

CERN LEAR arrives

The CERN antiproton project, already with a fine list of achievements to its credit, now has new muscles to flex. The LEAR Low Energy Antiproton Ring in the South Hall of the PS is now catering for a large array of experiments, providing antiproton beams of an intensity and quality never before achieved. These studies could turn out to be no less fruitful than their high energy counterparts at the SPS.

LEAR is the last major phase of CERN's antiproton project as initially planned. Whereas experiments at the SPS and the ISR involve accelerating the antiprotons supplied by the Antiproton Accumulator, antiprotons for low energy experiments are instead decelerated, first in the PS proton synchrotron and subsequently in LEAR, down to very low momenta.

During the excitement of the latest high energy proton-antiproton run, LEAR quietly supplied low energy proton test beams to the experiments being prepared downstream. Towards the end of July, LEAR received its first scheduled supply of low energy antiprotons. Initial performance was encouraging, and in a few hectic days, the experts readied the machine for action.

The LEAR 'ring' looks in fact more like a square, with four long straight sections and magnets at each corner. Its 78 m perimeter is one-eighth that of the neighbouring PS ring. It exploits ultra slow (stochastic) extraction, a new technique developed at CERN, in which carefully controlled r.f. noise is used to drive particles smoothly towards the extraction resonance in order to avoid spill irregularities due to ripple. Preliminary

tests at the PS several years ago promised well, but in initial LEAR operation 308 MeV/c antiprotons were nudged out of the ring at the rate of 300 000 per second for fifteen minutes — just one antiproton in the stored beam left the ring in every three revolutions!

Judged by the number of experiments lined up in its experimental hall, LEAR is already a great success. It has attracted more than 250 physicists, from some 50 institutes in CERN Member States and the USA, Canada, Israel, Poland and the USSR.

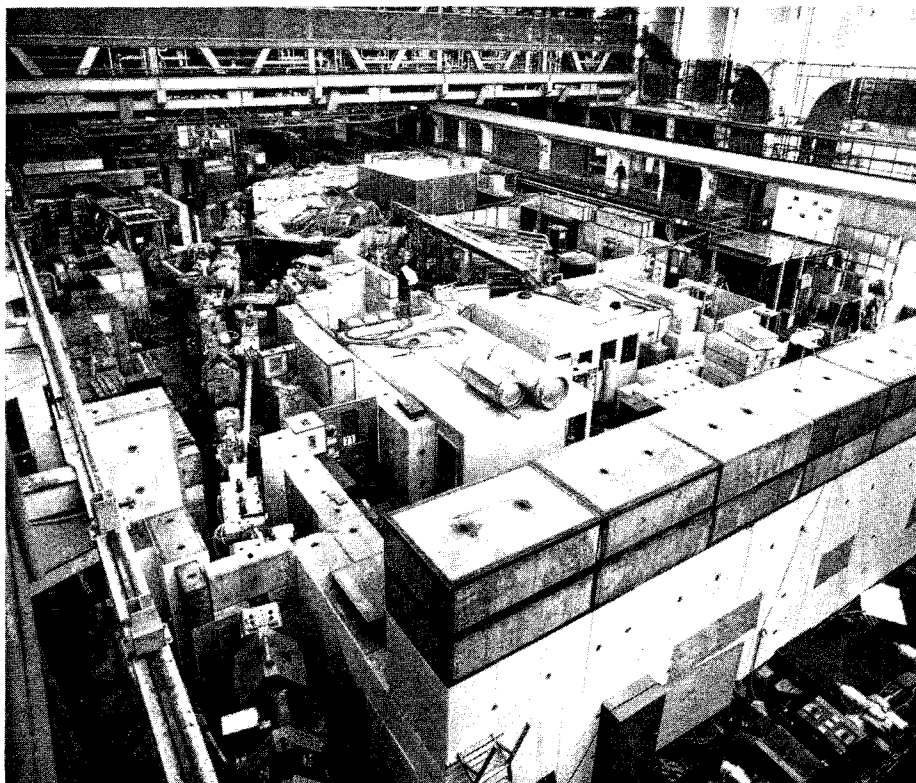
In sharp contrast to the nucleon-nucleon case, where the low energy interaction has been charted in detail, nucleon-antinucleon data is relatively thin on the ground. Comparison of nucleon-nucleon and nucleon-antinucleon (and nucleus-nucleon and nucleus-antinucleon) data will provide important new insights into

hadronic (and nuclear) forces, while investigation of the annihilation mechanism could considerably extend our knowledge of quark behaviour. Certainly LEAR should help clear up the spectroscopy of low energy nucleon-antinucleon resonances or bound states, where controversy has raged for years.

