

main ring, the r.f. power must be able to cope with an overall injection time of 5.2 μ s.

Before entering the separators the beam diverging from the target has passed through two collimators then four quadrupole magnets which focuses the beam in the horizontal plane and gives a horizontal acceptance of ± 5 mrad and a vertical acceptance of ± 3.8 mrad. It then passes through two 6 m bending magnets, two collimators, two more bending magnets and finally two quadrupoles which focuses the beam in two planes into the centre of the first r.f. separator. In between each of the three separators with an intercavity distance of 88 m (1-2) and 164.6 m (2-3) respectively are two pairs of quadrupoles and following the last separator is a transport line containing a further series of collimators, and dipole and quadrupole magnets which makes a second momentum analysis and beam shaping for the bubble chamber.

Work began on the design of the separators soon after the signing of the agreement, by a group under H. Lengeler as project leader and made up of the following: — from CERN — deputy project leader: Ph. Bernard; mechanical design: M. Candolfi, M. Kubly; electronics design: Cl. Dalmas, F. Grabowski, A. Imsomby; J.F. Malo; J.P. Moussard (part-time); J.-Cl. Prelaz; R. Romijn; electronic-mechanical work: H. Preis; vacuum: P. Cottet; drawing office: Cl. Ruitet; from Serpukhov - electronics: B. Prossin; deflecting structures and general design: V. Vaghin; modulators: V. Zelenin. Much of the precision manufacture has been carried out at CERN. Contributions from industry include three modulators from Ling-Altec of the U.K., the three 6 m disc loaded waveguides which are the heart of the separator cavities from CSF, France and high power klystrons from Thomson-Varian, France.

The tests on the whole system began in March of this year in order to be ready for transport to Serpukhov by road in mid-July, and the beginning of assembly in early August. This work should take about two months. It will be followed by a commissioning and tuning period in time for operation to start, all being well, early in 1972. For some time after that it will be providing separated beams of the highest energies available anywhere.

Mirabelle

After ejection, beam transport, the target, separation of secondary particles and further focusing and transport, the surviving particles finally arrive at their destination — Mirabelle. This large liquid hydrogen bubble chamber with a total volume of 11 000 l, 7 000 l of which are in the field of view of the cameras, has been described in earlier volumes of the CERN COURIER (see volume 9, page 308 and volume 10, page 117) as well as the first tests which were performed at the laboratory responsible for its construction — Saclay. This series of tests and the improvements based on them enabled a physics test experiment to be carried out in March, 1970, during which, with a beam injected from the Saturne accelerator, 50 000 pictures were taken. These photos have served as the basis for the final evaluation of the film measuring equipment.

Dismantling of Mirabelle at Saclay began in May 1970. The components weighing altogether approximately 3 600 tons were dismantled, packed and listed item by item, according to a programme carefully worked out to fit in with the schedules for shipment and reassembly at Serpukhov. The crates were dispatched by road to Le Havre, from where they went by sea to Leningrad and then on by rail to Serpukhov. This complicated operation was successfully completed for the equipment to be all on the site by December. Meanwhile, the team responsible for the reassembly and operation of Mirabelle, consisting of about fifty persons with their families had moved to Serpukhov in September. Reassembly began at once and was completed on schedule by the end of the year. The speed with which the operation was performed reflects great credit on all the participants.

The necessary links were established between Mirabelle and the Soviet support systems: supply of electricity, cryogenic and other fluids etc... All of

which had been prepared well in advance by both teams.

So, on the morning of 10 June of this year, in the hall at one end of the 450 m long experimental area, Mirabelle came back to life. In four days, using a 70 GeV/c proton beam, 20 000 expansions were performed and 4 000 photos taken. These were the first in the world to be taken using a proton beam of this energy and in a liquid hydrogen bubble chamber of this size. They are now being studied. A quick examination has already shown up some interesting points and some of the pictures will probably be selected for measurement.

This first technical experiment at the Serpukhov site, coming after the many complexities of dismantling, shipment and reassembly, has proved very encouraging, especially as regards the sensitivity and reliability of the chamber. Mirabelle has shown that, with its large photographable volume, it is a device eminently suitable for experiments at high energies. What is more, because of the large photographable length (4.70 m), interactions occurring at the beginning of the chamber can be recorded and followed through far enough for the physicists to be able to investigate them very thoroughly as can be judged from the photograph.

