ENTRY NO. 30

NAME OF MACHINE Karlsruhe Isochronous Cyclotron DATE 1.8.1978
INSTITUTION Kernforschungszentrum, Zyklotronlaboratorium
ADDRESS D-7500 Karlsruhe, Postfach 3640, Germany

IN CHARGE H. Schweickert REPORTED by H. Schweickert

HISTORY AND STATUS

DESIGN, date 1958 MODEL tests 1958-60
ENG. DESIGN, date
CONSTRUCTION, date 1960-1962
FIRST BEAM date (or goal) int.1962,ext.1964
MAJOR ALTERATIONS axial injection 1971

OPERATION, 168 hr/wk; On Target ∿135 hr/wk
TIME DIST., in house x %, outside x %
USERS' SCHEDULING CYCLE 1 weeks
COST, ACCELERATOR 4.6×10^6 DM
COST, FACILITY, total 20×10^6 DM/to date
FUNDED BY Federal Government & State of Baden-Württemberg

ACCELERATOR STAFF, OPERATION and DEVELOPMENT

SCIENTISTS 3 ENGINEERS 5
TECHNICIANS 10 CRAFTS 20
GRAD STUDENTS involved during year
OPERATED BY Res staff or 10 Operators
BUDGET, op & dev 2×10^6 DM
FUNDED BY Federal Government & State of Baden-Württemberg

RESEARCH STAFF, not included above

USERS, in house 40x outside 90
GRAD STUDENTS involved during year
RES. BUDGET, in house
FUNDED BY

FACILITIES FOR RESEARCH

SHIELDED AREA, fixed 225 m^2
movable m^2
TARGET STATIONS 8 in 2 rooms
STATIONS served at same time, max 1
MAG SPECTROGRAPH, type
COMPUTER, model 3-NOVA 2
OTHER FACILITIES
Time-of-Flight Spectrometer (190 m)
Isotope production
Beam pulsing systems

REFERENCES/NOTES

Proc. Int. Conf. SF Cyclotrons
CERN 63-19, p. 24
Nucl. Inst. Meth. 13, 55 (1961)
KFK 754 (1968)

x In house refers to users from KFK

MAGNET

POLE FACE diameter 225 cm; R extraction 105 cm
GAP, min 8 cm; Field 19.5 kG; max 16 cm; Field 19.5 kG — at 0.16×10^6 ampere turns
AVERAGE FIELD at R ext 14.7 kG
CURRENT STABILITY 5 parts/10^6; $B_{max}/\langle B \rangle$ 1.3
NUMBER OF SECTORS 3 ; SPIRAL, max – deg
POLE FACE COIL PAIRS: AVF – /sec;
Harmonic correction
Rad grad 5 /sec or Circ coils
WEIGHT: Fe 280 tons; Coils 8.5 tons
CONDUCTOR, Material and type Cu
STORED ENERGY MJ
COOLING SYSTEM water
POWER: Main coils 32 max, kW
Trimming coils 1 max, kW
YOKE/POLE AREA 100 %
SECTOR ANGLE (Sep Sec) – deg
ION ENERGY (Bending limit) E/A = 104 q^2/A^2 MeV
(Focusing limit) E/A = q/A MeV

ACCELERATION SYSTEM

DEES, number 3 angle 60 deg
BEAM APERTURE 3.5 cm; DC BIAS 0 kV
TUNED by, coarse – fine rotating loop
RF – to 33 mHz, stable ± 5 /10^6
Orb F – to 11 mHz; GAIN, max 240 kV/turn
HARMONICS, RF/Orb F, used 3 only
DEE-Gnd, max 40 kV, min gap 1 cm
STABILITY, (pk-pk noise)/(pk RF volt) 0.001
RF PHASE stable to ± deg
RF POWER input, max 50 kW
RF PROTECT circuit, speed 1 μsec
Type Ignitron
FREQUENCY MODULATION, rate 0 /sec
MODULATOR, type –
BEAM PULSE, width –

