The UCL isochronous cyclotron conceptual design and status report

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1. INTRODUCTION

The U.C.L. isochronous cyclotron is to be a versatile variable energy and multiparticle accelerator. This paper describes the main features of the machine as they appear after completion of the basic studies and initiation of the procurement of the components.

This cyclotron is funded by the Catholic University of Louvain. Studies, engineering, procurement construction, and testing are performed by Thomson-CSF (France). The major part of the heavy components and power supplies are manufactured by ACEC (Belgium).

The maximal energy of the machine is 80 MeV protons. The general arrangement of the cyclotron is similar to the Grenoble and Maryland machines using a four sector magnet and two 90° dees connected to panel tuned rf cavities.

2. PERFORMANCE SPECIFICATIONS

The particle energies for various ions are given below:

	Specifications	*Design value*
Proton energy	10 to 80 MeV	5 to 100 MeV
Deuteron energy	10 to 40 MeV	10 to 52 MeV
α-energy	20 to 80 MeV	20 to 104 MeV
He-3 energy	20 to 120 MeV	15 to 137 MeV
Extracted current	20 μA	50 μA
Extraction radius	0·91 m	0·92 m

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3. MAGNETIC FIELD

The machine has been designed to accelerate protons up to at least 100 MeV and the magnetic field has been checked on a 4:1 scale model magnet. The general arrangement is a four-fold symmetry field with a high spiral angle (55°) giving a minimum ν_z value of 0·16 at 100 MeV proton radius.

The isochronous field is fitted with 12 pairs of circular trimming coils giving a smooth correction even for heavy ions and low energies.

A careful shaping of the outer hill tips has been made in order to decrease the power consumption of the trimcoil set. The avaerage power needed to fit the 100 MeV proton field is 16 kW; only 12 kW are needed for the C^{4+}. These numbers should be compared with the 300 kW consumption of the main coils.

4. RADIOFREQUENCY SYSTEM

The cavities are driven by two 70 kW rf final amplifiers which are fed through wide band amplifiers by a high stability frequency synthesiser.

The dee voltage has a peak value of 50 kV in the 10·5 to 22 MHz frequency band width.

The phase difference between the two dees is clamped within 1° in push-push or push-pull operation modes by a slow action loop acting on the movable panel with a stepping motor in connection with a fast action loop acting on a small signal phase modulator.

The amplitudes of the dee voltages are stabilised by feedback loops acting on two small signal amplitude modulators designed to keep drift and ripple below 10^{-3}.

The resonators are of a very simple design allowing an operation frequency variation by means of a panel, moving without contact, along a curved wall.

5. EXTRACTION SYSTEM

The beam pattern is controlled in the extraction region by a set of harmonic coils which increase the turn separation by a resonant effect at $\nu_r = 1$.

An electrostatic deflector, 55° long, creates the beam separation needed in order to place a 25° magnetic channel. The beam spread, due to the gradient of the fringe field, is corrected by a quadrupole magnet in such a way that the beam parameters reach the right values before passing through the steering magnet and quadrupole lenses which surround the beam pipe.

An extraction efficiency of 80% in multiturn extraction operation and better values for single turn operation with a vertical slit reducing the phase width of the beam pulses, are expected.

6. TIME SCHEDULE

Studies for this machine were initiated at the beginning of 1969, the main procurements are now underway and the magnet measurements are expected for September 1970. The completion of the machine is planned for January 1971, with a ten month test schedule ending the three year contract.