ENT	ΓRΥ	'NO.	. 77

NAME OF MACHINESloan - Kettering	Institute Cyclotron
INSTITUTION <u>Sloan-Kettering</u>	Institute for Cancer Research
LOCATION New York, New York	DATE May, 1975
	, ,
in charge T, Y, T, Kuo	REPORTED by T.Y.T. Kuo
HISTORY AND STATUS	MAGNET
DESIGN, date CS-15, Cycletton Corporat:	i On POLE FACE dia 80 cm; R ext 36 cm
ENG. DESIGN, date	GAP, min 5 cm; Field 20 kG
ENG. DESIGN, date	max 10 cm; Field 12 kG at 0.2×10^6
FIRST BEAM date (or goal)	AVE FIELD at R max 16 kG A-turns
MAJOR ALTERATIONS <u>see features</u>	CURRENT, STABILITY ± 100 parts/ 10^6
OPERATION, 60 hr/wk; On Target 30 hr/wk	B max/ =
TIME DIST., in house 9.8 %, outside 2 %	AVF SECTORS 3 SPIRAL, max 0 deg
USERS' SCHEDULING CYCLE weeks	POLE FACE coil pairs, AVF/sec
COST, ACCELERATOR	Harmonic/sec; Rad Grad/sec, or
COST, FACILITY, total	circular; HEAVY ION, E max = q ² /A
FUNDED BY ERDA	WEIGHT, Fe 14 , Cu, or Al tons
ACCELEDATOR CTAES COSPATION	POWER, main coils 40 , pole tips
ACCELERATOR STAFF, OPERATION and DEVELOPMENT	total kW; cooled by <u>Water</u>
SCIENTISTS 1/2 ENGINEERS 1,2	YOKE/POLE area%; θ sec (Sect Mag) deg
TECHNICIANS 0 CRAFTS 0.2	TOTAL POWER, installed 0.06 MW normal load 0.04 MW
ADMIN & CLER 0 TOTAL 1.9	normal load 0.04 MW
GRAD. STUDENTS involved during year0	ION SOURCE, int PIG *
OPERATED BY X Res staff or X Sp operators	ext
BUDGET, op & dev	
FUNDED BY NCI, ERDA	ACCELERATION SYSTEM
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside	DEES, number 2 , width 120 deg BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC , $Trimmer$ RF 12 , 16 , 24 MHz, stable \pm 10 /106
USER GROUPS, in house 8 outside 1	BEAM APERTURE $\frac{2}{\text{cm}}$, cm; DC BIAS $\frac{1.5}{\text{kV}}$ TUNED by, coarse $\frac{\text{MP}}{\text{NP}}$, fine $\frac{\text{VC}}{\text{Trimmer}}$ RF $\frac{12}{\text{MP}}$, $\frac{24}{\text{MHz}}$, stable $\frac{10}{\text{MPz}}$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year	BEAM APERTURE $\frac{2}{\text{cm}}$, cm; DC BIAS $\frac{1.5}{\text{kV}}$ TUNED by, coarse $\frac{\text{MP}}{\text{MP}}$, fine $\frac{\text{VC}}{\text{Trimme}}$ r RF $\frac{12}{\text{16}}$, $\frac{24}{\text{MHz}}$, stable $\pm \frac{10}{\text{120}}$ /10 ⁶ Orb F $\frac{12}{\text{16}}$, $\frac{24}{\text{Mc/s}}$; GAIN $\frac{120}{\text{kV/t}}$ HARMONICS, RF/OF, used $\frac{1}{\text{MC}}$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside outside GRAD STUDENTS involved during year RES. BUDGET, in house	BEAM APERTURE $\frac{2}{2}$ cm; DC BIAS $\frac{1.5}{1.5}$ kV TUNED by, coarse $\frac{MP}{MP}$, fine $\frac{VC}{NP}$, $\frac{Trimmer}{NP}$ RF $\frac{12}{16}$, $\frac{16}{24}$ MHz, stable $\frac{1}{20}$ /106 Orb F $\frac{12}{16}$, $\frac{16}{24}$ Mc/s; GAIN $\frac{120}{120}$ kV/t HARMONICS, RF/OF, used $\frac{1}{20}$ DEE-Gnd, max $\frac{30}{20}$ kV, x/field, min $\frac{1}{20}$ cm,
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year	BEAM APERTURE $\frac{2}{\text{cm}}$ cm; DC BIAS $\frac{1.5}{\text{kV}}$ TUNED by, coarse $\frac{MP}{\text{MP}}$, fine $\frac{\text{VC}}{\text{Trimme}}$ r RF $\frac{12}{\text{16}}$, $\frac{24}{\text{MP}}$ MHz, stable $\frac{10}{\text{MP}}$ MC/s; GAIN $\frac{120}{\text{kV/t}}$ HARMONICS, RF/OF, used $\frac{1}{\text{DEE-Gnd}}$ max $\frac{30}{\text{kV}}$ kV, x/field, min $\frac{\text{cm}}{\text{cm}}$, STABILITY, (pk-pk noise)/(pk RF volt) $\frac{0.0005}{\text{kV}}$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA	BEAM APERTURE $\frac{2}{\text{cm}}$ cm; DC BIAS $\frac{1.5}{\text{kV}}$ TUNED by, coarse $\frac{\text{MP}}{\text{MP}}$, fine $\frac{\text{VC}}{\text{Trimme}}$ r RF $\frac{12}{\text{16}}$, $\frac{24}{\text{MP}}$ MHz, stable $\frac{10}{\text{MP}}$ MC/s; GAIN $\frac{120}{\text{kV/t}}$ HARMONICS, RF/OF, used $\frac{1}{\text{DEE-Gnd}}$ max $\frac{30}{\text{kV}}$ kV, x/field, min $\frac{\text{cm}}{\text{STABILITY}}$, (pk-pk noise)/(pk RF volt) $\frac{0.0005}{\text{MP}}$ RF PHASE stable to $\frac{1}{\text{MP}}$ deg
