ENTRY No. FM-7

NAME OF MACHINE 160 MeV Synchrocyclotron DATE 26 April 1989

INSTITUTION Harvard Cyclotron Laboratory, Harvard University

ADDRESS 44 Oxford St., Cambridge, Massachusetts 02138 USA

TEL (617) 495-2885 FAX (617) 495-8054

IN CHARGE A.M. Koehler REPORTED BY A.M. Koehler

HISTORY AND STATUS

DESIGN, date Model tests

ENG DESIGN, date

CONSTRUCTION, date 1946

FIRST BEAM, date (or goal) June 1949

MAJOR ALTERATIONS increased energy and external beam in 1957, medical facility 1963 and 1975

COST, ACCELERATOR $1 million

COST, FACILITY, total $1.7 million

FUNDED BY Office of Naval Research 1946-67

ACCELERATOR STAFF, OPERATION AND DEVELOPMENT

SCIENTISTS 4 ENGINEERS 1

TECHNICIANS 6 CRAFTS 2

GRAD STUDENTS involved during year 1

OPERATED BY 10% Research staff or 90% Operators

OPERATION c. 54 hr/wk, On target hr/wk

TIME DISTR. in house 90 %, Outside 10 %

BUDGET, op & dev $920,000 total direct costs

FUNDED BY users' fees and subcontracts

RESEARCH STAFF, not included above

USERS, In house c. 1 outside c. 15

GRAD STUDENTS involved during year 2

RESEARCH BUDGET, In house $230,000

FUNDED BY operations

MAGNET

POLE FACE, diameter [illegible] 241 cm, R extraction 105 cm

R injection 0 cm

GAP, min 29.6 cm, Field 19.0 kG
max 30.5 cm, Field 18.3 kG
} at 0.6×10^6 Ampere turns

AVERAGE FIELD at R ext 18.1 kG

B max/ <B>

NUMBER OF SECTORS { compact / separated } Spiral, max deg

SECTOR ANGLE (SSC) deg

TRIMMING COILS none

CONDUCTOR, material and type copper strip

STORED ENERGY (cryogenic) MJ

POWER : main coils 160 max, kW ; current stability

trimming coils 0 max, kW ; current stability

WEIGHT : Fe 641 tons ; coils 74 tons

COOLING system deionized water

ION ENERGY (bending limit) E/A = q^2/a^2 MeV/amu

(focusing limit) E/A = q^2/a^2 MeV/amu

ACCELERATION SYSTEM

DEES, number 1 ; angle 180 deg

BEAM APERTURE 6 cm ; DC Bias -2 kV

TUNED by, coarse fine

RF to mHz, stable ±

Orb F to mHz

HARMONICS, RF/Orb F, used

DEE - Gnd, max 12 kV, min gap cm

STABILITY, (pk-pk noise)/(pk RF volt)

ENERGY GAIN, max kV/turn

RF PHASE, stable to ± deg

RF POWER input, max 8 kW

FREQUENCY MODULATION, rate variable, c. 180 /s

modulator, type rotating capacitor

beam pulse, width 200 μsec

VACUUM SYSTEM

OPERATING PRESSURE 3×10^{-6} (3×10^{-7} base) Torr or mbar

PUMPS, No, Type, Size four NRC 6 inch oil

ION SOURCES

hot filament pulsed arc "volcano"

INJECTION SYSTEM

EXTRACTION SYSTEM

passive regenerator and channel

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed 4 m² ; movable m²

TARGET STATIONS 4 in 3 rooms

STATIONS served at same time, max 1

MAG SPECTROGRAPH, type

COMPUTER model MICROVAX

OTHER FACILITIES three specialized patient irradiation stations

CHARACTERISTIC BEAMS

PARTICLE	ENERGY (MeV) Goal	ENERGY (MeV) Achieved	CURRENT (pμA) Internal	CURRENT (pμA) External
proton.		159	2.μA	25 nA
SECONDARY				(part/s)

BEAM PROPERTIES

MEASURED	CONDITIONS
PULSE WIDTH RF deg	pμ A of MeV ions
PHASE EXC, max RF deg	pμ A of MeV ions
EXTRACT eff %	pμ A of MeV ions
RESOL ΔE/E %	pμ A of MeV ions
EMITTANCE (π mm. mrad) { 12 axial / 18 rad }	25 nA pμA of 160 MeV H^+ ions

OPERATING PROGRAMS, time distribution

BASIC NUCLEAR PHYSICS 0 SOLID STATES PHYSICS

BIOMEDICAL APPLICAT. 90 ISOTOPE PRODUCTIONS

Radiation damage studies 10%

REFERENCES/NOTES

PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS

Since 1967 operation of this machine has been on a fee for service basis, mostly for the treatment of patients with the proton beam, now at a rate of 370 patients per year. The fee is currently about $230/hr. The equipment and techniques developed here for irradiating patients have proved to be convenient for radiation damage studies often related to satellites and space probes. A fourth beam area is under construction to serve as a permanent base for such studies.