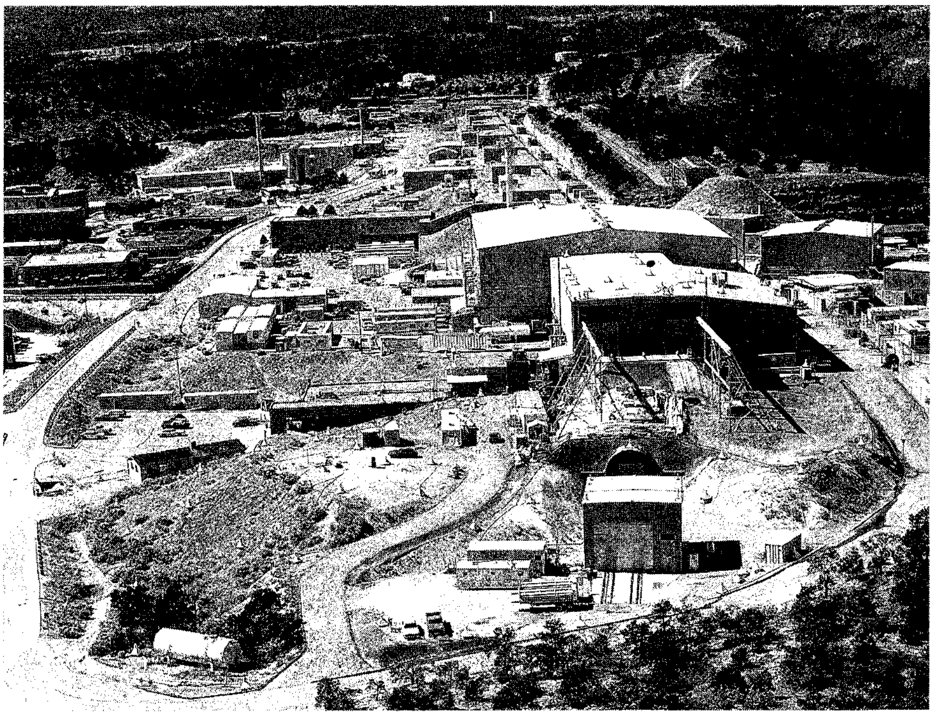
proposes a tau-neutrino beam dump which could use the 800 GeV proton beam prior to the completion of the Main Injector. This proposal will soon be submitted for formal consideration.

Also being developed are plans for a long baseline experiment. One idea is to extract the Main Injector beam in a direction so that the neutrinos travel toward Soudan, Minnesota, 800 kilometres to the northwest of Fermilab, home of a major underground laboratory. In such a scheme, the near and distant detectors would use the same beam and some common modules.

Other long baseline options being studied involve using protons extracted from the existing 120 GeV Main Ring, the 8 GeV Booster, or the Antiproton Debuncher Ring, the idea being to produce a high intensity neutrino beam, albeit of low energy. This gives good sensitivity to oscillations over a shorter distance, allowing the "far" detector to be much nearer, even on the Laboratory site.



An aerial photograph of the LAMPF facility with the experimental areas in the foreground. The tunnel housing the LSND neutrino experiment is visible in the lower centre of the photo behind a service building. LSND is about 11 metres downstream of the LAMPF beam stop.

LOS ALAMOS

Following the historic observation of neutrinos in the mid-1950s by two Los Alamos scientists, Fred Reines and Clyde Cowan, Jr, using inverse beta decay, there has been a long and distinguished history of experimental neutrino physics at LAMPF, the Los Alamos Meson Physics Facility. LAMPF is the only meson factory to have had an experimental neutrino programme.

In the late 1970s, the first LAMPF neutrino experiment used a 6-tonne water Cherenkov detector 7 metres from the beam stop. A collaboration of Yale, Los Alamos and several other institutions, this experiment searched for the forbidden decay of a muon into an electron and two neutrinos, and measured the reaction rate of a neutrino interacting with a deuteron to give two protons and an electron - the inverse of the reaction that drives the sun's primary energy source.