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside outside GRAD STUDENTS involved during year RES. BUDGET, in house	$\begin{array}{c ccccccccccccccccccccccccccccccccccc$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA	BEAM APERTURE $\frac{2}{}$ cm; DC BIAS $\frac{1.5}{}$ kV TUNED by, coarse $\frac{MP}{}$, fine $\frac{VC}{}$, $\frac{Trimmer}{}$ RF $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MHz, stable $\frac{10}{}$ $\frac{10^6}{}$ Orb F $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MC/s; GAIN $\frac{120}{}$ kV/t HARMONICS, RF/OF, used $\frac{1}{}$ DEE-Gnd, max $\frac{30}{}$ kV, x/field, min ${}$ cm, STABILITY, (pk-pk noise)/(pk RF volt) $\frac{0.0005}{}$ RF PHASE stable to $\frac{1}{}$ deg RF POWER input, max $\frac{30}{}$ kW RF PROTECT curcuit, speed ${}$ μ S
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m ²	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC , $Trimmer$ RF 12 , 16 , 24 MHz, stable \pm 10 /10 ⁶ Orb F 12 , 16 , 24 MC/s; GAIN 120 kV/t HARMONICS, RF/OF, used 1 DEE-Gnd, max 30 kV, x/field, min cm, STABILITY, (pk-pk noise)/(pk RF volt) 0 , 0005 RF PHASE stable to \pm deg RF POWER input, max 30 kW RF PROTECT curcuit, speed μ s typeIgnitron crowbar
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² movable 0 m²	BEAM APERTURE $\frac{2}{}$ cm; DC BIAS $\frac{1.5}{}$ kV TUNED by, coarse $\frac{MP}{}$, fine $\frac{VC}{}$, $\frac{Trimmer}{}$ RF $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MHz, stable $\frac{10}{}$ /106 Orb F $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MC/s; GAIN $\frac{120}{}$ kV/t HARMONICS, RF/OF, used $\frac{1}{}$ DEE-Gnd, max $\frac{30}{}$ kV, x/field, min ${}$ cm, STABILITY, (pk-pk noise)/(pk RF volt) $\frac{0.0005}{}$ RF PHASE stable to $\frac{1}{}$ deg RF POWER input, max $\frac{30}{}$ kW RF PROTECT curcuit, speed ${}$ ${}$ ${}$ kW RF PROTECT System ${}$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² movable 0 m² TARGET STATIONS 1 in 1 ROOMS	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC , $Trimmer$ RF 12 , 16 , 24 MHz, stable \pm 10 /10 ⁶ Orb F 12 , 16 , 24 MC/s; GAIN 120 kV/t HARMONICS, RF/OF, used 1 DEE-Gnd, max 30 kV, x/field, min cm, STABILITY, (pk-pk noise)/(pk RF volt) 0 , 0005 RF PHASE stable to \pm deg RF POWER input, max 30 kW RF PROTECT curcuit, speed μ s typeIgnitron crowbar
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USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² m² movable 0 m² TARGET STATIONS 1 in 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 MAG SPECTROGRAPH, type ON-LINE COMPUTER, model IRM 1800 FACILITIES for:	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC , $Trimmer$ RF 12 , 16 , 24 MHz, stable \pm 10 /10 ⁶ Orb F 12 , 16 , 24 MC/s; GAIN 120 kV/t HARMONICS, RF/OF, used 1 DEE-Gnd, max 30 kV, x/field, min cm, STABILITY, (pk-pk noise)/(pk RF volt) 0 , 0005 RF PHASE stable to \pm deg RF POWER input, max 30 kW RF PROTECT curcuit, speed \pm
