Rutherford Laboratory

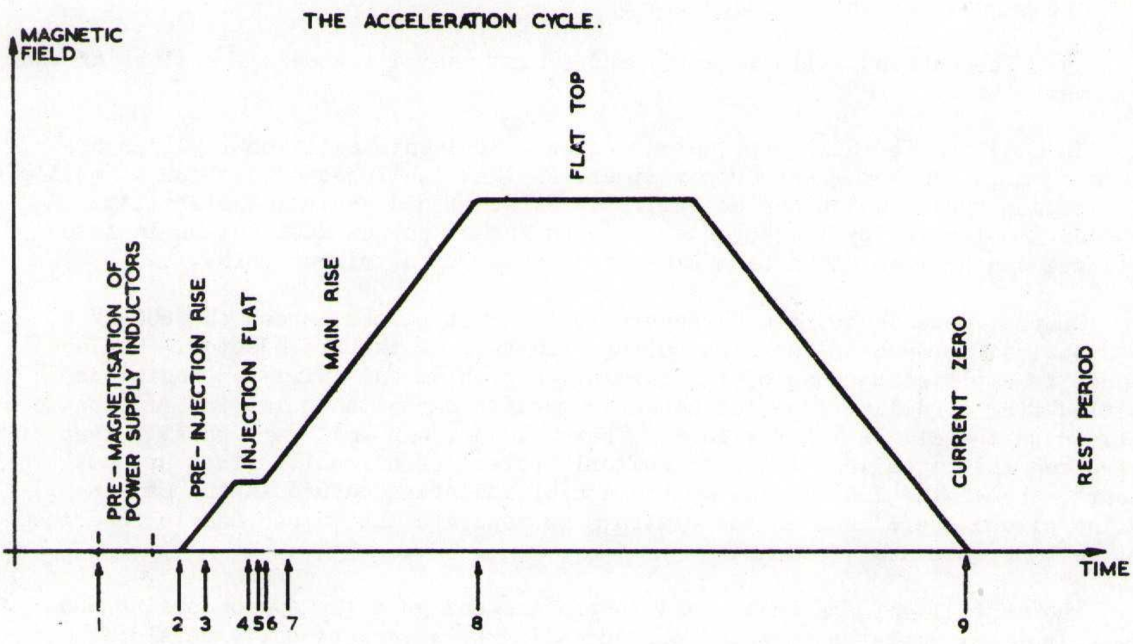
Technical Leaflet

A10

NIMROD SYNCHRONISING SYSTEM

Many of the sections of NIMROD (Magnet Power Supply, Injector etc.) have internal timing sequences. When these sections are integrated, each must operate at the correct instant in the sequence of events making up an "acceleration cycle".

Because the operation of the magnet involves such a large amount of energy, it is the most difficult component to control precisely and all the other equipment is therefore controlled relative to the magnetic field. Information on the precise value of the field at any instant is supplied to other sections of NIMROD in the form of pulses. These are derived from one of the peaking strips (Technical Leaflet A5.1) or from a re-cycling type of field integrator which gives a pulse for each 20 gauss interval during the acceleration cycle starting from one of the peaking strip pulses.



The following sequence of events makes up an acceleration cycle which can be repeated once every two seconds.

(1) Certain parts of the Magnet Power Supply require to be energised before the acceleration cycle proper begins and the initiating pulse for this operation is also used as an 'alerting' pulse for the Injector.

(2) The start of Current Rise in the Magnet sends a warning pulse to the experimental teams on the beam lines.

(3) Peaking strip 'A' fires at 173 gauss and starts the 20 gauss pulse train.

(4), (5) Two trigger pulses at chosen values of the magnetic field, (depending on the rate of rise of the field) prepare different parts of the Injector.

(6) Peaking strip 'B' fires at 292 gauss and injection of protons into the synchrotron begins.

(7) The r.f. accelerating cavity is switched on after about 50 msec. The frequency of the r.f. is kept in the correct relationship to the Magnet field by the 'Primary Frequency Generator.'

(8) 'Flat top' start and the r.f. is switched off. The accelerated protons start to hit targets which are raised during the latter part of the acceleration process (controlled from a suitable 20 gauss pulse) and particle beams are fed to the beam lines. After a suitable interval of time the magnet current is reduced.

(9) The current falls to zero, and a rest period preceeds the start of the next cycle.

In addition to this complicated sequence of events additional pulses are taken from the Magnet Power Supply timers so that the Injector can run at multiples of the main cycle, which may be desirable for beam and equipment stability. Protons accelerated by the Injector between Magnet pulses must not be injected into the synchrotron and a beam stop is operated by a trigger pulse.

Special techniques, are necessary to transmit pulses across the 600 kV potential difference to the high voltage platform of the Preinjector. Cables cannot be employed because of the insulation problem and infra-red radiation emitted from a gallium arsenide diode is used to carry the pulse information to a silicon photo-cell on the platform. These diodes, can emit very short pulses of infra-red radiation when fed with suitable pulses of current. (They are not Lasers, though the fundamental generation of radiation occurs in the same way.) Gating circuits are used on the platform to separate the pulses and to send them to their correct destinations.

The majority of the units used to provide and gate the synchronising and timing pulses, employ semiconductors including some very recently developed devices.

Exhibits

A working model, demonstrating the sequence of events described here, is on show in the Main Control Room.

A working exhibit in the Injector Room shows how timing pulses for the proton source are derived in correct sequence and fed to the high voltage platform of the Preinjector. The exhibit shows how independent control of three timing pulses is maintained even though the information is transmitted via one infra-red link.