

NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE

Physics Sub-Committee
PROPOSAL FOR A 7 GeV PROTON SYNCHROTRON

Note by the Secretary

1. There is now general agreement, following discussions between physicists of the Universities and the Atomic Energy Authority, that the most urgent need in the field of high energy research in Britain is a machine giving intense proton beams of energy 6 GeV or a little more. Studies have been in progress at A.E.R.E., Harwell, of machines of this and other types, and sufficient progress has now been made on the design of a 7 GeV proton synchrotron for a detailed proposal to be made.

2. The object of the design study of this first machine has been to achieve an intensity of 10^{12} protons per pulse, with about 20 pulses per minute, without demanding fundamentally new developments in particle dynamics, in order to proceed to manufacture at an early date.

3. The more important parameters of the proposed accelerator are:

Maximum proton kinetic energy	7 GeV
Maximum magnetic field	14,000 gauss
Magnet steel weight	6,500 tons
Machine radius	60 feet
Radial aperture	3 feet
Vertical aperture	9 inches
Peak stored energy	35 Mega-joules
Acceleration time	0.7 seconds
Repetition rate	20-30 pulses per minute.
Number of straight sections	8
Number of accelerating units	2
Injection energy	45 MeV (proton linear accelerator)
Frequency of injector accelerator	100 Mc/s
Magnet power supply	Motor and two alternators, with flywheels and rectifier inverter system.

4. The building design provides for complete shielding of the accelerator, with concrete walls and earth tanks. There are two large experimental halls, which can be merged into one larger space if required and into which may be admitted external proton beams and a great variety of secondary beams from internal targets. There is also a smaller, separate room suitable for low background experiments, and special provision is made in one of the main halls for apparatus of exceptional weight and bulk. The large number of straight sections and the open-sector type of magnet will ensure adequate flexibility of target arrangements.

5. Most of the improvement in intensity, compared with existing machines of this type, is expected to be obtained by an improved design of linear accelerator used as the injector. In order to achieve the short acceleration time without loss of intensity, and ultimately to increase the intensity, it is hoped to develop a special transformer of large size; this will be incorporated in the magnet power-supply circuit and will modify the rate of rise of the magnetic field near injection time in a controlled manner.

6. The two items which mainly determine the overall time scale are the buildings and the magnet yoke. Both are sufficiently well advanced in design to enable contracts to be placed immediately. Three industrial organisations have submitted plans and provisional prices for manufacture of the magnet yoke; all are eager to take on the job, and one could be chosen immediately.

7. If formal approval of this project can be granted within the next two months, it is believed that the buildings can be completed before the end of 1959, and the whole machine made ready for initial tests during 1961.

8. Cost estimates are attached as an Appendix.

7 GeV Proton Synchrotron - Cost Estimates (25th March, 1957.)

MAGNET

£ million

<u>Yoke:</u> 7,000 tons of special steel plates are assumed to be available at £80 per ton.	
340 fabricated magnet blocks (The highest of the three estimates received)	1.5
<u>Pole pieces</u> (250 tons)	0.2
<u>Coils</u> (275 tons of copper)	
Finished coils and auxiliary windings	0.6
<u>Special jigs and support structures</u>	0.15
<u>Installation</u>	0.15
	<u>2.6</u>

2. POWER SUPPLY

Motor (6,500 H.P.) and alternators (2 of 60 MVA cont. rating) . . ?	0.6
Ignitrons (72) and firing circuits	0.2
Flywheels, bearings and bedplate	0.1
Cabling, installation, exciter and auxiliaries	0.2
	<u>1.1</u>
Extra for double-wound saturating choke, for control of field rise characteristic (500 tons)	<u>0.2</u>

3. RADIOFREQUENCY AND TRACKING EQUIPMENT

0.15

4. INJECTOR 15 MeV linear accelerator complete

0.3

5. VACUUM SYSTEM

Vacuum chamber, pumps, traps, valves, etc.	0.35
Installation and sundries	0.05
	<u>0.4</u>

6. COOLING SYSTEM

0.1

7. CONTROLS

0.15

8. BUILDINGS

Building work	1.4
Engineering and services	0.4
Fees	0.1
	<u>1.9</u>

TOTAL 6.9

NOTES

1. No allowance is included for contingencies, and the estimates are provisional. However, it is believed that a 10% addition for contingencies should be adequate to cover the inevitable uncertainties.
2. These estimates are for bought-out equipment and services, and do not include the internal costs of running the group at Harwell. The internal costs, including overheads, amount to about £150,000 per annum for the 7 GeV project.
3. An item of £600,000 has been included in the 1957/8 ^{Institute} A.R.R.L. Budget, for work on the 7 GeV accelerator. This should be sufficient to cover the first year's operations.