

And to come...

A brief sketch of the further developments in PS performance and in experimental facilities which will come about in the next few years in the context of the PS Improvement Programme and the coming into operation of the Intersecting Storage Rings.

At the December Session of the CERN Council in 1965 an Improvement Programme was approved to increase the capacity of the PS for particle physics at energies up to 28 GeV. This programme has five prongs:

1. To increase the PS repetition rate by installing a new magnet power supply
2. To increase the PS accelerated beam intensity by means of a new higher energy injector (second stage of PS improvement programme)
3. To provide facilities for Gargamelle, a large heavy liquid bubble chamber built by Saclay
4. To build a large hydrogen bubble chamber (BEBC) in cooperation with France and Germany
5. To build a large spectrometer magnet and spark chamber system (the Omega project).

At the same meeting, the Intersecting Storage Rings (ISR) project was approved and in addition to the storage rings themselves was included an experimental hall for 28 GeV physics (the West Hall), somewhat larger than the total area of the existing South, North and East Halls.

To date, the first point of this programme is completed — the new main magnet power supply was commissioned in mid 1968; the rest of the programme is scheduled to come into operation as follows:

- 1970 ejection from PS towards ISR, commissioning of Gargamelle
- 1971 commissioning of ISR and BEBC
- 1972 commissioning of Omega and the higher energy injector (the Synchrotron Injector or Booster).

Thus, in the next three years the complexity of the PS facility will increase considerably. BEBC, Omega and other electronics experiments in the West Hall will require both fast and slow ejected beams down the same channel. The technique of sharing simultaneously between this slow ejection and the internal target

in straight section 1, feeding the South Hall experiments, must be developed, and, as now, fast ejected beams will be necessary in the East Hall (for the 2 m chamber) and the South East Area (for Gargamelle). All this during the same machine cycle.

The ISR will make more stringent demands on the quality of the accelerated beam; the PS will become an injector and not just a provider of protons for internal or external targets.

All these operations will have to be carried out with a beam intensity an order of magnitude greater than in 1968. The double problem facing the PS is, firstly, the production of this higher intensity, with the minimum beam blow-up, and, secondly, living with this beam once it has been achieved.

The first proposal to increase the PS intensity per pulse was to replace the 50 MeV Linac by a Linac of 200 MeV; it was demonstrated, however, that a multi-ring slow-cycling booster synchrotron operating between 50 and about 800 MeV would, for about the same cost, give more flexibility and greater development possibilities, particularly for the ISR. A detailed design study for a four-ring booster (described in CERN COURIER vol. 8, page 3) was completed in 1967 and in January 1968 the Synchrotron Injector Division was formed to build it.

With adding the Synchrotron Injector, considerable modifications are necessary to the PS itself. The repetition rate of the Linac must be doubled and its beam pulse length increased to 100 μ s. In order to cope with the increased beam loading due to the higher intensity beam and to provide the higher accelerating voltages necessitated by the increased rate of rise of the magnetic field, the r.f. acceleration system will be replaced. Sputter ion pumps are being installed to improve the vacuum. A variety of instrumentation will be added to keep a good watch on, and good control of, the beam.

In order that beam losses (and thus induced radioactivity) are kept within manageable limits the average operational efficiency of ejection must be kept very close to the peak efficiency obtainable, despite the necessity of sharing with targets. To this end considerable effort

is going into computer control of ejection. Here again good instrumentation is of great importance. Equipment inside the ring and especially around internal and external targets and ejection systems must be radiation hardened and designed for rapid maintenance (or maintenance by remotely-controlled manipulator).

By the mid-1970's the PS complex really will be complex. A proton leaving the ion source will have a wide variety of opportunities for its immediate future. It will be accelerated to 50 MeV in the Linac. From there it can go into any one of four vertically stacked rings in the synchrotron injector where its energy will be taken to 800 MeV (crossing the Franco-Swiss border over a million times in the process) before being transferred (in various possible combinations with its friends who went into the other three rings) into the main PS ring. There it can be taken to peak energy of 28 GeV and then the possibilities really open wide. It can remain in Switzerland and be fired into an internal target to feed experiments in the South Hall, slow ejected to feed experiments in the East Hall, or fast ejected to feed 'local' bubble chambers — Gargamelle or the 2 m hydrogen. It can return to France and travel several kilometres to the West Hall being slow ejected for the Omega or fast ejected for BEBC. If it is not tired of going round and round, it can spend as much as a full day at it by choosing fast ejection into one or other of the storage rings.

Hopefully all these manoeuvres will not in fact be at the will of the proton but under the control of the PS operators. However, bringing all these systems into operation together efficiently is a challenge which sustains the interest which fired the first builders of the PS.

The PS: past, present and future. Drawn in black are the Linac, the PS ring and the North (1) and South (2) Experimental Halls which existed in 1959.

In hatched red are the additions up to 1969 — the East Experimental Hall (3), the 2 m bubble chamber (4) and the South East Area (5) to be used eventually for Gargamelle.

In red are the coming additions — the synchrotron injector (SI), the intersecting storage rings (ISR) with the beam transfer lines (6) and experimental halls (7, 8), the West Experimental Hall (9) and the large European bubble chamber (10).