VACUUM SYSTEM

PUMPS, No., Type, Size 2 Diffusion pumps (8000 l/sec + 12000 l/sec)
OPERATING PRESSURE 4 μTorr,
PUMPDOWN TIME 1/2 hrs

ION SOURCES/INJECTION SYSTEM

Internal Penning, External: Penning, Lambshift,Axial Injection (10 keV)

EXTRACTION SYSTEM

Two electrostatic deflectors+magn.iron channel

CONTROL SYSTEM

Two NOVA-2 computers plus conventional

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CHARACTERISTIC BEAMS

	Particle	Goal (MeV)	Achieved (MeV)
ENERGY	p(H_2^+)		26(52)
	d		52
	α		104
	$^6Li^{3+}$		156
CURRENT		(μA)	(μA)
Internal	p		50
	d		>1000
	α		100
External	p,d,α		>10
	$^6Li^{3+}$		0.1
	pol.d.		0.1
		(part/s)	(part/s)
Secondary			

BEAM PROPERTIES

	Measured		Conditions		
Pulse Width	10 RF deg	1 μA of	52	MeV	d
Phase Exc, max	20 RF deg	1 μA of	52	MeV	d
Extract Eff	>70 %	1 μA of	52	MeV	d
Res, ΔE/E	0.3 %	1 μA of	52	MeV	d

Emittance

(mm-mrad) { 9 axial, 6 radial } 5 μA of 52 MeV d

OPERATING PROGRAMS, time dist

Basic Nuclear Physics	42 %
Solid State Physics	24 %
Bio-Medical Applications	1 %
Isotope Production	3 %
Development	5 %
Neutron Physics	10 %
Engineering	15 %

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

The Karlsruhe Cyclotron was originally designed for internal isotope production for radiochemistry. After the implementation of the extraction system im 1964 the machine was used by more than 90 % of all operation for basic nuclear physics with light ions (protons, deuterons, alphas). More recently, experimental program has shifted to application oriented research projects (wear studies of machine parts[1]), radiation damage[1]), routine produciton of iodine-123[2]), etc.)with about 50 % of all operation.At present a large amount of the basic nuclear physics experimental program is performed using the polarized deuteron- and the $^6Li^{3+}$-beams injected by the axial injection system[3]).The actual beam currents available in the scattering chamber for both particles are in the range of 50-100 enA.
In 1978 it was decided to build up a MAFIOS-ion source at the axial injection system.With this type of ion source completely stripped "light heavy ions" can be produced. Examples of beams to be available in late 1981: ^{12}C, ^{14}N, ^{16}O, ^{20}Ne(?) with a fixed energy of 26 MeV/A.

Neutron time-of-facility: 190 m flight path, neutron pulse length <1 nsec; neutron flux at detector position $>10^3$ n/cm^2 sec
Rev. Sci. Instr. 39 (1968) 1279; KFK 2298 (1976)

Beam analyzing magnet: double focussing (n=0.5), deflection radius 130 cm, deflection angle 150°; resolution at 1 mm slits 5×10^{-4}.

Computer aided operation:
W.R. Kappel, W. Kneis, J. Möllenbeck, H. Schweickert,these Proceedings.

1) Applications of cyclotrons in technical and analytical studies:
A. Gervé, G. Schatz; Proc. 7th Int. Conf. on Cyclotrons and their Applications (Birkhäuser, Basel, 1975) p. 496-502.

2) Routine production of iodine-123:
K.H. Assmus, K. Jäger, R. Schütz, F. Schulz,H.Schweickert,these Proc.

3) Axial injection system:
G. Haushahn, J. Möllenbeck, G. Schatz,F.Schulz, H. Schweickert;
Proc. 7th Int. Conf. on Cyclotrons and their Applications (Birkhäuser Basel, 1975). p. 376-380.