The next LAMPF neutrino experiment, a UC Irvine/Maryland/Los Alamos collaboration, ran from 1982 through 1986 and measured the elastic scattering rate of electron-neutrinos and protons, where both neutral and charged weak currents contribute.

With its precision of about 15%, the experiment provided the first demonstration of (destructive) interference between the charged and neutral currents.

More recent neutrino experiments at LAMPF have searched for neutrino oscillations, especially between muon- and electron-neutrinos.

The newest experiment to pursue this physics (as well as oscillations in other channels) is LSND (July/August, page 10 and cover).

In addition to searching for these oscillations, LSND will measure neutrino-proton elastic scattering at low momentum transfer, providing a sensitive measure of the strange-quark contribution to the proton spin. LSND began taking data in August.

Los Alamos physicists have also been busy in neutrino physics experiments elsewhere.

One such experiment looked at the beta decay of free molecular tritium to obtain an essentially model-independent determination of the electron-neutrino mass. The present result gives an upper limit on the electron-neutrino mass of 9.3 eV, showing that electron neutrinos cannot by themselves 'close' the universe.

Pioneer solar neutrino experiments (see page 21) suggested that the observed flux of high-energy neutri-

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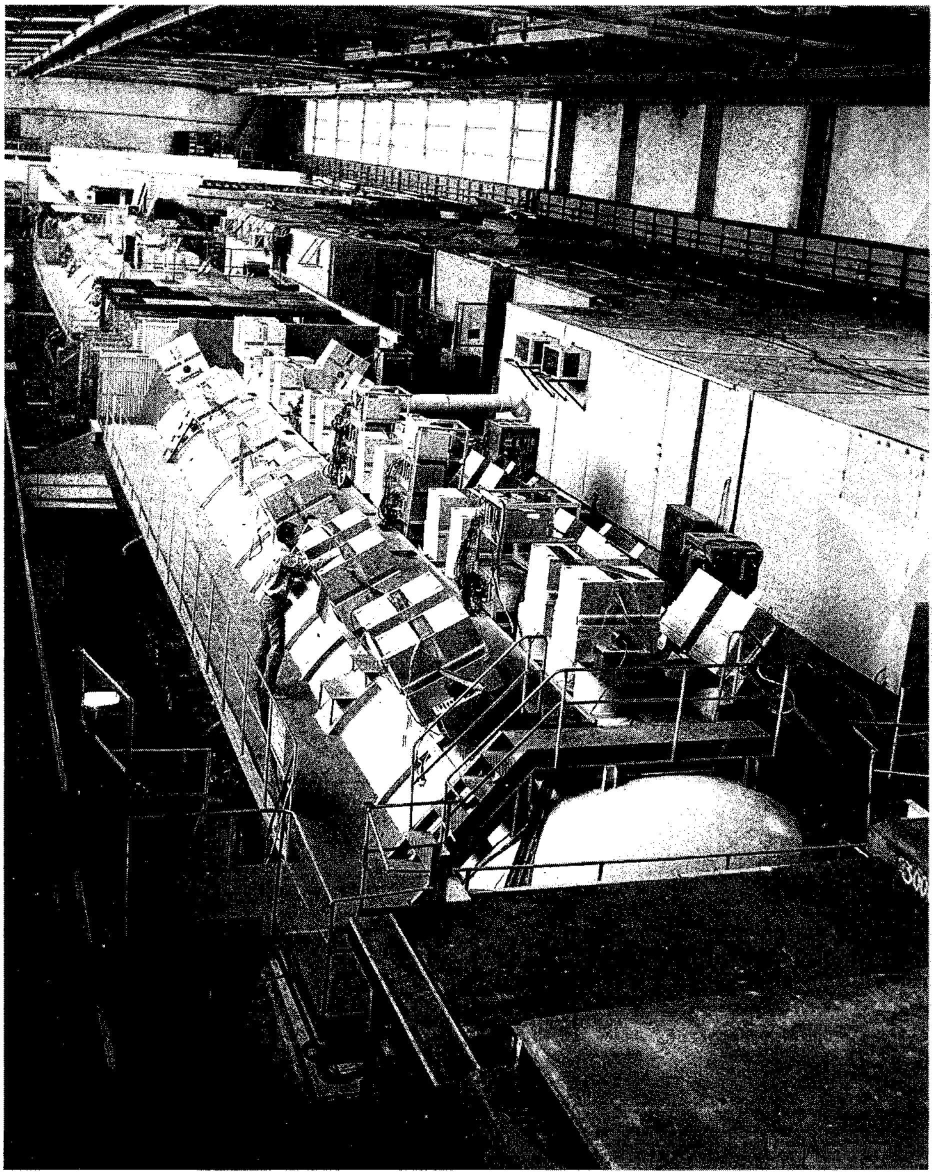
nos from the sun is lower than expected. This could be a manifestation of neutrino oscillations or could be due to a problem with the solar models used to predict the expected neutrino flux. Los Alamos has played a major role in the SAGE experiment in Russia to detect solar neutrinos using gallium. With gallium, the detection energy threshold is low enough that neutrinos from the main energy-producing solar (proton-proton) reactions can be detected; should the flux measured in this experiment also be low, new neutrino properties must be the culprit.