Each of the initial 49 pulses given to the LEAR experiments contained almost as many low energy antiprotons as the total number given to low energy antiproton physics experiments in the 28 years since the particle was discovered. At this rate, the eagerly awaited physics results should not be far away.

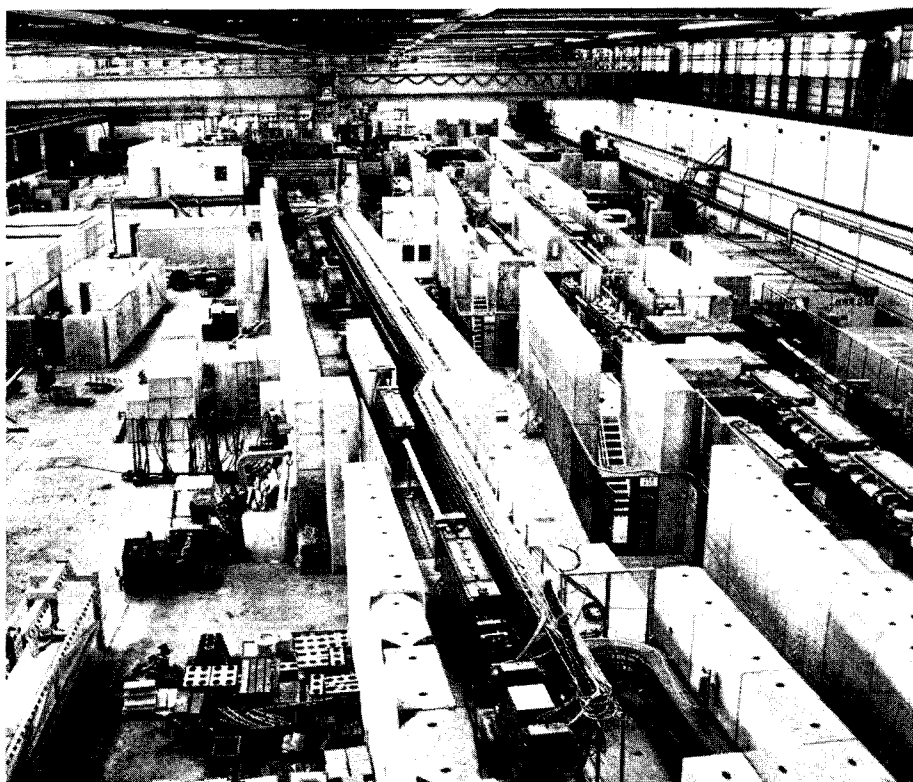
The crowded experimental hall at CERN's LEAR Low Energy Antiproton Ring. Judging by the number of physicists it has attracted — over 250 from 50 institutes — LEAR is a major success. First physics results are eagerly awaited.

(Photo CERN 1.5.83)



The new-look West Experimental Area at CERN now receiving beams at maximum energy (450 GeV) from the SPS proton synchrotron.

(Photo CERN 181.7.83)



Fixed objectives

After the excitement of the proton-antiproton collider run (see September issue, page 247), the SPS Super Proton Synchrotron returned on 14 July to the job it had been built for — delivering high energy beams of protons to fixed targets.

However this time it was doing it with a difference. The particles from the SPS serve two distinct experimental areas, one to the west of the site, and the other to the north. For five years after it came into operation in 1976, the main hall in the West Experimental Area used 40-200 GeV secondary beams derived from protons extracted from an intermediate SPS flat top at 250 GeV. Maximum machine energy (usually 400 GeV) was limited to the better shielded North Experimental Area and the West Area neutrino beam.

While the SPS was operating as a collider, the primary West Area target was placed underground, thus enabling the main West Area to profit from the full energy of the machine. Old beamlines, clad in 50 000 tons of concrete and 5 000 tons of iron shielding, were dismantled, and over 2 km of new beamlines installed, containing over 280 magnets and quadrupoles.

While this was going on, additional r.f. equipment was installed in the SPS itself to boost its normal peak operating energy from 400 to 450 GeV. However initial 1983 fixed target operations concentrated a firm consolidation of 400 GeV running before stepping up to 450 GeV.

