also been installed in the A1 Service Building itself.

The large Central Helium Liquefier cold box has been completed and tested at the manufacturer's plant and is being delivered this month. The compressors and fin coolers for this plant, which were recovered as surplus equipment from an Air Force installation, have been refurbished and installed and the interconnecting piping is now being connected. Tests are scheduled to start in early spring.

The special C stand rotates to remove interference.

(Photo by Fermilab Photo Unit)



Rich Orr, Peter Limon (standing), and Gene Fisk inspect the installation of the Energy Doubler/Saver magnet.

(Photo by Fermilab Photo Unit)

Jack Smith connects two Energy Doubler/Saver magnets.

(Photo by Fermilab Photo Unit)

POSITION AVAILABLE AT FERMILAB

A new position is available in the Electronic Support Group of Research Services. This person will be responsible, under Bob Shafer, for the design, and fabrication, of specialized electronic circuits and electronic systems for the PREP electronics pool, and will also assist in the development and bringing into operation of improved computer-controlled testing and fault diagnosis systems for electronic circuit modules; a vigorous liaison role with the users of the PREP pool is another important facet of this job opening. A master's degree in physics or electronic engineering is required. A strong interest in electronic circuit design is essential. Candidates with a Ph. D. or with extensive experience in experimental high-energy physics will be preferred. Interested persons should contact R. Shafer.