Los Alamos is also participating in the Sudbury Neutrino Observatory (SNO) experiment in Canada using 1000 tonnes of heavy water to observe solar neutrinos both via charged current and neutral current reactions. This is a promising experiment because the rate of neutral current events should be independent of whether or not neutrinos oscillate, while the charged current rate is initiated only by electron neutrinos. SNO is expected to begin data-taking in late 1995.

SERPUKHOV

Neutrino investigations at the Serpukhov accelerator of the Institute for High Energy Physics, Protvino, Russia, date back to 1968. A neutrino channel for wide band beams, consisting of a 70 GeV proton transport system, target, focusing system for secondary hadrons, 140m decay pipe and 12,000 ton iron muon filter, under the leadership of V.Kotov, A.Samoilov and R.Rzaev from the Beam Department, was constructed from 1969 to 1974.


The neutrino detector of Serpukhov's Tagged Neutrino Facility (TNF) with its two Big liquid ARgon Spectrometers (BARSes) interleaved with muon iron toroid spectrometers.

The original focusing system proposed by A. Samoilov still gives neutrino fluxes of about 20 billion particles per square metre per spill over 5 microsec.

The initial 20-ton neutrino detector based on optical spark chambers was a joint IHEP-ITEP(Moscow) effort led by A.Mukhin and V. Kaftanov. First neutrino events were detected in April 1974. The next eight years with this detector covered many aspects of neutrino behaviour - dimuon production, quasielastic and total cross-sections, and 'prompt' neutrinos from beam dump experiments.

Initial experience with emulsion targets for neutrinos showed feasibility of this technique for studying charmed particle production.

The average neutrino energy from the Serpukhov accelerator is around 10 GeV. At these energies, neutrinos do not probe deeply and low multiplicity final states dominate.

This called for a neutrino detector capable of seeing individual particles in the final state. The result was the 7 cubic metre SCAT (from the Russian abbreviation for Serpukhov CAmera Heavy) propane-freon bubble chamber.

Construction of this chamber took almost a decade (1965-1974). Many USSR industrial enterprises took part, supervised by the Efremov Laboratory, Leningrad (V.Titov) and IHEP (E.Kuznetzov). First neutrino event pictures were obtained in May 1975.

This bubble chamber went on to provide the bulk of the neutrino data, with the international Protvino/ Zeuthen (East Germany) team, co-spokesmen V.Ammosov and