ENTRY NO. 90
NAME OF MACHINE Cleveland Clinic/ NASA Cyclotron
INSTITUTION NASA- Lewis Research Center
ADDRESS 21000 Brookpark Rd. Cleveland, OH 44135
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IN CHARGE J.W. Blue REPORTED BY J.W. Blue

HISTORY AND STATUS
DESIGN, date see note 1 Model tests
ENG DESIGN, date
CONSTRUCTION, date 1970
FIRST BEAM, date (or goal) July 1972
MAJOR ALTERATIONS 1976 Modified beam room for vertical and horizontal neutron beams for cancer therapy.
COST, ACCELERATOR $1,000,000
COST, FACILITY, total $400,000
FUNDED BY NASA, NCI and Cleveland Clinic

ACCELERATOR STAFF, OPERATION AND DEVELOPMENT
SCIENTISTS 2 ENGINEERS 1
TECHNICIANS 1 CRAFTS none 1
GRAD STUDENTS involved during year
OPERATED BY Research staff or 1 Operators
OPERATION 40 hr/wk. On target 32 hr./wk
TIME DISTR. in house 70 % Outside 30 %
BUDGET, op & dev $200,000
FUNDED BY NCI

RESEARCH STAFF, not included above
USERS, in house 7 outside 6
GRAD STUDENTS involved during year none
RESEARCH BUDGET, in house $25,000
FUNDED BY NCI

MAGNET
POLE FACE, diameter (compact) 1.75 cm, R extraction 73 cm
R injection cm
GAP, min 17 cm, Field 8.8 kG
min cm, Field 19.2 kG at 0.5×10^6
AVERAGE FIELD at R ext 15.2 kG Ampere turns
B max/ < B > 1.26
NUMBER OF SECTORS compact 3 Spiral, max deg
separated
SECTOR ANGLE (SSC) deg
TRIMMING COILS 8

CONDUCTOR, material and type water cooled copper
STORED ENERGY (cryogenic) MJ
POWER: main coils 200 max, kW; current stability 10^{-5}
trimming coils 35 max, kW; current stability 10^{-3}
WEIGHT: Fe 300 tons; coils tons
COOLING system distilled water
ION ENERGY (bending limit) E/A = 55 q^2/a^2 MEV/amu
(focusing limit) E/A = 45 q/a MeV/amu

ACCELERATION SYSTEM
DEES, number 2 deg
BEAM APERTURE 3.8 cm cm; DC Bias none kV
TUNED by, coarse panels fine panels
RF 13.5 to 22.5 mHz, stable ± 10^{-6}
Orb F 6.7 to 23 mHz
HARMONICS, RF/Orb F, used 1&2
DEE—Gnd, max 70 kV, min gap 1.0 cm
STABILITY, (pk-pk noise)/(pk RF volt) 10^{-3}
ENERGY GAIN, max 220 kV/turn
RF PHASE, stable to ± one deg
RF POWER input, max 200 kW
FREQUENCY MODULATION, rate /s
modulator, type
beam pulse, width

VACUUM SYSTEM
OPERATING PRESSURE 8×10^{-6} Torr or mbar
PUMPS, No, Type, Size 2 oil diffusion 16 inch

ION SOURCES
hooded internal

INJECTION SYSTEM
Axial Mounted ion source

EXTRACTION SYSTEM
eletrostatic followed by magnetic channel

FACILITIES FOR RESEARCH
SHIELDED AREA, fixed 200 m²; movable none m²
TARGET STATIONS 5 in 4
STATIONS served at same time, max none
MAG SPECTROGRAPH, type none
COMPUTER model PDP-15
OTHER FACILITIES vertical and horizontal neutron beam, shielded & collimated for therapy

CHARACTERISTIC BEAMS

PARTICLE	ENERGY (MeV) Goal	ENERGY (MeV) Achieved	CURRENT (pμA) Internal	CURRENT (pμA) External
proton	50	45	100	35
deuteron	26	26	100	25
He-3		78		1
He-4		56		5
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) axial	pμ A of MeV
rad	

OPERATING PROGRAMS, time distribution
BASIC NUCLEAR PHYSICS SOLID STATES PHYSICS
BIOMEDICAL APPLICAT ISOTOPE PRODUCTIONS

REFERENCES/NOTES
1) This cyclotron has the dee design of the MSU cyclotron and RF design described in NASA TN 5546. The Iron, Coils and power supplies were from a GE supplied 60 inch fixed frequency cyclotron.

PLAN VIEW OF FACILITY, COMMENTS, ETC.