

ENTRY No. **C 67**  
 NAME OF MACHINE Cleveland Clinic Fast Neutron Therapy Facility  
 INSTITUTION National Aeronautics & Administrations Lewis Research Center  
 ADDRESS M. S. 49.2 21000 Brookpark Rd. Cleveland, OH 44135  
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 IN CHARGE James. Blue REPORTED BY James. Blue

**HISTORY AND STATUS**

DESIGN, date Ref. 1 Model tests  
 ENG DESIGN, date 1968-69  
 CONSTRUCTION, date 1970  
 FIRST BEAM, date (or goal) 1972  
 MAJOR ALTERATIONS Vertical and horizontal beams of fast neutrons for cancer therapy  
 COST, ACCELERATOR \$ 1.5 M  
 COST, FACILITY, total \$ 2.0 M  
 FUNDED BY NASA, Cleveland Clinic, NCI  
 ACCELERATOR STAFF, OPERATION AND DEVELOPMENT SCIENTISTS 0 ENGINEERS 1  
 TECHNICIANS 1 CRAFTS  
 GRAD STUDENTS involved during year 0  
 OPERATED BY Research staff or 1 Operators  
 OPERATION 30 hr/wk, On target hr/wk  
 TIME DISTR. in house 90 % Outside 10 %  
 BUDGET, op & dev \$ 75,000  
 FUNDED BY NCI  
 RESEARCH STAFF, not included above  
 USERS, in house 2 outside 10  
 GRAD STUDENTS involved during year 0  
 RESEARCH BUDGET, in house \$ 25,000  
 FUNDED BY NCI, NASA  
**MAGNET**  
 POLE FACE, diameter (compact) 175 cm, R extraction 73.5 cm  
 R injection 1.5 cm  
 GAP, min 17 cm, Field 19.2 kG }  
 max 41 cm, Field 8.8 kG } at  
 AVERAGE FIELD at R ext kG } Ampere turns  
 B max/ <B >  
 NUMBER OF SECTORS { compact 3 } Spiral, max deg  
 separated }  
 SECTOR ANGLE (SSC) deg  
 TRIMMING COILS 8 pair  
 CONDUCTOR, material and type copper-hollow H<sub>2</sub>O cooled  
 STORED ENERGY (cryogenic) MJ  
 POWER: main coils 250 max, kW; current stability 10  
 trimming coils 10 max, kW; current stability 100  
 WEIGHT: Fe 206 tons; coils 28 tons  
 COOLING system deionized water  
 ION ENERGY (bending limit) E/A = 55 q<sup>2</sup>/a<sup>2</sup> MeV/amu  
 (focusing limit) E/A = 45 q<sup>2</sup>/a<sup>2</sup> MeV/amu  
**ACCELERATION SYSTEM**  
 DEES, number 2; angle 134 deg  
 BEAM APERTURE 2.5 cm; DC Bias 0 kV  
 TUNED by, coarse panels fine panels  
 RF 13.5 to 23 MHz, stable ± 10<sup>-8</sup>  
 Orb F 6.7 to 23 MHz  
 HARMONICS, RF/Orb F, used 1 & 2  
 DEE - Gnd, max 70 kV, min gap 5 cm  
 STABILITY, (pk-pk noise)/(pk RF volt)  
 ENERGY GAIN, max 220 kV/turn  
 RF PHASE, stable to ± 2 deg  
 RF POWER input, max 200 kW  
 FREQUENCY MODULATION, rate /s  
 modulator, type  
 beam pulse, width  
**VACUUM SYSTEM**  
 OPERATING PRESSURE 10<sup>-5</sup> Torr or mbar  
 PUMPS, No, Type, Size two 40 cm diam diffusion pumps  
 with freon baffles  
**ION SOURCES**  
 Internal, hooded, hot filament

**INJECTION SYSTEM**

**EXTRACTION SYSTEM**  
 Electrostatic deflector and magnetic channel  
**FACILITIES FOR RESEARCH**  
 SHIELDED AREA, fixed m<sup>2</sup>; movable m<sup>2</sup>  
 TARGET STATIONS 3 in two rooms  
 STATIONS served at same time, max 1  
 MAG SPECTROGRAPH, type 000E  
 COMPUTER model two IBM-PC  
 OTHER FACILITIES Cobalt-60 teletherapy unit

**CHARACTERISTIC BEAMS**

PARTICLE	ENERGY (MeV)		CURRENT (pA)	
	Goal	Achieved	Internal	External
p	50	46		50
d	26	26		50
<sup>3</sup> He	80	80		5
<sup>4</sup> He	52	52		5

SECONDARY neutrons from 43 MeV p on Be yields 20 rad/min (part/s)  
 125 cm \$50

**BEAM PROPERTIES**

MEASURED CONDITIONS  
 PULSE WIDTH RF deg μA of MeV ions  
 PHASE EXC, max RF deg μA of MeV ions  
 EXTRACT eff 60 % 30 μA of 43 MeV p ions  
 RESOL ΔE/E % μA of MeV ions  
 EMITTANCE  
 (π mm. mrad) { axial } μA of MeV ions  
 { rad }

**OPERATING PROGRAMS, time distribution**  
 BASIC NUCLEAR PHYSICS SOLID STATES PHYSICS  
 BIOMEDICAL/APPLICAT. 95% ISOTOPE PRODUCTIONS 1%  
 RADIATION DAMAGE 4%

**REFERENCES/NOTES**

1) Modified 60" fixed freq. cycl. to MSU magnetic field and dee design with redesigned rf system.

**PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS**