NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

RUTHERFORD HIGH ENERGY LABORATORY

The National Institute for Research in Nuclear Science was formed to provide facilities for nuclear research. The main concern of the Institute is the design, construction and operation of high energy particle accelerators. The Rutherford High Energy Laboratory is the Institute's first Laboratory and is situated adjacent to the A.E.R.E. at Harwell. The Laboratory houses two accelerators, one a machine for accelerating protons to energies of 50 MeV which is operational, and the other still under construction is NIMROD a proton synchrotron designed to accelerate protons to energies of 7 GeV. Beams of high energy particles from these machines will be used to investigate further the structure of atomic nuclei and the properties of the fundamental particles associated with them.

NIMROD

7 GeV PROTON SYNCHROTRON

The name NIMROD ("A mighty one in the earth."—Genesis 10. 8-12) has been given to the 7 GeV proton synchrotron at present under construction. The main feature of this machine is a large ring shaped electromagnet, 155 ft. in diameter and weighing 7,000 tons. A toriodal shaped evacuated chamber made from glass fibre reinforced epoxy resin is situated between the poles of this magnet. A pulse of protons given an initial acceleration of 15 MeV in a linear accelerator is injected into this chamber and the protons are forced by the magnetic field into a circular orbit in which they receive an acceleration from a radio-frequency electric field once each revolution. When after approximately 1 million revolutions the protons have reached their maximum energy, they are extracted from the vacuum chamber and channelled into an adjoining building where they will be used for experiments. During the acceleration period lasting 0.72 secs. the magnetic field strength and the frequency of the electric accelerating field have both to be increased steadily to confine the proton orbits to the magnet ring, and in such a manner as to maintain the delicately balanced stability in the motion of the protons. The whole machine is housed in a semi-underground reinforced concrete circular building 200 ft. in diameter with 6 ft. concrete roof on which a 20 ft. layer of earth is placed as additional shielding.

Heavy currents up to 9,000 amps with an applied voltage up to 15 kV are needed to energise the electromagnet in the short acceleration time. Furthermore, the power requirements are intermittent since the magnetising current is only required for the duration of the pulse while the protons are being accelerated; some form of energy storage is therefore required. This is provided by heavy flywheels incorporated in a motor alternator set, connected to the magnet through a bank of rectifiers. This equipment supplies direct current of gradually increasing strength during the pulse followed by a period of current decay. Energy is thus stored in the inductive windings of the magnet coils during the current rise period and is subsequently returned to the flywheels in the intervals when power is no longer required. The amount of energy being shuttled to and fro amounts to some 40 megajoules. In this way the flywheels act as a buffer between the load (the magnet windings) and the electrical supply.

The machine is designed to produce at least 10^{12} protons per pulse at a repetition rate of 28 pulses a minute. NIMROD will be used for fundamental research into the physics of elementary particles, in particular the unstable strange particles; hyperons, heavy mesons and anti particles.