One major objective for the revamped West Area is to provide extensive test facilities for the experiments to be built for CERN's big new LEP electron-positron ring. In this

way, the components of the complex detectors can be assembled and taken through their paces while the machine itself is still under construction.

Thus the West Area now provides simultaneous beams for physics and for testing apparatus. The incoming proton beam hits a primary target, and is split into two main components, one of which delivers high energy pions and electrons to the large Omega detector, now resited.

The other secondary beam is further divided into three by septum magnets. Two of these branch beams hit secondary targets to provide two tertiary electron/hadron test beams. The third secondary branch beam can either be used for physics (H3 beam), or to provide a third tertiary test beam.

The first recipient of the H3 beam is the big WA 75 experiment (Bari / Brussels / CERN / Dublin / Japan / London / Rome / Turin) looking for signs of beauty particles. The interactions in a thick emulsion target are pinpointed with the help of silicon microstrip detectors sandwiching the emulsion target, plus downstream wire chambers. The experiment is interested in decays producing muons. Other particles are removed by a thick metallic absorber, and the muons are measured in a large superconducting magnet moved in from the North Area. The emulsion will be scanned using the newly developed automatic technique (see June issue, page 184).

Another beauty search using sophisticated emulsion techniques, this time concentrating on the charm signature, is being carried out by a CERN / Genoa / Milan / Moscow / Paris / Rome / Santander / Valencia team using the Omega detector.

Other experiments lined up for the big Omega detector cover photoproduction (long a speciality at Omega),

Physics monitor

the study of direct photons and a search for exotic phenomena ('glueballs').

ARGONNE IPNS reaches 500 million pulses

As briefly reported last month (page 268), the Rapid Cycling Synchrotron (RCS) of Argonne's Intense Pulsed Neutron Source (IPNS) reached 500 million pulses in May, delivering a total of 10^{21} protons in only 43 weeks of operation. The RCS accepts 50 MeV negative hydrogen ions from the old ZGS linac, strips and accelerates them to 450-500 MeV, and directs the extracted beam to a uranium target producing spallation neutrons.

The machine started operation in 1977 as the proton source for the prototype pulsed neutron source ZING-P', then operated from 1981 until the present for the IPNS. It is now delivering up to 2.5×10^{12} protons per pulse (12 microamp average) at 450 MeV in 100 ns-wide pulses at 30 Hz. Acceleration losses are low (12-17 % difference between beam injected and on target) and availability exceeds 90%. The present high current results from continuous improvements in hardware, beam control, and most significantly, installation of a new, high current negative hydrogen ion source.

The IPNS is the world's most intense pulsed spallation neutron source and is used in condensed matter research. 25 % of the accelerator time is devoted to fast-neutron (about 1 MeV) radiation damage studies at the Effects Facility and 75 % to the slow neutron (less than 1 eV) Neutron Scattering Facility. High energy and medical test beams run parasitically.

IPNS has operated as a national user facility since November 1981, with experiment time allocated by a Scientific Program Committee. As the current leader in this new generation of neutron sources for low energy neutron research, it has attracted worldwide attention. To date, 307 proposals have been processed, but only half could be accepted due to budget-imposed limitations on operation (about 26 weeks per year).

Instrumentation at the thirteen slow neutron beams and five irradiation facilities provides capabilities that significantly extend the range of low energy neutron studies beyond that provided by research reactors (until now the mainstay of this research). Each capitalizes on either the pulsed feature of source operation or the fact that the moderated neutron spectrum is especially rich in 'epithermal' (less than 0.1 eV) neutrons. Future prospects are especially exciting since there is scope within accelerator and neutron source technology for at least two orders of magnitude improvement in intensity. Projects to provide higher intensity are well under way elsewhere; at the Rutherford Laboratory, for example, the SNS is expected to come on line next year, ultimately delivering about thirty times the present IPNS intensity.

The two techniques for producing holograms in big bubble chambers. Above, in the 'two-beam' method, the laser beam is split into a low power reference beam which passes directly to the photographic emulsion, and a higher intensity component which goes into the bubble chamber and is reflected back. Below, in the 'in-line' method, the laser beam diverges through a specially designed lens. A small fraction of the light goes directly to the chamber's fisheye window to form the reference beam.

