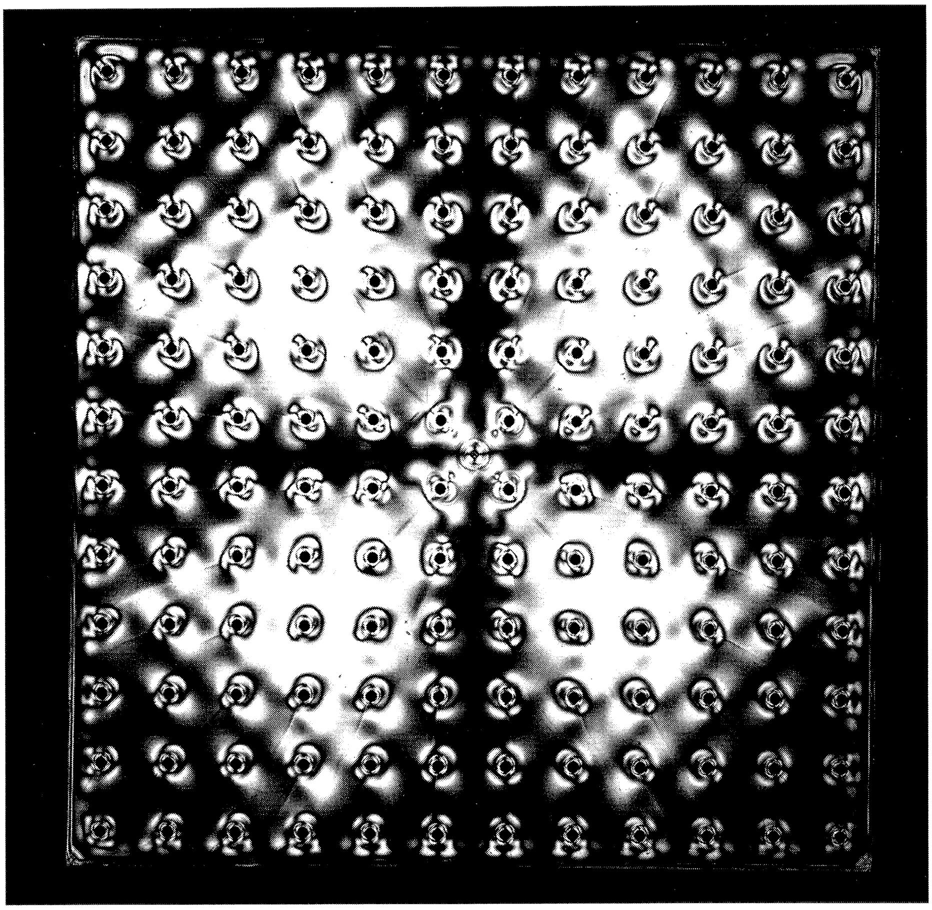
Moulded scintillator tiles with precision-positioned holes are mass produced in Russia for use in the "Shashlyk" sampling calorimeters with wavelength-shifting fibre readout developed recently by IHEP with INR (Moscow), and becoming of increasing interest for new detector applications.



type of sampling calorimeter with wavelength-shifting fibre readout developed recently by IHEP with INR (Moscow), where "perforated" scintillator tiles (see cover photograph, April 1993) with many precision-positioned holes.

The first Shashlyk-type calorimeters are in final phase of the construction and tests for the E-865 experiment at Brookhaven and for the STIC luminosity-measuring electromagnetic calorimeter for the Delphi detector at LEP. More ambitious Shashlyks are in the design stage for the Phenix set-up at Brookhaven's RHIC heavy ion collider and for CMS, one of the major detectors planned for CERN's LHC proton collider.

Recently the other proposed major detector for LHC, ATLAS, has tested a hadron calorimeter prototype with scintillator tiles moulded in sophisticated shapes. These were also produced in Protvino. The technique has also been used for grooved tiles, such as those once considered for the central calorimeter of the SDC detector at SSC.

It is claimed that this techology has not yet been adopted by any Western firm.

GRONINGEN/ORSAY First AGOR beam

AGOR (Accélérateur Groningen-ORsay) delivered its first beam on at Orsay on 12 April. This small-scale superconducting machine, to be used for nuclear physics studies, is the result of a particularly fruitful collaboration between the French Institut de Physique Nucléaire et de Physique des Particules (IN2P3/CNRS) and the Netherlands' Fundamenteel Onderzoek der Materie (FOM).

Built at a cost and on a schedule close to original estimates despite the innovative nature of the project, the facility is shortly due to be dismantled and reinstalled for use at the Kernfysisch Versneller Instituut (KVI) at Groningen, where French physicists will have 20% of the beam time.

