ENTRY No. **C4** University of Manitoba
NAME OF MACHINE Spiral Ridge Cyclotron DATE
INSTITUTION University of Manitoba Accelerator Laboratory
ADDRESS University of Manitoby, Winnipeg, Manitoba, R3T 2N2, CANADA
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IN CHARGE J.S.C. McKee REPORTED BY S. Oh, V. Derenchuk, J. Anderson

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HISTORY AND STATUS
DESIGN, date 1959 Model tests 1959-1961
ENG DESIGN, date 1960-63
CONSTRUCTION, date 1960-64
FIRST BEAM, date (or goal) 1965
MAJOR ALTERATIONS 100% external injection (1965), Magnetic field reshaped (1985) & a new dee system (1985).
COST, ACCELERATOR $ 600,000.00 (1960)
COST, FACILITY, total $ 1,500,000.00
FUNDED BY University of Manitoba and NSERC

ACCELERATOR STAFF, OPERATION AND DEVELOPMENT
SCIENTISTS 5 ENGINEERS 1
TECHNICIANS 3 CRAFTS 1
GRAD STUDENTS involved during year 8
OPERATED BY X Research staff or Operators
OPERATION hr/wk, On target hr/wk
TIME DISTR. in house %, Outside %
BUDGET, op & dev $ 500,000.00
FUNDED BY NSERC, University of Manitoba

RESEARCH STAFF, not included above
USERS, in house 13 outside 14
GRAD STUDENTS involved during year 12
RESEARCH BUDGET, in house
FUNDED BY NSERC

MAGNET
POLE FACE, diameter (compact) 117 cm, R extraction 30-52cm
R injection 0.8 cm
GAP, min 3.6 cm, Field 26.5 kG } at 280,000
max 15 cm, Field 15.5 kG } Ampere turns
AVERAGE FIELD at R ext 19.2-19.7 kG
B max/ <B> 1.4
NUMBER OF SECTORS { compact 4 / separated } Spiral, max 50 deg
SECTOR ANGLE (SSC) deg
TRIMMING COILS Total of 64 Invar blocks situated on the four hills+
CONDUCTOR, material and type Water cooled copper
STORED ENERGY (cryogenic) MJ
POWER : main coils 113 max, kW ; current stability 1/10⁴
trimming coils + max, kW ; current stability +
WEIGHT : Fe 38 tons ; coils 4 tons
COOLING system Demineralized water
ION ENERGY (bending limit) E/A = 50 q²/a² MeV/amu
(focusing limit) E/A = q²/a² MeV/amu

ACCELERATION SYSTEM
DEES, number 2 ; angle 55 deg
BEAM APERTURE 1.8 cm ; DC Bias -1 kV
TUNED by, coarse sliding short fine variable capacitor
RF 21 to 31 mHz, stable ± 1/10⁶
Orb F 15.25 to 28.3 mHz
HARMONICS, RF/Orb F, used 1 or 2
DEE - Gnd, max 42 kV, min gap 0.3 cm
STABILITY, (pk-pk noise)/(pk RF volt) 1/10³
ENERGY GAIN, max 80 for H 140 for D kV/turn
RF PHASE, stable to ± 10 deg
RF POWER input, max 2 x 15 kW
FREQUENCY MODULATION, rate /s
modulator, type E
beam pulse, width

VACUUM SYSTEM
OPERATING PRESSURE 15-25 x 10^{-6} Torr or mbar
PUMPS, No, Type, Size 2 x 16" Balzers diffusion pumps, 1 x 6" NRC diffusion pump, 2 cryopumps on injection system

ION SOURCES
Duoplasmatron, Ehlers source for H^- & D^-, Lamb-shift nuclear spin filter source for H^- & D^- ions.

INJECTION SYSTEM
Axial injection

EXTRACTION SYSTEM
Stripping of electrons from H^- & D^- by a stripping foil

FACILITIES FOR RESEARCH
SHIELDED AREA, fixed 300 m² ; movable 20 m²
TARGET STATIONS 7 in 2 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type
COMPUTER model VAX 11/750
OTHER FACILITIES PIXE, Neutral Hydrogen Beam, 10-50 MeV, Proton Microprobe, High resolution spectroscopy, Isotope production.

CHARACTERISTIC BEAMS

PARTICLE	ENERGY (MeV) Goal	Achieved	CURRENT (pμA) Internal	External
P	20-50	20-50	10-1	10-1
d	10-27	11-21	5-1	5-1
H^0	10-50	23-47	4	0.25
d	10-27	11-21		12-2 nA
SECONDARY			(part/s)	
n			4×10^7 sr^{-1}	

BEAM PROPERTIES

MEASURED		CONDITIONS
PULSE WIDTH	20 RF deg	1 pμ A of 20-50 MeV P, ions
PHASE EXC, max	12 RF deg	pμ A of MeV P, ions
EXTRACT eff	100 %	pμ A of 20-50 MeV P, ions
RESOL ΔE/E	1,2 %	pμ A of MeV P, ions
EMITTANCE		
(π mm. mrad)	{ axial / rad }	pμA of MeV ions

OPERATING PROGRAMS, time distribution
BASIC NUCLEAR PHYSICS 40% SOLID STATES PHYSICS
BIOMEDICAL APPLICAT. 20% ISOTOPE PRODUCTIONS 5%
Applied Physics 35%

REFERENCES/NOTES
1) IEEE Trans.Nucl.Sci. NS-32, No.5 (1985) 2724
+) Invar is an alloy with temperature dependent permeability. Magnetic field is shaped by controlling the temperature of each Invar block.

PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS