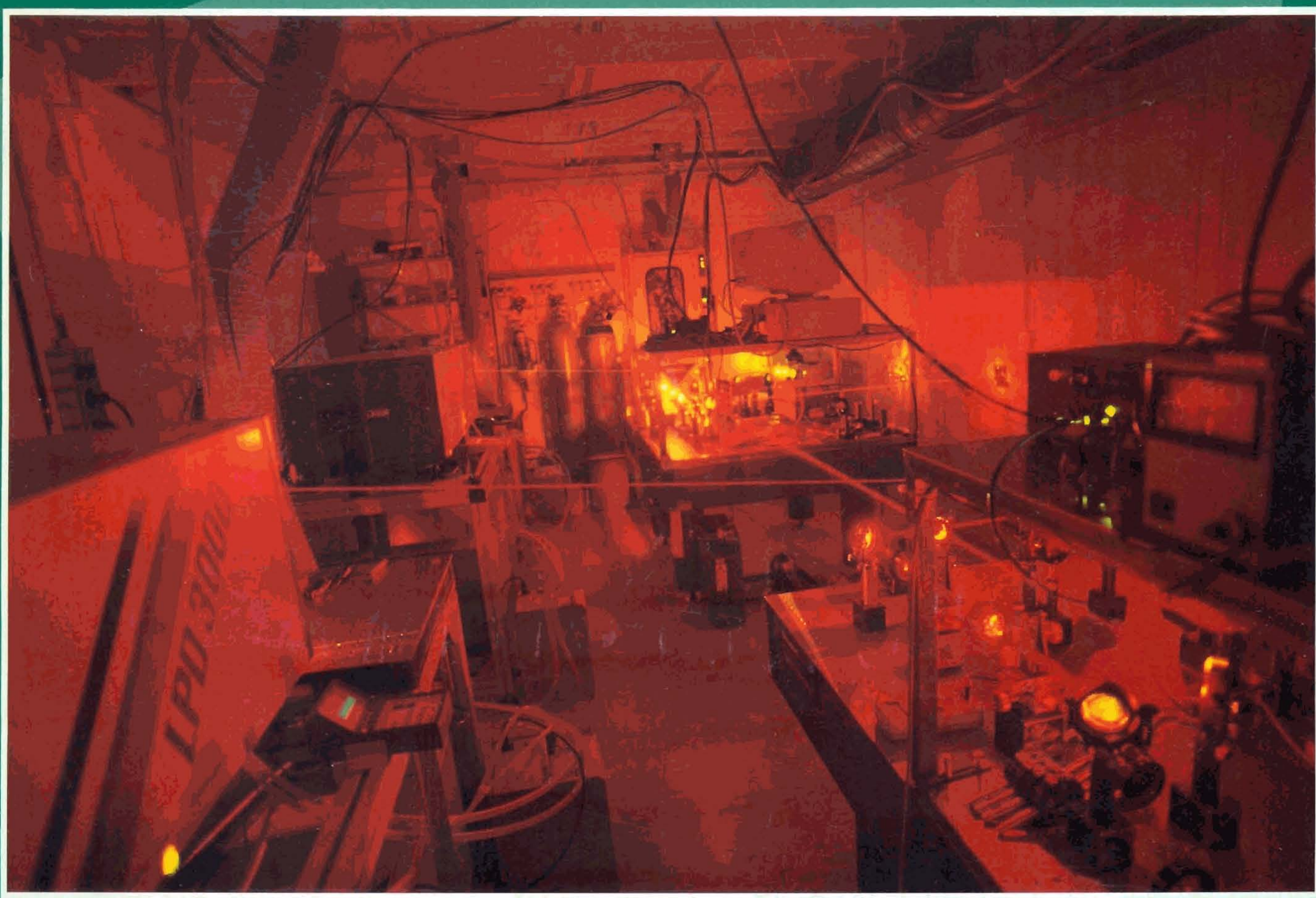
CERN COURIER

INTERNATIONAL JOURNAL OF HIGH ENERGY PHYSICS

VOLUME 34 | 10 | DECEMBER 1994



atoms are now around the corner.

The Conference closed with the award of N. Hamann Prize to A. Masoni of Cagliari, for his presentation on a high statistics study of iota decay with the Obelix spectrometer. This Prize, funded by the Jozef Stefan Institute, Ljubljana, is in memory of Niklaus Hamann, PS coordinator and LEAR physicist who died last year, aged 40.

Dubna - the great survivor

This year, as CERN celebrates its 40th anniversary (November, page 26), not far behind in the celebration stakes is the Joint Institute for Nuclear Research, Dubna, near Moscow, established in 1956. While CERN's goal was to provide a physics platform on which to rebuild Western European science after World War II, JINR had a similar mission for the USSR and the socialist countries, including Eastern Europe.

The fact that both organizations are reaching their 40th anniversary testifies to their success. While their aims were very similar, their political contexts and scientific strategies have led along very different routes.

Faced with the challenge of building a major machine, CERN took the bull by the horns and went for the new technique of strong focusing. The bet succeeded, and the dividends were rich and numerous. Dubna chose a more conventional solution, designed under the guidance of the legendary Vladimir I. Veksler, co-discoverer of the principle of phase stability. For several years the resulting 10 GeV synchrophasotron, commissioned in 1957, was the highest energy machine in the world. This machine is still operational, and features in the Guinness Book of records as the planet's largest electromagnet.

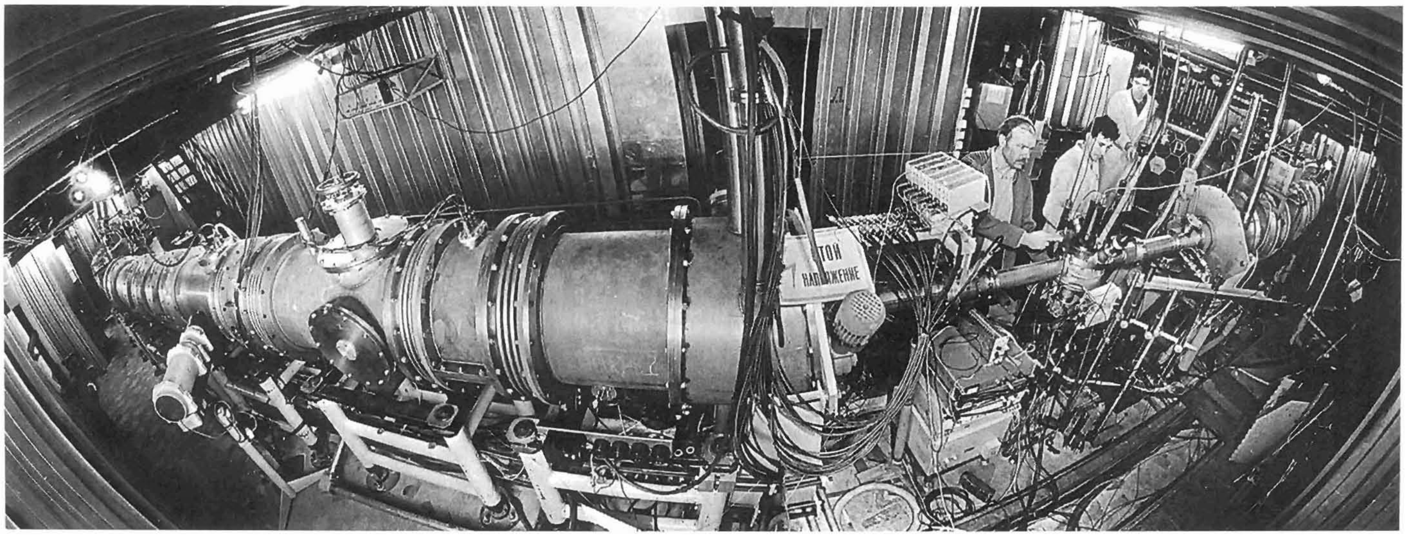
While eclipsed by the new generation of strong focusing machines, the Synchrophasotron enjoyed a new lease of life as a heavy ion machine (up to silicon-28), as well as providing polarized deuteron beams. The machine currently runs for some 1,500 hours per year, providing research material for more than 500 scientists from 100 institutions.

The next energy step had very different scenarios at CERN and at JINR. In in the early 1970s, CERN decided to build the '300 GeV Project' (now the 450 GeV SPS Super Proton Synchrotron) on site, with the 28 GeV PS proton synchrotron as its injector, rather than building a totally new infrastructure somewhere else in Europe (there was no shortage of candidate sites).

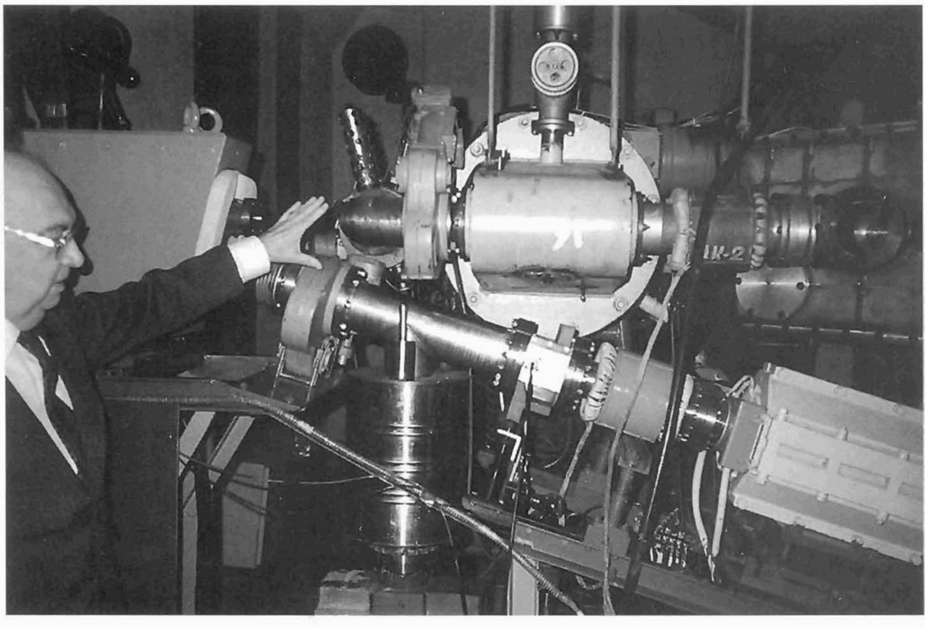
In the prestige field of high energy physics, the USSR chose a different route. Their next major machine was the 70 GeV proton synchrotron, which was pushed through rapidly, coming into operation in 1967 at the new Institute for High Energy Physics

The jewel in the research crown at the Joint Institute for Nuclear Research, Dubna, is the superconducting Nuclotron.

(Photo Yu. Tumanov)



The parting of the ways. Dubna's Laboratory of High Energies Director Alexander Baldin explains the injection scheme which feeds the Synchrophasotron (top beamline) and the Nuclotron (below). (Photo G. Fraser)



at Protvino, roughly as far south of Moscow (100 kilometres) as Dubna is north.

Until the arrival of CERN's Intersecting Storage Rings and Fermilab in the early 1970s, the Protvino machine provided the world's highest energies. The USSR had wrested back the high energy crown, but the price had been high for Dubna. Much Dubna expertise and manpower migrated, never to return.

Despite these two cruel twists of fate, and the current financial difficulties after the breakup of the Soviet Union, Dubna has stuck courageously to its guns and remains a valuable focus of research. Although it has no glamorous new machines, it covers a wider field of science than does CERN.

The decision to go for research using heavy ion beams in 1971 and open up relativistic nuclear physics has paid off. Heavy ion beams are also provided by Dubna's veteran U200 and U400 cyclotrons and the new U400M accelerator (December 1993, page 28). Together, these machines provide a wide range of ions to suit many tastes.

