BABY CYCLOTRON MAGNET AND MAGNETIC FIELD MAPPING

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BABY CYCLOTRON aims particularly at the short-lived radionuclides production of carbon-11, nitrogen-13, oxygen-15, and fluorine-18 for medical diagnostic studies. It is the fixed energy Thomas type AVF cyclotron. For radionuclides production, it is not necessary to vary the energy of accelerating particles. The first commercial cyclotron can accelerate protons to 10MeV and deuterons to 7MeV.

In this report we described the electro-magnet of the first commercial cyclotron. The electro-magnet consists of two parts (upper and lower) which are machined from special solid forgings of low carbon steel with a carbon content less than 0.05%. The magnetic field is 2.3 Tesla at the hill which is made of ferromagnetic materials (Fe-Co). In order to reduce the magnet gap, dees are placed in the opposite valleys. This results in the ampere-turns being not so large and the electro-magnet being compact.

The electro-magnet is shown in Fig.1 and its detailed parameters are listed in Table 1.

A Hall plate (Siemans FC-33) was used for measuring the field, of which the temperature was kept constant at 30°C. The Hall plate was moved on a polar mesh of 5° intervals azimuthally between 0° and 360° and of 10mm intervals from the radius of 0 to 400mm.

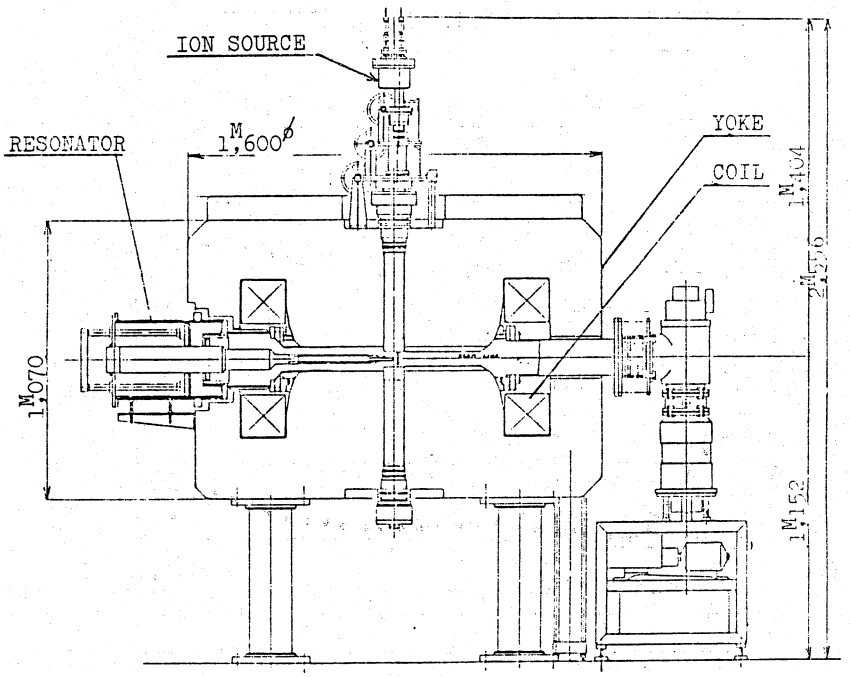

Fig.1 Vertical View of BABY CYCLOTRON

Table 1. Electro-Magnet Parameters

Pole tip diameter	72 cm
Hill gap	5.5 cm
Valley gap	9.5 cm
Number of sectors	4
Spiral angle of sector	0°
Outside diameter	160 cm
Height	107 cm
Weight	13 ton
Extraction radius	30 cm
Magnetic field for	
proton	1.52 Tesla
deuteron	1.8 Tesla
Maximum number of ampere turns in main coils	1.2×10^5 ampere-turns
Number of trimming coils	none
Number of harmonic coils	4 pairs (central)

The radial distributions of magnetic fields are shown in Fig.2, comparing with the theoretical isochronous fields. This was achieved by machining off hill segments and attaching thin steel shims to the valleys. And the hill ridges take special forms resembling the B-constant profiles to change the the degree of saturation in the high field regions (hill).

Therefore, the variation in radial distribution of the magnetic field required for proton vs. deuteron is achieved only by controlling the main coil excitation current without the circular trimming coil.

The cyclotron, of which the target beam current is obtained up to 60μA, has been put into operation for radionuclides productions.

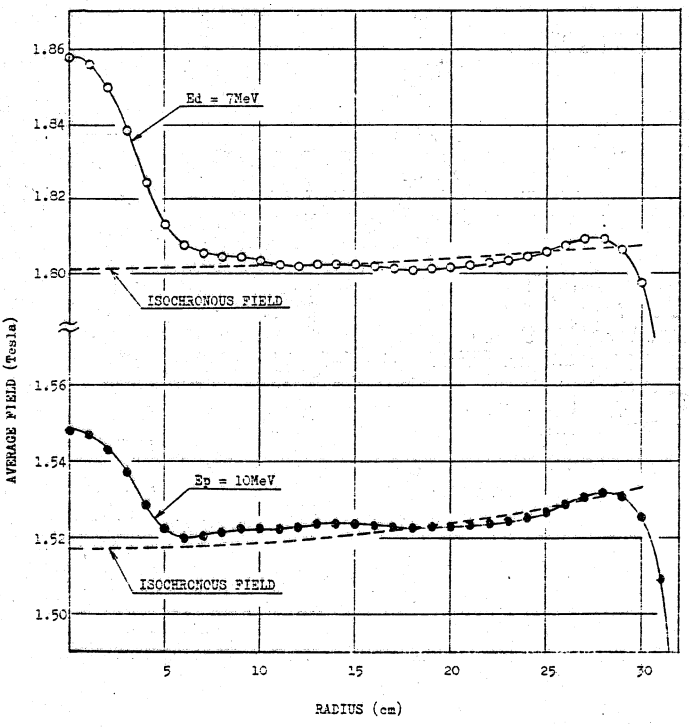

Fig.2 Radial Distributions of Magnetic Fields