

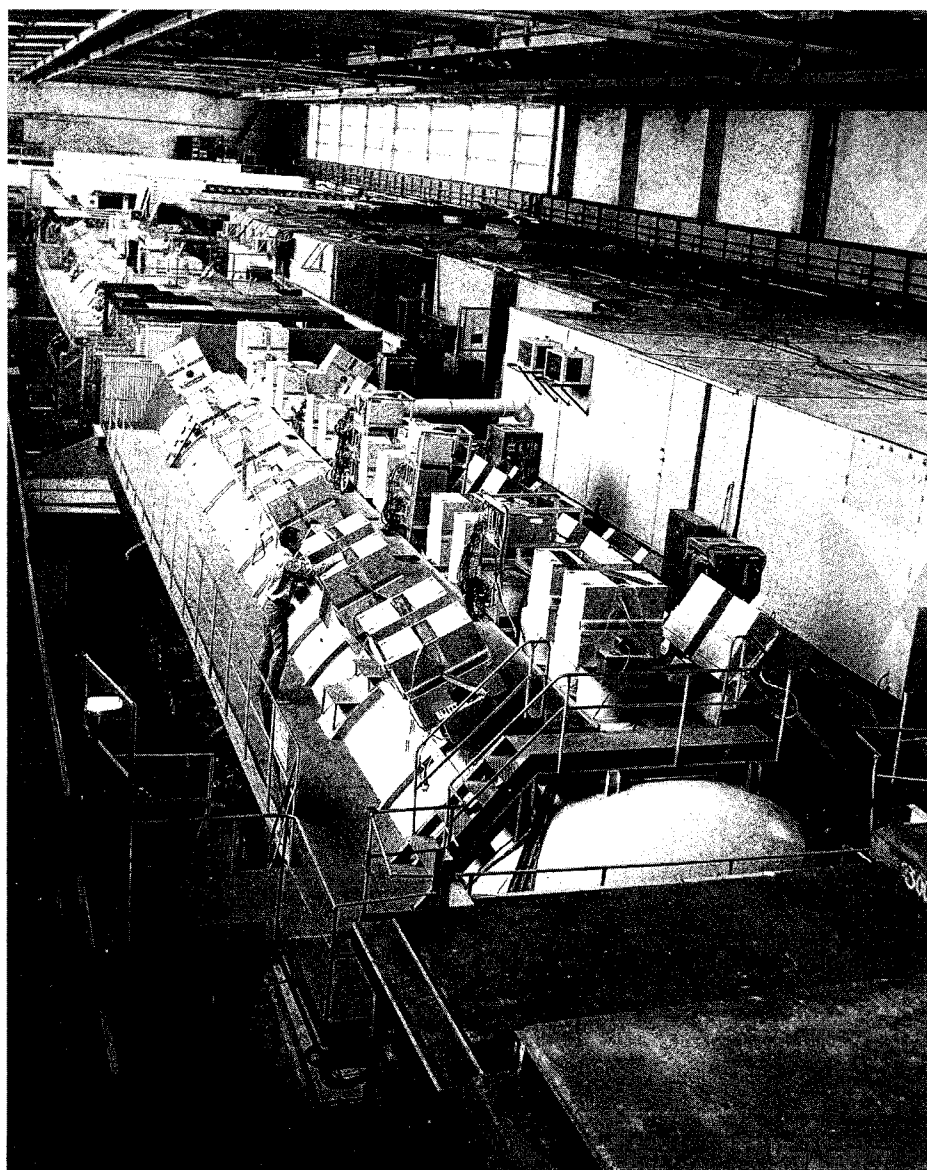
The neutrino detector of Serpukhov's Tagged Neutrino Facility (TNF) with its two Big liquid ARgon Spectrometers (BARSes) interleaved with muon iron toroid spectrometers.