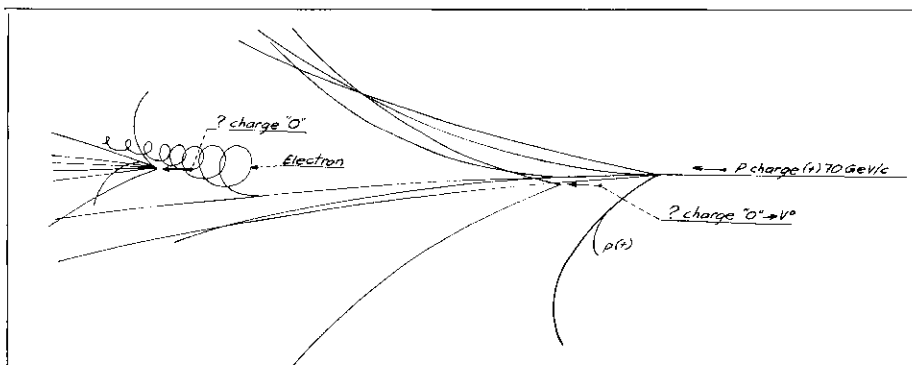
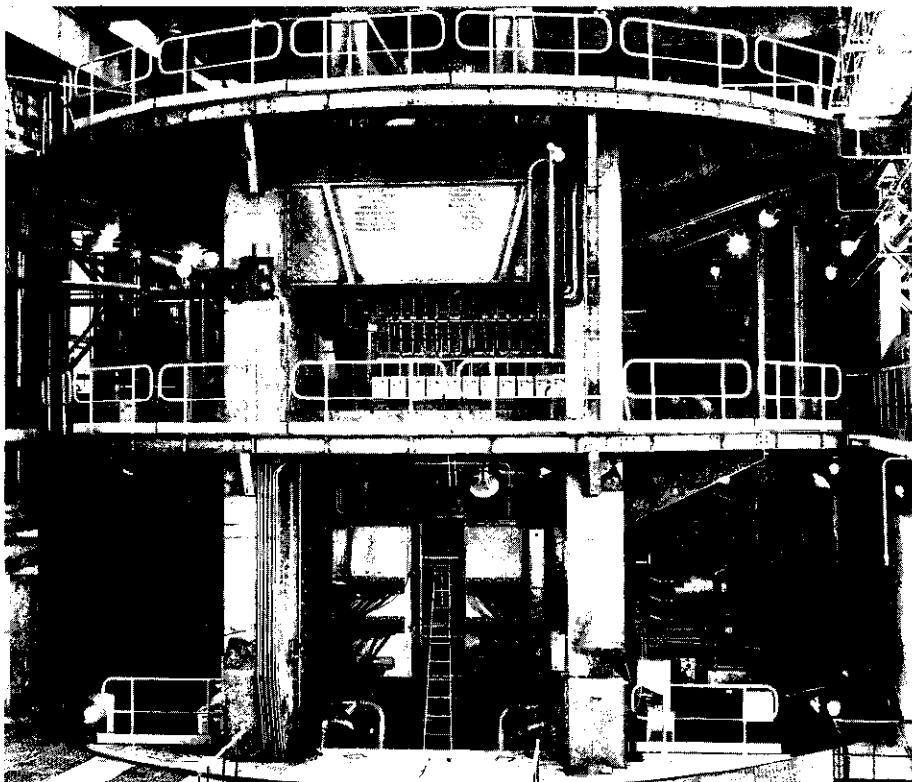
Other experiments will take place between now and the end of the year and then besides the 70 GeV/c proton beam already mentioned the radio frequency separated beams will become available at the end of 1971 or the beginning of 1972. A neutrino beam has also been planned but it is dependent on an increase in intensity of the accelerator and on future decisions regarding the experimental programme.

A general view of Mirabelle re-assembled at Serpukhov. Note the revolving platform which simplified assembly and the alignment of the chamber with respect to the beam.

(Photo CEA)

A photograph taken in the bubble chamber during the first tests at Serpukhov in June of this year. A representation of an interesting sequence of events is shown below. This is one of the first ever bubble chamber photographs with such a high energy incoming beam (70 GeV/c protons) and note how the length of the chamber (4.7 m) enables a series of related events to be recorded.

CERN - Serpukhov collaborative experiments



Most of the above information has covered the preparations for experiments using the bubble chamber technique. But we can also now talk of three CERN-Serpukhov collaborative experiments using electronic detectors. The second of them is now in full swing at the 76 GeV proton synchrotron; the third is taking data at lower energies at the CERN PS.

The first experiments yielded some of the most important results of recent years (reported in vol. 9, page 232). They showed that the total cross-sections for negative particles became virtually constant at much lower energies than expected and that for positive particles, the cross-section instead of approaching the negative value in a regular and steady way, has a dip in the curve at intermediate energies. These results then do not allow one to extrapolate simply from the data obtained over lower energy ranges nor do they conform with the favoured predictions of theory. It looks from some of the very first measurements at the Serpukhov machine as if, as has happened so often in the past, access to higher energies is feeding completely new knowledge, and we hope ultimately understanding, of the behaviour of matter.

The second experiment performed by a joint Serpukhov-CERN team, the CERN component being in turn a collaboration between CERN, Geneva and Munich, has been taking data since about a year ago. It is extending to higher energies the very fruitful application of the missing mass technique developed at CERN in the mid-60 s.

The experiment is to study essentially the characteristics of the x^- particle which is produced together with a proton when a pion strikes a proton: $\pi^- p \rightarrow p + x^-$. The boson spectrometer in its present form (see vol. 10, p. 80) not only allows the x^- mass to be reconstructed but the decay behaviour to be followed in some detail.