Through this work, Dubna has made major contributions to ion source technology, while on the experimental side Dubna's Flerov Laboratory of Nuclear Reactions has made its mark in the study of superheavy elements (see the article by Laboratory Director Yuri Oganessian which appeared in the November issue, page 16). The quality of Dubna's beams has attracted a steady stream of informed specialists. A US team from the Lawrence Livermore Laboratory has been working at JINR since 1990.

But the jewel in Dubna's heavy ion crown is undoubtedly the superconducting Nuclotron (July/August 1993, page 9), brainchild of Laboratory of High Energies Director Alexander Baldin. This 250-metre ring, assembled in the synchrophasotron's basement, provided its first beams last year.

Experiments currently use internal targets, achieving luminosities of 10^{33} cm^{-2} s^{-1}, but the plan is to develop external beams too, with energies up to 6 GeV per nucleon. Progressively, users are expected to switch from the synchrophasotron to the Nuclotron. A useful Nuclotron bonus is surplus liquid helium, piped off to waiting trucks and supplied to the European market, adding a useful cash bonus to JINR funds.

The initial goal of the Nuclotron was 20 GeV per nucleon. While this is still a dream, Baldin is optimistic about the physics that can be explored nevertheless. Nuclotron beams can be used for studying practically all the characteristics of highly excited nuclear matter.

Another Dubna on-site feature, further extending the range of applications, is a well-equipped six-cabin facility for radiotherapy using synchrocyclotron beams. The good localization of these beams is valuable for treating eye and cranial tumours, while a neutron beam is used to treat larger radioresistant tumours.

The IBR-2 reactor, commissioned in 1982 and with a spectacular pulsing system using strobed plates, has a wide range of spectrometers covering both nuclear and condensed matter research. As well as JINR Member States and ancillary special programmes, Dubna's neutron programme includes bilateral agreements with Saclay and the international Institut Laue-Langevin in France and with the Rutherford Appleton Laboratory in the UK.

Other neutron beams are provided by the older IBR-30 pulsed machine using an electron linac as injector. The plan is to replace this with an Intense Resonance Neutron Source - IREN - using a 150 MeV electron linac and a sub-critical uranium booster. This project involves close collaboration with Novosibirsk's Budker Institute. Three klystrons are being supplied by the Stanford Linear Accelerator Center in the US.

In 1989 Dubna celebrated the 80th birthday of former Dubna Director and renowned scientist Nikolai N. Bogolubov (left, who died in 1992). On Bogolubov's left is Dubna Vice-Director Alexei Sissakian, responsible for Dubna high energy physics and an enthusiastic supporter of CERN-Dubna collaboration.

JINR is especially proud of its theory group, with traditions dating back to its establishment under Nikolai N. Bogolubov and Dimitri I. Blokhintsev and which maintains the high traditions of Russian mathematics and analysis.

With its ready source of knowledge and expertise, coupled with the attractions of a leafy site and the proximity (but not the disadvantages) of Moscow, Dubna's vigorous programme of special schools attracts good participation.

More ambitious are Dubna's plans for a fully-fledged international university on the site, with teaching in English. Already some 100 students pass through Dubna each year for lectures and practical work.

For the future, Dubna is pushing for an electron-positron ring to mass-produce charmed particles and tau leptons - a 'tau-charm factory'. This project involves a close collaboration with the electron machine specialists at Novosibirsk's Budker Institute.

Experiments at other Laboratories

Away from Dubna, JINR teams are prominent on the world stage, participating in experiments either planned or underway at Protvino, CERN, Saclay, PSI (Villigen), Jülich and Prague. Flagship of Dubna participation in the current CERN research programme is the Delphi experiment at CERN's LEP electron-positron collider, where Dubna produced more than 20,000 streamer tubes to equip the detector's hadron calorimeter.

In total, about 100 Dubna physicists are involved in experiments at other Laboratories. About half are at CERN, where JINR teams are heavily involved in detector development for the Atlas and CMS experiments planned for the LHC proton-proton collider, as well as the major NA48 CP-violation study. The programme of experiments currently underway includes the SMC spin study, where JINR polarized target expertise has been useful. The large-scale Dubna involvement in current CERN experiments sets the pace for ongoing collaboration.