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house 50 outside 7 TOTAL RES STAFF, in house 15 outside 7 GRAD STUDENTS involved during year 7 RES. BUDGET, in house 7 FUNDED BY NCI ERDA 7 FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² m² movable 0 m² m² movable 1 n 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 mAG SPECTROGRAPH, type 7 ON-LINE COMPUTER, model IRM 1800 FACILITIES for: 1 sotope production Internal & External	BEAM APERTURE $\frac{2}{}$ cm; DC BIAS $\frac{1.5}{}$ kV TUNED by, coarse $\frac{MP}{}$, fine $\frac{VC}{}$, $\frac{Trimmer}{}$ RF $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MHz, stable $\frac{10}{}$ /106 Orb F $\frac{12}{}$, $\frac{16}{}$, $\frac{24}{}$ MC/s; GAIN $\frac{120}{}$ kV/t HARMONICS, RF/OF, used $\frac{1}{}$ DEE-Gnd, max $\frac{30}{}$ kV, x/field, min ${}$ cm, STABILITY, (pk-pk noise)/(pk RF volt) $\frac{0.0005}{}$ RF PHASE stable to $\frac{1}{}$ deg RF POWER input, max $\frac{30}{}$ kW RF PROTECT curcuit, speed ${}$ ${}$ ${}$ kW RF PROTECT System ${}$
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² movable 0 m² TARGET STATIONS 1 in 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 MAG SPECTROGRAPH, type ON-LINE COMPUTER, model IBM 1800 FACILITIES for: Isotope production Internal & External Irradiation, Solid State Yes	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC , $Trimmer$ RF 12 , 16 , 24 MHz, stable \pm 10 /10 ⁶ Orb F 12 , 16 , 24 MC/s; GAIN 120 kV/t HARMONICS, RF/OF, used 1 DEE-Gnd, max 30 kV, x/field, min cm, STABILITY, (pk-pk noise)/(pk RF volt) 0 , 0005 RF PHASE stable to \pm deg RF POWER input, max 30 kW RF PROTECT curcuit, speed \pm
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USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² movable 0 m² movable 1 n 1 ROOMS STATIONS 1 n 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 MAG SPECTROGRAPH, type ON-LINE COMPUTER, model IBM 1800 FACILITIES for: Isotope production Internal & External Irradiation, Solid State Yes	BEAM APERTURE 2
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USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² m² movable 0 m² TARGET STATIONS 1 in 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 MAG SPECTROGRAPH, type ON-LINE COMPUTER, model IBM 1800 FACILITIES for: Isotope production Internal & External Irradiation, Solid State Yes Biological Yes Time-of-Flight Study Being developed	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarseMP, fineVC , Trimmer RF12 ,16 ,24MHz, stable ±10/10^6 Orb F_12 ,16 ,24Mc/s; GAIN120kV/t HARMONICS, RF/OF, used1 DEE-Gnd, max30kV, x/field, mincm, STABILITY, (pk-pk noise)/(pk RF volt)0 0.0005 RF PHASE stable to ±deg RF POWER input, max30kW RF PROTECT curcuit, speed
USER GROUPS, in house 8 outside 1 STAFF SCIENTISTS, in house outside TOTAL RES STAFF, in house 15 outside GRAD STUDENTS involved during year RES. BUDGET, in house FUNDED BY NCI, ERDA FACILITIES FOR RESEARCH PROGRAMS SHIELDED AREA, fixed 60 m² movable 0 m² movable 1 nn 1 ROOMS STATIONS SERVED AT THE SAME TIME, max 1 MAG SPECTROGRAPH, type ON-LINE COMPUTER, model IBM 1800 FACILITIES for: Isotope production Internal & External Irradiation, Solid State Yes Biological Yes Time-of-Flight Study Being developed On-Line Mass Separation Distributed Internal Research In	BEAM APERTURE 2 cm; DC BIAS 1.5 kV TUNED by, coarse MP , fine VC, Trimmer RF 12, 16, 24 MHz, stable ± 10 /106 Orb F12, 16, 24 Mc/s; GAIN 120 kV/t HARMONICS, RF/OF, used 1 DEE-Gnd, max 30 kV, x/field, min cm, STABILITY, (pk-pk noise)/(pk RF volt) 0.0005 RF PHASE stable to ± deg RF POWER input, max 30 kW RF PROTECT curcuit, speed μs type Ignitron crowbar EXTRACT System See features FREQUENCY MODULATION, rate // sec MODULATOR, type BEAM PULSE, width nsec L SELECTED REFERENCES 1. Radiology 93,331-337,1969. 2. IEEE Tran. Nucl. Sci. NS-14(3) 1967. 3. Proc. of the 5th Int. Cyc. Conf.