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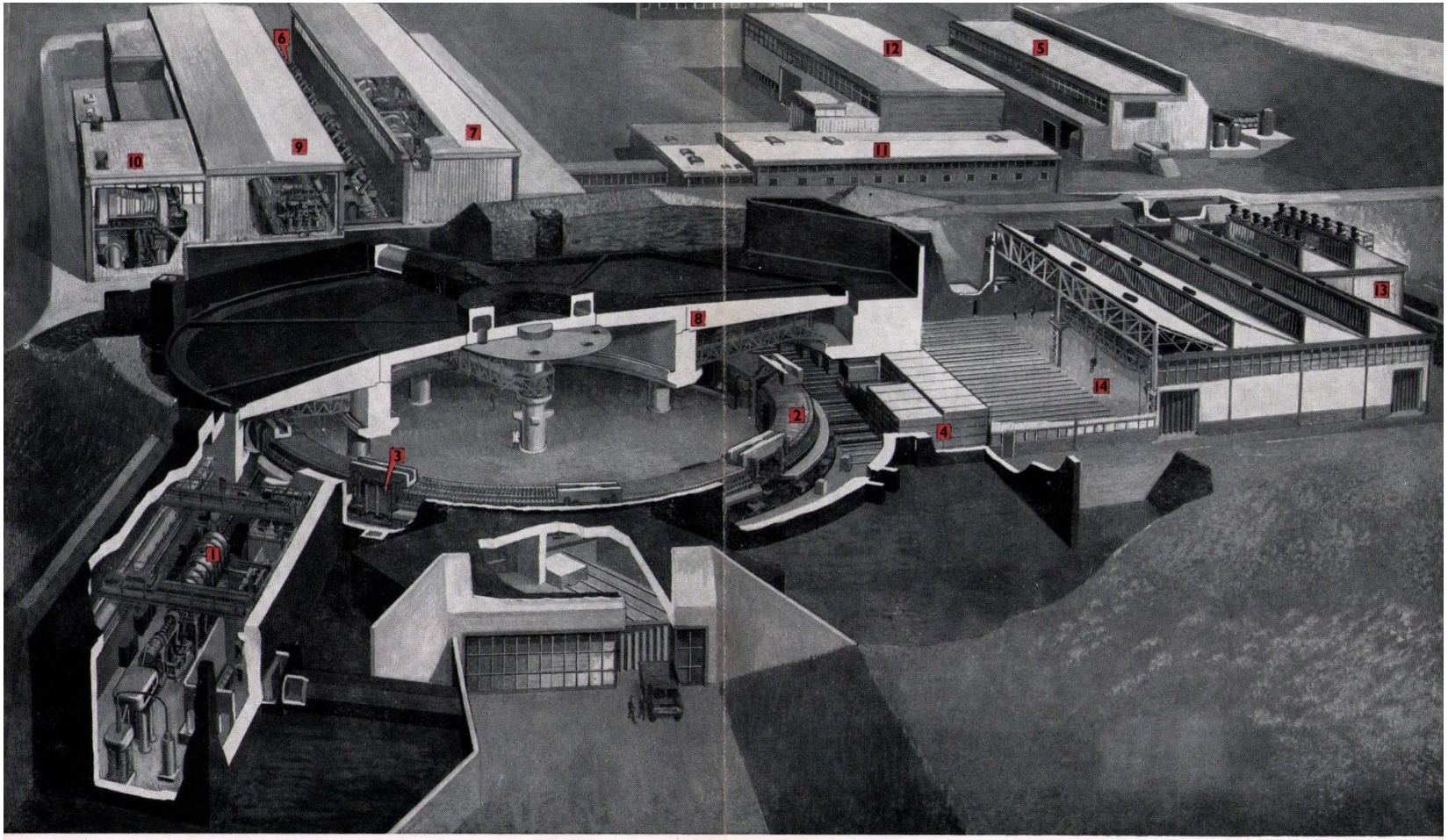
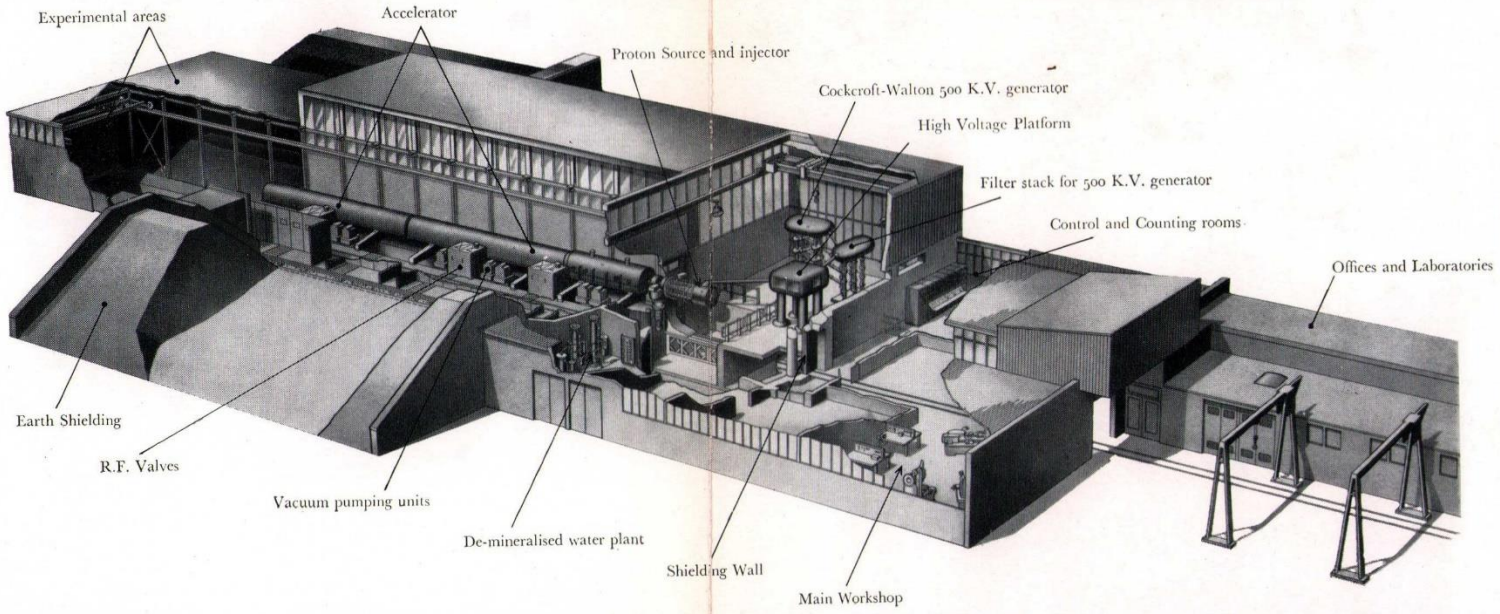