Support

JINR was established to cater for the USSR and satellite countries. Unlike CERN, truly international despite being sited near Geneva, JINR today is predominantly Russian, both in terms of funding (60 per cent) and sociology.

With the breakup of the Union, many of the former Soviet republics still regard Dubna as a research focus. Support comes in kind as well as in cash. While Hungary has left the family and departed for CERN, a special Hungarian agreement continues to cover that country's involvement in JINR neutron physics and heavy ion research.

Poland, now also a CERN Member State, retains its ties to Dubna, as do the Czech and Slovak Republics. The most conspicuous empty seat is that of East Germany, whose membership lapsed when the country ceased to exist as such. However special support from Germany, earmarked for cooperation in specific topics and the use of Dubna facilities is the subject of a special annual agreement.

Although the shine may have worn off some of its research facilities, JINR remains an important interface between Western and Eastern science and is packed with know-how. Many Dubna specialists would be happy to work on 'sub-contract' research projects.

Even when the Cold War was at its most frigid, Dubna cherished the bright flame of international collaboration. In 1957, the possibility of collaboration between the infants CERN and JINR began to be explored, and a framework for future collaboration emerged which went on to involve several major Soviet centres. In the early 1970s, inspired by Fermilab Director Robert Wilson, fruitful contacts were made with the US.

While new sources of funding have opened up to support former Soviet

Science, JINR Director General Vladimir Kadyshevsky prefers to take a more pragmatic approach, paraphrasing a Japanese proverb - 'do not give me fish, invite me to go fishing'. 'Science is by nature international', he continues, adding that he was pleased to find a US Department of Energy report quoting the Russian writer Anton Chekhov 'Science cannot be national, in the same way that a multiplication table cannot be national. If a science becomes national it ceases to be a science.'

By Gordon Fraser

Physics revelations

by Christine Sutton

Christine Sutton, Oxford physicist, well-known science writer and regular contributor to the CERN Courier, reports on the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics, held at the Ettore Majorana Centre, Erice, Sicily, this summer.

Erice must be not only one of the most picturesque settings for a conference on history, but also one of the most appropriate, founded so the legends say more than 3000 years ago. Particle physics, by contrast, is strikingly modern, but the Ettore Majorana Centre at Erice was a fitting location for physicists to gather and discuss their subject in the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics, from 29 July to 3 August.

The setting of the Ettore Majorana Centre, Erice, Sicily. Erice, founded so the legends say more than 3000 years ago, was a fitting location for physicists to gather and discuss their subject in the International Conference on the History of Original Ideas and Basic Discoveries in Particle Physics this summer.

Particle physics can probably be said to have begun during the 1930s, a decade that saw Pauli's invention of the neutrino and Fermi's theory of beta-decay, as well as the discovery of the neutron, antimatter (the positron) and the first heavy lepton (the muon). In the relatively short time since then the subject has grown enormously, with many more discoveries, many new theoretical concepts, and many new experimental techniques. For the conference at Erice to cover all of this in five days required the gathering of a large number of experts from a broad range of fields, so that the list of 49 scheduled speakers resembled a "Who's Who" of particle physics.

Speakers such as Vicky Weisskopf really could go back to the first days of particle physics, telling the audience of how in 1933 he had learned physics from Rudolf Peierls in Cambridge (as it was impossible to learn from Dirac!) before becoming Wolfgang Pauli's assistant in 1934. Other speakers of a younger generation came to Erice straight from the frontiers of present-day research. Risto Orava, for example, brought the audience up to date on work on linear colliders, while Blas Cabrera discussed various detectors designed to pick up signals from the dark matter particles that could account for up 99 per cent of the Universe.

Talks on theoretical ideas ranged from the early days of quantum electrodynamics (Weisskopf) through asymptotic freedom and confinement in quantum chromodynamics (David Gross) to supergravity (Dmitrij Volkov and Dimitri Nanopoulos) and superstrings (John Schwarz), and thus spanned the complete period from the early 1930s to the present day. Reminiscences of discoveries stretched back nearly as far across