ENTRY NO. 77 (cont.)

CHARACTERISTIC BEAMS

BEAM PROPERTIES

					Measured	Condition	\$
		Goal	Achieved				
	Particle	(MeV)	(MeV)	Pulse Width	RF deg	μA of	MeV
				Phase Exc, max	RF deg 70 % 200	μA of	MeV
ENERGY	p	<u> 15</u>	14.7	Extract Eff	<u>70</u> % 200	μ A of 23	MeV <u>He</u>
	<u>d</u>	7.5	$\frac{7.9}{23.3}$	Res, ∆E/E	%	μA of	MeV
	$3_{\text{He}} + +$	20		Emittance	$\left\{\frac{50}{50} \underset{\text{radial}}{\text{axial}}\right\} 90^{9}$	e "A of	Ma\/
CURRENT		(μA)	(μ Α)	(mm-mrad)	$\left(\frac{50}{} \right)$ radial	μΑ 01	ivie v
Internal	<u>p</u>	$\frac{100}{100}$	500 800 *	VACUUM norn	n 1 μ torr; PU	MPDOWN time	2hr
	3 _{He} ++	$\frac{100}{100}$	400 *				
	He	100		OPERATING P	ROGRAMS, time di	st	
External	p	50	100 **				
	<u>d</u>	<u> 50</u>	400 **	Basic Nuclea	ar Physics/Chemistry		%
	3 _{He} ++	50	<u>200 *</u> *	Solid State F	Physics		%
		(part/s)	(part/s)	Bio-Medical	Applications	100	%
			2-1013	Isotope Prod	duction		%
Secondary	<u>n **</u> *		2x1013	Materials Sc	ience		%
		* *	700114		····		%
HEAVIEST ion	<u>alpha</u>		O O PIL				
		*	400µA in	ıt.			

OTHER FEATURES and OPERATION SUMMARY

This is the first proto-type cyclotron built by the Cyclotron Corporation, Berkeley, California. Major modifications included: Dees and RF system, ion source and extraction system.

* There are four independent coordinate controls for the ion source. The high beam currents are resulted from high operating power density in the order of 140 kW/cm 3 .

** The extraction system:

Harmonic coils: azimuthal angle and current controls

Deflector: fine adjust of extraction radius (change of energy also)

taper angle adjust channal gap adjust dc voltage adjust

Magnetic channel: compensated-iron type

entrance position control exit position control channel curvature control

*** Neutron programs: Dosimetry

Neutron Physics

Activation Therapy