ENTRY NO. FM-10

NAME OF MACHINE 160 MeV Synchrocyclotron DATE 2 Jan. 1979
INSTITUTION Harvard Cyclotron Laboratory, Harvard University
ADDRESS 44 Oxford St., Cambridge, MA 02138

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) 1949
MAJOR ALTERATIONS increased energy
external beam, 1957
OPERATION, 45 hr/wk; On Target _____ hr/wk
TIME DIST., in house 5 %, outside 95 %
USERS' SCHEDULING CYCLE ad lib. weeks
COST, ACCELERATOR $1 million
COST, FACILITY, total $1.7 million
FUNDED BY ONR 1946-1967

ACCELERATOR STAFF, OPERATION and DEVELOPMENT

SCIENTISTS 2 ENGINEERS 1
TECHNICIANS 3 CRAFTS 3
GRAD STUDENTS involved during year 0
OPERATED BY x Res staff or x Operators
BUDGET, op & dev $250 K direct costs
FUNDED BY users fees & subcontracts

RESEARCH STAFF, not included above

USERS, in house ~1 outside ~ 15
GRAD STUDENTS involved during year 0
RES. BUDGET, in house ~ $5 K
FUNDED BY _____

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed _____ m^2
movable _____ m^2
TARGET STATIONS 3 in 3 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type _____
COMPUTER, model PDP11/34
OTHER FACILITIES _____

REFERENCES/NOTES

MAGNET

POLE FACE diameter 241 cm; R extraction 105 cm
GAP, min 29.6 cm; Field 19.0 kG
max 30.5 cm; Field 18.3 kG
} at 0.6 X 10^6 ampere turns
AVERAGE FIELD at R ext 18.1 kG
CURRENT STABILITY ~ 100 parts/10^6; $B_{max}/\langle B \rangle$ _____
NUMBER OF SECTORS _____ ; SPIRAL, max _____ deg
POLE FACE COIL PAIRS: AVF _____ /sec;
Harmonic correction _____
Rad grad _____ /sec or Circ coils _____
WEIGHT: Fe 641 tons; Coils 74 tons
CONDUCTOR, Material and type copper strip
STORED ENERGY _____ MJ
COOLING SYSTEM Deionized water
POWER: Main coils 160 max, kW
Trimming coils none max, kW
YOKE/POLE AREA _____ %
SECTOR ANGLE (Sep Sec) _____ deg
ION ENERGY (Bending limit) E/A = _____ q^2/A^2 MeV
(Focusing limit) E/A = _____ q/A MeV

ACCELERATION SYSTEM

DEES, number 1 angle 180 deg
BEAM APERTURE 6 cm; DC BIAS -2 kV
TUNED by, coarse _____ fine _____
RF _____ to _____ mHz, stable ± _____ /10^6
Orb F _____ to _____ mHz; GAIN, max _____ kV/turn
HARMONICS, RF/Orb F, used _____
DEE-Gnd, max 10 kV, min gap _____ cm
STABILITY, (pk-pk noise)/(pk RF volt) _____
RF PHASE stable to ± _____ deg
RF POWER input, max 8 kW
RF PROTECT circuit, speed _____ μsec
Type _____
FREQUENCY MODULATION, rate 0 to 250 /sec
MODULATOR, type Rotating capacitor
BEAM PULSE, width 250 microsec. typ.

VACUUM SYSTEM

PUMPS, No., Type, Size 4 NRC 6" oil
OPERATING PRESSURE 6×10^{-6} (3×10^{-7} base) μTorr
PUMPDOWN TIME 4 to 10 hrs

ION SOURCES/INJECTION SYSTEM
hot filament, pulsed arc "volcano"

EXTRACTION SYSTEM
Passive regenerator & channel

CONTROL SYSTEM
Relays

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CHARACTERISTIC BEAMS

	Particle	Goal (MeV)	Achieved (MeV)
ENERGY	Proton		160
CURRENT		(μA)	(μA)
Internal			2
External			0.05
		(part/s)	(part/s)
Secondary			

BEAM PROPERTIES

	Measured	Conditions
Pulse Width	____ RF deg	____ μA of ____ MeV ____
Phase Exc, max	____ RF deg	____ μA of ____ MeV ____
Extract Eff	5 %	____ μA of ____ MeV ____
Res, ΔE/E	1 %	____ μA of ____ MeV ____
Emittance (mm-mrad)	100 axial, 85 radial	____ μA of ____ MeV ____

OPERATING PROGRAMS, time dist

Basic Nuclear Physics	%
Solid State Physics & Rad. damage	2 %
Bio-Medical Applications	90 %
Isotope Production	2 %
Development	6 %
	%
	%

PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, OPERATION SUMMARY, ADDITIONAL REFERENCES

Since 1967 this machine has been operated as required by the needs of several users. The entire operating expense is derived from a fee, currently $1820 per 24-hour day, collected from each user. Principal use is for the treatment of patients, more than 1200 so far. Treatment of pituitary gland disorders has been most important, but clinical applications have been expanding rapidly, now making full use of two separate treatment rooms with beam switching between treatments. Patient load is now 150 to 200 per year.

The equipment and techniques developed for medical work are also convenient for radiation damage studies and for development of particle detection systems. Other applications being developed are proton activation analysis and proton radiography.

References:

A.M. Koehler and K. Johnson, in these Proceedings
A.M. Koehler, in Cyclotrons 1972, AIP Conf. Proc. No. 9