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 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.Kuznetsov). 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.Amosov and



EPAC94

FOURTH EUROPEAN PARTICLE ACCELERATOR CONFERENCE
Queen Elizabeth II Conference Centre, London,
27 June to 1 July 1994

After Rome, Nice and Berlin, the fourth conference in the series will be held at the prestigious Queen Elizabeth II Conference Centre, opposite Westminster Abbey and only a short walk from the Houses of Parliament, in the city of Westminster, London.

The conference aims to provide a comprehensive overview of research, technology and special applications in the field of accelerators. In the planning of the programme special emphasis is placed on excellent review papers and particular attention will be paid to high-intensity accelerators. The programme will include invited talks, contributed papers, oral poster presentations and poster sessions. Parallel sessions will be kept to a minimum.

Papers from the whole field of accelerators are solicited, including low- and high-energy machines and accelerators for medical and industrial purposes. The deadline for the receipt of Abstracts at the Scientific Secretariat is 15 December 1993.

An industrial exhibition, as well as an exhibition of CERN's proposed LHC Project, will be held during part of the conference and the conference programme will include a special session whose theme will be the transfer of technology from accelerator laboratories to industry. Information regarding the exhibition and seminar may be obtained from the Exhibition Manager.

Local organization is in the hands of the RAL and Daresbury laboratories. The registration fee is £225 if received before the deadline of 27 April 1994 and is increased to £250 thereafter. Due to the huge demand for accommodation in London in June and July, requests for accommodation should also be made prior to this date. Complete information concerning registration and accommodation may be obtained from the Conference Secretariat.

World-Wide Web (W3) and Internet Gopher will be used as additional means of disseminating information on the conference as it becomes available. Indications as to how to use these systems, as well as complete information on the conference are given in the First Announcement and Call for Papers available from the Conference Secretariats.

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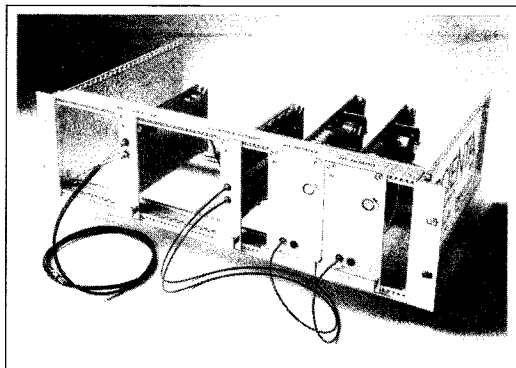
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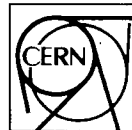
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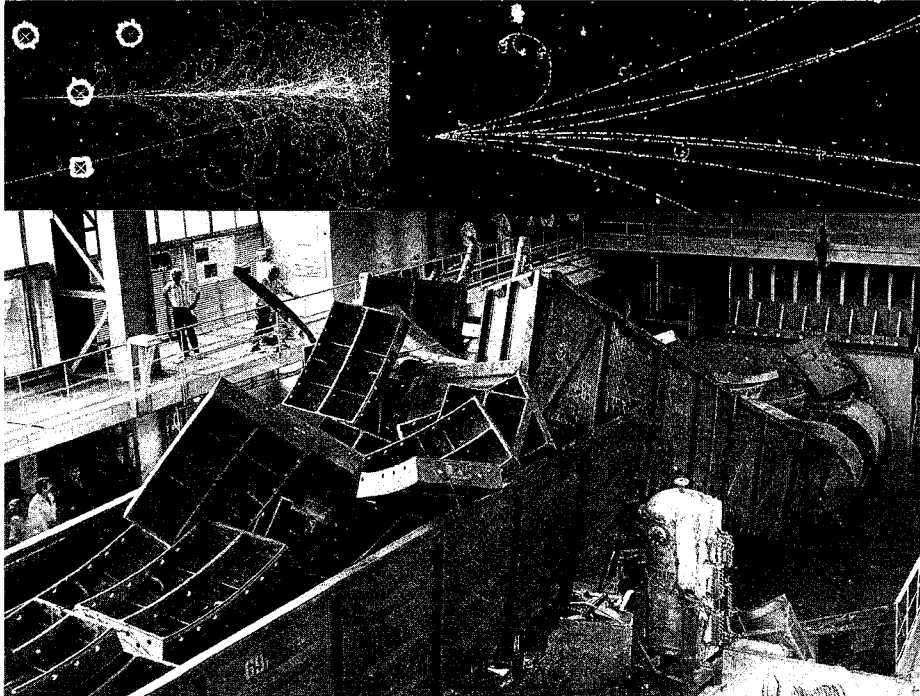
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The first 'impact' of perestroika on Russian fundamental science was on 11 June 1989, when three railway wagons loaded with slabs for Serpukhov's new UNK synchrotron and moving at 50 km/h slammed into the SCAT heavy liquid bubble chamber, ready for its autumn neutrino run. With characteristic determination, the Serpukhov physicists