1. **Injector** This unit does the initial acceleration of the protons up to 15 MeV energy level.
2. **Electro magnet** The large magnet guides and focusses the protons to an orbit of constant radius.
3. **R.F. System** The radio-frequency accelerating unit gives the protons a 5-7 KeV kick on each orbit.
4. **Shielding Wall** This comprises a 30 ft. thick wall of transportable concrete blocks.
5. **Plant Room** For housing plant and equipment for use with the Bubble Chamber.
6. **Transformer Yard** Eight 12 MVA phase splitting transformers.
7. **Alternator House** The rotating plant comprises two 50 MVA, 1,000 rev./min. alternators and two 24 ton flywheels driven by two 5,000 h.p. induction motors.
8. **Shielding** The synchroton is enclosed in a shield of concrete with additional earth shielding on the roof and around the sides.
9. **Converter House** Contains the 96 water cooled single anode, grid controlled mercury arc converters.
10. **Plant Room** Contains the air-conditioning plant for the Magnet Room.
11. **Control Room** Contains all the instruments relative to the operation of NIMROD.
12. **Preparation Room** Used for preparatory work in connection with experiments.
13. **Bubble Chamber** A chamber containing liquid hydrogen used for the study of collisions between nuclear particles.
14. **Experimental Area** Beams of protons are admitted through collimating channels in the 30 ft. concrete wall into this area where the nuclear research equipment will be set up.



50 MeV PROTON LINEAR ACCELERATOR

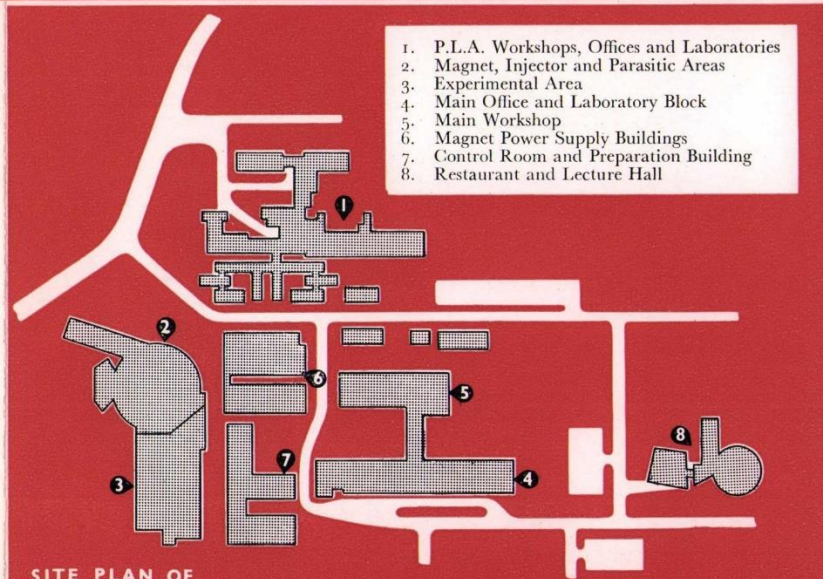
The first accelerator at the Rutherford High Energy Laboratory to become operational was the Proton Linear Accelerator. This machine accelerates protons in a straight path as against synchrotrons etc., which accelerate protons in circular paths.

The machine consists of three evacuated tanks with a total length of 100′. Each tank consists of a resonant cavity excited at 200 Mc/s by pulsed R.F. power. Protons are injected at 500 KeV into the machine and progressively accelerated up to 50 MeV. Increase in energy occurs in the gap between a series of hollow cylindrical electrodes spaced at intervals down the axis of each resonant cavity.

In full operation it is expected that the mean proton current will exceed 5 micro-amperes (3×10^{13} protons/sec), corresponding to a peak pulse current of 0.5 milliamperes. This beam will be many times greater in intensity than is achieved with other accelerators of this kind. The beam has a well-defined energy, a very important factor in nuclear physics research.

Nuclear research is carried out with the emergent pulses of protons from the accelerator. Teams of physicists from the Universities, the Atomic Energy Authority and the National Institute carry out experiments, all broadly aimed at studying details of nuclear structure. It is the prime purpose of the Rutherford Laboratory to provide all facilities including the design, manufacture and installation of experimental equipment, to user requirements.

A planned programme of development of the accelerator to higher energies and intensities is being carried out by a combined team of physicists and engineers.



SITE PLAN OF
RUTHERFORD LABORATORY