**ENTRY No.** 5

NAME OF MACHINE CICLOTRON DE ENERGIA VARIÁVEL DATE 04/04/89
INSTITUTION INSTITUTO DE ENGENHARIA NUCLEAR/CNEN
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## HISTORY AND STATUS

DESIGN, date - Model tests -
ENG DESIGN, date CYCLOTRON CORPORATION CV-28
CONSTRUCTION, date '71 - '74
FIRST BEAM, date (or goal) Dec'74
MAJOR ALTERATIONS main magnet and harmonic coils changed iron added
COST, ACCELERATOR US$ 500 x $10^3$
COST, FACILITY, total US$ 1.2 x $10^6$
FUNDED BY CNEN-BRAZIL, FINEP-BRAZIL

## ACCELERATOR STAFF, OPERATION AND DEVELOPMENT

SCIENTISTS 1 ENGINEERS 2
TECHNICIANS 6 CRAFTS 2
GRAD STUDENTS involved during year 0
OPERATED BY Research staff or / Operators
OPERATION 16 hr/wk, On target 10 hr/wk
TIME DISTR. in house 80 %, Outside 20 %
BUDGET, op & dev US$ 80 x $10^3$
FUNDED BY CNEN - BRAZIL

## RESEARCH STAFF, not included above

USERS, in house 16 outside 4
GRAD STUDENTS involved during year 3 3
RESEARCH BUDGET, in house US$ 20 x $10^3$
FUNDED BY CNEN - BRAZIL, IAEA

## MAGNET

POLE FACE, diameter (compact) 96 cm, R extraction 42 cm
R injection - cm
GAP, min 5.6 cm, Field 21 kG
max 11 cm, Field 14.5 kG
at 2 x $10^5$ Ampere turns
AVERAGE FIELD at R ext 18.5 kG
B max/ <B> 1.2
NUMBER OF SECTORS compact 3 / separated - Spiral, max 50 deg
SECTOR ANGLE (SSC) - deg
TRIMMING COILS 4 circular coils

CONDUCTOR, material and type Hollow copper
STORED ENERGY (cryogenic) - MJ
POWER : main coils 60 max, kW ; current stability $10^{-5}$
trimming coils 1.2 max, kW ; current stability $10^{-3}$
WEIGHT : Fe 23 tons ; coils 2 tons
COOLING system deionized water
ION ENERGY (bending limit) E/A = 28 $q^2/a^2$ MeV/amu
(focusing limit) E/A = 24 $q^2/a^2$ MeV/amu

## ACCELERATION SYSTEM

DEES, number 2 ; angle 81 deg
BEAM APERTURE 2 cm ; DC Bias 2.5 kV
TUNED by, coarse MSP fine V.C.
RF 25.6 to 6.0 mHz, stable ± 4 x $10^{-5}$
Orb F 25.6 to 6.0 mHz
HARMONICS, RF/Orb F, used 1 rst
DEE - Gnd, max 30 kV, min gap 1.3 cm
STABILITY, (pk-pk noise)/(pk RF volt) $10^{-3}$
ENERGY GAIN, max 100 kV/turn
RF PHASE, stable to ± - deg
RF POWER input, max 40 kW
FREQUENCY MODULATION, rate - /s
modulator, type -
beam pulse, width -

## VACUUM SYSTEM

OPERATING PRESSURE 5 x $10^{-5}$ Torr or mbar
PUMPS, No, Type, Size 2 x 10 inch diffusion pumps

## ION SOURCES

internal PIG

## INJECTION SYSTEM

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## EXTRACTION SYSTEM

Electrostatic with mag. channel

## FACILITIES FOR RESEARCH

SHIELDED AREA, fixed 50. m² ; movable 250. m²
TARGET STATIONS 5 in 4 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type -
COMPUTER model -
OTHER FACILITIES 2 scattering chambers, He-jet tranp. sys., neutron production and spect. station, radioisotope production and separation cells, ion implantation station

## CHARACTERISTIC BEAMS

| PARTICLE | ENERGY (MeV) Goal | Achieved | CURRENT (pμA) Internal | External |
|---|---|---|---|---|
| p | | 24 | 100 | 70 |
| d | | 14 | 140 | 100 |
| $^3$He | | 36 | 80 | 50 |
| α | | 28 | 80 | 50 |
| SECONDARY | | | | |
| n | | | $10^7$ (part/s) | |

## BEAM PROPERTIES

| MEASURED | | CONDITIONS | | |
|---|---|---|---|---|
| PULSE WIDTH | 14 RF deg | 1 | pμ A of 28 | MeV α ions |
| PHASE EXC, max | RF deg | | pμ A of | MeV ions |
| EXTRACT eff | 82 % | 6.6 | pμ A of 19 | MeV p ions |
| RESOL ΔE/E | 0.3 % | .5 | pμ A of 28 | MeV α ions |
| EMITTANCE | | | | |
| (π mm. mrad) | 23 axial / 13 rad | 1 | pμA of 28 | MeV α ions |

**OPERATING PROGRAMS**, time distribution

BASIC NUCLEAR PHYSICS 40 % SOLID STATES PHYSICS
BIOMEDICAL APPLICAT. ISOTOPE PRODUCTIONS 40 %

## REFERENCES/NOTES

A.G. da Silva and L.T. Auler, Nuclear Data for Science and Technology, ed. K.H. Bookhoff (1983) p.843.

## PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS

A.G. da Silva et al, Nucl. Instr. and Method. A264(1988) 381.

A.G. da Silva et al, Proc. Intern. Symp. on Applications and Technology of Ionizing Radiation (1982) p.1007.