'down' and 'up' off 'down') contrast with the behaviour seen in unpolarized (spin averaged) proton-proton scattering (data first obtained about 20 years ago at CERN).

This suggests some large effect at medium transverse momentum, invisible in the unpolarized experiments, but showing up clearly when spin is labelled. Spinning protons have not yet finished yielding their secrets.

BROOKHAVEN
More light

In February 1987, the X-ray ring of the US National Synchrotron Light Source (NSLS) at Brookhaven was shut down for major improvements to double (from 30 to 60) the possible number of experiments and to boost machine performance.

New equipment in the ring includes high brightness insertion chambers, replacing six of the sixteen dipole vacuum chambers, and the Laser Electron Gamma Source (LEGS) experiment.

In an impressive series of pre-commissioning tests in April the revamped machine circulated, stored and stacked electron beam in seventeen hours, boding well for the restart of research this summer using 2.5 GeV beams. This follows an earlier upgrade of the NSLS ultra-violet ring.

Keeping protons polarized

Brookhaven's latest polarized proton physics run was preceded by a three-week commissioning effort. Keeping the proton spins lined up during the acceleration cycle is a complicated business due to both horizontal focusing fields and to magnet imperfections which also give rise to horizontal fields.

These horizontal fields typically cancel in their effect on the polarization, but resonances occur at certain energies when the effect of the fields becomes cumulative. 'Imperfection' resonances are avoided by changing the orbit of the circulating beam using small magnetic fields while 'intrinsic' resonances are avoided by changing the tune of the machine.

An added complication presented itself when the Siemens motor generator set powering the AGS ring magnets developed a short. A vintage backup generator (Westinghouse), unused for 20 years, could only provide enough power for an 18.5 GeV run.

The commissioning successfully negotiated the 30 imperfection depolarizing resonances and the five intrinsic resonances which must be crossed to achieve 18.5 GeV. The physics run had $2 \times 10^9$ protons every 2.8 seconds, with an average polarization of 42 per cent (80 per cent being supplied by the linac). The ramp of the backup power supply was necessarily slower and increased the time spent at resonance energies, making tuning even more tricky. One resonance was extremely sensitive and required frequent retuning - until it was decided to mistune the resonance sufficiently to completely reverse the polarization at that point! This did the trick, and three other resonances were also flipped for the physics run.

As a result of a considerable alignment effort for main ring magnets and ferrite quadrupoles (used to jump intrinsics) which took place over last summer, beam problems (emittance growth when intrinsic resonances were jumped) were minimized.

INDIANA
Electron cooling ring in action

A new proton storage ring with electron cooling is being commissioned at Indiana University in the US. The cooling system came into action on April 16, and already the next day interaction of the cooled beam with an internal jet target was being studied.

Initial off-line tests of the electron beam on March 30 gave electron beam currents to 1 Ampere (cathode diameter 25 mm), energies from 50 to 125 keV, and very good current collection (to 99.99%). The system was so well-behaved that further off-line testing was halted and the cooling device rolled into the ring during an eight day break between test runs.

Cooling (smoother beam properties) was observed as soon as the electron and stored proton beam positions and angles were measured and shifted to coincide. Although the ring has stored $10^9$ to $10^8$ particles at the injection energy of 45 MeV, and electron beam currents from 0.05 to 0.7 A.

With no radiofrequency, Schottky signals showed the injected frequency spread of 0.06% narrowing
Cryogenic Components

Manufacturing Line
- Cryogenic Valves
- Bellows seal Valves
- Cryogenic Transferline Couplings
- Cryostats and Ejectors
- Tailor made Cryogenic Components

Cryogenic On/Off Valve
Manually operated with position indication and limit switches "Y" pattern

WEKA Ltd.
Hofstrasse 8, CH-8620 Wetzikon, Switzerland
Phone 01/932 2302, Telex 875 744
Fax 01/932 43 03

Stop leaking high pressure valve problems.
Switch to Battig high sealed valves.

Alfred Battig AG
CH-8400 Winterthur/Switzerland
Phone: 052/25 27 69
Telex: 896 371 valv ch
Telefax: 052/25 02 24

We assure better quality, sealing and valve life because we're • "the valve makers".

