Grenoble cyclotron progress report

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ABSTRACT

The cyclotron has been tested and was accepted at 50 MeV proton energy in 1968. It has been used for physics experiments since January 1969. The beam energy is at present limited to 40 MeV proton, because of an accidental short-circuit on the main coils. After the repair, the proton energy could be increased to 60 MeV.

The polarised proton source and the axial injection are in operation. The results are modest, but are improving.

1. BEAM CHARACTERISTICS

There is no practical limitation in intensity for the internal beam, but with helium a maximum of 10 μA can be obtained. The internal beam is extremely stable and reproducible.

Forty per cent to seventy per cent of the internal beam can be extracted if the total beam power does not exceed 200 W. This limitation is imposed by the structure of the septum which was not designed for high intensity.

The emittance of the external beam is 80 mm mrad horizontally and 30 mm mrad vertically.

The overall energy dispersion is not known. By means of the switching magnet the beam can be analysed in energy; the resolution is better than 70 keV for a 40 MeV proton beam with a loss in intensity of 80%.

2. MAGNETIC FIELD

The stability of the main field is 10^{-4} long term. An improvement by a factor 2 is under way.

The magnetic field is limited in intensity because of a short-circuit between a few turns of the main coil. A new coil made of separate elements will be put in place at the end of the year. An internal beam of protons of 60 MeV had been obtained before the main coil failure.

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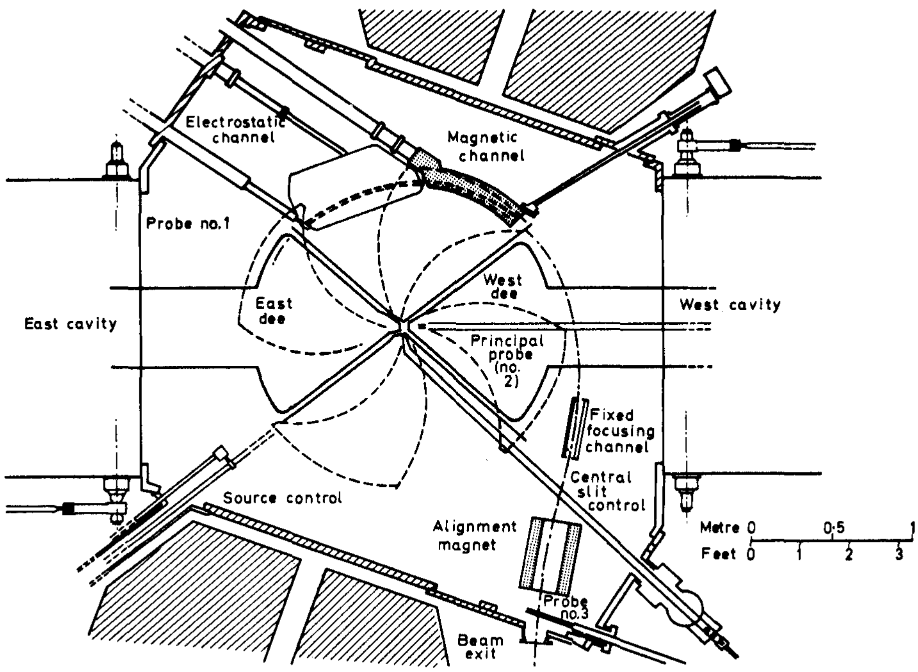

Fig. 1. Accelerating chamber and deflector of the Grenoble cyclotron

3. RADIOFREQUENCY SYSTEM

The cyclotron has two active dees and two resonant cavities. The whole system is driven by a Marconi amplifier, and a frequency synthesiser.

The two dees must be exactly in phase, or opposite in phase, depending on the mode. This is possible in the present system because a coupling capacitor has been installed between the tips of the dees. The phase drift between the dees is 0·5°, long term, this value being better than necessary. The capacitor however reduces the gap and flashes occur for a dee voltage of 40 kV which is needed to produce a beam at 60 MeV.

A modification is under way to double the intermediate amplification stage; a phase control will be added; the coupling capacitor, no longer needed, will be suppressed.

4. BEAM EXTRACTOR

The extraction of the beam is made in two steps: electrostatic, then magnetic deflection. The electrostatic deflector is equipped with a septum of tungsten, 0·4 mm thick. The magnetic deflector is composed of four current layers and is supposed not to introduce any considerable amount of first harmonic in the magnetic field.

Before the extracted beam leaves the vacuum tank, it passes through a magnetic quadrupole which compensates the divergence created by the fringe field.

5. BEAM HANDLING SYSTEM

The beam can be sent in five different directions. A pair of analysing magnets will be installed next year. They will be followed by a spectrometer.

6. POLARISED PROTON SOURCE–AXIAL INJECTION

The polarised proton source has been built with the collaboration of M. Thirion's Laboratory in Saclay. The source is running satisfactorily. It gives an intensity of 1·6 μA of protons.

The matching of the emittance of the source and the acceptance of the canal of the axial injector is being improved. The canal consists of a series of magnetic quadrupoles; its transparency is 37%. An internal beam of 23 nA has been obtained; 7 nA of current have been measured on target.

The axial injector itself works nicely if a duoplasmatron source is used. Internal currents of protons or deuterons amounting to 20 μA have been accelerated. The polarised source and the duoplasmatron can be easily exchanged.

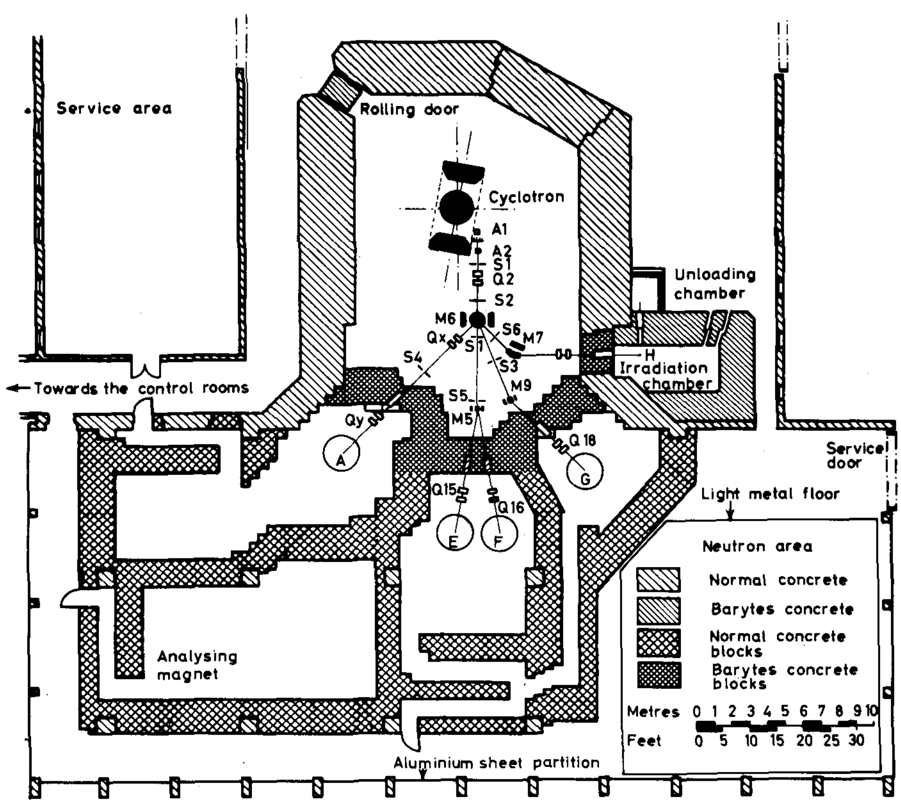

Fig. 2. The beam handling system in use

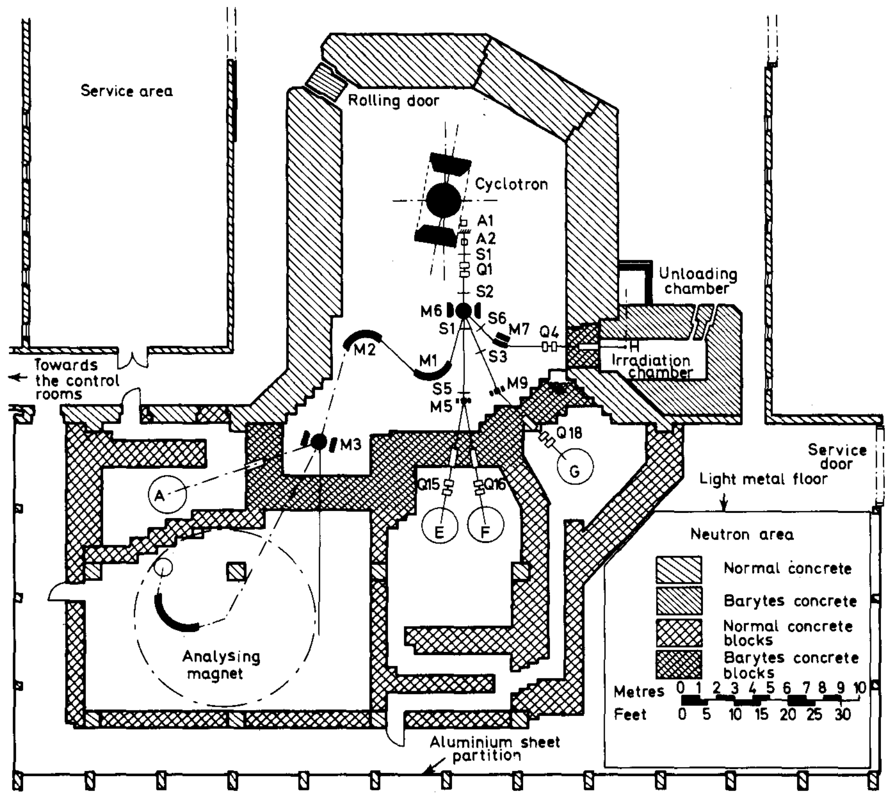

Fig. 3. The projected extension of the beam handling system, which includes a spectrometer