ENTRY NO. 55

NAME OF MACHINE S.I.N. Isochronous Ring 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 1962 MODEL tests 1962/68
ENG. DESIGN, date 1967/71
CONSTRUCTION, date 1969/74
FIRST BEAM date (or goal) Jan. 18, 1974
MAJOR ALTERATIONS energy from 520 to 590 MeV
OPERATION, 120 hr/wk; On Target 90 to 100 hr/wk
TIME DIST., in house ____ %, outside ____ %
USERS' SCHEDULING CYCLE 2 to 3 weeks
COST, ACCELERATOR 35 MSw.Fr. (1974)
COST, FACILITY, total 134 MSw.Fr. (1975)
FUNDED BY Swiss Federal Government

ACCELERATOR STAFF, OPERATION and DEVELOPMENT (1975)

SCIENTISTS 14 ENGINEERS 12
TECHNICIANS and CRAFTS : 20
GRAD STUDENTS involved during year -
OPERATED BY 6 Res staff or 15 Operators
BUDGET, op & dev 6 MSw.Fr. (w.o. salaries)
FUNDED BY Swiss Federal Government

RESEARCH STAFF, not included above

USERS, in house ____ outside approx. 50
GRAD STUDENTS involved during year approx. 50
RES. BUDGET, in house 50 MSw.Fr. (w.o. sal.)
FUNDED BY Swiss Federal Government

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed - m^2
movable total 2700 m^2
TARGET STATIONS 3* in 2 rooms
STATIONS served at same time, max 10
MAG SPECTROGRAPH, type pion spectrometer
COMPUTER, model several PDP 11 /QDD
OTHER FACILITIES
2 superconducting muon channels, superconducting medical pion channel under construction

REFERENCES/NOTES

*two meson production targets in one beam line, one p-target (scattered polarized p parasitic)

MAGNET (8 separate magnets)

POLE FACE diameter 360-930 cm; R extraction 445 cm
GAP, min 5 cm; Field 20.9 kG at .15 X 10^6 ampere turns
max ____ cm; Field ____ kG
AVERAGE FIELD at R ext 8.7 kG
CURRENT STABILITY 5 parts/10^6; $B_{max}/\langle B \rangle$ 2.4
NUMBER OF SECTORS 8 ; SPIRAL, max 35 deg
POLE FACE COIL PAIRS: AVF 18(9) correction /sec;
Harmonic correction ____
Rad grad ____ /sec or Circ coils ____
WEIGHT: Fe 1960 total tons; Coils 28 tons
CONDUCTOR, Material and type ____
STORED ENERGY ____ MJ
COOLING SYSTEM demin. water
POWER: Main coils ~650 max, kW
Trimming coils ____ max, kW
YOKE/POLE AREA 120 %
SECTOR ANGLE (Sep Sec) 20 deg
ION ENERGY (Bending limit) E/A = - q^2/A^2 MeV
(Focusing limit) E/A = - q/A MeV

ACCELERATION SYSTEM

Cavities: 4
BEAM APERTURE 4 cm; DC BIAS ____ kV
TUNED by, coarse - fine change dimen.
RF 50.63 to - mHz, stable ± 1 /10^6
Orb F 8.41 to - mHz; GAIN, max 2000 kV/turn
HARMONICS, RF/Orb F, used 6th
DEE-Gnd, max 600 kV, min gap 15 cm
STABILITY, (pk-pk noise)/(pk RF volt) 3×10^{-4}
RF PHASE stable to ± < 1 deg
RF POWER input, max 4 x 200 kW
RF PROTECT circuit, speed 100 μsec
Type low level amplifier clamp
FREQUENCY MODULATION, rate ____ /sec
MODULATOR, type -
BEAM PULSE, width -

VACUUM SYSTEM

PUMPS, No., Type, Size 4 titanium-sublimators, 12000 l/s
OPERATING PRESSURE 2 μTorr,
PUMPDOWN TIME 5 hrs

ION SOURCES/INJECTION SYSTEM 72 MeV p beam injected at 200 cm radius, pulse rate 50.63 or 16.88 Mc/s

EXTRACTION SYSTEM electrostat. deflector, magn. focusing channel, extr. magnet

CONTROL SYSTEM

computer-aided

ENTRY NO. 55 (cont.)

CHARACTERISTIC BEAMS

	Particle	Goal (MeV)	Achieved (MeV)
ENERGY	p	590	588 ± 1
CURRENT		(μA)	(μA)
Internal	p	>100	110
External	p	~100	110
		("routine"	60-80)
		(part/s)	(part/s)
Secondary	$\pi^+(-)$	10^9	10^8(30msr)
	$\mu^+(-)$	10^8	10^7(30 cm^2)

BEAM PROPERTIES

	Measured		Conditions		
Pulse Width	~ 6°*	RF deg	80	μA of 588	MeV p
Phase Exc, max		RF deg		μA of	MeV
Extract Eff	> 99.5%		80	μA of 588	MeV p
Res, ΔE/E	~ .1*	%	80	μA of 588	MeV p
Emittance		*fwhm			
(mm-mrad)	2π axial / 2π radial		80	μA of 588	MeV p

OPERATING PROGRAMS, time dist see below

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

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

S. I. N. Isochronous Ring Cyclotron - Operational time distribution 1977 (shutdown of 105 shifts and separate Injector operation of 270 shifts not included)

Total operation time of 720 shifts (5760 hours)		= 100 %
Ring in operation with beam	78 %	
Standby	10.6 %	
Regular service	7.6 %	
Component failures	3.8 %	= 100 %

Distribution of effective beam time (4490 hours = 100 %)

A. Experimental beams			
High intensity c.w. 590 MeVp	43.5 %) 137000		
Pulsed 400 kHz, 40 % d.f.	28.0 %) μAh		
Polarized p	2.0 %	= 73.5 %	
B. Beam development		= 12.0 %	
C. Overhead (setup, tuning, etc.)		= 14.5 %	= 100 %

Isochronous ring cyclotron with eight separated small gap magnets, four high voltage TE-cavities. Large ΔE/turn, extraction near $\nu_r \approx 1.5$ → Large ΔR/turn → Extraction efficiency over 99 %.

Design of components for easy access and repair. Power consumption total 4.5 MW (including injector and beam lines up to 2 π-production targets).

Transmission through ring cyclotron of 99 % (at 80 μA level) achieved.

Essential use of beam: π-production.