

OPERATING CHARACTERISTICS OF THE BIRMINGHAM PROTON SYNCHROTRON

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The engineering design of the Birmingham Proton Synchrotron was started by Oliphant and his team in 1946. Constructional work was commenced in the winter of 1947-8 and the machine was first operated in summer 1953, about a year later than the Brookhaven Cosmotron. The magnet is 10 metres in diameter and stands on the edge of the pit that contains the Nuffield Cyclotron. A shield of pre-cast concrete blocks extends round the three remaining sides of the magnet room, and has an average thickness of 2 metres. On the sides where the control room and main experimental facilities are located, the concrete is composed of iron pyrites, bonded with aluminous cement; this has a density of 3.6. The building containing the synchrotron, the cyclotron and their experimental areas is 30 metres square.

The synchrotron accelerates 10^{10} protons in each pulse, with six pulses per minute. The maximum energy is 1000 Mev but the orbits can be expanded or contracted at lower energies so as to strike a target at the outer or inner side of the vacuum vessel. The range of energies normally employed is from 200 to 950 Mev. The radial width of the high-energy beam is one or two centimetres and, according to the method and the time chosen for bringing it on to the target, the duration of the target pulse may be up to 80 milliseconds.

A target at the outer edge of the vacuum vessel must, in general, be retracted beyond the radius of the steering electrode, while protons are being injected into the synchrotron and plunged into the desired bombardment radius after the beam has shrunk to small dimensions.

However, the axis of magnetic symmetry moves slightly as the iron begins to saturate, so the high-energy orbits have a different centre from the low energy orbits. On account of this, at the azimuth towards which the orbits are displaced, a stationary target may be used at a radius a little greater than the injection radius. This target is a thin-walled, thin-ended tube projecting into the machine; specimens placed in the tube can be irradiated, in air, almost as intensely as if they had been carried on a normal plunging target. Bombardments for spallation studies have been made in both ways.

The vacuum vessel is of porcelain, with walls 3 cm. thick. Protons scattered at small angles from internal targets can, however, emerge through thin windows at two places. The intensity immediately outside a window is about 10^5 per cm^2 per pulse, which is very convenient for the irradiation of nuclear emulsions. With appropriate targets and angles (within the diffraction maximum) this external beam has an energy peaked around 925 Mev if the full acceleration time is permitted. Passing through a tungsten-alloy collimator just outside the window, the beam is brought to a horizontal focal line by travelling a further 150 cm. in the fringing field of the magnet; any inelastically-scattered protons having thus been removed, the beam is now effectively monoenergetic. With an angle of scatter of about 5 degrees from a carbon target, a polarization of about 60 per cent has been observed.

Some of this polarized beam passes through a channel in the concrete wall to an experimental room (8×15 metres) where cloud-chamber and counter-experiments are done. Magnets will be installed along the path to give a further focus within this room and permit experiments of greater refinements. Neutrons and mesons generated in internal targets may be studied at other azimuths, though they have traversed a considerable thickness of porcelain and the intensities beyond the shielding wall are somewhat low.

The synchrotron operates under the charge of Dr. J. L. Symonds, assisted by Dr. P. D. Whitaker. Two physicists and five technicians, backed by mechanical shop services equivalent to about three men, maintain the machine and operate it on a single shift basis of approximately eight hours for five days per week. Three more technicians have now been trained so that two-shift operation can be introduced. In addition, three graduates, with workshop assistance, are engaged on an ejection programme. The total staff of the machine is thus about twenty; its experimental facilities are used by 27 physicists and radio-chemists, not including members of other Universities who collaborate with us in nuclear emulsion work.