

ENTRY NO. **CU105**  
 NAME OF MACHINE **FMI CYCLOTRON**  
 INSTITUTION **Franklin McLean Memorial Research Institute**  
 ADDRESS **5841 S. Maryland Avenue, Chicago, Illinois 60637**  
 TEL **TELEX**  
 IN CHARGE **S. J. Gatley** REPORTED BY **A. J. Creer/N. Odeh**

**HISTORY AND STATUS**  
 DESIGN, date **1965** Model tests **1967**  
 ENG DESIGN, date **1965-67**  
 CONSTRUCTION, date **1969**  
 FIRST BEAM, date (or goal) **July, 1969**  
 MAJOR ALTERATIONS **Deflector**

COST, ACCELERATOR **240,000**  
 COST, FACILITY, total **600K**  
 FUNDED BY **Department of Energy**  
**ACCELERATOR STAFF, OPERATION AND DEVELOPMENT**  
 SCIENTISTS **5** ENGINEERS **11**  
 TECHNICIANS **4** CRAFTS **1**  
 GRAD STUDENTS involved during year **-**

OPERATED BY **X** Research staff or Operators  
 OPERATION **15** hr/wk On target **10** hr/wk  
 TIME DISTR. in house **100** % outside **-**  
 BUDGET, op & elev **-**

FUNDED BY  
 RESEARCH STAFF, not included above  
 USERS, in house **Yes** outside **-**  
 GRAD STUDENTS involved during year **4**  
 RESEARCH BUDGET, in house  
 FUNDED BY

**MAGNET**  
 POLE FACE, diameter (compact) **81** cm, R-extraction **35** cm  
 R injection **-** cm  
 GAP, min **5** cm, Field **20** kG  
 max **10** cm, Field **12** kG at **2 x 10<sup>5</sup>**  
 AVERAGE FIELD at R ext **16** kG Ampere turns  
 B max / < B > **1.25**

NUMBER OF SECTORS **compact separated** Spiral, max **-** deg  
 SECTOR ANGLE (ISSC) **-** deg  
 TRIMMING COILS **1 ea.** **8 Turns** **100A. max.**

CONDUCTOR, material and type **Al Foil** **1 mm**  
 STORED ENERGY (cryogenic) **-** MJ  
 POWER: main coils **58** max kW current stability **5 x 10<sup>-4</sup>**  
 trimming coils **-** max kW current stability  
 WEIGHT Fe **14** tons coils **-** tons  
 COOLING system **Water**  
 ION ENERGY (Bending limit) E/A = **-** q<sup>2</sup>/A<sup>2</sup> MeV/amu  
 (Focusing limit) E/A = **-** q/A MeV/amu

**ACCELERATION SYSTEM**  
 DEES, number **2** angle **-** deg  
 BEAM APERTURE **2** cm, DC Bias **1.5** KV **1.5** kV  
 TUNED by, coarse **MS** fine **VC Trimmer** **-4**  
 RF **12** to **25** MHz, stable  $\pm$  **1 x 10<sup>-4</sup>**  
 Orb F **12** to **25** MHz  
 HARMONICS, RF/Orb F, used  
 DEE-Gnd, max **30** kV, min gap **-** cm  
 STABILITY, (pk-pk noise)/(pk RF volt)  
 ENERGY GAIN, max **60** max **-** kV/turn  
 RF PHASE, stable to **-** deg  
 RF POWER input, max **29** kW  
 FREQUENCY MODULATION, rate **-** /s  
 modulator, type  
 beam pulse, width

**VACUUM SYSTEM**  
 OPERATING PRESSURE **1 x 10<sup>-5</sup>** Torr or mbar  
 PUMPS, No, Type, Size **1 ea.** **10"** Oil Diffusion,  
**1 ea.** **21** CFM Mechanical

**ION SOURCES**  
 Ion Heated Pig

**INJECTION SYSTEM** **None**

**EXTRACTION SYSTEM**  
**Electrostatic Channel with Compensated Iron Chann**

**FACILITIES FOR RESEARCH**  
 SHIELDED AREA, fixed **62** m<sup>2</sup>, movable **-** m<sup>2</sup>  
 TARGET STATIONS **2** in **2** rooms  
 STATIONS served at same time, max **1**  
 MAG SPECTROGRAPH, type **-**  
 COMPUTER model **-**  
 OTHER FACILITIES

**CHARACTERISTIC BEAMS**

PARTICLE	ENERGY (MeV)		CURRENT ( $\mu$ A)	
	Grid	Approved	Internal	External
Proton	15	14.9	110	55
Deut.	8	8.3	400	270
He 3 <sup>++</sup>	20	20.3	120	53
He 4 <sup>++</sup>	15	15	80	40

SECONDARY (part/s)

**BEAM PROPERTIES**

MEASURED		CONDITIONS	
PULSE WIDTH	RF deg	$\mu$ A of	MeV ions
PHASE EXC, max	RF deg	$\mu$ A of	MeV ions
EXTRACT eff.	<b>55</b> %	<b>270</b> $\mu$ A of	B. MeV D. ions
RESOL $\Delta E/E$	<b>1</b> %	$\mu$ A of	MeV ions
EMITTANCE			
( $\pi$ mm-mrad)	50, axial	90, <del><math>\mu</math>A of</del>	<del>MeV</del>
	50, rad		

**OPERATING PROGRAMS, time distribution**  
 BASIC NUCLEAR PHYSICS **-** SOLID STATES PHYSICS **-**  
 BIOMEDICAL APPLICAT **100** % ISOTOPE PRODUCTIONS **-**

**REFERENCES/NOTES** In AIP Conference Proceedings, #9, 1  
 1) Compact Cyclotron Engg. G.O. Hendry  
 2) ACRH Cyclotron, P.V. Harper  
 3) Design of Neutron Therapy Facility, F.T. Kuchnier

**PLAN VIEW OF FACILITY, COMMENTS, ETC.**

- <sup>3</sup>He recovery system for economical <sup>3</sup>He<sup>++</sup> operation
- Particle changes are made in 30 minutes
- Targets may be irradiated internally or externally
- Two external target stations; one for isotope, the other for neutron production
- External beams transport system includes two quadrupole doublets, one steering magnet, one switching magnet, and four collimators