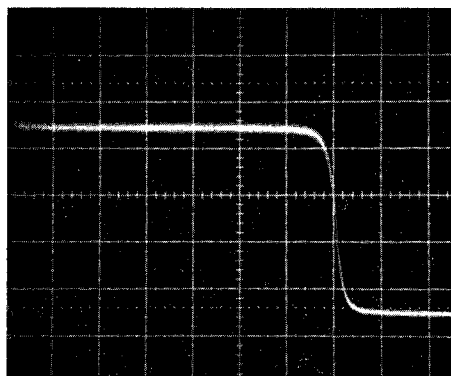


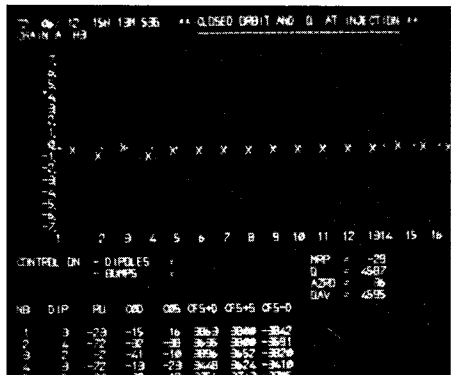
For the delight of accelerator specialists - four scope pictures illustrating the behaviour of beams in the Booster :

1. Signal from a beam transformer showing single turn injection which is practically loss-less. The beam circulates, without being accelerated, for 7 ms until the rising magnetic field drives it against the vacuum chamber. The steepness of the loss when this happens indicates the small size of the beam. (Scale - horizontal 1 ms per division, vertical 8 mA per division.)

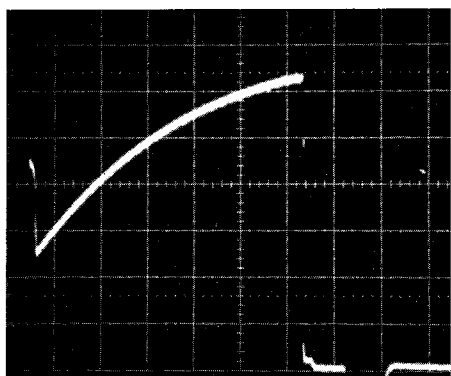
2. Signals from 16 pick-up stations are acquired by a computer on two successive turns shortly after injection. The closed orbit distortions are



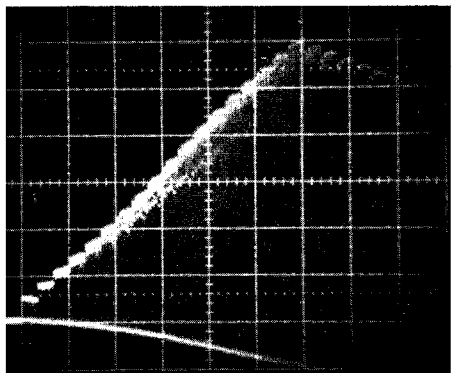
1.



2.



3.



4.

so small that no use is made of the correcting dipoles.

3. Acceleration to 800 MeV. The signal from the beam transformer increases in amplitude as the particles gain speed and thus represent a higher current. The intensity at design energy is 2×10^{11} protons. (Scale - horizontal 100 ms per division, vertical 8 mA per division.)

4. Multi-turn injection over eighteen turns is demonstrated by the signal from a fast beam transformer. The individual spikes result from the use of a chopped beam. (Scale - horizontal 5 μ s per division, vertical 80 mA per division.)

Computer simulation of beam behaviour carried out before commissioning started, has proved an invaluable help. It has made it possible to understand rapidly what is happening and to adjust conditions quickly and appropriately. Adiabatic trapping is now being tried to increase the fraction of particles which can be captured by the r.f. accelerating fields. By the end of the month the final septum magnets should be in place so that all four rings will be in action.

The five year project has been carried out to schedule. The Booster team have carried through design, construction and commissioning excellently.

CERN-Serpukhov Experiment No. 3

On 1 June equipment set off by rail from Geneva en route to the Institute of High Energy Physics, Serpukhov, to be used in the third collaborative experiment on the 76 GeV proton synchrotron. The experiment involves groups from Karlsruhe, CERN, ITEP (the Institute of Theoretical and Experimental Physics, Moscow, under the direction of I.B. Chuvilov) and, possibly, a few scientists from Moscow State University. It is concerned with studying neutron-proton charge exchange at high energies.

A lot of data on the phenomenon of charge exchange has been collected at lower energies. What happens is that a neutron is fired into a target and a proton emerges in the forward direction, a neutron coming off at the side. The simple interpretation is that a pion, carrying a positive charge, has hopped from the 'stationary' proton in the target to the neutron as it hurtled by thus converting it to a positively charged proton (leaving a neutron in its wake). This simple interpretation gains weight, at first glance, from

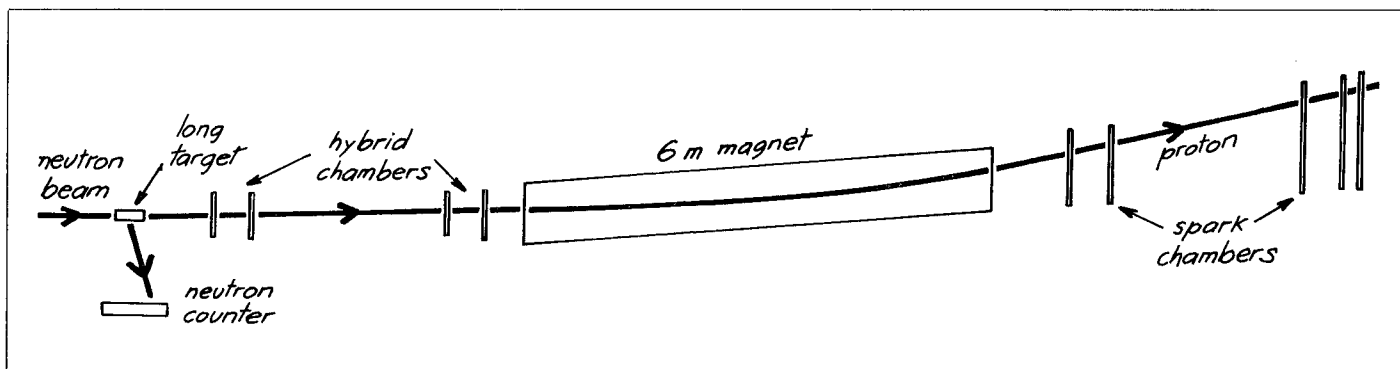
looking at the graphs obtained at all the energies investigated so far—they all show a very sharp peak at small t values (i.e. when little momentum is transferred from the incoming particle to the target particle). The slope of this peak (which is much sharper than that observed in any other scattering cross-section) is of the order of magnitude of the inverse of the pion mass squared — a seemingly clear pointer that the pion is involved.

However when the detailed calculation is done concerning the results which should be obtained with a simple one-pion exchange, a dip should be found rather than a peak. It is still probable that the pion is involved but its effect must be superimposed on other things which go on during the charge exchange (superimposed on a more complicated background).

One of the main aims of the new experiment at Serpukhov is to try to learn more about this background — for example, whether it has to do with pomeron-pion exchange (Regge cuts) or rho and A2 exchange. The way in which the phenomenon is dependent on the energy should settle this question.

A second aim is to try to get more information on whether the pion is 'Reggeized'. Regge theory has been one of the most successful theories in linking particles together and in linking the existence of particles with the observed scattering amplitudes. When only spin and parity are changing, particles lie on so-called Regge trajectories in orderly fashion and the slopes of the trajectories are parallel. The pion however is isolated and is not linked with other particles — a trajectory for the pion cannot be drawn. The indications from the latest measurements at CERN are that the trajectory may have zero slope — the pion may not be Reggeized at all. Extending the measurements to higher

Schematic diagram of the layout of the detection system for the third collaborative electronics experiment at the 76 GeV proton synchrotron at Serpukhov. The experiment will study neutron-proton charge exchange using a neutron beam from the accelerator and detecting the proton and neutron emerging from the interaction.



energies should clinch this question.

A schematic representation of the experimental set up can be seen in the diagram. The neutron beam emerges from the synchrotron at a tangent where the accelerated proton beam (about 5×10^{11} protons per burst) strikes an internal target. Magnets and lead blocks take out the charged particles and the gamma rays, respectively, leaving a neutron beam which strikes a hydrogen target about 60 m away. The experiment can cope with all neutrons with a momentum between 20 and 70 GeV/c.

Since the probability that the charge exchange interaction will take place goes down as the energy increases, a long target (25 cm) filled with liquid hydrogen is used to put more protons in the way of the neutrons. However using a long target would mean that the point of interaction would not be known to adequate precision unless special measures were taken. Therefore a system to measure the amplitude of the Cherenkov light emitted by the emerging proton was developed with the group of L. Mazzone. The amplitude of the photomultiplier signal from the Cherenkov light gives the point of interaction.

The neutron emerging from the target with low momentum is detected in a neutron counter (four vertical scintillator blocks). The angle and time of flight can be measured and neutrons

with momentum between 1 and 250 MeV can be detected. (This corresponds to studying t values, or momentum transfers, between 0.001 and 0.6 (GeV/c)².)

The outgoing proton is detected and measured in a spectrometer involving hybrid chambers (described in vol. 11, page 231) which are used near the target to take advantage of all the intensity possible, a 6 m magnet (a standard Serpukhov bending magnet), and spark chambers with core read-out. The detectors are all linked with an on-line computer, a CDC 1700. We will not describe the various tricks such as the use of anti-counters and shields which ensure that only the events of interest are being recorded.

All the equipment, with the exception of the large Serpukhov magnet, has worked at CERN in an experiment covering a lower energy range. It is scheduled to arrive at Serpukhov on 22 June and to be set up ready to receive its first high energy neutron beam on 18 August. The experiment will be at Serpukhov for about a year. The people who will go for varying lengths of time are V. Bohmer, J. Engler, W. Flauger, B. Gibbard, H. Keim, F. Monning, G. Novellini, K. Ratz, K. Runge, H. Schopper and K. Pack. Their Soviet colleagues will be led by V. A. Ljubimov and one of the Vice-Directors of the Institute, V. G. Shevchenko will participate.

A fourth collaborative experiment involving a Karlsruhe, Pisa, Serpukhov and Vienna team will study negative pion-proton charge exchange and neutral meson resonances. They will be using some of the equipment of the second experiment (described in vol. 10, page 78) which finished earlier this year. The fourth experiment will start only a few months after the neutron-proton experiment we have described above. Thus two collaborative experiments will be under way at the same time. This goes beyond the terms of the initial Agreement and is yet another indication of just how well the CERN-Serpukhov collaboration is working.

On the way to Omega experiments

Two more important steps have been taken en route to the start of experiments in the Omega spectrometer. One coil of the superconducting magnet has been successfully tested and beam has been brought from the 28 GeV proton synchrotron to the Omega target in the West Experimental Hall.

The magnet of the spectrometer is designed to give a 1.8 T field at the centre of a large aperture (3 m diameter, 2 m high between the magnet poles where detectors can be installed). It