HI-TEC
Debitmètre massique
Le debitmètre massique thermique HI-TEC utilisable pour des mesures en laboratoire et dans l'Industrie. Pratiquement indépendant des variations de pression et de temperature.

voglin Instruments SA
Debit Pression Niveau
Langenhagstrasse 1 Bureau Lausanne,
CH-4147 Aesch BL Rematec: 021/81 26 29
Tel. 061/78 63 00 Bureau Frauenfeld: 054/21 55 39

Mesure et règle sans problème des débits gazeux et liquides!
in a fraction of a second to 0.003%. With r.f. at 6 MHz, the time spread of the beam was quickly reduced to less than 2 ns, and the beam lifetime increased from a second or two to over 40 seconds.

The new Cooler is injected with beams from the 2 Tesla-metre isochronous cyclotron at the Indiana University Cyclotron Facility (IUCF). It heralds a second generation of small cooled storage rings for research in atomic, nuclear, and particle physics. Several other rings at Heidelberg, Uppsala, Tokyo, and Aarhus are scheduled to come into operation soon.

The 86.82 m circumference is similar to that of the LEAR ring at CERN, but has a smaller magnetic rigidity of 3.6 Tesla-metres (corresponding to a momentum of 1.08 GeV/c for singly-charged particles). This means that an unusually large fraction of the ring is left open for internal target experiments.

The Cooler* can be filled by stripping light ions, or kickers can be used to inject beams without stripping. A first look at this process was obtained on May 8 and 9 with storage and cooling of unpolarized and then polarized protons of 148 MeV from the cyclotron. This gave essentially the same 3 keV energy spread as at 45 MeV, time spreads below 1.2 ns and beam lifetimes of 3 to 4 minutes. These tests were carried out at low intensity with single turn injection. Longitudinal stacking of polarized protons and deuterons, heavily used by the IUCF research community, is planned for the autumn.

Acceleration in the Cooler will extend the energy range of all ions, and the electron cooling system has been designed to match any of the stored beams (requiring electron kinetic energies up to 270 keV).

Although proton beams of IUCF energies have been available from accelerators for nearly forty years, the superior beam quality of the isochronous cyclotron has made possible a number of new results from IUCF and the other large cyclotrons that began operation in the mid 70s.

According to Robert E. Pollock, one of the Cooler’s designers and its project manager during the construction years, plans for electron-cooled antiproton beams in LEAR, with markedly better phase space density than the proton beams from IUCF, were a revelation (January/February issue, page 10).

Internal target experiments can exploit this beam quality, and the Cooler concept was born. Of course the Novosibirsk (USSR) originators of the electron cooling had anticipated applications such as those planned for the Cooler, but the Indiana group was the first to go for cooling with internal target.

One Cooler straight section has an experiment with a jet target operating at densities up to $10^{11}$ atoms per square cm, and detectors covering the forward cone, designed for a pion threshold measurement. The second straight section is used by a Michigan group preparing a ‘Siberian snake’ to further control the beam. A third target location in the ring has a 6 degree bend to separate reaction products for an experiment by a Pittsburgh-Illinois collaboration.

The experimental programme approved so far includes seven experiments, with five more to be considered. Future plans include a polarized target, spectrometers in the ring, and experiments with recoil ions and tagged secondaries.

The Cooler project was funded by the US National Science Foundation ($7.7 million) and by the State of Indiana ($4 million).

MEETING
Warsaw 1938-1988

Each year the University of Warsaw organizes a one-week meeting on theoretical particle physics in the charming little town of Kasimierz on the Vistula, 150 km south of Warsaw. These meetings are a lively testimony to the important work on theoretical physics in Poland.

The latest meeting, in May, brought together about 120 participants, about half from abroad, and marked the 50th anniversary of a milestone meeting in Warsaw on new theories in physics, with contributions from Niels Bohr, Louis de Broglie, Louis-Marcel Brillouin, Sir Arthur Eddington, Hendrik Kramers, Oskar Klein and Paul Langevin.

The 1938 proceedings were widely reread this time, and 1988 summarizer David Gross preferred to summarize instead the 1938 meeting. Besides much discussion about the interpretation of quantum mechanics, in those days people were trying to reconcile the strong nuclear force and the Fermi theory, formulated for weak nuclear forces (beta decay), but the only tractable picture available at the time and the object of much speculation.

The heavy particle postulated by Yukawa as the origin of strong nuclear forces was then widely believed to have spin (intrinsic angular momentum) of one unit (the pion, the first nuclear meson to be discovered, has zero spin). Meanwhile the photon ('a daring abstraction') was being associated with