recalled the words of a folk song - "Our armour was strong and our hands were still quick." SCAT was fixed in just two months and started to work with new propane-freon mixture (event in right corner) just as successfully as it did before with freon (electron-neutrino event in left corner).



R. Nahnauer, publishing more than 30 articles.

Among the research highlights were measurements of the electroweak mixing angle from full measurement of single pion coherent production, pioneer measurements of charmed baryon production, and the recent first observation of quasielastic production of the charmed doubly charged sigma* (2450).

The chamber lived for a respectable 18 years and just managed to survive through the 1989 "perestroika" (see photo). It saw a new era in neutrino investigations at IHEP with the availability of the booster. It was only in 1992, after 1.7 million pictures, that the last of the large bubble chamber "Mohicans" finally disappeared from the scene.

The new booster increased the intensity of the proton beam on the neutrino target from 3 billion to 12 billion particles per cycle. The first successful run with the booster was in October 1987. For this SCAT was

filled with light propane-freon mixture (90% propane).

A 100-ton conventional fine-grain calorimetric neutrino detector with a downstream muon spectrometer of magnetized steel toroids was built by a collaboration of IHEP, JINR (Dubna) and IHEP (Zeuthen) (cospokesmen A. Vovenko, S. Bunyatov and M. Walter). The target consists of 36 horizontal planes of liquid scintillation counters alternating with aluminium plates inside magnetized iron frames. This detector can detect both muon- and electron-neutrino interactions, and analysis of nucleon quark structure (structure functions) for momentum transfer is in progress.

A new experiment aims to push back the limits in the search for electron-tau-neutrino oscillations in unfocussed hadron decays in a short 12.5m decay pipe.

Looking to make maximum use of neutrino beams at full booster intensities, Neutrino Department head Sergei Denisov hit on the idea

of tagged neutrinos. Recently physicists from Pisa, Dubna, Zeuthen and Protvino, led by Denisov, have completed construction of the Tagged Neutrino Facility (TNF).

The novel idea is to detect simultaneously all other particles in the decays of kaons giving electron- and muon-type neutrinos. It uses a special tagging station (TS) between the decay pipe and muon shielding, consisting of eight 4x4 metre planes of scintillation hodoscopes and a 2000-cell electromagnetic calorimeter. This information allows electron and muon identification, reconstructs their trajectories, and measures energies of emerging electrons and gammas to tell where the kaon decay happened, together with the direction of the neutrino and its energy.

A special narrow-band neutrino beam and a novel neutrino detector were constructed for TNF. The detector consists of two Big liquid ARGON Spectrometers (BARSes), each containing 300 tons of liquid argon. An important BARS feature is its high ratio of active to passive material, giving good energy resolution, especially for electrons.

BARSes are followed by muon spectrometers of 5-m diameter magnetized iron toroids interleaved with drift tubes. The main advantages of the tagged neutrino beam are good energy resolution (3-5%) and low background (2-3 orders of magnitude less than in usual neutrino beams). It is hoped that the TNF will start data collection next year.

