ENTRY NO. 43

NAME OF MACHINE philips Variable Energy AVF cyclotron DATE july 1987
INSTITUTION Eindhoven University of Technology (EUT)
ADDRESS Eindhoven, The Netherlands

IN CHARGE H.L. Hagedoorn REPORTED by J.I.M. Botman

HISTORY AND STATUS

DESIGN, date 1960 MODEL tests 1960
ENG. DESIGN, date 1961-1962
CONSTRUCTION, date 1962-1963
FIRST BEAM date (or goal) April 1963
MAJOR ALTERATIONS moved to Eut 1968

OPERATION, 70 hr/wk; On Target 50 hr/wk
TIME DIST., in house 100 %, outside %
USERS' SCHEDULING CYCLE 2 weeks
COST, ACCELERATOR gift from Philips
COST, FACILITY, total M$3 (1968)
FUNDED BY EUT

ACCELERATOR STAFF, OPERATION and DEVELOPMENT

SCIENTISTS 1 ENGINEERS 2
TECHNICIANS 2 CRAFTS
GRAD STUDENTS involved during year 1
OPERATED BY Res staff or 1 Operators
BUDGET, op & dev k$50
FUNDED BY EUT

RESEARCH STAFF, not included above

USERS, in house 10 outside
GRAD STUDENTS involved during year 20
RES. BUDGET, in house k$80
FUNDED BY EUT

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed 120 m^2
movable 230 m^2
TARGET STATIONS 4 in 4 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type
COMPUTER, model PDP 11
OTHER FACILITIES isotope production
time of flight study
PIXE analyses facility
microbeam (under developpment)

REFERENCES/NOTES

MAGNET

POLE FACE diameter 130 cm; R extraction 51 cm
GAP, min 15 cm; Field 20 kG
max 30 cm; Field 10 kG
AVERAGE FIELD at R ext 15 kG
(at 0.4 X 10^6 ampere turns)
CURRENT STABILITY 20 parts/10^6; $B_{max}/\langle B \rangle$ 1.3
NUMBER OF SECTORS 3 ; SPIRAL, max 35 deg
POLE FACE COIL PAIRS: AVF /sec;
Harmonic correction
Rad grad 3 /sec or Circ coils 10
WEIGHT: Fe 80 tons; Coils 10 tons
CONDUCTOR, Material and type Al
STORED ENERGY MJ
COOLING SYSTEM water
POWER: Main coils 130 max, kW
Trimming coils 20 max, kW
YOKE/POLE AREA 115 %
SECTOR ANGLE (Sep Sec) deg
ION ENERGY (Bending limit) E/A = 30 q^2/A^2 MeV
(Focusing limit) E/A = q/A MeV

ACCELERATION SYSTEM

DEES, number 1 angle 180 deg
BEAM APERTURE 2.0 cm; DC BIAS 0.7 kV
TUNED by, coarse MS fine VC
RF 5 to 23.3 mHz, stable ± 20 /10^6
Orb F 5 to 23.3 mHz; GAIN, max 100 kV/turn
HARMONICS, RF/Orb F, used 1
DEE-Gnd, max 50 kV, min gap cm
STABILITY, (pk-pk noise)/(pk RF volt) 10^{-3}
RF PHASE stable to ± 1 deg
RF POWER input, max 100 kW
RF PROTECT circuit, speed μsec
Type
FREQUENCY MODULATION, rate /sec
MODULATOR, type
BEAM PULSE, width

VACUUM SYSTEM

PUMPS, No., Type, Size oil diffusion,1,8000 1/sec
OPERATING PRESSURE 10 μTorr,
PUMPDOWN TIME 2 hrs

ION SOURCES/INJECTION SYSTEM

internal: Livingston type
external: polarised,trochoidal injection

EXTRACTION SYSTEM

electrostatic,80deg,60kV/4mm, followed by magnetic channel

CONTROL SYSTEM

conventional, plus computer control

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CHARACTERISTIC BEAMS

	Particle	Goal (MeV)	Achieved (MeV)
ENERGY	p		2.5-29.5
	d		3-15
	^{4}He		6-30
	^{3}He		5-40
CURRENT		(μA)	(μA)
Internal	p,d		1000
	^{4}He, ^{3}He		50
	pol. p		0.05
External	p,d		100
	^{4}He, ^{3}He		30
	pol. p		0.03
		(part/s)	(part/s)
Secondary			

BEAM PROPERTIES

	Measured		Conditions		
Pulse Width	36 RF deg	μA of	MeV		
Phase Exc, max	5 RF deg	μA of	MeV		
Extract Eff	80 %	μA of	MeV		
Res, ΔE/E	0.3 %	μA of	MeV		
Emittance (mm-mrad)	10-20 axial, 10-20 radial	5 μA of	20 MeV	p	

OPERATING PROGRAMS, time dist

- Basic Nuclear Physics 50 %
- Solid State Physics %
- Bio-Medical Applications %
- Isotope Production for medical appl 10 %
- Development and machine research 20 %
- Pixe 20 %

PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, OPERATION SUMMARY, ADDITIONAL REFERENCES

Automatic control project (with CAMAC and PDP 11)

1. Internal beam
   Computer control of HF phase, measured with capacitive phase probes, using 3 concentric correction coils. Maximum phase deviation from the desired phase is 2 degrees; control action every 6 sec.
2. Extraction efficiency
   Measured by applying small disturbances of the currents through 4 harmonic coils and the outermost circular coil; optimisation by computer control.
3. External beam
   Control of both analysing magnets by a NMR measuring and control unit.
   Control of beam position, measured by beam scanners, by computer setting of steering magnets.
   Determination of emittances at several places.

Ref. Van Heusden, EUT thesis 1976.