

**ENTRY NO. 77**

NAME OF MACHINE SIN 590 MeV Ring Cyclotron Date: September, 1986  
 INSTITUTION Swiss Institute for Nuclear Research  
 ADDRESS CH-5234 Villigen, Switzerland  
 TEL (0)56/99'31'11 TELEX 59276 sin.ch  
 IN CHARGE U. Schryber REPORTED BY M. Olivo and W. Joho

**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 Flattop RF-System since 1979

COST, ACCELERATOR 35 MSFr. (1974)  
 COST, FACILITY, total 134 MSFr. (1975)  
 FUNDED BY Swiss Federal Government

**ACCELERATOR STAFF, OPERATION AND DEVELOPMENT**

SCIENTISTS 15 ENGINEERS 15  
 TECHNICIANS 25 CRAFTS 5  
 GRAD STUDENTS involved during year 2  
 OPERATED BY 8 Research staff and 10 Operators  
 OPERATION 160 hr/wk. On target 140 hr/wk  
 TIME DISTR. in house 20 % outside 80 %  
 BUDGET, op & dev 5 MSFr. (no salaries)  
 FUNDED BY Swiss Federal Government

**RESEARCH STAFF, not included above**

USERS, in house outside 60  
 GRAD STUDENTS involved during year 50  
 RESEARCH BUDGET, in house 10 MSFr. (no salaries)  
 FUNDED BY Swiss Federal Government

**MAGNET**

POLE FACE, diameter (compact) cm, R-extraction 445 cm  
 R injection 210 cm  
 GAP, min 5 cm, Field 20.9 kG  
 max 9 cm, Field 15 kG at 1.5E5  
 AVERAGE FIELD at R ext 8.7 kG Ampere turns  
 B max/<B> 2.4

NUMBER OF SECTORS {compact 8 separated 8} Spiral, max 35 deg  
 SECTOR ANGLE (SSC) 18 deg  
 TRIMMING COILS 18

CONDUCTOR, material and type OFHC copper  
 STORED ENERGY (cryogenic) MJ  
 POWER: main coils 650 max kW: current stability 5E-6  
 trimming coils 20 max kW: current stability  
 WEIGHT: Fe 1960 tons: coils 28  
 COOLING system demin. water  
 ION ENERGY (Bending limit) E/A = 590 q<sup>2</sup>/A<sup>2</sup> MeV/amu  
 (Focusing limit) E/A = q/A MeV/amu

**ACCELERATION SYSTEM**

DEES, number 4 cavities angle deg  
 BEAM APERTURE 4 cm; DC Bias kV  
 TUNED by, coarse fine change of dimension  
 RF 50, 63 to MHz, stable ± 1E-6  
 Orb F 8.41 to MHz  
 HARMONICS, RF/Orb F, used 6  
 DEE-Gnd, max 550 kV, min gap 15 cm  
 STABILITY, (pk-pk noise)/(pk RF volt) < 3E-4  
 ENERGY GAIN, max 2200 kV/turn  
 RF PHASE, stable to ± 0.01 deg  
 RF POWER input, max 4x200 kW  
 FREQUENCY MODULATION, rate /s  
 modulator, type  
 beam pulse, width

**VACUUM SYSTEM**

OPERATING PRESSURE 2E-6 Torr or mbar  
 PUMPS, No, Type, Size 4 one-stage forepumps 200m<sup>3</sup>/h each,  
 4 two-stage forepumps 100m<sup>3</sup>/h ea.; 4 Turbomolecular-  
 500 l/s ea.; 4 Cryogenics- 800 l/s ea. (N<sub>2</sub>) and 2000 l/s (H<sub>2</sub>O)  
**ION SOURCES** 4 Ti-sublimators 14000 l/s ea.  
 see preceding entries: SIN Injector 1 and 2

**INJECTION SYSTEM**

Magnetic and electrostatic channel

**EXTRACTION SYSTEM**

Electrostatic septum

**FACILITIES FOR RESEARCH**

SHIELDED AREA, fixed m<sup>2</sup>; movable 600 m<sup>2</sup>  
 TARGET STATIONS 2 in series  
 STATIONS served at same time, max 10  
 MAG SPECTROGRAPH, type 2 pion spectrometers  
 COMPUTER model PDP's and VAX's  
 OTHER FACILITIES 2 superconducting muon channels and  
 annexes for medical pion therapy, nucleon area,  
 crystal spectrom. and material irradiation

**CHARACTERISTIC BEAMS**

PARTICLE	ENERGY (MeV)		CURRENT (µA)	
	Goal	Achieved	Internal	External
p	590	590		200-300
SECONDARY				
π <sup>+</sup>		260	9E9/100	µA
μ <sup>-</sup>		57	3E7/100	µA

**BEAM PROPERTIES**

MEASURED	CONDITIONS	
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PULSE WIDTH .6 RF deg	150 µA of 590 MeV	p ions
PHASE EXC. max ±3 RF deg	150 µA of 590 MeV	p ions
EXTRACT eff. 99.98%	150 µA of 590 MeV	p ions
RESOL ΔE/E < 0.05 %	150 µA of 590 MeV	p ions
EMITTANCE		
(π mm-mrad) .1 axial	150 µA of 590 MeV	p
.2 rad		

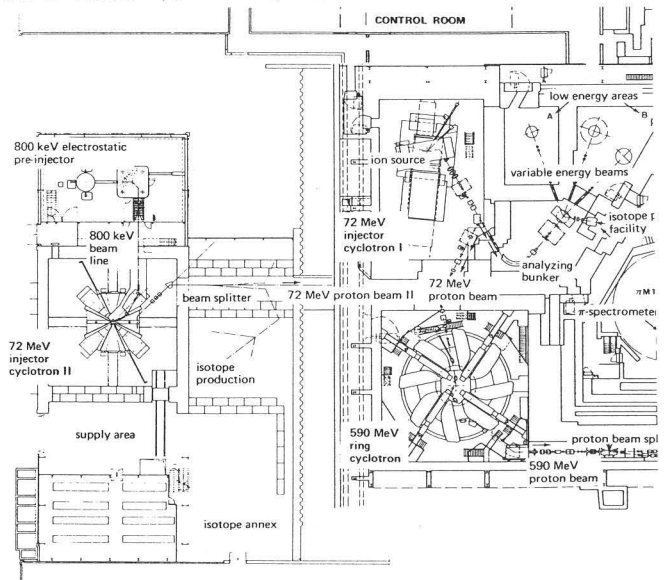
**OPERATING PROGRAMS, time distribution**

BASIC NUCLEAR PHYSICS 100% SOLID STATES PHYSICS 100%  
 BIOMEDICAL APPLICAT.\* 20% ISOTOPE PRODUCTIONS  
 \* approx. 15 µA are splitted from the main beam  
 and directed towards the pion target serv. med. annex.

**REFERENCES/NOTES**

- 1) W. Joho, M. Olivo, T. Stambach, H. Willax; IEEE NS-24, (1977) 1618
- 2) W. Joho, IEEE NS-26 (1979) 1950

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



\* additional flattop cavity at 152MHz, 350kV