Plans for IHEP neutrino experiments were linked to the construction of the new 3 TeV UNK, whose proton beam intensity would have been considerably higher than other synchrotrons. However these hopes began to fade and vanished last year for the present generation of physicists when a decision was taken to

complete the construction of the initial 600 GeV UNK machine and to limit work on the superconducting 3 TeV UNK accelerator to R&D. But even at 600 GeV the rate of neutrino interactions is interesting, and sighting the tau-neutrino and searching for oscillations into tau-neutrinos in new kinematic regions are still on the cards.

JAPAN

With the research structure for high energy physics attaining maturity, experimental neutrino physics flourished in Japan in the 1980s. Neutrino studies during this period used three approaches: accelerators, nuclear beta decays, and a deep underground experiment. The latter, using an imaging water Cherenkov detector, was so successful that it is being considerably expanded and will dominate Japanese research in this field in the 90s.

In the 80s, the E10 experiment (KEK/Tokyo/Osaka) was the first to search for a heavy neutrino in stopped-kaon decays at the Japanese KEK Laboratory's 12 GeV Proton Synchrotron, and was soon followed by dedicated experiments, E89 and E104 (Tokyo/KEK). Using a high resolution magnetic spectrometer with an extensive photon-veto system, a good 1982 limit linked mass and mixing probability in the 100 MeV mass range. After ten years, the synchrotron is again to go into action for neutrino-related research (experiment E261a - see below).

At KEK's TRISTAN electron-positron collider, the VENUS Collaboration studied radiative neutrino-

pair production, and combining their data with those from other electron-positron colliders, concluded that the number of light neutrino species had to be less than four, even before LEP experiments made their definitive 1989 measurement.

In late 1980, motivated by a claim by a Moscow experiment for the finite mass of the electron antineutrino, a group including physicists from INS (Institute for Nuclear Study, Tokyo) had proposed a precision measurement of the tritium beta-ray spectrum near its end point. Emphasis from the beginning was on reliable calibration.

About four years were spent developing an optimal beta-ray source and on calibration to give high quality measurements. Over the subsequent four years, a series of measurements gave a 13 eV upper mass limit.

Early in 1991, a KEK/INS collaboration, including also some American physicists, embarked on a decisive experiment on the controversial 17 keV neutrino. Knowing the danger of relying on subtle effects in beta spectrum slopes, they searched for a neutrino emission threshold effect in the spectrum with high resolution, low background and unprecedentedly high statistics. The result of a three month measurement clearly excluded such a neutrino.

Towards the end of the 1970s, the very attractive idea of the Grand Unification of forces had fostered a new generation of large underground experiments to search for the predicted decay of the proton. In Japan the large Kamiokande underground experiment (Tokyo/Institute for Cosmic Ray Research/KEK/Niigata collaboration) looked for proton decay in the 3000-ton imaging water Cherenkov detector 1000 m underground. Installation of 1000 specially

designed photomultiplier tubes was completed in July 1983 and the first result reported six months later.

Detector response was calibrated using electrons (below 5 MeV) from stopped cosmic-ray muons.

Successful measurement of such low energy electrons showed how the detector could also recognize recoil electrons from low energy neutrino interactions. To improve sensitivity to nucleon decay and to lower the energy threshold for solar neutrino detection, the collaboration was expanded to include a Pennsylvania group. A water Cherenkov veto counter was constructed around the main body, and the water purifier as well as the electronic system considerably improved. The upgraded detector, Kamiokande-II, went live at the end of 1985 and produced its first result the following year from 48.5 days of data.

To further reduce background radioactivity, work continued through 1986 to improve the water purification system.

These painful efforts were dramatically rewarded. On 25 February 1987, a telefax informed the group of an astronomically 'nearby' supernova. Perhaps the detector's routine running could have intercepted neutrinos from this explosion. Data tapes were immediately rushed to Tokyo for analysis.

On 27 February a whole night was spent scanning the few hundred pages of energy-versus-time plots collected over 2.5 days. An unmistakable burst of activity soon showed up. Recorded on 23 February at 07:35:35 UT (± 1 minute) and lasting 13 seconds, it contained 11 electron events with each energy ranging from 7.5 to 36 MeV. These neutrinos from the SN1987A supernova marked the beginning of neutrino astronomy.