

**ENTRY No. FM-7**

NAME OF MACHINE CERN 600 MeV Synchrocyclotron DATE July 1981  
 INSTITUTION European Organization for Nuclear Research (CERN)  
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 IN CHARGE G. Le Dallic REPORTED BY B.W. Allardyce

**HISTORY AND STATUS**

DESIGN, date 1952/3 Model tests 1953/4  
 ENG DESIGN, date 1953  
 CONSTRUCTION, date October 1954 to July 1957  
 FIRST BEAM, date (or goal) August 1957  
 MAJOR ALTERATIONS 1973/1974 SC Improvement Programme (SCIP)  
 COST, ACCELERATOR 30 M.Swiss.Francs  
 COST, FACILITY, total 60 M.Swiss.Francs  
 FUNDED BY CERN Member States

**ACCELERATOR STAFF, OPERATION AND DEVELOPMENT**

SCIENTISTS 2 ENGINEERS 5  
 TECHNICIANS 35 CRAFTS 11  
 GRAD STUDENTS involved during year  
 OPERATED BY 14 Operators  
 OPERATION 150 hr/wk, On target 135 hr/wk  
 TIME DISTR. in house 5 % , Outside 95 %  
 BUDGET, op & dev 9 M.Swiss.Francs  
 FUNDED BY CERN Member States

**RESEARCH STAFF, not included above**

USERS, in house 8 outside ~200  
 GRAD STUDENTS involved during year  
 RESEARCH BUDGET, in house 4 M.Swiss.Francs  
 FUNDED BY CERN Member States

**MAGNET**

POLE FACE, diameter (compact) 500 cm, R extraction 225 cm  
 R injection cm  
 GAP, min 36 cm, Field 18.1 kG  
 max 45 cm, Field 19.4 kG } at 1.23.10<sup>6</sup>  
 AVERAGE FIELD at R ext 18.1 kG } Ampere turns  
 B max/ <B>

NUMBER OF SECTORS { compact } Spiral, max .. deg  
 { separated }  
 SECTOR ANGLE (SSC) deg

**TRIMMING COILS**

CONDUCTOR, material and type Aluminum  
 STORED ENERGY (cryogenic) MJ  
 POWER: main coils 800 max, kW ; current stability 5.10<sup>-5</sup>  
 trimming coils max, kW ; current stability

WEIGHT: Fe 2500 tons; coils 60 tons  
 COOLING system Demineralized water  
 ION ENERGY (bending limit) E/A = 800 q<sup>2</sup>/a<sup>2</sup> MeV/amu  
 (focusing limit) E/A = q/a MeV/amu

**ACCELERATION SYSTEM**

DEES, number 1 ; angle 180 to 95 deg  
 BEAM APERTURE 6-12 cm ; DC Bias 1.1 kV  
 TUNED by, Rotating capacitor  
 RF 30.4 to 16.6 mHz, stable ±  
 Orb F to mHz  
 HARMONICS, RF/Orb F, used 1  
 DEE - Gnd, max 20 kV, min gap cm  
 STABILITY, (pk-pk noise)/(pk RF volt)  
 ENERGY GAIN, max kV/turn  
 RF PHASE, stable to ± deg  
 RF POWER input, max 120 kW  
 FREQUENCY MODULATION, rate 360 /s  
 modulator, type Rotary capacitor  
 beam pulse, width 30 μs

**VACUUM SYSTEM**

OPERATING PRESSURE 2-3 10<sup>-7</sup> Torr or  
 PUMPS, No, Type, Size Two 38000 l/s. (baffled) oil  
 diffusion

**ION SOURCES**

Mid-plane calutron (hooded-arc PIG source, pulsed)  
 Radius of first orbit ~1cm

**INJECTION SYSTEM**

Internal source

**EXTRACTION SYSTEM** Regenerator plus electrical  
 septum magnet followed by passive magnetic channel

**FACILITIES FOR RESEARCH**

SHIELDED AREA, fixed m<sup>2</sup> ; movable m<sup>2</sup>  
 TARGET STATIONS in rooms

STATIONS served at same time, max  
 MAG SPECTROGRAPH, type  
 COMPUTER model

OTHER FACILITIES By the use of orbit displacement coil  
 the total duty cycle of the beam is around 60 % without  
 RF micro-structure

**CHARACTERISTIC BEAMS**

PARTICLE	ENERGY (MeV)		CURRENT (pμA)	
	Goal	Achieved	Internal	External
Protons	600	~7	~7	~5
<sup>3</sup> He <sup>++</sup> ions	910			0.5
<sup>12</sup> C <sup>4+</sup> ions	1032			0.2
<sup>20</sup> Ne <sup>6+</sup> ions	1400			
SECONDARY			(part/s)	
e.g. PIONS (-)	300 MeV/C		~ 3.10 <sup>6</sup>	
MUONS (+)	250 MeV/C		~ 3.10 <sup>4</sup>	

**BEAM PROPERTIES**

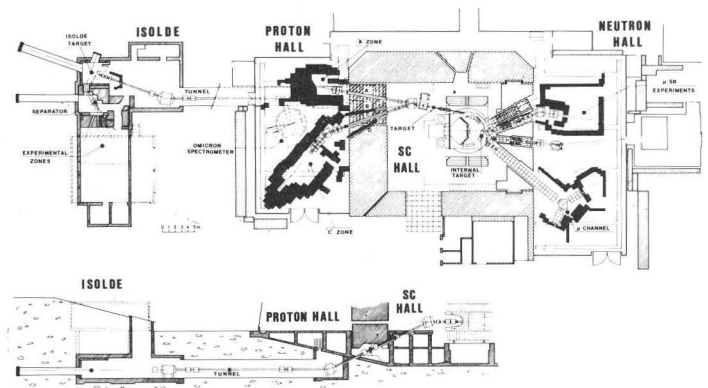
MEASURED CONDITIONS  
 PULSE WIDTH RF deg μA of MeV ions  
 PHASE EXC, max RF deg μA of MeV ions  
 EXTRACT eff 50-70 % μA of MeV ions  
 RESOL ΔE/E % μA of MeV ions  
 EMITTANCE  
 (π mm. mrad) { .6 axial }  
 { 11 rad } μA of MeV ions

**OPERATING PROGRAMS, time distribution**

BASIC NUCLEAR PHYSICS ~75 % SOLID STATES PHYSICS ~25 %  
 BIOMEDICAL APPLICAT. 0 ISOTOPE PRODUCTIONS 0  
 (including ISOLDE FACILITY ~30 %, HEAVY IONS ~30%,  
 DEVELOPMENT ~5 %)

**REFERENCES/NOTES**

W. Gentner et al., Philips Tech. Rev. 22, p. 141, 1961  
 H. Beger et al., Proc. 7, Int. Cycl. Conf. 1975, p. 149  
 B.W. Allardyce et al., Status Report 1981 to Int. Cycl.  
 Conf.

**PLAN VIEW OF FACILITY, NOTEWORTHY FEATURES, COMMENTS**

1. The pulsed field coil (Kim Coil) allows very high overall duty cycle to be obtained with no r.f. micro-structure.

2. Roughly 30 % of beam time is currently used for the acceleration of particles other than protons, with very high intensities. <sup>20</sup>Ne<sup>6+</sup> will become available as an extracted beam in 1982 but 0.5 pμA has already been obtained from the ion source.