**ENTRY NO. 43**

NAME OF MACHINE . . NIRS Isochronous Cyclotron for Medical Use
INSTITUTION . . . . . National Institute of Radiological Sciences
ADDRESS . . . . . 9-1, Anagawa-4-chome, Chiba-shi, 260 JAPAN
TEL . 0472 (51) 2111 . . . . TELEX . . . . . 3722205 NIRS J
IN CHARGE . . . . T. Kondo . . . . . REPORTED BY . . . . H. Ogawa

**HISTORY AND STATUS** Thomson-CSF (CGR-MeV Model 930)

DESIGN, date . . . . . Model tests
ENG DESIGN, date
CONSTRUCTION, date . . . . 1972 ∿ 1973
FIRST BEAM, date (or goal) . . . . . Dec. 1973
MAJOR ALTERATIONS
COST, ACCELERATOR
COST, FACILITY, total
FUNDED BY . . the Science and Technology Agency

**ACCELERATOR STAFF, OPERATION AND DEVELOPMENT**

SCIENTISTS . . . . 3 . . . . . ENGINEERS . . . . . 1
TECHNICIANS . . . . 5 . . . . . CRAFTS
GRAD STUDENTS involved during year
OPERATED BY . . . . . Research staff or . . . . 5 . . . . . Operators
OPERATION . . . . 38 . . . hr/wk. On target . . . . . hr/wk
TIME DISTR. in house . . . . 100 . . . . %, outside . . . . . %
BUDGET, op & dev
FUNDED BY

**RESEARCH STAFF,** not included above

USERS, in house . . . . . outside
GRAD STUDENTS involved during year
RESEARCH BUDGET, in house
FUNDED BY

**MAGNET**

POLE FACE, diameter (compact) . . . . . cm, R-extraction . . . . . cm
R injection . . . . . cm
GAP, min 16.6 cm, Field 20.1 kG
max 40.5 cm, Field 11.7 kG } at 0.36 × $10^6$ Ampere turns
AVERAGE FIELD at R ext . . . . 16.4 kG
B max/<B>
NUMBER OF SECTORS { compact . . . 4 . . . / separated . . . . . } Spiral, max 53 deg
SECTOR ANGLE (SSC) . . . . . deg
TRIMMING COILS . . . . . 12 Circular Coils
. . . . . 2 per sector
CONDUCTOR, material and type . . . . . Cu, hollow
STORED ENERGY (cryogenic) . . . . . MJ
POWER: main coils . 360 . max kW: current stability ±2×$10^{-5}$
trimming coils . . 75 . max kW: current stability ±1×$10^{-4}$
WEIGHT: Fe . . . . . 200 . . . . . tons: coils . . . . . .6 . . . . . tons
COOLING system . . . . Demineralized water
ION ENERGY (Bending limit) E/A = . . . ∿ 110 . $q^2/A^2$ MeV/amu
(Focusing limit) E/A = . . . . . 93 . . q/A MeV/amu

**ACCELERATION SYSTEM**

DEES, number . . . . . 2 . . . . . angle . . . . . 86 . . . . . deg
BEAM APERTURE . . . . 3.8 . . . . cm; DC Bias . . . 0 . . . . . kV
TUNED by, coarse . . . MP . . . . . fine MP Auto . . . . . .
RF . . . . . 10.6 . . . . to . . . . 22.0 . . . . MHz, stable ± ≦ 1 × $10^{-6}$
Orb F . . . . 5.3 . . . . . to . . 21.14 . . . . . MHz
HARMONICS, RF/Orb F, used . . . . . 1..2
DEE–Gnd, max . . . . 50 . . . . . kV, min gap . . . . . 4 . . . . . cm
STABILITY, (pk-pk noise)/(pk RF volt) . . . . . 0.001 . . . .
ENERGY GAIN, max . . . . . 200 . kV/turn
RF PHASE, stable to ± . . . . . 0.5 . . deg
RF POWER input, max. . . . . 160 . . . . kW
FREQUENCY MODULATION, rate . . . . . /s
modulator, type
beam pulse, width

**VACUUM SYSTEM**

OPERATING PRESSURE . . . . . 2 × $10^{-6}$ . . . . . Torr or mbar
PUMPS, No, Type, Size . . 2 × 22 in. Oil diffusion pumps . .

**ION SOURCES**

. . . . . Ho filament for light ions and penning for heavy ions.

**INJECTION SYSTEM**

**EXTRACTION SYSTEM**

Electrostatic deflector and magnetic channels

**FACILITIES FOR RESEARCH** (Active and passive)

SHIELDED AREA, fixed 376. . . . . $m^2$; movable . . . . . $m^2$
TARGET STATIONS . . . . . 7 . . . . . in . 4 rooms . . . . rooms
STATIONS served at same time, max . . . . . 1
MAG SPECTROGRAPH, type
COMPUTER model
OTHER FACILITIES Cyclotron radiotherapies
. . Facility, Radiopharmaceuticals production
. . and Nuclear Medical diagnosis Facilities

**CHARACTERISTIC BEAMS**

| PARTICLE | ENERGY (MeV) Goal | Achieved | CURRENT (pμA) Internal | External |
|---|---|---|---|---|
| . . . p . . . . | . . . . . | . 8∿89 . . | . . . . . | . . . 20 . . . . . |
| . . $_3$d . . . | . . . . . | 12∿52.5 | . . . . . | . . . 40 . . . . . |
| . . . He . . . | . . . . . | 24∿140. | . . . . . | . . . 15 . . . . . |
| . . . α . . . . | . . . . . | 24∿105. | . . . . . | . . . 10 . . . . . |
| SECONDARY | | | (part/s) | |
| . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |
| . . . . . | . . . . . | . . . . . | . . . . . | . . . . . |

**BEAM PROPERTIES**

| | MEASURED | | CONDITIONS | | | |
|---|---|---|---|---|---|---|
| PULSE WIDTH | 25 . . | RF deg | 20 . . | pμ A of | 30 . . MeV | d . . . . ions |
| PHASE EXC. max | . . | RF deg | . . . . | pμ A of | . . . . MeV | . . . . . ions |
| EXTRACT eff. | 80 . . | % | 35 . . | pμ A of | 30 . . MeV | d . . . . 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. 68% . . ISOTOPE PRODUCTIONS . 32% . . . .

**REFERENCES/NOTES**


1) H. Ogawa et al. IEEE NS-26, No.2, 1968-1991(1979)
2) Y. Sato et al. Proc. of 9th Intern. Conf. on Cyclotrons, 597-599(1981)


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