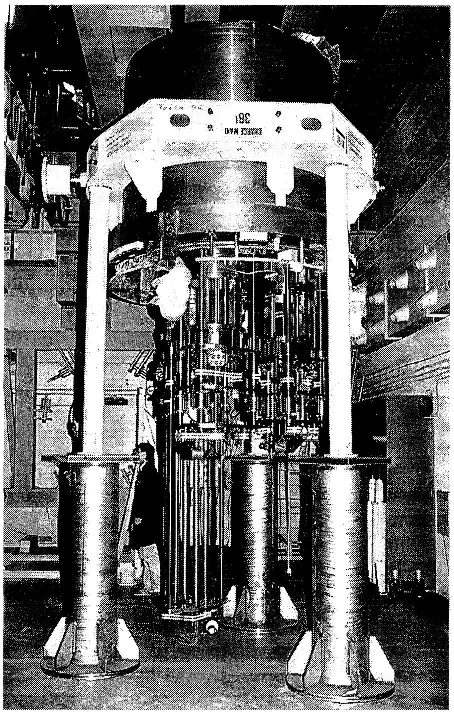
AGOR's debut marked the entry into service of Europe's first superconducting cyclotron, with a beam of double-charged helium atoms accelerated to 200 MeV.

As well as being a second-generation machine, AGOR is the only facility of its type in the world capable of supplying the whole range of ion beams, from hydrogen to the heaviest (lead, uranium) in a very broad energy range, attaining 200 MeV for hydrogen and 6 MeV per nucleon for the heaviest ions.

AGOR's capacity to accelerate beams of light ions such as protons that can be polarized as well as alpha particles has broadened the scope for research into nuclear structure. In the heavy ion field, it supplements a series of European facilities, notably GANIL at Caen and the Gesellschaft für Schwerionenforschung (GSI) at Darmstadt.

AGOR incorporates a number of technological innovations, in particular the use of superconducting coils of niobium/titanium alloy, superconducting at liquid helium temperature (4 K) to produce the magnetic field.

In addition, the superconducting wire is wound round a mandrel and the windings impregnated with resin, *Radiofrequency-equipped insertion for AGOR (Accélérateur Groningen-ORsay). This small-scale superconducting machine, to be used for nuclear physics studies, is the result of a particularly fruitful collaboration between the French Institut de Physique Nucléaire et de Physique des Particules (IN2P3/CNRS) and the Netherlands' Fundamenteel Onderzoek der Materie (FOM).*



a technique which allows the mandrel to be cooled by circulating liquid helium rather than by immersing the coil. This also avoids micro-movements which cause local overheating. High magnetic fields of 4 to 5 Tesla can therefore be achieved over a substantial distance (2 to 3 metres).

Its geometry, based on a design developed at Orsay's Institut de Physique Nucléaire (IPN) at the beginning of the eighties, enables the AGOR accelerator to also handle light ions.

The project was launched at the beginning of 1986 following the signing of the agreement between IN2P3 and FOM in December 1985. Under the terms of this agreement, the facility has been financed by the Netherlands at a cost of 90 million French francs and has been built by French physicists and engineers from IPN who had originally put forward this accelerator concept.

The construction team of about 50 has been supervised by a joint IN2P3/FOM Management Committee and has made extensive use of European industry in such varied fields as computerized control systems, power electronics, precision mechanics, composite materials, superconductivity and cryogenics.

CERN Accelerator School
Cyclotrons, linacs and applications

When the CERN Accelerator School (CAS) was set up over ten years ago it was expected that its job of training a new generation of accelerator scientists would slacken off after a few years as recruitment eased back. It has therefore been a puzzle to explain why, a decade later, there is still a steady flow of 200 or 300 participants a year coming to CAS Courses.

The explanation seems to be that the "graduates" are from the many laboratories considerably smaller than CERN and from university physics departments and hospitals where accelerators are used. There are also factories and even production lines where small accelerators are produced.

This year CAS, whose purpose is to help train accelerator specialists throughout Europe and not just for CERN, decided to dedicate its specialist course to the interests of this varied community. The initiative was amply rewarded by the enthusiasm of the 64 participants and the 25 lecturers who came to the course called "Cyclotrons, Linacs and their Applications" in the IBM Centre in La Hulpe just south of Brussels. The location was close to the Catholic University of Louvain la Neuve and the IBA factory where cyclotrons are developed and manufactured. These organizations and the University of Ghent who arranged a visit to their linac, cyclotron and reactor, helped sponsor the course and handled local organization.

Small linear electron accelerators are widely used for cancer therapy, and the virtues of protons and other ions at a few hundred MeV whose sharp Bragg peak concentrates the deposition of energy with millimetre precision are well exploited. Complementing beam therapy is the use of radioisotopes for research, treatment and diagnosis in medicine. Isotope production worldwide is an industry with an annual output worth 1000 million dollars, about a third of which involves production with accelerators. With the number of hospitals with small cyclotrons to produce short-lived isotopes for positron emission tomography (PET) and other techniques mushrooming, factories have set up new production lines.

The catalogue of non-medical industrial and research applications of small accelerators - and this school did not include synchrotron radiation machines - is never-ending. It includes, polymerization, food sterilization, manufacture of micro-mechanisms, and removing noxious pollutants, not to mention ion implantation and semiconductor production.

New applications for intermediate size machines include nuclear waste disposal and energy production from sub-critical assemblies of thorium. In the even bigger league are proposals for linacs for heavy ion fusion. All these, and the various proposals for new spallation sources, tax the ability of the cyclotron and linac builder alike to produce higher intensities in the GeV range.

The next CAS - Basic Accelerator