ENTRY NO. 53

NAME OF MACHINE S. I. N. Injector Cyclotron DATE Aug. 78
INSTITUTION Swiss Institute for Nuclear Research (S. I. N.)
ADDRESS CH - 5234 Villigen, Switzerland

IN CHARGE J. -P. Blaser REPORTED by H. A. Willax

HISTORY AND STATUS

DESIGN, date 67/69 MODEL tests 1968/71
ENG. DESIGN, date 1969/73
CONSTRUCTION, date 1970/73
FIRST BEAM date (or goal)
Aug. 1, 1973 int.
Jan. 1, 1974 ext.
OPERATION, 150 hr/wk; On Target 120 hr/wk
TIME DIST. as Inject. 75 %, outside 25 %
USERS' SCHEDULING CYCLE 2 to 3 weeks
COST, ACCELERATOR 14 MSw. Fr. (1975)
COST, FACILITY, total 134 MSw. Fr. (1975)
FUNDED BY Swiss Federal Government

ACCELERATOR STAFF, OPERATION and DEVELOPMENT

Design and construction:
Philips Company, Eindhoven, Netherlands

OPERATED BY S. I. N. Operators
BUDGET, op & dev see S. I. N. Isochronous Ring Cyclotron

RESEARCH STAFF, not included above

USERS, in house - outside 14 groups
GRAD STUDENTS involved during year approx. 15
RES. BUDGET, in house -
FUNDED BY Swiss National Science Foundation

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed - m^2
movable approx. 400 m^2
TARGET STATIONS 5 in 3 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type 110° analyz. magnet
COMPUTER, model PDP 11/40
OTHER FACILITIES
Isotope production 1
Irradiation 1

REFERENCES/NOTES

- A. Baan et al., IEEE Trans. Nucl. Sci. NS 20, No. 3 (1973) 257
- N. Hazewindus et al., Nucl. Instr. + Meth. 118 (1974) 125
- J. M. v. Nieuwland, N. Hazewindus, Philips Res. Rep. 29 (1974) 528

MAGNET

POLE FACE diameter 250 cm; R extraction 105 cm
GAP, min 24 cm; Field - kG } at .6 X 10^6 ampere turns
max 45 cm; Field - kG }
AVERAGE FIELD at R ext 16.5 kG
CURRENT STABILITY 10 parts/10^6; $B_{max}/\langle B \rangle$ 1.25
NUMBER OF SECTORS 4 ; SPIRAL, max 55 deg
POLE FACE COIL PAIRS: AVF - /sec;
Harmonic correction 4
Rad grad /sec or Circ coils 12
WEIGHT: Fe 470 tons; Coils 20 tons
CONDUCTOR, Material and type Al
STORED ENERGY MJ
COOLING SYSTEM
POWER: Main coils 400 max, kW
Trimming coils 100 max, kW
YOKE/POLE AREA 105 %
SECTOR ANGLE (Sep Sec) deg
ION ENERGY (Bending limit) E/A = 135 q^2/A^2 MeV
(Focusing limit) E/A = q/A MeV

ACCELERATION SYSTEM

DEES, number 1 angle 180 deg
BEAM APERTURE 3 cm; DC BIAS .5 kV
TUNED by, coarse MS fine VC, auto
RF 4.7 to 17.5 mHz, stable ± 1 /10^6
Orb F 4.7 to 17 mHz; GAIN, max 140 kV/turn
HARMONICS, RF/Orb F, used 3 (injector mode)
DEE-Gnd, max 80 kV, min gap 25 cm
STABILITY, (pk-pk noise)/(pk RF volt) 1/1000
RF PHASE stable to ± .5 deg
RF POWER input, max 80 kW
RF PROTECT circuit, speed 100 to 1000 μsec
Type low level amplifier clamp + series tube mod. (1 ns (injector mode)
BEAM PULSE, width (ca. 20° (V. C. mode)

VACUUM SYSTEM Oil diffusion pumps
PUMPS, No., Type, Size (Balzers) 20 000 + 12 000 l/s + Philips Cryo-pump
OPERATING PRESSURE 1 μTorr,
PUMPDOWN TIME 8 hrs

ION SOURCES/INJECTION SYSTEM Livingstone-type + axial injection, Ortec Duo-plasmatron + polarized p, d

EXTRACTION SYSTEM electrostatic + electro-magnetic + magnetic channel

CONTROL SYSTEM
with computer access

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CHARACTERISTIC BEAMS

	Particle	Goal (MeV)	Achieved (MeV)
ENERGY	p	10-75	14-72
	d	10-65	10-65
	heavy ions	< 10 MeV/ nucl.	-
CURRENT		(μA)	(μA)
Internal	p	300	160
	d	50-100	70
	heavy ions	3-5	-
External	p	120	~120
	d	30	25
	polarized p+d		
		(part/s)	(part/s)
Secondary	-	-	-

BEAM PROPERTIES (typical for (injector mode

	Measured		Conditions				
Pulse Width	8°*	RF deg	80	μA of	72	MeV	p
Phase Exc, max		RF deg		μA of		MeV	
Extract Eff	90	%	80	μA of	72	MeV	p
Res, ΔE/E	.2	%	80	μA of	72	MeV	p
Emittance		* fwhm					
(mm-mrad) { 2π axial / 2π radial }			80	μA of	72	MeV	p

OPERATING PROGRAMS, time dist

Basic Nuclear Physics see below %
Solid State Physics %
Bio-Medical Applications %
Isotope Production %
Development %
%
%

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

S.I.N. Injector Cyclotron - Operational time distribution 1977
(shutdown of 105 shifts not included)

Total operation time of 990 shifts (7920 hours)		= 100 %
Cyclotron in operation with beam	81 %	
Standby	5.6 %	
Regular service	6.7 %	
Component failures	6.7 %	= 100 %

Distribution of effective beam time (6415 hours = 100 %)

A.1 Experimental beams from Injector cyclotron only:		
variable energy, α, p, d	12.5 %	
polarized d, p	5.5 %	
72 MeV p for isotope production	2.6 %	= 20.6 %
A.2 Injection beams for high-energy beam production		
high-intensity c.w. 72 MeV p	30.6 % (150 000	
pulsed, 400 kHz, 40 % d.f.	19.6 % (μAh	
polarized p	1.4 %	= 51.6 %
B. Beam development (both operational modes)		12.4 %
C. Overhead (setup, tuning, etc.)		15.4 % = 100 %

Injector Cyclotron: Philips design. Mainly used as injector for the S.I.N. Ring Cyclotron (72 MeV p at 50.7 Mc/s, 3rd harmonic mode), variable energy operation 1/4 of scheduled time.

Axial injection system and source for polarized p and d operational.